

Digital Hybrid ANA
Advanced Nulling Algorithm

GENTNER

ELECTRONICS
CORPORATION

OPERATIONS MANUAL

Digital Hybrid ANA
Advanced Nulling Algorithm

GENTNER
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SECTION ONE -- THE BASICS

1.1 Introduction

This manual will provide you with all the information you need to properly use and maintain the Digital Hybrid ANA. We urge you to read this manual thoroughly before attempting to use your Digital Hybrid ANA.

Appendix A of this manual, "Telephone Basics", is a valuable primer on standard telephone systems and provides an excellent review for those persons already familiar with telephone interfacing requirements.

Please refer to this manual first if you have any questions or problems regarding the use of the Digital Hybrid ANA. If you can't find an answer in the manual, please contact:

Gentner Electronics Corporation
Customer Support
1825 Research Way
Salt Lake City, Utah 84119
Tel: (801) 975-7200
FAX: (801) 977-0087

Please check your Digital Hybrid ANA shipment to be certain that each item listed below is included. If any item is missing, notify Gentner immediately.

ITEM	GENTNER PART NUMBER
a) [1] Digital Hybrid ANA Unit Assembly	850-009-001
b) [1] Operations Manual	800-009-001
c) [4] Rack Screws	681-400-001
d) [6] Rack Cups	684-400-001
e) [1] Warranty Registration Card	432-600-000
f) [1] Modular Telephone Cord	830-000-012
g) [1] DC-37 Socket	671-020-037
h) [1] Hood for DC-37 Socket	671-000-037

1.2 Overview

The Gentner Digital Hybrid ANA is a revolutionary telephone hybrid. The system's Advanced Nulling Algorithm provides you with the maximum performance available from any telephone hybrid available.

The Digital Hybrid ANA utilizes highly sophisticated digital circuitry and digital signal processing techniques to optimize the isolation between the Send and Receive sides of a telephone conversation. The unit works well in both broadcast and teleconferencing applications.

The performance advances provided by the Advanced Nulling Algorithm help eliminate feedback over the hybrid, even when you have an open microphone in the same room with a loudspeaker.

The Digital Hybrid ANA provides a Caller Control circuit, which causes Caller audio to be slightly dimmed under Send audio. The amount of Caller Control is adjustable in the range of 0 dB to 40 dB of dimming.

The Digital Hybrid ANA connects directly to the telephone line, provides auto-answer/auto-disconnect capability, and all functions of the unit can be remotely controlled through a single rear panel REMOTE connector.

The unit incorporates Automatic Gain Controls (AGC's) for the Send and Caller circuits. The AGC's may be enabled or disabled.

A removable metal panel on the front of the unit allows access to controls for Caller Level, Send Level, and Caller Control Level, as well as a series of DIP switches which enable and disable automatic functions and other features of the Digital Hybrid ANA.

The unit has two LED indicators on the front panel which go green to indicate the presence of audio on the Send and Caller sides of the telephone conversation. In the Send Level Test mode, the SEND indicator goes red on peaks, helping you to prevent unwanted distortion due to overdriven telephone lines.

The Gentner Digital Hybrid ANA provides you with these benefits:

- a) Exclusive Advanced Nulling Algorithm provides the fastest possible null, prevents feedback and discoloration of Send audio, and maximizes isolation between the Send and Caller sides of telephone conversations.
- b) The Digital Hybrid ANA adapts automatically and instantly to telephone line conditions.
- c) Carefully designed bandpass filters on both the Send and Caller circuits mask unwanted hum, Central Office switching noise, and telephone multiplex distortion.
- d) Audio processors on the Send and Caller circuits help maintain consistent audio levels.
- e) Caller Control circuitry momentarily reduces Caller audio by a variable amount. This allows for a smooth interchange between the announcer and the caller in broadcast applications.
- f) Auto-answer, auto-disconnect, and automatic muting of caller audio are standard features.
- g) The Advanced Nulling Algorithm, all microcontroller instructions, and complete system timing functions are contained in PROM (Programmable Read Only Memory) chips, allowing for future updates of the Digital Hybrid ANA.

The Digital Hybrid ANA's ease of use and capabilities make it suitable for use in the following applications:

- a) Radio and Television Talk Shows. The Digital Hybrid ANA provides the best possible sound for all types of telephone call-in shows. The unit's fast response to variable telephone line conditions, and superior null performance make it the ideal choice where clean, consistent audio quality is required.

- b) Audio and Video Tele-conferencing. The Digital Hybrid ANA can be used in any tele-conferencing installation. The unit provides maximum intelligibility and audio quality. Use it for return audio in video conferences, or for any high quality audio conference. The Advanced Nulling Algorithm helps eliminate feedback in conferencing rooms.

1.3 Brief Technical Description

The Digital Hybrid ANA is based on Digital Signal Processing (DSP) technology, which utilizes an exclusive Advanced Nulling Algorithm to maximize the separation between the Send and Caller sides of a telephone conversation.

Refer to Figure 1, Figure 2, and Figure 3 in this section while reading the following brief overview of the Digital Hybrid ANA.

When the ON button is pushed, the Digital Hybrid ANA activates a relay that connects the hybrid circuitry to the telephone line. The internal microprocessor mutes Caller audio, waits for the telephone loop current to become stable and then applies a 300 millisecond burst of white noise to the telephone line. The Advanced Nulling Algorithm instantly analyzes the noise and adapts the digital filter coefficients to maximize the hybrid null. After the white noise burst is completed, the microprocessor removes the mute from the Caller audio amplifier, allowing Caller audio to appear at the Caller XLR connector on the rear panel of the unit.

If the ON button is pushed during the course of a telephone call, the Advanced Nulling Algorithm is re-initialized and the nulling/muting process repeats itself without disconnecting the telephone line.

While the Digital Hybrid ANA is on line, the Advanced Nulling Algorithm constantly optimizes the null to adjust for changing telephone line conditions. Additionally, the Advanced Nulling Algorithm reacts to audio material on the telephone line to maximize the separation between Caller and Send audio.

When the OFF switch is pushed, the Digital Hybrid ANA disconnects the telephone line and illuminates the red LED in the OFF switch.

If the OFF button is pushed and held, the SEND LED will indicate the magnitude of the Send audio. The SEND LED is a bi-color (red/green) LED, with green indicating a Send level within the adjustment range of the Send AGC processor and telephone line limiter. The red condition indicates peaks 10 dB above the nominal send level.

When the hybrid is on line, the SEND LED glows green to indicate the presence of send audio. The same logic that drives this green LED also drives the Caller Control circuit, which can be used to dim the Caller audio whenever Send audio is present.

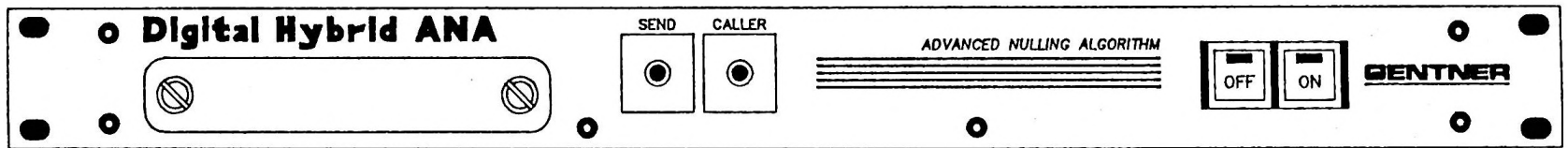
When the Digital Hybrid ANA is on line, the CALLER LED glows green to indicate the presence of Caller audio. The same logic that drives this LED is also fed to the DSP to stop the nulling process whenever the caller speaks and to operate the gate threshold of the Caller AGC processor.

A removable metal panel on the main front panel conceals three user adjustable trim-pots and ten option switches. The functions of these controls are detailed on the reverse side of this removable panel.

Two Send inputs are provided on the rear panel of the unit. The main SEND input may be selected to accept either a microphone level signal, or a line level signal. The AUX SEND input accepts a line level signal only.

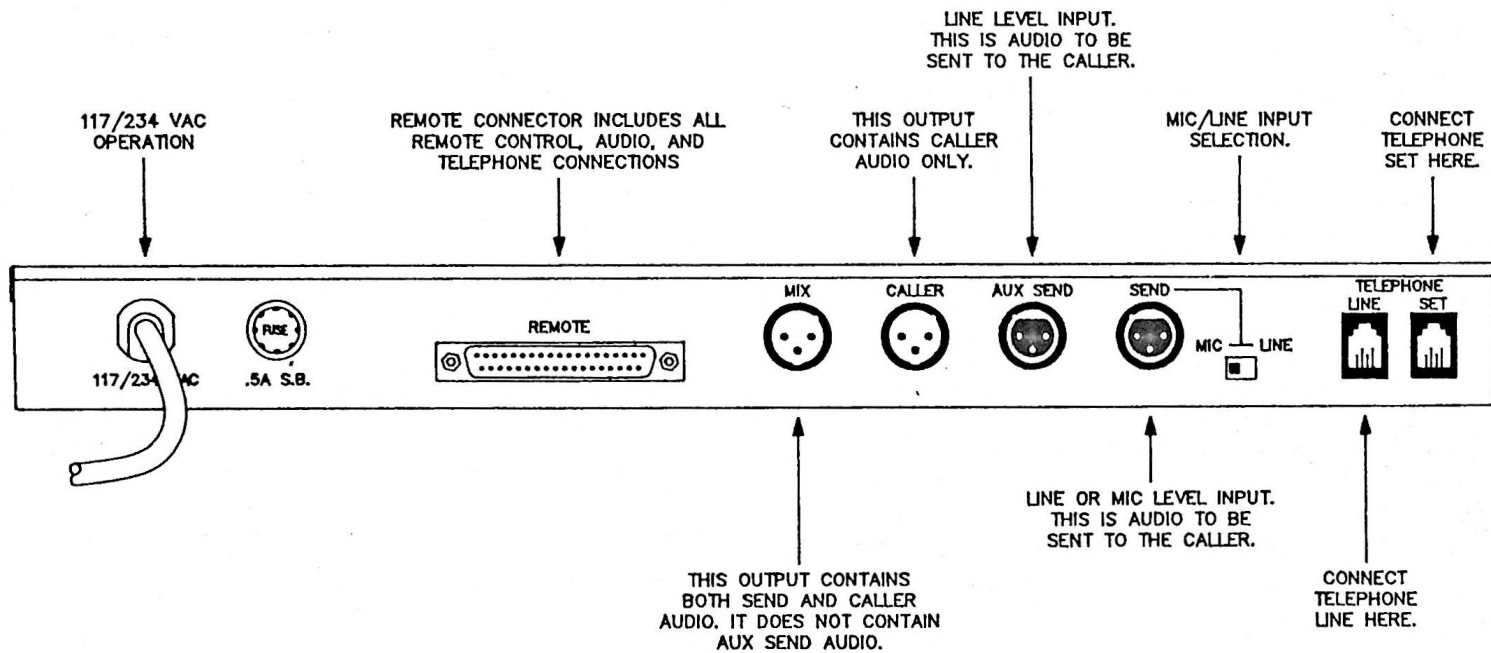
The CALLER output provides a line level output of Caller audio.

The MIX output contains both SEND and CALLER (receive) audio; it does NOT contain audio going into the AUX SEND connector.



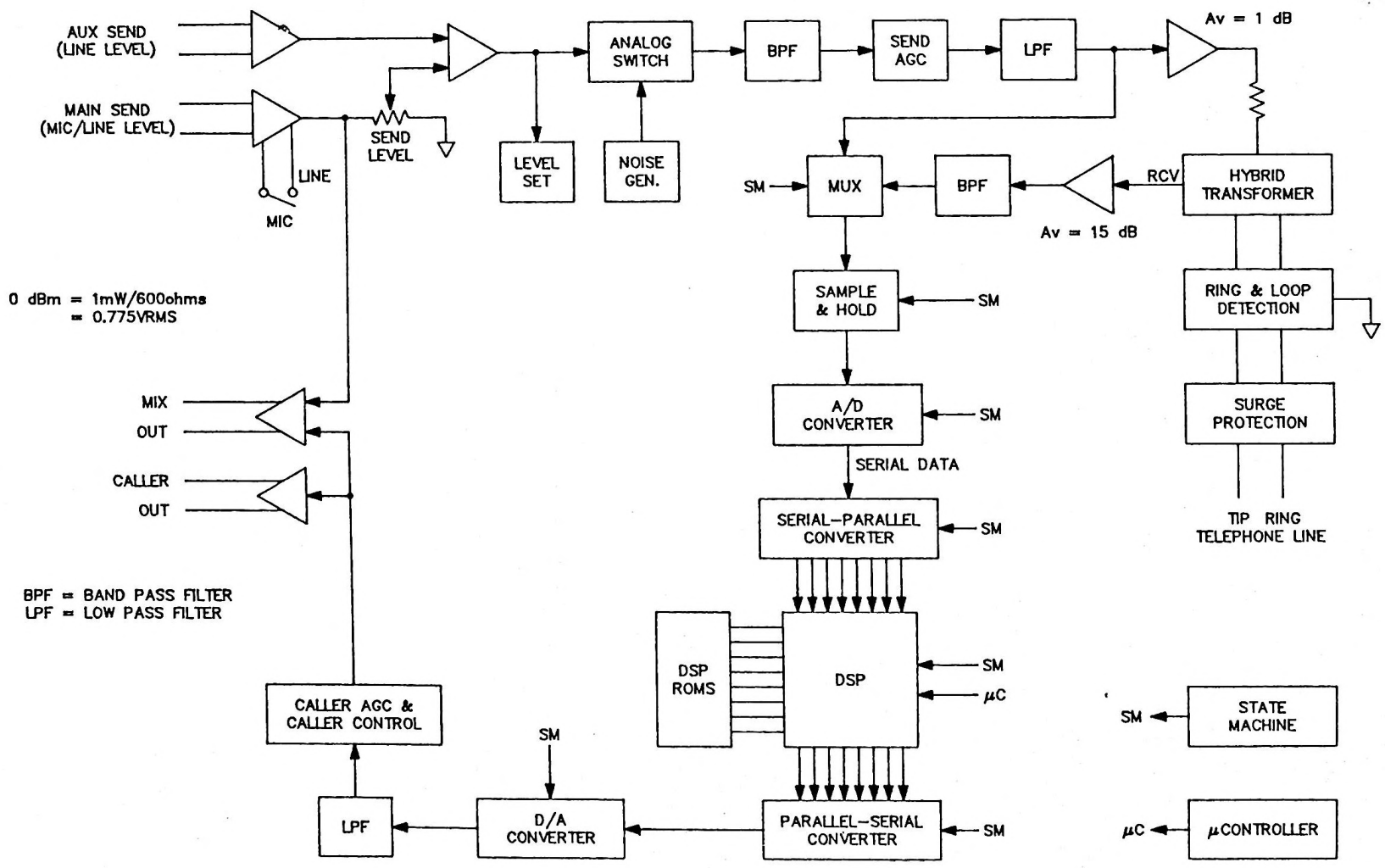
DIGITAL HYBRID ANA FRONT VIEW

FIGURE 1



DIGITAL HYBRID ANA REAR VIEW

FIGURE 2



DIGITAL HYBRID ANA FUNCTIONAL BLOCK DIAGRAM

FIGURE 3

1.4 Physical Specifications

The Digital Hybrid ANA is enclosed in a rugged metal case, which may be mounted in a standard 19" equipment rack. The actual physical dimensions of the main system are:

Height: 1.75"/ 4.45 cm
Width: 19.0"/48.26 cm
Depth: 12.0"/30.48 cm

Weight (dry): 10 lbs/4.5 kg
Shipping weight: 13 lbs/5.9 kgs

1.5 Electrical Specifications

- a) Power Requirements: 117/234 VAC; 60/50 Hz; 15 watts maximum.
- b) Telephone Interface: Internal hybrid couplers with DSP leakage suppression; 600 ohm nominal impedance; Transient voltage protection with intentional path to ground from Tip and Ring at +/- 230 volts; Ringing voltage detection >45 volts RMS, 15 to 90 Hz; Automatic answer (if enabled) after one complete ring; Automatic disconnect on interruption of loop current or reversal of loop current.
- c) SEND Input: Active balanced input; user selectable for microphone or line level input; -55 dBm nominal input level in microphone position; 0 dBm nominal input level in line position (level is user-adjustable via a front panel trim-pot).
- d) AUX SEND Input: Active balanced, bridging input; 0 dBm nominal input level (non-adjustable).
- e) CALLER Output: 600 ohm nominal output impedance; Actively balanced output; +20 dBm clip level, 0 dBm nominal output level (user-adjustable via a front panel trim-pot).
- f) MIX Output: 600 ohm nominal output impedance; Active balanced output; 0 dBm nominal output level (non-adjustable).
- g) Caller Control: Internally or externally adjustable dimming of caller audio when Send audio is present; 0 to 40 dB linear.
- h) Connectors: TELEPHONE LINE and SET connectors are female modular RJ11C; SEND and AUX SEND inputs are female XLR; CALLER and MIX outputs are male XLR; REMOTE connector is male DC-37.

- i) Switches: ON and OFF switches are high reliability Microswitch AML 12 units with integral LED indicators.
- j) Signal Processing: All digital signal processing is performed by proprietary architecture using a Texas Instruments TMS 320C10L-25 32 bit DSP. Control of DSP is performed by a set of four on-board PROM chips containing Advanced Nulling Algorithm firmware.

SEND and CALLER AGC processing is performed in the analog domain. AGC processing may be enabled or disabled. Maximum shelved SEND gain is 15 dB; maximum SEND gain reduction is 20 dB; SEND gate threshold is -26 dBm. Maximum shelved CALLER gain is 10 dB; maximum CALLER gain reduction is 20 dB; Caller gate threshold is -32 dBm.

- k) Tip/Ring Switching: Omron 4-pole bifurcated contact relay.
- l) Internal Audio Specifications (measured from SEND input to MIX output):

Frequency Response:
10 Hz to 100 kHz, +/- 1 dB

Total Harmonic Distortion: <.005%

SNR: >100 dB below level of clipping.

- m) Telephone Send Audio Specifications (measured from SEND input to TELEPHONE LINE connector, referenced to -15 dBm Send level):

Frequency Response:
350 Hz to 2550 Hz, +/- 1 dB
190 Hz to 3100 Hz, +/- 30 dB

Total Harmonic Distortion: < 1%

SNR: > 65 dB referenced to -15 dBm Send Level

- n) Telephone Caller Audio Specifications (measured at CALLER output, referenced to -15 dBm Caller level):

Frequency Response:

250 Hz to 3000 Hz, +/- 1 dB

135 Hz to 4200 Hz, +/- 30 dB

Total Harmonic Distortion: < .4%

SNR: > 65 dB referenced to -15 dBm
Caller Level

- o) Temperature Range: Gentner recommends the operation of the Digital Hybrid ANA in an environment of between 0 and +50 degrees Celsius. It is recommended that the mounting rack environment be ventilated, with forced-air ventilation preferred.

SECTION TWO -- WARRANTY AND FIRMWARE LICENSE

2.1 Digital Hybrid ANA Firmware License

The Digital Hybrid ANA is a microprocessor-based system. All firmware for the unit was developed by Gentner Electronics Corporation.

By purchasing the Digital Hybrid ANA, you accept the terms of the Gentner Firmware License Agreement stated below. This License Agreement becomes effective as of the date of purchase of the Digital Hybrid ANA.

GENTNER FIRMWARE LICENSE AGREEMENT

Gentner Electronics Corporation, (hereinafter referred to as Gentner), is the sole owner of the Digital Hybrid ANA firmware. The Digital Hybrid ANA firmware is defined as all software stored in the memory device supplied with this license. Gentner grants to the purchaser and/or the end-user of the Gentner Digital Hybrid ANA unit a non-exclusive license to use the firmware under the following terms and conditions.

This firmware is:

- a) For use on only the Digital Hybrid ANA which has been purchased and properly registered by serial number with Gentner.
- b) Not to be copied or duplicated in any way, and not to be transferred or delivered to any other person or entity without the written consent of Gentner.
- c) Protected by all applicable copyright and patent laws. Any copyrights and patents assigned to Gentner for the Digital Hybrid ANA remain the sole property of Gentner.

This license does not assign or transfer ownership of the firmware. Included in this license is all information contained in the instruction manuals, schematic diagrams, and related materials.

This license shall remain in effect for the life of your Digital Hybrid ANA. You may terminate the license by returning the Digital Hybrid ANA to Gentner in its original container. This license is automatically terminated if you violate any of the terms and conditions of this license. Upon such termination, the Digital Hybrid ANA must be returned to Gentner.

This license agreement is granted solely to the original purchaser of the Digital Hybrid ANA. If the Digital Hybrid ANA, and thus the firmware and this license, is to be passed to another person or entity in any way, the original purchaser must advise Gentner in writing of this transfer. The new holder of the Digital Hybrid ANA must acknowledge in writing acceptance of the terms and conditions of this license. The license shall be deemed terminated if such written acceptance is not presented to Gentner.

2.2 Warranty Agreement

The Gentner Warranty Agreement on the following page is effective as of the date of receipt by the purchaser of the Digital Hybrid ANA. This warranty shall not be effective unless Gentner is notified in writing by the purchaser of the receipt of the unit and the unit's serial number.

You have been supplied with a Gentner Warranty Registration Card. Use this card to notify Gentner of your purchase of the Digital Hybrid ANA and the serial number of your unit.

WARRANTY

GENTNER ELECTRONICS CORPORATION (Manufacturer) warrants that this product is free of defects in both materials and workmanship. Should any part of this equipment be defective, Manufacturer agrees, at its option, to:

A. Repair or replace any defective part free of charge (except transportation charges) for a period of 12 months from the date of the original purchase, provided the owner returns the equipment to Manufacturer at the address set forth below. No charge will be paid for parts or labor during this period.

B. Replace or furnish replacement for any defective parts in the equipment for a period of one year from the date of original purchase. Replacement parts shall be furnished without charge except labor and transportation.

This Warranty excludes assembled products not manufactured by Manufacturer whether or not they are incorporated in a Manufacturer product or sold under a Manufacturer part or model number.

THIS WARRANTY IS VOID IF:

A. The equipment has been damaged by negligence, accident, act-of-God or mishandling, or has not been operated in accordance with the procedures described in the operating and technical instructions; or,

B. The equipment has been altered or repaired by other than manufacturer or provided by authorized service representative of Manufacturer; or,

C. Adaptations or accessories other than those manufactured or provided by Manufacturer have been made or attached to the equipment which, in the determination of Manufacturer, shall have affected the performance, safety, or reliability of the equipment; or,

D. The equipment's original serial number has been modified or removed.

NO OTHER WARRANTY EXPRESS OR IMPLIED, INCLUDING WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR USE, APPLIES TO THE EQUIPMENT, nor is any person or company authorized to assume any warranty for Manufacturer or any other liability in connection with the sale of Manufacturer products.

Manufacturer does not assume any responsibility for consequential damages, expenses or loss of revenue or property, inconvenience or interruption in operation experienced by the customer due to a malfunction in the purchased equipment. No warranty service performed on any product shall extend the applicable warranty period.

In case of unsatisfactory operation, the purchaser shall promptly notify Manufacturer at the address set forth below, in writing, giving full particulars as to the defects or unsatisfactory operation. Upon receipt of such notice, Manufacturer will give instructions respecting the shipment of the equipment, or such other matters as it elects to honor this warranty as above provided. This warranty does not cover damage to the equipment during shipping and Manufacturer assumes no responsibility for such damage. All shipping costs shall be paid by customer.

This warranty extends only to the original purchaser and is not assignable or transferable.

GENTNER
ELECTRONICS
CORPORATION

P.O. Box 27647
Salt Lake City, UT 84127-0647
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2.3 Special Notices

The information contained in this manual is subject to change without notice. Gentner Electronics Corporation makes no warranty of any kind with regard to this material including, but not limited to, the implied warranties of merchantability and fitness for a particular purpose. Gentner Electronics Corporation shall not be liable for errors contained herein or for incidental or consequential damages in connection with the furnishing, performance, or use of this material.

The copyright on this manual is held solely by Gentner Electronics Corporation.

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2.4 Product Line Updates

Gentner Electronics will offer, from time to time, new products, options, and firmware updates for its product line. As a registered owner of a Gentner product, you will automatically be notified of updates when they become available.

You must return a completed Warranty Card in order to notified of updates to the product line. (If the card is lost, you may notify us by letter. Your letter must include the following information: Digital Hybrid ANA serial number; your name; the name of your organization; your address; date of purchase; the name of the company from whom you purchased your Digital Hybrid ANA.)

Mail your Warranty Registration Card to:

Gentner Electronics Corporation
P.O. Box 27647
Salt Lake City, Utah 84127-0647

SECTION THREE -- INSTALLATION

3.1 Unpacking Your Digital Hybrid ANA

Carefully unpack your shipment and check for any damage. Be sure that all the parts listed in Section 1.1 of this manual are included in your package.

If you notice any damage to the unit, notify your shipping carrier immediately. Be sure to retain the original boxes and packing material for inspection by the carrier. Gentner is not responsible for shipping damage. You must make claims directly with the carrier.

