

Accuphase

INTEGRATED STEREO AMPLIFIER

E-405

- 5-parallel push-pull output stage (170W/channel into 8 ohms)
- Low-impedance drive capability
- Completely direct-coupled DC servo design from MC input to output terminals
- Balanced input circuitry
- Signal switching with logic relays
- Peak power meters



Thanks to separate power transformers for the preamplifier and power amplifier sections, the E-405 achieves the same level of performance as separate-type amplifiers. Direct-coupled DC servo design from the

The overall gain of an integrated amplifier amounts to as much as 100dB, which signifies amplification by a factor of 100,000. Even the slightest interference or noise arising in the input stage will be magnified manifold and have a detrimental effect on sound quality. Important advantages of an integrated amplifier are, of course, convenience and ease of operation, but achieving outstanding performance is a considerable design challenge with this amplifier type.

The Accuphase E-405 was designed from the outset with the goal of advancing the state of the art in integrated amplifier performance. To achieve this aim, the amplifier actually consists of a separate preamplifier and power amplifier section which are housed in a common enclosure. Even the power transformers, rectifying circuitry etc. are separate for the two sections.

In the power amplifier section, five pairs of transistors are used in a parallel push-pull configuration, to ensure drastically improved drive capability. The advantages of this approach are apparent not only under extreme low-impedance load conditions, but also when driving speakers in the 4 to 8 ohm range. Drive current supply always remains stable and reliable, unperturbed even by drastic signal fluctuations. The power amplifier stage with its massive power transformer, large 33,000 μ F $\times$ 2 filtering capacitors and 170 W/channel rating into 8 ohms (250 watts/channel into 4 ohms, 350 watts/channel into 2 ohms) far surpasses the domain of conventional integrated amplifiers.

The preamplifier section features the same design as a high-end stand-alone preamplifier, with a 20-dB line amplifier stage and 30dB (MM)/60dB (MC) phono stage which are powered by their own power transformer and rectifiers. Separate stabilizer circuits ensure totally uniform current supply and prevent interference between the respective amplifier stages. Latest digital program sources as well as traditional analog program sources can develop their full fascination with this amplifier.

To accommodate even the most demanding system setup, the E-405 provides a total of twelve inputs (including two power amplifier inputs). Three of these (including one power amplifier input) are balanced inputs, to permit signal transmission with ideal characteristics. Facilities for tape recording also leave nothing to be desired. An independent recording source selector and a tape copy switch provide unlimited versatility. Tone controls employing the summing active filter principle and a loudness compensator circuit are designed to provide the required amount of user control without impairing sound quality as such.

Another important convenience feature of this amplifier is the supplied remote commander for program source switching and volume adjustment. The latter uses a motor-driven design which does not suffer from the sound-quality problems inherent in electronic controls.

The external design of the E-405 stands in the Accuphase tradition, with a champagne

gold brushed front panel and elegant side panels made of exquisite persimmons wood. The front panel layout is simple and uncluttered. Two large power meters in the center are flanked by the input selector section and the volume control. Less frequently used controls are arranged behind a hinged panel. Overall, sensible human engineering is in evidence throughout, contributing to the unsurpassed musical enjoyment afforded by this amplifier.

POWER AMPLIFIER SECTION

1 Powerful 5-Parallel Push-Pull Output Stage with Combined Maximum Heat Dissipation of 1,300 Watts per Channel Reliably Drives Low-Impedance Loads and Delivers 170 watts/channel into 8 ohms, 250 watts into 4 ohms, and 350 watts into 2 ohms.

Fig. 1 shows the circuit principle of this amplifier's power amplifier section. The output stage consists of the ten transistors Q_{21} to Q_{30} which are arranged in a parallel push-pull configuration. Each transistor has a maximum heat dissipation rating (P_c) of 130 watts, resulting in a combined maximum heat dissipation of 1,300 watts. This is more than ample to drive low-impedance loads with sufficient power, but it also contributes to improved linearity when using speakers with normal impedance characteristics.

The E-405 delivers 170 watts of clean power per channel into 8 ohms, 250 watts into 4 ohms (from 20 to 20,000 Hz, at 0.02% THD), and 350 watts into 2 ohms.

2 Cascode Push-Pull + MOS FET Drive Tuned for Perfection

The quality of the drive stage is an important consideration in a no-compromise amplifier. In the E-405, as shown in Fig. 1, the transistors Q_{12} to Q_{15} and Q_{17} to Q_{20} are used to form a direct

dual cascode connection circuit. This principle guarantees superior linearity up to highest frequencies, and the use of MOS FETs keeps distortion at low signal levels to an absolute minimum. The signal voltage used to drive the output stage is therefore of impeccable quality.

