2700 Series Specifications

2700 series instrument with
AP2700 version 3.00

Part Number 8211.0188 Revision 0

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2700 Series Instruments

Specifications

Analog Signal Outputs

All 2700 series configurations except SYS-2720 contain an ultra-low distortion analog sine wave generator and two independent transformer-coupled output stages.

The SYS-2712 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 Unbalanced	 40 Ω (±1 Ω), 150 Ω[1] (±1.5 Ω), or 600 Ω (±3 Ω). 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 Unbalanced	 +30.1 dBm (Rs = 40 Ω). +24.4 dBm (Rs = 20 Ω).
Output Related Crosstalk 10 Hz–20 kHz 20 kHz–100 kHz	 ≤ –120 dB or 5 µV, whichever is greater. ≤ –106 dB or 10 µV, whichever is greater.

Low Distortion Sine Wave Generator

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

NP0020.0006.000 R0

[1] *200 Ω ±2 Ω with option "EURZ"*

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–26.66 Vrms [+30.7 dBu].
Unbalanced	<10 μV–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	≤(0.0003% + 1.0 μV) [–110.5 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–75.4 Vpp.
Unbalanced	30 μVpp–37.7 Vpp.
Amplitude Accuracy	±2.0% [±0.17 dB].
Residual IMD[6]	0.0015% [–96.5 dB], 60 Hz + 7 kHz or 250 Hz + 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 2700 series 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 2700 series 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 Unbalanced	 30 µVpp–75.4 Vpp. 30 µVpp–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 Unbalanced	 30 µVpp–75.4 Vpp. 30 µVpp–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 cycle–65535 cycles, or externally gated.
Interval Range	2 cycle–65536 cycles.

Square Wave

Frequency Range	20 Hz–20 kHz.
Frequency Accuracy	Same as Sinewave.
Amplitude Range[4] Balanced Unbalanced	 30 µVpp–37.7 Vpp. 30 µVpp–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–37.7 Vpp.
Unbalanced	30 µVpp–18.8 Vpp.

Graphs of Typical Analog Generator Performance

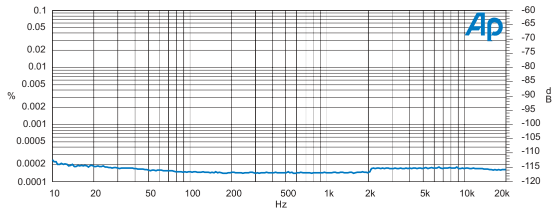

Figure 1. Typical system THD+N versus Frequency at 2 Vrms (analog sine).

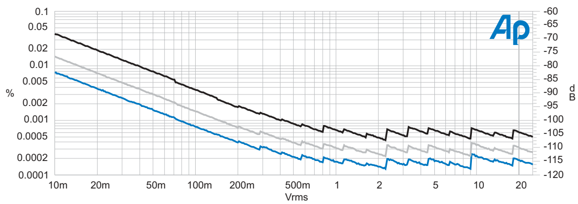

Figure 2. Typical system THD+N versus amplitude at 1 kHz. Lower trace is with 22 kHz bandwidth limiting. Middle trace is with 80 kHz.

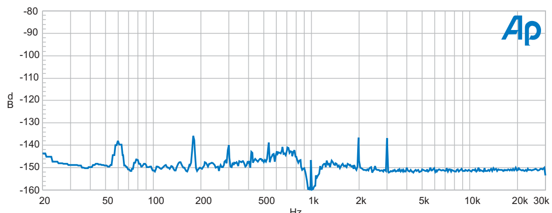

Figure 3. Typical residual THD+N spectrum at 1 kHz, 2 Vrms. (32768 point FFT of notch filter output, Sample Rate = 65.536 ks/s, 16 averages).

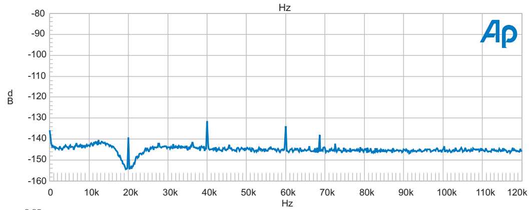

Figure 4. Typical residual THD+N spectrum at 20 kHz, 2 Vrms. (32768 point FFT of notch filter output, Sample Rate = 262 ks/s, 16 averages).

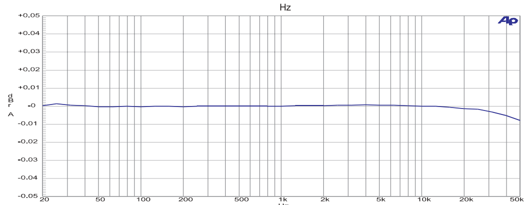

Figure 5. Typical analog system flatness at 2 Vrms signal level (measured with the analog analyzer's Level meter, dc input coupling).

D/A Generated Analog Signals

Available only in the SYS-2720 and SYS-2722 configurations. Except for arbitrary and Pass Thru waveforms, the digitally generated analog output signals and the embedded output signals are independently selectable and concurrently available. If both analog and digital outputs are selecting arbitrary waveform, it must be the same one. If Pass Thru waveforms are selected for both analog and digital generators, they must be at the same sample rate.

Common Specifications

Sample Rate	
Sine, IMD signals	fixed at 65.536 ks/s or 131.072 ks/s.
Other signals	8 ks/s–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 27).

Frequency Ranges	10 Hz–30 kHz (65.536 ks/s), or 10 Hz–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 cycle–65536 cycles.
Shaped Burst On Time	1 to (number of interval cycles minus 1).

