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SONY APR-5002 ANALOG TWO-TRACK RECORDER

Reviewed by Peter Butt

The APR-5002 is the first new product to emerge from the former MCI Fort-Lauderdale facility since that firm was sold to Sony more than two years ago. At only 91 pounds, the APR-5002 is smaller and lighter than other professional quality mastering recorders have ever been. The machine accommodates reels of up to 12½ inches diameter, and quarter- or half-inch tape widths. The APR-5000 is supplied in a number of configurations, from monophonic, full-track ¼-inch, to two-track NAB-or DIN-track geometry, to two-track ½-inch format in two speed configurations, covering the range from 3.75 to 30 ips. Equalization characteristics are IEC, NAB, and AES selectable. The model tested is the one featuring the higher three common analog tape speeds: 7.5, 15 and 30 ips with NAB geometry.

The machine is small enough to be used as a table-top unit or as console mounted in the optional SU-14 stand, allowing deck orientation to be horizontal or 15-degree tilt.

A tertiary central tape track intended for timecode purposes is to be available on APR-5003 two-track models within a few months. The exact nature of this feature remains obscure, although it is to include an internal SMPTE generator and the capability for "chase" mode operation. No mention is made of timecode offset accommodation capability, an important feature for real-life synchronization applications. The preliminary service manual accompanying the machine refers to a "special" timecode track equalization used with record/play functions provided by a fourth head situated between the erase and record heads. No further description of the timecode recording process is given, although one would infer that it is based on linear analog recording/reproduction, rather than a modulated carrier to permit data scanning at high tape shuttle speeds. The machine is configured to facilitate synchronized applications with all deck and audio/data channel status/control functions accessible through parallel and RS-422 serial ports at the rear of the deck assembly. Flux-frequency references for timecode track alignment have not been indicated thus far.

The APR-5000 is microprocessor controlled; evidently, the CPU is time-shared between deck-control duties and signal-channel functions. All signal-channel functions, except manually uncalibrated input and output gain adjustments, are controlled by the CPU. All audio control settings are indicated in a two-digit hexadecimal code, giving 256 discrete values for input-monitor level, record level, record-HF boost, record-bias drive, reproduce and sync gain, LF

Figure 1: Input impedance magnitude versus frequency for input port 1, typical.

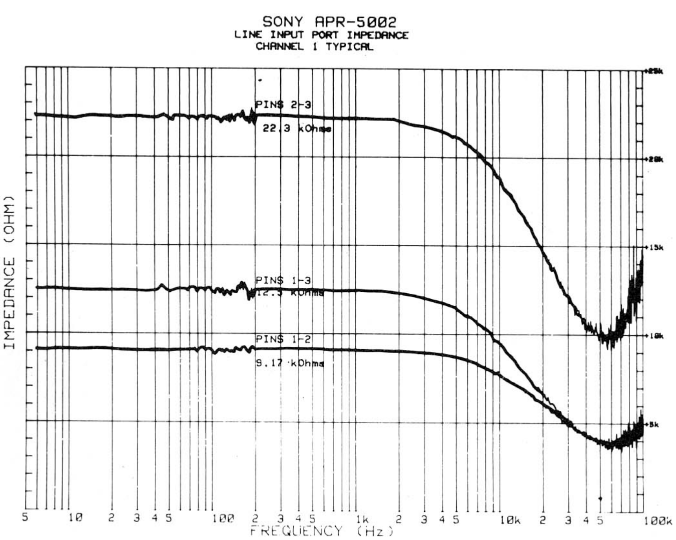
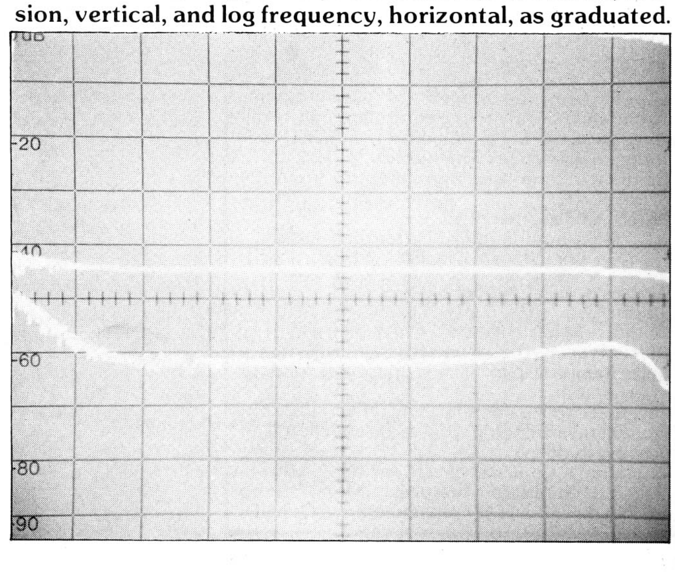


Figure 2: Input port common-mode response. Top trace is the normal-mode response of channels 1 and 2 overlaid; top graticule reference is +4 dBv. Common mode responses for channels 1 and 2 are shown as the center and bottom traces, respectively. Scale factors are 10 dB/division, vertical, and log frequency, horizontal, as graduated.



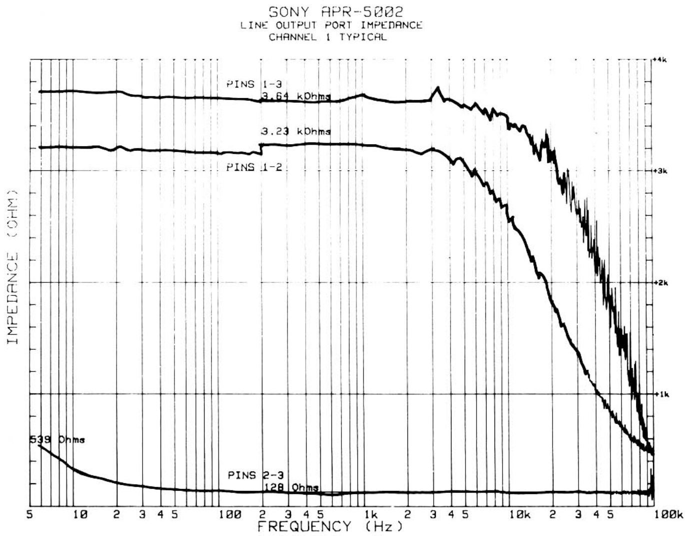


Figure 3: Output impedance magnitude versus frequency for output port 1, typical.

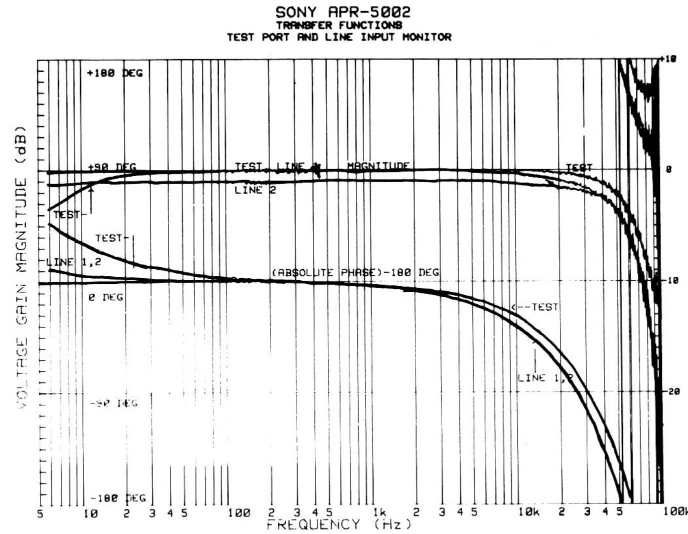


Figure 4: Input monitor transfer functions for main audio channels and Calibration Input/Output ports. Main audio channels phase contours are rotated -180 degrees for clarity.

and HF equalization. (Oddly, the hex code for maximum setting values is "00," while minimum values are indicated by "FF." The numerical weight of the indication is inversely related to the magnitude of the indicated variable.)

