2XR
Two Line Decoder
Product Manual

2XR TWO LINE FREQUENCY EXTENDER DECODER OPERATING & TECHNICAL MANUAL

Comrex Corporation
65 Nonset Path
Acton, MA 01720
Tel: 508 263-1800
FAX: 508 635-0401
Twx: 710 347-1049

The Model 2XR Two Line Frequency Extender Decoder is a direct replacement for the Model RTLX Two Line Frequency Extender Decoder. The 2XR may be used with 2XP & PTLX Two Line Encoders as well as the 3XP Multiline Encoder (operating in the two line mode). The 2XR is NOT suitable for use with One Line Encoders.

The 2XR incorporates a new metering system for manual setting of program lines to equal level and internally adjustable equalization to compensate for poor high frequency response on the telephone lines between the receive site and the local telephone central office.

Description of Front Panel Controls and Indicators:

SET LEVEL LINE 1/SET LEVEL LINE 2 - These controls are used to establish equal receive gain levels for the two incoming lines.

LINE 1 & 2 LEVEL INDICATORS - These consist of two groups of LEDs (red, green, red) and are used to set the incoming program lines to equality. When the 1000 Hz tones are sent down both program lines from the 2XP, the level set knobs will be adjusted at the receiving end so that green LED on each line is illuminated. It is normal for the LEDs to vary to the + and - sides when program material is being transmitted. (Note: the Comrex Model LX-L Auto Leveler will make these adjustments automatically, if desired.)

2 LINES/1 LINE - This switch converts the 2XR to one line operation.

NORMAL/REVERSE LINE 1 & 2 - The low band may be switched to the surviving line in the event of failure of the low band line.

POWER - This indicates that A/C power is connected through the 2XR.

Rear panel connections:

BARRIER STRIP POSITIONS 1-10 - These terminals provide connections into the 2XR from the telephone lines and out of the 2XR into the customer's audio facilities. Pin connections are as follows:

Pins 1 & 2 - line 1 audio in (transformer balanced)
Pin 3 - line 1 ground
Pins 4 & 5 - line 2 audio in (transformer balanced)
Pin 6 - line 2 ground
Pins 7 & 8 - audio out (0 dB active balanced)
Pins 9 & 10 - ground.

A/C POWER - This is a three terminal power connector.

Dial Telephone Lines to Model 2XR

Connection to the dial telephone circuits will require some type of telephone coupler. This coupler will serve to hold the telephone line and to isolate the input circuits of the 2XR from the direct currents that are on the telephone line.
There are many couplers available and the selection of these devices is left to the customer. As a note of caution, however, some couplers are designed primarily for data transmission and contain clippers and filters which can substantially degrade the audio quality. In addition, amplified couplers are in use which are intended for connection to message recorders. Neither the amplifier or the automatic gain control circuitry contained in these couplers is designed for broadcast audio.

Comrex Corporation manufactures two telephone couplers which may be used for interfacing the 2XR and dial telephone lines. The Model TCB-1A is a manually operated coupler and the Model TCB-2A is an automatic answering coupler. When the sending end

dials the line to which the TCB-2A is connected, the ringing signals cause the line to "pick up" the line. When the 2XP is disconnected from the line, the TCB-2A hangs up the line and is ready for the next call. (Two TCB-2A couplers are used with the LX-L Auto Leveler and the 2XR for unattended receive operation.)

Assuming the two telephone couplers are connected to the telephone lines, the coupler outputs should be connected to the inputs of the 2XR. Pin connections on the 2XR rear barrier strip are:

Line 1 - Pins 1 & 2 audio, Pin 3 ground.
Line 2 - Pins 4 & 5 audio, Pin 6 ground.

Model 2XR To Receiving End Program Facilities

The output of the 2XR is 0 dBm into a 600 ohm load, actively balanced. The output connections of the 2XR are at the barrier strip pins 7 & 8. Pins 9 & 10 are ground.

Setup of the 2XR:

1. If the 2XR couplers are connected to telephones, the phones will ring when they are dialed. After the operator has answered and finished communication, the line can be held by placing the toggle switch on the TCB-1A coupler in the hold position. **THE TELEPHONE HANDSET MUST BE HUNG UP** so that unencoded background noise is not picked up by the microphone of the telephone instrument and fed into the line along with the encoded program material. Also, the telephone set will load down the line and reduce the signal level. Check to see that there are no extension telephones off hook on the line as well.

2. Check that switches are set as follows:

1 LINE/2 LINES switch in 2 LINES position
NORMAL/REVERSE LINES 1&2 switch to NORMAL

3. When lines 1 and 2 have been picked up and the test tone is being fed down the lines from the 2XP, the 1 KHz tones from the 2XP will appear at the output of 2XR as 750 Hz (line 1) and 3000 Hz (line 2). While the test tone is on, adjust the two level controls on the 2XR front panel so that the green center LEDs are illuminated on both lines.

4. Have the remote site send a program test and determine whether the EQ in the 2XP should be IN or OUT. During program transmission, it will be normal for the LEDs to flash red into the + and - sides of each line.

This completes the setup of the 2XR.

NOTE: THE ABOVE SETUP PROCEDURE MAY BE MADE FULLY AUTOMATIC WITH THE ADDITION OF THE LX-L AUTO LEVELER AND 2 TCB-2A AUTO-ANSWER COUPLERS.

In Case of Line Failure:

The receive site is likely to be the first to know if a line has been lost. If line 1 fails, the receiving site operator will hear a loss of low frequencies or a downshifted dial tone. If Line 2 fails, the operator may notice the loss of high frequencies as the program material is cut from 5000 Hz to 2400 Hz or he may hear an upshifted dial tone.

If a line fails, it will be necessary to contact the transmit site and convert the system to one line operation. This is done as follows:

1. If Line 1 fails, put the NORMAL/ REVERSE LINES 1&2 switch in the REVERSE LINES 1 & 2 position at both the 2XR and 2XP. Then, put the 2 LINES/1 LINE switch in the 1 LINE position on both the 2XR and 2XP.

2. If Line 2 fails, leave the NORMAL/ REVERSE switch in the NORMAL position and set the 2 LINES/1 LINE switch to 1 LINE at both the 2XR and 2XP.

The NORMAL/REVERSE LINES 1&2 switch puts the low frequency content of the program onto the surviving line (Line 2). The 2 LINES/1 LINE switch sums the output of the highband compressor with the lowband compressor resulting in a wideband feed to the low band upshifter. The transmission will go through the telephone line and emerge as 50 to 2850 Hz. Naturally, it will not be of the same bandwidth as that of the full system, but it will still be quite usable until the second line can be re-established.

To better understand the operations of the these switches, assume that you have set up the system as described previously and that it is working properly. Assume that the receive site is in contact with the transmit site via the third line. Now assume that Line 2 fails. (This presumption is that the telephone line itself has failed.) At the transmitting end, the operator will have no way of knowing that the line has failed, but at the receiving end, the high frequencies will either disappear or an upshifted dial tone will be heard. The receiving site operator will immediately throw his 2 LINES/1 LINE switch to 1 LINE and the dial tone will disappear, but there will be no frequencies above 2400 Hz. The transmitting site operator, upon notification that line 2 has failed, will then throw his 2 LINES/1 LINE switch from 2 LINES to 1 LINE. This will increase the high frequency response of the system to 2850 Hz. The operators can then reestablish the lost line connection and return to 2 line operation. NOTE: THIS SHOULD BE DONE DURING A PROGRAM BREAK AS IT WILL BE NECESSARY TO RESET THE LINE LEVELS WITH THE TEST TONE.

Line Equalization:

As part of the second generation 2X system, Comrex has included user adjustable EQ circuits on both the send and receive portions of the system. Once set properly, these equalizers should significantly improve your performance when working on poor telephone lines. Both the 2XP and 2XR EQ circuits will lift the response of the high end of the telephone line, where response "droop" is most common.

It is important to understand that any phone line response problem exists between you and your central office, not on the toll network. With few exceptions, all Central Office interconnects are digitized and can be assumed to have a flat response. For this reason, you must keep in mind that you are equalizing ONLY your local loop to your central office.

The 2XR EQ is added via jumpers clearly labeled on the PC board. We assume you will always use the 2XR on the same two telephone lines, so it is wise to run a frequency response sweep on those lines before installing the extender. (See "How To Measure a Telephone Line" in the back of this manual.) If either of the lines you are connecting to the 2XR show a frequency response similar to the "Response of a Poor Line," place the EQ jumper(s) on the 2XR board in the IN position for the appropriate line(s). The aomount of EQ is factory set to fix the "average bad line." This setting may be adjusted for each line by the pots associated with each EQ network. By using the measuring techniques described later, you can equalize the high end of each line by as much as 10dB to the flattest possible response.

Basic Trouble Shooting

The Comrex two line frequency extension system is designed to operate for long periods of time without adjustments of any kind. The frequency determining components are crystals and will stay on frequency without need for adjustment almost indefinitely. In the event that trouble does occur, Comrex Corporation stands ready to assist in any way it can.

As a first step, may we suggest a careful inspection of connecting cables and fuses. Most often these are the causes of failures.

Please feel free to call our engineering department at (508) 263-1800. We are usually available between the hours of 0900 & 1800 (US Eastern Time) Monday - Friday of each week. Our FAX number is (508) 635-0401. If, due to time zone problems, you are unable to reach us during the above hours, please notify us by FAX and we will make an engineer available for a call in your time frame or advise you by return FAX.

Our factory service is always available. Express services, able to provide next day service, are available from most parts of the United States and many other parts of the world.

How to Measure a Telephone Line

If your station puts telephone calls on air in any of your locally produced programming, we urge you to make the time to take a careful look at the actual telephone lines you are using. Comrex Corporation has been involved in telephone interface for over 15 of its 28 years. In the course of our work, we've measured several hundred telephone circuits. (Indeed, we're lucky that our chart recorders don't put in for overtime!) What we have found is that all telephone lines are definitely NOT created equal and to the degree that they fall away from the norm, they can wreak havoc with any telephone interface equipment on that line. Telephone hybrids won't balance properly, frequency extenders produce poor results, noise reduction systems run amok and so on.

In this application note we will discuss how you can measure your phone lines and what you are actually looking at. We'll go on to look at what might be the causes of any deficiencies in your lines and give you some suggestions as to how you might go about dealing with them.

First, we'd like to point out that the only portion of a telephone circuit over which you are likely to have any control is the subscriber loop running from your station to the telephone central office. The subscriber loop consists of a SLIC (Subscriber Line Interface Card) at the central office, a loop usually made up of #24 or #26 gauge twisted wire and a modular or punch block connector at the station end. Unless the phone company reconstructs that line or moves to another location, the characteristics of that loop remain constant.

One of the functions of the SLIC is to convert your "two wire" subscriber loop to "four wire." The send and receive ports of the hybrid are then connected to digital encoder/decoders for transmission to other central offices through other CODECs and SLICs to other subscriber loops and callers. Once your call has been digitized, you have no further "metallic" connection to the outside world and therefore it is impossible for your to control the impedance characteristics of the circuit beyond the SLIC.

When Comrex moved to a new facility, we made frequency response measurements of all our subscriber loops by sending a frequency sweep of 50 Hz to 5000 Hz out one line and back into another line, measuring at the point the line entered the building and not downstream of our in house PABX. We repeated this, choosing different lines until we found a fairly flat response from 300 Hz to 3000 Hz on a pair of lines (see Chart 1). We then knew that both Lines A and B were reasonably good and we established Line A as our reference against the rest of the lines to our building. When we looked at Line A through Line C, we found that there was a marked difference in the high frequency response between 2000 and 3000 Hz. (See chart 2) The A to B circuit was down 2 dB at 2 KHz and 6 dB at 3 KHz while the A to C circuit was down 8 dB at 2 KHz and 12 dB at 3 KHz. While Line C might be acceptable for normal telephone use, it would be very difficult to obtain an adequate hybrid balance for on air use. Similarly, any companding or processing system on that line will accentuate the high end droop. The likely cause of the high frequency rolloff of line C is a bridged tap on the subscriber loop.

