User Manual

Tektronix

**AM700
Audio Measurement Set
with Color Display**

070-9585-01

This document applies to firmware version 1.02
and above.

The following copyright covers the TIFF Code used in the AM700. Source code is not provided.

WARRANTY

Tektronix warrants that this product will be free from defects in materials and workmanship for a period of one (1) year from the date of shipment. If any such product proves defective during this warranty period, Tektronix, at its option, either will repair the defective product without charge for parts and labor, or will provide a replacement in exchange for the defective product.

In order to obtain service under this warranty, Customer must notify Tektronix of the defect before the expiration of the warranty period and make suitable arrangements for the performance of service. Customer shall be responsible for packaging and shipping the defective product to the service center designated by Tektronix, with shipping charges prepaid. Tektronix shall pay for the return of the product to Customer if the shipment is to a location within the country in which the Tektronix service center is located. Customer shall be responsible for paying all shipping charges, duties, taxes, and any other charges for products returned to any other locations.

This warranty shall not apply to any defect, failure or damage caused by improper use or improper or inadequate maintenance and care. Tektronix shall not be obligated to furnish service under this warranty a) to repair damage resulting from attempts by personnel other than Tektronix representatives to install, repair or service the product; b) to repair damage resulting from improper use or connection to incompatible equipment; or c) to service a product that has been modified or integrated with other products when the effect of such modification or integration increases the time or difficulty of servicing the product.

THIS WARRANTY IS GIVEN BY TEKTRONIX WITH RESPECT TO THIS PRODUCT IN LIEU OF ANY OTHER WARRANTIES, EXPRESSED OR IMPLIED. TEKTRONIX AND ITS VENDORS DISCLAIM ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. TEKTRONIX' RESPONSIBILITY TO REPAIR OR REPLACE DEFECTIVE PRODUCTS IS THE SOLE AND EXCLUSIVE REMEDY PROVIDED TO THE CUSTOMER FOR BREACH OF THIS WARRANTY. TEKTRONIX AND ITS VENDORS WILL NOT BE LIABLE FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES IRRESPECTIVE OF WHETHER TEKTRONIX OR THE VENDOR HAS ADVANCE NOTICE OF THE POSSIBILITY OF SUCH DAMAGES.

EC Declaration of Conformity

We

Tektronix Holland N.V.
Marktweg 73A
8444 AB Heerenveen
The Netherlands

declare under sole responsibility that the

AM700 Audio Measurement Set

meets the intent of Directive 89/336/EEC for Electromagnetic Compatibility. Compliance was demonstrated to the following specifications as listed in the Official Journal of the European Communities:

EN 50081-1 Emissions:

EN 55022	Class B Radiated and Conducted Emissions

EN 50082-1 Immunity:

IEC 801-2	Electrostatic Discharge Immunity
IEC 801-3	RF Electromagnetic Field Immunity
IEC 801-4	Electrical Fast Transient/Burst Immunity

High-quality shielded cables must be used to ensure compliance to the above listed standards.

Table of Contents

Configuring the AM700

Applications

List of Figures

List of Tables

Table of Contents

AM700 Audio Measurement Set

General Safety Summary

Review the following safety precautions to avoid injury and prevent damage to this product or any products connected to it.

Only qualified personnel should perform service procedures.

To avoid potential hazards, use this product only as specified.

Injury Precautions

Use Proper Power Cord

To avoid fire hazard, use only the power cord specified for this product.

Avoid Electric Overload

To avoid electric shock or fire hazard, do not apply a voltage to a terminal that is outside the range specified for that terminal.

Avoid Electric Shock

To avoid injury or loss of life, do not connect or disconnect probes or test leads while they are connected to a voltage source.

Ground the Product

This product is grounded through the grounding conductor of the power cord. To avoid electric shock, the grounding conductor must be connected to earth ground. Before making connections to the input or output terminals of the product, ensure that the product is properly grounded.

Do Not Operate Without Covers

To avoid electric shock or fire hazard, do not operate this product with covers or panels removed.

Use Proper Fuse

To avoid fire hazard, use only the fuse type and rating specified for this product.

Do Not Operate in Wet/Damp Conditions   To avoid electric shock, do not operate this product in wet or damp conditions.

Do Not Operate in Explosive Atmosphere   To avoid injury or fire hazard, do not operate this product in an explosive atmosphere.

Product Damage Precautions

Use Proper Power Source   Do not operate this product from a power source that applies more than the voltage specified.

Use Proper Voltage Setting   Before applying power, ensure that the line selector is in the proper position for the power source being used.

Provide Proper Ventilation   To prevent product overheating, provide proper ventilation.

Do Not Operate With Suspected Failures   If you suspect there is damage to this product, have it inspected by qualified service personnel.

Safety Terms and Symbols

Terms in This Manual   These terms may appear in this manual:

WARNING. Warning statements identify conditions or practices that could result in injury or loss of life.

CAUTION. Caution statements identify conditions or practices that could result in damage to this product or other property.

Terms on the Product   These terms may appear on the product:

DANGER indicates an injury hazard immediately accessible as you read the marking.

WARNING indicates an injury hazard not immediately accessible as you read the marking.

CAUTION indicates a hazard to property including the product.

Symbols on the Product   The following symbols may appear on the product:

DANGER
High Voltage

Protective Ground
(Earth) Terminal

ATTENTION
Refer to
Manual

Static-Sensitive
Devices

Certifications and Compliances

CSA Certified Power Cords   CSA Certification includes the products and power cords appropriate for use in the North America power network. All other power cords supplied are approved for the country of use.

Compliances   Consult the product specifications for IEC Installation Category, Pollution Degree, and Safety Class.

General Safety Summary

Introduction and Installation

Introduction and Installation

The Tektronix AM700 Audio Measurement System is a programmable, high-performance, mixed signal audio analyzer designed for use in product design, characterization, quality control, manufacturing test, and servicing. The AM700 is also a valuable tool for monitoring and testing of signal distribution systems used in broadcasting and related applications.

The AM700 Audio Measurement System is an audio test set combining the signal generating capability of a two-channel analog and digital audio generator with the measurement and analysis capability of a two-channel analog and digital audio analyzer. Extensive use of digital signal processing provides this mixture of advanced capabilities.

All hardware control, instrument configuration, data storage and I/O operations can be accomplished with the front-panel interface. The AM700 can be operated remotely through its GPIB port. Timed functions can be programmed using remote control.

Key Features of the AM700

- The AM700 is compact, light weight, and self contained making it suitable for both bench and portable audio testing applications.

- The AM700 is the first advanced audio analyzer to employ the proven touch/turn/zoom interface consisting of hard keys, knobs, and touch screen soft key controls.

- Graphical and text displays of measurements are viewed on a flat-panel LCD color display. A touch screen and soft key menu structure provides the user interface to the extensive applications of the AM700. Larger, external color displays of the AM700 screens are supported with a VGA port and user-supplied VGA monitor.

- Printed copies of screens of the AM700 can be output to printers connected to RS-232C or GPIB ports. In addition, you can store the information on a 1.44 Mbyte, 3.5-inch floppy disk, using the internal disk drive, for later use or analysis.

- The SOUND function in all applications (except Digital Interface Tester) allows monitoring of signals through headphones.

- The physical size of the AM700 is approximately 7.7 inches high, 18.2 inches wide (with handle), 18.8 inches deep, and it weighs about 31 pounds. This size allows the instrument to fit laboratory bench space and enhances portability. The standard accessory front cover provides extra protection to the face of the AM700 when used as a portable instrument or when stored. The AM700 can also be rackmounted in a standard 19-inch rack using the optional rackmounting accessory kit.

Operation and Controls

The flat-panel display face is overlaid with a touch screen that is used for selection of many of the operating parameters. Screen areas are firmware defined for touch control of the various application menus and configuration screens used to control the operation of the AM700. Touches to the screen are indicated by a click when an active area has been selected. Touches outside an active area produce no sound. Viewing parallax of the control zones cam cause you to touch in the wrong area when the zones are close together. If the touch screen control zones become misaligned with the underlying display, you should do a touch screen calibration.

NOTE. A small blunt-pointed tool, such as the top of a pen or pencil eraser may be of help in touching the correct zone. A light press is all that is needed to record the touch. Touches to the screen are queued and multiple actions will occur if you touch the screen several times in succession without waiting for the first requested action to occur.

Most operating modes are accessible by a single front-panel button. More features are accessed with short combinations of front-panel buttons and soft key selections that appear on menus in the display viewing area. Menu selections are made by pressing the touch screen in the menu selection area. Front-panel knobs control the internal audio generator and zoom/position function.

The color LCD display of the AM700 produces sharp, clear images. Displays are designed to provide a great deal of graphical measurement information yet eliminate

a cluttered viewing area. The display screens can be formatted for any external PostScript, Laserjet, or Epson-compatible printer for generating printed copies of the measurements and waveforms. Graphic images in PostScript and TIFF formats can be formatted for color copy.

The AM700 has a unique view window feature that lets you view multiple graphical measurement displays. Use this feature to make distortion, phase, or crosstalk measurements while still viewing a critical signal parameter, such as signal level.

Measurement Capability

Analog and digital signal applications include Audio Analyzer, FFT Analyzer with multitone capabilities, and an Audio Monitor. You cam apply analog signals to one measurement channel and digital signals to the other measurement channel and simultaneously make measurements on both.

Features of the Digital Interface Tester include an Eye Height display, a Bit Activity display, Jitter and Sample Rate measurements, and a decoded Channel Status display. Extensive monitoring and measurement capability on a variety of digital audio signals are standard.

With the AM700 you can perform several related measurement or monitoring tasks at once.

Audio Signal Generator Capabilities

The AM700 includes signal generating capability allowing users to create test signals in Analog and Digital Audio domains. These generators can be operated in concert with the analyzer function or as a stand-alone test signal source. The analog and digital generators can also be used either simultaneously or independently.

The analog generator has a great deal of operation flexibility. Its balanced output signals can be referred to either chassis ground or floating. The analog signal generator can produce different signals on each of its pair of output channels. In addition, a front-panel selected internal connection permits the output of the generator to be directly connected to the analog and digital inputs without the need for external cabling when checking out the operation of the AM700.

The digital generator is also very flexible. It can produce test signals in AES/EBU, SPDIF, Optical, and raw data forms at a variety of sample rates. Like the analog generator, it can produce independent signals on either channel. In addition to the audio test signals, you can use this generator to manipulate the Channel Status Data and User Data bits in the serial data stream. Varying types and degrees of corruption can be added to the output to permit testing of devices under real-world conditions.

When the Audio Analyzer application is in use, the internal generator sweeps can be driven in a closed-loop mode of operation. This mode is very useful for stimulating a device under test and waiting for the Analyzer to acquire the signal output from the device under test before stepping to the next step in the sweep. Propogation delays through the device under test and the settling time needed to produce a stable signal are accounted for by the Settling Detection feature so that, if possible, settled data is acquired at each step before advancing to the next step.

Installation of the AM700

This information includes the power requirements, power cord information, and fuse information for installing the AM700. Calibrating the touch screen and setting the real time clock are also included here as part of the initial start-up routine after installation.

Power Requirements

The AM700 operates with line frequencies of 50 Hz or 60 Hz over two line voltage ranges. The nominal setting of the low voltage range is 115 VAC. The nominal setting of the high voltage range is 230 VAC. The AM700 power requirement is 185 watts or 230 volt-amperes at maximum power consumption.

There are two power switches on the AM700. They are the main power switch, a push button switch on the rear panel above the power cord receptacle (see Figure 1-1), and the Stby/On button on the front panel. Both must be on to operate the instrument.

WARNING. *Dangerous voltages are present within the Power Supply module when the rear-panel power switch is on, regardless of the position of the front-panel power switch. Do not operate the AM700 with any covers removed. Refer all servicing of the instrument to a qualified service person.*
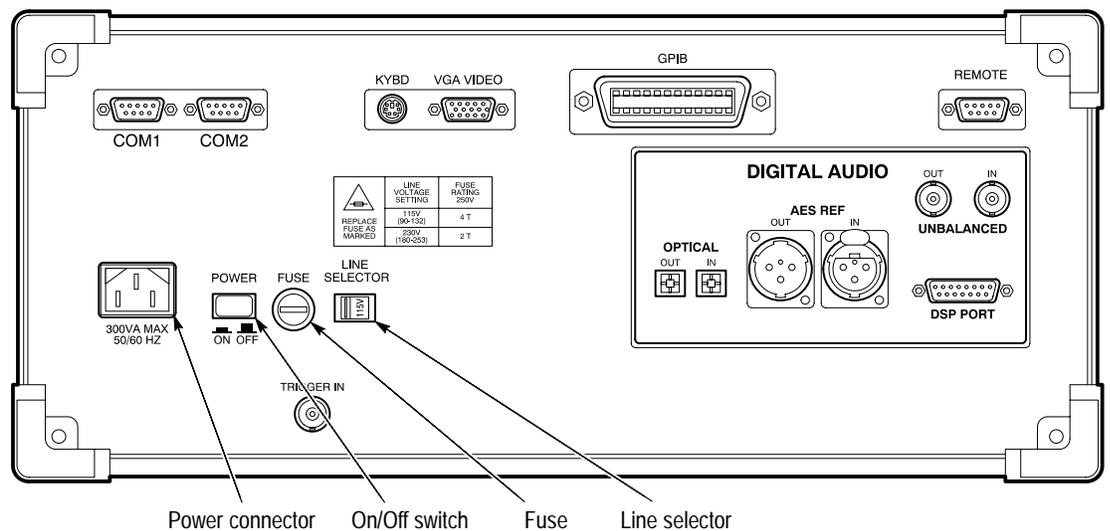
Figure 1-1: Rear panel fuse, power connector, On/Off Switch, and line selector

Changing the Line Voltage Range and Fuse

The AM700 is shipped from the factory set for the operating voltage of the destination country (115 VAC or 230 VAC). If the setting is not correct, it must be changed before connecting the power cord to the power source.

1. Turn off the rear-panel power switch and disconnect the power cord from the mains supply (see Figure 1-1).

2. Set the voltage range selection switch (located on the rear panel of the AM700) to the correct position for operation.

Instruments are shipped with the power cord most appropriate for the country of destination. Available power-cord option information is given in Table 1-1. Contact your Tektronix representative or local Tektronix field office for additional power-cord information.

⚠ *CAUTION. When changing the line voltage selector switch you must also change the fuse to provide proper protection for the operating voltage in use.*

The mains fuse provides protection in the event of a major failure of the AM700 power supply. Two sizes of fuses are specified, one for 115 V operation and the other for 230 V operation. Refer to *Fuse Rating* on page A-27 of Appendix A for the correct fuse rating to use for each voltage range.

3. Replace the fuse with the correct one, as indicated on the rear panel, for the new mains voltage selection.

⚠ **CAUTION.** *Use only the power cord and connector specified for your product. Use only a power cord that is in good condition with a proper safety ground connector.*

---

4. Replace the power cord with the correct one for use with the local mains outlets.

5. Turn on the rear power switch. Then turn on the front power switch to operate the AM700.

Power Cord A detachable three-wire power cord with a three-contact plug is provided with each instrument for connecting to both the power source and protective ground. The protective-ground connector in the plug connects (through the protective-ground conductor) to the accessible metal parts of the instrument. For electrical-shock protection, insert this plug only into a power-source outlet that has a properly grounded protective-ground contact. The voltage to ground from either pole of the power source must not exceed 250 V_{RMS}. For electric-shock protection, the grounding connection must be made before making connections to the instrument input or output terminals.

Power Up Procedure At power up the AM700 normally bypasses the power-up diagnostics and starts the FFT application. You can start an application other than FFT by pressing and holding in the front-panel button for the application you want to start as you turn on the front panel power switch. The AM700 will beep twice, and you can then release the application front-panel button. To run the power-up diagnostics, press and hold in the front-panel Limits button as you press the front-panel power button. The AM700 beeps twice, displays the message 'Start mode "RUN DIAGNOSTICS" recognized,' and then runs the diagnostics before initialization.

Should a power-up diagnostic fail, the AM700 should be referred to your local Tektronix representative for servicing. Should the AM700 go into a continuous reset condition, refer to Appendix A of the *AM700 Programmer Manual* for the procedure used to clear the NVRAM of possible undefined states.

Table 1-1: Optional Power Cords

Power Plugs	Description	Reference Standards[1]
	Standard North American 120 V plug	ANSI C73.11 NEMA 5-15-P IEC 83 UL 198.6
	Option A1 Universal Euro 220 V plug	CEE(7) II, IV, VII IEC 83 IEC 127
	Option A2[2] United Kingdom 240 V plug	BS 1363 IEC 83 IEC 127
	Option A3 Australian 240 V plug	AS C112 IEC 127
	Option A5 Switzerland 220 V plug	SEV IEC 127
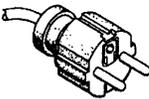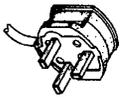
[1]Reference Standards Abbreviations:
    ANSI—American National Standards Institute
    AS—Standards Association of Australia
    BS—British Standards Institution
    CEE—International Commission on Rules for the Approval of Electrical Equipment
    IEC—International Electrotechnical Commission
    NEMA—National Electrical Manufacturer's Association
    SEV—Schwetzervischer Elektrotechischer Versin
    UL—Underwriters Laboratories Inc.

[2]A 6 A, type C fuse is also installed inside the plug of the Option A2 power cord.

Calibrating the Touch Screen	The AM700 is shipped from the factory with its touch screen fully calibrated. Although it will seldom be necessary, the touch screen can easily be recalibrated.

To calibrate the touch screen:

- Press the front-panel button labeled "Other."

- Use the large control knob to scroll through the menu choices and select the touch screen calibration choice from the menu that appears (see Figure 1-2). Press Enter on the keypad to activate the selection.

The choice can be made by touching the selection directly on the touch screen interface. However, the above procedure may be used if the touch screen becomes uncalibrated.
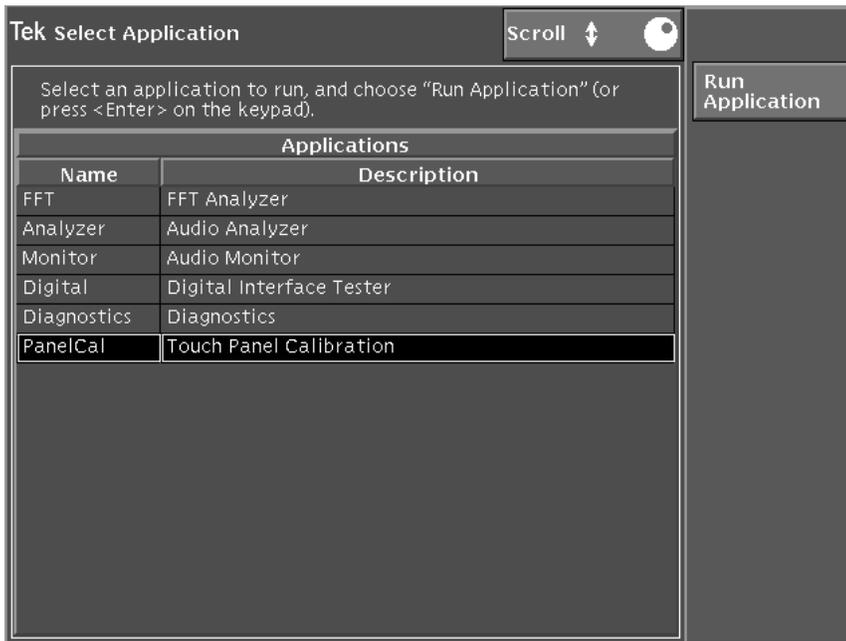
Figure 1-2: Application selection menu under the Other button

Full instructions for calibration are given on the screen when the calibration display appears (see Figure 1-3).

■   A small circle with a dot is highlighted in succession in each of three corners. View the screen directly on to avoid parallax errors and use a small blunt pointed tool, such as a pencil eraser tip, to produce the best accuracy for the calibration. Touch the screen directly over the first dot. The dot in the next corner then lights. Touch the second dot, and then touch the third dot to finish the calibration.
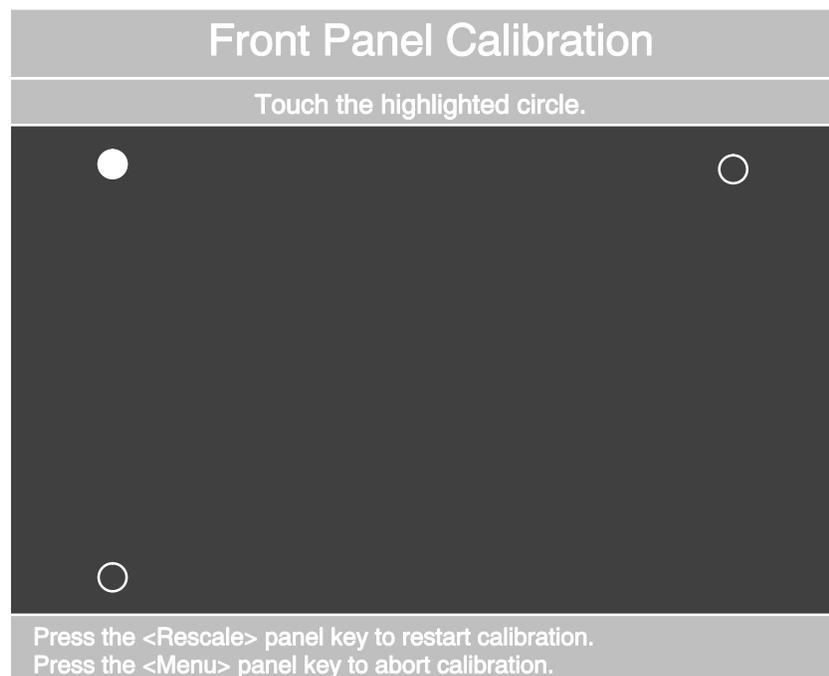
Figure 1-3: Touch screen calibration

■   After calibration, the screen will display the Paint screen. You can test areas of the screen for activity by touching the screen at various points. The touch point will become highlighted. The Clear soft key on the touch screen erases the highlighted areas of the Paint screen.

■ Press any application front-panel button to exit the paint screen and start the application.

Setting the AM700 Clock

The AM700 has a system clock with an internal backup battery. After setting for your local time, it is ready to use. Performing this exercise for the first time will also introduce you to the Configure menus that you will use as you set up the AM700. To set the clock use the following procedure:

1. Press the Configure button on the front panel. This displays the choices for configuring the various user selections of the AM700. Clock setting is done in the System Setup option.
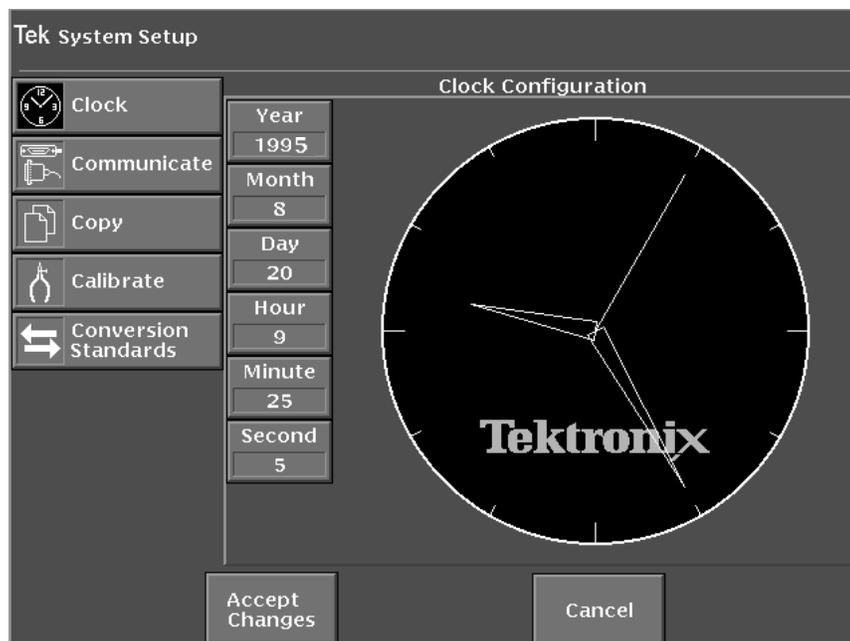
Figure 1-4: AM700 System Clock

2. Touch "System Setup" to display the choices under that option. Clock is the default selection, and the clock face appears as seen in Figure 1-4.

3. Check the date and time settings. If any are not correct, select them individually to adjust to the correct setting. A selected choice changes intensity to show that editing of that setting is active.

4. Set the correct number by rotating the large control knob or by entering the correct number with a direct keypad entry and pressing the Enter button. Changes made to the time are shown in the clock as they are entered, but those changes are not permanent until the Accept Changes soft key is touched.

5. When the date and time are correct, touch the Accept Changes soft key. This changes the time to the new values and returns to the previous application.

CAUTION. The backup battery used to retain stored data has an operating life of greater than 10 years when operating between 0° and 50° C. If operating out of that range for extended periods of time, the battery life can be reduced or stored data can be lost.

Internal Backup Battery

The nonvolatile memory of the AM700 is held by an internal backup battery. Stored data will be retained for the life of the battery. A fresh battery installed at the factory has a life of greater than 10 years when operated and stored at an ambient temperature between 0° and 50° C. Battery life can be reduced if the AM700 is stored for an extended time above 50° C, and retained data can be lost if the AM700 is stored for extended periods below 0° C.

Options

The following options are available for use with the AM700:

■ Options A1 through A5 substitute an appropriate power cord for the country of use (see Table 1-1).

■ Remedial Service Support   Option M2

■ Repair Protection   Option M9

Standard Accessories

- AM700 User Manual

- AM700 Programmer Manual

- AM700 Programmer Quick Reference Manual

- Standard power cord (optional power cord substituted when ordered)

- Front Cover

Optional Accessories

Accessories can be used for remote control, signal interfacing, and rackmounting. The following optional accessories are available:

- GPIB Cable: double shielded in various lengths

    - 1 meter   Tektronix part number 012-0991-01

    - 2 meter   Tektronix part number 012-0991-00

    - 4 meter   Tektronix part number 012-0991-02

- Tektronix ASW 100F Input Signal Switcher

- Tektronix ASW 100M Output Signal Switcher

- Rackmounting kit   Tektronix part number AM7FR1

- External keyboard   Tektronix part number 119-4254-01

User-supplied Accessories

- Standard VGA monitor (connect to the VGA Video output connector for viewing the AM700 color display on an external monitor)

- Ariel digital microphone (for direct audio input to the DSP input port)

- XLR interconnection audio cables

- BNC to XLR adapters

- RCA Phone to XLR adapters

- AT-compatible keyboard with 6-pin, mini-DIN connector (in lieu of Tektronix part numbered optional accessory)

Operating Basics

Operating Basics

This section describes the AM700 user interface and connections and introduces basic instrument operations. Topics discussed in this section include: front-panel controls, touch-screen interface, and analog and digital connections. This section also describes the basic operations that must be performed while using the AM700 for audio measurement and analysis.

Touch Screen and Front Panel Buttons

The AM700 is controlled by selecting from measurement parameters and menus on the instrument display. A touch screen over the display (shown in Figure 2-1) detects your selections.

Figure 2-1: Touch screen interface without menus

Many AM700 operations are started by selecting soft keys (shown in Figure 2-2) using the touch screen (touching the display in the right place to invoke some function). In some menus, numerical values are entered either from the keypad or with the control knob.

Front panel buttons with gold outlines (Copy, Average, Cursor, Sound, Filter, Sound On, User, and Units) have two possible behaviors, depending on how you use them and the application or display that is running. If you press a button that is not used by an application, no action occurs.[1]

1. When pressed and immediately released, each of the gold-outlined buttons performs a default action (turning on or off the specified feature).

2. When any of the gold-outlined buttons is pressed and held for one second or more, a configuration menu related to its operation is displayed.

NOTE. The button default action (selected when you press and release the front-panel button) does not occur when exiting a press/hold menu. Instead, you must again press and release the button to perform the default action.

The LEDs associated with these buttons track the action you select, not the configuration menu associated with the hard key. For example, the Filter hard key LED lights only when you select filtering.

During operation of the AM700 the following objects can appear in the display:

- One to four measurement view windows

- Generator Status area

- Generator Control Panel

- Menu and Soft Keys selections

- Operational status and Real Time measurement displays

- Notifier messages

---

[1]An example is the Filter menu. Filters are only available in Audio Analyzer, so when the Digital Interface Tester or the FFT analyzer is running, pressing the Filter button has no effect.

Application name   Input signal source

Submenu bar appears when
a Main Menu selection is made.

Main Menus appear when the front-panel menu button is pressed.
When selected, the button is highlighted.
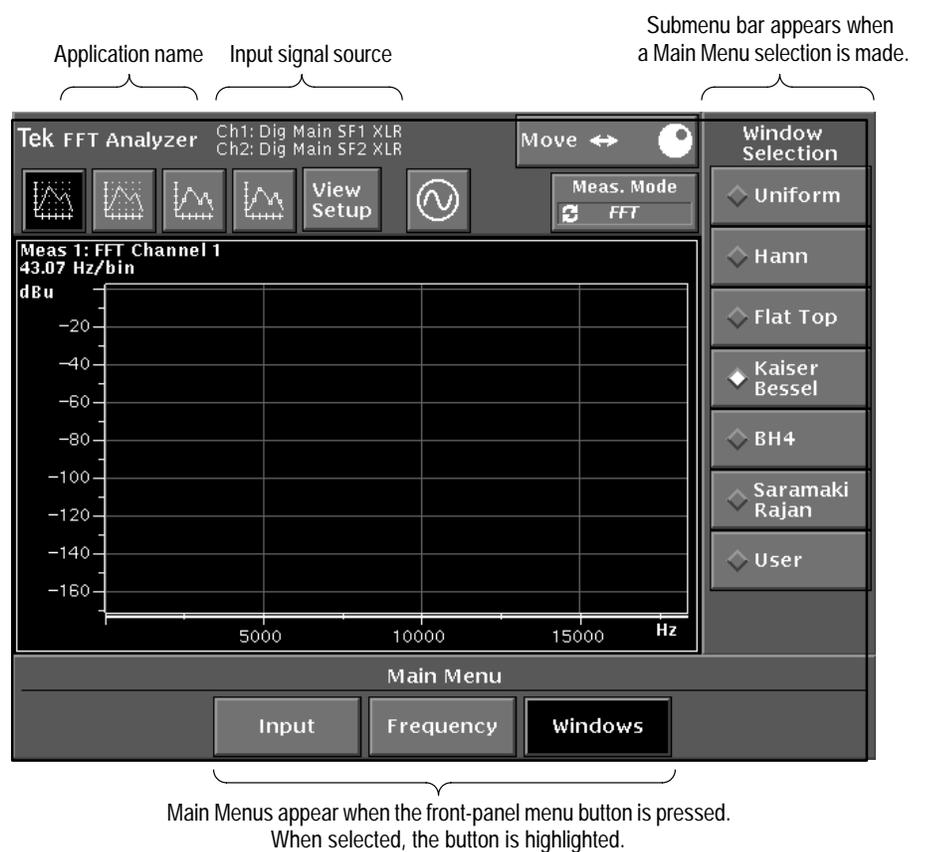
Figure 2-2: Touch screen interface with main menus and submenus displayed

NOTE. When menus or soft key selections are grayed out, it means those choices are not currently available for selection. This will be seen when the selections are not applicable to the active view window or the selections cannot be used in the current operation of an application.

Application Control

An AM700 application is started by pressing a button (if it has a dedicated front-panel button) or by selecting it from the menu displayed when the "Other" front-panel button is pressed and released.

Each AM700 measurement application corresponds functionally to a dedicated measurement instrument. The AM700 runs one measurement application at a time. The Generator is independent of the application and maintains its settings between applications.

Display Icons

The AM700 uses icons in its menus and control panels to represent actions or available choices. Some of these icons are displayed in Figure 2-3. The display view selections icons are application specific and are introduced in the *Applications* section of this manual beginning on page 4-1.

Views

Figure 2-4 shows the Views selection bar displayed at the top of the FFT Analyzer application. Touching a Views icon toggles the display of that view on and off. Each selected view is size adjusted to accommodate all the views you request in the display.[2] In the most applications, the four views can be displayed as one to four windows in any combination with a selection of measurements possible in each view. In FFT Analyzer, the four views are initially set up with views 1 and 2 as FFT measurements and views 3 and 4 as multitone measurement, but you can change this set up.

[2] **An exception to this is seen in the Digital Interface Tester. In that application each view is a different measurement that cannot be made with the other measurements running. In that application only one measurement view window at a time is displayed.**

DISPLAY VIEW

GENERATOR STATUS READOUT

REAL TIME MEASUREMENTS

TWO OR MORE CHOICES ARE TOGGLED

A LIST OF CHOICES IS AVAILABLE

CHOICE IS SELECTED

CHOICE IS NOT SELECTED

SELECTION IS ENABLED

SELECTION IS NOT ENABLED

MOVE OR EXPAND HORIZONTALLY

MOVE OR EXPAND VERTICALLY

HORIZONTAL ZOOM POINT

VERTICAL ZOOM POINT

LARGE CONTROL KNOB

GENERATOR KNOBS ASSIGNED
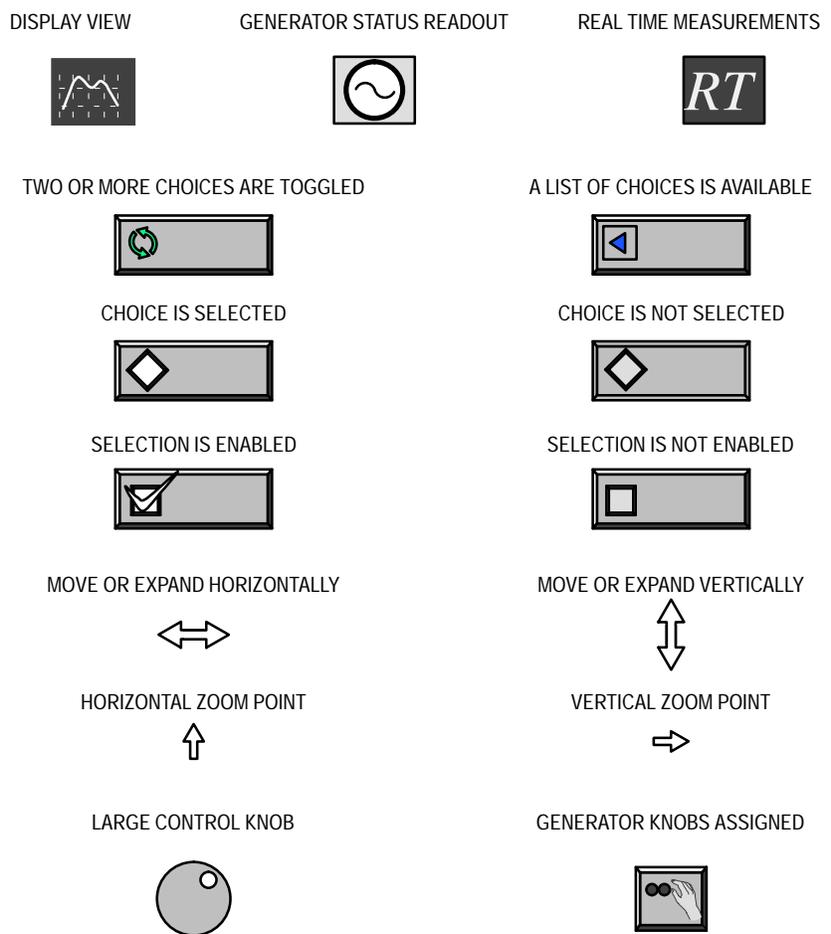
Figure 2-3: Representative icons and arrows seen in the AM700 display

Figure 2-4: Views selection bar with only View 1 selected for display

When multiple view windows are displayed (including the RT and Generator Status views), assigning the controls to a particular view is done by touching the screen in that view. The touched view then becomes the active view and is indicated by a brighter border around that view window as shown in Figure 2-5. Cursor controls and the move/expand action are directed to the traces in the active view.

You can set each view to display a different measurement or combinations of measurements. For example, in the Audio Analyzer, view 1 can be set to display Channel 1 frequency versus Channel 1 level, view 2 can be of Channel 1 level versus Channel 1 THD, view 3 can be of Channel 1 level versus Channel 2 level, and view 4 can be of Channel 2 level versus Channel 2 THD. The choice of measurement channel and measurement type assigned to an axis in the graphical views is flexible. Refer to *View Setup* on page 3-7 for more information on setting up the views and selecting the measurement traces for the views.

Graphical Display Types

The AM700 offers several choices for displaying data in a view window. Where applicable, the following display types are possible.

- Point-to-point plots of measurement results (traces)
- Traditional Y-Axis versus X-Axis waveform display
- Table of data (updating as new data is acquired)
- Spectrogram
- Eye diagram
- Histogram
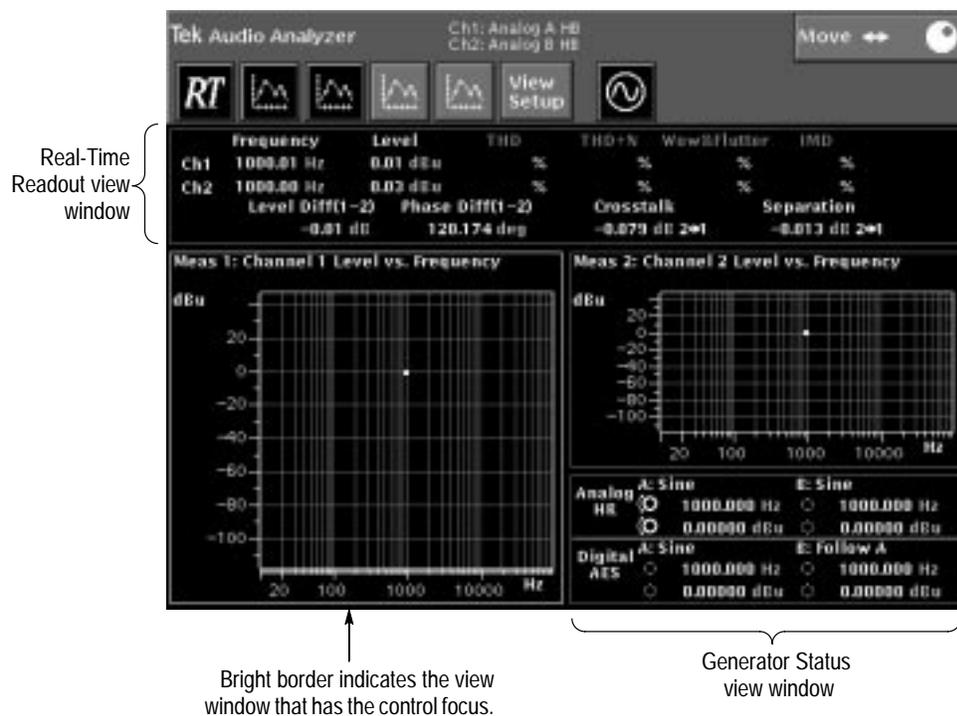
Figure 2-5: View windows and control assignment

Measurement Units   You can also select the units in which the data is displayed. These unit selections apply to measurement readouts, parameter settings, and graphical display axes. Where appropriate, the following units choices are available.

- Hz, kHz

- V, ΔV, mV, ΔmV

- dB, dBu, dBV, dBr, dBFS

- dBm

- %

- S, mS

Front-panel Operation

The AM700 front panel consists of a touch screen, selections buttons and control knobs divided into functional control areas, and a numeric keypad. Figure 2-6 illustrates the front panel of the AM700.
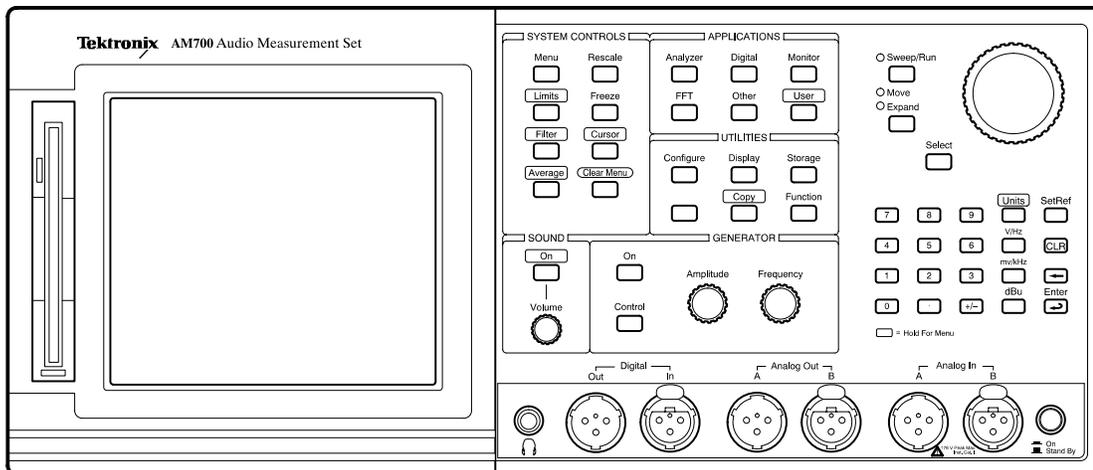
Figure 2-6: AM700 front panel

Front Panel Button General Information

Many of the front panel button labels have back lights. These back lights are on to light up a button label when the selection for that button is active. Other front-panel button labels have a gold outline. The buttons with gold-outlined labels have two operations; the first is to turn on and off the selection indicated by the button label. This action occurs with a quick press and release of the button. The second action is to display a menu for setting user-selectable settings for the associated action or to provide additional control selections. The menu associated with a gold-outlined button is reached by pressing and holding the button until the menu is displayed.

System Control Buttons

The System Control buttons shown in Figure 2-7 provide control of function that are not application specific. In general the system functions are available for use with all the applications.

SYSTEM CONTROLS

Menu   Rescale

Limits   Freeze

Filter   Cursor

Average   Clear Menu
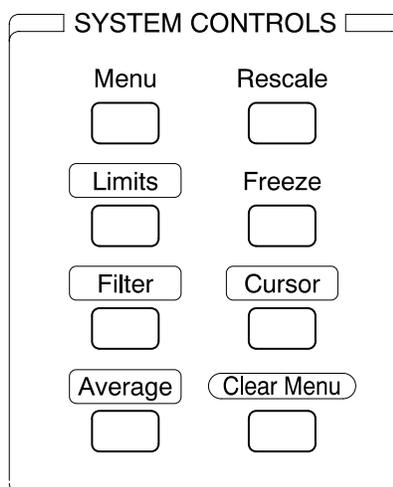
Figure 2-7: System control buttons

Menu   Pressing the Menu button displays the soft key controls that are available for the application currently in use.

Limits   The Limits feature of the AM700 has not been activated.

Rescale   Pressing the Rescale button adjusts the vertical and horizontal resolution for optimum display of the measured data. The Rescale button has two actions. Press and quickly release the button to rescale only on the plotted data points in the view that has been selected by touching it. Press and hold the Rescale button to rescale all views.

Freeze   Pressing the Freeze button (a toggle) halts display updates. Some frozen displays cam be expanded horizontally and vertically. When expanding a frozen display, the AM700 interpolates acquired data to provide display points for the expanded displays. Also, cursors can be used on the frozen display to make measurements. Display updates are resumed when Freeze is pressed a second time.

Filter   A selection of input filters is available in AM700 firmware for use with the Audio Analyzer. Other types of filter are available from within applications that require specific filtering to obtain the measurement. Refer to *Input Filtering* on page 4-75 for information on filter types and operation.

When the Audio Analyzer application is running, pressing the Filter button (a toggle) applies the selected filter to the measurement data. You can select from a menu of available filters by pressing and holding the Filter button to display the choices available for Channel 1 and Channel 2. To access the choices, the Filter front-panel button must be lighted (Filter on).

Cursors   Pressing the Cursors front-panel button places two cursors on the display and lets you position them to mark display features. The numerical display shows frequency and level at each cursor location and the timing difference between the two cursors.

Cursors can be used to select measurement points in a waveform. Cursor position is adjusted using the Control Knob with cursor positioning active. The cursors can be used to provide a continuous readout of the amplitude and frequency at the cursor position. The active cursor position is also the expansion point when horizontal expand (Zoom) is enabled.

The difference readouts (both amplitude and time or frequency) shown in the view window above the graticule are based on the position of cursor 1 (the solid cursor) minus the position of cursor 2 (the dashed cursor).

NOTE. When cursors are visible in the display window, cursor position is shown above each cursor. When cursors are positioned beyond the display window, cursor position is shown in either upper corner of the display with an arrow pointing toward the cursor.

Pressing and holding the Cursor button brings up the Cursor menu as shown in Figure 2-8. The menu controls permit you to select cursors and employ some special positioning actions.
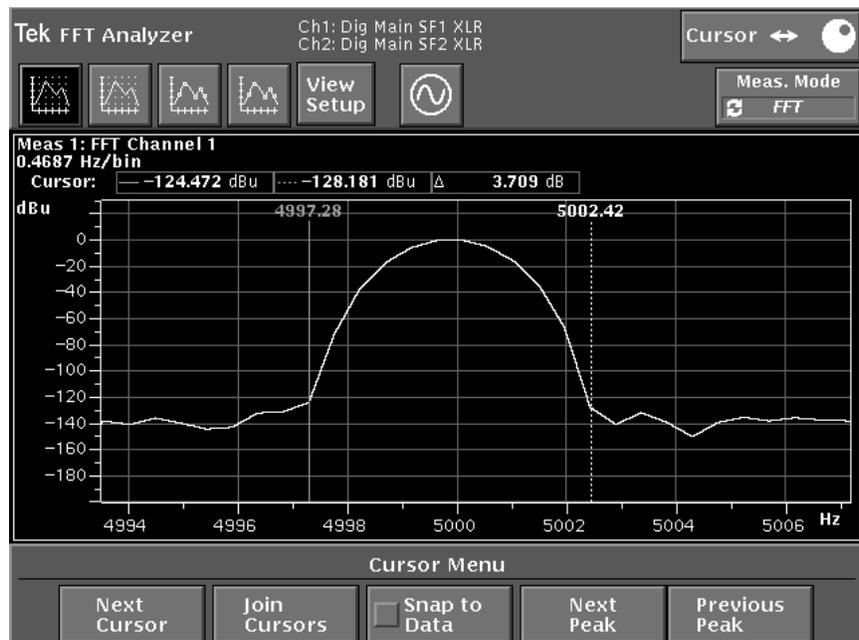
Figure 2-8: Cursor menu showing frequency and level readouts

Next Cursor. Next Cursor toggles the active cursor selection between the two cursors. Cursor 1 is indicated as a solid vertical line; cursor 2 is indicated as a dashed vertical line. The active cursor is brightened. You can position the active cursor by rotating the large control knob or by touching it and dragging it to a new position.

Join Cursors. Join Cursors moves the two cursors together so that the starting positions of the cursor can be quickly set. If one cursor is active, the other will move to meet it. If neither is selected, they will both be centered in the display. You will typically use this selection when first bringing up the cursors to help you find them since it places both cursors together.

Snap to Data. Snap to Data, when enabled, causes the cursors to be positioned from data point to data point (not interpolated points) in the trace. When not enabled, cursors are not held to the acquired data points and they are positioned smoothly along the trace.

Next Peak and Previous Peak. The Next Peak and Previous Peak soft keys are available with either cursor active. Next Peak moves the active cursor on the nearest signal peak to the right of the cursor while showing the frequency and signal level of the peak in the numerical display. The cursor does not automatically go to the highest peak; it goes to the next closest peak.

NOTE. In the FFT application, the "finding the peak" functions can miss some peaks if the Uniform window is in use (refer to Uniform *on page 4-82).*

Previous Peak. Previous Peak moves the active cursor to the nearest signal peak to the left of the cursor. The frequency and signal level of the peak is displayed in the numerical display.

Press the Clear Menu button to exit the cursor menu.

Averaging
An Average feature is available for use with measurements in the FFT Analyzer and the Jitter Spectrum function in the Digital Interface Tester. Pressing and releasing the Average button turns Averaging on and off in applications that can use averaging. Pressing the Average button when the feature is not available for use has no effect. Averaging is used to remove random noise from the display trace so that small amplitude frequency components are easily observed.

To turn on averaging for a trace, first touch the view that contains the trace you want to average. As indicted by the gold-outlined label, the Average button has two operations: pressing and releasing turns averaging on or off for the selected view; pressing and holding the Average button brings up the Average menu as shown in Figure 2-9. You can select the number of acquisitions to be averaged either using the control knob or by making a keyboard entry with the Averaging menu number selection active. Other choices in the averaging menu are Holding Minimum and Holding Maximum.

With the Average menu displayed, touch the Avg Count soft key to activate the field editor and either use the control knob to adjust the number or use the numeric keypad to enter a new average count number. The Avg Count can be set for 1 to 9,999 averages.

Touch the Processing soft key and turn the control knob to specify averaging or holding minimum or maximum signal values. Touch the Processing soft key to accept the change. With Hold Maximum or Hold Minimum is selected, the Avg Count soft key is not accessible.

Press Clear Menu to exit the Average menu.
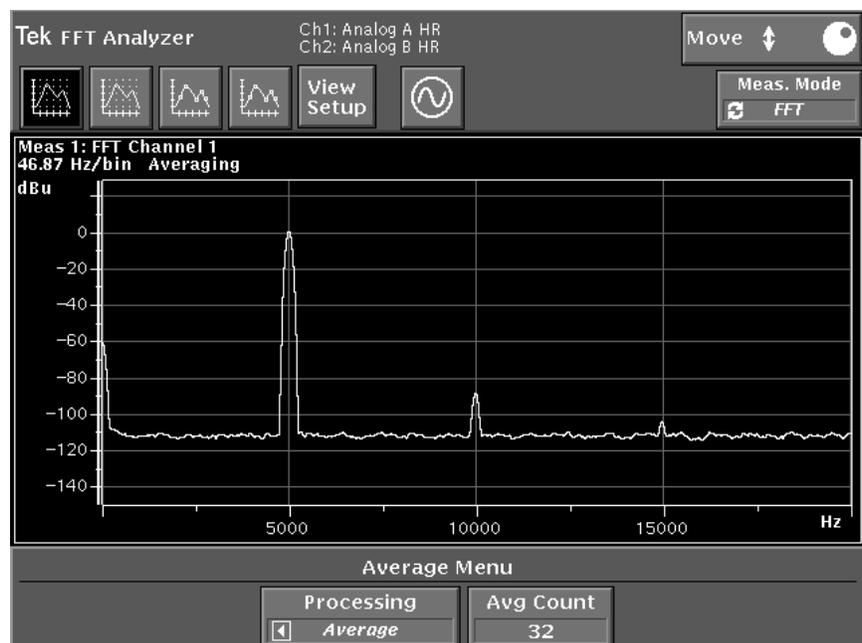
Figure 2-9: Average menu and FFT trace with averaging applied

Clear Menu   The Clear Menu button removes configuration screens, menus, and dialog boxes from the display when they are no longer needed.

Applications Buttons

The AM700 applications are introduced here. Refer to *Applications* beginning on page 4-1 for detailed information on each application. Operation of the generator is included in the applications information, followed by the Analyzer, FFT, Digital, Monitor, and Functions, in that order.

The buttons in the Applications area control, shown in Figure 2-10, provide access to AM700 measurement applications. You can start an application by pressing its button. You can also start applications by pressing the Other button, turning the knob to select an application, and touching the Run Application soft key. This means of accessing an application is also available for accessing diagnostics and the touch-panel calibration routine.


```
  ┌──────────┐ APPLICATIONS ┌──────────┐
  │                                      │
  │   Analyzer      Digital     Monitor  │
  │    ┌───┐        ┌───┐       ┌───┐    │
  │    └───┘        └───┘       └───┘    │
  │                                      │
  │     FFT          Other     ┌ User ┐  │
  │    ┌───┐        ┌───┐       ┌───┐    │
  │    └───┘        └───┘       └───┘    │
  │                                      │
  └──────────────────────────────────────┘
```
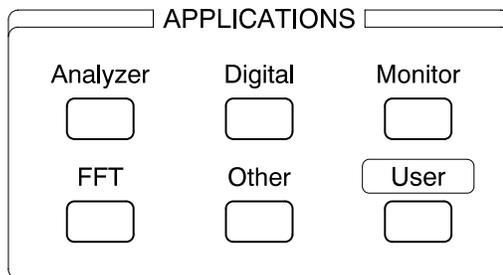
Figure 2-10: Applications buttons

NOTE. Press the Clear Menu button to exit the Select Application screen (displayed when you press the Other button) and cancel any changes you may have made.

Requesting a new application causes the AM700 to stop the current application and replace it with the new application.

Analyzer   The Audio Analyzer application accepts analog or digital audio input signals for analysis. This application makes the following measurements:

- Signal Level and Frequency

- Stereo Phase Difference

- Level Difference

- THD (total harmonic distortion)

- THD + N (total harmonic distortion plus noise)

- IMD (intermodulation distortion)

- Crosstalk + noise

- Channel separation

- Wow and Flutter

Refer to *Audio Analyzer* beginning on page 4-37 for more information.

Digital   The Digital Interface Tester application can be used to evaluate electrical and data characteristics of industry standard digital audio interfaces including AES/EBU, SPDIF (also known as consumer), and optical consumer.

The Digital Interface Tester makes the following measurements:

- Bit Activity

- Channel Status

- Eye Diagram

- Jitter Spectrum

Refer to *Digital Interface Tester* beginning on page 4-107 for more information.

Monitor   The Audio Monitor application displays applied audio signals in the style of a dual-trace digitizing oscilloscope presentation. You can make simple time-domain measurements on these displayed signals. Cursors are provided to aid amplitude and time measurements. Refer to *Audio Monitor* beginning on page 4-97 for more information.

FFT Analyzer   The FFT Analyzer has both FFT Measurement and Multitone Measurement applications.

FFT Measurements. The FFT Analyzer can display two channels simultaneously. These displays can either be on separate frequency and amplitude axes or overlaid onto the same frequency and amplitude axes. Using any combination of analog and digital inputs set up in the Configure menu, the FFT Analyzer produces displays of frequency domain data much like those of a spectrum analyzer. The span (bandwidth of the FFT display) can be zoomed (expanded or contracted horizontally) and panned (scrolled left or right through the display).

Multitone Measurements. The multitone mode of the FFT Analyzer uses short duration test signals composed of multiple tones spread across the audio spectrum to measure a wide variety of audio system parameters. Differences between known test signals and the acquired response from the system under test can be rapidly analyzed to determine frequency response, distortion and noise, and channel separation. Multitone measurements can be made on any combination of analog or digital input signals.

Refer to *FFT Analyzer* beginning on page 4-81 for further information.

Other   All applications including the diagnostics and touch screen calibration are accessible through the menu displayed when you press the Other button.