3 Completely Direct-Coupled DC Servo Design

All stages of this amplifier, including the preamplifier, are linked directly, without any coupling capacitors in the signal path. This design is ideal for optimum performance and clean, uncolored sound. However, as the E-405 also provides power amplifier inputs, any possibility of DC drift must be prevented, as this could otherwise lead to speaker damage. A special DC servo design developed by Accuphase (IC_2 in the center of Fig. 1) detects any DC component in the output and feeds it back to the input for cancellation, resulting in zero DC in the final output.

4 Inputs for Separate Use of the Power Amplifier

Separate outputs and inputs controlled by a selector switch permit use of the preamplifier section and the power amplifier section as separate components. The jacks can also be used to introduce components such as a graphic equalizer or a sound processor into the signal path. The power amplifier input offers a choice between RCA type phono jacks and balanced XLR inputs. (For details on balanced signal connections, please refer to the paragraph on preamplifier features.)

5 Speaker Selector and Large Power Meters

The easy-to-read and highly accurate output power meters in the center of the front panel are precisely following the rapid changes in amplitude and frequency that are common with music signals. A speaker selector employing large, heavy-duty relays offers switching facilities for

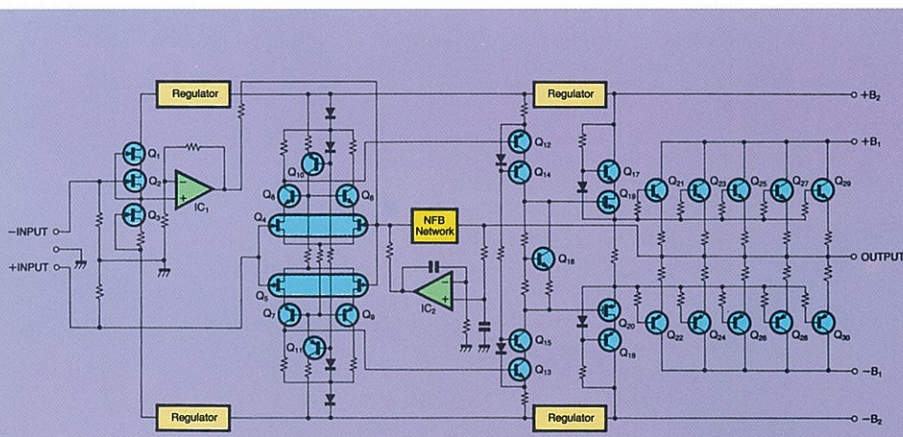


Fig. 1 Circuit diagram of power amplifier section

analog disc input to the loudspeaker outputs assures absolute signal purity. Ample power and superb low-impedance drive design deliver 350 watts per channel into 2-ohm loads.

two pairs of speakers. The A + B position can also be used for "bi-wiring" (supplying the same signal via dual leads to speakers with separate high-frequency and low-frequency inputs).

PREAMPLIFIER SECTION

1 High-Quality Line Amplifier with Balanced Inputs

Signals from audio components other than analog record players are processed by the so-called line amplifier which in the E-405 is a high-performance design employing a low-noise dual FET input stage and differential cascode bootstrap connection. This principle assures high S/N ratio and delivers optimum conditions regarding the position of the volume control or variations in output impedance of connected equipment. Another advantage of the line amplifier in the E-405 is the provision of XLR type balanced connectors.

The principle of balanced signal connection is shown in Fig. 2. At the source component, the signal is converted into a positive and negative signal with identical voltage potential, but phase-inverted by 180 degrees. The receiving equipment feeds the two signals to a + amplifier

and a - amplifier and mixes their output. As any noise which was picked up by the connecting cable etc. has the same phase in both lines, it is cancelled by the mixing process, ensuring noise-free signal transmission with optimum sonic purity. The advantages of this principle are especially apparent with long cable runs normally subject to various adverse influences.

2 MM/MC Phono Stage Brings Out the Best in Analog Records

Although digital program sources are becoming ever more popular, high-quality reproduction of analog records is still an important consideration for the true audiophile and music lover. The E-405 is designed to excel in this respect also, with a no-compromise phono stage designed to deliver top-notch performance. Fig. 3 shows the circuit configuration of this stage. Separate input circuits are provided for moving-coil (MC) and moving-magnet (MM) cartridges, to bring out the advantages of each design.

