

AM Broadcast Audio Processor

SW210

Setup and Operating Guide



Initial Release
(Starting S/N 001)

TABLE OF CONTENTS

INTRODUCTION	1
Features	1
Warnings	2
NRSC Compliance Disclaimer	2
CONNECTING THE SW210	3
Ins and Outs	3
XLR 'Pro' Line Inputs and Outputs	3
Mini-Jack 'Semi-Pro' Line Inputs	4
Mini-Jack 'Semi-Pro' Line Outputs	4
PLACING THE SW210 IN SERVICE	5
Important Setup Instructions <u>PLEASE READ</u>	5
INPUT SIGNAL CONDITIONING	5
The AGC and Input Gain Adjustment	5
Auto Polarity Reversal	6
Articulation Enhancement	7
Pre-Emphasis	8
TRIBAND PROCESSING	8
Processor Drive and the Readouts	9
Bass Split	9
Equalization	9
FINAL PEAK CONTROL AND OUTPUT FILTER	10
Asymmetrical 'Supermodulation'	10
The Low-Pass Output Filter	11
SETTING THE OUTPUT LEVEL	11
Locking-Down Critical Settings	13
YOUR "SIGNATURE SOUND"	14
Limiting vs. Clipping	14
Keep On Tweaking!	15
SW210 WARRANTY INFORMATION	15
Your Satisfaction	15
Warranty Terms	16

INTRODUCTION



The Legacy SW200

Our SW210 builds on the reputation of its predecessor, the SW200. Although originally intended for Part 15 low-power and license-free hobbyist use, the SW200 quickly found ready acceptance across a wide range of AM transmission applications.

This successor SW210 offers additional features and performance improvements to further widen its possible uses for amateur ('ham') radio, LPAM community radio, along with commercial AM and shortwave broadcasting.

Features

...of the SW210 include:

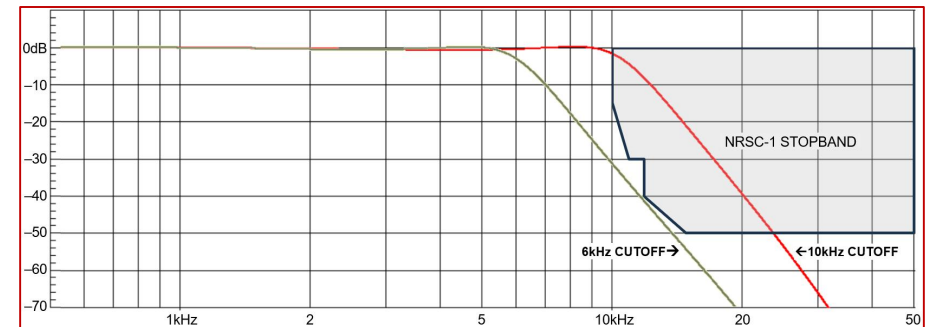
- Separate high-level 'pro' balanced program audio I/Os (XLR, +4dBu), and low-level 'prosumer' unbalanced I/Os (3.5mm TRS, -10dBV). Includes an unbalanced input that sums stereo program sources to L+R mono.
- Subsonic high-pass input filtering that removes very-low-frequency artifacts that compromise modulation.
- Slow, gated 'gain-riding' AGC that normalizes long-term input level variations from various program feeds.
- Automatic and inaudible program phase rotation that optimizes the asymmetrical, positive-modulation advantage.
- Program audio pre-emphasis to the NRSC Standard, plus variable 'peaking' pre-emphasis curves for services with restricted bandwidths.
- Variable 'Articulation' equalization that enhances speech intelligibility and adds presence to music vocals.
- 3 bands of frequency-discriminate 'spectral' compression and limiting that utilize stable and colorless PWM (Pulse Width Modulation) gain-control architecture.
- Basic low- and high-frequency program equalization with a variable 'Bass Split' (LOW/MID crossover) adjustment for control over the bottom-end sonic signature.
- Tight, asymmetrical final peak control with a variable ratio between limiting and clipping. Positive-peak values may be adjusted between +100 and +200%, relative to negative peaks.
- Overshoot-compensated, sixth-order output filter continuously variable between 3kHz and 12.5kHz.

