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CIRCUIT DESCRIPTION
The Quad 405 is a two channel power amplifier primarily intended for use in high quality sound reproducing systems. The amplifier is usually used with Quad control units though other signal sources can readily be accommodated.

The amplifier uses a current dumping output circuit, a Quad invention which eliminates many of the problems associated with transistor amplifiers, and covered by patents in several countries.

In a current dumping amplifier there is in effect both a low powered very high quality amplifier and a high powered heavy duty amplifier. The low power amplifier controls the loudspeakers at all times, calling upon the high power section to provide most of the muscle. The small amplifier is so arranged—it carries an error signal—that provided the larger power transistors (the dumpers) get within the target area of the required output current it will fill in the remainder accurately and completely. The reproduced quality is solely dependent on the small amplifier which because of its low power can be made very good indeed.

Problems of crossover, crossover distortion, quiescent current adjustment, thermal tracking, transistor matching, all disappear. There are no internal adjustments or alignments and the choice of power transistor types is less restrictive.

Fig. 1

Simplified Schematic of 405 Amplifier showing Class A, Dumpers and Bridge Components.
TEST EQUIPMENT

Sound Technology Distortion Analyser 1700A (ST1700A)
Dual Beam Oscilloscope
4Ω and 8Ω loads of 100W Dissipation
1Ω load of 25W dissipation
2.5 KHz Square Wave Generator
Input Sensitivity Indicator (0 to 1V Rms)
Avmeter (or similar multimeter)
0 to 12V d.c. power supply
Variac AC power supply

Fig. 2 illustrates a simple switching circuit which may assist if much testing is anticipated.

![Image of a circuit diagram]

**Fig. 2**

Before testing, the cover of the 405 should be removed.

**DISCONNECTING CLAMP CIRCUITS**

When servicing a 405 fitted with a clamp circuit, it may be necessary to bypass this circuit.

For 405's fitted with amplifier boards M12368, this may be done by removing the push-on connectors carrying the brown wires from the amplifier boards, and connecting the loads between the black output terminals and the output terminals on the amplifier boards.

For 405's fitted with amplifier boards type M12565, it will be necessary to remove the side panels to gain access to the printed copper side of the amplifier boards. The three screws securing each side panel should be removed, the panel may then be slid outwards from the amplifier. If the solder is removed from the link pad shown in Fig.18 (A), the clamp circuit will be disconnected.

Care should be taken to ensure that when testing is completed, the link pad is re-soldered.
AMPLIFIER CIRCUIT TESTING M12368 – M12565

The following test procedure is with reference to a 240V amplifier with no voltage limiters.

Select:

Controls
- Y1 – 0.5V/cm DC coupled
- Y2 – 0.1V/cm DC coupled
- Timebase 0.2 ms/cm

ST. 1700A –
- Volts/power 100W RMS
- Distortion Ratio 0.01%
- 80KHz and 400Hz filters both in
- Frequency 1KHz
- Low Distortion
- Osc. level minimum

Connections
- Load 8Ω
- S1 Sine Wave (ST1700A)
- S2 Left Input
- S3 Left Output

If the Amplifier fails any of the following tests, refer to the appropriate part of the fault finding section, page 6.

1. Check inside the amplifier for obvious faults such as burnt components, blown internal fuses etc. Each of the following checks should be repeated on the other channel.
2. Apply the AC Supply Volts whilst observing the current consumption which should not exceed 0.12A.
3. Increase the oscillator level to 0.5V Rms ± 0.5dB. The output should be 100W with no sign of clipping.
4. Select set level and adjust meter deflection for zero. Select distortion which should be less than 0.01%. Select volts/power, decrease the applied frequency to 100Hz, remove 400Hz filter and adjust oscilloscope timebase to 2 ms/cm. Set level, select distortion which should be less than 0.01%. Select volts/power, increase the applied frequency to 3KHz, select 400Hz filter and adjust timebase to 50µs/cm. Select distortion which should again be less than 0.01%.
5. Select volts/power, increase applied frequency to 10KHz and adjust timebase to 20µs/cm. Adjust oscillator level so that output is 100W. Set level then select distortion which should be less than 0.05%.
6. Select volts/power, increase applied frequency to 20KHz and adjust timebase to 10µs/cm. Reduce output level to 80W. Set level and measure distortion which should be less than 0.1%.
7. Select volts/power and decrease frequency to 1KHz. Adjust oscillator level so that output is 100W and adjust timebase to 0.2ms/cm. The following checks are to monitor the low frequency roll off of the 405. Select 30Hz and the output level should fall by approximately 0.3dB. Select 20Hz and the output level should fall by approximately 1dB. Select 10Hz and the output level should fall by 7dB ± 1.5dB.
8. Increase frequency to 1KHz. For 405's with amplifier boards type M12368 insert 1K8 voltage limiting resistors into the mini sockets on each amplifier board. For 405's with amplifier boards type M12565-3 insert a link into these sockets. The output waveform should indicate clipping. Reduce the oscillator level until the clipping just disappears at which point the output level should be 20V Rms ± 1V. Remove voltage limiters, and adjust oscillator level for 100W output.
9. Select volts/power and square wave input, (S1). Adjust timebase to 0.1ms/cm. Remove load and note the difference in the waveform with load and no load. There should be a slight difference in gain (10mV) but no overshoot. Re-connect 8Ω load.
10. The following checks should be carried out with no input signal and the input to the amplifier board loaded by a 1K resistor, (S1). Remove 400Hz filter and select noise which should be better than –83dB unweighted.
11. Select volts/power 400Hz filter and sine wave input at a frequency of 1 KHz and adjust oscillator level for 100W output. Select 1Ω load. The output should clip equally on both halves of the waveform as shown in Fig. 11.
12. Select 4Ω load, output level should be 70W just prior to clipping.
13. CLAMP CIRCUIT TESTING

