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PROTON D940 RECEIVER

Manufacturer's Specifications

FM Tuner Section

Usable Sensitivity: 10.3 dBf.
50-dB Quieting Sensitivity: Mono, 15.3 dBf; stereo, 33.2 dBf.
THD at 65 dBf: 0.1%.
S/N: Mono, 83 dB; stereo, 74 dB.
Hum and Noise at 65 dBf: Mono, 75 dB; stereo, 70 dB.
Capture Ratio: 1.5 dB.
Image Rejection: 55 dB.
I.f. Rejection: 90 dB.
AM Suppression: 60 dB.
Stereo Separation: 45 dB at 1 kHz.

AM Tuner Section

Usable Sensitivity: 20 µV.
Selectivity: 35 dB.
I.f. Rejection: 50 dB.
THD (30% Modulation at 10 mV): 0.5%.
S/N: 43 dB at 10 mV.

Amplifier Section

Rated Continuous Power: 40 watts per channel, 20 Hz to 20 kHz, 8-ohm loads.
Dynamic Headroom: 6 dB at 8, 4, or 2 ohms (see text).
THD: 0.02% at rated power.
IM Distortion: 0.008% at rated power.
Clipping Power: 50 watts at 8 ohms, 80 watts at 4 ohms, and 100 watts at 2 ohms.
Damping Factor: Greater than 90.
Frequency Response: High level, 20 Hz to 20 kHz, ±0.2 dB; MM phono, RIAA ±0.2 dB; MC phono, RIAA ±0.2 dB.
Input Sensitivity: High level, 150 mV (for rated output); MM phono, 2.5 mV (for rated output); MC phono, low, 0.1 mV; MC phono, high, 0.2 mV.
S/N (Re: Rated Output, A-Weighted): High level, 105 dB; MM phono, 92 dB; MC phono, 75 dB.
Channel Crosstalk: 75 dB at 1 kHz.
Function Crosstalk: 78 dB at 1 kHz.
MM Phono Overload: 250 mV.
Tone-Control Range: Bass, ±9 dB at 100 Hz; treble, ±9 dB at 10 kHz.
Bass EQ at 75 Hz: +3 dB.
Loudness at −30 dB: +6 dB at 100 Hz and +3 dB at 10 kHz.

General Specifications

Power Requirements: 120 V, 60 Hz.
Dimensions: 16½ in. W × 3¾ in. H × 11⅓ in. D (42 cm × 9.6 cm × 28.8 cm).
Weight: 18.7 lbs. (8.5 kg).
Price: $450.
Company Address: 737 West Artesia Blvd., Compton, Cal. 90220.
For literature, circle No. 91

Some manufacturers adapt their products to the new age of digital audio by simply changing the name of a high-level input from "AUX" to "CD" or "DAD." Others really design their new products with digital audio in mind. Proton's new D940 receiver is in the latter category. Though modest in its continuous-power rating, this 40-watt-per-channel receiver can, when called upon, deliver short-term peaks of up to 160 watts per channel into 8-ohm loads, or 280 watts per channel into 4-ohm loads. Talk about dynamic headroom—this receiver has plenty of it. Nor is the short-term reserve-power capability limited to 20 mS (the duration of the EIA/IHF Dynamic Headroom test). Even if a musical burst of 200 mS comes along, the D940 will supply up to 150 watts of power per channel into 8-ohm loads, or up to 190 watts per channel into 4-ohm loads, for the duration of that musical peak. Proton calls this novel amplifier circuit DPD (Dynamic Power on Demand); I'll explain how it works a bit later on.

Innovation is not limited to the D940's amplifier section. For good FM tuner design, Proton turned to that Midwest master of FM science, Larry Schotz, whose exploits in the field of FM and stereo FM are, by now, well known to regular readers of *Audio*. Schotz Noise Reduction, or SNR, effectively removes noise from FM broadcasts without altering frequency response. At low modulation levels, and in the presence of mid-strength signals (around 45 dBf or lower), the SNR circuit introduces just the right amount of channel "blend" to reduce noise to acceptable levels without sacrificing too much stereo separation. At strong signal levels, or at full modulation (where the noise will be psychoacoustically masked), the circuit has no effect. (Ordinary auto-blend circuits sense only signal strength, not modulation level, and so can sometimes blend more than they need to.)

