# APPENDIX E
# SPECIFICATIONS

*Specifications describe the instrument's warranted performance. Supplemental characteristics are intended to provide information useful in applying the instrument by giving typical, but non-warranted, performance specifications. Supplemental characteristics are denoted as 'typical,' 'nominal,' or 'approximately.'*

## Frequency and Time

**MEASUREMENT MODES:**

**Narrowband:** 125 μHz to 100,000 Hz frequency range. Resolution is frequency span/400. All window, trigger and averaging types are available.

**Phase:** Phase spectrum is available with or without triggering. When triggered, phase is referenced to the trigger.

**⅓ Octave:** 0.8 Hz to 80 kHz - see separate Octave section.

**Full Octave:** 1 Hz to 63 kHz - see separate Octave section.

**Time Capture:** Time record can be extended from 1k to 40k samples of continuous input data. Up to 40x zoom expansion factor can be applied to this data.

**External Sampling:** Input sample rate can be externally controlled up to 256 kHz. TTL compatible sample rate input on rear panel. (Note: Some specs may be degraded in external sample mode).

**FREQUENCY SELECTION:**

**0 to 100 kHz:** Measurement is made over the full frequency range of the analyzer with 250 Hz resolution.

**Define Start or Center:** Measurement is made over the selected frequency span. Start or center frequency can be set anywhere in the 0 to 100 kHz range with resolution of 0.25 Hz.

**Define Span:** Measurement frequency spans are provided in a 1, 2, 2.5, 5, 10 sequence. (Other spans exist between these intervals, but are too numerous to list in the space available.)

**Define Time Length:** Measurement time can be set from 0.004 seconds to 651 minutes per time record. Time setting is rounded up to agree with next available span.

**ACCURACY:**

**Frequency Accuracy:** ± 0.003% of frequency reading

**RESOLUTION:**

**Frequency Resolution:** Span/400

**SPANS:**

| | Zoom | Baseband |
|---|---|---|
| # spans available | 43 | 52 |
| min span | 0.25 Hz | 0.01 Hz |
| max span | 100 kHz | 100 kHz |
| time record length | 400/span | 400/span |
| resolution | span/400 | span/400 |

**MEASUREMENT WINDOWS:**

*Windows are weighting functions which are applied to input data to reduce measurement errors due to leakage.*

**Flat Top:** Provides optimum amplitude accuracy.

**Hann:** Provides an amplitude accuracy/frequency resolution compromise. Useful for general purpose and measurements using random noise.

**Uniform:** Equal weighting of the time record for measuring transients, or response measurements using the internal periodic noise source.

**Exponential:** Variable exponential decay weighting is applied to the time record. Useful for transients which have a duration greater than the time record.

**Window Parameters:**

| | Flat Top | Hann | Uniform |
|---|---|---|---|
| Noise Equiv. BW (% of span) | 0.955 | 0.375 | 0.25 |
| 3dB BW (% of span) | 0.90 | 0.37 | 0.25 |
| Shape factor (60dB BW/3dB BW) | 2.6 | 9.1 | 716 |

**TYPICAL REAL TIME BANDWIDTH:**

| Operating mode | Real time bandwidth | Spectra/sec |
|---|---|---|
| HP-IB transfer | 750 Hz | 1.9 |
| Single display | 3 kHz | 7.5 |
| Fast Averaging | 7.5 kHz | 20 |

## Amplitude and Input

**AMPLITUDE:**

**Input Range:** The calibrated input range is 27 dBV (+22.4 V) to −51 dBV (3 mV) maximum input level (single tone RMS). Range is adjustable in 1 dB (10%) increments.

**Autorange:** The optimum input range is automatically selected prior to processing. This feature can be deactivated.

**Amplitude Overload/Underload:** Overload occurs when the input level exceeds input range by nominally 1.0 dB or 10%. Overload measurements can be automatically rejected during averaging. The HALF range indicator lights when input signal is within 6 dB of full scale.