The unit's service manual gives the use of each of the control and alignment functions in a step-by-step sequence, where proper CPU responses are indicated, as well as the precise stimulus sequences required. The sequential and conditional precision demanded by semi-smart devices is difficult to convey by general discussion. The hand-holding instructional approach taken by the writers of the APR-5000 manual is appreciated, and should be emulated by other manufacturers as well. All visual annunciators or indicators are either LEDs or electroluminescent devices that need no external lighting for functional visibility, and can therefore be clearly seen in low ambient lighting. LCDs don't serve well in the dark.

Provision is made for the retention of data for up to three audio electronics alignment settings, for each of the three tape speeds. The alignment-data memory is kept alive during power interruptions by an internal battery; tape counter and the 30-address program cue point data are not retained during power interruptions, however. This oversight would seem to be minor, as all sections of random-access memory could be easily serviced by the same stand-by power source.

The mechanics of the APR-5000 show vestiges of the MCI heritage. The MVC control is still a deck feature, although it mechanically resembles the Sony videodeck counterpart, relying on body capacitance sensing for activation in shuttle modes only. Head suspension is substantially identical to that of the JH-110 machines, with ISO metric hardware. The head assembly is rotated approximately 45 degrees counter-clockwise from the customary parallel-front position. Mercifully, the sheet of ¼-inch aluminum that served as the deck chassis for MCI tape machines has been replaced with a true aluminum casting. Although still in use by at least one tape-machine manufacturer, the single-slab approach to deck design has been proven inadequate, and should have been universally abandoned by the industry years ago.

A spooling function is provided through use of the MVC control in shuttle mode. Winds are smooth and clean, although they do tend toward the uneven at the higher of the MVC speed range. Spooling does not engage the capstan.

Head-shield activation and tape-

Figure 5: Input monitor high-frequency group delay response. Curves are derived from the phase curves of Figure 4.

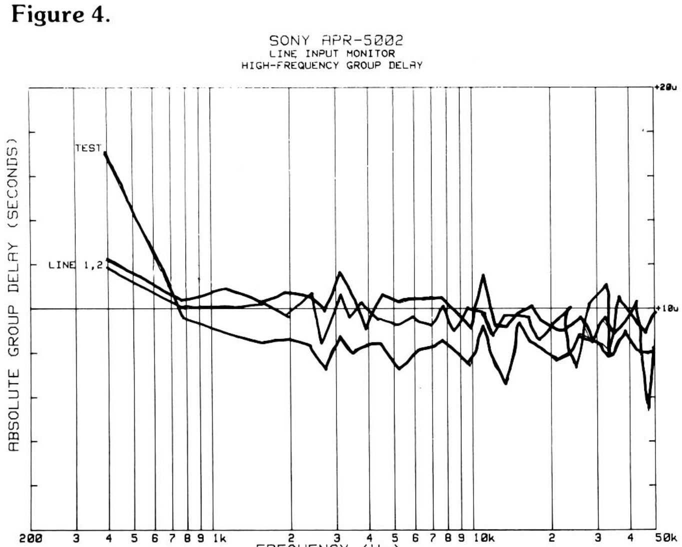
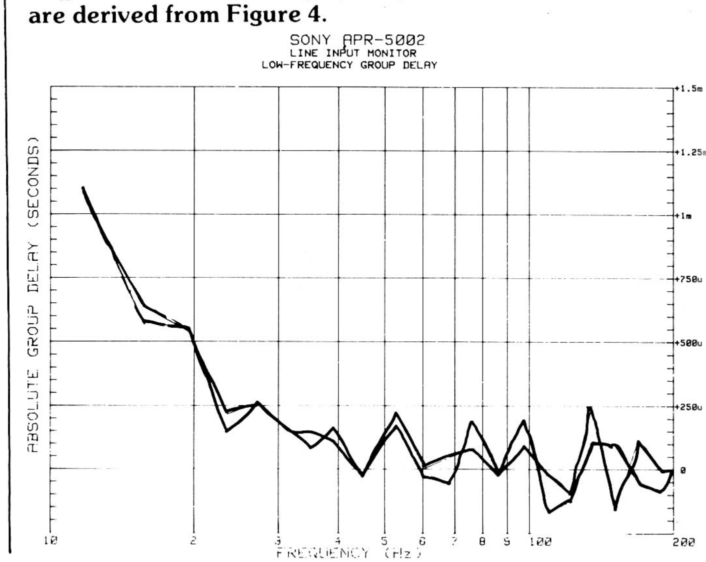


Figure 6: Input monitor low-frequency group delay response. Calibration Input/Output curve deleted. Curves are derived from Figure 4.



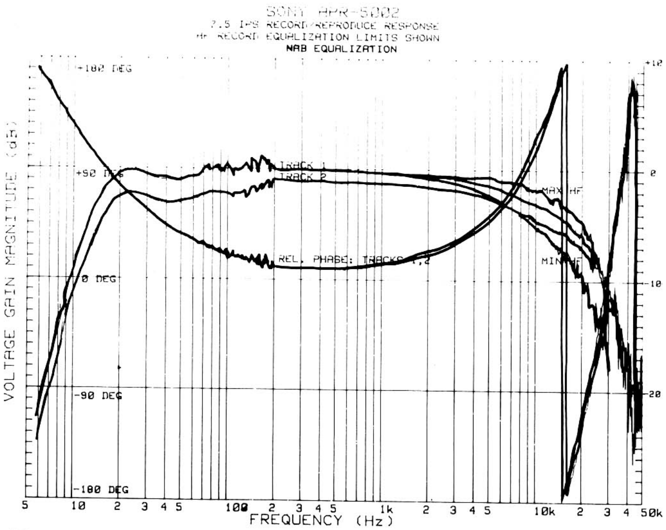


Figure 7: Record/reproduce transfer functions at 7.5 ips. Tracks #1 and #2 magnitudes are shown separated by 1 dB for clarity. The effects of maximum and minimum record HF boost are shown for track #1. Note that phase advances with frequency.

