Phase Linear Seven-Hundred- Watt Amplifier

MANUFACTURER'S SPECIFICATIONS:
Power Output: Greater than 350 watts/channel, both channels driven, into 8 ohms, 0 Hz to 20 kHz. **Power at clipping:** Typically 450 watts/channel into 8 ohms; 730 watts/channel into 4 ohms. **Harmonic or I.M. Distortion:** Less than 0.25%; typically less than .01%. **Frequency Response:** 0 Hz to 250 kHz, direct-coupled inputs; 10 Hz to 250 kHz, normal inputs. **Sensitivity:** 1.15 V for rated output. **Hum and noise:** Better than 100 dB below 350 watts. **Input Impedance:** 100 k ohms, normal input, regardless of input level control position; 10 k ohms direct-coupled input, level controls bypassed. **Power Requirements:** 122% of maximum rms signal power output. Standby power is 55 W. **Controls:** Independent front-panel level controls, rotary power switch, input-mode selector switch. **Dimensions:** 19 in. wide, 7½ in. high, 10 in. deep. Bolt spacing will accommodate standard rack mount. **Weight:** 45 lbs. **Price: $749.00.** Cabinet available. Three-year warrantee. Phase Linear Co., 19555 23rd N.W., Seattle, Wash. 98177.

Each of us has experienced, at some time or another, the annoyance of a breakup of our amplifiers on an unexpected high-level signal, such as when a soprano hits her high C near the end of an aria. Whenever this happens, we learn to cringe every time this same passage appears, and it's all due to failure of an amplifier to handle the enormous momentary burst of power for that one note.

This never need happen again, for now there is the extremely powerful Phase Linear amplifier with its seven-hundred watt capability, *rms.* And it doesn't clip until it encounters a peak of around 450 watts. Not that it will put out 350 watts continuous for an extended period of time, although it might with fan cooling, but no amplifier is likely to be operated at maximum power for a long period—at least not for audio signals. But when the enormous reserve of power is needed, the Phase Linear is capable of handling practically anything you care to feed it. Should be a good background music amplifier for a rock session.

Description

The Phase Linear amplifier is constructed on a heavy aluminum chassis fronted by an anodized aluminum panel on which are mounted two large VU meters, illuminated by pale blue lumiline lamps under each one; the two input level controls, a power switch, and two pilot lights—one indicating when power is on, and the other indicating when it is off due to overheating. Power is automatically shut off when the output transistors reach temperatures exceeding 70 degrees C, and when they have cooled down sufficiently, power is restored and the amplifier operates again.

On the rear of the chassis is the enormous power transformer—2500 watts capacity—and four heat sinks, each consisting of two fins 4 in. deep by 6¾ in. high. Each sink mounts four PL-283 output transistors, a total of sixteen in all. Since the collector voltage is of the order of 100 the output transistors are covered by perforated metal shields. Along the rear of the chassis and adjacent to the sink farthest from the power transformer is the terminal section which mounts four phono input jacks, four binding posts, a switch for selecting normal or direct-coupled inputs, an a.c. receptacle which might be used for plugging in a fan, and five fuse holders—two for each channel in the supply lines, and one for the a.c. line. The silicon bridge rectifier is rated for 600 peak inverse volts at 25 amps.

The rest of the circuit uses 20 transistors, including 2 ICs, but in the absence of a schematic, we are unable to describe the circuit further. Suffice that it is direct coupled to the output and can be direct coupled to the input for amplification down to d.c. The d.c. supply to the amplifier is filtered by two 9800 μF, 100-volt capacitors.

Circuitry

Our first problem was to find a load capable of dissipating 350 watts per channel, since our regular test load panel will accommodate 50 watts/channel at 4 and 8 ohms, and only 100 watts at 16 ohms. Consequently, we secured six 25-ohm 100-watt adjustable resistors and paralleled them in two sets of three each, finally adjusting one so the actual load was 8.0 ohms at the end of the three-foot cables feeding the combination. This resulted in the desired wattage capability, but it also resulted in a measurable inductance in the load, which is a condition strongly to be avoided. Our usual practice is to get a resistor of four times the desired value and center tap it, then connect the two ends together. This quite effectively eliminates any inductance in the resulting load, but since we did not build up this load in the prescribed fashion, we ended up with a load