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(508) 263-1800

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Telephone companies usually follow major arteries and their cross streets when installing cables. Whenever these cables cross, a junction box is provided. If new service is requested, a connection is made at the nearest junction box and later if that service is stopped, the service on that line is denied by a digital command to the SLIC at the central office. If another new service request comes for a site a couple of blocks down, the telephone company may use the same line on the main artery and simply connect to the junction box two blocks down. If they don't remember to disconnect the first cross street cable, the new line will consist of a cable between the central office and the new site PLUS an open ended piece of cable going down the first cross street.

This is called a bridged tap and it is quite possible to have more than one on a line. Because it is open ended and not terminated, it is simply a large capacitor connected across your line. It's a great source of noise and its capacitance is more sensitive to the environment than a discrete capacitor would be. Also, its presence will make hybrid balance difficult.

Bridge taps are a fairly common problem. Other hazards include loading coils which are often used by the phone company to improve the high end response of subscriber loops over 6000'. These can produce widely varying impedances across the 300 to 3000 Hz band and provide complications for any telephone hybrid on that loop.

If you have identified certain lines as "problem lines," what can you do about them? In the case of the bridge tap, armed with your frequency response measurements, you can call the telephone company and ask them to remove it. We know of some broadcasters who have actually been able plead their case and get results. If you can't get the line fixed, you might try asking for a special "data conditioned" line. In this instance, the phone company installs a "conditioning box" at your SLIC which equalizes the loop to some extent. This is typically used for high speed modem applications. The line has all the characteristics of a normal dial business line but costs somewhat more (about $15/mo).

Another approach would be to put an equalizer on the line at the station. This would not help a hybrid since it won't equalize both ways, but it would take care of one-way feed applications. Perhaps the simplest approach would be to mark all the lines you do not want to use on air and give them to the business office. They're fine for run of the mill conversation and you can save the good ones for your programs.

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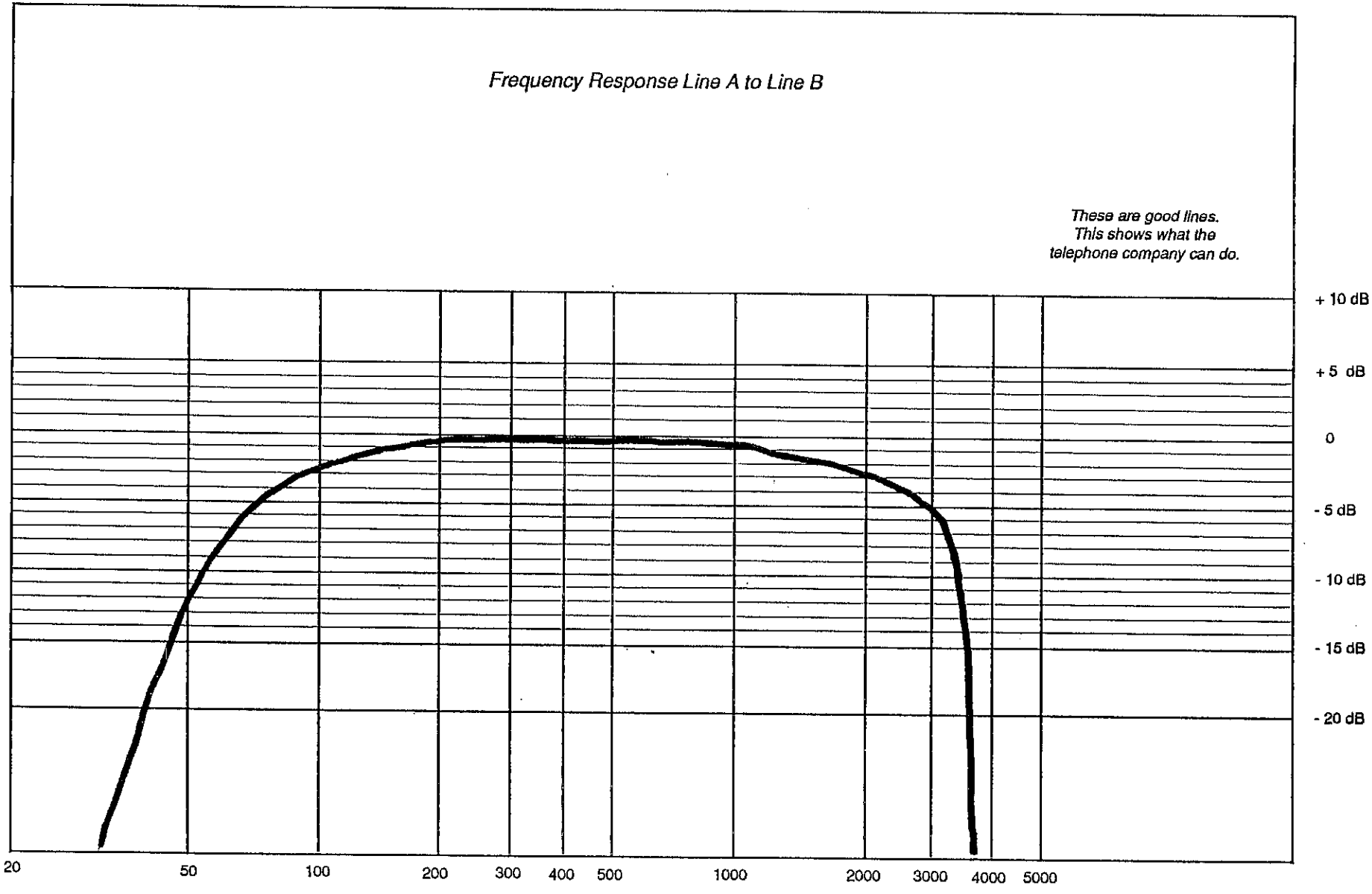

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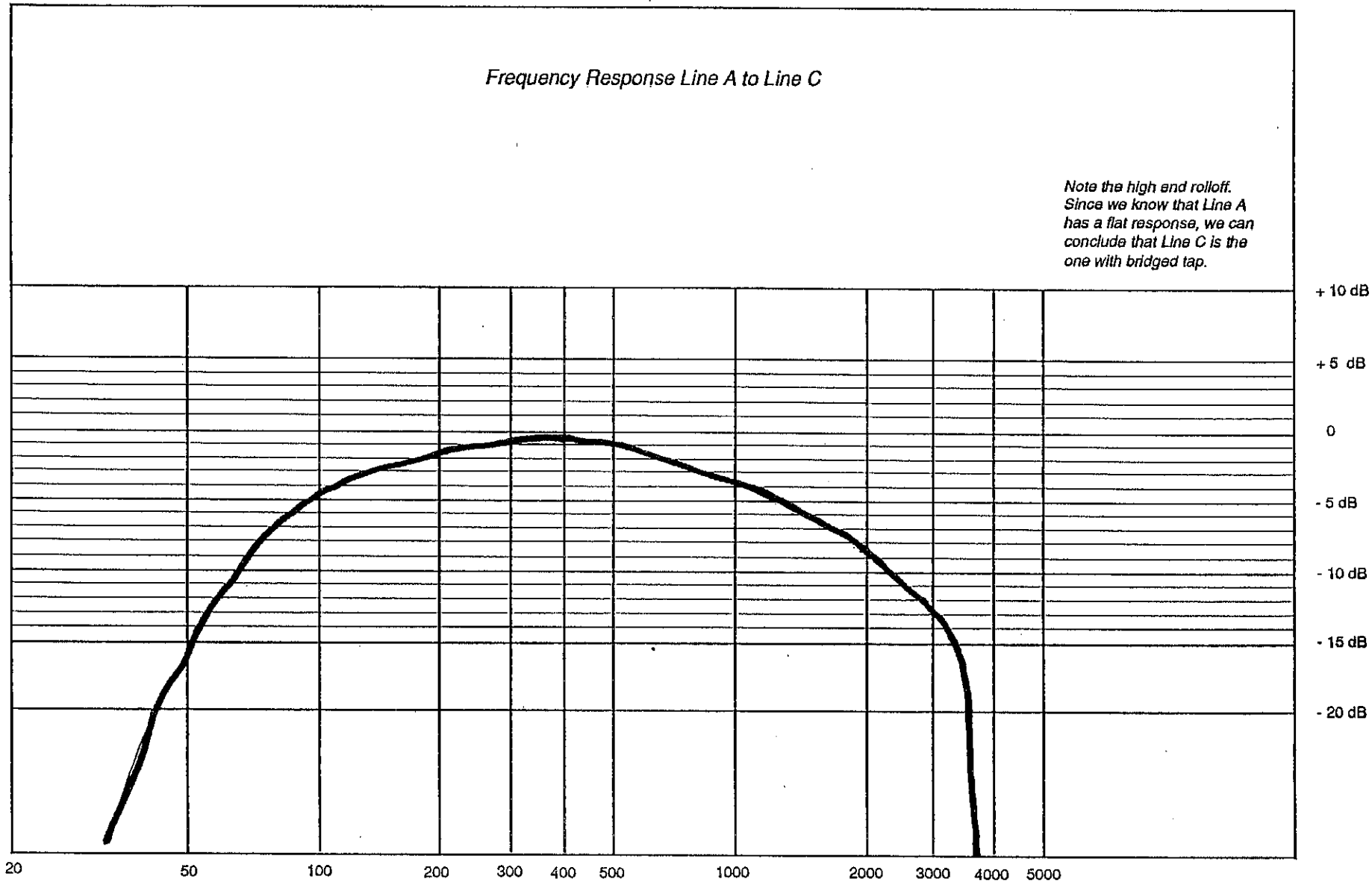
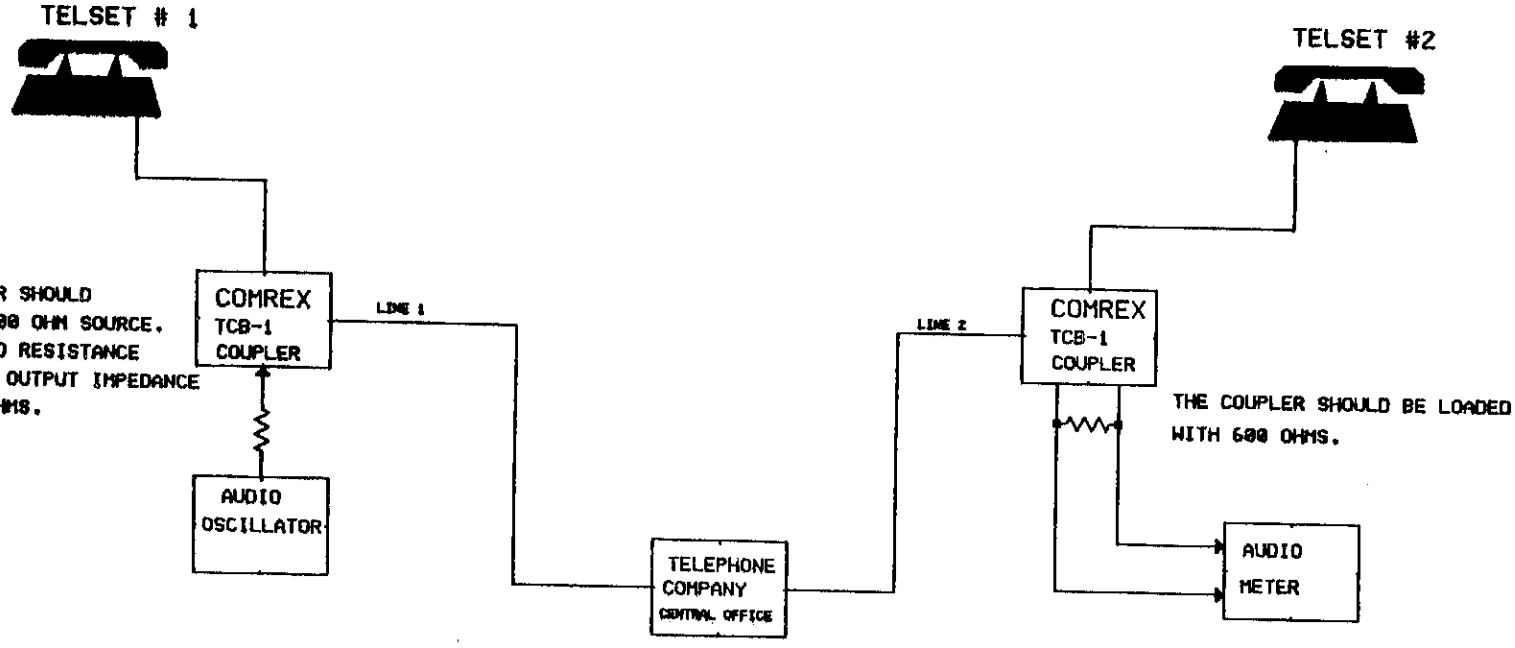


HOW TO MEASURE THE FREQUENCY RESPONSE OF YOUR TELEPHONE LINES.



