Operating Manual

OPTIMOD-FM

5500i

Digital Audio Processor

Version 2.0 Software

orban

IMPORTANT NOTE: Refer to the unit's rear panel for your Model Number.

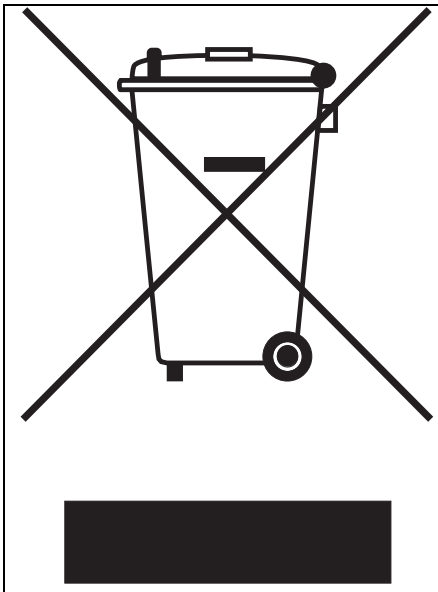
Model Number:	**Description:**
5500i	OPTIMOD 5500i, Stereo Encoder, Digital I/O, Protection Structure, Two-Band Structure, Five-Band structure, Stand-Alone Stereo Encoder structure. RDS generator. 85-264V operation at 50-60 Hz via universal switching power supply. Switchable to 50µs or 75µs.

CAUTION: TO REDUCE THE RISK OF ELECTRICAL SHOCK, DO NOT REMOVE COVER (OR BACK).
NO USER SERVICEABLE PARTS INSIDE. REFER SERVICING TO QUALIFIED SERVICE PERSONNEL.

WARNING: TO REDUCE THE RISK OF FIRE OR ELECTRICAL SHOCK,
DO NOT EXPOSE THIS APPLIANCE TO RAIN OR MOISTURE.

This symbol, wherever it appears, alerts you to the presence of uninsulated dangerous voltage inside the enclosure — voltage that may be sufficient to constitute a risk of shock.

This symbol, wherever it appears, alerts you to important operating and maintenance instructions in the accompanying literature. Read the manual.



In accordance to the WEEE (waste electrical and electronic equipment) directive of the European Parliament, this product must not be discarded into the municipal waste stream in any of the Member States. This product may be sent back to your Orban dealer at end of life where it will be reused or recycled at no cost to you.

If this product is discarded into an approved municipal WEEE collection site or turned over to an approved WEEE recycler at end of life, your Orban dealer must be notified and supplied with model, serial number and the name and location of site/facility.

Please contact your Orban dealer for further assistance.

www.orban.com

IMPORTANT SAFETY INSTRUCTIONS

All the safety and operating instructions should be read before the appliance is operated.

Retain Instructions: The safety and operation instructions should be retained for future reference.

Heed Warnings: All warnings on the appliance and in the operating instructions should be adhered to.

Follow Instructions: All operation and user instructions should be followed.

Water and Moisture: The appliance should not be used near water (e.g., near a bathtub, washbowl, kitchen sink, laundry tub, in a wet basement, or near a swimming pool, etc.).

Ventilation: The appliance should be situated so that its location or position does not interfere with its proper ventilation. For example, the appliance should not be situated on a bed, sofa, rug, or similar surface that may block the ventilation openings; or, placed in a built-in installation, such as a bookcase or cabinet that may impede the flow of air through the ventilation openings.

Heat: The appliance should be situated away from heat sources such as radiators, heat registers, stoves, or other appliances (including amplifiers) that produce heat.

Power Sources: The appliance should be connected to a power supply only of the type described in the operating instructions or as marked on the appliance.

Grounding or Polarization: Precautions should be taken so that the grounding or polarization means of an appliance is not defeated.

Power-Cord Protection: Power-supply cords should be routed so that they are not likely to be walked on or pinched by items placed upon or against them, paying particular attention to cords at plugs, convenience receptacles, and the point where they exit from the appliance.

Cleaning: The appliance should be cleaned only as recommended by the manufacturer.

Non-Use Periods: The power cord of the appliance should be unplugged from the outlet when left unused for a long period of time.

Object and Liquid Entry: Care should be taken so that objects do not fall and liquids are not spilled into the enclosure through openings.

Damage Requiring Service: The appliance should be serviced by qualified service personnel when: The power supply cord or the plug has been damaged; or Objects have fallen, or liquid has been spilled into the appliance; or The appliance has been exposed to rain; or The appliance does not appear to operate normally or exhibits a marked change in performance; or The appliance has been dropped, or the enclosure damaged.

Servicing: The user should not attempt to service the appliance beyond that described in the operating instructions. All other servicing should be referred to qualified service personnel.

The Appliance should be used only with a cart or stand that is recommended by the manufacturer.

Safety Instructions (European)

Notice For U.K. Customers If Your Unit Is Equipped With A Power Cord.

WARNING: THIS APPLIANCE MUST BE EARTHED.

The cores in the mains lead are coloured in accordance with the following code:

GREEN and YELLOW - Earth BLUE - Neutral BROWN - Live

As colours of the cores in the mains lead of this appliance may not correspond with the coloured markings identifying the terminals in your plug, proceed as follows:

The core which is coloured green and yellow must be connected to the terminal in the plug marked with the letter E, or with the earth symbol, or coloured green, or green and yellow.

The core which is coloured blue must be connected to the terminal marked N or coloured black.

The core which is coloured brown must be connected to the terminal marked L or coloured red.

The power cord is terminated in a CEE7 / 7 plug (Continental Europe). The green / yellow wire is connected directly to the unit's chassis. If you need to change the plug and if you are qualified to do so, refer to the table below.

WARNING: If the ground is defeated, certain fault conditions in the unit or in the system to which it is connected can result in full line voltage between chassis and earth ground. Severe injury or death can then result if the chassis and earth ground are touched simultaneously.

Conductor		WIRE COLOR	
		Normal	Alt
L	LIVE	BROWN	BLACK
N	NEUTRAL	BLUE	WHITE
E	EARTH GND	GREEN-YELLOW	GREEN

AC Power Cord Color Coding

Safety Instructions (German)

Gerät nur an der am Leistungsschild vermerkten Spannung und Stromart betreiben.
Sicherungen nur durch solche, gleicher Stromstärke und gleichen Abschaltverhaltens ersetzen. Sicherungen nie überbrücken.
Jedwede Beschädigung des Netzkabels vermeiden. Netzkabel nicht knicken oder quetschen. Beim Abziehen des Netzkabels den Stecker und nicht das Kabel enfassen. Beschädigte Netzkabel sofort auswechseln.
Gerät und Netzkabel keinen übertriebenen mechanischen Beaspruchungen aussetzen.
Um Berührung gefährlicher elektrischer Spannungen zu vermeiden, darf das Gerät nicht geöffnet werden. Im Fall von Betriebsstörungen darf das Gerät nur Von befugten Servicestellen instandgesetzt werden. Im Gerät befinden sich keine, durch den Benutzer reparierbare Teile.
Zur Vermeidung von elektrischen Schlägen und Feuer ist das Gerät vor Nässe zu schützen. Eindringen von Feuchtigkeit und Flüssigkeiten in das Gerät vermeiden.
Bei Betriebsstörungen bzw. nach Eindringen von Flüssigkeiten oder anderen Gegenständen, das Gerät sofort vom Netz trennen und eine qualifizierte Servicestelle kontaktieren.

Safety Instructions (French)

On s'assurera toujours que la tension et la nature du courant utilisé correspondent bien à ceux indiqués sur la plaque de l'appareil.
N'utiliser que des fusibles de même intensité et du même principe de mise hors circuit que les fusibles d'origine. Ne jamais shunter les fusibles.
Eviter tout ce qui risque d'endommager le câble seceur. On ne devra ni le plier, ni l'aplatir. Lorsqu'on débranche l'appareil, tirer la fiche et non le câble. Si un câble est endommagé, le remplacer immédiatement.
Ne jamais exposer l'appareil ou le câble ä une contrainte mécanique excessive.
Pour éviter tout contact averc une tension électrique dangereuse, on n'oouvrira jamais l'appareil. En cas de dysfonctionnement, l'appareil ne peut être réparé que dans un atelier autorisé. Aucun élément de cet appareil ne peut être réparé par l'utilisateur.
Pour éviter les risques de décharge électrique et d'incendie, protéger l'appareil de l'humidité. Eviter toute pénétration d'humidité ou fr liquide dans l'appareil.
En cas de dysfonctionnement ou si un liquide ou tout autre objet a pénétré dans l'appareil couper aussitôt l'appareil de son alimentation et s'adresser à un point de service aprésvente autorisé.

Safety Instructions (Spanish)

Hacer funcionar el aparato sólo con la tensión y clase de corriente señaladas en la placa indicadora de características.
Reemplazar los fusibles sólo por otros de la misma intensidad de corriente y sistema de desconexión. No poner nunca los fusibles en puente.
Proteger el cable de alimentación contra toda clase de daños. No doblar o apretar el cable. Al desenchufar, asir el enchufe y no el cable. Sustituir inmediatamente cables dañados.
No someter el aparato y el cable de alimentación a esfuerzo mecánico excesivo.
Para evitar el contacto con tensiones eléctricas peligrosas, el aparato no debe abrirse. En caso de producirse fallos de funcionamiento, debe ser reparado sólo por talleres de servicio autorizados. En el aparato no se encuentra ninguna pieza que pudiera ser reparada por el usuario.
Para evitar descargas eléctricas e incendios, el aparato debe protegerse contra la humedad, impidiendo que penetren ésta o líquidos en el mismo.
En caso de producirse fallas de funcionamiento como consecuencia de la penetración de líquidos u otros objetos en el aparato, hay que desconectarlo inmediatamente de la red y ponerse en contacto con un taller de servicio autorizado.

Safety Instructions (Italian)

Far funzionare l'apparecchio solo con la tensione e il tipo di corrente indicati sulla targa riportante i dati sulle prestazioni.
Sostituire i dispositivi di protezione (valvole, fusibili ecc.) solo con dispositivi aventi lo stesso amperaggio e lo stesso comportamento di interruzione. Non cavallottare mai i dispositivi di protezione.
Evitare qualsiasi danno al cavo di collegamento alla rete. Non piegare o schiacciare il cavo. Per staccare il cavo, tirare la presa e mai il cavo. Sostituire subito i cavi danneggiati.
Non esporre l'apparecchio e il cavo ad esagerate sollecitazioni meccaniche.
Per evitare il contatto con le tensioni elettriche pericolose, l'apparecchio non deve venir aperto. In caso di anomalie di funzionamento l'apparecchio deve venir riparato solo da centri di servizio autorizzati. Nell'apparecchio non si trovano parti che possano essere riparate dall'utente.
Per evitare scosse elettriche o incendi, l'apparecchio va protetto dall'umidità. Evitare che umidità o liquidi entrino nell'apparecchio.
In caso di anomalie di funzionamento rispettivamente dopo la penetrazione di liquidi o oggetti nell'apparecchio, staccare immediatamente l'apparecchio dalla rete e contattare un centro di servizio qualificato.

PLEASE READ BEFORE PROCEEDING!

Manual

The Operating Manual contains instructions to verify the proper operation of this unit and initialization of certain options. You will find these operations are most conveniently performed on the bench before you install the unit in the rack.

Please review the Manual, especially the installation section, before unpacking the unit.

Trial Period Precautions

If your unit has been provided on a trial basis:

You should observe the following precautions to avoid reconditioning charges in case you later wish to return the unit to your dealer.

(1) Note the packing technique and save all packing materials. It is not wise to ship in other than the factory carton. (Replacements cost $35.00).

(2) Avoid scratching the paint or plating. Set the unit on soft, clean surfaces.

(3) Do not cut the grounding pin from the line cord.

(4) Use care and proper tools in removing and tightening screws to avoid burring the heads.

(5) Use the nylon-washered rack screws supplied, if possible, to avoid damaging the panel. Support the unit when tightening the screws so that the threads do not scrape the paint inside the slotted holes.

Packing

When you pack the unit for shipping:

(1) Tighten all screws on any barrier strip(s) so the screws do not fall out from vibration.
(2) Wrap the unit in its original plastic bag to avoid abrading the paint.
(3) Seal the inner and outer cartons with tape.

If you are returning the unit permanently (for credit), be sure to enclose:

- The Manual(s)
- The Registration / Warranty Card
- The Line Cord
- All Miscellaneous Hardware (including the Rack Screws and Keys)
- The Extender Card (if applicable)
- The Monitor Rolloff Filter(s) (OPTIMOD-AM only)
- The COAX Connecting Cable (OPTIMOD-FM and OPTIMOD-TV only)

Your dealer may charge you for any missing items.

If you are returning a unit for repair, do not enclose any of the above items.

Further advice on proper packing and shipping is included in the Manual (see Table of Contents).

Trouble

If you have problems with installation or operation:

(1) Check everything you have done so far against the instructions in the Manual. The information contained therein is based on our years of experience with OPTIMOD and broadcast stations.

(2) Check the other sections of the Manual (consult the Table of Contents and Index) to see if there might be some suggestions regarding your problem.

(3) After reading the section on Factory Assistance, you may call Orban Customer Service for advice during normal Arizona business hours. The number is +1 856.719.9900.

WARNING

This equipment generates, uses, and can radiate radio-frequency energy. If it is not installed and used as directed by this manual, it may cause interference to radio communication. This equipment complies with the limits for a Class A computing device, as specified by FCC Rules, Part 15, subject J, which are designed to provide reasonable protection against such interference when this type of equipment is operated in a commercial environment. Operation of this equipment in a residential area is likely to cause interference. If it does, the user will be required to eliminate the interference at the user's expense.

WARNING

This digital apparatus does not exceed the Class A limits for radio noise emissions from digital apparatus set out in the radio Interference Regulations of the Canadian Department of Communications. (Le present appareil numerique n'emet pas de bruits radioelectriques depassant les limites applicables aux appareils numeriques [de las class A] prescrites dans le Reglement sur le brouillage radioelectrique edicte par le ministere des Communications du Canada.)

IMPORTANT

Perform the installation under static control conditions. Simply walking across a rug can generate a static charge of 20,000 volts. This is the spark or shock you may have felt when touching a doorknob or some other conductive surface. A much smaller static discharge is likely to destroy one or more of the CMOS semiconductors employed in OPTIMOD-FM. Static damage will not be covered under warranty.

There are many common sources of static. Most involve some type of friction between two dissimilar materials. Some examples are combing your hair, sliding across a seat cover or rolling a cart across the floor. Since the threshold of human perception for a static discharge is 3000 volts, you will not even notice many damaging discharges.

Basic damage prevention consists of minimizing generation, discharging any accumulated static charge on your body or workstation, and preventing that discharge from being sent to or through an electronic component. You should use a static grounding strap (grounded through a protective resistor) and a static safe workbench with a conductive surface. This will prevent any buildup of damaging static.

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This manual was published in August 2016.

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Orban Labs Inc., 7209 Browning Road, Pennsauken NJ 08110 USA

Phone: +1 856.719.9900; E-Mail: custserv@orban.com; Site: www.orban.com

Operating Manual

OPTIMOD-FM

5500i

Digital Audio Processor

Version 2.0 Software

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Section 1
Introduction

About this Manual

The Adobe pdf form of this manual contains numerous hyperlinks and bookmarks. A reference to a numbered step or a page number (except in the Index) is a live hyperlink; click on it to go immediately to that reference.

> If the bookmarks are not visible, click the "Bookmarks" tab on the left side of the Acrobat Reader window.

This manual has a table of contents and index. To search for a specific word or phrase, you can also use the Adobe Acrobat Reader's text search function.

The OPTIMOD-FM 5500i Digital Audio Processor

Orban's all-digital OPTIMOD-FM 5500i Audio Processor can help you achieve excellent audio quality in FM stereo broadcasting. Because all processing is performed by high-speed mathematical calculations within Freescale digital signal processing chips, the processing has cleanliness, quality, and stability over time and temperature that is unmatched by analog processors.

The 5500i can be used either as a full-featured multiband FM audio processor (including stereo encoder) or as an extremely high-quality stand-alone stereo encoder operating at 64 kHz to 512 kHz sample rates and offering lowpass filtering, overshoot limiting, composite limiting, and an ITU412 multiplex power controller. When used in the latter mode, the 5500i must be driven (usually via an STL) by a full-featured FM audio processor (like Orban's 8500) that incorporates preemphasis-aware HF limiting and peak control.

OPTIMOD-FM 5500i is descended from the industry-standard OPTIMOD-FM audio processors. Thousands of these processors are on the air all over the world. They have proven that the "OPTIMOD sound" attracts and keeps an audience even in the most competitive commercial environment.

Because OPTIMOD-FM incorporates several audio processing innovations exclusive to Orban products, you should not assume that it should be operated in the same way as less sophisticated processors. If you do, you may get disappointing results.

Take a little time now to familiarize yourself with OPTIMOD-FM. A small investment of your time now will yield large dividends in audio quality.

The rest of Section 1 explains how OPTIMOD-FM fits into the FM broadcast facility. Section 2 explains how to install it and set it up. Section 3 tells how to operate OPTIMOD-FM. Sections 4 through 6 provide reference information.

OPTIMOD-FM was designed to deliver a high quality sound while simultaneously increasing the average modulation of the channel substantially beyond that achievable by "recording studio"-style compressors and limiters. Because such processing can exaggerate flaws in the source material, it is very important that the **source audio be as clean as possible.**

For best results, **feed OPTIMOD-FM unprocessed audio.** No other audio processing is necessary or desirable.

If you wish to place level protection prior to your studio/transmitter link (STL), use an Orban studio level control system expressly designed for this purpose. (At the time of this writing, this is the Orban 8200ST OPTIMOD-Studio Compressor/Limiter/HF Limiter/Clipper.) The 8200ST can be adjusted so that it substitutes for the broadband AGC circuitry in OPTIMOD-FM, which is then defeated.

User-Friendly Interface

- An **LCD** and **full-time LED meters** make setup, adjustment and programming of OPTIMOD-FM easy — you can always see the metering while you are adjusting the processor. Navigation is by dedicated buttons, soft buttons (whose functions are context-sensitive), and a large rotary knob. The LEDs show all metering functions of the processing structure (Two-Band or Five-Band) in use.

Absolute Control of Peak Modulation

- The 5500i provides **universal transmitter protection and audio processing** for FM broadcast. It can be configured to interface ideally with any commonly found transmission system in the world.

- The 5500i provides **pre-emphasis limiting** for the two standard pre-emphasis curves of 50µs and 75µs. Its pre-emphasis control is seldom audibly apparent, producing a clean, open sound with subjective brightness matching the original program.

- The 5500i achieves extremely tight **peak control** at all its outputs — analog left/right, AES3 left/right, and composite baseband.

- By integrating the **stereo encoder** with the audio processing, the 5500i eliminates the overshoot problems that waste valuable modulation in traditional external encoders. The stereo encoder has **two outputs with independent level**

controls, each capable of driving 75Ω in parallel with 47,000pF, (100ft/30m of coaxial cable).

- The 5500i prevents aliasing distortion in subsequent stereo encoders or transmission links by providing **bandwidth-limiting and overshoot-compensated** 15 kHz low-pass filters ahead of the 5500i's audio outputs and stereo encoder.

- **Anti-aliased clippers** running at 256 kHz sample rate prevent any trace of "digital clipper" sound.

- The stereo encoder's stereo subchannel modulator can operate in normal double sideband mode and in an experimental **compatible single sideband mode** that is offered to enable users to compare and assess the two modes. See *SSB Stereo Encoder Operation* on page 3-9.

Flexible Configuration

- The 5500i includes **analog** and **AES3 digital** inputs and outputs. Both digital input and digital output are equipped with sample-rate converters and can operate at 32 kHz, 44.1 kHz, 48, 88.2, and 96 kHz sample rates. The pre-emphasis status and output levels are separately adjustable for the analog and digital outputs.

- The 5500i has an **internal, DSP-based stereo encoder** (with a patented **"half-cosine interpolation" composite limiter** operating at 512 kHz sample rate) to generate the pilot tone stereo baseband signal and control its peak level. The composite limiter is a unique, "you can only do this in DSP" process that beats composite clippers by **preserving stereo imaging** while **fully protecting the stereo pilot tone, RDS/RBDS, and subcarriers**.

- The analog inputs are **transformerless, balanced 10kΩ instrumentation-amplifier circuits**, and the analog outputs are transformerless balanced, and floating (with 50Ω impedance) to ensure highest transparency and accurate pulse response.

- A built-in **RDS/RBDS encoder** supports the most important RDS features and can be associated with processing presets so that mixed-format stations can automatically update the "program type" field to complement the programming by recalling a audio processing preset for a given program type.

- The 5500i has **two independent composite baseband outputs** with digitally programmable output levels. Robust line drivers enable them to drive 100 feet of RG-59 coaxial cable without audible performance degradation.

- The 5500i has two **subcarrier inputs** that are mixed with the output of OPTIMOD-FM's stereo encoder before application to the composite output connectors. One input can be re-jumpered to provide a 19 kHz pilot reference out-

put. Rear-panel accessible PC-board-mounted trim pots allow the user to adjust the sensitivities of the two SCA inputs, allowing both inputs to accommodate subcarrier generators with output levels as low as 100 mV p-p.

- The 5500i precisely **controls the audio bandwidth** to 15 kHz. This prevents overshoots in uncompressed digital links operating at a 32 kHz-sample rate and prevents interference to the pilot tone and RDS (or RBDS) subcarrier.

- The 5500i has a defeatable **multiplex power limiter** that controls the multiplex power to ITU-R BS412 standards. An adjustable threshold allows a station to achieve maximum legal multiplex power even if the downstream transmission system introduces peak overshoots into the 5500i-processed signal. Because this limiter closes a feedback loop around the audio processing, it allows the user **to adjust the processor's subjective setup controls freely** without violating BS412 limits, regardless of program material. The multiplex power limiter acts on all outputs (not just the composite output). It reduces clipper drive when it reduces power, simultaneously reducing clipping distortion. To prevent audible gain pumping, a user-adjustable gain offset control allows the user to minimize the amount of gain control that the controller performs.

- The 5500i has a **Wordclock/10 MHz Sync Reference Input (**called REF IN), which can be used to lock the stereo pilot tone to a high precision external reference like a GPS-based frequency standard. This facilitates using the 5500i in single-frequency network applications.

- The 5500i can **delay its output** by as much as 16 seconds. This delay can be used as the **diversity delay** in HD Radio™ installations, which allows the 5500i's stereo encoder (including composite limiter) to be used in an HD Radio installation.

- All input, output, and power connections are **rigorously RFI-suppressed** to Orban's traditional exacting standards, ensuring trouble-free installation.

- The 5500i is designed and certified to **meet all applicable international safety and emissions standards**.

Adaptability through Multiple Audio Processing Structures

- A **processing structure** is a program that operates as a complete audio processing system. Only one processing structure can be on-air at a time. OPTIMOD-FM realizes its processing structures as a series of high-speed mathematical computations made by Digital Signal Processing (DSP) chips.

- The 5500i features four processing structures: **Stand-Alone Stereo Encoder**, **Optimum Five-Band** (or "Multiband"; 15 ms delay) for a consistent, "processed" sound, free from undesirable side effects, **Ultra-Low-Latency Five-Band** (5 ms delay) for environments where talent monitors live off-air and they object

to the delay of Optimum Five-Band, and **Two-Band** for a transparent sound that preserves the frequency balance of the original program material. A special Two-Band preset creates a no-compromise "Protect" function that is functionally similar to the "**Protect**" structures in earlier Orban digital processors. The Optimum Five-Band and the Two-Band structures can be switched via a mute-free crossfade.

Note: Switching to or from the Ultra-Low Latency Five-Band structure causes the audio to mute for about two seconds because the DSP code must be reloaded.

- The 5500i **can increase the density and loudness** of the program material by multiband compression, limiting, and clipping. This improves the consistency of the station's sound and increasing loudness and definition remarkably, without producing unpleasant side effects.

- The 5500i **rides gain** over an adjustable range of up to 25 dB, compressing dynamic range and compensating for both operator gain-riding errors and gain inconsistencies in automated systems.

- The 5500i's Two-Band processing structure is **phase-linear** to maximize audible transparency.

- The 5500i can **import and run any 8300, 8400, or 8500 "LL" (Low-Latency) preset** via the 5500i PC Remote application. This means that you can use an 8300, 8400, or 8500 to develop presets for 5500i if you do not use features in the other processors not supported by the 5500i. (If you try to import a preset that uses features unsupported by 5500i, the 5500i will interpret that preset as best it can by using the available 5500i features — see *To Import Archived 8300, 8400, 8500 and 5500i Presets into Your* 5500i *on page 3*-71 for details.)

Controllable

- Starting with v1.1 software, **silence alarm** and **digital audio fault tally** outputs are available in both audio processing and stand-alone stereo encoder modes.

- The 5500i **can be remote-controlled** by 5-12V pulses applied to eight programmable, optically-isolated "general-purpose interface" (GPI) ports available at the REMOTE INTERFACE connector on the rear panel.

- **5500i PC Remote software** is a graphical application that runs under Windows 2000/XP/Vista/7. It communicates with a given 5500i **via TCP/IP** over **modem, direct serial,** and **Ethernet** connections. You can configure PC Remote to switch between many 5500is via a convenient organizer that supports giving any 5500i an alias and grouping multiple 5500is into folders. Clicking a 5500i's icon causes PC Remote to connect to that 5500i through an Ethernet network, or initiates a Windows Dial-Up or Direct Cable Connection if appropriate. The PC Re-

mote software allows the user to access all 5500i features (including advanced controls not available from the 5500i's front panel), and allows the user to archive and restore presets, automation lists, and system setups (containing I/O levels, digital word lengths, GPI functional assignments, etc.).

- OPTIMOD-FM contains a versatile **real-time clock**, which allows automation of various events (including recalling presets) at pre-programmed times. The clock can be set automatically from an Internet timeserver.

- A Bypass Test Mode can be invoked locally, by remote control (from either the 5500i's GPI port or the 5500i PC Remote application), or by automation to permit broadcast system **test and alignment** or "proof of performance" tests.

- OPTIMOD-FM contains a built-in **line-up tone generator**, facilitating quick and accurate level setting in any system.

- OPTIMOD-FM's **software can be upgraded** by running Orban-supplied downloadable upgrade software on a PC. The upgrade can occur remotely through the 5500i's Ethernet port or serial port (connected to an external modem), or locally (by connecting a Windows® computer to the 5500i's serial port through the supplied null modem cable).

- The **SNMP** (Simple Network Management Protocol) features allow you to monitor your Optimod's status and to send Alarm notifications via your Optimod's Ethernet connection to your network.

Stand-Alone Stereo Encoder Operation

- Starting with v1.1 software, improved DSP code allows changing between normal two-band and five-band audio processor modes and stand-alone stereo encoder modes via **a smooth cross-fade**. This facilitates switching between preprocessed network feeds (where only overshoot limiting is needed) and local origination (where full audio processing is required).

  Switching between UL presets and two-band, five-band, or stand-alone stereo encoder presets still requires DSP code to be reloaded, which causes the audio to mute for about one second.

- The **sample rate is 64 kHz and multiples thereof**, up to 512 kHz. The internal audio bandwidth is high enough to prevent overshoot caused by spectral truncation of the left/right input signals that are band-limited to 18 kHz or lower.

- 15, 16, or 17 kHz linear-phase **lowpass filtering** can be applied to the input signal. To minimize input/output delay, this filter can be bypassed, which is appropriate if the input signal is correctly band-limited by the audio processor driving the 5500i.

- A **left/right domain overshoot limiter** is available. This combines look-ahead and band-limited clipping techniques to control STL-induced overshoots while minimizing artifacts.

- A **dual-mode composite limiter** is available. The composite limiter uses a unique, "you can only do this in DSP" process that beats composite clippers by **preserving stereo imaging** while **fully protecting the stereo pilot tone, RDS/RBDS, and subcarriers**. It can operate in either "Half-Cosine Interpolation" mode or conventional hard clipper mode. The "Half-Cosine" mode provides better separation and preservation of stereo imaging, while the "Hard" mode provides brighter sound because it creates waveforms that are closer to square waves. Both modes provide excellent spectral protection of the pilot tone and subcarrier regions. To ensure accurate peak control, the limiter operates at 512 kHz sample rate.

- A high-accuracy **ITU412 multiplex power controller** is available, with user control over the multiplex power threshold. This allows you to compensate for overshoots in the signal path upstream from the 5500i, preventing excessive reduction of the multiplex power.

- The input signal can be **flat or pre-emphasized** to 50 µs or 75 µs.

- The 5500i can apply **J.17 de-emphasis** to the input signal.

- Versatile **remote control** is available via RS232 serial, GPI, and Ethernet.

- All normal 5500i **inputs and outputs** are available, including **analog and digital inputs, two composite outputs** with independent level controls, and **two subcarrier inputs** (one of which can be repurposed to emit a **19 kHz pilot reference output** for RDS/RBDS generators).

Presets in OPTIMOD-FM

There are two distinct kinds of presets in OPTIMOD-FM: **factory presets** and **user presets**.

Factory Presets

The Factory Presets are our "factory recommended settings" for various program formats or types. The description indicates the processing structure and the type of processing. Each Factory Preset on the Preset list is really a library of more than 20 separate presets, selected by navigating to *Modify* PROCESSING > LESS-MORE and using the LESS-MORE control to adjust OPTIMOD-FM for less or more processing. The factory presets are listed and described starting on page 3-18.

Factory Presets are stored in OPTIMOD-FM's non-volatile memory and cannot be erased. You can change the settings of a Factory Preset, but you must then store those settings as a User Preset, which you are free to name as you wish. The Factory Preset remains unchanged.

To select "audio processor mode" or "stand-alone stereo encoder mode," recall a Factory or User Preset that uses this mode. Starting with V1.1 software, the 5500i will automatically cross-fade between modes. Note that an audio mute will still occur when switching to and from a "UL" (ultra-low-latency) preset because this also requires DSP code to be reloaded.

User Presets

User Presets permit you to change a Factory Preset to suit your requirements and then store those changes.

You can store more than 100 User Presets, limited only by available memory in your 5500i (which will vary depending on the version of your 5500i's software). You can give your preset a name up to 18 characters long.

User Presets cannot be created from scratch. You must always start by recalling a Factory Preset. Make the changes and then store your modified preset as a User Preset. You can also recall a previously created user preset, modify it, and save it again, either overwriting the old version or saving under a new name. In all cases, the original Factory Preset remains for you to return to if you wish.

User Presets inherit the structure of their parent Factory Presets (Five-Band, Two-Band, Ultra-Low-Latency Five-Band, or Stand-Alone Stereo Encoder). The *only* way you can choose the structure of a User preset is to edit it from a Factory preset having that structure (or to edit it from an older User Preset having the desired structure). You cannot change the structure that an existing User Preset uses.

User Presets are stored in non-volatile memory that does not require battery backup. *To Create or Save a User Preset* on page 3-16 has more about User Presets.

Input/Output Configuration

OPTIMOD-FM simultaneously accommodates:

- Digital AES3 left/right inputs and outputs.
- Analog left/right inputs and outputs.
- Composite stereo outputs.
- Subcarrier (SCA and RDS/RBDS) inputs.
- A sync reference input (called REF IN) that can accept 10 MHz or 1 x wordclock (32, 44.1, 48, 88.2, and 96 kHz) and lock the digital output sample rate and the

19 kHz pilot tone frequency to this input. Do not apply an AES3 signal to this input.

Digital AES3 Left/Right Input/Output

OPTIMOD-FM provides digital and analog inputs and outputs. You select whether OPTIMOD-FM uses the digital or analog input either locally or by remote interface. If OPTIMOD-FM is set to accept a digital input and the feed fails, OPTIMOD-FM will automatically switch back to the analog input.

The digital input and output conform to the professional AES3 standard. They both have sample rate converters to allow operation at 32, 44.1, 48, 88.2, and 96 kHz sample frequency.

The left/right digital input is on one XLR-type female connector on the rear panel; the left/right digital output is on one XLR-type male connector on the rear panel.

Level control of the AES3 input is accomplished via software control through System Setup (see step 5 on page 2-30) or through PC Remote.

Both analog and digital outputs are active continuously.

The 5500i's output sample rate can be locked either to the 5500i's internal crystal clock or to the sample rate present at its AES3 input.

The 5500i can apply J.17 de-emphasis to signals applied to its digital input and J.17 pre-emphasis to the processed signal emitted from its digital output. J.17 is a 6 dB/octave shelving pre-emphasis/de-emphasis standard with break points at 400 Hz and 4 kHz. It is used mainly in older studio/transmitter links that use NICAM technology. The 5500i's provisions for J.17 make it fully compatible with systems using this standard.

When the 5500i is operated as a stand-alone stereo encoder, the analog and digital outputs emit the same signal that drives the 5500i's stereo encoder DSP block. This signal may be lowpass filtered and/or protection-limited, depending on control settings in the active preset. The level, de-emphasis, and other parameters of these outputs are set in System Setup and are the same regardless of whether the 5500i is operating in its audio processor or stand-alone stereo encoder modes.

Analog Left/Right Input/Output

The left and right analog inputs are on XLR-type female connectors on the rear panel. Input impedance is greater than 10kΩ; balanced and floating. Inputs can accommodate up to +27 dBu (0 dBu = 0.775Vrms).

The left and right analog outputs are on XLR-type male connectors on the rear panel. Output impedance is 50Ω; balanced and floating. The outputs can drive 600Ω or higher impedances, balanced or unbalanced. The peak output level is adjustable from –6 dBu to +24 dBu.

Level control of the analog inputs and outputs is accomplished via software control through System Setup (see step 3 on page 2-29 and step 8 on page 2-32) or through PC Remote.

Stereo Analog Baseband Composite Output

The stereo encoder has two unbalanced analog baseband outputs on two BNC connectors on the rear panel. Each output can be strapped for 0 or 75Ω source impedance and can drive up to 16dBu (±13.82V peak) into 75Ω in parallel with up to 0.047μF (100ft/30m of RG-59/U cable) before any significant audible performance degradation occurs.

See the footnote on page 1-15 and refer to Figure 2-3 on page 2-8.

Independent level control of each output is available via software (see step 6 on page 2-31.

Subcarriers

The stereo encoder has two unbalanced 600Ω subcarrier (SCA) inputs with rear-panel BNC connectors to accept any subcarrier at or above 23 kHz. The subcarriers are mixed into each composite output and their level is not affected by the composite level control for that output. The 5500i does not digitize subcarriers; the mixing occurs after D/A conversion and is analog.

Subcarrier inputs sum into the composite baseband outputs. Rear-panel accessible PC-board-mounted trim pots allow the user to adjust the sensitivities of the two SCA inputs from <100 mV p-p to >10 V p-p to produce 10% injection with respect to 100% modulation = 4 V p-p at the 5500i's composite outputs (the factory setting is 4 V p-p to produce 10% injection). Thus both inputs accommodate subcarrier generators with output levels as low as 100 mV p-p.

The correct peak level of the stereo program applied to the stereo encoder sometimes depends on the number of subcarriers in use. Some regulatory authorities require that total baseband peak modulation be maintained within specified limits. The 5500i's remote control feature allows you to reduce the stereo main level by connecting an on/off signal from your subcarrier generator (See page 2-7). You define the amount of reduction in percent using the procedure in step 21 on page 2-21. See page 2-42 for information on programming the remote control.

A jumper (J6) on the circuit board can reconfigure the SCA 2 input to provide the stereo pilot tone only, which can provide a pilot reference for an RDS subcarrier generator.

Remote Control Interface

The Remote Control Interface is a set of eight optically-isolated GPI inputs on a DB-25 connector, which can be activated by 5-12V DC. They can control various functions of the 5500i:

- Recall any Factory Preset, User Preset, Test Mode state (Bypass or Tone), or exit from a Test Mode to the previous processing preset.
- Switch the stereo encoder to stereo, mono from left, mono from right, or mono from sum audio input. This also determines the feed to the entire processing chain so that facilities that do not use the 5500i's stereo encoder can change stereo/mono mode and select the source when in mono mode.
- Switch the 5500i to use either the analog input or the digital input.
- Mute any output configured to emit the low-delay monitor signal.
- Independently activate and defeat the diversity delay applied to the analog, digital, and composite outputs.
- Reduce the stereo main and subchannel modulation to compensate for transmitter overshoot and subcarrier inputs (SCAs).

  The remote control of overshoot compensation and SCA modulation (see page 2-42) is not latching. You must supply a continuous current to the programmed remote input to hold the gain at its compensated level. Use the status outputs of your transmitter and/or SCA generators to provide the switching signal so the compensation will automatically follow the transmitter and/or subcarrier generator on the air.
- Reset the 5500i's internal clock to the nearest hour or to midnight.

The tally outputs can be programmed to indicate the following:

- Input: Analog: Indicates that the 5500i is processing audio from its analog input.
- Input: Digital: Indicates that the 5500i is processing audio from its AES3 digital input.
- Analog Input Silent: Indicates that the level at either or both analog input channels is below the threshold set in step (A) on page 2-27.
- AES Input Silent: Indicates that the level at either or both digital input channels is below the threshold set in step in step (A) on page 2-27.
- AES Input Error: Indicates that the 5500i's AES input receiver chip has detected a problem with the data being received such that the data is unusable. When the chip detects such an error, it automatically switches the input to Analog.
- No Function: Tally output is disabled.

You can reconfigure the functions of the inputs and outputs via System Setup. For example, if you are not using the stereo encoder, the three inputs ordinarily dedicated to controlling the state of the stereo encoder can instead be re-configured to call three additional presets.

See page 2-42 for information on programming the remote control interface.

Computer Interface

On the rear panel of the 5500i are an RS-232 serial port and an Ethernet port for interfacing to IBM-compatible PCs. These computer interfaces support remote control and metering, and allow downloading software upgrades.

Each 5500i package ships with 5500i PC Remote software, an application for any IBM-compatible PC running Microsoft Windows 2000 (Service Pack 3 or higher), XP, Vista, or 7. 5500i PC Remote permits you to adjust any 5500i preset by remote control or to do virtually anything else that you can do from the 5500i's front panel controls. The program displays all of the 5500i's LCD meters on the computer screen to aid remote adjustment.

RS-232 Serial Port

5500i PC Remote can communicate at up to 115 kbps via modem or direct connection between the computer and the 5500i through their RS-232 serial ports.

RJ45 Ethernet Connector

The 5500i can be connected to any Ethernet network that supports the TCP/IP protocol.

See *Networking and Remote Control* on page 2-50 for more information.

Wordclock/10 MHz Sync Reference Input

The sync reference input (labeled REF IN) appears on a female BNC jack grounded to the 5500i's chassis. It accepts a 1x 5V p-p squarewave wordclock signal at 32, 44.1, 48, 88.2, or 96 kHz, or a 10 MHz sinewave or squarewave signal, 0.5 to 5 V peak. 10 MHz is a common output frequency produced by GPS and rubidium frequency standards. You can configure the 5500i to lock its 19 kHz pilot tone and output sample frequency to this input.

The sample frequency at the 5500i's digital output does not have to be the same as the reference frequency to be locked to it. If the output frequency is different, the output sample frequency will be the product of a quotient of integers times the reference frequency. For example, if the reference frequency is 96 kHz and the output frequency is set to 32 kHz, the actual output frequency will be 1/3 x the reference frequency. If the reference frequency is 48 kHz and the output frequency is set to 44.1 kHz, the actual output frequency will be 147/160 x the reference frequency.

Do not apply an AES3 signal to this input.

Location of OPTIMOD-FM

Optimal Control of Peak Modulation Levels

The audio processing circuitry in OPTIMOD-FM produces a signal that is pre-emphasized to either the 50μs or 75μs standard pre-emphasis curve. It is precisely and absolutely high-frequency-controlled and peak-controlled to prevent over-modulation, and is filtered at 15 kHz to protect the 19 kHz pilot and prevent distortion caused by aliasing-related non-linear crosstalk. If this signal is fed directly into a stereo encoder, peak modulation levels on the air will be precisely controlled. However, if the audio processor's signal is fed to the stereo encoder through any circuitry with frequency response errors and/or non-constant group delay, the peaks will be magnified. Peak modulation will increase, but average modulation will not. The modulation level must therefore be reduced to accommodate the larger peaks. Reduced average modulation level will cause reduced loudness and a poorer signal-to-noise ratio at the receiver.

Landline equalizers, transformers, and 15 kHz low-pass filters and pre-emphasis networks in stereo encoders typically introduce frequency response errors and non-constant group delay. There are three criteria for preservation of peak levels through the audio system:

1) The system group delay must be essentially constant throughout the frequency range containing significant energy (30-15,000Hz). If low-pass filters are present, this may require the use of delay equalization. The deviation from linear-phase must not exceed $\pm 10°$ from 30-15,000Hz.

2) The low-frequency –3 dB point of the system must be placed at 0.15Hz or lower (this is not a misprint!). This is necessary to ensure less than 1% overshoot in a 50Hz square wave and essentially constant group delay to 30Hz.

3) Any pre-emphasis used in the audio transmission system prior to the stereo encoder must be canceled by a precisely complementary de-emphasis: Every pole and zero in the pre-emphasis filter must be complemented by a zero and pole of identical complex frequency in the de-emphasis network. An all-pole de-emphasis network (like the classic series resistor feeding a grounded capacitor) is not appropriate. However, this network could be corrected by adding a second resistor between ground and the capacitor, which would introduce a zero.

Low-pass filters (including anti-aliasing filters in digital links), high-pass filters, transformers, distribution amplifiers, and long transmission lines can all cause the above criteria to be violated, and must be tested and qualified. It is clear that the above criteria for optimal control of peak modulation levels are most easily met when the audio processor directly feeds the stereo encoder. In the 5500i, no circuit elements that might distort the shape of the waveform are interposed between the audio processor and the stereo encoder. We therefore recommend using the 5500i with its built-in stereo encoder whenever practical.

Best Location for OPTIMOD-FM

The best location for OPTIMOD-FM is as close as possible to the transmitter, so that its stereo encoder output can be connected to the transmitter through a circuit path that introduces the least possible change in the shape of OPTIMOD-FM's carefully peak-limited waveform — a short length of coaxial cable. If this is impossible, the next best arrangement is to feed the 5500i's AES3 digital output through an all-digital, uncompressed path to the transmitter's exciter.

Use the 5500i's left and right analog audio outputs in situations where the stereo encoder and exciter are under the jurisdiction of an independent transmission authority, and where the programming agency's jurisdiction ends at the interface between the audio facility and the link connecting the audio facility to the transmitter. (The link might be telephone/post lines, analog microwave radio, or various types of digital paths.) This situation is not ideal because artifacts that cannot be controlled by the audio processor can be introduced by the link to the transmitter, by transmitter peak limiters, or by the external stereo encoder.

If the transmitter is not accessible:

All audio processing must be done at the studio and you must tolerate any damage that occurs later. If you can obtain a broadband (0-75 kHz) phase-linear link to the transmitter, and the transmitter authority will accept the delivery of a baseband encoded signal, use the 5500i's internal stereo encoder at the studio location to feed the STL. Then feed the output of the STL receiver directly into the transmitter's exciter with no intervening processing.

If an uncompressed AES3 digital link is available to the transmitter, this is also an excellent means of transmission, although it will not pass the effects of the 5500i's composite processor (if you are using it). However, if the digital link employs lossy compression, it will disturb peak levels.

If only an audio link is available, use the 5500i's left and right audio outputs and feed the audio, without pre-emphasis, directly into the link. If possible, request that any transmitter protection limiters be adjusted for minimum possible action — OPTIMOD-FM does most of that work. Transmitter protection limiters should respond only to signals caused by faults or by spurious peaks introduced by imperfections in the link. To ensure maximum quality, all equipment in the signal path after the studio should be carefully aligned and qualified to meet the appropriate standards for bandwidth, distortion, group delay and gain stability, and such equipment should be re-qualified at reasonable intervals. (See *Optimal Control of Peak Modulation Levels* on page 1-13).

If the transmitter is accessible:

You can achieve the most accurate control of modulation peaks by locating OPTIMOD-FM at the transmitter site and then using its stereo encoder to drive the transmitter. You can usually also obtain good results by locating OPTIMOD-FM at the studio and connecting the baseband output of its stereo encoder to the transmitter through a composite baseband STL (see page 1-17). However, many composite baseband STLs do not control peaks perfectly because of bounce (see page 1-19), and lo-

cating OPTIMOD-FM at the transmitter site (where it can control peaks just prior to the transmitter's RF exciter) is thus likely to maximize loudness.

Because OPTIMOD-FM controls peaks, it is irrelevant whether the audio link feeding OPTIMOD-FM's input terminals is phase-linear. However, the link should have low noise, the flattest possible frequency response from 30-15,000Hz, and low non-linear distortion.

We strongly recommend that you use the 5500i's internal stereo encoder to feed the output of the encoder directly to the baseband input of the exciter through less than 100 feet (30 meters) of coaxial cable. 100 feet of coaxial cable (assuming 30pF/foot capacitance) will reduce measured separation at 15 kHz (worst case) to approximately 55 dB. (See Figure 2-3 on page 2-8.) This separation is comfortably above the separation (approximately 20 dB) that starts to cause perceptible changes in the stereo image.[1]

You will achieve a louder sound on the air, with better control of peak modulation, than if you use most external stereo encoders.

An exception is Orban's 5518 stereo encoder, which does not add overshoot and contains its own overshoot limiter and composite limiter equivalent to the one in the 5500i when operated in its stand-alone stereo encoder mode.

The shorter the baseband cable from OPTIMOD-FM to exciter, the less likely that ground loops or other noise problems will occur in the installation. If you require a long cable run, you can use a Jensen JT-123-BMCF transformer[2] to break any ground loops. This transformer will ordinarily cure even the most stubborn hum or noise caused by the composite connection between OPTIMOD-FM and the exciter. For connection instructions, please refer to the Orban CIT25 Composite Isolation Transformer schematic diagram, which is shown on page 12 of the CIT25 manual. This is available from: ftp.orban.com/CIT25/CIT25_Instructions.pdf (Please note that Orban no longer manufactures the CIT25, which used the Jensen transformer.)

If a separate stereo encoder must be used, feed the encoder directly from the 5500i's left and right analog or (preferably) digital outputs. If possible, bypass the pre-

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[1] Julie M. Adkins and Robert D. Sorkin: "Effect of Channel Separation on Earphone-Presented Tones, Noise, and Stereophonic Material," *J. Audio Engineering Society*, vol. 33 pp. 234-239, 1985.

Subjects listened to 500-Hz tones, broadband noise, and stereophonic program material through earphones and adjusted the channel separation, via a manual control, until the degradation of the spatial effect became detectable. Mean channel separations ranged from 10 to 15.9 dB for the musical selections employed and from 13.7 to 16.8 dB for the noise and tonal stimuli. The results are discussed in terms of existing data on detectable stereo separation and on the discrimination of interaural time differences. [Abstract ©Audio Engineering Society, Inc.]

[2] http://www.jensen-transformers.com/wp-content/uploads/2014/08/jt-123-bmcf.pdf

emphasis network and the input low-pass filters in the encoder so that they cannot introduce spurious peaks. Because of their special design, OPTIMOD-FM's pre-emphasis network and low-pass filters perform the same functions while retaining tight peak control.

Studio-Transmitter Link

Transmission from Studio to Transmitter

There are five types of studio-transmitter links (STLs) in common use in broadcast service: uncompressed digital, digital with lossy compression (like MPEG, Dolby®, or APT-x®), microwave, analog landline (telephone/post line), and audio subcarrier on a video microwave STL.

STLs are used in three fundamentally different ways. They can either (1) pass unprocessed audio for application to the 5500i's input, (2) they can pass the 5500i's peak-controlled analog or digital left and right audio outputs, or (3) they can pass the 5500i's peak-controlled composite stereo baseband output. The three applications have different performance requirements. In general, a link that passes unprocessed audio should have very low noise and low non-linear distortion, but its transient response is not important. A link that passes processed audio does not need as low a noise floor as a link passing unprocessed audio. However, its transient response is critical. At the current state of the art, an uncompressed digital link using digital inputs and outputs to pass audio in left/right format achieves best results. We will elaborate below.

Digital Links

Digital links may pass audio as straightforward PCM encoding, or they may apply lossy data reduction processing to the signal to reduce the number of bits per second required for transmission through the digital link. Such processing will almost invariably distort peak levels, and such links must therefore be carefully qualified before you use them to carry the peak-controlled output of the 5500i to the transmitter. For example, the MPEG Layer 2 algorithm can increase peak levels up to 4 dB at 160kB/sec by adding large amounts of quantization noise to the signal. While the desired program material may psychoacoustically mask this noise, it is nevertheless large enough to affect peak levels severely. For any lossy compression system the higher the data rate, the less the peak levels will be corrupted by added noise, so use the highest data rate practical in your system.

It is practical (though not ideal) to use lossy data reduction to pass unprocessed audio to the 5500i's input. The data rate should be at least of "contribution quality" — the higher, the better. If any part of the studio chain is analog, we recommend using at least 20-bit A/D conversion before encoding.

Because the 5500i uses multiband limiting, it can dynamically change the frequency response of the channel. This can violate the psychoacoustic masking assumptions made in designing the lossy data reduction algorithm. Therefore, you need to leave "headroom" in the algorithm so that the 5500i's multiband processing will not un-

mask quantization noise. This is also true of any lossy data reduction applied in the studio (such as hard disk digital delivery systems).

For MPEG Layer 2 encoding, we recommend 384 kB/second or higher.

If you use a lossy codec between the Optimod's output and the transmitter's input, the codec must see a "flat" signal to ensure that its psychoacoustic model works correctly. Hence, the Optimod output driving the codec must be set to FLAT, which applies deemphasis to the output of the Optimod's preemphasis processing. 50µs or 75µs preemphasis must then be applied to the codec's output signal. This usually occurs in the FM transmitter's stereo encoder or in a stand-alone stereo encoder like an Orban 5518.

Some links may use straightforward PCM (pulse-code modulation) without lossy data reduction. If you connect to these through an AES3 digital interface, these can be very transparent provided they do not truncate the digital words produced by the devices driving their inputs. Because the 5500i's output is tightly band-limited to 15 kHz, it can be passed without additional overshoot by equally well by any link with 32 kHz or higher sample frequency.

Currently available sample rate converters use phase-linear filters (which have constant group delay at all frequencies). If they do not remove spectral energy from the original signal, the sample rate conversion, whether upward or downward, will not add overshoot to the signal. This is not true of systems that are not strictly band-limited to 15 kHz, where downward sample rate conversion will remove spectral energy and will therefore introduce overshoot.

If the link does not have an AES3 input, you must drive its analog input from the 5500i's analog output. This is less desirable because the link's analog input circuitry may not meet all requirements for passing processed audio without overshoot.

NICAM is a sort of hybrid between PCM and lossy data reduction systems. It uses a block-companded floating-point representation of the signal with J.17 pre-emphasis.

Older technology converters (including some older NICAM encoders) may exhibit quantization distortion unless they have been correctly dithered. Additionally, they can exhibit rapid changes in group delay around cut-off because their analog filters are ordinarily not group-delay equalized. The installing engineer should be aware of all of these potential problems when designing a transmission system.

Any problems can be minimized by always driving a digital STL with the 5500i's AES3 digital output, which will provide the most accurate interface to the STL. The digital input and output accommodate sample rates of 32 kHz, 44.1 kHz, 48 kHz, 88.2 kHz, and 96 kHz.

Composite Baseband Microwave STLs

The composite baseband microwave STL carries the standard pilot-tone stereo baseband, and therefore receives the output of a stereo encoder located at the studio site. The receiver output of the composite STL is the stereo baseband signal, which is

applied directly to the wideband input of the FM broadcast transmitter's exciter. Thus, no stereo encoder is needed at the transmitter.

In general, a composite microwave STL provides good audio quality, as long as there is a line-of-sight transmission path from studio to transmitter of less than 10 miles (16 km). If not, RF signal-to-noise ratio, multipath distortion, and diffraction effects can cause serious quality problems. Where a composite STL is used, use the 5500i's stereo encoder to drive the composite STL transmitter.

Uncompressed digital composite baseband microwave STLs, if properly designed, have excellent performance and we recommend them highly. They are particularly desirable in a 5500i installation because they allow you to use the 5500i's composite limiter to increase on-air loudness. However, the fact that they are digital does not eliminate the requirement that they have low frequency response that is less than 3 dB down at 0.15 Hz. Any such STL should be qualified to ensure that it meets this specification.

Dual Microwave STLs

Dual microwave STLs use two separate transmitters and receivers to pass the left and right channels in discrete form. Dual microwave STLs offer greater noise immunity than composite microwave STLs. However, problems include gain- and phase-matching of the left and right channels, overloads induced by pre-emphasis, and requirements that the audio applied to the microwave transmitters be processed to prevent over-modulation of the microwave system.

Lack of transparency in the path will cause overshoot. Unless carefully designed, dual microwave STLs can introduce non-constant group delay in the audio spectrum, distorting peak levels when used to pass processed audio. Nevertheless, in a system using a microwave STL, the 5500i is sometimes located at the studio and any overshoots induced by the link are tolerated or removed by the transmitter's protection limiter (if any). The 5500i can only be located at the transmitter if the signal-to-noise ratio of the STL is good enough to pass unprocessed audio. The signal-to-noise ratio of the STL can be used optimally if an Orban Optimod-PC 1101, Optimod 1600PCn, Optimod 6300, 8200ST Compressor/Limiter/HF Limiter/Clipper or a 4000 Transmission Limiter protects the link from overload. Of these, the 1101, 1600PCn and 6300 are currently manufactured as of this writing and are the preferred choices because their AGCs are particularly well matched to the AGC in the 5500i.

The 1600PCn has a throughput delay of about 450 ms, which limits its use to installations where talent does not need to monitor off-air through headphones. However, the 1600PCn's AGC provides our latest refinements and is a particularly good choice if this amount of delay is tolerable. Additional features make the 1600PCn useful as a pre-processor for Optimod-FM. These include mono bass summation and left/right phase correction (both of which can reduce multipath distortion) and parallel compression, which brings up low-amplitude program material without compromising the transient impact of high-amplitude material. If the 5500i is located at the transmitter and fed unprocessed audio from a microwave STL, it may be useful to use a companding-type noise reduction system (like dbx Type 2 or Dolby SR) around the link. This will minimize any audible noise buildup caused by compression within the 5500i.

Some microwave links can be modified so that the deviation from linear phase is less than ±10° from 20 Hz to 15 kHz and frequency response is less than 3 dB down at 0.15Hz and less than 0.1 dB down at 20 kHz. This specification results in less than 1% overshoot with processed audio. Many such links have been designed to be easily configured at the factory for composite operation, where an entire FM stereo baseband is passed. The requirements for maintaining stereo separation in composite operation are similar to the requirements for high waveform fidelity with low overshoot. Therefore, most links have the potential for excellent waveform fidelity if they are configured for composite operation (even if a composite FM stereo signal is not actually being applied to the link).

Nevertheless, in a dual-microwave system, the 5500i is usually located at the main FM transmitter and is driven by the microwave receivers. One of Orban's studio level control systems, such as the 8200ST, protects the microwave transmitters at the studio from overload. These units also perform the gain riding function ordinarily executed by the AGC section of the 5500i's processing and optimize the signal-to-noise ratio obtainable from the dual-microwave link.

If the STL microwave uses pre-emphasis, its input pre-emphasis filter will probably introduce overshoots that will increase peak modulation without any increases in average modulation. If the studio level control system is capable of producing a pre-emphasized output, we strongly recommend that the microwave STL's pre-emphasis be defeated and pre-emphasis performed in the studio level control system. This frees the system from potential overshoot. (The Orban 8200ST can be readily configured to produce a pre-emphasized output.)

Further, it is common for a microwave STL to bounce because of a large infrasonic peak in its frequency response caused by an under-damped automatic frequency control (AFC) phase-locked loop. This bounce can increase the STL's peak carrier deviation by as much as 2dB, reducing average modulation. Many commercial STLs have this problem.

Some consultants presently offer modifications to minimize or eliminate this problem. If your exciter or STL has this problem, you may contact Orban Customer Service for the latest information on such services.

Analog Landline (PTT/Post Office Line)

Analog landline quality is extremely variable, ranging from excellent to poor. Whether landlines should be used or not depends upon the quality of the lines locally available, and upon the availability of other alternatives. Due to line equalizer characteristics and phase shifts, even the best landlines tend to veil audio quality slightly. They will certainly be the weakest link in a FM broadcast chain.

Slight frequency response irregularities and non-constant group delay characteristics will alter the peak-to-average ratio, and will thus reduce the effectiveness of any peak limiting performed prior to their inputs.

Using the Orban 8100AST (or 8100A/ST) External AGC with the 5500i

If you have an OPTIMOD-FM 8100A1 (or 8100A or 8100A/1) installation that uses an Orban 8100AST (or 8100A/ST) external AGC at the studio to protect an STL (with the main 8100A, 8100A1 or 8100A/1 chassis at the transmitter), you may wish to continue to use the external AGC to protect the STL when you install the 5500i at the transmitter.

If you are keeping your analog OPTIMOD-FM as a standby processor, you will probably want to use the external AGC to drive both the 5500i and the 8100A1 (also called 8100A/1) transmitter chassis in parallel. This is usually practical. However, complications will occur if you are not using an Orban 8100AXT2 (also called 8100A/XT2) Six-Band Limiter Accessory with your 8100A1, because, to correctly drive a 5500i, the external AGC must be strapped as if it were driving an 8100A1 (or 8100A/1) + 8100AXT2 (or 8100A/XT2) system. Therefore, if you have only an 8100A1 (or 8100A/1), you will have to re-strap the external AGC for operation *without* the XT2 before you can put the standby 8100A1 (or 8100A/1) on the air.

STL and Exciter Overshoot

Earlier in this section, we discussed at length what is required to prevent STLs from overshooting. There are similar requirements for FM exciters. Nevertheless, in some installations some overshoot is inevitable. If this is a problem in your installation, the 5500i's remote control feature offers the means to reduce the peak level of the 5500i's audio output as necessary. This way, you can still use the 5500i's line-up tone to adjust the steady-state deviation to ±75 kHz. Yet, the reduced peak level of the audio emitted from the 5500i ensures that the carrier deviates no further than ±75 kHz after overshoot. This overshoot reduction can be selected on the input/output screen, and the remote operation can be selected in System Setup: Network > Remote.

Using Lossy Data Reduction in the Studio

Many stations are now using lossy data reduction algorithms like MPEG-1 Layer 2 or Dolby AC2 to increase the storage time of digital playback media. In addition, source material is often supplied through a lossy data reduction algorithm, whether from satellite or over landlines. Sometimes, several encode/decode cycles will be cascaded before the material is finally presented to OPTIMOD-FM's input.

All such algorithms operate by increasing the quantization noise in discrete frequency bands. If not psychoacoustically masked by the program material, this noise may be perceived as distortion, "gurgling," or other interference. Psychoacoustic calculations are used to ensure that the added noise is masked by the desired program material and not heard. Cascading several stages of such processing can raise the added quantization noise above the threshold of masking, such that it is heard. In addition, at least one other mechanism can cause the noise to become audible at

the radio. OPTIMOD-FM's multiband limiter performs an "automatic equalization" function that can radically change the frequency balance of the program. This can cause noise that would otherwise have been masked to become unmasked because the psychoacoustic masking conditions under which the masking thresholds were originally computed have changed.

Accordingly, if you use lossy data reduction in the studio, you should use the highest data rate possible. This maximizes the headroom between the added noise and the threshold where it will be heard. Also, you should minimize the number of encode and decode cycles, because each cycle moves the added noise closer to the threshold where the added noise is heard.

About Transmission Levels and Metering

Meters

Studio engineers and transmission engineers consider audio levels and their measurements differently, so they typically use different methods of metering to monitor these levels. The VU meter is an average-responding meter (measuring the approximate RMS level) with a 300ms rise time and decay time; the VU indication usually under-indicates the true peak level by 8 to 14 dB. The Peak Program Meter (PPM) indicates a level between RMS and the actual peak. The PPM has an attack time of 10ms, slow enough to cause the meter to ignore narrow peaks and under-indicate the true peak level by 5 dB or more. The absolute peak-sensing meter or LED indicator shows the true peak level. It has an instantaneous attack time, and a release time slow enough to allow the engineer to read the peak level easily. *Figure 1-2* on page 1-23 shows the relative difference between the absolute peak level, and the indications of a VU meter and a PPM for a few seconds of music program.

Studio Line-up Levels and Headroom

The studio engineer is primarily concerned with calibrating the equipment to provide the required input level for proper operation of each device, and so that all devices operate with the same input and output levels. This facilitates patching devices in and out without recalibration.

For line-up, the studio engineer uses a calibration tone at a studio standard level, commonly called line-up level, reference level, or operating level. Metering at the studio is by a VU meter or PPM (Peak Program Meter). As discussed above, the VU or PPM indication under-indicates the true peak level. Most modern studio audio devices have a clipping level of no less than +21 dBu, and often +24 dBu or more. So the studio standardizes on a maximum program indication on the meter that is lower than the clipping level, so those peaks that the meter does not indicate will not be clipped. Line-up level is usually at this same maximum meter indication. In facilities that use VU meters, this level is usually at 0VU, which corresponds to the studio standard level, typically +4 or +8 dBu.

For facilities using +4 dBu standard level, instantaneous peaks can reach +18 dBu or higher (particularly if the operator overdrives the console or desk). Older facilities with +8 dBu standard level and equipment that clips at +18 or +21 dBu will experience noticeable clipping on some program material.

In facilities that use the BBC-standard PPM, maximum program level is usually PPM4 for music, PPM6 for speech. Line-up level is usually PPM4, which corresponds to +4 dBu. Instantaneous peaks will reach +17 dBu or more on voice.

In facilities that use PPMs that indicate level directly in dBu, maximum program and line-up level is often +6 dBu. Instantaneous peaks will reach +11 dBu or more.

Transmission Levels

The transmission engineer is primarily concerned with the peak level of a program to prevent overloading or over-modulation of the transmission system. This peak overload level is defined differently, system to system.

In FM modulation (FM/VHF radio and television broadcast, microwave or analog satellite links), it is the maximum-permitted RF carrier frequency deviation. In AM modulation, it is negative carrier pinch-off. In analog telephone/post/PTT transmission, it is the level above which serious crosstalk into other channels occurs, or the level at which the amplifiers in the channel overload. In digital, it is the largest possible digital word.

For metering, the transmission engineer uses an oscilloscope, absolute peak-sensing meter, calibrated peak-sensing LED indicator, or a modulation meter. A modulation meter usually has two components — a semi-peak reading meter (like a PPM), and a peak-indicating light, which is calibrated to turn on whenever the instantaneous peak modulation exceeds the overmodulation threshold.

Line-Up Facilities

Metering of Levels

The meters on the 5500i show left/right input levels and composite modulation. Left and right input level is shown on a VU-type scale (0 to –27 dB), while the metering indicates *absolute instantaneous peak* (much faster than a standard PPM or VU meter). The input meter is scaled so that 0 dB corresponds to the absolute maximum peak level that the 5500i can accept (+27 dBu). If you are using the AES3 digital input, the maximum digital word at the input corresponds to the 0 dB point on the 5500i's input meter.

Composite Output Level

The Orban 5500i Audio Processor controls instantaneous, absolute peak levels to a tolerance of approximately ±0.1 dB. Composite modulation is indicated in percentage modulation, absolute instantaneous peak indicating. 100% is calibrated to the

highest composite peak modulation level that the processing will produce, including the pilot tone, under any program, processing, or setup condition (except when the processing is switched to BYPASS, is being operated in stand-alone stereo encoder mode without overshoot limiting, or when the final clipper is defeated in Setup). 100% ordinarily corresponds to ±75 kHz-carrier deviation.

Note that if the 5500i's subcarrier inputs are used, the meter will not indicate the subcarriers' effect on composite modulation because the subcarriers are mixed into the composite signal in the analog domain, after it is metered. Therefore, you must mentally add the subcarriers to the meter indication, or refer to an external, calibrated modulation monitor.

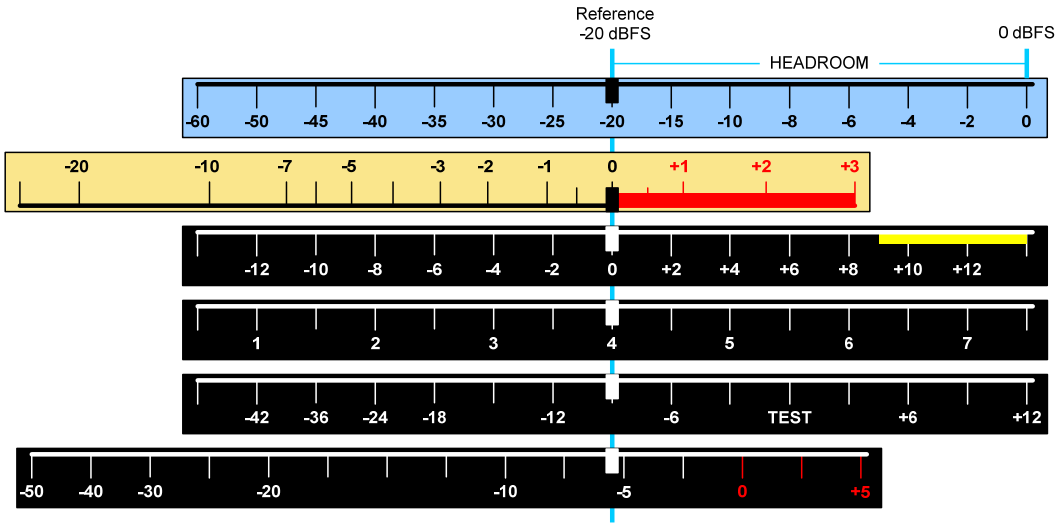


Figure 1-1: Common Audio Meter Scales, Aligned to the Same Reference Level

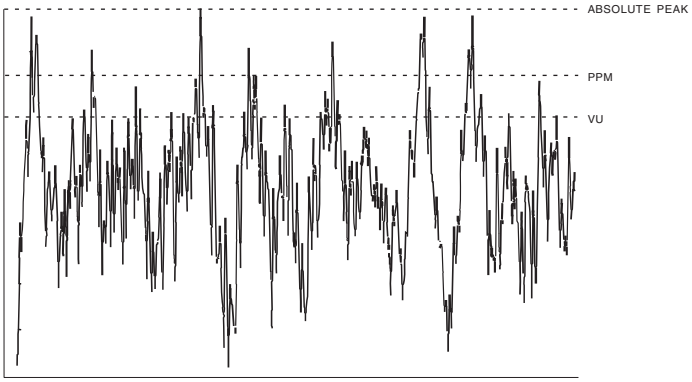


Figure 1-2: Absolute Peak Level, VU and PPM Indications

Built-in Calibrated Line-up Tones

To facilitate matching the output level of the 5500i to the transmission system that it is driving, the 5500i contains an adjustable test tone oscillator that produces sine waves at 5500i's (analog or digital) left, right and composite outputs. The frequency and modulation level of the line-up tones can be adjusted from the front panel (as described in Section 3).

The stereo encoder is calibrated so that 100% left or right modulation will provide 100% modulation of the stereo composite signal, including pilot tone but excluding any SCA subcarriers.

The pilot tone stereo system has an *interleaving* property, which means that the stereo composite modulation is approximately equal to the *higher* of the left or right channels. Because the pilot tone is phase-synchronous with the stereo subcarrier, the composite modulation will actually increase about 2.7% when the modulation is changed from pure single-channel to L+R modulation while the peak audio level is held constant.

When the 5500i's left/right analog output is switched to FLAT, a de-emphasis filter is inserted between output of the 5500i's audio processing and its line output. Thus, as the frequency of the Test Tone is changed, the level at the 5500i's line output will follow the selected de-emphasis curve. In most cases, the pre-emphasis filter in the driven equipment will undo the effect of the 5500i's internal de-emphasis, so the 5500i's output level should be adjusted such that the tone produces 100% modulation of the transmission link as measured after the link's pre-emphasis filter. At 100Hz, switching the de-emphasis out or in will have negligible effect on the level appearing at the 5500i's left and right audio outputs.

You can adjust the frequency and modulation level of the built-in line-up tone. You can use the front panel, the PC Control software, or the opto-isolated remote control interface ports to activate the Test Tone.

Built-in Calibrated Bypass Test Mode

A BYPASS Test Mode is available to transparently pass line-up tones generated earlier in the system. It will also pass program material, with no gain reduction or protection against overmodulation. It can transparently pass any line-up tone applied to its input up to about 130% output modulation, at which point clipping may occur.

Monitoring on Loudspeakers and Headphones

In live operations, highly processed audio often causes a problem with **the DJ or presenter's headphones.** Some talent moving from an analog processing chain will require a learning period to become accustomed to the voice coloration caused by "bone-conduction" comb filtering. This is caused by the delayed headphone sound's mixing with the live voice sound and introducing notches in the spectrum that the talent hears as a "hollow" sound when he or she talks. All digital processors induce this coloration to a greater or lesser extent. Fortunately, it does not cause confusion or hesitation in the talent's performance unless the delay is above the psy-

choacoustic "echo fusion" (Haas) threshold of approximately 20 ms and the talent starts to hear slap echo in addition to frequency response colorations.

The normal delay through the 5500i is about 15 ms. A 15 ms delay is comfortable for most talent because they do not hear echoes of their own voices in their headphones. Further, the 5500i offers a second, ultra-low-latency multiband structure with a delay of about 5 ms. Although this does not offer the same favorable tradeoff between loudness, presence, and low distortion as the optimum multiband structure, it is available for use in situations where a given individual cannot tolerate the 15 ms delay of the optimum structure. (However, management should carefully consider whether compromising the sound of the radio station for its entire audience is an acceptable price for indulging a given personality's demands.)

Because of the availability of both optimum and low latency structures, customers can confidently replace an older, low-delay processor with the 5500i with no studio wiring changes. Moreover, off-air cueing of remote talent is routine.

A better solution to the monitoring conundrum is this: The 5500i's analog outputs can be switched to provide a low-delay monitoring feed while still keeping the optimum multiband structure on-air (by using the digital or composite output to drive the transmitter). The monitor feed has no peak limiting and thus cannot drive a transmitter, but its 5 ms delay is likely to be more comfortable to talent than the 15 ms delay of the optimum processing chain because of less acoustic comb filtering.

If the talent relies principally on headphones to determine whether the station is on the air, simple loss-of-carrier and loss-of-audio alarms should be added to the system when the 5500i's monitor output is used. The 5500i can be interfaced to such alarms through any of its eight its GPI remote control inputs, cutting off the low-delay audio to the talent's phones when an audio or carrier failure occurs.

EAS Test

For stations participating in the Emergency Alert System (EAS) in the United States, broadcast of EAS tones and data can be accomplished in three different ways:

1. **Run EAS tones and data through the 5500i.**

   Note that 5500i processing may not allow the full modulation level as required by EAS standards. It may therefore be necessary to temporarily defeat the 5500i's processing during the broadcast of EAS tones and data. Placing the 5500i in its BYPASS Test Mode can defeat the processing. The BYPASS GAIN control allows a fixed gain trim through the 5500i. See "Test Modes," on page 3-55 for more information.

2. **Place the 5500i in Bypass mode locally.**

   A) Navigate to *Setup* > MODE and set MODE to BYPASS.

You can set the bypass gain with the BYPASS GAIN control located to the right of the MODE control.

B) Begin EAS broadcast.

After the EAS broadcast, resume normal processing:

C) Set the MODE to OPERATE.

This will restore the processing preset in use prior to the Test Mode.

3. **Place the 5500i in Bypass mode by remote control. Then program any two Remote Interface inputs for "Bypass" and "Exit Test," respectively.**

A) Connect two outputs from your station remote control system to the REMOTE INTERFACE connector on the rear panel of the 5500i, according to the wiring diagram in Figure 2-2 on page 2-3.

B) Program two GPI ports for BYPASS and EXIT TEST according to the instructions in *Remote Control Interface Programming* starting on page 2-42.

C) Place the 5500i in bypass mode by remote control.

a) Switch the 5500i into BYPASS mode by a momentary command from your station's remote control to the GPI port programmed as BYPASS.

b) Begin EAS broadcast.

c) When the EAS broadcast is finished, switch the 5500i from BYPASS mode by a momentary command from your station's remote control to the GPI port programmed as EXIT TEST.

You may also choose to insert EAS broadcast tones and data directly into the transmitter, thus bypassing the 5500i for the duration of the EAS tones and data broadcast.

PC Control and Security Passcode

PC software control provides access to OPTIMOD-FM via network, modem or direct (null modem cable) connection, with IBM PC-compatible computers running Windows. PC access is permitted only with a valid user-defined passcode.

PC remote control can be ended from the front panel; this feature effectively prevents simultaneous remote and local control.

See *Security and Passcode Programming* (starting on page 2-39) for more detail.

Warranty, User Feedback

User Feedback

We are very interested in your comments about this product. We will carefully review your suggestions for improvements to either the product or the manual. Please email us at custserv@orban.com.

LIMITED WARRANTY

[Valid only for products purchased and used in the United States]

Orban warrants Orban products against defects in material or workmanship for a period of five years from the date of original purchase for use, and agrees to repair or, at our option, replace any defective item without charge for either parts or labor.

IMPORTANT: This warranty does not cover damage resulting from accident, misuse or abuse, lack of reasonable care, the affixing of any attachment not provided with the product, loss of parts, or connecting the product to any but the specified receptacles. This warranty is void unless service or repairs are performed by an authorized service center. No responsibility is assumed for any special, incidental, or consequential damages. However, the limitation of any right or remedy shall not be effective where such is prohibited or restricted by law.

Simply take or ship your Orban products prepaid to our service department. Be sure to include a copy of your sales slip as proof of purchase date. We will not repair transit damage under the no-charge terms of this warranty. Orban will pay return shipping. (See *Technical Support* on page 5-13.)

No other warranty, written or oral, is authorized for Orban Products.

This warranty gives you specific legal rights and you may have other rights that vary from state to state. Some states do not allow the exclusion of limitations of incidental or consequential damages or limitations on how long an implied warranty lasts, so the above exclusions and limitations may not apply to you.

INTERNATIONAL WARRANTY

Orban warrants Orban products against evident defects in material and workmanship for a period of five years from the date of original purchase for use. This warranty does not cover damage resulting from misuse or abuse, or lack of reasonable care, or inadequate repairs performed by unauthorized service centers. Performance of repairs or replacements under this warranty is subject to submission of this Warranty/Registration Card, completed and signed by the dealer on the day of purchase, and the sales slip. Shipment of the defective item for repair under this warranty will be at the customer's own risk and expense. This warranty is valid for the original purchaser only.

Section 2
Installation

Installing the 5500i

Allow about 2 hours for installation.

Installation consists of: (1) unpacking and inspecting the 5500i, (2) mounting the 5500i in a rack, (3) connecting inputs, outputs and power, (4) optional connecting of remote control leads and (5) optional connecting of computer interface control leads.

When you have finished installing the 5500i, proceed to "Quick Setup," on page 2-14.

DO NOT connect power to the unit yet!

1. Unpack and inspect.

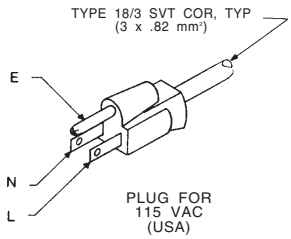
A) If you note obvious physical damage, contact the carrier immediately to make a damage claim. Packed with the 5500i are:

Quantity	Item
1	Operating Manual
2	Line Cords (domestic, European)
4	Rack-mounting screws, 10-32 x ¾—with washers, #10
1	PC Remote Software CD

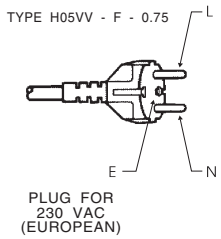
B) Save all packing materials! If you should ever have to ship the 5500i (e.g., for servicing), it is best to ship it in the original carton with its packing materials because both the carton and packing material have been carefully designed to protect the unit.

C) Complete the Registration Card and return it to Orban. (please)

> The Registration Card enables us to inform you of new applications, performance improvements, software updates, and service aids that may be developed, and it helps us respond promptly to claims under warranty without our having to request a copy of your bill of sale or other proof of purchase. Please fill in the Registration Card and send it to us today. (The Registration Card is located after the cover page).
>
> Customer names and information are confidential and are not sold to anyone.



CONDUCTOR		WIRE COLOR	
		NORMAL	ALT
L	LINE	BROWN	BLACK
N	NEUTRAL	BLUE	WHITE
E	EARTH GND	GREEN-YELLOW	GREEN



CONDUCTOR		WIRE COLOR
L	LINE	BROWN
N	NEUTRAL	BLUE
E	EARTH GND	GREEN-YELLOW

Figure 2-1: AC Line Cord Wire Standard

2. Install the appropriate power cord.

AC power passes through an IEC-standard mains connector and an RF filter designed to meet the standards of all international safety authorities.

The power cord is terminated in a “U-ground” plug (USA standard), or CEE7 / 7 plug (Continental Europe), as appropriate to your 5500i’s Model Number. The green/yellow wire is connected directly to the 5500i chassis.

If you need to change the plug to meet your country’s standard and you are qualified to do so, see Figure 2-1. Otherwise, purchase a new mains cord with the correct line plug attached.

3. Mount the 5500i in a rack.

The 5500i requires one standard rack unit (1 ¾ inches / 6.4 cm).

There should be a good ground connection between the rack and the 5500i chassis — check this with an ohmmeter to verify that the resistance is less than 0.5Ω.

Mounting the unit over large heat-producing devices (such as a vacuum-tube power amplifier) may shorten component life and is not recommended. Ambient temperature should not exceed 45°C (113°F) when equipment is powered.

Equipment life will be extended if the unit is mounted away from sources of vibration, such as large blowers and is operated as cool as possible.

4. Connect inputs and outputs.

See the hookup and grounding information on the following pages.

TOPIC	PAGE
Audio Input and Audio Output Connections	2-5
AES3 Digital Input and Output	2-7
Composite Output and Subcarrier Inputs	2-7
Wordclock/10 MHz Sync Reference Input	2-9
Grounding	2-10

5. Connect remote control interface. (optional)

For a full listing of 5500i's extensive remote control provisions, refer to *Remote Control Interface Programming* on page 2-42.

Optically-isolated remote control connections are terminated in a type DB-25 male connector located on the rear panel. It is wired according to Figure 2-2. To select the desired function, apply a 5-12V AC or DC pulse between the appropriate REMOTE INTERFACE terminals. The (–) terminals can be connected together and then connected to ground at pin 17 to create a Remote Common. A current-limited +12VDC source is available on pin 25. If you use 48V, connect a 2kΩ ±10%, 2-watt carbon composition resistor in series with the Remote Common or the (+) terminal to provide current limiting.

In a high-RF environment, these wires should be short and should be run through foil-shielded cable, with the shield connected to CHASSIS GROUND at both ends.

PIN ASSIGNMENT

1.	COMMON	
2.	REMOTE	1+
3.	REMOTE	2+
4.	REMOTE	3+
5.	REMOTE	4+
6.	REMOTE	5+
7.	REMOTE	6+
8.	REMOTE	7+
9.	REMOTE	8+
10.	TALLY	1
11.	TALLY	2
12.	N/C	
13.	POWER COMMON	
14.	REMOTE	1-
15.	REMOTE	2-
16.	REMOTE	3-
17.	REMOTE	4-
18.	REMOTE	5-
19.	REMOTE	6-
20.	REMOTE	7-
21.	REMOTE	8-
22-24.	N/C	
25.	+12 VOLTS DC	

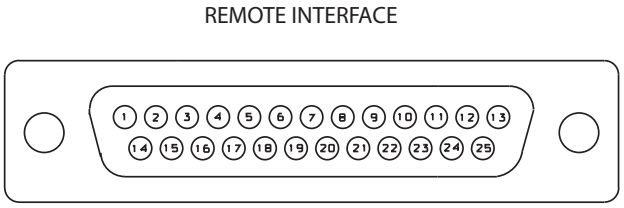


Figure 2-2: Wiring the 25-pin Remote Interface Connector

6. Connect tally outputs (optional)

See the schematic on page 6-32.

The 5500i supports two hardware tally outputs, which are NPN open-collector and operate with respect to pin 1 (common). Therefore, the voltage applied to the load (such as a relay or opto-isolator) must be positive. You can use the 12 VDC source on pin 25 to drive the high side of the load, taking into account the fact that the voltage on pin 25 is current limited by a 300 Ω resistor.

The tally outputs are protected against reverse polarity.

To avoid damaging the 5500i, limit the current into a tally output to 30 mA. DO NOT connect a tally output directly to a low-impedance voltage source! The tally outputs are not protected against this abuse and the output transistors are likely to burn out.

Note that the tally outputs have no special RFI protection. Therefore, it is wise to use shielded cable to make connections to them.

See step 10.C) on page 2-27 for instructions on using the tally outputs.

7. Connect to a computer

You can connect to a computer via the 5500i's serial connector or via an Ethernet network. (See *Networking* on page 2-50.)

Procedures and instructions for connecting to a PC are subject to development and change. We advise you to download the latest version of this manual in pdf format from ftp.orban.com/5500i/Documentation.

You can use Adobe's .pdf reader application to open and read this file. If you do not have the .pdf reader, it is available for free download from www.adobe.com.

See *Installing 5500i PC Remote Control Software* on page 2-56 for more detail.

5500i Rear Panel

[See page 3-1 for a description of the 5500i's front panel.]

The **Power Cord** is detachable and is terminated in a "U-ground" plug (USA standard), or CEE7 / 7 plug (Continental Europe), as appropriate to your 5500i's Model Number.

An **RS-232 (PC Remote) Computer Interface,** labeled SERIAL, is provided to connect the 5500i to IBM PC-compatible computers, directly or via modem, for remote control, metering and software downloads.

A **Remote Interface Connector** allows you to connect the 5500i to your existing transmitter remote control or other simple contact-closure control devices. The 5500i remote control supports user-programmable selection of up to eight optically-isolated inputs for any one of the following parameters: recalling any factory- or user presets, tone or bypass modes, selecting stereo encoder modes (stereo, mono-

left, mono-right, mono-sum), selecting analog, digital or digital+J.17 input, overshoot compensation, SCA modulation compensation, and clock synchronization. (See *Remote Control Interface Programming* on page 2-42.) The 5500i remote control accepts a DB-25 connector.

The **Ethernet Port** accepts a 10Mb/second or 100Mb/second Ethernet connection terminated with an RJ45 connector.

Digital AES3 Input and **Output** are provided to support two-channel AES3-standard digital audio signals through XLR-type connectors.

Analog Inputs and **Outputs** are provided to support left and right audio signals through XLR-type connectors.

Two **Composite Baseband Outputs** are provided, each with independent output level control. Each output uses a BNC connector.

Two **SCA Inputs** are provided for stations that use additional subcarriers (SCAs). Each input uses a BNC connector. The second SCA input can be reconfigured via an internal hardware jumper as a Pilot Reference Output useful for RDS (RBDS) subcarrier generators that require an external sync reference.

A **Wordclock/10 MHz Sync Reference Input** called (REF In) on a BNC connector allows you to lock the 5500i's internal clock generator (which determines the clock frequency applied to the DSP) to a reference signal. Typically, the reference signal comes, directly or indirectly, from a GPS-derived frequency standard or a rubidium frequency standard. You can lock the 5500i's DSP clock to this reference, which in turn locks the 19 kHz pilot tone to the reference. This is useful in single frequency networks to prevent beating between various transmitters' pilot tones in areas of mutual interference. Do not apply an AES3 signal to this input.

Input and Output Connections

Cable

We recommend using two-conductor foil-shielded cable (such as Belden 8451 or equivalent) for the audio input and output connections because signal current flows through the two conductors only. The shield does not carry signal and is used only for shielding.

Connectors

- Input and output connectors are XLR-type connectors.

  In the XLR-type connectors, pin 1 is CHASSIS GROUND, while pin 2 and pin 3 are a balanced, floating pair. This wiring scheme is compatible with

any studio-wiring standard: If pin 2 or 3 is considered LOW, the other pin is automatically HIGH.

Analog Audio Input

- Nominal input level between –14 dBu and +8 dBu will result in normal operation of the 5500i.

  (0 dBu = 0.775Vrms. For this application, the dBm @600Ω scale on voltmeters can be read as if it were calibrated in dBu.)

- The peak input level that causes overload is +27.0 dBu.

- The electronically balanced input uses an ultra-low-noise-and-distortion differential amplifier for best common mode rejection, and is compatible with most professional and semi-professional audio equipment, balanced or unbalanced, having a source impedance of 600Ω or less. The input is EMI suppressed.

- Input connections are the same whether the driving source is balanced or unbalanced.

- Connect the red (or white) wire to the pin on the XLR-type connector (#2 or #3) that is considered HIGH by the standards of your organization. Connect the black wire to the pin on the XLR-type connector (#3 or #2) that is considered LOW by the standards of your organization.

- In low RF fields (like a studio site not co-located with an RF transmitter), connect the cable shield at 5500i input only—it should not be connected at the source end. In high RF fields (like a transmitter site), also connect the shield to pin 1 of the male XLR-type connector at the 5500i input.

- If the output of the driving unit is unbalanced and does not have separate CHASSIS GROUND and (–) (or LOW) output terminals, connect both the shield and the black wire to the common (–) or ground terminal of the driving unit.

Analog Audio Output

- Electronically balanced and floating outputs simulate a true transformer output. The source impedance is 50Ω. The output is capable of driving loads of 600Ω or higher; the AO 100% control can adjust the 100% modulation level over a –6 dBu to +24 dBu range. The outputs are EMI suppressed.

- If an unbalanced output is required (to drive unbalanced inputs of other equipment), it should be taken between pin 2 and pin 3 of the XLR-type connector. Connect the LOW pin of the XLR-type connector (#3 or #2, depending on your organization's standards) to circuit ground; take the HIGH output from the remaining pin. No special precautions are required even though one side of the output is grounded.

