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DAC1

DIGITAL-ANALOG CONVERTER

6-10-91

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## PREFACE

Please take the time to carefully read this Instruction Manual prior to installation or use of your DAC1 Digital-Analog Converter. Because it is a highly advanced electronic instrument, there are several facts and procedures you should know before you place it in operation.

Just as you would not purchase and attempt to operate an expensive camera, computer system or high-performance automobile without first learning something about performance parameters and correct operating procedures, so too your digital-analog converter requires some familiarization before you make it part of your music system. Your reward, in terms of maximum performance and a long service life, will be well worth the effort.

## INTRODUCTION

The development of digital recording and playback technology has been driven not so much by "breakthroughs" as by numerous incremental improvements and refinements over several generations of digital-domain products -- CD players, DAT recorders, digital processors and digital preamps. The cumulative result of these refinements today is that digital audio technology has achieved mainstream status, with a degree of technological maturity that allows the introduction of products that will provide years of cutting-edge performance without the threat of rapid (and costly) obsolescence.

It is in this context of product stability that Audio Research Corporation is pleased to introduce its first digital product, the DAC1 digital-to-analog converter. The DAC1 incorporates the most significant, time-proven digital advances with the most useful real-world operational functions -- yielding a truly state-of-the-art product that is also accessible in price to many, many music lovers.

There is no single key to the DAC1's remarkable performance, but the three basic sections of its overall architecture merit discussion: power-supply topology and regulation; the digital-analog converter itself; and the all-discrete analog output stage. The first and last of these areas draw heavily upon Audio Research's many years of experience and leadership in analog circuit design.

First, three separate power transformers are used in the DAC1: one for the digital input and filtering stages, another for the digital converter and a third for the analog output stage. Three transformers allow tighter regulation of the supplies they feed, with better isolation between analog and digital circuitry, than a single multi-winding transformer can offer; the final result is cleaner, more dynamic musical performance. In addition, a total of five costly discrete regulators help maintain a clean supply of power to each critical stage. Finally, two linear regulators are dedicated to the digital input stage and to the automatic muting circuit. In-circuit capacitors are all audio-grade polypropylene or polystyrene types which have been individually evaluated for best sonic performance.

The DAC1's heavy, double-sided circuit board typifies the Audio Research approach: heavy plating and extra-wide traces laid down in a clean, "shortest-path" layout. Special care was taken in the design of grounding paths to prevent infiltration of the analog signal path by digital noise.



In addition to the meticulously executed power supply, the digital converter used inside the DAC1 merits further discussion. Manufactured for Audio Research by UltraAnalog Inc., an acknowledged leader in high-resolution digital design, the converter itself is offered in both 18-bit and 20-bit, eight-times-oversampling versions with full linearity over 108 dB of dynamic range (112dB for the DAC1-20). These specifications are inherent in the design of the converter itself (rather than "trimmed" in), and thus will not degrade or vary over time. While present consumer CD and DAT technology is based on 16-bit word length, 18-bit or 20-bit processing is used to reduce digital noise and extract the full 16-bit resolution inherent in this digital format. The converter itself is preceded in-circuit by an eight-times oversampling digital filter providing de-emphasis in the digital domain, scaled to all incoming frequencies. An initial digital "receiver" automatically locks on the incoming sampling frequency (32, 44.1 or 48 kHz) and reclocks all data via a single phase-locked-loop circuit, thus minimizing data "jitter" at the input -- a contributing cause of poor digital audio quality.

The DAC1 is an elegant, straightforward design, carefully executed, which does not require so-called "on-board computers" to "reconfigure" the digital data input.

The analog output stage of the DAC1 clearly exhibits Audio Research's belief that this section of the overall design has been seriously compromised in many previous digital products. The DAC1 is a high-current, all-discrete analog stage employing J-FET transistors at the input and MOSFETs at the output. Only costly discrete regulators are used, along with a patent-pending DEC (Decoupled Electrolytic Capacitor) circuit. The latter is a new circuit technique employed by Audio Research engineers to enable critical bypass capacitors to operate more effectively (i.e. with lower distortion) at the middle and high frequencies, where the human ear is most sensitive.

