

# *Model 4010*

## *Central Electronics*

### *User Manual*

*Includes:*

<i>Model 4001</i>	<i>Control Station for 4IFB, 1 SA</i>
<i>Model 4001M</i>	<i>Control Station for 4IFB, 1SA with Microphone</i>
<i>Model 4002</i>	<i>Control Station for 8 IFB, 2SA</i>
<i>Model 4002M</i>	<i>Control Station for 8 IFB, 2SA with Microphone</i>
<i>Model 4003</i>	<i>Control Station for 12 IFB, 3SA</i>
<i>Model 4003M</i>	<i>Control Station for 12 IFB, 3SA with Microphone</i>
<i>Model 4020</i>	<i>Portable User Station / Talent Electronics</i>

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12000 Portland Avenue South  
Burnsville, MN 55337 USA  
Telephone: 877-863-4169  
Fax: 800-323-0498  
Info@rtsintercoms.com

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Customer Service Department  
Bosch Security Systems, Inc. (Lincoln, NE)  
Telephone: 402-467-5321  
Fax: 402-467-3279  
Factory Service: 800-553-5992

Please include a note in the box which supplies the company name, address, phone number, a person to contact regarding the repair, the type and quantity of equipment, a description of the problem and the serial number(s).

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Factory Service Department  
Bosch Security Systems, Inc.  
8601 East Cornhusker Hwy.  
Lincoln, NE 68507 U.S.A.  
Attn: Service

 THE LIGHTNING FLASH AND ARROWHEAD WITHIN THE TRIANGLE IS A WARNING SIGN ALERTING YOU OF "DANGEROUS VOLTAGE" INSIDE THE PRODUCT.	 CAUTION: TO REDUCE THE RISK OF ELECTRIC SHOCK, DO NOT REMOVE COVER. NO USER-SERVICABLE PARTS INSIDE. REFER SERVICING TO QUALIFIED SERVICE PERSONNEL.	 THE EXCLAMATION POINT WITHIN THE TRIANGLE IS A WARNING SIGN ALERTING YOU OF IMPORTANT INSTRUCTIONS ACCOMPANYING THE PRODUCT.
SEE MARKING ON BOTTOM/BACK OF PRODUCT		
<b>WARNING:</b> APPARATUS SHALL NOT BE EXPOSED TO DRIPPING OR SPLASHING AND NO OBJECTS FILLED WITH LIQUIDS, SUCH AS VASES, SHALL BE PLACED ON THE APPARATUS.		
<b>WARNING:</b> THE MAIN POWER PLUG MUST REMAIN READILY OPERABLE.		
<b>CAUTION:</b> TO REDUCE THE RISK OF ELECTRIC SHOCK, GROUNDING OF THE CENTER PIN OF THIS PLUG MUST BE MAINTAINED.		
<b>WARNING:</b> TO REDUCE THE RISK OF FIRE OR ELECTRIC SHOCK, DO NOT EXPOSE THIS APPRATUS TO RAIN OR MOISTURE.		
<b>WARNING:</b> TO PREVENT INJURY, THIS APPARATUS MUST BE SECURELY ATTACHED TO THE FLOOR/WALL/RACK IN ACCORDANCE WITH THE INSTALLATION INSTRUCTIONS.		
	This product is AC only.	

## *Important Safety Instructions*

1. Read these instructions.
2. Keep these instructions.
3. Heed all warnings.
4. Follow all instructions.
5. Do not use this apparatus near water.
6. Clean only with dry cloth.
7. Do not block any ventilation openings. Install in accordance with the manufacturer's instructions.
8. Do not install near any heat sources such as radiators, heat registers, stoves, or other apparatus (including amplifiers) that produce heat.
9. Do not defeat the safety purpose of the polarized or grounding-type plug. A polarized plug has two blades with one wider than the other. A grounding type plug has two blades and a third grounding prong. The wide blade or the third prong are provided for your safety. If the provided plug does not fit into your outlet, consult an electrician for replacement of the obsolete outlet.
10. Protect the power cord from being walked on or pinched particularly at plugs, convenience receptacles, and the point where they exit from the apparatus.
11. Only use attachments/accessories specified by the manufacturer.
12. Use only with the cart, stand, tripod, bracket, or table specified by the manufacturer, or sold with the apparatus. When a cart is used, use caution when moving the cart/apparatus combination to avoid injury from tip-over.
13. Unplug this apparatus during lightning storms or when unused for long periods of time.
14. Refer all servicing to qualified service personnel. Servicing is required when the apparatus has been damaged in any way, such as power-supply cord or plug is damaged, liquid has been spilled or objects have fallen into the apparatus, the apparatus has been exposed to rain or moisture, does not operate normally, or has been dropped.



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# *Introduction and Specification*

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## *Introduction*

The IFB System is a one-way **IFB** (Interruptible Feedback)<sup>1</sup> communications system (a program interrupt system) created especially to meet the critical requirements of the television broadcast industry, as well as other live or recorded media applications. The system is composed of User Stations, Central Electronics and Control Panels. A modular approach assures the optimum configuration for each installation. Should system expansion be desired, additional components may be added as necessary. A typical system may consist of the following: up to four (4) Control Panels, one (1) Central Electronics unit, four (4) User Stations, and assorted cabling and interconnect units. The maximum standard configuration allows four (4) Control Panels, three (3) Central Electronics, and 12 User Stations.

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## *User Station Model 4020*

The User Station, a small belt pack package, allows the talent to receive the audio signals designated by the Central Electronics and the Control Stations and may be worn by talent, such as newscasters, musicians, sportscasters, etc. Behind-the-scenes personnel may also find the IFB feeds useful for production coordination and control. These may be production assistants, audio boom operators, stage monitor mixers, on stage producers, etc. Each belt pack contains the necessary electronics to provide a stereo audio signal to the user. Two (2) power amplifiers rated at 1/2Watt each are capable of driving any set of headphones or loudspeakers. Thus, the IFB can be conveniently extended to dressing rooms or other off-camera areas where communication is desirable.

The line input to the belt pack is driven from the Central Electronics unit. This signal contains the audio information as well as the DC voltage necessary to power the belt pack. Both the left and right signals are carried on a standard 2-conductor microphone cable. The left channel is designated as interruptible, the right channel non-interruptible. Separate jacks are provided for mono and stereo headphones. Individual left and right volume controls on the belt pack enable the user to adjust listening levels for personal comfort. When mono headphones are used, they are fed only the left channel program – interrupted program audio.

A standard TW Intercom belt pack is fully compatible with this system and may be used in place of the Model 4020 User Station, if necessary.

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1. IFB is also known as IRF, Interrupted Return Feed and foldback.

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## *Central Electronics – Model 4010*

The Central Electronics unit contains all the necessary control functions and electronics to provide the active link between the Control Station and the User Station. It accepts three (3) program inputs, four (4) microphone inputs and with keying signal inputs from up to four (4) Control Stations. In addition, it supplies composite output feed to the User Station belt packs, line-level audio feeds to the SA (Stage Announce) amplifier, relay contacts for monitor muting, and interconnection to the Control Stations.

The three (3) bridging program inputs are available on a rear panel terminal strip. These signals are attenuated and fed to eight front-panel selector switches that assign any one (1) of the three (3) program sources to the respective front-panel level control. The output of this level control is fed to a driver amplifier which sends audio to the non-interrupted output. This uninterrupted signal feeds the User Station right channel line input. For the interrupted channel, the output of the level control is fed to an electronic switch then to a summing amplifier. The summing amplifier drives a power output stage which adds the audio signal to a 29 volt DC potential. This audio feeds the User Station left channel line input. This allows for program interrupt in the left channel only. However, the right channel may be assigned the same signal as the left channel via an internal circuit board switch. The User Station may now have the interrupt signal in both ears when using stereo headphones.

The SA feature routes any of the three (3) program signals to the SA Output connector. This SA Output is similar to the left channel of a User Station feed, except it does not carry DC and it is fully floating transformer-balanced. This output may be amplified and fed to a stage announce speaker, dressing room speaker or some other area. The program signal assigned to the SA output can be interrupted by a microphone signal from any of the control panels. Should a production not require a program feed to the stage, the program level control may be turned off, in which case only the microphone signal is heard.

When the SA function is used, one (1) or two (2) relays are activated inside the Central Electronics. Their contacts appear on the rear panel terminal strip and can be connected to a control room monitor amplifier input. They can be used to mute the local monitor speaker and prevent feedback when the SA is in use. In addition, internal programming jumpers may be configured to allow two (2) separate areas of speaker muting, e.g., the audio booth Control Station SA function may be engaged, muting that local speaker only, and not affecting the production control room speaker.

SA is also known as Studio Announce or Studio Address. A front panel monitor section allows for selectable monitoring of any input or output signal via a stereo phone jack. A volume control and a selector switch affect only the monitor circuits and do not interfere with other functions.

Inside the Model 4010, a single large circuit board is used to mount all electronic components. A rear panel terminal strip provides connections for the program inputs, IFB outputs, SA output, and relay contacts. Connection between the Control Stations and the Central Electronics is made through a 50-pin micro-ribbon connector.