User   The User button has two actions, as indicated by the gold-outlined label. Press and quickly release the User button to run the application or function you have assigned to the User button. Press and hold the User button to display the User menu. This screen displays the available AM700 applications and functions. You can select one of these to be run when the User button is pressed.

To assign an application or function to the User button, touch the Show Applications or Show Functions soft key as appropriate to select an application or function. Turn the control knob to select the application or function you want to assign to the User button, touch the Set User soft key, and exit the screen by pressing the Clear Menu button. Now, when you press the User button, the assigned function or application will run.

Utilities Buttons

Utility buttons, shown in Figure 2-11, activate and control these support functions: Configure, Display, Storage, Copy, and Function.

```
┌─────────────────┐ UTILITIES ┌───────────┐
│                                          │
│   Configure      Display       Storage   │
│   ┌──────┐      ┌──────┐      ┌──────┐   │
│   └──────┘      └──────┘      └──────┘   │
│                                          │
│                 ┌ Copy ┐      Function   │
│   ┌──────┐      ┌──────┐      ┌──────┐   │
│   └──────┘      └──────┘      └──────┘   │
│                                          │
└──────────────────────────────────────────┘
```
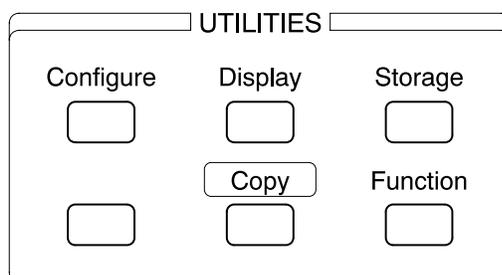
Figure 2-11: Utilities buttons

Configure   Pressing this button displays soft keys that provide access to various system configuration menus. Refer to *AM700 Setup for Operation* beginning on page 3-1 for more information on the configure choices.

Quick Setup. Touch this soft key to display a menu of template selections. These selections save time by providing one-touch instrument configuration for some common AM700 measurements. Refer to *Quick Setup* on page 3-22 for information on the quick setup templates and the measurements that are available with the quick setups.

Input Selection. Touch this soft key to display the Input Configuration menu. From this menu you can select the type of input and front panel connection, input impedance and whether the instrument is to auto range on the input signal, and the type of signal source that is applied to the input channels.

Measurement Setup. Touch this soft key to display the Measurement Configuration menu. From this display other soft keys display various measurement configuration options in various categories. The contents of the menus are application specific and change by application.

System Setup. Touch this soft key to display the System Setup menu. Soft keys in this display allow you to set the date and time, configure the serial and GPIB communications parameters, select copy format and destination for display captures, activate calibration, and specify the external input and output resistance values to be used for units conversions between volts, dBu, and dBm, and to specify the conversion factor to dBFS.

View Setup. Touch this soft key to display the View Setup menu. Here is where you select the measurements to be displayed and the type of view in which the selected measurement is displayed. In this menu you can also touch the View Options soft key to display a menu where you can configure the type of display axes and waveform, whether cursors are enabled (turned on or not), and whether the cursors will be constrained to the trace data (Snap to Data) or will permitted to be positioned anywhere in the display window.

System Status. Touch this soft key to display a summary of the AM700 system configuration selections as seen in Figure 2-12 on page 2-19. This display is useful for quickly determining what measurement the views in the running application are set up to display, how the trace data is displayed (interpolator, point plot, or tabular), the measurement channel input selection, and the generator signal type choices for the analog and digital generators.

State Saving. This selection provides two choices: one saves the present state of instrument settings that can be saved, and the other restores the factory default settings. If you want to save a particular setup state for an application, it should be done immediately before turning off the AM700. Settings for many of the controls are saved each time an application is changed. Any settings that are saved when State Save is used are overwritten if further changes are made and another application is started prior to power off. State Save does not return the application that was running at power off when power is again turned on, but the user selections for an application that were saved will be restored.

Also, refer to the *Save AM700 State* function discussion on page 4-136. The Save AM700 State function generates new functions that store customized application setups. These application setup functions are then used in making repetitive tests and for building a standardized set of application setups that can be transferred to other AM700 Audio Measurement Sets.
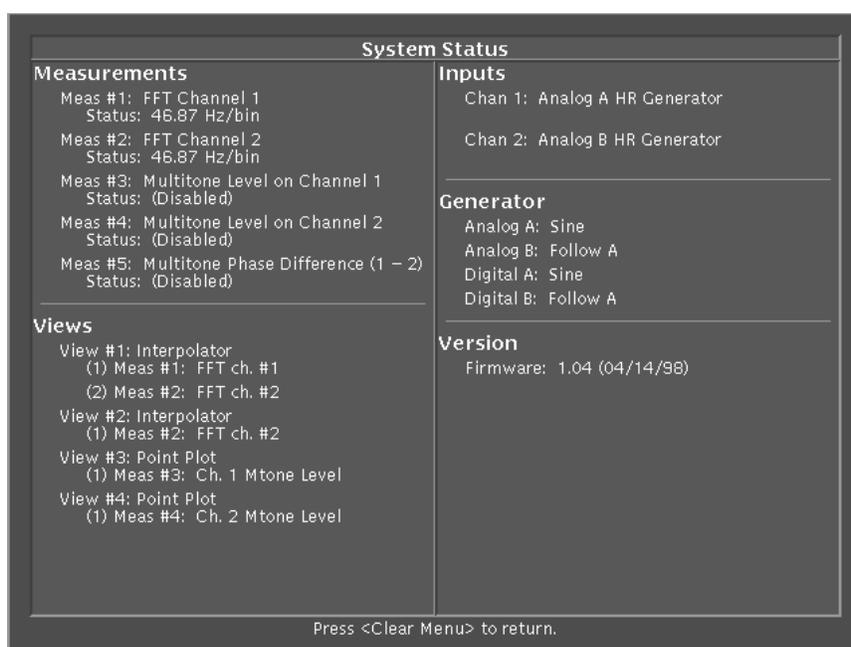
Figure 2-12: System Status display

Display   When the Display button is pressed and held, the large control knob adjusts the display intensity. Display intensity values range from about 10% for full dim to 100% for full brightness. The power on default setting for display intensity is 90%. When the display brightness is reduced to 40% or lower, pressing the Display button immediately sets the brightness to 90%.

Storage   Files can be transferred between the DOS system (floppy-disk drive) and the memory system of the AM700. In the AM700, the files are those stored in ROM at the time of shipment and those that are user created and stored in NVRAM.

File transfers and moving through the directories is done using the Storage Manager control screen that is called up when the front-panel Storage button is pressed (see Figure 2-13). This feature is of primary importance for using the Function application as it is currently implemented and in the creation of other user files.

Function files and user files written on an external PC can be downloaded to the appropriate NVRAM directory for use.

The Storage Manager detects the presence of a floppy disk in the disk drive. If file names from the dos: directory are being displayed when the disk is removed, another directory list (either rom: or nvram:) is displayed instead.

Renaming a File. When you want to rename a file, select that file and touch the Rename soft key. This presents a keyboard used to type in the new file name as shown in Figure 2-14. The keyboard is presented in any of the file browsers that require or permit a file name change or addition of a file to the directory, as when a hard copy output file needs to be named. An AT-compatible external keyboard can also be used for this purpose.
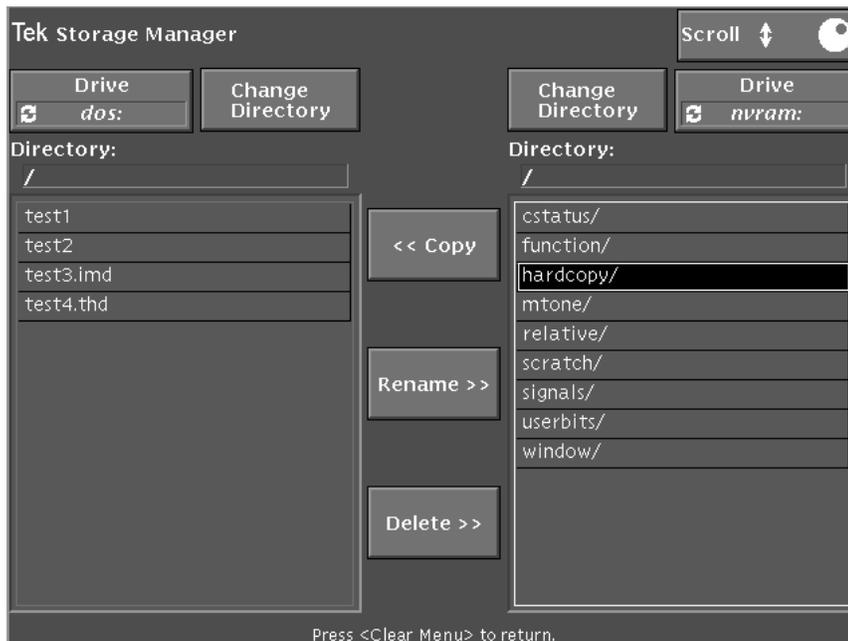
Figure 2-13: Storage Manager control screen

Figure 2-14: File renaming keyboard

Copy   Pressing the Copy button sends a copy of the display in the selected format to the print spooler (temporary memory space) where it is queued for printing. The LED in the Copy button flashes as long as the copy remains in the spooler.

To select the output format for a copy, you must use the menu selections for Copy found in the Configure menu under System Setup. Refer to *System Copy* on page 3-13 for information on setting up the Copy choices.

NOTE. Pressing and holding the Copy button immediately brings up the Configure menu, with the System Setup choices for Copy displayed. This is the same screen that is displayed by pressing the Configure button, and touching the System Setup soft key.

Function   Functions are pre-programmed routines residing in AM700 memory. Refer to the AM700 Programmer manual and *Function Operation* beginning on page 4-129 for further information on programming functions.

Running a Function. You can run stored functions from the front panel using menu choices selected with the Function button.

1. Press the Function button to display the menu of available functions.

2. Touch the screen at the function name or turn the large control knob to scroll to the function you wish to run. All available function files from rom:/function and nvram:/function directories are listed.

3. Touch the Run Function soft key to start the function running. If the function is not self terminating you can use the Stop Function soft key to halt the function in progress. When a function runs repetitively, the number of times that it has run appears in the Running column. Multiple functions can be running at the same time as long as they are not mutually exclusive operations, such as one function trying to run FFT multitone operations and another function trying to make Digital Interface Tester applications measurements.

Creating a Function. A function can be created externally and loaded either through the GPIB interface or the floppy disk drive as an executable file of SCPI commands. Once loaded, the file of SCPI commands can be used to run the function programmed. That function is identified by its DOS file name, so a descriptive name (label) for the file is helpful for selecting it from the Function list. Refer to *Function Operation* beginning on page 4-129 for a more complete description of the Function feature.

Control Knob and Display Control Buttons

Control Knob   The control knob, shown in Figure 2-15, lets you perform positioning, selection, or expansion. Control knob operation depends on the current instrument operating mode, and its functions are described as a part of instrument operations.
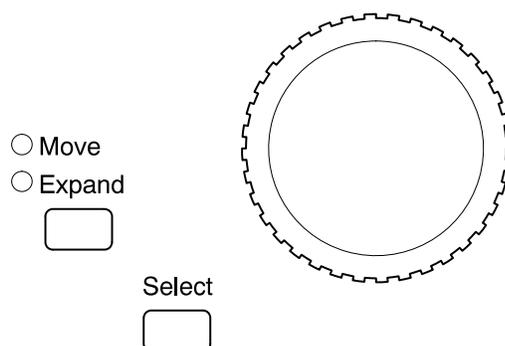
Figure 2-15: Control knob and display control buttons

The general operation of this knob is to permit continuously variable positioning or selection when user selections are active. An active user selection includes choosing menus, positioning the cursor or waveform, and expanding the display.

Move/ Expand   The Move and Expand button selects the action of the control knob in positioning or zooming the waveform display.

Waveform Expansion and Positioning. When the control knob is assigned to waveform operation, turning the control knob affects display horizontal or vertical movement or expansion. The axis (x or y) that is active gets the focus of the control knob, and the action of the knob depends on whether Move or Expand is selected. You can use the Move/Expand front-panel button to select the action. Small LED indicators next to the Move and Expand labels show the selected action.

Touch and Zoom. You can select the expansion point by touching the screen where you want it to expand. This is the Touch and Zoom feature. In this case, the selected (highlighted) axis is assumed to be the expansion axis. You can use the Select front-panel button to switch between the axes. The expansion point is marked by a small arrow on the graticule scale of the axis that will expand or contract when you turn the control knob.

In Move mode, expansion or contraction is around the touched point while you touch the screen, but reverts to the display center and back to Move (positioning either horizontal or vertical) when you lift your finger from the screen. Vertical or horizontal positioning in Move mode is selected either by touching the scale of the axis you wish to position or you can use the Select button to choose.

In Expand mode, the normal expansion (horizontal or vertical, depending on your selection) is around the display center. If you touch the display on the horizontal scale, the x-axis (horizontal) is assumed to be the expansion axis. If you touch the display on the vertical scale, the expansion point is assumed to be the y-axis (vertical). When cursors are displayed, and one is active, the horizontal expansion point is around the active cursor when Expand is selected.

Select   The Select button works with the keypad and the control knob. In some cases, such as the Generator Status display, you can use the Select button to activate an edit field for making changes. (The keypad can be used to enter numbers directly into a field editor menu selection after it is highlighted.)

When working with the Move/Expand feature, the Select button is used to switch between horizontal or vertical axis actions (you can also use the touch screen to specify axis selections). Another use of the Select button is to select which trace is the front trace in a dual-trace display in those applications that permit dual-trace displays. The front trace in a dual-trace display is the brighter one, and cursor readouts apply to that trace. To switch the traces, touch the dimmer trace vertical scale and press the Select button. This makes the alternate trace the front trace, and switches the cursor readouts to apply to that trace. The effects of the Average button are also switched between traces using this method for selecting the front trace.

Generator Control Knobs and Buttons

The Amplitude and Frequency knobs shown in Figure 2-16 provide easy access for controlling the generator, regardless of the state of the instrument or current control function of the general purpose knob.
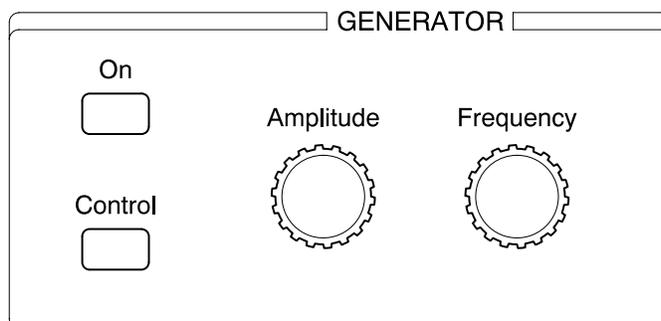
Figure 2-16: Audio Generator controls

Amplitude and Frequency Knobs The Amplitude and Frequency knobs are both assigned to one generator output at a time or, when the generators are set to Follow, the knobs also affect all following generators. Follow mode is discussed in the *Audio Generator* application on page 4-5. For the assigned generator, rotating a knob adjusts the signal amplitude or frequency as appropriate. These knobs are used to quickly adjust the amplitude and frequency of the generator which has the knobs assigned.

NOTE. Do not adjust the amplitude or frequency knob when sweeping. The knobs are not locked out and will still make adjustments. Alternately, assign the knobs to an unused generator to prevent accidental changes to a sweep signal.

On Pressing this button toggles the analog and digital audio generators on and off. When a sweep is run, the generator will be turned on if it was not. At the end of the sweep, the generators will remain on at the last frequency and amplitude setting in the sweep signal.

Control   Press this button to display the Generator Control menu (see Figure 2-17).

Refer to *Audio Generator* on page 4-1 for complete details on the Generator Control panel.
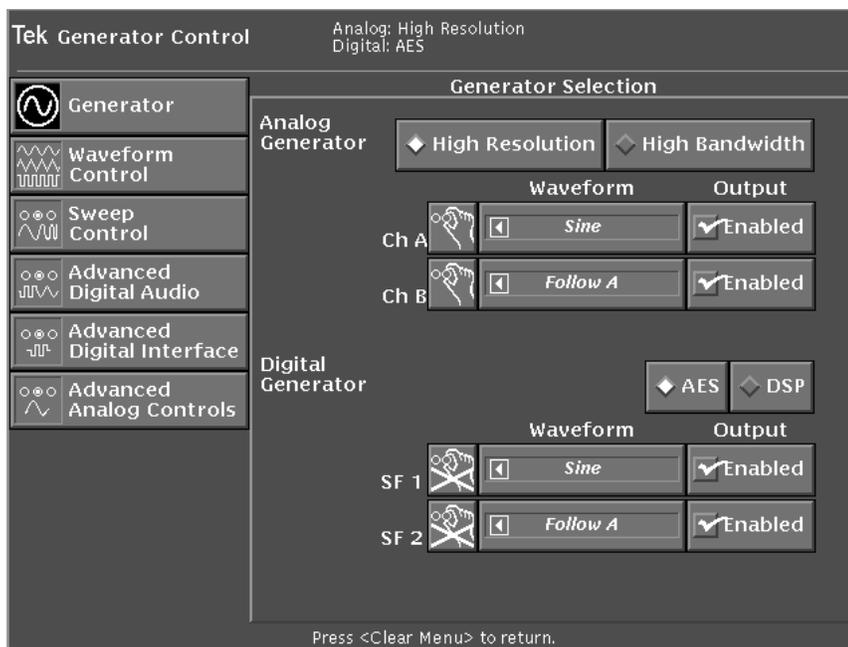
Figure 2-17: The Generator Control panel

Audio Control Knob, Button, and Headphones
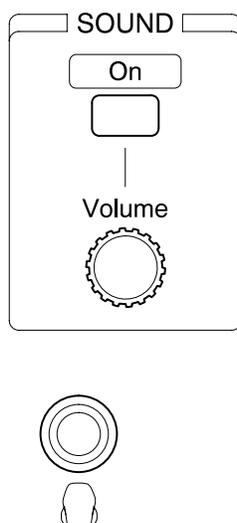
Figure 2-18: Headphone audio controls

On Button
Pressing and releasing the On button turns sound on to the headphones. When Sound is on, the AM700 stops making measurements.

Pressing and holding the On button displays the Sound source menu where you can select either Digital or Analog as the source to listen to with the headphones.

Volume Knob
The Volume control knob adjust the sound level at the headphone jack. Full volume supplies a minimum of 20 mW to the headphones.

Headphone Jack (1/4 inch Stereo)
When sound is on, signals that produce audio are available for listening at this standard stereo connector. Turning the volume control adjusts the sound level.

Headphone impedances of 8 to 2000 Ohms can be used (a low-valued series resistance prevents overloading if low-impedance headphones are used).

Sweep / Run Button

○ Sweep/Run

Figure 2-19: Sweep/Run button and LED indicator

Sweeps   When you press the Sweep/Run button or when the AM700 receives a remote Start trigger event, the generator turns on (if it was not already on), and all applicable sweeps are started. Set the sweep count number to make a selected number of sweeps or set the sweep count number to 0 to run the sweep continually. At the end of the set number of sweeps for all enabled sweeps, the generator stops sweeping. While sweeps are occurring, an LED indicator next to the Sweep/Run button will be on.

You can press the Sweep/Run button a second time to turn off the sweep. To disable a generator sweep for unused channels, turn off the generator output enable in the Generator Control panel for the those outputs.

Refer to *Sweep Control* on page 4-19 in the Audio Generator application for information on creating a sweep list or file, and other sweep capabilities of the AM700.

Keypad Entry Buttons
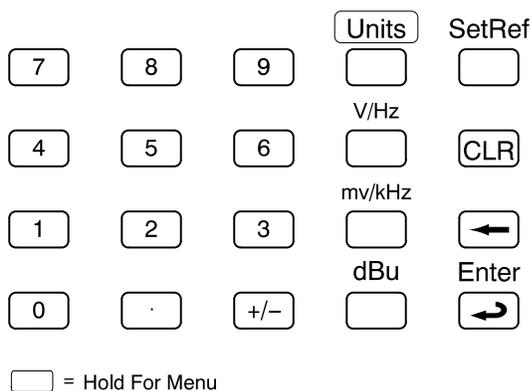
Figure 2-20: Keypad entry buttons

The keypad is used to make numerical input to the menus, set units on readouts and graphical display axes, and in setting a reference. When numerical values are selected for editing, numbers can be entered directly using the number keys and the Enter key. The number in the field being editing is erased as the first keypad number is pressed. When the field has the number you want, press the Enter key to make the entry into the field take effect. The field being edited then becomes unselected.

In the keypad, the ⬅ (backspace) key is the only key that auto-repeats if you hold it down.

Units Key   When a measurement readout that specifies units is displayed and selected, you can select the units used to display information. Touch the measurement readout that you want to set new units for to enable editing of the units type for that readout.

Press and hold the Units button to display the pop-up menu where you can choose the alternate units. Only those units permitted for the enabled choice are displayed in the menu. Pressing and releasing the Units button toggles through the available choices, or you can use the large control knob to scroll the list of choices in the pop-up menu.

When you have selected the unit you want used for a readout, touch the select button or, if a pop-up menu is displayed, touch the menu to make the selection. In the column beneath the Units button are units choices for the more common selections. These buttons can be used to select V, Hz, mV, kHz, or dBu directly. Additional choices are available in the pop-up menu. The numerical value of the measurement also changes to reflect the selected units.

You can change the units assigned to the graticule display axes by touching the axis you want to change and pressing and holding the Units key to bring up the pop up menu for selections. Make the units selection for the axis as just described for the measurement readouts.

Set Ref Key
When a measurement has been made, you can select it as a reference against which following measurements can be checked. Pressing the Set Ref front-panel button sets the current measurement as the reference and saves it in memory for later use. A reference file can also be saved to a floppy disk for permanent storage and future use when needed for comparison.

In the numerical fields, you can set a current setting to be a reference value. Select the field you want to make a reference, set the number you want to be the reference value, then press the Set Ref key. The new value in the numerical field now indicates the difference between the reference setting number and the value in the field as it changes. For example, in the Real-Time readout of Ch1 Level in the Audio Analyzer application, select the Level readout by touching it or activate the RT window by touching it. Then, use the Select button to highlight the Ch 1 Level readout. Now press Set Ref. The new value seen is in dBr, delta V, or delta mV, depending on the units of the readout at the time it was set to a reference. The numerical value shows the difference between the reference level and the new level as the level of the input signal changes.

Front Panel Lock and Unlock
You can lock the front panel controls and touch screen by using the FP_LOCK selection in the Functions menu or via the remote control interface. To unlock the front panel, press the Enter key on the front panel.

Front-Panel Signal Connectors
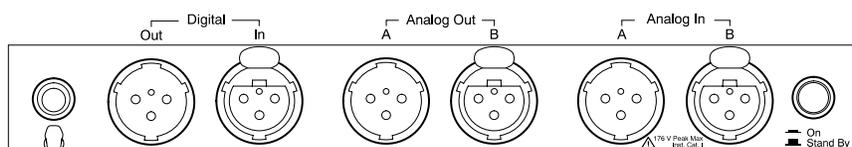
Figure 2-21: Front-panel signal connectors

Specifications for the input and output connectors and signals are found in *Appendix A*, *Specifications*. Pin outs for the Analog XLR connectors are shown in Figure 2-22.

Analog Out   The internal analog generator output signals are present on these XLR connectors when the generator is active. The Channel A and Channel B outputs are independently buffered and can be independently enabled. They can also have the same amplitude and frequency or, in high-resolution mode, they can have different frequency, amplitude, or even different signal-type outputs.
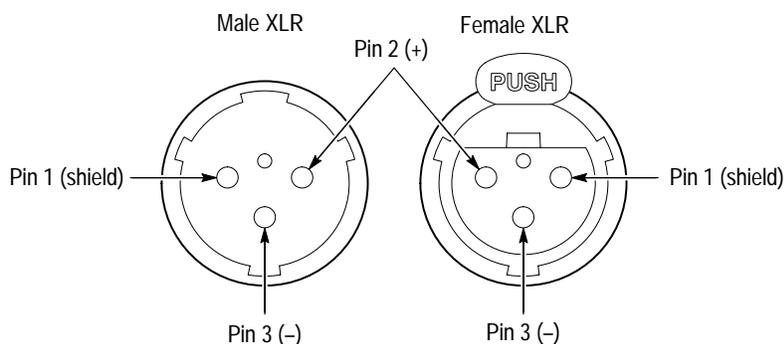
Figure 2-22: Analog XLR connector pin outs

Driving Unbalanced Loads. While the AM700 generator is designed to drive balanced loads, the outputs can be used, in some applications, to drive unbalanced or

single-ended loads. The generator output level driving an unbalanced load will be half of the indicated value (6 dB less), and the source resistance will be half the selected output impedance value. For example, if the selected output impedance of the generator is 10 Ω, the single-ended output source impedance is 5 Ω nominal.

The proper output connections for driving an unbalanced load are made using pin 2 (the + output) as the hot lead and pin 1 (shield) as the common lead as shown in Figure 2-23. No connections should be made to Pin 3 (the – output).

NOTE. If pin 3 of the XLR analog generator output connector is connected to common, internal circuitry will current limit, but no damage will result. If pin 2 is connected to common, the – signal at pin 3 will be reduced or muted, especially if the 10 Ω source resistance is selected. There is no need to connect pin 3 when driving an unbalanced load with the AM700.
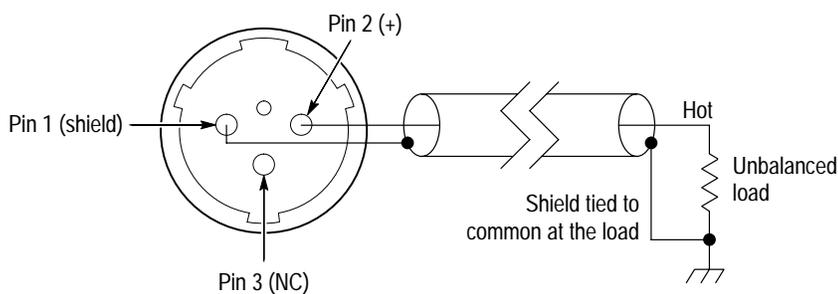
Figure 2-23: Driving an unbalanced load with the AM700 generator

Configurations using unbalanced loads are more susceptible to ground loops. The best method for driving an unbalanced load is to use the floating ground feature of the generator. With floating ground selected, the analog output of the generator can be grounded at the load end of a signal cable, thereby reducing the effects of any ground-loop currents. The best practice in all cases is to use the same power source for the AM700 and the device under test, whether using balanced or unbalanced signal connections.

NOTE. The floating common is shared by both analog generator outputs. If the loads on the two generator outputs are at different potentials, ground currents can still flow, regardless of the AM700 connections.

Analog In Channel A and Channel B are the input connectors for balanced analog audio signals. For polarity test purposes, the AM700 follows the AES standard (AES14-1992) that pin 2 is +, pin 3 is –, and pin 1 is common. The analog inputs are balanced, differential inputs. The common is connected to ground and cannot be floated. It is common practice to float the generator common if it is determined that the measurement needs to float to reduce ground loops.

Using Single-Ended Inputs. To help reduce pickup of extraneous noise, it is best to connect pin 3 (– input) to pin 1 (common) when using single-ended inputs. The input impedance is reduced from 200 kΩ to 100 kΩ (the 600 Ω and 150 Ω terminations remain accurate within an added 0.3%, and the accuracy of the measured signal amplitude remains within the specified measurement accuracy of the AM700.

Digital Inputs and Outputs These XLR connectors provide connection for AES/EBU balanced digital audio signals. Digital Out is the output connector for the digital signal from the internal generator. Digital In is the input connector for digital audio signals.

Floppy Disk Drive

The 3.5-inch, 1.44-Meg floppy disk drive (shown in Figure 2-24) provides a means to transfer DOS-formatted files into and out of the AM700 file system. The disk drive is the dos: directory when using a File Browser or the Storage Manager control screen. Firmware upgrades are also done through the disk drive.
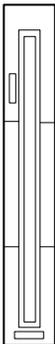
Figure 2-24: Disk drive

NOTE. The AM700 requires a preformatted disk (DOS 1.44 megabytes).

Rear-Panel Signal Connectors and Controls

The rear panel of the AM700 is shown in Figure 2-25 to show the location of all the controls and connectors. A description of each control and connector follows.
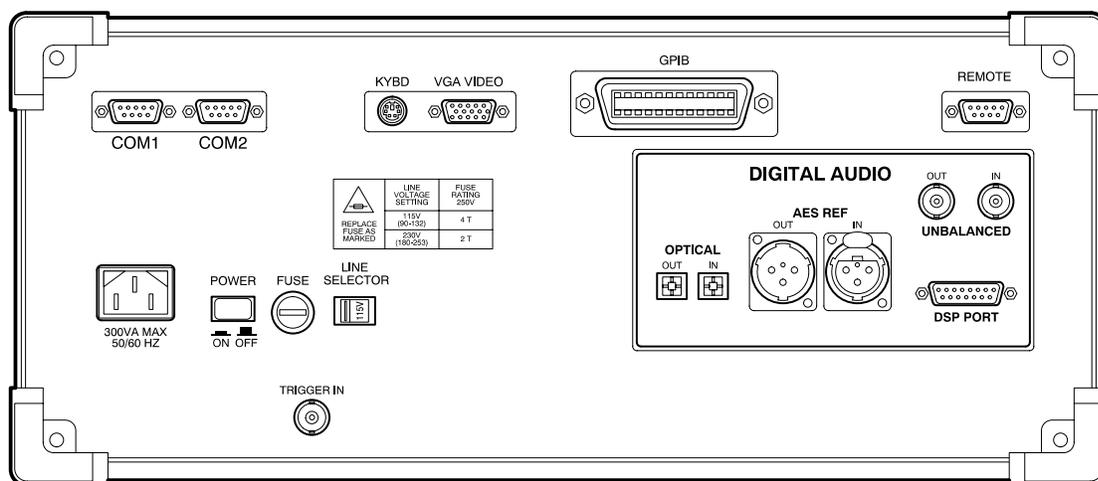
Figure 2-25: AM700 rear panel

Mains Connector

A detachable three-wire power cord with a three-contact plug is provided with each instrument for connecting to both the power source and protective ground. The protective-ground connector in the plug connects (through the protective-ground conductor) to the accessible metal parts. For electrical-shock protection, insert this plug only into a power-source outlet that has a properly grounded protective-ground contact.

Instruments are shipped with the power cord most appropriate for the country of destination. Available power-cord option information is given in Table 1-1, Optional Power Cords, on page 1-7. Contact your Tektronix representative or local Tektronix field office for additional power-cord information.

Power Switch, Fuse, and Trigger — These rear-panel power controls, shown in Figure 2-26, include the mains ON/OFF push button switch, the Line Selector switch for 115 or 230 VAC operation, the mains fuse holder, and the external trigger input connector.

REPLACE FUSE AS MARKED	LINE VOLTAGE SETTING	FUSE RATING 250V
	115V (90-132)	4 T
	230V (180-253)	2 T

300VA MAX 50/60 HZ   POWER ON OFF   FUSE   LINE SELECTOR 115V
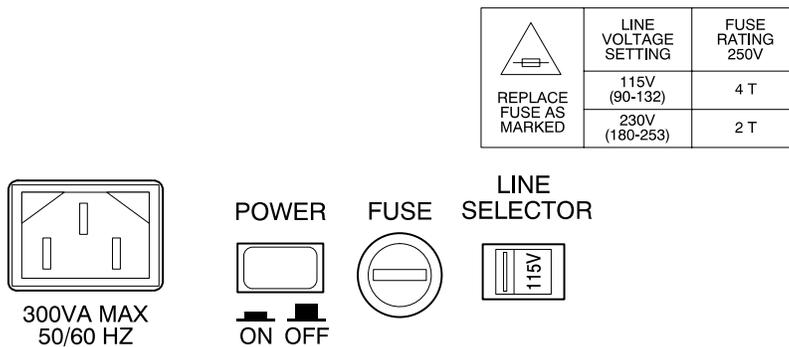
Figure 2-26: Mains connector, power switch, fuse, and line selector

ON/OFF Push Button. The AM700 main power switch is on the rear panel. It is a push-push switch (push on, push off) that is on when latched in. The front panel Power switch must also be on for the AM700 to power up.

WARNING. Dangerous voltages are present within the power supply when the rear-panel power switch is on, regardless of the position of the front-panel power switch. Do not operate the AM700 with any covers removed. Refer all servicing of the instrument to a qualified service person.

Line Selector (115/230). The Line Selector switch must be set to the proper mains voltage before the AM700 is connected. The AM700 is shipped from the factory set for the operating voltage of the destination country (115 V or 230 V). If the setting is not correct, it must be changed before connecting the power cord to the mains voltage. When switching to a different range, the fuse must also be changed to provide the protection needed for the selected operating voltage. At each nominal voltage setting (115 or 230), the power supply operates over a range of voltage. The 115 V range is 90 VAC to 132 VAC, and the 230 V range is 180 VAC to 253 VAC. In either range, the power supply operates from 50 Hz or 60 Hz mains.

⚠️ **CAUTION.** *When changing the line voltage selector switch, to prevent damage to the AM700 you must also change the fuse to provide proper protection for the operating voltage in use.*

Fuse. The mains fuse provides protection in the event of a major failure of the AM700 power supply. Two sizes of fuses are specified, one for 115 VAC operation and the other for 230 VAC operation. Refer to the *Fuse Rating* specifications on page A-27 in *Appendix A* for fuse ratings.

Analog Trigger Input. The analog trigger BNC input, shown in Figure 2-27, is for application of a TTL-level trigger signal for use with the Audio Monitor application. Other sources for the trigger signal are the signals applied to the Channel 1 or Channel 2 measurement channels. You can specify the trigger source selection in the Audio Monitor menu when the Audio Monitor application is active.

TRIGGER IN

Figure 2-27: Analog TTL-level trigger input connector

Input/ Output Ports
The input/output ports of the AM700 are used for printer support, remote control, driving an external VGA monitor, input of commands from a keyboard, and the digital signal interface.

COM1 and COM2. These unidirectional serial RS-232C DTE ports with DB-9 connectors, shown in Figure 2-28, allow serial printers or plotters to be connected. Refer to the *AM700 Programmer Manual* for information about operating with printers or plotters on the serial communications ports. The conventional choices of baud rate, stop bits, parity, and hardware or software handshaking for RS-232 serial communications are provided.

COM1   COM2
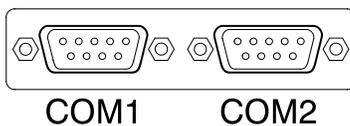
Figure 2-28: COM1 and COM2 serial ports

KYBD (Keyboard). An optional, PS/2, AT-compatible keyboard with a mini DIN connector can be attached to the KYBD connector shown in Figure 2-29. The keyboard is active whenever a parameter change or qwerty keyboard entry is expected. Using the external keyboard to make directory and file name entries makes navigating the file system faster, but one is not necessary for any AM700 operation.
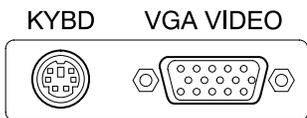
KYBD   VGA VIDEO

Figure 2-29: Keyboard and VGA video connectors

VGA Video. The output of the VGA Video connector permits viewing the AM700 display on a VGA monitor. The connector provides drive signals for an external color display of the AM700 screen. Refer to *VGA Output* on page A-23 of Appendix A for VGA connector pin outs and signal information.

GPIB. The GPIB connector, shown in Figure 2-30, allows the AM700 to be operated using a remote GPIB controller. The GPIB port can also be used to send hard copy data to a GPIB printer or plotter. It meets all the electrical specifications for a standard GPIB connector as described in IEEE-488.
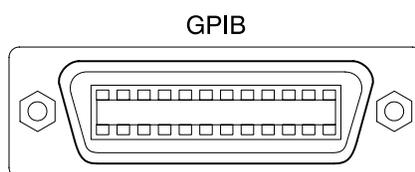
GPIB

Figure 2-30: GPIB connector

Refer to the *AM700 Programmer Manual* for information on operating with remote control.

Remote Connector. This DB9 connector, shown in Figure 2-31, provides a user interface for contact-closure remote control. Its switching actions must be defined in a function to be useful for controlling the actions of the AM700. Refer to *Rear Panel Hardware* on page A-26 in Appendix A for pin-out information.
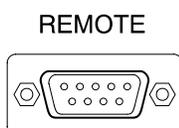
REMOTE

Figure 2-31: Remote contact-closure connector

Digital Input/ Output Connectors
The Digital Input/Output connectors, shown in Figure 2-32, include the optical in and out ports for fiber optics applications, the AES REF XLR in and out connectors, the two BNC unbalanced in and out connectors, and the DSP Port connector for input and output directly to and from the DSP (digital signal processor).

Optical IN, OUT. Digital audio signals on an optical fiber cable can be connected to the TOSLINK™ IN fiber optic connector to be measured. The AM700 digital audio generator output is available for application to an optical fiber cable at the OUT optical connector. The IN connector is selectable to provide the digital signal input; the OUT connector provides an output signal whenever the AES digital generator is supplying a signal.
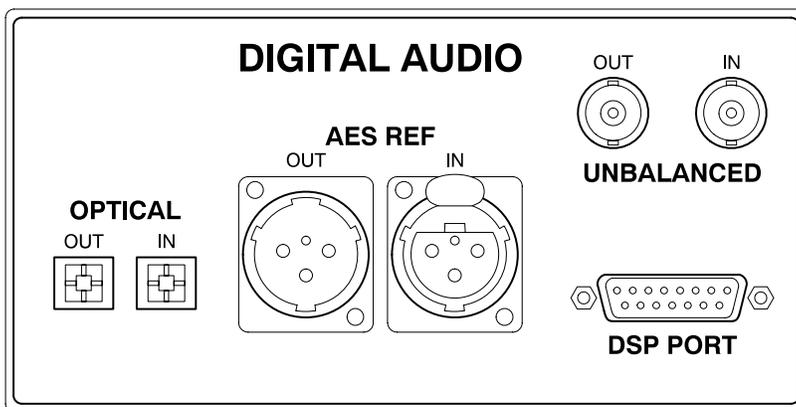
Figure 2-32: Digital audio connectors

AES REF IN, OUT. These connectors meet the AES standard for AES/EBU digital audio (AES11-1991) signals. The AES REF OUT signal is locked to the AES REF IN signal in From Ref mode. This permits you to connect to your reference signal for the sample clock and provides an output that you can connect to a device under test. When the AM700 is used in stand-alone measurements, the AES REF OUT connector can be used to provide the sample clock to the device under test when it needs an external reference.

NOTE. In order to meet radiated EMI regulations, the cable connected to the rear panel AES REF OUT must be wired with the cable shield connected to both pin 1 and to the shell of the female XLR connector (sometimes labeled G within the connector). Both of these connections should be as short as possible, less than 0.25 inch (0.635 cm).

Unbalanced IN, OUT. These BNC connectors provide the same signal connections as the front-panel Digital XLR connectors, but unbalanced, as an alternative to the balanced XLR front-panel connectors. The IN connector is selectable to provide the digital signal input; the OUT connector provides an output signal whenever the AES digital generator is supplying a signal.

DSP Port. You can connect a compatible digital microphone or other compatible digital signal source directly to the DSP for processing through the DSP Port connector (pinout shown in Figure 2-33). When the AM700 generator and input are set to DSP, the external device on the DSP port supplies the Bit Clock, Frame Clock, and Receive Data. When sending data, the AM700 supplies Transmit Data that is synchronized with Bit and Frame Clocks of the external device. Rate 0, Rate 1, Rate 2, Flag 0, and Flag 1 are reserved for future use. The DSP port timing diagram is shown in Figure 2-34.

The external device connected to the DSP port determines the sampling rate. The sampling rate to the AM700 must be no greater than 48 kHz. Also, the generator audio sample rate must match the incoming sample rate with the Interface Clock Frequency control set to Audio Sample Rate. Applications will yield correct measurement values only if the sample rate of the DSP input signal is 32 MHz, 44.1 MHz, or 48 MHz, and the AM700 is set to match. The incoming signal must also have a 16-bit audio word in order to be correctly acquired by the hardware.

A valid signal must be applied to the DSP port when selecting the DSP input. If not, the AM700 halts in the waiting-for-clock mode. Bit and Frame Clocks must always be clean, with no extra transitions, while the AM700 is in DSP mode. If extra transitions occur, the clock register can overflow and halt operation of the digital audio board. If this occurs, the AM700 must be powered off and back on to clear the register on the digital audio board. For this reason, the AM700 should be set to AES mode when switching the sample rate of any external device attached to the DSP port. The maximum input voltage for the DSP port is –0.5 V to +5.5 V. For good noise immunity, the rise and fall time of the transitions should be less than 100 ns.

NOTE. The DSP generator must be selected to permit the DSP to acquire input from the DSP port.
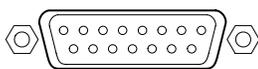
DSP PORT

DB-15 female connector

Pin 1	Bit Clock	Pin 9	Chassis ground
Pin 2	Receive Data	Pin 10	Chassis ground
Pin 3	Transmit Data	Pin 11	Chassis ground
Pin 4	Rate 2	Pin 12	Frame Sync
Pin 5	Rate 1	Pin 13	Flag 1
Pin 6	Rate 0	Pin 14	Flag 0
Pin 7	+12 V	Pin 15	Chassis ground
Pin 8	−12 V		

Figure 2-33: Digital signal processor port connector

NOTE. To meet radiated EMI regulations, the cable connected to the DSP port must be well shielded, and the connector housing must be conductive. The cable shield must be clamped by the housing where the cable enters the connector.
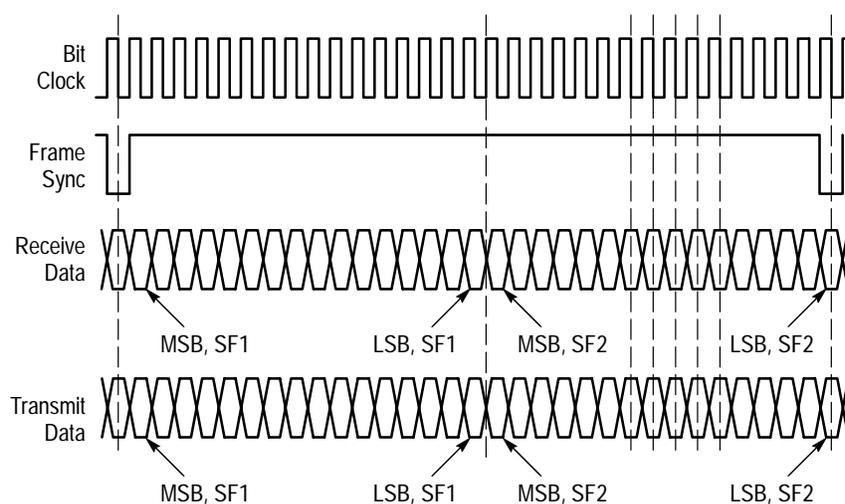
Note: All Data is sampled on the falling edge of Bit Clock.

Receive Data and Frame setup time
before falling Bit Clock edge = 25 ns

Receive Data and Frame Sync hold time
before falling Bit Clock edge = 40 ns

Signal level –0.5 V to +5.5 V
Rise and fall time < 100 ns

Max sample rate = 48 kHz
Data bits = 16

Figure 2-34: DSP port timing diagram

Configuring the AM700

Configuring the AM700

This section is a general discussion of how you set up the AM700 Audio Measurement Set.

AM700 Setup for Operation

Turn the AM700 on. Unless otherwise directed, it loads and runs the FFT Analyzer application. After the FFT Analyzer application begins running, you can select any other application you wish to use. The choices are shown in Figure 3-1.

You can start an application other than FFT by pressing and holding in the front-panel button for the application you want to start. The AM700 will beep twice, and you can then release the application front-panel button. To run the power-up diagnostics, press and hold in the front-panel Limits button as you press the front-panel power button. The AM700 beeps twice, displays the message 'Start mode "RUN DIAGNOSTICS" recognized,' then runs the diagnostics before initialization.
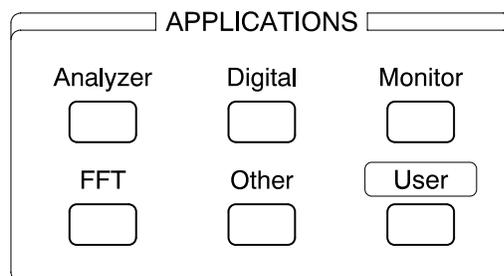
Figure 3-1: Applications selection buttons

Configuration

Press the Configuration button, shown in Figure 3-2, to display the Configuration options menu. There are seven selection choices displayed in the Configuration menu shown in Figure 3-3. Refer to *Configure* on page 2-17 for a summary of each of the Configuration options.
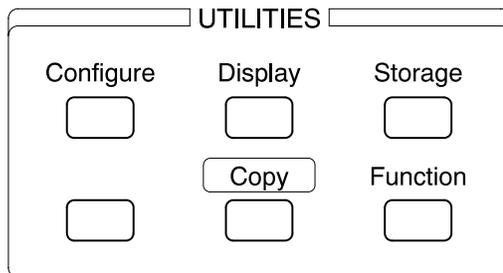
Figure 3-2: Configure button in the Utilities selection block

Input Selection
From the Configure screen, first select Input Selection. In here are the choices you need to make for input connector selection for the digital and analog signals, the input impedance and gain range of the analog inputs, and the signal selections to apply to the two measurement channels of the AM700. Alternately, you may want to select a Quick Setup. In the Quick Setup choices there are setup templates for often-used measurements. A list of those templates is given Table 3-1 in the *Quick Setup* discussion beginning on page 3-22.

The Input Selection block diagram shown in Figure 3-4 on page 3-4 graphically shows the input section of the AM700. Touch screen selections allow you to choose a wide variety of signal sources and paths.
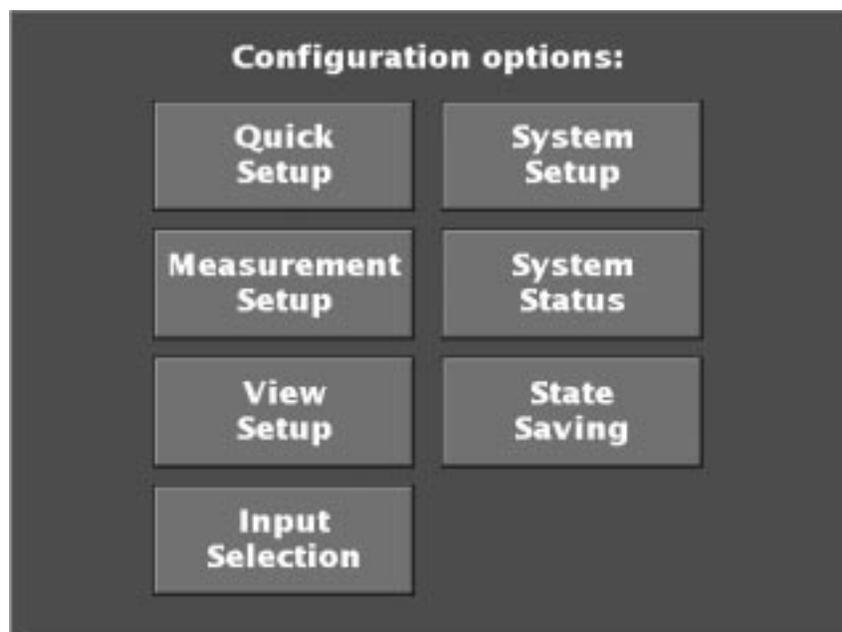
Figure 3-3: Configuration menu initial selection screen

Analog Input Connections. Touch the select soft key associated with the Analog A and Analog B input connections to toggle between the front-panel XLR connector and the internal Generator routing. The front-panel XLR inputs are the default choice for signal input to the AM700.

Input Impedance. Analog Input Impedance is selected from a three-choice pull-down menu. The choices are 150 Ω , 600 Ω , and 200 kΩ (high). The 200 kΩ choice is the default selection. Perform the following steps to change input impedance:

1. Touch the Impedance soft key to display the pull-down menu choices.

2. Rotate the large control knob to select the proper choice for your measurement.

3. Touch the Impedance soft key a second time to make the assignment and clear the menu.

The Input Impedance choice is not available for an internally connected generator.

Input Range and Auto. The gain range for the analog inputs defaults to Auto enabled to provide auto ranging on the applied signal. This avoids possible overloading of the A/D converters and is the recommended setting for normal operation. When you know the amplitude of the signal being measured, you can choose to make a manual gain setting. Follow these steps when changing the input range setting:

1. Turn off the Auto enabling (check goes away) by touching the Auto soft key.

2. Make the new gain range setting by either rotating the large control knob to the new setting and again touching the soft key or make a direct keypad entry of the new number and press enter.
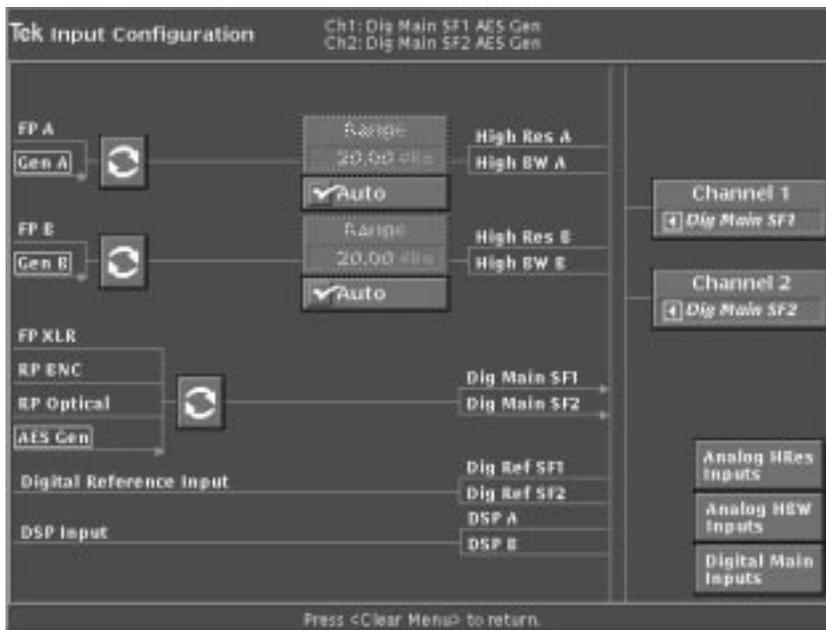
Figure 3-4: Input Configuration control panel

The gain ranges of the AM700 have fixed upper limits for each step; therefore, when a number is entered that is not exactly one of the available range numbers, the gain switches to the next highest valid setting above the number you entered.

Input gain range settings are also available as menu choices from within the applications that make measurements on analog signals. From within a running application, you can make the change and observe the effects on the signal.

Digital Input Connector Selection. The Digital Main Input connector selection choices are: Front-panel XLR connector (the most common selection and made by default), the Rear-panel BNC, and the Rear-panel Optical connector. An internal connection to the AES generator is also available. Touching the selection soft key associated with the digital generator choices advances the selection box through the list.

Measurement Channel Assignment. A pull-down menu (see Figure 3-5) is used to individually assign the signal to the two measurement channels of the AM700. The same input signals choices are available for both Channel 1 and Channel 2, and the channels can have the same signal applied to each as well. If you want both inputs to be obtained from the same type of generator (High Resolution, High Bandwidth, or Digital Main), the fast selection soft keys along the lower right of the screen can be used (see Figure 3-5). With a single touch of the choice, both measurement channels can be set simultaneously to the A and B High Resolution generator, the A and B High Bandwidth generator, or the Digital Main Inputs. (The measurement channel assignment choices are also available in the application Main menus using the Input menu.)

Pull-down Input Selection Menu. Use the large knob to move the selection box to the signal you want.

High Res A
High BW A
High Res B
High BW B
Dig Main SF1
Dig Main SF2
Dig Ref SF1
Dig Ref SF2
DSP A
DSP B

Channel 1
◄ High Res A

Channel 2
◄ High Res B

Analog HRes Inputs
Analog HBW Inputs
Digital Main Inputs

Touch the measurement channel soft key to display the pull-down menu.

Touch the measurement channel soft key a second time to assign the input to the channel and clear the pull-down menu.

Use the quick select soft keys to set both channels to the same generator type.

Figure 3-5: Measurement channel assignment pull-down menu

If you want to use the digital generator or the digital reference signal as inputs to the measurement channels, select the appropriate one instead of the analog high bandwidth or analog high resolution route. The most common selections (and the default connections) are the Analog A high resolution input connected to measurement Channel 1 and the Analog B high resolution input connected to measurement Channel 2.

When you finish making your selections, press the Clear Menu button to exit the Input Selections menu.

View Setup

The View Setup menu permits you to specify how measurement results should be displayed on the screen. Contents of this menu vary depending upon the current application. In the following description, the FFT application is active.

View Selection Bar. The top line in the View Setup screen is a view selection bar as shown in Figure 3-6. The selections that are made in the remaining portion of the View Setup window apply only to the selected view. The view choices in the view selection bar include an icon that indicates the type of view that is selected. For example, the possible choices for FFT Analyzer in FFT mode are Interpolator, Bar Graph, and Spectrogram. View Setup choices are illustrated in each of the applications in *Applicatons*.
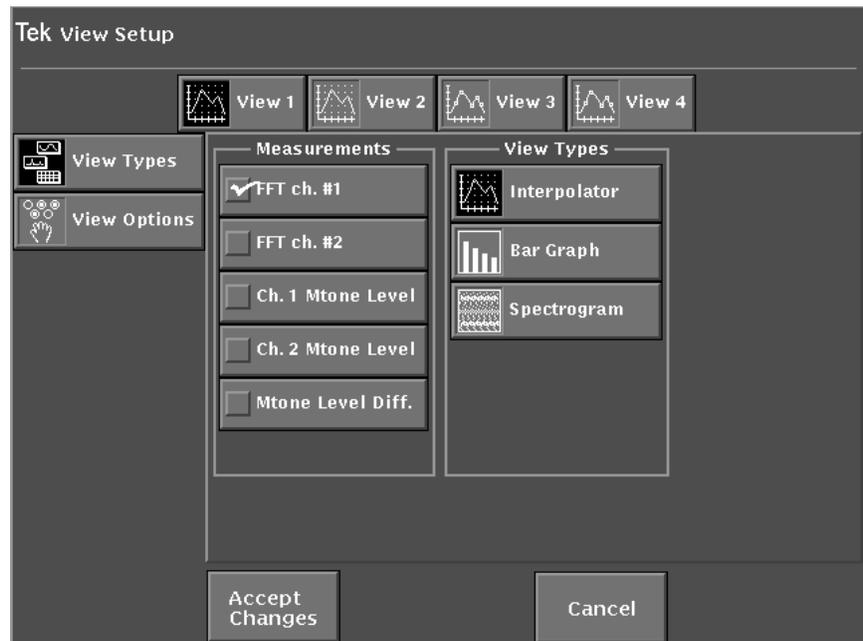
Figure 3-6: A typical View Setup control menu

For each type of view, the AM700 also offers options that allow you to configure the display for your viewing requirements. You can configure the display in the View Setup menu (see Figure 3-6).

