ISS

User Guide

ISS
Integrated Simulator System

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Introduction

Your ISS was inspected and carefully checked at the factory. We suggest, however, that you inspect the shipping cartons and all contents for any damage.

If you do find damage, save the cartons and all packing material and notify the shipper. You are responsible for any shipping claims that must be made.

The shipping carton will contain your ISS mainframe, ISS circuit cards, ISS front panel, ISS instruction manual, mainframe instruction manual, warranty cards, and a power cord. If any of these materials are missing, contact your dealer or Studio Technologies, Inc. immediately.

General Description

The Studio Technologies ISS Integrated Simulator System is designed for use in conjunction with MTS television broadcast operations. The television broadcaster is faced with the reality of having to broadcast a combination of stereo and mono audio material. Stereo simulators can greatly improve the listener's appreciation of "stereo" TV. The ISS combines excellent stereo simulation with advanced control circuitry to provide superior audio and operational performance.

Major Functions

The ISS provides several major functions:

Stereo Simulation: The ISS produces great sounding simulated stereo. To create this "sound" the ISS contains two stereo simulator circuit cards. These cards work together to transform a mono signal into left and right channel signals that give an excellent stereo "feel," while keeping the voice signals in the center. The ISS Type I simulator card provides simulation over the entire audio spectrum. The Type II simulator card adds a specialized filter to give greater simulation to all frequencies except those in the voice band. The Type II card ensures that excellent voice centering is maintained. The simulated stereo is completely mono compatible. The sound of the ISS is factory optimized for the best overall performance.

Input/Output Circuitry: The input/output circuitry of the ISS provides switch selectable 0, +4, or +8dBu operation to match the requirements of most broadcast facilities. Careful circuit design provides excellent audio performance. The Transfer Relay Assembly connects the audio input signals directly to the audio output connectors in the event of a system malfunction, power failure, or operator request, thus ensuring no interruption of broadcast audio.

Audio Control: A smooth electronic crossfade circuit routes either the line inputs, or the outputs of the stereo simulator cards to the ISS line outputs. Three crossfade speeds are used to ensure the appropriate action. The ISS has been designed to provide the best simulated stereo sound with the least obtrusive operation.

Remote Control Operation: Extensive features allow the operating status of the ISS to be displayed and controlled remotely. Relay contacts provide system status indication. These are also known as tally signals. Continuous or pulse logic level inputs give the user complete control over the ISS operating status.

Mono/Stereo Recognition: The Recognition Card determines the mono/stereo status of the incoming left and right audio signals. The Recognition Card contains circuitry to determine if the incoming audio is two channel mono, mono with signal on the left channel only, or mono with signal on the right channel only. Each condition can be defeated by a switch. The circuitry has been designed to minimize the chance of incorrect recognition, i.e., seeing a true stereo input as mono, or vice versa.

Polarity Correction: ISS circuitry can monitor and correct 180 degree polarity reversals. The Polarity Correction Card ensures that mono compatibility is maintained.

Design Criteria

We are pleased that you already have, or will soon be purchasing an ISS. A great deal of care and effort was put into developing this product. Our first design requirement was that the simulated stereo produced must sound *very* good. We, by all means, love real stereo recordings, but these, especially for TV broadcasters, are in limited supply. The ISS provides the stereo listener with a high quality, enhanced version of the mono source.

The second design criteria was to provide the broadcaster with a set of features that would allow complete interfacing into their broadcast facility. We required that the completed ISS have the operational characteristics to integrate easily with existing facilities. We hope you share our enthusiasm about the ISS. Questions and comments can be directed to Gordon Kapes, president of Studio Technologies. Your praise or verbal thrashing is welcome!

Jim Cunningham designed the audio sections in the ISS. He is responsible for the very effective stereo simulation method used. Mitch Budniak designed most of the logic circuitry and made suggestions that added considerably to the overall reliability of the ISS. The printed circuit cards were designed by Fred Levine. Gordon Kapes designed the overall architecture and coordinated the project.

Installation

Overview

In this section you will be:

- Taking an ISS inventory
- Mounting and powering the ISS Mainframe
- Connecting the audio signals
- Connecting the remote control input signals
- Connecting to the status relay outputs
- Configuring the circuit cards

Getting Ready

Carefully remove the ISS Mainframe from the shipping carton. For protection, the circuit cards are shipped installed in the mainframe. Use your fingers to take out the four front panel fasteners, allowing the front panel to be removed. You can now take an inventory:

Qty	Description
1	Mainframe
1	Front Panel
4	Front Panel Fasteners (knurled screws)
1	Power Cord
1	Ribbon Cable Bus

1 ISS Manual (you're reading it!)
1 Mainframe Manual
2 Warranty Cards
1 I/O Card
1 Type I Simulator Card
1 Polarity Correction Card
1 Type II Simulator Card
1 Recognition Card
1 Crossfade Card
1 Mode Select Card

An extender card can be purchased as an option and may be part of your system. It consists of 4 pieces: two ribbon cables and two interface boards.

In some cases you may have purchased a Tone Detection Card. It is an option and in most cases will not be present.

Mounting

The ISS is rack-mountable, requiring three standard rack spaces (5.25") in a standard EIA 19.00" rack. Ensure that air flow is maintained, especially on the right side (when looking from the front) where the ISS power supply section is located. A good basic rule to remember is that most electronic equipment failures are power supply related. Power supplies tend to generate heat which, when not adequately dissipated, serve to cook the power supply, drying out electrolytic capacitors and stressing semiconductor junctions. Keeping all equipment relatively cool will reduce the likelihood of problems occurring.

Connecting the Unit to Power

The ISS may be operated from either nominal 115 or 230Vac, 50/60 Hz. Units selected for 115V operation utilize a 0.75A 3AG Slow-Blow fuse; 230V operation utilizes a 0.375A Slow-Blow fuse. Before connecting the ISS to power, determine the actual line voltage and check to see that the voltage selector switch, visible through the square cutout in the Transfer Relay Assembly, is set to the appropriate voltage. If the voltage selector switch is set for 230V, ensure that the fuse, located adjacent to the voltage selector switch, is 0.375A. PLEASE NOTE THAT AN INCORRECT SETTING AND/OR INCORRECT FUSE COULD SERIOUSLY DAMAGE THE UNIT.

The ISS utilizes an IEC standard connector to mate with the line cord. The line cord supplied has a North American standard plug at one end and an IEC connector at the other. In non-North American applications, the plug must be cut off and an appropriate plug attached. The wire colors in the line cord conform to the internationally recognized CEE color code and should be wired accordingly:

Connection	Wire Color
Neutral (N)	Light Blue
Live (L)	Brown
Protective Earth (E)	Green/Yellow

Signal Connections

All signal connections to and from the ISS are made via connectors located on the back panel. Four, three pin XL-type connectors handle audio input and output signals; female for input, male for output. One 25-pin male D-type subminiature connector handles all remote control and status signals. Refer to Figure 1, located at the end of this manual, for detailed connection information.

Audio Signals

Left and right audio input and output connections must be made. For hum, noise, and RF pickup rejection, shielded cable must be used for the audio signals. Studio Technologies uses the convention of pin 2 high, in honor of the European microphone makers! In most cases, it is correct to connect the shield lead to pin 1 of the XL connectors. Pin 1 on the audio input and output connectors are common with the ISS Mainframe power supply ground, chassis ground, and power cord ground leads. Maintaining consistent left and right audio input and output polarity is *very* important for correct performance of the ISS.

If possible, use patch points on the input and output signals of the ISS. Installation, testing, and servicing procedures will be greatly improved if the ISS is easily placed on and off line. Make sure that the ISS can be “patched around” while allowing test signals to be sent to and returned from the ISS.

The ISS audio input signals generally arrive from the master control switcher, an STL, leased telephone lines, etc. All audio processing (limiting, compressing, etc.) should be performed prior to the audio getting to the ISS. This helps to ensure that the ISS simulated stereo remains mono compatible. The source should be balanced and line level. If the audio equipment contains audio output transformers, load resistors matching the source impedance may need to be inserted and soldered into the I/O card. In many cases the value of the resistors would be 600 ohms. Loading of the output transformers can prevent “ringing” of the audio signals. The quality of the output transformers is the determining factor when deciding whether to load or not to load. Bad transformers tend to need loading; good ones generally do not. Refer to the Technical Notes section of this manual for more information on installing load resistors.

The ISS audio output signals usually go directly to the transmitter, or to the transmitter via an STL or leased lines. The ISS audio outputs are low impedance, electronically balanced, line level, direct coupled. They are capable of driving virtually all line inputs (low or high impedance, transformer or transformerless). The ISS can even drive 150 ohm loads at high signal levels, not bad huh!

The ISS uses electronically balanced input and output circuitry. Best performance is achieved if the equipment sending signal to, and receiving signal from the ISS is operating in a balanced mode. The ISS input and output stages will operate correctly in an unbalanced mode, but selected performance characteristics will be sacrificed. On the input side you will lose the ability to reject common-mode signals that balanced operation affords. On the output side you will lose 6dB maximum output level. This is not a technical fault but is inherent in electronically balanced output stages. If unbalanced input operation is required, strap pin 3 to pin 1 on the male connector that will mate with the ISS. Connect the unbalanced input signal high lead to pin 2, and signal ground to pin 1. If unbalanced output operation is required, strap pin 3 to pin 1 on the female connector that will mate with the ISS. Connect the unbalanced output signal high lead to pin 2, and signal ground to pin 1.

In most cases, transformer coupling between audio equipment is neither required, nor desirable. If the equipment sending signal to, or receiving signal from the ISS requires the isolation given by a transformer, but does not contain internal transformers, external transformers can be added. Refer to the Technical Notes section of this manual for recommended transformers.

Connecting the Remote Control Signals

Provision has been made for remotely controlling a number of ISS functions. These signals interface with the ISS via a 25-pin male D-type connector located on the back panel. In most cases, the ISS will be located some distance from the TV master control point. It may be desirable to control the ISS's operation using a telemetry system or switches connected via cable pairs. The following is a description of the remote control inputs:

Remote Control Enable: Activating this allows use of the Remote Simulate from Left and Remote Simulate from Right commands. Activating the Remote Control Enable will override the commands from the Recognition Card.

Remote Simulate from Left: This command is only active when Remote Control Enable is in effect. Remote Simulate from Left allows you to place the ISS in the simulate from the left channel mode.

Remote Simulate from Right: This command is only active when Remote Control Enable is in effect. Remote Simulate from Right allows you to place the ISS in the simulate from the right channel mode.

Remote I/O Bypass: Activating this command forces the relays on the Transfer Relay Assembly to release, connecting the audio input signals directly to the audio output connectors. This electrically takes the ISS out of the audio path.

Remote Polarity Correction Function Disable: Activating this command disables the polarity correction function.

Low voltage, current limited logic type signals are required for remote control operation. Continuous or pulse (momentary) signals can be used. These logic signals are usually nominally 5 or 12Vdc. LED based optical couplers, located on the ISS circuit cards, are utilized to eliminate interfacing problems. The couplers require current, rather than voltage or a contact closure, to operate. The minimum current required is 4mA; the maximum is 20mA. For protection, 680 ohm resistors, located on the ISS circuit boards, are in series with the optical couplers. These resistors limit a 5Vdc signal to 4.5mA, and limit a 12Vdc signal to 13mA. If higher DC voltages are used, additional current limiting resistors, connected in series with the remote control inputs, are required. Failure to provide current limiting will damage and/or shorten the life of the opto couplers.

Connecting to the Status Relay Outputs

Relay contacts indicating several ISS operating characteristics are provided for user-designated functions. These contacts are accessible via the 25-pin male D-type connector located on the back panel. These can be extremely useful for local or remote monitoring. An automation system can watch for an error condition, or a master control operator can monitor ISS operation through a set of indicator lights. Dry (isolated) relay contacts are provided so that virtually any monitoring scheme can be implemented without interfering with ISS operation due to ground loops, noise pickup, etc. The following gives a description of the Status Relay Outputs.