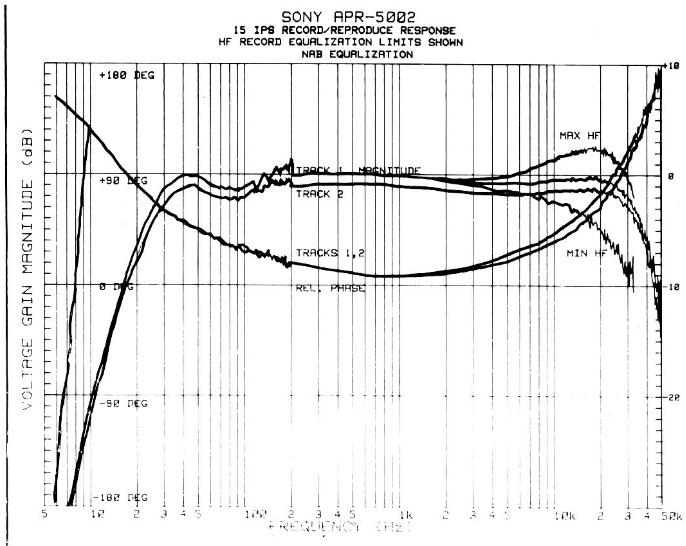


Figure 8: Record/reproduce transfer functions at 15 ips. The effects of maximum and minimum record HF boost are shown for track #1. Note that phase advances with frequency.

lifter functions can be defeated with toggling deck buttons. Changing the head-shield status does introduce a "thump" in the main audio channels, and should be avoided during play operation of the machine. Command of the machine can be transferred to an external controller and back by use of Network and Local command buttons. One should be able to safely presume that there is no interferance with Local manual operation of the deck from any external controller when the machine is set for Local control, and that the external controller is sheltered from deck status signals, which should be ignoring anyway when the APR-5000 is being manually controlled. Inasmuch as some machine controllers are not impervious to information that may be none of their business, this is a detail that can make a difference in convenience and efficiency of operations.

It is stated that local control of the deck is impossible in the Network mode. If this is absolutely true it could prove inconvenient, should a manual Stop command be necessary during external-control operations. Good sense dictates that the Stop command, from whatever source, should be able to override any other tape machine function, and that the user must never be denied his manual Stop option.

The RS-422 control port protocols and data timing schemes are not given in the manual. Attention is drawn to the possibility of the Sony Sync Master and BVE-5000 serving as machine controllers, but no promises are being made at this time; the relevant SMPTE documents governing the protocols are referenced, and that is all. The reluctance of most synchronizer and editing-system manufacturers to offer usable interfacing and control software for non-video devices is disheartening. It would be refreshing to encounter use of a standard data transfer and control system, such as the IEEE-488 standard, that would serve everyone's needs even though the overkill in using it would be extensive. It would seem that the tendency for equipment manufacturers to strive for new, unique and unfamiliar control interfaces, compatible only with a specific controller, is not in the long-term interest of anyone. I think it is time for the audio/video hardware industry to

Figure 9: Record/reproduce transfer functions at 30 ips. The effects of maximum and minimum record HF boost are shown for track #1. Note that phase advances with frequency.

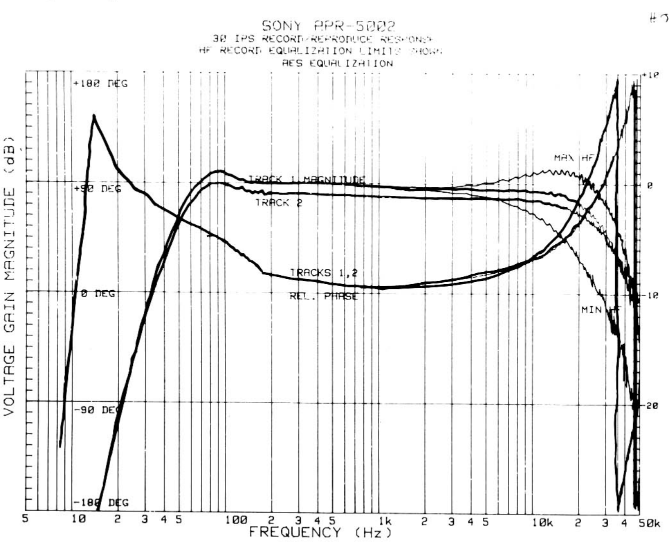
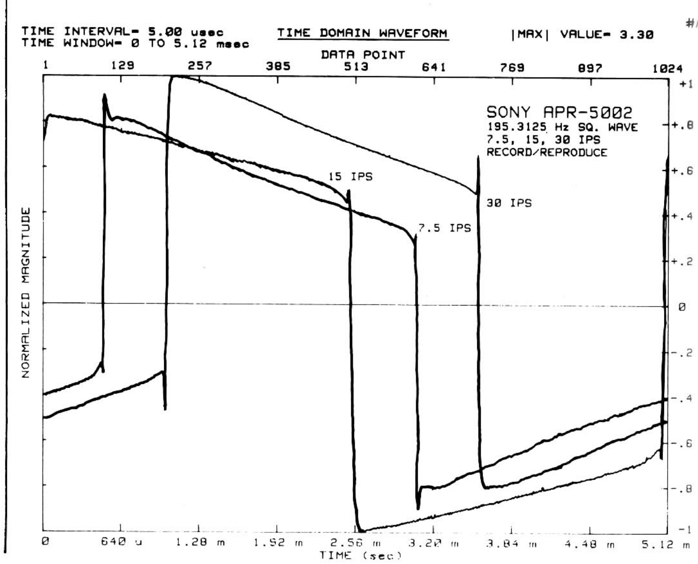


Figure 10: Time domain response at 7.5, 15, and 30 ips. The traces are displaced vertically and shifted in time for clarity.



stop re-inventing the wheel, and use technology that has served the rest of the electronics industry for over 10 years, and which has the capability of meeting its every possible need.

Spot erasure capability for either or both of the audio tracks, and perhaps for the timecode track, has been included as standard deck function. In this mode only the selected sections of the erase head are driven, so that manually-swept erasures can be accomplished without interference from any bias drive to the record head. If the timecode option does include this capability for the timecode channel, it should be used with great discretion since discontinuities in the timecode channel can render an otherwise perfect master unusable in synchronized applications.

The audio channels may be optionally muted during Lifter Defeat or, other non-play operation by transmission of a FDR Start Enable command via the parallel control port or, presumably, the RS-422 port as well.

Triggering of external noise-reduction devices is possible by use of optically-coupled conductances between pins of a rear-panel connector provided for this purpose. These conductances are rated at 24 VDC in their "off" condition, and 100 mA in their "on" state.

Cue monitoring of the audio channels is provided through a small speaker located to the right of the VU-meter panel. Acoustic level should be adequate for most applications, and a ¼-inch stereo headphone jack is available.

Rear-panel BNC coaxial connectors provide access to the audio channels for a test generator and measuring instrument. Activation of the audio-channel alignment function connects the signal appearing at the Calibration Input BNC, so that it is added to the normal audio channel inputs to provide calibration drive to the record electronics. The output signal of the channel selected to be controlled by the computer is routed to the Calibration Output BNC for observation. I'm not entirely sure that this feature is of great value for a one-, two- or four-channel tape machine, although such a feature can be extremely helpful in multitrack checks and alignments. Phase (not polarity) relationships between channel outputs cannot be observed directly through the Calibration facilities, because only one output is observable at a time — although the vector sum of the two channel outputs should be available if "All" channel adjustment mode is selected while in Sync or Reproduce mode. Optimal azimuth alignment could then be determined by adjusting for a maximum magnitude indication at the Calibration Output port.

