# Agilent Voice Quality Tester (VQT)

Technical Overview







Agilent Technologies

# The Complete Voice Quality Testing Solution

The Agilent Voice Quality Tester (VQT) is a comprehensive and objective voice quality test system. It enables the design, deployment, and operation of voice services on next generation networks by providing accurate and objective testing of voice service quality.

The VQT provides detailed test and analysis capabilities for voice quality on modern telephony networks such as IP Telephony and Voice Over ATM. It provides robust and reliable measurements that go beyond giving test scores. The VQT provides detailed scoring analysis that exposes the impairments to voice quality. By including testing for voice clarity, delay, echo, silence suppression, DTMF, and signal loss, all on one box, the VQT provides a total solution for testing voice quality on next generation networks.

Equipped with analog, T1, E1, and 10/100 Ethernet VoIP interfaces, the VQT enables testing across any telephony network. Connect the VQT to voice gateways and routers, Telco POTS and T1/E1 trunks, IP and PC phones, telephone switches, PBXes, cable modem Multi-media Terminal Adapters, DSL Integrated Access Devices, channel banks, IP access networks, and more.

Distributed test capabilities allow network professionals to remotely operate multiple VQT test systems anywhere on the network. This remote control capability drastically reduces costly, time-consuming travel requirements, and the need for trained staff working in multiple locations.

The VQT enables companies to shorten the development and deployments of IP telephony networks by identifying and exposing voice quality impairments early in the development life-cycle when they are much less expensive to fix. The VQT also enables companies to maintain networks easier and for less cost by allowing engineers to troubleshoot quality impairments efficiently and remotely.

- Certify Network Deployments for Voice Services
- · Determine if Network Meets Voice Quality Standards
- Baseline Network Performance Under Varying Conditions
- Optimize Systems and Networks for Voice Quality
- Monitor Network for Voice Quality Impairments
- Troubleshoot Voice Quality Impairments
- Assess Network Performance Against Competitor Networks and the PSTN
- Test New Products and Designs for Voice Quality
- DELIVER TOLL QUALITY!

# Design and Maintain Networks to Meet Quality Standards while Optimizing Network Efficiency

IP Telephony and other next generation network technologies have the real potential of increasing network efficiencies, and decreasing capital and operating costs, by orders of magnitude. But delivering toll quality of service is critical to win market share and maximize service revenue.

The VQT enables network engineers and technicians to design, troubleshoot, and maintain voice networks to carefully balance network efficiency with voice quality.

- Objectively measure voice quality from an end user perspective, and from different access points on a network.
- Isolate voice quality impairments and identify network resources that require improvement or reconfiguration.
- Perform detailed analysis of voice clarity, delay, echo, and DTMF measurements to get to the cause of the problem.
- Use the VQT in conjunction with the Agilent Advisor's IP Telephony Analyzer to measure VoIP packet performance and correlate with voice quality.
- Optimize networks by determining the exact effects that network configuration and design changes have on voice quality. Test the impacts of voice codecs, silence suppression, comfort noise generation, jitter buffers, IP network configurations, QoS and traffic prioritization mechanisms, and other technologies.
- Automate voice tests use pre-configured Task Lists or design your own. Experts can
  design tests that can be quickly performed in the field.
- Certify and troubleshoot deployments on a global network, remotely from a central site.
- Test voice clarity and distortion one-way across any sites on a network determine the real experience that your network provides for your users.

# Portable and Network-Installed Platforms

The VQT is offered on four different platforms, in order to meet the different needs of engineers and technicians. All platforms come with distributed and remote testing functionality. In addition, VQT Responders are available to enable a low-cost, large-scale deployment of the Distributed VQT Solution.



# VQT Portable Analyzer – J1981B

The VQT Portable Analyzer is a ruggedized portable industrial PC that provides on-board keyboard, touchpad, mouse, and monitor. Designed for field service, it can be controlled locally or remotely over a TCP/IP network. It can also be used as a benchtop tester.