ISS Remote Control Enabled: This contact closes (shorts) when a Remote Control Enable condition is in effect. This contact gives acknowledgment of a valid Remote Control Enable condition.

ISS Simulating from Left: This contact closes (shorts) when the ISS is in the simulating from the left channel mode. This contact closes any time the ISS is simulating from the left channel, whether due to a Remote Simulate from Left command, a command from the front panel controls, or a command from the Recognition Card.

ISS Simulating from Right: This contact closes (shorts) when the ISS is in the simulating from the right channel mode. This contact closes any time the ISS is simulating from the right channel, whether due to a Remote Simulate from Right command, a command from the front panel controls, or a command from the Recognition Card.

Polarity Correction Taking Place: This contact closes (shorts) when polarity correction is taking place. You may want to let this contact control an audible alerting device in master control, a tape room, etc. The audio source may need to be corrected, or at least marked to show that a polarity reversal is present.

Polarity Correction Function Disabled: This contact closes (shorts) when a Remote Polarity Correction Function Disable condition is in effect. This contact acknowledges a valid Polarity Correction Function Disable command.

Configuring and Installing the Circuit Cards

Once the connections have been made, the cards are ready to be configured. Do not remove or insert any of the cards with the mainframe power on. Do not "hot" install or remove the cards! We will be working with the cards in the order in which they are housed in the cabinet: left to right, when viewed from the front.

Mainframe card position 1 is on the left side (viewed from the front); card position 9 is on the right side.

The ISS mainframe is shipped with the cards installed and the ribbon cable bus attached. If you haven't done so already, carefully remove the ribbon cable bus from all the cards. The connector on the front of each card has latches that must be opened for the ribbon cable bus connector to be removed. Don't fear the ribbon cable bus! It is fast, reliable, and easy to work with. Once you are used to it, you'll like it!

I/O Card: The ISS is designed to accept nominal audio signal levels of 0, +4, or +8dBu. The desired input and output levels must be set using the two switches located on the I/O Card. Remove the I/O Card from mainframe position 1 (the far left position when facing the front of the mainframe). The INPUT LEVEL switch selects the nominal line input level for both channels. The OUTPUT LEVEL switch sets the nominal output level. Set these switches to match your broadcast facility's desired nominal operating level. The A position corresponds to 0dBu operation, the B position to +4dBu, and the C position to +8dBu. The nominal input and output levels do not have to be the same. If input loading is required, refer to the Technical Notes section of this manual. After setting the switches, and possibly installing load resistors, install the card back into mainframe position 1. Remember, do not install this or any card when the mainframe power is on.

Type I Simulator Card: Remove the Type I Simulator Card from mainframe position 2. In addition to the identification label, this card can be identified by the empty parts locations on the circuit board. You will observe a section in the middle of the board where parts have not been inserted. There are no switches to be set, or initial adjustments to be made on the Type I Simulator Card. Confirm that single turn trim potentiometer R43 is set to the 50% rotation point, i.e., halfway between fully clockwise and fully counterclockwise. R43 is small and basically round, and is located near the front edge of the card. This pot was preset at the factory but a visual check is a good idea. DO NOT TOUCH ANY OTHER POTENTIOMETER ON THIS CARD OR FACTORY CALIBRATION MAY BE REQUIRED. This card is now installed in mainframe card position 2.

Polarity Correction Card: Remove the Polarity Correction Card from mainframe position 3. One switch must be set on the Polarity Correction Card. This switch determines the type of remote control signal that is going to be used for the Remote Polarity Correction Function Disable command. In the CONT position a continuous signal will be applied. In the PULSE position a momentary signal will be applied. If you are not going to be connecting a remote control signal the switch should be in the CONT position. This card is now installed in card position 3.

Type II Simulator Card: Remove the Type II Simulator Card from mainframe position 4. In addition to the identification label, this card can be identified by the fact that, unlike the Type I card, most of the components in the Type II printed circuit board have been inserted. There are no switches to be set, or initial adjustments to be made on the Type II Simulator Card. Confirm that single turn trim potentiometer R43 is set to the 50% rotation point, i.e., halfway between fully clockwise and fully counterclockwise. This pot is in the same location, and is labeled R43 on both the Type I and Type II cards. This pot was preset at the factory and should only require a visual confirmation of the correct setting. This card is now installed in card position 4.

Crossfade Card: Remove the Crossfade Card from mainframe card position 5. One switch, INPUT, must be set on the Crossfade Card. This switch selects which audio signal is connected to the card from the ribbon cable bus. If, as is usual, the Polarity Correction Card is installed, set the switch to the B position. If, for reasons such as repair, etc., the Polarity Correction Card is not installed, set the switch to the A position. If a Tone Detection Card is present in your system the INPUT switch is set to the C position. This card is installed in card position 5.

Recognition Card: Remove the Recognition Card from mainframe card position 6. There are two switches that must be set on the Recognition Card. The INPUT switch selects which audio signal is connected to the card from the ribbon cable bus. If, as is usual, the Polarity Correction Card is installed, set the switch to the B position. If, for reasons such as repair, etc., the Polarity Correction Card is not installed, set the switch to the A position. If a Tone Detection Card is present in your system the INPUT switch is set to the C position. The other switch is a four position DIP type. This switch decides which recognition modes will be active. One, two, or all three modes can be turned on at the same time. Switch position 1 controls if L=R is recognized as mono. Place switch position 1 to ON if you want a mono signal on both left and right to be recognized as mono. Switch position 2 controls if a signal on the left channel only will be recognized as mono. Place switch position 2 to ON if left only is to be recognized as mono. Switch position 3 controls if a signal on the right channel only will be recognized as mono. Place switch position 3 to ON if right only is to be recognized as mono. Remember that all three modes can be, and in most cases will be, turned on at once. Switch position 4 is not used and should be left in the OFF position. Confirm that the single turn trim potentiometer R10 is set to the 50% rotation point, i.e., halfway between fully clockwise and fully counterclockwise. It is the only trim pot on the Recognition Card. The pot was preset at the factory, but a visual double check is a good idea. This card is now installed in card position 6.

Mode Select Card: Remove the Mode Select Card from mainframe card position 7. One switch must be set on the Mode Select Card. This switch determines the type of remote control signals that are going to be applied to the four remote control inputs: Remote Control Enable, Remote Simulate from Left, Remote Simulate from Right, and Remote I/O Bypass. In the CONT position, continuous signals will be applied. In the PULSE position, momentary signals will be applied. If remote control signals are not going to be connected, the switch should be set to the CONT position. This card is now installed in card position 7.

Card Position 8: Card position 8 is reserved for an option, the Tone Detection Card. This card places the ISS in the electronic bypass mode if a continuous, specific frequency is detected. If your installation includes this card, refer to the separately supplied documentation for complete installation instructions.

Card Position 9: Card position 9 is not utilized at this time.

The Ribbon Cable Bus

Once the cards are configured and reinstalled, the ribbon cable bus can be installed, linking all the cards together. Start with the I/O card, located in card position 1, and work to the right. Orient the ribbon cable bus so that the colored stripe, usually red or blue, that indicates pin 1 will mate with the top pins of the card connectors. Mate the left most ribbon cable bus connector with the I/O Card connector. A mechanical key on the I/O Card prevents the ribbon cable bus from being installed upside down. Repeat this process for the remainder of the cards. Use the latches to secure the ribbon cable bus connectors to the card connectors.

For future reference note that the ribbon cable bus can be removed or attached with the mainframe power on or off. The ribbon cable bus carries only audio and logic signals. No damage will occur if one or more of the cards are operated with their respective ribbon cable bus connectors disconnected. Remember that the cards themselves cannot be "hot" plugged into, or pulled out of, the mainframe.

Securing the Front Panel

Carefully place the front panel over the front of the mainframe and secure using the four screws.

Using the ISS

In this section we will first review the controls and indicator lights on the ISS front panel. Next we will run some basic tests on the system and give you a feel for its operation.

I/O Card

One LED and one switch relate to the I/O Card and its' functions. When lit, the green NORMAL LED indicates that the relays on the Transfer Relay Assembly, located on the back panel, are energized and that the audio input and output signals are connected to the ISS circuitry. When the NORMAL LED is off, the relays on the Transfer Relay Assembly de-energize, directly connecting the left line input to the left line output, and the right line input to the right line output. The NORMAL LED will not light if a valid remote I/O Bypass command is received, if the I/O switch is in the I/O BYPASS position, or if a power supply error is detected. A red LED on the Transfer Relay Assembly mimics the operation of the I/O card's LED. This LED is visible through an access hole in the back panel.

When the I/O switch is in the I/O BYPASS (down) position, the Transfer Relay Assembly is held in the I/O Bypass mode, removing the ISS from the audio path. In the NORMAL (middle) position, the ISS will be in the audio path but will ignore a remote command to go into the I/O Bypass mode. In the NORMAL + REMOTE (up) position, a remote command to initiate I/O Bypass will be executed.

Polarity Correction

Two LED's and one switch relate to the Polarity Correction Card and its' functions. When the red CORRECTING LED is lit, it indicates that a polarity reversal has been detected and is being corrected.

When the yellow REMOTE DISABLED LED is lit, it indicates that the polarity correction function is disabled via the remote control input.

When the switch is in the DISABLE (down) position, the polarity correction function has been turned off. This is useful when testing the ISS or related equipment. In the OPERATE (middle) position, the polarity correction function is active but the card will ignore a remote control command to go into the disable mode. In the OPERATE + REMOTE (up) position, a remote command to disable the polarity correction function will be executed.

System Status

Three LED's indicate the bypass/simulate status of the ISS. When the green BYPASS LED is lit, it indicates that the electronic crossfade circuitry is routing the input audio to the audio outputs; the stereo simulators are not in the audio path. When the red SIM LEFT LED is lit, it indicates that the left audio input is being sent to the simulators and the resulting simulated stereo signal is being sent to the audio outputs. When the red SIM RIGHT LED is lit, it indicates that the right audio input is being sent to the simulators and the resulting simulated stereo signal is being sent to the audio outputs.

Mode Select

One LED and two switches relate to the Mode Select Card and its' functions. When lit, the yellow REMOTE LED indicates that the ISS bypass/simulate status is being controlled via remote control, indicating that the remote manual mode is in effect.

The top switch, SYSTEM MODE, sets the overall ISS operating mode. In the MANUAL (down) position, the bypass/simulate status is controlled by the lower switch. In the AUTO (middle) position, the Recognition Card will control the bypass/simulate status, but a remote control override request is ignored. In the AUTO + REMOTE (up) position, the remote control override can be used.

The lower switch, MANUAL, is active when the SYSTEM MODE switch is in the MANUAL (down) position. The MANUAL switch selects bypass, and simulate from the left input or simulate from the right input operation.

Initial Operation

The installation is over and you're somewhat familiar with the controls; now the fun can begin as you see what the ISS can do. You must first connect a source of audio to the ISS inputs via your patch bay. A good signal source would be left and right audio from master control via an audio router; a better signal would be a great sounding compact disc run through a line amp to come up to your required audio level! Do not use sine waves, or other obscure non-program type signals in these tests. The ISS was designed to work with actual program material!

A method of monitoring the ISS audio outputs is also required, such as a set of high quality audio speakers with an associated power amplifier. Set up the speakers so that a good stereo image can be heard; i.e., don't put them too far apart—set them up in a normal listening position. Set the audio amplifier level controls to the OFF position. Headphones are also a good method of monitoring.