Control Layout

Like other Proton products, the D940 has an uncluttered black front panel that contains only those controls and switches which really relate to sonic performance and operation. A "Power" on/off pushbutton is at the extreme left. Nearby are a stereo headphone jack, a speaker selector (for choosing either or both of two sets of speakers—or neither, for headphone-only listening), and detented rotary bass and treble tone controls. A small display area near the center of the panel shows tuned-to FM or AM frequency and indicates whether or not you are in the automatic ("Search") or manual tuning mode, whether or not the DPD circuit is being called upon, and whether an FM stereo signal is being received. To the right of the display area are eight station preset buttons for memorizing eight FM and eight AM station frequencies. Alongside these numbered keys are buttons to tune up and down, select manual or automatic tuning, choose the AM or FM band, and enter stations into the memory.

Below the display area are four pushbuttons for activating the SNR circuitry, selecting mono or stereo, introducing a moderate amount of fixed bass boost ("Bass EQ"), and turning on a "Loudness" compensation circuit for low-level listening. Separate rotary selectors nearby allow you to record one program source while listening to another. The "Record" selector includes settings for dubbing from the Tape 1 inputs to Tape 2, and vice versa. "Balance" and

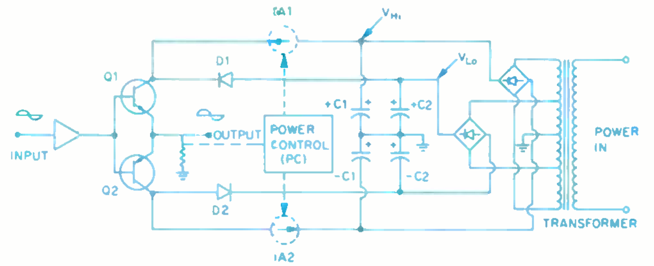
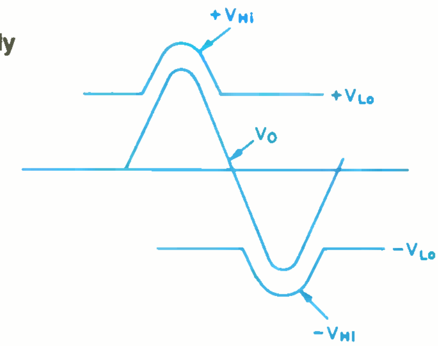


Fig. 1—The DPD (Dynamic Power on Demand) circuit.

Fig. 2— How power-supply voltage tracks the signal during DPD operation.



"Volume" knobs at the lower right corner of the panel complete the control layout.

If the front panel seems particularly uncluttered, the rear panel of the D940 is *loaded* with jacks, terminals, receptacles and switches. There are, of course, the usual high-level and phono inputs, two sets of tape out/in jacks, color-coded four-way speaker binding posts, conventional AM and FM antenna terminals as well as a 75-ohm coaxial FM antenna connector, and three convenience a.c. outlets (two unswitched, one switched). Besides all of this, there are a pair of two-position switches adjacent to the phono inputs. One of these selects "MM" or "MC" cartridge preamplification, and the other selects high or low gain for the MC circuit. The high-gain setting provides an extra 6 dB of pre-preamplification for lowest output moving-coil cartridges. Another unusual switch found on the rear panel is labelled "ACC" (Anti-Clipping Circuit). When you depress this switch, the circuit gently limits any waveform which would otherwise drive the amplifier into clipping. Proton recommends using this switch when Compact Discs are to be played at loud levels. Finally, a three-position slide switch at the upper left of the rear panel provides three values of loading capacitance (100, 200, or 320 pF) which can be switched in parallel with your moving-magnet cartridge for optimum high-frequency loading

Circuit Description

Figure 1 shows the approach that Proton used for the DPD circuit to increase power output during the brief peri-

On demand, this receiver's DPD circuit quadruples output power for 400 mS, 20 times longer than required by the EIA/IHF test for Dynamic Headroom.

