Section 4
Maintenance

page contents

CAUTION

The installation and servicing instructions in this manual are for use by qualified personnel only. To avoid electric shock do not perform any servicing other than that contained in the Operating Instructions unless you are qualified to do so. Refer all servicing to qualified service personnel.

Routine Maintenance

The 8200 OPTIMOD-FM Audio Processor uses highly stable analog and digital circuitry throughout. Recommended routine maintenance is minimal.

1. **Periodically check audio level and gain reduction meter readings.**

   Become familiar with normal audio level meter readings, and with the normal performance of the G/R metering. If any meter reading is abnormal, see Section 5 for troubleshooting information.

2. **Listen to the 8200's output.**

   A good ear will pick up many faults. Familiarize yourself with the "sound" of the 8200 as you have set it up, and be sensitive to changes or deteriorations. But if problems arise, please don't jump to the conclusion that the 8200 is at fault. The troubleshooting information in Section 5 will help you determine if the problem is with OPTIMOD-FM or is somewhere else in the station's equipment.

3. **Periodically check for corrosion.**

   Particularly in humid or salt-spray environments, check for corrosion at the input and output connectors and at those places where the 8200 chassis contacts the rack.

4. **Periodically check for loss of grounding.**

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

5. **Clean the front panel when it gets soiled.**

   Wash the front panel with a mild household detergent and a damp cloth. Stronger solvents should not be used because they may damage plastic parts, paint, or the silk-screened lettering (99% isopropyl alcohol can be safely used).

Getting Inside the Chassis

- Access the **AC POWER** switch by opening the 8200's front panel (see below). The **AC POWER** switch is located on the power supply module to the right of the chassis.
- The **VOLTAGE SELECTOR** switch and the two fuses are on the 8200's rear panel.
- Access the **circuit cards** by opening the 8200's front panel.
- Most set-up and adjustment of the 8200 can be done from the front panel without accessing the interior of the chassis. Alignment of the 8200 requires access only to the front and rear panels and to those interior parts of the unit behind the front panel. Almost all servicing can be done without removing either the top or bottom covers.

Further disassembly of the 8200 may be required for some service procedures.

For access to:	**See page:**
Behind front panel	4-3
Behind rear panel	4-4
Input Filter Board	4-5
D-Connector Board	4-6
Power Supply	4-6

For best RFI protection, replace *all* screws and tighten them firmly. If screws are lost, replace them with screws of the same length (longer screws may cause mechanical interference or internal short circuits). Most screws used in the 8200 are equipped with integral lockwashers for secure fastening. If a pan head screw is substituted, use an internal-star lockwasher. All screws are steel, plated with zinc.

Front panel — open and close

To open:

1) Disconnect power to the unit.

   WARNING: Hazardous voltage is exposed with the front panel open and the power ON.

2) Remove the six Philips head screws at the top and bottom of the front panel with a Philips screwdriver.

3) Grasp the edges of the panel, pull slightly forward, and, while holding the panel vertical, guide it forward and downward on its supports. Then rotate the top of the panel toward you and down until it rests on its supports.

To close:

1) Check that the internal AC POWER switch is set to ON (depressed).

2) Rotate the panel until it is vertical. Raise the panel while guiding it in on its supports.

3) Fasten the six screws that secure it in place with a Philips screwdriver.

Rear panel — remove and replace

To remove:

1) Disconnect the 8200 and remove it from the rack.

   It is not practical to remove the rear panel when the 8200 is mounted in a rack.

2) Set the unit upright on a padded surface with the rear panel facing you.

3) Remove the four screws holding the power supply.

4) Remove the sixteen screws that hold the rear panel to the chassis.

   Leave about six inches (15cm) between the rear panel and the edge of your work surface.

5) *Very carefully* pull the rear panel about ¾-inch (2cm) toward you until the internal connectors become unplugged.

   The internal connectors are delicate and easily damaged. Be sure to pull the panel directly and straight away from the chassis.

   Take care to not damage the connector pins on the Motherboard while they are exposed.

6) Tilt the top of the panel slightly downward and disconnect the cables that plug into the Motherboard.

To replace:

1) Tilt the rear panel up until it is nearly vertical and plug the two or three cables (depending on your unit's Model #) into the Motherboard.

2) *Very carefully* line up the three connectors on the input Filter Board and the two or three connectors on the D-Connector Board with their mating connectors on the Motherboard. Be sure that all six connectors are properly engaged and push the rear panel in to seat the connectors.

   The connectors are delicate and easily damaged. Do not force them.

   Take care that no wires are pinched between the panel and the chassis.

   If you encounter difficulty, you may remove the top cover to gain visual access to the connectors. When replacing the top, be sure that the circuit cards and the card guides are aligned.

3) Replace all twenty screws previously removed.

   Do not tighten any screws until they are all loosely in place.

4) Return the 8200 to its rack, connect and ground unit.

Input Filter Board — remove, replace

To remove Input Filter Board:

1) Remove the rear panel.

   See page 4-4.

2) Remove the hex nuts from the SCA input, composite 1 output, and composite 2 output BNC connectors.

3) Remove the 4-40 machine screw between the left input and output XLR connectors.

4) Using a small screwdriver, unlock each XLR connector insert.

   The lock is accessible through a small hole in the face of the connector. Turn the lock ¼ turn counter-clockwise to release.

5) Remove the Input Filter Board by gently pulling the board away from the panel.

To replace Input Filter Board:

1) Place the board in position over the panel and insert the XLR and BNC connectors into the panel.

   Be sure that the washers on the BNC connectors are in place.

2) Lock the XLR connectors

   Turn the lock ¼ turn clockwise.

3) Replace the screw between the left input and output XLR connectors and replace the BNC connector hex nuts.

4) Replace the rear panel.

   See page 4-4.

D-Connector Board — remove, replace

To remove:

1) Remove the rear panel.

   See page 4-4.

2) Remove the six hex nut jackscrews holding the D-connectors to the rear panel.

3) Remove the one 4-40 screw holding the D-Connector Board to the rear panel.

To replace:

1) Position the board with the D-connectors through the rear panel. Replace the one 4-40 screw and the six jackscrews.