1) Check to ensure that audio is indeed feeding the ISS.
2) Set the following ISS switches: I/O switch to BYPASS, POLARITY CORRECTION switch to DISABLE, SYSTEM MODE switch to MANUAL, and MANUAL switch to BYPASS.
3) Push the ISS power switch to the ON (in) position. The red LED located just above the power switch should light. Of the other LEDs, only the green BYPASS LED on the Crossfade card should be lit.
4) Raise the level of the audio amplifier until your left and right test signals are comfortably heard. You are listening to the input signals connected directly to the audio outputs via the Transfer Relay Assembly.
5) It is a good idea to ensure that at the start of our tests, audio input and output polarity has been correctly connected. To test this, feed the same signal into the left and right inputs. Sum the left and right audio outputs and listen to the resulting mono signal. You should not have any cancellation, as this would indicate a 180 degree reversal on an audio input or output.

The easiest way to listen to L+R is to use an audio amplifier with a mono button on it. Of course, you can always use a scope to determine if the polarity of the wiring or associated patch bay is correct. Get this test over with now and you won't have to worry about it later! Be warned that a polarity reversal on the same channel's input and output will not show up with this test. A "double flip" could later lead to incorrect Polarity Correction Card or Recognition Card performance. After you have confirmed the connection polarity you should resume monitoring in stereo.

6) Place the I/O switch to the NORMAL position. The green NORMAL LED on the I/O Card should light; the red LED on the Transfer Panel Assembly should also light. You should hear audio at the same level as heard in the previous step. You are hearing audio through the ISS circuitry! If the level does not match, the most likely cause is an incorrect INPUT LEVEL or OUTPUT LEVEL switch setting on the I/O Card. Recheck your switch settings.

7) Move the MANUAL switch to the SIM LEFT position. The BYPASS LED will fade out while the SIM LEFT LED will light up. The audio you hear is stereo simulated from the left input channel. Listen to the left and right output signals in mono. The simulated stereo effect should drop out and you should hear a faithful rendition of the left input signal. If listening to the sum (L + R) of the ISS outputs degrades the level and/or quality of the audio you most likely have a "double flip," as was discussed in step 5. This mono compatibility problem must be corrected **NOW!** Once you confirm mono compatibility, move the MANUAL switch back to the BYPASS position. The output will fade from simulated stereo back to the input signals. Try simulating from the right audio input by moving the MANUAL switch to the SIM RIGHT position. Then return the MANUAL switch to BYPASS.

8) Place the SYSTEM MODE switch to the AUTO position. This lets the ISS mode be controlled by the Recognition Card. Remember, during system setup you chose which of the three recognition modes you wanted active. Most people will have enabled all three modes, so mono will be recognized as L=R, left only, and right only.

   Feed a stereo signal into audio inputs. Remember, do not use sine waves as your signal source. The BYPASS LED should be lit.

   Feed a mono signal into both the left and right audio input. If you enabled L=R is mono, the SIM LEFT LED will light showing the ISS is simulating stereo from the left input. If you did not enable L=R is mono, then the ISS will stay in the Bypass mode.

   Feed a signal only into the left audio input. If you enabled left only is mono, the SIM LEFT LED will light showing the ISS is simulating stereo from the left input. If you did not enable left only is mono, then the ISS will stay in the Bypass mode.

   Feed a signal only into the right audio input. If you enabled right only is mono, the SIM RIGHT LED will light showing the ISS is simulating stereo from the right input. If you did not enable right only is mono, then the ISS will stay in the Bypass mode.

9) Place the POLARITY CORRECTION switch to the OPERATE position. The CORRECTING LED should not be lit. Feed signals into the left and right audio inputs with the signals 180 degrees out of phase with each other. This could be a mono or stereo signal into both channels, 180 degrees out of phase. The CORRECTING LED should light when this condition is detected, and will hold in the correcting mode until signals with correct polarity are presented on the inputs. The closer the signals are to 180 degrees out of phase with each other, the quicker the correction will take place. Mono signals 180 degrees out of phase and fed into the left and right audio inputs will correct very quickly. Audio material with lots of stereo content, but 180 degrees out of phase, will take longer to correct. Great stereo signals are in a sense out of phase between left and right; there is lots of phase incoherence. The circuitry has to cut through the valid phase differences and find the error! To ensure that the input select switches are correctly set on the Crossfade and Recognition Cards, listen in mono to the sum of the left and right outputs. Feeding out of phase input signals, listen to the output corrected and uncorrected. Uncorrected, you should hear significant cancellation. Corrected, you should hear the sum of left and right in full fidelity.

10) If you have connected remote control input signals, now is a good time to try them out. Place the I/O switch to the NORMAL + REMOTE position, making the circuit accept a remote control signal. Apply the Remote I/O Bypass signal, either a continuous or momentary signal depending on your previously selected configuration. The I/O NORMAL LED should go out and the audio input signals will connect to the audio output connectors. Either stop the continuous signal, or again apply the momentary signal. The NORMAL LED should light again.

    On the Polarity Correction Card, place its switch in the OPERATE + REMOTE position. Apply the Remote Polarity Correction Function Disable signal, either a continuous or momentary signal depending on your previously selected configuration. The REMOTE DISABLE LED should light. Either stop the continuous signal, or again apply the momentary signal. The REMOTE DISABLE LED should stop lighting.

    Place the SYSTEM MODE switch to AUTO + REMOTE, making the circuit accept remote control signals. Apply the Remote Control Enable signal, either a continuous or momentary signal depending on your previously selected configuration. The REMOTE LED should light. Apply a continuous or momentary Remote Simulate from Left signal. The system should immediately go into the simulate from left channel mode. Removing the continuous signal, or again applying a momentary signal, returns you to the Bypass mode. Try applying the Remote Simulate from Right command, then return to the Bypass mode. Either stop the continuous signal, or again apply the momentary signal on the Remote Control Enable input. The REMOTE LED should go out, making the Remote Simulate from Left and Remote Simulate from Right inputs inactive.

11) If you have connected the Status Relay Outputs, you can test them now. Any time the I/O NORMAL LED is *not* lit, the ISS I/O Bypass Enabled relay contact will close (short). The device connected to this contact should indicate this condition.

    Any time the CORRECTING LED on the Polarity Correction Card is lit, the Polarity Correction Taking Place relay contact will close (short). The device connected to this contact should indicate this condition.

    Any time the REMOTE DISABLE LED on the Polarity Correction Card is lit, the Polarity Correction Function Disabled relay contact will close (short). The device connected to this contact should indicate this condition.

    Any time the SIM LEFT LED on the SYSTEM STATUS section is lit, the ISS Simulating from Left relay contact will close (short). The device connected to this contact should indicate this condition.

    Any time the SIM RIGHT LED on the SYSTEM STATUS section is lit, the ISS Simulating from Right relay contact will close (short). The device connected to this contact should indicate this condition.

    Any time the REMOTE LED on the SYSTEM MODE section is lit, the ISS Remote Control Enabled relay contact will close (short). The device connected to this contact should indicate this condition.

Normal Operation

You should now feel confident that the ISS has been carefully installed and tested, and is ready to go to work in the exciting TV business. (You remember excitement... that's 3am Monday morning working on the transmitter!) Seriously, if you have any questions concerning the ISS, now is a good time to give us at Studio Technologies a call. Otherwise, set the front panel controls to your desired operating mode and that's it. If one or more remote control signals have been connected, be sure to set the appropriate switches to allow remote operation. You'll most likely want the SYSTEM MODE switch in either the AUTO or the AUTO + REMOTE position.

Technical Notes

Definition of Level

Studio Technologies has opted to use the dBu designation as it seems to be quite rational. Using dBm was fine when all audio line outputs were terminated with 600 ohm loads. In this way, it is easy to say that 0dBm is 1 milliwatt dissipated in the known load (i.e., 0dBm across 600 ohms will measure 0.7746V). In contemporary situations, an audio output line is rarely terminated in 600 ohms; generally 5k ohms or higher. The dBu designated is a better reference because it refers to dB referenced to 0.7746V, with no reference to load impedance. This takes into account today's audio scene with load impedances varying greatly. When the ISS specifications refer to the maximum output level in dBu, this would translate to dBm only when the output is terminated with 600 ohms.

Transformer Coupling

As discussed in the Installation section of this manual, there may be cases where transformer isolation of the ISS audio input and/or output signals may be required. As the ISS has excellent electronically balanced input and output circuitry, interfacing with most other equipment should not require transformer isolation except in the strangest of cases. If you do find a case where you need them, we suggest using transformers from Jensen Transformers Inc., website: www.jensentransformers.com. They make excellent parts and we recommend their JE-11-DMCF, a 600 to 600 ohm output type transformer. This should give very good results on both the input and output sides of the ISS. If you want to splurge and go for the premium transformer, you could use their JE-11-BMCF; overkill but terrific specs! Because of Jensen's high quality, load resistors do not have to be used.

Resistor Loading

Some broadcast operations as standard practice load the outputs of audio equipment. This is not really necessary with the design of contemporary audio equipment. Current practice call for low source impedances and high input impedances; the ISS follows this practice. Provision has been made on the I/O Card for load resistors to be added if required; resistor location R88 for the left input, R64 for the right input. Carefully insert and solder your selected resistors. Use diagonal cutters to clip the excess resistor lead. Do not install load resistors on the input connectors—only install them on the I/O Card. This ensures that double loading will not occur in cases where the Transfer Relay Assembly connects the inputs directly to the outputs.

Output Load vs. Output Level

The I/O Card is user selectable for three nominal operating levels. The input operating levels are measured in dBu and do not have to take into account whether the inputs are terminated (loaded) or not. The outputs are a different matter. The output stage, although excellent, is not completely "stiff," and will allow the nominal output level to change slightly with different output load impedances. The 0, +4, and +8dBu output levels are stated under the assumption that a 600 ohm termination will be present. The nominal output level will change up to 0.5dB with a lower or higher load impedance, e.g. 150 or 20k ohms. This is to be expected and should pose no operational problem. Only a "perfect" line output stage (if it can be found) will maintain an exactly constant output level with a widely varying load. This variance with load is constant with frequency and does not effect frequency response linearity.

Signal Paths

All signals from the outside world come in and go out via connectors on the Transfer Relay Assembly. The Transfer Relay Assembly links with the mainframe via screw terminal strips on the mainframe back panel. The mainframe links with the cards via 15-position card edge connectors. Power (+15 and +24Vdc), signal ground, and earth ground also come into each card via the edge connectors. All inter-card connections are made via a 20-conductor ribbon cable bus. The ribbon cable bus serves as the audio and logic signal highway between the cards. Cross talk is not a problem as the signal level, type, and physical positions were carefully chosen.

The ISS utilizes an internal operating level of –6dBu. This keeps adjacent positions in the ribbon cable bus from significant coupling. The logic signals are asynchronous, very low speed, and physically separated from the audio signals. Power and ground connection were kept off of the ribbon cable bus to minimize the chance of current (ground) loops. For your interest, Figure 2, located at the end of this manual, describes the signals that are carried on the ribbon cable bus.

Crossfade Speed

We at Studio Technologies hope that the crossfade times we have selected will be right for you. If for some reason you have to change one or more of the speeds, we will now describe how to do it. The crossfade circuitry is contained on the Crossfade Card, and is discussed in depth in the circuit description section of this manual. Three crossfade speeds are used to optimize the audio output signal transition between simulated and real stereo. Logic circuitry on the Crossfade Card selects which speed is appropriate for the operational situation. The SLOW speed is used in two situations: the first is going from the simulating stereo from left or right back to a stereo input signal; the second is going from a stereo input signal to simulated stereo from left when there is a two channel mono input signal. The FAST speed is used when the input signal goes from a left and right stereo input (not simulating) to left input only, or right input only (going to simulating stereo from left or right only input). FAST is used so that the listener hears only a minimal loss of left or right channel audio, while the simulated stereo is coming on line. The IMMEDIATE speed is used whenever Remote Control Enable is active. The ISS assumes that the remote control input signals for Sim from Left and Sim from Right are very precise and do not require a time lag as a crossfade is performed. Note that the IMMEDIATE speed is really just a fast crossfade. No audio clicks are created during the transition.