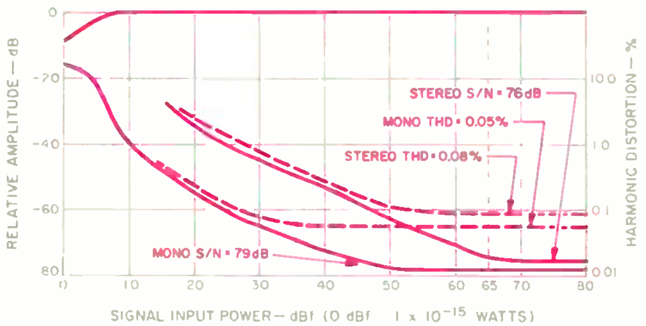


Fig. 3—Mono and stereo quieting and distortion characteristics, FM section.

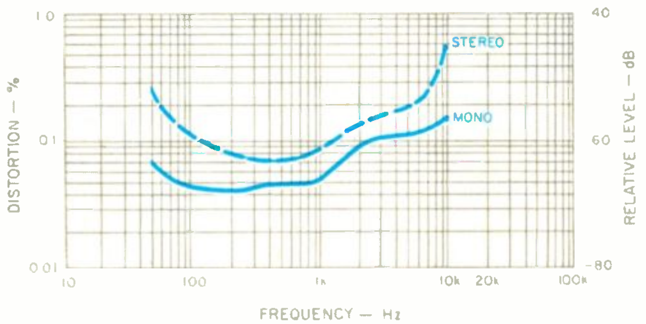


Fig. 4—THD vs. frequency, FM section.

ods when high power levels are demanded by a program's musical content. The circuit has two pairs of power-supply rails, with V_{Hi} at twice the voltage of V_{Lo}. The two supply-rail pairs are isolated from each other by D1 and D2; V_{Hi} stores its energy in +C1 and −C1.

When the Power Control senses a high-level signal whose peak approaches the V_{Lo} value, it turns on linear current amplifiers IA1 and IA2 before clipping can occur. This allows +C1 and −C1 to discharge, providing V_{Hi} voltage to output devices Q1 and Q2 and increasing the output power by a factor of 4. The value of capacitors C1 is chosen so that the higher power level can be sustained for up to 400 mS, 20 times longer than the EIA/IHF 20-mS Dynamic Headroom test requirement. If a continuous high-level signal is applied instead of a music signal, the DPD circuit's extra power reserve gradually declines until current amplifiers IA1 and IA2 turn off and V_{Lo} again takes over as the operating supply voltage.

Since the change to high-voltage operation occurs only at high output-signal levels, and the linear current amplifiers are turned on and off gradually (Fig. 2), switching effects are not audible or detectable. The DPD circuit enables the receiver to deliver as much as 6 dB of dynamic headroom—more than four times its rated continuous power—during music peaks.

Tuner Measurements

Figure 3 shows FM mono and stereo quieting and harmonic distortion characteristics as a function of signal input levels for 100% modulation by a 1-kHz tone. Usable sensitivity in mono measured 10.8 dBf; in stereo, 17.8 dBf of input signal was required to deliver a signal whose noise plus distortion was no more than 3%. In mono, 50-dB quieting was reached with input signal levels of only 15 dBf; in stereo, the 50-dB quieting point occurred with an input of 36 dBf, somewhat short of the 33.2 dBf claimed by Proton. Signal-to-noise-plus-hum ratio measured 79 dB in mono and 76 dB in stereo; both figures exceed Proton's claims by a significant margin.

Distortion in the FM tuner section was also better than claimed. For a 1-kHz test signal, I measured 0.05% in mono and 0.08% in stereo. (Proton doesn't specify whether their published specification of 0.1% THD applies to mono or stereo, nor do they mention the frequency at which the measurement was taken.) Figure 4 shows how THD in FM varies with frequency for both mono and stereo. Although THD tended to rise at higher frequencies, it did so to a lesser degree than is typically the case with receivers in this price class. The 0.55% reading at 10 kHz, in stereo, was obtained without the use of any band-pass filters. Had the EIA/IHF recommended band-pass filter been used, the THD reading would have been somewhat lower, around 0.25%. It's not unusual to find tuner sections that produce well over 1% THD at 6 kHz, so the performance of this FM section must be regarded as superior compared with much of the competition. I suspect there's more of the Larry Schotz touch in this tuner section than just his effective SNR noise-reduction circuitry.

