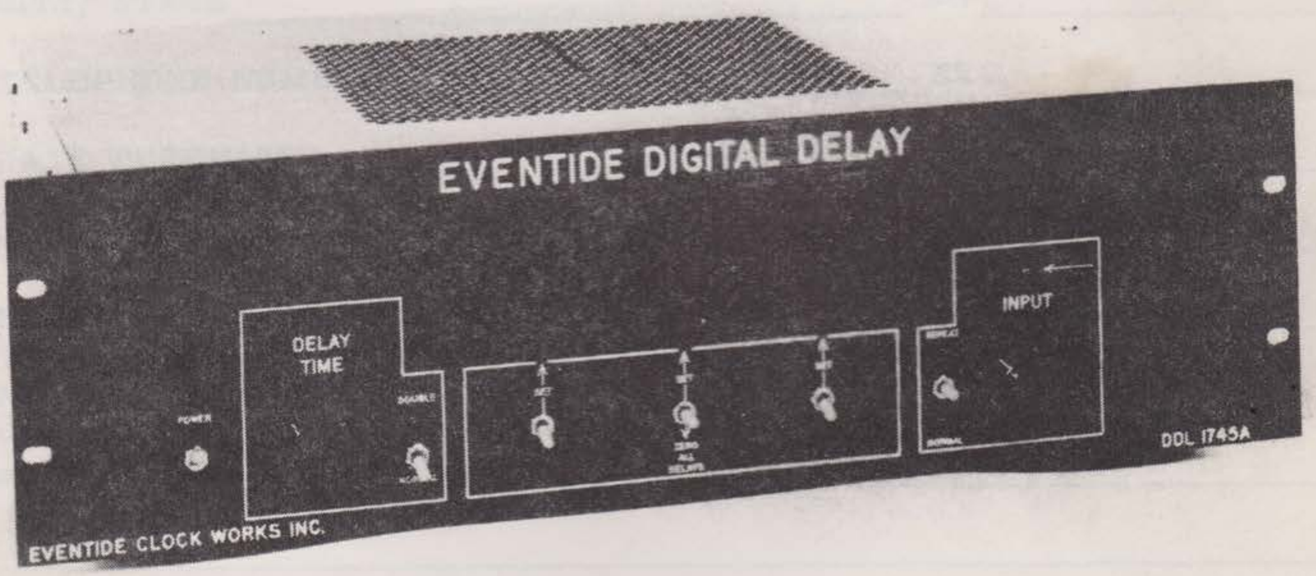
Eventide
the next step

1745A



INSTRUCTION MANUAL

EVENTIDE CLOCKWORKS, INC. – 265 WEST 54TH STREET, NEW YORK CITY, 10019 – (212) 581-9138

ENVIRONMENT

1: THE DELAY LINE LIKES FRESH AIR. DO NOT MOUNT IT IMMEDIATELY ADJACENT TO HEAT-PRODUCING DEVICES OR IN ANY LOCATION IN WHICH ROOM-TEMPERATURE OR COOLER AIR IS NOT AVAILABLE.

2: DO NOT MOUNT THE DDL BY ITS FRONT PANEL EXCLUSIVELY. THE DELAY LINE IS HEAVY AND, ALTHOUGH THE PANEL WILL PROBABLY SUPPORT THE UNIT, IT IS NOT STRESSED FOR ANY G LOADING WHATSOEVER WITHOUT ADDITIONAL SUPPORT. IT IS RECOMMENDED THAT A SHELF OR SLIDES BE USED FOR RACK INSTALLATION.

3: DO NOT OPERATE THE DDL ON AN INCORRECT LINE VOLTAGE. IT MAY BE INTERNALLY WIRED FOR A LARGE SELECTION OF LINE VOLTAGES. IF YOUR LINE VOLTAGE IS NOT NORMALLY BETWEEN 110 and 120 VAC, SEE THE INSTRUCTIONS BEFORE PROCEEDING.

Give your delay line a good home and it will be your friend.

