Tascam CD-RW900SL CD Recorder

By Gary Galo, Regular Contributor

PHOTO 1: Front view of the Tascam CD-RW900SL CD recorder. Rack mounts are included with the recorder.

Teac Corporation
7733 Telegraph Road
Montebello, CA 90640
323-726-0303
www.tascam.com
$699
12.2" × 19" × 3.7"
(309mm × 483mm × 94mm)
10.4 lbs. (4.7kg)

The CD-RW900SL is one of two stand-alone, single-disc CD recorders manufactured by Tascam, the professional audio division of Teac. The CD-RW900SL is an updated version of the CD-RW900, which improves on its predecessor mainly in added features. As Tascam notes in its product overview, "Recently added features include Auto Cue and Auto Ready from the menu, selectable I/R remote Enable/Disable, and MP3 Action Setting (prevents accidental termination of continuous MP3 playback)." The earlier version also had conventional tray loading; the "SL" version has a trayless, slot-loading transport. The "SL" version also has 24-bit A/D and D/A converters (the previous version may have, but the manufacturer didn't specify).

Although the list price of the CD-RW900SL is $699, street prices vary and are often considerably less. I bought mine on eBay for $439, but there's one catch: Make certain that you buy from an authorized Tascam dealer, and that the unit you intend to purchase is covered by the US warranty. My eBay dealer was Jim's Music Center, which met both criteria. They have a 99.9% positive rating, shipped the same day I ordered (and emailed me the UPS tracking number), and provided a one-year extended warranty for free. As of this writing, a number of dealers are still selling the original version; if you want the new features, make sure yours has the "SL" suffix.

ANALOG AND DIGITAL I/O

The CD-RW900SL has unbalanced (RCA) analog inputs and outputs, plus S/PDIF coaxial (RCA) and Toslink optical digital inputs and outputs. Tascam also makes the CD-RW901SL, which adds balanced XLR analog inputs and outputs, plus AES/EBU digital I/O. The 901 version also allows external control via both 9-pin RS-232C serial and 15-pin parallel "D" connectors, and is supplied with a *wired* remote control (not infrared) that you must plug into a mini-phone jack on the back of the unit. Otherwise, the two versions are identical (if you prefer a wireless remote, you'll want the unbalanced 900 version, reviewed here).

The Tascam records on standard CD-R and CD-RW (rewritable) discs. Because the unit is a professional recorder, you can use any recordable CD media—data or music. Even if you are not a professional user, I would consider purchasing a pro CD recorder rather than a consumer unit. With a consumer unit, you must use "music CD-R" media, which are often twice the price of regular CD-R media. If you do a lot of recording, you'll save money using a professional recorder (I am assuming that the recorder will be used for legal purposes only; don't use any recorder to violate copyright laws!).

Tascam's technical sheet on the CD-RW900SL lists approved brands of CD-R and CD-RW media. In my work as audio engineer at The Crane School of Music, SUNY Potsdam, I use mostly Mitsui Gold CD-R discs for long-term archiving and Fuji discs for general-purpose distribution. Neither is listed among the approved brands, but both seem to work fine.

The safest bet is to stick with reputable, name-brand discs, and steer clear of the cheap no-name or "house brand" discs sold by your local office supply store. With CD recording, there's no substitute for reliable and repeatable performance, and with blank media you get what you pay for. The Tascam will work with media designed for high-speed duplicating, so you don't need to search for discs designed specifically for "1×" (real-time) recording.

PLAYBACK FUNCTIONS

The Tascam recorder features a fluorescent display that offers a generous amount of data. You can activate most of the CD-RW900SL's functions, including the menu system, from the front panel. The wireless remote control makes getting to some of them easier, however.

The Tascam remote has an intelligent keypad system for track selection. Only "0" through "9" appear—there is no "10" button for selection of tracks 10 and higher. Simply enter the track numbers directly—2 then 3 for track 23, for example—then press the play button. The "direct search" function allows you

to go to a specific place within a track. If you want track 3 at 1:15, simply enter 003 001 15 on the remote, and the player will begin at that spot.

With many CD players, you must toggle the skip button to select a specific track if you're not using the remote. The CD-RW900SL has a jog wheel—which you can also use for menu selection—that allows you to simply dial up the track you want (then press play). The time key on the front panel or remote allows you to toggle between elapsed track time, remaining track time, total elapsed disc time, and total remaining disc time.

The Tascam supports other playback functions that have become standard on most CD players, including random playback, repeat playback, and programmed playback. "A-B" repeat playback allows you to select start and stop points within a track (but not across tracks). Autocue allows playback of any track to commence after the level rises above a predetermined point, and audio-ready cues up the next track after a single track has been played. A timer playback function allows you to start a previously loaded disc when the player is powered up from an external AC timer.

The Tascam will also play MP3 files, and the "directory" mode allows you to select nested directories and play/select files within each directory. CDs that contain MP3 files can be played on the CD-RW900SL as long as there are no more than 999 MP3 files on one CD. The track display on the recorder is three digits long, but the Red Book CD specification limits the number of tracks on a CD to 99. The three-digit display is only used to select MP3 files above 99, or when using the direct search feature on CDs, as noted.

PROBLEMATIC PITCH CONTROL

Tascam has made several CD players over the past few years with variable pitch. My main interest in variable-pitch playback is to correct commercial CD reissues of historical material when the original recordings have been transferred at the wrong speeds. Unfortunately, Tascam's previous variable-pitch players have allowed adjustment in only 1% increments, which is *way* too coarse. They must have responded to complaints about their pitch controls: the CD-RW900SL has a pitch control which operates up to ±16% in 0.1% increments (you can change the increment to 1.0%, if you wish). Most variable-pitch players will allow adjustment up to ±12%, which is a whole tone, but the wider range of the Tascam will be welcome for severe errors on the part of transfer engineers (I've seen recordings off by a minor 3rd, which even the Tascam won't quite fix).