NOTE:
THE COUPLER SHOULD BE DRIVEN FROM A 600 OHM SOURCE. YOU MAY HAVE TO ADD RESISTANCE IF YOUR OSCILLATOR OUTPUT IMPEDANCE IS LESS THAN 600 OHMS.

THE COUPLER SHOULD BE LOADED WITH 600 OHMS.

PROCEDURE:

1. CONNECT THE COUPLERS TO THE DIAL TELEPHONE LINES.
2. MAKE CERTAIN THAT THE COUPLERS ARE NOT IN "SEIZE".
3. FROM TELSET #1 DIAL TELSET #2.
4. WHEN TELSET #2 RINGS PICKUP TELSET #2 OR PLACE COUPLER IN "SEIZE".
5. PLACE BOTH COUPLERS IN "SEIZE" AND HANG UP THE TELEPHONE SETS.
6. SET THE OSCILLATOR FOR 250 MILLIVOLTS OUTPUT AT 1 KHz. YOU SHOULD SEE A READING ON THE AUDIO METER. ADJUST EITHER THE OSCILLATOR OUTPUT OR THE METER SENSITIVITY TO OBTAIN A CONVENIENT READING.
7. VARY THE OSC. FREQ. OVER THE RANGE 50Hz TO 5KHz.
8. RECORD THE READINGS AND PLOT THE RESPONSE CURVE.

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TITLE TELEPHONE LINE FREQUENCY RESPONSE MEASUREMENT

DATE 27 SEPT 91

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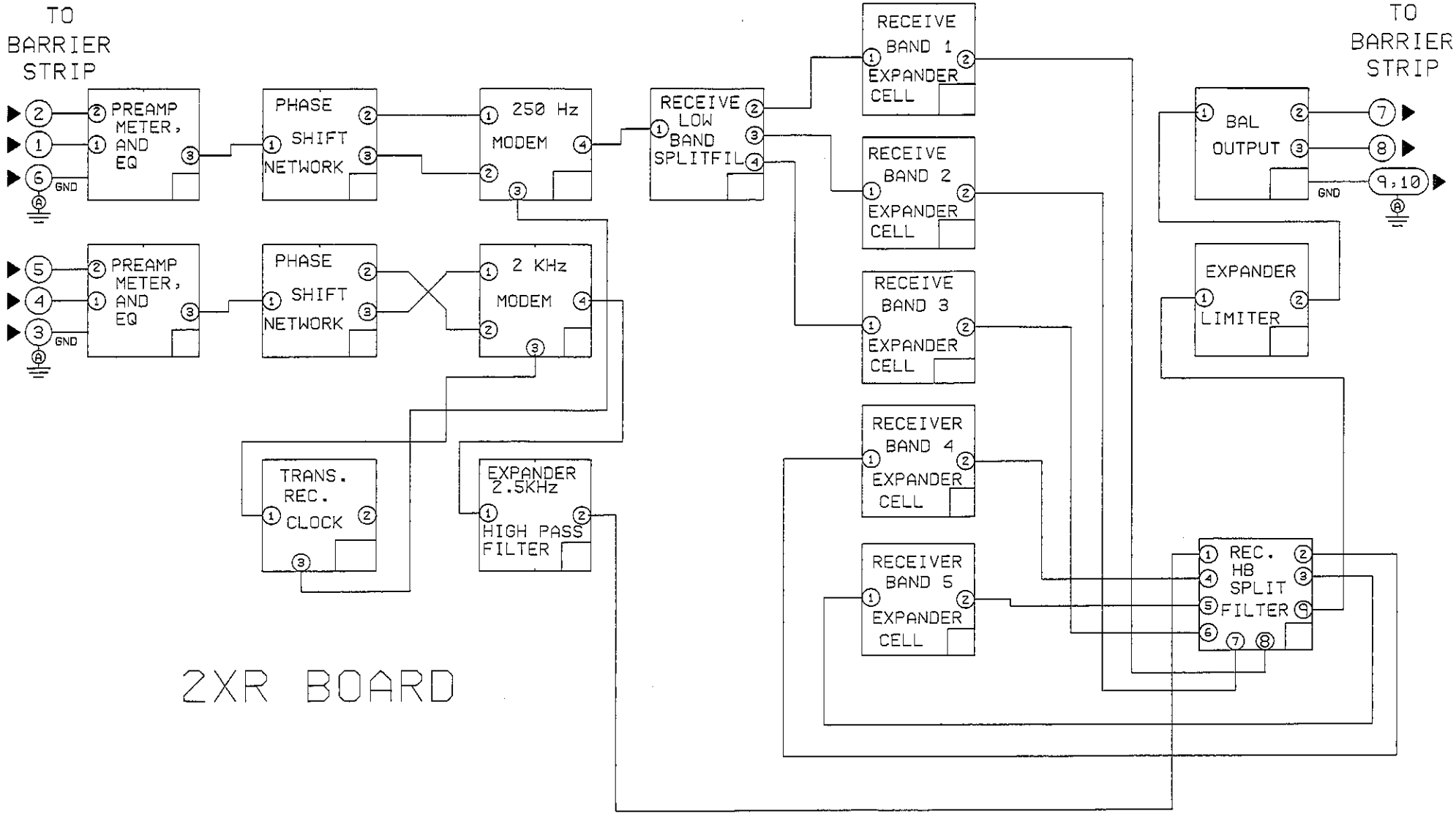
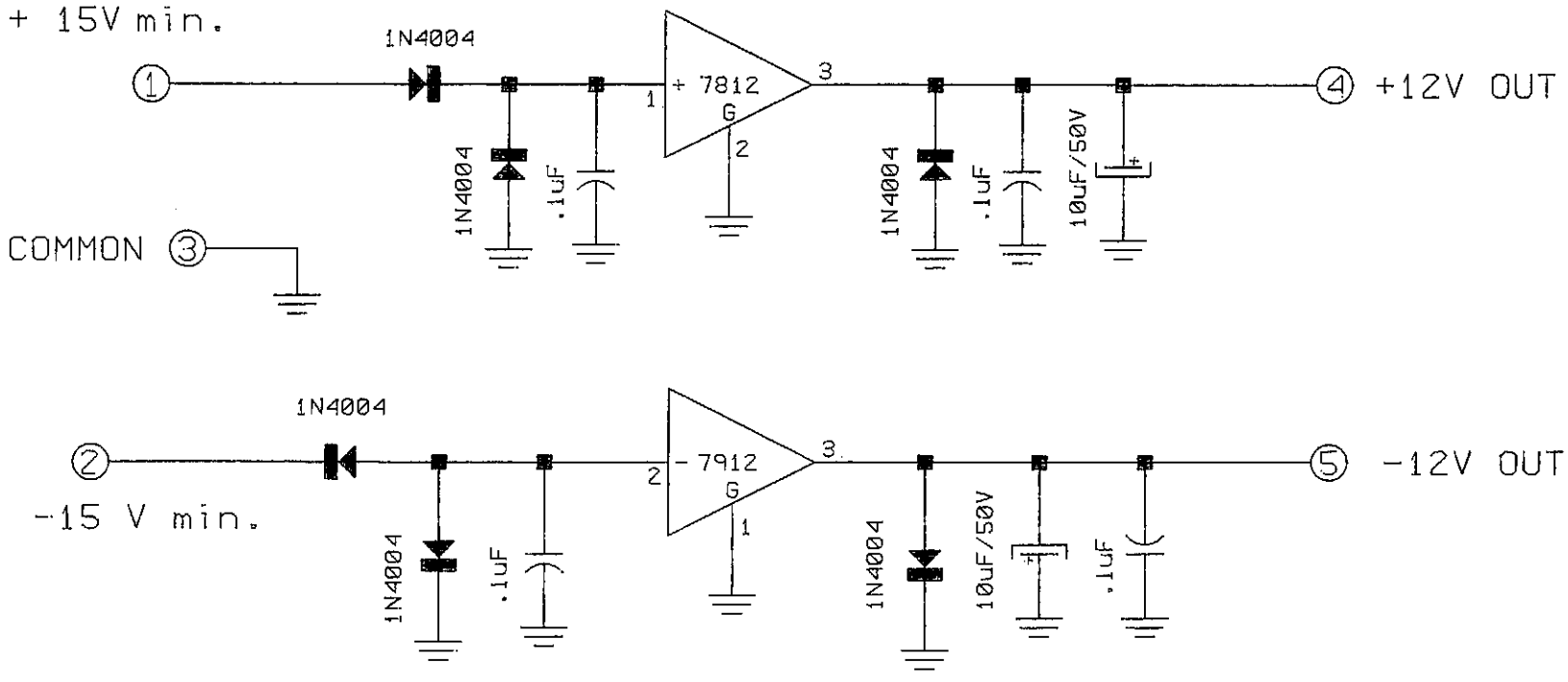

TO BARRIER STRIP
PREAMP METER, AND EQ
GND
PHASE SHIFT NETWORK
250 Hz MODEM
RECEIVE LOW BAND SPLITFIL
RECEIVE BAND 1 EXPANDER CELL
RECEIVE BAND 2 EXPANDER CELL
RECEIVE BAND 3 EXPANDER CELL
RECEIVER BAND 4 EXPANDER CELL
RECEIVER BAND 5 EXPANDER CELL
TO BARRIER STRIP
BAL OUTPUT
9,10
EXPANDER LIMITER
REC. HB SPLIT FILTER
PREAMP METER, AND EQ
GND
PHASE SHIFT NETWORK
2 KHz MODEM
TRANS. REC. CLOCK
EXPANDER 2.5KHz HIGH PASS FILTER
2XR BOARD