Warnings

- 1) The SW210 is supplied with an AC adapter that delivers regulated and isolated (floating) 18 volts DC. *Please* use this adapter. This supplied "wall-wart" is available from a number of sources, and we can supply or advise you in selecting a proper replacement if you ever need one. Do not try to bootleg-in power from other equipment, as that could seriously damage the unit.
- 2) For cost considerations, the SW210 is packaged in an economical, yet surprisingly smart-looking and sturdy 1U ABS-plastic rack-mount enclosure. The implied tendency toward induced, E-field RF susceptibility has been addressed with internal shielding. Nevertheless, always try always to locate the SW210 away from abnormally high RF fields.

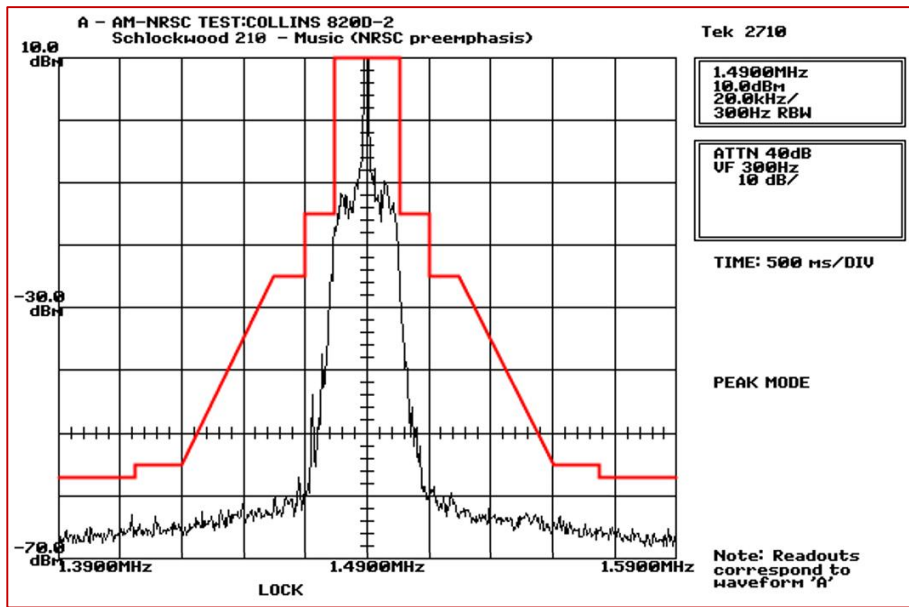
NRSC Compliance Disclaimer

Even with the output CUTOFF (Hz) control set at the 10kHz (NRSC) panel marking, the SW210 falls a bit short of meeting the original NRSC-1 audio cutoff spec for commercial AM broadcasting, as depicted below. CUTOFF (Hz) would need to be reduced to 6kHz (the green plot) to slide-in under the NRSC-1 stopband.



Nevertheless, even at the 10kHz (NRSC) setting, the SW210 does meet the updated NRSC-2 Occupied Bandwidth Mask specification. This has been tested by an independent laboratory, the results shown at the top of the following page. That test was made using pop-music program material, typical processing settings, NRSC pre-emphasis and a 10kHz cutoff. The NRSC-2 'mask' is overlaid in red.

While the updated NRSC-2 RF Mask is *sine qua non* (the essential authority) for bandwidth compliance, licensed broadcasters should still be aware of our NRSC-1 disclaimer.



CONNECTING THE SW210

Ins and Outs

The SW210 has multiple program audio inputs and outputs, allowing it to interface properly both with professional +4dBu-balanced, and semi-pro (“prosumer”) -10dBV-unbalanced equipment. It operates happily pro-in/semi-pro-out, and vice-versa.

Any combination of line *outputs* may be connected simultaneously, but the presence of multiple program line *inputs* should in no way suggest any sort of built-in mixing function. *Use only a single input at a time!*

XLR ‘Pro’ Line Inputs and Outputs

The 3-pin XLR connectors interface with +4dBu studio-level input and output lines. +4dBu is the nominal ‘zero-VU’ level, meaning that the ± 15 dB range of the front-panel INPUT GAIN control may be adjusted for actual average levels between -11dBu and +19dBu. Similarly, the ± 10 dB range of the OUTPUT LEVEL control will deliver balanced output levels between -6dBu and +14dBu, corresponding to 100% AM carrier modulation. Per AES convention, pin 2 of the XLR connector carries

the positive signal phase (associated with positive peak modulation) and pin 3 is the opposite signal phase. Pin 1 is ground.

