OPERATING AND MAINTENANCE INSTRUCTION MANUAL

The "Sentinel"

MODEL 550

PROGRAM AUDIO MONITOR RECEIVER

- USER'S RECORD -

Model 550 - Serial No.________

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MODEL 550

PROGRAM AUDIO MONITOR RECEIVER

July, 1993

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Section I

INTRODUCTION

BACKGROUND OF THE *SENTINEL*

Subjective Evaluation Shortcomings

Until now the radio broadcaster had limited means of evaluating his own off-air signal, or to compare his with other signals on the dial in the immediate market. Decisions regarding dynamic range compression, equalization and other forms of audio processing were generally based on how the signal *sounded*; how it sounded, that is, to someone whose expertise or opinion commanded sufficient respect. All too often opinions vary, leading to frequent program audio quality variations or to blind acceptance of a particular processing equipment manufacturer's preferences.

The ultimate responsibility for audio signal quality will (and *should!*) always be based on whether or not the signal pleases the ear, or a *majority* of ears when considering a vast listening audience. Psychoacoustics, the science of human hearing, tells us how a listener perceives sound. Plenty of articles have been written on the subject, and, like so many areas of study involving subjective perceptions, many of the findings are contradictory. Nevertheless, psychoacousticians tend to at least agree in the areas which broadcasters should consider important, making the job of providing an acceptable program signal somewhat easier.

Objective Evaluation Advantage

Because hearing does vary between individuals (and to some degree *for* an individual from day-to-day), and because a person's perception of what he hears may easily be skewed by what he is *expected* to hear, an objective means of evaluating program audio quality would be a decided advantage to the radio broadcaster. The *Sentinel* was developed to offer just such an advantage.

THE *SENTINEL*: PRODUCT DESCRIPTION IN BRIEF

The Radio Receiver

The *Sentinel* is, first of all, an all-mode radio receiver patterned after the NAB's specification for a "super radio." It tunes the newly extended AM band, receiving mono and C-QUAM® Stereo broadcasts to the NRSC and AMAX® specifications, with dual IF bandwidth and noise blanking. Tuning is continuous; that is, bandswitching is automatic – as you tune to the top of the AM band, the receiver automatically steps to the bottom of the FM band. The FM section receives mono, traditional multiplex stereo and FMX®-Stereo broadcasts, and demodulates analog and digital SCA/RDS subcarriers. Both AM and FM feature a defeatable "blend" function and selectable IF bandwidths. 24 station memory presets may be assigned any combination of AM and FM frequencies, and both U.S.A. and European frequency assignments are supported.

The Sentinel includes a built-in monitor amplifier capable of driving headphones or a pair of loudspeakers to adequate monitoring levels. Associated with the amplifier are the usual Volume, Balance, Bass and Treble controls. A defeatable Contour Equalizer is also included to compensate for the ear's expected response deficiencies at low listening levels.

A complement of auxiliary inputs and outputs increases the usefulness of the *Sentinel* by permitting A/B comparisons between off-air signals and line-level inputs. The line-level output may be used to feed a tape recorder or alternate monitor amplifier. In/out access is also provided for the FM "composite" (baseband) signal.

Audio Diagnostics

What makes the Sentinel more than just a radio, however, is the quite comprehensive audio program signal evaluation section built into the product. An array of bargraph readouts gives an objective overview of the various signal parameters which have proven of particular interest to broadcasters. These include **Total Modulation**, calibrated directly in percent; and from the demodulated Left and Right program channels: **Left, Right, L+R Sum, L−R Difference** and a unique **QDM Mono** "mix," from which definitive measurements of **Loudness** (to the CBS Labs spec) and **Dynamic Range** are derived. Also presented is a real-time **Program Spectral Display; Stereo Balance** and **Stereo Image** metering, and **Program Symmetry** readout. The exact meaning of, and use for, these displays is discussed in depth in Section IV.

