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SANSUI C-2301 PREAMP AND B-2301 AMP

Manufacturer's Specifications

Preamplifier

Frequency Response: Line inputs, d.c. to 500 kHz, +0, −3.0 dB; MM phono inputs, RIAA 20 Hz to 20 kHz, ±0.2 dB.

Maximum Output: 20 V and 1 kHz.

THD (New IHF Standard): 0.005%, phono; 0.003%, high level.

IM Distortion: 0.005%, phono; 0.003%, high level.

Phono Input Sensitivity for 0.5-V Output at 1 kHz: 2.0 mV input for MM (47 kilohms) or High MC (100 ohms); 70 μV (3 ohms) for MC (Trans Low) or 200 μV (30 ohms) for MC (Trans High).

Phono Input Overload: 350 mV at 1 kHz for MM; 40 mV at 1 kHz for MC input.

S/N Ratio: 80 dB, short-circuit, A-weighted, for 5-mV signal at MC input.

High-Level Sensitivity: 150 mV.

Phono Input Impedances: 47 kilohms for MM cartridges; selectable 3/30/100-ohm input impedance for MC cartridges.

Dimensions: 18-11/16 in. (47.5 cm) W × 6-5/16 in. (16 cm) H × 16-5/8 in. (42.2 cm) D.

Weight: 46 lbs. (20.9 kg).

Price: $2,700.

Power Amplifier

Power Output: 300 watts rms per channel continuous, 20 Hz to 20 kHz, into 8 ohms.

Rated THD: Less than 0.003% at or below minimum rms power output.

Frequency Response: D.c. to 300 kHz, +0, −2 dB for 1-watt output at the maximum input-level control position.

S/N Ratio: 120 dB, inputs shorted, A-weighted.

IM Distortion: Less than 0.003% at rated output.

Slew Rate: ±400 V/μS (internal).

Damping Factor: 300, stereo; 150, mono; 50 Hz into 8 ohms.

Input Impedance: 15 kilohms unbalanced or 1 kilohm balanced, switch selectable.

Input Sensitivity: 1.0 V for rated output at normal inputs, 2.0 V for balanced inputs.

Dimensions: 18-11/16 in. (47.5 cm) W × 8-15/32 in. (21.5 cm) H × 19-11/16 in. (50 cm) D.

Weight: 81.4 lbs. (37 kg).

Price: $2,600.

Company Address: 1250 Valley Brook Ave., Lyndhurst, N.J. 07071.

For literature, circle No. 93

Sansui's B-2301 amplifier and C-2301 preamplifier are the company's top-of-the-line separates, intriguingly designated on the front panels with "Basic Audio Legacy Vintage" labels. Chassis size, choice of wood-veneer paneling, and user ergonomics are first-rate on both units, and the high prices are justified by high performance and exacting specifications.

Among the design features incorporated into these units is what Sansui calls "X-Balanced circuitry." Balanced inputs and outputs have long been used by broadcast and recording studios to overcome the effects of magnetic and electromagnetic radiation from a.c. power lines, broadcast signals, and other sources. When this radiation strikes the two twisted conductors of a balanced interconnecting cable, it produces the same voltage or current in each. A balanced input rejects this "common mode" signal while accepting the desired audio signal. The audio signal is transmitted in a "differential mode" as a voltage *between* the conductors by the preceding balanced output. The twisted pair is generally shielded, as well, to reduce high-frequency interference which, in practice, is not always effectively rejected by balanced inputs.

In the past, recording and broadcast studios have utilized transformers to obtain balanced, floating (not ground-referenced) inputs and outputs. Today, professional equipment usually employs electronically balanced inputs (ground-referenced) and floating transformer outputs. Good transformers are very expensive, and even the best have much greater distortion and frequency-range limitations than amplifier circuitry. Electronically balanced outputs which are ground-referenced but symmetrical are used, but they are not directly compatible with unbalanced inputs.

The Sansui engineering team of S. Takahashi and S. Tanaka ("Fully Balanced Bridge Amplifier," *Journal of the Audio Engineering Society*, Vol. 32, No. 6, June 1984, pp. 415-421) developed a prototype amplifier with balanced differential inputs and balanced outputs with separate power-supply grounds for the first and final stages. This amplifier was electrically equivalent to a transformer with a frequency response from direct current to several hundred kilohertz, low total harmonic distortion, and large power-handling capacity. Sansui feels that there are subtle distortions and loss of detail that arise from conventional grounding schemes in home audio.

Control Layouts

The C-2301 preamplifier's cabinet is surfaced with a dark, rich, persimmon-wood veneer. Heavier than most preamps, it tips the scales at 46 pounds. Although it measures the standard 19-inch rack width, the C-2301 does not have the decorative mounting brackets found in some high-end home audio gear today. Rotary controls on the front panel are, from left to right, "Tape/PCM Play," "Master Volume" and "Input Selector." Below these controls are the "Output Selector," "Balance," "Attenuator," "Mode," "Rec Selector" and "Cartridge Selector." Square pushbutton switches include "Power," "Source Direct," "Subsonic," "Muting," and "Adaptor." Each switch position illuminates an LED display

Sansui's top-of-the-line separates, the B-2301 amp and C-2301 preamp, feature first-rate styling and usability, but they are rather costly.

on the otherwise black faceplate. On the rear panel are the usual signal connections: Two unbalanced RCA phono jack inputs, a large variety of high-level inputs (including RCA jacks for three tape decks, a CD player, and an equalizer), RCA output jacks labelled "Normal," a balanced XLR output jack for each channel, and six a.c. outlets with two switched (200-watt total capacity) and four unswitched (400-watt total capacity). There is also a pair of binding posts for connecting the chassis to signal common. The preamp does not have any balanced inputs, which could have carried Sansui's X-Balanced circuitry to the source.

