Phase Linear Model 1000

Autocorrelator Noise Reduction System

You have just purchased the most advanced and most versatile noise reduction and dynamic range recovery system available. Proper use of your Phase Linear 1000 will allow you to reproduce music with less noise and greater dynamic range than previously thought possible. We hope you will read this manual thoroughly in order to appreciate all the benefits of the 1000.

Recording studios and record processing companies employ a number of "necessarily evil" techniques brought about by the state of the recording art. Taken together, these techniques may be described as processes which serve to limit and restrict the dynamic range of recorded material. Unfortunately, their use is necessary in order to put the tremendous dynamic range of live music onto the surface of modern phonograph discs and tapes. When used properly, the Phase Linear 1000 will significantly correct these shortcomings inherent in the recording process.

Before leaving our factory your Phase Linear 1000 was tested and certified to be in perfect operating condition. This manual has been prepared to help you operate your Phase Linear as well as keep it in perfect condition. Your Phase Linear when used with care befitting all fine instruments, is capable of truly providing a lifetime of musical fulfillment.

CONNECTIONS

1. Check front panel to insure:
   a. The power switch is in the off position.
   b. The 1000's tape switch is in the source position (out).

2. Connect tape output on your receiver (preamp) to the input on the 1000 and connect the 1000's outputs to your receiver's (preamp) tape input jacks.

3. Plug in the 1000's AC cord while leaving the unit turned off.

4. Turn on your receiver (preamp), and then turn on the 1000.

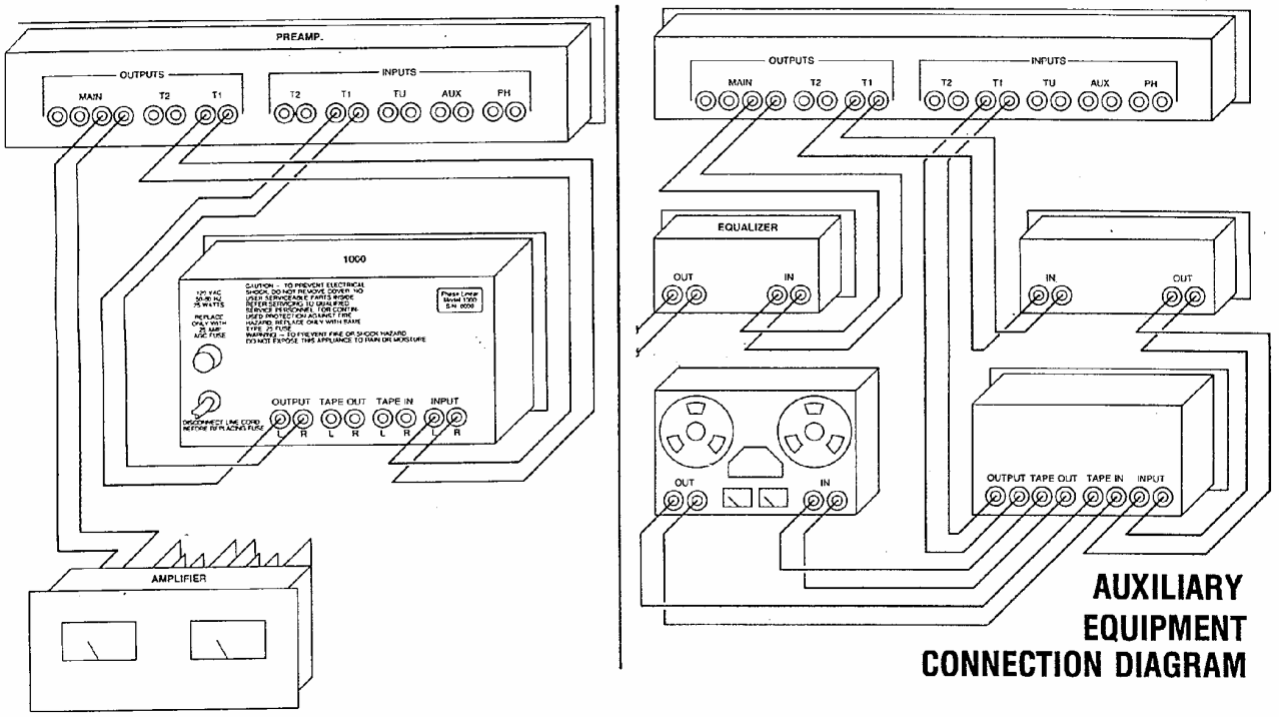
5. The tape monitor on your receiver or preamp should be in the monitor position.

