PART 4:

Initial Setup Procedure

If you have a single-chassis OPTIMOD-FM, you may skip to **Stereo Generator,** below.

If you have a dual chassis OPTIMOD-FM, you must first align the gain of the STL and transmitter chassis to a standard to assure that both STL and transmitter chassis are driven at correct levels.

4

Dual-Chassis Alignment: This procedure is repeated twice: once for the left channel and once for the right. It is assumed that the STL is a pair of land-lines, a pair of microwave STL's, or a PCM link.

1) Adjust the operating controls on the studio chassis as follows:

Proof/Operate Switch:	OPERATE
L and R Input Attenuators:	0
Clipping:	+2
Release Time:	10
Bass Coupling:	10
Gate Threshold:	0
HF Limiting:	10
L and R Output Level:	Fully CW (up to 18 turns)

2) Connect an audio oscillator to the LEFT INPUT of the studio chassis. Set its frequency to 1kHz, and its output level to produce 10dB G/R as indicated on the studio chassis MASTER TOTAL G/R meter.

With the L and R OUTPUT LEVELs fully CW, the studio chassis will produce an output level on a 1kHz tone of 1.17Vrms (+3.6dBm) when loaded by 600 ohms. This is equivalent to 0VU in a +8dBm system when fed with program material.

3) Feeding phone lines: With the L and R OUTPUT LEVEL controls fully CW, the output level and impedance of the studio chassis are appropriate for directly driving a USA-standard telephone line requiring a nominal input level of +8dBm and a resistive balanced driving impedance of 600 ohms.

If your phone lines require a lower drive level to prevent clipping of audio by in-line amplifiers, reduce the OUTPUT LEVEL controls accordingly.

4) Feeding microwave systems: The frequency spectrum of audio at the output of the studio chassis approximates a 25us deemphasis. Therefore, an STL system with 25us deemphasis/preemphasis is most appropriate for maximizing signal-to-noise ratio while preventing clipping. Consult the STL manufacturer for information on converting STL preemphasis/deemphasis to 25us.

If the STL is un-preemphasized, or preemphasized at 25us, adjust the OUTPUT LEVEL of the studio chassis and/or the STL's input level to produce a level 9dB below 100% modulation.

If the STL is preemphasized at 50 or 75us, adjust the OUTPUT LEVEL of the studio chassis and/or the STL's input level to produce a level 15dB below 100% modulation.

5) Connect the output of the STL receiver to the LEFT INPUT of the OPTIMOD-FM transmitter (main) chassis. Place the VU meter FUNCTION switch in L COMPR OUT. Adjust the LEFT INPUT ATTEN on the OPTIMOD-FM transmitter chassis to make the VU meter read 100%.

Jumper Cards #3TX and #4TX are shipped with 20dB pads before the input amplifiers. If the reading is too low with the INPUT ATTEN fully CW, and the input pads are strapped for 20dB attenuation, restrap them for 0dB attenuation. This is done by removing Cards #3TX and #4TX from the chassis according to the instructions on p. C-1 of **Appendix C,** and by moving the jumpers according to Fig. 3-5. The cards and subpanel are then replaced.

If the reading is too high with the INPUT ATTEN fully CCW, and the input pads on Cards #3 and #4 in the transmitter chassis are strapped for 0dB attenuation, follow the same instructions to restrap the pads for 20dB attenuation.

6) Repeat steps (2) through (4) for the RIGHT CHANNEL.

Stereo Generator: From this point on, the procedure is identical for single- and dual-chassis units. "OPTIMOD-FM INPUT" means the input of the studio chassis in dual-chassis systems, and the main input in single-chassis systems.

1) Adjust the OPTIMOD-FM operating controls to the positions specified in step **1** of the **Dual-Chassis Alignment** section above. Apply a 1kHz tone to the left OPTIMOD-FM INPUT, and adjust the oscillator output level to produce 10dB TOTAL MASTER G/R.

2) Turn the 15-turn OPTIMOD-FM OUTPUT ATTEN control fully CCW (zero). Turn the OPTIMOD-FM HF LIMITING control to 10. Turn the OPTIMOD-FM PILOT switch OFF.

3) Turn on the carrier. Watch the TOTAL MODULATION meter on your stereo monitor, and turn the OPTIMOD-FM OUTPUT ATTEN control CW until the TOTAL MODULATION meter reads 68%.

4) Turn the OPTIMOD-FM PILOT switch ON, and adjust the OPTIMOD-FM PILOT LEVEL control until the monitor reads 9% on its PILOT LEVEL meter. TOTAL MODULATION should now read 77%. This procedure adjusts the OPTIMOD-FM output level to produce 100% modulation on program material, accurate to within a few percent.

5) Remove modulation, and listen to the demodulated carrier for abnormal hum, buzz or noise. If any of these are present, the problem should be fixed before proceeding further. In a dual-chassis installation, verify that the STL is not causing noise problems. Hints regarding OPTIMOD-FM/exciter interface are found in **Composite Output Connection** in **Part 3 (Installation).**

6) **Separation:** Connect a DC-coupled oscilloscope with at least 5MHz vertical bandwidth and triggered sweep to the WIDEBAND OUTPUT of your FM monitor. DO NOT USE AN ATTENUATOR PROBE; it may compromise the accuracy of the adjustment. Trigger the scope externally from the oscillator.

4

Turn the OPTIMOD-FM PILOT switch OFF. Continue to modulate the left channel with 1kHz. Adjust the scope's vertical sensitivity and sweep rate to produce a trace similar to Fig. 4-2. Note the flat baseline in Fig. 4-2, indicating ideal separation. Adjust the OPTIMOD-FM SEPARATION (L-R GAIN) control to secure a maximally-flat baseline. The vertical display should be expanded 10x to make the final adjustment.

CAUTION!

Do not adjust separation by observing your stereo monitor. Most monitors are insufficiently stable to accurately indicate separation. The oscilloscope method specified above is the only satisfactory way to make this adjustment!

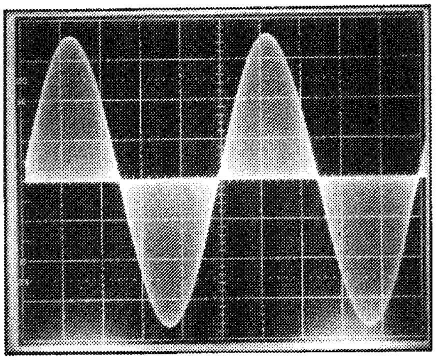


Fig. 4-2: Separation Trace

You should now measure left-into-right and right-into-left separation at 50, 1000, and 15,000 Hz to make sure that adequate separation is achieved through your system. The undriven OPTIMOD-FM input should be shorted or properly terminated to avoid crosstalk.

