

# Audio precision<sup>®</sup>

## Digital Domain



GETTING STARTED WITH ATS-2

# Getting Started with ATS-2



## An Introductory Guide to ATS-2 For ATS Version 1.0

October 2001  
Audio Precision PN 8211.0136

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# Contents

|   |          |
|---|----------|
| Safety Information . . . . .                              | vii      |
| Safety Symbols . . . . .                                  | viii     |
| Disclaimer . . . . .                                      | viii     |
| <b>Chapter 1</b>  |          |
| <b>General Information . . . . .</b>                      | <b>1</b> |
| ATS-2: An Overview . . . . .                              | 1        |
| ATS-2 Capabilities . . . . .                              | 2        |
| Conceptual Architecture of ATS-2 . . . . .                | 2        |
| About This Manual . . . . .                               | 4        |
| Online Help . . . . .                                     | 4        |
| Other Documentation for ATS-2 . . . . .                   | 4        |
| ATS-2 User's Manual . . . . .                             | 4        |
| AP Basic User's Guide and Language Reference . . . . .    | 5        |
| AP Basic Extensions Reference for ATS-2 . . . . .         | 5        |
| Filter Design Package Manual . . . . .                    | 5        |
| Other Publications . . . . .                              | 5        |
| <b>Chapter 2</b>  |          |
| <b>Installation and Setup . . . . .</b>                   | <b>7</b> |
| ATS-2 Components . . . . .                                | 7        |
| Getting up and Running . . . . .                          | 8        |
| Installing ATS Software on a PC . . . . .                 | 8        |
| PC System Requirements . . . . .                          | 8        |
| Installing the Software . . . . .                         | 8        |
| Setting Up the ATS-2 Hardware . . . . .                   | 9        |
| Connecting ATS-2 to the Electrical Mains Supply . . . . . | 9        |

|   |    |
|---|----|
| Checking the Mains Supply Voltage Configuration . . . . . | 10 |
| Changing the Mains Supply Voltage Configuration. . . . .  | 10 |
| Fuse Information. . . . .                                 | 11 |
| Changing the Fusing Arrangement . . . . .                 | 11 |
| Connecting ATS-2 to Your PC . . . . .                     | 12 |
| Installing the ISA APIB Card . . . . .                    | 13 |
| ISA Card Address Jumper Settings . . . . .                | 13 |
| Installing a PCI APIB Card . . . . .                      | 14 |
| Using the PCM-WIN PCMCIA Interface Card. . . . .          | 15 |

|                                    |           |
|------------------------------------|-----------|
| <b>Chapter 3</b>                   |           |
| <b>Hardware Overview . . . . .</b> | <b>17</b> |
| ATS-2 Front Panel. . . . .         | 17        |
| ATS-2 Rear Panel . . . . .         | 18        |

|  |           |
|--|-----------|
| <b>Chapter 4</b>                       |           |
| <b>ATS-2 User Interface . . . . .</b>  | <b>21</b> |
| Overview . . . . .                     | 21        |
| A Note on Nomenclature . . . . .       | 21        |
| Starting up the ATS Software . . . . . | 22        |
| ATS Workspace . . . . .                | 22        |
| ATS Panels. . . . .                    | 23        |
| Panel Settings . . . . .               | 23        |
| Panel Readings . . . . .               | 24        |
| ATS Menus. . . . .                     | 25        |
| File Menu . . . . .                    | 25        |
| Edit Menu. . . . .                     | 25        |
| View Menu . . . . .                    | 25        |
| Panels Menu . . . . .                  | 25        |
| Sweep Menu . . . . .                   | 25        |
| Compute Menu. . . . .                  | 26        |
| Macro Menu . . . . .                   | 26        |
| Utilities Menu. . . . .                | 26        |
| Window Menu . . . . .                  | 26        |
| Help Menu . . . . .                    | 26        |
| Status Bar . . . . .                   | 26        |
| Toolbars and Buttons . . . . .         | 27        |
| Standard Toolbar. . . . .              | 27        |
| Panels Toolbar . . . . .               | 27        |
| Macro Toolbar . . . . .                | 27        |
| Learn Mode Toolbar . . . . .           | 28        |
| Quick Launch Toolbar . . . . .         | 28        |
| Using Files with ATS . . . . .         | 28        |
| Test Files . . . . .                   | 28        |
| Macro Files . . . . .                  | 29        |

|  |    |
|--|----|
| Data Files . . . . .                               | 29 |
| Waveform Files. . . . .                            | 29 |
| Log File . . . . .                                 | 30 |
| Downloadable Filter Files . . . . .                | 30 |
| <b>Chapter 5</b>                                   |    |
| <b>Quick Guides</b> . . . . .                      | 31 |
| Introduction . . . . .                             | 31 |
| Quick Guide to the Analog Signal Path . . . . .    | 31 |
| Analog Input Panel. . . . .                        | 31 |
| Analog Generator Panel . . . . .                   | 31 |
| Analyzer Panel . . . . .                           | 32 |
| Signal Monitor . . . . .                           | 33 |
| Controlling the Analog Generator . . . . .         | 33 |
| Units. . . . .                                     | 34 |
| Quick Guide to Sweeps. . . . .                     | 35 |
| Sweep Fundamentals . . . . .                       | 36 |
| Settings and Readings. . . . .                     | 36 |
| Source Range, Steps, and Spacing . . . . .         | 37 |
| Data Display Range. . . . .                        | 37 |
| Review . . . . .                                   | 37 |
| Example Sweep: Frequency Response . . . . .        | 38 |
| Example Sweep: Amplitude Linearity . . . . .       | 39 |
| Quick Guide to the FFT Spectrum Analyzer . . . . . | 40 |
| Real-Time vs. Batch-Mode Instruments . . . . .     | 40 |
| The FFT Concept . . . . .                          | 40 |
| Setting up an FFT. . . . .                         | 41 |
| Panel Fields . . . . .                             | 41 |
| Time vs. Frequency . . . . .                       | 41 |
| Quick Sweep Setup . . . . .                        | 42 |
| Fine-Tuning the Display . . . . .                  | 43 |
| Saving and Loading Tests . . . . .                 | 43 |
| The Next Step. . . . .                             | 44 |
| <b>Chapter 6</b>                                   |    |
| <b>Specifications</b> . . . . .                    | 45 |



## Safety Information

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Do NOT service or repair this product unless properly qualified. Servicing should be performed only by a qualified technician or an authorized Audio Precision distributor.

Do NOT defeat the safety ground connection. This product is designed to operate only from a 50/60 Hz AC power source (250 V rms maximum) with an approved three-conductor power cord and safety grounding. Loss of the protective grounding connection can result in electrical shock hazard from the accessible conductive surfaces of this product.

For continued fire hazard protection, fuses should be replaced **ONLY** with the exact value and type indicated on the rear panel of the instrument and discussed on page 11 of this manual. The AC voltage selector also must be set to the same voltage as the nominal power source voltage (100, 120, 230, or 240 V rms) with the appropriate fuses. Different fuses are required depending on the line voltage.

The International Electrotechnical Commission (IEC 1010-1) requires that measuring circuit terminals used for voltage or current measurement be marked to indicate their Installation Category. The Installation Category is defined by IEC 664 and is based on the amplitude of transient or impulse voltage that can be expected from the AC power distribution network. This product is classified as INSTALLATION CATEGORY II, abbreviated “CAT II” on the instrument front panel.

Do NOT substitute parts or make any modifications without the written approval of Audio Precision. Doing so may create safety hazards.

This product is for indoor use—pollution degree 2.



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## Safety Symbols

The following symbols may be marked on the panels or covers of equipment or modules, and are used in this manual:



**WARNING!**—This symbol alerts you to a potentially hazardous condition, such as the presence of dangerous voltage that could pose a risk of electrical shock. Refer to the accompanying warning label or tag, and exercise extreme caution.



**ATTENTION!**—This symbol alerts you to important operating considerations or a potential operating condition that could damage equipment. If you see this marked on equipment, refer to the Operator's Manual or User's Manual for precautionary instructions.



**FUNCTIONAL EARTH TERMINAL**—A terminal marked with this symbol is electrically connected to a reference point of a measuring circuit or output and is intended to be earthed for any functional purpose other than safety.



**PROTECTIVE EARTH TERMINAL**—A terminal marked with this symbol is bonded to conductive parts of the instrument and is intended to be connected to an external protective earthing system.

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## Disclaimer

Audio Precision cautions against using their products in a manner not specified by the manufacturer. To do otherwise may void any warranties, damage equipment, or pose a safety risk to personnel.

# Chapter 1

## General Information



Figure 1. The Audio Precision ATS-2 audio test and measurement system.

### ATS-2: An Overview

The Audio Precision ATS-2 is a powerful computer-controlled audio test and measurement system consisting of two key components:

- The ATS-2 hardware: the connectors and circuitry necessary for precise signal generation and analysis, and for interfacing to devices. The hardware is mounted in a compact (2 U) aluminum and steel chassis that can be installed in a standard equipment rack using optional mounting hardware.
- The ATS measurement software, which runs on a personal computer (PC), and provides the control, display, report and automation functions for the ATS-2 system. The ATS software will run under Windows 95, Windows 98, Windows 2000, Windows ME, and Windows NT 4.0.

With the exception of the mains power switch on the rear panel, there are no knobs, dials, controls, readouts, meters or switches on the ATS-2 chassis. All of these functions are performed via the ATS software on the controlling PC.

The PC communicates with the ATS-2 chassis via a proprietary bus interconnection called the Audio Precision Interface Bus (APIB), which requires a dedicated cable and a PC-mounted interface card or adapter. APIB interfaces can be ordered as ISA, PCI, and PCMCIA compatible devices. See Chapter 2 for further information on these interfaces.

---

## ATS-2 Capabilities

- ATS-2 can make amplitude, frequency, THD+N, noise, phase, crosstalk, bandpass, and IMD measurements for analog or digital audio devices. In a special function, ATS-2 can perform detailed analysis and measurement of harmonic distortion products.
- ATS-2 can perform complex sweeps, and display and print the results with a powerful graphing engine. ATS-2 offers control over instrument regulation and settling parameters. Data obtained from sweeps can be compared to pre-defined limits. A variety of computations can be performed on the measured data after acquisition. Tests and data can be saved and recalled, and ATS-2 measurements can be automated by macros written in the AP Basic programming language.
- ATS-2 can perform measurements using fast Fourier transform (FFT) analysis. Advanced high-speed FFT analysis techniques are available, including multitone recognition and analysis, frequency adjustment for bin centering, synchronous FFT processing, and advanced post-FFT analysis.
- ATS-2 can examine an AES/EBU digital interface signal and assure the integrity of digitally transmitted data. It can also measure and examine the jitter in the waveform. ATS-2 can extract a variety of statistics from a digital waveform, including the sample rate, the interface waveform voltage, the jitter amplitude, and the active and inactive data bits. ATS-2 also has the capability of transmitting and receiving a full complement of AES/EBU status bits.
- ATS-2's sample rate may be synchronized to an external AES/EBU signal, a square wave, or an NTSC or PAL video source.
- ATS-2 has two auxiliary control connectors for control of external equipment.

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## Conceptual Architecture of ATS-2

The functional components implemented in ATS-2 include two audio signal generators, an audio signal analyzer, digital and analog input and output modules, and a module for external timebase synchronization.

All signal generation is performed in the digital domain. One of the two signal generators is dedicated to the digital output. The signal from this digital generator is buffered and conditioned for the balanced, unbalanced and optical outputs. The output of the second signal generator is converted to an analog signal by a digital-to-analog converter (DAC). The two-channel output of the DAC is conditioned and ranged for the balanced and unbalanced analog outputs.

All signal analysis is also performed in the digital domain. The digital input is buffered and directly applied to the analyzer. Analog inputs are first ranged and conditioned, and then digitized by a high-resolution analog-to-digital converter (ADC) before being applied to the analyzer. An optional high-bandwidth ADC is available to increase measurement bandwidth.

#### **Analog Domain vs. Digital Domain**

*Analog audio signals are electrical analogies of the sound waves that they represent, varying in frequency and amplitude in a continuous fashion. In analog audio electronics, these voltages and currents are manipulated, processed, and measured by modifying their amplitude or frequency. The term analog domain refers to signals represented and processed in this fashion.*

*Digital audio signals, on the other hand, are numerical representations of the sound waves. The representation is often carried on an electrical signal called the interface signal. Digital audio is processed mathematically in processes gathered together under the name of Digital Signal Processing, or DSP. The term digital domain refers to signals represented and processed in this fashion.*

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## About This Manual

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You're reading *Getting Started with ATS-2*. This manual describes how to set up the ATS-2 hardware and ATS software. It also contains a quick tutorial to familiarize you with the system. It is organized as follows:

- Chapter 2: Software installation and hardware setup information.
- Chapter 3: Description of the hardware and its connectors.
- Chapter 4: Description of the user interface.
- Chapter 5: Introductory tutorial.

Chapter 6 lists the specifications of the system.

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## Online Help

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Much of the information contained in the *ATS-2 User's Manual* is also available in the online help system included in the ATS software. You can access the help system in two ways:

- ATS has context-sensitive help. Almost every control and display on each software panel has a help topic associated with it. To view the topic, click on the field or control, then press the **F1** function key.
- On the Menu bar, click **Help**. The Help menu offers commands to search the **Help Index**, browse through the **Help Topics**, or select a specific help library such as **AP Basic Language**.

