

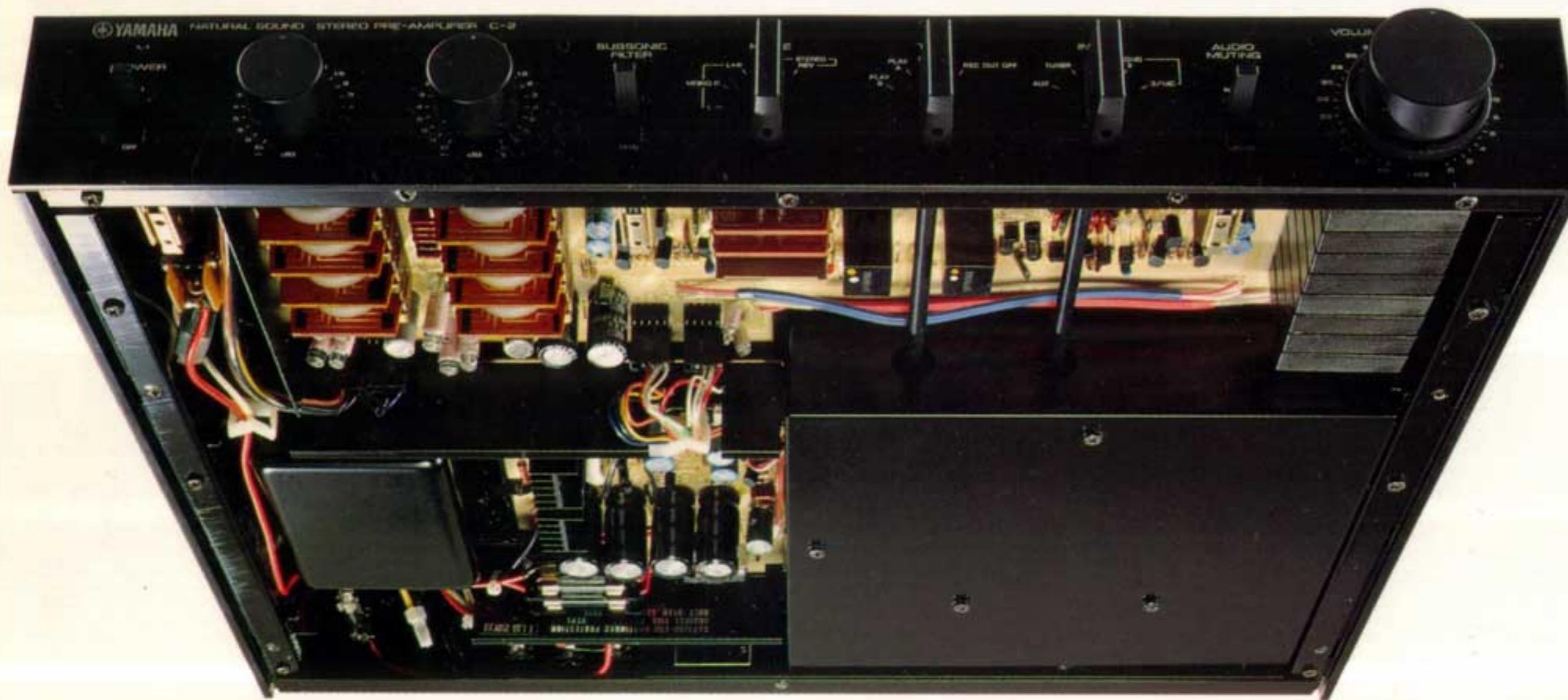
THE C-2 PRE- AMPLIFIER OWNER'S MANUAL

*Everything You Need to Know
for Operation of
this Technically Sophisticated
and Aurally
Satisfying Precision
Audio Component*

C-2

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YAMAHA offers you thanks and congratulations on your choice of the C-2 preamplifier. Product of research directed at the ultimate in audio quality, based on a unique combination of sophisticated circuitry and advanced FET manufacturing know-how, the C-2 is currently setting the standards by which the 'State-of-the-Art' is judged.



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ABOUT THIS MANUAL

The C-2 is an advanced and sophisticated precision instrument. This owner's manual is required reading if you are to understand all that the C-2 has to offer for your greater listening pleasure. Although style, functions, and controls have been designed for the utmost simplicity and ease in use, they will still require familiarization before you can feel fully at home with them. By all means use this manual to speed your mastery of the C-2 preamplifier.

BEFORE YOU SWITCH ON

You are probably anxious to connect up the C-2. Skip straight to pages 8 and 9 for the names of the control functions and the location of connections. Full details for connecting and operating the C-2 preamplifier are on pages 12 to 14.

After you have heard for yourself the superb quality of which it is capable, browse through the next few pages to learn the how and why of the top performance, and meet the other members of the YAMAHA top quality line.

For the more technically minded, performance graphs and full circuit details are given in pages 15 to 21. Read this manual carefully and thoroughly to ensure that you get the fullest possible enjoyment from your C-2 preamplifier. Be sure to keep it in a safe place for future reference.

NOW A WORD OF WARNING

The following simple precautions will help to ensure that your C-2 preamplifier gives you the long years of trouble-free service of which it is capable.

1. Do not drop or otherwise jar the C-2, which is a precision instrument.
2. Do not mount the C-2 where it will be exposed to direct sunlight, excessive heat, moisture, or dust.
3. Do not mount directly on top of other electrical equipment likely to generate heat (the B-1, B-2, or other power amplifier, etc.)
4. Do not use chemical solvents (such as benzene or alcohol) to remove traces of dirt. Wipe only with a soft, slightly damp cloth.
5. Do not attempt to carry out internal adjustments or repairs. Leave this to your local service representative.
6. Do read the special CAUTIONS on page 10.

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B-1 OR B-2? THE CHOICE IS YOURS

ALL-FET BASIC 150-WATT AMPLIFIER OR 100-WATT FET POWER AMPLIFIER

The smooth, quiet and faithful reproduction given by the C-2 is such an advance that it can reveal new delights in long-familiar favorite program sources with your other existing audio components. But if power amplifier performance is the limiting factor in your equipment, YAMAHA offers two superb power amplifiers, either of which will combine with the C-2 preamplifier to give audio quality literally a whole order of magnitude better than most competitive equipment.

With every stage of the signal path handled by field-effect transistors (FETs) specially developed by YAMAHA's Semiconductor Division, the B-1 offers superb performance specifications with a full 150 Watts rms power per channel, both channels driven, from 20Hz to 20kHz with 0.1% total harmonic distortion, into 4 or 8-ohm speakers.

The world's first basic power amplifier with all-FET signal path, it has won enthusiastic reviews and delighted owner reactions for the uncolored, wholly natural reproduction, and the tremendous sense of power, particularly in the low bass fre-



quencies, which the unique FET circuitry gives. It has outstanding stability, and in every performance category (signal-to-noise ratio, power bandwidth, frequency response, etc.) it represents the ultimate in current state-of-the-art amplifier design.

The optional UC-I control unit offers switched selection of up to five sets of speaker systems, with wide scale peak level meters (reading from 0.001 Watt to 300 Watt B-1 output into 8-ohm speakers in one, unswitched range). Remote control of all B-1 functions is possible up to 5 meters away (over 16 feet) with the RU-I remote control unit.

Externally similar to the B-1/UC-I, the B-2 also makes use of YAMAHA vertical FETs to give exceptional performance. YAMAHA engineers completely re-thought conventional amplifier design, developed novel circuits which could lift performance to new highs, and then set to work to

develop the FETs and other circuit elements which would meet the severe requirement imposed. The result is a DC amplifier (with frequency response flat to DC or 0 Hz) which gives almost incredibly low distortion at normal listening levels (0.008% THD from 20Hz to 20kHz for all output powers from 1 Watt to 60 Watts) and only 0.08% for rated maximum power of 100 Watts rms per channel, both channels driven, 20Hz to 20kHz, into 8 ohms.

The same meters as provided in the UC-I unit, with peak response so fast that a single sine-wave cycle at 10kHz can be read within -2dB, are built into the B-2, which also features switched inputs, outputs, and independent speaker level settings. External metering is also possible, so that the B-2 meters can display your C-2 output. Stability and overall audio quality match the exceptionally good S/N figure (115dB IHF-A). Slew-rate, waveform fidelity and phase deviation all set new standards for the state-of-the-art.

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INTRODUCING OTHER TOP-OF-THE-LINE YAMAHA PRODUCTS



Ideal for the C-2 plus B-I or B-2 are the three-way NS-1000 and NS-1000M (for monitor) speaker systems. Both de luxe ebony and professional all-black monitor cabinets form matched symmetrical stereo pairs.

Mid-range and high frequency drivers feature beryllium domes only 30 microns thick, produced by YAMAHA-developed vapor-deposition technology. Mastery of beryllium, previously dismissed as virtually unworkable, has made this exceptionally light and strong metal available for a new generation of YAMAHA speakers.

The result has been to give these speakers outstandingly even diffusion of sound and an excellent transient response that comes from ultra-light dome structures. With massive power-handling capacity and correspondingly rapid heat dispersion, and a wide, flat response, the open and unforced clarity of reproduction is perfectly balanced by dynamic transients and an impressive sense of scale.



The smooth uncluttered lines of the CT-7000 tuner give little hint of the technical sophistication hidden within it. Designed to combine the ultimate in radio reception performance with strictly comparable audio quality, it shares with the B-I, B-2, C-2 and C-I the honor of setting the standards by which the state-of-the-art is judged.

Low distortion is one important theme: the choice of wide or narrow selectivity enables local stations (on 'wide') to be received with only 0.04% harmonic distortion.

Phase-locked loop plus negative feedback, direct metering of multipath signal levels, adjustable muting levels, Auto Blend function for optimum S/N ratios with all signal strengths, and AFC which cuts out when you touch the tuning knob, are some of the unusual features of this highly sensitive and stable tuner. Most important of all is the superb audio quality.



This, the YAMAHA top performer in the reproduction of recorded discs, features direct drive by high precision DC servomotor. Motor rpm are low, and the small number of moving parts (no idler pulley or belt) means less to go wrong or wear out, so full performance specifications should be preserved throughout a long service life. A mere 10 Watts drives the motor, so little energy is wasted in potentially harmful heat and vibration.

Discreet stroboscopic indication of speeds (each individually adjustable) with wow and flutter levels more like a professional disc-cutter than a turntable unit make the YP-800 a pleasure to use.

The sensitivity of the S-type static-balance arm is so high that perfect tracking is possible with the latest high compliance cartridges. Full anti-skating inside force cancellation is provided, and both headshell cartridge contacts and pin plugs are gold plated to give low contact resistance. A superb unit. The YP-800.

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THE DEVELOPMENT OF THE C-2 PREAMPLIFIER

A MAJOR STEP NEARER THE IDEAL PREAMPLIFIER

YAMAHA's aim for the C-2 was a major advance in preamplifier performance, with higher signal-to-noise ratio, lower distortion, and better overall audio quality than anything currently available, combining this superior performance with the ultimate in refined simplicity of operational control functions.

That obviously meant completely re-thinking conventional preamplifier design, and resulted in the C-2, probably unique in the combination of super-sophisticated circuitry, second generation vertical FETs in mirror-image super pairs, and the honed-down simplicity of basic preamplifier functions from which every non-essential element has been eliminated.

Design, too, is a reflection of the simple elegance of the advanced electronics and outstanding audio quality which the C-2 offers. Slim, with clean, uncluttered lines, the C-2 is a real 'Black Beauty.'