- Use two-conductor foil-shielded cable (Belden 8451, or equivalent).
- At the 5500i's output (and at the output of other equipment in the system), do not connect the cable's shield to the CHASSIS GROUND terminal (pin 1) on the XLR-type connector. Instead, connect the shield to the input destination. Connect the red (or white) wire to the pin on the XLR-type connector (#2 or #3) that is considered HIGH by the standards of your organization. Connect the black wire to the pin on the XLR-type connector (#3 or #2) that is considered LOW by the standards of your organization.

AES3 Digital Input and Output

There is one AES3 input and one AES3 output. The program input and output are both equipped with sample rate converters and can operate at 32, 44.1, 48, 88.2, and 96 kHz.

Per the AES3 standard, each digital input or output line carries both the left and right stereo channels. The connection is 110Ω balanced. The AES3 standard specifies a maximum cable length of 100 meters. While almost any balanced, shielded cable will work for relatively short runs (5 meters or less), longer runs require used of 110Ω balanced cable like Belden 1800B, 1801B (plenum rated), multi-pair 180xF, 185xF, or 78xxA. Single-pair category 5, 5e, and 6 Ethernet cable will also work well if you do not require shielding. (In most cases, the tight balance of Category 5/5e/6 cable makes shielding unnecessary.)

The AES3id standard is best for very long cable runs (up to 1000 meters). This specifies 75Ω unbalanced coaxial cable, terminated in BNC connectors. A 110Ω/75Ω balun transformer is required to interface an AES3id connection to your Optimod's digital input or output.

The digital input clip level is fixed at 0 dB relative to the maximum digital word. The maximum digital input will make the 5500i input meters display 0 dB. The reference level is adjustable using the DI REF control.

The 5500i is a "multirate" system and its internal sample rate is 32 kHz and multiples thereof (up to 512 kHz). The output is strictly band-limited to 16 kHz. Therefore, the output can pass through a 32 kHz uncompressed link with bit-for-bit transparency. Because sample rate conversion is a phase-linear process that does not add bandwidth, the 5500i's output signal will continue to be compatible with 32 kHz links even if it undergoes intermediate sample rate conversions (for example, 32 kHz to 48 kHz to 32 kHz).

Composite Output and Subcarrier Input

There are two **composite outputs**. They carry the encoded stereo signal, the stereo pilot tone, and any subcarriers that may have been applied to the 5500i's **subcarrier inputs**.

These are unbalanced, with the shell connected directly to chassis/circuit ground. Each output's level is independently adjustable from –12 dBu to +16.0 dBu.

The output impedance of composite 1 output and composite 2 output can be set to 0Ω or 75Ω via jumpers J7 and J8 respectively (located on the Composite/SCA daughterboard). As shipped, the link is on pins 3 and 4, yielding 0 Ω impedance. To reset a given output to 75Ω, place the link on pins 1 and 2 of its associated jumper. (See the schematic on page 6-38 and the parts locator diagram on page 6-34.)

Each output can drive up to 75Ω in parallel with 0.047μF before performance deteriorates significantly (see Figure 2-3 on page 2-8).

Connect the 5500i's composite output to the exciter input with up to 100 feet (30.5m) of RG-58/U or RG-59/U coaxial cable terminated in BNC connectors.

Longer runs of coax may increase problems with noise, hum, and RF pickup at the exciter. In general, the least troublesome installations place the 5500i close to the exciter and limit the length of the composite cable to less than 6 feet (1.8m).

We do not recommend terminating the exciter input by 50Ω or 75Ω unless this is unavoidable. The frequencies in the stereo baseband are low by comparison to RF and video, and the characteristic impedance of coaxial cable is not constant at very low frequencies. Therefore, the transmission system will usually have more accurate amplitude and phase response (and thus, better stereo separation) if the coax is driven by a very low impedance source and is terminated by greater than 1kΩ at the exciter end. This also eases thermal stresses on the output amplifier in the stereo encoder, and can thus extend equipment life.

Ground loops can occur if your exciter's composite input is unbalanced, although you can usually configure system grounding to break them (for example, by connecting the 5518's and exciter's power cords to adjacent sockets on an AC power strip). In difficult cases, you can always break a ground loop by using a Jensen JT-123-BMCF transformer (see page 1-15). If the isolation transformer is in use, the GROUND LIFT switch will almost

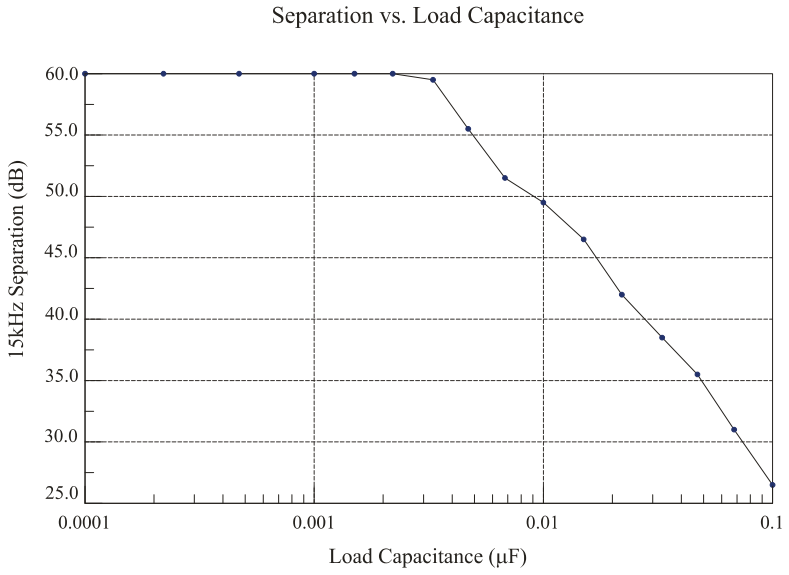


Figure 2-3: Separation vs. load capacitance

always be set to GROUND.

Even when its composite limiter is being used heavily, the 5500i will always protect the stereo pilot tone by at least 60 dB (±250Hz from 19 kHz) and will protect the region from 55 kHz to 100 kHz by at least 75 dB (re 100% modulation). See *Figure 5-1* on page 5-4.

The **subcarrier (SCA) inputs** are provided for convenience in summing subcarriers into the baseband prior to their presentation to the FM exciter.

The subcarrier inputs will accept any subcarrier (or combinations of subcarriers) above 23 kHz. Below 5 kHz, sensitivity rolls off at 6 dB/octave to suppress hum that might otherwise be introduced into the subcarrier inputs, which are unbalanced.

The subcarrier inputs are mixed into the 5500i's composite output in the analog domain, after D/A conversion of the 5500i stereo encoder's output. Rear-panel accessible PC-board-mounted trim pots allow the user to adjust the sensitivities of the two SCA inputs from <100 mV p-p to >10 V p-p to produce 10% injection with respect to 100% modulation = 4 V p-p at the 5500i's composite outputs. (The factory setting is 4 V p-p to produce 10% injection.)

As shipped from the factory, the second SCA connector emits a **stereo pilot tone reference** for RDS or RBDS subcarrier generators. If you wish to reconfigure it to accept an SCA signal, move the link on jumper J6 (on the Composite/SCA daughterboard) from pins 3 and 4 to pins 1 and 2.

To access J6, remove the 5500i's top cover according to the instructions in step 1 on page 4-2. The schematic showing J6 is on page 6-38.

Connect your subcarrier generator(s) to the 5500i's subcarrier input(s) with coaxial cable terminated with BNC connectors.

The subcarrier inputs have greater than 600Ω load impedance and are unbalanced. The sensitivity of both inputs is user-adjustable from <100 mV p-p to >10 V p-p to produce 10% injection with respect to 100% modulation = 4 V p-p at the 5500i's composite outputs. (The factory setting is 4 V p-p to produce 10% injection.)

VR1 and VR2 on the Composite/SCA daughterboard set the sensitivity of SCA1 IN and SCA2 IN respectively and are accessible on the rear panel.

You can use the 19K REF control in *Setup* to determine whether the 19 kHz pilot reference output will be in-phase (0 DEG) with the pilot tone present in the composite output or will lead it by 90 degrees (90 DEG). 0 DEG is correct for most installations. Use 90 DEG only if your RDS/RBDS generator's 19 kHz reference input specifically requires this phase relationship.

Wordclock/10 MHz Sync Reference Input

The sync reference input (called REF IN) accepts a 1x 5V p-p squarewave wordclock signal or a 10 MHz sinewave or squarewave signal, 0.5 to 5 V peak. A menu item allows you to synchronize the output sample frequency to the frequency present at the sync. The connector is a female BNC with the shell grounded to chassis.

To permit daisy-chaining sync signals, the input impedance is greater than 1 KΩ. If the 5500i is the last device driven by the sync coaxial cable, you should terminate it by using a BNC Tee connector and a 75Ω BNC terminator. This will prevent performance-degrading reflections in the cable.

WARNING: Do not apply an AES3 signal to this input. Doing so will eventually cause your Optimod to suffer a "communications board error."

Grounding

Very often, grounding is approached in a "hit or miss" manner. However, with care it is possible to wire an audio studio so that it provides maximum protection from power faults and is free from ground loops (which induce hum and can cause oscillation).

In an ideal system:

- All units in the system should have balanced inputs. In a modern system with low output impedances and high input impedances, a balanced input will provide common-mode rejection and prevent ground loops — regardless of whether it is driven from a balanced or unbalanced source.
- The 5500i has balanced inputs. Its subcarrier inputs are unbalanced, but frequency response is rolled off at low frequencies to reject hum.
- All equipment circuit grounds must be connected to each other; all equipment chassis grounds must be connected together.
- In a low RF field, cable shields should be connected at one end only — preferably the source (output) end.
- In a high RF field, audio cable shields should be connected to a solid earth ground at both ends to achieve best shielding against RFI.
- Whenever coaxial cable is used, shields are automatically grounded at both ends through the terminating BNC connectors.

Power Ground

- Ground the 5500i chassis through the third wire in the power cord. Proper grounding techniques never leave equipment chassis unconnected to power/earth ground. A proper power ground is essential for safe operation. Lifting a chassis from power ground creates a potential safety hazard.

Circuit Ground

To maintain the same potential in all equipment, the circuit (audio) grounds must be connected together:

- When the 5518's stereo encoder is driving an **unbalanced exciter input**, you may encounter a ground loop. (Some older exciters have unbalanced inputs.) Unlike some older Orban FM processors, the 5518 does not have a ground lift switch. If you cannot reconfigure your grounding scheme to eliminate such a loop, you can balance and float the exciter input with a Jensen JT-123-BMCF transformer (see page 2-15).

- In high RF fields, the system is usually grounded through the equipment rack in which the 5500i is mounted. The rack should be connected to a solid earth ground by a wide copper strap — wire is completely ineffective at VHF because of the wire's self-inductance.

Studio Level Controller Installation (optional)

[This section does not apply to a 5500i being used as a stand-alone stereo encoder. In this mode, the 5500i must be driven by a full–featured FM audio processor (like Orban's 8500), usually via an STL].

[Skip this section if you are not using a studio level controller ahead of the 5500i. Continue with "Quick Setup" on page 2-14.]

- If you are using an Orban 8100AST (or 8100A/ST) external AGC, refer to page 1-20.

- If you are using an Orban 6300 as a studio level controller, refer to its Operating Manual.

If you are using Orban 8200ST external AGC

If the STL uses pre-emphasis, its input pre-emphasis network will probably introduce overshoots that will increase peak modulation without any increase in average modulation. We therefore strongly recommend that the STL transmitter's pre-emphasis be defeated (freeing the STL from such potential overshoot), and that the 8200ST be used to provide the necessary pre-emphasis.

If the STL transmitter's pre-emphasis cannot be defeated, then configure the 8200ST for flat output. In this case average modulation levels of the STL may have to be reduced to accommodate the overshoots.

1. Configure the 8200ST's internal jumpers.

A) Remove all screws holding the 8200ST's cover in place; then lift it off.

Refer to Figure 2-4 on page 2-13.

B) Place jumper JA in the CLIPPER ON position.

C) If you have defeated the STL transmitter's pre-emphasis, place jumpers JE and JF in the PRE-EMPHASIZED position.

D) If you cannot defeat the STL transmitter's pre-emphasis, place jumpers JE and JF in the FLAT position.

E) Replace the top cover, and then replace all screws snugly. (Be careful not to strip the threads by fastening the screws too tightly.)

2. Install the 8200ST in the rack. Connect the 8200ST's audio input and output.

Refer to the *8200ST Operating Manual* if you require information about installation, audio input, and audio output connections to the 8200ST.

3. Set 8200ST Output Level with tone.

A) Press the TONE button on the 8200ST.

The TONE lamp should light and the modulation meters should indicate "0." If they do not, re-strap jumpers JB and JC to "peak." (Refer to Figure 2-4 on page 2-13.)

The 8200ST is now producing a 400Hz sine wave at each output. The peak level of this tone corresponds to 100% modulation.

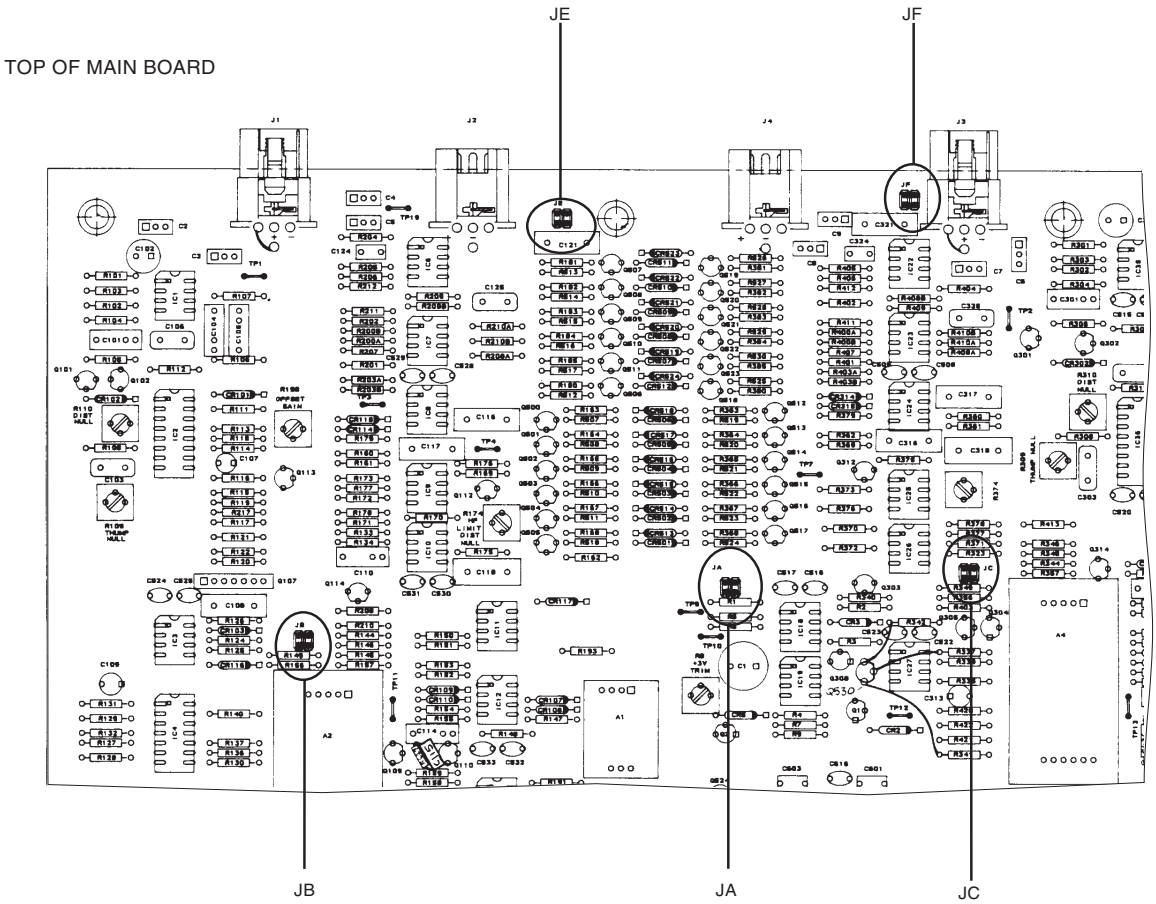
B) Adjust the 8200ST's L OUT and R OUT controls so that the STL transmitter is being driven to 100% modulation.

The L OUT and R OUT controls are now correctly calibrated to the transmitter. If no significant overshoot occurs in the transmitter, the MODULATION meter will now give an accurate indication of peak modulation of the STL.

If the STL transmitter suffers from bounce or overshoot, you may have to reduce the L OUT and R OUT control settings to avoid peak overmodulation caused by overshoots on certain audio signals.

4. Set controls for normal operation with program material.

The following assumes that a VU meter is used to determine 8200ST line drive levels with program material.



Clipper Jumpers

*CLIPPER ON

JA

CLIPPER OFF

JA

Output Pre-Emphasis Jumpers

*FLAT

LEFT OUTPUT

JE

RIGHT OUTPUT

JF

PRE-EMPHASIZED

LEFT OUTPUT

JE

RIGHT OUTPUT

JF

Line-up Level Jumpers

*PEAK

LEFT OUTPUT

JB

RIGHT OUTPUT

JC

AVG

LEFT OUTPUT

JB

RIGHT OUTPUT

JC

Figure 2-4: 8200ST Jumper Settings (*Factory Configuration)

A) Turn off the tone by pressing the TONE button.

B) Set controls as follows:

HF LIMITER... Set to match the pre-emphasis of the transmission system
L&R Out .....do not change
GATE 12:00
RELEASE 12:00
VOICE .....OFF
AGC .....ON
COUPLE .....ON

C) Feed the 8200ST either with tone at your system reference level (0VU), or with typical program material at normal levels.

D) Adjust the GAIN REDUCTION control for the desired amount of gain reduction.

We recommend 8-15 dB gain reduction for most formats.

If the STL uses pre-emphasis, its input pre-emphasis network will probably introduce overshoots that will increase peak modulation without any increase in average modulation. We therefore strongly recommend that the STL transmitter's pre-emphasis be defeated (freeing the STL from such potential overshoot), and that the 464A be used to provide the necessary pre-emphasis.

If the STL transmitter's pre-emphasis cannot be defeated, configure the 8200ST for flat output. In this case, average modulation levels of the STL may have to be reduced to accommodate the overshoots.

Quick Setup (Audio Processor Mode)

Quick Setup guides you through 5500i setup. It is appropriate for users without special or esoteric requirements. Following this section, you can find more detailed information regarding setup beyond the Quick Setup screens. In most cases, you will not need this extra information.

Regardless of whether you will be using the 5500i in audio processor or stereo encoder mode, you should complete this procedure. See *Setup for Stand-Alone Stereo Encoder Mode* on page 2-22 for additional steps that apply to the stereo encoder mode.

For the following adjustments, use the appropriately labeled soft button to choose the parameter you wish to adjust. To change a parameter (like an output level), it is usually necessary to hold down the soft button while turning the knob. However, if there is only one parameter on a screen (like choosing 50 or 75µs pre-emphasis), you can change this with the knob alone. (You do not have to hold down a button.) Let the text on the screen guide you through the process.

1. **Press the front-panel Setup button.**

2. **Press the Quick Setup soft button when its label appears on the display.**

   Quick Setup presents a guided sequence of screens into which you must insert information about your particular requirements. In general, the screens are self-explanatory.

   Use the *Next* and *Prev* buttons to navigate between screens. These buttons will flash to indicate that they are active.

   > If you leave Quick Setup before you complete all of the setup screens, re-invoking Quick Setup will return you to the screen you were on before you left Quick Setup.

3. **Set the time.**

   > Note that if your 5500i can be connected to the Internet via its Ethernet jack, you can configure the 5500i's internal clock to sync to an Internet timeserver. See *Synchronizing Optimod to a Network Time Server* on page 2-53. If you intend to synchronize the 5500i's clock to a timeserver, you may skip setting the time, date, and daylight savings time setting steps below. In this case, press the *Next* button six times, or until "Select Pre-emphasis with knob" appears. At this point, you will be at step 5.F) in this Quick Setup procedure.

   When you enter Quick Setup for the first time, the set time screen appears.

   A) Hold down the appropriate soft button while turning the knob to enter the hour, minute, and seconds. Enter seconds slightly ahead of the correct time.

   B) Wait until the entered time agrees with the correct time. Then press the ENTER TIME button to set the clock.

4. **Set the date.**

   Hold down the appropriate soft button while turning the knob to enter the day, month, and year.

5. **Set up Daylight Saving Time (Summer Time).**

   A) After you press ENTER DATE, you will see the SET DAYLIGHT SAVING screen. Turn the knob to specify the date at which Daylight Saving Time begins in your area.

   B) Press the *Next* button.

   C) Turn the knob to specify the date at which Daylight Saving Time begins in your area.

   D) Press the *Next* button.

   E) Turn the knob to specify the date at which Daylight Saving Time ends in your area.

F) Press the NEXT button.

G) Turn the knob to specify the week of the month when Standard Time begins.

6. Set pre-emphasis.

A) Press the *Next* button.

B) Select the pre-emphasis (either 75μS or 50μS) used in your country by turning the knob.

7. Set external AGC mode.

Most of the 5500i's processing structures control level with a preliminary AGC (Automatic Gain Control). If you are using a suitable Automatic Gain Control at the studio (such as an Orban 8200ST OPTIMOD-Studio or 464A Co-Operator), the AGC in the 5500i should be defeated. This is so that the two AGCs do not "fight" each other, and so they do not simultaneously increase gain, resulting in increased noise.

A) Press the *Next* button.

B) Set external AGC mode by turning the knob.

- Set the field to YES if you have a external AGC (such as an Orban 6300, 1100V2, 1101, Orban 8200ST OPTIMOD-Studio, Orban 464A Co-Operator, or similar AGC) installed at your studio feeding the studio-to-transmitter link. This setting appropriately defeats the 5500i's AGC for all presets.
- Set the field to NO if you do not have a external AGC installed; this setting enables the 5500i AGC status to be determined by the selected preset.
- If you are using an Orban 4000 Transmission Limiter, set field to NO (so that the AGC function in the 5500i continues to work). The Orban 4000 is a transmission system overload protection device; it is normally operated below threshold. It is not designed to perform an AGC or gain-riding function, and it cannot substitute for the AGC function in the 5500i.

8. Select your primary input (analog or digital).

A) Press the *Next* button.

B) If your main input source is digital, turn the knob to select DIGITAL or DIGITAL+J17. Otherwise, select ANALOG.

> DIGITAL, not DIGITAL+J17, is appropriate for almost anyone using the digital input. The only digital encoding that typically uses J.17 pre-emphasis (of which we are aware) is NICAM.

9. Set operating levels.

[If you are setting up the 5500i for use as a stand-alone stereo encoder, skip this step by pressing the Next button twice.]

You will set the operating levels of the 5500i to match the input levels it is receiving so the 5500i's AGC can operate in the range for which it was designed. There are separate settings for the analog and digital inputs. If you provide both analog and digital inputs to the 5500i, optimum adjustment is achieved when the gain reduction meters show the same amount of processing for both analog and digital inputs.

This will allow you to switch between analog and digital inputs without sudden level changes.

A) Press the *Next* button.

B) Feed normal program material to the 5500i.

C) Play program material from your studio, peaking at normal program levels (typically 0VU if your console uses VU meters).

D) *[Skip this step if you are not using the analog input.]*

Hold down the ANALOG soft button and adjust the knob so that the AGC meter indicates an average of 10 dB gain reduction.

> The procedure does not apply to the 5500i's stand-alone stereo encoder mode. In this mode, the level indicated on the screen during this step is the r.m.s. level (in dBu) of a 50 Hz input tone that produces 100% peak modulation at the 5500i's composite output when the 5500i's COMPOSITE LIMITER DRIVE control is set to 0 or OFF.

E) *[Skip this step if you are not using the digital input.]*

Hold down the DIGITAL soft button and adjust the knob so that the AGC meter indicates an average of 10 dB gain reduction.

> The procedure does not apply to the 5500i's stand-alone stereo encoder mode. In this mode, the level indicated on the screen during this step is the r.m.s. level (in dBfs) of a 50 Hz input tone that produces 100% peak modulation at the 5500i's composite output when the 5500i's COMPOSITE LIMITER DRIVE control is set to 0 or OFF.

10. Set analog output feed.

A) Press the *Next* button.

B) Turn the knob to choose FM, FM+Delay, or Monitor.

11. Set analog output to be flat or pre-emphasized.

A) Press the *Next* button.

B) *[Skip this step if you will not be using the analog left/right outputs.]*

Turn the knob to choose PRE-E (for pre-emphasis) or FLAT.

> If you will use the analog output to drive a stereo encoder, PRE provides the best performance because the stereo encoder that receives the analog output does not have to restore the pre-emphasis. However, if you cannot defeat the pre-emphasis in your stereo encoder, or if you will use the analog output for monitoring, set the output FLAT.

If you are sending the analog output of the 5500i through a digital link that uses lossy compression (like MPEG, APT-X, or Dolby), set the output FLAT. Lossy codecs cannot handle pre-emphasized signals.

12. Set digital output to be flat or pre-emphasized.

(See the notes in step 10 above.)

A) Press the *Next* button.

B) [Skip this step if you will not be using the digital output.]

Turn the knob to choose PRE-E (for a 50 or 75µs pre-emphasized output), J.17 (for a J.17 pre-emphasized output), PRE+J17 (for 50 or 75µs pre-emphasis cascaded with J.17 pre-emphasis), or FLAT (which applies 50 or 75µs de-emphasis after the processing).

Regardless of the setting of this control, the processing is always internally pre-emphasized and thus always controls peaks to follow the 50 or 75µs pre-emphasis curve.

13. Set the digital output sample rate.

A) Press the *Next* button.

B) *[Skip this step if you will not be using the digital output.]*

Turn the knob to set the Digital OUTPUT SAMPLE RATE to 32, 44.1, 48, 88.2, or 96 kHz.

The internal sample rate converter sets the rate at the 5500i's digital output. This adjustment allows you to set the output sample rate to ensure compatibility with equipment requiring a fixed sample rate. In all cases, the 5500i's fundamental sample rate is 32 kHz, ensuring that the output bandwidth is always strictly limited to 16 kHz and that the processed signal can be passed through a 32 kHz uncompressed STL without addition of overshoot.

If the DO SYNC and PILOT SYNC controls have been previously set in the IO / DIGITAL OUT calibration screens, the OUTPUT SAMPLE RATE control might be defeated. To set this control internally you must have the PILOT SYNC set to Internal and the DO SYNC set to PILOT SYNC.

14. Prepare to set output levels.

A) Press the *Next* button.

You can use either program material or tone to set the output level (and thus, the on-air modulation).

- To use tone, press the YES button.

  You must use tone if you are setting up the 5500i as a stand-alone stereo encoder.

- To use program material, press the NO button.

15. Set the composite output level.

[Skip this step if you will not be using the composite output(s).]

A) Observe the modulation produced by the 5500i's COMPOSITE OUTPUT 1 on a modulation monitor or modulation analyzer. Turn the knob to make the modulation monitor read 100% modulation (usually ±75 kHz deviation).

If you are using program material, make sure that the program material is loud enough to produce peaks of frequent recurrence that hit the 5500i's peak limiting system, thereby defining the maximum peak level that the 5500i will produce. In the U.S., we recommend using 900µs peak weighting on the peak modulation indicator, as permitted by F.C.C. rules. This will cause the monitor to ignore very low energy overshoots and will result in the highest peak modulation permitted by law.

In other countries, use a peak-indicating instrument as specified by the regulatory authority in your country.

If you are required to obey the multiplex power limits specified by ITU-R BS412-9, you may seldom see peaks hitting ±75 kHz deviation. In this case, we advise you to set the output level using the 5500i's reference 100Hz tone.

B) Press the *Next* button and repeat for COMPOSITE OUTPUT 2.

16. Set the digital output level.

A) Press the *Next* button.

B) *[Skip this step if you are not using the digital output.]*

Turn the knob to set the desired digital output level corresponding to 100% modulation, in units of dB below full-scale.

The most accurate way to set this control is by observing a modulation monitor or analyzer connected to your transmitter.

17. Set the analog output level.

A) Press the *Next* button.

B) *[Skip this step if you are not using the analog output.]*

Turn the knob to set the desired analog output level corresponding to 100% modulation, in units of dBu (0 dBu = 0.775 Vrms).

The most accurate way to set this control is by observing a modulation monitor or analyzer connected to your transmitter.

C) Press the *Next* button.

If you activated the modulation setup tone in step (14.A) on page 2-18, the tone will turn off automatically.

D) Press the *Next* button.

You have now completed the guided Quick Setup procedure and are in the normal *Recall* PRESET screen. However, if your country requires you to comply with the multiplex power ceiling specified in ITU-R BS412-9, you will also need to set up the 5500i's Multiplex Power Controller by following the instructions in step 20 on page 2-21.

18. Choose a processing preset.

[If you are setting up the 5500i for use as a stand-alone stereo encoder, skip this step.]

A) Turn the knob until your desired preset is visible in the lower line of the display.

B) Press the *Recall Next* button to put your desired preset on-air.

This step selects the processing to complement the program format of your station.

After this step, you can always select a different processing preset, program the 5500i to automatically change presets on a time/date schedule, use a GPI input to trigger preset changes, modify presets to customize your sound, and store these presets as User Presets.

Preset names are *just suggestions*. Feel free to audition different presets and to choose the one whose sound you prefer. This preset may have a very different name than the name of your format. This is OK.

You can easily modify a preset later with the 5500i's one-knob LESS-MORE feature. Refer to Section 3.

Congratulations! You are now on the air with your initial sound. Feel free to read the material in Section 3 of this manual, which describes the various presets and how you can customize them to achieve your desired signature sound.

19. Complete Station ID (optional).

The Station ID is an optional setting that you can provide to associate the 5500i with the station providing the program material (e.g., "Z-100"). The name can be up to eight characters long. It is used to identify your 5500i to Orban's PC Remote application, and appears on the Main Screen when the 5500i is being controlled by the PC Remote application.

A) Navigate to *Setup* > *Next* > TIME DATE AND ID > STATION ID.

B) Use the knob to set the each character in the ID. Use the *Next* and *Prev* buttons to control the cursor position.

C) When finished entering your name, press the SAVE button. If you escape to the main screen from Setup, you can now see the station name toggle on the main screen.

20. Activate the 5500i's ITU-R BS412-9 multiplex power controller (optional).

[Skip this step if ITU-R BS412 is not enforced in your country. At the time of this writing, it is only enforced in certain European countries. If your country does not enforce ITU-R BS412, set the ITU412-9 control to OFF.]

[If you are planning to use the 5500i in its stand-alone stereo encoder mode, make sure that the multiplex power controller is turned off until you have finished setting up the other stereo encoder parameters. Otherwise, it will interfere with setting output levels.]

A) Navigate to *Setup* > STEREO ENCODER > *Next* > ITU412.

B) Set the multiplex power threshold by holding the ITU412 button down and turning the knob so that the display indicates 0.0 dB.

If your transmission system introduces overshoot in the signal path after the 5500i (including the transmitter), instead set the multiplex power threshold so that it equals the amount of peak overshoot (in dB) in the transmission system. If you do not do this, the 5500i's ITU-R BS412 controller will set the average multiplex power too low.

The easiest way to measure system overshoot is to turn the multiplex power controller off temporarily. Then set the 5500i's output level (using its built-in 100Hz reference tone) so that the transmitter produces ±75 kHz deviation. Finally, play program material with lots of high frequency energy and bass transients (like bright rock music with heavy kick drum) and observe the peak deviation produced by the program material. The overshoot is the amount (in dB) by which the deviation with program material exceeds ±75 kHz deviation.

See the notes on the MPX POWER OFFSET control on page 3-37 and *ITU-R Multiplex Power Controller* on page 3-55.

21. Set up modulation reduction to compensate for subcarriers, if needed.

In the United States, F.C.C. Rules permit you to add 0.5% modulation for every 1% increase in subcarrier injection. For example, if your subcarrier injection totals 20%, you can set the total modulation to 110% (±82.5 kHz deviation). The 5500i has the ability to reduce audio modulation to compensate for subcarriers.

The advantage of using the modulation reduction function is that the pilot injection stays constant when the audio modulation is reduced. However, using the modulation reduction function is slightly inconvenient because it requires programming and activating at least one 5500i GPI input. *If you have the same subcarrier injection at all times*, a more convenient alternative is to set the desired modulation level by using the COMPOSITE LEVEL control(s). Then turn up the pilot injection control until the injection equals 9% modulation.

If you wish to use the modulation reduction function anyway:

A) Navigate to *Setup* > *Next* > MODULATN REDUCTN.

B) Hold down the appropriate MOD. REDUCTION button and turn the knob to set the amount of modulation reduction produced by the MOD. REDUCTION 1 and MOD. REDUCTION 2 functions.

You can program these to be activated via any rear-panel GPI input or by the 5500i's clock-based automation.

When both modulation reduction functions are active, the modulation reduction is the sum of their settings.

To comply with FCC Rules, set the modulation reduction to one-half the injection of the associated subcarrier. For example, if your subcarrier injection totals 20% from two 10% subcarriers, set MODULATION REDUCTION 1 TO "5%" and MODULATION REDUCTION 2 to 5%. This will reduce your audio modulation to 90% (100% – 5% – 5%). When you add back the 20% modulation due to the subcarriers, you get the required 110% total modulation.

The Modulation Reduction function is active as long as signal is applied to its associated GPI input.

C) Program the GPI input(s).

a) Navigate to *Setup* > *Next* > NETWORK&REMOTE > REMOTE INTERFACE.

b) Using the *Next* button, scroll the screen until you see the button corresponding to the GPI terminal you wish to program.

c) Hold down this button and turn the knob until you see MOD. REDUCTION 1 or MOD. REDUCTION 2 as desired.

To program clock-based automation to activate modulation reduction, follow the instructions found in "Using Clock-Based Automation" on page 2-36.

Setup for Stand-Alone Stereo Encoder Mode

[Skip this section if you are not going to use your 5500i in stand-alone stereo encoder mode.]

In the 5500i's stand-alone stereo encoder mode, several controls that you might expect to find in I/O *Setup*, such as input preemphasis status, are instead included in the Factory/User Presets. This allows you to save several setups as User presets and to recall them by remote control (GPI or PC Remote) or by the 5500i's internal clock-based automation.

1. Set up your 5500i using the Quick Setup instructions starting on page 2-15.

This will set the composite output level, preemphasis, and several other functions correctly.

2. Turn the 5500i's ITU-412 MPX power controller off.

When on, it causes gain reduction that makes it impossible to set the AI and DI reference level controls correctly with test tones. See step 20 on page 2-21.

3. Recall the ST ENC NO LIM preset.

A) Press the *Recall* button on the 5500i's front panel.

B) Turn the knob until ST ENC NO LIMIT is visible in the lower line of the display.

C) Press the *Recall Next* button.

The 5500i is now in stand-alone stereo encoder mode. The L/R protection limiting and composite limiter are inactive in this preset but may be turned on after you have finished aligning levels. This makes it easier to adjust modulation using a test tone.

4. Adjust the input to accept a flat or preemphasized signal.

Note for users of J.17 preemphasis: If you are using the digital input and set it to DIGITAL+J17 in step (8.B) on page 2-16, the 5500i will first apply J.17 deemphasis to the digital input signal. It will then leave it unchanged or preemphasize it at 50 or 75 µs, following the setting of the INPUT PRE-EMPH CONTROL, as adjusted in the steps immediately below.

The J.17 option is rarely used; it applies mainly to NICAM links. You can set most Optimod-FMs to emit a J.17-preemphasized signal with or without additional 50 or 75 µs preemphasis. For example, see step (12.B) on page 2-18.

A) Press the *Modify* button.

B) If you do not see the APPLY EMPH soft button, press the *Next* button until it appears.

C) While holding down the APPLY EMPH soft button, rotate the knob to match the 5500i to the input signal's preemphasis.

All FM audio processing chains must include a preemphasis limiter to prevent high frequency overmodulation. Therefore, regardless of whether you choose YES or NO in this step, you must ensure that the signal driving the 5500i stereo encoder has already received 50 µs or 75 µs preemphasis limiting. (Any Optimod-FM will perform preemphasis limiting.) You must set the 50 or 75 µs preemphasis in the audio processor driving the 5500i to be the same as the 5500i's preemphasis setting.

If the signal driving the 5500i has not already received preemphasis limiting, you must run the 5500i in its audio processing mode (not its stand-alone stereo encoder mode) so that the 5500i can perform the preemphasis limiting.

- Choose YES if the input signal has no 50 or 75 µs preemphasis.

YES causes the 5500i to apply 50 or 75 µs preemphasis to the input signal, following the preemphasis setting you specified in step 5.F) in Quick Setup (page 2-16).

- Choose NO if the input signal has already been pre-emphasized.

  In step 6 in Quick Setup (page 2-16), make sure that you have set the 5500i's preemphasis to match the preemphasis of the input signal. Even though the 5500i is not applying preemphasis, its L/R overshoot limiter needs to be aware of the input signal's preemphasis because the overshoot limiter uses different algorithms for 50 and 75 µs. This minimizes audible limited-induced artifacts.

  Usually, the STL adds less peak overshoot to its input signal if its input and output signals are preemphasized. Doing this eliminates several stages of deemphasis and preemphasis. However, if the STL uses lossy digital compression (like MP2), you must apply a flat signal to the STL and restore preemphasis in the 5500i. *Studio-Transmitter Link* (starting on page 1-16) has a thorough discussion of these issues.

5. Adjust the input lowpass filter.

A) If you do not see the INPUT LPF soft button, press the *Next* button until it appears.

B) While holding down the INPUT LPF soft button, rotate the knob to set the cutoff frequency of the phase-linear lowpass filter at the 5500i's input.

It is usually unnecessary to use this filter; you may set it OUT unless you need to remove out of band noise from a noisy STL.

To minimize filter-induced overshoot, set the cutoff frequency as high as possible. While this filter introduces no phase distortion, it will add overshoot if it removes a significant amount of the high frequency energy that was present at the output of the audio processing driving the 5500i.

If you are using an Optimod-FM 8000, 8100, 8500, or 5500i audio processor to drive the STL, set the 5500i's LOWPASS FILTER to OUT or 17 KHZ. If you are using any other Optimod-FM, set the filter to OUT, 16 KHZ or 17 KHZ.

6. Set the drive level.

Starting with V1.1 software, the stand-alone stereo encoder mode is invoked without reloading DSP code when normal two-band or five-band presets are used. This permits a smooth crossfade to occur between stand-alone stereo encoder mode and audio processing modes. To optimize the utility of this feature, we have added a INPUT LEVEL control to the stereo encoder processing presets. (Note that this control is not in I/O SETUP.) This allows you to set up the AI REF and DI REF controls in normal audio processing mode and then to set the drive level to the stand-alone stereo encoder's overshoot limiters without having to change the settings of the AI REF and DI REF controls.

If you are using the 5500i as a stand-alone stereo encoder and will never use its audio processing presets, you may set the INPUT LEVEL control to 0 DB and instead use the AI REF or DI REF controls (depending on whether you are using the analog or digital inputs) to set the drive level.

A) Apply a 50 Hz sine wave the 5500i's active input (usually through an STL) and set the peak level of the tone to equal the maximum peak output level produced by the FM audio processor driving the 5500i.

> All digital Optimod-FM processors have a built-in tone oscillator that can generate this tone. Set the modulation in the Optimod's tone generator to 100%.
>
> Tone alignment does not account for any overshoots that the STL might generate with program material. Normally, you will use the 5500i's left/right overshoot limiter and/or composite limiter to eliminate such overshoots. Do not substitute these limiters for the peak limiters in the audio processor driving the STL. The 5500i's overshoot limiters should *only* be used to eliminate 3 dB or less STL-induced overshoot.

B) Press the *Modify* button.

C) If you do not see the INPUT LEVEL soft button, press the *Next* button until it appears.

D) Adjust the INPUT LEVEL control to produce 100% composite modulation (usually ±75 kHz carrier deviation) as indicated on a modulation monitor or analyzer connected to your FM transmitter's output.

> If you set the composite output level correctly in step 15 (page 2-19) of Quick Setup, you should see the 5500i's composite level meter indicate 100% modulation when the INPUT LEVEL control is set correctly. It is very important to have set the composite output level correctly in this earlier step. This will correctly match the 5500i's composite limiter threshold to the FM carrier deviation produced by the transmitter and will ensure that the 5500i's headroom is used correctly. If you are not sure whether the 5500i's composite output level was set correctly, refer to step (7.H) on page 2-32. Use "tone" method to set modulation. This uses the 5500i's internal tone oscillator.

7. Activate the L/R Peak Limiter (optional)

A) Press the *Modify* button.

B) If you do not see the L/R LIM soft button, press the *Next* button until it appears.

C) Set the control to IN.

This activates a peak limiter similar to the one in Orban's 8218 and 5518 Stereo Encoders. The limiter controls peaks with a combination of look-ahead limiting and band-limited clipping. There are two limiters, operating independently on the left and right channels. They are intended only to remove overshoots caused by the STL. If used for more than 3 dB of peak reduction, they can cause audible side effects. To minimize audible distortion, it always better to minimize overshoots in the STL itself instead of relying on the L/R peak limiter to remove them.

8. Activate the Composite Limiter (optional)

A) Press the *Modify* button.

B) If you do not see the MPX LIMIT MODE soft button, press the *Next* button until it appears. Then select either HARD or HALFCOS modes.

When operating as a hard clipper, the composite limiter will produce maximum brightness in the frequency range from 5 to 15 kHz because, unlike left/right audio-domain clippers, it can produce square waves in this frequency range. The downside compared to Half-Cosine mode is that it can noticeably compromise stereo imaging.

When operating in Half-Cosine mode, the composite limiter produces somewhat less brightness but does not compromise stereo imaging. Because this mode produces lower subjective distortion, Orban's factory programmers prefer the sound of the Half-Cosine mode.

In either mode, the baseband output is overshoot compensated and bandlimited to 53 kHz, unlike conventional composite clippers.

C) If you do not see the MPX LIM DR soft button, press the *Next* button until it appears.

D) Adjust the control as desired.

We recommend setting the control to "0." This sets the limiter threshold to be the same as the analog and digital reference levels, which correspond to 100% baseband tone modulation. This setting only removes overshoots.

Setting the control higher than "0" drives the limiter harder, causing progressively more limiting action but also more distortion, the texture of which depends on whether the MPX LIMIT MODE is set to HARD or HALFCOS. The composite limiter is less forgiving than the L/R Peak Limiter because it operates more like a pure clipper. In general, it should be used with less than 1.0 dB of limiting. See COMP DRV on page 3-36.

9. Save your work as a User Preset.

It is important to save your settings as a User Preset to preserve your work. You can create as many User Presets as you wish, each customized for a particular application, although most stand-alone stereo encoder applications will require only one User Preset. See *To Create or Save a User Preset* on page 3-16.

10. Program Silence Sense (optional)

You can program the 5500i to switch automatically from its digital input to its analog inputs if the INPUT SOURCE is set to DIGITAL and the signal at the digital input falls silent. Conversely, you can also program the 8600 to switch automatically from its analog inputs to its digital input if the INPUT SOURCE is set to ANALOG and the signal at the analog input falls silent.

Starting in v1.1, this feature is available in both audio processing and stereo encoder modes.

There are two silence detectors, one for the analog input and one for the digital input. The silence sense parameters apply to both simultaneously. Both detectors are available to drive the 5500i's tally outputs, and either silence detector can be used to instigate automatic input switching. (See step C) below.)

Silence sense will be activated if either audio channel falls silent, thus also protecting against "loss-of-one-stereo-channel" faults.

If silence is detected at the analog input as well as the digital input (as in the case of a studio operational fault), automatic switching will not occur.

When an active signal is restored to the digital input, the 5500i will automatically switch back to that input.

A) Navigate to *Setup* > SILENCE THRESHOLD and set the Silence Threshold to the level below which the 5500i will interpret the input as being silent.

This setting is with respect to the current analog reference level and digital reference level.

B) Press *Next* as necessary to see the SILENCE DELAY control. Set it to the amount of time that the input must be below the Silence Threshold before the 5500i automatically switches to the fallback input.

C) Press *Next* as necessary to see the ANALOG FALLBACK control. Set it to YES if you wish the 5500i to switch automatically from the digital to analog input when silence is detected. Set the control to NO to defeat automatic switching.

D) Press *Next* as necessary to see the DIGITAL FALLBACK control. Set it to YES if you wish the 5500i to switch automatically from the analog to digital input when silence is detected. Set the control to NO to defeat automatic switching.

11. Program Tally Outputs.

[Skip this step if you do not wish to use the tally outputs.]

See step 6 on page 2-4 for wiring instructions.

You can program the two tally outputs to indicate a number of different operational and fault conditions.

A) Navigate to *Setup* > NETWORK REMOTE > REMOTE INTERFACE > TALLY 1.

B) Program tally output #1.

To program a given tally output, press and hold the soft button associated with the output you are programming. As you turn the control knob, the functions listed below will appear in the highlighted field.

- **Input: Analog**: Indicates that the 5500i is processing audio from its analog input.
- **Input: Digital**: Indicates that the 5500i is processing audio from its AES3 digital input.
- **Analog Input Silent**: Indicates that the level at either or both analog input channels is below the threshold set in step 9 on page 2-26.
- **AES Input Silent**: Indicates that the level at either or both digital input channels is below the threshold set in step 9 on page 2-26.

- **AES Input Error**: Indicates that the 5500i's AES input receiver chip has detected a problem with the data being received such that the data is unusable. When the chip detects such an error, it automatically switches the input to ANALOG.
- **Sync Reference Input Error**: Indicates that the 5500i has detected a problem with the signal being received at the sync reference input such that the signal is unusable.
  - When pilot sync is specified (SETUP > I/O CALIB > DIG OUT CALIB > DO SYNC) and such an error is detected, the 5500i automatically switches the sync source to the digital input.
  - If there is no valid digital input signal at the digital input, the sync source defaults to the 5500i's internal clock.
- **No Function**: Tally output is disabled.

C) Program tally output #2 if you wish, following the procedure in step (B) above with the TALLY OUT2 button.

12. If required, activate the MPX Power Controller.

See step 20 on page 2-21.

The following material provides detailed instructions on how to set up the 5500i. If QUICK SETUP does not fully address your setup needs or if you wish to customize your system beyond those provided with QUICK SETUP, then you may need the additional information in the sections below. However, for most users, this material is only for reference because QUICK SETUP has enabled them to set up the 5500i correctly.

Analog and Digital I/O Setup

For the following adjustments, use the appropriately labeled soft button to choose the parameter to be adjusted. To change a parameter (like an output level), it is usually necessary to hold down the soft button while turning the knob.

1. Temporarily set the external AGC mode to "No."

A) Navigate to *Setup* > *Next* > *Next* > EXT AGC and set EXT AGC to NO. (It may be set to NO already.)

If you are using a external AGC like the Orban 6300, you should restore this setting to YES after the setup procedure is complete.

2. Adjust Input selector.

A) Navigate to *Setup* > I/O CALIB > ANLG IN CALIB > INPUT.

B) Set the INPUT to ANALOG.

The 5500i will automatically switch to analog input if signal lock is unavailable at the AES3 input.

3. Adjust Analog Input Reference Level.

[–9 dBu to +13 dBu (VU), or –1 to +21 dBu (PPM)] in 0.5 dB steps

The reference level VU and PPM (Peak) settings track each other with an offset of 7 dB. This compensates for the typical indications with program material of a VU meter versus the higher indications on a PPM.

This step sets the center of the 5500i's gain reduction range to the level to which your studio operators peak their program material on the studio meters. This assures that the 5500i's processing presets will operate in their preferred range.

You may adjust this level with a standard reference/line-up level tone from your studio or with program material.

Note that in this step, you are calibrating to the normal indication of the studio meters; this is quite different from the actual peak level.

If you know the reference VU or PPM level that will be presented to the 5500i, set the reference level to this level, but please verify it with the steps shown directly below.

A) Press the *Recall* button.

B) Turn the knob until ROCK-MEDIUM appears in the lower line of the display.

C) Press the *Recall Next* button.

D) Navigate to *Setup* > I/O CALIB > ANLG IN CALIB > AI REF (VU or PPM, depending on which metering system you use).

E) Calibrate using Tone.

[Skip to step (F) if you are using Program material to calibrate the 5500i to your standard studio level.]

a) Verify EXT AGC is set to NO.

Refer to step 1 on page 2-28.

b) Feed a tone at your reference level to the 5500i

If you are not using a studio level controller, feed a tone through your console at normal program levels (typically 0VU if your console uses VU meters).

If you are using a studio level controller that performs an AGC function, such as an Orban 8200ST OPTIMOD-Studio, adjust it for normal operation.

c) Adjust the AI REF (VU or PPM) control to make the 5500i's AGC meter indicate 10 dB gain reduction.

d) Skip to step (G).

F) Calibrate using Program.

[Skip this step if you are using Tone to calibrate the 5500i to your standard studio level — see step (D) above.]

a) Verify EXT AGC is set to NO.

Refer to step 1 on page 2-28.

b) Feed normal program material to the 5500i

Play program material from your studio, peaking at the level to which you normally peak program material (typically 0VU if your console uses VU meters).

c) Adjust the AI REF (VU or PPM) control to make the 5500i's AGC meters indicate an average of 10 dB gain reduction when the console's VU meter or PPM is peaking at its normal level.

If the AGC gain reduction meter averages less than 10 dB gain reduction (higher on the meter), re-adjust the AI REF (VU or PPM) to a lower level.

If the AGC gain reduction meter averages more gain reduction (lower on the meter), re-adjust the AI REF (VU or PPM) to a higher level.

G) When finished, reset EXT AGC to YES, if required (e.g., if that was its setting prior to setting AI REF (VU or PPM) level).

Refer to step 1 on page 2-28.

4. Adjust Right Channel Balance.

[Skip this step if the channels are already satisfactorily balanced.]

[–3 dB to +3 dB] on right channel only, 0.1 dB steps

Adjust the R CH BAL control to achieve correct left/right channel balance.

This is not a balance control like those found in consumer audio products. This control changes gain of the right channel only. Use this control if the right analog input to the 5500i is not at exactly the same level as the left input. Be certain that the imbalance is not caused by one program source, but is instead introduced through distribution between the console output and 5500i input. This adjustment is best accomplished by playing program material that is known to be monophonic or by setting the mixing console into mono mode (if available).

5. Adjust the Digital Input Reference Level and Right Balance controls.

[Skip this step if you will not be using the digital input.]

A) Navigate to *Setup* > I/O CALIB > DIG IN CALIB > INPUT and set the input to Digital.

B) Repeat steps 1 through 4 (starting on page 2-28), but use the DI REF (VU OR PPM) and R CH BAL controls for the digital section.

6. Defeat final clipper (optional).

If you are using the 5500i to drive a network with protection audio processors (like Orban's Optimod-FM 2300) at each transmitter, you may wish to defeat the 5500i's final clipper to prevent double clipping, which will unnecessarily increase distortion on-air. To do this:

A) Navigate to the *Setup* > FINAL CLIP. If FINAL CLIP does not appear, repeatedly press the *Next* button until it does.

In PC Remote, this control is located in I/O > UTILITIES.

B) Set FINAL CLIP DEFEAT to DEFEAT.

This will also defeat the overshoot compensator.

Note that defeating the final clipper and overshoot compensator will increase peak output levels, possibly to the point where the 5500i's output amplifier and/or digital output clips. It is wise to customize any presets you are using by reducing the FINAL CLIP DRIVE and OSHOOT COMP DRIVE controls to their minimum values. This will greatly reduce the probability of inadvertently clipping the 5500i's output.

Unless defeated, the 5500i's composite limiter will continue to control the composite output level. However, you should not use the composite output when the 5500i's final clipper is defeated because this will remove the advantages of the distortion cancellation in the 5500i's final clipper. (The composite limiter does not cancel distortion.)

7. Configure Composite Outputs

A) Navigate to *Setup* > STEREO ENCODER > *Next* > PRE-EMPH. Set the pre-emphasis to 50µs or 75µs, depending on your country's standard.

B) Set PILOT LVL to 9%.

If you have to reduce the setting of the composite level (COMP1 LV or COMP2 LV) control to accommodate overshoots in the transmission path following the 5500i (including the transmitter), you may have to increase the setting of the PILOT LEVEL so that the pilot is still at 9% modulation.

C) If your country enforces the ITU-412 multiplex power standard, set ITU412 to ON. See step 20 on page 2-21.

D) If you are using the 5500i's pilot reference output to drive a subcarrier generator, set the 19K REF control to the phase relationship between the 19 kHz reference and the 5500i's pilot tone required by your subcarrier generator. In most cases, this will be 0 degrees.

E) Press the *Next* button. If you need to apply the 5500i's diversity delay to the composite outputs, set DVRSTY DLY to IN. Otherwise, set it to OUT.

It is not possible to apply the delay to only one of the two composite outputs.

F) If you are using the diversity delay, set its value using the DVRSTY DLY TRIM control. The control sets the delay applied to the composite, analog, and digital outputs when these outputs have been configured to receive delay.

While it is possible to activate or defeat the diversity delay independently for the analog output, digital output, and composite outputs, it is not possible to apply different amounts of delay to different outputs.

G) Press the *Next* button. Be sure that MODE is set to STEREO and XTALK TEST is set to OPERATE. Reset these parameters if necessary.

H) Using the COMP1 LV and COMP2 LVL controls, adjust the level for each composite output to produce 100% modulation of the FM carrier on modulation peaks.

Alternately, you can use the 5500i's built-in calibration tone oscillator. To do this:

a) Navigate to *Setup* > TEST.

b) Set the MODE to TONE.

c) Set TONE FREQ to 100 HZ.

d) Set TONE LVL to 91%. (This assumes you are using 9% pilot injection, in which case the peak level at the composite output is now the same as the maximum peak level under program conditions.)

e) Press the *Next* key.

f) Set TONE CHAN to L+R.

g) Verify that PILOT is ON.

h) Adjust the relevant output level control so that your peak modulation is 100%.

i) When you have finished with the tone, set the MODE to OPERATE.

I) You can specify the amount by which the 5500i automatically reduces main and stereo subchannel modulation to accommodate subcarriers within the modulation limits specified by the governing authority. See step 21 on page 2-21.

8. Set analog output and configuration level.

A) Navigate to *Setup* > I/O CALIB > ANLG OUT CALIB > AO PRE-E. Set the analog output pre-emphasis to PRE-E (for pre-emphasis) or FLAT.

If you will use the analog output to drive a stereo encoder, PRE-E provides the best performance because the stereo encoder does not have to restore the pre-emphasis. (Its magnitude and phase response may not perfectly complement that of the deemphasis applied by the 5500i to its processed output when the 5500i's output is set FLAT. This can introduce overshoots in the overall transmission chain.) However, if you cannot defeat the pre-emphasis in your stereo encoder or if you will use the analog output for monitoring, set the output FLAT.

If you are sending the analog output of the 5500i through a digital link that uses lossy compression (like MPEG, APT-X, or Dolby), set the output FLAT. Lossy codecs cannot handle pre-emphasized signals.

If you are going to use the analog output for headphone monitoring [see step (B) below], set the output FLAT.

B) Set the AO SOURCE to FM, FM+DELAY, or MONITOR.

FM: This produces a fully peak-controlled output suitable for driving a transmitter.

FM+Delay: This produces a fully peak-controlled output suitable for driving a transmitter. Up to 16 seconds of diversity delay can be applied to this output. To set the amount of delay, refer to step (F) on page 2-31.

Monitor: If you do not need the 5500i's analog output to drive a transmitter, you may configure it to receive the output of the multiband compressor before peak limiting. This signal is suited for driving headphones. The input/output delay is approximately 3-8 milliseconds (depending on the setting of AGC CROSSOVER TYPE). Even though normal 5500i presets have a delay of about 15 ms, which most DJs, announcers, and presenters can learn to use without discomfort (although they may need some time to become accustomed to it), the low-delay output will cause less bone-conduction comb filtering. However, in most cases, the low-delay output will not be necessary to ensure adequate talent comfort.

The normal delay is 15 ms except for "UL" (ultra-low latency) presets, which have approximately 5 ms delay.

If have set the source to Monitor, be sure to set analog pre-emphasis to Flat. See step (A).

C) You can use either program material or tone to set your output level (and thus, your on-air modulation). If you want to use tone, turn on the 100 Hz calibration tone and set it to 91%.

The tone is calibrated with reference to the composite output and assumes 9% pilot injection: 91% + 9% = 100%. The peak level at the analog output is now the same as the maximum peak level under program conditions when the AO PRE-E control is set to PRE-E.

This peak level should agree with the setting of the AO 100% control. AO 100% is equal to the RMS value of a sinewave whose peak value is equal to the maximum peak output of the analog output under program conditions if the AO PRE-E control is set to PRE-E. For example, when AO PRE-E = +10.0 dBu, the peak output is 5.77 volts, which corresponds to a sinewave whose RMS values is 4.08 volts. Program material peaks of frequent recurrence will not exceed 5.77 volts peak.

See step (7.H) on page 2-32 for instructions on how to turn on the calibration tone and set its frequency and level.

D) Using the AO 100% button, set the desired analog output level corresponding to 100% modulation, using units of dBu (0 dBu = 0.775 Vrms).

The most accurate way to set this control is by observing a modulation analyzer connected to your transmitter.

If you have (inappropriately) set AO SOURCE: MONITOR in step (B) above, the peak level will not be well controlled because no peak limiting has been applied to this signal. This will also be true if you have defeated the final clipper (step 6 on page 2-31).

If you are using program material, make sure that the program material is loud enough to produce peaks of frequent recurrence that hit the 5500i's peak limiting system, thereby defining the maximum peak level that the 5500i will produce. In the U.S., we recommend using 900µs peak weighting on the peak modulation indicator, as permitted by F.C.C. rules. This will cause the monitor to ignore very low energy overshoots and will result in the highest peak modulation permitted by law.

In other countries, use a peak-indicating instrument as specified by the regulatory authority in your country.

If you are required to implement the average modulation limits specified by ITU-R 412-9, you may seldom see peaks hitting ±75 kHz deviation. In this case, we advise you to set the output level by using the 5500i's reference 100Hz tone.

In the United States, F.C.C. Rules permit you to add 0.5% modulation for every 1% increase in subcarrier injection. For example, if your subcarrier injection totals 20%, you can set the total modulation to 110% (±82.5 kHz deviation). This implies that you must set the 5500i's composite output level for the equivalent of 90% modulation, not counting the subcarriers. (90% + 20% = 110%.) The pilot injection will thus be about 8% modulation instead of the desired 9%. Adjust the *Setup* > STEREO ENCODER > *Next* > PILOT LVL control as necessary to produce 9% modulation (±6.75 kHz deviation). This will ordinarily require you to set the PILOT LVL parameter to "10%."

9. Set digital output and configuration level.

[Skip this step if you will not be using the digital output.]

[See the notes in step 8 immediately above.]

A) Navigate to *Setup* > I/O CALIB > DIG OUT CALIB.

B) Set the DO PRE-E control to PRE-E (for pre-emphasis), PRE+J17, J.17 or FLAT.

C) Set the DO RATE to 32, 44.1, 48, 88.2, or 96 kHz.

The 5500i's fundamental sample rate is always 32 kHz, ensuring that the output bandwidth is always strictly limited to 16 kHz and that the processed signal can be passed through a 32 kHz uncompressed STL without addition of overshoot. However, the internal sample rate converter sets the rate at the 5500i's digital output. This adjustment allows you to set the output sample rate to ensure compatibility with equipment requiring a fixed sample rate.

D) Set the PILOT SYNC.

The PILOT SYNC control determines the reference frequency source to which the 19 kHz pilot tone frequency is locked. (To do this, the DSP clock is locked to this frequency.) The choices are DIG IN (the AES3 or AES11 signal appearing at the 5500i's digital input), REF IN (the 10 MHz or 1x wordclock applied to the 5500i's REF IN BNC connector), or INTERNAL (the internal crystal-controlled DSP clock oscillator).

- If DIG IN is chosen and no valid signal is available at the unit's digital input, the 5500i automatically switches the sync source to the REF IN

BNC connector. If there is no valid digital input signal at the reference input, the sync source defaults to the 5500i's internal clock.

- If REF IN is chosen and there is no valid input signal at the REF IN BNC connector, the sync source defaults to the 5500i's internal clock.

E) Press *Next*. Then set the DO SYNC.

You can choose PILOT SYNC (the DSP clock frequency reference as determined by the PILOT SYNC control) or DIG IN (the output sample rate is synchronized to the sample rate appearing at the 5500i's AES3 input).

- If DIG IN is chosen and no valid signal is available at the unit's digital input, the 5500i automatically switches the sync source to the source determined by the PILOT SYNC control.

F) Set the desired output WORD LENGTH.

[14], [16], [18], [20], or [24], in bits

The largest valid word length in the 5500i is 24 bits

The 5500i can also truncate its output word length to 20, 18, 16 or 14 bits. The 5500i can add dither for input material that is insufficiently dithered for these lower word lengths (see the next step).

G) Adjust DITHER to IN or OUT, as desired.

[In] or [Out]

When set to In, the 5500i adds "high-pass" dither before any truncation of the output word. The amount of dither automatically tracks the setting of the WORD LENGTH control. This is first-order noise shaped dither that considerably reduces added noise in the midrange by comparison to white PDF dither. However, unlike extreme noise shaping, it adds a maximum of 3 dB of excess total noise power when compared to white PDF dither. Thus, it is a good compromise between white PDF dither and extreme noise shaping.

If the source material has already been correctly dithered (as is true for virtually all commercially recorded material), you may set this control to OUT. However, particularly if you use the Noise Reduction feature, the processing can sometimes attenuate input dither so that it is insufficient to dither the output correctly. In this case, you should add dither within the 5500i.

H) Set DIGITAL FORMAT to AES or SPDIF.

SPDIF is the standard consumer format; AES is almost always correct in professional facilities.

I) Set the DO SOURCE to FM, FM+DELAY, or MONITOR.

See the notes in step (8.B) in page 2-33.

J) Press the *Prev* button.

K) Using a modulation monitor or modulation analyzer, adjust the DO 100% control to make the modulation monitor read 100% modulation (usually ±75 kHz deviation).

See the notes in step (8.D) on page 2-33.

10. End Analog and Digital I/O setup.

If you are using an external AGC and you temporarily set the EXT AGC to NO in step 1 on page 2-28, set the EXT AGC to YES.

11. Select a processing preset.

See step 18 on page 2-20.

Automation Using the 5500i's Internal Clock

1. If you have not already done so, set the system clock.

[You can also set the clock automatically via PC Remote or the Internet. See *Synchronizing Optimod to a Network Time Server* starting on page 2-53.]

A) Navigate to *Setup* > *Next* > TIME DATE AND ID > SET TIME.

a) Set hours and minutes.

b) Enter seconds slightly ahead of the correct time.

c) Wait until the entered time agrees with the correct time. Then press the ENTER TIME button to set the clock.

B) Press the SET DATE button.

a) Set today's date, using the days, month, and year buttons.

b) Press the ENTER DATE button.

C) Press the DAYLIGHT TIME button.

a) Using the Daylight Saving (DT MONTH and DT WEEK) buttons, set the month and week when Daylight Saving Time (Summer Time) begins, or OFF.

b) Using the Standard Time (ST MONTH and ST WEEK) buttons, set the month and week when Daylight Saving Time (Summer Time) ends.

Note that setting DT MONTH, DT WEEK, ST MONTH, or ST WEEK to OFF will defeat Daylight Time functionality.

c) Press the *Escape* key to back out of the daylight saving screen.

D) (Optional) Press the STATION ID button to specify your station's identifier (call sign or call letters).

a) Use the knob to select characters. Use the *Prev* and *Next* buttons to move the cursor.

b) When you are finished, press SAVE.

2. Navigate to Setup > Next > Automation.

If the AUTOMATION button reads DISABLED, hold it down and turn the knob to enable automation.

> This button allows you to easily enable or disable all automation events without having to edit individual automation events.

3. To add an automation event:

A) Push the ADD EVENT button.

B) Choose whether you wish to program an event that occurs only once or an event that follows a daily or weekly schedule.

C) For events that occur only once:

a) Use the *Prev* and *Next* buttons to move the cursor over the word "DAILY:" and turn the knob so that is reads "DATE:" instead.

b) Use the *Prev* and *Next* buttons to move the cursor to the day, month, and year when the automation event will occur. Set the desired values with the knob.

c) Use the *Prev* and *Next* buttons to move the cursor set the hour, minute, and second (in 24-hour format) when the automation event is to occur. Set the desired values with the knob.

D) For events that occur on a daily or weekly schedule:

a) Use the *Prev* and *Next* buttons to move the cursor the each day of the week in turn, and use the rotary encoder to turn the day on or off.

> You can program the event to occur on as many days of the week as you wish.

b) Use the *Prev* and *Next* buttons to move the cursor set the hour, minute, and second (in 24-hour format — e.g., 18:00:00 for 6:00 PM) when the automation event is to occur. Set the desired values with the knob.

> Automation events have a "start" time but no "stop" time. The 5500i will indefinitely remain in the state specified by an existing automation event until its state is changed by another automation event or by another action (such as a user's interacting with the front panel or PC Remote software).

E) For all events:

a) Press the SELECT EVENT button.

b) Turn the knob to set the desired event. The available events are:

- Recall factory preset
- Recall user preset
- stereo mode
- mono-from-left-channel (MONO-L) mode

- mono-from right-channel (MONO-R) mode
- mono-from-sum-of-channels (MONO-SUM)
- bypass mode
- Independently activate and defeat the diversity delay applied to the analog, digital, and composite outputs.
- exit test (restores the operating preset that was on-air before a test mode was invoked)
- mod. reduction 1
- mod. reduction 2
- exit mod. reduction

F) When you have programmed an event to your satisfaction, press the SAVE EVENT button.

You will return to the automation menu.

4. To edit an existing event:

A) Press the VIEW/EDIT EVENT button.

B) Select *Next/Prev* to sort by either the event times or event tasks.

C) Turn the knob until you see the event you wish to edit.

D) Press the EDIT EVENT button.

E) Edit the event as desired. Use the same technique as adding an event.

See step 3 on page 2-37.

F) Press the SAVE EVENT button to store your edits.

5. To delete an event:

A) Press the DELETE EVENT button.

B) Select *Next/Prev* to sort by either the event times or event tasks.

C) Choose the event to delete with the knob.

You can search by date or by event (i.e., recalling a given preset). Use the *Next* button to navigate from one type of search to the other type.

D) When you have located the event you want to remove, press the DELETE EVENT button.

This action will immediately delete the event. There is no “are you sure” warning message. To abort the deletion, press the ESC button, not the DELETE EVENT button.

Security and Passcode Programming

[Skip this step if you do not plan to use PC Remote software or do not plan to lock out the front panel locally.]

The 5500i has several levels of security to prevent unauthorized people from changing its programming or operating state. Security controls access to the front panel and to anyone connecting to the 5500i through a direct serial connection, dial-up networking (through modems), or its Ethernet port.

The security levels are:

1. All Access (i.e., administrator level)
2. All Access except Security
3. All Access except Modify and Security
4. Recall, Modify and Automation
5. Recall Presets and Program Automation
6. Recall Presets

Starting with version 1.1 software, there is a default All-Access passcode: `1234`. This allows PC Remote users to connect to the 5500i if they forgot to add a passcode from the 5500i's front panel. *Like any other default passcode, it should be erased and replaced by a strong custom passcode as soon as possible.* See *To Delete a Passcode* on page 2-40 and *To Create a Passcode* below. Note that if you fail to create a custom passcode and merely delete the `1234` passcode, the `1234` passcode will be regenerated automatically the next time your Optimod is turned off and back on.

The Optimod's front panel cannot be locked out unless the Optimod has been assigned at least one All Access passcode.

The Optimod secures User Presets by encrypting them (using the Advanced Encryption Standard algorithm with the session passcode as its key) when PC Remote fetches them. Hence, a packet sniffer cannot intercept User Presets in plaintext form. PC Remote then writes the fetched User Presets in encrypted form on your hard drive, where they remain for the duration of your PC Remote session.

> If PC Remote exits normally, it will erase these temporary User Preset files from your computer's hard disk. If it does not exit normally, these files will remain in encrypted form. However, the next time that PC Remote starts up, it will automatically clean up any orphaned files.

To Create a Passcode:

A) Navigate to *Setup* > SECURITY > ADD PASSCODES.

> If the front panel is already password protected, you can only access this screen by entering a passcode with All Access privileges.

B) Use the four soft buttons, labeled"1," "2," "3," and "4," to create a passcode.

Passcodes can be up to eight characters long but can only contain the characters "1," "2," "3," and "4." This limitation makes it easy to enter a passcode using the four available soft buttons.

C) When you have finished entering your new passcode, write it down so you do not forget it. Then press the *Next* button.

If you wish to discard the passcode you just entered, press the ESC button instead. Then return to step (B).

D) The PERMISSIONS screen appears. Turn the knob to choose the permission level for the passcode you just created.

If you wish to discard the passcode you just entered, press the PREV button to return to the Enter Passcode screen or ESC to return to the Security screen.

E) Press the *Next* button to save your new passcode.

To Edit a Passcode:

A) Navigate to *Setup* > SECURITY > VIEW-EDIT PASSCODES.

If the front panel is already password protected, you can only access this screen by entering a passcode with ALL ACCESS privileges.

B) Turn the knob until you see the passcode you want to edit.

C) Press the *Next* button. The Permissions screen appears.

D) Turn the knob to set the desired permission level for the passcode you are editing.

E) Press the *Next* button to confirm your choice.

Your new permission level is stored and the Security menu appears.

To Delete a Passcode:

A) Navigate to *SETUP* > SECURITY > DELETE PASSCODES.

If the front panel is already password protected, you can only access this screen by entering a passcode with All Access privileges.

B) Turn the knob until you see the passcode you want to delete.

C) Press the *Next* button. The Confirm Delete screen appears.

D) Press the YES soft button to delete the passcode. Press the NO or *ESCAPE* buttons to abort deleting the passcode.

To Lock the Front Panel Immediately:

After you have adjusted the processor, to maximize security you will often want to lock it immediately without waiting for the timeout. To do so:

A) Press the *Setup* button.

B) Press the LOCK NOW soft button.

To Program local lockout:

A) Navigate to *Setup* > SECURITY.

If the front panel is already password protected, you can only access this screen by entering a passcode with ALL ACCESS privileges.

B) Hold down the AUTOLOCK soft button and turn the knob to set the desired lockout time (if any).

You can program the lockout delay time (in hours:minutes) from 15 minutes to 8 hours, or OFF. This is the time delay between the last access to a local front panel control and when the front panel automatically locks itself out, requiring that you enter a passcode to regain front panel control of the 5500i.

Autolock can only be turned on if at least one passcode exists with ALL ACCESS privileges because an ALL ACCESS passcode is required to fully unlock the panel or to turn off the Autolock function.

C) Press the *Escape* button to leave the Security menu.

To Unlock the Front Panel:

A) On the 5500i front panel, operate any button or the knob.

The PASSCODE screen will appear.

B) Enter a passcode using the four soft buttons.

The 5500i functionality that you can access depends on the security level of the passcode that you entered.

After you have finished working, the panel will automatically re-lock after the time delay you set in *Setup* > SECURITY > AUTOLOCK. (You can set a new delay at any time if you have an ALL ACCESS passcode.)

Dial-up Networking and the Passcode

When you make a Windows Dial-up Networking connection, Windows will ask you for your passcode. To allow the connection to occur, enter any passcode that you set at the 5500i's front panel. Once your PC is connected to the 5500i, you will be able to access the 5500i functionality corresponding to the security level of your passcode.

If you have not set a passcode, leave the Windows dialog box blank.

If You Have Forgotten Your Passcode

You can reset factory defaults and wipe out security passcodes (in case you forgot your ALL ACCESS passcode).

A) Remove power from the 5500i.

B) While pressing both the *Escape* and *Setup* buttons, restore power.

The Restore Defaults screen appears.

C) To gain access to the 5500i, press the ERASE ALL PASSCODES soft button.

D) Reprogram passcodes as necessary; see *To Create a Passcode* on page 2-39.

The RESTORE DEFAULTS button (in the Restore Defaults screen) restores all System Setup and Input/Output parameters to their factory default settings. It also erases all passcodes. You should never need to use this button in an existing installation, although it is a convenient way to make the 5500i "factory fresh" if it is being installed in a different facility.

The RESTORE DEFAULTS button takes you to a screen that allows you to keep or erase any user presets that exist in your unit.

Administering the 5500i through its Serial Port or Ethernet

Connecting to the 5500i's Ethernet Port or Serial Port via a Terminal Program on a PC

You can connect a terminal emulation application to the 5500i's Ethernet or Serial ports via TCP/IP, port 23 (which is the standard Telnet port and the 5500i factory default). When connected like this, you can:

- recall presets (step 1 on page 2-46)
- turn the diversity delay on and off for a specified output (step 2 on page 2-46)
- trim the diversity delay (step 3 on page 2-47)
- Select the analog or digital input as the audio source (step 4 on page 2-47)
- Fetch real-time operational status information from the Optimod (step 5 on page 2-48)
- Fetch information about the active processing preset (step 6 on page 2-48)
- Fetch diagnostic information from the 5500i (step 7 on page 2-48)

This interface can be used to allow custom third-party applications (including automation systems) to recall presets, view status and set the controls listed above. However, you cannot restore defaults, set security passcodes and change networking controls via Ethernet or the serial port. You can set those controls by using 5500i PC Remote software. (See *Installing 5500i PC Remote Control Software* on page 2-56.)

- The serial port connection uses the PPP protocol.

- To set a different port number:

  A) From the main menu, navigate to *Setup* > NETWORK&REMOTE > NETWORK.

  B) Press the TERMINAL PORT soft button.

  The current setting of the Terminal Port appears.

  If the TERMINAL PORT soft button is not visible, press the *Next/Prev* buttons until it is.

  a) Use the *Next* and *Prev* keys to move the cursor in turn to each digit in the terminal port number. Use the knob to set the digit to the desired value. Repeat until you have selected all the numbers in the IP address assigned by your network administrator

  b) Press the SAVE soft button to confirm your setting.

- The IP address for this Ethernet connection is the same as the IP address set in step (1.B) on page 2-51 and is visible in the *Setup* > NETWORK&REMOTE > NETWORK screen. A serial connection uses a fixed IP address: 192.168.168.101.

To control the 5500i directly through its Serial or Ethernet port, you can use the freeware terminal emulation application PuTTY. If you wish to automate control, download Plink. Both of these applications are available for free download. Search "PuTTY" with Google to find a download site.

Note that Windows 7 does not install a Telnet Client by default, so you must do this manually if you wish to initiate a Telnet connection between a Windows 7 machine and your Optimod. Refer to: http://technet.microsoft.com/en-us/library/cc771275(WS.10).aspx

Direct Control Using PuTTY

A) If you are using a serial connection, establish a Direct Serial Connection between your computer and the Optimod. See *Appendix: Setting Up Serial Communications* starting on page 2-59.

A connection through the serial port uses a fixed IP address: 192.168.168.101

B) Start PuTTY.

The SESSION window appears.

C) Click the RAW button, and set the Port to 23, or whatever terminal port you have set at the Optimod.

The Terminal Port is visible in the Optimod's SYSTEM SETUP > NETWORK REMOTE > NETWORK screen.

D) In the TERMINAL category, check "Implicit CR in every LF."

You should not have to change any other PuTTY Terminal, Window, or Connection defaults

E) Specify the host name or IP address:

- If you are connecting through the serial port, type 192.168.168.101 into the "Host Name (or IP address)" field.
- If you are connecting through the 5500i's Ethernet interface, type the 5500i's IP address into the "Host Name (or IP address)" field.

  The IP address for this connection is the same as the IP address set in step (1.B) on page 2-51 and is visible in the SYSTEM SETUP > NETWORK REMOTE > NETWORK screen.

F) Name and save the Session if you wish.

G) Click OPEN.

H) Activate the CAPS LOCK on your computer to ensure that you type in uppercase.

You can now perform the operations described in steps 1 through 7 starting on page 2-46.

To automate control of the 5500i externally, establish a Telnet/SSH connection and issue commands and parameters, either by typing them directly into a Telnet/SSH client or by placing them within batch files. Then process them with a scriptable Telnet/SSH client that supports this operation, such as PuTTY, along with its companion command-line interpreter, Plink. You can also use netcat.exe. Below, we provide instructions for both PuTTY/Plink and Netcat.

Custom third party applications can be developed to use this protocol. Additionally, you can include this protocol in an existing application by using small subsets of the standards-based Telnet/SSH protocols directly, or for simplicity, by using scripting or by calling batch files with a Telnet/SSH client such as PuTTY along with its companion command-line interpreter, Plink.

Automating control changes is possible using the Windows Task Scheduler to launch batch files at the desired time.

CAUTION: Because of the powerful features and potential security risks of Netcat, many virus programs may detect this software as a threat. If Netcat is detected as such, configure virus software to allow, and use the software with the normal security precautions. The outbound configurations shown here do not provide any security risks. Inbound connections, if used for other applications, require careful security configuration.

In the examples below, replace "123.45.67.89" with the IP address of the 5500i you are controlling. Replace "23" with the terminal port you specified using the method described on page 2-43. Port 23 is the factory default.

Automated Control Using PuTTY/Plink

This method is scripted with a .cmd file and calls a .txt file. Via plink.exe, the .cmd file calls putty.exe, which then makes the network connection between the computer executing putty.exe and 5500i, and specifies the .txt file to use.

The .txt file contains the 5500i commands.

The following two examples recall the presets JAZZ and ROCK-OPEN respectively.

The file “5500i_P1_Jazz.cmd” contains:

```
plink -raw -P 23 123.45.67.89 < 5500i_P1_JAZZ.txt
```

The file “5500i_P1_JAZZ.txt” contains:

```
RP JAZZ [PASSWORD]
disconnect
```

The file “5500i_P2_Rock-Open.cmd” contains:

```
plink -raw -P 23 123.45.67.89 < 5500i_P2_ROCK-OPEN.txt
```

The file “5500i_P2_Rock-Open.txt” contains

```
RP ROCK-OPEN [PASSWORD]
disconnect
```

Automated Control Using Netcat

Only one utility is required to use this method: netcat.exe. This is available as a free download. Google “netcat.”

This method is scripted with a .cmd file and calls a .txt file.

- The .cmd file calls netcat.exe to make the network connection between the computer executing netcat.exe and 5500i, and specifies the .txt file to use.
- The .txt file contains the 5500i commands.

The following two examples recall the presets JAZZ and ROCK-OPEN respectively.

The file “5500i_P1_JAZZ.cmd” contains:

```
nc.exe -v -n -w 1 123.45.67.89 23 < 5500i_P1_JAZZ.txt
```

The file “5500i_P1_JAZZ.txt” contains:

```
RP JAZZ [PASSWORD]
disconnect
```

The file “5500i_P2_ROCK-OPEN.cmd” contains:

```
nc.exe -v -n -w 1 123.45.67.89 23 < 5500i_P2_ROCK-OPEN.txt
```

The file “5500i_P2_GreggOpen.txt” contains:

```
RP ROCK-OPEN [PASSWORD]
disconnect
```

Administrative Operations Available via the Serial Port

In the following tables of commands and responses:

- Text that the user enters appears in **MONOSPACED BOLD**.
- Responses that the 5500i transmits appear in `monospaced normal`.
- The symbol "↵" means CR (for received commands) and CR+LF (for transmitted responses from 5500i).

Available Commands

1. **To recall a preset:**

Command	Response

RP XXXXXXX[PASSCODE]↵	(valid passcode and preset name)
	`ON AIR: XXXXXXX`
	(invalid passcode)
	`[no error message is issued]`

In the above table: **XXXXXXX** = the preset name;
PASSCODE = any valid passcode.

- If a non-existent control value and/or an invalid passcode is entered, the 5500i will ignore the command. If a non-existent preset name is entered, your Optimod will return an error message to indicate that the preset you entered does not exist.
- You can apply this command anytime after the 5500i boots up.
- This command is useful in interfacing automation systems to the 5500i.

2. **To turn the analog diversity delay on or off for a given output:**

Command	Response

DE XXX[PASSCODE]	(valid passcode and argument)
	`DIVERSITY DELAY: [ON,OFF] (for each output)`
	(invalid passcode)
	`[no error message is issued]`

In the above table: **XXX = ANALOG_ON, ANALOG_OFF, DIGITAL1_ON, DIGITAL1_OFF, COMPOSITE_ON, COMPOSITE_OFF,** or **?**

PASSCODE = ANY VALID PASSCODE.

- If a non-existent control value and/or an invalid passcode is entered, the 5500i

will ignore the command.

- You can apply this command anytime after the 5500i boots up. The 30-minute timeout does not apply.

3. To set the analog diversity delay:

Command	Response
TR X.XXXXXXXXX[PASSCODE]	(valid passcode and argument) DELAY: X.XXXXXXXXX (invalid passcode) [no error message is issued]

In the above table: **X.XXXXXXXXX** = the delay time. Acceptable values are 0.000015625 to 8.192 for the 8-second board and 0.000015625 to 16.384 for the 16-second board (10 total digits) in increments of 0.000015625

PASSCODE = ANY VALID PASSCODE.

- This command is useful when a station has two transmission chains (typically main and backup) that require different diversity delay settings. We recommend first using 5500i PC Remote to set the correct delays for the main and backup chains. When you have found the correct delay for each transmission chain, write down the delay times that PC Remote displays. Then program these into "main" and "standby" batch files that, when executed, send the appropriate TR command to the 5500i when the on-air transmission chain is swapped.
- If a non-existent control value, and/or an invalid passcode is entered, the 5500i will ignore the command.

4. To select the analog or digital input as the audio source:

Note: When the input is set to DIGITAL and no valid digital signal is present at the input, the setting of the DI ANALOG FALLBACK control will determine whether the Optimod automatically switches to its analog input. See step 10 on page 2-26.

Command	Response
IN X[PASSCODE]	(valid passcode and argument) INPUT: [ANALOG, DIGITAL, DIGITAL J17] (for each output) (invalid passcode) [no error message is issued]
IN [PASSCODE]?↵	Returns active Input.

In the above table: **X = A, D, J17**
where A = analog input, D = digital input, and J17 = Digital J.17.

PASSCODE = ANY VALID PASSCODE.

- ? returns the active input setting.
- If a non-existent control value and/or an invalid passcode is entered, the 5500i will ignore the command.

5. To fetch real-time operational status information from the Optimod:

This provides a real-time status report including the following information:

Command	Response
RT [PASSCODE]↵	5500i Status: digital input 1 lock [active][inactive] remote contact closure 1 [active][inactive] remote contact closure 2 [active][inactive] remote contact closure 3 [active][inactive] remote contact closure 4 [active][inactive] remote contact closure 5 [active][inactive] remote contact closure 6 [active][inactive] remote contact closure 7 [active][inactive] remote contact closure 8 [active][inactive] tally out 1 [active][inactive] tally out 2 [active][inactive]

6. To fetch information about the active processing preset:

Command	Response
AP [PASSCODE]?↵	Returns active processing preset name
AP [PASSCODE]??↵	Returns active processing preset control settings
LP [PASSCODE] ↵	Returns a list of all available processing presets

7. To fetch diagnostic information from the 5500i:

This provides a status report indicating technical parameters:

Command	Response
ST [PASSCODE]↵	5500i Status: 5500i V 1.2.4.156 Station Name: XXXX Access Level: 0: all access Bootup: Thu Nov 21 23:17:40 2013

```
MAC Address: 00-0E-EC-E8-0B-99
Memory Available: 11086976
Available Space: 8578 Kbytes
i/o board version: 5.00
SNMP active
```

Remote Control Interface Programming

[Skip this step if you do not wish to program the GPI (contact closure) remote control interface.]

1. **Navigate to *Setup* > *Next* > NETWORK & REMOTE > REMOTE INTERFACE.**

2. **Program one or more remote control interfaces.**

   A) Navigate to the desired Remote Interface button (1 through 8) by repeatedly pressing the *Next* button.

   B) Hold down the button while turning the knob to select the desired function for the interface.

   Use either button below the appropriate graphics; both work the same.

   A momentary pulse of voltage will switch most functions except as noted.

   - **Preset Name**: switches the named preset on the air. The control interface can recall any factory or user preset.
   - **Input**: **Analog**: selects the analog inputs.
   - **Input**: **Digital**: selects the digital input and but does not apply de-emphasis to it.
   - **Input**: **Digital+J.17**: selects the digital input and applies J.17 de-emphasis to it.
   - Independently activate and defeat the **diversity delay** applied to the analog, digital, and composite outputs.
   - **Bypass**: switches the Bypass Test Mode on the air.
   - **Tone**: switches the Tone Test Mode preset on the air.

- **Exit Test**: If a test preset is presently on the air, EXIT TEST reverts to the previous processing preset.
- **Stereo**: Determines the operating mode of the audio processing (STEREO, MONO-FROM-LEFT, MONO-FROM-RIGHT, or MONO-FROM-SUM.)

- **Mono from Left, Mono from Right, or Mono from Sum**: switches the 5500i's stereo encoder off, using the Left, Right, or Sum (L+R) respectively as the program source. This also determines the feed to the entire processing chain so that facilities that do not use the 5500i's stereo encoder can change stereo/mono mode and select the source when in mono mode.
- **Mod Reduction 1, or Mod Reduction 2**: reduces the program modulation by the percentage programmed in SETUP > NEXT > MODULATION REDUCTION (see step 21 on page 2-21). When voltage is removed, these functions are deactivated.
- **Reset Clock To Hour**: resets the internal clock to the nearest hour. For example, 3:03:10 would be reset to 3:00:00, while 3:53:40 would be reset to 4:00:00. Use this function to periodically re-sync the 5500i's internal clock to your station's master clock.
- **Reset Clock to Midnight**: Resets the clock to 0:00:00. You can use this function to periodically re-sync the 5500i's internal clock to your station's master clock.
    - **No Function**: remote input is disabled.

3. End remote control interface programming.

When you are finished programming the remote control interface, press the Escape button to return to higher menu levels.

Networking and Remote Control

[Skip this step if you do not wish to connect to your 5500i remotely, either for downloading software upgrades or for PC Remote Control.]