The speeds are created in the Crossfade Card circuitry using simple resistor/capacitor combinations. The SLOW speed is created with resistor R7 and capacitor C7. An analog switch adds resistor R9 in parallel with R7 to create the FAST speed. Another analog switch adds resistor R8 in parallel with R7 to create the IMMEDIATE speed. You can see that all three speeds are based on the SLOW rate. Changing R7 will change all three speeds. Now do you really want to change the SLOW speed? Anyway, choose the speed(s) you want to change.

If you want to change the SLOW speed, remove R7 and increase its' value if you want a slower speed (longer RC time constant), or decrease its' value if you want to speed it up (shorter RC time constant). Now check the FAST speed and see what effect the new R7 value has made. If the FAST speed is now not to your liking, remove R9 and replace it with a revised value. Now check the IMMEDIATE speed. Adjusting R7 really shouldn't greatly effect the IMMEDIATE speed, but if it does, remove R8 and replace it with a revised value.

If SLOW is OK but you want to change the FAST speed, remove R9 and increase its' value if you want a slower speed (longer RC time constant), or decrease its' value if you want to speed it up (shorter RC time constant).

If SLOW is OK but you want to change the IMMEDIATE speed, remove R8 and increase its' value if you want a slower speed (longer RC time constant), or decrease its' value if you want to speed it up (shorter RC time constant).

Recognition Card Adjustment

The Recognition Card recognition criteria has been factory set for what we feel is optimum performance. The Left Only and Right Only recognition characteristics are fixed by the design of the circuits. There is no provision for changing their performance. The L=R recognition circuit does contain a calibration trim pot. This pot, R10, adjusts the sensitivity of the L=R recognition. The sensitivity determines when L=R is recognized. It is factory set at 50% of rotation. If you determine that stereo signals are being recognized as L=R, adjust R10 counterclockwise. This serves to desensitize the circuit. If two channel mono signals are not being recognized as L=R, adjust R10 clockwise. This increases the sensitivity of recognition. Be certain that you really need to adjust this control. The factory setting should give the best overall performance.

Non-Standard Input and Output Levels

Studio Technologies designed the ISS to match the audio operating levels of most broadcast facilities. If you are the creative type who likes to experiment, or the unlucky one who inherited a station that has an operating level different from 0, +4, or +8dBu (ref. 0.7746V), don't despair. The 0, +4, or +8 settings are used to optimize ISS performance, and using a slightly different operating level will make only minor differences in performance. If you are within two dB of one of the ISS's preset levels, set the input and output switches to the closest value. If you are exactly in between two of the choices, go for the lower one. An example would be a station running +6. Set the input and output levels for +4. If you are running an operating level below –2 dB or above +10dB, contact Studio Technologies for details on simple I/O Card operating level modifications.

I/O Bypass versus Bypass

Frankly, when we named two ISS functions, we inadvertently created a confusing situation. In this section we hope to clearly explain just what we meant. Once you see the similar names with different functions we hope that long-term confusion will be minimized. As penance, the designers have spent one weekend listening to the Greatest Hits collections of Donnie and Marie, The Turtles, and The Kingsmen. Extra time was put in trying to figure out the actual words to "Louie Louie."

I/O Bypass: I/O Bypass is the name we chose for a function performed by the I/O Card and the Transfer Relay Assembly. Relays on the Transfer Relay Assembly connect the ISS audio inputs to the ISS audio outputs in the event of a system failure, operator request, or remote control request. The I/O Bypass is a hard (relay contact) bypassing of the ISS circuitry. During normal ISS on-air operation, the I/O Bypass mode will rarely be invoked.

Bypass: Bypass is the name we chose for a function performed by the Crossfade Card. When the ISS is in the Bypass mode the crossfade circuit electronically connects the left and right audio inputs to the left and right audio outputs. This is an electronic, or "soft" bypass. The ISS will usually be in this mode when stereo program material is present on the left and right audio inputs. When a Simulate from Left or Simulate from Right command is given, the ISS mode will change from Bypass to Sim from Left or Sim from Right. During normal ISS on-air operation, the state of the Bypass mode will be changing in response to mono and stereo input signals.

ISS Mainframe Grounding

The ISS mainframe contains two ground circuits: earth and signal. Earth ground is connected to all metal parts of the chassis, the ground pin of the AC power connector, pin 3 on each of the circuit card edge connectors serving the mainframe card slots, and pin 1 of the four XL-type connectors. Signal ground is the common point for the power supplies and is connected to pins 4 and 11 on the mainframe card slots, and to the relay driver circuitry on the Transfer Relay Assembly. These grounds, electrically isolated in the stock mainframe arrangement, are connected together via one point in the ISS. This point is a jumper wire connecting pins 3 and 4 of edge connector P1 on the I/O Card. In most cases, this is the preferred ground arrangement, insuring safety and good shielding of the audio signal wires. In certain cases it may be desirable to isolate this ground. IN NO CASE IS IT PERMISSIBLE TO FLOAT THE CHASSIS FROM EARTH GROUND. This is a safety ground and must connect via the third wire of the power cord to an approved ground. To isolate the signal ground from the chassis, remove the previously mentioned jumper wire. Note this change on your schematics for later reconnection if required.

Remote Control Signals

One of the nicest features of the ISS is the ability to control many functions remotely. Two types of input signals can be used: continuous or momentary. Switches on the I/O Card, Polarity Correction Card, and Mode Select Card set which type of signal is to be recognized. We'll consider a remote control signal as a logic high whenever current meeting the ISS specifications is flowing into a remote control input. When set for continuous, the remote control input circuitry is enabled whenever a logic high is present. When set for momentary, the remote control input circuitry is leading edge triggered. The transition from low to high is considered a valid remote control signal; a high to low transition is ignored.

Testing the ISS

Proof of performance tests on your broadcast facility commonly use sine waves of different frequencies and levels to check such things as frequency response, noise, and distortion. Very unusual results can occur if ISS performance tests are made using sine wave or constant frequency signals. These results are due to the way the stereo simulator boards perform their function, taking a mono input and delaying, randomizing, and gyrating the signal into a stereo image. Simulating stereo from a fixed single frequency input will usually result in different left and right output levels that will appear to change randomly as the input frequency is varied slightly. This is completely normal and expected. Remember that the usual input signal to the simulator cards is a complex music, voice or other natural sound. To get rational proof of performance data, place the ISS in the

Bypass mode, putting the simulator cards out of the broadcast chain. (This does not mean removing the ISS from the audio path by the use of the I/O Bypass mode!) If you wish to check the ISS with the Stereo Simulator cards in the broadcast chain, you need to use pink noise. The randomness of pink noise will allow left verses right frequency response observation. Studio Technologies uses pink noise for testing the Stereo Simulator cards.

The Sound of the ISS

The ISS has been factory adjusted to give what we feel is a very good overall simulated stereo "sound." We spent a lot of time doing listening tests with music, voice, sound effects, and actual television audio signals. If you feel you must adjust the ISS stereo simulators, provisions have been made for you to do so; trimmer potentiometers (trim pots) are buried behind the front cover, but are accessible. The simulated stereo is created by the two stereo simulator cards. The Type I Card is located in card slot 2. The Type II Card is located in card slot 4. Trim pot R43 on the Type I Simulator Card controls the amount of simulation on the full audio bandwidth. It is factory set at 50% of its rotation. Trim pot R43 on the Type II Simulator Card controls the amount of simulation over the upper and lower portions of the audio band, but simulates little on the voice band. It is factory set at 50% of its rotation. The outputs of the Type I and Type II Simulator cards are combined in the Crossfade Card to form the simulated stereo signal you hear.

The following is a suggested procedure for resetting the Stereo Simulator cards. You should have a wide variety of sample program material available, especially men's and women's voices and music with a very wide frequency range. Remove the ISS front panel by removing the four knurled screws. Place the ISS in the SIM LEFT manual mode. The trim pots to be adjusted are located near the front of the simulators cards. The cards do not have to be removed, nor the ISS power turned off, for pot adjustment. However, you will need a small screw driver and a little care. Turn trim pots R43 on both simulator cards fully counterclockwise. This turns off all stereo simulation. Feed a voice signal into the ISS left channel input. Listening in stereo to the ISS left and right audio outputs, you should hear the left input audio coming from both the left and the right outputs, i. e., you should be hearing two channel mono.
On the Type I Simulator Card, adjust R43 clockwise until an acceptable amount of simulation is heard. Listen to make sure that the voice does not sound over-processed. Better too little simulation than too much. Use the factory setting of 50% pot rotation as a reference. Now feed a high quality audio signal into the left input. By high quality, we mean a music source that has lots of low and high frequency content. On the Type II Simulator Card, adjust R43 until your desired amount of simulated stereo is heard. Listen carefully to the low and high frequencies as this is where the Type II Card is adding its affect. Switch back to feeding voices and make sure they still sound good. If they sound too affected, adjust Type II R43 counterclockwise until the voices again sound good. Go back to the music, the simulated stereo should still sound good. Confirm your settings by doing listening tests with many different audio signals, especially a wide variety of voices. Once you are satisfied with your settings, cut out this section of the manual

and lock it in your desk. Practice saying to everyone at your station, “Gee, I’d love to let you adjust the ISS but it’s preset at the factory.”

Using the Extender Card Assembly

An Extender Card Assembly can be purchased to allow testing and maintenance of individual ISS cards. Since signals connect to an ISS card at both its’ front and back edges, a rather unique extender arrangement has been devised. The Extender Card Assembly consists of four parts: Extender Cards 1 and 2, a 34-position ribbon extension cable, and a 20-position ribbon extension cable. To use the Extender Card assembly:

1) If the ISS is currently on-air, arrange to patch around the unit. Even though the Transfer Relay Assembly can be used to send the input audio to the audio output connectors, it is better not to be working on equipment when a minor slip of the hand can result in on-air errors. After patching around the ISS, proceed.
2) Turn the ISS main power to the OFF position.
3) Remove the ribbon cable bus from the cards until the specific card to be serviced is disconnected. You don’t have to remove the entire ribbon cable bus.
4) Remove the card to be serviced.
5) Install either of the two connectors on the 34-position ribbon extension cable into the connector marked P1 Extension on Extender Card 1 (the larger card). The colored stripe (usually red) indicates pin 1 and should be mated accordingly.
6) Install Extender Card 1 with the attached 34-position ribbon extension cable into the mainframe card slot previously vacated by the card to be serviced.
7) Reconnect the ribbon cable bus to Extender Card 1 and to the other cards that were previously detached.
8) Install one connector on the 20-position ribbon extension cable into the connector marked P2 Extension on Extender Card 1. (Extender 1 was just installed in one of the mainframe’s card slots.) This connector is directly above the connector that mates with the ribbon cable bus. The colored stripe (usually red) indicates pin 1 and should be mated accordingly.
9) Install the other end of the 20-position ribbon extension cable into connector P2 on the card to be serviced. Ensure that pin 1 is mated with pin 1.
10) Install the free end of the 34-position ribbon extension cable to the connector marked P1 Extension on Extender Card 2. Ensure pin 1 connects to pin 1.
11) Mate the card edge connector on Extender Card 2 with edge card plug P1 on the card under test. Ensure that pin 1 mates with pin 1. The components on the card under service and the test points on Extender Card 2 should be facing up.
12) Double check that all connectors are mated correctly and pin 1 goes to pin 1 on all connectors.
13) Place the card (with the attached Extender Card 2) on a non-conducting surface to protect the components from accidental shorting.

14) You are now ready to turn the ISS power switch to the ON position and perform your required procedures. Some minor cross talk or hum pickup can occur due to the physical positions of the ribbon cables connecting the mainframe to the card being serviced. Avoid placing the ribbon extension cables (especially the 20-position) and the card near strong magnetic fields (such as near the ISS power supply) that could induce hum or noise. Simply moving the ribbon extension cable(s) should clear up any major problems encountered. The short interconnecting distances on the actual ISS minimize the chance of undesirable pickup under operating conditions.

15) A service hint is to always begin testing by checking the power supply voltages that are easily accessed on the Extender Card 2 test points.