Disclaimer

A description of what the *Sentinel* is, and what it does, would not be complete without a note of what it is *not*. **The *Sentinel* is not a Modulation Monitor!** Despite its quite accurate measurement and display of Total Modulation, the *Sentinel* is intended solely for relative comparisons between off-air signals. Off-air signals are prone to noise and distortions from reception conditions which can sabotage the accuracy of absolute measurements. Moreover, the calibration accuracy and traceability of the *Sentinel* was never intended to be more than what is required for comparative analysis.

Readings of Total Modulation taken from the *Sentinel* must *never* be used as a basis for adjustment of transmitter modulation. A notation to this effect is permanently imprinted on the rear panel of the unit as well. This product is not a substitute, either in form or in function, for a bona-fide Modulation Monitor.

Section II

INSTALLATION

UNPACKING AND INSPECTION

Immediately upon receipt of the equipment, inspect carefully for shipping damage. If any damage is observed, notify the carrier at once; if not, proceed as outlined below. It is recommended that you save the original shipping carton and packing materials in case future reshipment become necessary. In the event of return for Warrant repair, shipping damage sustained as a result of improper packing for return may *invalidate the Warranty!*

IT IS VERY IMPORTANT that the Warranty Registration Card found at the front of this Manual be completed and returned. Not only does this assure coverage of the equipment under terms of the Warranty, and provide some means of trace in the case of lost or stolen gear, but the user will automatically receive specific SERVICE OR MODIFICATION INSTRUCTIONS should they be issued by the factory.

MOUNTING

Rack Requirement

The Inovonics *Sentinel* is intended either for desk-top use or for mounting in 5¼inches (3U) of standard 19-inch rack space. Because of its appreciable weight, always secure the *Sentinel* in an equipment rack with all four mounting screws. The use of plastic "finishing" washers is recommended to protect the painted finish around the mounting holes.

If the *Sentinel* is destined solely for desktop or portable use, the two rack-mounting "ears" may be detached, though this removes the two quite handy handles.

Heat Dissipation

The bottom of the aluminum chassis serves as a heatsink for power supply voltage regulators and monitor amplifier output stages. In normal operation the bottom and the right-hand side of the enclosure become quite warm to the touch.

The *Sentinel* should be located so that air is free to circulate around the chassis. It should not be mounted adjacent to equipment which generates appreciable heat, except in cabinets which provide forced-air ventilation. The *ambient* operating temperature of the equipment should not exceed 120°F / 50°C.

AC (MAINS) POWER

As-Delivered Unless specifically ordered for export shipment, the *Sentinel* is factory-delivered for operation from 125V, 50/60Hz AC mains. The back-panel designation next to the fuseholder will confirm both the mains voltage selected and the value of the fuse to be used.

Voltage Selector There is a mains voltage selector switch beneath the top cover of the *Sentinel*, near the rear of the far right-hand circuit board, adjacent to the fuseholder. *With mains power removed,* slide the red switch actuator with a small screwdriver so that the proper mains voltage (115 or 230) shows. An appropriate fuse must always be installed, and the back-panel voltage/fuse designation marked. It is factory practice to cross out the *inappropriate* markings with black felt marking pen. You may remove this strikethrough with solvent if the markings need be changed.

BE SURE that the mains voltage selector setting and primary fuse value are appropriate for the mains supply before plugging the *Sentinel* into the wall socket.

Power Cord The detachable power cord supplied with the *Sentinel* is fitted with a North-American-standard male connector. The individual cord conductors are *supposedly* color-coded in accordance with CEE standards:

BROWN = AC "HOT," BLUE = AC NEUTRAL, GRN/YEL = GROUND.

If this turns out *not* to be the case, we offer our apologies (cord vendors vary) and advise that U.S. color coding applies:

BLACK = AC "HOT," WHITE = AC NEUTRAL, GREEN = GROUND.

RADIO FREQUENCY INTERFERENCE (R F I)

Location Though the *Sentinel* is intended to operate in the vicinity of broadcast station equipment, care should be exercised in locating the unit away from *abnormally* high RF fields.

Ground Loops In some installation situations an RF ground loop may be formed between the AC power cord ground and the antenna cable shield grounds and, if used, input or output cable shield grounds. Use of a "ground-lifting" AC adapter should remedy any problem, though the chassis must ultimately be returned to earth ground for safety.

