System Two Cascade *Plus* Specifications

Cascade *Plus* with APWIN v 2.2x

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Specifications

Analog Signal Outputs

All System Two Cascade *Plus* configurations, except the SYS-2700, contain an ultra-low distortion analog sine wave generator and two independent transformer-coupled output stages.

The SYS-2622 and SYS-2722 configurations also contain a dual-channel D/A signal generator for enhanced capabilities. Option "BUR" adds analog-generated sine burst, square wave, and noise signals. Option "IMD" adds analog-generated IMD test signals.

Unless otherwise noted, all specifications are valid only for outputs ≥150 µVrms [420 µVpp].

Analog Output Characteristics

Source Configuration	Selectable balanced, unbalanced, or CMTST (common mode test)
Source Impedances	
Balanced or CMTST	40 Ω (±1 Ω), 150 Ω[1] (±1.5 Ω), or 600 Ω (±3 Ω)
Unbalanced	20 Ω (±1 Ω) or 600 Ω (±3 Ω)
Max Floating Voltage	42 Vpk (outputs are isolated from each other)
Output Current Limit	Typically >80 mA
Max Output Power into 600 Ω	
Balanced	+30.1 dBm (Rs = 40 Ω)
Unbalanced	+24.4 dBm (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 10 µV, whichever is greater

Low Distortion Sine Wave Generator

Frequency Range	10 Hz–204 kHz
Frequency Accuracy	
High-accuracy mode	±0.03%
Fast mode	±0.5%

[1] *200 Ω ±2 Ω with option "EURZ"*

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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[2]	
Balanced	<10 μV to 26.66 Vrms [+30.7 dBu]
Unbalanced	<10 μV to 13.33 Vrms [+24.7 dBu]
Amplitude Accuracy	±0.7% [±0.06 dB] at 1 kHz
Amplitude Resolution	0.003 dB or 0.05 μVrms, whichever is larger
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 THD+N[3,4]	
At 1 kHz	≤(0.00025% + 1.0 μV) [–112 dB], 22 kHz BW (valid only for analyzer inputs ≤8.5 Vrms)
20 Hz–20 kHz	≤(0.00032% + 1.0 μV) [–110 dB], 22 kHz BW ≤(0.0005% + 2.0 μV) [–106 dB], 80 kHz BW ≤(0.0010% + 5.0 μV) [–100 dB], 500 kHz BW
10 Hz–100 kHz	≤(0.0040% + 5.0 μV) [–88 dB], 500 kHz BW

Intermodulation Distortion Test Signals

with option "IMD"

SMPTE (or DIN)

LF Tone	40, 50, 60, 70, 100, 125, 250, or 500 Hz; all ±1.5%
HF Tone Range	2 kHz–200 kHz
Mix Ratio	4:1 or 1:1 (LF:HF)
Amplitude Range[5]	
Balanced	30 μVpp to 75.4 Vpp
Unbalanced	30 μVpp to 37.7 Vpp
Amplitude Accuracy	±2.0% [±0.17 dB]
Residual IMD[6]	0.0015% [–96.5 dB], 60+7 kHz or 250+8 kHz

[2] *20 Hz–50 kHz only. Decrease maximum output by a factor of 2 (–6.02 dB) for the full 10 Hz–204 kHz range.*

[3] *System specification measured with the Cascade Plus analog analyzer set to the indicated measurement bandwidth (BW). Generator amplitude setting must be ≤12 Vrms balanced or ≤6 Vrms unbalanced for specified performance below 30 Hz. At higher amplitude settings generator THD derates to 0.0020% from 20 Hz–30 Hz.*

[4] *Individual harmonics are typically <–130 dBc at 1 kHz, and <–120 dBc from 25 Hz to 20 kHz measured with a passive notch filter and FFT analyzer.*

[5] *Calibration with other amplitude units is based upon an equivalent sinewave having the same Vpp amplitude.*

[6] *System specification measured with the Cascade Plus analog analyzer at any amplitude ≥200 mVrms.*

CCIF and DFD

Difference Frequency	80, 100, 120, 140, 200, 250, 500 or 1 kHz; all ±1.5%
Center Frequency	4.5 kHz–200 kHz
Amplitude Range[5]	
Balanced	30 µVpp to 75.4 Vpp
Unbalanced	30 µVpp to 37.7 Vpp
Amplitude Accuracy	±3.0% [±0.26 dB]
CCIF Residual IMD[6]	≤0.0004% [–108 dB], 14 kHz+15 kHz (odd order & spurious typ <0.05%)
DFD Residual IMD[6]	≤0.0002% [–114 dB], 14 kHz+15 kHz (odd order & spurious typ <0.025%)

DIM (or TIM)

Squarewave Frequency	3.15 kHz (DIM-30 and DIM-100); 2.96 kHz (DIM-B); both ±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	±2.0% [±0.17 dB]
Residual IMD[5]	≤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 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 to 65535 cycles, or externally gated
Interval Range	2 to 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	±2.0% [±0.17 dB] at 400 Hz
Rise/fall time	Typically 2.0 µs

Noise Signals

White Noise	Bandwidth limited 10 Hz–23 kHz
Pink Noise	Bandwidth limited 20 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 Interval	Typically 262 ms (synchronized to the analyzer 4/s reading rate)
Amplitude Range[5]	(Approximate calibration only)
Balanced	30 µVpp to 37.7 Vpp
Unbalanced	30 µVpp to 18.8 Vpp

Graphs of Typical Analog Generator Performance

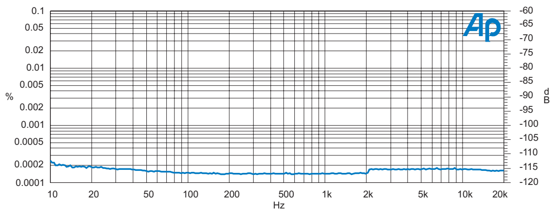

Figure 1. Typical system THD+N versus Frequency at 2 Vrms (analog sine)

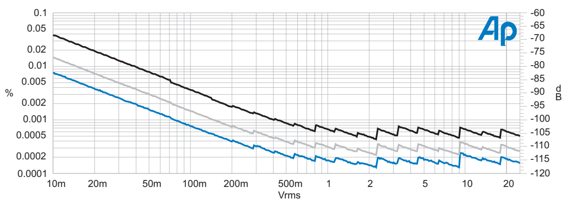

Figure 2. Typical system THD+N versus amplitude at 1 kHz. Lower trace is with 22 kHz bandwidth limiting. Middle trace is with 80 kHz. Upper trace is with 500 kHz.

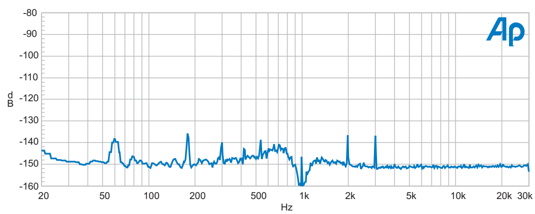

Figure 3. Typical residual THD+N spectrum at 1 kHz, 2 Vrms. (32768 point FFT of notch filter output, SR = 65.536 ks/s, 16 averages).

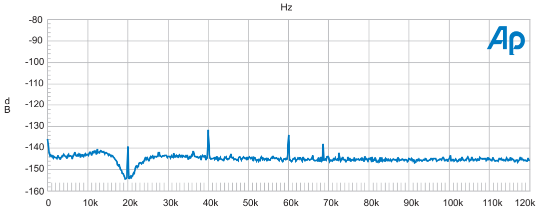

Figure 4. Typical residual THD+N spectrum at 20 kHz, 2 Vrms. (32768 point FFT of notch filter output, SR = 262 ks/s, 16 averages).

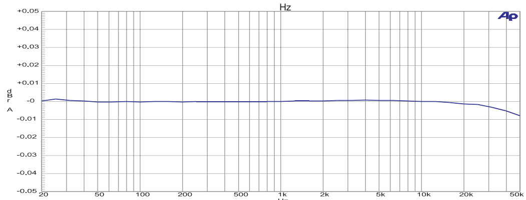

Figure 5. Typical analog system flatness at 2 Vrms signal level (measured with the analog analyzer's Level meter, dc input coupling)

D/A Generated Analog Signals

Available only in the SYS-2622 and SYS-2722 configurations. Except for arbitrary waveforms, the digitally-generated analog signals and the digital output signals are independently selectable and concurrently available. If both analog and digital outputs are selecting Arbitrary Waveform, it must be the same one.