As MM cartridges have high output voltages as well as high output impedance (often reaching several dozen kilohms in the upper frequency range), the FETs Q_1 and Q_2 with high input impedance and the transistors Q_3 to Q_6 are arranged in a cascode bootstrap connection. In the MC section on the other hand, which has to

deal with very low-level signals, S/N ratio has uppermost priority. Q_7 and Q_8 , strictly selected for lowest residual noise, complement Q_3 to Q_6 , also in a cascode bootstrap connection. Relays 1 and 2 serve to switch between these two sections. The overall result is highly musical and detailed reproduction of analog records.

3 Separate Preamplifier Power Supply

The preamplifier section is powered by its own power supply, employing a toroidal transformer with low leakage flux and high-speed diode rectifier circuitry. The "± dual tracking series regulator" principle further contributes to unsurpassed stability and smooth operation.

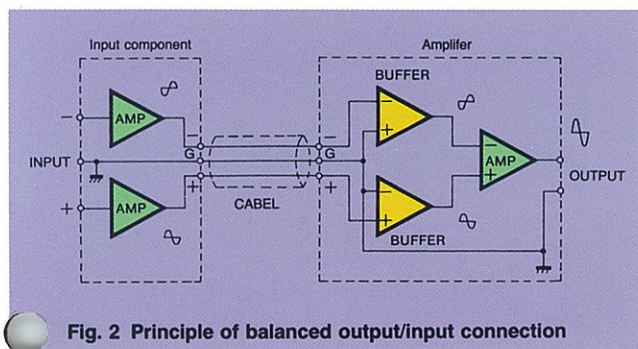
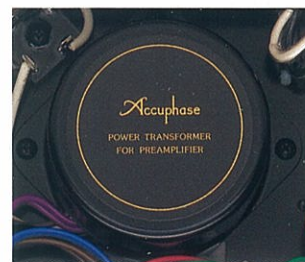
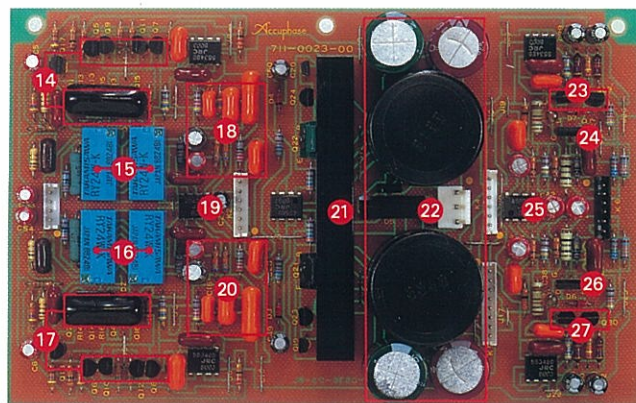
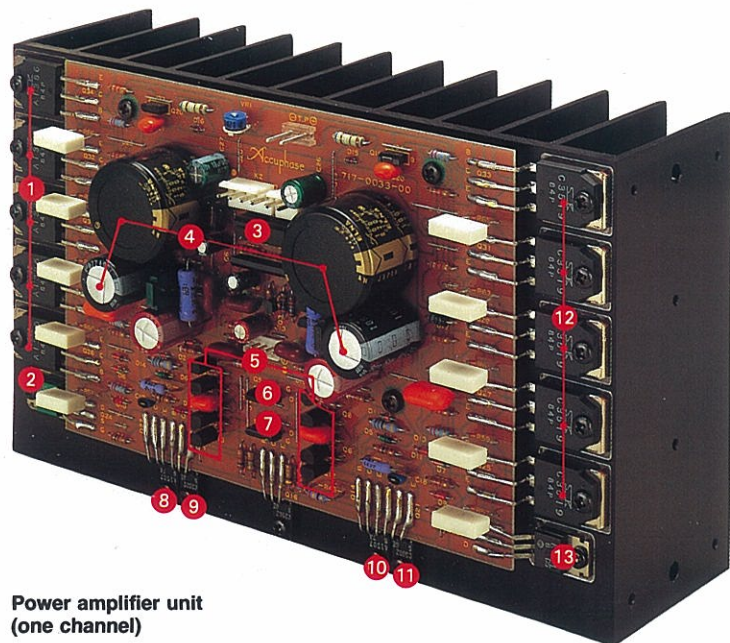


Fig. 2 Principle of balanced output/input connection



Printed circuit board of preamplifier section



Power amplifier unit (one channel)