3.2 Mounting Your Digital Hybrid ANA

If desired, you can mount the Digital Hybrid ANA in a standard 19" equipment rack.

The Digital Hybrid ANA does not require an internal cooling fan. As long as the unit receives adequate ventilation, it will operate normally.

Be careful not to block any of the ventilation holes in the unit's chassis. Always be sure that a free flow of air gets to the unit while it is operating.

You can also mount the Digital Hybrid ANA in a road case, making it easy to transport and protect it from the elements and other environmental hazards.

If you install your Digital Hybrid ANA in a road case, you should mount a cooling fan in the road case to insure that your Digital Hybrid ANA receives adequate ventilation.

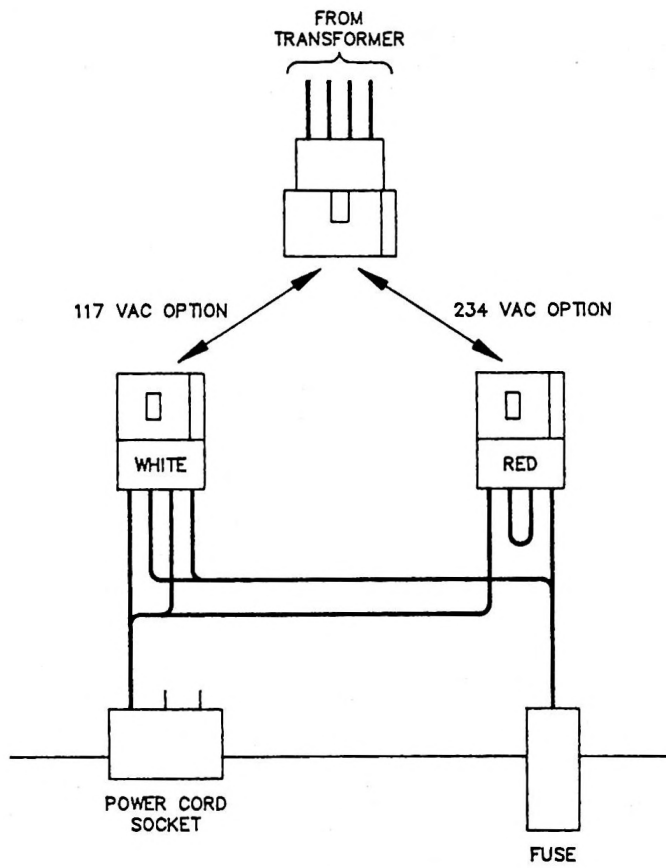
3.3 Setting Up the AC Power Input

Your Digital Hybrid ANA was shipped to you ready to use with a 117 VAC/60 Hz power source (unless otherwise marked.) You can easily alter the AC power input to accept a 234 VAC/50 Hz power input.

To change the operating voltage for the Digital Hybrid ANA:

- a) DISCONNECT THE UNIT FROM AC POWER, then place the unit on a static-free work surface to avoid damage to the internal CMOS components.
- b) Remove the top cover by loosening its four screws.
- c) Locate the power transformer and its wiring harness that is connected to transformer pins 1 through 4. Refer to Figure 4 on the next page.
- d) If the unit is to be operated at 117 VAC, connect this harness to the WHITE molex mating connector.
- e) If the unit is to be operated at 234 VAC, connect this harness to the RED molex mating connector.
- f) Replace the top cover and tighten the screws.

CAUTION: Always be sure that the Digital Hybrid ANA is configured for the correct power source prior to operation.



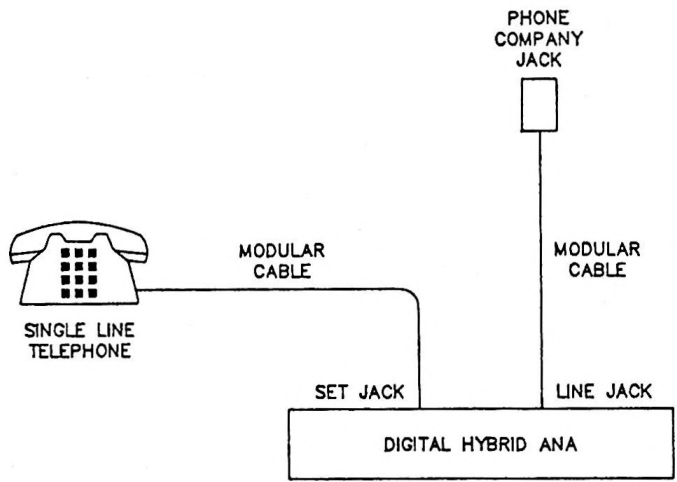
SETTING UP THE AC POWER INPUT

FIGURE 4

3.4 Connecting the Digital Hybrid ANA Directly to a Single Central Office Telephone Line

Refer to Figure 5 on the next page. Connect the incoming telephone line to the Digital Hybrid ANA's LINE jack with the appropriate modular telephone cable.

An optional telephone instrument can be connected to the SET jack. Telephone calls can be placed and received normally with the telephone instrument when the Digital Hybrid ANA is OFF line.



CONNECTION TO A SINGLE CENTRAL OFFICE LINE

FIGURE 5

3.5 Connecting the Digital Hybrid ANA to a 1A2 Key Service Unit

The Digital Hybrid ANA may be used in conjunction with an existing 1A2 key service unit in one of three ways:

- a) Using an existing multi-line telephone set as a call director;
- b) Using an existing Gentner Telemix IX as a call director;
- c) Using a Gentner Telemix X as a call director.

Detailed instructions for using the Digital Hybrid ANA in each of these ways are given next. Please take the time to carefully study them.

3.5.1 Using an Existing Multi-Line Telephone Set

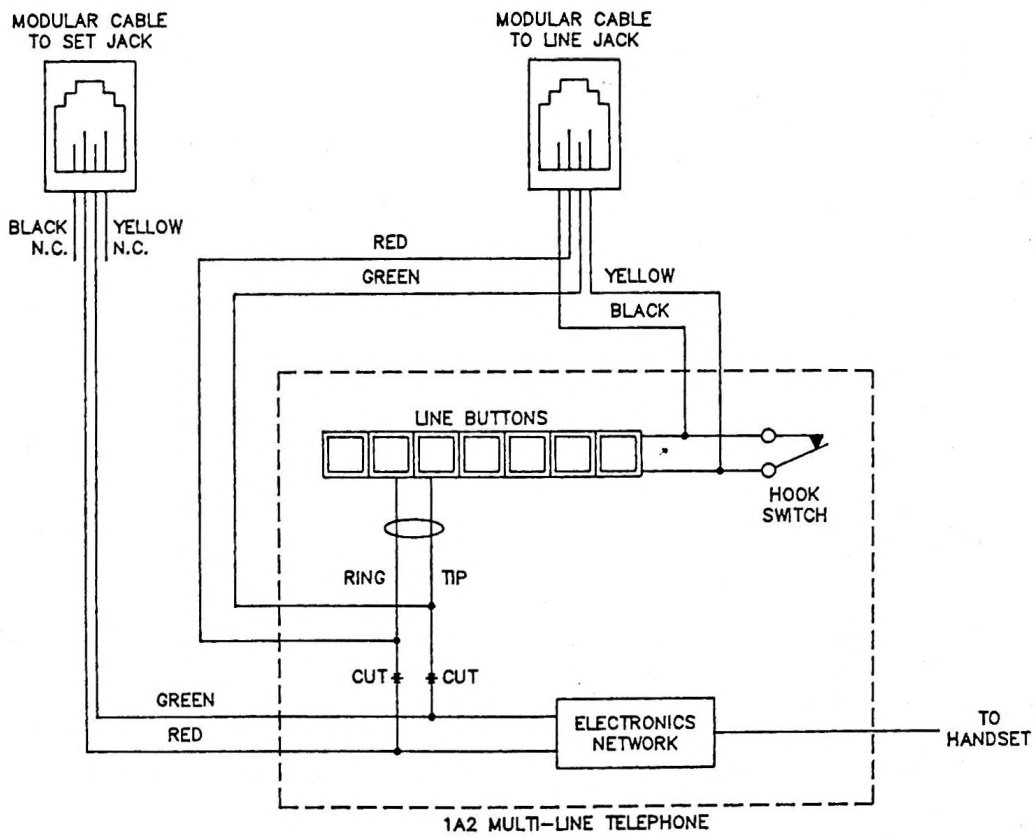
Refer to Figure 6 on the next page. The buttons on the existing multi-line set will provide the necessary line selection function for the Digital Hybrid ANA. Remove the telephone's cover and locate the common tip and ring connections that go from the line selector button array to the telephone electronics network. Sever this connection, as shown in the diagram.

Connect the tip and ring wires coming from the line selector button array to the red and green conductors of a modular cable. The yellow and black conductors provide the A-lead closure and should be connected to the common A-lead at the telephone hook switch. This modular cable can now be connected to the LINE jack on the Digital Hybrid ANA.

The red and green conductors of a second modular cable should be connected to the severed tip and ring of the telephone electronics network as indicated in Figure 6. The yellow and black conductors of this cable should be left unconnected. This second cable should be connected to the SET jack on the Digital Hybrid ANA.

This installation will allow the multi-line instrument to operate as it normally would when the Digital Hybrid ANA is OFF line. When the Digital Hybrid ANA is placed ON line, it will provide the necessary A-lead closure to light the selected line and it will automatically disconnect the telephone instrument's electronics network.

It is not possible to specify wire colors or terminal numbers for 1A2 telephone equipment in this manual due to the wide variety of telephone instruments and manufacturers of 1A2 equipment. Additional help can be obtained by contacting your telephone interconnect company or Gentner Customer Support.



CONNECTION TO A MULTI-LINE TELEPHONE SET

FIGURE 6

3.5.2 Using a Gentner Telemix IX as a Call Director

A simple method of connecting a Digital Hybrid ANA to a Telemix IX uses one modular telephone cable. Strip one end of the cable and connect spade lugs to the red and green wires. Attach these wires to the Telemix IX rear barrier strip as follows:

To use the Digital Hybrid ANA on the upper bus (lines 1 through 9), connect to barrier strip pins 1 and 2.

To replace the lower bus hybrid with the Digital Hybrid ANA, connect to barrier strip pins numbered 3 and 4.

Plug the other end of the modular cable into the Digital Hybrid ANA's LINE jack.

NOTE: Two external hybrids are required to replace the hybrids in the Telemix IX system. Any combination of hybrids may be used. The best audio quality will be achieved through the use of two Digital Hybrid ANA's.

Open the Telemix IX and locate the Mascon connector on the audio board that routes to the rear panel barrier strip. Four jumpers are located on the audio board near this connector. These jumpers route tip and ring to the internal hybrids. Removal of the plug-in jumpers will disconnect the internal hybrids and allow external control via Digital Hybrid ANA's.

In the Telemix IX system, conferencing of upper and lower bus callers is accomplished on the audio board. When the internal hybrids are defeated, the system will no longer provide bus conferencing. This must be done by cross-connecting the external hybrids. Refer to Section 5.2 for instructions on conferencing two Digital Hybrid ANA's.

Set the Digital Hybrid ANA's front panel Switch #3 (Re-nulling Enable) to the UP position. This setting will cause the Digital Hybrid ANA to mute and re-null every time a new line is selected.

Place Switch #4 (Momentary Control Enable) to the DOWN position.

Solder a jumper between pins #18 and #36 on the 37-pin female connector supplied with the Digital Hybrid ANA.

Plug the 37-pin female connector into the Digital Hybrid ANA's REMOTE connector. The combination of this jumpered connector and the front panel Switch #4 setting will force the Digital Hybrid ANA to be on line at all times. However, when the Telemix IX switches a telephone line to the hybrid, the unit will automatically null and unmute in the normal fashion.

When this configuration is used, a slight 'pop' will be heard in the audio when a line is placed on hold or disconnected.

3.5.3 Using a Gentner Telemix X as a Call Director

Connection of the Digital Hybrid ANA to a Telemix X is very easy. If the Digital Hybrid ANA's were ordered in conjunction with Telemix X, all necessary interconnect cables should have been provided with the system. These cables are:

a) Two (2) Digital Hybrid ANA interface cables

and

b) One (1) Universal Call Director cable.

Installation is very simple and is explained in the Telemix X manual.

Simply connect the 25-pin connector on the Universal Call Director cable to its mating connector marked HYBRID on the rear panel of the Telemix X Call Director. Connect the small Molex connector marked HYBRID 1 on the Universal Call Director cable to the Molex connector on one end of a Digital Hybrid ANA Interface cable. Plug the 37-pin connector on the opposite end of the interface cable onto the REMOTE connector of the Digital Hybrid ANA. Connect the second hybrid in a similar manner, using the small Molex connector marked HYBRID 2.

3.6 Connecting the Digital Hybrid ANA to an Electronic Key Service Telephone Set

Many broadcast facilities and offices employ new state-of-the-art telephone equipment that uses microprocessor controlled key service units. Even though many of these systems are referred to as digital, the actual audio to the multi-line telephone instrument is carried on an analog balanced pair. Such systems can be interfaced to the Digital Hybrid ANA.

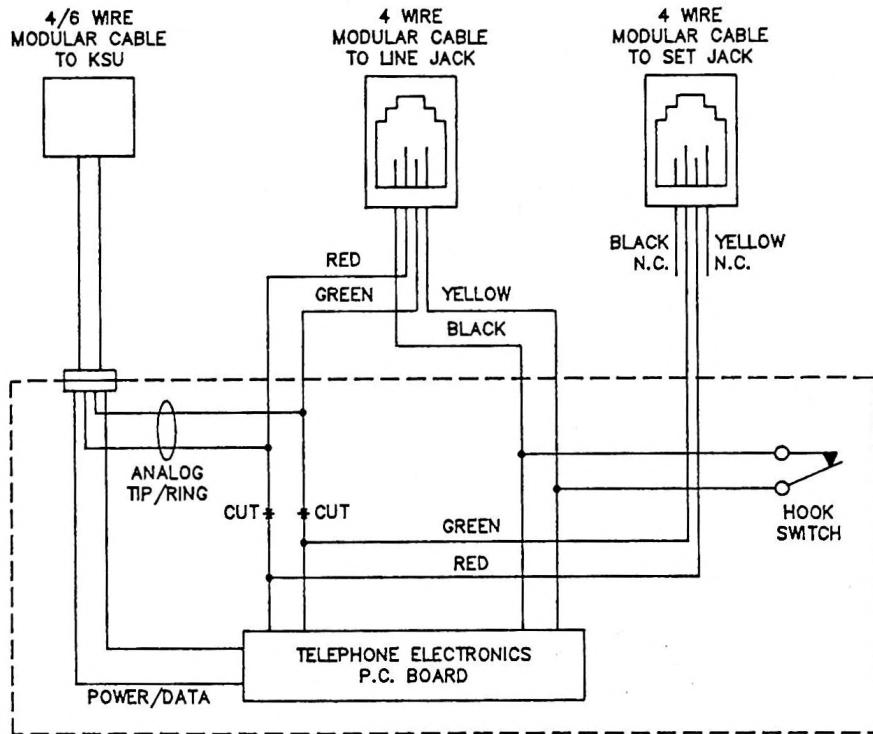
Because of the number of different manufacturers and variety of equipment available, this discussion can only give a general overview of how to interface the Digital Hybrid ANA to electronic key service systems.

It is recommended that you contact your interconnect company prior to interfacing a Digital Hybrid ANA to their equipment. Some manufacturers of digital telephone systems offer units (often called "jack sets" or "modem interface units" or "tip and ring equivalent jacks") that bring out the necessary connections for interface to the Digital Hybrid ANA.

Asking for a "line that a FAX machine can be connected to" or "a line that a telephone answering machine can be connected to" will usually solve any problems in getting the right connections for a Digital Hybrid ANA from an electronic key service system.

Refer to Figure 7 on the next page while reading the next few paragraphs.

Most digital telephones connect to the key service unit with either a 4 or 6 wire modular connection cable. Unplug this cable from the telephone and carefully remove the set's cover. Locate the wires coming from the KSU connector. Two of these wires will contain the analog pair described above. The remaining wires are used for telephone power, intercom and microprocessor communications. In most digital telephones, this analog pair is found in the red and green wires. This can be verified by connecting a pair of high impedance headphones through 10 uF capacitors across the suspected analog pair. The telephone instrument can then be connected to the KSU and a line selected. If dial tone is heard in the headphones, the analog pair has been located. Sever this pair between the jack and the electronics of the telephone as indicated in Figure 7.



CONNECTION TO DIGITAL TELEPHONES

FIGURE 7

Prepare two telephone cables with modular connectors on one end of each. Make sure the cables have sufficient length to reach from the normal location of the telephone to the location of the Digital Hybrid ANA. Connect the red and green wires of one of these cables to the analog pair coming from the KSU jack. Connect the yellow and black wires of this cable in parallel with the hook switch contacts of the digital telephone. This cable connects to the LINE jack on the Digital Hybrid ANA.

Connect the red and green wires of the second modular cable to the analog pair going to the electronics of the telephone set. The yellow and black cables of this wire are left unconnected. This cable connects to the SET jack of the Digital Hybrid ANA. The telephone instrument can now be re-assembled and reconnected to the KSU.

The configuration just described allows the digital telephone to be used normally when the Digital Hybrid ANA is OFF line.

When the Digital Hybrid ANA is ON line, the analog path to the telephone electronics is automatically disconnected and the hook switch connection is closed, allowing line selection to be made on the telephone without having to lift the handset.

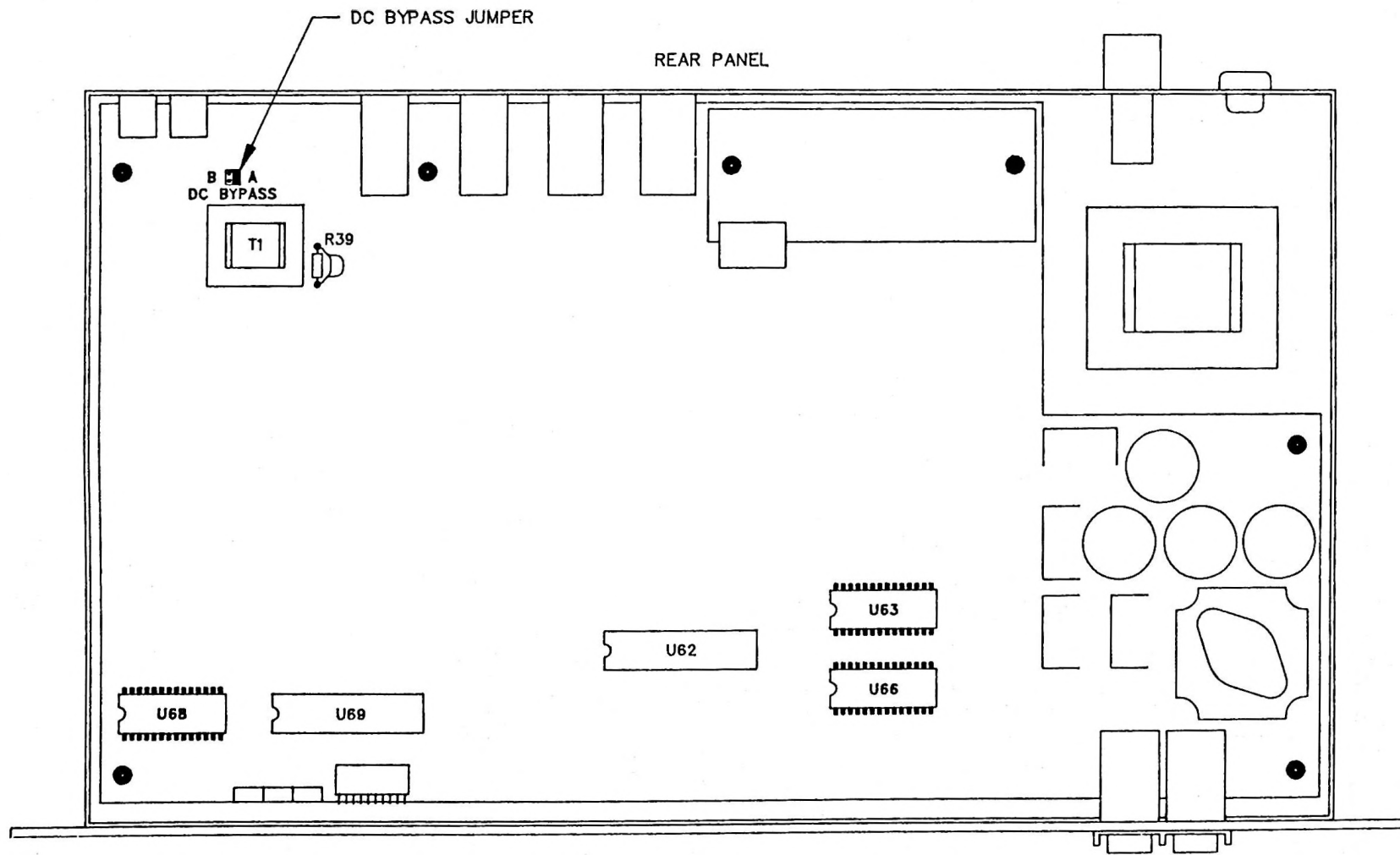
When installing the Digital Hybrid ANA on some digital telephone systems, it may be necessary to change an internal jumper. This jumper bypasses the line sensing circuitry of the Digital Hybrid ANA and allows non-DC biased audio to flow. Without the jumper in place, the rectifiers would block the pure AC audio signal. See JMP 2 in the telephone interface area of schematic drawing # 710-009-001. Follow the instructions below to change this jumper:

- a) DISCONNECT THE DIGITAL HYBRID ANA FROM AC POWER.
- b) Remove the top cover of the Digital Hybrid ANA by loosening the four retaining screws and lifting the cover straight up.
- c) Locate the modular telephone jacks on the rear panel of the Digital Hybrid ANA with the help of Figure 8.
- d) Locate the jumper posts labeled DC BYPASS on the circuit board near the telephone jacks.

- e) For digital telephone lines with AC only (no DC bias), the jumper must be placed in the B position.

For normal telephone lines that have a DC bias, the jumper must be placed in the A position. The Digital Hybrid ANA is shipped from the factory with the jumper in the A position.

NOTE: If the jumper is used in the B position, front panel Switches #1, #2, and #3 must be in the down position in order for the Digital Hybrid ANA to operate properly.



FRONT PANEL
TOP VIEW WITH COVER REMOVED

DC BYPASS JUMPER LOCATION

FIGURE 8

Other methods of interfacing to multi-line telephones are possible. Gentner Electronics Corporation has considerable experience in interfacing our wide line of hybrid products to digital telephone systems. Contact Gentner Customer Support if you need further assistance.

3.7 Connecting the Digital Hybrid ANA to Audio Equipment

The basic function of the Digital Hybrid ANA is to separate audio being sent to the caller (SEND audio) from audio being received from the phone line (CALLER audio).

Figure 9 in this section illustrates this basic function.

The Digital Hybrid ANA has been designed so that interface to audio equipment is adaptable to most user applications.

Figure 10 in this section illustrates the four audio connections of the Digital Hybrid ANA which include main SEND, AUXiliary SEND, CALLER out and MIX out.

All four audio connections are made with XLR's. The AUXiliary SEND (labeled AUX SEND on the Digital Hybrid ANA) provides a balanced, bridging line level send input to the device.

The main Send (labeled SEND) is balanced, bridging and may either be Mic or line level depending on the position of the switch located near the connector.

The Send inputs must contain the audio to be sent to the caller.

CAUTION: This audio should not contain any of the caller's audio as this can create feedback and a hollow sound on the talent's audio.

The MIX out provides a balanced, line level sum of the main SEND and CALLER out audio. It should be noted that the AUXiliary SEND audio does not appear at this output.

The CALLER out is caller audio only. It is a balanced line level output.

All four connections are made via XLR cables to your equipment. If a mixing console will be used to feed the main SEND input of the Digital Hybrid ANA, the audio going down the line must not contain any caller audio. There are several ways to accomplish this:

- a) Creation of a separate mix channel: If the console has an extra mixing output channel, use this channel to mix all audio you want to send to

the Digital Hybrid ANA, EXCEPT the channel that will be connected to Caller audio.

b) Internal mix-minus bus: Many console manufacturers now provide an internal mix-minus bus designed for this purpose. Mix-minus refers to a sum of the audio sources in the console MINUS caller audio.

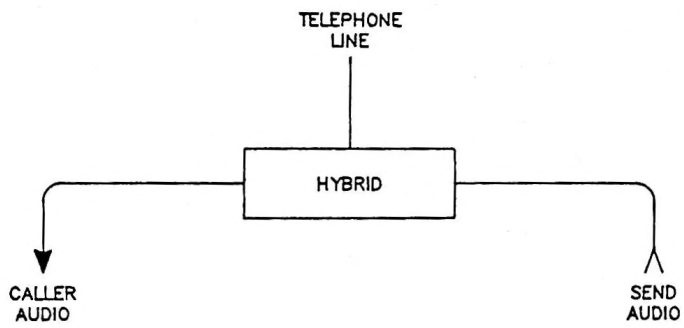
c) "Build your own" mix-minus: It is possible to build your own mix-minus bus by resistively summing all audio sources to be sent down the phone line. Be careful to provide isolation between channels. Contact Gentner Customer Support if you need assistance.

d) Discrete Mic mixer: If only microphone audio will be sent down the line, a separate Mic mixer may be utilized. This audio can then be sent to the send input of the Digital Hybrid ANA as well as the input of the console.

e) One Channel Send. If a single source of audio will be sent to the caller (such as a microphone), simply use this audio. The SEND XLR can be selected for either Mic or line level via the adjacent switch.