Separation can be approximately calculated from the scope trace by the formula: $S=20\log(D/P)$, where:

S is the separation (dB)

D is the peak-to-peak deviation of the baseline from flatness (volts)

P is the peak-to-peak level of the total baseband signal (volts)

Most separation problems are due to system problems or measurement error. If you cannot meet separation specifications, you should verify the performance of OPTIMOD-FM alone using the procedure in **a.6** of the **Stereo Generator** section in **Appendix D.**

Dried-out coupling capacitors in your FM monitor can cause failure to correctly measure 50Hz separation because excellent low frequency response and phase linearity are necessary to avoid distorting the signal upon demodulation. Similarly, if you have accidentally left your scope AC-coupled, it will cause measurements to be completely inaccurate at low frequencies.

Real separation problems can be caused by:

a) Incorrect phase adjustments in your exciter Wideband Interface.

b) Insufficiently wide frequency response or inadequate phase linearity in composite STL or exciter.

c) Mistuned or severely narrowband RF amplifiers and/or antenna.

7) **Pilot Phase:** Connect the oscillator to the right OPTIMOD-FM input. Switch the OPTIMOD-FM CROSSTALK TEST switch to SUB-TO-MAIN. Switch the OPTIMOD-FM PILOT switch ON.

You should see a trace on the scope like Fig. 4-3. If pilot phase is correct, the "tips" on this waveform will be perfectly horizontal, as in Fig. 4-3.

Expand the vertical scale of the scope by 10x, and expand the sweep to look more closely at the "tips", as in Fig. 4-4. Adjust the OPTIMOD-FM PILOT PHASE control until the tips are horizontal, as in Fig. 4-4.

Return the OPTIMOD-FM CROSSTALK TEST switch to OPERATE.

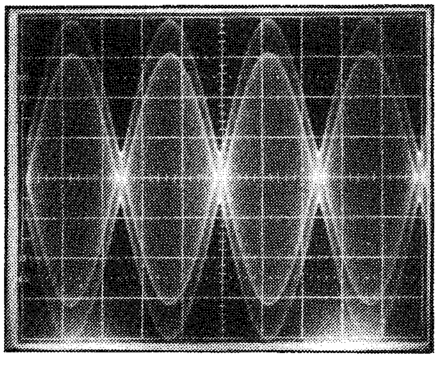


Fig. 4-3: Pilot Phase Trace

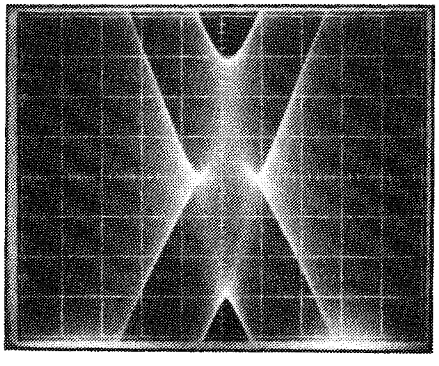


Fig. 4-4: Pilot Phase Trace, 10x

Program Tests: These listening tests are made with OPTIMOD-FM set up according to our recommended initial control settings. They are intended to detect obvious problems with audio quality which must be resolved before final adjustments are made. Once initial listening tests are passed, you can proceed to adjust OPTIMOD-FM setup controls according to format and competitive requirements.

a) Adjust OPTIMOD-FM controls according to Fig. 4-5. DO NOT adjust the OUTPUT ATTEN and INPUT ATTEN controls at this time. If you have a dual-chassis system, DO NOT READJUST THE TRANSMITTER CHASSIS INPUT ATTEN CONTROLS UNDER ANY CIRCUMSTANCES!

b) Play program material typical of your format. Set your console in MONO mode, such that both channels are putting out identical levels. Peak the console VU meters at 0VU.

c) Adjust the OPTIMOD-FM INPUT ATTEN controls (in a dual-chassis unit, on the STUDIO chassis) to "0". Advance the LEFT INPUT ATTEN until the MASTER TOTAL G/R meter reads approximately 10dB G/R.

d) Observe the L-R meter position (or the L-R stereo monitor meter in the case of a dual-chassis unit), and advance the OPTIMOD-FM RIGHT INPUT ATTEN until the meter nulls.

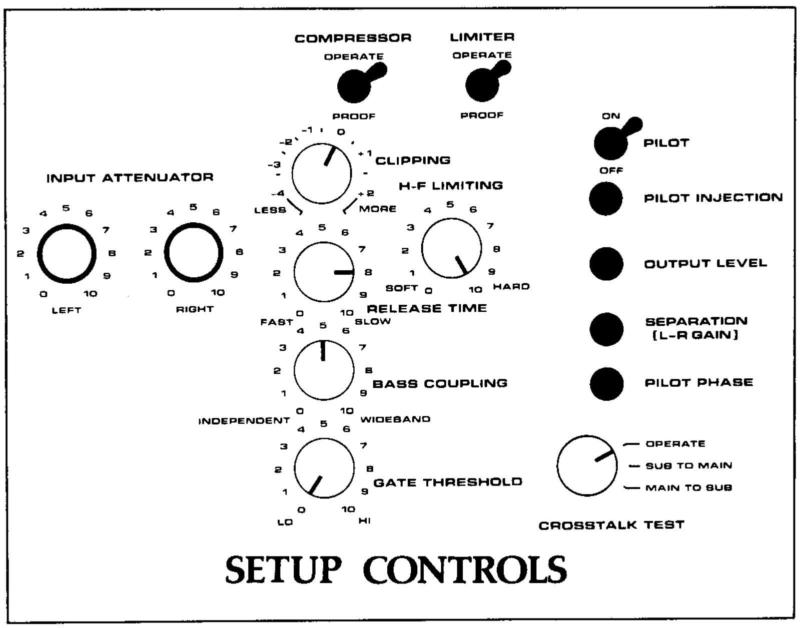


Fig. 4-5: Setup Controls

e) Place the console in STEREO mode. Observe the TOTAL MODULATION meter on the FM monitor. Make slight adjustments to the OPTIMOD-FM OUTPUT ATTEN as necessary to achieve desired modulation levels.

Many FM modulation monitors more than a few years old exhibit problems with low-frequency tilt and high-frequency ringing. The LF tilt is caused by insufficient low-frequency response (LF response should be -3dB at 0.15Hz or below). High-frequency ringing is usually not as much of a problem.

Tilt becomes a problem at the comparators that control the peak flashers. This can cause flashers to turn on when no overmodulation actually exists. LF tilt problems show up when the monitor is measuring program material, resulting in an indication of modulation that is higher than the actual percentage of modulation. This is true even though the monitor reads flat on sine waves from 50-15,000Hz. A 50Hz square wave can be used to test for tilt: you must connect the output of the square-wave generator to the composite input of the exciter to test the monitor. (If the exciter has LF tilt problems, you will see these in addition to any problems in the monitor.)