Common Specifications

Sample Rate (SR)	
Sine, IMD signals	fixed at 65.536 ks/s or 131.072 ks/s
Other signals	7.2 ks/s to 108 ks/s variable; or fixed at 65.536 ks/s or 131.072 ks/s
Frequency Accuracy	±0.0002% [2 PPM] internal reference, lockable to external reference
D/A Resolution	24-bit sigma-delta

"SINE (D/A)" Signal Family

The Sine family includes "Normal," "Var Phase," "Stereo," "Dual," "Shaped Burst," and "EQ Sine." Normal and EQ Sine produce a monaural signal with the best (lowest) residual THD+N performance. EQ Sine varies the amplitude in accordance with a selected EQ file. Var Phase produces the same sine wave in both channels but with settable phase offset. Stereo provides sine waves of independently settable frequency in each channel (phase is random if both frequencies are set equal). Dual produces a monaural test signal containing a mixture of two sine waves of independently settable frequency and amplitude ratio. Shaped Burst produces a monaural sine burst signal with a raised cosine amplitude envelope (see Figure 30 on page 25).

Frequency Ranges	10 Hz to 30 kHz (65.536 ks/s), or 10 Hz to 60 kHz (131.072 ks/s)
Frequency Resolution	Sample Rate ÷ 2^{23} [0.0078 Hz in the 30 kHz range]
Flatness (1 kHz ref)	
20 Hz–20 kHz	±0.01 dB
10 Hz–30 kHz	±0.03 dB
30 kHz–50 kHz	±0.10 dB (typically –0.5 dB at 60 kHz)
THD+N[7] (20Hz–20kHz)	
30 kHz range	0.0007% [–103 dB]
60 kHz range	0.0014% [–97 dB]
Variable Phase Range	–180.0 to +179.9 deg
Dual-Sine Ratio Range	0 dB to –100 dB, usable to –138 dB
Shaped Burst Interval	2 to 65536 cycles
Shaped Burst On Time	1 to (number of interval cycles minus 1)

[7] *System specification measured with the Cascade Plus analog analyzer set for a 22 kHz measurement BW.*

“IMD (D/A)” Signal Family

SMPTE/DIN Test Signal

LF Tone	40 Hz to 500 Hz
HF Tone	2.00 kHz to 50 kHz
Mix Ratio	4:1 or 1:1 (LF:HF)
Residual IMD[7]	≤0.0010% [–100 dB], 60/7 kHz or 250/8 kHz

CCIF/DFD Test Signal

Difference Frequency	80 Hz to 2 kHz
Center Frequency	4.50 kHz to >50 kHz
Residual CCIF IMD[8]	CCIF: ≤0.0004% [–108 dB], 14 kHz/15 kHz DFD: ≤0.0002% [–114 dB], 14 kHz/15 kHz

DIM Test Signal

Squarewave Frequency	3.15 kHz for DIM30 and DIM100; 2.96 kHz for DIMB
Sinewave Frequency	15.00 kHz for DIM30 and DIM100, 14.00 kHz for DIMB
Residual IMD[8]	≤0.0020% [–94 dB]

Other Signals

Arbitrary Waveform and Multitone ("Arb Wfm")

Signal	Determined by specified file name
Length	256 to 16384 points per channel. Utility is provided to prepare waveform from frequency, amplitude, and phase data.
Frequency Range	20 Hz to 47% of sample rate
Frequency Resolution	Sample rate ÷ Length [2.93 Hz at 48 ks/s and 16384 Length]
Maximum Number of Tones	(Length / 2) minus1 [8191 for Length = 16384]

Maximum Length Sequence ("MLS")

Sequences	Four pink, four white
Sequence Length	“32k” (32767) or “128k” (131071)
Frequency Range	10 Hz to 43% of sample rate, ±0.1 dB

Special Signals

Polarity	Sum of two sine waves phased for reinforcement with normal polarity.
Pass Thru	Passes the embedded audio signal from the rear panel Reference Input. Ratio of reference rate to output Sample Rate may not exceed 8:1.

[8] *System specification measured with the Cascade Plus analog analyzer at any voltage ≥200 mVrms.*

Squarewave

Frequency Range	20 Hz–20.0 kHz
Risetime	Typically 2.0 μs

Noise Signal

True random white

Analog Analyzer

All System Two Cascade Plus configurations, except SYS-2700, contain an input module with two independent auto-ranging input stages, each having its own level (rms) and frequency meters; a phase meter; plus a single channel multi-function analyzer module providing additional signal processing and gain stages. Standard analog analyzer functions include amplitude and noise (both wideband and selective), THD+N, and crosstalk.

The SYS-2622 and SYS-2722 configurations add dual-channel A/D converters for FFT and other special forms of analysis. Option “IMD” adds inter-modulation distortion measurement capability. Option “W&F” adds wow & flutter measurement capability.

Unless otherwise noted, all specifications assume dc coupling, rms detection, and auto-ranging operation.

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	200 kΩ / 95 pF (differential)
Unbalanced	100 kΩ / 185 pF
Terminations	Selectable 600 Ω or 300 Ω, each ±1%; 1 Watt [+30 dBm] maximum power
CMRR[9]	
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 μV, whichever is greater
20 kHz–100 kHz	≤ –126 dB or 2.5 μV, whichever is greater

Level Meter Related

Measurement Range	5 mV to 160 V for specified accuracy and flatness, usable to <100 μV
Resolution (full scale)[10]	
4/s and 8/s	1/40,000 [0.00022 dB]
16/s	1/20,000 [0.00043 dB]
32/s	1/10,000 [0.00087 dB]
64/s	1/5,000 [0.0017 dB]
128/s	1/2,500 [0.0035 dB]
Accuracy (1 kHz)	±0.5% [±0.05 dB]

9 Not valid below 50 Hz with ac coupling.

10 Resolution within a given range is equal to its full scale value multiplied by the fraction indicated for the selected reading rate. (Example: 40 mV input range reading resolution = 4 μV, using the 32/s reading rate). Numerical displays using a dB unit are rounded to the nearest 0.001 dB.

Flatness (1 kHz ref)[11]	
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)

Frequency Meter Related

Measurement Range	10 Hz–500 kHz
Accuracy	±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[12]	
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

Wideband Amplitude/Noise Function

Measurement Range	<1 μV to 160 Vrms
Accuracy (1 kHz)	±1.0% [±0.09 dB]
Flatness (1 kHz ref)[11]	
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	*see Figure 6*
LF –3 dB	<10 Hz, 22 Hz per IEC468 (CCIR), 100 Hz ±5% (3-pole), or 400 Hz ±5% (3-pole)

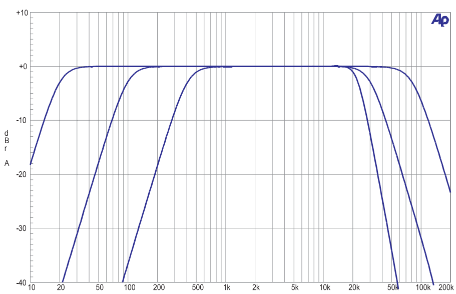

Figure 6. Typical responses of the standard band-limiting filters.

[11] *Derate flatness above 5 kHz by an additional ±0.02 dB in the 20 V, 40 V, 80 V, and 160 V input ranges.*

[12] *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.*

HF –3 dB	22 kHz per IEC468 (CCIR), 30 kHz ±5% (3-pole), 80 kHz ±5% (3-pole), or >500 kHz
Optional Filters	up to 7 *(see section on Option Filters)*
Detection	RMS (τ = 25 ms or 50 ms), Average, QPk per IEC468 (CCIR), Pk (pseudo-peak), or S-Pk (0.7071 × Pk reading)
Residual Noise	
22 Hz–22 kHz BW	≤1.0 μV [–117.8 dBu]
80 kHz BW	≤2.0 μV [–111.8 dBu]
500 kHz BW	≤6.0 μV [–103.8 dBu]
A-weighted	≤0.5 μV [–123.8 dBu]
CCIR-QPk	≤2.5 μV [–109.8 dBu]

Bandpass Amplitude Function

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

Bandreject Amplitude Function

Tuning Range (f_o)	10 Hz–200 kHz
Tuning Accuracy	±2%
Bandreject Response	typically –3 dB at 0.725 f_o & 1.38 f_o –20 dB at f_o ±10% –40 dB at f_o ±2.5%
Accuracy	±0.3 dB, 20 Hz–120 kHz (excluding 0.5 f_o to 2.0 f_o)

THD+N Function

Fundamental Range	10 Hz–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 filter selection also affects bandwidth)
Residual THD+N[13]	
At 1 kHz	≤(0.00025% + 1.0 μV) [–112 dB], 22 kHz BW

[13] *System specification measured with the Cascade Plus analog generator and the analog analyzer set to the indicated measurement bandwidth (BW). Generator amplitude setting must be ≤12 Vrms balanced or ≤6 Vrms unbalanced for specified system performance below 30 Hz. At higher amplitude settings generator THD derates to 0.0020% from 20 Hz–30 Hz.*

	(valid only for analyzer inputs ≤8.5 Vrms.)
20 Hz–20 kHz	≤(0.00032% + 1.0 μV) [–110 dB], 22 kHz BW ≤(0.0005% + 2.0 μV) [–106 dB], 80 kHz BW ≤(0.0010% + 5.0 μV) [–100 dB], 500 kHz BW
10 Hz–100 kHz	≤(0.0040% + 5.0 μV) [–88 dB], 500 kHz BW
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

Crosstalk Function

Frequency Range	10 Hz–200 kHz
Accuracy[14]	±0.4 dB, 20 Hz–120 kHz
Residual Crosstalk[14]	
10 Hz–20 kHz	≤ –140 or 1 μV
20 kHz–100 kHz	≤ –126 dB or 2.5 μV

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-2622 and SYS-2722 configurations.