[7] *System specification measured with the 2700 series analog analyzer set for a 22 kHz measurement BW.*

"IMD (D/A)" Signal Family

SMPTE/DIN Test Signal

LF Tone	40 Hz–500 Hz.
HF Tone	2.00 kHz–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–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 and Multitone Waveforms ("Arb Wfm")

Signal	Determined by the associated file specified in the panel drop-down box.
Frequency Range	20 Hz to 47% of Sample Rate.
Length	256 points–16384 points per channel. Utility is provided to prepare waveform from frequency, amplitude, and phase data.
Frequency Resolution	Sample Rate ÷ Length [2.93 Hz at 48 ks/s for a waveform 16384 points in length].
Maximum Number of Tones	(Length / 2) –1 [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 2700 series analog analyzer at any voltage ≥200 mVrms.*

Squarewave

Frequency Range	20 Hz–20.0 kHz.
Rise Time	Typically 2.0 μs.

Noise Signal

Pseudo-random white

Analog Analyzer

All 2700 series configurations except SYS-2720 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-2712 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–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–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–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).

[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.*

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).
HF –3 dB	22 kHz per IEC468 (CCIR), 30 kHz ±5% (3-pole), 80 kHz ±5% (3-pole), or >500 kHz.

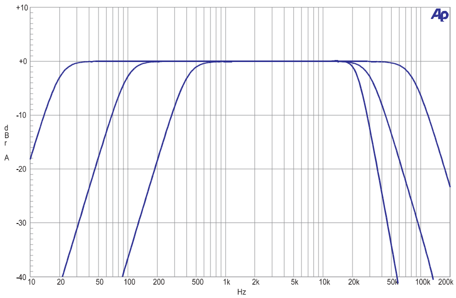

Figure 6. Typical responses of the standard band-limiting filters.

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 0.73 f_o & 1.37 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–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 HF –3 dB	 <10, 22, 100, or 400 Hz. 22k, 30k, 80k, or >500 kHz (Option filter selection also affects bandwidth).
Residual THD+N[13] At 1 kHz 20 Hz–20 kHz 10 Hz–100 kHz	 ≤(0.00025% + 1.0 µV) [–112 dB], 22 kHz BW (valid only for analyzer inputs ≤8.5 Vrms). ≤(0.0003% + 1.0 µV) [–110.5 dB], 22 kHz BW, ≤(0.0005% + 2.0 µV) [–106 dB], 80 kHz BW, ≤(0.0010% + 5.0 µV) [–100 dB], 500 kHz BW . ≤(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 20 kHz–100 kHz	 ≤ –140 or 1 µV. ≤ –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-2712 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.

[13] System specification measured with the 2700 series 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.

[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.

Measurement Range	0%–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–100 kHz spaced 80 Hz–1 kHz.
IMD Measured	
CCIF	2^{nd} 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).
Measurement Range	0%–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%–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-2712 and SYS-2722 configurations.

Test Signal Compatibility	
Normal	2.80 kHz–3.35 kHz.
"High-band"	11.5 kHz–13.5 kHz.
Measurement Range	0%–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).

15 System specification measured with the 2700 series analog generator at any valid input level ≥200 mVrms.

16 IEC 268-3 defines nine possible DIM products. The 2700 series 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 dB–8 dB lower (better) than the results obtained using FFT-based techniques which sum all nine products.

Response Selections	
Weighted	4 Hz bandpass per IEC/DIN/NAB.
Unweighted	0.5 Hz–200 Hz.
Scrape[17]	200 Hz–5 kHz.
Wideband[17]	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 seconds–6 seconds.
JIS	Typically 15 seconds–20 seconds.

[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*

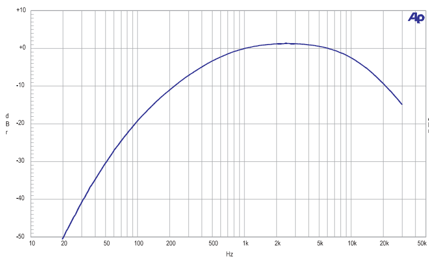

Figure 7. FIL-AWT. ANSI-IEC "A" Weighting Filter.

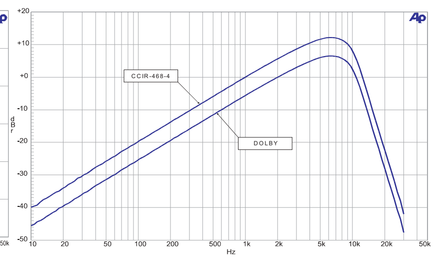

Figure 8. FIL-CCR. IEC468 (CCIR)/ DIN 45404 Noise Weighting Filter.

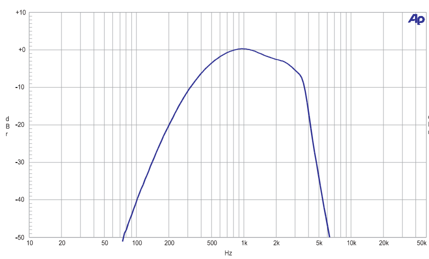

Figure 9. FIL-CIT. CCITT P53 Noise Weighting Filter.

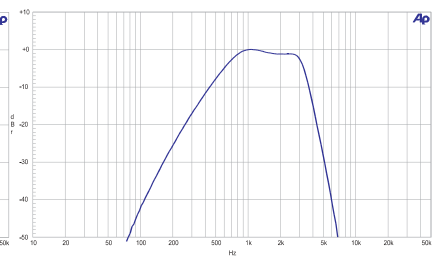

Figure 10. FIL-CMS.C-Message Weighting Filter (ANSI/IEEE 743-1984).

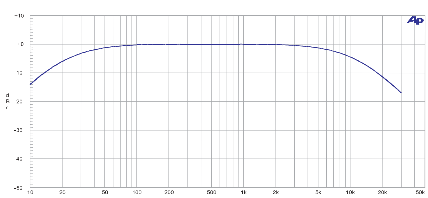

Figure 11. FIL-CWT. "C" Weighting (IEC-179).

