

*Magnetostriction*

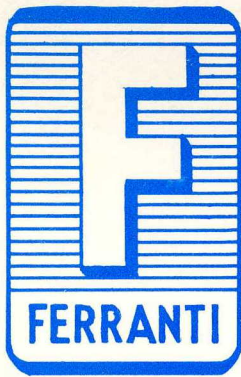
DELAY

LINES



FERRANTI ELECTRIC, Inc.

Driver & Amp ~ \$200/pair



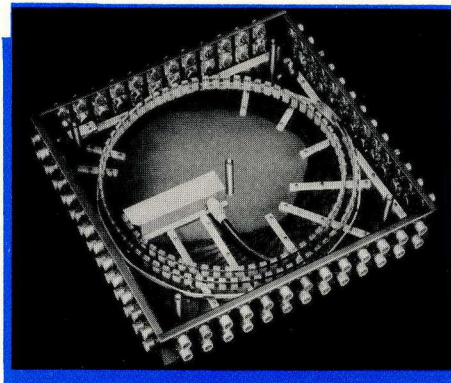
# MAGNETOSTRICTION DELAY LINES

BACKED BY  
10 YEARS EXPERIENCE  
IN MANUFACTURE  
AND USE



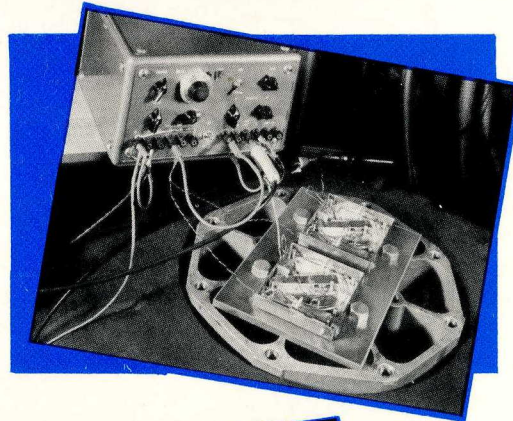
DIGIT RATES  
UP TO 5 Mc/s NRZ  
OR 2.5 Mc/s RZ

PROVEN  
RUGGED UNITS  
AVAILABLE  
ON SHORT DELIVERY



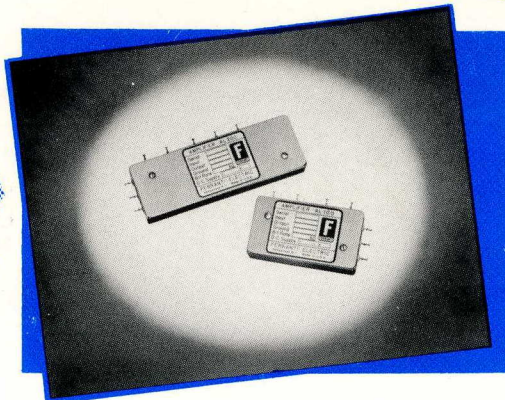
WIDE BAND  
SIGNAL TO NOISE  
TO 100:1

STANDARD OR  
SPECIAL PACKAGING  
MILITARY  
OR  
COMMERCIAL



TEMPERATURE  
COEFFICIENTS  
DOWN TO  
 $0 \pm .1$  PPM/°C

DIGITAL—ANALOG  
TIME DELAY  
CORRELATION  
APPLICATIONS



FIXED, VARIABLE  
OR TAPPED.  
8 MICROSECONDS  
ADJUSTMENT  
STANDARD

## Initiation and Detection of Acoustic Waves

Magnetostrictive effects can be used to launch and detect acoustic waves and, by suitable transducer design, operation over a wide frequency range can be obtained.

The transducers are coils wound around magnetostrictive material in the form of wire or tape. The dimensions of the coils and of the wire, or tape, are chosen to suit the required operating frequencies.

## Taps

It is often desirable to have tapped delays and techniques have been developed which permit a virtually unlimited number of taps to be fitted. The taps may be pre-set to 0.1 microsecond accuracy, may be adjustable over a specified range or may be continuously variable over the entire delay range of the line. Output from taps can be adjusted to be uniform within 1 db irrespective of the total delay. The exact tapping technique will vary according to the other line specifications.

## Bandwidth and Resolution

The delay system has bandpass characteristics with 3 db points symmetrical about the center frequency at half and one and one-half times that frequency. For example, a line designed for center frequency of 1 Mc/s will give 3 db points at 500 Kc/s and 1.5 Mc/s. The lines are thus inherently broad band.

Delay lines can be supplied with transducers and transmission systems designed for any center frequency within the range for a given package. (But the center frequency must be specified at the time of ordering.)

For pulsed operation the line should be specified in terms of the required input pulse width. The repetition, or digit rate, is not important except that the minimum pulse width which can be handled will limit the maximum rate. For example, input pulses of 0.5 microseconds can be handled at 1 microsecond intervals. A given line will operate over a small range of pulse widths about the width for which it was designed.

## Dynamic Range

A dynamic range of 30 db can be achieved without difficulty and a greater range is feasible. If the type of operation for which line is to be used makes dynamic range important, it should be specified when ordering.

## Terminations

The acoustic waves generated by the drive transducer travel from it in both directions. The desired wave proceeds toward the far end of the line but the other wave, unless absorbed, will be reflected from the near end and then travel to the far end, arriving, as noise, a few microseconds after the main signal. Similarly, after it passes the receiving transducer, the main signal too must be absorbed to avoid reflections. Terminations have been developed which are small but provide ample attenuation at the ends of the line and are not affected by aging or temperature.

## Impedances

Low impedance transducers are normally used and *unless otherwise specified*, the impedances at both input and output will be in the range 500 to 1000 ohms. Any impedance transducers within the range of 10 to 2000 ohms can be furnished and higher impedances are possible. Input and output impedances can be suited to circuit requirements.