   Do not tighten any screws until all screws are loosely in place.

2) Replace the rear panel.

   See page 4-4.

Power Supply — remove, replace

To remove:

1) Disconnect the line cord.

2) Remove the four screws holding the power supply to the rear panel.

3) Open the front panel.

   See page 4-3.

4) Grasp the power supply module (located at the far right of the chassis) by its handle and pull it forward until it un-mates from its connector. Then slide the module out of the chassis to free it.

To replace:

1) Align the power supply module with its guide rails and push it back until it mates firmly with its connector on the Motherboard.

2) Replace and tighten the four screws that mount the power supply to the rear panel.

3) Close the 8200's front panel.

   See page 4-3.

   Be sure that the internal AC POWER switch is set to ON (depressed).

4) Re-connect the line cord.

In-System Testing ("Proof of Performance")

The FCC (Federal Communications Commission — U.S.A.) no longer requires periodic Proof of Performance measurements for FM stations. However, many stations will still wish to make periodic equipment performance measurements to ensure that their transmission system is working correctly and that they comply with all government regulations. The text below provides the general information that is needed to perform measurements verifying the performance of a transmission system including the 8200. Instructions for bench-top verification of 8200 performance *outside of the transmission system* are found below in **Field Audit of Performance** starting on page 4-15.

These instructions are written with the assumption that the analog inputs and outputs are used. If the optional digital I/O is used instead, follow the procedures below by analogy — you will have to supply digitized test tones.

The **NAB Broadcast and Audio System Test CD** provides a good source of digitally-generated test tones on compact disc. Note, however, that these tones are at a 44.1kHz sampling rate. They cannot be directly applied to the 8200's optional 8200D/32 AES/EBU digital input, which only accepts audio digitized at a 32kHz sample rate. They can be applied to the 8200's AES/EBU input if you are using the 8200D/SRC interface card. This test CD is available from:

NAB Services
1771 N Street N.W.
Washington, D.C. 20036, U.S.A.
order: (1) (800) 368-5644

Required Equipment:

- Ultra-low distortion sine-wave oscillator/THD analyzer/audio voltmeter

  (With verified residual distortion below 0.01%. Sound Technology 1710B; Audio Precision System One, or similar high-performance system.)

  (The **NAB Broadcast and Audio System Test CD** is an excellent source of test signals when used with a high-quality CD player.)

- Precision FM modulation monitor or demodulator

  (Belar FMM-2; TFT 844, or similar.)

- Precision stereo monitor or demodulator

  (Belar FMS-2; TFT 844, or similar.)

- **optionally**, baseband spectrum analyzer, 0-100kHz

  (Tektronix 5L4N plug-in with 5111 bistable storage mainframe or similar.)

Monophonic Performance Verification

Monophonic performance verification is straightforward. Put the 8200 in MONOL Mode, recall the test preset BY BYPASS, and drive the left OPTIMOD-FM input with the test signal. Sufficient headroom is available to modulate well beyond 100% at all frequencies from 50 to 15,000Hz.

1. Prepare the unit.

A ☐ From the IDLE screen, press SYSTEM SETUP button, then press I/O CALIB to access the I/O CALIB screen.

B ☐ Scroll to the MODULATION TYPE parameter and set to MONOL.

C ☐ Press ESC to return to the IDLE screen.

D ☐ From the IDLE screen, press RECALL PRESET button to access the RECALL PRESET screen.

E ☐ Scroll to BY BYPASS.

F ☐ Press RECALL& MODIFY button to put BY BYPASS on the air and access its screen controls.

This test tone defeats all compression, limiting, and clipping, but leaves the 15kHz low-pass filter in the signal path.

G ☐ Set the controls, as follows:

BYPASS GAIN dB	+6
30Hz HPF	OFF

This scales the gain through the 8200 so that a 50Hz tone applied to the analog input at 6dB below the A-I CLIP LVL dBu that you preset (in the I/O CALIB screen) produces the following output levels:

a) at the left and right analog outputs: the level in dBu that you preset as the A-O MAX LVL dBu (in the I/O CALIB CONTROL screen);

b) at the optional AES/EBU digital output: 2.76dB below the maximum digital word on both left and right channels (8200D/32 Card) or the level that you preset as the D-O 100% LVL dB (in the I/O CALIB CONTROL screen), if you're using the 8200D/SRC I/O Card; and

c) at the output of the optional stereo encoder (analog or digital): 100% monophonic modulation.

Please note that OPTIMOD-FM's frequency response drops off extremely rapidly above 15kHz. If the test oscillator is mis-calibrated, OPTIMOD-FM may appear not to meet its frequency response specification at 15kHz. Before blaming OPTIMOD-FM, measure the output frequency of the test oscillator with an accurate counter to make sure that it is actually producing 15kHz, and not some slightly higher frequency.

H ☐ Press ESC to return to the IDLE screen.

Stereo Performance Verification

Many stations may wish to verify that they meet the requirements of the old part 73.322 of the FCC Rules (which was deleted in 1983, and which referred to stereo performance). Part 73.322 referred to the performance of the *transmitter only* (starting with stereo encoder input terminals), and measurements may be made by connecting the test oscillator directly to the OPTIMOD-FM main audio inputs. Following is an outline of the appropriate measurements and how to perform them.

1. Prepare the unit.

A ☐ From the `IDLE` screen, press SYSTEM SETUP button, then press I/O CALIB to access the `I/O CALIB` screen.

B ☐ Scroll to the MODULATION TYPE parameter and set to STEREO.

C ☐ Press ESC to return to the `IDLE` screen.

D ☐ From the `IDLE` screen, press RECALL PRESET button to access the `RECALL PRESET` screen.

E ☐ Scroll to BY BYPASS.

F ☐ Press RECALL& MODIFY button to put BY BYPASS on the air and access its screen controls.

This test tone defeats all compression, limiting, and clipping, but leaves the 15kHz low-pass filter in the signal path.