Additionally, if an RF amplifier is used in the monitoring environment, any multipath picked up in the system will be indicated as additional modulation on the monitor (it probably will show on the peak flasher before it will be seen on the meter).

f) Observe the PILOT LEVEL meter on your stereo monitor, and adjust the OPTIMOD-FM PILOT LEVEL control as necessary to produce 9% pilot injection.

g) Listen to the audio quality of the air sound on a good monitor system, and verify that it sounds natural and free from noise and distortion. Comparing "AIR" and "PROGRAM" may reveal a bass increase in "AIR" due to the "hybrid" operation of OPTIMOD-FM as initially set up.

h) You may now proceed to **Part 5 (Operating Instructions)** of this Manual, and adjust OPTIMOD-FM's setup controls to your specific requirements.

Part 5: Operating Instructions

5

page contents

5-2 8100A Controls and Meters

5-4 Recommended Settings for the Best Sound
5-4 Fig. 1: Recommended Control Settings

5-6 Getting the Sound You Want

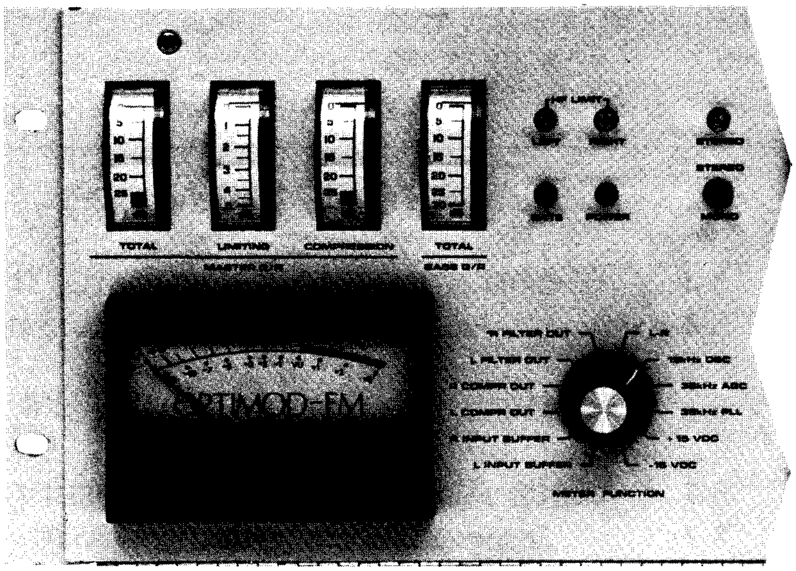
5-7 More About Audio Processing
5-7 Some audio processing concepts
5-8 Loudness and density
5-9 Gain reduction metering
5-9 Gating
5-9 Spectral balance
5-10 High-frequency limiting to reduce distortion
5-10 Peak control
5-11 Equalization and "missing controls"
5-12 Quality of source material

5-13 Some Hints to Help You Achieve Your Processing Goals

IMPORTANT

If you have installed the optional 8100A/ST Studio Chassis, adjust the controls on that unit, rather than on the 8100A.

8100A Controls and Meters



MASTER G/R meters show the amount of gain reduction in the "master" band compressor, which processes audio above 200Hz:

> **TOTAL** shows the peak value of gain reduction in dB. **LIMITING** shows the amount of fast gain reduction above and beyond that provided by slow compression. 0 on this meter indicates no additional limiting, and 3 (for example) indicates an extra 3dB peak-limiting gain reduction over that indicated by the **COMPRESSION** meter, which shows the amount of gain reduction in dB resulting from slow compression.

TOTAL BASS G/R meter shows the amount of gain reduction in the "bass" band compressor, which processes audio below 200Hz. Because almost all of the bass band gain reduction is effected by slow compression, there is no need for separate limiting and compression meters.

HF LIMIT lamps light when the high-frequency content of audio is being limited by the very fast high-frequency limiters.

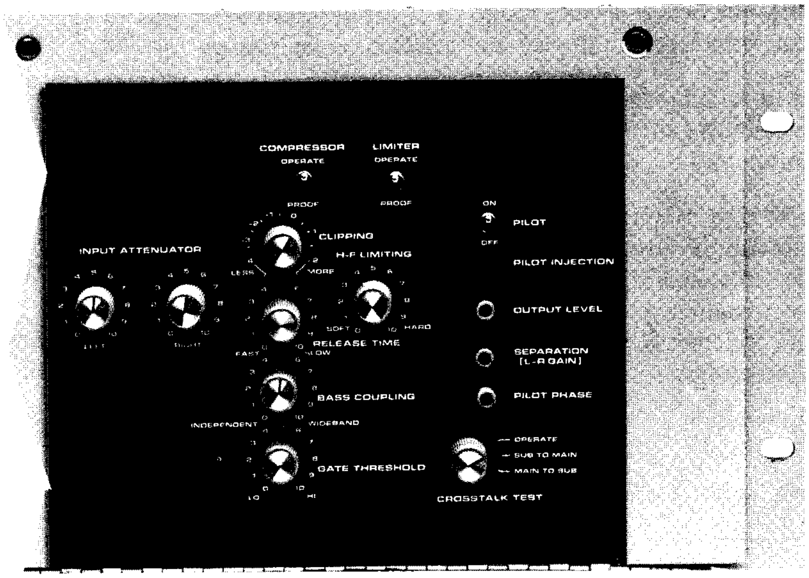
GATE lamp lights when the input audio level falls below the threshold set by the GATE THRESHOLD control. When this happens, the compressor's recovery time is drastically slowed to prevent noise rush-up during low-level passages.

POWER lamp lights when the unit is powered. (It monitors the unregulated −22V DC bus.)

VU meter and selector switch display signal levels at various points in the circuitry (see Block Diagram on page J-20) to aid in diagnosing faults. The meter also displays +15V and −15V power supply voltages (100% corresponds to 15VDC).

INPUT ATTENUATOR controls adjust the signal level driving the 8100A's dual-band compressor. This level determines the relative amount of gain reduction, and therefore the amount of compression and the increase in the loudness of quiet program material.

COMPRESSOR switch is used for testing. When set to PROOF, it disables the dual-band compressor.



LIMITER switch is used for testing. When set to PROOF, it disables the high-frequency limiters, distortion-canceling clippers, FCS Overshoot Compensators, and safety clippers.

CLIPPING control adjusts signal level going into the distortion-canceling clippers, and therefore determines the amount of peak limiting accomplished by clipping. Range is −4dB to +2dB (where 0dB represents our judgment of a setting that provides a high-quality "undistorted" sound without compromising loudness or modulation efficiency). The loudness/distortion trade-off is primarily determined by this control.

H-F LIMITING control determines the amount of high-frequency limiting. When set toward SOFT, the highs are controlled more by limiting, which may reduce brightness. When set toward HARD, the highs are controlled more by clipping, which may introduce some high-frequency distortion.

RELEASE TIME control determines how fast the gain of the master band compressor increases when the program material gets quieter. Settings toward SLOW cause the compressor to act as a slow, subtle "hand on the fader". Settings toward FAST will result in increased program density.