## Delay Adjustment

A feature of Ferranti Magnetostriction Delay Lines is that they all incorporate a delay adjustment. This adjustment of the total delay is of the vernier type and normally has a range of plus and minus 4 microseconds from the specified nominal. One turn of the adjusting screw changes the delay 1/8 microsecond and makes adjustment to the order of 1/50 microsecond very easy. The total adjustment range may be made, to special order, greater than 8 microseconds if required, or may be made less if circuit requirements permit and minimum size packaging is important.

Where taps are provided on a line they may have a similar type of vernier adjustment, either individually or in blocks, or they may be manually adjustable with screw locking depending on the requirement and packaging configuration.

## Temperature Coefficient of Delay

The development of materials which exhibit small temperature coefficients of delay and amplitude combined with good acoustic transmission characteristics has been one of the most important factors in making Ferranti Magnetostriction Delay Lines reliable system elements.

Delay materials are currently available whose delay temperature coefficients can be controlled closely to provide lines with either large or small delay coefficients. Most generally the smaller the delay temperature coefficient the better. In this direction lines have been built with delay coefficients of less than 1/2 part per million /°C over the range -10 to +50°C.

## Temperature Coefficient of Amplitude

Amplitude coefficient is generally most important in trigger applications where a change in amplitude can cause an effective change in delay. If the requirements are known, lines can be designed where the amplitude and delay coefficients are made to compensate and the effective change in delay over a range of -70 to +100°C held to less than 1 part per million /°C.

In digital applications the changes in amplitude are not generally sufficiently great to be troublesome. Careful choice of materials used for line supports and terminations prevents variation of signal to noise ratio with temperature.

## Operating Environment and Package Construction

Packages can be supplied to suit either military or commercial environments.

Having no moving parts, the delay lines are inherently rugged. Standard packages to suit many environmental conditions are available as fully engineered products and on short delivery. Lines to any one of a wide range of delays and any specified center frequency or digit rate, within their respective ranges, can be supplied using these packages.

Where the required environmental or packaging specifications cannot be met with existing packages, these packages can often be used for initial engineering models and enable work to proceed during the development of special packages. Work is proceeding all the time to improve delay line techniques and obtain higher operating frequencies, longer delays and smaller packages. The emphasis at any given time is a reflection of the interests of our customers. If your specifications cannot be met by existing packages, they may still be feasible. We are always glad to submit quotations and proposals for special lines.



**FERRANTI ELECTRIC INC.**

**ELECTRONICS DIVISION**

**95 Madison Ave.**

**Hempstead, L. I., N. Y.**

**IVanhoe 3-8244**

**TWX Hempstead N Y 1452**

**WUX LBI Hempstead N Y**

**CONTINUOUSLY VARIABLE DELAY LINES**

The techniques involved in the manufacture of continuously variable lines have been extensively developed in recent months and units of this type are now available. Since the requirements tend to vary widely, no range of standards has yet evolved but lines with the characteristics below can be made with various packaging configurations to meet individual requirements.

**Delay Range Continuously Variable**  
2 microseconds to 10,000 microseconds

**Digit Rate or Bandwidth**  
Up to 500 Kc/s

**Reproducibility and Linearity of Setting**  
0.1%

**Jitter**  
Less than 1 millimicrosecond

**Control**  
Low torque recirculating ball race drive suitable for manual or servo control

**End Stops**  
Microswitches provide electrical indication. Mechanical stops prevent overdriving.

**Packaging**  
MIL or commercial as required

**Size and Weight**  
Dependent on delay

FEI/53

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**FERRANTI ELECTRIC INC.**

**ELECTRONICS DIVISION**

## **NEW PRODUCT ANNOUNCEMENT**

### **MAGNETOSTRICTION DELAY LINE TYPE 5912**

The Type 5912 is a rugged unit designed for military or industrial use where severe environments may be encountered.

Designed originally for digital storage applications the 5912 with its capacity of over 2000 bits at a 1 Mc/s (RZ) digit rate or 4000 bits at 2 Mc/s (NRZ) represents a further advance in the techniques of the design and manufacture of small sized, rugged magnetostriction delay lines.

To permit operation over a useful temperature range without the use of any temperature control facilities and with this large storage capacity a very close control of the delay temperature characteristic is required and the Type 5912 can be supplied with a temperature coefficient of delay of  $0.5 \text{ ppm}/^{\circ}\text{C}$ .

W151

5/60

# MAGNETOSTRICTION DELAY LINES

# Ferranti

## DATA SHEET

# L20

The L20 is a fixed delay line with fine adjustment, suitable for commercial and less severe military environments. Militarized units of proven design are also available.

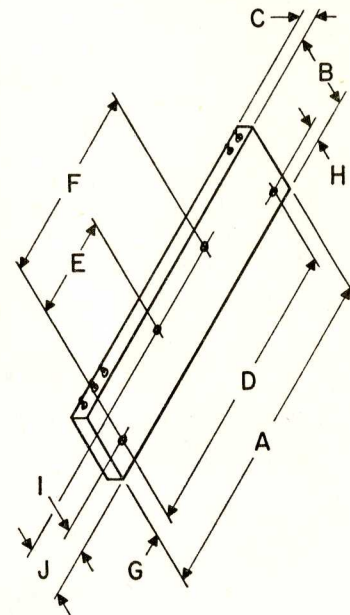
### RATINGS

Delay	{ Type 1 --- 5-20 microseconds* Type 2 --- 20-50 microseconds* Type 3 --- 50-70 microseconds*	
Pulse width		0.5-5 microseconds*
Center frequency range		100 Kc/s - 1 Mc/s*
Maximum band width	1 Mc/s (Bandpass Characteristic)	
Maximum storage capacity	70 binary digits	

### TYPICAL OPERATING CONDITIONS

Transducer impedance	50-2000 ohms*
Nominal input drive	20 milliamperes
Nominal output (2.2K)	25 millivolts
Delay adjustment range	8 microseconds (± 4 microseconds from specified delay)
Signal to noise ratio	At least 20:1 (larger ratios can be supplied)*
Dynamic range	At least 30db
Insertion loss	35-50db
Temperature coefficient of delay	5 to 10 PPM/°C unless otherwise specified (can be held to 0 ± 1 PPM/°C for most delays if required)*
Digit Rate	RZ recording: Any rate up to 1 Mc/s NRZ recording: Any rate up to 2 Mc/s

**NOTE** — The maximum digit rate of any given delay line is governed by the input pulse width for which the line was designed. For example, to operate at a 1 Mc/s digit rate (RZ recording) a pulse width of 0.5 microseconds is required.