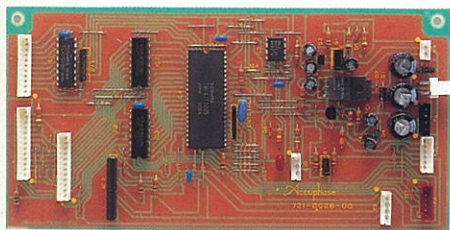
- 1 PNP output transistors
- 2 P-ch power MOS FET driver
- 3 High-speed rectifier diode for drive stage
- 4 Filter capacitors for drive stage power supply
- 5 Pure complementary push-pull input circuit transistors
- 6 One-chip P-ch dual FET
- 7 One-chip N-ch dual FET
- 8 Cascode driver transistor
- 9 Class A predrive transistor
- 10 Class A predrive transistor
- 11 Cascode driver transistor
- 12 NPN output transistors
- 13 N-ch power MOS FET driver
- 14 Input stage amplifier devices (left channel)
- 15 MM/MC switching relay (left channel)
- 16 MM/MC switching relay (right channel)
- 17 Input stage amplifier devices (right channel)
- 18 RIAA circuit devices (left channel)
- 19 DC servo IC
- 20 RIAA circuit devices (right channel)
- 21 Low-noise regulated power supply
- 22 Filter capacitors for power supply
- 23 Cascode transistor (left channel)
- 24 High-level input one-chip dual FET (left channel)
- 25 DC servo IC for high-level amplifier
- 26 High-level input one-chip dual FET (right channel)
- 27 Cascode transistor (right channel)

Supplied remote commander for enhanced convenience.

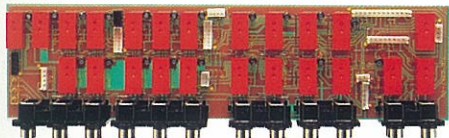
Accuphase E-405
INTEGRATED STEREO AMPLIFIER

4 Straight and Short Signal Paths with Logic Relay Control

Long signal paths for functions such as input switching and tape monitoring tend to degrade high-frequency response and impair imaging. In the E-405, all switching is performed by relays which are arranged so as to permit the shortest possible signal paths. These relays are controlled electronically by a logic circuit to assure accurate and precise operation.



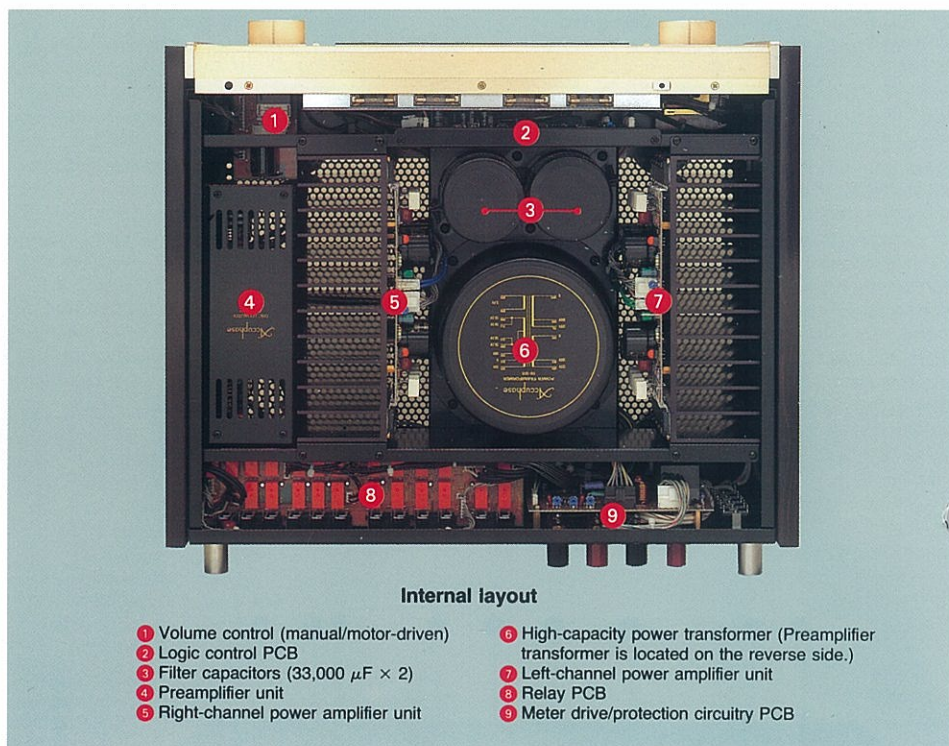
The quality of the relays themselves is, of course, very important. The units in the E-405 are specially developed for audio applications and have twin crossbar contacts plated with silver palladium alloy for minimum contact resistance and outstanding long-term reliability.



