IEEE-488

PRECISION ATTENUATOR

NEW

WAVEGUIDE BELOW CUTOFF ATTENUATOR AND LASER INTERFEROMETER

MODEL PA-4

1.25 MHz & 30 MHz

MICROPROCESSOR-CONTROLLED ATTENUATION STANDARD

Instruments, Support Prod.

FEATURES

DUAL FREQUENCY OPERATION — Operates at 1.25 MHz and 30 MHz without modification.

RESOLUTION — 0.0001 dB and 0.002 dB absolute.

INCREMENTAL ADJUSTMENT RANGE—Exceeds 100 dB.

ACCURACY — ±0.001 dB/10 dB ±0.0005 dB for ΔA between 15 and 115 dB.

VSWR — Maximum 1.2:1; typically 1.05:1.

SELF CORRECTING — For higher modes, leakage, temperature and pressure.

APPLICATIONS

LABORATORY STANDARD FOR IF SUBSTITUTION SYSTEMS

- **Attenuator calibration.**
- **Measurement of insertion loss.**
- **Receiver or power meter linearity measurement.**
- **VM-3, VM-4A and VM-24 reference attenuator calibrator.**

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PRECISION ATTENUATOR

MODEL PA-4

DESCRIPTION

The heart of the instrument is a precisely machined stainless steel circular waveguide which is operated in the TE11 mode. The sending antenna is movable manually or by a stepping motor and the receiving antenna by an electrically controlled vernier drive.

The separation of the antennas, which is a measure of attenuation is measured with an optical encoder and the incremental separation is measured with a Helium-neon laser interferometer system.

Attenuation is displayed on a digital front panel readout directly in dB with a resolution of 0.0001 dB. The total useful incremental measurement range exceeds 100 dB. Input and output are nominally matched to 50Ω impedances.

Error corrections to compensate for temperature and air pressure are made by either manual settings or an automatic correction system. The correction factors are indicated by the LED display. The attenuator can be controlled and read through an IEEE-488 Bus.

SPECIFICATIONS

OPERATING FREQUENCY:[1] 30 MHz ±0.1 MHz and 1.25 MHz ±0.05 MHz.

WAVEGUIDE MODE: TE11 operated below cutoff.

INCREMENTAL ATTENUATION RANGE: Greater than 100 dB.

SETABILITY:
Manual ΔA: 0.0005 dB.
By bus A: 0.01 dB.

MINIMUM INSERTION LOSS: 10 dB nominal.

RESOLUTION OF READOUT: 0.0001 dB for ΔA; 0.002 for A.

READOUT:
Attenuation: Front Panel 7 digit LED

CONNECTORS: Type N Jack.

VSWR (input/output): 1.2 maximum.

ACCURACY OF INCREMENTAL ATTENUATION AS INDICATED BY THE LED DISPLAY:
(In Linear Range): ±0.001 dB/10 dB ±.0005 dB
Deviation from Linearity:[2] Individual data supplied

OPERATING TEMPERATURE: 23°C ±5°C.

WEIGHT:
Net: 68 kg (150 lbs.)
Shipping: 114 kg (250 lbs.)

DIMENSIONS: 28-1/4 in. L × 15-5/8 in. W × 11-1/4 in. H (71.8 cm L × 39.7 cm W × 28.6 cm H)

PRICE: SEE PRICE LIST AT BACK OF CATALOG.

[1] Dual tuned launching and receiving antennae are provided so no mechanical or calibration changes are required in changing frequency.

[2] Corrections for other modes in initial region and leakage in the high attenuation region are stored in NOVRAM and corrected values of attenuation are displayed.

