MODEL RLX
OPERATIONS & TECHNICAL
MANUAL

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GENERAL

1. What is a RLX?

The Comrex RLX is a rack mount version of the receiver/decoder portion of the Comrex single line frequency extension system.

2. What does it do?

When set up properly, the RLX will receive signals from either a dial or dedicated telephone line. If the signals have been encoded at the transmit end with a Comrex single line encoder, the audio spectrum of the encoded program will be 250 Hz higher in every frequency. The function of the RLX is to downshift the upshifted audio by 250 Hz so that all the frequencies come out as they originated. As an example, if 500 Hz is fed into the encoder, it becomes 750 Hz. The 750 Hz will pass through the telephone line (or dedicated circuit) and arrive at the input of the RLX. The RLX then downshifts the 750 Hz by 250 Hz and the original 500 Hz is available at the output of the RLX.

3. Why do I need Frequency Extenders?

Since the deregulation of AT&T, there has been a dramatic increase in the cost of broadcast lines (100-5000 Hz and better) and their availability has decreased equally as dramatically. Often broadcast lines are given installation times as long as a year and indeed in certain locations broadcast lines are not available at all. Satellite distribution has become commonplace, but the problems of "first and last mile" delivery, order lead time, cost and reliability remain.

In terms of cost, reliability, flexibility and availability, the dial telephone network is a very attractive facility for remote program transmission and broadcast network distribution. AT&T and the telephone companies are making the dial network even more attractive by offering services such as the "900 net". The main drawback of dial telephone circuits for broadcast purposes is their restricted frequency response (300-3100 Hz).

The effect on the perceived quality of program material transmitted on lines which have restricted frequency ranges can be described as follows: As the high end cutoff frequency is lowered, first "transparency" begins to be lost. Then "sibilance" is reduced. As the low end cutoff is increased, "timbre" and "naturalness" are forfeited. When the low frequency response cutoff reaches 250 Hz, the sound quality is best described as "thin". Broadcast quality becomes telephone quality.

Various attempts have been made to improve the frequency response of dial telephone lines as well as dedicated Schedule C & D lines, which have similar response curves. Some success has been obtained in increasing high frequency response by use of graphic equalizers, particularly on local lines. Less successful are devices which artificially generate high frequencies. In the telephone line environment, these tend to accentuate noise and distortion.

Those who have tried to boost low frequency response have found that, instead of increasing the low frequency content of the program material, significant increase was made in the hum level. The reason for this is that telephone cables share poles with power circuits which induce hum in the phone lines. As the low frequency response at the receiving site is enhanced by equalization, the hum increases.

The Comrex frequency extension system was developed to improve the quality of schedule C & D dedicated circuits and dial telephone circuits. As mentioned above, these grades of service are deficient in both low and high frequency response. The Comrex single line frequency extender addresses primarily the restoration of low frequencies in the program transmission, with built-in EQ achieving some high end improvement as well. For those who require a full 50-5000 Hz program channel, Comrex manufactures the Model 2X system which uses two lines to restore both the high and low frequency response. The 2X system also incorporates a sophisticated multiband noise reduction system which can handle even the high noise on many long-haul international circuits.

4. How does it work?

The Comrex single line frequency extension system is an encode/decode system. At the transmitting end, program material is upshifted by 250 Hz. Thus 50 Hz becomes 300 Hz and now passes through the 300 Hz cutoff on dial or dedicated voice grade circuits. At the receiving end, the program material is downshifted by 250 Hz and restored to its original state. It will be noted that 250 Hz is gained at the low end and that 250 Hz is lost at the high end. The 50 Hz to 300 Hz gained at the low end is equal to 2 1/2 octaves of program material, thus restoring the lost "timbre" and "naturalness". The 250 Hz loss in the high frequency range is equal to 1/7th of an octave, a loss which would be difficult to detect by ear.

A bonus feature of the low frequency extender is hum reduction. There is an extremely sharp high pass filter with a cutoff frequency of 300 Hz in the decoder. Hum is injected into the signal after transmission. The signal fed to the decoder will consist of upshifted program material with components from 300 Hz to the high frequency cutoff of the circuit. (These are the desired components). Along with the desired components, hum components at 60 Hz, 120 Hz and 180 Hz may be present on the circuit. The 300 Hz and up components will pass through the high pass filter in the decoder but the hum components will not. The desired program material will then be downshifted and the hum will be eliminated.