Other, less obvious aspects of the DAC1's design are important as well. A built-in AC line filter at the input helps deliver cleaner AC power to all three transformers for better sonics. And, none of the DAC1's three front-panel switches (Power on-off, phase inversions, and input selector) invade the audio signal path. Phase inversion is accomplished in the digital domain for maximum purity.

In terms of connective flexibility, the DAC1 offers both sonic purity and real-world convenience. Three digital inputs are provided: one set is switchable between glass fiber-optic (AT&T, ST® type) and BNC - coaxial. The second is the EIAJ CP-340 plastic fiber digital audio interface which matches the plastic fiber digital outputs of many CD changers and video disc players. The third input is BNC-coaxial. The BNC connector was chosen because, when used with a quality coaxial interconnect, it maintains a constant 75-ohm impedance in the transmission line between the CD drive and the DAC1 -- resulting in sonics far superior to conventional RCA-type connectors. Additionally, the ST-type glass fiber optic was chosen because it offers superior transmission of data and better sonics. It should be noted that the latest generation of high-quality CD transports are offering glass-optic and BNC outputs as the connective standards of choice. Two RCA-to-BNC adaptors are provided with the DAC1, for use with CD players or changers having a conventional RCA-type digital output. A hard-wired BNC connector is strongly preferred.

At the output of the DAC1 are two audiophile-grade, gold-plated RCA-type connectors; these were selected for their sonic superiority and convenient connection to the vast majority of today's preamplifiers.

The control side of the DAC1 reflects the need for useful controls without excess. Of the three toggle switches, one controls AC line power to the DAC1; it has a correlated green LED. (An automatic start-up and powerline interruption muting circuit dims this LED whenever it is triggered.) A second toggle controls absolute phase inversion, for use with recordings originally produced out-of-phase. Finally, a third three-position toggle selects among the three inputs -- for example, among a CD drive, multi-disc changer and videodisc player. A second green LED, located just left of the input selector, illuminates as soon as the DAC1 locks on an incoming frequency, indicating the reception of valid data.

Note that the DAC1 has no manual provision for selecting among the three sampling frequencies, since this is done automatically by the incoming receiver circuit.

The DAC1 has undergone comprehensive testing and fully complies with FCC regulations for digital equipment in a residential installation.

Sonically, the DAC1 brings CD playback to a new level of realism and enjoyment. Use in conjunction with a high-quality CD transport, the DAC1 is capable of recreating a musical soundstage that is remarkably akin to high-resolution analog in its presentation of spatial cues, low-level ambient detail, high-frequency information and musical dynamics. In short, the DAC1 is a new window opened upon the world of digital playback.

#### WARNINGS

1. Note: This equipment has been tested and found to comply with the limits for a class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures.

- \*Re-orient or relocate the receiving antenna.
- \*Increase the separation between the equipment and the receiver.
- \*Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- \*Consult the dealer or an experienced radio/TV technician for help.

2. To prevent fire, or shock hazard, do not expose your DAC1 to rain or moisture.

3. This unit contains voltages which can cause serious injury or death. Never operate with cover removed. Refer servicing to your authorized Audio Research dealer or other qualified personnel.



4. The power cord on your DAC1 is equipped with a removeable 16-gauge, 3-conductor cable and a standard three-prong grounding plug. For absolute protection, do not defeat the ground power plug. This provides powerline grounding of the DAC1 chassis to provide absolute protection from electrical shock.

5. For continued protection against fire hazard, replace the internal fuses only with the same type and rating.

#### PACKAGING

Save all packaging in a dry place away from fire hazard. Your DAC1 preamplifier is a precision electronic instrument and should be properly cartoned any time shipment is made. You may not have occasion to return your unit to the factory for service, but if that should prove necessary, or other occasion requiring shipment occurs, the original packaging will protect your DAC1 from unnecessary damage or delay.

#### DESCRIPTION OF CONTROLS

POWER SWITCH: Supplies power from AC wall outlet to DAC1 when in "Power" position.

NORMAL/INVERT SWITCH: Inverts the absolute phase of the signal 180° when switched to "Invert" position (inversion accomplished in the digital domain).

INPUT SWITCH: Allows user to select one of three possible digital sources. When a digital source is connected properly, the "Lock" LED will light when that input is selected.

#### CONNECTIONS

OUTPUT CONNECTORS: There is one (1) set of RCA output connectors, which should be connected to your preamplifier or line-stage amplifier.