It takes a very high degree of achievement to make the lack of anything attractive, but the uncolored reproduction of the C-2 has all the attraction of plate-glass window: displaying all the beauties that lie behind it. In the same way the C-2 lets the music sound for itself, in all its inherent beauty, with virtually no noise or distortion to get in the way.

VERTICAL FET SUPER-PAIRS

YAMAHA ability to control precisely the purity of the silicon used in FETs, and the inherent superiority of the vertical FET as an audio amplifier device, enabled development of FETs with excellent linearity, in perfectly matched N- and P-channel pairs, literally custom-built for the special C-2 circuits, and with ultra-low noise.

High linearity means faithful amplifier response from the lowest to extremely high levels, with lower inherent distortion, reduced negative feedback, and correspondingly improved dynamic performance.

Super-accurate matching of FET pairs which are virtually perfect mirror images of each other, is essential if the full advantages are to be gained from complementary circuits. The YAMAHA super pairs greatly improve circuit symmetry, for reduced crossover and harmonic distortion. The improvement is particularly evident at low listening levels where, with the extremely low noise levels, reproduction remains sweet and true down to a whisper against a silent background.

The new FETs are used in both equalizer and tone-control circuits, where they make the critical contribution to improved performance. The MC cartridge head amp. is a specially developed YAMAHA IC with S/N of 70dB for a rated 0.05mV input.

NEW SUPER CIRCUITS

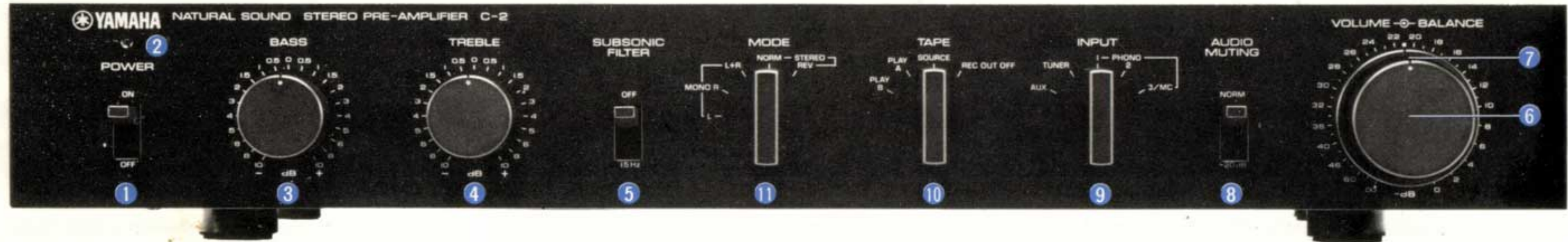
YAMAHA's experience in developing the circuits to exploit the unique advantages of the FETs used in the C-1 and B-1 amplifiers is one secret of the unique C-2 circuit design. With the C-2, however, the circuits came first: then the best components were chosen for each circuit function, with FETs specially developed for the purpose playing the most important role.

The equalizer uses YAMAHA original super low-noise paired FETs in a cascode-bootstrap/current-mirror configuration differential amplifier input stage. This eliminates the distortion which can arise from changes in input impedance. The following constant current grounded-emitter Darlington amplifier and fully complementary parallel push-pull class A output stage ensure low inherent distortion, correspondingly reduced need for NFB, and overall distortion from PHONO input to PRE OUT better than 0.003%, 20Hz to 20kHz.

Negative feedback type tone controls have true tone defeat zero settings, eliminating all tone-control generated distortion when tonal correction is unnecessary. Volume control is designed to improve S/N ratio at low listening levels, and very high maximum output levels are possible with low load impedance.

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FRONT PANEL AND CONTROLS



1 POWER ON/OFF Switch

Switch ON to connect main electrical supply. The C-2 will remain silent for a few seconds while the muting relay isolates PRE OUT and REC OUT terminals from unwanted shock noise.

2 POWER LED Indicator

This illuminates when the POWER switch is ON and the main supply connected, unless the power fuse has blown.

3 BASS Tone Control

This 21-position, 20-step switch offers extremely precise and delicate control of bass frequency response, with a 350 Hz turnover frequency. The figures indicate dB of lift or cut at the 50 Hz reference frequency.

4 TREBLE Tone Control

Similar to the BASS tone control, this control has a 3.5 kHz turnover frequency, and the figures indicate dB of lift or cut at the 20 kHz reference fre-

quency. The zero ('0') setting for both TREBLE and BASS controls is a full tone-defeat position.

5 SUBSONIC FILTER OFF/15 Hz

This cuts frequencies below 15 Hz, which can swamp power amplifiers and speakers without contributing to musical enjoyment, at 12 dB/octave.

6 VOLUME Control

Turning this control counter-clockwise from the maximum ('0') position gives the indicated degree of output signal attenuation. Control is continuous, and the degree of attenuation extremely accurate over the whole range.

7 BALANCE Control

The knurled ring around the VOLUME control is the BALANCE control, which determines the relative volume of L and R channels. Normally set with the indentation beneath the white central dot, it is used to achieve the correct stereo balance between channels by turning to L or R.

8 AUDIO MUTING NORM/−20 dB

This offers a straight 20 dB reduction in signal level without having to adjust the volume control.

9 INPUT Selector Switch

This switch selects either AUX, TUNER, PHONO 1 and 2 (for MM cartridges) or PHONO 3 (for low output level MC cartridges) as program source.

10 TAPE Selector Switch

This switch selects the playback output from either of two tape decks (A or B). In the SOURCE position, the program source selected by the INPUT selector can be auditioned while recording is in progress. At the REC OUT OFF position, tape deck A and B recording terminals are isolated from the C-2 program signal.

11 MODE Selector Switch

This offers the choice of either L or R channel reproduction only, L + R (monaural), and reversal of L and R channels in addition to the normal stereo mode.

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REAR PANEL AND CONNECTIONS



1 INPUT Terminals

These are the terminals to which the sources selected by the INPUT Selector should be connected, including PHONO 1, 2, and 3 (MC), TUNER, and AUX. Note that the left channel sockets are uppermost. Blind or 'keeper' short-circuit plugs are provided with the C-2. Use them to blank off unused INPUT terminals of this group.

2 GND (Ground) Terminals

Two heavy-duty terminals are provided for effective grounding of the C-2. Under NO CIRCUMSTANCES should the common or ground terminal from a power amplifier output be connected to these terminals.

3 TAPE A/B PB and REC OUT Terminals

A total of two tape decks can be attached to these input and output terminals. When the TAPE selector switch on the front panel is set at REC OUT

OFF, the C-2 output will be completely isolated from the tape recorders, so that any possible influence from tape-deck input impedances is completely eliminated while recording is not actually taking place.

4 PRE OUT 1/2 Terminals

Two pairs of output terminals are provided, for connection to a second power amplifier, or for passage via a frequency dividing network for multi-amplifier configurations or, with the B-2 power amplifier, for level measurement by external meters. The terminals are in parallel, and both carry the same signal.

5 Spare AC OUTLETS (SWITCHED and UNSWITCHED)

Units with moderate electrical power consumption, such as turntables, tuners, etc., can receive their main power supply via the spare electrical AC

OUTLET sockets at the rear of the C-2. The two SWITCHED sockets can only supply a total of 100 Watts, and the one UNSWITCHED socket only 400 Watts maximum.

Do NOT exceed these figures. Note that some C-2 models (in certain areas) have no spare AC outlets.

6 AC Electrical Power Line

The electrical power line will have been provided with the type of plug used in your area, and your dealer will confirm that the voltage of your local supply is suitable. Just plug in to normal domestic AC supply outlets or, since power demand is small, to the spare AC outlet on a power amplifier or other piece of audio equipment.

7 Angled Supporting Feet

The special hinged feet under the C-2, near the front panel, can be swung out to support the C-2 at a slight angle for easier visibility and control operation in certain locations. Please make use of them if you feel them appropriate in your situation. (See page 14.)

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CAUTION — READ THIS BEFORE OPERATING YOUR C-2 PREAMPLIFIER

- 1 Note that the muting circuit keeps the C-2 silent for several seconds after switching ON, to prevent the pops and clicks that can sometimes occur.
- 2 Only connect units which have modest power requirements, such as tuners and turntable units, to the spare AC power outlets on the rear panel of the C-2. Connect high output power amplifiers like the B-1 and B-2 to their own main electrical supply outlets. Ensure that the total power demand of all units connected to the spare sockets does not exceed the maximum permitted level.
- 3 Ensure that a good GND (ground) connection is made. This should NEVER be connected to the ground or common terminal of the speaker (output stage) of a power amplifier.
- 4 Always check the main VOLUME setting before returning the AUDIO MUTING switch to NORMAL. The sudden increase in level is enough to damage some speakers with high output power amplifiers if the initial level was too high. If in doubt, turn the VOLUME well down.
- 5 The pin plugs inserted into the INPUT sockets are shorting plugs intended to reduce noise levels in the input circuits. They should only be removed while the inputs are actually in use.
- 6 The shorting pin plugs should NEVER be inserted into the REC OUT or PRE OUT terminals.
- 7 Always switch the POWER OFF and disconnect all terminals if the C-2 is to be relocated. If any length of journey is involved, the C-2 should be carefully packed to protect it against undue impact damage. If the original packing has been retained, it will be ideal for the purpose.
- 8 Observe the cautions on mounting location inside the front cover of this manual: nowhere hot, dirty or wet, nor in the direct rays of the sun.