To select a view type and define the view options:

1. Press the Configure button and touch the View Setup soft key to enter the View Setup menu.

2. Select the desired view type by touching the icon on the display.

3. If desired, touch the View Options icon to display available options for the view you have selected.

4. Select the desired view options (a checked box indicates that an option is selected).

5. Save your selections and return to the main display by touching the Accept Changes soft key or cancel your changes and return to the main display by touching the Cancel soft key.

View Types. The View Types column in the View Setup menu shows the icons for these view types. Each view can be a different view type. Selecting a particular view type is done by first selecting the view you want to change in the View Selection bar. Only the selected view is affected by a change in the choices. The Measurement column shows the measurement types that are available for viewing in a view window. Altering those choices is done in the Measurements Setup menu that is discussed on page 3-11.

You can set up a view to display FFT measurements or Multitone measurements but not both. The View Types that are available also depend on the measurement selected, since they are different for FFT and Multitone. The applicable choices will be displayed for the Measurement Type selected for a view. Notice that both FFT traces can be displayed in the same view window. Refer to *FFT Analyzer* on page 4-81, for more information about the FFT application.

View Options. The View Options menu permits selection of axis types, display persistence, and cursor actions as shown in Figure 3-7. When a choice is selected (by touching the enabling soft key), a check mark appears in the soft key to show that the choice is enabled. Touch the enabling soft key again to unselect the choice. This removes the check mark and returns to the alternate choice.
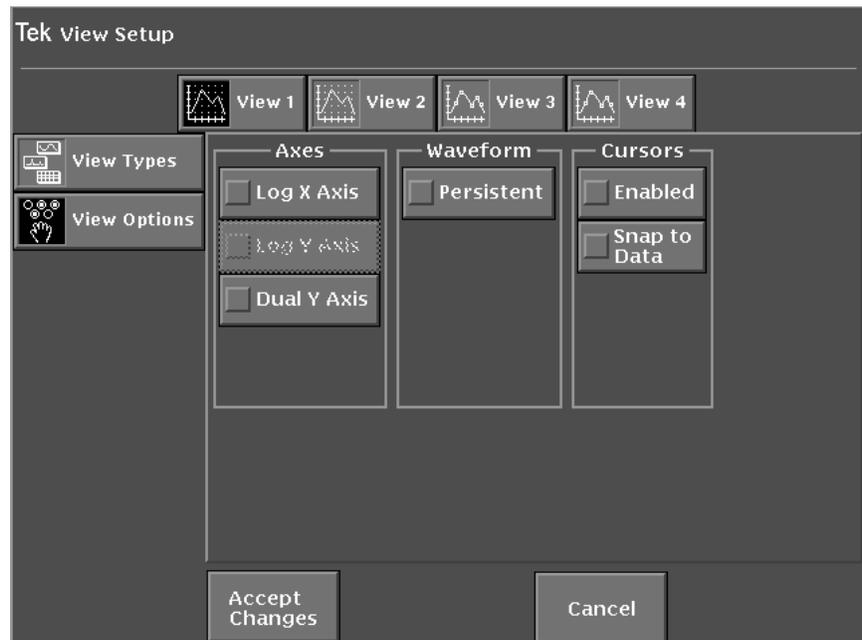
Figure 3-7: FFT Analyzer View Options in the View Setup controls

The choices in the Axes column allow the linear/log selection for the x- and y-axes and a choice of Dual Y-Axis. Dual Y-Axis displays are permitted when more than one trace is displayed in a single view. In Dual Y-Axis displays, the vertical or y-axis scale of the front trace is seen on the left side of the graticule and y-axis scale for the back trace is seen on the right side of the graticule. Other axes choices are determined by the view type.

When persistent is enabled, trace data is accumulated and held in the display in a continuous storage mode. This feature is very useful for gathering history on the waveform changes and showing the bounds of varying signals in either frequency, voltage, or both. Turning persistent off restores the trace to showing trace data for a single acquisition only.

Cursor controls for enabling the cursors and holding the cursors to the displayed data are found in the Cursors column. Enabling or disabling cursors is the same as turning them on or off using the Cursor button on the front panel. Selecting Snap to Data is used to hold the cursors on actual data points in the trace display.

NOTE. When cursors are viewed on a Dual Y-Axis display, they are associated only with the front trace. The amplitude readouts accompanying the cursors reflect the amplitude at the cursor positions in the front trace.

Saving Changes and Exiting the Input Selections Menu. Soft keys to exit the input selection menu are located at the bottom of the screen. When the Accept Changes soft key is touched, any selections made are entered. If the Cancel soft key is touched, all changes are deleted before returning to the current application. Pressing the Clear Menu button also exits back to the application.

Measurement Setup Menu

The Measurement Setup menu permits you to define which measurements are to be performed and displayed by the current application. An example of setting up different measurements in the four measurement views of Audio Analyzer is shown in Figure 3-8. Figure 3-9 shows the FFT and Multitone Measurement Setup controls. See the specific application discussions beginning on page 4-37 for information on setting up the measurements for the applications.
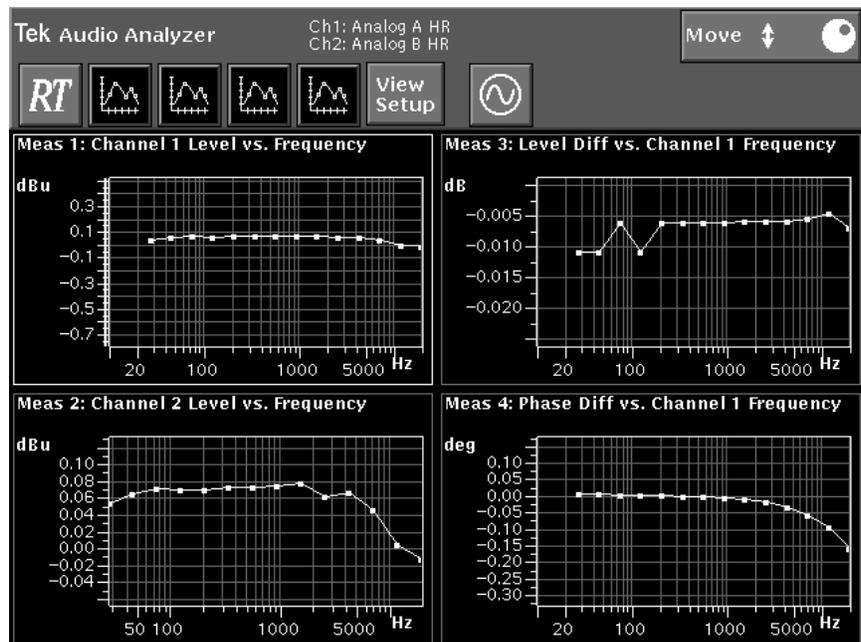
Figure 3-8: Four different measurements in the four views of Audio Analyzer
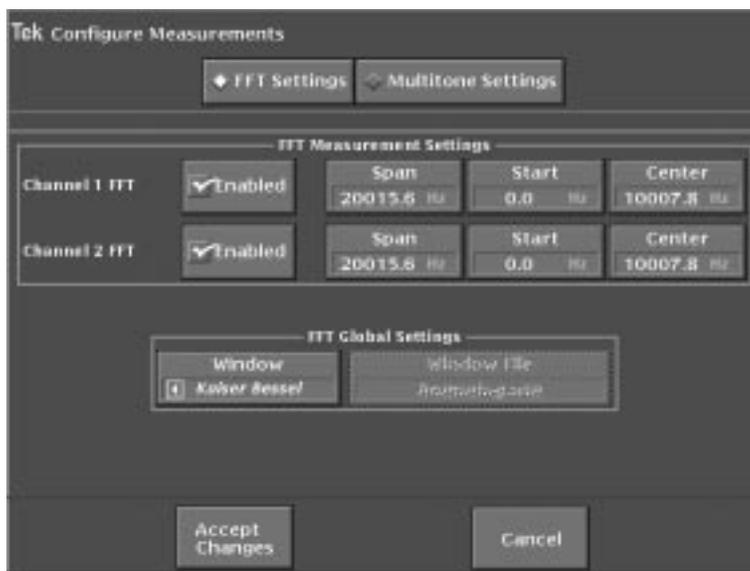
FFT configure
measurements
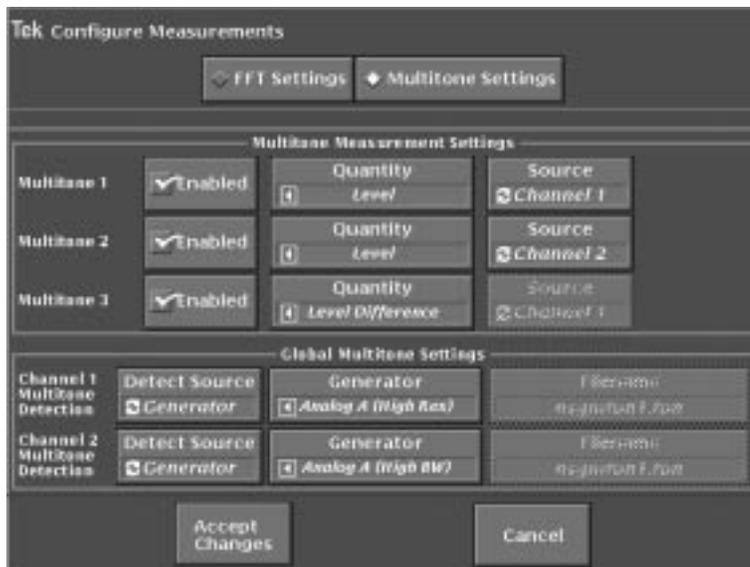
Multitone
configure
measurements

Figure 3-9: FFT Analyzer configure measurement screens for FFT and for Multitone

System Setup Menu

The System Setup menu is used to set the system clock, the serial and GPIB communication parameters, the hard copy output format, run the AM700 calibration routine, and set the input, output, and dBFS conversion factors.

Setting the System Clock

Refer to *Setting the AM700 Clock* on page 1-10 for a detailed procedure for setting the system clock. Select the parameter to change, then set the new number. When all the numbers have been set correctly, press Accept Changes to set the clock to the new time.

System Copy

The control screen display for setting the Copy parameters is reached either through the Configure System Setup menu or directly by pressing and holding the Copy front-panel button to bring up the same menu. Press and hold the Copy button to display the Copy Configuration screen (see Figure 3-10 on page 3-14).

NOTE. Pressing and holding the Copy button immediately brings up the Configure menu with the System Setup choices for Copy displayed. This is the same screen that is displayed by pressing the Configure button, then System Setup.

In this screen you can set the following copy functions:

- Copy output format
- Copy destination
- File name when File is the selected copy destination

After setting copy options, touch the Accept Changes soft key to save your selections, exit the Copy Configuration screen, and return to the measurement display.
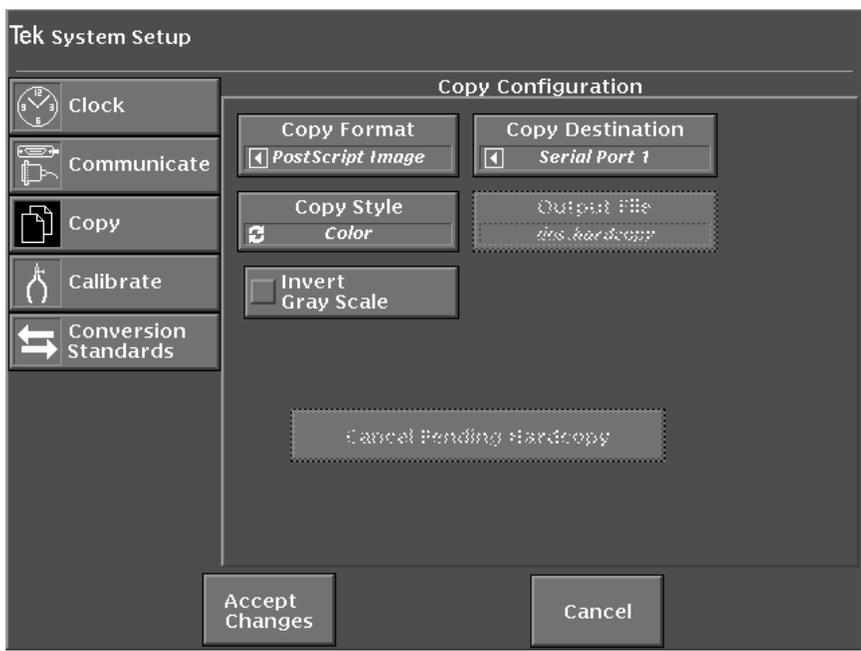
Figure 3-10: The Copy Configuration menu

To delete all copies from the spooler, press and hold the copy button to display the Copy Configuration menu. Touch the Cancel Pending Hardcopy soft key to delete all the spooled hard copies.

The image displayed on the screen is sent to the printer when you press the Copy button. Graphic displays are printed only when the printer port is formatted for a graphics printer. Text only is sent when not formatted for a graphics printer.

Copy Formats. The AM700 supports the following printer and hard-copy types:

- PostScript Image
- HP DeskJet
- Epson (24 pin)
- Tag Image File Format (TIFF)
- Interleaf Image

When the Copy Format is either PostScript or TIFF, the Copy Style can be set to Color. When using monochrome PostScript printing, the black and white areas are color inverted to reduce the toner use for laser printers.

Copy Destination. Printouts are spooled to the currently selected printer port. The following printer port choices are selectable:

- GPIB
- COM 0 or COM 1 (RS-232)
- File on floppy disk
- File in internal nonvolatile file system
- None (This choice disables hard copy output.)

When the Copy Destination is set to File, the Output File selection is active. This choice brings up a file browser, shown in Figure 3-11. The file browser lets you select or name the output file name for the hard copy. You can name a file by touching the Filename soft key. This displays a keyboard to type in the new file name. Enter a new file name and press SELECT to designate that name as the file name to copy to. Hard copy files can be sent directly to the floppy disk for later printing. A limited number of screen dumps can be stored in NVRAM for later transfer to a floppy disk. The available memory in the internal NVRAM of the AM700 depends on how much of the memory is used for other user files.
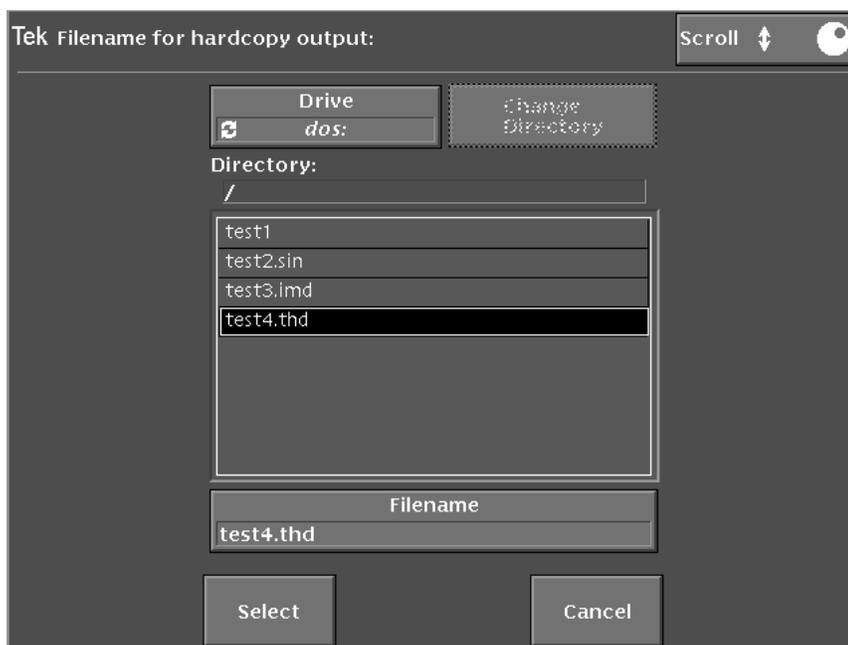
Figure 3-11: Hard copy output file selector

Copy Styles. You can select the choice of color output for PostScript and TIFF formatted files. When set to Color, printer output will be color formatted. If you select a copy format other than PostScript or TIFF, the Color state is ignored, and the file is output as monochrome (gray scale) only.

System Communica-tion Menu

Use the Communicate Configuration menu, shown in Figure 3-12, to define the serial communication parameters for serial port 1, serial port 2, and the GPIB port.

GPIB choices permit you to select the mode of operation and the GPIB address of the AM700. GPIB modes of operation are Talk/Listen, Hardcopy, and Off Bus. Talk/Listen mode is used for remote control of the AM700 through the GPIB port. Hardcopy is the talk-only mode and is used to output screens and data to a GPIB printer. Off Bus turns off the GPIB interface, and the AM700 will not communicate with any other device on the bus.
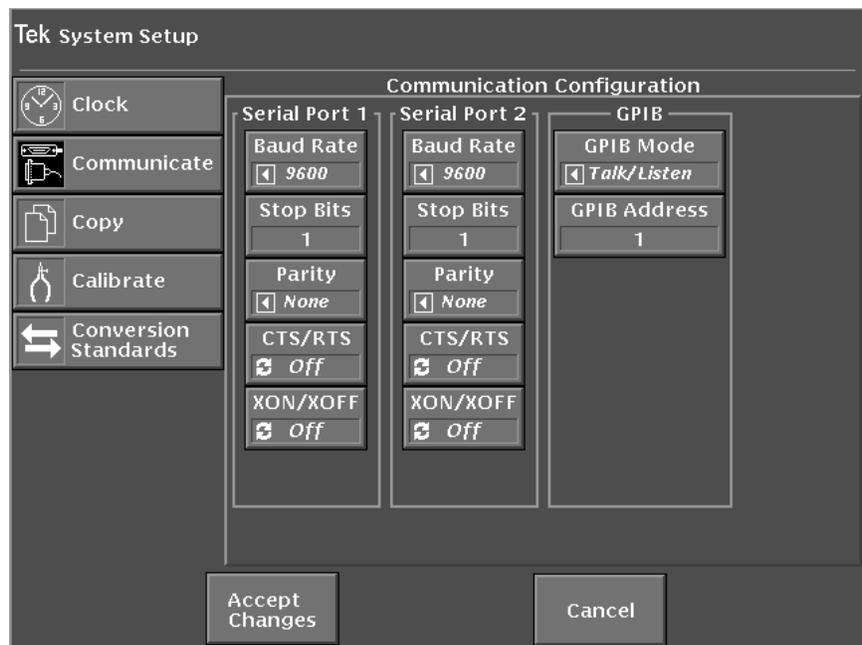
Figure 3-12: System Setup Communicate Configuration menu

Saving Changes and Exiting the Input Selections Menu. Soft keys to exit the Input Selection menu are located at the bottom of the screen. When you touch the Accept Changes soft key, any selections made are entered. If you touch the Cancel soft key, all changes are deleted before returning to the current application. Pressing the Clear Menu button also exits back to the application.

System Calibration Menu

The Calibrate menu provides a soft key to start calibration. Calibration of the analog acquisition system is done after touching the Calibrate Now soft key. Offset changes that occur with temperature will be removed. If operating the AM700 in conditions that permit large ambient temperature changes, a calibration of the analog system improves the accuracy of the measurements. If ambient temperatures are stable, a calibration done infrequently is adequate to compensate for component aging. A calibration should be done at the ambient operating temperature to produce the best accuracy.

When Audio Analyzer, FFT Analyzer, or Monitor is the running application, calibration switches the analog acquisition system to a known test signal (a 120 Hz symmetrical square wave). The AM700 then acquires the positive and negative peak values seen at the output of the A and B high resolution A/D converters and at the output of the A and B high bandwidth A/D converters. The values obtained are used to determine the DC offset of the acquisition system at the time of calibration and the calibration factor needed to remove the offset from the converted data values. The calibration constants obtained are stored and used until a subsequent calibration is done.

If the Digital Interface Tester application is running when calibration is performed, the digital acquisition system offset is calculated, and the calibration factor obtained is used to remove the offset from the peak-to-peak jitter measurements.

NOTE. Calibrate does not perform an analog acquisition system calibration when Digital Interface Tester is the running application.

System Conversion Standards Menu

The Conversion Standards menu shown in Figure 3-13 permits you to define certain values to be used in deriving measurement results.

Output dBm. This setting defines the value of the external load resistor. The divider formed by load resistance and the internal series resistance selected for use (10 Ω, 150 Ω, or 600 Ω) is taken into account for the calculation (see Figure 3-14). Thus, generator signal level can be specified in dBm, and the correct power will be delivered to the load.

NOTE. This is calculated dBm, so if the external load is not as stated in the Output dBm box, the output value stated in dBm will not be correct.

When the generator is driving an output load of 600 Ω, and the internal series resistor is also set for 600 Ω, the generator dBm reading will be correct. This is also true when driving a 150 Ω load with the internal 150 Ω series resistor selected. Since half the voltage is dropped across the internal resistor and half across the external resistor, the dBu (voltage across the load) output will be 6 dBu down from the output value in dBm for these matching conditions.
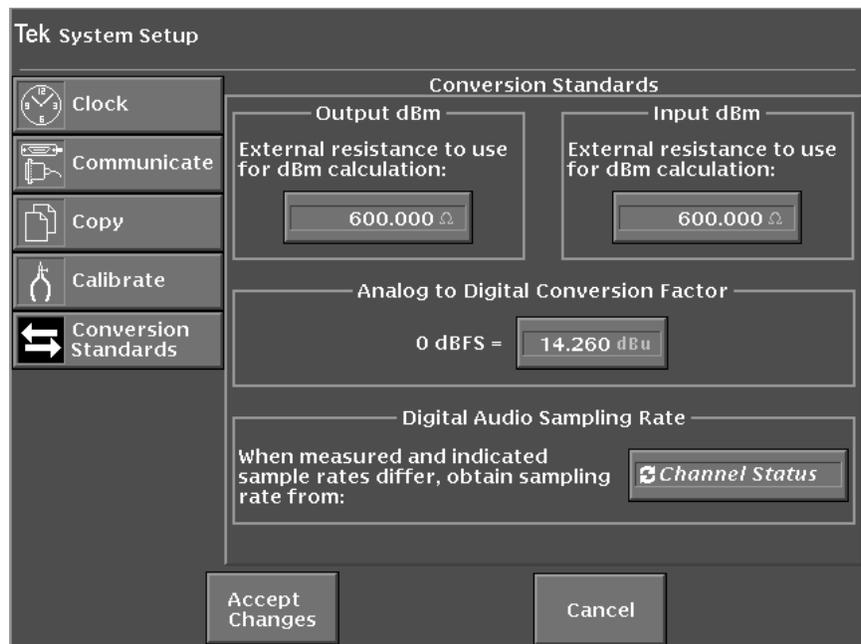
Figure 3-13: System Setup Conversion Standards menu
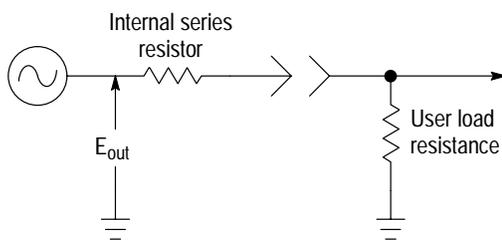
Figure 3-14: AM700 generator output voltage divider for dBm calculations

Input dBm. This setting defines the external resistance on the input of the AM700 and is used for calculating the input signal amplitude in terms of dBm. Since the AM700 is measuring voltage, the internal termination load of the AM700, which is in parallel with the external load, has no effect on the calculation as the applied voltage is dropped across both in parallel (see Figure 3-15).

NOTE. This is calculated dBm, so if the external load is not as stated in the Input dBm box, the measured value stated in dBm will not be correct.
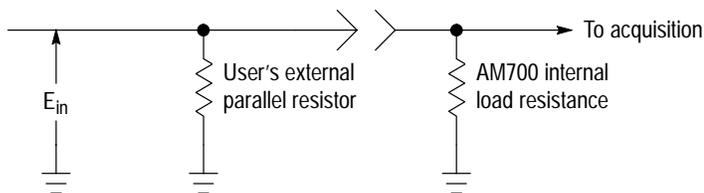
Figure 3-15: AM700 input circuit for dBm calculation

Analog to Digital Conversion Factor. This selection permits measurement results obtained from digital audio sources to be represented as analog values as if they were produced by a D/A converter. The scale factor of a hypothetical D/A converter is specified in this entry.

Digital Audio Sampling Rate. In certain situations, the actual sample rate of a digital audio signal can differ from the value contained in the channel status bits. When digital audio is a source of input signals, the frequency measurements of the AM700 can be referred to the actual sample rate or the sample rate obtained from the channel status byte. Selection of the choice depends on whether you want the calculation to reflect frequencies present in the original sampled data, or those which will result from a playback at the actual sample rate. You must make the appropriate choice.

NOTE. When the actual sample rate and the channel status content match, either setting produces identical measurement results.

Saving Changes and Exiting the Input Selections Menu. Soft keys to exit the menu are located at the bottom of the screen. When the Accept Changes soft key is touched, any selections you made are entered. If the Cancel soft key is touched, any changes you made are deleted before returning to the current application. Pressing the Clear Menu button also exits back to the application.

Quick Setup

One of the configuration choices is the Quick Setup selection. Under this selection is a set of application specific setups that can be used to quickly make the needed instrument configuration changes for an often used measurement setup. Figure 3-16 shows the selection screen with the Audio Analyzer selections; Table 3-1 gives the application-specific choices and the views that the selection produces. In the table, those views in parentheses are available but not displayed. To do a quick setup, touch the measurement you want to make. When the setup has finished, the selection screen is exited. If you want to exit the screen without making a selection, press the Clear Menu button.
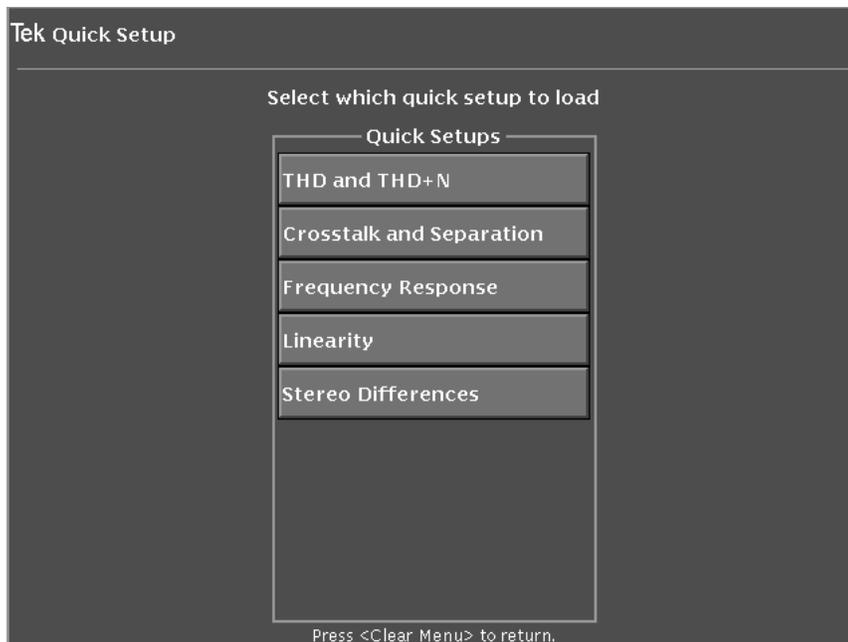
Figure 3-16: Quick Setup selections for Audio Analyzer

Table 3-1: Quick Setups by Application

Application	Measurements	Views Displayed (Views available but not displayed)
FFT Analyzer	FFT Analysis	FFT1: Channel 1
		FFT2: Channel 2
	Multitone Level Measurements	Meas1: Level Ch1
		Meas2: Level Ch2
		Meas3: Level Diff Ch1 -> Ch2
Digital Interface Tester	View Enables	Jitter Spectrum
		Eye Height
		Bit Activity
		Channel Status
Audio Analyzer	THD and THD+N	Meas1: Ch1 THD+N versus Frequency
		Meas2: Ch2 THD+N vs. Freq.
		(Meas3: Ch1 THD vs. Freq.)
		(Meas4: Ch2 THD vs. Freq.)
	Crosstalk and Separation	Meas1: Ch1 Crosstalk 1->2
		Meas2: Ch2 Crosstalk 2->1
		(Meas3:Ch1 Separation 1->2)
		(Meas4: Ch2 Separation 2->1)
	Frequency Response	Meas1: Ch1 Level vs. Freq.
		Meas2: Ch2 Level vs. Freq.
		(Meas3: Level Difference)
		(Meas4: Phase Difference)
	Linearity	Meas1: Ch1 Level versus Gen A Level
		Meas2: Ch2 Level versus Gen A Level
		(Meas3: Not defined)
		(Meas4: Not defined)

Table 3-1: Quick Setups by Application (Cont.)

Application	Measurements	Views Displayed (Views available but not displayed)
Audio Analyzer (cont.)	Stereo Differences	(Meas1: Ch1 Level vs. Freq.)
		(Meas2: Ch2 Level vs. Freq.)
		Meas3: Level Difference
		Meas4: Phase Difference
Monitor	Single Trace	View 1 - Meas1 on View 1 (View 2 - Meas 2 on View 2)
	Dual Trace	View 2 - Meas2 and Meas1 on View 2

Applications

Applications

This section of the User Manual describes the many audio applications and user-selectable features available with the AM700.

Audio Generator

The AM700 includes both Analog and Digital test signal generators. Each generator can send user-configurable waveforms over two channels or subframes. The analog generator offers two user-selectable modes of operation: high resolution and high bandwidth. In high resolution mode, the generator can produce independent true stereo waveforms. In high bandwidth mode, both channels output the same signal.

Capabilities   The analog generator has these capabilities:

True Stereo Operation. In high resolution mode, for frequencies up to 20 kHz, the generator has true stereo operation. Output A and Output B can produce different signals types at the same time. In high bandwidth mode, for frequencies up to 80 kHz, identical signals are produced from Output A and Output B.

Output Signal Selection. The analog generator produces the following output signals: Sine, Tone Burst, SMPTE IMD, CCIF IMD, Shaped Noise, Chirp, Polarity, Tek Polarity, User, or Multitone. These are described in more detail later in this section.

The digital generator offers these capabilities:

True Stereo Operation. The digital generator provides true stereo operation. The digital generator drives the front-panel digital, rear-panel optical, and rear-panel unbalanced outputs with the same signals.

Output Signals. Within the constraints of the digital sample rate range (27 kHz - 55 kHz) the digital generator can produce all signals listed for the analog generator plus the jittered sine signal used in the Digital Interface Tester. You can define the digital audio sample length from 8 to 24 bits.

Signal Postprocessing. A phase offset can be imposed between the digital generator output signals and the digital audio reference input and output. The digital generator can simulate the output signal attenuation effects of long cables. Clock jitter can be added to the output signal to simulate system jitter effects.

Subframe Bit Control. The contents of the channel status and user data blocks can be varied independently of the companion subframe.

Synchronization. The digital generator can use the clock present on the digital audio reference input or output as its reference. This allows a constant sample relationship between the digital generator and an external device.

Front Panel Generator Controls
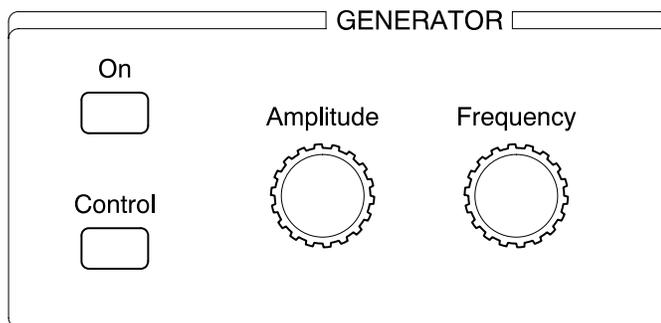
Figure 4-1: Audio generator front panel controls

On. Use the front panel On button to switch the audio generator output on or off. When the generator is on the label above the button is back lighted.

NOTE. Each digital generator channel sends a continuous clock pulse regardless of whether it is enabled or disabled or switched on or off at the front panel.

Control. Press the Control button to display the Generator Control panel shown in Figure 4-2. This is the first of several control panels from which you can configure signal generator characteristics. You can switch between the control panels by touching the soft keys on the left side of the display.

Setting Up and Running the Generator

Use the selections in the Generator Control menu, displayed when you press the Control button, to configure output, waveform type, sweep parameters, and advanced functions.
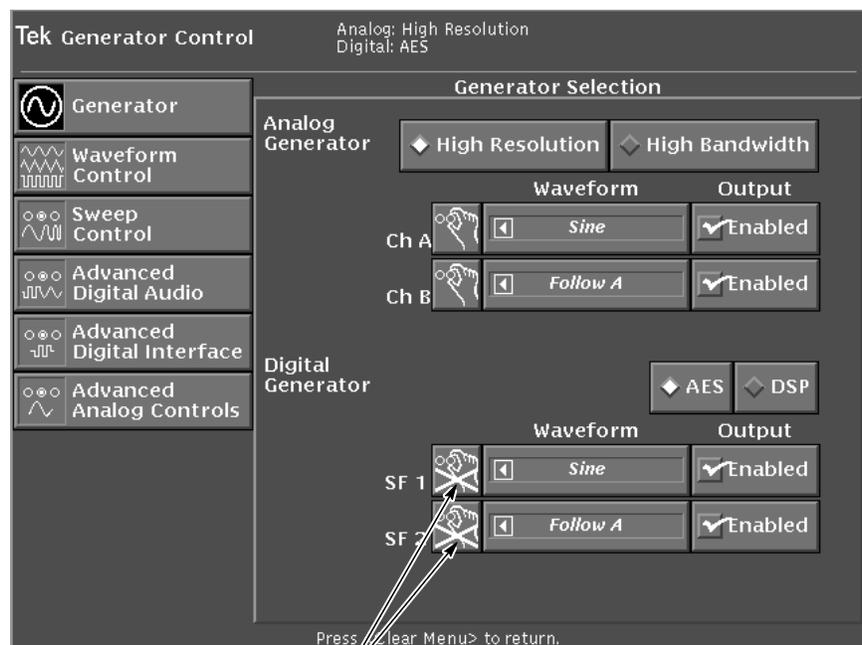
Amplitude and frequency knob assignment icons

Figure 4-2: The Generator Selection display

Generator Selection

Use the Generator Selection display shown in Figure 4-2 to specify the following generator functions:

- Generator type (analog or digital)
- Generator mode (high resolution or high bandwidth)
- Type of waveform
- Digital generator mode (AES or DSP)

This display also allows you to assign the front-panel Amplitude and Frequency knobs to a generator and switch generator output on or off.

Touch a generator choice soft key in the top row of the Generator Selection display to select the analog generator mode—High Resolution or High Bandwidth. In high resolution mode the analog generator produces two independent, true stereo signals. In high bandwidth mode the analog generator drives one or both channels with the same signal.

Icons, buttons, and check boxes in the other rows of this display allow you to select the following:

- Amplitude and Frequency control-knob assignment
- Output signal parameters
- Enabled or disabled generator output
- Type of digital signal output

Assigning Control Knobs

Touch the knob assignment icon (see Figure 4-2) to assign the front-panel Amplitude and Frequency controls to a generator. Once assigned to a generator, these controls allow you to adjust the generator frequency and amplitude. You can view frequency and amplitude values in the generator status window by touching the generator icon in the main display. You can also display these values by touching the Waveform Control icon in the Generator Control menu.

NOTE. These controls remain active during sweeping. If you do not want to be able to change the Frequency or Amplitude during a sweep, set the knob assignment to an unused generator. If running analog sweeps set the knobs to control the digital generator.

Follow Mode. Controls are always assigned to at least one generator. They can be assigned to two generators if Follow A is selected and to all generators if both Follow A and Digital Follow Analog choices are selected. An X through an icon shows that the associated generator does not have amplitude and frequency controls assigned to it (see Figure 4-3).
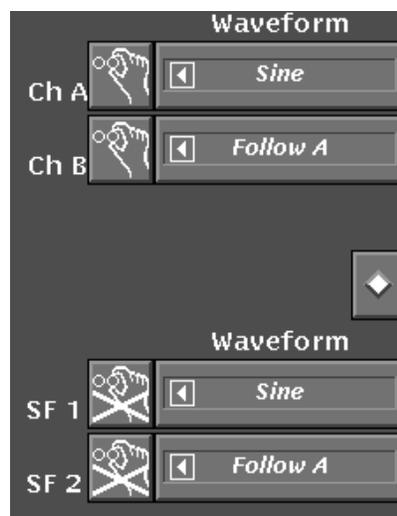
Figure 4-3: Amplitude and Frequency control knob assignment selectors

NOTE. The choices for a master generator to follow are limited to the B generator following the A generator for both the analog and the digital generators, and Digital A follow Analog A.

Specifying an Output Waveform

Next to the knob assignment icon is the Waveform pop-up soft key. Touch this soft key to display a pop-up menu from which you can select the type of generator output waveform. Dimmed selections in the pop-up menu are unavailable. Turn the knob to select a waveform and touch the pop-up menu to accept it. You can also touch the waveform pop-up soft key, use the Enter button, or Clear Menu to accept your selection.

Available waveforms include the following:

Sine. The most common waveform used in audio analysis. This waveform can be used for testing frequency response, for example, where you measure sine-wave amplitude at various frequencies. The sine wave signal is also the only one that can be swept.

Tone Burst. This is a sine wave that is periodically switched on and off. Tone burst parameters are: sine-wave frequency and amplitude, period (the number of cycles during which the on/off condition repeats), and burst width (number of cycles). Available in high resolution mode only (with the analog and the digital generators), this waveform is used for testing audio compressors, PPM meter ballistics, and other devices that must adapt to audio-level changes.

IMD (intermodulation distortion). An IMD signal consists of two sine waves of specific amplitude (or amplitude ratio) at specific frequencies. The AM700 analog and digital audio generators can produce both SMPTE and CCIF IMD signals. This signal is not available in high bandwidth generator mode.

A SMPTE IMD signal consists of a variable high-frequency and a fixed low-frequency tone. By definition, a SMPTE IMD signal contains a variable-frequency sine wave at 7 kHz and a fixed-frequency sine wave at 60 Hz. The amplitude ratio between the sine waves is 4. SMPTE IMD settable parameters include signal amplitude, ratio (the voltage difference between the high and low tones), and frequency. The SMPTE IMD signal is typically used with an audio analyzer to measure intermodulation distortion. In SMPTE IMD measurements, the IMD signal components are looked for in two sideband areas around the center frequency of 7 kHz. Any distortion components are the result of mixing of the of the two signals to produce upper and lower sidebands near the center frequency.

CCIF IMD signals, like those of SMPTE IMD, consist of two frequencies. CCIF tones are closely spaced and at a higher frequency than SMPTE tones. By definition, the CCIF IMD signal has a center frequency of 13.5 kHz and a frequency spacing of 1,000 Hz. The amplitude ratio is generally 1:1. CCIF IMD parameters that can be set include center frequency, frequency spacing, amplitude, and amplitude ratio. With the CCIF IMD signal, the close spacing of the two frequency components produces difference components that are located near 1 kHz. The sum components are out of the measurement band. The IMD distortion components are looked for in a band around the expected difference of the two signals.

NOTE. *Note: SMPTE and CCIF signal parameters are defined by these organizations. Changing the parameters of the IMD signals from those preset in the AM700 makes the resulting signal noncomplying with SMPTE or CCIF standards.*

Shaped Noise. This signal can be either white noise or pink noise. White noise contains equal energy across the band, while pink noise contains equal energy per octave. This signal is available from either the analog or digital generator in high resolution mode. It is not available in high bandwidth generator mode.

Signal parameters that can be specified include the type of noise (white or pink) and the amplitude.

Chirp. This signal is a sine wave that rapidly and repetitively transitions from a high to a low frequency. The chirp waveform can be used for quickly characterizing frequency response. Parameters that can be set include amplitude, low-frequency band edge, and high-frequency band edge (band edges are the chirp signal start and stop frequencies).

Polarity. This clipped sine wave can be used with an oscilloscope to verify that a stereo circuit is wired correctly. Parameters that can be set include frequency and amplitude. This signal is available from either the analog or digital generator but is not available in high bandwidth generator mode.

The polarity waveform contains harmonics that can produce undesirable effects in certain circuits under test. For this reason, the Tek Polarity signal may be a better choice for polarity tests.

Tek Polarity. This waveform consists of the sum of two equal-amplitude sine waves. One has a fundamental frequency of 440 Hz and the other is the second harmonic of that frequency, 880 Hz. The amplitude parameter can be set.

Like Polarity, Tek Polarity can be used to check wiring polarity of stereo channels.

User. The User waveform selection allows you to play a custom waveform from a file. AM700 signal generators are able to play the contents of a block of memory, repeating at the end of the block (the memory block holds a maximum of 16 K samples of audio per channel). Data for the custom waveform comes from an audio source file that can be created on a PC and transferred to the AM700 user files using the disk drive.

On playback, the contents of the audio source file are copied into a buffer and the generator is set to play the signal from the buffer.

The data format is binary 32-bit long words, one long word for each audio sample point. The AM700 uses the lower 24 bits of each word; the upper 8 bits are ignored. Data must be in Motorola fractional audio format (each 24-bit number is expressed as a fraction ranging from 1 to –1, or 7FFFFF to 800000). For details about the Motorola fractional audio format, refer to Motorola documentation.

Once created, the user signal file is transferred to the AM700 by floppy disk. For information about transferring files using the floppy disk drive, refer to *Storage* on page 2-19 and to *AM700 Storage Manager* on page 4-132.

NOTE. *In converting data from Motorola fractional audio format to volts, for example, if you want the voltage to be calibrated, it must be scaled to place one or more of the sample points at 7FFFFF or 800000.*

NOTE. *If you apply a user signal when the digital generator is not in Follow mode, the volume control is inoperative, and the data is sent exactly as it appears in the file. However, if the digital generator is set to follow the analog, when you apply an analog user file, the volume can be controlled.*

Multitone. This signal contains selected sets of sine-wave frequencies. The amplitude of a multitone test signal is defined as the RMS value of the combined signal frequencies (not the peak amplitude of any single frequency in the signal). Multitone test signals are used to check audio-circuit frequency response, phase response, and total harmonic distortion and noise levels. Multitone signal amplitude can be specified using the Amplitude soft key in the Waveform Control display. Refer to *Multitone Files* on page 4-9 for information on constructing a multitone test signal.

NOTE. *The overall signal-to-noise ratio of a multitone signal is lower than that of a normal sine wave.*

Jittered Sine (digital generator in AES mode only). This selection adds a sine wave on the audio and jitters (phase modulates) the digital interface. The frequency (modulating) signal and jitter amplitude can be set in the Waveform Control screen. Measurement units for jitter amplitude are in unit intervals peak-to-peak.

One common use for a jittered sine wave is in testing D-to-A converters. This is done by sending a jittered sine wave to a D-to-A converter and observing the resulting audio sine wave for sidebands with an FFT analyzer. The purpose of this test is to see how much of the jitter on the interface finds its way into the audio. If the D-to-A converter derives its clock from the interface, jitter on the interface can enter the D-to-A clock and phase-modulate the A-to-D converter clock, creating unwanted sidebands.

Follow. Follow A selections are available in the Waveform pop-up menus of the Channel B and SF1 generators. Follow Analog is an available choice in the SF1 digital generator. These waveform selections cause the following generators to send the same signal on both channels in phase, effectively producing a monaural output. In Follow mode, any change made to the output configuration of one generator channel is reflected on the following generator. Using the Follow selections, it is possible to configure analog generator Channel A and slave the remaining generators to produce the same output signal and amplitude. When generators are following, they also follow the same list for sweep and multitone signal generation.

NOTE. This is not the same as explicitly selecting the same output for each generator channel. When you select the same output explicitly, the signals may not be in phase.

Additional waveform parameters can be specified by selecting the Waveform Control soft key.

Multitone Files   There are four multitone files included in the AM700 firmware. These are files that generate multitones corresponding to the four signals generated by the Tektronix ASG 100 Audio Signal Generator. They are located in the file system in the dos:/mtone directory and are named asgmton1.ton, asgmton2.ton, asgmton3.ton, and asgmton4.ton.

User-specified multitone files can be created and used to set the frequency, amplitude, and phase of the individual tones used to make up the multitone signal. These files must be created externally using an editor that generates ASCII files in DOS format. When constructing a multitone signal there are some rules to make sure the multitone signal will be properly detected by the AM700. Those rules follow the multitone file description.

NOTE. The amplitude level is for individual tones that make up the multitone signal. The generator amplitude setting is 0.707 x peak voltage, which is RMS voltage for sine waves only. The level of transmitted multitones depends on the crest factor of the signal. That varies each time the multitone signal is sent by the generator (unless in file mode with absolute phases provided).

In both file mode and list mode the amplitude parameter for an individual tone is used only to control the relative amplitude of that tone with respect to the other tones.

Summary: The only way you can determine the received level of each tone is to work backwards from the peak level of the complex waveform, with knowledge of the crest factor.

Creating a User Multitone File. Here is an example AM700 multitone file indicating frequency in Hertz, amplitude in dBV, and phase in degrees:

```
am700 multitone 1.0 10
1000.0 0 12.0
2000.0 0 45.0
```

This example makes two tones:

1000 Hz at 0 dBV with a phase of 12 degrees, and 2000 Hz at 0 dBV with a phase of 45 degrees.

The following explains the format of an AM700 multitone file:

```
<Header>
<Data>
```

where <Header> is:

```
am700 multitone <version> <log2bufsize>

<version> is 1.0
<log2bufsize> is the base 2 log of the buffer size in bytes, that is, 10 for
```
1024, and so on.

<Data> consists of a series of lines, each containing <ToneSpec>. (Each tone is on its own line.)

<ToneSpec> is

```
<Freq in Hz> <level in dBV> [<phase in degrees>]
```

NOTE. *The phase parameter is optional. If phase parameters are present for all tones they will be used for the generated multitone. If phase parameters are missing from any tone, all tones will get randomized phases.*

---

1. When phases are randomized, this occurs each time the multitone is computed, Switching to and from multitone will cause a recomputation. This could have a negative effect on repeatability of very sensitive tests.

2. The same file used for two channels (without setting B to follow A) will produce different time-domain signals in each channel.

3. To guarantee repeatability you must use the phase parameter. A reasonably good crest factor results from randomized phases in the interval [0 . . . 360] degrees.

Once created and edited on a PC, a multitone description file can be copied to the nvram:/mtone directory on the AM700 using the Storage Manager. For more information, refer to *AM700 Storage Manager* on page 4-132.

To select a multitone description file, in the Waveform Control screen, touch the Filename soft key and turn the knob to select the file. Then, touch the Select soft key to accept the selected file. Touch the File soft key to direct the audio generator to the multitone description file as the source for generating multitone signals.

Rules for Constructing a Detectable Multitone Signal. Constructing a multitone signal for reliable FFT Multitone detection by the AM700 is based on tone separation, sampling rate, and record length. How many tones you use in constructing the signal is limited by the constraints of the minimum spacing of the tones as determined in the following text. How low or high a frequency you can use is also constrained. Things to consider when constructing a multitone signal file are:

■ Record lengths are in powers of 2 and the following lengths can be specified in the multitone file.

2^9 - 512, 2^{10} - 1024, 2^{11} - 2048, 2^{12} - 4096, and 2^{13} - 8192 bytes.

■ Sampling rates are different in each of the three acquisition systems.

High Resolution Mode	48 kHz
High Bandwidth Mode	192 kHz
AES Digital Input	32, 44.1, or 48 kHz

■ Each component of a multitone signal should be separated from the adjacent components by an amount based on the following formula:

Minimum Tone Separation in Hz = (Sampling Rate ÷ Record Size) X 5

■ The lowest tone that can be reliably recognized is equal to or greater than that determined by the following formula:

Minimum Tone Frequency in Hz = (Sampling Rate ÷ Record Size) X 3

■ The highest tone that can be reliably recognized in based on the sampling rate. Tones approaching half the sampling frequency will be incorrectly sampled.

For example, if you want a multitone signal with 10 tones, a record length of 1024, at a sampling rate of 48 kHz, the following constraints on tone selection will apply:

$$Minimum\ Tone\ Separation = (48\ kHz \div 1024)\ X\ 5$$
$$= 234\ Hz$$

$$Minimum\ Tone\ Frequency = (48\ kHz \div 1024)\ X\ 3$$
$$= 141\ Hz$$

$$Maximum\ Tone\ Frequency < 24\ kHz$$

The two limits that have to be considered in the example are the minimum spacing and the minimum tone frequency. The number of tones involved does not create spacing problems, and the maximum tone frequency is limited in this case by the bandwidth of the high resolution A/D converter rather than sampling frequency.

Using List to Create a Multitone Signal. The AM700 can also create multitones from a list. A multitone list is created from the same list used to create frequency sweeps. The List Editor appears in the Generator Control panel as one of the Sweep control selections. There is one list available for each generator in the AM700; making a change here also affects the sweep from a list option for the associated generator. Refer to *Sweep List* on page 4-21 for more information.

NOTE. When the list is used to generate a multitone test signal, the level setting for each tone is used only to provide the relative amplitude relationship between the individual tones. The absolute value of each tone depends on the generator amplitude setting for the peak value of the multitone test signal.

When you set the generator to multitone and use the list as the source for setting the included tones in the signal, use the same considerations that are used for selecting tones as when you create one from a file. The exception is that the record length is set to 8192 bytes, and you cannot change it. The record length used for list is set to provide the most flexibility in minimum tone separation and minimum tone frequency.

For example, with a sampling rate of 48 kHz and a record length of 8192, the minimum tone separation is 29 Hz and the minimum tone frequency is 18 Hz. The

time required to acquire the record increases a small amount, but you benefit from the improved flexibility in constructing a detectable multitone signal.

**Enabling
Generator
Output**

The Output check boxes are on the right side of the Generator Selection display (see Figure 4-2). Touch an Output check box to switch on or off the output of the selected generator. When the generator is switched on using the front-panel On button, outputs from enabled generators are sent to the front- and rear-panel generator outputs.

You may want to disable the output of a particular generator, for example, to generate silence in a channel when measuring crosstalk or separation. A disabled generator also does not run when the front-panel Sweep button is pressed to start all enabled sweeps. This is a good way to make sure only the needed sweep or sweeps run when using sweep test signals.

**Selecting
Digital
Generator
Mode**

Touch the AES or DSP generator selection soft key to select the digital generator mode. AES is the more common operating mode for the digital generator, since it causes the generator to produce AES/EBU output.

In DSP mode, generator output exits the AM700 from a special connector on the rear panel. The DSP output is compatible only with specific equipment. It can be used, for example, to test compatible off-platform D-to-A components.

NOTE. Placing the generator in DSP mode also causes digital acquisition to enter DSP mode. In this mode the AM700 receives data from its DSP input rather than the AES/EBU digital input.

You can connect a compatible digital microphone or other compatible digital signal source directly to the DSP Port connector for processing. The external device supplies the sampling rate, but the port should only be used at one of the standard three sampling rates of the AM700: 33, 44.1 or 48 kHz. Also, the sampling rate on the external equipment must not be switched while the AM700 is in DSP mode.

Adjusting Generator Frequency and Amplitude

You have two ways to adjust generator frequency and amplitude:

■ From the Generator Status panel on the main display.

■ From the Waveform Control menu (for appropriate waveforms).

From the Generator Status Panel. In the main display, touch the generator icon to display the generator status panel as shown in Figure 4-4.
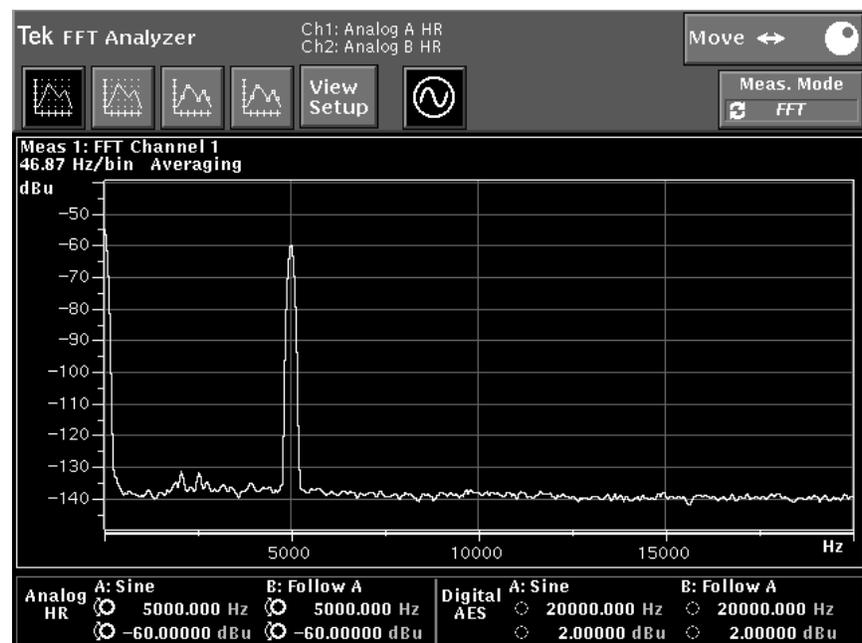
Figure 4-4: Generator status panel in an FFT Analyzer display

Information shown on the generator status panel includes the following:

■ Type of signal sent on each generator channel

■ Signal frequency and amplitude

■ Active channel indicator (active channel or channels are highlighted, disabled channels are grayed out).

- The assignment of the Amplitude and Frequency control knobs (shown by the small circular arrow indicators next to the generator and amplitude readouts as shown in Figure 4-5).

Amplitude and Frequency knob generator assignment indicators.
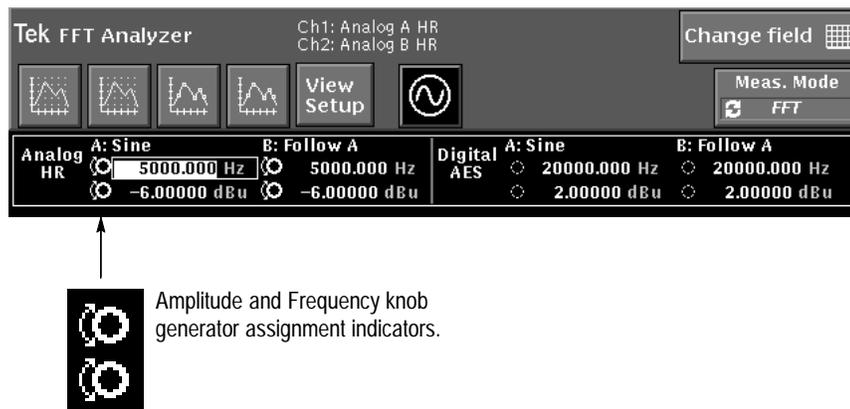
Figure 4-5: Generator status panel

You can coarse adjust the active channel amplitude or frequency by turning the Amplitude or Frequency knob. For fine adjustments select the active channel with the Select button (keep pressing the Select button until the value you want to change is highlighted in the Generator Status panel). Turn the large control knob or enter the new value from the numeric keypad, and press the Enter key to accept the change.