In the case of inclusion of a timecode option, it is not clear that a squared timecode signal would not be present also in the reproduce vector sum. Nor is it clear how the timecode bias, level, and equalization adjustments could be done without use of the extender card. Timecode and output will evidently be available as a retriggered, squared binary-level signal as seen at the timecode output connector.

Performance Assessment

The machine provided for testing featured transformerless audio signal paths. Audio-port inputs are of the single op-amp, differential amplifier-type, while the audio output ports are dual op-amp, quasi-balanced push-pull drive. Single-ended output connections may cause significant, non-destructive ground currents in the grounded audio lead, and may cause difficulties in some applications; caution is advised. Inclusion of transformers in the audio input and/or output ports is optional.

The main audio input ports look into a single op-amp differential input. Impedance versus frequency characteristics between audio connector pins 1 and 2, 1 and 3, and 2 and 3 are shown in Figure 1. The differential load measured 22.3 kohms at 200 Hz, greater than the 10 kohms claimed. The impedances between each side of the audio input pair and ground were

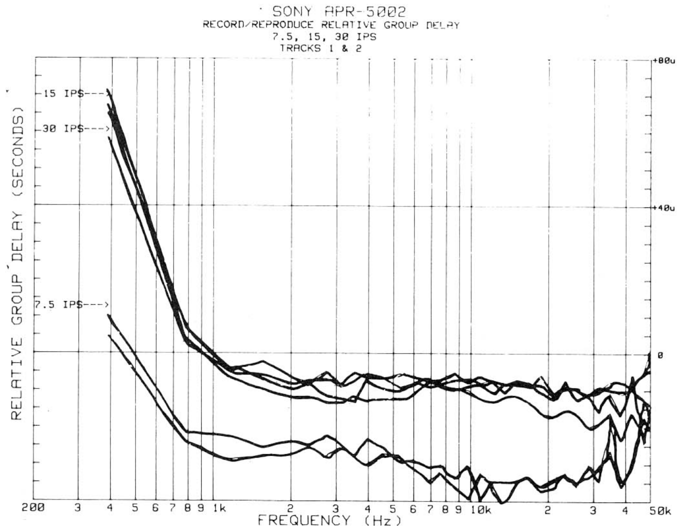


Figure 11: Record/reproduce relative group delay response. Group delays derived form Figures 7, 8, and 9 are shown overlaid.

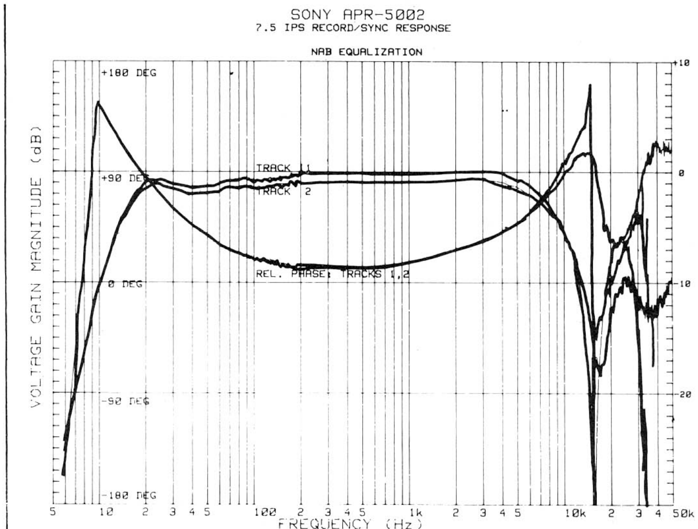


Figure 12: Record/sync transfer functions at 7.5 ips. Tracks #1 and #2 magnitudes are shown separated by 1 dB for clarity. The gap-loss null is readily observable in the magnitude null and phase reversal circa 15 kHz. Note that phase advances with frequency.

measured at 12.5 and 9.17 kohms, an imbalance of about 4:3. Inclusion of R-C lowpass filtering and cable capacitance is likely responsible for the drop in impedance magnitude at frequencies above about 2 kHz. Normal mode impedance magnitude declines to about 10 kohms at about 60 kHz, while the imbalance side impedances bottom out at about 3.8 kohms at the same frequency.

Input port common-mode performance is shown in the photograph of Figure 2 as observed at the respective main audio channel output ports. The top trace is the normal mode response at +4 dBv, channels 1 and 2 overlaid. The center trace is channel 1 common-mode response, and the bottom trace is the channel 2 common-mode response. Channel 1 and 2 CMRR is seen to be about 45 and 62 dB, respectively. Input port interfacing should present no problems.

Figure 3 shows the output-port impedance magnitudes for channel 1 output typical. Normal mode source impedance measured 128 ohms at 200 Hz, remaining constant to about 90 kHz. Line imbalance is about 3.62/3.23 or 9:8 for a perfectly floating load. I would like to see an output balance ratio closer to 1:1 for balanced outputs, although this condition seems to serve well enough. In situations where an active-balanced output is driving an imbalanced differential input (the most common condition), the resulting degree of line balance is determined by the parallel combination of side impedances of each port from signal pair to ground. If the output port has a fairly low impedance magnitude of side impedance, and is closely balanced, the condition of the entire circuit will tend to be in balance, even though the differential input load is imbalanced when observed by itself. This can be a significant matter in the case of high-intensity RF and magnetic fields where transmission line imbalance is most apparent. A common-mode rejection ratio of about 18 dB could be expected for a line imbalance of this magnitude.

Input-monitor transfer functions for the APR-5002, surprisingly, were found to be inverting for the normal audio channels. The Calibration Input proved to be the exception, having an erect polarity (not phase) response as observed at the Calibration Output port and at the main audio channel output connectors, pin 3 taken as "HI." Audio-connector pin 3 was taken as the "HI" signal terminal for