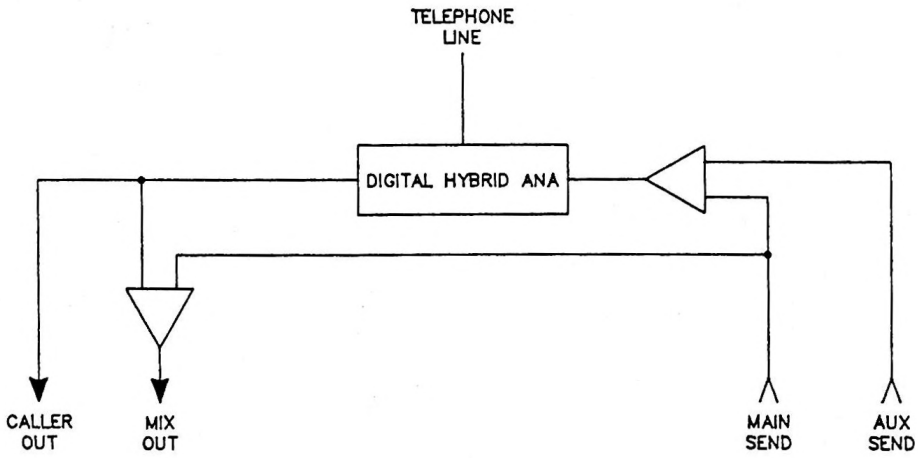
The CALLER output XLR must be connected to a separate channel of an audio console or the input of an audio amplifier. This will allow monitoring of caller audio.

The MIX XLR contains a sum of both send and caller audio. This audio combination is useful for recording both sides of telephone conversations.



FUNCTION OF A TELEPHONE HYBRID

FIGURE 9



DIGITAL HYBRID ANA AUDIO CONNECTIONS

FIGURE 10

3.8 The REMOTE Connector

The REMOTE connector is a 37-pin D-type connector located on the rear panel of the Digital Hybrid ANA. Remote control functions and all rear panel connections appear on the REMOTE connector to allow for a single cable interconnection between the Digital Hybrid ANA and user equipment.

When looking at the rear panel of the Digital Hybrid ANA, Pins #1 through #19 appear left to right on the top row of pins. Pins #20 through #37 appear left to right on the bottom row of pins.

Functions are remoted on this connector as follows:

#1 SET Tip
#20 SET Ring

These connections are used for route-through of the telephone line. They are in parallel with the RJ-11C SET connector on the rear panel of the Digital Hybrid ANA.

#2 LINE Tip
#21 LINE Ring

These pins provide connection to the actual telephone line. They are in parallel with the RJ-11C LINE connector on the rear panel of the Digital Hybrid ANA.

#3 A1
#22 A-Common

These pins provide the A-lead closure for 1A2 and other key service units. They are in parallel with the A lines of the RJ-11C LINE connector on the rear panel of the Digital Hybrid ANA.

#4, #5, #23 Ground

This ground has the same potential as the chassis.

#6 MIX Out +
#24 MIX Out -

This is balanced MIX audio output and is the same audio that appears at the MIX XLR on the rear panel.

#7 CALLER Out +
#25 CALLER Out -

This is balanced CALLER audio output and provides the same audio that appears at the CALLER XLR connector.

#8, #26 Analog Ground

These are ground returns for balanced audio connections.

#9 AUX SEND +
#27 AUX SEND -

This is a balanced AUXiliary SEND audio input. These pins are in parallel with the rear panel AUX SEND XLR connector.

#10 SEND +
#28 SEND -

This is a balanced SEND audio input and is in parallel with the rear panel SEND XLR connector.

#11 Port Conference +
#29 Port Conference -

Application of a DC voltage in the range of 4 to 25 VDC to these pins, in the polarity indicated, will force the Digital Hybrid ANA into its Port Conferencing mode.

When using these pins to control the Port Conference function, front panel DIP switch #8 (Port Conference Disable) must be in the UP position.

#12 Caller Control
#30 Caller Control Return

These connections provide the ability to remote the front panel Caller Control trim-pot.

When an external potentiometer (1K linear taper) is connected across these pins, the front panel Caller Control trim-pot is automatically disabled, and the Caller Control function is controlled by the external potentiometer.

A 1K linear taper pot should be wired so that at full counterclockwise rotation, 0 ohms is placed across these two connections.

When installed as noted above, full counterclockwise rotation will correspond to 0 dB of caller dimming, mid-scale rotation will correspond to approximately 20 dB of caller dimming, and full clockwise rotation will correspond to 40 dB of caller dimming.

#13 SEND Indicator Negative
#31 +5V through 180 Ohms

These pins are used to remote the SEND indicator LED. Pin #13 provides an open collector output capable of sinking 100 mA. If a single remote LED is to be used, connect the cathode to Pin #13. Pin #31 provides a convenient +5V source with a 180 ohm limiting resistor, allowing the LED to operate at approximately 20mA. Tie the LED's anode to Pin #31.

#14 CALLER Indicator Negative
#32 +5V through 180 Ohms

These pins are used to remote the CALLER indicator LED. Pin #14 provides an open collector output capable of sinking 100 mA. Operation is similar to the SEND indicator described above.

#15 ON Indicator Negative
#33 +5V through 180 Ohms

These pins are used to remote the ON indicator LED. Pin #15 is an open collector device which will sink up to 100 mA of current to drive a remote LED. Operation is similar to the SEND indicator described above.

#16 OFF Indicator Negative
#34 +5V through 180 ohms

These pins are used to remote the OFF indicator LED. Pin #16 is an open collector device which will sink up to 100 mA to drive a remote LED. Operation is similar to the SEND indicator described above.

#17 Mute Switch
#35 Switch Common

Connecting these two pins together will cause the Digital Hybrid ANA's Caller amplifier to be muted. The logic for this function is optically isolated from the remote pins to provide protection of Digital Hybrid ANA circuitry from possible damage caused by improper voltages.

NOTE: A special version of firmware is available which provides for muting of Send audio rather than Caller audio. This firmware may be of interest to teleconference users to allow private discussion during a teleconference session. Contact Gentner Customer Support for further information.

#19 OFF Switch
#37 Switch Common

A momentary closure across these two pins will cause the Digital Hybrid ANA to go off-line (hang up).

Additional information on remote control functions is given in Section 4.7 of this manual.

3.9 The XLR Audio Connectors

MIX XLR: This is a 600 ohm balanced output fixed at 0 dBm. Audio available at this connector is the sum of the audio input at the SEND XLR and the CALLER audio. This connector does not contain AUX SEND audio.

Pin 1 = Analog ground
Pin 2 = Mix out -
Pin 3 = Mix out +

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CALLER XLR: This is a 600 ohm balanced output adjustable via the front-panel CALLER LEVEL trim-pot. Nominal output level is 0 dBm, with a clipping threshold of 20 dBm. Audio at this connector contains CALLER (receive) audio.

Pin 1 = Analog ground
Pin 2 = Caller out -
Pin 3 = Caller out +

AUX SEND XLR: This is a balanced, bridging input to the Digital Hybrid ANA. Nominal input level is fixed at 0 dBm. Line level audio applied to this input will be sent to the caller. This audio does not appear at the MIX output.

Pin 1 = Analog ground
Pin 2 = Aux send -
Pin 3 = Aux send +

MIXE INPUS

SEND XLR: This input is a balanced, bridging input. It is the main SEND input to the Digital Hybrid ANA. This input will accept either MIC or LINE level inputs as selected by the adjacent switch. Audio applied to this input will be sent to the caller, and also appear at the MIX output. The SEND level can be adjusted via the front panel SEND LEVEL trim pot.

Pin 1 = Analog ground
Pin 2 = Send -
Pin 3 = Send +

3.10 The Telephone Connectors

LINE Connector:

This modular RJ-11C connector allows direct connection to the telephone line or an associated call director.

Pin designations are, right to left:

Pin 1 = Not Used
Pin 2 = A1
Pin 3 = Tip
Pin 4 = Ring
Pin 5 = A Common
Pin 6 = Not Used

SET Connector:

This modular RJ-11C connector provides connection for a local single line telephone instrument.

When the Digital Hybrid ANA is in the OFF mode, the telephone line is routed to this jack. When the hybrid is in the ON mode, this jack is disabled.

Pin designations are, right to left:

Pin 1 = Not Used
Pin 2 = A Common
Pin 3 = Ring
Pin 4 = Tip
Pin 5 = A1
Pin 6 = Not Used

SECTION FOUR -- OPERATION

4.1 Overview

After the Digital Hybrid ANA has been installed (see Section Three for installation information), the controls behind the removable front panel must be adjusted. These controls consist of three trim-pots and ten switches. See Figure 11.

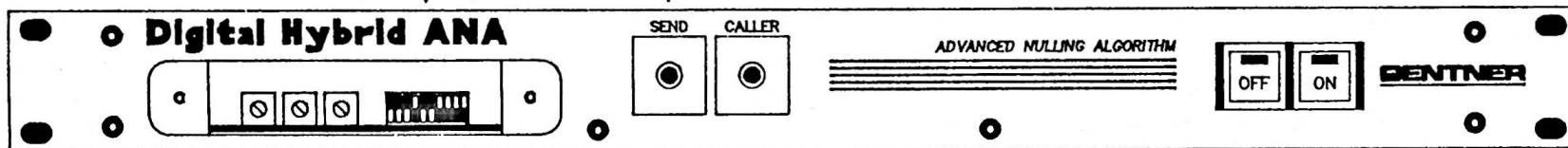
Remove the front access panel. Note that the reverse side of the access panel identifies the three trim pots and the functions of eight user option switches.

**FRONT PANEL DIP SWITCH ASSIGNMENTS
(NUMBERED LEFT TO RIGHT)**

1. AUTO-ANSWER ENABLE
2. AUTO-DISCONNECT ENABLE
3. RE-NULLING ENABLE
4. MOMENTARY CONTROL ENABLE
5. SEND AGC ENABLE
6. CALLER AGC ENABLE
7. ENHANCED NULLING MODE ENABLE
8. PORT CONFERENCE DISABLE
9. SPARE
10. SPARE

IF 'OFF' BUTTON IS PUSHED,
RED/GREEN LED INDICATES
PROPER SEND LEVEL.
RED LED GLOWS WHEN
SEND IS TOO HIGH.

PUSHING THIS SWITCH
CAUSES UNIT TO ANSWER.
CALLER AUDIO IS MUTED FOR 3/4
SECOND AFTER ANSWER TO MASK
POPS AND CLICKS.



SEND LEVEL
WHILE PUSHING 'OFF' SWITCH
ADJUST UNTIL 'SEND' LED
GLOWS GREEN, AND OCCASIONALLY
RED ON PEAKS.

CALLER LEVEL
ADJUST LEVEL TO MATCH
INPUT LEVEL TO YOUR
AUDIO EQUIPMENT.

GREEN LED INDICATES
THE PRESENCE OF
CALLER AUDIO.

PUSHING THIS SWITCH
CAUSES UNIT TO HANG-UP
AFTER CALLER AUDIO HAS BEEN MUTED.
IF HELD, THE SEND LED WILL
GLOW RED IF SEND LEVEL
IS TOO HIGH.

CALLER CONTROL

WHEN REMOTE CALLER CONTROL
IS NOT USED, THIS CONTROL
ADJUSTS THE AMOUNT OF CALLER
REDUCTION WHEN SEND AUDIO
IS PRESENT.

DIGITAL HYBRID ANA FRONT PANEL

FIGURE 11

4.2 Adjusting the Send Level Trimmer

Locate the SEND LEVEL trimmer potentiometer. It is the left-most trim-pot seen when looking at the front panel.

To adjust the Send audio level, apply normal SEND audio while pushing the OFF switch on the Digital Hybrid ANA front panel. Keep the OFF switch pushed, and adjust the SEND LEVEL trim-pot so that the front panel SEND LED glows green most of the time and flashes red occasionally on peaks.

Following the procedure just described will allow you to quickly set up the Digital Hybrid ANA's Send audio level. It may be desirable to adjust the SEND LEVEL control from this point, depending on your particular needs.

Generally speaking, you will want to avoid Sending too much audio level down the telephone line. By Sending a minimum audio level, the hybrid leakage into the Caller (receive) output is reduced. Also, Sending a minimum audio level causes the Caller to speak louder, thereby improving the signal to noise ratio on the telephone line.

4.3 Adjusting the Caller Level Trimmer

Locate the CALLER LEVEL trimmer potentiometer. It is the right-most trim-pot as seen from the front of the Digital Hybrid ANA.

Make certain that the Digital Hybrid ANA is OFF, then initiate a telephone call using a telephone connected to the SET jack on the Digital Hybrid ANA. Press the Digital Hybrid ANA's ON button. While the party on the other end of the call is speaking, adjust the CALLER LEVEL trim-pot for the proper output level to your audio equipment.

4.4 Adjusting the Caller Control Trimmer

Locate the CALLER CONTROL trimmer potentiometer. It is the middle trim-pot.

The CALLER CONTROL feature of the Digital Hybrid ANA automatically reduces (dims) the level of the Caller audio when Send audio is present (when the Talent is talking).

The purpose of this control is to allow the talent to dominate the conversation simply by speaking normally.

The amount of this caller dimming is determined by the Caller Control trim-pot.

With the CALLER CONTROL trim-pot fully counterclockwise, there is no caller control action (0 dB of caller dimming).

With the CALLER CONTROL trim-pot fully clockwise, approximately 40 dB of caller dimming will occur whenever the talent is speaking (Send audio is present).

The CALLER CONTROL trim-pot will provide approximately 20 dB of caller dimming when it is at mid-rotation.

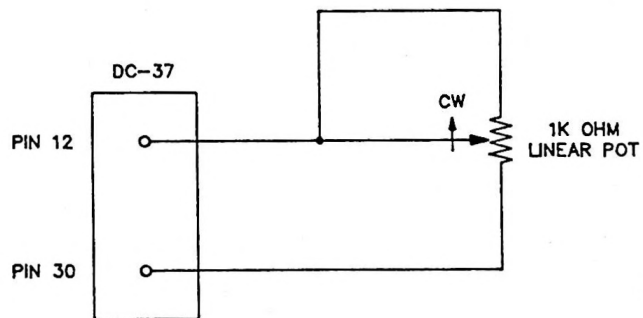
The trimmer may be set for any amount of caller dimming desired within the 0 dB to 40 dB range.

For most broadcast applications, we have found that 8 dB of caller dimming allows the talent to always be on top of a telephone conversation. The 8 dB setting allows the caller to still be heard clearly in a double-talk situation.

One additional advantage of using the CALLER CONTROL to dim caller audio is that the hybrid return product is reduced 8 dB when the announcer speaks, further enhancing the superb null performance of the Digital Hybrid ANA.

To remotely adjust the CALLER CONTROL, connect a 1K ohm linear taper pot between Pin #12 and Pin #30 as shown in Figure 12. Connect the remote potentiometer so that 0 ohms appear across Pins #12 and #30 when the pot is in the full counterclockwise position.

When a remote CALLER CONTROL potentiometer is connected, the front panel CALLER CONTROL trim-pot is electronically disabled by the Digital Hybrid ANA.



REMOTE CALLER CONTROL POT CONNECTION

FIGURE 12

4.5 Setting the DIP Switches

There are ten switches contained in a single DIP package located behind the removeable front panel of the Digital Hybrid ANA. These switches are numbered 1 through 10, left to right, as viewed from the front of the unit.

Switch #1: Auto-Answer Enable

With this switch in the UP position, the Digital Hybrid ANA will automatically answer a telephone after one complete ring.

After the unit answers, it automatically goes through the same nulling procedure as if the front panel ON switch had been pushed.

Switch #2: Auto-Disconnect Enable

If this switch is in the UP position, the unit will automatically disconnect from the telephone line when telephone line loop current is either removed or reversed.

Most central offices provide a loop drop or loop reversal as an indication that the calling party has hung up. When loop current is dropped, the Digital Hybrid ANA immediately mutes Caller audio to prevent the "pop" of the loop current interruption from reaching the audio equipment.

Switch #2 is ignored (auto-disconnect is disabled) if Switch #3 is in the UP position. See explanation of Switch #3's operation.

Switch #3: Re-null and Mute Enable

When this switch in the UP position, the Digital Hybrid ANA will automatically go through the nulling/muting process when telephone loop current is dropped and then re-established.

When the line is dropped (loop current goes away), the Digital Hybrid ANA will mute the Caller (receive) audio. When the line returns (loop current returns), it will re-null and unmute the Caller audio.

This allows the unit to be used with very simple call directors such as a multi-line 1A2 telephone

instrument. The Digital Hybrid ANA will automatically provide the muting function necessary for a smooth, "pop-less" transition from line to line.

When Switch #3 is in the UP position, the operation of Switch #2 (Auto Disconnect) is disabled.

Switch #4: Momentary Control Enable

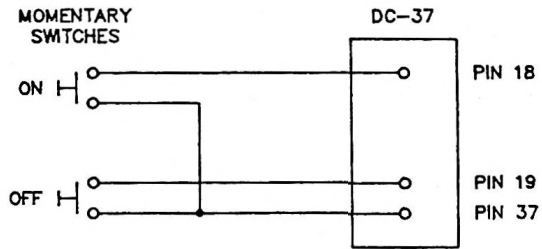
This switch is normally used in the UP position so that the Digital Hybrid ANA can be placed on-line and off-line using the front panel ON/OFF momentary switches.

The ON/OFF switches are also remoted on the 37-pin REMOTE connector on the rear panel of the Digital Hybrid ANA. Refer to Section 4.7 for pin-out information. The Digital Hybrid ANA may be remotely controlled using either a momentary or latching closure.

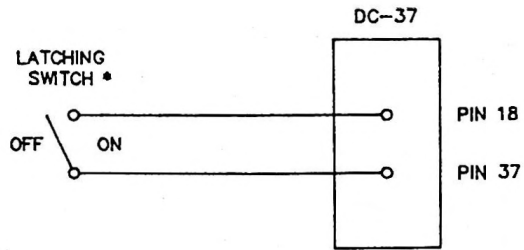
If the user's equipment provides a latching closure output, front panel Switch #4 should be placed in the DOWN position. When a closure is made to the REMOTE connector's ON pins, the Digital Hybrid ANA will go through its normal routine of nulling and then unmute the Caller audio output. When the closure is re-opened, the hybrid will mute and return to the off-line state. Note that this means a single switch (rather than two switches) can be used to control the Digital Hybrid ANA if desired.

NOTE: There is no need to use a latching OFF switch if a latching ON switch is used. Do not connect a latching OFF switch to the Digital Hybrid ANA's remote connector since this would force the unit into a continuous SEND LEVEL Test mode. See Section 4.6 for more discussion of the OFF switch.

Figure 13 on the next page shows two examples of connection for remote ON/OFF control.



OR



* FRONT PANEL DIP SWITCHES #3 AND #4 MUST BE DOWN

REMOTE ON/OFF CONTROL

FIGURE 13

Switch #5: Send AGC Enable

When this switch is in the UP position, the Digital Hybrid ANA's send processor (AGC) will be operational. The processor can be used to guarantee that a consistent level is sent to the caller.

When Switch #5 is in the DOWN position, the Send amplifier will provide unity gain. However, a limiter circuit in the Send amplifier will ensure that the Send audio level never exceeds -12 dBm on the telephone line, keeping the unit well within FCC part 68 specifications.

Switch #6: Caller AGC Enable

With this switch in the UP position, the Digital Hybrid ANA's Caller (receive) processor (AGC) will be operational. The processor can be used to guarantee consistent Caller audio levels from line to line.

When Switch #6 is in the DOWN position, the receive amplifier is forced to unity gain.

NOTE: The SEND AGC and CALLER AGC processors controlled by front panel Switches #5 & #6 may cause a perceived decrease in hybrid performance under some conditions.

These processors typically add more gain to the SEND and CALLER (receive) signals. Every dB of gain on these signals will increase the hybrid leakage by an equal amount. For example, if the SEND audio level increases by 1 dB, then 1 dB more of SEND audio will leak through to the CALLER audio output.

Many broadcasters prefer to leave the SEND AGC and CALLER AGC disabled. This gives a more natural on-air sound and provides a perceived improvement of the hybrid performance.

Switch #7: Enhanced Nulling Mode Enable

With this switch in the UP position, the Enhanced ANA nulling mode of operation is Enabled.

This function can be likened to a "Turbo" switch on a personal computer because it substantially enhances the

perceived performance of the hybrid under most conditions. It is recommended that the Digital Hybrid ANA be operated with the Enhanced Nulling Mode Switch in the UP position for most applications.

If this switch is in the DOWN position, the Normal ANA nulling operation is active.

When the Enhanced ANA nulling is enabled, additional absolute nulling can be obtained.

The choice of which mode to use will be a matter of personal preference. Use of the Enhanced ANA mode may cause the received telephone line noise level to increase and decrease more noticeably than the Normal ANA mode.

A summary of the Enhanced ANA nulling operation is given below:

IF

a) Enhanced ANA mode is enabled,

AND

b) Send audio is present (talent is speaking),

AND

c) No Caller audio is present (caller listening to talent),

THEN

The Digital Hybrid ANA will reduce the Caller (receive) level an additional amount to achieve a deeper absolute null.

As soon as the Caller begins talking, an extremely sensitive level detection function will cause Caller audio to be instantly brought back to its normal level.

Therefore, the Caller audio determines the instantaneous amount of extra null achieved when this option is enabled.

Note that this is NOT the same function that Caller Control performs. The Caller Control function is controlled by the Send (talent) audio, as opposed to the Enhanced ANA nulling which is controlled by the Caller (receive) audio.

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Switch #8: Port Conference Disable

With this switch in the DOWN position, the Port Conferencing function of the Digital Hybrid ANA is enabled. Port Conferencing forces the Digital Hybrid ANA into a half-duplex mode. When the Caller speaks, Send audio is electronically switched off.

This function can be very useful in teleconferencing to eliminate conference room acoustic echo from being sent back to the caller.

In broadcast uses, Switch #8 would normally be set in the UP, or disabled, position.

Switch #9 and Switch #10: Spares

These switches are not used by the Digital Hybrid ANA.

4.6 Front Panel Controls and Indicators

In addition to the trim-pots and DIP switches behind the access panel, the front panel of the Digital Hybrid ANA contains the following controls and indicators from right to left:

ON Switch
ON LED

OFF Switch
OFF LED

CALLER LED

SEND LED

ON Switch: When the ON button is pushed, the Digital Hybrid ANA closes its line relay, connecting the hybrid circuitry to the telephone line. At this time, the green LED in the ON switch will illuminate, indicating an on-line status. The hybrid mutes caller audio, waits for the telephone loop current to become stable, and then applies a 300 millisecond burst of white noise to the telephone line. This noise is used by the Digital Signal Processor (DSP) to adjust its filter coefficients to maximize the hybrid null.

100 milliseconds after the white noise has been removed, the hybrid removes the mute from the caller amplifier, allowing telephone line audio to appear at the CALLER XLR connector on the rear panel.

If the ON button is pushed again during the course of a call, the DSP is re-initialized and the nulling/muting process repeats itself without dropping the current caller.

OFF Switch: When the OFF button is pushed, the Digital Hybrid ANA disconnects from the telephone line and illuminates the red LED in the OFF switch.

If the OFF button is pushed and held, the hybrid will go into a SEND-LEVEL setup mode. In this mode, the SEND LED will indicate the magnitude of the Send audio. The SEND LED is a bi-color (red/green) LED, with green indicating a Send level within the adjustment range of the SEND AGC and the telephone line limiter. The red

condition indicates peaks 10 dB above the nominal Send level.

To adjust for proper SEND level, apply program audio to the SEND input of the Digital Hybrid ANA. Push and hold the OFF switch. While pushing the OFF switch, adjust the front panel SEND LEVEL trim-pot so that the SEND LED glows green most of the time, and so that it glow red on occasional audio peaks.

SEND LED: When the Digital Hybrid ANA is on-line, the SEND LED will glow green when it senses that Send audio is present.

When the Digital Hybrid ANA is off-line, the SEND LED can be used to indicate proper level for Send audio. See the discussion for the OFF switch given above for instructions on using the SEND LED as a Send level indicator.

CALLER LED: This LED will glow green when the Digital Hybrid ANA senses Caller (receive) audio from the telephone line.