5 Remote Commander for Program Source Switching and Volume Control

With equipment such as CD players and video recorders, remote control is now almost taken for granted. The E-405 provides similar convenience, but with special regard to sound quality, because for Accuphase it would not do to sacrifice sonic purity for convenience. As the inputs of the preamplifier are switched using electronically controlled relays, operation of the logic circuits via the remote commander has no in-

fluence at all on sound quality. The volume adjustment is performed by a motor-driven manual potentiometer, as this ensures minimum degradation of signal quality.



Internal layout

- | | |
|---|--|
| 1 Volume control (manual/motor-driven) | 6 High-capacity power transformer (Preamplifier transformer is located on the reverse side.) |
| 2 Logic control PCB | 7 Left-channel power amplifier unit |
| 3 Filter capacitors (33,000 μ F $\times$ 2) | 8 Relay PCB |
| 4 Preamplifier unit | 9 Meter drive/protection circuitry PCB |
| 5 Right-channel power amplifier unit | |

6 Versatile Input and Output Configuration

The E-405 can easily accommodate a variety of program sources and it can also be used, for example, to switch and compare different audio components.

Inputs are provided for two tape recorders, one analog record player, two CD players, one tuner, and four additional line-level components, resulting in a total of ten inputs. Three sets of outputs and one headphone jack ensure versatility on the output side as well. The two balanced inputs (one for CD and one additional line input), and the balanced output use XLR type connectors. Selected input sources are shown by indicators below the power meters.

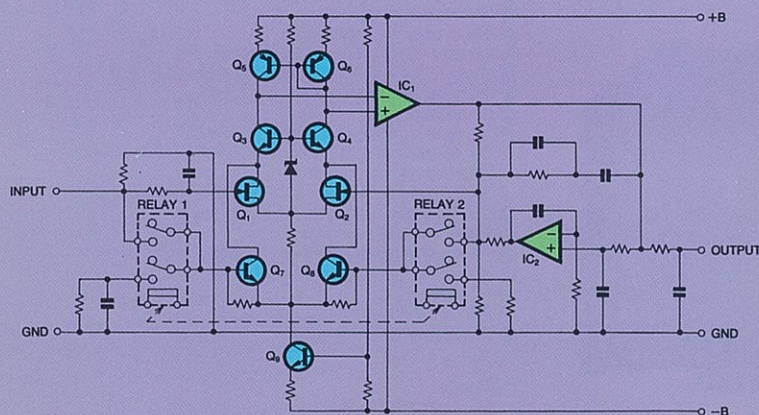


Fig. 3 Circuit diagram of equalizer amplifier

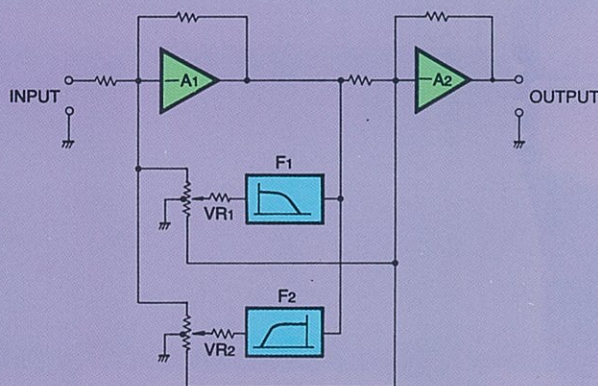


Fig. 4 Principle of tone control circuitry (summing active filter type)

7 Summing Tone Controls Designed for Optimum Sound Quality

In a high-quality component, a means for fine-tuning the sonic energy balance of program sources is sometimes highly desirable, but it, of course, would not do if such a circuit detracted from signal quality as such. The E-405 excels in this regard also, with a set of newly developed tone controls using the summing filter principle.

Consisting entirely of circuit components selected for their sonic performance, the tone controls introduce no deterioration whatsoever. Although not strictly necessary, an On/Off switch also lets you remove the controls entirely from the signal path when not desired.