Generally, if a CD player has a pitch control, the sample rate at the digital output will change as the pitch is changed. This will cause many outboard D/A converters to unlock, as will some other digital recorders, unless a sample rate converter is inserted between the player's digital output and the digital input of the device being fed. The Tascam CD-RW900SL has a unique feature—the built-in sample rate converter also functions in playback, keeping the digital output

PHOTO 2: Rear view of the Tascam CD recorder. The CD-RW900SL has unbalanced analog inputs and outputs, plus S/PDIF and Toslink Optical digital I/O. The CD-RW901SL version adds balanced analog connection, plus AES/EBU digital I/O.

at 44.1kHz when the pitch control is activated (when the pitch control is off, the sample rate converter is not activated). This would be an extremely thoughtful feature if it had been implemented properly, since it would eliminate the need for an outboard sample rate converter.

Unfortunately, as Chuck Hansen notes in his measurements (see accompanying article), the high frequency response rolls off when the pitch control is engaged. This happens even when the player's digital output feeds an outboard D/A converter. I have three other variable-pitch players and none has this problem (Denon DCD-1015, Denon DN-600F, and Marantz PDM-340). Chuck also notes an increase in distortion when the pitch control is turned on, even if the pitch is set to 0.0%, which is another annoyance.

The high THD Chuck observed with the pitch control engaged is also unacceptable. If the Tascam is turned off with the pitch control engaged, it remains that way the next time it's turned on. My Marantz and Denon players all default to "Pitch Off" when powered up, which is much more sensible.

The digital pitch control functions just like an analog pitch control, changing both pitch and tempo. This is true whether you're monitoring the unit via its analog or digital outputs. If you wish to change the pitch while leaving the tempo unaltered, Tascam has also included a "key" control, which allows you to change the key up to ± half an octave, in half-tone increments. If the key and pitch controls are activated simultaneously, the pitch control will change the playback speed while leaving the pitch (key) unchanged. DJs may find the key control useful. The pitch and key controls will not operate on MP3 files.

RECORDING DETAILS

Basic recording is extremely easy on the CD-RW900SL, and can be done via the analog or digital inputs. Like most modern CD recorders, the Tascam allows you to adjust the record level for both analog and digital sources. You can also monitor recording levels even if a disc is not inserted by simply pressing the record button. The word "Monitor" appears in the display, and the recorder functions as a D/A converter, with the fluorescent meters showing record levels.

Most CD recorders have come with a built-in sample rate converter on the digital inputs, including the ancient HHB CD-R800 (my first CD recorder). When I was recording concerts to DAT, I always recorded at 48kHz, and then made copies to the HHB, which provided the necessary sample rate conversion automatically. The Tascam CD-RW900SL also has a built-in sample rate converter, but you can turn it on or off in the record menu.

If the digital source is within 1% of 44.1kHz, the recorder will lock onto the incoming signal. If it's off by more than 1%, you'll get the error message **Not Fs44.1kHz!**, in which case you should activate the sample rate converter. If the source is 44.1kHz, it's better to leave it off; otherwise, the incoming data will be re-written even though it doesn't need to be.

The CD-RW900SL has a number of advanced recording features, including automatic fade-ins and fade-outs. The fade-in or fade-out functions must be activated with the remote control. You can sync-record with both analog and digital inputs. With analog inputs, the recorder can add a new track each time the level rises above a predetermined level, which you can adjust using the sync level option in the record sub-menu.

In the digital direct (DD) sync mode, a new track will be entered each time one is detected in the source. This is extremely useful when making direct digital copies of CDs, DAT tapes, or MiniDiscs. You can also manually add tracks by simply pressing the record button while the unit is recording (each track must be at least four seconds long, as dictated by the Red Book specification).

When you are finished recording, you must finalize the CD. This writes a table of contents, making the disc playable on a regular CD player. The Tascam recorder finalizes a CD in about 100 seconds, the fastest I've seen in a stand-alone recorder. My old HHB CD-R800 took over four minutes; the more recent HHB CDR-830 and the Sony CD-RW66 will do it in just over two minutes.

Once a CD is finalized, you can't add any more material to the CD. The Tascam recorder allows you to "unfinalize" a CD-RW, which erases the table of contents, allowing you to continue recording on the disc. On CD-RW discs, you can also erase either the entire disc or individual tracks.

The Tascam also allows you to add titles to discs and individual tracks, using the text edit function on the text submenu. Entering text is a bit cumbersome unless you have an external keyboard. Fortunately, the CD-RW900SL has a PS/2-style keyboard jack on the front panel, allowing you to plug in any computer keyboard with a PS/2 connector.