The 5500i has a built-in Ethernet connector that can be used with 10 Mbps or 100 Mbps ports using the TCP/IP protocol. You can also connect a PC to the 5500i through the 5500i's RS-232 serial port, either by modem or directly through a null modem cable.

1. Prepare the 5500i for an Ethernet network connection:

[Skip this step if you will not be using an Ethernet connection.]

- See your network administrator to get the data required in the following procedure.
- Note that if you wish to do this from the 5500i PC Remote software, then you must first be able to connect to the 5500i. Therefore, you will usually perform this procedure from the 5500i's front panel to prepare it for connection.

A) Navigate to *Setup* > NETWORK & REMOTE > *Next*.

B) Press the SET IP ADDRESS soft button.

The IP Address Screen appears.

a) Use the *Next* and *Prev* keys to move the cursor in turn to each digit in the IP address. Use the knob to set the digit to the desired value. Repeat until you have selected all the numbers in the IP address assigned by your network administrator

b) Press the SAVE soft button to confirm your setting.

C) Set the Subnet Mask assigned by your network administrator if necessary:

a) Press the SET SUBNET MASK soft button.

b) Use the *Next* and *Prev* keys to move the cursor in turn to each digit in the subnet mask. Use the knob to set the digit to the desired value. Repeat until you have selected all the numbers in the subnet mask assigned by your network administrator

c) Press the SAVE soft button to confirm your setting.

D) Set the Gateway Address assigned by your network administrator if necessary:

a) Press the GATEWAY ADDRESS soft button.

b) Use the *Next* and *Prev* keys to move the cursor in turn to each digit in the gateway address. Use the knob to set the digit to the desired value. Repeat until you have selected all the numbers in the gateway address assigned by your network administrator

c) Press the SAVE soft button to confirm your setting.

E) Set the IP Port assigned by your network administrator if necessary:

a) Press the IP PORT soft button.

b) Use the *Next* and *Prev* keys to move the cursor in turn to each digit in the IP port. Use the knob to set the digit to the desired value. Repeat until you have selected all the numbers in the IP port assigned by your network administrator

c) Press the SAVE soft button to confirm your setting.

F) Connect your Ethernet network to the RJ45 jack on the rear panel of your 5500i.

- If you are connecting to a hub or router, use a standard Ethernet cable.
- If you are connecting directly to the Ethernet jack on a computer, use a "crossover" or "reverse" Ethernet cable.

G) Press the *Next* button.

2. Prepare the 5500i for modem connection through the serial port:

[Skip this step if you will not be using a modem connection.]

A) Navigate to *Setup* > NETWORK & REMOTE.

B) Hold down the PC CONNECT soft button and turn the knob until you see MODEM on the display.

C) Press the MODEM INIT soft button.

D) If the string that appears in the display is S0=4, this is correct. Press the *Escape* button and skip steps (E) and (F) below.

> S0=4 is the 5500i default setting. This activates auto-answer functionality in the modem.

E) Set the INIT STRING to S0=4. Use the *Next* and *Prev* KEYs to move the cursor in turn to each character in the modem initialization string. Use the knob to set the character to the desired value. Repeat until you have set all the characters in the initialization string.

F) Press the SAVE soft button to confirm your setting.

3. Modem setup:

You will need two modems and two available phone lines, one of each for your PC and your 5500i. Orban Customer Service supports only the 3Com/U.S. Robotics® 56kbps fax modem EXT on the 5500i side of your connection, although other 56kbps modems will often work OK.

You can use either an internal or an external modem with your PC.

A) Connect the telephone line from the wall phone jack to the wall connection icon on the back of the modem (modem in).

B) Connect the modem to the 5500i's serial port with a standard (not null) modem cable.

> The cable provided with your 5500i is a null modem cable and will not work.

C) Set the modem to AUTO ANSWER and turn it on.

> For 3Com/U.S. Robotics® 56kbps fax modem EXT, set dipswitches 3, 5, and 8 in the down position to activate the AUTO ANSWER setting. All other dipswitches should be set to the up position.

4. Prepare the 5500i for direct serial connection through the serial port:

[Skip this step if you will not be using a modem connection.]

A) Navigate to *Setup* > NETWORK & REMOTE.

B) Hold down the PC CONNECT soft button and turn the knob until you see DIRECT on the display.

You are now ready to connect your computer to your 5500i through a null modem cable connected to your computer's serial port. Refer to *Installing 5500i PC Remote Control Software on page 2-56*.

Synchronizing Optimod to a Network Time Server

[Skip this section if you do not wish to automatically synchronize your Optimod's internal clock to a network timeserver, which may be part of your local network or located on the Internet.]

1. Navigate to SETUP > NEXT > TIME DATE AND ID > NEXT > TIME SYNC.

A) Use the PROTOCOL control to choose either TIME PROT or SNTP.

- Select TIME PROT if the Optimod is behind a firewall that does not pass UPD packets. TIME PROT selects the Time Protocol as described in the standard RFC868. This method uses TCP on port 37.
- Select SNTP if your network timeserver supports the Simple Network Time Protocol as described in standard RFC1769. This method uses UDP on port 123.

Ask your network administrator which protocols are available. SNTP is slightly more accurate.

B) Using SYNC PERIOD, choose how often your Optimod will automatically update its internal clock to the timeserver you selected.

The choices are OFF, 8 HOURS, and 24 HOURS.

If the connection to the timeserver fails (due to network overload or other problems), your Optimod will try once per hour to synchronize until it is successful.

C) Set the OFFSET to the difference (in hours) between your time zone and Universal Time (UTC).

UTC is also known as GMT, or Greenwich Mean Time.

- The value can range between –12 and +12 hours in increments of 30 minutes. If this value is set to 0, your Optimod's time will be the same as UTC.
- You can empirically adjust this value until the correct time for your location is displayed after you synchronize your Optimod to a timeserver.

2. Choose a timeserver.

As of August 2011, http://tf.nist.gov/tf-cgi/servers.cgi# provides a current list of timeservers available on the Internet. You network may also have a local timeserver; ask your network administrator.

3. Press the NEXT button to set up timeserver parameters.

The TIME SERVER button is located on the second page of the TIME SYNC functions. (You can access this function from anywhere in the Optimod menu tree by navigating to *Setup* > *Next* > TIME DATE AND ID > *Next* > TIME SYNC > *Next*.)

You can specify the timeserver either from your Optimod's front panel or from its PC Remote software. From the front panel, you can only enter the timeserver's IP address (for example, 192.43.244.18). If you specify the timeserver from PC Remote, you can specify either its named address (for example, time.nist.gov) or its IP address. The PC Remote method is easier.

4. Specify the time sync parameters from your Optimod's front panel:

[Skip this step if you wish to specify the timeserver and time sync parameters from your Windows XP computer.]

A) Press the TIME SERVER button.

The timeserver IP Address Screen appears.

a) Use the *Next* and *Prev* keys to move the cursor in turn to each digit in the IP address. Use the knob to set the digit to the desired value. Repeat until you have selected all the numbers in the desired IP address.

b) Press the SAVE soft button to confirm your setting.

B) Press the SYNC NOW soft button to test your settings. Your Optimod's display should indicate that it is connecting to the IP address that you specified. When the connection is successful, the Optimod's clock will automatically synchronize to the timeserver.

- If the connection is not successful within five seconds, the display will indicate that the connection failed. This means either that the timeserver is too busy or that your setup cannot connect to the timeserver. Double-check the IP address. If you are behind a firewall, make sure that port 123 is open.

- If your connection failed, the gateway address might not be set correctly on your Optimod. The gateway address for the timeserver connection is the same gateway address that you set in step (1.D) on page 2-51. If you do not know the correct gateway address, you can often discover it by connecting a Windows computer to the same Ethernet cable that is ordinarily plugged into your Optimod. Ascertain that the computer can connect to the Internet. At the command prompt, type `ipconfig`. The computer will return the "Default Gateway."

5. Specify the time sync from the Optimod PC Remote software:

[Skip this step if you wish to specify the timeserver and time sync parameters from your Optimod's front panel.]

Optimod PC Remote software can automatically set your Optimod's local time, OFFSET, and TIME SERVER to reflect the Windows settings in the machine running PC Remote software.

> If you are running Windows 2000, you cannot specify the timeserver from your computer. However, you can still set your Optimod's clock and offset.

A) In Windows, navigate to the CONTROL PANEL > DATE AND TIME > TIME ZONE tab.

B) Set time zone to correspond to your local time zone.

C) In Windows, navigate to the CONTROL PANEL > DATE AND TIME > INTERNET TIME tab.

D) If you are running Windows XP:

a) Check "Automatically synchronize with an Internet time server" to set your Optimod's SYNC PERIOD to "24."

b) Set "Server" to the desired timeserver.

c) Click the "Update Now" button to synchronize your computer's clock to the selected timeserver. If this is successful, this means that you can connect to the selected timeserver over your network.

- The INTERNET TIME tab is not available in Windows 2000. If you are running Optimod PC Remote on Windows 2000, you must enter the timeserver from your Optimod's front panel as an IP address (step 4 on page 2-54).
- If the timeserver you selected in Windows is a named address, not an IP address, the 5500i will resolve it correctly but the IP address that appears in your Optimod's display will be 0.0.0.0.
- To use PC Remote to turn off your Optimod's automatic synchronization, uncheck "Automatically synchronize with an Internet time server" on your PC. Then click the "Update Now" button on PC Remote.

E) Navigate to Optimod PC Remote's SETUP > UTILITY tab and click the SET 5500I CLOCK button.

- If you are running Windows XP, PC Remote will download your computer's currently specified timeserver into your Optimod.
- PC Remote will adjust your Optimod's OFFSET setting to correspond to your computer's time zone setting.
- PC Remote will synchronize your Optimod's clock with your computer's clock.

F) It is wise to disconnect from PC Remote and then to press the SYNC NOW button on your Optimod [step (4.B) on page 2-54]. This is to test the ability of your Optimod to synchronize to the selected timeserver and to ensure that your Optimod's clock is set accurately.

NOTE: Manually setting your Optimod's clock via Set Time, Set Date, Daylight Time, and the remote contact closure Reset to Hour and Reset to Midnight will not work when the automatic synchronization function is active. To inactivate this function (thereby permitting manual setting to work), set the SYNC PERIOD to OFF.

Installing 5500i PC Remote Control Software

This section briefly summarizes the procedure for installing 5500i PC Remote software on existing 5500is. If required, you will find more detailed instructions in the .pdf file automatically installed on your computer by Orban's installer program, `Setup5500i_x.x.x.x.exe`, where "x.x.x.x" represents the software version you are installing. (For example, for version 1.0 software, this would be 1.0.0.0.)

The PC Remote software is supplied on a CD shipped with your 5500i. You can also download it from `ftp.orban.com/5500i`.

Instructions for using the PC Remote software begin on page 3-62.

Installing the Necessary Windows Services

The 5500i PC Remote application uses Windows' built-in communications and networking services to deal with the low-level details necessary to communicate with the 5500i's serial port. (These services are also used to upgrade your 5500i's firmware when updates are available from Orban.) The exact process will vary, depending on how you wish to set up the communications. That is:

- If you want to communicate through a local PC, you will need to establish a connection between a serial (COM) port of the PC and the COM port of your 5500i through a null modem cable (supplied with your 5500i). You will then use Windows Direct Serial Connect to make the basic connection.

- If you want to communicate through a pair of modems, you will use the Windows Dial-Up networking service to make the connection.

  You must install the appropriate communications services in Windows (if they are not already installed) before you can run 5500i Remote software. *You may therefore need to have access to the Windows install disk(s) — or have their image copied onto your computer's hard drive — before you attempt to use the 5500i PC Remote application*.

  In all cases, regardless of whether your PC communicates to the 5500i through its serial port or Ethernet connector, it uses the ppp and the TCP/IP protocols to communicate with the 5500i.

Check Hardware Requirements

To connect your PC to your 5500i, regardless of the method you choose, you will need the following:

- Orban 5500i OPTIMOD-FM.

- *If connecting by serial cable:* a null modem cable (also called a "reverse" cable). This cable has DB9 female connectors at both ends for connecting the 5500i to

the serial port on your computer. If your computer has a DB25 connector, you will need to obtain an adapter.

- *If connecting by modem:* a 3Com/U.S. Robotics® 56kbps fax modem EXT and normal (not null) modem cable for the 5500i side of the connection. Note that Orban Customer Service does not support any other type of modem for connecting to the 5500i.

- *If connecting by network:* a standard Ethernet cable (with RJ45 connectors) to connect to a network hub or router, or a crossover Ethernet cable to connect directly to your PC's Ethernet jack.

- PC running Windows 2000 (SP3 or higher)/XP/Vista/7.

5500i PC Remote will not run on older Windows versions.

Recommended Components

Computer ..... Pentium II or higher
Available Disk Space 25MBessRAM
..... Depends on your computer's OS
Display ..... SVGA or higher
Microsoft Windows ..... 2000 (SP3 or higher)/XP/Vista/7/8
COM Port ..... 16550 (or compatible) UART

WARNING!

When connecting your 5500i, use shielded cable to protect the pins in the RS-232 connector from electrostatic discharge.

The following subsections provide steps for connecting to your 5500i OPTIMOD-FM software using the Windows 2000/XP Direct Cable Connect or via modem connection.

Running the Orban Installer Program

Insert the installer CD into your computer's CD drive.

The installer should start up and ask you if you wish to install the PC Remote application on your computer. If it fails to do so, navigate to Start \ Run on your computer, and type `X:setup` (where "X" is the drive letter of your CD drive).

Follow the prompts on your screen to install the PC Remote software automatically on your computer.

- You might have obtained the automatic installer application from some other source than Orban's CD, like Orban's ftp site or another computer on your network. If so, just run the application and follow the on-screen instructions.

- This program installs the necessary files and adds an Orban/Optimod 5500i folder to your computer's Start Menu. This folder contains shortcuts to the PC Remote application and to the documentation. If you accepted the option during installation, there is also a shortcut to the PC Remote application on your desktop.

You have now installed all files necessary to use the PC Remote software. If you are using a direct serial or a modem connection, the next step is to install and configure the Windows communications services that allow your computer to communicate with your 5500i. *Appendix: Setting Up Serial Communications* on page 2-59 provides details.

Setting Up Ethernet, LAN, and VPN Connections

If you are using an Ethernet connection and your computer can successfully connect to the Internet through its Ethernet port, it already has the correct (TCP/IP) networking set up to communicate with the 5500i. In most cases, all you need is your 5500i's IP address, Port, and Gateway number, as set in step 1 on page 2-50. You will enter these when you create a "connection" to your 5500i from the 5500i PC Remote application — see step (E) on page 3-63. If your computer does not have a working Ethernet port, you will need to add one and then following the instructions provided by Microsoft to set it up to enable TCP/IP networking.

If you wish to connect to your 5500i through your LAN or VPN (through a WAN or the Internet), consult your network administrator. Note that to cross subnets, you must specify a gateway. If the PC and 5500i are on the same subnet, then it is unnecessary to specify a gateway.

If you are behind a firewall, you must open the port you specified in step (1.E) on page 2-51. If the gateway, port, and firewall (if used) are configured correctly, it is possible to connect 5500i PC Remote to a 5500i via a VPN.

Conclusion

By carefully following the instructions in the Appendix, you should have successfully installed the necessary Windows services and connected to your 5500i. However, if you experience any problems with this process, or have any other 5500i questions, please contact Orban Customer Service:

Phone: +1 856.719.9900

email: custserv@orban.com

For details on your new 5500i software, from new features to operational suggestions, refer to our FTP site (`ftp.orban.com/5500i`).

Appendix: Setting Up Serial Communications

This appendix provides instructions for setting up both direct serial and modem connections from your 5500i to your PC. You must do this when you define a new connection from the 5500i PC Remote application. The appendix provides procedures for both the Windows 2000 and Windows XP operating systems and can be readily extended by analogy for Windows Vista and 7, although we recommend using Ethernet connections with Vista or 7. Note that the screen shots were prepared using Orban's Optimod-FM 8300 but apply equally well to the 5500i.

Preparing for Communication through Null Modem Cable

1. **Configure your 5500i.**

   A) On your 5500i's front panel, navigate to *Setup* > NETWORK & REMOTE.

   B) Hold down the PC CONNECT soft button and turn the knob until you see DIRECT on the display.

2. **Connect the cable.**

   A) Connect one end of the null modem cable that we supplied with your 5500i to the DB9 serial connector on the 5500i's rear panel.

   Be sure to use a null modem cable. A normal serial cable will not work.

   B) Connect the other end of the cable to your computer's COM port.

Connecting Using Windows 2000 Direct Serial Connection:

Ordinarily, a direct serial connection through a null modem cable is used only when you are controlling one 5500i per available COM port on your computer. If you wish to control multiple local 5500is, it is better to use an Ethernet network connection. However, in principle you could control multiple 5500is serially from one COM port, using a hardware serial switch to select the 5500i you wish to control. In this case, you should set up a separate 5500i "connection" for each 5500i to be controlled, following the instructions below. All connections should reference the same COM port.

This connection is used both for upgrading your 5500i and for connecting the 5500i PC Remote application to your 5500i.

Important: The Direct Serial Connection must have exclusive access to the PC COM port that connects to your 5500i. Make sure than any software that monitors this COM port (such as HotSync manager, etc) is disabled before running Direct Serial Connection.

If you have already configured your direct serial cable connection, skip to step 2 on page 2-64.

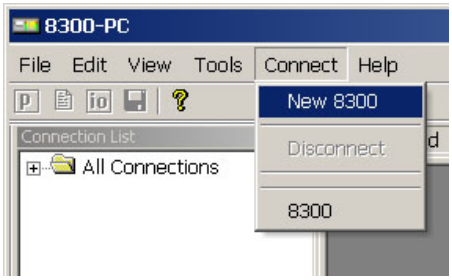
If you cannot access the Internet after making a Direct or Modem connection, you will have to reconfigure certain networking parameters in Windows. Please see *You Cannot Access the Internet After Making a Direct or Modem Connection of the 5500i* on page 5-8.

1. Add and configure a Direct Connection for Windows 2000:

A) Create a New Windows 2000 Direct Connection:

a) Launch 5500i PC Remote.

b) Choose "Connect > New 5500i"

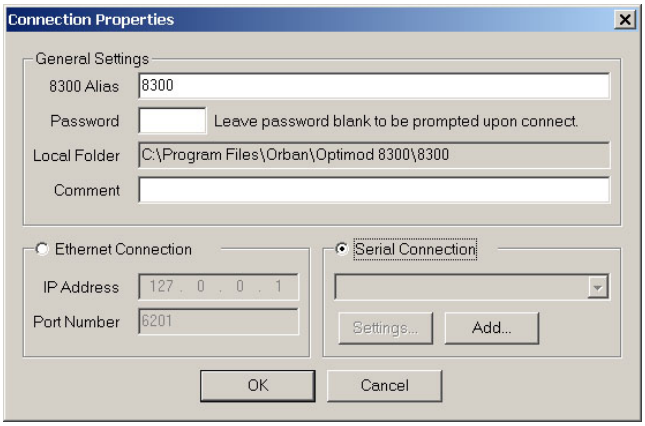


c) Give your 5500i a name (e.g., "KABC") by entering this name in the "5500i Alias" field.

d) If you wish to have 5500i PC Remote remember the password for this Optimod, enter the pass-word in the "Password" field.

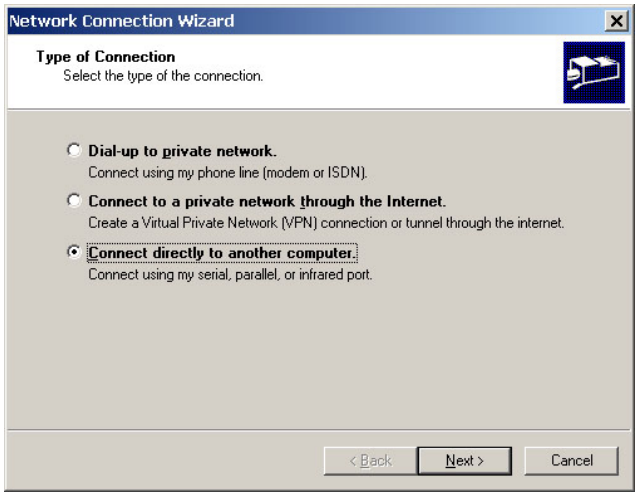
e) Select "Serial Connection."

f) Click "Add."



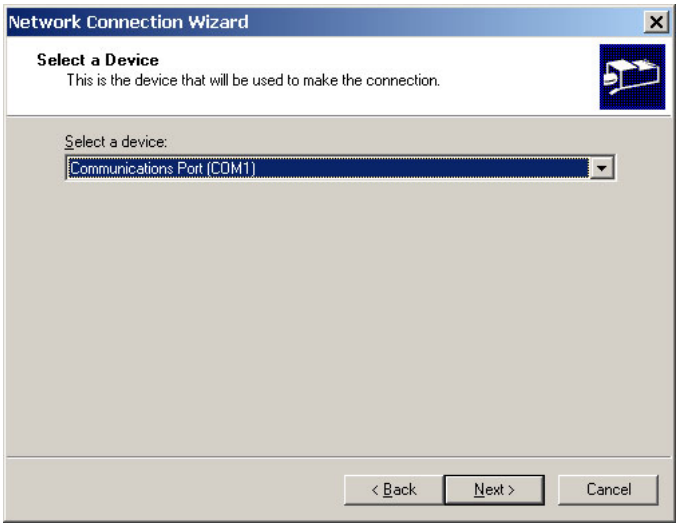
g) Select "Connect Directly to another computer."

h) Click "Next."



i) In the drop-down box, select the serial port you will be using to make the connection.

j) Click "Next."



k) Select either "For all users" or "Only for myself."

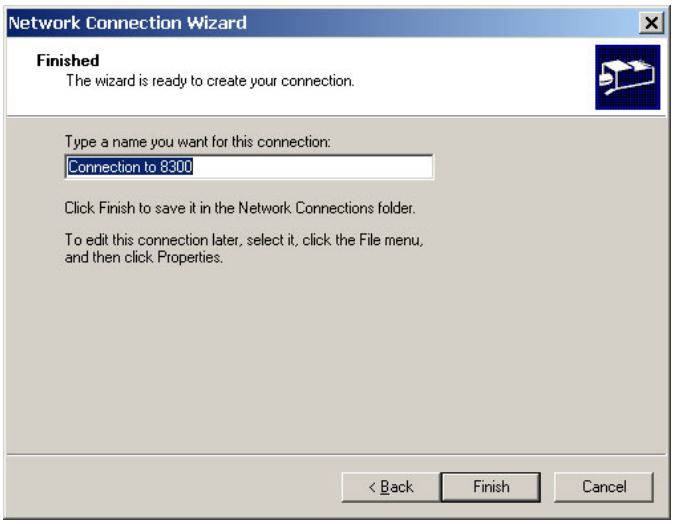
The correct setting depends on how your network and security are configured.

Your wizard may not display this field if your computer is set up for a single user only.

l) Click "Next."

m) Enter a name for your Connection such as: "Connection to 5500i."

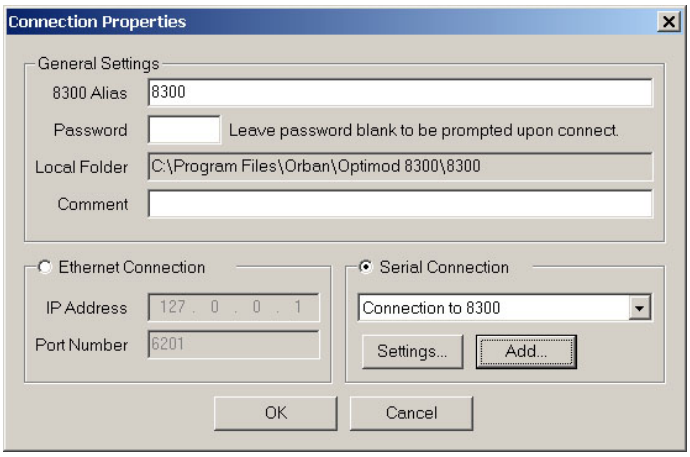
n) Click "Finish."



o) Click “Yes.”

B) Edit your new Direct Connection properties:

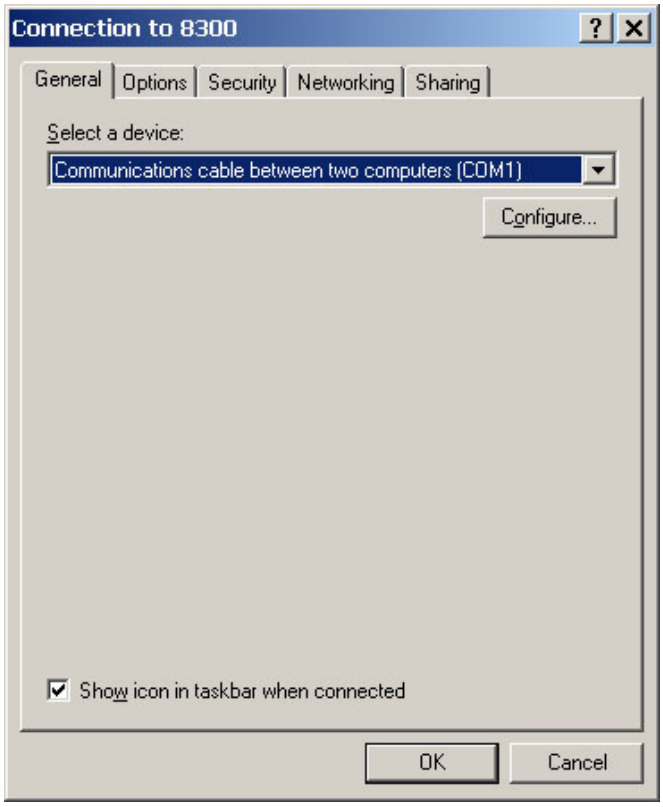
a) Click “Settings.”



b) Click the “General” tab.

c) Select the device you set up in step (i) on page 2-61. This will usually be “Communications cable between two computers (COM1).”

d) Click “Configure.”

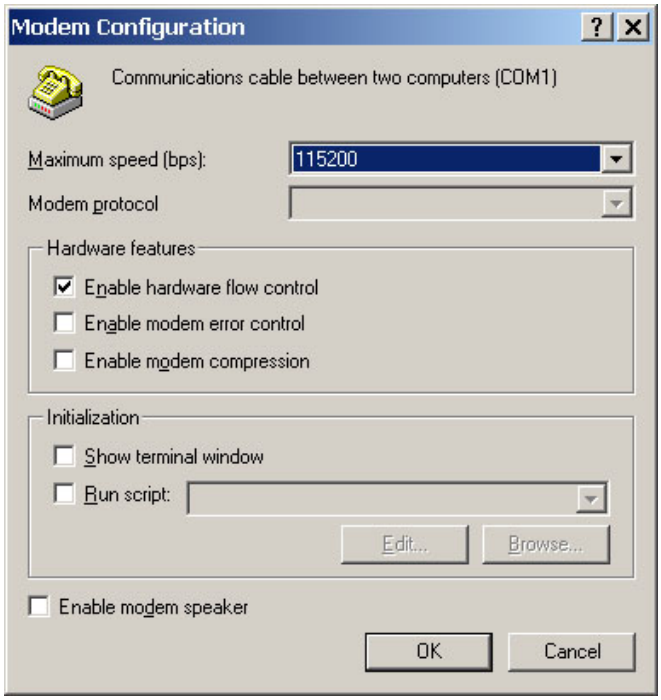


e) Set "Maximum speed (bps)" to "115200."

f) Check "Enable hardware flow control."

g) Make sure that all other boxes are not checked.

h) Click "OK."



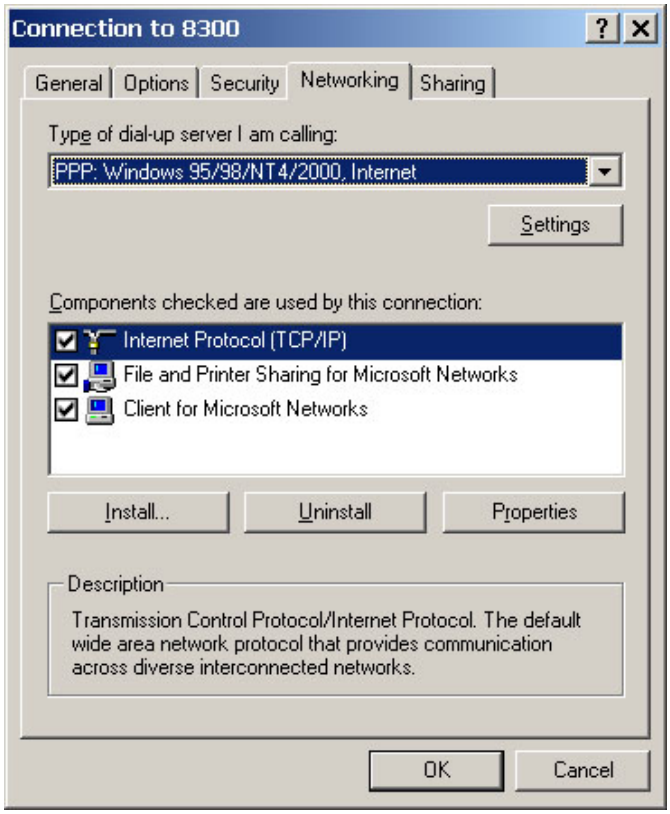
i) Select the Networking tab.

j) Make sure that "PPP: Windows 95/98/NT 4/2000, Internet" appears in the "Type of dial-up server I am calling" field.

k) Make sure that "Internet Protocol (TCP/IP) is checked.

You may leave "File and Printer Sharing for Microsoft Networks" and "Client for Microsoft Networks" checked if you like.

l) Click "OK."



When the "Connection properties" window appears, click "OK."

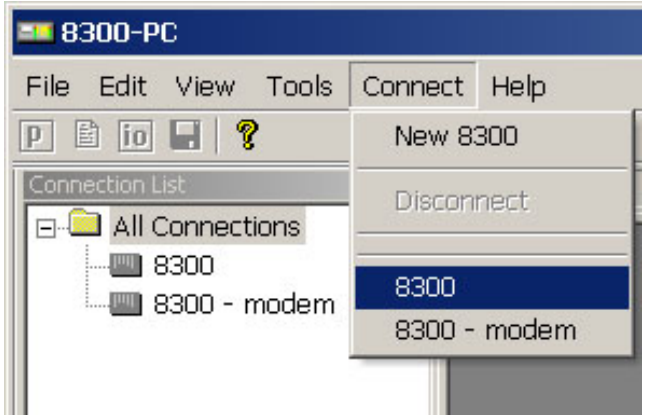
2. Launch an existing Windows 2000 Direct connection.

Once you have set up a "connection" specifying Direct Connect in the 5500i PC Remote application (see *To set up a new connection* on page 3-63), choosing this connection from 5500i PC Remote automatically opens a Windows Direct Connection to your 5500i.

You can connect by selecting the desired connection from the drop-down list in the CONNECT menu.

You can also connect by double-clicking the connection in the "Connection List" window.

A dialog bubble will appear on the bottom right hand corner of the screen verifying your connection if the connection is successful.



If you have trouble making a connection, refer to *OS Specific Troubleshooting Advice: Troubleshooting Windows 2000 Direct Connect* on page 5-9. If you have trouble the first time after creating a connection according to the instructions above, try restarting your computer to clear its serial port.

3. To change the properties of an existing connection:

Right-click the connection in the "connection List" window and choose "Properties." The "Connection properties" window opens (see page 2-60).

Connecting Using Windows XP Direct Serial Connection

If you have already configured your direct serial cable connection, skip to step 2 on page 2-68.

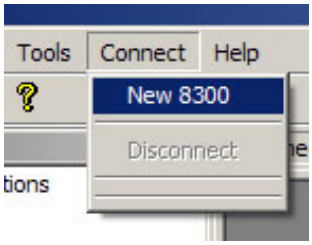
> If you cannot access the Internet after making a Direct or Modem connection, you will have to reconfigure certain networking parameters in Windows. Please see *You Cannot Access the Internet After Making a Direct or Modem Connection to the 5500i* on page 5-8.

1. Add and configure a Direct Connection for Windows XP:

A) Create a New Windows XP Direct Connection:

a) Launch 5500i PC Remote.

b) Choose "Connect > New 5500i"

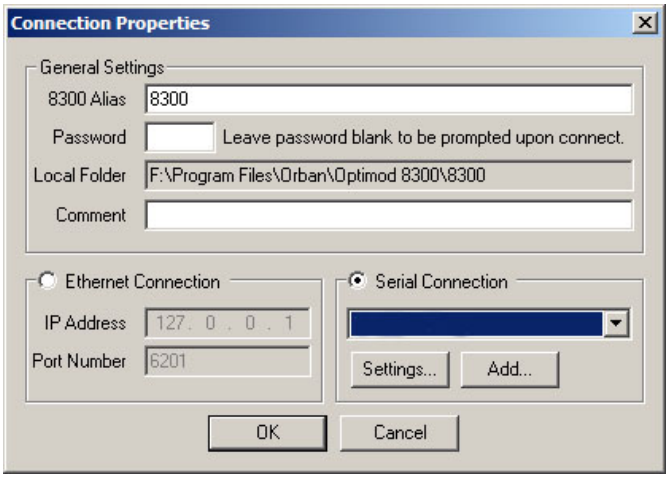


c) Give your 5500i a name (e.g., "KABC") by entering this name in the "5500i Alias" field.

d) If you wish to have 5500i PC Remote remember the password for this Optimod, enter the password in the "Password" field.

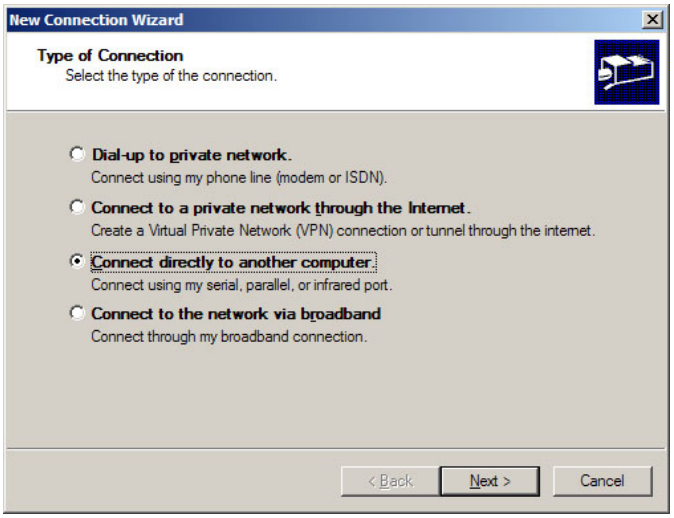
e) Select "Serial Connection."

f) Click the "Add" button.



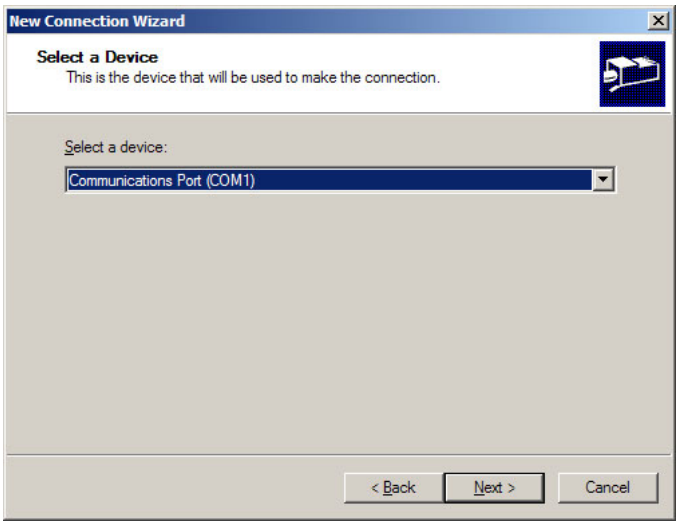
g) Choose "Connect directly to another computer."

h) Click "Next."



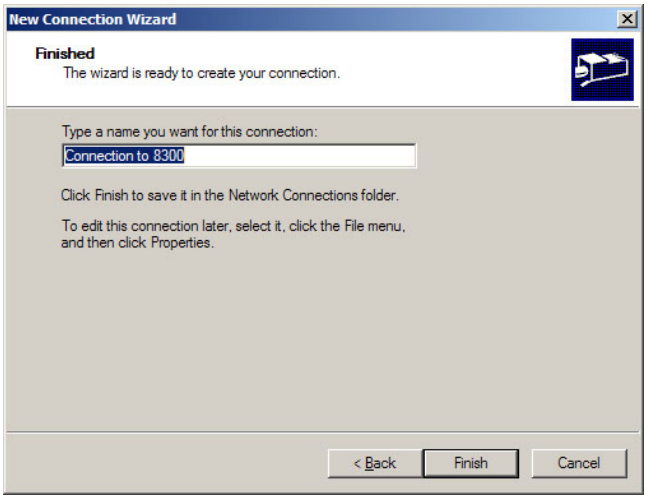
i) In the drop-down box, select the serial port you will be using to make the connection.

j) Click "Next."

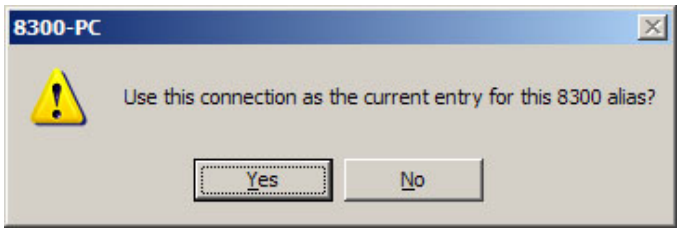


k) Type in a name for your Connection such as: "Connection to 5500i."

l) Click "Finish."

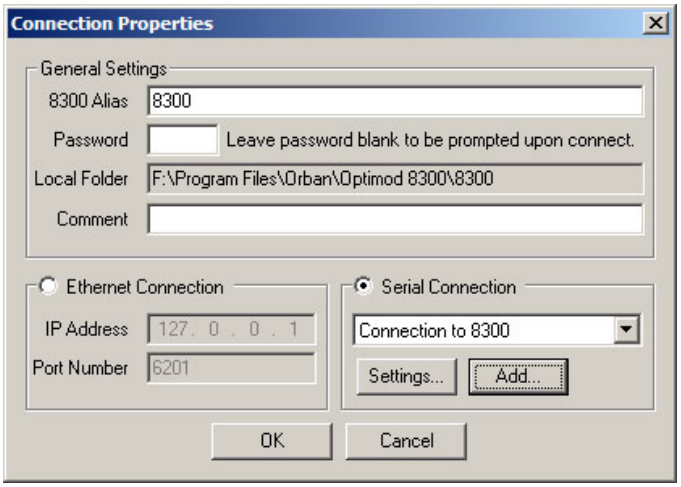


m)Click "Yes."



B) Edit your new Direct Connection properties:

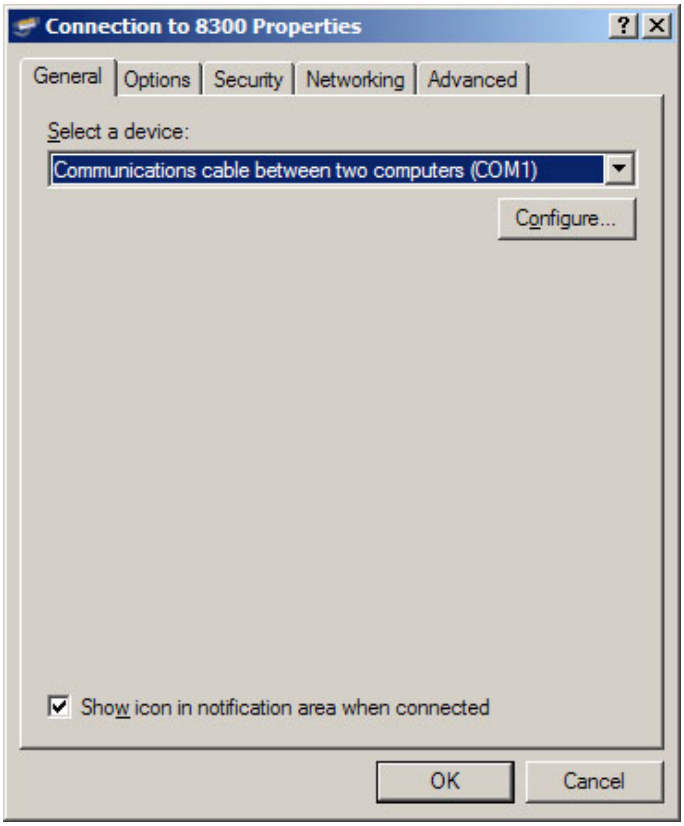
a) Click "Settings."



b) Click the "General" tab.

c) Select the device you set up in step (i) on page 2-65. This will usually be "Communications cable between two computers (COM1)."

d) Click "Configure."

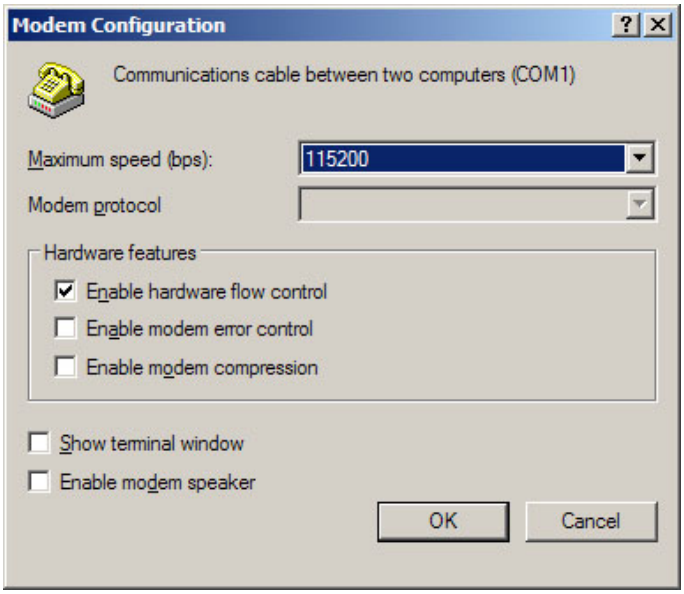


e) Set the "Maximum Speed (bps)" to 115200.

f) Check "Enable hardware flow control."

g) Make sure all other hardware features are unchecked.

h) Click "OK."



i) Select the Networking tab.

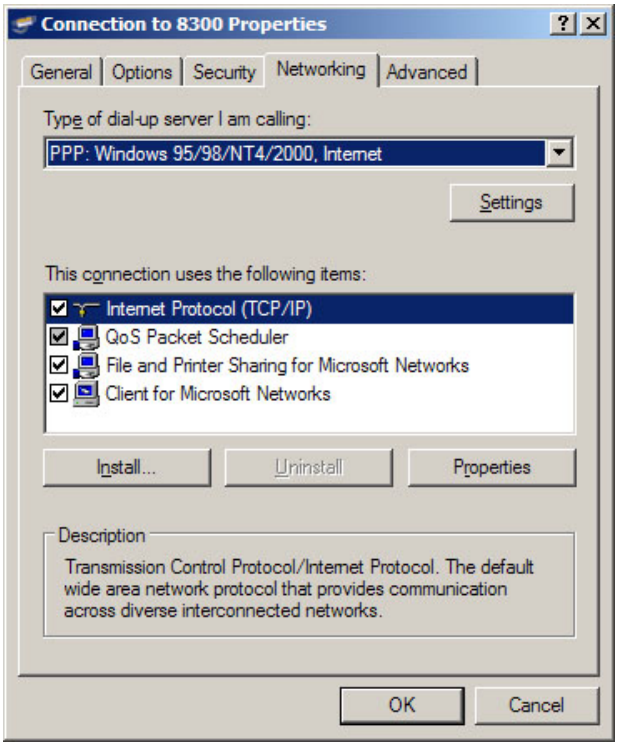
j) Make sure that "PPP: Windows 95/98/NT 4/2000, Internet" appears in the "Type of dial-up server I am calling" field.

k) Make sure that "Internet Protocol (TCP/IP) is checked.

You may leave "File and Printer Sharing for Microsoft Networks" and "Client for Microsoft Networks" checked if you like

l) Click "OK."

m) When the "Connection properties" window appears, click "OK."



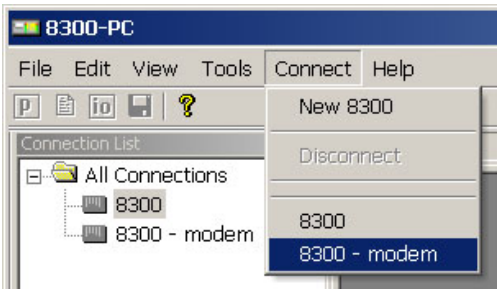
2. Launch an existing Windows XP Direct connection.

Once you have set up a "connection" specifying Direct Connect in the 5500i PC Remote application (see *To set up a new connection* on page 3-63), choosing this connection from 5500i PC Remote automatically opens a Windows Direct Connection to your 5500i.

You can connect by selecting the desired connection from the drop-down list in the CONNECT menu.

You can also connect by double-clicking the connection in the "Connection List" window.

A dialog bubble will appear on the bottom right hand corner of the screen verifying your connection if the connection is successful.



If you have trouble making a connection, refer to *Troubleshooting Windows XP Direct Connect* on page 5-11. If you have trouble the first time after creating a connection according to the instructions above, try restarting your computer to clear its serial port.

3. To change the properties of an existing connection:

Right-click the connection in the “connection List” window and choose “Properties.” The “Connection properties” window opens (see page 2-60).

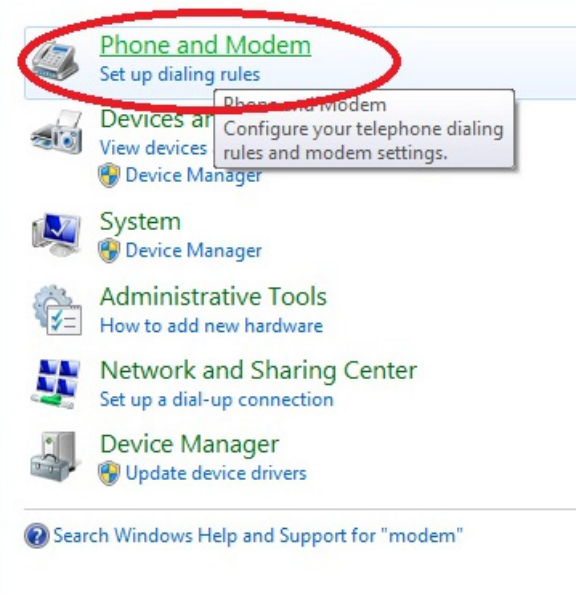
Connecting Using Windows 7 Direct Serial Connection:

You must install the Windows 7 direct serial connection as a modem device using the Modem setup procedures as shown in the steps below.

1. Add and configure a Direct Connection for Windows 7.

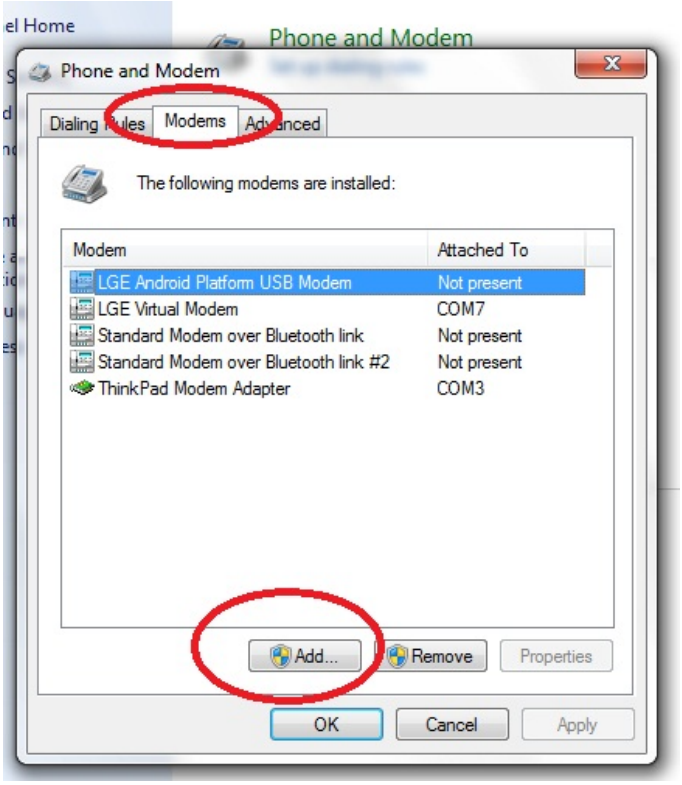
A) Go to the Control Panel. Find the Modem applet. This is normally under the Phone and Modem section.

Click on it to start the Phone and Modem applet.



B) In the Phone and Modem applet, click on the Modems tab and click "Add."

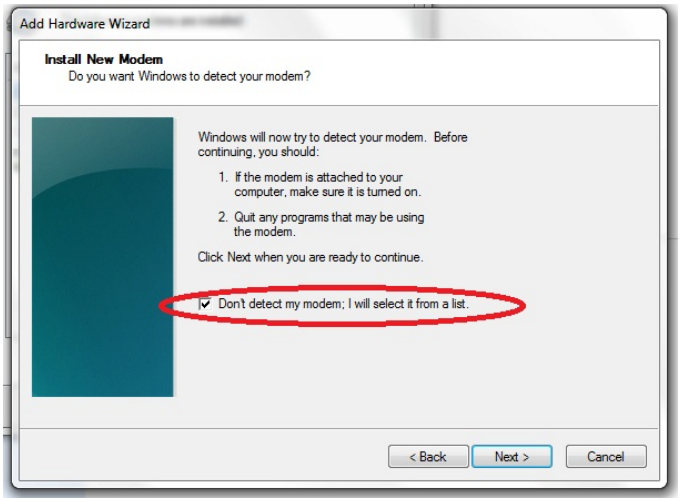
You need administrator's rights to do this. If UAC comes up, provide the relevant credentials and proceed.



C) The Add Hardware Wizard will appear.

a) Tick "Don't detect my modem; I will select it from a list."

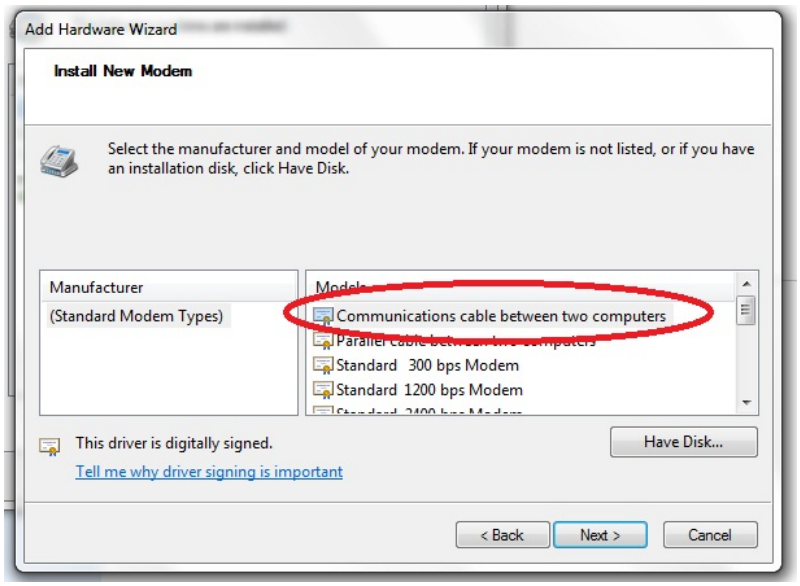
b) Proceed to next step by clicking on the NEXT button.



D) The *Install New Modem* window will appear.

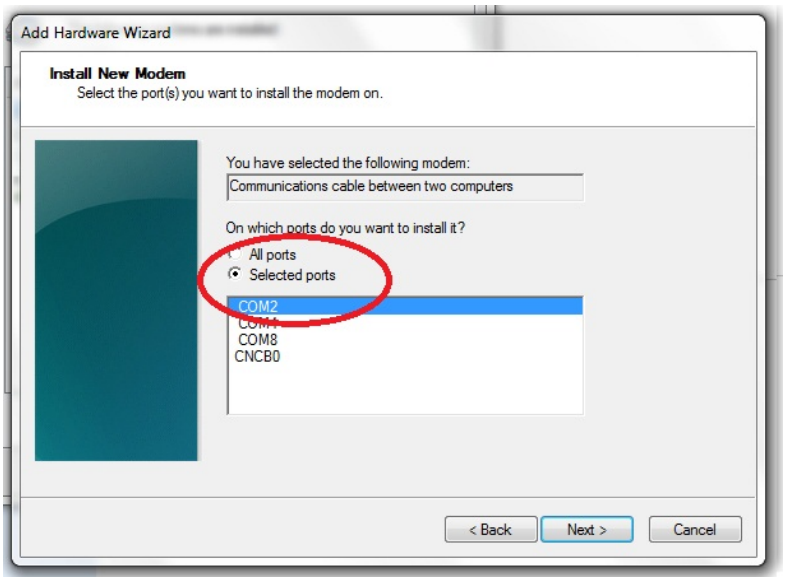
a) Select Communications cable between two computers.

b) Proceed to next step by clicking on the NEXT button.

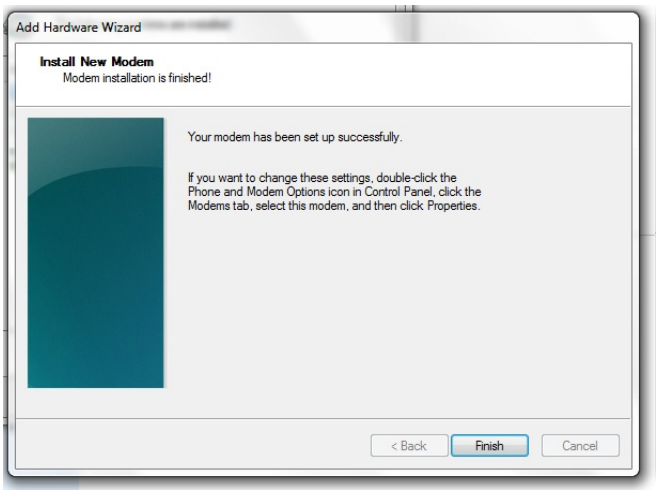


E) Select the Serial com port to which the NULL cable is connected.

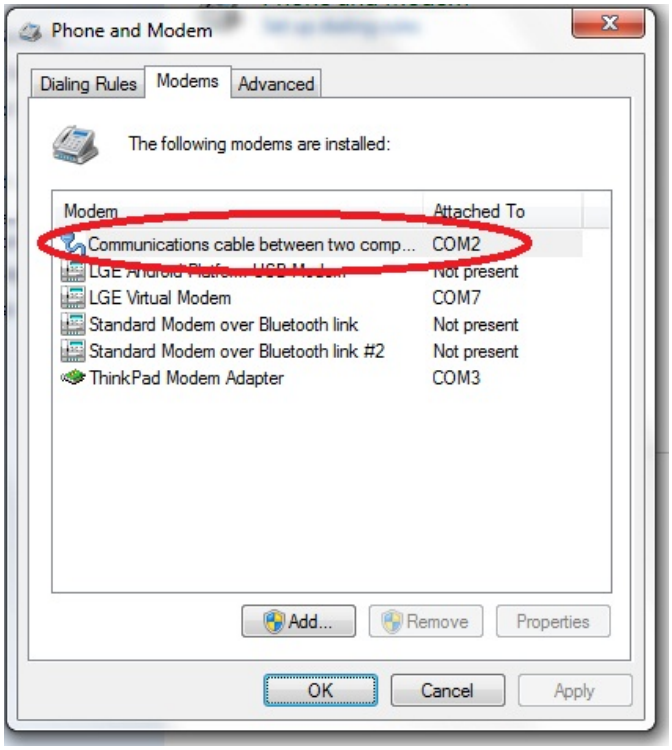
Proceed to next step by clicking on the NEXT button.



F) At the *Modem installation is finished* window, click FINISH to complete the installation.



G) Once you are back at the *Phone and Modem* window, you will see your newly installed communication cable attached to the serial com port that you specified earlier.



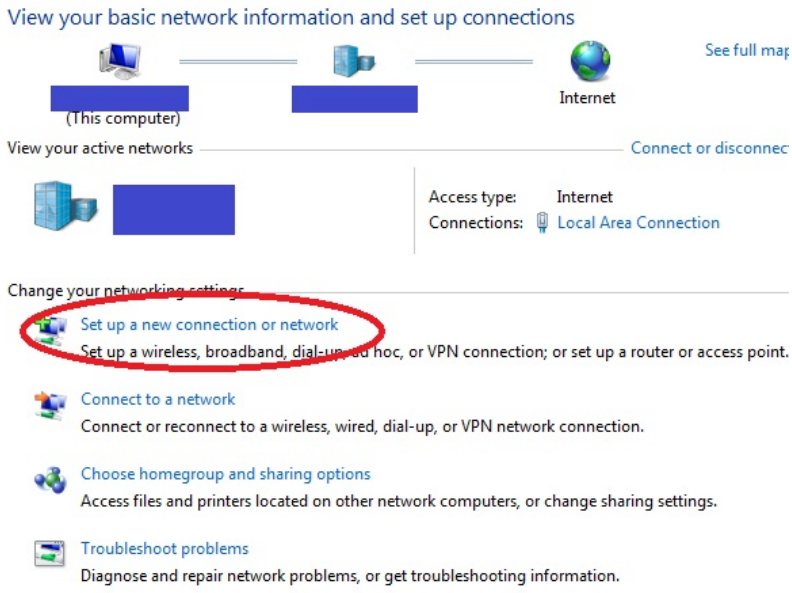
This completes the installation of the device driver for the device "Communications cable between two computers." This configuration is also commonly known as "Direct Cable Communications."

2. Set up the Network for the Direct Cable Connection.

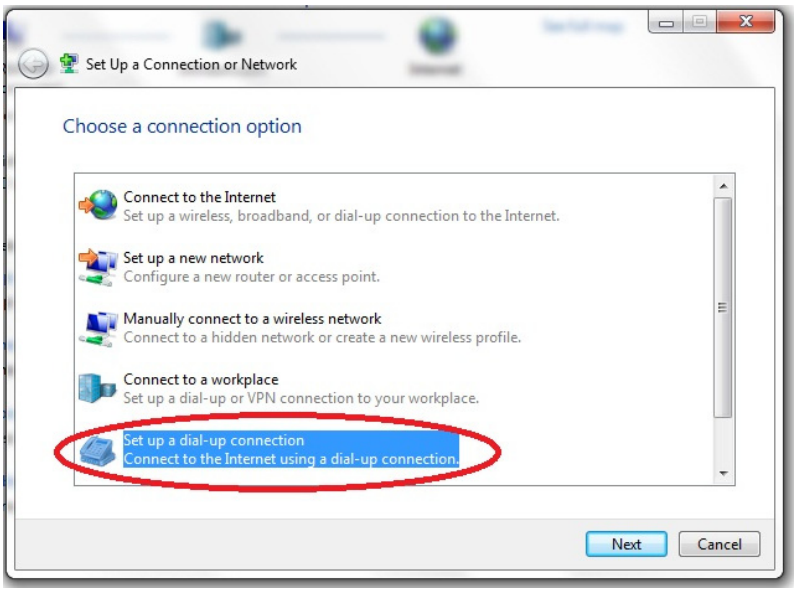
You must next bind the Direct Cable Connection driver to a particular Network. This is where Microsoft will make this connection using the PPP protocol.

It will do this for you automatically. Previous Windows version requires you to install the PPP protocol separately.

A) Go to the *Network and Sharing Center* and click on *Set up a new connection or network link*.

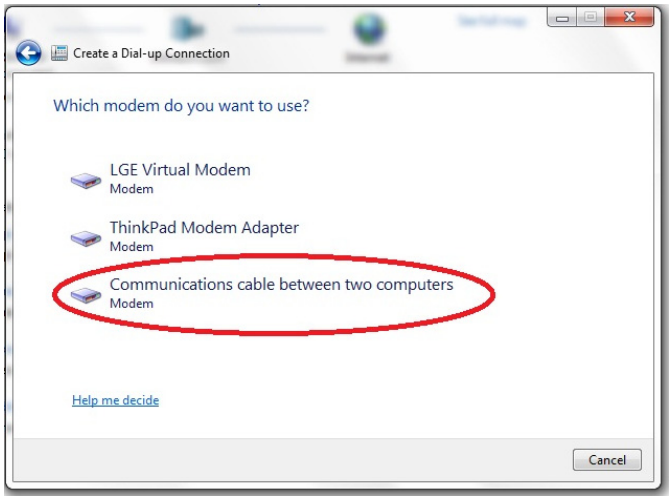


B) In the *Choose a connection option* window, select *Set up a dial-up connection*.



C) If you are asked *Which modem do you want to use?*, select *Communications cable between two computers/modem*.

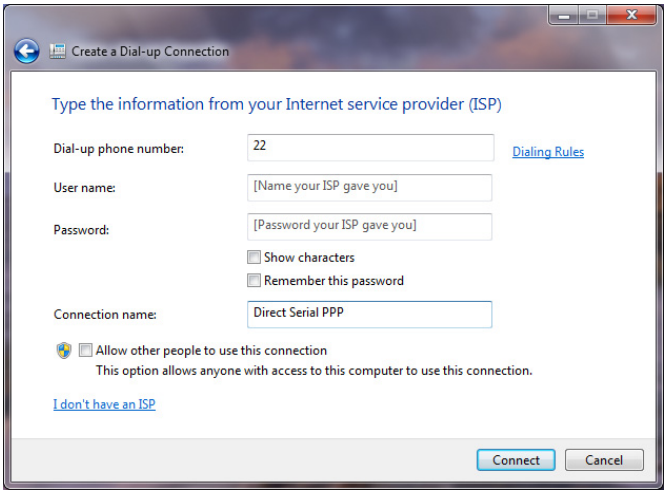
This only query will open appear if you have configured more than one modem device.



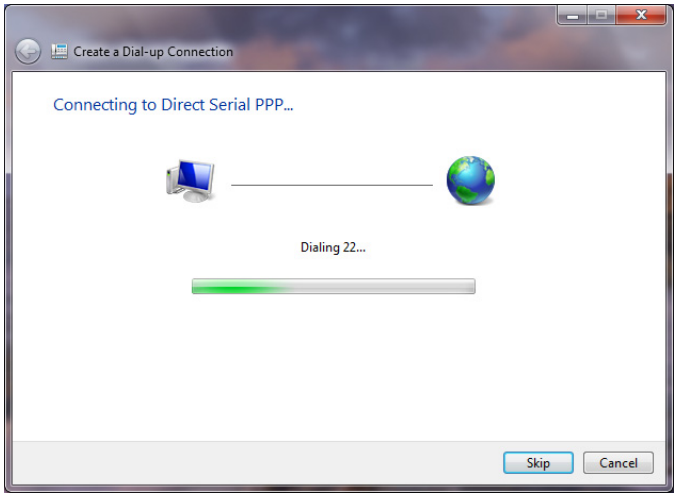
D) When prompted to "Type the information from your Internet Service Provider," enter a dummy number to the phone number field; Windows will not use it.

E) Choose a name for your connection and enter it into the *Connection name:* box. Choose a name that will remind you that this is a PPP connection, such as "Direct Serial PPP."

F) Proceed to next step by clicking on the CONNECT button.

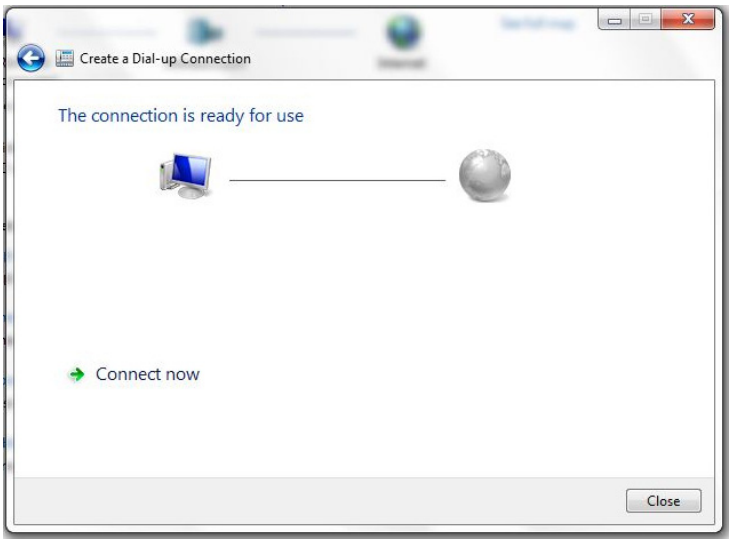


G) Click the SKIP button.



Windows will emit a message stating *The connection is ready for use*. However, you must to configure some of the PPP settings before you can make a connection to your Optimod

Although you did not specifically install anything that states "PPP," the PPP protocol has nevertheless been installed.



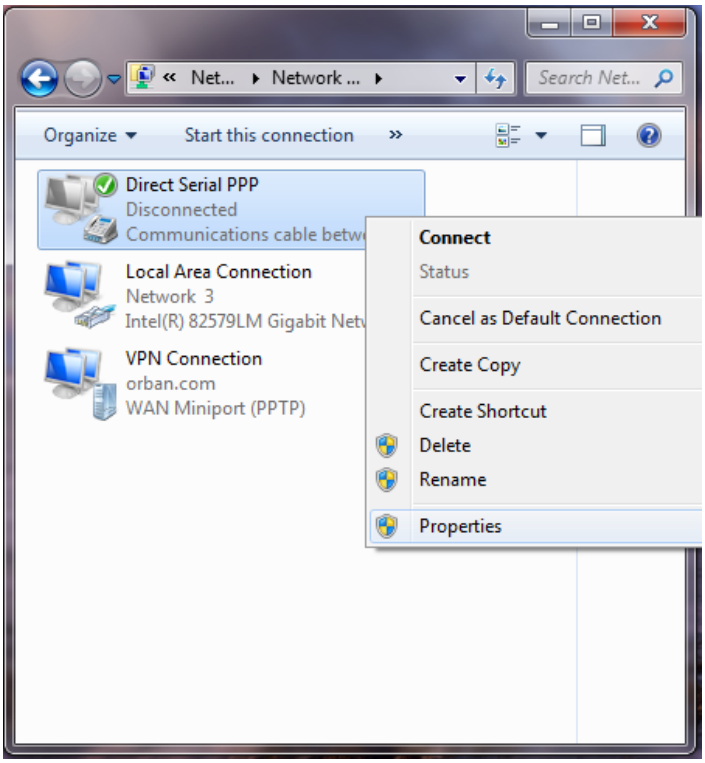
3. Configure the Direct Cable Connection adapter.

In this step, you will customize the PPP settings on Windows 7 so that it can talk to your Optimod.

A) Go to the Windows 7 Network and Sharing Center and click the *change adapter settings* link. This is on the left side of the window.

B) In the *Network adapter* window, right-click the *Direct Serial PPP* icon and click on the properties.

You need administrator rights to proceed from here. If UAC comes up, provide the relevant credentials and continue.



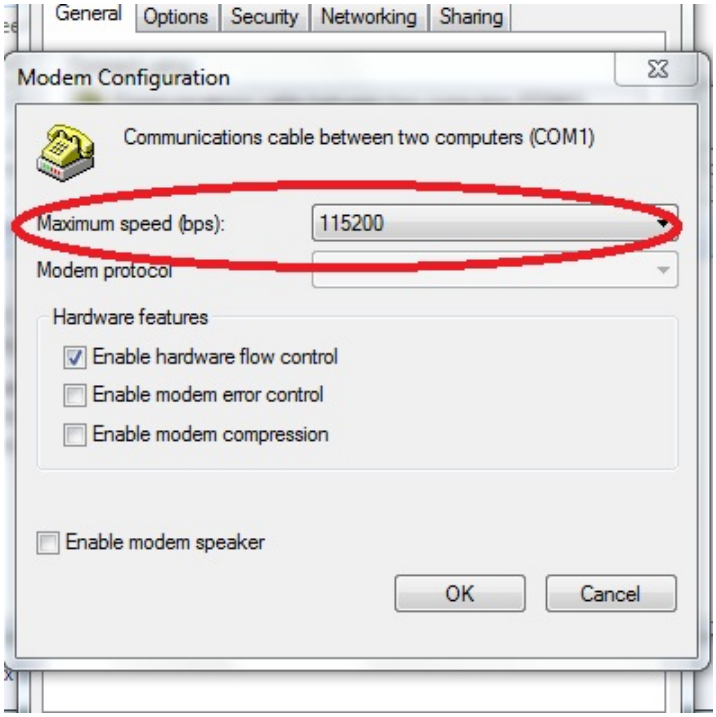
C) In the Direct Serial PPP Properties window, select the General tab.

D) Click the Configure button and select 115200 bps.

E) Click OK to close the window.

F) Make sure your bps settings saves correctly:

a) Dismiss the Direct Serial PPP Properties window by selecting OK.



b) Reopen the Properties window and select the General tab again. If your bps setting is correct, the value has saved and you may skip to step (G) below.

c) If it is not correct, reset it to 115200 bps.

d) Click OK to close the window.

e) Click OK to dismiss the Properties window.

f) Restart your computer.

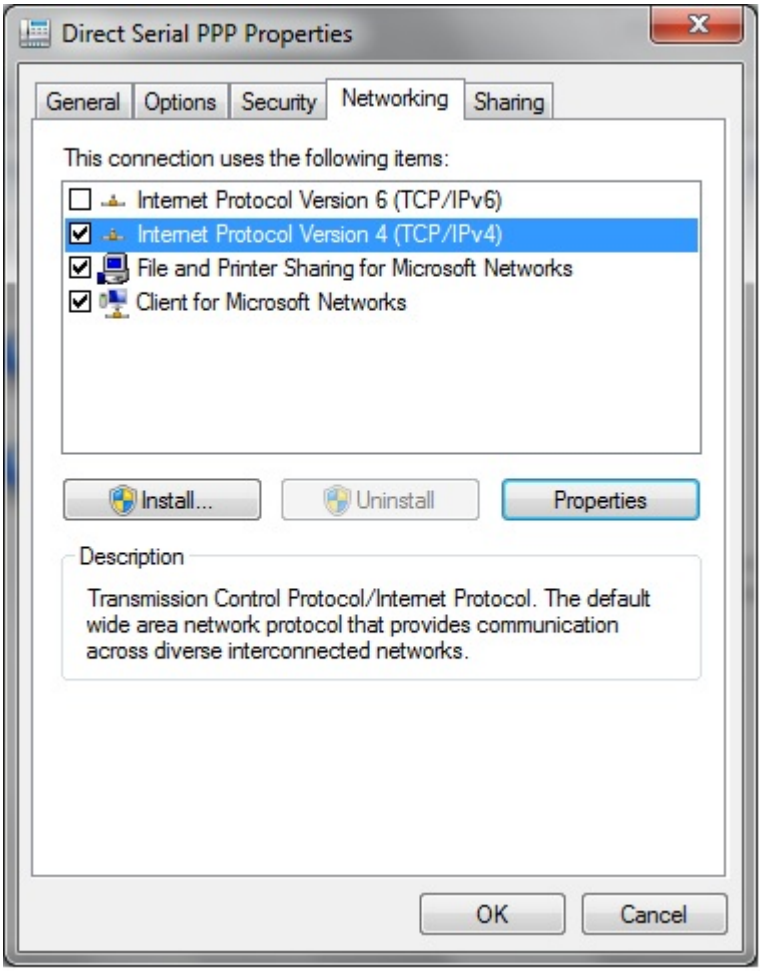
Restarting should ensure that the bps setting is saved.

G) Select the Networking tab.

a) Unselect the Internet Protocol Version 6.

b) Click on the Internet Protocol Version 4.

c) Click the *Properties* button.



H) In the *Advance TCP/IP Settings* window, click on the *Advance* button.

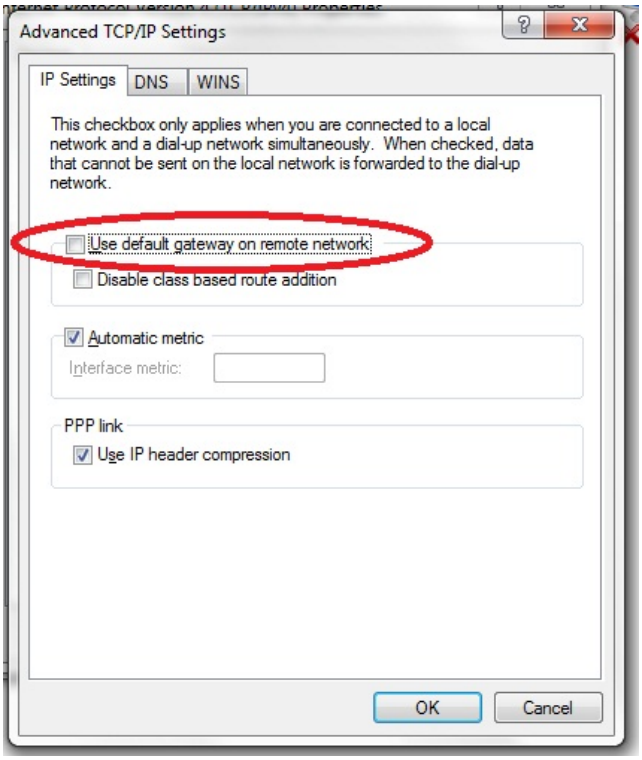
a) Unselect *Use default gateway on remote network*.

b) Click OK to close this window.

This prevents Windows 7 from routing all networking requests to your Optimod.

c) Click OK to close the *Internet Protocol version 4 Properties* window.

d) Click OK at the *Direct Serial PPP Properties* window to save the *Direct Serial PPP* settings.



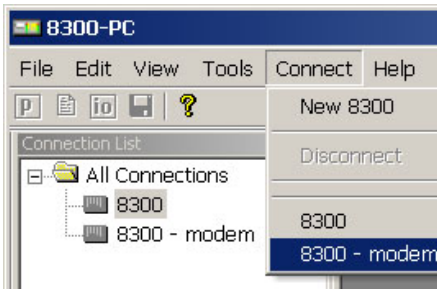
4. Launch an existing Windows 7 Direct connection.

Once you have set up a "connection" specifying Direct Connect in the 5500i PC Remote application (see *To set up a new connection* on page 3-63), choosing this connection from 5500i PC Remote automatically opens a Windows Direct Connection to your 5500i.

You can connect by selecting the desired connection from the drop-down list in the CONNECT menu.

You can also connect by double-clicking the connection in the "Connection List" window.

A dialog bubble will appear on the bottom right hand corner of the screen verifying your connection if the connection is successful.



If you have trouble making a connection, double-check step (3.F) on page 2-76. If you have trouble the first time after creating a connection according to the instructions above, try restarting your computer to clear its serial port.

5. To change the properties of an existing connection:

Right-click the connection in the "connection List" window and choose "Properties." The "Connection properties" window opens (see page 2-60).

Preparing for Communication through Modems

1. **Prepare your 5500i for a modem connection through the serial port.**

   See step 2 on page 2-51.

2. **If you have not already done so, create an 5500i passcode.**

   See *To Create a Passcode* on page 2-39.

3. **Modem setup:**

You will need two modems and two available phone lines, one of each for your PC and your 5500i.

> Reminder: Orban supports only the 3Com / U.S. Robotics® 56kbps fax modem EXT on the 5500i side (although other 56kbps modems will often work OK).

Connect the modem to the 5500i's serial port with a standard (not null) modem cable. The cable provided with your 5500i is a null modem cable and will not work.

You can use either an internal or an external modem with your PC.

A) Connect the telephone line from the wall phone jack to the wall connection icon on the back of the modem (modem in).

B) Connect the modem cable from the modem to the serial port of the 5500i.

C) Set the modem to AUTO ANSWER and turn it on.

> For 3Com / U.S. Robotics® 56kbps fax modem EXT, set dipswitches 3, 5, and 8 in the down position to activate the AUTO ANSWER setting. All other dipswitches should be set to the up position.

Connecting Using Windows 2000 Modem Connection

This connection is used both for upgrading your 5500i and for connecting the 5500i PC Remote application to your 5500i.

1. **Add and configure modem for Windows 2000:**

If your modem is already installed, skip to Launch a Windows 2000 Modem connection *on page 2-84.*

A) Install Windows 2000 modem:

Use either an internal modem or external modem with your computer.

a) If you are using an external modem, connect the modem to a serial port on your PC and make sure the modem is connected to a working phone line.

b) On your PC, click “Start / Settings / Control Panel / Phone and Modem Options.”

c) Click the “Modems” tab.

d) Verify that your modem appears in the list available under “The following Modems are installed.”

e) Verify that your modem is “Attached to” the correct port.

If your modem is unavailable or not attached to the correct port, you will need to Add it. See your Windows documentation.

f) If your modem is available in the list available under “The following Modems are installed” and it is attached to the correct port, then click “Properties” for that modem.

g) Make sure the port speed is set at 115200.

h) Click “OK.”

B) Create a New Windows 2000 Dial-Up Connection:

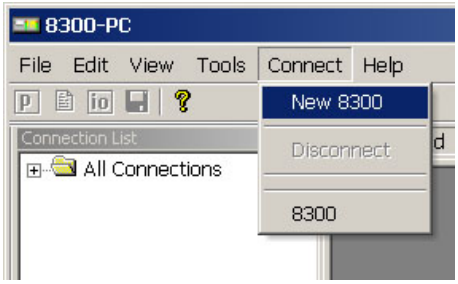
a) Click “Start / Settings / Network and Dial-up Connections / Make New Connection.”

b) Once the New Connection Wizard has opened, Click “Next.”

C) Create a New Windows 2000 Direct Connection:

a) Launch 5500i PC Remote.

b) Choose “Connect / New 5500i”

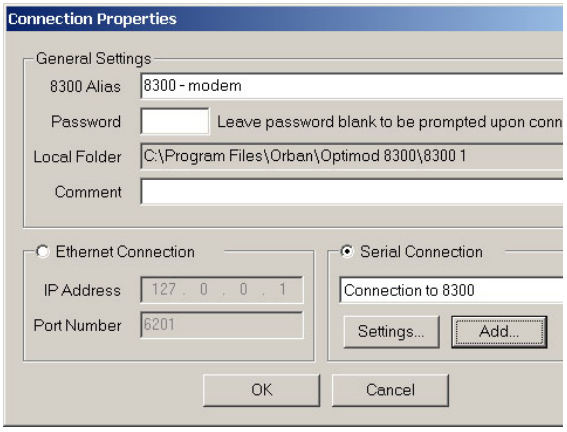


c) Give your 5500i a name (e.g., “KABC”) by entering this name in the “5500i Alias” field.

d) If you wish to have 5500i PC Remote remember the password for this Optimod, enter the password in the “Password” field.

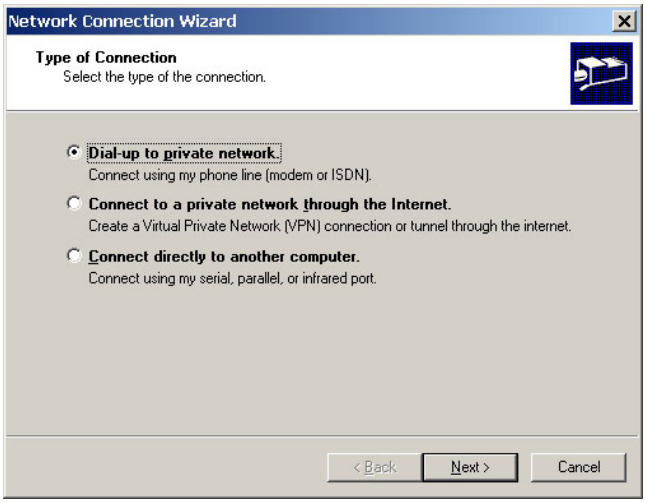
e) Select “Serial Connection.”

f) Click the “Add” button.



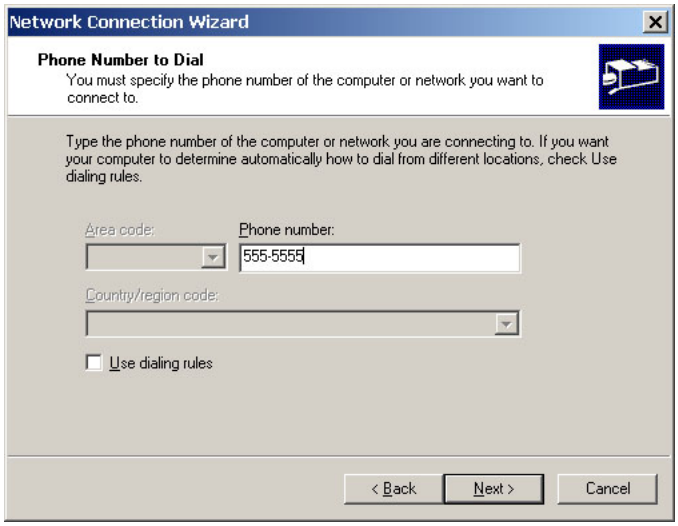
g) Select “Dial-up to private network.”

h) Click “Next.”



i) Enter the phone number of the modem connected to the 5500i that you are setting up.

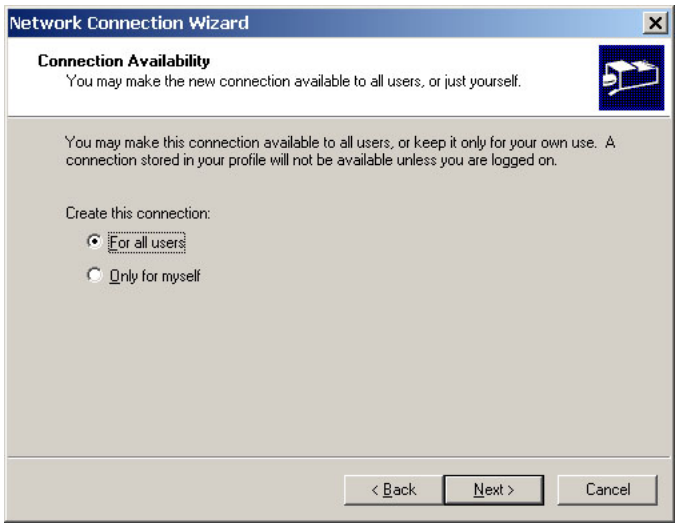
j) Click the “Next” button.



k) Select either “For all users” or “Only for myself.”

The correct setting depends on how your network and security are configured.

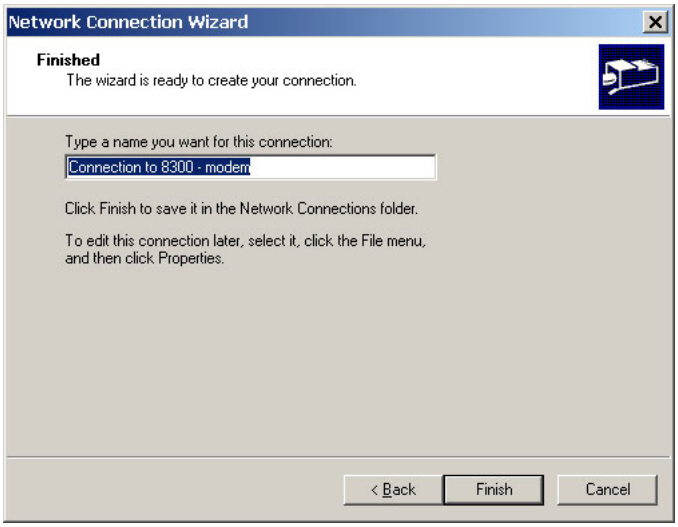
l) This screen may not appear in computers set up for single users.



m) Click the "Next" button.

n) Type in a name for your Connection such as: "Connection to 5500i – Modem."

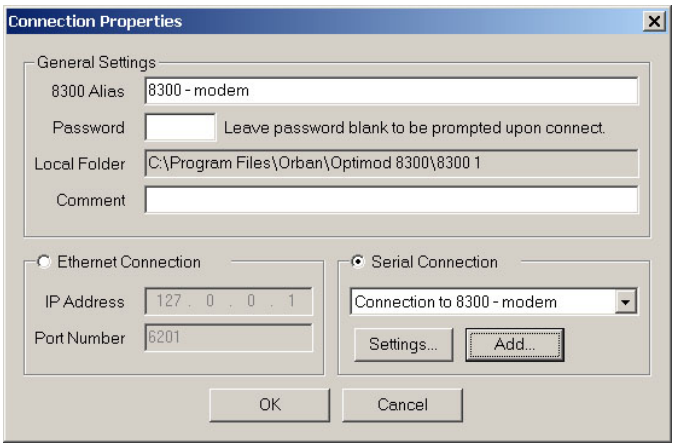
o) Click the "Finish" button.



p) Click "Yes."

D) Edit your new Direct Connection properties:

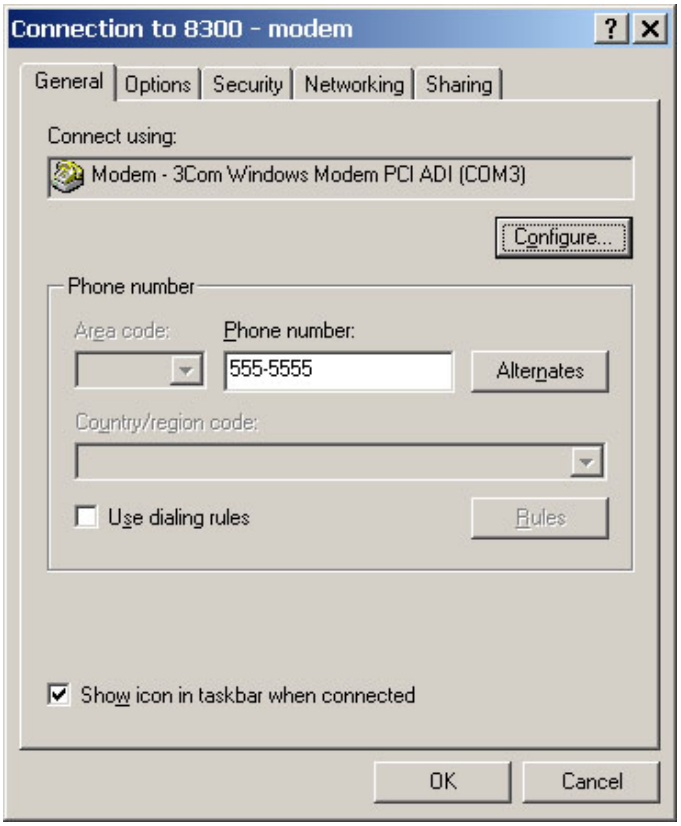
a) Click "Settings."



b) Click the "General" tab.

c) In the "Connect using" field, select the modem you will be using to make the connection on the PC side.

d) Click "Configure."



e) Set "Maximum speed (bps)" to "115200."