4.7 Remote Control of Digital Hybrid ANA Functions

Many functions of the Digital Hybrid ANA can be controlled and monitored remotely as indicated below:

REMOTE FUNCTIONS

ON Switch
OFF Switch
Caller Muting
Port Conference Enable
Caller Dimming Control

REMOTE MONITORING

ON Indicator
OFF Indicator
SEND Indicator
CALLER Indicator

The ON and OFF functions of the Digital Hybrid ANA may be remoted using separate momentary ON and OFF switches or by a single toggle switch. If momentary switches are used, front panel Switch #4 must be in the UP position; if a toggle switch is used, front panel Switch #4 must be DOWN. Figure 14 illustrates both methods of remote control.

A remote Mute switch (to mute Caller (receive) audio output) can be connected across the 37-pin REMOTE connector Pins #17 and #35. This will provide a control function which has no corresponding front panel control.

NOTE: A special version of firmware is available which provides for muting of Send audio rather than Caller audio. This firmware may be of interest to teleconference users to allow private discussion during a teleconference session. Contact Gentner Customer Support for further information.

The Digital Hybrid ANA can be remotely placed in the Port Conferencing mode by applying a voltage in the range of 4 VDC to 25 VDC between Pins #11 and #29 of the 37-pin connector. Negative must go to Pin #29 and positive must go to Pin #11. When using this function, front panel Switch #8 should be in the UP position.

To remotely adjust the Caller Control, connect a 1K ohm linear taper pot to Pins #12 and #30 as shown in Figure 15. When a remote Caller Control potentiometer is connected, the front panel Caller Control trim-pot is ignored by the Digital Hybrid ANA.

The four front panel LED indicators can also be remoted. Figure 16-A shows the typical remoting of the ON LED. Pin #15 of the 37-pin REMOTE connector connects to an open-collector output which provides a path to switch common (ground) when activated. Pin #33 provides +5V through a 180 ohm resistor for current limiting.

Figure 16-B shows how an incandescent lamp could be used as the remote ON indicator. An external DC power supply that provides the lamp voltage is required. Care must be taken to reference the external power supply to ground as indicated via Pin #35, and the DC voltage must be limited to a MAXIMUM of 40 VDC.

An external relay could be driven from any of the four remote indicator outputs (ON, OFF, Send, Caller) for various applications, e.g. activation of a digital delay. A sample configuration for a relay connection is shown in

Figure 16-C. An external power supply capable of providing the relay's coil voltage is required. Care must be taken to reference the external power supply to ground as indicated via Pin #35, and the DC voltage must be limited to a MAXIMUM of 40 VDC.

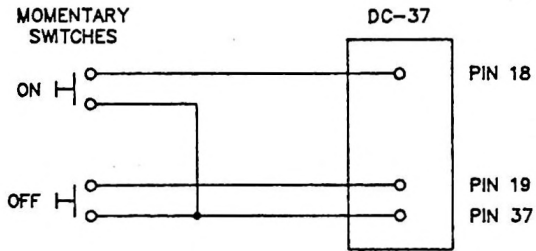
Each of the four indicator outputs is capable of sinking 100mA with a maximum external supply voltage of 40V.

The 37-pin REMOTE connector on the rear panel of the Digital Hybrid ANA also contains paralleled connections to each of the four XLR's and two RJ-11C telephone jacks of the hybrid.

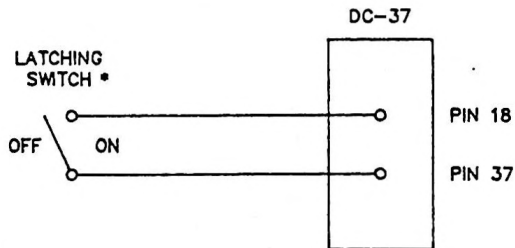
A summary of the 37-pin REMOTE connector pin-out is shown below:

1 SET Tip	20 SET Ring
2 LINE Tip	21 LINE Ring
3 A1	22 A Common
4 Protective ground	23 Protective ground
5 Protective ground	24 Balanced Mix Out -
6 Balanced Mix Out +	25 Balanced Caller Out-
7 Balanced Caller Out +	26 Analog ground
8 Analog ground	27 Balanced Aux Send -
9 Balanced Aux Send +	28 Balanced Send In -
10 Balanced Send In +	29 Port Conference -
11 Port Conference +	30 Caller Control Return
12 Caller Control Pot	31 +5V / 180 Ohm
13 Send Indicator	32 +5V / 180 Ohm
14 Caller Indicator	33 +5V / 180 Ohm
15 ON Indicator	34 +5V / 180 Ohm
16 OFF Indicator	35 Switch Common
17 Mute switch	36 Switch Common
18 ON switch	37 Switch Common
19 OFF switch	

Refer to Section 3.8 of this manual for a more detailed discussion of each of the pins on the remote connector.



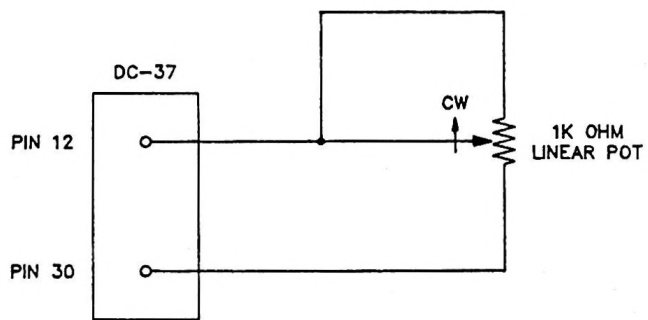
OR



• FRONT PANEL DIP SWITCHES
#3 AND #4 MUST BE DOWN

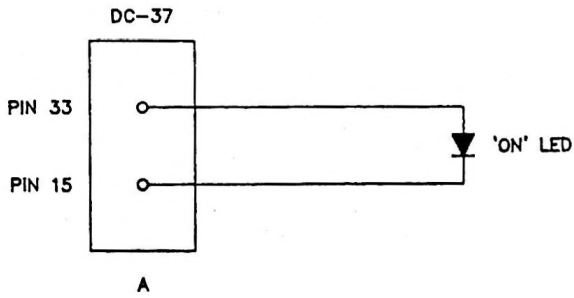
REMOTE ON/OFF CONTROL

FIGURE 14

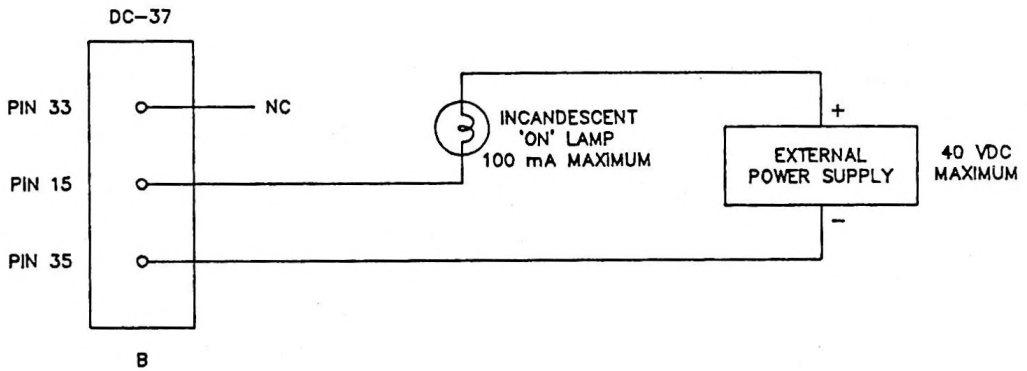


REMOTE CALLER CONTROL POT CONNECTION

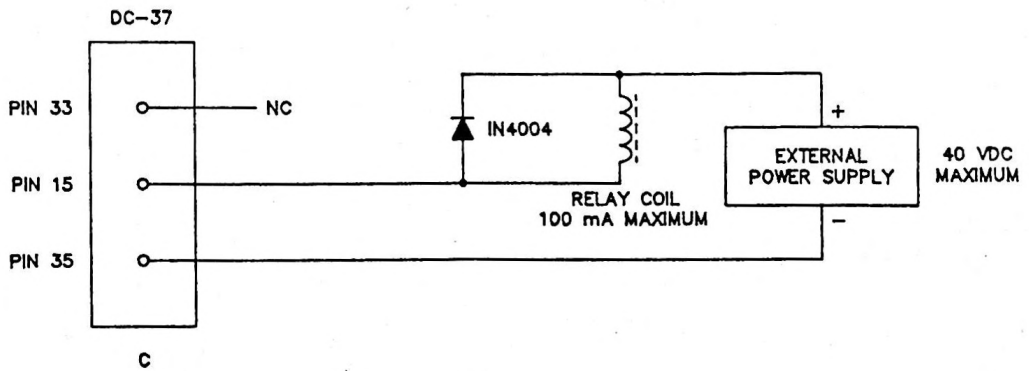
FIGURE 15



OR



OR



REMOTE 'ON' INDICATOR CONNECTIONS

FIGURE 18

SECTION FIVE -- TYPICAL APPLICATIONS

5.1 Typical Broadcast Application

Figure 17 shows how a typical broadcast station would use the Digital Hybrid ANA. A multi-line telephone is used to select a telephone line to be routed to the Digital Hybrid ANA. When the talent desires to put the call on the air, the remote ON button is pushed. The following then occurs:

- a) The selected phone line is terminated.
- b) A 300 millisecond burst of white noise is sent down the phone line.
- c) The hybrid automatically nulls to the noise burst.
- d) The output audio is unmuted and the Caller audio is routed to the input of the console.

The muting function is useful in broadcast applications because it masks the termination pops and clicks, making telephone connection clean and clear.

If the Caller AGC is activated (front panel Switch #6 is UP), the audio level to the console is maintained at a consistent level.

Audio from the mix-minus output of the console (Send audio) is routed to the caller. If the Send AGC is activated (front panel Switch #5 is UP), the level to the caller via the telephone line is kept consistent.

The unit continues to automatically null whenever there is Send audio present but stops nulling when Caller (receive) audio is present.

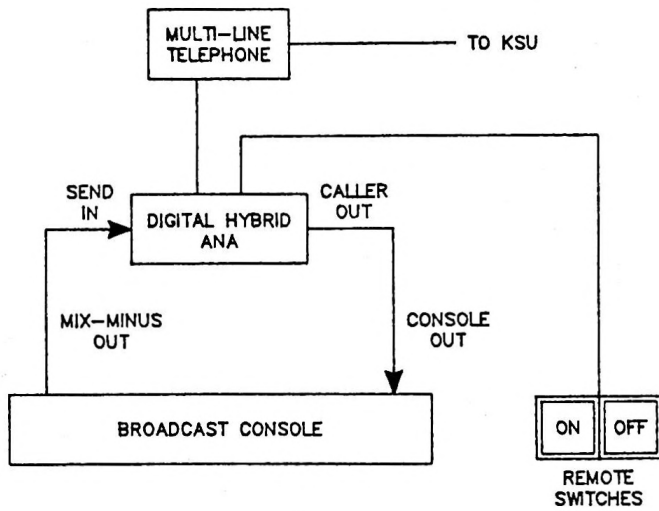
In the application illustrated by Figure 17, the Digital Hybrid ANA should be selected to renull on loop drop (front panel Switch #3 in the UP position). This will allow the talent to select another line on the multi-line telephone without pushing any buttons on the Digital Hybrid ANA. In this mode of operation, the following occurs whenever a new line is selected:

- a) The unit senses loop drop.
- b) The Caller output audio to the console is muted.
- c) The unit senses selection of the next line.

d) The nulling/unmute process is repeated.

This mode of operation provides clean connection (no "pops" or "clicks" on the air) to each selected telephone line, with maximum hybrid performance ensured.

Multiple callers may be conferenced, as described in Section 5.2 of this manual, using two or more Digital Hybrid ANA's. Each hybrid should be cross-connected to the other hybrid(s) so that the callers can hear each other.



TYPICAL BROADCAST INSTALLATION

FIGURE 17

5.2 Conferencing Multiple Digital Hybrid ANA Units

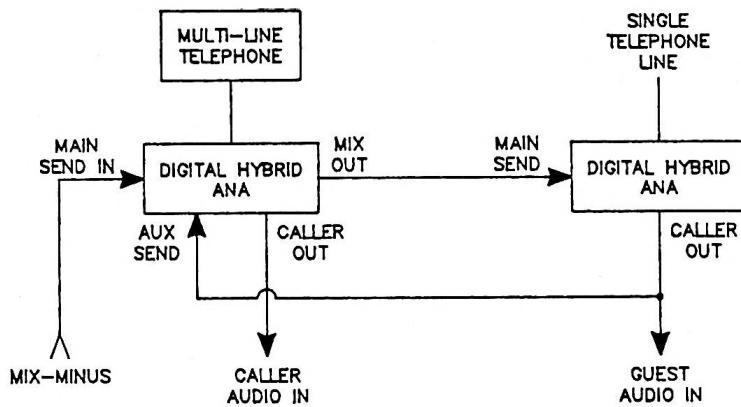
Multiple Digital Hybrid ANA units can be conferenced for the airing of multiple callers or for use as a telephone conference bridge. Figures 18, 19, and 20 show three methods of conferencing two units for different applications.

Figure 18 shows a talk show application where an out-of-studio guest is to participate via a dedicated telephone line through a hybrid. The second hybrid, connected to a multi-line telephone, is conferenced to the guest hybrid. In this configuration, both callers can hear the studio announcer and each other in a fully amplified conference. Separate Caller and guest Caller audio signals are available for application to two console channels.

Figure 19 shows two Digital Hybrid ANA's that could be connected to either a dedicated telephone line or to multi-line call directors. When connected to multi-line call directors, maximum flexibility in placing two callers in a fully amplified conference could be achieved. In this configuration, both callers would hear the studio announcer and each other. Separate Caller audio outputs are available for application to the mixing console.

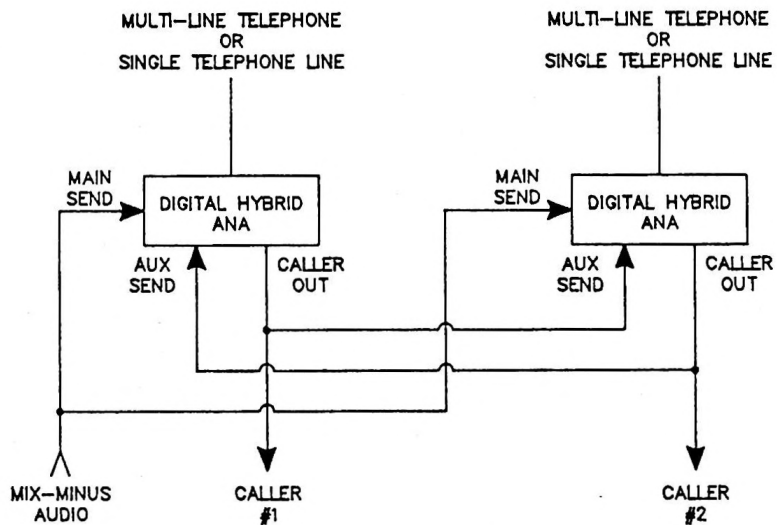
Figure 20 shows two Digital Hybrid ANA's in a conference setting where both Caller outputs are mixed together for application to one console input.

Additional units could be stacked, in a similar manner to those shown above, depending on individual applications. If a particularly large architecture or unique application is desired, please contact Gentner Customer Support.



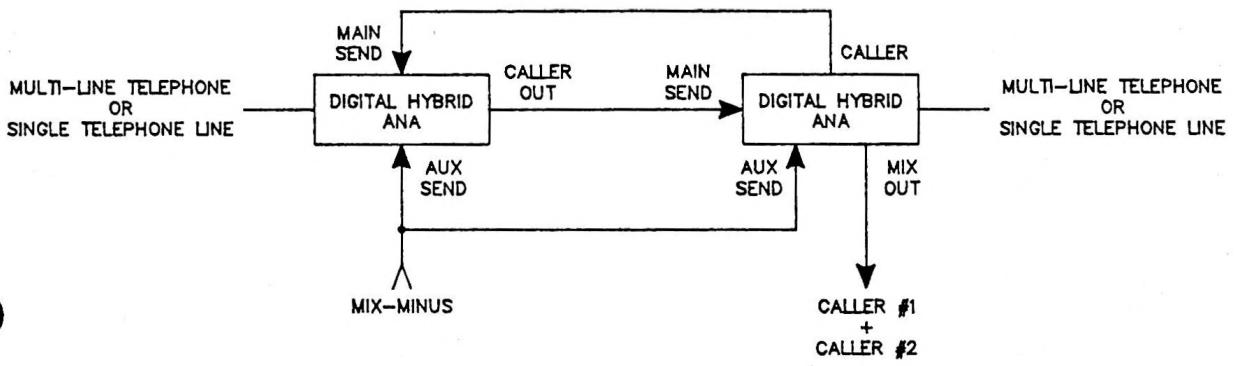
DUAL HYBRID SINGLE & MULTI-LINE CONFERENCE

FIGURE 18



DUAL HYBRIDS WITH SEPARATE AUDIO OUTPUTS

FIGURE 19



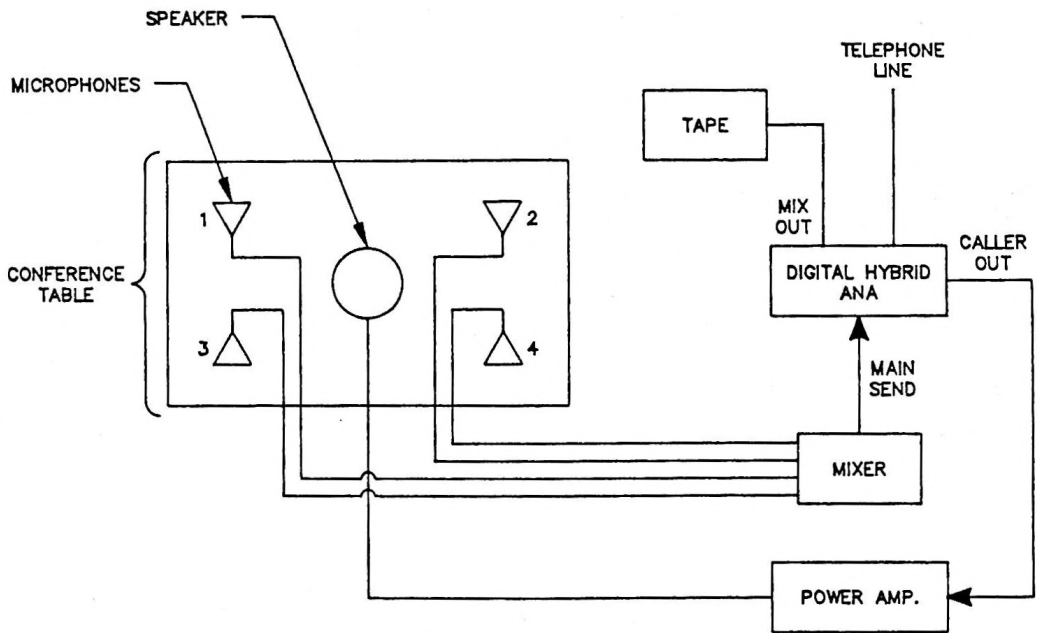
DUAL HYBRIDS WITH MIXED AUDIO OUTPUT

FIGURE 20

5.3 Typical Tele-Conferencing Application

The Digital Hybrid ANA was specifically designed for teleconferencing. Figure 21 illustrates a typical conference room setup. The major advantage of this system is that the participants can listen while talking - the speaker is not turned off as it would be on a speakerphone. This permits a more natural, two-way flow of conversation between boardrooms, without annoying cut-offs.

In this setup, four directional microphones are mixed together. The output of the mixer is sent to the SEND input of the Digital Hybrid ANA. The CALLER output of the Digital Hybrid ANA is sent to the input of a power amplifier. The power amp drives a speaker that is placed in the middle of the conference room table. The placement of the directional microphones and speakers are important to maximize acoustic isolation to avoid echo and feedback.



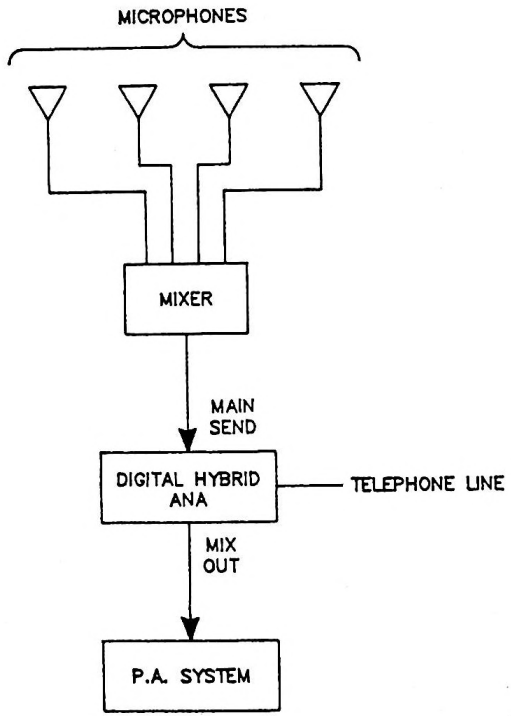
CONFERENCE ROOM SET-UP

FIGURE 21

5.4 Using the Digital Hybrid ANA in Auditoriums or Large Meeting Rooms

The Digital Hybrid ANA can be used to provide conferencing in an auditorium, church, arena or other large area. As indicated in Figure 22, the Caller is heard through loudspeakers while anyone speaking on a microphone is heard by the caller. This permits guests to speak at large meetings without requiring them to be on location.

The Digital Hybrid ANA is adaptable to many different applications. If you need further assistance, contact Gentner Customer Support.



AUDITORIUM SET-UP

FIGURE 22

SECTION SIX -- THEORY OF OPERATION

6.1 Overview

The basic theory of operation for the Digital Hybrid ANA presented in this section is divided into three general areas based on signal flow:

- a) Send Audio Circuitry
- b) Caller (Receive) Audio Circuitry
- c) Telephone Interface Circuitry

Figure 23 of this section shows a functional block diagram of the Digital Hybrid ANA. Schematic diagrams of the Digital Hybrid ANA are found in Section Eight of this manual.

Examine these illustrations while reading the discussion of circuit operation provided in this section.

6.2 Send Audio Circuit Description

Audio that is to be sent to the caller is applied at the main SEND input on the rear panel of the Digital Hybrid ANA. This input can be either microphone or line level. When the switch adjacent to this input is in the Mic position, its preamplifier circuit applies 55 dB of gain to the input level. The output of this amplifier is fed to two places, one being the front panel SEND LEVEL trimmer potentiometer, the other being the MIX output amplifier.

An additional send audio input is available at the AUX SEND connector on the rear panel of the Digital Hybrid ANA. This input feeds a unity gain balanced amplifier. Its signal is not applied to the SEND LEVEL potentiometer, but is mixed with the output of the main SEND input to be applied to the telephone send circuit. This fixed-gain AUXiliary SEND input allows easy conferencing of multiple Digital Hybrid ANA's.

After these two SEND signals are mixed together, their combined level is presented to an ANALOG SWITCH and a LEVEL SET circuit that is comprised of two analog comparators and some digital logic circuitry.

The LEVEL SET circuitry drives a red/green LED that can yield a quick indication of level into the Digital Hybrid ANA. When the momentary OFF switch of the hybrid is pushed and held, the front panel SEND indicator LED will light green when the audio level is adequate to properly gate the send AGC and the telephone line limiter's circuitry. The window of this green indication is approximately 14 dB wide. When the signal reaches +10 dBm, the LED turns red to indicate that the dynamic range of the Send circuitry is close to being compromised. There is an additional 10 dB of headroom above the point where the red LED lights.

The Digital Hybrid ANA's microcontroller controls the ANALOG SWITCH circuit. When the Digital Hybrid ANA is in the OFF mode, the ANALOG SWITCH is left open, providing no Send audio to the telephone circuit.

When the ON button is pushed, the microcontroller connects the NOISE GENERATOR to the Send circuit. A 300 millisecond burst of noise is generated to allow the Digital Signal Processor (DSP) to properly null the hybrid.

After the nulling process is completed, the microcontroller allows the ANALOG SWITCH to provide Send audio to the caller.

If the Digital Hybrid ANA is in the Port Conferencing mode (front panel Switch #8 DOWN), and Caller audio is detected, the microcontroller will use the ANALOG SWITCH to turn off Send audio to the caller.

The output of the ANALOG SWITCH is fed to the BandPass Filter. The frequency response of this filter has been carefully designed to provide the best compromise between Send audio intelligibility and hybrid nulling performance. The one dB bandwidth of this filter is 350 Hz to 2550 Hz. The 30 dB response of this filter is 190 Hz to 3100 Hz.

Audio at the output of the BandPass Filter is applied to the SEND AGC circuit. The SEND AGC circuit has been designed with a gate threshold of -26 dBm. When audio crosses this threshold, the SEND AGC will provide up to 15 dB of gain to increase the amplitude of the Send audio to a listenable level. As Send audio of a higher magnitude comes into the SEND AGC, the SEND AGC will provide up to 20 dB of gain reduction, thus attempting to keep a consistent level to the caller on the telephone line. Any time the Send audio drops below the - 26 dB threshold, the SEND AGC reverts to unity gain. Front panel Switch #5 can be used to disable the SEND AGC, causing it to revert to unity gain.