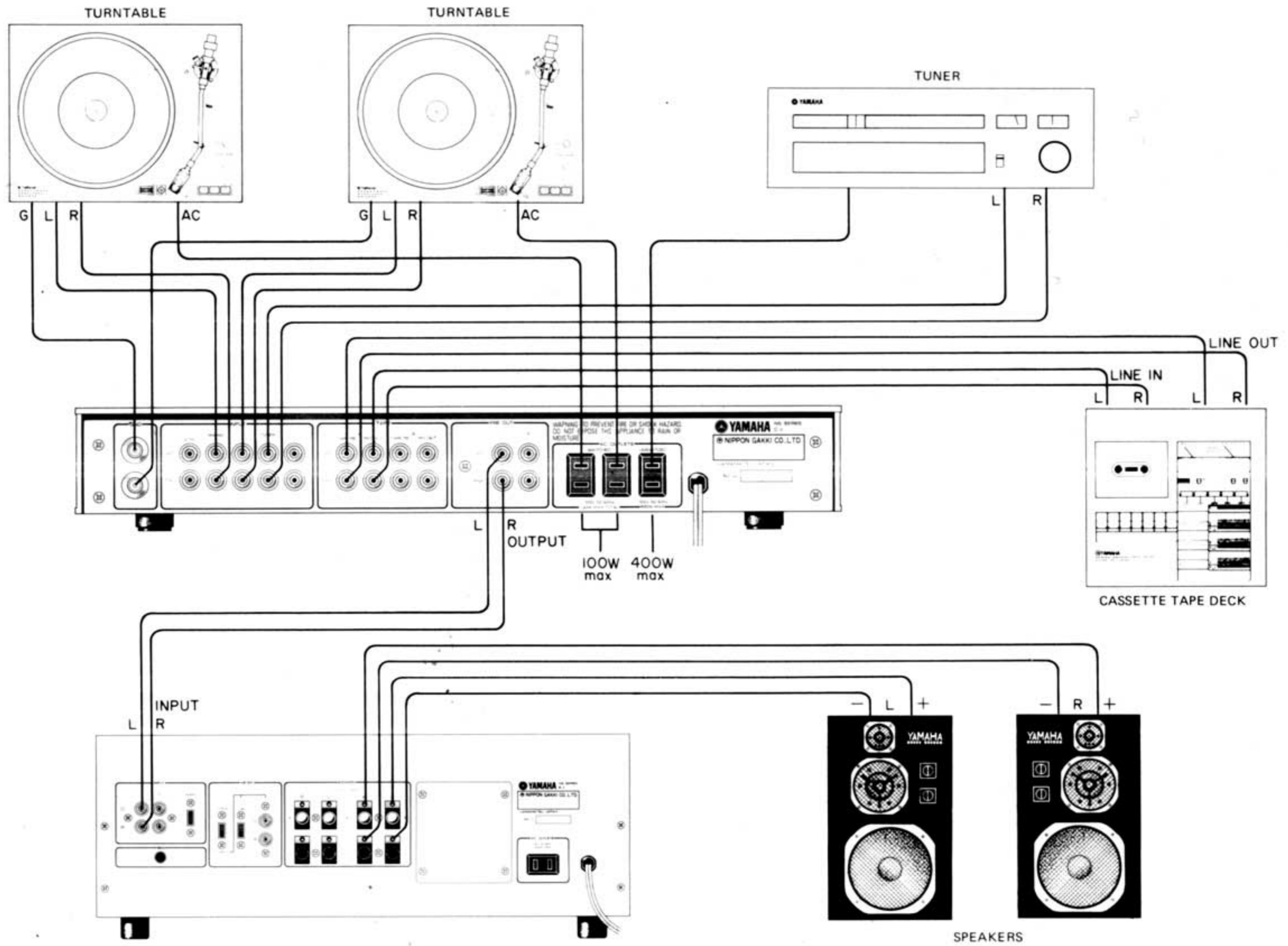
C-2

THE SUPERB C-2 PREAMPLIFIER



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CONNECTING AND OPERATING THE C-2 WITH OTHER COMPONENTS



CONNECTING THE POWER SUPPLY

The fairly low power demand of the C-2 means that it can be plugged into the spare AC outlet of another item of audio equipment, if one is provided. Before connecting yet further items of equipment to the C-2 spare outlet sockets in this case, however, check that the total power required exceeds NEITHER the maximum for the C-2 NOR for the unit from which the C-2 is supplied.

ALWAYS ensure that the main POWER switch is OFF before plugging into a power supply socket.

CONNECTING A POWER AMPLIFIER

The input terminals on the power amplifier may be connected to the PRE OUT terminals 1 or 2 via standard pin-plug cables. The provision of two sets of output terminals means that two power amplifiers can be connected, although the power amplifier switches will have to be used to select which output is amplified: the C-2 has no output switch.

Note CAREFULLY the following points:

1. Connections must always be made with the POWER switch OFF.
2. Care should be taken not to reverse the L and R channel connections.
3. The C-2 GND (ground) terminals must NOT be used to connect the ground (common) terminals for the output of a power amplifier.

CONNECTING AND OPERATING VARIOUS AUDIO COMPONENTS

Where your C-2 is provided with spare rear panel AC outlets, use these to plug in the components to be used. The switched outlets should be used for turntable units and tuners, etc., which are used frequently. In this way you will turn them on and off with the C-2, with no chance of forgetting to switch off afterwards. Do NOT connect your power amplifier to spare outlet sockets.

CONNECTING A TURNTABLE AND TONE-ARM UNIT

First check whether your turntable unit is fitted with a moving magnet (MM) or low output moving coil (MC) cartridge. If the former (and this includes so-called IM and VR types – your dealer will advise you) use either PHONO 1 or 2 inputs. If the latter, use PHONO 3. Use the shorting plugs to short the terminals not in use. Check that the L and R pin plugs have been correctly and firmly inserted. Do not forget to connect the turntable ground line to one of the GND terminals on the C-2.

RECORD REPRODUCTION

Turn the POWER switch ON and note that the power indicator lamp illuminates to check that the electrical power supply is connected. The BASS and TREBLE tone controls and BALANCE controls should be in the mid-position, and the VOLUME at minimum ($-\infty$). Turn the SELECTOR switch to the PHONO position corresponding to the input terminals to which the turntable unit has been connected. Lower the cartridge stylus onto the record, and gradually raise the VOLUME control.

The MODE switch will enable you to hear a stereophonic recording monaurally, and to reverse the two stereo channels, etc. Make use of the MUTING switch to cut the volume instantly by 20dB while changing records or altering the SELECTOR switch, without having to turn down the VOLUME each time.

LISTENING TO A TUNER

Connect the tuner output to the TUNER input terminals with a standard pin-plug to pin-plug connecting cable. If more than one tuner is to be connected, the AUX terminals can be used. Level adjustment should be made, if the tuner has an output level control, so that there are no sudden changes in volume when switching from PHONO to TUNER or vice versa.

TAPE DECK PLAYBACK/RECORDING

Pin-plug to pin-plug connecting cables are normally provided with tape decks. Use one cable to connect the tape deck LINE OUT terminals to the TAPE PB terminals on the rear panel of the C-2. Use the A terminals, and keep the B terminals for a second deck as needed. Be careful to insert the L and R plugs correctly. The TAPE selector switch will select which tape deck is heard.

For recording, use a cable to connect tape deck LINE IN terminals to the REC OUT terminals on the C-2. Both A and B terminals carry the same signal (the source signal selected by the INPUT selector).

If a three-head tape recorder is used, the recording can be monitored while it is in progress and compared directly with the source by switching the TAPE selector between SOURCE and TAPE A (or B). Most open-reel decks have three heads, but very few cassette decks do.

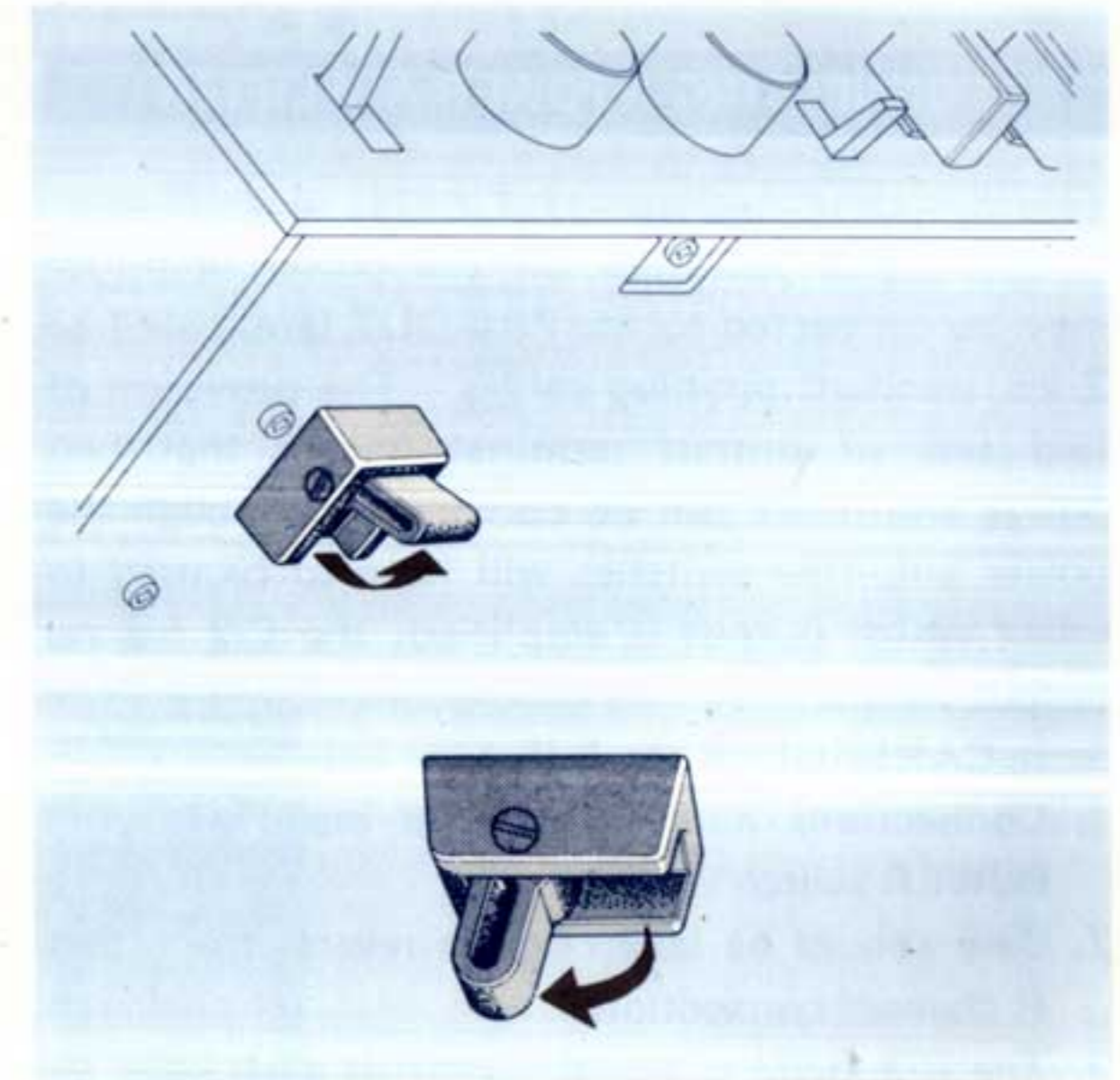
With the TAPE selector at REC OUT OFF, no signal is supplied to the REC OUT terminals, which are completely isolated from the C-2, eliminating any possible effect of tape deck impedance upon the C-2 output to the power amplifier, etc. This switch should be left in the REC OUT OFF position when recordings are not actually being made, as long as the tape deck remains connected.

tone controls and RIAA curve compensation

No separate tone defeat switch is provided in the C-2, but the zero ('0') center position on BASS and TREBLE tone controls has the same effect: with both controls in this position the C-2 functions as a flat amplifier. The provision of the extremely fine gradations of tone control (± 0.5 , ± 1 , and ± 1.5 dB) in addition to the more usual broader settings is useful in giving subtle compensation for individual phono cartridge characteristics, functioning to lift or depress response by exactly the amount selected, and effectively shifting the RIAA compensation curve.

ANGLED SUPPORTING FEET

In certain locations it is convenient to be able to angle the control facia panel of the C-2 slightly upwards for greater accessibility and visibility. The special hinged feet under the C-2, near the front panel (see the illustration below), can be swung out to support the C-2 at a slight angle. Please make use of them if you feel they help in your situation. Note that nothing should be placed on top of the C-2 when it is in the tilted position, particularly not a power amplifier.



THE NEW C-2 VERTICAL FETS

The novel circuitry chosen for the C-2 imposed severe conditions upon the semiconductors to be used. The super low-noise paired vertical FETs used in the differential amplifier stages of the C-2 were specially developed in order to satisfy the rigorous requirements. It is widely recognised that the characteristics of semiconductors display considerable variation, and it is far from simple even to obtain closely matched elements of the same polarity. YAMAHA investigated exhaustively the chip size of P-channel and N-channel devices, the impurity levels, and gate-mesh structure, etc., and established rigorous production controls, to achieve a wide operational range over which paired characteristics could be obtained. A final special stage of pair selection eventually yields the super-pair FETs used. Among the advantages of these pairs are:

- Good complementarity
- Good linearity over a wide operating range
- Excellent matching of the paired characteristics
- Extremely low intrinsic noise levels
- Single package construction ensures identical temperature-dependent effects.

The technology required to develop and exploit FETs with these characteristics includes the ability to design the devices, to translate them into practical terms, to manufacture them, and particularly to grow high purity epitaxial layers of adequate depth.