For those who are interested in a technical explanation, the Comrex system uses single sideband suppressed carrier techniques. The carrier frequency is 250 Hz. At the transmitter, the upper sideband is selected. Carrier and lower sideband are suppressed. At the receive end, the incoming upper sideband is fed into a product detector. The system by which sidebands are selected is the "phasing" method which is well covered in the literature.

5. **Half-speed technique**

The single line frequency extender used with dual speed high quality tape recorders can provide a program of 100 Hz to 5700 Hz over a single dial (or Schedule C & D) line having a response of 300 - 3100 Hz. Known as half speed, the technique is simple but very effective.

The program material is recorded and played back into the Comrex encoder and through the telephone line at half the original recorded speed. All the components of the program are shifted to one half their original frequencies. 50 Hz becomes 25 Hz, 100 Hz becomes 50 Hz, etc. The encoder shifts the half speed material upward by 250 Hz. The original 50 Hz in the program material will be lost because it is only shifted to 275 Hz and will not pass through the 300 Hz cutoff of the telephone line. The original 100 Hz, halved to 50 Hz and shifted up to 300 Hz will pass through the line. At the high end, 5700 Hz is halved to 2850 Hz. 250 Hz is added by the encoder resulting in 3100 Hz, which will pass through the typical high end cutoff of the telephone line.

SPECIFICATIONS

INPUT

Impedance - 600 ohms, balanced
Level - -40 dBm to +8 dBm

OUTPUT

Impedance - 600 ohms balanced
Level - +8, 0, or -10 VU (internally selectable)

POWER

120V, 50/60 Hz
(May be ordered optionally at 120/240V, 50/60 Hz)

SIZE W x H x L

inches 7.5 x 1.75 x 19
cm 19 x 4.4 x 4

WEIGHT

5 Lbs 6 oz
2.4 Kg

AF RESPONSE

+/- .75 dB 50 Hz to 5 KHz (back to back)
+/- 2 dB 50 Hz to 3 KHz (on dial line)

TRANSLATION ACCURACY

+/- 0.02 HZ

(Note: Translation accuracy is the comparison of a frequency fed into a Comrex single line encoder and taken out of a Comrex single line decoder. Since the translation accuracy of the Comrex system is + or - 0.02 Hz, 100 Hz into an encoder may exit from a decoder anywhere between 99.98 Hz and 100.02 Hz. The telco specs are a different matter. The usual accuracy is plus/minus 2 Hz. Therefore a telephone circuit without Comrex will deliver an accuracy of plus/minus 2 Hz and with Comrex it will be plus/minus 2.02 Hz.

CIRCUIT DESCRIPTIONS

The Model RLX circuitry contains 8 sections:

Pre-amplifier
High pass filter
Demodulator
Carrier generator
Output amplifier
Regulated power supply
Overload indicator
8 Khz notch filter

PRE-AMPLIFER - The pre-amplifier consists of input transformer T1, gain control R2, integrated circuit U1 and its associated circuitry. The function of R2 is to control the input level to the pre-amplifier. It should be adjusted so that the overload indicator blinks approximately 15% of the time.

HIGH PASS FILTER - The high pass filter is an active type with a "Butterworth" type of response. Its cutoff frequency is 300 Hz. It is made up of I.C. sections U2A and U2B and associated circuitry. The function served by this filter is one of eliminating any very low frequency interference present of the incoming line.

DEMODULATOR - The demodulator circuit's audio input is derived from the high pass filter and its pilot comes from the crystal controlled carrier generator. The modulator module contains both the modulator circuit and sideband filters. These filters are of the active type and their adjustment is quite complex. Equipment capable of measuring the performance of these filters is not available in service shops, therefore the filter adjusting potentiometers are covered to preclude casual adjustment which can only degrade performance.

CRYSTAL CONTROLLED CARRIER GENERATOR - This circuit produces a very low distortion 250 Hz sine wave. A 16 KHz crystal is the heart of the carrier generator. I.C.s U8A, U9A, U9, U10, U11, U12, U13, along with their associated circuitry, divide the crystal derived 16 KHz to 250 Hz and provide wave shaping and filtering. The basic accuracy is such that the 250 Hz remains within plus/minus 0.04 Hz of the proper value.

