radio

orban

audio processing

OPTIMOD-FM 8500v3

That great 8500 sound is now available
at an intermediate price.
Upgrade it to 8600 flagship status —

anytime you're
ready.

Featuring versatile five-band and two-band processing for analog FM transmission, the 8500 provides consistent sound, track-to-track and source-to-source. This consistency allows you to create a sonic signature for your station with the assurance that your signature will stay locked in, uniquely branding your sound.

The OPTIMOD-FM 8500 provides stereo enhancement, equalization, AGC, multiband compression, low-IM peak limiting, stereo encoding, and composite limiting — everything that even the most competitive major market station needs to stand out on the dial.

More than 20 excellent sounding, format-specific factory presets get you started. Although the factory presets are fully competent "out of the box," you can customize them with easy one-knob LESS-MORE control or with more than 60 advanced controls, whose versatility will satisfy even the most finicky on-air sound designer.

OPTIMOD-FM 8500 — HD FM OPTIMOD Audio Processor

If you choose to use the 8500's superb DSP-based stereo encoder and composite limiter, be assured that they deliver an FM analog signal that is always immaculately clean and perfectly peak limited, with full spectral protection of subcarriers and RDS/RBDS regardless of the amount of composite limiting.

For HD Radio broadcasters who prefer using a separate processor for the HD channel, the 8500FM's built-in delay (up to 16 seconds) in the analog processing path vastly improves installation versatility in HD Radio facilities, freeing you from the need to use the delay line built into the HD Radio exciter.

details

Two-band AGC with window gating rides gain without unnecessary increasing density.

A new MPX Power Level Meter indicates MPX power according to the ITU-R BS.412 standard. The improved MPX Power Controller makes the audible action more subtle by moving it after the OPTIMOD's left and right peak limiters.

Versatile multiband compressor can be adjusted to be punchy and loud or open and transparent, all while maintaining the industry's best source-to-source consistency.

Headphone volume control.

Headphone jack offers plenty of drive to over-come ambient noise at transmitters.

Built-in stereo encoder offers excellent technical specifications and Orban's patented, second-generation "Half-Cosine Interpolation" composite limiter.

Easy-to-use user interface makes navigation and adjustment effortless.

This allows you to use the 8500FM's built-in stereo encoder and composite limiter to drive the analog FM transmitter, ensuring no-compromise analog-channel loudness.

Ethernet connectivity is standard, as is an easy to use PC remote control application that can control many 8500s on a TCP/IP network. In addition, RS232 serial control and programmable contact-closure (GPI) control give you total freedom to interface the 8500 with your facility's remote control infrastructure, whatever it might be.

An intuitive user interface round out the package. Features include an easy-to-use joystick, knob, and button navigation system and a bright, active-matrix color LCD that makes it easier to program the 8500 from its front panel. The panel's eye-catching metallic blue styling makes the processor look as great in your rack as it sounds on the air.

There are two versions of OPTIMOD-FM 8500. Model 8500HD is the full HD radio version and the analog FM-only version is 8500FM. Both models can be upgraded to OPTIMOD-FM 8600 functionality.

we've done all the thinking inside the box so you have perfect sound

outside the box

New in Version 3 Software:

A new SPEECH DETECT control allows the 8500 to be forced into Music or Speech modes, overriding the automatic Speech/Music detector. This control is contained in the processing preset. Creating pairs of "Music" and "Speech" user presets gives you the ability to switch between Music or Speech modes by recalling one of the pair via the 8500's API, GPI, clock-based automation, PC Remote, or the 8500's front panel.

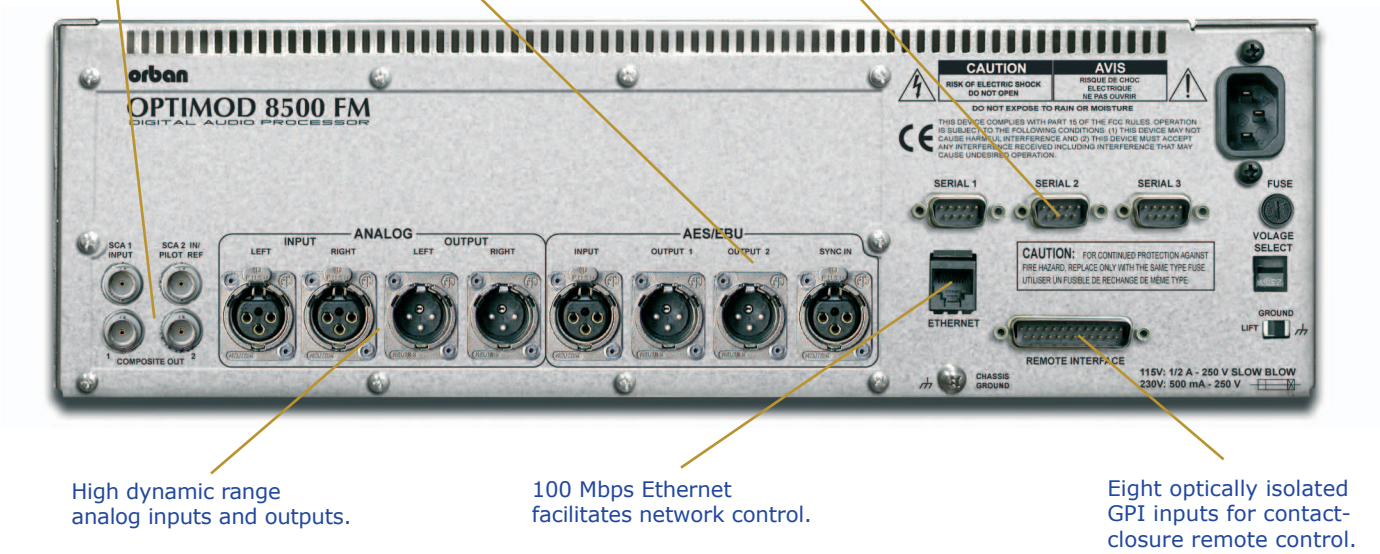
The stereo/mono status of the digital radio processing chain can now be independent of the status of the analog processing chain and stereo encoder. It is useful when a station is transmitting its FM analog signal in mono (to minimize noise in receivers), yet wishes to transmit its program material in stereo on the HD1 channel (because doing so creates no noise penalty).

crisp & clean optimized sound

The audible action of the Multiplex Power Controller is now more subtle because it has been moved after the OPTIMOD's left and right peak limiters. Previously, the controller was located between output of the OPTIMOD's multiband compressor and the input of the OPTIMOD's peak limiters.

