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Heath's Modulus: A Four-Channel Super-Kit

Part One of a Two-Part Report

Heath Modulus, a kit consisting of: AN-2016 AM/FM digital control center; AD-1504 FM Dolby Module; AM-1503 SQ decoder module; AD-1507 CD-4 demodulator module. Dimensions: 20 inches wide by 6¼ inches high by 13½ inches deep. Weight: 28 lbs. Prices: AN-2016, \$599.95; AD-1504, \$39.95; AM-1503, \$49.95; AD-1507, \$79.95. Warranty: "Limited." 90 days on parts (prepaid shipping); free consultation on any assembly problems.

At a time when most high-fidelity equipment manufacturers are pulling in their horns or, at best, fence-sitting when it comes to four-channel equipment, Heath has taken the plunge and introduced a new system. And I use the word "system" advisedly, for the new Heath Modulus is a fresh approach to the uncertainties of the four-channel future. As its name implies, Heath's new entry is modular in construction. Each of the main blocks is on its own plug-in PC card, so that each

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section can be updated as improved circuitry becomes available.

The Modulus system centers around the AN-2016 AM/FM digital control center. This unit incorporates the AM/FM tuner with digital readout, all of the tone and level controls, and the input and function switching. A built-in headphone amplifier makes the AN-2016 "self standing" and immediately usable to the headphone buff who eschews, or simply has not yet invested in, power amps and loudspeakers. There are three optional modules available for the control center: an FM Dolby decoder (AD-1504), an SQ matrix decoder (AM-1503), and a CD-4 demodulator (AD-1507). They can be added immediately, or at any time in the future, merely by building the card and plugging it in.

For this issue, we constructed the AM/FM digital control center with its three optional boards (FM Dolby, SQ, and CD-4). In our next issue we'll report on the companion AA-1506 60-watt-per-channel power amps and give you our view of the total Modulus as a four-channel sound system.

To quote Heath: "With 28 ICs, 134 transistors, and 55 diodes, obviously some kit-building experience would be helpful in assembling the AN-2016." We would concur in that. But lest we turn you off, we hasten to add that Heath's assembly manuals are excellent—about the best we've seen. The instructions per page have been kept to a relatively small number, and just about every page has an illustration of the precise area you're working in, with lines to indicate just where every part goes. Except for an occasional reference to the illustration book for specific blowups, you work from one book only.

If you are really careful, have the proper tools, take the time to read, and understand each instruction, and have some facility in soldering, you can construct this very complex kit without years of kit-building experience. But expect to spend some time. For our very experienced kit-builder, total assembly time of the basic unit was just shy of 42 hours. About six hours more were required to assemble and install the three accessory boards. We would suggest that you adopt a more leisurely pace. Figure 50 hours for the basic unit, if you've had a good bit of kit-

building experience—perhaps 60 or 70 hours if you haven't.

The first part of the assembly covers the switchboard construction. This is the slowest going of the whole kit, so don't be discouraged. But be extremely careful not to make a mistake, and handle the board and cable harness carefully. This is one of the few assemblies that you can't check electrically before you install it, and it's also one of the few that are very difficult to get at after installation. The rest of the construction is much simpler. There are 13 additional PC boards to assemble (plus three more if you build all the accessories). All but one of these are pretested in critical areas using a built-in test meter. (That last one simply connects up the button indicator lamps and is not critical.) There are the usual sockets, transformer, etc., to be mounted to the chassis, and a bit of point-to-point wiring is also required. The majority of the interconnections are made through several precut and color-coded harnesses supplied by Heath. There is very little alignment required at the end. The few necessary adjustments are easy to make by following Heath's procedures and do not require test instruments.

The over-all appearance of the AN-2016 is flat black and chrome, with walnut-grained metal side panels. The chassis and shields seem to be copperclad steel for good electrostatic shielding. On the sloped lower front panel are an array of knobs and jacks. From left to right are a pair of headphone jacks for front and rear stereo channels, followed by four level controls for left and right, front and rear (there is no balance control as such). Immediately to the right of these chrome-and-black knobs are four more to control front and rear, bass and treble. Below this cluster are four stereo phone jacks labeled "Dubbing." These provide a front-panel connection for a second two- or four-channel tape recorder. You may play a tape from this extra deck (and copy it onto the permanently connected tape recorder if you wish) by connecting it to the dubbing in jacks and pushing the DUB button. Or you may copy a program onto an external recorder by connecting it to the dubbing out jacks. To the right of the tone controls are two larger knobs for VOLUME and TUNING.