12 V.

DUAL REGULATOR

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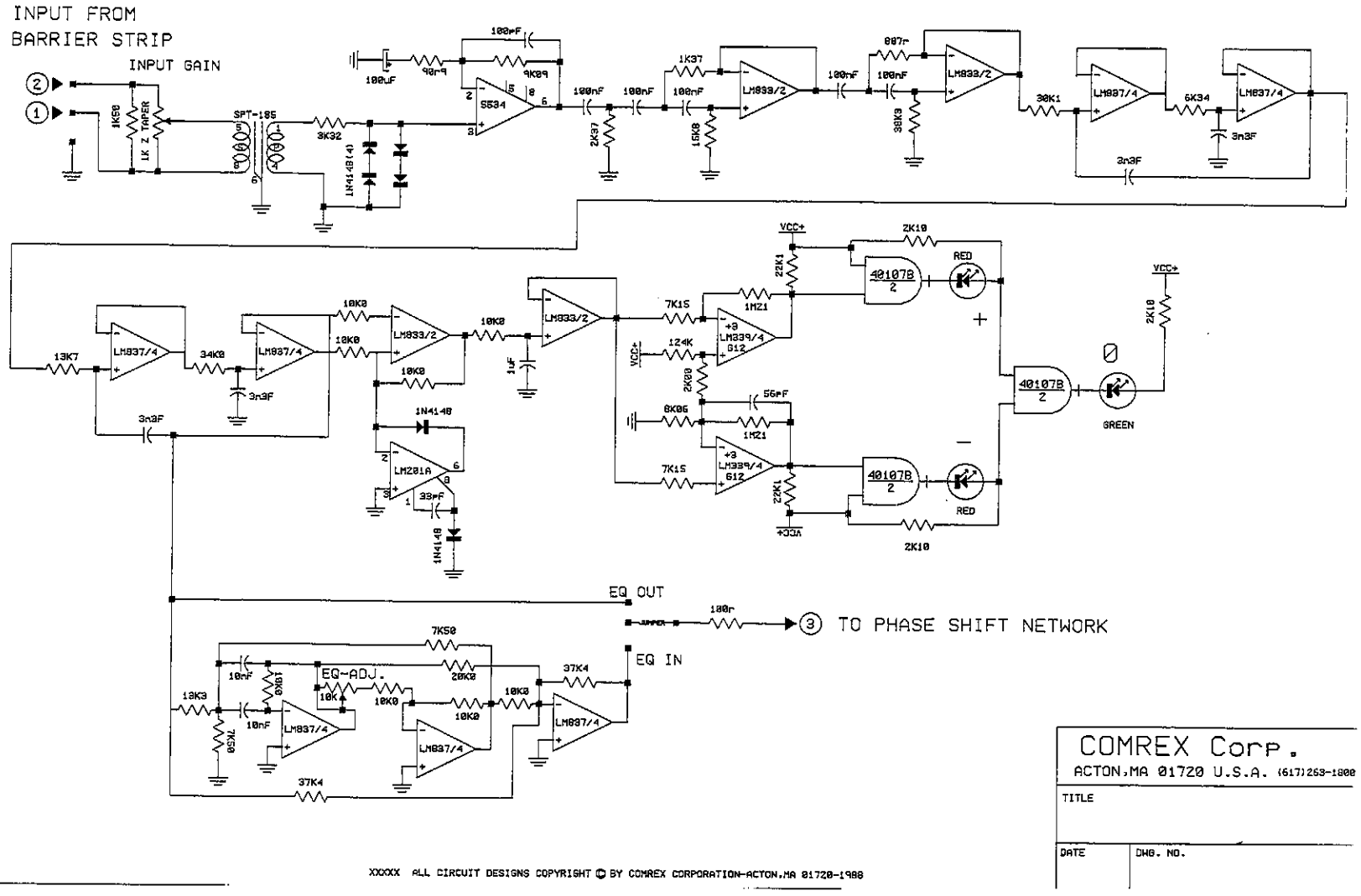
2XR PREAMP, METER, & EQ



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TITLE

DATE

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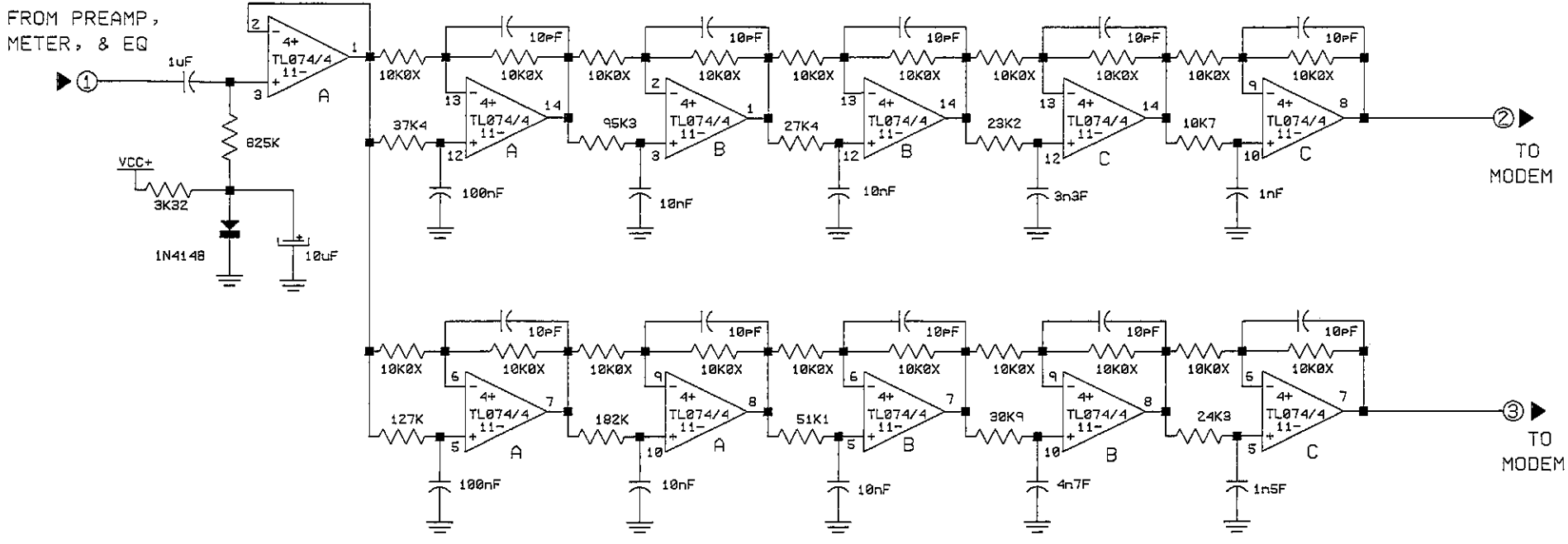

TRANSMIT/RECEIVE

PHASE SHIFT NETWORK

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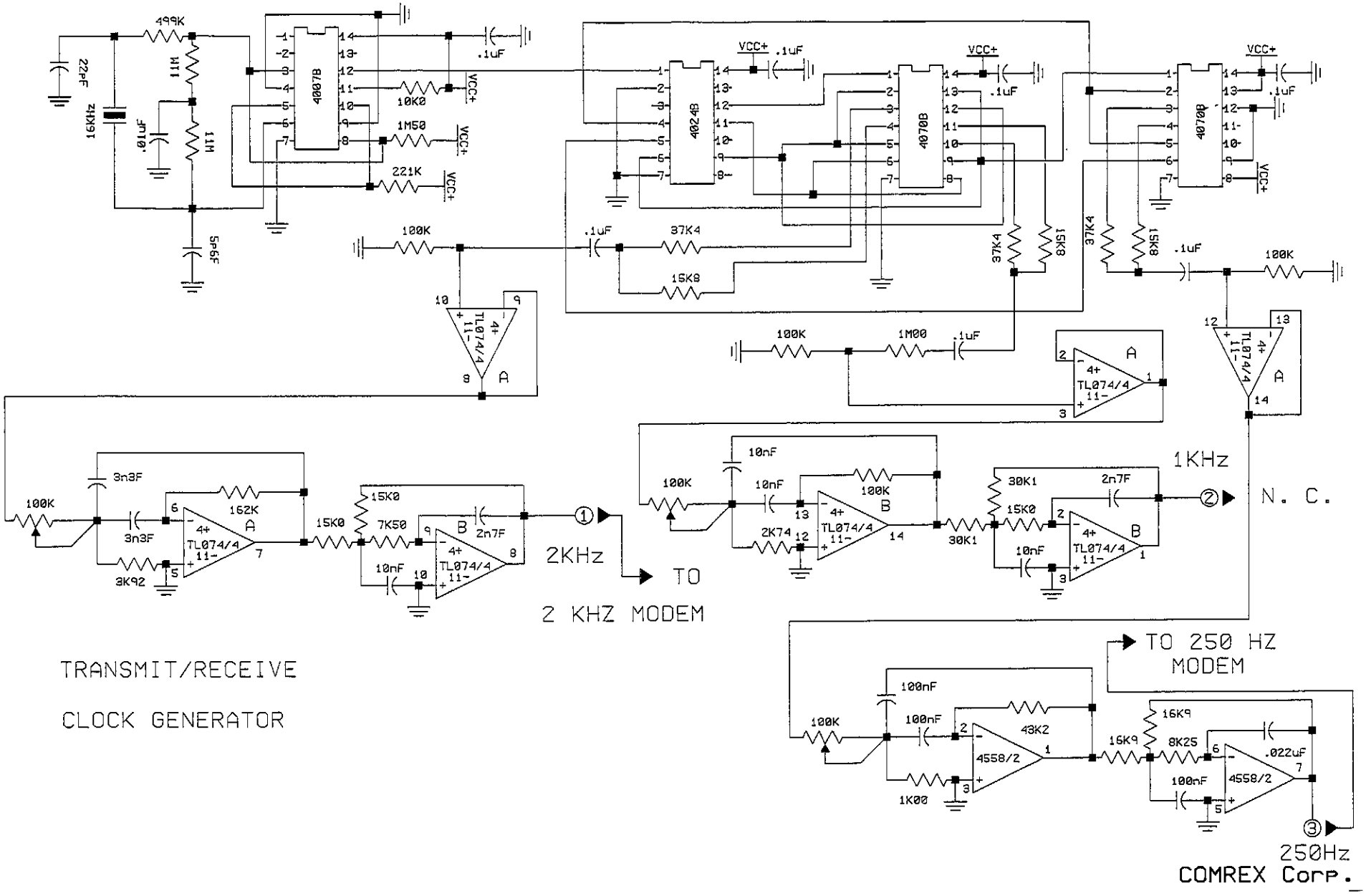
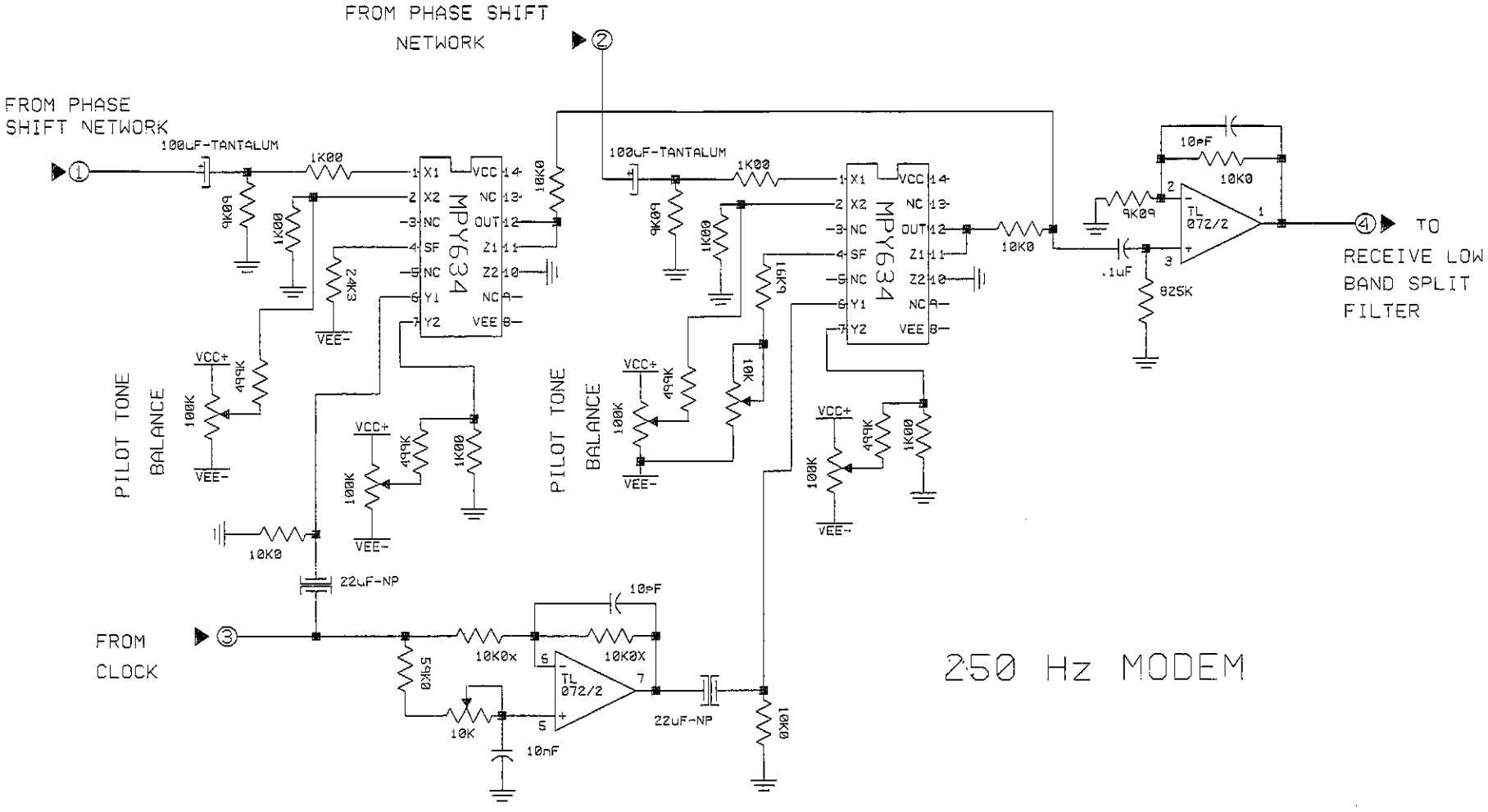

TRANSMIT/RECEIVE
CLOCK GENERATOR
2KHZ
TO
2 KHZ MODEM
1KHz
N. C.
TO 250 HZ
MODEM
250Hz
COMREX Corp.