Figure 5 is a plot of FM frequency response and separation at strong signal levels, with the SNR circuit turned off. Separation was a high 55 dB at mid-frequencies, decreasing to a still excellent 48 dB at 10 kHz and 46 dB at 100 Hz. More important, separation from left to right channel was identical to that measured from right to left. For the spectrum-analyzer sweeps shown in Fig. 6, the SNR noise-reduction circuit was activated. The first thing I noted was that this circuit did alter stereo frequency response somewhat. At strong signal levels, separation (bottom trace) remained identical to what it had been without SNR turned on, but at about 45 dBf, separation decreased markedly (middle trace), and so did background noise. For this plot, modulation amounted to around 20% to 25% at 1 kHz. Had the modulation percentage been greater, separation would have been greater as well, since the SNR circuit takes into account both signal strength and instantaneous modulation levels, as I mentioned earlier. For Figs. 5, 6, 8, 10 and 11, sweeps are logarithmically plotted from 20 Hz to 20 kHz, and vertical calibration is 10 dB per division.

For a 5-kHz modulating signal, I plotted the crosstalk and other distortion components appearing in the unmodulated channel's output (Fig. 7). In this plot, the sweep is linear from 0 Hz to 50 kHz and vertical sensitivity is 10 dB per division. While you can see small second- and third-order distortion components, there is no visible 19-kHz carrier output present, and only a very small amount of 38-kHz subcarrier product can be seen near the right-hand side of

The amp's short-term power output was remarkable for loads down to 2 ohms. Into 4 ohms, it was a full 280 watts per channel!

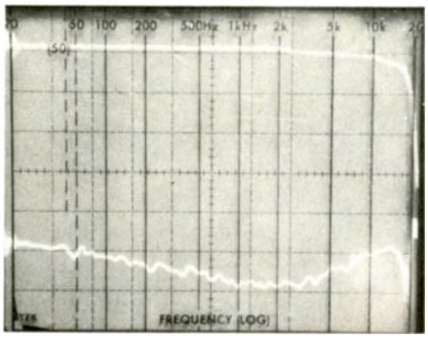


Fig. 5— FM frequency response (top trace) and separation (bottom trace) with SNR circuit off.

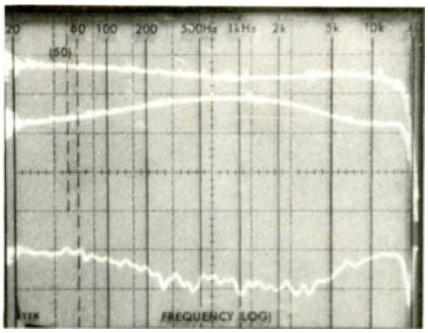


Fig. 6— Same as Fig. 5 but with SNR on; middle trace shows reduced separation at lower signal strengths. Note also slight difference in frequency response compared to Fig. 5.

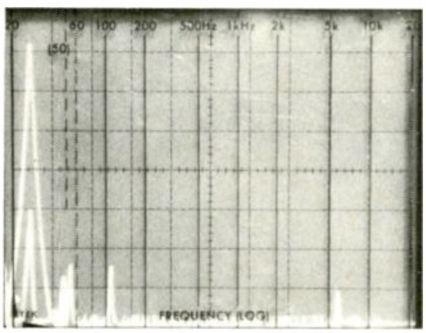


Fig. 7— Separation and crosstalk components for a 5-kHz modulating signal.

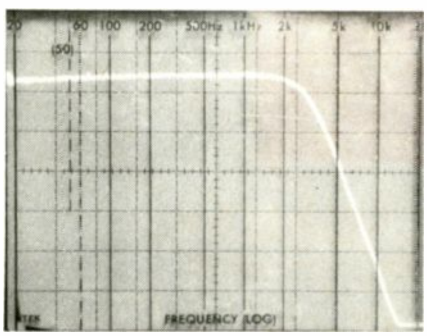


Fig. 8— AM frequency response.

the 'scope display. Measured on a VTVM, the 19- and 38-kHz components were 70 dB below maximum modulation levels, and SCA rejection measured better than 66 dB. Image and AM suppression both measured 60 dB, and FM i.f. rejection was 92 dB, slightly better than claimed. Capture ratio measured 1.3 dB, and alternate-channel selectivity was 62 dB.