Mini-Jack ‘Semi-Pro’ Line Inputs

There are two 3.5mm TRS PROGRAM LINE INPUT jacks for the lower, -10dBV signal levels common to computer sound cards, MP3 players and ‘party DJ’ mixers.

The input jack designated (MONO) accepts signals only on the tip of the mini phone plug, the plug ring is not connected and the plug sleeve is ground/return.

You may feed stereo program sources to the other jack that is labeled (STEREO SUM). The SW210 will then combine left and right program audio to L+R monaural. Typically, the plug tip carries the left channel, the ring the right channel and the sleeve is ground/return for both.

For both mini phone jacks, -10dBV is the nominal program signal level. INPUT GAIN adjusts for actual average levels between -25dBV and +5dBV. Again, do not try to use a combination of the LINE INPUT connectors, as this may result in unexpected behavior.

Mini-Jack ‘Semi-Pro’ Line Outputs

Two 3.5mm TRS PROGRAM LINE OUTPUT jacks deliver -10dBV processed audio. -10dBV is the nominal level, the OUTPUT LEVEL control allows adjustment between -20dBV and 0dBV, corresponding to 100% AM carrier modulation.

The jack marked BALANCED -10dBV does indeed yield a balanced output at the lower program line level. With the single exception noted below, this output may be utilized by the more advanced low-power transmitters that feature balanced inputs at this lower signal level. The plug tip carries the positive signal phase (associated with positive modulation), the plug ring is the opposite signal phase, and the plug sleeve is ground/return.

Should you need a reversed-phase unbalanced feed (see situation **1**) on Page 12), you may take this from the ring of the BALANCED -10dBV jack, with the sleeve as ground/return, and the tip left unconnected.

PLACING THE SW210 IN SERVICE

Important Setup Instruction PLEASE READ

Experience with the original SW200 processor provided us important insight into how it is installed and used in the field. This has prompted our addressing what could be similar issues when setting up the SW210.

The majority of setup complications stemmed from trying to set everything up at once. Initially, it is best by far to treat the SW210 as an independent entity, rather than as a link in a chain, and get the processor first up and running by itself as much as possible. For this reason, we urge you to follow the setup procedure described here rather than cranking randomly on all the various adjustments. In fact, for the first step noted below we urge you *not* to connect the SW210 to your transmitter or even monitor the output of the processor at all.

Explanations of the various controls and their attendant setup procedures pretty-much follow the signal path, which proceeds from left to right across the front panel.

INPUT SIGNAL CONDITIONING

The AGC and Input Gain Adjustment

The most-reported problem during setup of the earlier model SW200 was a result of “input starvation.” This is a situation where insufficient input signal triggers the AGC between its working and its ‘gated,’ resting state.

‘Gating’ assigns a fixed input signal threshold to represent valid program audio. This threshold is actually about 20dB below the average program level. During pauses in the program, or when the program level falls 20dB or more, AGC gain freezes, and then slowly makes its way back to the 0dB, unity-gain resting point. To understand the value of this mode, think of the broadcast of a baseball game. During an extended pause in the play-by-play, AGC gating prevents the noise of the crowd from slowly rising to a deafening roar.

The INPUT AUDIO indicator LED represents the gating threshold. This LED should remain lighted almost constantly during your program, going dark only when a music track fades all the way out and the DJ hasn’t yet started talking. You should never see this indicator flash on and off during music program-

ming, or even during continuous speech, although it will go dark for extended speech pauses. If the INPUT AUDIO LED does flash a lot, you may well be suffering ‘input starvation’ and should turn INPUT GAIN up. If you’re already at the top of the INPUT GAIN pot, then you need to increase the signal level going into the SW210.

Apply typical programming to the SW210 and adjust INPUT GAIN so that the AGC GAIN display remains mainly within the 10dB window defined by the three green LEDs in the middle. AGC action is quite slow, so take your time, making your adjustments in small increments and waiting a few seconds to see the result. An occasional yellow LED is still okay, but should not remain lighted for very long. Red LEDs will warn you of an out-of-range condition, that the incoming signal level is far too low or far too high, or outside the correction range.

