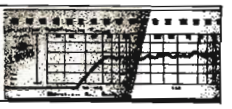
Equipment Reviews



Quad 405 power amplifier

Price: £142·30. Manufacturer: The Acoustical Manufacturing Co. Ltd., St Peter's Road, Huntingdon, Cambs., PE18 7DB.

THE majority of delegates to the fiftieth Convention of the Audio Engineering Society in March 1975 probably thought there was a spelling error when they saw the title of the lecture to be given by P. J. Walker and M. P. Albinson on a new amplifier design. They termed this new design a "current dumping" amplifier, and so added a new phrase to the audio vocabulary. Throughout the history of his Acoustical Manufacturing Co., Peter Walker has always maintained that, if a design is technically superior to the competition and the aesthetic appearance is acceptable and functional, there is no need to introduce new models each year. So, when a new piece of Quad equipment appears on the market, it is quite an event and it may be expected to have unusual features not found in other manufacturers' products.

The considerable success of this company, which exports to over 60 countries around 70% of its total production, is based on this philosophy that only the very highest quality is good enough, and that each piece of equipment must have a working life of many years. Peter Walker's phrase that the Quad amplifier is "only a piece of wire with gain" is typical, and yet it has taken some six years of detailed experiment to develop this new 100 + 100 watt power amplifier.

Externally the new Quad 405 could not be more simple, the front panel consisting of a vertically finned heatsink covering the whole frontal area. The end plates are plastic mouldings of considerable strength which also act as minor heat dissipating surfaces. The black finished base plate carries the power supply components, and a separate rear panel supports the four-contact DIN input socket, the left and right channel spring loaded sockets for connections to the loudspeakers, the six-position mains voltage selector with a coin operated slot, a 2·5A fuse for 220-240V operation, or 5A for 110-130V, and finally a three-contact IEC accepted mains socket. Recent IEC standards now require fully insulated loudspeaker terminals and, at first sight, I thought that it would be possible for the loudspeaker cables to short easily with the Quad terminals. However, the design of the spring-loaded connectors is such that external wires or pins cannot pass through the terminal holes and cause short circuits.

The top cover is readily removable to reveal one of the neatest designs I have met. I have often praised Japanese manufacturers on the neatness of their layouts and inter-panel wiring, but I have seen none better than the Quad 405's first-class assembly and wiring. In the near centre of the base panel is a massive screened mains transformer which, in conjunction with a full-wave silicon rectifier, provides rail voltages of +50 and −50 volts, smoothed by two 10,000μF capacitors. At the bottom right hand side of the frontal heat sink is a neat red on-off indicator lamp. Two printed circuit boards carry the whole of the left and right channels and, although they measure only 130mm x 75mm, they carry some 40 resistors, 12 capacitors, 10 transistors, 6 diodes and one integrated circuit. All the components are of the highest grade, and each is identified by silk screen printing on the glass-fibre PCB. The board is bolted to a heavy section T-angle which carries the output transistors and which in turn is screwed to the front heatsink. Thermally conducting compound is used between the metal-to-metal surfaces.

As delivered, the Quad 405 amplifier is capable of supplying in excess of 100 watts per channel into 8 ohm loudspeakers, which corresponds to an output voltage of about 28-29 volts. On full output this might damage certain loudspeakers, including the Quad Electrostatic, and therefore the designers have introduced a method of limiting the system to 20 volts, giving an output of 50 watts per channel. Provided in the expanded polystyrene packaging are two 1·8k ohm resistors and a spare fuse. Removing the top panel, which is held in place with only two slotted screws, one has ready access to a pair of tubular rivets on each circuit board. The preformed wires on the resistors automatically locate in the hollow rivets. The PCBs also carry two 4A quick-blow fuses but no difficulty should be experienced if the fuses require replacement. If it is ever necessary to remove a whole board, this can be easily done by undoing four cross-slotted screws, and five push-on flat connectors.

Neatness of assembly and wiring apparent with top cover removed

The whole amplifier is finished in the well-known Quad bronze and is supplied with a 1·25m (4ft) twin-core mains lead terminated with an American type flat-pin plug. Also provided is a 1·25m signal lead with a four-pin DIN plug at each end, which automatically couples with the Quad 33 control unit. Where the Quad 405 is to be used with another pre amplifier, an alternative cable is supplied having a pair of phono plugs at one end.

