MODEL TLX
LOW FREQUENCY
EXTENDER

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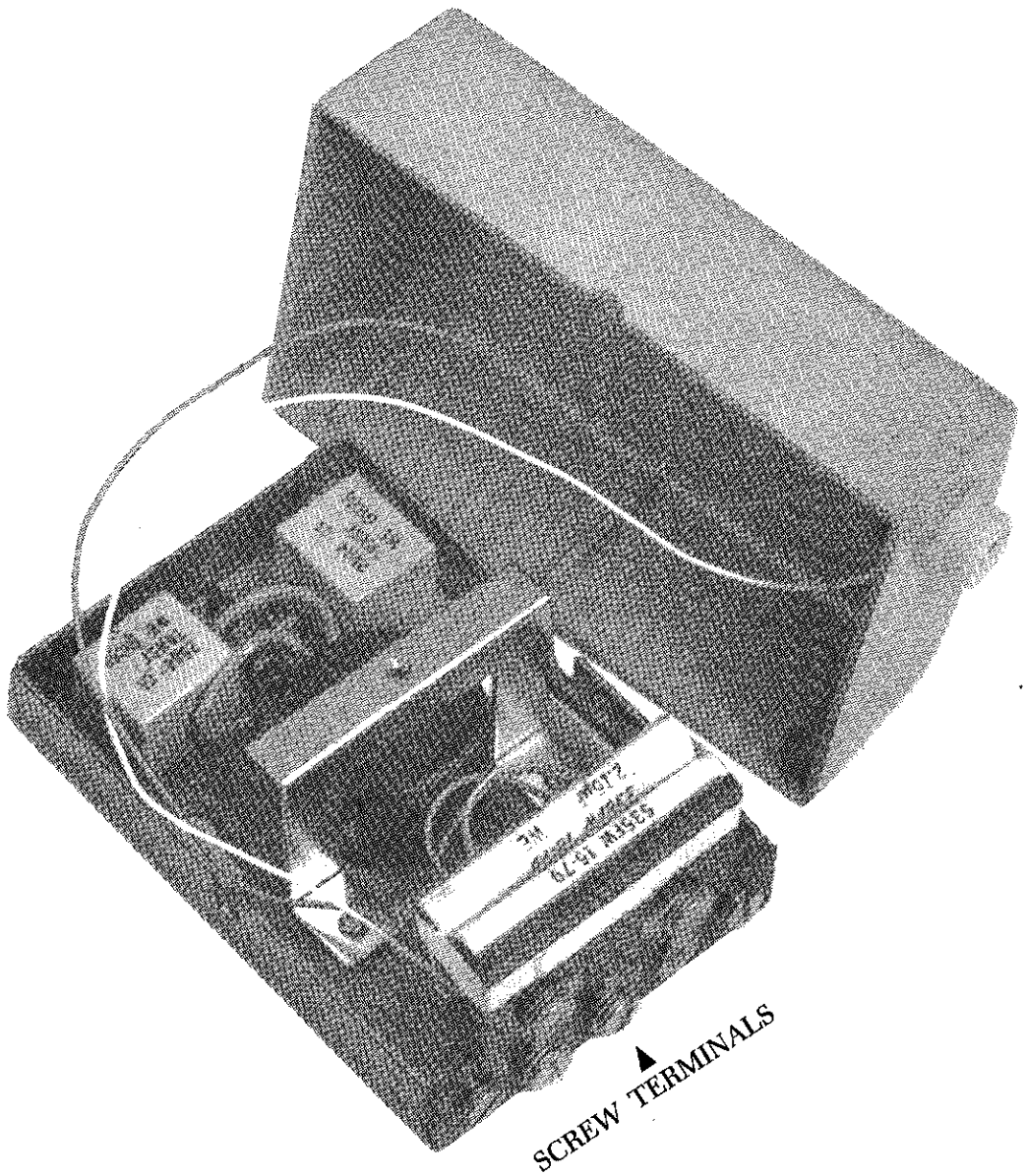
AVOID POP COUPLERS

WARNING: In some areas, telephone companies are installing the POP in lieu of the QKT coupler. The POP coupler can be identified by the screw terminals on the end of the box. The QKT does not have screw terminals.

POP couplers should be avoided because they are designed to control the 3 second maximum power that can be fed into the DDD network by means of clipping diodes. The clipping point of the POP coupler is such that program material with a feed level of -10Vu will be clipped 6 to 8dB. This steady state clipping on program material causes unacceptable intermodulation distortion.

. . . . Also, it sounds terrible.



OPERATING

I. General, The Comrex Low Frequency Extension System

Broadcast networks in the past have generally used program transmission facilities provided by a telephone operating company or a telecommunications authority. Individual stations have used these types of facilities for transmitting descriptions of sporting events and, in some cases, news reports from the event sites to their stations. Various grades of audio services are available. They are:

Designation	Approximate Frequency Range Hz	Notes
Schedule AAA	50-15,000	Full time 24 hr. day
Schedule AA	50-8000	Full time 24 hr. day
Schedule A	100-5000	Full time 24 hr. day
Schedule B	100-5000	Part time
Schedule C	200-3500	Full time 24 hr. day
Schedule D	200-3500	Part time
Schedule E	300-2500	

Certain networks have begun to use satellite circuits provided by various common carriers.

The switched or dial telephone network provides quality almost as good as schedule C and D and is available in most parts of the world 24 hours a day at reasonable cost. Its frequency range is 250 to 3500Hz.

In recent years the cost of broadcast lines has increased rapidly and their ready availability has decreased. Often broadcast lines are given installation times as long as a year and indeed in certain locations broadcast grade lines are not available at all.

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 cut off frequency is lowered, first "transparency" begins to be lost. Then "sibilance" is reduced. As the low end cut off is increased, "timbre" and "naturalness" are forfeited. When the low frequency response reaches 250Hz, the sound quality is best described as "thin". Broadcast quality becomes telephone quality.

Various attempts have been made to improve the frequency responses of the schedule C or D lines or the switched telephone system. Some success has been obtained in increasing the high frequency response by the use of graphic equalizers.

Attempts to improve the low frequency response have not worked. Those who have tried it have found that, instead of increasing the low frequency content of the program material, a significant increase was made in the hum level. The reason for this is that the telephone cables share poles with power circuits and these induce hum in the phone lines. As the low frequency response at the receiving site is enhanced by equalization, the hum increases.