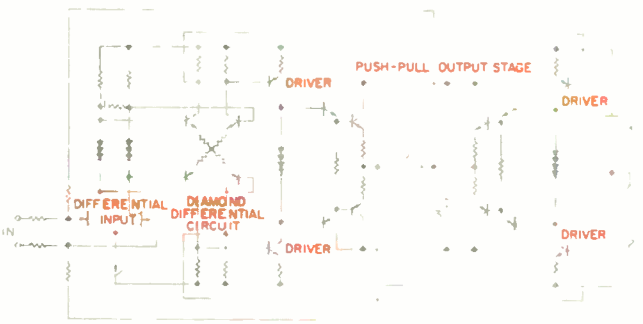

Fig. 1—Partial schematic of the Sansui B-2301 amplifier.

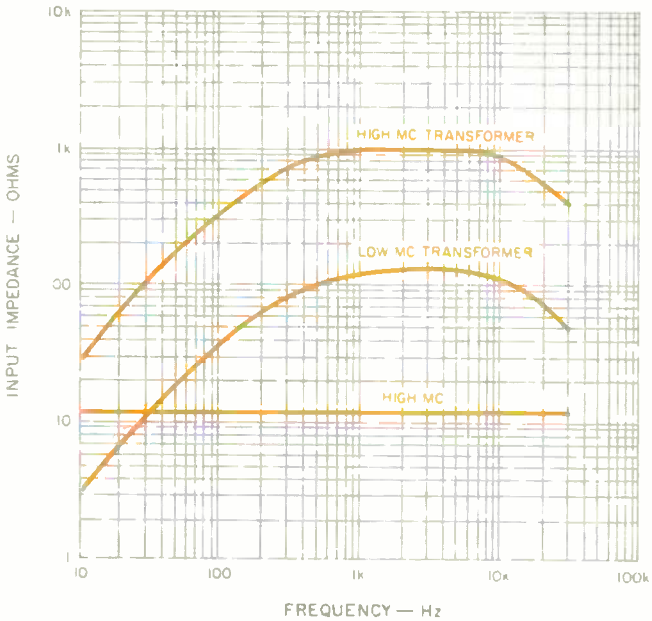

Fig. 2—Input impedance vs. frequency of the MC transformer, Sansui C-2301 preamp.

The B-2301 amplifier exactly matches its companion preamp in exterior finish, and its stunning appearance makes it the finest-looking high-power amplifier we have so far encountered. The chassis is rack-width, but no mounting brackets are supplied for this 82-pound block—a sensible move on Sansui's part since the B-2301 is intended for home use. Front-panel pushbuttons, from left to right, include "Power," "Peak Hold" and a "Display" switch to turn off the unit's large, 32-element, LCD power meters which have logarithmic scales. Other front-panel LEDs include an "Over Swing" clipping indicator, a "Protector" indicator to show activation of the protection circuit, and a "DC Leak" indicator. The back panel includes standard RCA input jacks as well as balanced XLR inputs, selectable via an input selector switch; individual, detented, rotary level controls are located next to each input as well. A ground terminal and an a.c. outlet are provided. Both the preamp and the amp feature two-prong a.c. line cords, in accordance with Sansui's ground separation philosophy.

Mechanical Construction

Amp and preamp were carefully inspected and found to utilize similar construction. Sansui mostly uses aluminum and steel in these products, though copper is also frequently utilized as a structural material. For example, a large, copper chassis plate, 17 inches wide by 6 inches deep, holds up the transformer and circuit boards in the middle of the preamp. This is a somewhat unusual application of this soft material, and according to Sansui, it is intended to provide utmost isolation of the audio signal from both internal and external magnetic distortion. Ordinarily, isolation screens surround the circuitry on all sides. The metal is a better conductor than steel, though it is expensive and soft for a chassis component. Other, more usual features appear inside where the preamp's highly styled internal modules have short blurbs on circuitry and performance screened on their covers; our preference would have been to leave the copy out.

The preamplifier's chassis consists of an extruded aluminum front panel attached to steel side panels which, in turn, are bolted to a steel back panel. Dark, persimmon-wood side panels, favored in several high-end Japanese components, decorate the steel inner chassis. Circuitry is mounted on 11 circuit boarcs, seven of which are mounted on the large, copper subchassis that covers most of the inner space. All major metal parts are fastened together with thread-forming sheet-metal screws.

Circuit boards in the preamp are very high-quality glass-epoxy, single-sided, with solder mask and component designators. Circuit-board interconnects mainly use nickel-plated contacts in nylon housings; the cartridge-level internal wiring, on the other hand, utilizes thick cable and gold-plated RCA connectors. Component quality is very high, e.g., 1% resistors predominate. A particularly nice design touch in the C-2301 is the use of cable controls for the front panel's selectors. Each drives a push-pull steel band in a

These Sansui "Vintage" components use some cost-cutting construction techniques and some that are very expensive.

plastic sheath that winds its way to a printed-circuit slide switch near the rear panel. This keeps input selection switching near the input jacks, so long leads do not run to the front panel, acting as antennas for hum, r.f.i. or crosstalk from the other channel.