Upgradable to 8600 Functionality: 8500 Version 3 software supports both versions of the DSP board used in 8500s over its production life. Version 1 of this

details



board contains 12 Freescale (formerly Motorola) DSP56367 24-bit fixed-point DSP chips that execute DSP software code to implement digital signal processing algorithms. Version 2 of the board contains nine Freescale 250 MHz DSPB56724 dual-core 24-bit fixed-point DSP chips. This is the same as the DSP board used in OPTIMOD-FM 8600 and allows 8500 units with V2 DSP boards to be upgraded to 8600 functionality (via a purchased upgrade kit) without replacing their DSP boards. Pre-V2 8500s can also be upgraded to 8600 functionality, but with these units, it is necessary to replace the DSP board.

The upgrade kits can be installed in the field. Orban offers three versions of the upgrade kit at prices that are commensurate with the features that a given kit adds. These three versions upgrade 8500FM to 8600FM, 8500FM to 8600HD, or 8500HD to 8600HD. A given kit is compatible with all versions of 8500 hardware and includes a V2 DSP board. If your 8500 has a V2 board already installed, upgrading is more convenient (there is no need to remove the 8500 from the rack) and you may retain the DSP board in the upgrade kit as a spare.

Diversity Delay Considerations: Unlike some older pre-V2 8500s, all V2 hardware offers up to 16 seconds of diversity delay. If you have an 8500 that requires an 8-second to 16-second upgrade, it is wise to consider spending the extra money to upgrade to full 8600 functionality at the same time.

The HD Radio system generates a digital carrier that shares a given station's allocated bandwidth with the normal analog FM carrier. The receiver crossfades between the analog and digital channels to minimize the effect of RF dropouts. This scheme requires audio processing for the two channels to be closely matched in texture to ensure that the receiver's crossfades are seamless.

Optimum peak limiting for the two channels is very different. The analog channel requires state-of-the-art pre-emphasis limiting to achieve competitive loudness and minimize pre-emphasis-induced high frequency loss. This usually implies use of sophisticated distortion-canceled clipping. The digital channel, on the other hand, has no pre-emphasis but is heavily bit-reduced with the HDC perceptual codec. The highest available rate is 96 kbps, and many broadcasters are now multicasting with two 48 kbps channels. This limited bit rate creates an entirely different set of requirements: the peak limiting must not use clipping because there is no bit budget available to encode clipping-induced distortion products. However, pre-emphasis limiting is unnecessary. The best technology for peak limiting the digital channel is therefore look-ahead limiting, which can perform very clean peak reduction

we understand...
you just like
being in
total
control

on flat channels, but which is unsuitable for pre-emphasized channels unless it is used as one element in a sophisticated system that also includes distortion-canceled clipping (as in the 8500's analog FM limiter).

OPTIMOD-FM 8500 offers a solution to this problem. It's a single box processor where AGC and stereo enhancement are shared between the two processing paths, while equalization, multiband compression/limiting, and peak limiting are separate. The equalizer and multiband compressor/limiter controls can be coupled or adjusted independently at the user's discretion. This yields great flexibility: coupling the controls maximizes the smoothness of analog/digital crossfades at the receiver, while independent operation allows the user to adjust the digital channel for greater sonic impact, or to minimize artifacts in low bit rate codecs, or to achieve other goals.

The peak limiters for the two paths are separately optimized. The analog FM path provides distortion-canceled clipping with intelligent distortion control, overshoot compensation, stereo encoding, and composite limiting using Orban's patented "Half-Cosine Interpolation" algorithm. Meanwhile, the digital radio output receives low-IM look-ahead peak limiting. This look-ahead limiting is optimized to make the most of the limited bit rate codecs used digital radio and netcasting channels. By eschewing any clipping, the HD processing prevents the codec from wasting precious bits encoding clipping distortion products, allowing the codec to use its entire bit budget to encode the desired program material.

The digital processing chain also allows the station to insert a high frequency shelving equalizer either before or after the look-ahead limiter. Inserted before, it can reduce codec artifacts caused by excessive brightness in the previous processing. (This brightness is frequently introduced to compensate for HF limiter-induced roll offs in the analog chain.) Inserted after, it can realize the same advantage and reduce codec-induced overshoot too. A separate "digital path" mixer for the various bands of the multiband processing provides an alternate means for determining audio texture and controlling codec artifacts.

Another alternative, offered first with v3 software, is adjusting the compression thresholds in the digital path's multiband limiter. Fortunately, the Spectral Band Replication® technology used in the HDC codec is far more forgiving of bright-sounding program material than was the technology used in the first-generation iBiquity codec (PAC). This allows the user to adjust the digital channel's audio texture far more freely in the quest for the "perfect sound".

The 8500's 64 kHz base samplerate allows it to provide up to 20 kHz audio bandwidth at its digital radio output — the digital radio bandwidth is user-settable between 15 and 20 kHz to optimize the processing for the codec employed in the digital transmission chain. Many low bit rate codecs operate better when fed 15 kHz audio because this enables them to use their available bit bandwidth most efficiently. This is particularly true for low rates, like 32 kbps. However, at higher samplerates, full 20 kHz bandwidth provides the same bandwidth as typical source material, so the user may prefer to use it for these higher rates.

Auditioned directly, the 8500's digital output sounds dramatically cleaner and more open than its FM output, particularly in the high frequencies — it's obvious just how much the analog channel is handicapped by the standard FM pre-emphasis curve, which compromises its high frequency headroom. Using program material, we've measured as much a 12 dB difference in favor of the digital channel at high frequencies! Even after the digital signal passes through the 96 kbps codec, a significant amount of this audible superiority remains — the HD Radio system really does provide noticeably better sound to the consumer.

The HD Radio exciter requires 44.1 kHz AES/EBU audio streams for both its analog-FM and digital inputs. The samplerates for both streams must be identical. This requires two AES/EBU outputs from a single-box processor, both of which can be locked to an external AES reference signal.