The Comrex low frequency extension system was developed to improve the quality of schedule C and D circuits and switched or dial telephone circuits. As mentioned above, these grades of service are deficient in both low and high frequency responses. As the name implies, the system addresses the problem of poor low frequency response in

these lines. The way in which the improvement is obtained is quite straightforward. Utilizing single sideband supressed carrier techniques, the "baseband" or original program material is upshifted or translated by 250Hz. A spectral component at 50Hz is shifted to 300Hz; one at 1000Hz becomes 1250Hz; one at 5KHz becomes 5250Hz, etc. The shifted 50Hz component (now 300Hz) will pass through the telephone circuits. At the receiving site, 250Hz is subtracted from the upshifted signal and the output of the decoder is the original material. The telephone circuits have been improved as shown below.

Designation	Frequency Range (Old) Hz	Frequency Range (New) Hz
Schedule C	200-3500	50-3250
Schedule D	200-3500	50-3250

It will be noted that 250Hz (1/7 of an octave) has been lost in high frequency range, but the same 250HZ equals a gain of 2½ octaves on the low end. The lost "timbre" and "naturalness" have been restored.

The low frequency extender is able to improve the low frequency response of the lower grades of audio service and the dial telephone system to that of schedules AAA and AA. It will even upgrade the low frequency response of schedule A to that of schedules AAA or AA.

Although the above examples are restricted to showing the improvement that may be expected on the lower grades of leased line and the switched telephone networks, there is nothing to preclude its use on circuits with responses which extend to 15KHz or higher. A circuit with a response of 250Hz to 15KHz will be upgraded to 50Hz to 14,750Hz by the use of a Comrex low frequency extender.

Appropo to the previous paragraph, there are certain satellite and microwave circuits which because of $\frac{1}{F}$ or "phase noise" problems, must limit their low frequency response to 250Hz even though they are able to deliver high frequency responses above 20KHz. An extender system used with such satellite or microwave systems makes possible 50Hz-15KHz services.

A bonus feature of the low frequency extender system is hum reduction. There is an extremely sharp high pass filter with a cut off frequency of 300Hz in the decoder. Hum is injected into the signal after transmission. The signal fed to the decoder will consist of program material with components from 300Hz to the high frequency cut off of the system (the desired components) and hum components at 60Hz, 120Hz and 180Hz. The program material (desired components) will pass through the high pass filter but the hum components will not. The 300Hz and up components will be restored by downshifting and the hum components will be eliminated.

The low frequency extension used together with two high quality speed tape recorders can provide a frequency range of 100Hz to 6000Hz over a schedule C, D, or a dial telephone network. Known as half speed, the technique is simple but very effective. The program material is recorded at one speed at the sending location and played back into either a Comrex Model PLX or TLX transmitting encoder at half the recording speed. All of the components of the program are shifted to frequencies one half their original frequencies. 50Hz becomes 25Hz, 100Hz becomes 50Hz, 1000Hz is shifted to 500Hz and 6KHz to 3KHz. In the Model PLX or TLX these components are shifted upward by 250Hz. The original 50Hz which was shifted to 25Hz is lost because it is only shifted to 275Hz but the original 100Hz, halved to 50Hz, is shifted to 300Hz and will pass through the telephone circuits. At the receiving end, the Comrex Model RLX decoder translates the spectrum and feeds a tape recorder. The recorder is then played back at twice its recording

speed and the original program material becomes available. A telephone circuit which can pass only 250Hz to 3500Hz will have passed 100Hz to 6000Hz, better than a schedule A line. In simple arithmetic, 100Hz goes through the system thusly:

$$\underset{\text{encode}}{\left(\frac{100}{2} + 250\right)} \xrightarrow{\text{TELCO}} \underset{\text{decode}}{(300-250) \times 2 = 100\ \text{Hz}}$$

The low frequency extender is a truly utilitarian tool which is finding increasing use in the broadcast industry. It not only will improve the quality of domestic program transmissions but its use can give news reports from overseas broadcast quality sound. It is ideal for STL backup, for satellite backup and for ENG microwave backup. There are entire networks which use only the Comrex low frequency extender and the dial teletelephone network for program transmission.

II. System Components

A. PLX

The Model PLX is the portable transmitting encoder used in the Comrex low frequency extender system. It contains all the circuitry necessary for field transmission. Included are: a microphone preamplifier, an AGC system featuring a peak limiter with program controlled release time, a crystal controlled carrier generator, encoder, and output amplifier. In addition, a tape input jack is provided. Power for the PLX is obtained either from readily available internal 9V ALKALINE batteries or from external AC power supplies, Models LX-P or LX-PC.

1. Levels, PLX

The required input and output levels of the PLX were very carefully chosen to insure optimum program transmission quality. The output levels will be discussed in section D of this portion of the manual. The input levels are discussed below.

a. Microphone

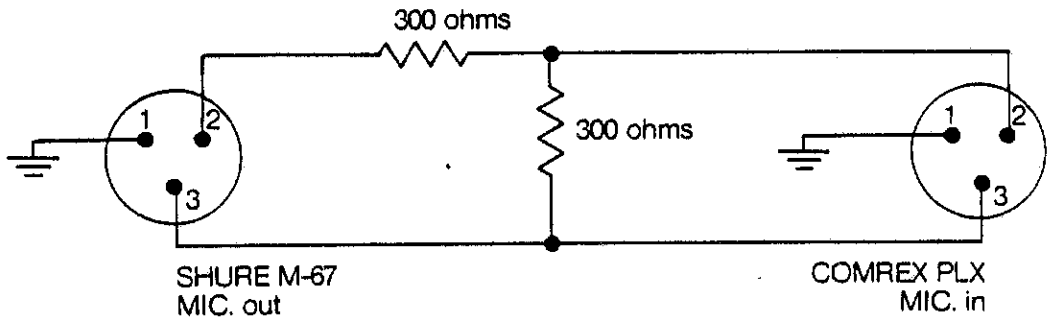
The PLX is designed to accept the output of a dynamic microphone. The correct input level range is -65 dBm @ 150 ohms to -56 dBm @ 150 ohms. The input impedance of the PLX microphone circuit is 10K ohms unbalanced.

b. Tape

The tape input is intended for use with portable tape recorders. The correct input level is 0.56 VRMS and the input impedance is 10K ohms unbalanced.

c. SHURE M-67 Mixer

In many applications, the Comrex Model PLX is used with a portable mixer amplifier. One of the most popular types is the Shure Model M-67, manufactured by Shure Brothers, Inc. of Evanston Illinois, U.S.A. This mixer works very well with the PLX, but proper operation requires that the microphone level output of the M-67 be connected to the microphone input of the PLX through a simple 6 dB pad which may be constructed according to the diagram shown below. The VU range switch on the M-67 should be placed in its +4 position.



d. Mixers, other

Other types of mixer amplifiers will be suitable for use with the Model PLX. Either the microphone input or the tape input may be used. The levels should be kept within the ranges specified. Further, it should be remembered that the impedance of the two inputs are 10K ohms. Also, because the Model PLX has a peak limiter with program controlled release time, any AGC system contained in the mixer should be disabled. Otherwise the two systems may work against each other.

