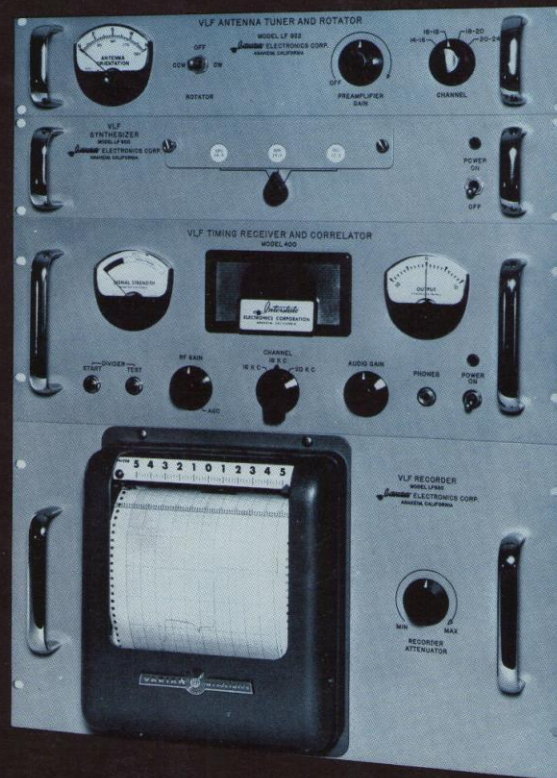


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VLF TIME/FREQUENCY SETS

MODEL LF 100



MORE  *Interstate* SOLID - *state* INSTRUMENTS

SOLID-STATE

WORLDWIDE

VLF

0.00000003%

1 μ VOLT

MULTI-CHANNEL

VLF

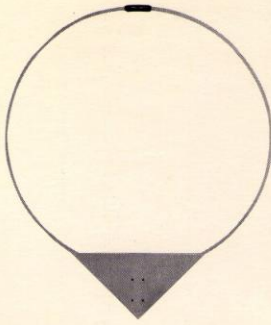
2 KC AUDIO OUT

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2 KC AUDIO OUT

ANTENNA & ANT

VLF LOOP ANTENNA, IEC MODEL LF-901



The IEC Model LF-901 loop antenna is a four foot diameter balanced loop, untuned, and electrostatically shielded. The loop is designed to operate over the frequency range of 14 to 24 kc with external series tuning. When tuned at the receiver end of a transmission line, the loop exhibits a moderate Q, and by proper impedance transformation, may be used with excellent results with IEC series 400 or other similar VLF receivers.

SPECIFICATIONS:

Electrical

1. Tuned Q approx. 5
2. Effective height approx. 2 cm.
3. Impedance (typical at 20 kc, tuned) 16 ohm series tuned.
4. Output connector, UG-22/u, balanced output

Mechanical

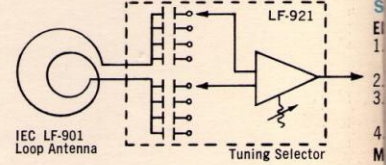
1. Diameter, 4'
2. Weight, 25 Lbs. approx.
3. Typ. mounting, 1 3/4 dia. mast.

FEATURES: Remote tuning at receiver end of transmission line, with LF-921 and LF-922 tuners. Rugged construction.

VLF ANTENNA TUNER/AM



The IEC Model LF-921 Antenna Tuner is a pre-amplifier for additional gain and reception on a 3 1/2" x 19" rack panel, complete with



IEC LF-901 Loop Antenna

Tuning Selector

SERVO MODULE, IEC MODEL 405

The IEC Model 405 Servo Module is an optional accessory for use with the IEC Model 400 Series of VLF Receivers. The servo, when used with the receiver, adjusts the phase of the 20 kc internally derived signal to phase lock the divider chain to the received signal. In addition, an analog voltage output is provided to monitor the phase correction applied.

SPECIFICATIONS:

Inputs

1. 20 kc from divider module
2. Phase coherent signal from second detector (IF module)

3. -12 volts DC
4. 117 VAC

(All provided by "plug-in" to IEC Model 400 Series VLF Receivers)

Outputs

1. 20 kc phase corrected signal to divider module
2. 0-5 volts or 0-1 ma for recorder, analog voltage proportional to phase correction, zero to full scale equals 50 microseconds phase correction.