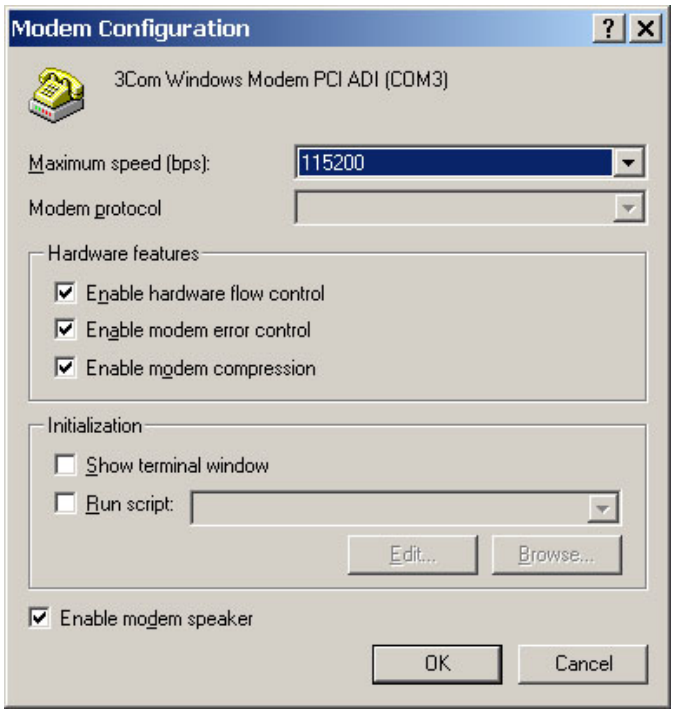
f) Check "Enable hard-ware flow control."

g) Check "Enable modem error control."

h) Check "Enable modem compression."

i) Make sure that all other boxes are not checked.

j) Click "OK."



k) Select the Networking tab.

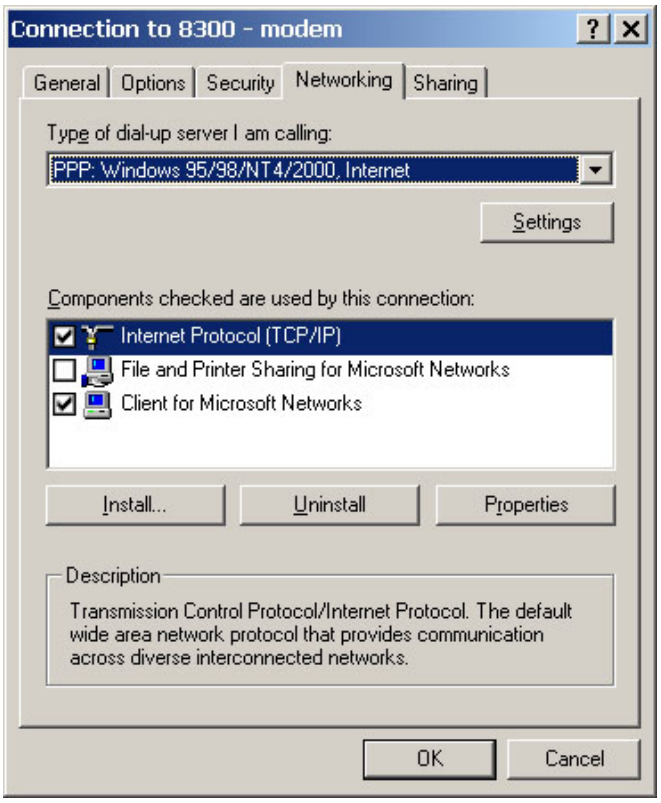
l) Make sure that "PPP: Windows 95 / 98 / NT 4 / 2000, Internet" appears in the "Type of dial-up server I am calling" field.

m) Make sure that "Internet Protocol (TCP/IP) is checked.

You may leave "Client for Microsoft Networks" checked if you like.

n) Click "OK."

o) When the "Connection properties" window appears, click "OK."



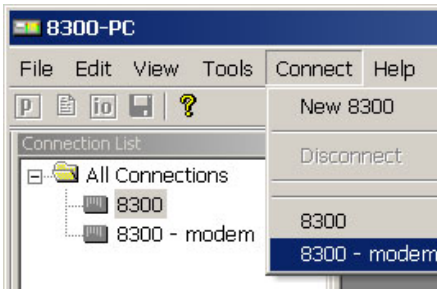
2. Launch a Windows 2000 Modem connection.

Once you have set up a "connection" specifying a modem connection in the 5500i PC Remote application (see *To set up a new connection* on page 3-63), choosing this connection from 5500i PC Remote automatically opens a Windows modem connection to your 5500i.

You can connect by selecting the desired connection from the drop-down list in the CONNECT menu.

You can also connect by double-clicking the connection in the "Connection List" window.

If the connection is successful, a dialog bubble will appear on the bottom right hand corner of the screen verifying your connection.



If you have trouble making a connection, refer to *OS Specific Troubleshooting Advice: Troubleshooting Windows 2000 Modem Connect* on page 5-10. If you have trouble the first time after creating a connection according to the instructions above, try restarting your computer to clear its serial port.

3. **To change the properties of an existing connection:**

   Right-click the connection in the "connection List" window and choose "Properties." The "Connection properties" window opens (see page 2-80).

Connecting using Windows XP Modem Connection

1. **Add and configure modem for Windows XP:**

   Skip this step if your modem is already configured and working.

   A) Configure the Windows XP PC ports:

   Use either an internal modem or external modem with your computer.

   a) If you are using an external modem, connect the modem to a serial port on your PC.

   b) Make sure the modem is connected to a working phone line.

   c) Click "Start / Control Panel / Systems."

   d) Go to the "Hardware" tab and click "Device Manager."

   e) In the Device Manager dialog box click the "+" next to the "Ports (COM and LPT)" icon.

   A list will branch off, showing your available ports.

   f) Double-click "Communications Port (COM1) or (COM2)," depending on how you set up your system.

   The "Communications Port (Comx) Properties" dialog box opens.

   Not all PCs have a COM2.

   IMPORTANT: The COM port you choose at this point *must* match the COM port to which you connected your modem.

   g) From the tabs at the top, choose "Port Settings" and configure the settings to match your PC modem.

   If you are using a U.S. Robotics® external modem, the settings will be: Bits per second= 115200, Data bits = 8, Parity = None, Stop bits = 1, Flow Control = None.

   h) When you are finished, click the OK button to close the "Communications Port (Comx) Properties" dialog box.

   i) Click the OK button in the "Systems Properties" dialog window.

   j) Close the "Control Panel" window.

If your modem is already installed, skip to Launch an existing Windows XP modem connection *on page 2-89.*

   B) Install the Windows XP modem:

   a) Use either an internal modem or external modem with your computer.

If you are using an external modem, connect the modem to a serial port on your PC and make sure the modem is connected to a working phone line.

b) On your PC, click "Start / Settings / Control Panel / Phone and Modem Options."

c) Click the "Modems" tab.

d) Verify that your modem appears in the list available under "The following Modems are installed."

e) Verify that your modem is "Attached to" the correct port.

If your modem is unavailable or not attached to the correct port, you will need to Add it. See your Windows documentation.

f) If your modem is available in the list available under "The following Modems are installed" and it is attached to the correct port, then click "Properties" for that modem.

g) Make sure the port speed is set at 115200.

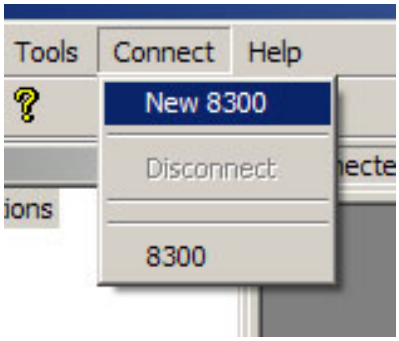
h) Click "OK."

C) Create a new Windows XP modem connection:

a) Launch 5500i PC Remote.

b) Choose "Connect / New 5500i."

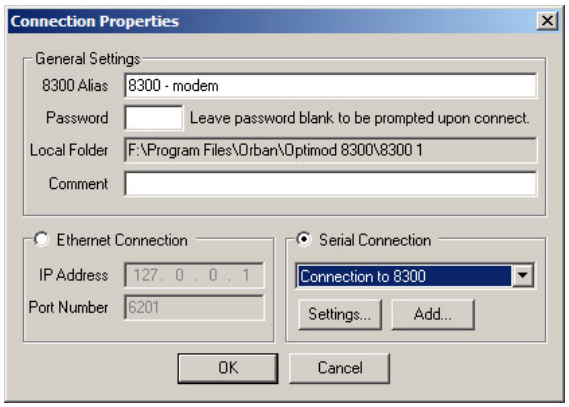
The Connection Properties window opens.



c) Give your 5500i a name (e.g., "KABC") by entering this name in the "5500i Alias" field.

d) If you wish to have 5500i PC Remote remember the password for this Optimod, enter the password in the "Password" field.

You must enter a valid password to connect. This means that at least one 5500i passcode must have been assigned via the 5500i's front panel. (See *To Create a Passcode* on page 2-39.)



e) Click "Add."

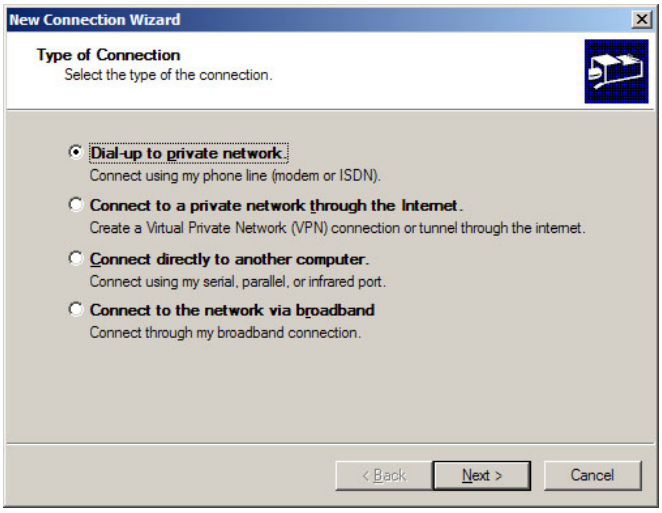
The Windows New Connection Wizard starts up.

f) Select "Serial Connection."

g) Click the "Add" button.

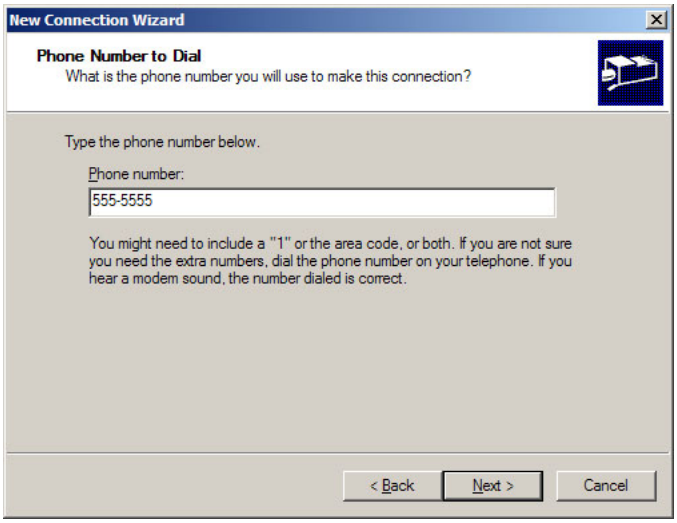
h) Select "Dial-up to private network."

i) Click "Next."



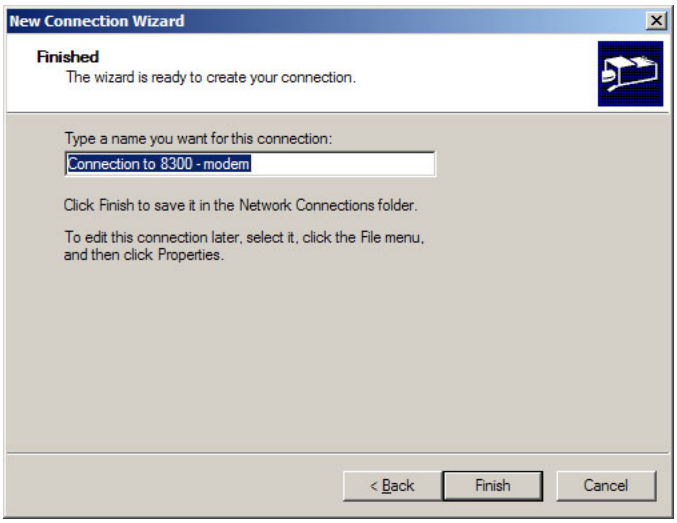
j) Enter the phone number of the modem connected to the 5500i you are setting up.

k) Click "Next."

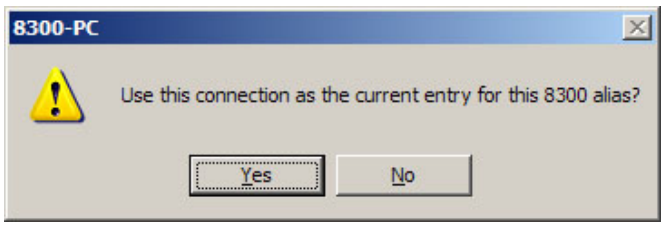


l) Type in a name for your Connection such as: "Connection to 5500i – Modem"

m) Click the "Finish" button.

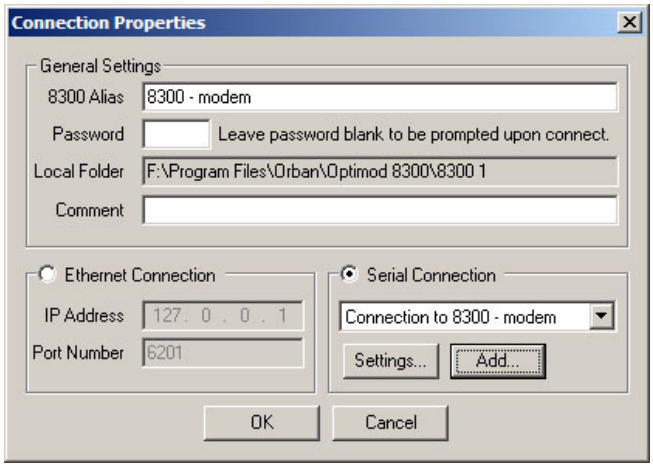


n) Click "Yes."



D) Edit your new Direct Connection properties:

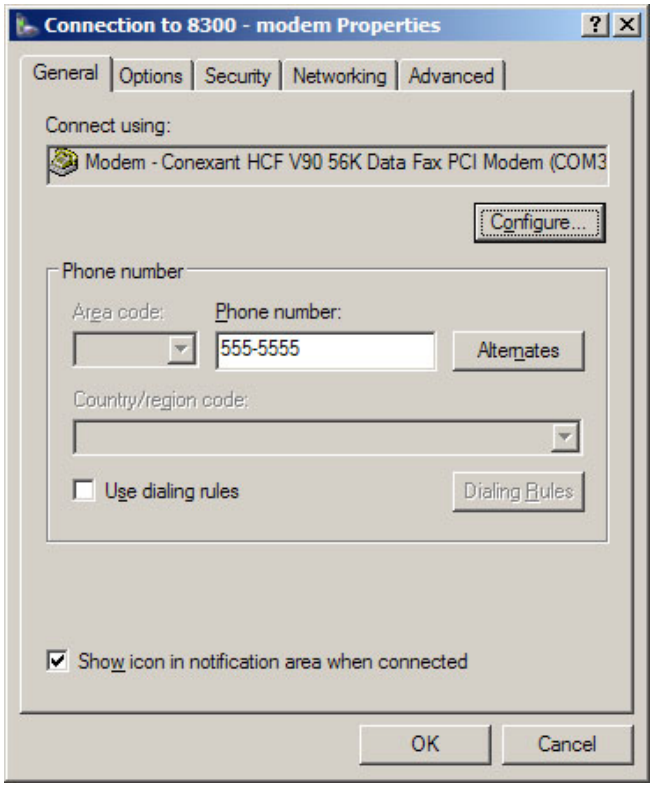
a) Click "Settings."



b) Click the "General" tab.

c) Select the modem you will be using to make the connection on the PC side.

d) Click "Configure."



e) Set "Maximum speed (bps)" to "115200."

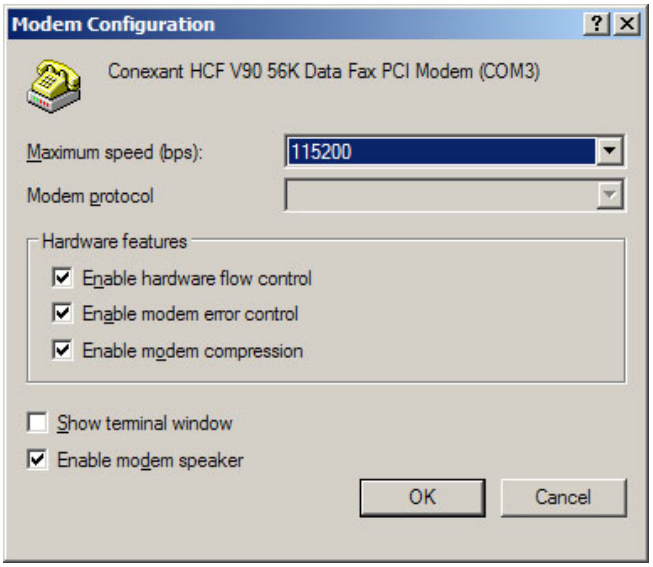
f) Check "Enable hardware flow control."

g) Check "Enable modem error control."

h) Check "Enable modem compression."

i) Make sure that no other box is checked.

j) Click "OK."



k) Select the Networking tab.

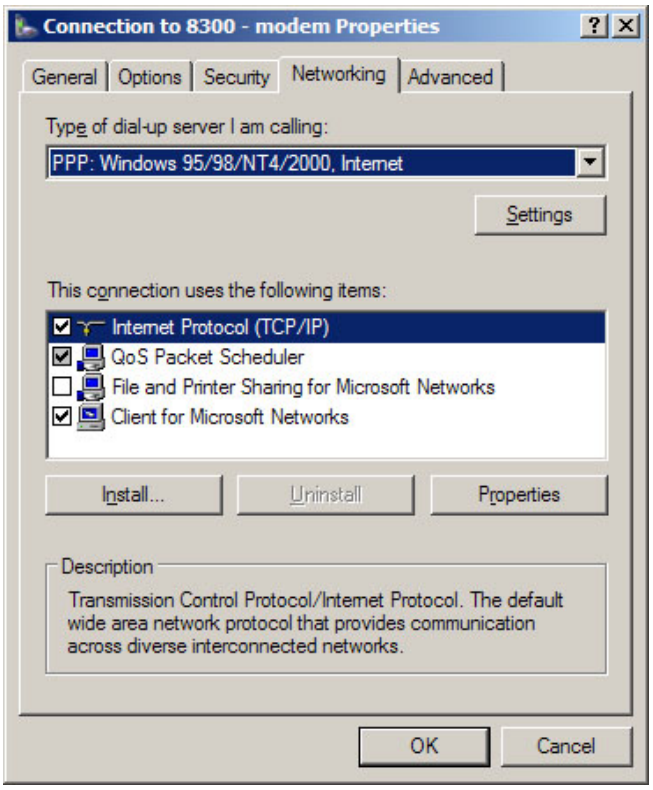
l) Make sure that "PPP: Windows 95 / 98 / NT4 / 2000, Internet" ap–pears in the "Type of dial-up server I am calling" field.

m) Make sure that "Internet Protocol (TCP/IP) is checked.

You may leave "Client for Microsoft Networks" checked if you like.

n) Click "OK."

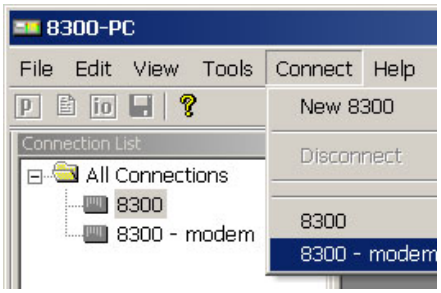
o) When the "Connection properties" window ap-pears, click "OK."



2. Launch an existing Windows XP modem connection.

Once you have set up a "connection" specifying a modem connection in the 5500i PC Remote application (see *To set up a new connection* on page 3-63), choosing this connection from 5500i PC Remote automatically opens a Windows modem connection to your 5500i.

You can connect by selecting the desired connection from the drop-down list in the CONNECT menu.



You can also connect by double-clicking the connection in the "Connection List" window.

If the connection is successful, a dialog bubble will appear on the bottom right hand corner of the screen verifying your connection.

If you have trouble making a connection, refer to *Troubleshooting Windows XP Modem Connect* on page 5-12. If you have trouble the first time after creating a connection according to the instructions above, try restarting your computer to clear its serial port.

3. **To change the properties of an existing connection:**

   Right-click the connection in the "connection List" window and choose "Properties." The "Connection properties" window opens (see page 2-80).

Updating your 5500i's Software

The software version number of PC Remote must be the same as the version number of the software running within your 5500i. If the software version of PC Remote is higher than the version running in your 5500i, PC Remote will automatically detect this and will offer to update your 5500i's software automatically.

1. **If you have not already done so, prepare your computer and the 5500i for a direct serial, modem, or Ethernet connection.**

   See *Networking and Remote Control* starting on page 2-50.

2. **Install the latest version of 5500i PC Remote software on your computer.**

   This is available from

   ftp://orban.com/5500i

   See *Installing* 5500i PC Remote Control Software on page 2-56.

   See the readme5500i_x.x.x.x.htm file (where x.x.x.x is the version number) for details about the upgrade not given in this manual. The PC Remote installer will install this file on your computer's hard drive.

3. **If you have not previously done so, start 5500i PC Remote and set up a "connection" to the 5500i you will be updating.**

   See *To set up a new connection* on page 3-63.

4. Update your 5500i.

A) Attempt to initiate communication to your 5500i via your connection.

See *To initiate communication* on page 3-64.

5500i PC Remote will automatically detect that the 5500i software version on your 5500i is not the same as the version of 5500i PC Remote. PC Remote will then offer to update your 5500i automatically.

This procedure will only work for a connection using an "all-screens" (administrator) passcode.

B) Choose YES and wait for the update to complete. *Note that this will cause an interruption in the audio of approximately 3 seconds when your 5500i automatically reboots after the update is complete.* If you cannot tolerate such an interruption, choose NO or CANCEL to abort the update.

Please be patient; this will take several minutes. (The exact time will depend on whether the 5500i has to do any "housekeeping" to its flash memory as part of the update.)

Completion will be indicated by the updater's command-line window's closing automatically and your 5500i's rebooting.

Your 5500i will continue to pass audio normally while the update is occurring. *However, the audio will be interrupted for approximately 3 seconds when your 5500i reboots.*

Do not interrupt power to your 5500i or your computer, close PC Remote or the update application's command-line window, or reboot your computer during this time. While doing any of these things is unlikely to damage your 5500i (because of extensive backup and error-checking provisions in your 5500i), they will certainly cause the update to fail.

C) When the 5500i screen display returns after its automatic reboot, the 5500i will be running with the updated software.

If the update fails for some reason, try repeating the procedure in steps (A) through (C) again.

D) If the 5500i screen remains blank for more than one minute after the update has completed, manually reboot the 5500i by removing AC power from the 5500i for at least ten seconds and then powering the 5500i back up.

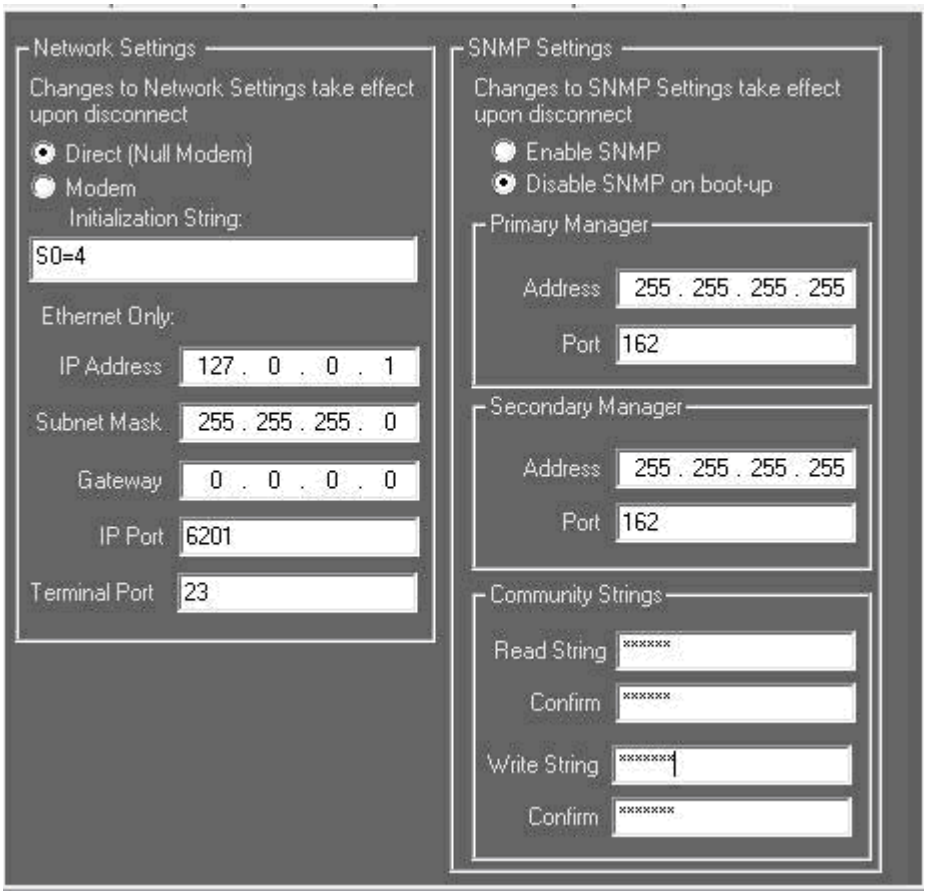
E) The 5500i software update is now complete. You should now be able to connect to your 5500i via PC Remote.

NOTE: If you cannot make a serial connection after a software upgrade, manually reboot the 5500i with a normal "power-off/power-on" sequence.

SNMP Support

The SNMP (Simple Network Management Protocol) features allow you to monitor your Optimod's status and to send Alarm notifications via your Optimod's Ethernet

connection to your network. It is beyond the scope of this manual to provide a general explanation of how SNMP works. The text below provides sufficient information to use your Optimod in your specific SNMP setup if you are already familiar with the general principles of setting up SNMP.



SNMP Network Setup

- **SNMP** (Enable/Disable): enables or disables the SNMP feature. Select "enable" and disconnect from the PC remote to update the unit and allow SNMP access.

  If you wish to disable SNMP access after it has been enabled, select "disable" and then reboot your Optimod.

  A) From the main menu, navigate to *Setup* > NETWORK&REMOTE > NETWORK > SNMP ENABLE.

  If the SNMP ENABLE soft button is not visible, press the *Next/Prev* buttons until it is.

  B) While holding down the SNMP ENABLE soft button, turn the knob to set the SNMP ENABLE field to YES.

The controls below are only available from Optimod PC Remote.

In the I/O menu, select the NETWORK tab to access the SNMP configuration controls.

- **Primary Manager Address**: (255.255.255.255) sets the address of the Primary SNMP Manager.
- **Primary Manager Port**: (162) sets the port of the Primary SNMP Manager.
- **Secondary Manger Address**: (255.255.255.255) sets the address of a Secondary SNMP Manager.
- **Secondary Manger Port**: (162) sets the address of a Secondary SNMP Port.

SNMP Mib file

The orban5500i.mib file is in the location where you installed your PC Remote application.

The default 5500i install location is:

`Program Files\Orban\Optimod 5500i PC Remote`
or
`Program Files(x86)\Orban\Optimod 5500i PC Remote`

SNMP Default Settings

- **SNMP Agent**: Disabled
- **Primary Manager(Alarm) Address**: 255.255.255.255
- **Primary Manager (Alarm) Port**: 162
- **Secondary Manger (Alarm) Address**: 255.255.255.255
- **Secondary Manger (Alarm) Port**: 162

SNMP Features

Get/Query:

- Station Name
- System Diagnostics Orban (walks through all of the “get” commands and displays their status.)
- Primary and Secondary Manager IP
- Primary and Secondary Manager Port
- Analog Input Silent
- Analog Input Active (The analog input is selected as the input source)

- AES Input Silent
- AES Error
- Digital Input Active (The digital input is selected as the input source)
- Current value of diversity delay

Set/Control:

- Primary and Secondary Manager IP
- Primary and Secondary Manager Port
- Station Name
- Diversity Delay

Traps/Alert:

- Analog Input Silent
- Analog Input Active (selected as input source)
- AES Input Silent
- AES Error
- Digital Input Active (The digital input is selected as the input source)

SNMP Community String:

The "SNMP Community string" is like a user id or password that allows access to a router's or other device's statistics. It is set at Optimod PC Remote to implement SNMP security. PRTG sends the community string along with all SNMP requests. If the community string is correct, the device responds with the requested information. If the community string is incorrect, the device simply discards the request and does not respond.

- **Read String** allows users to set a password for SNMP to retrieve information from the Optimod. Default is PUBLIC.
- **Write String** allows users to set a password for SNMP to write (set) information from the Optimod. Default is PRIVATE.

RDS/RBDS Generator

Your Optimod includes a full-featured RDS/RBDS generator that supports dynamic PS. We presume that you are already familiar with the basics of RDS and you wish to implement RDS via your Optimod. See the *References* on page 2-105 for more about RBS and RBDS.

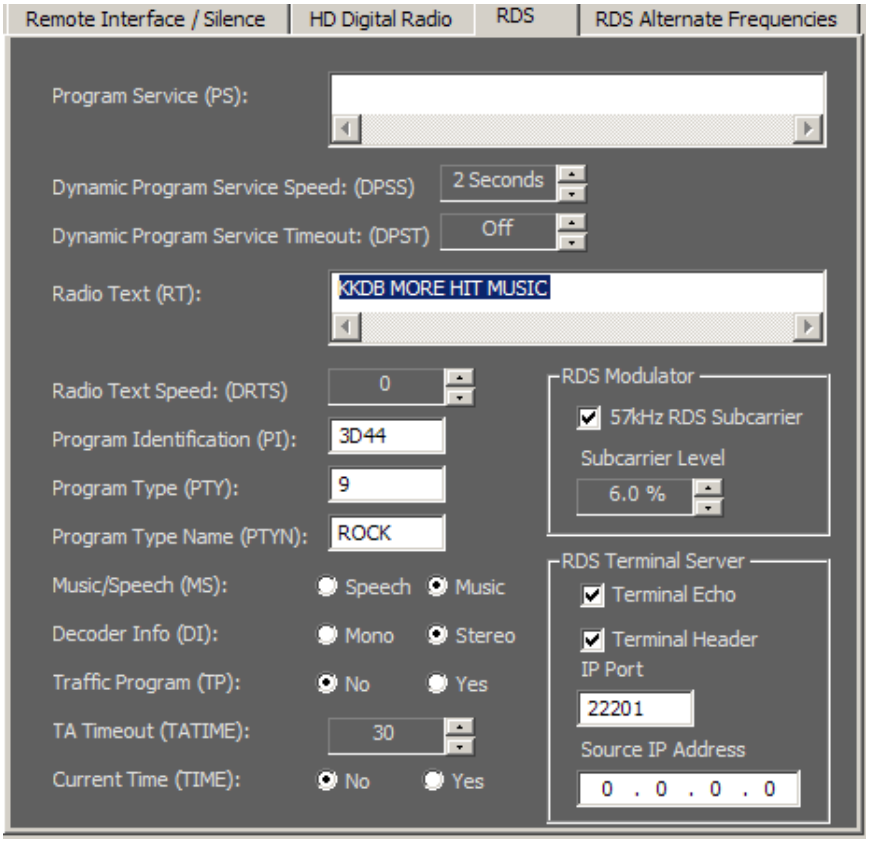
There are three ways to control RDS generation from your Optimod:

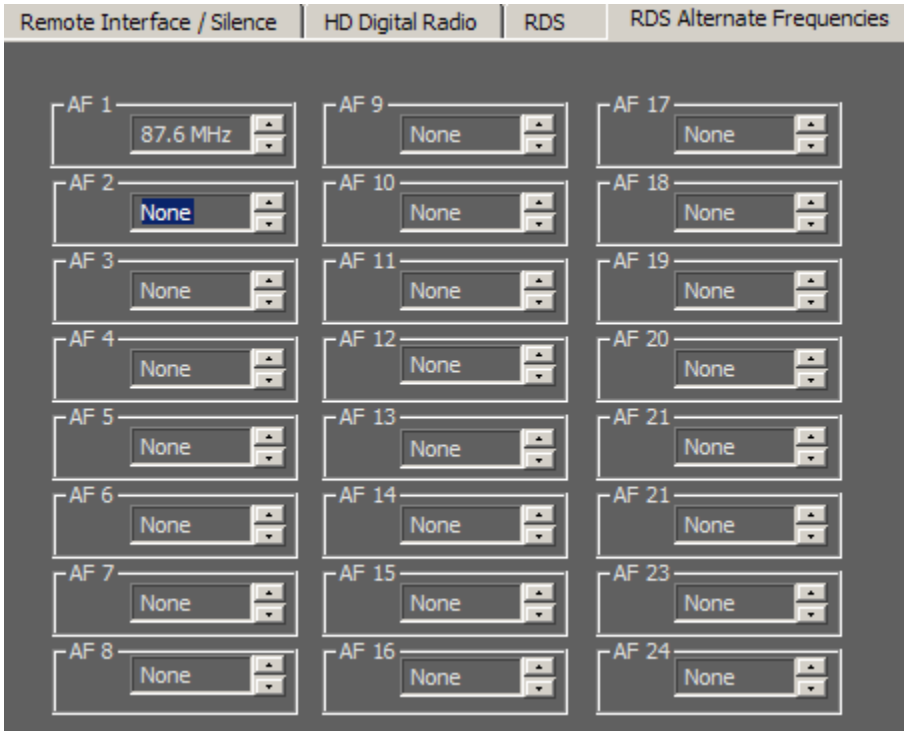
- Use the **System I/O** [the default] to set up the RDS to generate static RDS.
- Change the RDS data dynamically by using **processing presets**.
- Change the RDS data dynamically by using **terminal control**.

You can use both User Presets and the RDS terminal control to change the RDS dynamically. For example, if you are running a mixed format where part of the broadcast day is devoted to news and part to jazz, you may want the RDS Program Type to change when you recall a preset appropriate for the format that is currently on-air.

Using System I/O

RDS Setup via System I/O is available only from PC Remote software.





RDS	
Program Service (PS= / DPS=)	Default: undefined
Radio Text (RT= / TEXT=)	Default: undefined
Radio Text Speed (DRTS=)	Default: Off
Program Identification (PI=)	Default: undefined
Program Type (PTY=)	Default: undefined
Program Name (PTYN=)	Default: undefined
Music/Speech (MS=)	Default: Music
Decoder Info (DI=)	Default: Stereo
Traffic Program (TP=)	Default: 0
TA Timeout (TATIME)	Default: 30
57kHz RDS Subcarrier (RDS=)	Default: Off
Subcarrier Level (RDSLEVEL=)	Default: 6%
Terminal Echo (ECHO=)	Default: yes
IP Address	Default: 0.0.0.0
RDS Terminal Port (PORT1=)	Default: 22201
Current Time (TIME=)	Default: No
Alternate Frequency 1-24 (AF=)	Default: None

Table 2-1: System I/O RDS controls and defaults

In the **System I/O** RDS tab, turn on the RDS generator by setting 57 kHz RDS control to YES. You can also set up the Modulation level and all other RDS I/O controls in the System I/O RDS screens per the screenshot above. Table 2-1 shows a list of RDS controls available in System I/O.

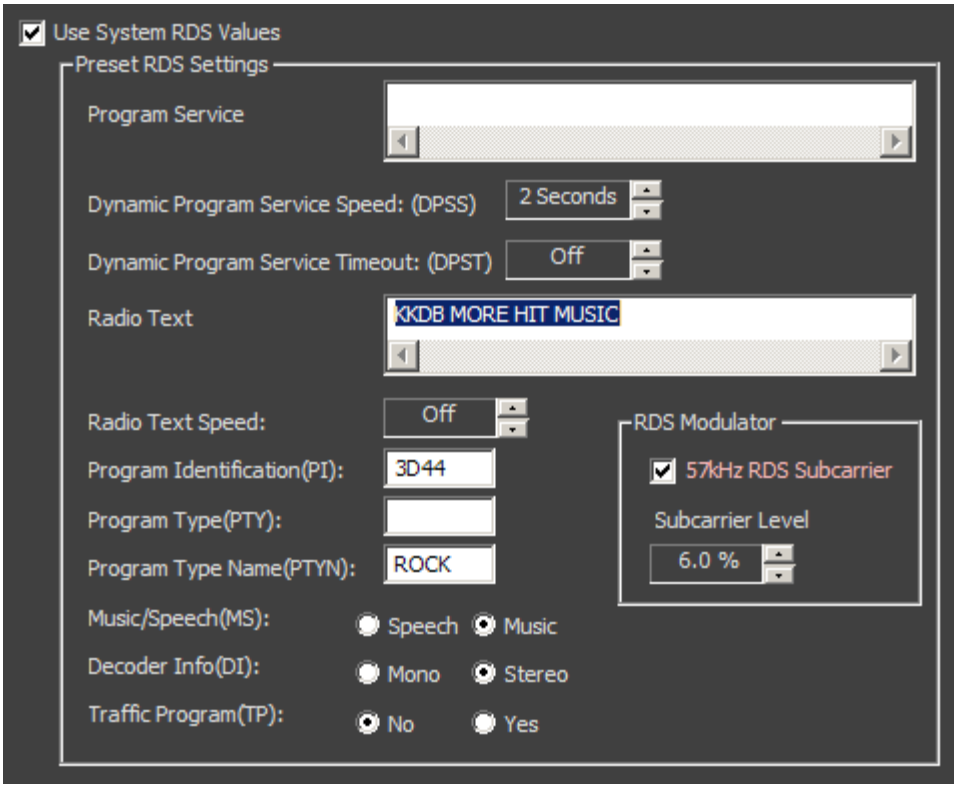
When you open I/O RDS screen in the PC remote when the System RDS controls are active, the Optimod will update the RDS output when a control is changed or if you select the DONE button.

Using Processing Presets

RDS adjustment via processing presets are available only from PC Remote.

To use **processing presets**, edit your on-air preset with the RDS checkbox USE SYSTEM RDS VALUES deselected. Then set the RDS preset controls as required and save the result as a new user preset. It is possible to make as many user presets as you want whose audio processing controls are set identically, but the RDS controls are set differently.

These controls are located in the processing preset's RDS tab in PC remote.



Note that because of buffering to ensure reliable RDS encoding, there is a delay of about four seconds between when you change a control and when your Optimod puts it on-air.

Using the Terminal Server

The **terminal server** is another way to change RDS dynamically. Your Optimod will update the outgoing RDS to whatever RDS control value it receives via the terminal, overwriting the system and preset RDS values. The terminal connects via TCP/IP, using the IP address and port specified in SETUP > RDS.

The values received via the terminal only persist until overwritten by a change in the system or processing preset. When you change a value in a System I/O RDS control at the Optimod front panel or via PC Remote, or if you recall a preset that has RDS activated, the new system/preset will overwrite whatever the Optimod last received from the terminal.

Although the terminal RDS will override the RDS settings in the active system or processing preset, it will not overwrite the RDS setting for the I/O or preset. For example, if you are using a processing preset to generate RDS with the ***PS 1234,*** then you send the terminal command ***PS ABCD***, the RDS will generate **ABCD,** but if you recall the processing preset again, the RDS generator will revert to transmitting ***1234*** because the terminal settings are not saved.

The `INIT` command clears any values previously sent from the Terminal connection and causes the RDS to revert to the System values.

By using the SAVE command, you can rewrite the SYSTEM RDS settings from the terminal server. For security, this command requires you to include a currently active password (see *Security and Passcode Programming* on page 2-39).

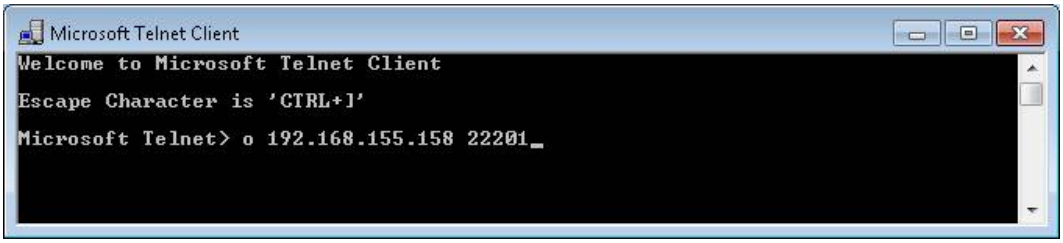
Using Telnet to Control the Terminal Server

Although the terminal server is usually used to accept commands from an automation system, batch file, or application like Modulation Index's PAD::bridge, you can also control RDS from Windows directly via the Windows Telnet command line utility or the free utility PuTTY.

A) Open the Windows Telnet client by typing `telnet` into the Windows Run box in the Start menu and hitting the Enter key on your keyboard.

> In Windows 7 and higher, you must enable the Telnet client; it is not enabled by default. If you do not know how, use a search engine to find out. The general idea is to navigate to CONTROL PANEL > PROGRAMS > TURN WINDOWS FEATURES ON OR OFF and check "Telnet."

B) Connect the Telnet client to the Optimod by typing `open [IP address] [IP Port]`, where `[IP address]` is the IP address of the Optimod and `[IP Port]` is the IP Port you assigned to the Optimod RDS terminal server in System .



C) You may now type any of the terminal commands in the chart of RDS Terminal Commands below.

> If you have checked the Optimod's TERMINAL ECHO box, when you type a command, the Optimod will return a status line relevant to the command to the Telnet client, which will write it to the screen.

The returned information will look similar to the following:

```
?
PS=undefined
DPS=undefined
DPSS=2 Seconds
DPST=Off
RT=KKDB MORE HIT MUSIC
DRTS=Off
PI=3D44
PTY=9
PTYN=ROCK
MS=Music
DI=Stereo
TP=No
TA=No
TATIME=30
TIME=No
RDS=Yes
RDSLEVEL= 6.0 %
AF 1=87.7 MHz
AF 2=0
AF 3=0
AF 4=0
AF 5=0
AF 6=0
AF 7=0
AF 8=0
AF 9=0
AF 10=0
AF 11=0
AF 12=0
AF 13=0
AF 14=0
AF 15=0
AF 16=0
AF 17=0
AF 18=0
AF 19=0
AF 20=0
AF 21=0
```

```
AF 22=0
AF 23=0
AF 24=0
```

Security

In the System I/O RDS control screen, you can set the RDS *Terminal control security* by specifying an RDS IP address from which to accept commands. Once set, this IP will be the only IP that can connect to the unit to update RDS. The 8500S will default to 0.0.0.0, which will allow any IP to connect to the RDS terminal control.

To prevent the Optimod from disconnecting and being unable to reconnect if the terminal connection drops out temporarily, set the TIMEOUT value (as shown in Table 2-1) to the maximum expected duration of the dropout (in minutes). Default is 4 minutes. Note that the timeout reverts to the default each new connection; if you change the timeout for one connection, it is not retained for the next one.

RDS Terminal Commands

Table 2-2 lists the terminal commands.

Note that you can fetch the status of the RDS generator as follows:

[command] ? returns current value
ST *returns current value of all controls*
HELP *returns a list of the RDS terminal commands*
↵ = CR/LF in Table 2-2

COMMAND	PARAMETER	INFORMATION	EXAMPLE
PS= / DPS=	Dynamic PS	256 (max) characters for scrolling messages in the PS field	DPS=Artist Goes Here :: Title Goes Here↵
DPSS=	DPS Dynamic Program Service Speed	OFF = Default PS Option Disabled 2 - 9 = wait time in seconds between receipt of last incoming DPS and transmission of DPS Default. Default is the DPS control value as designated in the I/O Setup.	DPSS = 2
DPST=	DPS Dynamic Program Timeout	0 = Default PS Option Disabled 1 - 7 = wait time in minutes between receipt of last incoming DPS and transmission of DPS Default. Default is the DPS control value as designated in the I/O Setup.	DPSTIMEOUT=0
RT=	Radio Text	128 (max) character message to be displayed by the receiver if so equipped	RT=KRD :: (800) 111-1111 :: www.domain.com↵

COMMAND	PARAMETER	INFORMATION	EXAMPLE
DRTS=	RadioText Speed	0 = RadioText OFF 0,5,10,…45 (steps of 5) = Refresh rate for RadioText message transmission (15 recommended for text messaging, higher values for RT+ applications)	DRTS=15
PI=	Program Identification	**4-digit HEX number**[1] corresponding to the Station Call Letters — RDS North America ONLY	PI=3D44↵ (for KRDS)
PTY=	Program Type (Format)	1 or 2 digit number from PTY list describing the station broadcast format — RDS & RBDS are DIFFERENT	PTY=9↵ (for North American "TOP 40")
PTYN=	Program Type Name	8-character refined format definition — RDS & RBDS are DIFFERENT	PTYN=TOP 40↵
MS=	Music/Speech Switch	0 = Music 1 = Speech	MS=0↵ (Music)
DI=	Decoder Information	0 = Mono 1 = Stereo	DI=1↵ (Stereo)
TP=	Traffic Program	0 = Station does not carry traffic info 1 = Station broadcasts routine traffic info	TP=0↵ (No Traffic)
TA=	Traffic Alert ON-AIR NOW	0 = Flag Off 1 = Flag On (Flag valid only when TP=1)	TA=0↵ (No Traffic Alert)
TATIME=	TA Timeout	0 = Timer Off 1 - 255 = seconds between start of TA flag and automatic reset to OFF; 30 is recommended	TATIME=30↵ (Display TA for 30 Seconds)
AFxx=	Alternative Frequency List	Enter each AF in MHz 0 = Clear	AF1=88.1↵ AF1=0↵ (Clear AF1)
ECHO=	Terminal Echo	0 = no echo of sent data 1 = sent data echoed to Terminal window	ECHO=1↵ (Default Terminal Echo Characters)
HEAD=	Head Mode	0 = No Head 1 = Head This takes effect upon disconnect from terminal.	HEAD=1↵ (Default with Head)
TIME=	Time Data on RDS	Determines if time and date are transmitted in the RDS data stream; 0=No, 1=Yes.	TIME=0↵ (turn time transmission off))
RDS=	57kHz RDS Subcarrier	0 = RDS subcarrier On 1 = RDS subcarrier Off	RDS=1↵ (Default - Disabled)
RDSLEVEL=	Subcarrier Level	% Modulation (0…120) - 6% Default	RDSLEVEL=6.0↵ (Default - 6%)

[1] See section D.7 of the NRSC-4-B Standard and section 5.1 of the NRSC-G300-B RBDS Usage Guidelines.

COMMAND	PARAMETER	INFORMATION	EXAMPLE
TIMEOUT=	RDS terminal connection time-out	Timeout (in minutes) between last transmitted command and when the Optimod disconnects automatically. Use it to allow the Optimod to reconnect automatically if the terminal connection is lost temporarily. *This command only affects the current connection; you must reissue it each time you connect.*	TIMEOUT=15↵ (current connection stays up for 15 minutes) TIMEOUT=0↵ (no auto-disconnect occurs)
VER↵	RDS Welcome Header	{ 0=No, 1=Yes } Sets whether the RSD welcome header is sent to the Network client upon connection..	VER 0↵
INIT↵	Use System RDS parameters	Use RDS parameters from System.	INIT↵
SAVE↵	Save RDS parameters	saves the current RDS parameters to the currently active RDS control set (either the System Settings or the User Preset group) NOTE: Any changes will not appear in the PC application if it is open. You must reconnect to see the saved values.	SAVE↵

QUERIES		
[command] ↵	Any command and '?' returns the status of the encoder memory for that specific command..	PS?↵
ST↵	Returns all settings in encoder memory.	ST↵
HELP↵	Reports a list of available commands	HELP↵
TI↵	Returns the current time, as read from the Optimod's real-time clock.	TIME=20:15:36 DATE=Jan. 1, 2015

RESPONSES		
(Return Echo)	The command received was properly formatted and was received and executed by the encoder.	TATIME=30
Invalid Data Entered	Incoming data is not properly formatted and hence was not accepted and executed by the encoder.	Invalid Data Entered
(none)	Data that has been sent either has not reached the encoder or the encoder has no response for that command.	(none)

Table 2-2: Preset/Terminal RDS controls and defaults

Alternative Frequency Channel Numbers

MHz	CHAN	MHz	CHAN	MHz	CHAN	MHz	CHAN
87.6	1	92.7	52	97.8	103	102.9	154
87.7	2	92.8	53	97.9	104	103.0	155
87.8	3	93.9	54	98.0	105	103.1	156
87.9	4	93.0	55	98.1	106	103.2	157
88.0	5	93.1	56	98.2	107	103.3	158
88.1	6	93.2	57	98.3	108	103.4	159
88.2	7	93.3	58	98.4	109	103.5	160
88.3	8	93.4	59	98.5	110	103.6	161
88.4	9	93.5	60	98.6	111	103.7	162
88.5	10	93.6	61	98.7	112	103.8	163
88.6	11	93.7	62	98.8	113	103.9	164
88.7	12	93.8	63	98.9	114	104.0	165
88.8	13	93.9	64	99.0	115	104.1	166
88.9	14	94.0	65	99.1	116	104.2	167
89.0	15	94.1	66	99.2	117	104.3	168
89.1	16	94.2	67	99.3	118	104.4	169
89.2	17	94.3	68	99.4	119	104.5	170
89.3	18	94.4	69	99.5	120	104.6	171
89.4	19	94.5	70	99.6	121	104.7	172
89.5	20	94.6	71	99.7	122	104.8	173
89.6	21	94.7	72	99.8	123	104.9	174
89.7	22	94.8	73	99.9	124	105.0	175
89.8	23	94.9	74	100.0	125	105.1	176
89.9	24	95.0	75	100.1	126	105.2	177
90.0	25	95.1	76	100.2	127	105.3	178
90.1	26	95.2	77	100.3	128	105.4	179
90.2	27	95.3	78	100.4	129	105.5	180
90.3	28	95.4	79	100.5	130	105.6	181
90.4	29	95.5	80	100.6	131	105.7	182
90.5	30	95.6	81	100.7	132	105.8	183
90.6	31	95.7	82	100.8	133	105.9	184
90.7	32	95.8	83	100.9	134	106.0	185
90.8	33	95.9	84	101.0	135	106.1	186
90.9	34	96.0	85	101.1	136	106.2	187
91.0	35	96.1	86	101.2	137	106.3	188
91.1	36	96.2	87	101.3	138	106.4	189
91.2	37	96.3	88	101.4	139	106.5	190
91.3	38	96.4	89	101.5	140	106.6	191
91.4	39	96.5	90	101.6	141	106.7	192
91.5	40	96.6	91	101.7	142	106.8	193
91.6	41	96.7	92	101.8	143	106.9	194
91.7	42	96.8	93	101.9	144	107.0	195
91.8	43	96.9	94	102.0	145	107.1	196
91.9	44	97.0	95	102.1	146	107.2	197
92.0	45	97.1	96	102.2	147	107.3	198
92.1	46	97.2	97	102.3	148	107.4	199
92.2	47	97.3	98	102.4	149	107.5	200

MHz	CHAN	MHz	CHAN	MHz	CHAN	MHz	CHAN
92.3	48	97.4	99	102.5	150	107.6	201
92.4	49	97.5	100	102.6	151	107.7	202
92.5	50	97.6	101	102.7	152	107.8	203
92.6	51	97.7	102	102.8	153	107.9	204

Table 2-3: Alternative Frequency Channel Numbers:

Program Type (PTY)

PTY	Program Type – US	Program Type – EU
0	None	None
1	News	News
2	Information	Current Affairs
3	Sports	Information
4	Talk	Sports
5	Rock	Education
6	Classic Rock	Drama
7	Adult Hit Music	Culture
8	Soft Rock Music	Science
9	Top 40 Music	Varied
10	Country Music	Pop Music
11	Oldies Music	Rock Music
12	Soft Music	Easy Listening Music
13	Nostalgia Music	Light Classics Music
14	Jazz	Serious Classics Music
15	Classical Music	Other Music
16	Rhythm and Blues Music	Weather
17	Soft R and B Music	Finance
18	Foreign Language	Children's Programs
19	Religious Music	Social Affairs
20	Religious Talk	Religion
21	Personality	Phone-In
22	Public Non-Commercial	Travel
23	College	Leisure
24	Spanish Talk	Jazz Music
25	Spanish Music	Country Music
26	Hip-Hop	National Music
27	(unassigned)	Oldies Music
28	(unassigned)	Folk Music
29	Weather	Documentary
30	Emergency Test	Alarm Test
31	Emergency!	Alarm!

Table 2-4: Program Type (PTY)

SCA/Subcarrier Phase Relationship

During stereo broadcast, the SCA subcarrier must be locked either in-phase or in quadrature to the third harmonic of the 19 kHz pilot tone. The tolerance of the phase angle is ±10° measured at the modulation input to the FM transmitter.

With no modulation other than the pilot tone, an oscilloscope trigged from the 19kHz pilot tone should display the following:

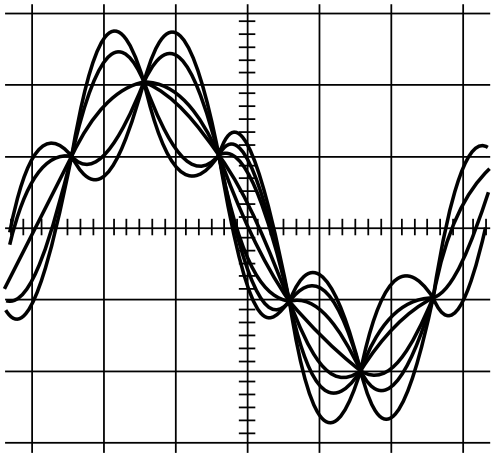


Figure 2-5: Pilot/SCA Phasing Scope Trace

To minimize the amount of peak level that the RDS subcarrier adds to the composite baseband, your Optimod's RDS generator is locked in quadrature with respect to the pilot tone, so Figure 2-5 is for reference only. If your transmission system is broadcasting stereo correctly, it will also correctly pass the phasing built into your Optimod's SCA generator.

References

- IEC 62016 Edition 2.0, 2009-07 (European RDS and most of North American RBDS)
- NRSC-4-B (ways in which the RBDS standard deviates from IEC 62016)
- NRSC-G300-B (guidelines for usage of RBDS)

Section 3
Operation

5500i Front Panel

- **Screen Display** labels the four soft buttons and provides control-setting information.

- Screen **Contrast** button adjusts the optimum viewing angle of the screen display.

- Four **Soft buttons** provide access to all 5500i functions and controls. The functions of the soft buttons change with each screen, according to the labels at the bottom of each screen.

- **Next** and **Prev** (← and →) buttons scroll the screen horizontally to accommodate menus that cannot fit in the available space. They also allow you to move from one character to the next when you enter data into your 5500i.

  These flash when such a menu is in use. Otherwise, they are inactive.

- **Control Knob** is used to change the setting that is selected by the soft buttons. To change a value, you ordinarily have to hold down a soft button while you are turning the control knob.

- **Recall** button allows you recall a Factory or User Preset.

  Selecting the Recall button does not immediately recall a preset. See step 18 on page 3-20 for instructions on recalling a preset.

- **Modify** button brings you to list of controls that you can use to edit a Factory or User Preset. If you edit a Factory Preset, you must save it as a new User Preset to retain your edit.

- **Setup** button accesses the technical parameters necessary to match the 5500i to your transmission system.

- **Escape** button provides an escape from current screen and returns user to the next higher-level screen. Repeatedly pressing *Escape* will always return you to the Idle screen, which is at the top level of the screen hierarchy.

- **Input** meters show the peak input level applied to the 5500i's analog or digital inputs with reference to 0 = digital full-scale. If the input meter's red segment lights up, you are overdriving the 5500i's analog to digital converter, which is a very common cause of audible distortion.

- **Gate** LED indicates gate activity, lighting when the input audio falls below the threshold set by the AGC gate threshold control (via the Full Modify screen's AGC GATE control). When this happens, the AGC's recovery time is slowed to prevent noise rush-up during low-level passages.

  There is also an independent gate for the multiband compressor (3-band and 5-band). You can only see its action from the Optimod PC Remote software.

- **Gain Reduction** meters normally show the gain reduction in the multi-band compressor. Full-scale is 25 dB gain reduction.

  When the Five-Band structure is operating, all the meters indicate gain reduction.

  When the Two-Band structure is operating, the Band 1 and 2 meters indicate gain reduction in the Master and Bass bands, the Band 3 meter indicates the larger of the actions of the left and right HF enhancers, and the Band 4 and 5 meters indicate left and right HF Limiter gain reductions.

  When the 5500i is in stand-alone stereo encoder mode, the Band 4 and 5 meters show the gain reduction in the left/right overshoot limiter meters. Full scale is 5 dB gain reduction. If the overshoot limiter is turned off, these meters will not illuminate. The Band 3, 4, and 5 meters are not used in stand-alone stereo encoder mode.

- **Composite** meter shows the output level of the stereo encoder before the composite output attenuators. The meter's reading is calibrated in percent modulation.

- **Multiplex Power Gain Reduction** meter indicates the action of the ITU412 Multiplex Power controller. It shows how much the MPX Power Controller has reduced the clipper drive, thereby reducing the average power in the processed audio. It will show no gain reduction unless the MPX Power Controller is turned on.

- **Multiplex Power Level** meter indicates multiplex power according to the ITU-R BS.412 standard. Its calibration will be correct if the Optimod's output level control was adjusted using the tone method (see step 14 and subsequent steps starting on page 2-18) and the transmission path following the Optimod has no overshoot. See *ITU-R Multiplex Power Controller* starting on page 3-55 for a full discussion of the Multiplex Power Gain Reduction and Level meters.

The following meters and indicators do not operate when the 5500i is in stand-alone stereo encoder mode:

- **Gate** LED indicates gate activity, lighting when the input audio falls below the threshold set by the multiband gate threshold control (with the Full Modify screen's 2B GATE control). When this happens, the multiband compressor's recovery time slows drastically to prevent noise rush-up during low-level passages.

- **AGC** meter shows the gain reduction of the slow two-band AGC processing that precedes the multi-band compressor. Full-scale is 25 dB gain reduction. You can switch the meter so that it reads the gain reduction of the Master (above-200 Hz) band, the Bass (below-200Hz) band, or the difference between the gain reductions in the Master and Bass bands.

  The latter reading is useful for assessing the dynamic bass equalization that the AGC produces, and it helps you set the AGC BASS COUPLING control.

  5500i PC Remote software provides meters for both AGC bands.

- **HF Enhance** meter only appears in Two-Band mode and uses the array ordinarily dedicated to indicating B3 gain reduction. The HF ENHANCE meter indicates the amount of HF boost provided by the dynamic, program-adaptive high frequency enhancer located in the Equalization section. Calibration is in relative units because the amount of enhancement (in dB) depends on frequency. Because the left and right HF enhancers are independent, we have programmed this meter so that it reads the larger of the left and right HF enhancement.

  The 5500i's HF enhancer operates in both Two-Band and Five-Band modes and in the 5500i PC Remote software is metered in both modes. On the unit's front panel, there are not enough arrays to meter the HF enhancer and Five-Band gain reduction simultaneously.

  On the 5500i's display, the HF Enhancer reads upside down compared to PC Remote. This is to avoid constantly lighting the red segment at the bottom of the meter. (Red indicates overload when the meter is indicating gain reduction.)

- **HF Limiter** meter only appears in Two-Band mode and uses the arrays dedicated to indicating B4 and B5 gain reduction in Five-Band mode.

Introduction to Processing

Some Audio Processing Concepts

Reducing the peak-to-average ratio of the audio increases loudness. 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 (such as pumping or intermodulation 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 peak level 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 that affect the density of the processed sound.

Clipping sharp peaks does not produce any audible side effects when done moderately. Listeners will perceive excessive clipping as audible distortion.

Look-ahead limiting is limiting that prevents overshoots by examining a few milliseconds of the unprocessed sound before it is limited. This way the limiter can anticipate peaks that are coming up.

The 5500i uses look-ahead techniques in several parts of the processing to minimize overshoot for a given level of processing artifacts (among other things).

Distortion in Processing

In a competently designed processor, distortion occurs only when the processor is controlling peaks to prevent the audio from exceeding the peak modulation limits of the transmission channel. The less peak control that occurs, the less likely that the listener will hear distortion. However, to reduce the amount of peak control, you must decrease the drive level to the peak limiter, which causes the average level (and thus, the loudness) to decrease proportionally.

Loudness and Distortion

In FM processing, 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 others. Thanks to Orban's psychoacoustically optimized designs, this is less true of Orban processors than of any others. Nevertheless, all intelligent processor designers must acknowledge and work within the laws of physics as they apply to this trade-off.

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 low distortion. A listener can compensate for loudness by simply adjusting the volume control. However, there is nothing the listener can do to make an excessively compressed or peak-limited signal sound clean again.

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 are. 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.

OPTIMOD-FM — from Bach to Rock

OPTIMOD-FM can be adjusted so that the output sounds:

- as close as possible to the input at all times (using the Two-Band structure)
- open but more uniform in frequency balance (and often more dramatic) than the input (using the Five-Band structure with slow release times)
- dense, quite squashed, and very loud (using the Five-Band structure with fast or medium-fast release times)

The dense, loud setup 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. The loudness/distortion trade-off explained above applies to any of these setups.

You will achieve best results if Engineering, Programming, and Management go out of their way to communicate and cooperate with each other. It is important that Engineering understand the sound that Programming desires, and that Management fully understands the trade-offs involved in optimizing one parameter (such as loudness) at the expense of others (such as distortion or excessive density).

Never lose sight of the fact that, while the listener can easily control loudness, he or she cannot 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.

Fundamental Requirements: High-Quality Source Material and Accurate Monitoring

A major potential cause of distortion is excess peak limiting. 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 OPTIMOD-FM — particularly if a large amount of gain reduction is used. Very clean audio can be processed harder without producing objectionable distortion. A high-quality monitor system is essential. To modify your air sound 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!

At this writing, there has been a very disturbing trend in CD mastering to apply levels of audio processing to CDs formerly only used by "aggressively-processed" radio stations. These CDs are audibly distorted (sometimes blatantly so) before any further OPTIMOD processing. The result of 5500i processing can be to exaggerate this distortion and make these recordings noticeably unpleasant to listen to over the air.

There is very little that a radio station can do with these CDs other than to use conservative 5500i presets, which will cause loudness loss that may be undesired in competitive markets. There is a myth in the record industry that applying "radio-style" processing to CDs in mastering will cause them to be louder or will reduce the audible effects of on-air processing. In fact, the opposite is true: these CDs will not be louder on air, but they will be audibly distorted and unpleasant to listen to, lacking punch and clarity.

Another unfortunate trend is the tendency to put so much high frequency energy on the CDs that this energy cannot possibly survive the FM pre-emphasis/de-emphasis process. Although the 5500i loses less high frequency energy than most other processors (due to its sophisticated high frequency limiting and clipping technology), it is nevertheless no match for CDs that are mastered so bright that they will curl the vinyl off car dashboards.

We hope that the record industry will come to its senses when it hears the consequences of these practices on the air.

About the 5500i's Signal Processing Features

Signal Flow

The signal flows through the 5500i through the following blocks (see page 6-51):

- **Input Conditioning**, including sample rate conversion, defeatable 30Hz high-pass filtering, and defeatable phase rotation
- **Stereo Enhancement**
- **Two-Band Gated AGC**, with target-zone window gating and silence gating
- **Equalization**, including high-frequency enhancement
- **Multiband Compression** with embedded HF clipping and additional HF limiter
- "**Intelligent" Clipping** with distortion control, distortion cancellation, and anti-aliasing
- **Overshoot Compensation**
- **DSP-derived Stereo Encoder** (stereo generator)
- **Composite Level Control Processor**

Input Conditioning: The 5500i operates at 32 kHz sample rate and power-of-two multiples thereof (up to 512 kHz in the stereo encoder). No commercial A/D converters or sample rate converter chips convert to 32 kHz while maintaining the standards we demanded for this product. Therefore, to ensure high quality A/D and sample rate conversion, we operate both the SRC and A/D chips at 64 kHz-output sample rate and then downsample to 32 kHz in DSP. By designing and implementing

our own downsampler, we can ensure full frequency response to 15 kHz with very low spurious images.

The 5500i's output spectral control is immaculate, ensuring maximum stereo and RDS coverage. Moreover, the 5500i's digital output will pass through any uncompressed digital STL (including those operating at 32 kHz sample rate) without added overshoot and without the need for distortion-producing overshoot compensation schemes.

A defeatable 30Hz 18 dB/octave highpass filter and a defeatable phase rotator complete the input-conditioning block. These have both been features in Orban FM processors for many years. Most users will defeat the 30Hz filter and leave the phase rotator in-circuit, although the choice is always yours.

Stereo Enhancement: The 5500i provides a stereo enhancement algorithm based on Orban's patented analog 222 Stereo Enhancer, which increases the energy in the stereo difference signal (L–R) whenever a transient is detected in the stereo sum signal (L+R). By operating only on transients, the 222 increases width, brightness, and punch without unnaturally increasing reverb (which is usually predominantly in the L–R channel).

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

Two-Band Gated AGC: The AGC is a two-band device, using Orban's patented "master/bass" band coupling. It has an additional important feature: target-zone gating. If the input program material's level falls within a user-settable window (typically 3 dB), then the release time slows to a user-determined level. It can be slow enough (0.5 dB/second) to effectively freeze the operation of the AGC. This prevents the AGC from applying additional, audible gain control to material that is already well controlled. It also lets you run the AGC with fast release times without adding excessive density to material that is already dense.

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

The AGC has its own silence-gating detector whose threshold can be set independently of the silence gating applied to the multiband compressor.

Equalization: The 5500i has steep-slope bass shelving equalizer and three bands of fully parametric bell-shaped EQ.

You can set the slope of the bass shelving EQ to 6, 12, or 18 dB/octave and adjust the shelving frequency.

The 5500i's bass, midrange, and high frequency parametric equalizers have curves that were modeled on the curves of Orban's classic analog parametrics (like the 622B), using a sophisticated and proprietary optimization program. The curves are

matched to better than 0.15 dB. This means that their sound is very close to the sound of an Orban analog parametric. They also use very high quality filter algorithms to ensure low noise and distortion.

The 5500i HF Enhancer is a program-controlled HF shelving equalizer that was originally introduced in Orban's 2200 OPTIMOD-FM. It intelligently and continuously analyzes the ratio between broadband and HF energy in the input program material, and can equalize excessively dull material without over-enhancing bright material. It interacts synergistically with the five-band compressor to produce sound that is bright and present without being excessively shrill.

Multiband Compression: The multiband compressor can be operated in five-band or two-band mode. In addition to using a special high-frequency limiter, we control high frequencies with distortion-canceled clipping. The clipper in the 5500i operates at 256 kHz-sample rate and is full anti-aliased.

With the factory presets, the gain reduction in band 5 is set to follow the gain reduction in band 4 (as determined by the setting of the B4>B5 COUPLE control); these bands are only independent from the viewpoint of the downward expander and multiband clippers. A high frequency limiter causes additional gain reduction in band 5 when band 5 multiband clipping alone would be insufficient to prevent HF distortion. The HF limiter uses a sophisticated analysis of the signal conditions in the 5500i's clipping system to do this.

> Starting with v1.1, band 5 has a compressor sidechain identical to the sidechains in bands 1 to 4. This gives users more detailed control over the 5500i's HF texture compared to the arrangement in v1.0, which relied solely on the 5500i's HF limiter.

A clipper, embedded in the crossover, protects bands 1 and 2 from transient overshoot. This clipper has a shape control, allowing you to vary the "knee" of its input/output transfer curve from hard (0) to soft (10).

"Intelligent" Clipping: In all buts its "ultra-low-latency" mode (i.e., factory presets with "UL" in their names and User Preset derived from them), the 5500i prevents excess clipping distortion by dynamically reducing the drive level to the clippers as required, using an intelligent analysis of the clipping distortion produced in the final clipper and overshoot compensator.

DSP-derived Stereo Encoder: The 5500i's stereo encoder is derived from algorithms first developed for the high-performance Orban 8218 stand-alone encoder. The 5500i's stereo encoder operates at 512 kHz-sample rate to ease the performance requirements of the D/A converter's reconstruction filter, making it possible to achieve excellent stereo separation that is stable over time and temperature.

The 5500i has two independent composite outputs, whose levels are both software-settable. For convenience, two SCA inputs sum into the 5500i's analog composite output amplifier. The second input can be configured to provide a 19 kHz-reference output for subcarrier generators that need it.

> The 5500i does not digitize SCAs.

SSB Stereo Encoder Operation: Starting with version 1.2, the 5500i allows its stereo encoder's stereo subchannel modulator to operate in an experimental compatible single sideband/vestigial sideband mode.

SSB/VSB operation suppresses the upper sideband of the stereo subcarrier above 38,150 Hz, which reduces the occupied bandwidth of the FM-modulated RF signal. In SSB mode, the subchannel modulator acts as a pure SSB generator for L–R material in the frequency range of 150 Hz to 17 kHz and as a vestigial sideband generator below 150 Hz.

In normal operation, the stereo subchannel modulator produces a double sideband suppressed carrier signal with pairs of mirror image sidebands around 38 kHz. With respect to an L+R gain of 1, the gain of each sideband is 0.5. In SSB/VSB mode, the upper sideband is suppressed by at least 80 dB above a modulating frequency of 150 Hz and the gain of the lower sideband is 1.0. Below 150 Hz, the sum of the gains of the sideband pairs is 1.0. (The conventional DSB case is a limiting case of this, where the gains of the upper and lower sidebands are both 0.5 and sum to 1.) This "summation to 1" criterion is necessary to achieve compatibility with normal FM radios that use synchronous demodulation of the stereo subchannel. Almost every radio manufactured since 1973 works like this. We have verified that the 5500i's SSB generator produces more than 60 dB of separation from 50 to 15,000 Hz when measured on a Belar FMSA-1 "Wizard" modulation monitor, which was originally designed for convention double sideband operation.

In SSB/VSB mode, the bandwidth of the 5500i's composite output signal extends to 38,150 Hz when the 5500i's composite limiter is not used. When the composite limiter is used, the limiting action will produce energy up to 55 kHz (as it does with normal DSB operation) but this energy will be much lower in level than the energy that would have been produced by normal DSB operation in the frequency range occupied by the upper sideband.

SSB operation causes irreducible, "laws of physics" composite peak modulation overshoots to occur with certain combinations of left and right channel signals that are independently peak limited to 100% modulation, which is the correct limiting technique for conventional double-sideband transmission. The worst-case irreducible SSB overshoot occurs when the left and right channels contain correlated signals whose phase difference is 90°.

Suboptimal system design can cause additional overshoots. To prevent this type of overshoot, the 5500i's SSB/VSB generator uses constant-delay filters and its frequency response extends to DC (because of the VSB operation below 150 Hz).

The group delay of the phase-linear filters needed to create the SSB/VSB waveform and the audio delay in the look-ahead limiter together add approximately 12 ms to the delay of the stereo encoder. When diversity delay is applied to the 5500i's composite output, the 5500i adjusts the delay automatically so that it is constant regardless of mode.

To control irreducible overshoots, the SSB generator includes a look-ahead overshoot limiter. To eliminate all overshoots, this limiter must be used together with the

5500i's Half-Cosine Interpolation composite limiter, which is located after the look-ahead limiter in the system block diagram.

To activate SSB mode:

A) Navigate to *Setup* > STEREO ENCODER > MODE and select SSB.

SSB mode can also be activated via the 5500i's GPI inputs and by PC Remote.

B) Check the setting of the COMP DRIVE control in the active processing preset (see page 3-36). If it is not set to 0.0 dB, set it to 0.0 dB and save the result as a user preset.

Because the composite limiter must work harder in SSB mode than in normal DSB mode to control peak levels, we recommend setting the COMP DRIVE control to 0.0 dB even if the preset has this control set higher than 0 dB when used in normal DSB mode. This will minimize any audible distortion caused by additional peak limiting when the composite limiter in SSB mode.

The look-ahead overshoot controller is always active in SSB mode, while the Half-Cosine Interpolation Composite Limiter is controlled by the active processing preset's COMP DRV control as usual.

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

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

We succeeded in our effort. The 5500i offers a patented "Half-Cosine Interpolation" composite limiter that provides excellent spectral protection of the pilot tone and SCAs (including RDS), while still providing approximately 50 dB of separation when a single-channel composite waveform is clipped to 3 dB depth. To ensure accurate peak control, the limiter operates at 512 kHz sample rate.

For those who prefer the sound of conventional composite clipping, we also offer a defeatable composite clipper, which is available only when the 5500i is in standalone stereo encoder mode. This also provides excellent spectral protection for the pilot tone and subcarriers. The composite clipper drives the "Half-Cosine Interpolation" composite limiter, which serves as an overshoot compensator for the composite clipper when it is active. (Overshoot compensation necessary to remove overshoots introduced by the pilot- and SCA-protection filters following the composite clipper.)

Like conventional composite clipping, the "Half-Cosine Interpolation" composite limiter can still cause aliasing distortion between the stereo main and subchannels. However, this is the inevitable cost of increasing the power-handling capability beyond 100% modulation above 5 kHz—the characteristic that makes some people like composite clipping. This exploits the fact that the fundamental frequency in a square wave has a higher peak level than the square wave itself. However, any process that makes squared-off waveforms above 5 kHz creates higher harmonics that end up in the stereo subchannel region (23-53 kHz). The receiver then decodes these harmonics as if they were L–R information and the decoded harmonics appear at new frequencies not harmonically related to the original frequency that generated them.

While the processing never clips the pilot tone, the extra spectrum generated by the processing can fall into the 19 kHz region, compromising the ability of receivers to recover the pilot tone cleanly. Therefore, the 5500i's composite processor has a 19 kHz notch filter to protect the pilot tone. This filter does not compromise stereo separation in any way.

We still prefer to use the 5500i's main clipping system to do the vast majority of the work because of its sophisticated distortion-controlling mechanisms. This means that the 5500i does *not* rely on composite processing to get loud. Consequently, broadcasters using its left/right-domain AES3 digital output can enjoy the loudness benefits of the 5500i's processing—the 5500i gets competitively loud without composite clipping. However, it is also possible to reduce the drive level to the 5500i's left/right domain overshoot compensators and to increase the composite limiter drive by a corresponding amount. This arrangement uses the overall composite limiter (with or without the composite clipper's being active) to provide overshoot compensation. It has a different sound than using the left/right domain overshoot compensators—the sound is brighter but has more aliasing distortion (as discussed above). If the composite clipper is active (i.e., if the MPX LIM MODE is set to HARD), stereo separation will decrease.

Stand-Alone Stereo Encoder Mode

When the 5500i's is in stereo encoder mode, the signal flows through the 5500i through the following blocks:

- **Input Conditioning**, including sample rate conversion to 64 kHz, defeatable 15, 16, or 17 kHz lowpass filtering, and the requisite preemphasis and deemphasis filters to allow the 5500i to accept, flat, preemphasized, or flat+J17 preemphasized audio.
- **Left/Right Overshoot Limiter.** This is intended to remove overshoots in studio/transmitter links caused by lossy digital audio compression (like MP2) or by unflat frequency response and group delay distortion. This is a very fast limiter using look-ahead and anti-aliased clipper technology. We recommend using no more than 3 dB of gain reduction.
- **DSP-derived Core Stereo Encoder** (stereo generator), which has the experimental SSB mode available (see *SSB Stereo Encoder Operation* on page 3-9.)
- **Composite Limiter/Clipper**.

ITU-R 412 Compliance

ITU-R 412 requires the "average multiplex power" to be limited to a standard value. The 5500i contains a patented, defeatable feedback multiplex power limiter that constantly monitors the multiplex power according to ITU-R 412 standards. The power controller automatically reduces the average modulation to ensure compliance. It allows you to set the "texture" of the processing freely, using any preset. If a given processing setting would otherwise exceed the multiplex power limit, the power controller automatically reduces the drive to the peak limiting system by increasing the amount of multiband compression. This action retains the processing texture but reduces distortion while controlling multiplex power.

The 5500i gives you control over the multiplex power threshold. This allows you to compensate for overshoots in the signal path upstream from the 5500i, preventing excessive reduction of the multiplex power.

The ITU412 control is found in the MODIFY > STEREO ENCODER screen.

Power control is applied to all outputs, not just the composite output.

For more information, refer to *ITU-R Multiplex Power Controller* starting on page 3-55.

Two-Band Purist Processing

In addition to five-band processing, suitable for pop music and talk formats, the 5500i offers a very high-quality two-band algorithm. This is phase-linear and features the same AGC as the five-band processor, followed by a two-band processor. Sophisticated multiband high frequency limiting and distortion-controlled clipping complete the chain.

We believe that this is the ideal processing for classical music because it does not dynamically re-equalize high frequencies; the subtle HF limiter only acts to reduce high frequency energy when it would otherwise cause overload because of the FM pre-emphasis curve. We have heard four-band, allegedly "purist" processing that caused dynamic HF lift. This created a strident, unnatural sound in strings and brass. In contrast, the 5500i's two-band phase-linear structure keeps the musical spectrum coherent and natural.

Input/Output Delay

The algorithmic improvements in the 5500i over earlier generations of Orban DSP-based processing (8200 and 2200) have one significant cost — the input/output time delay is typically 15 ms. To make intelligent decisions about how to process, the 5500i needs to look ahead at the next part of the program waveform. As digital on-air processing advances further and further from its analog roots, this is the inevitable price of progress.

15 ms is comfortably below the psychoacoustic "echo fusion threshold," which means that talent will not hear discrete slap echoes in their headphones. This means that they can monitor comfortably off-air without being distracted or confused.

Some talent moving from an analog processing chain will require a learning period to become accustomed to the voice coloration caused by "bone-conduction" comb filtering. This is caused by the delayed headphone sound's mixing with the live voice sound, which introduces notches in the spectrum that the talent hears when he or she talks. All digital processors induce this coloration to a greater or lesser extent. Fortunately, it does not cause confusion or hesitation in the talent's performance unless the delay is above the psychoacoustic "echo fusion" (Haas) threshold of approximately 20 ms, where the talent starts to hear slap echo in addition to frequency response colorations.

If talent cannot live with 15 ms delay yet needs to monitor off-air, you can use one of several ultra-low latency ("UL") presets, which have approximately 5 ms delay. These provide a poorer tradeoff between loudness, brightness, and distortion than the optimum latency presets because they do not use the 5500i's intelligent look-ahead distortion control mechanism. We therefore recommend their use only when necessary.

If the talent is in the same location as the 5500i, you can configure the 5500i's analog outputs to supply a special low-latency monitor signal to drive headphones only. (See step 8 on page 2-32.)

Customizing the 5500i's Sound

The subjective setup controls on the 5500i give you the flexibility to customize your station's sound. Nevertheless, as with any audio processing system, proper adjustment of these controls consists of balancing the trade-offs between loudness, density, and audible distortion. The following pages provide the information you need to adjust the 5500i controls to suit your format, taste, and competitive situation.

When you start with one of our Factory Presets, there are two levels of subjective adjustment available to you to let you customize the Factory Preset to your requirements: Basic Modify and Full Modify. A third level, *Advanced Modify*, is accessible *only from the 5500i's PC Remote software*.

See page 6-51 for a block diagram of the processing.

Basic Modify

BASIC *MODIFY* allows you to control three important elements of 5500i processing: the stereo enhancer, the equalizer, and the dynamics section (multiband compression, limiting, and clipping). At this level, there is only one control for the dynamics section: LESS-MORE, which changes several different subjective setup control settings simultaneously according to a table that we have created in the 5500i's permanent ROM (Read-Only Memory). In this table are sets of subjective setup control settings that provide, in our opinion, the most favorable trade-off between loudness, density, and audible distortion for a given amount of dynamics processing. We believe that most 5500i users will never need to go beyond the Basic level of control. The combinations of subjective setup control settings produced by this control have been

optimized by Orban's audio processing experts on the basis of years of experience designing audio processing, and upon hundred of hours of listening tests.

As you increase the setting of the LESS-MORE control, the air sound will become louder, but (as with any processor) processing artifacts will increase. Please note that the highest LESS-MORE setting is purposely designed to cause unpleasant distortion and processing artifacts! This helps assure you that you have chosen the optimum setting of the LESS-MORE control, because turning the control up to this point will cause the sound quality to become obviously unacceptable.

You need not (in fact, cannot) create a sound entirely from scratch. All User Presets are created by modifying Factory Presets, or by further modifying Factory Presets that have been previously modified with a LESS-MORE adjustment. It is wise to set the LESS-MORE control to achieve a sound as close as possible to your desired sound before you make further modifications at the Advanced Modify level. This is because the LESS-MORE control gets you close to an optimum trade-off between loudness and artifacts, so any changes you make are likely to be smaller and to require resetting fewer controls.

In the 5500i, LESS-MORE affects only the dynamics processing (compression, limiting, and clipping). Unlike Orban's OPTIMOD-FM 8200, the 5500i has equalization and stereo enhancement that are decoupled from LESS-MORE. You can therefore change EQ or stereo enhancement and not lose the ability to use LESS-MORE. When you create a user preset, the 5500i will automatically save your EQ and stereo enhancement settings along with your LESS-MORE setting. When you recall the user preset, you will still be able to edit your LESS-MORE setting if you wish.

Full Modify

Full Modify is the most detailed control level available from the 5500i's front panel. It allows you to adjust the dynamics section at approximately the level of "full control" available in Orban's 8200 processor. Because of improvements in the 5500i's signal processing by comparison to the 8200, these controls are not extremely dangerous (although you can still get into trouble if you try hard enough). Most people will never have any reason to go beyond Full Modify, even if they want to create a "signature sound" for their station.

> **Note:** Full Modify does not provide LESS-MORE control. Furthermore, once you have edited a preset's dynamics parameters in Full Modify, LESS-MORE control is no longer available in Basic Modify and will be grayed-out if you access its screen. As noted above, we recommend using the Basic Modify LESS-MORE control to achieve a sound as close as possible to your desired sound before you make further modifications at the Full Modify level.

Advanced Modify

If you want to create a signature sound for your station that is far out of the ordinary or if your taste differs from the people who programmed the LESS-MORE ta-

bles, Advanced Modify is available to you from the 5500i PC Remote software *only* (not from the 5500i's front panel). At this level, you can customize or modify any subjective setup control setting to create a sound exactly to your taste. You can then save the settings in a User Preset and recall it whenever you wish.

Compressor attack times and thresholds are available, along with settings affecting the automatic clipping distortion control. These controls can be exceedingly dangerous in inexperienced hands, leading you to create presets that sound great on some program material and fall apart embarrassingly on other material. We therefore recommend that you create custom presets at the Advanced Modify level only if you are experienced with on-air sound design, and if you are willing to take the time to double-check your work on many different types of program material.

The PC Remote software organizes its controls in tabbed screens. The first three tabs (EQUALIZATION, STEREO ENHANCER, and LESS-MORE) access the Basic Modify controls. The remaining tabs combine the Full Modify and Advanced Modify controls, logically organized by functionality.

> **Important Note:** Once you have edited a preset's dynamics parameters in Full or Advanced Modify, LESS-MORE control is no longer available in Basic Modify. As noted above, we strongly recommend using the LESS-MORE control to achieve a sound as close as possible to your desired sound before you make further modifications at the Full or Advanced Modify levels.

Gain Reduction Metering

Unlike the metering on some processors, when any OPTIMOD-FM gain reduction meter indicates full-scale (at its bottom), it means that its associated compressor has run out of gain reduction range, that the circuitry is being overloaded, and that various nastinesses are likely to commence.

Because the various compressors have 25 dB of gain reduction range, the meter should never come close to 25 dB gain reduction if OPTIMOD-FM has been set up for a sane amount of gain reduction under ordinary program conditions.

> To accommodate the FM pre-emphasis curve, Band 5 of the Five-Band Structure is capable of 30 dB of gain reduction.

Further, 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 10 dB more peak gain reduction than does music! (A PPM will indicate relative peak levels much more accurately.)

The AGC meter can be switched (within the Full Control screens) so that it either reads the gain reduction of the Master (above-200 Hz) band, or the difference between the gain reduction in the Master and Bass bands.

> The latter reading is useful for assessing the dynamic bass equalization that the AGC produces and it helps you set the AGC BASS COUPLING control.

To Create or Save a User Preset

Once you have edited a preset, you can save it as a user preset. The 5500i can store an indefinite number of user presets, limited only by available memory.

The 5500i will offer to save any edited, unsaved preset when the main screen is visible. To save a preset:

A) Press the ESC button repeatedly until you see the main screen, which shows the current time and the preset presently on air.

If there is an unsaved preset on air, the rightmost button will be labeled SAVE PRESET.

B) Press the SAVE PRESET button.

The Save Preset screen appears.

C) Choose a name for your preset.

Some non-alphanumeric characters (such as < and >) are reserved and cannot be used in preset names.

D) Use the knob to set the each character in the preset name. Use the *Next* and *Prev* buttons to control the cursor position.

E) Press the SAVE CHANGES button.