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## *Control Station Models – 4001, 4002, 4003/4001M, 4002M, 4003M*

The Control Station is designed to mount in a console or equipment rack. It provides a given number of switch functions according to a model number. The 4001 offers IFB1 through IFB4, IFB ALL, and SA. The 4002 has IFB1 through IFB8, IFB ALL, SA 1 and SA 2. Model 4003 supplies IFB 1 through IFB 12, IFB ALL, SA1, SA2, and SA3. Each model number may be ordered with an M suffix. This refers to a gooseneck microphone attached to the panel. Should an existing microphone be more suitable for operations, a connection on the Control Station microphone preamp circuit board may be used to accept a microphone-level or line-level signal from that microphone.

Each Control Station is connected to the Central Electronics via a Model 4025 Splitter and 50-conductor cable with micro-ribbon connectors. All the Control Stations converge at the 4025 and a single cable then connects to the 4010. This configuration allows up to four (4) Model 4001 Control Stations to be connected to a single Central Electronics unit. When two (2) Model 4010 Central Electronics units are used in an eight (8) output configuration, the Model 4002 controls all outputs from up to four (4) locations. Priority of Control Stations switch signals is programmable and may be set at the time of installation. The system may be used without priority switching, if desired.

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## *Splitter Assembly – Models 4022 and 4025A*

The splitter assemblies connect the control stations with the central electronics via 25-pair cable with micro-ribbon connectors. The Model 4022 features a single male connector paralleling two (2) female connectors to connect two (2) controls/stations to the central electronics.

The Model 4025A features a single male connector with four (4) female connectors for use with up to four (4) control stations. All connectors are held securely in place with a snap-on cover housing.

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## *Special Options*

A return-send function may be incorporated with some small modifications. This feature allows the talent at the User Station to communicate with the Control Stations via a closed-circuit loop. This is done at the User Station by switching in an extra load, usually a lamp, across the feed to that station. Sensor circuits in the Central Electronics turn on relay-driving circuits, the outputs of which connect to a 9-pin miniature D connector on the rear panel. This allows an external relay to be used to transfer the announcer's microphone from the program line to a monitor amplifier or intercom in the control room. The person at the control station may now listen to the announcer without having the signal go over the air.

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## Specifications

### Model 4010 Central Electronics

#### **Frequency Response**

30Hz to 16kHz, +1,-2dB

#### **Noise<sup>a</sup>**

Interrupt Channel, <-75dBu

Non-Interrupt Channel, <-83dBu

#### **Total Harmonic Distortion**

<0.5%

#### **Nominal Input Level**

Microphone @ line-level

-10dBu/input Z=2k Ohms

Program

0dBu/input Z=2k Ohms

#### **Nominal Output Level**

To User Stations

-8dBu/unbalanced, Z=10 Ohms

To SA Amplifier, -5dBu/balanced, Z=800 Ohms

#### **Crosstalk**

From other program inputs, > 67dB

Between left & right channels, > 64dB

#### **Dimensions/Weight**

1.72"Hx19"Wx15"D

10.4lbs.

43.7Hx215.9Wx381.0D mm

#### **Mains Power**

Consumption, 45 Volt-Amps 120/240 VAC,  
50/60Hz

### Models 4001/4001M, 4002/4002M, 4003/4003M

#### **Frequency Response**

50Hz to 16kHz, +0,-3dB

#### **Signal-To-Noise**

>58dB

#### **Total Harmonic Distortion**

<0.2%

#### **Nominal Input Level**

Microphone, 123mV p-p

Line, -15dBu to -5dBu

#### **Input Impedance, Unbalanced Input**

Microphone, 470 Ohms

Line, 4.7k Ohms

#### **Gain**

54dB to 14dB

#### **Nominal Output Level**

-10dBu, balanced, Z=300 Ohms

#### **Size And Weight**

4001/4001M

1.72"H x 8.5"W x 3.4"D

2.1lbs/2.7lbs

43.7H x 215.9W x 86.4D mm

.953kg/1.225kg

4002/4002M

1.72"H x 12.25"W x 3.4"D

2.3lbs./2.9lbs.

43.7H x 311.2W x 86.4D mm

4003/4003M

1.72"H x 19.0"W x 3.4" D

2.4lbs/3.0lbs

43.7H x 215.9W x 86.4D mm

1.089kg/1.361kg

#### **Power Supply**

2.0"H x 2.37"W x 2.62" D

1.4 lbs.

50.8H x 60.33W x 66.68D

0.635kg

#### **Power Requirements**

4001/4001M

14VAC@200mA

4002/4002M

14VAC@450mA

4003/4003M

14VAC@1.0 Amps

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a. Ref: 0.5V@1kHz, measure at output terminal terminated into 600 Ohms @+10dBV, 20Hz to 20kHz, average responding meter.

**NOTE:** All product information and specifications are subject to change without notice.

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### *Standard Installation*

The Central Electronics, Model 4010, is a rack mounted unit. The rear of the Model 4010 must be supported with the brackets provided. Installation dimensions and outline drawings for all components of the Series 4000 IFB System are located in the Service Manual. The Central Electronics, Model 4010, provides a rear panel terminal strip for connection to the Model 4020 User Stations. This is a low-impedance, line-level signal and may be sent over standard microphone cable or telco cable. The User Station will work at distances of up to 760 meters (2500 feet) with #22 cable. With an option battery adapter, this range can be extended to 1500 meters (5000 feet). Connections for SA Output, SA relays, and Program Inputs may be made at this terminal.

The Control Stations use either individual or common local AC power supplies. This allows the interconnect cables (to the Central Electronics) to remain signal carrying only, avoiding the chance that a shorted cable might bring the entire system down. This local power supply provides power for the electronics and the switch lamps.

### **Input Electrical Power (Mains)**

The standard Model 4010 IFB Central Electronics is designed to operate on 120Volts AC 10% at either 50 or 60Hz. The 90-100 Volt model is designed to operate at 96 VOLTS AC 10%, 50 or 60Hz. The 220-Volt model operates on 220Volts AC 10%, 50 or 60Hz. The series 4000 control stations require 12-14 Volts AC or 16-20 Volts DC. A wall mounted power module with an output of 12-14 Volts AC at 1 Amp is provided for this. Any external supply or transformer capable of supplying this may be used. The output connects to TM2, terminals 3 and 4 on the microphone preamplifier board of the control station. See Figure 1.

### **Configurations**

A standard interrupted feedback system can consist of one(1) Model 4010 Central Electronics, four (4) Model 4020 User Stations, one(1) Model 4025 Splitter Assembly, and at least one (1) Model 4001 Control Station. As many as four (4) Control Stations may be used. See Figure 2.

### **Wire and Cable Considerations**

The Control Stations are connected to the Central Electronics with 50-conductor ribbon cables. Model 4015-XX. The XX is the cable length in feet. These cables may be ordered in 5-foot increments from five (5) feet to 100 feet. The maximum recommended cable length is 100 feet from any Control Station to the Central Electronics. The user stations are connected to the Central Electronics through standard 2-conductor-plus-shield microphone cable (e.g., Belden #9451). A Smith #5209 spade-lug attaches to the rear panel terminal strip. See Figure 5.

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The Stage Announce output is balanced and provides an average signal level of about -5dBu. See Figure 6. The program inputs accept balanced lines with a signal level of +4 to +8dBu. See Figure 6.

### **Connection To Existing Microphones, TW Type User Stations and Other Sources**

Any series 4000 Control Station can be connected to existing microphones (Figure 7 and Figure 8) and TW type user stations. A series 4000 Control Station can use the microphone in an existing TW type user station. Connect the Unswitched Mic output (USM) from the TW user station to the line level input on the Control Station. See Figure 9. For connection to a Model 801 Master Station, see the service manual.

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## ***Options Installation***

The design of the Series 4000 IFB system permits easy field installation and adjustment of the options and features discussed below. Options/features include priority control, speaker muting zones or areas, return IFB, expansion of the IFB ALL function and selection of monaural IFB (same signal the interrupted program in both ears). The return IFB option requires additional equipment to be supplied by the customer or to be custom-ordered from RTS Systems. The additional equipment would normally consist of relays to switch line-level microphone signals in a suitable junction box and a power supply for the relays. The relays are controlled from the Model 4010 Central Electronics unit. In addition, a modification to the Model 4020 for TW system type user station is required.

### **Setting Up Priority**

The Model 4010 IFB Central Electronics, as supplied, has a priority arrangement by which one Control Stations will override another. The priority of a Control Stations is determined at the Control Station. By changing which plug (Figure 10) goes to which jack on the Control Station's switchboard, the priority of that Control Station can be changed. See Figure 11 through Figure 13. If desired, the priority may be defeated by removing U6 and U16 in the Model 4010 Central Electronics. In this mode all Control Stations have equal priority. The priority override function works only with the IFB keys. The stage announce has no priority feature. The signals are merely mixed together should two (2) Control Stations be keyed simultaneously.

### **Setting Up Speaker Muting Zones**

Two (2) sets of relay contacts are provided at the back panel of the 4010 Central Electronics for area control of speaker muting. These relays work in conjunction with the Stage Announce (SA) buttons on the Control Stations. This permits, for example, the audio operator to use the SA without interrupting the director's program monitor speaker and vice versa. By cutting out the resistors, shown in Figure 14, the relay will be deactivated for that station. The station numbers are determined by their priority selection priority 1, station 2 has priority 2, etc. Normally, with all resistors intact, both relays work when an SA button is pressed on any Control Station.