Gain-riding AGC is widely used with most all program formats, but AGC can be turned OFF under OPTIONS on the rear panel. This might be desirable for classical music broadcasts or ham radio ‘VOX’ operation.

Auto Polarity Reversal

In most countries, commercial AM broadcasting regulations allow a station to modulate ‘asymmetrically’; that is, to maintain a 100% modulation limit for negative program peaks, but allow natural positive program peaks to achieve up to a +125% value. What’s important here is the reference to *natural* program peaks.

Speech and music waveforms contain harmonics that add to the amplitude of the fundamental frequency, quite often in just one polarity or the other. The SW210 can be adjusted to pass these naturally-asymmetrical waveforms to give you a modest modulation advantage. The SW210 does not generate asymmetry by clipping negative peaks. Negative peak clipping is an outdated practice associated with audible distortion and ‘splatter.’

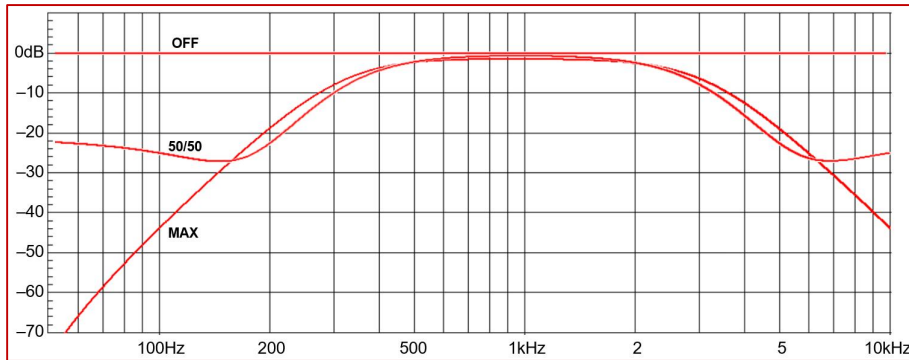
The SW210 employs program *phase rotation* in the AUTO POLARITY function to maintain a predominance of positive-modulation peaks. Rather than the simple switching means used in early processors, the SW210 puts the signal through a slow ‘roll’ that is virtually inaudible. The SW210 can pass positive program peaks up to 200% of negative peak values. This is an adjustable value covered in detail on Page 10.

An exception to the claim of inaudibility of this feature is listening to your *own* voice off-air with headphones. When what your *ears* hear reverses phase with what's transmitted through the *bones in your head*, the effect may be somewhat unnerving to you, although listeners hear nothing unusual at all. Thus AUTO PHASE can be turned OFF under OPTIONS on the rear panel.

Articulation Enhancement

Multiband audio processing creates an unexpected, yet not-unpleasant sonic phenomenon that we have named "Spectral Loading." Processor frequency bands that are low in energy will increase their gains to fill holes in the audio spectrum. The SW210, a 3-band processor, will exhibit a discernable increase in BASS BAND and HIGH BAND program components, as the MID BAND, which typically has the greatest energy, undergoes greater gain reduction than its upper and lower neighbors.

While this does appear to create a more 'hi-fi' sound with plenty of thump and sparkle, the intelligibility of speech, even including pop-music lyrics, may have a tendency to suffer a bit. One way of mitigating this is with the ARTICULATION control, which adds static emphasis at speech frequencies to help restore vocal intelligibility. The graph below shows action of the ARTICULATION control at various settings.



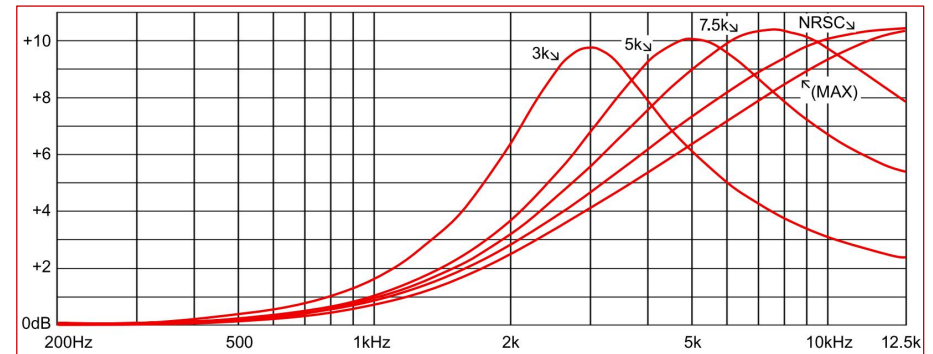
Exercise care in setting the ARTICULATION control. Wide-open it can certainly help speech cut through noise, but such an aggressive setting tends to impart a "two-tin-cans-and-a-string" quality to music and mixed programming. Mixed formats (music and speech) will usually dictate a setting between OFF and 50/50.

