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# **EFT-100**

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*Installation and  
Operations Manual*

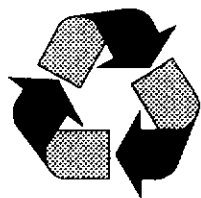
## **EFT-100 Installation and Operations Manual**

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*Gentner Part No. 800-054-001  
December 1993*



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This manual has been printed entirely on recycled paper.

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SECTION ONE  
GENERAL INFORMATION

1.1 Introduction

The purpose of this manual is to provide the required information necessary for operation of the Gentner EFT-100. A complete study of all text will ensure maximum performance and simple operation.

If questions arise in the installation, operation, or maintenance of a EFT-100, please contact:

Gentner Electronics Corporation  
1825 Research Way  
Salt Lake City, Utah 84119  
(801) 975-7200

For Gentner Electronics Corporate Warranty information please turn to inside of rear cover of this manual.

1.2 Overview

The Gentner EFT-100 dramatically improves telephone audio quality by extending the low end frequency response and reducing ambient noise level. This process is known as Frequency Extension.

The Frequency Extension process encodes "send" audio by frequency shifting the signal into the most linear and noise free band of standard telephone lines. "Receive" audio is decoded by reverse frequency shifting. This provides the user with the clearest and most intelligible audio available over standard telephone lines. Using the Frequency Extension process, the typical bandwidth of audio sent over standard telephone lines is 50 Hz to 3 kHz. This is an improvement of 2.5 octaves of bandwidth over normal telephone lines.

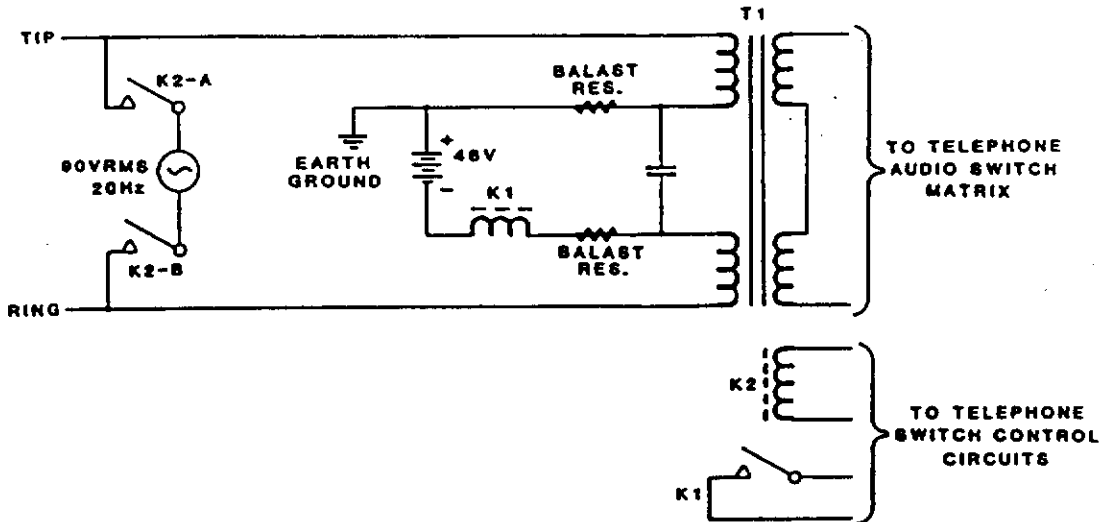
"EFT" stands for "Extended Frequency Transceiver". This indicates that an "EFT" unit is capable of both sending and receiving audio simultaneously, as long as a true telephone hybrid or coupler is used in conjunction with the EFT-100. This is a mandatory requirement in teleconferencing and an important consideration in getting cues back to a remote site.

The EFT-100 does not include a built in telephone coupler, and is intended for use with a separate telephone coupler or hybrid. (Call Gentner for information regarding our complete line of telephone hybrids and couplers.)

### 1.3 Telephone Theory

To fully understand the application of Gentner telephone products, it is essential that the user have a basic understanding of the telephone system.

The telephone company provides a single pair of wires for every telephone line within the service area of the Central Office (C.O.). The pair of wires is twisted to form a balanced transmission line. This twisting of the two identical wires provides for the rejection of hum and noise on the telephone line. This single pair of wires provides simultaneous transmission of both send and receive audio, D.C. current to power the user's telephone, and ringing voltage to signal the user of an incoming call. Diagram A is a schematic of the subscriber interface circuit at the C.O.



TELEPHONE SUBSCRIBER INTERFACE CIRCUIT

The two wires coming from the C.O. are called TIP and RING. These names carry over from the days of the old manual switchboard when an operator manually interconnected callers with patch cords. The "tip" and the "ring" terminals of the plug on the patch cord provided the connections to the caller's telephone. It is very easy to identify tip and ring using a standard voltmeter; as Diagram A indicates, tip is positive and ring is negative. The open circuit voltage on the telephone line is 48 Volts.

When the telephone instrument is taken off hook, current will be drawn from the C.O. battery, closing the contacts of K1. These contacts tell the C.O. switching mechanism the user demands service. The 'switch' then provides dial tone and waits for the user to dial a number. If an incoming call is to be directed to a user, the C.O. switch will operate K2 and apply 90 Volts (RMS) at 20 Hz to tip and ring. This voltage, now superimposed on the 48 Volts D.C., will cause the user's instrument to ring. When the called party takes the instrument off hook, K1 will close and the switch will interconnect the two parties.