### DIMENSIONS

Type No.	1	2	3
A	12"	16"	20"
B	1 1/2"	1 1/2"	1 1/2"
C	13/32"	13/32"	13/32"
D	11 1/2"	15 1/2"	19 1/2"
E	3 3/4"	5 1/4"	6 1/2"
F	7 3/4"	10 1/4"	13"
G	1/4"	1/4"	1/4"
H	1/4"	1/4"	1/4"
I	9/16"	9/16"	9/16"
J	1 1/4"	1 1/4"	1 1/4"

### WEIGHT

6 oz.	7 oz.	8 oz.
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(Cont'd)

\* SPECIFY WHEN ORDERING



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## **TEST DATA**

Individual test reports are supplied with each line. These test reports cover all performance characteristics and include photographs of output wave shapes.

## **TAPPED LINES**

Taps can be provided subject to a minimum tap spacing of 1 microsecond except that the delay between the drive transducer and the first tap may not be less than 2 microseconds. The taps are adjustable over a small range by loosening of the set screws located on the underside of the package. The output from the taps will be similar to those obtained from the end of the line.

## **ENVIRONMENTAL CONDITIONS**

The L20 package is designed for commercial or less severe military applications.

Operating temperature range  $-50^{\circ}$  to  $+85^{\circ}\text{C}$ . Can also be supplied for  $100^{\circ}\text{C}$  operation.\*

## **CONSTRUCTION**

Anodized aluminum cases with aluminum and molded internal parts.

**\* SPECIFY WHEN ORDERING**



# MAGNETOSTRICTION DELAY LINES

*Ferranti*

DATA SHEET

## L25

The L25 is a fixed delay line with fine adjustment, suitable for commercial and less severe military environments. Militarized units of proven design are also available.

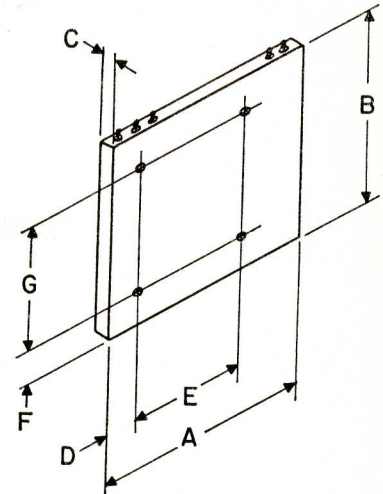
*\$ 120.00  
100-100*

### RATINGS

Delay .....	20-250 microseconds*
Pulse width .....	0.5-5 microseconds*
Center frequency range .....	100 Kc/s - 1 Mc/s*
Maximum band width .....	1 Mc/s (Bandpass Characteristic)
Maximum storage capacity .....	250 binary digits

### TYPICAL OPERATING CONDITIONS

Transducer impedance .....	50-2000 ohms*
Nominal input drive .....	20 milliamperes
Nominal output (2.2K) .....	25 millivolts
Delay adjustment range .....	8 microseconds ( $\pm 4$ microseconds from specified delay)
Signal to noise ratio .....	At least 20:1 (larger ratios can be supplied)*
Dynamic range .....	At least 30db
Insertion loss .....	35-50db
Temperature coefficient of delay .....	5 to 10 PPM/ $^{\circ}$ C unless otherwise specified (can be held to $0 \pm 1$ PPM/ $^{\circ}$ C for most delays if required)*
Digit Rate .....	RZ recording: Any rate up to 1 Mc/s NRZ recording: Any rate up to 2 Mc/s



### DIMENSIONS

A .....	4 1/2"
B .....	3 1/2"
C .....	1 3/32"
D .....	
E .....	
F .....	
G .....	

### WEIGHT

6 oz.

**NOTE** — The maximum digit rate of any given delay line is governed by the input pulse width for which the line was designed. For example, to operate at a 1 Mc/s digit rate (RZ recording) a pulse width of 0.5 microseconds is required.

(Cont'd)

\* SPECIFY WHEN ORDERING



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## **TEST DATA**

Individual test reports are supplied with each line. These test reports cover all performance characteristics and include photographs of output wave shapes.

## **ENVIRONMENTAL CONDITIONS**

The L25 package is designed for commercial or less severe military applications.

Operating temperature range  $-50^{\circ}$  to  $+85^{\circ}\text{C}$ . Can also be supplied for  $100^{\circ}\text{C}$  operation.\*

## **CONSTRUCTION**

Anodized aluminum cases with aluminum and molded internal parts.

**\* SPECIFY WHEN ORDERING**

# MAGNETOSTRICTION DELAY LINES

*Ferranti*

DATA SHEET

**L30**

The L30 is a fixed delay line with fine adjustment, suitable for commercial and less severe military environments. Militarized units of proven design are also available.