The Quad 405 consists basically of two amplifier sections, the first amplifier being a very high quality Class A design having an output of a few watts, capable of giving the full voltage swing but providing only a relatively small current. When larger powers are required, the Class A amplifier switches on the "current dumping" power transistors, each pair of which is capable of giving a power output in excess of 100 watts. The considerable advantages accruing from the new design are that it is unnecessary to match the pairs of output transistors and that all the problems associated with Class B crossover distortion are eliminated. Further, as there are no adjustable components, long term component changes have no effect on the amplifier performance. Components may be replaced, if ever necessary, without any need for alignment or trimming. A full description of the circuit would require several pages, but the complete diagram is given in the instruction book, and it is possible for anyone interested to consult the AES paper.

The simple exterior of the Quad 405 stereo power amplifier

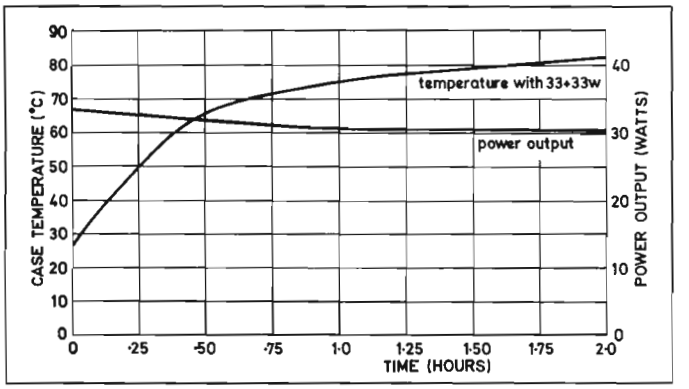


Fig. 1. The rise in temperature was timed, and its effect on power output measured

How it performed

As the Quad 405 power amplifier is destined for world markets, its design is required to meet various international standards. Some are primarily concerned with electrical safety and others with performance, or a combination of both. Recently the American Federal Trade Commission introduced a new requirement that before measurements are made on an amplifier, it should be driven at one third full power with a 1kHz sinewave signal for one hour. Although this most severe test is being strongly criticized

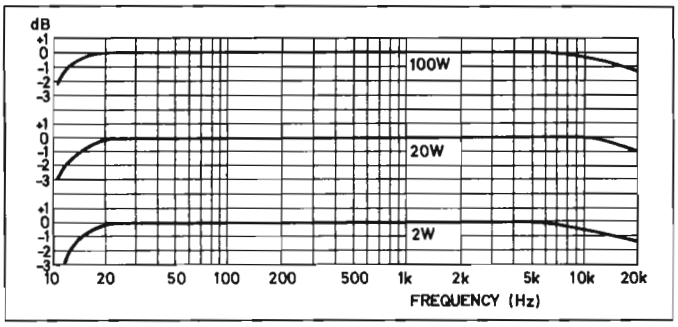
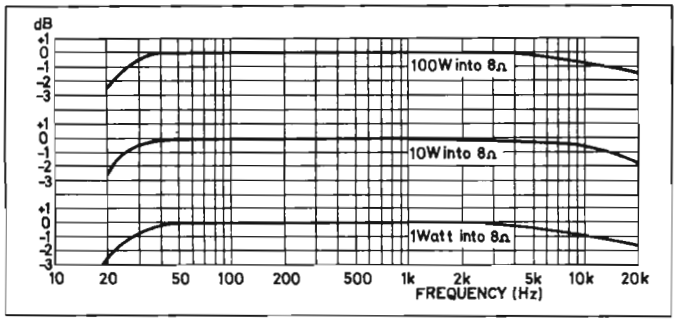


Fig. 2. Frequency response (a) for the Quad 405



(b) for the Quad 405 with 33 control unit

in American technical journals, for the average power during an orchestral concert is certainly less than one third of the peak power, I nevertheless felt it would be desirable to see how the Quad 405 performed under these conditions, particularly as The Acoustical Manufacturing Co. has made considerable inroads into the US and Canadian markets. The accompanying graph (Fig. 1) shows that the temperature measured between two adjacent fins rises fairly rapidly during the first half-hour and is rather too hot to touch, but then it rises more slowly and, even after 2 hours, it is still well below the maximum transistor junction temperature. The rise in temperature has only a small effect on the power output. The test was started with no signal input for an hour, by which time the fin temperature was only 27°C. The 1kHz signal was then applied to the amplifier with a measured output of 33 watts per channel and, after 2 hours, this had been reduced to just over 30 watts.