The SEND AGC contains a limiter circuit to protect the telephone line from excessive amplitude. This limiter circuit functions whether the SEND AGC is enabled or disabled. The output of the SEND AGC is applied to a LowPass Filter.

The LowPass Filter serves as an anti-aliasing filter for the process of digitizing the Send audio being sent to the DSP. Audio out of this anti-aliasing filter is applied to the input of the analog multiplexer (MUX). This audio is additionally buffered with a unity gain buffer and a 600 Ohm sourcing resistor, and applied to the SEND winding of the HYBRID TRANSFORMER.

6.3 Caller Audio Circuit Description

The telephone HYBRID TRANSFORMER has a winding on which receive (Caller) audio from the telephone will appear. The output of this winding is applied to an amplifier where 15 dB of gain is achieved. Output of this amplifier is fed to the receive BandPass Filter. The receive BandPass Filter has been designed with a 1 dB bandwidth of 250 Hz to 3000 Hz and a 30 dB bandwidth of 135 Hz to 4200 Hz.

This filter allows Caller audio to pass with excellent fidelity, while eliminating telephone line hum at both 60 and 120Hz and low frequency telephone company signaling noise. The response at the high end of the filter eliminates telephone company multiplex noise and also serves as the anti-aliasing filter for the digitization of Caller audio.

Audio out of this BandPass Filter is applied to an analog multiplexer. The Digital Hybrid ANA has a ROM-based state machine which generates all the necessary timing waveforms that provide for the digitization of both Send and Caller audio, and the digital to analog conversion of audio out of the DSP. Audio in the Digital Hybrid ANA is digitized at the rate of 10,000 samples per second. Therefore, one sample period is 100 microseconds long (one ten-thousandth of a second). During each sample period the analog multiplexer (MUX) first selects the Send audio and applies it to the SAMPLE & HOLD circuit. The SAMPLE & HOLD circuit effectively takes a snapshot of the varying analog Send signal and momentarily holds it at a finite value. This finite value is then applied to the analog to digital convertor (A/D CONVERTER).

The A/D CONVERTER produces a 14 bit number that represents the amplitude of this finite sample. SERIAL DATA from the A/D CONVERTER is changed into a parallel format for presentation to the DSP by the SERIAL-PARALLEL CONVERTER.

After the process of digitization of the Send audio has taken place, the analog multiplexer (MUX) switches over to the Caller audio circuit. Caller audio is then digitized in the same manner and its digital value is presented to the DSP in a parallel format.

The Digital Signal Processor (DSP), in conjunction with its associated instruction ROMs, implement an automatic adaptive finite impulse response filter. The DSP takes 30 consecutive samples of Send and Caller audio and compares them in such a way that it can automatically

adjust this finite impulse response filter to provide the best overall subtraction of Send audio from Caller audio. To achieve this, the DSP performs approximately 200 calculations in each 100 microsecond sample period.

Each time this mathematical process is completed the DSP produces one fourteen bit sample of Caller-only audio that is fed to a PARALLEL TO SERIAL CONVERTER.

Serial data out of this converter is fed to a D/A CONVERTER that performs the process of taking a finite digital sample and turning it into a finite analog quantity. These finite steps of 100 microseconds' duration are then smoothed into a continuous analog signal by a LowPass Filter. The output of this LowPass Filter then drives the CALLER AGC and CALLER CONTROL circuit.

The CALLER AGC is very similar to the SEND AGC, except that while providing the same gain reduction of 20 dB the CALLER AGC is shelved at a positive gain of 10 dB.

The CALLER AGC can be disabled via front panel Switch #6, forcing the CALLER AGC to unity gain.

This circuit also provides CALLER CONTROL, meaning that when there is Send audio present (talent speaking), the Caller audio can be dimmed (reduced) by an adjustable number of decibels. The amount of dimming is determined by the front panel CALLER CONTROL trim-pot, or a remotely connected CALLER CONTROL pot.

Audio out of the CALLER AGC and CALLER control circuit is applied to a balanced amplifier to provide the balanced CALLER out signal. Additionally, this audio is applied to the MIX output amplifier. The MIX output contains the sum of the SEND input signal and the CALLER audio. This output is ideally suited to drive an audio tape recorder to record both sides of a telephone conversation.

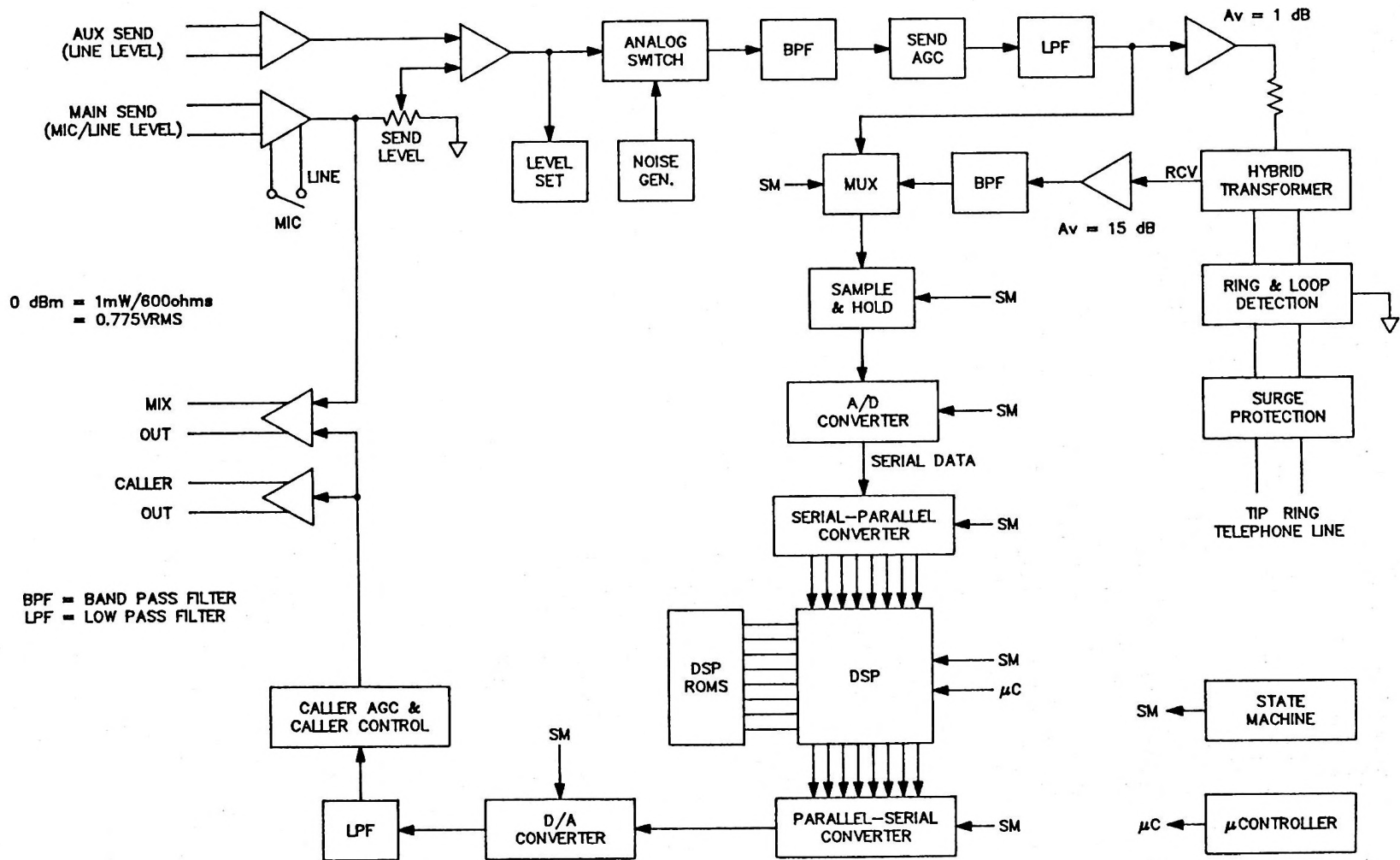
6.4 Telephone Interface Circuit Description

The TIP and RING conductors of the telephone line are applied to a RJ11C connector on the Digital Hybrid ANA. TIP and RING are then routed thru a fusing resistor and SURGE PROTECTION circuitry. This protects the hybrid from telephone line surges caused by lightning or other electrical events.

TIP and RING are then routed through a circuit that provides for detection of ring voltage and telephone loop current. These detected signals are then sent to the microcontroller so it can determine if the telephone line is ringing, or if the telephone line has been disconnected from the central office (caller has hung up).

As TIP and RING progress through this circuitry they are applied to the primary of the HYBRID TRANSFORMER.

The HYBRID TRANSFORMER has been designed to provide proper audio coupling and a small amount of hybrid isolation in the presence of up to 70 milliamps of telephone company loop current.



DIGITAL HYBRID ANA FUNCTIONAL BLOCK DIAGRAM

FIGURE 23

SECTION SEVEN - UPGRADING A DIGITAL HYBRID

7.1 Instructions for Upgrading to a Digital Hybrid ANA

This section is intended for use by those persons who want to upgrade their existing Digital Hybrid to a Digital Hybrid ANA.

This section contains all the information needed to perform the Digital Hybrid ANA upgrade installation procedure.

All of the advantages of Gentner's new Digital Hybrid ANA can be enjoyed by users of existing Digital Hybrids by simply installing the new firmware integrated circuits which are part of the ANA Upgrade Kit, and modifying the hardware as instructed.

If any of the items listed below are missing, please contact:

Gentner Customer Support
1825 Research Way
Salt Lake City, Utah 84119

Telephone: (801) 975-7200
FAX: (801) 977-0087

ITEM	GENTNER PART NUMBER
a) [1] Digital Hybrid ANA Operations Manual	800-009-001
b) [1] Warranty Registration Card	432-600-000
c) [1] Label for Front Access Panel	432-009-001
d) [1] U63 I.C. - Version 2.0	805-009-003
e) [1] U66 I.C. - Version 2.0	805-009-004
f) [1] U68 I.C. - Version 2.0	805-009-002
g) [1] .1 uF Capacitor	603-050-112

7.2 Firmware Upgrade Procedure

The new Digital Hybrid ANA firmware is contained in the three integrated circuits (I.C.'s) supplied with the Upgrade Kit.

Anti-static precautions must be taken when performing any service operation for the Digital Hybrid ANA.

General precautions to observe during this firmware upgrade procedure include the following:

- a) Avoid handling the I.C.'s by their leads.
- b) Always handle the I.C.'s in a static free environment.
- c) Keep the I.C.'s in the anti-static container used for shipping until called for in the installation procedure.

STEP #1

Remove all connections from the Digital Hybrid, and remove the unit from service.

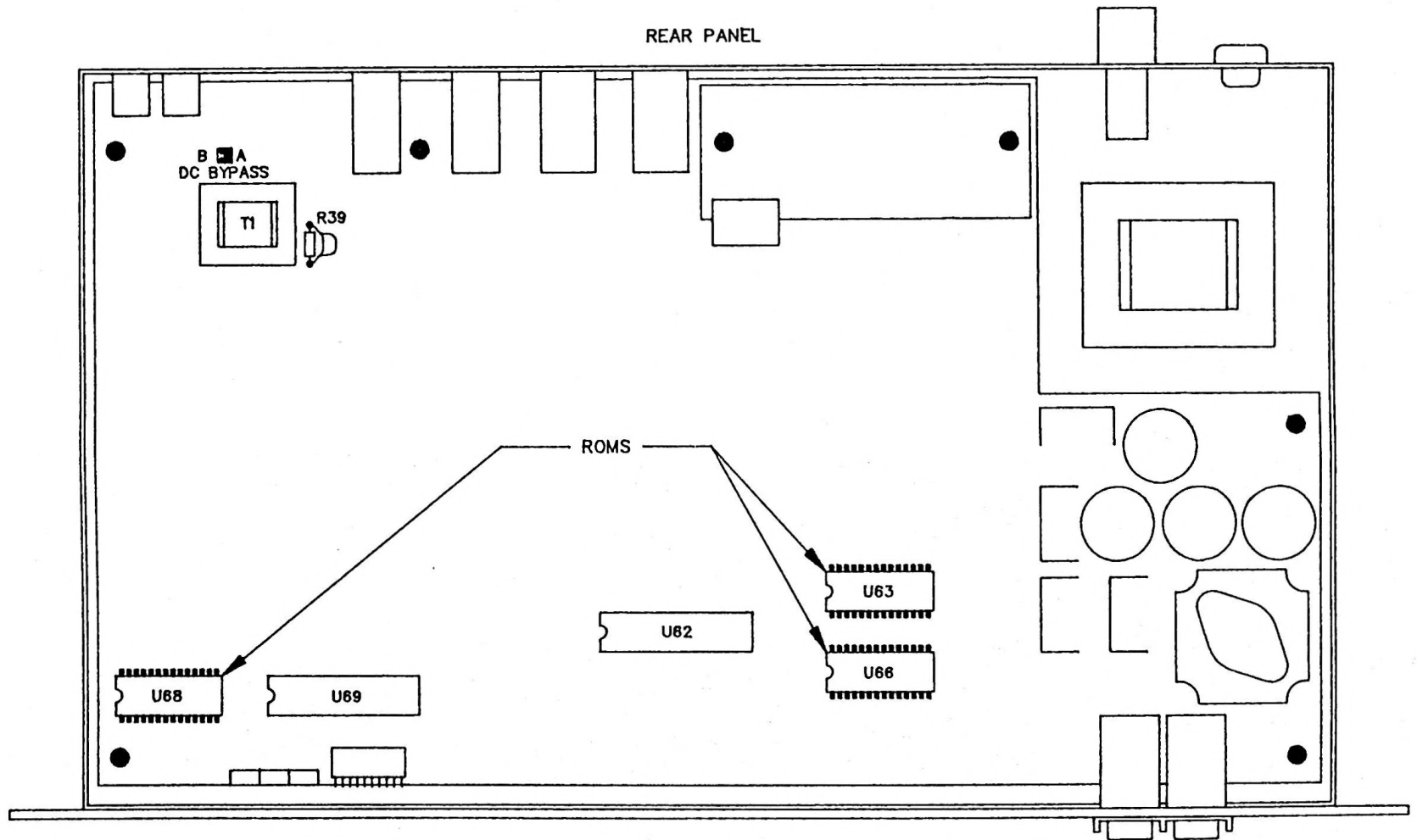
CAUTION: DISCONNECT THE DIGITAL HYBRID ANA FROM A.C. POWER.

Remove the cover from the Digital Hybrid by loosening the four cover screws. (Note that the screws need only be loosened, not removed.)

STEP #2

Place the Digital Hybrid in front of you, top side up, with the front panel of the unit facing you. The removeable front panel should now be on the left-hand side, and the OFF and ON switches should be on the right-hand side of the unit.

Do not remove any I.C.'s during this step - just locate their positions using Figure 24 as a reference.



FRONT PANEL
TOP VIEW WITH COVER REMOVED

LOCATION DIAGRAM FOR U63, U66, AND U68

FIGURE 24

Identify the following I.C.'s on the Digital Hybrid ANA circuit board (they should be clearly marked by an adhesive label):

U68: This I.C. is located near the front of the unit on the far left-hand side.

U63 and U66: These I.C.'s are located toward the front of the unit, on the right half of the circuit board, approximately two inches left of the power supply area.

NOTE THAT U63, U66, & U68 ARE ORIENTED SUCH THAT THE SMALL NOTCHES ARE ON THE LEFT-HAND SIDES OF THE I.C.'S.

IDENTIFY THE NOTCHES AND VERIFY THEIR ORIENTATIONS BEFORE PROCEEDING.

NOTE: In the following steps a small screwdriver can be used to remove an I.C. from its socket. Slip the screwdriver carefully under the I.C. and lift up on the I.C. while gently rocking the screwdriver back and forth to loosen the I.C.

STEP #3

Carefully remove the old U68 from its socket on the circuit board and set it aside.

Locate the new U68 provided with the Upgrade Kit and remove it from its shipping container.

Orient the new U68 so that the notch on the top is on the left-hand side.

Carefully insert the new U68 into its socket on the circuit board. Be extremely careful not to bend any of the pins on the I.C. during insertion.

Make certain that the I.C. is firmly seated in its socket.

STEP #4

Carefully remove the old U63 from its socket on the circuit board and set it aside.

Locate the new U63 provided with the Upgrade Kit and remove it from its shipping container.

Orient the new U63 so that the notch on the top is on the left-hand side.

Carefully insert the new U63 into its socket on the circuit board. Be extremely careful not to bend any of the pins on the I.C. during insertion.

Make certain that the I.C. is firmly seated in its socket.

STEP #5

Carefully remove the old U66 from its socket on the circuit board and set it aside.

Locate the new U66 provided with the Upgrade Kit and remove it from its shipping container.

Orient the new U66 so that the notch on the top is on the left-hand side.

Carefully insert the new U66 into its socket on the circuit board. Be extremely careful not to bend any of the pins on the I.C. during insertion.

Make certain that the I.C. is firmly seated in its socket.

STEP #6

Place the old I.C.'s into the shipping container that previously held the new I.C.'s. Discard or store the old I.C.'s according to your preference.

STEP #7

Locate the new front access panel label provided with the Digital Hybrid ANA Upgrade Kit.

Remove the front access panel from the Digital Hybrid ANA.

Remove the protective backing from the new front access panel label and install the new label over the existing label.

NOTE: THE FUNCTION OF FRONT PANEL DIP SWITCH #7 HAS BEEN CHANGED. IT NO LONGER ENABLES/DISABLES THE CALLER CONTROL FUNCTION. SEE SECTION 4.5 OF THIS MANUAL FOR INFORMATION ON SETTING THE DIP SWITCHES.

Please continue to Section 7.3 "Hardware Upgrade Procedure."

7.3 Hardware Upgrade Procedure

This section is a continuation of the procedure started in Section 7.2, "Firmware Upgrade Procedure". If you have not completed the steps outlined in that section, please do so now.

STEP #1

In this step, a .1 uF cap will be "piggybacked" across resistor R39 of the Digital Hybrid ANA.

Use Figure 25 to help locate R39 in conjunction with the following information.

Locate the PREM transformer on the circuit board near the telephone jacks.

Near this transformer is a 430 ohm resistor labeled R39. R39 is located near the front, right-hand corner of the PREM transformer, between the PREM transformer and U5. The R39 designation is silk-screened onto the circuit board next to the resistor. Take the time now to locate this resistor.

Locate the .1 uF monolithic capacitor supplied with the Upgrade Kit.

Carefully dress the capacitor leads as needed and install the capacitor across R39 by "piggybacking" the capacitor onto the resistor.

Carefully solder the leads of the .1 uF capacitor to the leads of R39.

Thoroughly inspect your solder work and the surrounding area. If necessary, clip excess lead lengths from the capacitor just installed. Check for any solder which may have unintentionally been placed onto the circuit board or surrounding components and remove as needed.

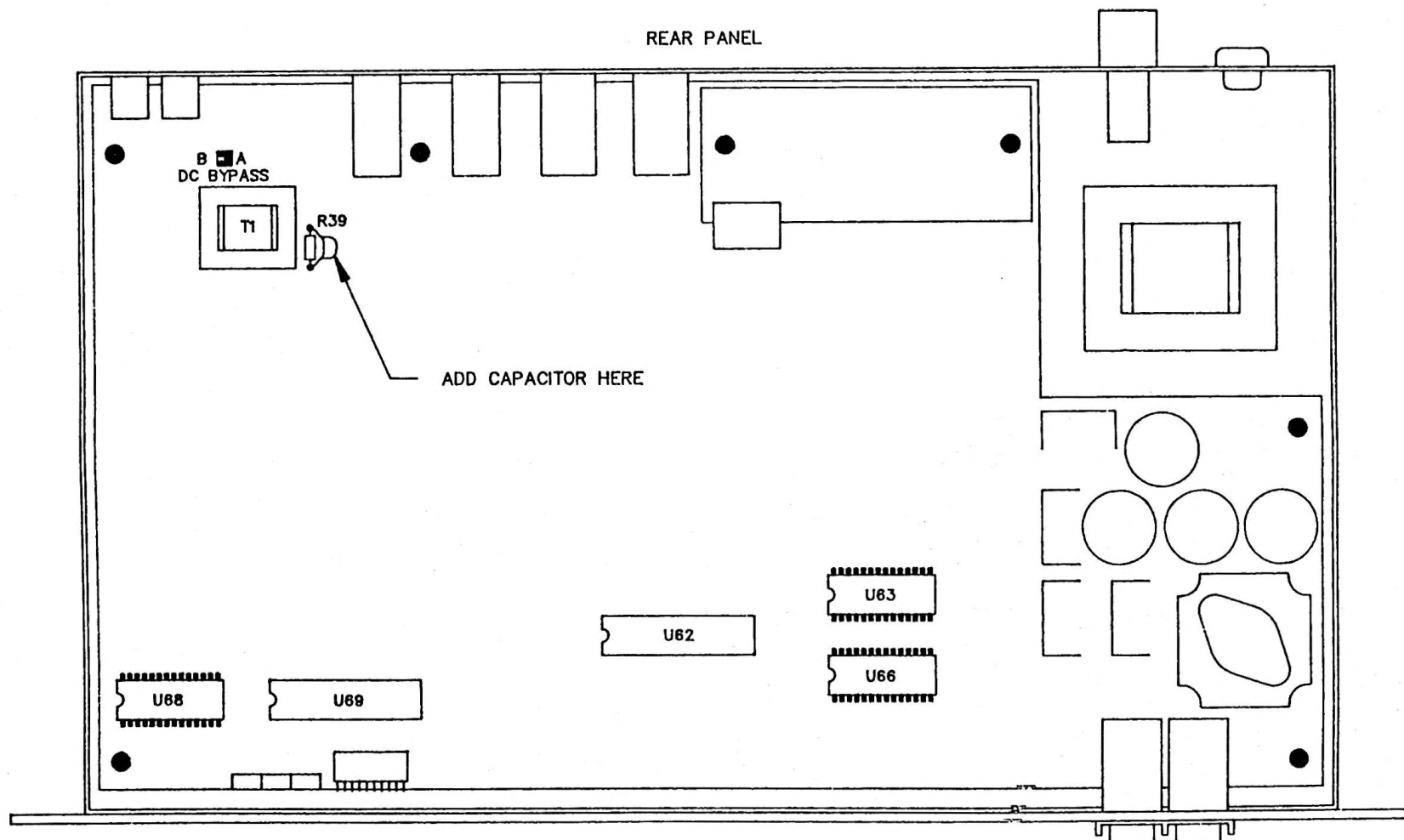
STEP #2

Secure the cover to the Digital Hybrid ANA using the four cover screws on the chassis.

Re-connect all inputs and outputs for the Digital Hybrid ANA.

Restore the unit to service.

The Digital Hybrid ANA upgrade procedure is now completed.



FRONT PANEL
TOP VIEW WITH COVER REMOVED

LOCATION DIAGRAM FOR R39

FIGURE 25

SECTION EIGHT -- MAINTENANCE

8.1 Digital Hybrid ANA Maintenance

Your Digital Hybrid ANA is a highly reliable device. It was thoroughly tested at the factory before being shipped to you.

To protect your Digital Hybrid ANA from damage, do not operate it in an excessively hot or cold environment and avoid subjecting the unit to physical shock.

If you leave your Digital Hybrid ANA permanently connected to a telephone line, it is strongly recommended that you provide external surge protection for the telephone line and the AC power input.

Gentner can provide highly reliable surge protection devices for both the telephone lines and the AC power input. Call the Gentner sales office for more information.

The Digital Hybrid ANA does not contain any user serviceable parts. Should your unit not operate satisfactorily, call Gentner and ask for Customer Support.

WARNING: THE DIGITAL HYBRID ANA CONTAINS CMOS INTEGRATED CIRCUITS. ALL SERVICE TO THE UNIT MUST BE PERFORMED IN A STATIC FREE ENVIRONMENT.

8.2 Questions and Answers

This section is intended to answer the most common questions about installation and operation of the Digital Hybrid ANA.

If you need further assistance, call Gentner Customer Support.

Question: My Digital Hybrid ANA seems to run hot. Is something wrong?

Answer: It is normal for the unit to run warm to the touch. The unit's power supply is properly heat-sinked to support the power usage. It is recommended that the unit be operated in a well ventilated area.

Question: Is it OK to do a "button-mash" conference, that is, direct more than one telephone line to the Digital Hybrid ANA at a time?

Answer: "Button-mash" conferences can be done, but much better results can be achieved by using multiple hybrids.

Question: My Digital Hybrid ANA needs to put louder Send audio on the telephone line. What can I do?

Answer: Increase the audio level at the main SEND input to 0 dBm. If you've already rotated the front panel SEND LEVEL trimmer to the full clockwise position with 0 dBm input to the main SEND, the Digital Hybrid ANA is transmitting -9 dBm on to the telephone line. This level is the maximum level permitted by the FCC. Increasing the level above -9 dBm will cause clipping to occur and intelligibility to decrease.

A simple way to set the proper Send audio level is:

Apply program audio to the SEND input of the unit. While pushing the OFF switch, adjust the SEND LEVEL trim-pot so that the SEND LED glows green most of the time, and occasionally red on audio peaks.