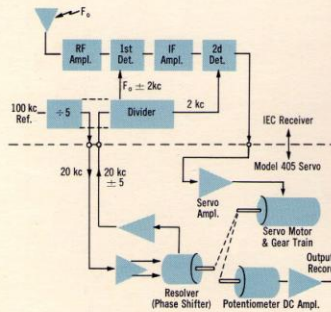
CHARACTERISTICS:

1. Accuracy

Phase correction holds phase coherence to ± 0.5 microseconds ($\pm 3.6^\circ$ at 20 kc) in absence of noise.

2. Response

Phase corrector will follow offset of 25 usec/min. (resolver speed 1/2 rev. per minute, bandwidth = .008 cy/sec. Will hold correction of frequency offset of 2.4 parts in 10^4). Other bandwidths on request; down to 0.0006 cps (correction 3 parts in 10^4 max.).



VLF RECORDER PANEL MODEL LF-930

The IEC Model LF-930 VLF Recorder Panel is a companion unit to the 400 series receivers for use in recording the beat frequency output signal. It contains an integrating network, gain control and strip chart recorder and is connected to the 400 series receivers by a single coax cable.

Input: 400 series receiver, recorder output. 110 VAC, 60 watts, 60 cps.

Chart Speed: Recommended - 12"/hour and 1/2" per hour.

Mechanical: RETMA 19" x 10 1/2" panel, 6 1/2" deep, 10 lbs.

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RECEIVERS & REL

VLF RECEIVER M



The IEC Model LF 500 VLF Receiver is a general purpose receiver for signals within the range of 14 kc to 23.5

SPECIFICATIONS:

Tuning Range

14 kc to 23.5 kc

Sensitivity

35 μ v into high impedance input

5 μ v into low impedance input

for 1 volt peak-to-peak output

6 db down at ± 30 cps

1500 cps, 1 v RMS nominal int

Tuning, level, speaker muting

RETMA 19" x 3 1/2" panel, 7" d

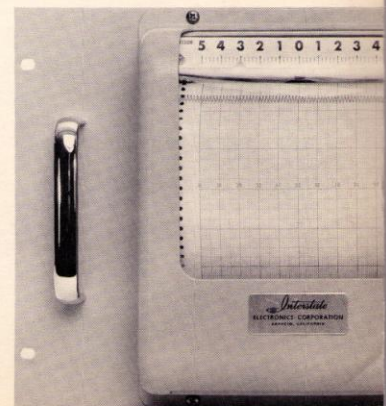
115 volts $\pm 10\%$, 60 cps

6 VA

FEATURES:

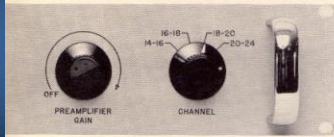
Provision is made for disconnection of internal oscillator for frequency comparison purpose

OUTPUT EC



ANTENNA TUNERS

AMPLIFIER, MODEL LF-921



Designed to be used with the IEC Model LF-901 Loop Antenna. The unit incorporates band switch tuning and a matching network. The entire unit is mounted on a 3 1/2" x 19" rack panel and contains a self-contained power supply.

SPECIFICATIONS:

Electrical

Inputs (a) balanced input from IEC Model LF-901

(b) Power—117VAC $\pm 10\%$, 60 cps

Gain 0-30 db.

Output—Low impedance, unbalanced output, for driving any receiver input impedance

Tuning range 14-16, 16-18, 18-20, 20-24 kc/s

Mechanical 3 1/2" x 19" rack panel

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VLF ANTENNA ROTATOR and ANTENNA TUNER/AMPLIFIER MODEL LF-922



The IEC Model LF-922 Rotator-Tuner-Amplifier is designed to be used with the IEC Model LF-901 Loop Antenna. The unit incorporates an antenna tuner identical to that used in IEC Model LF-921 Tuner/Amplifier.

In addition, a control unit for a heavy duty antenna rotator is incorporated for rotating the loop. The control unit will rotate the antenna through 360+ degrees, allowing orientation in any plane perpendicular to the earth.

Rotator

Vertical load—1,000 lbs. Rotating Torque—365 in lbs.

Braking Torque—3,500 in lbs.

Control Unit Mounted on 3 1/2" x 19" rack panel, with direction indicating meter, control switch, and antenna pre-amp/tuner.