If you must make an adjustment in a waveform display (for example, if you want to move a cursor) you can remove the generator status panel from the display by touching the generator icon. You can also access a waveform display window without dismissing the Generator Status panel by touching the display in the window to change focus to that window.

From the Generator Control Panel. Press the Control button on the front panel and display the Waveform Control menu by touching the selection (see Figure 4-6 on page 4-18). Activate the desired generator by touching its selection soft key near the top of the display.

If necessary, select the desired waveform from the Waveform pop-up selection. Set the amplitude or frequency by turning the front panel Amplitude or Frequency knob, as appropriate, or activate the field editor by touching it. With the field editor active, you can rotate the large control knob to change the value in the field. You can also enter the desired value in the active window from the keypad. Press Enter or touch the field editor to accept the changes.

Waveform Control

Touch the soft key to display the Waveform Control screen (see Figure 4-6). Menus in this screen apply only to the parameters of the selected generator (the one that has the diamond highlighted at the top of the display). The generators being edited are indicated at the top of the display. In Figure 4-6 the generators for which choices can be made are the Analog High Resolution Generator and the AES Digital Generator. If Analog A is generating a sine wave, then the available waveform control parameters are frequency and amplitude. However, if you touch the Digital SF 1 soft key and the digital generator is generating another type of waveform the parameters accessible in the Waveform Control screen may change, depending on the waveform being generated.

NOTE. Sine wave only can be used for generating a sweep signal. If a sweep is wanted from a particular generator, it must be set to generate a sine wave signal either in the Waveform Control menu or in the Generator Control panel.
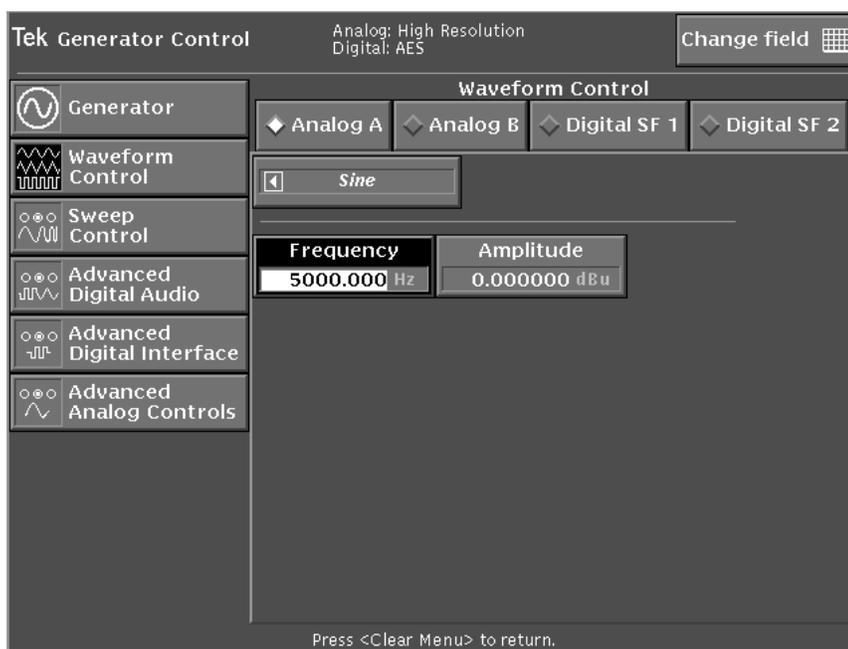
Figure 4-6: Waveform control display

The amplitude and frequency setting for the selected generator are displayed in the edit fields for Frequency and Amplitude. Values in these fields are parameters of the generator output signal when not sweeping. When sweeping, using the sine wave signal, if one of the sweep parameters is fixed, the amplitude for example, then the value set here for amplitude is the fixed amplitude for the frequency sweep.

To enable you to quickly change the type of waveform sent by the generator, the Waveform selection soft key (described previously) is also available in this screen.

Sweep Control

The Sweep Control screen allows you to change the sine wave parameters that define the sweep signal for each generator. Use the soft keys at the top of the Sweep Control menu, shown in Figure 4-7, to make the generator selection. When the generators are set to follow, one sweep definition is all that is required, but individual sweep definitions are possible for each generator. All defined and enabled sweep signals are started, or stopped if running, by a press of the front-panel Sweep/Run button.

NOTE. It is very important to observe the generator selection and follow mode settings to avoid making changes to the sweep or list for the wrong generator when individual sweep definitions are used.

Sweep control settings include the following:

■ Direction—whether the sweep begins at Start and goes to Stop or begins at Stop and goes to Start.

NOTE. Sweep and List directions can be from Start to Stop or Stop to Start without regard to the values that are specified for Start and Stop. The Start values can be higher or lower in frequency and larger or smaller in amplitude than the Stop values.

■ Spacing—linear or logarithmic calculation of the next dwell point

■ Sweep Count—number of sweeps (set to 0 for continuous sweep)

■ Points per Sweep—number of pause points in the sweep

■ Automatic Timing—adjusts dwell times for faster sweeps

■ Point Dwell—time at each point in the sweep when Auto Timing is off

■ Total Time—duration of the sweep when Auto Timing is off

NOTE. *When running a voltage sweep, especially with Automatic Timing enabled, the Input Range setting can be set for the highest voltage expected and Auto Range disabled. This eliminates a possible loss of a data point due to the Auto Range action that can occur when the sweep voltage level changes (either up or down).*
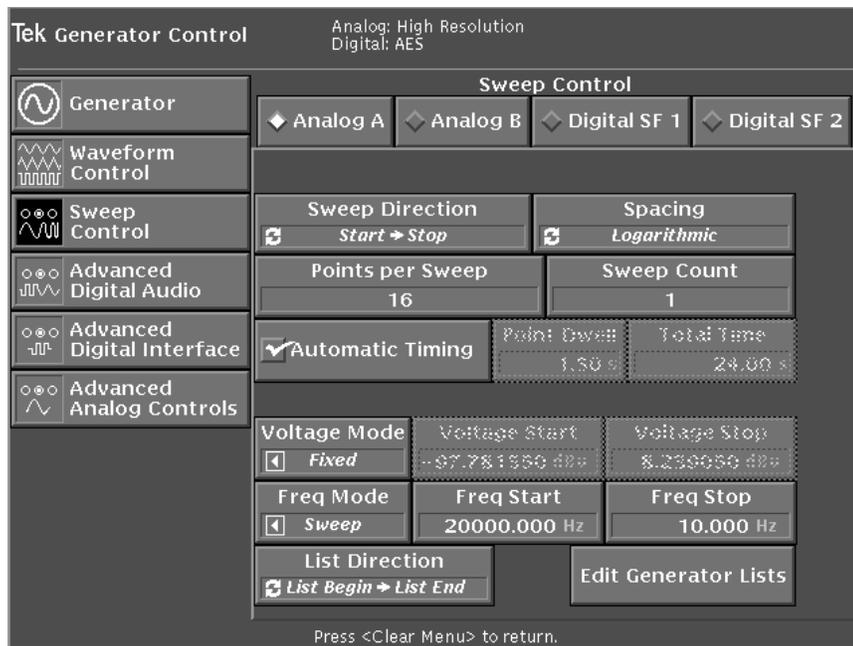
Figure 4-7: Sweep control display

Sweep Direction. Direction, Automatic Timing, and Spacing parameters are toggled by touching the soft keys, while Count, Points per Sweep, Dwell, and Time parameters are changed by touching the desired soft key and entering a value at the keypad (or you can turn the large control knob). Touch the soft key to accept the entered value (or press the Enter key). As a standard measurement practice, sweeps are run from high to low so that data can be acquired more quickly. The default sweep starts is set to the highest frequency in the sweep, and the sweep direction is from Start to Stop.

Automatic Timing. When auto timing the sweep, the dwell times are calculated and set for the fastest sweep time possible based on the step frequency. Higher frequencies are acquired more quickly than lower frequencies, so dwell times for the high end of the sweep are shorter than those at the low end of the sweep. With Automatic Timing enabled, the number of points can be set, but the dwell and time settings are disabled.

Points per Sweep, Point Dwell, and Total Time. Points per Sweep, Dwell, and Time parameters are interactive. If you enter any two of the three values, the AM700 calculates the third. In a sweep, the number of pause points and the dwell time at each point are most important. For this reason, when setting up a sweep, you will typically enter the number of points and the dwell, allowing the AM700 to calculate total sweep time. Automatic Timing adjusts Point Dwell time based on the frequency of the dwell point to produce the fastest possible sweep time that still obtains settled data at each dwell point.

When set to independent operation, both channels of every generator can have a voltage sweep, a frequency sweep, or a combined voltage and frequency sweep. If Analog B is set to follow A then the Analog channels will both use the same Analog A list. If the Digital channels are also set to Follow Analog, then both analog and both digital generators use the same list for generating a sweep.

NOTE. The exception to this is that the analog high bandwidth Channel B generator can only be set to Follow A. The two generator outputs cannot be used to generate separate high bandwidth outputs.

Sweep List

Mode selections for Voltage or Frequency are Fixed (CW for Frequency mode), Sweep, or List. List mode allows you to define, with the List Editor, a list of frequencies, amplitudes, and dwell times that the AM700 steps through during the sweep. Lists, which can be up to 128 steps in length, offer a way to create a test sequence that is more flexible than a sweep.

Creating or editing a voltage or frequency list is done by bringing up the List Editor and editing, adding, or removing one or more points on the list and saving the list. You apply the list as the test sequence by selecting List in the Voltage Mode or the Frequency Mode menu of the Waveform Control display.

NOTE. To use the list parameters to generate a frequency sweep, you must set Freq Mode to List. To use the list parameters to generate a voltage sweep, you must set Voltage Mode to List. Both must be set to List if you want the voltage and frequency to sweep. If you want to use a fixed voltage level, set the Voltage Mode to Fixed and set the amplitude you want to use in the Waveform Control amplitude editor.

List Editor. Start the List Editor from the Sweep Control display by touching the Edit Generator Lists soft key (see the List Editor in Figure 4-8). Each generator has a list that can be created for its use. At the top of the List Editor display, the generator list being edited is shown. There can be as many as seven different lists: Analog A high resolution, Analog B high resolution, Digital SF1, Digital SF2, Analog A and B High Bandwidth (use a single list), and DSP A and DSP B.

With the List Editor you can configure each frequency, amplitude, and dwell element of a list with the soft keys, control knob, or keypad. You can also add, remove, or sort points in the list. As you add, edit, or remove points, the graphical view (if selected) displays the points in the list on a frequency and level display.

NOTE. When the list is used to generate a multitone test signal, the level setting for each tone is used only to provide the relative amplitude relationship between the individual tones. The absolute value of each tone depends on the generator amplitude setting for the peak value of the multitone test signal.

After specifying the points in the list touch the Accept Changes soft key to accept the list and leave the List Editor.

The default list has frequencies given in ascending order to match the standard practice of sweeping from the higher frequency to the lower frequency. If you use the Sort by Frequency soft key, the list will be sorted in descending order. You will then have to reverse the sweep direction selection (make it List End to List Begin) if you want to sweep from highest to lowest after using Sort by Frequency. If you want to sweep from lowest to highest frequency, you will have to set Sweep Detection to Rising Frequency.
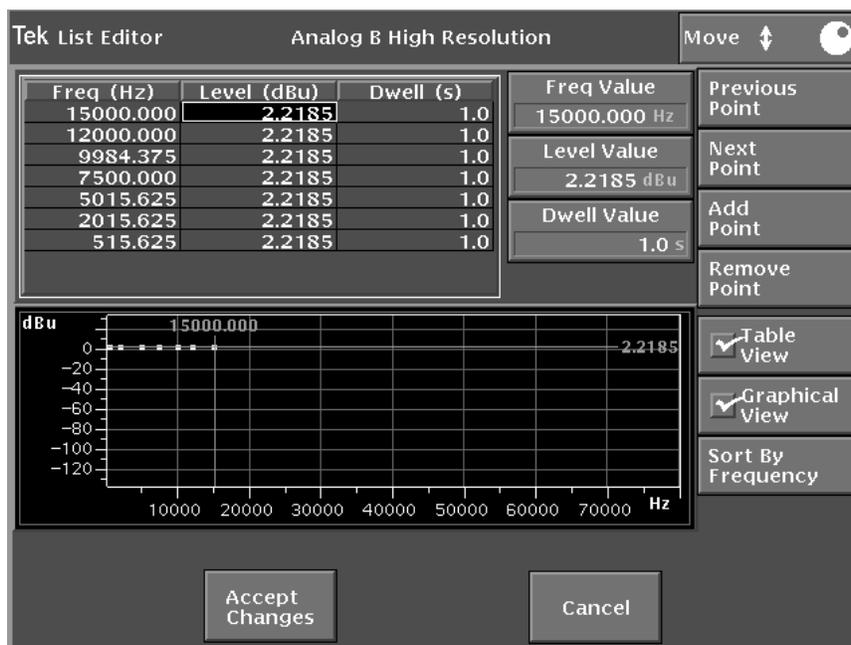
Figure 4-8: The List Editor display

Advanced Digital Audio

Controls in the Advanced Digital Audio screen (see Figure 4-9) include the following:

Sample Rate. Touch this soft key and turn the knob to select the audio sampling rate. Signals are calculated with any of the available three sampling rates: 32, 44.1, or 48 kHz. The sample rate selected may or may not change the clock speed of the interface.
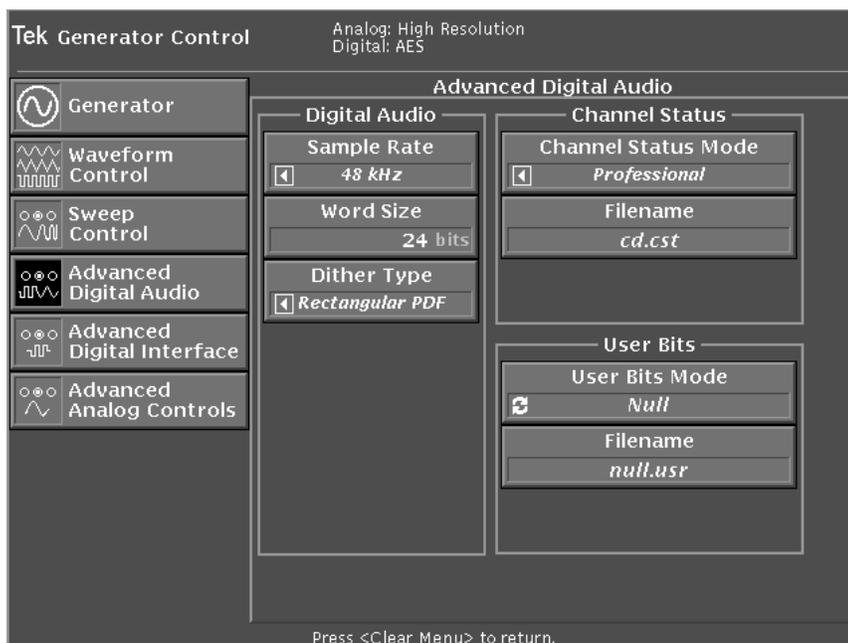
Figure 4-9: Advanced Digital Audio display

Word Size. Use this field editor to specify the number of audio bits that are sent in a digital signal word (the maximum word size that can be sent on an AES interface is 24 bits). Change the word size by touching the Word Size field editor and entering a new value at the keypad. Press the Enter key to accept the entry. After touching the Word Size field editor you can also turn the large knob to display a new value. Touch the field editor icon (or press the Enter key) to accept the word size value.

The ability to change the word size can be used, for example, in testing the behavior of a receiver while changing the number of audio bits it receives. A receiver can either truncate or dither the input when receiving a word size larger than it is designed to accept.

Dither Type. Selections are None, Rectangular PDF, or Triangular PDF. An 18-bit signal is typically produced by generating a 24-bit signal and either truncating or rounding it. When generating signals of fewer than 24 bits, dithering reduces truncation noise. The dither selections allow you to choose the type of probability density functions (PDF) used in dithering.

Channel Status Mode. Touching this soft key displays a menu from which you can select the type of signal produced by the audio generator. Selections are Professional, Consumer, Non Audio, and File.

Every audio sample has a specific number of audio bits. Included with the audio bits are validity, user, channel status, and parity (VUCP) bits. Channel status (C) information is organized in 192-bit blocks that are subdivided into 24 bytes. Examples of information carried in channel status are: length of audio sample words, number of audio channels, sampling frequency, sample address code, alphanumeric source and destination codes, and emphasis.

The Channel Status mode soft key allows you to specify the type of audio signal generated by the AM700. Channel status information sent by the audio generator can cause specific behavior or display messages on equipment receiving the test signal.

You can also select a file (created on a PC, saved to a floppy disk, and transferred to the AM700) from which the audio generator reads channel status information. Refer to AES3-1992 (ANSI S4.40-1992) for more information about channel status.

User Bits. Touching this soft key displays a menu from which you can select the type of user data produced by the audio generator. Selections are Null (logic 0, the default) or File. No firm standards currently exist that describe uses for the information in user bits. Refer to AES3-1992 (ANSI S4.40-1992) for more information about the user data format.

You can also select a file (created on a PC, saved to a floppy disk, and transferred to the AM700) from which the audio generator reads user information. Refer to *AM700 Storage Manager* on page 4-132 for information on file transfers.

Creating a User Bits or Channel Status File

The following file is an example that emulates the channel status from a CD player:

```
am700 cstatus 1.0
0 10000000 0x00
0 0 0
0 0 0
0 0 0
0 0 0
0 0 0
0 0 0
0 0 0
```

There are two parts to this file: a header and the data. All channel status or user-bit files consist of a header followed by data.

Header. The header is a line of text that identifies the type of file and the version of the file structure. The syntax is:

```
am700 <type> <version>
```

The `<type>` is `'cstatus'` for channel status files, or `'userbit'` for user bit files. For now, there is only one valid <version>, and that is 1.0. All columns should be separated by a blank space and the header must be on one line. When a filename is chosen either from the user interface or remotely using SCPI commands, the AM700 opens the file and makes sure the header is present and valid.

Data. The data in the example file is:

```
00000000 10000000 00000000
0 0 0
0 0 0
0 0 0
0 0 0
0 0 0
0 0 0
0 0 0
```

Things to note are:

■   The data consists of 24 bytes separated by white space.

■   Line feeds only are used to advance between lines. If a carriage return is used, the file will not be interpreted correctly.

■   You can describe each byte in decimal, binary, or hexadecimal. The AM700 determines the base by looking at the number of characters you use to describe the byte. Hexadecimal values must be preceded by '0x'

■   Data is entered in transmission order.

NOTE. If you create or edit a User Bits or CStatus file, do not use an editor that converts linefeeds to carriage returns. Files containing carriage returns will not be interpreted correctly.

User Bit and Cstatus File Locations. The AM700 expects these files to be in certain directories. Channel status files are placed in the following directories:

rom:/cstatus, or nvram:/cstatus

User bit files are placed in the following directories:

rom:/usrbit, or nvram:/usrbit

Users can store files only in the nvram: directory.

Filename. Touching this soft key displays a screen where you can specify the drive (NVRAM or ROM), directory, and the file name where channel status or user information is stored (see Figure 4-10).
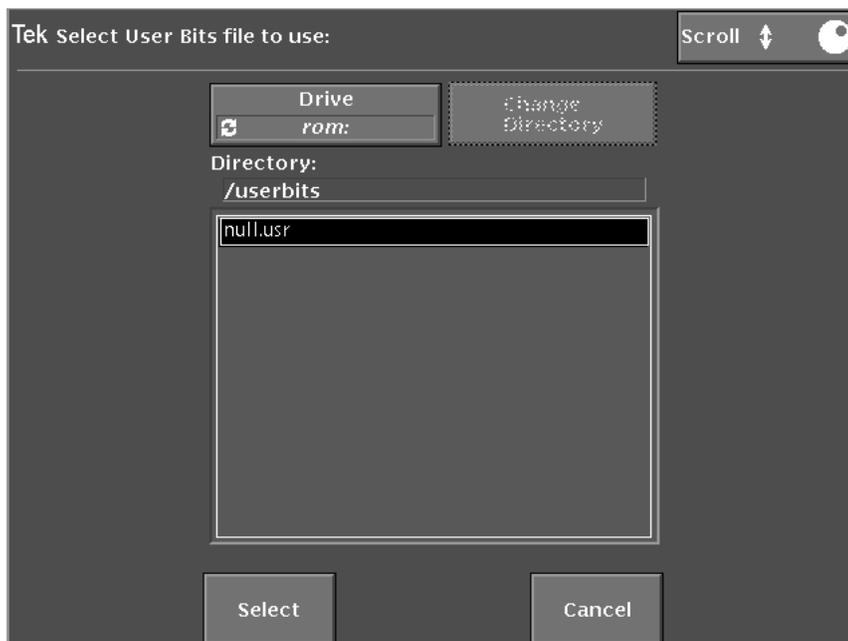

Figure 4-10: User Bit filename selection list

To switch between NVRAM and ROM, touch the Drive soft key. If there is a directory available in the selected drive, the Change Directory soft key can be used to move into that directory if it is selected. To select a directory or file in the list, touch the directory or file name to make the selection. Alternately, the large control knob can be used to scroll through the choice in the list. When the correct file has been highlighted, touch the Select soft key to make the selection and exit the screen. Touching the Cancel soft key aborts any changes and exits the screen.

Advanced Digital Interface

The AES11 audio standard recommends the use of a master clock for audio in studio applications. The AM700 generates a digital audio reference signal that simulates this master clock, allowing you to test the ability of equipment to lock to a reference. Controls in the Advanced Digital Interface screen, shown in Figure 4-11, also allow you to precisely adjust the frequency or phase of the digital audio generator clock with respect to an external reference. This can be useful, for example, when testing the lock-in range of a device under test or its behavior with a drifting clock.

Several soft key selections in the Interface Clock Frequency Control section of this screen determine the characteristics of digital generator and reference clocks. Selections in this screen area are: Frequency Mode, Variable Freq, Offset, and Phase Offset. In all cases, the clock frequency of the digital audio output is the same as that of the reference output.

NOTE. *Many of these controls are also accessed using the Digital Interface Tester menu. This feature permits immediate access to the digital generator signal parameters without the need to call up the Generator Control panel. When accessed from within the Digital Interface Tester, the measurement application remains displayed when adjusting the digital signal parameters.*
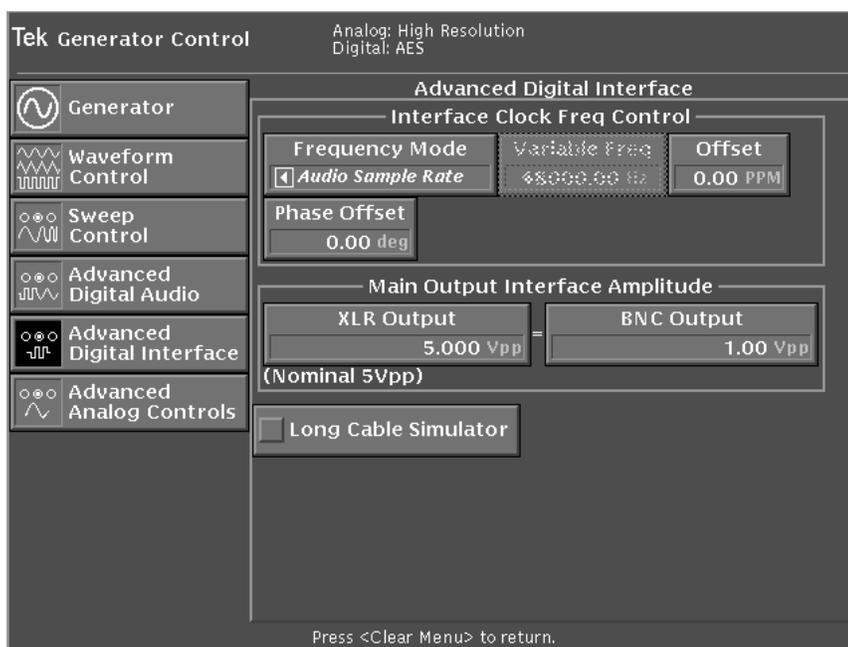
Figure 4-11: Advanced Digital Interface display

Frequency Mode. Touch this soft key to display a menu containing these selections: Audio Sample Rate, Reference Input, and Variable. The Audio Sample Rate selection sets the base clock frequency for the digital audio and reference outputs to the current audio sample rate (you can specify the audio sample rate in the Advanced Digital Audio screen). The clock frequency can be offset (in parts per million) from this base, and the clock phase difference between the digital audio and reference outputs can be varied to check the locking range of a device under test.

The Reference Input selection sets the base clock frequency for the digital audio and reference outputs to the clock frequency present at the rear-panel reference input. The clock frequency and digital-to-reference output phase can again be offset.

The Variable selection allows you to adjust the clock frequency over the full range from less than 27 kHz to greater than 54 kHz in steps of approximately 1 Hz.

Variable Freq. Edit this field to specify the clock frequency when in Variable Frequency mode.

Offset. Edit this field to adjust the output clock signal frequency offset (in parts per million) with respect to the internal audio sample rate or the external reference input.

Phase Offset. Edit this field to change the phase (in unit intervals) of the digital audio output clock with respect to the reference output clock.

Main Output Interface Amplitude. Use the Main Output Interface Amplitude section of the Advanced Digital Interface screen to adjust the voltage on the XLR or the BNC output connectors. This is useful when you want to determine the lowest input voltage at which an instrument can lock to an input signal. The ratio of BNC-to-XLR connector output voltage is always 1:5. Selecting one field editor and changing the voltage automatically updates the voltage value shown in the other field editor in this ratio.

Long Cable Simulator. Use the Long Cable Simulator check box to switch a low-pass filter circuit in and out of the XLR digital audio output. The purpose of this is to distort the signal in such a way that it simulates the signal that is present on a cable roughly 100 meters long. This can be used, for example, in acceptance testing to determine whether an instrument is able to lock to a signal received from a long cable.

Advanced Analog Controls

Selections in the top two rows of the Advanced Analog Controls choices, shown in Figure 4-12, apply to Channels A and B separately, while selections in the third row apply to both channels.
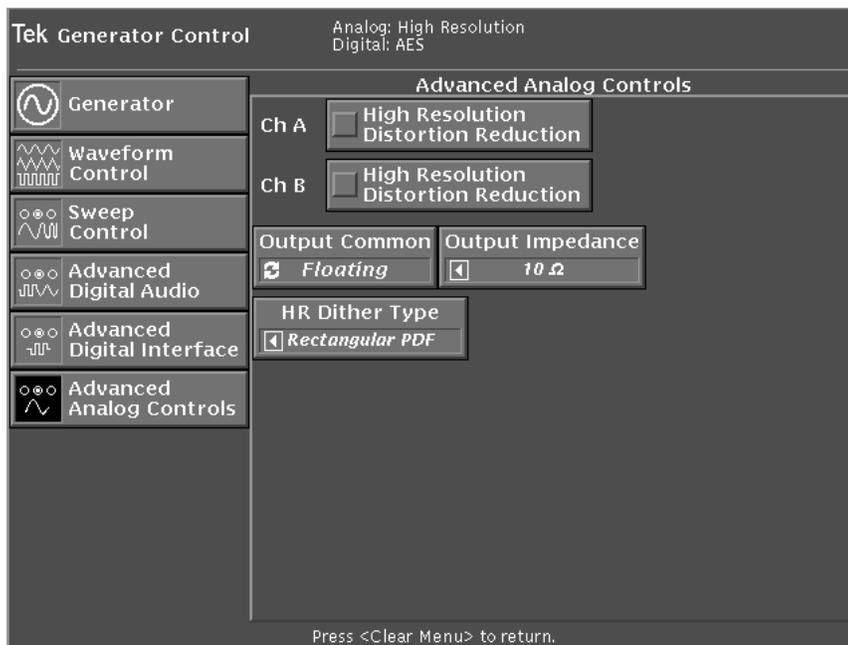
Figure 4-12: The Advanced Analog Controls display

Selections in this screen include the following choices:

High Resolution Distortion Reduction. Touch this soft key to toggle between distortion reduction enabled and disabled for both generator channels. Each generator channel contains a bandpass filter that can be switched in or out. When the generator produces sine waves, selecting Distortion Reduction mode centers the bandpass filter around the generated sine wave to attenuate surrounding distortion.

Because this is an analog bandpass filter, time is required to center the filter during a sweep. Disabling Distortion Reduction mode switches the bandpass filter out of the circuit and improves sweep time.

Frequency response sweeps can be performed with no distortion reduction; however, measuring a signal that has extremely low residual distortion (in which the distortion of the generator becomes potentially significant) may require selecting Distortion Reduction mode to reduce generator distortion.

Output Common. Selections are Floating or Ground. Audio entering and exiting the AM700 is balanced. Under some conditions, it may be useful to break any ground loops between the AM700 and the load by floating the AM700 audio signal common. In other situations, for example in high RF environments, it may be necessary to ground the AM700 common to prevent its floating on RF that can be induced in output cables.

Output Impedance. Use this field you to select 10 Ω, 150 Ω, or 600 Ω output impedance. You can also enter the output impedance at the keypad and press Enter to accept.

NOTE. Entering any number greater than 10 or 150 and pressing Enter causes the AM700 to substitute the next higher valid impedance value.

HR Dither Type. Selections are None, Rectangular PDF, or Triangular PDF. Dither is used to reduce truncation noise, but raises the noise floor. The dither selections for the high resolution generator allow you to choose the type of probability density functions (PDF) used in dithering. Dithering is not available for the high bandpass generators.

Changing Display Measurement Units in the Status Panel

If you want to change display units (for example, to change the displayed frequency units from Hz to kHz or the voltage units from dBu to V) you must first select the editor for the value to be changed by touching it. With the value selected, press the Units front-panel button to display the Units pop-up menu (seen in Figure 4-13). Turn the knob to select the desired units and press the Select key to accept the change. You can also select units by making a direct selection with a press of the appropriate units key (in the column under the Units button) and by repeatedly pressing the Units button to rotate through the choices (with or without the Units pop-up menu being displayed). When the unit is set to what you want, press the Select key to accept the choice and deselect the editor. The associated number changes appropriately for the unit selection.
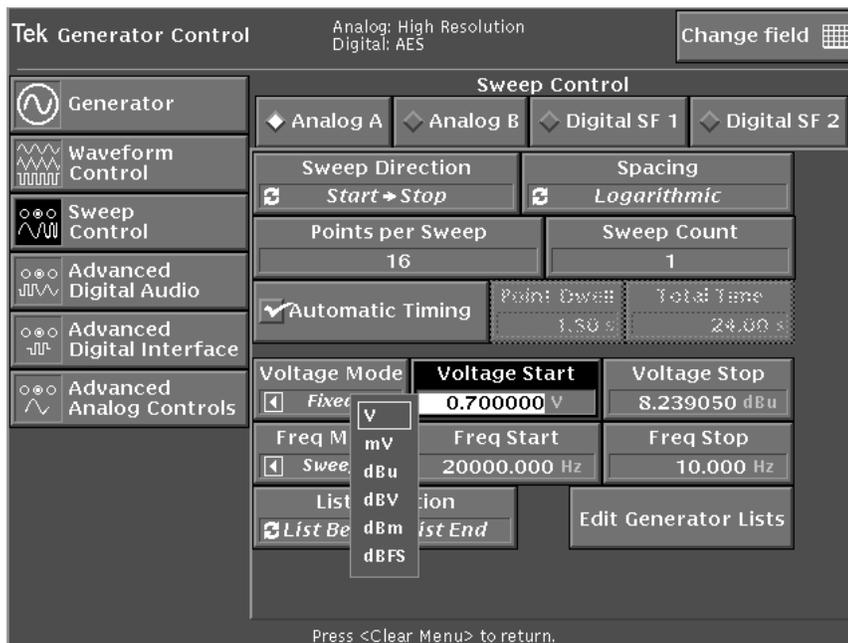

Figure 4-13: Units menu with choice for voltage units shown

Set Reference

Within the generator status window you can set a generator frequency or level setting to be displayed with reference to a value you specify. This feature can be used, for example, when you want to display the generator output level as a delta from a specified reference value. To set a generator reference, perform the following steps:

1. With an application running, touch the generator status icon to display the generator status window.

2. Touch the generator status window to focus the controls to the generator.

3. Press the Select button one or more times to highlight (select) the generator parameter you want to display as a reference value.

4. Set that parameter to the value you wish to be the reference number for that generator parameter using either the large control knob (for small changes) or the keypad (for direct entry of the reference value).

NOTE. If you make the setting using the keypad and Enter keys, you will have to reselect the parameter again to use the Set Ref feature for that parameter.

5. Press the Set Ref button.

The AM700 now displays any changes as deltas (changed values) from the reference value you specified. Level values are displayed in dBr, delta V, or delta mV as appropriate for the units, and frequency values are displayed in delta hertz.

NOTE. When touched, a function soft key having a triangle in a box displays a pop-up menu of selections for the function. You can choose a selection by turning the control knob, then accept the selection by touching the pop-up menu. The most recent selection is displayed on the soft key.

Audio Generator

Audio Analyzer

The AM700 Audio Analyzer application provides both graphical displays of audio measurements made on stepped sine-wave signals (either frequency or amplitude sweeps or both) and real-time measurement readouts of the applied signal. Measurements can be made on a single channel, dual channels, and stereo pairs. Available measurements include frequency, level, THD+N, THD, IMD, level difference between channels, phase difference between channels, crosstalk and separation. The graphical displays can be configured to display any of these measurements against either frequency or level from either channel in any of the four views. The real time measurements are displayed in a separate view window (see Figure 4-14). A real time Wow and Flutter measurement is also available.
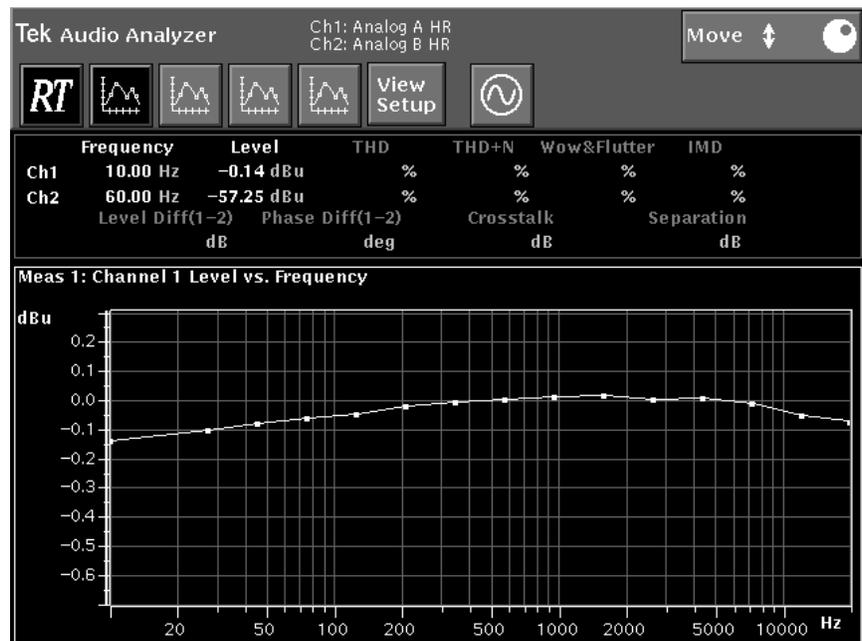

Figure 4-14: Audio Analyzer graphical display with real time (RT) view visible

Acquired audio samples can be processed through one of several standard filters before the measurements are made. Measurements are then made on the filter output and those results are plotted or displayed in the real time measurement readouts. Sweep detection and data settling features assist in defining when acquired data will be accepted and plotted. These features are discussed beginning on page 4-61.

Measurement modes available are XY mode and Regulation mode. XY mode has two options for operation, open-loop and closed-loop. In open-loop operation, XY measurements are made independently of the source of the applied signals. Either the audio generator of the AM700 or an external generator can be used to provide test signals to the device being tested by the analyzer in open-loop operation. When operating in closed-loop, the internal generator of the AM700 supplies the test signal, normally a sweep signal. As the sweep progresses in closed-loop, the Analyzer tells the generator when to step to the next point in the sweep.

Regulation mode is also closed-loop operation. In Regulation mode, the Analyzer has more control than just telling the generator when to step. It drives the generator to obtain specific output, for example a certain level of harmonic distortion, from the device under test. Both of these modes are discussed in the following text.

NOTE. The requirements of Regulation mode and closed-loop XY mode measurements are such that they should not be made at the same time.

XY Measurement Mode

Measurement mode is selected in the General Controls section of the Configure Measurements display (accessed when you press the Configure button and touch the Measurement Setup soft key). See Figure 4-15. In this mode, the Audio Analyzer assembles settled data points into a trace that is displayed either graphically or in a table, depending on how you configure the display.

Axis Assignment. The display X-axis (the independent variable) can be either a frequency or a level, and its source can be Channel 1, Channel 2, or the output of one of the generators.

The display Y-axis (the dependent variable) can be one of the following: frequency, level, THD, THD+N, IMD, phase difference, separation, crosstalk plus noise, or

level difference. Its source can be either Channel 1 or Channel 2. You can plot a dependent variable against the independent variable, which can come from one of the generators. For example, you can plot an acquired level versus a generated level to test response linearity. This allows the linearity test to be performed directly against generator output, eliminating the need to loop the generator back to one of the inputs.
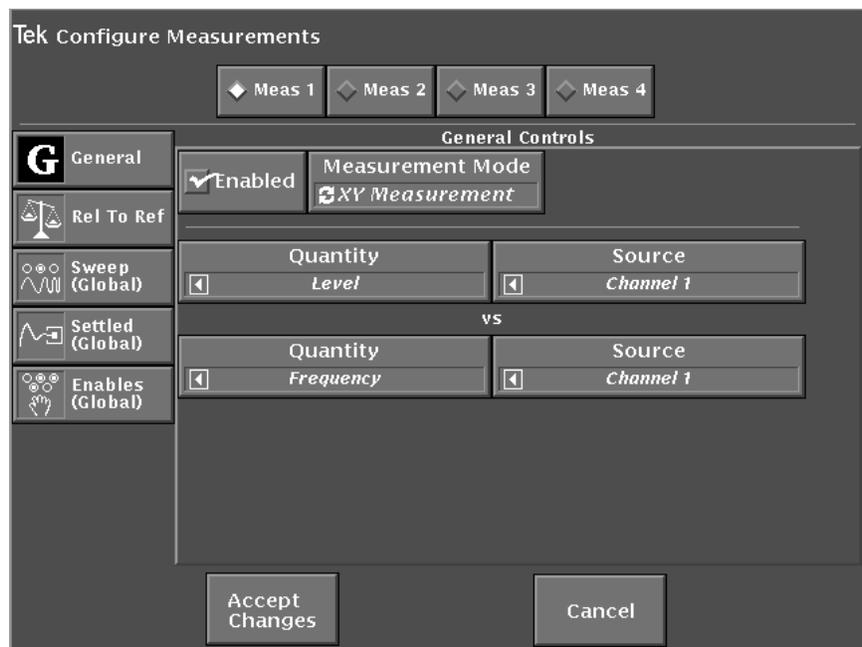
Figure 4-15: General controls XY Measurement mode menu selections

Regulation Mode Measurements

Like XY measurement mode, Regulation mode can be accessed when you press the Configure button and touch the Measurement Setup soft key. Setting the Measurement mode to Regulation mode displays the choices shown in Figure 4-16.

Regulation mode operation is a combined generator and analyzer system for checking the quality of an external device. The analyzer takes charge of the generator and drives it to produce a specified measurement result at the output of the device under test. The parameter being checked is selected in the Quantity field editor from a choice of Frequency, Level, THD, or THD + N.

Figure 4-16: General controls with Regulation mode menu selections

For example, when checking for THD at the specified starting frequency the analyzer causes the generator to vary its amplitude until the analyzer receives a

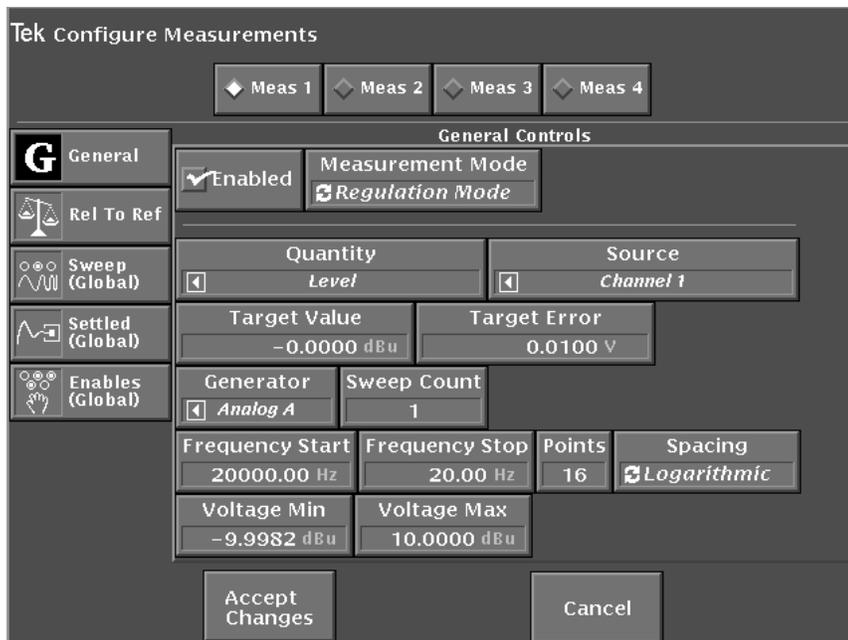measured THD as set in the Target Value field editor (the starting and ending frequencies are specified with the Frequency Start and Frequency Stop field editors). See Figure 4-16.

Generator and Frequency Selection. In the General Controls menu, you can select the generator to be used (from the Generator selection menu). You can also set the sweep count. A 0 sweep count setting causes a continuous repetitive sweep. Specify the sweep frequency range with the Frequency Start and Frequency Stop settings and set the number of steps in the sweep with the Points field editor.

Target Value and Target Error. Target Value is the value the analyzer attempts to locate as it sweeps the generator in the range specified by the Frequency Start, Frequency Stop, Voltage Min, and Voltage Max settings. Target Error is how much the acquired value can differ from the target value and be considered valid data.

When the target value is realized, the analyzer moves to the next specified frequency and causes the generator to repeat the process for the next measurement point. The points that are displayed in the trace are the level/frequency pairs that actually produce the target input to the analyzer. For example, if you are looking for a specific THD value, the target value does not appear on the graph — the level/frequency pair that produces the target value does.

NOTE. *Do not set the Voltage Min to 0 V or to the minimum possible dBu level. Regulation must be able to find a frequency to determine that it has started.*

Search Limits. The Voltage Min and Voltage Max settings are the boundaries for the range of voltages that the generator operates over as it attempts to produce the required target value. Set the limits to cover the expected response characteristic of the device under test. If the device has gain, the input limits must be divided by the gain to provide the correct output voltage from the generator to drive the device to the target value. Knowledge of the acceptable input level range to the device under test must be used to determine the acceptable limits. Setting the limits wider than needed increases the search time. In particular, if the Voltage Max is set to a level that can cause the device under test to clip or overload, Regulation may not be able to obtain the Target Value setting. This is because if the device under test does clip while the generator is being adjusted, the combined system will be nonlinear and may no longer be monotonic.

Delay Time. Most devices that you might test with Regulation mode do not have instantaneous response time, so you must specify a delay (the amount of time between generator adjustment and first data-point acquisition). Setting a delay is done in the Settled Data Point Detection Controls screen. (See the *Settled Data Point Detection Controls* discussion on page 4-65.) The suggested minimum delay value for use with Regulation mode measurements is 1.0 to 1.5 seconds.

Timeout. In certain instances a data point may never settle. The Timeout setting in the Settled Data Point Detection screen tells the generator to go ahead to the next point when settling does not occur within the time permitted. See *Settled Data Point Detection Controls* on page 4-65.

NOTE. Settled measurement criteria are the same in both regulation and XY mode. Frequency or level dropout on the input causes data points to be discarded. If the frequency or level is not stable, the datum point is displayed as an unfilled point (unsettled).

Linear or Log Spacing. Frequency spacing of the test points can be set to logarithmic or linear by touching the Spacing soft key. A touch toggles between the two choices.

Running Regulation Mode. After setting up the target values, settling adjustments, and making the external electrical connections to the device under test, Regulation mode is ready for use. The Regulation mode measurement is controlled by soft keys in the Plot Control menu (see Figure 4-17). Press the Menu front-panel button to display the Audio Analyzer menu and touch the Plot Control soft key. This brings up the Plot Control soft keys. Their operation is discussed in *Controlling Plotted Data* on page 4-58.

NOTE. A Regulation mode sweep is not started by pressing the Sweep/Run button. You must use the Start and Stop Regulation soft keys in the Plot Control menu to control Regulation mode.
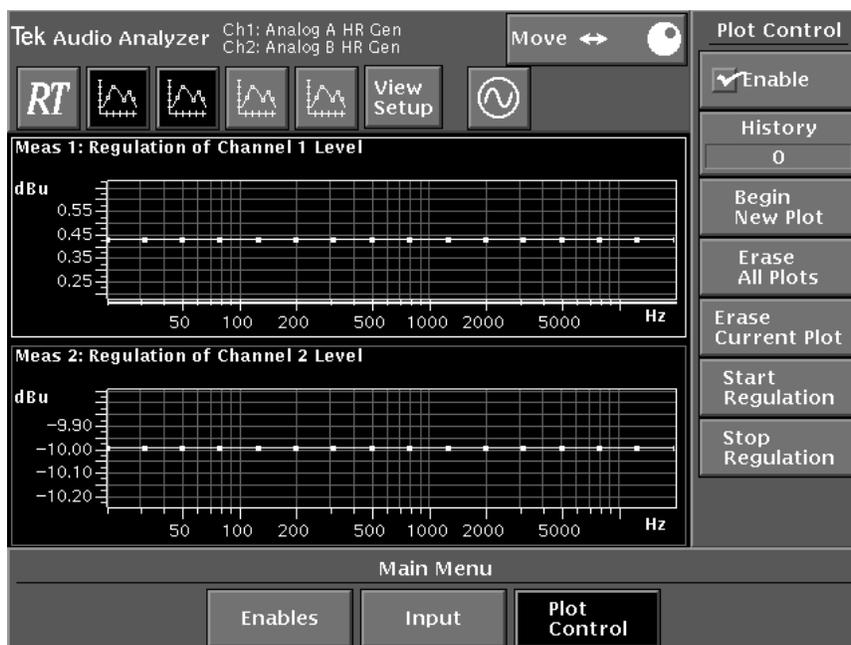
Figure 4-17: Regulation mode with Plot Control menu

When the selected view is displaying a Regulation mode measurement (as determined by the Measurement mode selection in the Configure Measurement controls shown in Figure 4-16 and the View Setup selection shown in Figure 4-18) the Start Regulation and Stop Regulation soft keys are accessible. (Refer to *View Setup* on page 3-7 and the *View Setup* discussion on page 4-74 for more information on setting up a View Type.)

Figure 4-18: View Setup for Regulation mode measurements

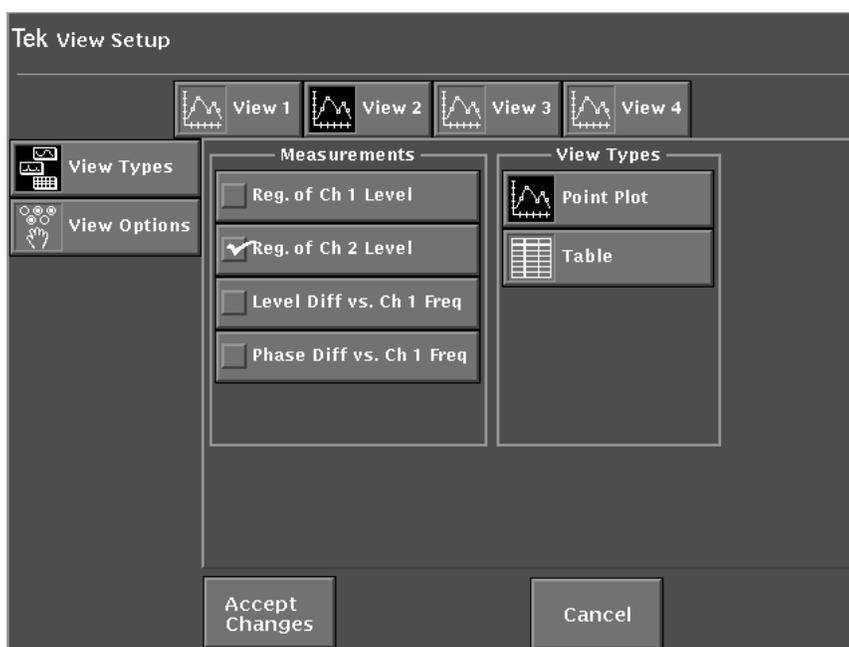Touch the Start Regulation soft key to begin the measurement plot. If you want to stop the measurement before the plot has completed, touch the Stop Regulation soft key. If more than one view is displaying a Regulation mode measurement, as in the example shown in Figure 4-19, touch the view window you want to run Regulation mode in before touching the Start Regulation soft key. Regulation is started in the active view window only. If you have set up separate generators for use, for example A Analog is running on measurement 1 and B Analog is running on measurement 2, you can immediately touch the second view window and touch Start Regulation to commence that measurement as well. Both will run concurrently.
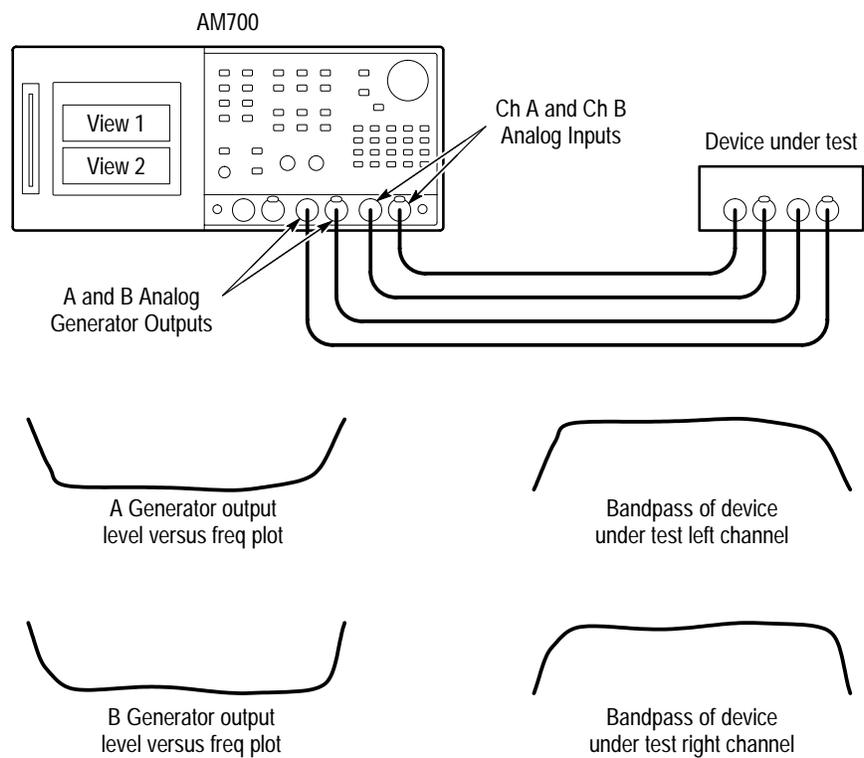
Figure 4-19: Regulation mode bandpass measurement of level versus frequency

Making a Closed-Loop XY Measurement

There are many parameters that are possible to change when using the Analyzer in closed-loop operation. Some of these are the same with either closed-loop (Analyzer drives the internal generator) or open-loop (Analyzer and generator are independent) operation. Many of the settings presented in the following procedure are already correctly set as the default settings of the AM700 on power up and will not have to be changed for most measurements. They are given in this example exercise as a reminder of the choices that can be made.

Some knowledge of the type of information you want to extract from a measurement is required to optimize the generator for your testing application. The example procedure described here uses the Analog generator. The Digital generator can be used for testing digital audio devices. Setting up Meas 1 for a Level versus Frequency measurement is the example used, but the procedure for setting up any of the other available measurements is the same. When closed-loop operation of the Analyzer is selected (Generator chosen as the sweep source), all the measurements are globally set to closed-loop.

The following procedure sets up the audio Analyzer:

Audio Analyzer Setup

1. Press the Analyzer button to start the Audio Analyzer application if not already running.

2. Press the Configure button; then touch the Measurement Setup choice.

    a. Select Meas 1 for configuration.

    b. Enable Meas 1 if it is not enabled. You can enable all the measurement choices, but only those you want to define need to be enabled. Disabling those measurements that are not wanted improves the measurement speed.

3. Define the measurement you want to make in Meas 1. The Quantity and Source selections are used to define the axes of the graphical display. A common selection is to make a Level versus Frequency sweep to determine frequency response. The top Quantity and Source line is used to define the Y-Axis of the graph. The bottom Quantity and Source line is used to define the X-Axis.

    a. On the top line, touch the Quantity choice to display the available Y-axis choices in a pop-down menu.

    b. Select Level (using the large control knob to scroll through the choices).

    c. Touch the pop-down area to enable the selection.

    d. Touch the Source choice to display the choices in a pop-down menu.

    e. Select Channel 1 and touch the pop-down area to enable the selection.

    f. On the second line, repeat the previous steps to define the X-Axis. Select Frequency as the Quantity and Channel 1 as the Source.

4. Touch the Sweep choice to display the Sweep Detection Controls.

    a. Enable Sweep Detection.

    b. Select Generator as the Sweep Source (this puts the Analyzer in closed-loop mode). Notice that all the External Sweep Attributes are grayed out. In closed-loop mode, the Analyzer controls the sweep timing and pressing the Sweep/Run button explicitly determines the start of the sweep.

5. Touch the Settled (Global) choice to display the Settling controls.

    a. Enable Settling Detector if it is not enabled. The default settings for the remaining choices can be used as a first guess about what will finally be needed for your measurement. If you find that Timeout is reached without finding settled data, you may need to increase the Tolerance setting. Read the *Settled Data Point Detection Controls* on page 4-65 and the Sweep Source information in *Sweep Detection Controls* on page 4-61 for more information on each of the possible choices. Generally you must decide on the Settling choices based on the test being made and the electrical parameters associated with the device being tested. Some of these are the following:

- Propagation delay of the signal through the device

- Amount of time it takes for the signal to settle after a step

- Amount of noise or distortion accompanying the signal

- Length of time to wait for a timeout when settled data is not found

- Number of samples to consider in determining if the data is stable

- Minimum amplitude of the signal to be accepted for settling

6. Touch the Enables (Global) choice to display the choices for enabling the measurements and channels. In this example only Channel 1 is being used and no THD, IMD, or Wow & Flutter measurements are being made.

    a. Enable Channel 1 Measurements and disable the remaining selections. Notice that if either Channel 1 or Channel 2 is disabled, Stereo Measurements is not an available choice.