Question: Why doesn't my Digital Hybrid ANA automatically answer the telephone?

Answer: Make certain that front panel Switch #1 is in the UP position and that the DC BYPASS jumper on the circuit board is in the A position. This jumper is labeled JMP 2 on the Digital Hybrid ANA schematic.

Question: Why won't the unit automatically disconnect? I have placed front panel Switch #2 in the UP position like it should be.

Answer: In order for the unit to automatically disconnect, it must see a loop drop or loop reversal on the telephone line to signal that a disconnect should occur.

Some telephone companies do not provide loop drop or reversal on disconnect.

Make certain that Switch #3 is in the DOWN position.

Question: Why can't I hear any Caller audio output from the Digital Hybrid ANA? Why don't the ON/OFF switches seem to work correctly?

Answer: If you are using the DC BYPASS jumper (JMP 2) in the B position, then front panel Switches #1, #2, and #3 must be DOWN. Section 3.6 of the manual provides more information about the DC BYPASS jumper.

If the front panel ON/OFF switches are being used, front panel Switch #4 must be in the UP position.

If you are using remote ON/OFF controls, front panel Switch #4 must be UP if momentary switches are used. Switch #4 must be DOWN if a latching remote ON switch is used.

Question: When I enable the SEND AGC or the CALLER AGC (front panel Switches #5 and #6) it seems to affect the performance of the hybrid. Why?

Answer: These processors typically add more gain to the SEND and CALLER (receive) signals.

Every dB of gain on these signals will increase the hybrid leakage by an equal amount. For example, if the SEND audio level increases by 1 dB, then 1 dB more of SEND audio will leak through to the CALLER audio output.

Many broadcasters prefer to leave the SEND AGC and CALLER AGC disabled. This gives a more natural on-air sound and provides a perceived improvement of the hybrid performance.

Question: My hybrid seems to have power, but I can't get any Send or Caller (receive) audio. The unit acts dead.

Answer: Check front panel Switches #2 and #3. Only one of them should be in the UP position. If both of the switches are in the UP position, the Digital Hybrid ANA will not operate properly.

Rough handling during shipping may cause internal connectors or components to come loose. DISCONNECT THE UNIT FROM AC POWER. Then remove the cover and inspect the interior for loose connectors, or socketed I.C.'s which may be unseated. Correct any problems discovered, then replace the cover.

Question: I'm using the Digital Hybrid ANA on my PBX. The signal-to-noise ratio (SNR) and hybrid performance is poor. Why?

Answer: The Digital Hybrid ANA reduces line noise by using a bandpass filter to limit extraneous low and high frequencies coming in on the telephone line. Any unwanted noise which falls in the passband (approximately 300 Hz to 3000 Hz) will not be filtered out. One source of noise on digital telephone systems is the CPU noise induced into adjacent audio wires in a cable.

Hybrid performance can be severely degraded when something other than the telephone Central Office hybrid is seen by the Digital Hybrid ANA. When other inductive or capacitive components such as switches, relays, chokes, or transformers are added to

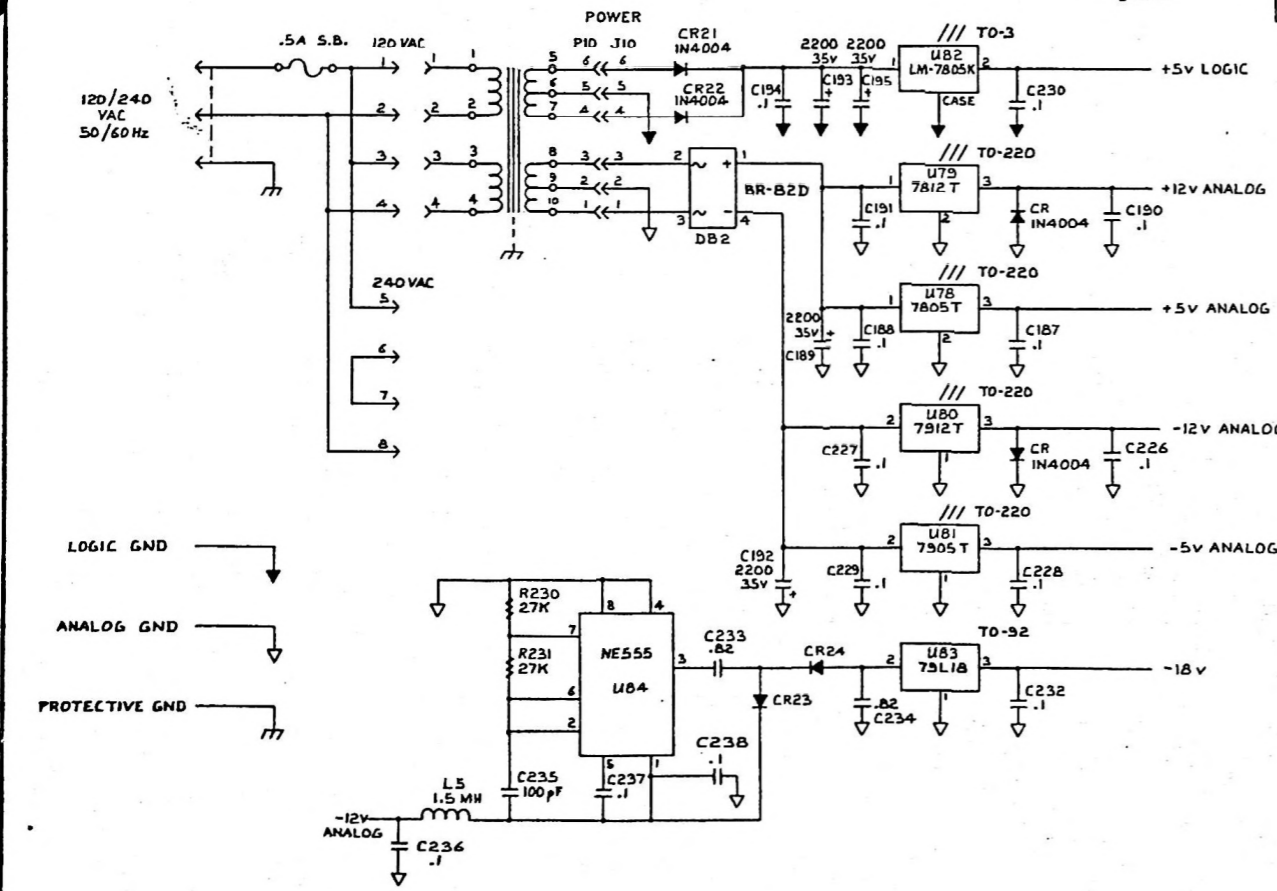
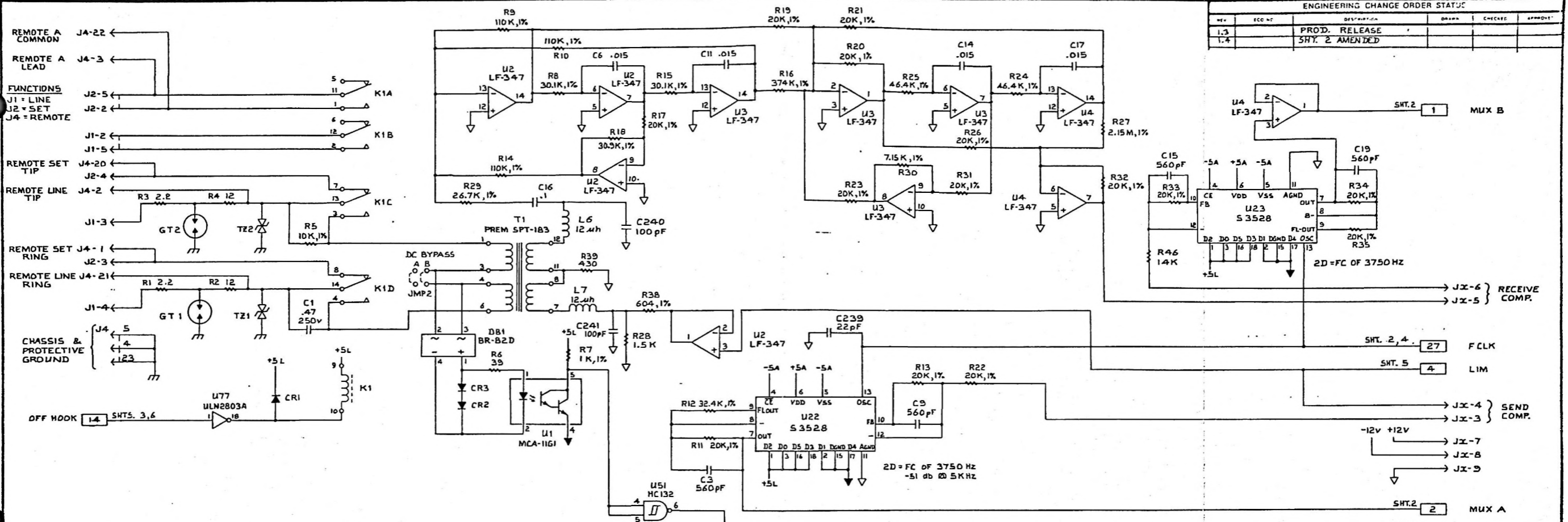
the circuit, it becomes much more difficult for the hybrid to match the line characteristics.

For some applications, using an outside telephone line which bypasses the PBX is the only way to achieve satisfactory performance.

8.3 Schematics

A complete set of schematic diagrams for the Digital Hybrid ANA unit is presented on the following pages.

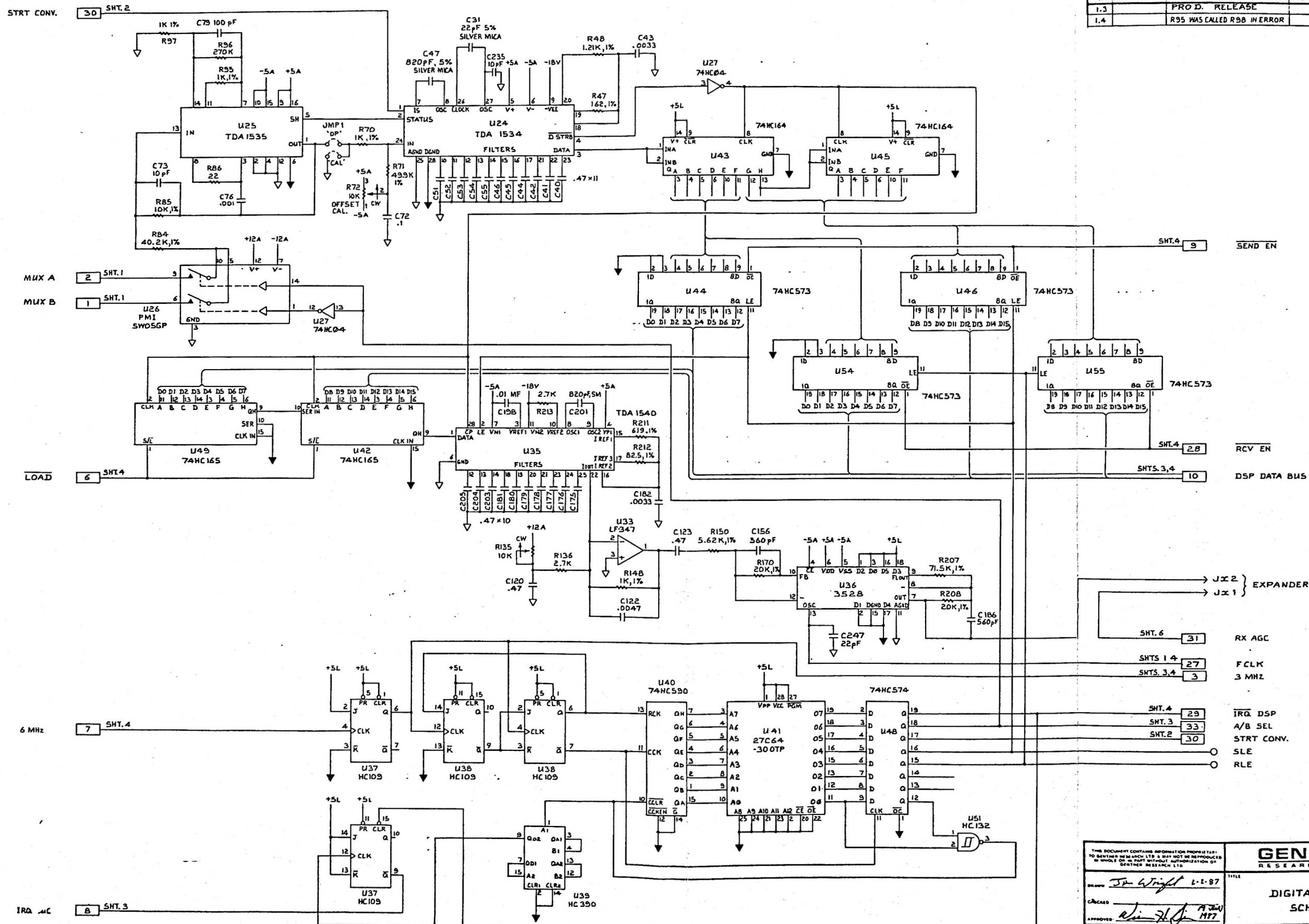
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1.4		SHT. 2 AMENDED		



- NOTE.
- UNLESS OTHERWISE SPECIFIED:
 - FIXED RESISTOR VALUES ARE IN OHMS, 1/4 WATT, ± 5%.
 - CAPACITOR VALUES ARE IN MICROFARADS.
 - DIODES ARE IN4148.
 - VOLTAGES ARE D.C.
 - OP. AMPS. ARE LF347.
 - 1 2 ETC INDICATE CONNECTIONS BETWEEN DRAWING SHEETS.
 - FOR BYPASS CAPS AND POWER & GND CONNECTIONS ICs REFER TO SHEET 7, (C-SIZE).

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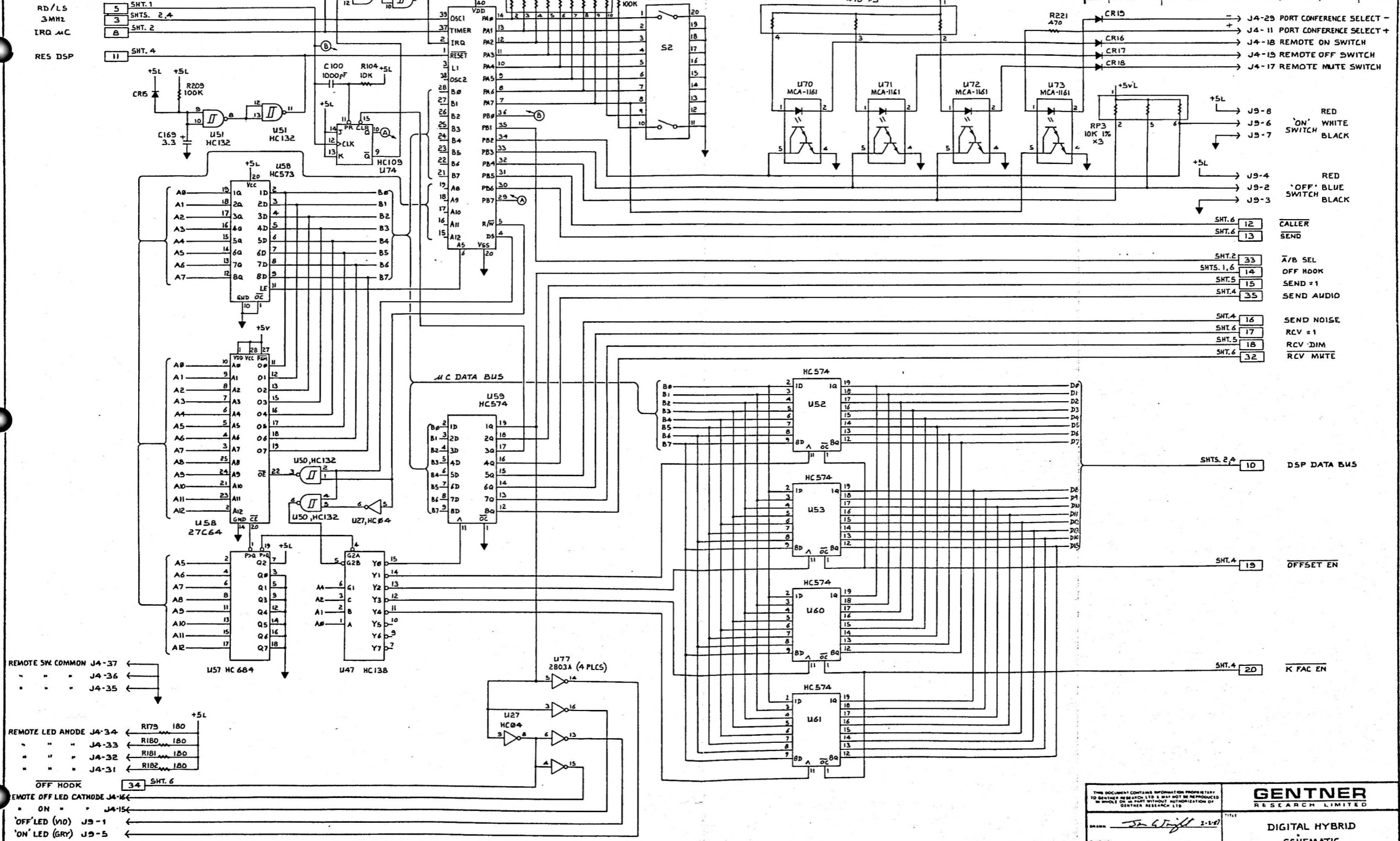
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CHECKED: *John Wright* 7/26/87
APPROVED: *John Wright* 7/27/87

TOLERANCE ARE: SCALE: DWG NO: 710-009-001
SHEET: 2 of 7

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- J4-29 PORT CONFERENCE SELECT -
- J4-11 PORT CONFERENCE SELECT +
- J4-18 REMOTE ON SWITCH
- J4-19 REMOTE OFF SWITCH
- J4-17 REMOTE MUTE SWITCH
- J9-8 RED SWITCH
- J9-6 WHITE SWITCH
- J9-7 BLACK SWITCH
- J9-4 RED SWITCH
- J9-2 'OFF' BLUE SWITCH
- J9-3 BLACK SWITCH
- SHT. 6 12 CALLER SEND
- SHT. 6 13 SEND
- SHT. 2 33 A/B SEL
- SHTS. 1,6 14 OFF HOOK
- SHT. 5 15 SEND = 1
- SHT. 4 35 SEND AUDIO
- SHT. 4 16 SEND NOISE
- SHT. 6 17 RCV = 1
- SHT. 5 18 RCV DIM
- SHT. 6 32 RCV MUTE
- SHTS. 2,4 10 DSP DATA BUS
- SHT. 4 19 OFFSET EN
- SHT. 4 20 K FAC EN

- REMOTE SW COMMON J4-37
- " " " J4-36
- " " " J4-35
- REMOTE LED ANODE J4-34 ← R179 180
- " " " J4-33 ← R180 180
- " " " J4-32 ← R181 180
- " " " J4-31 ← R182 180
- OFF HOOK 34 SHT. 6
- REMOTE OFF LED CATHODE J4-16
- " ON " " J4-15
- 'OFF' LED (VIO) J9-1
- 'ON' LED (GRY) J9-5

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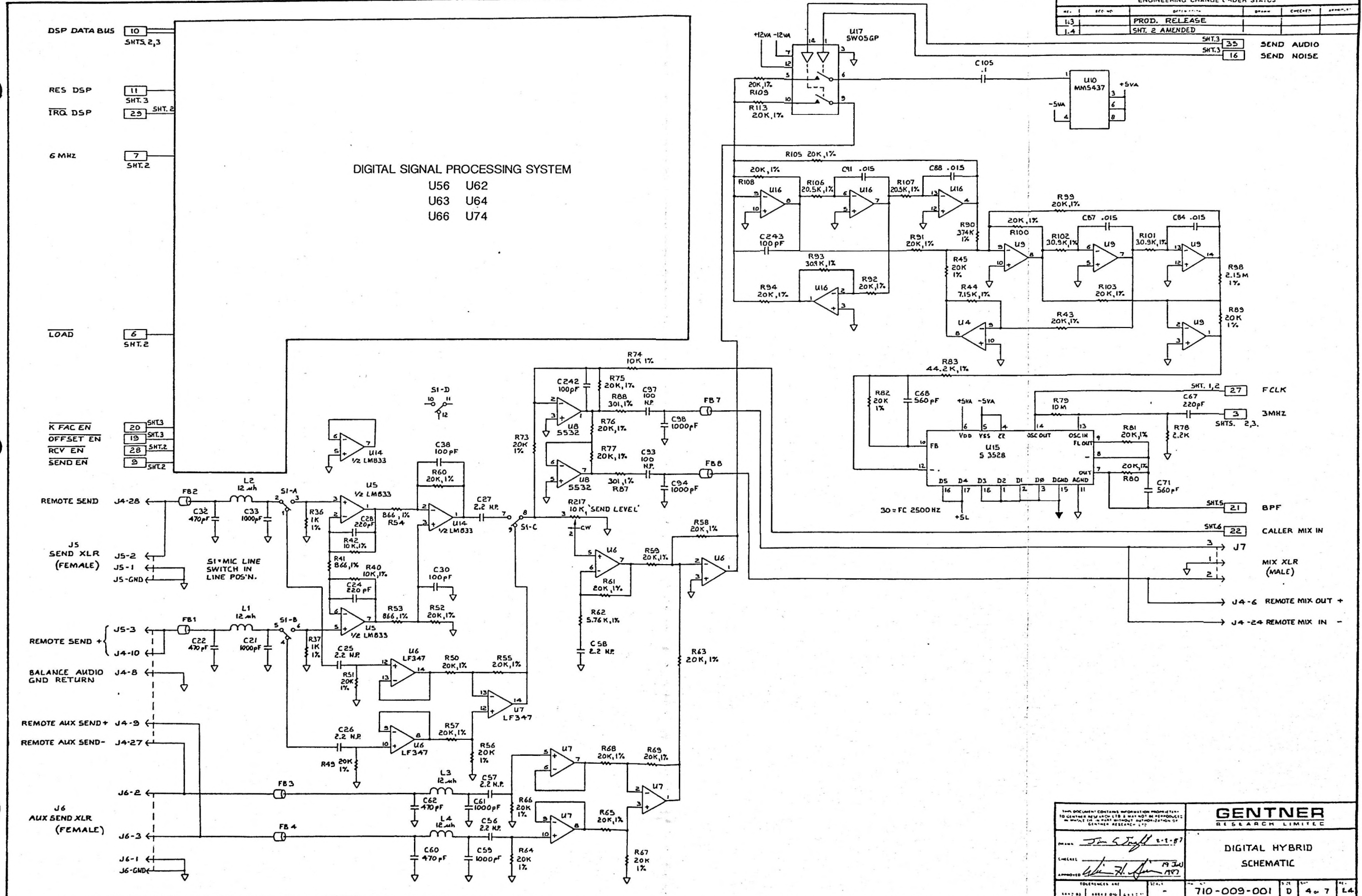
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CHECKED: *[Signature]* 17 JUN 1987