*# 225<sup>00</sup>  
100-125<sup>00</sup>*

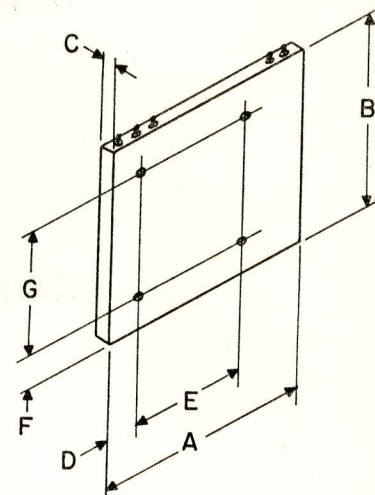
## RATINGS

Delay .....	250-850 microseconds*
Pulse width .....	0.5-5 microseconds*
Center frequency range .....	100 Kc/s - 1 Mc/s*
Maximum band width .....	1 Mc/s (Bandpass Characteristic)
Maximum storage capacity .....	850 binary digits

## TYPICAL OPERATING CONDITIONS

Transducer impedance .....	50-2000 ohms*
Nominal input drive .....	20 milliamperes
Nominal output (2.2K) .....	25 millivolts
Delay adjustment range .....	8 microseconds ( $\pm 4$ microseconds from specified delay)
Signal to noise ratio .....	At least 20:1 (larger ratios can be supplied)*
Dynamic range .....	At least 30db
Insertion loss .....	35-50db
Temperature coefficient of delay .....	5 to 10 PPM/ $^{\circ}$ C unless otherwise specified (can be held to $0 \pm 1$ PPM/ $^{\circ}$ C for most delays if required)*
Digit Rate .....	RZ recording: Any rate up to 1 Mc/s NRZ recording: Any rate up to 2 Mc/s

**NOTE** — The maximum digit rate of any given delay line is governed by the input pulse width for which the line was designed. For example, to operate at a 1 Mc/s digit rate (RZ recording) a pulse width of 0.5 microseconds is required.



## DIMENSIONS

A .....	6 $\frac{3}{4}$ "
B .....	5 $\frac{5}{8}$ "
C .....	13/32"
D .....	1 $\frac{5}{8}$ "
E .....	4 $\frac{1}{2}$ "
F .....	9/16"
G .....	4 $\frac{1}{2}$ "

## WEIGHT

8 oz.

(Cont'd)

\* SPECIFY WHEN ORDERING



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## **TEST DATA**

Individual test reports are supplied with each line. These test reports cover all performance characteristics and include photographs of output wave shapes.

## **TAPPED LINES**

A limited number of taps can be provided. The maximum number is generally 5 depending on the tap positions required. The taps are adjustable over a total range of 8 microseconds but this adjustment is not normally available to the user except by removing the case cover. The outputs from the taps will be similar to those obtained from the end of the line.

## **ENVIRONMENTAL CONDITIONS**

The L30 package is designed for commercial or less severe military applications.

Operating temperature range  $-50^{\circ}$  to  $+85^{\circ}\text{C}$ . Can also be supplied for  $100^{\circ}\text{C}$  operation.\*

## **CONSTRUCTION**

Anodized aluminum cases with aluminum and molded internal parts.

**\* SPECIFY WHEN ORDERING**

# MAGNETOSTRICTION DELAY LINES

# Ferranti

## DATA SHEET

# L35

The L35 is a fixed delay line with fine adjustment, suitable for commercial and less severe military environments. Militarized units of proven design are also available.

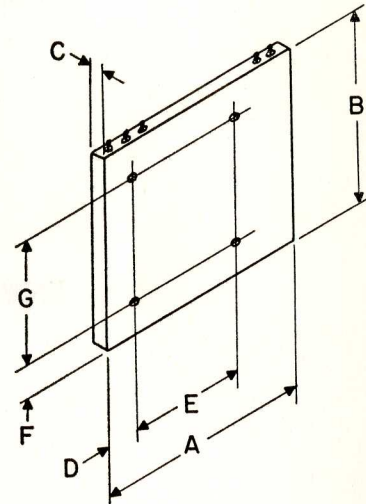
### RATINGS

Delay .....	850-2500 microseconds*
Pulse width .....	0.5-5 microseconds*
Center frequency range .....	100 Kc/s - 1 Mc/s*
Maximum band width .....	1 Mc/s (Bandpass Characteristic)
Maximum storage capacity .....	2500 binary digits

### TYPICAL OPERATING CONDITIONS

Transducer impedance .....	50-2000 ohms*
Nominal input drive .....	20 milliamperes
Nominal output (2.2K) .....	25 millivolts
Delay adjustment range .....	8 microseconds (± 4 microseconds from specified delay)
Signal to noise ratio .....	At least 20:1 (larger ratios can be supplied)*
Dynamic range .....	At least 30db
Insertion loss .....	35-50db
Temperature coefficient of delay .....	5 to 10 PPM/°C unless otherwise specified (can be held to $0 \pm 1$ PPM/°C for most delays if required)*
Digit Rate .....	RZ recording: Any rate up to 1 Mc/s NRZ recording: Any rate up to 2 Mc/s

**NOTE** — The maximum digit rate of any given delay line is governed by the input pulse width for which the line was designed. For example, to operate at a 1 Mc/s digit rate (RZ recording) a pulse width of 0.5 microseconds is required.



### DIMENSIONS

A .....	9 7/8"
B .....	8 7/8"
C .....	13/32"
D .....	1 9/16"
E .....	7"
F .....	1 5/16"
G .....	6"

### WEIGHT

1 lb.

(Cont'd)

\* SPECIFY WHEN ORDERING



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## **TEST DATA**

Individual test reports are supplied with each line. These test reports cover all performance characteristics and include photographs of output wave shapes.

## **TAPPED LINES**

A limited number of taps can be provided. The maximum number is generally 5 depending on the tap positions required. The taps are adjustable over a total range of 8 microseconds but this adjustment is not normally available to the user except by removing the case cover. The outputs from the taps will be similar to those obtained from the end of the line.

## **ENVIRONMENTAL CONDITIONS**

The L35 package is designed for commercial or less severe military applications.

Operating temperature range  $-50^{\circ}$  to  $+85^{\circ}\text{C}$ . Can also be supplied for  $100^{\circ}\text{C}$  operation.\*

## **CONSTRUCTION**

Anodized aluminum cases with aluminum and molded internal parts.