The B-2301 amplifier chassis is built from four U-section channels running from front to back, with various sheet-metal and extruded assemblies attached to them. Heat radiators for each channel are parallel to the sides and designed for vertical air flow through the matching slots in the top and bottom panels. Amplifier circuit boards run parallel to the heat radiators and are fastened to them at their edges and by the output devices in each channel. Pairs of output transistors are bolted to four blocks which are, in turn, bolted to the radiator for each channel. The ability of the circuit board to flex a small amount reduces mechanical stress in the output devices from thermal cycling. Lead length is still desirably short, and service access is reasonable.

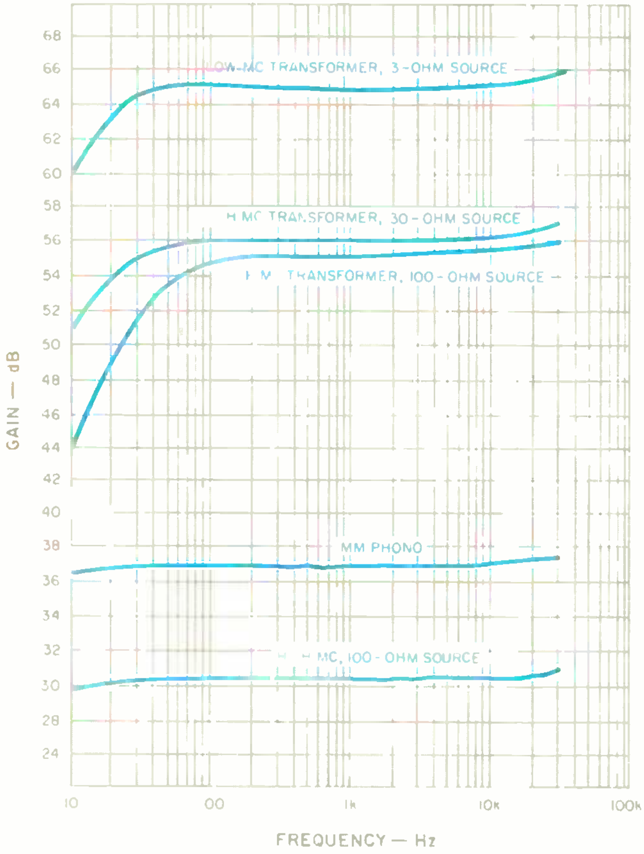

Fig. 3—Gain vs. frequency for the various phono inputs of the C-2301.

The large power transformer and four filter capacitors occupy the center portion of the amplifier. The power-supply regulator board is under the transformer and accessible from below. A copper subchassis attaches to the frame and holds the filter capacitors and front-panel components. Copper can be bent more easily than steel, and we found one small bracket had indeed been deformed, apparently through rough handling during shipping, so that it was only 1/16 inch from 120 V a.c. on the power switch terminal—a potentially dangerous situation.

Front and rear panels are aluminum, and each holds several circuit boards in conjunction with nearby terminals and controls. As with the C-2301 preamp, all the amp's panels that make up the chassis are fastened together with thread-forming screws. Using them eliminates a separate threading operation and, Sansui tells us, makes for a more rigid chassis. Unfortunately, small metal particles from the forming operation were found inside the chassis and are potential short-circuits on p.c. boards. For repeated-access rigidity, we prefer costlier tapped holes or threaded steel inserts, which we associate with instrument-grade products.

Circuit-board component quality and wiring are good but not exceptionally so. The glass-epoxy boards are well finished and laid out, and are screened with component designations and solder mask. Electrolytic capacitors, rated at an adequate 85° C, and the many polypropylene capacitors are stand-up mounted. Nickel-plated, push-on connectors are widely used to interconnect the circuit boards, a contrast to the gold-plated connectors used for external inputs and in the phono stage of the preamp. The ones carrying high currents could fatigue and provide poor contact in the unlikely event that a lot of service work had to be done. In our experience, push-on connectors can be a major source of service problems, though these were tight and secure.

Preamplifier Circuitry

The signal circuitry in Sansui's C-2301 preamp features their X-Balanced design. Overall, there are two blocks of gain, consisting of a phono preamp/equalizer and a balanced output amplifier. A second, identical output amp is driven in opposite polarity to form the other half of a balanced output symmetrically referenced to ground. The preamp's line output would have been a good place to apply Sansui's new floating, balanced output circuit, but the *floating* circuitry is reserved for the power amp's output. The conventional output used here shorts one of the output amps when connection is made to a usual unbalanced power-amp input.

The MC transformer in the preamp added distortion to an otherwise clean design, so we recommend an external step-up unit.

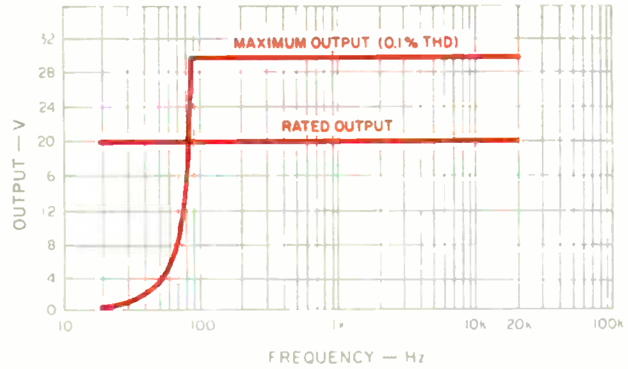

Fig. 4—Frequency vs. rated output and maximum output at 0.1% THD + N from the C-2301's "High MC" transformer input to tape output with a 30-ohm source.