BASS COUPLING control determines the degree to which the bass band of the compressor tracks the master band. Settings toward WIDEBAND produce an air sound that is more faithful to the spectral balance of the source material, while settings toward INDEPENDENT produce bass balances that are more uniform between program segments (often with increased bass).

GATE THRESHOLD control determines the lowest input level that the system considers program. Levels below this are considered noise, and the AGC/compressor gates, effectively freezing its gain to prevent noise breathing during pauses or low-level passages.

Recommended Settings for the Best Sound

The 8100A OPTIMOD-FM offers a wide range of flexibility, enabling you to fine-tune your air sound for your target audience and aesthetic sensibilities.

Fig. 1 shows five sets of recommended settings. Each set produces a different sound texture, and each incorporates a different set of trade-offs between openness, loudness, brightness, and distortion.

Start with one of these sets of recommended settings. Spend some time listening critically to your on-air sound. Listen to a wide range of program material typical of your format, and listen on several types of radios (not just on your studio monitors). Then, if you wish to customize your sound, read the rest of this Addendum — it is important to understand the functions and interactions of the audio processing controls before experimenting with them.

	TYPICAL PROGRAM				
	Classical	**Talk**	**Smooth Popular**	**Competitive Popular**	**Combination**
INPUT ATTENUATORs — Adjust to produce approximately the indicated gain reduction on typical program material as shown on OPTIMOD-FM's TOTAL MASTER G/R meter:					
G/R Meter:	*0–10dB*	*10–15dB*	*10–15dB*	*10–15dB*	*
CLIPPING	–1	–1	0	1	–1
H-F LIMITING	10	10	10	6.5	10
RELEASE TIME	8	6	6.5	4.5	7
BASS COUPLING	8	8	5	2	8
GATE THRESHOLD	2.5	3	0	0	2.5
COMPRESSOR	OPERATE	OPERATE	OPERATE	OPERATE	OPERATE
LIMITER	OPERATE	OPERATE	OPERATE	OPERATE	OPERATE

* For combination formats, adjust the INPUT ATTENUATORs to produce 10–15dB gain reduction on popular music when the console's VU meters or PPMs indicate your normal peaking level. During operation, adjust console levels to your normal operating level for popular music and talk programs; adjust console levels 5–10dB below your normal operating level for classical music programs.

Fig. 1: Recommended Control Settings
8100A OPTIMOD-FM Audio Processor

The sound characteristics of the recommended settings are:

Classical

For classical, background music formats.

Classical music is traditionally broadcast with a wide dynamic range. However, many broadcasters now realize that the dynamic range of live performances and modern recordings is so great that the soft passages disappear into the noise on most car, portable, and table radios. As a result, the listener hears nothing, or must turn up the volume control to hear all the music. Then, when the music gets loud, the radio blasts and distorts, making the listening rather unpleasant.

Typically, a daytime listener to classical music listens in the home while getting ready for work, listens in the car, or uses the radio as source of background music at work. When adjusted to the recommended Classical settings, OPTIMOD-FM controls the level of the music in ways that are, for all practical purposes, undetectable to this listener. Low-level passages are increased in level by up to 10dB, while the dynamics of crescendos are maintained.

In the evening, when more people may be listening seriously, a wider dynamic range can be achieved by simply reducing the input drive level to OPTIMOD-FM to reduce or eliminate gain reduction. Either set the peak levels lower on the mixing desk, or use an switchable attenuator between the desk and the OPTIMOD-FM inputs.

Talk

For talk, radio drama formats.

Processing for this sound keeps the levels of announcers, presenters, guests, and telephone calls more consistent. And it keeps a proper balance between voice and commercials. Voice is the most difficult program element to process. These settings result in a favorable trade-off between consistency, listening fatigue, and distortion.

Smooth Popular

For popular, Album-Oriented Rock, Adult Contemporary, Modern Country, Oldies, talk formats.

The sound texture for the station that values a clean, easy-to-listen-to sound on the air. This is an "unprocessed" sound that sounds just right on both music and voice when listened to on small table radios, car radios, portables, or home hi-fi systems.

Competitive Popular

For Adult Contemporary, Contemporary Hit Radio, Oldies, Modern Country, Urban formats.

This is the major market competitive sound, emphasizing loudness while retaining clean audio. With these settings, the sound gets farther away from the balance and texture of the original recording. This is as far as we think processing can go without causing noticeable listener fatigue.

Combination

For combinations of the above.

It is of course difficult to optimize the control settings if your your station broadcasts several different types of program material. Fortunately, there is a set of control settings that works surprisingly well in this situation. With these settings: popular music will have the depth and punch that attracts and holds listeners, while still sounding open; classical music won't disappear on soft passages, and it will retain its dynamics and drama on loud passages; and talk programs will sound very natural, but with consistent levels for host and guests.

Getting the Sound You Want

OPTIMOD-FM can be adjusted so that the output sounds as close as possible to the input at all times, *or* so that it sounds open but more uniform in frequency balance (and often more dramatic) than the input, *or* so that it sounds dense, quite squashed, and very loud. The dense, loud set-up will make the audio seem to jump out of car and table radios, but may be fatiguing and invite tune-outs on higher quality home receivers.

In *any* of these set-ups, there is *a direct trade-off* between loudness, brightness, and distortion. You can improve one only at the expense of one or both of the other two. This is true of any processor.

Perhaps the most difficult part of adjusting a processor is determining the best trade-off for a given situation. We feel that it is usually wiser to give up ultimate loudness to achieve brightness and low distortion. A listener can compensate for loudness by simply adjusting the volume control. But there is *nothing* the listener can do to make a dirty signal sound clean again, or to undo the effects of excessive high-frequency limiting.

If processing for high quality is done carefully, the sound will also be excellent on small radios. Although such a signal might fall slightly short of ultimate loudness, it will tend to compensate with an openness, depth, and punch (even on small radios) that cannot be obtained when the signal is excessively squashed.

If women form a significant portion of the station's audience, bear in mind that women are more sensitive to distortion and listening fatigue than men. In any format requiring long-term listening to achieve market share, great care should be taken not to alienate women by excessive stridency, harshness, or distortion.

Best results will be achieved if Engineering, Programming, and Management go out of their way to *communicate* and *cooperate* with each other. It is important that Engineering understand well the sound that Programming desires, and that Management fully understand the trade-offs involved in optimizing one parameter (such as loudness) at the expense of others (such as brightness or distortion).

Never lose sight of the fact that, while loudness is easily controlled by the listener, the listener can't undo excessive high-frequency limiting or make a distorted signal clean again. If such excessive processing is permitted to audibly degrade the sound of the original program material, the signal is irrevocably contaminated and the original quality can never be recovered.

A high-quality monitor system is essential. To modify your airsound effectively, you must be able to *hear* the results of your adjustments. In too many stations, the best monitor is significantly inferior to the receivers found in many listeners' homes! See *Audio Quality in the FM Plant* (a separate Orban publication included with each unit) for a detailed discussion of how to efficiently create an accurate monitoring environment (and otherwise bring the audio plant up to state-of-the-art quality).

