# APx555
# audio analyzer

# Installation Instructions
# and Specifications


model APx555

**October, 2014**

Audio Precision
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pn 8211.0335 rev 000

XIV1014062852

## Documentation and Support

This booklet contains safety information, installation instructions and full specifications for the Audio Precision APx555 audio analyzer.

### The APx500 User's Manual

Detailed information on the operation of the APx555 is available from the embedded Help installed with the APx500 measurement software, and in the APx500 User's Manual, included with the analyzer. The user's manual is also available as a PDF on the APx500 Application Disc and on the Web at ap.com; additional copies can be ordered from Audio Precision or your local distributor.

### Audio Test Discs

These discs are included with your analyzer system:

- APx-DVD1 is a playable video DVD with menu-driven linear and coded audio test signals for external source use with DVD players.
- APx-CD1 is a playable audio CD with linear audio test signals for external source use with CD players.

### ap.com

Visit the Audio Precision Web site at ap.com for APx support information. APx resources are available at ap.com/downloads/apx. You can also contact our Technical Support staff at techsupport@ap.com, or by telephoning 503-627-0832 extension 4, or 800-231-7350 extension 4 (toll free in the U.S.A.).

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# Safety

## Safety Information

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

Do NOT defeat the safety ground connection. This equipment is designed to operate only with an approved three-conductor power cord and safety grounding. Loss of the protective grounding connection can result in electrical shock hazard from the accessible conductive surfaces of this equipment.

Do NOT exceed mains voltage ratings. This equipment is designed to operate only from a 50–60 Hz ac mains power source at 100–240 Vac nominal voltage. The mains supply voltage is not to exceed ±10 % of nominal (90–264 Vac).

For continued fire hazard protection, fuses should be replaced ONLY with the exact value and type indicated on the rear panel of the instrument and discussed on page 4 of this manual.

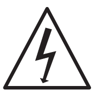
The International Electrotechnical Commission (IEC 1010-1) requires that measuring circuit terminals used for voltage or current measurement be marked to indicate their Measurement Category. The Measurement Category is based on the amplitude of transient or impulse voltage that can be expected from the AC power distribution network. This product is classified as Measurement Category I, abbreviated "CAT I" on the instrument front panel. This product should not be used within Categories II, III, or IV. The 2-channel input module measurement terminals are rated for a maximum voltage of 230 Vpk to ground, and a signal input of 160 Vrms unbalanced, 300 Vrms balanced; the 8-channel input module measurement terminals are rated for a maximum input of 160 Vpk to ground, and a signal input of 115 Vrms, balanced or unbalanced. These terminals are intended to be used for the measurement of audio signals only.

Do NOT substitute parts or make any modifications without the written approval of Audio Precision. Doing so may create safety hazards. Using this product in a manner not specified by Audio Precision can result in a safety hazard.

This product is for indoor use—Installation Category II, Measurement Category I, pollution degree 2.

## Safety Symbols

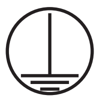
The following symbols may be marked on the panels or covers of equipment or modules, and are used in this manual:



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

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

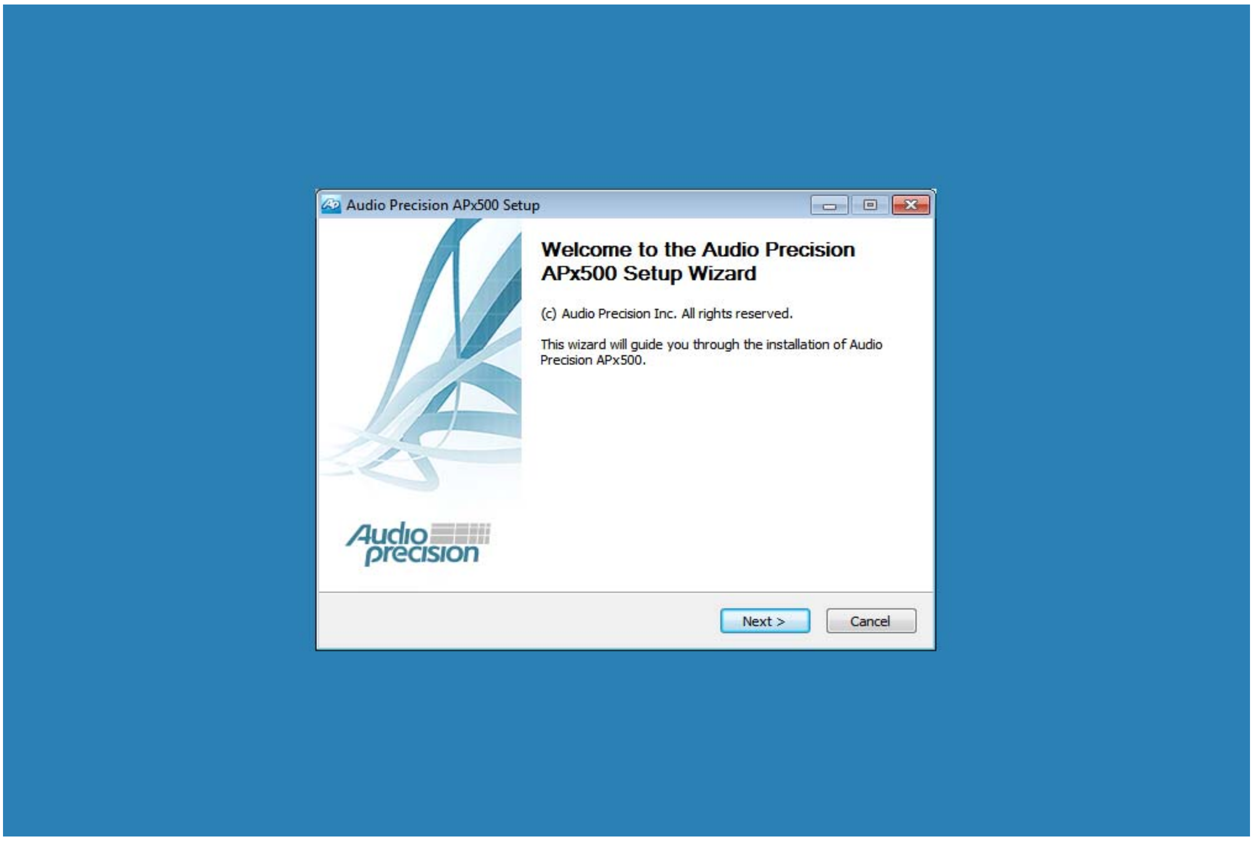
FUNCTIONAL EARTH TERMINAL—A terminal marked with this symbol is electrically connected to a reference point of a measuring circuit or output and is intended to be earthed for any functional purpose other than safety.



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

## Disclaimer

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


Audio Precision APx500 Setup
Welcome to the Audio Precision APx500 Setup Wizard
(c) Audio Precision Inc. All rights reserved.
This wizard will guide you through the installation of Audio Precision APx500.
Audio precision
Next >
Cancel

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# Installation

## Software

All APx systems use the same award-winning measurement software, APx500.

### PC system requirements

The APx500 measurement software version 4.0 and later requires a personal computer (PC) with the following features and capabilities:

- Operating system: Microsoft Windows 8, Windows 7 or Windows Vista.
- A multi-core processor (at least dual-core) running at a clock speed of at least 2 GHz. Most current processors from Intel and AMD meet these requirements.

*Note: the Intel Atom processor does not meet our minimum specification.*

- At least 2 GB of RAM.
- At least 300 MB of free hard disk space.
- A CD-ROM optical disc drive.
- A USB 2.0 port; two are required for optional switcher or DCX-127 use.
- A color monitor and a video card with at least VGA capabilities. Video resolution of 1024 x 768 or greater is recommended.

System performance is sensitive to processor speed; faster processors will yield faster results.

APx500 is data intensive and it is recommended that other data-intensive applications not be run concurrently. This includes Audio Precision's AP2700, APWIN or ATS.

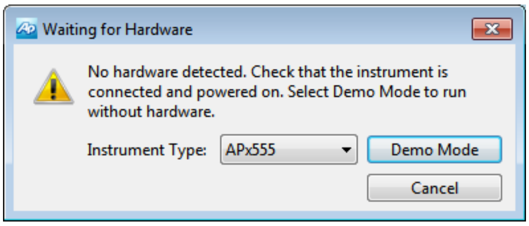
## Installation

To install the measurement software, insert the APx500 CD-ROM into the optical drive on the PC and follow the instructions in the installation dialog.

*NOTE: You must have local administrator rights to install APx500 software. Go to User Accounts in the Windows Control Panel, or check with your network administrator.*

## Running the software without instrument hardware attached

You can launch the APx500 software without instrument hardware attached. When no hardware is detected, APx500 will present you with the following dialog box:




Select “Demo Mode.” APx500 will run in demo mode, which allows you to explore the user interface but does not enable any measurement functions. Input data shown in Demo Mode is false data, generated for display only.

From the Instrument Type menu, select an instrument to be emulated in Demo Mode.

## Running the software with instrument hardware attached

*NOTE: You must have standard user rights or administrator rights to operate APx500 software. Guest users are not supported.*

### *Connecting the instrument to your PC*

Before connecting your APx instrument to your PC, install the APx500 measurement software as described above. Connecting the instrument prior to software installation may cause Windows to select an incorrect USB driver for the instrument.

### *USB driver selection*

The measurement software communicates with the instrument using a USB 2.0 interconnection. Once the software is successfully installed, connect one end of the USB cable to a USB 2.0 port on the PC, and the other end to the PC INTERFACE port on the rear of the instrument. We strongly recommend that you use the USB cable included with your instrument (AP order number CAB-APSI). We have tested other USB cables that perform poorly.

*Note: Some PCs have optional USB ports on the front of the PC, or on extension brackets on the rear. In many cases these convenience ports have compromised performance due to the extra cable length within the PC. We recommend using USB ports directly connected to the PC motherboard, typically at the rear of the PC.*

Connect the instrument mains power cord to the instrument and to a source of ac mains power. See **Setting up the hardware** below for more information about mains connections.

Turn the instrument ON by pressing the pushbutton on the front of the instrument. Microsoft Windows will detect the presence of the instrument on the USB and will open the Hardware Update Wizard to search for the correct software driver. Select “Install the software automatically.” Windows will find the Audio Precision driver software installed with APx500 and connect to the instrument.

Launch APx500 by double-clicking on the installed shortcut. With the instrument connected, you may be asked to update the instrument firmware during the first launch of the measurement software. APx500 will start, and in a short time you will be presented with the opening screen. Refer to the APx500 User’s Manual for more information about making measurements.

*A copy of the APx500 User’s Manual is included with your instrument. The manual is also available as a PDF on the APx500 Application Disc and online at ap.com.*

## Setting up the hardware

### Connecting your instrument to the electrical mains supply

The APx500 series instrument must be connected to a 50–60 Hz alternating current (ac) electrical mains supply. The minimum voltage is 90 Vac; maximum voltage is 264 Vac. The instrument is fitted with a universal power supply that does not require voltage configuration or change of fuse type to accept mains voltages within the specified range.

### Removing and installing mains fuses

To remove the mains fuse carrier module, refer to the figures below and proceed as follows:

Power entry module

Fuse carrier removal

Remove the mains power supply cord from the connector on the power entry module, located on the instrument rear panel. The mains fuse carrier module is part of the power entry module, to the right of the power cord connector.

Insert a small screwdriver into the power cord connector area, reaching into the slot on the mains fuse carrier module. Pry the module out slightly, until you can grasp the module firmly with your fingers. Pull the fuse carrier module out of the power entry module. The two mains fuses are loosely mounted within the fuse carrier module; take care not to let them fall.

Replace the fuses if necessary, using fuses as described below. Carefully reinsert the fuse carrier module into the power entry module, and press it firmly into place.

