

AUDIO PRECISION SYSTEM TWO

SPECIFICATIONS

(Effective with APWIN version 1.52a or higher software)



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ANALOG SIGNAL OUTPUTS

All System Two configurations, except the SYS-2300, contain an analog signal generator consisting of an ultra-low distortion analog sinewave generator and two independent transformer coupled output stages that can be driven from both the analog sources and optional hardware signal generators. Option "BUR" adds analog generated sine burst, square wave, and noise signals. Option "IMD" adds analog-generated IMD test signals. SYS-2222 and SYS-2322 configurations also contain dual channel D/A-based signal generation capability. Unless otherwise noted, all specifications are valid for outputs $\geq 150 \mu\text{Vrms}$ [420 μVpp].

ANALOG SIGNAL GENERATOR

Low Distortion Sine Wave

| | |
|--|--|
| Frequency Range | 10 Hz to 204 kHz |
| Frequency Accuracy | |
| High-accuracy mode | $\pm 0.03\%$ |
| Fast mode | $\pm 0.5\%$ |
| Frequency Resolution | |
| High-accuracy mode | 0.005% |
| Fast mode | 0.025 Hz, 10 Hz – 204.75 Hz; 0.25 Hz, 205 Hz – 2.0475 kHz; 2.5 Hz, 2.05 kHz – 20.475 kHz; 25 Hz, 20.5 kHz – 204 kHz |
| Amplitude Range ¹ | |
| Balanced | <10 μV to 26.66 Vrms [+30.7 dBu] |
| Unbalanced | <10 μV to 13.33 Vrms [+24.7 dBu] |
| Amplitude Accuracy | $\pm 0.7\%$ [± 0.06 dB] at 1 kHz |
| Amplitude Resolution | |
| $V_{\text{out}} \geq 150 \mu\text{Vrms}$ | 0.003 dB |
| $V_{\text{out}} < 150 \mu\text{Vrms}$ | 0.05 μVrms |
| Flatness (1 kHz ref) | |
| 10 Hz-20 kHz | ± 0.008 dB (typically <0.003 dB) |
| 20 kHz-50 kHz | ± 0.03 dB |
| 50 kHz-120 kHz | ± 0.10 dB |
| 120 kHz-200 kHz | +0.2/-0.3 dB |
| Residual Distortion ² | |
| 20 Hz – 20 kHz at 1 kHz | typically <0.0001% [-120 dBc]; typically <0.00003% [-130 dBc] |
| Residual THD+N ³ | |
| 20 Hz-20 kHz | $\leq (0.0004\% + 1 \mu\text{V})$, 22 kHz BW [-108 dB] $\leq (0.0006\% + 2 \mu\text{V})$, 80 kHz BW [-104 dB] $\leq (0.0015\% + 6 \mu\text{V})$, 500 kHz BW [-96.5 dB] $\leq (0.0040\% + 6 \mu\text{V})$, 500 kHz BW [-88 dB] |
| 10 Hz-100 kHz | $\leq (0.0040\% + 6 \mu\text{V})$, 500 kHz BW [-88 dB] |

Note 1 20 Hz-50 kHz only. Decrease maximum available output by a factor of 2 (-6.02 dB) for the full 10 Hz-204 kHz range.

Note 2 Relative amplitude of any individual harmonic ≤ 80 kHz measured with a passive notch filter and FFT analyzer. Not valid for outputs above 12 Vrms balanced, or 6 Vrms unbalanced.

Note 3 Measured with System Two analyzer (system specification). Derate 20-25 Hz THD to 0.002% for outputs >20 Vrms balanced, or >10 Vrms unbalanced.

Intermodulation Distortion Related Signals

with option "IMD"

SMPTTE (or DIN) Test Signals

| | |
|------------------------------|---|
| LF Tone | 40, 50, 60, 70, 100, 125, 250, or 500 Hz; all $\pm 1.5\%$ |
| HF Tone Range | 2 kHz-200 kHz |
| Mix Ratio | 4:1 or 1:1 (LF:HF) |
| Amplitude Range ⁴ | |
| Balanced | 30 μVpp to 75.4 Vpp |
| Unbalanced | 30 μVpp to 37.7 Vpp |

| | |
|---------------------------|---|
| Amplitude Accuracy | $\pm 2.0\%$ [± 0.17 dB] |
| Residual IMD ⁵ | 0.0015% [-96.5 dB], 60+7 kHz or 250+8 kHz |

CCIF and DFD Test Signals

| | |
|--------------------------------|---|
| Difference Frequency | 80, 100, 120, 140, 200, 250, 500 or 1 kHz; all $\pm 1.5\%$ |
| Center Frequency | 4.5 kHz-200 kHz |
| Amplitude Range ⁴ | |
| Balanced | 30 μVpp to 75.4 Vpp |
| Unbalanced | 30 μVpp to 37.7 Vpp |
| Amplitude Accuracy | $\pm 3.0\%$ [± 0.26 dB] |
| CCIF Residual IMD ⁵ | $\leq 0.0004\%$ [-108 dB], 14 kHz+15 kHz (odd order & spurious typ <0.05%) |
| DFD Residual IMD ⁵ | $\leq 0.0002\%$ [-114 dB], 14 kHz+15 kHz (odd order & spurious typ <0.025%) |

DIM (or TIM) Test Signals

| | |
|------------------------------|--|
| Squarewave Frequency | 3.15 kHz (DIM-30 and DIM-100); 2.96 kHz (DIM-B); both $\pm 1\%$ |
| Sinewave Frequency | 15 kHz (DIM-30 and DIM-100); 14 kHz (DIM-B) |
| Amplitude Range ⁴ | |
| Balanced | 30 μVpp to 75.4 Vpp |
| Unbalanced | 30 μVpp to 37.7 Vpp |
| Amplitude Accuracy | $\pm 2.0\%$ [± 0.17 dB] |
| Residual IMD ⁵ | $\leq 0.0020\%$ [-94 dB] |

Special Purpose Signals

with option "BUR"

Sine Burst

| | |
|--------------------|--|
| Frequency Range | 20 Hz – 100 kHz |
| Frequency Accuracy | Same as Sinewave |
| ON Amplitude Range | Bal 30 μVpp to 37.7 Vpp Unbal 30 μVpp to 18.8 Vpp |
| Accuracy, Flatness | Same as Sinewave |
| OFF Ratio Range | 0 dB to -80 dB |
| OFF Ratio Accuracy | ± 0.3 dB, 0 to -60 dB |
| ON Duration | 1-65535 cycles, or externally gated |
| Interval Range | 2-65536 cycles |

Square Wave

| | |
|------------------------------|--|
| Frequency Range | 20 Hz – 20 kHz |
| Frequency Accuracy | Same as Sinewave |
| Amplitude Range ⁴ | |
| Balanced | 30 μVpp to 37.7 Vpp |
| Unbalanced | 30 μVpp to 18.8 Vpp |
| Amplitude Accuracy | $\pm 2.0\%$ [± 0.17 dB] at 400 Hz |
| Rise/fall time | Typically 2.0 μsec |

Noise Signals

| | |
|------------------------------|--|
| White Noise | Bandwidth limited 10 Hz – 23 kHz |
| Pink Noise | Bandwidth limited 10 Hz – 200 kHz |
| Bandpass Noise | Approximately 1/3-octave (2-pole) filtered pink noise, continuously tunable from 20 Hz – 100 kHz |
| Generator | True random or Pseudo-random |
| Pseudo-Random Repeat Time | Typically 262 msec (synchronized to the analyzer 4/sec reading rate) |
| Amplitude Range ⁴ | (Approximate calibration only) |
| Balanced | 30 μVpp to 37.7 Vpp |
| Unbalanced | 30 μVpp to 18.8 Vpp |

Note 4 Calibration with other amplitude units is based upon an equivalent sinewave having the same Vpp amplitude.

Note 5 Measured with System Two analyzer (system specification).

D/A GENERATED ANALOG SIGNALS

Signals generated by DSP and converted to analog via stereo D to A converters. Available only on models SYS-2222 and SYS-2322. All digitally-generated sine variants, MLS, and IMD signals for the D to A converter outputs are independently generated and may be selected simultaneously but independently from the concurrently available digital signals for the digital domain outputs.

D/A Converter

| | |
|--------------------|---|
| Resolution | 18-bit dual channel delta-sigma |
| Data Rate | 28.8 ks/sec to 52.8 ks/sec, 48.0 ks/sec for specified performance |
| Frequency Accuracy | $\pm 0.0002\%$ [2 PPM] using internal reference, lockable to ext reference |
| D/A Distortion | -96.5 dB THD+N at 48 ks/sec sample rate. Typically -100 dB THD+N at 48 ks/sec sample rate, 20 kHz bandwidth; D/A distortion products typically ≤ -106 dB |

Variable Phase Sine Wave

Two sine waves, same frequency, independently settable phase

| | |
|----------------------|--|
| Frequency Range | 10 Hz to 20 kHz |
| Frequency Resolution | Typically 0.0078 Hz |
| Phase accuracy | $\pm 1^\circ$, 10 Hz – 5 kHz; $\pm 3^\circ$, 5 kHz – 20 kHz |
| Phase range | -360° to $+359.9^\circ$ |
| Amplitude Range | |
| Balanced | $<10 \mu\text{V}$ to 26.66 Vrms [+30.7 dBu] |
| Unbalanced | $<10 \mu\text{V}$ to 13.33 Vrms [+24.7 dBu] |
| Amplitude Accuracy | $\pm 0.7\%$ [± 0.06 dB] at 1 kHz |
| Flatness (1 kHz ref) | |
| 10 Hz-18 kHz | ± 0.03 dB |
| 18 kHz-20 kHz | +0.03/-0.15 dB |

Stereo Sine Wave

Sine waves of independent frequency and amplitude on each channel

| | |
|----------------------|--|
| Frequency Range | 10 Hz to 20 kHz, each channel independently settable. (Phase random if both frequencies set the same) |
| Frequency Resolution | Typically 0.0078 Hz |
| Amplitude Range | |
| Balanced | $<10 \mu\text{V}$ to 26.66 Vrms [+30.7 dBu] |
| Unbalanced | $<10 \mu\text{V}$ to 13.33 Vrms [+24.7 dBu] |
| Amplitude Accuracy | $\pm 0.7\%$ [± 0.06 dB] at 1 kHz |
| Flatness (1 kHz ref) | |
| 10 Hz-18 kHz | ± 0.03 dB |
| 18 kHz-20 kHz | +0.03/-0.15 dB |

Dual Sinewave

Twin sine waves of independent frequency and settable amplitude ratio; applied to both output channels

| | |
|----------------------|---|
| Frequency Range | 10 Hz to 20 kHz, each component independently settable |
| Frequency Resolution | Typically 0.0078 Hz |
| Amplitude Range | |
| Balanced | $<10 \mu\text{V}$ to 26.66 Vrms [+30.7 dBu] |
| Unbalanced | $<10 \mu\text{V}$ to 13.33 Vrms [+24.7 dBu] (Channel amplitudes individually settable) |
| Amplitude Accuracy | $\pm 0.7\%$ [± 0.06 dB] at 1 kHz |
| Amplitude Ratio | 0 dB to -100 dB |
| Flatness (1 kHz ref) | |
| 10 Hz-18 kHz | ± 0.03 dB |
| 18 kHz-20 kHz | +0.03/-0.15 dB |

Shaped Sine Burst

Sine burst with raised cosine envelope (see graph on page 12)

| | |
|----------------------|--|
| Frequency Range | 10 Hz to 20 kHz |
| Frequency Resolution | Typically 0.0078 Hz |
| Interval | 2 - 65536 cycles |
| Burst On | 1 to number of Interval cycles minus 1 |
| Flatness (1 kHz ref) | |
| 10 Hz-18 kHz | ± 0.03 dB |
| 18 kHz-20 kHz | +0.03/-0.15 dB |

Multitone Signals

Stored waveform consisting of multiple sine waves, each of independent frequency, amplitude, and phase

| | |
|----------------------|--|
| Number of Tones | 1 to 128 typical, 4095 maximum |
| Frequency Range | 20 Hz to 50% of sample rate |
| Frequency Resolution | Sample Rate $\div 2^{13}$ (typically 5.86 Hz at 48 ks/sec) |

Arbitrary Waveforms

| | |
|---------------|---|
| Record Length | 256-8192 points, user specified waveform. Utility is provided to prepare a time record file from user specified frequency, amplitude, and phase data. |
|---------------|---|

Maximum Length Sequence Signals

Pseudo-random noise signal for speaker testing with MLS analyzer (page 14)

| | |
|-----------------|---|
| Signals | Four pink sequences, four white sequences |
| Frequency Range | 22 Hz-20 kHz |
| Repetition Rate | 32767 samples |

Polarity Signal

Asymmetric waveform to facilitate polarity identification

| | |
|-----------------|--|
| Frequency Range | 20 Hz to 23.5% of sample rate (11.28 kHz at 48 ks/sec) |
|-----------------|--|