Because the output samplerate on either or both of the 8500's AES3 outputs can be locked to either the 8500's sync reference input or to its AES3 input, the 8500 fully meets the requirements. Moreover, because of the 8500'sbuilt-in diversity delay (up to 16 seconds) on the analog FM channel, it is possible (and usually desirable) to entirely bypass the analog-FM side of the iBiquity exciter and to use the 8500's built-in stereo encoder and composite limiter to drive the analog FM exciter directly.

features & benefits

USER-FRIENDLY INTERFACE	
Large (quarter-VGA) **active-matrix color liquid crystal display** (LCD)	Makes setup, adjustment and programming of the 8500 easy. Navigation is by a miniature joystick, two dedicated buttons, and a large rotary knob. The LCD shows all metering functions of the processing structure in use.
Locate **joystick**	Used to navigate through a menu that lets you recall a preset, modify processing (at three levels of expertise), or to access the system's setup controls.
ABSOLUTE CONTROL OF PEAK MODULATION	
Universal transmitter protection & audio processing for FM broadcast	Can be configured to interface ideally with any commonly found transmission system in the world, analog or digital.
Pre-emphasis limiting for the internationally used pre-emphasis curves of 50 µs & 75 µs	Produces a clean, open artifact-free sound whose subjective brightness matches the original program as closely as possible.
Tight **peak control** at all its outputs	Analog, AES3 (x2), and composite baseband.
Stereo encoder integrated with audio processing	Eliminates the overshoot problems that waste valuable modulation in traditional external encoders.
Bandwidth limiting & overshoot compensation	By providing 15 kHz low-pass filters ahead of the 8500's audio outputs and stereo encoder, the 8500 prevents aliasing distortion in subsequent stereo encoders or transmission links.
Internal, DSP-based stereo encoder (with a patented **"Half-Cosine Interpolation" composite limiter** operating at 512 kHz samplerate)	Generates the pilot tone stereo baseband signal and controls its peak level. The composite limiter is a unique, "you can only do this in DSP" process that beats composite clippers by **preserving stereo imaging** while **fully protecting the stereo pilot tone, RDS/RBDS and subcarriers**.
FLEXIBLE CONFIGURATION	
Analog & AES3 digital inputs & outputs	The analog inputs are transformerless, balanced 10 kΩ instrumentation-amplifier circuits. The analog outputs are transformerless, balanced, and floating to ensure highest transparency and accurate pulse response. The digital input and the two digital outputs can operate at 32 kHz, 44.1 kHz, 48 kHz, 88.1 kHz and 96 kHz samplerates. The pre-emphasis status and output levels are separately adjustable for the analog and digital outputs. Each output can emit the analog FM processed signal, the digital radio processed signal, or the low-delay monitor signal.
AES11 **sync input**	Allows you to synchronize the output samplerate of either (or both) AES3 outputs to this input. You can also **synchronize the outputs to the AES3 digital input or to 8500's internal clock**. The sync source of each AES3 output is independently selectable.
Defeatable **delay line**	Delays the FM analog processing output up to **16.2 seconds**. Delay can be trimmed in intervals of one sample of 64 kHz to **match the analog and digital paths** in the HD Radio system, eliminating the need to use the delay built into the HD Radio exciter and **permitting the 8500's internal stereo encoder and composite limiter to drive the analog FM exciter**. Starting with V2 software, the diversity delay can be independently applied to any output emitting the FM-processed signal can.
Two independent composite baseband outputs with digitally programmable output levels	Robust line drivers enable them to drive 100 feet of RG-59 coaxial cable without audible performance degradation.
Two **subcarrier inputs**	The inputs are mixed with the output of the 8500's stereo encoder before application to the composite output connectors. One input can be re-jumpered to provide a 19 kHz pilot reference output. Both inputs have internal level trims to accommodate subcarrier generators with output levels as low as 220 mV.
Defeatable **multiplex power limiter**	Controls the multiplex power to ITU-R BS412 standards. An adjustable threshold allows a station to achieve maximum legal multiplex power even if the downstream transmission system introduces peak overshoots into the 8500-processed signal. Because this limiter closes a feedback loop around the audio processing, it allows the user to **adjust the processor's subjective setup controls freely** without violating BS412 limits, regardless of program material.

Defeatable **multiplex power limiter** *(continued)*	The improved multiplex power limiter acts on all outputs (not just the composite output). Further improvements in V3 make the audible action of the Multiplex Power Controller more subtle by moving it after the OPTIMOD's left and right peak limiters. Previously, the controller was located between output of the OPTIMOD's multiband compressor and the input of the OPTIMOD's peak limiters.
Rigorously RFI-suppressed input, output & power connections	Orban's traditional exacting standards ensure trouble-free installation.
Certified	**Meets all applicable international safety and emissions standards**.
ADAPTABILITY THROUGH MULTIPLE AUDIO PROCESSING STRUCTURES	
Rides gain over an adjustable range of up to 25 dB	Compresses dynamic range and compensates for both operator gain-riding errors and gain inconsistencies in automated systems.
Multiband compression, limiting, & clipping	**Increases the density and loudness** of the program material, improving the consistency of the station's sound and increasing loudness and definition remarkably, without producing unpleasant side effects.
Four processing structures	A **processing structure** is a program that operates as a complete audio processing system. Only one processing structure can be on-air at a time, although all are active simultaneously to permit mute-free switching between them. Use the **Optimum** (17 ms delay), **Low-Latency** (12 ms), **Ultra-Low-Latency** (3 ms) **Five-Band** structures for a consistent, "processed" sound. Use **Two-Band** (17 or 22 ms delay) for a transparent sound that preserves the frequency balance of the original program material. A special Two-Band preset creates a no-compromise "Protect" function that is functionally similar to the "Protect" structures in earlier Orban digital processors.
Speech Mode	You can program **two sets of processing parameters into the on-air preset** and have the 8500's speech/music detector switch between them automatically, eliminating the compromise usually required between speech and music programming.
CONTROLLABLE	
Eight programmable GPI inputs	Contact closures or 5-12V AC/DC pulses can recall presets, force test mode, and more.
Serial port #1	Can interface to an IBM-compatible computer running Orban's PC Remote software. The connection can be either direct or through an external modem.
Tally Outputs	Two open-collector tally outputs can be **programmed to indicate errors** or **silence in the input audio** or to indicate which input (analog or digital) is active.
Serial port #2	Allows the user to set up **security and communications parameters** through a simple ASCII terminal program running on any PC. It also permits **simple ASCII strings to trigger preset recall**, facilitating interface to automation systems that can emit such strings through an RS232 serial port.
Built-in 100 Mbps **Ethernet port**	The 8500 can be connected through its built-in 100 Mbps Ethernet port to a **TCP/IP network**.
Bypass Test Mode	Can be invoked locally or by remote control to permit broadcast system **test and alignment** or "proof of performance" tests.
Software upgrades	**The 8500 can be upgraded** remotely or locally through its serial or Ethernet port.
Hardware upgrades	Any 8500 can be **upgraded to full OPTIMOD-FM 8600 functionality** via upgrade kits available for purchase. Three kits are available: 8500FM to 8600FM, 8500FM to 8600HD, and 8500HD to 8600HD.
8500 PC Remote software	A graphical application that runs under Windows 2000 and XP. It communicates with a given 8500 **via TCP/IP** over **modem, direct serial,** and **Ethernet** connections. You can configure PC Remote to switch between many 8500s via a convenient organizer that supports giving any 8500 an alias name and grouping multiple 8500s into folders. Clicking an 8500's icon causes PC Remote to connect to that 8500 through an Ethernet network, or initiates a Windows Dial-Up or Direct Cable Connection if appropriate. The PC Remote software allows the user to access all 8500 features and allows the user to **archive and restore presets, automation lists, and system setups** (containing I/O levels, digital word lengths, GPI functional assignments, etc.).
Built-in **line-up tone generator**	Facilitates quick and accurate level setting in any system.
Versatile **real-time clock**	Allows **automation** of various events (including recalling presets) at pre-programmed times. To maintain accuracy, this clock can be synchronized automatically via the Internet to a reference time source.