SMPTE (DIN) IMD Function

Test Signal Compatibility	Any combination of 40 Hz–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 to 20%
Accuracy	±0.5 dB
Residual IMD[15]	≤0.0015% [–96.5 dB], 60/7 kHz or 250/8 kHz

CCIF and DFD IMD Functions

Test Signal Compatibility	Any combination of equal amplitude tones from 4 kHz to 100 kHz spaced 80 Hz to 1 kHz
IMD Measured	
CCIF	2nd order difference frequency product relative to the amplitude of either test tone
DFD	u_2 (2nd order difference frequency product) per IEC 268-3 (1986)

[14] 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.

[15] System specification measured with the Cascade Plus analog generator at any valid input level ≥200 mVrms.

Measurement Range	0 to 20%
Accuracy	±0.5 dB
Residual IMD[15]	CCIF ≤0.0004% [–108 dB], 14 kHz + 15 kHz, DFD ≤0.0002% [–114 dB], 14 kHz + 15 kHz

DIM (TIM) IMD Function

Test Signal Compatibility	2.96 kHz–3.15 kHz squarewave mixed with 14 kHz–15 kHz sine wave (probe tone)
IMD Measured[16]	u_4 and u_5 per IEC 268-3 (1986)
Measurement Range	0 to 20%
Accuracy	±0.7 dB
Residual IMD15	≤0.0020% [–94 dB]

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-2622 and SYS-2722 configurations.

Test Signal Compatibility Normal "High-band"	 2.80 kHz–3.35 kHz 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 Unweighted Scrape[17] Wideband[17]	 4 Hz bandpass per IEC/DIN/NAB 0.5 Hz–200 Hz 200 Hz–5 kHz 0.5 Hz–5 kHz
Residual W+F Weighted Unweighted Scrape or Wideband	 ≤0.001% ≤0.002% ≤0.005%
Minimum Input	5 mV, 20 mV for specified residual
Settling Time IEC/DIN or NAB JIS	 Typically 3 to 6 seconds Typically 15 to 20 seconds

16 IEC 268-3 defines nine possible DIM products. The Cascade Plus 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.

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

Option Filters

Up to seven option filters can be installed in the analog analyzer for weighted noise or other special measurements. Only one option filter may be enabled at a time, and it is cascaded with the standard bandwidth limiting filters. The following tables list only the most popular types. Consult Audio Precision for custom designs.

Weighted Noise Measurement

FIL-AWT	"A" weighting per IEC Rec 179	*see Figure 7*
FIL-CCR	Weighting per IEC468 (CCIR) and DIN 45404 (Also for CCIR/ARM)	*see Figure 8*
FIL-CIT	Weighting per CCITT Rec P53	*see Figure 9*
FIL-CMS	"C-message" per BSTM 41004 and ANSI/IEEE Std 743-1984	*see Figure 10*
FIL-CWT	"C" weighting per IEC Rec 179	*see Figure 11*

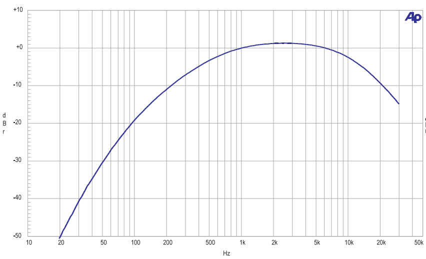

Figure 7. FIL-AWT. ANSI-IEC "A" Weighting Filter

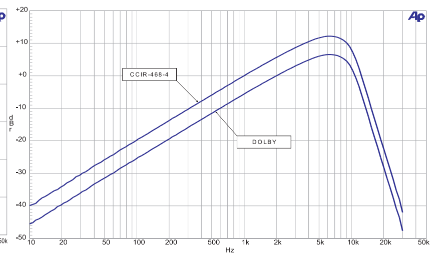

Figure 8. FIL-CCR. IEC468 (CCIR)/ DIN 45404 Noise Weighting Filter

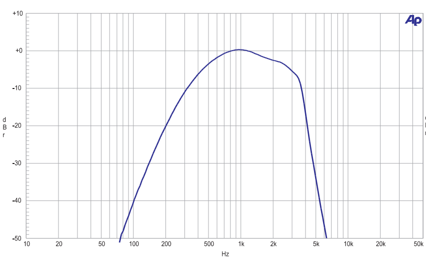

Figure 9. FIL-CIT.CCITT P53 Noise Weighting Filter

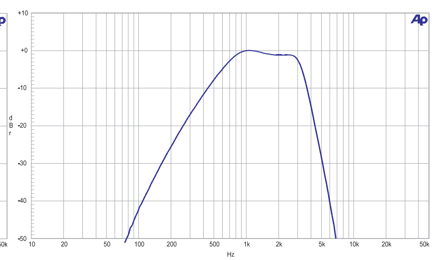

Figure 10. FIL-CMS.C-Message Weighting Filter (ANSI/IEEE 743-1984)

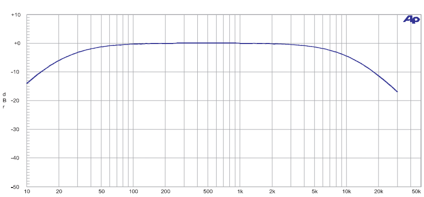

Figure 11. FIL-CWT. "C" Weighting (IEC-179)

Precision De-emphasis Family

FIL-D50	50 μs ±1%	*see Figure 12*
FIL-D50E	50 μs ±1% + 15.625 kHz notch	
FIL-D50F	50 μs ±1% + 19.0 kHz notch	*see Figure 13*
FIL-D75	75 μs ±1%	*see Figure 14*
FIL-D75B	75 μs ±1% + 15.734 kHz notch	*see Figure 15*
FIL-D75F	75 μs ±1% + 19.0 kHz notch	*see Figure 16*

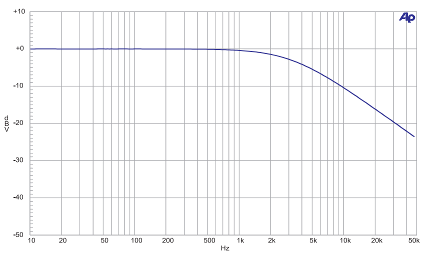

Figure 12. FIL-D50.50 μs De-emphasis Filter.

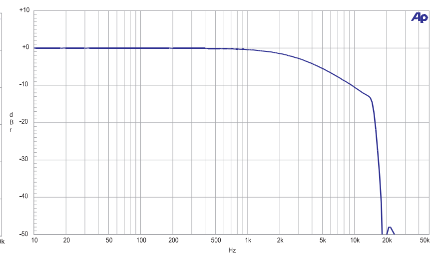

Figure 13. FIL-D50F. 50 μs with 19 kHz (FM) notch De-emphasis Filter.

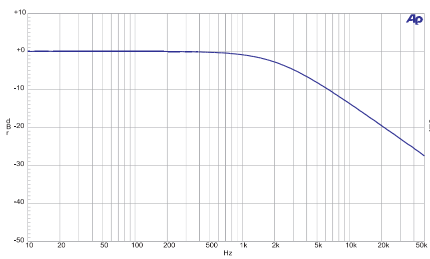

Figure 14. FIL-D75. 75 μs De-emphasis Filter.