The principle of this circuit is shown in Fig. 4. The flat signal passes straight through, and

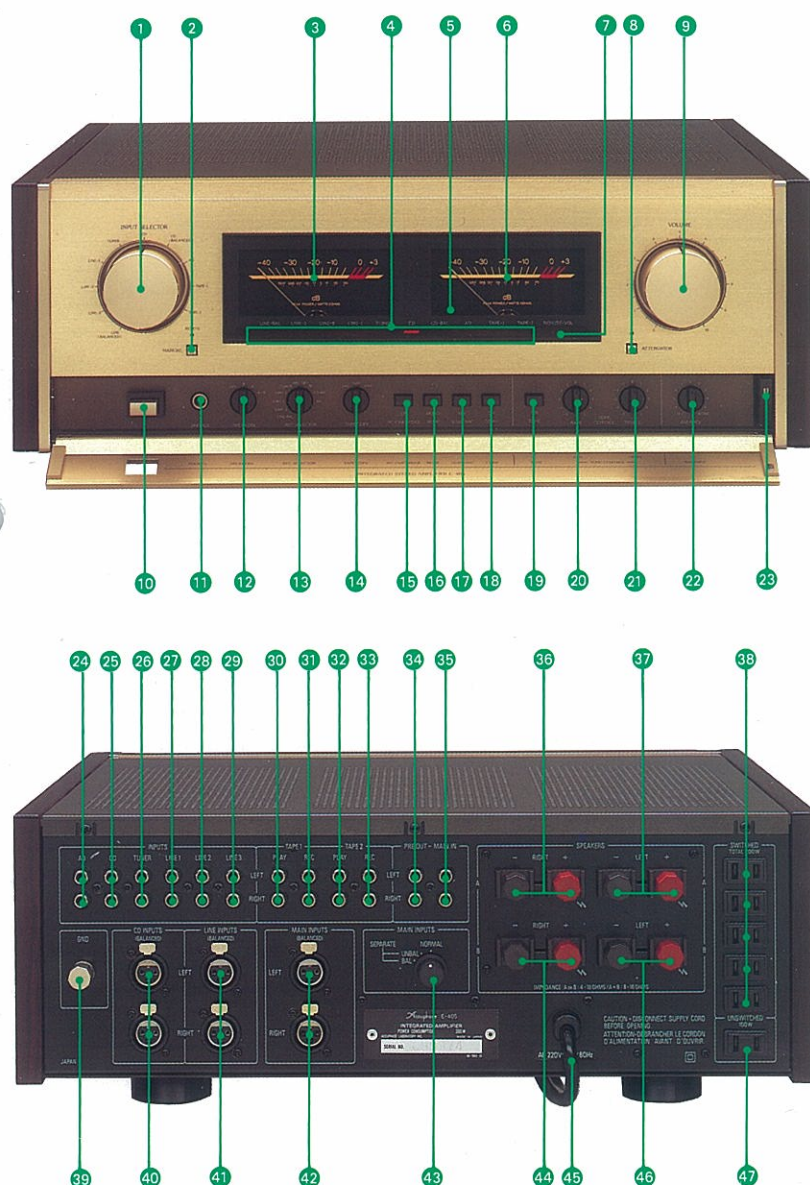
necessary characteristics are generated in F_1 and F_2 and added to the signal, thereby producing the desired change. This design provides efficient control without degrading signal purity.

8 Separate Recording Output Selector and Copy Switch

To make recording from various program sources easy, the E-405 provides a versatile and logical switching arrangement including a recording output selector which is independent of the program source selector. This lets you for example record an FM broadcast while listening to a CD. The copy switch permits easy dubbing between two connected tape recorders.

9 Other Features

Other useful controls and functions include a mode switch to combine the left and right channels, a subsonic filter to remove low-frequency noise during phono playback, a loudness compensator to augment the aural impression at low listening levels, and a headphone jack. All of these are arranged behind a hinged door in the lower section of the front panel, giving the unit an uncluttered appearance quite unusual for an integrated amplifier. The only controls visible in normal operation are the volume control, function selector, and attenuator switch. This design is a good example of intelligent human engineering.