16) When storing the ribbon extension cables, avoid sharp bends in the cable which can cause permanent damage.

17) Feel free to call Studio Technologies with any service or operation questions you may have.

Technical Description

In this section, we will first review the ISS system architecture. This will give an outline of how the ISS relates to the outside world, and how the circuit cards work together. Then we will review the functionality and circuitry contained on each ISS circuit card. This information should greatly assist you in understanding the operation of the ISS, as well as providing a guide to troubleshooting problems that may arise.

ISS System Architecture

As a complete unit, the ISS consists of a mainframe, Transfer Relay Assembly, circuit cards, ribbon cable bus, and front panel. Studio Technologies chose to utilize a commercially available powered mainframe. By using a “stock” mainframe, the customer benefits by getting the reliability that a product built in quantity supplies; this powered mainframe design is completely field proven with thousands of units in operation. The mainframe, manufactured by dBx, Inc., includes a sophisticated power supply and card slots for nine circuit cards. The ISS circuit cards were designed to mechanically and electrically interface into this mainframe. Associated with each card slot is a 10-position screw terminal strip located on the mainframe back panel. All connections to the Transfer Relay Assembly, i.e., audio signals, remote control inputs, and status relay outputs, are made via these screw terminal strips. Five connectors on the back of the Transfer Relay Assembly interface the ISS with the outside world. Connections are made between the circuit cards using a ribbon cable bus assembly. The ribbon cable bus assembly consists of a length of 20-conductor flat ribbon cable (commonly used in the computer industry) with eight 20-position sockets installed evenly along the length of the ribbon cable. The sockets on the ribbon bus connect with connectors located on each of the ISS circuit cards. All connections on the ribbon cable bus go to every card in the ISS. A circuit card uses only those signals on the ribbon cable bus that are needed. The signals on each of the 20 positions of the ribbon cable are described in Figure 2, located at the end of this manual. As the 20 conductors on the ribbon cable bus are .050" apart, care was taken during the design phase to limit the chance of cross talk occurring between adjacent signal paths. This was achieved by two means: signal path selection and limiting signal level. Physical isolation was implemented by keeping the audio signals away from control (logic) signals. The audio signal levels are limited by the nominal internal audio operating level of –6dBu. Logic signal transitions are limited in number due to the non-synchronous design of the system. No clock signals or reoccurring logic transitions are produced within the system.

I/O Card

There are four main sections of circuitry on the I/O Card: ±18V power supplies, undervoltage and I/O Bypass sensing and control, line input, and line output.

+18V Power Supplies: With nominal input and output levels of up to +8dBu, the input and output audio circuitry on the I/O Card requires ±18Vdc for excellent audio performance. Operation at lower power supply rails, such as +15Vdc, will not provide adequate peak signal levels; i.e., will give inadequate headroom. The mainframe provides ±15Vdc and ±24Vdc. The I/O Card utilizes two integrated circuit type voltage regulators (and supporting circuitry) to reduce the ±24Vdc to ±18Vdc. As a note, other sections of the I/O Card use the ±15Vdc and ±24Vdc.

Undervoltage Sensing and I/O Bypass: As a product intended for continuous on-air duty, major ISS failures must not take a station's audio off the air. Relays on the Transfer Relay Assembly act as a "hard" (mechanical) bypass switch. We call this the I/O Bypass function. A control signal is generated by the I/O Card which controls the Transfer Relay Assembly. When the ISS is operating normally, the relays are held in the energized state. The left and right line input signals connect to the line input circuitry; the left and right line output circuitry connects to the line output connectors. When the I/O Card goes into the I/O Bypass state, the transfer relays de-energize, connecting the line input signals to the line output connectors. In this mode, the ISS's line input and output circuitry is disconnected from the outside world.

The I/O Bypass function can occur because of three reasons: an undervoltage condition on one or more of the four power supply voltages; a manually initiated command from the front panel switch; or a command via the remote control input.

A 5.1V zener diode provides a reference voltage for the undervoltage sensing circuitry. This reference voltage is scaled and connected to four sections of integrated circuit voltage comparator. Two sections of comparator monitor the mainframe ±15Vdc, and two sections monitor the ±18Vdc from the I/O Card voltage regulators. If the +15Vdc or +18Vdc drop below +10Vdc, an error condition is detected and the transfer relays de-energize. If the –15Vdc or –18Vdc go less negative than –12Vdc, an error condition is detected and the transfer relays de-energize.

A switch located on the front edge of the I/O Card allows manual I/O bypassing.

The Remote I/O Bypass function allows an external signal to place the ISS in the I/O Bypass condition. The actual signal that controls the I/O Bypass function is derived from remote control input circuitry located on the Mode Select Card. Pin 20 of the ribbon cable bus carries the signal between the two cards. The switch on the I/O Card selects whether the Remote I/O Bypass function is active.

Working in conjunction with the I/O Bypass circuitry on the I/O Card is the I/O status relay on the Crossfade Card. A contact on the I/O status relay controls the Transfer Relay Assembly. The I/O status relay is controlled by the I/O Card via pin 19 of the ribbon cable bus.

Line Input Stage: The purpose of the line input stage is to take a balanced audio input signal, reduce the level by a fixed amount, and convert it to unbalanced. For best operating performance, the internal operating level of the ISS was selected to be –6dBu. This level combines a good signal to noise figure with ample peak signal headroom for circuits operating with ±15Vdc power sources. Since television broadcast facilities run different average operating levels, the line input stage has three switch selectable input levels: 0, +4, or +8dBu. This translates to attenuating the input signal by 6, 10, or 14dB.

Two sections of operational amplifier and a 3-position switch serve as the gain reduction section. The input signal is capacitor coupled to the op amps. Two 100pf capacitors in conjunction with the input resistors provide a high frequency roll-off to limit the chance of a radio frequency interference problem. An op amp connected in a differential mode unbalances the signal. The output of the unbalancing op amp is capacitor coupled to the ribbon cable bus for use by other ISS cards. Resistor locations are available on the I/O Card for the installation of input load resistors. In most cases this is not required, or desirable, and the card is manufactured with no load resistors installed.

Line Output Stage: The purpose of the line output stage is to take an unbalanced signal with a nominal level of –6dBu, add gain, and convert it to a balanced, differential type. This –6dBu signal is the final output of the other ISS cards. The amount of gain in this circuit is set by a 3-position switch. The audio output stage uses a modern, sophisticated electronically balanced circuit to eliminate the need for an audio transformer.

Signal enters the line output stage using an op amp configured as a summing junction. In this way, signals from more than one ISS card can be combined. The summed signal then connects to another op amp that boosts the level by 6, 10, or 14dB. This level increase has been switch selected to give a nominal output level of 0, +4, or +8dBu. After being boosted in level, the signal connects to two op amps, one as an inverting buffer and the other as one side of a balanced line driver circuit. The inverted signal connects to the other side of the balanced line driver circuit. Each side of the line driver uses an op amp to feed a set of current boost transistors. To preserve the low frequency response, no output capacitors are used. This is one tough circuit—it is capable of driving high signal levels into 150 ohms! The balanced line driver circuit utilizes cross feedback to insure stability even when driving unbalanced loads. This means that if one side of the line output is grounded, the circuit is not harmed and the other side of the line output still functions correctly. A trim potentiometer, in series with the non-inverting input of one of the output op amps, is used to balance the positive and negative output signal excursions. This ensures that, as an example, a 1.00V positive excursion AC signal on the "+" line output connection will be matched by a 1.00V negative excursion AC signal on the "–" line output connection.

Transfer Relay Assembly

The Transfer Relay Assembly provides the capability to connect the audio inputs to the audio outputs in the event of a system malfunction or an operator initiated command. The simple circuitry consists of three relays and a transistor control circuit. In the normal operating mode, the transistor is forward biased, and the relays are held energized. One relay routes the left channel line input signal to the ISS mainframe. The ISS left channel line output is routed to the output connector. The right channel is handled the same way via another relay. A third relay provides the I/O Bypass Enabled Status Relay Contact, accessible to the user via the 25-pin plug. An LED and current limiting resistor is in parallel with the relay coils as a status indicator. The relays can release for two reasons: loss of 24Vdc power coming from the mainframe, or closing of the I/O Bypass status relay contact that comes from the mainframe. When the relays de-energize, the left audio input is connected directly to the left audio output. The left channel input and output signals to/from the mainframe are disconnected. The same action occurs for the right channel. In the I/O Bypass mode, the aforementioned relay contact shorts, providing the I/O Bypass status relay contact. The LED is now not lit, showing that the Transfer Relay Panel is in the transfer mode.

Stereo Simulator Cards

The input signal enters the Type I and Type II cards via pin 9 of the ribbon cable bus. One section of an op amp U7 acts as an inverting buffer. The signal then goes through a simple Resistor/Capacitor pre-emphasis network that precedes U4a, which acts as a compressor in a compandor circuit. U5 is an integrated circuit compandor. The compressor attack time is speeded by a charge pump, which reduces transient distortion that is often associated with compandors.

The signal now proceeds in different directions in the Type I and Type II cards. In the Type I Card the companded signal connects to the anti-aliasing low-pass filter discussed in the next paragraph. In the Type II Card the signal proceeds to a band reject filter. The band reject filter is made up of four sections of op amp U9. The 3dB points are at 400 and 2200Hz, with an 11dB dip at 1100Hz. This filter is set to attenuate signals in the voice band, while leaving low and high frequency audio signals unaffected. This filter is the reason why the Type II Card can add simulation only in the non-voice region of the audio spectrum. The filtered signal leaves the band-reject filter and proceeds to the low-pass filter section.

Low-Pass Filter: Three sections of op amp U7 form a 6-pole, 20kHz Butterworth low-pass filter. This reduces the possibility of audio frequencies aliasing with the clock frequency produced by U3.

The audio is delayed by bucket brigade delay (BBD) integrated circuit U2. The length of the delay is directly proportional to the frequency of the clock signals sent to U2 by U3. U3 produces three signals for BBD U2: Clock 1, Clock 2, and a voltage reference. Clock 1 and 2 are identical square wave signals 180 degrees apart in phase. The frequency of Clock 1 and 2 is set by the resistor/capacitor combination C17 and R19/R20. A reference voltage is produced by U3 (for use by the BBD) and is not adjustable.

The clock is set for 119.5kHz for the Type I Simulator Card and 64kHz for the Type II Simulator Card.

The time delayed audio enters a 5-pole, 20kHz low-pass Butterworth filter created using three sections of operational amplifier U1. This filter removes clock frequency from the output signal.

The signal was previously compressed in anticipation of being delayed. It is now expanded to recreate the initial dynamic range. The expander portion of compandor U5 restores the dynamic range. Again a charge pump is used, this time in the compandor rectifier.

The signal now enters a proprietary randomizing circuit, labeled N1. Frankly, the great sound of the ISS's simulated stereo is a result of this network. It modifies the delayed signal so as to ensure that the peaks and dips in the soon to be created combs do not fall on objectionable harmonics, preserving the natural sound of the audio.

The final outputs of the Stereo Simulator cards are created by two sections of operational amplifier U6.

For the Type I Card: The left channel output is created by summing the output of N1 with the direct input signal. The right channel output is created by connecting the direct input signal to the inverting input and connecting the output of N1 to the non-inverting input.

For the Type II Card: The left channel output is created by inverting the signal from N1. The right channel output is created by simply buffering the signal from N1.

The left and right channel outputs of the Type I Card are actually a complete simulated stereo signal. The left and right channel outputs of the Type II Card are actually just an inverted and non-inverted stereo information signal. Summing op amps on the Crossfade Card combine the Type I and Type II signals to form the full ISS simulated stereo signal. If you were to remove the Type II Card, the ISS would still produce a usable, but much less full stereo sound. The Type II Card adds the extended low and high frequency simulation. Removing the Type I Card, while leaving the Type II Card in place, would result in a left and right channel signal with no simulated stereo on it at all. Summing the left and right signals would leave the ISS with no signal, i.e., they completely cancel out. The Type II Card outputs left and right stereo information to be added to the simulated stereo produced by the Type I.

