# Agilent 35670A
# Dynamic Signal Analyzer

## Versatile two- or four-channel high-performance FFT-based spectrum/network analyzer
## 122 µHz to 102.4 kHz 16-bit ADC

Data Sheet

## Key Specifications

| | |
|---|---|
| Frequency range | 102.4 kHz 1 channel<br>51.2 kHz 2 channel<br>25.6 kHz 4 channel |
| Dynamic range | 90 dB typical |
| Accuracy | ±0.15 dB |
| Channel match | ±0.04 dB and ±0.5 degrees |
| Real-time bandwidth | 25.6 kHz/1 channel |
| Resolution | 100, 200, 400, 800 & 1600 lines |
| Time capture | > 6 Msamples |
| Source types | Random, burst random, periodic chirp, burst chirp, pink noise, sine, swept-sine ( Option1D2), arbitrary ( Option 1D4) |

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# Summary of Features on Standard Instrument

The following features are standard with the Agilent 35670A:

## Instrument modes

FFT analysis
Correlation analysis
Histogram/time
Time capture

## Measurement

Frequency domain
Frequency response
Linear spectrum
Cross spectrum
Power spectrum
Coherence
Power spectral density

Time domain (oscilloscope mode)
Time waveform
Cross-correlation
Autocorrelation
Orbit diagram

Amplitude domain
Histogram, PDF, CDF

## Trace coordinates

Linear magnitude
Log magnitude
dB magnitude
Group delay
Phase
Unwrapped phase
Real part
Imaginary part
Nyquist diagram
Polar

## Trace units

**Y-axis amplitude:** combinations of units, unit value, calculated value, and unit format describe y-axis amplitude
**Units:** volts, g, meters/sec$^2$, inches/sec$^2$, meters/sec, inches/sec, meters, mils, inches, pascals, Kg, N, dyn, lb, user-defined EUs
**Unit value:** rms, peak, peak-to-peak
**Calculated value:** V, V$^2$, V$^2$/Hz, √Hz, V$^2$s/Hz (ESD)
**Unit format:** linear, dB's with user selectable dB reference, dBm with user selectable impedance.
**Y-axis phase:** degrees, radians
**X-axis:** Hz, cpm, order, seconds, user-defined

## Display formats

Single
Quad
Dual upper/lower traces
Small upper and largelower
Front/back overlay traces
Measurement state
Bode diagram
Waterfall display with skew, -45 to 45 degrees
Trace grids on/off
Display blanking
Screen saver

## Display scaling

Autoscale
Manual Scale
Input range tracking
Selectable reference
Linear or log X-axis
Y-axis log
X & Y scale markers with expand and scroll

## Marker functions

Individual trace markers
Coupled multi-trace markers
Absolute or relative marker
Peak search
Harmonic markers
Band marker
Sideband power markers
Waterfall markers
Time parameter markers
Frequency response markers

## Signal averaging (FFT mode)

Average types (1 to 9,999,999 averages)
RMS
RMS exponential
Time
Time exponential
Peak hold

## Averaging controls

Overload reject
Fast averaging on/off
Update rate select
Select overlap process percentage
Preview time record

## Measurement control

Start measurement
Pause/continue measurement

## Triggering

Continuous (Freerun)
External (analog or TTL level)
Internal trigger from any channel
Source synchronized trigger
GPIB trigger
Armed triggers
Automatic/manual
RPM step
Time step
Pre- and post-trigger measurement Delay

## Tachometer input:

±4 V or ±20 V range
40 mv or 200 mV resolution
Up to 2048 pulses/rev
Tach hold-off control

## Source outputs

| | |
|---|---|
| Random | Burst random |
| Periodic chirp | Burst chirp |
| Pink noise | Fixed sine |

Note: Some source types are not available for use in optional modes. See option description for details.

## Input channels

| | |
|---|---|
| Manual range | Anti-alias filters On/Off |
| Up-only auto range | AC or DC coupling |
| Up/down auto range | LED half range and overload indicators |
| Floating or grounded | A-weight filters On/Off |

Transducer power supplies (4 ma constant current)

## Frequency

20 spans from 195 mHz to 102.4 kHz (1 channel mode)
20 spans from 98 mHz to 51.2 kHz (2 channel mode)
Digital zoom with 244 µHz resolution throughout the 102.4 kHz frequency bands.