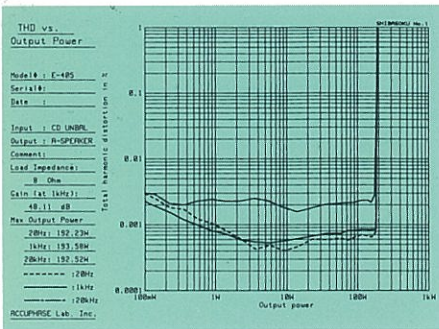
- 1 Input selector: LINE(BALANCED), LINE-3, LINE-2, LINE-1, TUNER, CD, CD (BALANCED), AD, TAPE-1, TAPE-2
- 2 Remote commander priority release button
- 3 Left-channel peak indicating power meter (dB- and wattage-scales)
- 4 Input position display LED
- 5 Remote sensor
- 6 Right-channel peak indicating power meter (dB- and wattage-scales)
- 7 Remote volume indicator (when the remote commander is used)
- 8 Attenuator
- 9 Volume control
- 10 Power switch
- 11 Output jack for headphones
- 12 Speaker selector switch: OFF, A, B, A+B
- 13 Recording output selector: LINE-BAL, LINE-3, LINE-2, LINE-1, TUNER, REC OFF, CD, CD-BAL, AD
- 14 Tape copy switch: 1→2, OFF, 2→1
- 15 MC (moving coil) cartridge ON/OFF switch: ON (MC), OFF
- 16 Mode selector switch
- 17 Subsonic filter switch: 17Hz, -12dB/oct
- 18 Compensator switch
- 19 Tone control ON/OFF switch
- 20 Bass control
- 21 Treble control
- 22 Balance control
- 23 Sub-panel magnet lock
- 24 Analog player input jacks
- 25 High-level CD input jacks (unbalanced type)
- 26 Tuner input jacks
- 27 LINE-1 input jacks
- 28 LINE-2 input jacks
- 29 LINE-3 input jacks
- 30 TAPE-1 tape recorder playback jacks
- 31 TAPE-1 tape recorder recording jacks
- 32 TAPE-2 tape recorder playback jacks
- 33 TAPE-2 tape recorder recording jacks
- 34 Preamplifier output jacks
- 35 Power amplifier input jacks
- 36 Speaker A right-channel output jacks
- 37 Speaker A left-channel output jacks
- 38 Switched AC power outlets*
- 39 Ground terminal
- 40 CD input connectors for balanced inputs
The equivalent of XLR-3-31; 1: GROUND; 2: inverted; 3: Not-inverted
- 41 The suitable connectors: XLR-3-12C or the equivalent
- 42 Line input connectors for balanced inputs
- 43 Power amplifier balanced inputs
- 44 Preamplifier/power amplifier separator switch
- 45 Speaker B right-channel output jacks
- 46 AC power cord
- 47 Speaker B left-channel output jacks
- 48 Unswitched AC power outlet*

Remarks:

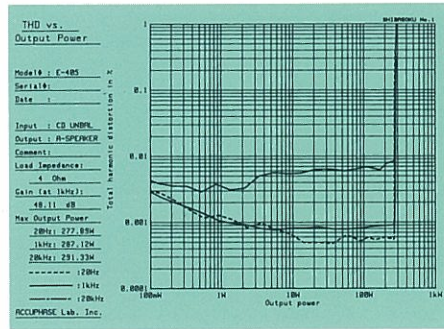
* These SWITCHED and UNSWITCHED outlets may not be supplied depending on the safety standards or regulations applicable in the particular country to where the unit is destined.

Accuphase E-405

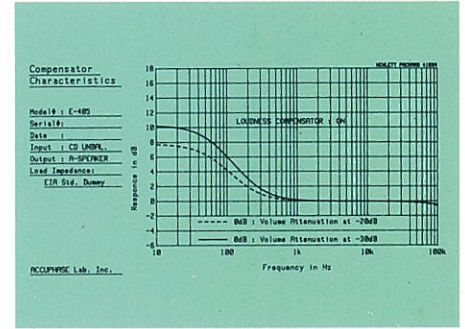
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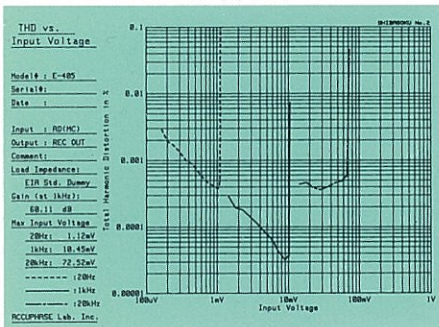
● Power output vs. THD (8-ohm load)



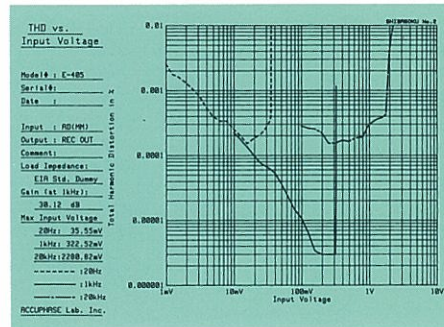
● Power output vs. THD (4-ohm load)



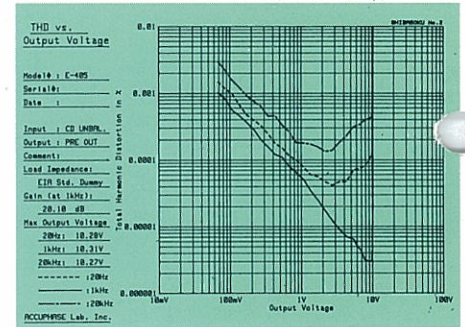
● Compensator characteristics



● Input voltage vs. THD (input: MC, output: tape output)



● Input voltage vs. THD (input: MM, output: tape output)



● Output voltage vs. THD (input: CD unbalanced, output: pre out)

GUARANTY SPECIFICATIONS (Guaranty specifications are measured according to EIA standard RS-490. AD denotes Analog Disc input.)