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

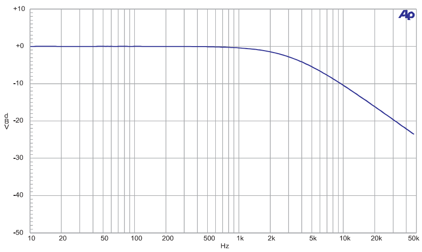

Figure 12. FIL-D50.50 µs De-emphasis Filter.

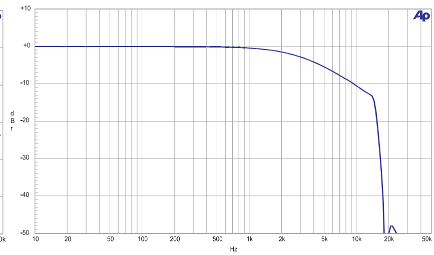

Figure 13. FIL-D50F. 50 µs with 19 kHz (FM) notch De-emphasis Filter.

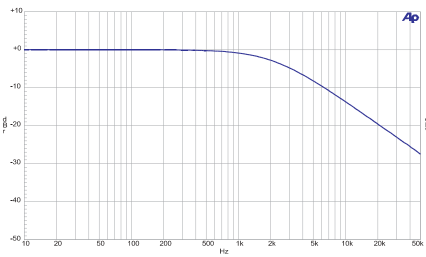

Figure 14. FIL-D75. 75 µs De-emphasis Filter.

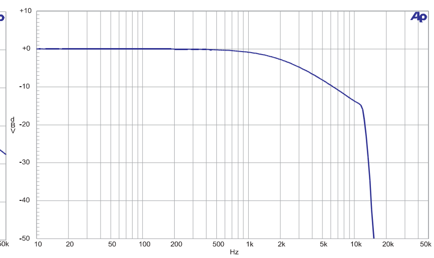

Figure 15. FIL-D75B. 75 µs with 15.734 kHz (NTSC) notch De-emphasis Filter.

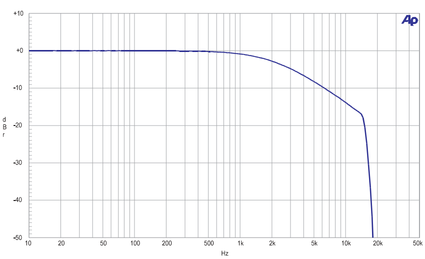

Figure 16. FIL-D75F. 75 µs with 19 kHz (FM) notch De-emphasis Filter.

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.

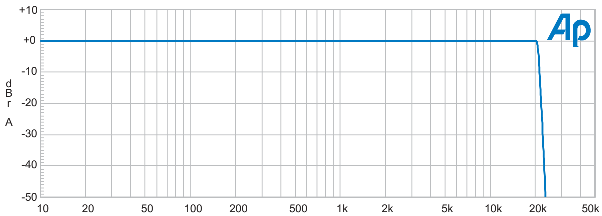

Figure 17. FLP-B20K "Brick Wall" 20 kHz low pass filter. Complies with requirements of AES17 for D/A converter THD+N measurements.

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.

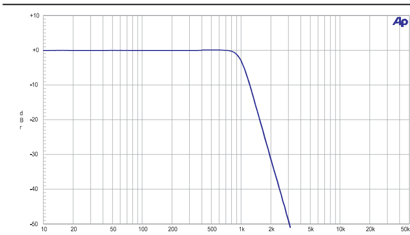

Figure 18. 1 kHz 5-pole Low Pass Filter.

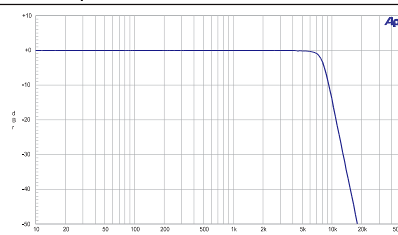

Figure 19. 8 kHz 7-pole Low Pass Filter.

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.

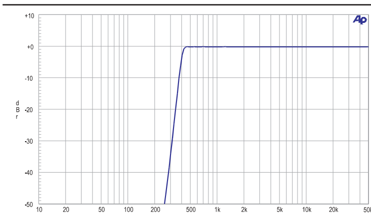

Figure 20. FHP-400. 400 Hz 9-pole High Pass Filter.

1/3-Octave (Class II) Bandpass Family

Family Response	Class II (4-pole) ±0.2 dB from 0.97 f_o–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.

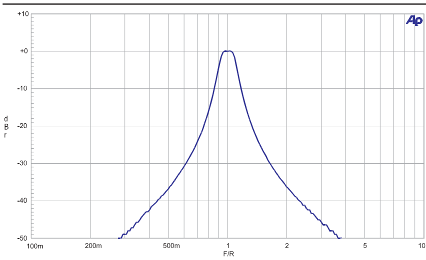

Figure 21. FBP-xxxx. Normalized Response of 1/3-Octave Band Pass Filters

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*

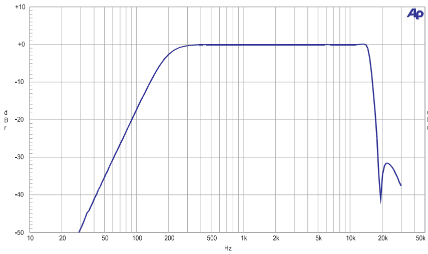

Figure 22. FIL-RCR. 200 Hz to 15 kHz with 19 kHz (FM) notch.

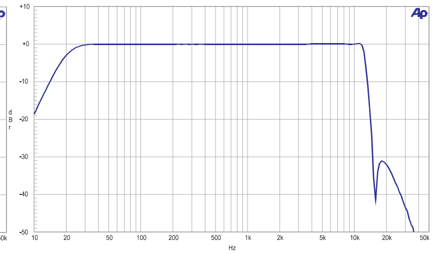

Figure 23. FIL-IECR. 20 Hz to 15 kHz with 15.625 kHz (PAL) notch.