More About Audio Processing

[If you use one of the set-ups recommended in Fig. 1, there is no need to read this section. Read this section only if you really want to understand the operating controls in detail.]

The controls on the 8100A give you the flexibility to customize your station's sound. But, as with any audio processing system, proper adjustment of these controls consists of balancing the trade-offs between loudness, density, brightness, and audible distortion. The following provides the information you need to adjust the 8100A controls to suit your format, taste, and competitive situation.

Some audio processing concepts.

Loudness is increased by reducing the peak-to-average ratio of the audio. If peaks are reduced, the average level can be increased within the permitted modulation limits. The effectiveness with which this can be accomplished without introducing objectionable side effects (like clipping distortion) is the single best measure of audio processing effectiveness.

Compression reduces the difference in level between the soft and loud sounds to make more efficient use of permitted modulation limits, resulting in a subjective increase in the loudness of soft sounds. It *cannot* make loud sounds seem louder. Compression reduces dynamic range relatively slowly in a manner similar to "riding the gain"; limiting and clipping, on the other hand, reduce the short-term peak-to-average ratio of the audio.

Limiting increases audio density. Increasing density can make loud sounds seem louder, but can also result in an unattractive busier, flatter, or denser sound. It is important to be aware of the many negative subjective side effects of excessive density when setting controls which affect the density of the processed sound.

Clipping sharp peaks does not produce any audible side effects when done moderately. Excessive clipping will be perceived as audible distortion.

Loudness and density.

The amount of **gain reduction** determines how much the loudness of soft passages will be increased (and, therefore, how consistent overall loudness will be). It is controlled both by the setting of the INPUT ATTENUATOR controls and by the level at which the console VU meter or PPM is peaked.

The RELEASE TIME control determines how fast the compressor releases (and therefore how fast loudness increases) when the program material gets quiet. Settings toward FAST result in a more consistently loud output, while settings toward SLOW allow a wider variation in dynamic range. The actual release time of the compressor is determined by *both* the setting of the RELEASE TIME control *and* the dynamics and level of the program material.

Release automatically becomes faster as more gain reduction is applied (up to about 10dB), making the program progressively denser and creating a *sense of increasing loudness.* This preserves some feeling of dynamic range, even though peak levels are not actually increasing. Once 10dB of gain reduction is exceeded, full loudness is achieved — no further increase in short-term density occurs as more gain reduction is applied. This avoids the unnatural, fatiguing sound often produced by processors at high gain reduction levels, and makes OPTIMOD-FM remarkably resistant to operator gain-riding errors.

When the RELEASE TIME control is set between 7 and 10, the amount of gain reduction is surprisingly non-critical. Since gating prevents noise from being brought up during short pauses, and pumping does not occur at high levels of gain reduction, the primary danger of using large amounts of gain reduction is that the level of soft passages in input material with wide dynamic range may eventually be increased unnaturally.

The action of the RELEASE TIME control has been optimized for resolution and adjustability. But its setting is *critical to sound quality* — listen carefully as you adjust the controls. There is a point beyond which increasing density (with faster settings of the RELEASE TIME control) will no longer yield more loudness, and will simply degrade the punch and definition of the sound. And with faster RELEASE TIME control settings (below 4), the sound will change substantially with the amount of gain reduction. This means that operator gain riding is more critical. Decide on the basis of listening tests how much gain reduction gives you the density you want without a creating feeling of overcompression and fatigue. We feel that our recommended setting (8) is clearly optimal, yielding the most natural sound with least detectable compression.

Regardless of the release time setting, we feel that the optimal amount of gain reduction for popular music and talk formats is 10–15dB. If less gain reduction is used, loudness can be lost. For classical formats, operating with 0–10dB of gain reduction maintains the sense of dynamic range while still controlling levels effectively. Since OPTIMOD-FM's density gently increases between 0 and 10dB of compression, 10dB of compression sounds very natural, even on classical music.

Gain reduction metering.

Unlike the metering on some processors, the **red zone** on the OPTIMOD-FM gain reduction meter's scale is a warning that must be observed. When the meter is in the red, it means that the compressor has run out of gain reduction range, that the circuitry is being overloaded, and that various nastinesses are likely to commence.

Because the compressor has 25dB of gain reduction range, the meter should never enter the red zone if OPTIMOD-FM has been set up for a sane amount of gain reduction under ordinary program conditions. But be aware of the different peak factors on voice and music — if voice and music are peaked identically on a VU meter, voice may cause up to 10dB more peak gain reduction than does music! (A PPM will indicate relative peak levels much more accurately.)

Gating.

The GATE THRESHOLD control determines the lowest input level that will be recognized as program by OPTIMOD-FM; lower levels are considered to be noise and cause the compressor to gate, effectively freezing its gain.

The gain reduction will eventually recover to zero even when the compressor is in a gated condition, but recovery is slow enough to be imperceptible. This avoids OPTIMOD-FM's getting stuck with a large amount of gain reduction on a long, low-level musical passage immediately following a loud passage.

It is common to set the GATE THRESHOLD control to 0. Higher settings are primarily useful for radio drama, outside sports broadcasts, and other non-musical programming in which it is undesirable to pump up ambiance, low-level crowd noise, and the like. Slightly higher settings may increase the musicality of the compression by slowing down recovery on moderate- to low-level musical passages. When such passages cause the gate to cycle on and off, recovery time will be slowed down by the ratio of the "on time" to the "off time". This effectively slows down the release time as the input gets softer and softer, thus preserving musical values in material with wide dynamic range (classical music, for example).

Spectral balance.

The compressor processes audio in two bands: a *master band* for all audio above 200Hz, and a *bass band* for audio below 200Hz. The BASS COUPLING control determines how closely the on-air balance between material below 200Hz and material above 200Hz matches that of the program material.

Settings toward WIDEBAND make the output sound most like the input. Because setting the BASS COUPLING control at 10 will sometimes cause bass loss, the most accurate frequency balance will often be obtained with this control between 7 and 10. The optimal setting depends on the amount of gain reduction applied. Adjust the BASS COUPLING control until the TOTAL BASS G/R and COMPRESSION MASTER G/R meters track as closely as possible.

With the RELEASE TIME control set to 8, setting the BASS COUPLING control toward INDEPENDENT will produce a sound that is very open, natural, and non-fatiguing, even with large amounts of gain reduction. Such settings will provide a bass boost on some program material that is bass-shy.

With fast release times, settings toward WIDEBAND are not appropriate for achieving ultimate loudness. Settings toward INDEPENDENT provide maximum loudness and density on small radios. But such processing may fatigue listeners with high-quality receivers, and will therefore require more careful operator gain riding. In applications where the greatest possible loudness and density are desired, the optional 8100A/XT2 Six-Band Limiter provides more effective control.

High-frequency limiting to reduce distortion.