APPROVED: *[Signature]*

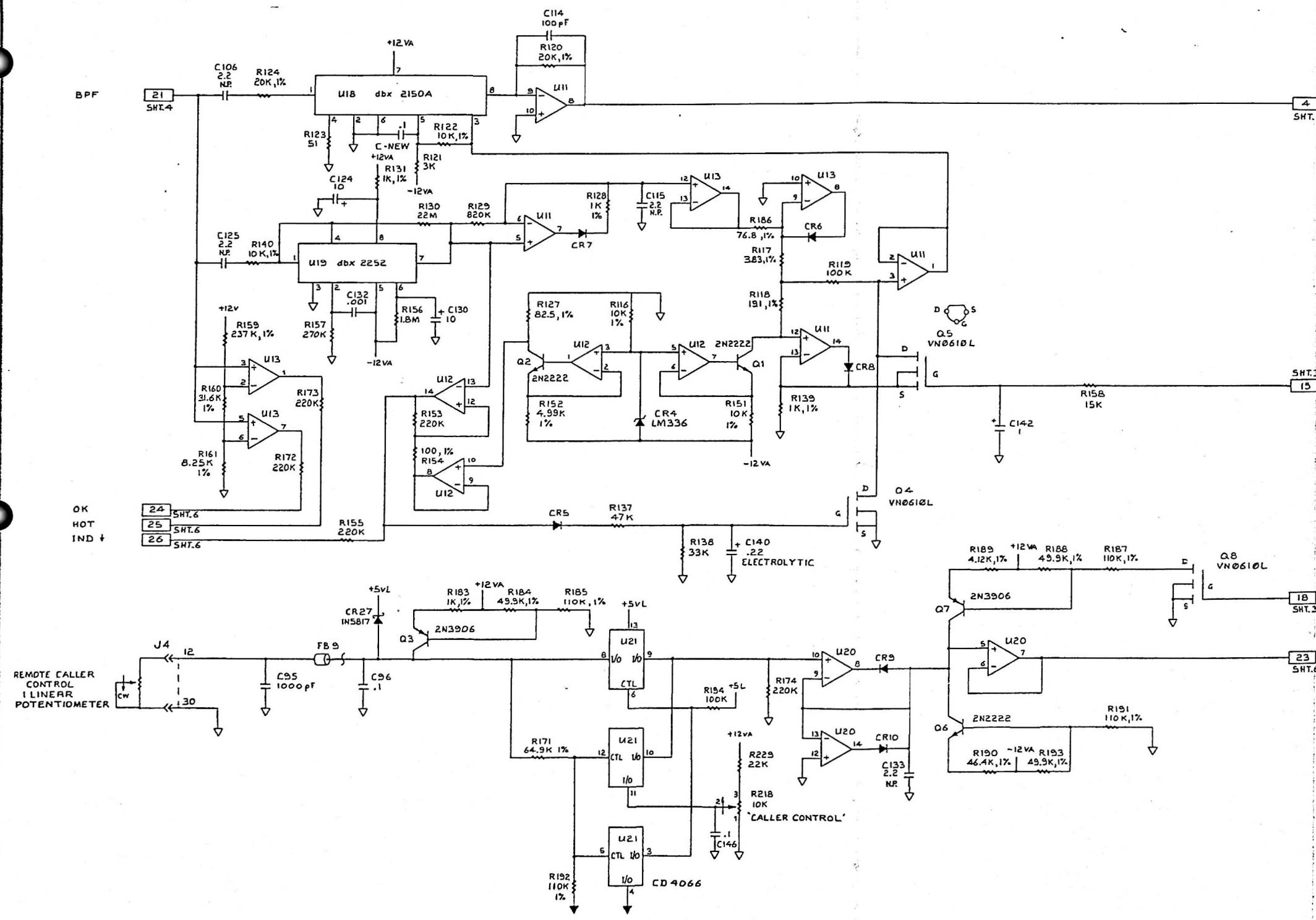
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L4				SHT. 2 AMENDED



LIM

SEND = 1

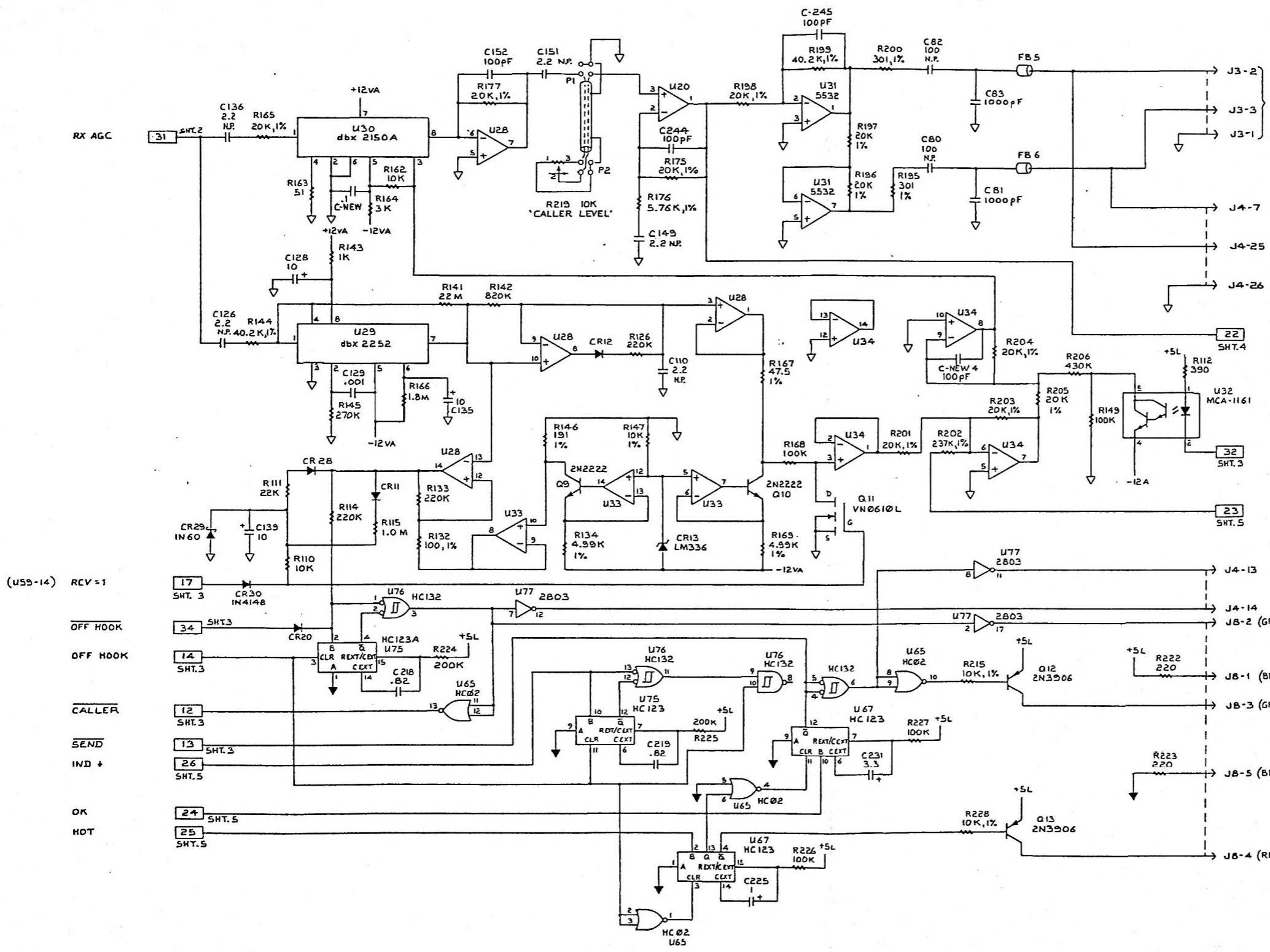
RCV DIM

(U59-13)

DIM CV

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CALLER OUT
MALE XLR

J4-7 REMOTE CALLER OUT +

J4-25 REMOTE CALLER OUT -

J4-26 BALANCED AUDIO GND RETURN

MIX IN

RCV MUTE (U59-12)

DIM CV

REMOTE SEND LED CATHODE

REMOTE CALLER LED CATHODE
CALLER LED CATHODE

CALLER LED ANODE

GREEN ANODE

COMMON CATHODE

RED ANODE

SEND LED

- (U59-14) RCV = 1
- OFF HOOK
- OFF HOOK
- CALLER
- SEND
- IND +
- OK
- HOT

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REV.	ECO NO.	DESCRIPTION	DATE	CHECKED	APPROVED
1.3		PROD. RELEASE			
1.4		SMT 2 AMENDED			

COMP. REF.	TYPE	+5vL	BYPASS CAP.	+5vA	BYPASS CAP.	-5vA	BYPASS CAP.	+12vA	BYPASS CAP.	-12vA	BYPASS CAP.	-18v	BYPASS CAP.	LOGIC GND	ANALG GND
U1	MGA11G1													4	
U2	LF347							4	C4	11	C2				3,5,10,12
U3	LF347							4	C13	11	C12				3,5,10,12
U4	LF347							4	C20	11	C18				3,5,10,12
U5	LM833							8	C23	4	C29				
U6	LF347							4	C35	11	C34				3
U7	LF347							4	C65	11	C63				
U8	NE5532							8	C64	4	C66				3,5
U9	LF347							4	C86						3,5,10,12
U10	MMS437			36,8	C99	4	C101								
U11	LF347							4	C116	11	C113				11
U12	LF347							4	C112	11	C111				
U13	LF347							4	C143	11	C141				10
U14	LM833							8	C36	4	C39				5
U15	S3528	16	C37	6	C70	5								15	11
U16	LF347							4	C90						3,5,10,12
U17	SW05GP							12	C104	7	C107				3
U18	dbx 2150A							7	C117						2,6
U19	dbx 2252									5	C131				3
U20	LF347							4	C134	11	C144				12
U21	CD4066	14	C145											4	
U22	S3528	18	C5	6	C8	5	C7							15	11
U23	S3528	18	C10	6	C127	5	C238							15	11
U24	TDA1534			5	C48	6	C49					5	C50	28	25
U25	TDA1536			16	C74	15	C75							6	4
U26	SW05GP							12	C78	7	C92				3
U27	74HC04	14	C108											1,7	
U28	LF347							4	C119	11	C118				5
U29	dbx 2252									5	C148				3
U30	dbx 2150A							7	C147						2,6
U31	NE5532							8	C150	4	C153				3,5
U32	MCA11G1									4	C121				
U33	LF347							4	C138	11	C137				3
U34	LF347							4	C155	11	C154				5,10,12
U35	TDA1540			4	C197	7	C194					11	C200		6
U36	S3528	18	C183	6	C185	5	C184							15	11
U37	74HC109	16	C157											8	
U38	74HC109	16	C158											8	
U39	74HC390	16	C159											8	

COMP. REF.	TYPE	+5vL	BYPASS CAP.	+5vA	BYPASS CAP.	-5vA	BYPASS CAP.	+12vA	BYPASS CAP.	-12vA	BYPASS CAP.	-18v	BYPASS CAP.	LOGIC GND	ANALG GND
U40	74HC590	16	C160												8
U41	27C64-30	28	C163												14
U42	74HC165	16	C164												8
U43	74HC164	14	C77												7
U44	74HC573	20	C165												10
U45	74HC164	14	C109												7
U46	74HC573	20	C166												10
U47	74HC138	16	C161												8
U48	74HC574	20	C162												10
U49	74HC165	16	C171												8
U50	74HC132	14	C167												7
U51	74HC132	14	C168												7
U52	74HC574	20	C170												10
U53	74HC574	20	C172												10
U54	74HC573	20	C173												10
U55	74HC573	20	C174												10
U56	74HC138	16	C202												8
U57	74HC684	20	C207												10
U58	74HC573	20	C208												10
U59	74HC574	20	C209												10
U60	74HC574	20	C210												10
U61	74HC574	20	C211												10
U62	TMS-32010-25	30	C214												10
U63	82S181A	24	C199												12
U64	74HC138	16	C206												8
U65	74HC02	14	C223												7
U66	82S181A	24	C222												12
U67	74HC123	16	C224												8
U68	27C64-30	28	C212												14
U69	MCM6805E2	40	C213												20
U70	MCA11G1														4
U71	MCA11G1														4
U72	MCA11G1														4
U73	MCA11G1														4
U74	74HC109	16	C217												8
U75	74HC123	16	C220												8
U76	74HC132	14	C221												7
U77	2803A														
U84	NE555														4,8

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APPENDIX A -- TELEPHONE BASICS

APPENDIX A -- TELEPHONE BASICS

A.1 The Telephone System

A telephone system can be described as a two-way, or full duplex, transmission system. It gives the user the ability to send and receive information simultaneously.

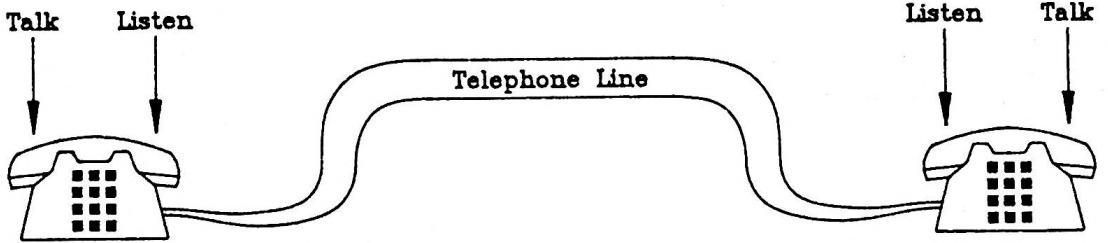
Local telephone lines use a two-wire system between the Central Office (local telephone exchange) and each residence or business. These two wires are called Tip and Ring. The names are carried over from the early days of manual switching when operators used patch cords to tie calls together. Tip and Ring refer to the physical position on the patch plug. The term Ring in this usage has nothing to do with the ringing mechanism of the telephone. See Figure A-1.

In a modern telephone line cable, the Tip and Ring wires are usually green and red. The cable may also contain a yellow and black wire but these wires are generally not used except in multi-line telephone systems.

The local two-wire system is only used to connect local telephones to the Central Office or local telephone exchange. At the Central Office, and also in each telephone, the two-wire system is converted to a four-wire system via a Hybrid Coil (also known as an Induction Coil) in order for the transmission to have full duplex operation. This means that the send and receive audio is fully separated with two wires for each. The two-wire local lines are able to accomplish duplex operation by using the Tip and Ring wires for a variety of different purposes (voice transmission, signal transmission, power to ring the bell, etc.), each controlled at the Central Office, and by using a Hybrid Coil to convert to a four-wire system at both ends.

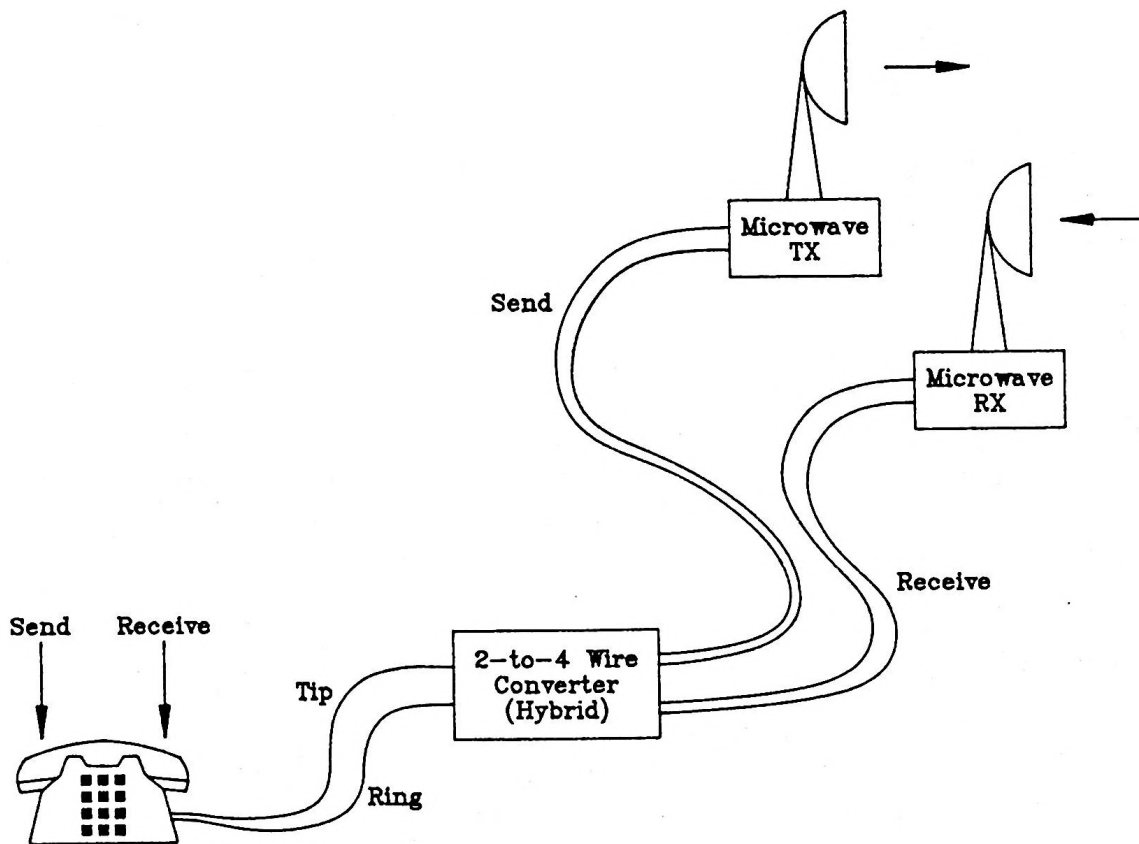
Figure A-2 shows how the send audio is converted from a two-wire to a four-wire transmission at the Central Office hybrid coil and is then transmitted via a microwave transmitter. Meanwhile, the receive audio arrives from the microwave receiver, is converted for two-wire transmission, and arrives at the telephone set to be processed by the set's hybrid coil before reaching the receiver.

It is important to note the totally separate send and receive paths provided by the microwave transmitter (or by cable or satellite). The telephone transmission path is often thought of as a single path when in reality it is a dual system. The entire system is illustrated in Figure A-3.



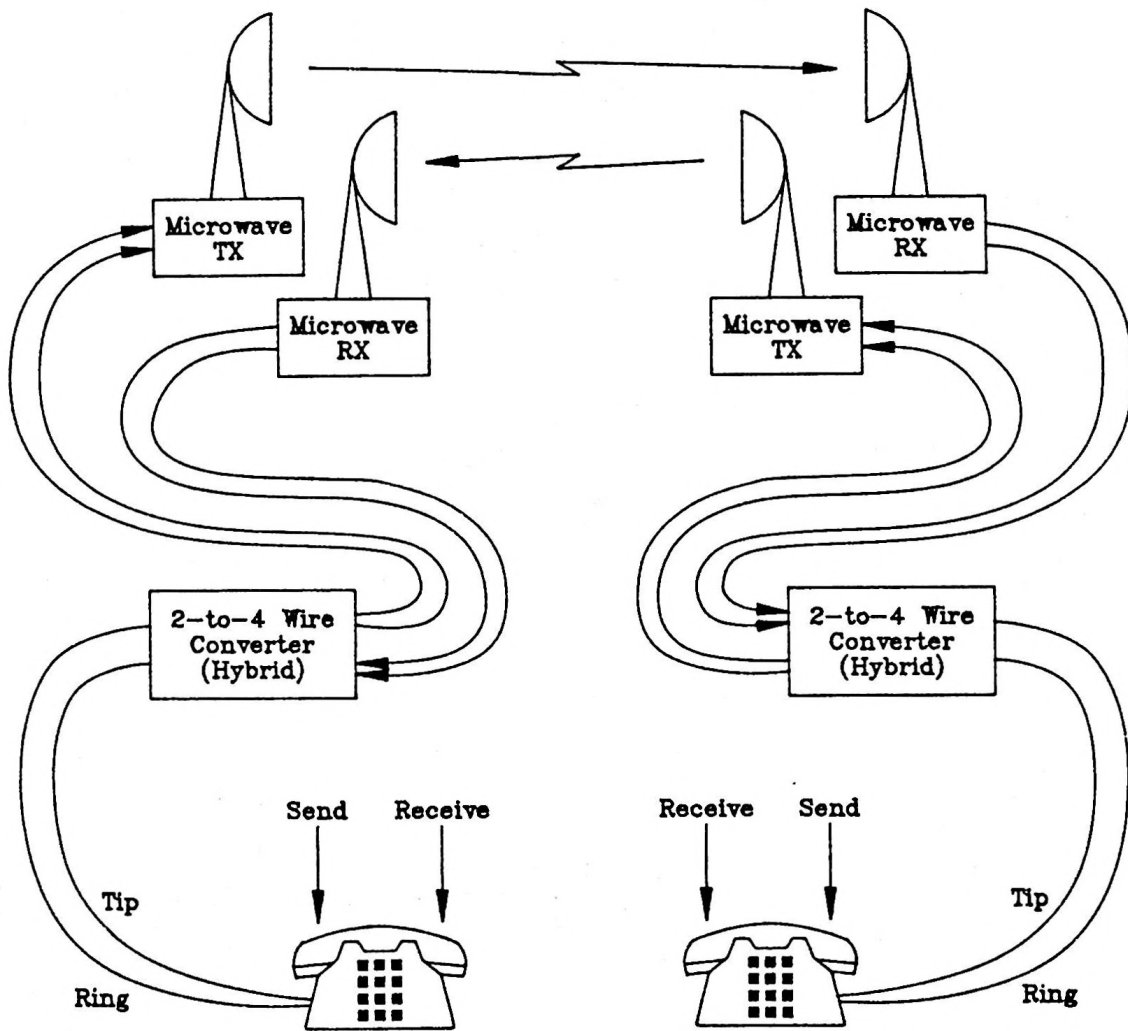
A Telephone Line

Figure A-1



Tip and Ring Processing

Figure A-2



A Telephone Transmission System

Figure A-3

A.2 The Telephone Set

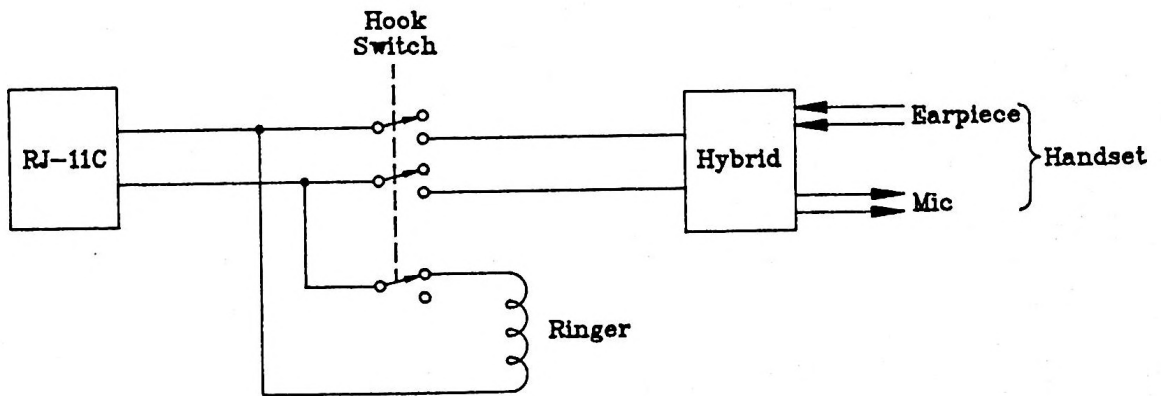
Inside the telephone set, the Tip and Ring wire pair go to the hook switch. When the handset is picked up, Tip and Ring are routed to the hybrid coil which provides separation for the talk and listen paths going to the handset.

Refer Figure A-4. The telephone set, known to most of us simply as a telephone, consists of a receiver, a transmitter, a bell or buzzer, and a calling device (push button or dial). The telephone set must perform several functions in order to send and receive calls. It must first request and gain access to the local telephone system, then send a number, all the while keeping the user informed as to the status of the call (busy, ringing, out-of-service, etc.). When the call is finally connected, it must convert speech into electrical energy and, at the other end, back into speech or acoustical energy. Finally, it signals that the call has ended when the handset is placed back on the hook.

- a) On Hook: When the handset is in the cradle, only the ringer circuit has access to the line. While in this state, the hook switch is open, isolating the rest of the phone from the local line.
- b) Ringing: When someone calls your number, the local office sends a 105 volt AC (alternating current) signal to drive the ringing generator, but this current is isolated from the rest of the telephone and stops abruptly as soon as the handset is lifted (hook switch contacts are closed). This process is known as terminating the line. Anytime a DC (direct current) path of 600 ohms or less is provided to Tip and Ring, the line will be terminated and the call will be connected.
- c) Off Hook: When the handset is picked up (hook switch contacts are closed) a Supervisory Signal (see Section 4) is sent, requesting use of the line.

- d) Disconnect: When the calling party hangs up, the Central Office senses disconnect (change in load on Tip and Ring) and generally reverses the DC voltage on the receiving phone's Tip and Ring. Some systems, however, simply provide a dial tone without DC reversal. This stops long distance billing (if applicable) and gives a dial tone to the receiving caller.
- e) Calling Device: This device allows the user to enter telephone numbers. On a rotary telephone the numbers are defined by pulses in the loop current, each number identified by the number of pulses. A touch tone telephone uses a method called Dual Tone Multi-Frequency (DTMF), which generates tones by using a combination of high and low frequency signals.
- f) Transmitter: A transmitter is the sending portion of the handset, the part into which you speak. It is comparable to a microphone, sensing your speech and then converting the speech (acoustical energy) into electrical energy. The signal is then carried by wire to the Central Office and by either cable, microwave, or satellite to the receiver or the person you are calling, where it is converted back to acoustical energy. With a Gentner Telephone Hybrid, a microphone is used in the place of a transmitter.
- g) Receiver: The Receiver is the receiving portion of the handset. It is comparable to a small speaker, receiving electrical current and converting it to acoustical energy or speech.

- h) Hybrid Coil (as used in telephones and in the Central Office): A Hybrid Coil is used at the Central Office and at the telephone set to convert two-wire circuits to four-wire circuits, permitting full duplex operation. The Hybrid Coil is necessary because a two-wire cable, instead of a four-wire cable, is used for local lines. The Hybrid Coil at the Central Office has a Null setting, meaning that there is no crossover between the transmit and receive signals. The Hybrid Coil in the telephone set, however, is deliberately unbalanced to permit sidetone (a portion of the transmission heard at the receiver). This enables you to hear your own voice so you can determine how loudly you should speak.