## Resolution

100, 200, 400, 800 and 1600 lines

## Windows

| | |
|---|---|
| Hann | Uniform |
| Flat top | Force/exponential |

## Math

| | |
|---|---|
| +,-,*, / | Conjugate |
| Magnitude | Real and imaginary |
| Square Root | FFT, $FFT^{-1}$ |
| LN | EXP |
| *jω or /jω | PSD |
| Differentiation | A, B, and C weighting |
| Integration | Constants K1 thru K5 |
| | Functions F1 thru F5 |

## Analysis

Limit test with pass/fail
Data table with tabular readout
Data editing

## Time capture functions

Capture transient events for repeated analysis in FFT, octave, order, histogram, or correlation modes (except swept-sine). Time-captured data may be saved to internal or external disk, or transferred over GPIB. Zoom on captured data for detailed narrowband analysis.

## Data storage functions

Built-in 3.5 in., 1.44-Mbyte flexible disk also supports 720-KByte disks, and 2 Mbyte NVRAM disk. Both MS-DOS® and HP-LIF formats are available. Data can be formatted as either ASCII or binary (SDF). The 35670A provides storage and recall from the internal disk, internal RAM disk, internal NVRAM disk, or external GPIB disk for any of the following information:

| | |
|---|---|
| Instrument setup states | Trace data |
| User-math | Limit data |
| Time capture buffers | Agilent Instrument BASIC |
| Waterfall display data | Programs |
| Data tables | Curve fit/synthesis tables |

## GPIB capabilities

Conforms to IEEE 488.1/488.2
Conforms to SCPI 1992
Controller with Agilent Instrument Basic Option

## Calibration & memory

Single or automatic calibration
Built-in diagnostics & service tests
Nonvolatile clock with time/date
Time/date stamp on plots and saved data files

## Online help

Access to topics via keyboard or index

## Fan

On/Off

# Agilent 35670A Specifications

Instrument specifications apply after 15 minutes warm-up and within 2 hours of the last self-calibration. When the internal cooling fan has been turned OFF, specifications apply within 5 minutes of the last self-calibration. All specifications are with 400 line frequency resolution and with anti-alias filters enabled unless stated otherwise.

## Frequency

| | |
|---|---|
| **Maximum range**** | |
| 1 channel mode | 102.4 kHz,<br>51.2 kHz (opt AY6*) |
| 2 channel mode | 51.2 kHz |
| 4 channel mode (Option AY6 only) | 25.6 kHz |
| **Spans** | |
| 1 channel mode | 195.3 mHz to 102.4 kHz |
| 2 channel mode | 97.7 mHz to 51.2 kHz |
| 4 channel mode (Option AY6 only) | 97.7 mHz to 25.6 kHz |
| **Minimimum resolution** | |
| 1 channel mode | 122 µHz (1600 line display) |
| 2 channel mode | 61 µHz (1600 line display) |
| 4 channel mode (Option AY6 only) | 122 µHz (800 line display) |
| **Maximum real-time bandwidth** | |
| FFT span for continuous data acquistion) (Preset, fast averaging) | |
| 1 channel mode | 25.6 kHz |
| 2 channel mode | 12.8 kHz |
| 4 channel mode (Option AY6 only) | 6.4 kHz |
| **Measurement rate** | |
| (Typical) *(Preset, fast averaging)* | |
| 1 channel mode | ≥ 70 averages/sec |
| 2 channel mode | ≥ 33 averages/sec |
| 4 channel mode (Option AY6 only) | ≥ 15 averages/sec |
| **Display update rate** | |
| Typical (Preset, fast average off) | ≥ 5 updates/Sec |
| Maximum | ≥ 9 updates/Sec |

*(Preset, fast average off, single channel, single display, undisplayed trace displays set to data registers)*

## Accuracy

±30 ppm (.003%)

**Single channel ampltude**

**Absolute amplitude accuracy (FFT)**

(A combination of full scale accuracy, full scale flatness, and amplitude linearity.)