Miscellaneous

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

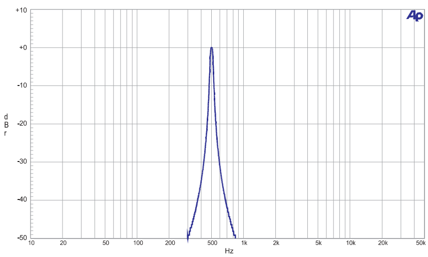

Figure 24. FBP-500X. High-Q 500 Hz Band Pass Filter (for CD linearity testing).

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.

Pre-Analyzer Filter Response

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

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

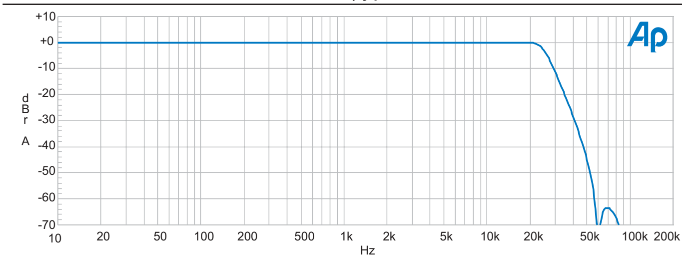

Figure 25. Typical response of 20 kHz “pre-analyzer” filter.

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-2712 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 “f_s” refers to sample frequency (also called sample rate), in hertz.

High Resolution Converter

A/D Resolution	24-bit sigma-delta.
Sample Rate (f_s)	8 ks/s–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 x f_s.
Distortion	–105 dB for $f_s \leq$65.536 ks/s, –102 dB for f_s up to 100 ks/s.

High Bandwidth Converter

A/D Resolution	16-bit sigma-delta.
Sample Rate (f_s)	16 ks/s–200 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 x f_s.
Distortion	–92 dB for $f_s \leq$200 ks/s, –90 dB with f_s = 262.144 ks/s.

FFT Signal Analyzer

(With “FFT” DSP program)

Acquisition Length	800 samples to 4 M samples in 15 steps.
Transform Length	256–32768 samples in binary steps.
Processing	48 bit.
Amplitude Accuracy	±0.09 dB, 20 Hz–20 kHz, Flat-top or Move to Bin Center windows.
Averaging	1–4096 averages 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 Figures 26 and 37.*	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.
Move to bin center Window	
Frequency Range	±4% of input frequency, 7th FFT bin (low limit), to 0.45 x f_s (high limit).
Spurious Products	<–120 dB.

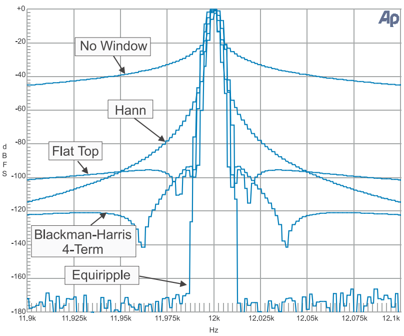

Figure 26. Windowing functions for FFT (A)

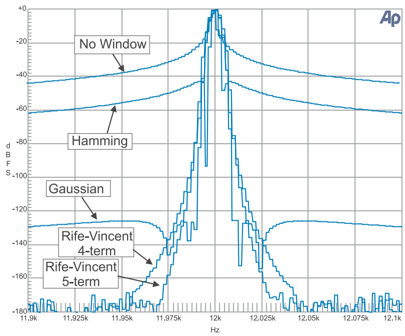

Figure 27. Windowing functions for FFT (B)

DSP Audio Analyzer

with "Analyzer" DSP program

Wideband Level/Amplitude

Accuracy (1 kHz)	±0.09 dB [±1.0%]
Frequency Range	<10 Hz to 45% of Sample Rate [10 Hz–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	F_S/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.

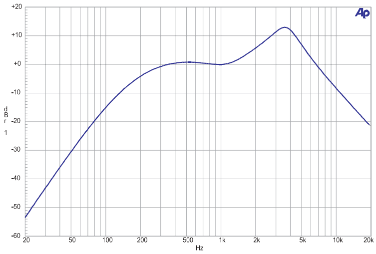

Figure 28. Digital Analyzer F-weighting curve.

Narrow Band Amplitude

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

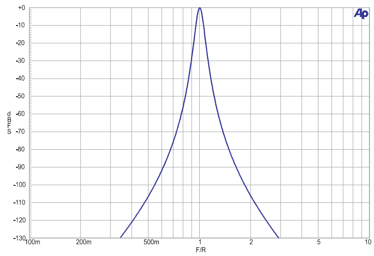

Figure 29. Digital Domain Bandpass filter response.

THD+N Measurements

Frequency Range	<10 Hz to 47% of Sample Rate [10 Hz–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	$F_S/2$ (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	±0.5 degree.
5 kHz–20 kHz	±1 degree.
20 kHz–50 kHz	±2 degrees.
Resolution	0.01 degree.
Minimum Input	1 mV, both inputs.

SMPTE IMD Measurements

Test Signal Compatibility	Any combination of 40 Hz–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–750 Hz.
Measurement Range	0%–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 or 131071 samples.
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	1–4096 averages in binary steps. Averaging algorithm is synchronous.

[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 2700 series analog generator. Valid for input levels ≥200 mVrms.

Multitone Audio Analyzer

With "FASTTEST" DSP program

Acquisition Length	512–32768 samples in binary steps.
Transform Length	512–32768 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 f_s = 48 ks/s & Transform Length = 32768].
Frequency Correction Range	±3%.
Distortion	≤–115 dB.

Digital Signal Generator

Available only in the SYS-2720 and SYS-2722 configurations. The 2700 series digital generator consists of a DSP signal generator, hardware impairment generators and processing (for example, variable risetime and induced jitter), and digital output stages supporting the most popular formats.