In order to test the clamp circuit, the circuit should first be disconnected from its amplifier board, as described on page 4.

For 405’s fitted with amplifier boards M12368 apply 8V d.c. across the output terminals of the relevant channel with an ammeter in circuit.

For 405’s fitted with amplifier boards M12565 a wire should be soldered to the back of the amplifier board as shown in Fig. 18(B), 6V d.c. should be applied between this wire and the black output terminal of the relevant channel, with an ammeter in circuit.

In both cases the current should not exceed 0.5mA. Reverse the polarity of the supply and repeat the test. The test may then be carried out on the other channel.

The complete test should then be repeated using a 12V d.c. supply with a 10Ω resistor in series, when the current should be approximately 1A.
FAULT FINDING
The following information may assist in locating faults occurring on the amplifier boards of a 405.
In each case only the faulty channel of the 405 is driven, as in the test procedure. The input should be a sine wave of 0.5V Rms and the output should be applied to an 8Ω load unless otherwise stated. The numbers refer to the relevant test check.
*Board type M12368 only **Board type M12565 only.

<table>
<thead>
<tr>
<th>Effect</th>
<th>Cause</th>
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<tbody>
<tr>
<td>1.</td>
<td>Collector-base TR10 O/C</td>
</tr>
<tr>
<td>R33 Burnt</td>
<td>L1 O/C</td>
</tr>
<tr>
<td>R37 Burnt*</td>
<td>L3 O/C</td>
</tr>
<tr>
<td>R41 Burnt*</td>
<td>R20 O/C, R21 O/C</td>
</tr>
<tr>
<td>R39 Burnt</td>
<td>D5 or D6 O/C</td>
</tr>
<tr>
<td>R38 Burnt</td>
<td></td>
</tr>
</tbody>
</table>

2. High Current

* TR2 O/C, TR3 O/C, TR7 O/C, TR9 S/C |
** TR10 S/C, R7 O/C C8 S/C |
** C3 S/C |
** D2 O/C R8 O/C |
** R14 O/C |

3. No increase in AC supply current for increase in signal
Signal is unstable and clips
100W o/p for 0.3V input
Waveform trace as in Fig. 3
Waveform trace as in Fig. 4
Approximately 4W output

4. Second Harmonic Distortion
Second Harmonic Distortion especially at 100Hz and on O/C load.
Third Harmonic Distortion especially at 100Hz
Third Harmonic Distortion
Hum and noise
Hum*
Waveform trace as in Fig. 5*
Waveform trace as in Fig. 6*
Waveform trace as in Fig. 7*
Waveform trace as in Fig. 8*
Waveform trace as in Fig. 9

5. Distortion at 20KHz

6. Limiting resistor R11 has no effect

7. Square Wave Trace as in Fig. 10

8. Noise especially at 100Hz
Noise with large Spikes
Noise

9. Current limiting check with 1Ω load.
Waveform trace as in Fig. 12
Waveform trace as in Fig. 13
Waveform trace as in Fig. 14
Waveform trace as in Fig. 8

10. Draws high current with 6V D.C. supply

T2 S/C
MODIFICATIONS TO PRINTED CIRCUIT BOARDS.

1. **Amplifier Board M12368.6**
   - Copper track layout modified component layout unchanged.

2. **Amplifier Board M12368.7**
   - Circuit diagram issue 3.
   - R4 changed from 10K to 22K
   - R5 changed from 10K to 4K7
   - R9 changed from 180Ω to 220Ω
   - R19 3K3 removed
   - R23 changed from 3K3 to 1K2
   - C9 330p removed
   - C18 47nF added as on circuit diagram
   - FS1 and FS2 effectively changed places
   - R2 changed from 2.2Ω to 10Ω
   - Copper track width reduced.