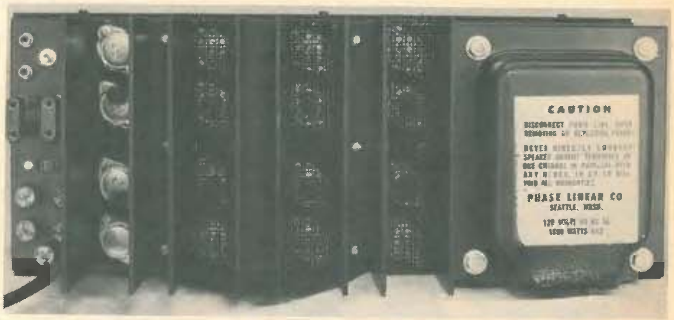

Fig. 1—Rear view of the amplifier with one protective perforated metal shield removed from one group of transistors. All input and output connections are made at the left end of the unit.

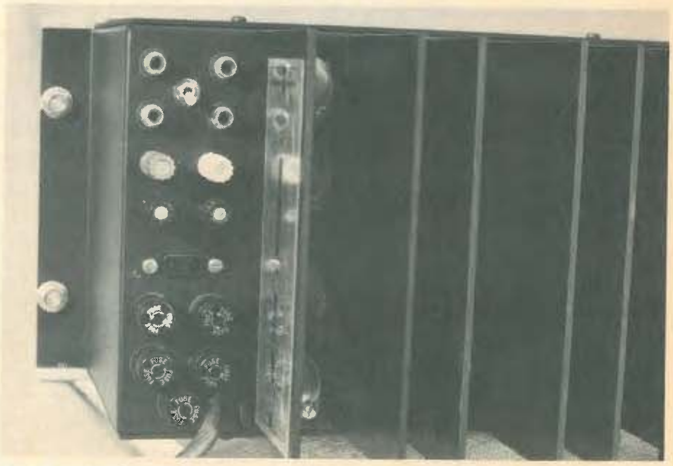

Fig. 2—The terminal panel with normal inputs at top, direct inputs immediately below, together with selector switch. Then come the four heavy-duty binding posts, an a.c. receptacle, four d.c. supply fuses, and the a.c. line fuse and line cord.

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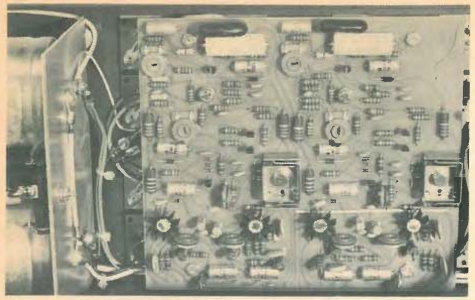

Fig. 3—The circuit board is neatly laid out on glass epoxy laminate for its permanence and high insulating qualities.

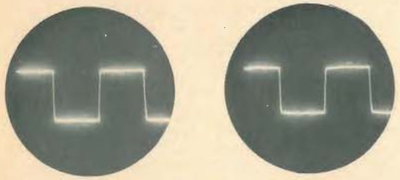

Fig. 4—Left, a 10 kHz square wave with normal load, and right, the same signal fed into a load consisting of 20 µH in series with the normal 8 ohms paralleled by 2 µF. Note that there is only the slightest difference at the leading edge of the latter pattern.

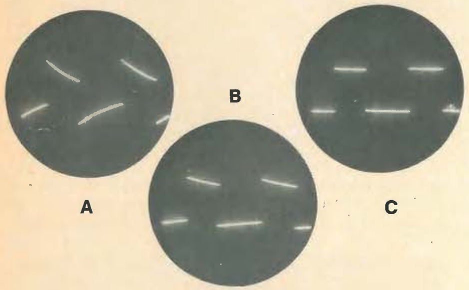

Fig. 5—Three versions of a 20 Hz square wave signal. A, normal input, with signal fed to a.c. coupling to scope; B, direct input, with a.c. scope input, and C, direct input with d.c. coupling to scope.