- You cannot give a user preset the same name as a factory preset. If the name that you have selected duplicates the name of a factory preset, the 5500i will suggest an alternate name.
- If the name you have selected duplicates the name of an existing user preset, the 5500i warns you that you are about to overwrite that preset. Answer YES if you wish to overwrite the preset and NO otherwise. If you answer NO, the 5500i will give you an opportunity to choose a new name for the preset you are saving.

You can save user presets from the 5500i PC Remote application. (See *Using the 5500i PC Remote Control Software* on page 3-62.) Please note that when you save presets from the PC Remote application, you save them in the 5500i's memory (as if you had saved them from the 5500i's front panel). The PC Remote application also allows you to *archive* presets to your computer's hard drive (or other storage device) and to restore them. However, archiving a preset is not the same as saving it. Archived presets reside on a storage medium supported by your computer, while saved presets reside in the 5500i's local non-volatile memory. You cannot archive a preset until you have saved it. (See *To back up user presets, system files, and automation files onto your computer's hard drive* on page 3-65.)

Note that if, for some reason, you wish to save an unmodified preset (either Factory or User) under a new name, you must temporarily make an arbitrary edit to that preset in order to make the SAVE PRESET button appear. After you have saved the preset, reverse the edit and save the preset again.

About the Processing Structures

If you want to create your own User Presets, the following detailed discussion of the processing structures is important to understand. If you only use Factory Presets, or if you only modify them with LESS-MORE, then you may still find the material interesting, but you do not need to understand it to get excellent sound from the 5500i.

In the 5500i, a processing structure is a program that operates as a complete audio processing system. Only one processing structure can be active at a time. Just as there are many possible ways of configuring a processing system using analog components (like equalizers, compressors, limiters, and clippers), the 5500i's DSP hardware can realize several possible processing structures. Unlike an analog system, where creating a complete processing system involves physically wiring its various components together, the 5500i realizes its processing structures as a series of high-speed mathematical computations made by Digital Signal Processing (DSP) integrated circuit chips.

Not counting the stand-alone stereo encoder, there are three basic structures: **Two-Band**, **Five-Band**, and **Ultra-Low-Latency Five-Band**. To select a structure, choose a factory preset having the desired structure, and, if you wish, edit it to create a user preset.

Two-Band is a purist, phase-linear structure. When correctly configured, it can be used for protection limiting and we provide a preset that uses it for this. It is also the basis for the CLASSICAL-2 BAND presets. It can have higher latency than the five-band presets (up to 23 ms).

Five-Band is the basic structure used for popular music in its many variations. Because it provides effective automatic re-equalization of program material, it is also used for news, talk, and sports.

The stereo enhancer, AGC, equalizer, and "back end" clippers are common to both Two-Band and Five-Band processing and therefore stay the same when the 5500i switches between two-band and five-band operation. However, different controls appear in the screens containing dynamics processing controls, as appropriate for Two-Band or Five-Band multiband compression. The meters also change functionality to display the Two-Band or Five-Band gain reduction.

Both the Two-Band and Five-Band multiband compressors always operate in the background. So switching between Two-Band and Five-Band occurs with a seamless cross-fade. Unlike older Orban processors like the 8200, no DSP code is reloaded and no audio mute is necessary.

Ultra-Low-Latency Five-Band reduces the input-to-output delay of the processor to about 5 ms at the cost of a less favorable tradeoff between loudness, brightness, and distortion than the other presets. It is comparable in performance to Optimod-FM 8200 version 3.0 except that the clippers are anti-aliased and it offers the same stereo enhancement, equalization section, advanced-technology AGC, composite limiter, and multiplex power controller as the other 5500i structures.

The Optimum Five-Band and the Two-Band structures can be switched via a mute-free crossfade (because they are both active simultaneously); the Ultra-Low Latency Five-Band structure causes an audio mute of approximately two seconds when activated (because DSP code must be reloaded).

To put a given structure on the air, recall a factory or user preset associated with that structure.

Factory Programming Presets

Factory Programming Presets are our "factory recommended settings" for various program formats or types. The Factory Programming Presets are starting points to help you get on the air quickly without having to understand anything about adjusting the 5500i's sound. You can edit any of these presets with the LESS-MORE control to optimize the trade-off between loudness and distortion according to the needs of your format. Because it is so easy to fine-tune the sound at the LESS-MORE level, we believe that many users will quickly want to customize their chosen preset to complement their market and competitive position after they had time to familiarize themselves with the 5500i's programming facilities.

It is OK to use unmodified factory presets on the air. These represent the best efforts of some very experienced on-air sound designers. We are sometimes asked about unpublished "programming secrets" for Optimods. In fact, there are no "secrets" that we withhold from users. Our "secrets" are revealed in this manual and the presets embody all of our craft as processing experts. The presets are editable because other sound designers may have different preferences from ours, not because the presets are somehow mediocre or improvable by those with special, arcane knowledge that we withhold from most of our customers.

Start with one of these presets. 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, customize your sound using the information in the Protection Limiter, Two-Band and Five-Band sections that follow.

Each Orban factory preset has full LESS-MORE capability. The table shows the presets, including the source presets from which they were taken and the nominal LESS-MORE setting of each preset. Some of the Five-Band presets appear several times under different names because we felt that these presets were appropriate for more than one format; these can be identified by a shared source preset name.

Some of the presets come in several "flavors," like "medium" and "open." These refer to the density produced by the processing. "Open" uses a slow multiband release time and "Medium" uses a medium-slow release. Only the NEWS-TALK and SPORTS presets use fast release.

> **Important!** If you are dissatisfied with the sound available from the factory presets, please understand that each named preset is actually 19 presets that can be accessed via the LESS-MORE control. Try using this control

to trade off loudness against processing artifacts and side effects. Once you have used LESS-MORE, save your edited preset as a User Preset.

Do not be afraid to choose a preset other than the one named for your format if you believe this other preset has a more appropriate sound. Also, if you want to fine-tune the frequency balance of the programming, feel free to use Basic Modify and make small changes to the Bass, Mid EQ, and HF EQ controls. Unlike some earlier Orban's processors, the 5500i lets you make changes in EQ (and stereo enhancement) without losing the ability to use LESS-MORE settings.

Of course, LESS-MORE is still available for the unedited preset if you want to go back to it. There is no way you can erase or otherwise damage the Factory Presets. So, feel free to experiment.

If a preset has 2-Band in its name, it will activate the Two-Band structure.

Switching between the Two-Band and Five-Structures occurs via a smooth cross-fade.

If the preset has "UL" in its name, it will load the Ultra-Low Latency Five-Band struc-

FACTORY PROGRAMMING Presets		
Preset Names	**Source Preset**	**Normal Less-More**
ST ENC NO LIM	ST ENC NO LIM	NA
PROTECTION	PROTECTION	7.0
CLASSICAL-2 BAND	CLASSICAL-2 BAND	7.0
CLASSICAL-2B+AGC	CLASSICAL-2B+AGC	7.0
CLASSICAL-5 BAND	CLASSICAL-5 BAND	7.0
CLASSICAL-5B+AGC	CLASSICAL-5B+AGC	5.0
BASS-PUNCH	BASS-PUNCH	9.5
COUNTRY-LIGHT	ROCK-LIGHT	7.0
COUNTRY UL	COUNTRY UL	7.0
COUNTRY-MEDIUM	ROCK-SMOOTH	7.0
EXTREME	EXTREME	9.5
JAZZ	JAZZ	7.0
NEWS-TALK	NEWS-TALK	7.0
OLDIES	OLDIES	9.5
ROCK-GENERAL	ROCK-GENERAL	7.0
ROCK-GEN UL	ROCK-GEN UL	9.0
ROCK-LIGHT	ROCK-LIGHT	7.0
ROCK-LOUD	ROCK LOUD	9.5
ROCK-MEDIUM	ROCK-MEDIUM	7.0
ROCK-OPEN	ROCK-OPEN	9.0
ROCK-SMOOTH	ROCK-SMOOTH	7.0
ROCK-SOFT	ROCK-SOFT	8.5
SPORTS	SPORTS	7.0
URBAN	URBAN	7.0
URBAN UL	URBAN UL	9.0
URBAN-LOUD	URBAN	9.5

Table 3-1: Factory Programming Presets

ture. Note that if you switch between an "UL" preset and any other preset, the audio will mute for about two seconds to allow time for new DSP code to load into the DSP chips and to initialize. "UL" presets are not as competitive as other presets and should only be used if you absolutely need the low delay (for example, when driving talent headphones off-air during remote broadcasts).

PROTECTION: PROTECTION is a two-band preset with a high amount of band coupling. It is intended for use below threshold most of the time, to provide protection limiting in the highest quality applications such as serious classical music intended for an attentive audience. Its LESS-MORE control determines the normal amount of gain reduction but does not increase distortion or other processing artifacts when turned up.

If you only need overshoot limiting, start with the ST ENC NO LIM factory preset and turn on the L/R Limiter. However, this preset is only usable with sources that have already been preemphasis-limited and peak-limited. If you need these functions, use the PROTECTION preset instead.

CLASSICAL: As their names imply, the CLASSICAL-FIVE-BAND and CLASSICAL-TWO-BAND presets are optimized for classical music, gracefully handling recordings with very wide dynamic range and sudden shifts in dynamics. The Five-Band version uses heavy inter-band coupling to prevent large amounts of automatic re-equalization, which could otherwise cause unnatural stridency and brightness in strings and horns, and which could pump up very low frequency rumble in live recording venues.

The Five-Band preset defeats the AGC, using only the multiband compressor for gain reduction. It also defeats phase rotation to ensure the most transparent Five-Band sound available.

Even more transparent, "purist" classical processing is available from the CLASSICAL-TWO-BAND preset. This is phase-linear and which preserves the spectral balance of the original material as much as possible. However, if you need a bit more automatic re-equalization than the CLASSICAL-TWO-BAND preset provides, use the CLASSICAL-FIVE-BAND preset.

CLASSICAL-5B+AGC uses the AGC, set for 2:1 compression ratio. Because of the AGC, it affects more of the total dynamic range of the recording than does the CLASSICAL-5 BAND preset. However, the AGC provides extremely smooth and unobtrusive compression because of the gentle ratio and window gating. This preset uses the Five-Band compressor very lightly with a fast release time as a peak limiter. The AGC does almost all of the compression.

There is also a corresponding two-band preset called CLASSICAL-2B+AGC. In our opinion, this provides an ideal combination of unobtrusive compression and low coloration, typically raising low-level material about 10 dB.

BASS-PUNCH produces a slight increase in bass energy below 100 Hz and a decrease of bass energy centered at 160 Hz. This bass sound works particularly well with radios having good bass response, such as many auto radios today.

In terms of loudness, midrange texture, and HF texture, BASS-PUNCH similar to the URBAN-LOUD preset.

COUNTRY: The COUNTRY-MEDIUM preset uses the ROCK-SMOOTH source preset. It has a gentle bass lift and a mellow, easy-to-listen-to high end, along with enough presence energy to help vocals to stand out. The COUNTRY-LIGHT preset uses the ROCK-LIGHT source preset. Modern country stations might also find ROCK-MEDIUM or ROCK-OPEN useful if they want a brighter, more up-front sound.

EXTREME: EXTREME is intended for CHR and similar formats where attracting a large audience (maximizing cume) is more important than ensuring long time-spent-listening. This is a loud, bright, "major-market" preset that is competitive with other processors that are not as scrupulous as the 5500i about controlling audible distortion with certain program material. It also has a great deal of presence energy to cut through on lower-quality radios.

> Its sound changes substantially as the LESS-MORE control is turned down — distortion decreases while bass punch and transparency improve. Therefore, exploring various Less-More settings is very worthwhile with EXTREME, because, for many markets, this preset will be "over the top" unless it is turned down with LESS-MORE.

JAZZ: JAZZ is specifically tailored toward stations that play mostly instrumental music. It is a quiet preset with a very clean, mellow high end to prevent stridency on the saxophone solos so often heard in "light jazz" programming. The preset produces very low listening fatigue, so it is a good choice for stations that want listeners to stay all day.

NEWS-TALK: This preset is quite different from the others. It is based on the FAST multiband release time setting, so it can quickly perform automatic equalization of substandard program material, including telephone. It is very useful for creating a uniform, intelligible sound from widely varying source material, particularly source material that is "hot from the field" with uncontrolled quality. It extensively exploits distortion control to achieve a very clean, highly compressed, but unclipped sound quality.

OLDIES: OLDIES is loud and "hi-fi"-sounding, while still respecting the limitations and basic flavor of the recordings from the era of the 1950s through 1970s.

> For example, we do not attempt to exaggerate high frequency energy in the OLDIES preset. The highs in recordings of this era are often noisy, distorted, or have other technical problems that make them unpleasant sounding when the processor over-equalizes them in an attempt to emulate the high frequency balance of recently recorded material.

SPORTS: Similar to NEWS-TALK except the AGC RELEASE (AGC Release Time) is slower and the GATE THRESH (Gate Threshold) is higher. This recognizes that most sports programming has very low signal-to-noise ratio due to crowd noise and other on-field sounds, so the preset does not pump this up as the NEWS-TALK preset would tend to do.

ROCK: There are several ROCK presets:

ROCK-LOUD is very bright and present, with up-front vocals. Release time is medium.

> In order to get the punchiest and loudest sound, beyond LESS-MORE=7.0 we progressively reduce the protection provided by the distortion-controlling mechanism. So LESS-MORE settings beyond 7.0 are progressively more risky and can exhibit audible distortion (as can competing products!). Speech will nevertheless be cleaner than with competing products and the bass is never permitted to "shut down" the main clipper on bass waveform peaks.

ROCK-GENERAL provides a bright high end and punchy low end (although not as exaggerated as URBAN). A midrange boost provides enough presence energy to ensure that vocals stand out. A modest amount of high frequency coupling (determined by the BAND CLIPPING 3>4 setting) allows reasonable amounts of automatic HF equalization (to correct dull program material), while still preventing exaggerated frequency balances and excessive HF density.

The ROCK-MEDIUM and ROCK-OPEN variations refer to the compression density, which is determined by the release time settings in the AGC and multiband limiter sections.

These three presets are appropriate for general rock and contemporary programming. All of these presets have distortion control implemented at their nominal levels of LESS-MORE to ensure clean speech. At high LESS-MORE levels the distortion control may be relaxed somewhat to increase bass punch.

There are also several more ROCK presets that are intended for gentler formats:

ROCK-LIGHT has an open sound with little audible compression and less brightness than the first three presets. It is a compromise between ROCK-OPEN and ROCK-SOFT.

ROCK-SOFT has a mellow, easy-to-listen-to high frequency quality that is designed for female-skewing formats. It is also a candidate for "Quiet Storm" and "Love Songs" light rock or smooth jazz formats.

ROCK-SMOOTH has the same mellow, easy-to-listen-to high frequency quality as ROCK-SOFT, but with more density. Again, it is a good choice for female-skewing formats, but where you need more compression and density than you get with ROCK-SOFT.

For Contemporary Hit Radio (CHR) we recommend BASS-PUNCH, ROCK-LOUD, URBAN-LOUD or EXTREME. However, the "rock" presets are noticeably cleaner, and are therefore more likely to encourage longer times spent listening than are these "loud" presets.

For Album-Oriented Rock (AOR) we recommend the ROCK-LOUD or BASS-SLAM with LESS-MORE turned down somewhat (depending on your market and competitive situation). A LESS-MORE setting of 5.0 will yield reasonable loudness along with very clean sound.

URBAN-LOUD was derived by modifying ROCK-LOUD. URBAN LOUD is tuned for the maximum amount of bass we could add without creating obvious distortion on some program material.

> This amount of bass may be excessive with certain consumer radios (particularly "boom-boxes") that already have substantial bass boost. Use it with care.

URBAN: This is identical to URBAN-LOUD but with a lower LESS-MORE setting.

Equalizer Controls

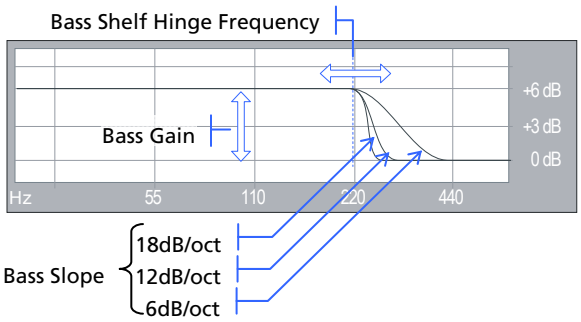
Table 3-2 summarizes the equalization controls available for the Five-Band structure. (Note that "advanced" controls are accessible only from 5500i PC Remote software.)

Most equalization controls are common to both the Two-Band and Five-Band structures. The equalizer is located between the AGC and multiband compressor sections of both structures.

Any equalization that you set will be automatically stored in any User Preset that you create and save. For example, you can use a User Preset to combine an unmodified Factory Programming Preset with your custom equalization. Of course, you can also modify the Factory Preset (with Basic Modify, Full Modify, or Advanced Modify) before you create your User Preset.

In general, you should be conservative when equalizing modern, well-recorded program material.

Except for BASS GAIN, most of the factory presets use less than 3 dB of equalization.



Bass Shelf Controls, the Five-Band structure's low bass equalization controls are designed to add punch and slam to rock and urban music. They provide a parametric shelving equalizer with control over gain, hinge frequency, and slope (in dB/octave).

BASS FREQ sets the frequency where shelving starts to take effect.

BASS GAIN sets the amount of bass boost (dB) at the top of the shelf.

BASS SLOPE sets the slope (dB/octave) of the transition between the top and bottom of the shelf.

Because the Five-Band structure often increases the brightness of program material, some bass boost is usually desirable to keep the sound spectrally well balanced. Adjustment of bass equalization must be determined by individual taste and by the requirements of your format. Be sure to listen on a wide variety of radios — it is possi-

ble to create severe distortion on poor quality speakers by over-equalizing the bass. Be careful!

The moderate-slope (12 dB/octave) shelving boost achieves a bass boost that is more audible on smaller radios, but which can sound boomier on high-quality receivers. The steep-slope (18 dB/octave) shelving boost creates a solid, punchy bass from the better consumer radios with decent bass response. The 6 dB/octave shelving boost is like a conventional tone control and creates the most mid-bass boost, yielding a "warmer" sound. Because it affects the mid-bass frequency range, where the ear is more sensitive than it is to very low bass, the 6 dB/octave slope can create more apparent bass level at the cost of bass "punch."

There are no easy choices here; you must choose the characteristic you want by identifying your target audience and the receivers they are most likely to be using. Regardless of which curve you use, we recommend a +2 to +5 dB boost for most formats. Larger amounts of boost will increase the gain reduction in the lowest band of the multiband compressor, which may have the effect of reducing some frequencies. So be aware the large fixed bass boosts may have a different effect than you expect

Equalizer Controls

Group	Basic/ Full Modify Name	Advanced Name	Range
Bass Shelf	BASS FREQ	Bass Frequency	80, 85, 90, 95, 100, 105, 110, 115, 120, 125, 130, 135, 140, 145, 150, 160, 170, 180, 190, 200, 210, 220, 230, 240, 250, 270, 290, 310, 330, 350, 380, 410, 440, 470, 500Hz
	BASS GAIN	Bass Gain	0 … 12 dB
	BASS SLOPE	Bass Slope	6,12,18 dB/Oct
Low	LF FREQ	Low Frequency	20 ... 500 Hz
	LF GAIN	Low Gain	–10.0 … +10.0 dB
	LF WIDT	Low Width	0.8 ... 4 octaves
Mid	MID FREQ	Mid Frequency	250 ... 6000 Hz
	MID GAIN	Mid Gain	–10.0 … +10.0 dB
	MID WIDTH	Mid Width	0.8 ... 4 octaves
High	HIGH FREQ	High Frequency	1.0 … 15.0 kHz
	HIGH GAIN	High Gain	–10.0 … +10.0 dB
	HIGH WIDTH	High Width	0.8 ... 4 octaves
Brilliance	BRILLNCE	Brilliance	0.0 … +6.0 dB
HF Enhancer	HF ENH	High Frequency Enhancer	0 … 15
DJ Bass	DJ BASS	DJ Bass Boost	Off, 1… +10 dB
30HZ HPF	30HZ HPF	30 Hz High Pass Filter	Off/On
Phase Rotate	PH-ROTATE	Phase Rotator	Out/In

Table 3-2: Five-Band Equalization Controls

because of the way that they interact with the multiband compressor.

Low Frequency Parametric Equalizer is a specially designed parametric equalizer whose boost and cut curves closely emulate those of a classic Orban analog parametric equalizer with conventional bell-shaped curves (within ±0.15 dB worst-case). This provides warm, smooth, "analog-sounding" equalization.

> **LF FREQ** determines the center frequency of the equalization, in Hertz. Range is 20-500Hz.
>
> **LF GAIN** determines the amount of peak boost or cut (in dB) over a ±10 dB range.
>
> **LF WIDTH** determines the bandwidth of the equalization, in octaves. The range is 0.8-4.0 octaves. If you are unfamiliar with using a parametric equalizer, 1.5 octaves is a good starting point. These curves are relatively broad because they are designed to provide overall tonal coloration, rather than to notch out small areas of the spectrum.

The LF parametric can be used in the mid-bass region (100-300Hz) to add "warmth" and "mellowness" to the sound when boosting. When cutting, it can remove a "woody" or "boxy" sound. In our presets, we tend to use it very sparingly (in the order of 1 dB boost) to add a bit of extra bass warmth.

One formula for producing a very "big" bass sound on the air is to use a peaking boost at 100Hz in combination with a Bass Shelf boost at 6 dB/octave.

The equalizer, like the classic Orban analog parametrics such as the 622B, has constant "Q" curves. This means that the cut curves are narrower than the boost curves. The width (in octaves) is calibrated with reference to 10 dB boost. As you decrease the amount of EQ gain (or start to cut), the width in octaves will decrease. However, the "Q" will stay constant.

"Q" is a mathematical parameter that relates to how fast ringing damps out. (Technically, we are referring to the "Q" of the poles of the equalizer transfer function, which does not change as you adjust the amount of boost or cut.)

The curves in the 5500i's equalizer were created by a so-called "minimax" ("minimize the maximum error," or "equal-ripple") IIR digital approximation to the curves provided by the Orban 622B analog parametric equalizer. Therefore, unlike less sophisticated digital equalizers that use the "bilinear transformation" to generate EQ curves, the shapes of the 5500i's curves are not distorted at high frequencies.

Midrange Parametric Equalizer is a parametric equalizer whose boost and cut curves closely emulate those of an analog parametric equalizer with conventional bell-shaped curves.

> **MID FREQ** determines the center frequency of the equalization, in Hertz. Range is 250-6000Hz.
>
> **MID GAIN** determines the amount of peak boost or cut (in dB) over a ±10 dB range.

MID WIDTH determines the bandwidth of the equalization, in octaves. The range is 0.8-4.0 octaves. If you are unfamiliar with using a parametric equalizer, 1 octave is a good starting point.

The audible effect of the midrange equalizer is closely associated with the amount of gain reduction in the midrange bands. With small amounts of gain reduction, it boosts power in the presence region. This can increase the loudness of such material substantially. As you increase the gain reduction in the midrange bands (by turning the MULTIBAND DRIVE (Multiband Drive) control up), the MID GAIN control will have progressively less audible effect. The compressor for the midrange bands will tend to reduce the effect of the Mid frequency boost (in an attempt to keep the gain constant) to prevent excessive stridency in program material that already has a great deal of presence power. Therefore, with large amounts of gain reduction, the density of presence region energy will be increased more than will the level of energy in that region. Because the 3.7 kHz band compressor is partially coupled to the gain reduction in the 6.2 kHz band in most presets, tuning MID FREQ to 2-4 kHz and turning up the MID GAIN control will decrease energy in the 6.2 kHz band — you will be increasing the gain reduction in both the 3.7 kHz and 6.2 kHz bands. You may wish to compensate for this effect by turning up the BRILLIANCE control.

Use the mid frequency equalizer with caution. Excessive presence boost tends to be audibly strident and fatiguing. Moreover, the sound quality, although loud, can be very irritating. We suggest a maximum of 3 dB boost, although 10 dB is achievable. In some of our factory presets, we use 3 dB boost at 2.6 kHz to bring vocals more upfront.

High Frequency Parametric Equalizer is a parametric equalizer whose boost and cut curves closely emulate those of an analog parametric equalizer with conventional bell-shaped curves.

HIGH FREQ determines the center frequency of the equalization, in Hertz. The range is 1-15 kHz

HIGH GAIN determines the amount of peak boost or cut over a ±10 dB range.

HIGH WIDTH determines the bandwidth of the equalization, in octaves. The range is 0.8-4.0 octaves. If you are unfamiliar with using a parametric equalizer, one octave is a good starting point.

Excessive high frequency boost can exaggerate tape hiss and distortion in program material that is less than perfectly clean. We suggest no more than 4 dB boost as a practical maximum, unless source material is primarily from compact discs of recently recorded material. In several of our presets, we use this equalizer to boost the upper presence band (4.4 kHz) slightly, leaving broadband HF boost to the BRILLIANCE and/or HF ENHANCE controls.

BRILLNCE ("Brilliance") controls the drive to Band 5. The high frequency limiter and Band 5 clipper dynamically control these boosts, protecting the final clipper from excessive HF drive. We recommend a maximum of 4 dB of BRILLNCE boost, and most people will prefer substantially less.

DJ BASS ("DJ Bass Boost") control determines the amount of bass boost produced on some male voices. In its default OFF position, it causes the gain reduction of the lowest frequency band to move quickly to the same gain reduction as its nearest neighbor when gated. This fights any tendency of the lowest frequency band to develop significantly more gain than its neighbor when processing voice because voice will activate the gate frequently. Each time it does so, it will reset the gain of the lowest frequency band so that the gains of the two bottom bands are equal and the response in this frequency range is flat. The result is natural-sounding bass on male voice.

If you like a larger-than-life, "chesty" sound on male voice, set this control away from OFF. When so set, gating causes the gain reduction of the lowest frequency band to move to the same gain reduction (minus a gain offset equal to the numerical setting of the control) as its nearest neighbor when gated. You can therefore set the maximum gain difference between the two low frequency bands, producing considerable dynamic bass boost on voice.

The difference will never exceed the difference that would have otherwise occurred if the lowest frequency band was independently gated. If you are familiar with older Orban processors like the 8200, this is the maximum amount of boost that would have occurred if you had set their DJ BASS BOOST controls to ON.

The amount of bass boost will be highly dependent on the fundamental frequency of a given voice. If the fundamental frequency is far above 100Hz, there will be little voice energy in the bottom band and little or no audio bass boost can occur even if the gain of the bottom band is higher than the gain of its neighbor. As the fundamental frequency moves lower, more of this energy leaks into the bottom band, and you hear more bass boost. If the fundamental frequency is very low (a rarity), there will be enough energy in the bottom band to force significant gain reduction, and you will hear less bass boost than if the fundamental frequency were a bit higher.

> This control is only available in the Five-Band structure.
>
> If the GATE THRESH (Gate Threshold) control is turned OFF, the DJ BASS boost setting is disabled.

HF ENH ("High Frequency Enhancer") is a program-adaptive 6 dB/octave shelving equalizer with a 4 kHz turnover frequency. It constantly monitors the ratio between high frequency and broadband energy and adjusts the amount of equalization in an attempt to make this ratio constant as the program material changes. It can therefore create a bright, present sound without over-equalizing material that is already bright.

30HZ HPF ("30 Hz High Pass Filter") determines if a 30Hz 18 dB/octave highpass filter is placed in-circuit before other processing. Although not a stereo enhancer control, it is found on the stereo enhancer page (for convenience) because, like the stereo enhancer, it can be adjusted without eliminating LESS-MORE functionality.

PH-ROTATE ("Phase Rotator") is not a stereo enhancer control. It determines if the phase rotator will be in-circuit. The purpose of the phase rotator is to make voice waveforms more symmetrical. This can substantially reduce distortion when they are peak limited by the 5500i's back end processing.

In most cases, we recommend that the phase rotator be left active. However, because it can slightly reduce the clarity and definition of program material, you can defeat it if you are operating the 5500i conservatively and not attempting to achieve very high on-air loudness.

You have somewhat more leeway than you do in older Orban FM processors like the 8200 because the 5500i's new distortion control will work to help prevent audible speech distortion even when the phase rotator is switched out.

Stereo Enhancer Controls

Stereo Enhancer Controls		
Basic/Full Modify Name	**Advanced Name**	**Range**
ENH AMT	Stereo Enhancer Amount	0.0 ... 10.0
RATIO LMT	L–R/L+R Ratio Limit	70 … 100%

Table 3-3: Stereo Enhancer Controls

The stereo enhancer emulates the Orban 222 analog stereo enhancer. The enhancer has gating that operates under two conditions.

- The two stereo channels are close to identical in magnitude and phase.

  In this case, the enhancer assumes that the program material is actually mono and suppresses enhancement to prevent the enhancement from exaggerating the undesired channel imbalance.

- The ratio of L–R/L+R of the enhanced signal tries to exceed the threshold set by the L-R/L+R Ratio Limit control.

  In this case, the enhancer prevents further enhancement in order to prevent excess L–R energy, which can increase multipath distortion.

The stereo enhancer has the following controls. Note that "advanced" controls are accessible only from 5500i PC Remote software.

ENH AMT sets the maximum spatial enhancement. When set to OUT, it bypasses the stereo enhancer.

RATIO LMT ("L–R/L+R Ratio Limit") sets the maximum amount of enhancement to prevent multipath distortion. However, if the original program material exceeds this limit with no enhancement, the enhancer will not reduce it.

AGC Controls

The AGC is common to the Two-Band and Five-Band structures.

Five of the AGC controls are common to the Full Modify and Advanced Modify screens, with additional AGC controls available in the Advance Modify screen, as noted in the following table. (Note that "advanced" controls are accessible only from 5500i PC Remote software.)

These controls are explained in detail below.

Each Factory Preset has a LESS-MORE control that adjusts on-air loudness by altering the amount of processing. LESS-MORE simultaneously adjusts all of the processing controls to optimize the trade-offs between unwanted side effects.

If you wish, you may adjust the Advanced Modify parameters to your own taste. Always start with LESS-MORE to get as close to your desired sound as possible. Then edit the Advanced Modify parameters using the Advanced Modify screen, and save those edits to a User Preset.

AGC ("AGC Off/On")control activates or defeats the AGC.

AGC Controls		
Full Modify Name	**Advanced Name**	**Range**
AGC	AGC Off/On	Off/On
AGC DRIVE	AGC Drive	–10 ... 25 dB
AGC REL	AGC Master Release	0.5, 1.0, 1.5, 2 … 20 dB/s
AGC GATE	AGC Gate Threshold	Off, –44 ... –15 dB
AGC B CPL	AGC Bass Coupling	Off, –12…0 dB
AGC METR	AGC Meter Display	Master, Delta
---	AGC Maximum Delta Gain Reduction	0 … 24 dB, Off
---	AGC Window Size	–25 … 0 dB
---	AGC Window Release	0.5 … 20 dB
---	AGC Matrix	L/R, sum/difference
---	AGC Ratio	∞1, 4:1, 3:1, 2:1
---	AGC Bass Threshold	–12.0 … 2.5 dB
---	AGC Idle Gain	–10 … +10 dB
---	AGC Bass Attack	1 … 10
---	AGC Master Attack	0.2 … 6
---	AGC Bass Release	1 … 10 dB/sec
---	AGC Master Delta Threshold	–6 … +6 dB
---	AGC Bass Delta Threshold	–6 … +6 dB
---	AGC Crossover	Allpass, LinearNoDelay, Linear

Table 3-4: AGC Controls

It is usually used to defeat the AGC when you want to create a preset with minimal processing (such as a CLASSICAL preset). The AGC is also ordinarily defeated if you are using a studio level controller (like Orban's 8200ST). However, in this case it is better to defeat the AGC globally in System Setup.

AGC DRIVE control adjusts signal level going into the slow dual-band AGC, and therefore determines the amount of gain reduction in the AGC. This also adjusts the "idle gain" — the amount of gain reduction in the AGC section when the structure is gated. (It gates whenever the input level to the structure is below the threshold of gating.)

The total amount of gain reduction in the Five-Band structure is the sum of the gain reduction in the AGC and the gain reduction in the multiband compressor. The total system gain reduction determines how much the loudness of quiet passages will be increased (and, therefore, how consistent overall loudness will be). It is determined by the setting of the AGC DRIVE control, by the level at which the console VU meter or PPM is peaked, and by the setting of the MULTIBAND DRIVE (compressor) control.

AGC REL ("AGC Master Release") control provides an adjustable range from 0.5 dB/second (slow) to 20 dB/second (fast). The increase in density caused by setting the AGC RELEASE control to fast settings sounds different from the increase in density caused by setting the Multiband's MULTIBAND RELEASE control to FAST, and you can trade the two off to produce different effects.

Unless it is purposely speeded-up (with the AGC RELEASE control), the automatic gain control (AGC) that occurs in the AGC prior to the multiband compressor makes audio levels more consistent without significantly altering texture. Then the multi-band compression and associated multiband clipper audibly change the density of the sound and dynamically re-equalize it as necessary (booming bass is tightened; weak, thin bass is brought up; highs are always present and consistent in level).

The various combinations of AGC and compression offer great flexibility:

- Light AGC + light compression yields a wide sense of dynamics, with a small amount of automatic re-equalization.
- Moderate AGC + light compression produces an open, natural quality with automatic re-equalization and increased consistency of frequency balance.
- Moderate AGC + moderate compression gives a more dense sound, particularly as the release time of the multiband compressor is sped up.
- Moderate AGC + heavy compression (particularly with a FAST multiband release time) results in a "wall of sound" effect, which may cause listener fatigue.
- Adjust the AGC (with the AGC DRIVE control) to produce the desired amount of AGC action, and then fine-tune the compression and clipping with the Five-Band structure's controls.

AGC GATE ("AGC Gate Threshold") control determines the lowest input level that will be recognized as program by OPTIMOD-FM; lower levels are considered to be

noise or background sounds and cause the AGC or multiband compressor to gate, effectively freezing gain to prevent noise breathing.

There are two independent gating circuits in the 5500i. The first affects the **AGC** and the second affects the **multiband compressor**. Each has its own threshold control.

The multiband compressor gate causes the gain reduction in bands 2 and 3 of the multiband compressor to quickly move to the average gain reduction occurring in those bands when the gate first turns on. This prevents obvious midrange coloration under gated conditions, because bands 2 and 3 have the same gain.

The gate also independently freezes the gain of the two highest frequency bands (forcing the gain of the highest frequency band to be identical to its lower neighbor), and independently sets the gain of the lowest frequency band according to the setting of the DJ BASS boost control (in the Equalization screen). Thus, without introducing obvious coloration, the gating smoothly preserves the average overall frequency response "tilt" of the multiband compressor, broadly maintaining the "automatic equalization" curve it generates for a given piece of program material.

> If the MB GATE THR (Gate Threshold) control is turned OFF, the DJ BASS control is disabled.

AGC B CPL ("AGC Bass Coupling") control clamps the amount of dynamic bass boost (in units of dB) that the AGC can provide. (In V1.0, the unit of measure was percent.)

The AGC processes audio in a master band for all audio above approximately 200 Hz and a bass band for audio below approximately 200 Hz. Starting with V1.1 software, the AGC Master and Bass compressor sidechains operate without internal coupling. The gain reduction in the Bass audio path is either the output of the Bass compressor sidechain or the output of the Master band sidechain. The AGC BASS COUPLING control sets the switching threshold. For example, if the AGC BASS COUPLING control is set to 4 dB and the master gain reduction is 10 dB, the bass gain reduction cannot decrease below 6 dB even if the gain reduction signal from the Bass compressor sidechain is lower. However, the audio path bass gain reduction can be larger than the master gain reduction without limit. In the previous example, the bass gain reduction could be 25 dB

The normal setting of the AGC BASS COUPLING control is 0 dB, which allows the AGC bass band to correct excessive bass as necessary but does not permit it to provide a dynamic bass boost.

Note that the operation of this control was changed in 5500i V1.1 software to work as explained above. You may have to tweak this control to achieve the same bass balance that you had previously with V1.0 software.

AGC METR ("AGC Meter Display") determines what signal the front-panel AGC meter displays. MASTER displays the gain reduction of the Master (above-200 Hz) band. DELTA displays the difference between the gain reduction in the Master and Bass bands. Full-scale is 25 dB gain reduction.

Although it is located in the Full Modify screen (to make it easy for a preset developer to switch meter modes), this control is *not* part of the active preset and its setting is not saved in User Presets, unlike the other controls in the Full Modify screens. The meter mode always reverts to MASTER when the user leaves Full Modify.

Advanced AGC Controls

The following AGC controls are available only in the 5500i PC Remote software.

AGC Maximum Delta Gain Reduction determines the maximum gain difference permitted between the two channels of the AGC. Set it to "0" for perfect stereo coupling.

This control works the same regardless of whether the AGC operates in left/right or sum/difference MATRIX modes, in both cases controlling the maximum gain difference between the "channels." Depending on the MATRIX mode setting, the "channels" will handle left and right signals or will handle sum and difference signals. When the AGC operates in sum/difference MATRIX mode, this control determines the maximum amount of width change in the stereo sound field.

AGC Window Size determines the size of the "target zone" window in the AGC. If the input level falls within this target zone, the AGC release time is set to the number specified by the AGC WINDOW RELEASE control. This is usually much slower than the normal AGC release, and essentially freezes the AGC gain. This prevents the AGC from building up density in material whose level is already well controlled. If the level goes outside the window, then the AGC switches to the release rate specified by AGC MASTER RELEASE, so the AGC can still correct large gain variations quickly.

The normal setting for the AGC WINDOW SIZE is 3 dB.

AGC Window Release (see AGC WINDOW SIZE above.)

AGC Matrix allows you to operate the AGC in left/right mode, or in sum/difference mode. Usually you will operate in left/right mode. However, sum/difference mode can give a type of stereo enhancement that is different from the enhancement modes offered in the 5500i's built-in stereo enhancer. This will only work if you allow the two channels of the AGC to have different gains. To do this, set the AGC MAXIMUM DELTA GAIN REDUCTION control greater than zero.

It is unwise to set this control beyond 3 dB. Multipath distortion could increase because the amount of L–R energy builds up excessively. We prefer using the 5500i's stereo enhancer because its built-in gating circuits prevent over-enhancement.

AGC Ratio determines the compression ratio of the AGC. The compression ratio is the ratio between the change in input level and the resulting change in output level, both measured in units of dB.

Previous Orban AGCs had compression ratios very close to ∞:1, which produces the most consistent and uniform sound. However, the 5500i compressor can reduce this

ratio to as low as 2:1. This can add a sense of dynamic range and is mostly useful for subtle formats like classical and jazz.

AGC Bass Threshold determines the compression threshold of the bass band in the AGC. It can be used to set the target spectral balance of the AGC.

As the AGC B CPL control is moved towards "100%," the AGC BASS THRESHOLD control affects the sound less and less.

The interaction between the AGC BASS THRESHOLD control and the AGC B CPL control is a bit complex, so we recommend leaving the AGC BASS THRESHOLD control at its factory setting unless you have a good reason for readjusting it.

AGC Idle Gain. The "idle gain" is the target gain of the AGC when the silence gate is active. Whenever the silence gate turns on, the gain of the AGC slowly moves towards the idle gain.

The idle gain is primarily determined by the AGC DRIVE setting — a setting of 10 dB will ordinarily produce an idle gain of –10 dB (i.e., 10 dB of gain reduction). However, sometimes you may not want the idle gain to be the same as the AGC DRIVE setting. The AGC IDLE GAIN control allows you to add or subtract gain from the idle gain setting determined by the AGC DRIVE setting.

You might want to do this if you make a custom preset that otherwise causes the gain to increase or decrease unnaturally when the AGC is gated.

For example, to make the idle gain track the setting of the AGC DRIVE control, set the AGC IDLE GAIN control to zero. To make the idle gain 2 dB lower than the setting of the AGC DRIVE control, set the AGC IDLE GAIN control to –2.

AGC Bass Attack sets the attack time of the AGC bass compressor (below 200Hz).

AGC Master Attack sets the attack time of the AGC master compressor (above 200Hz).

AGC Bass Release sets the release time of the AGC bass compressor.

AGC Master Delta Threshold allows you to set the difference between the compression thresholds of the sum and difference channels. (This control is only useful when you set the AGC MATRIX to SUM/DIFFERENCE.) If you set the threshold of the difference channel lower than the sum channel, the AGC will automatically produce more gain reduction in the difference channel. This will reduce the separation of material with an excessively wide stereo image (like old Beatles records). To make this work, you must set the AGC MAXIMUM DELTA GAIN REDUCTION control away from zero. For example, to limit an excessively wide image while preventing more than 3 dB difference in gain between the sum and difference channels, set the AGC MAXIMUM DELTA GAIN REDUCTION control to 3.0 and the AGC MASTER DELTA THRESHOLD control to some positive number, depending on how much automatic width control you want the 5500i to perform.

AGC Bass Delta Threshold works the same as AGC MASTER DELTA THRESHOLD, but applies to the bass band. You will usually set it the same as AGC MASTER DELTA THRESHOLD.

AGC Crossover allows you to choose ALLPASS, LINEARNODELAY, or LINEAR modes.

ALLPASS is a phase-rotating crossover like the one used in the 8200's two-band AGC. It introduces one pole of phase rotation at 200 Hz. The overall frequency response remains smooth as the two bands take different degrees of gain reduction — the response is a smooth shelf without extra peaks or dips around the crossover frequency. The two bands are down 3 dB at the crossover frequency.

All Five-Band factory presets automatically use ALLPASS because of its smooth, shelving behavior and low delay. Its allpass characteristic complements the existing phase rotator that reduces voice distortion. Because the Five-Band structure uses phase-rotating crossovers in the five-band compressor/limiter, there is little or nothing to be gained by using a phase-linear crossover in the Five-Band structure's AGC.

LINEARNODELAY (Linear-Phase; no delay) is a phase-linear crossover whose upper band is derived by subtracting its lower band from the crossover's input. When the upper and lower bands have the same gain, their sum is perfectly flat with no phase rotation. However, when the upper and lower bands have different gains, peaks and dips appear in the frequency response close to the crossover frequency.

LINEARNODELAY is available in Two-Band presets only. It is useful if you need a crossover with low delay and no phase distortion when flat. Its downside is the possibility of coloration when the gains of the two bands are widely disparate.

LINEAR is a phase-linear crossover whose upper band is derived by subtracting its lower band from the crossover's input, as passed through a delay equal to the group delay of the lowpass crossover filter. The overall frequency response remains smooth as the two bands take different degrees of gain reduction — the response is a smooth shelf without extra peaks or dips around the crossover frequency. The two bands are each down 6 dB at the crossover frequency. This crossover has constant delay even when the two bands have unequal gains.

LINEAR is available for Two-Band presets only. While it has the ideal combination of no phase distortion (even when non-flat) and smooth shelving behavior, it adds about 4 ms to the overall delay (compared to ALLPASS and LINEARNODELAY), so it is not a good choice if you need to drive talent headphones.

Clipper Controls

The clipper controls are common to the Two-Band and Five-Band structures, except as noted in the control descriptions on the following pages.

All of the clipper controls are common to the Full Modify and Advanced Modify, except OVERSHOOT COMPENSATOR DRIVE, which is only available in the Advanced Modify

screen. (Note that "advanced" controls are accessible only from 5500i PC Remote software.)

Bass Clip ("Bass Clip Threshold") sets the threshold of Orban's patented embedded bass clipper with reference to the final clipper. The bass clipper is embedded in the multiband crossover so that any distortion created by clipping is rolled off by part of the crossover filters. The threshold of this clipper is usually set between 2 dB and 5 dB below the threshold of the final limiter in the processing chain, depending on the setting of the LESS-MORE control in the parent preset on which you are basing your Modify adjustments. This provides headroom for contributions from the other three bands, so that bass transients don't smash against the back-end clipping system, causing overt intermodulation distortion between the bass and higher frequency program material.

Some 5500i users feel that the bass clipper unnecessarily reduces bass punch at its factory settings. Therefore, we made the threshold of the bass clipper user-adjustable. The range (with reference to the final clipper threshold) is 0 to –6 dB. As you raise the threshold of the clipper, you will get more bass but also more distortion and pumping. Be careful when setting this control; do not adjust it casually. Listen to program material with heavy bass combined with spectrally sparse midrange material (like a singer accompanied by a bass guitar) and listen for IM distortion induced by the bass' pushing the midrange into the clipping system. In general, unless you have a very good reason to set the control elsewhere, we recommend leaving it at the factory settings, which were determined following extensive listening tests with many types of critical program material.

In the Five-Band structure, the clipper is located after bands 1 and 2 are summed. In the Two-Band structure, the clipper is located after the Bass band.

Speech Bass Clip set the threshold of the bass clipper when the 5500i detects the presence of speech. It is usually set to "0" to prevent the bass clipper from adding distortion on speech.

CLIP SHAPE ("Bass Clip Shape") allows you to change shape of the knee of the input/output gain curve of the bass clipper. The "knee" is the transition between no clipping and flat topping. A setting of "0" provides the hardest knee. "10" is the softest knee, where the transition starts 6 dB below BASS CLIP THRESHOLD setting and

Clipper Controls		
Full Modify Name	**Advanced Name**	**Range**
---	Overshoot Compensator Drive	–2.0 … +2.0
BASS CLIP	Bass Clip Threshold	–6.0 … 0.00
	Bass Clip Shape	0 … 10
FINAL CLIP	Final Clip Drive	–3.0 … +5.0
COMP DRV	Composite Limiter Drive	Off, 0 ... 3 dB
	Speech Bass Clip	–6.0 … 0.00
MPX LIMIT MODE	MPX Limiter Mode	Hard, HalfCos

Table 3-5: Clipper Controls

occurs gradually. The factory default setting is "7.6."

FINAL CLIP ("Final Clip Drive") adjusts the level of the audio driving the back end clipping system that OPTIMOD-FM uses to control fast peaks. This control primarily determines the loudness/distortion trade-off.

Turning up the FINAL CLIP control drives the final clipper and overshoot compensator harder, reducing the peak-to-average ratio, and increasing the loudness on the air. When the amount of clipping is increased, the audible distortion caused by clipping also increases. Although lower settings of the FINAL CLIP control reduce loudness, they make the sound cleaner.

If the RELEASE control is set to its faster settings, the distortion produced by the back-end clipping system will increase as the MULTIBAND DRIVE control is advanced. The FINAL CLIP DRIVE and/or the MULTIBAND LIMIT THRESHOLD controls may have to be turned down to compensate. To best understand how to make loudness/distortion trade-offs, perhaps the wisest thing to do is to recall a factory multiband preset, and then to adjust the LESS-MORE control to several settings throughout its range. At each setting of the LESS-MORE control, examine the settings of the MULTIBAND DRIVE and MULTIBAND LIMIT THRESHOLD controls. This way, you can see how the factory programmers made the trade-offs between the settings of the various distortion-determining controls at various levels of processing.

> The 5500i's multiband clipping and distortion control system works to help prevent audible distortion in the final clipper. As factory programmers, we prefer to adjust the FINAL CLIP control through a very narrow range (typically –0.5 dB to –1.0 dB) and to determine almost all of the loudness/distortion trade-off by the setting of the Multiband Clipping control.
>
> The final clipper operates at 256 kHz sample rate and is fully anti-aliased.

COMP DRV ("Composite Limiter Drive") sets the drive level, in dB, into the 5500i's composite limiter.

This control has no effect on the 5500i's left and right analog or digital outputs.

> The COMP DRV control is set to "0 dB" for most factory presets. At this setting, it removes a few tenths of a dB of residual overshoot from the audio processing without affecting audio quality. We prefer to use the audio-domain overshoot compensation to do most of the work because it operates at a 256 kHz sample rate and is fully anti-aliased, whereas the composite limiter will inevitably introduce aliasing around 38 kHz upon demodulation in the receiver. This is because it introduces spectrum in the stereo subchannel area when it clips material in the 0 to 15 kHz area. The receiver will "see" this as stereo material, and will demodulate it as if it were part of the stereo subchannel. Accordingly, harmonics of L+R material will be frequency-shifted upon demodulation, and will no longer bear a harmonic relationship to the material that produced them. Mathematically, these harmonics will be located at the same frequencies as harmonics caused by clipping in a simple digital-domain clipper (with no anti-aliasing) operating at 38 kHz sample rate.
>
> If you want to use the composite limiter more heavily, one option is to trade off composite limiting against left/right domain overshoot com-

pensation. To do this, reduce the OVERSHOOT COMPENSATOR DRIVE control and increase the COMP DRV control setting proportionately. (The OVERSHOOT COMPENSATOR DRIVE control is accessible only from the 5500i PC Remote software.)

MPX LIMIT MODE ("Multiplex Limiter Mode") sets the composite limiter to operate in either hard-clip or Half-Cosine Interpolation modes.

- When operating as a hard clipper, the composite limiter will produce maximum brightness in the frequency range from 5 kHz to 15 kHz because, unlike left/right audio-domain clippers, it can produce square waves in this frequency range. The downside compared to Half-Cosine mode is that it can noticeably compromise stereo imaging.
- When operating in Half-Cosine mode, the composite limiter produces somewhat less brightness but does not compromise stereo imaging. Because this mode produces lower subjective distortion, Orban's factory programmers prefer the sound of the Half-Cosine mode.

In either mode, the baseband output is overshoot compensated and bandlimited to 53 kHz, unlike conventional composite clippers.

Overshoot Compensator Drive sets the drive level into the overshoot compensator with reference to the final clip threshold, in units of dB. The normal setting is "0 dB."

The overshoot compensator can produce audible distortion on material with strong high frequency content (like bell trees), and this control lets you trade off this distortion against loudness. (Such material can cause strong overshoots, forcing the overshoot compensator to work hard to eliminate them.) We do not recommend operating this control above "0" because this would reduce the effectiveness of the distortion cancellation used in earlier processing. However, you can reduce it below "0" if you value the last bit of high frequency cleanliness over loudness.

The overshoot compensator works at 256 kHz sample rate and is fully anti-aliased.

MPX POWER OFFSET operates only when the ITU-412 multiplex power controller is active (and is thus irrelevant to users in countries that do not enforce this standard). See *ITU-R Multiplex Power Controller* on page 3-55. The control introduces a fixed loss before the FM analog peak limiting chain. If the MULTIPLEX POWER THRESHOLD control (in the INPUT/OUTPUT > UTILITIES screen) is set to 0, the MPX POWER OFFSET control produces the same amount of loss (in dB) as this control's setting. Resetting the MULTIPLEX POWER THRESHOLD control away from 0 will change the loss. (For example, setting the MULTIPLEX POWER THRESHOLD control to +3 will cause the loss to decrease by 3 dB.)

The MULTIPLEX POWER THRESHOLD control can only introduce loss, never gain.

Regardless of the setting of the MULTIPLEX POWER THRESHOLD and MPX POWER OFFSET controls, the resulting gain offset can never be larger than 0 dB.

The MPX POWER OFFSET control's purpose is to reduce unnatural loudness variations that the multiplex power controller might produce. These can occur because the ITU specification does not call for psychoacoustic weighting. The Optimod does not force the multiplex power controller to dynamically produce all of the required gain reduction (which could vary widely, depending on the program material). Instead, the MPX POWER OFFSET control produces most of the gain reduction. The gain reduction produced by the control is, of course, unchanging and cannot introduce audible artifacts.

The ideal dynamic gain reduction for the multiplex power controller is 2 to 3 dB with typical program material. However, the actual gain reduction will vary widely depending on whether the underlying processing preset is "loud" or "quiet." Therefore, the appropriate setting of the MPX POWER OFFSET control depends strongly on what preset is in use. Accordingly, each preset has its own setting of the MPX POWER OFFSET, which is a processing parameter like any other in a given preset. Hence, adjustments that affect the multiplex power controller appear in two independent places in the Optimod: The MULTIPLEX POWER THRESHOLD control is a *system setup* control, while the MPX POWER OFFSET is *part of the on-air preset*.

Depending on the preset, the MPX POWER OFFSET control's setting can vary from 0 dB (no effect) to as much as –9 dB. If you customize a preset in any way (including using LESS-MORE), you may wish to trim the MPX POWER OFFSET for that preset so that the multiplex power controller produces 2-3 dB of indicated gain reduction with typical program material. This will achieve the maximum on-air loudness that complies with the ITU standard while minimizing the potential for unnatural and audibly disturbing loudness inconsistencies caused by the operation of the multiplex power controller.

The Two-Band Structure

The Two-Band structure consists of a slow two-band gated AGC (Automatic Gain Control) for gain riding, followed by an equalization section, a gated two-band compressor, a high-frequency limiter, and a complex peak limiting system similar to the one used in the Five-Band structure. Like the "Two-Band Purist" structure in Orban's OPTIMOD-FM 8200, the 5500i's Two-Band Structure is phase-linear throughout to maximize sonic transparency.

The Two-Band structure has an open, easy-to-listen-to sound that is similar to the source material if the source material is of good quality. However, if the spectral balance between the bass and high frequency energy of the program material is incorrect, the Two-Band structure (when its BAND COUPLING 2>1 control is operated toward 0%) can gently correct it without introducing obvious coloration.

The Two-Band structure is mainly useful for classical or "fine arts" programming that demands high fidelity to the original program source.

The Protection Presets

There are two Protection Factory Presets. Both use the same DSP code as the Two-Band Purist structure, but the AGC is defeated.

PROTECTION 0DB sets the limiting threshold so that limiting almost never occurs, while PROTECTION 5DB sets the limiting threshold so that program material at the maximum normal input level (as determined by a PPM or VU meter monitoring the input program line) produces an average limiting of 5 dB.

To set up the Protection Limiter, recall preset PROTECTION 0DB if you want limiting to occur only when the program level *exceeds* the maximum normal input level as determined by a PPM or VU meter monitoring the input program line. Recall preset PROTECTION 5DB if you want about 5 dB of limiting to occur at the maximum normal input level.

The LESS-MORE control affects only the input drive, and you can use it to set a nominal limiting level different from 0 dB or 5 dB.

The Protection presets have the same Intermediate and Advanced Modify controls available as the Two-Band structure.

Setting Up the Two-Band Structure for Classical Music

To set up the Two-Band structure, recall preset CLASSICAL-2 BAND or CLASSICAL-2B+AGC.

These are the only two-band presets (other than the PROTECTION presets).

Classical music is traditionally broadcast with a wide dynamic range. However, with many recordings and live performances, the dynamic range is so great that the quiet passages disappear into the noise on most car, portable, and table radios. Consequently, the listener either 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 listening unpleasant.

The Two-Band structure is well suited for classical formats during daytime hours when most people in the audience are likely to be listening in autos or to be using the station for background music. This audience is best served when the dynamic range of the program material is reduced by 10-15 dB so that quiet passages in the music never fade into inaudibility under these less-favorable listening conditions. OPTIMOD-FM controls the level of the music in ways that are, for all practical purposes, inaudible to the listener. Low-level passages are increased in level by up to 10 dB, while the dynamics of crescendos are maintained.

The CLASSICAL-2 BAND preset is a two-band preset with the AGC turned off. It uses considerable bass coupling to preserve the spectral balance of the input as well as possible. Its LESS-MORE control primarily affects the amount of compression, rather than maximum loudness. It sounds essentially identical to the Protection structure.

CLASSICAL-2B+AGC uses the AGC set for 2:1 compression ratio. Because of the AGC, it affects more of the total dynamic range of the recording that does the CLASSICAL-2 BAND preset. However, the AGC provides extremely smooth and unobtrusive compression because of the gentle ratio and window gating. In this preset, the Two-Band compressor is used very lightly with a fast release time as a peak limiter. The AGC does almost of the compression.

During the evening hours when the audience is more likely to listen critically, a classical station may wish to switch to a custom preset (derived from the CLASSICAL-2 BAND preset) that performs less gain reduction. You can create such a preset by modifying the CLASSICAL-2 BAND preset with the LESS-MORE control — turn it down to taste.

There are also two five-band classical presets. The CLASSICAL-5 BAND preset uses the five-band structure with AGC defeated. It uses substantial interband coupling to retain much of the frequency balance of the original source, but is capable of somewhat more "automatic equalization" than is CLASSICAL-2 BAND. It can therefore re-equalize older program material, but there is also more risk that it will cause coloration that might offend the classical purist.

CLASSICAL-5B+AGC, like its two-band counterpart, uses the AGC set for 2:1 compression ratio.

The five-band structure is not phase-linear, so the CLASSICAL-5 BAND preset is likely to have slightly less audible transparency than the CLASSICAL TWO-BAND structure.

Customizing the Settings

Each Two-Band Factory Preset has a LESS-MORE control (located in the Basic Modify screen) that adjusts on-air loudness. LESS-MORE simultaneously adjusts all of the processing controls to optimize the trade-offs between unwanted side effects as processing levels are decreased or increased.

If you wish, you may adjust the Modify parameters to your own taste. Always start with LESS-MORE to get as close to your desired sound as possible. Then edit the Modify parameters using the Basic, Intermediate or Advanced Modify screen, and save those edits to a User Preset.

The Two-Band Structure's Full and Advanced Setup Controls

Table 3-6 shows a summary of the Two-Band controls in the dynamics section.

AGC, Equalizer, Stereo Enhancer, and Clipper controls are common to both Two-Band and Five-Band structures and are described in their own sections earlier in Section 3.

Some of the Two-Band controls are common to the Full Modify and Advanced Modify screens, with additional Two-Band controls available in the Advanced Modify

screen. (Note that "advanced" controls are accessible only from 5500i PC Remote software.)

2B DRIVE control adjusts signal level going into the two-band compressor, and therefore controls the density of output audio by determining the amount of gain reduction in the two-band compressor. The resulting sound texture can be open and transparent, solid and dense, or somewhere in between. The range is 0-25 dB.

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

2B REL ("2B Release") control determines how fast the two-band compressor releases (and therefore how quickly loudness increases) when the level of the program material decreases. This release time only applies when the silence gate does not gate the Two-Band Compressor.

The control can be adjusted from 0.5 dB/second (slow) to 20 dB/second (fast). Settings toward 20 dB/second result in a more consistently loud output, while settings toward 0.5 dB/second allow a wider variation of dynamic range. Both the setting of the 2B REL control and the dynamics and level of the program material determine the actual release time of the compressor. In general, you should use faster release times for mass-appeal pop or rock formats oriented toward younger audiences, and slower release times for more conservative, adult-oriented formats (particularly if women are an important part of your target audience).

> We expect that the Two-Band structure will be rarely used for pop music formats because the Five-Band structure gives better results in almost all cases.

The action of the 2B REL control has been optimized for resolution and adjustability. But its setting is critical to sound quality — listen carefully as you adjust it. There is a point beyond which increasing density (with faster settings of the 2B REL control) will no longer yield more loudness, and will simply degrade the punch and definition of the sound.

When the 2B REL control is set between 8 and 1 dB/second (the slowest settings), the amount of gain reduction is surprisingly non-critical. Gating prevents noise from being brought up during short pauses and pumping does not occur at high levels of gain reduction. Therefore, the primary danger of using large amounts of gain reduction is that the level of quiet passages in input material with wide dynamic range may eventually be increased unnaturally. Accordingly, when you operate the 2B REL control between 8 and 2 dB/second, it may be wise to defeat the gain-riding AGC and to permit the two-band compressor to perform all of the gain riding. This will prevent excessive reduction of dynamic range, and will produce the most natural sound achievable from the Two-Band structures.

With faster 2B REL control settings (above 8 dB/second), the sound will change substantially with the amount of gain reduction in the two-band compressor. This means that you should activate the gain-riding AGC to ensure that the two-band compressor is always being driven at the level that produces the amount of gain reduction desired. Decide based on listening tests how much gain reduction gives you the density that you want without creating a feeling of over-compression and fatigue.

Release in the two-band compressor automatically becomes faster as more gain reduction is applied (up to about 10 dB). This makes the program progressively denser, creating a sense of increasing loudness although peaks are not actually increasing. If the gain-riding AGC is defeated (with the AGC on/off control), you can use this characteristic to preserve some feeling of dynamic range. Once 10 dB 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.

2B GATE ("2B Gate Threshold") threshold control determines the lowest input level that will be recognized as program by OPTIMOD-FM; lower levels are considered to be noise or background sounds and will cause the AGC or two-band compressor to

Two-Band Controls		
Full Modify Name	**Advanced Name**	**Range**
2B DRIVE	2B Drive	–10 … 25 dB
2B REL	2B Release	0.5 … 20 dB/s
2B GATE	2B Gate Threshold	Off, –44 … –15 dB
BASS CPL	2B Bass Coupling	0 … 100 %
BASS CLIP	2B Bass Clip	-6.0 … 0.0 dB
2B CLIP	2B Clipping	–4 … +5
---	Maximum Distortion Control	0 … +18 dB
---	MB Limit Speech Thresh	–3.0 … +6.0 dB
HF LIMIT	2B High Frequency Limiting	–4.0 … +2.0
6K+HF LIM	2B 6-15kHz HF Limiter	Off, –23.8 ... 0.0 dB
FINAL CLIP	Final Clip	-3.0 … 5.0 dB
	2B HF Clip Thresh	–16.0 … – 0.2, Off
COMP DRIVE	Composite Limit Drive	Off, 0.0 … 3.0 dB
PARENT PRESET		[read-only]
LESS-MORE	Less-More Index	[read-only]; 1.0 … 10.0
---	2B Master Compression Threshold	–15 … 0, Off
---	2B Bass Compression Threshold	-10.0 … 5.0 dB, Off
---	2B Master Attack	4 … 50, Off
---	2B Bass Attack	4 … 50, Off
---	2B Clipping	–4 … +5
---	2B Crossover	LinearNoDelay, Linear

Table 3-6: Two-Band Controls

gate, effectively freezing gain to prevent noise breathing.

There are two independent gating circuits in the 5500i Two-Band structure. The first affects the *AGC* and the second affects the *two-band compressor*. Each has its own threshold control.

The two-band gain reduction will eventually recover to 0 dB and the AGC gain reduction will eventually recover to –10 dB even when the compressor gate is gated. However, 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 2B GATE control to –40. Higher settings are primarily useful for radio drama, outside sports broadcasts, and other non-musical programming that contain ambiance, low-level crowd noise and the like. Slightly higher settings may increase the musicality of the compression by slowing down recovery on moderate-level 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 quieter and quieter, thus preserving musical values in material with wide dynamic range (classical music for example).

BASS CPL ("2B Bass Coupling") is used to set the balance between bass and the rest of the frequency spectrum.

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

Settings toward 100% (wideband) make the output sound most like the input. Because setting the BASS CPL control at 100% will sometimes cause bass loss, the most accurate frequency balance will often be obtained with this control between 70% and 90%. The optimal setting depends on the amount of gain reduction applied. Adjust the BASS CPL control until the band 1 and band 2 Gain Reduction meters track as closely as possible.

With the 2B REL (2B Release) control set to 2 dB/second, setting the BASS CPL control toward 0% (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 lacks bass.

With fast release times, settings of the BASS CPL toward 100% (wideband) do not sound good. Instead, set the BASS CPL control toward 0% (independent). This combination of fast release and independent operation of the bands provides the maximum loudness and density on small radios achievable by the Two-Band structure. However, such processing may fatigue listeners with high-quality receivers, and requires you to activate the AGC to control the average drive level into the two-band compressor, preventing uncontrolled build-up of program density. Instead of operating the Two-Band structure like this, you should choose a Five-Band preset instead.

Bass Clip ("Bass Clip Threshold"): See page 3-35.

2B Clip is a compression threshold control that equally affects the bass and master bands. It sets the drive level to the high frequency limiting and multiband distortion-controlling processing that precedes the final clipping section. The distortion-controlling section uses a combination of distortion-cancelled clipping and look-ahead processing to anticipate and prevent excessive clipping distortion in the final clipper.

2B High Frequency Limiting sets the threshold of the high frequency limiter in the Two-Band structure. When this control is set lower, gain reduction does more high frequency limiting. When this control is set higher, distortion-cancelled clipping does more high frequency limiting. This control controls the tradeoff between loss of high frequencies (due to high frequency limiting) and excessive distortion (due to clipping).

2B 6-15 kHz Frequency Limiter sets the amount of additional gain reduction occurring in 6-15 kHz band of the 2-band high frequency limiter. This extra gain reduction is triggered whenever high frequency energy would otherwise cause excessive distortion in the final clipper. The algorithm uses an analysis of the activity in the final clipper to make this determination.

Functionally, this control is a mix control that adds a HF limiter gain reduction signal to higher of the two bands of the 2-band high frequency limiter. Higher settings produce more extra HF limiting in this band. The control therefore allows you to trade off reduced high frequency distortion against HF loss.

FINAL CLIP ("Final Clip Drive"): See page 3-36.

COMP DRV ("Composite Limiter Drive"): See page 3-36.

PARENT PRESET and **LESS-MORE INDEX** are read-only fields.

The 5500i's front-panel LCD display does not show all of the parameters in a given User Preset; only the PC Remote software can display the Advanced Controls that set all the parameters. PARENT PRESET shows the preset that was edited to produce the current User Preset. The LESS-MORE INDEX shows the Parent Preset's Less-More setting when it was edited. This information is needed because two different User Presets can appear to be the same when you view only the parameters that the 5500i's front panel exposes.

Please note that if a User Preset was created by in the PC Remote software by editing Advanced controls, an asterisk will appear in front of the displayed parent preset. This asterisk means that you cannot duplicate a given user preset by starting with its parent preset and then setting a target 5500i's front panel controls to correspond to the user preset you want to duplicate. The only way to duplicate such a user preset accurately is via the PC Remote software's backup and restore features, or by opening the preset in the PC Remote software and manually duplicating each control setting you see.

The asterisk feature is not included in version 1.0 software.

Advanced Two-Band Controls

The following Two-Band controls are only accessible from the 5500i PC Remote software.

2B Master Compression Threshold sets the level where gain reduction starts to occur in the Master (above 200Hz) band of the Two-Band Compressor.

2B Bass Threshold determines the compression threshold of the bass band in the Two-Band Compressor. It can be used to set the target spectral balance of the Two-Band Compressor. As the Two-Band Compressor BASS CPL control is moved towards "100%," the 2B BASS THRESHOLD control affects the sound less and less.

2B Master Attack sets the attack time of the Two-Band Compressor master compressor (above 200Hz).

2B Bass Attack sets the attack time of the Two-Band Compressor bass compressor (below 200Hz).

The relationship and interaction between 2B Clip, 2B High Frequency Limiting, and the next two controls is complicated and is best appreciated by listening and experimenting:

2B High Frequency Clip Threshold sets the threshold of the multiband, distortion-cancelled clipper in the Two-Band structure's high frequency limiter. Higher numbers yield more brightness, but also cause more high frequency distortion.

2B Crossover sets the structure of the two-band crossover to Linear or Linear with No Delay. See AGC CROSSOVER on page 3-34 for more detail about these modes.

Maximum Distortion Control. See page 3-54.

MB Limit Speech Threshold lets you set the increment (in dB) by which the setting of the MB LIMIT THR control is reduced when speech is detected. This control allows the main clipping distortion controller to work harder on speech while preserving punch in music.

The Five-Band Structure

The Five-Band structure consists of a stereo enhancer, a slow gain-riding two-band AGC, an equalization section, a five-band compressor, a dynamic single-ended noise reduction system, an output mixer (for the five bands), and a complex peak limiting system.

Unlike the Two-Band structure, whose two-band compressor has a continuously variable release time, the release time of the Five-Band compressor is switchable to

seven increments between slow and fast. Each setting makes a significant difference in the overall flavor and quality of the sound.

When the input is noisy, you can sometimes reduce the noise by activating the single-ended noise reduction system. Functionally, the single-ended noise reduction system combines a broadband downward expander with a program-dependent low-pass filter. This noise reduction can be valuable in reducing audible hiss, rumble, or ambient studio noise on-air.

Putting the Five-Band Structure on the Air

The Five-Band structure is very flexible, enabling you to fine-tune your on-air sound to complement your programming. There are numerous Factory Programming Presets. They offer considerable variety, with various combinations of release time, equalization, low frequency coupling, and high frequency coupling.

Start with one of these presets. 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, customize your sound using the information in "Customizing the Settings," which follows.

Customizing the Settings

The LESS-MORE control can edit each of these presets to optimize the trade-off between loudness and distortion according to the needs of the format. The presets can be further edited with Basic, Full Modify, or Advanced Modify to fine-tune them.

The controls in the Five-Band structure give you the flexibility to customize your station sound. Nevertheless, as with any audio processing system, proper adjustment of these controls requires proper balancing of the trade-offs between loudness, den-

Multiband Controls		
Full Name	**Advanced Name**	**Range**
MB DRIVE	Multiband Drive	0 ... 25
MB GATE	Multiband Gate Threshold	Off, –44 ... –15 dB
MB LIM DR	Multiband Limiter Drive	–4.0 ... +5.0 dB
DWNEXP THR	Downward Expander	Off, –18.0 … 12.0 dB
B5 DWNEXP THR	B5 Down Exp Delta Thresh	–18.0 … +12.0 dB
MB LIM THR	Multiband Limit Threshold	–3.0 … +6.0, Off
HF CLIP	High Frequency Clip Threshold	–16.00 … 0.0, Off
LESS-MORE	Less-More Index	[read-only]; 1.0 … 10.0
PARENT PRESET	Parent Preset	[read-only]
---	MB Limit Speech Thresh	–3.0 +6.0 dB
---	Maximum Distortion Control	0 … 18 dB
---	High Frequency Limiter	Off, –23.8 ... 0.0 dB
---	B1/B2 XOVER	100 Hz, 150Hz, 200 Hz

Table 3-7: Multiband Controls

sity, and audible distortion. The following provides the information you need to adjust the Five-Band structure controls to suit your format, taste, and competitive situation.

The Five-Band Structure's Full and Advanced Setup Controls

The tables below summarize the Multiband and Band Mix controls in the dynamics section. The AGC, Equalizer, Stereo Enhancer, and Clipper controls are common to both the Two-Band and Five-Band structures and are discussed in their own sections in Section 3. (Note that "advanced" controls are accessible only from 5500i PC Remote software.)

MB DRIVE ("Multiband Drive") control adjusts the signal level going into the multiband compressor, and therefore determines the average amount of gain reduction in the multiband compressor. Range is 25 dB.

Adjust the MULTIBAND DRIVE control to your taste and format requirements. Used lightly with slower multiband release times, the multiband compressor produces an open, re-equalized sound. The multiband compressor can increase audio density when operated at faster release times because it acts increasingly like a fast limiter (not a compressor) as the release time is shortened. With faster release times, den-

MB Attack/Release/Threshold		
Full Name	**Advanced Name**	**Range**
MB REL	Multiband Release	Slow, Slow2, Med, Med2, MFast, MFast2, Fast
B1 THR	B1 Compression Threshold	–16.00 … 0.0, Off
B2 THR	B2 Compression Threshold	–16.00 … 0.0, Off
B3 THR	B3 Compression Threshold	–16.00 … 0.0, Off
B4 THR	B4 Compression Threshold	–16.00 … 0.0, Off
B5 THR	B5 Compression Threshold	–16.00 … 0.0, Off
---	B1 Attack	4.0 … 50.0 ms, Off
---	B2 Attack	4.0 … 50.0 ms, Off
---	B3 Attack	4.0 … 50.0 ms, Off
---	B4 Attack	4.0 … 50.0 ms, Off
---	B5 Attack	4.0 … 50.0 ms, Off
---	B1 Limiter Attack	0 … 100%
---	B2 Limiter Attack	0 … 100%
---	B3 Limiter Attack	0 … 100%
---	B4 Limiter Attack	0 … 100%
---	B5 Limiter Attack	0 … 100%
---	B1 Delta Release	–6 … 6
---	B2 Delta Release	–6 … 6
---	B3 Delta Release	–6 … 6
---	B4 Delta Release	–6 … 6
---	B5 Delta Release	–6 … 6

Table 3-8: MB Attack/Release Controls

sity also increases when you increase the drive level into the multiband compressor because these faster release times produce more limiting action. Increasing density can make sounds seem louder, but can also result in an unattractive busier, flatter, or denser sound. It is very important to be aware of the many negative subjective side effects of excessive density when setting controls that affect the density of the processed sound.

The MULTIBAND DRIVE interacts with the MULTIBAND RELEASE setting. With slower release time settings, increasing the MULTIBAND DRIVE control scarcely affects density. Instead, the primary danger is that the excessive drive will cause noise to be increased excessively when the program material becomes quiet.

You can minimize this effect by carefully setting the MULTIBAND GATE THRESHOLD control to "freeze" the gain when the input gets quiet and/or by activating the single-ended noise reduction.

When the release time of the multiband compressor is set to its faster settings, the setting of the MULTIBAND DRIVE control becomes much more critical to sound quality because density increases as the control is turned up. Listen carefully as you adjust it. With these fast release times, there is a point beyond which increasing multiband compressor drive will no longer yield more loudness, and will simply degrade the punch and definition of the sound.

We recommend no more than 10 dB gain reduction as shown on the meters for band 3. More than 10 dB, particularly with the FAST release time, will often create a "wall of sound" effect that many find fatiguing.

To avoid excessive density with the FAST multiband release time, we recommend using no more than 5 dB gain reduction in band 3, and compensating for any lost loudness by speeding up the MULTIBAND RELEASE instead. This is what we did in the factory LESS-MORE presets for the FAST multiband release time.

MB REL ("Multiband Release") control can be switched to any one of seven settings:

The **Slow** settings produce a very punchy, clean, open sound that is ideal for Adult Contemporary, Soft Rock, Soft Urban, New Age, and other adult-oriented formats whose success depends on attracting and holding audiences for very long periods. The SLOW and SLOW2 settings produce an unprocessed sound with a nice sense of dynamic range. With these settings, the Five-Band structure provides gentle automatic equalization to keep the frequency balance consistent from record to record (especially those recorded in different eras). In addition, for background music formats, these settings ensure that your sound doesn't lose its highs and lows. Because it creates a more consistent frequency balance between different pieces of source material than does the Two-Band structure, SLOW is almost always preferable to the Two-Band structure for any popular music format.

The **Medium Slow** settings (MED and MED2) are appropriate for more adult-oriented formats that need a glossy show-business sound, yet whose ratings depend on maintaining a longer time spent listening than

do conventional Contemporary Hit Radio (CHR) formats. With the single-ended noise reduction activated, it is also appropriate for Talk and News formats. This is the sound texture for the station that values a clean, easy-to-listen-to sound with a tasteful amount of punch, presence, and brightness added when appropriate. This is an unprocessed sound that sounds just right on music and voice when listened to on small table radios, car radios, portables, or home hi-fi systems.

The **Medium Fast** settings (MFAST and MFAST2) are ideal for a highly competitive Contemporary Hit Radio (CHR) format whose ratings depend on attracting a large number of listeners (high "cume") but which does not assume that a listener will listen to the station for hours at a time. This is the major market competitive sound, emphasizing loudness as well as clean audio. The sound from cut to cut and announcer to announcer is remarkably consistent as the texture of music is noticeably altered to a standard. Bass has an ever-present punch, there is always a sense of presence, and highs are in perfect balance to the mids, no matter what was on the original recording.

The **Fast** setting is used only for the TALK and SPORTS factory programming formats. Processing for this sound keeps the levels of announcers and guests consistent, pulls low-grade telephone calls out of the mud, and keeps a proper balance between voice and commercials. Voice is the most difficult audio to process, but these settings result in a favorable trade-off between consistency, presence, and distortion.

The Factory Presets for this sound are quite different from the other three release time settings. The amount of gain reduction in the multi-band compressor is substantially lower (so that it operates more like a limiter than like a compressor), and the release time of the gain-riding AGC is speeded up (so that it provides compression and some increase of

Band Mix		
Full Name	**Advanced Name**	**Range**
B2>B1 CPL	B2>B1 Coupling	0 ... 100 %
B2>B3 CPL	B2>B3 Coupling	0 ... 100 %
B3>B2 CPL	B3>B2 Coupling	0 … 100 %
B3>B4 CPL	B3>B4 Coupling	0 ... 100 %
B4>B5 CPL	B4>B5 Coupling	0 ... 100 %
B1 OUT	B1 Output Mix	–3.0 … +3.0
B2 OUT	B2 Output Mix	–3.0 … +3.0
B3 OUT	B3 Output Mix	–3.0 … +3.0
B4 OUT	B4 Output Mix	–3.0 … +3.0
B5 OUT	B5 Output Mix	–3.0 … +3.0
---	B1 On/Off	Band On, Band Off
---	B2 On/Off	Band On, Band Off
---	B3 On/Off	Band On, Band Off
---	B4 On/Off	Band On, Band Off
---	B5 On/Off	Band On, Band Off

Table 3-9: MB Band Mix Controls

density). We made these trade-offs to prevent excessive build-up of density.

It is possible to experiment with this sound for music-oriented programming as well. However, even with these settings, your sound is getting farther away from the balance and texture of the input. We think that this is as far as processing can go without causing unacceptable listener fatigue. However, this sound may be quite useful for stations that are ordinarily heard very softly in the background because it improves intelligibility under these quiet listening conditions. Stations that are ordinarily played louder will probably prefer one of the slower release times, where the multiband compressor takes more gain reduction and where the AGC is operated slowly for gentle gain riding only. These slower sounds are less consistent than those produced by the FAST setting. Using SLOW preserves more of the source's frequency balance, making the sound less dense and fatiguing when the radio is played loudly.

Bx THR ("Band x Compression Threshold") controls set the compression threshold in each band, in units of dB below the final clipper threshold. We recommend making small changes around the factory settings to avoid changing the range over which the MB CLIPPING control operates. These controls will affect the spectral balance of the processing above threshold, but are also risky because they can strongly affect the amount of distortion produced by the back-end clipping system.

MB GATE ("Multiband Gate Threshold") control determines the lowest input level that will be recognized as program by OPTIMOD-FM; lower levels are considered to be noise or background sounds and cause the AGC or multiband compressor to gate, effectively freezing gain to prevent noise breathing.

There are two independent gating circuits in the 5500i. The first affects the AGC and the second affects the multiband compressor. Each has its own threshold control. The 5500i's input drives the AGC gate detector; the output of the 5500i's AGC drives the MB gate detector.

The multiband compressor gate causes the gain reduction in bands 2 and 3 of the multiband compressor to move quickly to the average gain reduction occurring in those bands when the gate first turns on. This prevents obvious midrange coloration under gated conditions, because bands 2 and 3 have the same gain.

The gate also independently freezes the gain of the two highest frequency bands (forcing the gain of the highest frequency band to be identical to its lower neighbor), and independently sets the gain of the lowest frequency band according to the setting of the DJ BASS boost control (in the Equalization screen). Thus, without introducing obvious coloration, the gating smoothly preserves the average overall frequency response "tilt" of the multiband compressor, broadly maintaining the "automatic equalization" curve it generates for a given piece of program material.

If the MB GATE control is turned OFF, the DJ BASS control (in the Equalization screen) is disabled.

MB LIM DR ("Multiband Limiter Drive") sets the drive level to the multiband distortion controlling processing that precedes the final clipping section. The distortion-

controlling section uses a combination of distortion-cancelled clipping and look-ahead processing to anticipate and prevent excessive clipping distortion in the final clipper.

Like any other dynamics processing, the distortion-controlling section can produce artifacts of its own when overdriven. These artifacts can include loss of definition, smeared high frequencies, a sound similar to excessive compression, and, when operated at extreme settings, audible intermodulation distortion. You can adjust the MB LIM DR control to prevent such artifacts or to use them for coloration in "highly processed" formats.

MB LIM THR ("Multiband Limit Threshold") sets the threshold of the clipping distortion controller with reference to the threshold of the final clipper, in dB.

The most effective setting for this control is "0 dB" for almost all program material. However, the loudest and most intense-sounding presets rely on considerable clipping to achieve their loudness and brightness. For these presets, we found it necessary to set the MB LIM THR control substantially higher than "0" to permit more clipping depth. In some cases, this results in substantially objectionable distortion artifacts with isolated program material. However, this is the price to be paid for this extreme level of on-air loudness.

> For the NEWS-TALK and SPORTS presets, we set the MB LIM THR control slightly below "0." This ensures the cleanest possible speech quality at the cost of highest loudness. If you want higher loudness in these presets, you can edit them to increase the setting of the MB LIM THR control.
>
> In the UL presets only, this control sets the threshold of the Band-4 multiband clipper. (Unlike the normal latency presets, the UL presets do not have a program-adaptive clipping distortion controller, so repurposing the control does not cause a conflict.) Because the Band-4 multiband clipper helps control distortion in the final clipper, its setting is relatively critical and it is usually unwise to set it away from the default found in the source factory UL preset you are editing.

DwnExp Thr ("Downward Expander Threshold") determines the level below which the single-ended noise reduction system's downward expander begins to decrease system gain and below which the high frequencies begin to become low-pass filtered to reduce perceived noise. There are two controls: the MB DOWN EXPANDER control sets the expansion threshold in Bands 1-4, while the B5 DOWN EXPANDER DELTA THRESH control allows you to fine-tune the Band 5 downward expander's threshold by adding or subtracting an offset from the setting of the MB DOWN EXPAND control. Activate the single-ended dynamic noise reduction by setting these controls to a setting other than OFF.

The single-ended noise reduction system combines a broadband downward expander with a program-dependent low-pass filter. These functions are achieved by causing extra gain reduction in the multiband compressor. You can see the effect of this extra gain reduction on the gain reduction meters.

The gating on the AGC and multiband limiter will usually prevent objectionable build-up of noise and you will want to use the single-ended noise reduction only on unusually noisy program material. Modern commercial recordings will almost never

need it. We expect that its main use will be in talk-oriented programming, including sports.

Please note that it is impossible to design such a system to handle all program material without audible side effects. You will get best results if you set the MB DOWN EXPANDER control of the noise reduction system to complement the program material you are processing. The MB DOWN EXPANDER should be set higher when the input is noisy and lower when the input is relatively quiet. The best way to adjust the MB DOWN EXPANDER control is to start with the control set very high. Reduce the control setting while watching the gain reduction meters. Eventually, you will see the gain increase in sync with the program. Go further until you begin to hear noise modulation—a puffing or breathing sound (the input noise) in sync with the input program material. Set the MB DOWN EXPANDER control higher until you can no longer hear the noise modulation. This is the best setting.

Obviously, the correct setting will be different for a sporting event than for classical music. It may be wise to define several presets with different settings of the MB DOWN EXPANDER control and to recall the preset that complements the program material of the moment.

Note also that it is virtually impossible to achieve undetectable dynamic noise reduction of program material that is extremely noisy to begin with, because the program never masks the noise. It is probably wiser to defeat the dynamic noise reduction with this sort of material (traffic reports from helicopters and the like) to avoid objectionable side effects. You must let your ears guide you.

Band 5 is particularly critical for noise reduction because much of the Downward Expander's utility lies in hiss reduction. Hiss has most of its energy in band 5, while program material typically has less energy in this band, so the B5 DOWN EXPANDER DELTA THRESHOLD control's setting is critical to removing hiss while minimizing removal of desired program energy.

Band 5 is uncoupled from the lower bands, so the band 5 downward expander can produce less gain reduction than other bands. This can help prevent loss of desired high frequency material in the program.

B3>B4 CPL ("Band 3>4 Coupling") control determines the extent to which the gains of bands 4 (centered at 3.7 kHz) and 5 (above 6.2 kHz) are determined by and follows the gain of band 3 (centered at 1 kHz). Set towards 100% (fully coupled) this control reduces the amount of dynamic upper midrange boost, preventing unnatural upper midrange boost in light pop and instrumental formats. The gain of band 5 is further affected by the B4>B5 CPL control.

B4>B5 CPL ("Band 4>5 Coupling") controls the extent to which the gain of band 5 (6.2 kHz and above) is determined by and follows the gain of band 4.

The sum of the high frequency limiter control signal, the output of the band 5 compressor sidechain, and the output of the B4>B5 CPL CONTROL determines the gain reduction in band 5. The B4>B5 CPL control receives the independent left and right band 4 gain control signals; this feed is

unaffected by the band 4 MAX DELTA G/R control. Range is 0 to 100% coupling.

B3>B2 CPL and **B2>B3 CPL** controls determine the extent to which the gains of bands 2 and 3 track each other.

When combined with the other coupling controls, these controls can adjust the multiband processing to be anything from fully independent operation to quasi-wideband processing.

B2>B1 CPL control determines the extent to which the gain of band 1 (below 100Hz or 200Hz, depending on crossover setting) is determined by and follows the gain of band 2 (centered at 400Hz). Set towards 100% (fully coupled) it reduces the amount of dynamic bass boost, preventing unnatural bass boost in light pop and talk formats. Set towards 0% (independent), it permits frequencies below 100Hz (the "slam" region) to have maximum impact in modern rock, urban, dance, rap, and other music where bass punch is crucial. The default setting is 30%.

Bx Out ("Band x Output Mix") controls determine the relative balance of the bands in the multiband compressor. Because these controls mix *after* the band compressors, they do not affect the compressors' gain reductions and can be used as a graphic equalizer to fine-tune the spectral balance of the program material over a ±3 dB range.

Their range has been purposely limited because the only gain control element after these controls is the back-end clipping system (including the multiband clipper/distortion controller), which can produce considerable audible distortion if overdriven. The thresholds of the individual compressors have been carefully tuned to prevent audible distortion with almost any program material. Large changes in the frequency balance of the compressor outputs will change this tuning, leaving the 5500i more vulnerable to unexpected audible distortion with certain program material. Therefore, you should make large changes in EQ with the bass and parametric equalizers and the HF enhancer, because these are located *before* the compressors. The compressors will therefore protect the system from unusual overloads caused the chosen equalization. Use the multiband mix controls only for fine-tuning.

You can also get a similar effect by adjusting the compression threshold of the individual bands. This is comparably risky with reference to clipper overload, but unlike the MB BAND MIX controls, does not affect the frequency response when a given band is below threshold and is thus producing no gain reduction.

HF CLIP ("High Frequency Clipper Threshold") sets the threshold of the multiband clipper in band 5 with reference to the final clipper threshold, in dB. This clipper helps prevent distortion in the final clipper when the input program material contains excessive energy above 6 kHz.