OPTIONS

The *Sentinel* incorporates a number of circuit board pin strips with moveable jumpers to select various options. A primary option is selection between U.S. and European channel spacings for both AM and FM reception.

As delivered, the *Sentinel* is configured for operation appropriate to the delivery destination, and should operate properly in all modes. Should it become necessary to change any of the options, please consult with the factory.

Section III

AUDIO DIAGNOSTICS

General This section describes the various panel readouts and serves as a guide in their interpretation as it applies to broadcast station practices.

TOTAL MODULATION

Total carrier modulation is a peak measurement calibrated linearly in percent without regard for polarity. This means that the higher of the positive or negative peaks of AM modulation, or the greater of the positive or negative FM deviation shifts, will be displayed.

Ballistics TOTAL MODULATION is peak-responding and incorporates a peak-hold function so that even very brief modulation peaks are displayed for an adequate time period. Whenever the display is updated to a higher reading by a program peak, this reading will be held for about 2 seconds before the display will fall to a current lower value. During this peak-holding time, however, a peak with greater amplitude than the current reading will immediately bring the bargraph to the new, higher value, and hold at the new level.

Display Gain Scaling of the TOTAL MODULATION readout normally shows peaks between 16% and 130% in 3% increments. The button below the display can be used to switch in an additional gain of X10 (20dB). This changes the full-scale reading from 130% to 13%, and the meter measures down to 1.6% in 0.3% steps. (The 100% point becomes 10%, etc.) When the additional gain has been switched into the metering circuit, the single red LED above the button will light.

AM Carrier Modulation Modulation theory defines 100%-modulation of an amplitude-modulated carrier wave as the point at which negative modulation peaks decrease the carrier amplitude to zero, and positive peaks increase the amplitude to twice the unmodulated value. Though this definition supposes a symmetrical modulating waveform, such as a sinewave, complex waveshapes encountered in voice and music program signals are not symmetrical and follow different rules. It is quite possible, in fact, for unprocessed speech to have positive-to-negative peak ratios of 3:1 or more.

Asymmetrical AM Modulation "Super modulation" describes the practice of permitting positive peak modulation in excess of the defined 100% value. This is valid only for asymmetrical waveshapes which exhibit higher positive-going than negative-going amplitudes, and, by convention, has been restricted to modest values of asymmetry; "+125% peaks" are typically permitted in standard broadcasting.

This means that the *Sentinel's* TOTAL MODULATION readout may frequently reach 125% without indicating carrier overmodulation. It is desirable, in fact, to maintain consistent peak readings between 100% and 125% during speech, which is asymmetrical by nature.

We must once more stress that the *Sentinel* is **not** a Modulation Monitor. A true Mod-Monitor should always be used to adjust the AM audio processor/peak limiter for optimum carrier modulation, and to verify the proper relationship between positive and negative peaks.

AM Display Errors

Certain reception factors can falsify the TOTAL MODULATION reading of AM broadcasts. Very weak signal reception can cause either a false high or a false low reading. When there is insufficient signal to keep the receiver AGC in its normal operating range, a very quiet environment will cause the indicated modulation to register below its true value. In a location with excessive (or even "typical") RF noise, the AGC will simply elevate the noise to dominate the display. In either case the predominance of noise should be obvious to the listener.

Though a short length of wire stapled to the wall will serve as an AM receiving antenna, an outdoor antenna impedance-matched to 50-ohm coax may be located away from man-made noise sources and provide dramatically better reception. Several of the "active" or "passive" antennas intended for shortwave listening also cover the AM broadcast band and may be located in a quieter environment. These are available through mail-order or retail ham radio outlets.

FM Modulation

Whereas 100% *amplitude* modulation of a carrier is clearly defined, such is not the case with frequency modulation. ±75kHz deviation is recognized, if not specified, as a worldwide FM broadcasting standard. Thus the *Sentinel's* TOTAL MODULATION indication of 100% has been factory-calibrated to this ±75kHz deviation. Stereo FM broadcasts include the 19kHz stereo pilot in this ±75kHz deviation, along with the "interleaved" multiplex signal "main" and "sub" band components. Additional carrier deviation from SCA or other subcarriers will be addressed separately.