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## Other Documentation for ATS-2

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Audio Precision publishes a variety of documents, many in electronic form, about hardware and software products, audio theory, and test and measurement techniques. The following list describes the documents that are included as Adobe Acrobat Portable Document Format (PDF) files on the CD-ROM that comes with your instrument. They can also be downloaded from our Web site at [audioprecision.com](http://audioprecision.com).

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### ATS-2 User's Manual

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The *ATS-2 User's Manual* is the primary operation and reference manual for the system. Consult the *ATS-2 User's Manual* for:

- Detailed descriptions of every ATS-2 feature, software panel, control, and display.
- Reference information on audio test and measurement techniques, sample and utility file listings, and an audio glossary.

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## AP Basic User's Guide and Language Reference

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You can create *tests* and *macros* to automate your measurements. Macros are written in the AP Basic programming language, which is a subset of Microsoft Visual Basic. The *AP Basic User's Guide and Language Reference* contains a list of the AP Basic commands, each with a full description and examples of usage.

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## AP Basic Extensions Reference for ATS-2

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The *AP Basic Extensions Reference for ATS-2* contains a list of OLE/ActiveX automation commands that control the specific features of the ATS-2 hardware and the ATS software.

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## Filter Design Package Manual

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ATS-2 can access and use *downloadable filter files*. This feature allows you to install custom software high-pass, low-pass and weighting filters for use with the ATS-2 analyzer.

The ATS CD-ROM includes a version of Momentum Data Systems' QEDLite filter design package. This special version creates filter files in the format used by ATS. The *Filter Design Package* manual describes the operation of this software.

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## Other Publications

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Audio Precision publishes application notes, technical papers, TECHNOTES, and AUDIO.TST, a quarterly newsletter. These cover all aspects of audio test and measurement. Information about our library of technical papers and announcements of new papers is available from Audio Precision Technical Support, and on the Audio Precision Web site.



# Chapter 2

## *Installation and Setup*

### **ATS-2 Components**

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The following items are included with ATS-2:

- A box containing the ATS-2 interface kit.
- The ATS-2 hardware chassis.
- A mains power cord.
- A packet of printed materials.

The following items are inside the ATS-2 kit box:

- An Audio Precision Interface Bus (APIB) interface card, as ordered<sup>1</sup>.
- An APIB interface cable.
- A CD-ROM containing the ATS measurement software and documentation files.
- This guide, *Getting Started with ATS-2*.
- Another packet of printed materials, including a product registration card. Please look through these materials and follow the instructions to register your ATS-2.

We recommend that you retain the shipping box and packing materials to protect your instrument if you need to ship it in the future.

<sup>1</sup> The ATS-2 APIB interface card is available for ISA, PCI, and PCMCIA slots. Refer to Page 12 for detailed installation information.



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## Getting up and Running

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There are three main tasks to setting up ATS-2:

- Installing the ATS software on a personal computer (PC);
- Configuring ATS-2 for the local power supply; and
- Installing the APIB card in the PC and connecting it to ATS-2.

These tasks are described below.

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## Installing ATS Software on a PC

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### PC System Requirements

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ATS-2 needs to be connected to an IBM-compatible PC to operate. The PC must have the following minimum features and capabilities:

- Pentium or compatible processor recommended.
- At least 16 MB of RAM (more recommended).
- An open ISA, PCI, or PCMCIA slot to mount the APIB interface card.
- At least 300 MB of hard disk space.
- A CD-ROM drive.
- A color monitor and a video card with at least VGA capabilities. Video resolution of 1024×768 is recommended.
- Windows 95, Windows 98, Windows 2000, Windows ME, or Windows NT 4.0.

You will also need signal interface cables to connect ATS-2 to your device for testing. Since there are many possible connection configurations, signal cables are not provided with ATS-2. Audio Precision offers cable kits with common connectors and adapters for purchase. Contact a sales representative or Audio Precision Technical Support for more information.

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### Installing the Software

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To install the ATS software, use the following procedure:

- Close all Windows programs.
- Insert the ATS CD-ROM into the CD-ROM drive. The installation program should start automatically. If it does not, click on the Start menu and choose Run. Click Browse and choose the file Setup.exe on the ATS CD-ROM. Click OK in the Run dialog box.

- In the main menu, click 'Install ATS Software'. Follow the on-screen instructions. The installation program prompts you to enter the required information.
- The installer may prompt you to reboot the machine. Although you do not need to reboot immediately, you must reboot before you can use the ATS-2 hardware.

## Setting Up the ATS-2 Hardware

### Connecting ATS-2 to the Electrical Mains Supply

ATS-2 must be connected to a 50–60 Hz alternating current (AC) electrical mains supply, maximum voltage 250 V rms.

The units are configured at the factory for the expected voltage at their intended destination. The voltage setting and fusing arrangement will normally be correct unless the unit has been transported into another area. The power entry module has a strip of indicator tape showing its mains voltage setting. This tape must be removed before use.

*You **MUST** be sure that the ATS-2 mains power configuration is correct for the electrical mains power supplied in your area. If you are not sure, do **not** plug ATS-2 in to the mains power. Follow the instructions below to check or change the ATS-2 mains supply voltage selection.*



The mains power supply is applied to ATS-2 through the power entry module located on the rear panel. Before connecting the power cord, confirm that the input voltage selection and fusing arrangement in the power entry module are correct for your mains power supply.

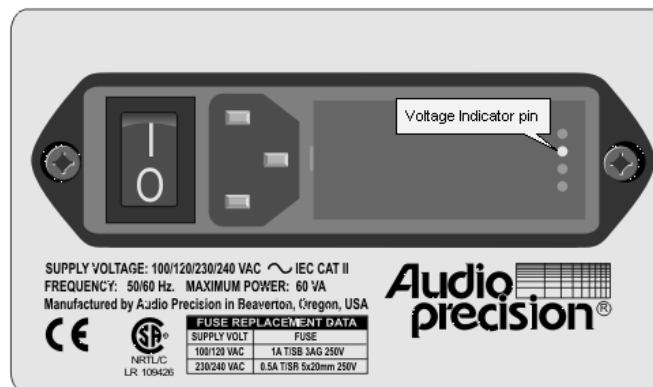


Figure 2. Detail, power entry module on ATS-2 rear panel.

### Checking the Mains Supply Voltage Configuration

The voltage indicator pin protrudes through one of the four labeled holes in the module cover to indicate the selected input voltage, as shown in Figure 2. Check that the indicated voltage matches your mains supply voltage.

### Changing the Mains Supply Voltage Configuration

Unplug the power cord from the instrument before changing fuses or performing any other operations described in this section.

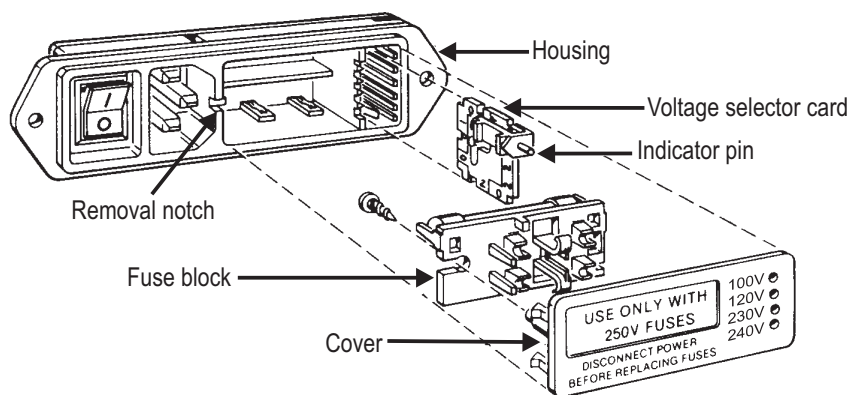


Figure 3. Changing the mains power supply voltage.

To change the input voltage, refer to Figure 3 and proceed as follows:

- Remove the mains power supply cord from the power cord connector.
- Open the power entry module cover with a small screwdriver or similar tool. Set aside the cover / fuse block subassembly.
- Pull the voltage selector card straight out of the housing, using narrow pliers to grab the card. Do not use the indicator pin as a handle.
- Orient the selector card so that the desired input voltage is readable at the bottom, shown in Figure 4. Then move the indicator pin to point up, with the pin assembly seated in the notch on the board edge.
- Insert the voltage selector card into the housing with the printed side of the card facing toward the connector. The edge indicating the desired voltage should enter the housing first.

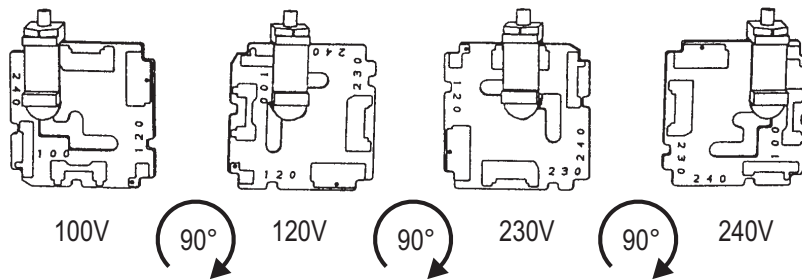


Figure 4. Voltage selector card positions.

- Confirm that the correct fuse or fuse combination is installed for the intended input voltage (refer to the fuse ratings marked on the rear panel). If necessary, change the fuse type as described in the following section.
- Replace the cover and verify that the indicator pin shows the desired voltage.

Once you have verified that the line voltage selection is correct, connect the power cord from a mains power outlet to the power cord connector on the ATS-2 rear panel.

## Fuse Information

The power entry module accommodates two fusing arrangements: North American and European, as illustrated in Figure 5. The North American fusing arrangement uses a single type 3AG (0.25×1.25 in.) SB (slow blow) fuse; the European fusing arrangement uses two 5×20 mm IEC-approved type T fuses. Refer to the label on the rear panel for fuse current ratings.

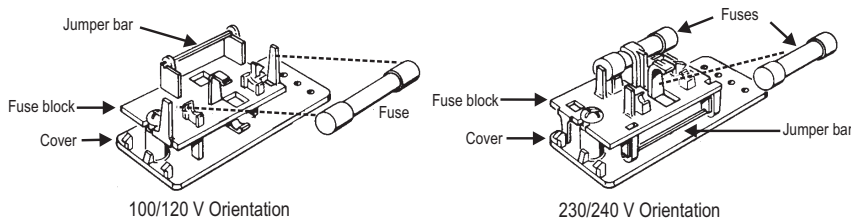


Figure 5. North American (left) and European (right) fusing arrangements.

## Changing the Fusing Arrangement

To change the fusing arrangement, proceed as follows:

- Remove the mains power cord from the power cord connector.

- Open the cover of the power entry module with a small screwdriver or similar tool.
- On the back of the cover, loosen the Phillips screw two turns, then remove the fuse block by sliding it up and away from the screw, and lifting it from the pedestal at the other end, as shown in Figure 6.

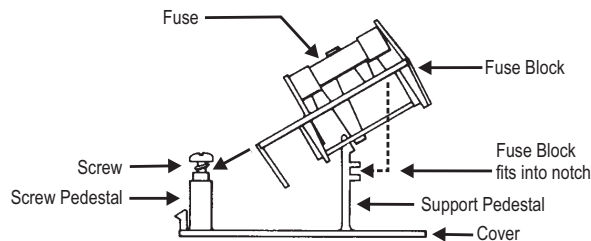


Figure 6. Changing fuse types.

- Invert the fuse holder and reassemble it on the Phillips screw and pedestal, and tighten the screw.
- Change or add the correct fuses as necessary (again, refer to the rear panel for the correct fuse current rating).
- Confirm the line voltage setting as described in the previous section, then replace the cover.

Once you have verified that the line voltage selection is correct, connect the power cord from a mains power outlet to the power cord connector on the ATS-2 rear panel.

## Connecting ATS-2 to Your PC

Before connecting ATS-2 to your PC, install the ATS software. See page 8 for details.

The ATS software communicates with the ATS-2 chassis through the Audio Precision Interface Bus (APIB). We offer three options for the APIB interface:

- The ISA card. Older PCs use the ISA bus exclusively.
- The PCI card. Some newer PCs use the PCI bus exclusively; many PCs have a mix of both ISA and PCI bus slots available.
- The PCMCIA card. This card allows you to use an existing PCMCIA interface found in many laptop computers. We offer an adapter for desktop PCs without a PCMCIA slot.

Your system was shipped with an APIB interface cable and with the interface option you ordered. Refer to the appropriate section for your interface below.

## Installing the ISA APIB Card

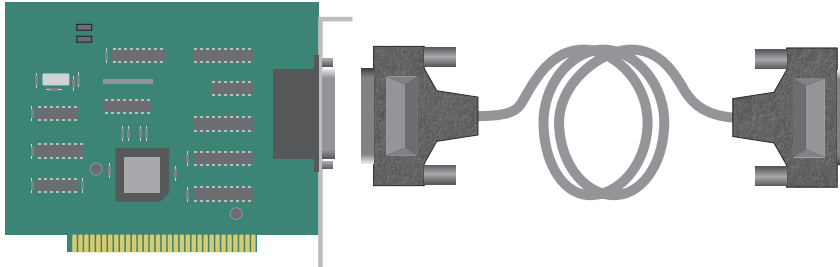


Figure 7. ISA card and APIB cable.

The Audio Precision ISA card is a half-size, 8-bit ISA card. To install the ISA card, use the following procedure:

- Turn off your computer, remove the cover, and install the ISA APIB interface card in an open ISA bus slot. Remember to handle the card properly to minimize static electricity discharges while installing it. Be sure the card is well seated in the slot; it should snap down firmly into the bus connector.
- Secure the card bracket with the mounting screw and replace the computer cover.
- Connect the APIB cable between ATS-2 and the ISA card.
- Turn on the computer.