Performance Guaranty:

All Accuphase product specifications are guaranteed as stated.

● Continuous Average Power Output

250 watts per channel into 4 ohms
170 watts per channel into 8 ohms
(Both channels driven, 20 to 20,000Hz, 0.02% THD)

● Total Harmonic Distortion

0.02% with 4 to 16 ohms load (both channels driven,
0.25W to continuous average power output, 20 to 20,000Hz)

● Intermodulation Distortion

0.01%

● Frequency Response

MAIN INPUT: 20~20,000Hz, +0, -0.2dB
(for rated output)
0.5~150,000Hz, +0, -3.0dB
(for 1-watt output)

HIGH LEVEL INPUT: 20~20,000Hz, +0, -0.2dB
(for rated output)

LOW LEVEL INPUT: 20~20,000Hz, +0.2, -0.5dB
(for rated output)

● Input Sensitivity and Input Impedance

Input	Sensitivity		Input impedance
	For rated output	EIA (1W-output)	
AD INPUT (MC)	0.14mV	0.011mV	100Ω
AD INPUT (MM)	4.38mV	0.335mV	47kΩ
HIGH LEVEL INPUT	143mV	10.8mV	20kΩ
BALANCED INPUT	143mV	10.8mV	40kΩ
MAIN INPUT (UNBAL)	1.47V	110mV	20kΩ
MAIN INPUT (BAL)	1.47V	110mV	40kΩ

● Damping Factor

150 (8 ohms load, 50Hz)

● Maximum AD Input Level (1kHz, 0.005% THD)

MM INPUT: 300mVrms (REC OUT)

MC INPUT: 9.5mVrms (REC OUT)

● Rated Output Level and Impedance

PRE OUTPUT: 1.47V at 200Ω

TAPE REC OUTPUT: 143mV at 200Ω (AD source)

HEADPHONES: 0.36V (Suitable load impedance: 4 to 100 ohms)

● Gain

MAIN INPUT → OUTPUT : 28dB

HIGH LEVEL INPUT → PRE OUTPUT : 20dB

AD INPUT (MM) → TAPE REC OUTPUT : 30dB

AD INPUT (MC) → TAPE REC OUTPUT : 60dB

● Tone Controls

Turnover frequency and adjustment range

BASS: 300Hz ±10dB (50Hz)

TREBLE: 3kHz ±10dB (20kHz)

● Loudness Compensator Characteristics

+6dB (100Hz) at volume setting -30dB

● Signal-to-Noise Ratio

Input	Rated input (A-weighting)	EIA
MAIN INPUT	124dB	102dB
HIGH LEVEL INPUT	110dB	83dB
BALANCED INPUT	98dB	83dB
AD INPUT (MM)	89dB	80dB
AD INPUT (MC)	74dB	78dB

● Subsonic Filter Characteristics

Cutoff frequency: 17Hz, -12dB/oct.

● Attenuator Characteristics

-20dB

● Power Level Meter

Peak level indication, calibrated to read 0dB when amplifier produces 170 watts into 8-ohm load.

● Output Load Impedance

4 to 16 ohms

● Semiconductor Complement

85 transistors, 22 FETs, 30 ICs, 65 diodes

● Power Requirements

100V, 117V, 220V, 240V AC, 50/60Hz

● Power Consumption

90 watts idle

390 watts in accordance with ICE-65

● Dimensions

Width 475mm (18-11/16"), Height 180mm (7-1/16") max

Depth 375mm (14-3/4")

● Weight

25kg (55.1 lbs.) net

30.6kg (67.5 lbs.) in shipping carton

● Supplied Remote Commander RC-3

Remote control principle: infrared pulse

Power supply: 3V DC (IEC R6 batteries×2)

Dimensions: Width 64mm (2-1/2"), Height 149mm (5-7/8"),

Depth 18mm (11/16")

Weight: 140g (0.3 lbs.) (including batteries)

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