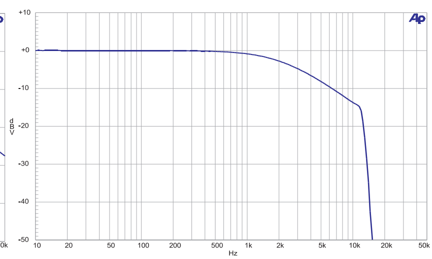

Figure 15. FIL-D75B. 75 μs with 15.734 kHz (NTSC) notch De-emphasis Filter

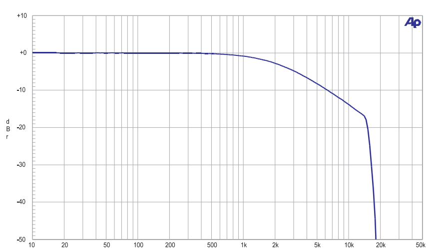

Figure 16. FIL-D75F. 75 μs with 19 kHz (FM) notch De-emphasis Filter.

Very Sharp Cutoff Low-Pass Filter Family

FLP-B20K	±0.1 dB, 10 Hz–20 kHz; >60 dB attenuation at 24 kHz and higher. Complies with AES17. *see Figure 17*
FLP-B40K	±0.1 dB, 10 Hz–40 kHz; >60 dB attenuation at 48 kHz and higher. Complies with AES17.

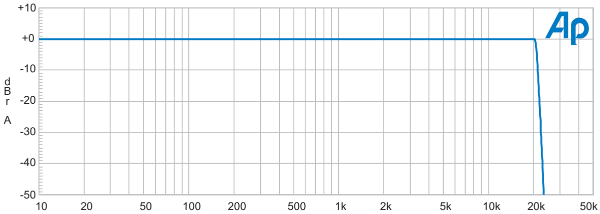

Figure 17. FLP-B20K "Brick Wall" 20 kHz low pass filter. Complies with requirements of AES17 for D/A converter THD+N measurements.

General Purpose Low-Pass

FLP-300	300 Hz ±3%, 5-pole	
FLP-400	400 Hz ±3%, 5-pole	
FLP-500	500 Hz ±3%, 5-pole	
FLP-1K	1 kHz ±3%, 5-pole	*see Figure 18*
FLP-3K	3 kHz ±3%, 7-pole	
FLP-4K	4 kHz ±3%, 7-pole	
FLP-8K	8 kHz ±3%, 7-pole	*see Figure 19*
FLP-50K	50 kHz ±5%, 3-pole	

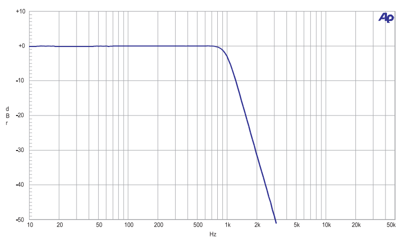

Figure 18. 1 kHz 5-pole Low Pass Filter.

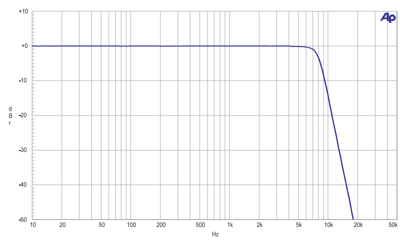

Figure 19. FLP-8K. 8 kHz 7-pole Low Pass Filter.

General Purpose High-Pass

FHP-70	70 Hz ±3%, 8-pole	
FHP-400	400 Hz ±3%, 9-pole	*see Figure 20*
FHP-2K	2 kHz ±3%, 9-pole	

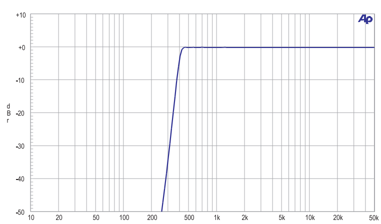

Figure 20. FHP-400. 400 Hz 9-pole High Pass Filter.

1/3-Octave (Class II) Bandpass Family

Family Response	Class II (4-pole) ±0.2 dB from 0.97 f_o to 1.03 f_o ; <–12 dB at 0.8 f_o and 1.25 f_o ; <–32 dB at 0.5 f_o and 2.0 f_o *see Figure 21*
FBP-120	f_o = 120 Hz
FBP-250	f_o = 250 Hz
FBP-300	f_o = 300 Hz
FBP-400	f_o = 400 Hz
FBP-500	f_o = 500 Hz
FBP-600	f_o = 600 Hz
FBP-800	f_o = 800 Hz
FBP-1000	f_o = 1.00 kHz
FBP-1200	f_o = 1.20 kHz
FBP-1500	f_o = 1.50 kHz
FBP-2000	f_o = 2.00 kHz
FBP-3000	f_o = 3.00 kHz
FBP-4000	f_o = 4.00 kHz
FBP-5000	f_o = 5.00 kHz
FBP-6000	f_o = 6.00 kHz
FBP-8000	f_o = 8.00 kHz
FBP-10000	f_o = 10.0 kHz
FBP-12500	f_o = 12.5 kHz
FBP-15000	f_o = 15.0 kHz
FBP-20000	f_o = 20.0 kHz
FBP-30000	f_o = 30.0 kHz

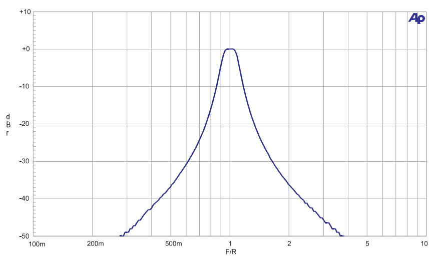

Figure 21. FBP-xxxx. Normalized Response of 1/3-Octave Band Pass Filters

Receiver Testing

FIL-RCR	200 Hz–15 kHz + 19.0 kHz notch	*see Figure 22*
FIL-IECR	20 Hz–15 kHz + 15.625 kHz notch	*see Figure 23*

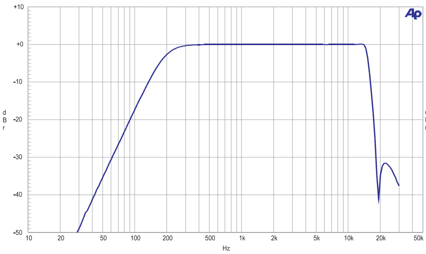

Figure 22. FIL-RCR. 200 Hz to 15 kHz with 19 kHz (FM) notch.

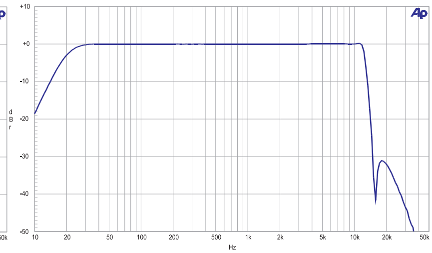

Figure 23. FIL-IECR. 20 Hz to 15 kHz with 15.625 kHz (PAL) notch.

Miscellaneous

FBP-500X	High-Q 500 Hz bandpass for CD DAC linearity measurements	*see Figure 24*
FIL-USR	Kit for building custom filters	

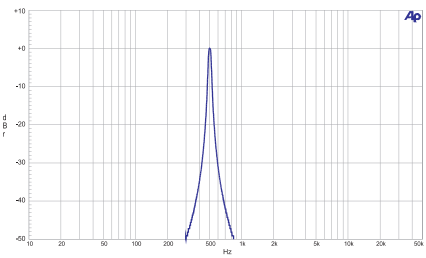

Figure 24. FBP-500X. High-Q 500 Hz Band Pass Filter (for CD linearity testing).

Option S-AES17

Option S-AES17 adds the capability to insert a 20 kHz or 40 kHz low-pass filter following the selected analog input preamplifier, but before any signal processing within the analog analyzer. It enables accurate noise and THD+N measurements of sigma-delta converters and switching power amplifiers that contain large amounts of unwanted energy above the normal audio bandwidth.

High performance sigma-delta converters and switching power amplifiers often contain out-of-band energy that can exceed the in-band audio signal. Standard bandwidth limiting and noise weighting filters will not give accurate measurements due to their relatively low roll-off rates.

Option S-AES17 also includes the FLP-B20K and FLP-B40K option filters. These have been designed to work in tandem with the selectable pre-analyzer filters to provide THD+N measurements in accordance with AES17-1998. When the option is present, four new choices appear in the bandwidth (HF) drop down menu of the analog analyzer. “20k AES17” enables both the 20 kHz pre-analyzer filter and the FLP-B20K option filter. “20k SPCL” enables only the 20 kHz pre-analyzer filter for special applications such as weighted noise measurements using a different option filter. The “40k AES17” and “40k SPCL” choices provide similar functionality using the 40 kHz pre-analyzer filter and the FLP-B40K option filter. Enabling any of these four new choices will introduce a significant phase shift into the selected analog channel that will not be matched in the unselected channel. Thus phase measurements will be invalid whenever the pre-analyzer filter is active. Operation with the analog analyzer’s standard “22 kHz,” “30 kHz,” “80 kHz,” and “>500kHz” bandwidth limiting selections remains unchanged.