G ☐ Set the controls, as follows:

BYPASS GAIN dB	+6
30Hz HPF	OFF

This scales the gain through the 8200 so that a 50Hz tone applied to the analog input at 6dB below the A-I CLIP LVL dBu that you preset (in the `I/O CALIB` screen) produces the following output levels:

a) at the left and right analog outputs: the level in dBu that you preset as the A-O MAX LVL dBu (in the `I/O CALIB CONTROL` screen);

b) at the optional AES/EBU digital output: 3dB below the maximum digital word on both left and right channels; and

c) at the output of the optional stereo encoder (analog or digital): 100% monophonic modulation

d) at the output of the optional stereo encoder (analog or digital): 100% modulation including pilot tone.

[NOTE: Because of the “interleaving” effect in the pilot tone stereo system, the peak modulation of the composite baseband signal is approximately equal to the *higher* of the peak modulations that would have been caused by a given channel’s (left or right) driving the system *alone*. This is an analog OR function; there is no summation. The relationship is *exact* when the pilot tone is not present; however, when the pilot tone is present the peak composite modulation increases about 2.8% when first one, and then both channels are driven at maximum level. This occurs because the pilot tone has a fixed phase relationship to the suppressed 38kHz stereo subcarrier and is thus correlated to it and does not add randomly to the composite waveform.]

H ☐ Press ESC to return to the `IDLE` screen.

2. Test the main channel.

A ☐ Connect the oscillator to the left and right OPTIMOD-FM analog inputs in-polarity (“in-phase”).

B ☐ Set the oscillator to 50Hz and its level to 6dB below the reference clipping level in your system.

C ☐ Observe the L–R meter on your stereo monitor.

If L–R fails to null below –40dB, suspect a differential phase error between the left and right channels within the 8200. 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 could be caused by certain failures in the phase correctors for the analog reconstruction filters located on Card #1.

If you are doing the measurement from a remote location and driving the oscillator into a transmission link prior to the 8200’s input terminals, suspect a differential phase error between the left and right channels of the transmission link. If L–R fails to null below –20dB, this indicates that the phase error is large enough to potentially cause audible errors in the frequency response of the L+R signal.

D ☐ Using the L+R meter and output of your stereo monitor, measure the frequency response, total harmonic distortion, and noise characteristics of the main channel.

As a minimum, measure harmonic distortion at 50, 100, 400, 1000, 5000, 10000, and 15000Hz, at 25%, 50%, and 100% modulation. If you have an automatic sweeping distortion test set, this can provide substantially more detailed information about system performance than does the spot-frequency tests because the distortion is measured at many more frequencies. However, bear in mind that the oscillator output level of any such instrument must be conditioned to follow the inverse of the FM pre-emphasis curve to hold percentage modulation constant and to prevent over-modulation at high frequencies. (The **NAB Broadcast and Audio Systems Test CD** has a series of tones whose levels precisely follow the 75µs and 50µs de-emphasis curves, and which can be applied to a pre-emphasized system without need to readjust levels to hold modulation approximately constant.)

The old FCC Rules were ambiguous regarding the bandwidth of the stereophonic distortion measurements. Strict interpretation requires measurement of all distortion products up to 30kHz. The only way this can be done is by using a spectrum analyzer to examine the demodulated baseband, and by calculating a R.S.S. (root-sum-square) sum of all harmonics to 30kHz with appropriate correction for de-emphasis. However, all stereo monitors introduce a sharp-cutoff lowpass filter at 15kHz, and practical considerations thus limit stations without a spectrum analyzer to measuring only distortion products extending to 15kHz.

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.

3. Test the stereophonic subchannel.

A ☐ Reverse the polarity of the right channel input to the 8200.

B ☐ Observe the L+R meter on your stereo monitor.

You should see the same amount of crosstalk as seen in the subchannel in step 2-C.

C ☐ Measure frequency response, total harmonic distortion, and noise for the stereo subchannel using the same techniques that you used for the main channel, but using the L–R meter and output of your stereo monitor.

Once again, only a spectrum analyzer can measure harmonic distortion to 30kHz (in this case, 38kHz±30kHz), and practical considerations usually limit the bandwidth of the measurement to 15kHz.

Measuring L–R noise is particularly problematical because most stereo monitors have no provision for applying de-emphasis 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:

$$s = 10 \log (10^{c/10} - 10^{m/10})$$

where

s is the L–R noise in dB below 100% modulation;
c is the left or right channel noise in dB below 100% modulation (assuming left and right noise measurements are almost equal); and,
m is the L+R noise in dB below 100% modulation.

4. Measure separation.

Careful reading of the old FCC Rule 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 to 15,000Hz, left-into-right and right-into-left.

A ☐ Connect the oscillator to the left OPTIMOD-FM analog input.

B ☐ Short out the right OPTIMOD-FM analog input by connecting pin #2 of the input XLR connector to pin #3.

If you fail to do this, the right input can pick up stray crosstalk from the oscillator that will falsify the separation measurement.

C ☐ As a minimum, measure left-into-right separation at 50, 100, 400, 1000, 5000, 10000, and 15000Hz at 100% modulation.

Remember to reduce the oscillator level at high frequencies to compensate for the FM pre-emphasis curve.

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 misalign the OPTIMOD-FM stereo encoder to compensate for a misaligned stereo monitor. In general, the only stable and reliable way of aligning the OPTIMOD-FM stereo encoder for correct separation is the oscilloscope baseline method described in step 8-C on page 4-27. If you use this technique, turn off the pilot tone by scrolling the cursor to PILOT on the 8200's display, and turning the soft knob so that the pilot is OFF.

D ☐ Disconnect the oscillator from the left OPTIMOD-FM analog input, and connect it to the right OPTIMOD-FM analog input.

E ☐ Short out the left OPTIMOD-FM analog input by connecting pin #2 of the input XLR connector to pin #3.

F ☐ As a minimum, measure right-into-left separation at 50, 100, 400, 1000, 5000, 10000, and 15000Hz at 100% modulation.

5. Measure main-channel-to-subchannel and subchannel-to-main-channel crosstalk.

This step measures the crosstalk in the *transmitter* by using the 8200's internal CROSSTALK TEST switch to eliminate trivial linear crosstalk due to slight phase differences between the left and right channels. The CROSSTALK TEST switch is operated by inserting a $^3\!/_{32}$ size screwdriver through the access hole on the front panel.