“IMD” RELATED SIGNALS *Digitally generated*

SMPTE (or DIN) Test Signal

| | |
|------------------------------|---|
| LF Tone | 40 Hz to 500 Hz, continuously settable |
| HF Tone Range | 2 kHz – 20 kHz |
| Mix Ratio | 4:1 or 1:1 (LF:HF) |
| Amplitude Range ⁴ | |
| Balanced | 30 μVpp to 75.4 Vpp |
| Unbalanced | 30 μVpp to 37.7 Vpp |
| Amplitude Accuracy | $\pm 3\%$ [± 0.26 dB] |
| Residual IMD ⁵ | $\leq 0.0050\%$ [-86 dB], 60 Hz + 7 kHz or 250 Hz + 8 kHz (measured using analog analyzer) |

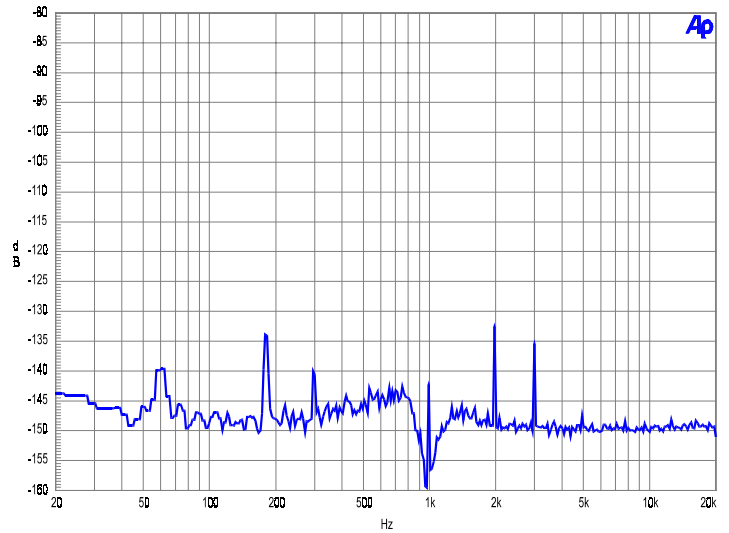
CCIF and DFD Test Signals

| | |
|------------------------------|--|
| Difference Frequency | 80 Hz to 2 kHz, continuously settable |
| Center Frequency | 3 kHz to 22 kHz, continuously settable |
| Amplitude Range ⁴ | |
| Balanced | 30 μVpp to 75.4 Vpp |
| Unbalanced | 30 μVpp to 37.7 Vpp |
| Amplitude Accuracy | $\pm 3\%$ [± 0.26 dB] |
| Residual IMD ⁵ | $\leq 0.0010\%$ [-100 dB], 14 kHz + 15 kHz (measured using analog analyzer) |

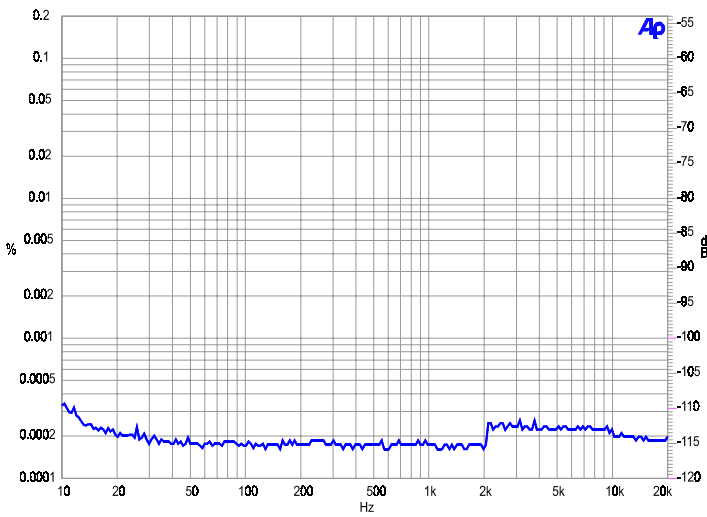
OUTPUT CHARACTERISTICS

| | |
|--------------------------|--|
| Source Configuration | Selectable balanced, unbalanced, or CMTST (common mode test) |
| Source Impedances | |
| Balanced or CMTST | 40 Ω (±1 Ω), 150 Ω ⁶ (±1.5 Ω), or 600 Ω (±3 Ω) |
| Unbalanced | 20Ω (±1 Ω) or 600 Ω (±3 Ω) |
| Max Floating Voltage | 42 Vpk |
| Output Current Limit | ≥80 mA peak (typically >120 mA at +25°C) |
| Max Output Power | |
| Balanced | +30.1 dBm into 600 Ω (Rs = 40 Ω) |
| Unbalanced | +24.4 dBm into 600 Ω (Rs = 20 Ω) |
| Output Related Crosstalk | |
| 10 Hz-20 kHz | ≤-120 dB or 5 μV, whichever is greater |
| 20 kHz-100 kHz | ≤-106 dB or 10μV, whichever is greater |

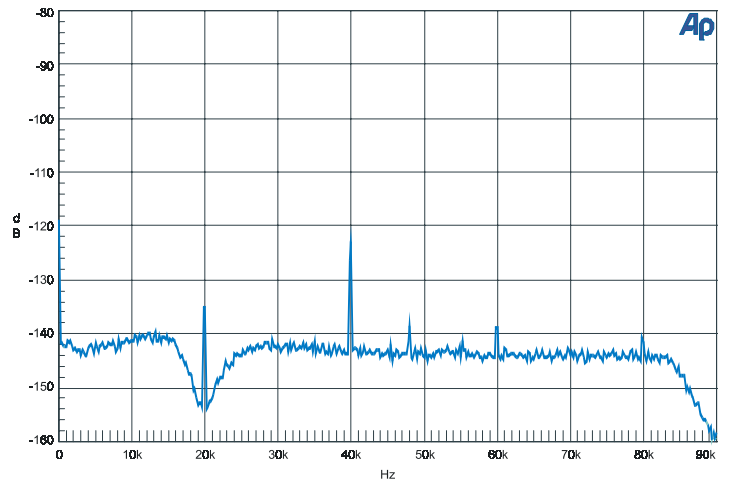
Note 6 200Ω with option "EURZ"



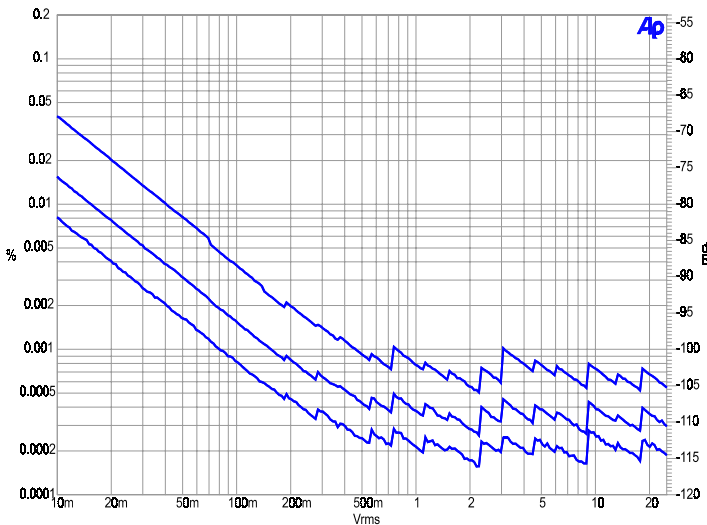
Typical analog generator residual THD+N spectrum at 1 kHz, 2 Vrms. (16384 point FFT of notch filter output, Fs = 48 kHz, 16 averages)



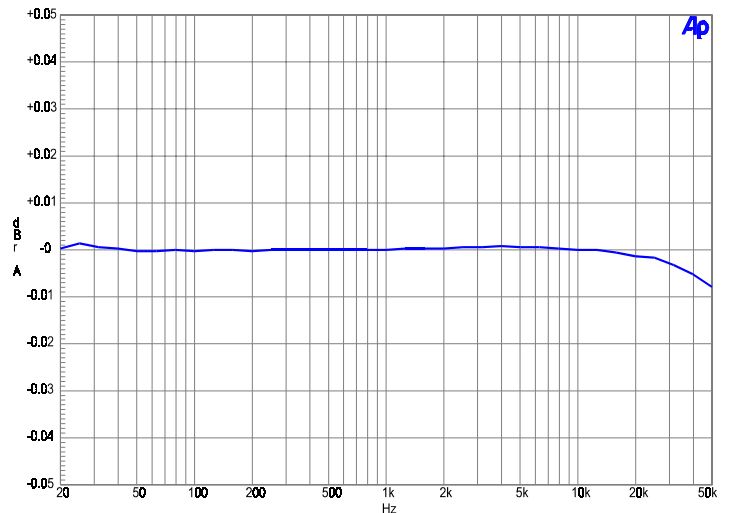
Typical total system THD+N versus Frequency using analog sinewave at 2Vrms



Typical analog generator residual THD+N spectrum at 20 kHz, 2 Vrms. (16384 point FFT of notch filter output, Fs = 192 kHz, 16 averages)



Typical THD+N versus Amplitude at 1 kHz for three different analog analyzer measurement bandwidths. Lower curve is with 22 kHz bandwidth limiting. Middle curve is with 80 kHz. Upper curve is with 500 kHz.



Typical analog System flatness at 2 Vrms signal level.

ANALOG ANALYZER

All System Two configurations, except SYS-2300, contain an analog analyzer consisting of an input module with two independent auto-ranging input stages, each having its own level (rms) and frequency meters; a phase meter connected between the channels; plus a single channel multi-function analyzer module providing additional signal processing and gain stages.

SYS-2222 and SYS-2322 configurations also include dual channel A/D converters for FFT and other special forms of analysis on the analog input and analyzer output signals. Unless otherwise noted, all specifications assume dc coupling and rms detection.

Standard analyzer functions include amplitude and noise (both wideband and selective), THD+N, and crosstalk. Option "IMD" adds intermodulation distortion (IMD) measurement capability. Option "W&F" adds wow and flutter measurement capability.

ANALOG INPUT CHARACTERISTICS

| | |
|-------------------------|--|
| Input Ranges | 40 mV to 160 V in 6.02 dB steps |
| Maximum Rated Input | 230 Vpk, 160 Vrms (dc to 20 kHz); overload protected in all ranges |
| Input Impedance | |
| Balanced (each side) | Nominally 100 k Ω // 185 pF (typ) |
| Unbalanced | Nominally 100 k Ω // 185 pF (typ) |
| Terminations | Selectable 600 Ω or 300 Ω , $\pm 1\%$; 1 Watt [+30 dBm] maximum power |
| CMRR ⁷ | |
| 40 mV-2.5 V ranges | ≥ 80 dB, 10 Hz-20 kHz |
| 5 V and 10 V ranges | ≥ 65 dB, 10 Hz-20 kHz |
| 20 V-160 V ranges | ≥ 50 dB, 10 Hz-1 kHz |
| Input Related Crosstalk | |
| 10 Hz-20 kHz | ≤ -140 dB or 1 μ V, whichever is greater |
| 20 kHz-100 kHz | ≤ -126 dB or 2.5 μ V, whichever is greater |

Note 7 Not valid below 50 Hz with ac coupling.

Level Meter Related (both channels)

| | |
|--------------------------------------|---|
| Measurement Range | 5 mV – 160 V for specified accuracy and flatness, useable to <100 μ V |
| Resolution (full scale) ⁸ | |
| 4/sec | 1/40,000 [0.00022 dB] |
| 8/sec | 1/40,000 [0.00022 dB] |
| 16/sec | 1/20,000 [0.00043 dB] |
| 32/sec | 1/10,000 [0.00087 dB] |
| 64/sec | 1/5,000 [0.0017 dB] |
| 128/sec | 1/2,500 [0.0035 dB] |
| Accuracy (1 kHz) | $\pm 0.5\%$ [± 0.05 dB] |
| Flatness (1 kHz ref) ⁹ | |
| 20 Hz-20 kHz | ± 0.008 dB (typically <0.003 dB) |
| 15 Hz-50 kHz | ± 0.03 dB |
| 10 Hz-120 kHz | ± 0.10 dB |
| 120 kHz-200 kHz | +0.2/-0.3 dB (typically <-0.5 dB at 500 kHz) |

Note 8 Resolution within a given range is equal to its full scale value divided by the full scale counts value determined by the selected reading rate. (Example: 40 mV input range reading resolution = 4 μ V, using the 32/sec reading rate). Numerical displays using a dB unit are rounded to the nearest 0.001 dB.

Note 9 Derate flatness above 5 kHz by an additional ± 0.02 dB in the 20 V, 40 V, 80 V, and 160 V input ranges.