A row of illuminated pushbuttons is situated on a narrow vertical panel above the sloped control panel. The legends above the buttons are illuminated whenever the unit is on, and the button face also glows when it is depressed, so that you can readily determine the mode of operation from a distance. A recitation of the lineup will give you an indication of the switching flexibility of the Modulus. The leftmost button disconnects the main outputs when in the "out" position. (The headphone jacks are *always* active.) Normally it would be depressed and glow to match the POWER button on the extreme right. Just to the right of the OUTPUT switch is a group of eight buttons from which to select the program. They are PHONO, CD-4, AUX, TAPE, MON, DUB, AM and FM. With the exception of the monitor switch, which is a push-on/push-off type, the rest are self-clearing.

A group of five self-clearing buttons in the center control the mode: MONO (the program from all four inputs is combined and routed to all four outputs), STEREO 2 (a stereo program from the front inputs is routed only to the front outputs), STEREO 4 (a stereo program from the front inputs is routed to all four outputs, the left appearing equally in the left-front and left-back channels, similarly for the right), SQ (functional only if an SQ board is installed—the front program is SQ-decoded and routed to the four outputs), and 4 CHANNEL (a four-channel program from the quad inputs—CD-4, AUX, TAPE, MON, or DUB—is routed to the four outputs).

Six more buttons control the miscellaneous functions: TONE FLAT (bypasses the tone control

circuitry), LO FILTER (rolls off the amplifier below 30 Hz), HI FILTER (rolls off the amplifier above 6 kHz), LOUD (engages the loudness compensation circuitry), FM DOLBY (routes the signal through an FM Dolby processor if that auxiliary board is installed), and SQUELCH DEFEAT (disables the FM muting circuit).

The top tier is set back and hidden behind a smoked plexiglas panel. On the left are four peak-reading output meters with a logarithmic scale from -30 dB to +10 dB. There is also a secondary voltage scale with 0 dB being equivalent to 1.5 volts output. A 1/2-inch-tall red LED display in the center comes on in the FM or AM modes to indicate the frequency to which you are tuned. The logic circuitry used by Heath assures a stable display at only "allowed" frequencies. Thus, in the FM mode, the last digit will *always* be odd, since all FM stations end in an odd number. In AM, the last digit is always 0. While this makes for an easy-to-read, stable display, which always indicates the precise station you're on, it does not provide any "tuning aid." For that reason, there is a pair of tuning meters on the far right. The outer one indicates signal strength and is illuminated and operable in both the FM and AM modes. (It also functions as the test meter during construction.) The inner one is illuminated only in the FM mode and indicates the center of the channel. Between the digital display and the tuning meter is a pair of back-illuminated legends indicating the presence of a stereo FM station or a CD-4 carrier.

The rear panel contains terminal-strip inputs for a 300-ohm or a 75-ohm FM antenna, and a phono plug input for the static-shielded AM

antenna, a main reason for the much-better-than-average AM reception of the Modulus. Four convenience outlets are provided, two switched at 250 watts each, and two unswitched at 140 watts each. The line cord and power fuse are just below the outputs.

Ten phono jacks provide the four main outputs, the four tape outputs, and a pair of scope outputs for multipath indication. A panel of twelve phono plugs provides quad inputs for aux, tape, and tape monitor. At the lower right of the panel are two pairs of phono inputs with associated grounding lugs. One pair is for a stereo pickup, the other for a CD-4 pickup. A two-position slide switch sets the phono sensitivity for the stereo cartridge input only.