EQUALIZER CIRCUIT

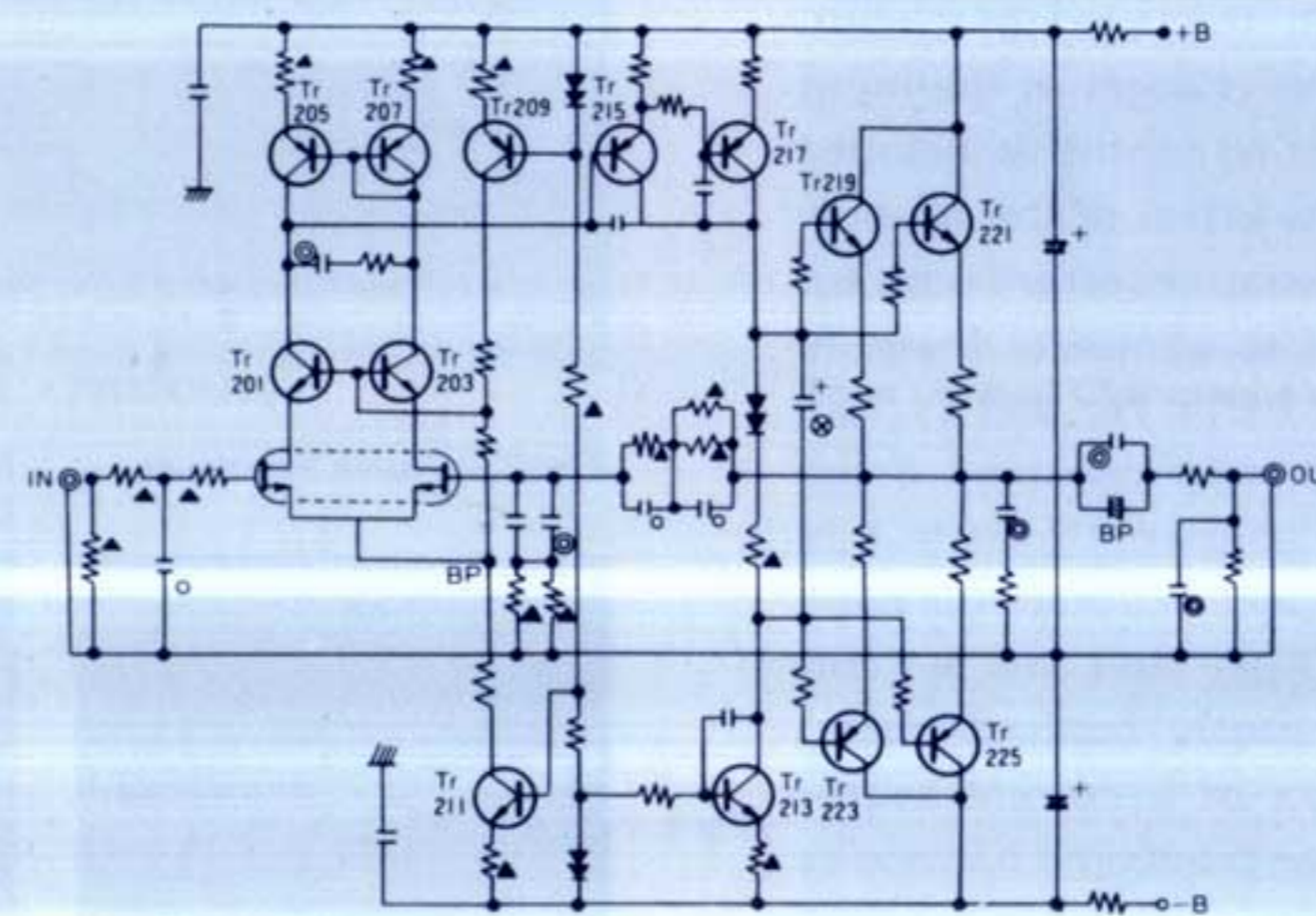
The equalizer amplifier uses YAMAHA original super low-noise paired FETs in a circuit configuration of the kind more often expected in power amplifiers. It features the paired FETs in the cascode-bootstrap/current mirror differential amplifier input stage, followed by constant current grounded-emitter Darlington amplifier, and fully complementary parallel push-pull class A output stage.

In considering S/N figures for amplifiers, we should remember that the commonly used ratio expresses the noise level in dB below rated output. This, however, is not strictly comparable for all amplifiers: a high gain amplifier will necessarily

suffer from higher output noise levels. What is needed is a re-statement of the output noise in terms of the input level which would take care of the effect of amplifier gain. Such a calculation for conventional equalizer circuits typically gives values of -120 to -128 dB/V (IHF-A). The figure for the C-2 is an outstanding -139 dB/V, a gain of not less than 10 dB under similar conditions.

This differential amplifier stage operates with constant current bias, using current mirror/cascode bootstrap circuitry. There is no input capacitor to block DC inputs, giving advantages in terms of reduced noise and increased low frequency stability. The use of the cascode bootstrap circuit largely eliminates the increased distortion which would otherwise accompany increases in signal source impedance.

Equalizer Amplifier Circuit Diagram



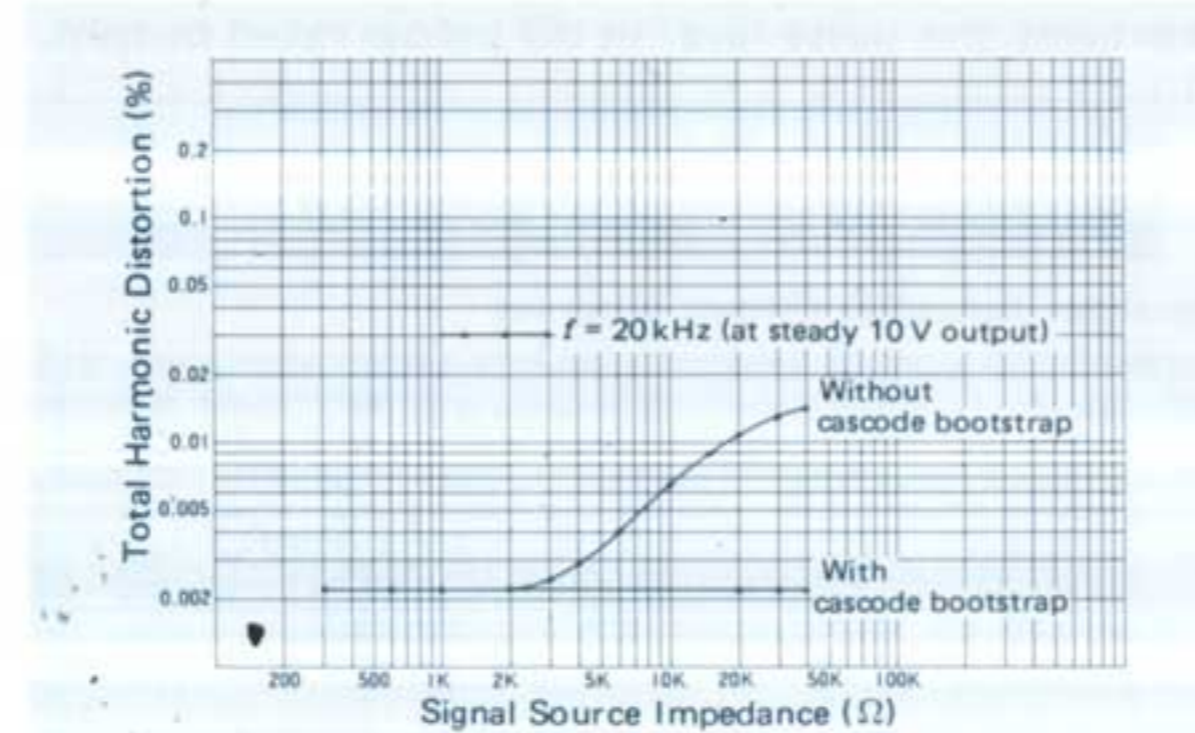
NOTES ON THE CASCODE-BOOTSTRAP CIRCUIT

In grounded (or common) source circuits, there are drain-gate leakage currents I_{DGX} , and feedback capacitance C_{rss} , the values of which are dependent upon the potential between the drain and gate. This results in changes in the input impedance, as seen from the signal source, which depend upon the drain-gate potential. Any increases in source impedance therefore lead to increased distortion at the input terminals. Since this distortion is outside the NFB loop, it cannot be reduced by the application of increased NFB levels.

This is far from being a merely theoretical point: MM cartridges, due to the increased impedance of the cartridge coil windings at higher frequencies, can have impedances high enough to generate distortion with this kind of circuit. Also, there may be effective changes in the input impedance when a level setting control is included in the input side (due to the effect of the attenuation). The cascode-bootstrap constant current circuit shown was adopted to eliminate these increases in distortion. The FETs Tr_1 and Tr_2 are maintained with approximately constant drain-source potential by the constant current bias applied to the bases of Tr_3 and Tr_4 from the common source. Changes in I_{DGX} and C_{rss} are correspondingly small, with greatly reduced distortion. The further addition of a current mirror circuit also ensures that even-numbered harmonics cancel out, reducing distortion.

The second stage in the equalizer amplifier reduces the load on the first stage by using a constant current load common emitter type Darlington input section, with ample gain. The output section gives high output voltages at very low distortions and with low output impedance (660 ohms) so that stability with respect to load impedance is improved. These are achieved by the use of class A parallel push-pull fully complementary circuitry with two pairs of output transistors which combine an extremely high upper frequency limit (f_t approx. 100MHz) with particularly well matched complementary characteristics.

Reduction in Distortion Due to Cascode Bootstrap Circuit



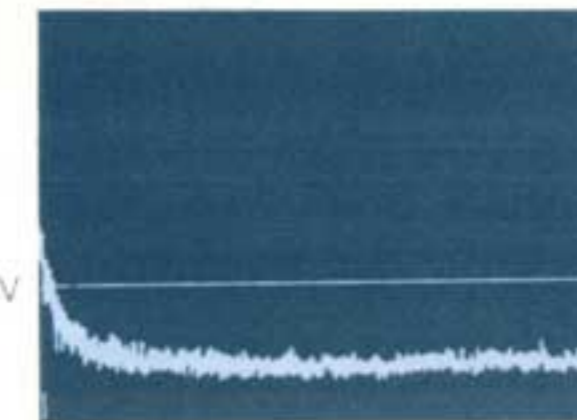
The C-2 Noise Spectrum



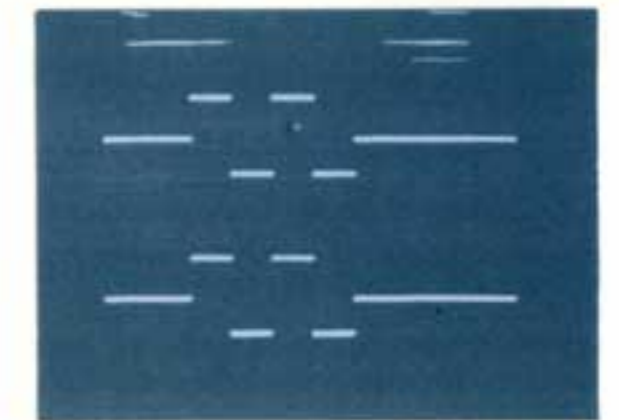
Noise Spectrum for Conventional Amplifier