2. Batteries

The PLX is designed to use 4 each ALKALINE 9V batteries, Mallory MN 1604 or equivalent. A fresh set of these batteries will provide approximately 3½ hours of operation. No type of battery other than the ALKALINE type is considered suitable for the PLX. There is a battery indicator on the front panel. It has three sections: red, green and white. When the pointer is in the green portion of the meter, sufficient battery voltage is available for operating the PLX. When the pointer is at the white line in the center of the meter, the batteries have reached the end of their useful lives and should be replaced. The PLX should not be operated when the meter is in the RED portion. The voltage regulator cannot operate and the crystal controlled carrier generator may fail. If a battery does not have the word ALKALINE printed on it, it is not an ALKALINE battery.

3. A.C. Adapters

There are two types of A.C. adapters available for operation of the PLX. The LX-P A.C. Adapter is designed for operation from either 115 or 230 VAC, 50 Hz - 400 Hz. The LX-PC A.C. Adapter is designed to operate within the U.S.A. only at 115V, 50-60 Hz.

B. TLX

The Model TLX is the studio or network type transmitting encoder. It is designed for mounting in a 19" equipment rack. It is A.C. operated. The carrier generator is crystal controlled. It is designed to accept -4VU to +10VU outputs from consoles. It provides the -10VU level required for feeding dial telephone lines. A +8VU output is also available for feeding program circuits.

1. Levels, TLX

The output levels will be discussed under section D of this portion of the manual. The input levels for which the TLX is designed are -20VU in the "bridging " mode and -4VU to +10VU (adjustable) in the "terminating" mode. The bridging impedance is 15K balanced, operation from a 1K ohm maximum source. The terminating impedance is 600 ohms.

2. Hookup sequence, TLX

The TLX will usually be driven from the output of a console or distribution amplifier producing either +4 or +8VU or from a jackfield whose level is -20VU. The hookup sequence is as follows:

a. -20VU Jackfield

The bridging/terminating switch is placed in the bridging position. The potentiometer on the back of the TLX has no effect.

b. Console output

The bridging/terminating switch is placed in the terminating position. A 1 KHz tone is injected into the console and adjusted for a 0 indication on the console VU meter and the level adj. potentiometer is adjusted until the output of the TLX as measured between pins 4 and 7 on the output barrier strip on the rear of the TLX chassis is +8VU as measured on a VU meter which meets the requirements of ANSI Standard C 16.5 - 1954.

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C. Couplers

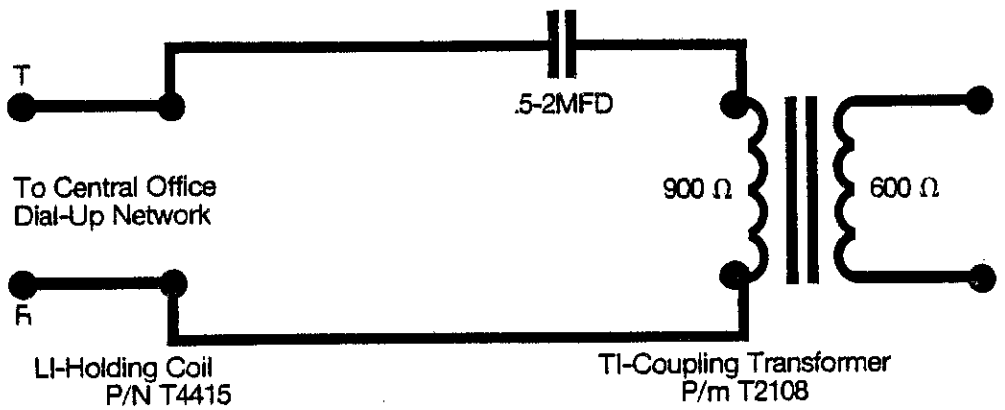
Telephone operating companies and telecommunications administrations usually refer to equipment not owned by them as "foreign" equipment. The rules of the Federal Communications Commission in the U.S.A. and the various administrations in other countries require that a protective coupler must be placed between the foreign equipment and the telephone lines. In the U.S.A., the protective couplers must be certified under Part 68 of the F.C.C. Rules. A certification number is assigned to the coupler.

When a customer wishes to connect a piece of foreign equipment to the telephone line, he informs the telephone company that he wishes to have the appropriate jack installed. The telephone company will then ask for the F.C.C. registration number and the Ringer Equivalence Number (R.E.N.) of the coupler to be installed. Although there are many coupling arrangements which can be used with the low frequency extenders, there are two couplers manufactured by Elgin Electronics, Waterford, PA which find extensive use in connection of the Models RLX, TLX and PLX to the telephone lines. These are the EC30-A voice coupler (QKT in the Uniform Service Ordering Code USOC) and ESC20721-1 (USOC, RDMZR).

The QKT (Elgin EC30-A) is a transformer with a capacitor for D.C. isolation and varistors for over-drive protection. The F.C.C. registration number is AE 498D-62644-PC-N. The R.E.N. is 0.0B. The jack most commonly used with the EC30-A is an RJ-11.

The RDMZR (Elgin ESC20721-1) is an automatic answering coupler and is mainly used at the receiving site. It may be strapped for either auto answer or seize/release operation. The F.C.C. registration number is AE489D-62825-PC-E. The R.E.N. is 0.5A. The jack most commonly used with the ESC20721-1 is an RJ-35X. More information regarding these couplers may be obtained through Elgin Electronics, Walnut Street, Waterford PA 16441. TWX 510-699-6859 - Phone (814) 796-2601. The U.S. Broadcast Distributor for Elgin is Allied Broadcast Equipment, P.O. Box 786, Richmond, IN 47374. TWX 810-345-1394 - Phone (317) 935-5193

For those customers who are not prohibited by regulation from connecting to the telephone line without a certified coupler, a simple coupling arrangement may be made. The schematic is shown below. Comrex Corporation does not recommend or take any responsibility for the use of this circuit. It is presented only for customer information.



D. TELCO

Telephone Operating Company (TELCO) or Telecommunications Administration Circuits

The International Telephone and Telegraph Consultative Committee (CCITT) makes studies and recommendations to the telephone industry. Most operating groups adhere to their recommendations as closely as possible.

A typical telephone system will consist of 5 basic parts that are described below.