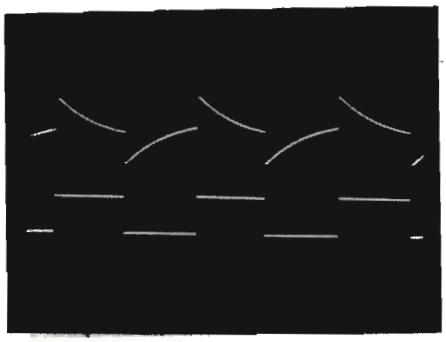
Measurements of harmonic distortion followed, using the Radford Distortion Measuring Set, and the following table gives the results:

Power into 8 ohms (watts)	100Hz	1kHz	10kHz
1	0·055	0·016	0·018
10	0·018	0·01	0·008
100	0·007	0·005	0·0035

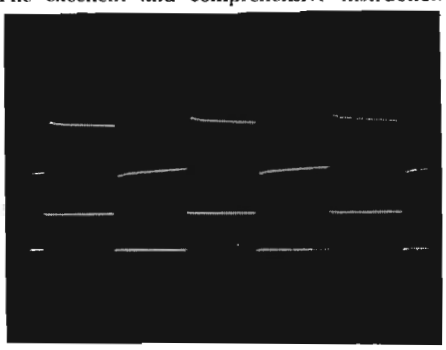
The input sensitivity was measured to be exactly 500mV for an output of 100 watts across a load of 8 ohms, 160mV for 10 watts, and 50mV for 1 watt. It will be seen from the frequency response curves (Fig. 2) that there is a steep cut-off below 20Hz, which greatly assists in overcoming rumble problems, whilst at the high frequency end there is a gentle roll-off above 20kHz. The oscillogram (Fig. 3) shows the very symmetrical clipping which occurs with a power output of 128 watts into 8 ohms.

Fig. 3. Symmetrical clipping at 128W

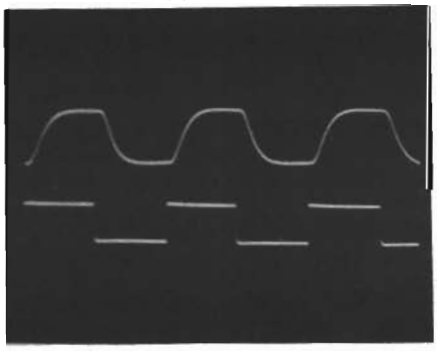
Square-wave testing often shows up amplifier deficiences which are not noticeable under sinewave conditions and the Quad 405 gave an exemplary performance (see Figs. 4a, b and c). Using a simulated load as might be presented to the amplifier by an electrostatic loudspeaker (8 ohm non-inductive resistor in parallel with a 2 microfarad capacitor) the resulting square wave (Fig. 4d) shows only the slightest amount of ringing which is rapidly damped. With the usual toneburst test of 16 sinewave cycles at 1kHz on and off, the output waveform is virtually identical with the input (Fig. 5a). An even more severe test of the stability and fast recovery rate is to apply an asymmetrical toneburst, that is one in which the usual sinewave signal is replaced with a square wave (Fig. 5b). It will be seen that with the exception of a slight droop the output signal is practically the same as the input signal.