Frequency Meter Related (both channels)

| | |
|-------------------|-------------------------------|
| Measurement Range | 10 Hz to 500 kHz |
| Accuracy | |
| SYS-2022 | $\pm 0.003\%$ [± 30 PPM] |
| SYS-2222/2322 | $\pm 0.0006\%$ [± 6 PPM] |
| Resolution | 6 digits + 0.000244 Hz |
| Minimum Input | 5 mV |

Phase Measurement Related

| | |
|------------------------|-------------------------------------|
| Measurement Ranges | ± 180 , -90/+270, or 0/+360 deg |
| Accuracy ¹⁰ | |
| 10 Hz-5 kHz | ± 0.5 deg |
| 5 kHz-20 kHz | ± 1 deg |
| 20 kHz-50 kHz | ± 2 deg |
| Resolution | 0.1 deg |
| Minimum Input | 5 mV, both inputs |

Note 10 Both analyzer input channels must have same coupling (ac or dc) selection. Accuracy is valid for any input signal amplitude ratio up to ± 30 dB.

Wideband Amplitude/Noise Function

| | |
|-----------------------------------|--|
| Measurement Range | <1 μ V – 160 Vrms |
| Accuracy (1 kHz) | $\pm 1.0\%$ [± 0.09 dB] |
| Flatness (1 kHz ref) ⁹ | |
| 20 Hz-20 kHz | ± 0.02 dB |
| 15 Hz-50 kHz | ± 0.05 dB |
| 50 kHz-120 kHz | ± 0.15 dB |
| 120 kHz-200 kHz | +0.2 dB/-0.3 dB (typically < -3 dB at 500 kHz) |
| Bandwidth Limiting Filters | |
| LF -3 dB | <10 Hz, 22 Hz per CCIR Rec 468, 100 Hz $\pm 5\%$ (3-pole), or 400 Hz $\pm 5\%$ (3-pole) |
| HF -3 dB | 22 kHz per CCIR Rec 468, 30 kHz $\pm 5\%$ (3-pole), 80 kHz $\pm 5\%$ (3-pole), or >500 kHz |
| Optional Filters | up to 7 (see pages 7, 8, and 9) |
| Detection | RMS ($\tau = 25$ msec or 50 msec), AVG, QPk per CCIR Rec 468, Pk (pseudo-peak), or S-Pk (0.7071 x Pk reading) |
| Residual Noise | |
| 22 Hz-22 kHz BW | ≤ 1.0 μ V [-118 dBu] |
| 80 kHz BW | ≤ 2.0 μ V [-112 dBu] |
| 500 kHz BW | ≤ 6.0 μ V [-102 dBu] |
| A-weighted | ≤ 0.5 μ V [-124 dBu] |
| CCIR-QPk | ≤ 2.5 μ V [-110 dBu] |

Bandpass Amplitude Function

| | |
|------------------------|---|
| Tuning Range (f_0) | 10 Hz to 200 kHz |
| Tuning Accuracy | $\pm 2\%$ |
| Bandpass Response | 1/3-octave class II (4-pole); <-32 dB at 0.5 f_0 and 2.0 f_0 |
| Accuracy (at f_0) | ± 0.3 dB, 20 Hz-120 kHz |
| Residual Noise | |
| 10 Hz-5 kHz | ≤ 0.25 μ V [-130 dBu] |
| 5 kHz-20 kHz | ≤ 0.5 μ V [-124 dBu] |
| 20 kHz-200 kHz | ≤ 1.5 μ V [-114 dBu] |

Bandreject Amplitude Function

| | |
|------------------------|--|
| Tuning Range (f_0) | 10 Hz to 200 kHz |
| Tuning Accuracy | $\pm 2\%$ |
| Bandreject Response | typically: -3 dB at 0.73 f_0 & 1.37 f_0 -20 dB at $f_0 \pm 10\%$ -40 dB at $f_0 \pm 2.5\%$ |
| Accuracy | ± 0.3 dB, 20 Hz-120 kHz (excluding 0.5 f_0 to 2.0 f_0) |
| Residual Noise | same as Amplitude Function |

THD+N Function

| | |
|------------------------------|---|
| Fundamental Range | 10 Hz to 200 kHz |
| Measurement Range | 0 – 100% |
| Accuracy | ±0.3 dB, 20 Hz – 120 kHz harmonics |
| Measurement Bandwidth | |
| LF -3 dB | <10, 22, 100, or 400 Hz |
| HF -3 dB | 22k, 30k, 80k, or >500 kHz; option filters are also functional |
| Residual THD+N ¹¹ | |
| 20 Hz-20 kHz | ≤(0.0004% + 1.0 μV), 22 kHz BW [-108 dB] ≤(0.0006% + 2.0 μV), 80 kHz BW [-104 dB] ≤(0.0015% + 6.0 μV), 500 kHz BW [-96.5 dB] |
| 10 Hz-100 kHz | ≤(0.0040% + 6.0 μV), 500 kHz BW [-88 dB] |
| Minimum Input | 5 mV for specified accuracy, usable to <100 μV with fixed notch tuning |
| Notch Tuning Modes | Counter Tuned, Sweep Track, AGen-Track (analog generator), DGen-Track (digital generator), or Fixed (set by direct entry) |
| Notch Tracking Range | ±2.5% from fixed setting |

Note 11 System specification including contribution from generator. Generator residual THD may limit system performance below 25 Hz if output is >20.0 Vrms balanced, or 10.0 Vrms unbalanced.

Crosstalk Function

| | |
|----------------------------------|--------------------------|
| Frequency Range | 10 Hz to 200 kHz |
| Accuracy ¹² | ±0.4 dB, 20 Hz – 120 kHz |
| Residual Crosstalk ¹² | |
| 10 Hz-20 kHz | ≤-140 dB or 1 μV |
| 20 kHz-100 kHz | ≤-126 dB or 2.5 μV |

Note 12 Uses the 1/3-octave bandpass filter to enhance the measured range in the presence of wideband noise. Alternate (interfering) channel input must be ≥ 5 mV.

IMD MEASUREMENTS with option “IMD”

Option “IMD” adds the capability to measure intermodulation distortion (IMD) using three of the most popular techniques. The demodulated IMD signal can also be selected for FFT analysis in SYS-2222 and SYS-2322 configurations.

SMPTE (DIN) IMD Function

| | |
|----------------------------|--|
| Test Signal Compatibility | Any combination of 40-250 Hz (LF) and 2 kHz-100 kHz (HF) tones, mixed in any ratio from 0:1 to 8:1 (LF:HF) |
| IMD Measured | Amplitude modulation products of the HF tone. -3 dB measurement bandwidth is typically 20 Hz-750 Hz |
| Measurement Range | 0 – 20% |
| Accuracy | ±0.5 dB |
| Residual IMD ¹³ | ≤0.0015%, 60 + 7 kHz or 250 + 8 kHz |

CCIF and DFD IMD Functions

| | |
|----------------------------|---|
| Test Signal Compatibility | Any combination of equal amplitude tones from 4 kHz – 100 kHz spaced 80 Hz-1 kHz (difference frequency) |
| IMD Measured | |
| CCIF function | 2 nd order difference frequency product relative to the amplitude of either test tone |
| DFD function | u ₂ (2 nd order difference frequency product) per IEC 268-3 (1986) |
| Measurement Range | 0-20% |
| Accuracy | ±0.5 dB |
| Residual IMD ¹³ | CCIF ≤0.0004%, 14 kHz + 15 kHz [-108 dB], DFD ≤0.0002%, 14 kHz + 15 kHz [-114 dB] |

DIM (TIM) IMD Function

| | |
|----------------------------|---|
| Test Signal Compatibility | 2.96 – 3.15 kHz squarewave mixed with 14 – 15 kHz sine probe tone |
| IMD Measured ¹⁴ | u ₄ and u ₅ per IEC 268-3 (1986) |
| Measurement Range | 0 – 20% |
| Accuracy | ±0.7 dB |
| Residual IMD ¹³ | ≤0.0020% |

Note 13 System specification measured with the System Two generator. Valid for input levels ≥200 mVrms.

Note 14 IEC 268-3 defines nine possible DIM products. The System Two IMD option analyzer is sensitive only to the u₄ and u₅ products using the simplified measurement technique proposed by Paul Skritek. DIM measurements using this technique will typically be 6-8 dB lower (better) than the results obtained using FFT-based techniques which sum all nine products.

WOW & FLUTTER MEASUREMENTS

with option “W&F”

Option “W&F” adds the capability to make both conventional wow & flutter and scrape flutter measurements (using the technique developed by Dale Manquen of Altair Electronics, Inc.) The demodulated W&F signal can also be selected for FFT analysis in SYS-2222 and SYS-2322 configurations.

| | |
|---------------------------|---|
| Test Signal Compatibility | |
| Normal | 2.80 kHz – 3.35 kHz |
| “High-band” | 11.5 kHz – 13.5 kHz |
| Measurement Range | 0 to 1.2% |
| Accuracy (4 Hz) | ±(5% of reading + 0.0005%) |
| Detection Modes | IEC/DIN (quasi-peak per IEC-386), NAB (average), JIS (per JIS 5551) |
| Response Selections | |
| Weighted | 4 Hz bandpass per IEC/DIN/NAB |
| Unweighted | 0.5 Hz – 200 Hz |
| Scrape ¹⁵ | 200 Hz – 5 kHz |
| Wideband ¹⁵ | 0.5 Hz – 5 kHz |
| Residual W+F | |
| Weighted | ≤0.001% |
| Unweighted | ≤0.002% |
| Scrape or Wideband | ≤0.005% |
| Minimum Input | 5 mV (20 mV for specified residual) |
| Settling Time | |
| IEC/DIN or NAB | Typically 3 – 6 seconds |
| JIS | Typically 15 – 20 seconds |

Note 15 Operational with high-band test signals (11.5 kHz-13.5 kHz) only. Upper -3 dB rolloff is typically 4.5 kHz using 12.5 kHz.

OPTION FILTERS

Up to 7 option filters can be installed in the System Two analyzer for weighted noise or other special measurements. Option filters are selected one at a time and are cascaded with the standard bandwidth limiting filters.

The following tables list only the most popular types. Contact Audio Precision for a quotation regarding other possible designs. The maximum usable dynamic range will be limited to about 40-50 dB because system auto-ranging is based upon the peak value of the unfiltered wideband signal. Custom designs may be constructed on the FIL-USR blank card.

Weighted Noise Measurement

| | |
|---------|--|
| FIL-AWT | "A" weighting per IEC Rec 179 |
| FIL-CCR | Weighting per CCIR Rec 468 and DIN 45404 (Also for CCIR/ARM) |
| FIL-CIT | Weighting per CCITT Rec P53 |
| FIL-CMS | "C-message" per BSTM 41004 and ANSI/IEEE Std 743-1984 |
| FIL-CWT | "C" weighting per IEC Rec 179 |

Precision De-emphasis Family

| | |
|----------|--|
| FIL-D50 | 50 μ sec \pm 1% |
| FIL-D50E | 50 μ sec \pm 1% + 15.625 kHz notch |
| FIL-D50F | 50 μ sec \pm 1% + 19.0 kHz notch |
| FIL-D75 | 75 μ sec \pm 1% |
| FIL-D75B | 75 μ sec \pm 1% + 15.734 kHz notch |
| FIL-D75F | 75 μ sec \pm 1% + 19.0 kHz notch |

Precision Sharp Cutoff Low-Pass Family

| | |
|-----------------|--|
| Family Response | -3 dB at $f_c \pm 1.5\%$; ± 0.2 dB to $0.5 f_c$, ± 0.4 dB to $0.8 f_c$; <-50 dB above $1.8 f_c$ |
| FLP-10K | $f_c = 10.0$ kHz, quasi-elliptic |
| FLP-15K | $f_c = 15.0$ kHz, quasi-elliptic |
| FLP-18K | $f_c = 18.0$ kHz, quasi-elliptic |
| FLP-19K | $f_c = 19.0$ kHz, quasi-elliptic |
| FLP-20K | $f_c = 20.0$ kHz, quasi-elliptic |

See also FLP-A20K under Miscellaneous

Bandwidth Limiting, Low-Pass

| | |
|---------|-------------------------------------|
| FLP-400 | 400 Hz \pm 3%, 5-pole |
| FLP-500 | 500 Hz \pm 3%, 5-pole |
| FLP-1K | 1 kHz \pm 3%, 5-pole Butterworth |
| FLP-3K | 3 kHz \pm 3%, 7-pole Butterworth |
| FLP-4K | 4 kHz \pm 3%, 7-pole Butterworth |
| FLP-8K | 8 kHz \pm 3%, 7-pole Butterworth |
| FLP-50K | 50 kHz \pm 5%, 3-pole Butterworth |

Bandwidth Limiting, High-Pass

| | |
|---------|-------------------------|
| FHP-70 | 70 Hz \pm 3%, 8-pole |
| FHP-400 | 400 Hz \pm 3%, 9-pole |
| FHP-2K | 2 kHz \pm 3%, 9-pole |
| FHP-20K | 20 kHz \pm 3% |