In bench tests and listening evaluations, the Heath AN-2016 acquitted itself very well indeed and, in some respects, was superb. The frequency response through the main amplifier proved flat, $+0$, $-1/4$ dB from 15 Hz to 20 kHz. The 1-dB-down points were below 10 Hz and at 35 kHz. It was 3 dB down at 71 kHz. The tone controls are of the Baxandall type, the treble being hinged at about 4 kHz and the bass at 200 Hz. The treble provided a $+7\frac{1}{2}$ -dB, $-8\frac{3}{4}$ -dB range at 10 kHz; and $+10\frac{1}{2}$, -12 dB at 15 kHz. The bass provided a $\pm 7\frac{1}{2}$ -dB spread at 100 Hz, and $\pm 12\frac{1}{4}$ dB at 50 Hz. Below 30 Hz the maximum boost tapered off—a good idea since excessive boost at very low frequencies can damage a woofer on subsonic signals.

The filters were top-notch. The cutoff frequency (-3 dB point) of the low filter was at 30.4 Hz, below which the response fell at an admirable 12 dB per octave. The high filter is also a nominal 12-dB-per-octave affair, with a cutoff frequency of 6.2 kHz. On our unit, the initial slope was greater than 12 dB/octave, being down $28\frac{1}{2}$ dB at 20 kHz. The maximum rejection was $33\frac{1}{2}$ dB at 30 kHz, after which the response slowly came up to $-22\frac{1}{2}$ dB at 140 kHz. We don't consider this anomaly particularly significant, since that's well beyond the region of audibility.

The loudness contour came into play rather high up on the volume control. With the control 10 dB down from maximum (pointer at about 3 o'clock), we measured a very slight $3/4$ -dB boost at

20 kHz and a modest $+2\frac{1}{4}$ -dB shelf below 70 Hz. At a -20 -dB setting (pointer at noon), the 20-kHz boost went up to $+5\frac{1}{2}$ dB, and the shelf below 70 Hz rose to $+7$ dB. Further reductions in volume setting did not cause a significant change.

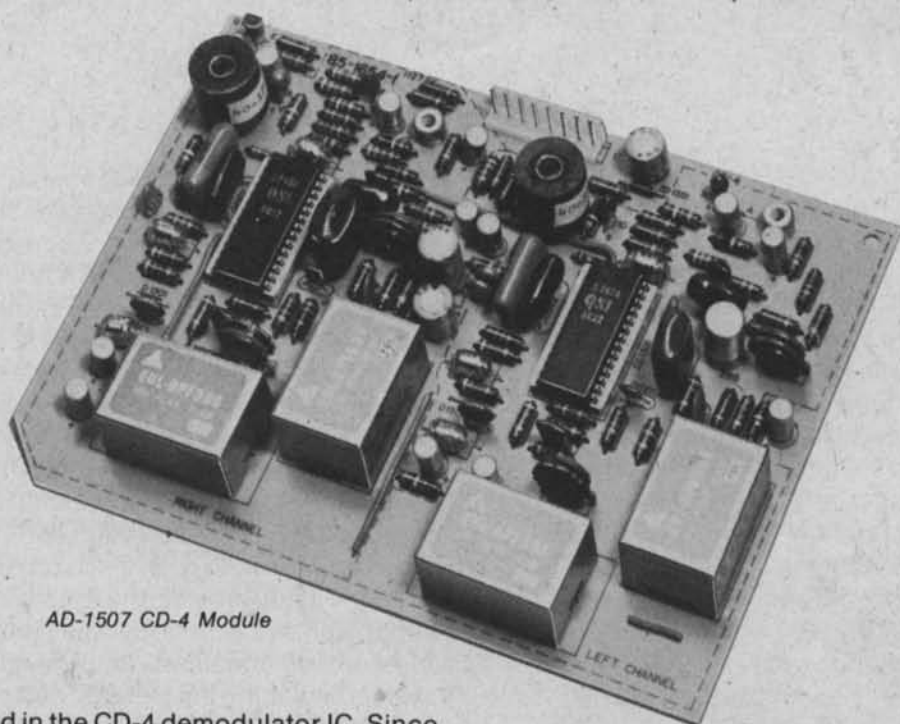
The total harmonic distortion across the frequency band at the rated 1.5-volt output (0 dB on the meters) was in the order of 0.03% to 0.05%. At a 5-volt output (about $+10\frac{1}{2}$ dB re meter zero), the distortion was unchanged. At 1 kHz, the maximum output at clipping into a 10,000-ohm load was 6.8 volts rms ($+13$ dB re meter 0).