## ISA Card Address Jumper Settings

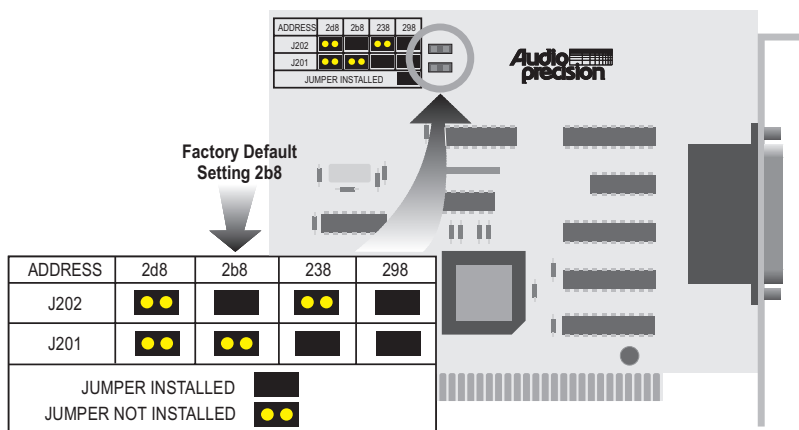


Figure 8. ISA card address jumper settings.

The ISA bus requires a unique hardware address setting for each device sharing the bus. The ISA APIB interface card uses jumpers to select one of four possible addresses, as shown in Figure 8.

| Address | 2d8     | 2b8       | 238       | 298       |
|---------|---------|-----------|-----------|-----------|
| J202    | Removed | Installed | Removed   | Installed |
| J201    | Removed | Removed   | Installed | Installed |
| Notes   |         | Default   |           |           |

The card is shipped with the jumpers in the factory default position shown in the table above. If there is a device conflict with the installation of the ISA APIB card, that is, if another device is already using the address, move the jumpers to change the card's address.

### Installing a PCI APIB Card

*The PCI interface is compatible with Windows 98, Windows 2000, Windows ME, and Windows NT 4.0. See the Compatibility Chart in the Software area of the Audio Precision Web site for current compatibility listings.*

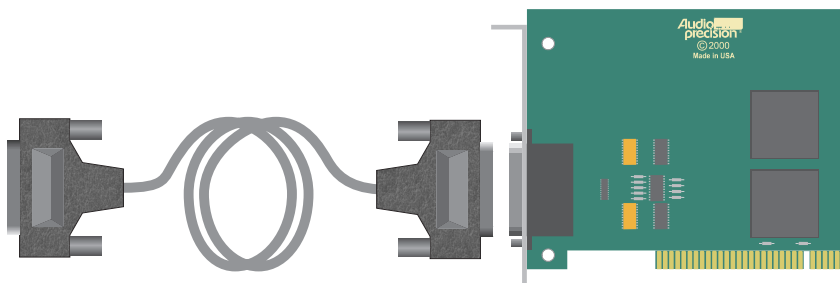


Figure 9. PCI card and APIB cable.

To install the PCI card, use the following procedure:



- Turn off your computer, remove the cover, and install the PCI APIB interface card in an open PCI bus slot. Remember to handle the card properly to minimize static electricity discharges while installing it. Be sure the card is well seated in the slot; it should snap down firmly into the bus connector.
- Secure the card bracket with the mounting screw and replace the computer cover.

- Connect the APIB cable between ATS-2 and the PCI card.
- Turn on the computer. Windows should automatically find and identify the APIB interface and install the correct driver.

### Using the PCM-WIN PCMCIA Interface Card

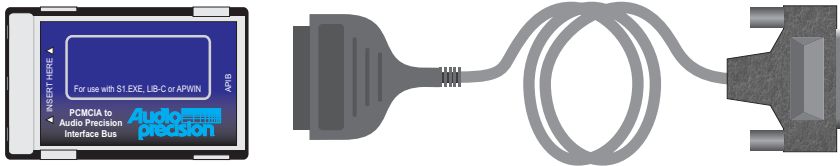


Figure 10. PCMCIA card and APIB cable.

---

*The ATS-2 PCMCIA interface is most commonly used with laptop computers, but can be used in other computers with the appropriate adapter.*

---

To use the PCMCIA card, you must have a working PCMCIA interface already installed in your computer. If you do not have a PCMCIA interface, Audio Precision offers two adapters: one for an ISA slot, and one for a PCI slot. Please contact Audio Precision Technical Support for details, or visit the Audio Precision Web site.

To install the PCMCIA card, use the following procedure:

- Install the PCMCIA adapter and drivers if necessary by following the instructions supplied with the adapter.
- Insert the PCMCIA card into the PCMCIA interface.
- Connect the APIB cable between ATS-2 and the PCMCIA card.





## Chapter 3

### Hardware Overview

The ATS-2 hardware includes input and output connectors, ranging and signal conditioning modules, digital signal processors, memory, and other circuitry needed to perform audio measurements. It is connected to the controller PC by the Audio Precision Interface Bus (APIB). In this chapter, the features of the hardware are described. For a full list of hardware specifications, see Chapter 6.

#### ATS-2 Front Panel

The ATS-2 front panel, shown in Figure 11, includes the digital and analog inputs and outputs and a power indicator.

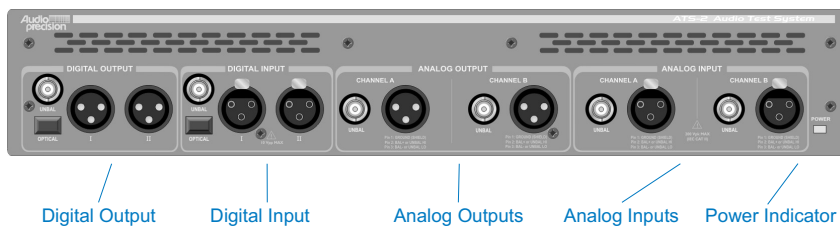


Figure 11. ATS-2 front panel.

#### ■ DIGITAL OUTPUTS

In single-connector mode, ATS-2 transmits stereo digital audio simultaneously on the XLR “I” connector, the BNC connector, and the optical connector. In dual-connector mode, channels A and B are transmitted on the XLR “I” and “II” connectors, respectively.

#### ■ DIGITAL INPUTS

In single-connector mode, ATS-2 receives stereo digital audio from the XLR “I” connector, the BNC connector, or the optical connector.

In dual-connector mode, channels A and B are received on the XLR “I” and “II” connectors, respectively.

#### ■ ANALOG OUTPUTS

The ATS-2 analog generator outputs (both “A” and “B” channels) are available as unbalanced signals on the BNC connectors and as balanced signals on the XLR connectors.

#### ■ ANALOG INPUTS

The XLR balanced and the BNC unbalanced connectors (both “A” and “B” channels) are connected to the ATS-2 analyzer inputs.

See Chapter 4 of the *ATS-2 User’s Manual* for more information about the ATS-2 inputs and outputs and the panels associated with them.

## ATS-2 Rear Panel

The ATS-2 interface, monitor, headphone, trigger, sync, and utility connections are mounted on the rear panel.

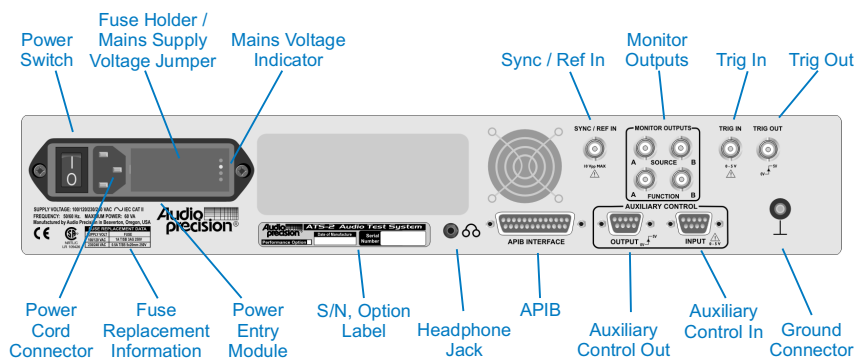


Figure 12. ATS-2 rear panel.

#### ■ POWER ENTRY MODULE—this module includes:

- **POWER SWITCH**—This switch turns the mains power supply to the ATS-2 hardware ON ( I ) or OFF ( O ).
- **POWER CORD CONNECTOR**—This is a standard grounded connector for the mains power supply cord.
- **FUSE HOLDER/MAINS SUPPLY VOLTAGE JUMPER**—Contains the mains power fuse and the mains supply voltage configuration jumper card. See Chapter 2.

- MAINS SUPPLY VOLTAGE INDICATOR—The white tip of the plastic indicator on the voltage configuration jumper card appears in one of four small holes to show the mains voltage selection.
- FUSE REPLACEMENT INFORMATION—This chart lists the fuse values required for correct operation at the four supply voltage options.
- SERIAL NUMBER/OPTIONS LABEL—The Audio Precision serial number for this ATS-2 chassis, and the hardware options (if any) included in the chassis.
- MONITOR JACK—This is a 3.5 mm jack suitable for driving stereo headphones or other audio monitors.
- SYNC/REF IN—This connector provides an input for an external digital audio signal, a square wave, or an NTSC/PAL video signal for sample rate synchronization (“house sync”).
- AUDIO MONITORS—The ‘source’ connectors monitor the signal currently being analyzed. The ‘function’ connectors monitor the function meter in the audio analyzer. These signals can also be monitored on the internal speaker.
- TRIG IN—This connector provides an input to trigger or initiate certain measurement functions.
- TRIG OUT—This connector provides an output for triggering an external oscilloscope or other equipment.
- APIB INTERFACE—This connector provides the two-way Audio Precision Interface Bus connection between ATS-2 and the personal computer running the ATS software.
- AUXILIARY CONTROL INPUT—A 9-pin DSUB connector for external control of certain ATS processes. See the *ATS-2 User’s Manual* for details.
- AUXILIARY CONTROL OUTPUT—A 9-pin DSUB connector to allow ATS-2 to control other instruments. See the *ATS-2 User’s Manual* for details.
- GROUND CONNECTOR—This is connected to chassis ground.



# Chapter 4

## ATS-2 User Interface

### Overview

ATS-2 is controlled by the ATS software running on the controller PC via the Audio Precision Interface Bus (APIB). The hardware is configured through *settings* in *fields* on software *panels*, and *readings* (measurements) are taken from *meters* on other panels. It is also possible to change settings and collect readings programmatically using the AP Basic language.

Like many Windows applications, the ATS user interface has a menu bar, a status bar, toolbars, and a workspace. With these tools you can save test and data files, export and print measurement results, configure the hardware and software to your needs, access online help, design and launch automated processes and, of course, open and operate the instrument panels where the core test and measurement work is performed.

The ATS software is a powerful and complex program. This chapter provides a quick introduction to its features. For an in-depth discussion, refer to the *ATS-2 User's Manual*.

### A Note on Nomenclature

In this chapter we use the following shorthand:

- **Menu > Item**. This refers to choosing an item from one of the pulldown menus located at the top of the workspace. For instance, 'choose **Utilities > Restore**' means that you select the Utilities pulldown menu, then click on the Restore item.

## Starting up the ATS Software

As part of the ATS installation process, an 'ATS' icon is placed on the desktop of your PC. Click on this icon to start the software. If you have hardware connected and powered up, the software will automatically detect the hardware and initialize it. If you do not have hardware connected, or it is not powered up, the software will prompt you to start demo mode. At this point, you have three options:

- Yes. Choose this option to invoke demo mode. In this mode, the software presents panels and menus as if hardware were connected, but panel meters show random data. This mode can be used for creating tests, editing data, etc.
- Retry. Choose this option if you have since connected the hardware and powered it up.
- Exit. Choose this option to exit the software.

If you have chosen to run the software, ATS will start up and show the workspace.

## ATS Workspace

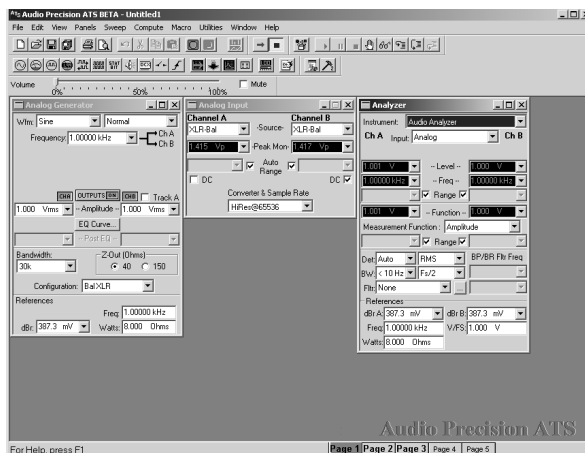


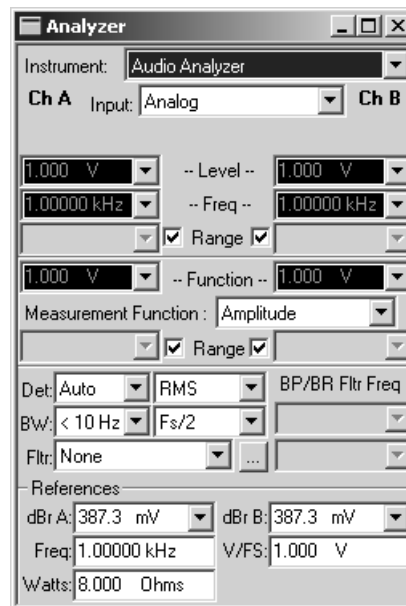
Figure 13. The ATS workspace.