Connect the power cord from a mains power outlet to the power cord connector on the instrument rear panel.

## Fuse Information

APx500 series instruments are fitted with a universal power supply. For all rated voltages, use two mains fuses of type 2A T/SB (5 x20 mm) 250 V.

# Abbreviations, Terms and Symbols

## used in the following specifications

ADC or A/D . . . . . . . . Analog to Digital converter or conversion.
BW . . . . . . . . . . . . . . . Bandwidth or Measurement Bandwidth, nominally at –3 dB; a single number indicates only the upper limit.
DAC or D/A . . . . . . . . Digital to Analog converter or conversion.
DSP . . . . . . . . . . . . . . . Digital Signal Processing or Digital Signal Processor.
DUT . . . . . . . . . . . . . . Device Under Test, the device to which the generator or analyzer is connected.
EMC . . . . . . . . . . . . . . Electro-Magnetic Compatibility, usually refers to both emissions (radiated and conducted via AC mains) and susceptibility.
ENBW . . . . . . . . . . . . . Equivalent Noise Bandwidth, the frequency of an ideal filter having the same rms response to white noise.
FFT . . . . . . . . . . . . . . . Fast Fourier Transform, a mathematical process converting a signal in the time domain to the frequency domain.
IMD . . . . . . . . . . . . . . . Inter-Modulation Distortion, a measure of non-linearity using a test signal with two or more components.
RMS or rms . . . . . . . . . Root Mean Square, an equivalent-power expression of signal amplitude.
SR . . . . . . . . . . . . . . . . Sample Rate, usually as it applies to the conversion rate of A/D and D/A converters or digital audio formats.
THD . . . . . . . . . . . . . . Total Harmonic Distortion, rms summation of d2 to d9 (may be bandwidth limited), usually derived from an FFT.
THD+N . . . . . . . . . . . . Rms measurement of ALL harmonics, spurious signals, and noise within a specified bandwidth.
Typical or Typ . . . . . . . A characteristic that is not guaranteed, usually due to a practical limitation in testing or metrology.
UI . . . . . . . . . . . . . . . . . Unit Interval, a measure of time is it applies to digital audio formats. 1 UI= 1/(128 • SR)
[ ] . . . . . . . . . . . . . . . . Indicates a specification in an equivalent unit, for example: 0.030 dB [0.35%] or 10.61 Vrms [30.00 Vpp].
≈ . . . . . . . . . . . . . . . . . Indicates an approximate or nominal value, or range of values; not guaranteed.

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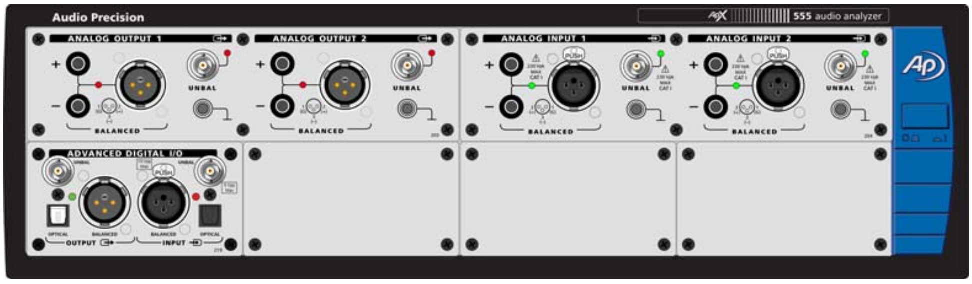
# Analog I/O specifications
# APx555 audio analyzer

**with APx500 v4.0 or higher measurement software**
**September 2014   NP0020.00022 r000**




**This illustration shows an APx555 in its standard configuration, with an ADIO module installed.**

These specifications cover the analog input and output functions of the Audio Precision APx555.

Specifications for the ADIO interface and other available interface modules including DSIO, HDMI, PDM, Bluetooth and AMC, are found in other sections of this document, as are General and Environmental specifications for the entire APx family.
Analog specifications begin on the next page.

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| Characteristic | Specifications | Supplemental Information |
|---|---|---|
| **ANALOG GENERATOR** | | |
| **Number of Channels** | 2, independent amplitude control | |
| **Waveforms** | Sine, sine split frequency, sine split phase, sine+DC offset, continuously swept-sine, square-wave, noise, IMD signals, multi-tone, wave file playback | *DC offset capability applies to all DAC waveforms. Projects created with the Hi-Perf Sine will load as Sine in other APx analyzers.* |
| **High Performance Sine** | | |
| Generation Technique | | *Exceptionally stable RC oscillator* |
| Frequency Range (Fs) | 5 Hz to 204 kHz | |
| Frequency Setting Resolution | | |
| 5.0 Hz to 205.0 Hz | | *≈0.025 Hz* |
| 205.0 Hz to 2.050 kHz | | *≈0.25 Hz* |
| 2.050 kHz to 20.50 kHz | | *≈2.5 Hz* |
| 20.50 kHz to 204 kHz | | *≈25 Hz* |
| Frequency Accuracy | | |
| 10 Hz to 100 kHz | ±0.35% | *Typically <25 ppm/°C* |
| 5 Hz to 204 kHz | ±0.5% | |
| Amplitude Range [1] | | |
| 10 Hz to 100 kHz | 0-26.66 Vrms [75.4 Vpp] bal;<br>0-13.33 Vrms [37.7 Vpp] unbal & CMT | *Will drive 600 Ω balanced load to at least +30.0 dBm when Rs = 40 Ω* |
| 5 Hz to 204 kHz | 0-21.22 Vrms [60.0 Vpp] bal;<br>0-10.61 Vrms [30.0 Vpp] unbal & CMT | |
| Amplitude Accuracy, 1 kHz | | |
| +15°C to +30°C | ±0.030 dB [±0.35%] | |
| 0°C to +45°C | ±0.040 dB [±0.46%] | |
| Flatness, 1 kHz ref | | |
| 5 Hz to 20 kHz | ±0.008 dB | *Typically <0.003 dB* |
| 20 kHz to 50 kHz | ±0.015 dB | |
| 50 kHz to 100 kHz | ±0.060 dB | |
| 100 kHz to 204 kHz | ±0.15 dB | |
| Settling Time | | *Typically <(40 cycles + 100 ms) to within 0.001 dB of final value* |

| Characteristic | Specifications | Supplemental Information |
|---|---|---|
| Residual THD+N [2,3,4] | | |
| 10 Hz to 20 kHz, 22 kHz BW | ≤ (–117 dB + 1.0 µV), V ≤ 9.3 Vrms; ≤ –115 dB, V > 9.3 Vrms. | *Typically <–120 dB at 1 kHz from 2.0–2.3 Vrms, 3.7–4.6 Vrms, and 7.3–9.3 Vrms.* |
| 10 Hz to 20 kHz, 80 kHz BW | ≤ (–111 dB + 2.0 µV) | |
| 10 Hz to 20 kHz, 100 kHz BW | ≤ (–110 dB + 2.3 µV) | |
| 10 Hz to 50 kHz, 250 kHz BW | ≤ (–105 dB + 3.8 µV) | |
| 10 Hz to 100 kHz, 500 kHz BW | ≤ (–100 dB + 5.5 µV) | |
| Residual THD only [2,3,4] | | |
| 10 Hz to 40 Hz | | *Typically <–125 dB* |
| 40 Hz to 5 kHz | | *Typically <–130 dB* |
| 5 kHz to 20 kHz | | *Typically <–120 dB* |
| 20 kHz to 50 kHz | | *Typically <–110 dB* |
| 50 kHz to 100 kHz | | *Typically <–102 dB* |
| **Dual Sine, Continuous Swept Sine** | | |
| Generation Technique | | *24-bit Σ-Δ DACs, SR = 192 kS/s.* |
| Frequency Range (Fs) | 0.001 Hz to 80.1 kHz | *Setting resolution is typically 45 µHz [192 kHz / $2^{32}$] over full range* |
| Frequency Accuracy [5] | ±0.0003% [3 ppm] | *Lockable to external reference* |
| Amplitude Range [1] | | |
| 10 Hz to 80 kHz | 0-26.66 Vrms [75.4 Vpp] bal; 0-13.33 Vrms [37.7 Vpp] unbal & CMT | *Will drive 600 Ω balanced load to at least +30.0 dBm when Rs = 40 Ω* |
| 0.001 Hz to 10 Hz | 0-21.22 Vrms [60.0 Vpp] bal; 0-10.61 Vrms [30.0 Vpp] unbal & CMT | |
| Amplitude Accuracy, 1 kHz | | |
| +15°C to +30°C | ±0.030 dB [±0.35%] | |
| 0°C to +45°C | ±0.040 dB [±0.46%] | |
| Amplitude Setting Resolution | | *Typically <0.001 dB or 0.05 µVrms* |

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| Characteristic | Specifications | Supplemental Information |
|---|---|---|
| Flatness (1 kHz ref) | | |
| 10 Hz to 20 kHz | ±0.008 dB | |
| Fs = 20 kHz to 50 kHz | ±0.030 dB | |
| Fs = 50 kHz to 80 kHz | ±0.10 dB | |
| Residual THD+N [2, 3, 4] | | |
| 10 Hz to 20 kHz, 22 kHz BW | ≤ (–105 dB + 1.0 µV) | |
| 5 Hz to 20 kHz, 80 kHz BW | ≤ (–95 dB + 2.0 µV) | |
| Spurious Content | | |
| 5 Hz to 20 kHz | | *Typically <–100 dB to 500 kHz* |
| 20 kHz to 50 kHz | | *Typically <–85 dB at (384 kHz ± 2 • Fs)* |
| 50 kHz to 76 kHz | | *Typically <–70 dB at (384 kHz ± 2 • Fs)* |
| 76 kHz to 80 kHz | | *Typically <–55 dB at (192 kHz – Fs)* |
| Phase Offset Range | –179.999 to +180.000 deg | |
| DC Offset Range | ±12.00 Vdc bal;<br>±6.00 Vdc unbal | *DC offset limits maximum ac signal and degrades residual THD+N* |
| Residual DC Offset | ≤0.25% of Vrms setting + 100 µV | |
| **Sine Burst** | | |
| Generation Technique | | *Zero-crossing synchronized analog switching between Low/High states* |
| Frequency Range | 10 Hz to 80.1 kHz | |
| Frequency Accuracy [5] | ±0.0003% [3 ppm] | |
| Amplitude Range [1] | 0–75.4 Vpp bal<br>0–37.7 Vpp unbal | |
| Amplitude Accuracy (1 kHz) | ±0.05 dB [0.58%] | |
| Low/High Ratio Range | 0 to –80 dB, and zero | |
| Ratio Accuracy (1 kHz) | ±0.15 dB, 0 to –60 dB | *Unspecified below -60 dB.* |
| Amplitude Flatness | | |
| 10 Hz to 50 kHz | | *Typically <0.03 dB* |
| 50 kHz to 80 kHz | | *Typically <0.10 dB* |
| High Cycles (Duration) | 1 to 16,777,214 | |
| Total Cycles (Interval) | 2 to 16,777,215 | *>4.6 hours at 1 kHz* |