±2.92% (0.25 dB) of reading

±0.025% of full scale

FFT full scale accuracy at 1 kHz (0 dBfs)

±0.15 dB (1.74%)

FFT full scale flatness (0 dBfs) relative to 1 kHz

±0.2 dB (2.33%)

FFT amplitude linearity at 1 kHz measured on +27 dBVrms range with time avg, 0 to -80 dBfs

±0.58% (0.05 dB) of reading

±0.025% of full scale

**Amplitude resolution**

(16 bits less 2 dB over-range) with averaging 0.0019% of full scale (typical)

**Residual DC response (FFT mode)**

**Frequency display (excludes A-weight filter)**

<-30 dBfs or 0.5 mVdc

**FFT dynamic range**

Spurious free dynamic range

(Includes spurs, harmonic distortion, intermodulation distortion, alias products). Excludes alias responses at extremes of span.

Source impedence = 50 Ω.

800 line display.

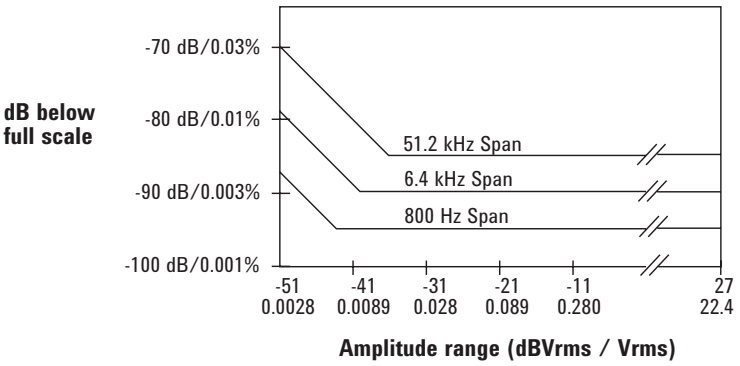
90 dB typical (<-80 dBfs)

* *Option AY6 single channel maximum range extends to 102.4 kHz without anti-alias filter protection.*

** *Show all lines mode allows display of up to 131.1, 65.5 and 32.7 kHz respectively. Amplitudes accuracy is unspecified and not alias protected.*

**Full span FFT noise floor** (typical)
Flat top window, 64 RMS averages, 800 line display.

**Typical noise floor vs. range for different frequency spans**




| | |
|---|---|
| **Harmonic distortion** | <-80 dBfs |
| Single Tone (in band), ≤ 0 dBfs | |
| **Intermodulation distortion** | <-80 dBfs |
| Two tones (in-band), each ≤ -6.02 dBfs | |
| **Spurious and residual responses** | <-80 dBfs |
| Source impedence = 50 Ω. | |
| **Frequency alias responses** | |
| Single tone (out of displayed range), ≤ 0 dBfs, ≤ 1 MHz (≤ 200 kHz with IEPE transducer power supply On) | |
| 2.5% to 97.5% of the frequency span | <-80 dBfs |
| Lower and upper 2.5% of frequency span | <-65 dBfs |

## Input noise

**Input noise level**
Flat top window, -51 dBVrms range
Source impedance = 50 Ω

| | |
|---|---|
| Above 1280 Hz | <-140 dBVrms/$\sqrt{2}$Hz |
| 160 Hz to 1280 Hz | <-130 dBVrms/$\sqrt{2}$Hz |

Note: To calculate noise as dB below full scale:
Noise [dBfs] = Noise [dB/$\sqrt{2}$Hz] + 10LOG(NBW) - Range [dBVrms]; where NBW is the noise equivalent BW of the window (see below).

| Window parameters | Uniform | Hann | Flat top |
|---|---|---|---|
| -3 dB bandwidth* | 0.125% of span | 0.185% of span | 0.450% of span |
| Noise equivalent bandwidth* | 0.125% of span | 0.1875% of span | 0.4775% of span |
| Attenuation at ±½ bin | 4.0 dB | 1.5 dB | 0.01 dB |
| Shape factor (-60 dB BW/-3 dB BW) | 716 | 9.1 | 2.6 |

* *For 800 line displays. With 1600, 400, 200, or 100 line displays, multiply bandwidths by 0.5, 2, 4, and 8, respectively.*

## Single channel phase

| | |
|---|---|
| **Phase accuracy relative to external trigger**<br>16 time averages center of bin,<br>DC coupled 0 dBfs to -50 dBfs only<br>0 Hz < freq ≤ 10.24 kHz only | ± 4.0 deg |

For Hann and flat top windows, phase is relative to a cosine wave at the center of the time record. For the uniform, force, and exponential windows, phase is relative to a cosine wave at the beginning of the time record.