**Dynamic Range:** Distortion, spurious and alias products ≥80 dB below input range

**DC Response:** (With Auto-Cal on)
+27 dBV to −35 dBV: >30 dB below input range
−36 dBV to −51 dBV: >20 dB below input range

**Amplitude Marker Resolution:**
Log: 0.01 dB
Linear: 4 digits

**Amplitude Accuracy:**
Full Scale Accuracy at calculated frequency points. Overall accuracy is the sum of absolute accuracy, window flatness and noise level.

**Absolute Accuracy:**
±0.15 dB ±0.015% of input range:
+27 dBV to −40 dBV
±0.25 dB ±0.025% of input range:
−41 dBV to −51 dBV

**Window flatness:**
Flat top: +0, −0.01 dB
Hanning: +0, −1.5 dB
Uniform: +0, −4.0 dB

**Noise Level:** Flat top filter, 50Ω source impedance,
20 Hz to 1 kHz (1 kHz span) < −131 dBV
(−141 dBV/√Hz)
2 kHz to 100 kHz (100 kHz span) < −120 dBV
(−150 dBV/√Hz)

**Phase Marker Resolution:** 0.1 degree
**Phase Accuracy:** ±2°, dc-10 kHz. ±10° 10 kHz - 100 kHz referenced to the trigger point.

**INPUT:**

**Input Impedance:** 1MΩ ±5% shunted by 95 pF maximum.
Floating Ground to Case Capacitance: < 0.25 μF

**DC Isolation:** Input low may be connected to chassis ground or floated up to 30 volts RMS (42 Vpk).

**Input Coupling:** The input signal may be ac or dc coupled. Low frequency 3 dB roll off < 1.0 Hz for ac.

**Anti-Alias Filter Roll-Off:** Analog and digital anti-aliasing filters roll off at a nominal rate of 130 dB/octave with a cut-off frequency at 105 kHz nominally.

**A-Weight Filter:** The hardware A-weight input filter conforms to ANSI Standard S1.4-1971.(R1976)

**ICP Current:** Nominal 4 mA current source provided on input BNC connector. Compatible with Integrated Circuit Piezoelectric accelerometers. Open circuit voltage is 24 volts nominal.

## Octave Analysis

*The measurement is made in synthesized 1/3 or full (1/1) octave bands. Filter bandwidth, center frequency, and bandshape meet ANSI Class III (Class II for full octave) specifications.*

| | # Bands Available | # Bands Displayed |
|---|---|---|
| 1/3 | 51 | 33 |
| 1/1 | 17 | 11 |

**1/3 and 1/1 Octave Analysis Parameters:**

| | Band center Frequency Range | Data Collection Time | Band #'s Displayed |
|---|---|---|---|
| 1/3 Octave | 50 Hz to 80 kHz | 0.4 sec | 17 to 49 |
| | 25 Hz to 40 kHz | 0.8 sec | 14 to 46 |
| | 12.5 Hz to 20 kHz | 1.6 sec | 11 to 43 |
| | 6.3 Hz to 10 kHz | 3.2 sec | 8 to 40 |
| | 3.15 Hz to 5 kHz | 6.4 sec | 5 to 37 |
| | 1.6 Hz to 2.2 kHz | 12.8 sec | 2 to 34 |
| | 0.8 Hz to 1.25 kHz | 25.6 sec | −1 to 31 |
| 1/1 Octave | 63 Hz to 63 kHz | 0.4 sec | 18 to 48 |
| | 31.5 Hz to 31.5 kHz | 0.8 sec | 15 to 45 |
| | 16 Hz to 16 kHz | 1.6 sec | 12 to 42 |
| | 8 Hz to 8 kHz | 3.2 sec | 9 to 39 |
| | 4 Hz to 4 kHz | 6.4 sec | 6 to 36 |
| | 2 Hz to 2 kHz | 12.8 sec | 3 to 33 |
| | 1 Hz to 1 kHz | 25.6 sec | 0 to 30 |