1/3-Octave (Class II) Bandpass Family

| | |
|-----------------|--|
| Family Response | Class II (4-pole) ± 0.2 dB from $0.97 f_0$ to $1.03 f_0$; <-12 dB at $0.8 f_0$ and $1.25 f_0$; <-32 dB at $0.5 f_0$ and $2.0 f_0$ |
| FBP-120 | $f_0 = 120$ Hz |
| FBP-180 | $f_0 = 180$ Hz |

| | |
|-----------|------------------|
| FBP-250 | $f_0 = 250$ Hz |
| FBP-300 | $f_0 = 300$ Hz |
| FBP-400 | $f_0 = 400$ Hz |
| FBP-500 | $f_0 = 500$ Hz |
| FBP-600 | $f_0 = 600$ Hz |
| FBP-666 | $f_0 = 666$ Hz |
| FBP-800 | $f_0 = 800$ Hz |
| FBP-945 | $f_0 = 945$ Hz |
| FBP-1000 | $f_0 = 1.00$ kHz |
| FBP-1200 | $f_0 = 1.20$ kHz |
| FBP-1500 | $f_0 = 1.50$ kHz |
| FBP-2000 | $f_0 = 2.00$ kHz |
| FBP-3000 | $f_0 = 3.00$ kHz |
| FBP-3150 | $f_0 = 3.15$ kHz |
| FBP-4000 | $f_0 = 4.00$ kHz |
| FBP-4500 | $f_0 = 4.50$ kHz |
| FBP-5000 | $f_0 = 5.00$ kHz |
| FBP-6000 | $f_0 = 6.00$ kHz |
| FBP-8000 | $f_0 = 8.00$ kHz |
| FBP-10000 | $f_0 = 10.0$ kHz |
| FBP-12500 | $f_0 = 12.5$ kHz |
| FBP-15000 | $f_0 = 15.0$ kHz |
| FBP-16000 | $f_0 = 16.0$ kHz |
| FBP-20000 | $f_0 = 20.0$ kHz |
| FBP-22000 | $f_0 = 22.0$ kHz |

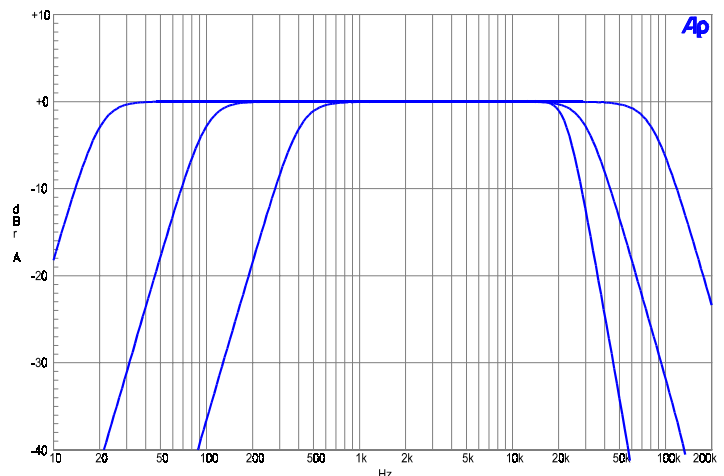
Receiver Testing

| | |
|----------|---------------------------------|
| FIL-RCR | 200 Hz-15 kHz + 19.0 kHz notch |
| FIL-IECR | 20 Hz-15 kHz + 15.625 kHz notch |

Miscellaneous

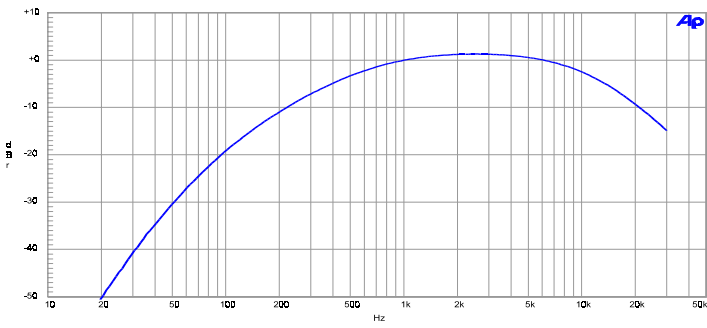
| | |
|----------|--|
| FBP-500X | High-Q 500 Hz bandpass for CD dac linearity measurements |
| FLP-A20K | Apogee 20 kHz "brickwall" filter (OEM design) |
| FIL-USR | Kit for building custom filters |

Note: the optional filters described here can be added to the standard band-limiting filters shown below

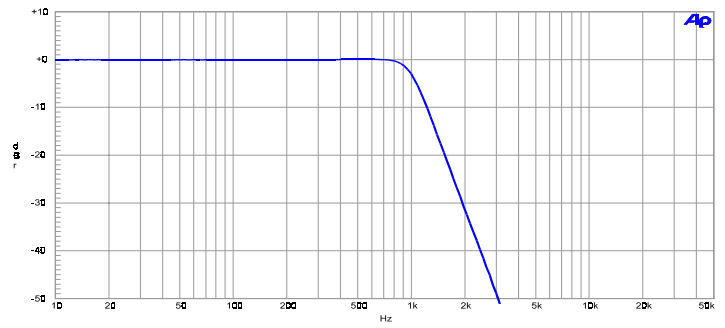


Standard Band-limiting filters included with every System Two

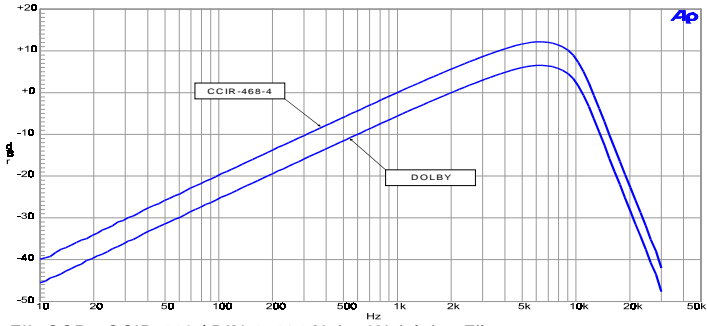
High pass selectable 22Hz, 100 Hz, 400 Hz
Low pass selectable: 22 kHz, 30 kHz, 80 kHz



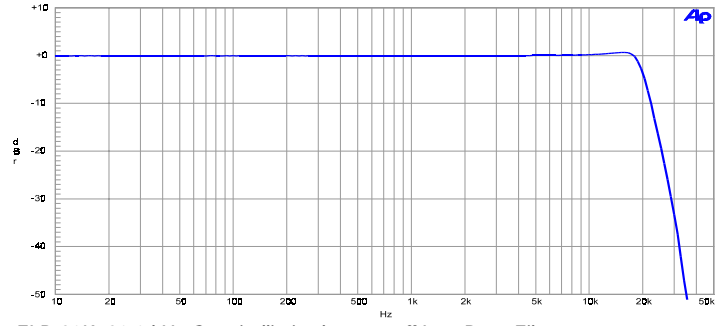
FIL-AWT ANSI-IEC "A" Weighting Filter



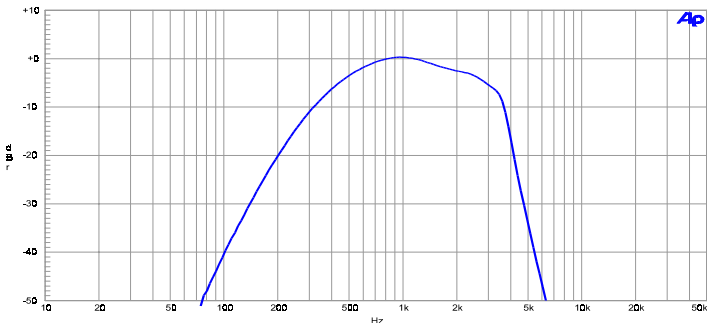
FLP-1K 1 kHz Low Pass 5-pole Butterworth Filter



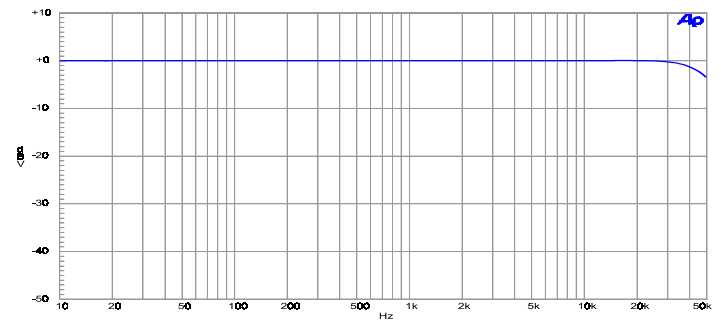
FIL-CCR CCIR-468 / DIN 45404 Noise Weighting Filter



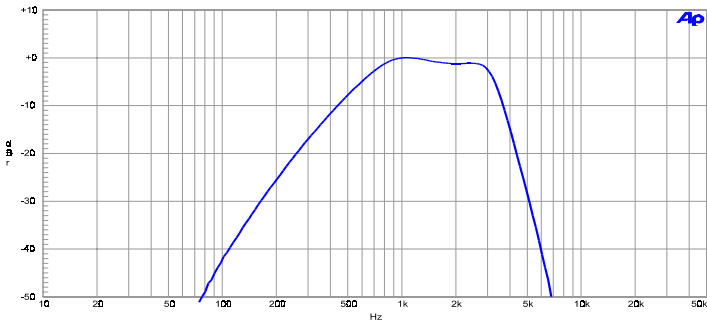
FLP-20K 20.0 kHz Quasi-elliptic sharp cutoff Low Pass Filter



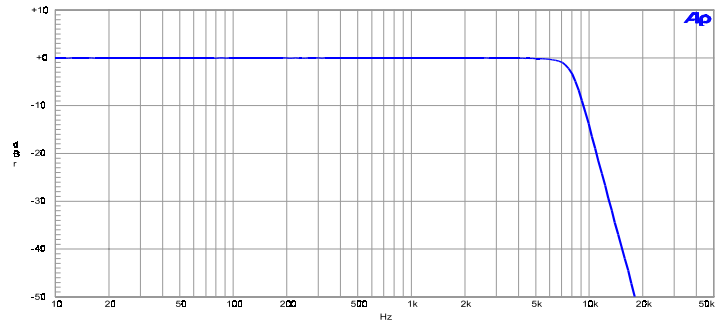
FIL-CIT CCITT P53 Noise Weighting Filter



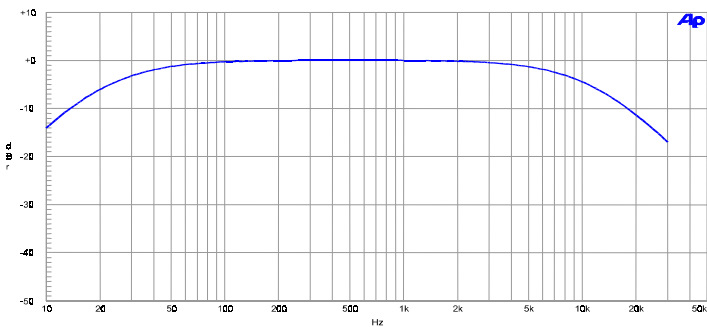
FLP-50K 50 kHz 3-pole Butterworth Low Pass Filter



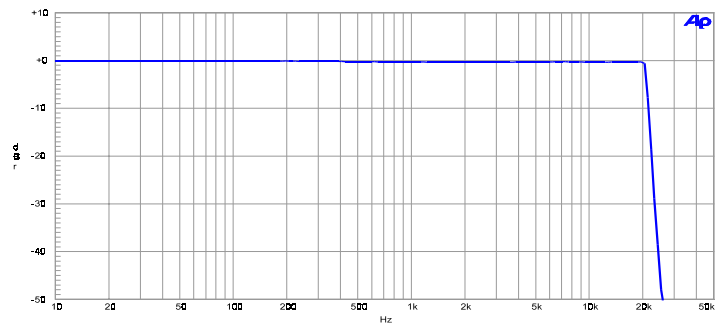
FIL-CMS C-Message Weighting Filter (ANSI/IEEE 743-1984)



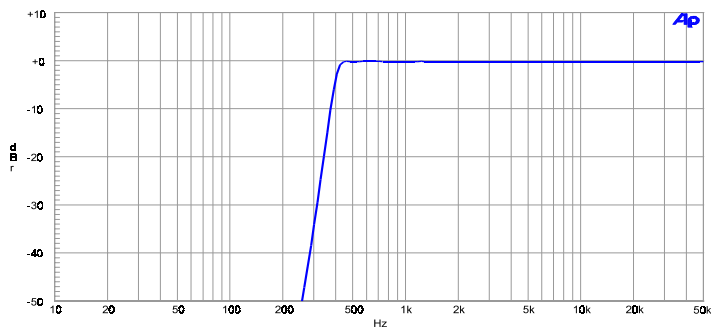
FLP-8K 8 kHz 7-pole Butterworth Low Pass Filter