The ATS workspace has five pages that you can select by menu commands (**View > Page #**) or by clicking the numbered tabs on the Status Bar. The workspace is a multi-layered desktop where you can display and organize the instrument panels you are using for a particular set of tests.

## ATS Panels

Interaction with ATS-2 is performed through control and measurement windows called *panels*. These duplicate the function of physical control panels found on conventional test and measurement equipment. The panels are available through menu commands, toolbar icons, and keyboard shortcuts.

Figure 14.  
An ATS instrument  
panel.



A panel can be placed on one or more workspace pages. (Duplicate panels show the same information.) Many panels come in two sizes, the smaller having the most commonly used fields visible, and the larger showing every option. Double-click on a panel title bar to expand or contract the panel.

You can minimize or close a panel without canceling its function or effect. For example, you can set a signal's output voltage and frequency on the generator panel, and then close the panel window. The signal will continue at those settings until you turn the generator **OFF**.

### Panel Settings

Settings for tests and measurements are made using several different controls on the panels:

- *Setting fields*, which come in several versions:





- A Windows text box, in which you can directly enter a value from the keyboard.
- A Windows drop-down list box, from which you can make a selection of a fixed number of choices.
- A combination text box with an added drop-down list from which you can choose the units to express your value.

Setting fields display black characters on a white field, except when an EQ waveform is selected, when the generator amplitude fields show blue text.

- **Check boxes**, which allow you to set non-exclusive conditions.
- **Option buttons**, which provide for exclusive conditions.
- **Browser buttons**, which open Windows browsers. These allow you to navigate lists of options, search for a file by browsing through a hierarchy of folders, and so on. Browser buttons are identified by the ellipsis mark ( ... ).
- **Custom buttons**, which have a special function, such as **GO**, **ON**, **OFF**, and so on.
- **Sliders**, with which you can continuously adjust a value. Sliders are found on Bar-Graph panels and the Volume Bar. Sliders can be operated by the mouse pointer or the arrow keys.

## Panel Readings

Results of tests or measurements are called *readings*, which ATS-2 can display in several ways:



- **Reading fields**, sometimes called *meters*. Reading fields come in two variations, with and without a drop-down list to select units. Reading fields display green characters on a black field.
- **Status indicators**, which show the presence or absence of a condition by a small colored rectangle.
- **Bar-graphs**, which display values as a continuous colored bar, like a conventional analog meter.

---

## ATS Menus

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The Menu bar extends across the top of the ATS workspace and is always visible. Here, we give a brief overview of each menu item. Please refer to Chapter 2 of the *ATS-2 User's Manual* for more details.



File Edit View Panels Sweep Compute Macro Utilities Window Help

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### File Menu

---

The File menu offers commands for opening, saving, appending, importing, exporting and printing ATS files, and accessing the Quick Launch menu.

Since there are several file types used by ATS, submenus are available (at the small black arrows ▶ accompanying some menu choices) to choose, for example, whether to **Save As** a **Test**, **Data**, or **Macro** file.

The listings at the bottom of the File menu show the last tests opened by ATS, and provide a convenient way to open a recent test.

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### Edit Menu

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The Edit Menu provides editing commands. The standard Windows editing functions **Undo**, **Cut**, **Copy**, and **Paste** are available, together with functions unique to ATS. Consult the *ATS-2 User's Manual* for details.

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### View Menu

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The View menu allows you to select which workspace page is visible, and which toolbars are displayed. A checkmark next to a View menu item indicates that the selection is visible. See the Toolbars and Buttons section below for more information on toolbars.

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### Panels Menu

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The Panels menu allows you to select which panels are visible on the current page. It duplicates the functions of the Panel toolbar, described below.

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### Sweep Menu

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The Sweep menu controls operation of the sweep. The sweep is the fundamental method used to collect measurements in ATS. For more information, see Chapter 5 of this manual, and Chapter 15 of the *ATS-2 User's Manual*.

## Compute Menu

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The Compute menu gives access to ATS's built-in post-processing functions. Data collected during a sweep is available for post-processing. See Chapter 19 of the *ATS-2 User's Manual* for details.

## Macro Menu

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The Macro menu allows you to access the editing and debugging functions for AP Basic *macros*. AP Basic is the programming language supplied with ATS, and macros can be written to control all aspects of ATS-2 functionality. See Chapter 23 of the *ATS-2 User's Manual* for details.

## Utilities Menu

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The Utilities menu allows you to initialize and configure the hardware, and manipulate the system log file. It also launches the multitone creation tool. See Chapter 25 of the *ATS-2 User's Manual* for details.

## Window Menu

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The Window menu lists the current open panels and allows them to be arranged automatically in the workspace.

## Help Menu

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The Help menu allows you to access ATS's on-line help system. You can also use the F1 key to access help for a particular control or panel field.

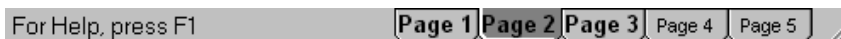
## Status Bar

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The Status bar runs across the bottom of the workspace. The left portion displays the following information:

- Current hardware status.
- Information about the button or menu item currently under the mouse pointer.

At the right, the Status bar shows the workspace page tabs. A bold tab label indicates that a page contains at least one panel. The currently displayed page is highlighted. Click on a tab to switch pages.

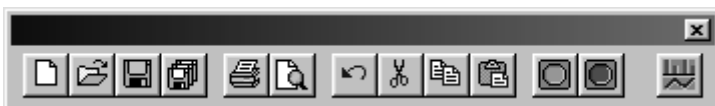


## Toolbars and Buttons

ATS has five toolbars for quick access to panels and common functions. The toolbars can float at any location in the workspace, or they can be docked to the Menu bar. Whether floating or docked, the toolbars appear on every workspace page.

Buttons on the toolbars control ATS functions. A ToolTip describing the button's function appears when the mouse is held over a button for a short time. See Chapter 2 of the *ATS-2 User's Manual* for more information.

### Standard Toolbar



The Standard toolbar gives you quick access to ATS file, printer and editing operations, as well as Sweep Stop/Start and Sweep Spectrum/Waveform switching.

### Panels Toolbar



The Panels toolbar gives you quick access to commonly used ATS panels. The panels are also available from the Panels menu.

### Macro Toolbar



The Macro toolbar offers operations for running and editing an AP Basic Macro. See Chapter 23 of the *ATS-2 User's Manual* for explanations of Macro toolbar button functions.

### Learn Mode Toolbar

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The Learn Mode toolbar gives you the ability to turn Learn Mode on and off. Learn Mode logs your ATS operations as you perform them, building a macro for automation purposes. See Chapter 23 of the *ATS-2 User's Manual* for more information on Learn Mode.

### Quick Launch Toolbar

---

The Quick Launch toolbar allows you to access user-defined functions. You can create Quick Launch buttons to open ATS tests, run AP Basic macros, and launch other Windows programs. See Chapter 2 of the *ATS-2 User's Manual* for instructions on customizing and using the Quick Launch toolbar.

## Using Files with ATS

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Part of the power of ATS is its ability to create, store, load, and run files which contain test setup and measurement data information. The primary document in the ATS software is the *test*, although ATS uses other file types as well.

### Test Files

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When you first launch ATS, a default setup is loaded. You can modify this initial setup by opening or closing panels, changing configuration, making settings, running a sweep, and so on. You can then save your custom setup as a test. ATS saves the instrument and sweep setup information, the input and output configuration, and the panel sizes and positions. If you have run a sweep and collected data, the data is also saved in the test file.

The filename extension for test files is:

- ATS-2 test file—\*.ats2



To return to the default setup, click the **New Test** button or the **File > New > Test** command. ATS will discard your current settings and data and reload the default setup.

You can open previously saved tests and use them as they are, or you can modify and re-save the tests under the same name or a new name.

Sample tests are included with ATS-2, and you can use them as starting points for your own custom tests.

## Macro Files

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A *macro* file is a programming script which automates program functions. ATS macros are written in the AP Basic programming language, which is included with ATS.

The filename extension for macro files is:

- AP Basic macro file—\*.atsb

## Data Files

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ATS stores data from test results in memory as the test is run. As mentioned, this information is saved along with panel and sweep setup information in a test file. The data can also be viewed and edited in the Data Editor panel, and can be saved as a separate file.

ATS can open saved data files to attach previous data to a current test. There are four different data file types:

- AP data file—\*.atsa
- AP limit file—\*.atsl
- AP sweep file—\*.atss
- AP EQ file—\*.atsq

---

*The four ATS data file types are identical except for their filename extensions. Data saved as \*.atsa, \*.atsl, \*.atss or \*.atsq files can be opened or attached for any data function. The four filename extensions serve as a way to organize your data files.*

---

It is also possible to export ATS data as an ASCII text file for use in a spreadsheet or text editor program. The filename extension for an ASCII data file is:

- AP ASCII data file—\*.atsx

## Waveform Files

---

For certain functions, including FFT displays and some types of interface analysis, ATS-2 acquires a sample of the input waveform. These samples can be saved as waveform files and later opened by ATS for further use.

The filename extensions for waveform files are:

- AP stereo waveform file (generator)—\*.ags
- AP stereo waveform file (analyzer)—\*.aas
- AP mono waveform file (generator)—\*.agm
- AP mono waveform file (analyzer)—\*.aam
- AP digital interface waveform file—\*.aai

### Log File

---

ATS can generate a log file for debugging. The log file contains error messages, file and sweep activity, graph information, and pass/fail test results.

The filename extension for the log file is:

- AP log file—\*.alg

The log file is enabled and set up on the Configuration panel, and is discussed in detail in Chapter 25 of the *ATS-2 User's Manual*.

### Downloadable Filter Files

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ATS-2 can make use of custom filters designed and downloaded by the user. Downloadable filters are defined in text files whose format is described in Appendix D of the *ATS-2 User's Manual*.

The filename extensions for downloadable filter files are:

- AP downloadable lowpass filter file—\*.afl
- AP downloadable highpass filter file—\*.afh
- AP downloadable weighting filter file—\*.afw

The use of downloadable filters is described in detail in Chapter 10 of the *ATS-2 User's Manual*.

# Chapter 5

## Quick Guides

### Introduction

The Quick Guides in this chapter provide a way to get used to the ATS user interface, and to get some immediate results from ATS-2. As you become more familiar with the system, please refer to the *ATS-2 User's Manual* for further information.

The Quick Guides begin with the assumption that ATS-2 is turned on and connected to your PC, and that the ATS software has been launched and is properly controlling your instrument. No cables or external devices are needed for the Quick Guides.

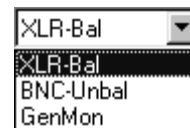
### Quick Guide to the Analog Signal Path

When the ATS software is launched, the default workspace is loaded with three panels, labeled **Analog Generator**, **Analog Input**, and **Analyzer**. To return to this configuration at any time, click the **New Test** button. Previous settings and data will be discarded.



### Analog Input Panel

ATS-2 has two channels of analog input. Each channel can receive a signal from its front panel XLR connector, its front panel BNC connector, or via an internal path from the analog generator. The **Source** fields on the **Analog Input** panel present these choices as a drop-down list. Choose 'GenMon' for each channel to engage the internal path.



### Analog Generator Panel

In the default configuration, the **Analog Generator** panel is set for a **1 V, 1 kHz sine** wave, but the analog outputs are disabled. To turn on





the outputs, click the OUTPUTS “OFF” button near the center of the panel. The button will turn green, and you will hear relays click in the ATS-2 hardware. The peak meters in the analog input panel will show approximately 1.414 V<sub>pp</sub>. The peak meters indicate the presence of signal at the analog inputs.



The stereo generator outputs can be individually disabled with the ‘CHA’ and ‘CHB’ buttons next to the ‘OUTPUTS’ field. Click on the ‘CHB’ button. The button will turn gray, relays will click in the hardware, and the Channel B peak meter on the analog input panel will indicate a level close to zero.

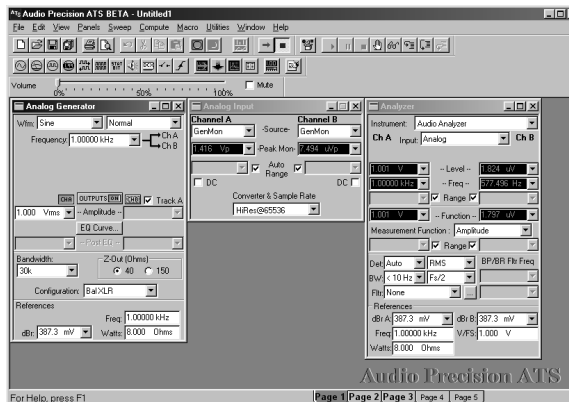
## Analyzer Panel

The default **Analyzer** panel is a real-time audio analyzer. It provides continuous *readings* of signal level and frequency. It also allows you to filter the audio signal and measure parameters such as total harmonic distortion, phase, and so on. It is a stereo instrument, with the meters on the left of the panel reporting channel A readings, and those on the right reporting channel B readings.

At this point, you should have the setup shown in Figure 15:

- Analog generator channel A producing a 1 V, 1 kHz sine wave.
- Analog generator channel B disabled.
- Analog inputs A and B set to the internal generator path (GenMon).

Figure 15. Current workspace.



The topmost meters in the default Analyzer panel show the audio level in V rms. You should see approximately 1 V in the left-hand meter (channel A), and approximately 0 V in the right-hand meter (channel B).