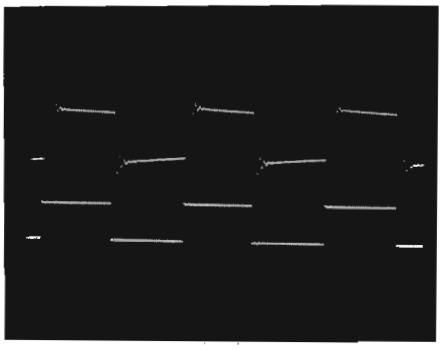
(a) 100Hz



(b) 1kHz



(c) 10kHz



(d) 1kHz with capacitive load

Fig. 4. Square-wave performance

SPECIFICATION AND TEST RESULTS
QUAD 405 STEREO POWER AMPLIFIER

	Maker's Specification	Test Result
1. Rated output power (watts at 1kHz)	100 per channel	128 (clipping)
2. Harmonic distortion at 100 watts	100Hz 0·01% 1kHz 0·01% 10kHz 0·05%	0·012% 0·008% 0·012%
3. Load impedance	Suitable for 4–16 ohms speakers	Agreed
4. Frequency response (see also Fig. 2)	−1dB at 20Hz −0·5dB at 20kHz −3dB at 50kHz	−0·5dB −0·6dB −3·1dB
5. Output internal impedance	3·3μH in series with 0·03 ohm	0·04 ohm at 1kHz
6. Offset (mV)	less than 7	2·3
7. Input sensitivity (Volt)	0·5	Agreed: see table
8. Crosstalk	100Hz 80dB 1kHz 70dB 10kHz 60dB	69dB 67dB 56dB
9. Signal input slew rate limit	0·1/μs	0·13/μs
10. Hum and noise (dB)	−95 weighted −90 unweighted	−95 −93
11. Stability	Unconditional	Agreed
12. Weight (kg)	9	—
13. Dimensions (mm)	340·5 x 195 x 115	—

The Quad 405 has been in use for some two months in conjunction with the Quad 33 control unit. Inter-connection is simplicity itself, there being only two connecting leads, the mains supply and the 4-pin DIN terminated cable. The excellent and comprehensive instruction

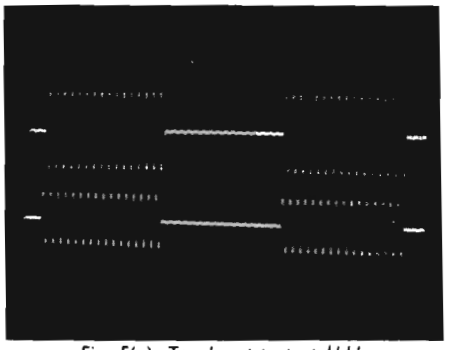


Fig. 5(a). Toneburst test at 1kHz

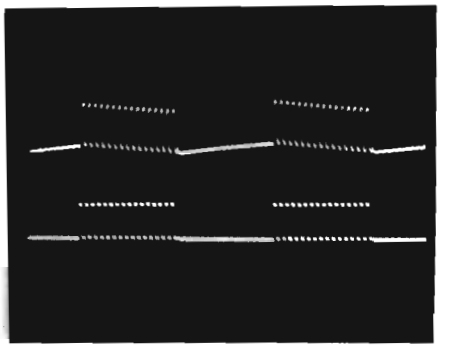


Fig. 5(b). Asymmetrical toneburst test

book suggests that, when the 405 is used in conjunction with the 33, the fuse fitted to the 33 should be increased from the 2A rating to 2·5A. Also, if the Quad 405 is to be used with a pair of Quad Electrostatic speakers, it is imperative that the voltage limiting resistors should be brought into circuit. If the Electrostatic speakers have a serial number prior to 16800 (March 1966) they will need slight modification before being used, as is also necessary for use with the Quad 303 power amplifier.

Before the Quad 405 was modified for use with Quad Electrostatic speakers, the opportunity arose to try the amplifier with a pair of Bowers and Wilkins DM6 speakers in the very large dining hall at the Institution of Electrical Engineers. It was on the occasion of a meeting to celebrate Graham Bell's invention of the telephone, and some 150 visitors enjoyed hearing the combination. Back at home, I also used a pair of DM6 speakers and was surprised at the complete absence of background breathing sounds or hum. Although measurements indicated a very low hum and noise figure, one often finds that there is a slight audible background with some amplifiers, but this was completely absent with the 33/405 combination.

The Quad 405 is certainly one of the finest British designed and manufactured power amplifiers on the market. As in the past, it will be a long time before The Acoustical Manufacturing team will find it necessary to develop a successor. Already the demand exceeds the factory production capacity and, as it finds itself in the world markets, the demand for this amplifier will continue for years to come.

JOHN GILBERT.

Goodmans Achromat 250 loudspeaker

Price: £74·32. Manufacturer: Goodmans Loudspeakers Ltd., Downley Road, Havant, Hampshire, PO9 2NL.

GOODMANS have now released three new loudspeakers in a range called Achromat; of these the Achromat 250 is the middle-sized model. The speakers are marketed in pairs and safely packed in a large container. The review models were finished in teak with a darker, tapered front edge, the sculpted front made from a reticular plastic foam and carrying a neat Goodmans motif. Although it has a very open mesh, thus making it acoustically transparent, its thickness makes it opaque and the drive units cannot be seen through the material. There are several interesting features about the new design which have been the subject of detailed research and development in the Goodmans laboratories. The target set was to produce a loudspeaker which, under room conditions, would produce constant energy distribution over the operating range with negligible distortion. Complete inspection is made at every step of manufacture and Goodmans are so confident in their products that they offer a 5-year warranty.