# VQT Network Server – J1987B

The VQT Network Server is a rackmount industrial PC that is designed for network installations and distributed testing. It can be controlled remotely over a TCP/IP network and comes with a VQT Client license for remote control. It can also be used as a benchtop tester, and can be controlled via an Ethernet cable by a user's PC that is running the VQT Client software.

# **Agilent Advisor VQT**

The Agilent Advisor VQT adds voice quality testing to the industry-leading Advisor Protocol Analyzer. The VQT Analog Undercradle (J4630A) attaches to the WAN Advisor (J2300D/E) and the LAN Advisor (J3446D/E), and provides VQT analog interface testing. The VQT 10/100 VoIP software (J5479A) provides VQT testing over a 10/100 network interface card on the Advisor mainframe, using SIP and H.323 for cell signaling.

Industry wide, this is the only solution that provides VoIP protocol analysis, VoIP RTP packet analysis, IP QoS testing, and voice quality testing under one handle.



## VOT Responders J5426A

VQT Responders are small-footprint, low-cost devices that extend the VQT's capabilities to dozens or hundreds of network sites. They enable a cost-effective, large-scale deployment of the Distributed VQT solution, and are ideal for customer sites, remote sites, and off-net terminations. Acting as a VQT endpoint, a VQT Responder interacts with any VQT to perform voice quality testing.



# Analog, Digital, and VolP Telephony Interfaces

The VQT offers a complete range of telephony interfaces that enable testing across different types of networks, and at different access points for network segmentation and troubleshooting.

# **T1 and E1 Interfaces**

The VQT's T1 and E1 interfaces allow multiple simultaneous call generation and traffic loading on all channels. Users can fully load a dual-port T1 or E1 interface and measure the performance of a network under various traffic conditions.

- Dual-port Interface Supports T1/E1 CAS and ISDN PRI
- Multiple Simultaneous Call Generation and Traffic Loading on All Channels
- Test voice quality directly into a T1/E1 access network. Test at different access points and across different types of networks
- Fully load dual-port T1 or E1 interface and measure performance of network under various traffic conditions
- Test voice quality characteristics of digital-access end users

# **Analog Interfaces**

- Quad-port Interface Supports FXO and E&M
- Test voice quality into POTS lines, Cable Modem MTAs, DSL IADs, FXS VoIP Access Routers, and Residential Gateways. Easy to setup and get started!
- · Test voice quality characteristics of analog-access end users

# 10/100baseT VoIP Interface

- 10/100 Mbps Ethernet interface supports VoIP call generation using the Session Initiation Protocol (SIP) and H.323, and G.711 and G.729 codecs
- Test voice quality directly into an IP network Troubleshoot voice quality impairments by segmenting an IP network for fault isolation
- Available on all VOT platforms, including Advisors and VOT Responders

# Test Voice Quality on IP Phones and PC Phones

As IP telephony networks extend VoIP to the end user, IP phones and PC phones become more common as network access devices. These next generation phones present new challenges to optimizing voice quality on a network, and the VQT can help.

The VQT Phone Adapter enables the VQT to test voice quality on IP phones and PC phones by providing an audio interface between the phone's handset interface or a PC's soundcard, and the VQT analog FXO or E&M ports.

With the VQT Phone Adapter, users can test voice quality from an IP/PC phone to an IP/PC phone, or from an IP/PC phone to a PSTN phone, gateway, or any access device. Measure voice quality as it is truly experienced by an IP/PC phone end user.



# Easy-to-use One-Click Testing

The VQT offers simple one-click testing for each measurement, and pre-designed Task Lists. No scripting or programming is required. Users can turn on the VQT and get real results within minutes. The self-guiding user interface allows novice and expert users to easily navigate through comprehensive Task Lists, execute tests, and determine the success or failure of a test. Pass/fail testing and detailed analysis allow all levels of testing to be performed.