OPTIMOD-FM's internal CROSSTALK TEST switch facilitates measurement of main-channel-to-subchannel and subchannel-to-main-channel crosstalk. The CROSSTALK TEST switch applies the output of the left channel audio processing directly to either the main channel or subchannel stereo encoder input, and scales internal gains appropriately in the stereo encoder to keep total composite modulation constant.

A ☐ Connect the oscillator to the 8200's left analog input.

B ☐ Set the 8200's CROSSTALK TEST switch to MAIN-TO-SUB.

C ☐ Set the oscillator to the desired frequency, and adjust its output level to obtain 100% composite modulation.

As a minimum, do the test at 50, 100, 400, 1000, 5000, 10000, and 15000Hz.

D ☐ Measure the signal level appearing in the stereophonic subchannel (L–R) on your stereo monitor. This is the main-channel to subchannel crosstalk.

E ☐ Set the 8200's CROSSTALK TEST switch to SUB-TO-MAIN.

F ☐ Measure the signal level appearing in the stereophonic main channel (L+R) on your stereo monitor. This is the subchannel to main-channel crosstalk.

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.

You can also measure the crosstalk levels on a spectrum analyzer connected to the demodulated composite output of the modulation monitor. This can be revealing, because the spectrum analyzer shows the difference between linear crosstalk and non-linear crosstalk. Linear crosstalk appears in the main channel at the same frequency as the oscillator, and in the subchannel at 38kHz ± [the oscillator frequency]. Non-linear crosstalk is crosstalk appearing at other frequencies than the linear crosstalk. Linear crosstalk is innocuous unless its level is very high (less than 20dB below 100% modulation), while non-linear crosstalk is distortion and will be demodulated as such by the receiver.

G ☐ Repeat steps 5-B through 5-F for each frequency at which crosstalk is to be measured.

6. Measure 38kHz Subcarrier Suppression.

A ☐ Set the CROSSTALK TEST switch to SUB-TO-MAIN.

B ☐ Be sure that the oscillator is still connected to the 8200's left analog input.

C ☐ Set the oscillator frequency to 7.5kHz.

D ☐ Set the oscillator output level to produce 100% composite modulation.

E ☐ Measure the 38kHz subcarrier level on your stereo monitor.

You can also measure the 38kHz subcarrier level on a spectrum analyzer connected to the composite output of the modulation monitor.

7. Measure pilot tone frequency.

A ☐ Suppress the oscillator.

B ☐ Connect a frequency counter to the 8200's composite output.

C ☐ Make sure that the pilot tone is turned on, and, measure the pilot tone frequency on the counter.

It should be 19,000Hz ±1Hz.

8. Measure pilot tone injection.

This is most easily measured on your stereo monitor. All monitors have the ability to directly indicate the pilot tone injection, which should be between 8% and 10% modulation.

If you do not have a stereo monitor, you can measure the pilot tone injection with a spectrum analyzer connected to the 8200's composite output. The pilot tone should be 19kHz at −21dB below 100% modulation (for 9% injection).

The 8200 itself has pilot injection metering. Reach it from the IDLE screen by the following menu sequence:

IDLE→SYSTEM SETUP→I/O CALIB→PILOT LEVEL.

Note that if the 8200's PILOT INJECTION control has been seriously misadjusted, the 8200's pilot injection meter can read incorrectly. If turning the 8200's PILOT INJECTION control down (counterclockwise) causes the meter to rise, then the pilot injection is below 7.5%. Turn the PILOT INJECTION control clockwise until the meter dips to 7.5% and then starts to rise. It is now reading correctly. (Ordinarily, you adjust the PILOT INJECTION to make the meter read 9% injection.)

Field Audit of Performance

Required Equipment:

- Ultra-low distortion sine-wave oscillator/THD analyzer/audio voltmeter

  (With verified residual distortion below 0.01%. Sound Technology 1710B; Audio Precision System One, or similar high-performance system.)

  (The **NAB Broadcast and Audio System Test CD** is an excellent source of test signals when used with a high-quality CD player.)

- Spectrum analyzer with tracking generator

  (Tektronix 5L4N plug-in with 5111 bistable storage mainframe, or similar. Alternatively, a sweep generator with 50 – 15,000Hz logarithmic sweep can be used with an oscilloscope in X/Y mode, or you can use a computer-controlled test set like the Audio Precision System One.)

- Two 620Ω ±5% resistors.

This procedure is useful for detecting and diagnosing problems with the 8200's performance. It includes checks of frequency response, noise and distortion performance, and output level capability. It requires the Analog I/O Card.

The 8200 performs a self-test of important digital circuitry upon power-up. Many problems that could occur in the digital circuitry can be automatically diagnosed by this self-test. If the 8200 fails the self-test, this will be indicated on the front panel, along with a fault diagnosis (if possible).

The self test does not test the Analog I/O Card, the analog stereo encoder, part of the optional AES/EBU digital I/O circuitry, and some of the microprocessor-based control circuitry. (The microprocessor supervises the self-test, and will obviously be unable to complete it if the microprocessor or its vital supporting circuitry is faulty.)

This performance audit assesses the performance of the analog-to-digital and digital-to-analog converters and verifies that the digital signal processing section (DSP) is passing signal correctly. Ordinarily, if the DSP section passes signal normally in this static test mode, and if it passes the power-up self-test, then there is a high probability that it is performing the dynamic signal processing correctly. There is therefore no need to measure such things as attack and release times — these are defined by software, and will automatically be correct if the DSP is otherwise operating normally.

It is often more convenient to make measurements on the bench away from high RF fields which could affect results. In a high RF field it is, for example, very difficult to accurately measure the very low THD produced by a properly-operating 8200 at most frequencies. However, in an emergency situation (and is there any other kind?), it is usually possible to detect many of the more severe faults which could develop in the 8200 circuitry even in high-RF environments.

See the assembly drawings in Section 6 for component locations. Be sure to turn the power off before removing or installing circuit cards.

Follow these instructions in order without skipping steps.