INPUT CONNECTORS: Input number one is switchable between a BNC-type coaxial, and an AT&T, ST® type glass fibre optical input. Connecting both coaxial and optical inputs to input number one could cause sonic degradation.

Input number two is the EIAJ CP-340 plastic fiber digital audio interface.

Input number three is a BNC-type coaxial input. Two RCA to BNC adapters are included with each DAC1.

#### INSTALLATION INSTRUCTIONS

While the DAC1 does not dissipate an unusual amount of heat, it is important that it be provided with reasonable airflow to assure long, trouble-free operation. In addition, the following installation guidelines will help insure maximum sonic performance as well as reliable service.

1. Upright and horizontal mounting is suggested if extended operation (longer than one hour) is contemplated.
2. Do not "stack" the DAC1 on top of a power amplifier.
3. Do not place or operate your DAC1 on a soft or irregular surface such as a rug. This will prevent proper ventilation.
4. Never operate your DAC1 without the top and bottom covers installed. These are required both for safety as well as shielding from interference (except in service operations, obviously).

#### OPERATING/START-UP PROCEDURE

1. Make sure Power switch is set to "Off" position.
2. Secure all rear-panel connections between DAC1, preamplifier, and digital input source(s).
3. Plug 3-prong power cord from the rear of the DAC1 into a grounded AC wall receptacle.
4. Turn Power switch to "On". The green "Power" LED will glow dimly for approximately 15 seconds while the power supply stabilizes, indicating operation of the automatic muting circuit. After this warm-up period, the LED will brighten, indicating that your DAC1 is ready for operation.

#### CLEANING

To maintain the visual appearance of your DAC1 preamplifier, occasionally wipe the front panel and top cover surfaces with a soft, damp (not wet) cloth to remove dust. A mild, non-alkaline soap solution may be used to remove fingerprints or similar smudges. Cleaners containing abrasives should not be used as they will damage the "brushed" grain of the front panel finish.



### 3-YEAR LIMITED WARRANTY TERMS AND CONDITIONS

1. **LIMITED WARRANTY.** Audio Research warrants the product designated herein to be free of manufacturing defects in material and workmanship, subject to the conditions hereinafter set forth, for a period of three (3) years from the date of purchase by the original purchaser or no later than five (5) years from the date of shipment to the authorized Audio Research dealer, whichever comes first, excepting vacuum tubes which are warranted for 90 days only (See 6).
2. **CONDITIONS.** This Warranty is subject to the following conditions and limitations. The Warranty is void and inapplicable if the product has been used or handled other than in accordance with the instructions in the owner's manual, abused or misused, damaged by accident or neglect or in being transported, or the defect is due to the product being repaired or tampered with by anyone other than Audio Research or an authorized Audio Research repair center. The product must be packed and returned to Audio Research or an authorized Audio Research repair center by the customer at his or her sole expense. Audio Research will pay return freight of its choice. A RETURNED PRODUCT MUST BE ACCOMPANIED BY A WRITTEN DESCRIPTION OF THE DEFECT AND A PHOTOCOPY OF THE ORIGINAL PURCHASE RECEIPT. This receipt must clearly list model and serial number, the date of purchase, the name and address of the purchaser and authorized dealer and the price paid by the purchaser. Audio Research reserves the right to modify the design of any product without obligation to purchasers of previously manufactured products and to change the prices or specifications of any product without notice or obligation to any person.
3. **REMEDY.** In the event the above product fails to meet the above Warranty and the above conditions have been met, the purchaser's sole remedy under this Limited Warranty shall be to return the product to Audio Research or an authorized Audio Research repair center where the defect will be rectified without charge for parts or labor, except vacuum tubes (See 6).
4. **LIMITED TO ORIGINAL PURCHASER.** This Warranty is for the sole benefit of the original purchaser of the covered product and shall not be transferred to a subsequent purchaser of the product.
5. **DURATION OF WARRANTY.** This Warranty expires on the third anniversary of the date of purchase or no later than the fifth anniversary of the date of shipment to the authorized Audio Research dealer, whichever comes first.
6. **VACUUM TUBES.** Vacuum tubes are warranted for the original 90-day period only.
7. **DEMONSTRATION EQUIPMENT.** Equipment used by an authorized dealer for demonstration purposes is warranted to be free of manufacturing defects in materials and workmanship for a period of three (3) years from the date of shipment to the dealer. Vacuum tubes are warranted for 90 days. Demo equipment needing warranty service must be packed and returned to Audio Research by the dealer at his sole expense. Audio Research will pay return freight of its choice. A returned product must be accompanied by a written description of the defect on an AUDIO RESEARCH RETURNED GOODS AUTHORIZATION form. Dealer-owned demonstration equipment sold at retail within three (3) years of date of shipment to the dealer is warranted to the first retail customer to be free of manufacturing defects in materials and workmanship for the duration of the 3-Year Limited Warranty remaining (as measured from the date of shipment of the equipment to the dealer). Vacuum tubes are not warranted for any period under these conditions of sale. In the event warranty service is needed under these conditions,