The H-F LIMITING control determines how the processor avoids high-frequency overloads due to the pre-emphasis curve. When set toward SOFT, the highs are controlled mostly by limiting (a form of dynamic filtering), which tends to soften highs — and this could improve the sound of marginally distorted program material. When set toward HARD, the highs are controlled mostly by clipping, which could potentially distort highs.

Control of highs by limiting tends to slightly dull the sound. Control of highs by clipping doesn't reduce brightness, but the resulting sound can tend towards grittiness and smearing.

Because the OPTIMOD-FM clipper cancels distortion at low frequencies, the H-F LIMITING control will have a different effect on clipping distortion than you might expect. Gross break-up (principally sibilance splatter) will not occur — you must listen to the upper midrange and the highs to hear the effect of the clipper. Program material containing highly equalized hi-hat cymbals will clearly demonstrate the effect of adjusting the control.

When the CLIPPING control is set to 0 or below and the RELEASE TIME control is set to 8, it is possible to set the H-F LIMITING control to 10 without producing objectionable distortion (provided that the program material is super-clean). If the CLIPPING control is set above 0 and/or faster release times are used (such that greater level and density is produced), it is usually necessary to readjust the H-F LIMITING control closer to SOFT to avoid objectionable distortion. Fortunately, the high-frequency limiter "knows" that greater density and level have been produced when these other controls are set this way, and most of the necessary increases in high-frequency limiting will occur automatically. In fact, you will clearly hear a loss of highs when you adjust any control to produce greater loudness and density — this is an automatic response to the inherent loudness/brightness/distortion trade-off discussed above.

Peak control.

OPTIMOD-FM controls fast peaks by distortion-canceled clipping. The CLIPPING control adjusts the level of the audio driving the clippers, and therefore adjusts the peak-to-average ratio. The loudness/distortion trade-off is primarily determined by the CLIPPING control.

Turning up the CLIPPING control drives the clippers harder, reducing the peak-to-average ratio, and increasing the loudness on the air. Since the amount of clipping is increased, the audible distortion caused by clipping is increased. Lower settings reduce loudness, of course, but result in a cleaner sound and better high-frequency response.

Please note that the 0 setting does not mean that no clipping is occurring; rather, it is a suggested initial setting for many formats. In our opinion, when the RELEASE TIME control is set between 7 and 10, the best setting for the CLIPPING control is between −1 and 0. If the program material is clean, this setting produces an output that sounds undistorted even on high-quality receivers.

5

If faster settings of the RELEASE TIME control are used, or if program material is not always clean, use lower settings of the CLIPPING control. Ultimately, your ears must judge how much distortion is acceptable. But use difficult program material like live voice and piano to make your final decision.

Equalization and "missing controls".

The 8100A is available in two very different configurations. By itself, it is designed to produce an output that is relatively faithful to the frequency balances of the original source material. With the optional 8100A/XT2 Six-Band Limiter, it can produce a highly-processed sound that may be attractive when auditioned without reference to the original source, but which does not attempt to preserve the textures or tonal balance of the source.

If you are accustomed to conventional multiband systems, be aware of the differences between that type of processing and OPTIMOD-FM. Multiband systems usually have *threshold* and *gain* controls on their compressors. The gain controls can be used as fixed equalizers, and the threshold controls determine the average level produced by each band.

Adjusting a conventional multiband threshold control to produce bass that is balanced to your taste involves serious compromises, because it usually results in excessive reduction of heavy bass that is intended to be there to make a musical point. A better solution is the 8100A's BASS COUPLING control, which can control bass balances without unnecessarily reducing bass impact.

Missing from OPTIMOD-FM are attack and release time adjustments for the bass compressor band, and an attack time adjustment for the master band. The reason is simple: there is a clearly optimal choice for these time-constants — making them adjustable would simply be an invitation to trouble.

Finally, there is no high-band gain control that would permit the 8100A to be used as an high-frequency equalizer. The argument for omitting such a control is that the ear is far more sensitive to the frequency balance between midrange and highs than to the balance between midrange and bass. If high-frequency automatic re-equalization is done, it must be done with the greatest care. The 8100A/XT2 Six-Band Limiter has been configured (by use of two high-frequency bands, and by correct choice of crossover frequencies, crossover slopes, and high-frequency limiter characteristics) to provide powerful control over high-frequency sound texture while minimizing the probability that the processing will cause audibly undesirable side-effects.

The processing required to achieve this goal is complex and expensive — it is not possible to optimize this processing simply. Because of this, and because many may not require such processing, we have taken a modular approach to the design of OPTIMOD-FM. The 8100A therefore has no high-frequency equalizer control, and its high-frequency limiter operates in a way that highs are never increased. If such features are required, the 8100A/XT2 can be readily added to the system.

To achieve a particular sound, some stations boost highs and lows with a parametric equalizer before the audio signal is fed to the 8100A (the Orban 642B Equalizer works well for this). The 8100A handles this well, but we recommend that high-end pre-processing be done in moderation (3 to 4dB equalization) to avoid the further increase in overload distortion and clipping which could result from highly pre-processed material being reprocessed to match the 8100A's pre-emphasis curve.

Quality of source material.

As indicated above, a major potential cause of distortion is excess clipping. Another cause is poor-quality source material, including the effects of the station's playback machines, electronics, and studio-to-transmitter link. If the source material is even slightly distorted, that distortion can be greatly exaggerated by the OPTIMOD-FM — particularly if a large amount of gain reduction is used. Super-clean audio can be processed harder without producing objectionable distortion. See *Audio Quality in the FM Plant* (a separate Orban publication included with each unit) for a discussion of how to improve source quality.

SOME HINTS TO HELP YOU ACHIEVE YOUR PROCESSING GOALS

ALWAYS START WITH OUR SUGGESTED INITIAL SETTINGS (SEE FIG. 4-5) AND WORK FROM THERE.

-- To obtain more loudness

1. Operate "multiband" (BASS COUPLING at "0") with fast release times. Turn down CLIPPING and H-F LIMITING as necessary to avoid objectionable distortion.
2. Clean up audio. Super-clean audio can be processed harder without objectionable side-effects.
3. Use SCA Protection Filter (card #0).
4. Use 8100A/XT Six-Band Limiter Accessory Chassis.

5

-- To obtain more brightness

1. Turn the H-F LIMIT CONTROL fully clockwise. To avoid objectionable distortion with fast RELEASE TIME, you may have to turn down the CLIPPING control. This will further increase brightness at the expense of loudness.
2. Be sure that program material is properly equalized, and that STL is flat to 15kHz (see **Appendix K**).
3. Use Orban **642B** Parametric Equalizer ahead of 8100A/1.