Pre-Analyzer Filter Response

(also affects the LEVEL and FREQUENCY meters of the selected channel)

20 kHz	±0.10 dB, 10 Hz to 20 kHz (typ –3 dB at 25 kHz, <–60 dB above 60 kHz)
40 kHz	±0.10 dB, 10 Hz to 40 kHz (typ –3 dB at 50 kHz, <–60 dB above 120 kHz)

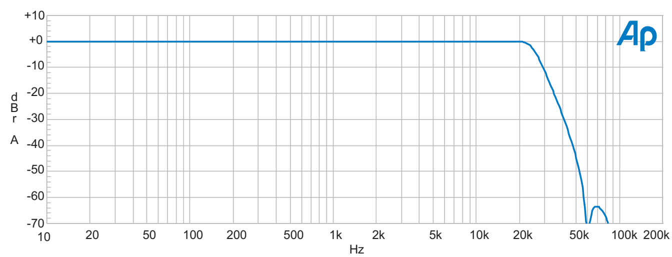

Figure 25. Typical response of 20 kHz “pre-analyzer” filter.

Residual THD+N (1 kHz)

"20k AES17" mode	≤(0.00030% + 1.0 μV) [–110.5 dB]
"40k AES17" mode	≤(0.00040% + 1.4 μV) [–108 dB]

DSP Analysis of Analog Signals

Available only in SYS-2622 and SYS-2722 configurations. Signals connected to the analog analyzer input connector may be routed through stereo A/D converters for enhanced analysis capabilities. There are two selectable converters. The high-resolution converter (“HiRes A/D”) is optimized for signal analysis and FFT displays up to 30 kHz. It offers the best residual noise and distortion performance. The high bandwidth converter (“HiBW A/D”) is optimized for signal analysis up to 120 kHz.

The term “SR” refers to sample rate, in hertz.

High Resolution Converter

A/D Resolution	24-bit sigma-delta
Sample Rate (SR)	7.2 ks/s to 108 ks/s variable; or 65.536 ks/s fixed
Flatness (1 kHz ref)	±0.01 dB to 0.45 SR or 20 kHz, whichever is lower
Alias Rejection[18]	typically >115 dB for signals >0.554 SR
Distortion	–105 dB for SR ≤65.536 ks/s, –102 dB for SR up to 100 ks/s

High Bandwidth Converter

A/D Resolution	16-bit sigma-delta
Sample Rate (SR)	56 ks/s to 216 ks/s variable; or 131.072 ks/s or 262.144 ks/s fixed
Flatness (1 kHz ref)	±0.01 dB to 20 kHz, ±0.10 dB to 120 kHz (262.144 ks/s)
Alias Rejection[18]	typically >85 dB for signals > 0.540 SR
Distortion	–92 dB for SR ≤216 ks/s, –90 dB with SR = 262.144 ks/s

FFT Signal Analyzer

(With “FFT” DSP program)	
Acquisition Length	800 to 4 M samples in 15 steps
Transform Length	256 to 32768 samples in binary steps
Processing	48 bit
Amplitude Accuracy	±0.05 dB, 20 Hz to 20 kHz Flat-top or Move to Bin Center windows
Averaging	1 to 4096 in binary steps. Averaging is power-based (frequency domain), or synchronous (time domain).
Waveform Display Modes	
Time Domain	Normal, Interpolate, Peak or Max
Frequency Domain	Peak pick (highest bin amplitude is displayed between the requested graph points)
Frequency Display Modes	Peak pick, individual bin

[18] *Alias rejection is provided by digital filters within the A/D converters.*

Windows *see Figure 26 and Figure 27*	Blackman-Harris (4-term with –92 dB sidelobes) Hann Flat-top Equiripple (AP design with –160 dB sidelobes) None None, move to bin center Hamming Gaussian Rife-Vincent 4-term Rife-Vincent 5-term

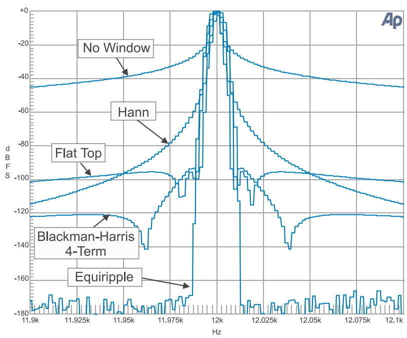

Figure 26. Windowing functions for FFT (A)

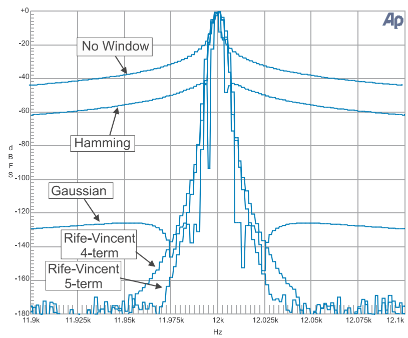

Figure 27. Windowing functions for FFT (B)

Move to bin center Window	
Frequency Range	±4% of input frequency, 7th FFT bin (low limit); to 0.45 SR (high limit).
Spurious Products	<–120 dB

DSP Audio Analyzer

with "Analyzer" DSP program

Wideband Level/Amplitude

Frequency Range	<10 Hz to 45% of sample rate [10 Hz to 21.6 kHz at 48 ks/s]
High pass Filters	<10 Hz 4-pole 22 Hz 4-pole 100 Hz 4-pole 400 Hz 4-pole (4-pole Butterworth or 10-pole elliptic if no other filters are enabled)
Low pass Filters	Fs/2 (maximum bandwidth) 20 kHz (6-pole elliptic) 15 kHz (6-pole elliptic)
Weighting Filters	ANSI-IEC "A" weighting, per IEC Rec 179 CCIR QPk per IEC468 (CCIR) CCIR RMS per AES17 C-message per IEEE Std 743-1978 CCITT per CCITT Rec. O.41 "F" weighting corresponding to 15 phon loudness contour *see Figure 28* HI-2 Harmonic weighting

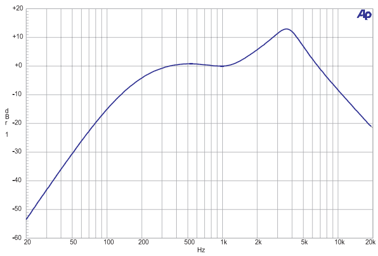

Figure 28. Digital Analyzer F-weighting curve.

Narrow Band Amplitude

Frequency Range	<10 Hz to 47% of sample rate [10 Hz to 22.56 kHz at 48 ks/s]
Filter Shape	10-pole, Q=19 (BW = 5.3% of f_o) *see Figure 29*

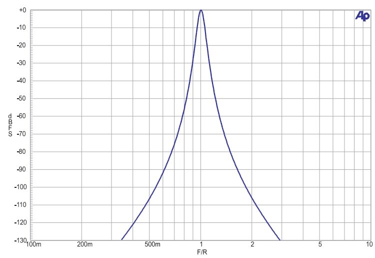

Figure 29. Digital Domain Bandpass filter response.