SPECIFICATIONS

Input level	Adjustable by front panel control. —10 to plus 16 dbm nominal for full output level as evidenced by illumination of LIMIT (red) indicator.
Output Level	Without optional transformer output, +18 dbm peak on program material begins clipping.
Impedances	Input impedance 22K ohms nominal, balanced, transformerless. Combination common mode and signal should not exceed ± 12 V on either line, or 50V peak to peak signal swing. Output impedance is 150 ohms (600 ohms with optional transformers.)
Frequency response	± 1db, 30Hz to 16KHz. Extremely rapid rolloff after 16KHz.
Distortion	Measured with sine wave at +4 or +8 output, less than 1% (typ. .5%) at 1 KHz.
Dynamic range	78db between minimum usable signal and clipping level. Solid state indicator flashes red at clipping level, flashes green at approx. 12 db below clipping.

DELAY CHARACTERISTICS

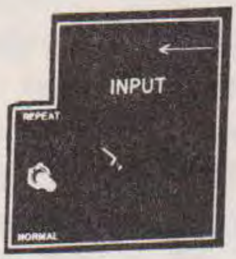
Delay	Variable in 1 millisecond steps to 199 milliseconds. (Variable in 2 ms. steps to 398 ms. in DOUBLE mode, reduced frequency response-see text.)
Delay match	When outputs set at 0 or identical delay, relative delay less than 500 ns.
Minimum I/O delay	Nominal 100 us between input and any output set to 0 delay.
Short term stability (wow and flutter)	.001%. (1 part in 10^5 averaged over 100ms interval.)
Long term stability	.01% per month.

PHYSICAL

Height	13.34cm (5-1/4") standard rack mountable.
Width	58.26cm (19") " " "
Depth behind panel	38.10cm (15")
Power requirement	115 VAC, 50-60Hz. Nominal 100 VA. May be internally wired for ± 10% line or for 230V, ±10%.

CONTROL DESCRIPTION

This control is the main power switch for the DDL. Turning it to the UP position applies primary power to all the circuitry.



The INPUT group controls the signal level and source for the DDL. The knob is a level control which must be adjusted in accordance with the level indicator immediately above it. Instructions for proper level setting are elsewhere in this manual.

The switch to the left of the INPUT control determines the source of the signal. When briefly depressed to the NORMAL position, the audio input is conveyed (through the level control) to the delay section and then to the output. When briefly put in the REPEAT position, the digital signal available at the right hand output is sent back to the input after being delayed.

The operation of the DDL is latched electronically into whichever position was last selected on the REPEAT switch. The solid state lamps above and below the switch indicate the selected mode.

The DELAY TIME group is used to select the total delay of each of the DDL outputs. The knob controls an optical incremental encoder which produces digital pulses determined by angle and direction of rotation. These pulses set the delay in 1 millisecond steps. The control has no detents, and several complete rotations are required to vary the delay from minimum to maximum.

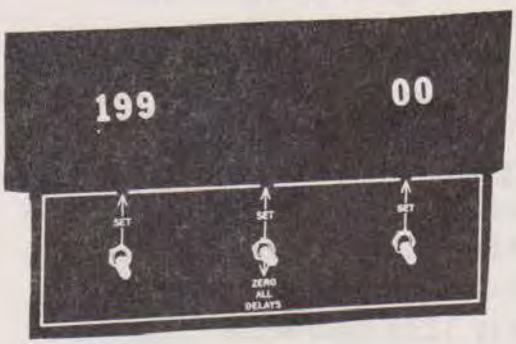
The DOUBLE/NORMAL switch is used to set the maximum delay available from the DDL. With the switch in the NORMAL position, the delay time shown in the window is applicable. In the DOUBLE position, the actual delay is twice that shown in the readout for all outputs. There are also certain restrictions on input frequency in this mode. The lamp associated with this switch indicates that the DDL is in the DOUBLE mode.

CONTROL DESCRIPTION

continued

The three switches labelled SET route the digital pulses from the DELAY TIME control to the individual outputs. When any of these switches is in the UP position, the output associated with it is adjusted by the DELAY TIME control as described earlier.

The delay line comes in a standard, two output, configuration, or an optional, three output, configuration. The three output unit will have three groups of digital readouts installed in the window above the SET switches. In the two output unit, the center switch does not control a delay. However, in either configuration, the center switch has a spring return position, which, when activated, may be used to reset all the delays to zero.



The two (or three) delays may be set individually or simultaneously by activating any combination of the SET switches. Once the desired delay setting is achieved, the set switches should be deactivated if there is any chance that the DELAY TIME control will be accidentally touched or brushed against. (This control moves very freely so that it may be spun for rapid delay change.)