The mono compatibility of the ISS's simulated stereo can be easily understood by a careful study of how the stereo is actually made in op amp U6. The output of network N1 is really our "stereo information." To create the left channel of our simulated stereo we simply add some of our stereo information to the incoming mono signal; to create the right channel we subtract the same amount. The amount we add and subtract is directly related to how much stereo effect we desire. Trim pot R43, Stereo Depth, controls how much of N1's output is combined with the incoming mono. Our resulting stereo signal for the left channel is the sum of the input signal (mono) and our stereo information; the right channel is the difference between the input signal and our stereo information. When listening in MTS stereo, you hear a good stereo "feel." When listening in MTS mono, the left and right signals are summed (added together), giving you just the original signal. Our stereo information simply cancels out! Remember, what we added to the left channel, we subtracted from the right channel. Add left and right together and our stereo information drops out. This process holds true when we have two simulator cards. The Type I Card adds and subtracts full bandwidth stereo information. The Type II Card adds and subtracts bandpassed stereo information. Add left and right together and the stereo information from both cards cancels out. Perfect mono compatibility!

Mode Select Card

The Mode Select Card features a simple set of logic circuitry that efficiently controls ISS system operation. The Mode Select Card directs and creates logic signals that are sent to the Crossfade Card, which in turn creates the signals you hear on the air and observe with your remote controls.

Dual 4 input/1 output analog switch U8 serves to route logic signals to the simulate from left and the simulate from right inputs on the Crossfade Card.

The Mode select switch chooses one of three operating modes. In the manual mode, the Crossfade speed is held in the SLOW position, and the X1/Y1 signals on U8 are routed to the Crossfade Card. The Manual front panel switch is then used to control the Crossfade Card. This mode is primarily intended for testing or special applications.

In the AUTO mode, the FAST/SLOW speed line is no longer held logic low, and the X0/Y0 signals on U8 are routed to the Crossfade Card. Signals originating from the Recognition Card (if present in the system) are processed and then sent to X0/Y0. Three signals come from the Recognition Card: R=L, L Only and R Only.

Logic Signal	R=L	L Only	R Only
Logic High	X0	X0	Y0
Logic Low	Y0	Y0	X0
FAST/SLOW Logic	Low for Slow	High for Fast	High for Fast

In the AUTO + REMOTE mode, the signal going to the Crossfade Card depends on the state of the B input to U8. When B is logic low, remote control has not been enabled and operation is the same as in the AUTO mode. When B is logic high, remote control has been enabled. The signals present on X2/Y2 are sent to the Crossfade Card. When simulate from left is requested via remote control, X2 is high and Y2 is low. When simulate from right is requested via remote control, X2 is low and Y2 is high. When no simulation is requested, X2 and Y2 are low.

Four identical circuits buffer the remote control inputs. Optocoupler integrated circuits provide complete isolation between the source of the remote control signals and the ISS circuitry. A resistor in series with the optocoupler photodiode provides current limiting to protect the remote control signal source and the photodiode. A diode is connected anode to cathode/cathode to anode across the photodiode to prevent a polarity reversal on the remote control signal from damaging the optocoupler.

The optocoupler output signals are buffered using inverting Schmidt trigger logic buffers. The output of the buffer is now truly a "clean" logic signal. This logic signal directly follows the remote control input. A feature of the ISS is that continuous or pulse remote control signals can be interfaced. To accommodate this, a four pole switch selects whether the ISS will respond to continuous or pulse signals. In the continuous mode, the output of the Schmidt inverting buffer is sent directly to the next section of circuitry. In the pulse mode, the output of a D flip-flop, whose input is from the Schmidt inverting buffer, is connected to the next section of circuitry. The four signals from the remote control inputs go to different paths.

The Remote I/O Bypass signal drives the base of NPN transistor Q1. Q1 is connected to the ribbon cable bus in an open collector configuration. The I/O Card uses this signal to control its I/O Bypass control circuit. Notice that the reset pin of the Remote I/O Bypass flip-flop is connected to one section of the inverting Schmidt trigger acting as a power-up reset circuit. This power-up reset circuit insures that upon power-up the flip-flop starts in the desired state.

The signal from Remote Control Enable is active only when the mode select switch is in the AUTO + REMOTE position. A tricky arrangement is used to provide power-up reset and a circuit active signal using a Schmidt trigger inverting buffer. When in the AUTO + REMOTE mode, the remote enable signal connects to three places: selector pin B of U8, the ribbon cable bus as the IMMEDIATE signal, and to a buffer acting as an LED driver. When the remote enable signal is high, U8 selector pin B goes high, selecting the signals on pins X2 and Y2 to go to the outputs. This lets the Remote Sim L and Remote Sim R control the Crossfade Card. The remote enable command is buffered and sent to the Crossfade Card as the IMMEDIATE command. (This triggers the Remote Control Enabled relay and changes the crossfade speed to immediate.) The remote enable signal also causes the Remote Enabled LED to light on the front edge of the Mode Select Card.

The Remote Sim L and Remote Sim R signals have a set of NAND gates (U11) associated with them to insure that only one can be selected at a time.

Crossfade Card

The Crossfade Card contains two major sections: audio control and logic control.

Audio Control: The audio inputs to the Crossfade Card are selected via the three position INPUT switch. These three input sources are connected to the Crossfade Card via the ribbon cable bus. The switch chooses the input source: signals from the I/O Card, the Polarity Correction Card, or the optional Tone Detection Card. The switch selected audio inputs connect to two points in the circuit: analog switch U9 and voltage controlled amplifier (VCA) integrated circuits U8 and U3. Analog switch U9 selects which input, left or right, gets sent to the simulator cards.

The left and right audio output signals from the Type I and Type II simulator cards come into the Crossfade Card via two sections of op amp U5, which serve as inverting summing junctions to combine the signals from the two simulator cards. The outputs of the summing amplifiers each connect to two points in the circuit: summing with the line input signal going into the VCA, and summing with the output of the VCA going into another op amp section of U5.

The crossfade action occurs by the cancellation process that is directly proportional to the output level of the VCA. The VCA output level is determined by a 0 to 800mV control voltage whose source will be discussed later. A control voltage of 800mV gives maximum attenuation; 0mV gives unity gain (0 attenuation). When 0mV is fed to a VCA, the summed signal from the simulator cards is cancelled out; when 800mV is fed to the VCA the line input signal is canceled out. The null adjusts, trim pots R6 and R25, are set at the factory to provide the best attenuation at the extreme end of the crossfade. An incorrectly set null adjustment would give cross talk between the inputs and the outputs of the stereo simulator cards.

Logic Control: The logic and crossfade control voltage circuitry is quite straight forward. Four logic input signals, entering via the ribbon cable bus, give the functional commands to the Crossfade Card. These signals request simulate from the left channel, simulate from the right channel, crossfade at FAST, and crossfade at IMMEDIATE.

The “heart” of the circuitry is a simple resistor/capacitor circuit created by C7 and R7, and 5V and 10V reference voltages created by R31, R32 and R38. We add to this three op amps acting as comparators (sections of U7 and U11) which allow the RC circuit to swing between 5V and 10V. The 5V to 10V swing is controlled in direction (up or down) and speed. Two sections of NAND gate U1 provide a logic high when simulate from left or simulate from right is requested. This logic high (15V) moves the voltage on the RC circuit from 5V to 10V. Since the capacitance is fixed, the speed at which the RC circuit goes from 5V to 10V is dependent on the resistance in the RC circuit. The FAST/SLOW and IMMEDIATE speed logic signals determine if additional resistance is placed in parallel with R7, decreasing the time constant and speeding up the crossfade. The additional resistance is placed in or out of the RC circuit using two sections of analog switch U2. When simulate from left or simulate from right is not requested, the RC circuit moves back to 5V; the speed is again determined by the status of the speed logic signals.

The 5V to 10V ramp signal is sent to two places in the circuitry. A section of op amp U11 provides a linear conversion, taking the 5V to 10V swing and changing it to a 0V to 800mV swing. This voltage swing provides the VCAs with the crossfade voltage. The circuit is designed so as to “lock” within a few mV of 0V so as to keep the VCA precisely at unity gain. Another section of op amp U11 converts the 5V to 10V swing to a 0V to 15V swing. This swing is used to light the crossfade status lights. Note that two sections of analog switch U2 control the simulate from left and simulate from right LEDs.

Two sections of op amp U7 act as comparators to create an indication of when the reference ramp signal is at 5V or 10V. These signals are used for two functions: maintain feed to the simulator cards and enable the simulating from right and simulating from left relays.

There are four relays contained on the Crossfade Card. Three of the relays are not integral to the operation of the ISS but are used to provide status indication to the associated broadcast system. The fourth provides the Transfer Relay Assembly with the I/O Bypass status. Four normally open (not shorted) relay contacts provide the following indications: simulating from left, simulating from right, ISS operating via the remote control input (remote operation enabled), and I/O Bypass request. Notice that Remote Enable relay energizes whenever the IMMEDIATE crossfade speed is selected. This is because the only time the immediate speed is active is when the ISS is remotely controlled.

Recognition Card

The Recognition Card contains four major sections: Band-Pass Filters, Peak Detection, L=R Recognition, and Left Only/Right Only Recognition.

Band-Pass Filters: Left and right channel audio signals enter the Recognition Card via the three position INPUT switch. This switch selects the input source. In the A position the signals come from the output of the I/O Card. In the B position the signals come from the output of the Polarity Correction Card. In the C position signals come from the output of the optional Tone Detection Card. The input signals then enter low-pass Butterworth filters consisting of three op amp sections. The signals then go through high-pass Butterworth filters that use two op amp sections. The resultant signals have a 3dB band-pass of 100 to 1kHz. For accurate left versus right performance, all resistors and capacitors have 1% tolerance. The band-pass filters have a unity gain design so that the input and output levels should be roughly identical within the pass band; 500Hz should enter and leave at the same level. The signals are filtered so that accurate recognition is possible. If the high frequencies are not removed, the normal phase shifts due to tape head azimuth errors or short differential time delays will interfere with actual left versus right differences. If the low frequencies are not removed, the large amounts of energy at the low frequencies will create false recognition results. The band-passed output signals then go to the three other sections.

Peak Detector: The band-passed left and right signals are summed using one op amp section. This op amp, along with one other, creates a half-wave rectifier circuit that produces a DC signal that is representative of the summed amplitude of the left and right signals. A comparator serves to gate the DC signal so as to “speed up” the rectification. This “speeded up” signal is a peak DC picture of the band-passed left and right signals. This peak DC is used by the remaining two sections.

L=R Recognition: This circuit determines if signals present on the left and right channels at the same time are mono, i.e., identical. A comparator is used to compare the band-passed left channel signal with a resistor divider scaled version of the peak reference signal. The output of this comparator is 0 volts when the left channel meets this criteria; 15 volts when it does not. This results in a series of short pulses representative of the phase activity of the signal. Another comparator is used for the band-passed right channel. These two output signals are sent to an exclusive-OR (XOR) gate which produces a logic high only when the input signals are phase coherent. If the pulses sent to the inputs of the XOR gate are not in phase, the XOR gate output will stay at logic low. Input pulses that are coherent will result in a logic high output pulse. These XOR gate output pulses charge a resistor-capacitor low pass filter. The output of this filter represents the amount of phase coherency. This output is fed to a comparator whose trigger has been calibrated so that when sufficient phase coherency is detected a L=R logic high is generated. A feedback path is used to hold the state of the final comparator during periods of time when the peak detector amplitude is not sufficient for accurate recognition. During actual broadcast operation this "hold" would come into effect when an audio track fades out at the end of a commercial, etc. The result is a logic high when the two channels are determined to be phase coherent. This logic high, called L=R, is sent via one section of DIP switch, and the ribbon cable bus, to the Mode Select Card. The DIP switch allows disabling of the L=R recognition feature.