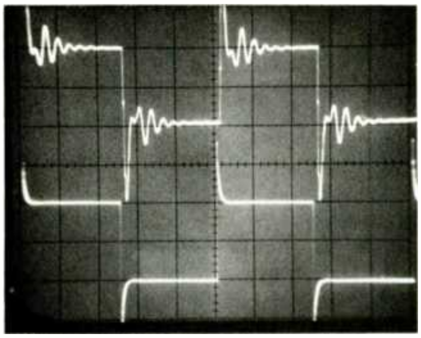

Fig. 5A—C-2301's response at tape output to pre-equalized square waves. Top: 10-kHz signal from 3-ohm source into "Low MC" transformer input. Bottom: 1-kHz square wave into MM input. (Scales: 20 μV and 0.5 V per div.)

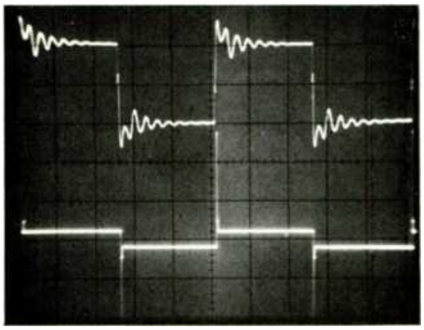

Fig 5B—C-2301's response at tape output to pre-equalized 10-kHz square waves fed from a 30-ohm source. Top: Input at "High MC" transformer. Bottom: Input at "High MC" with no transformer. (Scales: As in Fig. 5A.)

The RIAA preamp is capacitively coupled at its output as opposed to using the popular servo-amp approach of eliminating d.c. offset. The designers use four paralleled capacitors of different dielectric types, and this bundle of capacitors is coated with a gooey substance to reduce rattles.

The circuits used in the phono section and in the two halves of the balanced output consist of similar, discrete-transistor gain blocks. The first stage of each is an unbalanced differential-FET input and transistor cascade. The collector outputs feed a balanced dual-differential stage followed by two more stages of balanced push-pull transistors. The RIAA version uses feedback equalization overall, while the output amp uses flat feedback.

Does this design provide any sonic benefits? Sansui claims their balanced circuit yields clearer sound, with less interference from external electrical fields or internal power-supply ripple currents. The telephone company, for one, agrees with them and has used balanced circuits since the invention of the telephone pole. We would like to have seen a full realization, including balanced cartridge leads and tonearm cables to feed the preamp. The cartridge signal is already balanced, and Sansui could have preserved this state in the very hum-prone interconnects and inputs all the way to the loudspeaker.

Amplifier Circuitry

The B-2301 amplifier is basically a bridged design. It has balanced differential inputs and balanced outputs with separate power-supply grounds for the first and final stages. The B-2301 features six separate power supplies, three per channel. The Diamond Differential circuit used in the bridge amplifier has four outputs in a symmetrical and complementary configuration, and it simultaneously drives a pair of push-pull output stages. In this balanced bridge design, distortion is reduced by both feedforward and the usual negative-feedback networks. The circuit utilizes each output stage as an error amp for the other.

The basic feature of this power amp is that the first stages drive the final stages through a constant-current source. The unit's Diamond Differential circuit puts out a constant current, regardless of the voltage required. The output voltage is not referenced to the input ground terminal or the power-supply ground terminal. This is in contrast to normal bridged operation, where the two amps forming the bridge operate at a stiff, constant voltage referenced to ground. In the Sansui, the output terminals are floating and designated either "hot" or "cold." Unlike conventional bridged amps, no damage is caused when one side of the B-2301's output is short-circuited to the chassis. The impedance between the ground and the amplifier is kept high, and little current flows between them. The hot or cold terminals can float up or down, independent of ground, and provide the same performance. The power-supply circuit of the amplifier is also floated from ground.

Figure 1 shows the basic circuit of the balanced bridge amplifier. There are three amplifying stages. The Diamond Differential circuit is used as the second stage to drive a pair of push-pull stages that follow. These stages are powered by ground-based positive and negative supply source E1 and E2, and the final stages are powered by a

Listening tests on these two units were made with both blind A/B and open (or subjective) procedures, giving an unusually thorough comparison.

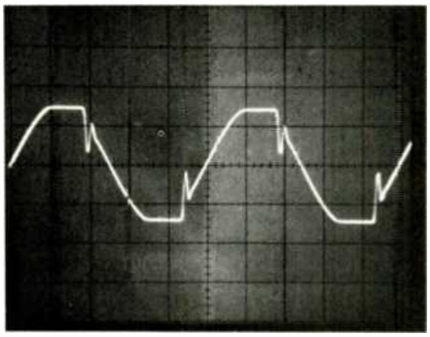

Fig. 6—Response of B-2301 amplifier to large-signal, 20-kHz sine wave driving an 8-ohm load. (Scales: 10 μS and 50 V per div.)