7. Touch Accept Changes to make the selections valid. This saves the setup and exits from the Configuration Menu.

The following procedure describes how to select the generator and waveforms:

Generator and Waveform Selection

1. Press the Control button in the Generator section of the front panel to display the Generator Control panel.

   a. Select the High Resolution generator. Either analog generator can be selected as needed for your test requirement. The High Resolution generator has a range up to 20 kHz and provides a monophonic pair of signals if Channel B is set to Follow A or a stereo pair if Channel B is set to produce a signal independently of Channel A. The High Bandwidth generator goes up to 80 kHz, but can only produce the same signal on both A and B, not a stereo pair.

   b. Set Waveform to Sine on Ch A and to Follow A on Ch B. Follow A is the only choice with the High Bandwidth generator. Sine waves are used for the majority of tests made using a sweep signal in closed-loop testing.

   c. Enable the Output of both Ch A and Ch B if both are going to be used. Disable the Output of any generators that are not needed. This prevents them from sweeping. Remember, all enabled sweeps will run when the Sweep/Run button is pressed. Having undefined and unneeded sweeps running can cause some testing delays. For example, if the digital generators are enabled, the sweep definitions for those generators can have many more points and include different start and stop frequencies than the analog generator that you are using for making the test. If those sweeps are permitted to run, they have to complete before the sweep ends.

2. Touch Waveform Control to display the Waveform Control choices. Two of the choices are used to set the frequency of a CW signal and amplitude of a fixed amplitude signal. Since the test signal is a frequency sweep, the Frequency setting is not required. However, you must set the amplitude of the sweep signal needed for the test.

   a. Select Analog A. The type of signal (Sine) was previously set in the Generator choices screen. That same selection ability is provided in this screen so you don't have to switch between control screens to change to the signal type.

   b. Touch Amplitude and set the amplitude to 0.00000 dBu either using the control knob or by making a direct keypad entry (the fast way—press 0 then Enter).

3. Touch Sweep Control to display the Sweep Control settings. Notice the message "Sweep timing is being controlled by Analyzer" near the middle of the display area. This confirms that the generator is set for closed-loop operation with the Analyzer. Automatic Timing, Point Dwell, and Total Time are not available choices in closed-loop mode. The Sweep Count setting can be changed.

4. The following choices are made based on the test requirements. For this example, make the following choices:

    a. Set Sweep Direction to Start to Stop.

    b. Set Sweep Count to 1.

    c. Set Spacing to Logarithmic.

    d. Set Points per Sweep to 24.

    e. Set Voltage mode to Fixed (this makes the Voltage Start and Voltage Stop choices unavailable).

    f. Set Freq mode to Sweep. (A list can also be used in closed-loop testing.)

    g. Set Freq Start to 15000 Hz. (Direct keypad entry is best for making these types of changes.)

    h. Set Freq Stop to 100 Hz.

5. Press Clear Menu to exit the Generator Control panel.

The following procedure describes how to connect the signal to the measurement channel:

Connecting the Signal

1. Connect the Analog Out A signal to the device to be tested. The type of cable required depends on the device being tested, but XLR to XLR is the assumed cable requirement.

2. Connect the output of the device to be tested to the Analog In A connector. Again XLR to XLR is assumed.

3. Press the Configure button on the front panel and touch Input Selection.

    a. Select the FP A (front panel A XLR connector) as the input source. Both A and B are set to the front panel XLR connectors in most applications.

    b. Set the Impedance to 200 kΩ. The matching requirement for the device being tested is used to determine the setting for your testing application.

    c. Enable Auto Range.

    d. Touch the Analog HRes Inputs to quickly set both measurement channels for the High Resolution A/D converters. This can be done individually to make selections for different input sources to the measurement channels (for example, the Analog Generator on Channel 1 and the Digital Generator on Channel 2).

NOTE. Do not confuse input channels A and B with measurement Channels 1 and 2. You can put the same input channel on both measurement channels if you so choose.

---

    e. Press Clear Menu to return to the application.

The following procedure explains how to select a view window to display the measurement:

Selecting a View to Display the Measurement

1. The View Selection Icons are shown across the top of the application window. Select the first View to the right of the RT icon. This is View 1. Deselect all other views so that only one view is displayed.

2. Set View 1 for a point plot if it is not. This is done in the View Setup menu that is accessed by touching View Setup. (An alternate route to this same screen is to press the Configure button and select View Setup.)

    a. Select View 1 for configuration.

    b. Enable Ch 1 Level vs. Frequency for View 1 if not enabled in the Measurements column. This will deselect any other choice that may have been selected.

    c. In View Types select Point Plot. This provides the graphic display of X versus Y. The Table display is very useful to supply a list of the test frequencies and the level at those frequencies.

    d. Touch Accept Changes to make the selections and return to the application screen.

3. Press the Sweep/Run button to start the measurement sweep.

Related Information   Refer to *Controlling Plotted Data* on 4-58 for directions about how to keep a history of traces for comparison, as shown in Figure 4-20, and to *Making Valid Measurements* on page 4-52 for directions on enabling the measurements and channels and selecting inputs using the menu choices. These paths are provided in the Analyzer menu to allow quicker access to some of the more often used setup controls without the need to exit the Analyzer screen. Each of the control screens accessed in the above example, for instance View Type, are discussed in greater detail in the descriptions of those screens.
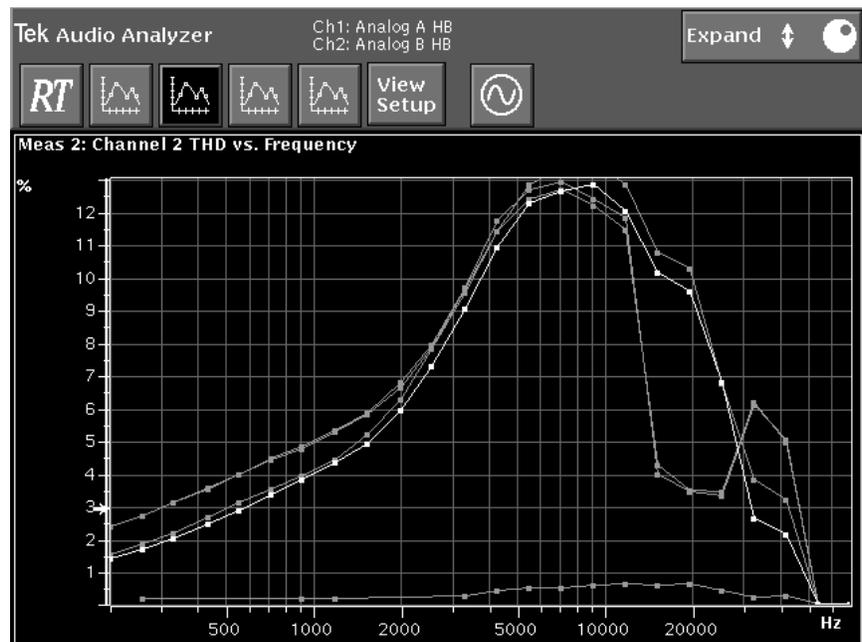
Figure 4-20: History display of Channel 2 THD versus frequency obtained using closed-loop operation

Making Valid Measurements

The Audio Analyzer application must be configured properly if it is to yield meaningful results. Values generated by Audio Analyzer measurements are not meaningful in all cases. Whether or not a measurement is meaningful depends on the type of input test signal.

For example, crosstalk and separation measurements require placing a signal on one channel and monitoring the other (undriven) channel for the presence of audio. When the AM700 has a signal on both channels, a measurement such as phase difference has value, but any displayed crosstalk and separation readings are meaningless. However, when the signal is removed from one channel, crosstalk and separation readings on the silent channel now contain useful information, while any displayed phase difference readings become meaningless.

Other measurements require special signals. For example, the IMD (intermodulation distortion) measurement needs two sine waves in order to measure their distortion product. If the two sine waves of the IMD test signal are not present, any displayed IMD measurement value is meaningless.

Configuring Input Channels

As with many AM700 applications, the Audio Analyzer makes measurements on two input channels. You can specify input signals for the two channels by pressing the Configure button and touching the Input Selection soft key to display the Input Configuration screen. Input Selection is discussed on page 3-2 in *Configuring the AM700.*

In this screen, select the desired type of input by touching the Channel 1 or Channel 2 selector to display the input selection pop-up menu. Turn the control knob to the desired input type and touch the selector to accept it. Repeat for the other input channel, if desired.

NOTE. *If either Channel 1 or Channel 2 is not enabled, stereo measurements are not enabled. Also, if the Channel 1 and Channel 2 sources are not a stereo pair, stereo measurements are not enabled. For instance, if the Channel 1 source is the High Resolution generator and the Channel 2 source is the High Bandwidth generator, the inputs are not a stereo pair, so stereo measurements cannot be made.*

Touch the Accept Changes soft key (or the Cancel soft key) to exit the Input Configuration display and return to the application.

NOTE. As with most AM700 applications, you can also make an input selection from a subset of the list in the Input Configuration screen by pressing the Menu button (from the main Audio Analyzer display) and touching the Input soft key. Refer to Selecting Input Options *below.*

The Audio Analyzer settings that control measurements, input, and how measurement data is displayed are accessed when you press the Menu button. A discussion of the menus displayed (Enables, Input, and Plot Control) follows.

Selecting Input Options

You can select the type of input from the Main menu by touching the Input soft key to display input options, or by pressing the Configure button and touching the Input Selection soft key. This was described previously.

The AM700 input digitizers operate over a fixed input dynamic range. Input attenuators and gain cells maintain input accuracy and adjust the input to the digitizer to operate over the whole dynamic range the audio input signal. In Auto Mode, the input signal level is automatically sensed; and the appropriate gain or attenuation is applied.

If you want the instrument to operate in a specific range, you must uncheck the Auto selection and use the field editor to specify the maximum RMS voltage or dBu value expected at the input for measurement, see Figure 4-21. The advantage of doing so is that measurements can occur faster because the instrument is not spending time sensing the input signal and applying appropriate gain or attenuation to the input.

Another advantage of forcing the instrument to operate in a specific range is that it eliminates switching as the sensing circuitry attempts to apply the appropriate gain or attenuation to the changing signal levels. In Auto range mode, particularly with program audio, relays in the attenuator/gain circuitry can be continually switching as they attempt to apply the appropriate gain or attenuation to a wide ranging input signal.

The Input Select choices allow you to select from analog high-resolution, analog high-bandwidth, or digital input sources.
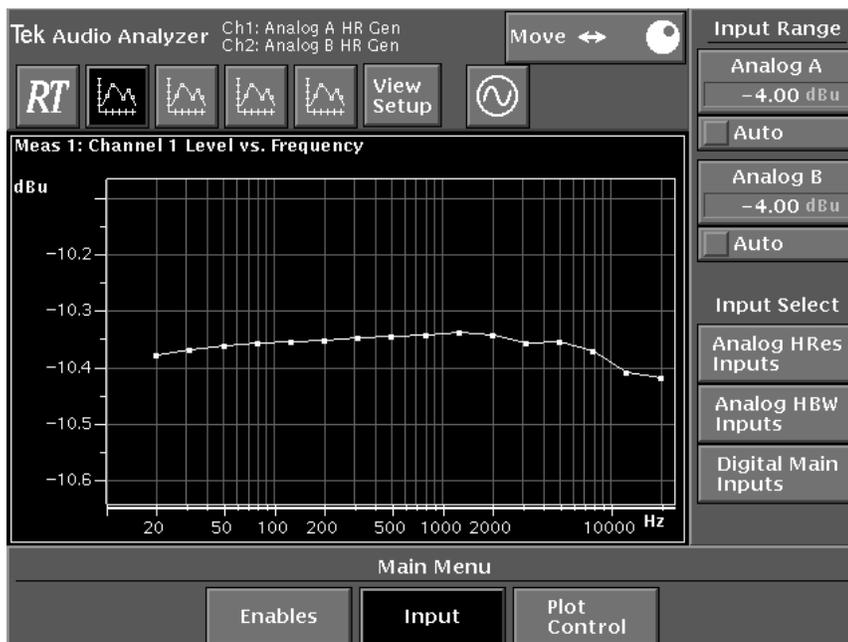
Figure 4-21: Audio Analyzer main menu with Input Range and Input Select submenus

The input selections that you make in the Main menu are a subset of the input selections available when you press the Configure button and touch Input Selection. For example, from the Input Configuration menu you can configure a digital input signal to appear on one channel and an analog signal on the other. Measurement channel assignment is discussed in *Input Selection* beginning on page 3-2.

The status lines at the top of the display list the selected input configurations.

Real Time Readout of Measurements

A real time display of the Audio Analyzer measurement readouts can be displayed either separately or together with the graphical displays. The RT View selector toggles the real-time measurements display on and off. Figure 4-22 shows the real-time measurement readouts along with the generator status readout. No graphical displays are shown as none are selected in the Views selection bar. Measurements to be made for display in the RT view are enabled or disabled by selections in the Enables submenu.
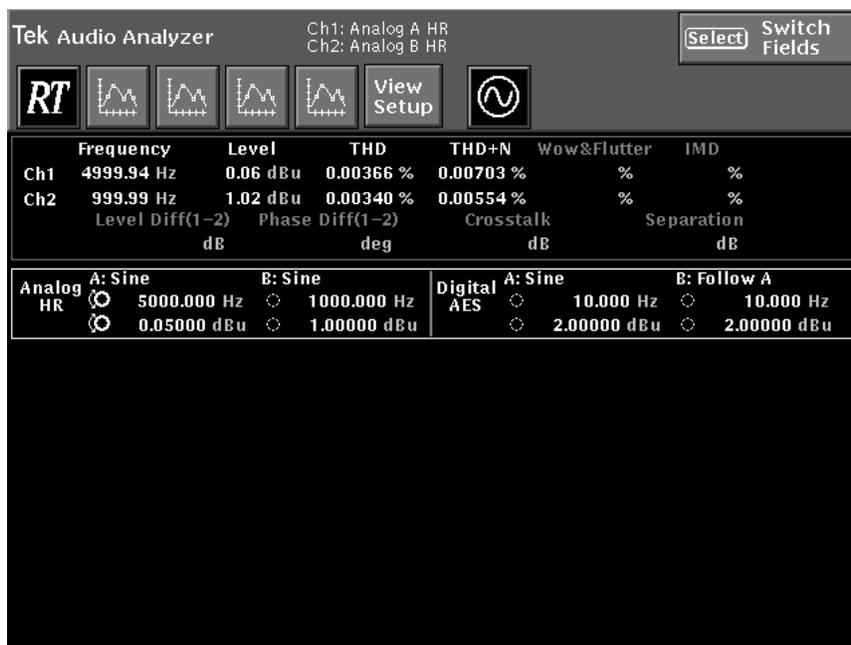
Figure 4-22: Audio Analyzer Real Time Measurements and Generator Setup display

Enabling and Disabling Measurements

You can improve the measurement speed of the Analyzer by disabling (shutting off) unneeded measurements. This is especially important when acquiring a fast external sweep. To disable unneeded measurements, press the Menu button to display the Audio Analyzer menus. Touch the Enables soft key to display the Audio Analyzer measurement selections (see Figure 4-23). Use the check boxes displayed in this submenu to select (or unselect) the desired Audio Analyzer measurements. These controls affect both the RT Measurements and the graphical measurements.
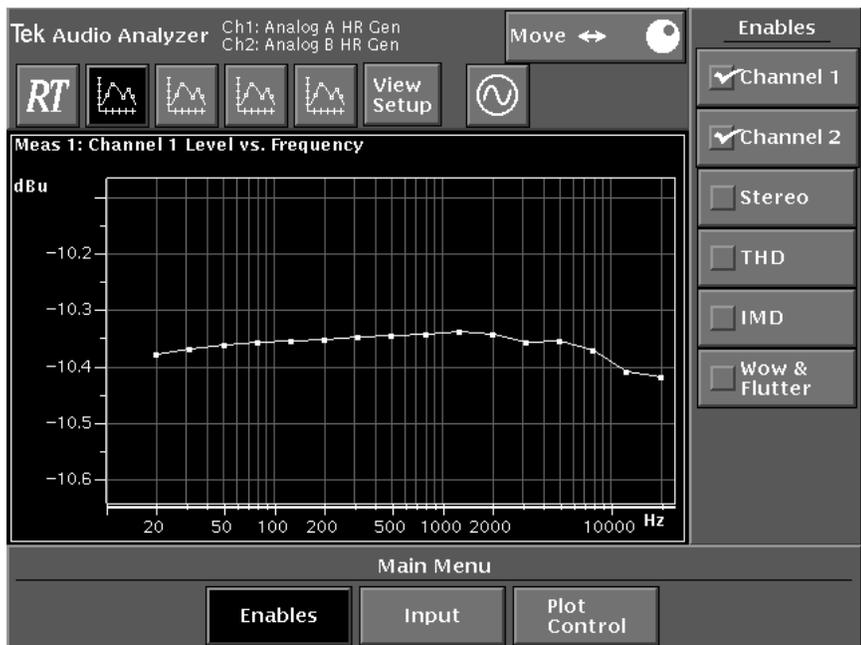
Figure 4-23: Audio Analyzer graphical display showing measurement Enables menu selections

If stereo measurements are not being made, unselect that choice, and if measurements are being made only on one channel, the unused channel can be unselected. The AM700 does not make the measurements that are dimmed in the real-time box. When unneeded measurements are off (particularly THD, THD+N, IMD, and Wow and Flutter), the enabled measurements are made more quickly.

NOTE. If measurements on either Channel 1 or Channel 2 are not enabled, stereo measurements cannot be enabled. Also, if the Channel 1 and Channel 2 sources are not a stereo pair, stereo measurements are not enabled. For instance, if the Channel 1 source is the High Res generator and the Channel 2 source is the High BW generator, the inputs are not a stereo pair and stereo measurements cannot be made.

Remember also, that when making channel separation and crosstalk measurements, setup of the channels is important to obtain the expected results. Crosstalk is a wideband measurement of the level difference between the undriven channel and the driven channel, while channel separation is a measurement of the level difference between the driven channel and the undriven channel with a bandpass filter centered on the frequency of the driven channel.

As an aid to you, the display provides feedback if a measurement choice you have defined for a view does not have the needed measurements or channels enabled. An example of the type of setup error that is possible is where the measurement defined for a view is of THD or THD+N versus Level and the THD measurement is not enabled. The error message "THD measurements are disabled" then appears below the measurement name in the view. Enable the channel and measurements you have selected for a view as indicated by the error message. In the case of the example given, press the front panel Menu button, touch the Enables soft key to display the Channel and measurement enable choices. then touch the THD soft key to enable THD measurements.

Wow and Flutter Measurement

Wow and Flutter makes an NAB type measurement that characterizes the signal degradation caused by short-term speed variations of analog recording and playback devices such as tape recorders and turntables. Frequency deviations are converted into proportional amplitude variations that can be measured. This measurement requires enough time to make that it should not be enabled except when you want to make the Wow and Flutter measurement, and other measurements should be disabled to decrease the time required to made the measurement.

Measurement Operating Information. Wow and Flutter measurements in the AM700 require approximately two seconds per channel to make. If the measurement is only being made on one channel, faster turn around time for the measurement is obtained by turning off the unused measurement channel (Channel 1 or Channel 2) in the Enables. The input signal frequency must be above 1200 Hz. If the dominant frequency is below that frequency, the measurement will not be made. Also, the measurement cannot be done using the High Bandwidth inputs of the AM700.

Controlling Plotted Data

Use the selections in the Plot Control screen to control the plotted trace displays (see Figure 4-24).

Enable   Check the Enable soft key in the Plot controls menu to enable the measurement.

History   Specify the number of traces to keep for a historical display. Touch the History soft key and enter a value (0 to 4) with the keypad or by turning the control knob. The history setting determines how many previous data traces are displayed. As a new traces is acquired, the last acquired trace becomes a history trace. When the history count is filled the oldest history trace is erased to make room for a newer one.

NOTE. Unsettled data points that are shown as unfilled circles rather than as filled points are not saved in history traces.

Begin New Plot   If History is set to zero, touching the Begin New Plot soft key causes the Audio Analyzer to erase the current plot and plot any incoming data on a blank display. If History is set to any value except zero, touching the Begin New Plot soft key causes the Audio Analyzer to convert the current trace to a historical trace and plot any incoming data to a new trace.

NOTE. Touching the Begin New Plot soft key causes the Audio Analyzer to begin a new plot, but that does not begin a new sweep. You must press the Sweep/Run front-panel button to begin a new sweep.

If Sweep Detection is enabled (see Figure 4-25 on page 4-62), it is not necessary to touch the Begin New Plot soft key before a new sweep begins; a new plot is started automatically when the start of a new sweep is detected.
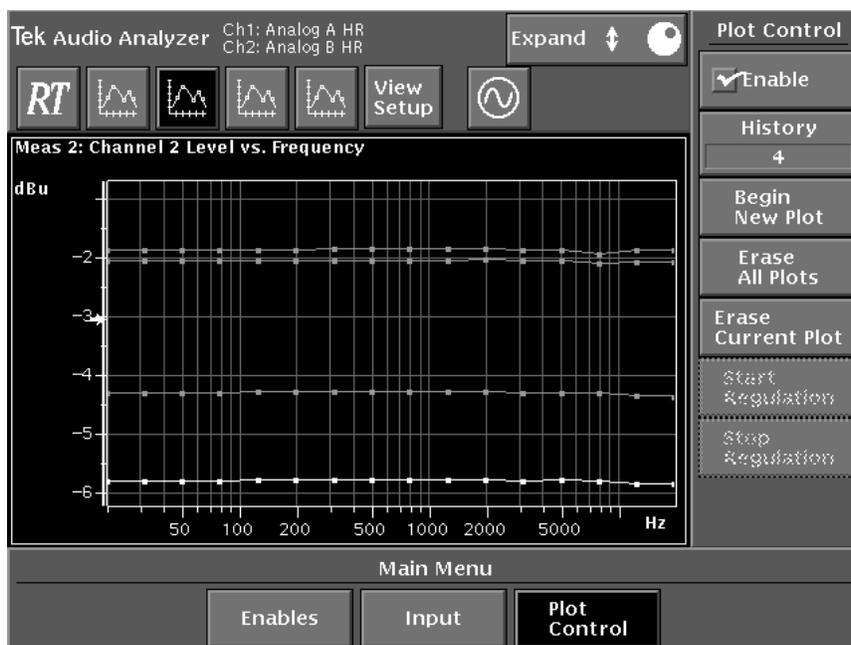
Figure 4-24: Graphical display with Plot Control menu

Erase All
Plots — Touch the Erase All Plots soft key to erase the displayed current and all historical plots.

Erase Current
Plot — Touch the Erase Current Plot soft key to erase the current plot but retain any historical plots.

Configuring Measurements

Audio Analyzer has up to four graphical views of a measurement and the real-time measurement view. You can display each of these either individually or at the same time if desired. Views can be displayed or dismissed by touching any of the five view selection icons.

To specify the measurement to be displayed in a graphical view, press the Configure button to display the Configuration menu selections, and touch the Measurement Setup soft key to display the Configure Measurements menu. In the General Controls and Relative to Reference controls, the measurements across the top of the screen are selectable. In the global controls (Sweep, Settled, and Rel to Ref), the measurement choices are not selectable and are grayed out. When the measurement choices at the top of the display are not grayed out, touch Meas 1, Meas 2, Meas 3, or Meas 4 to select the measurement you want to configure.

On the left side of the Configure Measurements screen, the selections displayed when you touch the Enables (Global) soft key permit you to enable or disable specific measurements by touching the check boxes in the Enables section of the display. Another selection in the menu allows you to specify the history count for the plotted data. With the exception of history count, these are the same selections that you can make by touching the Enables soft key in the Audio Analyzer Main menu display. History Count appears in the Plot Control submenu of the Audio Analyzer Main menu.

Settled Data Point Detection Control settings and Sweep Detection Control settings are also global; they apply to all the measurements.

General Controls
In the General Controls display you can specify the measurement mode and the characteristics associated with the selected mode.

In XY Measurement mode, the AM700 plots measurements on input signals or data. In this mode you can specify the desired measurement characteristics to be displayed and the sources for these measurements. Refer to *XY Measurements Mode* on page 4-38.

For closed-loop operation in Regulation mode, one or more generator parameters are controlled by a measured value from the analyzer. In Regulation mode, the application assumes control of the AM700 audio generator, forcing it to generate a signal that produces the desired measurement results.

Regulation mode can be used, for example, to produce a plot of the generator output level versus frequency to yield a constant 1 percent distortion. This capability is typically used by broadcast engineers for proof-of-performance testing. Refer to *Regulation Mode Measurements* on page 4-40.

Sweep Detection Controls

The Audio Analyzer works by collecting a series of settled points and assembling them into a trace. Generally, these data points are collected as a result of a sweep in either frequency or amplitude (or both).

Sweep detection can be turned on or off globally for all four measurements. Sweep detection is also configurable when the signal source is External (open-loop operation). Touch the Sweep soft key to display the Sweep Detection Controls menus seen in Figure 4-25. In this menu you can configure the settings associated with the sweep detection capabilities of the AM700. Using the Sweep Detection Controls you can select the source of the sweep and the sweep attributes. The sweep detection attributes are the direction of the sweep, detection on rising or falling edge, the sweep type (frequency or amplitude), and the minimum change in either frequency or amplitude that is necessary for sweep detection.

NOTE. Sweep detection controls have no effect in Regulation mode or closed-loop operation.

Sweep Detection Off. When sweep detection is off, all sweep source and sweep attributes selections are grayed out. All generated points plot if they settle. If they do not settle within the time out setting, an empty circle is plotted. Each data point becomes part of the same trace. You may want to operate with sweep detect off if the steps of a sweep are not settled enough to prevent the sweep detection from detecting a new sweep and starting the plot over. Turn the generator off and use the Plot controls to erase the current plot, if one is present. Press Sweep to start the new sweep plot. When the sweep light goes out to signify that the sweep is finished, turn off the generator to prevent further data from being plotted.
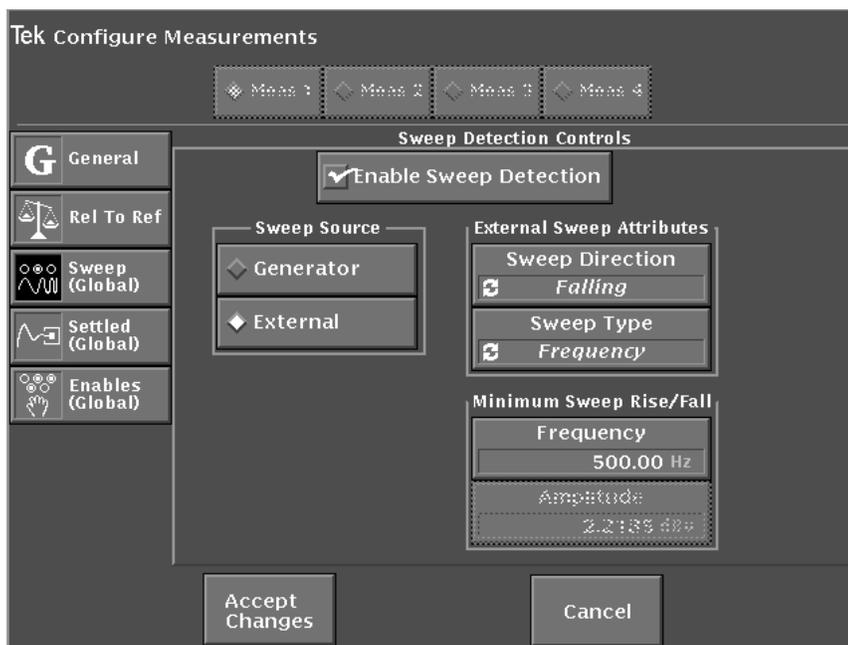
Figure 4-25: Sweep detection controls

Sweep Detection On. In open-loop operation, the sweep detector determines when one sweep ends and another begins as defined by the External Sweep Attributes and Minimum Sweep Rise/Fall settings. A new sweep is detected when a data point value changes more than the detection level minimum settings (Frequency or Amplitude) in the correct direction (rising or falling) to indicate a sweep start, and a new plot is started. Data from previous sweep traces (or previous data in the same trace) is discarded unless held in history traces.

Sweep Detection Attributes

Enable sweep detection and select External Sweep Source to access the External Sweep Attributes choices. The detection settings are global; they apply to all the measurements.

External Sweep Attributes. Select the direction of sweep to detect (rising or falling) and the sweep type to detect (frequency or amplitude) for the selected measurement.

When a frequency sweep is selected the Frequency choice in the Minimum Rise/Fall menu is enabled, and when an amplitude sweep is selected the Amplitude choice in enabled.

Minimum Sweep Rise/Fall. Specify the frequency or amplitude rise or fall (as determined by the direction choice in the External Sweep Attributes menu) that must occur to indicate the start of a new sweep. The default minimum rise/fall settings are defined in the instrument specifications.

Sweep Source   The sweep source can be either the internal generator or an external sweep source.

Generator. The Generator/External selection in Sweep Controls is for either Generator (closed-loop) or External (open loop). When in closed-loop mode, the Analyzer drives the Generator. A text line in the Generator Sweep Controls menu display, "Sweep timing is being controlled by Analyzer" tells you that the Analyzer is operating in a closed loop with the generator. During a sweep, additional feedback is provided in the measurement view beneath the Measurement name. For those measurements that have Generator as the selected source, the words "Controlling Generator" are added.

In closed-loop mode, when a sweep is started, the generator begins at the first step in the sweep. The analyzer waits for the delay time (set in the Settling settings), then looks for settled data. When the data has settled, the generator is advanced to the next frequency step. Now the analyzer uses the variance settings (amplitude or frequency) or delay setting (whichever comes first) to determine when a change occurs. After it sees a signal change that is larger than that defined by the variance setting (either frequency or amplitude as specified), the analyzer begins looking for settled data again. And again, when found, the generator is advanced to the next step.

All enabled closed-loop measurements, displayed or not, must either find settled data or time out at each generator step to permit the generator to advance to the next step. This process continues for each generator step to the end of the sweep. An illustration of these steps is shown in Figure 4-26 on page 4-65.

Closed-Loop Operating Hint. All enabled measurements, displayed or not, need to find settled data or time out before the generator is allowed to advance to the next step. Since some measurements take longer to make than others, you should be sure that only the needed measurements are enabled.

It is possible to set up a different sweep setting for each measurement. If some measurements have more independent variable points specified than others, remember that the sweep does not complete until all the points are taken. As an example, assume measurement 1 is specified as Level versus Frequency in Channel 1 with 16 data points and measurement 2 is enabled and specified as THD+N versus Frequency in channel 2 with 24 data points. The THD+N measurement, which takes longer to settle than the Level measurement, will control how often the generator frequency is allowed to advance. The closed-loop sweep will not complete (Sweep/Run LED go off) until all 24 THD+N data points have been taken. The 16 point and 24 point sweeps will both have their data points evenly distributed between the start and stop frequencies.

External. This is the open-loop mode of Analyzer/Generator operation. For open-loop operation, the generator and the analyzer are independent of each other. Sweep detection is still available to recognize the start of a sweep. Set the External Sweep Attributes for the direction of the sweep (up or down), the type of sweep (frequency or amplitude), and the minimum change of either frequency or amplitude (as appropriate to type of sweep) to be recognized as a change to identify sweep start. When Sweep Detection is enabled, only those settled data points that occur after a sweep is recognized are plotted.
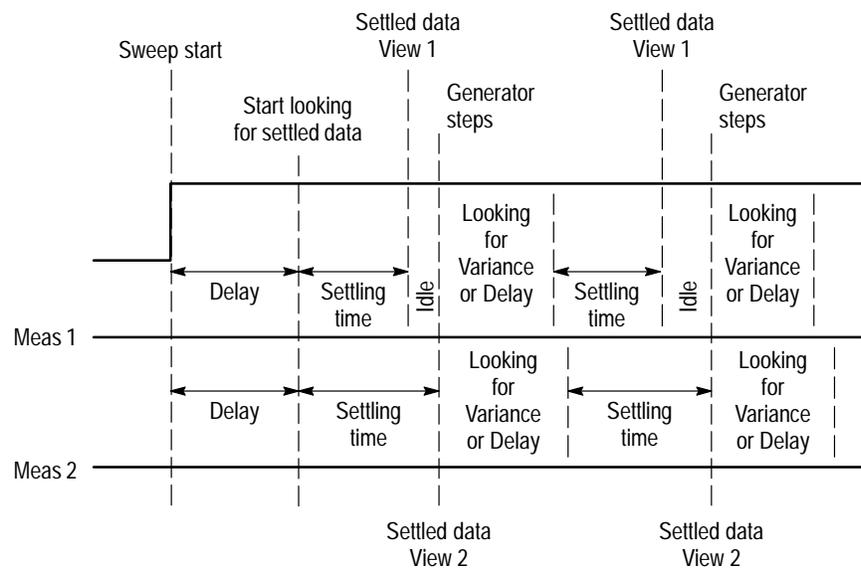
Delay Settling is Global and both measurements wait for the same Delay time to start looking for settled data on the first data point.

After both measurements have settled data, the generator is stepped. Both measurements then use either the Delay or Variance to determine when to start looking for new settled data.

Again, after both measurements have settled data, the generator is stepped. This process continues until the sweep has finished.

Figure 4-26: Closed-loop measurement showing how delay, settling time, and variance affect the generator steps

Settled Data Point Detection Controls

The AM700 makes measurements continuously, but any particular data point may not be a representative value, especially after a frequency or amplitude step change in a test signal. Display of these momentary variations in the input signal is not desirable, because they are momentary and do not represent the true response of the device under test. Settled data detection allows the instrument to evaluate groups of measurements to determine when the incoming data is stable so that a settled measurement can be made.

Touch the Settled soft key in the Configure Measurements Setup screen to display the Settled Data Point Detection Controls (see Figure 4-27). In this display are the controls for defining a settled data point to the Audio Analyzer. You can select the settling mode, the minimum settling level, the amount of delay time for a data sample to settle before it is accepted, and the amount of time to wait for a sample to be acquired. You can also define data sample variation and the number of raw data samples that will be acquired for each settled data point. This screen consists of Controls, Tolerance, and Resolution sections.

NOTE. The settings for all of the controls in the Settled menu are global and need only to be set one time for it to be effective in all four measurements.
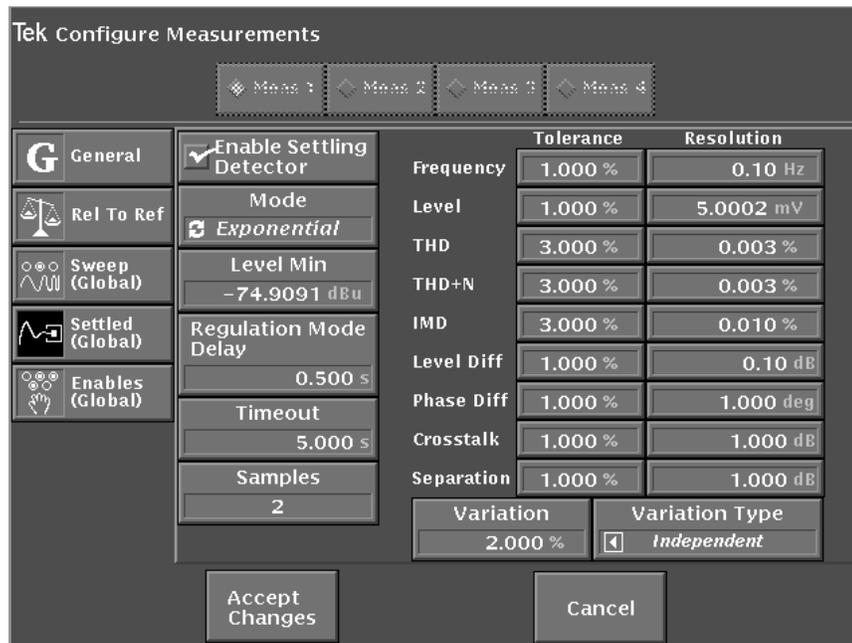
Figure 4-27: Settled data point detection controls display

Settling Detector Enable. Checking the Enable Settling Detector causes the Audio Analyzer to use only settled data; leaving it unchecked permits the Audio Analyzer to accept all measurement data from the DSP (digital signal processor).

NOTE. Unsettled data points, shown as unfilled circles in a plot, are not considered valid data and are not saved in a history plot if History is enabled in Plot Control.

Settling Mode. You can define the settling curve by setting the mode to Exponential or Flat. The Tolerance and Resolution curves are both affected by this selection. An exponential settling curve applies an exponentially-shaped window (window height is determined by the Tolerance or Resolution setting) backwards over time from the last data sample (see Figure 4-28). Exponential is the recommended settling curve selection for most applications, since most transient signals settle exponentially.
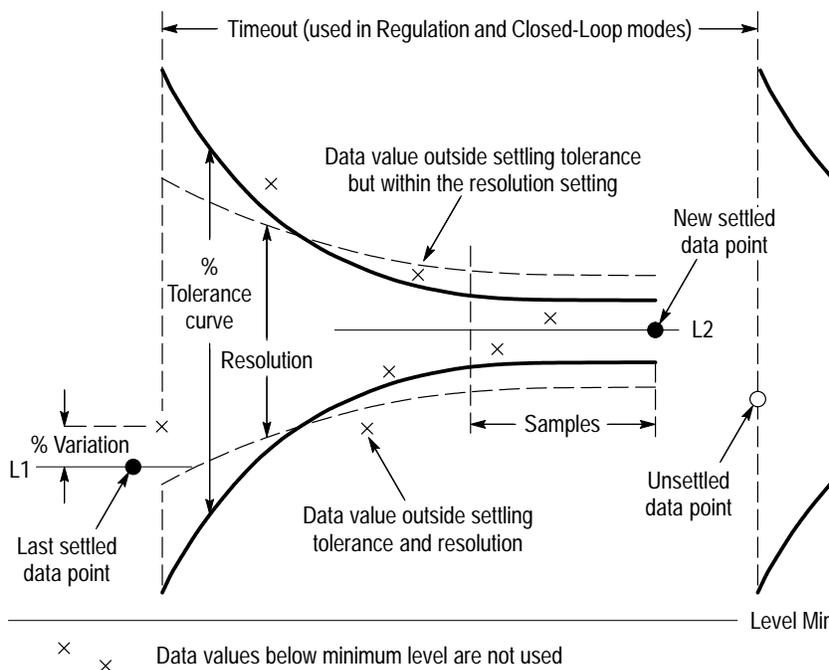
Figure 4-28: Exponential settling in Audio Analyzer

A flat settling curve applies the Tolerance and Resolution parameters backwards horizontally instead of exponentially and will yield the most accurate settled data points but at the expense of increased settling time.

Level Min. You can specify level minimum value. Level values below the specified minimum are not plotted.

Delay Time. In Regulation mode and in closed-loop XY mode, the Audio Analyzer restarts the settled data point process each time the generator frequency or amplitude is changed. This causes the Audio Analyzer to pause the delay amount of time before looking for the first data point (see Figure 4-29). By adjusting the delay you can allow for the response time of the audio generator and the propagation delay time of the device under test. A minimum of 1.0 second delay is suggested for Regulation mode measurements; smaller delays can be used in closed-loop XY mode, but the delay time can require adjustment to obtain a useful measurement.
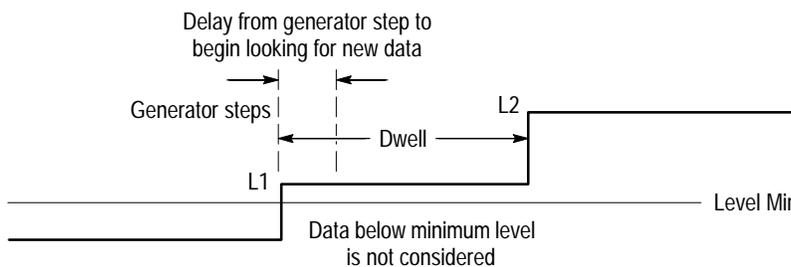
Figure 4-29: Regulation mode delay time setting

For example, assume that because of audio generator response time and propagation time in the device under test, 0.7 sec is required after adjusting the audio generator before attempting to acquire a response from the device under test. If the delay is set to some smaller value, the generator is adjusted and the analyzer attempts to acquire a response before the new settings arrive at the input of the AM700. The resulting incorrect data can cause duplicate data points to be plotted on the display.

NOTE. In Regulation mode, continuous rapid plotting of unsettled data points typically means that the settled data criteria are not appropriate. Though it slows data acquisition and display, making the settled data criteria more restrictive and increasing the delay time usually eliminates this behavior. When the correct delay time for a device under test is determined, it should be noted for future testing.

Timeout. The Timeout editor specifies how long the instrument will attempt to fit incoming data into the defined tolerances. When the timeout expires, if a settled data point is not defined, the data is considered to be unsettled and is displayed on the trace as an open circle rather than a point. The generator can then progress to the next output level, and a new data point settling time begins after the Delay Time has elapsed. A time-out condition can occur when the tolerance setting is too tight for a noisy signal.

Samples. This setting specifies the number of consecutive settled data samples that are used to define a settled measurement. The specified number of consecutive samples must fall within the tolerance or resolution you specify in the Tolerance and Resolution boxes for a measurement, or they are not considered to be part of a settled measurement and rejected. If the selected number of consecutive samples are within the specified tolerance or resolution, they are used to determine that a data point has settled.

Tolerance. The Tolerance setting is the percentage of difference between data point values allowed to be considered as settled data. A data point value is checked against the previous measurement samples to determine if it is within tolerance for settling. The number of samples checked is set in the Samples editor. Tolerance settings can be made for all of the Audio Analyzer measurements (Frequency, Level, THD, THD+N, IMD, Level Diff, Phase Diff, Crosstalk, and Separation) as needed for the measurements being made. For example, if measurement 1 is set to Level Diff and measurement 2 is Phase Diff, only those Tolerance settings need be considered if adjustments are needed to produce settled data.

Setting tolerance percentage for tight settling provides more accurate measurements but will usually require longer generator dwell times and longer timeout settings to avoid missing points. For very quiet instruments, the tolerance percentage can be reduced well below the default setting for tolerance. When measuring noisy devices, the tolerance percentage may have to be increased for testing purposes. The selected Settling mode selection (Exponential or Flat) also affects the action of the Tolerance setting.

Resolution. This setting is in units appropriate to the measurement being made. The resolution setting is the absolute difference of a data point value that is considered settled. The default settings for resolution for a measurement are the measurement resolution of the AM700 and can be used in many instances. Tolerance and the Resolution act together across the measurements range. At the low end of the measurement range, where the noise level has more influence on the measurement, the Resolution setting will determine if a data point value has settled; at the high end of the range, the Tolerance setting is used to determine if a data point is settled.

There is a usually a crossover region when Tolerance (percentage of a measurement data point value) and Resolution (absolute difference) will produce the same result for determining that a data point has settled.

Variation. In XY mode the Audio Analyzer restarts settling when the acquired data is outside of the limit you specify in the Variation section of the Settled Data Point Detection Controls display. The Variation setting is in percentage of difference between a settled data point and the incoming data that is permitted before settling is restarted. This value is chosen to prevent small changes in a data point value, as might be seen with accompanying noise, from being seen as a new value.

Variation Type. This selection is used to determine which parameter or parameters are to be checked for variation. The setting choice of Either looks at either measurement axis (X or Y) and restarts settling when a value outside of the Variation setting for either axis is detected. The Both selection is used to detect when the incoming data values are outside the Variation setting in both axes. The two other choices, Dependent and Independent, are used to select either axis of a measurement to check while ignoring the other. The Dependent axis is the Y-axis and the Independent axis is the X-axis. These choices would be used, for example, when you want to check for amplitude variations while running a fixed frequency or to check for frequency variations when running a fixed amplitude signal.

Relative to Reference Controls

In the Audio Analyzer application, a measurement trace can be displayed with respect to a reference. When the front-panel Set Ref is pressed, a reference is stored in memory for immediate use (see Figure 4-30). To use a reference for comparison it must contain valid data and be appropriate for the measurement. For example, a THD+N measurement cannot be used as a reference for a Level versus Frequency measurement. If the reference selected, either from memory or from a file, is not appropriate or does not have valid data, the "reference available" label is removed from the display.

Acquiring a Reference. Set up the Audio Analyzer and make a measurement that provides a trace or single data point to use as a reference. On the front panel, press the Set Ref button to save the acquired data (trace or point) as a reference. On the display status line the AM700 displays a message that a reference trace is available.

To acquire a single data point as a reference, sweep detection must be disabled so that a single point can be plotted. After acquiring the single data point, press Set Ref to store the reference. You can then enable sweep detection if your measurement needs to be able to detect a sweep start.

Displaying a Trace Relative to Reference. To display new trace data relative to the reference you have just acquired, set the display units to one of the relative units settings. You do this by touching the vertical axis and selecting delta V, delta mV, or dBr, as appropriate for the measurement, using either the Units key or the Units menu. The reference is positioned at the zero graticule line. Traces from following measurements are displayed with respect to the reference. The plot of new trace data is done relative to the reference and shows the differences between the new trace and the reference.

Setting Up a Rel to Ref File. The reference can also be stored in a file for use at a later time as shown in Figure 4-31 on page 4-73. To setup a Rel to Ref file, press the Configure front-panel button, select Measurement Setup, and touch the Rel To Ref soft key. This displays the Relative to Reference control panel as seen in Figure 4-31. When a reference is stored in memory, a message is displayed to show what type of reference it is (Level vs. Frequency is shown in Figure 4-31) and if the reference is saved to a file.

Touch Save to a File to save the reference in the default reference file. If not saved to a file, the reference will be lost if Set Ref is pressed a second time (if the acquired trace or point has changed or has been cleared), since the reference memory is overwritten every time the Set Ref button is pressed. You can clear the reference from memory by touching the Clear Reference Memory Contents soft key.
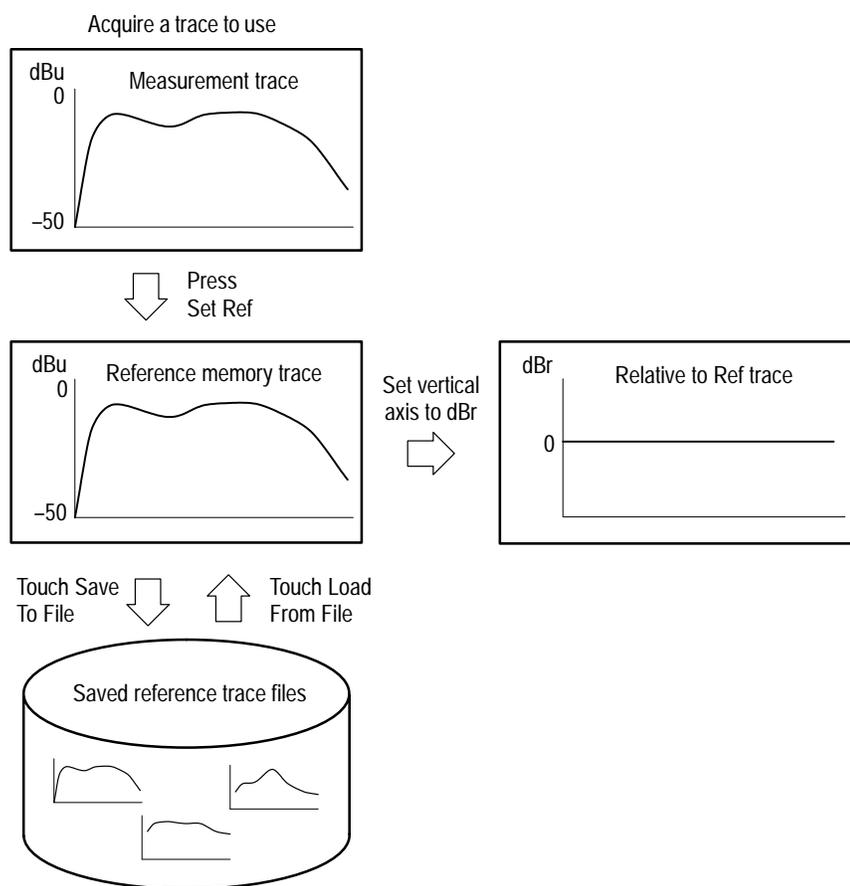
Figure 4-30: Rel to Ref memory model

Naming a Reference File. When designating a file other than the default to save to, touching Filename brings up the Select Reference control screen. This screen displays the directories and file names for selection. When naming a new file for storage, touch file name again to bring up a keyboard to use in naming the file. Type in a descriptive file name for use in storing the reference (use a legal DOS name).
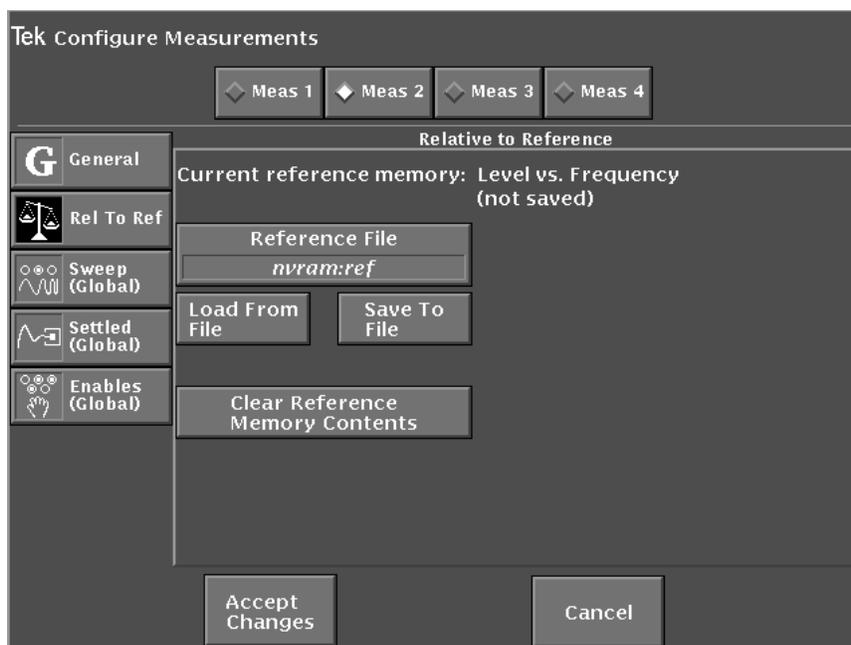
Figure 4-31: Relative to Reference setup menu

Touch Enter or Done to save the file name and exit the keyboard. Touch Select to exit the Select Reference screen; this selects the file name. You can touch Save to File to store an acquired reference trace to the selected file. The front trace in the active window will be used as the reference trace when there is more than one trace in a view (history traces or dual-trace displays).

Load a Ref From a File. To load a previously saved reference trace from a file, press the Configure button and touch the Measurement Setup selection. In the Measurement Configuration menu, Touch the Rel To Ref selection to display the Relative to Reference controls. Specify the file name to use for the reference using the Select Reference file system File Browser. Touch Load From File to restore the reference trace data from that file. The file information appears over the Filename touch space. The loaded reference trace must be appropriate for the measurement trace to be available for use.

> **NOTE.** *A reference trace is not displayed for comparison. The plot of new data shows the difference between the reference trace and the new data.*

To exit the Rel to Ref control screen and save the changes, touch the Accept Changes soft key.

View Setup   In setting up a measurement view you can select a view type (graphical or table) and select the one of the available measurement traces to display in a view. There are also several option selections for axis scaling and waveform plotting.

View Type. You can change the measurement display from a graphical to a table view of the measurement data. To do so, press the Configure button and touch the View Setup soft key to display the View Setup menu. In the View Types box, select Table as the display mode; then touch the Accept Changes (or Cancel) soft key to exit and return to the main Audio Analyzer display.

Besides allowing you to select the type of view (plot or table) for each of the four views, the View Setup menu also lets you select which of the available measurements traces are put in the view. (The available measurement traces are the measurements that are enabled in the General screen of the Configure Measurements menu.)

View Options. Each view also has associated options that you can specify. Touching the View Options soft key in the View Setup screen displays the view options. Options include logarithmic or linear display axes, type of waveform display (lines, points, or both), and cursor behavior (these are a subset of the cursor controls that are accessible when you press the Cursors button).

> **NOTE.** *Touching the View Setup icon (in the Audio Analyzer main display) is a more direct way of accessing the settings that are displayed when you press the Configure button and touch the View Setup soft key.*

Input Filtering

The AM700 provides several weighting and bandwidth limiting filters. Weighting filters are designed to provide measurements that correlate better with human perception than do unweighted measurements (not only is human ear sensitivity not flat with frequency, but human ear frequency response varies with the amplitude of the sound level). Not all weighting filters are identical. Each filter is an approximation to the sensitivity curve of the ear under certain conditions. Filter characteristics are defined by various audio standards organizations. Refer to documentation provided by these organizations for more information on use of a particular weighting filter.

While bandwidth-limiting filters have flat frequency response over the center part of the audio band between their lower and upper roll-off frequencies, weighting filters have no flat-response characteristics. AM700 filter selections are: CCIR468, CCIR ARM, A Weighting, F Weighting, B Weighting, C Message, C Weighting, 15 kHz Low-Pass, 20 kHz Low Pass, 22 kHz Low Pass, and 400 Hz High-Pass. Curves for these filters are illustrated in Figures 4-33, 4-34, and 4-35. The curves for the 15, 20 and 22 kHz Low Pass filters are similar; the only difference is the location of the –3 dB roll off frequency.

The most common bandwidth for noise measurements in professional audio, broadcasting, and consumer audio applications is 20 Hz to 20 kHz (or 22 Hz to 22 kHz, as specified in CCIR 468). Certain communications applications typically specify a narrower bandwidth for communications-quality voice: 300 Hz to 3.5 kHz. The various weighting filters produce the require response curves for noise testing in these specialized bandwidths.

To specify an input filter do the following:

■ Press and hold the Filter button to display the Filter menu. In this menu you can choose an input filter for either input channel from a pop-up list.

■ Touch the Channel 1 or Channel 2 soft key to bring up the pop-up list of filters for that channel as shown in Figure 4-32. (Touch the Filter front panel button to permit access to the soft keys if they are grayed out.)