Since bailing out of the defunct DAT

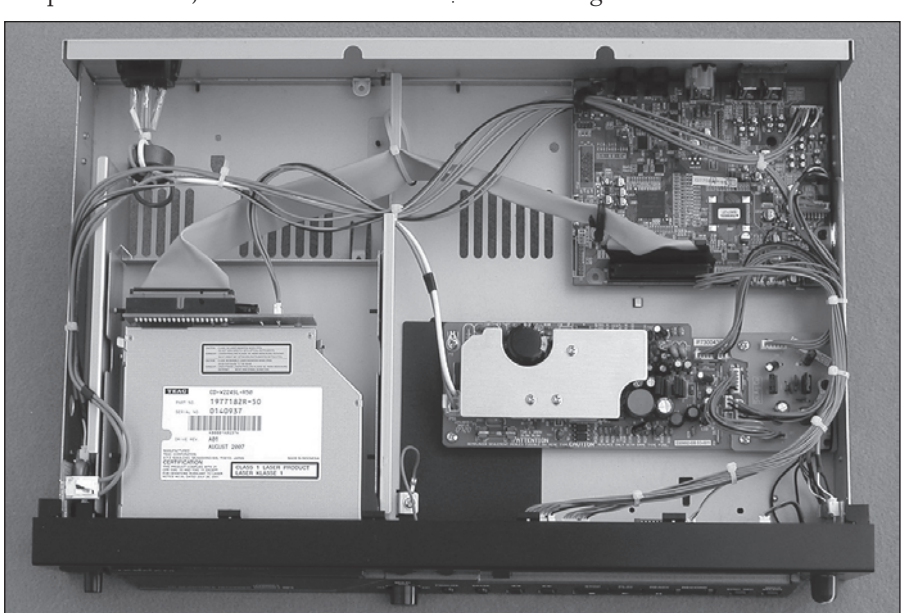

PHOTO 3: Inside view of the CD-RW900SL. Build quality is solid, if not robust. The switching power supply is typical of professional digital recorders.

format, my main digital recorders are a pair of Tascam DV-RA1000HDs, which also allow the connection of a PS/2 keyboard for text entry. The manual for those recorders warns you to turn the power off before connecting the keyboard—otherwise damage to the recorder and/or the keyboard may result. The manual for the CD-RW900SL has no such warning, which seems strange. User beware!

DESIGN DETAILS

For many years the HHB CDR-830 was an industry standard among CD recorders selling for around $600 street price. The CDR-830 was discontinued last fall and the Tascam CD-RW900SL seems to have replaced it as the best-selling CD recorder in this price range. I think it's appropriate to compare the two.

We have seven HHB CDR-830 recorders at The Crane School of Music at SUNY Potsdam, so I have considerable experience with this unit. All ICs in the CDR-830 are mounted on the bottom of the PC board, so I removed the board to investigate. At the heart of the HHB CDR-830 is an AKM Semiconductor AK4524 Audio CODEC, a 96kHz/24-bit combination ADC and DAC chip. AKM Semiconductor, a Japanese company, has been around since 1983, and during the past few years their conversion chips have been used increasingly in affordable pro audio equipment (Behringer uses AKM chips in a number of their digital products).

The AK4524 ADC has single-ended analog inputs and 64× oversampling, with a dynamic range of 100dB, with S/(N+D) specified as 90dB. The DAC section of the AK4524 features 128× oversampling and differential outputs. Dynamic range is 110dB and S/(N+D) is 94dB. AKM also claims high jitter tolerance for this chip.

The three surface-mount dual op amps used in the CDR-830 are all made by NJR: one 4560 for the headphone amp, one 4565 for the analog input amplifier, and one 4558 for the analog output amplifier. Slew rate and gain-bandwidth product are 4V/µS and 10MHz for the 4560; those specs are 4V/µS and 4MHz for the 4565. The rather pathetic 4558 has a slew rate of 1V/µS and a bandwidth of 3MHz, and shouldn't be used in *any* self-respecting piece of audio equipment. Fortunately, the 4558 is only used in playback and won't affect recordings made on the HHB.

The digital core of the Tascam CD-RW900SL is based on three AKM chips (I have a service manual for the Tascam recorder). The AK4528, another 96kHz/24-bit audio CODEC, is used for A/D and D/A conversion. AKM designates the AK4528 as a "high performance" chip, and it appears to be a slightly improved version of the AK4524. All specifications are identical to those of the AK4524 except for dynamic range and S/(N+D) of the ADC section, which are 108dB and 94dB, respectively. This, presumably, translates into improved low-level linearity in the A/D converters. The ADC section also has differential analog inputs.

Input and output sample rate conversion are done with the AD4121A asynchronous sample rate converter. The S/PDIF input receiver and transmitter are also housed in a single combo chip, the AK4113 digital audio interface.

It's strange that the Tascam CD recorder doesn't perform de-emphasis, because all three AKM chips support the Red Book de-emphasis function. All IC op amps in the CD-RW900SL are NJM4580 dual types which, while hardly state-of-the-art, are a distinct improvement over the op amps used in the HHB CDR-830. The 4580 has a slew rate of 5V/µS and a gain-bandwidth product of 15MHz. NJR intended this op amp for audio applications and specifies 1kHz THD as 0.0005% at 5V out into a 2kΩ load (they don't specify THD for any of the op amps used in the HHB recorder). Both the HHB and Tascam recorders have a switching-type power supply, which seems universal in professional CD recorders.

Tascam has taken advantage of the differential inputs of the AK4528. The unbalanced input from the RCA jack is buffered with half a 4580 configured as an inverting amplifier. The next stage, after the input level controls, consists of two halves of a 4580—both operated in the inverting mode—converting the single-ended signal to true differential. This differential signal is fed to the ana-

log inputs of the AK4528's differential inputs.

Strangely, Tascam seems to have "tacked on" the balanced inputs on the CD-RW901SL version of this recorder. The balanced inputs are converted to single-ended with a differential amplifier—half of a 4580 per channel—and then fed to the single-ended input level controls and converted back to differential using the same circuitry as the CD-RW900SL. Performance would be improved, and the signal path simplified, if Tascam had made the signal path fully differential from the XLR jacks to the analog inputs of the AK4528.