Figure 8 shows frequency response of the AM tuner section. As is the case with many AM tuner sections found in "high-fidelity" components, response falls off rapidly above 3 kHz or so. But unlike many other AM tuner sections I've measured, this one is remarkably flat over its pass-band, with response extending smoothly all the way down to the bass extreme.

Amplifier Measurements

The power amplifier section of the Proton D940 is remarkable. Though rated at only 40 watts per channel, continuous, into 8-ohm loads (from 20 Hz to 20 kHz), my sample delivered more than 50 watts per channel at the bass and treble frequency extremes, and a full 55 watts per channel at mid-frequencies. That, in and of itself, is not so unusual; many amplifiers are conservatively rated when it comes to their continuous power-output capabilities. What was remarkable was the short-term power-output capability of this amplifier with a variety of load impedances—all the way down to 2 ohms. Using the EIA/IHF Dynamic Headroom testing technique (20-mS pulses of 1-kHz signal), the amplifier delivered exact'y four times its rated power into 8-ohm loads—160 watts per channel—for those short-duration pulses. Even when the duty cycle of this music-signal simulation was increased to 200 mS per burst (with 800 mS of "no signal" in between), the amp still delivered nearly 150 watts per channel during the "on" time of the signal bursts. Figure 9 is a "three-dimensional" computer-generated plot of distortion as a function of power output and frequency.

Switching to 4-ohm loads, I measured a continuous power output of 70 watts per channel at mid-frequencies for the rated 0.02% THD. Again using 4-ohm loads, dynamic headroom still measured a full 6 dB; for short musical peaks, this amplifier can deliver a full 280 watts per channel of power into 4-ohm loads!

Figure 10's spectrum-analyzer photo shows the boost and cut range of the bass and treble controls. At the left edge of the middle trace, you can see the slight bass boost that takes place when the "Bass EQ" switch is engaged. Figure 11 shows the action of the "Loudness" control at various volume settings from 0 dB (upper trace) down to approximately −50 dB.

Input sensitivity ('or 1 watt output) measured 25 mV for the high-level inputs, 0.4 mV for the MM phono input, and 31 μV and 16 μV for the low and high settings of the MC phono input. Overall frequency response of the receiver, from high-level inputs to speaker outputs, was −1.0 dB at 17 Hz and 25 kHz, and −3 dB at 14 Hz and 55 kHz. RIAA equalization accuracy was within +0, −0.5 dB from 20 Hz to 20 kHz. Phono overload for the MM input was 250 mV, and for the low-level MC phono input it measured 25 mV.

Signal-to-noise ratio, referred to 0.5 V input and with the volume control set for 1 watt output, measured 82 dB, A-

Playing CDs through my inefficient speakers, the D940 did better than my 90-watt amp. Good dynamic headroom really made a difference here.

weighted. MM phono S/N was 81 dB (referred to 5 mV input and the same standard 1 watt output); for the MC inputs (referenced to 500 mV input), S/N measured 71.5 dB. With the volume control set at minimum, noise was −89 dB below 1 watt output. While these results are not easily compared with the published specs (Proton references all S/N numbers to rated output, with the volume control wide open), they are nevertheless excellent compared to results obtained from other receivers in this or in more expensive price categories.

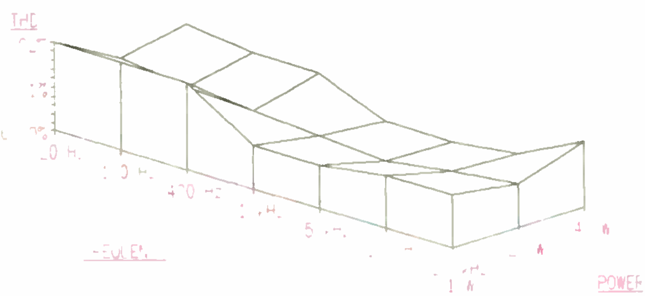


Fig. 9—THD vs. frequency for three power levels.