FROM PHASE SHIFT NETWORK
FROM PHASE SHIFT NETWORK
100uF-TANTALUM
1K00
9K09
1K00
24K3
MPY634
X1
X2
NC
SF
NC
Y1
Y2
VCC
NC
OUT
Z1
Z2
NC
VEE
10K0
VEE-
VCC+
499K
100K
PILOT TONE BALANCE
10K0
22uF-NP
FROM CLOCK
10pF
10K0x
10K0X
5K0
10K
10nF
TL 072/2
22uF-NP
10K0
100uF-TANTALUM
1K00
9K09
1K00
MPY634
10K0
.1uF
10pF
10K0
9K09
825K
TL 072/2
TO RECEIVE LOW BAND SPLIT FILTER
PILOT TONE BALANCE
499K
100K
10K
VEE-
VCC+
499K
100K
1K00
VEE-
250 Hz MODEM

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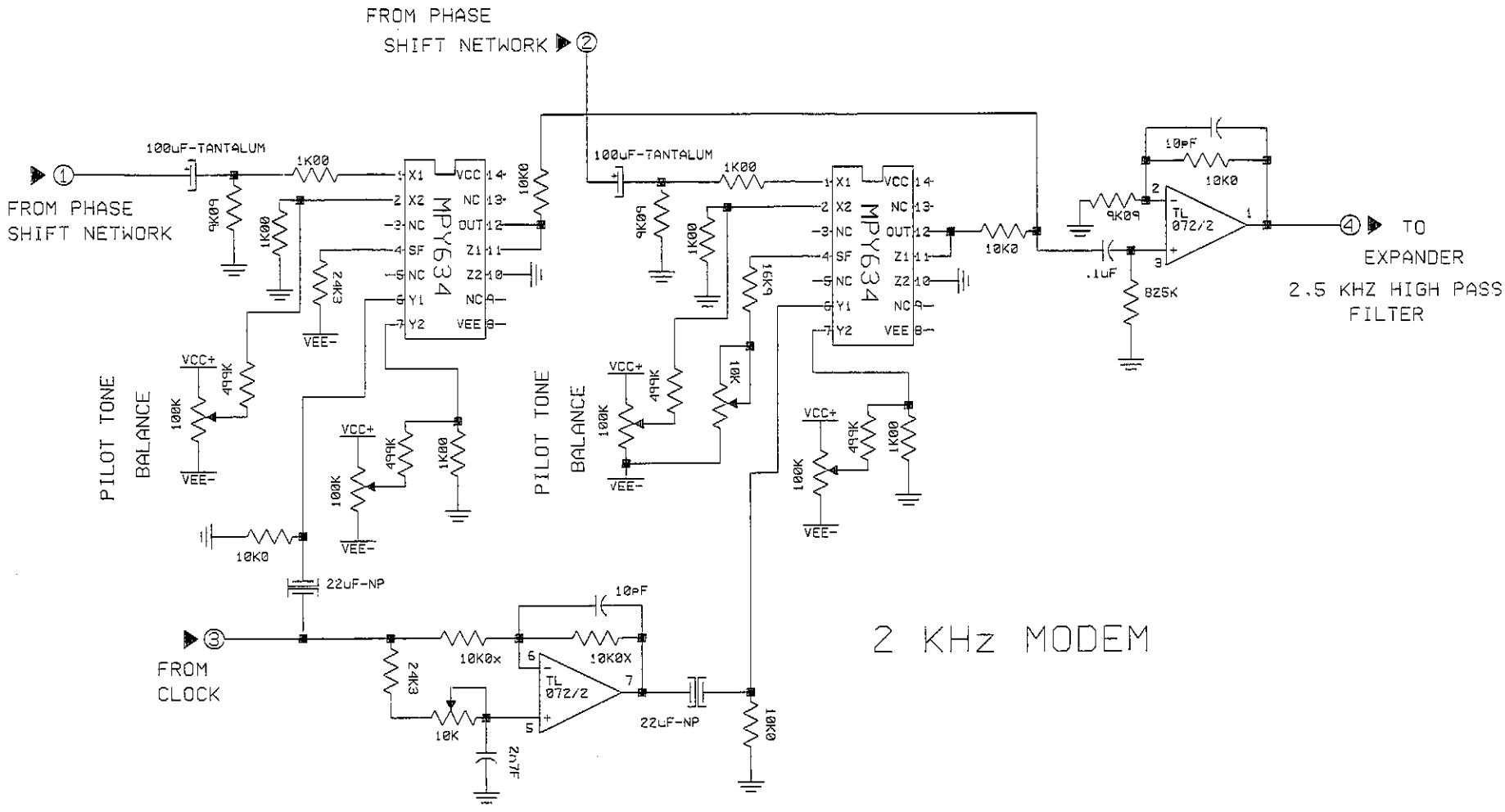
FROM PHASE
SHIFT NETWORK
2
1
FROM PHASE
SHIFT NETWORK
100uF-TANTALUM
1K00
9K09
1K00
2K43
VEE-
MPY634
X1
X2
NC
SF
NC
Y1
Y2
VCC
NC
OUT
Z1
Z2
NC
VEE
14
13
12
11
10
9
8
10K0
VCC+
499K
100K
VEE-
PILOT TONE
BALANCE
1K00
10K0
22uF-NP
3
FROM
CLOCK
10K0x
10pF
10K0X
2K43
TL
072/2
10K
2n7F
22uF-NP
10K0
100uF-TANTALUM
1K00
9K09
1K00
16K9
10K
499K
100K
VEE-
PILOT TONE
BALANCE
VCC+
499K
100K
VEE-
1K00
10K0
10pF
10K0
9K09
TL
072/2
.1uF
82.5K
4
TO
EXPANDER
2.5 KHZ HIGH PASS
FILTER
2 KHz MODEM

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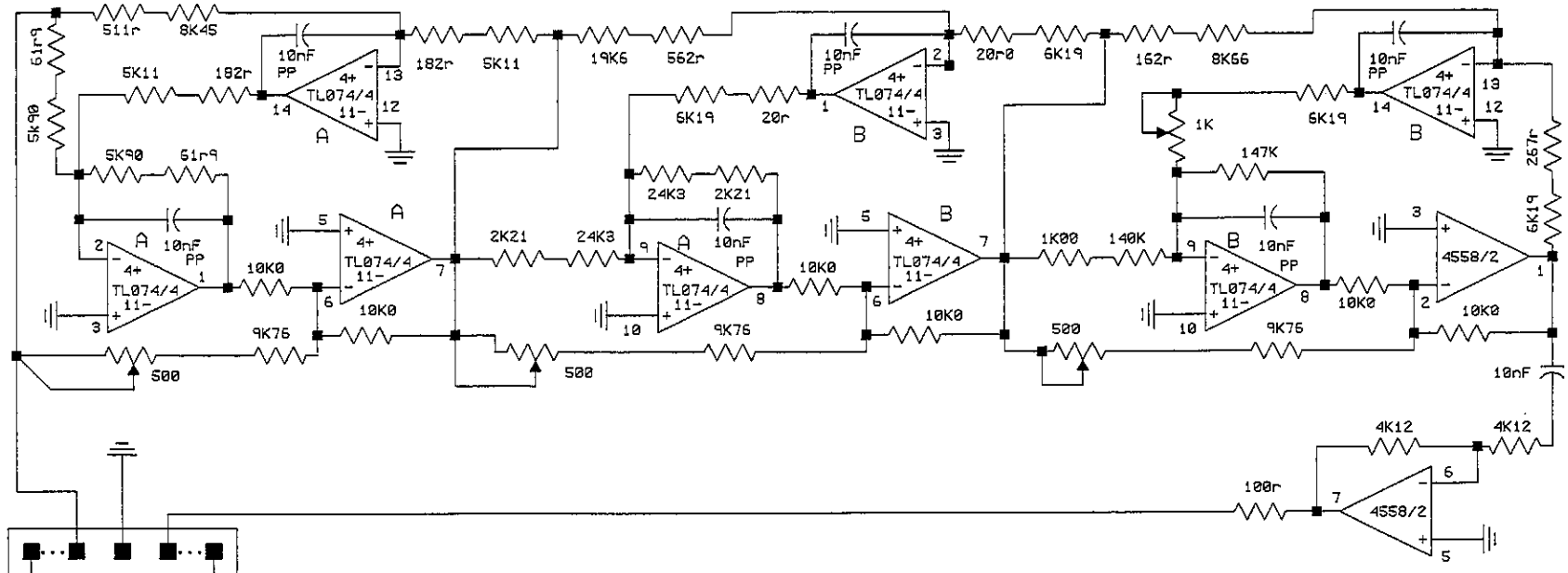