ELECTRICAL

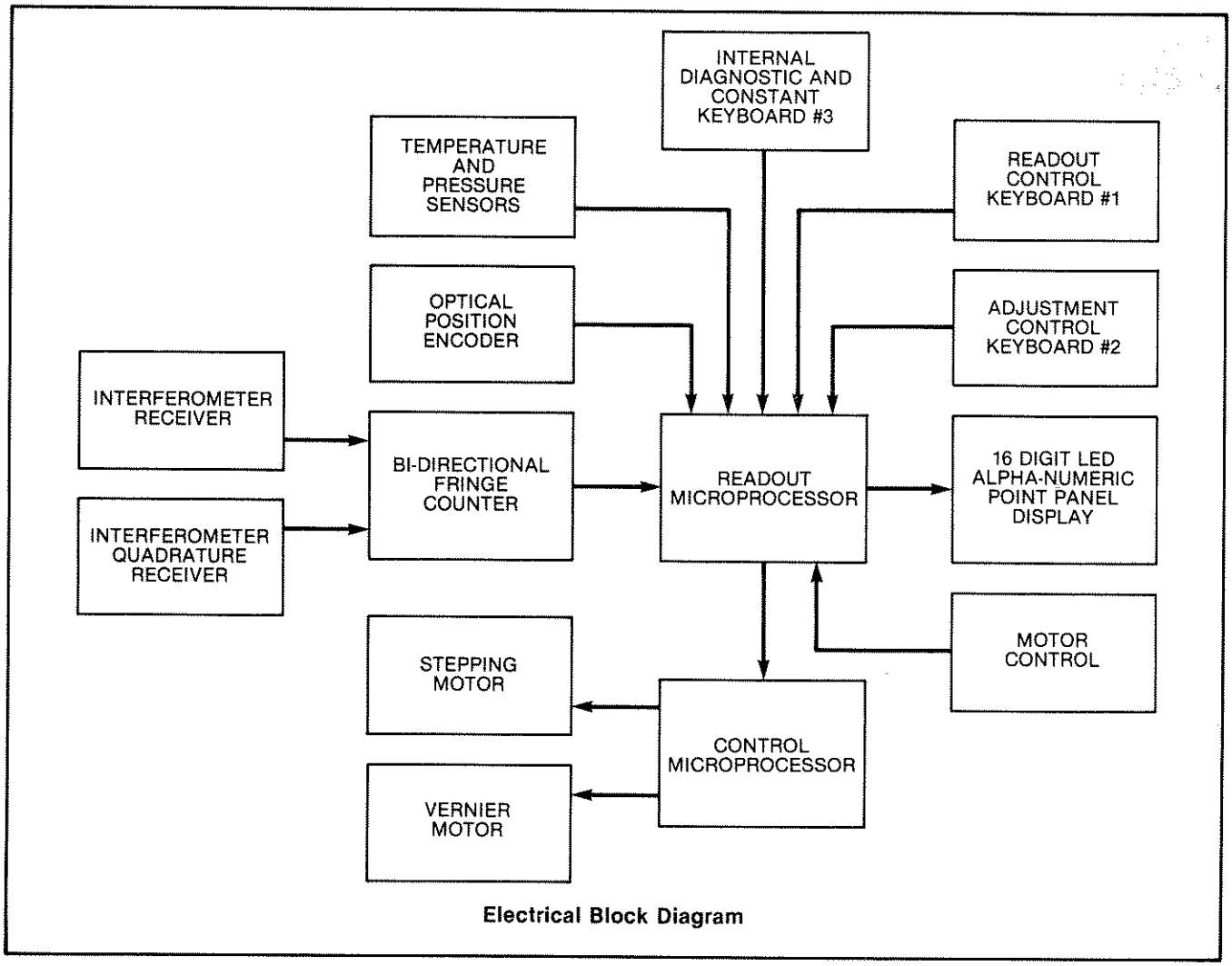
The two outputs from the interferometer are connected to the bi-directional counter. This circuit, in principle, counts the periods of the signals. If the piston is moved, the period differences are counted which are exactly proportional to the mechanical displacement in wavelengths.

There are eight counts to a movement of one wavelength. This signal is then digitally correlated to attenuation in dB by the internal microprocessor. It is digitally corrected for changes of the refractive index of air due to temperature and air pressure which influence the wavelength of the laser light.

Other corrections are made for compensation of the waveguides' thermal expansion and change of skin depth with temperature and frequency for internal leakage, and for other modes in the initial region.

The approximate insertion loss and attenuation increments can be controlled and all data available on the LED display can be read through the IEEE-Bus connector on the rear panel. The corrections are made either manually by the operator with the help of tables provided with the instrument, or automatically by a correction circuit.

The dB reading is displayed on the front panel. Corrections can be optically displayed on the front panel as well as constants used in the calculations, the coil separation, insertion loss, temperature, pressure and other quantities.



Electrical Block Diagram

OPERATION

From the front panel the attenuator may be set either with the handwheel or by the motor drive control which operates both the stepping and vernier motors. The display may be scrolled to read the attenuation, the change of attenuation from a given reference, the estimated errors in attenuation and attenuation change, and the frequency for which the attenuator is set. The attenuation reference may also be set from the front panel.

A second keyboard, accessible through the front panel door, permits adjusting the frequency setting, the value of attenuation per unit length when an uncorrected value is selected, and values for the reflection coefficients of the source and load to which the attenuator is attached. Corrected or fixed values of the attenuation constant may be selected and the display scrolled to read corrected values for temperature, air pressure, the cavity material properties, skin depth, index of refraction, laser wavelength, piston position and other quantities useful in assuring proper operation. Any adjustments made from this keyboard return to nominal values on reset or power on.

A third keyboard which may be accessed only by removing the instrument covers permits resetting all constants and corrections used in the calculations so the instrument may be recalibrated without making any other adjustments. Many other diagnostic quantities may be scrolled on the display from this keyboard and provision is made to permit hardwiring other diagnostic voltages which may be found useful. The instrument may be operated with constants changed on this keyboard (being in temporary memory) which will return to nominal values on reset or power on. However, by inserting a jumper and pressing store enable and store keys the new values will replace previous values in non-volatile RAM.