The Band 5 multiband clipper operates at 256 kHz and is fully anti-aliased.

Advanced Multiband Controls

The following Advanced Multiband controls are available only from 5500i PC Remote software.

Bx On/Off switches allow you to listen to any band (or any combination of bands) independently. This is a feature designed for intermediate or advanced users and developers when they are creating new 5500i presets.

Please note that a single band will interact with the back-end clipping system quite differently than will that band when combined with all of the other bands. Therefore, do not assume that you can tune each band independently and have it sound the same when the clipping system is processing all bands simultaneously.

B1-B5 Attack (Time) controls set the speed with which the gain reduction in each band responds to level changes at the input to a given band's compressor. These controls, which have never previously been available in an Orban processor, are risky and difficult to adjust appropriately. They affect the sound of the processor in many subtle ways. The main trade-off is "punch" (achieved with slower attack times) versus distortion and/or pumping produced in the clipping system (because slower attack times increase overshoots that must be eliminated in the clipping system). The results are strongly program-dependent, and must be verified with listening tests to a wide variety of program material.

The ATTACK time controls are calibrated in arbitrary units. Higher numbers correspond to slower attacks.

The look-ahead delay time in bands 3, 4, and 5 automatically tracks the setting of the ATTACK time controls to minimize overshoot for any attack time setting.

MB Limit Speech Threshold. See page 3-45.

Maximum Distortion Control limits the maximum amount of final clipper drive reduction (in dB) that the 5500i's clipping distortion controller can apply, preventing over-control of transient material by the distortion controller. Instead, the final clipper is permitted to control some of the transient material (to increase "punch"), even though, technically, such clipping introduces "distortion." A setting of 4 to 5 dB works best in most cases. Factory default is 5 dB for virtually all presets.

High Frequency Limiter sets the amount of additional gain reduction occurring in band 5 when high frequency energy would otherwise cause excessive distortion in the final clipper. It uses an analysis of the activity in the final clipper to make this determination, and works in close cooperation with the band-5 multiband clipper. Functionally, this control is a mix control that adds a HF limiter gain reduction signal to the band 4 gain reduction signal to determine the total gain reduction in band 5. Higher settings produce more HF limiting. A setting of "–18" provides a good tradeoff between brightness and distortion at high frequencies.

Starting with v1.1 software, band 5 has a compressor sidechain, which can be used in conjunction with the HF Limiter to fine-tune the HF texture as desired. The gain of band 5 is the sum of the outputs of the B5 downward expander, the B5 compressor sidechain, the HF limiter, and the B4>B5 COUPLING control.

Limiter Attack controls allow you to set the limiter attack anywhere from 0 to 100% of normal in the Five-Band compressor/limiters. Because the limiter and compressor characteristics interact, you will usually get best audible results when you set

these controls in the range of 70% to 100%. Below 70%, you will usually hear pumping because the compressor function is trying to create some of the gain reduction that the faster limiting function would have otherwise achieved. If you hear pumping in a band and you still wish to adjust the limiter attack to a low setting, you can sometimes ameliorate or eliminate the pumping by slowing down the compressor attack time in that band.

Delta Release controls are differential controls. They allow you to vary the release time in any band of the Five-Band compressor/limiter by setting an offset between the MULTIBAND RELEASE setting and the actual release time you achieve in a given band. For example, if you set the MULTIBAND RELEASE control to medium-fast and the BAND 3 DELTA GR control to –2, then the band 3 release time will be the same as if you had set the MULTIBAND RELEASE control to medium and set the BAND 3 DELTA GR control to 0. Thus, your settings automatically track any changes you make in the MULTIBAND RELEASE control. In our example, the release time in band 3 will always be two "click stops" slower than the setting of the MULTIBAND RELEASE control.

If your setting of a given DELTA RELEASE control would otherwise create a release slower than "slow" or faster than "fast" (the two end-stops of the MULTIBAND RELEASE control), the band in question will instead set its release time at the appropriate end-stop.

B1/B2 Xover (Band 1 to Band 2 Crossover Frequency) sets the crossover frequency between bands 1 and 2 to either 100 Hz or 200 Hz. It significantly affects the bass texture, and the best way to understand the differences between the two crossover frequencies is to listen.

ITU-R Multiplex Power Controller

The ITU-R recommends that the power in the composite baseband signal (including the pilot tone), integrated over any 60-second interval, not exceed the power in a sinewave that modulates the FM carrier to ±19 kHz (25.3% modulation re ±75 kHz deviation). Many European countries are now enforcing this recommendation. (See *ITU-R 412 Compliance* on page 3-12 for more information.)

MPX Power Meter

Version 1.1 of 5500i software added a MPX POWER meter that indicates MPX power according to the ITU-R BS.412 standard. All samples are weighted equally in a 60-second sliding window.

BS.412 requires limiting the integrated power of the composite signal so that it does not exceed the power in a sinewave that deviates the FM carrier by ±19 kHz (25.333% modulation with reference to ±75 kHz deviation). The 5500i's MPX POWER meter is therefore calibrated so that it indicates 0 dB when the composite output of the 5500i is a sinewave at 25.333% modulation, which is –11.92615 dB with reference to a sinewave at 100% modulation.

The meter is calibrated with reference to the 5500i's 100% peak modulation level. This calibration is only correct if the transmitter and/or studio-transmitter link do not

add overshoots to program material processed by the 5500i. Such overshoots necessitate turning down the 5500i's output level control after it has been calibrated with tone using an FM modulation meter and the 5500i's built-in line-up tone oscillator. If the output level is turned down after a tone calibration, the MPX POWER LEVEL meter will read high compared to the actual on-air MPX power. The error will be equal to the amount that the 5500i's output level control was turned down.

See *Optimal Control of Peak Modulation Levels* starting on page 1-13 for a discussion of overshoots and how they force the average modulation to be reduced to prevent peak overmodulation of the FM carrier.

Because the 5500i does not digitize subcarriers applied to its subcarrier inputs, the 5500i's MPX POWER meter (which operates in the DSP domain) cannot indicate the power added by such subcarriers. These usually have constant power, so it is easy to compensate for them. For example, if an FM subcarrier is injected at 4% modulation, it adds power that can be calculated with an R.M.S. summation of the subcarrier and the rest of the composite signal.

Assuming that the subcarrier and composite signal are uncorrelated and that the composite signal is limited so that its power is equivalent to a sinewave at 25.3% modulation, we calculate their R.M.S. sum as follows:

$$\sqrt{0.25333^2 + 0.04^2} = \sqrt{0.06418 + 0.0016} = 0.25647$$

$$20 \log(0.25647) = -11.81921 \text{ dB}$$

Recalling that the MPX POWER LEVEL meter is calibrated so that it indicates 0 dB when the composite output of the 5500i is a sinewave at –11.92615 dB below 100% modulation, we conclude that our subcarrier at 4% injection will add 0.10694 dB to the multiplex power. Another calculation (not shown) indicates that 10% injection will add 0.62889 dB to the MPX power.

Multiplex Power Threshold

Your Optimod provides a means to limit the integrated multiplex power to the ITU standard by a closed-loop technique that allows you to use any preset and to create customized presets freely. The multiplex power controller is adjusted via the ITU412-9 control (see step 20 on page 2-21). Set it OFF if your country does not enforce the standard.

The control is located in the *Setup* > STEREO ENCODER screen because the regulation applies to all operation of the processor in a given installation.

If your country enforces the standard, you should set the control to complement the amount of peak overshoot in the transmission system following your Optimod. Setting the control at "0" will correctly control the multiplex power when there is no overshoot after the 5500i. This will typically be true when you are using your Optimod's built-in stereo encoder to drive the transmitter directly.

Section 1 of this manual has an extensive discussion of overshoot in transmission paths. See page 1-16 and following pages.

Many paths have overshoot, and this forces you to reduce the average modulation to avoid overmodulating the transmitter. This would reduce the multiplex power by the same amount, forcing the multiplex power below the ITU requirement.

To compensate for this, match the ITU412-9 control to the peak overshoot of the transmission system following the 5500i. For example, if RF peak deviation exceeds the peak deviation produced by the 5500i's sinewave oscillator (set for 100% modulation) by 3 dB, set the MULTIPLEX POWER THRESHOLD to "+3."

Audio Processing and the Multiplex Power Threshold Control

Starting with version1.1 software, the multiplex power controller reduces multiplex power by applying gain reduction after the Optimod's FM peak limiting system, which reduces the tendency of the MPX power controller to produce unnatural-sounding gain reduction because the standard forces MPX power to be measured after preemphasis and without psychoacoustically weighting.

With no power control, some of the louder 5500i presets can exceed the ITU standard by as much as 12 dB. This means that the controller must reduce gain by as much as 12 dB depending on the dynamics and spectral content of the input program material. To prevent unnatural loudness variations, your Optimod applies a

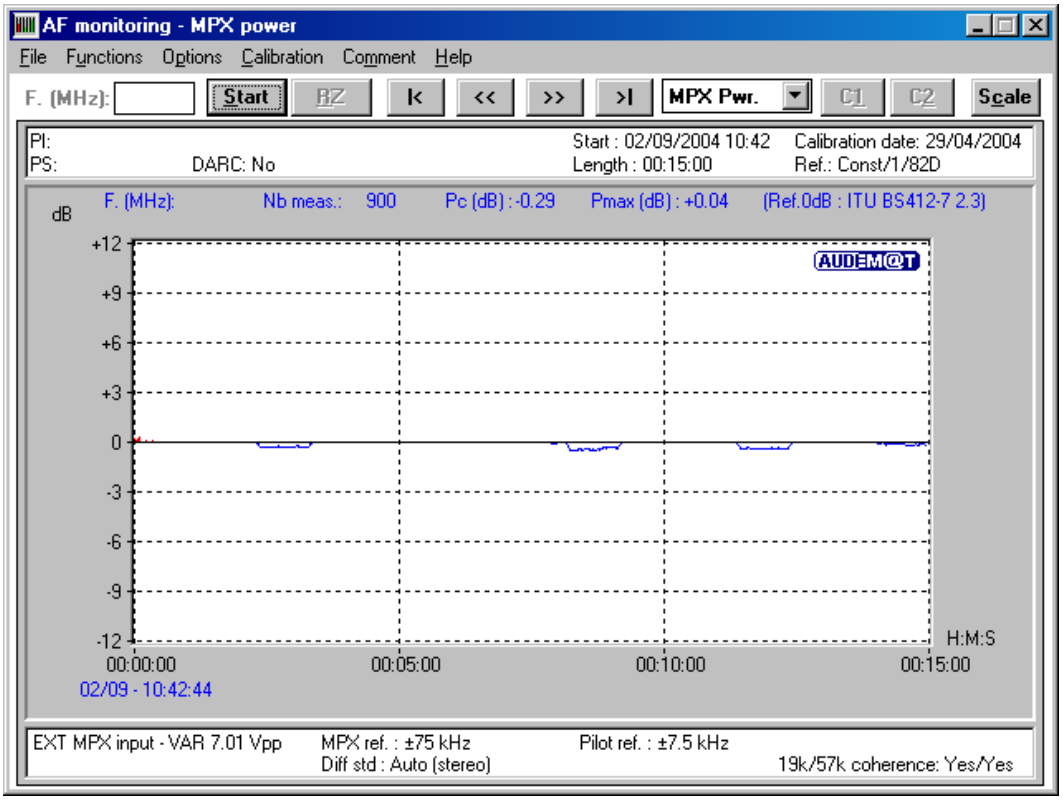


Figure 3-1: Multiplex power over 15 minute observation interval
with Multiplex power controller active, measured at the Optimod's composite output

static loss (preset-dependent and set by the MULTIPLEX POWER OFFSET control) before the FM peaks limiters when the multiplex power controller is activated. This complements the dynamic gain reduction produced by the multiplex power controller. See the notes on the MULTIPLEX POWER OFFSET control on page 3-37.

In version 1.1 and higher software, the MPX offset is still applied before the peak limiters. Turning it up (for example, from –12 to –9 dB) increases both the amount of peak limiting and the amount of wideband gain reduction performed by the MPX Power Controller

The multiplex power controller does not use the output of the 5500i's stereo encoder as its reference. Instead, it computes the multiplex power directly from the left and right audio signals, the setting of the PILOT LEVEL control, and the setting of the COMPOSITE LIMIT DRIVE control. Hence, the multiplex power controller does not take into account the effect of any composite limiting on the multiplex power. This is not a problem because a BS412-compliant broadcast does not cause enough composite limiting to affect the multiplex power measurably. The purpose for this change was to allow the multiplex power controller to work even diversity delay is applied to the stereo encoder.

The multiplex power controller is operational with all of the Two-Band and Five-Band processing structures. *It is not active in Test mode and will not prevent the 5500i's test oscillator from producing illegal modulation.* It is the responsibility of the operator to make sure that the test oscillator does not violate the ITU requirements. (To ensure this, never modulate the carrier with a single L+R tone that produces total carrier modulation, including pilot tone, of more than 24%.)

About the Multiplex Power Controller's Time Constants

Although the BS412 specification calls for a 60-second integration time, the integration time of the Optimod's MPX power controller is about 10 seconds. The problem with making the integration time longer is that the BS412 standard states that the integrated MPX power in any *arbitrary 60-second time period* cannot exceed the average power of the sinewave that produced ±19 kHz carrier deviation. In other words, *whenever you start measuring*, you must not exceed the total integrated power limit over the following 60 seconds.

This makes it impractical to "bank" power over the full 60-second window. For example, at first glance one might think that a classical music station could exploit a period of quiet music to allow a crescendo to get louder than it would using the 5500i's relatively fast integration time. However, what happens if someone starts an arbitrary 60-second measurement period not at the beginning of the quiet passage but at the beginning of the crescendo?

Because an automatic MPX power controller does not know what is coming after the crescendo, it must reduce the level of the crescendo so that it complies with the MPX requirement over with an integration time that is shorter than 60 seconds. Otherwise, it might have to dramatically reduce the level of following (as yet unknown) program material in order to ensure that the MPX power limit is not exceeded over the 60-second measurement period in question. This kind of gain pumping would be far worse than the pumping produced by using a relatively short integration time.

Multiplex Power Control in Stand-Alone Stereo Encoder Mode

When you use the 5500i in stand-alone stereo encoder mode, we recommend setting up your transmission system to produce approximately 3 dB of average MPX power control. This avoids unnatural loudness variations.

To achieve this goal when an Optimod-FM drives the 5500i stereo encoder, reduce the drive into the Optimod's peak limiters by turning down the MULTIBAND CLIPPING control in the on-air preset until the MPX Power gain reduction meter on the 5500i indicates an average of 3 dB of gain reduction. Save the result as a User Preset.

Do not reduce the drive level to the 5500i by turning down the driving Optimod's output level control because this does not decrease distortion in the Optimod's peak limiter, unlike turning down the MULTIBAND CLIPPING control.

Test Modes

Setup: Test				
Parameter Labels	**Units**	**Default**	**Range (CCW to CW)**	**Step**
MODE	---	Operate	Operate, Bypass, Tone	---
BYPASS GAIN	dB	0.0	–18 … +25	1
TONE FREQ	Hz	400	16, 20, 25, 31.5, 40, 50, 63, 80, 100, 125, 160, 200, 250, 315, 400, 500, 630, 800, 1000, 1250, 1600, 2000, 2500, 3150, 4000, 5000, 6300, 8000, 9500, 10000, 12500, 13586.76, 15000	LOG
TONE LVL	%	91	0 … 121	1
TONE CHAN	---	L+R	L+R, L–R, LEFT; RIGHT	---
PILOT	---	ON	ON, OFF	---

Table 3-10: Test Modes

The Test Modes screen allows you to switch between OPERATE, BYPASS, and TONE. When you switch to BYPASS or TONE, the preset you have on air is saved and will be restored when you switch back to OPERATE.

Table 3-10 shows the facilities available. Facilities are self-explanatory, except for the following:

- The TONE LVL control is calibrated under the assumption that the stereo pilot tone contributes 9% to the total modulation. Hence, a TONE LVL setting of 91% produces 100% modulation (91% + 9%).

Note that when the Optimod is in TONE mode and its analog or digital L/R outputs are set to FLAT (instead of PRE-EMPH), these outputs apply 50µs or 75µs deemphasis to the output of the tone oscillator. Applying deemphasis this way is only correct if equipment downstream from the Optimod, like a transmitter's stereo encoder, applies preemphasis before final transmission.

- In BYPASS mode, preemphasis is still applied to the signal path. The BYPASS GAIN control calibration allows enough internal headroom to make swept frequency response measurements without internal clipping. When the BYPASS GAIN control is set to 0.0 dB and the AI REF VU control is set to 0.0 dBu, you will observe a gain of approximately –17 dB from the analog input to the analog output at 100 Hz. If the AO PRE-E control is set to PRE-E and the 5500i is configured for 75 µs preemphasis, the gain from analog input to analog output will be approximately 0 dB at 15 kHz.

  While this calibration may seem unintuitive, experience has shown that it greatly reduces calls to Orban customer service complaining that the frequency response of the transmission path is not flat when in fact the measurement in question was causing undetected clipping at high frequencies due to preemphasis.

Getting the Bass Sound You Want

Probably the most frequently asked question we get regarding 5500i setup is "How do I get a (such-and-such) bass sound?" It seems that individual preference varies in this area more than it does anywhere else.

There are no magic formulas. The 5500i has extremely versatile controls affecting bass sound, and will allow you to get almost any sound you want as long as that sound respects the laws of physics — or, in this case, the laws of psychoacoustics.

The ear is far less sensitive to bass than to midrange sounds. You can see this for yourself by examining the classic Fletcher-Munson "equal-loudness" curves. This means that if you want effusive bass, it is going to take up a great deal of room in your modulation waveform. This room could otherwise be used for midrange, where far smaller amounts of energy yield the same amount of loudness. Accordingly, there is an important tradeoff between loudness and bass — if you want more bass, you will have to accept either less loudness or noticeably more distortion, the distortion occurring when the bass waveforms push the midrange and high frequency material into the 5500i's final clipper.

There is one psychoacoustic trick you can exploit to create more apparent bass while efficiently using modulation headroom. For hundreds of years, pipe organ makers have tricked the ear into hearing non-existent fundamental tones (which would require huge, expensive pipes) by replacing them with several, smaller pipes tuned to the lower harmonics of the missing fundamental. In the 5500i, you can use the bass clipper to make harmonic distortion for this purpose. (The B-CL SHAPE control determines the shape of the harmonic spectrum that is introduced by this gambit.)

Further, the bass clipper is particularly effective in increasing bass punch because it flat-tops bass transients, and this allows the waveform to accommodate fundamentals that have a larger peak level (by up to 2 dB) than the peak level of the flat-top. (The fundamental of a square wave has a peak level 2.1 dB higher than the peak level of the square wave.) Bass fundamentals can thus exceed 100% modulation even if the composite stereo waveform does not exceed this level.

The attack time of the band 1 compressor also affects bass punch by determining the amount of bass transient that is allowed to pass through the compressor before the attack clamps down on the rest of the waveform. Any transient that passes through the band 1 compressor will hit the bass clipper, so slower attack times on band 1 will increase bass punch at the expense of distortion (particularly on voice). The BAND 1 ATTACK TIME settings in the factory presets have been adjusted with this tradeoff in mind, but you might like to make a different one. Further, the SPEECH BASS CLIPPER THRESHOLD control exploits the 5500i's speech/music detector to allow the bass clipper threshold to be raised during speech, minimizing clipper-induced speech distortion.

The threshold of the band 1 compressor also affects bass punch. We recommend that you carefully study the setting of this control (and the BAND 1 ATTACK TIME control) in the various 5500i factory presets before making your own adjustments, so you can get a feel for how we made the tradeoff between punch and distortion at the factory. If you set the threshold much above –6 dB, you will typically get some distortion even on steady-state waveforms (depending on where you have set the BASS CLIP control).

This control is the primary means of trading off bass punch against IM distortion caused the bass' pushing non-bass material into the final clippers. Set it more negative for less punch but less IM distortion.

There are two bass equalizer sections — the *low bass shelving equalizer* and the *bass parametric equalizer*. The main thing to remember about these sections is that they are fixed tone controls that apply coloration equally to all program material going into the main dynamics processing section of the 5500i. (They do not affect the AGC section because they are located after it in the signal flow.) Accordingly, the five-band compressor in the 5500i will attempt to undo any coloration added in the equalizer setting and will automatically re-equalize the sound to the standard established by the band threshold controls.

Therefore, to get bass to survive the dynamics processing in the 5500i, it is usually necessary to apply substantial bass boost to the input by using the equalizer controls. (A small amount of boost will just be "automatically re-equalized" away; check the factory presets to see what we mean by "substantial.") Bear in mind that using large amounts of shelving bass boost (particularly with 12- or 18 dB/octave slopes) can cause an effective loss of mid-bass because the band 2 compressor will be forced to produce additional gain reduction.

Another important control that affects bass is the B1 OUT control, a mixer control that determines the contribution of band 1 to the total mix of the five bands. Because this control is located after the dynamics processing, the dynamics processing will not fight any adjustments you make to this control. However, the downside is

that the bass compressor will not act to prevent excessive drive to the clipping system (and consequent distortion), so be very careful when boosting this control.

The crossover between band 1 and band 2 is adjustable to 100 Hz or 200 Hz by the B1/B2 XOVER control, which you can only access from the 5500i PC Remote software. When the crossover is set to 100 Hz, band 1 affects extreme low bass (the kind of bass that is *not* reproduced by small clock and portable radios), while band 2 affects the mid-bass and lower midrange. Setting the crossover at 200 Hz will cause more gain reduction to occur below 200 Hz because more energy is applied to the band 1 compressor. If you now increase the fixed bass boost by using the LOW BASS equalizer with an 18 dB/octave slope and 120 Hz tuning, the net result will be a dynamic reduction of bass power, typically centered around 160 Hz. If you use enough low bass boost, there will also be a slight increase in the bass power below 100 Hz or so. This 160 Hz suck-out can give an extremely solid, punchy bass sound on radios with good bass response (particularly on radios with subwoofers) but may cause smaller radios to sound thin. (This is the bass formula used in the BASS-PUNCH preset, and starting with BASS-PUNCH will allow you to create a User Preset using the 200 Hz crossover without using 5500i PC Remote software to access the B1/B2 XOVER control.) The rest of the presets use the 100 Hz crossover and have more mid-bass.

To summarize: Bass is a matter of preference, but the canny broadcast engineer will be aware of the variability of radios out there and will not apply excessive bass boost that can sound awful on “boom-boxes” and other consumer radios with bass boost already built-in. It is usually wise to emulate the bass balance of hit CDs, because very experienced mastering engineers who make these trade-offs every day have mastered these CDs.

The 5500i provides enormous flexibility to get the bass sound you want, but this flexibility comes at a price — you have to familiarize yourself with the relevant controls and truly understand what you are doing. This manual is there to help, and it is worthwhile to reserve some time with if you want to become a 5500i bass expert.

Using the 5500i PC Remote Control Software

5500i PC Remote control software allows you to access any 5500i control including all of the Advanced Modify controls that are unavailable from the 5500i’s front panel. The software also gives you the ability to backup user presets, system files, and automation files on your computer’s storage devices (hard drives, floppy drives, etc.) and to restore them later to your 5500i.

The 5500i PC Remote software can connect to your 5500i via modem, direct serial cable connection, or Ethernet network. It communicates with your 5500i via the TCP/IP protocol, regardless of how it is connected to your 5500i.

> PC Remote works best on displays of 1024x768 pel or higher. Scroll bars will appear when using lower resolutions.

Before running 5500i PC Remote, you must have installed the appropriate Windows communications services on your computer. By default, the installer installs a short-

cut to 5500iPC.exe on your desktop and in your Start Menu under Orban\Optimod 5500i.

5500i PC Remote can control only one 5500i at a time, but it can readily switch between several 5500is. 5500i PC Remote has a built-in "address book" that allows it to select and connect to:

- any 5500i on the same network as the PC,
- a 5500i that can be accessed through a modem connected to the PC via dial-up networking, and,
- a 5500i that is connected directly to the PC's serial port.

Before your PC can communicate with a given 5500i, you must first set up a "connection," which is information that allows PC Remote to locate and communicate with the 5500i.

To set up a new connection:

A) Launch 5500iPC.exe.

B) Create a new 5500i connection by choosing NEW 5500I from the CONNECT file menu or by right-clicking on the ALL CONNECTIONS icon in the Connections List and selecting NEW 5500i.

The Connection Properties dialog box opens.

C) Enter an Alias name for your 5500i (like "KABC").

D) Leave the password field blank to prompt the user to enter a password when initiating a connection.

Refer to *Security and Passcode Programming* on page 2-*39*.

Otherwise, enter a password to allow PC Remote to connect to your 5500i without requiring a password when the connection is initiated.

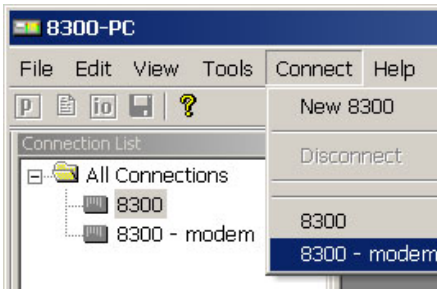
To initiate a successful connection, a password must have already been entered into your 5500i unit.

E) If you are communicating with your 5500i through a network, select the Ethernet radio button and enter the appropriate IP address, subnet mask, port, and gateway data. Note that these values must agree with the values that you set in your 5500i (see step 1 on page 2-50). See also *Setting Up Ethernet, LAN, and VPN Connections* on page 2-58.

If you are communicating via a direct serial cable connection or a modem connection, follow the appropriate procedure described in *Appendix: Setting up Serial Communications,* starting on page 2-59.

F) Click OK after entering all required information.

To initiate communication:



Initiate communication by double-clicking on the desired 5500i alias in the Connections List, or by selecting the desired 5500i alias from the CONNECT drop down menu.

If the connection is successful, a dialog bubble will appear on the bottom right hand corner of the screen verifying your connection.

- If a warning message appears stating: "No password is set at the 5500i…" go to your 5500i unit and enter a passcode.
- If an Enter Passcode dialog box appears, enter a valid passcode and the 5500i PC Remote software will initiate a connection to the 5500i unit.

A window will appear saying, "Connecting to the 5500i, please wait." A few moments later, a new message will appear: "Loading system files, please wait."

When run, the Orban PC Remote software installer makes copies of all 5500i factory preset files on your local hard drive. The PC Remote software reads these files to speed up its initialization. If any of these files have been deleted or damaged, the PC Remote software will refresh them by downloading them from the 5500i. If the PC Remote software needs to do this, it can substantially increase the time required for the software to initialize, particularly through a slow modem connection.

When this download is finished, the main meters will appear.

- A wheel mouse is the quickest and easiest interface to use — you will rarely (if ever) have to use the keyboard.
- The help box at the bottom of the screen always presents a short help message for the function you have selected.

To modify a control setting:

A) Choose PROCESSING PARAMETERS from the EDIT menu.

B) Select menu tabs for Less-More, Stereo Enhancer, and EQ to access Basic Modify controls. All other menu tabs contain Full or Advanced Modify controls.

> You can reset any Basic Modify Control without losing LESS-MORE functionality; Full and Advanced modify control adjustments will cause LESS-MORE to be grayed-out.

To set a control, click it (it will become highlighted) and then adjust it by dragging it with the mouse or moving the wheel on the mouse.

You can also use the + and – keys on the numeric keypad to adjust any control.

To recall a preset:

A) Choose *Recall* PRESET from the FILE menu to bring up the OPEN PRESET FILE dialog box.

B) Click the desired preset within the dialog box to select it.

C) Double-click the desired preset or select it and click the *Recall* PRESET button to put it on-air.

Continually clicking the RECALL PRESET button will toggle between the current and previous on-air presets.

D) Click DONE to dismiss the OPEN PRESET FILE dialog box.

The folder on your hard drive containing the preset files (both Factory and User) is automatically synchronized to the contents of its associated 5500i's memory each time 5500i PC Remote connects to that 5500i. The 5500i's memory is the "master." This means that if you delete a user preset from the 5500i's memory (whether locally via its front panel or via 5500i PC Remote), 5500i PC Remote will automatically erase this preset from this folder on your computer. *To archive a preset permanently, you must use the Backup function.* (See page 3- 65.)

To save a user preset you have created:

A) Select SAVE PRESET AS from the FILE menu to bring up the SAVE AS Dialog Box. The current preset name will appear in the File Name field.

B) Click in the field, and edit it.

C) Click SAVE to save the preset to the 5500i as a User Preset.

If you have made edits to a previously existing user preset, you can select SAVE PRESET from the FILE menu to overwrite the pre-existing user preset automatically.

To back up User Presets, system files, and automation files onto your computer's hard drive:

A) Select BACKUP TO PC from the FILE Menu.

B) Click OK.

PC Remote will offer three options:

- Save User Presets, system files, and automation in plain text.

  This allows the presets and files to be read with any text editor program and to be readily exchanged between Optimod users.

- Save User Presets, system files, and automation files using the session passcode to encrypt them.

- Save User Presets, system files, and automation files using the password of your choice to encrypt them.

The encryption options prevent archived presets, system files, and automation files from being restored if the user does not have the password used for the encryption. *There is no "back door"— Orban cannot help you to decrypt a preset whose password is unknown.*

All User Preset, system, and automation files are copied from your Optimod's internal memory to a folder called "backup" on your PC. This folder is a subfolder of the folder named the same as the alias of the Optimod that you are backing up.

This folder name ("backup") and location are hard-coded into the software. If you wish to move the backup files somewhere else later, use a file manager (like Explorer) on your computer.

To make more than one backup archive, rename the current backup folder (for example, to "Backup1"). 5500i PC Remote will create a new backup folder the next time you do a backup, leaving your renamed backup folder untouched. Later, you will be able to restore from any folder — the Restore dialog box allows you to choose the folder containing the files to be restored

If you attempt to back up a preset with the same name as a preset existing in the Backup folder, but with a different date, 5500i PC Remote will warn you and will allow you to overwrite the preset in the Backup folder or to cancel the operation. If you wish to keep the existing archived preset, you can first use a file manager to move the existing user preset in the Backup folder to another folder and then repeat the backup operation.

To restore archived presets, system files, and automation files:

In addition to restoring an archived preset to its original Optimod, you can also copy archived presets from one Optimod to another. The Optimod whose connection is active will receive the preset.

If the preset, system file, or automation file was encrypted when it was originally saved, PC Remote will request the password under which it was encrypted.

All User Presets are compatible with all 5500i software versions. If Orban adds new controls to a software version, the new software will assign a reasonable default value to any control missing in an old User Preset. If you archive such a User Preset after restoring it, the newly written archive file will now include the new controls (with the default values, unless you edit any of these values before you re-archive the preset).

A) Select RESTORE FROM PC from the FILE menu.

A standard Windows dialog box will open.

B) Select the type of files you want to restore using the FILES OF TYPE field at the bottom of the dialog box.

You can elect to restore all user presets (*.orb55user, *.orbu), 5500i user presets (*.orb55user), 8400 user presets (*.orbu), system files (*.orb55setup), and automation files (*.orb55autom).

If you want to restore files from a different directory (i.e., that might have been created on a different 5500i), navigate to that directory from

within the dialog box.

C) To restore a single user preset:

a) Set the FILES OF TYPE field to a user preset file type (*.orb55user, *.orbu).

b) Select the desired preset in the dialog box.

c) Click the RESTORE button.

D) To restore all the user presets from a specific location:

a) Set the FILES OF TYPE field to a user preset file type (*.orb55user, *.orbu)

b) Highlight all the user presets in the dialog window

c) Click the RESTORE button.

E) To restore a system file:

a) Set the FILES OF TYPE field to the System Setup file type (*.orb55setup).

b) Select the desired system file in the dialog box.

c) Click the RESTORE button.

F) To restore an automation file:

a) Set the FILES OF TYPE field to the Automation file type (*.orb55autom)

b) Select the desired automation file in the dialog box

c) Click the RESTORE button.

G) Click DONE to dismiss the RESTORE dialog box.

To share an archived User Preset between 5500is:

A) Navigate to the directory containing the desired User Preset from within the RESTORE FROM PC dialog box

B) Click the RESTORE button.

This User Preset will be downloaded to the 5500i to which 5500i PC Remote is currently connected.

If the User Preset is encrypted, PC Remote will request its password.

To modify INPUT/OUTPUT and SYSTEM SETUP:

Choose SETUP from the TOOLS menu.

To set a control, click it (it will become highlighted) and then use the wheel on the mouse to adjust it. You can also use the + and – keys on the numeric keypad to adjust any control.

To modify AUTOMATION:

A) Choose AUTOMATION from the TOOLS menu.

An Automation Dialog box will open.

B) Click the NEW EVENT to create a new event

Controls to set the event type and time are available on the right hand side of the dialog box.

C) Check the ENABLE AUTOMATION check box at the top of the dialog box to enable automation.

To group multiple 5500is:

Right-click ALL CONNECTIONS in the Connections List and select NEW GROUP.

You can add multiple 5500i to a single group to help organize a network of 5500i. However, only one 5500i from within a group can be connected to 5500i PC Remote at any one time.

Operation Using the Keyboard

As far as possible, PC Remote uses standard Windows conventions for navigation.

Navigate around the screens using the TAB key. Use CTRL-TAB to move to the next tabbed screen in PC Remote.

Use the + and – keys or the left and right arrow keys on the numeric keypad to adjust control settings.

To Quit the Program

Use standard Windows conventions: Press ALT-F4 on the keyboard, or click the X on the upper right corner with the mouse.

Also, please note the following behavior:

- If you close the PC Remote connection from the PC, you will be given the choice of staying connected through the ppp or disconnecting.
- If you close the connection from PC Remote but choose not to close the ppp connection, the END PC REMOTE button will remain displayed on the 5500i's front panel. If you then select that button, the ppp connection will close.

This behavior ensures that a user can tell from the 5500i's front panel if a remote connection is active. A user can disconnect the PC connection at the 5500i if he or she wishes. This minimizes the likelihood of someone's leaving a connection open while someone else tries to access that 5500i.

About Aliases created by Optimod 5500i PC Remote Software

When you ADD A NEW 5500I using Optimod 5500i PC Remote, your 5500i is automatically given a 5500i Alias name to differentiate it from other 5500is. You can change the name anytime in the 5500i Properties window inside 5500i PC Remote.

When you add a new 5500i or change the name of an existing 5500i Alias, an Alias folder is created in the same location as the executable for Optimod 5500i PC Remote (usually \Program Files\Orban\Optimod 5500i). The folder has the same name as the Alias name. Once you establish the initial connection to the 5500i, all presets for that 5500i are automatically copied to the Alias folder; thus, the folder contains all the preset files for that 5500i, both Factory and User. If you have backed up the 5500i using 5500i PC Remote, there will also be a "backup" subfolder located within the Alias folder.

> Archived user preset files are text files and can be opened in a text editor (like Notepad) if you want to examine their contents.

Alias folders and their associated backup subfolders are registered in your PC's Registry. This prevents folders from being accidentally deleted or moved. If you move or delete Alias folders from the PC, the Alias folders recreate themselves in the previous location and restore their contents by copying it from their associated 5500is when 5500i PC Remote connects to such a 5500i.

Multiple Installations of Optimod 5500i PC Remote

Rarely, you may want to have more than one installation of 5500i PC Remote on your computer. There are a few extra things to know if you have multiple installations.

If you install a new version of the Optimod 5500i PC Remote software on your PC, any Alias folders and backup subfolders created in an earlier software version still remain in their original location on your PC (and in its registry).

The version of 5500i PC Remote must match the version of the software in the 5500i controlled by it. Therefore, you will only need multiple installations of PC Remote (having separate version numbers) if:

- you are controlling multiple 5500is, and
- not all of your 5500is are running the same version of 5500i software, and
- you do not want to upgrade at least one controlled 5500i to the latest version of 5500i PC Remote software.

Each version of 5500i PC Remote has its own top-level folder, normally under \Program Files\Orban. (The default folder is \Program Files\Orban\Optimod 5500i.) When you install a new version of 5500i PC Remote, the default behavior is to overwrite the old version, which is usually the desired behavior. To prevent the installer from overwriting the old version, you must specify a different installation folder

when you install the new version (for example, \Program Files\Orban\Optimod 5500iv2).

Each version of 5500i PC Remote will display *all* 5500i Aliases, even those pointing to 5500is with incompatible version numbers. If you attempt to connect to an older version of 5500i from a newer version of 5500i PC Remote, 5500i PC Remote will offer to upgrade the software in the target 5500i so that it corresponds to the version of 5500i PC Remote that is active. If you attempt to connect to newer version of 5500i from an older version of 5500i PC Remote, it will refuse to connect and will emit an error message regarding incompatible versions.

If you decide to install the new software to a different location on your PC, new Aliases created using the new software will not be located in the same place as the old Aliases.

To Move Alias Folders:

Even though each version of 5500i PC Remote can see all aliases, you may wish to move the corresponding folders so they are under the folder corresponding to the highest version of 5500i PC Remote that is currently installed on your computer (although this is not required). If your Alias folders reside in different locations, you can move all the Alias folders to the same location by using the PC Remote software. *Do not use an external file manager to do this.* The old Alias folders need to be recreated under the Optimod 5500i PC Remote software you wish to use (so that the registry entries can be correctly updated). You can do this two different ways.

- **Rename the Alias** (preferred): Start the Optimod 5500i PC Remote executable you wish to use and rename your old Aliases with a slightly different name. A new Alias folder with the new name will be created in the same location as the Optimod 5500i PC Remote executable.

- **Delete and Recreate the Alias:** Start the Optimod 5500i PC Remote executable you wish to use. Delete the old 5500i Aliases and create new ones to replace them. New Alias folders will be created in the same location as the Optimod 5500i PC Remote executable.

  Important: The deletion process will automatically erase its associated folder, including the Backup directory. If you have anything in the Backup directory that you wish to keep, you should therefore move that directory elsewhere (or transfer the desired files to another, active backup directory).

  The erasure process will usually move the Backup directory to your computer's Recycle Bin, so you can recover a Backup directory that you have accidentally deleted in this way.

To Import Archived 8300, 8400, 8500 and 5500i Presets into Your 5500i

The 5500i shares some signal processing technology with Orban's Optimod-FM 8300, 8400, 8500 and 5500i[1]. However, the 5500i has fewer features. Using 5500i PC Remote software, you can import into the 5500i any User Presets that you archived using the 8400, 8300, 8500 or 5500i PC Remote software. If you try to import such an "8400 preset" using 8400 features that 5500i does not support, the 5500i will interpret the preset as best it can using 5500i features:

- The 5500i's "optimum" signal processing is equivalent to 8400's "low latency" processing. Therefore, the 5500i does not have look-ahead available in the multiband compressor/limiter. Its only available bass clipper mode is "hard low-latency" (to use 8400 terminology). It is thus somewhat quieter than the 8400 (operated in its normal latency mode) for a given level of distortion.

  A) The 5500i will always interpret the 8400 LOOK AHEAD parameter as set to OFF.

  B) The 5500i will always interpret the 8400 BASS CLIP MODE parameter as set to LL HARD.

Unless they use the features noted below, 8400 "Low Latency" presets will import correctly into the 5500i:

- The 5500i's stereo enhancer offers only "Orban 222-style" enhancement. Therefore, the 5500i will always interpret the 8400 STYLE parameter as set to 222. It will ignore the DIFFUSION and DEPTH parameters.

- The 5500i's multiband compressor/limiter cannot be operated in dual-mono or partially coupled mode. It is always fully stereo-coupled.

  A) The 5500i will always interpret the 8400 MB DOWNEXPSTCPL parameter as set to COUPLE.

  B) The 5500i will always interpret the 8400 BXMAXIMUM DELTA GAIN REDUCTION parameter as set to "0" (i.e., fully coupled).

  The 5500i's AGC is capable of dual-mono mode, so, unlike the multiband compressor/limiter coupling parameters, the 5500i interprets all 8400 AGC coupling parameters normally.

- The 5500i's 19 kHz protection filter is always ON. Therefore, the 5500i will always interpret the 8400 PILOT PROTECT parameter as set to ON.

The following differences between the 5500i and other Optimod-FMs do not affect the 5500i's ability to import these presets, but are included here for reference.

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[1] 5500i version 1.0 software does not support import of 5500i "MX" presets, which use the 5500i's improved peak limiter and have a different control set than 8300, 8400, 8500, and non-"MX" 5500i presets..

- The 5500i's "ultra-low latency" processing uses 8200 clipping technology, updated with anti-aliased clippers operating at 256 kHz sample rate. This mode is not available on the 8400 but is available on the 8300, 8500, and 5500i. It is available on the 5500i because one application of the 5500i is to replace the 8200 in installations requiring the very low delay (in the range of the 8200's delay). The 5500i can import 8300 and 8500 ultra-low latency user presets and run them without compromise.
- Switching between an "optimum" or "two-band" preset and an "ultra-low latency" preset requires re-loading DSP code, which causes a two-second audio mute in the 5500i. However, no mute occurs when switching between an "optimum" and "two-band" preset. In the 8400, all processing structures are simultaneously active and no audio mute occurs when switching between them.

Section 4
Maintenance

Routine Maintenance

The 5500i 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 5500i's output.**

   A good ear will pick up many faults. Familiarize yourself with the “sound” of the 5500i as you have set it up, and be sensitive to changes or deterioration. However, if problems arise, please do not jump to the conclusion that the 5500i 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 5500i 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 is soiled.**

   Wash the front panel with a mild household detergent and a damp cloth. Do not use stronger solvents; they may damage plastic parts, paint, or the silk-screened lettering. Do not use paper-based cleaning towels, or use cleaning agents containing ammonia, or alcohol. An acceptable cleaning product is “Glass Plus.” For best results when cleaning the lens, use a clean, lint-free cloth.

Subassembly Removal and Replacement

See page 6-27 for the *Circuit Board Locator and Basic Interconnections* diagram.

1. Removing the Top Cover:

To access any internal board (including the display assembly), you must remove the top cover.

A) Disconnect the 5500i and remove it from the rack.

Be sure power is disconnected before removing the cover.

Warning: Hazardous voltage is exposed with the unit open and the power ON.

B) Set the unit upright on a padded surface with the front panel facing you.

C) Remove all screws holding the top cover in place, and lift the top cover off.

Use a #1 Phillips screwdriver.

2. Removing the Front Panel Assembly:

A) Detach the cables that connect the display board assembly to the control board. Avoid bending or breaking the pins. Note the lead dress so you can re-assemble the unit correctly.

B) Detach the front panel from the unit.

a) On each side of the chassis, remove the three screws close to the front panel.

b) Remove the front panel by sliding it out.

C) Set the front panel, face down, on a soft cloth to prevent scratches.

D) Using a 3/16-inch hex nut driver, remove the four hex nuts holding the two side brackets and central shield to the front panel. Remove the brackets and shield and set them aside.

E) Using a #1 Philips screwdriver, remove and reserve the eight screws and spacers that fasten the display board assembly to the front panel.

F) Lift the display board assembly off its supporting standoffs.

G) Separate the two boards in the display board assembly by carefully unplugging the top board from the bottom board. Note that there are four plugs and jacks.

3. Removing the Composite/SCA daughterboard.

A) Unplug the cable connecting the Composite/SCA daughterboard to the I/O-DSP board.

B) Using a deep hex nut driver (preferred), a small crescent wrench, or a pair of slip-joint pliers (in an emergency), remove the nuts and lockwashers holding the four BNC connectors to the chassis.

The Composite/SCA daughterboard can now be removed.

4. Removing the Control board:

A) If you have not yet done so, remove the top cover and Composite/SCA daughterboard (steps 1 and 3, above).

B) Using a 3/16-inch hex nut driver, remove the four hex nuts holding the DB-25 and DB-9 connectors to the rear panel of the chassis.

C) If you have yet not done so, remove the cables that connect the display assembly to the control board (step 2 on page 4-2).

D) Disconnect the ribbon cable connecting the control board to the I/O+DSP board.

E) Disconnect the short two-conductor cable that connects the control board to the I/O+DSP board.

F) Using a #1 Philips screwdriver, remove the four corner screws holding the control board to the chassis standoffs.

G) The control board is now free and can be removed from the chassis.

5. Removing the I/O+DSP (Input/Output+DSP) Board:

A) If you have not yet done so, remove the top cover (steps 1 above).

B) Unlock all XLR connectors: Using a jeweler's screwdriver, engage the locking mechanism (in the center of the triangle formed by the three contact pins) and turn counterclockwise until the XLR connector is no longer attached.

C) Using a deep hex nut driver (preferred), a small crescent wrench, or a pair of slip-joint pliers (in an emergency), remove the nut and lockwasher fastening the BNC connector to the chassis.

D) If you have not yet done so, disconnect the ribbon cable that connects the I/O+DSP board to the control board.

E) If you have not yet done so, disconnect the short two-conductor cable that connects the I/O+DSP board to the control board.

F) Disconnect the cable connecting the power supply to the I/O+DSP board. There are two connectors; unplug both. Note the lead dress so you can reassemble the unit correctly.

G) If you have not yet done so, disconnect the cable going to the Composite/SCA daughterboard.

H) Remove the thirteen #1 Phillips screws (and their washers) that connect the I/O+DSP board to the chassis.

I) Carefully pull the I/O+DSP board toward the front panel to clear the XLRs from their housings. Then lift the board out of the chassis.

6. Removing the Power Supply:

IMPORTANT: The power supply has no user serviceable components because replacing components with other than exact replacements could cause the supply to become unsafe and/or to generate unacceptable EMI that violates FCC and/or CE regulations. If the power supply fails, please contact Orban Customer Service (custserv@orban.com) to obtain an exact replacement.

Verify that the 5500i is disconnected from the AC line.

A) If you have not yet done so, remove the top cover (step 1, above).

B) Remove the screw holding the power supply's insulating cover and remove the cover. For safety, this cover must always be in place when the 5500i is connected to the AC line.

C) Remove the plug that connects the power supply to the AC line socket.

D) Unplug the cable connecting the output of the power supply to the I/O+DSP board.

E) Using a hex nutdriver, remove the threaded standoff that supports the power supply's insulating cover.

F) Remove the three Phillips screws holding the power supply to the main chassis.

G) Carefully lift the power supply up to remove it.

7. Reattaching the Power Supply:

A) Set power supply into main chassis, so that it aligns with its associated standoffs.

B) Thread, but do not tighten, the three Phillips screws that hold the power supply board to the main chassis.

C) Thread the long threaded standoff in the remaining mounting hole. Tighten it firmly.

D) Tighten the three Phillips screws that hold the power supply board to the main chassis.

E) Reattach the plug that connects the power supply to the AC line socket.

F) Reattach the cable that connects the power supply board to the I/O+DSP board.

G) Secure the insulating cover to the long standoff. **This cover must be replaced for safety.**

8. Replacing the Control board and I/O Board+DSP board:

Referring to steps 4 and 5, follow the instructions in reverse.

9. Replacing the Composite/SCA Daughterboard

Referring to step 3, follow the instructions in reverse.

10. Replacing the Front Panel Assembly:

A) Set the front panel, face down, on a soft cloth to prevent scratches.

B) Lightly reattach the bottom and top circuit boards by mating the four plugs and jacks. Use care to align the pins with the jacks so that all pins are correctly aligned and no pins are bent. Do not push the pins all the way into the jacks yet; leave room between the upper and lower boards for spacers.

C) Reattach the board assembly to the front panel using the eight #1 Philips-head screws and spacers removed in step (2.E) on page 4-2:

a) Thread each screw through a spacer placed between the upper and lower circuit boards.

b) Push down the top board until it rests on the spacers.

c) Align the screws with the threaded standoffs on the front panel.

d) Evenly tighten all eight screws to reattach the board assembly to the panel.

D) Place the two side brackets over the captive screws located on each side of the front panel. Be sure that the large side of each bracket is oriented toward the rack-screw cutouts in the panel.

E) Place the metal shield over the captive screws on each side of the front panel. Align the shield so that its cutouts are aligned with the cables attached to the circuit board assembly. Using a 3/16" nut driver, screw four hex nuts onto the captive screws.

F) Attach the front panel assembly to the unit:

a) Verify that all cables are dressed through cutouts in the shield.

b) Slide the front panel assembly into the front of the chassis so that the three threaded holes in the side brackets line up with the holes in the sides of the chassis.

c) Attach the front panel assembly by screwing the six screws removed in step (2.B)a) on page 4-2 into the holes in the sides of the chassis.

G) Reattach the four cables that connect the display board to the control board. Each cable has a different type or size of connector, so it is obvious which cable mates with which jack on the control board.

Carefully align the cables and connectors to avoid bending the pins.

11. Replacing the Top Cover:

Place the cover on the unit and reinstall the Phillips screws. (Be careful not to pinch any cables.)

Field Audit of Performance

Required Equipment:

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

  With verified residual distortion below 0.01%. 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

  Stanford Research Systems SR760 or equivalent. Alternatively, a sweep generator with 50-15,000 Hz 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 Two.

- Digital voltmeter

  Accurate to ±0.1%.

- Oscilloscope

  DC-coupled, triggered sweep, X/Y display-capable with 10 MHz or greater vertical bandwidth.

- Optional: Audio Precision System 1 (without digital option) or System 2 (for digital tests).

- Optional: NTI Audio Digilyzer DL1 for digital output tests

- Optional: Synthesized 10 MHz function generator for sync tests

  Stanford Research Systems DS340 or equivalent.

The technician should be thoroughly familiar with the operation of this equipment.

This procedure is useful for detecting and diagnosing problems with the 5500i's performance. It includes checks of frequency response, noise and distortion performance, and output level capability.

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, there is a high probability that the DSP 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. For example, in a high RF field it is very difficult to accurately measure the very low THD produced by a properly operating 5500i at most frequencies. However, in an emergency it is usually possible to detect many of

the more severe faults that could develop in the 5500i circuitry even in high-RF environments.

See the assembly drawings in Section 6 for component locations.

Be sure to disconnect the AC line cord before removing or installing circuit boards.

Follow these instructions in order without skipping steps.

Note: To obtain an unbalanced output, jumper pin 1 (ground) to pin 3, and measure between pin 1 (ground) and pin 2 (hot).

Note: All analog output measurements are taken with a load resistance of 10K or higher, corresponding to the modern practice of terminating analog lines with a bridging load.

1. Test the power supply

The power supply is a module. In case of any power supply failure, the entire supply must be replaced by an exact replacement (available from Orban Service). Attempts to repair the supply on a component level and/or to replace the supply with a non-approved supply may compromise your Optimod's compliance with the EMI and safety regulations in your country.

The +3.3V, +1.2V, and +2.5V supplies are locally regulated on the DSP and control boards (see Section 6).

Measure the power supply's regulated voltages at the DVM and observe the ripple with an oscilloscope, AC-coupled. Convenient sources of these voltages are the inductors adjacent to power supply connectors on the I/O+DSP board. Connect your probe to the sides of the inductors away from the power supply connectors. The results in Table 4-1 are typical.

Power Supply Rail	DC Voltage (volts)	AC Ripple (mV p-p)
+15VDC	+15 ± 0.5	<20
–15VDC	–15 ± 0.5	<20
+5VDC	+5 ± 0.25	<20

Table 4-1: Typical Power Supply Voltages and AC Ripple

2. Prepare the unit for audio measurements.

A) Use the front panel controls to set the 5500i's software controls to their default settings as follows:

a) Navigate to *Setup* > I/O CALIB > ANLG IN CALIB. After writing down the old settings (so you can restore them later) or saving them via PC Remote, set controls as follows:

INPUT ..... analog
AI Ref VU ..... 0.0 dBu
R CH BAL.....0.0 dB

b) Navigate to *Setup* > I/O CALIB > DIG IN CALIB. Set controls as in the table below:

DI REF VU ..... –15.0 dBFS
R CH BAL ..... 0.0 dB

c) Navigate to *Setup* > I/O CALIB > ANLG OUT CALIB. Set controls as follows:

AO 100% ..... +10.0 dBu
AO PRE-E ..... Flat
AO SOURCE ..... FM

d) Navigate to *Setup* > I/O CALIB > DIG OUT CALIB. Set controls as follows:

DO 100% ..... –2.8 dBFS
DO PRE-E ..... flat
DO RATE ..... 32 kHz
DO SOURCE ..... FM
DO SYNC ..... PILOT SYNC
PILOT SYNC ..... Internal
DITHER ..... In
FORMAT ..... AES

e) Press the *Next* button. Set controls as follows:

WORD LENGTH 20

f) Navigate to *Setup* > STEREO ENCODER. Press the *Next* button. Set the ITU412 control to OFF.

g) Navigate to *Setup* > TEST. Set controls as follows:

MODE ..... Bypass

NOTE: Bypass defeats all compression, limiting, and program equalization, but retains the selected pre-emphasis (either 50µs or 75µs).

BYPASS GAIN ..... 0.0 dB
TONE FREQ ..... 400 Hz
TONE LVL 91%

h) Press the *Next* button.

i) Set controls as follows:

TONE CHAN ..... L+R
PILOT ..... ON

3. Adjust Analog Output Level Trim.

A) Verify 5500i software controls are set to their default settings. [Refer to step (2.A) on page 4-7.]

B) Feed the 5500i output with the built-in 400 Hz test tone:

a) Navigate to *Setup* > TEST.

b) Set the MODE to TONE.

C) Connect the audio voltmeter to the Left Analog Output.

D) Adjust output trim VR301 to make the meter read +10.0 dBu. (0 dBu = 0.775V rms.) Verify a frequency reading of 400 Hz.

E) Verify THD+N reading of <0.03% (<0.01% typical) using a 22 kHz low pass filter in the distortion analyzer.

F) Set the MODE to BYPASS.

BYPASS defeats all compression, limiting, and program equalization but retains pre-emphasis.

G) Verify a reading (noise) of <–80 dBu at the output of the unit.

H) Using VR302, repeat steps (C) through (G) for the Right Analog Output.

4. Check frequency response of Analog I/O.

A) Verify 5500i software controls are set to their default settings. [Refer to step (2.A) on page 4-7.]

B) Be sure you are still in BYPASS mode and that the BYPASS GAIN = 0.0 dB [see step (3.F)].

C) Connect the oscillator to the Left Analog Input XLR connector.

D) Inject the Analog Input XLR connector with a level of +10 dBu with the oscillator set to 100 Hz.

This is 17 dB below the clip level, which allows headroom for pre-emphasis. (75µs pre-emphasis will cause 17 dB of boost at 15 kHz.)

E) Connect the audio analyzer to the 5500i's Left Analog Output XLR connector.

F) Verify a level of 0 dBu ±1 dB. Use this level as the reference level.

G) Verify that frequency response at 50 Hz, 100 Hz, 400 Hz, 5 kHz, and 15 kHz is within ±0.1 dB of the reference level. Figure 4-1 shows a typical result.

This procedure tests the analog input circuitry, the A/D converter, the

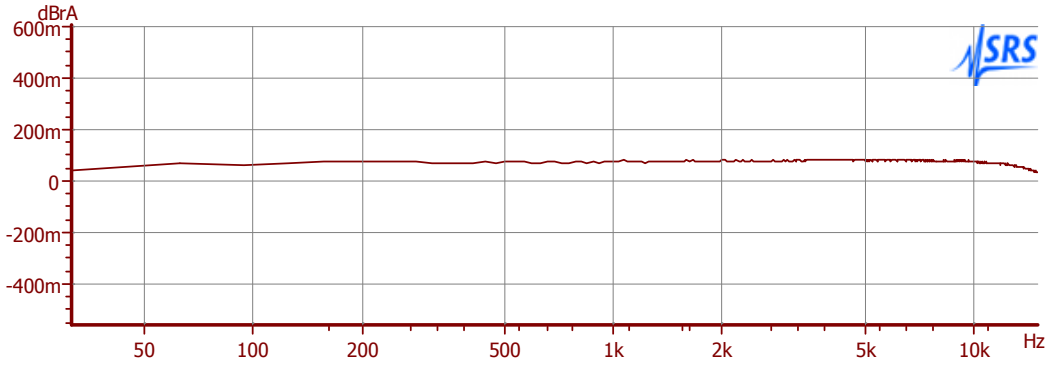

Figure 4-1: Typical Frequency Response, 30Hz to 15 kHz

DSP, the D/A converter, and the analog output circuitry.

H) Repeat steps (C) through (G) for the right channel.

5. Check distortion performance of Analog I/O.

A) Verify 5500i software controls are set to their default settings. (Refer to page 4-7.)

B) Be sure you are still in BYPASS mode [see step (3.F)] and set the BYPASS GAIN to +17.0 dB.

C) Set the AO 100% control to +20 dBu.

D) Connect a THD analyzer to the Left Analog Output XLR connector. Set the THD analyzer's bandwidth to 22 kHz.

E) Connect the oscillator to the Left Analog Input XLR connector. Set its frequency to 50 Hz and its output level to +10 dBu. This should produce a level of approximately +18 dBu at the 5500i's output.

F) For each frequency used to measure THD, adjust the output level of the oscillator to make the COMP meter on the 5500i read 100. You will have to reduce the output level of the oscillator at higher frequencies to compensate for the pre-emphasis boost in the 5500i. As the frequency increases, you will have to reduce the output level of the generator to follow the 75µs deemphasis curve. At 15 kHz, you should have to reduce the output of the generator to approximately –7 dBu.

G) Measure the THD+N at the frequency levels listed below.

Frequency	THD+N Typical	THD+N Maximum
50 Hz	0.015%	0.03%
100 Hz	0.015%	0.03%
400 Hz	0.015%	0.03%
1 kHz	0.015%	0.03%
2.5 kHz	0.015%	0.03%
5 kHz	0.015%	0.03%
7.5 kHz	0.015%	0.03%
10 kHz	0.015%	0.03%
15 kHz	0.015%	0.03%

H) Repeat the above measurements for the right channel. Connect the oscillator to the right analog input and the distortion analyzer to the right analog output.

I) Disconnect the oscillator and THD analyzer from the 5500i.

6. Test Digital Sample Rate Converter (Receiver).

A) Verify 5500i software controls are set to their default settings. (Refer to page 4-7.)

B) Be sure you are still in BYPASS mode [see step (3.F)].

C) Navigate to *Setup* > I/O CALIB > DIG IN CALIB.

D) Set the INPUT to DIGITAL.

E) Connect the digital source generator to the AES3 Digital Input XLR connector of the 5500i.

F) Set the frequency of the digital source generator to 400 Hz and its output level to 18 dB below full scale.

G) Inject the Digital Input with sample rates of 32 kHz, 44.1 kHz, 48 kHz, 88.2 kHz, and 96 kHz. Use 24-bit words.

H) Listen to the analog outputs of the 5500i and verify that the output sounds clean and glitch-free regardless of the input sample rate.

I) Leave the digital source generator connected to the 5500i.

7. Test Digital Sample Rate Converter (Transmitter).

A) Connect an AES3 analyzer (like the Audio Precision System 2) to the AES3 Digital Output XLR connector of the 5500i.

B) Set the sample rate of the digital source generator to 48 kHz.

C) Navigate to *Setup* > I/O CALIB > DIG OUT CALIB.

D) Change the DO RATE to 32 kHz, 44.1 kHz, 48 kHz, 88.2 kHz, and 96 kHz, and verify that the frequencies measured at the 5500i's AES3 Digital Output follow the values in the chart below within given tolerances:

Sample Rate	Tolerance (PPM)	Tolerance (Hz)
32.0 kHz	100 PPM	±3.20 Hz
44.1 kHz	100 PPM	±4.41 Hz
48.0 kHz	100 PPM	±4.80 Hz
88.2 kHz	100 PPM	±8.82 Hz
96.0 kHz	100 PPM	±9.60 Hz

E) Disconnect the digital source generator from the 5500i.

8. Test the 5500i's synchronization capabilities.

A) Navigate to *Setup* > I/O CALIB > DIG OUT CALIB.

B) Press the *Next* button. Set the 5500i's PILOT SYNC control to REF IN.

C) Sequentially apply a 32kHz, 44.1 kHz, 48 kHz, 88.2 kHz, and 96 kHz 1x wordclock signal to the 5500i's REF IN connector. For each sample frequency, set the 5500i's DO RATE control the same as the wordclock. Vary the frequency of the input reference slightly and verify that the sample frequency at the 5500i's digital output tracks the changes you make to the reference frequency.

This test is most readily accomplished by using a synthesized function generator with a crystal-controlled timebase. Such a generator can also generate a 10 MHz reference signal for the next step.

An analog oscilloscope can be used for a more thorough test. Set the scope for X/Y operation (i.e., so that it generates Lissajous patterns). Connect the reference generator to one input and the 5500i's digital output to the other input. If correct synchronization is occurring, you should see an essentially stationary (although complex-looking) Lissajous pattern as opposed to one that precesses slowly either left or right. This should be true at any combination of input and output sample frequencies and a thorough test will test every permutation.

This test verifies that for non-identical reference and output sample frequencies (for example, locking a 32 kHz output sample rate to a 48 kHz wordclock), the output and input sample rates are exactly a ratio of integers. In the example, the output sample rate is exactly 2/3 of the wordclock frequency.

A digital oscilloscope is unlikely to work satisfactorily for this test.

D) Connect either a source of 1x wordclock (a TTL-level squarewave at the sample frequency) or a high-accuracy 10 MHz sinewave or squarewave generator to the 5500i's REF IN BNC connector. Vary the frequency of the reference input by ±25 ppm and verify that the 5500i's output sample rate tracks it. See the comments in step (C) above.

E) Set the 5500i's PILOT SYNC control to DIG IN.

F) Sequentially apply AES3 or AES11 signals having 32kHz, 44.1 kHz, 48 kHz, 88.2 kHz, and 96 kHz sample frequencies to the 5500i's AES3 Digital Input. Using the oscilloscope technique described in step (C) above, verify that for each input sample frequency, any 5500i output sample frequency (as set via the DO RATE control) will lock to any reference sample frequency.

G) Disconnect the generator from the 5500i's REF IN connector.

H) Set the PILOT REF control to INTERNAL.

9. Test the 5500i's stereo encoder.

A) Connect an accurate stereo monitor like the Belar FMMS-1 ("Wizard") stereo demodulator to the COMPOSITE OUTPUT 1 BNC on the 5500i's rear panel.

NOTE: The recommended Belar monitor is the only instrument we have encountered that can accurately measure the performance of the 5500i's stereo encoder. With most older-technology monitors, you will be measuring the performance of the monitor, not the 5500i's encoder. (Of course, we have not evaluated every monitor on the market.) While we have not yet tested it, we are confident that the Belar FMCS-1 (a newer model than the FMMS-1) will also work correctly.

B) On the 5500i, navigate to *Setup* > TEST.

C) Set the MODE to TONE.

D) Set the test tone parameters as follows:

TONE FREQ ..... 400 Hz
TONE LVL 91%
TONE CHAN ..... L+R
PILOT ..... On

You will have to press the NEXT button to access all of these parameters.

E) Navigate to *Setup* > STEREO ENCODER.

F) Set the COMP1 LVL control to make the stereo monitor read 100% total modulation.

G) Navigate to *Setup* > TEST to access the 5500i's tone oscillator parameters.

H) Measure the L–R level on the stereo monitor at several frequencies, in units of dB below 100% modulation. This is the main channel to subchannel crosstalk. It should not exceed –70 dB, 50-15,000 Hz.

I) Set the TONE CHAN to L–R. (You will have to press the *Next* button to access this setting and then the *Prev* button to return to the TONE FREQ control.) Measure the L+R level on the stereo monitor at several frequencies, in units of dB below 100% modulation. This is the subchannel to main channel crosstalk. It should not exceed –70 dB, 50-15,000 Hz.

J) Set the TONE CHAN to LEFT. Measure the Right level on the stereo monitor at several frequencies, in units of dB below 100% modulation. This is left-into-right stereo separation. It should not exceed –55 dB, 50-15,000 Hz.

K) Set the TONE CHAN to RIGHT. Measure the Left level on the stereo monitor at several frequencies, in units of dB below 100% modulation. This is right-into-left stereo separation. It should not exceed –55 dB, 50-15,000 Hz.

L) Set the TONE CHAN to L–R and the TONE FREQ to 5000.0 HZ. Measure the 38 kHz subcarrier suppression on the stereo monitor. It should not exceed –60 dB.

M) Measure the Pilot Modulation on the stereo monitor. It should read 0%.

N) Set *Setup* > STEREO ENCODER > COMP1 LVL to 0.0%. Measure the de-emphasized noise at the left and right outputs of the stereo monitor. It should not exceed –80 dB below 100% modulation.

O) Repeat steps (D) through (N) for the 5500i's COMPOSITE OUTPUT 2. (Use the COMP2 LVL control instead of the COMP1 LVL control.)

P) Using the stereo monitor, verify that pilot tone injection is between 8% and 10% modulation. If it is outside these parameters, adjust it to 9% via *Setup* > STEREO ENCODER > *Next* > PILOT LVL.

If the measured pilot level varies by more than a few tenths of percent from the pilot level indicated, this indicates there may be a problem elsewhere — either in your measuring setup, or with the 5500i.

Q) With the COMP2 LVL still set to 0.0%, connect a frequency counter to either of the 5500i's composite outputs. Verify that the pilot tone frequency is 19,000 Hz ±1 Hz.

10. Optional tests.

A) You can test each GPI (Remote Interface) input for functionality in the obvious way, by programming a function for it and then verifying that the function executes when you activate the input. To program a GPI input, see

Connecting to the 5500i's Ethernet Port or Serial Port via a Terminal Program on a PC on page 2-42.

B) You can test the RS-232 port for functionality by verifying that you can connect to a PC through a null modem cable. See *Networking and Remote Control* starting on page 2-50 (in particular, step 4 on page 2-52).

11. Return OPTIMOD-FM to service.

A) Restore your normal operating parameters, using the notes you made in step (2.A) on page 4-7. If you are using PC Remote and saved your normal operating parameters as a setup file, you can restore it using the FILE > RESTORE FROM PC command.

B) Navigate to *Setup* > TEST > MODE and choose OPERATE.

C) Recall your normal operating preset.

Section 5
Troubleshooting

Problems and Potential Solutions

Always verify that the problem is not the source material being fed to the 5500i, or in other parts of the system.

RFI, Hum, Clicks, or Buzzes

A grounding problem is likely. Review the information on grounding on page 2-10. The 5500i has been designed with very substantial RFI suppression on its analog and digital input and output ports, and on the AC line input. It will usually operate adjacent to high-powered transmitters without difficulty. In the most unusual circumstances, it may be necessary to reposition the unit to reduce RF interference, and/or to reposition its input and output cables to reduce RF pickup on their shields.

Particularly if you are using a long run of coaxial cable between the 8500 and the exciter, a ground loop may inject noise into the exciter's composite input—especially if the exciter's input is unbalanced. A Jensen JT-123-BMCF transformer can almost always cure this problem—see page 1-15.

The AES3 inputs and output are transformer-coupled and have very good resistance to RFI. If you have RFI problems and are using analog connections on either the input or output, using digital connections will almost certainly eliminate the RFI.

Unexpectedly Quiet On-Air Levels

The ITU412 multiplex power controller may have been turned on accidentally. See step 20 on page 2-21.

The 5500i may be in stand-alone stereo encoder mode. The active on-air preset determines this.

The 5500i may not be controlling peak modulation as desired. See the next topic below.

Poor Peak Modulation Control

First, check whether the final clipper is active (step 6 on page 2-31). If you are using the analog or digital output to drive the transmitter, make sure that this output is not receiving the MONITOR signal (step (8.B) on page 2-33).

The 5500i normally controls peak modulation to an accuracy of ±2%. This accuracy will be destroyed if the signal path following the 5500i has poor transient response. Almost any link can cause problems. Even the FM exciter can have insufficient flatness of response and phase-linearity (particularly at low frequencies) to disturb peak levels. Section 1 of this manual contains a complete discussion of the various things that can go wrong.

Digital STLs using lossy compression algorithms (including MPEG1 Layer 2, MPEG1 Layer 3, Dolby AC2, and APT-X) will overshoot severely (up to 3 dB) on some program material. The amount of overshoot will depend on data rate — the higher the rate, the lower the overshoot.

Even if the transmission system is operating properly, the FM modulation monitor or reference receiver can falsely indicate peak program modulation higher than that actually being transmitted if the monitor overshoots at high and low frequencies. Many commercial monitors have this problem, but most of these problem units can be modified to indicate peak levels accurately.

Orban uses the Belar "Wizard" series of DSP-based monitors internally for testing, because these units do not have this difficulty.

Unexpected Delay Between the Program Feed and the On-Air Signal

The diversity delay may have been accidentally applied to the output you are using to drive your transmitter. See step (7.E) on page 2-31 and step (8.B) on page 2-33.

Audible Distortion On-Air

Make sure that the problem can be observed on more than one receiver and at several locations. Multipath distortion at the monitoring site can be mistaken for real distortion (and will also cause falsely high modulation readings).

Verify that the source material at the 5500i's audio inputs is clean. Heavy processing can exaggerate even slightly distorted material, pushing it over the edge into unacceptability.

The subjective adjustments available to the user have enough range to cause audible distortion at their extreme settings. There are many controls that can cause distortion, including MULTIBAND CLIPPING, FINAL CLIP DRIVE, and COMPOSITE CLIP DRIVE. Setting the LESS-MORE control beyond "9" will cause audible distortion of some program material with all but the Classical and Protect presets. Further, the "Loud" family of presets can sometimes cause audible distortion with certain program material; this is the price to be paid for "competitive" loudness as it is defined in certain markets.

If you are using analog inputs, the peak input level must not exceed +27 dBu or the 5500i's A/D converter will clip and distort.

> Unlike earlier digital Optimods, there is no input peak level adjustment for the A/D converter. Instead, we have provided adequate headroom for virtually any facility. This is possible because the A/D converter in the 5500i has higher dynamic range than older designs. Therefore, without

compromising the 5500i's noise level, we could eliminate a control that was frequently misadjusted.

If you are using the 5500i's stereo enhancer (which most "pop music"-oriented presets do), then this can exaggerate multipath distortion in high multipath environments. You may want to reduce the setting of the stereo enhancer's RATIO LIMIT control. A similar problem can occur if you are using sum-and-difference processing in the 5500i's AGC. In this case, reduce the setting of the AGC's MAXDELTAGR controls.

If you are using an external processor ahead of the 5500i, be sure it is not clipping or otherwise causing problems.

If the 5500i is in stand-alone stereo encoder mode, you may be overdriving its left/right protection limiter and/or composite limiter. It is unwise to do more than 3 dB of gain reduction in the protection limiter or to set the COMPOSITE LIMIT DRIVE control higher than 1.0 DB. See *Setup for Stand-Alone Stereo Encoder Mode* on page 2-22.

Audible Noise on Air

(See also "RFI, Hums, Clicks, or Buzzes" on page 5-1.)

Excessive compression will always exaggerate noise in the source material.

The 5500i has two systems that fight this problem. The *compressor gate* freezes the gain of the AGC and compressor systems whenever the input noise drops below a level set by the threshold control for the processing section in question, preventing noise below this level from being further increased.

There are two independent compressor gate circuits in the 5500i. The first affects the AGC and the second affects the Multiband Compressor. Each has its own threshold control. (See MB GATE on page 3-50.)

In the Multiband structure, *dynamic single-ended noise reduction* (see DWNEXP THR on page 3-51) can be used to reduce the level of the noise below the level at which it appears at the input.

If you are using the 5500i's analog input, the overall noise performance of the system is usually limited by the overload-to-noise ratio of the analog-to-digital converter used by the 5500i to digitize the input. (This ratio is better than 108 dB.) It is important to drive the 5500i with professional levels (more than 0 dBu reference level) to achieve adequately low noise. (Clipping occurs at +27 dBu.)

The 5500i's AES3 input is capable of receiving words of up to 24 bits. A 24-bit word has a dynamic range of approximately 144 dB. The 5500i's digital input will thus never limit the unit's noise performance even with very high amounts of compression.

If an analog studio-to-transmitter link (STL) is used to pass unprocessed audio to the 5500i, the STL's noise level can severely limit the overall noise performance of the system because compression in the 5500i can exaggerate the STL noise. For example, the overload-to-noise ratio of a typical analog microwave STL may only be 70-75 dB.

In this case, it is wise to use the Orban 8200ST Studio AGC to perform the AGC function prior to the STL transmitter and to control the STL's peak modulation. This will optimize the signal-to-noise ratio of the entire transmission system. An uncompressed digital STL will perform much better than any analog STL. (See *Studio-Transmitter Link,* starting on page 1-16.)

Whistle on Air, Perhaps Only in Stereo Reception

The most likely cause is oscillation in the analog input or output circuitry. If the oscillation is in the output circuitry and is between 23 and 53 kHz, it will be detected in a receiver's stereo decoder and translated down into the audible range.

If you encounter this problem, check the analog or digital outputs with a spectrum analyzer to see if the spurious tone can be detected here. If it appears at both outputs, it is probably an input problem. If it only appears at the analog output, then it is likely a problem with the left/right D/A converter or other analog circuitry. If it appears only when you use the composite output, then it is likely a problem in the composite D/A converter or output amplifiers.

A whistle could also be caused by power supply oscillation, STL problems, or exciter problems.

Interference from stereo into SCA

A properly operating 5500i generates an immaculately clean baseband, with program-correlated noise below –80 dB above 57 kHz even when the composite limiter is used aggressively. If the 5500i and the rest of the transmission system are operating correctly, subcarriers should experience no interference.

Interference from the stereo into a subcarrier is best diagnosed with a spectrum analyzer. First examine the spectrum of the 5500i's composite output to verify that program correlated noise is less than –80 dB below 100% modulation from 57 to 100 kHz. Any inadvertent composite clipping will dramatically degrade this protection. Make sure that the link between the 5500i's composite output and the transmitter has sufficient headroom.

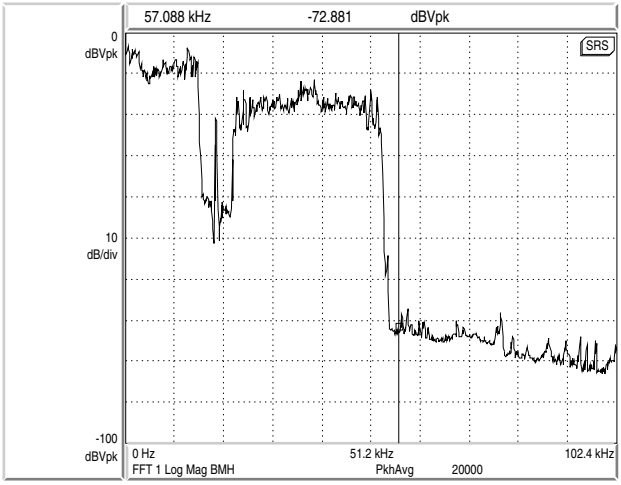

Figure 5-1: Typical 5500i baseband spectrum with heavy processing, 0-100 kHz.

If the exciter is nonlinear, this can cause crosstalk. In general, a properly operating exciter should have less than 0.1% THD at high frequencies to achieve correct operation with subcarriers.

To prevent truncation of the higher-order Bessel sidebands of the FM modulation, the RF system following the exciter must be wideband (better than ±500 kHz) and

must have symmetrical group delay around the carrier frequency. An incorrectly tuned transmitter can exhibit an asymmetrical passband that will greatly increase crosstalk into subcarriers.

Amplitude modulation of the carrier that is synchronous with the program ("synchronous AM") can cause program-related crosstalk into subcarriers. Synchronous AM should be better than 35 dB below 100% modulation as measured on a synchronous AM detector with standard FM de-emphasis (50µs or 75µs).

The subcarrier receiver itself must receive a multipath-free signal, and must have a wide and symmetrical IF passband and a linear, low-distortion FM demodulator to prevent program-related crosstalk into subcarriers.

If the 5500i is in stand-alone stereo generator mode, it is easy to accidentally drive its internal processing into clipping by applying too much level to the input while relying on the overshoot limiter and/or composite limiter to limit modulation to 100%. In addition, if the input signal has not been band-limited to 19 kHz or less, this can cause aliasing between the stereo main and subchannels. You can eliminate this aliasing (at the cost of overshoot, which the 5500i's overshoot limiter can remove) by activating the input lowpass filter (step 5 on page 2-24).

See *Setup for Stand-Alone Stereo Encoder Mode* on page 2-22.

Shrill, Harsh Sound

If you are using the Five-Band structure, this problem can be caused by excessive HF boost in the HF Equalizer and HF Enhancer. It could also be caused by an excessively high setting of the BAND 4 THRESH control, or by excessively high settings of the BAND 4 MIX and BAND 5 MIX controls (located in Intermediate and Advanced Modify).

If you are driving an external stereo encoder with built-in pre-emphasis, you must set the 5500i's output to Flat in the System Setup > Output screen to prevent double pre-emphasis, which will cause very shrill sound (and very poor peak modulation control).

You will *always* achieve better peak control by defeating the pre-emphasis and input filters of an external stereo encoder, permitting the 5500i to perform these functions without overshoot. Section 1 of this manual contains a detailed explanation of these, and other, system design considerations.

Dull Sound

If you are using the Two-Band structure, dull-sounding source material will sound dull on the air. The Five-Band structure will automatically re-equalize such dull-sounding program material to make its spectral balance more consistent with other program material.

If the 5500i's output is set to Flat in System Setup > Output, there will be no pre-emphasis unless it is supplied somewhere else in the system. This will cause very dull sound.

System Will Not Pass Line-Up Tones at 100% Modulation

This is normal. Sine waves have a very low peak-to-average ratio by comparison to program material. The processing thus automatically reduces their peak level to bring their average level closer to program material, promoting a more consistent and well-balanced sound quality.

The 5500i can generate test tones itself. The 5500i can also be put into Bypass mode (locally or by remote control) to enable it to pass externally generated tones at any desired level. (See *Test Modes* on page 3-55.)

System Will Not Pass Emergency Alert System ("EAS" USA Standard) Tones at the Legally Required Modulation Level

See *System Will Not Pass Line-Up Tones at 100% Modulation* (directly above) for an explanation. These tones should be injected into the transmitter after the 5500i, or the 5500i should be temporarily switched to BYPASS to pass the tones.

System Receiving 5500i's Digital Output Will Not Lock

Be sure that the 5500i's output sample rate is set match the sample rate that the driven system expects. Be sure that the 5500i's output FORMAT (AES3 or SPDIF) is set to match the standard expected by the driven system.

You See A "Communications Board Error" Message

This can be caused by applying an AES3, AES3id, AES11, or AES11id to the 10 MHz/wordclock input. Use the Optimod's AES3 digital input for AES3 sync sources.

19 kHz Frequency Out-of-Tolerance

First, verify that a problem really exists by using a second frequency-measuring device and/or verifying the problem with a monitoring service. If the problem is real, contact Orban Customer Service for a crystal replacement; there is no frequency trim available.

L–R (Stereo Difference Channel) Will Not Null With Monophonic Input

This problem is often caused by relative phase shifts between the left and right channels prior to the 5500i's input. This will cause innocuous linear crosstalk between the stereo main and subchannels. Such crosstalk does not cause subjective quality problems unless it is very severe.

Audio Mute Occurs When Switching Between UL and Non-UL Presets

This is normal. It occurs because the DSP code must be reloaded.

General Dissatisfaction with Subjective Sound Quality

The 5500i is a complex processor that can be adjusted for many different tastes. For most users, the factory presets, as augmented by the gamut offered by the LESS-MORE control for each preset, are sufficient to find a satisfactory "sound." However, some users will not be satisfied until they have accessed other Modify Processing controls and have adjusted the subjective setup controls in detail to their satisfaction. Such users *must* fully understand the material in Section 3 of this manual to achieve the best results from this exercise.

By comparison to competitive processors, the 5500i offers a uniquely favorable set of trade-offs between loudness, brightness, distortion, and build-up of program density. If your radio station does not seem to be competitive with others in your market, the cause is usually source material (including excess use of lossy digital compression), overshoot in the transmission link (including the FM exciter) following the 5500i, or an inaccurate modulation monitor that is causing you to under-modulate the carrier. A station may suffer from any combination of these problems, and they can have a remarkable effect on the overall competitiveness of a station's sound.

Section 1 of this manual provides a thorough discussion of system engineering considerations, particularly with regard to minimizing overshoot and noise.

Security Passcode Lost (When Unit is Locked Out)

Please see *If You Have Forgotten Your Passcode* on page 2-41.

Connection Issues between the 5500i and a PC, Modem, or Network

- **User Interface Slowdown**: The more user presets you make, the more slowly the 5500i will respond to front-panel commands. Delete any user presets you do not need.

- **Quick Setup**: On the Station ID screen (Quick Setup 9): Use Escape in place of Cancel. The Cancel button will not work.

- **Software Updates**: Close any running Windows programs before attempting to update.

- **Interrupted Software Updates**: If you canceled an update before it completed, wait at least one minute before attempting your next update.

- **Software Updates via Modem**: If you are updating via the modem, do not change the "connection type" parameter on the 5500i while the modem is connected or attempting to connect.

- **Security Passcode**: An ALL SCREENS (administrator) security passcode is required for upgrading, regardless of whether you are using a Direct, Modem, or Ethernet connection.

- **MAC Address**: To see the MAC address of your Optimod's Ethernet hardware, hold down the *Setup* button until the address appears.

Troubleshooting Connections

- If you get an error message such as "the specified port is not connected" or "There is no answer"…

You may have the wrong interface type set on your 5500i. Navigate to *Setup* > NETWORK & REMOTE > PC CONNEC and check the interface setting.

If you are connecting via Direct Serial Connection or modem, review the Properties you have set on that connection. Double-check to ensure that you have set Windows parameters as described in *Appendix: Setting Up Serial Communications* on page 2- 59.

- If your Direct Connect does not work:

  A) Check to make sure that the cables are connected properly.

  B) Check that you are using a null modem cable.

  C) Ensure that the null modem cable is connected to the 5500i's serial connector.

- If your Modem Connect does not work:

  A) Ensure that the modem cables and phone lines are connected properly.

  B) Check that you have entered the correct phone number for connection.

  C) Check that you have entered the passcode correctly on the 5500i, and the passcode has also been entered correctly on your PC.

  D) Ensure that you enabled the correct PC modem port settings.

  E) Ensure that the external modem attached to your 5500i is set to AUTO ANSWER.

  F) Make sure that the only "Allowed Network Protocol" is TCP/IP. "NetBUI" and "IPX/SPX Compatible" must *not* be checked.

You Cannot Access the Internet After Making a Direct or Modem Connection to the 5500i:

If you are connected to the 5500i via modem or direct connect, *you cannot access any other TCP/IP connection*. The PPP connection becomes the default protocol and the default gateway defaults to the 5500i unit's IP address. This means that all existing network connections point to the 5500i unit. To correct this:

A) In Start > Settings > Network and Dialup Connections, open the direct or modem connection you are using to connect to 5500i.

B) Select "Properties."

C) Click the tab that reads "Networking."

D) Highlight "Internet protocol (TCP/IP)."

E) Select "Properties."

F) Select "Advanced."

G) Uncheck the "Use default gateway on remote network" box.

H) Select "OK."

If this "Use default gateway on remote network" box is not selected, the

gateway will not point to the 5500i unit when you establish a direct or modem connection.

OS-Specific Troubleshooting Advice

Troubleshooting Windows 2000 Direct Connect:

If you are having trouble establishing a connection, check your New Connection's properties to make sure they are set up correctly:

A) Click "Start > Programs > Accessories > Communications > Network and Dialup Connections" to bring up the Network Connections screen.

B) In the "Network Connections" window, right-click "Optimod 5500i - Direct" and choose "Properties."

C) The "Properties" window opens for "Optimod 5500i - Direct

D) Click the "Networking" tab.

E) Set "Type of dial-up server I am calling" to "PPP: Windows 95/98/NT4/2000, Internet."

F) Select the "Settings" button and make sure all PPP settings are unchecked. Then click "OK."

G) In "Components checked are used by this connection," uncheck all except for "Internet Protocol (TCP/IP)."

H) Select "Internet Protocol (TCP/IP)" and then click the "Properties" button. The "Internet Protocol (TCP/IP) Properties" window opens.

I) Choose "Obtain an IP address automatically" and "Obtain DNS server address automatically"

J) Click the "Advanced…" button on the "Internet Protocol (TCP/IP)" Window.

K) In the "Advanced TCP/IP Settings" select the "General" Tab; make sure that no check boxes are checked.

L) In the "Advanced TCP/IP Settings" select the "DNS" Tab.

M) In the "Advanced TCP/IP Settings" select the "WINS" Tab.

N) Click "OK" to dismiss the "Advanced TCP/IP Settings" window.

O) Click "OK" to dismiss the "Internet Protocol (TCP/IP) Properties" window.

P) Click "OK" to dismiss the window whose name is your new connection.

Q) Click "Cancel" to dismiss the "Connect [nnnn]" dialog box

R) Restart your computer. (This resets the serial port and reduces the likelihood that you will encounter problems connecting to the 5500i.)

S) If you see: "Error 777: The connection failed because the modem (or other connecting device) on the remote computer is out of order":

The "remote computer" is actually the 5500i and it is not out of order; you just need to set the Maximum Speed (Bits per second) to 115200. If you already set this speed when you configured your PC ports, you shouldn't have this problem.

> The 5500i communicates at 115200 bps. COM ports on some older PCs are incapable of communications at this rate and may not work reliably. Most newer PCs use 16550-compatible UARTS, which support the 115200 bps rate.

If you do see this warning message, you can reset the Maximum BPS Speed by accessing PROPERTIES for the connection:

a) Click START > PROGRAMS > ACCESSORIES > COMMUNICATIONS > NETWORK AND DIAL-UP CONNECTIONS.

b) Right click the name of your connection and access "PROPERTIES."

c) Go to the "GENERALS" TAB and select the "CONFIGURE" button.

d) Set the MAXIMUM SPEED (BPS) to 115200.

e) Select OK and try your connection again.

T) If you see: "Error 619: The specified port is not connected."

Make sure the INTERFACE TYPE on the 5500i is correct:

a) On the 5500i, go to SETUP > NETWORK & REMOTE > PC CONNEC.

b) Set PC CONNECT to DIRECT.

c) Try your connection again.