6. Refer to the Operating Instructions for correct operation and adjustment of the Correlator and Peak Unlimiter circuits.

AUXILIARY EQUIPMENT

Outboard units such as Dolby or DBX may be used with your 1000 but the 1000 must be placed "after" the units in the signal path and "before" any equalizer in signal path, or as shown.

CONNECTION DIAGRAM



Any source played through the 1000 will be processed. It is not necessary, therefore, to process a signal prior to recording since it will be processed on playback. However, if you wish to make a tape to be played back on another system, simply install the 1000 between source and the tape recorder.

Note: It is not advisable to use the Expander during recording since it will stress the recorder's dynamic range capability.

FRONT PANEL CONTROLS

Unlimit Threshold Lamp: Provides visual indication of peak unlimit operation. This lamp should come on during the peaks in the program material but should not stay on all the time.

Unlimit Threshold: Rotate clockwise to increase dynamic range of program material. Adjust so that unlimit indicator lamp illuminates on peaks and extinguishes between musical peaks. This knob adjusts both the peak unlimiter and the downward expander.

Low Frequency Calibration: Adjusts low frequency noise reduction. Once this is adjusted properly it should not be changed unless your cartridge or turntable is changed. An incorrect setting of this control will cause a loss of bass response. (See Operating Instructions)

Correlation Threshold: Rotate counterclockwise to remove noise from program material. Correct adjustment is indicated by absence of random hiss and presence of all high frequencies associated with the musical program. Incorrect adjustment is indicated by complete loss of high frequencies or by presence of noise in the program. Typically, proper settings are found in the eleven to three o'clock positions though this setting will vary with the source material.

Power Indicator: Illuminates when unit is on.

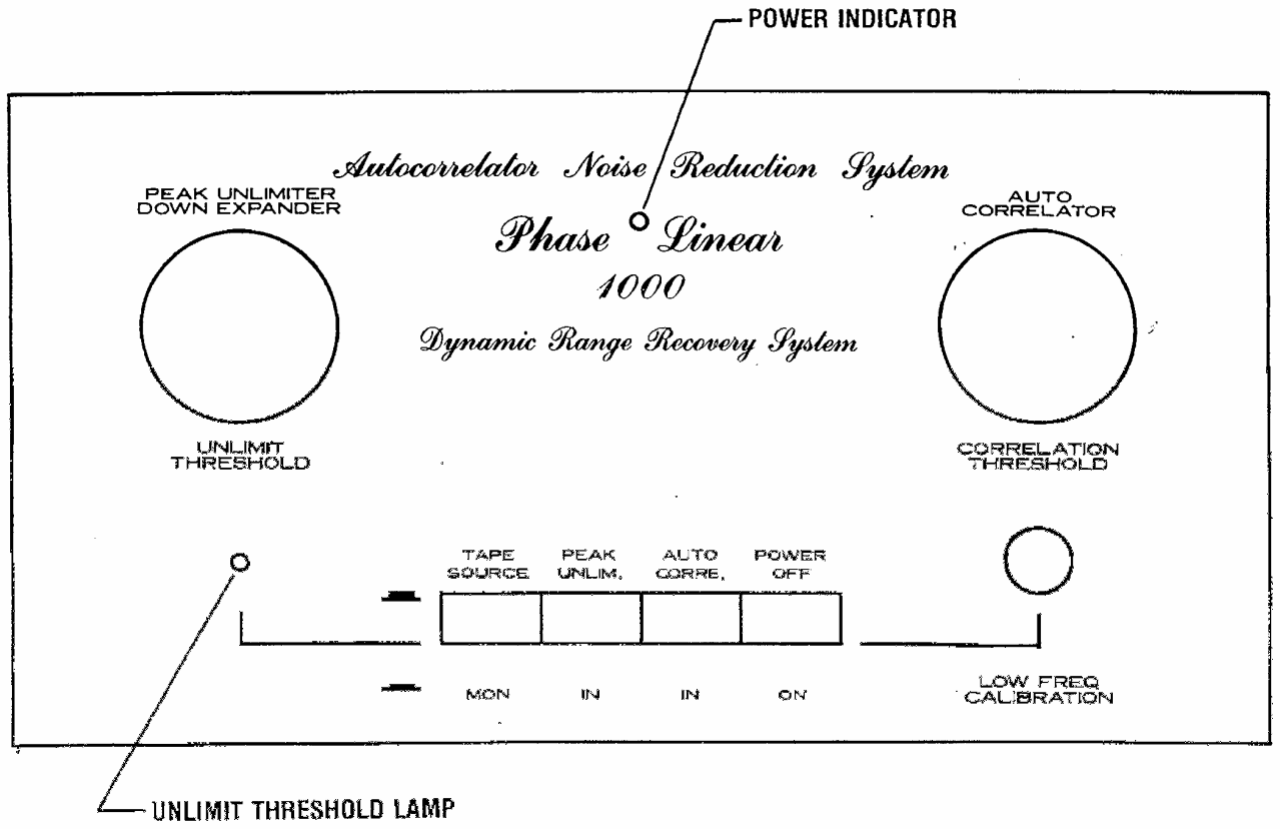
Power: Press in to turn unit on.