about the 8500v2's audio

Dual-Mono Architecture: The 8500 implements dual-mono architecture in both the AGC and the multiband compressor sections. You can couple each band in both the AGC and multiband compressors to a variable extent — anywhere from perfect stereo tracking to completely uncoupled operation. The coupling control determines the maximum amount of gain imbalance permitted between the left and right channels in a given band, therefore determining the amount of stereo image shift permitted in each frequency band.

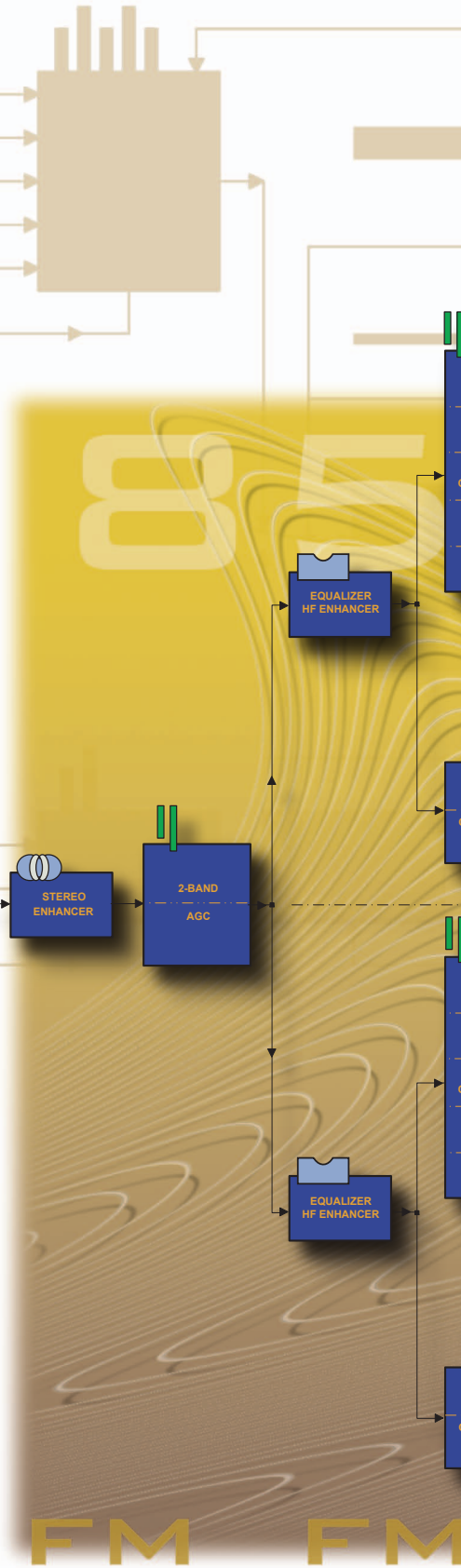
Input Conditioning: A defeatable 30 Hz 18 dB/octave high-pass filter and a defeatable phase rotator condition the audio for further processing. These have both been features in Orban FM processors for many years. Most users will defeat the 30 Hz filter and leave the phase rotator in-circuit, although the choice is always yours.

Stereo Enhancement: The 8500 provides two different stereo enhancement algorithms. The first is based on Orban's patented analog 222 Stereo Enhancer, which increases the energy in the stereo difference signal (L–R) whenever a transient is detected in the stereo sum signal (L+R). By operating only on transients, the 222 increases width, brightness, and punch without unnaturally increasing reverb (which is usually predominantly in the L–R channel).

Gating circuitry detects "mono" material with slight channel or phase imbalances and suppresses enhancement so this built-in imbalance is not exaggerated. It also allows you to set a "width limit" to prevent over-enhancement of material with significant stereo content, and will always limit the ratio of L–R / L+R to unity or less.

The second stereo enhancement algorithm passes the L–R signal through a delay line and adds this decorrelated signal to the unenhanced L–R signal. Gating circuitry similar to that used in the "222-style" algorithm prevents over-enhancement and undesired enhancement on slightly unbalanced mono material.

Two-Band Gated AGC: The AGC operates in two bands (above and below 200 Hz), using Orban's patented "master/bass" band coupling. The AGC also features target-zone gating. If the input program material's level falls within a user-settable window (typically 3 dB), then the release time slows to a user-determined level. It can be slow enough (0.5 dB/second) to effectively freeze the operation of the AGC. This prevents the AGC from applying additional, audible gain control to material that is already well controlled. It also lets you run the AGC with fast release times without adding excessive density to source material that is already dense. The AGC also has its own silence-gating detector whose threshold can be set independently of the silence gating applied to the multiband compressor.