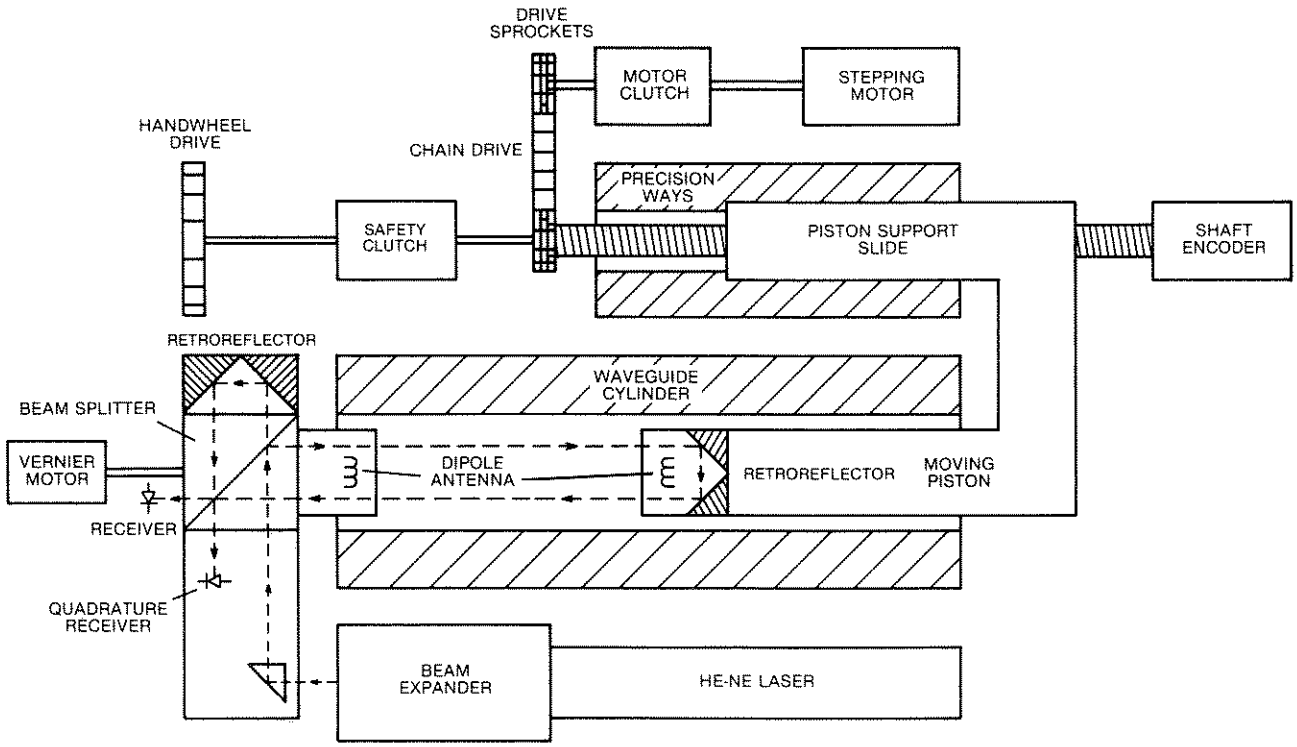
MECHANICAL ARRANGEMENT

The precision machined circular waveguide and interferometer are mounted on a stable surface plate. The waveguide temperature is monitored by a temperature sensor and the air pressure by another sensor. Temperature and pressure errors which would occur otherwise mainly due to expansion or contraction of the waveguide diameter, changes in material properties, and change of the laser wavelength are corrected for by the internal microprocessor.

The circular waveguide is machined from stainless steel to an accuracy of ±20 micro-inches. This guarantees the electrical attenuation accuracy as well as stability with time since there is little danger of surface corrosion.

The separation of the coils is adjusted by means of either a handwheel or stepping motor operated precision lead screw and a threaded slider combination. The slider moves in precision ways so that motion is smooth with little adverse movement. The piston containing one of the two coils is attached to this block. The other coil is moved by an electrically controlled vernier to interpolate between the motor steps allowing adjustment to about one eighth wavelength at the Helium-neon laser frequency.

The linear displacement of the sending and receiving coils is measured with a laser interferometer. An interferometer beam splitter and a corner cube reflector are mounted on the receiving and sending coils, respectively, which eliminates errors normally caused by temperature and backlash of mechanical linkages. The arrangement shown is a Michelson interferometer which measures only the displacement between the beam splitter and the corner cube reflector, while changes in the path length from the interferometer to the laser head and receiver respectively, are without influence.



Mechanical Arrangement