Pre-Emphasis

Historically, AM radio has been a frequency-flat system, lacking the complementary pre-emphasis and de-emphasis common to FM broadcasting. The 1980s saw a great deal of early enthusiasm behind the "AM Improvement" movement, a cooperative effort between broadcast and consumer standards groups. Sadly, during this same period AM radios, specifically radios in automobiles, were manufactured with increasingly narrow audio bandwidths to help overcome the growing RF noise floor from onboard 'computer boxes,' discharge-based street lighting and ever-higher-voltage utility power transmission.

The NRSC pre-emphasis standard is still on the books, and although the formal NRSC Standard does specify it, many broadcasters employ whatever emphasis curve they consider beneficial to their format and market presence.

The SW210 offers a continuously-variable peaking pre-emphasis function between 3kHz and 8kHz, above which it merges with the NRSC curve. Examples are graphed below.



Experiment with the PRE-EMPH. (Hz) control and pick a setting that complements your format and helps define your signature sound. If desired, PRE-EMPH may be completely turned OFF under the OPTIONS selections on the rear panel.

TRIBAND PROCESSING

The SW210 divides the audio spectrum into three distinct frequency bands. Each band undergoes independent dynamic-range compression, peak limiting and transitory (time domain) soft clipping before the three bands are recombined and passed to the final peak controller. The primary advantage of multiband processing is the increase it imparts to broadcast

program *density*, which is an important component of loudness as perceived by the listener. In the process of making the program louder, it also makes it ‘busier.’ Our term, ‘Spectral Loading’ defines this phenomenon, which was initially explained under **Articulation Enhancement** on Page 7.

Processor Drive and the Readouts

The PROC. DRIVE setting determines the total amount of tri-band audio processing in effect. Although control markings suggest +15dB as a maximum-action figure, these markings refer to the *average* program level, or the degree of dynamic range *compression*, which is largely what’s you’ll see on the three dB G/R (dB of Gain Reduction) LED readouts for each band. Nonetheless, program *peaks* exceeding the program’s average level are also effectively limited in these three bands, though many of them will be too quick to register visibly on the displays. ‘Transitory’ soft-clipping is exceedingly fast and generally does not register on the display.

Set the PROC. DRIVE control at your discretion. Increasing the drive will increase program density, a factor that always must be balanced with consideration and with regard to listener fatigue. A straight-up setting (about +7.5dB) is a good starting point.

Bass Split

The BASS SPLIT (Hz) control lets you select the crossover frequency between the BASS BAND and the MID BAND. A recommended starting-point setting of this control is straight-up, at about 95Hz. Formats heavy in sub-bass (e.g., hip-hop/urban) may profit from a lower-frequency setting, while a higher setting will shave a tendency to give additional warmth and naturalness to voices in talk-radio programming.

Equalization

The BASS EQ and HIGH EQ controls are individual, fine-tune drive adjustments *ahead* of their corresponding bands of compression and limiting. They allow you to dial-in more or less *energy* to those portions of the audio spectrum, and in a manner that does not place an additional burden on the final broadband peak controller that follows the tri-band processing section. This processing philosophy is associated with a reduced tendency for heavy bass or bright sibilants to ‘poke holes’ in, or ‘pump,’ the overall program level. Start straight-up

at 0dB and use the BASS EQ and HIGH EQ controls to help evolve your signature sound.