The maximum sensitivity from the high-level inputs was 110 mv for a 1-volt output (165 mv for meter 0). The A-weighted noise from a shorted high-level input was 94 dB below a 0.5-volt input. Left-to-right separation was 73 dB at 100 Hz, 64 dB at 1 kHz, and $46\frac{1}{2}$ dB at 10 kHz—not the most impressive we've measured, but adequate. Crosstalk from auxiliary to tape was 75 dB or better below 1 kHz, and 60 dB at 10 kHz, provided that the unused input was shorted.

The equalization of the stereo phono preamp was excellent at $+0$, $-1/2$ dB across the band independent of the sensitivity setting. In the Hi setting, the maximum 1-kHz gain was 57.6 dB for a sensitivity of 1.3 mv for a 1-volt output (2 mv for meter 0). The clipping level was an adequate, if not spectacular, 60 mv at 1 kHz, and the A-weighted noise was an excellent 83 dB below a 5-mv, 1-kHz input. With the phono sensitivity set to Lo, the gain dropped 10 dB so that 4.2 mv were required (at 1 kHz) for a 1-volt output ($6\frac{1}{4}$ mv for meter 0). The 1-kHz clipping level improved correspondingly to 185 mv, and the A-weighted noise level was $76\frac{1}{2}$ dB below a 5-mv, 1-kHz input. Phono separation was better than 50 dB at frequencies below 1 kHz, and was about 34 dB at 10 kHz, again better than a stereo pickup, but not extraordinary.

The impedance of the main output terminals was just about 500 ohms, and the output amplifier design such that extensive lengths of cable can be driven. The output impedance at the headphone jack is about 50 ohms. Maximum power (into a 50-ohm headset) was 125 mW. About 50 mW are available into a 10-ohm headset.

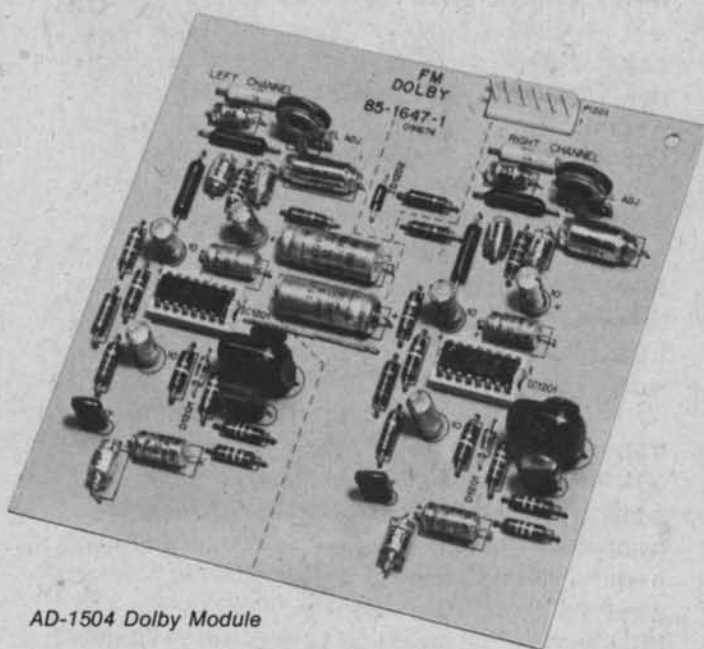
The CD-4 board contains its own phono preamp,