Left Only/Right Only Recognition: The band-passed left and right signals each come into this section via a section of op amp set for a gain of about 30dB. These op amps create what is effectively a "signal present" output. Very little input amplitude will cause the output of the op amps to go to 15 volts. Our friend the peak detector now comes into play again. Two identical circuits determine a left only or right only condition. We will discuss the right only circuit. A comparator is used to compare the left channel "signal present" level with the amplitude of the peak detector. The output of this comparator goes logic low when the amplitude of the peak detector is greater than the amplitude of left channel "signal present." This logic low, in effect, says that the left channel is not contributing much to the peak detector amplitude. This signal is further refined with another comparator section using a DC level as its reference. A logic low on the output of this comparator can be considered as a right only indication. Two other comparators produce a left only indication. These two signals are fed to a flip-flop whose outputs create the Left Only and Right Only outputs. Besides going to two sections of DIP switch, these outputs are fed back to the "signal present" points, creating a holding level. This holding level keeps the circuit stable when audio is not present at a sufficient level to produce an accurate detection result. The outputs of the DIP switches are sent to the Mode Select Card via the ribbon cable bus.

Polarity Correction Card

The Polarity Correction Card contains five major sections: Audio Input/Output, Band-Pass Filters, Peak Detection, Polarity Detection, and Mode Select and Remote Control.

Audio Input/Output: Left and right channel audio signals enter the Polarity Correction Card via the ribbon cable bus from the outputs of the I/O Card. The left channel signal connects to the input of the left channel band-pass filter, as well as directly out again via another pin in the ribbon cable bus. The right channel signal connects to three points. The first is to a comparator that produces a string of pulses that correspond to the signal's zero crossings. The purpose of this will be discussed later. The second point is to the input of an op amp configured as an inverting unity gain amplifier. The output of this op amp feeds an analog switch. The third point is to another analog switch. The outputs of the two analog switches connect together and feed the input of the right channel band-pass filter, as well as back out on another pin on the ribbon cable bus. The gate of one analog switch connects to the Q output of a flip-flop; the other to Q invert. The right channel output polarity depends on the state of this flip-flop. In one state the right channel input connects directly to the output; in the other state the right channel output is derived from the inverting op amp. In this simple way the left and right channels can be put in the same relative polarity.

Band-Pass Filters: The left and right signals enter the filter section via separate low-pass Butterworth filters consisting of three op amp sections. The signals then go through separate high-pass Butterworth filters that use two op amp sections. The resultant signals have a 3dB band-pass of 100Hz to 1kHz. For accurate left versus right tracking, all filter related resistors and capacitors have 1% tolerance. The band-pass filters have a unity gain design so that the input and output levels should be roughly identical within the pass band; a 500Hz signal should enter and leave at the same level. The signals are filtered so that an accurate determination of relative phase can be made. If the high frequencies were not removed, the normal phase shifts, due to tape head azimuth errors or short differential time delays, would interfere with relevant left versus right differences. If the low frequencies were not removed, the large amounts of energy at the low frequencies could create false results. The band-passed left and right signals go on to the Peak Detector and Polarity Detection sections.

Peak Detector: The band-passed left and right signals are summed using one op amp section. This op amp, along with one other, create a half-wave rectifier circuit that forms a DC signal that is representative of the summed amplitude of the left and right signals. A comparator serves to gate the DC signal so as to "speed up" the rectification. This "speeded up" signal is a peak DC picture of the band-passed left and right signals.

Polarity Detection: The band-passed left and right signals are fed differentially to the inputs of an op amp. The resultant output is the difference between the left and right signals. This difference signal, along with the peak signal, is fed into a comparator. This comparator acts as a polarity normal, polarity flipped detector. If the left and right signals have roughly the same polarity, the peak signal will be greater than the difference signal. If the opposite is true, the polarity of the left and right signals are, at least at any one instant, opposite. The output of this comparator feeds an RC low-pass filter, and then on to another comparator. This comparator uses a fixed voltage reference, along with hysteresis, to insure that a true polarity reversal is occurring, and not one that is very brief due to normal, phase complex stereo signals. The output of this comparator is effectively a logic signal that changes state when a polarity reversal is detected. This logic signal clocks a flip-flop, whose output is configured to change state on a clock transition. The flip-flop output feeds the D input of another flip-flop. This second flip-flop outputs the final polarity correction signals that control the polarity correction audio circuitry. The output of the second flip-flop has two constraints placed on it. The first requirement is that the D signal is sent to the output only during a zero crossing of the right channel audio signal. As previously discussed, the right channel audio is sent to a comparator that produces an invert clock signal. This invert clock signal is a string of pulses that correspond to the zero crossings of the right channel audio. The second requirement is that the flip-flop is enabled, or more accurately, has not been disabled by the front panel switch or remote control request.

To review: The Polarity Detection circuit simply looks to see if the left and right signals are in the same relative polarity; there is no absolute reference. The circuit performs the same action when going between what, to a broadcaster, is two different events. The first event is the transition from polarity correct to polarity reversed audio. The circuitry detects this condition and flips the right channel's polarity. The circuitry now detects the left and right signals as polarity correct. The second event is the broadcast audio source going from polarity incorrect back to polarity correct. The circuitry again sees a problem and flips the right channel again. The right channel audio now passes through the analog switches without a polarity flip.

Mode Select and Remote Control: A switch controls the operating mode of the Polarity Correction Card. One remote control input, and two relay outputs give remote control access to several Polarity Correction Card functions. Two LEDs provide status indication.

The Remote Disable input allows operation of the card to be disabled. An optocoupler integrated circuit provides isolation between the source of the remote control signal and the ISS circuitry. A resistor in series with the optocoupler photodiode provides current limiting to protect the remote control signal source and the photodiode. A diode is connected anode to cathode/cathode to anode across the photodiode to prevent a polarity reversal on the remote control signal from damaging the optocoupler. The optocoupler output signal is buffered using an inverting Schmidt trigger gate. The output of the buffer is now truly a "clean" logic signal. This logic signal directly follows the remote control input. A switch selects whether the Remote Disable input will respond to a continuous or pulse signal. In the continuous mode, the output of the Schmidt inverting buffer is sent directly to the next section of circuitry. In the pulse mode, the output of a D flip-flop, whose input is from the Schmidt inverting buffer, is connected to the next section of circuitry.

A single pole, three position switch controls three sections of analog switch which set the mode of the card. In the DISABLE position the flip-flop that controls the right channel audio analog switches is disabled. In the OPERATE position the flip-flop is active but a Remote Disable request is ignored. In the OPERATE + REMOTE position the flip-flop is active, and a Remote Disable request will disable the flip-flop.

Two relay contacts provide status indication to the outside world. The Remote Disable contact closes (shorts) when the card is in the OPERATE + REMOTE mode and a remote disable command is received. The Correcting contact closes (shorts) whenever the card has flipped the polarity of the right channel. Status LED's, located on the front of the card, mimic the operation of the relays.

Appendices

Appendix A

Specifications

Mounting
Three spaces in a standard 19-inch (48.3cm) rack

AC Mains Requirements
100 to 125Vac (nominal 115Vac), or 200 to 250Vac (nominal 230Vac), switch selectable 50/60Hz, 100 watts maximum

Fuse
0.75A, 3AG for 115V operation 0.375A for 230V operation Slow-Blow Type

Audio Connections
Line Inputs: 3-pin XL-Type, Female

Line Outputs: 3-pin XL-Type, Male Pin 2 Audio High

Remote Control/Status Relay Connections
25-pin D-type, Male

Input/Output Format
Discrete left and right

Input Level
0, +4, or +8dBu, switch selectable

Input Impedance
20k ohms (with no input load resistor installed), electronically balanced

Output Level
0, +4, or +8dBu, switch selectable

Output Impedance
60 ohms, electronically balanced

Output Level at Clipping (0dBu = 0.7746V)
+22dBu into 150 ohms, Balanced +28dBu into 600 ohms, Balanced Output level current limited for safety

Frequency Response
(Simulator VCA Bypassed) ±0.1dB, 20Hz to 20kHz

Signal to Noise Ratio (Simulator In Circuit)
76dB

Distortion (THD) (20Hz to 20kHz)
Simulator VCA Bypassed: less than 0.06% Simulator In Circuit: less than 0.40%

Remote Control Inputs
Optically coupled, current limited logic level, switch selectable for continuous or pulse type. +30Vdc maximum, 4mA minimum, 20mA maximum

Audio Switching
Electronic Crossfade: VCA based circuit Hard Bypass via Relay Contacts

Relay Contacts
Isolated, sealed, bifurcated type For noise control limit current to DC only, maximum 50mA

Recognition Card
Contains circuitry to detect left only as mono, right only as mono, and mono signal on left and right as mono. Each condition can be defeated by a switch.

Polarity Correction Card
Contains circuitry to detect and correct 180 degree phase reversal on input signals. Correction occurs at signal zero crossing.

Dimensions (Overall)
19.00 inches wide (48.3cm)
5.25 inches high (13.3cm)
13.75 inches deep (34.9cm)

Weight
22.5 pounds

Specifications subject to change without notice.

Appendix B

ISS Alignment Notes

Stereo Simulator Card Alignment

A number of trim potentiometers are factory adjusted on the Type I and Type II Simulator Cards. These pots do not require adjustment unless parts have been changed due to repair of the Simulator Card. Changing the setting of any pot without going through the entire procedure can cause incorrect operation of the Simulator Card and ISS System.

Type I and Type II Cards

Stereo Simulator Cards are built as Type I or Type II. The same raw printed circuit board is used for each version. The Type II Card contains a band dip filter; the Type I does not have the parts for the filter installed. Several minor differences between the two cards are also present but do not effect alignment.

Materials Required for Alignment

Procedure for Type I Card

1) Place the Type I Simulator Card onto the Extender Card System. Refer to the ISS Technical Manual for Extender Card installation details.
2) Turn the ISS mains power on.
3) Set the ISS to: I/O Normal, mode to MAN, SIM LEFT.
4) Set R4 and R43 to 50% clockwise; R18 to 75% clockwise.
5) Connect the signal generator output to the ISS left channel line input, located on the back of the ISS.
6) Set the signal generator frequency to 1kHz, with output level to OFF so that no signal is getting sent to the ISS left line input. The signal generator signal must be a sine wave.

Checking the Power Supply Voltages

With the DC voltmeter common lead connected to COM test point: check +15 test point for +15 ±1Vdc, –15 test point for –15 ±1Vdc.

Checking for the Correct Rough Setting of the Compander

1) Again insure that no audio is coming into the ISS.
2) With DC voltmeter common lead connected to COM test point: check TP5 for 1.35 ±0.3Vdc. If not within this range, set R69 to give 1.35Vdc at TP5.
3) With DC voltmeter common lead connected to COM test point: check TP7 for 1.35 ±0.3Vdc. If not within this range, set R56 to give 1.35Vdc at TP7.

Setting the Analog Delay Clock Frequency

1) Connect common lead of frequency counter to COM test point. Check TP2 for 119.5kHz ±0.5kHz. If not within this range, set R20 to give a value in this range.

Adjusting the Incoming Audio Test Signal

1) Connect the AC voltmeter common lead to the COM test point.
2) Adjust audio generator output level to give –10dBu reading at TP3.

Adjusting the Compressor

1) Move AC voltmeter lead to test point TP4. Note the reading that you observe. It should be –10 ±2.5dBu.

2) Reduce generator output level by 20dB. Note: This means *drop* the level by 20dB.

3) Observe level at TP4. It should have dropped 15 ±0.3dB. If not, adjust R69 to get this condition.

4) Raise generator level 20dB. Observe level at TP4.

5) Reduce generator output level 20dB. Observe level at TP4. It should drop 15 ±0.3dB. If not, again adjust R69 to get this condition.