Click the ‘CHB’ button on the Analog Generator panel to re-enable the channel B generator signal. You now see approximately 1 V in the

right-hand level meter on the Analyzer panel, since the channel B generator is now active and its signal is being routed to the analyzer via the GenMon internal path.

The meters in the next row of the Analyzer panel show the frequency of the signal in each channel. Both of these meters should be showing 1 kHz, the frequency of the analog generator.

## Signal Monitor

ATS-2 has an internal mono speaker to monitor both analog and digital input signals. In addition, the signal at the speaker is available (also in mono) at the headphone jack on the back of the instrument. When a headphone plug is inserted into the jack, the internal speaker is disconnected.

By default, the volume control for the speaker is below the toolbars near the top of the ATS workspace. Move the volume slider control to the right with the mouse. You will hear the 1 kHz tone from the generator become louder. In the default setup, the speaker monitors the signal presented to channel A of the analog analyzer. Click the 'CHA' button on the analog generator to disable the channel A generator. The speaker will no longer emit the 1 kHz tone.



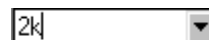
## Controlling the Analog Generator

The topmost two fields in the Analog Generator panel control the generator waveform. The analog generator is capable of producing sine waves, square waves, noise, and other waveforms. At this point the waveform should be set to **Sine/Normal**. Pull down the left-hand list box and choose **Square** to change the waveform to a square wave. If you are monitoring the signal with the internal speaker, you will hear the timbre of the signal change. You will also see the signal level change in the Analyzer panel. (The square wave has a higher rms level than the sine wave for a given amplitude setting.)



The square waveform has one parameter or *setting*: the **frequency**. This is set in the field below the waveform selection fields. We will now change the generator frequency to 2 kHz, as follows:

- Click in the Frequency field in the Analog Generator panel. The text '1.00000 kHz' becomes highlighted in blue.
- Use the keyboard to type '2k', the new generator frequency. As you can hear in the monitor speaker, the frequency does not change.
- Hit 'enter'. The text changes to '2.00000 kHz', the pitch increases from the monitor speaker, and the frequency reading in the Analyzer panel changes to 2.00000 kHz.


Now switch the waveform type back to sine. The current square wave frequency is used for the sine wave.

*You can enter standard SI prefixes for multipliers as you enter the value in the setting field. For example, '2000', '2k', '0.002M', and '2000000m' all produce the same frequency.*

Track A

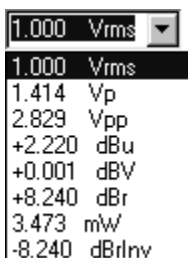
All waveforms can be generated at any **amplitude** from 0 V to the maximum output voltage of the instrument. The amplitude for each channel is controlled by fields below the 'OUTPUTS' field. If the 'Track A' selection is checked, the amplitude is identical in both channels and is set by the channel A Amplitude field at the left of the panel. If 'Track A' is unchecked, a channel B Amplitude field appears at the right of the panel, and the amplitudes of the two channels can be varied independently.

Change the channel A amplitude to 0.5 V by clicking in the Amplitude field on the Analog Generator panel, typing '0.5', and hitting enter. The level meter reading on the Analyzer panel will change. (You will also hear relays click if the system needs to change the analog range.) Now uncheck 'Track A' and set the channel B amplitude to 10 V. The level meters on the Analyzer panel will show the different levels. Both frequency meters, however, will show the same frequency. This is because the Sine/Normal waveform generates identical frequencies in the two channels.

The **Sine/Stereo** waveform, which is obtained by choosing Sine from the left-hand waveform field and Stereo from the right-hand waveform field, generates independent frequencies in the two channels. You can verify the frequency in each channel by referring to the frequency meters on the Analyzer panel.

## Units

Settings and readings consist of a *value* and a *unit*. ATS can convert the units of a setting or reading to a related unit. For instance, the analog generator amplitude can be set in Vp (volts peak-to-peak), dBV (decibels relative to 1 V), and several other units. Similarly, readings can be displayed on a meter in any of the related units.



The list of units for a setting or reading can be viewed by clicking the downward-pointing arrow next to the setting or reading field. For instance, the list of units for the analog generator amplitude can be displayed by clicking on the arrow next to the Amplitude field on the Analog Generator panel. ATS displays the value currently in the field, converted to each available unit. By clicking on the list, you can choose a setting unit.

As an example, if the amplitude is set to 1 Vrms, the drop-down list includes conversions such as 1.414 Vp and 2.220 dBu. If you click on the line displaying the amplitude in Vp, the setting changes to 1.414 Vp. The

generator amplitude has not changed; the setting is displayed in a different unit. You can now set the generator amplitude in  $V_p$ .

Some units, such as dB<sub>r</sub>, depend on a *reference* being set. Refer to Appendix A of the *ATS-2 User's Manual* for more information.

## Quick Guide to Sweeps

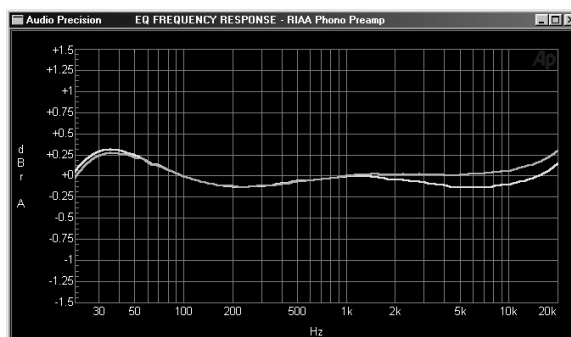
Most device testing with ATS-2 is performed with *sweeps*. In a sweep, a setting is stepped over a pre-defined range, while selected readings are gathered. The result is a table of data relating the readings to each value of the setting.

For instance, if you wanted to measure the frequency response of an analog amplifier, you might vary the frequency of the analog generator from 20 Hz to 20 kHz in 30 logarithmic steps, while monitoring the analyzer channel A and channel B level readings. The result would be a table of data with 30 rows (one for each frequency step) and 3 columns (one for the frequency setting, one for the channel A level reading, and one for the channel B level reading).

*You can force ATS-2 to perform a "single-point sweep" for special purposes, but generally the term sweep indicates that a number of data points are included in the measurement.*

When a sweep is performed, a *graph* is also created. This is a graphical representation of the data obtained during the sweep. Figure 16 shows an example of a stereo frequency response graph.

Figure 16. A typical frequency response graph.



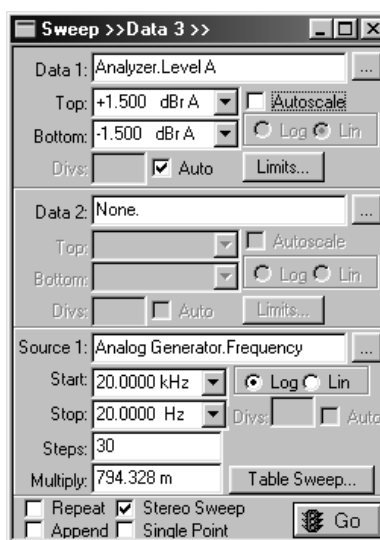
This section is an introduction to sweeps. The Sweep panel contains many more features that are described in Chapter 15 of the *ATS-2 User's Manual*.

## Sweep Fundamentals

### Settings and Readings

To set up a sweep, open the Sweep panel, either by choosing **Panels > Sweep**, or by clicking on the Sweep button. The Sweep panel is divided horizontally into two major areas: the **Data** (reading) area above, and the **Source** (setting) area below. During the sweep, the setting chosen in the Source 1 field is varied, and the readings specified in the Data fields are gathered.

Figure 17. The Sweep panel. This configuration was used to create the graph of Figure 16.



To choose the **setting** to be varied, click on the ellipsis button to the right of the **Source 1** field. In the browser, choose an instrument from the left pane and a setting from the right pane. For instance, if you choose 'Analog Generator' from the instrument side and 'Frequency' from the setting side, the frequency of the analog generator will be varied during the sweep. This is shown in the Source 1 field as 'Analog Generator.Frequency'.

To choose a **reading** to be gathered, click on the ellipsis button to the right of the **Data 1** field. The browser shows instruments in the left pane and readings in the right pane. If you choose the 'Analyzer' instrument and the 'Level A' reading, the level on channel A will be recorded during the sweep. This is shown in the Data 1 field as 'Analyzer.Level A'.

Stereo Sweep

The **Stereo Sweep** checkbox near the bottom of the Sweep panel automatically ensures that readings from both channels are gathered during the sweep. For instance, if you choose Analyzer.Level A as the

reading in Data 1 and then check the Stereo Sweep checkbox, the reading Analyzer.Level B will also be gathered during the sweep.

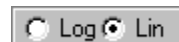
### Source Range, Steps, and Spacing

During the sweep, the setting in Source 1 is stepped from the **Start** value to the **Stop** value shown in fields below Source 1. The number of steps in the sweep is shown in the **Steps** field. A radio button to the right of these fields controls whether successive settings are separated **linearly** or **logarithmically**. In a linear sweep, the *difference* between successive settings is constant. In a logarithmic sweep, the *ratio* between successive settings is constant.

For example, if the start frequency is 20 Hz, the stop frequency is 20 kHz, there are 3 steps, and the spacing is logarithmic, ATS will first set the generator to 20 Hz, then 200 Hz, then 2 kHz, and finally 20 kHz. That is, the *ratio* between successive frequency settings is 10.



On the other hand, if the spacing is linear, the generator is first set to 20 Hz, then 6680 Hz, then 13340 Hz, and finally 20 kHz. That is, the *difference* between successive frequency settings is 6660 Hz.



### Data Display Range

A graph is automatically created when a sweep is run. The Start and Stop values for Source 1 define the extent of the horizontal (x-) axis. The extent of the vertical (y-) axis is determined by the values in the **Top** and **Bottom** fields beneath Data 1.

The units of the y-axis are the same as the units in the Top and Bottom fields. If you change the units of the Top or Bottom field, the units in the other field will also change. See the Units section on page 34 for more information on units.

#### Review

To set up a sweep, you must:

- set **Source 1** to the setting to be varied during the sweep;
- set **Data 1** to the reading to be collected during the sweep;
- click **Stereo Sweep** to collect data from both channels;
- set the **Start**, **Stop**, **Steps**, and **Lin/Log** for Source 1; and
- set the **Top** and **Bottom** values and units for Data 1.

Once the sweep is set up, you can run it by clicking the **Go** button at the bottom of the Sweep panel.

We will now perform two example sweeps: a frequency response sweep, and an amplitude linearity sweep.

### Example Sweep: Frequency Response

For this example, we will measure the frequency response flatness of the ATS-2 itself. We connect the analog output to the analog input, sweep the frequency of the analog generator over the audio range, and plot the level measured by the analyzer against frequency.



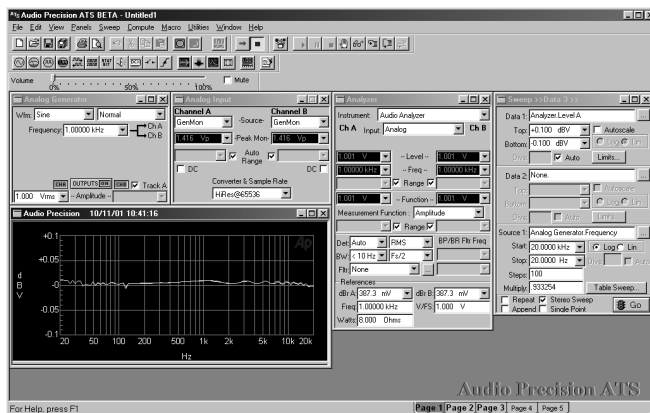
First, click the New Test button, turn the analog generator on, and set both analog input channels to GenMon so that the generator signal is sent directly to the analog input. Now open the Sweep panel. The default sweep is a mono frequency response sweep, so we only have make a few modifications:

- Check the Stereo Sweep box to create a stereo sweep.
- Change the Steps from 30 to 100 for a more detailed response.
- The default range for Data 1 is quite wide, and the units are Volts. Change the units to dBV by clicking on the arrow next to the Top field. From the list, choose the 'dBV' line. (Note that the units in the Bottom field change also.) In the Top field, type '0.1'. In the Bottom field, type '-0.1'.



You can now click the Go button to run the sweep. A graph is created, and the response is plotted as the sweep progresses. If you are monitoring using the internal speaker, you will hear the analog generator frequency step through the audio range. The result will be a response curve that deviates only slightly from 0 dBV, as shown in Figure 18.

Figure 18. Current workspace after frequency response sweep, showing typical results.



## Example Sweep: Amplitude Linearity

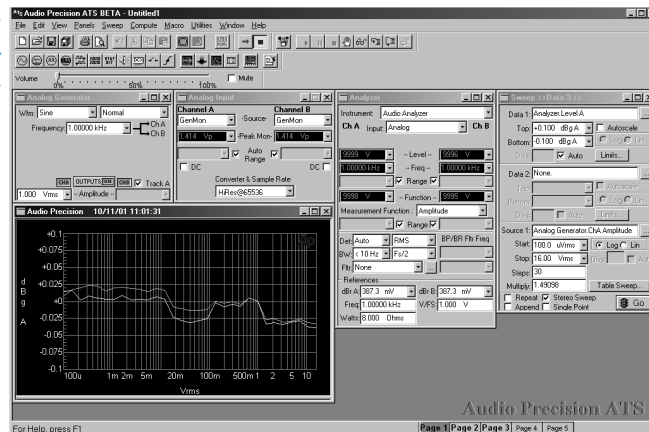
For this example, we will measure the amplitude linearity of the ATS-2. With the analog output connected to the analog input, we sweep the amplitude of the analog generator over its full range, and plot the ratio of the level measured by the analyzer to the generator output level, in dB. Any amplitude non-linearity in the system will show as a deviation from 0 dB.