**\* SPECIFY WHEN ORDERING**

# MAGNETOSTRICTION DELAY LINES

# Ferranti

## DATA SHEET

# L40

The L40 is a fixed delay line with fine adjustment, suitable for commercial and less severe military environments. Militarized units of proven design are also available.

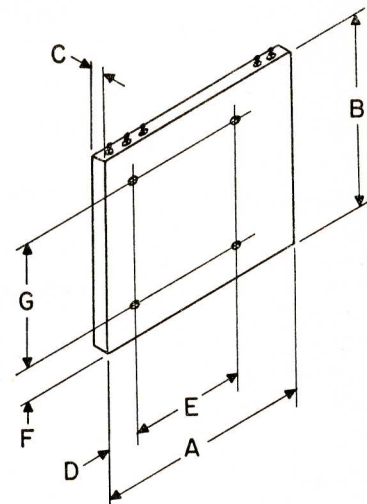
### RATINGS

Delay -----	{	Type 1 --- 2500-3500 microseconds*
		Type 2 --- 2500-5000 microseconds*
Pulse width -----	{	Type 1 --- 0.5-5 microseconds*
		Type 2 --- 1-5 microseconds*
Center frequency range -----	{	Type 1 --- 100 Kc/s - 1 Mc/s*
		Type 2 --- 100 Kc/s - 500 Kc/s*
Maximum band width -----		1 Mc/s or 500 Kc/s (Bandpass Characteristic)
Maximum storage capacity -----	{	Type 1 --- 3500 binary digits
		Type 2 --- 2500 binary digits

### TYPICAL OPERATING CONDITIONS

Transducer impedance -----	50-2000 ohms*
Nominal input drive -----	20 milliamperes
Nominal output (2.2K) -----	25 millivolts
Delay adjustment range -----	8 microseconds (± 4 microseconds from specified delay)
Signal to noise ratio -----	At least 20:1 (larger ratios can be supplied)*
Dynamic range -----	At least 30db
Insertion loss -----	40-60db
Temperature coefficient of delay -----	5 to 10 PPM/°C unless otherwise specified (can be held to 0 ± 1 PPM/°C for most delays if required)*
Digit Rate -----	RZ recording: Any rate up to 1 Mc/s
	NRZ recording: Any rate up to 2 Mc/s

**NOTE** — The maximum digit rate of any given delay line is governed by the input pulse width for which the line was designed. For example, to operate at a 1 Mc/s digit rate (RZ recording) a pulse width of 0.5 microseconds is required.



### DIMENSIONS

A -----	12 7/8"
B -----	1 1/8"
C -----	13/32"
D -----	1 11/16"
E -----	9/8"
F -----	1 9/16"
G -----	8 1/2"

### WEIGHT

1 3/4 lb.

(Cont'd)

\* SPECIFY WHEN ORDERING



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## **TEST DATA**

Individual test reports are supplied with each line. These test reports cover all performance characteristics and include photographs of output wave shapes.

## **TAPPED LINES**

A limited number of taps can be provided. The maximum number is generally 5 depending on the tap positions required. The taps are adjustable over a total range of 8 microseconds but this adjustment is not normally available to the user except by removing the case cover. The outputs from the taps will be similar to those obtained from the end of the line.

## **ENVIRONMENTAL CONDITIONS**

The L40 package is designed for commercial or less severe military applications.

Operating temperature range  $-50^{\circ}$  to  $+85^{\circ}\text{C}$ . Can also be supplied for  $100^{\circ}\text{C}$  operation.\*

## **CONSTRUCTION**

Anodized aluminum cases with aluminum and molded internal parts.

**\* SPECIFY WHEN ORDERING**



# MAGNETOSTRICTION DELAY LINES

# Ferranti

## DATA SHEET

# L45

The L45 is a fixed delay line with fine adjustment, suitable for commercial and less severe military environments. Militarized units of proven design are also available.

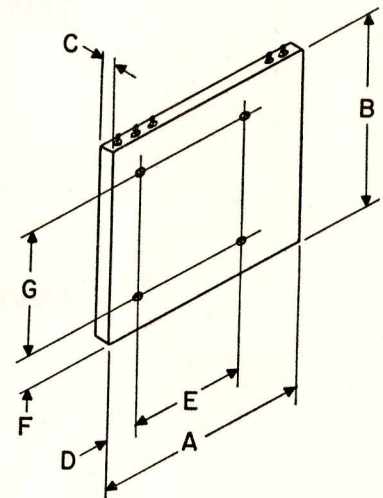
### RATINGS

Delay .....	5,000-10,000 microseconds*
Pulse width .....	1-5 microseconds*
Center frequency range .....	100 Kc/s - 500 Kc/s*
Maximum band width .....	500 Kc/s (Bandpass Characteristic)
Maximum storage capacity .....	5000 binary digits

### TYPICAL OPERATING CONDITIONS

Transducer impedance .....	50-2000 ohms*
Nominal input drive .....	20 milliamperes
Nominal output (2.2K) .....	25 millivolts
Delay adjustment range .....	8 microseconds ( $\pm 4$ microseconds from specified delay)
Signal to noise ratio .....	At least 20:1 (larger ratios can be supplied)*
Dynamic range .....	At least 30db
Insertion loss .....	50-70db
Temperature coefficient of delay .....	5 to 10 PPM/ $^{\circ}$ C unless otherwise specified (can be held to $0 \pm 1$ PPM/ $^{\circ}$ C for most delays if required)*
Digit rate .....	RZ recording: Any rate up to 500 Kc/s NRZ recording: Any rate up to 1 Mc/s

**NOTE** — The maximum digit rate of any given delay line is governed by the input pulse width for which the line was designed. For example, to operate at a 500 Kc/s digit rate (RZ recording) a pulse width of 1 microsecond is required.