SUMMARY OF SONY APR-5002 SPECIFICATIONS

Specification	Quoted	Observed
Power Require-ments:	102/120/138/ 204/240/276 VAC; 48 to 60 Hz.	Yes
Power Consump-tion:	300W max.	Not checked.
Fuse Rating:	5A (102V), 4A (120V) 2A (240V); normal or fast blow.	Yes
Reel Size:	3 to 12.5 inches; NAB or EIA hubs; DIN hubs optional.	Yes
Tape Format:	0.25-inch, two-track NAB track-standard; 0.25 inch, two-track DIN track standard; 0.25 inch, 3-track center-track timecode. (0.5 inch, two-track timecode feature optional.)	As tested.
Tape Speed:	Standard (high-speed) 7.5, 15 and 30 ips; optional (low speed) 3.75, 7.5 and 15 ips; ±50% variable.	As tested.
Speed Stability:	Better than 0.02%.	±0.017% head to tail; 2,490 feet.
Start-Up Time	30 ips 900 mS; 15 ips 500 mS; 7.5 ips: 500 mS.	Not checked.
Fast-Wind Time:	2,400 feet 110 sec; 4,800 feet 170 sec;	2,490 feet 114 sec; Not checked.
Spool-Wind Time:	2,400 feet 370 sec;	2,490 feet 387 sec.
MVC Velocity:	0 to 1.9 meters per sec.	Not checked.
Wow and Flutter:	30 ips less than 0.025% 15 ips less than 0.035% 7.5 ips less than 0.055% 3.75 ips less than 0.10% (±peak, DIN-weighted).	30 ips: ±0.017% 15 ips: ±0.027% 7.5 ips: ±0.037% 3.75 ips: Not Tested W+F, peak, DIN-weighted.
Frequency Response: *Record/Play*	**30 ips:** 40 Hz to 28 kHz; +0.75/-2 dB. **15 ips:** 30 Hz to 24 kHz; +0.75/-2 dB. **7.5 ips:** 30 Hz to 20 kHz; +0.75/-1.5 dB.	**30 ips:** 53 Hz to 20.9 kHz; +0.8/-2 dB. **15 ips:** 29 Hz to 30.0 kHz; +0.1/-2 dB. **7.5 ips:** 14 Hz to 5.27 kHz; +1.3/-1.5 dB.
Frequency Response: *Record/Sync*	**30 ips:** 50 Hz to 16 kHz; +0.75/-2 dB. **15 ips:** 30 Hz to 10 kHz; +0.75/-2 dB. **7.5 ips:** 30 Hz to 4 kHz; +0.75/-2 dB.	**30 ips:** 42 Hz to 25.6 kHz; +1.4/-2 dB. 15 ips: 27 Hz to 21.3 kHz; +0/-2 dB. **7.5 ips:** 15 Hz to 6.8 kHz; +0/-1.5 dB.
Recorded (S+N)/N Ratio: Record/ Reproduce	30 ips 66 dB. 15 ips 64 dB. 7.5 ips 63 dB. 20 Hz to 20 kHz UNWTD; Ref: 510 nW/m.	30 ips 66.5 dB. 15 ips 62 dB. 7.5 ips 57.5 dB.
Recorded Distortion: (1 kHz; 510 nW/m) *3rd Harmonic*	30 ips less than 0.35%; 15 ips less than 0.52%; 7.5 ips less than 1.6%.	30 ips 0.16% 15 ips 0.50% 7.5 ips 1.8%.
2nd Harmonic	30 ips less than 0.10%; 15 ips less than 0.10%; 7.5 ips less than 0.10%.	30 ips: Unreadable at 15 ips: 30 Hz; analyzer 7.5 ips: resolution.
3% 3rd Harmonic Fluxivity Level:	30 ips: 1,040 nW/m. 15 ips: 1,020 nW/m; 7.5 ips: 1,000 nW/m.	Not measured.
Bias Frequency:	400 kHz.	Not measured.
Erase Frequency:	100 kHz.	Not measured.
Depth of Erasure:	Greater than 76 dB below 1 kHz at 250 nW/m; all speeds and track formats.	Erasure below 1 kHz at 520 nW/m: 30 ips 78/82 dB; Tk 1/2. 15 ips 80/84 dB; Tk 1/2. 7.5 ips 83/83 dB; Tk 1/2.
Audio Amplifier Electronics:		
Input Impedance	10 kohms, balanced.	22.3 kohms, imbalanced differential input.
Output Impedance	120 ohms, balanced.	128 ohms, imbalanced active differential.
Maximum Audio Output level	Not quoted.	+22.4 dBv (600 ohms); IHF load.
Weight *Table Top*	91 pounds; 46.26 kg.	Not measured.
Stand type	110 pounds; 49.89 kg.	Not measured.
ADDITIONAL OBSERVED:		
Polarity Response:		Audio port pin #3 taken as "HI":
Record/play		Negative
Record/Sync		Negative
Line In/Out		Inverting
Generator In/ Meter Out		Non-inverting
Generator In/ Line Out		Inverting
Line In/ Meter Out		Non-inverting
Repro/ Meter Out		Inverting
Sync/ Meter Out		Inverting
Hardware:		ISO Metric: Hex socket-head; Totsu head ("slot 'n' dot")
Testing tape stock:		3M 226-¼
Flux-Frequency References:		MRL 21L221, 21J205, 21T204.

Suggested End-User Price: APR-5001 (Mono) $6,800; 5002 (DIN/NAB stereo) $7,500; 5003 (DIN stereo plus IEC timecode) $9,000; SU-14 stand $500.

Manufacturer: Sony Corporation of America, Sony Drive, Park Ridge, NJ 07656. (201) 930-6137.

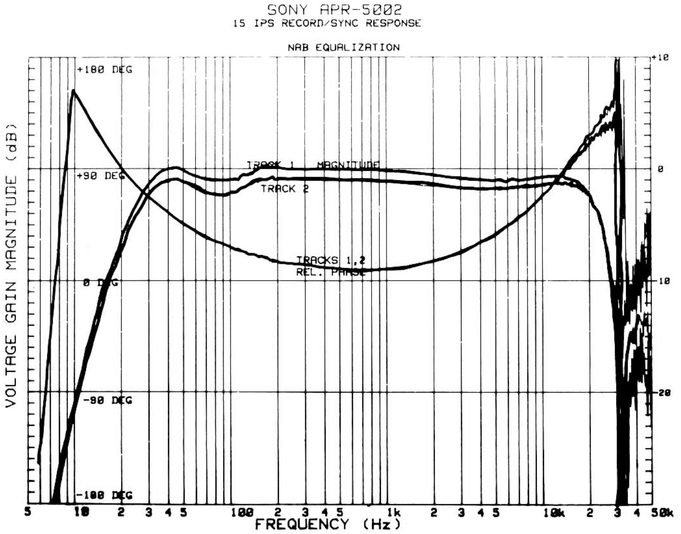


Figure 13: Record/sync transfer functions at 15 ips. Tracks #1 and #2 magnitudes are shown separated by 1 dB for clarity. The gap loss null is readily observable in the magnitude null and phase reversal circa 33 kHz. Note that phase advances with frequency.

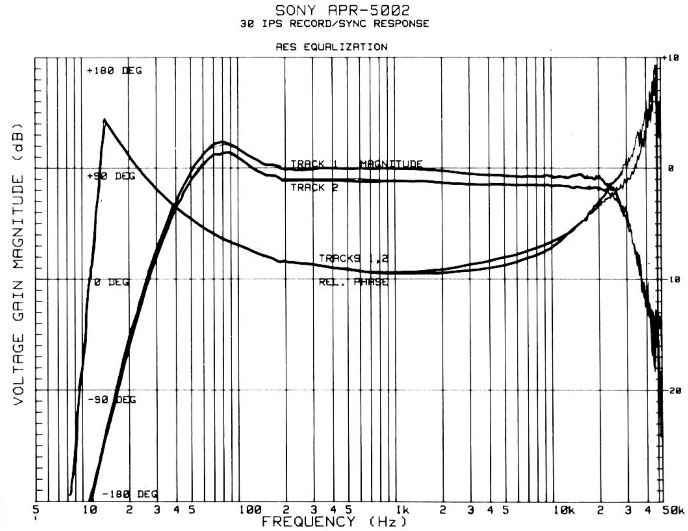


Figure 14: Record/sync transfer functions at 30 ips. Tracks #1 and #2 magnitudes are shown separated by 1 dB for clarity. Note that phase advances with frequency.

all measurements given here, which conforms with the conventions followed by both Sony and MCI in the past.