The delay time of each output is indicated by a numerical readout. This readout is a two or three digit display composed of seven segments per digit. These segments are selectively illuminated to form numbers. If a DDL with the minus 100 millisecond option is supplied, only two digits will be present. If the unit is standard, three digits will be available. Note that in the standard unit, when the delay is set for 99 ms or less the first digit will be blanked.

Rotating the DELAY TIME control past the maximum delay available will result in a reading in excess of the delay available. However, the actual delay will revert to zero and then begin to increase. (Display will read 200 ms, delay will be 00 ms., for example).

INPUT LEVEL SETTING

The EVENTIDE Delay Line is similar to amplifiers, equalizers, tape recorders, and virtually every other electronic device (with the possible exception of a piece of wire at absolute zero) in that it has a certain DYNAMIC RANGE. Dynamic range is defined as the levels between which operation of the device is useful or acceptable. As a practical matter, this is usually bounded on the high level side by distortion and on the low level side by noise. In many equipments, a VU meter is provided to indicate when the unit is operating at the proper level. A tape recorder, for instance, has a certain percentage distortion at 0 VU, and this percentage rapidly increases as the signal level increases. The noise level is some number of decibels below 0 VU. This number of decibels is defined as the dynamic range.

Signal sources typically have a dynamic range much greater than that of electronic devices. Likewise, the ear can hear a dynamic range much greater than that of electronic devices. Since the electronic unit (the DDL in this case) is the limiting factor, it is advantageous to set the input level to the Delay Line to take advantage of its maximum dynamic range capability. This is the equivalent of making sure that the meter on the tape recorder is reading around 0 VU most of the time.

To enable accurate setting of input level, a solid state lamp is provided on the front panel. This lamp can emit red, green, or both. It is located immediately above th INPUT level control. The DDL is internally adjusted so that, at 1KHz input frequency, the red light will come on as the analog and digital portions of the unit both approach the clipping level. This corresponds to an output signal level of between +16 and +18 dbm into 600 ohms. Thus, a red flash of the indicator shows that the system absolute dynamic range has been momentarily exceeded. The green light is set to come on with an input signal level at approximately 12db below the clipping level.

ALTHOUGH THE RED LIGHT INDICATES CLIPPING,
IT IS DESIRABLE TO OPERATE THE UNIT WITH
THE RED LIGHT FLASHING INTERMITTENTLY.

The internal signal processing circuitry assures that with normal program material, intermittent flashing of the red light does not mean that the signal is being significantly distorted. This is important because most signals will have some high peaks which are much greater in amplitude than the average level, and attempting to preserve these peaks faithfully results in a serious compromise in dynamic range. In operation, it will be found that the red light flashes more frequently as the DDL is connected closer electrically to the microphone, and that it can flash more frequent ly before the distortion becomes objectionable. This is because other equipments in the audio chain have similar peak clipping properties.

When the INPUT level control is properly adjusted, the green light will be on most of the time, and the red light will be flashing intermittently. This flashing may be anywhere from several times per second to once every few seconds. The table below gives a rough indication of proper settings.

INPUT LEVEL SETTING CRITERIA		
Type of Source	Green duty cycle	Red duty cycle (flash frequency)
Integrated program material (radio)	80%	once/2 sec.
Integrated program material (live mix)	50%	once/sec.
Voice (talking)	30%	2/sec.
Piano	30%	2-3/sec.
Guitar, acoustic	30%	2/sec.
Guitar, fuzz	60%	1/sec.
Synthesizer	80%	infrequent
Organ	80%	infrequent
Drums	20-70%	once for each well-defined beat.

All the above numbers are approximate. They may vary widely if the signals are pre-processed through limiters, equalizers, or any other amplitude-distorting processor.

In general, it is not necessary to be very critical about the level setting, any more than it matters if you record at +1 or -1. However, it is good practice to get the most from your equipment, and the above settings will give you the most dynamic range. For most applications, the dynamic range will be adequate as long as the green light is flashing regularly on program material.

DELAY DOUBLING

As much as we'd like to, we cannot furnish a 400 millisecond delay line for the price of a 200 ms. unit. "There ain't no such thing as a free lunch", and shift registers cost more than munchies. We can, however, do the next best thing: We have put a switch on the front panel which says "DELAY DOUBLE" and turning this switch will double the delay capacity of the 1745A. BUT, at the same time, the frequency response is degraded. In other words, in the DELAY DOUBLE position, we do not consider the 1745A to be a studio quality unit.