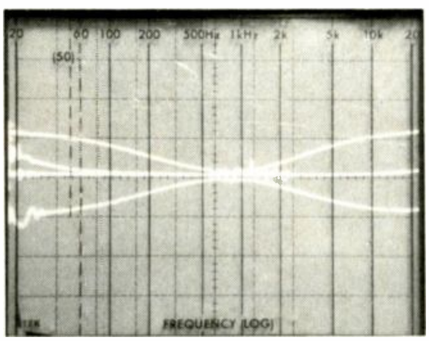


Fig. 10—Bass and treble tone-control range. The effect of the "Bass EQ" boost can be seen at the left edge of the middle trace.

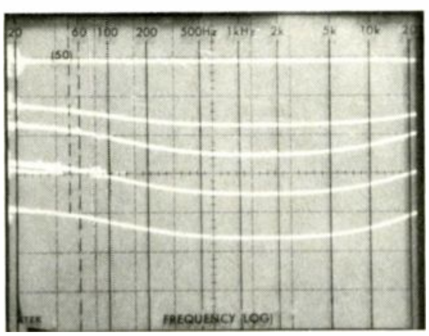


Fig. 11—Loudness-control characteristics at various volume settings.

Use and Listening Tests

I have never made a secret of the fact that my reference speakers are the rather low-efficiency KEF 105.2s. When I bought my first CD player, I discovered, much to my chagrin, that the 90-watt-per-channel amplifier I had been using to drive those speakers just wouldn't do the job, what with the dynamic range and uncompressed signal peaks now generated by CDs. You can therefore appreciate my initial doubts about whether the "40-watt-per-channel" Proton D940 would be able to drive those low-efficiency speakers to satisfactory listening levels. To my utter and complete amazement, it did. Here's a case where dynamic headroom really made a difference. I was able to play some of my CDs which have a very wide dynamic range at comfortable listening levels, and at no time did the D940 clip or show any other audible signs of overload. This, mind you, was accomplished without using the rear-panel anti-clipping circuit switch. To find out just what the "ACC" switch did, I activated it and slowly turned up the volume. At a level which many would find intolerably loud, the ACC took hold and I could hear some compression of peaks that had otherwise been reproduced full tilt. The ACC is a nice feature, but one which you're not likely to need very often unless your speakers are considerably less efficient than mine or you insist upon listening to music at ear-damaging levels.

FM reception was as great as I would expect from any tuner to which Larry Schotz has applied his expertise. I have been a devoted fan of Mr. Schotz ever since he developed the first frequency-synthesized tuner many years ago, well ahead of others which followed. Larry Schotz was perhaps constrained here somewhat because of price considerations, so FM selectivity was a bit lower than I would have liked to find. You may have trouble pulling in really weak signals if they are adjacent to strong local signals, but even in the crowded FM signal environment of metropolitan New York, only a couple of distant Connecticut signals gave me grief. More than 40 acceptable stereo signals were received with good quieting, and about 10 more became listenable in stereo when I activated the SNR circuit. I would have had to bypass those 10 stations because of intolerable noise levels had it not been for Schotz's novel noise-reduction circuitry.

I was as impressed with the ergonomics and layout of the D940 as I was with its excellent sound reproduction. I found myself reaching for the various controls and finding them just where they ought to be. You won't need an owner's manual to figure out this front panel—though the handy booklet supplied with the D940 is well organized and well written. Neither will you have to cash in your entire savings account to own a D940. Incidentally, if you own a good tuner but are interested in some of the amplifier characteristics of the D940 that I've described, Proton offers an integrated amp, Model D540, which contains the same amplifier and preamplifier circuitry as does the D940 receiver. I had both models in the lab at the same time and can attest to the fact that both amplifier sections perform and measure identically. The amplifier has a suggested price of $350; that's a pretty good deal. But getting a Schotz-designed tuner section for another $100 is so tempting that you may want to go for the full receiver even if you already own a tuner!

Leonard Feldman