OUTPUT AMPLIFIER - The output of the modulator is fed to the output amplifier which is of the active balanced type. It is designed to drive a 600 ohm load. Three different output levels (internally selectable) may be obtained. These are +8, 0 and -10 VU. The RLX output is set at +8 VU when it leaves the factory.

POWER SUPPLY - The regulated power supply converts 117V 50/60 Hz (or optional 117/234V, 50/60 Hz) into +12 and -12 VDC. The regulator I.C.s are U13 and U14.

OVERLOAD INDICATOR - The overload indicator is provided to permit the operator to determine when the correct level is being fed to the demodulator, which is the heart of the system. If the input is too high, distortion can occur. If it is too low, the signal to noise ratio will not be all that it could. The overload indicator operates on peaks. Input level should be set so that the LED blinks occasionally - about 15% of the time.

8 KHZ NOTCH FILTER - Telephone companies employ in general two types of multiplex systems. These are frequency division multiplex (or F carrier) and time division multiplex (or T carrier). In some locations where T carrier is used, the filtering of the clock is not adequate and some residue remains on the user's telephone line. The frequency of this residue is 8 KHz. The telephone handset receiver will not reproduce 8 KHz and therefore the residue is not noticeable in regular telephone use. On wideband equipment, however, it becomes quite annoying. The sound is that of a "ringing" which is heard with the program material.

In order to prevent this 8 Khz T carrier residue from getting onto the air, we have included an 8 Khz notch filter in the RLX (all models after May 15, 1984). This filter is factory adjusted. No field adjustments are required or should be attempted.

SETUP

CONNECTIONS:

Pins 1 & 2 - Output (Active balanced 600 ohms)
Pin 3 - Chassis ground

Pins 6 & 7 - Input (balanced) **An external telephone coupler is needed to connect to and hold the telephone line, such as the Comrex TCB-1A (manual) or TCB-2A (auto answer) couplers.**
Pin 8 - Chassis ground

INPUT

As stated above, connecting the RLX to dial telephone circuits will require some type of telephone line coupler. This coupler will serve to hold the telephone line and to isolate the input circuits of the RLX from the direct currents that are on the line. Excellent couplers for this purpose are manufactured by Comrex Corporation. They are the Model TCB-1A (manually operated) and the Model TCB-2A (automatic answering).

There are many couplers on the market 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. Telco provided "POP" couplers are such devices and should be avoided at all costs. 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. The Comrex couplers mentioned above provide a transparent transformer connection to the line. All Comrex couplers are FCC registered and approved.

If the RLX is connected to a dial telephone line, the gain control on the front panel of the RLX must be set on each call so that the overload indicator flashed approximately 15% of the time on program peaks. This level needs to be set once when the call is established. It is absolutely necessary to do this since dial lines will deliver a signal which may vary from call to call anywhere from -15 VU to -35 VU. As stated in the circuit description section, the demodulator must be fed its optimum feed level. If it is overdriven, distortion will occur. If it is underdriven, poor signal to noise will result.

If the RLX is connected to a dedicated line, the received level on that line will usually remain the same from use to use. The input level adjustment, therefore, will probably be necessary only at the time the dedicated line is connected to the RLX.

OUTPUT

Connect the output of the RLX (Pins 2 & 3) to the audio facility which it will feed. Pin 1 is chassis ground.

As shipped from the factory, the output selector, located on the main board within the RLX is set for a nominal output of +8 VU. If you desire either 0 VU or -10 VU, it is only necessary to move the jumper plug to the proper position. A diagram showing the proper position for the various output levels is on the RLX set-up diagram at the back of this manual. When you have placed the jumper plug in the desired position, replace the cover of the RLX case. Mount the RLX in the rack and connect the power.