### **Return IFB Installation**

A return-send function may be incorporated with some small modifications (see Figure 15). This feature allows the talent at the User Station to communicate with the Control Stations via a closed-circuit loop. This is done at the User Station by switching in an extra load, usually a lamp, across the feed to that station. A sensor circuit in the Central Electronics turns on a transistor whose collector terminal appears open ended at a 9-pin miniature D connector on the rear panel. This allows a relay to be used to transfer the announcer's microphone from the program line to a monitor amplifier in the control room. The person at the Control Station may now listen to the announcer without the signal going over the air. The output through the miniature D connector is capable of operating a 12- to 24-volt relay at up to 50 milliAmps. The relay will trigger when 60 milliamps to 200 milliamps is drawn from the line. The exact value is set by R4 for channel 1, R33 for channel 2, R62 for channel 3, and R91 for channel 4. See Figure 15. To trigger the relay, switch a 12-volt 90 milliAmps lamp across the 12 Volts in the user station.

**NOTE:** Only one (1) user station per output may be used when the return option is used.

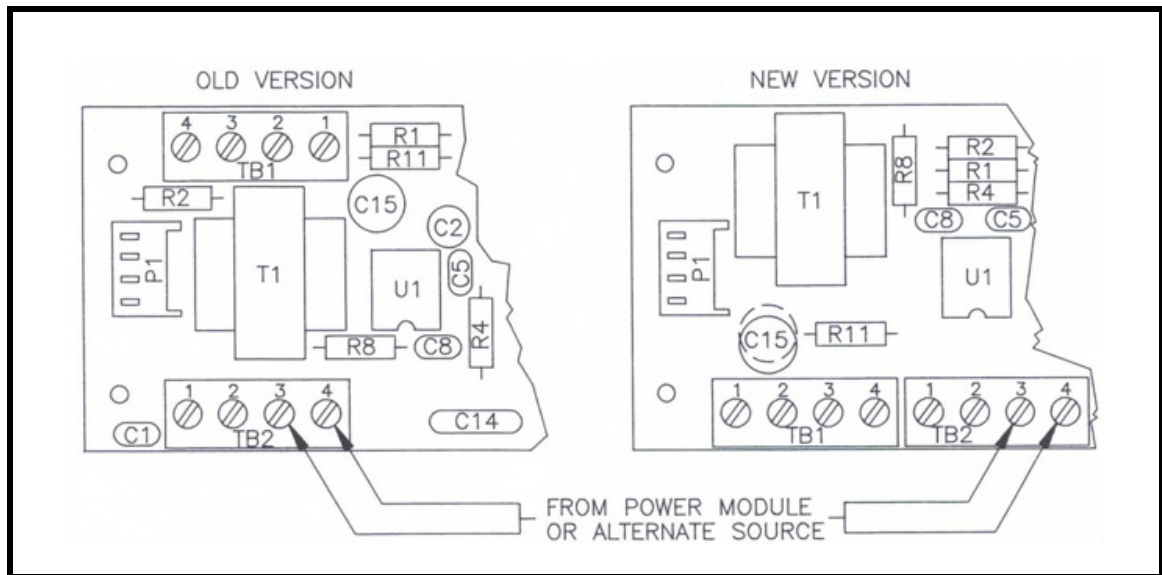
## Expanding the Control Stations All Function

The IFB ALL button on the Control Station causes all of the IFB buttons to be activated. The SA button is not activated. To make the SA work with the IFB ALL button, add the following diodes.

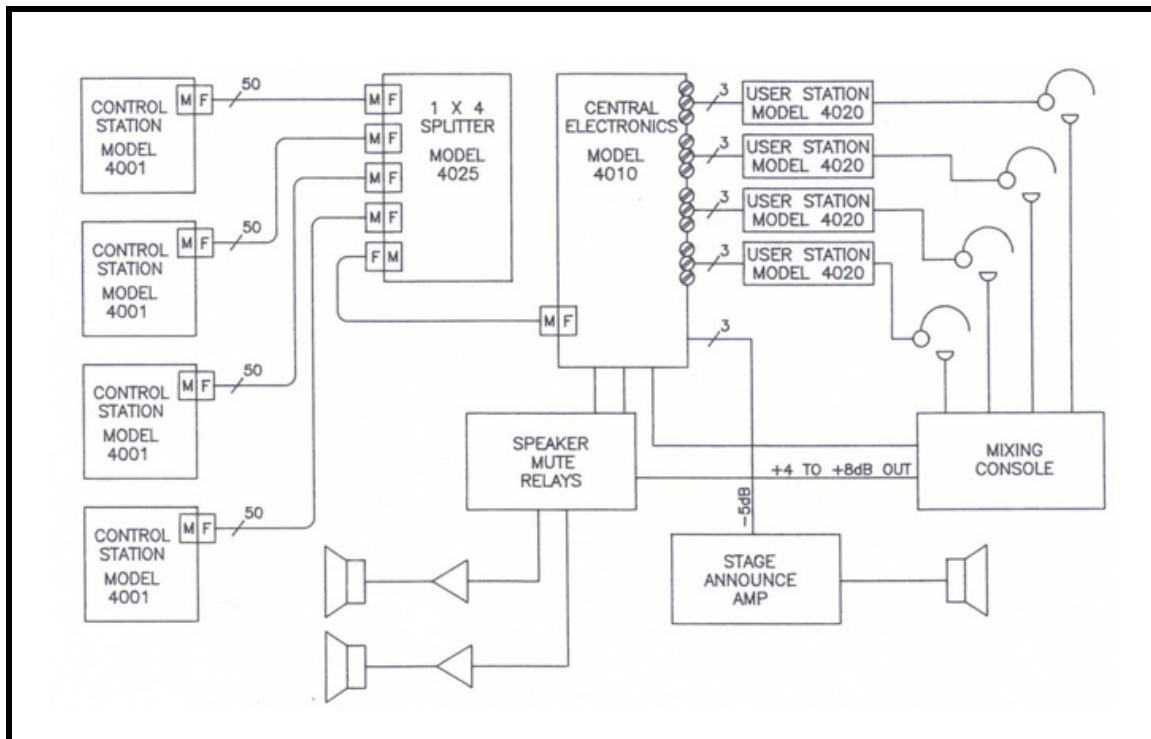
Model	Diode(s)
4001(M)	D25
4002(M)	D56, D61
4003(M)	D100, D105, D110

## Mono IFB

When the switches inside the 4010 Central Electronics are switched to the right, both left and right channels at the user station will receive the interrupted program feed. See Figure 16.