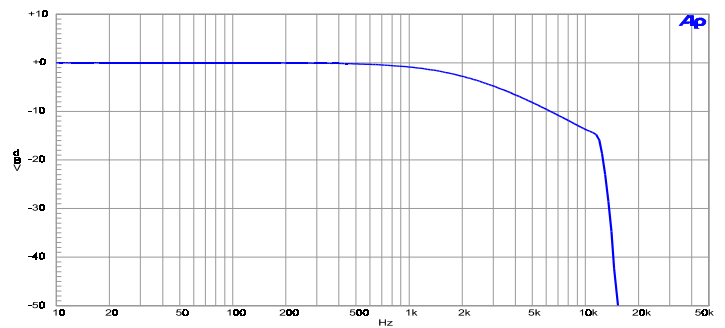
FIL-CWT "C" Weighting (IEC-179)



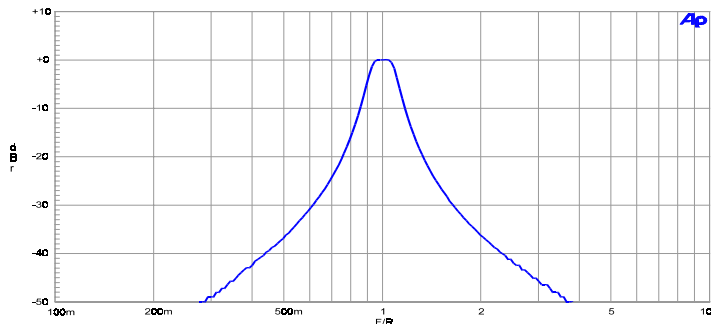
FLP-A20K Apogee "Brick-Wall" 20 kHz Low Pass Filter



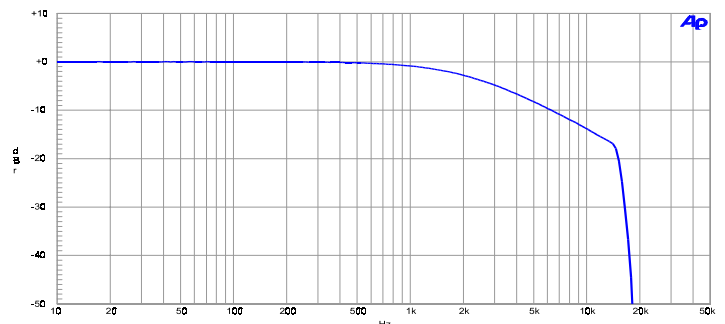
FHP-400 400 Hz 9-pole High Pass Filter



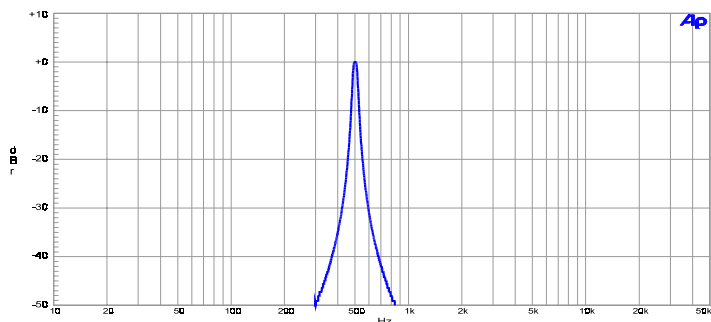
FIL-D75B 75 μsec with 15.734 kHz (NTSC) notch De-emphasis Filter



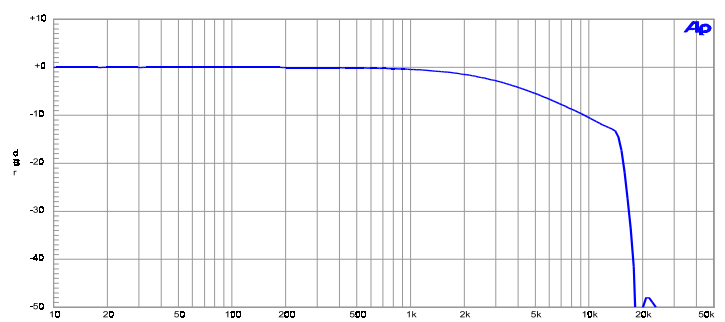
FBP-XXXX Fixed 1/3 Octave Band Pass Filter



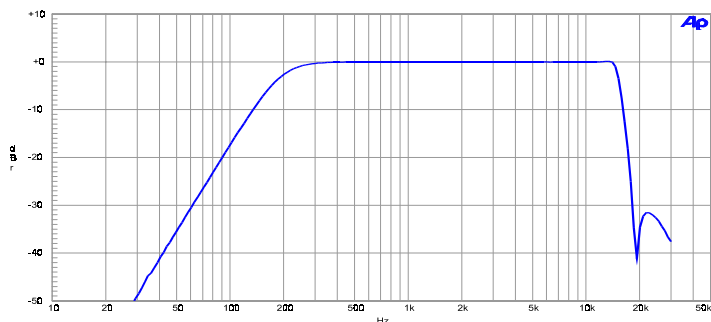
FIL-D75F 75 μsec with 19 kHz (FM) notch De-emphasis Filter



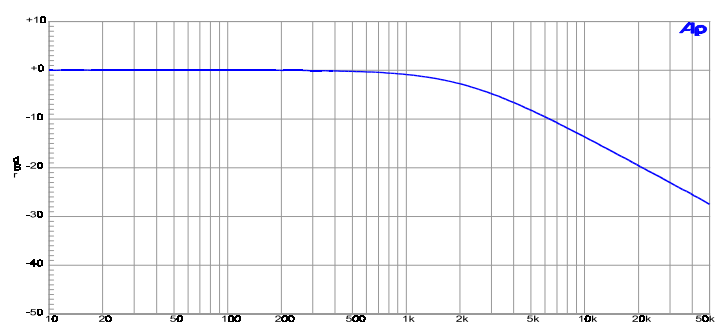
FBP-500X High-Q 500 Hz Band Pass Filter (for CD linearity testing)



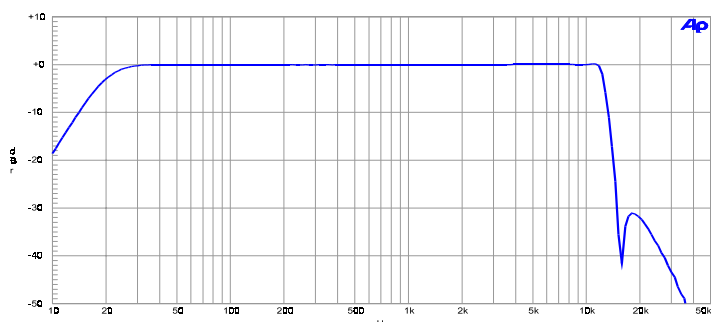
FIL-D50F 50 μsec with 19 kHz (FM) notch De-emphasis Filter



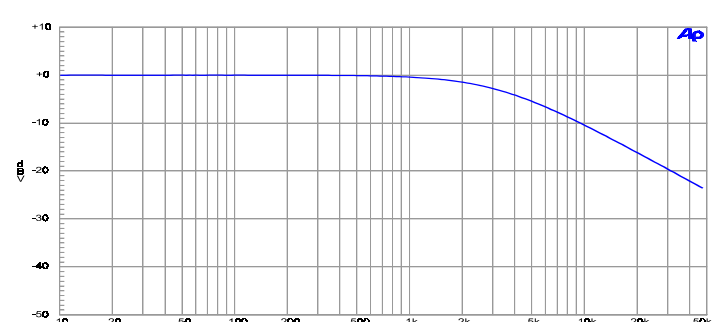
FIL-RCR 200 Hz to 15 kHz with 19 kHz (FM) notch Receiver Testing Filter



FIL-D75 75 μsec De-emphasis Filter



FIL-IECR 20 Hz to 15 kHz with 15.625 kHz (PAL) notch Receiver Testing Filter



FIL-D50 50 μsec De-emphasis Filter

DSP ANALYSIS OF ANALOG SIGNALS

Available in SYS-2222 and SYS-2322 configurations only. The low bandwidth high resolution dual converters are optimized for applications up to 20 kHz and are available to convert input signals for use by the FFT, DSP, MLS, and Multitone audio analyzers. It contains a linear phase digital anti-alias filter that allows some degree of aliasing to occur near the pass-band edge (see Note 16). The higher bandwidth converter contains a 9-pole analog anti-alias filter optimized for general purpose applications up to 80 kHz and is available to the FFT analyzer.

Low Bandwidth (x1 or +4) Converter

Available for both FFT and DSP Audio Analyzers

| | |
|-------------------------------|---|
| A/D Resolution | 20 bits |
| Sample Rates | x1 mode: 28.8 ks/sec to 52.8 ks/sec +4 mode: 7.2 ks/sec to 13.2 ks/sec |
| Flatness (1 kHz ref) | ±0.01 dB to 0.45 * sample rate |
| Alias Rejection ¹⁶ | Typically >100 dB for out of band signals above 0.605 * sample rate |
| Distortion | -100 dB (relative to full scale of analyzer range) |

High Bandwidth (x4) Converter

Input Converter available for FFT Analyzer

| | |
|----------------------------|---|
| A/D Resolution | 16 bits |
| Sample Rates ¹⁷ | 192 ks/sec to 200 ks/sec |
| Flatness (1 kHz ref) | |
| 10 Hz-20 kHz | ±0.05 dB |
| 20 kHz-65 kHz | ±0.10 dB |
| 65 kHz-80 kHz | ±0.30 dB |
| Alias Rejection | ≥75 dB |
| Distortion | -85 dB, 10 Hz – 20 kHz (relative to full scale of analyzer range) |

Note 16 From converter manufacturer's data. Rejection near the band edge is typically -80 dB at 0.600*sr decreasing to -44 dB at 0.58*sr, -26 dB at 0.56*sr, and -3 dB at 0.50*sr.

Note 17 Usable at lower sample rates with degraded alias rejection.

FFT Analyzer ("FFT.AZ2")

| | |
|-----------------------------------|---|
| Acquisition Length | 256 – 16384 samples in binary steps; or 24,576 samples |
| Transform Length | 256 – 16384 samples in binary steps |
| Processing | 48 bit |
| Windows (see graph on page 15) | Blackman-Harris (4 term with -92 dB sidelobe) Hann Flat-top (±0.02 dB) Equi-ripple (-145 dB sidelobes) None None, sync to sine |
| Amplitude Accuracy | ±0.1 dB, 20 Hz – 20 kHz, using Flat-top window |
| Averaging | 1 – 4096 in binary steps, averaging algorithm is power (spectrum only) or synchronous |
| Waveform Display Modes | Normal, interpolate, peak, max |
| Frequency Display Modes | Peak pick, individual bin |
| Sync to Sine Window | |
| Frequency Range | 7 th bin to 45% of sample rate (21.6 kHz at 48 ks/sec) |
| Amplitude Accuracy | ±0.025 dB |

DSP Audio Analyzer ("ANALYZER.AZ2")

Wideband Level/Amplitude

| | |
|-------------------|---|
| Frequency Range | 5 Hz – 22.0 kHz at 48 ks/sec |
| High pass Filters | <10 Hz, 4-pole Butterworth 22 Hz, 4-pole Butterworth |

100 Hz, 4-pole Butterworth
400 Hz, 4-pole Butterworth
400 Hz, 10-pole elliptical *when not using notch filter or bandpass mode* (response is -120 dB for ≤220 Hz, ±0.1 dB for ≥400 Hz)

| | |
|-------------------|--|
| Low pass Filters | 20 kHz 6-pole elliptic low-pass 15 kHz, 6-pole elliptic low-pass <i>both: 0.1dBpp ripple, ≥110 dB stopband attenuation</i> |
| Weighting Filters | ANSI-IEC "A" weighting, Type 0 CCIR QPk per CCIR Rec 468 CCIR RMS per AES 17 C-message per IEEE Std 743-1978 CCITT per CCITT Rec. P.53 "F" weighting corresponding to 15 phon loudness contour (see graph on page 12) |

Narrow Band Amplitude

| | |
|-----------------|--|
| Frequency Range | 0.02% to 40% of sample rate (10 Hz-19.2 kHz at 48.0 ks/sec) |
| Filter Shape | 10-pole, Q=19 (BW = 5.3% of f ₀) (see graph page 15) |