the owner of the equipment must provide a copy of his purchase receipt, fulfilling the requirements described under "2. Conditions" above. The product must be packed and returned to Audio Research or an authorized Audio Research repair center by the customer at his or her sole expense. Audio Research will pay return freight of its choice.

8. MISCELLANEOUS. ANY IMPLIED WARRANTIES RELATING TO THE ABOVE PRODUCT SHALL BE LIMITED TO THE DURATION OF THIS WARRANTY. THE WARRANTY DOES NOT EXTEND TO ANY INCIDENTAL OR CONSEQUENTIAL COSTS OR DAMAGES TO THE PURCHASER. Some states do not allow limitations on how long an implied warranty lasts or an exclusion or limitation of incidental or consequential damages, so the above limitations or exclusions may not apply to you. This Warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

9. WARRANTOR. Inquiries regarding the above Limited Warranty may be sent to the following address:

Audio Research Corporation  
6801 Shingle Creek Parkway  
Minneapolis, MN 55430

#### WARRANTY OUTSIDE THE USA

Audio Research has formal distribution in many of the countries of the free world. In each country the Audio Research Importer has contractually accepted the responsibility for product warranty. Warranty should normally be obtained from the importing dealer or distributor from whom you obtain your product.

In the unlikely event of service need beyond the capability of the Importer, Audio Research does, of course, back up the warranty. Such product would need to be returned to Audio Research, together with a photostatic copy of the bill of sale.

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## DAC-1 DIGITAL-ANALOG CONVERTER PRELIMINARY SPECIFICATIONS

Frequency Response: 0.01-20,000Hz,  $\pm 2$ dB

Signal to Noise Ratio: 100dB (unweighted 20-20000Hz)

Distortion: -94 dB (0.002%) 1kHz

Channel Separation: 100dB (1kHz)

Phase Linearity:  $\pm 0.5^\circ$  (20-20,000Hz)

Digital Input 1 (Switch selectable): BNC COAX 75 ohm (S/P DIF) / ST TYPE GLASS  
FIBER OPTICS; 1300 nm, 62.5/125 FIBER

Digital Input 2: EIAJ CP340 PLASTIC FIBER DIGITAL AUDIO INTERFACE

Digital Input 3: BNC COAX 75 ohm. (S/P DIF)

Format: 32 kHz, 44.1kHz (CD), 48 kHz (DAT)

Converter Resolution: 18 bits or 20 bits, 8 x oversampled

Monotonicity: DAC1-18, 18 bits min; DAC1-20, 20 bits typ.

Input Resolution: 16 bits

Stereo Analog Output: 1.75 Vrms (+5dBV full output) Unbalanced RCA Phono Jacks

Output Impedance: 30 Ohms

Reclocking Method: PLL

Inverting Switch: Digital Domain

Panel Controls: Switches for Power On, Phase Invert, Input Select

Panel Indicators: Power On, Digital Lock

Compliance: RF interference complies with FCC and VDE

Power Supply: 3 Transformers, 5 Discrete Regulators, 2 IC Regulators

Power Requirements: 95-135VAC 60Hz (190-270VAC 50/60 Hz), 25 Watts Maximum

Line Fuse: 1/2A Fast (3/8A Fast 240V)

Dimensions: 19" (48 cm) W x 5 1/4" (13.4 cm) H 10 1/4" (26 cm) D Handles extend 1 5/8" (4.1 cm) forward of front panel. Rear chassis fittings extend 7/8" (2.3 cm).

Weight: 12 lbs. (5.5 kg) Net; 20 lbs. (9.1 kg) Shipping.