Autocorrelator: Press in to activate correlator.

Peak Unlimiter: Push in to activate Peak Unlimiter/Downward Expander.

Tape Source: Press in to use tape path on Model 1000.

FRONT PANEL DIAGRAM



OPERATING INSTRUCTIONS

AUTOCORRELATOR

The AUTOCORRELATOR is a noise reduction system designed to remove noise from any signal source. The following steps should be used to adjust the AUTOCORRELATOR:

Step 1: Rotate the CORRELATION THRESHOLD control fully clockwise.

Step 2: Check to insure that the Correlator is turned on.

Step 3: Put on a good quality record, advance the treble controls to full maximum on your preamplifier or receiver. Select a portion of the record in which hiss may readily be heard against the musical program. Slowly rotate the Correlation Threshold counterclockwise. As the control is progressively rotated counterclockwise, a point will be reached at which the record hiss drops to a very reduced level while the high frequencies of the musical program remain unaffected. Further counterclockwise rotation will have no effect on the program until a rather extreme counterclockwise rotation results in an abrupt and complete loss of high frequencies associated with the music. The Correlator is said to be "in lock" when the threshold control is set anywhere within the two limits outlined above. The correct setting is midway between these

two limits. This setting is rather broad and not at all critical. The action is very similar to the familiar "vertical-hold" control on your television set. To far in one direction will cause the picture to "roll" down. As with the vertical hold control on your television set, a CORRELATOR THRESHOLD setting too close to either extreme may cause the Correlator lock-in ability to become impaired and it may occasionally and briefly fall out of lock. This is caused by random disturbances on the record surface.

The symptoms of this condition are:

1. If the control is set too close to the clockwise limit, the Correlator may momentarily fall out of lock and a brief noise pulse or burst will be heard against the music.

2. If it is set too close to the counterclockwise limit, a momentary loss of highs will occur. In general, a split second loss of highs is never noticeable, but even the briefest noise pulse is highly audible and extremely objectionable. This fact suggests that if you should have a record that seems to cause the Correlator to occasionally fall out of lock, the CORRELATION THRESHOLD should be set somewhat to the left (counterclockwise) of the theoretically optimum position. This will absolutely insure that an objectionable noise burst never occurs.

After some experience has been gained in use of the noise reduction system you will find that the threshold adjustment may be made easily and quickly by ear without boosting treble.