| Characteristic | Specifications | Supplemental Information |
|---|---|---|
| **IMD Test Signals** | | |
| Generation Technique | | *Analog summation of separately generated test signal components* |
| MOD & SMPTE | | |
| Lower Frequency (LF) | 40 Hz to 1 kHz | *LF must be ≤500 Hz for SMPTE* |
| Upper Frequency (HF) | 2.00 kHz to 60.00 kHz | *HF must be ≥ 6 • LF* |
| Frequency Accuracy[5] | ±0.0003% [3 ppm] | |
| Mix Ratio (LF:HF) | Selectable 10:1, 4:1 or 1:1 | *Ratio accuracy typically <1%* |
| Amplitude Range [1] | 0 to 75.4 Vpp, bal;<br>0 to 37.7 Vpp, unbal | |
| Amplitude Accuracy | ±0.07 dB [±0.81%] | |
| Residual IMD [2,3,6] | ≤ –100 dB [0.0010%], SMPTE<br>≤ –102 dB [0.00080%], MOD | *60 Hz + 7 kHz, 4:1 mix* |
| DFD | | |
| Difference Frequency ($F_{diff}$) | 80 Hz to 2.00 kHz | $F_{diff} = \|F2 - F1\|$ |
| Mean Frequency | 250 Hz to 60 kHz | $F_{mean} = (F1 + F2)/2$<br>$(F_{mean} / F_{diff})$ *must be* ≥6 {see note 7} |
| Frequency Accuracy [5] | ±0.0003% [3 ppm] | |
| Amplitude Range [1] | 0 to 75.4 Vpp, bal;<br>0 to 37.7 Vpp, unbal | |
| Amplitude Accuracy | ±0.07 dB [±0.81%] | |
| Residual IMD [2,3,6,7] | ≤ –110 dB [0.00032%] d2+d3;<br>≤ –115 dB [0.00018%] d2 only | |
| DIM | | |
| Square + Sine Frequencies | 3.15 kHz +15 kHz [DIM-100, DIM-30]<br>2.96 kHz + 14 kHz [DIM-B], or<br>2.96 kHz / 8 kHz [DIM-B8] | *DIM-100 square-wave BW limited by 100 kHz 1-pole filter (tr ≈3.5 µsec); other DIM square-waves BW limited by 30 kHz 1-pole filter (tr ≈11.7 µsec)* |
| Frequency Accuracy [5] | ±0.0003% [3 ppm] | |
| Mix Ratio | 4:1 based on Vpp | *Ratio accuracy typically <1.5%* |
| Amplitude Range [1] | 0 to 75.4 Vpp, bal;<br>0 to 37.7 Vpp, unbal | |
| Amplitude Accuracy | ±0.09 dB [±1.0%] | |
| Residual IMD[2,3,6] | ≤ –95 dB [0.0018%] | *DIM-100 or DIM-30* |

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| Characteristic | Specifications | Supplemental Information |
|---|---|---|
| **Square Wave** | | |
| Generation Technique | | *Special circuit, optimized for time domain response and symmetry.* |
| Frequency Range (Fq) | 0.1 Hz to 30 kHz | |
| Frequency Accuracy [5] | ±0.0003% [3 ppm] | |
| Amplitude Range | 0 to 60.0 Vpp, balanced;<br>0 to 30.0 Vpp, unbalanced | |
| Amplitude Accuracy | ±0.09 dB [±1.0%] | |
| Risetime | ≤1.7 µsec | *Rs ≤200 Ω (not valid if Rs = 600 Ω); total load C must be ≤800 pF* |
| Aberrations | | *Typically <1%* |
| Even Harmonic Content | | |
| Fq = 10 Hz to 5 kHz | ≤(–100 dB + 0.2 µV) to 80 kHz | |
| Fq = 5 kHz to 20 kHz | ≤(–90 dB + 0.2 µV) to 500 kHz | |
| Spurious Content | | *Typically <(–110 dB + 0.2 µV)* |
| **Noise Signals** | | |
| Generation Technique | | *DAC based, pseudo-random with IIR filtering and additional processing.* |
| Types | White (5 Hz to >80 kHz),<br>Pink (10 Hz to >80 kHz),<br>IEC 60268-1, or BS EN 50332-1 | |
| Amplitude Range [1] | 0 to 60.0 Vpp, balanced;<br>0 to 30.0 Vpp, unbalanced | *Calibration is approximate only* |
| **Multitone, Wave File Playback** | | |
| Sample Rate Range (SR) | 8 kS/s to 108 kS/s, and<br>175 kS/s to 216 kS/s | *Operation from 109 kS/s to 174 kS/s is possible, but with degraded flatness* |
| Maximum File Size | 32 MSamples | |
| Amplitude Range [1] | 0 to 60.0 Vpp, bal;<br>0 to 30.0 Vpp, unbal | *".Wav" file must peak at digital full scale for calibrated amplitude.* |
| Flatness (1 kHz ref) | | |
| SR = 175 kS/s to 216 kS/sec | | *Typically <0.015 dB to 20 kHz* |
| SR = 8 kS/s to 108 kS/sec | | *Typically <0.010 dB to 20 kHz or 0.45 • SR, whichever is lower* |
| Spurious Content | | *Typically <(–100 dB + 0.2 µV)* |

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| Characteristic | Specifications | Supplemental Information |
|---|---|---|
| **Output Equalization** | Arbitrary 30-pole output filter, scaled so the maximum gain is –1 dB. | *Filter cannot be applied to square and IMD test signals.* |
| **Source Resistance (Rs)** | | |
| Balanced | Selectable 40 Ω ±1.5%, 100 Ω ±1%, 150 Ω ±1%, 200 Ω ±1%, or 600 Ω ±0.5%. | *Grounded, symmetrical* |
| Unbalanced | Selectable 20 Ω ±2%, 50 Ω ±1.5%, 75 Ω ±1.2%, 100 Ω ±1%, or 600 Ω ±0.5%. | *BNC shield to ground ≈10 Ω \|\| 1 μF; Unbal outputs can float up to 0.6 Vpk to reject DUT ground noise.* |
| Common Mode Test | Same as Balanced selections, or 10 Ω Unbalanced per IEC-60268. | |
| **Output Related Crosstalk** | ≤ (–130 dB + 0.2 μV) to 20 kHz | |
| **Maximum Output Current** | | *Typically >80 mA peak, 50 mA dc* |
| **Peak Reverse Overload** | | *Up to 1A or 30 W, whichever is less. Outputs automatically disconnect if a damaging potential is sensed* |
| **ANALOG ANALYZER** | | |
| **Number of Channels** | 2, independently auto-ranging | |
| **Maximum Rated Input** | 230 Vpk, 160 Vrms, dc to 100 kHz; 0.6 Vpk from BNC shields to ground | *Up to 300 Vrms differentially may be applied to the Balanced inputs* |
| **Input Ranges** | 310mV, 620mV, 1.25V, 2.5V, 5V, 10V, 20V, 40V, 80V, 160V, and 320V | *Auto-ranging thresholds are ≈48-50% and ≈107-111% of range value (Vac)* |
| **Input Impedance** | | |
| Balanced, each side to ground | 100 kΩ ±0.5% \|\| ≈190 pF | *200 kΩ \|\| ≈95 pF, differentially* |
| Unbalanced, to BNC shield | 100 kΩ ±0.5% \|\| ≈190 pF | *BNC shield to ground ≈500 Ω \|\| 1 μF* |
| **Input Terminations** | 600 Ω ±0.5%, 1.5 W max<br>300 Ω ±0.5%, 3.0 W max | *Terminations automatically open in the 80 V and higher input ranges* |
| **Input Coupling** | DC or AC | *Input bias current typically <0.35 μA with DC coupling. Coupling is set by high-pass filter selection* |

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| Characteristic | Specifications | Supplemental Information |
|---|---|---|
| **Common Mode Rejection[8,9]** | | *The maximum peak input signal, each side to ground, must not exceed:* |
| 310 mV to 2.5 V input ranges | ≥ 90 dB, 5 Hz to 5 kHz;<br>≥ 80 dB, 5 kHz to 20 kHz | *±6 V* |
| 5 V and 10 V input ranges | ≥ 65 dB, 5 Hz to 20 kHz | *±160% of input range value* |
| 20 V to 320 V ranges | ≥ 50 dB, 5 Hz to 1 kHz | *±160% of input range value or ±230 Vpk, whichever is less* |
| **Input Crosstalk ($R_s$ ≤600Ω)** | ≤ (–140 dB + 0.1 μV) to 20 kHz | |
| **Level (Amplitude) Measurement** | | |
| Range | < 1 μV to 300 Vrms, bal;<br>< 1 μV to 160 Vrms, unbal | |
| Accuracy (1 kHz) | | |
| +15°C to +30°C | ±0.03 dB [±0.35%] | |
| 0°C to +45°C | ±0.05 dB [±0.58%] | |
| Flatness (1 kHz ref, no filters) | | |
| 20 Hz to 20 kHz | ±0.008 dB; ±0.020 dB above 5 kHz in the 20 V to 320 V input ranges | |
| 10 Hz to 50 kHz | ±0.030 dB | |
| 50 kHz to 100 kHz | ±0.080 dB | |
| 100 kHz to 300 kHz | ±0.20 dB | |
| **Residual Noise ($R_s$ ≤ 40 Ω)** | | |
| 22 kHz BW | ≤ 1.0 μVrms [–117.8 dBu] | *Typically <6.2 nV / √Hz at 1 kHz* |
| 80 kHz BW | ≤ 2.0 μVrms [–111.8 dBu] | |
| 250 kHz BW | ≤ 4.2 μVrms [–105.3 dBu] | |
| 500 kHz BW | ≤ 6.0 μVrms [–102.2 dBu] | |
| **THD/THD+N/SINAD Measurement** | | |
| Fundamental Range ($F_o$) | 5 Hz to 200 kHz | |
| Tuning Control | Generator tracking,<br>Input tracking, or<br>Fixed (directly entered value) | *Signal must be ≥100 μVrms for input tracking; $F_O$ must be within ±0.5% of the entered value for fixed tuning.* |
| Measurement Range | 0 to 100% [0 dB] | |

| Characteristic | Specifications | Supplemental Information |
|---|---|---|
| Measurement Technique | | |
| High Perf Sine Analyzer ON | Signals are passed through analog notch filters to minimize the distortion contribution from the A/D converters. | *If distortion exceeds about 5-6%, the analog notch filters are automatically bypassed.* |
| High Perf Sine Analyzer OFF | Signals are passed directly to the A/D converters with no analog filtering. | *Projects created using other APx analyzers will load with the HPSA OFF.* |
| Accuracy ($F_o \le 100$ kHz) | | |
| Harmonics to 100 kHz | ±0.3 dB | |
| Harmonics to 300 kHz | ±0.5 dB | |
| Residual THD+N [2,3,4] | | |
| 10 Hz to 20 kHz, 22 kHz BW | ≤ (–117 dB + 1.0 µV), V ≤ 9.3 Vrms; ≤ –115 dB, V > 9.3 Vrms. | *Typically < (–105 dB + 1.0 µV) with the High Performance Sine Analyzer OFF* |
| 10 Hz to 20 kHz, 80 kHz BW | ≤ (–111 dB + 2.0 µV) | *Typically < (–92 dB + 2.0 µV) with the High Performance Sine Analyzer OFF* |
| 10 Hz to 20 kHz, 100 kHz BW | ≤ (–110 dB + 2.3 µV) | |
| 10 Hz to 50 kHz, 250 kHz BW | ≤ (–105 dB + 3.8 µV) | |
| 20 Hz to 100 kHz, 500 kHz BW | ≤ (–100 dB + 5.5 µV) | *Only one channel can be measured at a time when BW >250 kHz and the High Perf Sine Analyzer is ON.* |
| Residual THD only [2,3,4] | | |
| 10 Hz to 40 Hz | | *Typically <–125 dB* |
| 40 Hz to 5 kHz | | *Typically <–130 dB* |
| 5 kHz to 20 kHz | | *Typically <–120 dB* |
| 20 kHz to 50 kHz | | *Typically <–110 dB* |
| 50 kHz to 100 kHz | | *Typically <–102 dB* |
| **Bandwidth Limiting Filters** | | |
| High-Pass | | |
| DC | DC Coupling | |
| AC (< 10 Hz) | AC coupling | *Response is 2-pole via a combination of analog and digital filters, and is typically –3 dB at ≈ 4 Hz* |
| Butterworth | $F_{HP}$ (–3 dB) = 10 Hz to 1.0 kHz, 4-pole | |