**Computation Time:** *1/3 octave and 1/1 octave computation is made in less than 0.80 seconds*

## Trigger

**TRIGGER MODES:**

**Free Run:** *A new measurement is initiated by completion of the previous measurement.*

**External:** *A new measurement is initiated by a TTL pulse applied to the rear panel external trigger input.*

**Internal:** *Allows measurements to be initiated by pressing manual arm.*

**Input:** *A new measurement is initiated when the input signal meets the defined trigger level conditions.*

**Source:** *New measurements are synchronized with the internal source.*

**HP-IB:** *A new measurement is initiated by sending a group execute trigger from an external controller over the HP-IB.*

**TRIGGER ARM:**

**Auto Arm:** *Measurements are initiated automatically when trigger conditions are met.*

**Manual Arm:** *Enables a single measurement when the trigger conditions are met.*

**TRIGGER LEVEL:**

*Triggering can be set to occur when the input reaches a user definable input level. Definable from 0 to 110% of full range setting. Positive and negative levels and slopes can be set.*

**TRIGGER DELAY:**

**Pre-Trigger:** *The measurement can be based on input data from 1/1024 to 8 time records before trigger conditions have been met, with resolution of 1/1024 of a record. Time capture mode can be used for pre-trigger delays of up to 40 records.*

**Post-Trigger:** *The measurement is initiated from 1/1024 to 1023 time records after trigger conditions have been met. Resolution is 1/1024 of a record.*

## Measurement Averaging

**AVERAGING TYPES:**

**RMS:** *For each calculated frequency point the displayed amplitude is averaged in a root mean square fashion.*

**Peak Hold:** *Same as RMS except the maximum amplitude value is stored for each frequency bin. Phase is not available.*

**RMS Exponential Weighting:** *After each spectrum measurement the average is updated by weighting the new spectrum and the previous average as follows, where k is a user defined factor.*

$$A_i = (1-k)A_{i-1} + (k)A_{new}$$

**Time:** *For each calculated frequency point the displayed amplitude and phase are averaged linearly. In this mode, a trigger signal is required, and signals that are not synchronous with the trigger will average toward zero.*

**Number of Averages:** *1 to 16,383.*

**AVERAGE CONTROL:**

**Start:** *Starts a new average or measurement.*

**Pause/Cont.:** *Pauses the average, or continues a paused average.*

**Overload Reject:** *Automatically detects and rejects overloaded blocks from the average.*

**Fast Display:** *Provides maximum averaging rate by not displaying intermediate results.*

**Normal Display:** *The average is computed and displayed for each new spectrum.*

**Repeat Display:** *The Repeat Display function inhibits the display of intermediate average results. Only the final computed average is displayed, and then the measurement is restarted. Available in RMS and time average modes only.*

## Source

*Band limited, band translated pseudo random, random, impulse or TTL "sync" signals are available on the rear panel. Impulse produces nominal 2 V peak into 50 Ω, with no attenuation.*

**Impedance:** *50 ±5 ohms.*

**LEVEL AND ACCURACY:**

| | | | |
|---|---|---|---|
| Baseband | All spans* | 0.7 V rms ± 10% |
| Zoom | All spans | 0.5 V rms ± 15% |

* *Random Source in 0-100 kHz span has level accuracy of ±20%.*

**FLATNESS:**

| | | Periodic | Random** |
|---|---|---|---|
| Baseband | 0-50 kHz | ±0.7 dB | ±0.7 dB |
| | 0-100 kHz | ±0.8 dB | ±1.6 dB |
| zoom | all spans | ±2.0 dB | ±2.0 dB |

** *Random Source flatness approaches these specs as number of RMS Averages increases.*
*Note: All zoom flatness specs are valid if center frequency >0.7 × span*

**ATTENUATION:**

| (nominal 1.5 dB steps) | max attenuation |
|---|---|
| pseudo random, random | 40.5 dB |
| impulse | 30 dB |

## Display

Magnitude, Phase, Time and Math traces may be selected. Units available are: Horizontal: Hz, Seconds, RPM, and Orders with linear or logarithmic spacing. Vertical: Volts, dBV, dBm (selectable R), and user defined units.