LOW FREQUENCY CALIBRATION ADJUSTMENT (L F Cal)

L F Cal adjustment is an adjustment that is performed upon initial installation. Adjustment procedure is as follows:

1. With Correlation circuit engaged, apply as much bass boost with your preamp or receiver as possible.
2. Rotate the L F Cal adjustment control fully clockwise.
3. Turn down the main volume control.
4. Put the phono stylus pickup on the blank portion of a lead groove on a good quality record. Advance the volume control until rumble and/or hum is heard in the speakers.
5. Carefully rotate the L F Cal control counterclockwise until an abrupt drop in rumble and/or hum occurs. Rotate the L F Cal control slightly further counterclockwise past the drop-out point. You may verify correct operation of the Dynamic Low Filter by switching the correlator switch in and out. There should be no loss of bass material-only the disappearance of rumble and hum.

   This completes L F Cal adjustment and will require readjustment only it the pickup cartridge is replaced with a unit whose sensitivity varies significantly from the first.
6. You should make a mental note of the final setting of this adjustment in the event that it is inadvertently moved

THE DOLBY NOISE REDUCTION SYSTEM AND THE AUTOCORRELATOR

The Autocorrelator differs from the Dolby system in that it is a single pass or open ended system which removes noise from the source without the necessity of the source material undergoing special encoding. The Dolby system is a noise preventing system designed to prevent additional noise from adding to the signal during tape recording. The Dolby system is a two pass or closed system which cannot remove noise once it has contaminated the signal, but prevents it from

increasing during the tape recording process Both systems provide approximately 10dB of signal to noise improvement.

It is possible to obtain a full 20dB increase in signal to noise by operating the Dolby system in tandem with the AUTOCORRELATOR. A tape recording that has been "Dolbyized" during recording may be "de-Dolbyized" by a Dolby decoder, then processed through the 1000.

An interesting psychological phenomenon occurs when high frequency hiss is removed from the program source. It often seems that the absence of hiss is accompanied by a loss of high frequency program material, when in fact, no loss has occurred. At first, with certain kinds of music, the psychological suggestion that high frequency material has been removed along with the hiss is very difficult to overcome. With other kinds of music, it is very obvious that only hiss has been removed. However, after a brief exposure to noise-tree music, this psychological phenomenon seems to vanish as one becomes accustomed to a noise free background. Once acclimated to a noise free background, it becomes rather unbearable to listen to hiss-contaminated music.

Historically, it took several years before Ray Dolby was able to convince the world his system was able to reduce noise without affecting the high frequencies. This situation was caused by the aforementioned psychological effects.

PEAK UNLIMITER/DOWNWARD EXPANDER

Actual operation of the Peak Unlimiter circuit is relatively simple. Initially, set threshold control to the full counterclockwise position with the circuit engaged and source turned on.

Gradually rotate the threshold control knob clockwise until the peak indicator lamp flashes on the peaks of the program material. The indicator lamp should NOT stay on all the time. No setting is necessary for the downward expand circuit since it is automatic

CHARACTERISTICS OF THE EXPAND CIRCUIT

The threshold adjustments will vary with the type of program material being played due to the different degrees of compression and gain riding used at the studio. You will find that the threshold setting for phono is different from either FM or tape sources. Generally the more compression used in recording and broadcasting, the more difficult it will be to make the indicator lamp flash on the peaks. It will want to continuously stay either on or off, which is not an optimum setting. This is because there are few if any peaks to expand due to excessive compression.

MAINTENANCE & SERVICING

CLEANING

To keep your 1000 clean and looking like new, occasionally clean the front panel with a soft paper towel and full strength ammonia This will remove dulling films which have a tendency to build up on the brushed finish.

REPAIR FACILITIES

Only qualified technicians should be allowed to repair your Phase L near 1000. The Phase Linear Corporation and its authorized warranty stations have the trained personnel and special equipment required to repair your unit. Should you have any trouble with your unit write to the

factory for the address of the nearest repair facility Please include the model and serial number of the unit together with a description of the problem.

RETURN AUTHORIZATION

No preamplifier should be returned to the factory without an Authorized Return card which will be supplied by Phase Linear. Write to the factory in care of the Service Department for the authorization. Packages returned without an authorization card will not be accepted.

SHIPPING

Never ship your Phase Linear in any shipping carton other than the original or a replacement supplied by Phase Linear. For a replacement write to the factory or see your local dealer. If the preamplifier is shipped in other than a Phase Linear cart on which is properly packed, all damages must be paid for by the store or person shipping the unit. Ship only via a reputable carrier. DO NOT USE PARCEL POST! Insure the unit for the full value and double check to ensure the unit is properly packed.