## Cross-channel amplitude

| | |
|---|---|
| **FFT cross-channel gain accuracy**<br>Frequency response mode<br>Same amplitude range<br>At full scale: Tested with 10 RMS averages on the -11 to +27 dBVrms ranges, and 100 RMS averages on the -51 dBVrms range | ± 0.04 dB (0.46%) |

## Cross-channel phase

| | |
|---|---|
| **Cross-channel phase accuracy**<br>(Same conditions as cross-channel amplitude) | ± 0.5 deg |

## Input

**Input ranges** (full scale)
(Auto-range capability)
+27 dBVrms (31.7 Vpk) to -51 dBVrms (3.99 mVpk) in 2 dB steps

| | |
|---|---|
| **Maximum input levels** | 42 Vpk |
| **Input impedance** | 1 MΩ ±10%<br>90 µF nominal |
| **Low side to chassis impedance** | 1 MΩ ±30% (typical) |
| Floating mode | <0.010 µF |
| Grounded mode | ≤100 Ω |
| **AC coupling rolloff**<br>Source impedance = 50 Ω | <3 dB rolloff at 1 Hz |
| **Common mode rejection ratio**<br>Single tone at or below 1 kHz | |
| -51 dBVrms to -11 dBVrms ranges | >75 dB typical |
| -9 dBVrms to +9 dBVrms ranges | >60 dB typical |
| +11 dBVrms to +27 dBVrms ranges | >50 dB typical |

## Common mode range

| | |
|---|---|
| (floating mode) | ± 4 V pk |
| **IEPE transducer power supply** | |
| Current source | 4.25 ± 1.5 mA |
| Open circuit voltage | +26 to +32 Vdc |
| **A-weight filter**<br>Conforms to ANSI Standard S1.4-1983; and to IEC 651-1979; 10 Hz to 25.6 kHz | Type 0 tolerance |
| **Crosstalk**<br>Between input channels, and source-to-input (Receiving channel source impedance = 50 Ω) | < -135 dB below signal or < -80 dBfs of receiving channel, whichever response is greater in amplitude |

## Time domain

Specifications apply in histogram/time mode, and unfiltered time display

| | |
|---|---|
| **DC amplitude accuracy** | ±5.0 %fs |
| **Rise time of -1 V to 0 V test pulse** | <11.4 µSec |
| **Settling time of -1 V to 0 V test pulse** | <16 µSec to 1% |
| **Peak overshoot of -1 V to 0 V test pulse** | <3% |

**Sampling period**

| | |
|---|---|
| 1 channel mode | 3.815 µSec to 2 Sec in 2x steps |
| 2 channel mode | 7.629 µSec to 4 Sec in 2x steps |
| 4 channel mode (Option AY6 only) | 15.26 µSec to 8 Sec in 2x steps |

## Trigger

| | |
|---|---|
| **Trigger modes** | Internal, source, external (analog setting) GPIB |
| **Maximum trigger delay** | |
| Post trigger | 8191 seconds |
| Pre trigger | 8191 sample periods |
| No two channels can be further than ±7168 samples from each other. | |
| **External trigger max. input** | ±42 Vpk |
| **External trigger range** | |
| Low range | -2 V to +2 V |
| High range | -10 V to +10 V |
| **External trigger resolution** | |
| Low range | 15.7 mV |
| High range | 78 mV |

## Tachometer

| | |
|---|---|
| **Pulses per Revolution** | 0.5 to 2048 |
| **RPM** | 5 ≤ RPM ≤ 491,519 |
| **RPM Accuracy** | ±100 ppm (0.01%) (typical) |
| **Tach level range** | |
| Low range | -4 V to +4 V |
| High range | -20 V to +20 V |
| **Tach level resolution** | |
| Low range | 39 mV |
| High range | 197 mV |
| **Maximum tach input level** | ±42 Vpk |
| **Minimum tach pulse width** | 600 nSec |
| **Maximum tach pulse rate** | 400 kHz (typical) |