So, what do you get in a state-of-the-art digital recorder, in comparison to CD-RW900SL? I have been using a pair of Tascam DV-RA1000HD digital recorders for live concert recording at The Crane School for about two years—they replaced our third-generation Sony PCM-R500 DAT recorders. The DV-RA1000HD uses state-of-the-art Burr-Brown/TI converter chips—a PCM1804 A/D and a DSD1792 D/A converter. Differential current-to-voltage conversion is accomplished with a pair of OPA2134 op amps, a device well-known in high-end audio. All other op amps are New Japan Radio NJM2114M, a high-performance chip several notches above those mentioned (or the still-popular 5532), with a slew rate of 15V/μS, gain-bandwidth product of 15MHz, and high output current of 60mA.

The DV-RA1000HD records onto a 60GB hard drive at 24-bit resolution and all standard sampling rates from 44.1 up to 192kHz. The hard drive is intended only as a temporary holding area. You can archive 44.1kHz recordings to the optical drive as a standard Red Book CD, or copy individual tracks as files to a DVD. Recordings made at higher sampling rates are archived to DVD.

The DV-RA1000HD can also record in Direct Stream Digital format. DSD recordings can be archived to DVD, but the recorder won't make SACDs, and the exorbitant cost of DSD editing and SACD mastering software make the DSD capability a moot point for me. Even the high-end DV-RA1000HD has not escaped the use of switching power supplies.

SONIC PERFORMANCE

I've found the Tascam DV-RA1000HD to be a reference digital recorder. It is the most natural-sounding digital recorder I've used—extremely detailed, with a smooth treble region, extremely low noise floor and a wide, spacious soundstage. These qualities are apparent even at 44.1kHz, and get even better at higher sampling rates.

Red Book CDs archived to its internal optical drive are sonically superior to those made on *any* CD recorder I've used, and it's also miles ahead of the various DAT recorders I've used over the past 18 years. The CD-RW900SL doesn't match the performance of the DV-RA1000HD, and it shouldn't be expected to. But, it certainly offers a noticeable sonic improvement over the HHB CDR-830.

For comparison to the HHB CDR-830, I recorded excerpts from three of my favorite high-resolution digital discs on the HHB and the Tascam recorders (**Table 1**). These carefully prepared discs are among the finest in my collection sonically, and are probably as close to rolling the original analog tapes in my listening room as I'm likely to get. (I believe that the Rachmaninoff *Symphonic Dances* DVD was actually made from a 15-ips copy that engineer David Hancock prepared from his original 30-ips tape, but it's still a knockout.) I played these high-res discs back on my reference multi-format player, a recently-purchased NAD M55, and fed the tape outputs of my reference preamp (my redesigned Adcom GFP-565) to the analog inputs of the CD recorders.

After making the test recordings, I extracted them to my digital editor (Sony's Sound Forge 8.0), carefully normalized levels on each track individually to ensure level matching between the HHB and Tascam recordings, and burned the results to a new CD-R (using Sony's CD Architect 5.2). I then compared the HHB and Tascam tracks by playing this CD-R on the NAD M55.

Both recorders shrink the soundstage somewhat, but the Tascam fares better than the HHB. Localization within the soundstage is more precise on the Tascam, and comparatively vague on the HHB. Some of the HHB's soundstage shortcomings may be related to its somewhat dry sonic character. The Tascam captures hall ambience better, which results in superior reproduction of the spatial qualities of the test recordings.

The HHB adds a layer of grain to the treble, particularly on orchestral violins and has a somewhat "tizzy" quality on cymbal crashes. The Tascam is not the ultimate in high-frequency smoothness, but it is noticeably better in the treble than the HHB. The Tascam also captures inner detail better than the HHB, and orchestral climaxes become less congested on the Tascam. In the bass end of the spectrum, the Tascam is slightly fuller and weightier than the HHB.

To get the most out of recordings made on the CD-RW900SL, I recommend using an outboard D/A converter, which most professional users will probably have. As a stand-alone player, the Tascam is decidedly mid-fi. I found it rather thin and somewhat dry sounding, with a rather narrow soundstage, and not particularly impressive in revealing inner detail. The liquid, transparent, three-dimensional sound that I'm used to with the Monarchy M24 DAC (reviewed in *aX* Oct. 2007, with measurements by Chuck Hansen in the June 2007 issue) just isn't there with the CD-RW900SL as a stand-alone. It does make a very respectable transport, however, when used with a high-performance outboard DAC. The CD-RW900SL is a better-sounding recorder than stand-alone player.

CONCLUSION

The Tascam CD-RW900SL is a solid performer in its price range. Though its performance falls short of the state-of-the-art in stand-alone digital recorders, it makes audibly superior recordings to the previous generation of CD recorders, specifically the HHB CDR-830. The pitch

TABLE 1: High-Resolution Reference Discs

Rachmaninoff: *Symphonic Dances*, Op. 45. Dallas Symphony Orchestra conducted by Donald Johanos. Classic Records DAD 1004. (96kHz, 24-bit PCM transfer of 30-ips analog tape, or possibly a 15-ips copy, engineered by David Hancock.)

Rachmaninoff: Piano Concerto No. 3. Byron Janis, pianist; London Symphony Orchestra conducted by Antal Dorati. Mercury Living Presence SACD 470 639-2.

Stravinsky: *The Firebird*. London Symphony Orchestra conducted by Antal Dorati. Mercury Living Presence SACD 470 643-2.

control should be redesigned to eliminate the high-frequency rolloff and increase in distortion. I also prefer a conventional tray-loading mechanism, and agree with Chuck Hansen's concern about the possibility of scratching CDs.