EXPANDER 2.5 KHz HIGH PASS FILTER

① FROM 2 KHZ MODEM

② TO REC. HIGH BAND SPLIT FILTER

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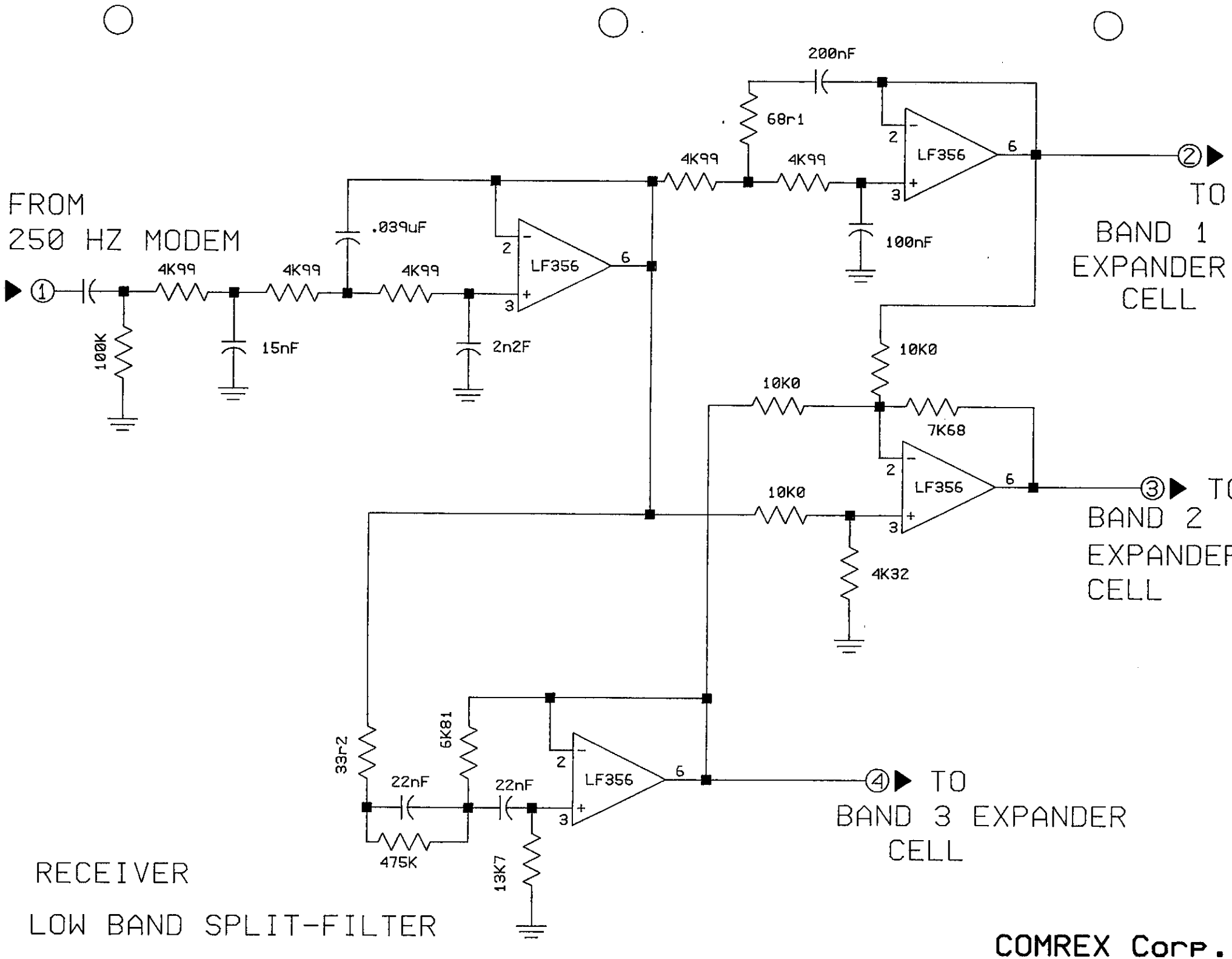
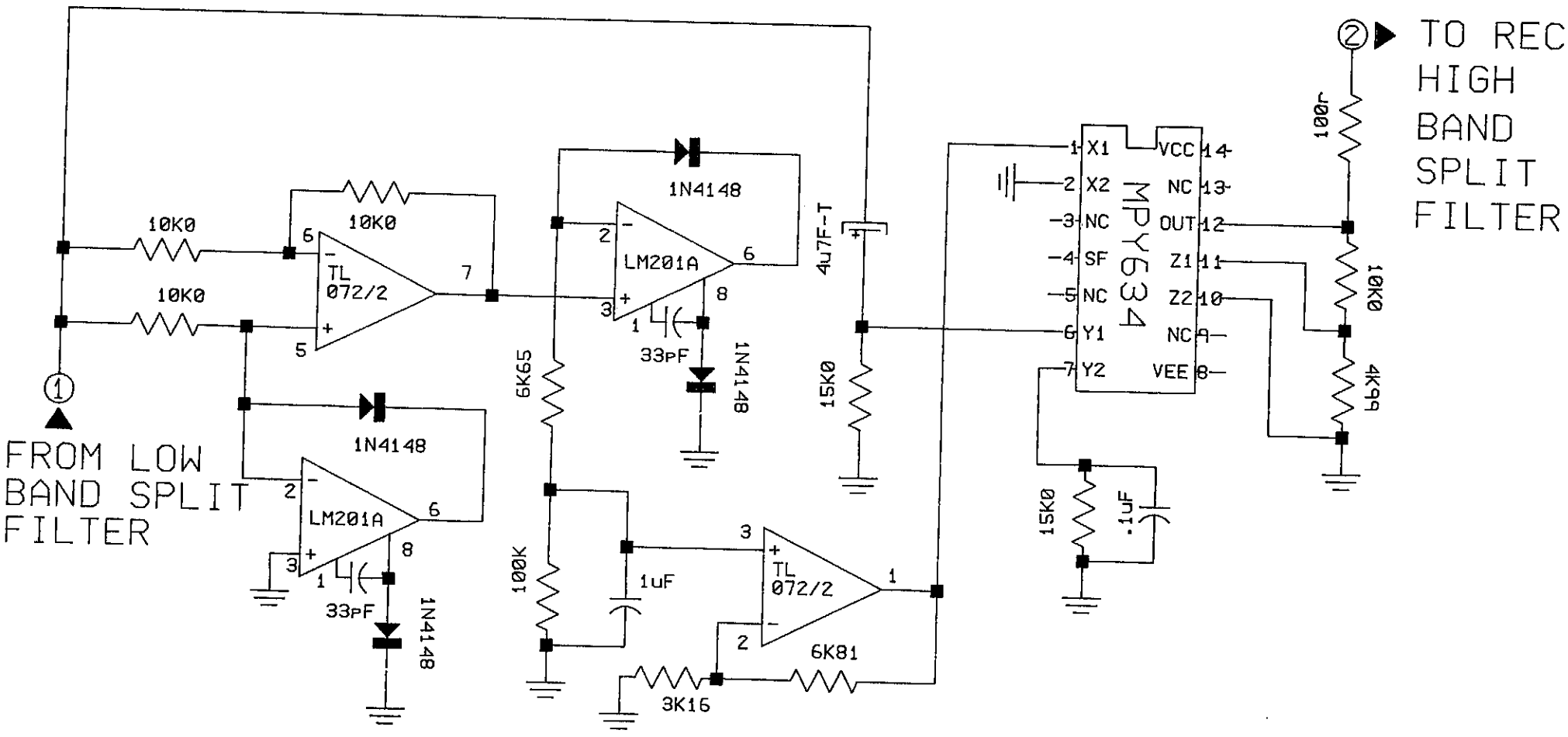

FROM
250 HZ MODEM
①
100K
4K99
4K99
4K99
15nF
.039uF
2n2F
LF356
200nF
68r1
4K99
4K99
100nF
LF356
②
TO
BAND 1
EXPANDER
CELL
10K0
10K0
7K68
10K0
4K32
LF356
③
TO
BAND 2
EXPANDER
CELL
33r2
6K81
22nF
22nF
475K
13K7
LF356
④
TO
BAND 3 EXPANDER
CELL
RECEIVER
LOW BAND SPLIT-FILTER
COMREX Corp.



RECEIVER

BAND 1 EXPANDER CELL

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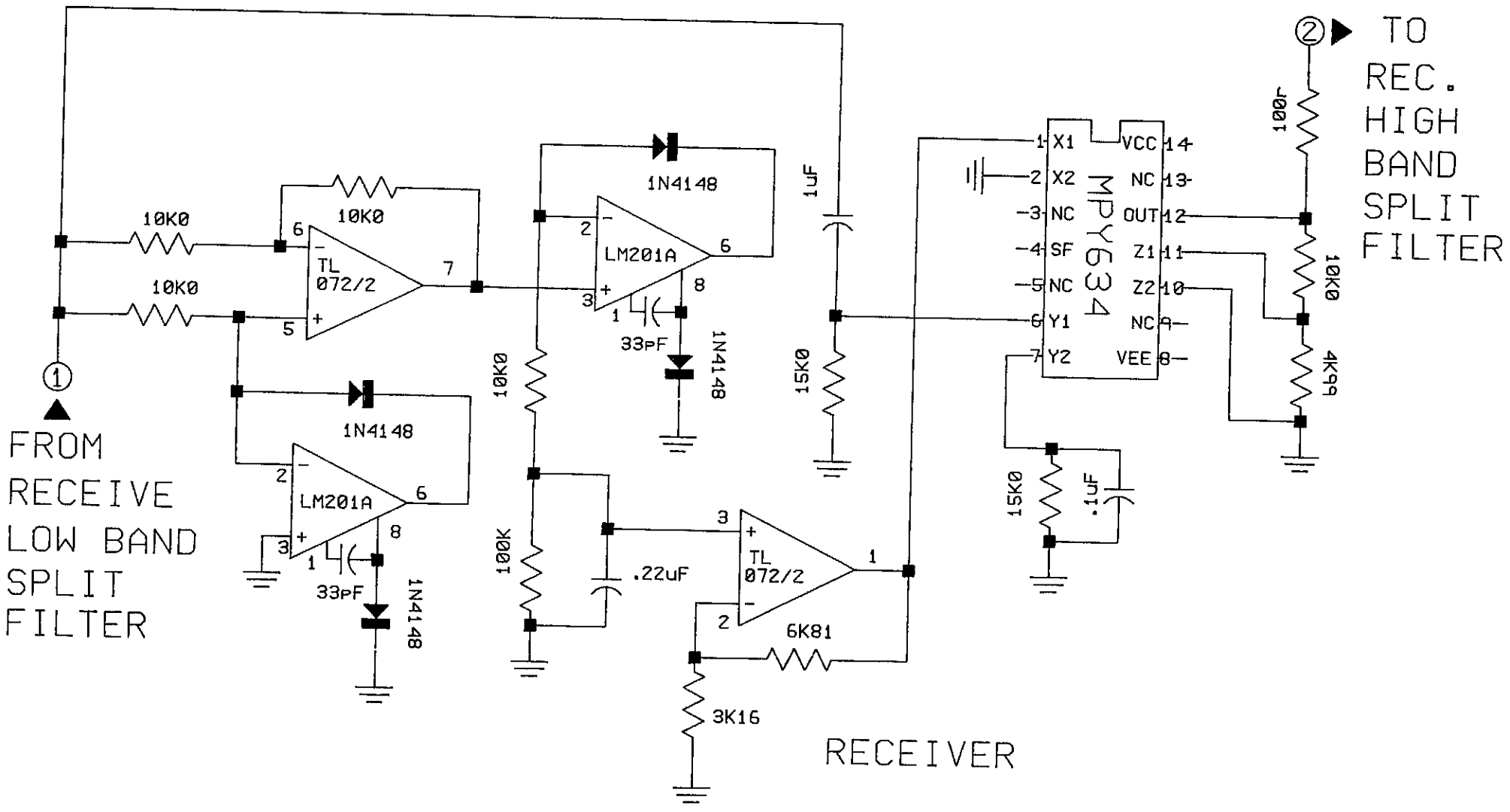
FROM
RECEIVE
LOW BAND
SPLIT
FILTER
10K0
10K0
10K0
TL
072/2
LM201A
1N4148
33pF
1N4148
1uF
15K0
10K0
100K
.22uF
3K16
6K81
MPY634
X1
X2
NC
SF
NC
Y1
Y2
VCC
NC
OUT
Z1
Z2
NC
VEE
100r
10K0
4K99
15K0
.1uF
TO
REC.
HIGH
BAND
SPLIT
FILTER
RECEIVER
BAND 2 EXPANDER CELL