### DIMENSIONS

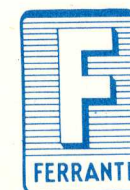
A .....	12 $\frac{7}{8}$ "
B .....	11 $\frac{5}{8}$ "
C .....	3/4"
D .....	1 11/16"
E .....	9 $\frac{7}{8}$ "
F .....	1 9/16"
G .....	8 $\frac{1}{2}$ "

### WEIGHT

2 lb.

(Cont'd)

\* SPECIFY WHEN ORDERING



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## TEST DATA

Individual test reports are supplied with each line. These test reports cover all performance characteristics and include photographs of output wave shapes.

## TAPPED LINES

A limited number of taps can be provided. The maximum number is generally 5 depending on the tap positions required. The taps are adjustable over a total range of 8 microseconds but this adjustment is not normally available to the user except by removing the case cover. The outputs from the taps will be similar to those obtained from the end of the line.

## ENVIRONMENTAL CONDITIONS

The L45 package is designed for commercial or less severe military applications.

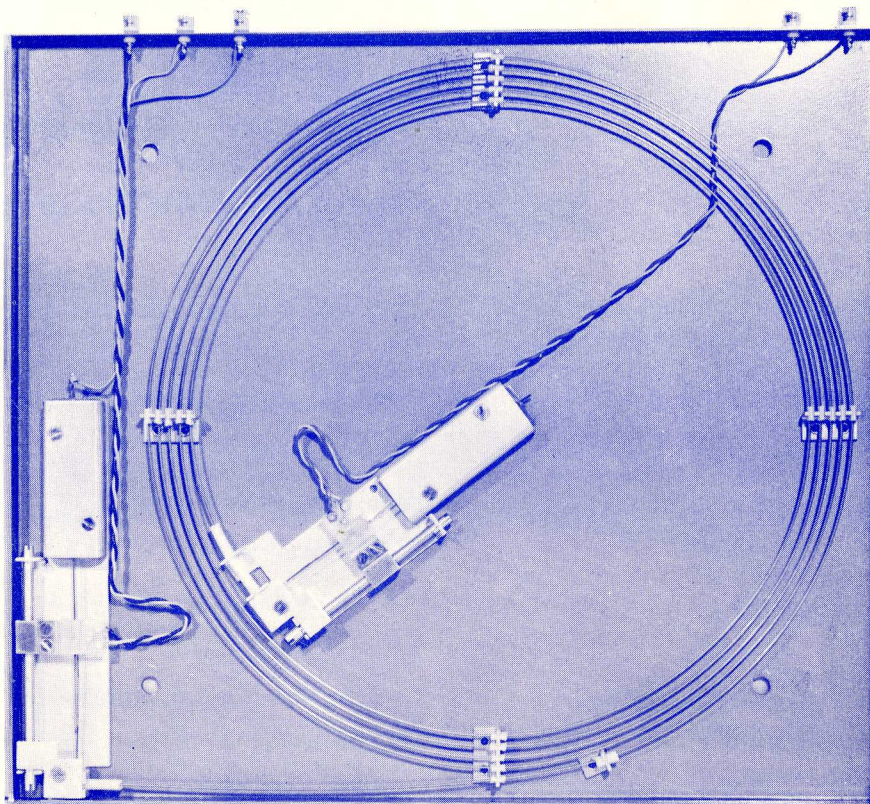
Operating temperature range  $-50^{\circ}$  to  $+85^{\circ}\text{C}$ . Can also be supplied for  $100^{\circ}\text{C}$  operation.\*

## CONSTRUCTION

Anodized aluminum cases with aluminum and molded internal parts.

**\* SPECIFY WHEN ORDERING**

MAGNETOSTRICTION  
DELAY LINE  
L35



FERRANTI ELECTRIC

# MAGNETOSTRICTION DELAY LINE L 35

The Ferranti Electric L35 Magnetostriction Delay Line package is designed to house torsional mode lines operating in the same general manner as the L30 and L40. (A detailed description of the method of operation is given in brochure FEI 26A.)

For lines up to 2.5 milliseconds delay, operating at up to 500 Kc/s the L35 provides a convenient intermediate size package. The L35 will also house lines up to 1 millisecond delay, operating at up to 1 Mc/s. This doubles the maximum delay previously available at 1 Mc/s using the L30 package.

## SPECIFICATIONS

Delay Range*	500 microseconds - 2,500 microseconds at up to 500 Kc/s
	500 microseconds - 1,000 microseconds at up to 1 Mc/s.

\*See L20 and L30 packages for delays less than 500 microseconds, L40 package for delays greater than 2,500 microseconds.

Storage Capacity (Binary Digits)	1,250 at 500 Kc/s 1,000 at 1 Mc/s
Input	40 mA at 10 V
Output into 1,000 Ohms	Greater than 20mV
Size	9" x 10" x 3/8"
Weight	Approximately 1 lb.
Temperature Coefficient of Delay	Positive, less than 5 parts/million/°C
Working Temperature Range	-50°C - +70°C
Attenuation	50 db approximately
Signal to Noise Ratio	Greater than 20:1
Delay Adjustment Range	± 4 microseconds