FM signals are not degraded by noise in the same manner as AM broadcasts, and the warning about false AM readings due to noise do not similarly apply to FM. So long as at least one SIGNAL (Signal Strength) bar element is lighted, the TOTAL MODULATION indication for FM should be valid.

Multipath Effects

What *will* invalidate the FM TOTAL MODULATION reading is distortion of the received signal from *multipath* effects. This refers to multiple reception of the same signal displaced slightly in time, as would be the case of direct and reflected transmitter signals reaching the receiving antenna. Multipath distortion causes the demodulated composite signal to appear much higher in amplitude than it really is, giving an indication of gross overmodulation on the TOTAL MODULATION display.

Multipath Detector

A multipath detector has been built into the *Sentinel*, with a MULTIPATH display near the frequency readout. More than one bargraph element lighted signifies sufficient multipath to invalidate the TOTAL MODULATION reading.

Flashing Red LEDs

The multipath detector is interconnected with the TOTAL MODULATION display. The top (red) group of LEDs above 100% will flash rapidly when a high modulation measurement should be ignored.

Multipath effects may be reduced or eliminated by using a proper antenna. A roof-mounted, directional antenna, which may be rotated to point at the desired transmitter location, is the only insurance that readings (particularly TOTAL MODULATION) can be depended upon.

Additional Subcarriers

Since TOTAL MODULATION is an absolute-peak-responding display, any additional SCA or RDS subcarriers will add to the stereo program and pilot components and increase total carrier deviation. It is practice in the U.S. (and some other countries) to permit a certain amount of overmodulation (beyond the ±75kHz deviation) from these additional subcarriers. The U.S. practice is to allow an additional 5% modulation for one SCA subcarrier, or an additional 10% for two or more. Thus the TOTAL MODULATION display can legally reach 110% when two subcarriers are present. Presence of these subcarriers may be verified by monitoring the *Sentinel's* SCA decoder and tuning through its range to identify any modulated or unmodulated subcarriers.

Subcarrier Deviation Measurement

When the *Sentinel* is switched to monitor SCA or RDS subcarriers, the TOTAL MODULATION readout continues to display the *main-channel* signal. The *demodulated subcarrier,* however, is routed to the Audio Diagmostics section, and subcarrier modulation (deviation) is read as LEFT (or RIGHT) CHANNEL audio. In this reception mode, the peak-responding LEFT/RIGHT CHANNEL displays are scaled so that 0dB represents ±5kHz subcarrier deviation with SCA deemphasis (DE-EMPH) switched off.

FM Peak Duration

On the subject of "legal" overmodulation, the controversy surrounding peak duration and measurement integration should probably be mentioned.

In the U.S., the definition of just which modulation peaks do (or do not) constitute overmodulation has become the subject for considerable discussion. It is argued that peaks of "insignificant duration" may be completely ignored in a measurement of total modulation, since the corresponding instantaneous overdeviations would *probably* not cause interference to an adjacent channel. While such interpretation of the rules would give the broadcaster a decided modulation advantage (particularly those broadcasters who do not employ aggressive audio processing), a precise definition of measurement methods or integration time has not been made completely clear in the official guidelines. *Sentinel* TOTAL MODULATION readings do not necessarily conform to any recognized integration standard, and are intended for *comparative* measurements only.

LEFT AND RIGHT CHANNELS

The AM or FM carrier is demodulated into the Left and Right stereo program channels and displayed on the corresponding bargraph displays.

Ballistics

LEFT and RIGHT CHANNEL displays are peak-responding, and will closely follow the TOTAL MODULATION display in response to program peak content. These displays do not incorporate a peak-hold function, however. In this respect, LEFT and RIGHT CHANNEL measurements will *approximate* UK/EBU PPM (Peak Program Meter) performance, except that display fallback has been made faster than the traditional PPM specification to yield a better representation of program dynamics. (Though the true European PPM gets high marks for revealing peak levels, its sluggish fallback makes it practically useless for telling anything else about the program dynamics.)