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| Characteristic | Specifications | Supplemental Information |
|---|---|---|
| Low-Pass [10] | | |
| Butterworth | $F_{LP}$ (–3 dB) = 1 kHz to 500 kHz, 8-pole | *ENBW ≈ 1.006 • $F_{LP}$* |
| Elliptic | $F_{LP}$ (–0.01 dB) = 1 kHz to 500 kHz, 8-pole; 0.01 dB pass-band ripple; ≤–60 dB stop-band | *ENBW ≈ (1.012–1.062) • $F_{LP}$ (varies due to warping)* |
| 20k (AES17), 40k (AES17) | Special filters conforming with AES17 | |
| ADC Bandpass (Maximum) | No filter is implemented, bandwidth and response are limited by the A/D and sample rate (SR) | *–3 dB at ≈ 0.490 • SR, SR ≤ 216 kS/s*<br>*–3 dB at ≈ 260 kHz for 624 kS/s*<br>*–3 dB at ≈ 520 kHz for 1.248 MS/s*<br>*–3 dB at ≈ 1 MHz for 2.496 MS/s* |
| Weighting | A-wt, B-wt, C-wt, CCIR-1k, CCIR-2k, CCITT, C-message, 50 µs or 75 µs de-emph (with and without A-wt), or None | *Weighting filter is cascaded with both high-pass and low-pass filters* |
| **IMD Measurement** | | |
| Test Signal Compatibility | | |
| SMPTE & MOD | Any combination of 40 Hz-1 kHz (LF) and 1 kHz-60 kHz (HF) tones, mixed in any ratio from 1:1 to 10:1 (LF:HF) | *HF tone must be ≥ 6 • LF;*<br>*LF must be ≤ 500 Hz for SMPTE* |
| DFD & CCIF[7] | Any two-tone combination with mean frequency of 250 Hz–60 kHz and a difference frequency of 80 Hz–2.0 kHz | *$F_{diff}$ = \|F2 - F1\|*<br>*$F_{mean}$ = (F1 + F2)/2.*<br>*($F_{mean}$ / $F_{diff}$) must be ≥6 [see note 7}* |
| DIM | DIM100, DIM30, DIM-B, or DIM-B8 | |
| IMD Products Measured | | |
| SMPTE | Amplitude modulation of HF tone | *Demodulator BW is ≈ 40–750 Hz* |
| MOD | d2, d3, d2+d3, or d2...d5 | *Use "d2+d3" for IEC60268* |
| DFD | d2, d3, d2+d3, or d2...d5 | *Use "d2+d3" for IEC60268* |
| CCIF | d2 only | *"CCIF" is an archaic form of DFD that measures only the d2 product. It uses a different 0 dB reference than DFD causing 2x higher readings* |
| DIM | U1...U9 or "Emulation" | *Use "U1…U9" for IEC-60268; "Emulation" matches the response of earlier AP analyzers* |
| Measurement Range | 0 to 20% | |

| Characteristic | Specifications | Supplemental Information |
|---|---|---|
| Accuracy | ±0.5 dB | |
| Residual IMD[2,3,6,7] | | |
| SMPTE | ≤ –100 dB [0.0010%] | *60 Hz + 7 kHz, 4:1 mix* |
| MOD | ≤ –102 dB [0.00080%], d2+d3 | *60 Hz + 7 kHz, 4:1 mix* |
| DFD | ≤ –110 dB [0.00032%], d2+d3<br>≤ –115 dB [0.00018%], d2 only | *19 kHz + 20 kHz*<br>*[$F_{mean}$ = 19.5 kHz, $F_{diff}$ = 1 kHz]* |
| CCIF | ≤ –109 dB [0.00036%] | *12 kHz + 13 kHz*<br>*[$F_{mean}$ = 12.5 kHz, $F_{diff}$ = 1 kHz]* |
| DIM | ≤ –95 dB [0.0018%] | *DIM-100 or DIM-30* |
| **Frequency Measurement** | | |
| Range | <5 Hz to 1.0 MHz | *Maximum frequency is limited to ≈0.45 • SR of the analyzer A/Ds.* |
| Accuracy [5] | ±(0.0003% [3 ppm] + 100 µHz) | |
| Minimum Input | 3 mV | *Usable down to 100 µV* |
| **Phase Measurement** | | |
| Ranges | –90 to +270, ±180, or 0 to 360 deg | |
| Accuracy [9] | | |
| 5 Hz to 5 kHz | ±0.15 deg | |
| 5 kHz to 20 kHz | ±0.6 deg | |
| 20 kHz to 50 kHz | ±1.5 deg | |
| Minimum Input | 3 mV | |
| **DC Voltage Measurement** | | |
| Maximum Rated Input | ±160 Vdc, 230 Vpk (dc + peak ac) | |
| Input Ranges | 310mV, 620mV, 1.25V, 2.5V, 5V, 10V, 20V, 40V, 80V, 160V, and 320V | *Auto-ranging thresholds are ≈66-70% and ≈150-158% of range value (Vpk)* |
| Accuracy | | |
| 315 mV & 630 mV input range | ±(0.7% reading + 800 µV) | |
| All other input ranges | ±(0.7% reading + 0.1% range) | |
| Normal Mode Rejection | | *Typically > 90 dB, 20 Hz to 20 kHz.* |

**NOTES to SPECIFICATIONS:**

| | |
|---|---|
| 1 | Generator performance is not guaranteed for amplitude settings below 100 µVrms [283 µVpp]. |
| 2 | System specification including contributions from both generator and analyzer. |
| 3 | Generator load must be ≥600Ω balanced or ≥300Ω unbalanced. |
| 4 | The "+" symbol in "THD+N" indicates rms summation of the two components. "THD" is the rms summation of H2 to H9. Specified residual THD+N and THD assumes the High Performance Sine Analyzer (HPSA) is ON. |
| 5 | Drift of the internal reference is typically 0.3 to 1 ppm / year, however it is lockable to an external reference. |
| 6 | Signal must be ≥200 mV for specified residual IMD; analyzer must be set to “d2+d3” for MOD and DFD, or “U1…U9” for DIM. |
| 7 | The ratio (Fmean / Fdiff) can be as low as 2.6 when measuring d2+d3 or d2 only. Avoid ratios near 3.5, 4.5, or 5.5. |
| 8 | Valid only for the balanced input configuration within the common range shown. |
| 9 | Valid only with DC coupling, both channels. High-pass filters may significantly degrade performance at low frequencies. |
| 10 | DSP warping may significantly increase roll-off rate and lower ENBW. |

# ADIO
# Advanced Digital Input/Output module specifications

**with APx500 v4.0 or higher measurement software**
**as fitted in APx52x, 555, and 58x audio analyzers**
**NP0020.00021 rev 000**
**October 2014**


**This illustration shows a stand-alone APx ADIO module, model 219.**

These specifications cover the digital input and output functions of the Audio Precision Advanced Digital Input/Output (ADIO). The ADIO is available as a stand-alone module (model 219).

The APx ADIO provides balanced digital input and output compatible with AES3, AES/EBU and IEC60958-4, on XLR connectors; unbalanced digital input and output compatible with S/PDIF and IEC60958-3 and also AES3id and SMPTE 276 M, on BNC connectors; and optical digital input and output compatible with Toslink interfaces.

ADIO also enables certain carrier and metadata impairments, and it supports the imposition of jitter on the transmitted carrier, and jitter measurement, when used with the Advanced Master Clock (AMC).

ADIO specifications begin on the next page.

ADIO

| Characteristic | Specifications | Supplemental Information |
|---|---|---|
| **ADVANCED DIGITAL I/O** | | |
| *DIGITAL OUTPUT RELATED:* | | |
| **Formats** | | |
| Electrical, unbalanced | SPDIF-EIAJ per IEC60958 | |
| Electrical, balanced | AES-EBU per AES3-1992 | |
| Optical | Toslink® or equivalent | |
| **Sample Rate (SR) Range** | | |
| Electrical | 27 kS/s to 200 kS/s | *Usable over the extended range of 16 kS/s to 216 kS/s with degraded waveform fidelity, accuracy, and jitter* |
| Optical | 27 kS/s to 108 kS/s | |
| **Sample Rate (SR) Accuracy** | ±0.0003% [3 PPM] | |
| **Output Amplitude** | | |
| Unbalanced | | |
| Range | 0.0 Vpp to 2.50 Vpp into 75 Ω | *1 mV resolution* |
| Accuracy | ±(8 % + 20 mV) | |
| Source Impedance | | *Typically 75 Ω* |
| Balanced | | |
| Range | 0.0 Vpp to 8.00 Vpp into 110 Ω | *1 mV resolution* |
| Accuracy | ±(10 % + 80 mV) | |
| Source Impedance | | *Typically 110 Ω* |
| Optical | Fixed, determined by transducer. | |
| **Channel Status Bits** | Full implementation per IEC-60958 (consumer) and AES3 (professional) | *Automatically set or manual override, hex or plain English, CRC override and auto-increment local address and time of day* |
| **User Bits and Validity Flag** | Fully settable | *Hex* |

| Characteristic | Specifications | Supplemental Information |
|---|---|---|
| **Residual Jitter[1]** | | |
| Unbalanced, Balanced | | |
| 700 Hz-100 kHz BW | ≤600 ps | *Peak detection* |
| 50 Hz-100 kHz BW | ≤1.0 ns | *Peak detection* |
| Optical | | *Typically <2.5 ns, SR ≤96 kS/s* |
| *INTERFACE SIGNAL IMPAIRMENTS* | | |
| **Variable Rise/Fall Time** | | |
| Range | 12 ns to 100 ns | *1 ns typical resolution* |
| Accuracy | ±(10% + 2 ns) | |
| **Cable Simulation** | | *Approximates the signal degradation of 100 meters of Belden 1696A.* |
| **Induced Jitter** | | |
| Waveforms | Sine, Square, Noise | |
| Sine Wave Jitter | | *Above 200 Hz, maximum allowable jitter decreases in a "1/f" fashion to 0.20 UI at $F_J$ =10 kHz and higher.* |
| Frequency Range ($F_J$) | 2 Hz to 200 kHz | |
| Amplitude Range | 0-1.591 µs for $F_J$ ≤20 Hz and derating linearly to 0.1591 µs at 200 kHz | *Equivalent to 0-9.775 UI at 48 kHz sample rate, derating to 0.9775 UI* |
| Amplitude Resolution | 100 ps | |
| Accuracy (1 kHz) | ±(0.01%) | |
| Flatness | ±0.01 dB | |
| Jitter Spectrum[1] | | *Spurious products are typically –40 dBc (below jitter signal) or –60 dBUI, whichever is larger.* |
| **Normal Mode Noise** | | |
| Waveform | Psuedo-random pulse train | |
| Unbalanced | 0 to 635 mVpp, 2.5 mV steps<br>±(10% + 25 mV) | |
| Balanced | 0 to 2.55 Vpp, 10 mV steps<br>±(10% + 100mV) | |