Although the circuits look very simple, certain deficiencies exist when we attempt to use telephone lines for high quality audio feeds. One deficiency is found at T1 of the subscriber interface circuit. Every user connected to the C.O. requires one of these transformers, which means they must be very small to accommodate several thousand of them in a limited space. This small design causes the transformer to perform poorly at frequencies below 300 Hz. Another deficiency is in the twisted wire pair that connects the subscriber to the C.O.

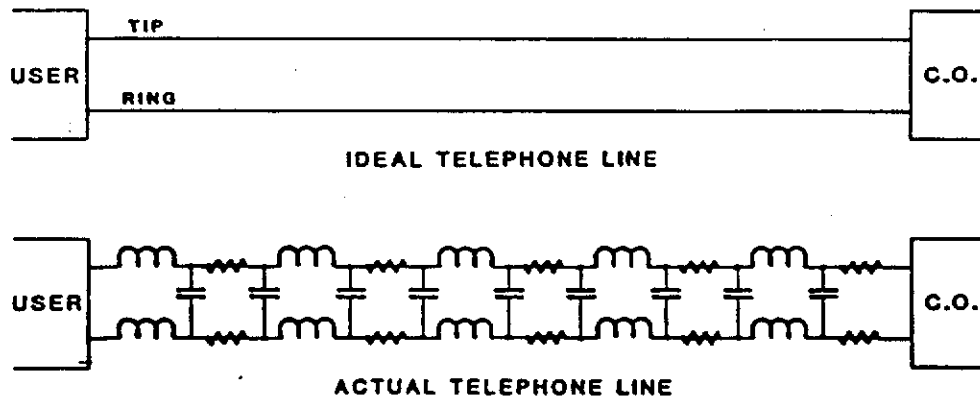
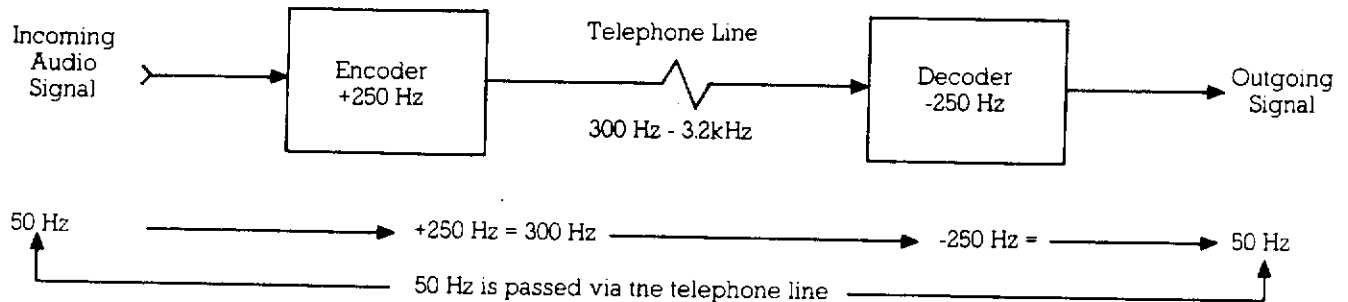


Diagram B shows what the 'ideal' telephone line looks like (simply two conductors between the user and the C.O.) compared to the actual telephone line. Any wire conductor has a small amount of resistance and inductive reactance. As we increase the length of this conductor beyond 100 feet these two components 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.

## 1.4 EFT-100 Frequency Extension Basics

User's who desire to improve the telephone networks' audio quality, either within their telephone service area or from distant locations, may find the dial-up telephone network unacceptable. The problem with direct dial lines is their frequency response of 300 to 3300 Hz. The frequencies lost in the low end (bass) are very important to the perceived quality and fidelity of the audio.



One way to make use of the cost effective convenience of direct dial lines, and at the same time remedy the low frequency response problem, is to employ a process called Frequency Extension. A frequency extender takes the remote audio and shifts all frequencies up 250 Hz. Thus, 50 Hz becomes 300 Hz and 3000 Hz becomes 3250 Hz. This new, shifted audio band more closely fits the frequency response of the direct dial telephone line. At the receiving end of the call, another piece of frequency extension equipment down-shifts the audio. 300 Hz from the phone line is returned to its original 50 Hz. This process preserves 2-1/2 octaves of critical low frequencies while sacrificing only 1/7th of an octave at the high end.

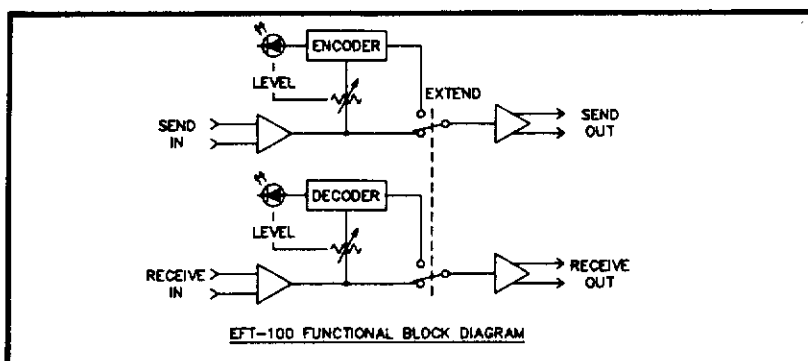
Gentner's frequency extension systems employ patented circuitry for generating additional new high frequency components from the remote audio, thus giving the line an apparent increase in high frequency response. This yields a more natural sound from the telephone-transmitted audio.