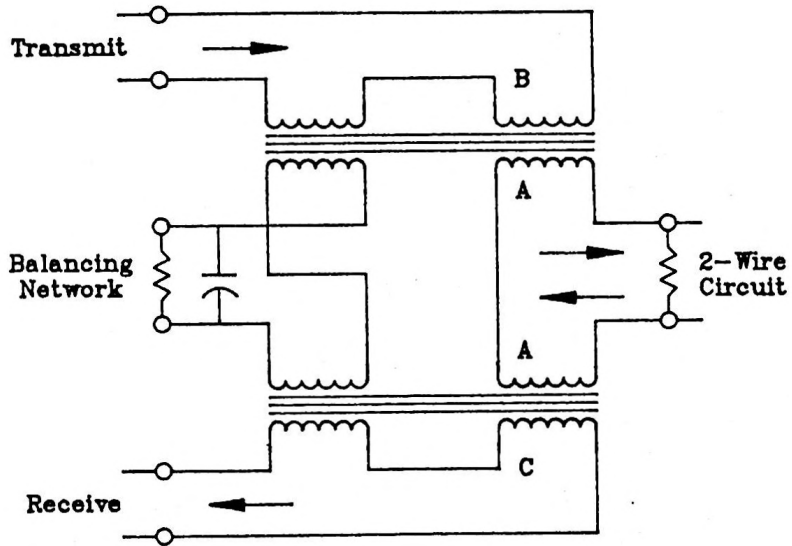


Single Line Telephone Set - Simplified

Figure A-4

A.3 The Hybrid Coil

A Hybrid Coil is a differential transformer typically consisting of four windings. The Hybrid Coil transfers speech currents from A to B (see Figure A-5) and from C to A with little loss in terms of dB, but approximately half of the total energy is lost to the balancing network. For a Hybrid Coil to work properly, the impedance of both systems needs to be nearly matched.



Hybrid Coil

Figure A-5

A.4 Telephone Signaling

The Central Office connects a DC charge to the Tip and Ring wire loop, provided by a trickle-charged battery (the battery keeps the system working during power outages). The voltage varies between 20 Volts DC to about 48 Volts DC with the Tip and Ring on hook (no load). This current powers everything but the actual ringing of the telephone.

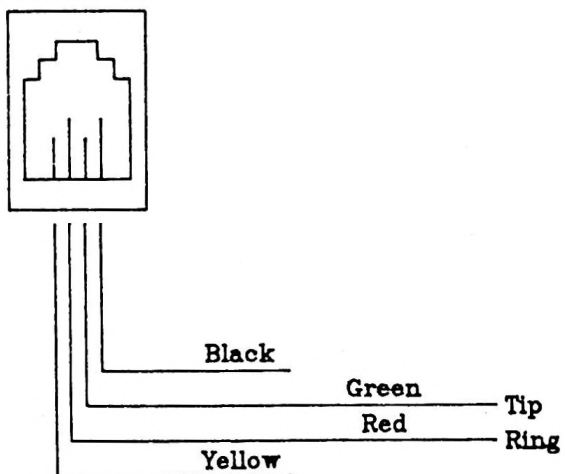
There are three basic types of signals used within the telephone system:

- a) Information Signals: These are audible tones intended to inform the user about the progress or status of a call (ring-back tone, busy signal, etc.) These tones are produced at the Central Office.
- b) Supervisory Signals: These signals request service, and are not heard by the user. When the handset is lifted, the hook switch makes contact and sends an off-hook signal which tells the Central Office that use of that line is requested. Hanging up the phone will send an on-hook signal indicating that the line has been disconnected. Loop current from the Central Office battery supplies the power for these tones.
- c) Control Signals: These are the pulses (rotary dialing) or tones (push button) generated by the calling device when a telephone number is being sent.

A.5 Telephone Connections and the Key Service Unit (KSU)

A single line telephone system consists of a single Tip and Ring pair. The incoming telephone line is generally connected to the telephone set via a modular phone jack (USOC RJ-11C). This jack can have up to four wires connected to it. The inner two wires (green and red) are Tip and Ring; the outer two wires (black and yellow) are not normally used in single line connections.

Modular Jack
USOC RJ-11C



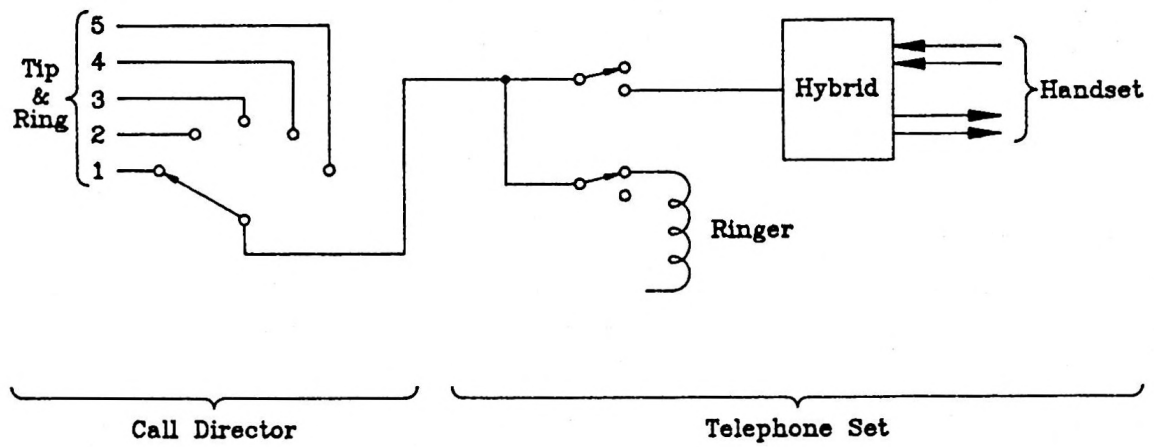
USOC RJ-11C

Figure A-8

When a single location has several incoming telephone lines (separate Tip and Ring wire pairs) they will initially connect to a switching device called a Key Service Unit.

- a) KSU (Key Service Unit): This unit provides mechanical switching and routing for the telephone sets within the multi-line system, supplies power for ringing, and an A-lead for lamp functions (to show which lines are in use or on hold). The KSU may also be used as an intercom and for other functions. There are two types of key service units: mechanical 1A2, identified here as Fat Wire; and electronic (EKSU) identified here as Slim Wire.

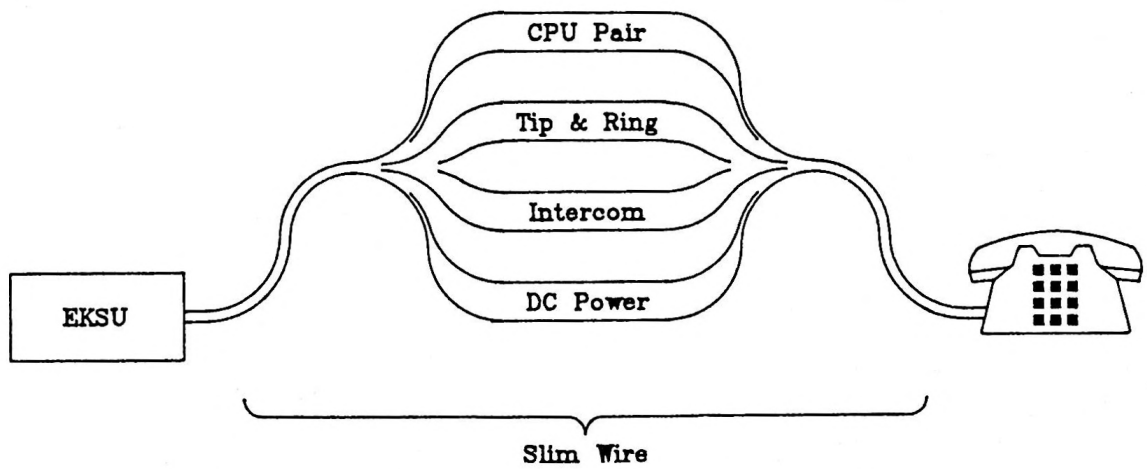
- b) Fat Wire Telephone Systems: The Fat Wire system uses at least one 25 pair cable going to each telephone, which gives each set access to all incoming lines. Each telephone in the Fat Wire system has a switching device of its own, making the job of the KSU secondary and invisible. The rotary switch selects a line when a line button is depressed and the appropriate Tip and Ring wire pair is routed to the telephone set. A secondary system closes the A-lead and the button lamp for that line is lit. The rotary switch mechanism is commonly called a Call Director because it directs the appropriate phone line to the rest of the telephone instrument. The A-line or A-lead (black and yellow wires) supplies the power to light the buttons. Figure A-7 shows how lines are selected within a multi-line telephone set.



Multiple Line 'Fat Wire' Call Direction

Figure A-7

- c) Slim Wire Phone System and Electronic Key Service Unit (EKSU): A digital telephone system uses a Slim Wire cable with one to four pairs of wires. The Slim Wire system has the help of a microprocessor at the EKSU (electronic key service unit). The EKSU takes incoming calls and routes them, one at a time, to individual telephone sets. Only one line can be routed to a telephone set at a time. See Figure A-8.



Slim-Wire (Digital) Phone System

Figure A-8

The wire pairs in a digital telephone system are defined as follows:

- a) CPU Serial Data Pair: This pair sends data back and forth between the EKSU (electronic key switching unit) and the telephone sets. The EKSU acts as the central controller, responding to various signals and directing calls to the appropriate telephone set. This line will be referred to as the A-lead.
- b) Tip and Ring: This pair allows for a single line connection to the telephone set. Unlike a Fat Wire telephone system that routes all incoming telephone lines to each telephone set, Slim Wire systems can route just one line to a telephone set at a time.
- c) Intercom and Additional Lines: These are used for intercom or other auxiliary purposes.

When a call is directed to a telephone set, the phone will ring, but the line will not be connected until the handset is taken off-hook. Then the following occurs:

- a) A signal is sent to the microprocessor, telling it the line has been answered.
- b) The EKSU routes the Tip and Ring for that line to the telephone set.

With digital telephone systems, taking the handset off-hook requests use of the system. To request use of an outside line, a signal must be entered that tells the EKSU of your intentions.

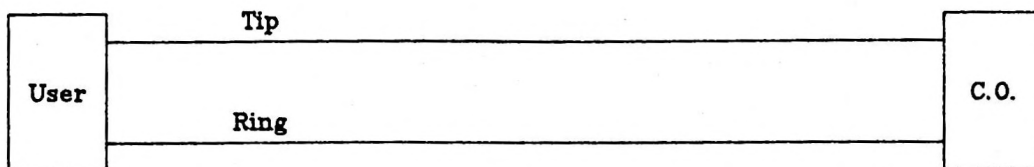
NOTE: Some newer electronic telephone systems digitize the audio signals routed from the EKSU to the telephone sets, and multiplex the control, audio, and power functions on a single pair of wires.

A.6 Why Telephone Lines Have Limited Bandwidth

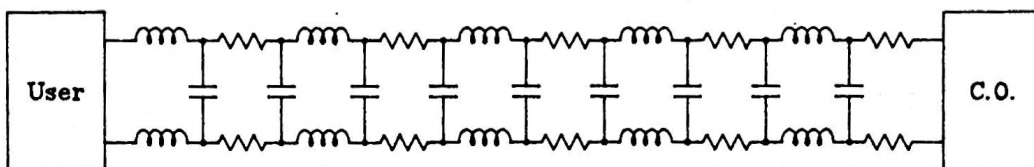
The direct dial telephone network is bandwidth limited because of two deficiencies in the system. One deficiency is found in the Central Office (C.O.) subscriber interface. Every telephone user is connected through a transformer. The transformers must therefore be very small to accommodate several thousand of them in a limited space. This small design causes the transformers to perform poorly at frequencies below 300 Hz.

Another deficiency is in the twisted wire pair that connects the subscriber to the C.O. Figure A-9 shows what the ideal telephone line looks like (simply two conductors between the user and the C.O.) compared to the actual telephone line. Any wire conductor has a small amount of resistance and inductive reactance. As the length of this conductor is increased beyond 100 feet these two components begin to have significant effects at audio frequencies. In addition, two of these conductors are twisted together, creating a significant amount of shunt capacitance between the two wires. This distributed inductance, resistance and capacitance will cause a loss at the higher audio frequencies.

These two deficiencies in tandem limit the frequency response of the telephone line to a band that extends from 300 to 3300 Hz. Since capacitive and inductive reactance both change with frequency, the complex impedance of the telephone line will be different at every frequency in the voice band.



Ideal Telephone Line



Actual Telephone Line

The Ideal Telephone Line
vs
The Actual Telephone Line

Figure A-9

A.7 Telephone Hybrids

A Telephone Hybrid separates the full duplex (simultaneous send/receive) audio on the telephone line into separate ports for send and receive. Figure A-10 shows a simplified Telephone Hybrid.

In a typical application, such as in a broadcast studio, audio from the microphone chain or mix-minus bus of the console is connected to the send audio input, allowing the caller to hear the announcer. The caller audio output of the Hybrid is connected to an input channel of the console, allowing the caller's audio to be mixed with other studio inputs and transmitted to the audience.

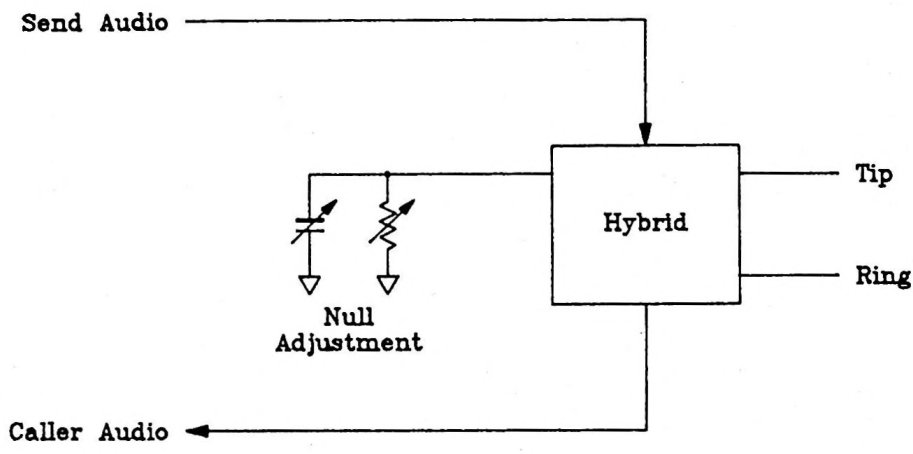
This separation of send and receive audio is very important to preserve the acoustic quality of the announcer's voice. When the announcer talks to a caller, his voice is transmitted on the telephone line and the acoustics of the announcer's voice become altered by the frequency response of the telephone lines. If some of this altered announcer audio gets mixed in with the caller audio, the announcer's voice will have a hollow sound.

The measurement of performance of a telephone hybrid is how well it isolates, or attenuates, the send audio input port from the caller audio output port. A telephone hybrid provides Null controls which allow the user to optimize this attenuation. When the resistive/capacitive impedance of the Null circuit matches the impedance of the telephone line connected to the hybrid, a perfect Null or attenuation of the send audio will result. However, the impedance of the telephone line is different for every frequency in the voice band, thus making the perfect Null impossible. All the same, satisfactory results can be obtained using this method for most broadcast applications.

Some telephone hybrids feature automatic Nulling, which means the hybrid will automatically adapt itself to the telephone line on connection. This feature is very useful due to the impedance changes from line to line.

Most telephone hybrids contain audio filtering circuitry that eliminates the low frequency hum induced into telephone lines from adjacent power lines. In addition, these filters eliminate high frequency noise above the voice band that is often caused by telephone company multiplexing equipment. Gentner hybrids also provide all of the circuitry necessary for direct connection to the telephone line.

The new technology of Digital Signal Processing has provided a new generation of telephone hybrids that offer the best possible performance for the most demanding applications. Gentner's Digital Hybrid digitizes both the send and the caller audio and then, using an elaborate processing algorithm, carefully subtracts the send audio from the caller's audio. A distinct advantage of the Digital Hybrid is that its Null is relatively uniform across the entire voice band. This type of telephone hybrid works well for any application requiring maximum isolation between send and caller audio.



Simplified Telephone System

Figure A-10

A.8 Installing Telephone Hybrids

A telephone hybrid converts the balanced two-wire medium into a four-wire circuit. This basic function is required in many applications to separate audio being sent to the caller from audio being received from the caller.

When installing a telephone hybrid, a raw Central Office telephone loop (single line) typically provides the best performance and easiest set-up (you simply plug the line into the hybrid). However, since most facilities use multiple line telephones, you'll probably need to access the telephone line from inside a telephone set to install the hybrid.

Analog and Digital Key Service Units (see Section A-5.) typically route a Tip and Ring pair to each telephone. This pair is what you need to connect to the hybrid. Finding the Tip and Ring pair can be tricky at times and a little research and testing is required.

A quick way to find the Tip and Ring pair is to probe inside the telephone set with a pair of high impedance headphones, isolated by 10uF capacitors. Look for a set of red and green wires that enter the phone from the Key Service Unit; these are usually, but not always, the Tip and Ring pair. Connect the headphones across these wires and select a line. You'll hear dial tone on each line selected if you have found the correct terminals.

Another common problem in hybrid installation is the desire to route the output of an audio console to the input of the hybrid for feeding audio to the caller. Although simply sending the main audio output of a console to the caller may seem like a good idea, it electronically sends the caller's audio back to himself, thus creating a feedback loop.

Most hybrid installation instructions call for sending Mix-Minus audio down the phone line. Mix-Minus audio is simply a mixture of the audio sources on the console, MINUS the caller's audio. If Mix-Minus is not available, a good alternative is to use audio from the microphone pre-amp for the send feed. Keep in mind this idea: "Send the caller anything EXCEPT his own audio."

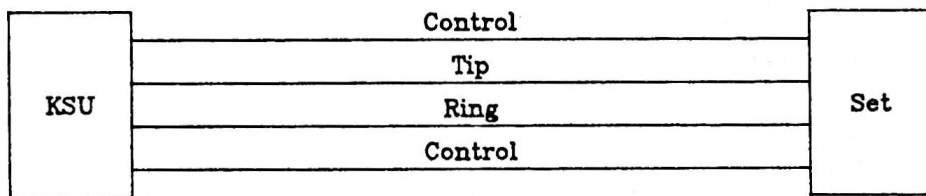
A.9 Installing Telephone Hybrids in Digital Telephone Systems

So-called digital telephone systems provide a great variety of features including speed dialing, call forwarding, and so on. However, these same systems that make business calls so easy tend to make the engineer's life a little more complicated when adapting them for use with telephone hybrids.

In most cases, a telephone hybrid can be installed into a digital telephone system with good results. Hybrids require a Tip and Ring pair, which is usually supplied to extension phones from the EKSU when a line is selected.

NOTE: Some digital telephone systems actually digitize the audio signals being fed to the telephone sets. In such cases, it may be very difficult or impossible to make a hybrid work from an EKSU extension. Some manufacturers of such all-digital telephone systems can supply an adaptor which will allow you to easily connect a telephone hybrid to the system. Contact your telephone system's manufacturer for more information.

Installation of telephone hybrids in digital telephone systems is more complicated than with standard, non-digital systems. Digital telephone systems can use as little as four or as many as eight wires to connect the EKSU to each telephone set. A typical four wire system is shown in Figure A-11.



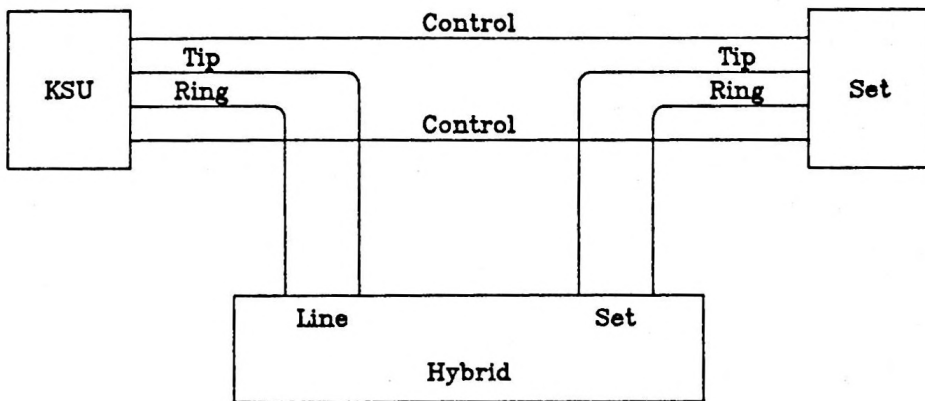
Typical Digital Telephone System

Figure A-11

The Tip and Ring wires, usually the middle pair, carry the audio while the outer wires carry control information. A system with six or eight wires uses the additional wires for intercom or power. When interfacing a telephone hybrid to this type of system, the goal is to separate the audio pair from the rest of the lines.

Basic installation in a four-wire system is shown in Figure A-12. Note that the control lines remain untouched. If your system uses six or eight wires, you will also interface to just the audio pair.

This typical set-up permits the telephone to operate normally when the hybrid is off. When the hybrid is turned on, the Tip and Ring are routed to the hybrid but the control functions are still active at the telephone. This allows line selection commands to be sent to the EKSU.

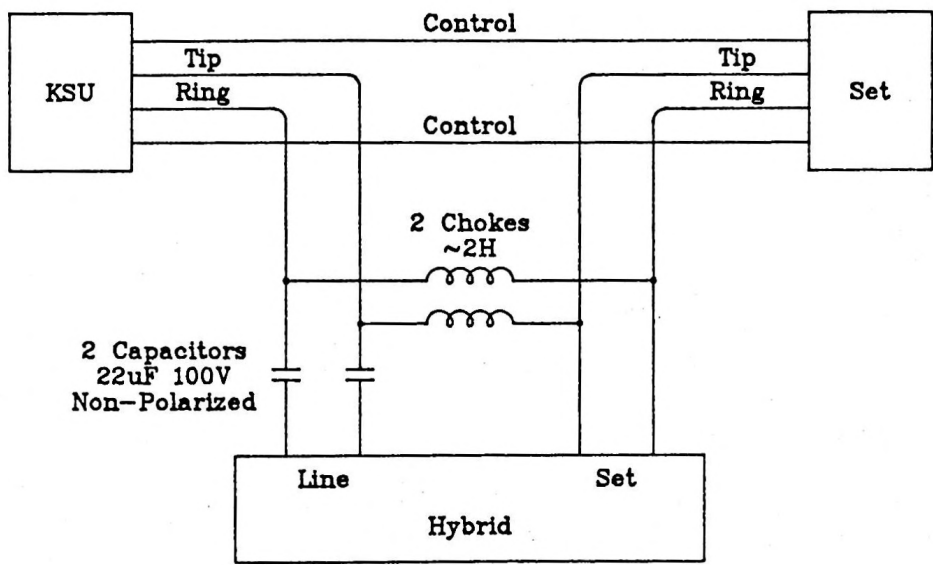


Basic Installation of Telephone Hybrid
in Digital Telephone System

Figure A-12

Some digital phone systems also use the Tip and Ring pair to provide DC power to the telephone set, or they might use a differential voltage between the audio and control lines to carry the DC power. This sort of phone system is easy to spot after you try the interface shown in Figure A-12. If your system has DC on the audio path, the telephone set will function normally when the hybrid is off, but will go dead about three seconds after the hybrid is turned on. In this case, you need a DC path around the hybrid that does not allow the hybrid to load down the DC. This is accomplished with the addition of four components as shown in Figure A-13.

When operating your hybrid with a digital phone, bear in mind that the telephone set will have to be off hook to send line selection commands to the KSU. If you prefer to leave the handset on hook, you can try selecting the hands free mode on the telephone set (in many cases, this will route audio to the hybrid); you could optionally interface to the hook switch wiring inside the telephone.



Installation of a Telephone Hybrid in a Digital Telephone System
with DC Voltage on the Audio Pair

Figure A-13

A.10 Frequency Extension

A major problem with standard, untreated telephone lines is that their frequency response extends from 300 to 3300 Hz. Almost all male voices have significant vocal energy below 300 Hz, which is lost on the untreated telephone line.

Frequency Extenders help resolve this problem by extending the frequency response of the telephone line. A single line Frequency Extender (in the Encode mode) shifts the Transmit audio of all frequencies up 250 Hz. Thus, 50 Hz becomes 300 Hz and 3000 Hz becomes 3250 Hz, placing the low frequencies within the bandwidth of the telephone line. At the Receive side of the telephone line, another Frequency Extender (in the Decode mode) downshifts the audio, returning the 300 Hz to its original 50 Hz position. This process preserves two and a half octaves of critical low frequencies while sacrificing only one seventh of an octave at the high end.

All of Gentner's single line Extended Frequency Transceiver (EFT) units employ patented circuitry for generating additional new high frequency components from the remote audio, thus giving the line an apparent increase in high frequency response. This produces a more natural sound from the telephone-transmitted audio.

Frequency Extenders that provide greater audio bandwidth are also available. Dual line Frequency Extenders deliver a frequency response of 50 Hz to 5 kHz, using two telephone lines, by upshifting low frequencies and downshifting higher frequencies so that they will be passed by the telephone lines.

For those who require maximum performance, Gentner's three-line EFT-3000 uses three standard telephone lines to deliver audio with a frequency response of 50 Hz to 7.5 kHz.

Frequency Extenders are very useful in remote broadcast applications, or for any application where full fidelity audio transmissions are desirable.

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