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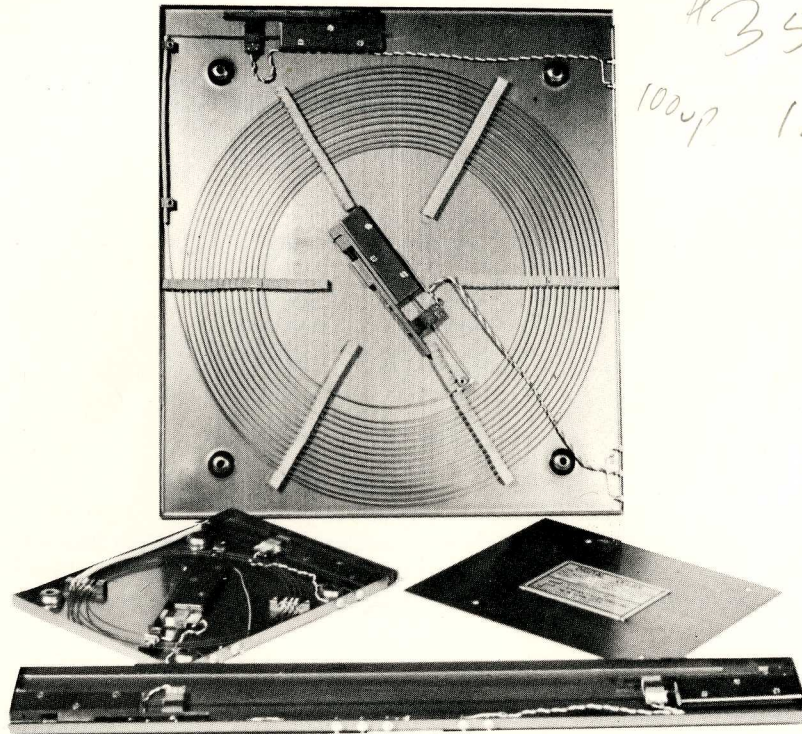
**95 Madison Ave.**

**Hempstead, L. I., N. Y.**

**Ivanhoe 3-8244**

# MAGNETOSTRICTION DELAY LINES

L20      L30      L40



*2.5 ms + 5 ms  
#350 upto 100  
100 up 125*

## FERRANTI ELECTRIC

# MAGNETOSTRICTION DELAY LINES

## L20                      L30                      L40

As a result of extended development work, Ferranti Electric has brought to product form a range of delay lines using acoustic transmission. By using a special, low temperature coefficient of delay transmission medium, many of the limitations previously imposed by acoustic delays have been removed.

Advances in the techniques for launching and detecting acoustic waves by magnetostriction have been coupled with advances in propagating and line supporting techniques. Combined, these have lead to compact, robust and inexpensive delay lines little affected by temperature.

The L20, L30 and L40 Ferranti Electric Magnetostriction Delay Lines can be custom built to any specification within their performance ranges. Ovens or temperature compensating circuits are not normally required for use with these lines, further reducing costs, greatly improving reliability and simplifying installation. No carrier is required for digital operation.

Though originally conceived for use as digital storage, the Magnetostriction Delay Lines are useful for analog applications where the required band width does not exceed  $\pm 50\%$  of the carrier or center frequency.

### Delay System

The delay system is shown diagrammatically in Fig. 1. Current flow through the transmitting transducer generates equal stress waves travelling in both directions. One is absorbed by the near termination; the other travels down the line and is absorbed by the far termination after passing the receiving transducer. At the receiving transducer, the stress wave disturbs the field set up by the bias magnet and causes an induced voltage to appear across the coil.

An input current step causes a di-pulse in the receiver coil with a time interval 't' between the positive and negative peaks. (The time 't' is determined by the transducer coil geometry.) When the current is turned off, a further di-pulse occurs, opposite in sign to the first. (Fig. 2).

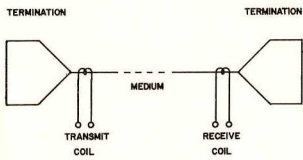


FIGURE - 1

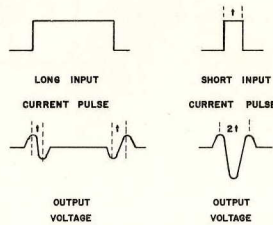


FIGURE - 2

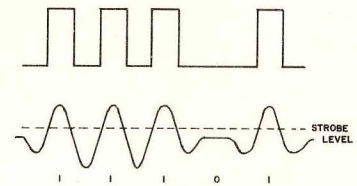


FIGURE - 3

The best compromise between signal amplitude and resolution occurs when the time interval between turn-on and turn-off is made equal to 't'. A symmetrical voltage pulse is then generated in the receiving coil. Under these conditions, the maximum packing of binary digits can be achieved and results in a pattern as shown in Fig. 3.

### Input

To maintain these conditions, the transducers are designed to suit the input pulse width, with which the line is required to operate. This input pulse width then determines the maximum digit rate (or carrier frequency) which can be used with the particular line. Any digit rate less than this can be used so long as the pulse width remains the same. If a line is used with an input pulse wider than that for which it was designed, the di-pulses will separate and there will be a loss of amplitude. If a line is used with a narrower input pulse than that for which it was designed, the di-pulses will not separate but there will be a reduction of amplitude due to the reduced energy available. For maximum utilization of line storage capacity, it is desirable to work with the narrowest permissible input pulse. Multiple, interlaced, inputs may be used where the external digit rate is lower than the maximum digit rate for the line. The package designs allow for this by permitting up to three transmit and three receive coils to be mounted.

### Temperature Coefficient of Delay

Extensive work has led to the formulation of line material in which the temperature coefficient of delay can be predicted and controlled. The temperature coefficient for all Ferranti Electric Magnetostriction Lines is always positive and less than 10 parts per million per °C.

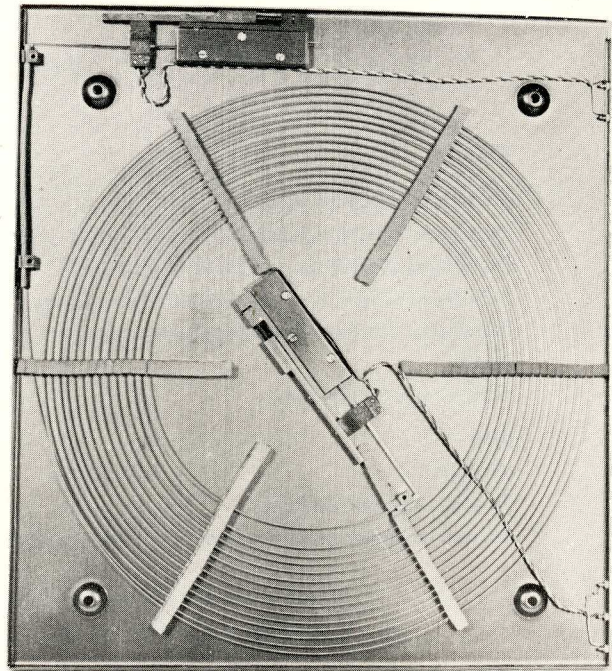
Because of this low value (c.f. 75 parts per million per °C for Quartz and 140 parts per million per °C for Nickel) it is very rarely necessary to use any ovens or other forms of temperature compensation.