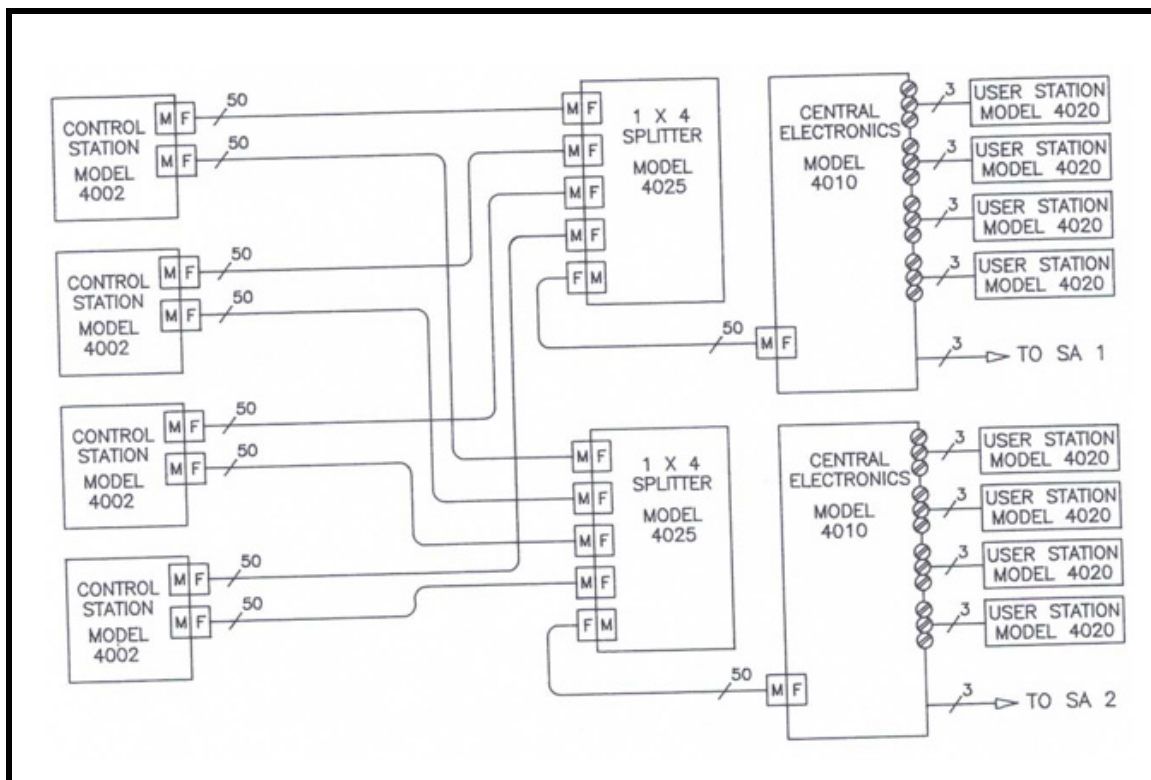


**FIGURE 1.** Power Connection to Series 4000 Control Stations



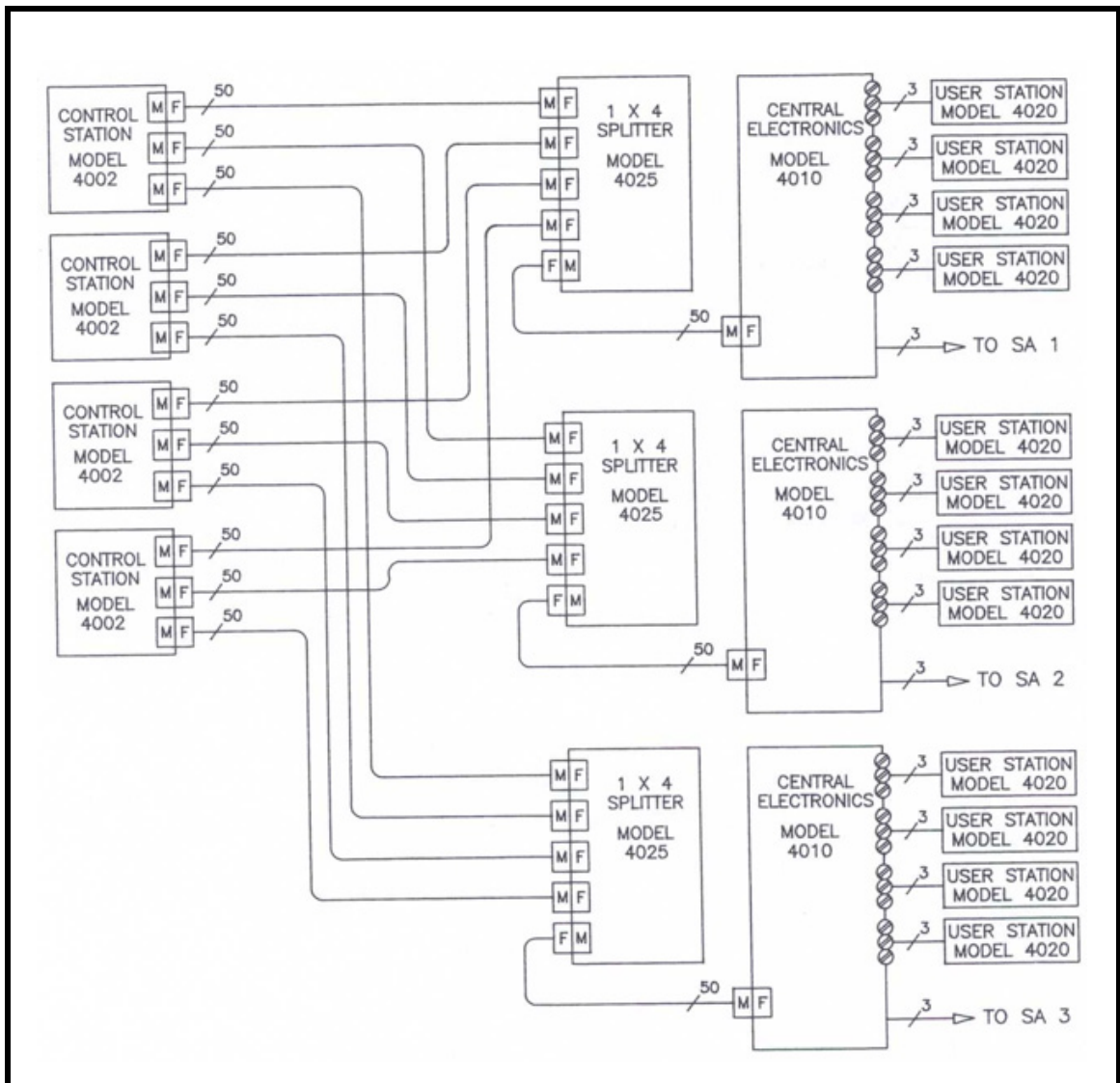
**FIGURE 2.** A Typical Configuration

The system may be expanded for up to 12 User Stations, three (3) Central Electronics, three (3) Splitter Assemblies, and four (4) Control Stations.