The cabinet is constructed from 18mm thick dense chipboard, finely veneered with teak. Removing the front grille shows that the two drive units are recessed into the front panel. To reduce cabinet resonance, there is a square-section post wedged and secured between the front and rear panels. Recessed into the rear panel is a plastic moulding carrying two 4mm sockets and a DIN socket for connections to the loudspeaker. Two 6·5m leads are supplied, each with male and female terminating plugs.

Although I have been associated with the reviewing of audio equipment for over forty years, I am sure this is the first time that I have seen a loudspeaker unit with a transparent diaphragm. At last the purchaser can see the working parts of the diaphragm assembly. The frame carrying the magnet assembly and diaphragm is a ribbed, high pressure diecasting sprayed black and carrying a trough into which is fitted a foam ring which seals the frame against the front panel. The 127mm x 15mm ceramic magnet is sandwiched between two heavy steel discs. The diaphragm is centred with a 127mm diameter corrugated disc and the outer edge uses a neoprene moulded roll surround. The transparent diaphragm is doped and has a doped black dustcover, the diaphragm excursion being at least 12·5mm.

The high frequency dome unit consists of a dense plastic moulding and is totally enclosed. The diaphragm is a small 25mm dome attached to the side of a short exponential horn which is part of the moulding carrying the magnet assembly. To secure the unit to the cabinet there is a separate plastic ring, and air leakage is prevented by the use of a foam ring. Mounted on the internal face of the rear panel is a printed circuit board carrying the crossover network. This six-element network consists of two air-cored inductors, three reversible electrolytic capacitors and a fixed wirewound resistor to equalize the sensitivity between the two units. The whole of the interior volume of the cabinet is filled with 75mm thick plastic foam and the air sealing is so good that, on depressing the bass diaphragm, it takes a second or two for it to return to its zero-signal position.

How it performed

The impedance curve shown in Fig. 1 never falls below 6 ohms and therefore the Achromat 250 is suitable for amplifiers having a rated load of 4 to 8 ohms. The frequency response curve (Fig. 2) has a reasonably flat characteristic from 100 to 10,000Hz as measured in a large anechoic

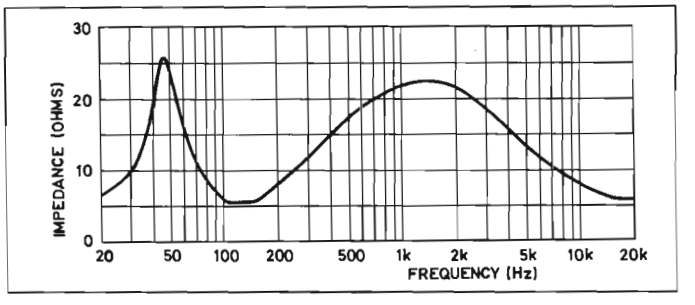


Fig. 1. Impedance/frequency curve

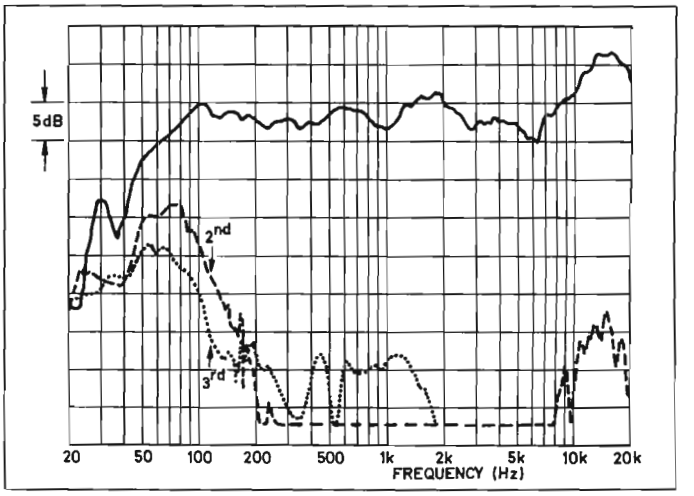


Fig. 2. Axial response and 2nd and 3rd harmonic distortion (raised 20dB)