Except for arbitrary and Pass Thru waveforms, the embedded output signals and the digitally generated analog output signals are independently selectable and concurrently available. If both digital and analog outputs are selecting arbitrary waveform, it must be the same one. If Pass Thru waveforms are selected for both analog and digital generators, they must be at the same sample rate.

Interface Signal Characteristics

Output Formats	Balanced XLR (AES/EBU per AES3-r1997), Dual Connector XLR, Unbalanced BNC (SPDIF-EIAJ per IEC-60958), Dual Connector BNC, Optical (Toslink®) per IEC-60958, General purpose parallel, or Serial interface to chip via optional PSIA-2722.
Sample Rate ("SR")	
Range	
Electrical Formats	28 kHz–200 kHz for fully specified performance; usable from 8 kHz–216 kHz.
Optical Format	28 kHz–108 kHz for fully specified performance; usable down to 8 kHz. Upper rate is limited by Toslink® technology.
Resolution	<0.0001 Hz.
Accuracy	±0.0002% [±2 PPM], lockable to external reference.
Output Amplitude	
Balanced (XLR)	
Range	0 Vpp–10.20 Vpp into 110 Ω. Output is unspecified above 8.00 Vpp if SR >108 kHz, or above 5.00 Vpp if SR <16 kHz.
Resolution	40 mV, 4 mV below 1 Vpp.
Accuracy	±(10% + 80 mV).
Unbalanced (BNC)	
Range	0 Vpp–2.55 Vpp into 75 Ω. Output is unspecified above 2.00 Vpp if SR >108 kHz, or above 1.25 Vpp if SR <16 kHz.
Resolution	10 mV, 1 mV below 0.25 Vpp.
Accuracy	±(8% + 20 mV).
Optical	Fixed.
Output impedance	
Balanced (XLR)	Nominally 110 Ω.
Unbalanced (BNC)	Nominally 75 Ω.
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, common to both outputs.

Interface Signal Impairments

Variable Rise/Fall Time	12 ns–100 ns, ±(10% + 2 ns).
Cable Simulation	Approximates the signal degradation of 40 m–100 m of typical digital audio cable.
Induced Jitter (sine wave)	
Frequency Range[21]	2 Hz–200 kHz.
Amplitude Range[21]	0 UI–0.127 UI in 0.0005 UI steps, 0.13 UI–1.27 UI in 0.005 UI steps, 1.3 UI–12.7 UI in 0.05 UI steps.
Accuracy	±(10% + 2.0 ns), peak calibrated.
Flatness[22]	±1 dB, 100 Hz–50 kHz.
Residual Jitter[23]	≤600 ps (700 Hz–100 kHz analyzer bandwidth), ≤1.0 ns (50 Hz–100 kHz analyzer bandwidth).
Spurious Jitter Products	Typically 30 dB below jitter signal or 0.001 UI, whichever is larger.
Normal Mode Noise	
Waveform	Pseudo-random pulse train.
Balanced (XLR)	0 Vpp–2.55 Vpp in 10 mV steps, ±(10% + 100 mV).
Unbalanced (BNC)	0 mVpp–635 mVpp in 2.5 mV steps, ±(10% + 25 mV).
Common Mode Signal	Applies to Balanced (XLR) outputs only.
Frequency Range	20 Hz–100 kHz.
Amplitude Range	0 Vpp–20.4 Vpp in 80 mV steps, ±(10% + 160 mV).
Delay from rear panel Reference Output	–64 UI to +63.5 UI in 0.5 UI steps.

Embedded Signal Generation

Encoding is selectable 8–24 bit Linear, µ-Law, or A-Law

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 47% of Sample Rate [22.56 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].

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

[22] System specification at 32, 44.1, 48, 88.2, 96, 176.4, and 192 ks/s. Flatness of the jitter generator will exhibit degradation at other sample rates.

[23] Applies to balanced and unbalanced signal formats only. Specification subject to the following conditions: (1) all jitter generator impairments must be turned off or disabled including the delay from reference output feature, (2) the digital input signal must be ≥ 1.5 Vpp (AES/EBU) or ≥ 300 mVpp (SPDIF-EIAJ) and have a risetime ≤ 20 ns. Jitter via the optical path may be considerably worse with embedded audio or dither enabled.

Variable Phase Sine Wave

Phase Range	±180 deg.
Phase Resolution	0.01 deg.

Sine + Offset

Offset Amplitude	Sine amplitude + |offset amplitude| ≤100% F_S.

Sine Burst and Shaped Sine Burst

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

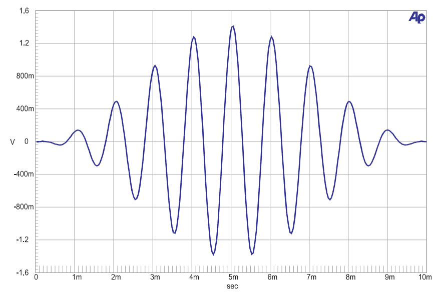

Figure 30. Shaped Sine Burst signal. (1 kHz, 10 cycles)

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 47% of Sample Rate [22.56 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	3.00 kHz to (47% 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 (Digital dc)	32-bit resolution when using triangular dither.

Random (Bittest)	Pseudo-random binary states of all bits.
Pass Thru	Passes the signal from the rear panel Ref Input. Accepts sample rates from 27 kHz–200 kHz and outputs at programmed sample rate. Ratio of rates may not exceed 7.75:1.

Quasi-Anechoic Acoustical Tester (MLS)

(Also see MLS in Digital Analyzer section, page 34)

Signals	Four pink sequences, four white sequences.
Frequency Range	dc to Sample Rate ÷ 2.
Sequence Length	32767 samples or 131071 samples.