1. Send loop

This is a pair of wires running from the customer's location to a central office. TELCO practice limits the lengths of these lines to distances between 6000' and 12,000'.

2. Central office, sending

The send loop pairs terminate in the send central office. From this office, the signals put on the send loop by the customer are sent to various destinations over various types of equipment. They may be sent over another local loop to a receive site within 6000' to 12,000' of the send central office or they may be sent to another central office or toll office by analog carrier or digital carrier.

At the sending central office, the signals sent by the customer are conditioned to make them acceptable to the telephone transmission system. In particular the line levels are adjusted to about -16VU, which is the level required for input to carrier equipment. These adjustments are made by compandors. The TELCO standards for the switched telephone network call for a received level at the central office of -12VU averaged over three seconds. The average attenuation of a local loop is on the order of 2-3 dB. Therefore, to present the proper level at the central office, the customer should send at a level of approximately -10VU. If a customer decides to send at a level of, say, 0VU then the compandor at the central office will be into heavy limiting for a large part of the time. The fast attack and release times of the compandors cause the limiting to seem as though it is being effected by clippers. A voice signal sent in this form will sound distorted. An upshifted voice signal sent into the send loop at excessive level will, when distorted at the central office by the compandor, generate non-related harmonic components and will sound like "sideband". Comrex constrains the output of the PLX to -11VU so that the central office will not be over driven.

3. Long haul TELCO circuits

The customer signals arriving at a toll office are transmitted to distant toll offices and subsequently to distant central offices by whatever type of circuit TELCO has available or chooses to use. These may be microwave, satellite, submarine cable, or coaxial land line circuits. The length of these circuits may be 60,000 miles long.

4. Central office receiving

The signals which have travelled over the send loop into the central office and out to the long haul circuits are transferred from the toll office to the central office servicing the distant customer. Transmission may be by either analog or digital carrier system.

At the receiving central office, the carrier signals are demodulated back to their basebands and sent over the receive loops (6000'-12,000' long) to the receiving customer.

It sometimes happens that the carrier is not completely removed from digital carrier systems and continues to travel with the demodulated audio, naturally at a reduced level. If a telephone set were to be the receiving instrument this would present little problem because the earphone would not reproduce it as audible sound. But a wideband

device such as an amplifier fed into a good speaker, would produce a sound which could be described as audio with "ringing" sounds in the background. The frequency of this carrier residue from a digital carrier system is 8KHz.

Fortunately this digital residue is receiving central office associated. A customer using a Comrex low frequency extender, who experiences this sound can eliminate it by ordering an 8KHz notch filter from Comrex. This filter provides a deep notch at 8KHz and equalizes the group delay which results when a sharp notch filter is added to an audio system.

5. Receiving Loop

The receiving loop is of the same type as the sending loop, having a maximum length of 6000' to 12,000'. At the end of the receiving loop is located a protective coupler which will feed the foreign equipment connected to it. The levels received from the output of the protective coupler will vary over a range of -15VU to -35VU from call to call.

6. Scheduled Grade Service

The above description centers on the telephone system's dial or switched network when discussing received levels. In the case of the scheduled grades of services, these are specially constructed by TELCO, even though they are made up of elements from the switched system. Because the equipment used to provide these services are dedicated to that service for the length of the lease, the delivered levels can be constant. TELCO will specify input and output levels when construction takes place.

E. RLX

The RLX is the decoder for the Comrex low frequency extension system. It is A.C. operated and constructed for mounting in a 19" equipment rack. The input signal to the Model RLX is the upshifted program material which has passed through anywhere from one mile to 60,000 miles of TELCO circuits. As this signal passes through the RLX circuitry, the 250 Hz which was added to the signal before transmission is subtracted. The original material is thus extended down to 50 Hz instead of 250 Hz, which would be the lower limit without an extension system.

1. Levels, RLX

As mentioned previously, the signals received from TELCO over their scheduled lines will be for the most part fixed in level. Those received over the switched network will vary in level from -15VU down to -35VU. These variations must be accommodated if satisfactory performance is to be achieved. There is no statistical average receive level for which the receiving end could be adjusted with any confidence that only a few calls would reach either extreme.

There are two ways to adjust for the varying receive levels of switched network lines. One, install an external potentiometer between the protective coupler and the RLX and adjust the level on each call. The adjustment needs only to be done once for each call. Two, install a Thompson-CSF "Audimax" between the coupler and the RLX.

2. Hookup Sequence

Depending upon the level control scheme selected, the Bridging/Terminating switch will be placed in one or the other position.

a) The bridging mode is used where the potentiometer control method is chosen. As mentioned above, the received line level on switched network calls varies between -15VU and -35VU. The Bridging/Terminating switch is placed in the Bridging position. The sensitivity of the RLX is then -40VU for full output. The external potentiometer is set once for each call to produce proper output level.

b) When the switch is in the terminating position, the sensitivity of the RLX becomes variable. Levels of -4VU to +10VU will then drive the RLX to full output. An Audimax unit may be connected between the protective coupler and the RLX. The level adjust potentiometer on the back of the RLX is then adjusted to provide +8VU output between pins 4 and 7 on the output barrier strip for the nominal output level of the Audimax.

III. Things to Avoid

A. Private Telephone Systems?

Certain private telephone systems use multiplex techniques for providing telephone circuits within an office or plant area. Unfortunately, these systems lack sufficient filtering in their output circuitry. Large switching residues are found on the lines. The frequency of these undesirable components are located at various parts of the spectrum. To utilize such systems for program transmission is to invite very objectionable interference.

A conventional telephone service to the RLX is recommended.

B. Acoustic Couplers

There are several types of acoustic couplers available. These are used with portable tape recorders for playing back into the microphone of a telephone handset. Basically, they are small loud speakers which can be held by a strap up to the handset microphone.

These units are not suitable for use with the PLX because of the fact that the carbon button in telephone handsets distorts the audio signals. This distortion is acceptable for telephonic uses but not suitable for program transmission.

C. Handset Carbon Buttons

When using a circuit which has a telephone instrument connected to it, the microphone in the handset must be disabled. The simplest way is to have TELCO install a push to talk handset. If this is not feasible, the microphone element can be removed temporarily.

In no case should the handset microphone be left active either on the sending end or the receiving end of the system. Left operating, the handset microphone will pick up background noises and inject them into the system only to product "phasy" type sounds.

IV. Troubleshooting

If problems are encountered with a low frequency extension system, the following chart may prove helpful. This chart is the product of Comrex's efforts to assist customers in finding solutions to their problems. If a problem not covered below is experienced, the Comrex Engineering Department stands ready to assist. Simply call Comrex Corp. at (617) 443-8811 and ask for the Engineering Department.