ADIO

ADIO

| Characteristic | Specifications | Supplemental Information |
|---|---|---|
| **Common Mode Signal (Bal only)** | | |
| Waveform | Sine | |
| Frequency Range | 20 Hz to 100 kHz | |
| Amplitude Range | 0 to 20.0 Vpp, 20 mV steps: ±(10% + 50 mV) | |
| *EMBEDDED OUTPUT SIGNAL RELATED:* | | |
| **Waveforms** | Sine, sine split frequency, sine split phase, sine+DC offset, continuously swept-sine, square-wave, noise, IMD signals, multi-tone, constant value, walking ones/zeros, bittest random, wave file playback | *8–24 bit word width, triangular PDF dither* |
| **Sine Characteristics** | | |
| Frequency Range | 0.001 Hz to 0.499 • SR | |
| Flatness[1] | | *Typically < 0.001 dB* |
| Offset Range | To maximum digital code [±1D] | *Offset limits maximum ac signal* |
| Harmonics & Spurious[1] | | *Typically < –190 dBFS* |
| **Square Characteristics** | | |
| Frequency Range (Fq) | 10 Hz to SR / 6 | *Fq must equal SR / N where N is an even integer ≥6.* |
| Even Harmonic, Spurious Content | | *Typically < –190 dBFS* |
| **Noise Characteristics** | | |
| Shape | White (<5 Hz to 0.499 • SR), Pink (<10 Hz to 0.45 • SR), IEC 60268-1 or BS EN 50332-1 | IEC 60268-1 is shaped pink noise. BS EN 50332-1 is similar, but with soft clipping to limit crest factor to ≈2. |
| **IMD Test Signals** | | |
| SMPTE & MOD | | |
| LF Tone Range | 40 Hz to 1 kHz | |
| HF Tone Range | 2 kHz to (0.499 • SR) or 20 kHz, whichever is lower | *HF tone must be ≥ 6 • LF tone* |
| Mix Ratio (LF:HF) | 10:1, 4:1 or 1:1 | |
| Residual IMD[1,2] | | *Typically < –140 dBFS* |

| Characteristic | Specifications | Supplemental Information |
|---|---|---|
| DFD | | |
| Tone Pair Mean Range | 2.5 kHz to (0.499 • SR – $F_{diff}$ / 2) or 20 kHz, whichever is lower | $F_{mean} = (F1 + F2)/2$ |
| Tone Pair Difference Range | 80 Hz to 2.0 kHz | $F_{diff} = \|F2-F1\|$; $F_{mean}$ must be ≥ 6 • Fdiff |
| Residual IMD[1,2] | | *Typically < –150 dBFS* |
| **Multitone, Wave File Playback** | | |
| Sample Rate (SR) | 8 kS/s to 216 kS/s | |
| Maximum File Size | 32 MSample | |
| Flatness (1 kHz ref) | | *Typically <0.001 dB to 0.499 • SR* |
| Spurious Content | | *Typically <–140 dBFS* |
| *DIGITAL INPUT RELATED:* | | |
| **Formats** | | |
| Unbalanced | SPDIF-EIAJ per IEC 60958, ≤5 Vpp | *Input typically 75 Ω or ≈8.3 kΩ* |
| Balanced | AES-EBU per AES3-2003, ≤10 Vpp | *Input typically 110 Ω or ≈2.5 kΩ* |
| Optical | Toslink® or equivalent | |
| **Sample Rate (SR) Range** | | |
| Electrical | 27 kS/s to 200 kS/s | *Usable over the extended range of 16 kS/s to 216 kS/s with degraded waveform fidelity, accuracy, and jitter* |
| Optical | 27 kS/s to 108 kS/s | |
| SR Measurement Accuracy | ±0.0003% [±3 ppm] | |
| **Input Amplitude Measurement** | | |
| Unbalanced | 0 to 2.50 Vpp, ±(5% + 6 mV) | |
| Balanced | 0 to 8.0 Vpp, ±(5% + 25 mV) | |

ADIO

| Characteristic | Specifications | Supplemental Information |
|---|---|---|
| **Jitter Measurement** | | |
| Range | 0-4.0 UI at $F_J$ ≤500 Hz | |
| Detection | Peak, RMS, or Average | *"Peak" detection must be used for residual measurements per AES3. "Average" detection is recommended for jitter response measurements.* |
| Bandwidth | | |
| Low Limit | 50 Hz or 700 Hz (AES3) | |
| High Limit | Variable from 1 kHz to 150 kHz in 0.1 kHz steps, Butterworth or Elliptic response. | |
| Accuracy (1 kHz) | ±(10% + 1.0 ns) | |
| Flatness[1] | ±0.5 dB, 100 Hz to 80 kHz | |
| Residual Jitter[1] | | |
| 700 Hz - 100 kHz BW | ≤600 ps | |
| 50 Hz - 100 kHz BW | ≤1.0 ns | |
| Jitter Spectrum[1] | | *Spurious products are typically –40 dBc (below jitter signal) or –60 dBUI, whichever is larger.* |
| **Channel Status Bits** | Full implementation per IEC-60958 (consumer) and AES3 (professional) | |
| **User Bits** | Displayed in hex | |
| **Validity Flag** | Displayed for each channel | |
| **Receiver Lock** | Displayed, both channels combined | |
| *EMBEDDED INPUT SIGNAL RELATED:* | | |
| **Level (Amplitude) Measurement** | | |
| Measurement Range | < –120 dBFS to +3 dBFS | |
| Accuracy (1 kHz) | | *Typically < 0.001 dB* |
| Flatness[1] | | *Typically < 0.001 dB* |
| **Residual Noise** | | *Typically < –140 dBFS* |

ADIO

| Characteristic | Specifications | Supplemental Information |
|---|---|---|
| **THD+N Measurement** | | |
| Fundamental Range | 5 Hz to 0.49 • SR or 50 kHz, whichever is lower | *Tuning can be set to track measured frequency, generator setting or fixed* |
| Measurement Range | 0 to 100% | |
| Accuracy | ±0.5 dB | |
| Residual THD+N[1,2] | | *Typically < –140 dBFS* |
| **Level & THD+N Filters** | | |
| High-Pass | | |
| DC | DC coupling | |
| AC(<10 Hz) | AC coupling, 1-pole | *–3 dB at ≈1.6 Hz* |
| Butterworth | $F_{HP}$ (–3 dB) = 10 Hz to 1.0 kHz, 6-pole | *Combined with AC coupling* |
| Low-Pass[3] | | |
| Butterworth | $F_{LP}$ (–3 dB) = 1 kHz to 150 kHz, 8-pole | *ENBW ≈1.006 • FLP* |
| Elliptic | $F_{LP}$ (–0.01 dB) = 1 kHz to 150 kHz, 8-pole; 0.01 dB pass-band ripple; ≤ –60 dB stop-band. | *ENBW ≈(1.012-1.062) • FLP* |
| SR / 2 (Maximum) | No filter is implemented, bandwidth and response are limited by the A/D | *–3 dB at ≈0.490 • SR* |
| Weighting | A-wt, B-wt, C-wt, CCIR-1k, CCIR-2k, CCITT, C-message, 50 µs or 75 µs de-emph (with and without A-wt), or None | *Weighting filter is cascaded with the high-pass and low-pass bandwidth limiting filters.* |

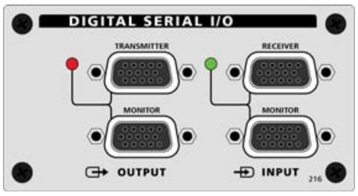
| Characteristic | Specifications | Supplemental Information |
|---|---|---|
| **IMD Measurement** | | |
| Test Signal Compatibility | | |
| SMPTE & MOD | Any combination of 40 Hz–1 kHz (LF) and 2 kHz–20 kHz (HF), mixed in any ratio from 1:1 to 10:1 (LF:HF) | *HF tone must be ≥ 6 • LF tone* |
| DFD | Any two-tone combination with mean frequency of 2.5 kHz–50 kHz and a difference frequency of 80 Hz–2.0 kHz | $F_{mean} = (F1 + F2)/2$<br>$F_{diff} = \|F2 - F1\|$<br>$F_{mean}$ *must be* $\geq 6 \cdot F_{diff}$ |
| IMD Measured | | |
| SMPTE | Amplitude modulation of HF tone | *Measurement BW is typ. 40–500 Hz xxx* |
| MOD | d2, d3, d2+d3, or d2+d3+d4+d5 | *Use "d2+d3" for measurements per IEC-60268* |
| DFD | d2, d3, d2+d3, or d2+d3+d4+d5 | *Use "d2+d3" for measurements per IEC-60268* |
| CCIF | d2 only | *CCIF"" is an archaic form of DFD that measures only the d2 product using a different 0 dB reference* |
| Measurement Range | 0 to 20% | |
| Accuracy | ±0.5 dB | |
| Residual IMD[2] | | |
| SMPTE & MOD | | *Typically < –140 dBFS* |
| DFD | | *Typically < –150 dBFS* |
| **Frequency Measurement** | | |
| Range | < 5 Hz to 0.499 • SR | |
| Accuracy | ±(0.0003% + 100 µHz) | |
| **Phase Measurement** | | |
| Ranges | –90 to +270, ±180, or 0 to 360 deg | |
| Accuracy | | *Typically < 0.001 deg* |

| NOTES to SPECIFICATIONS: | |
|---|---|
| 1 | System specification including contributions from both generator and analyzer subject to the following conditions: (A) SR = 27 kS/s to 200 kS/s, (B) interface signal ≥1.5 Vpp Bal or ≥300 mVpp Unbal, (C) rise-time ≤20 nsec, and (D) no impairments.<br>Optical interface is unspecified for residual jitter. |
| 2 | Digital generator word width must be set to 24 bits for specified performance; shorter word widths may degrade performance. |
| 3 | Maximum low-pass filter frequency is limited by input sample rate (SR). |

ADIO

# DSIO digital serial input/output module specifications

**with APx500 v4.0 or higher measurement software**
**as fitted in APx52x, 555, and 58x audio analyzers**
**NP0020.00013 rev 005**
**October 2014**




**This illustration shows a stand-alone APx DSIO module, model 216.**

These specifications cover the digital serial input and output functions of the Audio Precision DSIO. The DSIO is available as a stand-alone module (model 216), and in a combination module, combined with DIO (models 111 or 211).

The Digital Serial Input/Output (or DSIO) option provides a flexible chip- or board-level serial input and output interface. With separate Master Clock, Bit Clock, Frame Clock, Channel Clock and four Data lines, variable signal formats, variable word width, bit depth and synchronization options, the DSIO can address almost any serial interface need.

Formats include TDM, $I^2S$, DSP (bit-wide pulse) and custom formats. Up to 16 channels can be transmitted and received using the TDM format.

DSIO specifications begin on the next page.