The reason for this is inherent in the construction of the DDL, and in engineering arcana known as "sampling theory", which is discussed on a technical basis in the service section. Suffice it to say that the DDL looks at the incoming signal at a certain rate known as the sampling rate, and transmits these samples through a delay to the output. In the DELAY DOUBLE position, alternate samples are ignored and are not sent to storage. Since the storage capacity remains constant, it is only filled half as fast, and so it will store a signal for twice as long, thus doubling the delay. However, since the samples are taken less frequently, anything occurring between samples (i.e., during the sample which was ignored) is likewise ignored. In practice, this means that high frequency signals greater than about 10 KHz are subject to heterodyning and various forms of distortion. High frequency sine wave tests produce wierd results. Fortunately, normal program material does not contain high frequency sine waves and so is only slightly modified. The difference shows up as a harshness in the treble register. Some of this can be eliminated by EQ'ing down the highs on both input and output, at the expense of frequency response.

Do not let the foregoing scare you into not using the delay doubling feature. Despite the harshness, program quality is perfectly acceptable except for fairly critical listening. Speech, especially, is relatively unaffected by delay doubling, as are other signals which do not have a large high frequency component.

APPLICATIONS

The DELAY DOUBLE provision is primarily of use in instances where greater than 200 milliseconds of delay is required and less than optimum quality can be tolerated. Sound reinforcement applications particularly suggest themselves due to the normal high frequency attenuation of the atmosphere, and the fact that it is rarely possible to listen critically to a P.A. speaker. The harshness at high frequencies will be inaudible if there is any masking signal present.

Other applications which suggest themselves are special effects (see recirculation) and communications uses in which the signal and channel parameters will be more limiting than the DDL response. (See associated applications notes.)

SIGNAL RECIRCULATION

A unique feature of the Eventide Delay Line is its ability to "capture" a signal in its "memory" and to continuously repeat this signal through the outputs. Since the signal is stored digitally, there is no decay or noise build-up as would be present if mechanical repetition (tape loop and feedback) were used. Additionally, the signal may be "looped" up to the full extent of the delay line's delay capability, or down to the smallest delay increment- 1 millisecond.

Applications for this feature include special effects (in recording studios) spectrum analysis of short signal segments, speech studies, etc. More on each of these below.........

On the right hand side of the DDL front panel, immediately to the left of the INPUT control, is a momentary toggle switch labeled REPEAT and NORMAL. This switch is normally centered, and has a spring-return to center if it is deflected. Electronic circuitry in the delay line remembers the last switch position and illuminates the appropriate front panel LED to indicate in which mode the DDL is operating. Although a standard toggle switch can be used for this function, the center-off toggle switch allows remote control of this feature. (See suggestions on "live" use of the DDL). Remote control recirculation also allows it to be operated under electronic control in instrumentation applications.

When the switch is momentarily deflected to the REPEAT position, circuitry is activated which taps the digital signal after all the delay associated with the right hand output. This signal is then sent through a multiplexer back to the input of the shift register chain. All the data currently in the memory when the switch is thrown will be recirculated in the loop thus formed.

The REPEAT control does not affect anything other than the <u>input</u> to the shift register chain. All the outputs remain operative and remain connected to the delay chain in the same relative position. Since the signal is recirculated, the right hand output (from which the signal is tapped) is at the same point in time as the input to the delay chain. Thus, the amount of time by which the other output is offset from the right hand output is equal to either the delay setting of the other output, or the <u>difference</u> in settings between the right hand output and the other output, <u>whichever is smaller</u>. The maximum relative delay obtainable in the recirculate mode is equal to one-half the delay setting of the right output. Incidentally, there is no technical reason why the non-recirculated output (s) cannot be set for a longer time delay than the right hand output. However, this does not give a longer relative delay between signals. It simply means that a short recirculated signal may be repeated one or more times before it reaches the later output. The signal does not change in storage and so there is no way to determine how many repetitions it has undergone before reaching the second tap.

The above description may seem relatively complicated, but one should make an attempt to understand it fully to get the most from the recirculation feature.