True UK/EBU PPM metering specifies a certain integration. 10ms was originally advanced as about the greatest duration that the ear could be subjected to a distorted signal without perceiving the distortion. It was argued that program peaks of less than 10ms could be hard-clipped and not noticed. Many broadcast audio processors delay limiter attack time for up to 10ms, and simply clip the faster peaks.

In the interest of providing the most accurate and useful *visual* indication of demodulated program audio, integration is *not* included in the LEFT and RIGHT CHANNEL displays.

Scaling/Gain LEFT and RIGHT CHANNEL bargraphs are dB-linear displays with a normal range of +10dB to −29dB. The button beneath the readout switches-in an additional 20dB GAIN, changing the scaling to a range of −10dB to −49dB. With GAIN enabled, the 0dB mark actually represents −20dB.

Signal Deemphasis 0dB corresponds to the nominal 100%-modulation level of the Left and Right program signals, except that demodulated audio will always conform to the appropriate deemphasis curve in both the AM and FM reception modes. For either the U.S. "NRSC" AM curve, or for the 75-microsecond FM curve, full modulation at 1kHz will read about 1dB lower than at frequencies below the turnover point of 400Hz. Higher frequencies, even when they modulate the carrier to 100%, will measure proportionally lower on the LEFT and RIGHT CHANNEL displays. Deemphasis curves for 50μs and 75μs FM transmissions, and for the NRSC AM standard, are found in broadcasting reference books, or can be ordered from organizations such as the U.S. National Association of Broadcasters (NAB).

The AUX 1 and AUX 2 Line Inputs are *not* subject to deemphasis and will maintain a "flat" characteristic throughout the audio range.

AM For AM broadcasts, LEFT and RIGHT CHANNEL displays will read 0dB when the amplitude modulation component of the carrier is symmetrically modulated to 100% at frequencies below deemphasis turnover. This will be the case either for fully-modulated monaural broadcasts, or stereocasts with full L=R modulation.

FM Monaural FM transmissions contain no energy at the 19kHz stereo pilot frequency nor in the stereo subcarrier region. *Program audio* alone deviates the mono FM carrier to the full ±75kHz. The *Sentinel* LEFT and RIGHT CHANNEL displays will read 0dB when a *monaural* carrier is 100%-modulated by a test signal below the deemphasis turnover frequency. Under similar circumstances, FM-Stereo channel measurements will read about 1dB lower than mono because approximately 10% of the total modulation is taken up by the 19kHz pilot tone.

"Interleaving" of the FM-multiplex signal will cause TOTAL MODULATION to indicate 100% under several circumstances. At modulating frequencies below the deemphasis turnover of 400Hz, LEFT and/or RIGHT CHANNEL readouts will indicate a full-level, −1dB when: (1) the Left Channel is fully modulated irrespective of Right Channel modulation (and vice-versa); (2) when both channels are fully-modulated in-phase (L=R); and (3) when both channels are modulated out-of-phase (L=−R).

L+R STEREO SUM / L−R DIFFERENCE

Ballistics, Scaling and Gain Left and Right Channel program signals are matrixed into Left + Right "Sum," and Left − Right "Difference" channels, and displayed alongside the independent Left and Right Channel readouts. SUM and DIFFERENCE are average-responding displays with ballistics of the traditional "VU" meter. These will be noted as slower than the independent LEFT and RIGHT CHANNEL bargraph displays, and will represent more an "average energy" level than program peak content. Scaling and gain of these displays are the same as the LEFT and RIGHT CHANNEL readouts.

Since they are derived from Left and Right Channel signals, the SUM and DIFFERENCE displays also follow the applicable deemphasis curve. Calibration is such that a fully-modulated Left (only) or Right (only) Channel will take both the SUM and DIFFERENCE displays to −6dB (AM) / −7dB (FM). A fully-modulated L=R or L=−R carrier will indicate 0dB (AM) / −1dB (FM) SUM or DIFFERENCE, respectively, with the other display off the bottom of the scale.

Because the *Sentinel* incorporates a more meaningful display of Stereo Image and Balance information, the SUM and DIFFERENCE readouts are useful mostly in *verifying* the amount of stereo information and the accuracy of stereo balance in the program signal. When a monaural signal is being broadcast, the L−R DIFFERENCE reading should be off the bottom of the scale, even when the additional 20dB gain is switched in.