First, perform a New Test, turn the analog generator on, and set both analog input channels to GenMon so that the generator signal is sent directly to the analog input. Now open the Sweep panel and make the following changes:

- Click the Source 1 browser button, and choose 'Analog Generator' as the instrument and 'ChA Amplitude' as the setting.
- Change the Start value for Source 1 to 100  $\mu\text{V}$ . (ATS understands the prefix 'u' to stand for ' $\mu$ '.)
- Choose the dBg A units for Data 1 by clicking on the arrow next to the Top field, and choosing the 'dBg A' line from the list. The dBg A units (decibels relative to generator channel A) show the ratio of the reading to the level of the analog generator, in dB.
- Set the Data 1 Top value to 0.1, and the Bottom value to  $-0.1$ .

Click Go to start the sweep. The ranging relays will click as the generator changes amplitude. The result will be a curve that deviates only slightly from 0 dBg A, as shown in Figure 19.

Figure 19. Current workspace after amplitude linearity sweep, showing typical results.





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## Quick Guide to the FFT Spectrum Analyzer

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At the top of the Analyzer panel is a drop-down list of the instruments available in ATS. Up to this point, we have been using the *audio analyzer* to make measurements. We will now take a look at the *FFT spectrum analyzer*. This instrument displays audio signals in time (oscilloscope-style) and in frequency (spectrum analyzer-style). It operates in a different fashion from the audio analyzer, as explained next.

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### Real-Time vs. Batch-Mode Instruments

---

The audio analyzer is a *real-time* instrument. That is, it returns readings continuously, whether or not a sweep is in progress. These readings include level and frequency, as well as functions such as distortion or phase. During a sweep, readings from the audio analyzer are diverted from the panel meters to the sweep engine for graphing. After the sweep, the readings are once again displayed in the panel meters.

By contrast, the FFT spectrum analyzer is a *batch-mode* instrument. It does not generate readings if a sweep is not being performed. When a sweep is started, the spectrum analyzer first *acquires* a segment of audio by storing it in memory. This is indicated on the Status bar as 'DSP Acquiring Data'. Once the acquisition is complete, the spectrum analyzer processes the data. This is indicated as 'DSP Transforming Data' on the Status bar. Once processing is complete, ATS fetches a *batch* of readings from the spectrum analyzer. At that point, the data is graphed.

---

### The FFT Concept

---

The FFT (fast Fourier transform) is an efficient way to decompose a periodic signal into its component frequencies. It transforms a *time-domain* signal (such as you might see in an oscilloscope trace) into a *frequency-domain* representation.

As an example, a high-quality power amplifier fed with a sinusoidal input will produce harmonic distortion at its output that is invisible in an oscilloscope trace. If an FFT is performed on the output signal, however, the individual distortion harmonics can be seen. The pattern of harmonics provides insight into the mechanisms responsible for the distortion.

The FFT process consists of the following steps:

- *Triggering*. The system waits for a trigger event from the selected source, for instance, a positive-going zero crossing of the analog generator.
- *Acquisition*. The system stores the input audio in memory until the selected number of audio samples has been received. The more

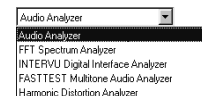
audio data acquired, the more frequency points there will be in the result, and hence the higher the resolution will be. However, longer acquisitions take more time.

- *Windowing.* Before transformation, the audio data is shaped in time by multiplying it with a pre-defined envelope. This increases the accuracy of the amplitude values returned from the FFT.
- *Transformation.* The windowed audio data is transformed by the FFT. This results in an array of points describing the magnitude and phase of each frequency in the audio signal.
- *Display.* ATS fetches the transformed audio data and graphs it. Because the number of transformed points is typically larger than the number of points in the graph, a *peak-picking* method is used to ensure that peaks in the frequency data are not missed.

For more information, see Appendix C of the *ATS-2 User's Manual*.

## Setting up an FFT

After a New Test, ATS defaults to the audio analyzer. To switch to the spectrum analyzer, click the down arrow next to the Instrument field at the top of the Analyzer panel. From the list of instruments, choose FFT Spectrum Analyzer. The panel changes to display the new instrument.



### Panel Fields

There are two peak monitors near the top of the panel, one for each of the stereo channels. These meters give an indication of the presence of signal at the FFT input.

Below the peak meters is an array of fields for configuring the analyzer. Here, we will use the default settings. For more details on the settings, see Chapter 11 of the *ATS-2 User's Manual*.

### Time vs. Frequency

As mentioned, the FFT spectrum analyzer can display audio signals in the time domain and the frequency domain. The choice of domain is determined by the Source 1 field on the Sweep panel. If it is set to FFT.Time, a time domain display results. If it is set to FFT.Frequency, a frequency domain display results.

The Sweep Spectrum/Waveform button in the standard toolbar allows FFT sweeps to be set up quickly. We will use this feature to examine harmonic distortion in the ATS-2 system.



### Quick Sweep Setup



First, perform a New Test, turn the analog generator on, and set both analog input channels to GenMon so that the generator signal is sent directly to the analog input. Choose FFT Spectrum Analyzer from the Instrument field at the top of the Analyzer panel.

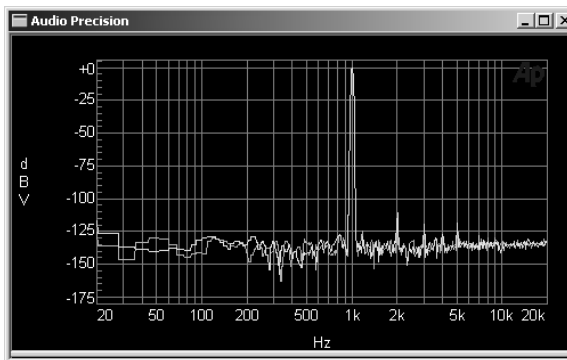


Bring up the Sweep panel and click the Sweep Spectrum/Waveform button on the Standard toolbar. The sweep is automatically set up for a stereo frequency domain display from 20 Hz to 20 kHz. Click Go to



perform the sweep. A graph similar to Figure 20 is created.

Figure 20. Typical default FFT stereo frequency domain graph.

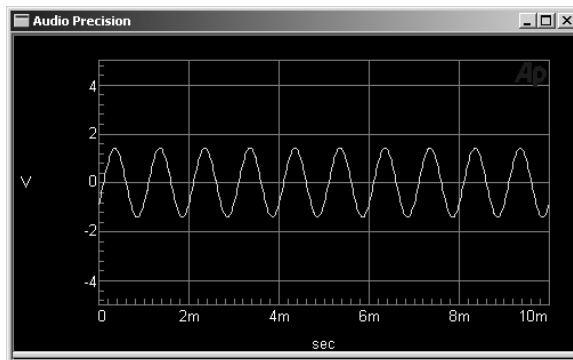


The large peak in the middle of the spectrum is the 1 kHz, 1 V sine wave *fundamental* produced by the analog generator. There are smaller peaks spaced at 1 kHz intervals above the fundamental. These are *harmonic distortion* components generated in the ATS-2 hardware. These harmonics rise out of a wideband system *noise floor*.



To look at the audio signal in the time domain, click the Sweep Spectrum/Waveform button again. Source 1 changes to FFT.Time and the graph updates to show the new data. You should see a graph similar to Figure 21.

Figure 21. Typical default FFT stereo time domain graph.



The display shows a sine wave with a period of 1 ms (corresponding to a frequency of 1 kHz) and a peak excursion of 1.414 V (corresponding to an amplitude of 1 Vrms). The effect of the distortion on the waveform is not visible in the time domain.

You can switch between the time domain and frequency domain displays at any time by clicking the Sweep Spectrum/Waveform button.



### Fine-Tuning the Display

There are several ways to adjust the graph display to more closely examine features of the acquired waveform:

- **Zoom.** On the graph, draw a box by holding down the left mouse button and moving the mouse. When you release the button, ATS zooms the selected area to the full graph size.
- **Zoomout.** After zooming, click the right mouse button on the graph. From this right-click menu, choose Zoomout. The graph zooms out to the pre-zoom size.
- **Optimize.** From the right-click menu, choose Optimize Left Only. The vertical axis changes to best fit the data in the graph.

For more details, see Chapter 16 of the *ATS-2 User's Manual*.

## Saving and Loading Tests

At any time, the current workspace setup can be saved to a file. The file contains the settings on all the panels (including panels that are not visible in the workspace), the panel positions, and references to any other files that were attached, such as limit data. The file also contains the most recent data obtained from any sweeps that were run.

When a test is loaded, the workspace reverts to the exact configuration it had when the test was saved. The data from the test is available and can be further processed. It can also be re-graphed automatically when the test is loaded. See Chapter 25 of the *ATS-2 User's Manual* for more details.



To save the current workspace, choose **File > Save > Test**, or click the Save Test button in the Standard toolbar. To load a test, choose



**File > Open > Test**, or click the Open Test button in the Standard toolbar.

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## The Next Step

In this chapter, we have introduced two *instruments*: the audio analyzer, and the FFT spectrum analyzer. ATS has other instruments to measure audio signals in different ways. The *ATS-2 User's Manual* describes all the instruments in detail.

We have also introduced the *sweep*, which is at the heart of ATS automated measurements. The sweep engine and its features are described in more detail in Chapter 15 of the *ATS-2 User's Manual*.

We set up tests by hand using the mouse and keyboard, and saved them to disk. ATS also contains a complete programming language to allow you to execute complex measurement sequences programmatically. Chapter 23 of the *ATS-2 User's Manual* describes how to program the instrument, and the *AP Basic User's Guide and Language Reference* describes the language itself.

# Chapter 6

## Specifications

Unless otherwise noted, all analyzer specifications assume dc coupling, rms detection, autoranging on, and high resolution conversion at 65.536 kS/s. The abbreviation “SR” refers to the relevant output or input sample rate (1 kS/s = 1 kHz).

### ANALOG SIGNAL GENERATOR

|                                   |   |
|-----------------------------------|---|
| Waveforms                         | Sine Family (Normal, Var Phase, Stereo, Dual, Shaped Burst, EQ)<br>IMD (SMPTE/DIN 4:1, 1:1)<br>Square<br>Noise<br>Arbitrary Waveform (Multitone)<br>Special (Polarity, Pass Thru) |
| Sine Family Characteristics       |   |
| Frequency Range                   |   |
| 30 kHz BW<br>(SR=65.536 kS/s)     | 2 Hz–30.8 kHz   |
| 60 kHz BW<br>(SR=131.072 kS/s)    | 2 Hz–61.6 kHz   |
| Frequency Resolution              |   |
| 30 kHz BW                         | 0.0078125 Hz  |
| 60 kHz BW                         | 0.015625 Hz   |
| Flatness (500 Hz ref)             |   |
| 20 Hz to 20 kHz                   | ±0.01 dB  |
| 10 Hz to 50 kHz                   | +0.06/–0.1 dB   |
| THD+N <sup>1</sup> (20 Hz–20 kHz) | ≤0.0009% [–101 dB] +1.6 μV  |
| Variable Phase Range              | –180.00 to +179.99 deg  |
| Dual Sine Ratio Range             | 0 dB to >100 dB   |

<sup>1</sup> System specification including contributions from both generator and analyzer, 20 kHz measurement bandwidth.

|                                    |   |
|------------------------------------|---|
| Shaped Burst                       |   |
| Envelope                           | Raised cosine   |
| Burst Interval                     | 2 to 65536 cycles (max number of cycles may be limited at low frequencies)  |
| Burst On Time                      | 1 to number of interval cycles minus 1  |
| Arbitrary Waveform (Multitone)     |   |
| Sample Rates (SR)                  | 65.536 kS/s, 131.072 kS/s, OSR (programmed output rate), or ISR (selected input sample rate)  |
| Length                             | 256 to 16384 points per channel   |
| Frequency Range                    | DC to 0.47×SR   |
| Frequency Resolution               | Sample Rate / Length  |
| Maximum Number of Tones            | (Length / 2) minus 1 [8191 with Length=16384]   |
| IMD Test Signal (SMPTE/DIN)        |   |
| LF Tone Range                      | 40 Hz to 500 Hz   |
| HF Tone Range                      | 2 kHz to 60 kHz   |
| Mix Ratio                          | 4:1 or 1:1 (LF:HF)  |
| Residual IMD <sup>2</sup>          | ≤0.0025% [−92 dB]   |
| Square wave                        |   |
| Frequency Range                    | 10 Hz to 20 kHz   |
| Risetime                           | Typically 2.0 μs  |
| Noise Signal                       | White, Pseudo-Random, Rectangular PDF, 30 kHz or 60 kHz BW  |
| Polarity Test Signal               | Sum of two sinewaves phased for reinforcement with normal polarity  |
| Frequency Range                    | 2 Hz to 30 kHz  |
| Pass Thru                          | Passes the embedded audio signal from the rear panel Sync/Ref Input. Output Sample Rate (OSR) must be within the range of 0.334 to 3.000 of the Sync/Ref Input sample rate. |
| Frequency Accuracy (all Waveforms) | ±0.0002% [2 PPM] internal reference, lockable to external reference   |