THD+N Measurements

| | |
|-------------------|---|
| Fundamental Range | 0.02% to 45% of sample rate (10 Hz – 22.0 kHz at 48.0 ks/sec) |
| High pass Filters | <10 Hz, 4-pole Butterworth 22 Hz, 4-pole Butterworth 100 Hz, 4-pole Butterworth 400 Hz, 4-pole Butterworth |
| Low pass Filters | 20 kHz, 6-pole elliptic low-pass 15 kHz, 6-pole elliptic low-pass <i>both: 0.1dBpp ripple, ≥110 dB stopband attenuation</i> |
| Weighting Filters | ANSI-IEC "A" weighting, per IEC Rec 179 CCIR QPk per CCIR Rec 468 CCIR RMS per AES 17 C-message per IEEE Std 743-1978 CCITT per CCITT Rec. P.53 "F" weighting corresponding to 15 phon loudness contour (see graph on page 12) |

Frequency Measurements

| | |
|------------|---|
| Range | 5 Hz to 47% of sample rate (5 Hz – 21.0 kHz at 44.1 ks/sec) (5 Hz – 23.0 kHz at 48.0 ks/sec) |
| Accuracy | ±0.01% of reading or 0.0001% of sample rate, whichever is greater |
| Resolution | 0.003% of reading or 0.0001% of sample rate, whichever is greater |

Maximum Length Sequence Analyzer ("MLS.AZ2") Quasi-anechoic acoustic tester

| | |
|---|--|
| Signals | Four pink sequences, four white sequences |
| Frequency Range | 22 Hz to 20 kHz |
| Frequency Resolution (Max) | 2.93 Hz at 48.0 ks/sec |
| Acquisition Length | 32767 samples |
| FFT Length | 16384 |
| Energy Time Windows | half Hann Hann <240 Hz > 8 kHz <120 Hz > 16 kHz |
| Time Windows (percent of data record to transition from 0 to full amplitude) | <5% <10% <20% <30% |

Multitone Analyzer ("FASTTEST.AZ2")

| | |
|----------------------------------|---|
| Acquisition Length | 512 – 16384 samples in binary steps |
| Transform Length | 512 – 16384 samples in binary steps |
| Processing | 24 bit |
| Measurements | Level vs frequency, Total distortion vs frequency, Noise vs frequency, Phase vs frequency, Crosstalk vs frequency, Masking curve |
| Frequency Resolution | 1.95 Hz with 32.0 ks/sec 2.69 Hz with 44.1 ks/sec 2.93 Hz with 48.0 ks/sec |
| Frequency Error Correction Range | ±3% |
| Distortion | ≤-115 dB |

DIGITAL SIGNAL GENERATOR

Available in the SYS-2300 and SYS-2322 configurations only. The System Two digital generator consists of a DSP signal generator, selectable pre-emphasis filters, two hardware dither generators, and several digital output stages supporting the most popular formats.

All digitally-generated sine variants, MLS, and IMD signals for the digital domain outputs are independently generated and may be selected simultaneously but independently from the concurrently available digital signals for the analog domain via the D to A converter outputs.

DIGITAL OUTPUT CHARACTERISTICS

| | |
|------------------------|---|
| Output Formats | AES/EBU (per AES3-1992) SPDIF-EIAJ Optical (Toslink®) General purpose serial General purpose parallel Serial interface to chip level via optional SIA-2322 accessory |
| Sample Rates | 28.8 kHz – 52.8 kHz AES/EBU, general purpose serial; 8 kHz to 52.8 kHz parallel, SIA-2322; independent from input sample rate |
| Sample Rate Resolution | 1/128 Hz (approx. 0.0078 Hz) |
| Sample Rate Accuracy | ±0.0002% [±2 PPM] using internal reference, lockable to external reference |
| Word Width | 8 to 24 bits |
| Output impedance | |
| Balanced (XLR) | 110Ω |
| Unbalanced (BNC) | approx. 75Ω |

DIGITAL SIGNAL GENERATION

Sine Wave

| | |
|----------------------|---|
| Frequency Range | 10 Hz to 47% of sample rate (22.56 kHz at 48 ks/sec) |
| Frequency Resolution | Sample Rate ÷ 2 ²³ (typically 0.006 Hz at 48 ks/sec) |
| Flatness | ±0.001 dB |
| Residual Distortion | ≤0.00001% [-140 dB] |

Sine Burst

Sine burst with rectangular envelope

| | |
|----------------------|---|
| Frequency Range | 10 Hz to 47% of sample rate (22.56 kHz at 48 ks/sec) |
| Frequency Resolution | Sample Rate ÷ 2 ²³ (typically 0.006 Hz at 48 ks/sec) |
| Interval | 2 – 65536 cycles |
| Burst On | 1 to number of Interval cycles minus 1 |
| Flatness | ±0.001 dB |
| Residual Distortion | ≤0.00001% [-140 dB] |

Variable Phase Sine Wave

Two sine waves, same frequency, independently settable phase

| | |
|----------------------|---|
| Frequency Range | 10 Hz to 47% of sample rate (22.56 kHz at 48 ks/sec) |
| Frequency Resolution | Sample Rate ÷ 2 ²³ (typically 0.006 Hz at 48 ks/sec) |
| Phase Range | ±180° |
| Phase Resolution | 0.01° |
| Flatness | ±0.001 dB |
| Residual Distortion | ≤0.00001% [-140 dB] |

Stereo Sine Wave

Sine wave of independent frequency and amplitude on each channel

| | |
|----------------------|--|
| Frequency Range | 10 Hz to 47% of sample rate (22.56 kHz at 48 ks/sec) Stereo frequencies may be set independently for each channel |
| Frequency Resolution | Sample Rate ÷ 2 ²³ (typically 0.006 Hz at 48 ks/sec) |
| Flatness | ±0.001 dB |
| Residual Distortion | ≤0.00001% [-140 dB] |

Dual Sine Wave

Twin sine waves of independent frequency and settable amplitude ratio; applied to both output channels

| | |
|----------------------|---|
| Frequency Range | 10 Hz to 47% of sample rate (22.56 kHz at 48 ks/sec) |
| Frequency Resolution | Sample Rate ÷ 2 ²³ (typically 0.006 Hz at 48 ks/sec) |
| Flatness | ±0.001 dB |
| Residual Distortion | ≤0.00001% [-140 dB] |
| Amplitude ratio | 0 dB to -120 dB |

Sine + Offset

Sine wave plus a constant value

| | |
|----------------------|---|
| Frequency Range | 10 Hz to 47% of sample rate (22.56 kHz at 48 ks/sec) |
| Frequency Resolution | Sample Rate ÷ 2 ²³ (typically 0.006 Hz at 48 ks/sec) |
| Offset Amplitude | Sinewave amplitude + offset amplitude ≤ 100% FS |
| Flatness | ±0.001 dB |
| Residual Distortion | ≤0.00001% [-140 dB] |

Shaped Sine Burst

Sine burst with raised cosine envelope (see graph on page 12)

| | |
|----------------------|---|
| Frequency Range | 10 Hz to 47% of sample rate (22.56 kHz at 48 ks/sec) |
| Frequency Resolution | Sample Rate ÷ 2 ²³ (typically 0.006 Hz at 48 ks/sec) |
| Interval | 2 - 65536 cycles |
| Burst On | 1 to number of Interval cycles minus 1 |
| Flatness | ±0.001 dB |
| Residual Distortion | ≤0.00001% [-140 dB] |

Square Wave

| | |
|-----------------------|---|
| Frequency Range | 10 Hz to 1/6 sample rate (7350 Hz at 44.1 ks/sec, 8000 Hz at 48 ks/sec) |
| Frequencies available | $f_s \div 4096$ to $f_s \div 6$, in even integer divisors |
| Even Harmonic Content | $\leq 0.00001\%$ [-140 dB] |

SMPT/DIN Waveform

| | |
|----------------------------|---|
| Upper Tone Frequency Range | 2 kHz to 47% of sample rate (22.56 kHz at 48 ks/sec) |
| Lower Tone Frequency Range | 40 Hz-500 Hz |
| Frequency Resolution | Sample Rate $\div 2^{23}$ (typically 0.006 Hz at 48 ks/sec) |
| Flatness | ± 0.001 dB |
| Amplitude Ratio | 1:1 to 10:1 [0 to 20 dB] (LF:HF) |
| Residual Distortion | $\leq 0.00001\%$ [-140 dB] at 4:1 ratio |

CCIF and DFD IMD Waveforms

| | |
|------------------------|---|
| Center Frequency Range | 3000 Hz to (47% of sample rate - 1/2 IM frequency) (22.51 kHz at 48 ks/sec; 20.67 kHz at 44.1 ks/sec) |
| IM Frequency Range | 80 Hz-2000 Hz |
| Frequency Resolution | Sample Rate $\div 2^{23}$ (typically 0.006 Hz at 48 ks/sec) |
| Flatness | ± 0.001 dB |
| Residual Distortion | $\leq 0.00001\%$ [-140 dB] |

DIM IMD Waveform

| | |
|--------------------------------|---|
| Sine wave Frequency | 100/21 * squarewave frequency (15 kHz at 44.1 ks/sec; 14285.7 Hz at 48 ks/sec) |
| Sine wave Frequency Resolution | Data Rate $\div 2^{23}$ (typically 0.006 Hz at 48 ks/sec) |
| Square wave Frequency | sample rate < 35 ks/sec 1/10 sample rate 35 ks/sec to 42 ks/sec 1/12 sample rate 42 ks/sec to 46 ks/sec 1/14 sample rate (3150 Hz at 44.1 ks/sec) |
| | ≥ 46 ks/sec 1/16 sample rate (3000 Hz at 48 ks/sec) |
| Amplitude Ratio | 4:1 (squarewave:sinewave) |
| Residual Distortion | $\leq 0.00001\%$ [-140 dB] |
| Frequencies available | $f_s \div 4096$ to $f_s \div 6$, in even integer divisors |
| Even Harmonic Content | $\leq 0.00001\%$ [-140 dB] |

Noise

| | |
|-------|---------------------------|
| Types | Pink, White, Burst, USASI |
|-------|---------------------------|

Special Signals

| | |
|----------------|--|
| Monotonicity | Low level staircase waveform for D/A linearity testing |
| J-Test | Produces a maximum amount of data-induced jitter on low-bandwidth transmission links |
| Polarity | Two sinewaves phased for reinforcement with normal polarity |
| Walking Ones | A single binary one value "walked" from LSB to MSB |
| Walking Zeros | A single binary zero value "walked" from LSB to MSB |
| Constant Value | (Digital DC) |
| Resolution | 32 bit when using triangular dither |

Maximum Length Sequence Signals

Pseudo random noise signal for speaker testing with MLS analyzer (Page 14)

| | |
|-----------------|---|
| Signals | Four pink sequences, four white sequences |
| Frequency Range | DC to 50% of sample rate |
| Repetition Rate | 32767 samples |

Multitone Signals

Stored waveform consisting of multiple sine waves, each at independent frequency, amplitude, and phase

| | |
|----------------------|--|
| Number of Tones | 1 to 128 typical, 4095 maximum |
| Frequency Range | DC to $f_s \div 2$ |
| Frequency Resolution | Sample Rate $\div 2^{13}$ (typically 5.86 Hz at 48 ks/sec) |
| Flatness | ± 0.001 dB |
| Residual Distortion | $\leq 0.00001\%$ [-140 dB] |

Arbitrary Waveforms

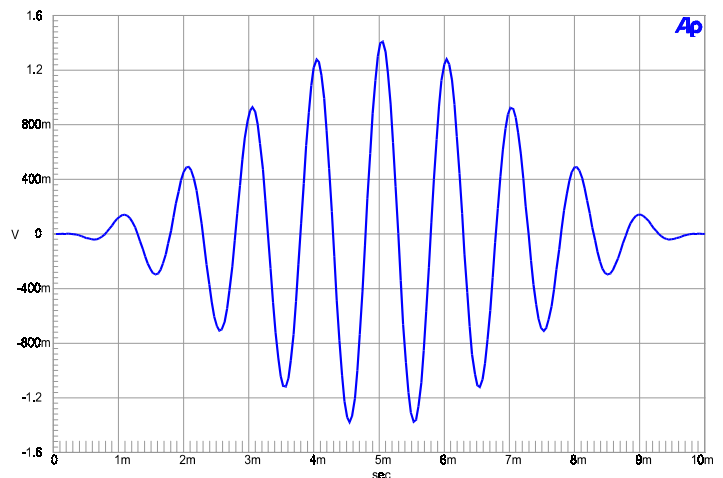
| | |
|--------|---|
| Length | 256-8192 points per channel, user specified waveform. Utility is provided to prepare a time record file from user specified frequency, amplitude, and phase data. |
|--------|---|

Dither (all waveforms)