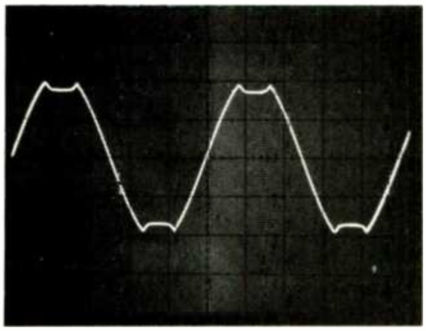

Fig. 7—Response of B-2301 when driven into clipping, no load, with 200-Hz sine wave. (Scales: 1 mS and 50 V per div.)

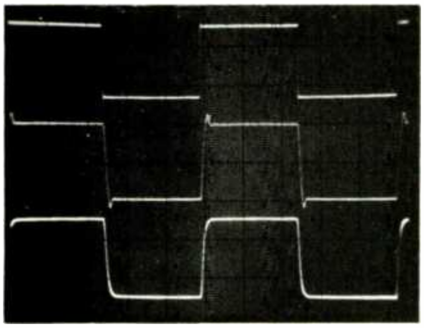

Fig. 8—Response of B-2301 to 20-kHz square waves at various signal levels into 8-ohm loads. Top: 1-watt output; scale is 1 V per div. Middle: Clipping; scale is 50 V per div. Bottom: Below clipping; scale is 25 V per div. Time base is 10 μS per div. for all.

separate floating source E3. Feedback is applied from the two outputs to the two inputs of the initial differential circuit.

Preamplifier Measurements

Designers of MC transformers have three main problems, which the transformer in the C-2301 exhibits in varying amounts. The first is distortion. To achieve high inductance, transformer coils are usually wound on a magnetic material such as an iron alloy. If the magnetic properties of these alloys are not perfectly linear with magnetic field strength, the transformer will be prone to low-frequency distortion from this source. The second problem is irregular frequency response. At high frequencies, inter-winding capacitance resonates with the transformer's inductance, causing peaks and dips in the response if steps are not taken to damp them. In the case of the Sansui transformer, these resonances are above the audible range, but lend a small high-end boost. The third problem is the most serious because it is audible: The transformer's input impedance drops as frequency drops, causing the output of moving-coil cartridges to drop off severely below 100 Hz due to excessive loading of the source by the transformer.

The MC inputs marked 30 ohms and 3 ohms utilize this transformer and are both gain and input-impedance options, with maximum gain available at the lower impedance. The IHF standard for measuring noise, gain, and response of MC inputs calls for a 100-ohm source. Because this yields poor results with the Sansui's transformer inputs, we assumed that 30- and 3-ohm sources were required. An MC cartridge of lower output impedance will have lower output, all other things being equal; to relate our noise measurements of the Sansui transformer inputs to IHF standards, we assumed output proportional to impedance. This results in a 71.2-dB S/N at 30 ohms and a 62.6-dB S/N at 3 ohms.

The 30- and 3-ohm inputs do not indicate true input impedance but only a nominal level. Figure 2 shows that input impedance is a function of frequency and that it drops at low frequencies. This drop in impedance causes roll-off of 6 dB at 20 Hz (Fig. 3) because it loads the cartridge, thus reducing output.

The transformer added frequency-dependent distortion to this otherwise clean preamp (Fig. 4). We tried to drive the inputs to produce the rated 20-V output, but the preamp would not deliver the full 20 V at lower frequencies. The 'scope showed ringing in a pre-equalized 10-kHz square wave, both at 3 ohms (Fig. 5A) and at 30 ohms (Fig. 5B) in comparison to both the moving-magnet (MM) phono input and the "High MC" inputs. One can avoid the problems of the transformer by using the "High MC" phono input, which bypasses the transformer, but with a loss in gain. This phono input's circuitry is simply a 100-ohm load and an attenuator ahead of the MM RIAA preamp, thereby dropping the "High MC" input's gain below that of the MM input. In any case, the low 30.3-dB gain of this input position makes it inappropriate for many MC cartridges; the other MC stages of the C-2301 each have about 60-dB gain. The bottom line is that the Sansui preamp will function most linearly with a moving-magnet cartridge. For flat response with a moving-coil cartridge, an external step-up device plugged into the MM phono stage is recommended.

A new short-circuit current test is designed to show how well the test amp will drive a speaker that is a difficult load.

Standard preamplifier measurements are shown in Table I. Phono equalization error versus frequency for a resistive source was very flat for the phono MM input, but there was rolled-off bass response of its transformer inputs. However, the preamp's nonstandard, 100-kilohm MM phono input impedance means that some MM cartridges will not have flat response, since a few cartridges might respond oddly to this load impedance. The subsonic filter had a shallow cutoff slope of 6 dB per octave starting at 20 Hz, not fully adequate to filter out the effect of warped records, and it does not filter the tape outputs.

Phono crosstalk is measured by driving one channel to 0.5-V output and measuring the output of the undriven channel with input terminated in accordance with IHF standards rather than a short. Results show −54.2 dB of leakage at 20 kHz, which is not on a par with the performance of the quietest competition.

The Sansui preamp's high-level section performed in an exemplary manner. It provided 18 dB of gain at a signal-to-noise ratio of 89.2 dB, A-weighted. It had a slew rate of 25 V/μS at 10-V peak-to-peak output. Oscilloscope observations suggest this stage is bandwidth-limited, which is preferable to slew-rate limiting. THD + N measured below 0.005%, 20 Hz to 20 kHz, at 0.5-V out. The C-2301 was capable of putting out 27 V at 20 kHz with less than 0.1% THD + N when driven "CD" in to "Normal" out.