Arbitrary and Multitone Waveforms (“Arb Wfm”)

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

Signal	Determined by the associated file specified in the panel drop-down box.
Frequency Range	dc to Sample Rate ÷ 2.
Length	256 points–16384 points per channel. Utility is provided to prepare waveform from user specified frequency, amplitude, and phase data.
Frequency Resolution	Sample Rate ÷ Length [2.93 Hz at 48 ks/s for a waveform 16384 points in length].
Maximum Number of Tones	(Length / 2) –1 [8191 for Length = 16384].

Dither

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

Probability Distribution	Triangular or rectangular; pseudo random, independent for each channel.
Spectral Distribution	Flat (white) or Shaped (+6 dB/oct).
Amplitude	8 bit–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].

Digital Analyzer

Available only in the SYS-2720 and SYS-2722 configurations.

Digital Interface Signal Measurements

Input Sample Rate	
Range	28 kHz–200 kHz for fully specified performance, typically <24 kHz–216 kHz.
Accuracy	
Int. Reference	±(0.0003% + 1 digit) [±3 PPM].
Ext. Reference	±(0.0001% + 1 digit) [±1 PPM].
Input Amplitude	
Balanced (XLR)	0 Vpp–10.00 Vpp, ±(5% + 25 mV).
Unbalanced (BNC)	0 Vpp–2.5 Vpp, ±(5% + 6 mV).
Optical	Displays voltage of internal logic signal (not linearly related to optical input power).
Jitter Measurement	
Range[24]	0 UI–0.200 UI [0 ns–32 ns at 48k, 0 ns–8.0 ns at 192k, etc.].
Accuracy	±(10% + 1.0 ns), peak calibrated.
Detection	"Pk" (for measurements per AES-3), or "Avg" (for transfer function measurements).
Bandwidth	<50 Hz–100 kHz, 120 Hz–100 kHz, 700 Hz–100 kHz, or 1.2 kHz–100 kHz.
Flatness[25]	±1 dB, 100 Hz–50 kHz.
Residual Jitter[26]	≤600 ps with "700 Hz–100 kHz" bandwidth, ≤1.0 ns with "50 Hz–100 kHz" bandwidth.
Jitter Spectrum	Spurious products are typically 40 dB below jitter signal or <0.0003 UI [–70 dBUI], whichever is larger.
Common Mode Amplitude	0 Vpp–20.0 Vpp, ±(10% + 50 mV), 100 Hz–100 kHz.
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).
Output to Input Delay	Measures propagation from the rear panel AES/EBU Reference Output to the input.
Range	–12.7 to +115.1 UI [–10% to +90% of frame] in seconds, 60 ns resolution.

[24] The maximum measureable jitter increases to 1.000 UI for sine wave jitter signals below 1 kHz decreasing to 0.200 UI at or above 8 kHz.

[25] System specification at 32, 44.1, 48, 88.2, 96, 176.4, and 192 ks/s using the "50 Hz to 100 kHz" analyzer bandwidth selection. Flatness of the jitter generator will exhibit degradation at other sample rates.

[26] Applies to balanced and unbalanced signal formats only. Specification subject to the following conditions: (1) all jitter generator impairments must be turned off or disabled including the delay from reference output feature, (2) the digital input signal must be ≥ 1.5 Vpp (AES/EBU) or ≥ 300 mVpp (SPDIF-EIAJ) and have a risetime ≤ 20 ns. Jitter via the optical path may be considerably worse with embedded audio or dither enabled.

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).

Digital Interface Analyzer

with "INTERVU" DSP program

The Digital Interface Analyzer (Intervu) operates in conjunction with an 8-bit A/D converter clocked at 80.0 MHz. The analyzer can display the interface signal in time or frequency domain, as an eye pattern, or probability graphs of amplitude or pulse width. The Digital Interface Analyzer can also demodulate the jitter signal and display it in 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	0 Vpp–10.00 Vpp, ±(10% + 50 mV).
Unbalanced	0 Vpp–2.5 Vpp, ±(8% + 12 mV).
Jitter Amplitude	0 UI–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 Vpp–20.00 Vpp, ±(30% + 50 mV), 20 kHz–1 MHz.
Jitter Probability Display	256 bins, auto-ranging.
Input Probability Display	256 bins, auto-ranging.
Bit Width Probability Display	32768 bins.
Risetime	Typically 17 ns–20 ns.
Acquisition time / memory	19.66 ms / 1,572,864 samples.

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 45.8% of Sample Rate, [10 Hz–20.2 kHz at 44.1 ks/s], [10 Hz–22.0 kHz at 48 ks/s], [10 Hz–44.0 kHz at 96 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	$f_S/2$ (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 CCIR Rec. 468, 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 22* HI-2 Harmonic weighting.
Residual Noise (at 48 ks/s and 96 ks/s f_s)	–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 40% of Sample Rate, [10 Hz–17.6 kHz at 44.1 ks/s], [10 Hz–19.2 kHz at 48 ks/s], [10 Hz–38.4 kHz at 96 ks/s].
Filter Shape	10-pole, Q=19 (BW = 5.3% of f_o). *–see Figure 29, page 22*
Residual Distortion	≤–150 dBFS.

THD+N Measurements

Frequency Range	<10 Hz to 47% of Sample Rate, [10 Hz–19.9 kHz at 44.1 ks/s], [10 Hz–21.6 kHz at 48 ks/s], [10 Hz–43.2 kHz at 96 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	$F_S/2$ (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–21.0 kHz at 44.1 ks/s], [10 Hz–23.0 kHz at 48 ks/s], [10 Hz–46.0 kHz at 96 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[27]	±0.05 degree, 10 Hz to 45% of Sample Rate.
Resolution	0.01 degree.
Minimum Input	–30 dBFS, both inputs.

SMPTE IMD Measurements

Test Signal Compatibility	Any combination of 40 Hz–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. (–3 dB measurement bandwidth is 10 Hz–750 Hz.)
Measurement Range	0%–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.