FINAL PEAK CONTROL AND OUTPUT FILTER

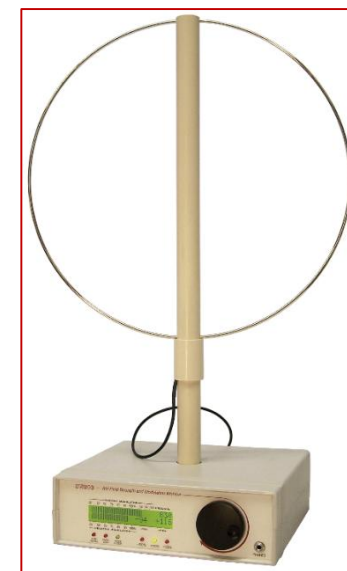
The final peak controller follows tri-band compression and limiting. The circuit is in a feedback configuration that enables the user to control the ratio between limiting and clipping. The two actions are displayed, respectively, by the green and red LED indicators just below the PK CTRL. knob.

The PK CTRL. panel annotations refer to the aforementioned limit/clip ratio, but the extremes of the control (MAXLIMIT and MAX CLIP) should not be considered 100%, full-action values. MAXLIMIT will always be protected by ‘safety clipping’ to prevent overmodulation, and MAX CLIP will summon-up the limiting function to avert severe audible distortion. Furthermore, the clipping utility is ‘distributed’ within in the SW210’s low-pass output filter to further minimize clipping artifacts and growth of the RF spectrum.

Asymmetrical ‘Supermodulation’

Asymmetrical modulation was initially mentioned in the **Auto Polarity Reversal** discussion on Page 6. An AM carrier can be modulated only to -100% (carrier cutoff) in the negative direction, but positive-going peaks of asymmetrical waveforms can modulate the carrier to higher levels *if the transmitter is capable*. Commercial broadcast transmitters are generally quite proficient in this regard, but others may *not* be able to modulate beyond +100% and, if pushed by high positive audio peaks, may distort excessively.

Without a good oscilloscope, or better yet a modulation monitor, it is difficult to determine whether a transmitter is linear to +100% modulation and beyond. Our SW300 Field Strength and Modulation Monitor, pictured above, is a quite capable off-air monitor for all AM broadcast applications.



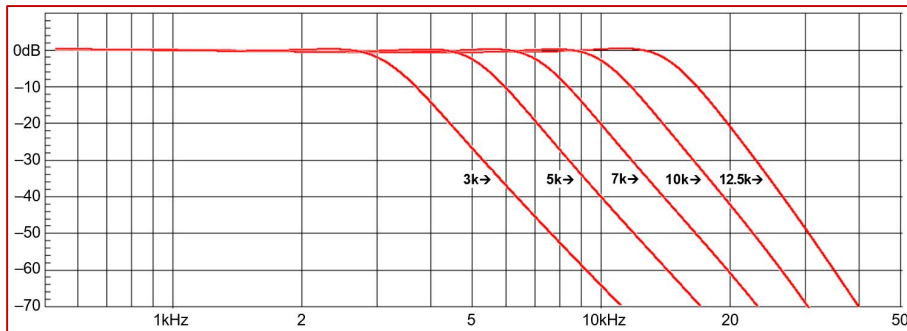
SW300 AM Field Strength and Modulation Monitor

SW210 design has been optimized to enable clean asymmetrical modulation up to +200%. This degree of positive modulation is far in excess of what is allowed for commercial stations, but may be legal in other AM applications. Commercial US broadcasters are limited to +125%, and a tic mark on the POS. PEAKS control scale defines this point.

NOTE: Leave the POS. PEAKS control set at 100% until you have reached the last step in the setup procedure. If in doubt as to whether or not your transmitter is capable of asymmetrical modulation, it is best to leave the control at +100%.

The Low-Pass Output Filter

Frequency response through the SW210 is within 1dB of flat between 50Hz and 10kHz, about 3dB down at 12.5kHz, and has a relatively sharp cutoff above that point. The cutoff frequency is, in fact, continuously variable between 3kHz and 12.5kHz. The illustration below graphs the response at different settings of the CUTOFF (Hz) control.



SETTING THE OUTPUT LEVEL

At this point your transmitter should be connected to the output of the SW210.

- If you are using the XLR (pro) BALANCED output, be sure that a positive-going waveform on Pin 2 of this connector will drive your transmitter to higher positive modulation. Pin 3 is the program return, and Pin 1 is chassis ground.
- The 3.5mm Mini Jack BALANCED OUTPUT delivers positive-going modulation on the tip, the ring is the opposite-phase program return, and the sleeve is chassis ground. You may also take an unbalanced feed from the tip and sleeve only, leaving the ring of the plug unconnected.