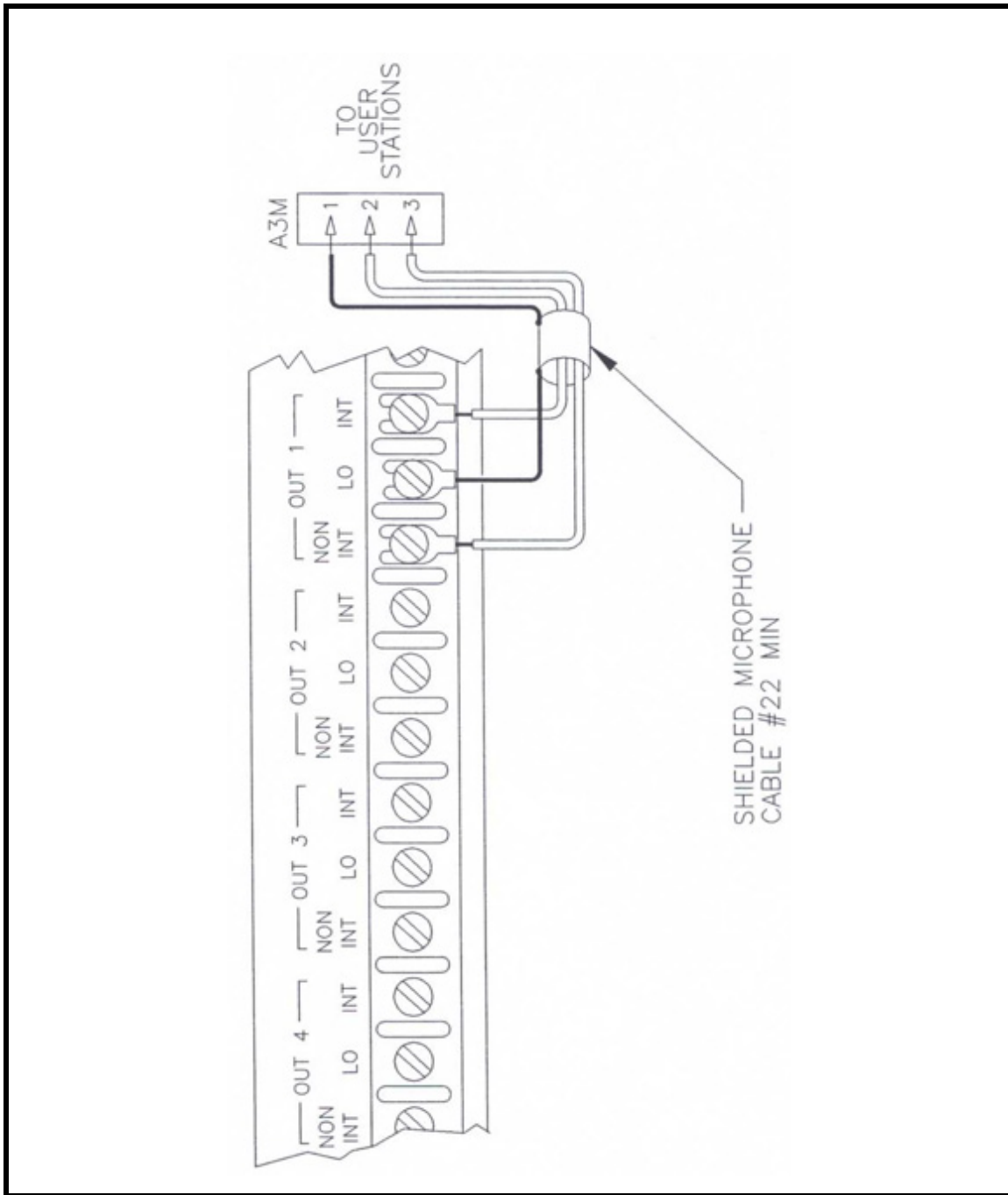


**FIGURE 3.** A Configuration- 2 System

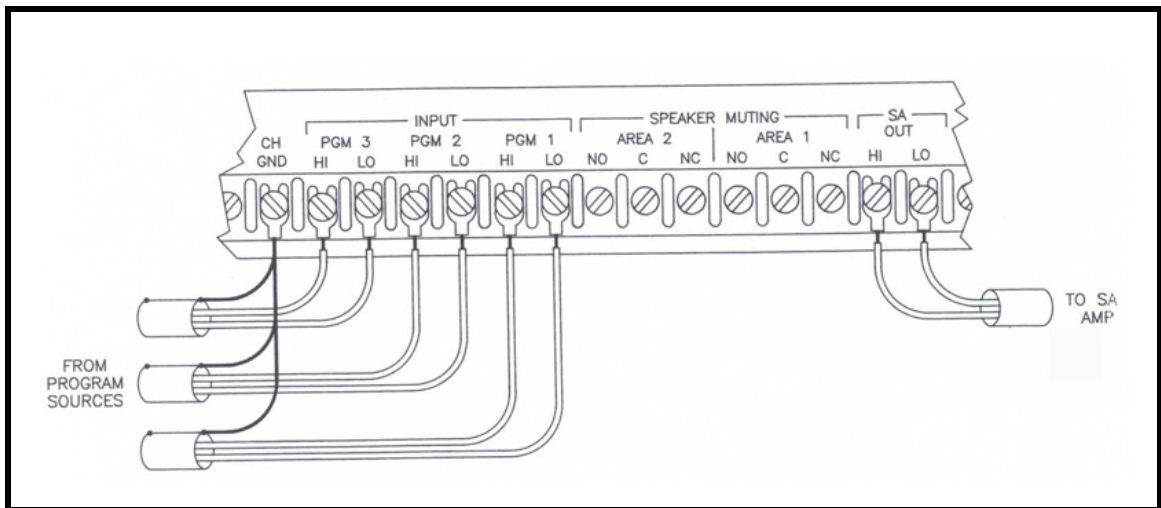




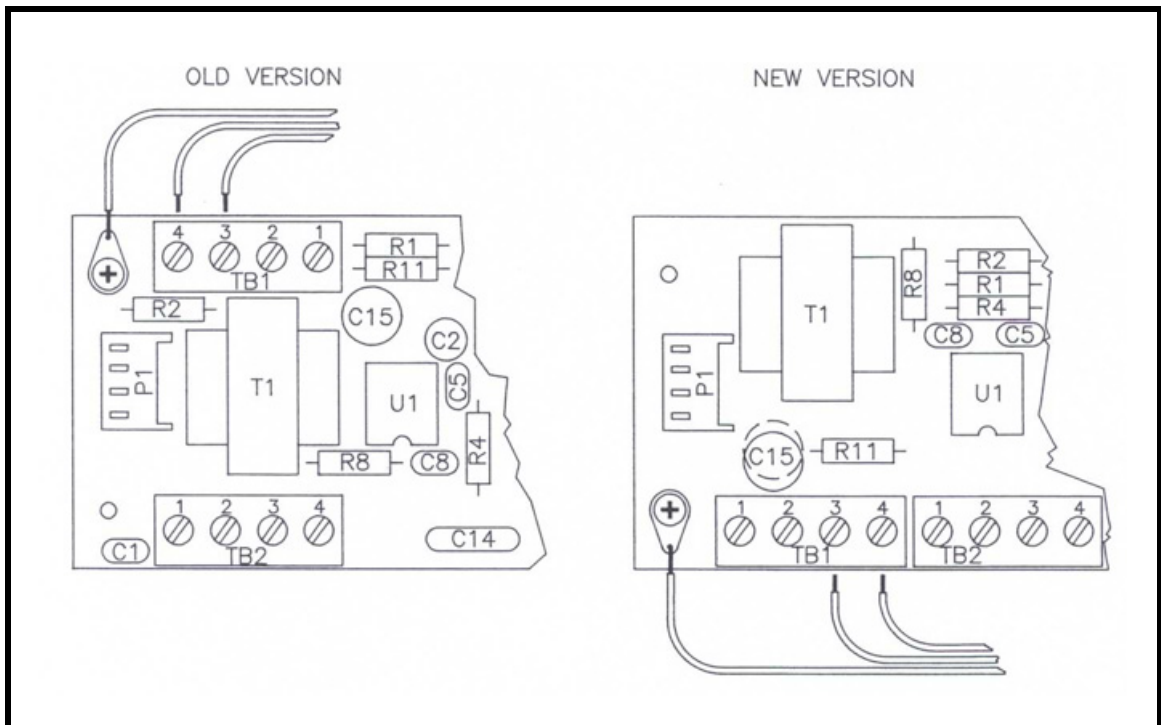
**FIGURE 4.** A Configuration – 3 System