THD+N Measurements

Frequency Range	<10 Hz to 47% of sample rate [10 Hz to 22.56 kHz at 48 ks/s]
High pass Filters	<10 Hz (4-pole) 22 Hz (4-pole) 100 Hz (4-pole) 400 Hz (4-pole Butterworth)
Low pass Filters	Fs/2 (maximum bandwidth) 20 kHz (6-pole elliptic) 15 kHz (6-pole elliptic)
Weighting Filters	ANSI-IEC "A" weighting, per IEC Rec 179 CCIR QPk per IEC468 (CCIR) CCIR RMS per AES17 C-message per IEEE Std 743-1978 CCITT per CCITT Rec. O.41 "F" weighting corresponding to 15 phon loudness contour *see Figure 29* HI-2 Harmonic weighting

Frequency Measurements

Range	<10 Hz to 47% of sample rate [10 Hz–23.0 kHz at 48 ks/s]
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

Phase Measurements

Measurement Ranges	±180, –90/+270, or 0/+360 degrees
Accuracy[19] 10 Hz–5 kHz 5 kHz–20 kHz 20 kHz–50 kHz	 ±0.5 degree ±1 degree ±2 degrees
Resolution	0.01 degree
Minimum Input	1 mV, both inputs

SMPTE IMD Measurements

Test Signal Compatibility	Any combination of 40 to 250 Hz (LF) and 2 kHz to 45% of sample rate (HF) tones, mixed in any ratio from 1:1 to 5:1 (LF:HF)
IMD Measured	Amplitude modulation products of the HF tone. –3dB measurement bandwidth is 10 Hz to 750 Hz.
Measurement Range	0 to 20%
Accuracy	±0.5 dB
Residual IMD[20]	≤0.0025%, 60 + 7 kHz or 250 + 8 kHz

Quasi-Anechoic Acoustical Tester

With "MLS" DSP program

Signals	Four pink sequences, four white sequences
Frequency Range	(Sample rate ÷ 2000) to (sample rate ÷ 2)
Frequency Resolution (Max)	1.465 Hz at 48.0 ks/s
Acquisition Length	32767 samples or 131071 samples
FFT Length	32768
Energy Time Windows	half Hann Hann <240 Hz to >8 kHz <120 Hz to >16 kHz

[19] Both analog analyzer input channels must have same coupling (ac or dc) selection, and both DSP analyzer input channels must have same coupling (ac or dc) selection. Accuracy is valid for any input signal amplitude ratio up to ±30 dB. Upper frequency range limited to 45% of sample rate.

[20] System specification measured with the System Two Cascade Plus analog generator. Valid for input levels ≥200 mVrms.

Time Windows (percent of data record to transition from 0 to full amplitude)	<5% <10% <20% <30%
Averaging	1 to 4096 in binary steps. Averaging algorithm is synchronous.

Multitone Audio Analyzer

With "FASTTEST" DSP program

Acquisition Length	512 to 32768 samples in binary steps
Transform Length	512 to 32768 samples in binary steps
Processing	48 bit
Measurements	Level vs frequency (Response), Total distortion vs frequency, Noise vs frequency, Phase vs frequency, Crosstalk vs frequency, Masking curve
Frequency Resolution	(Sample Rate ÷ Transform Length) [1.465 Hz with SR = 48 ks/s & Transform Length = 32768]
Frequency Correction Range	±3%
Distortion	≤–115 dB

Digital Signal Generator

Available only in the SYS-2700 and SYS-2722 configurations. The System Two Cascade Plus 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.

Except for arbitrary waveforms, the digital outputs and the digitally generated analog signals are independently selectable and concurrently available. If both digital and analog outputs are selecting arbitrary waveform, it must be the same one.

Digital Output Characteristics

Output Formats	AES/EBU (per AES3-1992) SPDIF-EIAJ per IEC 60958 Optical (Toslink®) per IEC 60958 General purpose serial General purpose parallel Serial interface to chip level via optional SIA-2722
Sample Rates	11 kHz–108 kHz AES/EBU, 22 kHz–216 kHz dual connector AES/EBU, general purpose serial; 8 kHz to 216 kHz parallel; independent of input sample rate
Sample Rate Resolution	1/64 Hz (approx. 0.0156 Hz)
Sample Rate Accuracy	±0.0002% [±2 PPM] using internal reference, lockable to external reference
Word Width	8 to 24 bits
Encoding	Linear, μ-Law, A-Law
Nominal Output Impedance	
Balanced (XLR)	110 Ω
Unbalanced (BNC)	75 Ω

Digital Signal Generation

Sine Family Common Characteristics

Waveforms	Sine, Sine Burst (rectangular envelope), Variable Phase Sine (two sine waves of same frequency but settable phase), Stereo Sine (independent frequency and amplitude in each channel), Dual Sine (sum of two sine waves with variable ratio), Sine + Offset, and Shaped Sine Burst (raised cosine envelope)
Frequency Range	10 Hz to <50% of Sample Rate [<24 kHz at 48 ks/s]
Frequency Resolution	Sample Rate ÷ 2^{23} [0.006 Hz at 48 ks/s]
Flatness	±0.001 dB
Harmonics/Spurious Products	≤0.000001% [–160 dB]

Variable Phase Sine Wave

Phase Range	±180 deg.
Phase Resolution	0.01 deg.

Sine + Offset

Offset Amplitude	Sine amplitude + |offset amplitude| ≤100% Fs

Sine Burst and Shaped Sine Burst

Envelope	Rectangular for Sine Burst, Raised cosine for Shaped Burst *see Figure 30*
Interval	2 to 65536 cycles
Burst On	1 to (number of Interval cycles minus 1)

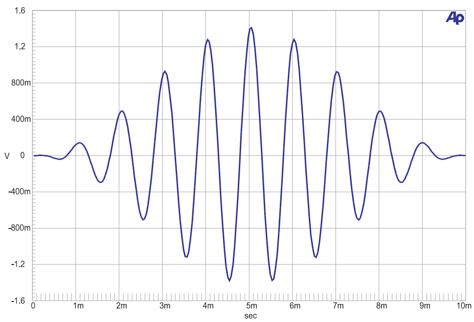

Figure 30. Shaped Sine Burst signal. (1 kHz, 10 cycles)

Square Wave

Frequency Range	≤1 Hz to 1/6 sample rate. Frequencies are limited to even integer sub-multiples of the Sample Rate.
Even Harmonic Content	≤0.000001% [–160 dB]

SMPTE/DIN Waveform

Upper Tone Range	2 kHz to <50% of sample rate [<24 kHz at 48 ks/s]
Lower Tone Range	40 Hz–500 Hz
Amplitude Ratio	1:1 or 4:1 (LF:HF)
Distortion/Spurious	≤0.000001% [–160 dB] at 4:1 ratio

CCIF and DFD IMD Waveforms

Center Frequency Range	3000 Hz to (<50% of sample rate –½ IM freq.)
IM Frequency Range	80 Hz–2.00 kHz
Distortion/Spurious	≤0.000001% [–160 dB]

DIM IMD Waveform

Square/Sine Frequencies	Determined by Sample Rate (see Note below)
Distortion/Spurious	≤0.000001% [–160 dB]

The DIM test signal consists of a square wave and a sine wave mixed in a 4:1 amplitude ratio. Since digital square waves are generated by alternately turning the output on and off for the same number of sample periods, the frequencies achievable are limited to even sub-multiples of the Sample Rate. Because of this constraint, the square wave frequency is chosen first to be as close to the "ideal" analog test frequency as possible. The sine wave frequency is then chosen based upon the ideal sine/square frequency ratio. The following table lists some examples for the DIM and DIMB signals:

DIM: "ideal" square frequency = 3150, sine/square frequency ratio = 100/21		
Sample Rate	Square Wave Frequency	Sine Wave Frequency
44100	3150	15000
48000	3000	14285.7
DIMB: "ideal' square frequency = 2960, sine/square frequency ratio = 175/37		
44100	3150	14898.65
48000	3000	14189.19

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 (applies only to DC)	(Digital DC)
Bittest Random	Random binary states of all bits
Pass Thru	Passes the signal from the rear panel Ref Input. Accepts sample rates from 27 kHz to 100 kHz and outputs at programmed sample rate. Ratio of rates may not exceed 8:1.
Resolution	32 bit when using triangular dither

Quasi-Anechoic Acoustical Tester (MLS)

(Also see MLS in Digital Analyzer section, page 33)

Signals	Four pink sequences, four white sequences
Frequency Range	DC to 50% of sample rate
Sequence Length	32767 samples or 131071 samples, automatically selected between 32 k or 131 k sequence as supplied by generator

Multitone Signals

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

Maximum Number of Tones	Up to 8191 (maximum length)
Frequency Range	DC to Sample Rate ÷ 2
Frequency Resolution	Sample Rate ÷ 2^{14} (typically 2.93 Hz at 48 ks/s)

Arbitrary Waveforms ("Arb Wfm")

Signal	Determined by the associated file specified in the panel drop-down box.
Length	256 to 16384 points per channel. Utility is provided to prepare waveform from user specified frequency, amplitude, and phase data.
Frequency Resolution	Sample Rate ÷ Length [typically 2.93 Hz at 48 ks/s]

Dither

(may be enabled for all waveforms except Monotonicity, J-Test, Walking Ones and Zeroes, and Random)

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

Pre-Emphasis Filters

(all waveforms)

Filter Shape	50/15 μs or J17
Response Accuracy	±0.02 dB, 10 Hz to 45% of Sample Rate
Residual Distortion	≤0.00003% [–130 dB]