DESCRIPTION OF CIRCUITS

PEAK UNLIMITER AND DOWNWARD EXPANDER — The Dynamic Range Recovery System

The peak unlimiter, together with the downward expander, combine to greatly increase the available dynamic range. Before discussing the system several words should be defined. Compression is the function of intentionally altering the musical signal level in such a manner that loud musical passages are recorded more softly, and soft material passages are recorded more loudly than the live counterpart. Peak compression refers to the compression operation being performed exclusively on brief musical peaks and is generally referred to as peak limiting. Low level compression refers to the compression operation performed on very low level signals and normally compresses the average signal level. This operation is generally referred to as low level gain riding or upward compression

When a phonograph record is made, compression is performed by the combination of an electronic compressor together with the skillful application of manual level changes by the recording engineer (gain riding). During high level musical transients, a device called a compression-limiter or peak limiter is employed at the recording studio to compress and limit the level of musical peaks. This is necessary to prevent a system overload associated with the mastering of the phonograph record. During quiet, low level passages, the recording engineer manually raises the overall recording gain in order to produce a recording that will be loud enough to cause the background noise level to be acceptable

The peak-unlimiter is designed to restore to a significant extent the musical peaks that are removed by the peak-limiter during recording. The amount of peak-unlimiter operation is a function of the time rate of change, the duration, and the instantaneous level of the input signal (the recording). Tracking is designed to closely compliment the dynamics of recording studio peak-limiter. The maximum amount of unlimit action is + 1.5dB and the maximum attack rate is .5dB/micro second

The goal of this system is to expand the dynamic range of standard (uncoded) musical material such that the loudest passages wilt produce levels of 105dB and yet during quiet passages noise or hiss will not be heard. In addition, the dynamic range expansion system must not cause any detectible sonic anomalies such as breathing, swishing or any obvious volume manipulation. Basically, dynamic range expansion entails making the loud parts louder and the soft parts softer in a way which significantly improves the dynamic range of music in a manner which does not make it sound as if the volume has been changed. It is possible to make small

changes in volume that go undetected. It turns out that at high levels (above 90dB) a volume increase or decrease of 1.5dB is the maximum tolerable before change is perceptible. At very low levels, a change of 3.0dB is possible without detection

Since it is desirable not to “hear’ the system operate, the maximum possible expansion would be only 1.5dB. And the question arises . . . why bother?

The Peak Unlimiter—How It works: At very high levels, the gain of the system is increased by 1.5dB, while at levels just below this the system gain does not change at all. During moderately soft passages the system gain is changed with variations in program level by an amount of 1dB in every 10dB (i.e., if the input level changes 10dB the output will change 11dB) with an allowed cumulative maximum of 3.0dB. -that is the linear expander. During very soft passages the gain is changed by 3.0dB. -that is the downward expander. Conceptually, the scheme has been to limit any individual expansion operation to an amount small enough to be undetectable and only to operate on the extremes of the loudness spectrum.

Summary: The Phase Linear Dynamic Range Recovery System selectively expands (peak unlimit 1.5dB, linear expand 3 0dB and downward expand 3.0dB) in a way that produces no audible side effects and yet yields a significant total increase in dynamic range of approximately 7.5dB. That is a dynamic range increase of over tour times in terms of radiated power. This, when combined with the autocorretator, yields a 17.5dB increase in effective signal to noise ratio and dynamic range.

THE AUTOCORRELATOR

The following description of the Autocorretator was related to Bert Whyte by Bob Carver, President of Phase Linear, in the April, 1975 issue of Audio Magazine. The article was written by Bert Whyte:

Music energy appears in discrete energy “bundles” throughout the audio band and is therefore not continuous. In addition, if some musical energy appears, for example, at a particular frequency, we know for certain that even and odd harmonics will exist simultaneously throughout the passband, and that energy will not exist between these harmonics. In other words, with music we are able to “predict” where energy is likely to occur, if we know where the fundamental is, or even if we know where on/y one of the harmonics is. Also, and importantly, we know where the energy will not appear. In other words, music is coherent or correlated.’