-- To obtain more bass

1. Operate the BASS COUPLING control towards "0".
2. Use Orban **642B** Parametric Equalizer ahead of 8100A/1.

-- To obtain less bass (retaining original program material balance)

1. Operate the BASS COUPLING control towards "10".

-- To make "Air" sound most like "Program"

1. Operate with the BASS COUPLING close to "10". (Adjust the control to make the BASS and COMPRESSOR G/R meters track as closely as possible.)
2. Operate with the RELEASE TIME at "8" (optimum).
3. Use lesser amounts of gain reduction by backing off the INPUT ATTENUATORS.
4. Minimize the amount of clipping and h-f limiting by operating H-F LIMITING at "10" (full hard), and backing off the CLIPPING as far towards "0" as required to avoid audible distortion on difficult material like male voice or piano.

-- To obtain "open" sound with no audible compression

1. Operate the RELEASE TIME control at 8.
2. Do not pre-compress program material in the production studio.
3. Use relatively small amounts of gain reduction. (This may allow you to advance the CLIPPING control to compensate for loudness loss.)

-- To obtain a "heavily-processed" sound

1. Operate the RELEASE TIME control at "0" and the BASS COUPLING control at "0". (You may have to back off the CLIPPING and H-F LIMITING controls to avoid objectionable distortion. D.J. gain riding will also become more critical.)
2. Use 8100A/XT Six-Band Limiter Accessory Chassis.

-- To avoid "noise pump-up"

1. Operate with smaller amounts of gain reduction.
2. Adjust the GATE THRESHOLD more clockwise.
3. Use slower RELEASE TIME.

-- To achieve more subtle gain riding in wide-dynamic range material

1. Critically adjust the GATE THRESHOLD control so that medium- to low-level passages cause the GATE lamp to flash on and off, thus slowing down the release time as the music gets softer.

-- To avoid excessive sibilance (particularly on women's voices)

1. Use an Orban 536A Dynamic Sibilance Controller on the microphone chain only. (While the 8100A/1 will not distort sibilance, its excellent h-f power handling will result in its passing high-energy sibilance present at its input, instead of limiting it.)

PART 6:

System Performance Verification

The FCC (USA) has eliminated requirements for periodic Proof-of-Performance measurements. However, performance standards specified in the FCC Rules must still be met. Many stations will still wish to make periodic equipment performance measurements. The text below provides the general information which is needed to perform measurements verifying the performance of a transmission system including the 8100A/1. Instructions for bench-top verification of 8100A/1 performance outside of the transmission system are found in **Appendix D: Field Audit-of-Performance.**

6

Mono Performance Verification: This is totally straightforward. Merely enter the MONO LEFT or MONO RIGHT modes, switch both PROOF/OPERATE switches to PROOF, and drive the appropriate OPTIMOD-FM input with test signal. Sufficient headroom is available to modulate well beyond 100% at all frequencies from 50-15,000Hz.

NOTE

> OPTIMOD-FM frequency response drops off extremely rapidly above 15.0kHz. If the test oscillator is miscalibrated, OPTIMOD-FM may appear not to meet proof at 15.0kHz. Before blaming OPTIMOD-FM, measure the output frequency of the test oscillator with an accurate counter to make sure that it is actually producing 15.0kHZ, and not some slightly higher frequency.

Stereo Performance Verification: As of this writing, the law does not require that these measurements be made and be on file. However, the station is required to meet these performance specifications, and many stations therefore make these measurements as part of a routine performance verification.

Part 73.322 of the FCC Rules refers to the performance of the transmitter only (starting with stereo generator input terminals), and measurements may be made by connecting the test oscillator directly to the OPTIMOD-FM main audio inputs. All stereo measurements are made with both OPTIMOD-FM PROOF/OPERATE switches in PROOF. Following is an outline of the required measurements and how to perform them.

1) Main Channel: The main channel (L+R) must meet all mono requirements for frequency response, total harmonic distortion, and noise. Compliance may be verified by driving both OPTIMOD-FM main inputs in-phase, slightly adjusting the right INPUT ATTEN (studio chassis in dual-chassis versions) to null the L-R meter on your stereo monitor, and then using the L+R meter of your stereo monitor for measurement. If L-R fails to null below -20dB, suspect a differential phase error between the left and right channels. Such an error will also cause L+R and L-R to have poor frequency response, even if the left and right channels have accurate frequency response. Such an error can be caused by certain failures in the phase correctors located on Cards #6, #8, and #9. (See **Appendix** F for troubleshooting information).

If the monitor's 15kHz lowpass filter is inadequate, leakage of the pilot into the monitor output may influence both THD and noise measurements. If this is the case, an external 19kHz notch filter may have to be used before the noise and distortion meter.

2) Subchannel: Mono requirements for frequency response, harmonic distortion, and noise must also be met for the stereo subchannel (L-R). L-R can be generated by reversing the polarity of the oscillator connection to the OPTIMOD-FM right audio input only, and by slightly trimming the OPTIMOD-FM right INPUT ATTEN (on the studio chassis in dual-chassis units) to null the L+R meter on your stereo monitor.

Measuring L-R noise is particularly problematical because most stereo monitors have no provision for applying deemphasis to the L-R meter. Provided that the noise is uncorrelated (i.e., is dominated by hiss, rather than hum or discrete tones), then you can calculate the L-R noise by the formula:

$$S = 10 \times \log(10^{(L/10)} - 10^{(M/10)})$$, where:

S is the L-R noise in dB
L is the left or right channel noise in dB
(assuming L and R noise measurements are almost equal)
M is the L+R noise in dB

3) Careful reading of 73.322 reveals that there are no explicit requirements for **frequency response, harmonic distortion**, or **noise performance** of left or right channels. The only requirement specifically applicable to left and right channels is that **separation** must exceed 29.7dB, 50-15,000Hz, left-into-right and right-into-left.

IMPORTANT

Because of the instability of many stereo monitors, the monitor should always be aligned according to the manufacturer's instructions before separation measurements are performed. It is particularly important not to (mis)realign the OPTIMOD-FM stereo generator to compensate for a misaligned stereo monitor. In general, the only stable and reliable way of aligning the OPTIMOD-FM stereo generator for correct separation is the oscilloscope baseline method described in section **a.6** of **Stereo Generator** in **Appendix** D of this Manual.

Pilot phase also affects separation. Pilot phase should be verified according to section **a.7** of **Stereo Generator** in **Appendix D.** This method is more accurate than use of your stereo monitor.

4) Crosstalk: Measurement of main-channel-to-subchannel and subchannel-to-main-channel crosstalk is facilitated by the OPTIMOD-FM's internal CROSSTALK TEST switch. To make these tests, simply drive the OPTIMOD-FM right audio input, switch the OPTIMOD-FM CROSSTALK TEST switch to the appropriate mode, and read crosstalk on your stereo monitor. (The CROSSTALK TEST switch applies the output of the right channel audio processing directly to either the main channel or subchannel stereo generator input, and scales internal gains appropriately in the stereo generator to keep total modulation constant.)

NOTE

Because crosstalk measurements on stereo monitors are usually derived from stable passive filters, these measurements are usually far more stable and reliable than separation measurements.