DSIO

| Characteristic | Specifications | Supplemental Information |
|---|---|---|
| **Functional characteristics** | | |
| **Channels** | | |
| 1 data line, TDM | 1, 2, 4, 8 or 16 | *Time division multiplexing (TDM)* |
| Multiple data lines | 1, 2, 4 or 8 | *up to 4 data lines; 2 channels on each line by TDM* |
| **Data formats** | $I^2S$, DSP, custom (left/right justified, one bit/one subframe/50% duty cycle frame, inverted or normal frame, optionally 1-bit left-shifted frame). All modes LSB or MSB first | |
| **Word width** | 8–128 bits | *cannot be less than bit depth* |
| **Bit depth (data length)** | 8–32 bits | |
| **Sample rate (frame rate)** | 4 kS/s–216 kS/s | *1, 2 or 4 channels* |
| | 4 kS/s–192 kS/s | *8 or 16 channels* |
| **Master Clock range** | 4 kHz–55.296 MHz | *1, 2, or 4 channels. Actual clock rate is dependent upon channel count, word width, and sample rate settings.* |
| | 4 kHz–49.152 MHz | *8 or 16 channels. Actual clock rate is dependent upon channel count, word width, and sample rate settings.* |
| **Logic voltage levels** | 1.8 V, 2.5 V, 3.3 V | |

| Characteristic | Specifications | Supplemental Information |
|---|---|---|
| **DC characteristics, no load** | | |
| **1.8 volt setting** | | |
| High level input | | |
| Minimum | 1.0 V | |
| Low level input | | |
| Maximum | 0.8 V | |
| High level output | | |
| Minimum | 1.6 V | |
| Low level output | | |
| Maximum | 0.1 V | |
| Absolute range | | |
| Minimum | –0.5 V | |
| Maximum | 5.5 V | |
| **2.5 volt setting** | | |
| High level input | | |
| Minimum | 1.4 V | |
| Low level input | | |
| Maximum | 1.1 V | |
| High level output | | |
| Minimum | 2.2 V | |
| Low level output | | |
| Maximum | 0.1 V | |
| Absolute range | | |
| Minimum | –0.5 V | |
| Maximum | 5.5 V | |

DSIO

| Characteristic | Specifications | Supplemental Information |
|---|---|---|
| **3.3 volt setting** | | |
| High level input | | |
| Minimum | 1.8 V | |
| Low level input | | |
| Maximum | 1.5 V | |
| High level output | | |
| Minimum | 3.0 V | |
| Low level output | | |
| Maximum | 0.1 V | |
| Absolute range | | |
| Minimum | –0.5 V | |
| Maximum | 5.5 V | |
| **Input/Output impedance** | | |
| **All Outputs** | 50 Ω, nominal | |
| **All Inputs** | 10 kΩ, nominal | |
| **AC characteristics** | | |
| **Clock frequencies, input or output** | | |
| Master clock | 4 kHz–55.296 MHz | *1, 2, or 4 channels. Actual clock rate is dependent upon channel count, word width, and sample rate settings.* |
| | 4 kHz–49.152 MHz | *8 or 16 channels. Actual clock rate is dependent upon channel count, word width, and sample rate settings.* |
| Bit clock | 49.152 MHz maximum | |
| Frame | 216 kHz maximum | |
| **Output latency** | | |
| Frame | | *typ 3 ns referenced to Bit clock* |
| Data 1–4 | | *typ 3 ns referenced to Bit clock* |
| Monitor ports | | *typ 10 ns referenced to Signal pin* |
| **Input setup and hold requirements** | | |
| Frame, setup | | *6 ns referenced to Bit clock* |
| Frame, hold | | *2 ns referenced to Bit clock* |
| Data 1–4, setup | | *6 ns referenced to Bit clock* |
| Data 1–4, hold | | *2 ns referenced to Bit clock* |

DSIO

| Characteristic | Specifications | Supplemental Information |
|---|---|---|
| **Clock Jitter (Advanced Master Clock required)** | | |
| **Jitter Measurement** | | |
| Range | 0 to 650 ns | |
| Detection | Peak, RMS, or Average | *"Average" detection is recommended for jitter response measurements.* |
| Bandwidth | | |
| Low Limit | 50 Hz or 700 Hz | |
| High Limit | Variable from 1 kHz to 150 kHz in 0.1 kHz steps, Butterworth or Elliptic response | |
| Accuracy (1 kHz) | ±(1% + 300 ps) | *"Average" detection* |
| Flatness[1] | ±0.2 dB, 100 Hz to 100 kHz | |
| Residual Jitter[1] | | |
| 50 Hz to 100 kHz BW | ≤1.0 ns | |
| Jitter Spectrum[1] | | *Spurious products are typically –40 dBc (below jitter signal) or –60 dBUI, whichever is larger* |
| **Induced Jitter** | | |
| Waveforms | Sine, Square, Noise | |
| Signals Affected | Master Clk, Bit Clk, Frame Clock and Data | |
| **Sine Wave Jitter** | | |
| Frequency Range ($F_J$) | 2 Hz to 200 kHz | |
| Amplitude Range | 0 to 1591 ns for $F_J \leq 20$ kHz, derating linearly with frequency to 159.1 ns at 200 kHz | *Equivalent to 0 to 9.775 UI at 48 kHz sample rate, derating to 0.9775 UI* |
| Amplitude Resolution | 100 ps | |
| Accuracy (1 kHz) | ±0.01% | |
| Flatness | ±0.01% | |
| Jitter Spectrum[1] | | *Spurious products are typically –40 dBc (below jitter signal) or –60 dBUI, whichever is larger* |

DSIO

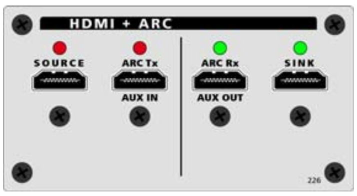
| Characteristic | Specifications | Supplemental Information |
|---|---|---|

| NOTE to SPECIFICATIONS | | |
|---|---|---|
| | 1 | System specification including contributions from both generator and analyzer subject to the following condition: Bit Clock ≥ 192 kHz. |

# HDMI+ARC input/output module specifications

**with APx500 v3.4 or higher measurement software**
**as fitted in APx52x, 555 and 58x audio analyzers**
**NP0020.00011 rev 003**
**October 2013**

HDMI




**This illustration shows the HDMI+ARC module, model 214.**

These specifications cover the input and output functions of the Audio Precision HDMI+ARC (High Definition Multimedia Interface plus Audio Return Channel) I/O module. HDMI+ARC is available as a stand-alone module (models 114 or 214).

The model HDMI+ARC module is fully compatible with HDMI 1.3a; additionally, it supports a subset of HDMI 1.4a, the ARC (Audio Return Channel) feature. With APx500 v3.1, HDMI EDID 1.4 is supported. HDMI+ARC modules manufactured after October, 2013 will support CEC communications on the Source and Sink connectors. Go to Help > About in APx500 to check feature availability.

HDMI is designed to carry high-bandwidth digital streams providing an audio/video interface that includes content protection and a bi-directional channel for interaction with connected electronic devices. ARC (Audio Return Channel) provides an additional digital audio channel, which can simplify interface cabling in certain applications, for user convenience.

NOTE: Earlier APx585 instruments may be fitted with a Model 112 HDMI module, which does not include ARC support. The HDMI specifications are the same.

HDMI+ARC specifications begin on the next page.

| Characteristic | | Specifications | Supplemental Information |
|---|---|---|---|
| **Revision** | | 1.3a + ARC. | *ARC (Audio Return Channel) implemented per HDMI 1.4a* |
| **Device Connections** | | | |
| | SOURCE | Typically connects to the sink input of a DUT. | *The video is an internally generated single color screen or the signal applied to the AUX IN connector. The audio is internally generated: see "Embedded Output Signal Related" under "DIGITAL I/O" for typical waveforms and parameters.* |
| | ARC Tx / AUX IN | HDMI ARC Tx configuration: Typically connects to an HDMI source that accepts ARC audio.<br><br>HDMI Source configuration: typically connects to an external source of video to be included in the Source output signal. | *Generates and transmits audio across ARC, per HDMI 1.4a. HDMI source should not transmit video.*<br><br>*Incoming audio is ignored. Incoming video is passed to HDMI Source in "pass through" mode.* |
| | ARC Rx / AUX OUT | HDMI ARC Rx configuration: Typically connects to an HDMI sink that produces ARC audio.<br><br>HDMI Sink configuration: Typically connects to an independent monitoring device. | *HDMI ARC Rx configuration: Receives and analyzes audio across ARC, per HDMI 1.4a. No video is transmitted.*<br><br>*HDMI Sink configuration: Contains video and audio sent to Sink input.* |
| | SINK | Typically connects to the source output of a DUT. | *The embedded and encoded audio signal components are recovered for analysis.* |
| **Hardware Interface** | | HDMI Type A | |
| **EDID** | | 256-byte EEPROM on both Sink and ARC TX / AUX IN connectors. | |

HDMI

| Characteristic | Specifications | Supplemental Information |
|---|---|---|
| **CEC (ARC connectors)** | HDMI ARC Tx configuration: ARC CEC implementation per HDMI 1.4a.<br><br>HDMI ARC Rx configuration: ARC CEC implementation per HDMI 1.4a. | *ARC link can be negotiated or forced on.*<br><br>*User can manually send a CEC ping or arbitrary CEC message to any of the standard logical addresses. An indicator confirms the receipt of an ACK (acknowledged) message from the messaged device.* |
| **CEC (HDMI Sink, Source Connectors)** | HDMI Source configuration: CEC implementation per HDMI 1.4a. Also, user-selectable CEC pass-through from AUX IN to Source.<br><br>HDMI Sink configuration: CEC implementation per HDMI 1.4a. Also, user-selectable CEC pass through from Sink to AUX OUT. | *User can manually send a CEC ping or arbitrary CEC message to any of the standard logical addresses. An indicator confirms the receipt of an ACK (acknowledged) message from the messaged device.* |
| **Color Support** | 24-bit, 30-bit, 36-bit (Deep Color) | |
| **Max Video Rate** | 1080p | |
| **<u>ARC DIGITAL I/O</u>** | | |
| *ARC DIGITAL OUTPUT RELATED:* | | |
| **Formats** | | |
| Signal level, single mode | 0.5 Vpp typical | *Output R is 55 Ω typical.* |
| Signal level, common mode | 0.4 Vpp typical | *Output R is 30 Ω typical.* |
| **Sample Rate (SR) Range** | 8 kS/s–216 kS/s | |
| **Sample Rate (SR) Accuracy** | ±0.0003% [3 PPM] | |
| **Channel Status Bits** | Full implementation per IEC60958 | *Automatically set or manual override, hex or plain English.* |
| **User Bits** | Fully settable | *Hex.* |
| **Validity Flag** | Set to 0, all channels | |
| **Residual Jitter[1,2]** | | *<1.0 ns typical* |

HDMI

| Characteristic | Specifications | Supplemental Information |
|---|---|---|
| *EMBEDDED OUTPUT SIGNAL RELATED:* | | |
| **Waveforms** | Sine, sine split frequency, sine split phase, sine+DC offset, continuously swept-sine, square-wave, noise, IMD signals, multi-tone, constant value, walking ones/zeros, bittest random, wave file playback. | *8–24 bit word width, triangular PDF dither.* |
| **Sine Characteristics** | | |
| Frequency Range | 5 Hz to 0.499 • SR | |
| Flatness[1] | | *Typically < 0.001 dB* |
| Harmonics & Spurious Products[1, 3] | | *Typically < –140 dBFS* |
| **Square Characteristics** | | |
| Frequency Range (Fq) | 10 Hz to SR / 6 | *Only specific values are allowed: Fq = SR / N where N is an even integer ≥6* |
| Even Harmonic, Spurious Content | | *Typically < –140 dBFS* |
| **Noise Characteristics** | | |
| Shape | White (<5 Hz to 0.499 • SR),<br>Pink (<10 Hz to 0.45 • SR),<br>IEC 60268-1 or BS EN 50332-1 | |
| **IMD Test Signals** | | |
| SMPTE & MOD | | |
| LF Tone Range | 40 Hz to 1 kHz | |
| HF Tone Range | 2 kHz to (0.499 • SR) or 20 kHz, whichever is lower | *HF tone must be ≥ 6 • LF tone.* |
| Mix Ratio (LF:HF) | 10:1, 4:1 or 1:1 | *4:1 maximum with SMPTE signal* |
| Residual IMD[1, 3] | | *Typically < –140 dBFS* |
| DFD | | |
| Tone Pair Mean Range | 2.5 kHz to (0.499 • SR – $F_{diff}$ / 2) or 20 kHz, whichever is lower | *$F_{mean}$ = (F1 + F2)/2.* |
| Tone Pair Difference Range | 80 Hz to 2.0 kHz | *$F_{diff}$ = \|F2-F1\|;<br>$F_{mean}$ must be ≥ 6 • Fdiff.* |

| Characteristic | Specifications | Supplemental Information |
|---|---|---|
| Residual IMD[1, 3] | | *Typically < –150 dBFS* |
| *DIGITAL INPUT RELATED:* | | |
| **Formats** | | |
| Single mode | ≤1.5 Vpp | *Input R is nominally 55 Ω* |
| Dual mode | ≤1.5 Vpp | *Input R is nominally 30 Ω* |
| **Sample Rate Range** | 22 kS/s–216 kS/s | *Typically locks down to 16 kS/s* |
| *EMBEDDED INPUT SIGNAL RELATED:* | | |
| **Level (Amplitude) Measurement** | | |
| Measurement Range | < –120 dBFS to +3 dBFS | |
| Accuracy (1 kHz) | | *Typically < 0.001 dB* |
| Flatness[1] | | *Typically < 0.001 dB* |
| **Residual Noise** | | *Typically < –140 dBFS* |
| **THD+N Measurement** | | |
| Fundamental Range | 5 Hz to 0.49 • SR or 50 kHz, whichever is lower | *Tuning can be set to track measured frequency, generator setting or fixed* |
| Measurement Range | 0 to 100% | |
| Accuracy | ±0.5 dB | |
| Residual THD+N[1, 3] | | *Typically < –140 dBFS* |
| **Level & THD+N Filters** | | |
| High-Pass Filter | 5 Hz to 500 Hz, or None | *1 Hz steps* |
| Low-Pass Filter[3] | 1 kHz to 97.2 kHz, or None | *100 Hz steps; very sharp roll-off characteristic exceeds AES-17* |
| Weighting | A-wt, B-wt, C-wt, CCIR-1k, CCIR-2k, CCITT, C-message, 50 µs or 75 µs de-emph (with and without A-wt), or None | *Weighting filter is cascaded with the high-pass and low-pass bandwidth limiting filters* |
| **IMD Measurement** | | |
| Test Signal Compatibility | | |
| SMPTE & MOD | Any combination of 40 Hz–1 kHz (LF) and 2 kHz–20 kHz (HF), mixed in any ratio from 1:1 to 10:1 (LF:HF) | *HF tone must be ≥ 6 • LF tone.* |