Since pure hiss is totally uncorrelated, it is assigned a correlation co-efficient, which is zero. Highly correlated signals, such as sine wave or a linear sum of sine waves, have a correlation co-efficient of one. As noted, music is a correlated signal, but the correlation value of music varies continuously from moment to moment.

The Autocorrelator may be considered a real-time Fourier analyzer with correlation co-efficient estimator. It's a very complex circuit, and the following is a simplified explanation of how/f works: A series of electronic gates or “windows,” each window controlling a certain frequency range and lust “overlapping” its neighbor, is p/aced in the audio passband. These windows can be either closed or open. If it is closed, energy, be it correlated (music) or uncorrelated (noise), cannot be transmitted at that point in the frequency spectrum assigned to the particular window. If the window is open, energy may be transmitted at that frequency. An operational description from Phase Linear says that each window is controlled by two sets of control circuits coupled together by diode logic “OR” gates. The primary circuit is located in the control band, between 200Hz and 2kHz. The secondary circuits are located throughout the harmonic band, if above a level of -65dB, will cause each window associated with the appropriate harmonic to open. If energy appears in the harmonic band at a particular frequency, each window associated with each upper harmonic

of that frequency will be opened. All lower windows will remain closed. Notice that as the frequency increases, fewer and fewer windows are required to be opened. Notice also that for the autocorrelator to recover a harmonic “buried” beneath the noise, it's necessary that the harmonic have associated with it a lower frequency fundamental whose energy level is above the noise. Fortunately, this condition is common in musical energy.

In similar fashion to most noise reduction systems, the autocorrelator commences with a reduction of 3dB at 2kHz, and reaches 10 to 12dB from 4kHz to 20kHz. As noted, the device has a circuit which estimates the degree of correlation of incoming signals and generates a control signal. This correlation function signal is combined with another signal which indicates the harmonic content of any incoming music energy. This controls a threshold level designed to detect musical information within each of the bandpass frequencies. It must be appreciated that in the music output of phono disc or tape, the noise (hiss or uncorrelated sound) is always present “outside” the gates, and is always ready to “rush in” along with the music when a gate is opened. By automatic adjustment of the various threshold levels at which the bandpass gates are opened, the incoming signal passed through the gates is almost always of such amplitude, frequency, and correlation that the well-known “masking” phenomenon occurs, and the noise is subjectively “covered.”

SPECIFICATIONS

TOTAL DISTORTION: Less than .250%.

INPUT IMPEDANCE: 70k ohm

INPUT LEVEL: 3 volts R.M.S. maximum

OUTPUT VOLTAGE: Full output 8 volts R.M.S. Better than 3 volts R.M.S. into 2000 ohms.

FREQUENCY RESPONSE: Within ‘ 1dB from 20Hz to 20k Hz.

PEAK UNLIMITER: (Nominal peak unlimit rate attack threshold, front panel variable) .5 dB/micro second for +6 dB peak unlimit operation.

NOMINAL AMPLITUDE ATTACK THRESHOLD: 2 volts peak at input to peak unlimiter.

SEMICONDUCTOR COMPLEMENT: 28 transistors, 8 integrated circuits, 91 diodes

DOWNWARD EXPANDER: Downward expansion commences at -35dB Ultimate limit is -41dB. Unlimiter window is 35dB wide, upper and lower thresholds are simultaneously variable by front panel unlimit threshold control.

AUTOCORRELATOR (NOISE REDUCTION SYSTEMS):
High frequency noise reduction commences at 2kHz and is
3dB, reaching 10dB from 4kHz to 20kHz. Low frequency
noise reduction begins at 200Hz, ultimately reaching 20dB @ 20Hz. Passive subsonic filter rejection of -35dB @ 5Hz. Weighted overall noise reduction is -10dB from 20Hz to 20kHz

TAPE MONITOR: The Model 1000 provides a tape monitor circuit to replace the one it utilized.

POWER CONSUMPTION: 35 watts.
SIZE: 9 1/2" wide x 5” high 11-4/5” deep.

WEIGHT: 6 pounds, Warranty: Three years, parts and labor.