Although I had no problems in this regard on the recorder I reviewed, another CD-RW900SL that we purchased at The Crane School occasionally makes hairline marks on discs (contact Tascam if you have this problem). But, all things considered, those in the market for a CD recorder in this price range will find the CD-RW900SL a good choice. ■

Tascam CD-RW900SL—Measurements

By Chuck Hansen

First, a couple of operational squawks about the Tascam CD-RW900SL CD Recorder. I don't particularly care for the slot-loading CD drive that Tascam used. The CD gets dragged through two plastic lips when it loads. If there is any dirt on them, they can scratch the CD. And if a CD becomes trapped inside, there is no pinhole to insert a paper clip and release the tray. The troubleshooting section of the 36-page manual tells you what to do if you can't insert a disc, but there is no remedy listed if a disc won't eject. I prefer open-tray-style computer drives.

Second, Gary Galo and I needed to troubleshoot the initial poor high-frequency response and high distortion problem I found during my initial tests. We finally noted that the variable pitch function had been left on, although set to 0.0%. My THD test set had no problem syncing to the test CD frequencies because pitch was not set off-frequency. The fact that it messes up both frequency response and THD makes it unacceptable to me, negating any benefit it might otherwise have. That "feature" ought to be restored to OFF whenever the unit is turned off, so you get Pitch Off when you power up again.

MEASUREMENTS

I operated the CD-RW900SL for one hour with the Pierre Verany test CD before making any measurements. I performed tests using the CBS Labs CD-1 and Pierre Verany test CDs (both available from Old Colony Sound Lab). I recorded tones onto 16-bit 44.1kHz CD-Rs from the oscillator in my distortion test set to check the recording function.

In order to check the MP3 playback, I used a custom CD-R I made by ripping analog test tones to 128k sampled MP3 files. I evaluated the CD-RW900SL digital output by connecting it to the 24/96 DAC input in my Alesis MasterLink ML-9600. **Table 1** summarizes the measured performance and the manufacturer's specifications.

The capacitor-coupled unbalanced RCA analog input impedance measured 24k at 20Hz, and 22.5k at 1kHz and 20kHz. The capacitor-coupled unbalanced RCA analog output impedance at

TABLE1: MEASURED PERFORMANCE

Parameter	Manufacturer's Rating	Measured Results–Variable pitch off (see text)
bit depth/sampling frequency	16-bit, 44.1kHz	verified
frequency response (44.1kHz) 20Hz-20kHz:	±0.8dB (playback) ±1.0dB (recording)	+0.23/-0.01dB (playback) +0/-0.56dB (recording)
signal-to-noise ratio and dynamic range:	95dB (playback) 90dB (recording)	96dB (playback) ref 2V RMS, A wtd
Total harmonic distortion:	0.006% (playback) 0.008% (recording)	0.0030% (playback) 0.0037% (recording) 1kHz, 0 dBFS
IMD - CCIF (11kHz + 12kHz and 19kHz + 20kHz):	N/S	-68dB (0.039%), 1kHz -65dB (0.056%), 1kHz
channel separation:	90dB (Playback) 80dB (recording)	96dB (playback) ref 2V RMS, A wtd
wow and flutter:	<0.001% (unmeasurable)	N/A
Analog input impedance:	22k ±10%	22.5k 1kHz
Analog output impedance:	600Ω ±60Ω	586Ω 1kHz
Phones output:	20mW 32Ω	24mW 32Ω 1kHz
Digital I/O:	coax RCA 75Ω, optical Toslink	76.1Ω (input)
Power requirements:	17W	N/A

20Hz was 836Ω, decreasing to 586Ω at 1kHz and 20kHz. Balance between the two channels was essentially perfect. The headphone jack output impedance measured 31Ω at 20Hz and 1kHz, and 39Ω at 20kHz. It delivered 24mW maximum at 1kHz. All analog outputs had normal polarity, a positive-going pulse producing a positive-going analog output.

The S/PDIF digital input presented the appropriate 75Ω impedance, while the digital output jack had a very high resistance. This may indicate that the digital output is capacitively coupled.

The DAC frequency response showed a slight rise of +0.23dB from 13kHz to the point where the digital output filters sharply rolled off the response (**Fig. 1**). The 0dBFS indicated unbalanced analog output was 2.04V RMS at 1kHz, or about 0.18dB above the CD Red Book standard of 2V RMS. The dB level display changed in 0.05dB increments in response to the analog input level controls.

I also measured the frequency response when the variable pitch control was on and set on-frequency (no pitch change commanded). This is the curved line at the HF end of **Fig. 1**, measured with a -0.05dBFS analog input signal (to avoid digital overload). The dash-dot line is the MP3 frequency response.

Crosstalk between channels and the playback signal-noise ratio at 1kHz were both 96dB referred to the Red Book 2V RMS. The headphone output at its maximum volume control setting (32Ω load) was 24mW at 20Hz and 1kHz, decreasing to 18.4mW at 20kHz. The maximum open-circuit headphone output voltage was 2.93V RMS at 1kHz.

The record-reproduce frequency response compared to the -0.05dB flat analog input signal is shown in **Fig. 2**. The top curve at 15kHz is the CD-R playback of the recorded signals. The dashed curve is the response to the analog input signal as measured at the analog output jack with the CD-RW900SL in Record/Pause mode. The lower curve at 15kHz

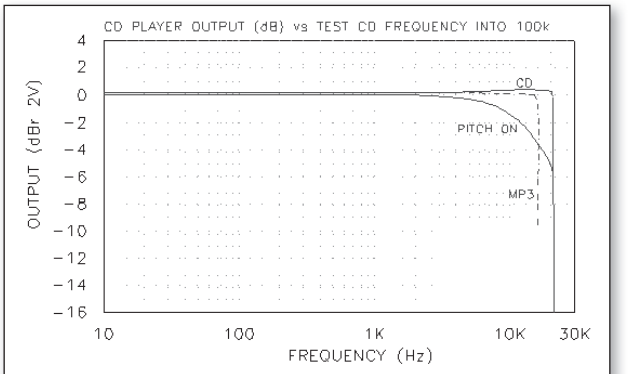

FIGURE 1: Frequency response.