The input-monitor transfer functions are shown in Figure 4. Phase (not polarity) curves for main audio channels 1 and 2 are displaced -180 degrees so that they will tend to rotate about the central abscissa of the graph. The line-input magnitude functions are remarkably flat at low frequencies, showing only about 10 degrees of lead at 6 Hz. By contrast, the Calibration Input/Output response is down about 3.5 dB at 6 Hz with a phase lead of around 53 degrees, and down about 0.5 dB at 20 Hz. It should be possible to improve this performance to match the main audio channel response. At the high-end of the band, the main audio channel 1 magnitude tends to roll off a bit faster than the channel 2 or Calibration Input/Output does. All three channels were found to exhibit very linear lagging phase response with increasing frequency.

Group-delay response for the APR-5002 main audio and Calibration Input/Output channels is shown in Figures 5 and 6. Figure 5 shows that, in all cases, the curves flatten out and are approximately horizontal to 50 kHz, indicating equal propagation delay at all frequencies in that range. The notable exception is the delay curve labeled "Test" which rises steeply below frequencies below about 800 Hz — is a consequence of the low frequency magnitude rolloff in the Calibration channel noted above. Low-frequency group delay is shown in Figure 6 with the Calibration delay curve deleted, as it is off-scale through most of this region. The main audio channels' group delay becomes fairly flat above about 60 Hz, and oscillates about the zero-second abscissa above that frequency — a remarkably good performance for any AC-coupled audio signal device.

The APR-5002 attends to its prime task of recording and reproduction very well indeed, as witnessed by the curves of Figures 7, 8 and 9. The low-frequency contour irregularities are restricted to a band +1.5/-1 dB about the magnitude reference. Record/reproduce magnitude response was adjusted to be flat at 1 and 10 kHz against the calibrated reproducer using the CW sinewave signal. Flatness was observed to be within -1 dB of that reference line between the two frequencies. The data shown is the result of a deconvoluted Fourier transform of a 195.3125-Hz squarewave, and therefore represents a more dense signal spectrum than would a sinewave sweep. The magnitude response limits given in the Summary of observed performance were determined from these curves.

A seasoned reader of these equipment assessments will note the unusual signal phase-function behavior shown in all of these record/reproduce graphs. In this case, the signal phase *leads* rather than lags with increasing frequency — as is more often encountered for electronic signal paths in general — due to the inclusion of a variable, single-pole allpass filter network in the record electronics signal path. The frequency of the allpass pole is adjusted by the computer to track the phase response of the record pre-emphasis filter. This can be done with reliability, because there is no phase contribution to the analog record/reproduce processes, leaving only the electrical responses of the various electronic stages involved to be contended with. The reproducer phase response is largely dictated by the time constants of the reproducing characteristic to be used, leaving only the record phase response as the major variable in the system.

Time-domain plots of track #1's 195.3125-Hz squarewave response are shown in Figure 10. Each of the displaced squarewave traces shows a pre-transition spike, which is fairly small at the 7.5 ips speed, growing somewhat at 15 ips and becoming quite large at 30 ips. The 7.5 ips waveform shows a post-transition spike, implying that as great as the induced corrective phase lead may be at that speed, it is still not adequate to minimize the overshoot due to the phase rotation caused by the radical HF boost required to overcome the tape-wavelength response for flat magnitude response at that speed. At 15 ips, the phase correction would appear to be about the correct value for minimal overshoot, while the phase correction for the 30 ips case appears to be more than required. The absence of any ringing in the region of the squarewave transitions of Figure 10 indicates very accurate reproducer head termination.

The APR-5002 record/reproduce, relative group-delay curves for tracks #1 and #2 are shown in Figure 11. The conclusions drawn from examination of the character of the time-domain traces of Figure 10 are confirmed for the cases of the 7.5 and 15 ips speeds. The slight drop in the 7.5 ips delay in the region 6 to 30 kHz does look like the delay compensation could profitably be increased in this region. The 30 ips curve is close to optimal, with a slight droop above about 10 kHz. The choice of delay compensation as shown here is very close to optimal, and likely could not be improved very much to yield truly flat group-delay response.

The flux-loop sweeps of Figure 15 show the linearity of the pre-equalized reproduce head response versus frequency, while Figure 16 shows the same kind of data for the sync head. The lack of any deviation from linearity about the peak due to undamped head resonance is clearly indicated, showing careful attention to critical termination of the respective track cores. The two channels are very closely matched in all cases.

The flatness of the APR-5002 metering is quite good; Table 1 gives the observed meter response for a constant main audio input level. Examination of the magnitude curve for track #1 given in Figure 4 shows that the meter follows the channel magnitude response closely over the range measured.

Analysis Summary

The APR-5002 is easily the best analog tape machine to emerge from any manufacturer over the past several years. The quality of performance exhibited in these tests indicate that there may be hope for high quality audio recording in the absence of any more Ampex ATR-100s, the benchmark against which I have tended to judge all other analog machines. The wow and flutter performance is very good, although there is a tendency for the flutter readings to rise above their lowest values at the extreme head and tail of the reel.

The service manual is very complete, and offers step-by-step procedures for most significant repair and maintenance actions. The schematics and parts lists show the same completeness that Sony has given to its video equipment. Once one is introduced to the documentation philosophy and the nomenclature, it is fairly easy to find the relevant section of the manual that applies to a given situation.

The Totsu (slot 'n' dot) hardware may present problems in tooling for the technician accustomed to dealing with slot, hex-socket, Phillips and Posidrive hardware. Yielding to the temptation to make do with careful application of a common slot-blade screwdriver rather than the proper Totsu tools will result in unnecessary mayhem. The investment in proper quality tooling is always a rewarding, if intangible, one.

The machine is small, light and easily moved. All major electronic assemblies are accessible from the front, or by removal of the rear panels. The audio mother board is more than just a carrier of interconnects and board receptacles; it contains a couple of data demultiplexers, LED drivers and the cue-speaker drive amplifiers. The placement of significant active components on relatively inaccessible mother boards is, I think, a poor choice of configuration from a tech support viewpoint. The obvious difficulty in observing a circuit contained on a mother board assembly can be frustratingly since installation of the daughter boards is often required to

TABLE 1: VU METER INDICATION VERSUS FREQUENCY. (Constant line input.)

Frequency	Meter Indication
5	0.0 (dB)
10	0.0
20	0.0
50	0.0
100	0.0
250	0.0
500	0.0
1 k	0.0
2 k	0.0
4 k	0.0
6 k	0.0
8 k	0.0
10 k	-0.05
12.5 k	-0.15
16 k	-0.25
20 k	-0.35
25 k	-0.60
30 k	-0.80
40 k	-1.65

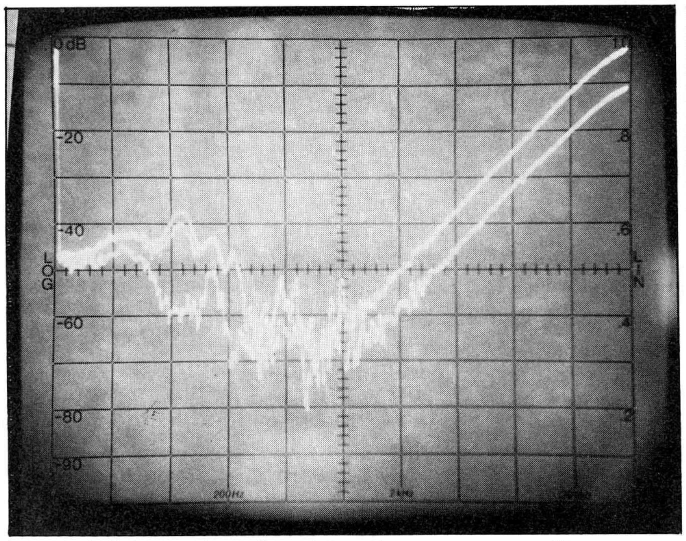


Figure 15: Reproduce head flux-loop response. The upper trace is track #1 response, track #2 is the lower trace. Scale factors are 10 dB/division, vertical, and log frequency, horizontal, as graduated.

