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LOW FREQUENCY AMPLIFIER IH-130-1

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BNL 6437

IHR-111

10/23/61

MASTER

A transistorized d.c. coupled amplifier having very good gain stability, as well as very low drift of the output d.c. level, has been designed. Low frequency input signals with an amplitude of .04 to 2 volts peak-to-peak, approximately, coming from a low impedance source (voice coil of a speaker system) are amplified to an approximate peak-to-peak amplitude of 4 volts. The output is intended to drive a load of the order of 100 kohm.

DESCRIPTION OF THE CIRCUIT

The amplifier consists of three d.c. coupled stages with a very high open-loop gain. The gain is controlled by a negative feedback, which also stabilizes the d.c. bias of the transistors and d.c. output level to a great extent.

The first two stages consist of long-tail transistor pairs to provide temperature compensation in these two very sensitive stages. Relatively high power supply voltages are used in order to be able to make the common emitter resistors large, improving stability.

The last step in stabilizing the output d.c. reference level is carried out by taking a fraction of the change in voltage across a forward biased germanium diode when the temperature changes and feeding it to the base of T2. The direction and magnitude of this correction is determined experimentally for the particular transistors used by placing the amplifier in a variable temperature chamber and changing the temperature slowly. Two different configurations are possible, of opposite sign, and they are both shown in the diagram.

ADJUSTMENTS

Calibrate-Use Switch: used to short out the input signal for calibration purposes.

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R1 and R2: Coarse and fine potentiometers to supply base current to T1; adjust so that there is no d.c. voltage between the base of T1 and the output lead (no d.c. across feedback resistors).

R3 : Controls magnitude of temperature correction.

Gain Control: The voltage gain can be varied from 2 to 100 in 11 steps.

PERFORMANCE

Gain Stability: Because the reserve gain in the feedback loop is high, the gain is primarily dependent on the relative sizes of the feedback resistors. These are encased in a Styrofoam compartment so that temperature changes are slow and uniform. No change in gain was observed with a 10°C change in temperature.

d.c. reference level stability: A d.c. output reference level of about -2.8 volts is obtained. By properly adjusting R3, a change of as little as .01 volts with a 10°C temperature change was obtained, observed at the output with maximum amplifier gain. This corresponds to an input temperature sensitivity of 10 microvolts/ $^{\circ}\text{C}$. When the amplifier is brought to a new environment, it should be allowed to operate for sufficiently long time (as much as 30 minutes) so that the chassis, parts, transistors, etc. have accommodated to the new temperature and the output level has attained equilibrium. This can be easily checked with a voltmeter between the output and ground.

Phase Shift: The phase shift at 1000 cps was observed to be approximately 1.5° . Assuming a normal RC rolloff, a phase shift of $.03^{\circ}$ is expected at 20 cps. This phase shift is caused mainly by the necessity of placing an RC network at the output of the amplifier in order to modify the high frequency phase shift of the circuit

and avoid regenerative oscillation. In order to minimize the time constant of this RC network, high frequency transistors are used in the circuit.

Harmonic Distortion: No appreciable distortion was observed with a GR Wave Analyzer.

Power Supplies: -15 volts, 40 ma

10 volts, 15 ma

CAL. USE

INPUT

-15V, 40MA

OUTPUT

+10V
15MA

IH-130-1-3

REV. A

ALTERNATIVE CONFIGURATION
FOR TEMPERATURE STABILIZATION

ALL RESISTORS ARE 1/2 WATT
UNLESS OTHERWISE SPECIFIED

ITEM NO.		USED ON DWS. NO.		NO. REGD.		BROOKHAVEN NATIONAL LABORATORY ASSOCIATED UNIVERSITIES, INC. UPTON, N. Y.	
CHECKED BY		I. L. R. NO.		ACCOUNT NO.		LOW FREQUENCY AMPLIFIER	
MATERIAL SPEC.		SIZE		WEIGHT		SCHEMATIC	
DATE		DRAWN BY		CHECKED BY		I H-130-1-3 A	
9-26-61		J. L. LACER		APPROVED BY		DRAWING NUMBER	
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