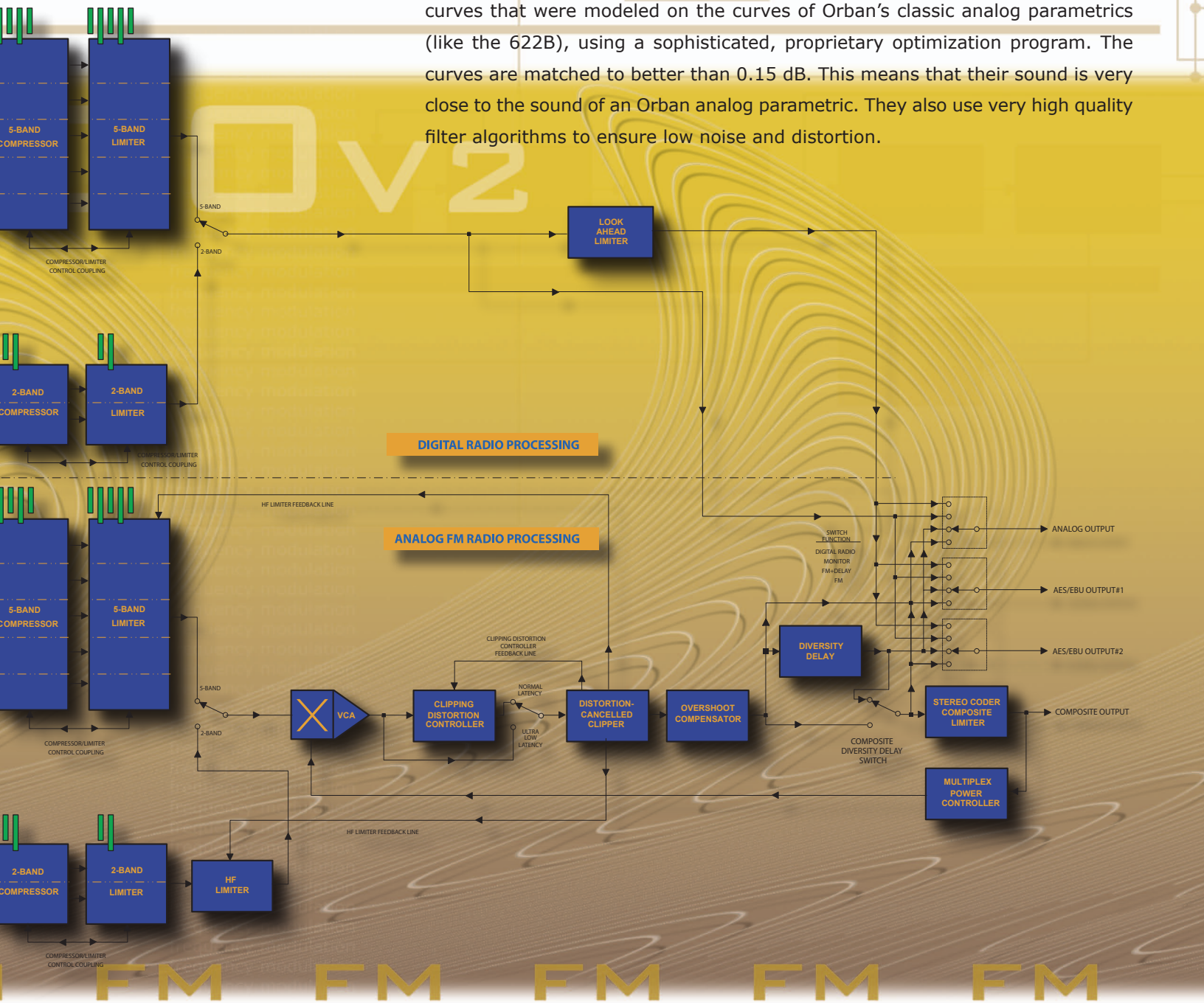
processing

The AGC contains a compression ratio control that allows you to vary to ratio between 2:1 and essentially ∞:1. Lower ratios can make gain riding subtler on critical formats like classical and jazz.

The AGC can be operated in left-right or sum-and-difference (MS) modes. You can specify the maximum gain difference permitted between the L+R and L-R channels in MS mode, allowing the AGC to correct the width of the stereo soundstage. This is particularly useful in oldies formats where the recordings may have all program elements panned hard left or hard right.

Equalization: The 8500 has a steep-slope bass shelving equalizer and three bands of fully parametric bell-shaped EQ. You can set the slope of the bass shelving EQ to 6, 12 or 18 dB/octave and adjust the shelving frequency.

The 8500's bass, midrange, and high frequency parametric equalizers have curves that were modeled on the curves of Orban's classic analog parametrics (like the 622B), using a sophisticated, proprietary optimization program. The curves are matched to better than 0.15 dB. This means that their sound is very close to the sound of an Orban analog parametric. They also use very high quality filter algorithms to ensure low noise and distortion.



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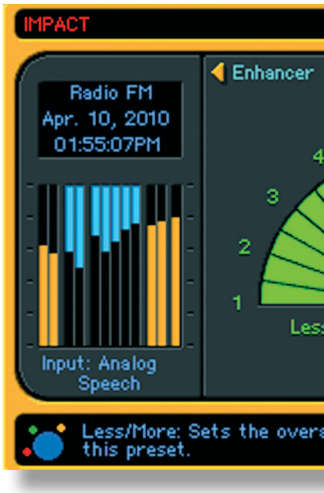
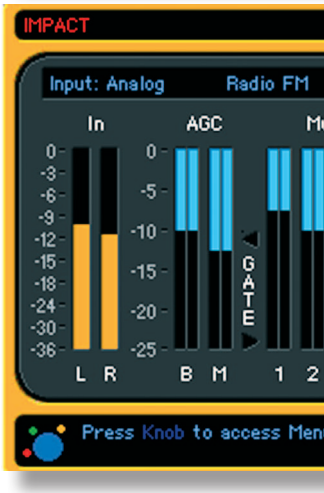
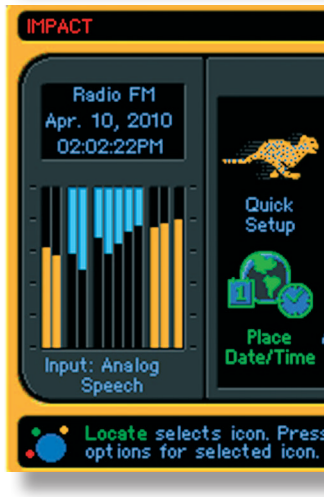






The 8500 HF Enhancer is a program-controlled HF shelving equalizer. It intelligently and continuously analyzes the ratio between broadband and HF energy in the input program material, and can equalize excessively dull material without over-enhancing bright material. It interacts synergistically with the five-band compressor to produce sound that is bright and present without being excessively shrill.