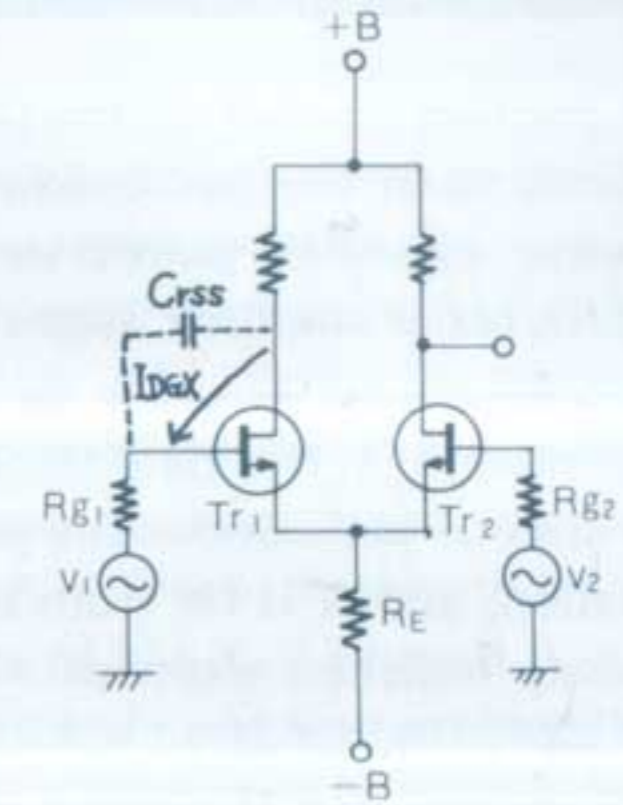
Residual Noise of Measuring Instrument



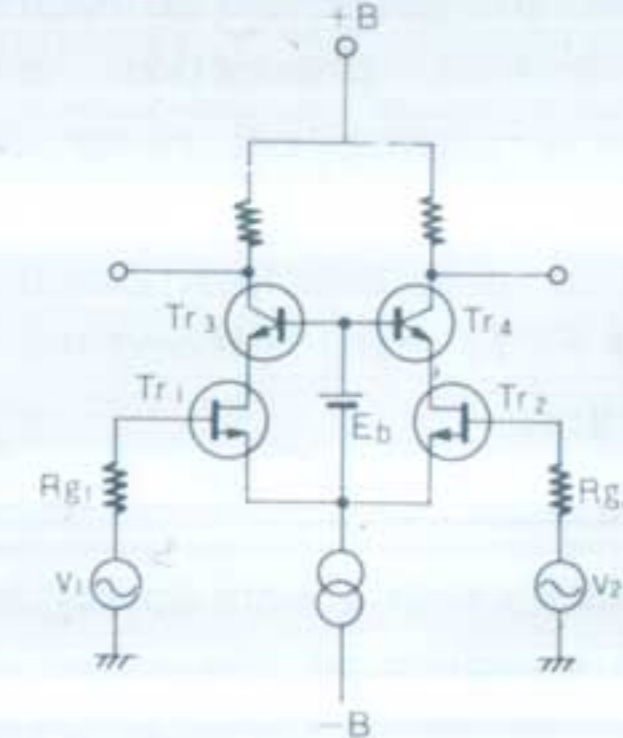
Tone Burst Response (PHONO - REC OUT)



Common Source Connection



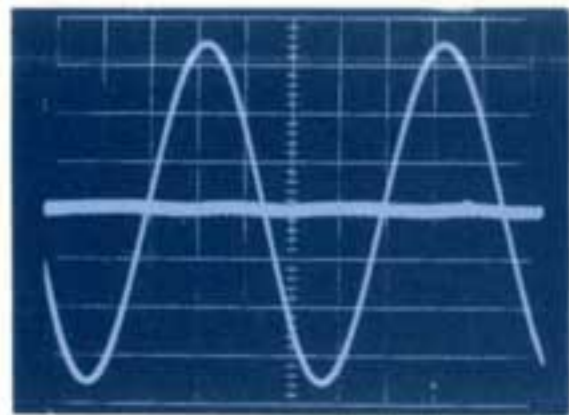
Cascode Bootstrap Connection



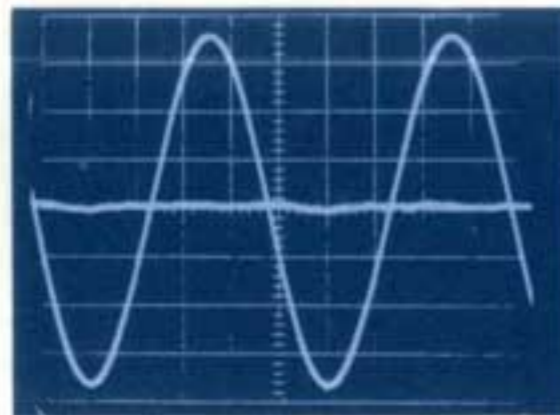
The combination of circuit features mentioned above, from the cascode-bootstrap to the Class A parallel push-pull output, gives this amplifier outstandingly good open-loop characteristics, and the application of adequate and stable NFB gives a distortion of 0.003% from 20Hz to 20kHz for PHONO input to PRE OUT terminals overall, a level which is very close to the measurable limit of high grade test equipment.

The use of high quality polystyrol film capacitors and metal film resistors gives deviation from RIAA characteristics well within ± 0.2 dB.

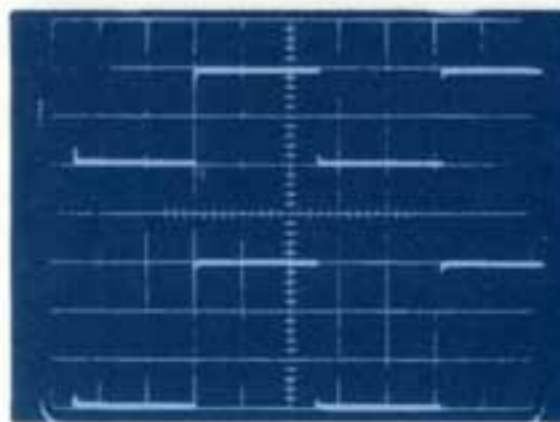
20kHz Oscillator Sine Wave Waveform



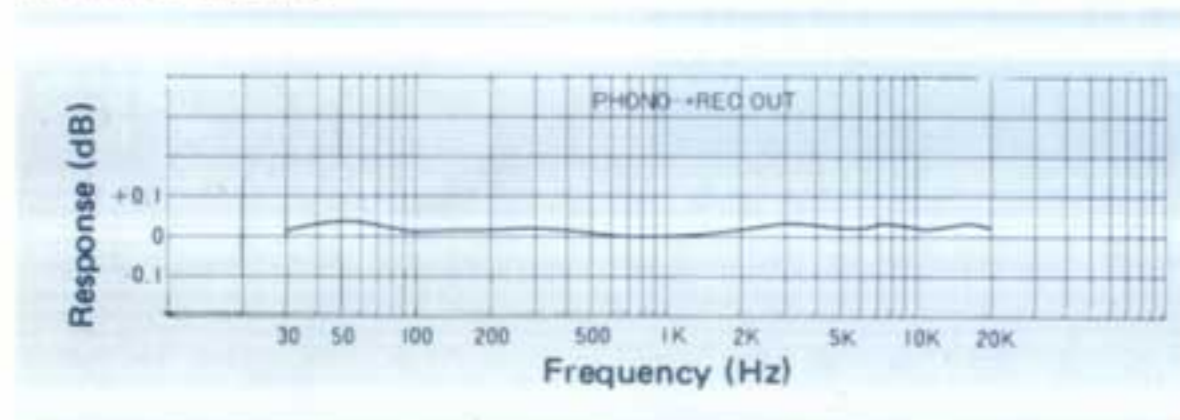
20kHz C-2 Sine Wave Distortion Waveform (PHONO → REC OUT)



1kHz Square Wave Input + C-2 Response



RIAA Deviation



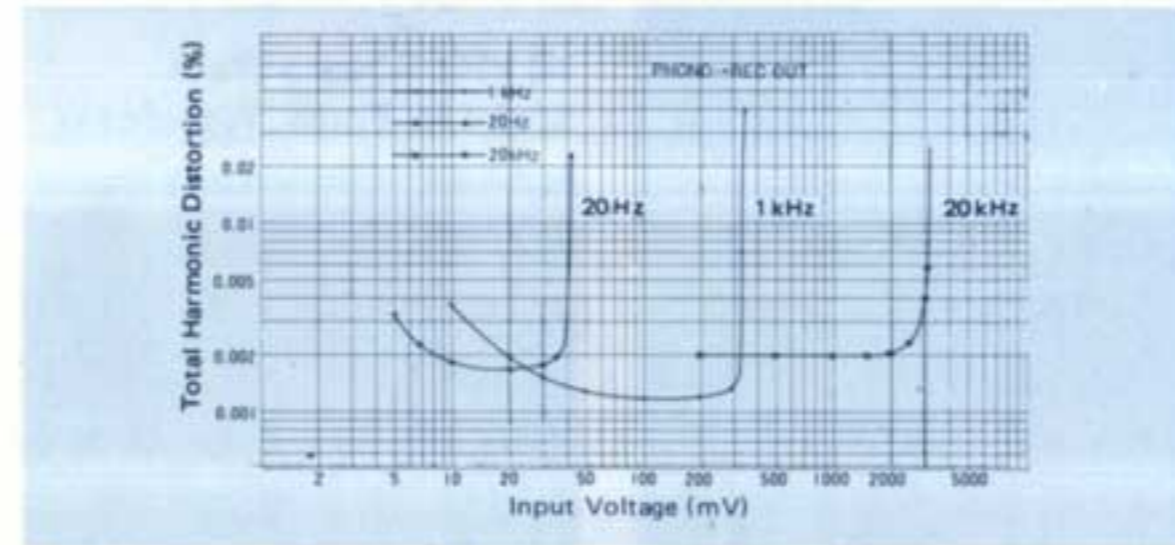
TONE CONTROL CIRCUIT

The overall configuration of the tone-control amplifier is similar to that of the equalizer amp., and is basically an NF-type tone-control circuit.

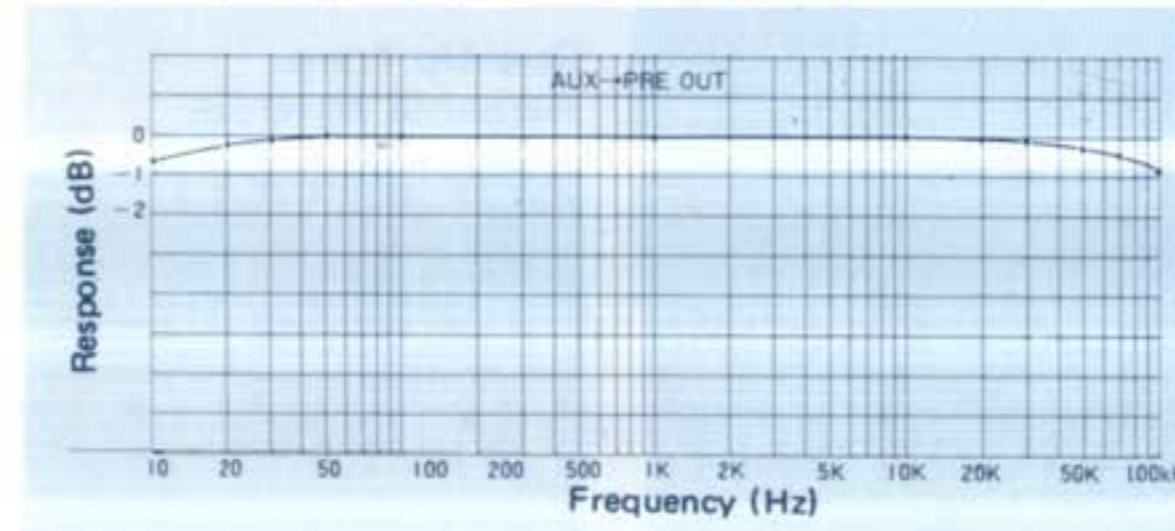
A high precision attenuator-type control is provided, and gives 20 steps (21 positions) each on treble and bass controls. Boost and cut may be set at ± 0.5 , ± 1 , ± 1.5 , ± 2 , ± 3 , ± 4 , ± 5 , ± 6 , ± 8 , and ± 10 dB measured at 50Hz for the bass, with a turnover frequency of 350 Hz, and at 20kHz for the treble, with a turnover frequency of 3.5kHz.