There are some countries where regulatory authorities require peak output levels to not exceed a specified level when driving post office lines. Germany, for example, limits the level to 4.5Vpeak (+12.3dBu). The `I/O CALIB CONTROL` screen allows you to preset the peak output level (A-O MAX LVL dBu) produced by the processing in its normal operating mode. The absolute maximum output level in any test mode is 3dB higher than this. So, for example, German users should never preset the peak output level higher than +9.3dBu if they are driving post lines.

There are no tests in this procedure that require output levels above +10dBu. Users in countries with a +12.3dBu limit should therefore have no difficulty completing the tests.

(The maximum possible output level from the analog outputs is +24dBu, as determined by the clipping point of the 8200's line driver amplifiers.)

1. Prepare the unit.

A ☐ Set the GROUND LIFT switch to CONNECT.

B ☐ From the `IDLE` screen, press RECALL PRESET button to access the `RECALL PRESET` screen. (Press the soft key directly below the words "RECALL PRESET.")

C ☐ Scroll to BY BYPASS.

D ☐ Press RECALL& MODIFY button to put BY BYPASS on the air and access its screen controls.

> This test tone defeats all compression, limiting, and clipping, but retains all audio bandwidth-limiting filters (both analog and DSP) in-line.

E ☐ Set the controls, as follows:

BYPASS GAIN dB	0
30Hz HPF	OFF

F ☐ Press ESC to return to the `IDLE` screen.

G ☐ Press SYSTEM SETUP button to access the `SYSTEM SETUP` screen. (Press the soft key directly below the words "SYSTEM SETUP.")

H ☐ Press I/O CALIB button to access a detailed listing of all system calibrations.

I ☐ Set the controls listed below, as follows:

A-I CLIP LVL dBu	+10.0
A-I BAL R CH dB	0
A/O	FLAT
A/O 100% LVL dBu	+10.0

J ☐ Connect one 620Ω ±5% resistor between pin #2 and pin #3 of the L ANALOG OUTPUT XLR connector, and one 620Ω ±5% resistor between pin #2 and pin #3 of the R ANALOG OUTPUT XLR connector.

K ☐ Connect the audio voltmeter between pin #2 and pin #3 of the L ANALOG OUTPUT XLR connector.

L ☐ Connect the sine-wave oscillator to pins #2 and #3 of the 8200's L ANALOG INPUT XLR connector. Set the oscillator to 50Hz, and adjust its output level to produce a level of 2.45Vrms (+10dBu) at the L ANALOG OUTPUT XLR connector.

This level corresponds to 100% modulation.

M ☐ Disconnect the oscillator from the L ANALOG INPUT XLR connector, and connect it to the R ANALOG INPUT XLR connector.

N ☐ Disconnect the audio voltmeter from the L ANALOG OUTPUT XLR connector, and connect it between pin #2 and pin #3 of the R ANALOG OUTPUT XLR connector.

O ☐ Verify that the level at the R ANALOG OUTPUT XLR connector is 2.45Vrms (+10dBu).

P ☐ Disconnect the oscillator and audio voltmeter from the 8200.

2. Check frequency response.

If a tracking or sweep generator and spectrum analyzer are not available, the frequency response can be measured with an audio oscillator and N/D test set. If you will be doing this, ignore the rest of step 2, and instead: Connect the oscillator as in step 1-L, but reduce its output level by 20dB (to avoid overloading the 8200 at high frequencies). Connect the N/D test set to pins #2 and #3 of the 8200's L ANALOG OUTPUT XLR connector. Measure the frequency response with the oscillator set to 1kHz, then verify that response at 50Hz, 100Hz, 400Hz, 5kHz, 10kHz, and 15kHz is within ±0.5dB of that measured at 1kHz. Repeat for the right channel.

A ☐ Connect the output of a tracking or sweep generator to pins #2 and #3 of the L ANALOG INPUT XLR connector. Set the generator for a 20 – 20,000Hz logarithmic sweep.

B ☐ Connect the input of a spectrum analyzer or oscilloscope to pins #2 and #3 of the 8200's L ANALOG OUTPUT XLR connector.

C ☐ Adjust the output level of the tracking or sweep generator to obtain 0.33Vrms (–7.4dBu) or less at the 8200's output (to avoid clipping the 8200 at high frequencies because of pre-emphasis).

D ☐ Verify that the swept output is flat ±0.5dB from 50 – 15,000Hz.

E ☐ Disconnect tracking or sweep generator from the L ANALOG INPUT XLR connector, and connect it to the R ANALOG INPUT XLR connector.

F ☐ Disconnect the spectrum analyzer or oscilloscope from the L ANALOG OUTPUT XLR connector and connect it to the R ANALOG OUTPUT XLR connector.

G ☐ Verify that the swept output is flat ±0.5dB from 50 – 15,000Hz.

H ☐ Disconnect the tracking or sweep generator and the spectrum analyzer or oscilloscope from the 8200.

3. Check noise and distortion performance.

A ☐ Connect a THD analyzer to the L ANALOG OUTPUT XLR connector. Set the THD analyzer's bandwidth to 80kHz.

B ☐ Connect the oscillator to the L ANALOG INPUT XLR connector.

C ☐ Set the oscillator's frequency to 1kHz and adjust its output level to produce 2.45Vrms at the 8200's L ANALOG OUTPUT XLR connector.

This level is equivalent to 100% modulation.

D ☐ Verify that THD does not exceed 0.01%.

In many cases, measured results will be constrained entirely by the quality of the oscillator and distortion analyzer, and/or by the presence of RF fields.

E ☐ Disconnect the THD analyzer from the L ANALOG OUTPUT XLR connector, and connect to the R ANALOG OUTPUT XLR connector.

F ☐ Disconnect the oscillator from the L ANALOG INPUT XLR connector and connect to the R ANALOG INPUT XLR connector.

G ☐ Repeat steps 3-C through 3-D for the right channel.

H ☐ Disconnect the oscillator and THD analyzer from the 8200.

I ☐ Short the 8200's left and right inputs by connecting pins #2 and #3 of the L ANALOG INPUT XLR connector together, and by connecting pins #2 and #3 of the R ANALOG INPUT XLR connector together.