**FIGURE 5.** User Station Connection to the 4010



**FIGURE 6.** Program Input and SA Output Connections



**FIGURE 7.** Balanced Mic Level Input

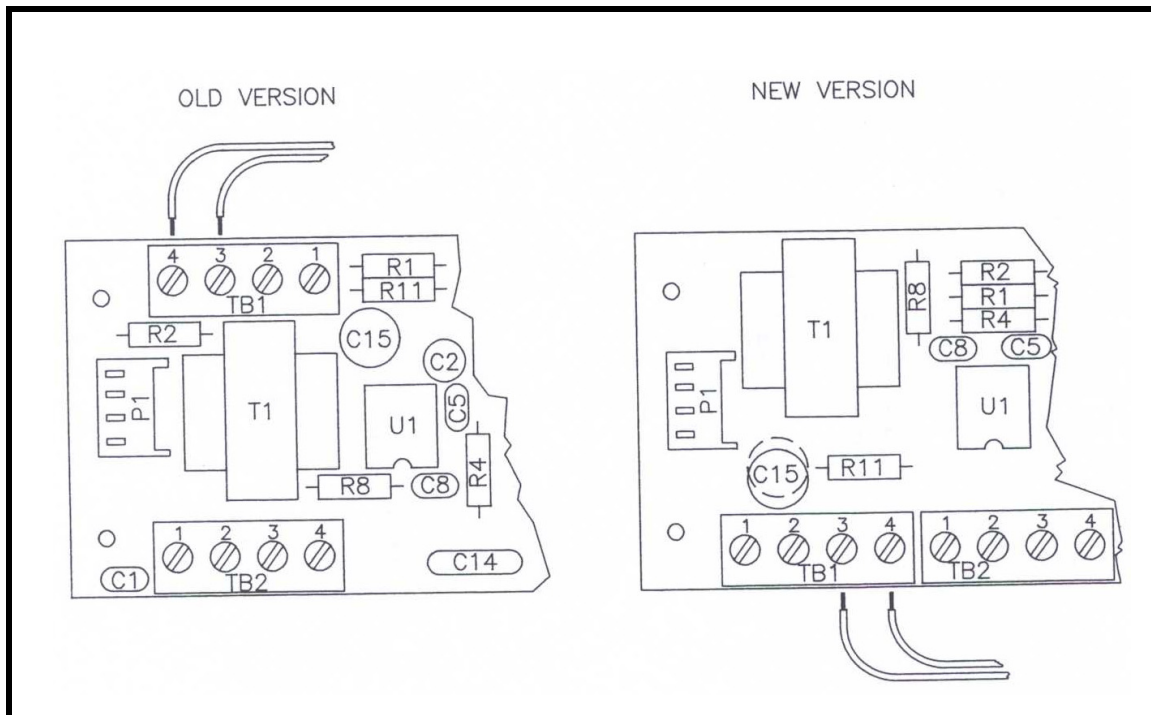


FIGURE 8. Unbalanced Mic Level Input

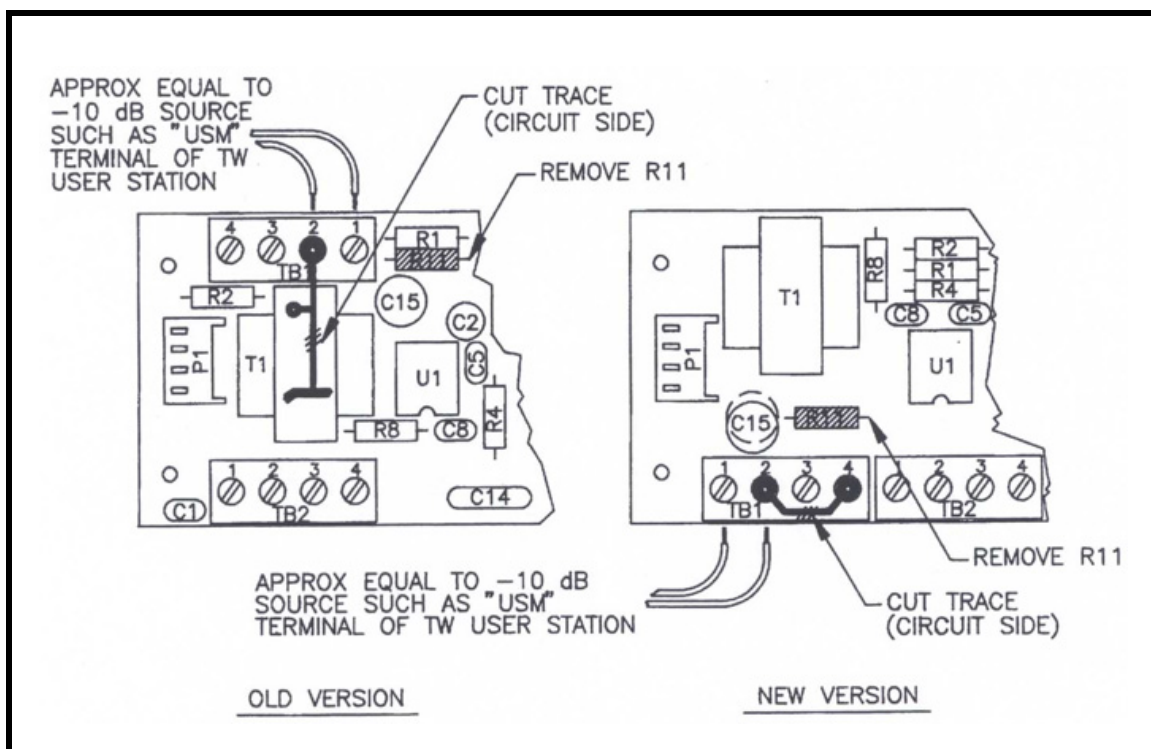
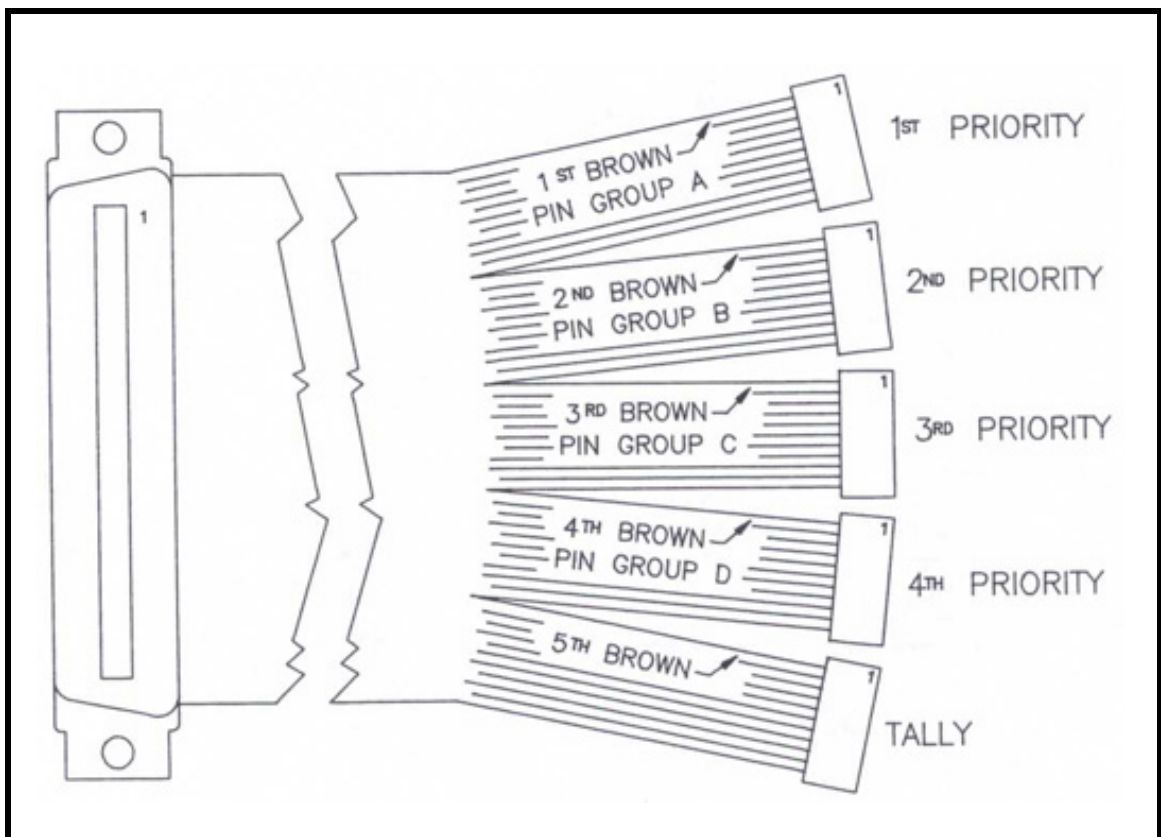
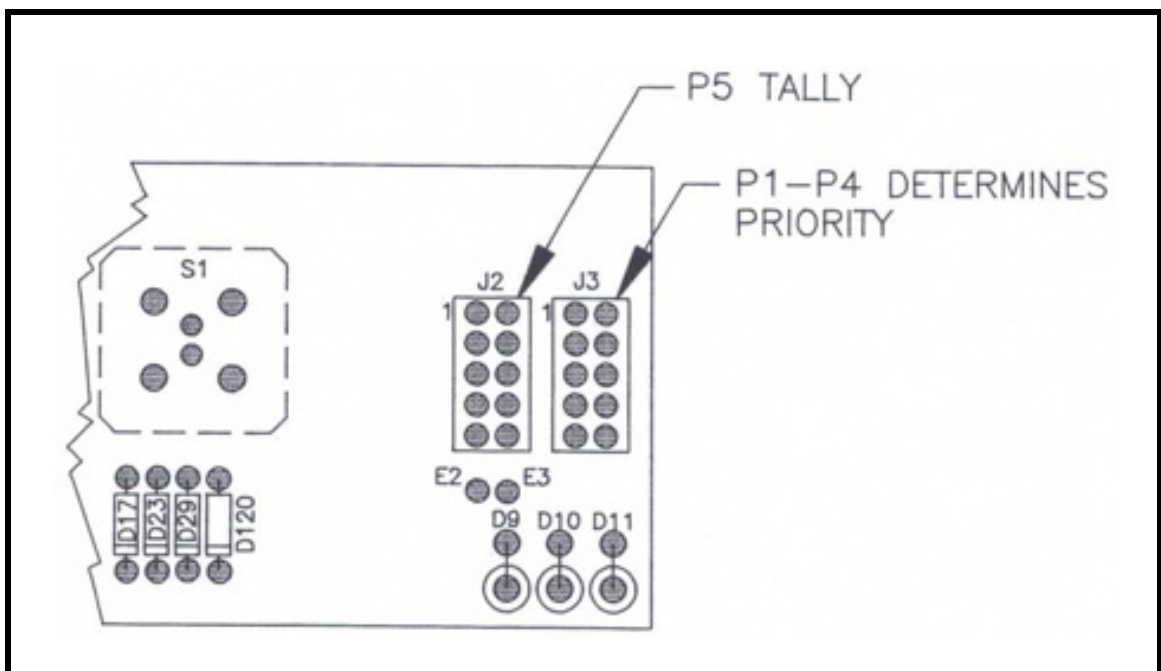