The precision attenuator bass and treble controls also have '0' settings, at which all elements having time constants are completely disconnected from the circuit, so that the amplifier functions as

Input Voltage vs. Total Harmonic Distortion



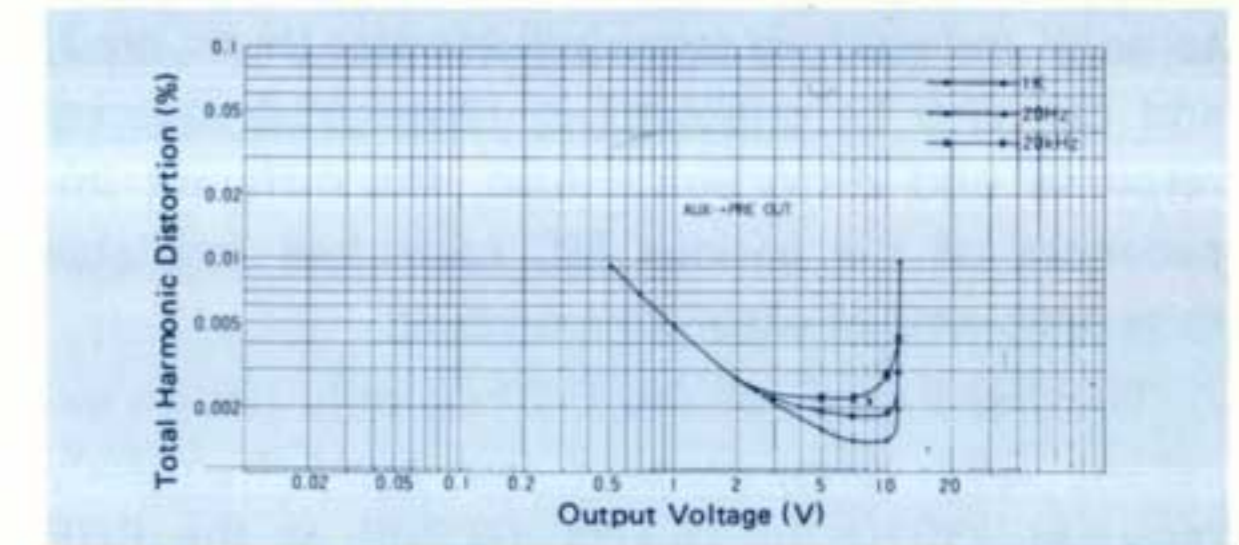
Frequency Response (AUX → PRE OUT)



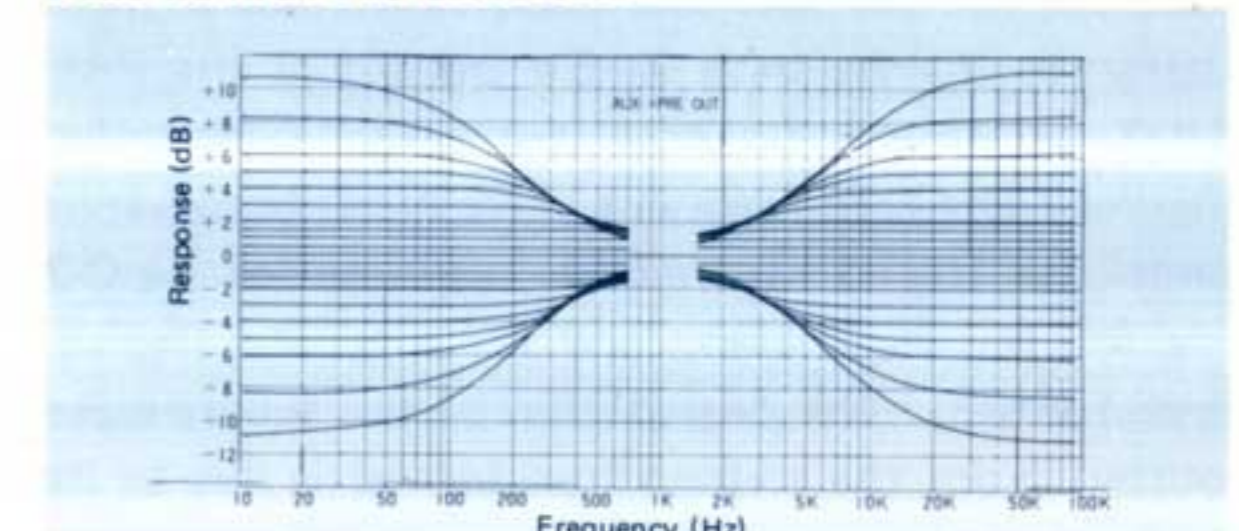
a 'flat amp.' The zero position is therefore a full tone defeat setting.

Volume control is effected partly at the input stage of the tone-control amplifier, so that with this volume turned well down, the apparent source impedance changes. There is, however, no increase in distortion, due to the effect of the same cascode-bootstrap circuit used for the equalizer. Also, the complementary class A parallel push-pull output stage gives an output impedance of only 400 ohms, which, with the high voltage power supply, gives a maximum output of 10 V for 10k Ω load, well above the rated output of 775mV (0dB). It can be used with equipment which has a load impedance as low as 600 ohms, as does much professional audio equipment.

Output Voltage vs. Total Harmonic Distortion



Tone Control Characteristics



HEAD AMPLIFIER FOR MOVING COIL CARTRIDGES

The YAMAHA original super low-noise IC used in the MC head amp. gives a S/N ratio of better than 70dB for a rated input of only 0.05mV (IHF-A), comparable with the typical S/N ratios for the MM phono terminals of most conventional amplifiers. After RIAA correction, this translates into a -147dB/V figure at the input. This performance is unquestionably the standard which establishes the current state-of-the-art.

Until now, the majority of MC cartridge users have preferred to use step-up transformers than head amps. (which usually had S/N ratios of about 55 to 60dB). Although step-up transformers have inherently better S/N than this, they are subject to noise induced via stray inductances (hum, etc.), and can also be criticized in terms of frequency response and distortion. Also, the different impedances of the various MC cartridges available raise problems of accurate matching.

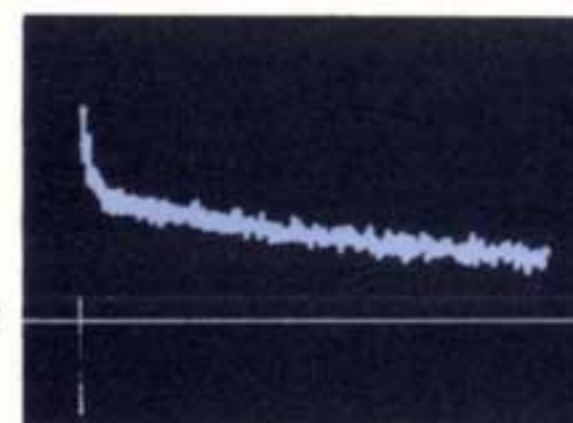
The head amp. of the C-2 not only has an excellent S/N ratio, it also has good frequency response (30Hz to 15 kHz $\pm 0.2\text{dB}$ at the PRE OUT terminals) and low distortion (0.02% from 20Hz to 20kHz with 7.75V output at the PRE OUT terminals). These are quite exceptional figures. The accompanying waveform photographs show the 10kHz square-wave response for the C-2 via the MC head amp., and for a typical step-up transformer. The degradation of the square-wave output from the step-up transformer is due to its rather poor frequency response.

Super Low Noise IC

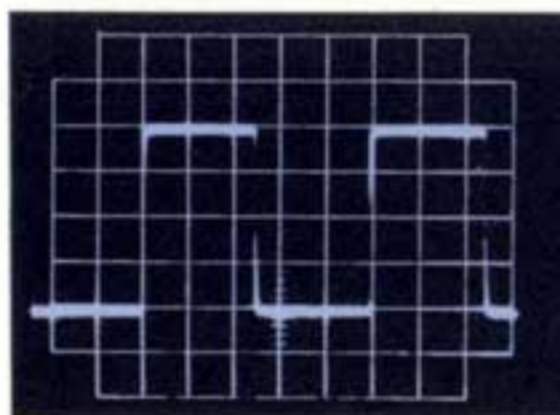


The Noise Spectrum of the MC Amplifier

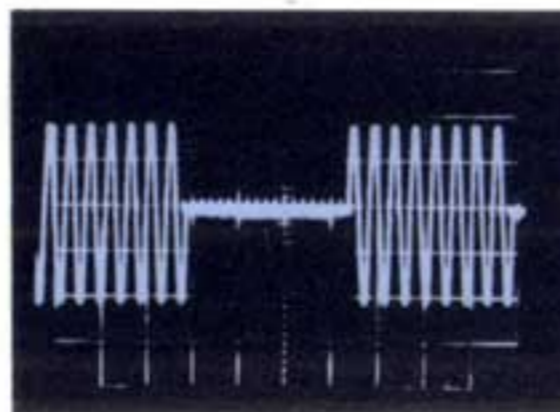
-120dB/V



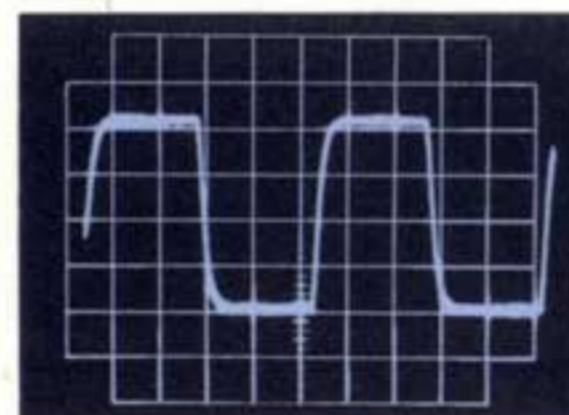
10 kHz Square Wave C-2 Waveform (MC Amp.)



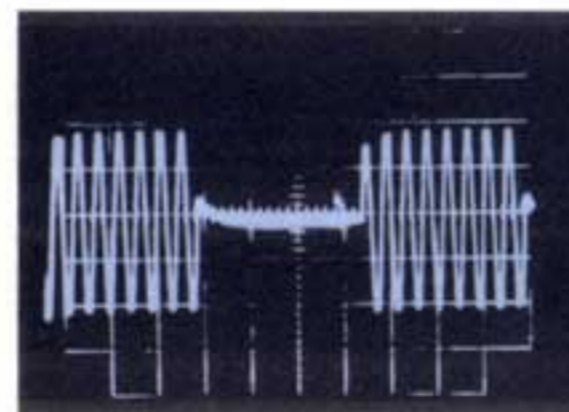
C-2 Tone Burst Response Waveform (MC Amp.)