## ANALOG SIGNAL GENERATOR OUTPUTS

|                                     |   |
|-------------------------------------|---|
| Source Configurations               | Balanced (XLR), Unbalanced (XLR and BNC), or Common Mode Test (XLR) |
| Source Impedances (R <sub>s</sub> ) |   |
| Balanced or Common Mode Test        | Nominally 40 Ω or 150 Ω (200 Ω with option EURZ)                    |
| Unbalanced                          | Nominally 20 Ω or 50 Ω  |
| Amplitude Range (all Waveforms)     | Each analog output is independently settable                        |

<sup>2</sup> System specification with 60 Hz/7 kHz or 250 Hz/8 kHz test signal combinations and V<sub>in</sub> ≥ 200 mV.

|                                    |   |
|------------------------------------|---|
| Balanced                           | <250 $\mu$ Vrms to 16.00 Vrms [700 $\mu$ Vpp to 45.2 Vpp] [-70.0 dBu to +26.30 dBu] |
| Unbalanced or Common Mode Test     | <250 $\mu$ Vrms to 8.00 Vrms [700 $\mu$ Vpp to 22.6 Vpp] [-70.0 dBu to +20.28 dBu]  |
| Amplitude Accuracy                 | $\pm 0.09$ dB [ $\pm 1.0$ %]  |
| Amplitude Resolution               | 0.007 dB or 0.60 $\mu$ Vrms, whichever is larger                                    |
| Max Output Power into 600 $\Omega$ |   |
| Balanced                           | +24.1 dBm ( $R_s = 40 \Omega$ )   |
| Unbalanced                         | +18.4 dBm ( $R_s = 20 \Omega$ )   |
| Output Current Limit               | Typically >50 mA  |
| DC Offset                          | $\leq 0.25\%$ of Vpp setting [0.7% of Vrms setting]                                 |
| Output Related Crosstalk           | $\leq (-100$ dB + 3 $\mu$ V), 20 Hz to 20 kHz                                       |

## DIGITAL SIGNAL GENERATOR

|                                    |   |
|------------------------------------|---|
| Waveforms                          | Sine Family (Normal, Var Phase, Stereo, Dual, Shaped Burst, EQ, Burst, Offset)<br>IMD (SMPTE/DIN 4:1, 1:1)<br>Square<br>Noise<br>Arbitrary Waveform (Multitone)<br>Special (Polarity, Pass Thru, Monotonicity, J-Test, Walking Ones, Walking Zeros, Constant Value, Random) |
| Common Sine Family Characteristics |   |
| Frequency Range                    | 2 Hz to $<0.50 \times SR$   |
| Frequency Resolution               | $SR / 2^{23}$   |
| Flatness                           | $\pm 0.001$ dB  |
| Harmonics and Spurious Products    | 0.000001% [-160 dB]   |
| Variable Phase Range               | -180.00 to +179.99 deg  |
| Dual Sine Ratio Range              | 0 dB to >100 dB   |
| Sine + Offset Amplitude Range      | Sinewave amplitude +  offset amplitude  < 1 FFS   |
| Burst & Shaped Burst Signals       | Burst signal envelope is rectangular, Shaped Burst envelope is raised cosine  |
| Interval                           | 2 to 65536 cycles (max number of cycles may be limited at low frequencies)  |
| Burst On                           | 1 to number of Interval cycles minus 1  |
| Square wave Frequencies            | 2 Hz to $SR / 6$ , in even integer sub-multiples of SR  |
| SMPTE/DIN Test Signal              |   |
| Lower Tone Range                   | 40 Hz to 500 Hz   |
| Upper Tone Range                   | 2 kHz to $0.47 \times SR$   |
| Mix Ratio                          | 1:1 or 4:1 (LF:HF)  |
| Noise Signal                       | White, Pseudo-Random White, Rectangular PDF, Bandwidth = $0.50 \times SR$   |



|                                |   |
|--------------------------------|---|
| Special Signals                |   |
| Polarity                       | Sum of two sinewaves phased for reinforcement with normal polarity  |
| Pass Thru                      | Passes the embedded audio signal from the rear panel Sync/Ref Input. Output Sample Rate (OSR) must be within the range of 0.334 to 3.000 of the Sync/Ref Input sample rate. |
| Monotonicity                   | Staircase waveform of lowest 10 levels for D/A linearity testing  |
| J-Test                         | Produces a maximum amount of data-induced jitter on low-bandwidth transmission links  |
| Walking Ones                   | A single binary one value "walked" from LSB to MSB  |
| Walking Zeros                  | A single binary zero value "walked" from LSB to MSB   |
| Constant Value (Digital DC)    | 32-bit resolution when using triangular dither  |
| Random                         | Random binary states of all bits  |
| Arbitrary Waveform (Multitone) |   |
| Sample Rates (SR)              | 65.536 kS/s, 131.072 kS/s, OSR (programmed output rate), or ISR (selected input sample rate)  |
| Length                         | 256 to 16384 points per channel   |
| Frequency Range                | DC to $0.47 \times \text{SR}$   |
| Frequency Resolution           | Sample Rate / Length  |
| Maximum Number of Tones        | $(\text{Length} / 2) \text{ minus } 1$ [8191 with Length = 16384]   |
| Dither                         | Applies to all waveform except Monotonicity, J-Test, Walking Ones, Walking Zeros, Random  |
| Types                          | None, Triangular, Rectangular, or Shaped  |
| Amplitude                      | 8 to 24 bit   |
| Pre-Emphasis Filters           | Applies to all waveforms  |
| Filter Shapes                  | 50/15 $\mu\text{s}$ or J17  |
| Response Accuracy              | $\pm 0.02$ dB, 10 Hz to $0.45 \times \text{SR}$   |
| Residual Distortion            | 0.00003% [–130 dB]  |

## DIGITAL SIGNAL GENERATOR OUTPUTS

|                    |                                   |
|--------------------|-----------------------------------|
| Formats            |                                   |
| Balanced (XLR)     | AES3 per AES3-1997                |
| Unbalanced (BNC)   | SPDIF-EIAJ per IEC 60958          |
| Optical (Toslink®) | per IEC 60958-3                   |
| Sample Rate Range  | 28.8 kHz to 108 kHz per connector |

|                              |   |
|------------------------------|---|
| Sample Rate Accuracy         | $\pm 0.0002\%$ [2 PPM] internal reference, lockable to external reference                                       |
| Word Width                   | 8 to 24 bits  |
| Output Impedance             |   |
| Balanced (XLR)               | Nominally 110 $\Omega$  |
| Unbalanced (BNC)             | Nominally 75 $\Omega$   |
| Output Amplitude             |   |
| Balanced into 110 $\Omega$   |   |
| Range                        | 0 to 5.10 Vpp   |
| Resolution                   | 20 mV   |
| Accuracy                     | $\pm(10\% + 60 \text{ mV})$   |
| Unbalanced into 75 $\Omega$  |   |
| Range                        | 0 to 1.275 Vpp  |
| Resolution                   | 5 mV  |
| Accuracy                     | $\pm(8\% + 15 \text{ mV})$  |
| Optical (Toslink®)           | Nominal intensity, not variable   |
| Channel Status Bits          | Full implementation per IEC 60958, English language decoded, common to both channels                            |
| Formats                      | Professional or consumer; or Direct Hex source  |
| User Bits                    | Set to 0  |
| Validity Flag                | Selectable—set or cleared, common to both channels  |
| Jitter Generator             |   |
| Waveform                     | Sine  |
| Frequency Range              | 20 Hz to 200 kHz, <0.1 Hz resolution  |
| Amplitude Range              | .05 to 0.1275 UI in 0.0005 UI steps<br>0.130 to 1.275 UI in 0.005 UI steps<br>1.30 to 12.75 UI in 0.05 UI steps |
| Accuracy (500 Hz)            | $\pm(10\% + 2 \text{ ns})$  |
| Flatness <sup>3</sup>        | $\pm 1 \text{ dB}$ , 100 Hz to 20 kHz   |
| Residual Jitter <sup>4</sup> | $\leq 1.6 \text{ ns}$ [0.012 UI at 48 kS/s, 0.024 UI at 96 kS/s]  |
| Spurious Jitter Products     | typically <0.003 UI [-50 dBUI] or 30 dB below jitter signal, whichever is larger                                |

## AUDIO ANALYZER

|                                 |   |
|---------------------------------|---|
| Level and Amplitude Measurement | Independent level and amplitude meters per channel        |
| Measurement Range               |   |
| Analog                          | <1 $\mu\text{V}$ rms to 140 V rms [-118 dBu to +45.1 dBu] |
| Digital                         | -120 dBFS to 0 dBFS (usable to -140 dBFS)                 |

<sup>3</sup> System specification including contributions from both analyzer and generator. Valid at 32.0, 44.1, 48.0, 65.536, 88.2, and 96.0 kS/s only. Flatness may degrade at other sample rates.

<sup>4</sup> System specification valid only if (1) the jitter generator amplitude is turned off; (2) the digital input is  $\geq 1.0 \text{ Vpp}$  (XLR) or  $\geq 250 \text{ mVpp}$  (BNC); and (3) the analyzer is set for 700 Hz–100 kHz bandwidth.

## Chapter 6: Specifications

|  |   |
|--|---|
| Accuracy (1 kHz)                         |   |
| Analog                                   | ±0.09 dB [±1.0%]  |
| Digital                                  | ±0.002 dB [±0.023%]   |
| Flatness <sup>5</sup>                    |   |
| Analog                                   | ±0.01 dB, 20 Hz to 20 kHz (0.45×SR if less);<br>±0.10 dB, 10 Hz to 120 kHz (with performance option)    |
| Digital                                  | ±0.002 dB, 10 Hz to 0.45×SR   |
| Detection                                |   |
|  | RMS, FAST RMS, or QPK per IEC 468 (CCIR)  |
| Frequency Measurement                    |   |
|  | Two independent meters, one per channel   |
| Range                                    |   |
| Analog                                   | <10 Hz to 30 kHz (SR = 65.536 kS/s),<br><10 Hz to 120 kHz (with performance option)                     |
| Digital                                  | <10 Hz to 0.47×SR   |
| Accuracy                                 | ±0.0002% [2 PPM]  |
| Resolution                               | 0.00001% of SR [0.007 Hz at 65.536 kS/s]  |
| Minimum Input                            |   |
| Analog                                   | 1 mV (S/N > 40 dB)  |
| Digital                                  | −100 dBFS (S/N > 40 dB)   |
| Phase Measurement                        |   |
| Measurement Ranges                       | ±180, −90 to +270, or 0 to +360 deg   |
| Accuracy                                 |   |
| Analog <sup>6</sup>                      | ±2 deg, 10 Hz to 5 kHz<br>±3 deg, 5 kHz to 20 kHz<br>±4 deg, 20 kHz to 50 kHz (with performance option) |
| Digital                                  | ±2 deg, 10 Hz to 0.45×SR  |
| Resolution                               | 0.01 deg  |
| Minimum Input (both channels)            |   |
| Analog                                   | 1 mV (S/N >40 dB)   |
| Digital                                  | −60 dBFS (S/N >40 dB)   |
| Residual Noise (Amplitude Function only) |   |
| Analog                                   |   |
| A-weighted                               | ≤1.2 μV rms   |
| Dolby 2K                                 | ≤2.0 μV rms   |
| IEC 468 (CCIR)                           | ≤5.0 μV Qpk   |
| 20 kHz LP                                | ≤1.6 μV rms   |
| Digital                                  |   |
| A-weighted                               | ≤−142 dBFS  |
| Dolby 2K                                 | ≤−134 dBFS  |

<sup>5</sup> 1 kHz ref. Flatness derates above 5 kHz by an additional ±0.02 dB in the 22.4 V, 45 V, 90 V, and 200 V input ranges.