3. (a) **Amplifier Board M12368.9** introduced at Serial Number 9000. Circuit diagram issue 4.
   - R41 22Ω added
   - L3 6.9μH added
   - C15 0.1μH added
   - C16 0.1μH added
   - C18 47nF removed
   - C19 1nF added
   - Copper track width reduced.
   - Also at Serial Number 9000 a clamp circuit, on PCB M12400, was mounted on the output terminals (fig. 15).
   - This detects excessive DC off-set at the output and short-circuits, blowing the internal 4 amp fuses FS1/FS2, to protect the loudspeaker.

3. (b) At Serial Number 29,000 the following changes occurred. Circuit diagram issue 5
   - R10 changed from 1K to 1K8
   - R27 changed from 8K2 to 15K
   - R29 changed from 8K2 to 15K
   - R35 changed from 0.08Ω to 0.091Ω
   - R36 changed from 0.08Ω to 0.091Ω
   - D1 changed from LR120C to LR150C
   - D2 changed from LR120C to LR150C

4. **Amplifier Board M12368.10**
   - Identical to M12368.9 except for copper pads for power transistors modified for production purposes.

5. **Amplifier Board M12565.3** introduced at Serial Number 59,001. Circuit diagram issue 6.
   - Other 405’s with this board are Serial Numbers 57,301 to 57,600 inc.
   - This board incorporates the clamp circuit and voltage limiter is now a link.

6. **Amplifier Board M12565.5**, circuit diagram issue 7, was also fitted from serial number 62500 onwards but with 405 nameplates. See 405.2, page 12.

**Alternatives**

Transistors – on M12368 issues 5, 6 and 7 BDY77 or BDY74 may have been used for TR9 and TR10. BDY77 is a suitable replacement for both, but faster transistors may cause instability.

On M12368 issues 9 and 10 and M12565.3 the following transistors may have been used, 2SD424, 17556, 2SD676 and are interchangeable.

- **TR2** – BC682, ZTX304, BCX32, BC546B interchangeable
- **TR3, TR4** – E5458, ZTX504, BC556B interchangeable
- **TR7, TR8** – 40872 or 2SA740 interchangeable

**L.E.D.**

- HP Hewlett Packard 5082-4850, Exciton XC5053, Toshiba TLR114A interchangeable.
**CLAMP CIRCUIT**

Introduced co-incident with amplifier board M12368.9 at serial number 9001. All 405's with serial numbers 9000 and under being returned for service, should be fitted with a clamp board as shown below.

At serial number 59,001 the clamp circuit was fitted as an integral part of the amplifier board M12565.3. The function of this circuit is to monitor the D.C. component of the output. In the event of a component failure which causes excessive D.C. volts, the circuit will short circuit the amplifier output and thus protect the speakers.

**REPLACING A CLAMP BOARD**

If it is necessary to replace a clamp board the following instructions should be followed:

1. Disconnect the wiring to the right channel circuit board and fold it back onto the transformer. Loosen the clamp holding the electrolytic capacitor next to the output terminals, and lift the capacitor out of the way.

2. Disconnect the leads to the output sockets, place the clamp board over the output connectors and re-solder. It is advisable to tin the output connector tags before positioning the clamp board. This makes soldering easier.

3. Replace the capacitor and re-connect the tags to the righthand amplifier board.

**CLAMP CIRCUIT ALTERNATIVES**

T1 2N4992 or BS08A 03
T2 SC141B or TIC226B or RCA T2800.
CONVERSION OF 405 TO A MONO 180 WATT AMPLIFIER

To carry out the conversion, the modification kit Q410MOD should first be obtained.

1. Remove 405 cover and baseplate.
2. Unplug the Amp connectors from the righthand channel printed circuit board (righthand side when viewed from the front).
3. Release the clip securing the rear 10,000μF capacitor (C14) and lay the capacitor over the righthand channel board.
4. Un solder the four leads from the output terminals.
   For 405's fitted with amplifier boards M12368 (i.e. serial numbers 59000 and below) remove the clamp board.
   To disconnect the clamp circuit on 405's fitted with amplifier boards M12565 (i.e. serial numbers above 59000) remove both of the side panels. The solder should then be removed from the link pads shown as A in fig 18. The side panels should then be refitted.
5. Remove the output terminals and replace those for the righthand channel with the sockets provided. Red at the top. Fit the blanking grommets provided in the vacant holes.
6. Fit the new printed circuit clamp board to the output sockets and reconnect the output leads. Brown/Red to the pin marked R. Brown/White to the pin marked L and both Green leads to the pin next to L.
7. Remove the 4 pin Din input socket and unsolder the leads from it.
8. Connect these leads to the new input board, White to L and Red to R and screens to the two E tags.
9. Fit the new input socket and board.
10. Refit the 10,000μF capacitor and Amp connectors to the righthand board.
11. Remove the output leads, Brown/White from lefthand and Brown/Red from righthand printed boards.
12. Connect a 4-8Ω speaker between the output tags of these two boards.
13. Switch on the amplifier, inject a signal of approximately 100mV at 1kHz at the input socket (left and right pins are now common). Remove the blanking grommet adjacent to the input socket and adjust the pre-set potentiometer through this hole for a null in the signal from the speaker, increasing the input signal level as required for final accurate setting.
14. Switch off, remove signal input, disconnect the loudspeaker, reconnect output leads, refit blanking grommet, base and cover.
REMOVING THE AMPLIFIER MODULES