Amplifier Measurements

The Sansui B-2301 coasted through the FTC's 1-hour, ⅓-power preconditioning at 8 and 4 ohms without "thermalling out." The top plate became only slightly warm and is not connected to the internal heat-sinks.

Voltage gain of the B-2301 amplifier loaded with 8 ohms was 24.0 dB, which is 2 dB below the usual power amp gain of 26 dB. Its steady-state power measurements easily exceeded Sansui's published ratings into 8 ohms (Table II). Minimum power was 316.3 watts into 8 ohms from 20 Hz to 20 kHz, and 443.1 watts into 4 ohms from 20 Hz to 20 kHz. Measurements were also made into 2-ohm loads (a condition not rated by the manufacturer), and the amplifier comfortably delivered a minimum of 141.3 watts per channel, limited only by Sansui's 15-ampere line fuse. THD + N at the amp's rated power output of 300 watts per channel (48.99 V into 8 ohms) was 0.0016% at 2 kHz, rising to a maximum of 0.0035% at 20 kHz and 0.088% at 50 kHz.

IHF dynamic headroom into 8-ohm loads proved to be 1.75 dB, with the amp putting out 59.9 V (448.5 watts per channel) at 1 kHz into 8 ohms using a 20-mS on/480-mS off

SHORT-CIRCUIT CURRENT TEST

Modern power amplifiers are designed to deliver an output voltage that is independent of load impedance, within limits. A short-circuit at the output terminals would quickly destroy an amplifier if it did not have protection. Partially reactive loads, like real loudspeakers, do require output current at the instant the voltage waveform is passing through 0 V. This instantaneous condition is similar to the continuous requirements of a short-circuit; thus, the protection circuitry may be activated even though there is not a true short-circuit present.

The tone-burst test for maximum current into a short is designed to simulate the requirements for driving a reactive load. The test consists of a 0.1-ohm output load, which is almost a short, and a 20-mS burst of a 1-kHz sine wave once every 0.5 S. The level of the input signal is gradually raised until distortion of the output voltage waveform appears. The peak-to-peak value of this waveform is recorded from the oscilloscope trace. The rms value of this current during the 20-mS burst is derived by calculation from Ohm's Law.

The rated current of an amplifier can also be derived from the power and load resistance ratings by another version of Ohm's Law: I equals the square root of P/R (rated power divided by resistance). Thus, an amplifier rated at 200 watts into 8 ohms has a rated current equal to the square root of [200 divided by 8], or 5 amperes. If the short-circuit current is equal to or greater than 5 A, the amp will drive a purely reactive load of 8 ohms, or virtually any loudspeaker that is rated at 8 ohms, without activating its protection circuitry.

It should be mentioned that no correlations yet exist to show that amplifiers yielding high current ratings on this test can be successfully differentiated from lower current amplifiers during double-blind listening tests.

A detail important to the accuracy of the short-circuit current measurement is also worth mentioning. Contact and wire resistance can cause inaccuracies unless a "four-wire" technique is used to derive the current. The voltage across the resistor must be measured at the resistor terminals and not at the amplifier terminals, as shown in Fig. B1. The important parameter is not the exact total load on the amplifier (even if various lead resistances brought the total up to 0.2 ohm, it would still be very nearly a short), but the voltage across precisely 0.1 ohm of the total. This voltage and resistance can be used to calculate the true current.

—L.L.G. and D.L.C.

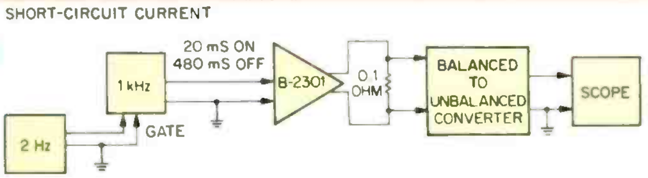

Fig. B1—Circuit for testing instantaneous current delivery capacity of amplifiers such as the B-2301.

Into 8 ohms, the amp delivered 316 watts, with 443 into a 4-ohm load. Several of the other measurements were likewise superb.

pulse. At 1-watt output, no harmonic distortion was detectible; only noise was found.

Other measurements on the amplifier proved to be superb. Damping factor was over 267 at low frequencies and 32 wide-band. IHF slew factor was 3.0, and the amp exhibited a slew rate of 80 V/µS. Large-signal rise-time is shown in Fig. 6, where the Sansui amplifier achieved a rise-time of 2.5 V/µS at 10 kHz, at 49-V out. With a 20-kHz square-wave input, the amp is stable, with some ringing from the output decoupling network, into a load consisting of 8 ohms and any capacitance up to 1.0 µF. The frequency response rises at 20 kHz by 0.2 dB when the amp has a 1.0-µF load. Otherwise, the small-signal frequency response is ±0.5 dB, 10 Hz to 150 kHz, and ±2.0 dB, 10 Hz to 300 kHz. The signal-to-noise ratio is 90.5 dBA from 1.0 watt in the left channel, and crosstalk is better than −71.3 dB at 20 kHz, worst case.

The B-2301's gorgeous, 32-element amber (on) and orange (off) LCD meters span the range from below −55 dB (0.001 watts) to greater than +2.0 dB (500 watts), referenced to 8-ohm loads. Driven by a single-cycle tone burst at 300-watts out, the meters read −6 dB at 10 kHz and −20 dB at 20 kHz, when they should have read 0 dB. For sustained signals, the meters showed +2 dB at 20 kHz and −6 dB at 20 Hz.