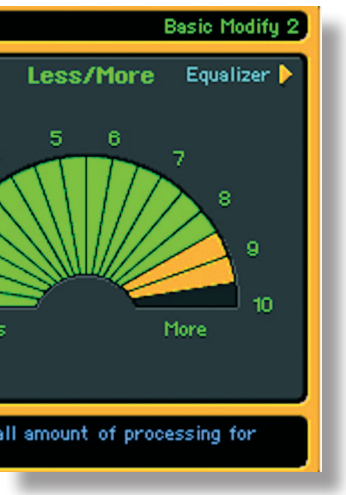
Multiband Compression: The multiband compressor can be operated in five-band or two-band mode. In the FM analog processing chain, a special high-frequency limiter and distortion-canceled clipping control high frequencies. Ordinarily, the gain reduction in band 5 is coupled to the gain reduction in band 4 (as determined by the setting of the B4>B5 Couple control); these bands are only independent from the viewpoint of the downward expander and multiband clippers. However, a high frequency limiter causes additional gain reduction in band 5 when band 5 multiband clipping alone would be insufficient to prevent HF distortion. The HF limiter uses a sophisticated analysis of the signal conditions in the 8500's clipping system to do this.

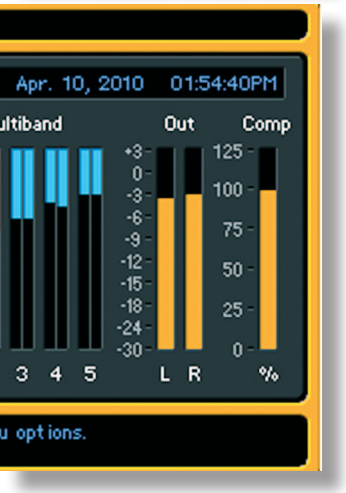
The 8500 incorporates an automatic speech detector. Thirteen of the advanced setup controls have separate "speech" and "music" settings, so you can optimize the processing independently for speech and music. Starting with v3 software, you can force the 8500 processor into "music" or "speech" mode via remote or local control, overriding the automatic speech/music detector.

A clipper in the FM analog processing chain, embedded in the crossover, protects bands 1 and 2 from transient overshoot. You can adjust this clipper for "hard," "medium," or "soft" operation. Each step gives a further reduction in audible distortion by means of increasingly sophisticated signal processing. Each step from "soft" to "hard" adds a touch more bass harmonic distortion, which can be used to improve the apparent bass response of small receivers like clock radios. The hard clipper also has a shape control, allowing you to control the "knee" of its input/output transfer curve.

Digital Radio Processing: The digital radio processing chain splits after the AGC and includes an independent equalizer, multiband compressor/limiter and low-IM-distortion look-ahead limiter. You can place a high frequency shelving filter either before or after the look-ahead limiter to control codec overshoots and tune audio spectral balance. You can further regulate spectral balance by adjusting the output mix of the compressor bands.

"Intelligent" Clipping: The 8500 prevents excess clipping distortion by dynamically reducing the drive level to the clippers as required, using an intelligent





analysis of the clipping distortion produced in the final clipper and overshoot compensator. Except for the bass clipper, all clippers and the overshoot compensator operate at 256 kHz samplerate and employ a special anti-aliasing algorithm that makes their equivalent samplerate approximately 10 MHz. This produces the coveted "analog clipper" sound.

The 15 kHz low-pass filtering in the analog processing's peak limiting section has a stopband that begins at 17 kHz. This provides the necessary ±2 kHz protection for RDS/RBDS subcarriers as well generous protection of the 19 kHz pilot tone. The 8500's output spectral control is immaculate, ensuring maximum stereo and RDS coverage. The 8500's digital output will pass through any uncompressed digital STL operating at 38 kHz samplerate or higher without adding noticeable overshoot and without the need for distortion-producing overshoot compensation schemes.

DSP-derived Stereo Encoder: The 8500's stereo encoder is derived from algorithms first developed for the high-performance Orban 8218 stand-alone encoder. The 8500's stereo encoder operates at 512 kHz samplerate to ease the performance requirements of the D/A converter's reconstruction filter, making it possible to achieve excellent stereo separation that is stable over time and temperature. DSP-based group delay and magnitude equalizers for the entire composite analog path further improve separation.

Composite Limiter: Orban has traditionally opposed composite clipping because of its tendency to interfere with the stereo pilot tone and with subcarriers, and because it causes inharmonic aliasing distortion, particularly between the stereo main and subchannels. Protecting the pilot tone and subcarrier regions is particularly difficult with a conventional composite clipper because appropriate filters will not only add overshoot but also compromise stereo separation — filtering causes the single-channel composite waveform to "lift off the baseline".

Nevertheless, we are aware that many engineers are fond of composite clipping. We therefore undertook a research project to find a way to peak-control the composite waveform without significantly compromising separation, pilot protection, or subcarrier protection, and without adding the pumping typical of simple gain-control "look-ahead" solutions.

success is dependent on effort
– Sophocles

We succeeded in our effort. The 8500 offers a dual-mode, ultra-low-overshoot composite limiter, providing either hard clipping or Orban's patented "Half-Cosine Interpolation" composite limiter. In "hard clipping" mode, the "Half-Cosine Interpolation" composite limiter is used as an overshoot compensator for the hard clipper. Both modes provide excellent spectral protection of the pilot tone and SCAs (including RDS). The "Half-Cosine Interpolation" mode provides approximately 50 dB of separation when a single-channel composite waveform is clipped to 3 dB depth. To ensure accurate peak control, the limiter operates at 512 kHz samplerate.

specifications

It is impossible to characterize the listening quality of even the simplest limiter or compressor based on specifications, because such specifications cannot adequately describe the crucial dynamic processes that occur under program conditions. Therefore, the only way to evaluate the sound of an audio processor meaningfully is by subjective listening tests.