J ☐ Verify that the noise at the L ANALOG OUTPUT XLR connector and the R ANALOG OUTPUT XLR connector is below –70dBu (80dB below 100% modulation).

Note that hum or buzz due to test equipment grounding problems and/or high-RF fields may result in falsely high readings. Such problems should become immediately apparent if the output of the THD analyzer is monitored with an oscilloscope.

K ☐ Remove the shorting jumpers from the 8200's inputs.

4. Return OPTIMOD-FM to service.

A ☐ Remove the 620Ω resistors connected across the output in step 1-J.

B ☐ Recall your normal operating preset.

Field Alignment

The only cards requiring calibration are the Analog Input/Output Card (Card #1) and the optional Analog Stereo Encoder (Card #2). Because the calibration procedure compensates only for the accumulated tolerances of stable metal film resistors used in the circuitry, calibration is usually done once at time of manufacture, and is very unlikely to be required again over the life of the equipment. These field alignment instructions are therefore included primarily for reference — *routine alignment is neither necessary nor desirable* due to the high stability of the circuitry.

Required Equipment

- Ultra-low distortion sine-wave oscillator/THD analyzer/audio voltmeter

  (With verified residual distortion below 0.01%. Sound Technology 1710B; Audio Precision System 1, or similar high-performance system.)

  (The **NAB Broadcast and Audio System Test CD** is an excellent source of test signals when used with a high-quality CD player.)

- Spectrum analyzer with tracking generator, ≥120kHz range

  Tektronix 5L4N plug-in with 5111 bistable storage mainframe, or similar.

  Audio Precision System One, or similar.

- Digital voltmeter

  Accurate to ±0.1%

- Oscilloscope

  DC-coupled, triggered-sweep, with 5MHz or greater vertical bandwidth.

  It is assumed that the technician is thoroughly familiar with the operation of this equipment.

CAUTION

If calibration is necessary, we *strongly recommend* that the circuit card in question be returned to the factory for calibration by our experienced technicians. They have access to special test fixtures and a supply of exact-replacement spare parts. Only in an emergency should you attempt to align and calibrate the 8200 in the field.

Follow these instructions in order, without skipping steps.

Refer to the drawings in Section 6 for locations of components and test points.

Prepare the Unit

1) Set the GROUND LIFT switch to CONNECT.

2) Remove the 8200 from its rack and place it on a test bench *away from RF fields*.

3) Open up the 8200's front panel.

   See page 4-3 for instructions.

4) Set the AC POWER switch to ON.

   Allow the 8200 to finish its diagnostic routine before proceeding.

Test Power Supplies (optional)

1. Test ±12 volt supply (Display Board).

A ☐ Measure the +12 volt supply with the DVM. Verify the presence of 12 volts (±0.75V).

The +12 volt supply appears between the positive lead of C301 and ground on the Display Board.

B ☐ Using the oscilloscope, measure the total ripple and noise on the +12 volt supply.

The ripple and noise should not exceed 75mVp-p.

C ☐ Measure the −12 volt supply with the DVM. Verify the presence of −12 volts (±0.75V).

The −12 volt supply appears between the negative lead of C302 and ground on the Display Board.

D ☐ Using the oscilloscope, measure the total ripple and noise on the −12 volt supply.

The ripple and noise should not exceed 50mVp-p.

2. Test Digital +5 volt supply (Display Board).

A ☐ Measure the +5 volt supply with the DVM. Verify the presence of 5 volts (±0.25V).

The +5 volt digital supply appears between the positive lead of C300 and ground on the Display Board.

B ☐ Using the oscilloscope, measure the total ripple and noise on the +5 volt digital supply.

The ripple and noise should not exceed 50mVp-p.

C ☐ Set the 8200's AC POWER switch to OFF.

3. Test Local ±5 volt supply (Stereo Encoder Card).

A ☐ Make sure that the 8200's AC POWER switch is OFF.

B ☐ Remove Card #2 from its slot, insert an extender card (included with your 8200) into slot #2, then insert Card #2 into the extender card.

C ☐ Set the AC POWER switch to ON.

Allow the 8200 to finish its diagnostic routine before proceeding.

D ☐ Measure the +5 volt supply with the DVM. Verify the presence of 5 volts (±0.25V).

The +5 volt supply appears between TP9 and ground test point TP13 on Card #2 (Stereo Encoder Card).

E ☐ Using the oscilloscope, measure the total ripple and noise on the +5 volt supply.

The ripple and noise should not exceed 25mV.

F ☐ Measure the −5 volt supply with the DVM. Verify the presence of 5 volts (±0.25V).

The −5 volt supply appears between TP11 and ground test point TP13 on Card #2 (Stereo Encoder Card).

G ☐ Using the oscilloscope, measure the total ripple and noise on the −5 volt supply.

The ripple and noise should not exceed 25mV.

H ☐ Set the 8200's AC POWER switch to OFF.

I ☐ Remove Card #2 from the extender card, remove the extender card from slot #2, then re-insert Card #2 into its slot.

4. Test ±15 volt supply (Analog I/O Card).

A ☐ Make sure that the 8200's AC POWER switch is OFF.

B ☐ Remove Card #1 from its slot, insert an extender card (included with your 8200) into slot #1, then insert Card #1 into the extender card.

C ☐ Set the AC POWER switch to ON.

Allow the 8200 to finish its diagnostic routine before proceeding.

D ☐ Measure the +15 volt supply with the DVM. Verify the presence of 15 volts (±0.75V).

The +15 volt supply appears between TP11 and ground test point TP7 on Card #1 (Analog I/O Card).

E ☐ Using the oscilloscope, measure the total ripple and noise on the +15 volt supply.

The ripple and noise should not exceed 100mVp-p.

F ☐ Measure the −15 volt supply with the DVM. Verify the presence of 15 volts (±0.75V).

The −15 volt supply appears between TP10 and ground test point TP7 on Card #1 (Analog I/O Card).

G ☐ Using the oscilloscope, measure the total ripple and noise on the −15 volt supply.

The ripple and noise should not exceed 100mVp-p.

5. Test Local ±5 volt supply (Analog I/O Card).

A ☐ Measure the +5 volt supply with the DVM. Verify the presence of 5 volts (±0.25V).