As an "in-line" device, the EFT-100 connects between your telephone hybrid and audio equipment. Connection is simple. The EFT-100 allows audio to pass through normally until you depress the "EXTEND" button. At this point, the audio to and from your telephone hybrid is frequency extended.



SECTION TWO  
PRODUCT DESCRIPTION

2.1 Functional Description

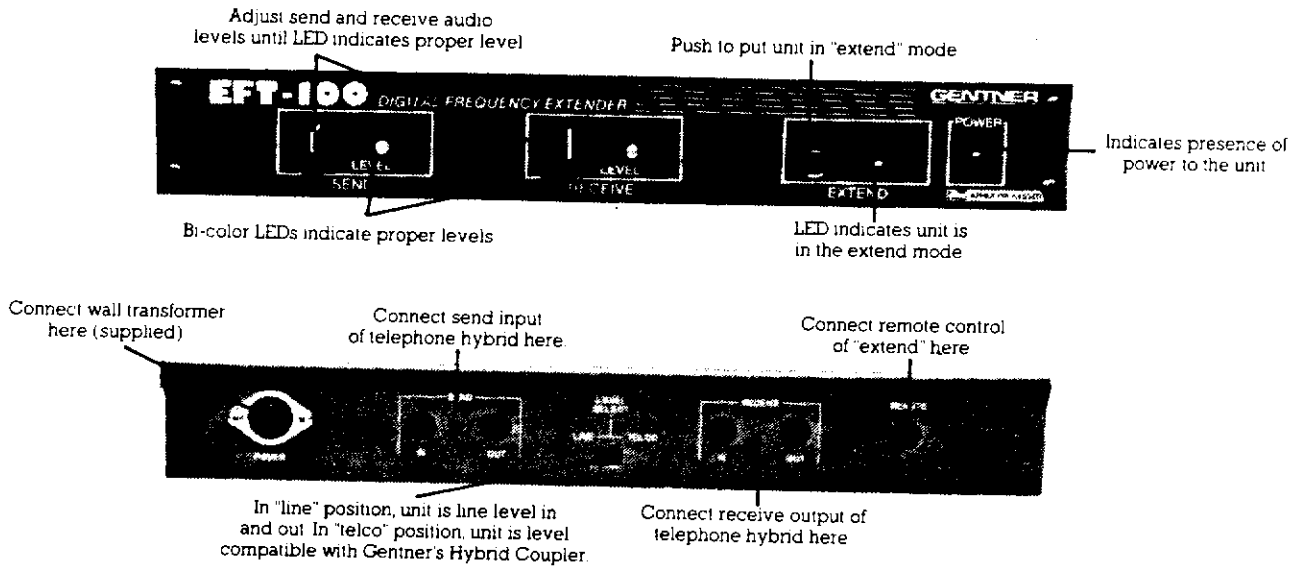


Input audio is balanced bridging, and is applied to both the send and receive input stages. In the "non-extended" mode, audio simply passes through the unit at unity gain and appears at the 600 Ohm balanced output.

Audio is applied to the encoder and decoder via the front panel level trimmers. Level indicating bicolor LED's are used to indicate that proper level is sent to the encoder and decoder. During operation, these LED's should constantly glow green and flash red on audio peaks. This ensures optimum SNR and headroom through these circuits.

The encoder shifts the audio up 250 Hz while the decoder shifts the audio down by 250 Hz. In the "extend" mode, the encoded and decoded audio is sent to the output. The "extend" relay can be removed. The EFT-100 simultaneously encodes and decodes audio, making it a true two-way device.

## 2.2 EFT-100 Front Panel and Rear Panels



### 2.3 Specifications

Dimensions: 11.75" W x 1.75" H x 8.75" D

Weight: 4.75 Lbs. (2.15 Kg) Dry  
7 Lbs. (3.18 Kg) Shipping

Power: 117/234 VAC 50/60 Hz  
11 Watts  
External Power Supply Included

Connectors: All 1/4" Phone

Line/Telco Switch: Makes unit directly compatible with Gentner Hybrid Coupler.

Inputs: Active balanced bridging  
0 dBm nominal, adjustable  
(-20 dBm receive input when switch is in "TELCO" position.)

Outputs: Active Balanced 600 Ohms  
0 dBm nominal  
(-12 dBm send output when switch is in "TELCO" position.)

Frequency Shift: 250 Hz (Comrex Compatible)

Frequency Response: 50 Hz to 3 KHz +/- .5 dB

SNR: > 80 dB Non-extended  
> 54 dB Extended

Distortion: < .01 % THD Non-extended  
< 0.6 % THD Extended

\*\*\* All specifications referenced to -9 dBm telephone level and an ideal phone line. \*\*\*

## SECTION THREE

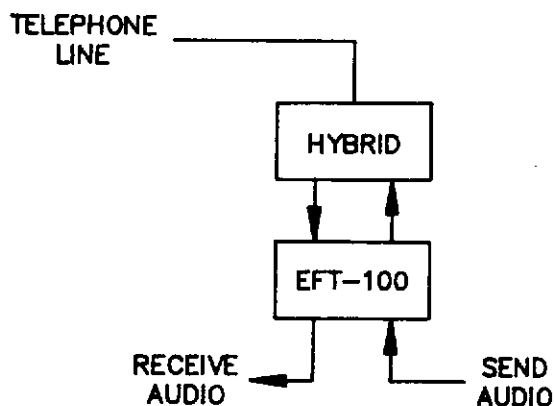
### INSTALLATION

#### 3.1 Remote Site Installation

Installation of an EFT-100 is simple. Power is supplied via a 34 VAC wall transformer. This connection is made via the rear panel DIN connector on the EFT-100.