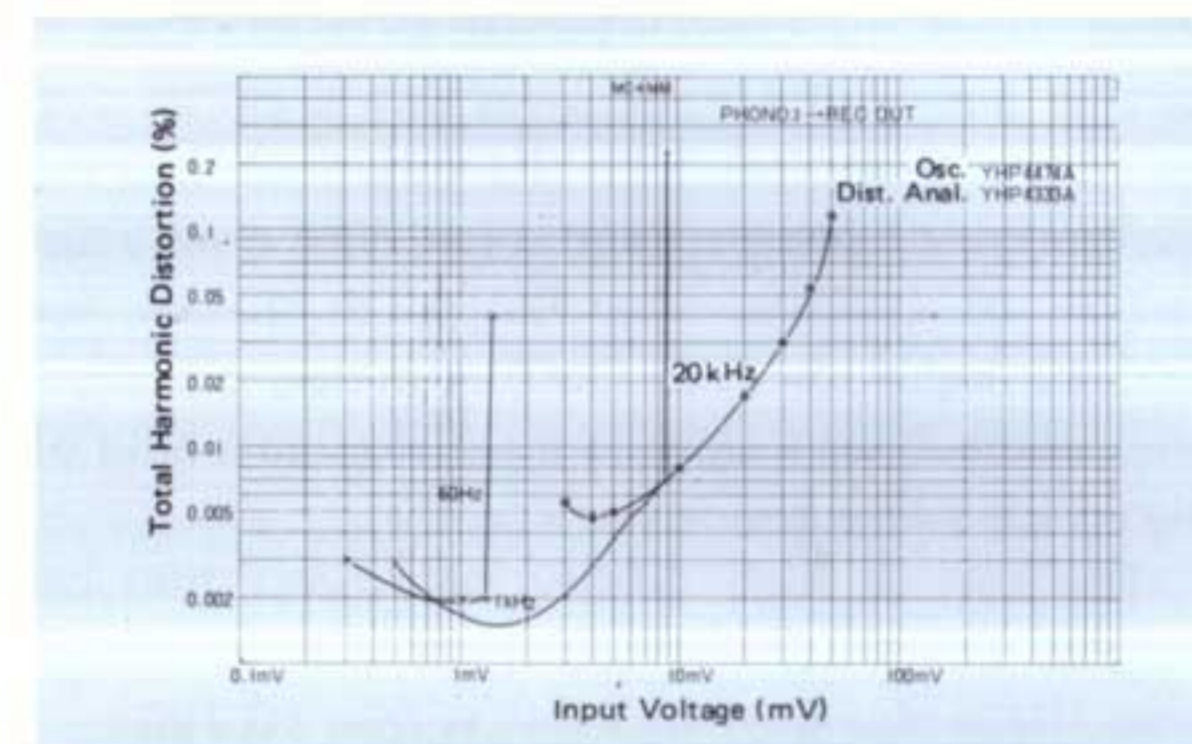
10 kHz Square Wave Step-Up Trans. Waveform



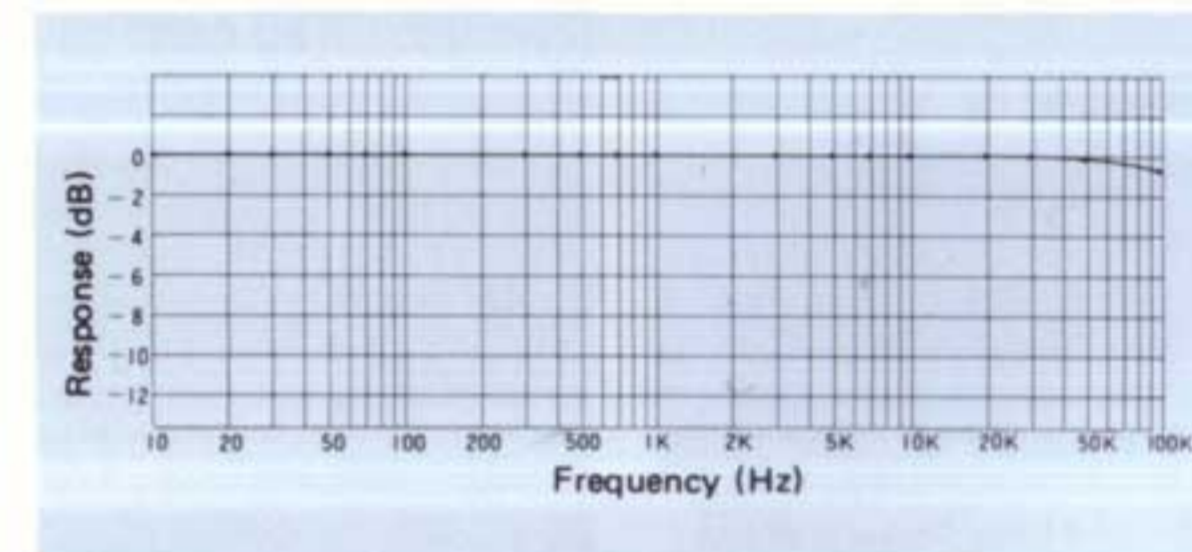
Step-Up Trans. Response Waveform



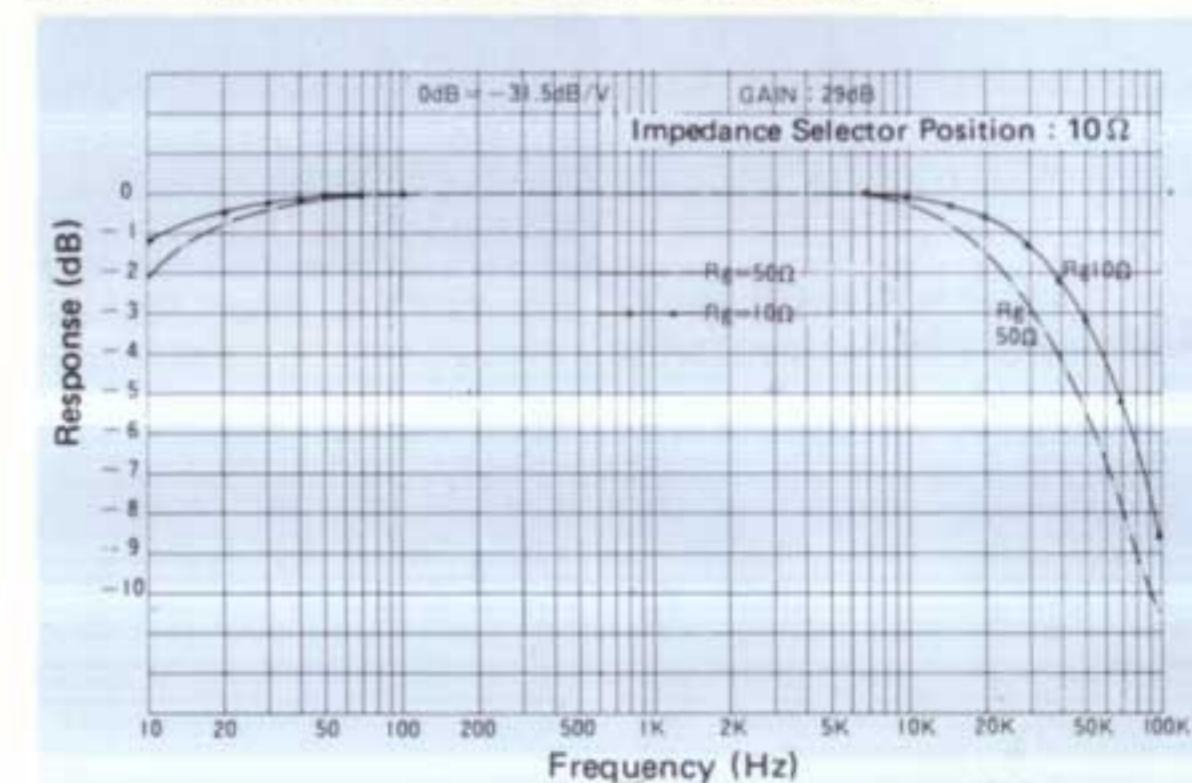
Input Voltage vs. Total Harmonic Distortion



Frequency Response (C-2 MC Head Amp.)



Frequency Response (Step-Up Transformer)



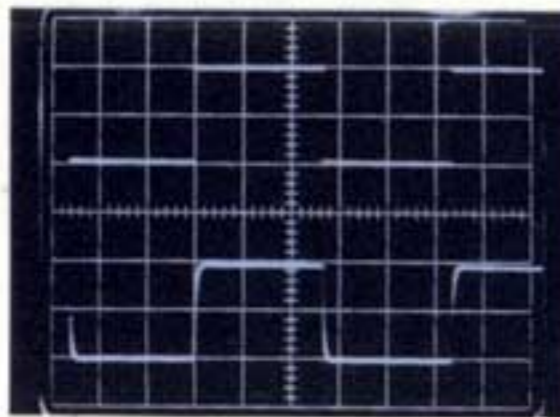
HIGH PRECISION FOUR-GANG VOLUME CONTROL

To improve the S/N ratio in actual use, the volume for each channel is controlled by two-gang volume controls, a total of four for the two channels. The two-gang volume controls are in-

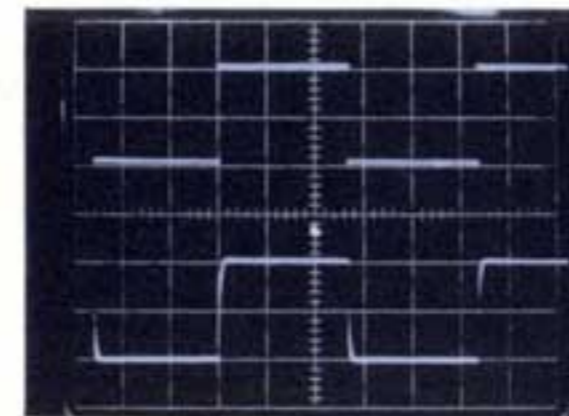
corporated one in the input side and one in the output side of the tone-control amplifier. The input-side controls volume levels from $-\infty$ to -20 dB, and the output-side controls volume levels from -20 dB to 0 dB. This special system gives a gain of between 6 dB and 14 dB in S/N in normal use, and when the volume is turned fully down, the residual noise becomes actually zero.

Changes in Characteristics with Reduction in Volume

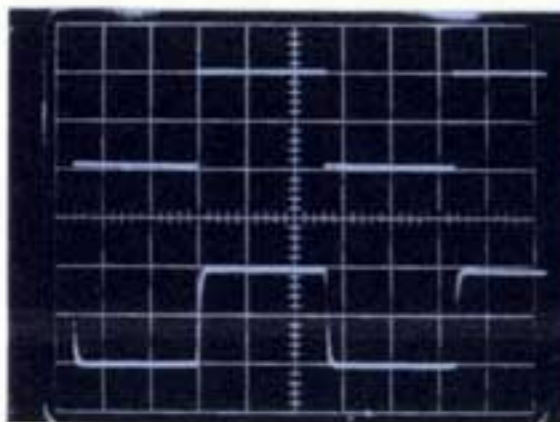
10 kHz Square Wave
+ C-2 Response (Vol. 0 dB)



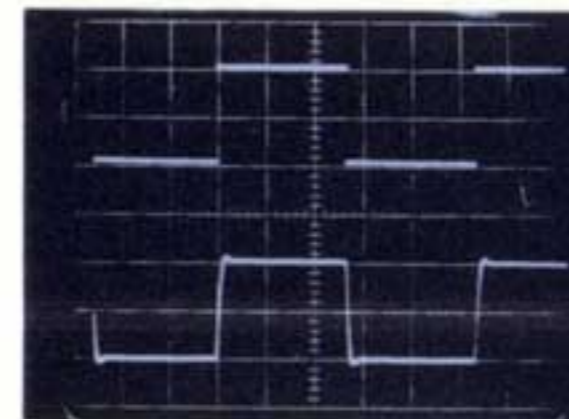
10 kHz Square Wave
+ Response from Amplifier
Subject to Volume-
Related Variation (Vol. 0 dB)