The +5 volt supply appears between TP6 and ground test point TP7 on Card #1 (Analog I/O Card).

B ☐ Using the oscilloscope, measure the total ripple and noise on the +5 volt supply.

The ripple and noise should not exceed 100mV.

C ☐ Measure the −5 volt supply with the DVM. Verify the presence of 5 volts (±0.25V).

The −5 volt supply appears between TP8 and ground test point TP7 on Card #1 (Analog I/O Card).

D ☐ Using the oscilloscope, measure the total ripple and noise on the −5 volt supply.

The ripple and noise should not exceed 100mV.

Calibrate and Test Card #1 (Analog Input/Output Circuitry)

1. Prepare for test.

A ☐ If Card #1 is not ready for testing (inserted in an extender card in slot #1), turn AC POWER switch to OFF, remove Card #1 from its slot, insert the extender card into slot #1, then insert Card #1 into the extender card.

B ☐ Turn the 8200's AC POWER switch is ON.

Allow the 8200 to complete its diagnostic routine.

C ☐ From the `IDLE` screen, press RECALL PRESET button to access the `RECALL PRESET` screen. (Press the soft key directly below the words "RECALL PRESET.")

D ☐ Scroll to TO USER TONE.

E ☐ Press RECALL& MODIFY button to put TO USER TONE on the air and access its screen controls.

F ☐ Set the controls, as follows:

FREQUENCY Hz	400Hz
MODULATION LEVEL %	100%
MODULATION TYPE	L+R
PILOT	OFF

This test tone applies a digitally-generated 400Hz sinewave at exactly 100% modulation to the 8200's D/A converters.

G ☐ Press ESC to return to the `IDLE` screen.

2. Calibrate reconstruction filter gains.

A ☐ Connect the audio voltmeter/THD analyzer between circuit ground and TP3 on Card #1.

B ☐ Adjust trimpot R175 (LEFT GAIN TRIM) so that the audio voltmeter indicates +12.6dBu ±0.1dBu.

C ☐ Connect the audio voltmeter between TP3 and TP9.

The voltmeter must have an accurately balanced, differential input. A portable battery-powered DVM (digital voltmeter) is ideal for this test because its common-mode rejection is essentially infinite.

D ☐ Adjust trimpot R177 to null the meter reading.

Increase the sensitivity of the meter as necessary. The null should be very deep (typically 60dB or better).

3. Test frequency response of reconstruction filters (optional).

A ☐ From the `IDLE` screen, press RECALL PRESET button to access the `RECALL PRESET` screen. (Press the soft key directly below the words "RECALL PRESET.")

B ☐ Scroll to TO USER TONE.

C ☐ Press RECALL& MODIFY button to put TO USER TONE on the air and access its screen controls.

D ☐ Set the controls, as follows:

FREQUENCY Hz	400Hz
MODULATION LEVEL %	0%
MODULATION TYPE	L+R
PILOT	OFF

This test tone applies a digitally-generated 400Hz sinewave at 0% modulation to the 8200's D/A converters. The result is no signal being applied to the reconstruction filters.

E ☐ Press ESC to return to the `IDLE` screen.

F ☐ Connect the sweep tone generator output of a spectrum analyzer to TP13. Set the sweep range from 20Hz to 150kHz.

This applies a swept sine wave input signal to the left channel reconstruction filter.

G ☐ Adjust the sweep tone level to 2.12 volts peak or less.

H ☐ Connect the spectrum analyzer input to TP3.

I ☐ Verify that the frequency response is a low pass type. It should have a peaked response of +0.35dB at 24kHz and +0.25dB at 15kHz.

J ☐ Connect the sweep tone generator output to TP14 and the spectrum analyzer input at TP9.

This applies a swept sine wave input signal to the right channel reconstruction filter.

K ☐ Repeat steps 3-C through 3-E for the right channel, then continue to step 3-H.

L ☐ Set the 8200's AC POWER switch to OFF.

M ☐ Remove Card #1 from the extender card, remove the extender card from slot #1, then re-insert Card #1 into its slot.

Calibrate and Test Card #2 (Analog Stereo Baseband Encoder)

1. Prepare for test.

A ☐ Make sure that the 8200's AC POWER switch is OFF.

B ☐ Remove Card #2 from its slot, insert the extender card into slot #2, then insert Card #2 into the extender card.

C ☐ Set the AC POWER switch to ON.

Allow the 8200 to complete its diagnostic routine.

D ☐ From the `IDLE` screen, press RECALL PRESET button to access the `RECALL PRESET` screen. (Press the soft key directly below the words "RECALL PRESET.")

E ☐ Scroll to TO USER TONE.

Press RECALL& MODIFY button to put TO USER TONE on the air and access its screen controls.

F ☐ Set the controls, as follows:

FREQUENCY Hz	5000Hz
MODULATION LEVEL %	91%
MODULATION TYPE	L+R
PILOT	ON

2. Measure 38kHz null.

A ☐ If it is not there already, place the TEST switch in the OPERATE position.

The TEST switch is a screwdriver-operated switch mounted on the front of Card #2. From counter-clockwise to clockwise, its three positions are MAIN-TO-SUB CROSSTALK TEST, SUB-TO-MAIN CROSSTALK TEST, and OPERATE. So OPERATE is the clockwise position.

B ☐ Connect the spectrum analyzer to the 8200's COMPOSITE OUTPUT 1. Adjust its span to 10kHz/div and its start frequency to 0kHz. Adjust its vertical scale to 10dB/division. Adjust its sensitivity so that the 5kHz spur is 6dB below the top of the screen.

The top of the screen now corresponds to 100% stereo modulation (±75kHz deviation).

C ☐ Using the spectrum analyzer, verify that the 38kHz component is <−65dB.

38kHz null is maintained by DC servos IC3-A and IC4-A. These prevent DC from appearing across analog switch IC10. If excessive 38kHz appears, check these servos for proper operation.

3. Null 114kHz sidebands.

A ☐ Place the TEST switch in the SUB-TO-MAIN position.