All other connections are made via rear panel 1/4" phone jacks. These 1/4" connector's electrical characteristics are as follows:

TIP	+ Audio
RING	- Audio
SHIELD	Ground



The send audio source is connected to the "SEND IN" 1/4" connector on the EFT-100 rear panel. This source is typically the output of a microphone mixer or an audio recorder.

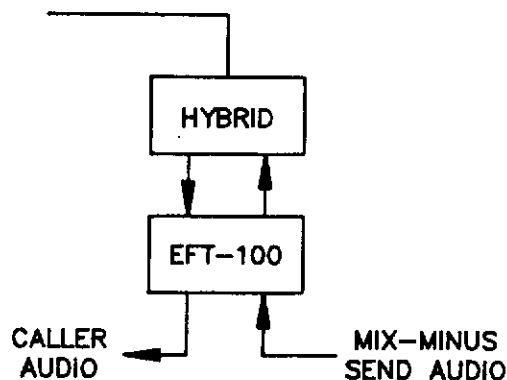
The "SEND OUT" 1/4" connector connects to the telephone interface (hybrid) send input.

The "RECEIVE OUT" 1/4" connector contains receive or "caller" audio and is typically connected to a headset amplifier or speaker amplifier input.

The "RECEIVE IN" 1/4" connector connects to the telephone interface (hybrid) caller output.

### 3.2 Studio Installation

Since the EFT-100 used at the studio is identical to the unit used at the remote site, installation is similar.



As the above diagram shows, the send audio source is connected to the "SEND IN" 1/4" connector on the EFT-100 rear panel. This source is typically the output of a microphone mixer, an audio recorder, or a broadcast console's mix-minus send audio.

The "SEND OUT" 1/4" connector connects to the telephone interface (hybrid) send input.

The "RECEIVE OUT" 1/4" connector contains receive or "caller" audio and is typically connected to a headset amplifier, speaker amplifier, or "caller" channel of a broadcast console.

The "RECEIVE IN" 1/4" connector connects to the telephone interface (hybrid) caller output.

### 3.3 The EFT-100 Used for Teleconferencing

Gentner Electronics Corporation recommends that for teleconferencing, a Gentner Digital Hybrid should be used in conjunction with an EFT-100. The Gentner Digital Hybrid optimizes its' hybrid (two-wire to four-wire conversion) performance by using a digital signal processor to continually and automatically match the telephone lines impedance.

To install a Digital Hybrid with an EFT-100 for teleconferencing purposes, the output of a microphone mixer is connected to the "SEND IN" 1/4" connector on the EFT-100 rear panel.

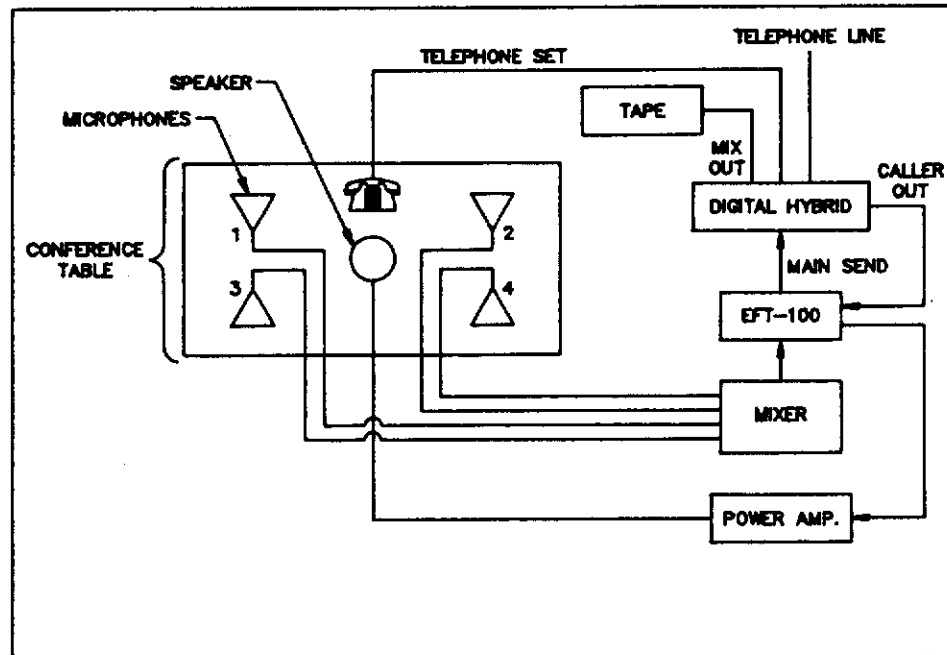
The "SEND OUT" 1/4" connector on the EFT-100 connects to the Digital Hybrid's main send input XLR.

Note: If only a microphone is required, it can be connected directly to the Digital Hybrids main input. The Digital Hybrid has a built in, one channel microphone pre-amplifier.

The "RECEIVE OUT" 1/4" connector on the EFT-100 is connected to a power amplifier's input.