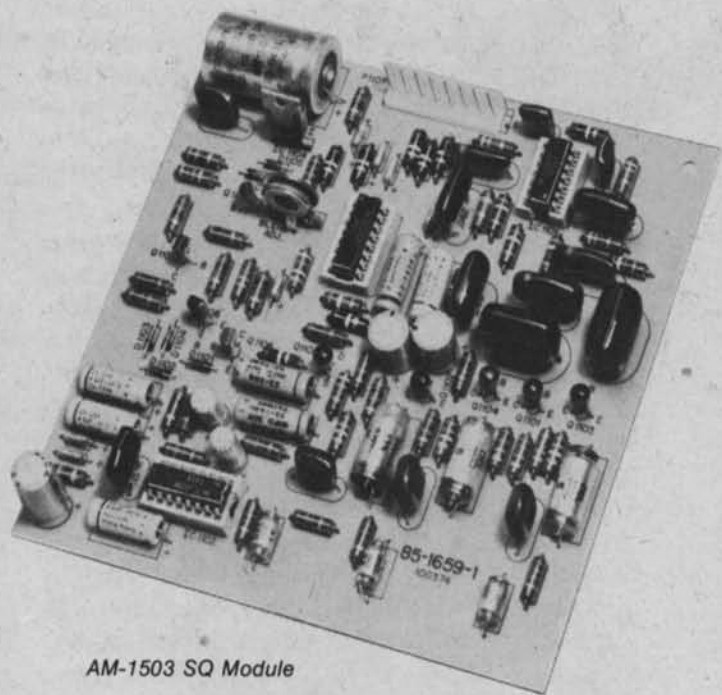
AD-1507 CD-4 Module

self-contained in the CD-4 demodulator IC. Since many users would play their stereo discs through the CD-4 input using a CD-4 pickup, we measured the equalization, noise level, and overload point of this preamp as well. Unfortunately, it did not match the discrete circuitry of Heath's stereo preamp and was significantly deficient in overload capability. The equalization error amounted to about $+2\frac{1}{4}$, $-1\frac{1}{2}$ dB across the baseband region. Separation was 56 dB at midband, 46 dB at 100 Hz, and 36 dB at 10 kHz. The noise level was adequate at 71 dBA below a 5-mV, 1-kHz input. The clipping level was precariously low (11 mV at 1 kHz) for all but the least efficient cartridges. Thus, total dynamic range was about 78 dB, whereas it was almost 105 dB on the high-sensitivity stereo input, and almost 108 dB on the low setting.

The CD-4 demodulator performance was measured using a custom test record and a JVC cartridge. Since we're measuring disc, cartridge, and demodulator together, it is difficult to assign the results to any one portion of the system. Nonetheless, the tests give you an indication of the performance level you're likely to achieve on CD-4 discs. We had no difficulty in setting up the CD-4 board for carrier lock and separation, but, since the controls are on the board, you must open up the AN-2016 and reset them if you change cartridges. Channel balance was excellent, the right channels being $\frac{1}{4}$ dB to $\frac{3}{4}$ dB above the left. Midband separation was also very good, being 21 to 25 dB across the front and rear, and 17 to 22 dB across the sides, with right front to



AD-1504 Dolby Module



AM-1503 SQ Module

right back being 15 dB. Diagonal separation was 21 to 26 dB. Center front to center back separation was $17\frac{1}{2}$ dB, while center back to center front was almost 20 dB. Center left to center right was $18\frac{1}{2}$ dB, while center right to center left was $23\frac{1}{2}$ dB. As we've seen in the past, the front/back separation degrades markedly at the frequency extremes. Also, as we've found previously, the total system CD-4 frequency response is not up to that of a good stereo system. Referenced to 1 kHz, we found the low end (40 Hz) to be up 3 to 5 dB and the high end (10 kHz) to be down 8 to 10 dB. On our "simultaneous tone" test, the CD-4 setup provided 12 to 14 dB of effective separation. We emphasize again that these measurements are made through the whole system, including the test disc and pickup.

Heath's SQ circuitry uses the latest IC design and employs both variable-blend and full logic. It is operable both from SQ-matrixed records and from SQ-encoded FM broadcasts. We measured the SQ board in a similar manner to the CD-4, using a special test record and a Shure V-15 Type III pickup. Midband separation from pure single tones (which permits the "logic" to function), was as follows:

Left/right separation, across both front and back, was a very good 20 to 29 dB. Across the sides, we measured a good (for matrix) 11 to 14 dB. Across the diagonals, we measured 12 to 15 dB. Center front to center back, we measured 11 dB, while center back to center front was $4\frac{1}{2}$ dB. Center left to center right was $7\frac{1}{2}$ dB, while center right to center left was $8\frac{1}{4}$ dB. The channel balance, left to right, was excellent, but both rear channels were about $4\frac{1}{2}$ dB below the front pair. The frequency response in each of the main channels was virtually the same as a good stereo disc, with a few dB loss apparent at 15 kHz, in the rear channels only. Expect to find the separation between any channel, and the pair diagonally opposite it, degraded at the frequency extremes. In our simultaneous tones test, meant to confuse the SQ logic enhancement, the effective separation was about 3 dB, as we might expect.