## Source output

| | |
|---|---|
| **Source types** | Sine, random noise, chrip, pink noise, burst random, burst chirp |
| **Amplitude range** | AC: ±5 V peak*<br>DC: ±10 V*<br>$^{*}\ Vac_{pk} + \lvert Vdc \rvert \leq 10\ V$ |
| **AC amplitude resolution** | |
| Voltage > 0.2 Vrms | 2.5 mVpeak |
| Voltage < 0.2 Vrms | 0.25 mVpeak |
| **DC offset accuracy** | ±15 mV ± 3% of ($\lvert DC \rvert$ + $Vac_{pk}$) settings |
| **Pink noise adder** | Add 600 mV typical when using pink noise |
| **Output impedance** | < 5 Ω |
| **Maximum loading** | |
| Current | ±20 mA peak |
| Capacitance | 0.01 µF |
| **Sine amplitude accuracy at 1 kHz** | ±4% (0.34 dB) of setting |
| Rload > 250 Ω | 0.1 Vpk to 5 Vpk |
| **Sine Flatness** (relative to 1 kHz) | ±1 dB<br>0.1 V to 5 V peak |
| **Harmonic and sub-harmonic distortion and spurious signals (In band)** | |
| 0.1 Vpk to 5 Vpk sine wave | |
| Fundamental < 30 kHz | < -60 dBc |
| Fundamental > 30 kHz | < -40 dBc |

## Digital interfaces

| | |
|---|---|
| **External keyboard** | Compatible with PC-style 101-key keyboard |

**GPIB**

Conforms to the following standards:
IEEE 488.1 (SH1, AH1, T6, TE0, L4, LE0, SR1, RL1, PP0, DC1, DT1, C1, C2, C3, C12, E2)
EEE 488.2-1987

Complies with SCPI 1992

| | |
|---|---|
| **Data transfer rate** (REAL 64 Format) | < 45 mSec for a 401 point trace |
| **Serial port** | |
| **Parallel port** | |
| **External VGA port** | |

## Computed order tracking – Option 1D0

$$\left( \frac{\text{Maximum order x Maximum RPM}}{60} \right) \leq$$

| | | |
|---|---|---|
| **Online (real time)** | 1 channel mode | 25,600 Hz |
| | 2 channel mode | 12,800 Hz |
| | 4 channel mode | 6,400 Hz |
| **Capture playback** | 1 channel mode | 102,400 Hz |
| | 2 channel mode | 51,200 Hz |
| | 4 channel mode | 25,600 Hz |

| | |
|---|---|
| **Number of orders ≤ 200** | 5 ≤ RPM ≤ 491,519 |

(Maximum useable RPM is limited by resolution, tach pulse rate,pulses/revolution and average mode settings.)

| | |
|---|---|
| **Delta order** | 1/128 to 1/1 |
| **Resolution** | ≤ 400 |

(Maximum order)/(Delta order)

| | |
|---|---|
| **Maximum RPM ramp rate** | 1000 RPM/second real-time (typical) |
| **1000 - 10,000 RPM run up** | |
| Maximum order | 10 |
| Delta order | 0.1 |
| RPM step | 30 (1 channel)<br>60 (2 channel)<br>120 (4 channel) |
| **Order track amplitude accuracy** | ±1 dB (typical) |

## Real time octave analysis – Option 1D1

**Standards**

Conforms to ANSI Standard S1.11 - 1986, Order 3, Type 1-D, extended and optional frequency ranges

Conforms to IEC 651-1979 Type 0 Impulse, and ANSI S1.4

1 second stable average

Single tone at band center: ≤ ± 0.20 dB

Readings are taken from the linear total power spectrum bin. It is derived from sum of each filter.

| | |
|---|---|
| **1/3-octave dynamic range** | > 80 dB (typical) per ANSI S1.11-1986 |

2 second stable average

Total power limited by input noise level

**Frequency ranges** (at centers)

Online (real time):

| | **Single channel** | **2 channel** | **4 channel** |
|---|---|---|---|
| 1/1 octave | 0.063 - 16 kHz | 0.063 - 8 kHz | 0.063 - 4 kHz |
| 1/3 octave | 0.08 - 40 kHz | 0.08 - 20 kHz | 0.08 - 10 kHz |
| 1/12 octave | 0.0997 - 12.338 kHz | 0.0997 - 6.169 kHz | 0.0997 - 3.084 kHz |
| **Capture playback** | | | |
| 1/1 octave | 0.063 - 16 kHz | 0.063 - 16 kHz | 0.063 - 16 kHz |
| 1/3 octave | 0.08 - 31.5 kHz | 0.08 - 31.5 kHz | 0.08 - 31.5 kHz |
| 1/12 octave | 0.0997 - 49.35 kHz | 0.0997 - 49.35 kHz | 0.0997 - 49.35 kHz |

One to 12 octaves can be measured and displayed.