OPERATION

Operation of the RLX is very simple. Assuming that you have connected to the telephone line with a simple manual coupler, the sequence of operation is as follows:

a. The send end dials in and the operator answers (or the operator dials the send end).

b. When program is ready to send, the operator places his coupler in the hold position and hangs up the telephone. The Comrex TCB-1A manual coupler will hold the line when the telephone set is hung up. If you use a "QKT" type voice coupler where the telephone handset must be left off the hook to hold the line, it will be necessary to have a push to talk button or exclusion key to disable the carbon button. You may also simply remove the carbon button. This is very important. Any sound picked up by the local telephone microphone will be unencoded and of much greater level than the program coming in on the line. This undesired audio will then be downshifted by the RLX and get into the program feed, overwhelming the incoming signal.

c. If the incoming feed is encoded, the operator should place the extend/bypass switch on the front panel in the extend position. If the send end is not using a Comrex encoder, the switch should be placed in the bypass position. This will prevent the RLX from downshifting the feed.

d. The operator should then adjust the gain control on program audio so that the overload indicator blinks about 15% of the time on program.

This is all that is required to operate the RLX.

IN CASE OF TROUBLE

It doesn't work at all

1. Does the power LED light? If not, check the fuse and check that the RLX is properly connected to A/C power.

2. Power LED lights, but no output. Inject a 1000 Hz signal into the input. If there is no output, the RLX should be returned to the factory.

It works, but it sounds like Donald Duck at the receive site.

1. Check to see that the EXTEND/BYPASS switch in the extend position.

2. Check to see that you are not permitting audio which has not been extended to get into the line along with extended audio. At the receiving site, the combination will sound "phasy." A telephone set off hook at either the send or receive site on the line you are using for program will create this problem. Be sure that all extension phones are hung up. If you are using a telephone to hold the line, disable the carbon button by removing it or having a push to talk button or exclusion key on your telephone.

3. You may be overdriving the RLX. This is unlikely, but if it happens, the overload LED will either be on all or most of the time. Turn the gain control down so that the overload LED lights for only 15% of the time.

The output is too low.

If the output is too low, but the overload LED is blinking properly, then the output selector is set too low. Refer to the setup section of this manual.

The output at the receive site is distorted

1. This could be overdrive of the RLX, but the overload LED would be on most of the time if this were the case.

2. If the encoder is being overdriven at the send end, distortion could result. Have the send end operator lower the level to the input. If the distortion goes away, then the input to the encoder was being overdriven.

3. Some encoders have variable output levels. The lowest output setting on all Comrex encoders is -9 dBm, which is the normal drive level for a dial telephone line. Check to see that the encoder is feeding the line at -9 dBm. A higher level could be producing distortion in the telephone equipment itself.

It seems to be off frequency

The design of the oscillator is such that it would quit before it could drift enough to be noticed as off frequency. Most likely, the cause of the apparent "off frequency" condition is overdrive or double drive (unencoded audio and encoded audio arriving at the same time, i.e. telephone off hook).

I hear hum.

1. If you hear 60 Hz hum, switch the extend/bypass switch to extend. If the hum persists, then check the way in which the output of the RLX is connected to your audio facilities.

2. If you hear 250 Hz hum in extend only, the output of the RLX may be fed into an input which is too sensitive for the output setting of the RLX. For instance, if the nominal sensitivity of the input of the equipment being fed by the RLX is -20 VU and the RLX output is set for +8 VU, the 250 Hz of carrier which is suppressed about 60 dB will only be 32 dB below normal program level.

3. 250 Hz hum can also be hear coming from an RLX in which the pilot balance has been misadjusted. Pilot tone balance procedures are detailed under the Service section of this manual. Once the pilot balance has been set, it is unlikely that this would need to be adjusted again.

It works in bypass but not in extend

Most likely, the carrier generator is not working. Return the unit to the factory or follow the procedure described in the SERVICE section on the next page.

SERVICE

THINGS WHICH SHOULD NOT BE CHANGED OR ADJUSTED

1. You should never adjust any potentiometer in the modem except the two specified in the pilot balance adjust procedure. (See below) To attempt to adjust any but those will result in severe misadjustment of the modulator. There is no way a modulator can be field adjusted. At our factory, we have unique test equipment and proprietary adjustment techniques for the modulator. If the modulator fails, the RLX should be returned to the factory. This is the only way the RLX can be put right.

2. You should avoid changing integrated circuits in the modulator. The modulator is factory adjusted as a unit. If an I.C. is changed, the modulator should be readjusted at the factory.