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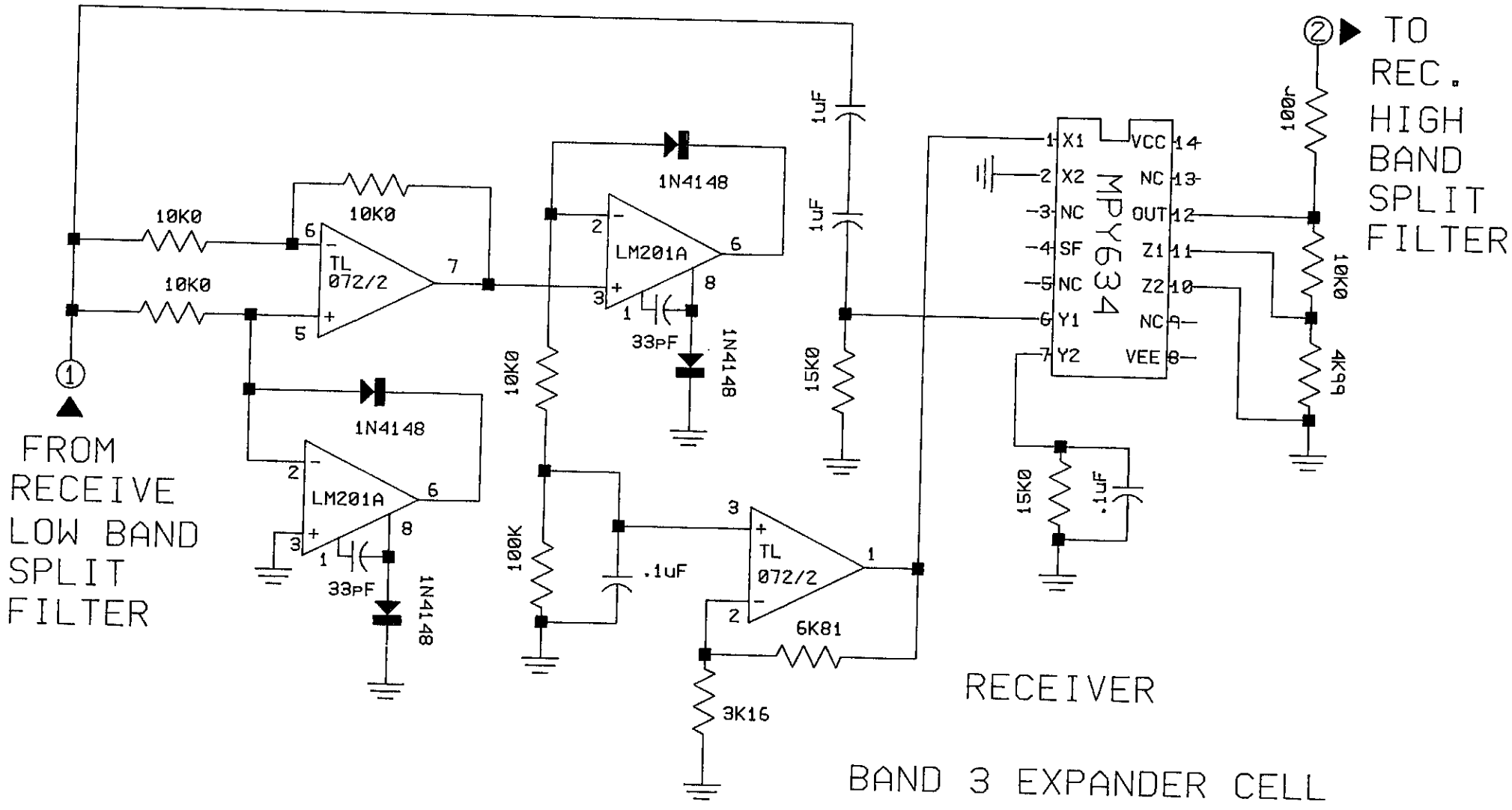
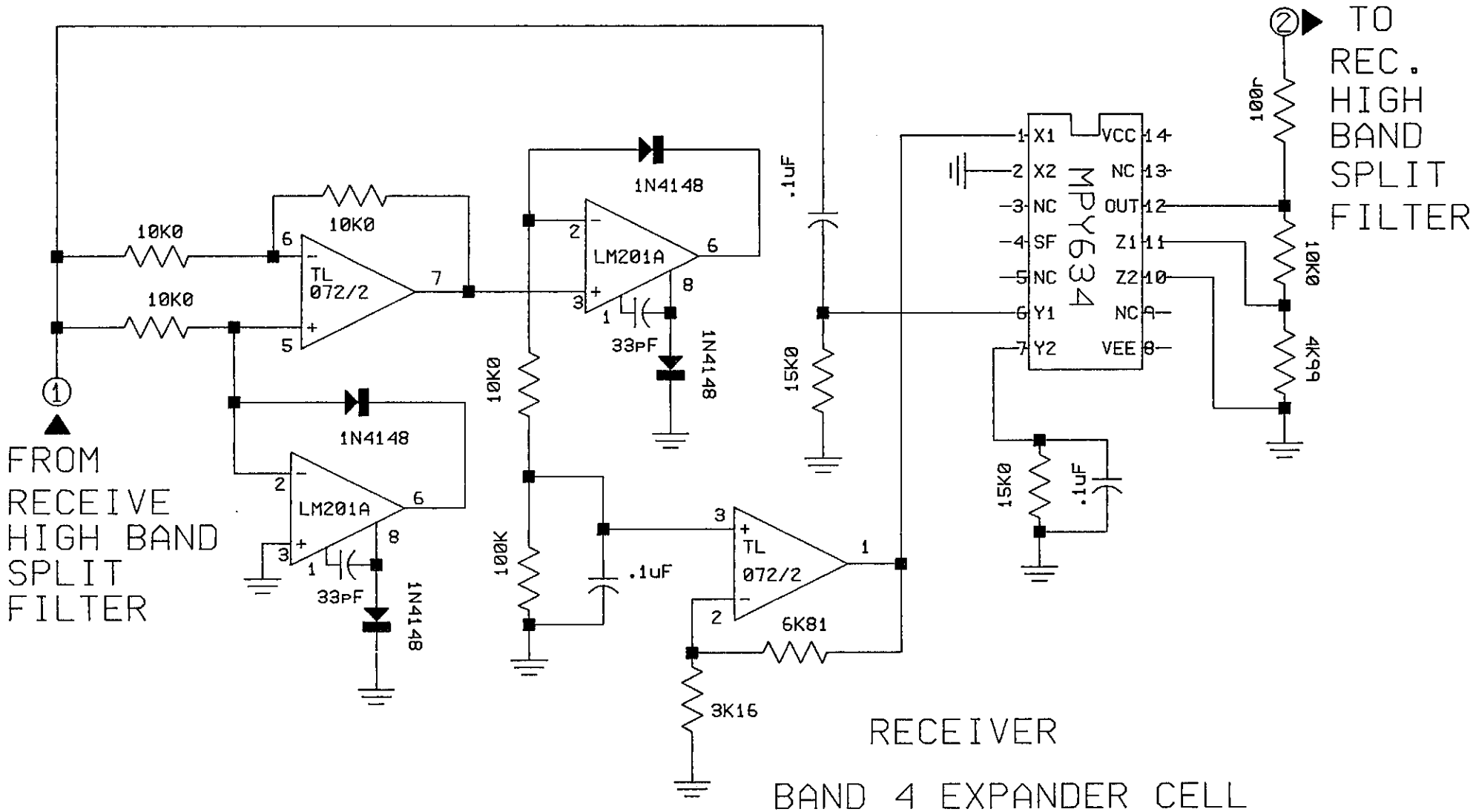
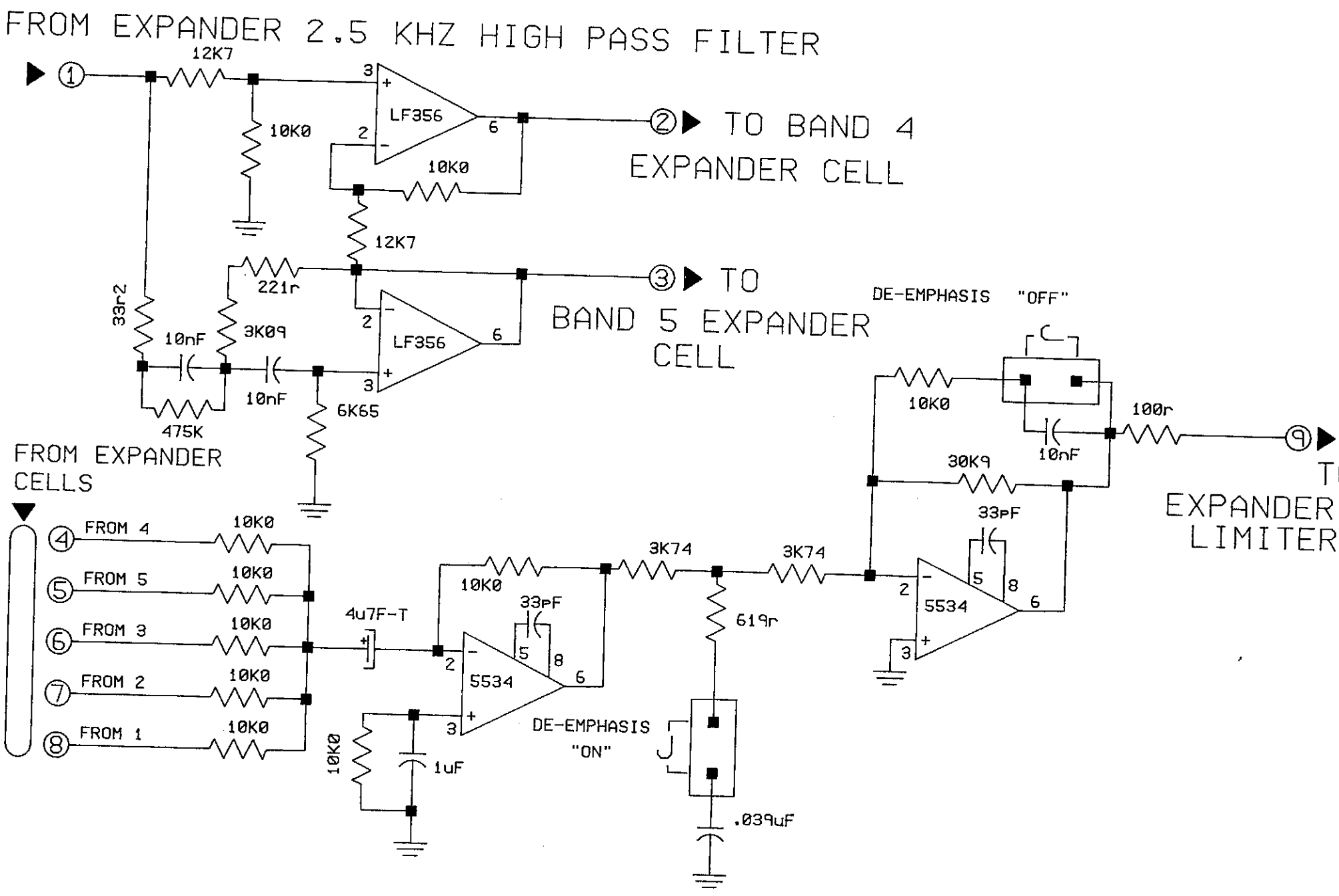
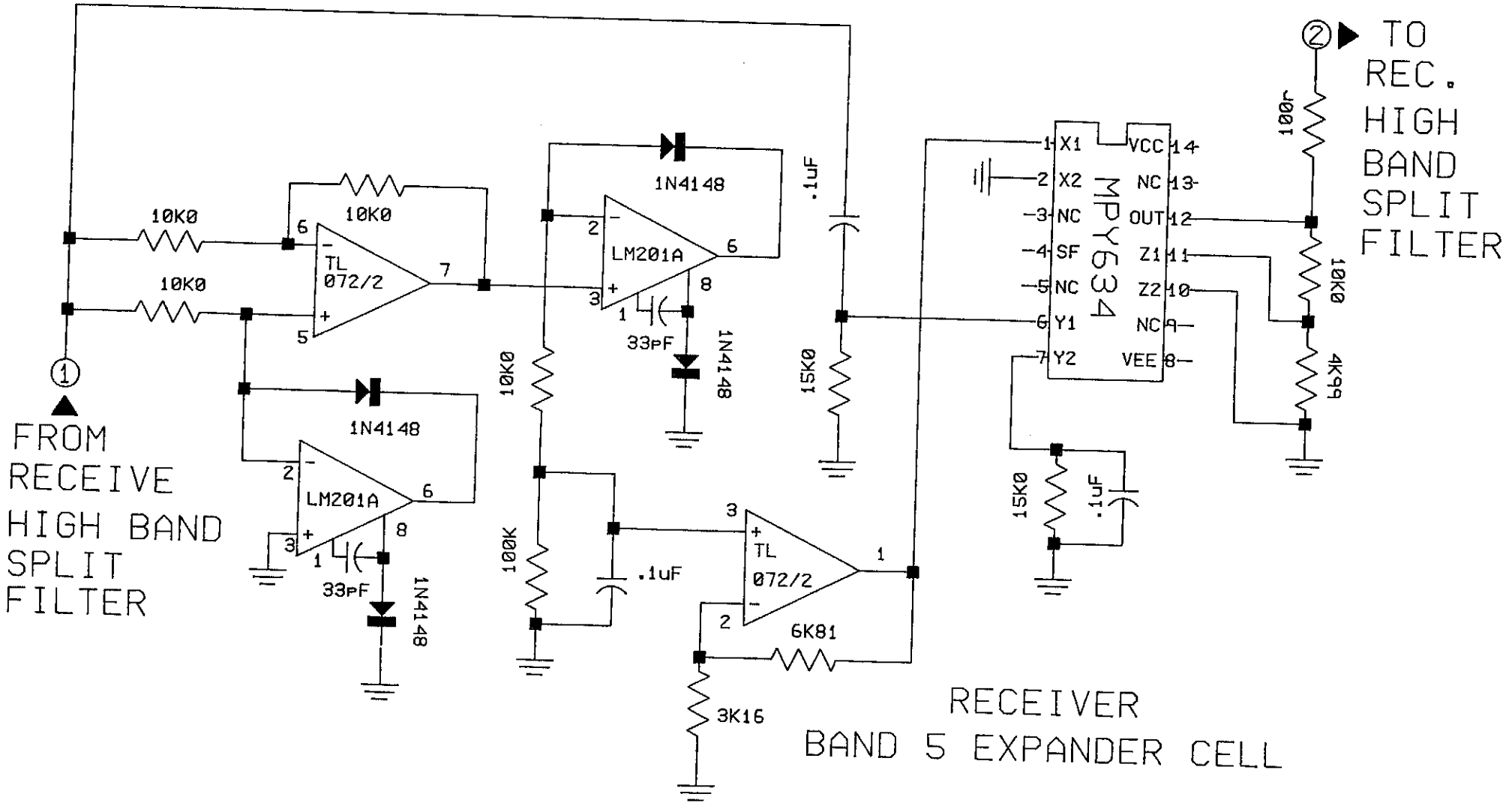