Certain specifications are presented here to assure the engineer that they are reasonable, to help plan the installation, and make certain comparisons with other processing equipment.

PERFORMANCE	*Specifications apply for measurements from analog left/right input to stereo composite output and to FM analog left/right output.*	
	Frequency Response (Bypass Mode; Analog Processing Chain)	Follows standard 50 µs or 75 µs pre-emphasis curve ±0.10 dB, 2.0 Hz – 15 kHz. Analog left/right output and Digital output can be user configured for flat or pre-emphasized output.
	Sample Rate	64 kHz to 512 kHz, depending on processing being performed.
	Noise	Output noise floor will depend upon how much gain the processor is set for (Limit Drive, AGC Drive, Two-Band Drive, and/or Multi-Band Drive), gating level, equalization, noise reduction, etc. It is primarily governed by the dynamic range of the A/D converter, which has a specified overload-to–noise ratio of 110 dB. The dynamic range of the digital signal processing is 144 dB.
	Total System Distortion (de-emphasized, 100% modulation)	< 0.01% THD, 20 Hz – 1 kHz, rising to <0.05% at 15 kHz. <0.02% SMPTE IM Distortion.
	Total System Separation	> 55 dB, 20 Hz – 15 kHz; 60 dB typical.
	Polarity (Two-Band and Bypass Modes)	Absolute polarity maintained. Positive-going signal on input will result in positive-going signal on output.
INSTALLATION	***Delay***	
	Defeatable Analog FM Processing Delay	16.2 seconds (maximum), adjustable in one-sample increments at 64 kHz samplerate to allow the delays of the analog and digital paths in the HD Radio system to be matched at the receiver output.
	Minimum Processing Delay	Processing structure dependent. Typically 17 ms for normal latency 5-band, 13 ms for low-latency 5-band, 3 ms for ultra-low-latency 5-band, and 17 or 22 ms for 2-band, depending on crossover structure chosen.
	Analog Audio Input	
	Configuration	Stereo.
	Impedance	> 10 kΩ load impedance, electronically balanced. (No jumper selection available for 600 Ω. Through-hole pads are available on I/O module for user-installed 600 Ω termination.)
	Nominal Input Level	Software adjustable from –10.0 to +13.0 dBu (VU).
	Maximum Input Level	+27 dBu.
	Connectors	Two XLR-type, female, EMI-suppressed. Pin 1 chassis ground, Pins 2 (+) and 3 electronically balanced, floating and symmetrical.
	A/D Conversion	24 bit 128x oversampled delta sigma converter with linear-phase anti-aliasing filter.
	Filtering	RFI filtered, with high-pass filter at 0.15 Hz.
	Analog Audio Output	
	Configuration	Stereo. The analog output can emit the analog FM processed signal, the digital radio processed signal, or the low-delay monitor signal. The FM processed signal can be flat or pre-emphasized (at 50 µs or 75 µs), software-selectable.
	Source Impedance	50 Ω, electronically balanced and floating.
	Load Impedance	600 Ω or greater, balanced or unbalanced. Termination not required or recommended.
	Output Level (100% peak modulation)	Adjustable from –6 dBu to +24 dBu peak, into 600 Ω or greater load, software-adjustable.
	Signal-to-Noise	≥ 90 dB unweighted (Bypass mode, de-emphasized, 20 Hz – 15 kHz bandwidth, referenced to 100% modulation).
	Crosstalk	≤ –70 dB, 20 Hz – 15 kHz.
	Distortion	≤ 0.01% THD (Bypass mode, de-emphasized) 20 Hz – 15 kHz bandwidth.
	Connectors	Two XLR-type, male, EMI-suppressed. Pin 1 chassis ground, Pins 2 (+) and 3 electronically balanced, floating and symmetrical.
	D/A Conversion	24 bit 128x oversampled.
	Filtering	RFI filtered.
	Digital Audio Input	
	Configuration	Stereo per AES3 standard, 24 bit resolution, software selection of stereo, mono from left, mono from right or mono from sum.
	Sampling Rate	32 kHz, 44.1 kHz, 48 kHz, 88.1 kHz and 96 kHz automatically selected.
	Connector	XLR-type, female, EMI-suppressed. Pin 1 chassis ground, pins 2 and 3 transformer balanced and floating, 110 Ω impedance.
	Input Reference Level	Variable within the range of –30 dBFS to –10 dBFS.
	J.17 De-emphasis	Software-selectable.
	Filtering	RFI filtered.
	Digital Audio Output	
	Configuration	Two outputs, each stereo per the AES3 standard. The outputs can be independently set to emit the analog FM processed signal (with or without diversity delay), the digital radio processed signal, or the low-delay monitor signal. The FM processed signal can be configured in software as flat or pre-emphasized to the chosen processing pre-emphasis (50 µs or 75 µs). The digital radio processing chain receives the output of the multiband limiter and processes it through a look-ahead peak limiter that operates in parallel with the main FM peak limiting system. The DR and FM signals are always simultaneously available. Each output can apply J.17 pre-emphasis if desired.
	Sample Rate	Internal free running at 32 kHz, 44.1 kHz, 48 kHz, 88.1 kHz or 96 kHz, selected in software. Can also be synced to the AES3 SYNC input or the AES3 digital input at 32 kHz, 44.1 kHz, 48 kHz, 88.1 kHz and 96 kHz, as configured in software.
	Word Length	Software selected for 24, 20, 18, 16 or 14-bit resolution. First-order highpass noise-shaped dither can be optionally added; dither level automatically adjusted appropriately for the word length.
	Connector	XLR-type, male, EMI-suppressed. Pin 1 chassis ground, pins 2 and 3 transformer balanced and floating, 110 Ω impedance.
	Output Level (100% peak modulation)	–20.0 to 0.0 dBFS, software controlled.
	Filtering	RFI filtered.
	Frequency Response through Digital Radio Processing Chain	For output samplerates of 44.1 kHz and above, the frequency response from input to DR-configured output is ±0.10 dB, 2.0 Hz – 20 kHz; flat or with J.17 pre-emphasis applied. The user may specify low-pass filtering to constrain the bandwidth to 15, 16, 17, 18, or 19 kHz.
	Relative Time Delay between FM & Digital Radio Outputs	Output of analog-FM processing chain can be delayed up to 16.2 seconds (adjustable in 15.6 microsecond increments) with respect to digital radio processing chain. Once set, relative delay between the FM and DR processing chains is constant, regardless of preset in use. The delay can be independently applied to any output emitting the FM-processed signal.