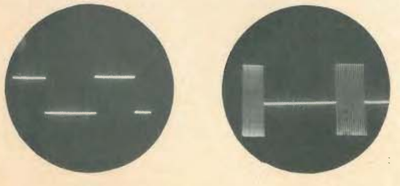

Fig. 6—Response to 1000 Hz square wave at left and tone burst of 20,000 Hz signal at right, both at a level of 50 watts.

having an inductance of about 250 µH—far too much for a wide-range amplifier. We should have obtained six 100-ohm resistors and followed this procedure, then paralleling three together for approximately 8 ohms, which could be obtained accurately by tapping down on one slightly.

However, using this 8-ohm, 300-watt load on each channel, we did perform the usual measurements of power output, and we found that the 350 watts per channel was obtained easily with a distortion of less than .04 per cent, which is as low as we can go with present equipment. Similarly, IM measured at less than 0.15 per cent. Then with a scope across the output of one channel, we increased the input signal until we saw a flattening of the tops of the sine wave, indicating clipping, and at this point we measured an output of 62 volts, which works out to be 480 watts per channel. Sixty-two volts across 8 ohms represents 7¾ amperes, which is a lot of current in *any* audio circuit, and the load resistors got hotter and hotter.

The manufacturer's circuit description states that the amplifier consists of two totally direct-coupled linear power amplifiers combined to form a single dual-channel unit. The output transistors are high-current, high-voltage, triple diffused silicon types arranged in a quasi-complementary format and biased for true Class B operation. The required bias current is carried by the driver transistors only, resulting in circuit efficiency which approaches the theoretical maximum. Bias control is accomplished by a bias regulator consisting of three voltage-reference diodes, a regulator transistor, and temperature-compensating circuitry.

The low-level stages consist of two complementary differential pairs, each pair providing voltage gain, while the second also provides voltage-level shifting to accommodate the pre-driver requirements. An emitter-coupled a.c. input stage is provided which blocks any signal appearing at the amplifier input for a brief period immediately following turn-on. A rear-panel-mounted switch connects the input signal direct to the first stage beyond the volume control when extremely low-frequency operation is desired.

The output terminals accommodate dual banana plugs which minimize the chance of a shorted output lead, and instructions specifically warn against any shorting of the output terminals

Performance

We made the specified IHF amplifier tests for stability which consist of operating the amplifier with no signal input and with no load, with 8-ohm loads, and with a load of .08 ohms on each channel, monitoring the output with a 'scope. In addition, loading with capacitive values from 100 pF to 10 µF, and with inductive loads from 10 µH to 1 H was observed, and in no case was there any spurious oscillation.

The specified load, according to one electrostatic speaker manufacturer, which simulates the electrical characteristics, consists of 20 µH in series with the normal resistive load of 8 ohms in parallel with 2 µF. For this purpose, we prepared a 100-watt load in the manner described previously, using two 50-watt, 75-ohm resistors, centertrapped with the ends shorted together resulting in a load of 9.26 ohms (½ × 75/4, with some shorting of turns on the resistor by the tapping to result in the 9.26-ohm value instead of the 9.375 which would be expected). The inductance of this load was measured and found to be less than 0.1 µH, which is essentially non-inductive.

We then applied a 10-kHz square wave and observed the output waveform, which is shown in Fig. 4 along with the same 10-kHz square wave, both at a 10-watt level. Note that there is practically no difference. Switching to a 20-Hz square wave, we observed the output with the signal fed to the normal input jacks, with the result shown in Fig. 5-A. Feeding the same 20-Hz square wave to the direct input jacks produced the result shown in Fig. 5-B. All of these figures were made with the oscilloscope switched to the a.c. input; switching to d.c. input provided the square wave of Fig. 5-C, which is essentially identical to that of 1000 Hz, Fig. 6.

There is no need to present a frequency-response curve of the amplifier, since it is perfectly flat from d.c. to 100 kHz, the limit of our audio generator. THD remained below .04 per cent from 20 to 100,000 Hz, and IM, using 7000 and 60 Hz mixed in a 4:1 ratio was also lower than specifications, actually measuring 0.15 per cent, with all measurements made with both channels operating and at the 350-watt level on each. Similar measurements made at a ¼-watt level gave measurements well below our measuring capabilities. Hum and noise figures were also well below anything we have encountered before, better than 100 dB below the 350-watt/channel rated output.