FROM
RECEIVE
LOW BAND
SPLIT
FILTER
1
10K0
10K0
10K0
TL
072/2
1N4148
LM201A
33pF
1N4148
1N4148
LM201A
33pF
1N4148
10K0
100K
.1uF
3
TL
072/2
2
6K81
3K16
1uF
1uF
15K0
1 X1
2 X2
3 NC
4 SF
5 NC
6 Y1
7 Y2
VCC 14
NC 13
OUT 12
Z1 11
Z2 10
NC 9
VEE 8
MPY634
15K0
.1uF
J001
10K0
4K99
2
TO
REC.
HIGH
BAND
SPLIT
FILTER
RECEIVER
BAND 3 EXPANDER CELL

COMREX Corp.

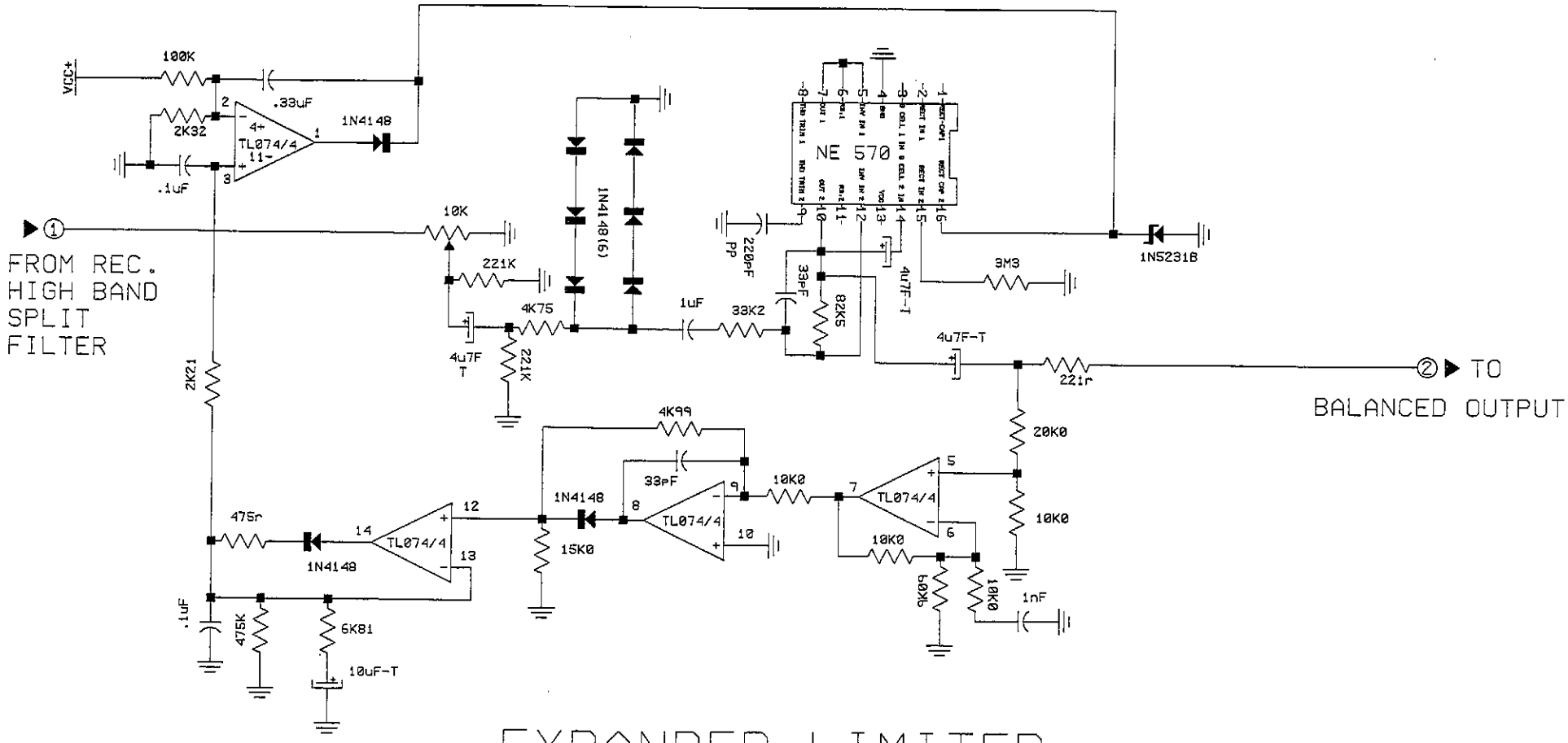

FROM
RECEIVE
HIGH BAND
SPLIT
FILTER
10K0
10K0
10K0
TL
072/2
LM201A
1N4148
33pF
1N4148
LM201A
1N4148
33pF
1N4148
10K0
100K
.1uF
3
TL
072/2
1
2
6K81
3K16
.1uF
15K0
MPY634
X1
X2
NC
SF
NC
Y1
Y2
VCC
NC
OUT
Z1
Z2
NC
VEE
100r
10K0
4K99
15K0
.1uF
TO
REC.
HIGH
BAND
SPLIT
FILTER
RECEIVER
BAND 4 EXPANDER CELL

COMREX Corp.


FROM EXPANDER 2.5 KHZ HIGH PASS FILTER
12K7
10K0
LF356
10K0
TO BAND 4 EXPANDER CELL
12K7
221r
33r2
3K09
10nF
10nF
475K
6K65
LF356
TO BAND 5 EXPANDER CELL
DE-EMPHASIS "OFF"
10K0
10nF
100r
30K9
33pF
FROM EXPANDER CELLS
FROM 4
FROM 5
FROM 3
FROM 2
FROM 1
10K0
4u7F-T
10K0
33pF
3K74
3K74
619r
5534
5534
DE-EMPHASIS "ON"
10K0
1uF
.039uF
RECEIVER HIGH BAND SPLIT-FILTER-SUMMER
COMREX Corp.

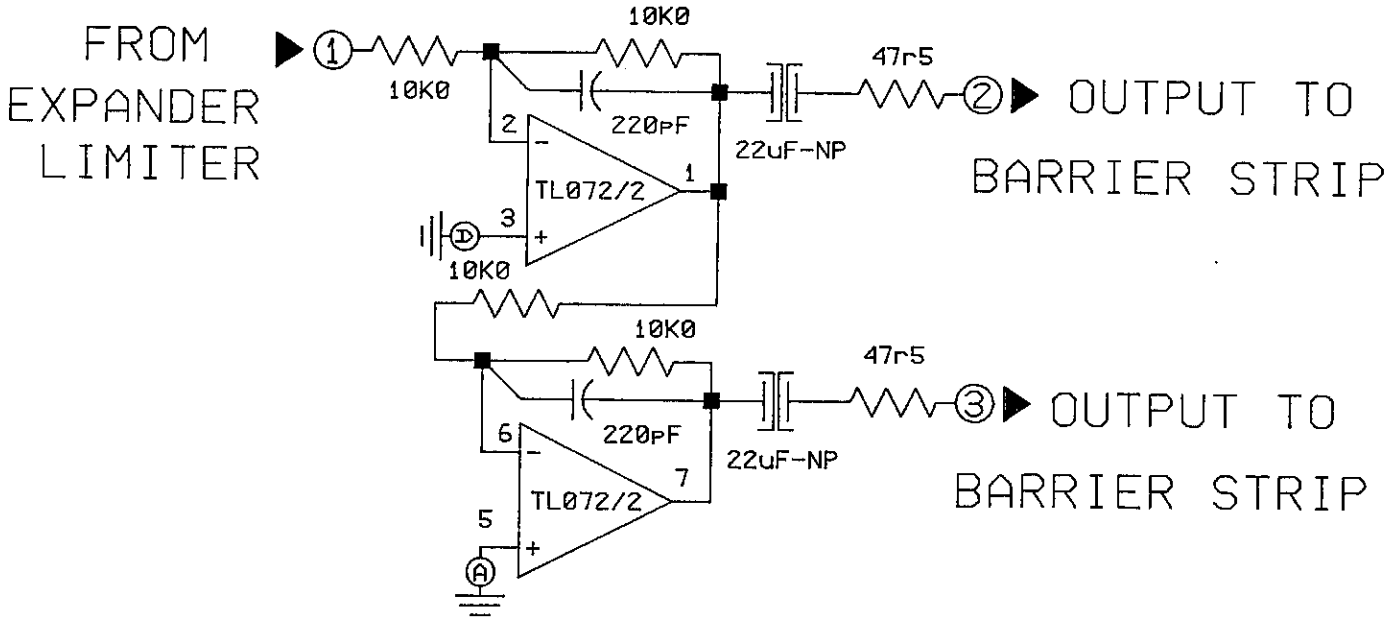

FROM
RECEIVE
HIGH BAND
SPLIT
FILTER
10K0
10K0
10K0
TL
072/2
LM201A
1N4148
33pF
1N4148
10K0
100K
.1uF
15K0
.1uF
LM201A
1N4148
33pF
1N4148
TL
072/2
6K81
3K16
MPY634
X1
X2
NC
SF
NC
Y1
Y2
VCC
NC
OUT
Z1
Z2
NC
VEE
100r
10K0
4K99
15K0
.1uF
TO
REC.
HIGH
BAND
SPLIT
FILTER
RECEIVER
BAND 5 EXPANDER CELL

COMREX Corp.



EXPANDER LIMITER

COMREX Corp.



BALANCED OUTPUT