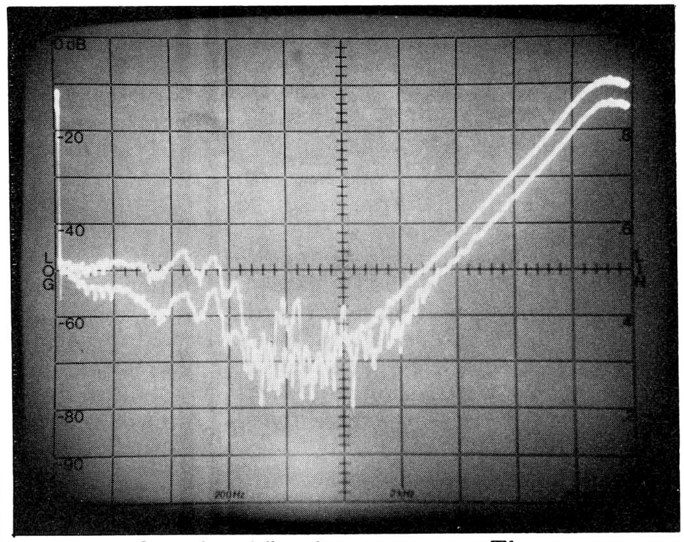


Figure 16: Sync head flux-loop response. The upper trace is track #1 response, track #2 is the lower trace. Scale factors are 10 dB/division, vertical, and log frequency, horizontal, as graduated.

place the system in a configuration permitting intelligent fault isolation and observation of dynamic signals.

The mechanical design is rugged, and the many exploded assembly drawings clear and uncluttered. Printed-circuit assemblies show the Sony influence, and bear white silk-screened component designations over a solder-resist coating. (There are a couple of "Oh yeahs" evident as components tacked onto foil runs in places they were obviously not originally intended — these problems will undoubtedly be corrected as serial numbers advance.)

The polarity-inversion problem is just one of those things that sometimes slip through the engineering design review process and, though mundane, needs to be corrected immediately. The most advantageous solution to this problem would seem to be reversal of the audio pairs at the main audio-input connectors, which would bring all signal ports into polarity agreement and result in erect recording and reproduction in both sync and play modes.

The matter of the inverse hexadecimal parameter indications is more a matter of preference on my part than a deficiency. The hex values are unique to any parameter magnitude, and serve their intended purpose.

The phase (not polarity) correction network seems to be designed very close to optimum for the speeds and equalizations observed. The ability of the microprocessor to track the record equalization delay as closely as it does is a compliment to its designers. Removing responsibility for proper delay compensation from the back of the maintenance technician is a definite technical step forward.

In closing, I should think that a deck having 14-inch reel capacity and four-track channel capacity would be a worthy entry for the pro audio/video market. Four-track is still widely used, since the central timecode track convention is not yet widespread, and new equipment capable of format compatibility with existing program libraries is still needed. ■■■

MANUFACTURER'S REPLY

Hiro Konno and Takeshi Yazawa, of the Product Management department, Professional Audio Division, Sony Corporation of America, reply as follows:

We appreciate the author's thorough evaluation and his report on our new product, the APR-5002. We have found it to be quite detailed, and our consensus is that the author did an excellent job.

However, there are some discrepancies in his findings, some misinterpretations of design goals, and general differences of opinion. We gratefully acknowledge the author's pointing out the polarity reversal in the audio path in production units. This problem has since been resolved by Engineering.

The areas requiring clarification are as follows:

1. **Published versus Measured Specifications Discrepancies:**

In this particular area, it appears as though the author's measured specifications were based on criteria other than those used by Sony engineering. Therefore his data is slightly different. Some of our specifications have recently been ammended (S/N ratio, 30 ips 65 dB; 15 ips 62 dB; 7.5 ips 62 dB), actually eliminating some discrepancies.

We do find a large variance, however, in his measured 7.5 ips frequency response and S/N and our factory measurement. We are not in a position to comment further without consulting the author on his test procedure and problems encountered. [We understand that Peter Butt used a 195-Hz squarewave excitation signal to provide frequency response measurements, which are available by examining the time-domain traces thus produced — *Editor.*]

2. **Timecode Processing:**

As this evaluation was intended to be on an APR-5002, we chose to provide no description of our timecode processing methods, or any actual operational specifications. The APR-5003 is uniquely different from the APR-5002, and trying to lump them together in an evaluation based on the APR-5002 alone would not be appropriate in our opinion. We are very pleased to supply an APR-5003 at a later date for a complete evaluation on its own.

3. **Memory Mapping and Data Back-Up:**

The APR-5000 Series retains all Audio Alignment, Search Cue points and Timecode status information in a battery backed-up memory system. Each specific type of data is mapped into its own unique locations, and is only written over by an operator performing a detailed alignment procedure. This data back-up also allows for each of the 12 possible head assemblies to have its own data for call-up at any time in the future. This data is also supported in the case of the power supply being reviewed for service. We do not understand why the author may have had a problem in this area.

4. **Serial Control Protocols:**

This is an area of conjecture by almost everybody today. We have chosen to support two protocols in the APR-5000 Series, both of which can only be practically realized in the

APR-5003, using a Time Referencing System (i.e. Timecode SMPTE/EBU). They are the Sync Master specific, RS-422A and specific sub-set of the Sony BV-type, emulating a BVU-800 for Transport Motion Control Commands. We refer to the work of SMPTE/EBU and the published documents to date in the manual. This is meant to give the readers some insight as to the work going on for the future implementation. In respect to protocol listings, Sony has a policy of supplying them on a controlled basis to qualified users, but not publishing them outright.

5. **Line Input Differential Coupling Imbalance:**

We do not agree with the author in his evaluation of this section at all. We use a hybrid Diff Amp for this section and, upon examination of the actual circuit, one can see that his results are not possible. We feel that he may have incorrectly connected his test equipment to the Input Amp and unbalanced it improperly, resulting in the results mentioned.

6. **Author's Comments on Signal Processing Performance:**

We feel that these are based upon personal opinion and, although valid on a strictly theoretical basis, are not achievable with the technology that is available today.

As always, we will continue to endeavor in achieving absolutely "perfect" audio performance, as technology allows.

7. **Audio Mother Board Servicing:**

The author comments on the lack of serviceability of this particular PCB. In actuality, this is *not* the Audio Mother Board, but the Audio Control Mother Board, located in the Meter housing. This PCB is easily accessed and serviced by anyone. In addition, the real Audio Mother Board is a passive backplane, which can be removed and repaired with the same relative ease.