**MAGNITUDE:**

**Log:** 0.5 to 40 dB/division. Units of dBV, dB relative, dBm (user defined impedance) and dBEU are provided.

**Linear:** Constant volts/division, milliwatts/division, or user defined units/division.

**PHASE:**

**Resolution:** 0.1 degree with marker

**Display Range:** ±240 degrees about user definable center reference. (±320 degrees)

**TIME:**

**Resolution** = Time Record Length (sec)/400

**Display Range:** ±110% of input range.

**MATH:**

Arithmetic operations can be performed on new and recalled traces. Addition, subtraction, multiplication, division, single and double integration, differentiation and user definable constants are provided. 1/BW is provided for PSD computations.

**FORMAT:**

**Single:** Selected data is displayed on full CRT trace height.

**Front-Back:** Two selected traces are displayed simultaneously, full CRT height. Back trace has no marker and is displayed at "half bright" intensity.

**Upper-Lower:** Two one-half height traces can be displayed.

**Map:** 1 to 60 amplitude spectra may be displayed simultaneously in a "spectral map" display. These may be consecutive measurement spectra, stored traces, or transformed from time capture records.

**SCALE:**

Linear or Log magnitude scales may be selected. Full scale, dB/div, and degrees/div are user definable. Center scale definable in time or phase traces.

**Autoscale:** Provides a one time automatic scaling of data to optimize display scale and units per division for best view.

## Internal Memory

| | Traces + States (non-volatile) | Time Buffer (volatile) |
|---|---|---|
| Standard | 2 traces + 6 states | 40 time records |
| Option 001 | traces + states + (1 + 2 × time capture records) = 127 | 40 time records |

## Marker

**Single:** Provides precision readout of X and Y axis values of currently displayed units. MKR → Peak, MKR → Center Frequency, MKR → Full Scale and Peak-track are provided. Relative marker provides measurements relative to a reference which can be set with the single marker or user-defined X and Y axis unit settings.

**Band Power:** Two independently controllable markers may be used to calculate power in a given band.

**Harmonic:** Up to 20 harmonics of the selected fundamental are marked. T.H.D. is calculated and displayed.

**Sideband:** Up to 10 modulation sidebands can be marked. Carrier frequency is user definable. The ratio of sideband to carrier power is displayed.

**Amplitude Marker Resolution:** log: 0.01 dB
linear: 4 digits

## Plot

Controls HP-GL compatible digital plotters and raster graphics printers directly. Replicates display contents. "MARKER plot" allows marker position and amplitude to be annotated on plots at user defined locations.

## General

**Specifications apply when:**
Warm-up time: None with AUTO-CAL enabled, or 30 minutes without AUTO-CAL enabled.
Within 5°C and 2 hrs of last internal calibration.
Ambient temperature: 0° to 55° C.
Relative Humidity: < 95% at 40° C.
Altitude: <4570m (15,000 ft.)

**Storage:** Temperature: −40° to +75° C.
Altitude: <15,240m (50,000 ft.)

**Power:** 100/120 VAC +5% −10%, 48-440 Hz
220/240 VAC +5% −10%, 48-66 Hz
150 VA maximum

**Weight:** 15 kg (33 lbs) net
21.6 kg (47.5 lbs) shipping

**Dimensions:** Without handle: 197mm (7.8") high
335mm (13.2") wide
595mm (23.4") deep

**HP-IB:** Implementation of IEEE Std 488-1978
SH1 AH1 T5 TE0 L4 LE0 SR1 RL1 PP0 DC1 DT1 C0

**Accessories Included:** Front (bail) handle, pouch, front cover, Operating and Service manuals.

**Accessories:**
Transit case for 3561A: HP # 9211-2459
Rack Adapter for 3561A: HP #10491B, also requires fixed slides (1490-0714) or pivot slides (1490-0768).