The "RECEIVE IN" 1/4" connector on the EFT-100 connects to the Digital Hybrid's caller output XLR.

A suggested conference room format is shown in the diagram below.



### 3.4 EFT-100 Remote Control

By depressing the EFT-100's front panel "EXTEND" switch the unit upshifts the send audio and downshifts the receive audio.

This process can be remoted by providing a sustained closure between the TIP and SLEEVE terminals of a 1/4" jack inserted into the "REMOTE" rear panel connection.

### 3.5 EFT-100 Line Selection Control Switch

The rear panel of the EFT-100 contains a LINE SELECT two pole switch. This switch controls the gain structure of the unit. In the LINE position, the EFT-100 is set for unity gain. In the TELCO position, the EFT-100's Send circuit is attenuated by 12 dB and the receive circuit is amplified an additional 20 dB.

The TELCO position should only be used in conjunction with passive hybrids and telephone couplers. Passive devices are those that do not provide amplification of audio. One such passive device is the Gentner Hybrid Coupler.

## SECTION FOUR

### OPERATION

#### 4.1 EFT-100 Control

Once EFT-100 installation is complete, operation is simple.

For normal, non-extended audio feeds the units' front panel "EXTEND" switch should not be engaged. During non-extended audio feeds the front panel trimmers are not active, however, the send and receive bi-color LED's signal proper audio levels. Remember, in non-extended mode both the send and receive circuits have unity gain.

If an audio feed requires frequency extension the "EXTEND" switch should be depressed. When "extended" the front panel EXTEND LED is lit and the front panel trimmers become active. When the front panel trimmers are set at 1:00 o'clock and the "EXTEND" switch is depressed, both the send and receive circuits have unity gain.

#### 4.2 EFT-100 Level Setting

By adjusting the front panel SEND and RECEIVE trimmers, the EFT-100 gain structure can be formatted to cleanly send and receive audio from all sources.



## SECTION FIVE

### TECHNICAL DESCRIPTION

#### 5.0 Theory of Operation

Refer to the electrical schematic drawings at the back of this manual during the following discussion.

The EFT-100 mechanical enclosure contains the following assemblies.

1. An input printed circuit card.
2. An Encoder/Decoder printed circuit card.

The input printed circuit card contains the necessary electronics to interface the Encoder/Decoder assembly to the outside connectors. It also contains the unit's power supply. This supply consists of +/- 15 VDC regulators to power the analog circuits and a + 5 VDC regulator to power the digital circuitry.

The input printed circuit card contains the "EXTEND" relay and its associated components.

The encode/decode assembly contains the necessary electronics to make the 250 Hz frequency shift.

The EFT-100 employs the phasing method to create a single sideband transmission and applies it to balanced mixers for modulation. This is done by phase shifting the carrier and the intelligence 90 degrees.

The various building blocks of the Encode/Decode board include clock/divider circuitry, data stored in a 27C16 EPROM, latches, phase filters, digital to analog converters, balanced mixers, and an APHEX hybrid integrated circuit.

The master clock of the Encode/Decode process is set by a 4.032 MHz Crystal. This input frequency is tuned to +/- 10 Hz by the parallel trimmer capacitor C1. The clock frequency is divided by 64 by U2, a 74HC4060 binary divider, to have an output frequency of 63 KHz. This pulse is sent to two more binary counters, U8 and U16, the 74HC163's, for further frequency division. The resultant clock rates are used in the creation of both a 126 sample digital sine and digital cosine wave. These two waves are also controlled by the data stored inside the 27C16 EPROM which is U9.

Two eight bit latches, U10 and U11 (74HC374's), are used to distinguish between the cosine and sine waveforms. On a positive transition of the clock the sine waveform is being latched onto the inputs of the digital to analog converters, U3, U4, U12 and U13 which are all PM-7533 DAC's. On the negative transitions, the cosine waveform is latched on the DAC's inputs.