1/1-, 1/3-, and 1/12-octave true center frequencies related by the formula: f(i+1)/f(i) = 2^(1/n); n=1, 3, or 12; where 1000 Hz is the reference for 1/1, 1/3 octave, and 1000*2^(1/24) Hz is the reference for 1/12 octave. The marker returns the ANSI standard preferred frequencies.

## Swept sine measurements – Option 1D2

| | |
|---|---|
| **Dynamic range** | 130 dB |

Tested with 11 dBVrms source level at: 100 mSec integration

## Curve fit/synthesis – Option 1D3

20 Poles/20 zeroes curve filter frequency response synthesis pole/zero, pole residue & polynomical format

## Arbitrary waveform source – Option 1D4

| | |
|---|---|
| **Amplitude range** | AC: ±5 V peak*<br>DC: ±10 V*<br>$^{*}\ Vac_{pk} + \lvert Vdc \rvert \leq 10\ V$ |
| **Record length** | # of points = 2.56 x lines of resolution, or # of complex points = 1.28 x lines of resolution |
| **DAC resolution** | |
| 0.2828 Vpk to 5 Vpk | 2.5 mV |
| 0 Vpk to 0.2828 Vpk | 0.25 mV |

# General Specifications

## General specifications

| | |
|---|---|
| **Safety standards** | CSA certified for electronic test and measurement equipment per CSA C22.2, NO. 231 This product is designed for compliance to: UL1244, Fourth Edition IEC 348, 2nd Edition, 1978 |
| **EMI / RFI standards** | CISPR 11 |
| **Acoustic power** | LpA < 55 dB (Cooling fan at high speed setting)<br>< 45 dB (Auto speed setting at 25 °C) |

Fan speed settings of high, automatic, and off are available. The fan off setting can be enabled for a short period of time, except at higher ambient temperatures where the fan will stay on.

## Abbreviations

| | |
|---|---|
| **dBVrms** | dB relative to 1 Volt rms. |
| **dBfs** | dB relative to full scale amplitude range. Full scale is approx. 2 dB below ADC overload. |
| **Typical** | Typical, non-warranted, performance specification included to provide general product information. |

## Environmental operating restrictions

| | **Operating:** Disk in drive | **Operating:** No disk in drive | **Storage & transport** |
|---|---|---|---|
| Ambient temp. | 4 °C to 45 °C | 0 °C to 55 °C | -40 °C to 70 °C |
| Relative humidity (non-condensing) | | | |
| Minimum | 20% | 15% | 5% |
| Maximum | 80% at 32 °C | 95% at 40 °C | 95% at 50 °C |
| Vibrations (5 - 500 Hz) | 0.6 Grms | 1.5 Grms | 3.41 Grms |
| Shock | 5 G (10 mSec ½ sine) | 5 G (10 mSec ½ sine) | 40 G (3 mSec ½ sine) |
| Max. altitude | 4600 meters (15,000 ft.) | 4600 meters (15,000 ft.) | 4600 meters (15,000 ft.) |

| | |
|---|---|
| **AC power** | 90 Vrms - 264 Vrms (47 - 440 Hz)<br>350 VA maximum |
| **DC power** | 12 VDC to 28 VDC nominal<br>200 VA maximum |
| **DC current at 12 V** | Standard: <10 A typical<br>4 channel: <12 A typical |
| **Warm-up time** | 15 minutes |
| **Weight** | 15 kg (33 lb) net<br>29 kg (64 lb) shipping |
| **Dimensions** (Excluding bail handle and impact cover) | |
| Height | 190 mm (7.5") |
| Width | 340 mm (13.4") |
| Depth | 465 mm (18.3") |

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|---|---|
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Revised: October 1, 2008

Product specifications and descriptions in this document subject to change without notice.


Printed in USA, January 9, 2009
5966-3064E

Agilent Technologies