The same but with Vol.
- 20 dB



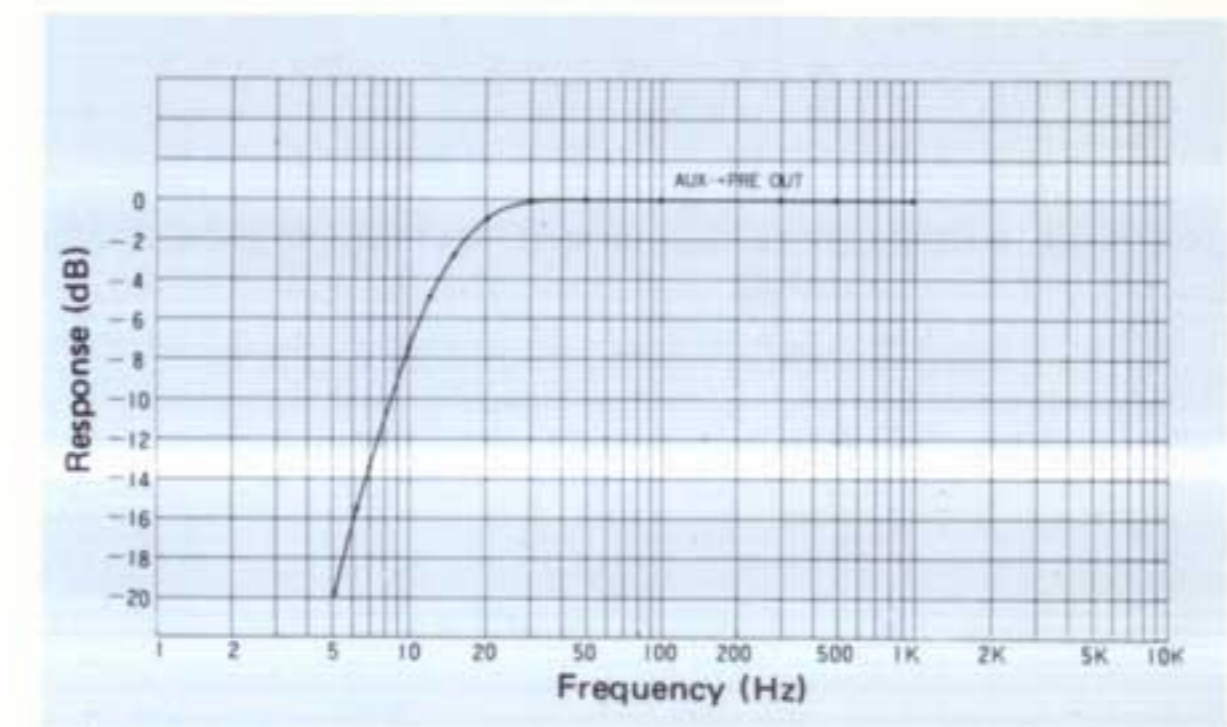
The same but with Vol.
- 20 dB



SUBSONIC FILTER

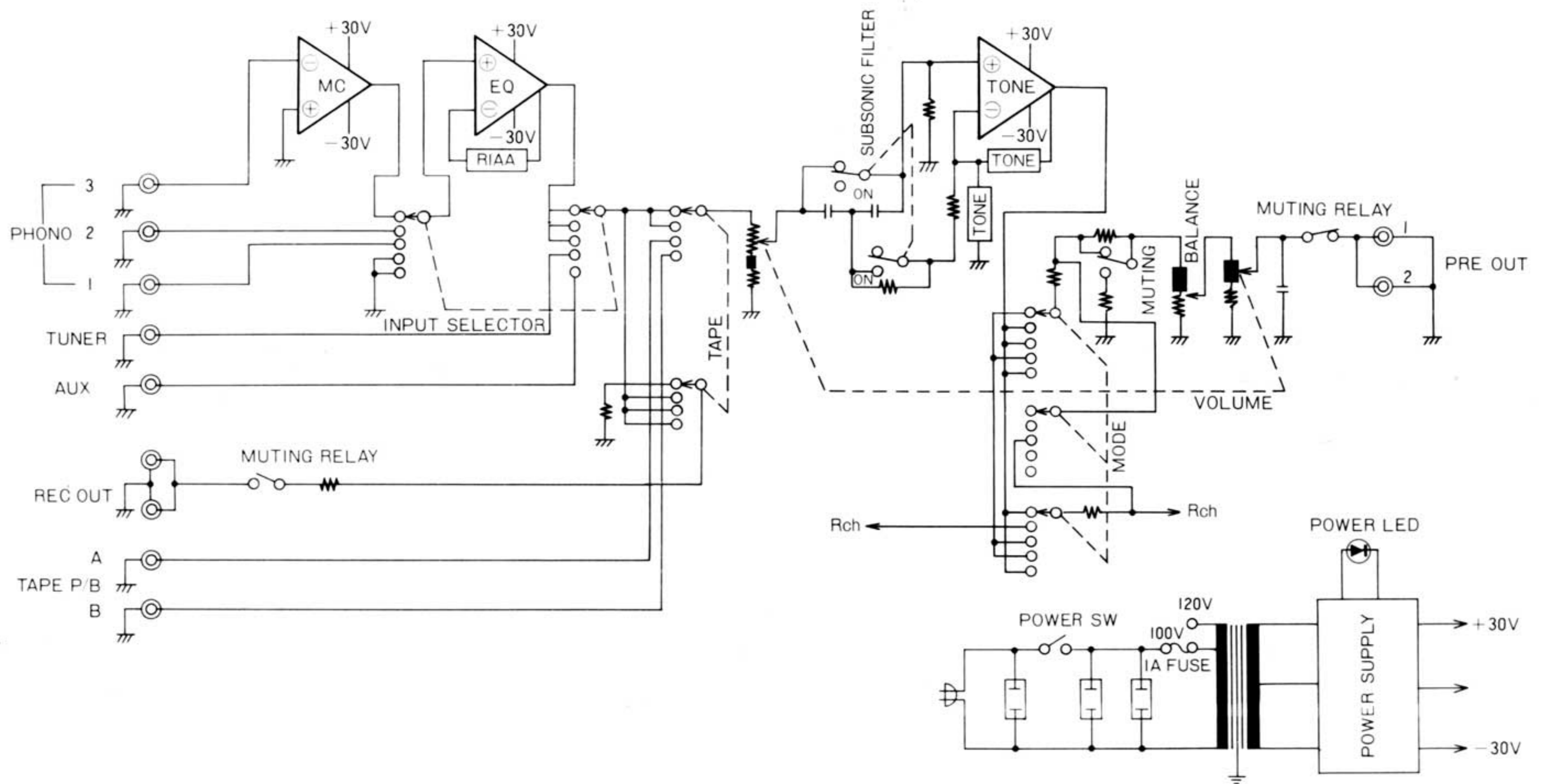
With C-2 response extending well beyond the range of human hearing into the subsonic frequencies below 20 Hz, there is a danger of high amplitude noise signals being amplified and applied to the power amplifier. With a low power amplifier this can lead to saturation and overall performance deterioration: with a high power amplifier it can seriously overload speakers, especially if the power amplifier itself has a response which is flat to DC (0 Hz) like the B-2. Such high amplitude low frequency noise signals are often generated by a record which is warped, or has a hole that is not in the center. They can be effectively eliminated by the 15 Hz subsonic filter. Only 3 dB down at 15 Hz, the response falls by 12 dB per octave at lower frequencies, leaving the audible frequencies virtually unaffected.

Sub-Sonic Filter Characteristic



C-2

BLOCK DIAGRAM



C-2

SPECIFICATIONS

Input Sensitivity, Impedance, and Maximum Rated Input

Input Terminal	Rated Sensitivity	Impedance	Max. Rated Input
PHONO 1, 2	2mV	47k Ω	1 kHz 300mV 20 Hz 30mV 20 kHz 3000mV
PHONO 3 (MC)	50 μ V	10 Ω	1 kHz 7.5mV 20 Hz 1.25mV 20 kHz 20mV
TUNER, AUX, TAPE	120mV	47k Ω	

Output Level, Impedance, and Maximum Rated Output

Output Terminals	Output Level	Impedance	Max. Rated Output
PRE OUT 1, 2	775mV	400 Ω	10V
REC OUT A, B	120mV	660 Ω	18V

Frequency Response

Input	Specification
PHONO 1, 2, 3	30Hz to 15kHz \pm 0.2dB (RIAA Deviation)
TUNER, AUX, TAPE	5Hz to 100kHz \pm _{-1.5} ⁰ dB

Signal-to-Noise Ratio (S/N)

Input	Specification
PHONO 1, 2	2mV rated input: 85dB (IHF-A, shorted input) 10mV input: 99dB (IHF-A, shorted input)
PHONO 3 (MC)	50 μ V rated input: 70dB (IHF-A, 50 Ω short)
TUNER, AUX, TAPE A, B	Better than 100dB (IHF-A, shorted input)
Residual Noise	$-\infty$ dB

Sub-sonic Filter Characteristics

$f_c = 15$ Hz	-12dB/octave
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Tone Control Characteristics

* The '0' position is flat (tone defeat).

	Turnover Frequency	Degree of Boost/Cut
BASS	350Hz	0*, \pm 0.5, \pm 1, \pm 1.5, \pm 2, \pm 3, \pm 4, \pm 5, \pm 6, \pm 8, \pm 10dB (at 50Hz)
TREBLE	3.5kHz	As above (at 20kHz)

Distortion

Input	Conditions	Specification
PHONO 1, 2	With -30dB (775mV output) and max. volume 0dB (7.75V output)	0.003% or less, 20Hz to 20kHz
PHONO 3 (MC)	With -30dB (775mV output) Max. volume 0dB (7.75V output)	0.02% or less, 20Hz to 20kHz 0.05% or less, 20Hz to 20kHz
TUNER, AUX, TAPE A, B	With -30dB (775mV output) and max. volume 0dB (7.75V output)	0.003% or less, 20Hz to 20kHz

General

Audio muting	-20dB, OFF
Power consumption	25W (rated)
Power supplies	U.S.A. & Canada AC 120V, 60Hz; Other areas AC 120/230V, 50/60Hz
Semiconductors used	2 ICs, 4 FETs, 63 Transistors, 23 Diodes, and 7 Zener Diodes
Dimensions (W x H x D)	435mm (17-1/8") x 72mm (2-7/8") x 320mm (12-5/8")
Weight	7.8kg (17 lb 3 oz)

Specifications subject to change without notice.

C-2

TROUBLE SHOOTING

Before assuming that your C-2 is malfunctioning, check the following trouble-shooting list.

Fault	Cause	Care
No sound although POWER switch is ON	AC power line not plugged into supply socket VOLUME set to $-\infty$ INPUT or TAPE switch in wrong position Pin plugs incorrectly inserted, loose, or disconnected Shorting pin plugs in PRE OUT or REC OUT sockets	Plug firmly into the supply socket Turn up VOLUME Check and change as necessary Check and insert fully in the correct positions Remove and use only on unused INPUT sockets
Sound is distorted : hum or noise present	Pin plugs loose or disconnected. Poor GND contact Poor contact between pin plug and braided shielding wire on the lead cable	Plug pins in firmly Ensure good contact Replace the lead cable
The R and L channels are reversed, or sound only comes from one of them	MODE switch in wrong position Pin plugs inserted wrong way round BALANCE control not central	Turn to the STEREO position Check input, output, and power amplifier connections: correct where necessary. Restore to center
Tape recording is impossible	TAPE selector switch set at REC OUT OFF	Restore to SOURCE

SINCE 1887



YAMAHA

NIPPON GAKKI CO., LTD., HAMAMATSU, JAPAN