HDMI

| Characteristic | Specifications | Supplemental Information |
|---|---|---|
| DFD | Any two-tone combination with mean frequency of 2.5 kHz–50 kHz and a difference frequency of 80 Hz–2.0 kHz | *$F_{mean}$ = (F1 + F2)/2*<br>*$F_{diff}$ = \|F2 - F1\|*<br>*$F_{mean}$ must be ≥ 6 • $F_{diff}$ .* |
| IMD Measured | | |
| SMPTE | Amplitude modulation of HF tone. | *Measurement BW is typ. 40–500 Hz.* |
| MOD & DFD | d2, d3, d2+d3, or d2+d3+d4+d5 | *Use "d2+d3" for measurements per IEC-60268.* |
| Measurement Range | 0 to 20% | |
| Accuracy | ±0.5 dB | |
| Residual IMD[1, 3] | | |
| SMPTE & MOD | | *Typically < –140 dBFS* |
| DFD | | *Typically < –150 dBFS* |
| **Frequency Measurement** | | |
| Range | < 5 Hz to 0.499 • SR | |
| Accuracy | ±(0.0003% + 100 µHz) | |
| Resolution | 6 digits | |
| **Phase Measurement** | | |
| Ranges | –90 to +270, ±180, or 0 to 360 deg | |
| Accuracy[1] | | *Typically < 0.001 deg* |
| Resolution | 0.001 deg | |

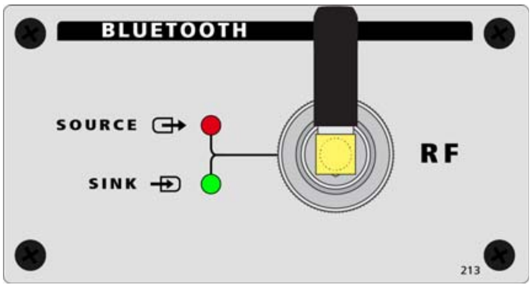
**Notes to Specifications**

1. System specification including contributions from both generator and analyzer. Generator-only and analyzer-only contributions are typically less.
2. Sample rate (SR) must be ≥ 27 kHz for specified performance. Jitter analyzer set for 700 Hz highpass response per AES3-1992.
3. Digital generator word width must be set to 24 bits for specified performance; shorter word widths may degrade performance.

# Bluetooth input/output module specifications

**with APx500 v3.2 or higher measurement software**
**as fitted in APx52x, 555 and 58x audio analyzers**
**NP0020.00015 rev 003**
**November 2012**






**This illustration shows the stand-alone Bluetooth module, model 213.**

These specifications cover the digital input and output functions of the Audio Precision Bluetooth interface. Bluetooth is available as a stand-alone module (model 213), and in a combination module, combined with DIO (model 217).

Bluetooth is a short-distance (a few meters) control, data, and audio communications wireless technology. Bluetooth uses low power, frequency-hopping radio in the 2.4 GHz band. Communication is two-way (for handshaking, metadata, etc); some profiles (HFP, for example) support duplex audio (both directions simultaneously); some profiles (A2DP) support only simplex audio (one direction per connection). Audio Precision supports several audio-specific Bluetooth profiles for audio test.

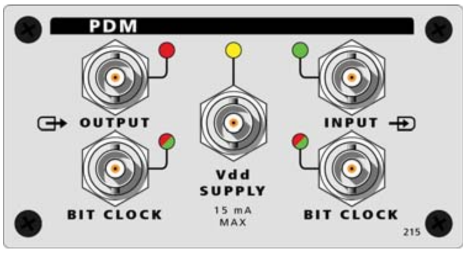
Bluetooth specifications begin on the next page.

BT

| Characteristic | Specifications | Supplemental Information |
|---|---|---|
| **Bluetooth Core Version** | | |
| | 2.1+EDR | |
| **Profiles/Roles Supported** | | |
| | A2DP Source | *With APx-BT-WB hardware module, there is a potential +/- 1 sample inter-channel phase error in A2DP Source or Sink operation.* |
| | A2DP Sink | *See note above.* |
| | HFP Audio Gateway | |
| | HFP Hands-Free | |
| | HSP Audio Gateway | |
| | HSP Headset | |
| | AVRCP Controller | |
| **Codecs Supported** | | |
| | SBC | |
| | APT-X | |
| | CVSD | |
| | mSBC | *Requires APx-BT-WB hardware module.* |
| **RF Connection** | | |
| | Type N, Female | |
| | Antenna | |
| **RF Input Impedance** | | *Typically 50 Ω* |
| **RF Output Impedance** | | *Typically 50 Ω* |
| **RF Power** | | *Typically 0 dBm* |
| | | *Typical maximum +4 dBm* |
| **RF Sensitivity (0.1% BER)** | | *Typically –81 dBm* |

# PDM input/output module specifications

**with APx500 v3.2 or higher measurement software**
**as fitted in APx52x, 555 and 58x audio analyzers**
**NP0020.00016 rev 001**
**October 2013**




**This illustration shows the stand-alone PDM module, model 215.**

These specifications cover the digital input and output functions of the Audio Precision PDM interface. PDM is available as a stand-alone module (model 215), and in a combination module, combined with DIO (model 218).

The PDM option provides a complete solution for addressing circuits or devices with a PDM input or output.

The PDM signal output consists of an APx generator audio signal, interpolated by a broad choice of oversampling ratios, and modulated into a 1-bit PDM bitstream. A 4th-order modulator is the default; a 5th-order modulator can be selected. The PDM Option also provides a signal input with its associated clock connection. The input accepts a 1-bit PDM bitstream, which is then decimated by one of a wide range of decimation ratios and filtered into baseband audio at the Decimated Rate. The input bitstream can also be analyzed directly (before decimation) in the Signal Analyzer to view out-of-band components.

PDM specifications begin on the next page.

PDM

## Technical Specifications

| Parameter | Symbol | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **TRANSMITTER** | | | | | | |
| Decimated Rate | $F_S$ | | 4 | | 216 | kHz |
| Bit Clock Rate | $F_B$ | Master or slave mode | 0.128 | | 24.576 | MHz |
| **INTERPOLATION FILTER** | | | | | | |
| Interpolation Ratio ($F_B/F_S$) | INTR | 16, 16.67, 21.33, 24, 25, 32, 33.33, 37.5, 42.67, 48, 50, 64, 66.67, 75, 85.33, 96, 100, 128, 150, 192, 200, 256, 300, 384, 400, 512, 500, 768, 800 | 16 | | 800 | |
| Passband Frequency Range | | | | | | |
| Passband Gain | | INTR = 32, 64, 128, 256, 512 | –0.0001 | | +0.0001 | dB |
| | | All other INTR | –0.0063 | | +0.0001 | dB |
| Stopband Frequency Range | | | 0.55 | | INTR / 2 | $F_S$ |
| Stopband Attenuation | | INTR = 32, 64, 128, 256, 512 | 115 | | | dB |
| | | All other INTR | 100 | | | dB |
| **MODULATOR: GENERAL** | | | | | | |
| Passband Frequency Range | | | 0 | | 0.45 | $F_S$ |
| Passband Gain | | | –0.0001 | | +0.0001 | dB |
| Maximum Input Level | MIL | | | | 0 | dBFS |
| Linearity | | –100 dBFS to MIL (order 4, 5) | –0.010 | | +0.001 | dB |
| | | MIL to 0 dBFS (order 4) | –0.010 | | +0.002 | dB |
| | | MIL to 0 dBFS (order 5) | –0.010 | | +0.001 | dB |
| Ones Density at Full Scale | | | 99.94 | 100 | | % |
| **MODULATOR: ORDER 4, 64x OSR** | | | | | | |
| Overload Point | OLP | 1 kHz | | | –7.8 | dBFS |
| Total Harm. Dist. + Noise | | @OLP; BW = 0.45 $F_S$ | | | –105 | dB |
| Signal-to-Noise Ratio | SNR | @OLP; BW = 0.45 $F_S$ | 106 | | | dB |

| Parameter | Symbol | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Dynamic Range | DNR | @MIL; $F_S$ = 48 kHz; per AES17 | 115 | | | dB |
| **MODULATOR: ORDER 5, 64x OSR** | | | | | | |
| Overload Point | OLP | 1 kHz | | | –9.4 | dBFS |
| Total Harm. Dist. + Noise | | @OLP; BW = 0.45 $F_S$ | | | –116 | dB |
| Signal-to-Noise Ratio | SNR | @OLP; BW = 0.45 $F_S$ | 116 | | | dB |
| Dynamic Range | DNR | @MIL; $F_S$ = 48 kHz; per AES17 | 125 | | | dB |
| **MODULATOR: ORDER 4, 128x OSR** | | | | | | |
| Overload Point | OLP | 1 kHz | | | –7.9 | dBFS |
| Total Harm. Dist. + Noise | | @OLP; BW = 0.45 $F_S$ | | | –127 | dB |
| Signal-to-Noise Ratio | SNR | @OLP; BW = 0.45 $F_S$ | 127 | | | dB |
| Dynamic Range | DNR | @MIL; $F_S$ = 48 kHz; per AES17 | 135 | | | dB |
| **MODULATOR: ORDER 5, 128x OSR** | | | | | | |
| Overload Point | OLP | 1 kHz | | | –9.6 | dBFS |
| Total Harm. Dist. + Noise | | @OLP; BW = 0.45 $F_S$ | | | –127 | dB |
| Signal-to-Noise Ratio | SNR | @OLP; BW = 0.45 $F_S$ | 127 | | | dB |
| Dynamic Range | DNR | @MIL; $F_S$ = 48 kHz; per AES17 | 135 | | | dB |
| **MODULATOR: ORDER 4, 256x OSR** | | | | | | |
| Overload Point | OLP | 1 kHz | | | –8.0 | dBFS |
| Total Harm. Dist. + Noise | | @OLP; BW = 0.45 $F_S$ | | | –130 | dB |
| Signal-to-Noise Ratio | SNR | @OLP; BW = 0.45 $F_S$ | 129 | | | dB |
| Dynamic Range | DNR | @MIL; $F_S$ = 48 kHz; per AES17 | 137 | | | dB |
| **MODULATOR: ORDER 5, 256x OSR** | | | | | | |
| Overload Point | OLP | 1 kHz | | | –9.8 | dBFS |
| Total Harm. Dist. + Noise | | @OLP; BW = 0.45 $F_S$ | | | –128 | dB |
| Signal-to-Noise Ratio | SNR | @OLP; BW = 0.45 $F_S$ | 127 | | | dB |
| Dynamic Range | DNR | @MIL; $F_S$ = 48 kHz; per AES17 | 137 | | | dB |