Listening tests

With this tremendous power available, we were chicken about connecting our speakers to the amplifier so we followed their instructions and put 1-amp. fuses in each speaker lead. After blowing out a few in trying to approach the sound level we normally get from our puny 60-watt/channel home amplifier, we finally connected a 50-watt, 1-ohm resistor in series with the 300-watt 8-ohm load-resistor assembly, and connected the speakers across the 1-ohm resistors in each channel. This way, we could assess the quality when the amplifier was working at full output. At 350 watts, the output signal voltage is approximately 53, and with this signal applied across the 8-ohms in series with the 1-ohm resistor paralleling the speakers, we were putting about 6⅔ volts across our speakers, and this results in about 5 watts across the speakers, which is still loud enough to judge quality. This, by the way, is how any super-power amplifier should be connected for listening tests, since one certainly cannot put 350 watts into any practical loudspeaker, and yet one wants to be able to hear what the amplifier sounds like when operating at capacity.

To all of this, all we can say is that the amplifier is everything claimed for it, as far as we can determine. We admit that we took every possible precaution with the listening-test lash-up, continually praying that the 1-ohm resistor wouldn't open-circuit. Reproduction was all anyone could possibly want as far as quality was concerned, and we wouldn't hesitate to recommend the Phase Linear amplifier to anyone who wants—and can accommodate—its enormous power capacity. *C.G.McP.*

Check No. 133 on Reader Service Card

Stanton Mark III Isophase Electrostatic Headset

MANUFACTURER'S SPECIFICATIONS

Frequency Response: 20-18,000 Hz ±2 dB. **Sensitivity:** 2 V input at 1000 Hz produces 100 dB SPL. **Linearity:** Within 0.1 dB over SPL range of 20 to 125 dB. **Harmonic Distortion:** Less than 1% at 115 dB SPL. **Ear piece dimensions:** 5" high x 3¾" wide x 2½" deep over cushion. **Weight:** 15 oz. including headphone cable.

POLARIZER: Source Impedance: Designed to work from 4-, 8-, or 16-ohm speaker output terminals of any amplifier of 10 watts rms rating, or higher. **Power Requirements:** 105-120 V a.c. 50-60 Hz, 4 watts. **Dimensions:** Unit, not including front panel: 2¾" high x 4¾" wide x 7⅝" deep. **Weight:** 5½ lbs. **Price:** Headset with Polarizer, $159.95; Second Headset, without Polarizer, $75.00; Two-Headphone Adapter, $9.95.

Stereo headphones are practically *de rigeur* in any modern high fidelity installation, and audio buffs are becoming more and more critical of the response of their headphones as compared to their favorite speaker systems—they are beginning to expect the same quality of response in both.

Electrostatic loudspeakers have long been recognized as ideal, but in order to reproduce low frequencies well they had to be large when radiating into free air. This problem does not exist with electrostatic headphones, and their response can easily compare with that from the finest loudspeakers, with the added advantage that the sound is more closely coupled to the ears, giving a greater sense of realism to most listeners.

The Stanton Isophase phones were not available to us when we made the series of tests which resulted in the roundup of stereo headphones in the December issue. Consequently, we recently obtained a set and gave them the same sort of measurement and listening tests as were given to the others.

The headset itself consists of a pair of earpieces mounted on an adjustable headband with a universal-joint type of connection which automatically adjusts them for optimum fit. A detented knob on the top of the headband permits the user to adjust for size and pressure to practically any desired degree. As with all electrostatic transducers, a polarizing voltage must be provided, and this is done in a separate unit known as the polarizer. It contains the step-up transformers necessary to increase the signal voltage by a factor of about 100 to 1 in order to drive the very high capacitive impedance of the transducers, and in addition, a power supply for the high-voltage, low-current requirements of the units. This voltage is about 1000, but the current requirement is minimal, since there are no conductive elements between the "plates" of the phones, and the only current is that due to possible leakage between the diaphragm and the rigid conductive screens which serve as the two outside "plates" of the capacitor. The whole principle of electrostatic transducers was covered thoroughly by George Tillett in the March issue and need not be repeated here.

Because of the limitations of movement of the diaphragm, maximum signal must be limited by some workable means. Fuses are inadequate, since the peak potentials between adjacent elements in the transducer are what govern the required limitation, and fuses are simply not fast enough. The circuit designed

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