Clipping behavior is shown in the 'scope photos in Figs. 7 and 8. When the amp is driven at 10-dB overdrive at 300 Hz, small "horns" of high-order harmonics appear on the clipped waves. There is no sign of line-frequency modulation, indicating independence from power-supply ripple. At 20 kHz, slight clipping caused mutual conduction, with the current draw rising from 17 to 22 amperes quickly, the amp shutting down after 3 S, then resetting.

Author Clark has devised a test setup, shown in Fig. B1 and described in the sidebar entitled "Short-Circuit Current Test," to gauge an amplifier's instant current delivery. Clark drove a 1-kHz pulse, 20 mS on/480 mS off, into the B-2301 amp, which was driving a 0.1-ohm load. This amp was able to deliver a peak of 2.8 V into this load—which means 20 A rms was delivered into a virtual short! This is a *substantial* output for any amplifier.

Use and Listening Tests

Initial listening tests suggested that the C-2301 preamplifier suffered from a lack of bass, as no deep bass was evident on organ recordings in comparisons between the Sansui and Greenhill's preamp. This was tested with an ABX comparator, which randomly switched the moving-coil cartridge output between the Sansui and the reference preamp. Details of this procedure are listed in the sidebar entitled "Comparator-Controlled Listening Tests." Under double-blind conditions, Greenhill was able to accurately identify the Sansui's comparative lack of bass in 16 out of 16 attempts, after both amps had been matched to within 0.2 dB at 1 kHz using the CBS STR-151 test record and a digital voltmeter. This finding has very high statistical significance.

On a more subjective basis, the Sansui preamp presented a flattened sonic perspective, with little depth of imaging. Dynamic range on a number of percussion recordings was compressed. Gain for the moving-coil was adequate using

Table I—Preamplifier measurements, Sansui C-2301.

Circuit Stage Gain, dB	
Phono to Tape Out	
MM	36.9
MC, Transformer High	56.2
MC, Transformer Low	64.6
MC, High (No Transformer)	30.3
CD Input to Main Out	18.0
S/N, Worse Channel, dB	
High-Level Inputs to Main Out	
IHF (0.5 V In/Out)	89.2
Maximum Gain	93.2
MM Phono to Tape Out	85.9
MC Phono to Tape Out	
Transformer High	71.2
Transformer Low	62.6
No Transformer, High, 100 Ohms	66.8
Phono EQ Error, 20 Hz to 20 kHz, dB	
MM Phono Input, 100 Kilohms	+0, −0.1
MC, Transformer, 30 Ohms	+1.0, −2.0
MC, Transformer, 3 Ohms	+1.0, −2.0
MC, No Transformer, 100 Ohms	+0.1, −0.1
Subsonic Filter Roll-Off, dB	
20 Hz	−0.5
10 Hz	−2.0
5 Hz	−5.1
Crosstalk, CD Input to Main Output, dB	
20 to 200 Hz	−87.0
1 kHz	−81.1
2 kHz	−76.7
5 kHz	−67.9
10 kHz	−62.3
20 kHz	−54.2
Phono Overload at 1 kHz, mV	
MM Phono Input	414.0
MC, Transformer High	44.9
MC, Transformer Low	17.1
MC, High (No Transformer)	487.0

Table II—Power output per channel and distortion, 8-ohm loads, Sansui B-2301 amplifier.

Freq., Hz	V	Power, Watts	THD, %
LEFT CHANNEL			
20	51.0	325.1	0.003
200	50.3	316.3	0.0017
2k	50.9	325.9	0.0017
20k	51.0	325.1	0.0051
RIGHT CHANNEL			
20	51.0	325.1	0.004
200	50.5	318.8	0.004
2k	50.7	321.3	0.003
20k	51.0	325.1	0.007

On a double-blind basis, the preamp's phono section lacked bass; this had been detected earlier during subjective listening tests.

the "Low" transformer position, but was insufficient on the transformer bypass position ("High MC") using a Yamaha MC-1000 MC cartridge. In addition, the Sansui preamp was more susceptible to hum fields than comparable units. The panel lights tended to flicker when controls were switched.

These drawbacks are unfortunate, for the ergonomic design of this C-2301 preamp is outstanding. The record-selector switch allows for recording one source (such as a tuner) while listening to another source (for example, records). In addition, the small attenuator control (with its detents) proved to be very useful; by switching to source direct, the line amps in the preamp are bypassed and the small attenuator takes over for the master volume control. This can be very helpful when one wishes to leave the central volume control at a precise setting for comparing preamps but wishes to adjust the volume in the meantime without disturbing the main setting.

The B-2301 amplifier is an excellent product. Speed, power and ultra-bandwidth have been emphasized, and this involves some rational design trade-offs, such as the mutual conduction at 20 kHz and the horns that appear on the waveforms when the amp is clipping.

Externally, the amp has few peers. Its color combination of reddish-black persimmon wood with the amber and orange of the LCD meters is visually stunning. The meters have the most attractive combination of peak-and-hold function we have come across, even if their accuracy was less than laboratory grade. The peak setting remains for 4 S, but the instantaneous display continues. This is more useful and interesting than the display in the Accuphase P-600 amplifier (reviewed in the August 1984 issue), which allowed only peak readings or instantaneous readings.