As an FM tuner, the AN-2016 proved to be among the best we've tested. We found tuning the Modulus very easy. There was a small amount of backlash in the planetary drive mechanism, and,

while without a flywheel it wasn't possible to spin the tuning knob, it was smooth acting, with a damped feel. About five turns of the knob spanned the FM band. The digital display was a great help in indicating the precise station tuned.

The tuner proved sensitive and quiet, with good stereo spread in multiplex reception. We logged in a total of 61 stations, of which 44 were broadcasting in stereo. Each of the stereo stations triggered the multiplex circuitry. Of them, 26 provided excellent stereo, 5 were judged very good and 6 more were passable, if somewhat noisy. Seven stereo stations were too noisy and/or distorted for high-fidelity listening. Oddly enough, the AN-2016 does *not* have a multiplex noise filter. But we found an interesting, if somewhat unconventional, use for the FM Dolby accessory. If we used it on a slightly noisy stereo station (not Dolbyized), we got a noticeable improvement in noise level, with just a touch of high-end brightening—and no loss of separation, of course. When receiving Dolbyized broadcasts, there is no added brightening, just an improvement in signal-to-noise ratio. While appreciable, the noise improvement is not all that outstanding. We suspect a certain amount of residual noise in the Dolby IC chip contributes to this, but then again, the 25-microsecond de-emphasis curve employed in Dolby broadcasting does result in a noisier (if cleaner) signal *into* the Dolby processor. Over-all, we found the Dolby board well worth the \$39.95 it costs.

Of our 61 stations, 54 provided excellent mono reception, with 2 more very good. Five were unacceptably weak, even in mono. The muting circuit (called SQUELCH on the Modulus) can be internally set in sensitivity. Set to *just* suppress interstation noise, it removed only one of our stations—and that one was totally unlistenable anyway. Stations snapped out of squelch rather abruptly.

As an AM tuner, the Modulus was far above average. With its shielded-loop antenna, rather than the typical ferrite rod, the sensitivity was higher than that of other tuners we've tested, and its susceptibility to hum and static pickup was much less than average. On the other hand, AM reception is still AM reception, and is much noisier and hissier (in weak signal areas) than FM. Even on the Modulus, it hardly qualifies as high fidelity.

Engaging the high filter and turning down the treble somewhat helps to improve listenability.

We rate the Modulus very highly over-all. In use, we found that the four individual level controls took a bit of getting used to. We finally decided to set them all at maximum and then move the image by reducing the appropriate control or controls. The tone control hinge frequencies were well chosen for a single frequency control, but they are not as flexible as the switchable controls found on some of the newer high-priced gear. The input selector array provided good flexibility, but we would have liked at least one extra quad tape input on the rear panel for a permanent hookup in a multideck system. The stereo phono preamp was totally noiseless in operation, and its overload point was fully satisfactory. As we said previously, the same is not true for the CD-4 preamp, a serious drawback in our mind for the audiophile who wishes to play both CD-4 and stereo discs from a single pickup through the CD-4 input. But we should state that Heath uses the standard CD-4 IC, and it is likely that other CD-4 equipment using this chip has a similar problem.

The low and high filters in the AN-2016 are first-rate indeed, especially the low filter, which has almost no audible effect on the music, while being quite effective in cutting out subsonic signals. The loudness contour is pleasant, but comes in a trifle too high on the volume control for our liking. The SQ and CD-4 circuitry measures about as well as any we've tested, and a far cry above many examples. The FM Dolby is a very welcome addition to a first-rate FM/AM tuner section. And of course, the peak-reading logarithmic output meters and digital frequency display add precision to the system. Our impression is that Heath did a considerable amount of soul searching when designing this unit to pack the most real value for the money without entering a "specsmanship" competition. While other equipment has tested better in specific regards, the test results on the Modulus (with the exception of the CD-4 preamp) are at a level at which further improvement would not result in significantly better sonic possibilities. This is a very fine kit for the adventurous audiophile.

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