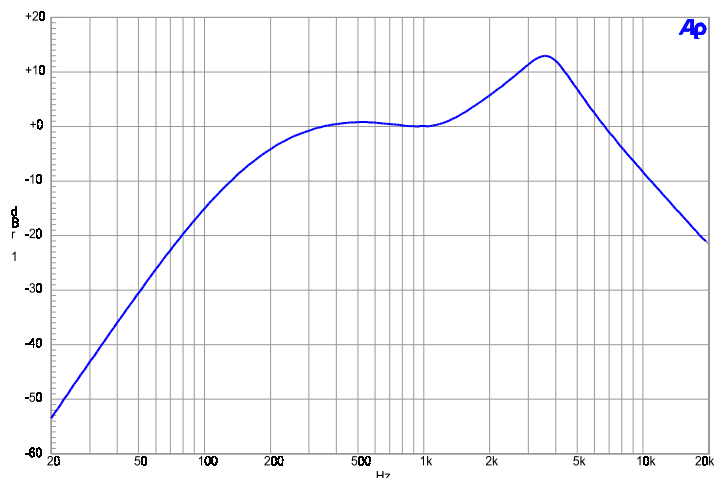
| | |
|--------------------------|--|
| Probability Distribution | Triangular or rectangular; true random; independent for each channel |
| Spectral Distribution | Flat (white) or Shaped (+6 dB/oct) |
| Amplitude | 8-24 bit or off |

Pre-Emphasis Filters (all waveforms)

| | |
|---------------------|--|
| Filter Shape | 50/15 μ s or J17 |
| Response Accuracy | ± 0.02 dB 10 Hz to 45% sample rate |
| Residual Distortion | $\leq 0.00003\%$ [-130 dB] |



Shaped Sine Burst signal. (1 kHz, 10 cycles)



Digital Analyzer F-weighting curve

AES/EBU INTERFACE GENERATION

Interface Signal

| | |
|---------------------|--|
| Amplitude Range | (Fixed RISE/FALL time) |
| Balanced (XLR) | 0 – 10.16 Vpp, $\pm(10\% + 80 \text{ mV})$ into 110 Ω in 40 mV steps |
| Unbalanced (BNC) | 0 to 2.54 Vpp, $\pm(8\% + 20 \text{ mV})$ into 75 Ω in 10 mV steps |
| Optical (Toslink®) | 0 to 256% of nominal intensity in 1% steps |
| Channel Status Bits | Full implementation, English language decoded, Pro or consumer or hex formats; independent in each channel |
| User Bits | set to 0 |
| Validity Flag | selectable, set or cleared |

AES/EBU Impairments

| | |
|-------------------------------------|--|
| Variable rise/fall time | 16 ns to 400 ns, $\pm 20\%$ |
| Induced Jitter | Selectable sinewave, squarewave lowpass noise, or wideband noise |
| Jitter Freq Range | 10 Hz – 99.864 kHz |
| Jitter Freq Accuracy | $\pm 0.0002\%$ [± 2 PPM] |
| Jitter Amplitude | 0 – 1.27 UI (pk), $\pm(10\% + 0.01 \text{ UI})$ in 0.005 UI steps 1.3 – 12.7 UI, $\pm(10\%)$ in 0.05 UI steps ¹⁸ |
| Jitter Flatness (500 Hz ref.) | ± 1 dB, 50 Hz to 20 kHz |
| Residual Jitter, peak calibrated | (total generator/analyzer) |
| Average response | ≤ 0.0175 UI (120 Hz – 100 kHz BW), ≤ 0.0035 UI (1.2 kHz – 100 kHz BW) |
| Peak response: | ≤ 0.045 UI (120 Hz – 100 kHz BW), ≤ 0.015 UI (1.2 kHz – 100 kHz BW) |
| Spurious Jitter Products | |
| Jitter & Ref Delay Off | ≤ 0.001 UI |
| Jitter On | ≤ -30 dB below jitter signal |
| Normal Mode Noise | |
| Balanced | 0 – 2.55 Vpp, $\pm(10\% + 100 \text{ mV})$, in 10 mV steps |
| Unbalanced | 0 – 635 mVpp, $\pm(10\% + 25 \text{ mV})$, in 2.5 mV steps |
| Common Mode Freq | 20 Hz to 40 kHz in octave steps |
| Common Mode Ampl | 0 – 20.48 Vpp, $\pm(10\% + 200 \text{ mV})$, in 80 mV steps |
| Cable Simulation | Multi-pole fit to AES 3-1992 filter to simulate the response degradation of a typical long cable |
| Offset from reference | -64 to +63.5 UI |

Note 18 Combinations of jitter amplitude and frequency may not result in greater than 50% reduction in transmitted bit width.

REFERENCE INPUT CHARACTERISTICS

A rear panel reference input is provided to synchronize the internal sample clock generator to an external signal. The internal sample rate is not dependent upon the rate or characteristics of the external reference. Reference input jitter below 5 Hz will pass to the output; jitter above 5 Hz is attenuated 6 dB/octave.

| | |
|--|--|
| Input Formats | AES/EBU (per AES 3-1992), NTSC/PAL/SECAM video, or squarewave |
| Input Sample Rates/ Frequency Range | 28.8 kHz – 52.8 kHz AES/EBU, 8.0 kHz – 10.0 MHz squarewave |
| Sample Rate Resolution | |
| 8 kHz – 65 kHz | 1/128 Hz [0.0078125 Hz] |
| 65 kHz – 256 kHz | 1/32 Hz [0.03125 Hz] |
| 256 kHz – 1 MHz | 1/8 Hz [0.125 Hz] |
| 1 MHz – 4 MHz | 1/2 Hz [0.5 Hz] |
| 4 MHz – 10 MHz | 2 Hz |

| | |
|---------------------------------------|--|
| Minimum Input Amplitude | 200 mVpp |
| Input Impedance | |
| AES/EBU (XLR) | Nominally 110 Ω or $>5 \text{ k}\Omega$ |
| Video (BNC) | Nominally 75 Ω or $>5 \text{ k}\Omega$ |
| Square wave (BNC) | Nominally 75 Ω or $>5 \text{ k}\Omega$ |
| Lock Range | $\pm 0.0015\%$ [± 15 PPM] |
| Input Delay from Reference Display | Measures delay from 0 to 127.9 UI in seconds, ± 60 ns |
| Reference Rate Display | Measures approximate reference input rate |

REFERENCE OUTPUT CHARACTERISTICS

A rear panel reference output is provided to drive devices under test that require their own reference input. The reference output signal is not jittered.

| | |
|---------------------------------------|--|
| Output Format | AES/EBU (per AES 11-1994) |
| Output Sample Rates | 28.8 kHz – 52.8 kHz AES/EBU; locked to front panel output |
| Status Bits | Format "Professional" Sample Rate indicates closest rate Type "Grade 2 reference" Origin "SYS2" Reliability flags implemented CRCC implemented Time of Day not implemented Sample Count not implemented |
| Output Delay from Reference Output | -64/+63.5 UI, $\pm(5\% + 0.5 \text{ UI})$, in 0.5 UI steps |
| Residual jitter | ≤ 0.005 UI pk (120Hz – 100 kHz) |

DIGITAL ANALYZER

Available in the SYS-2300 and SYS-2322 configurations only.

DIGITAL INPUT CHARACTERISTICS

| | |
|-----------------|---|
| Input Formats | AES/EBU (per AES 3-1992) SPDIF-EIAJ Optical (Toslink®) General purpose serial General purpose parallel Serial interface to chip level via optional SIA-2322 accessory |
| Sample Rates | 28.8 kHz-52.8 kHz AES/EBU, 8 kHz to 52.8 kHz parallel, general purpose serial, SIA-2322; independent from sample rate |
| Word Width | 8 to 24 bits |
| Input impedance | |
| AES/EBU | 110 Ω or $\geq 2.5 \text{ k}\Omega$ |
| SPDIF-EIAJ | 75 Ω or $\geq 3 \text{ k}\Omega$ |

EMBEDDED AUDIO MEASUREMENTS

Wideband Level/Amplitude ("ANALYZER.AZ2")

| | |
|-------------------|---|
| Range | 0 dBFS to -140 dBFS |
| Frequency Range | 5 Hz – 22.0 kHz at 48 ks/sec |
| Accuracy | ± 0.01 dB, ≥ -90 dBFS |
| Flatness | ± 0.01 dB, 15 Hz – 22 kHz, with <10 Hz high-pass filter selection |
| High pass Filters | <10 Hz, 4-pole Butterworth 22 Hz, 4-pole Butterworth 100 Hz, 4-pole Butterworth 400 Hz, 4-pole Butterworth |

| | |
|-------------------|---|
| | 400 Hz, 10-pole elliptical <i>when not using notch filter or bandpass mode</i> (response is -120 dB for ≤ 220 Hz, ± 0.1 dB for ≥ 400 Hz) |
| Low pass Filters | 20 kHz 6-pole elliptic low-pass 15 kHz, 6-pole elliptic low-pass |
| Weighting Filters | ANSI-IEC "A" weighting, Type 0 CCIR QPk per CCIR Rec 468 CCIR RMS per AES 17 C-message per IEEE Std 743-1978 CCITT per CCITT Rec. P.53 "F" weighting corresponding to 15 phon loudness contour (<i>see graph on page 12</i>) |
| Residual Noise | -140 dBFS unweighted -142 dBFS A-weighted -134 dBFS CCIR RMS -127 dBFS CCIR QPk -139 dBFS 20 kHz LP -140 dBFS 15 kHz LP -138 dBFS "F" weighting |

Narrow Band Amplitude ("ANALYZER.AZ2")

| | |
|---------------------|--|
| Frequency Range | 0.02% to 40% of sample rate (10 Hz – 19.2 kHz at 48.0 ks/sec) |
| Filter Shape | 10-pole, Q=19 (BW = 5.3% of f_0) (<i>see graph page 15</i>) |
| Residual Distortion | ≤ -150 dBFS |

THD+N Measurements ("ANALYZER.AZ2")

| | |
|-------------------|---|
| Fundamental Range | 0.02% to 45% of sample rate (10 Hz – 22.0 kHz at 48.0 ks/sec) |
| Residual THD+N | ≤ -130 dBFS (<i>see graph on page 15</i>) |
| High pass Filters | <10 Hz, 4-pole Butterworth 22 Hz, 4-pole Butterworth 100 Hz, 4-pole Butterworth 400 Hz, 4-pole Butterworth |
| Low pass Filters | 20 kHz, 6-pole elliptic low-pass 15 kHz, 6-pole elliptic low-pass <i>both: 0.1 dBpp ripple, ≥ 110 dB stopband attenuation</i> |
| Weighting Filters | ANSI-IEC "A" weighting, Type 0 CCIR QPk per CCIR Rec 468 CCIR RMS per AES 17 C-message per IEEE Std 743-1978 CCITT per CCITT Rec. P.53 "F" weighting corresponding to 15 phon loudness contour (<i>see graph on page 12</i>) |
| Residual Noise | Same as Wideband Level/Amplitude |

Frequency Measurements ("ANALYZER.AZ2")

| | |
|------------|--|
| Range | 5 Hz to 47% of sample rate (5 Hz – 21.0 kHz at 44.1 ks/sec) (5 Hz – 23.0 kHz at 48.0 ks/sec) |
| Accuracy | $\pm 0.01\%$ of reading or 0.0001% of sample rate, whichever is greater |
| Resolution | 0.003% of reading or 0.0001% of sample rate, whichever is greater |

FFT Analyzer ("FFT.AZ2")

| | |
|--|--|
| Acquisition Length | 256 – 16384 samples in binary steps; or 24,576 samples |
| Transform Length | 256 – 16384 samples in binary steps |
| Processing | 48 bit |
| Windows (<i>see graph on page 15</i>) | Blackman-Harris (4 term with -92 dB sidelobe) Hann Flat-top (± 0.02 dB) |

| | |
|-------------------------|---|
| | Equi-ripple (-145 dB sidelobes) None None, sync to sine |
| Amplitude Accuracy | ± 0.02 dB, 20 Hz to 20 kHz, using Flat-top window |
| Averaging | 1 – 4096 in binary steps, averaging algorithm is power based or synchronous |
| Distortion | ≤ -140 dB |
| Waveform Display Modes | Normal, interpolate, peak, max |
| Frequency Display Modes | Peak pick, individual bin |
| Sync to Sine Window | |
| Frequency Range | 7 th bin to 45% of sample rate (21.6 kHz at 48 ks/sec) |
| Amplitude Accuracy | ± 0.025 dB |

Multitone Analyzer ("FASTTEST.AZ2")

| | |
|----------------------------|---|
| Acquisition Length | 512 – 16384 samples in binary steps |
| Transform Length | 512 – 16384 samples in binary steps |
| Processing | 24 bit |
| Measurements | Level vs frequency, Total distortion vs frequency, Noise vs frequency, Phase vs frequency, Crosstalk vs frequency, Masking curve |
| Frequency Resolution | 1.95 Hz with 32.0 ks/sec 2.69 Hz with 44.1 ks/sec 2.93 Hz with 48.0 ks/sec |
| Frequency Error Correction | $\pm 3\%$ |
| Range | |
| Distortion | ≤ -115 dB |

Maximum Length Sequence Analyzer ("MLS.AZ2")