QDM MONAURAL

Stereo Channel Phasing

Left and Right stereo program channels almost always contain some common (L=R) information. *Electrical* addition can result either in an energy increase, when channels are in-phase, or a complete cancellation of the L=R "center channel" information when they are out-of-phase. This does not hold true, however, for *acoustical* additions in a typical listening environment, principally due to "phase scrambling" from propagation delays as sound is transmitted through the air, and dispersion of the sound through reflections off various surfaces. Speakers connected out-of-phase are sometimes noticed only because of a deficiency in bass response or the nebulous location of a vocal soloist.

To approximate this non-coherent, *acoustical* combination of Left and Right Channel program signals, Inovonics has developed the "QDM," or Quadrature-Derived Monaural channel. Left and Right program signals are combined through a network which introduces a fixed 90° phase difference between the channels, irrespective of frequency. This means that when L=R, and when L=−R, the reading will *increase* by 3dB, rather than the expected 6dB, over the Left-only or the Right-only value.

The QDM measurement is average-responding, just like the SUM and DIFFERENCE displays, and will tend to match the L+R STEREO SUM readout with normal program material. The QDM signal, because it more accurately represents what the ear would hear, is used for the CBS LOUDNESS LEVEL and DYNAMIC RANGE measurements, and the SPECTRAL PROFILE display.

CBS LOUDNESS LEVEL

Without a doubt, the one attribute of his signal which seems to be of paramount importance to the average broadcaster is "loudness."

Loudness Wars

"Loudness Wars" began in the U.S. sometime after radio was replaced by television as the primary multi-faceted entertainment source; radio, for the most part, relegated to the repetitious distribution of canned music. Stations have now become "formatted," with perhaps one or two formats of non-musical programming in any particular market, the balance falling into any of several predictable music categories characterized by the age and background of the listener.

Broadcasters found it necessary to compete with identical programming on perhaps as many as a dozen other stations in their market, rather than to compete on a basis of program content, variety, or personality. This fostered the supposed need to dominate the airwaves on the *strength* of one's signal, rather than its quality or *content.*

Perhaps the quest for loudness is simply an extension of that human nature which prompts us to raise our voice to dominate an audience or to help drive-home a point. This is frequently exemplified by foreign travelers who overcome a language barrier by shouting to be understood. Whatever the rationale or mentality behind "loudness" in broadcasting, be it legitimate or imagined, it *can* be defined and quantified.

CBS Studies

The most definitive study of the psychoacoustics of loudness was undertaken by the now-defunct (and much lamented) CBS Technology Center, more commonly known by their earlier name, "CBS Labs." Work begun in the 1960s by Emil Torick and the late Ben Bauer was continued well into the '80s, resulting in a series of technical papers, U.S. Patents, and several practical implementations.

The CBS studies were directly concerned with loudness in broadcasting, notably the offensively loud TV commercials which annoyed (or awakened!) viewers who had adjusted their volume controls for comfortable listening levels.

Until comparatively recently, audio processing had been used very conservatively (or not at all) in television production. But advertising agencies borrowed the power of audio processing from radio broadcasters to hot-rod commercials, so as to "snap the audience to attention," as it were. Ironically, a leading manufacturer of audio processing products includes a "CBS Loudness *Controller*" in his TV audio processor to thwart these despicable attention-control practices.

The substance of the CBS inventions is the analysis of program dynamics based on spectral weighting and level measurement in multiple frequency bands. The ear's threshold, as well as its response to sounds at typical communication levels, forms the basis for the algorithms initially used. Exhaustive tests with panels of both expert and untrained listeners helped determine final circuit values. The ultimate CBS design, which is faithfully reproduced in the *Sentinel,* exhibits a striking correlation between meter readings and listener-panel polls.

Scaling and Ballistics

The CBS LOUDNESS LEVEL scale is dB-linear and exhibits a ballistic response per the CBS specification, except that a peak-hold function has been added for a more consistent and less ambiguous display of peak levels.