■ Turn the control knob to select the desired filter (or choose None to choose no filter).
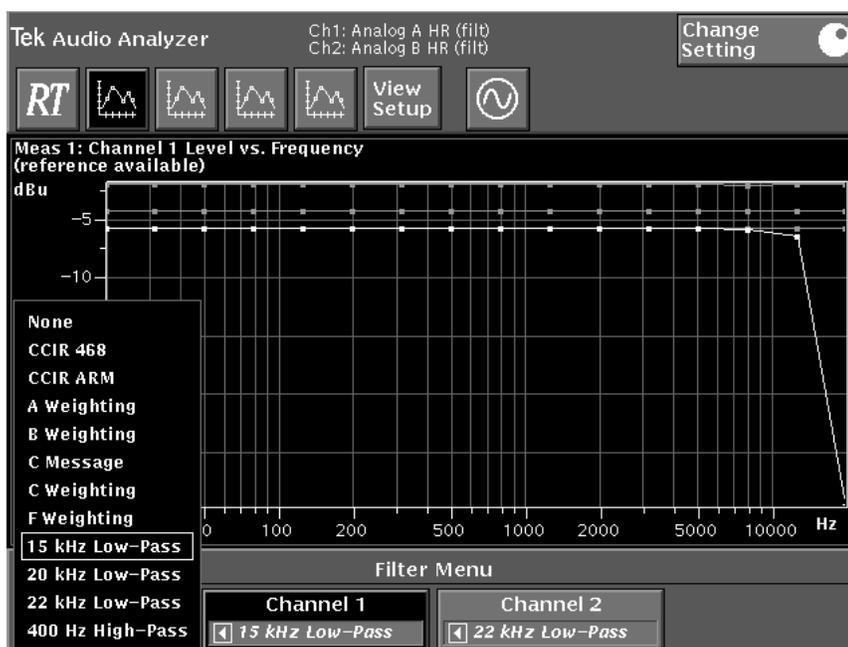
Figure 4-32: Filter menu selection with Audio Analyzer

- Touch the Channel 1 or Channel 2 soft key again to apply the filter selection.

- Repeat the selection process for the other channel if desired.

- Press the Clear Menu button to accept the filter selection and dismiss the Filter menu. The front-panel Filter button turns the selected filters on or off in both channels.

CCIR 468

CCIR ARM
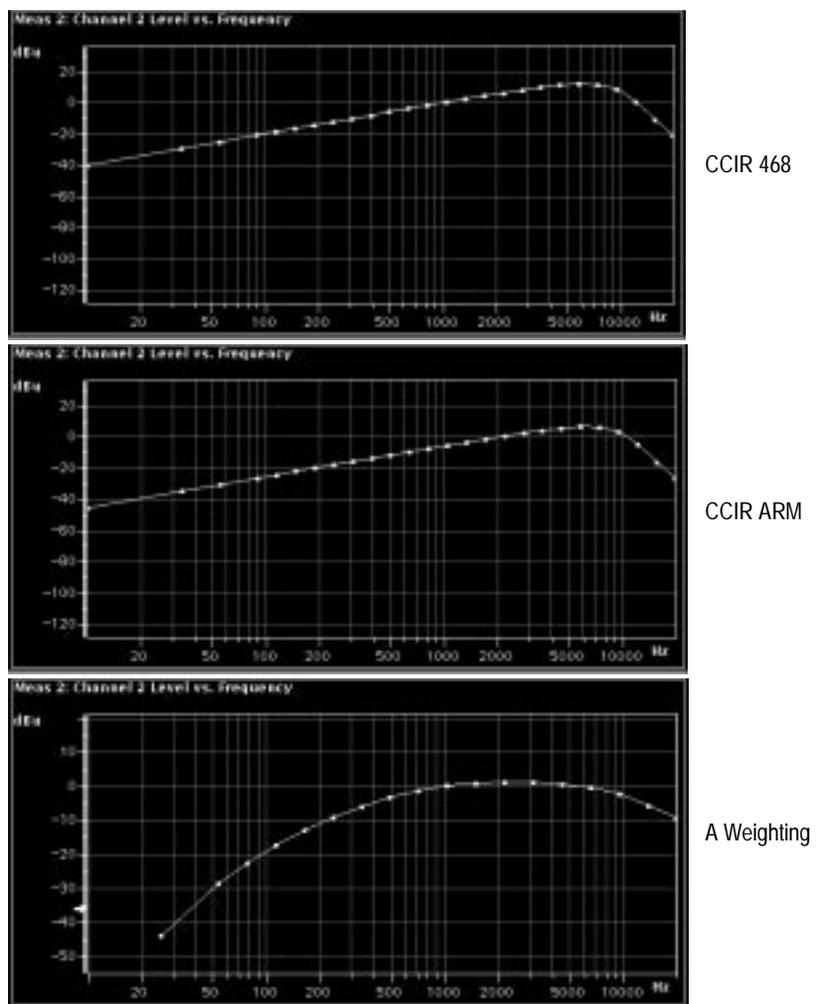
A Weighting

Figure 4-33: Filter curves: CCIR 468, CCIR ARM, and A Weighting

B Weighting

C Weighting
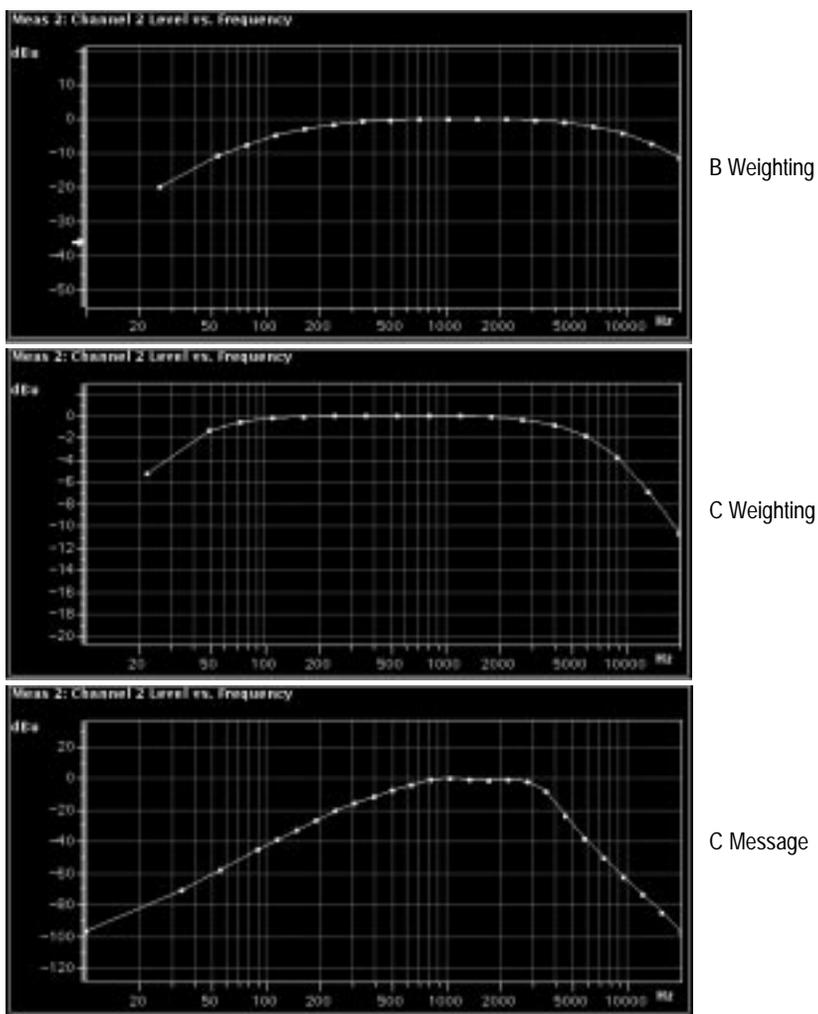
C Message

Figure 4-34: Filter Curves: B Weighting, C Weighting, and C Message
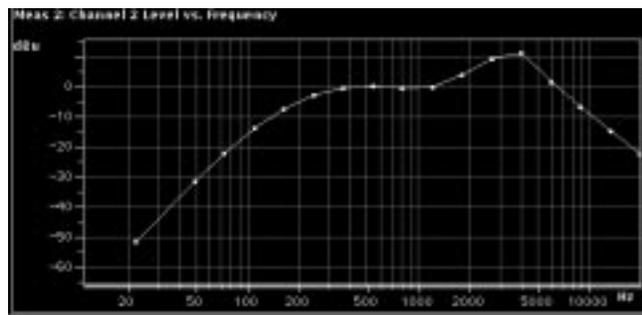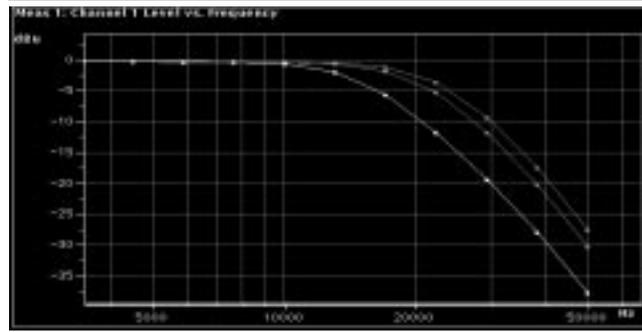
Figure 4-35: Filter Curves: F Weighting, 15 kHz, 20 kHz, and 22 kHz Low Pass, and 400 Hz High Pass

Cursors

Cursors can be used to select measurement points in a waveform. Cursor position is adjusted using the Control Knob with cursor positioning active. The cursors can be used to provide a continuous readout of the amplitude and frequency at the cursor position.

Pressing the Cursors button places two cursors on the display and lets you position them to mark display features. The numerical display shows frequency and level at each cursor's location and the timing difference between the two cursors. Refer to *Cursors* on page 2-10 for more details on cursor operation.

Generator Status Readout

The generator status window is available in all measurement applications. When the generator status readout is selected, the generator settings are displayed in the viewing area. The size and position of the generator status readout changes to accommodate graphical displays when they are also selected for viewing. Refer to *From the Generator Status Panel* on page 4-15 for more information on the generator status window.

FFT Analyzer

An audio signal is composed of many frequency components. Some of these components can be due to undesirable effects of harmonic distortion or noise. Using an oscilloscope to view the signal waveshape in the time domain does not permit these unwanted frequency components to be distinguished from the desired audio signal. The FFT Analyzer breaks the signal apart into its various frequency components. When the result is viewed in a amplitude (y-axis) versus frequency (x-axis) display, the distortion components and frequency-related noise components are displayed as separate frequencies as shown in Figure 4-36.

Figure 4-36: FFT Analyzer measurement showing a dual channel spectral display

Measurement Bandwidth

The FFT Analyzer has two measurement bandwidths. The high resolution mode provides a useable bandwidth of DC to 20 kHz, and the high bandwidth mode provides a useable bandwidth of DC to 80 kHz. Displayed data can be acquired over a changing span of 400 Hz to 80 kHz.

Windowing

Weighting functions are applied to the sampled window to reduce the effects of out-of-window spectral components. A choice of Hann, Kaiser-Bessel, BHR (Blackman-Harris), Flat-top, Uniform (no weighting), Saramäki Rajan, and a user-defined weighting function can be selected for use with the FFT Analyzer using the Window Selection menus shown in Figure 4-37. The effects of the different windows are shown in Figure 4-38.

Uniform. The Uniform window provides no weighting of the data. A signal will appear as narrow as a single frequency bin if it has a frequency exactly equal to a frequency bin. If a frequency lies between frequency bins its presence will be seen across the spectrum. The amplitude variation between the two cases is quite large. The Uniform window can be used to look for transients that do not fill the entire time record. A particular use of this window for multitone measurement occurs when the multitone frequencies lie exactly on the bin frequencies.

Hann. The Hann window is most often used as a good compromise between selectivity and amplitude accuracy. The roll off produced by the weighting function is not very steep; therefore, performance can be reduced when viewing the fft of a signal composed of close frequency components that are very different in amplitude. Other windows provide either more resolution or better amplitude accuracy and can be selected for a particular application.

Flat-top. Amplitude accuracy is improved using the flat-top window. Amplitude variations of signal components that are between frequency bins vary roll off only a small amount (about 0.02 dB). While the selectivity is reduced by the width of the flat-top, the roll off is very steep and adjacent frequency components can be resolved. While the signals may appear wide, they do not leak out of the bins.
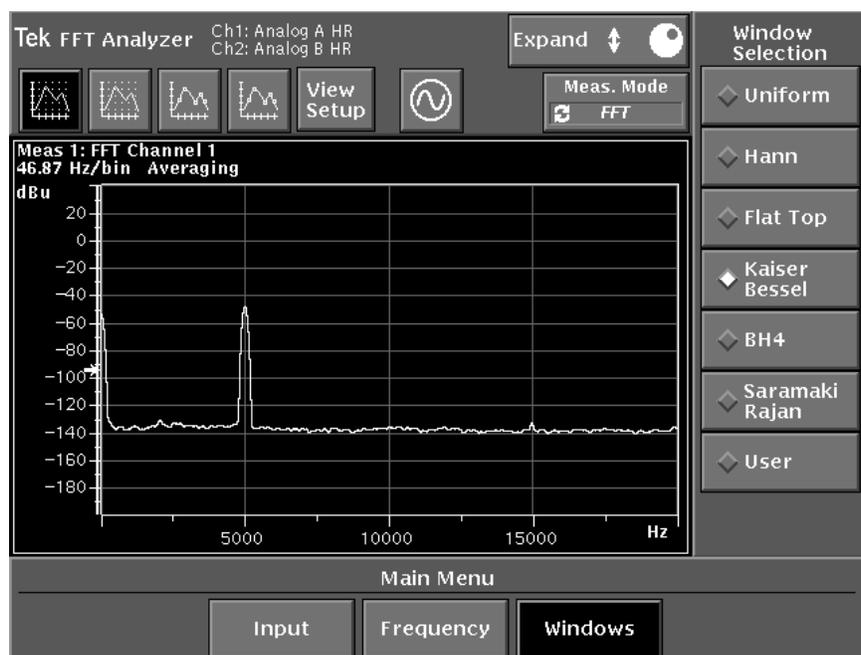
Figure 4-37: FFT Analyzer Window menu display

Kaiser-Bessel. The K-B window produces improved side-lobe attenuation resolution at the base and is similar to BH4 window for frequency resolution. It is very useful for looking for frequency components closer to the noise floor.

BH4 (**Blackman-Harris).** The BH4 window provides very good frequency resolution at the bin frequency but has less side-lobe attenuation.

Saramaki Rajan. This is a Tektronix-developed window similar to Kaiser-Bessel. This window provides a slight improvement over the Kaiser-Bessel window for digital input signals and is also very useful for looking for frequency components closer to the noise floor.

Uniform (no window)

Best selectivity if the signal frequency is exactly equal to a frequency bin, poor resolution of adjacent frequencies, poor amplitude accuracy. Used to look for transients that do not fill the entire record.

Hann

Most used compromise; good selectivity, good resolution, good amplitude accuracy.

Flat-top

Used for best amplitude accuracy; adjacent frequency resolution poorer.

Kaiser-Bessel

Similar to Blackman-Harris and Saramaki Rajan

Best resolution at base, fair resolution at center, fair amplitude accuracy.

Normalized
frequency deviation

Figure 4-38: Effects of Window selections

User. A user-developed window can be selected. That selection will draw its window definition from a user-generated file. A user-window file has the following form:

```
am700 window 1.0
0.01 0.015 0.020
etc. for 513 numbers separated by white space. Spaces,
tabs, and Carriage return/line feed are considered
blank space.
```

The file consists of the header that defines the file as a window file for the AM700 version 1.0 followed by 513 floating point numbers, in ASCII format, that define the weighting factor to be applied to the frequency bins. The numbers can be entered in either exponential or decimal form (1.2e–2 or 0.012, for example). The file is stored in the `nvram:/windows` directory for access by the AM700 when the User window choice is selected.

Measurement Modes

In the FFT Analyzer there are two mode of operation: FFT analysis and Multitone analysis. When you turn on the multitone analysis mode, the analyzer starts looking for a multitone. When the application detects the multitone signal it is looking for, it starts making various measurements and displays the results. It continues to make these measurements as long as the multitone signal lasts. You can use the Meas. Mode soft key, located beneath the large control knob assignment indicator, to toggle between FFT analysis and multitone measurement mode.

Displays

In FFT mode the following View Setup choices are available:

Spectral. This is an FFT display of amplitude versus frequency. You set the frequency span using either the control knob or directly through the FFT menus The frequency axis for the display can be selected to display either linear or logarithmic scaling.

Bar Graph. This display shows the bin widths and the bin amplitudes versus frequency. The bins are completely filled from the bottom of the display to the peak amplitude in a bin. When the display is expanded the rectangular shape of the bins is demonstrated. An example of a expanded Bar Graph display is shown in Figure 4-39.

Spectrogram. This is a display of time versus frequency versus amplitude. Amplitude is color coded in the AM700 display and in the VGA output to an external monitor. A comparison of the Bar Graph and Spectrogram display is shown in Figure 4-39.
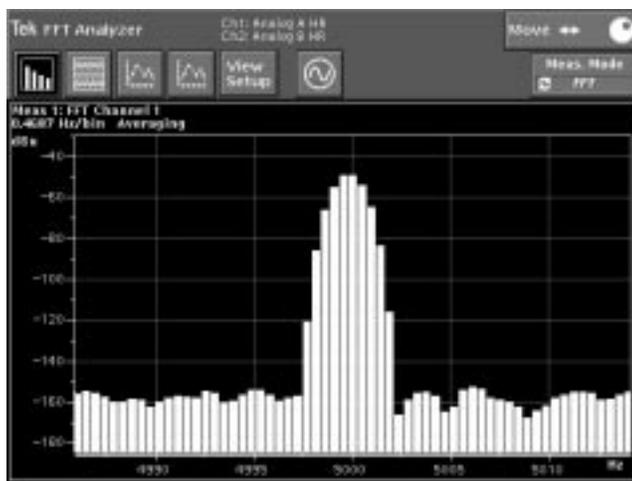
Expanded bar graph display of a single tone
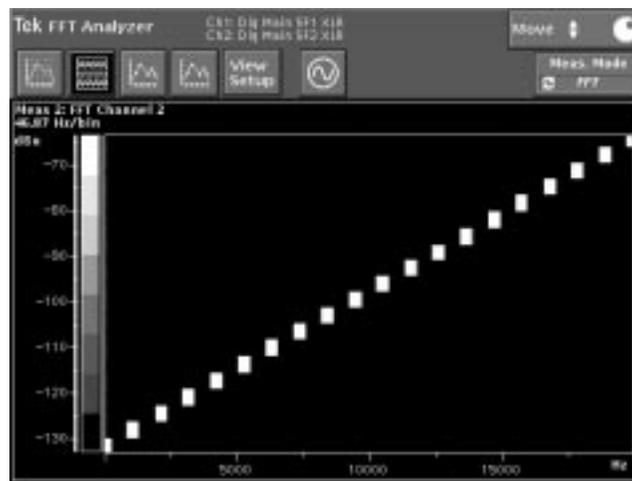
Spectrogram display of a stepped sweep signal

Figure 4-39: FFT Bar graph and Spectrogram displays

Contrast is adjustable using the scaling on the vertical axis of the Spectrogram display. Select the y-axis and rotate the control knob to adjust the contrast of the display or press the front-panel Rescale button. Horizontal expansion in the x-axis of the display can be used to closely examine the area around one of the spectral components.

In Multitone mode the choices are Point Plot and Table display.

Point Plot. Point Plot is a plot of settled data points with a choice of plotting only points, lines, or points with interconnecting lines.

Table. The acquired data is displayed in tabular format showing the vertical axis values in left column and the horizontal axis value in the right column.

Input Range

Input range can be set to a range that matches the dynamic range of the input signal amplitude. Input Range settings can be made either through the Main Menu Input selections in the FFT application, as shown in Figure 4-40, or through the Configure menu for Input Selection. There is a choice of 12 range steps and an auto selection that looks at the incoming signal and sets the input range accordingly.

NOTE. If the manual gain is set too high, the applied signal can overdrive the A/D converter and clip the incoming signal. This condition produces erroneous measurement;, therefore, setting the gain to auto is the usual manner of operation to avoid this possibility.
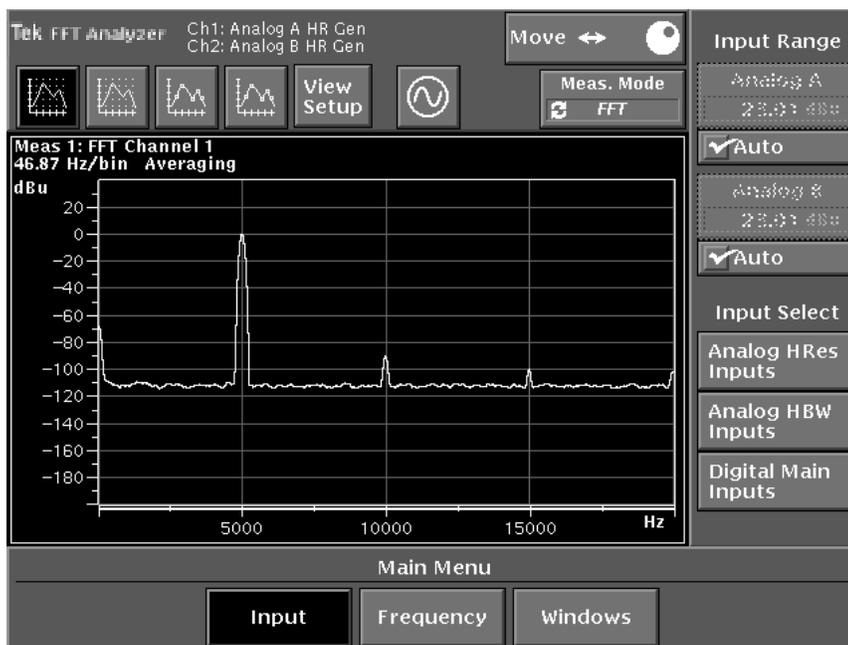
Figure 4-40: FFT Input Select and Input Range menus

Cursors

Cursors can be used to select measurement points in a waveform. Cursor position is adjusted using the control knob with cursor positioning active. The cursors can be used to provide a continuous readout of the amplitude and frequency at the cursor position.

Pressing the Cursors button places two cursors on the display and lets you position them to mark display features. The numerical display shows frequency and level at each cursor location and the amplitude difference between levels at the two cursor positions. Refer to *Cursors* on page 2-10 for more details on cursor operation.

Averaging

Averaging is available for the FFT Analyzer displays. Pressing the Average button lights the label on the front panel and enables the selected type of averaging (noise reduction) on the displayed signal (if Averaging is applicable). Pressing and holding the Average button displays the Average menu. In that menu you can set the number of averages (up to 9,999) and specify whether averaging is based on minimum, maximum, or average signal values. When averaging is not applicable for a display, the Average menu soft keys are not accessible. Refer to *Averaging* on page 2-12 for more details on averaging operation.

Zooming (Expanding) the Display

When the touch and zoom feature of the AM700 is used to rapidly expand or shrink the display horizontally, the trace expands and shrinks at a rate determined by the current bin resolution. As soon as the analyzer acquires new data at the new bin resolution, the trace data is updated to reflect the new bin width. That width is displayed in the upper left corner of the view window. At maximum span (no zoom) the bin width is 46.87 Hz per bin in the high resolution mode. At maximum zoom, the bin width is 0.4687 Hz per bin. If you want to expand the display without having the new acquisition rescaling the horizontal trace, press Freeze first. The acquired data is held and zooming works on that data without rescaling. A maximum zoom display is shown in Figure 4-41.
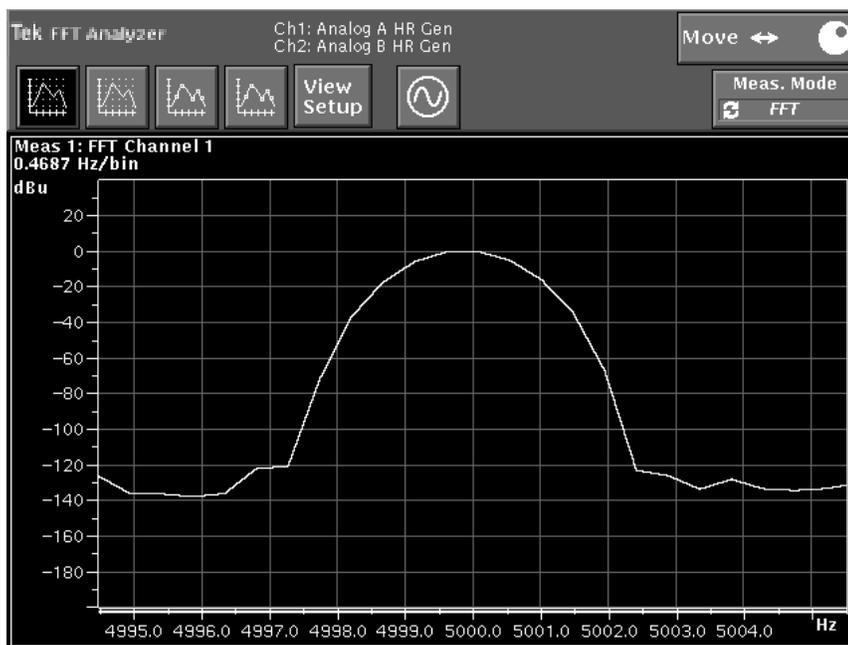
Figure 4-41: Zoomed FFT display showing maximum expansion of the trace

Multitone Measurement Mode

Most audio tests consist of measuring a sine-wave audio tone, then stepping the frequency and repeating the test. The process continues until measured level versus frequency graphs can be assembled and displayed. Each audio test typically takes several seconds.

The technique is accurate, and when time is not an issue, is the best way to perform an audio test. But when only a few seconds are available to perform a complete measurement, or for adjusting a processing device or nulling distortion, near real-time updates of measurement data are necessary.

The AM700 Multitone measurement addresses this problem. Instead of measuring a single-frequency sine wave, the measurement uses a test signal consisting of sine

waves at several frequencies. From the received multitone signal, Multitone measurements produce level versus frequency or distortion plus noise graphs.

Multitone detection and measurements are made using FFT techniques. In order to correctly detect and analyze multitone signals the FFT size should be greater than or equal to the record size used for generating multitone signals.

Multitone Detection

Multitone Measurement mode maintains multitone descriptions in the rom:/mtone directory and nvram:/mtone directory. You can choose any multitone from this file for detection and subsequent analysis. When the AM700 generator is used to generate the multitone signal, that signal can be selected as the one that will also be detected by the AM700 (see Figure 4-42).
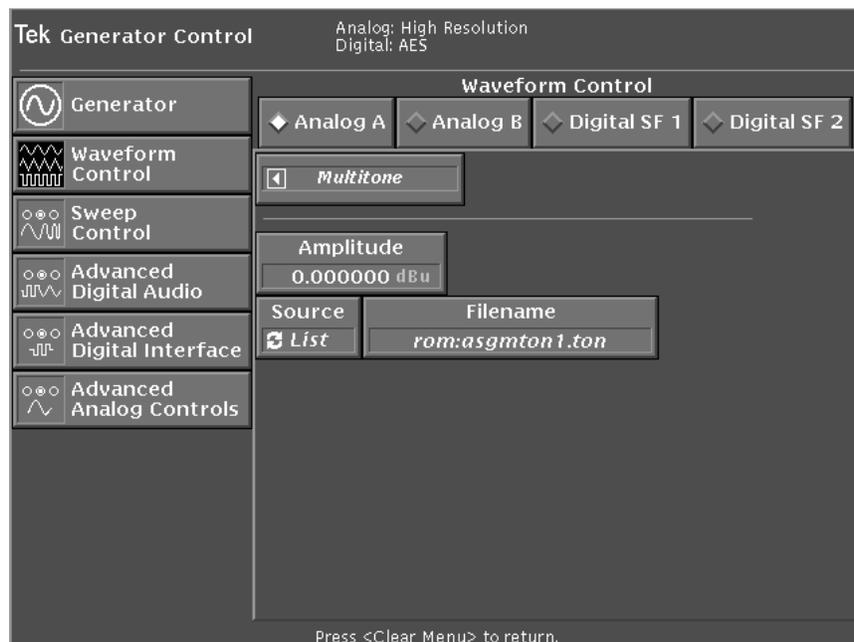
Figure 4-42: Generator Waveform Control setup for multitone detection

The files of multitones that are included in the rom:/mtone directory are those generated by the Tektronix ASG100 Audio Signal Generator. You can add more multitone descriptions to the nvram:/mtone directory by creating a file that has the description of the input multitone signal. Multitone files are described in the *Audio Generator* information on page 4-9.

NOTE. *When setting up to use multitone test signals, the generator and the multitone detection must be set to the same multitone signal. If not, the FFT display will show that a multitone signal is being generated, but the Multitone measurement should show the message "Waiting for Multitone." Check that the generator is set to generate the correct multitone signal in the Generator Control panel Waveform Control settings, and that the multitone settings in the Configure Measurements panel for Multitone Settings is set to match the expected signal.*

Multitone Mode Measurements and Graphical Displays

View 1 through View 4 can be set up to provide graphical displays of multitone measurements. The choices are accessed using the View Setup menus and the Measurement Setup menus in the Configure Measurement choices (see Figure 4-43).

In the Multitone Measurement mode, there are three multitone measurements available: Multitone 1, Multitone 2, and Multitone 3. These can be set to make different multitone measurements. After setting the desired measurements in the Measurements Setup window, those measurements will be available for selection in the View Setup choices from within the application or in the Configure View Setup choices. The possible measurement choices to apply to Multitone 1, 2, and 3 are the following:

- Level versus frequency

- Level difference versus frequency

- Phase difference versus frequency

- Channel crosstalk versus frequency

- Distortion + Noise versus frequency
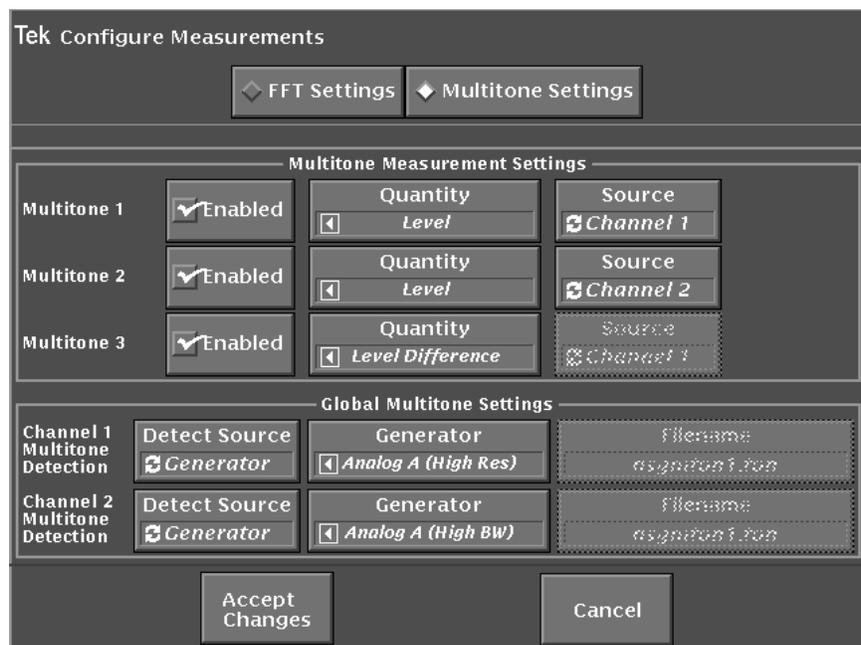
Figure 4-43: Multitone measurement settings in the Configure Measurements menu

These measurement selections must be made in the Measurement Setup choices of the Configure menu. Selection choices for the measurement trace or traces to be displayed in View 1, View 2, View 3, or View 4 are those that have been set up in the Measurement column when the View Setup menu is displayed (see Figure 4-44).
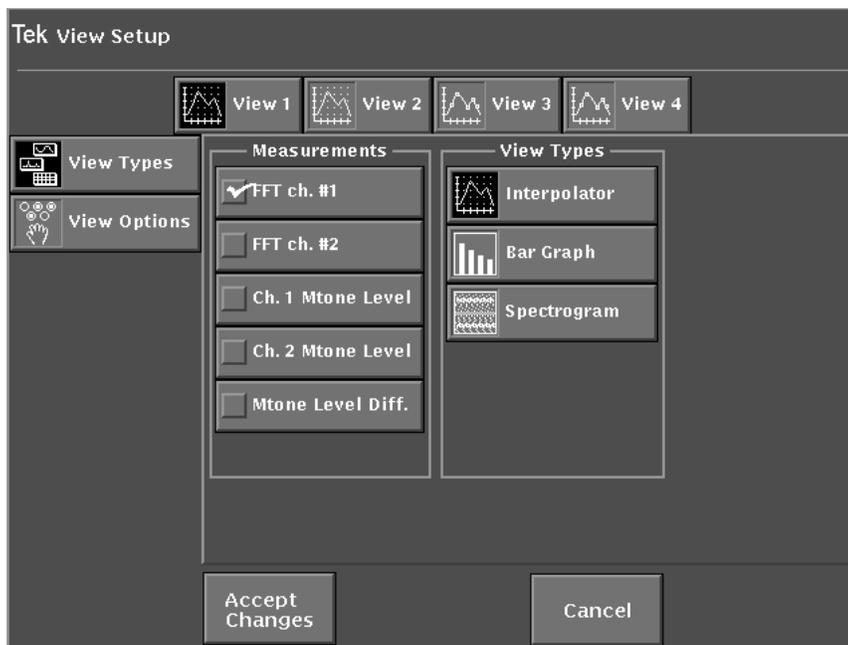
Figure 4-44: FFT View Setup

A typical multitone graphical display showing a two-view display is seen is Figure 4-45. A comparison between the FFT display of the multitone signal and the corresponding multitone measurement is shown in Figure 4-46. The table display is shown in Figure 4-47.
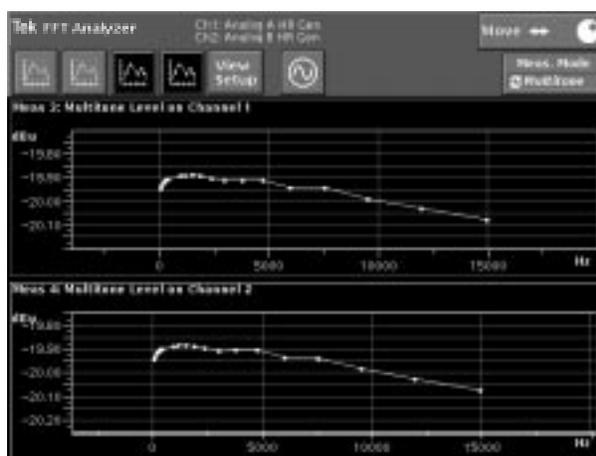
Figure 4-45: Multitone Analyzer display with two measurement windows

Figure 4-46: Display of FFT multitone signal and the corresponding multitone measurement

Figure 4-47: FFT multitone table display

NOTE. The amplitude of an individual tone in a multitone signal is not the amplitude that is set for the overall multitone signal. The overall multitone signal level is the RMS value of all the tones combined to produce the multitone signal.

Audio Monitor

You can use the Audio Monitor application to make time-domain measurements of signal amplitude on an audio signal and verify that audio signals are present. At the 48 kHz sampling rate of high resolution mode, the record is a little over 1 second in length, the sample buffer being 51,200 bytes in length. The record time varies with the sample rate. The sample rate in high bandwidth mode is 192 kHz, and the digital fixed sampling rates are 32, 44.1, and 48 kHz.
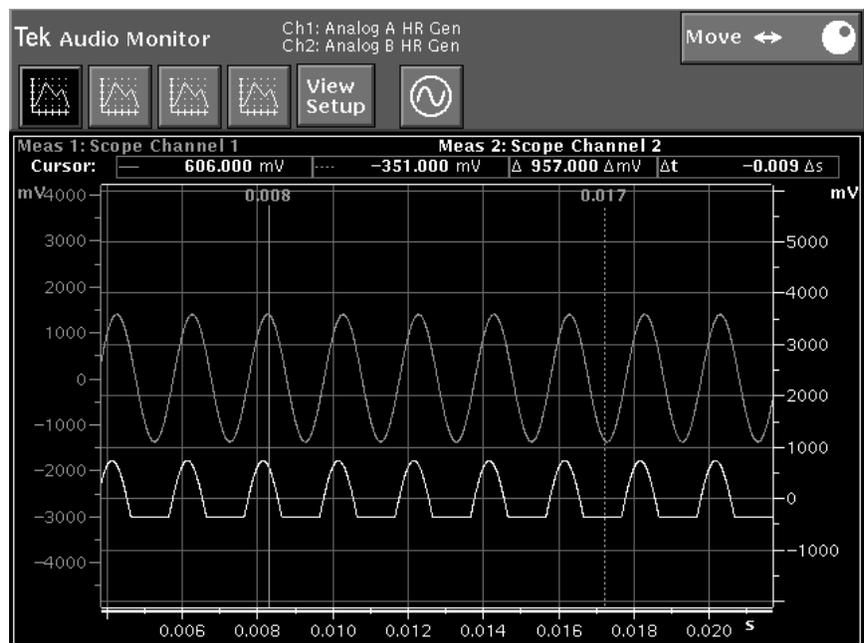
Figure 4-48: Audio Monitor display with dual Y-axis display

Displays

Audio Monitor provides a one- or two-channel view of signal amplitude versus time. At application startup, the scale factors are set for 0.7 V peak-to-peak and 0.5 seconds. Press the Rescale button to scale the view to the applied signal. The display is similar to that of a digitizing oscilloscope with a touch-and-zoom user interface for sizing and positioning the displayed waveform. You can zoom the horizontal and vertical display scales to view waveform features of interest (zoom affects each channel display separately).
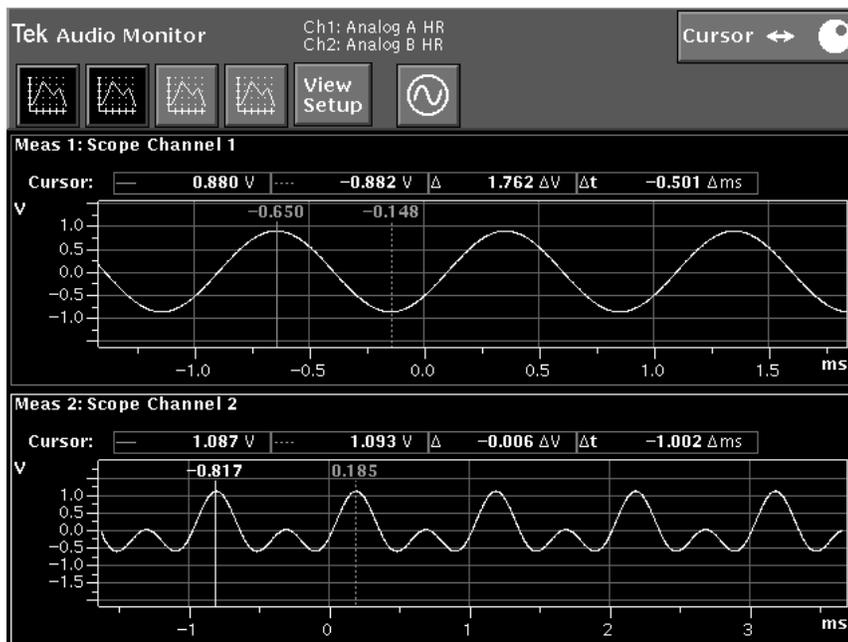
Figure 4-49: Dual channel display showing different signals on Channel 1 and Channel 2

View Setup   To configure Audio Monitor views, touch the Setup icon to display the View Setup
screen, then select the desired views, measurements, view types, and view options.
Touch Accept Changes (or Cancel) to exit the view setup screen and return to the
Audio Monitor display. The View Setup screen and its selections are shown in
Figure 4-50.
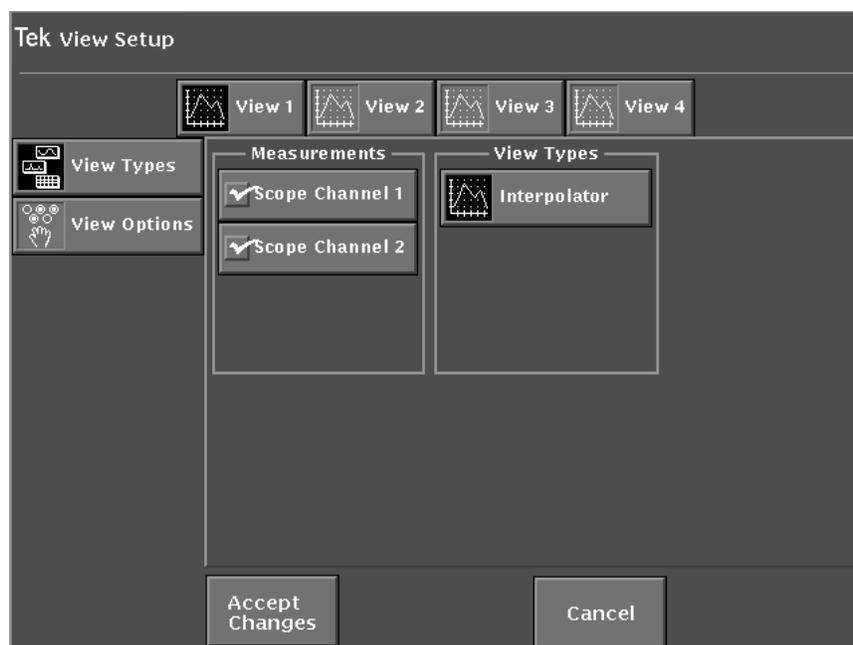
Figure 4-50: The View Setup screen for Audio Monitor

View Types. Only Interpolator View Type is supported for the Audio Monitor. In the
Measurements column you can choose to have either Scope Channel 1, Scope
Channel 2, or both channels displayed in any of the four views. The settings made
are per view and apply to the selected view (View 1, View 2, View 3, or View 4).

From the View Setup screen displayed when you touch the Setup icon (see Figure 4-50) you can configure up to four views of the two input channels. For example, Channels 1 and 2 can be displayed separately or overlaid in the same view, as shown in Figure 4-48 and Figure 4-49. When you overlay them in the same view, traces are distinguished by color. A channel label of the same color on the trace near the graticule identifies each displayed channel. There is a feature of dual trace displays in the same view that has no front-panel selections. To swap traces (make the back one the front one) touch the back trace, and press the Select button. If cursors are up, the readouts now indicate for the new front trace, and the opposite y-axis graticule should be highlighted as seen in Figure 4-48.

When you display the two channels in separate views, the touch-and-zoom controls affect each channel separately. The graticule in each view tracks amplitude-per-division separately. You can specify graticule scale units in volts or mV using the Units menu that appears when you press the Units button with a vertical graticule selected. Selecting the vertical axis and pressing and releasing the Units button will also toggle the units for the y-axis scaling. The x-axis scale has units of seconds and mS.

View Options. The View Options choices permit selection of x-axis scaling as linear or logarithmic, display persistence, and cursor enabling and constraining as shown in Figure 4-51. Making a selection places a check mark in the soft key and enables the selection as indicated by the soft key. Touching it again removes the check mark and restores the default condition. The choices in the Axes column allow the linear/log selection for the x-axis and a choice of dual y-axis. Dual y-axis displays are permitted when more than one trace is displayed in a single view. The vertical or y-axis of the front trace is seen on the left side of the display window and the right side displays the y-axis for the back trace.

In the Waveform column, when persistent is enabled, trace data is accumulated and held in the display. This feature is very useful for gathering history of waveform changes and showing the bounds of varying signals in either frequency, voltage, or both. Turning persistent off restores the trace to showing data for a single acquisition only.

Cursor controls for enabling the cursors and holding the cursors to the displayed data are found in the Cursors column. Enabling or disabling cursors is the same as turning them on or off using the Cursor button on the front panel. Selecting Snap to Data is useful for placing the cursors in the display window on the trace data.

Saving Changes and Exiting View Setup Menu. At the bottom of the control panel are
the choices for accepting and saving any changes you may have made or cancelling
the changes made. Accept Changes and Cancel both exit back to the application
window. Pressing Clear Menu also exits back to the application and cancels any
changes that were made as does the Cancel selection.
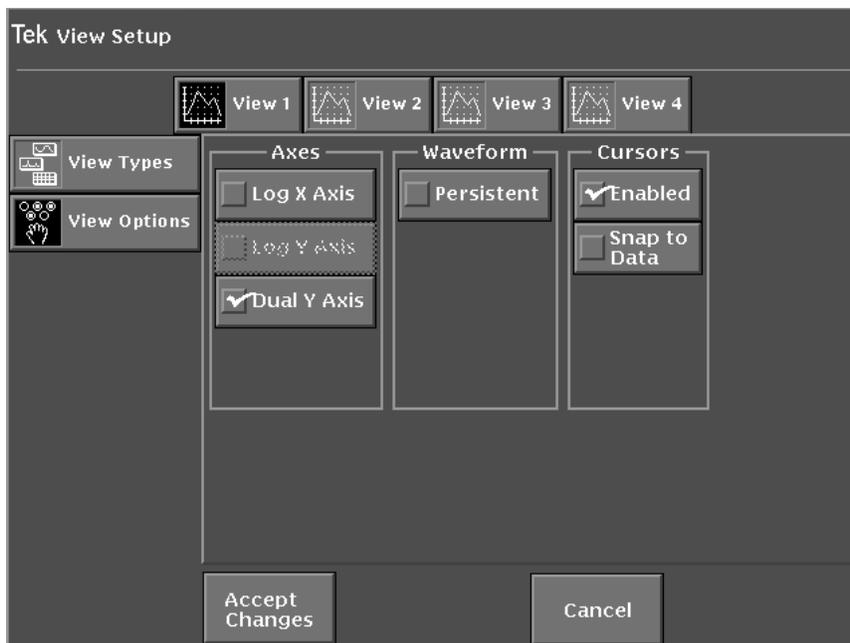
Figure 4-51: View Options in the View Setup controls

Cursors

Cursors can be used to select measurement points in a waveform. Cursor position is
adjusted using the control knob with cursor positioning active. The cursors can be
used to provide a continuous readout of the amplitude and frequency at the cursor
position as shown in Figure 4-52.
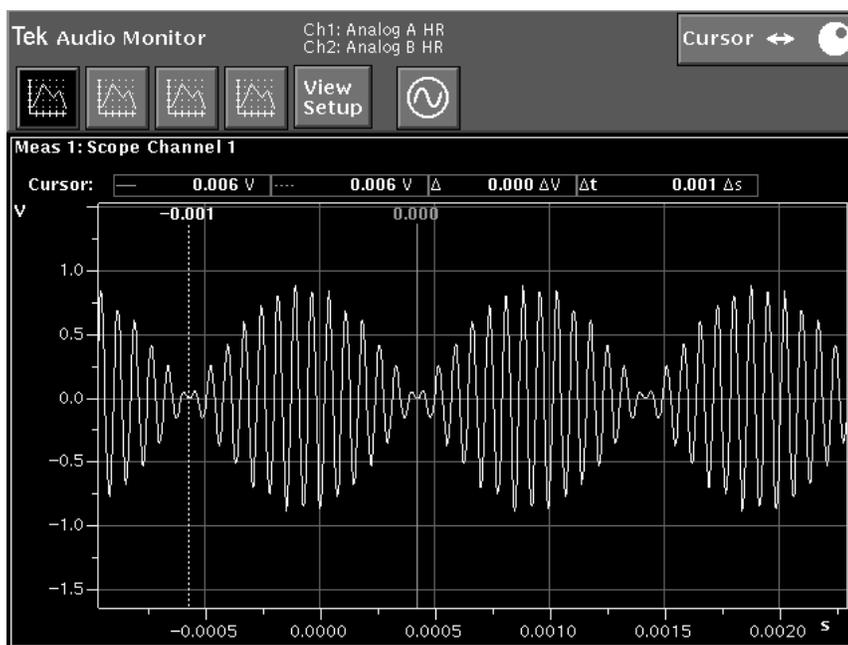
Figure 4-52: Use of Cursors to measure pulse time

Pressing the Cursors button places two cursors on the display and lets you position them to mark display features. The numerical display shows frequency and level at each cursor location and the timing difference between the two cursors. Refer to *Cursors* on page 2-10 for more details on cursor operation.

The difference readouts (both amplitude and time) shown are based on the position of cursor 1 (the solid cursor) minus the position of cursor 2 (the dashed cursor). Time readouts on the individual cursors are with respect to 0 time at the trigger point of the record.

NOTE. *When cursors are viewed on a dual y-axis display, they are associated only with the front trace. The amplitude readouts accompanying the cursors reflect the amplitude at the cursor positions in the front trace.*

Menu

Pressing the Menu button displays the Audio Monitor selections and corresponding submenus. The main menu selections are Input and Trigger.
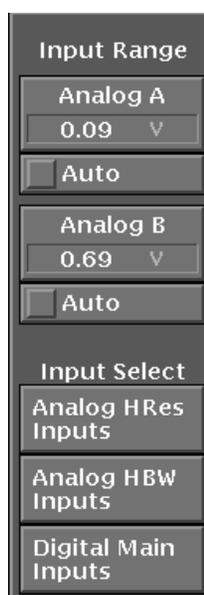
Figure 4-53: Input selections in Audio Monitor menu

Input Select   The Input submenu, shown in Figure 4-53, contains the selections for input range and types exactly as seen in the other applications. With the application running, the Input Range submenu is where you will want to specify a value for input amplitude or — if input amplitude is unknown — select Auto range (the power on default choice). The effect on the displayed trace of any changes you make can be seen immediately. You can also access the input selections from the Configure menu as with the other applications. When the choices are made using the Configure button, the application display will not be visible until the Configure menu is cleared.

The Input Select submenu also allows you to select input source: Analog High Resolution, Analog High Bandwidth, or Digital Main. When Digital Main is selected, applied digital signals are decoded and displayed as an analog audio signal.

Trigger Selects   The Trigger submenu shown in Figure 4-54 contains the selections for setting up trigger conditions and enabling the trigger. This menu displays the trigger controls.

Figure 4-54: Triggering selections in Audio Monitor menu

Trigger Source. Trigger source selections are Channel 1, Channel 2, or External (the external TTL input on the rear panel). When the applied signals are a stereo pair, the selected channel trigger provides stable displays on both Scope channels while retaining their phase difference information. If the applied signals are not a stereo pair, a trigger based on the trigger level setting is separately produced for both channels and phase difference information is not retained. The trigger point is positioned in the data record at the 0 (zero) time vertical graticule in the horizontal (x-axis) display. At the 48 kHz sampling rate, the waveform record of 1 second can be positioned +1 and –1 sec with respect to the trigger point by changing the horizontal position of the waveform.

External trigger can be used to determine the phase difference relationship between two signals that are both related to a common trigger, but are not a stereo pair.

Trigger Mode. Trigger mode can be Auto or Normal. In Normal mode the trace is displayed only when trigger level and slope conditions are satisfied. In Auto mode the trace is displayed either when trigger conditions are satisfied or when a predetermined timeout occurs.

Trigger Slope. Trigger Slope can be set for rising or falling slope to use as the triggering edge.

Trigger Level. Trigger Level control sets the triggering threshold voltage that will cause a triggering event when crossed in the selected Slope direction. Level range is from –173 to +173 volts. Units can also be set to mV.

You can also access the Audio Monitor trigger controls by pressing the Configure button and touching Measurement Setup to display the Trigger Controls section of the Configure Measurements menu (see Figure 4-55).
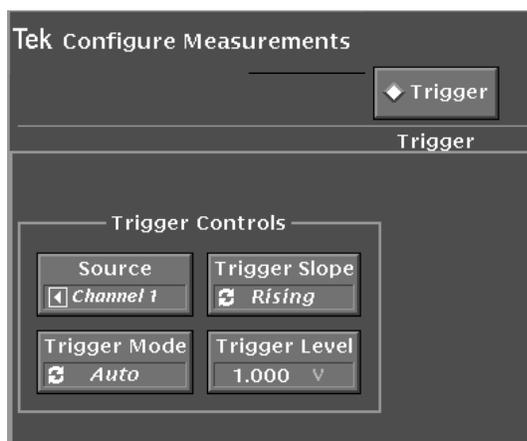
Figure 4-55: Audio Monitor Trigger Controls In the Configure menu under setup measurements

Audio Monitor

Digital Interface Tester

Use the Digital Interface Tester application to make extensive evaluations of the electrical and data characteristics of industry standard digital audio interfaces including AES/EBU, SPDIF (also known as consumer), and optical consumer.

Serial Data. The Digital Interface Tester is used to check the bit stream output of serial digital devices to look for bit settings, checking the number of bits, and comparing subframe data bits for differences. The serial data is made up of 32-bit subframes (two subframes to a frame) of which 20 or 24 bits are used to transmit the audio information. The remaining bits carry coding of various types. More information of the coding is provided in the material on Digital Interface Terminology included at the end of this application.

The Digital Interface Tester gathers 192 samples of the frame bits and displays them in standardized blocks. These data blocks may be displayed either in binary or hexadecimal format to examine the bits or bytes individually for their activity or decoded to provide readable information about the serial digital stream.

Bit Activity Display. Use the Bit Activity display to provide a graphical display of the statistical activity of all subframe bits. From this display you may determine the following characteristics of a digital audio signal at a glance: Parity, Validity, Channel Status and User Bit states, digital audio sample length, and the presence of stuck bits.

Channel Status Display. Use the Channel Status Block display to examine the contents of the Channel Status blocks in either raw binary, decoded (English language), or hexadecimal forms. From this display sources of interface problems caused by data format or content can be uncovered. You can select the appropriate decoding format from AES/EBU standards or consumer standards. The AES/EBU digital audio interface carries an embedded clock signal that is used by receiving equipment to decode the data on the interface. The receiving equipment usually also uses this (or a similar) embedded clock signal as a timing reference for synchronization purposes.

Eye Diagram Display. Use the Eye Diagram display to present a straightforward indication of the condition of a digital audio interface. Jitter, rise time, and interfering signal problems are all quite apparent in the Eye Diagram format.

Digital Jitter. Jitter can be present on the interface signal. This is contributed to by intrinsic clock generator phase noise, jitter amplification due to poor phase-locked-loop damping, and pattern-dependent jitter induced by high-frequency loss down long cables. The Jitter Spectrum display is used to check for jitter tolerance of the serial digital devices. Jitter Spectrum provides a frequency domain display of the jitter components. The jitter components give you an indication of the possible sources of jitter such as power-line hum or switching power supply ripple.