Problem	Cause	Cure
Sideband sound	A. Overdrive of the RLX because input potentiometer not used. B. Too high level fed into the PLX.	A. Install 600 ohms Potentiometer between the coupler and the RLX. Set proper level on each call B. When using microphone input on PLX, do not exceed input level of -56 dBm @ 150 ohms. When using tape input on PLX, do not exceed input level of 0.56 volts.
Ringing sound along with the audio	Digital carrier residue, 8 KHz.	Install 8 KHz notch filter available from Comrex.
Distortion when using with mixer and headset microphones.	The headset microphones provide such a high level that they overdrive the pre-amps in the mixer. Once generated, distortion is not removable by any process. It must be prevented.	Installation of Shure Model A15A microphone attenuator between microphone and mixer.
Distortion when using a Shure M-67 with a PLX. The microphone output of the mixer is fed into the microphone input of the PLX.	The Shure mixer microphone output is higher than the proper input to the PLX (-56 dBm @ 150 Ohms).	Install a simple 6 dB pad between microphone output of the Shure M-67 mixer and the microphone input of the Comrex Model PLX.
Phasy sound	The handset carbon button not disabled.	Remove the handset microphone or disable it.
Noise when using only tape input on PLX.	Microphone input open.	Place shorting plug in microphone input of PLX.
PLX operates on battery power when connected to external A/C power supply.	Power switch on PLX is in ON position.	Turn power switch on PLX to OFF. This places the PLX on A/C power.
Extremely short battery life in PLX operation.	Use of other than ALKALINE batteries.	Use ALKALINE batteries only.
I have problems but am unsure whether it is in the transmitter or the receiver.		A. To check out receiver, dial test tape at Comrex: (617) 443-3432. B. To check out transmitter, dial (617) 443-8811 and ask for Engineering.

V. Setup and Operation

1. Install TLX in equipment rack.

2. Connect power.

3. Connect the output of the TLX to the telephone line through a protective coupler if the dial network is being used. As stated previously, the level which should be fed into the line is -10VU. To obtain this level, connect to pins 6 and 7 on the output barrier strip which is located on the rear of the TLX chassis. If the TLX is to feed a Schedule A,B,C or D line, TELCO will specify the level which it requires. If the level specified by TELCO is +8VU, this level may be obtained by connecting to pins 4 and 7 on the output barrier strip. If the level required by TELCO is less than +8VU and more than -10VU, a pad can be connected between pins 4 and 7 and the TELCO equipment. The design of a pad to achieve the desired attenuation is covered in *Reference Data for Radio Engineers*, 6th edition, published by Howard W. Sams & Co., Inc. Chapter 11.

4. Connect the input of the TLX to the program source. As described previously, the program source may be either a jackfield on which the nominal level is -20VU or it may be the output of a console. If the source is a -20VU jackfield, the Terminating/Bridging switch is placed in the bridging position. Since the sensitivity of the TLX in this position is -20VU, it will match the level on the jackfield. If the source is to be a console, the TLX will require adjustment to properly operate at the output level for which the console is set. In many cases, the nominal output will be on the order of +4VU or +8VU. The Terminating/Bridging switch should be placed in the terminating position. The TLX sensitivity may then be adjusted to accept any level between -4VU and +10UV. The console is fed a 1 KHz tone and adjusted to produce its nominal output level. A VU meter is then connected between pins 4 and 7 on the output barrier strip on the rear of the TLX chassis. The "Level Adj" control, also located on the rear of the TLX chassis, is turned until the VU meter reads +8VU. This completes the adjustment of the TLX. It is ready for program transmission.

5. Place the EXTEND/BYPASS switch on the front of the panel of the TLX in the EXTEND position when it is desired to transmit program material in the low frequency extension mode. If the receive site does not have an RLX to decode the upshifted signals, the EXTEND/BYPASS switch may be placed in the BYPASS position. In this mode, the signal transmitted in to the line will not be upshifted.

TECHNICAL

I. Specifications of the Model TLX

Input Level and Impedance:
-20VU (15K ohms balanced)
-4 to +10VU adj. (600 ohms balanced)

Frequency Response:
50 HZ - 5 KHz ±1.5 dB

Output Level and Impedance:
+8VU into 600 ohms (75 ohms unbalanced)
-10VU into 600 ohms (600 ohms unbalanced)

Translation Accuracy:
±0.08 Hz

Power:
117 V 50/60 Hz or 234 V 50/60 Hz

Size:
WxHxL inches 7.5 x 1.75 x 19
WxHxL cm 19 x 4.4 x 48.3

Weight:
5 lbs. 6 oz/2.34 Kg

II. Circuit Descriptions

Referring to the schematic and synoptic diagrams included in the Charts and Diagrams sections of this manual, the Model TLX can be seen to consist of (7) seven sections: 1. the pre-amplifier; 2. high pass filter; 3. de-modulator; 4. crystal controlled carrier generator; 5. output amplifier; 6. regulated power supply; and 7. power supply board.

1. Pre-amplifier

The pre-amplifier consists of U1 and its associated circuitry. The input transformer T1 serves to provide a balanced input. It is electrostatically shielded. The pre-amplifier raises the input level to that required to drive the high pass filter. It will be noticed that there is a switch located on the rear panel of the Model TLX which is labeled "Terminating/Bridging." The functions performed when the switch is is each position are described below.

a. Bridging - In this position the input to rear panel input terminals is connected directly to the transformer T1 without any circuitry intervening. In this configuration the input sensitivity of the Model TLX is -20VU; i.e., a -20VU input will provide an output of +8VU between output terminals 4 and 7 and an output level of -10VU between terminals 6 and 7.

b. Terminating - When the switch is in this position, a variable attenuator and terminating circuit is interposed between the rear panel input terminals and the transformer T1. The attenuation inserted is 16 dB with the potentiometer set to its clockwise limit. Where in the Bridging position the input level required to produce +8VU at the output of the TLX was 20VU, it is now -4VU.

2. High Pass Filter

This filter is of the active second order high pass type with a cutoff frequency of 50Hz. It is made up of IC sections U2A and U2B and associated circuitry. The function served by this filter is one of eliminating any very low frequency components present in the program material.

3. Modulator

The modulator circuit is quite straightforward. Its 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 the 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 module is sealed so as to preclude casual adjustment which can only degrade performance.

A seal type label is used to prevent undetected field opening of this module. NOTE: Should the module be opened and misadjusted, the TLX must be returned to the factory for adjustment. The minimum charge for readjustment of a modulator module which has been tampered with is $300.