Since it is an "open-ended" measurement for comparative purposes, there is no absolute calibration standard for the CBS LOUDNESS LEVEL scale. The factory procedure sets a 0dB CBS reading for full modulation at 1kHz. At the frequency of greatest CBS meter sensitivity, approximately 4kHz, circuit response is +5dB. With most program material, this calibration keeps the CBS LOUDNESS LEVEL measurement close to the 0dB mark.

DYNAMIC RANGE

Dynamics and Audio Processing

Dynamic range is the one property of a program signal which is all-too-frequently destroyed in radio broadcasting. The "aggressive" audio processing used by most broadcasters often reduces program dynamics to a pathetic value of only a few dB. Engineers and program directors take great pride (?) in maintaining modulation at a consistent 95% to 100%, with the Modulation Monitor very seldom dropping below the 90% mark.

There are three primary factors to consider when one compromises dynamic range for greatest perceived loudness.

1. With all due respect to Phil Spector and his "wall of sound" concept, *most* composers, arrangers and performers utilize average level differences (dynamic range) as part of their artistic technique; "foreground vs. background," for instance. The broadcaster should feel *some* responsibility toward preserving at least a small amount of the artistic intent of the performer.
2. A constant level of noise (an unvarying program level) is *fatiguing;* it wears the listener out. This has been proven in tests – that people prefer *variety* in dynamics, and that highly compressed program audio with little or no dynamic range will cause listeners to *tune out!*
3. It is not necessary to obliterate dynamic range in order to gain a perceived high loudness. Honest!

Scaling and Ballistics

The DYNAMIC RANGE bargraph computes and displays, directly in dB, the variation in short-term program dynamics; that is, the ratio between the loudest and the softest passages. The dB scale is linear from zero to 20dB. The effects of audio processing will best be seen on music programming, as speech (with its pauses) will generally run the display off-scale. (The ratio between any speech level and silence is greater than 20dB.)

Short-term dynamic variations are integrated over a much longer period than their "real-time" durations. Hence the apparent sluggish nature of the DYNAMIC RANGE display.

SPECTRAL PROFILE

This display could be called a very elementary "RTA," or Real Time Analyzer, such as commonly used for room and sound system equalization. In fact, SPECTRAL PROFILE is a good deal more useful to the broadcaster than a ten-band, one octave; or thirty-band, one-third-octave RTA.

Spectral Division

SPECTRAL PROFILE is split into four separate frequency bands, each about 2.2 octaves wide.

The BASS band is a low-pass function, taking in the frequencies between 25Hz and 120Hz.

The BODY band contains the greatest full-time energy in typical program material. This includes the fundamental male and female voice frequencies, as well as musical content which conveys melody. The BODY band extends from 120Hz to 540Hz.

PRESENCE relates to those frequencies between 540Hz and 2.5kHz. This is the upper-register of voices, and the area which typifies the "color" of music. This part of the spectrum contributes to the "naturalness" of voice and music, giving an "up-front" quality to the program. When over-emphasized, components in the PRESENCE region are perceived as "shrill."

BRILLIANCE is a high-pass function, extending from 2.5kHz to system cutoff (typically, 15kHz for FM broadcasts, 9kHz for AM). Though this range may exceed the nominal two octaves, the amount of true program *energy* above 10kHz is minimal. Nevertheless, subtle overtones, as much as 30dB or more below average program levels, contribute to the subjective naturalness of the sound, sometimes referred-to as "air" or "breath."

Level Servo

A unique feature of the *Sentinel's* SPECTRAL PROFILE display is the *level servo* function. Scaling of the display is in percent, and the servo ensures that the *energy total* of the four bands will always equal 100%, despite fluctuations in overall program loudness.

It is the level servo feature which makes the SPECTRAL PROFILE display most useful. At a glance, you can tell what *percentage* of program energy is in which band. Because absolute program level and relative loudness are factored *out* of the equation, the reading remains surprisingly consistent despite wide variations in program material. This permits valid spectral comparisons, even between stations with different formats.

Spectral Variety

Much the same argument is offered in defense of multiband audio processing as is used to defend aggressive processing in general; the all-consuming quest for *loudness*. The same warnings are pertinent also.