Adjusting the Analog Delay for Minimum Distortion

1) Set generator frequency to 5kHz; adjust level to give –10dBu when measured at TP3.

2) Connect distortion analyzer to measure at TP1.

3) Adjust R18 to give minimum distortion (THD + Noise). The acceptable minimum distortion is 0.35% or lower. The usual minimum is 0.25% to 0.10%.

Adjusting the Expander

1) Set generator frequency to 1kHz; adjust level to give –10dBu when measured at TP3.

2) Measure level at TP1.

3) Drop generator level 20dB. Level at TP1 should drop 20 ±0.3dB. Adjust R56 to get this condition.

4) Raise generator level 20dB. Observe level at TP1.

5) Drop generator level 20dB. Observe level at TP1. It should drop 20 ±0.3dB. If not, again adjust R56 to get this condition.

Adjusting the Transient Response of the Expander

1) Adjust generator level to give 0dBu when measured at TP3. Set the generator to tone burst mode: two cycles open, 64 cycles closed. In this way, two cycles of audio pass to the ISS, then 64 cycles of no audio, etc.

2) Observe TP1 on the oscilloscope. Adjust R4 to give the flattest base band signal. The signal should not over or under shoot.

3) This completes the entire procedure.

Procedure for Type II Card

1) Temporarily remove op amp U9. Use jumper clip to connect TP4 to the top of resistor R63. Refer to schematic to see that you have removed the band dip filter from the circuit. This makes alignment much easier.

2) Place the Type II Simulator Card onto the Extender Card Assembly. Refer to the Technical Notes section of the ISS Technical Manual for Extender Card installation details.

3) Turn the ISS mains power on.

4) Set the ISS to: I/O Normal, mode to MAN, SIM LEFT.

5) Set R4 and R43 to 50% clockwise; R18 to 75% clockwise.

6) Connect the signal generator output to the ISS left channel line input, located on the back of the ISS.

7) Set the signal generator frequency to 1kHz, with output level to OFF so that no signal is getting sent to the ISS left line input. The signal generator signal must be a sine wave.

Checking the Power Supply Voltages

With the DC voltmeter common lead connected to COM test point: check +15 test point for +15 ±1Vdc, –15 test point for –15 ±1Vdc.

Checking for the Correct Rough Setting of the Compander

1) Again insure that no audio is coming into the ISS.

2) With DC voltmeter common lead connected to COM test point: check TP5 for 1.35 ±0.3Vdc. If not within this range, set R69 to give 1.35Vdc at TP5.

3) With DC voltmeter common lead connected to COM test point: check TP7 for 1.35 ±0.3Vdc. If not within this range, set R56 to give 1.35Vdc at TP7.

Setting the Analog Delay Clock Frequency

1) Connect common lead of frequency counter to COM test point. Check TP2 for 64kHz ±0.5kHz. If not within this range, set R20 to give a value in this range.

Adjusting the Incoming Audio Test Signal

1) Connect the AC voltmeter common lead to the COM test point.

2) Adjust audio generator output level to give –10dBu reading at TP3.

Adjusting the Compressor

1) Move AC voltmeter lead to test point TP4. Note the reading that you observe. It should be –10 ±2.5dBu.

2) Reduce generator output level 20dB.

3) Observe level at TP4. It should have dropped 15 ±0.3dB. If not, adjust R69 to get this condition.

4) Raise generator level 20dB. Observe level at TP4.

5) Reduce generator output level 20dB. Observe level at TP4. It should drop 15 ±0.3dB. If not, again adjust R69 to get this condition.

Adjusting the Analog Delay for Minimum Distortion

1) Adjust generator frequency to 5kHz. Set level to give –10dBu when measured at TP3.

2) Connect distortion analyzer to measure at TP1.

3) Adjust R18 to give minimum distortion (THD + Noise). The acceptable minimum distortion is 0.35% or lower. The usual minimum is 0.25% to 0.10%.

Adjusting the Expander

1) Adjust generator frequency to 1kHz. Set level to give –10dBu at TP3.

2) Measure level at TP1.

3) Drop generator level 20dB. Level at TP1 should drop 20 ±0.3dB. Adjust R56 to get this condition.

4) Raise generator level 20dB. Observe level at TP1.

5) Reduce generator output level 20dB. Observe level at TP1. It should drop 20 ±0.3dB. If not, again adjust R56 to get this condition.

Adjusting the Transient Response of the Expander

1) Adjust generator frequency to 1kHz. Adjust level to give 0dBu when measured at TP3. Set the generator to tone burst mode: two cycles open, 64 cycles closed. In this way, two cycles of audio pass to the ISS, then 64 cycles of no audio, etc.

2) Observe TP1 on the oscilloscope. Adjust R4 to give the flattest base band signal. The signal should not over or under shoot.

The Band Dip Filter Returns

1) Turn mains power to OFF.

2) Remove the Type II Card from the extender.

3) Remove the test clip linking the two test points.

4) Reinsert integrated circuit U9.

5) This ends the procedure.

Aligning the I/O Card

The I/O Card provides a balanced output. A positive excursion on the audio high lead should be matched in negative amplitude on the audio low lead. How closely these excursions match in amplitude is called AC balance. These excursions are referenced to signal ground. The I/O Card contains two potentiometers. These are set to provide the AC balance. One pot is set for each of the two channels.

Materials Required for Alignment

- ISS Extender Card System (two cards and two cables)
- Low Distortion Audio Signal (Sine Wave) Generator
- Audio Voltmeter with high input impedance (AC VTVM), quantity of 2
- DC Voltmeter, high input impedance type
- Test Probes for above

Procedure

1) Place the I/O Card onto the Extender Card System. Refer to the ISS Technical Manual for Extender Card installation details.

2) Turn the ISS mains power on.

3) Set the ISS to: I/O Normal, mode to MAN, BYPASS.

4) If your facility uses resistive loading of audio outputs, load the ISS left and right line outputs with your standard load, e.g., 150 ohms, 600 ohms, etc.

5) Connect the signal generator output to the ISS left channel line input, located on the back of the ISS.

6) Set the signal generator output to 1kHz, with level set to your nominal operating level, e.g., +4dBu

Checking the Power Supply Voltages

With the DC voltmeter common lead connected to COM test point: check +18 test point for +18 ±1Vdc, –18 test point for –18 ±1Vdc.

Setting the Left Channel AC Balance

1) Connect one of the AC voltmeters between COM and the left channel audio high connection, test point B+ on Extender Card 2. Connect the other AC voltmeter between COM and left channel audio low connection, test point B– on Extender Card 2.

2) Set pot R29 to give equal amplitude on the two meters. You should be able to adjust the balance within about 10 millivolts.

Setting the Right Channel Balance

1) Move the signal generator output to the ISS right channel line input.

2) Connect one of the AC voltmeters between COM and the right channel audio high connection, test point D+ on Extender Card 2. Connect the other AC voltmeter between COM and right channel audio low connection, test point D– on Extender Card 2.

3) Set pot R28 to give equal amplitude on the two meters. You should be able to adjust the balance within about 10 millivolts.

4) This ends the procedure.

Aligning the Crossfade Card

The Crossfade Card contains two potentiometers. These are set to provide the maximum attenuation of the input signals from the Type I and Type II Simulator Cards when the ISS is in the bypass mode. One pot is set for each of the two channels.

Materials Required for Alignment

- ISS Extender Card System (two cards and two cables)
- Low Distortion Audio Signal (Sine Wave) Generator
- Audio Voltmeter with high impedance input (AC VTVM)
- DC Voltmeter, high input impedance type
- Test Probes for above
- 10k ohm, ¼W Resistor
- Jumper wire with test clips at each end, 6-inch maximum length

Procedure

1) Place the Crossfade Card onto the Extender Card System. Refer to the ISS Technical Manual for Extender Card installation details.

2) Turn the ISS mains power on.

3) Set the ISS to: I/O Normal, mode to MAN, BYPASS.

4) Set the signal generator output frequency to 1kHz, level –6dBu.

Checking the Power Supply Voltages

With the DC voltmeter common lead connected to COM test point: check +15 test point for +15 ±1Vdc, +24 test point for +24 ±1Vdc, and, –15 test point for –15 ±1Vdc.

Checking the Ramp Voltage

With the DC voltmeter common lead connected to COM test point: check RAMP test point for 0Vdc ±0.050Vdc. This insures you are in the bypass mode.

Setting the Left Channel for Maximum Attenuation

1) Connect the common lead of the AC voltmeter to the COM test point. Connect the other lead to LEFT OUTPUT test point.

2) Connect the common lead of the audio generator to the COM test point. Connect the high lead to one end of the 10k resistor. Use the jumper wire to connect the other end of the resistor to the junction of U5 pin 2, C22, and R16. You can get at this point by connecting to the bottom of R16. The 10k resistor is acting as a summing resistor to feed a signal into the inverting input of an op amp.

3) Adjust 10-turn trim pot R25 to give a minimum reading on the AC VTVM. You are nulling the left channel crossfade circuit. A normal level when nulled for minimum would be –45 to –60dBu. There is no exact correct value.

Setting the Right Channel for Maximum Attenuation

1) Connect the common lead of the AC voltmeter to the COM test point. Connect the other lead to RIGHT OUTPUT test point.

2) Connect the common lead of the audio generator to the COM test point. Connect the high lead to one end of the 10k resistor. Use the jumper wire to connect the other end of the resistor to the junction of U5 pin 13, C9, and R18. You can get at this point by connecting to the bottom of R18.

3) Adjust R6 to give a minimum reading on the AC VTVM. You are nulling the right channel crossfade circuit. A normal level when nulled for minimum would be –45 to –60dBu. Again, there is no exact correct value.

4) This ends the procedure.

Figure 1 ISS Connection Diagram

Audio Signals

Pin Number	ISS Function
1	Chassis Ground
2	Audio High
3	Audio Low

Remote Control Input Signals

P1 Pin Number	ISS Function	
1	+	Remote Polarity Correction Function Disable
2	–	
3	+	Remote Control Enable
4	–	
5	+	Remote Simulate from Left
6	–	
7	+	Remote Simulate from Right
8	–	
9	+	Remote I/O Bypass
10	–	

Note: Use current limited DC signal, 4mA minimum, 20mA maximum.

Status Relay Outputs

P1 Pin Number	ISS Function
14	Polarity Correction Taking Place
15	
16	Polarity Correction Function Disabled
17	
18	ISS Remote Control Enabled
19	
20	ISS Simulating from Left
21	
22	ISS Simulating from Right
23	
24	ISS I/O Bypass Enabled
25	

Note: These are normally open relay contacts that close when the described functions are active.

Figure 2 ISS Ribbon Cable Bus

Note: This figure is for reference purposes only. It does not affect installation or operation.

Bus Number	Description
1	Left Audio from I/O (ISS Left Audio Input)
2	Right Audio from I/O (ISS Right Audio Input)
3	Left Audio from Polarity Correction Card
4	Right Audio from Polarity Correction Card
5	Left Audio from Tone Detection Card (Optional)
6	Right Audio from Tone Detection Card (Optional)
7	Left Audio to I/O (ISS Left Audio Output)
8	Right Audio to I/O (ISS Right Audio Output)
9	Audio Send to Simulators from Crossfade Card
10	Left Audio from Simulators
11	Right Audio from Simulators
12	Logic, high if Recognition Card detects L=R
13	Logic, high if Recognition Card detects L only
14	Logic, high if Recognition Card detects R only
15	Logic, high if Simulate from Left requested
16	Logic, high if Simulate from Right requested
17	Logic, high if Fast Crossfade Speed requested
18	Logic, high if Immediate Crossfade Speed requested
19	Logic, high if Remote Enable requested
20	Modified Logic, low if I/O Bypass requested

Notes: Audio Signals: unbalanced, –6dBu level, nominal
Logic Signals: 0Vdc for low, +15Vdc for high, nominal
Modified Logic Signal: 0Vdc for low, +13Vdc for high, nominal

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