Digital Sync Input	
Configuration	Used for synchronization of either or both AES3 signals to an external reference provided at this input.
Sampling Rate	32 kHz, 44.1 kHz, 48 kHz, 88.1 kHz and 96 kHz, automatically selected.
Connector	XLR-type, female, EMI-suppressed. Pin 1 chassis ground, Pins 2 and 3 transformer balanced and floating, 110 Ω impedance.
Filtering	RFI filtered.
Composite Baseband Output	
Configuration	Two outputs, each with an independent software-controlled output level control, output amplifier and connector.
Source Impedance	0 Ω voltage source or 75 Ω, jumper-selectable. Single-ended, floating over chassis ground.
Load Impedance	37 Ω or greater. Termination not required or recommended.
Maximum Output Level	+12.0 dBu (8.72 Vp-p).
Minimum Output Level	−12 dBu (0.55 Vp-p) for 0.5 dB adjustment resolution.
Pilot Level	Adjustable from 6.0% to 12.0%, software controlled.
Pilot Stability	19 kHz, ±0.5 Hz (10 to 40 °C).
D/A Conversion	24-bit
Signal-to-Noise Ratio	≤ −85 dB (Bypass mode, de-emphasized, 20 Hz – 15 kHz bandwidth, referenced to 100% modulation, unweighted).
Distortion	≤ 0.02% THD (Bypass mode, de-emphasized, 20 Hz – 15 kHz bandwidth, referenced to 100% modulation, unweighted).
Stereo Separation	At 100% modulation = ≥65 dB (30 Hz to 15 KHz).
Crosstalk-Linear	≤ −80 dB, main channel to sub-channel or sub-channel to main channel (referenced to 100% modulation).
Crosstalk-Non-Linear	≤ −80 dB, main channel to sub-channel or sub-channel to main channel (referenced to 100% modulation).
38 kHz Suppression	≥ 70 dB (referenced to 100% modulation).
76 kHz & Sideband Suppression	≥ 80 dB (referenced to 100% modulation).
Pilot Protection	−60 dB relative to 9% pilot injection, ±250 Hz (up to 2 dB composite processing drive).
Subcarrier Protection (60-100 kHz)	≥ 70 dB (referenced to 100% modulation; with up to 2 dB composite limiting drive; measured with 800 line FFT analyzer using "maximum peak hold" display).
57 kHz (RDS/RBDS) Protection	−50 dB relative to 4% subcarrier injection, ±2.0 kHz (up to 2 dB composite processing drive).
Connectors	Two BNC, floating over chassis ground, EMI suppressed.
Maximum Load Capacitance	0.047 µF (0 Ω source impedance). Maximum cable length of 100 feet / 30 meters RG−58A/U.
Filtering	RFI filtered.
Subcarrier (SCA) Inputs	
Configuration	Subcarrier inputs sum into composite baseband outputs before digitally controlled composite attenuator.
Impedance	> 600 Ω
SCA Sensitivity (Both Inputs)	Variable from 220 mV p-p to >10 V p-p to produce 10% injection. Two trim pots, adjustable from the rear panel, set sensitivities.
Connectors	Two BNC, unbalanced and floating over chassis ground, EMI suppressed.
19 kHz Pilot Reference	SCA2 input jack can be jumpered to provide a 19 kHz pilot reference output or to serve as a second SCA input.
Remote Computer Interface	
Supported Computer & Operating System	IBM-compatible PC running Microsoft Windows® 2000 (SP3 or higher) or XP.
Configuration	TCP/IP protocol via direct cable connect, modem, or Ethernet interface. Suitable null modem cable for direct connect is supplied. Modem and other external equipment is not supplied.
Serial Connectors	RS−232 port (3) DB−9 male, EMI-suppressed. Serial Connector 1 uses PPP to provide for direct or modem connection to the 8500 PC Remote application. Serial Connector 2 supports communication to a computer or remote control system via simple ASCII commands for administration and recalling presets. Serial Connector 3 is reserved for future developments.
Ethernet Connector	Female RJ45 connector for 10−100 Mbps networks using CAT5 cabling. Native rate is 100 Mbps. Provides for connection to the 8500 PC Remote application through either a network, or, using a crossover Ethernet cable, directly to a computer.
Ethernet Networking Standard	TCP/IP.
Remote Control (GPI) Interface	
Configuration	Eight (8) inputs, opto-isolated and floating.
Voltage	6 – 15 V AC or DC, momentary or continuous. 9 VDC provided to facilitate use with contact closure.
Connector	DB-25 male, EMI-suppressed.
Control	User-programmable for any eight of user presets, factory presets, bypass, test tone, stereo or mono modes, analog input, digital input.
Filtering	RFI filtered.
Tally Outputs	
Configuration	NPN open collector.
Maximum Voltage	30 V DC, reverse-polarity protected.
Maximum Current	30 mA.
Power	
Voltage	100 – 132 V AC or 200 – 264 V AC, switch-selected on the rear panel, 50 – 60 Hz, 50 VA.
Connector	IEC, EMI-suppressed. Detachable 3-wire power cord supplied.
Grounding	Circuit ground is independent of chassis ground can be isolated or connected with a rear panel switch.
Safety Standards	ETL listed to UL standards, CE marked.
Environmental	
Operating Temperature	32 to 122 °F / 0 to 50 °C for all operating voltage ranges.
Humidity	0 – 5% RH, non-condensing.
Dimensions (W x H x D)	19" x 5.25" x 15.5" / 48.3 cm x 13.34 cm x 39.4 cm. Depth shown indicates rack penetration; overall front-to-back depth is 17.75" / 45.1 cm. Three rack units high.
RFI / EMI	Tested according to Cenelec procedures.
Shipping Weight	28 lbs. / 12.7 kg
Warranty	
Two Years, Parts & Service	Subject to the limitations set forth in Orban's Standard Warranty Agreement.

Because engineering improvements are ongoing, specifications are subject to change without notice.

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