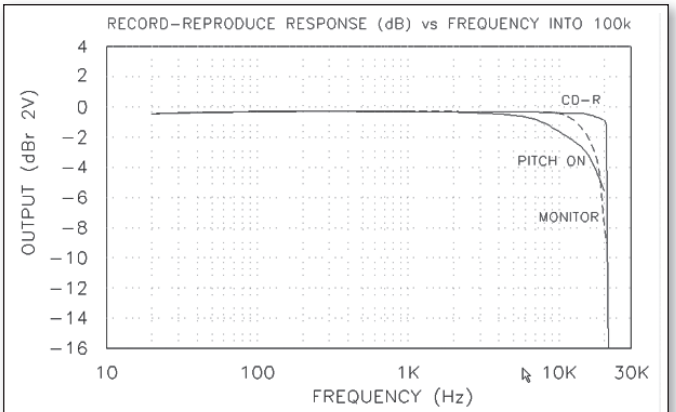

FIGURE 2: Record/playback frequency response.

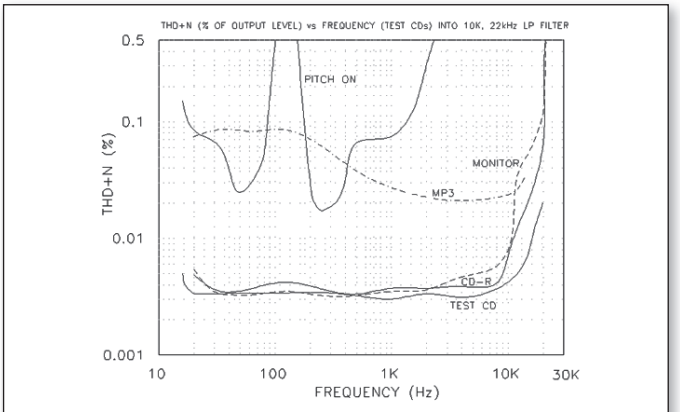

FIGURE 4: THD+N vs. frequency.

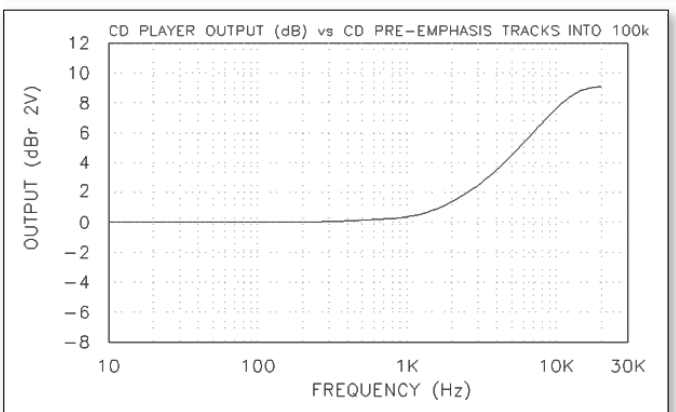

FIGURE 3: Pre-emphasis error.

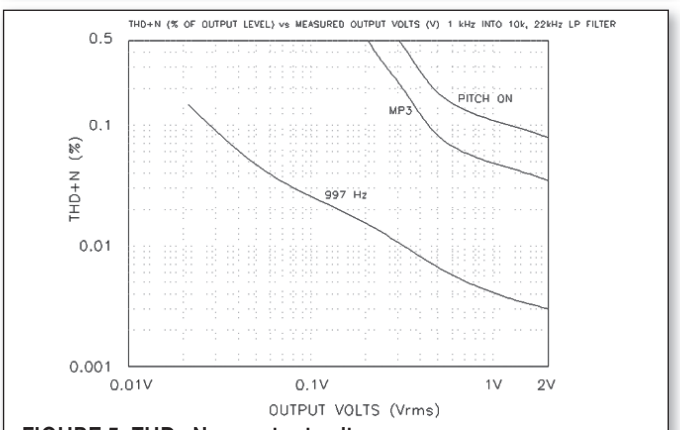

FIGURE 5: THD+N vs. output voltage.

is the CD-R playback response with the variable pitch control on with no pitch change commanded.

Playing the CD-R on my Alesis ML-9600 verified that the CD-RW900SL had accurately recorded the analog signal. Similarly, the CD-RW900SL made an accurate digital recording of selected Test CD tracks played from the ML-9600 S/PDIF digital output. It also showed flat response with its digital output connected to the 24-bit 96kHz DAC in the ML-9600 while I played the Red Book Test CD on the CD-RW900SL. There is no MP3 recording capability with the CD-RW900SL.

Figure 3 shows the pre-emphasis error when I played pre-emphasized digital test tracks. The CD-RW900SL does not appear to recognize the pre-emphasis flag on the test tracks.