AES/EBU Interface Generation

Interface Signal

Amplitude Range	
Balanced (XLR)	0 to 10.16 Vpp, ±(10% + 80 mV) into 110 Ω. 4 mV steps below 1 Vpp, 40 mV steps above.
Unbalanced (BNC)	0 to 2.54 Vpp, ±(8% + 20 mV) into 75 Ω. 1 mV steps below 0.25 Vpp, 10 mV steps above.
Optical (Toslink®)	0 to 256% of nominal intensity in 1% steps
Channel Status Bits	Full implementation per IEC 60958, English language decoded, Professional 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–400 ns, ±20%
Induced Jitter	Selectable sinewave, squarewave, or wideband noise
Jitter Freq Range[21]	2.00 Hz–200 kHz, <0.1 Hz resolution
Jitter Ampl Range[21]	0–1.27 UI (peak) in 0.005 UI steps; 1.3–12.7 UI (peak) in 0.05 UI steps
Jitter Accuracy	±(10% + 0.005 UI)
Jitter Flatness[22]	±1 dB, 100 Hz–20 kHz
Residual Jitter[23]	
48 ks/s	≤0.010 UI [1.6 ns]
96 ks/s	≤0.020 UI [1.6 ns]
Spurious Jitter Products	typically 30 dB below jitter signal or <0.001 UI, whichever is larger
Normal Mode Noise	
Balanced	0 to 2.55 Vpp, in 10 mV steps; ±(10% + 100 mV)
Unbalanced	0 to 635 mVpp, in 2.5 mV steps; ±(10% + 25 mV)
Common Mode Freq	20 Hz–40 kHz, <0.1 Hz resolution
Common Mode Ampl	0 to 20 Vpp, in 80 mV steps, ±(10% + 200 mV)
Cable Simulation	Multi-pole fit to AES3-1992 filter to simulate the response degradation of a long cable.
Offset from reference	–64 to +63.5 UI, in 0.5 UI steps

21 *Combinations of jitter amplitude and frequency must not result in greater than 50% reduction in transmitted bit width.*

22 *System specification including generator and analyzer contributions valid only at 32.0, 44.1, 48.0, 64.0, 88.2, and 96.0 ks/s only. Flatness may be degraded at other sample rates*

23 *System specification including analyzer contribution. The following conditions must be met: (1) the jitter generator amplitude must be turned off or set for 0.0000 UI, (2) all other forms of impairment must be off or disabled, and (3) the digital output must be ≥1.0 Vpp (XLR) or ≥250 mVpp (BNC).*

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 (ISR) is not dependent upon the rate or characteristics of the external reference. OSR need not be at 1:1 ratio to reference but will be phase-locked to reference over full specified range of OSR and Reference inputs. Phase lock loop bandwidth is approximately 5 Hz.

Input Formats	AES/EBU (per AES3-1992), NTSC/PAL/SECAM video, or squarewave
Input Sample Rates/ Frequency Range	28.8 kHz–100 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
Nominal Input Impedance	
AES/EBU (XLR)	110 Ω or >5 kΩ
Video, square wave (BNC)	75 Ω or >5 kΩ
Lock Range	±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 AES11-1994)
Output Sample Rates	28.8 kHz–100 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, in 0.5 UI steps; ±(5% + 0.5 UI)
Residual jitter	≤0.005 UI pk (120 Hz–100 kHz BW)

Digital Analyzer

Available only in the SYS-2700 and SYS-2722 configurations.

Digital Input Characteristics

Input Formats	AES/EBU (per AES3-1992) Dual Connector AES/EBU SPDIF-EIAJ per IEC-60958 Dual Connector SPDIF-EIAJ Optical (Toslink®) per IEC-60958 General purpose serial General purpose parallel Serial interface to chip level via optional SIA-2722
Sample Rates	28.8 kHz–100 kHz AES/EBU, 64 kHz–200 kHz Dual Connector AES/EBU, 8 kHz to 200 kHz parallel or via SIA-2722 (independent of output sample rate)
Word Width	8 to 24 bits
Nominal Input impedance	
AES/EBU	110 Ω or ≥2.5 kΩ
SPDIF-EIAJ	75 Ω or ≥3 kΩ

Embedded Audio Measurements

With "Analyzer" DSP program

Wideband Level/Amplitude

Range	–120 dBFS to 0 dBFS (usable to –140 dBFS)
Frequency Range	<10 Hz to 45% of sample rate [10 Hz–21.6 kHz at 48 ks/s]
Accuracy	±0.01 dB
Flatness	±0.01 dB, 15 Hz–22 kHz (<10 Hz high-pass filter selection)
High pass Filters	<10 Hz (4-pole) 22 Hz (4-pole) 100 Hz (4-pole) 400 Hz (4-pole Butterworth, or 10-pole elliptic if no other filters are enabled)
Low pass Filters	Fs/2 (maximum bandwidth) 20 kHz (6-pole elliptic) 15 kHz (6-pole elliptic)
Weighting Filters	ANSI-IEC "A" weighting, per IEC Rec 179 CCIR QPk per IEC468 (CCIR) CCIR RMS per AES17 C-message per IEEE Std 743-1978 CCITT per CCITT Rec. O.41 "F" weighting corresponding to 15 phon loudness contour *see Figure 28, page 21* HI-2 Harmonic weighting
Residual Noise (at 48 ks/s and 96 ks/s SR)	–141 dBFS unweighted –144 dBFS A-weighted

	–140 dBFS CCIR RMS –130 dBFS CCIR QPk –142 dBFS 20 kHz LP –143 dBFS 15 kHz LP –139 dBFS "F" weighting –152 dBFS CCITT –151 dBFS C Message

Narrow Band Amplitude

Frequency Range	<10 Hz to 47% of sample rate [10 Hz to 22.56 kHz at 48 ks/s]
Filter Shape	10-pole, Q=19 (BW = 5.3% of f_o) *see Figure 29, page 21*
Residual Distortion	≤–150 dBFS

THD+N Measurements

Frequency Range	<10 Hz to 47% of sample rate [10 Hz to 22.56 kHz at 48 ks/s]
Residual THD+N	≤–138 dBFS *see Figure 31, page 35*
High pass Filters	<10 Hz (4-pole) 22 Hz (4-pole) 100 Hz (4-pole) 400 Hz (4-pole Butterworth)
Low pass Filters	Fs/2 (maximum bandwidth) 20 kHz (6-pole elliptic) 15 kHz (6-pole elliptic)
Weighting Filters	Same as Wideband Level/Amplitude
Residual Noise	Same as Wideband Level/Amplitude

Frequency Measurements

Range	<10 Hz to 47% of sample rate [<10 Hz–22.56 kHz at 48.0 ks/s]
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

Phase Measurements

Measurement Ranges	±180, –90/+270, or 0/+360 degrees
Accuracy[24]	±2 degrees, 10 Hz to 45% of Sample Rate
Resolution	0.01 degree
Minimum Input	–60 dBFS, both inputs

[24] *Both DSP analyzer input channels must have the same coupling (ac or dc) selection.*

SMPTE IMD Measurements

Test Signal Compatibility	Any combination of 40 to 250 Hz (LF) and (2 kHz to <50% of sample rate) (HF) tones, mixed in any ratio from 1:1 to 5:1 (LF:HF)
IMD Measured	Amplitude modulation products of the HF tone. (–3 dB measurement bandwidth is typically 20 Hz–750 Hz.)
Measurement Range	0 to 20%
Accuracy	±0.5 dB
Residual IMD	≤–130 dB at 0 dBFS, 60 + 7 kHz or 250 + 8 kHz ≤–110 dB at –25 dBFS, 60 + 7 kHz or 250 + 8 kHz

FFT Spectrum Analyzer

with "FFT" DSP program (48 bit processing)

Acquisition Length	800 to 4 M samples in 15 steps
Transform Length	256 to 32768 samples in binary steps
Processing	48 bit
Windows (see Figures 26 and 27, page 20)	Blackman-Harris (4-term with –92 dB sidelobes) Hann Flat-top Equiripple (–160 dB sidelobes) None None, move to bin center Hamming Gaussian Rife-Vincent 4-term Rife-Vincent 5-term
Amplitude Accuracy	±0.001 dB, 20 Hz to 20 kHz, with Flat-top window
Phase Accuracy[25]	±0.05 degree, 10 Hz to 45% of Sample Rate
Resolution	0.01 degree
Averaging	1 to 4096 in binary steps. Averaging is power-based (frequency domain), or synchronous (time domain)
Distortion Products	≤–160 dB
Frequency Display Modes	
Time Domain	Normal, interpolate, peak or max
Frequency Domain	Peak pick, individual bin
Move to bin center Window	
Frequency Range	±4% of input frequency, 7th FFT bin (low limit); to 0.45 SR (high limit).
Amplitude Accuracy	±0.025 dB
Spurious Products	≤–120 dB