PDM

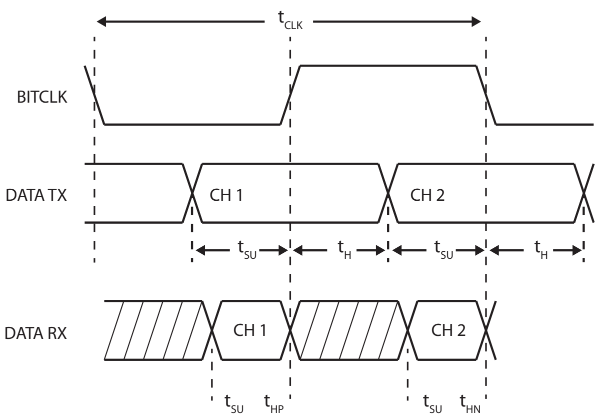
| Parameter | Symbol | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **MODULATOR: ORDER 4, 512x OSR** | | | | | | |
| Overload Point | OLP | 1 kHz | | | –8.2 | dBFS |
| Total Harm. Dist. + Noise | | @OLP; BW = 0.45 $F_S$ | | | –130 | dB |
| Signal-to-Noise Ratio | SNR | @OLP; BW = 0.45 $F_S$ | 129 | | | dB |
| Dynamic Range | DNR | @MIL; $F_S$ = 48 kHz; per AES17 | 137 | | | dB |
| **MODULATOR: ORDER 5, 512x OSR** | | | | | | |
| Overload Point | OLP | 1 kHz | | | –10 | dBFS |
| Total Harm. Dist. + Noise | | @OLP; BW = 0.45 $F_S$ | | | –128 | dB |
| Signal-to-Noise Ratio | SNR | @OLP; BW = 0.45 $F_S$ | 127 | | | dB |
| Dynamic Range | DNR | @MIL; $F_S$ = 48 kHz; per AES17 | 137 | | | dB |
| **RECEIVER** | | | | | | |
| Decimated Rate | $F_S$ | | 0.160 | | 768 | kHz |
| Bit Clock Rate | $F_B$ | Master or slave mode | 0.128 | | 24.576 | MHz |
| **DECIMATION FILTER** | | | | | | |
| Decimation Ratio (FB/FS) | DECR | 1, 3.125, 4, 6.25, 8, 8.33, 10.67, 12.5, 16, 16.67, 18.75, 21.33, 24, 25, 32, 33.33, 37.5, 42.67, 48, 50, 64, 66.67, 75, 85.33, 96, 100, 128, 150, 192, 200, 256, 300, 384, 400, 512, 500, 768, 800 | 1 | | 800 | |
| Passband Frequency Range | | All DECR except DECR = 1 | 0 | | 0.45 | $F_S$ |
| | | DECR = 1 | 0 | | 0.5 | $F_B$ |
| Passband Gain | | DECR = 1, 4, 8, 16, 32, 64, 128, 256, 512 | –0.0001 | | +0.0001 | dB |
| | | All other DECR | –0.001 | | +0.001 | dB |
| Stopband Frequency Range | | All DECR except DECR = 1 | 0.55 | | DECR/2 | $F_S$ |
| Stopband Attenuation | | All DECR except DECR = 1 | 120 | | | dB |

| Parameter | Symbol | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **LOGIC LEVEL** | | | | | | |
| Interface Voltage | $V_{INT}$ | | 1.80 | | 3.30 | V |
| Resolution | | | | | 0.01 | V |
| Accuracy | | | | ±0.05 | | V |
| **OUTPUT CHARACTERISTICS** | | | | | | |
| Output Voltage High | $V_{OH}$ | $I_{LOAD}$ = 0.5 mA | 0.7 • $V_{INT}$ | | | V |
| Output Voltage Low | $V_{OL}$ | $I_{LOAD}$ = 0.5 mA | | | 0.3 • $V_{INT}$ | V |
| **VDD OUTPUT** | | | | | | |
| DC Voltage | $V_{DD}$ | | 0.80 | | 3.60 | V |
| Resolution | | | | | 0.01 | V |
| Accuracy | | | | ±0.05 | | V |
| Maximum Current | $I_{MAX}$ | | | | 15 | mA |
| **VDD MODULATION** | | | | | | |
| AC output level | | All waveforms | 0.01 | | $V_{DD}$ / 5 | $V_{pp}$ |
| Square/Pulse Frequency | | Per GSM standard | | 216.667 | | Hz |
| Sine Frequency | | | 10 | | 22000 | Hz |
| Frequency Accuracy | | | | 3 | | ppm |

PDM

# Timing Characteristics

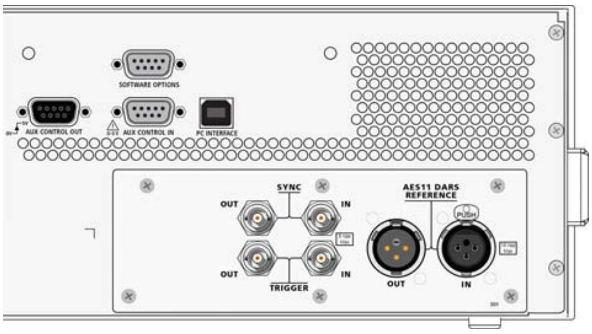
| | | | | |
|---|---|---|---|---|
| **PDM TRANSMITTER** | | | | |
| $t_{CLKTX}$ | Clock period (master or slave mode) | 41 | 7813 | ns |
| $t_H$ | Data hold time | 20 | | ns |
| $t_{SU}$ | Data setup time | | $t_{CLKTX}$ / 2-30 | ns |
| **PDM RECEIVER** | | | | |
| $t_{CLKRX}$ | Clock period (master or slave mode) | 41 | 7813 | ns |
| $t_{HP}$ | Data hold time, rising edge | 5 | | ns |
| $t_{HN}$ | Data hold time, falling edge | 10 | | ns |
| $t_{SU}$ | Data setup time | | 5 | ns |



AMC

# AMC Advanced Master Clock Rear Panel Sync, Trigger and Ref I/O specifications

**with APx500 v4.0 or higher measurement software**
**as fitted in APx52x, 555, and 58x audio analyzers**
**NP0020.00023 rev 000**
**October 2014**




**This illustration shows a section of the APx rear panel, focusing on the Auxiliary I/O and the Sync, Trigger and DARS reference connections for the AMC.**

These specifications cover rear panel Sync, Trigger and DARS Reference I/O functions for APx analyzers fitted with the Advanced Master Clock (AMC).

The Auxiliary I/O (GPIO) function is also described here. The Auxiliary I/O function is not part of the AMC option, but is fitted on all APx analyzers.

AMC

| Characteristic | Specifications | Supplemental Information |
|---|---|---|
| **REAR PANEL I/O** | | |
| **Auxiliary Digital Control** | | |
| Output | 8 bits | *Typically 0-5V, 9-pin male D-sub* |
| Input | 8 bits | *Internal pull-up, 9-pin female D-sub* |
| **Sync Input** | | |
| Signal Compatibility | Square or Sine | |
| Voltage Range | 0.8 Vpp to 5.0 Vpp | *$R_{IN}$ >10 kΩ, AC coupled* |
| Frequency Range | 4 kHz to 50 MHz, square;<br>1 MHz to 50 MHz, sine | |
| Lock Range | | *Typically 100 ppm* |
| **Sync Output** | | |
| Signal | Square | |
| Amplitude (VH) | +0.8 V to +3.6 V, 0.1 V steps | *$V_L \approx 0$ to 0.1 V* |
| Frequency Range | 8 kHz to 50 MHz | *Maximum recommended frequency when interfacing to low voltage logic:<br>50 MHz for VH = 1.5–2.0 V;<br>30 MHz for VH = 1.0–1.4 V;<br>10 MHz for VH = 0.8–0.9 V* |
| **Reference Input (AES11 / DARS)** | | |
| Voltage Range | 2.0 Vpp to 6.0 Vpp | *$R_{IN}$ selectable: >5 kΩ or ≈110 Ω* |
| Sample Rate Range | 27 kS/s to 216 kS/s | |
| Lock Range | | *Typically 100 ppm* |
| **Reference Output (AES11 / DARS)** | | |
| Amplitude | 5.0 Vpp into 110 Ω, balanced | |
| Sample Rate Range | 8 kS/s to 216 kS/s | *Usable below 27 kS/s with some loss in waveform fidelity* |

| Characteristic | Specifications | Supplemental Information |
|---|---|---|
| **Trigger Input** | | |
| Voltage Range | –0.5 V to +5.5 V | |
| Threshold Level | +0.8 to +3.6 V, 0.1 V steps | *$R_{IN}$ ≈10 kΩ, DC coupled, + or – edge selectable* |
| Minimum Pulse Width | | *Typically 20 ns* |
| **Trigger Output** | | |
| Trigger Sources | Analog Sine Generator, Audio Generator, and Jitter Generator | |
| Amplitude (VH) | +0.8 V to +3.6 V, 0.1 V steps | *VL ≈ 0 to 0.1 V* |

AMC

AMC

ENVR

# General and Environmental Specifications

**for APx555 audio analyzers**
**NP0020.00024 rev 000**
**September 2014**

| Characteristic | Specifications | Supplemental Information |
|---|---|---|
| **GENERAL/ENVIRONMENTAL** | | |
| **Power Requirements** | 100–240 Vac ±10% (90–264 Vac), 50–60 Hz, with safety ground via approved power cord, 160 VA max | *No range switching or fuse changes required over the full operating range of 90–264 Vac* |
| **Temperature** | 0°C to +45°C operating, –40°C to +75°C storage | |
| **Humidity** | 10% to 80%, non-condensing | |
| **Max Operating Altitude** | 3,000 m [9,840 feet] | |
| **Stabilization Time** | 20 minutes | *Allow up to 1 hour per 10°C if unit has been exposed to a significant change in temperature. Allow 24–48 hours to recover if condensation has occurred.* |

| Characteristic | Specifications | Supplemental Information |
|---|---|---|
| **EMC** | Complies with Directive 2004/108/EC, IEC 61326-1:2005, EN 61326-1:2006. Radiated and conducted emissions are within Class B limits of CISPR 11. Complies with Directive 1995/5/EC if option "BT" (Bluetooth) is installed. IEC 61326-2-1:2005 Section 5.2.401 is applied (controlled EM environment) for options "DSIO" and "PDM". | *Emissions and immunity levels are influenced by the quality of interface and signal cables attached to the unit. Compliance was demonstrated using Audio Precision cables.* |
| **Safety** | Complies with Directive 2006/95/EC, IEC 61010-1:2001, EN 61010-1:2001, CAN/CSA-C22.2 No. 61010-1-04, and UL Std No. 61010-1 (2nd Edition). | *Equipment Class I, Installation Category II, Pollution Degree 2, Measurement Category I* |
| **Dimensions (W, H, D)** | 432 mm. 129 mm, 475 mm<br>17.0 in, 5.08 in, 18.7 in | *3U rack mount kit available* |
| **Weight** | 10.8 kg [23.8 lbs] with no digital interface options installed | *Add ≈ 0.2 kg [0.4 lbs] for each digital interface option installed.* |

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