4. Crystal Controlled Carrier Generator

The carrier, or pilot, generator consists of U3, U4, U5, U6A, and U6B. The crystal Y1 operates at a frequency of 16 KHz. U4 divides the 16 KHz output of U6 down to 2 KHz and feeds U5 which divides the pilot to 250 Hz and produces a pseudo sine wave output. U6B is operated as a third order active low pass filter to remove harmonics from the 250 Hz pilot signal. U6B amplifies the output of U6A to a level sufficient to drive U6B.

5. Output Amplifier

The output amplifier is made up of "discrete" transistors Q1, Q2, Q3, Q4, Q5, Q6, and Q7 and associated components. The purpose of this amplifier is to raise the output of the demodulator to a level sufficient to provide an output level of +8VU into 600 ohms. An attenuator on the output provides a second output which will provide -10VU into a 600 ohm load. Both outputs are unbalanced.

6. Regulated Power Supply

There are two precision regulated power supplies on the main board. These receive preregulated +18 VDC and -18 VDC from the power supply board and drop it to +12.000 VDC and -12.000 VDC. The positive supply is made up of U7, Q11, CR9 and associated circuitry. R42, which is a 25 turn potentiometer, is used to set the power supply voltages. The negative supply consists of U8, Q12, and Q13 together with other circuitry. The negative power supply is "slaved" to the positive power supply.

7. Power Supply Board

This is a separate board which contains the rectifier filters, etc., to provide a regulated +18 VDC and a regulated -18 VDC at its output terminals.

III. Maintenance

Comrex Corporation takes great pains to design and construct equipment which will provide long trouble-free service. All components are operated at well below their maximum ratings. Each unit is carefully constructed and "burned in." 100% inspection several times over is performed to insure reliability.

When a TLX unit does fail to operate properly, there are two avenues toward restoring the unit to proper operating condition — field repair or factory repair. Where rapid transportation, such as Federal Express - Priority 1 (which guarantees delivery by noon of the next day) is available, we recommend factory repair. At our factory service department, all equipment necessary and skilled technicians are ready to repair the unit in the shortest possible time. Where the above is not feasible, one must resort to field repair. Regardless of the skill of the person performing field service, he will always lack one most important ingredient — proper test equipment. Much of the equipment used to test the TLX was developed by Comrex because it was unavailable from test equipment manufacturers. Therefore, we suggest that field service be confined to diagnosis. In some cases a reported failure of a TLX will be the result of "cockpit trouble," and reorientation of the operator will cure the problem. Where it is determined that there is a problem with the equipment, the following guide will be helpful in determining the portion of the circuit which is causing the failure:

1. If there is no output when in the processed or extended mode, place the Extend/ Bypass switch in the Bypass mode; if you have output, you can assume that the difficulty lies in one of two places: (a) the crystal controlled carrier generator, or (b) the modulator. To determine which of the above, first connect an oscilloscope and a frequency counter on the top of R51. If the indication is as shown on the schematic diagram, you may be certain that the carrier generator is operating properly and that the modulator module is the source of the problem. At this juncture, we must stress that "THE MODULE MUST NOT BE ADJUSTED IN THE FIELD" if one is to avoid a quite expensive returning of the module at the factory ($300.00 minimum). The modulator is warranteed for 5 years, and if it is found that the modulator is defective, return the entire TLX unit to the factory. We will repair the modulator at no charge. Customers outside the U.S. may return equipment to our representatives for repair. Under no conditions should the modulator alone be removed from the TLX and returned to the factory or representative because to do so would require breaking the seal and would result in the $300.00 minimum readjustment charge and still require that the TLX be sent to the factory for reinstallation of the seal to reinstate the warranty.

2. If there is no output in either mode, it is suggested that the voltages at the various test points indicated on the schematic diagram be measured and compared with those shown in the boxes as being nominal. If a discrepancy is found, the associated integrated circuits or semiconductors should be replaced. If after substituting new IC's or transistors proper operation is not achieved, conventional repair techniques may be employed to correct the problem. Or, the TLX may be returned to the factory service department (a recommended procedure).

Test and Alignment

There are two test and alignment functions which should be performed at one year intervals, or sooner if desired. These are pilot tone balance and +12 volt reference test. The procedures are listed below.

1. Pilot tone balance

Equipment required:

Monitor amplifier with sufficient gain for a low impedance microphone

Procedure - Short the input terminals of the TLX to ground. Allow the unit to warm up for approximately 5 minutes. Connect the output of the TLX to the input of the monitor amplifier so that hiss is audible. You will hear some pilot "leakthrough." With great care, adjust the pilot balance potentiometers accessible through holes in the top of the modulator, labeled pilot balance, first one and then the other, and again the first, etc., until the 250 Hz pilot feedthrough is reduced to about the level of the hiss. This completes the pilot balance adjustment.

2. +12 volt reference test

Equipment required:

High quality 4½ digit voltmeter

Procedure — Attach voltmeter to the +12 volt supply and measure the voltage. If it is within the range of +11.996V to +12.004V, no adjustment is required. If it is outside this range, R42 should be adjusted so that the indicated voltage is within a target of +11.999V to +12.001V. This completes the reference voltage test and alignment.