Digital Interface Tester Input Configuration

The Input Configuration menu for the Digital Interface Tester is simplified from that of the FFT Analyzer or Audio Analyzer. Only the Digital Inputs are available for use with this application so the input configuration provides a screen for making those selections only. The choices for input signal connector are the front-panel XLR connector, the rear-panel optical and BNC connectors, and the internal connection to the AES generator as indicated in Figure 4-56.
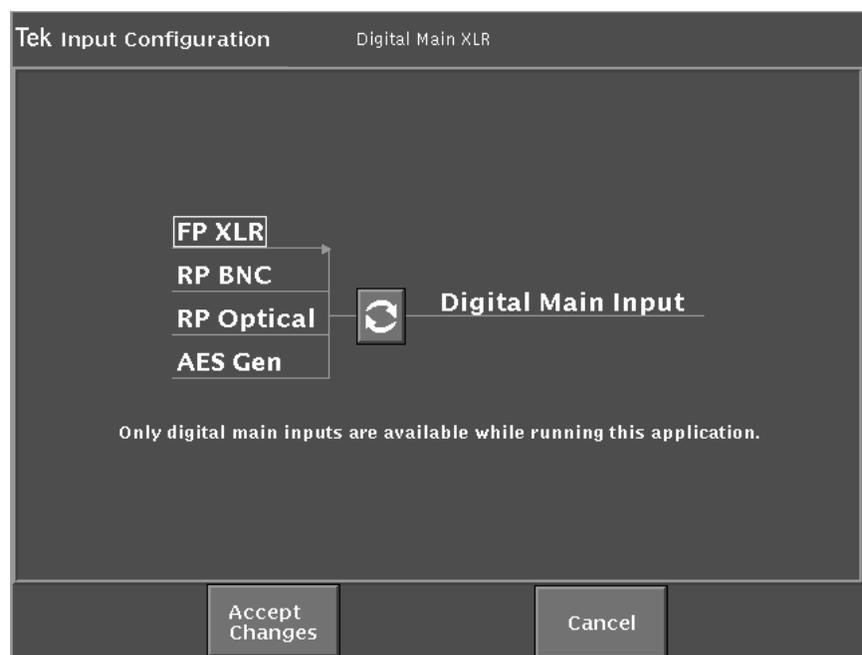
Figure 4-56: Digital Interface Tester Input Configuration menu

No Signal. When there is no digital signal applied, or the applied signal deteriorates to the point that the AM700 can no longer lock on, there some indicators that supply visual feedback as to what is occurring. In the absence of a signal, "No input" is displayed immediately below the measurement name in the view window or, in the case of the Bit Activity display, across the graticule display. If the signal is below the detection thresholds (such as too much jitter or amplitude too low), but is still detectable, the error message displayed is "Input unlocked." In either case, the trace or tabular data is no longer displayed.

View Setup

Make the choices for View Types and View Options in this menu. Choices made in either View Types or View Options apply only to the view selected in the top View Selection bar (View 1, View 2, View 3, and View 4). A small icon in the View Selection choice shows the current View Option in effect for the associated view. The meaning of the View Type icons appears in the label in the View Setup control screen.
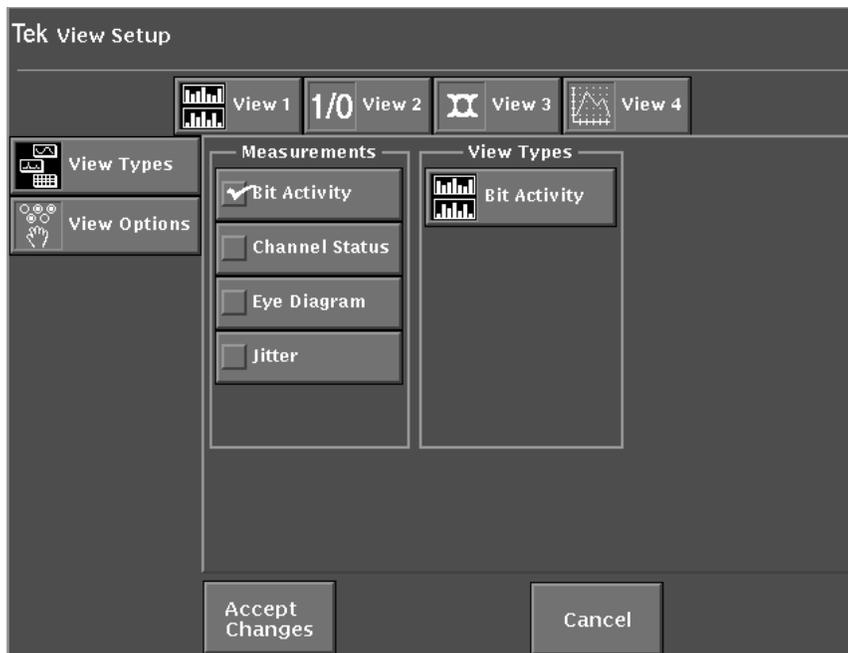
Figure 4-57: Digital Interface Tester View Setup controls

**View
Selection Bar**
Across the top of the Digital Interface Tester you see the view selection bar as shown in Figure 4-58. It has active soft keys that are used to select the view window to be displayed and to permit making View Option choices. The default selection is a display of view 1 with Bit Activity selected. Other views can be selected or they can all be hidden using the soft keys. Notice also that the icon of the view selection depicts the type of View Option display to be expected for that view.

Those View Type option choices are: Bit Activity (an averaged bit value bar graph of the serial digital word), Channel Status Data (a byte-by-byte table showing byte values of the audio data), Eye Diagram (a digital signal eye pattern showing digital data signal quality), and Jitter Spectrum (a spectrogram display of the jitter frequency components). In the Digital Interface Tester, generally only one view is permitted to be displayed at a time, because the type of data being displayed cannot be scaled down in size. The last view selected will be the one displayed. However, the generator status window can be displayed with any view.

Figure 4-58: Digital Interface Tester view selection bar showing Bit Activity selected

Bit Probability Display

View the bit activity for the serial digital frames using the Bit Probability display seen in Figure 4-59. When the digital generator is connected to the digital input, the C and P bits always have activity even if the generator output is off or if the generator output is on and the digital channels are disabled. When a digital audio signal is applied, the active bits of the digital word are displayed. This display can be used to see which bits are active, determine the word size, and check the channel status. If no digital signal is applied, a message to that effect is displayed.

Figure 4-59: Bit Probability display with 24-bit digital data

Channel Status Display

View the bit values (ones and zeros) of the digital signal information in a byte-by-byte table showing the byte number and value contained in the bytes (see Figure 4-60). Both subframe 1 and subframe 2 are displayed in the table for comparison. The display for views can be altered by selections available in the View Setup menu as shown in Figure 4-61.

Channel Status Data

Byte	Subframe 1	Subframe 2	Byte	Subframe 1	Subframe 2
0	10000101	10000101	12	01010011	01010011
1	00001000	00001000	13	01010100	01010100
2	00101100	00101100	14	10000000	10000000
3	00000000	00000000	15	00101011	00101011
4	00000000	00000000	16	10011000	10011000
5	00000000	00000000	17	00000001	00000001
6	01001111	01001111	18	10000000	10000000
7	01010010	01010010	19	00101011	00101011
8	01001001	01001001	20	10011000	10011000
9	01000111	01000111	21	00000001	00000001
10	01000100	01000100	22	11000000	11000000
11	01000101	01000101	23	00110111	00110111

Figure 4-60: 1/0 Display showing byte-by-byte binary data

X/Z and Y Subframes. X/Z is digital subframe 1 and Y is digital subframe 2 from the generator. Select either subframe to be displayed by itself or choose to show the differences between the two subframes. Differences are indicated by underlining the bits that differ. Other options are to show the data in hexadecimal format, show the data in the order of transmission, or to display the decoded data in tabular format as seen in Figure 4-62. The decoded Channel Status data display provides much information about the digital signal at a glance. This display may be the most used for serial data identification purposes as it is in an easily readable format.
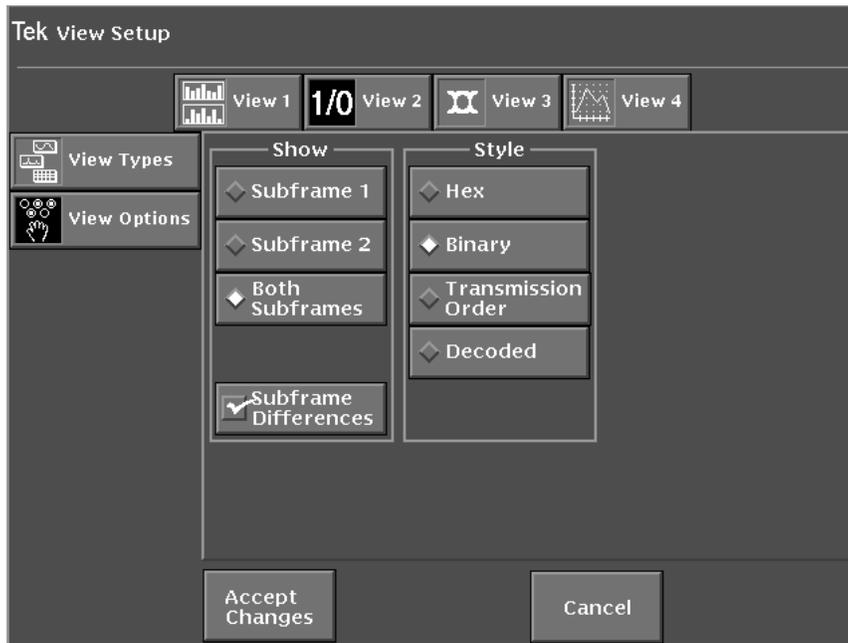
Figure 4-61: 1/0 View Options menu

Professional grade

Consumer grade

Figure 4-62: Decoded channel-status data display

Eye Diagram Display

Use the eye diagram display seen in Figure 4-63 is to view binary-coded digital signals to see the voltage levels used to represent the two logic states and the transitions between them. Proper distance between the logic levels, as well as proper position of the transitions, is important for error-free data transmission.
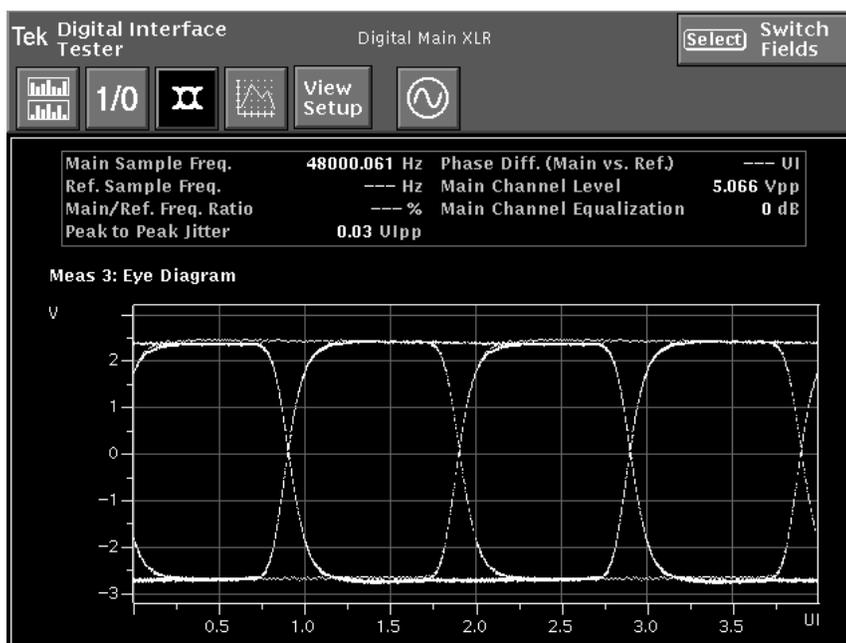
Figure 4-63: Digital Interface Tester eye diagram

Using an oscilloscope, eye patterns are typically formed by triggering at some fraction of the serial clock frequency while observing amplitude changes in the serial bit stream. Sometimes the serial signal is holding at a low or high logic level, and sometimes it is switching between levels. These combinations end up producing an overlaid display showing both logic levels and all transitions between the levels. In between the transitions, the separation or distance of the two logic levels must be

sufficient for the receiver to clearly detect whether a high or a low logic level occurs. This separation is the eye opening of the signals, so called because of it eye-shaped pattern.

Above the eye diagram display is a real-time readout area showing measured parameters of the digital signal. The information displayed in this area includes the following:

- Main sampling frequency

- Reference sampling frequency (when a reference is supplied)

- Main to reference frequency ratio

- Peak-to-peak jitter of the digital signal

- Phase difference between the main and the reference sample clock

- Main channel level

- Main channel equalization

Use the AM700 eye diagram to check data signal parameters such as amplitude, rise time, and jitter, and to identify signal distortions such as those caused by transmission line problems.

Long Cable Simulator. Figure 4-64 shows the effects of a long cable on the signal added by the long cable simulator. The rise time increases and the zero crossing width increases with the added jitter. Notice the change in measurement readouts between a good signal and the degraded signal. When adding jitter from the generator, the AM700 eye diagram remains locked to about 0.8 UI p-p of jitter. With that much jitter, the eye pattern appearance is nearly all random data points as the digital data edges constantly move at the applied jitter frequency and amplitude.
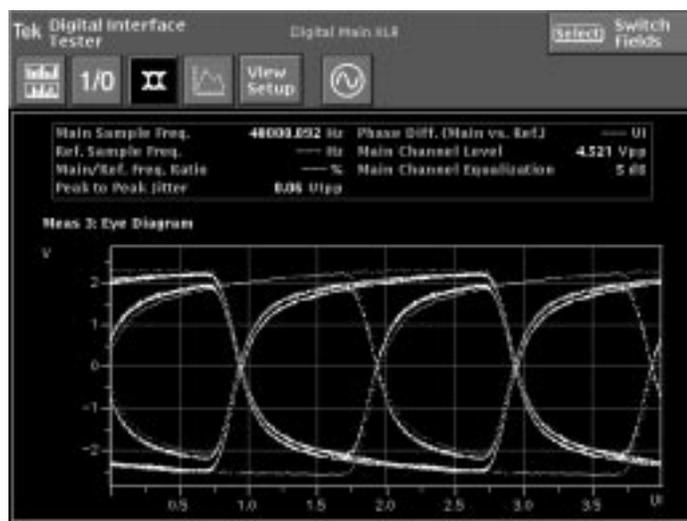
Long cable simulator only
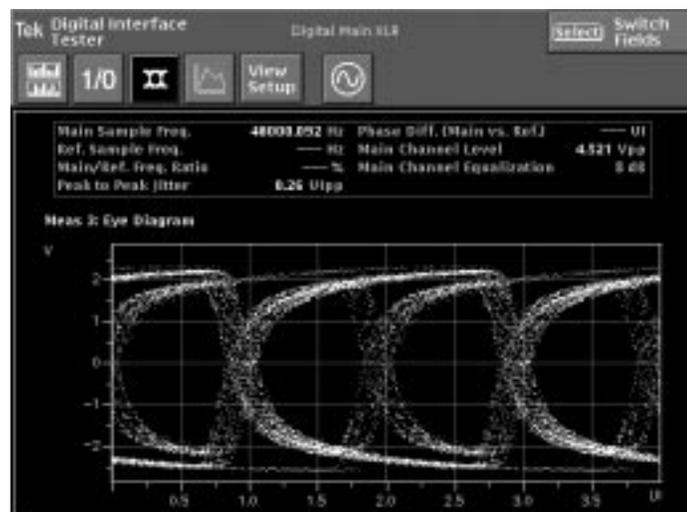
Long cable simulator with jitter added

Figure 4-64: Eye Diagram with jitter and long cable effects simulated with the Long Cable simulator

Digital Jitter Measurement

If several pieces of equipment are cascaded, jitter may accumulate. An input interface at the end of the chain will be required to correctly decode a signal with much more jitter than each earlier stage would produce when operating alone. There are many experiences of end users coming across problems related to this jitter build-up. These problems can occur despite all the equipment involved apparently conforming fully to the present interface standards.

A probable test is to apply defined levels of jitter to serial output and use the Jitter Spectrum display to see how well the device being tested handles the jittered signal. Set the AM700 generator for the amplitude and frequency of the jitter to apply to the test digital signal. A jitter frequency of 20000 Hz is shown in Figure 4-65.
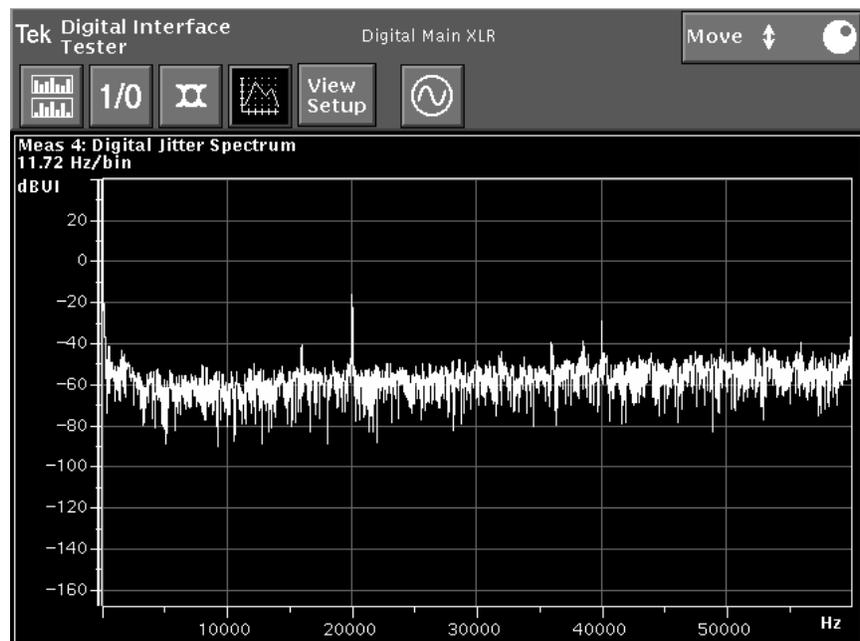
Figure 4-65: Jitter Spectrum display
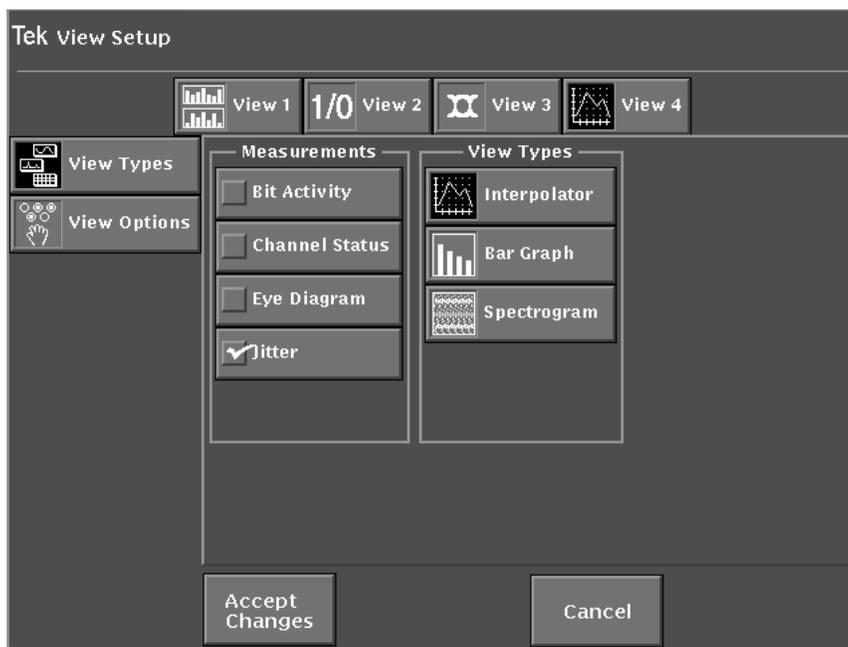
Figure 4-66: Jitter View Types

Jitter Spectrum View Types As with the FFT Analyzer, the jitter spectrum display may be as the point-to-point plot of the Interpolator, as a Bar Graph display, and as a Spectrogram as shown in Figure 4-66. The Bar Graph and Spectrogram displays are compared in Figure 4-67 on page 4-121.
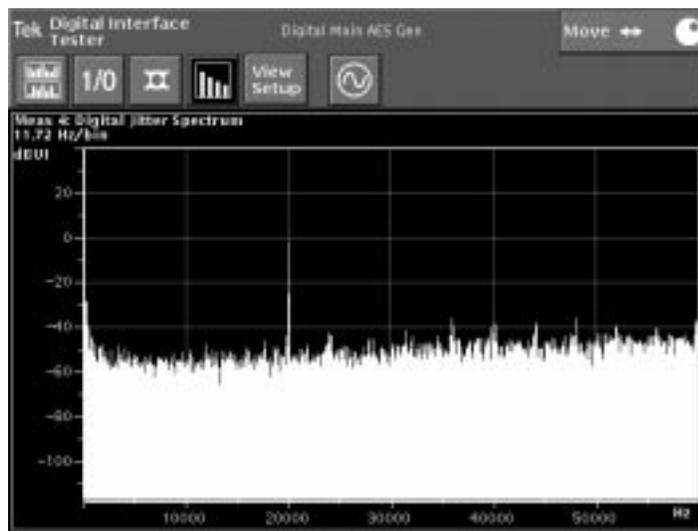
Bar graph display of jitter spectrum
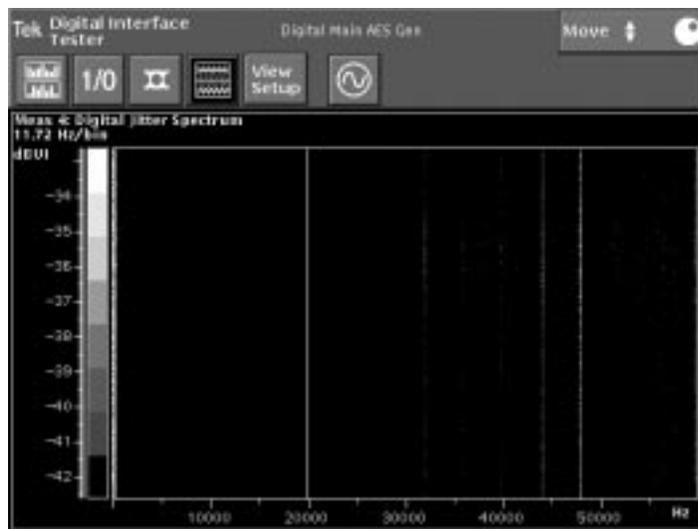
Spectrogram display of jitter spectrum

Figure 4-67: Comparison of Bar Graph and Spectrogram displays of a jitter spectrum

Digital Interface Tester Main Menu

The Digital Interface Tester menu selections provide unique functionality to the
application. The main menu bar, as shown in Figure 4-68, has five soft keys that
show additional submenu choices. You may also access many of these choices for
setting digital generator parameters through the Advanced Digital Interface and
Advanced Digital Audio soft keys found in the Generator Control panel. Refer to the
Audio Generator starting on page 4-1 for more information.
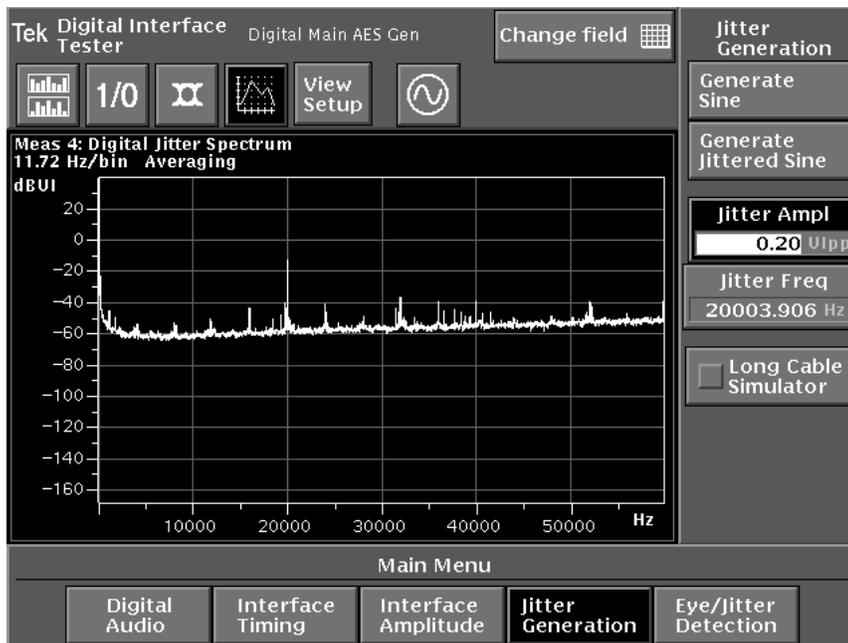
Figure 4-68: Digital Interface Tester Main Menu with Jitter Spectrum submenus

Digital Audio   The various settings available in this menu are the sample rate, the word size, and
the dither type.

Sample Rate. Configures the output sample rate for the audio created by the digital generator. Choices are 48 kHz, 44.1 kHz, and 32 kHz.

Word Size. Allows you to configure the number of bits used in each audio sample. The allowable range is 8 to 24 bits.

Dither Type. Use this choice to configure the type of dither. Options are None, Rectangular, and Triangular.

Interface Timing

Interface timing controls are the Clock Frequency mode, variable, and offset settings and the Clock Phase offset setting.

Clock Frequency-Mode. Configures the output clock frequency. Choices are From Audio, From Ref, and Variable. From Audio implies using the configured audio clock frequency (of 48 kHz, 44.1 kHz, or 32 kHz). From Ref implies locking the signal to the reference input. Variable implies using the Var Freq value (configured in the next button).

Clock Frequency-Var Freq. When the clock frequency is Variable, this button specifies the generated frequency. When the clock is generated using this frequency, the Frequency Offset (specified below) is ignored. The range is 30000.00 Hz to 52000.00 Hz.

Clock Frequency-Offset. This offset (in parts per million) specifies a small clock offset to be applied to the generated clock when the frequency mode is From Audio or From Ref. It is ignored in Variable mode. Range is –100 ppm to 100 ppm.

Clock Phase-Offset. This offset (specified in unit intervals) specifies the phase offset between the AM700 reference output and the digital main output. The offset range is –180 degrees to +178 degrees.

Interface Amplitude

These settings are for control of the XLR and BNC output voltage amplitudes.

XLR Output. Specifies the output voltage of the digital XLR connector. This is constrained to always be five times larger than the BNC output voltage. Adjusting this field also adjusts the BNC output voltage. XLR range is 0.01 V to 10.23 V.

BNC Output. Specifies the output voltage of the digital BNC connector. This is constrained to always be five times smaller than the XLR output voltage. Adjusting this field also adjusts the XLR output voltage. Range of the BNC output is 0.00 V to 2.05 V (one-fifth of the XLR output).

Jitter Generation These selections are used to control the generator. The choices are sine wave, jittered sine wave, jitter amplitude, and jitter frequency. The choice of Long Cable Simulator is also one of the available selection in this menu.

Generate Sine. This button is exactly equivalent to entering the Generator Control panel and selecting Sine for the Digital Generator SF 1 output, and Follow A for the Digital Generator SF 2 output. It is provided here as a convenience.

Generate Jittered Sine. This button is exactly equivalent to entering the Generator Control panel and selecting Jittered Sine for the Digital Generator SF 1 output, and Follow A for the Digital Generator SF 2 output. It is provided here as a convenience.

Jitter Ampl. Configures the amplitude of the jitter applied to the jittered sine wave. The useful amplitude limit at the high-frequency limit is approximately 0.5 Unit Intervals for testing though the AM700 tolerates higher level of jitter without losing lock. When the jitter becomes excessive, the measurement becomes unlocked and a message is displayed to that effect.

Jitter Freq. Specifies the frequency (in Hz) of the jitter applied to the jittered sine wave. The useful high-frequency limit is approximately 50 kHz.

NOTE. It is possible to set a combination of jitter amplitude and jitter frequency that causes the Digital Interface Tester to go in and out of lock. That condition indicates that the applied signal is at the detection threshold of the AM700.

Long Cable Simulator. When selected, applies the long cable simulator to the generated digital output. Degradation of the signal is used to test the ability of a device under test to handle such conditions in an installed system.

Eye/Jitter Detection The menu choices here control the low frequency jitter rejection bandwidth, the jitter gain, and the equalization feature.

LF Rejection - 120 Hz. When selected, filters out jitter below 120 Hz.

LF Rejection - 1200 Hz. When selected, filters out jitter below 1200 Hz. This filter attenuates the lower frequency jitter components and is used when those components are excessive.

Jitter Gain. Toggles between X1 gain and X8 gain only in jitter spectrum mode. Gain is applied to the jitter signal before it gets to the ADC. Since the ADC is only eight bits, small jitter levels might require this amplification. The most sensitive measurements are made in X8 gain with the 120 Hz filter in place.

Jitter Spectrum Measurement—Equalization. Toggles between Bypassed (the desired state) and Active. The equalization circuit suppresses some forms of jitter introduced by cable effects, so you will usually not want to enable it. However, some signals might be so bad that the hardware cannot lock to it unless equalization is enabled. You will rarely need to use equalization.

Subframe Format

24-bit audio sample word

0	3	4		27	28				31
Preamble		LSB		MSB	V	U	C	P	

20-bit audio sample word

0	3	4	7	8		27	28				31
Preamble		Aux		LSB		MSB	V	U	C	P	

V   Validity bit
U   User data bit
C   Channel status bit
P   Parity bit
Aux Auxiliary sample bits

Figure 4-69: AES serial digital subframe formats

Table 4-1: Subframe Time Slots

Time Slots	Information Carried
0 to 3	One of the three permitted preambles (X, Y, or Z)
4 to 27	Audio sample word in linear twos complement. The most-significant bit (MSB) is in time slot 27. When a 20-bit coding range is enough to carry the audio signal representation, time slots 8 to 27 are used for that purpose with the LSB in time slot 8. Time slots 4 to 7 (auxiliary bits) can then be coded to carry different data. Unused LSBs are set to logic 0.
28	Validity bit associated with the audio sample word.
29	1-bit user data associated with the audio channel transmitted in the same subframe.
30	1-bit channel status information associated with the audio channel transmitted in the same subframe.
31	Parity bit. Set such that time slots 4 to 31 inclusive will have an even number of ones and an even number of zeros (even parity). NOTE: Preambles have even parity as an explicit property.

Digital Interface Terminology

Sampling frequency	Frequency of the audio signal samples. If more than one audio signal is transmitted through the same interface, the signal samples are at the same frequency.
Audio sample word	Digital audio signal amplitude. Representation is linear in a twos complement binary form. Positive numbers correspond to positive analog voltages at the input of the analog-to-digital converter (ADC). The number of bits per word can be specified from 16 to 24 in two coding ranges (less than or equal to 20 bits and less than or equal to 24 bits).
Auxiliary sample bit	The four least-significant bits (LSBs) can be assigned as auxiliary sample bits and used to carry information when the number of audio sample bits is less than or equal to 20.
Validity bit	A bit used to indicate if the audio sample bits in the subframe (time slots 4 to 27 or 8 to 27, depending on the audio word length) are suitable for analog conversion.
Channel status	Bits that are coded with information associated with each audio channel. The bits are in a fixed format derived from a block (a group of 192 consecutive frames).
User data	Bits provided to carry any other information.
Parity bit	A bit used to detect an odd number of errors occurring in the interface.
Preambles	Specific bit patterns at the beginning of a subframe used for synchronization. There are three bit patterns and their inverse recognized as preambles in the digital data stream.
Subframe	Defined fixed data structure used to carry the digital information.
Frame	Two successive and associated subframes.

Block	A block is 192 consecutive frames in a group.
Channel coding	Coding describes how transmitted binary digits are represented.
Jitter	Intrinsic clock generator phase noise, timing error amplification due to poor phase-locked-loop damping, and pattern-dependent logic edge changes induced by high-frequency loss down long cables.

Function Operation

AM700 functions are user-defined sequences of commands. Functions can be written in SCPI command protocol for downloading to the AM700. The Function key provides a user interface for execution of stored functions (see Figure 4-70).
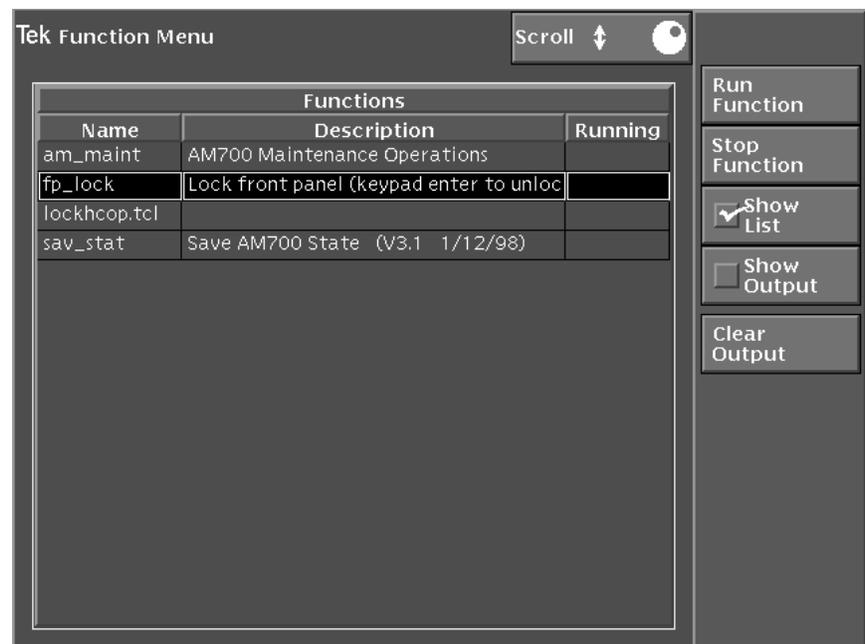
Figure 4-70: Function control menu

Function Control

You can create a function externally and load it through the GPIB interface or the floppy disk drive as an executable file of SCPI commands. A file of SCPI commands is identified in the Function choices by file name. Once a function is stored in the AM700, you can run it from the front-panel. Press the Function button to bring up the menu choices and select a function to run from the displayed list.

Running a Function

Functions are stored in two different directories in the AM700. Those stored in rom:/function are permanently stored for specific purposes by the factory. Those stored in nvram:/function are user generated. From the front panel, stored functions can be started using menu choices called up by the Function button.

1. Press the Function button to bring up the menu of available functions.

2. Touch the screen either in the File name area to select a function by file name or in the description area to select a function by description.

3. Rotate the large control knob to select the function you want to run. All the available function files from both the rom:/function and the nvram:/function directory will be listed.

4. Touch the Run Function soft key to start the function running. If the function is not self terminating, the Stop Function soft key can be used to halt the one in progress. When a function is running repeatedly, the number of times that it has run appears in the Running column.

Other choices in the Function menu are showing or not showing the available list of functions as read from the rom:/function and nvram:/function directories. If you are loading in a new function from the disk drive, you can turn off the list to clear the display of unneeded information. Another user option is to Show Output or not. If a function has textual output, it can be viewed in the window created when Show Output is enabled.

Writing a Function

Functions can be created externally to the AM700 using Tcl programming and loaded, using the floppy disk drive, into the file system of the AM700. Front-panel menus for loading files into the internal file system are called up by the Storage button. Functions can also be loaded through SCPI commands using the PROGram subsystem commands.

Sample Function Program. A function program can be very simple or it can contain many steps. A running function program in interpreted by the Tcl parser. Some Tcl formatting information is required. A few points are mentioned here to show why they are used in the sample. Full information on Tcl programming is found in Part 1 of *Tcl and the Tk Toolkit:* Addison-Wesley Publishing Company, 1994.

■ Tcl comments are preceded by a # symbol as the first nonblank character in the line. The # symbol appearing in the line at other locations is treated as any other character.

■ If double quote marks are used in a SCPI command, they must be escaped by a backslash (\"string\") in order to pass them to SCPI using the Tcl scpi command.

■ Precede all SCPI commands with the string "scpi".

The Tcl parser looks first to see if it is a Tcl command that it knows about; if so, it runs it as a Tcl command. If not, the parser looks for *, ?, or : in the command lines to see if it is a SCPI command. Putting the letters "scpi" in front of the SCPI commands tells the Tcl parser that it is a SCPI command, and the command is immediately passed to the SCPI parser.

The example function program shown uses some of the commands that can be needed to change application, signals, and displays. Some control changes may not be required, because the default setting is correct for the function. You can use the *RST command to set everything to its default state or the state of controls can be explicitly set to avoid the possibility that the control is not in the default setting.

The following program uses the AM700 digital generator to supply the signal to the AM700 Audio Monitor. The front panel XLR digital output connector must be connected to the front panel XLR digital input connector to complete the setup. In the sample function, the first line labels the function and the second line provides some visual feedback to the front panel in the Function Output window that appears in the Function control panel display.

```
#label: Digital Generator CCIF IMD
puts stdout "Digital CCIF IMD"
#Set the AM700 to its default states.
scpi *RST
#Select the digital generator for measurement
#CSTR1 has DSF1 and CSTR2 has DSF2
scpi CSTR1:FEED 'sens5'
scpi CSTR2:FEED 'sens6'
#Select the CCIF IMD test signal to be generated.
#DSF2 follows DSF1 by default.
scpi SOUR5:FUNC:SHAP CIMD
#Make sure the digital input path is the front-panel
#XLR connector
scpi ROUT3:CLOS 6
#Turn on the generator signal.
scpi GCON:OUTP:STAT ON
```

```
#Start the Audio Monitor application
scpi INST:SEL MONITOR
#Display two measurement windows; view 1 is displayed by default.
scpi DISP:WIND2:STAT ON
#The Function Control Panel remains displayed unless it is
#cleared by the front panel control.
puts stdout "Press Clear Menu to see the application display"
```

Editing Function Key Programs

Structured programming support (such as conditionals and subroutines) in the function scripting language is supported using the Tcl programming language for AM700 functions. Tcl for "Tool Command Language" is becoming popular because of its ease of implementation in new computing systems. Tcl is a simple interpretive programming language.

The function implementation runs SCPI commands under Tcl and will appear as plain SCPI if you are not interested in using the capabilities provided by Tcl. However, because Tcl is used to interpret the SCPI commands, if you are familiar with Tcl programming you can include code to do conditional branching, looping, and other special purpose testing not specifically designed into the applications of the AM700.

Loading Function Programs

Files are loaded into the NVRAM of the AM700 from the DOS format floppy disk drive using commands found in the Storage menus. The Storage Manager (see Figure 4-71 on page 4-133) has soft key choices for opening directories that files are to be directed to, making new directories, and selecting and copying files to and from the floppy drive (DOS format).

AM700 Storage Manager

The upper level of the AM700 files comprise ROM, NVRAM, and DOS logical directories. Under those, other directories or files can exist. You can use certain directories for storing files you create. Loading, renaming, copying, and deleting files is of particular importance to the Function feature of the AM700.

Changing directories is done using the Storage Manager control screen that is displayed when the front-panel Storage front-panel button is pressed (see Figure 4-71).
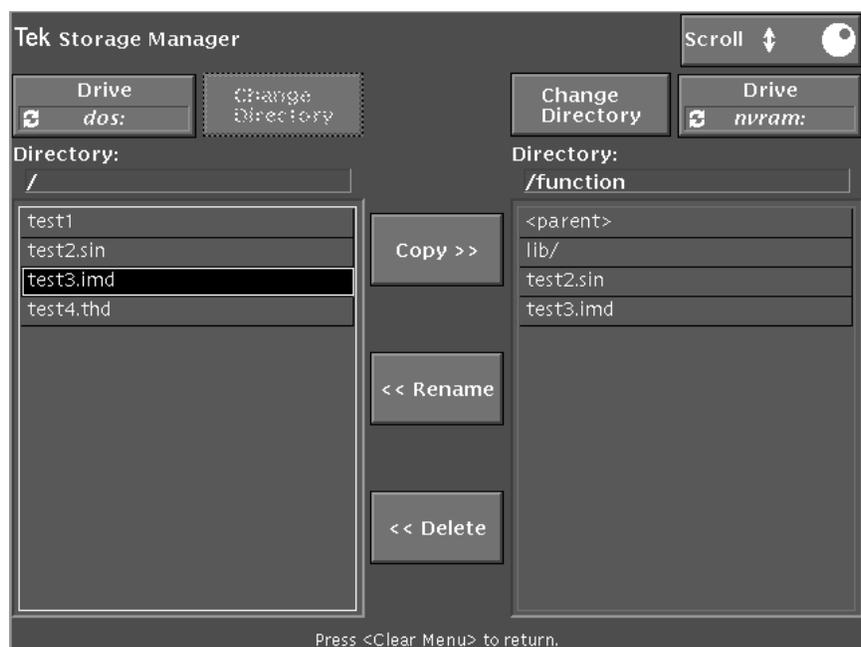
Figure 4-71: Storage Manager control screen

Copying a File. Copying a file from a floppy disk into the nvram function file is also done using the Storage Manager control screen also shown in Figure 4-71.

1. Touch Drive on the right side of the Storage Manager screen to select the *nvram:*.

2. On the right side of the Storage Manager screen select the function directory. This done by first touching the directory name to shift the knob focus to that side. Once the focus is shifted, you can use the large knob to make further selections by scrolling through the list.

3. With the function/ directory highlighted, touch the Change Directory soft key to go into that directory. You will then see a list of files if any are stored there.

4. Insert the floppy disk with function files you want to transfer into the disk drive.

5. Touch Drive on the left side of the Storage Manager to select *dos:*. A list of the directories and files at the top level of the disk directory will be displayed.

6. Touch a file name in the files display area to shift the knob focus to the left side, and use the large control knob to select the file to be transferred.

7. Touch Copy to transfer the file from *dos:* to *nvram:/function.* You will see a notifier that asks if you really want to create the file you have selected in the *nvram:.* Touch Ok or Cancel as appropriate.

Deleting a File. Deleting is done by highlighting the file to be deleted and touching the Delete soft key. Again you will get a notifier, this time asking you if you really want to delete the selected file. Touch Ok or Cancel as you choose. This works for *nvram:* files and *dos:* files. You cannot erase *rom:* files.

Renaming a File. If you need to rename a file, first select the file name you want to change. Touch Rename. This brings up a keyboard to type in the new file name. The old name will be displayed. You can use the Clear button to remove the whole file name or the Backspace button to remove the letters one at a time. Touch the keyboard buttons one at a time to enter the new file name. When you are done, touch Done. If you touch Cancel, any changes you have made in the file name line are thrown away, and the file name remains unchanged. The file name must be no more than 12 characters, and valid dos names are acceptable.

Timed Functions

Timed functions can be created as well. These functions monitor the internal clock of the AM700 to run a user-defined measurement sequence at specific times. These timed functions can be used to provide unattended round-the-clock monitoring and data logging. A timed function can be set to run at certain times by setting a time for it to start using the PROGram commands using remote control. Times for running functions are not settable from the front-panel controls.

The `PROG:SEL:NAME <progname>` command names the file that a following `PROG:SEL:TIMed:SET` command associates with the cron_string or strings that are given.

```
PROG:SEL:NAME progname
PROG:SEL:TIM[:SET] {'cron_string','cron_string'}
PROG:SEL:TIM:ADD 'cron_string'{,'cron_string'}
```

A cron_string is five fields consisting of the following:

```
MIN HOUR DAY_of_MONTH MONTH DAY_of_WEEK
```

The numerical ranges for the fields are as follows:

- Minutes: 0 through 59.
- Hours: 0 through 23.
- Day of the month: 1 through 31.
- Month: 1 through 12.
- Day of the week   0 through 6; Sunday is day 0.

Each field can contain any of the following type entries: a single number, a comma-separated list of numbers, a hyphen-separated pair of numbers, or an *.

A comma-separated list in a field specifies multiple occurrences for the timed program to run.

A pair of numbers separated by a hyphen in a field specifies the beginning number, the ending number, and all the integer numbers in between.

An * in a field means to do it on all occurrences. An exception to the * usage is that if both the day of the week and the day of the month fields have an *, it just means every day. If only one of these two fields has an *, that field is ignored, and if neither has an *, both fields are used.

Example: '0 0,12 * * *' specifies a time of midnight and noon every day.

Example: PROG:SEL:TIM:SET '30 * 1,15 5 *','45 17 19 5 *'

This sets the times for the timed function at every half past the hour, on the 1st and 15th of May and again at 1745, May 19th.

Use the PROG:SEL:TIM:ADD <cron_string> command to add new times to the same named function and use the PROG:SEL:TIM:CLE command to clear all the times for a named function. If you want other timed functions to run, change the named function and use the PROG:SEL:TIM:SET command to set a new cron_string or set of cron_strings for the newly named command.

PROG:EXPL commands are used in the same manner as the PROG:SEL commands but explicitly name the function to which the command applies. Refer to the *AM700 Programmers Manual* for further details on the PROGram commands and their use in running functions.

Example: PROG:EXPL:TIM <prog_name>,<cron_string>

Using the SCPI commands requires the following steps:

1. Send `PROG:CAT?` to get a comma-separated list of the available functions. The names are recovered both from the ROM:/FUNCTION and the NVRAM:/FUNCTION directories. You should not have the same named functions in both directories.

2. Use the `PROG:NAME` command to select the function program to run.

3. Use the `PROG:STAT RUN` command to start the named function. Send `PROG:STAT STOP` to stop the running function if it is not self terminating.

Save AM700 State Function

A special function is included in the function library to assist in saving state for repeated setups. The AM700 State Saving function file name is save1_06.tcl. To use this function do the following:

1. Configure the AM700 in the manner you want to save.

2. Start the Function utility. (Refer to *Running a Function* on page 4-130.)

3. Select save1_06.tcl either by touching it or using the knob to highlight it.

4. Touch Run Function to start the state saving operation.

5. Press the Clear Menu button.

A notice will appear on the screen while the AM700 State Saving function is running (if you pressed Clear Menu). When the message prompting you to rename the newly created file appears, the function is finished saving the setup state. The saved state files are themselves functions that you can run at any time to restore the saved setup. You must rename the file if you want to build a library of setup configuration functions. If you do not rename the file, it will be overwritten the next time you run the state saving function from the same application.

You can also save the setup files to a floppy disk for later use or transfer them to other AM700 Audio Measurement Sets to build a standardized set of application setup functions for repeated testing.

The AM700 State Save function saves the following settings:

- Application settings
- Generator settings
- Input settings
- COM port and GPIB settings
- Printer settings (except printer destination)

It does not save the following settings:

- Relative-to-reference information
- Regulation mode settings
- DSP generator settings

Function Operation

AM700 Audio Measurement Set User Manual

Appendices

Appendix A: Specifications

The performance limits in this specification are valid with the following conditions:

- This instrument must have been calibrated/adjusted at an ambient temperature between +20° C and +30° C.
- The instrument must be in an environment with temperature, altitude, humidity, and vibration within the operating limits described in Table A-14 on page A-29.
- The instrument must have had a warm-up period of at least 20 minutes.
- The instrument must have had its signal-path-compensation routine last executed after at least a 20 minute warm-up period at an ambient temperature within ±5° C of the current ambient temperature.

Any conditions that are unique to a particular characteristic are expressly stated as part of that characteristic.

Table A-1: Analog Analyzer Specifications

Capabilities	Description
Input Characteristics	
Number of Input Channels	Two channels: A and B
Input Type	Balanced, differential
Input Impedance	100 kΩ per side in parallel with $\approx$ 300 pF (with no internal loads)
Internal Load Impedance	600 Ω, 150 Ω, or 200 kΩ, software selectable
Vmax Internal Load	Approximately 34.65 V peak or 24.5 V_{RMS} (sinusoidal) at 600 Ω (+30 dBm)
	Overload exerted for inputs peaks greater than +35 V
Maximum Input Voltage	176 V (DC + peak AC)
	Note: Installation Category I - Signals must be isolated from the mains.
	DO NOT CONNECT TO MAINS VOLTAGES.

Table A-1: Analog Analyzer Specifications (Cont.)

Capabilities	Description
Input Characteristics	
Full Scale Input Ranges	From –22 dBu (62.5 mV$_{RMS}$) to +44 dBu (125 V$_{RMS}$) in 12 6-dB steps
	Input gain ranges are in 6 dB steps from –22 dBu to +8 dBu and in 12 dB attenuator steps (with intermediate 6 dB gain steps) from +8 dBu to +44 dBu.
	Autoranging may be selected to switch the gain appropriately on the level of the input signal.
Auto Ranging	Input level sensing circuitry exists which allows software control of the input gain and attenuation, automatically selecting the optimum dynamic range for the current input level.
Minimum Input for ±1 dB Accuracy	1 mV (–57.8 dBu) (–36 dB on 62.5 mV scale) in "high resolution mode "
Maximum Resolution	96 dB below 62.5 mV = 0.9875 μ V
Maximum Useable Bandwidth	
High Bandwidth Mode	80 kHz
High Resolution Mode	24 kHz
Common-Mode Rejection	
At 50 or 60 Hz	≥ 50 dB
At 1 kHz	≥ 50 dB. Typically 80 dB on +8 dBu scale, 60 dB on +14 dBu and up, and typically > 80 dB on less than +8 dBu scale
At 10 kHz	≥ 45 dB. Typically 80 dB on +8 dBu scale, 45 dB on +14 dBu and up, and typically > 80 dB on less than +8 dBu scale
At 20 kHz	≥ 40 dB. Typically 80 dB on +8 dBu scale, 45 dB on +14 dBu and up, and typically > 80 dB on less than +8 dBu scale

Isolation, Generator to Analog Acquisition	Load R = 200 kΩ	Load R = 600 Ω
10 Hz to 1 kHz	≥ 90 dB	≥ 140 dB
> 1 kHz to 80 kHz	≥ 80 dB	≥ 100 dB

Table A-1: Analog Analyzer Specifications (Cont.)

Capabilities	Description
Input Characteristics	
Crosstalk +Noise, Channel-to-Channel This is a wideband measurement of the level difference between the undriven channel and the driven channel.	Driven channel input is a +8 dBu sine wave. Undriven input terminated in $\leq 600\ \Omega$.
Both Channel Input Ranges Set to +8 dBu	
High Resolution Mode 15 Hz to 20 kHz	≤ -88 dB, typically ≤ -100 dB (noise-limited); Typically ≤ -100 dB at full scale on the +2, +8, +14, +20, and +26 dBu ranges from 10 Hz to 20 kHz
High Bandwidth Mode 70 Hz to 80 kHz	≤ -65 dB, typically ≤ -70 dB (noise-limited)
Crosstalk +Noise, Channel-to-Channel (cont.)	
Undriven Channel Set to Autorange (Set driven channel input range to FS value indicated below.)	
High Resolution Mode 15 Hz to 20 kHz Input (FS) +8 dBu +14 dBu +20 dBu	≤ -100 dB, typically ≤ -115 dB (noise-limited) Typically ≤ -120 dB Typically ≤ -125 dB
High Bandwidth Mode 70 Hz to 80 kHz Input (FS) +8 dBu	≤ -95 dB, typically ≤ -100 dB, 70 Hz to 40 kHz (noise-limited)

Table A-1: Analog Analyzer Specifications (Cont.)

Capabilities	Description
Input Characteristics	
Channel Separation (High Resolution Mode)	
This is a measurement of the level of the driven channel with respect to the undriven channel with a bandpass filter centered on the driven channel frequency. The measurement is primarily noise-limited; therefore, measured values improve as input amplitude increases.	
Channels A and B Equal Gain Settings (both channel input ranges at +8 dBu)	
10 Hz to 5 kHz	$\geq$ 100 dB
> 5 kHz to 20 kHz	$\geq$ 90 dB
	Typically $\geq$ 110 dB, 20 Hz to 5 kHz, from +2 dBu on the +2 dBu input range through +30 dBu on the +32 dBu input range
Undriven Channel Set to Auto Range	
15 Hz to 5 kHz	$\geq$ 120 dB (noise-limited)
> 5 kHz to 20 kHz	$\geq$ 110 dB
Channel Separation (High Bandwidth Mode)	
Channels A and B Equal Input range Settings (driven input = +8 dBu on +8 dBu input range)	
CH A into CH B	
70 Hz to 5 kHz	$\geq$ 85 dB
> 5 kHz to 40 kHz	$\geq$ 75 dB
> 40 kHz to 80 kHz	$\geq$ 65 dB
CH B into CH A	
70 Hz to 5 kHz	$\geq$ 85 dB
> 5 kHz to 40 kHz	$\geq$ 80 dB
> 40 kHz to 80 kHz	$\geq$ 70 dB (typically $\geq$ 85 dB)

Table A-1: Analog Analyzer Specifications (Cont.)

Capabilities	Description
Input Characteristics	
Undriven Channel Set to Autorange (driven input = +8 dBu on +8 dBu input range)	
CH A into CH B	
70 Hz to 5 kHz	≥ 115 dB
> 5 kHz to 40 kHz	≥ 105 dB
> 40 kHz to 80 kHz	≥ 95 dB
CH B into CH A	
70 Hz to 5 kHz	≥ 112 dB
> 5 kHz to 40 kHz	≥ 110 dB
> 40 kHz to 80 kHz	≥ 108 dB
Amplitude Measurement	
Amplitude Accuracy at CAL Frequency	
+8 dBu FS	±0.1 dB at 120 Hz
Other gain steps FS	±0.15 dB at 120 Hz
Amplitude Accuracy (relative to Accuracy at CAL Frequency) (High Resolution Mode)	
10 Hz to 20 kHz	
Inputs >1 mV (–57.8 dBu) to 10 mV (–37.8 dBu)	±1.0 dB
Input >10 mV (–37.8 dBu) to 1.946 V (+8 dBu)	±0.1 dB, typically ±0.05 dB, 50 Hz to 10 kHz
Input > 1.946 V (+8 dBu) to < 64 V (+36 dBu) for input frequencies below 20 kHz and to < 16 V (+26 dBu) for input frequencies from 20 to 80 kHz	±0.15 dB, typically ±0.05 dB, 50 Hz to 10 kHz

Table A-1: Analog Analyzer Specifications (Cont.)

Capabilities	Description		
Amplitude Measurement			
Amplitude Accuracy (relative to Accuracy at CAL Frequency) (High Bandwidth Mode)	10 Hz to 20 kHz	20 to 70 kHz	70 to 80 kHz
Inputs >1 mV (−57.8 dBu) to 10 mV (−37.8 dBu)	±1.0 dB	±1.0 dB	±2.0 dB
Input > 10 mV (−37.8 dBu) to 1.946 V (+8 dBu)	±0.15 dB	±0.2 dB	±1.0 dB
	(Typically ±0.05 dB from 50 Hz to 10 kHz)		
Input > 1.946 V (+8 dBu) to < 64 V (+36 dBu) for input frequencies below 20 kHz and to < 16 V (+26 dBu) for input frequencies from 20 to 80 kHz	±0.20 dB	±0.25 dB	±1.0 dB
	(Typically ±0.05 dB from 50 Hz to 10 kHz)		
Interchannel Amplitude Accuracy at 120 Hz			
High Resolution Mode			
At +8 dBu FS	±0.1 dB, typically ±0.05 dB		
At other gain steps FS	±0.15 dB		
High Bandwidth Mode			
At +8 dBu FS	±0.2 dB, typically ±0.05 dB		
At other gain steps FS ≥ 62.5 mV (−22 dBu)	±0.25 dB		
Interchannel Amplitude Flatness Relative to Interchannel Amplitude Accuracy at 120 Hz			
High Resolution Mode (10 Hz to 20 kHz)			
At +8 dBu FS	±0.1 dB, typically ±0.05 dB		
At other gain steps FS	±0.15 dB, typically ±0.05 dB		

Table A-1: Analog Analyzer Specifications (Cont.)