B ☐ Adjust the spectrum analyzer display so that the 109kHz and 119kHz sidebands around 114kHz are visible. (You will have to set the start frequency to at least 20kHz.)

C ☐ Adjust trimmer R12 (114KHZ NULL) for minimum 114kHz sidebands.

The sidebands will typically be >75dB below the top of the screen.

4. Null Subchannel-to-Main Channel crosstalk.

A ☐ Set the spectrum analyzer start frequency to 0kHz. 5kHz should be visible.

B ☐ The 5kHz component you see on the spectrum analyzer is sub-to-main crosstalk. Adjust trimmer R35 (SUB TO MAIN XTALK) to null the 5kHz as much as possible (typically −75dB)

Setting the spectrum analyzer to 5kHz per division will make the crosstalk easier to see.

C ☐ Set the controls, as follows:

FREQUENCY Hz	15000Hz
MODULATION LEVEL %	91%
MODULATION TYPE	L+R
PILOT	ON

D ☐ Adjust trimmer capacitor C3 (HF SUB-TO-MAIN XTALK) to null the 15kHz component as much as possible.

E ☐ Set the controls, as follows:

FREQUENCY Hz	5000Hz
MODULATION LEVEL %	91%
MODULATION TYPE	L+R
PILOT	ON

Re-check the null at 5kHz. If necessary, slightly trim R35 to improve the null.

5. Null Main-Channel-to Subchannel crosstalk.

A ☐ Place the TEST switch in the MAIN-TO-SUB XTALK position.

This is the counter-clockwise position of the TEST switch.

B ☐ Adjust the spectrum analyzer frequency span so that the 5kHz sidebands surrounding 38kHz (33kHz and 43kHz) are visible.

C ☐ The 5kHz sidebands that you see on the spectrum analyzer are the main-to-sub crosstalk. Adjust trimmer R4 (MAIN SUB XTALK) to null the 5kHz sidebands as much as possible (typically –80dB)

Setting the spectrum analyzer to 5kHz per division will make the crosstalk easier to see.

D ☐ Set the controls, as follows:

FREQUENCY Hz	15000Hz
MODULATION LEVEL %	91%
MODULATION TYPE	L+R
PILOT	ON

E ☐ Adjust trimmer capacitor C2 (HF MAIN-TO-SUB XTALK) to null the 15kHz component as much as possible.

F ☐ Set the controls, as follows:

FREQUENCY Hz	5000Hz
MODULATION LEVEL %	91%
MODULATION TYPE	L+R
PILOT	ON

Re-check the null at 5kHz. If necessary, slightly trim R35 to improve the null.

6. Test pilot tone.

A ☐ Place the TEST switch in the OPERATE position.

OPERATE is the clockwise position.

B ☐ Set the controls, as follows:

FREQUENCY Hz	5kHz
MODULATION LEVEL %	0%
MODULATION TYPE	L+R
PILOT	ON

C ☐ Verify that the 19kHz pilot is 21dB below the top of the screen (for 9% injection).

D ☐ Monitor the composite output with the frequency meter and verify that the pilot frequency is 19,000Hz (±1Hz).

E ☐ Monitor the composite output with the THD analyzer and verify that the THD of the pilot is below 0.25%.

7. Verify DC offset null.

A ☐ Set the controls, as follows:

FREQUENCY Hz	5kHz
MODULATION LEVEL %	0%
MODULATION TYPE	L+R
PILOT	OFF

B ☐ Connect COMPOSITE OUTPUT #1 to a DC voltmeter.

C ☐ Verify that the observed DC output voltage is 0.00V (±5mV).

DC offset null is maintained with servo IC4-B.

D ☐ Repeat for COMPOSITE OUTPUT #2.

8. Calibrate high frequency separation.

A ☐ Set the controls, as follows:

FREQUENCY Hz	15000Hz
MODULATION LEVEL %	100%
MODULATION TYPE	LEFT
PILOT	OFF

B ☐ Make sure that the TEST switch is in the OPERATE position.

This is the clockwise position of the TEST switch.

C ☐ Observe the COMPOSITE OUTPUT #1 with the scope. Trigger the scope externally from the L ANALOG OUTPUT. Set the scope sensitivity to 0.5V/div, and input coupling to "DC." Set the horizontal timebase to 0.2ms/div.

D ☐ Adjust R66 (8200 OUTPUT ATTEN 1 CONTROL) until the COMPOSITE OUTPUT LEVEL is 4Vp-p.

E ☐ Adjust trimmer R26 on Card #2 (HIGH FREQUENCY SEPARATION/TILT) and front-panel control R37 (SEPARATION) to obtain the flattest baseline possible. To make the final adjustment accurately, expand the vertical scale by a factor of ten and re-adjust the controls if necessary.

Variation from horizontal will typically be undetectable by eye. It must be less than ½ of a minor division on the scope graticule.

DO NOT USE AN ATTENUATOR PROBE. Such probes typically have enough phase error to completely invalidate any separation measurements. Note also that some scopes have enough phase error in their vertical amplifiers to make separation measurements inaccurate. If separation appears inadequate in this test, check it with another scope before assuming that the 8200 is faulty.

Figure 4-1: Separation Scope Trace

9. Check low-frequency separation.

A ☐ Set the controls, as follows:

FREQUENCY Hz	400Hz
MODULATION LEVEL %	100%
MODULATION TYPE	LEFT
PILOT	OFF

B ☐ Verify that the baseline is still flat.

You will have to slow the oscilloscope timebase to see the waveform.

Return OPTIMOD-FM to Service

1) Disconnect all test instruments from the 8200.

2) Set the AC POWER switch to OFF.

3) Remove Card #2 from the card extender, remove the card extender from the 8200, then insert Card #2 into slot #2.

4) Set the AC POWER switch to ON.

5) Close front panel.

    See page 4-3 for instructions.

6) Return the 8200 to its rack and reconnect it.

7) After the 8200 has been powered from the AC line, recall the desired operating preset, either locally or by remote control.

    If you recall presets by the 8200's internal automation, be assured that this function will start working as soon as you apply AC power. The next programmed preset will be recalled at the programmed time for that preset.

This Page Intentionally Left Blank.