SPECIAL EFFECTS

The data storage time of the delay line, especially in the DOUBLE mode, is sufficient to store a couple of words of speech or a beat or two of music. These segments may be added to program material to generate unusual echo effects or harmonies. The effect is particularly striking because no decay is evident even after many repetitions. Since people are accustomed to hearing decaying echo, the psychological effect is one of "good grief whazzat?" .

By capturing a section of vocal harmonies in which there is little pitch change (a prolonged "aahhhhhhhh" or "oooooooohhh",) the impression of continuous singing can be created. Thus it is possible to have a chorus harmonizing with itself in progression.

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SINGER  AAAAAAAAAAAAA
DDL         XXAAAAAAAAAAAAAAAA
SINGER                    BBBBBBBBBBBBBBBBBB
DDL                             XXBBBBBBBBBBBBBBBBBB
SINGER                                      CCCCCCCCCCCCCCCCCCC
DDL                                               XXCCCCCCCCCCCCCC
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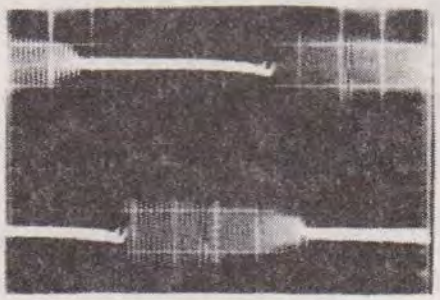
The XX areas denote capture time for the DDL. During the second and third capture periods, the output from the DDL will be data that was stored previously. There is no gap in the signal while the new note is being stored.

We do not wish to imply that the above procedure is a substitute for overdubbing or a substitute for the normal use of delay to expand the apparant size of vocals. Rather, it is a special effect which may be used to advantage under certain weird circumstances. Some experimentation may produce lots of effects which can't be generated by analog, asynchronous, human beings.

For instance, real people cannot repeat words along with themselves. Send a vocal signal through the delay line and alternately switch to the REPEAT and NORMAL modes at a fairly rapid rate (about 1-3 times per second). Some words will repeat, others will be deleted, still others will be fractioned. It sounds quite unusual. Two outputs separated by the maximum available delay can feed two physically spaced speakers to make the words and repetitions bounce back and forth between the locations.

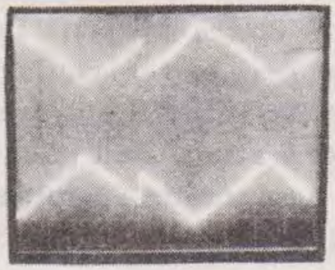
When using the Delay Line at a live performance, give the singer or musician control over the recirculation. Let the live signal come out undelayed or minimally delayed to prevent the performer from being distracted by an excessively delayed return echo. Set the right hand output for the loop length desired. At various points in the performance (presumably at the end of phrases), activate the recirculate control and the last word (or fraction) will be repeated. The performer can then step away from the microphone for a minute, to the amazement of the audience.

RECIRCULATION WAVEFORMS

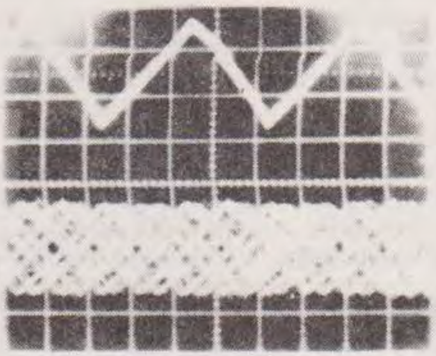


Tone burst stored in memory, both outputs have substantially different delays. The relative position of the two bursts may be varied, giving effect of bouncing signal between speakers. (2nd photo)

Other signals, such as voice segments may also be stored. If the segment fills the memory, a linking is performed between the beginning and end of the segment, and new forms may result. If the segment is listened to for several minutes, the sound may shift back and forth between alternate or even multiple sounds or words.



Short signal stored in memory. "Seam" in data is caused by the disparity between the storage length and the signal period. Changing the signal frequency in storage (or changing the delay) produces different overtones in the signal output.



This photograph shows recirculated signal in the top trace, and delay-varied signal (still recirculated) in the bottom trace. As the delay varies, the signal assumes different phase relationships. Adding the two signals generates different harmonic amplitudes. This effect can be added with the one immediately above to create unusual sounds.