Capabilities	Description		
Amplitude Measurement			
High Bandwidth Mode	10 Hz to 20 kHz	20 to 70 kHz	70 to 80 kHz
At +8 dBu FS	±0.2 dB (typically ±0.05 dB from 50 Hz to 10 kHz	±0.35 dB	±1.0 dB
At other gain steps FS ≥ 62.5 mV (−22 dBu)	± 0.25 dB	±0.35 dB	±1.0 dB
	The accuracy of the measurement may be noise-limited for amplitudes below 62.5 mV (−22 dBu).		
Interchannel Phase Difference			
High Resolution Mode	±1 degree from 100 Hz to 20 kHz		
ADC Sampling Rate			
High Resolution Mode	6.144 MHz, decimated to 48 kHz (two channels, 64 times oversampling on each channel).		
High Bandwidth Mode	192 kHz		

Table A-1: Analog Analyzer Specifications (Cont.)

Capabilities	Description	
THD + N Measurement		
High Bandwidth Mode Residual THD + N		
THD + N measured using the high bandwidth ADC over an 80 kHz BW. The measurement is noise-limited for amplitudes below 125 mV (–16 dBu).		
Input > 125 mV (–16 dBu); frequency $\leq$ 20 kHz to $\geq$ 72 Hz.	Typically $\leq$ 0.03% , maximum 0.05%.	
High Resolution Mode Residual THD + N		
Measurement bandwidth = 20 kHz		
Input Amplitude > 62.5 mV ($\approx$ –21.9 dBu)	$\leq$ 0.015%, noise-limited for amplitudes $<$ 250 mV ($\approx$ –10 dBu)	
Input Amplitude Between 250 mV ($\approx$ –10 dBu) and 16 V ($\approx$ +26 dBu) and frequencies between 20 Hz and 6.6 kHz		
On +2, +8, +14, +20, and +26 dBu Input Ranges	At Full Scale	At Full Scale –6 dB
400 Hz to 6.6 kHz	$\leq$ 0.003%, typ. $\leq$ 0.0015%	$\leq$ 0.003%, typ. $\leq$ 0.002%
100 Hz to $<$ 400 Hz	$\leq$ 0.005%, typ. $\leq$ 0.0025%	$\leq$ 0.003% typ. $\leq$ 0.0025%
20 Hz to $<$ 100 Hz	$\leq$ 0.011%	$\leq$ 0.005%, typ. $\leq$ 0.003% at 20 Hz

Table A-1: Analog Analyzer Specifications (Cont.)

Capabilities	Description	
THD + N Measurement		
High Resolution Mode Residual THD + N (cont.)		
On –4 dBu Input Range	At Full Scale	At Full Scale –6 dB
400 Hz to 6.6 kHz	≤ 0.003%	≤ 0.006%
100 Hz to < 400 Hz	≤ 0.0075%	≤ 0.006%
20 Hz to < 100 Hz	≤ 0.0125%	≤ 0.0075%
On –10 dBu Input Range		
400 Hz to 6.6 kHz	≤ 0.005%	≤ 0.010%
100 Hz to < 400 Hz	≤ 0.0075%	≤ 0.010%
20 Hz to < 100 Hz	≤ 0.015%	≤ 0.011%
	THD + N is limited by the A/D distortion (primarily 3rd harmonic) near full-scale at frequencies below 200 Hz. At –6 dB relative to FS, the increase in distortion at low frequencies is much less, typically 0.003% versus 0.0075% (FS) at 20 Hz. Under some conditions (measurements below 200 Hz), it may be desirable to manually set the input range one setting higher, sacrificing 6 dB of noise floor for better distortion readings. The autorange circuitry optimizes dynamic range, somewhat compromising distortion near full scale.	

Table A-2: Electronic Triggers Specifications

Capabilities	Description
Trigger Input	
Number of Trigger Inputs	One input located on the rear panel.
Electrical Characteristics	TTL-level, Schmitt-trigger input
Connector Type	BNC female
Psuedo Triggers	
Trigger Events	Two trigger events may be generated by remote control using the commands in the SCPI TRIGger subsystem: STARt starts the sweep running and STOP ends the sweep.

Table A-3: Analog Generator Specifications

Capabilities	Description		
Output Characteristics			
Number of Output Channels	Two, labeled A and B		
Signal Format	Switchable between balanced and unbalanced		
Source Impedance	Selectable between: 600 Ω, 150 Ω, and 10 Ω.		
	Minimum	Typical	Maximum
600 Ω	594	600	608
150 Ω	148.5	150	155
10 Ω (nominal)	9.5	11.8	13.5
	A user-defined impedance may be used in place of either the 600 Ω or the 150 Ω source impedance. (Internal modification is required.)		
Output Control Enable	Switchable on-off, with terminating resistance remaining as selected		
Output Float Enable	Switchable floating/grounded output		
Floating Mode R to Ground	≈ 1 kΩ		
Capacitance to Ground	≈ 1 nF (@ 1 kHz)		
Maximum Float Voltage	± 25 V peak		

Table A-3: Analog Generator Specifications (Cont.)

Capabilities	Description
Output Characteristics	
Channel Separation	
High Resolution Mode	≥ 100 dB for frequencies ≥ 20 Hz
High Bandwidth Mode	≥ 70 dB for frequencies ≥ 70 Hz
Signals and Control	
All signals are generated digitally using software running on a DSP56002 digital-signal processor, driving audio digital-to-analog converters.	
Types of Signals Supported by Hardware	Signals that are band limited to 80 kHz.
Independence of Generated Signal Outputs	The hardware allows either stereo or mono mode generation. In stereo mode, each channel is generated from a separate DAC, while for mono mode, a signal DAC is used, followed by separate output drivers for each channel (A and B).
	The AM700 does not support stereo mode with the high bandwidth generator.
Frequency Related Characteristics	
Sine Wave Frequency Range	
High Resolution Mode	10 Hz to 20 kHz
High Bandwidth Mode	11.719 Hz to 79992.188 kHz
Sine Wave Frequency Resolution	
High Resolution Mode	0.1 Hz
High Bandwidth Mode	11.719 Hz
Sine Wave Frequency Accuracy	±0.01%
Interchannel Phase Difference	These specifications apply only if generator channels are set to Follow A. When channels are not in follow, their relative phases are arbitrary.
High Resolution Mode	±1 degree at 1 kHz Typically ±1 degree, 100 Hz to 20 kHz
High Bandwidth Mode	Typically ±1 degree at 1 kHz; ±2 degrees at 20 kHz

Table A-3: Analog Generator Specifications (Cont.)

Capabilities	Description
Amplitude Related Characteristics	
Full Scale Output Amplitude Ranges (Balanced outputs with source R = 10 Ω nominal) Measured into a high impedance load. Amplitudes will be approximately 0.14 dB lower if measured across a 600 Ω load when the source R = 10 Ω nominal.	Every 6 dB from –22.1 dBu (60.8 mV$_{RMS}$) to +13.9 dBu (3.84 V$_{RMS}$) plus +20 dBu (7.75 V$_{RMS}$), +26.0 dBu (15.45 V$_{RMS}$), and +30 dBu (24.5 V$_{RMS}$) for frequencies up to 20 kHz. Maximum output is limited to +28 dBu from 20 kHz to 80 kHz. For 600 Ω source impedance, all amplitudes are 6 dB lower if measured across a 600 Ω load.
Maximum Generator Output Amplitude into a 600 Ω Load 10 Hz to 20 kHz	
Source Impedance = 10 Ω	+28 dBu
Source Impedance = 600 Ω	+24 dBu
Minimum Output Amplitude for ±1 dB Accuracy	1 mV
Maximum Resolution High Resolution Mode	
10 Hz to 20 kHz	1 μV
High Bandwidth Mode	
11.7 Hz to 80 kHz	3 μV

Amplitude Accuracy at 120 Hz, High Resolution Generator
 	
    Normal Mode
        At +13.9 dBu
        −16.1 dBu to +30 dBu
        −34.1 dBu to <−16.1 dBu
        −52.1 dBu to <−34.1 dBu
 	
    Low Distortion Mode
	
	±0.1 dB, typically ±0.05 dB
	±0.1 dB
	±0.15 dB, typically ±0.1 dB
	±0.25 dB
	
	+0.2 dB to −0.0 dB relative to Normal Mode

Amplitude Accuracy at 120 Hz, High Bandwidth Generator
 	
    At +13.9 dBu
    −16.1 dBu to +30 dBu
    −34.1 dBu to <−16.1 dBu
    −52.1 dBu to <−34.1 dBu
	
	±0.15 dB, typically ±0.1 dB
	±0.15 dB, typically ±0.1 dB
	±0.15 dB, typically ±0.1 dB
	±0.25 dB

Table A-3: Analog Generator Specifications (Cont.)

Capabilities	Description
Amplitude Related Characteristics	
Amplitude Flatness, High Resolution Generator Relative to 120 Hz	Levels from −22.1 dBu to +30 dBu
Normal Mode	
10 Hz to 10 kHz	±0.1 dB
>10 kHz to 20 kHz	+0.1 / −0.2 dB
Low Distortion Mode	
10 Hz to 1 kHz	+0.1 / −0.25 dB
>1 kHz to 10 kHz	+0.1 / −0.6 dB
Amplitude Flatness, High Bandwidth Generator Relative to 120 Hz	Level from −22.1 dBu to +30 dBu
11.7 Hz to 20 kHz	± 0.1 dB
>20 kHz to <70 kHz	+0.1 / −0.5 dB
70 kHz	Typically ≤−0.3 dB
>70 kHz to <80 kHz	+0.5 / −1.0 dB
80 kHz	Typically ≤−0.5 dB
Interchannel Amplitude Accuracy at 120 Hz	
High Resolution Mode	
At +13.9 dBu	±0.2 dB; with respect to amplitude accuracy at 120 Hz and 13.9 dBu, typically ±0.05 dB
−22.1 dBu to +30 dBu	±0.3 dB
High Bandwidth Mode	
At +13.9 dBu	±0.2 dB with respect to amplitude accuracy at 120 Hz and 13.9 dBu
−22.1 dBu to +30 dBu	±0.3 dB

Table A-3: Analog Generator Specifications (Cont.)

Capabilities	Description
Amplitude Related Characteristics	
Interchannel Amplitude Flatness Relative to 120 Hz	Levels from –22.1 dBu to +30 dBu
High Resolution Generator	
Normal Mode	
10 Hz to 10 kHz	±0.2 dB
> 10 kHz to 20 kHz	±0.4 dB
Low Distortion Mode	
10 Hz to 1 kHz	±0.5 dB
> 1 kHz to 10 kHz	±1.0 dB
High Bandwidth Generator	
11.7 Hz to 20 kHz	±0.2 dB
> 20 kHz to 70 kHz	±1.0 dB
> 70 kHz to 80 kHz	±1.0 dB
THD + N	
High Resolution Generator Residual THD + N (Normal Mode)	Measurements over 80 kHz BW are noise limited below –4 dBu.
Residual THD+N of the high resolution generator without the bandpass filter in place. These specifications are baseline for nonsine wave signals and for sine wave signals not generated in the low-distortion mode. Load R $\geq$ 600 Ω.	Measurements over 22 kHz BW are noise limited below –10 dBu.

	Over 22 kHz BW	Over 80 kHz BW
10 Hz to 5 kHz		
Amplitude $\geq$ –10 dBu	$\leq$ 0.01% (–80 dB) typ. $\leq$ 0.008% (–82 dB)	
10 Hz to 20 kHz		
Amplitude $\geq$ +8 dBu		$\leq$ 0.0175% (–75 dB) typ. $\leq$ 0.011% (–79 dB)
Amplitude $\geq$ –4 dBu		$\leq$ 0.025% (–72 dB)

Table A-3: Analog Generator Specifications (Cont.)

Capabilities	Description	
THD + N		
Residual THD + N (Low Distortion Mode)		
Residual THD+N with the bandpass filter in place. These specifications are baseline for sine waves generated in the low-distortion mode. Load resistance $\geq$ 600 Ω		
	Over 22 kHz BW	Over 80 kHz BW
100 Hz to 749 Hz Amplitudes $\geq$ +4 dBu to $\leq$ +26 dBu	Typ. $\leq$ 0.001% (−100 dB)	

20 Hz to 749 Hz
    Amplitudes $\geq$ +8 dBu
    Amplitudes $\geq$ 0 dBu
	$\leq$ 0.0025% (−92 dB), typ. $\leq$ 0.0015% (−96.5 dB)	$\leq$ 0.005% (−86 dB)
		$\leq$ 0.0075% (−82.5 dB)

Amplitudes $\geq$ −4 dBu	$\leq$ 0.0025% (−92 dB)	
Amplitudes $\geq$ −10 dBu	$\leq$ 0.005% (−86 dB)	
Amplitudes $\geq$ −16 dBu	$\leq$ 0.0075% (−82.5 dB)	

750 Hz to 7.3 kHz
    Amplitudes $\geq$ +8 dBu
    Amplitudes $\geq$ 0 dBu
	$\leq$ 0.005% (−86 dB), typ. $\leq$ 0.003% (−90.5 dB)	$\leq$ 0.005% (−86 dB)
		$\leq$ 0.0075% (−82.5 dB)

Amplitudes $\geq$ −4 dBu	$\leq$ 0.005% (−86 dB)	
Amplitudes $\geq$ −10 dBu	$\leq$ 0.005% (−86 dB)	
Amplitudes $\geq$ −16 dBu	$\leq$ 0.0075% (−82.5 dB)	
	Amplitudes less than −16 dBu are noise limited (22 kHz BW).	
High Bandwidth Generator Residual THD+N		
Residual THD+N of the high bandwidth generator. Load resistance $\geq$ 600 Ω, outputs $\geq$ −4.0 dBu		
	Over 22 kHz BW	Over 80 kHz BW
11.7 Hz to 5 kHz	$\leq$ 0.015% (−76.5 dB) $\leq$ typ. 0.01% (−80 dB)	$\leq$ 0.018% (−75 dB)
> 5 kHz to 20 kHz	Not applicable	$\leq$ 0.025% (−72 dB)
> 20 kHz to 40 kHz	Not applicable	$\leq$ 0.03% (−70.5 dB)
> 40 kHz	Not applicable	Not applicable

Table A-4: Digital Audio Unit Specifications

Capabilities	Description
The Digital Audio Unit includes a generator, a reference generator, a main receiver, and a reference receiver. These four sections can operate simultaneously, each at its own sample rate.	
Interface Characteristics	The generator always drives the Digital Out XLR, Unbalanced Out BNC, and Optical Out connectors. The main receiver selects one of the following: Digital XLR, Unbalanced In BNC, Optical In, or AES generator as its source.
	The reference receiver normally selects the Digital Ref In XLR as its source, except when the AES generator is selected as the main input, the reference receiver input switches to the reference generator.
Connector Types	
Front Panel	
Digital In, Digital Out	Balanced XLR, conforms to AES3-1992 and EBU 3250-E.
Rear Panel	
Unbalanced In, Unbalanced Out	BNC
Optical In, Optical Out	F05 snap-in type, 10 meter capability using APF (980/1000 mm [micrometer]) optical fiber
Digital Reference In, Digital Reference Out	Balanced XLR, conforms to AES3-1992 and EBU 3250-E
DSP	15-pin D, TTL/CMOS compatible; pinout compatible with Ariel Digital Microphone
Input and Output Impedances	
Digital In, Digital Out, Digital Reference In, Digital Reference Out	110 Ω ±10%, 0.1 MHz to 6 MHz
Unbalanced In, Unbalanced Out	75 Ω ±5%, 0.1 MHz to 6 MHz

Table A-4: Digital Audio Unit Specifications (Cont.)

Capabilities	Description
Input and Output Levels	
AES/EBU I/O Levels	
Input levels required for normal operation and the output levels available. For details on measured or programmable parameters, see either *Main Receiver Interface Parameter Measurements* or *Generator Variable Parameters*.	
Digital In	0.15 V to 10 V peak-to-peak
Unbalanced In	30 mV to 2 V peak-to-peak
Digital Reference In	0.2 V peak-to-peak minimum eye opening. 10 V peak-to-peak maximum amplitude, 20% minimum eye height.
Digital Out	Programmable from 0.2 V to 8 V peak-to-peak into 110 Ω.
Unbalanced Out	Programmable from 50 mV to 2 V peak-to-peak into 75 Ω.
Digital Reference Out	Fixed at 5.4 $\pm$0.5 V peak-to-peak into 110 Ω.
DSP I/O Levels	
DSP Inputs	Vil = 0.8 V, Vih = 2 V, Iil = 4 mA, Iih = 0 (CMOS with 1.2 kΩ pull-up)
DSP Outputs	Iol = 4 mA, Ioh = –5.3 mA, Vol = 0.6 V, Voh = 2.4 V
Optical I/O Levels	Conforms to TOSLINK™ parameters.
Receiver Interface Parameter Measurements	
Main Input Level	
This is the level in Volts peak-to-peak being applied to the selected digital input (the front-panel Digital In or rear-panel Unbalanced In).	
Measurement Range	XLR: 0.15 V to 8.0 V peak-to-peak BNC: 30 mV to 2.0 V peak-to-peak
Accuracy with Factory Calibration Factors	XLR: $\pm$(30 mV + 15% of reading) BNC: $\pm$(15 mV + 15% of reading)

Table A-4: Digital Audio Unit Specifications (Cont.)

Capabilities	Description
Receiver Interface Parameter Measurements	
Clock Rate	
Range	All inputs: 30 kHz to 52 kHz
Accuracy	±10 ppm
Input Equalization	
The Main Input includes automatic line equalization to measure and correct roll-off due to typical 110 Ω digital audio cable.	
Range	0 to 20 dB loss at 10 MHz
Accuracy	±2 dB
Static Phase Difference	
This is the phase difference between the selected main input and the reference input. The primary function of the measurement is to check compliance with AES11-1991; section 5.3.	
Range	+49.6% to –50.0% of the digital audio frame
Accuracy	±1% of the digital audio frame
Eye Diagram	
This is the data source for the eye diagram display and its accompanying peak-to-peak jitter measurement. It is the equivalent-time sample points of the selected main input.	
Time-base PLL Bandwidth	120 Hz or 1.2 kHz, user selectable
Bandwidth Accuracy	±10%
Amplitude Accuracy	±10% with calibration, ±20% with factory calibration factors
Eye Diagram Residual Jitter	0.03 UI (combined residual jitter of reference generator and main receiver, with 120 Hz time-base bandwidth)

Table A-4: Digital Audio Unit Specifications (Cont.)

Capabilities	Description
Receiver Interface Parameter Measurements	
Eye Diagram Peak-to-Peak Jitter	
Range	0 to 0.8 UI peak-to-peak jitter

Accuracy
        LF Reject = 120 Hz (response falls 6 dB
        per octave below about 100 Hz)
	$\pm$(0.02 UI + 5%) for sinusoidal jitter above 500 Hz

LF Reject = 1200 Hz (response falls 6 dB per octave below about 1000 Hz)	$\pm$(0.02 UI + 5%) for sinusoidal jitter above 30 kHz
Phase Jitter This is the jitter amplitude in unit intervals (UI) as a function of jitter frequency.	
Range	10 UI p-p from 20 Hz to 500 Hz, decreasing proportionally to 0.5 UI p-p from 10 kHz to 50 kHz
Accuracy For sinusoidal jitter greater than –20 dBUI (0.1 UI p-p) at jitter gain = 1, or greater than –40 dBUI (0.01 UI p-p) at jitter gain = 8	
Jitter Gain = X1 or X8	
50 Hz to 500 Hz	$\pm$2 dB
500 Hz to 10 kHz	$\pm$1 dB
Jitter Gain = X8	
10 kHz to 50 kHz	$\pm$2 dB
Spurious Response	
Jitter Gain = X1	
50 Hz to 100 Hz	–20 dBUI
100 Hz to 50 kHz	–30 dBUI
Jitter Gain = X8	
50 Hz to 100 Hz	–30 dBUI
100 Hz to 50 kHz	–40 dBUI

Table A-4: Digital Audio Unit Specifications (Cont.)

Capabilities	Description
Reference Input Parameter Measurements	
Clock Rate	
Range	30 kHz to 52 kHz
Accuracy	$\pm$10 ppm
Generator Variable Parameters	
Clock Rate Range	
All Inputs and Outputs	30 kHz to 52 kHz
Clock Rate Accuracy	
The primary clock rates (32, 44.1, and 48 kHz) are synthesized exactly, so accuracy depends solely on the accuracy of the reference used (internal or external).	
Internal Ref Accuracy	$\pm$10 ppm
Static Phase Difference	
This is the phase difference between the generator output and the selected reference (input or output). The primary function of the measurement is to check compliance with AES11-1991, section 5.3.	
Range	–64 to 63.5 UI (Unit Intervals)
Resolution	0.5 UI
Accuracy	Offset $<$ 50 ns, nonlinearity $<$ 5 ns
Phase Jitter Generation	
Range	0 to 10 UI p-p from DC to 500 Hz, decreasing proportionally to 0.5 UI p-p from 10 kHz to 50 kHz
Resolution	0.02 UI p-p
Accuracy	
DC to 20 kHz	$\pm$(10% of value + 0.02 UI)
20 kHz to 50 kHz	$\pm$(20% of value + 0.02 UI)

Table A-4: Digital Audio Unit Specifications (Cont.)

Capabilities	Description
Generator Variable Parameters	
Cable Simulator	A selectable cable simulator inserts the response of a long, typical digital audio cable in the front-panel Digital Out signal.
Simulated Cable Response	125 ns to 175 ns rise time measured at the second transition of the preamble of subframe 1
Output Level	
Range	XLR: 0 to 8.0 V p-p into 110 Ω BNC: 0 to 2.04 V p-p into 75 Ω
Resolution	XLR: 10 mV BNC: 2 mV
Accuracy	XLR: $\pm$(10 mV + 5% of setting) BNC: $\pm$(2 mV + 2% of setting)
Main Output Residual Jitter	
Clock Source From Audio Frequency Offset = 0	0.05 UI p-p maximum
Frequency Offset < > 0 or Clock Source is Variable	0.08 UI p-p maximum
Clock Source From Ref	(0.08 UI p-p + reference jitter) maximum
	Reference signal jitter up to 15 kHz adds directly to output jitter. Reference input jitter above 15 kHz is attenuated by 6 dB per octave.
Reference Output Variable Parameters	
Clock Rate Range	The reference output can be driven from the same clock that drives the main output, in which case the specifications of the main clock apply. Alternately, the reference output can be timed from the internal 48 kHz clock, or from the clock applied to the Digital Reference In connector.

Table A-4: Digital Audio Unit Specifications (Cont.)

Capabilities	Description
Reference Output Variable Parameters	
Clock Rate Accuracy	Same as Internal clock rate accuracy.
Reference Output Residual Jitter	
Clock Source From Audio Frequency Offset = 0	0.03 UI p-p maximum
Frequency Offset < > 0 or Clock Source is Variable	0.08 UI p-p maximum
Clock Source From Reference (external reference is required)	(0.08 UI p-p + reference jitter) maximum

Table A-5: Display System

Capabilities	Description	
Display		
Display Type	Color LCD flat panel; backlighted	
Display Size	6.4 inches (162.6 mm) diagonal	
Display Resolution	640 (H) X 480 (V) pixels (VGA)	
Touch Panel		
Description	Analog resistive touch screen	
Size		
Width	6.615 inches (168 mm)	
Height	5.33 inches (135.4 mm)	
VGA Output		
Resolution	640 X 480 VGA	
Signal Levels	Level	Voltage
	White Level	0.7 V
	Black Level	0 V
	Blanking	0 V
	Horizontal Sync	TTL, low true
	Vertical Sync	TTL, low true
Load Impedance	Signal	Load Impedance
	Red	75 Ω
	Green	75 Ω
	Blue	75 Ω
	Horizontal Sync	TTL compatible
	Vertical Sync	TTL compatible

Table A-5: Display System (Cont.)

Capabilities	Description	
VGA Output		
Timing	Signal	Time/Frequency
	Dot Clock	25.175 MHz
	Horizontal Rate	31.469 kHz
	Vertical Rate	59.940 Hz
Pin Out	Pin Number	Description
	1	Red
	2	Green
	3	Blue
	4	NC
	5	Ground
	6	Red Ground
	7	Green Ground
	8	Blue Ground
	9	NC
	10	Ground
	11	NC
	12	NC
	13	Horizontal Sync
	14	Vertical Sync
	15	NC

Table A-6: Software Update Procedure

Capabilities	Description
Update Procedure	AM700 firmware may be updated from a 1.44 Mbyte diskette.

Table A-7: Nonvolatile Memory

Capabilities	Description
Battery-backed SRAM	
Storage Capacity	1 Mbyte
Retention Time (the length of time that stored waveforms and setups are retained without power to the instrument)	Internal batteries, installed at the time of manufacture, have a life of greater than 10 years when operated and stored at an ambient temperature from $0°$ C to $50°$ C. Retention time of the nonvolatile memories is equal to the remaining life of the batteries. Battery life can be reduced when stored for extended time above $50°$ C. Retained data may be lost when stored for extended time below $0°$ C.
Backup Battery	Lithium
Rated Voltage	3.0 V
Flash EPROM	
Storage Capacity	8 Mbyte
Retention Time (The length of time that data stored in flash memory will remain useable)	10 years (minimum)
Maximum Rewrites	100,000

Table A-8: Floppy Disk Drive

Capabilities	Description
Mechanical	
Size of Floppy Disk	3.5 inches, 1.44 Mbytes, DSHD
Mounting Location and Orientation of Disk Drive	Left side of CRT, vertically oriented Disk drive must not be operated when it is upside down (with the left side of the AM700 down).
Ejection Tab Orientation	Toward the bottom of the cabinet
Logical	
User File Format	MS-DOS

Table A-9: Front Panel Hardware

Capabilities	Description
Audio Input and Output Connectors	
Analog Audio	Standard XLR female: pin 1 shield, pin 2+, pin 3 –
Digital Audio	Input: XLR female, Output: XLR male
Headphone Jack	Standard 1/4 inch, stereo
	Channel A is left; Channel B is right.
Headphone Nominal Impedance	8 to 2000 Ω
Output Power to Headphones	20 mW minimum into 8 Ω to 2000 Ω headphones at full volume

Table A-10: Rear Panel Hardware

Capabilities	Description
Remote Connector	Female DB9
Normally Open Contact, Pin 3 to Pin 9	
Maximum Voltage	28 VDC
Maximum Current	500 mA
Maximum Power	14 W
Relay Closure Input Pin 1	Pulled to +5 V $\leq$ 100 mA; input is protected
Ground Pins	2, 4, 6, and 8
Normally Closed Contact, Pin 5 to Pin 9	
Maximum Voltage	28 VDC
Maximum Current	500 mA
Maximum Power	14 W
+5 V Output, Pin 7	+ 5 V at 5 mA
	Use ground pins 2, 4, or 6 to pull the relay-closure input low through an external contact-closure relay.
	The +5 V output is provided to drive the relay-closure input pin through an external contact-closure relay.
GPIB Connector	Meets electrical specification described in IEEE–488

Table A-10: Rear Panel Hardware (Cont.)

Capabilities	Description
COM1 and COM2 Connectors	DB9 male, configured as RS–232C, DTE; provides connection for serial printers.
VGA Connector	DB15 female; supports external VGA monitor
Keyboard Connector	PS/2 (6-pin mini DIN); supports AT-type keyboard signals

Table A-11: Power Distribution System

Capabilities	Description
AC Power Source	
Source Voltage	
Low Range (115 V nominal)	90 VAC_{RMS} to 132 VAC_{RMS}
High Range (230 V nominal)	180 VAC_{RMS} to 253 VAC_{RMS}
Source Frequency	50 Hz or 60 Hz
Fuse Rating	
Low Range	4 A, 3AG, slow-blow
High Range	2 A, 3AG, slow-blow
Power Consumption	
Maximum	185 watts (240 VA)
Typical	180 watts

Table A-12: Safety Standards

Category	Standards
U.S. Nationally Recognized Testing Laboratory Listing	ANSI/ISA S8201 – Safety Standard for Electrical and Electronic Test, Measuring, Controlling, and Related Equipment, 1994
Canadian Certification	CAN/CSA C22.2 No. 1010.1 – Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use
European Union Compliance	Low Voltage Directive 72/23/EEC, Amended by 93/68/EEC
	EN61010-1 Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use
Additional Compliance	UL3111-1 Standard for Electrical Measuring and Test Equipment
	IEC1010-1 – Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use

Table A-13: Safety Certification Compliance

Category	Standards
Temperature (operating)	+5° C to +40° C
Altitude (maximum operating)	2000 meters
Equipment Type	Test and Measuring
Safety Class	Class I (as defined in IEC 1010-1, Annex H) – grounded product
Overvoltage Category	Mains – Overvoltage Category II (as defined in IEC 1010-1, Annex J)
	Analog Input – Overvoltage Category I
Pollution Degree	Pollution Degree 2 (as defined in IEC 1010-1).
	Note – Rated for indoor use only.

Table A-14: Environmental Characteristics

Capabilities	Description
Atmospherics	
Temperature	
Operating	−10° C to +50° C, Class 5
Nonoperating (storage)	−51° C to +71° C. Class 3
Humidity	To 95% relative humidity at or below +55° C.
Altitude	
Operating	To 15,000 feet (4572 meters)
	Maximum operating temperature to be decreased 1° C per 1000 feet (305 meters) above 5000 feet (1524 meters)
Nonoperating (storage)	To 50,000 feet (15240 meters)

Table A-15: Dynamic Characteristics

Capabilities	Description
Vibration	
Random Vibration	Class 5 levels
Shock	
Functional Shock (nonoperating)	30 g, 11 ms, half-sine input
Transit Drop	Nonoperating Transit Drop with 8-inch drops, front cover installed
Bench Handling	MIL-T-28800E, para. 4.5.5.4.3, Bench Handling test, with cabinet on and instrument operating. Each edge lifted four inches and allowed to free fall onto a solid wooden surface.
Packaged Product Drop	Drop of 18 inches on each edge, face, and corner of packaged product; additional drop of 36 inches on bottom face.
Warehouse Stacking	Up to five units high

Table A-15: Dynamic Characteristics (Cont.)

Capabilities	Description
Shock	
Loose Load Vibration	1 inch p-p sinusoidal at approximately 4.5 Hz with at least 1/16 inch peak separation between the packaged product and the surface. Thirty minutes in normal shipping orientation, 30 minutes split between other possible shipping orientations.
Vehicle Vibration	1.33 g_{RMS}, random vibration, from 5 to 500 Hz, 60 minutes on each axis.
Storage Shelf-Life (uncontrolled warehouse climate)	Six months or more if desiccant is included inside normal package, and normal package is placed inside a vacuum sealed bag with additional outer package.

Table A-16: Electromagnetic Compatibility

Capabilities	Description
EMC Requirements	
Emissions	Emissions are be within the limits specified by the following requirements.
	Enclosure EN55022 Class B limits for radiated emissions
	AC Mains EN55022 Class B limits for conducted emissions
	To ensure compliance with the above requirements, only high-quality shielded interface cable should be attached to this instrument. High-quality cables have a reliable, continuous outer shield (braid and foil) that has low impedance connections to shielded connector housings at both ends. The shield of the cable used to connect to the DSP must be clamped by the housing where the cable enters the connector.
	The cables used for the front panel Digital Out and the rear panel AES REF OUT must be wired with the cable shield connected to both pin 1 and to the shell of the female XLR connector (sometimes labeled "G" within the connector). Both of these connections should be as short as possible, less than 0.25 inch (0.1 cm).
Immunity, Enclosure, Electrostatic Discharge	IEC 801-2 1984
	Up to 8 kV with no loss of stored data, change to control settings, or temporary loss of function
Immunity, Enclosure, Radio Frequency Electromagnetic Field	IEC 801-3 1984
	No degradation of performance when the instrument is subjected to a 3 V/M electromagnetic field over the frequency range of 27 MHz to 500 MHz

Table A-16: Electromagnetic Compatibility (Cont.)

Capabilities	Description			
EMC Requirements				
Immunity, Fast Transients, Common Mode	IEC 801-4 1988			
	No loss of stored data, change to control settings, or temporary loss of function will occur when the instrument is subjected to transients as described below.			
	Port	Peak (kV)	Tr/Th (ns)	Rep Frequency (kHz)
	Signal & Control	0.5	5/50	5
	DC Power	0.5	5/50	5
	AC Power	1.0	5/50	5
FCC	The instrument complies with the radiated and conducted emissions requirements of FCC 47 CFR, Part 15, Subpart B, for Class A equipment.			
	To ensure compliance with the above requirements, only high-quality shielded interface cable should be attached to this instrument. High quality cable is described in the Emissions Specification.			

Table A-17: Mechanical Characteristics

Capabilities	Description
Standard Instrument	
Weight (nominal)	
Instrument by Itself	32.25 lbs (14.66 kg)
With Front Cover and Accessories	34 lbs (15.45 kg)
Domestic Shipping Weight (with shipping box, including instrument, manuals, foam, and snap-on cover. Optional service manual not included.)	45 lbs (20.454 kg)
Shipping Box	
Length	28 in (711.2 mm)
Width	23 in (584.2 mm)
Height	19.5 in (495.3 mm)
Volume	7.3 cubic feet (0.207m^3)
Overall Dimensions	
Height (with feet installed)	
Without Optional Front Cover	7.7 in (195.6 mm)
With the Optional Front Cover	8.0 in (203.2 mm)
Width	
Without the Handle	16.6 in (422 mm)
With Handle	18.2 in (462.3 mm)
Depth	
Instrument Alone	18.8 in (477.5 mm)
With Optional Front Cover	19.0 in (482.6 mm)
With Handle Fully Extended	23 in (584 mm)
Cooling Method	Forced-air circulation with no air filter
Finish Type	Gray paint finish on aluminum cabinet
Construction Material	Chassis parts constructed of aluminum alloy; front panel constructed of plastic laminate; circuit boards constructed of glass-laminate; plastic parts are polycarbonate

Table A-17: Mechanical Characteristics (Cont.)

Capabilities	Description
Rackmounted Instrument	
Weight of Rackmounted Instrument, and the Rack-mount Conversion Kit	The swing handle of the AM700 must be removed to mount it in the rackmount adapter.
Kit Weight	3.5 lbs (1.6 kg)
Domestic Shipping Weight	6 lbs (2.73 kg)
Weight of Rackmounted Instrument	30 lbs (13.64 kg) plus the weight of rackmount parts for the rackmounted instrument
Domestic Shipping Weight	45 lbs (20.5 kg) plus the weight of rackmount parts
Overall Dimensions of the Cradle Rackmount Adapter	
Height	8.75 in (222.3 mm)
Width	19 in (482.6 mm)
Depth	20 in (508 mm)

Table A-18: Remote Control Protocol

Capabilities	Description
Remote Control Protocol	SCPI (Standard Commands for Programmable Instruments) 1994
External Keyboard	
Keyboard Operation	An external AT-type keyboard can be used to enter text and numbers into those portions of the user interface that accept such input. The front-panel keypad may also be used for numeric entry. In the absence of an external keyboard, a keyboard that is operated using the touch-screen interface appears on the AM700 display when character input is permitted.

Table A-19: Generator Control

Capabilities	Description
Generator Capabilities	The analog and digital generators calculate signals in real time. The analog signals are derived digitally, providing a great deal of flexibility, but the output signals are restricted to those that can be realized with digital-to-analog converters and standardized sampling rates.
	Sine wave test signals may be swept in amplitude and frequency. The test signals may also be driven from a sequence within the capability of SCPI lists. More complicated modes may be created using the AM700 function capability as required by the user.
	There are some differences in the signal set and specifications between analog and digital generators, and the analog generator capabilities differ between high bandwidth and high resolution.
Analog Signal Generation	Several predefined signals or arbitrary user-defined signals are selectable.
Mono and Stereo Signals	Monophonic and stereophonic test signals.
	Each channel of a stereo pair is treated as a separate entity in SCPI and the AM700. This permits a great deal of flexibility in providing test signals to the outputs of the AM700. It is possible, for example, to have completely separate signals and sweeps at the A and B outputs.
	The same signal may be applied to both channel outputs. This mode is often needed for testing with the AM700. From a remote controller the `SOURce:FOLLow` command causes one channel to track the other.
	The high bandwidth generator outputs only monophonic signals (the same signal is on both A and B outputs).
User-Defined Signals	User-defined signals may be generated.
	User-defined signals may be loaded to the AM700 from a file in the internal file system or from a DOS formatted 1.44 Mbyte diskette.

Table A-19: Generator Control (Cont.)

Capabilities	Description
Time-Dependent Signals	Simple user-defined audio sweeps and tone sequences are permitted.
	The sweep feature permits sweeping frequency and amplitude separately, or both simultaneously if necessary. The sweep test signal is a set of discrete test frequencies, not a linear sweep of frequencies from start to stop.
Digital Signal Generation	Digital signal generation is similar to analog signal generation. This includes the ability to generate the same signal simultaneously on the analog and digital outputs.
	To operate analog and digital generators from the same controlling parameters, it is necessary for the user to supply a conversion factor between generator voltage and full-scale digital amplitude. This conversion factor can be entered from the user interface under System Setup Conversion Factors.
Generator Signals	Table A-20 describes each signal that can be generated in the AM700. Some signals cannot be generated by every generator. Please refer to the following table for each generator signal output capability.

Signal	Analog High Resolution Generator	Analog High Bandwidth Generator	Digital AES	Digital DSP
sine	Yes	Yes	Yes	Yes
tone burst	Yes	Yes	Yes	Yes
smpte imd	Yes	No	Yes	Yes
ccif imd	Yes	No	Yes	Yes
shaped noise	Yes	No	Yes	Yes
chirp	Yes	Yes	Yes	Yes
polarity	Yes	No	Yes	Yes
tek polarity	Yes	Yes	Yes	Yes
user	Yes	Yes	Yes	Yes
multitone	Yes	Yes	Yes	Yes
jittered sine	No	No	Yes	No

Table A-20: Generator Signals

Capabilities	Description
Generated Signals	
Sine	A single sine-wave tone with variable amplitude and frequency. The amplitude or frequency or both may be swept or stepped to provide a wide range of sinusoidal test signals.
Tone Burst	A sine-wave burst tone with variable amplitude, frequency, burst width, and burst period
Width	10 to 100000 cycles, resolution 1
Period	64 to 100064 cycles, resolution 1
	The generator converts the width time parameter into the nearest number of cycles of sine wave to generate.
SMPTE/DIN type IMD	A two-tone intermodulation signal with one tone variable in frequency
Amplitude Ratio	0.01 to 8
Variable Frequency	3 kHz to 18 kHz, resolution 0.1
Fixed Frequency	40 Hz and 500 Hz
	With appropriate parameter choices this signal can be used in a SMPTE or DIN intermodulation distortion test.
CCIF type IMD	A two-tone intermodulation signal. Both tones are typically swept in tandem with a constant frequency separation.
Amplitude Ratio	0.01, 100
Center Frequency	2.5 kHz, 19 kHz
Frequency Spacing	80 Hz, 1000 Hz
	With appropriate parameter choices, this signal can be used in a CCIF intermodulation distortion test.
Shaped Noise	A periodic pseudo-random noise signal with a specified spectral distribution
	The available colors of the noise are white and pink.

Table A-20: Generator Signals (Cont.)

Capabilities	Description
Generated Signals	
Chirp	A periodic sine sweep with a flat spectral distribution (equal energy per Hz of bandwidth). The chirp may optionally be restricted in bandwidth, with parameters for the lower and upper band edges.
Polarity	An IEC-type polarity test signal. The signal resembles a half-wave rectified sine wave with the negative values removed.
Tek Polarity	A Tektronix ASG100-style polarity test signal. The signal consists of a sine wave and its second harmonic added together.
Arbitrary Waveform	A user-defined waveform of up to 176,384 samples is repeatedly played. The waveform is provided by the user in a file loaded from a DOS formatted 1.44 Mbyte diskette.
Multitone	A multitone test signal with variable amplitude. This signal consists of multiple simultaneously generated sine waves. The multitone may be specified in either of two ways: file mode or list mode. File Mode: A user-provided file contains the description (frequency and amplitude) of each tone included in the multitone signal and the buffer size to use for the fft-based generation of the multitone. Up to 128 tones may be generated, in buffer sizes from 512 to 8192 bytes. List Mode: The multitone is generated using the same frequencies and amplitudes as used when making sweeps in list mode. The built-in list editor may be used to enter this information. The buffer size is fixed at 1024.
Jittered Sine	This is a jittered sine wave with user-controlled jitter frequency and amplitude.

Table A-21: Audio Analyzer Application

Capabilities	Description
Human Interface The analyzer has a touch and zoom interface.	
Number of Display Screens	1
Number of Measurements per Screen	Up to 4 measurements at once
Analysis Modes	
Major Modes of Operation	
Open Loop (External)	Acquisitions are controlled by the received signal. Measurements (except for the real-time readouts) are subject to settling criteria, and no special knowledge of the generated signal (either internal or external) is assumed by the analyzer.
Closed Loop (Generator)	The local generator is coupled to the analyzer. This mode enables the analyzer to signal the generator to advance to the next sweep step after settled data has been acquired.
Minor Modes of Operation	
Regulation Mode	The analyzer controls the generator amplitude or frequency to get a desired reading. When the reading is obtained, a measurement is triggered. This may be used to produce amplitude versus frequency plots at a constant distortion level, for example.
Relative to Reference	All measurements may be made relative to a previous measurement. This reference measurement may be recalled from a file or loaded through the GPIB.
Acquisition Modes	
Major Acquisition Modes	
An acquisition may take one of the following forms:	
Automatic	Whenever trigger conditions are met, and the measurement can be made, a new reading is taken.

Table A-21: Audio Analyzer Application (Cont.)

Capabilities	Description
Acquisition Modes	
Sweep Detection	Automatic sweep detection will be present for de-tecting the beginning of sweeps in open-loop mode The user can indicate whether sweeps are rising or falling, and data plotting will not com-mence until the appropriate sweep direction is de-tected.
Measurements	
Y-Axis Measurements	The analyzer is capable of measuring the follow-ing and displaying them on the Y-axis:
	Received level
	Stereo phase difference
	THD
	THD+N
	IMD
	Received frequency
	Crosstalk + noise
	Channel separation
	Received level difference
	In addition, a Wow and Flutter measurement is made and displayed in the Real Time measure-ments only.
	Sweep signals generated by the Tektronix ASG100 and ASG140 can be used as stimulus signals for making the above measurements (except IMD, THD, THD+N, and Wow and Flutter). These signal generators produce stepped sweeps as opposed to continuous frequency sweeps. Frequency content and dwell time for each step are described in the relevant user manual for each model.

Table A-21: Audio Analyzer Application (Cont.)

Capabilities	Description
Measurements	
X-Axis Measurements	
Types of measurements that may control the X-axis	Frequency (received or generated)
	Level
Filters This application gives the user a choice of several predefined filters.	
Supplied Filters	
Low Pass Filter	15 kHz, 20 kHz, and 22 kHz
High Pass Filter	400 Hz
Weighting Filters	A-weighting, CCIR-468-3 (required by AES 17-1993), C-messaging, B-weighting, F-weighting, CCIR-ARM

Table A-22: FFT Analyzer

Capabilities	Description
Frequency Related Characteristics	
Span (bandwidth of the displayed data)	Span is dependent on the input and Zoom as shown in the following table for typical inputs and sampling rates.

Input	Sampling Rate	Width	Zoom Factor
High Res	48 kHz	200.156	100
		400.312	50
		800.624	25
		1000.78	20
		2000.56	10
		4003.12	5
		5003.9	4
		10007.8	2
		20015.6	1 (full)
High Bw	192 kHz	16012.5	5
		20015.6	4
		40031.2	2
		80062.5	1 (full)
AES	48 kHz	Same as High Res	
AES	44.1 kHz	183.894	100
		367.787	50
		735.574	25
		918.468	20
		1838.94	10
		3677.87	5
		4597.34	4
		9194.69	2
		18389.4	1 (full)
AES	32 kHz	133.438	100
		266.875	50
		533.75	25
		667.187	20
		1334.38	10
		2668.75	5
		3335.94	4
		6671.82	2
		13343.8	1 (full)

Table A-22: FFT Analyzer (Cont.)

Capabilities	Description
Frequency Related Characteristics	
Measurement Range	
High Resolution Mode	DC to 20 kHz
High Bandwidth Mode	DC to 80 kHz
Displayed Bins	
Zoomed	16
Unzoomed	428
Bin Width	0.781 Hz (minimum span) to 156.3 Hz (maximum span); calculated as span divided by 512.
FFT Record Length	1024 data points
Window Parameters	
Window Functions	
Weighting Functions	Hann
	Kaiser-Bessel
	Blackman-Harris
	Flat-top
	Uniform
	Saramaki-Rajan
	User-defined
Amplitude Related Characteristics	
Amplitude Resolution	0.1 dB with a flat-top window
Absolute Amplitude Accuracy	±0.15 dB at 120 Hz

Table A-22: FFT Analyzer (Cont.)

Capabilities	Description
Amplitude Related Characteristics	
Full Span FFT Noise Floor	
Input terminated with 600 Ω or less, auto range and averaging ON.	
High Resolution Mode	
170 Hz to 1000 Hz	< −120 dBu
1 kHz to 20 kHz	< −140 dBu
High Bandwidth Mode	
> 400 Hz	< −120 dBu
Residual DC Response	< −60 dBFS within two hours of offset calibration
FFT Dynamic Range	
Spurious Free Dynamic Range	> 105 dB
Phase	
FFT Cross-Channel Phase Accuracy	±1 degree
Display Related Characteristics	
Displays Available	Spectral Display (amplitude versus frequency for A and B)
	Spectrogram (time versus frequency with amplitude color/gray coded)
Display Update Rate	> 10 updates per second at full span
Frequency Axis	Linear or Log
Averaging	
Displays	The following average displays are available:
	Max Hold
	Min Hold
	Average
Type of Averaging	Exponential only

Table A-22: FFT Analyzer (Cont.)

Capabilities	Description
Cursor Functions	
Number of Cursors	One or Two
Cursor Modes	The following cursor modes are provided:
	Continuously displayed amplitude and frequency at each cursor
	Peak locator function
Multitone	
Multitone analyzer is a measurement that may be run in the FFT application. When the user turns on the multitone analysis mode, the AM700 starts looking for a multitone signal. When it detects the specified multitone, it starts making the user-selected measurements, as long as the multitone is present.	
Multitone Measurements	The following measurements may be made in Multitone analysis:
	Level versus frequency: A, B
	Stereo interchannel level difference
	Stereo interchannel phase difference
	Stereo crosstalk versus frequency
	Distortion + Noise (with FFT-like display)
Multitone Graphical Displays	Graphical display will be available for each of the multitone measurements.
Multitone Record Size	16 Kbytes or less for detecting multitones

Table A-22: FFT Analyzer (Cont.)

Capabilities	Description
Multitone	
Multitone Detection	Each channel can be set to recognize one multitone, which can either be the current tone in one of the generator channels or a multitone described in a file.
	Files are provided in the AM700 file system that contain multitone specifications for the Tektronix ASG 100/140 audio generators.
Minimum Multitone Detection Level	–60 dBu
	The minimum detection level is for individual tones that make up the multitone signal. The generator amplitude readings are 0.707 x peak voltage, which is RMS voltage for sine waves only. The level of transmitted multitones depend on the crest factor of the signal, which varies each time the multitone signal is computed (unless in file mode with absolute phases provided).
	In both file mode and list mode, the amplitude parameters for individual tones are only used to control the relative amplitude of the tone with respect to the other tones.
	The only way you can determine the received level of each tone is to work backwards from the peak level of the complex waveform, with knowledge of the crest factor.

Table A-23: Audio Monitor

Capabilities	Description
Human Interface	
This application has the primary use of verifying the presence of audio and making simple time-domain measurements of the signal amplitude.	
Primary Display	Oscilloscope (voltage versus time)
Signal Acquisition	
Input Channels	High Resolution analog inputs
	High Bandwidth analog inputs
	Digital audio inputs
	Inputs from the DSP connector
	This application follows the <primary input> global SCPI parameter to determine which input to display.
Oscilloscope Display	
This display emulates a traditional digitizing oscilloscope, but with a touch-and-zoom touch screen human interface.	
Measurement Range	Depends on the analog performance and digital input word lengths
Display Appearance	Both channels may be overlaid or put in a split-window mode. Touch-and-zoom affects both channels in a window, and graticules track their signals.
Waveform Display Resolution	Nominal 400 pixels vertical x 500 pixels horizontal
	The reserved pixels for display will shrink during generator control and programmed text display.
Display Update Rate	Minimum of 15 screen updates per second with proper triggering and time base conditions
Digitized Record Length Amount of data in a waveform record obtainable without missing samples.	
Inputs with Sample Rates up to 48 kHz	Continuously variable from 32 to 48000 samples per channel
Inputs with Sample Rates Above 48 kHz	Continuously variable from 32 samples to 4 milli-seconds. All samples returned must be in the vicinity of the trigger.

Table A-23: Audio Monitor (Cont.)

Capabilities	Description
Oscilloscope Display	
Time Base Range	Four samples per screen to 48000 samples per screen, continuously variable with touch-and-zoom.
Trigger Sources	Channel 1 (A channel)
	Channel 2 (B channel)
	External (rear-panel TTL input trigger)
Trigger Modes	
Auto	New data is displayed in the absence of an edge trigger being detected.
Normal	New data is displayed only following detection of a trigger. Trace is erased if no trigger occurs.
Trigger Slope	Rising or falling edge
Trigger Level	Adjustable
Trigger Position	The trigger may be positioned anywhere in the digitized record, with all samples valid. Pretrigger samples and post-trigger samples must fit within one record. Trigger position is determined automatically from the views being displayed. There is no direct control for selecting trigger position in the record.
	Trigger position is at the 0 horizontal graticule marking.
Cursors	Cursors can measure time difference and level difference on a waveform. Cursor position difference for both amplitude and time is displayed in the cursor readout line above the view. Position difference is obtained by subtracting the readings obtained from cursor 2 (the dashed cursor) from the readings obtained from cursor 1 (the solid cursor). The time reading of the cursor position displayed above the cursor is with respect to the trigger point in the waveform.
Listen Capability	
LISTEN	User may listen to input channels.

Table A-24: Digital Interface Tester

Capabilities	Description
Intended Use	The digital interface tester application is used to monitor and troubleshoot the digital audio interface. It allows you to view incoming data streams at the logical (bit), or electrical interface level, and to create special signals to probe the interface.
Number of Primary Modes	There are four major modes of operation.
Bit Activity	Displays instantaneous bit probability (with no history or averaging) of each bit of each subframe. The four preamble bits are not available to be displayed, and are grayed out in the display.
Channel Status	Displays the current contents of the 192 channel status bits in both subframes of the digital input stream. The data can be displayed in four styles: Binary (most-significant-bit or MSB on the left) Transmission order (MSB on right) Hex (same bit order as binary, displayed in base 16) Decoded (raw data translated into words) In the raw and decoded styles, the user can optionally underline data elements which differ between the two subframes. This allows a quick visual check for identical subframe information. The user can choose to display either the subframe 1 data, the subframe 2 data, or both subframes.

Table A-24: Digital Interface Tester (Cont.)

Capabilities	Description
Eye Diagram	Displays a "cloud of dots" representing an equiva-lent-time sampled time-domain graph of the digital main inputs. The following seven numeric readouts are displayed above the diagram in a real-time readout box (when measurements are available for the category):
	Measured sample frequency on the main input
	Measured sample frequency on the reference input
	Measured ratio between the main and reference sample frequencies
	Phase difference between the main and reference
	Voltage level of the main input
	Equalization applied to the main input
	Peak-to-peak jitter of the interface
Jitter Spectrum	Displays the energy spectrum of the jitter on the digital main input signal. Like FFT, this spectrum can be viewed as an interpolated graph, a bar graph, or a spectrogram.
	Averaging is available (exponential averaging, min hold, and max hold) in the jitter spectrum display. Averaging is not available in the other displays.
Enhanced Stimuli	Within this application, the DIT menu choices provide extra features for controlling the digital generator.
	Electrical interface modifications include:
	Cable Simulator
	Jitter Generation with Controlled Frequency and Amplitude

Index

Index

A

B

backspace key, 2-29
Bar Graph display, FFT Analyzer, 4-85
Battery-life, reduced, 1-11
BH4 (Blackman–Harris) Window, 4-83
bin resolution, FFT Analyzer, 4-89
Bit Activity display, 4-107
Bit Probability Display, Bit Activity, 4-112
BNC Output, Digital (rear panel), 4-124
BNC Unbalanced IN/OUT, 2-40
Brightness, Display, 2-19

C

Calibration, 3-18
    Touch Screen, 1-8
CCIF IMD, 4-6
Channel Status, Digital Interface Tester,
        4-107
Channel Status Bits, 4-25
Channel Status display, ones and zeros,
        4-113
Channel Status file, 4-26
Chirp, 4-7
Clear Menu button, 2-13
Clear Reference Memory, 4-71
Clock Frequency
    Mode, 4-123
    Offset, 4-123
    Var Freq., 4-123
Clock Phase, Offset, 4-123
Clock Synchronization, Digital, 4-2
Closed-Loop Measurements, 4-45
COM1 and COM2, 2-37
Common Ground, 4-33
Configuration
    Advanced Analog Controls, 4-32
    Advanced Digital Audio, 4-24
    Advanced Digital Interface, 4-29

Analog Inputs, 3-3
Audio Analyzer input, 4-52
Audio Generator, 4-4
Digital Inputs, 3-5
Digital Interface Tester, 4-108
Generator Output Signal, 4-5
Input impedance, 3-3
Input Range and Auto, 3-4
Input Selections, 3-2
Measurement channels, 3-5
Measurement Setup, 3-11
Measurements, Audio Analyzer, 4-60
Quick Setup, 3-22
System Calibration, 3-17
System Communications, 3-16
System Conversion Standards, 3-18
System Copy, 3-13
View Options, 3-9
View Setup, 3-7
Configure button, 2-17
Configure Screen, 3-2
Connectors
    AES REF IN/OUT, 2-40
    Analog XLR, 3-3
    BNC unbalanced IN/OUT, 2-40
    COM1, COM2, 2-37
    Digital Audio, 2-39
    Digital Main, 3-5
    DSP port, 2-41
    front panel, 2-31
    GPIB, 2-38
    keyboard, 2-38
    Optical, 2-39
    rear panel, 2-35
    Remote, 2-39
    Trigger, 2-37
    VGA, 2-38
Control buttons, 2-26
Control Knob, 2-23

Index

H

I

J

K

Index

AM700 Audio Measurement Set User Manual