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

Multi-Tone Audio Analyzer

with "FASTTEST" DSP program (48 bit processing)

Acquisition Length	512 to 32768 samples in binary steps
Transform Length	512 to 32768 samples in binary steps
Processing	48 bit
Measurements	Level vs frequency, Total distortion vs frequency, Noise vs frequency, Phase vs frequency, Crosstalk vs frequency, Masking curve
Frequency Resolution	Sample Rate ÷ 2^{15} [1.465 Hz with 48.0 ks/s]
Frequency Correction Range	±3%
Distortion	≤–140 dB

Quasi-Anechoic Acoustical Tester

with "MLS" DSP program

Signals	Four pink sequences, four white sequences
Frequency Range	Sample rate/2000 to sample rate/2
Frequency Resolution (Max)	1.465 Hz at 48.0 ks/s
Acquisition Length	32767 samples, 131071 samples, automatically selected between 32 k or 131 k sequence as supplied by generator
FFT Length	32768
Energy Time Windows	half Hann Hann <240 Hz to >8 kHz <120 Hz to >16 kHz
Time Windows (percent of data record to transition from 0 to full amplitude)	<5% <10% <20% <30%
Averaging	1 to 4096 in binary steps, synchronous

Digital Interface Analyzer

with "INTERVU" DSP program

INTERVU operates in conjunction with an autoranged 8-bit A/D converter clocked at 80.0 MHz, providing interface signal measurements with >30 MHz bandwidth. INTERVU can display the interface signal in time or frequency domain, as an eye pattern, or as probability graphs of amplitude or pulse width. INTERVU also can demodulate the jitter signal and display it in the time or frequency domain or as a histogram. The jitter signal or the data on the interface may be reproduced through the monitor loudspeaker.

AES/EBU Input Voltage Balanced Unbalanced	 0 to 20.48 Vpp, ±(10% + 50 mV) 0 to 4.096 Vpp, ±(8% + 12 mV)
Jitter Amplitude	0 to 5 UI pk, ±(5% + 0.015 UI)
Residual Jitter	≤0.01 UI (50 Hz–1 MHz BW)
Spurious Jitter Products	≤0.001 UI, or ≤–60 dB below jitter signal
Common Mode Amplitude	0 to 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	32768 bins
Risetime	≤20 ns
Acquisition time / memory	19.66 ms / 1,572,864 samples

Digital Interface Measurements

AES/EBU Impairments, real time displays

Input Sample Rate	±0.0003% [±3 ppm] internal reference, ±0.0001% [±1 ppm] external reference
Output to Input Delay	Measures status propagation from the AES/EBU output to the input. Range is 0 to 1 frame, resolution ±60 ns.
AES/EBU Input Voltage XLR BNC	 100 mV to 10.16 Vpp, ±(5% + 50 mV) 50 mV to 2.54 Vpp, ±(5% + 12 mV)
Jitter Amplitude[26] 50 Hz–100 kHz BW Other BW selections	 0 to 3.00 UI, ±(10% + 0.01 UI) 0 to 1.00 UI, ±(10% + 0.005 UI)
Jitter Flatness[27]	±1 dB, 100 Hz–20 kHz
Residual Jitter[28]	≤1.6 ns [0.010 UI at 48 ks/s, 0.020 UI at 96 ks/s]

[26] *Jitter amplitude is peak calibrated.*

[27] *System specification including generator and analyzer contributions at 32.0, 44.1, 48.0, 64.0, 88.2, and 96.0 ks/s only. Flatness may be degraded at other sample rates.*

[28] *System specification including generator contribution. The following conditions must be met: (1) the jitter generator amplitude must be turned off or set for 0.0000 UI, (2) all other forms of impairment must be off or disabled, and (3) the digital input must be ≥1.0 Vpp (XLR) or ≥250 mVpp (BNC).*

Jitter Spectrum	Spurious products are typically 40 dB below jitter signal or <0.0003 UI [–70 dBUI], whichever is larger
Common Mode Ampl	0 to 20.48 Vpp, ±(10% + 300 mV), 315 Hz–200 kHz
Cable Equalization	Per AES3-1992
Channel Status Bits	Full implementation, English language decoded (Professional or Consumer) 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)

Graphs of Typical Digital Domain Performance

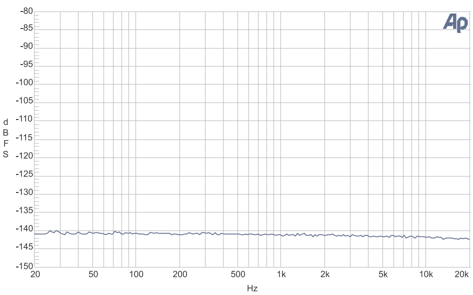

Figure 31. Typical Digital Domain system residual THD+N showing components below –140 dB.

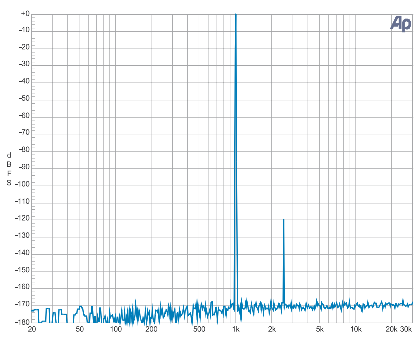

Figure 32. Illustration of typical Digital Domain FFT dynamic range. Signal is 0 dB 1 kHz with a secondary signal at –120 dB and 2.5 kHz.

Auxiliary Signals

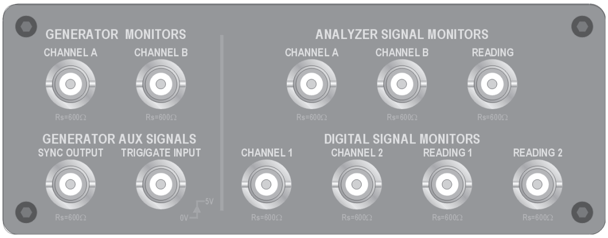

Figure 33. Monitors panel

Generator Signal Monitors

(All units except SYS-2700. See Figure 33)

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-2700. See Figure 33)

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-2700. See Figure 33)

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

Digital Signal Monitors

(SYS-2700.& SYS-2722 only. See Figure 33)

Via four 24-bit D/A converters. Function monitored depends upon analyzer program loaded; for example, noise and distortion products after notch filter are monitored with “DSP Audio Analyzer” 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
Reading 1	Distortion of the digital channel 1 signal
Reading 2	Distortion of the digital channel 2 signal

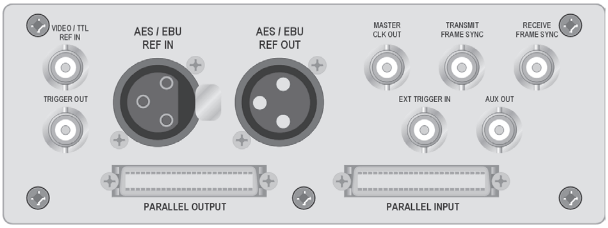

Figure 34. Miscellaneous digital I/O

Digital Interface Monitors

(SYS-2700.& SYS-2722 only. See Figure 34)

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	A squarewave at a multiple of the programmed output sample rate (SRO). The multiple is 1024x for sample rates of 6.8 kHz–12 kHz; 512x for sample rates of 12 kHz–24 kHz; and 256x for sample rates of 24 kHz–96 kHz. Selectable between jittered and unjittered signals.

Miscellaneous Digital I/O

(SYS-2700.& SYS-2722 only. See Figure 34)

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

Audio Monitor

All configurations contain an internal loudspeaker and headphone jack for listening to the generator, analyzer, or digital signal monitor points, 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)
Altitude	2000 m (operating)
EMC[29]	Complies with 89/336/EEC, EN 61326-1 Class B/CISPR 22, and FCC 15 subpart J (class B)
Dimensions	
Width	41.9 cm [16.5 inches]
Height	14.6 cm [5.75 inches] bench-top (with feet) 3U [5.25 inches] rack-mount
Depth	34.5 cm [13.6 inches]
Weight	Approximately 15.4 kg [34 lbs]
Safety	Complies with 73/23/EEC and 93/68/EEC. EN61010-1 (1990) + Amendment 1 (1992) + Amendment 2 (1995) Installation Category II—Pollution Degree 2.

[29] *Emission and immunity levels are influenced by the shielding performance of the connecting cables. The shielding performance of the cables will depend on the internal design of the cable, connector quality, and the assembly methods used. EMC compliance was demonstrated using Audio Precision cables CAB-XMF and CAB-AES2.*