FIGURE 9. Line Level Input

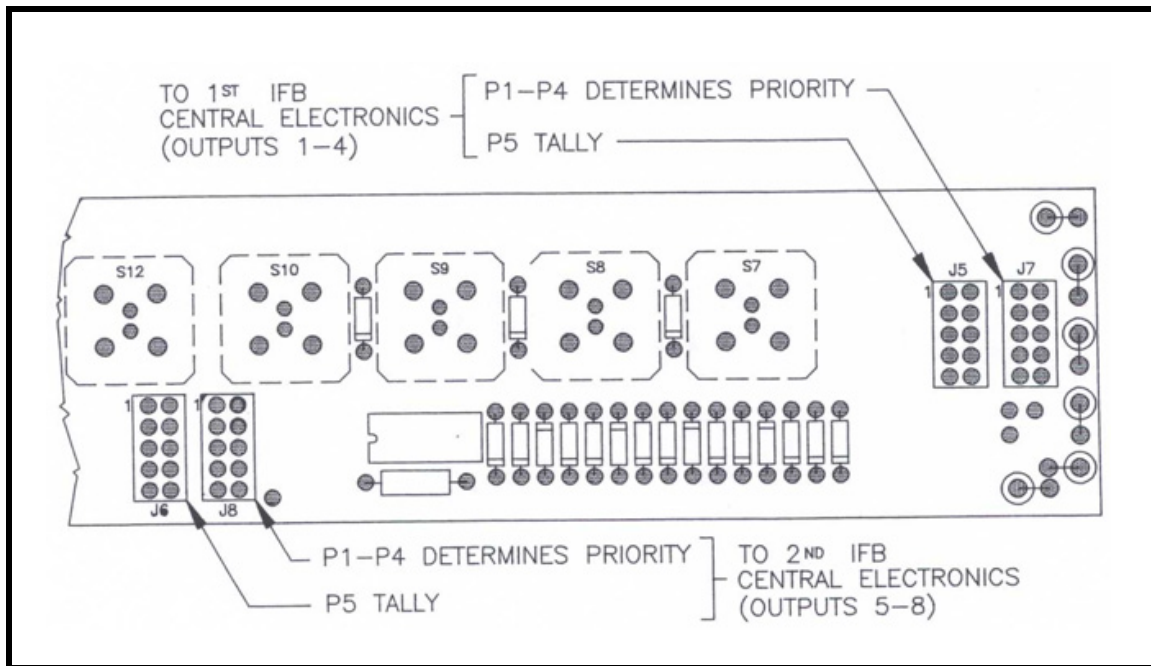


**FIGURE 10.** Control Station Cable Assembly

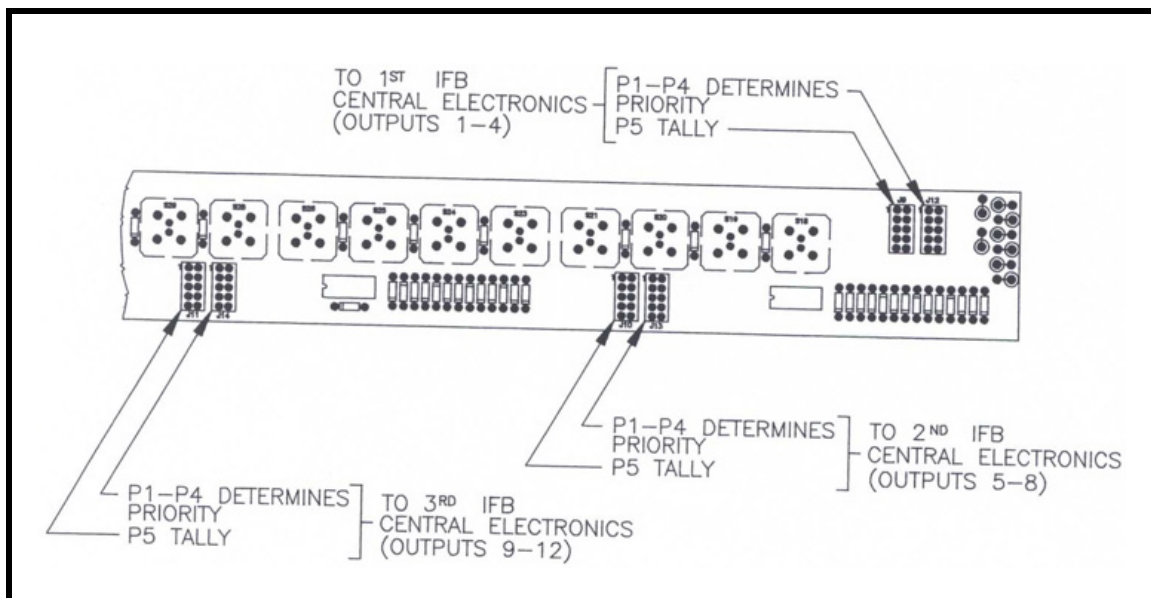


**FIGURE 11.** Priority Connections to 4001 Control Station

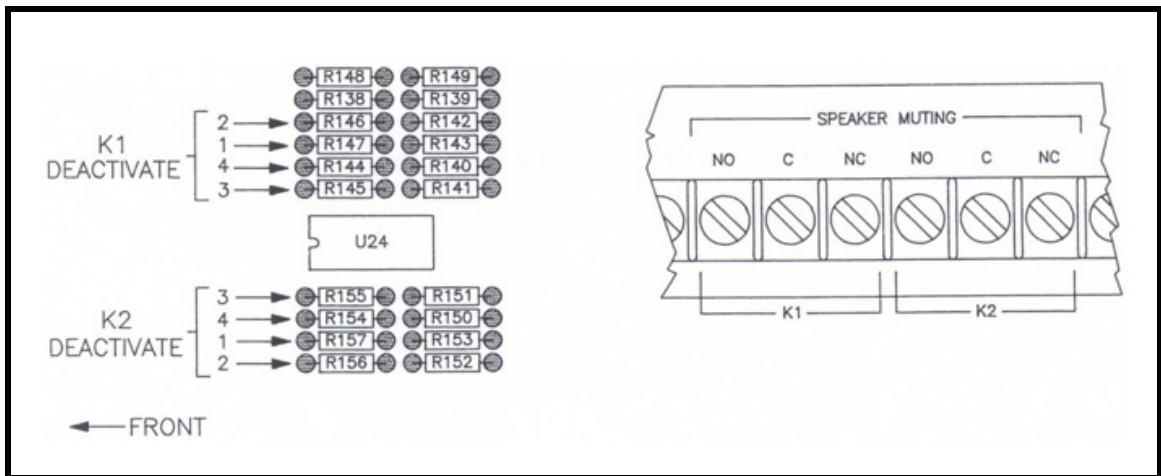




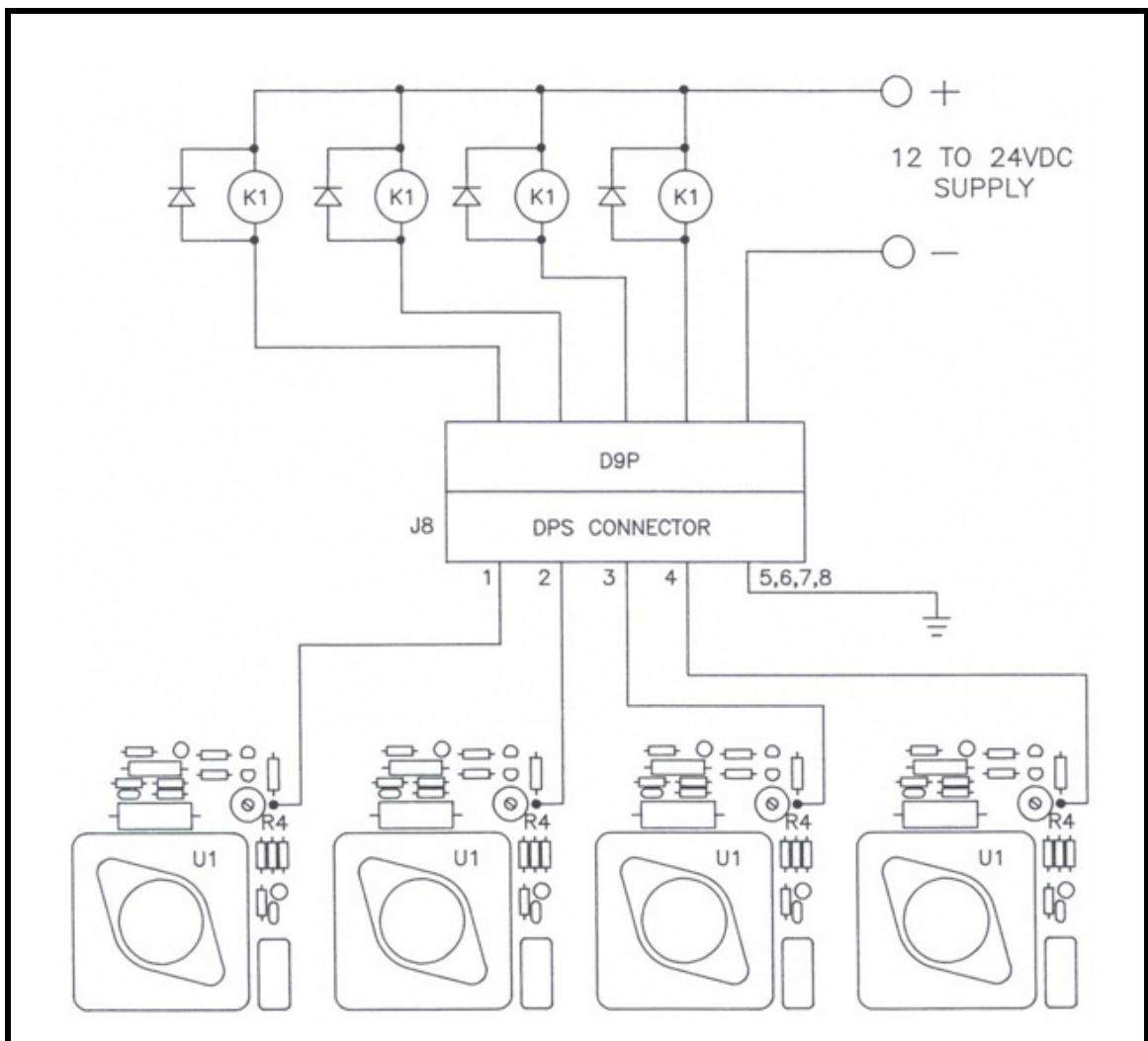
**FIGURE 12.** Priority Connections for 4002 Control Station