THINGS WHICH CAN BE DONE IN THE FIELD

1. As mentioned before, if the RLX works in bypass but not extend, there is a strong likelihood that the crystal oscillator has quit. To determine this, connect a scope to pin 12 of U12 (a 4007 I.C.). If you see 16 KHz square waves, it is oscillating. If not, replace U12 and check again. If you find that the oscillator is running but the RLX still does not operate in the extend mode, place a scope on pin 1 of U8. You should see a 250 Hz sine wave of about 16.346 volts peak to peak. If you do find the proper signal at this point and the RLX still fails to operate in extend, inject a 1 KHz signal into the microphone input connector and place a scope on pin 7 of U8. You should see a 750 Hz sine wave at this point. If not, replace U8 and check again. If no signal is seen, the modulator has probably failed and the unit should be returned to the factory.

Note: You may change integrated circuits on the Main Board if you suspect a malfunction due to failure of one of these. Sufficient negative feedback is used with our amplifier circuits to assure gain constancy to preclude the need for readjustment at the factory.

PILOT TONE BALANCE PROCEDURES

The instructions for adjusting pilot balance potentiometers are included in the manual to enable you to adjust them if at some time you are in doubt about whether the pilot tone suppression is sufficient. We have found that once they are set at our factory, there is little chance that they will ever need adjusting again.

1. Connect the output of the RLX to the input of an amplifier speaker system which has enough gain to amplify microphone levels to audibility. Also, the amplifier speaker system should have flat audio response down to 250 Hz.

2. Place a shorting plug into the microphone connector of the RLX.

3. Turn on the RLX. Listen for 250 Hz. If you hear a 250 Hz tone (which is unlikely), pilot tone adjustment is advisable. If you do not hear a 250 Hz tone, do not bother.

4. If you do hear 250 Hz, you will want to "null it out." To do this, adjust the pilot adjust potentiometers located on the accompanying drawing of the LX-3 MODEM for minimum 250 Hz tone. This completes the pilot tone balance adjustment procedure.

FACTORY SERVICE

When should the RLX be returned for factory service?

Whenever any component has been replaced on the modulator (modem) board or when any potentiometer on either board has been replaced

Anytime you prefer that we handle test and repair of your RLX

What is the cost of factory service?

Our service is not of the repair shop type. That is to say we do not diagnose and repair only on customer complaint. Our policy is to put your unit back through final manufacturing test. The unit is returned to proper operation per our exit factory specifications. The charge for this service is $75, plus parts and shipping charges both ways. Extra charges may occur if the RLX has been altered by the customer.

Occasionally, a customer will experience a problem and have difficulty determining whether the RLX is at fault or some equipment or hookup external to the RLX. We are happy to check the RLX to determine that it is operating according to exit factory specifications. The charge for this is $50 plus shipping.

(Note: The above charges are subject to change.)

What is the warranty policy?

We will repair your RLX free of charge for one year from date of purchase, provided that it has not been modified in any way, mishandled or damaged. Our warranty does not cover shipping charges.

Where should the RLX be sent for factory service?

Send it to: **Comrex Corporation**
65 Nonset Path
Acton, MA 01720 USA

Be sure to include a note briefly describing the nature of the problem.

Comrex engineering department assistance with applications or problems is always available. Call Comrex Corporation at (508) 263-1800 and ask for someone in engineering. Please state that you are calling for applications or service assistance. If no one is available at the time you call, please leave your name and number and the time you wish to be called. Someone will contact you shortly.

You may also telex any messages to us at our TWX 710-347-1049 or Western Union Easylink 62949250. If you wish a call back by telephone, leave your name, telephone number and time you wish to be called. We are happy to service our international customers in this manner when time zone differences make direct calling inconvenient.

THE COMREX TEST NUMBER

We have a test number which, if dialed, will place an extended and bypassed test program on the line. This will enable you to determine if your decoder is operating properly. The number is **508 263-9499.** This number answers automatically and is available every day, 24 hours per day.

If you dial the test number and find that your decoder is operating properly but you are still having problems, you may want us to listen to the feed from the encoder. Very often we can diagnose the fault over the telephone. Call our main number 508 263-1800 and tell the operator you wish to set up a test of an encoder.

We are happy to help at any time.