THD+N versus frequency is shown in **Fig. 4**. I engaged my distortion test set 22kHz 4-pole low-pass filter to remove out-of-band noise. The Red Book Test CDs produced the lowest level of distortion, followed by the CD-R of the analog test signals. The dashed line is the record

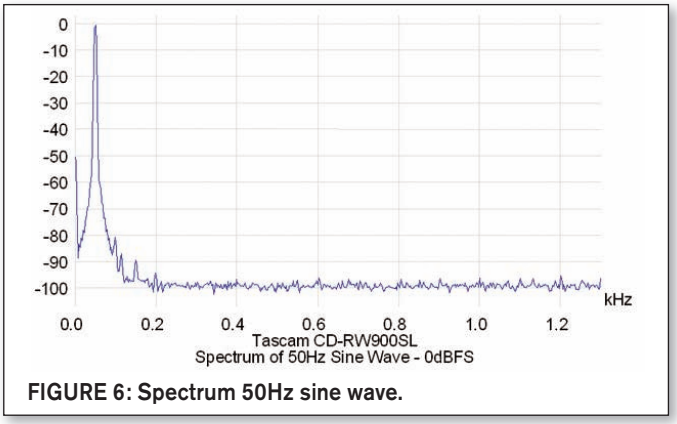

FIGURE 6: Spectrum 50Hz sine wave.

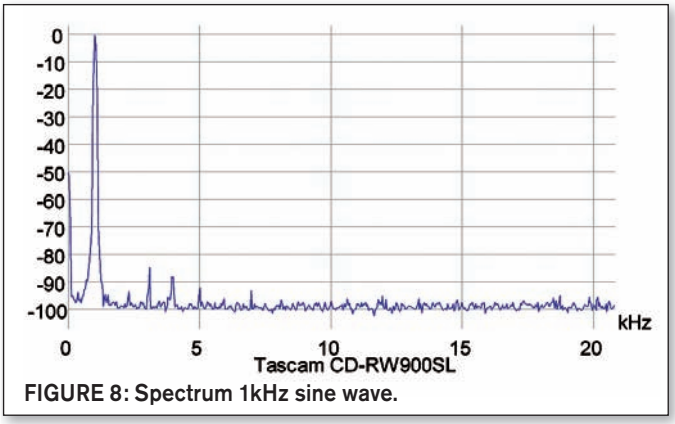

FIGURE 8: Spectrum 1kHz sine wave.

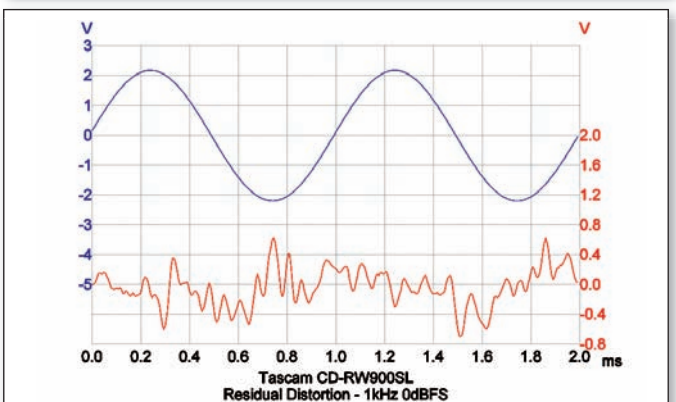

FIGURE 7: 1kHz THD residual.

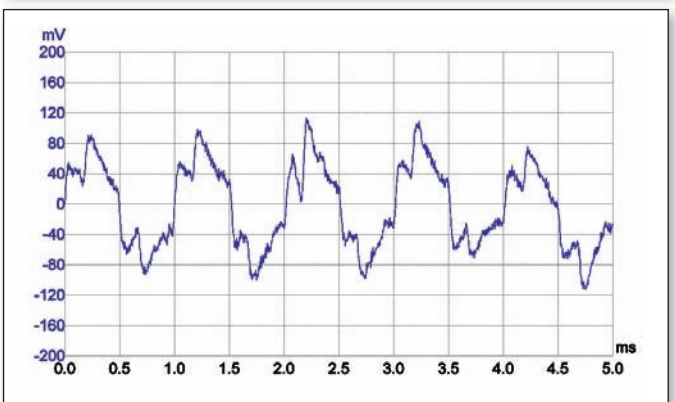

FIGURE 9: -90.31 dBfs 1kHz sine wave.

monitor signal at the analog output jack with the CD-RW900SL in Record/Pause mode. The dash-dot curve is the THD+N produced during the MP3 test track playback.

The wildly-varying upper curves represent the large increase in distortion with the variable pitch control on and with no pitch change commanded. The THD reached nearly 3% at 127Hz and is off the upper scale on the graph at that point. I also measured 1.3% at 4kHz, 5.4% at 8kHz, and 7.9% at 10kHz. It continued to increase in this fashion until it exceeded 18% at 20kHz.

The lower curve in **Fig. 5** shows the THD+N versus output voltage using the 997Hz decreasing amplitude signal on the CBS test disk. There is no clipping evident because of the CD test signal source. You can, however, drive the CD-RW900SL into clipping from the analog inputs. When I overdrove the unbalanced analog input, the distortion went straight up just above the point where the 0dB level indication occurred.

The middle curve is the THD+N ver-

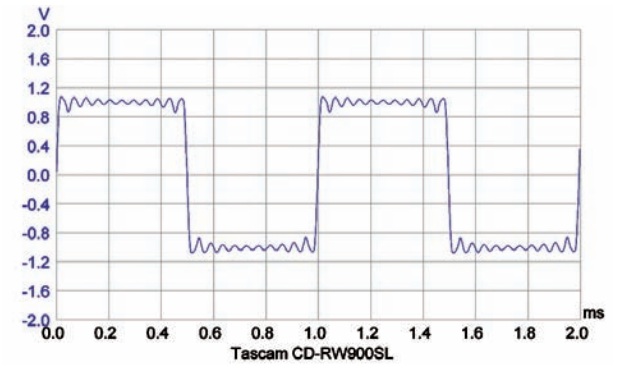

FIGURE 10: 1kHz square wave.