TESTED EQUIPMENT

MODEL LF 500

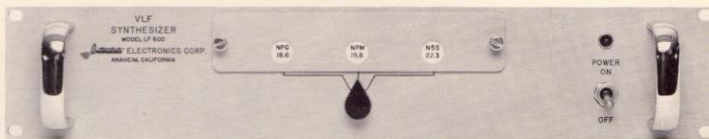


General purpose unit designed for reception of VLF signals.

5 k load
switch
ep

al oscillator and insertion of external

VLF SYNTHESIZER, IEC MODEL LF 600



The IEC Model LF 600 VLF Frequency Synthesizer is designed to generate phase locked signals in the range of 10 kc to 60 kc, and at 2 kc, for use with the IEC 400 series receivers as well as for other uses.

When used with the IEC 400 series VLF receivers, in place of the divider module, the synthesizer generates the necessary local oscillator frequency, 20 kc for the servo system, and 2 kc for the phase correlation detector. All frequencies are derived from an external 100 kc input and are phase locked to this input.

Channel selection for the local oscillator frequencies is determined by a 3 position front panel switch. The channels may be changed by simple front panel plug-in crystal filters.

SPECIFICATIONS:

Inputs

1. Signal—100 kc, 1.0 to 15.0 V, Peak-to-peak, sinusoidal or square wave.
2. Power—115 VAC, $\pm 10\%$ 60 cps, 30 watts

Outputs

1. 20 kc square wave
2. 2 kc square wave
3. Any of three panel switched frequencies in the ranges of 10.0 to 30.0 kc in increments of 0.1 kc 30.0 to 60.0 in increments of 0.2 kc

All outputs 11.0 volts ± 1.0 volt peak-to-peak.

All outputs phase locked to 100 kc source frequency.

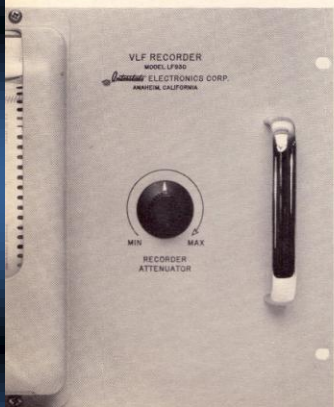
Maximum phase jitter, ± 0.1 microseconds

Maximum phase shift drift with temperature referred to 100 kc source, .04 microsec/degree C.

Mechanical:

Standard 3 1/2" x 19" rack panel mounting;
Chassis width, 17"; Depth behind panel, 16" including connectors.

EQUIPMENT



VLF SCOPE SWITCHING PANEL MODEL LF-940



The IEC Model LF-940 Scope Switching Panel is a unit offered as an accessory to the Model 400 series VLF Receivers. Its function is to take the outputs of the VLF Receiver and apply them to a dual channel oscilloscope for monitoring of timing and phase shift.

INPUTS

VLF Timing: 2 kc IF signal from 400 series receiver. 1 pps from external clock.

OSC Check: 2 kc IF and 2 kc product detector driving square wave from 400 series receiver.

Ext. input: Direct connection from front panel BNC connections to scope.

Outputs: Channels A & B and sync for external scope

Mechanical: RETMA 19" x 3 1/2" panel, 8 1/2" deep.



Interstate VLF Time/Frequency Sets are complete systems to measure frequency and time to a high degree of accuracy. Each standard set consists of a sensitive, solid state receiver plus a loop antenna, antenna controls, and output conversion equipment. Various combinations of the elements that go to make up a standard set can be combined into a modified set to fit a particular application.

Equipment available includes the receiver shown above, a loop antenna, an antenna tuner, an antenna rotator, a phase-locking servo module, a tunable receiver, a frequency synthesizer, a recorder panel, a rack-mounted oscilloscope and a scope switching panel.

A broad variety of output conversion equipment is available to fit your data system needs.

FREQUENCY CALIBRATION & SYNCHRONIZATION

This VLF equipment is useful for frequency correlation in virtually any geographical location in the world. Sensitivity of better than 1 microvolt is achieved with the basic solid state receiver. Rejection is greater than 80 db at the image frequencies.

Local frequency standards may be quickly and accurately calibrated by comparison with standard signals transmitted from VLF stations. GBR, NBA and WWVL are tuned by front panel switch selection in the standard Model LF 400 receiver. Other stations are tuned with Model LF 600 Synthesizers.