Embedded Audio, FFT Spectrum Analyzer

with "FFT" DSP program (48-bit processing)

Acquisition Length	800 samples–4 M samples in 15 steps.
Transform Length	256–32768 samples in binary steps.
Windows (see Figures 26 and 27, page 21)	Blackman-Harris (4-term with –92 dB sidelobes), Hann, Flat-top, Equiripple (AP design –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–20 kHz, with Flat-top window.
Phase Accuracy[28]	±0.05 degree, 10 Hz to 45% of Sample Rate.
Resolution	0.01 degree.
Averaging	1–4096 averages in binary steps. Averaging is power-based (frequency domain), or synchronous (time domain).

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

[28] *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*

Distortion Products	≤–160 dB.
Display Modes Time Domain Frequency Domain	 Normal, Interpolate, Peak or Max. Peak pick, individual bin, Smoothing.
Move to bin center Window Frequency Range Amplitude Accuracy Spurious Products	 7^{th} bin to 45% of Sample Rate, and ±4% of input frequency[21.6 kHz at 48 ks/s]. ±0.025 dB. ≤–120 dB.

Embedded Audio, Multitone Audio Analyzer

with “FASTTEST” DSP program (48 bit processing)

Acquisition Length	512–32768 samples in binary steps.
Transform Length	512–32768 samples in binary steps.
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 ks/s].
Frequency Correction Range	±3%.
Distortion	≤–140 dB.

Embedded Audio, Quasi-Anechoic Acoustical Tester

with “MLS” DSP program

Signals	Four pink sequences and four white sequences, selected by triggering generator MLS setting.
Frequency Range	(Sample Rate ÷ 2000) to (Sample Rate ÷ 2).
Frequency Resolution (Max)	1.465 Hz at 48 ks/s.
Acquisition Length	32767 or 131071 samples, selected by triggering generator MLS setting.
FFT Length	32768.
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%.
Averaging	1–4096 averages in binary steps, synchronous.

Graphs of Typical Digital Domain Performance

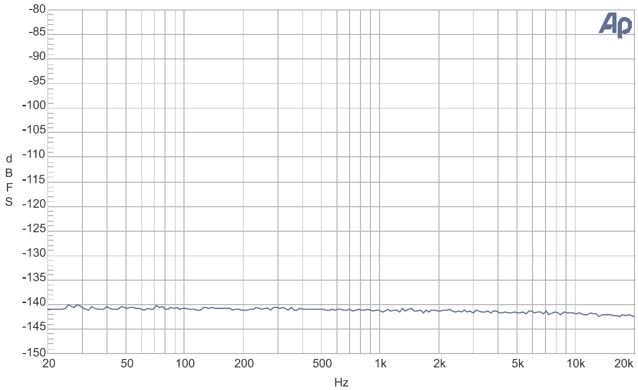

Figure 31. Typical Digital Domain system residual THD+N showing components below –140 dB.

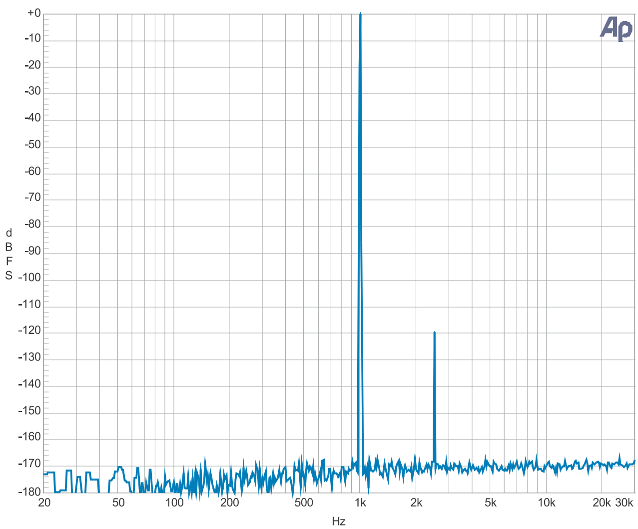

Figure 32. Illustration of typical Digital Domain FFT dynamic range. Signal is 0 dB 1 kHz with a secondary signal at –120 dB and 2.5 kHz.

Front Panel Auxiliary Signals

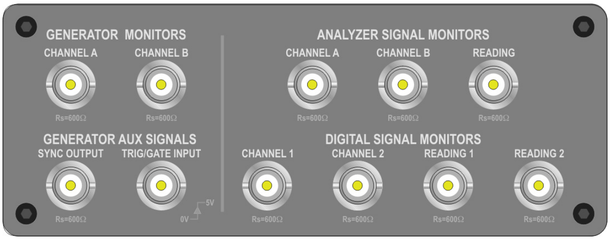

Figure 33. Monitors panel.

Generator Monitors

(all units except SYS-2720.)

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-2720.)

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-2720.)

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

Digital Signal Monitors

(SYS-2720 & SYS-2722 only.)

Via four 24-bit D/A converters. Function monitored depends upon analyzer program loaded; for example, noise and distortion products after the 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.

Rear Panel Auxiliary Signals

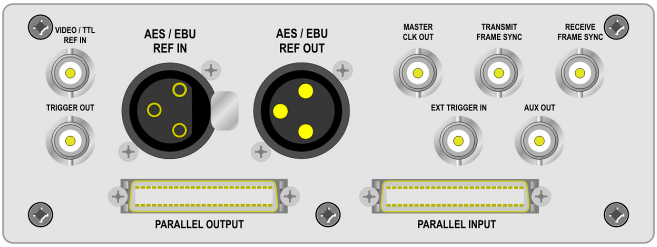

Figure 34. Miscellaneous digital I/O panel (rear of SYS-2720 and SYS-2722 instruments only).