6

5) 38kHz Subcarrier Suppression: Using the same setup as in **Crosstalk,** above, enter the SUB-TO-MAIN mode using the OPTIMOD-FM CROSSTALK TEST switch. Modulate the carrier to 100% using 7.5kHz, and read the 38kHz suppression on your stereo monitor.

NOTE

The two CROSSTALK TEST modes in OPTIMOD-FM will cause slight internal offset changes which will translate into somewhat poorer 38kHz suppression than that provided by the normal OPERATE mode. However, the suppression should never deteriorate even close to the -40dB legal limit.

6) Pilot Frequency: This is most conveniently measured by opening the access door and connecting the frequency counter input across two terminals (Fig. 6-1) located on the P.C. card mounted on the rear of the rotary switch to the left of the access door opening.

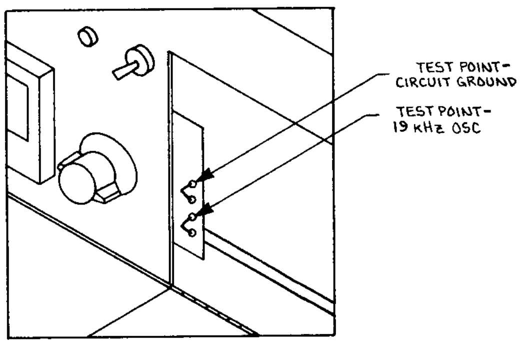


Fig. 6-1: Pilot Test Point

7) Pilot Injection: This is straightforwardly measured on your stereo monitor.

Rear-Panel TEST Jacks: The inputs of the stereo generator are available on the RCA phono jacks on the rear panel of OPTIMOD-FM when the rear-panel NORMAL/TEST switch is in TEST. (When the switch is in NORMAL, the output of the audio processing appears at these jacks.)

These inputs are unbalanced, apply no preemphasis, and require approximately 3.3V rms to produce 100% modulation, including 9% pilot injection.

To produce proper operation of the stereo generator, these jacks must be driven by a voltage source such as that produced by the output of an opamp. The 600-ohm output of a typical oscillator is too high-impedance to produce correct operation. IF THE SIGNAL SOURCE IS CONNECTED TO ONLY ONE JACK, THE OTHER MUST BE GROUNDED TO PRESERVE CORRECT STEREO GENERATOR OPERATION.

Orban Associates Inc., has been providing schematics upon request for construction of a separation-and-crosstalk test fixture for its older model OPTIMOD-FM, the 8000A. If you have already built such a fixture, be assured that it is also appropriate for driving the Model 8100A/1 test jacks. However, the 8100A/1's internal CROSSTALK TEST modes are usually much more convenient to use.

PART 7:

Routine Maintenance

OPTIMOD-FM is a highly stable device which uses solid-state circuitry throughout. Recommended routine maintenance is minimal.

1) Keep the outside of the unit clean. If the panel becomes dirty, it can be washed with a mild household detergent and water. Stronger solvents may damage plastic parts, paint, or the silkscreened lettering, and should not be used.

2) Particularly in humid or salt-spray environments, check periodically for corrosion around metal-to-metal contacts such as the audio and control wiring, and those places where the OPTIMOD-FM chassis contacts the rack.

3) Check for loss of grounding due to corrosion or loosening of rack mounting screws.

4) Familiarize yourself with the normal VU meter readings, and with the normal performance of the G/R meters. If any meter reading becomes abnormal, refer to **Appendix F (Trouble Diagnosis).**

5) A good ear will pick up many failures. Familiarize yourself with the "sound" of OPTIMOD-FM as you have set it up, and be sensitive to changes or deteriorations. But if problems arise, please don't blame OPTIMOD-FM by reflex. Refer to **Appendix F** for systematic troubleshooting instructions which will also help you determine if the problem is in OPTIMOD-FM or is somewhere else in the station's equipment.

7

ROUTINE PERFORMANCE VERIFICATION

This procedure can be performed very quickly, and provides tests of some of the more important OPTIMOD-FM performance parameters. A much more thorough and rigorous procedure is provided in **Appendix D (Field Audit-of-Performance Procedure).**

Stereo Generator Tests: These tests are made with normal program material, and can therefore be performed in seconds, without seriously interrupting normal programming.

1) **Dynamic Separation:** With bright music playing, suppress one of the two stereo input channels to OPTIMOD-FM, and observe the suppressed channel's meter on your stereo monitor. Ordinarily, the indication will be better than 45dB below 100% modulation.

Restore the suppressed channel, and repeat the test for the other channel.

If the undesired crosstalk into the "dead" channel sounds clean and distortion-free, this probably means that the SEPARATION adjustment on the stereo monitor has drifted, and that the problem is not actually in the transmission system. This should be verified by repeating the test with another monitor or high-quality tuner in WIDEBAND mode. If the problem is observed on more than one receiver, the OPTIMOD-FM stereo generator has probably drifted, and the cause of the drift should be investigated.

If the crosstalk sounds highly distorted (particularly if distortion is worst when considerable high frequency energy is present on the other channel), the distortion may be due to aliasing. If the problem occurs only in one direction (say, left-into-right), then the OPTIMOD-FM FCS Overshoot Corrector circuitry should be investigated. If the problem occurs symmetrically in both directions, check for clipping or severe non-linearity in exciter, composite STL, or the OPTIMOD-FM stereo generator.

2) **38kHz Suppression:** Briefly interrupt programming (or wait for a short pause), and observe the 38KHZ position on your stereo monitor. Verify that suppression is well below -40dB.

3) **Pilot Injection:** Measure this routinely on your stereo monitor and verify that it is between 8% and 10% modulation.

Audio Processing: There are no effective, quick instrument tests that can be made using ordinary program material. Your ear is the best test instrument here.

If a minute or so can be spared from normal programming, the "standard level" test can be made using a sinewave input. This is done as follows:

1) Record the settings of the CLIPPING, BASS COUPLING, RELEASE TIME, and H-F LIMITING controls so that they can be restored when you have completed the test.

2) Set the OPTIMOD-FM controls to the following "standard" settings:

Proof/Operate Switch:	OPERATE
CLIPPING:	+2
RELEASE TIME:	10
BASS COUPLING:	10
H-F LIMITING:	10

3) Drive the OPTIMOD-FM left channel (probably through a console input) with a 1kHz sinewave. Adjust the oscillator level until the OPTIMOD-FM MASTER TOTAL G/R meter reads 10dB G/R.

4) Verify that the OPTIMOD-FM L COMPR OUT VU meter switch position causes the meter to read 0VU, ±0.5VU., and that the OPTIMOD-FM L FILTER OUT meter position causes the meter to read 0VU, ±1.0VU.

5) Repeat steps (3) and (4) for the RIGHT channel.

6) Restore the OPTIMOD-FM setup controls to their normal settings.

Failure to produce these standard levels indicates a failure somewhere within the audio processing circuitry. Refer to **Appendix F (Trouble Diagnosis).**