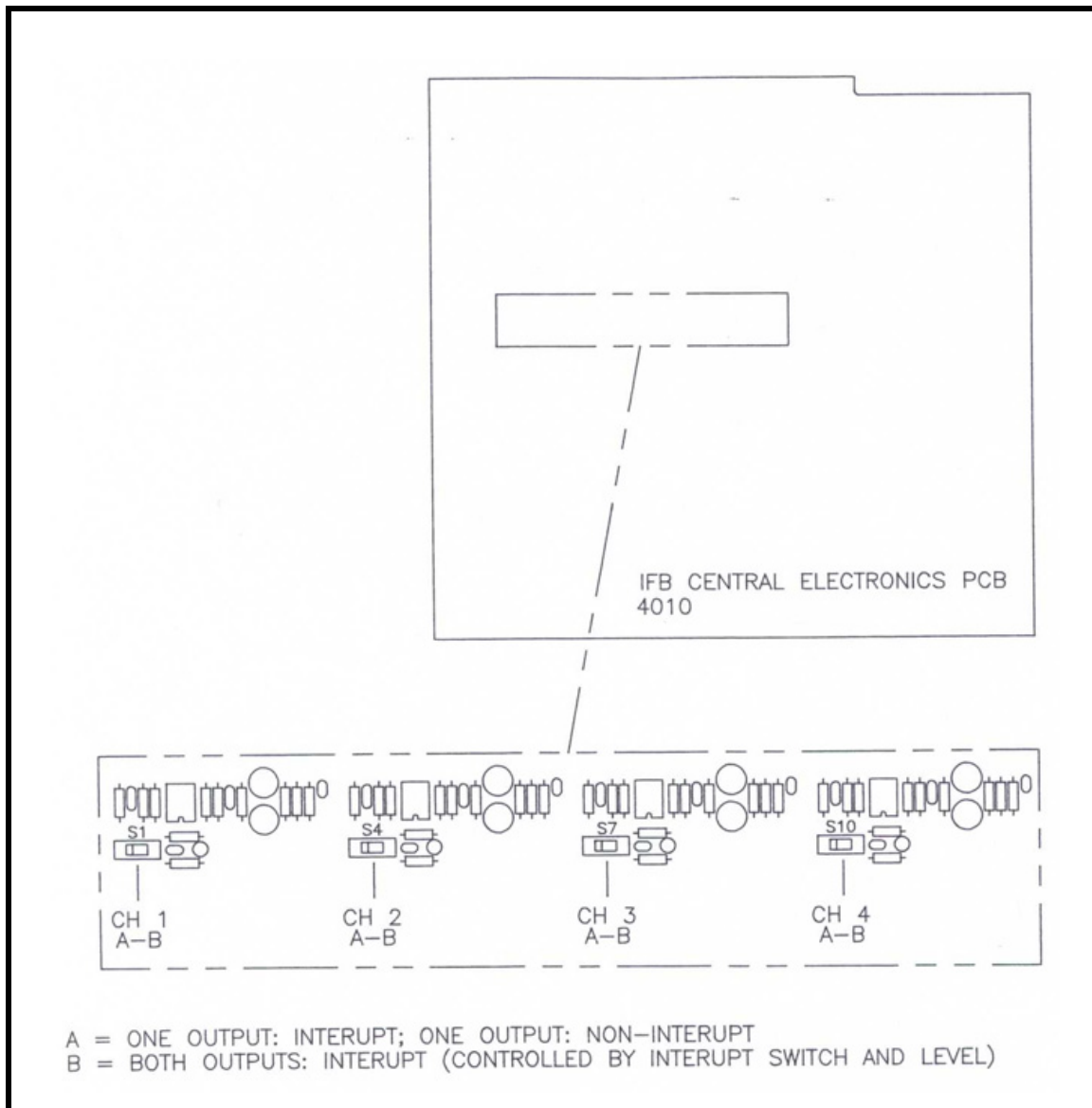
**FIGURE 13.** Priority Connections for 4003 Control Station



**FIGURE 14.** Speaker Muting Zones



**FIGURE 15.** Return IFB Connections



**FIGURE 16.** Stereo-Mono IFB Selection



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### *Operating Instructions*

The Series 4000 IFB System is very easy to use. The discussion below covers initial setup as well as the actual operation of the equipment. Field setup and connection of the Model 4020 User Station vary considerably depending on your needs and on the physical configuration of the studio, truck, arena, theatre, golf course, etc. you have to equip. The basics for Model 4020 setup are discussed throughout this chapter.

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### *Setup and Operation of the Central Electronics, Model 4010*

After you have **made all connections**, do the following:

1. Plug a **stereo headset** into the test jack on the front panel of the input 1.
2. Turn the monitor switch to **PGM 1**.
3. Verify **program**.  
*Then check programs 2 and 3.*

**CAUTION:** The program level is louder than the mic monitor and the output monitor levels.

To **set program level to the User Stations**, do the following:

1. Turn the monitor selector switch to **OUT 1**.
2. Set **program-select switches** under OUTPUT 1 to the desired channels.
3. Set the **program level** to its midpoint.
4. Have someone depress an **IFB 1 button** on a Control Station and **speak** into the microphone.
5. Compare the **interrupt level with the program level** and adjust **program levels** as needed for a balance between the program and interrupt audio.
6. Repeat this **procedure** for the remaining outputs.  
*When the monitor-select switch is in the SA position, the left headphone receives the SA program before it is interrupted. The right headphone receives SA audio after the interrupt switch.*

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## *Control Station Operation, Models 4001, 4001M, 4002, 4002M, 4003, 4003M*

To **use a Control Station**, do the following:

- > Press the **button** or **buttons** of the channel(s) you wish to interrupt and speak into the microphone.

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## *User Station Operation, Model 4020*

To **use the model 4020 user station**, do the following:

1. Connect the **User Station to the Central Electronics** via the 3-pin XLR-3 connector on the rear of the User Station.  
*Polarity and correct connections are important for proper operation.*
2. Check the **connections** to make sure that pin 1 is common and pin 2 has the +28 Volts DC on it with respect to pin 1.  
*In 3-wire operations, pin 3 will have only DC (positive) and that pin 1 be the common or return (negative).*
3. Plug a pair of **stereo headphones** into the stereo headphone jack on the rear of the Model 4020 User Stations.
4. Adjust **headphone levels** as desired.  
*The volume controls are made so that they cannot be turned all the way down, to prevent someone from missing a cue.*

When using a single earplug, do the following:

- > Plug its **cord** into the mono headphone jack.  
*This jack provides the interrupted audio. Use this jack when plugging a speaker into the Model 4020.*

**NOTE:** User Stations may be paralleled with our TW-4W or similar splitter box. The Central Electronics will power up to three (3) User Stations per outlet.

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## *Substituting TW Intercom Stations for IFB User Stations*

Any RTS TW intercom station may be substituted for a 4020 User Station. The BP-501 User Stations provide stereo IFB. Any other User Stations should have the channel-select a switch set to channel 1 to receive the interrupted monaural audio. A TW User Station with the **LP** (Local Power) option can be used to operate on a dry pair IFB feed providing long distance operation up to 8 kilometers (5 miles) with stepup and stepdown transformers. See Figure 17.

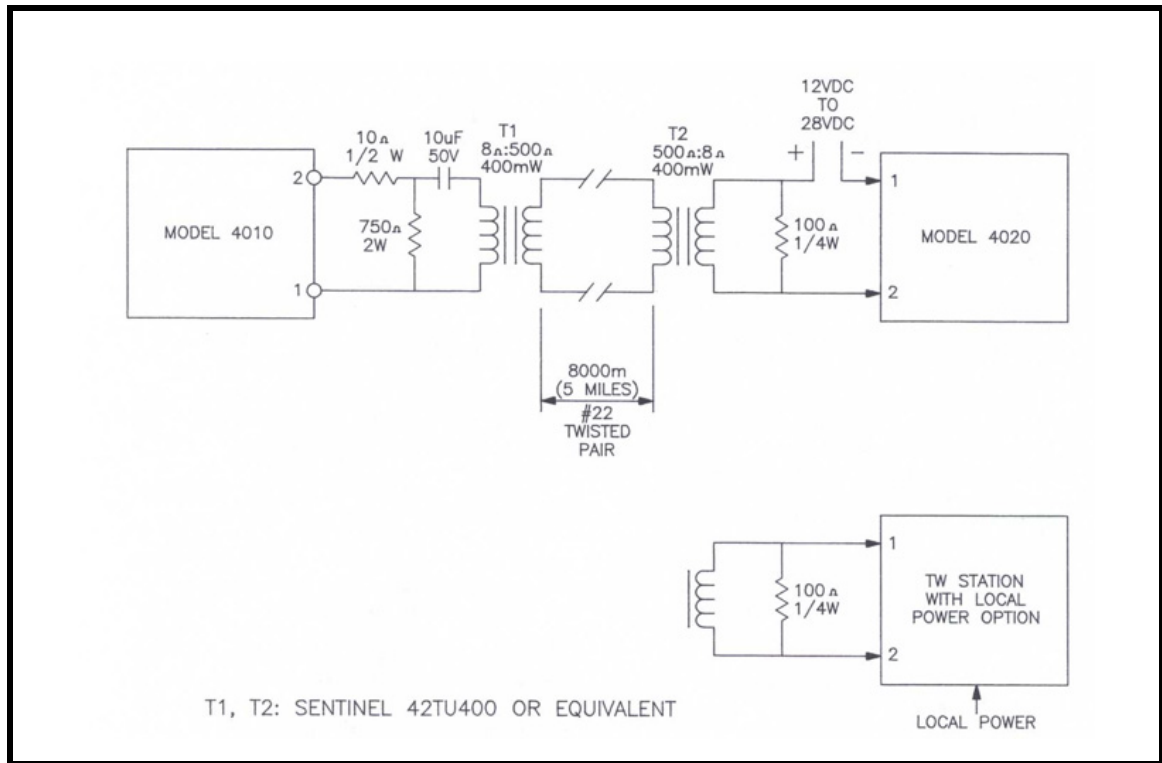
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## *Operating with Telco Dry Pair(s)*

The 4020 User Station can be operated on one dry telco pair. Just attach common and the interrupted output to pins 1 and 2 respectively on the XLR connector going to the User Station. For long distances, where hum is a problem, the 4020 can be operated on two (2) telco pairs in stereo with one (1) of our Balanced/Unbalanced converters at each end.

## Operating Distances

With a telco pair, maximum operating distance averages 800 meters (1/2 mile). Doubling up the conductors in a telephone quad extends the operating range to 1600 meters (1 mile). Utilizing an extra power supply and transformers, the range can be extended to 8 kilometers (5 miles) on telco dry pair. See Figure 17.



**FIGURE 17.** Range Extender