The amp does very well sonically. Subjectively, Clark

Table III—Power output per channel and distortion, 4-ohm loads, Sansui B-2301 amplifier.

Freq., Hz	V	Power, Watts	THD, %
LEFT CHANNEL			
20	43.9	482.9	0.005
200	43.1	464.4	0.005
2k	42.1	443.1	0.0023
20k	42.7	455.8	0.008
RIGHT CHANNEL			
20	42.6	453.7	0.004
200	42.8	457.9	0.004
2k	42.3	447.3	0.0038
20k	42.5	451.6	0.008

COMPARATOR-CONTROLLED LISTENING TESTS

Controlled listening tests are designed to avoid biases on the part of the critic and maximize psychoacoustical fairness. That is, in order to keep the critics' pet biases about the weight, appearance, cost or brand from influencing their sonic opinions, these tests are double blind so that neither the listener nor the test administrator (in this case, the same person) knows whether the reference amp or the amp being reviewed is playing. In our case, switching between different amps was practically instantaneous (less then 50 mS) in order to make subtle sonic differences as apparent as possible, since the human ear-brain system has a notoriously poor ability to store sounds well over time.

To make possible such an instantaneous-switching, double-blind test, we use a laboratory-grade audio comparator from the ABX Company. It consists of control circuits and relays that can rapidly switch between different inputs. The listener compares sounds and decides whether a particular source, designated X, is sonically the same or different from each of two known sources, designated A or B; X actually is either A or B, depending on the random connection made by the comparator's logic for that particular trial. The critic writes his response on a test paper. Digital memory circuits store the sequence of connections for retrieval and analysis at the end of the test.

The ABX comparator system generates data in a statistically similar manner to flipping a coin and predicting whether it will come up heads or tails. Each of the two results is equally probable, so random predictions are likely to be correct 50% of the time, as with Clark's comparison of the Sansui B-2301 and his reference amplifier in the accompanying review. Since each of our comparisons comprised 16 trials, a critic could obtain a score of 8 correct if he could hear no differences and were just guessing. Any score much above 8 correct is thus better than chance and might be significant. How far above 8 the results must be to determine significance depends on how certain one wants to be of the result.

Using published tables of the binomial statistical distribution, we have calculated the likelihood of correct scores for each listening test. We found that obtaining a score of 12 correct out of 16 trials gives a confidence level of 95% or more that the outcome was not due to chance. Results at this confidence level are the minimum commonly accepted by sciences such as medicine before they're judged to be statistically significant.—*L.L.G. and D.L.C.*

(*Editor's Note:* Readers of *Audio* are entitled to be aware that Author Clark is a director and partner in the ABX Co., makers of the comparator used in these tests, and potentially stands to gain from sales of the unit. I should say, too, that I know of no comparable product with all the features required for such testing.—*E.P.*)

The amp showed deep bass and etched highs during subjective listening tests, but double-blind tests showed no difference from the reference.

found it produced a rich, full bass and etched highs. Greenhill also observed the amp had a full bass, a boost in the warmth audio region, and good depth of imaging, with an openness and spaciousness heard on few other amps. The deepest bass of the organ and bass drum was not equal to that heard on Greenhill's reference Levinson ML-9 240-watt-per-channel (tested) amplifier driving Snell A/III speakers. Subjectively, the B-2301 seemed less apt to clip on mid-band orchestral music when driving B & W 801 loudspeakers than the reference amp when precisely gain matched and switched in; that would be expected. Greenhill's reference amp clips at 378.4 watts per channel into the 4-ohm loads presented by the Snell A/IIIs, while the Sansui puts out about 1 dB or 69 watts per channel more (447 watts per channel at clipping) at the same frequency.

Greenhill was unable to corroborate the subjective impressions of the B-2301's bass response during an A/B/X double-blind test against the reference amp, scoring 9 correct out of 16. Clark also carried out double-blind A/B/X testing in his listening room, but only correctly identified the Sansui amp 50% of the time when compared to a popular 115-watt-per-channel amplifier. These are chance scores.

What do the listening evaluations mean? Author Clark concluded that the B-2301 is an expensive, sonically neutral power amp. Greenhill pointed out that both of them had independently heard the amp's rich, full bass response and the etched highs in two different listening rooms with very different associated equipment. Didn't that mean anything? Clark responded that amplifiers housed in dark, rich persimmon wood often turn out to sound rich and full in bass response when reviewed by subjective critics. In the case of the Sansui B-2301, the double-blind listening tests didn't support the casual listening impressions. Greenhill replied that the amp continued to sound rich and full, even after he knew the results of the controlled tests.

In conclusion, we feel that the Sansui components examined here are physically beautiful and wonderful to operate. The lack of enthusiasm about the Sansui preamp comes from the frustration of finding a marvelously functional preamp hobbled by sonic limitations, particularly for MC cartridge lovers (the very folks most apt to buy this unit). A few internal circuit problems give us reservations about the C-2301 preamp, including the MC transformer, the subsonic filter and the MM phono load impedance. We believe such problems should not occur in a $2,700 preamp—but you must decide whether these are problems large enough to keep the C-2301 off your potential-purchase list. We would strongly recommend the B-2301 as a high-current amplifier with a subjectively (unproven in the double-blind comparisons, unfortunately) rich bass response and very smooth highs that provide strong revelation of detail.

Laurence L. Greenhill and David L. Clark