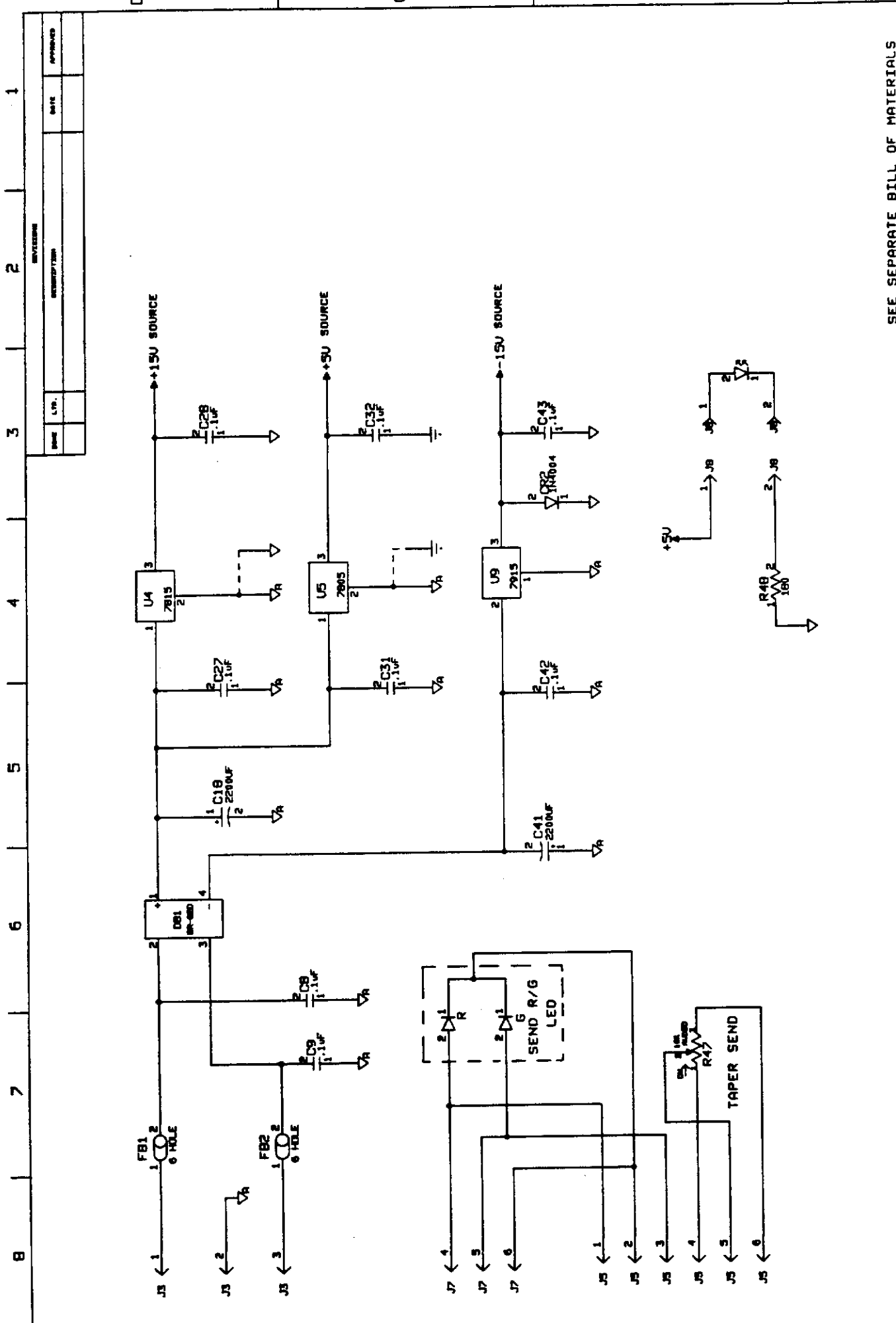
The physical trigometric frequency shift is performed by operational amplifiers, LF347's, biased as all-pass filters. The poles of each filter were chosen so that the necessary 90 degrees of phase shift occurs over the entire audible frequency spectrum. By using trigometric identities, the calculations for each capacitor and resistor value needed were obtained. The programmable DIP's installed with one percent resistors are used to set the corner frequencies because of the tolerance levels of electronic capacitors.

The digital-to-analog converters give ten bits of resolution when used as implemented. This, along with the latching process of distinguishing between sine and cosine waves, and the implementation of a compander, mathematically drops the noise floor to -54dB. The resistor feedback properties of DAC's help exact the cancellation of the unused sideband.

The APHEX circuitry was added to the EFT to re-create the high frequencies lost over telephone transmission mediums. The APHEX processor, in essence, adds two more octaves of otherwise lost high frequency intelligence.

The APHEX circuit contains a user settable trimmer option. This single turn trimmer pot is the only user adjustment internal to the EFT-100. It is located on the Encode/Decoder assembly and is factory set according to the ratio between receive signal strength of a 1 KHz tone and its harmonics. Additional APHEX processing can be inserted by rotating this trimmer clockwise.