<sup>6</sup> Both analyzer input channels must have same coupling (ac or dc) selection. Analog accuracy is valid for any input signal amplitude ratio up to ±30 dB.

|   |   |
|---|---|
| IEC 468 (CCIR)                            | $\leq -127$ dBFS  |
| 20 kHz LP                                 | $\leq -140$ dBFS  |
| <b>THD+N Function</b>                     |   |
| Fundamental Range                         | 10 Hz to $0.47 \times SR$   |
| Measurement Range                         | 0 to 100%   |
| Accuracy                                  | $\pm 0.3$ dB, 10 Hz to $0.45 \times SR$ (no filters selected)   |
| <b>Residual THD+N</b>                     |   |
| Analog                                    | $\leq 0.0009\%$ [ $-101$ dB] + $1.6 \mu V$ (with 20 kHz LP)   |
| Digital                                   | $-138$ dBFS   |
| <b>Minimum Input for Counter Tuning</b>   |   |
| Analog                                    | 1 mV (S/N > 40 dB)  |
| Digital                                   | $-65$ dBFS (S/N > 40 dB)  |
| Notch Tuning Modes                        | Counter Tuned, Sweep Track, Agen Track, Dgen Track, or Fixed (set by direct entry)  |
| <b>Amplitude &amp; THD+N Filters</b>      |   |
|   | One filter from each of the following three groups may be enabled (3 filters total)   |
| Low Pass Group                            | $F_s/2$ (no BW limiting)<br>20 kHz (6-pole elliptic, 0.1 dB ripple, 110 dB stopband)<br>15 kHz (6-pole elliptic, 0.1 dB ripple, 110 dB stopband)<br>User defined (6-pole max)   |
| High Pass Group                           | <10 Hz (4-pole)<br>22 Hz (4-pole Butterworth)<br>100 Hz (4-pole Butterworth)<br>400 Hz (4-pole Butterworth, or 10-pole elliptic if no other filters are enabled)<br>User defined (4-pole max)   |
| Weighting Filter Group                    | None<br>ANSI-IEC "A" weighting, per IEC 179<br>IEC 468 (CCIR) Qpk<br>Dolby 2K (CCIR-ARM)<br>C-message per IEEE 743-1978<br>CCITT per Rec O.41<br>"F" weighting per 15 phon loudness contour<br>HI-2 Harmonic weighting<br>User defined (8-pole max) |
| <b>Bandpass &amp; Crosstalk Functions</b> |   |
| Tuning Range                              | 20 Hz to $0.47 \times SR$   |
| Bandpass Response                         | 10-pole, Q=19   |
| <b>Accuracy (at center frequency)</b>     |   |
| Analog                                    | $\pm 0.2$ dB  |
| Digital                                   | $\pm 0.1$ dB  |
| <b>Residual Noise</b>                     |   |
| Analog                                    |   |
| 10 Hz to 5 kHz                            | $\leq 0.5 \mu V$ [ $-124$ dBu]  |
| 5 kHz to 20 kHz                           | $\leq 1.0 \mu V$ [ $-118$ dBu]  |
| 20 kHz to 50 kHz                          | $\leq 2.0 \mu V$ [ $-112$ dBu]  |
| Digital                                   | $\leq -150$ dBFS  |

|                           |   |
|---------------------------|---|
| SMPTE (DIN) IMD Function  |   |
| Test Signal Compatibility | Any combination of 40 Hz to 250 Hz (LF) and 2 kHz to 0.45×SR (HF), mixed in any ratio from 1:1 to 5:1 (LF:HF) |
| IMD Measured              | Amplitude modulation products of the HF tone. Measurement bandwidth is typically 20 Hz to 750 Hz              |
| Measurement Range         | 0 to 20%  |
| Accuracy                  | ±0.5 dB   |
| Residual IMD <sup>7</sup> |   |
| Analog                    | ≤0.0025% [−92 dB]   |
| Digital                   | ≤0.00003% [−130 dB] at 0 dBFS<br>≤0.0003% [−110 dB] at −25 dBFS   |

### FFT ANALYZER

|                                      |   |
|--------------------------------------|---|
| Acquisition Length                   | 800 to 256 k samples in 11 steps  |
| Transform Length                     | 256 to 32768 samples in binary steps  |
| Windows                              | None<br>None-move-to-bin-center<br>Hann<br>Hamming<br>Blackman-Harris (4 term, -92 dB sidelobes)<br>Equiripple (AP design with -160 dB sidelobes)<br>Flat-top<br>Gaussian<br>Rife-Vincent 4-term<br>Rife-Vincent 5-term |
| Amplitude Accuracy (Flat-top window) |   |
| Analog                               | ±0.10 dB [±1.2%]  |
| Digital                              | ±0.001 dB [±0.012%]   |
| Phase Accuracy                       |   |
| Analog <sup>8</sup>                  | ±0.5 deg, 10 Hz to 5 kHz<br>±1 deg, 5 kHz to 20 kHz<br>±2 deg, 20 kHz to 50 kHz (with performance option)   |
| Digital                              | ±0.05 deg, 10 Hz to 0.45×SR   |
| Averaging                            |   |
| Number of averages                   | 1 to 4096 in binary steps   |
| Algorithm                            | Power-based (frequency domain)<br>Synchronous (time domain)   |
| Display Modes                        |   |
| Time Domain                          | Normal, Interpolate, Peak, Absolute Value   |
| Frequency Domain                     | Displays highest FFT bin between graph points   |

<sup>7</sup> System specification with 60 Hz/7 kHz or 250 Hz/8 kHz test signal combinations and  $V_{in} \geq 200$  mV.

<sup>8</sup> Both analyzer input channels must have same coupling (ac or dc) selection. Analog accuracy is valid for any input signal amplitude ratio up to ±30 dB.

|                                |   |
|--------------------------------|---|
| None-Move-to-Bin-Center Window |   |
| Frequency Range                | $\pm 4\%$ of input frequency, 7th FFT bin (low limit) to $0.45 \times \text{SR}$ (high limit) |
| Spurious Products              | $\leq 120$ dB   |
| Residual Distortion            |   |
| Analog                         | $\leq -105$ dB, SR=65 kS/s<br>$\leq -90$ dB, SR=262 kS/s (with performance option)            |
| Digital                        | $\leq -180$ dB  |
| Analog Alias Rejection         |   |
| Standard (High Resolution) A/D | typically $>115$ dB for signals $>0.554 \times \text{SR}$                                     |
| Performance option A/D         | typically $>85$ dB for signals $>0.540 \times \text{SR}$                                      |

### MULTI-TONE AUDIO ANALYZER

|                      |  |
|----------------------|--|
| Acquisition Length   | 512 to 32768 samples in binary steps   |
| Transform Length     | 512 to 32768 samples in binary steps   |
| Measurements         | Amplitude vs Frequency, Total Distortion vs Frequency, Noise vs Frequency, Phase vs Frequency, Crosstalk vs Frequency, and Masking Curve |
| Frequency Resolution | $\text{SR} / \text{Length}$ [2.0 Hz with SR = 65.536 kS/s and Length = 32768]  |
| Frequency Correction |  |
| Frequency Range      | $\pm 4\%$ of input frequency, 7th FFT bin (low limit) to $0.45 \times \text{SR}$ (high limit)  |
| Spurious Products    | $< -120$ dB  |
| Residual Distortion  |  |
| Analog               | $\leq -105$ dB, SR=65 kS/s<br>$\leq -90$ dB, SR=262 kS/s (with performance option)   |
| Digital              | $-140$ dBFS  |

### ANALOG INPUT CHARACTERISTICS

|                          |   |
|--------------------------|---|
| Input Ranges             | 355 mVp to 200 Vp [250 mVrms to 140 Vrms] in binary (6.02 dB) steps |
| Maximum Rated Input      | 200 Vp, 140 Vrms (dc to 20 kHz); overload protected in all ranges   |
| Input Impedance          |   |
| Balanced                 | Nominally 200 k $\Omega$ // 95 pF                                   |
| Unbalanced               | Nominally 100 k $\Omega$ // 185 pF                                  |
| CMRR <sup>9</sup>        |   |
| 355 mVp to 5.6 Vp ranges | $\geq 80$ dB, 10 Hz to 20 kHz                                       |

<sup>9</sup> CMRR performance below 50 Hz degrades substantially with AC coupling.

|                          |  |
|--------------------------|--|
| 11.2 Vp to 200 Vp ranges | $\geq 50$ dB, 10 Hz to 1 kHz                       |
| Input Related Crosstalk  | $\leq (-100 \text{ dB} + 3 \mu\text{V})$ at 20 kHz |

## DIGITAL INPUT CHARACTERISTICS

|                    |  |
|--------------------|--|
| Formats            |  |
| Balanced (XLR)     | AES3 per AES3-1997                               |
| Unbalanced (BNC)   | SPDIF-EIAJ per IEC 60958                         |
| Optical (Toslink®) | per IEC 60958-3                                  |
| Sample Rates       | 28.8 kHz to 108 kHz per connector                |
| Word Width         | 8 to 24 bits                                     |
| Input impedance    |  |
| Balanced (XLR)     | Nominally 110 $\Omega$ or $>2.5 \text{ k}\Omega$ |
| Unbalanced (BNC)   | Nominally 75 $\Omega$ or $>3 \text{ k}\Omega$    |

## DIGITAL INTERFACE MEASUREMENTS

|                                    |  |
|------------------------------------|--|
| Input Sample Rate                  |  |
| Internal Reference                 | $\pm 0.0003\%$ [ $\pm 3$ PPM]  |
| External Reference                 | $\pm 0.0001\%$ [ $\pm 1$ PPM]  |
| Input Voltage                      |  |
| Balanced (XLR)                     | 200 mV to 5.10 Vpp, $\pm(10\% + 50 \text{ mV})$  |
| Unbalanced (BNC)                   | 100 mV to 1.275 Vpp, $\pm(10\% + 12 \text{ mV})$   |
| Jitter Amplitude (peak calibrated) |  |
| 50-100kHz BW                       | 0 to 3.00 UI, $\pm(10\% + 2 \text{ ns})$   |
| other BW selections                | 0 to 1.00 UI, $\pm(10\% + 2 \text{ ns})$   |
| Jitter Flatness <sup>10</sup>      | $\pm 1$ dB, 100 Hz to 20 kHz   |
| Residual Jitter <sup>11</sup>      | $\leq 2$ ns [0.012 UI at 48 kS/s, 0.024 UI at 96 kS/s]   |
| Jitter Spectrum                    | Spurious products are typically $<0.003$ UI [-50 dBUI] or 30 dB below jitter signal, whichever is larger |
| Channel Status Bits                | Full implementation per IEC 60958, English language decoded, common to both channels                     |
| Formats                            | Professional or consumer, or Direct Hex source   |
| User Bits                          | Not displayed  |
| Validity Flag                      | Displayed for each channel   |
| Parity                             | Displayed for total signal (both channels combined)  |

<sup>10</sup> System specification including contributions from both analyzer and generator. Valid at 32.0, 44.1, 48.0, 65.536, 88.2, and 96.0 kS/s only. Flatness may degrade at other sample rates.

<sup>11</sup> System specification valid only if (1) the jitter generator amplitude is turned off; (2) the digital input is  $\geq 1.0$  Vpp (XLR) or  $\geq 250$  mVpp (BNC); and (3) the analyzer is set for 700 Hz–100 kHz bandwidth.

|                   |   |
|-------------------|---|
| Signal Confidence | Displayed for total signal (both channels combined) |
| Receiver Lock     | Displayed for total signal (both channels combined) |
| Coding Error      | Displayed for total signal (both channels combined) |

## SYNC/REFERENCE INPUT CHARACTERISTICS

|                         |  |
|-------------------------|--|
| Signal Compatibility    |  |
| AES3                    | AES3id 1995, SPDIF (IEC 60958); 28.8–100 kHz |
| Video                   | NTSC, PAL, or SECAM                          |
| Squarewave              | 8.0 kHz to 10.0 MHz                          |
| Minimum Input Amplitude | 200 mVpp                                     |
| Input Impedance         | Nominally 75 $\Omega$ or >5 k $\Omega$       |
| Lock Range              | $\pm 0.0015\%$ [ $\pm 15$ PPM]               |

## AUXILIARY SIGNALS

|  |   |
|--|---|
| Monitor Outputs                        |   |
| Signals                                | Replicas of both analyzer inputs plus two additional signals depending on the measurement mode. Not guaranteed to operate with sample rates above 108 kS/s. |
| Typical Amplitude                      | 0 to 4 Vpp ( $R_s = 422 \Omega$ )   |
| Miscellaneous Digital I/O              |   |
| Inputs (8 bits)                        | 5 V TTL-compatible CMOS   |
| Absolute maximum range                 | –0.5 V to 5.5 V   |
| Float State                            | 20 k $\Omega$ pull-up to +5 V   |
| Outputs (8 bits)                       | 5 V TTL-compatible CMOS   |
| Voltage Range                          | 0 to 5 V  |
| Trigger Input                          |   |
| Absolute Maximum Range                 | –0.5 V to 30 V  |
| Minimum High Voltage                   | 1.25 V  |
| Maximum Low Voltage                    | 0.5 V   |
| Input Impedance                        | >50 k $\Omega$  |
| Contact resistance (for short control) | 5 k $\Omega$ maximum  |
| Trigger Output                         |   |
| Voltage Range                          | 0–5 V nominal   |
| Output Impedance                       | 150 $\Omega$ nominal  |
| Source                                 | Analog Generator<br>Digital Generator<br>Jitter Generator<br>External Trigger Input<br>Line (Mains)   |



Channel A Receive Sub-Frame  
 Channel B Receive Sub-Frame  
 Channel A Receive Sub-Frame De-jittered  
 Channel B Receive Sub-Frame De-jittered  
 Receive Block  
 Receive Error  
 Channel A Transmit Sub-Frame  
 Channel B Transmit Sub-Frame  
 Channel A Transmit Sub-Frame De-jittered  
 Channel B Transmit Sub-Frame De-jittered  
 Transmit Block  
 Channel A Sync/Ref Receive Sub-Frame  
 Channel B Sync/Ref Receive Sub-Frame  
 Sync/Ref Receive Block  
 Sync/Ref Receive Error

**GENERAL/ENVIRONMENTAL**

|                        |  |
|------------------------|--|
| Power Requirements     | 100/120/230/240 Vac (–10% +6%), 50–60 Hz, 75 VA max  |
| Temperature Range      |  |
| Operating              | +5°C to +45°C  |
| Storage                | –40°C to +75°C   |
| Humidity               | 90% RH to +40°C (non-condensing)   |
| Max Operating Altitude | 3000 m   |
| EMC <sup>12</sup>      | Complies with 89/336/EEC, CISPR 22 (class B), and FCC 15 subpart J (class B)   |
| Dimensions             |  |
| Width                  | 16.8 inches [42.7 cm]  |
| Height                 | 3.0 inches [7.6 cm]  |
| Depth                  | 14.2 inches [36.1 cm]  |
| Weight                 | Approximately 14.8 lbs [6.7 kg] unpacked   |
| Safety                 | Complies with 73/23/EEC, 93/68/EEC, and EN61010-1 (1990) + Amendment 1 (1992) + Amendment 2 (1995). Installation Category II, Pollution Degree 2 |

<sup>12</sup>Emission and immunity levels are influenced by the shielding performance of the connecting cables. EMC compliance was demonstrated using Audio Precision part numbers CAB-XMF and CAB-AES2.







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