Troubleshooting Windows 2000 Modem Connect:

If you are having trouble establishing a connection, check your New Connection's properties to make sure they are set up correctly:

A) Click "Start > Programs > Accessories > Communications > Network and Dialup Connections" to bring up the Network Connections screen.

B) In the "Network Connections" window, right-click "Optimod 5500i - Modem" and choose "Properties."

C) The "Properties" window opens for "Optimod 5500i – Modem".

D) Click the "Properties" button.

E) Select the "General" tab and make sure that "Connect Using" displays the correct modem and port.

F) Click the "Configure…" button.

G) Set the "Maximum Speed (bps) to 115200.

H) Check the “Enable hardware flow control,” make sure all other hardware features are unchecked. Then click “OK.”

I) Click the “Networking” tab on the “Properties” window.

J) Set “Type of dial-up server I am calling” to “PPP: Windows 95/98/NT4/2000, Internet.”

K) Select the “Settings” button and make sure all PPP settings are unchecked. Then click “OK.”

L) In “Components checked are used by this connection,” uncheck all except for “Internet Protocol (TCP/IP).”

M) Select “Internet Protocol (TCP/IP)” and then click the “Properties” button. The “Internet Protocol (TCP/IP) Properties” window opens.

N) Choose “Obtain an IP address automatically” and “Obtain DNS server address automatically”

O) Click the “Advanced…” button on the “Internet Protocol (TCP/IP)” Window.

P) In the “Advanced TCP/IP Settings” select the “General” Tab; make sure that no check boxes are checked.

Q) Click “OK” to dismiss the “Advanced TCP/IP Settings” window.

R) Click “OK” to dismiss the “Internet Protocol (TCP/IP) Properties” window.

S) Click “OK” to dismiss the window whose name is your new connection.

T) Click “Cancel” to dismiss the “Connect [nnnn]” dialog box

U) Restart your computer.

Although not strictly necessary, this resets the serial port and reduces the likelihood that you will encounter problems connecting to the 5500i.

Troubleshooting Windows XP Direct Connect:

If you are having trouble establishing a connection, check your New Connection’s properties to make sure they are set up correctly:

A) Click “Start > Programs > Accessories > Communications > Network Connections” to bring up the Network Connections screen.

B) In the “Network Connections” window, right-click “Optimod 5500i - Direct” and choose “Properties.”

C) The “Properties” window opens for “Optimod 5500i - Direct.”

D) Click the “Networking” tab.

E) Set “Type of dial-up server I am calling” to “PPP: Windows 95/98/NT4/2000, Internet”

F) Select the “Settings” button and make sure all PPP settings are unchecked, then click “OK.”

G) In “This connection uses the following items,” uncheck all except for “Internet Protocol (TCP/IP).” You can also leave “QoS Packet Scheduler” checked if you like.

H) In “This connection uses the following items,” select “Internet Protocol (TCP/IP)” and then click the “Properties” button. The “Internet Protocol (TCP/IP) Properties” window opens.

I) Choose “Obtain an IP address automatically” and “Obtain DNS server address automatically”

J) Click the “Advanced…” button on the “Internet Protocol (TCP/IP)” Window.

K) In the “Advanced TCP/IP Settings” select the “General” Tab; make sure that no check boxes are checked.

L) Click “OK” to dismiss the “Advanced TCP/IP Settings” window.

M) On the “Properties” window for “Optimod 5500i – Modem” click the “Advanced” tab.

N) Click “OK” to dismiss the window whose name is your new connection.

O) Click “Cancel” to dismiss the “Connect [nnnn]” dialog box

P) Restart your computer.

This resets the serial port and reduces the likelihood that you will encounter problems connecting to the 5500i.

Troubleshooting Windows XP Modem Connect:

If you are having trouble establishing a connection, check your New Connection’s properties to make sure they are set up correctly.

A) Click “Start > Programs > Accessories > Communications > Network Connections” to bring up the Network Connections screen.

B) In the “Network Connections” window, right-click “Optimod 5500i - Modem” and choose “Properties.”

The “Properties” window opens for “Optimod 5500i - Modem.”

C) Click the “Networking” tab.

D) Set “Type of dial-up server I am calling” to “PPP: Windows 95/98/NT4/2000, Internet”

E) Select the “Settings” button. Make sure all PPP settings are unchecked, and then click “OK.”

F) In “This connection uses the following items,” uncheck all except for “Internet Protocol (TCP/IP).” You can also leave “QoS Packet Scheduler” checked if you like.

G) In “This connection uses the following items,” select “Internet Protocol (TCP/IP)” and then click the “Properties” button.

The "Internet Protocol (TCP/IP) Properties" window opens.

H) Choose "Obtain an IP address automatically" and "Obtain DNS server address automatically."

I) Click the "Advanced…" button on the "Internet Protocol (TCP/IP)" Window.

J) In the "Advanced TCP/IP Settings," select the "General" Tab; make sure that no check boxes are checked.

K) Click "OK" to dismiss the "Advanced TCP/IP Settings" window.

L) Click "OK" to dismiss the window whose name is your new connection.

M) Restart your computer. (This resets the serial port and reduces the likelihood that you will encounter problems connecting to the 5500i.)

Troubleshooting IC Opamps

IC opamps are operated such that the characteristics of their associated circuits are essentially independent of IC characteristics and dependent only on external feedback components. The feedback forces the voltage at the (–) input terminal to be extremely close to the voltage at the (+) input terminal. Therefore, if you measure more than a few millivolts difference between these two terminals, the IC is probably bad.

Exceptions are opamps used without feedback (as comparators) and opamps with outputs that have been saturated due to excessive input voltage because of a defect in an earlier stage. However, if an opamp's (+) input is more positive than its (–) input, yet the output of the IC is sitting at –14 volts, the IC is almost certainly bad.

The same holds true if the above polarities are reversed. Because the characteristics of the 5500i's circuitry are essentially independent of IC opamp characteristics, an opamp can usually be replaced without recalibration.

A defective opamp may appear to work, yet have extreme temperature sensitivity. If parameters appear to drift excessively, freeze-spray may aid in diagnosing the problem. Freeze-spray is also invaluable in tracking down intermittent problems. But *use it sparingly,* because it can cause resistive short circuits due to moisture condensation on cold surfaces.

Technical Support

If you require technical support, contact Orban customer service. See http://www.orban.com/contact/ for contact information. Be prepared to describe the problem accurately. Know the serial number of your 5500i — this is printed on the rear panel of the unit.

Please check Orban's website, www.orban.com, for Frequently Asked Questions and other technical tips about 5500i that we may post from time to time. Manuals (in

.pdf form) and 5500i software upgrades will be posted there too — click "Downloads" from the home page.

Factory Service

Before you return a product to the factory for service, we recommend that you refer to this manual. Make sure you have correctly followed installation steps and operation procedures. If you are still unable to solve a problem, contact our Customer Service for consultation. Often, a problem is relatively simple and can be quickly fixed after telephone consultation.

If you must return a product for factory service, please notify Customer Service by telephone, *before* you ship the product; this helps us to be prepared to service your unit upon arrival. Also, when you return a product to the factory for service, we recommend you include a letter describing the problem.

Please refer to the terms of your Limited Five-Year Standard Warranty, which extends to the first end user. After expiration of the warranty, a reasonable charge will be made for parts, labor, and packing if you choose to use the factory service facility. Returned units will be returned C.O.D. if the unit is not under warranty. Orban will pay return shipping if the unit is still under warranty. In all cases, the customer pays transportation charges to the factory (which are usually quite nominal).

Shipping Instructions

Use the original packing material if it is available. If it is not, use a sturdy, double-walled carton no smaller than 7″ (H) x 15.5″ (D) x 22″ (W) — 18 cm (H) x 40 cm (D) x 56 cm (W), with a minimum bursting test rating of 200 pounds (91 kg). Place the chassis in a plastic bag (or wrap it in plastic) to protect the finish, then pack it in the carton with at least 1.5 inches (4 cm) of cushioning on all sides of the unit. "Bubble" packing sheets, thick fiber blankets, and the like are acceptable cushioning materials; foam "popcorn" and crumpled newspaper are not. Wrap cushioning materials tightly around the unit and tape them in place to prevent the unit from shifting out of its packing.

Close the carton without sealing it and shake it vigorously. If you can hear or feel the unit move, use more packing. Seal the carton with 3-inch (8 cm) reinforced fiberglass or polyester sealing tape, top and bottom in an "H" pattern. Narrower or parcel-post type tapes will not withstand the stresses applied to commercial shipments.

Mark the package with the name of the shipper, and with these words in red:

DELICATE INSTRUMENT, FRAGILE!

Insure the package properly. Ship prepaid, not collect. Do not ship parcel post. Your

Return Authorization Number must be shown on the label, or the package will *not* be accepted.

Section 6
Technical Data

Specifications

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

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

Performance

Specifications apply for measurements from analog left/right input to stereo composite output and to FM analog left/right output.

Frequency Response (Bypass Mode): Follows standard 50µs or 75µs pre-emphasis curve ±0.10 dB, 20 Hz–15 kHz. Analog left/right output and digital output can be user-configured for flat or pre-emphasized output.

Noise: Output noise floor will depend upon how much gain the processor is set for (Limit Drive, AGC Drive, Two-Band Drive, and/or Multi-Band Drive), gating level, equalization, noise reduction, etc. The dynamic range of the A/D Converter, which has a specified overload-to–noise ratio of 110 dB, primarily governs it. The dynamic range of the digital signal processing is 144 dB.

Total System Distortion (de-emphasized, 100% modulation): <0.01% THD, 20 Hz–1 kHz, rising to <0.05% at 15 kHz. <0.02% SMPTE IM Distortion.

Total System L/R Channel Separation: >50 dB, 20 Hz – 15 kHz; 60 dB typical.

Polarity (Two-Band and Bypass Modes): Absolute polarity maintained. Positive-going signal on input will result in positive-going signal on output.

Processing Sample Rate: The 5500i is a “multirate” system, using internal rates from 32 kHz to 512 kHz as appropriate for the processing being performed. Audio clippers operate at 256 kHz (and are anti-aliased), while the composite limiter operates at 512 kHz. In stand-alone stereo encoder mode, minimum sample rate is 64 kHz.

Processing Resolution: Internal processing has 24 bit (fixed point) or higher resolution.

Installation

Analog Audio Input

Configuration: Stereo.

Impedance: >10kΩ load impedance, electronically balanced[1].

Nominal Input Level: Software adjustable from –9.0 to +13.0 dBu (VU).

Maximum Input Level: +27 dBu.

Connectors: Two XLR-type, female, EMI-suppressed. Pin 1 chassis ground, Pins 2 (+) and 3 electronically balanced, floating and symmetrical.

A/D Conversion: 24 bit 128x oversampled delta sigma converter with linear-phase anti-aliasing filter. Converter outputs 64 kHz sample rate, which the 5500i then decimates to 32 kHz in DSP using an ultra-high-quality image-free synchronous sample rate converter. In strand-alone stereo encoder mode, 64 kHz output of converter is not down-sampled.

Filtering: RFI filtered.

Analog Audio Output

Configuration: Stereo. Flat or pre-emphasized (at 50µs or 75µs), software-selectable.

Source Impedance: 50Ω, electronically balanced and floating.

Load Impedance: 600Ω or greater, balanced or unbalanced. Termination not required or recommended.

Output Level (100% peak modulation): Adjustable from –6 dBu to +24 dBu peak, into 600Ω or greater load, software-adjustable.

Signal-to-Noise: >= 90 dB unweighted (Bypass mode, de-emphasized, 20 Hz–15 kHz bandwidth, referenced to 100% modulation).

L/R Crosstalk: <= –70 dB, 20 Hz–15 kHz.

Distortion: <= 0.01% THD (Bypass mode, de-emphasized) 20 Hz–15 kHz bandwidth.

Connectors: Two XLR-type, male, EMI-suppressed. Pin 1 chassis ground, Pins 2 (+) and 3 electronically balanced, floating and symmetrical.

D/A Conversion: 24 bit 128x oversampled, with high-pass filter at 0.15 Hz (–3 dB).

Filtering: RFI filtered.

Digital Audio Input

Configuration: Stereo per AES3 standard, 24 bit resolution, software selection of stereo, mono from left, mono from right or mono from sum.

Sampling Rate: 32, 44.1, 48, 88.2, or 96 kHz, automatically selected.

Connector: XLR-type, female, EMI-suppressed. Pin 1 chassis ground, pins 2 and 3 transformer balanced and floating, 110Ω impedance.

Input Reference Level: Variable within the range of –30 dBFS to –10 dBFS.

J.17 De-emphasis: Software-selectable.

Filtering: RFI filtered.

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[1] No jumper selection available for 600Ω. Surface-mount pads are available on I/O module for user-installed 600Ω termination.

Digital Audio Output

Configuration: Stereo per AES3 standard. Output configured in software as flat or pre-emphasized to the chosen processing pre-emphasis (50µs or 75µs), with or without J.17 pre-emphasis.

Sample Rate: Internal free running at 32, 44.1, 48, 88.2 or 96 kHz, selected in software. Can also be synced to the AES3 digital input at 32, 44.1, 48, 88.2 or 96 kHz, as configured in software.

Word Length: Software selected for 24, 20, 18, 16 or 14-bit resolution. First-order highpass noise-shaped dither can be optionally added, dither level automatically adjusted appropriately for the word length.

Connector: XLR-type, male, EMI-suppressed. Pin 1 chassis ground, pins 2 and 3 transformer balanced and floating, 110Ω impedance.

Output Level (100% peak modulation): –20.0 to 0.0 dBFS software controlled.

Filtering: RFI filtered.

Wordclock/10 MHz Sync Reference Input

Configuration: Accepts 1x wordclock or 10 MHz reference signals, automatically selected. The DSP master clock can be phase-locked to these signals, which in turn phase-locks the 19 kHz pilot tone frequency, facilitating singe-frequency network operation. The digital output sample frequency can also be locked to these signals.

Level: Unit will lock to 1x wordclock and 10 MHz squarewaves and sinewaves having a peak value of 0.5 V to 5.0 V.

Connector: BNC female, grounded to chassis, non-terminating to allow reference signals to be looped through via an external BNC “tee” connector (not supplied).

Composite Baseband Output

Configuration: Two outputs, each with an independent software-controlled output level control, output amplifier and connector.

Source Impedance: 0Ω voltage source or 75Ω, jumper-selectable.

Load Impedance: 37Ω or greater. Termination not required or recommended.

Maximum Output Level: +16.0 dBu (13.82Vp-p).

Pilot Level: Adjustable from 6.0% to 12.0%, software controlled.

Pilot Stability: 19 kHz, ±1.0 Hz (10 degrees to 40 degrees C).

D/A Conversion: 24-bit

Signal-to-Noise Ratio: >= 85 dB (Bypass mode, de-emphasized, 20 Hz – 15 kHz bandwidth, referenced to 100% modulation, unweighted).

Distortion: <= 0.02% THD (Bypass mode, de-emphasized, 20 Hz – 15 kHz bandwidth, referenced to 100% modulation, unweighted).

Stereo Separation: > 50 dB, 30 Hz - 15 kHz. 60 dB typical at 400 Hz.

Crosstalk-Linear: <= –80 dB, main channel to sub-channel or sub-channel to main channel (referenced to 100% modulation).

Crosstalk-Non-Linear: <= –80 dB, main channel to sub-channel or sub-channel to main channel (referenced to 100% modulation).

38 kHz Suppression: >= 70 dB (referenced to 100% modulation).

76 kHz & Sideband Suppression: >= 80 dB (referenced to 100% modulation).

Pilot Protection: 60 dB relative to 9% pilot injection, ±250 Hz (up to 2 dB composite processing drive).

Subcarrier Protection (60-100 kHz): >= 70 dB (referenced to 100% modulation; with up to 2 dB composite limiting drive; measured with 800 line FFT analyzer using “maximum peak hold” display).

57 kHz (RDS/RBDS) Protection: 50 dB relative to 4% subcarrier injection, ±2.0 kHz (up to 2 dB composite processing drive).

Connectors: Two BNC, shell connected to chassis ground, EMI suppressed.

Maximum Load Capacitance: 0.047 microfarad (0Ω source impedance). Maximum cable length of 100 feet/30 meters RG–58A/U.

Filtering: RFI filtered.

Subcarrier (SCA) Inputs

Configuration: Two subcarrier inputs sum directly into composite baseband outputs; COMPx LVL control settings have no effect on the absolute subcarrier levels.

Impedance: 600Ω

SCA Sensitivity: Variable from <100 mV p-p to >10 V p-p to produce 10% injection assuming 100% modulation = 4 V p-p at the 5500i’s composite outputs. Rear-panel accessible PC-board-mounted trim pots allow user to adjust the sensitivities of the two SCA inputs.

Connectors: Two BNC, shell connected to chassis ground, EMI suppressed.

19 kHz Pilot Reference: SCA2 input can be re-jumpered to provide a 19 kHz pilot reference output.

Remote Computer Interface

Supported Computer and Operating System: IBM-compatible PC running Microsoft Windows® 2000 (SP3 or higher) or XP.

Configuration: TCP/IP protocol via direct cable connect, modem, or Ethernet interface. Suitable null modem cable for direct connect is supplied. Modem and other external equipment is not supplied.

Serial Connector: RS–232 on DB–9 male connector, EMI-suppressed. Uses PPP to provide for direct or modem connection to the 5500i PC Remote application.

Ethernet Connector: Female RJ45 connector for 10-100 Mbps networks using CAT5 cabling. Native rate is 100 Mbps. Provides for connection to the 5500i PC Remote application through either a network, or, using a crossover Ethernet cable, directly to a computer.

Ethernet Networking Standard: TCP/IP.

Remote Control (GPI) Interface

Configuration: Eight (8) inputs, opto-isolated and floating.

Voltage: 6–15V AC or DC, momentary or continuous. +12VDC provided to facilitate use with contact closure.

Connector: DB–25 male, EMI-suppressed.

Control: User-programmable for any eight of user presets, factory presets, bypass, test tone, stereo or mono modes, analog input, digital input.

Filtering: RFI filtered.

Tally Outputs

Circuit Configuration: Two NPN open-collector outputs.

Voltage: +15 volts maximum. Do not apply negative voltage. When driving a relay or other inductive load, connect a diode in reverse polarity across the relay coil to protect the driver transistors from reverse voltage caused by inductive kickback.

Current: 30 mA maximum

Indications: Tally outputs can be programmed to indicate a number of different operational and fault conditions, including Input: Analog, Input: Digital, Analog Input Silent, AES Input Silent, and AES Input Error.

Power

Voltage: 85–264 VAC, 50–60 Hz, 30 VA.

Connector: IEC, EMI-suppressed. Detachable 3-wire power cord supplied.

Fuse: 2.5A 20mm Quick Acting HBC, mounted on the power supply circuit board.

Grounding: In order to meet EMI standards, circuit ground is hard-wired to chassis ground.

Safety Standards: ETL listed to UL standards, CE marked.

Environmental

Operating Temperature: 32° to 122° F / 0° to 50° C for all operating voltage ranges.

Humidity: 0–95% RH, non-condensing.

Dimensions (W x H x D): 19” x 1.75” x 14.25” / 48.3 cm x 4.5 cm x 36.2 cm. One rack unit high.

Humidity: 0–95% RH, non-condensing.

RFI/EMI: Tested according to Cenelec procedures. FCC Part 15 Class A device.

Shipping Weight: 10 lbs / 4.6 kg

Warranty

Five Years, Parts and Service: Subject to the limitations set forth in Orban's Standard Warranty Agreement.

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

Circuit Description

This section provides a detailed description of user-serviceable circuits used in the 5500i. We do not provide detailed descriptions of the digital circuitry because most of this is built with surface-mount components that cannot be removed or replaced with typical tools available in the field. Field repair ordinarily consists of swapping entire PC boards.

The section starts with an overview of the 5500i system, identifying circuit sections and describing their purpose. Then each user-repairable section is treated in detail by first giving an overview of the circuits followed by a component-by-component description.

The drawing on page 6-27 shows circuit board locations.

Overview

- The Control Circuits control the DSP, display, and input/output sections of the 5500i system.
- The Input Circuits include the connectors and RF filtering for the analog and digital audio inputs, as well as the circuitry to interface these inputs to the digital processing.
- The Output Circuits include the connectors and RF filtering for the analog and digital audio outputs, and the circuitry to interface the digital processing to these outputs.
- The DSP Circuits implement the bypass, test tone, and audio processing using digital signal processing.

  A block diagram of the DSP signal processing appears on page 6-51.
- The Power Supply provides power for all 5500i circuit sections.

Control Circuits

The control circuit is based on an AMD Elan SC520 microprocessor, which is a 586-class processor running an Orban executable program over a third-party real-time operating system. A flash memory emulates a hard drive. The memory is non-volatile and does not rely on a battery to retain information when mains power is off.

The flash memory holds the operating system, the Orban executable program, and all preset files, both factory and user. It also contains a write-protected “boot segment” that functions as a boot ROM.

The control circuits process and execute user-initiated requests to the system. The source of these requests is the front panel buttons and rotary encoder, the rear panel RS-232 port, Ethernet port, and the remote contact closures. These changes affect hardware function and/or DSP processing. The control circuits also send information to the LCD display.

The control circuit communicates with display circuitry through the SC520’s general-purpose bus and with the DSP via an SPI serial connection.

The SC520 periodically refreshes a watchdog timer. If the timer times out without being refreshed, it assumes that the control program has crashed and automatically reboots the SC520. The DSP chips will continue to process audio until the time comes to reload DSP program code into them. At this point, the audio will mute for about a second until the DSP code download has finished. If you hear a brief audio mute on air and you know that its input was not interrupted, you can assume that the 5500i has rebooted for some reason. Be prepared to convey this fact to Orban customer service if you call for technical assistance.

The control board contains interface circuitry, the CPU, the Ethernet interface chip, the flash memory, the DRAM, the RS-232 serial interface circuitry, the GPI/O interface circuitry, and the real-time clock, which keeps time for the 5500i's automation functions. The real-time clock is backed up by a DL2032 battery so that it keeps accurate time even when the 5500i is powered down. The battery is socketed and can be readily accessed by removing the 5500i's top cover; the battery is located on the control board.

User Control Interface and LCD Display Circuits

The user control interface enables the user to control the 5500i's functionality. A rear panel GPI connector allows optically-isolated remote control of certain functions, such as recalling presets, via contact closure. An RS-232 serial port and an Ethernet port allow you to connect a modem or computer to the 5500i. Front panel pushbutton switches select between various operational modes and functions. A rotary encoder allows the user to adjust parameters and enter data.

1. Remote Interface and RS-232 Interfaces

Located on control board

A remote interface connector and circuitry implements remote control of certain operating modes; Model 5500i OPTIMOD-FM has eight remote contact closure inputs.

A valid remote signal is a momentary pulse of current flowing through remote signal pins. Current must flow consistently for 50msec for the signal to be interpreted as valid. Generally, the 5500i will respond to the most recent control operation, regardless of whether it came from the front panel, remote interface, or RS-232.

Component-Level Description:

After being current limited by resistors, the GPI control signals are applied to two quad optoisolators, U17, U19, and then to the control circuitry.

Transceiver U12 interfaces the RS-232 signal levels at SERIAL DB-9 connector J5 to/from the TTL levels of the corresponding pins of the SC520 microcontroller.

U12, U17, and U19 are socketed for easy field replacement in the event of overload, lightning damage, etc. All other circuitry is surface-mount and is not field-repairable.

2. Switch Matrix and LED Indicators

Located on display board

Eleven front panel pushbutton switches are arranged in a matrix, configured as three columns and four rows. These switches are the primary element of the physical user interface to the 5500i control software. The host microprocessor controls the system setup and function of the DSP according to the switch/rotary

encoder entered commands, the AES status bits from the digital input signal, the RS-232, and the remote control interface status. The microprocessor updates the LED control status indicators accordingly.

Component-Level Description:

S1-S11 are the front panel pushbutton switches. CR11-CR15 are the front panel LED control status indicators. The control microprocessor communicates with these components through the general-purpose bus.

3. LED Meter Circuits

Located on display board

The meter LEDs are arranged in an 8x16 matrix, in rows and columns.

Each row of LEDs in the matrix has a 1/8 duty cycle ON time. The rows are multiplexed at a fast rate so that the meters appear continuously illuminated. Via the general-purpose bus, the DSP sends meter data values to the control microprocessor, which sends the appropriate LED control words (eight bits at a time) to the data latches that drive the LEDs directly.

Component-Level Description:

The meter LED matrix consists of ten 10-segment LED bar graph assemblies (CR1-CR9, CR16) and one discrete LED (CR10). Row selector latches IC4, IC5, IC6, and IC9 are controlled by the host microprocessor and alternately sink current through the LEDs selected by column selector latches IC1 and IC2, which are also controlled by the SC520. IC1 and IC2 drive the selected row of LEDs through current limiting resistor packs RP1 and RP2.

Input Circuits

This circuitry interfaces the analog and digital inputs to the DSP. The analog input stages scale and buffer the input audio level to match it to the analog-to-digital (A/D) converter. The A/D converts the analog input audio to digital audio. The digital input receiver accepts AES3-format digital audio signals from the digital input connector and sample rate-converts them as necessary. The digital audio from the A/D and SRC is transmitted to the DSP.

1. Analog Input Stages

Located on input/output/DSP board

The RF-filtered left and right analog input signals are each applied to a floating, balanced amplifier that has an adjustable (digitally controlled) gain. Analog switches set the gain. The outputs of a latch set the state of the switches. By writing data to the latch, the control circuits preset the gain. This circuit feeds an RC low-pass filter that applies the balanced signal to the analog-to-digital (A/D) converter.

The digitally controlled gain circuitry was included on the circuit board for possible use in future products. In the 5500i, its gain is preset so that the A/D will clip at +27 dBu with respect to the 5500i's analog inputs.

Note that the small RFI "tee" filter assemblies connected to the input and output connectors are socketed and user-replaceable.

Component-Level Description:

The left channel balanced audio input signal is applied to the filter / load network made up of the various passive components preceding IC201. (There are solder pads available in the PC board to accept an optional 600Ω termination load [R201] on the input signal if the user wishes to install one.) A conventional three-opamp instrumentation amplifier (IC201 and associated circuitry) receives the input signal. R225-231 and quad analog switch IC203 make up the circuit that sets the gain of IC201. The switches in IC203 set the gain of the instrumentation amplifier by switching resistors in parallel with R223. (Smaller total resistances produce larger gains.)

IC201 feeds IC205 and associated components. This stage balances, DC-biases, and scales the signal to the proper level for the analog-to-digital (A/D) converter IC208. IC207A and associated components comprise a servo amp to correctly DC-bias the signal feeding the A/D converter. R253, R255-R257, C217, C219 make an attenuator / RC filter necessary to filter high frequency energy that would otherwise cause aliasing distortion in the A/D converter.

The corresponding right channel circuitry is functionally identical to that just described.

IC201 and IC202 are through-hole parts, which permits easy field replacement using simple tools. All other circuitry is surface-mounted. Replacement requires surface-mount rework tools and skills to prevent circuit board damage.

2. Stereo Analog-to-Digital (A/D) Converter

Located on input/output/DSP board

The A/D converter, IC208, is a stereo 24-bit sigma-delta converter. (This is a surface-mount part and is not field-replaceable.)

The A/D oversamples the audio, applies noise shaping, and emits a bitstream at 64 kHz sample rate.

3. Digital Input Receiver and Sample Rate Converter (SRC)

Located on input/output/DSP board

The receiver IC501A accepts digital audio signals using the AES3 interface format (AES3-1992). It applies its output to sample rate converter (SRC) IC503B. This accepts and sample-rate converts any of the standard 32 kHz, 44.1 kHz, 48 kHz, 88.2 kHz, and 96 kHz rates in addition to any digital audio sample rate within the range of 32 kHz and 96 kHz. The SRC converts the input sample rate to 64 kHz for processing by the DSP.

4. Wordclock/10 MHz Sync Reference Input

Located on input/output/DSP board

The 5500i's internal system clock (which drives the DSPs) can be synchronized to a wordclock or 10 MHz reference applied to J502A. This allows the 19 kHz pilot tone in the 5500i's composite output to be frequency-synchronized to an accurate frequency standard like GPS or a rubidium-disciplined oscillator.

The input reference waveform is converted to a square wave via IC505 and associated circuitry, which implement a comparator with hysteresis. IC1103 is a CPLD (complex programmable logic device) that accepts the reference square wave.

IC1001 is a PIC microcontroller that measures the frequency of the reference square wave and (re)configures the CPLD as directed by the main microprocessor. In turn, the CPLD works with IC1101, IC1102, and IC1104 to implement a phase-locked loop to generate the system clocks. IC1104 is the phase comparator. The single-order loop filter consists of R1100, R1106, R1107 and C1100. The 27 MHz voltage-controlled oscillator IC1101 receives the output of the loop filter. The output of IC1101 drives IC1102, which is a phase-locked loop frequency generator that locks to the 27 MHz output of IC1101 and generates four clock signals from it. The four outputs of IC1102 are applied to the CPLD, which closes the phase-locked loop as directed by the PIC and main microprocessor. The CPLD generates the clocks (FCLK and BCLK) used by the DSP.

Output Circuits

This circuitry interfaces the DSP to the analog and digital audio outputs. The digital audio from the DSP is transmitted to the digital-to-analog converter (D/A) and output sample rate converter (SRC). The digital-to-analog (D/A) converter converts the digital audio words generated by the DSP to analog audio. The analog output stages scale and buffer the D/A output signal to drive the analog output XLR connectors with a low impedance balanced output. The digital output transmitter accepts the digital audio words from the output sample rate converter (SRC) and transmits them as AES3-format digital audio signals on the digital output connector.

1. Stereo Digital-to-Analog (D/A) Converter

Located on Input/Output/DSP board

The D/A, IC306, is a stereo, 24-bit delta-sigma converter. It receives the serial left and right audio data samples from the DSP at 64 kHz sample rate and converts them into audio signals requiring further, relatively undemanding analog filtering.

2. Analog Output Stages

Located on Input/Output/DSP board

The left and right analog signals emerging from IC306 are each filtered, amplified, and applied to a floating-balanced integrated line driver, which has a 50Ω output impedance. The line driver outputs are applied to the RF-filtered left and

right analog output connectors. These analog signals can represent either the transmitter or monitor output of audio processing.

Component-Level Description:

IC303 and associated components filter the left channel signal emerging from IC306. The purpose of these stages is to reduce the out-of-band noise energy resulting from the delta-sigma D/A's noise-shaping filter and to translate the differential output of the D/A converter into single-ended form. These components apply a 3rd order low-pass filter to the differential signal from the D/A. This filter does not induce significant overshoot of the processed audio, which would otherwise waste modulation.

IC305B and associated components form a low-frequency servo amplifier to remove residual DC from the signal. The 0.1Hz –3 dB frequency prevents tilt-induced overshoot in the processed audio.

The buffered output of IC303B is passed through gain trimmer VR301, which allows the gain of the output circuitry to be calibrated to a standard. IC301, a balanced output line driver, receives the output of VR301. This driver emulates a floating transformer; its differential output level is independent of whether one side of its output is floating or grounded. IC301 and its right channel counterpart IC302 are socketed in through-hole packages to facilitate field replacement with simple tools. All other circuitry is surface-mounted.

The corresponding right channel circuitry is functionally identical to that just described.

3. Digital Sample Rate Converter (SRC) and Output Transmitter

Located on Input/Output/DSP board

Output sample rate converter (SRC) IC503A converts the 64 kHz 5500i system sample rate to any of the standard 32 kHz, 44.1 kHz, 48 kHz, 88.2 kHz, and 96 kHz rates for the 5500i's Digital Out 1. The sample rate converter drives digital audio interface transmitter IC501B, which encodes digital audio signals using the AES3 interface format (AES3-1992).

4. Composite Output Circuit

Located on the Input/Output/DSP board and Composite/SCA daughterboard

A dual composite D/A converter drives the two composite outputs. Using a dual D/A converter permits the levels of the two composite outputs to be set independently in DSP. Each channel of the D/A converter drives a passive LC third-order anti-imaging filter.

The SCA inputs are summed with the composite output in the analog domain. The composite output level controls (COMP1 LVL and COMP2 LV) therefore do not affect the absolute level of the SCA appearing at the 5500i's outputs.

The second SCA input can be jumpered to serve as a pilot reference source for RDS generators (your 5500i is shipped from the factory in this configuration).

Component-Level Description:

We will describe the signal path for composite 1 output; the signal path for composite 2 output is exactly analogous. IC401 is a dual-channel high-speed D/A converter chip that receives the digital composite signal at a 170.66 (512/3) kHz sample rate. Its differential outputs drive current-to-voltage converter amplifier IC403, which drives differential amplifier IC405A. IC405A removes common-mode noise from the D/A output.

IC405B is a DC servo amplifier that removes DC offsets from the D/A output without introducing significant amounts of low frequency tilt to the composite waveform.

IC405A drives a third-order passive LC reconstruction filter C9, C10, L9, R17, R18, on the Composite/SCA daughterboard. (This filter is equalized and phase-corrected in DSP to obtain excellent flatness and phase-linearity. This optimizes stereo separation.) The resulting signal is a filtered analog representation of the composite signal generated by the DSP. IC2B buffers this signal and sums it with the SCA signals from SCA INPUT buffer IC1. Any contribution from the SCA inputs is therefore not indicated on the COMPOSITE LEVEL meter displayed by the 5500i, because this meter indicates only the composite signal generated by the DSP.

IC2B and IC3 together form a composite high-current buffer amplifier that receives the output of IC405A and drives the composite output connector J3 through RFI filter L3 and optional 75Ω build-out resistor R11.

The pilot reference D/A converter IC402 receives serial data from the DSP circuitry. After being buffered and low-pass filtered by IC407B, the resulting 19 kHz sine wave signal is passed to the Composite/SCA daughterboard and can be connected to J2 through jumper J6.

The composite line driver amplifiers IC3 and IC4 are socketed in through-hole packages to facilitate field replacement with simple tools. All other components are surface-mounted and are not field-replaceable.

DSP Circuit

The DSP circuit consists of two Freescale DSPB56724AG dual-core 24-bit fixed-point DSP chips that execute DSP software code to implement digital signal processing algorithms. The chips operate at a core clock frequency of 245.76MHz.

The algorithms filter, compress, and limit the audio signal. Each of the four DSP cores operates at approximately 250 million instructions per second (MIPS). A sampling rate of 32 kHz and power-of-two multiples thereof, up to 512 kHz, is used. In stand-alone stereo encoder mode, the minimum sample rate is 64 kHz.

System initialization normally occurs when power is first applied to the 5500i and can occur abnormally if the 5500i's watchdog timer forces the SC520 to reboot. Upon initialization, the SC520 CPU downloads the DSP executable code stored in the flash memory. This typically takes about 7 seconds. Once a DSP chip begins executing its program, execution is continuous. The SC520 provides the DSP program with pa-

rameter data (representing information like the settings of various processing controls), and extracts the front panel metering data from the DSP chips.

During system initialization, the SC520 queries the DSP hardware about its operational status and will display an error message on-screen if the DSP fails to initialize normally. Please note any such messages and be ready to report them to Orban Customer Service.

The DSP chips are located on the I/O+DSP board — see the drawings starting on page 6-35. IC1202 is a local voltage regulator on the DSP board that derives the +1.2V core supply for the DSP chips from the +5V Power Supply.

Power Supply

Warning! Hazardous voltages are present in the power supply when it is connected to the AC line. Several parts, including the heat sink, are hot to the AC power line. Except for servicing, do not remove the insulating shield from the power supply.

The power supply is a modular switching supply to minimize heat buildup and power consumption. It converts an AC line voltage input to +15, –15, and +5 volts. All other supply voltages are derived from these three voltages via local regulation. The supply accepts inputs from 85 to 264 VAC, 50 – 60 Hz.

The only fuse in your Optimod is a 2.5A 20mm Quick Acting HBC fuse mounted on the power supply's circuit board. Because the supply's outputs are automatically current-limited, the fuse will usually open only if the power supply fails. *Be sure to disconnect your Optimod from AC power before replacing the fuse!*

Because of safety and EMI suppression requirements in the power supply, there are no user-serviceable parts in it. In case of failure, replace the entire supply with an Orban-supplied replacement (Orban part number 29270.000.01.1), which ensures that your Optimod will continue to meet all regulatory requirements for safety and emissions.

Abbreviations

Some of the abbreviations used in this manual may not be familiar to all readers:

A/D (or A to D)	analog-to-digital converter
AES	Audio Engineering Society
AGC	automatic gain control
A-I	analog input
A-O	analog output
BAL	balanced (refers to an audio connection with two active conductors and one shield surrounding them).
BBC	British Broadcasting Corporation
BNC	a type of RF connector
CALIB	calibrate
CIT	composite isolation transformer

CMOS	complementary metal-oxide semiconductor
COFDM	Coded Orthogonal Frequency Division Multiplex — a robust type of digital modulation using many narrow-bandwidth, low data rate, mutually non-interfering carriers to achieve an aggregate high data rate with excellent multipath rejection.
COM	serial data communications port
D/A (or D to A)	digital-to-analog converter
dBm	decibel power measurement. 0 dBm = 1mW applied to a specified load. In audio, the load is usually 600Ω. In this case only, 0 dBm = 0.775V rms.
dBu	decibel voltage measurement. 0 dBu = 0.775V RMS. For this application, the dBm-into-600Ω scale on voltmeters can be read as if it were calibrated in dBu.
DI	digital input
DJ	disk jockey, an announcer who plays records in a club or on the air
DO	digital output
DOS	Microsoft disk operating system for IBM-compatible PC
DSP	digital signal processor (or processing). May also refer to a special type of microprocessor optimized for efficiently executing arithmetic.
EBU	European Broadcasting Union
EBS	Emergency Broadcasting System (U.S.A.)
EMI	electromagnetic interference
ESC	escape
FCC	Federal Communications Commission (USA regulatory agency)
FDNR	frequency-dependent negative resistor—an element used in RC-active filters
FET	field effect transistor
FFT	fast Fourier transform
FIFO	first-in, first-out
G/R	gain reduction
HD Radio	*See IBOC*
HF	high-frequency
HP	high-pass
IBOC	“In-Band On-Channel” — a form of digital radio commercialized by iBiquity Corporation where the digital carriers use a form of COFDM modulation and share the frequency allocation of the analog carriers. Also known by its trademarked name of “HD Radio.”
IC	integrated circuit
IM	intermodulation (or “intermodulation distortion”)
I/O	input/output
ITU	International Telecommunications Union (formerly CCIR). ITU-R is the arm of the ITU dedicated to radio.
JFET	junction field effect transistor
LC	inductor/capacitor
LCD	liquid crystal display
LED	light-emitting diode
LF	low-frequency
LP	low-pass
LVL	level
MHF	midrange/high-frequency
MLF	midrange/low-frequency
MOD	modulation
N&D	noise and distortion
N/C	no connection
OSHOOT	overshoot
PC	IBM-compatible personal computer
PCM	pulse code modulation
PPM	peak program meter
RAM	random-access memory

RC	resistor/capacitor
RDS/RBDS	Radio (Broadcasting) Data Service — a narrowband digital subcarrier centered at 57 kHz in the FM baseband that usually provides program or network-related data to the consumer in the form of text that is displayed on the radio. Occupied bandwidth is ±2500 Hz.
REF	reference
RF	radio frequency
RFI	radio-frequency interference
RMS	root-mean-square
ROM	read-only memory
SC	subcarrier
SCA	subsidiary communications authorization — a non program-related subcarrier in the FM baseband above 23 kHz (monophonic) or 57 kHz (stereophonic)
SMT	surface-mount
S/PDIF	Sony/Philips digital interface (standardized as IEC958)
TRS	tip-ring-sleeve (2-circuit phone jack)
THD	total harmonic distortion
TX	transmitter
µs	Microseconds. For FM pre-emphasis, the +3 dB frequency is $1 / (2 \pi \tau)$, where τ is the pre-emphasis time constant, measured in seconds.
VCA	voltage-controlled amplifier
VU	volume unit (meter)
XLR	a common style of 3-conductor audio connector
XTAL	crystal

Parts List

Many parts used in the 5500i are surface-mount devices ("SMT") and are not intended for field replacement because specialized equipment and skills are necessary to remove and replace them. The list below includes substantially all of the parts used in the 5500i (including surface-mount devices), and inclusion of a part in this list does not imply that the part is field-replaceable.

See the following assembly drawings for locations of components.

Obtaining Spare Parts

Special or subtle characteristics of certain components are exploited to produce an elegant design at a reasonable cost. It is therefore unwise to make substitutions for listed parts. Consult the factory if the listing of a part includes the note "selected" or "realignment required."

Orban normally maintains an inventory of tested, exact replacement parts that can be supplied quickly at nominal cost. Standardized spare parts kits are also available. When ordering parts from the factory, please have available the following information about the parts you want:

Orban part number
Reference designator (e.g., C3, R78, IC14)

Brief description of part
Model, serial, and "M" (if any) number of unit — see rear-panel label

To facilitate future maintenance, parts for this unit have been chosen from the catalogs of well-known manufacturers whenever possible. Most of these manufacturers have extensive worldwide distribution and may be contacted through their web sites.

Control Board

	Control Board	
PART #	**DESCRIPTION**	**COMPONENT IDENTIFIER**
20128.000.01	RESISTOR, 0 Ω, 0805	R21, R46
20128.010.01	RESISTOR, 10 Ω, 0805	R31, R34, R86, R89
20128.022.01	RESISTOR 22 Ω 1% 0805	R5, R6
20128.332.01	RESISTOR, 33.2 Ω, 0805	R10, R11
20128.499.01	RESISTOR 49.9 Ω 1% 0805	R19, R20, R22, R23
20129.301.01	RESISTOR, 301Ω, 0805	R24, R25, R47, R66
20130.100.01	RESISTOR, 1.00K 1% 0805	R17, R35
20130.200.01	RESISTOR, 2.00K, 0805	R71, R79, R84, R88, R3, R4, R7, R8, R26, R27, R28, R29, R30, R32
20130.475.01	RESISTOR, 4.75K, 0805	(R36, NO, STUFF), R205, R207, R209, R211, R213, R215, R217
20130.562.01	RESISTOR, 1/8W, 1%, 5.62K, 0805	R74
20131.100.01	RESISTOR, 10K, 0805	R1, R2, R9, R33, R37, R38, R39, R72
20131.113.01	RESISTOR, 1/8W, 1%, 11.3K, 0805	R87
20131.147.01	RESISTOR, 1/8W, 1%, 14.7K, 0805	R18, R73
20132.100.01	RESISTOR, 100K, 0805	R40, R41, R42, R43, R44, R45, R50, R54, R57, R59, R65, R70, R78, R83, R85
20135.002.01	RESISTOR, 0805, 5%, 2Ω	R63, R67, R75
20136.000.01	RESISTOR 300 Ω 5% 1/2W 2010	R81
20233.472.01	RESISTOR NETWORK 4.7K CTS745C 8R BUS	RN1, RN2, RN3, RN4
20237.472.01	RESISTOR NETWORK 8R, ISO, 5%	RN5
21136.010.01	CAPACITOR-SURFACE MOUNT 1206-10PF-5	C5
21139.000.01	CAPACITOR, X7R, 0.1UF, 10%, 0805	C6, C7, C8, C9, C19, C20, C21, C23, C24, C25, C26, C27, C28, C29, C30, C31, C32, C33, C39, C43, C45, C177, C179, C182, C184, C186, C187, C188, C200
21141.000.01	CAPACITOR, NPO, 1000PF, 1%, 0805	C11
21142.000.01	CAPACITOR, NPO, 100PF, 1%, 0805	C22, C34, C40, C46, C47, C48, C49, C50, C51, C52, C53, C54, C55, C56, C58, C59, C61, C62, C63, C64, C65, C66, C67, C68, C69, C70, C71, C72
21146.310.01	CAPACITOR, .01uf, 0805, 10%	C10, C126, C127, C133, C134, C156, C158, C160, C162, C180, C185
21167.047.01	CAPACITOR 4.7pf 50V X7R 0805	C1
21170.018.01	CAPACITOR 18pf 1% 50V COG 0805	C3, C4
21171.105.01	CAPACITOR 1uf X7R 0805	C14, C17, C36, C37, C38, C125, C132, C151, C153, C155, C157,

	Control Board	
PART #	**DESCRIPTION**	**COMPONENT IDENTIFIER**
		C159, C161, C175, C176, C178, C181, C183, (C201, NO, STUFF)
21322.547.01	CAPACITOR, 4.7uf, TANTALUM, 3528 10%	C12
21325.610.01	CAPACITOR 10UF 10% TANTALUM 3528	C13, C15, C16, C18, C35, C42, C44, C202
22101.001.01	DIODE, 1N4148WT/R	CR1, CR2, CR3, CR4, CR5
22209.000.01	DIODE, SHOT 1A, 60V, SMD	CR6, CR7, CR8, CR9
24331.025.01	IC VOLTAGE REGULATOR LT1963-2.5 SOT223	U14
24331.033.01	IC VOLTAGE REGULATOR LT1963-3.3 SOT223	U15
24417.000.01	IC OCT D-TYPE FLIPFLOP W/	U20
24541.000.01	IC SDRAM MT48LC16 TSOP54P	U2, U3
24638.000.01	IC, OCTAL BUS TRANS W/3	U22
24654.000.01	IC, PWRST MIC8115	U5
24656.475.01	IC, PWRST MCP120 SOT-23	U16
24900.000.01	IC, HEX INVERTER, SURFACE MOUNT	U23, U24
24965.000.01	IC, 74ALVC164245DGG	U7, U8, U9
24968.000.01	IC, MAX208ECNG	U12
24972.520.01	IC MICROPROCESSOR ELANSC520 BGA388	U1
24979.000.01	IC, BAT54C-7	CR11, CR12
24983.000.01	IC, 7064STC100-10	U6
25008.000.01	IC, PS2506-4 *	U17, U19
27017.009.01	CONNECTOR, RT AGL, PC MNT, 9P	J5
27017.025.01	CONNECTOR, RT AGL, PC MNT, 25P	J9
27147.124.01	IC, SCKT, DIP, 24 PIN, DUAL	SU12
27306.000.01	CONNECTOR RJ45 PCMT W/MAGS	J1
27406.014.01	CONNECTOR, SOCKET, STRIP, 14 PIN	JP1
27421.004.01	CONNECTOR, HDR, DBL RW, 4P, 2 X 2	J8, J10, J13
27421.006.01	CONNECTOR, HDR, DBL RW, 6P, 2 X 3	J14
27421.010.01	CONNECTOR, HDR, DBL RW, 23", 2 X 5	J3
27421.016.01	CONNECTOR, HDR, STR, .23", 2 X 8	(J6, NO, STUFF)
27451.005.01	CONNECTOR, STR, DBL ROW, 26 PIN	J11
27630.001.01	JUMPER, PC MNT, TEST POINT	TP100
28031.000.01	HOLDER, BATTERY, LITH CELL	BT1, HLDR
28041.000.01	CELL, COIN, BATTERY, LITHIUM, 3V	BT1
28089.000.01	OSCILLATOR 33MHZ SG636PCE 4P SMD	X1
28090.000.01	IC TCXO DS32KHZ 36P BGA	U13
28091.000.01	XTAL 25MHZ RXD MP35L SMD	Y1
44099.100.01	FIRMWARE 8300 U4 28F128	U4
20129.604.01.1	R0805 604Ω 1% 1/8W	R48, R49, R51, R53, R55, R56, R58, R60, R62, R64, R68, R69, R76, R77, R80, R82
20238.000.01.1	RESISTOR NET 100K 8RESISTOR 2512	RN52, RN61
22210.000.01.1	DIODE MBR530 SOD123	CR10
23216.000.01.1	TRANSISTOR MMBT4400 SOT23	Q1, Q2, Q3
24646.000.01.1	IC 74ACT244 OCTAL TSSOP	U18
24674.000.01.1	IC 10/100BT ETHERNET CONTROLLER (NATIONAL SEMICONDUCTOR)	U10
24761.000.01.1	IC LO POWER DC/DC CONVERT	U21
27374.000.01.1	HEADER, 2MM 2 X 10	(J4, NO, STUFF)

	Control Board	
PART #	**DESCRIPTION**	**COMPONENT IDENTIFIER**
27375.000.01.1	HEADER, 2MM 2 X 6	J7
27479.002.01.1	CONNECTOR HEADER .156 CENTER 2 PIN	J12
29535.000.01.1	INDUCTOR 3.9uH CHIP 1008	L1, L2, L3
29536.000.01.1	INDUCTOR SURFACE MOUNT 10uH 10%	L4
43050.014.01.1	SASY CBL IDC 60PIN 1.4"	J2

Combined Input/Output and DSP (I/O+DSP) Board

	I/O+DSP BOARD	
PART #	**DESCRIPTION**	**COMPONENT IDENTIFIER**
24421.000.01	IC SN74ALVCH16373DGGR	IC802
21139.101.01	CAPACITOR CER 100PF 10% 50V0805	C1221, C1222, C1223, C1224, C1225, C1226
27058.000.01	CONNECTOR BNC RIGHT ANGLE 75Ω	J502
21185.220.01	CAPACITOR 22uF 6.3V X5R 20% 080	C1215, C1216
24649.000.01	IC SN74AC11D AND-GATE	IC701
27426.005.01	HEADER UNSHRD	J1002
27408.003.01	CONNECTOR 3PIN SOCKET STRIP	SL203, SL204, SL205, SL206, SL303, SL304, SL305, SL306
27147.008.01	IC SOCKET DIP 8 PIN DUAL	SIC201, SIC202, SIC301, SIC302
44128.100.01	FIRMWARE FPGA IC1103 5500i	
44127.100.01	FIRMWARE PIC MCU IC1001 5500i	
24681.000.01	IC PCM1798DB D/A CONVERTER	IC401
24516.000.01	IC IDT5V40501DCG	IC400
21329.000.01	CAPACITOR TANTALUM 47uF 6.3V 20% SURFACE-MOUNT	C400
20129.604.01	RESISTOR 0805 604Ω 1% 1/8W	(R201, R202, NO, STUFF)
20133.100.01	RESISTOR 1/8W 1% 1.0M 0805	R251, R252, R305, R306, R425, R426, R513
24795.000.01	IC XC95144XL-10TQG144C	IC1103
27468.006.01	CONNECTOR 6P MOLEX PCB MOUNT	J401
24843.000.01	IC CD74HC4046AM 16-SOIC	IC1104
29552.000.01	INDUCTOR POWER 1.5UH 9A SMD	L1201, L1202
24348.000.01	IC REGULATOR SYNC BUCK CLK 4A	IC1201, IC1202
24794.000.01	IC DSP DSPB56724AG	IC601, IC606, (IC602, IC603, IC604, IC605, NO, STUFF)
24793.000.01	IC MT48LC2M32B2P-6	IC801
21325.622.01	CAPACITOR 22UF 10% TANTALUM 3528	C1201, C1202, C1203, C1204
24711.000.01	IC LMV7219M5 CMPRTR	IC505
20129.100.01	RESISTOR 100Ω 0805	(R335, R336, R337, R338, NO, STUFF)
27451.009.01	HEADER STR DOUBLE-ROW 60P PCB MOUNT	J1001
27426.003.01	CONNECTOR HEADER 3PIN SINGLE-ROW	J505, J1101, J5052

	I/O+DSP BOARD	
PART #	**DESCRIPTION**	**COMPONENT IDENTIFIER**
21137.447.01	CAPACITOR .47UF 25V 10% 1206	C215, C216, C319, C320, C428, C429
21325.610.01	CAPACITOR 10UF 10% TANTALUM 3528	C221, C222, C223, C224, C225, C401, C402, C403, C404, C405, C406, C1001, C1002, C1003, C1004, C1005, C1006, C1007, C1008, C1103, C1205, C1206, C1207, C1208, C1239
27421.010.01	CONNECTOR HEADER DOUBLE ROW 23" 2 X 5	J1102, J1204
24538.000.01	IC PCM1744 D/A SOIC14	IC402
24417.000.01	IC OCTAL D FLIP-FLOP AC374	IC209
28093.000.01	OSCILLATOR VCXO 3.3V 27MHz FVXO-	IC1101
24337.000.01	IC LOW-DROPOUT VOLT REGULATOR 1.8V 200m	IC1002
24772.000.01	IC PIC18LF4420 MICRO CONTROLLER	IC1001
24769.000.01	IC 4CHANNEL ASYNCHRONOUS CONVERTER	IC503, (IC504, NO, STUFF)
24768.000.01	IC 2CHANNEL ASYNCHRONOUS CONVERTER	IC501, (IC502, NO, STUFF)
27057.000.01	CONNECTOR DUAL BNC PCB MOUNT INTERNAL CAPACITOR	(J502 NO STUFF)
27630.001.01	JUMPER PC MOUNT TEST POINT	TP1201, TP1202 (TP1203, TP1204, TP1205, NO STUFF)
29539.000.01	CHOKE COMMON-MODE 1KΩ SM	L201, L202, L301, L302, L501, L503, L5022 (L502, L504, NO STUFF)
21138.247.01	CAPACITOR SMD1206 4700PF 50V 5%	C217, C218, C219, C220, C1229, C1230
21139.000.01	CAPACITOR X7R 0.1UF 10% 0805	C226, C227, C228, C229, C230, C231, C232, C233, C234, C235, C236, C237, C238, C239, C240, C241, C242, C243, C244, C304, C305, C306, C307, C308, C309, C310, C311, C312, C313, C314, C407, C408, C409, C410, C411, C412, C413, C414, C415, C416, C417, C418, C419, C420, C421, C501, C503, C505, C507, C901, C902, C903, C904, C905, C906, C907, C908, C909, C910, C911, C912, C913, C914, C915, C916, C917, C918, C919, C920, C921, C922, C923, C924, C925, C926, C927, C928, C929, C930, C931, C932, C933, C934, C935, C936, C937, C938, C939, C940, C941, C942, C943, C944, C945, C946, C947, C948, C1010, C1011, C1012, C1013, C1014, C1015, C1016, C1017, C1018, C1019, C1020, C1021, C1022, C1023, C1024, C1025, C1026, C1100, C1104, C1105, C1106, C1107, C1108, C1109, C1110, C1217, C1218,

	I/O+DSP BOARD	
PART #	**DESCRIPTION**	**COMPONENT IDENTIFIER**
		C1219, C1220, C1235, C1236, C1237, C1240, (C502, C504, C506, C508 NO-STUFF)
29015.000.01	TRANSFORMER SURFACE-MOUNT SCIENTIFIC CONVERSION	T501, T503, (T502, T504, NO, STUFF)
20130.499.01	RESISTOR R0805 4.99K 1% 1/8W	R211, R212, R213, R214, R215, R216, R217, R218, R1005, R1101, R1108, R1213, R1214
20130.150.01	RESISTOR 0805 1.50K 1% 1/8W	(R207, R208, R209, R210 NO STUFF), R245, R246, R247, R248, R249, R250
20135.002.01	RESISTOR 5% 2Ω 0805	R1001, R1002, R1201, R1202, R1203, R1204
20129.301.01	RESISTOR 301Ω 0805	R510
20129.110.01	RESISTOR 0805 110Ω 1% 1/8W	R260, R303, R304, R501, R503, R1217, R1218 (R502, R504 NO STUFF)
20129.475.01	RESISTOR 475Ω 1% 1/8W 0805	(R339, R340, R341, R342 NO STUFF)
21170.282.01	CAPACITOR 0805 .0082U 50 5% COG	(C211, C212, C213, C214 NO STUFF)
29522.000.01	INDUCTOR 1200UH 5% 1-M-10-22	L207, L208, L209, L210 (L311, L312, L313, L314, NO, STUFF)
20128.000.01	RESISTOR 0Ω 0805	R505, R506, R1007 (R1109 NO STUFF)
29537.102.01	INDUCTOR 0805 FERRITE 1000Ω	L1001, L1002, L1003, L1004, L1101, L1102, L1103
29508.210.01	FILTER EMI SUPPRESS 100V 10	L203, L204, L205, L206, L303, L304, L305, L306
29506.001.01	BEAD FERRITE ON WIRE	L505, L507, L509, L511, L5062, L5082 (L506, L508, L510, L512 NO STUFF)
27054.003.01	CONNECTOR FEMALE INSERT RIGHT ANGLE	J201, J202, J501
27053.003.01	CONNECTOR MALE INSERT RIGHT ANGLE	J301, J302, J503 (J504 NO STUFF)
24997.000.01	IC DAC AK4393VSP VSOP	IC306
24963.000.01	IC ADC AK5383 SOP IC,5383	IC208
24960.000.01	IC OPA2134UA	IC205, IC206, IC207, IC303, IC304, IC305, IC403, IC404, IC405, IC406, IC407
24958.000.01	IC DRV134PA	IC301, IC302
24307.901.01	IC LINEAR DC REGULATOR 5V POSITIVE I	IC1203
24024.000.01	IC OPA2134PA	IC201, IC202
23214.000.01	TRANSISTOR NPN MMBT3904	Q1001
22106.000.01	DIODE VSTT SMCJ26 DO214	CR201, CR202, CR203, CR204, CR301, CR302, CR303, CR304
22083.068.01	DIODE VOLTAGE SUPPRESSOR 6.8 VL	CR1201
20130.210.01	RESISTOR 1/8W 1% 2.10K 0805	R227, R228, R407, R408, R409, R410, R411, R412, R413, R414
21319.610.01	CAPACITOR 10uf TANTALUM SMT	C1231, C1232, C1233
21227.747.01	CAPACITOR RADIAL LEADS 470UF 16V	C1238

	I/O+DSP BOARD	
PART #	**DESCRIPTION**	**COMPONENT IDENTIFIER**
	HF	
21171.105.01	CAPACITOR 1uf X7R 0805	C301, C302, C303, C511, C805, C806, C807, C808, C949, C950, C951, C952, C953, C954, C955, C956, C957, C958, C959, C960, C1009, C1101, C1102, C1209, C1210, C1211, C1212, C1213, C1214, C1234
21147.022.01	CAPACITOR 22pf 0805 1%	C423, C424, C425, C426, C427
21146.310.01	CAPACITOR 0.01uf 0805 10% 0805	C430, C601, C602, C603, C604, C605, C606, C607, C608, C609, C610, C611, C612, C613, C614, C615, C616, C617, C618, C619, C620, C621, C622, C623, C624, C625, C626, C627, C628, C629, C630, C631, C632, C633, C634, C635, C636, C637, C638, C639, C640, C641, C642, C643, C644, C645, C646, C647, C648, C649, C650, C651, C652, C653, C654, C655, C656, C657, C658, C659, C660, C661, C662, C663, C664, C665, C666, C667, C668, C669, C670, C671, C672, C701, C801, C802, C803, C804, C1027, C1111, C1112, C1113, C1114, C1115, C1227, C1228, C5022
21144.000.01	CAPACITOR 5% 100V 47PF 1206	C200, C201, C202, C203, C204, C205, C206
21143.000.01	CAPACITOR NPO 1500PF 1% 0805	C321, C322, C422 (C327, C328, C329, C330 NO STUFF)
21141.000.01	CAPACITOR NPO 1000PF 1% 0805	C207, C208, C209, C210 (C323, C324, C325, C326 NO STUFF)
21140.000.01	CAPACITOR NPO 470PF 1% 0805	C315, C316, C317, C318
20511.310.01	TRIM-POT 10K 10% 3/8TOP ADJ	VR301, VR302
20237.472.01	RESISTOR NETWORK 8R ISO 5%	RN801, RN802
20151.536.01	RESISTOR 0.1% 5.36K 0805	R219, R220, R221, R222
20151.365.01	RESISTOR 0.1% 3.65K 0805	R233, R234, R235, R236, R237, R238, R239, R240
20132.100.01	RESISTOR 1/8W 1% 100K R0805	R1008, R1009, R1102, R1103, R1104, R1106, R1107
20131.825.01	RESISTOR 1/8W 1% 82.5K 0805	R223, R224, R317, R318, R319, R320, R419, R420, R421, R422, R423, R424
20131.147.01	RESISTOR 1/8W 1% 14.7K 0805	R231, R232
20131.113.01	RESISTOR 1/8W 1% 11.3K 0805	R327, R328, R329, R330
20131.100.01	RESISTOR 10K 0805	R301, R302, R401, R402, R403, R404, R405, R406, R511, R512, R601, R602, R603, R604, R605, R606, R607, R608, R609, R610, R611, R612, R1006, R1205, R1206, R1207, R1208, R1209, R1210, R1211
20130.845.01	RESISTOR 1/8W 1% 8.45K 0805	R307, R308, R309, R310, R311,

	I/O+DSP BOARD	
PART #	DESCRIPTION	COMPONENT IDENTIFIER
		R312, R313, R314, R315, R316
20130.562.01	RESISTOR 1/8W 1% 5.62K 0805	R229, R230
20130.348.01	RESISTOR 1/8W 1% 3.48K 0805	R321, R322, R323, R324, R325, R326, R415, R416, R417, R418, R1215
20130.162.01	RESISTOR 1/8W 1% 1.62K 0805	R241, R242, R243, R244, R1212
20130.100.01	RESISTOR 1.00K 1% 0805	R203, R204, R205, R206, R1003, R1004, R1100, R1216
20129.768.01	RESISTOR 1/8W 1% 768Ω 0805	R225, R226
20129.249.01	RESISTOR 1/8W 1% 249Ω 0805	R255, R256, R257, R258, R259
20129.150.01	RESISTOR 1/8W 1% 150Ω 0805	R253, R254, R507, R508, R509, R1105
20128.499.01	RESISTOR 49.9Ω 1% 0805	(R331, R332, R333, R334 NO STUFF)
24766.000.01	IC PLL1707DBQ	IC1102
27479.004.01	CONNECTOR HEADER .156CTR 4 PIN	J1202
29535.000.01	INDUCTOR 3.9uH CHIP 1008	L307, L308, L309, L310
27479.006.01	CONNECTOR HEADER .156CTR 6 PIN	J1201
27479.002.01	CONNECTOR HEADER .156CTR 2 PIN	J1203
24760.000.01	IC QUAD CMOS SPST SWITCH	IC203, IC204
22210.000.01	DIODE MBR530 SOD123	CR1001, CR1002

Composite/SCA Daughterboard

	COMPOSITE/SCA DAUGHTERBOARD	
PART #	DESCRIPTION	COMPONENT IDENTIFIER
29538.000.01	INDUCTOR 3300UH 10% RL-1160-33	L9, L10
27758.006.01	CONNECTOR 6P MOLEX RT ANGLE	J5
27421.004.01	CONNECTOR HEADER DOUBLE ROW 4P 2X2	J6, J7, J8
29508.210.01	FILTER EMI SUPPRESSOR 100V 10	L1, L2, L3, L4
27056.000.01	CONNECTOR BNC METAL RIGHT ANGLE	J1, J2, J3, J4
29535.000.01	INDUCTOR 3.9uH CHIP 1008	L5, L6, L7, L8
21142.560.01	CAPACITOR 560pf 50v 1% NPO 0805	C9, C10, C11, C12
24025.000.01	IC 8DIP BUF634P	IC3, IC4
24960.000.01	IC OPA2134UA	IC1, IC2
21147.022.01	CAPACITOR 22pf 0805 1%	C1, C2, C3, C4
21146.310.01	CAPACITOR 0.01uF 0805 10% 0805	C5, C6, C7, C8
20170.182.01	RESISTOR 1.82K 1/8W 0.1% 0805	R17, R18, R19, R20
20508.350.01	TRIMPOTS 50K 18T SIDE ADJUST	VR1, VR2
21139.000.01	CAPACITOR X7R 0.1UF 10% 0805	C13, C14, C15, C16
20135.100.01	RESISTOR 1/8W 5% 1.00M 0805	R1, R2
20129.604.01	RESISTOR 0805 604 Ω 1% 1/8W	R5, R6, R7, R8, R9, R10
20130.210.01	RESISTOR 1/8W 1% 2.10K 0805	R3, R4
20130.348.01	RESISTOR 1/8W 1% 3.48K 0805	R13, R14, R15, R16

	COMPOSITE/SCA DAUGHTERBOARD	
PART #	**DESCRIPTION**	**COMPONENT IDENTIFIER**
20128.075.01	RESISTOR 75 Ω 1% 0805	R11, R12

Display Board (Front)

	DISPLAY BOARD (FRONT)	
PART #	**DESCRIPTION**	**COMPONENT IDENTIFIER**
15057.010.01	SPACER, .100" HIGH	CR1, CR2, CR3, CR4, CR5, CR6, CR7, CR8, CR9, CR16
15061.005.01	LED MNT, 1 POS'N, .240"HIGH	MNTCR10
25106.001.01	LED, YELLOW, T-1, HIGH EFFICIENCY LAMP	CR11, CR12, CR13, CR14, CR15
25106.003.01	LED, RED, T-1, HIGH EFFICIENCY LAMP	CR10
25167.000.01	LED, ARRAY, 1 RED, 1 YEL, 8 GRN	CR7, CR16
25168.000.01	LED, ARRAY, 9 YELLOW, 1 RED	CR1, CR2, CR3, CR4, CR5, CR6
27368.000.01	CONNECTOR, 100 SCKT, 5X2 LOPRO	J1
27369.000.01	CONNECTOR, 100 SCKT, 8X2, LOPRO	J2, J3, J4
25172.000.01.1	LED ARRAY ALL YELLOW	CR8, CR9

Display Board (Back)

PART #	DESCRIPTION	COMPONENT IDENTIFIER
42007.100	FLAT CABLE 26P 10"	JP203
15065.355.01	LED-MNT-1 POS-0.355	FOR, CR1 USE 2
20122.110.01	RESISTOR, TF, 1/8W, 1%, 110 Ω	R17, R18, R19, R20, R21, R22, R23, R24
20124.100.01	RESISTOR TF 1/8W 1% 1206 10K	R29, R30
20125.100.01	RESISTOR, TF, 1/8W, 1%, 100K	R25, R26, R27, R28
20226.000.01	RESISTOR, NETWORK, DIL, 2%, 100 Ω	RP1, RP2
21131.410.01	CAPACITOR, SURFACE MOUNT 1206, .1UF, 50V, 20%	C2, C3, C4, C5, C6, C7, C8
21144.000.01	CAPACITOR, 5%, 100V, 47PF, 1206	C9, C10, C11, C12, C13, (C14, NO, STUFF)
21313.568.01	CAPACITOR, TANTALUM, 6.8UF, 25V, 10%	C1
24635.000.01	IC 74HCT374	IC3
24636.000.01	IC 74ACT574	IC1, IC2
24900.000.01	IC, HEX INVERTER, SURFACE MOUNT	IC7
24905.000.01	IC, CMOS OCTAL D REG. 3 ST	IC4, IC5, IC6, IC9
24967.000.01	IC, 74ACT245DW	IC8
25112.001.01	LED, RED/GREEN, BI-COLOR/POLAR	CR1
26085.000.01	SWITCH, ROT, VERTICAL MOUNT, 2 BIT	S12
27366.000.01	CONNECTOR, 100 POSTS, 5X2 MLE	P1
27367.000.01	CONNECTOR, 100 POSTS, 8X2	P2, P3, P4
27404.000.01	CONNECTOR, PLUG, POLAR, WHITE, NYL	P5-6
27420.002.01	CONNECTOR 2 PIN RIGHT ANGLE	J1
43008.501.01	ASSEMBLY-WIRE-BLK-12	
43008.503.01	ASSEMBLY-WIRE-RED-12	

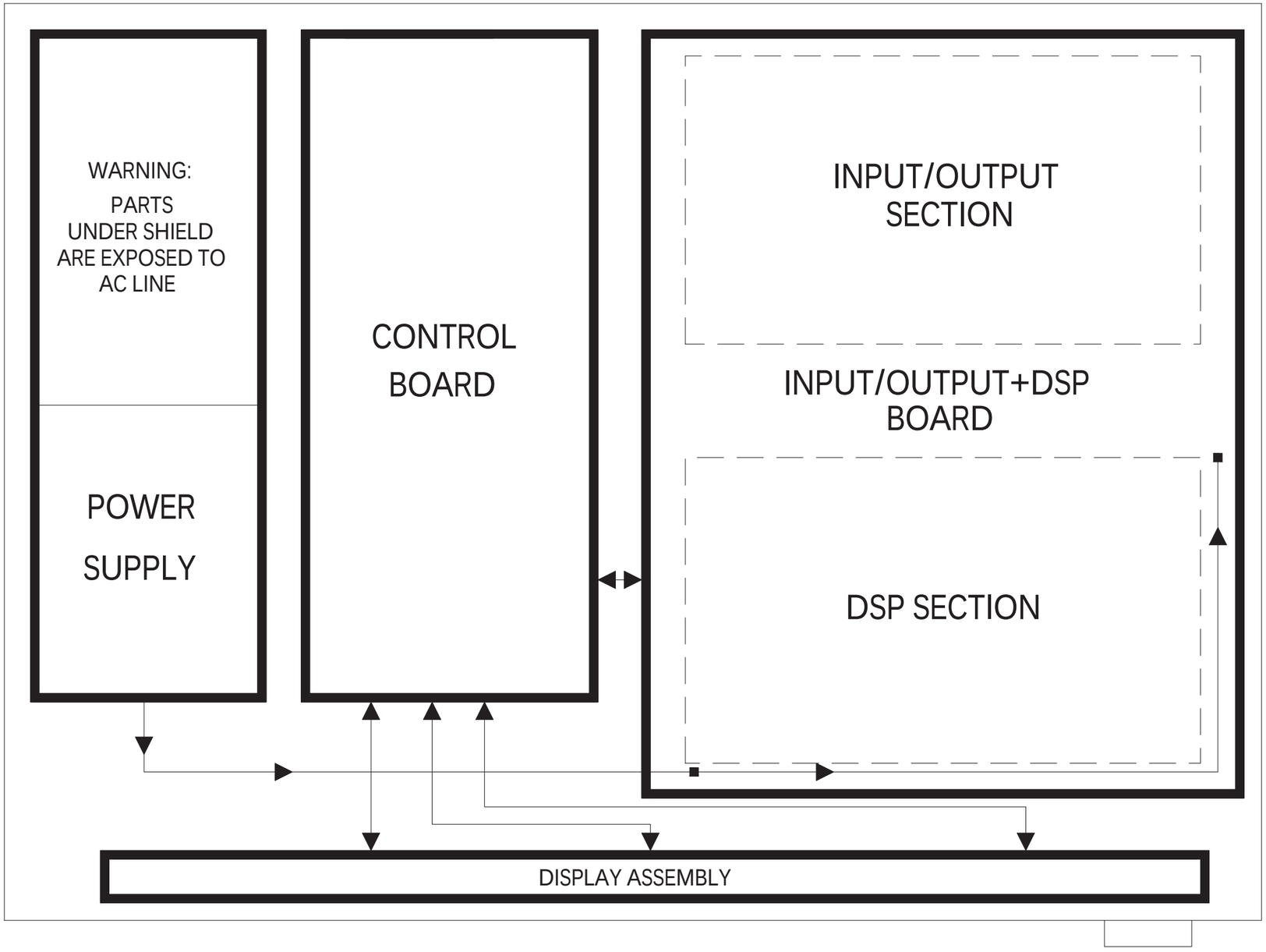
Schematics and Parts Locator Drawings

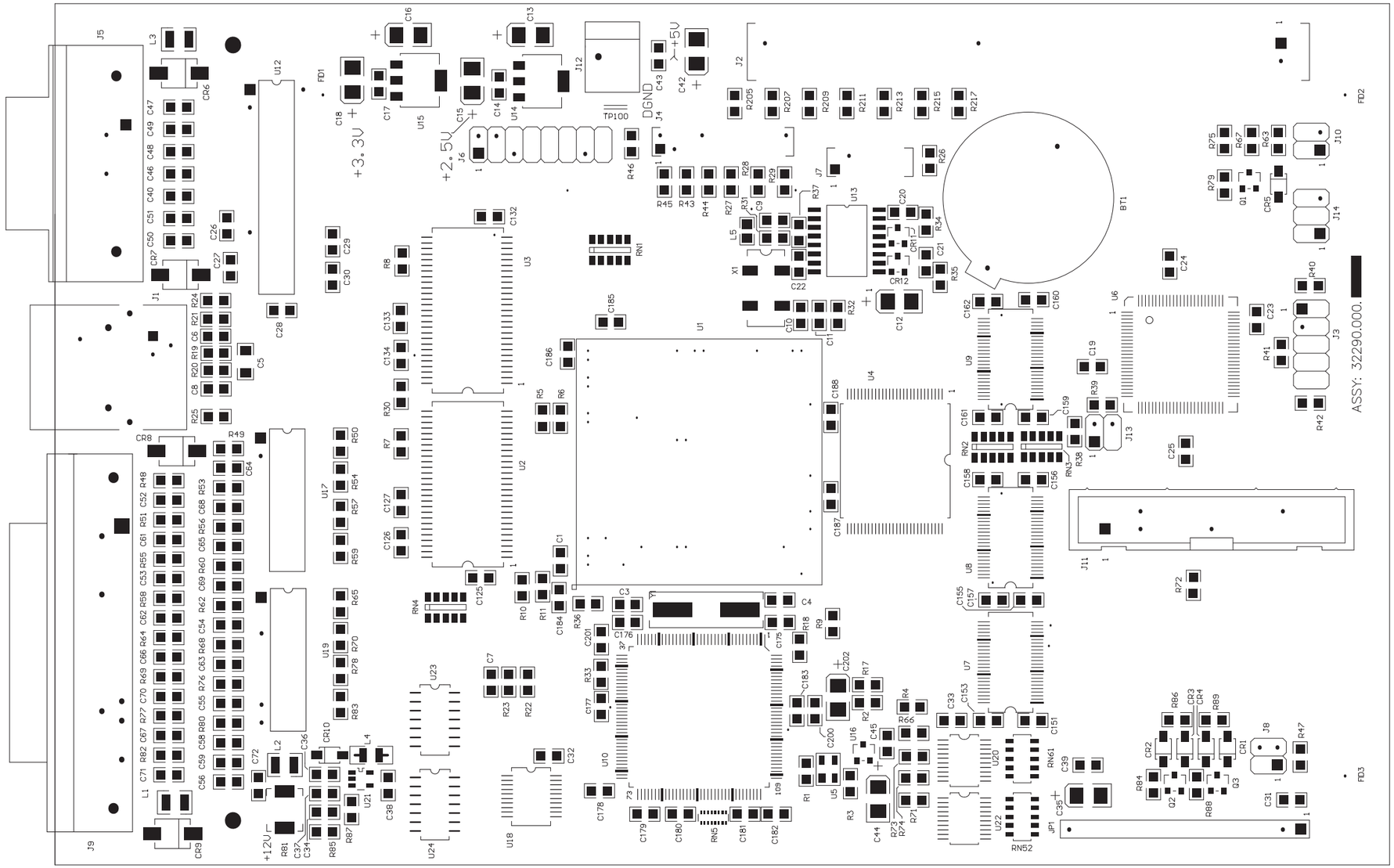
These drawings reflect the actual construction of your unit as accurately as possible. Any differences between the drawings and your unit are probably due to product improvements or production changes since the publication of this manual.

If you intend to replace parts, please read page 6-15. Please note that because surface-mount parts are used extensively in the 5500i, few parts are field-replaceable. Servicing ordinarily occurs by swapping circuit board assemblies. However, many vulnerable parts connected to the outside world are socketed and can be readily replaced in the field.