1. Over-use of multiband processing "loads" the audio spectrum, destroying fundamental/harmonic relationships; in effect, changing the timbre (hence the artistic composition) of the program.
2. A lack of variety in spectral composition is fatiguing. It may actually detract from the musicality of the program and cause listeners to subconsciously become bored.
3. It is not necessary to pervert the spectral content of the program in order to gain a perceived greater loudness. Honest!

STEREO BALANCE

During their original production, music sources are invariably mixed for equal Left/Right balance. Even those selections which appear to have a great amount of "separation"; that is, audibly diverse Left and Right channels, will have equal energy in the two channels when integrated over any appreciable time period.

The STEREO BALANCE bargraph shows *long-term* differences between the average values of Left and Right program channels. Classical music may cause the display to occasionally drift off-center; otherwise, the central two LEDs will almost always stay lit.

A legitimate *imbalance* situation will be shown by a constant, *fixed* off-center display. Monaural programming, such as local announce-mike, will additionally exhibit a discernable level difference between the LEFT CHANNEL and the RIGHT CHANNEL bargraph displays. A questionable STEREO BALANCE measurement can always be proven by manually switching the receiver to MONO. When the receiver is forced into the MONO mode, the STEREO BALANCE display will rest at center.

STEREO IMAGE

This display is unique to the *Sentinel,* and provides valuable information relating to the stereo program in a form which is most easy to interpret.

Traditional Displays

For the technically-inclined, an "X-Y" oscilloscope is generally the most trusted and widely used display device for presentation of Left/Right signal phase relationships. It is also able, to a certain degree, to give an approximation of stereo *image width;* that is, how "stereophonic" the program is. The disadvantage of the 'scope display is that it is a complex and very "busy" readout; that program peak levels are being shown in addition to, and to the detraction of, signal phase relationships.

***Sentinel* Display**

The *Sentinel's* STEREO IMAGE display does an analog computation involving L, R, L+R and L−R level differences and phase relationships. The display gives a direct visual representation of the "width" of the stereo image (or stereo "stage"), even to the point of showing "hole-in-the-middle," out-of-phase, and other problems with the stereo program which can result in monaural signal incompatibility.

The STEREO IMAGE readout employs an AGC circuit to remove the absolute program level factor from the presentation. This means that the stereo "stage width" is accurately shown despite short- or long-term program loudness variations.

PROGRAM SYMMETRY

All sounds in nature (and even some associated with rock music) have defined wave-shapes. Very few sounds are truly symmetrical, and there is a "proper" polarity for the waveform which should be preserved in the recording process, the broadcasting, and, ultimately, the listening environment.

You may consider this nonsense, but think about it. When a drum is hit, a steep wavefront (transient) propagates through the air. This should cause the listener's loudspeaker to "push," rather than "suck."

The human voice is a good example of a non-symmetrical waveform. This is frequently used to modulation advantage in AM broadcasting, where a limited degree of asymmetrical modulation is possible. Some AM audio processors incorporate a "phase-follower" which monitors program asymmetry and inverts the program signal, as required, to maximize modulation in the positive direction. This does not always preserve the proper (natural) waveform polarity, however.

No such modulation advantage can be realized in FM, so some audio processors perform a "phase-scrambling" function to purposely destroy natural asymmetry. Once again, this is in response to the quest for loudness, at the expense of sonic accuracy.

The Display

The PROGRAM SYMMETRY display gives a readout of program waveform polarity. The non-symmetrical nature of the signal is shown as a ratio, from 1:1 (symmetrical) to 2:1 in both the positive and negative directions. This display is useful in testing and maintaining signal polarity throughout the system and, if anyone cares, to display "absolute polarity" of the program signal.

Reference

Before you write this off as a useless feature of the *Sentinel*, you should obtain and read *The Wood Effect*, by R.C. Johnsen of the Modern Audio Association. This book (ISBN 0-929383-00-1), published by Harvard University, Cambridge, Massachusetts, delves with great detail into the subject of Absolute Polarity and its effect (not always subtle) on the sonic quality of recorded/reproduced music.