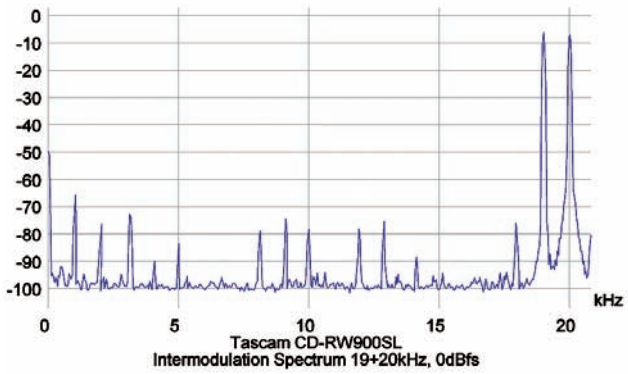

FIGURE 12: 19kHz + 20kHz IMD.

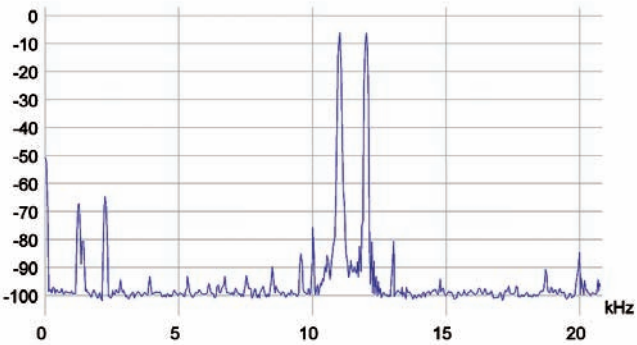

FIGURE 11: 11kHz + 12kHz IMD.

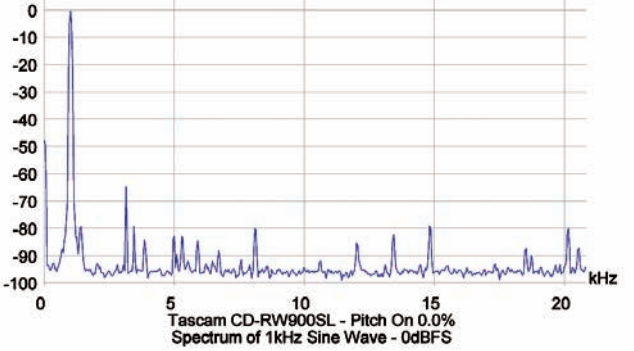

FIGURE 13: Spectrum 1kHz sine wave—pitch on 0.0%.

sus output for MP3 playback files, and the upper curve represents the test CD tracks when the variable pitch control is on with no pitch change commanded.

The spectrum of a 50Hz sine wave at 0dBFS is shown in **Fig. 6**, from DC to 1.3kHz. The calculated THD+N based on the first five harmonics is 0.0022%, with no significant harmonics and only low-level noise artifacts. The measured THD+N is just 0.0034%.

The distortion residual waveform for a 1kHz sine wave at 0dBFS is shown in **Fig. 7**. The upper waveform is the analog output signal, and the lower waveform is the monitor output (after the THD test set notch filter), not to scale. This distortion residual signal shows mainly lower order harmonics. THD+N at this test point is 0.0027%.

I also performed a spectrum analysis at 1kHz 0dBFS, as shown in **Fig. 8**, where THD+N measured 0.0030%. The most notable harmonics are 3rd, 4th, 5th, and 7th.

Figure 9 shows the reproduction of an undithered 16-bit/44.1kHz 1kHz sine wave at –90.31 dBFS. At this level the signal consists of ±1 bit of data, produc-

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ing two different voltage levels that are symmetrical about the horizontal (time) axis. These discrete voltage steps are indistinct and have a triangle shape rather than the expected flat levels.

Figure 10 shows the response of the CD-RW900SL to a 1kHz 16-bit 44.1kHz square wave from the CBS test disk. It shows the characteristic Gibbs Phenomenon ringing associated with the limited bandwidth produced by the digital filters. The ringing is nicely symmetrical with no sign of analog clipping at the peaks.

Figure 11 shows the spectrum response to equal level of 11kHz and 12kHz signals, each at –6dBFS, from DC to 20.8kHz. There are significant intermodulation products at 1kHz, 2kHz, 10kHz, and 13kHz, with the 1kHz product measuring -68dB (0.039%). This indicates a degree of nonlinearity somewhere in the reproduction chain of the CD-RW900SL.

Figure 12 shows the spectrum response to equal level of 19kHz and 20kHz signals, each at –6dBFS, from DC to 20.8kHz. The intermodulation products appear almost like a picket fence, showing higher nonlinearity as the IMD frequencies increase. The 1kHz product is -65dB (0.056%).

The CD-RW900SL ignored defects on the Pierre Verany Test CD-2 out to track 33. At track 34 (2mm defect) the unit cut off for a second after passing through the defect, going totally mute at track 36, which represents a large 2.5mm defect. The unit easily met the Red Book requirement of 0.2mm maximum.

Finally, **Fig. 13** shows the spectrum of the 1kHz sine wave at 0dBFS with the Pitch control On and set for 0.0% pitch change. Distortion measures 0.074%.

The Tascam CD-RW900SL is a serviceable CD recorder. The digital recording capability is quite good, with its main limitation in what I assume is the analog sections, as shown by the pronounced increase in THD at the higher frequencies, and the nonlinearity when reproducing the two sets of CCIF intermodulation tests.

The Variable Pitch function produces high levels of distortion and a premature rolloff in the high frequencies. Use it at your own sonic peril! *aX*