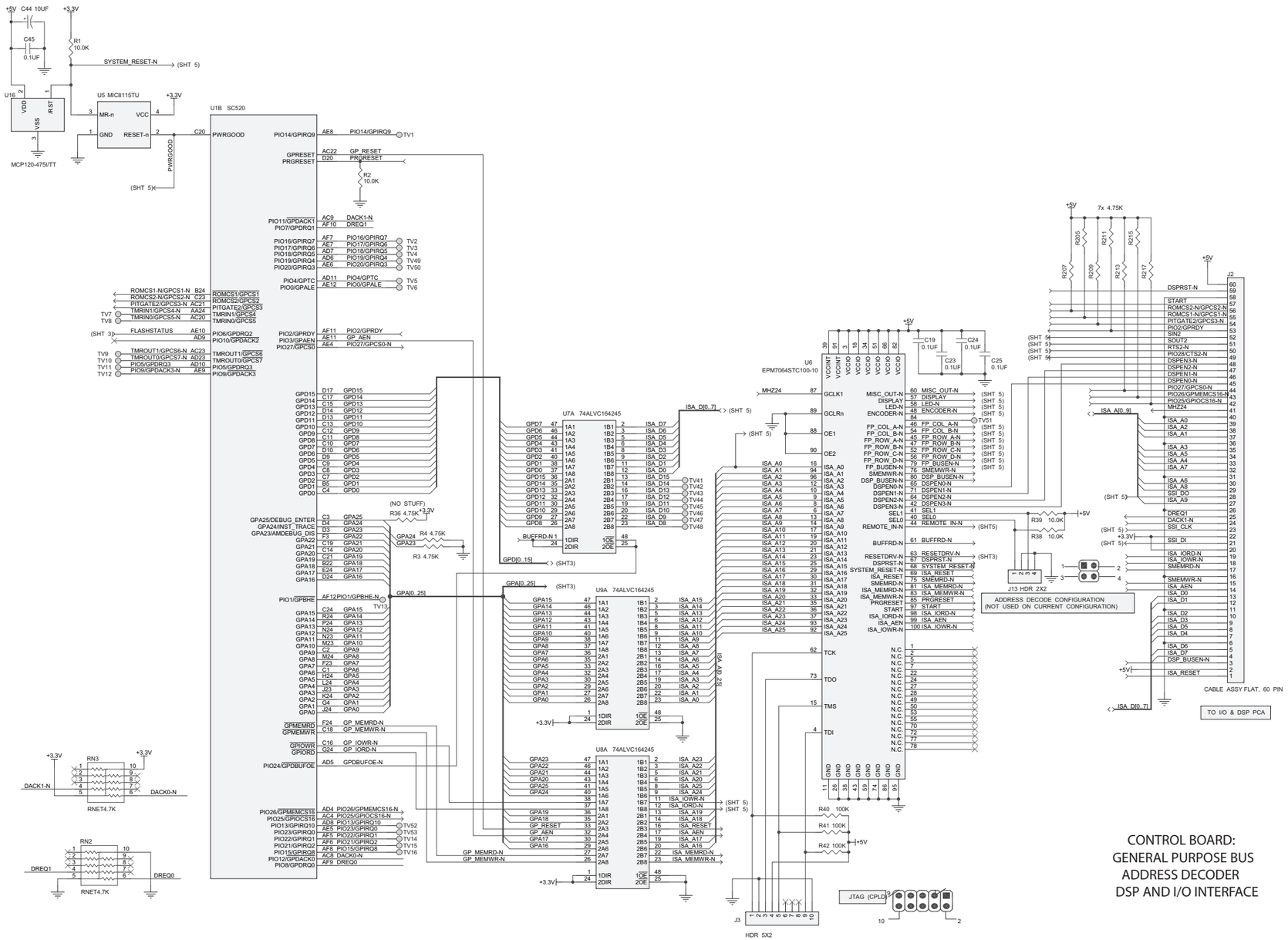
Function	Description	Drawing	Page
Chassis	Circuit Board Locator and Basic Interconnections	Top view (not to scale)	6-27
Control board	Control microprocessor. Services front panel, serial port, Ethernet, and DSP+I/O board. ***Contains***:	Parts Locator Drawing	6-28
	General Purpose bus, address decoder, I/O+DSP interface	Schematic 1 of 5	6-29
	Memory and clock generation	Schematic 2 of 5	6-30
	Ethernet	Schematic 3 of 5	6-31
	Miscellaneous input/output	Schematic 4 of 5	6-32
	Power and Ground	Schematic 5 of 5	6-33
I/O+DSP Board	Analog Input/output AES3 Input/output DSP Chips; Local regulators. Contains:	Parts Locator Drawing	6-34
	Interconnects	Schematic 1 of 12	6-35
	L and R Analog Inputs	Schematic 2 of 12	6-36
	L and R Analog Outputs	Schematic 3 of 12	6-37
	Composite And Pilot Reference Signal Generators	Schematic 4a of 12	6-38
	Composite/SCA Daughterboard	Schematic & Parts Locator 4b of 12	6-39
	Digital I/O & Sync Input	Schematic 5 of 12	6-40
	DSP Enhanced Serial Audio Interface	Schematic 6 of 12	6-41
	DSP Control Interface	Schematic 7 of 12	6-42
	DSP External Memory Control Interface	Schematic 8 of 12	6-43
	DSP Power and Ground	Schematic 9 of 12	6-44
	I/O Control Interface	Schematic 10 of 12	6-45
	Clock Generation and CPLD	Schematic 11 of 12	6-46
	Power Distribution	Schematic 12 of 12	6-47

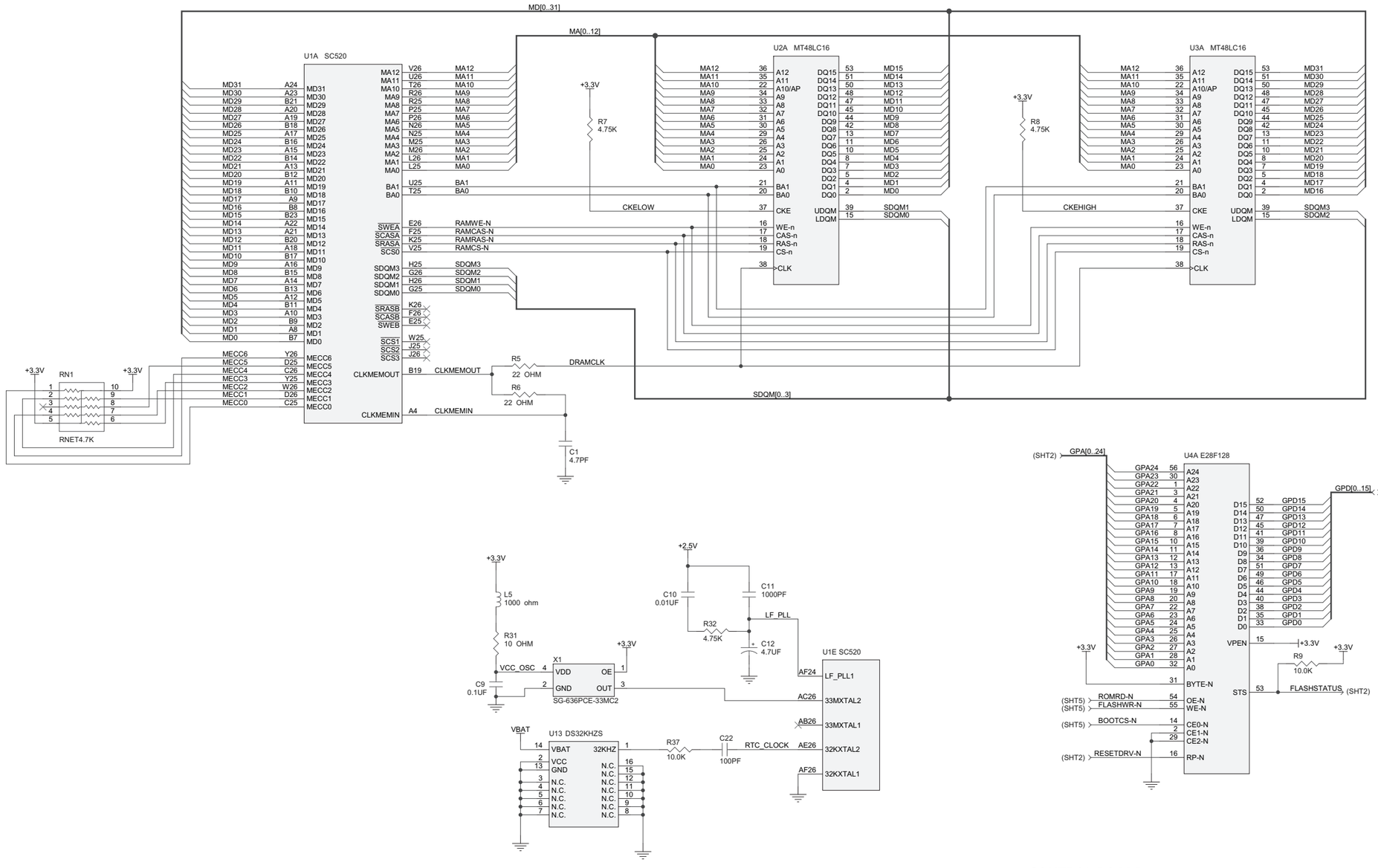
Function	Description	Drawing	Page
Display Board	Front-Panel LCD, LEDs, Buttons, and Rotary Encoder Contains:	Parts Locator Drawing	6-48
	Front of board	Schematic 1 of 2	6-49
	Rear of board		6-50
DSP Block Diagram	Shows signal processing		6-51


WARNING:
PARTS
UNDER SHIELD
ARE EXPOSED TO
AC LINE
POWER
SUPPLY
CONTROL
BOARD
INPUT/OUTPUT
SECTION
INPUT/OUTPUT+DSP
BOARD
DSP SECTION
DISPLAY ASSEMBLY

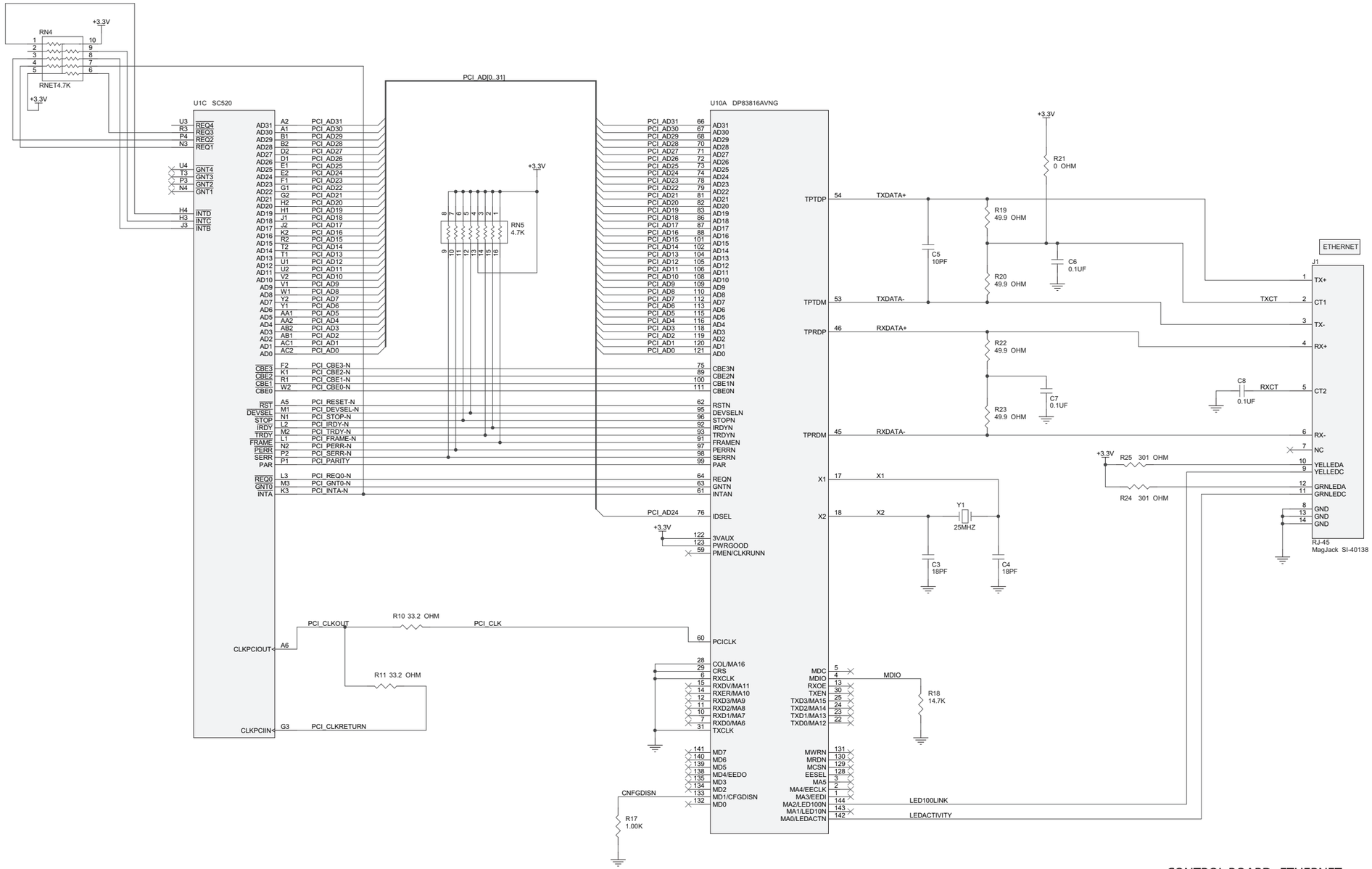


CONTROL BOARD PARTS LOCATOR

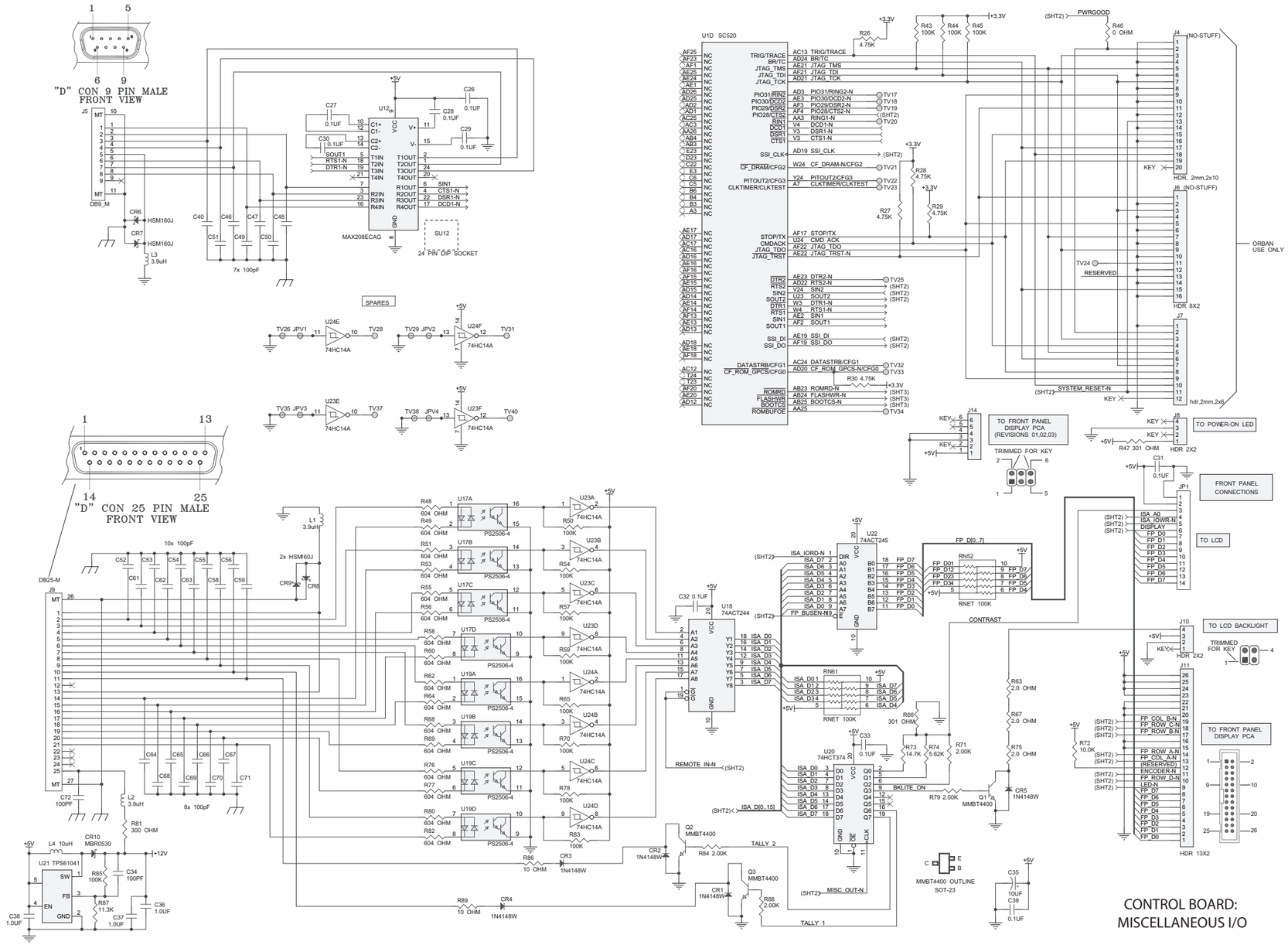

U1B SC520
U5 MIC8115TU
MCP120-475/TT
U6
EPM7064STC100-10
U7A 74ALVC164245
U9A 74ALVC164245
U8A 74ALVC164245
J2
CABLE ASSY FLAT, 60 PIN
TO I/O & DSP PCA
J13 HDR 2X2
ADDRESS DECODE CONFIGURATION
(NOT USED ON CURRENT CONFIGURATION)
J3
HDR 5X2
JTAG (CPLD)
RNET4.7K
CONTROL BOARD:
GENERAL PURPOSE BUS
ADDRESS DECODER
DSP AND I/O INTERFACE

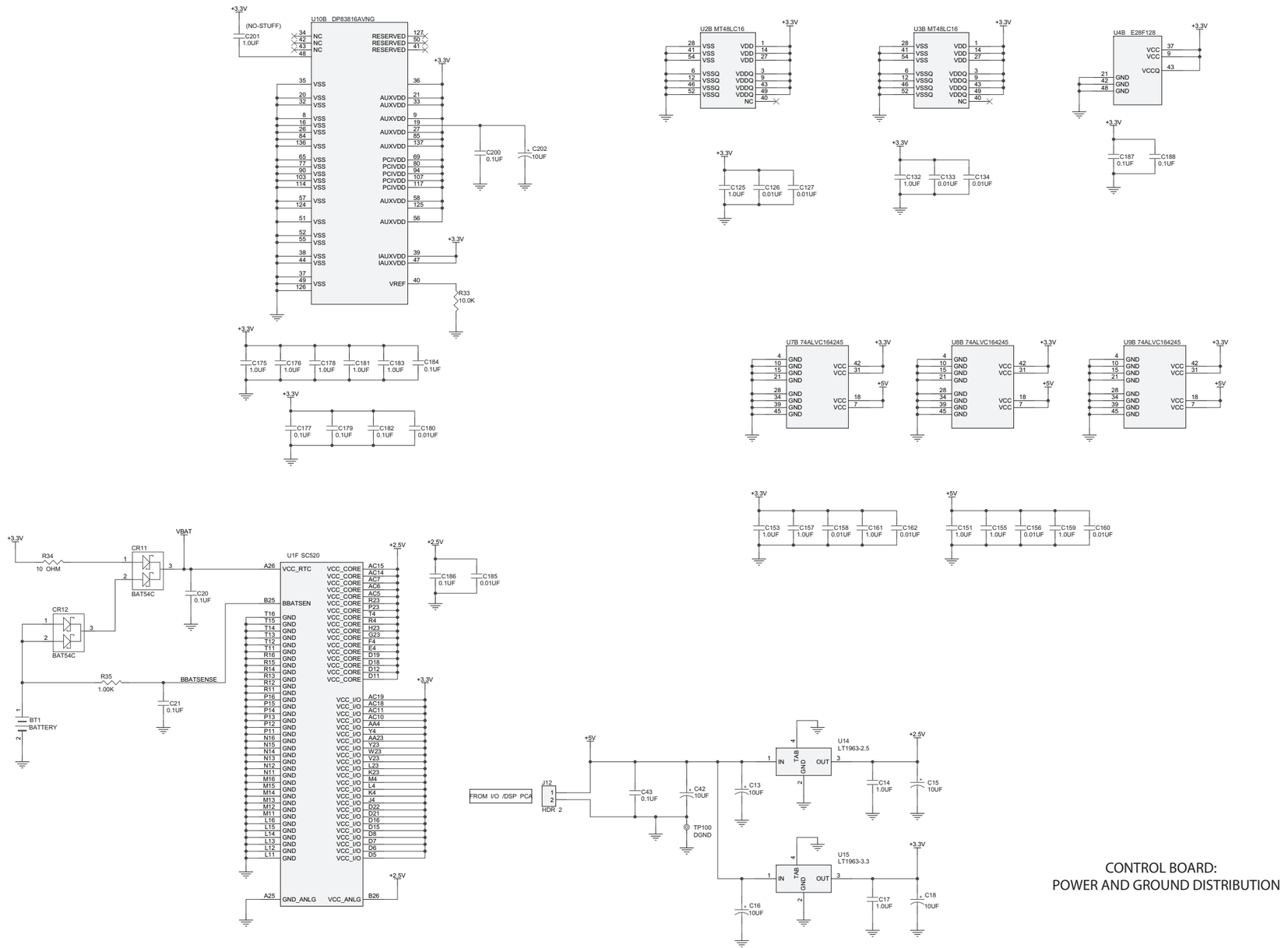


CONTROL BOARD:
MEMORY AND CLOCK GENERATION

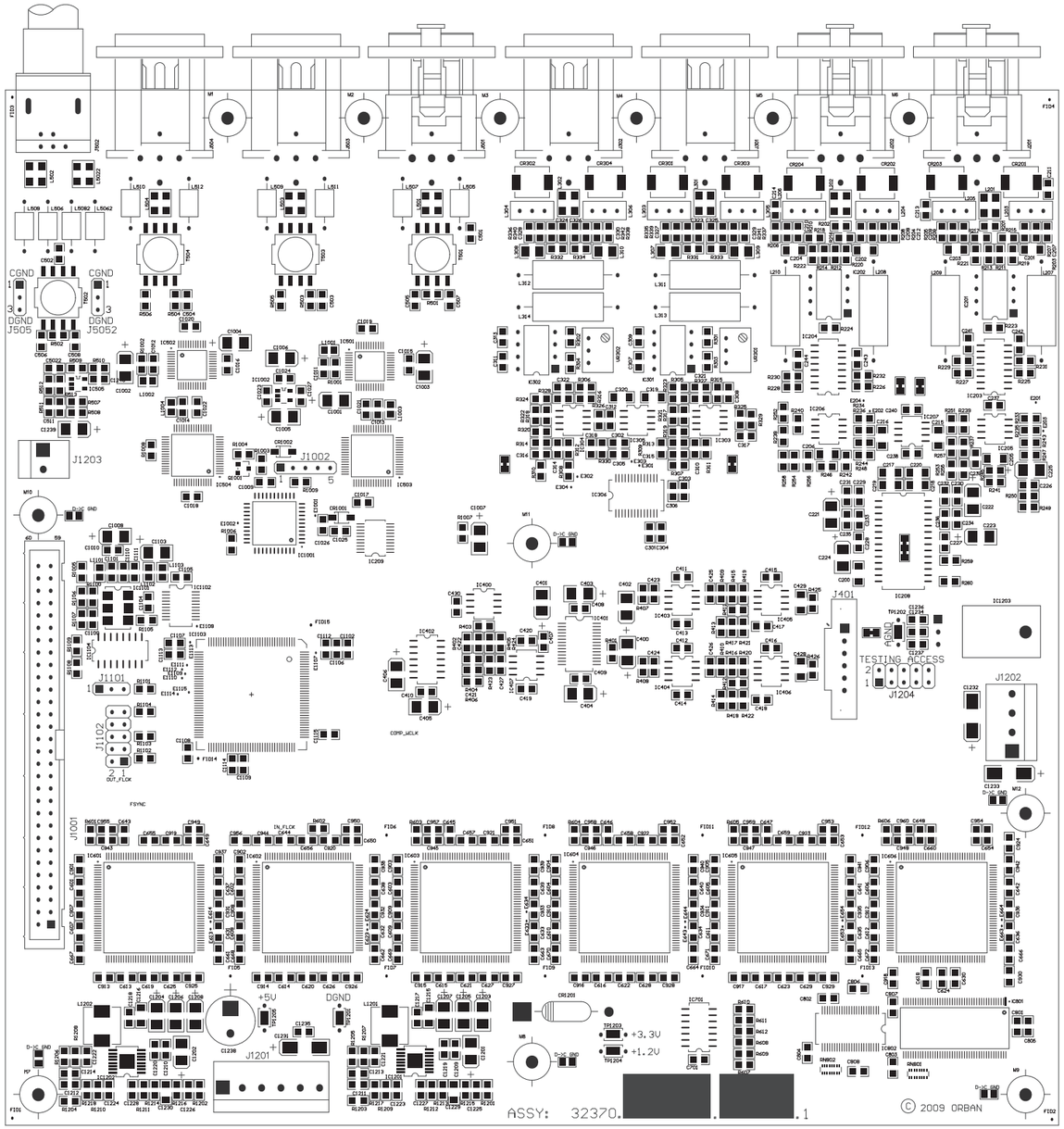


CONTROL BOARD: ETHERNET

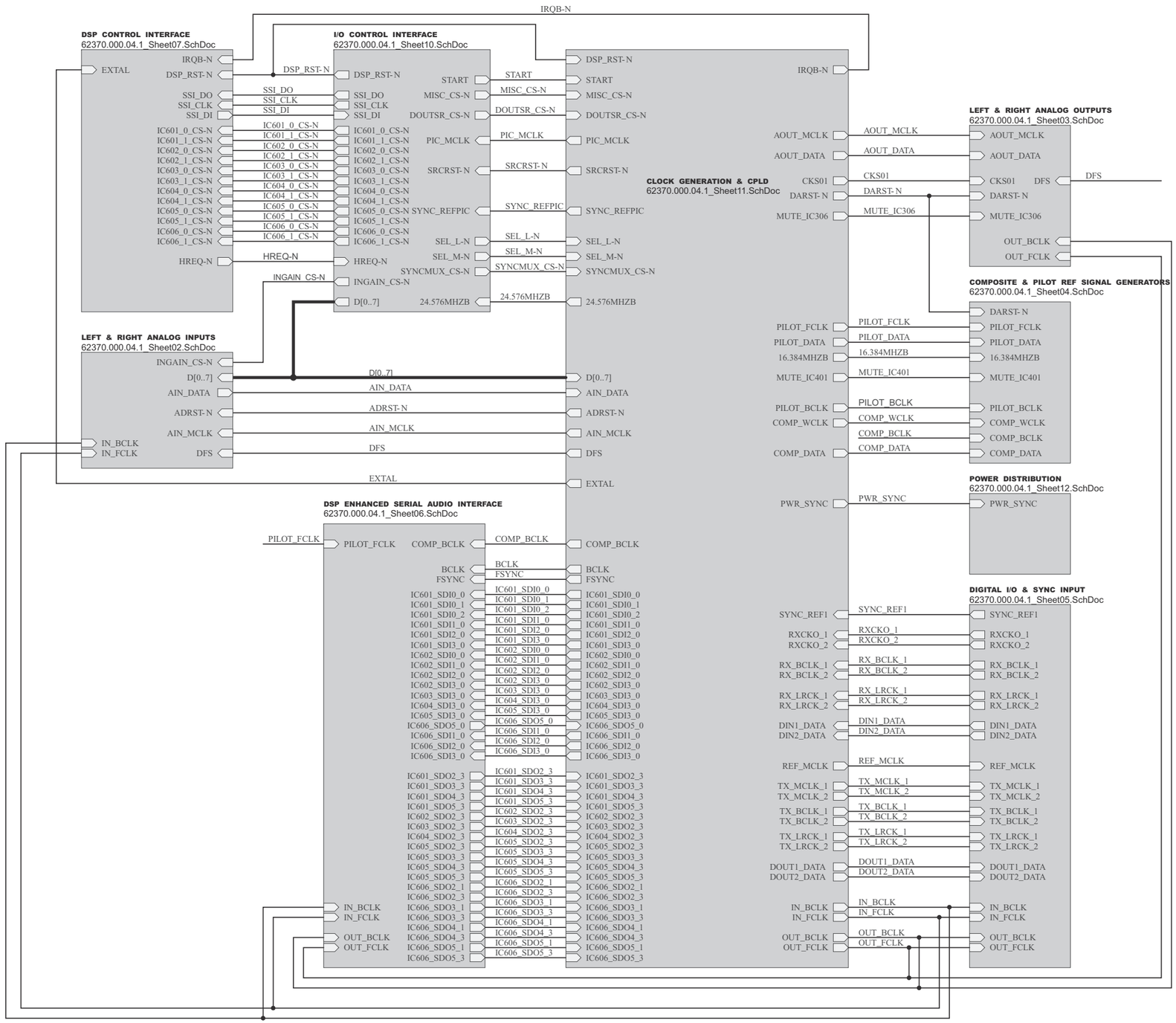

"D" CON 9 PIN MALE
FRONT VIEW
"D" CON 25 PIN MALE
FRONT VIEW
U12D SC520
MAX208ECAG
24 PIN DIP SOCKET
SPARES
74HC14A
PS2506-4
U22 74ACT245
U18 74ACT244
U20 74HCT374
U21 TPS61041
RNET 100K
REMOTE IN-N
TALLY 2
TALLY 1
MISC OUT-N
MMBT4400 OUTLINE SOT-23
TO FRONT PANEL DISPLAY PCA (REVISIONS 01,02,03)
TO POWER-ON LED
FRONT PANEL CONNECTIONS
TO LCD
TO LCD BACKLIGHT
TO FRONT PANEL DISPLAY PCA
ORBAN USE ONLY
CONTRAST
SYSTEM_RESET-N
PWRGOOD
CONTROL BOARD:
MISCELLANEOUS I/O



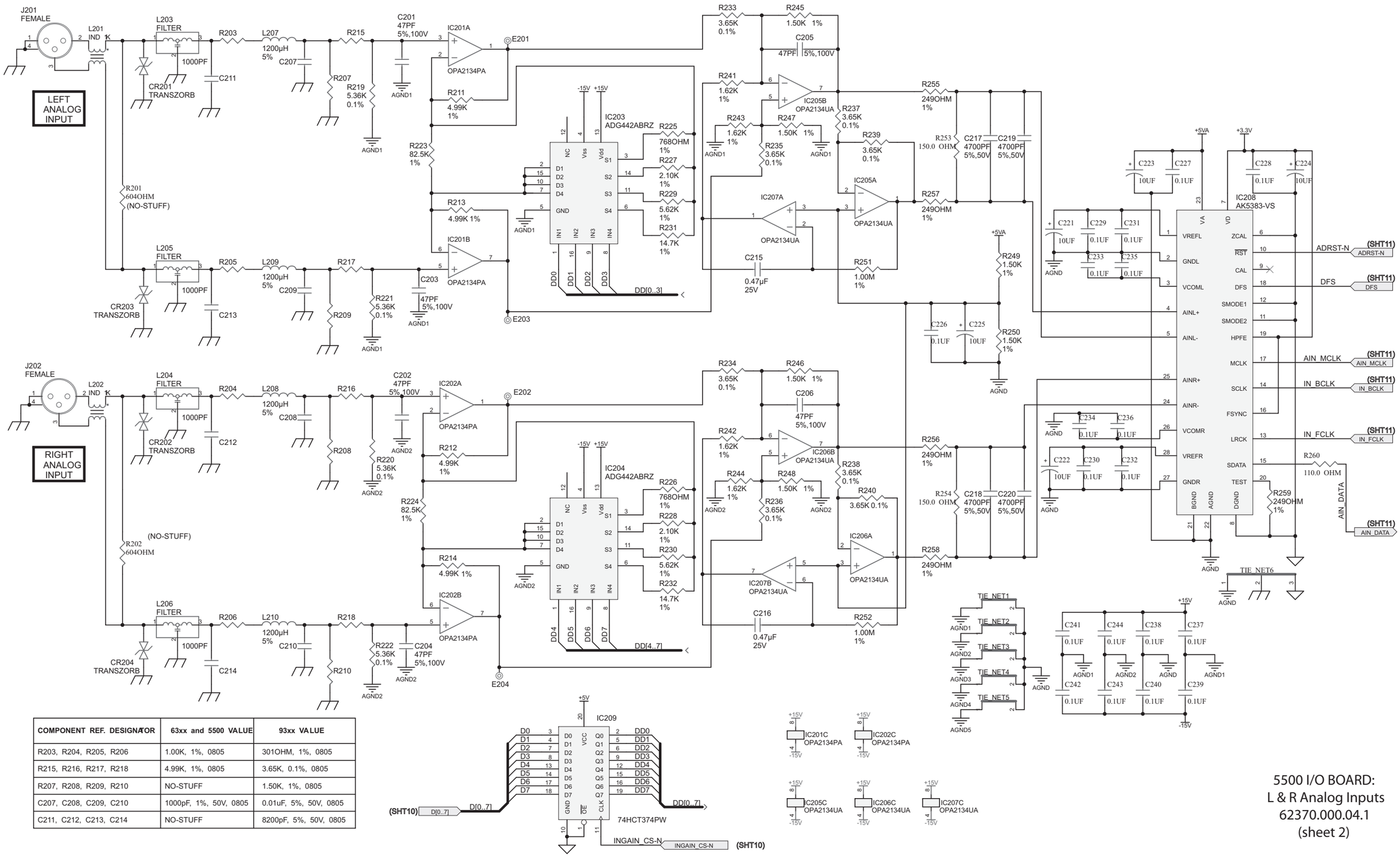
CONTROL BOARD:
POWER AND GROUND DISTRIBUTION



5500 I/O BOARD:
Parts Locator Drawing
32370.000.02.1
(sheet 1 of 1)

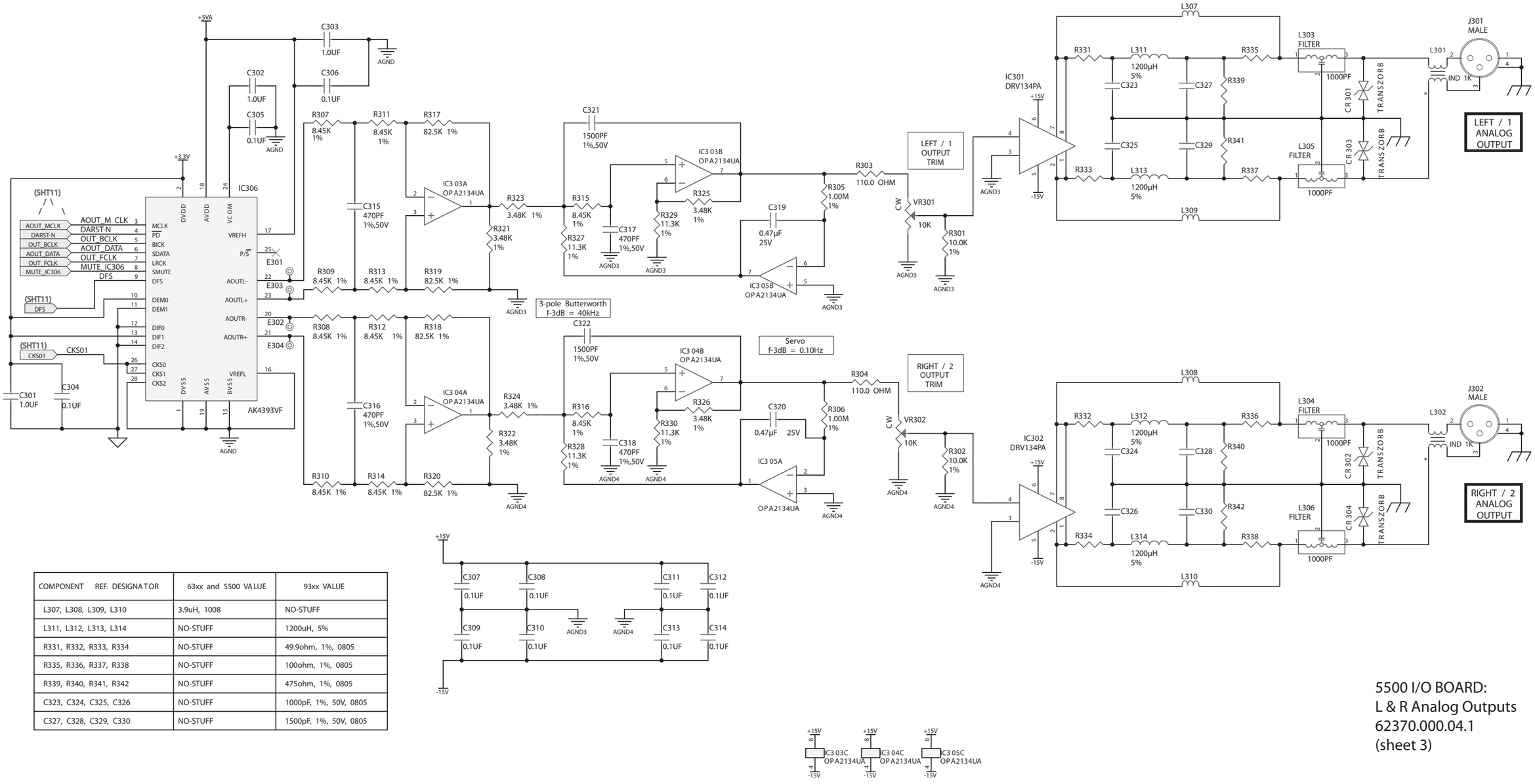


5500 I/O BOARD:
Interconnects
62370.000.04.1
(sheet 1)



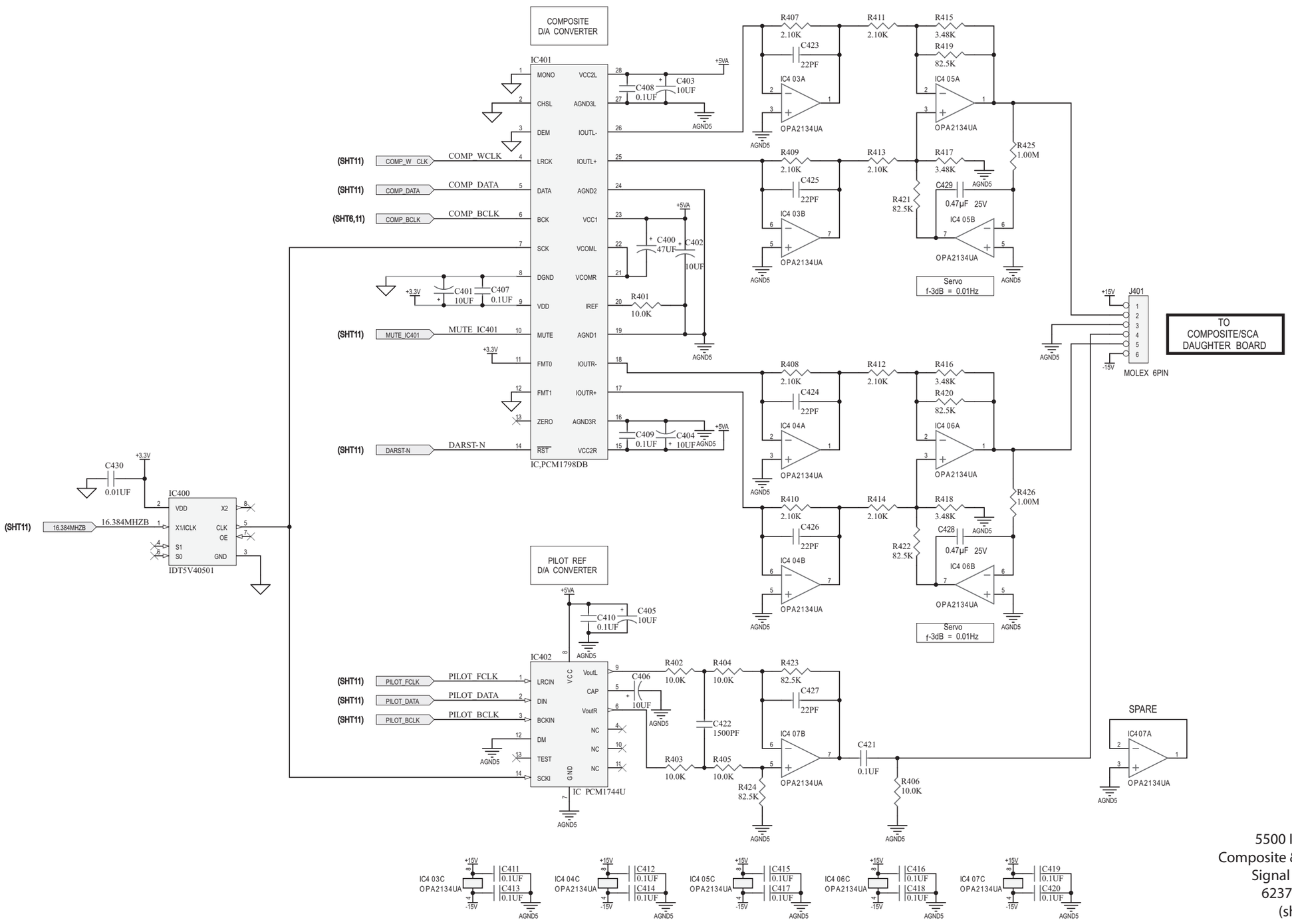
COMPONENT REF. DESIGNATOR	63xx and 5500 VALUE	93xx VALUE
R203, R204, R205, R206	1.00K, 1%, 0805	301OHM, 1%, 0805
R215, R216, R217, R218	4.99K, 1%, 0805	3.65K, 0.1%, 0805
R207, R208, R209, R210	NO-STUFF	1.50K, 1%, 0805
C207, C208, C209, C210	1000pF, 1%, 50V, 0805	0.01uF, 5%, 50V, 0805
C211, C212, C213, C214	NO-STUFF	8200pF, 5%, 50V, 0805

5500 I/O BOARD:
L & R Analog Inputs
62370.000.04.1
(sheet 2)

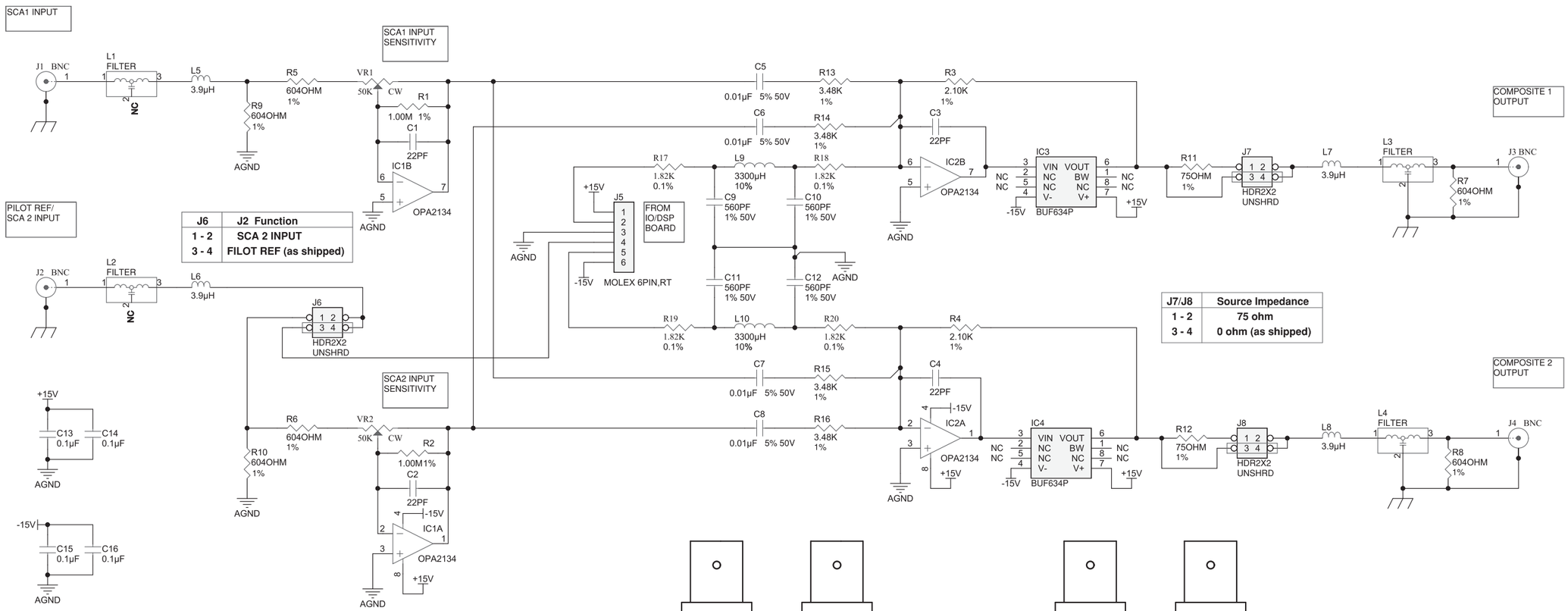


COMPONENT REF. DESIGNATOR	63xx and 5500 VALUE	93xx VALUE
L307, L308, L309, L310	3.9uH, 1008	NO-STUFF
L311, L312, L313, L314	NO-STUFF	1200uH, 5%
R331, R332, R333, R334	NO-STUFF	49.9ohm, 1%, 0805
R335, R336, R337, R338	NO-STUFF	100ohm, 1%, 0805
R339, R340, R341, R342	NO-STUFF	475ohm, 1%, 0805
C323, C324, C325, C326	NO-STUFF	1000pF, 1%, 50V, 0805
C327, C328, C329, C330	NO-STUFF	1500pF, 1%, 50V, 0805

5500 I/O BOARD:
L & R Analog Outputs
62370.000.04.1
(sheet 3)

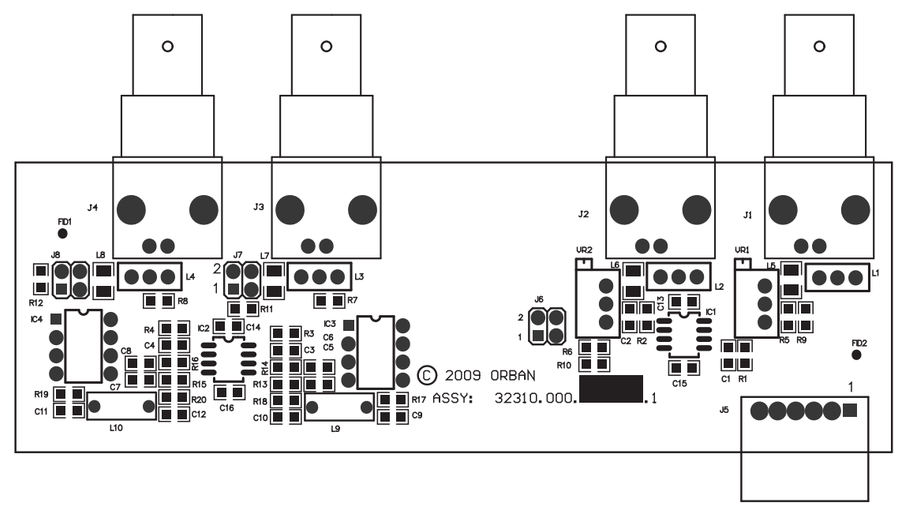


5500 I/O BOARD:
Composite & Pilot Reference
Signal Generators
62370.000.04.1
(sheet 4a)

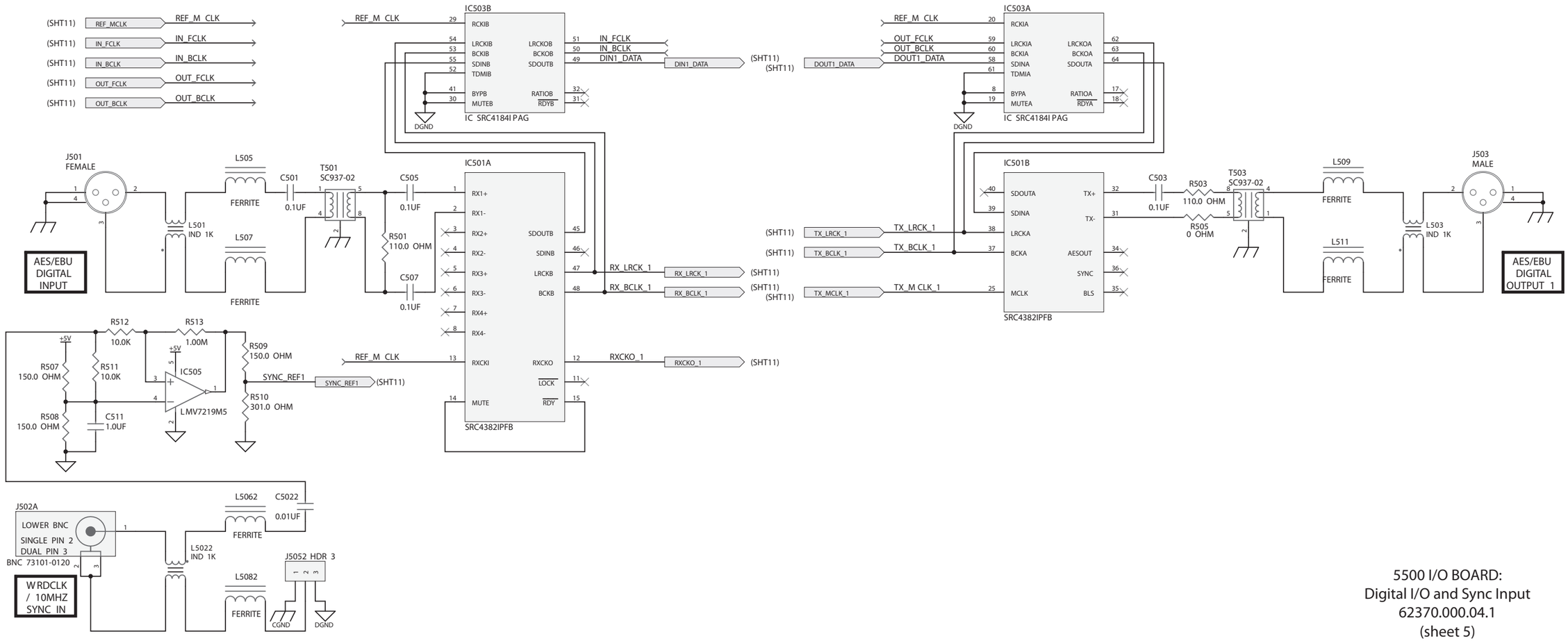


J6	J2 Function
1 - 2	SCA 2 INPUT
3 - 4	FILOT REF (as shipped)

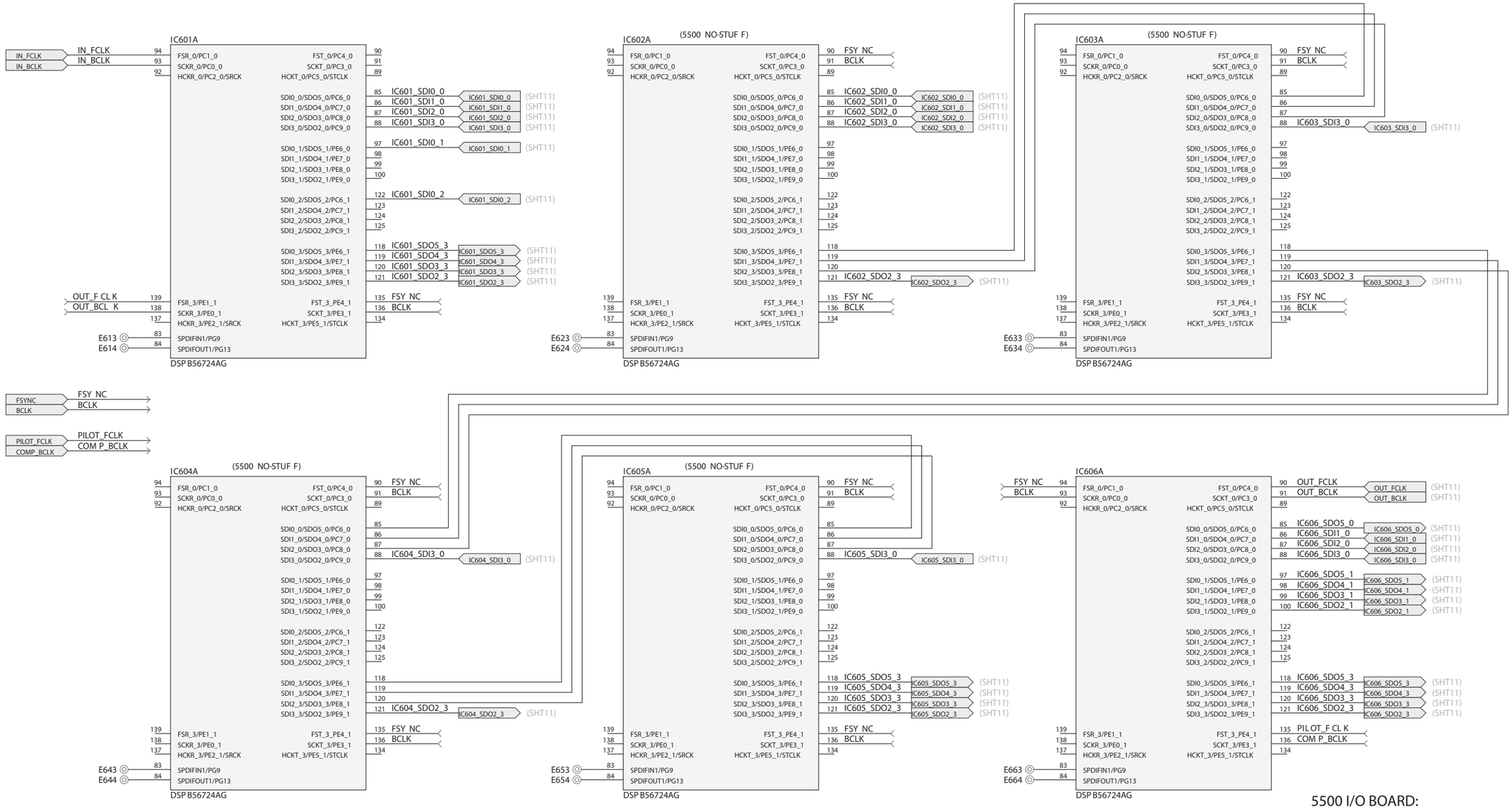
J7/J8	Source Impedance
1 - 2	75 ohm
3 - 4	0 ohm (as shipped)



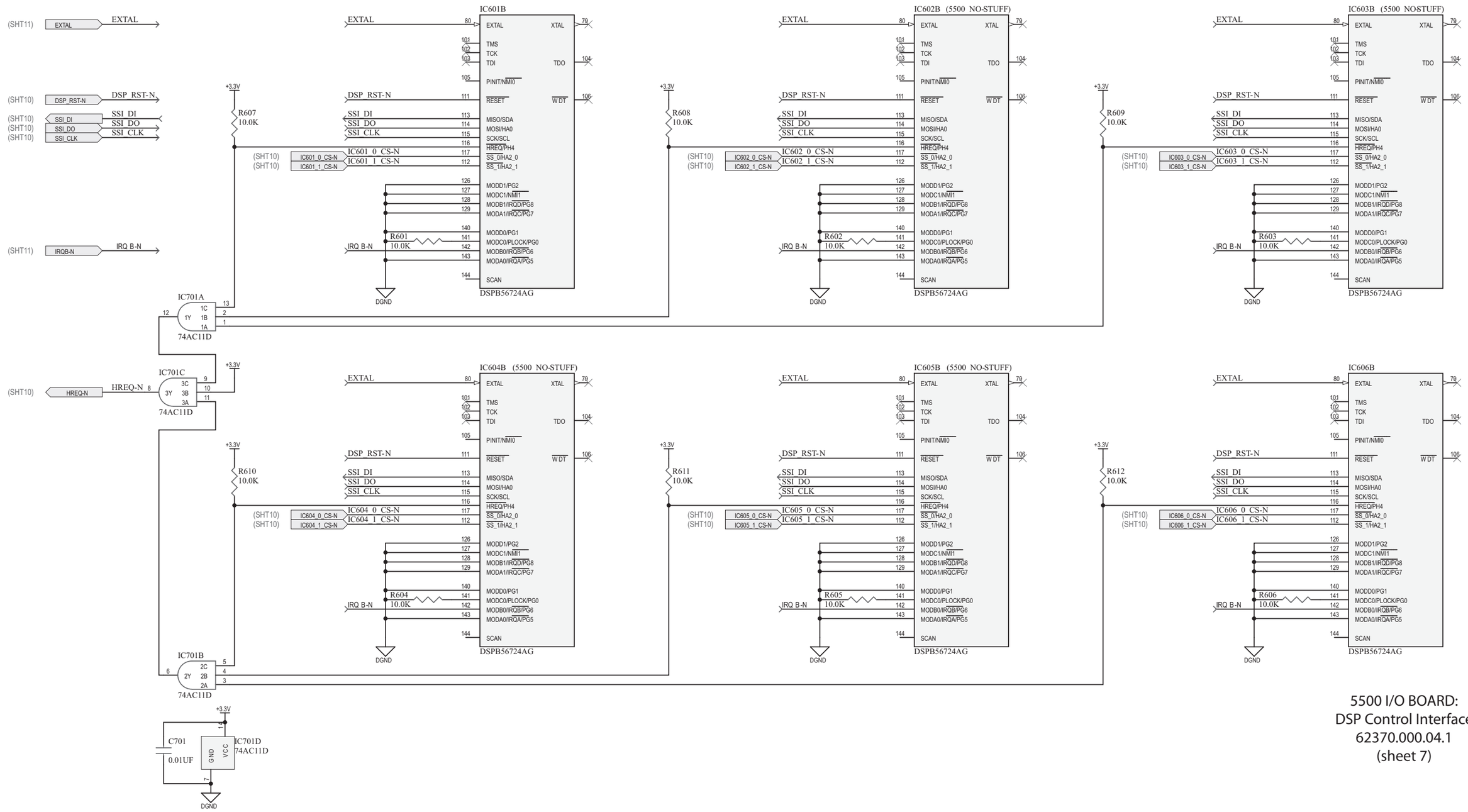
5500 I/O BOARD:
Composite/SCA
Daughter Board
62310.000.02.1
(sheet 4b)



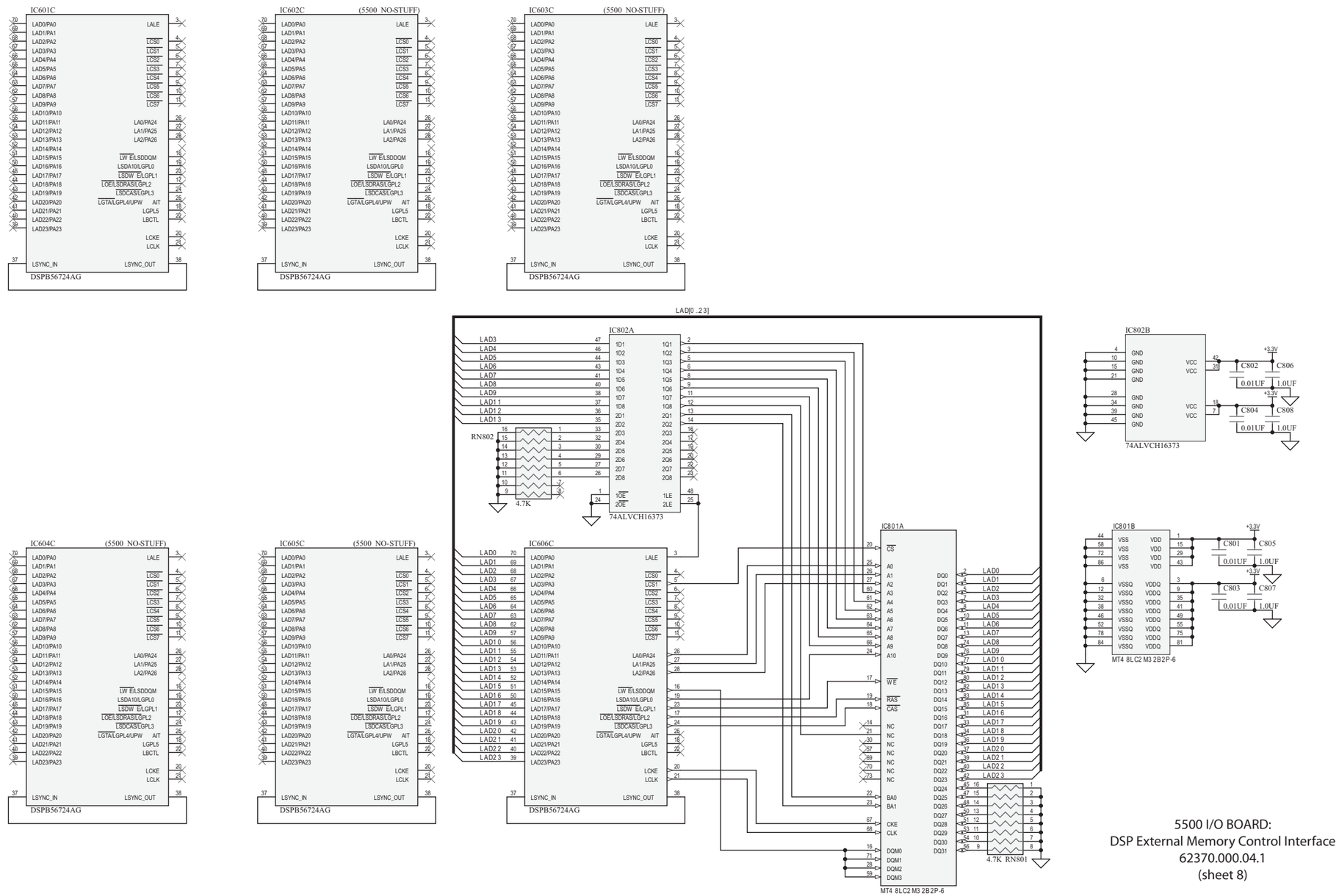
5500 I/O BOARD:
Digital I/O and Sync Input
62370.000.04.1
(sheet 5)



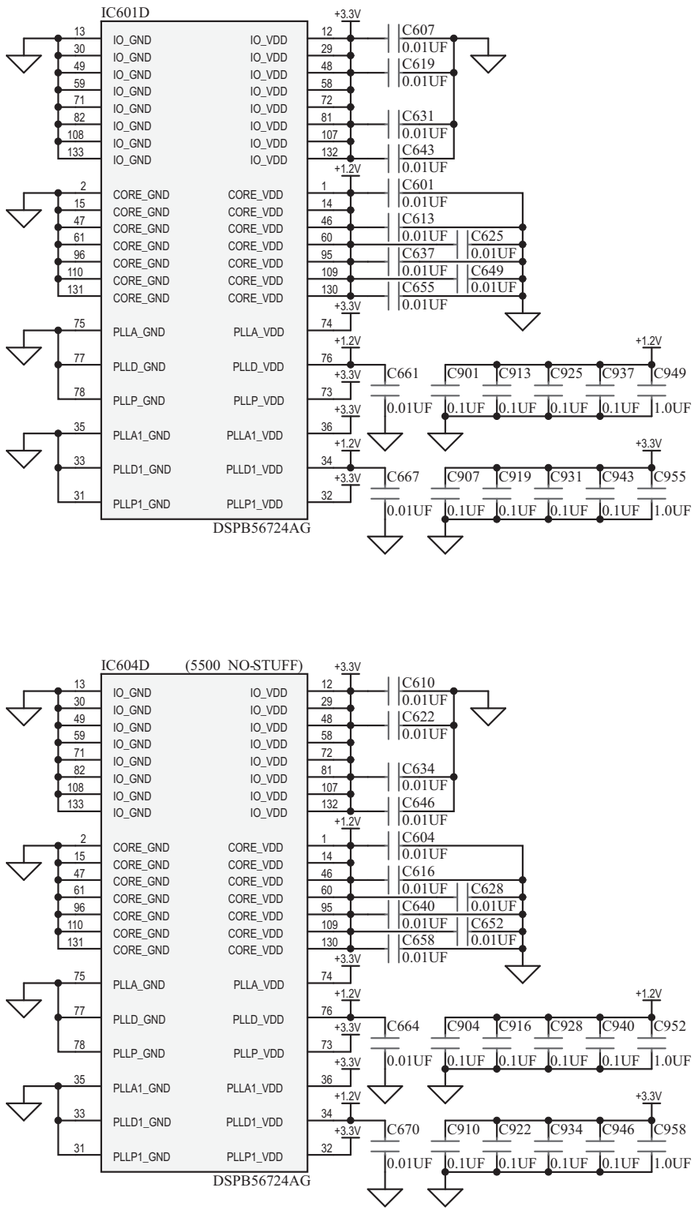
5500 I/O BOARD:
DSP Enhanced Serial Audio Interface
62370.000.02.1
(sheet 6)

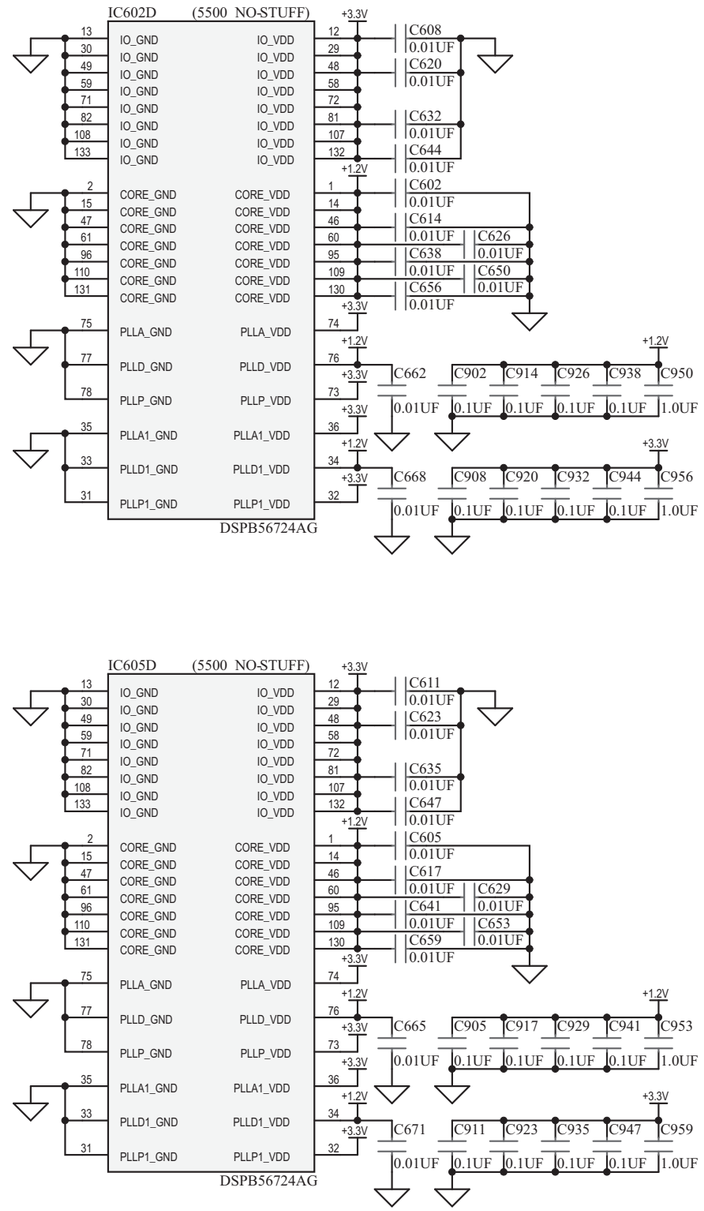


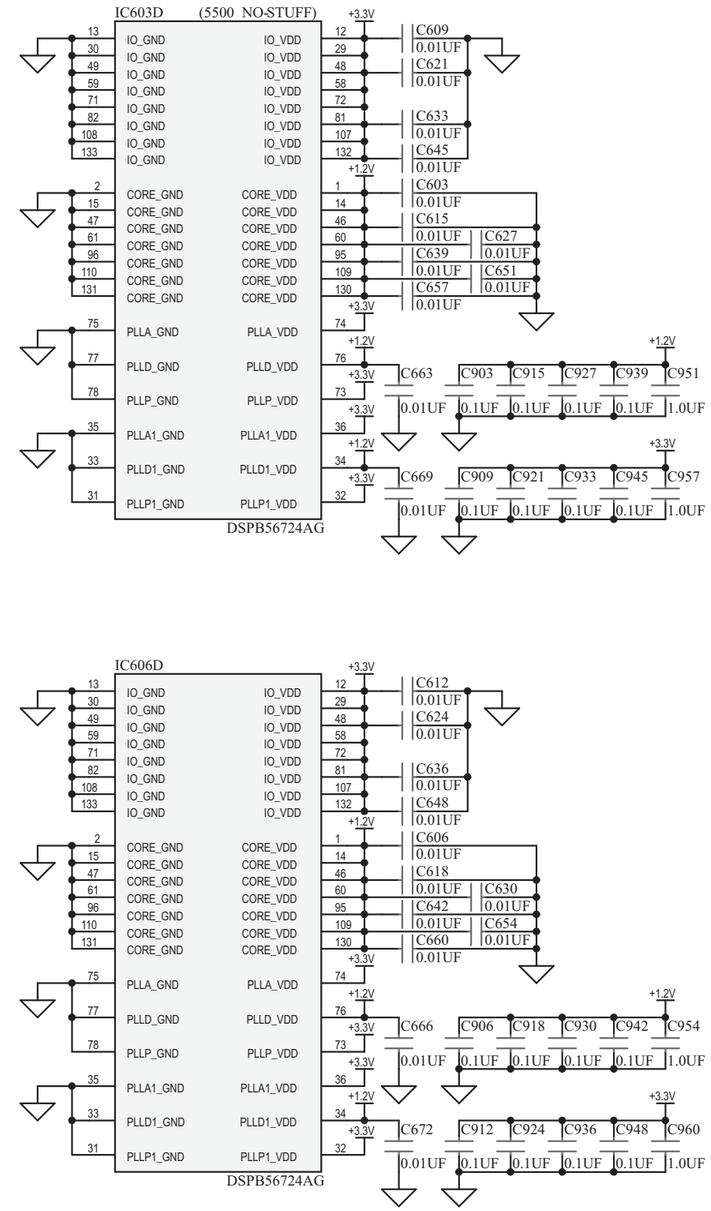
5500 I/O BOARD:
DSP Control Interface
62370.000.04.1
(sheet 7)



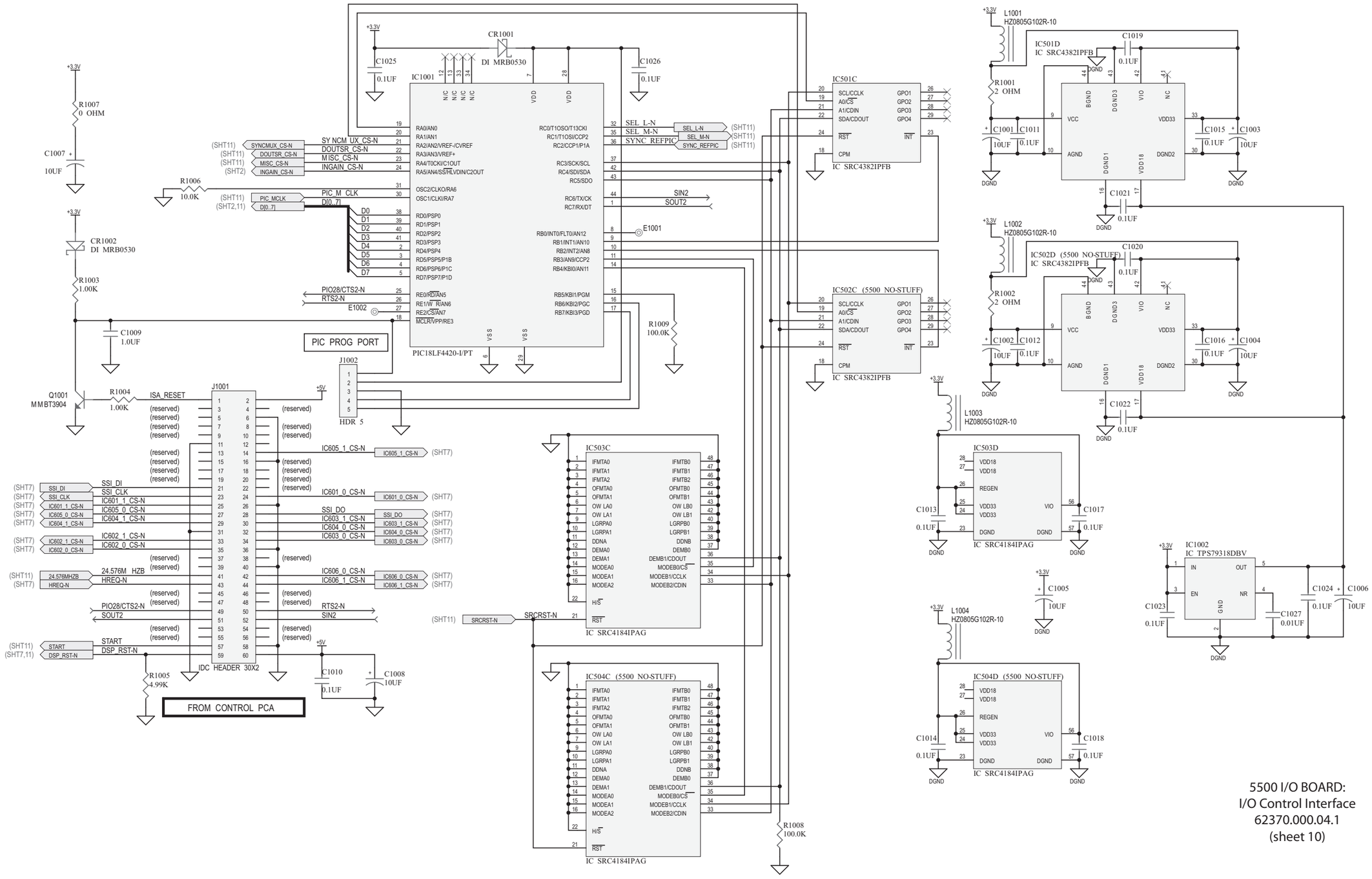
5500 I/O BOARD:
DSP External Memory Control Interface
62370.000.04.1
(sheet 8)



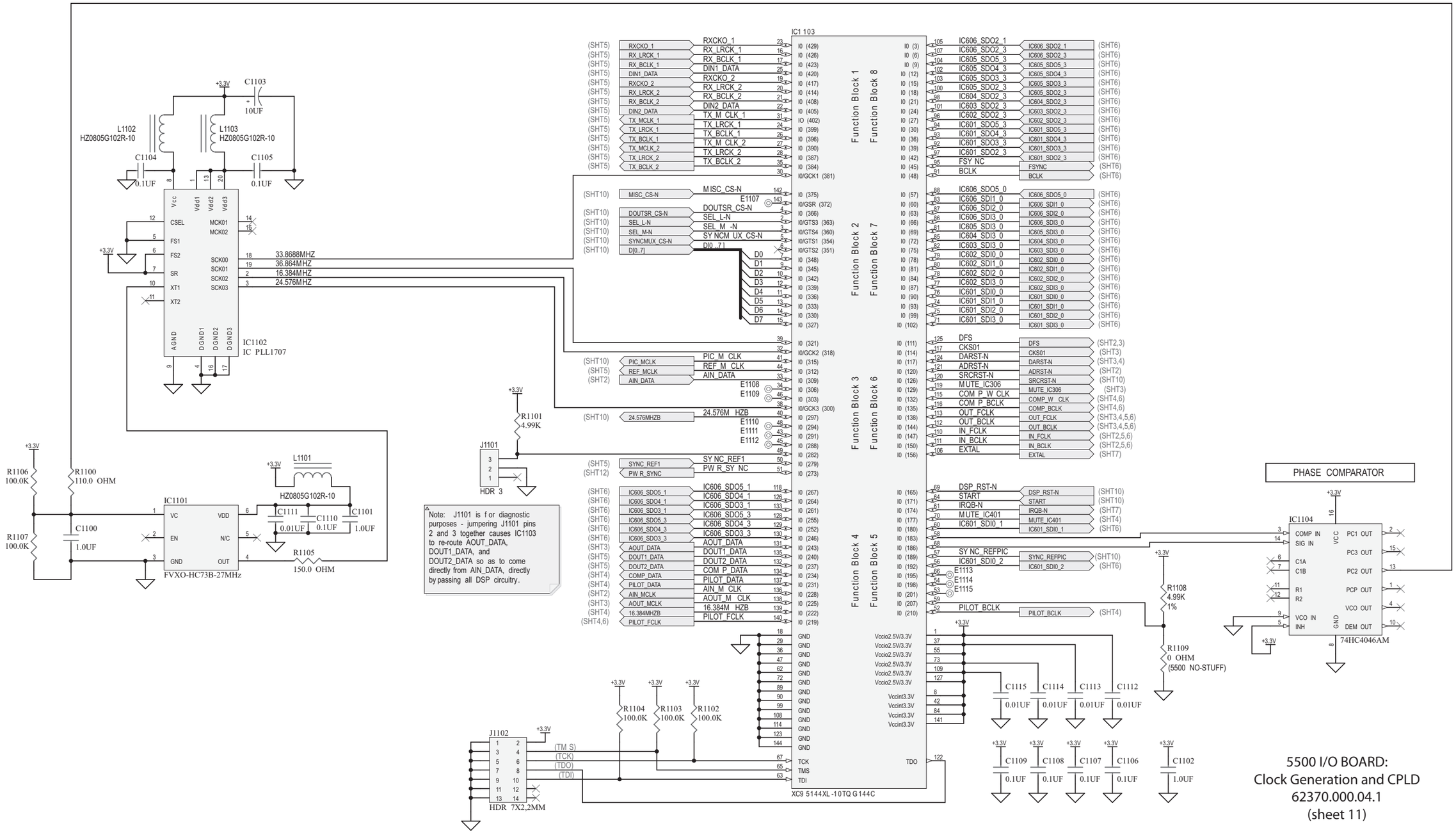




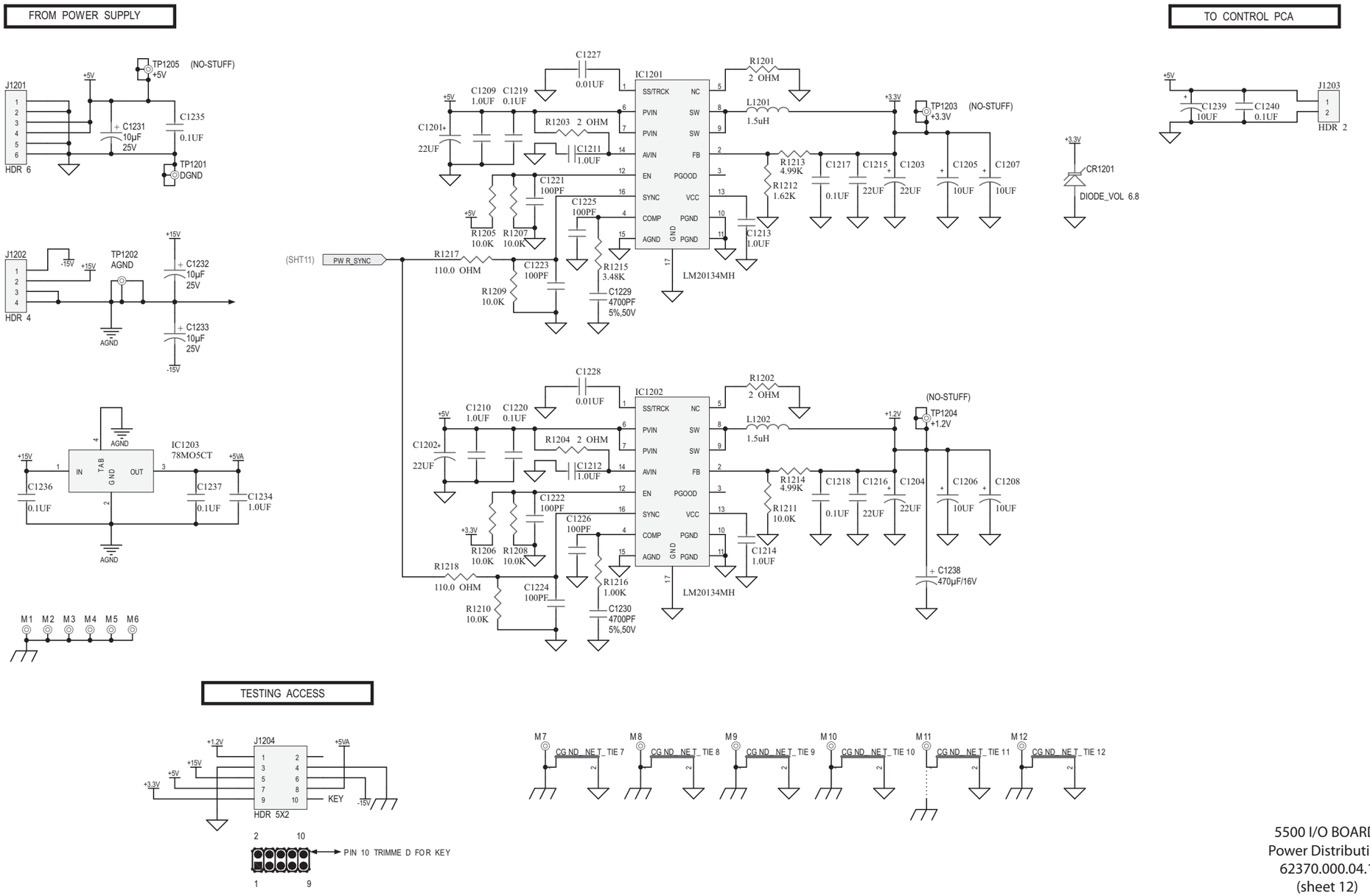
5500 I/O BOARD:
DSP Power and Ground
62370.000.04.1
(sheet 9)



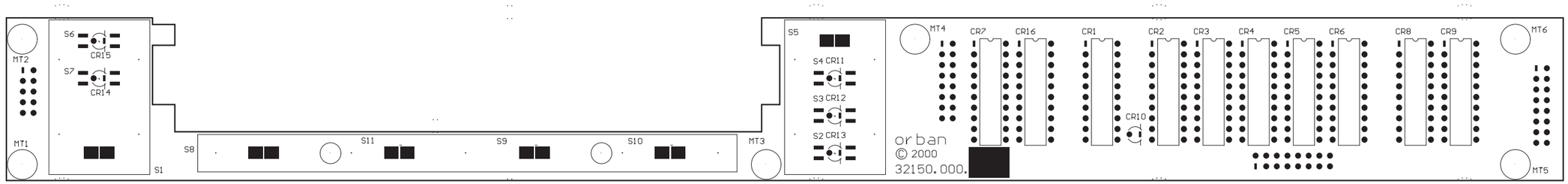
5500 I/O BOARD:
I/O Control Interface
62370.000.04.1
(sheet 10)



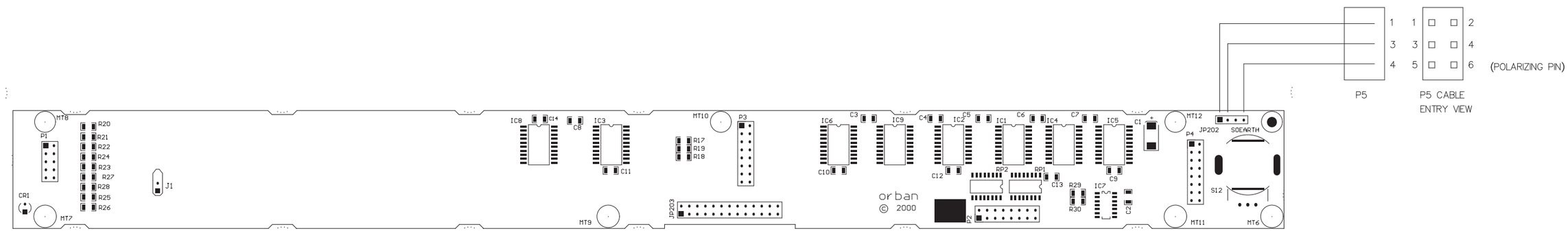
5500 I/O BOARD:
Clock Generation and CPLD
62370.000.04.1
(sheet 11)



5500 I/O BOARD:
Power Distribution
62370.000.04.1
(sheet 12)

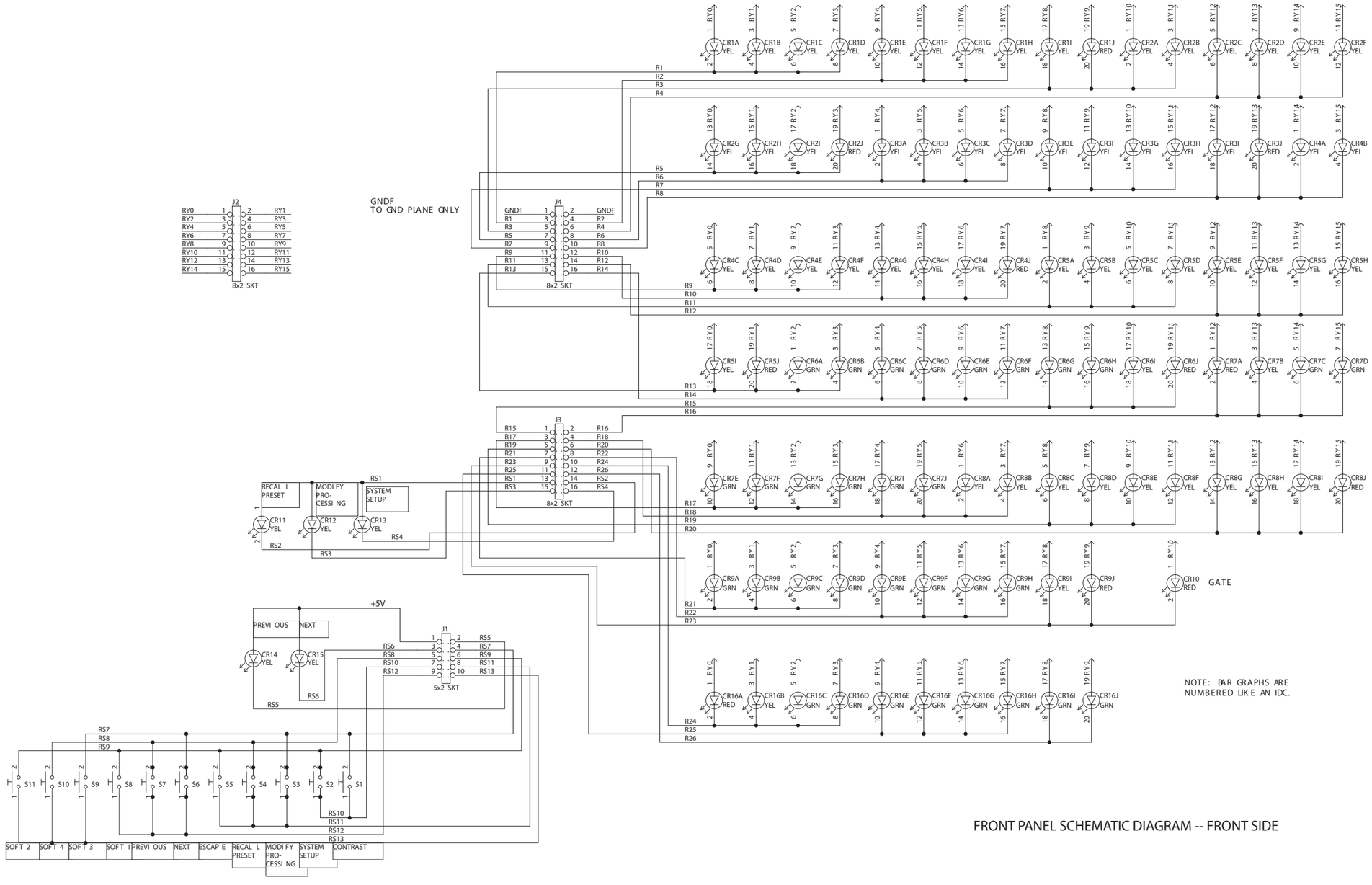


FRONT VIEW

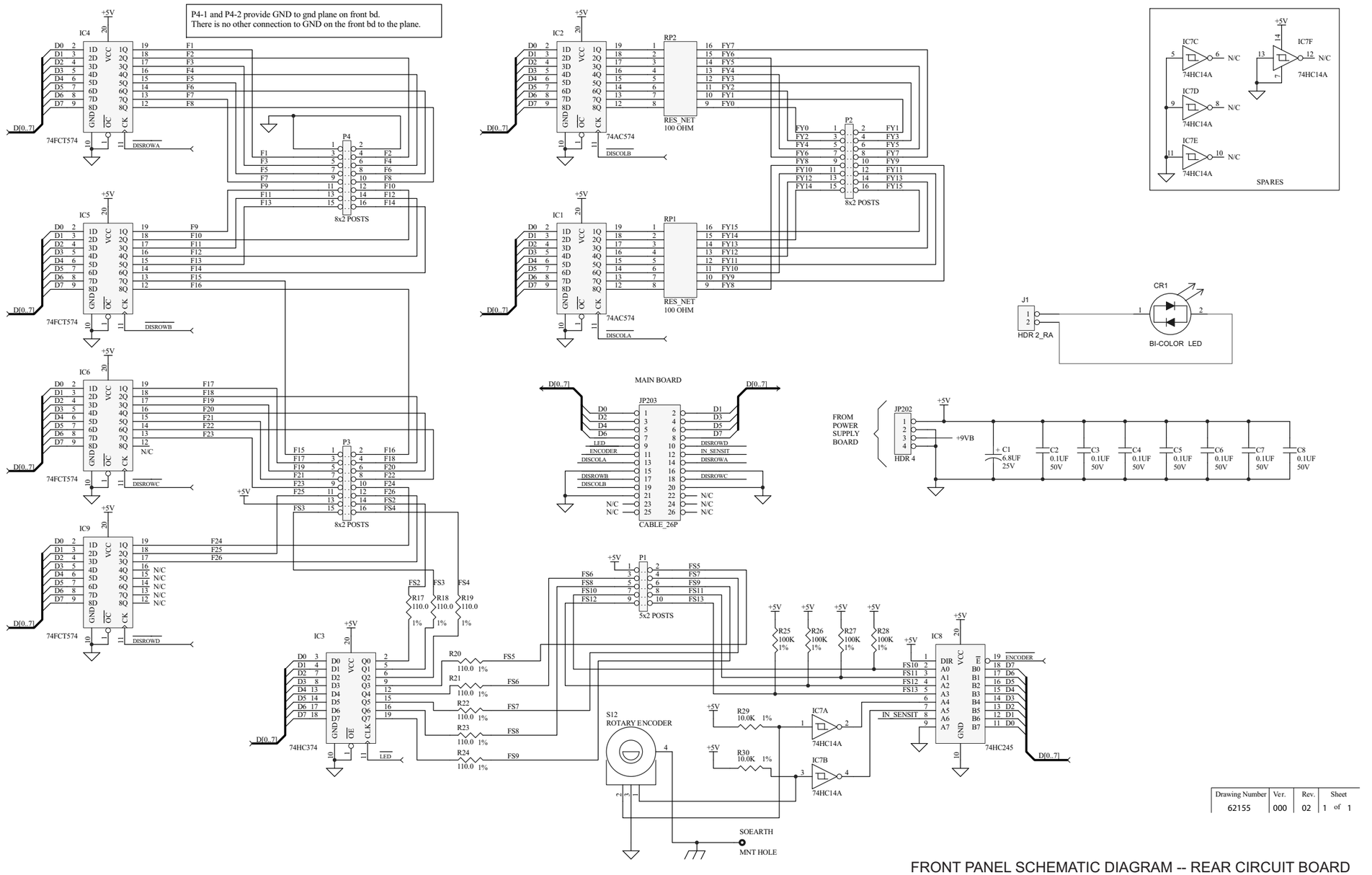


REAR VIEW

FRONT PANEL PARTS LOCATOR DIAGRAM

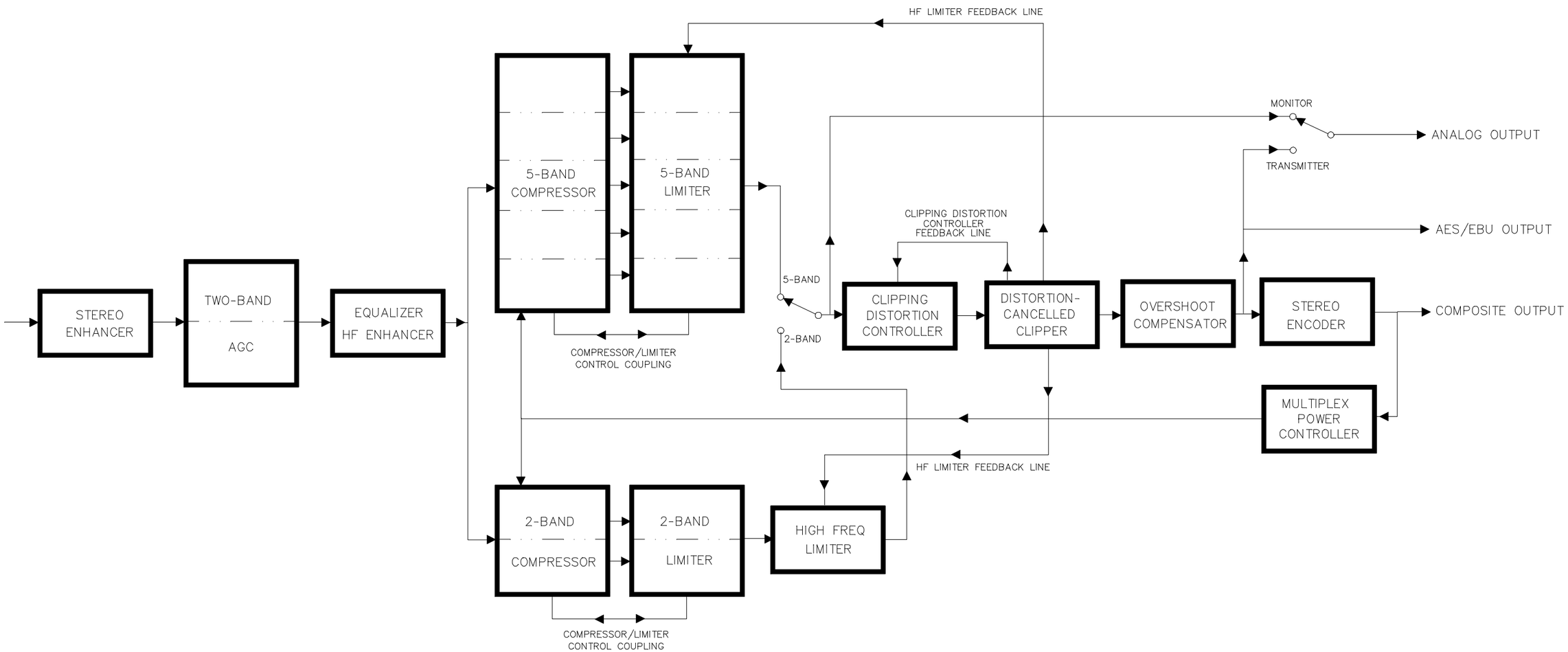


FRONT PANEL SCHEMATIC DIAGRAM -- FRONT SIDE



Drawing Number	Ver.	Rev.	Sheet
62155	000	02	1 of 1

FRONT PANEL SCHEMATIC DIAGRAM -- REAR CIRCUIT BOARD


HF LIMITER FEEDBACK LINE
MONITOR
ANALOG OUTPUT
TRANSMITTER
5-BAND COMPRESSOR
5-BAND LIMITER
CLIPPING DISTORTION CONTROLLER FEEDBACK LINE
AES/EBU OUTPUT
5-BAND
2-BAND
STEREO ENHANCER
TWO-BAND AGC
EQUALIZER HF ENHANCER
CLIPPING DISTORTION CONTROLLER
DISTORTION-CANCELLED CLIPPER
OVERSHOOT COMPENSATOR
STEREO ENCODER
COMPOSITE OUTPUT
COMPRESSOR/LIMITER CONTROL COUPLING
MULTIPLEX POWER CONTROLLER
HF LIMITER FEEDBACK LINE
2-BAND COMPRESSOR
2-BAND LIMITER
HIGH FREQ LIMITER
COMPRESSOR/LIMITER CONTROL COUPLING