Quasi-anechoic acoustic tester

| | |
|----------------------------|--|
| Signals | Four pink sequences, four white sequences |
| Frequency Range | 22 Hz to 20 kHz |
| Frequency Resolution (Max) | 2.93 Hz at 48.0 ks/sec |
| Acquisition Length | 32767 samples |
| FFT Length | 16384 |
| Energy Time Windows | half Hann Hann <240 Hz > 8 kHz <120 Hz > 16 kHz |
| Time Windows | <5% (percent of data record to transition from 0 to full amplitude) |
| | <10% <20% <30% |

DIGITAL INTERFACE MEASUREMENTS

AES/EBU Impairments, real time displays

| | |
|---------------------------|--|
| Input Sample Rate | $\pm 0.0003\%$ [± 3 PPM] internal ref, $\pm 0.0001\%$ [± 1 PPM] external ref |
| Output to Input Delay | Measures status propagation from the AES/EBU output to the input. Range is 0 – 192 samples (frames), resolution ± 60 ns. |
| AES/EBU Input Voltage | |
| Balanced | 100 mV to 10.16 Vpp, $\pm(5\% + 50$ mV) |
| Unbalanced | 25 mV to 2.54 Vpp, $\pm(5\% + 12$ mV) |
| Jitter Amplitude (500 Hz) | (peak sinewave calibrated) |
| Average Mode | 0 – 5 UI, $\pm(10\% + 0.015$ UI) |
| Peak Mode | 0 – 3 UI, $\pm(10\% + 0.040$ UI) |
| Jitter Flatness | ± 1.0 dB, 100 Hz – 80 kHz (50 Hz – 100 kHz BW selection, average detection, 48 kHz sample rate) |

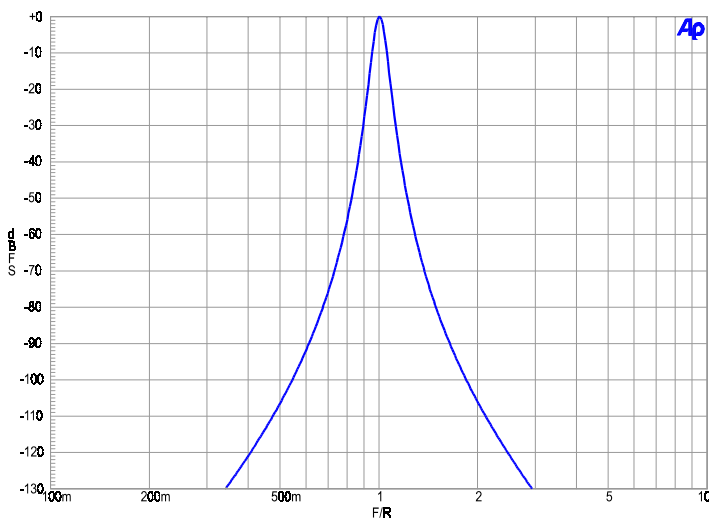
| | |
|--|--|
| Residual Jitter, peak calibrated (analyzer only) | |
| Average response | ≤0.015 UI (120 Hz – 100 kHz BW), ≤0.003 UI (1.2 kHz – 100 kHz BW) |
| Peak response | ≤0.04 UI (120 Hz – 100 kHz BW), ≤0.009 UI (1.2 kHz – 100 kHz BW) |
| Spurious Jitter Products | ≤0.002 UI (>1.2 kHz) or <-40 dB below jitter signal |
| Common Mode Amplitude | 0-20.48 Vpp, ±(10% + 300 mV), 315 Hz – 1 MHz, peak reading |
| Cable Equalization | Per AES 3-1992 |
| Channel Status Bits | Full implementation, English language decoded (Professional or Consumer) or hex formats, independent in each channel |
| User Bits | Not displayed |
| Validity Flag | Displayed for each channel |
| Parity | Displayed for total signal (both channels combined) |
| Signal Confidence | Displayed for total signal (both channels combined) |
| Receiver Lock | Displayed for total signal (both channels combined) |
| Coding Error | Displayed for total signal (both channels combined) |

AES/EBU Interface Analyzer ("INTERVU.AZ2")

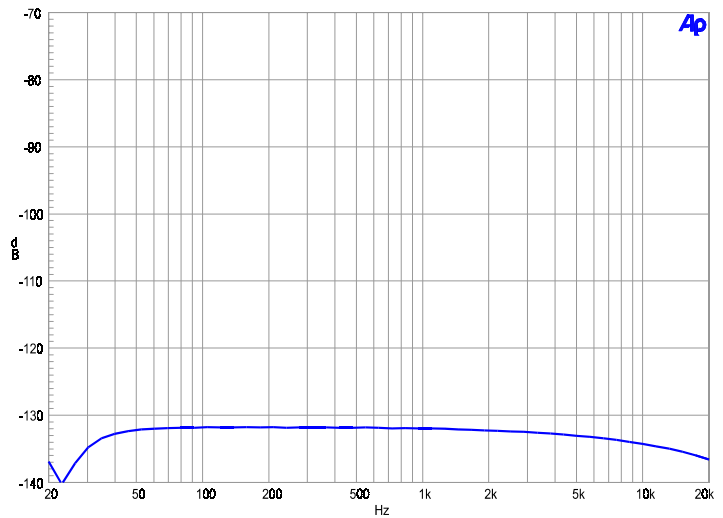
INTERVU operates in conjunction with an autoranged 8-bit A/D converter clocked at 67.108864 MHz, providing interface signal measurements with >20 MHz bandwidth. INTERVU can display the interface signal in time or frequency domain, as an eye pattern, or probability graphs of amplitude or pulse width. INTERVU also can demodulate the jitter signal and display it in time or frequency domain or as a probability graph. The jitter signal or the data on the interface may be reproduced through the monitor loudspeaker.

AES/EBU Input Voltage

| | |
|-------------------------------|---|
| Balanced | 0 – 20.48 Vpp, ±(10% + 50 mV) |
| Unbalanced | 0 – 4.096 Vpp, ±(8% + 12 mV) |
| Jitter Amplitude | 0 – 5 UI (pk), ±(5% + 0.03 UI) |
| Residual Jitter | ≤0.01 UI (250 Hz – 1 MHz BW) |
| Spurious Jitter Products | ≤0.001 UI, or ≤-60 dB below jitter signal |
| Common Mode Amplitude | 0 – 20.48 Vpp, ±(30% + 50 mV), 20 kHz – 1 MHz |
| Jitter Probability Display | 256 bins, autoranging |
| Input Probability Display | 256 bins, autoranging |
| Bit Width Probability Display | 8192 bins |
| Risetime | ≤20 ns |
| Acquisition time/memory | 3.9ms / 256k |



Digital Domain Band Pass filter response.



Typical Digital Domain system residual THD+N

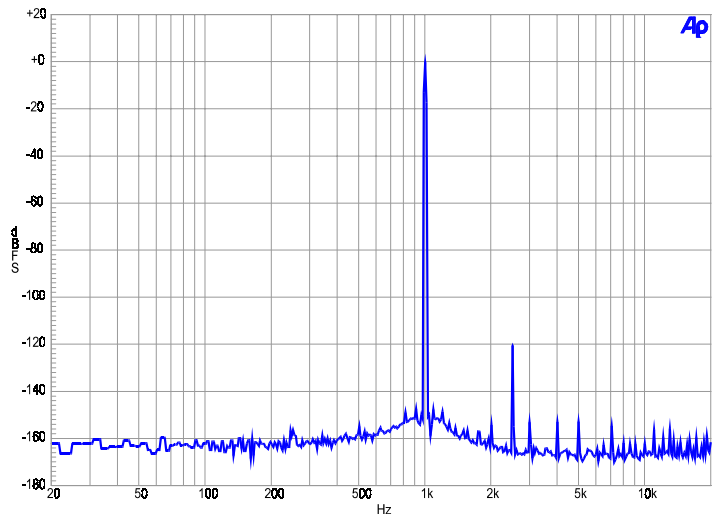
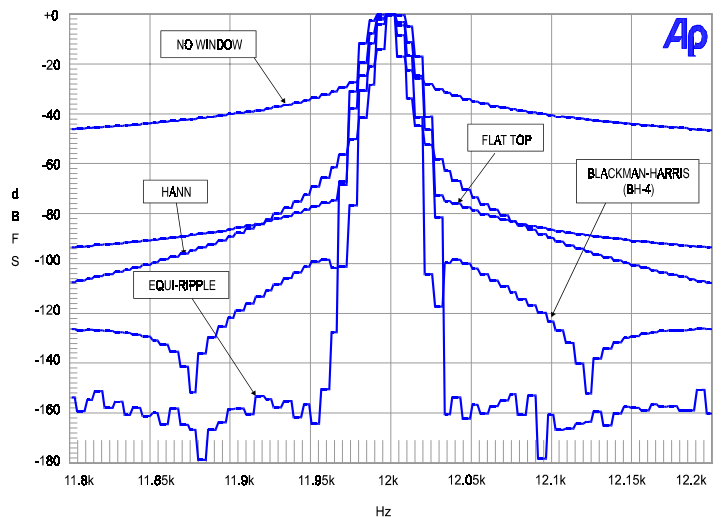


Illustration of typical Digital Domain FFT dynamic range. Signal is 0 dB 1 kHz with a secondary signal at -120 dB and 2.5 kHz. Harmonics of 1 kHz signal are visible at about -150 dB, consistent with 24-bit audio.



Windows available with FFT function

AUXILIARY SIGNALS

Generator Signal Monitors (all units except SYS-2300)

| | |
|-----------|--|
| Channel A | Buffered version of the channel A analog generator signal. Amplitude is typically 2.8 Vpp. |
| Channel B | Buffered version of the channel B analog generator signal. Amplitude is typically 2.8 Vpp. |

Generator Auxiliary Signals (all units except SYS-2300)

| | |
|-----------------|--|
| Sync Output | LSTTL compatible signal that is intended to be used as a trigger for stable oscilloscope displays. |
| Trig/Gate Input | LSTTL compatible input, functional with option "BUR" only. |

Analyzer Signal Monitors (all units except SYS-2300)

| | |
|-----------|--|
| Channel A | Buffered version of the channel A analog input signal. Amplitude is typically 0 – 3.6 Vpp. |
| Channel B | Buffered version of the channel B analog input signal. Amplitude is typically 0 – 3.6 Vpp. |
| Reading | Buffered version of the analog analyzer output signal after all filtering and gain stages. Amplitude is typically 0 – 3.6 Vpp. |

Digital Signal Monitors (SYS-2222 & SYS-2322 only)

Via stereo 16-bit D/A converters. Function monitored depends upon analyzer program loaded; for example, noise and distortion products after notch filter are monitored with "ANALYZER.AZ2" in its THD+N function.

| | |
|-----------|---|
| Channel 1 | Buffered version of the digital channel 1 signal. |
| Channel 2 | Buffered version of the digital channel 2 signal. |

Digital Interface Monitors (SYS-2322 & SYS-2300 only)

| | |
|---------------------|--|
| Transmit Frame Sync | Squarewave at the programmed internal sample rate |
| Receive Frame Sync | Squarewave at the rate of the received AES/EBU signal |
| Master Clock Out | Squarewave at 256 x the programmed internal sample rate. Selectable between jittered and unjittered signals. |

Miscellaneous Digital I/O (SYS-2322 & SYS-2300 only)

| | |
|------------------|---|
| Auxiliary Input | LSTTL compatible trigger input for dsp program data acquisition |
| Auxiliary Output | HCMOS signal, function under dsp program control |
| Trigger Output | HCMOS signal, pulse coincident with period of generated signal waveform |

AUDIO MONITOR

All System Two configurations contain an internal loudspeaker and headphone jack for listening to the generator, analyzer, or digital signal monitor points described at left, including noise and distortion following analog or digital notch filters or the AES/EBU jitter signal. Use of the audio monitor does not preclude the use of any measurements.

| | |
|--------------|------------------|
| Power Output | Typically 1 Watt |
|--------------|------------------|

GENERAL / ENVIRONMENTAL

| | |
|--------------------|---|
| Power Requirements | 100/120/230/240 Vac (-10%/+6%), 50 – 60 Hz, 240 VA max |
| Temperature Range | |
| Operating | 5°C to +40°C |
| Storage | -40°C to +75°C |
| Humidity | 90% RH to at least +40°C (non-condensing) |
| EMC ¹⁹ | Complies with 89/336/EEC, CISPR 22 (class B), and FCC 15 subpart J (class B) |
| Dimensions | 16.5 x 6.0 x 13.6 inches [41.9 x 15.2 x 34.5 cm] |
| Weight | Approximately 34 lbs [15.9 kg] |
| Safety | Complies with 73/23/EEC, 93/68/EEC, EN61010, and IEC 1010 (including Amendments 1 and 2) |

Note 19 The SYS-2300 and SYS-2322 configurations require high quality shielded cables when using any of the digital audio I/O ports. All XLR cables must be constructed with conductive shells that are connected to both pin 1 and the cable shield through the shortest distance possible.