- The 3.5mm Mini Jack UNBALANCED output delivers positive-going modulation independently on both the tip and the ring, the sleeve being chassis ground for both. This output may be directly connected to a transmitter with a stereo input.

First, make sure that the POS PEAKS control is turned all the way down to +100%.

With the SW210 connected to your transmitter, play normal program audio into the system. Your processing setup should have the LIMIT and CLIP LEDs winking-away. Monitor your off-air signal so you can compare your relative loudness to that of a local commercial station.

Adjust the OUTPUT LEVEL control until you have about the same loudness as a local station. Listen carefully for any 'splatter' distortion. With a Mod-Monitor you'd see that OUTPUT LEVEL lets you adjust the program peaks to a symmetrical $\pm 100\%$. You actually want to keep negative peaks around -95% , a good modulation level to totally avoid splattering.

If you question whether what you hear is splatter or another distortion mechanism, remember that splatter is quite often audible even when you are tuned to the next AM channel above or below your own frequency.

With good symmetrical modulation, you may now advance the POS PEAKS control to achieve a positive modulation advantage. If you are a commercial station, use your mod-monitor and limit positive peaks to the *occasional* 125% occurrence. That should give you consistent positive peaks at +120%.

If you are a noncommercial broadcaster who is not obligated to limit positive modulation to +125%, you can go ahead and advance the POS PEAKS control until you hear audible distortion. But as 'supermodulation distortion' may indicate a shortcoming in some radios, or certainly in your transmitter as well, perhaps +150% is a more realistic limit for this setting.

If you find that you do generate splatter or other distortion when you run the POS PEAKS control up, you may have one of two situations:

- 1) The program audio is not phased properly with respect to the transmitter. *Reverse* your balanced output connections. In other words, swap Pins 2 and 3 of the BALANCED XLR connector (or tip and ring of the BALANCED 3.5mm Mini

Jack). You may also take an *unbalanced* -10dBV output from just the *ring* of the BALANCED 3.5mm Mini Jack, leaving the *tip* unconnected. (The ring of the BALANCED Mini Jack is 180-degrees out of phase with the tip.)

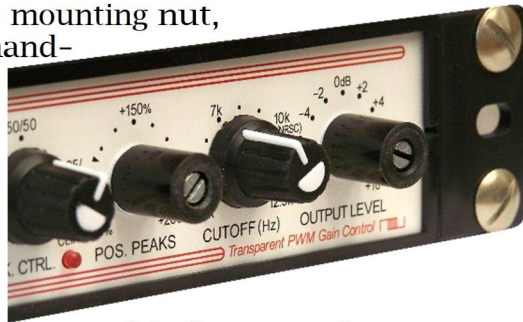
- 2) Your transmitter may suffer from poor phase response, or simply may not be capable of positive modulation beyond +100%. If this is the case, it's best to turn the POS. PEAKS control all the way down to 100%. You'll be losing only a dB-and-change in loudness, which really is not a huge deal.

Should your mod-monitor show that you cannot obtain much in the way of positive peaks, it may be that your program material was previously limited symmetrically, either with another processor ahead of the SW210 (not really a good idea anyway), or the music track was over-processed for the CD, MP3 or other release format. Previous symmetrical limiting will not allow you as many, or as high, 'natural' positive peaks.

Locking-Down Critical Settings

The OUTPUT LEVEL and POS. PEAKS controls determine your transmitter's peak-modulation values. These are normally set-and-forget controls that require little attention, once adjusted. For commercial broadcasters, these really need to be locked-down to prevent accidental changes (and subsequent citations!), perhaps by some clumsy oaf bumping against the knob or twiddling it by mistake.

An easy way to get these controls out of harm's way is to pull off the knob, remove the pot's mounting nut, and screw-on our nifty, hand-crafted shaft guards, pictured here. These ensure that nothing will interfere with your settings, yet you still have screwdriver access to the control without having to remove the guards. Do please put the knobs away in a safe place for possible future needs.



These shaft guards are available in pairs (two guards) at a cost of \$15, postage-paid in the U.S.