The signal on the channel selected is automatically correlated with a signal derived from the local standard by means of internal regenerative divider circuits. The result is an output beat frequency of approximately one cycle each fifty seconds for each part in one million of frequency difference. The external local oscillator frequency input is 100 kc.

The relative phase of the two signals is indicated on a front panel meter. Output connections at the rear of the instrument permit the beat frequency to be recorded externally.

An optional Servo Phase Tracking Module, Model LF 405, is available to allow an output which follows the phase difference between the received signal and the local standard. The output of the Model LF 405 is an analog signal suitable for driving a recorder and indicating full scale of 50 microseconds phase difference. The time constants are chosen to allow propagation anomalies to be plotted.

A 2-kilocycle audio output is also provided to an internal loudspeaker or to a phone jack, both located on the front panel.

TIME REFERENCE

An output timing pulse, synchronized to the incoming VLF signal, is also provided by the receiver.

This pulse is internally generated and is a square wave replica of the transmitted pulse, delayed by 10 ± 2 milliseconds nominally. Its amplitude is -12 volts into a 5000 ohm load, making it useful for the control of equipment such as clocks and counters, which can be supplied if desired.

OPERATION

The received VLF signal is amplified in a tuned rf section and is used as the input to the first synchronous demodulator. A local frequency from a regenerative divider network is compared with the received signal to provide a difference frequency of 2 kc. This frequency is then passed through a 2 kc IF amplifier to provide increased selectivity. The IF signal is used for aural presentation and is also supplied to a second synchronous demodulator for meter and recorder outputs.

Timing pulses are shaped by a keying detector and the restored pulse is a square wave replica of the transmitted pulse with a one microsecond rise time.

Satisfactory operation may be obtained from a conventional long wire (100 feet or more) antenna. In high noise areas, better operation is obtained with Model LF 901 Loop antenna, and Antenna Tuner Model LF 921 or 922.

SPECIFICATIONS — MODEL LF 400 RECEIVER

RF INPUT

Frequency Sensitivity

Switch-selected: 16 kc, 18 kc, or 10 kc. 1 microvolt or greater at antenna terminal for normal operation.

Selectivity

Adjacent Channel: Rejection greater than 50 db at 200 cps either side of tuned channel. Image: Rejection greater than 80 db at image frequencies.

EXTERNAL STANDARD FREQUENCY INPUT

Normal

100 kc, 1 volt rms nominal.

OUTPUTS

Recorder

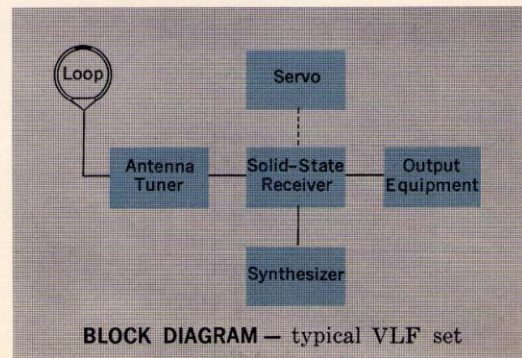
$\pm .25$ volt peak-to-peak into 5000 ohms for external recorder, internal one second time constant.

Audio

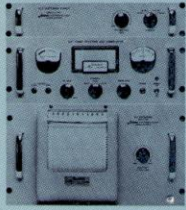
2000 cps audio, 1 volt rms into 5000 ohms.

Timing Pulse

-12 volts into 5000 ohms, 1 microsecond rise time.

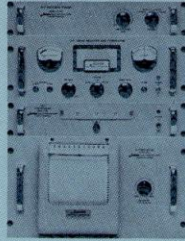


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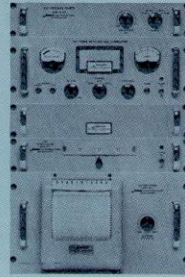
VLF SET LF-100

- 1—LF-901 Loop Antenna
- 1—LF-921 or 922 Tuner
- 1—LF-400 Receiver with or without Servo (Model 405)
- 1—LF-930 Recorder



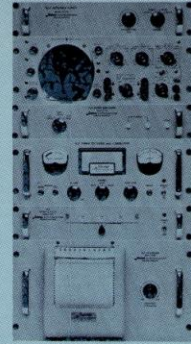
VLF SET LF-110

- 1—LF-901 Loop Antenna
- 1—LF-921 or 922 Tuner
- 1—LF-400 Receiver with or without Servo (Model 405)
- 1—LF-600 Synthesizer
- 1—LF-930 Recorder