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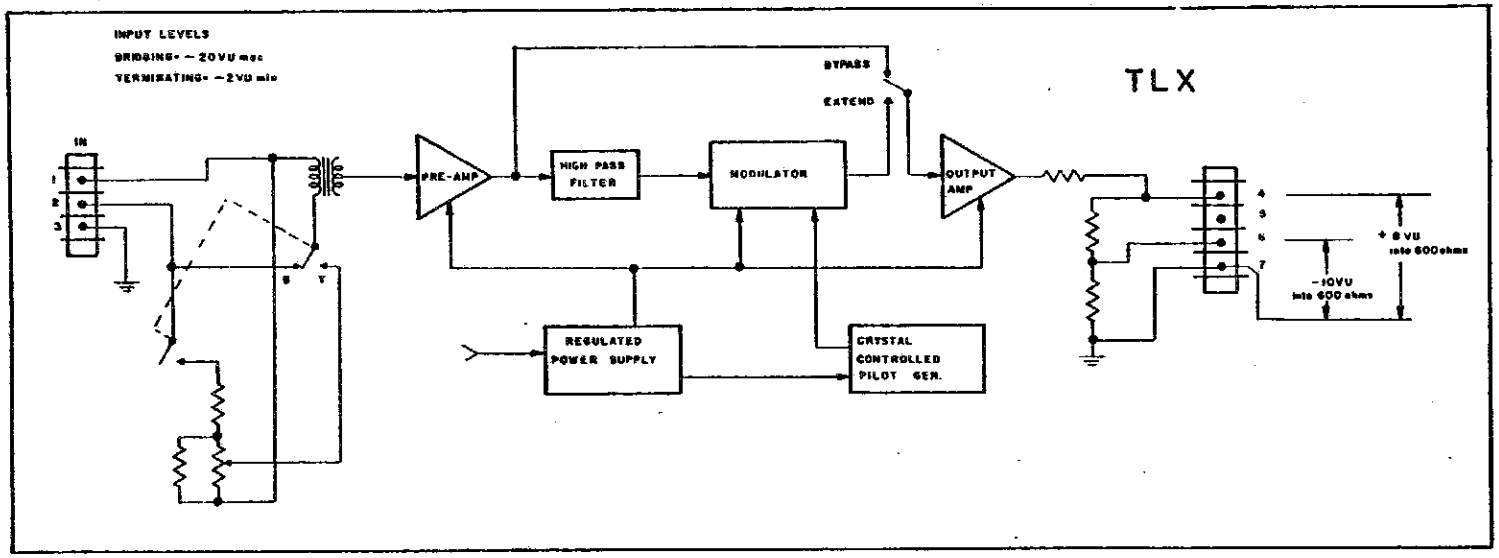
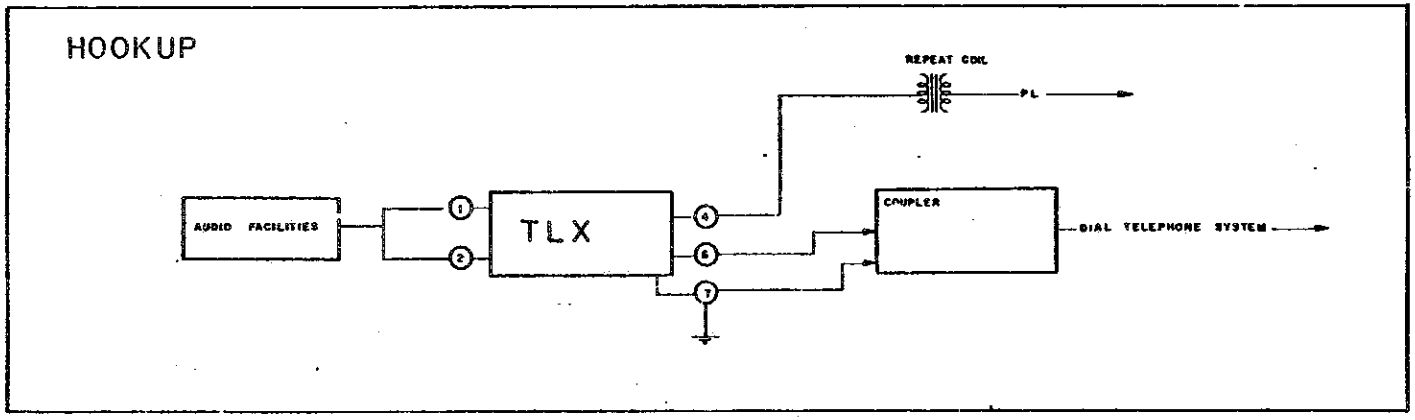


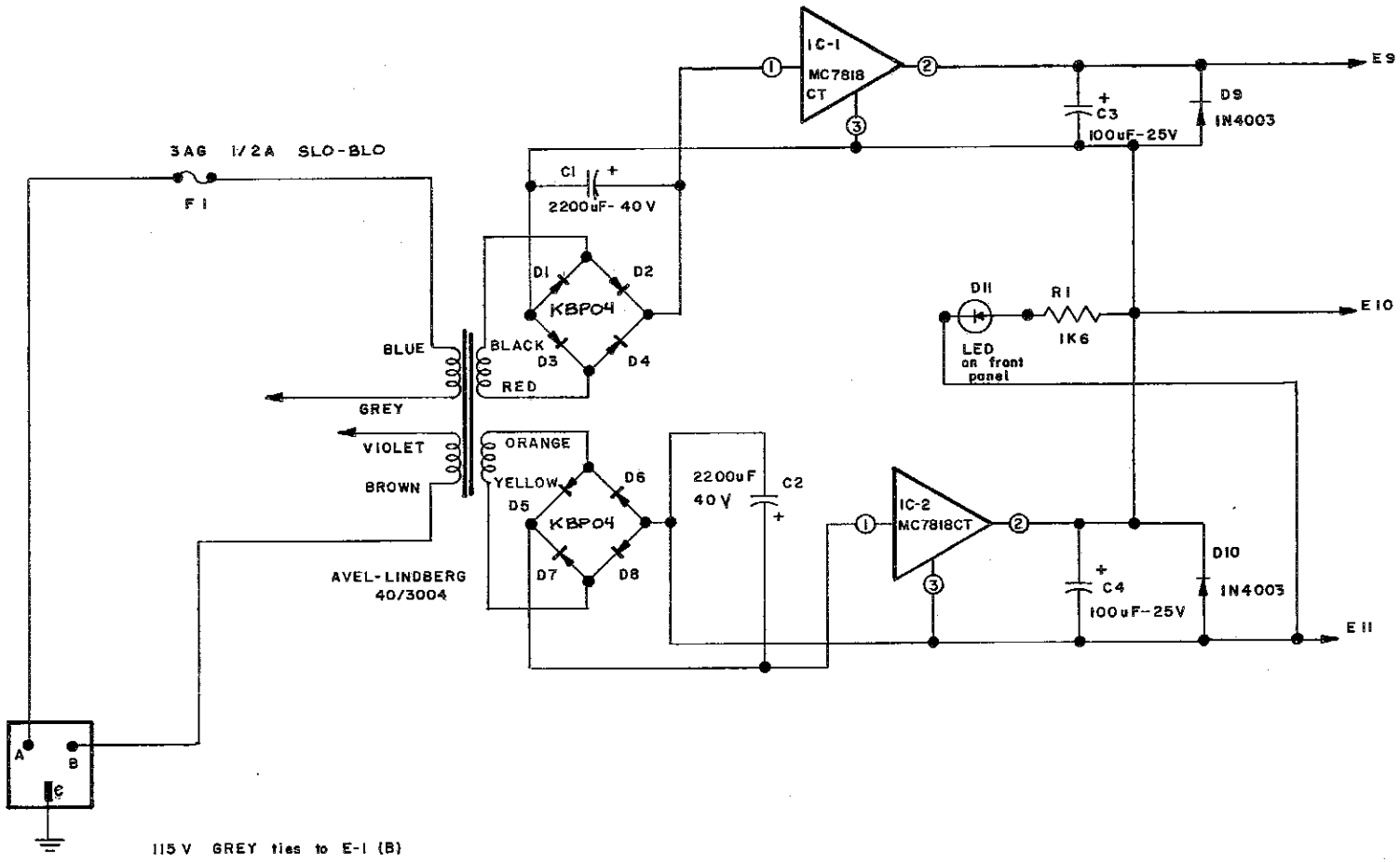


COMREX CORP.
SUDBURY, MA
01776 USA

MODEL TLX SYNOPTIC and HOOKUP DIAGRAMS

5-31-78

REVISIONS					
SYM	DESCRIPTION	DATE	DWN	CHD	APPD



115 V GREY ties to E-1 (B)
VIOLET ties to E-1 (A)

230V GREY ties to VIOLET

QTY.	ITEM NO.	PART NO.	DESCRIPTION	SPECIFICATION	CODE IDENT.