## Transmission Modes

Two modes are used in the Ferranti Electric Magnetostriction Delay Lines.

The longitudinal mode is used on all packages for launching and detecting the stress waves, and throughout on the L20 lines, which are comparatively short and straight.

On the L30 and L40 lines, it is necessary to coil the wire to achieve convenient packaging. With coiled lines of great length, it is advantageous to transmit in the torsional rather than the longitudinal mode. A mode conversion is made near the start and finish of the line. The advantages of torsional propagation are several. The velocity of propagation in the material is substantially reduced; dispersion is reduced; and it is not necessary for the line to be made from magnetostrictive material except at each end. The line material can be chosen for optimum propagation properties, combined with low temperature coefficient of delay.



L40 Package With Cover Removed

## Analog Operation

Signals other than those in digital form can be handled so long as the required band width does not exceed  $\pm 50\%$  of the carrier frequency.

## Attenuation

The losses in propagation lead to an attenuation of 3 db per millisecond of delay.

The overall line attenuation, which allows for the efficiency of the transducers is 50 db + 3 db per millisecond.

## Noise

Noise on a Magnetostriction Delay Line may originate from several sources—reflections from the ends of the line, reflections due to reaction at the supports, electrically induced noise in the coils and from external shock waves.

Considerable care has been used in designing the line packages to minimize these effects. The signal to noise ratio due to reflections at supports and terminations is better than 20:1. The aluminum housing provides adequate shielding against external fields and the line material is connected to a ground terminal on the housing. The support technique prevents adding-in or dropping bits due to external shocks, except under the most severe conditions.

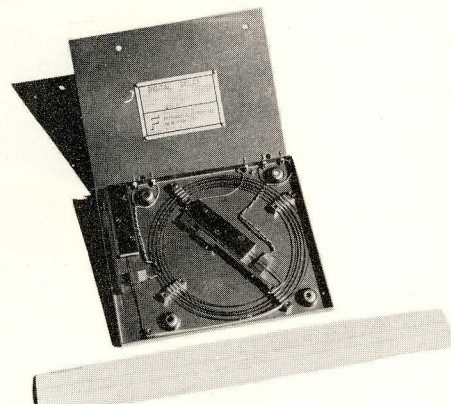
## Operating Environment

The L20, L30 and L40 line packages are designed for use in the environments normally encountered in commercial applications. They use, throughout, materials of good corrosion resistance—anodized aluminum for all metal parts, silicone rubber, Teflon and nylon for damping and insulation—and will give long reliable usage.

## Tapped Lines

Lines using the longitudinal mode may be tapped, as required, without significant attenuation. Hence, the L20 line can be supplied with taps.

Techniques for tapping lines using the torsional mode are still in the experimental stage, and it is not at present possible to provide taps on lines of greater than 70 microseconds delay (excepting in the short longitudinal mode section at each end of the longer lines) unless the limitations of long longitudinal mode lines can be accepted. This is possible in some applications, and lines of up to 5000 microseconds delay with an unlimited number of taps can be built to special order. Such lines are not covered by this brochure since they are beyond the scope of the L30 and L40 line packages.



L30 Package With Cover

## SPECIFICATIONS

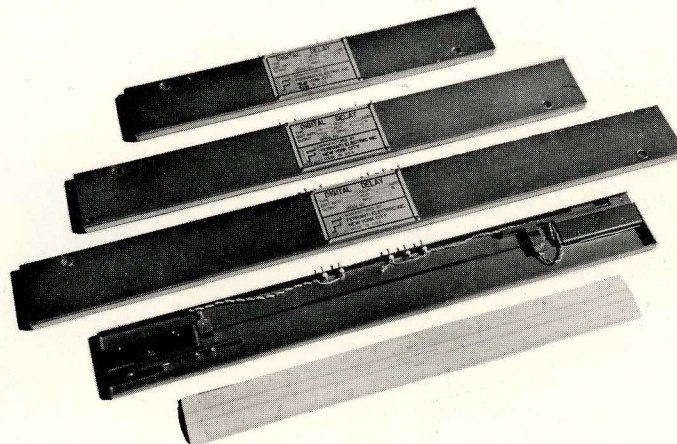
Package	L20	L30	L40
Minimum Delay microsecs.	10	70	500
Maximum Delay microsecs.	70	500	5000
Maximum Digit Rate or Carrier Frequency	1 mc/s	∅1 mc/s	500 kc/s
Minimum Digit Rate or Carrier Frequency**	100 kc/s	100 kc/s	100 kc/s
Maximum Storage Capacity (binary digits)	70	500	2500
Input		20 m A at 10 V	
Output into 5000 ohms	70 - 100 mv	25 - 40 mv	5 - 25 mv
Size	8 - 18" x 1½" x ¾"	6" x 7" x ¾"	12" x 13" x ¾"
Weight	*	8 ozs.	1 lb.

*\*varies with line length.*

\*\* refers to input pulse width, not absolute digit rate.

∅See type L35 for 1 mc/s operation with Delays up to 1 millisecond

Temperature Co-efficient of Delay	positive, < 10 parts/million/°C
Temperature Co-efficient of Amplitude	positive, function of line length.
Attenuation	50 db + 3 db/millisecond of delay
Signal to Noise Ratio	greater than 20:1
Delay Adjustment Range	± 4 microseconds
Band Width	± 50% of carrier



**L20 Packages**

# FERRANTI ELECTRIC INC.

## ELECTRONICS DIVISION

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