VLF SET LF-120

- 1—LF-901 Loop Antenna
- 1—LF-921 or 922 Tuner
- 1—LF-400 Receiver with or without Servo (Model 405)
- 1—LF-600 Synthesizer
- 1—LF-930 Recorder
- 1—Precision Local Oscillator & Power Supply



VLF SET LF-130

- 1—LF-901 Loop Antenna
- 1—LF-921 or 922 Tuner
- 1—LF-960 Scope
- 1—LF-940 Scope Switch Panel
- 1—LF-400 Receiver with or without Servo (Model 405)
- 1—LF-600 Synthesizer
- 1—LF-930 Recorder
- 1—Precision Local Oscillator & Power Supply

The four standard VLF Time/Frequency sets shown above represent the four most commonly used combinations of VLF modules. Individual modules may be eliminated from each set or swapped from set to set to fit your own particular application. The modules described herein are a family and are completely compatible.

Each set is normally supplied as a group of modules for rack mounting, with complete cable diagrams. Upon request, any set will be supplied racked and ready to operate, with all cabling factory installed. Please specify if racking is desired. Rack mounted sets furnished with cabinet rack are designated by an 'R' following the model number.

Interstate engineers are available to discuss your VLF system applications. The engineering sales representatives of Interstate Electronics Corp. can supply price, delivery, and installation information on any standard module or any standard set described here. If you do not find what you want in this brochure, please call Interstate at the

phone number listed below, and our engineering staff will be happy to supply additional information.

VLF Transmission has two primary advantages that make it attractive for world-wide timing and frequency calibration. First, VLF propagation is by ground wave, thus assuring that the transmission delay for any geographical location is essentially constant. This excellent stability of the propagation path allows precision frequency calibrations accurate to within a few parts in 10^{10} to be made within a matter of hours as compared to several days for systems operating at high frequencies. The second advantage is the low attenuation at VLF, allowing a few medium power stations to assure coverage of the entire surface of the earth. The major VLF stations are listed below.

NAA, CUTLER, MAINE—14.7 KC • GBR, RUGBY, ENGLAND—16.0 KC • NBA, PANAMA CANAL ZONE—18.0 KC • NPG, JIM CREEK, WASHINGTON—18.6 KC • NPM, LUA LUALEI, HAWAII—19.8 KC • WWVL, SUNSET, COLORADO—20.0 KC • NSS, ANNAPOLIS, MARYLAND—22.3 KC

REPRESENTATIVES

R-O-R Associates Limited
1470 Don Mills Road
Don Mills, Ontario (Toronto)
HI 4-4429

E. W. Stone Co. Inc.
P.O. Box 56 Eastwood Station
Syracuse 6, N.Y.
437-5997

The Thorson Company
2443 Ash Street
Palo Alto, California
DA 1-2414

The Thorson Company
444 Olive Street
San Diego, California
CY 8-8385

Cain and Co., Inc.
104 S. Broadway
Tarrytown, New York
914 ME 1-4992
8442 Pickering Ave.
Philadelphia 50, Pa.
215 VI 8-1700

Airep Engineering Co.
P.O. Box 9555
Dallas, Texas
TA4-3800

Micro Sales Corporation
Welsh Building, Suite 220
3300 S. Dixie Drive
Dayton 39, Ohio • 298-3033

The Thorson Company
7361 Melrose Avenue
Los Angeles 46, California
OL 1-4430

W. W. Ryder & Associates
3130 Kingsley Avenue
San Diego 6, California
AC 3-8594 • AC 4-3568

Engineering Associates
of New England
319 Lincoln St. Manchester.
New Hampshire NA 3-7294

Paddock-Joslow Company
8616 Georgia Avenue
Silver Spring, Maryland
588-7866

1925 Lee Road
Cleveland, Ohio
216/371-0522
104 W. Couron
Ann Arbor, Michigan
313/662-7497

The Thorson Company
3600 S. Lincoln Street
Englewood, Colorado
SU 9-1841

Cain and Co., Inc.
410 150th Ave.
St. Petersburg 8, Fla.
391-0151

Potter-Mac Company
3831 Industrial Avenue
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Chicago Phone SP 4-1050



ELECTRONICS CORPORATION

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