Reference Input ("REF IN") Characteristics

The reference input provides the ability to synchronize the internal sample rate generator to an external signal. The sample rate need not be at 1:1 ratio to the reference, but will be locked to the reference over the fully specified range of sample rate and Reference inputs. PLL bandwidth is approximately 5 Hz.

Input formats	28 kHz–200 kHz AES/EBU, NTSC, PAL, or SECAM video, or 8 kHz–10 MHz square wave.
Sample Rate Resolution 8 kHz–65 kHz 65 kHz–256 kHz 256 kHz–1 MHz 1 MHz–4 MHz 4 MHz–10 MHz	 1/128 Hz [0.0078125 Hz]. 1/32 Hz [0.03125 Hz]. 1/8 Hz [0.125 Hz]. ½ Hz [0.5 Hz]. 2 Hz.
Input Amplitude	200 mVpp–5.0 Vpp.
Input Impedance AES/EBU (XLR) Video/TTL (BNC)	Selectable terminated or high impedance. Nominally 110Ω or 5kΩ. Nominally 75Ω or 5kΩ.
Lock Range	±0.0015% [±15 PPM].
Input Delay from Reference Display	–12.7 to +115.1 UI [–10 to +90% of frame] in seconds, ±60 ns, AES/EBU signals only.
Reference Rate Display	Measures approximate reference input rate.

Reference Output ("REF OUT") Characteristics

Intended to drive devices under test that require their own reference input. The reference output signal is not jittered.

Output format	AES/EBU (per AES3-r1997).
Output Sample Rates	8 kHz–216 kHz, locked to front panel output.
Status Bits	Format "Professional," 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 to +63.5 UI in 0.5 UI steps, ±(5% + 0.5 UI).
Residual Jitter	≤600 ps (700 Hz–100 kHz BW).

Miscellaneous Digital I/O

Transmit Frame Sync	Square wave at the programmed internal sample rate (SR).
Receive Frame Sync	Square wave at the frame rate of the received AES/EBU signal.
Master Clock Out	Square wave at a multiple of the System Sample Rate (“SSR”). The multiple is: 1024x for SSR = 8 kHz to <13.5 kHz, 512x for SSR = 13.5 kHz to <27 kHz, 256x for SSR = 27 kHz–108 kHz. Selectable between jittered and un-jittered signals.
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.
Parallel Input and Output	For use with optional PSIA-2722 accessory.

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 (non-condensing).
Altitude	2000 m.
EMC[29]	Complies with 89/336/EEC, CISPR 22 (class B), and FCC 15 subpart J (class B).
Dimensions	
Width	41.9 cm [16.5 inches].
Height	14.6 cm [5.75 inches] bench-top (feet attached) 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, 93/68/EEC, and 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 will depend on the internal design of the cable, connector quality, and the assembly methods used. EMC compliance was demonstrated using Audio Precision pn 4155.0117 cables for all ports using XLR-type connectors, Audio Precision pn 4155.0301 cable for the Master Clk port, and Pasternack Model No. PE3067-36 for all remaining ports using BNC-type connectors.*

Cables and Adapters

Analog Audio Cables

These cables provide a convenient method to connect Audio Precision measurement equipment with a device under test. The cable kits consist of four cables, each with a unique color band at the connector ends to facilitate identification. The cables are high quality Mogami NEGLEX super flexible shielded cable, and are 8 ft (2.4 m) long. The cables and connector shells are satin black, and all connectors have gold plated contacts.

- CAB-XMF consists of a set of four XLR male to XLR female cables.
- CAB-XBR consists of a set of four cables: two with RCA/PHONO male to XLR male connectors, and two with RCA/PHONO male to XLR female connectors. Also provided are four adapters, from RCA female to BNC male. The cables are wired with pin 2 of the XLR connector as "hot" (center pin of the RCA connector) and pins 1 and 3 connected to ground and shield, to agree with the unbalanced wiring convention of Audio Precision instruments. See Figures 35 and 36.

Figure 35. CAB-XBR cable kit

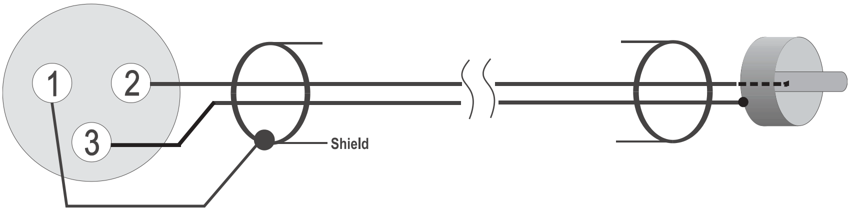

Figure 36. XLR to BNC wiring

Digital Audio Cables

Figure 37. CAB-AES cable set

These cables are designed for digital audio connections using the AES/EBU format, XLR connectors, 110 Ω cable, double-shielded for improved EMI performance.

- CAB-AES: Set of two AES/EBU cables, 39 in (1 m) long. See Figure 37.
- CAB-AES2: Set of two AES/EBU cables, 6.5 ft (2 m) long.
- CAB-AES4: Set of two AES/EBU cables, 13 ft (4 m) long.
- CAB-DIO: Set of two interface cables, 4.25 ft (1.3 m) long, to connect between the SYS-2722 rear panel 50-pin ribbon input/output connectors to a DUT fixture with 0.1 in spaced 2 x 25-pin headers. See Figure 38.

Figure 38. CAB-DIO cables.

Cable Adapters

- CAD-RCA: set of 14 RCA/Phono female to BNC male adapters, intended primarily for use with the SWR-2122U Unbalanced Switcher.

Digital Control (APIB) Cables

These cables can be used as extensions or replacements for the APIB cables that come with each switcher or DCX-127.

- CAB-D0: Extension APIB Interface cable, 20 in (0.5 m).
- CAB-D2: Extension APIB Interface cable, 6.5 ft (2 m).
- CAB-D6: Extension APIB Interface cable, 12.7 ft (6 m).