8. **Polarity Reversal:**

The description of the reversal in polarity of the Audio Signal Path is correct and incorrect. He assumes that we use pin #3 as "HI," and proceeds to describe the reversal in terms of input coupling problem. In actuality, we conform to IEC Standard #286, which calls for pin #2 to be the "HI" in XLR connectors. The conclusion that we came to is that the coupling problem is actually in the output path (where it was later actually found and corrected).

As time does not permit consultation with the author prior to publication, we are confident that *R-e/p* will afford us the opportunity to reply in greater depth following our dialog.

□□□

News Letters Views

SONY APR-5002 REVIEW

from: **Takeshi Yazawa and Hiro Konno**
Professional Audio Division.
Sony Corporation of America

As indicated in the review article by Peter Butt [published in the August issue], there are some discrepancies between our published performance data and his data as measured.

As Mr. Butt's measurement method could not have possibly been the same as the one we did, we felt it was appropriate to describe the measurement method that we use in all of our tape-recorder products. It is broken down into two categories, of which detailed descriptions are as follows.

A: Signal to Noise Measurements

Using an AC voltmeter w/dB scaling for appropriate sensitivity and range, the machine is measured for the above. We use a reference fluxivity of 510 nWb/m, with a shorted Audio input, and bulk-erased audio tape for Signal-to-Noise measurements of Record Input to Playback Output. This produces a measurement of both the Record and Playback Signal processing systems. The resultant of this measurement can be expressed in weighted, unweighted, and dB(A) scales.

B: Frequency Response Measurements

Assuming that the machine has been properly aligned for flat-frequency versus amplitude response using an approved reproducer alignment tape, and has been calibrated for proper bias, Record level and equalization for the tape being used, the machine can be measured for overall frequency response — Record/Play. A precision sinewave oscillator is connected to the line input or calibration input connector and an AC voltmeter w/dB scaling is connected to the line or calibration output connector. At constant amplitude output, the oscillator is swept from approximately 10 Hz to the upper frequency limit of the device. These upper and lower frequency limits are defined as the 3-dB down points in measured outputs. Throughout this sweeping upward, the operator denotes the amplitude response variations (if any). Upon completion, the results are mapped out on a frequency versus amplitude scale and the appropriate standard deviation is noted ±. This can then be verified against a reference specification. The resultant is called the frequency response. □□□

Peter Butt replies:

Sony/MCI Product Management is correct on points A and B.

A. The (S+N)/N figures given in the tabulation at the head of the article were measured using biased tape that had not been bulk erased, and then passed over the heads in Record mode at the speed of interest, inputs shorted. It was then replayed by the reproduce head at the speed of interest. The reproducer had previously been calibrated and equalized for a reference fluxivity of 260 nW/m at 1 kHz for each of the relevant speeds. Because 20×LOG (510/260 = +8.81 dB, this figure was added to the +4 dBv meter calibration to yield a reference correction factor of +12.81 dB. The indicating instrument is a Hewlett-Packard 334A Distortion analyzer, Option H05. The average-responding 334A meter 30-kHz LPF noise reading was corrected to RMS by adding the standard 1.11 dB. The 30-kHz meter bandwidth was corrected by subtracting 20×LOG (30/20) = 3.52 dB from the reading.

The reported (Signal + Noise)/Noise data reported was derived as follows: S = (8.81 - Em + 1.11 - 3.52) Decibels: 20-kHz LPF unweighted.

B. Frequency response tolerance data was determined by first aligning, biasing, and equalizing the machine for the tape used at each speed of interest for the reproducer characteristics required. Flux reference levels were set to 260 nW/m at 1 kHz for each case. All equalizations were set using CW [continuous wave] sinewave signals at: 1 kHz, 10 kHz, and 50 Hz. Deviations were checked with a sine sweep from less than 20 Hz to a frequency greater than the high-frequency 3 dB break at the high-end of each track/speed response. The 7.5 ips response data was equalized similarly at a signal level 10 dB below the flux reference.

These preparations having been completed, the record/reproduce/sync frequency response of each was taken by recording a squarewave having a frequency of 1.963125 Hz for the frequency band below 200 Hz, and 195.3125 Hz for the band above 200 Hz. These signals were then reproduced in the appropriate modes and digitized in the time domain. The time domain data was then operated upon to produce the Discrete Fourier Transform, and then deconvoluted by the digitized, DFTd time-domain data of the generator squarewave output waveform. This operation yields the transfer function of the transmission device responsible for the observed changes in the time-domain output response, as compared with the input-signal time-domain response.

The resulting data is then plotted in such a way as to show the two bands of

. . . *continued on page 12* —

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— continued from page 8 . . .

data as a continuous transfer function. The frequency response data are then reported from inspection of the plotted magnitude data to the tolerances indicated by the manufacturer (±2 dB).

The variance in magnitude response indicated for the test results is due to the energy of the squarewave signal occurring at odd multiples of the fundamental frequency. For convenience, I choose to call data obtained by the above method the Dense Spectrum response, as it contains many more frequency components than does the single- or swept-frequency sinusoidal magnitude response. High-frequency response is shown more pessimistically this way, as the squarewave harmonics act to contribute to their own recording bias signal in a way proportional to their respective magnitude and frequency. I feel that this approach better represents the system response for the case of linearized analog magnetic record/reproduce systems than does the pure sinewave method, as sinewaves rarely constitute modulation signals commonly encountered. I grant that this is a more severe representation of the record/play magnitude frequency response. I do think it is more representative of common application.

I have begun to suspect that reality rarely has the charm of fantasy. ■■■

EXPOSING AUDIO MYTHOLOGY

Laying to Rest Some of the Pro-Audio Industry's More Obvious "Old Wives' Tales"

by John H. Roberts

In this month's column only I'd like to address some of the subtleties to balancing signals for transmission across the room, and across the country.

A popular misconception is that transformers are the *only* way to truly balance a line. Not only is this untrue, but many transformer-coupled lines are imbalanced by incorrect termination, or floated from ground intentionally.

Before we get into a strict definition of what is and isn't balanced, let's back up a minute and look at *why* one would want to balance a line. The basic goal is to transmit a signal from point A to point B with maximum fidelity.

There are many things that can happen between here and there to degrade your signal, such as: signal losses in the line; crosstalk between the channels; interference from outside noise sources; and ground-potential differences.

Signals within a given piece of equipment are usually routed around single-ended configuration, based upon the assumption that ground potential at all points within that box will be virtually identical. But for signals sent over any distance (like the inside of a large recording console), we must consider differences in ground potential. The most popular, and cheapest, way to correct for ground-potential errors is to use a differential summing amplifier (Figure 1).

$$V1=Vs+Vg\times[R2/(R1+R2)]\times[1+(R4/R3)]+Vg(-R4/R3)$$

For $R1=R2=R3=R4$,

$$V1=Vs+Vg(0.5\times 2)+(-1\times Vg)$$

$$V_{load}=V_{source}$$

The ability of the circuit shown in Figure 1 to reject this common mode of ground potential is directly related to the matching of R1 to R3, and R2 to R4. Typically, 1% resistors will be used in such circuits with critical applications being trimmed. The ratio of R1, 3 to R2,