LIST OF MATERIALS

MATERIAL:

FINISH:

DIMENSIONS IN INCHES AND APPLY AFTER PLATING
REMOVE BURRS AND SHARP EDGES

TOLERANCE UNLESS SPECIFIED

FRACTIONS	±1/64	
DECIMALS	.XXX	±.010
	.XX	±.03
ANGLES	±0° 30'	

HOLE SIZES

0 - .250	+.005 - .002
.251 - .500	+.008 - .003
.501 - UP	+.010 - .005

MACHINED SURFACE FINISH TO BE 125
ALL PARTS TO BE PROCESSED TO GOOD COMMERCIAL PRACTICE

STOCK SIZES SUBJECT TO COMMERCIAL STANDARDS

DO NOT SCALE DWG.

DRAWN	DATE 11/6/86
CHECKED	JFC
PROJ ENG	
PROD ENG	
DRAFTING	

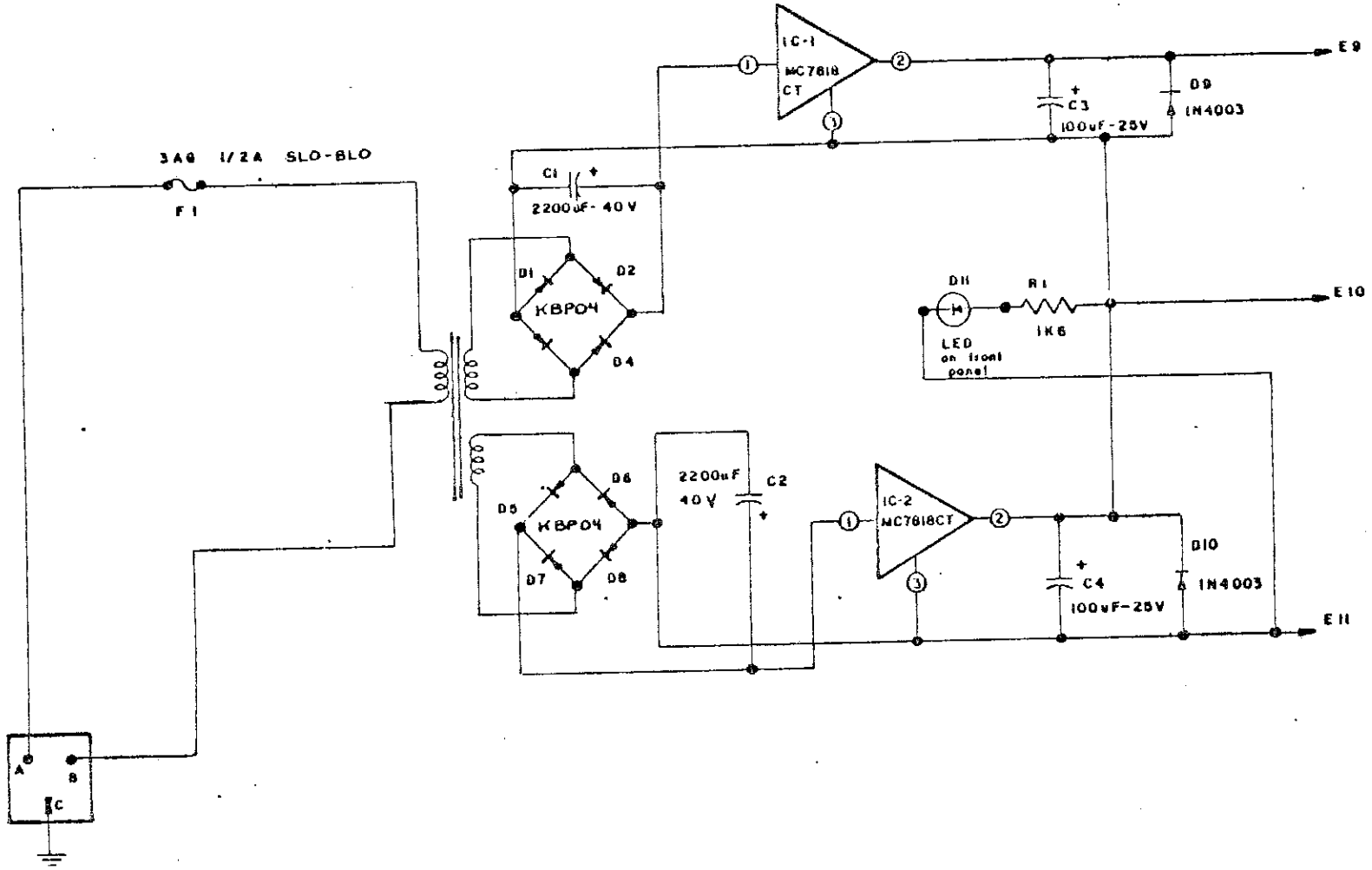
NEXT ASSY. | USED ON
APPLICATION

COMREX CORPORATION
SUDBURY, MASSACHUSETTS 01776

TITLE: RLX, TLX P.S.

CODE IDENT.	SIZE	DWG. NO.	REV

SCALE | SHEET OF



NOTE

THE COMREX RLX AND TLX ARE NOW MANUFACTURED FOR OPERATION FROM 115V 50-60 HZ ONLY. TO OPERATE FROM HIGHER VOLTAGES AN EXTERNAL STEP DOWN TRANSFORMER WILL BE REQUIRED.

QTY	ITEM NO	PART NO.	DESCRIPTION	SPECIFICATION	CODE IDENT

LIST OF MATERIALS

COMREX

SUDBURY, MASSACHUSETTS 01776

TITLE RLX, TLX P.S.