**CAUTION!** Too much APHEX processing causes severe distortion.



SEE SEPARATE BILL OF MATERIALS

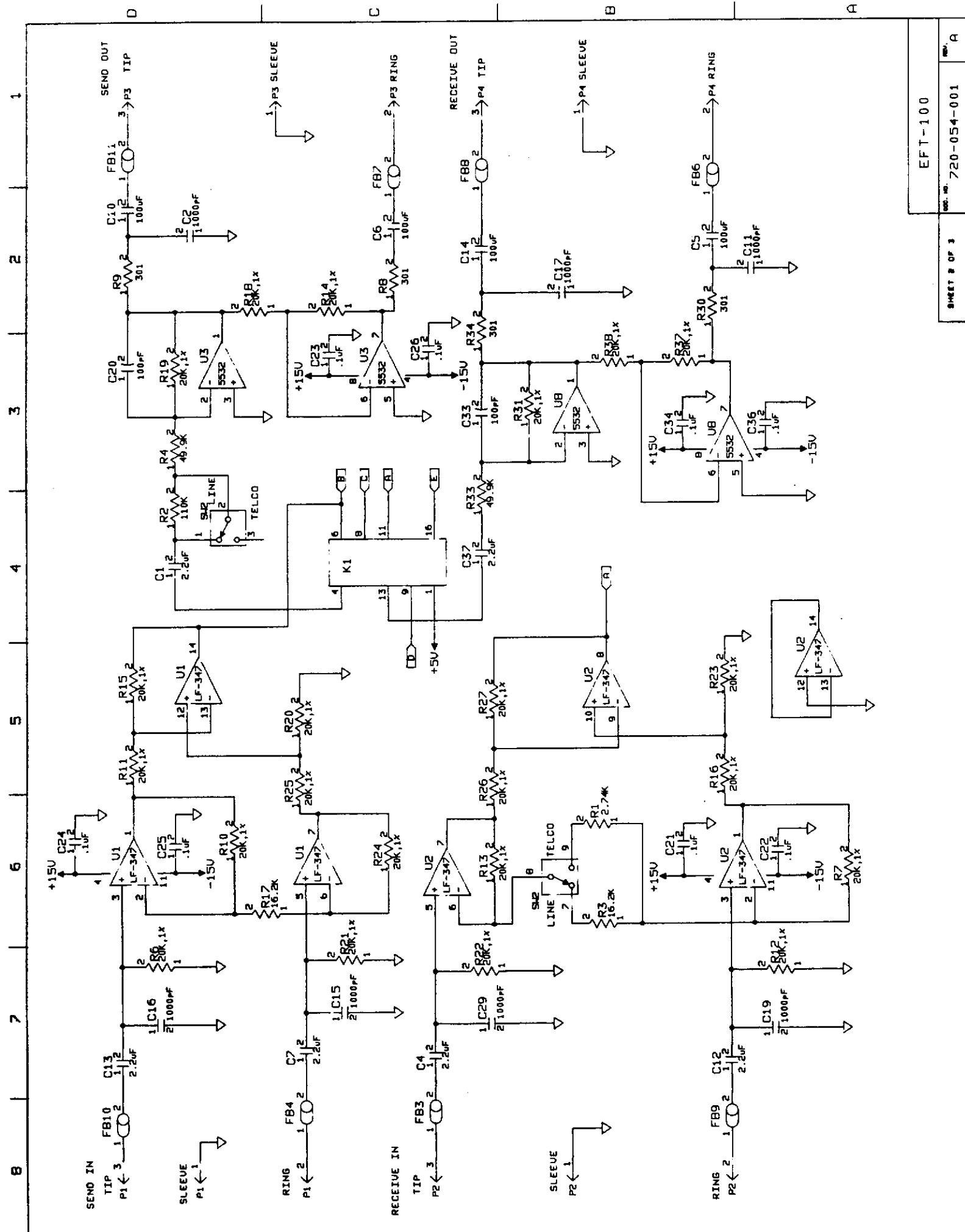
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CHECKED BY	W. J. GENTNER	DATE
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TITLE		
EFT-100		
ELECTRICAL SCHEMATIC		

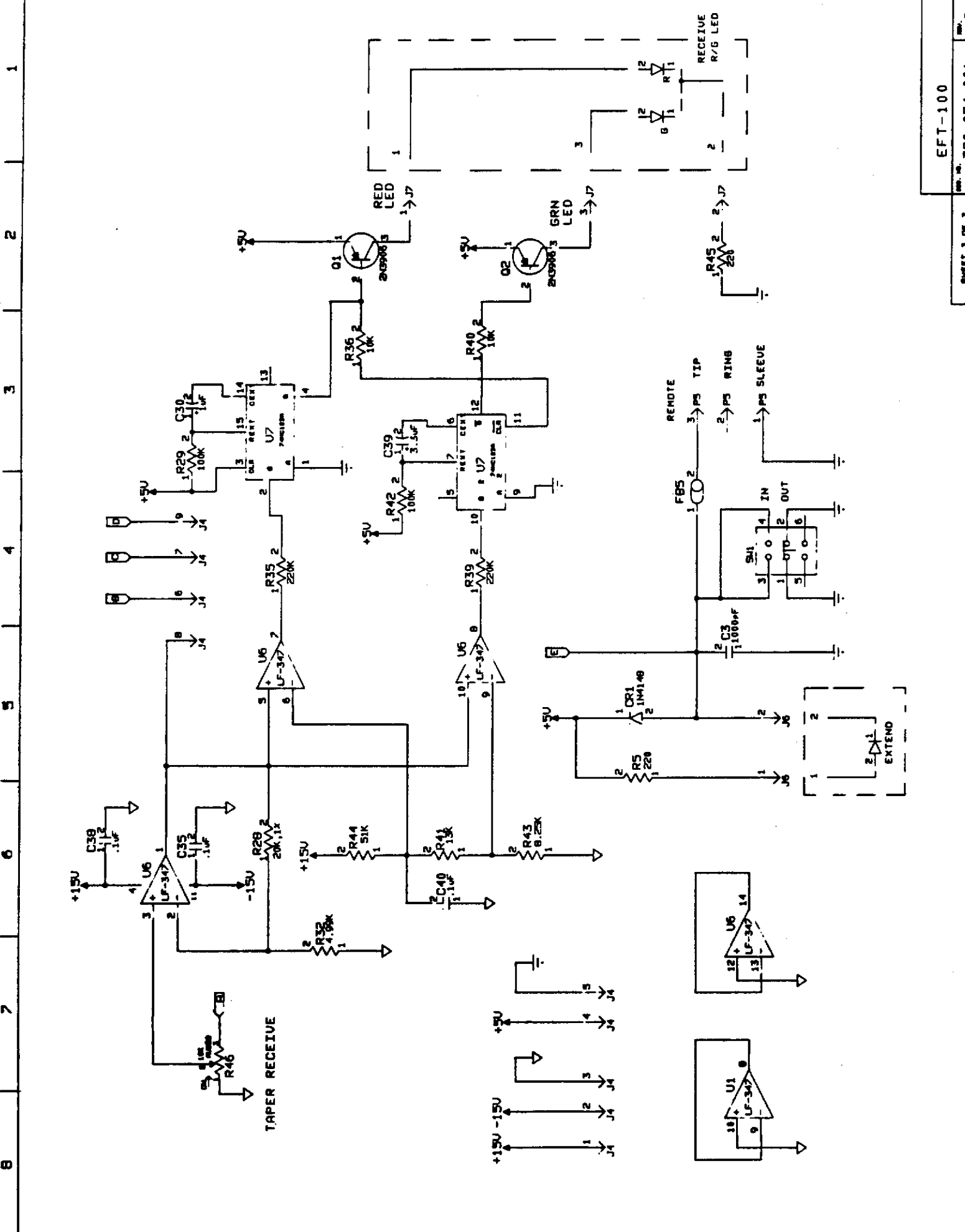
NOTES: UNLESS OTHERWISE SPECIFIED:

- RESISTANCE VALUES ARE EXPRESSED IN OHMS, "K" DENOTES 1000 OHMS. CAPACITANCE VALUES ARE EXPRESSED IN MICRO FARADS, (UF). INDUCTOR VALUES ARE EXPRESSED IN MICRO HENRIES, (UH).

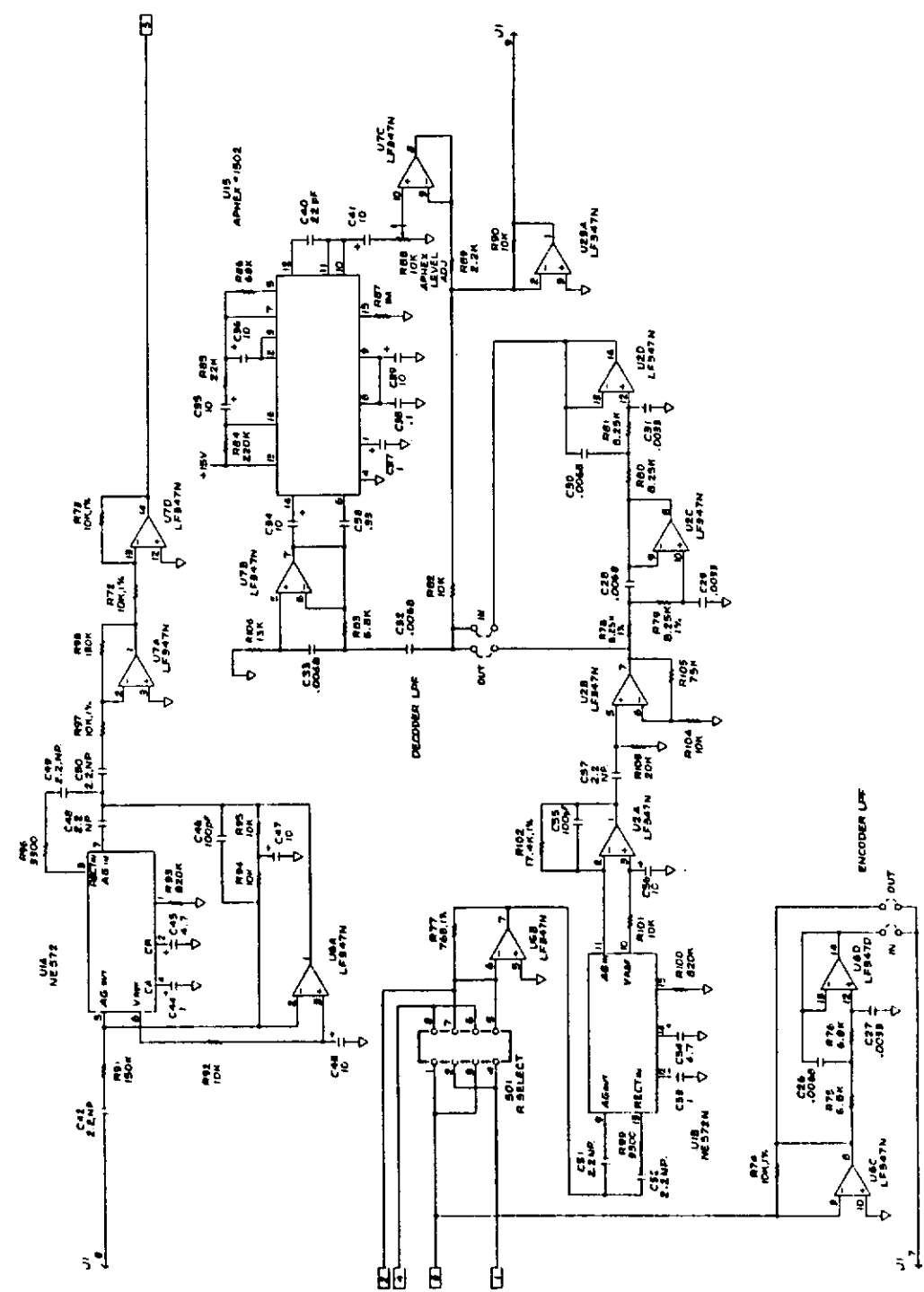
2. STANDARD GROUND SYMBOLS:

- DIGITAL GND
- ANALOG GND
- R.F.I. GND
- SPECIAL GND









# WARRANTY

GENTNER COMMUNICATIONS 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 one year from the date of the original purchase, provided the owner returns the equipment to the Manufacturer at the address set forth below. No charge will be made for parts or labor during this period;

B. 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 an 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's 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***

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