1. Note the colour coding for reconnection and remove the push-on tab connectors A.
2. Undo the four fixing screws B, for each module.
3. Remove the heatsink grease from the face of the aluminium T-section and retain for use when re-fitting.

REPLACING THE QUAD 405 TRANSFORMER

1. Disconnect the A.C. supply and remove top cover (2 screws) and bottom plate (4 screws).
2. Note carefully the connections and then unsolder the external wiring to the A.C. supply transformer.
3. Remove the two retaining screws through the large centre holes of the 6 in each amplifier board mounting, and then release the boards by undoing the other 4 in each. These 12 screws fasten into tapped strips located in slots in the rear of the finned heat sink sections, which now become free of the front plate.
4. Release the transformer by undoing 4 screws through the front plate and 2 through the bottom.
5. Reverse the procedure with the new transformer.

Note: It should not be necessary to remove the push-on connections from the boards but if they are removed they should be handled carefully and replaced correctly.
QUAD 405-2
The original 405 provided 100 watts per channel into load impedances between 4.5 and 8 ohms. To meet the need of 4 ohm loudspeakers and 8 ohm speakers whose impedance falls below 4.5 ohms, the 405-2 was introduced in January 1983 at serial number 65000, but the 405-2 modules had already been fitted from 62500 onwards. Many earlier amplifiers have also since been converted to 405-2 by owners and dealers, by replacing the modules.

The 405-2 has a more sophisticated current limiter circuit based on a thick film assembly N1/N2, permitting full output into loads between 3 and 10 ohms, and up to 50 watts into 1.5 ohms, provided the output transistors will not be hazarded by doing so. (See Fig. 17). As with earlier 405 models after serial number 59001, the output clamp circuit is incorporated in the main module boards and a shorting link used for the voltage limiter.

The first 405-2 circuit diagram was 12333 issue 7 and the printed board reference M12565.5.

Subsequent modifications were:

<table>
<thead>
<tr>
<th>Date</th>
<th>Serial No.</th>
<th>PCB 12565</th>
<th>Circuit Diagram 12333</th>
<th>Changes</th>
</tr>
</thead>
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<tr>
<td>May 83</td>
<td>66700</td>
<td>6</td>
<td>8</td>
<td>C20 (4n7) added to avoid mild instability when switching off. D13 added in series with D5 to correct response at 20kHz. R44 added to maintain unconditional stability.</td>
</tr>
<tr>
<td>July 83</td>
<td>67950</td>
<td>6</td>
<td>8</td>
<td>Output terminals replaced by 4mm sockets.</td>
</tr>
<tr>
<td>Aug 84</td>
<td>72501</td>
<td>7</td>
<td>9</td>
<td>TR4 changed to BC556B and R18 omitted replacing both TR3 and TR4.</td>
</tr>
<tr>
<td>Dec 85</td>
<td>83000</td>
<td>7</td>
<td>–</td>
<td>Voltage selector omitted.</td>
</tr>
<tr>
<td>Feb 86</td>
<td>85000</td>
<td>7</td>
<td>10</td>
<td>New mains input connector incorporating fuseholder. Din input replaced by phono sockets. Signal earth isolated from chassis by R2 to avoid hum loop when using mains earth.</td>
</tr>
</tbody>
</table>

![Graph showing power watts, output volts, peak, continuous sine wave drive, and load resistance](Fig. 17.)
Voltages shown are with no signal input, limiter resistors omitted and no speaker connected.

Unmarked = negative with respect to + rail.

Prefix E = relative to earth.

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Stock numbers listed for replacement parts may be equivalents for original parts which are no longer available, therefore manufacturers and tolerances may vary.

QUAD 405 CIRCUIT DIAGRAM DRG No. M1233 ISS3
Voltages shown are with no signal input, limiter resisters omitted and no speaker connected.

Unmarked = negative with respect to + rail.

Prefix E = relative to earth.

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THE ACOUTICAL MFG CO LTD HUNTINGDON ENGLAND

Stock numbers listed for replacement parts may be equivalents for original parts which are no longer available, therefore manufacturers and tolerances may vary.

QUAD 405 CIRCUIT DIAGRAM ORG No. M12333 ISS4

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