YOUR "SIGNATURE SOUND"

When developing your signature sound, put the SW210 on air and listen over a representative consumer radio. Keep in mind that the output of the SW210 is highly pre-emphasized to complement the steep high-end rolloff inherent in most AM receivers. Listening to the line output of the SW210 will not represent the off-air sound your listeners are going to hear.

The several processing functions interact to some degree, so you'll need to establish a balance between PROC. DRIVE, the various controls that offer static equalization, and the PEAK CTRL. pot to nurse-in your signature sound. There are no hard-and-fast rules here. The only advice we offer is to listen carefully *off-air* and let your ears and common sense be your guide. Solicit the opinion of others, as well. Hopefully you're not the only one that will be listening to the station.

Limiting vs. Clipping

Tight program peak control is crucial to the commercial broadcaster in keeping modulation within legal limits. While wide-band and/or multiband dynamic range compression increases program *density*, perceived *loudness* is also a function of the final program peak controller. This is especially true for fast-attack sounds, like drums.

In broadcast practice, peaks may be both limited and clipped. Fast peak limiting alone can lead to 'ducking' or 'pumping' effects in the program audio, sonic artifacts that can be particularly annoying. Brute-force clipping doesn't 'pump,' but it can certainly add objectionable harmonic and intermodulation distortion. The SW210 uses smooth *platform limiting* in concert with *time-domain* and *distributed clipping* to manage program peaks, and the user can balance these two peak control functions at his discretion.

Play program audio that shows an occasional 10dB of indicated gain reduction in the MID band and begin experimenting with the PK. CTRL. pot at MAX LIMIT. The green limiting LED will flash as peaks are reduced, although the red clipping indicator may also still flash occasionally or quite faintly.

As PK. CTRL. is turned clockwise, the program audio will get progressively louder, and with more of a 'solid' and 'open' sound. At MAX CLIP you'll note that the two indicators will have reversed their roles, the clipping LED flashing red continuously, and the green limit LED flashing only now and then.

The annotation around the PK. CTRL. pot represents the approximate ratio between limiting and clipping, noted in a relative-percent figure for the two functions. You'll find that most musical program material will tolerate a great deal of filtered clipping, albeit with perhaps some 'edge' to voices and solo instruments. Other program sources may demand a smoother, mostly-limited treatment. This is another control where straight-up (50/50) is a good starting point.

Remember that a certain degree of audible distortion will be somewhat masked by the audio response of typical AM radios, but you alone must weigh the tradeoffs in the smooth-versus-loud game.

Keep On Tweaking!

And that's it! At this point you should be set up and running. Do continue experimenting with various processing setups. As commercial broadcasters ultimately discovered, louder is not always better. If your program audio is over-squashed, a phenomenon known as "listener fatigue" sets in. Back off the processing a bit and see if it doesn't actually sound more pleasant over the longer term.

SW210 WARRANTY INFORMATION

Your Satisfaction

Your satisfaction with our products is of foremost concern to us. If for any reason you are not satisfied with your purchase, we will happily refund your purchase price, less shipping charges, with the following stipulations:

- 1) That we first work together to exhaust all possible avenues of reconciling the issues you have with the equipment.
- 2) That you make your return request within two weeks following receipt of the product. Please save the original shipping carton and materials until you are sure the equipment meets your expectations.
- 3) That you return the unit prepaid and in like-new condition, with all bits, pieces and documentation that came with it. Our costs for any required repair or refurbishment will be deducted from your refund. *Our return offer does not apply to gear that has been modified to a point that it cannot be restored to factory-new condition.*

Warranty Terms

- 1) The Schlockwood Laboratory guarantees its products against defects in materials and workmanship for a period of 90 days following delivery to the user.
- 2) Our products are shipped with full coverage against shipping loss or damage unless the buyer has waived this coverage at the time of order. The buyer assumes total responsibility for uninsured shipments. Shipping damage should first be referred to the carrier.
- 3) We reserve the right either to repair or to replace a defective product.
- 4) Defective or returned products must be packaged appropriately and returned by common carrier (e.g., USPS, UPS, FedEx) to the factory prepaid at the carrier's lowest-cost surface-shipping rate. On valid Warranty claims we will return the product prepaid and will reimburse the buyer's shipping expense.

This page is reserved for your notes.

The Schlockwood Laboratory
Brea, California
www.schlockwood.com