The VQT has been designed to closely match the way users are likely to test voice quality and is, therefore, easy to learn. The VQT provides common testing scenarios via its Task List Navigator and simple operating instructions via its unique multi-mode embedded Help system. Important measurement results are clearly displayed in a pass/fail format. For experienced users, or those needing to drill deeper, detailed test configuration parameters are available.

Remote Controllable via PC	VQT Servers can be controlled remotely by VQT Clients running on a PC. All test results from multiple servers can be compiled at a user's PC with no file transfers needed. In addition, test plans can be created on a user's PC, and executed on multiple VQT Servers with no file transfers needed.
Automated and Interactive Testing	The VQT offers both automated and interactive testing capabilities. The VQT provides users with the ability to easily create automated test scripts, known as Task Lists, using the same graphical user interface they use for interactive testing. The VQT also comes with pre-designed Task Lists, to enable testing from right out-of-the-box.
Key Features and Functionality •	<ul> <li>Test Voice Clarity using PESQ: Perceptual Evaluation of Speech Quality</li> <li>Based on the new ITU P.862 standard</li> <li>Provides objective measurements of speech quality based on human perception factors</li> <li>Simple scores that correlate to subjective test results</li> <li>Graphical results of frame disturbance values and the audible error surface</li> <li>Numerical results of PESQ scores and disturbance values</li> <li>Distributed one-way measurements across a global network</li> </ul> Test Voice Clarity using PSQM+: Perceptual Speech Quality Measurement <ul> <li>Based on the improved ITU P.861 standard to account for severe distortions encountered in packet networks</li> <li>Provides objective measurements of speech quality based on human perception factors</li> <li>Graphical frame-by-frame scoring over time, correlated with transmitted and received signal graphs, exposes impairments in voice quality <ul> <li>Numerical results of PSQM+ scores and statistical analysis</li> <li>Distributed one-way measurements of speech quality based on human perception factors</li> </ul> Est Voice Clarity using PAMS: Perceptual Analysis Measurement System <ul> <li>Provides objective measurements of speech quality based on human perception factors</li> <li>Simple scores that correlate to subjective test results</li> <li>Enhanced signal processing techniques for a robust measurement across variable-delay networks</li> <li>Graphical results of the audible error surface exposes impairments in voice quality</li> <li>Numerical results of PAMS scores</li> <li>Distributed one-way measurements across a global network</li> </ul></li></ul>

- Delay
  - End-to-end voice delay measurements with one-millisecond resolution
  - One-way and round-trip measurements
  - Single measurements and trending analysis
- Echo
  - Detect echo in a voice transmission and measure its impact on conversational quality
  - Measure echo delay and duration with user-set detection thresholds
  - Test echo using real human speech
- Echo Doubletalk
  - Test the performance of echo cancelers under conditions of Doubletalk
  - Test echo canceler performance using real human speech
- Signal Loss
  - Measure one-way and roundtrip signal loss using voice, tones, or noise
- DTMF distortion
  - Measure the attenuation, twist, and frequency deviation of DTMF signals
- Silence suppression analysis
  - Test the impact of Voice Activity Detectors and Comfort Noise Generators
- Test with over 150 different voice samples in 9 different languages
- Off-line clarity measurements on audio files, using PESQ, PSQM+, and PAMS
- · Automated and Interactive testing
- File Play and Record
- Tone and Noise Generator
- Port Loopback
- Impulse response measurement
- Network Simulator
- Active logging of all test results and configurations, and full graphical viewing of saved test logs
- Bearer Path confirmation
- Single, repetitive, and continuous test modes
- End-to-end and round-trip measurements
- Graphical and numerical presentation of test results
- Audio monitor with Remote Audio Playback

# You Do Not Need To Be A Voice Quality Expert To Operate This System!

Today, more developers and field engineers than ever are faced with the challenge of analyzing voice quality. For the VQT, ease of use was one of the primary design goals. A self-explanatory user interface and pre-designed scripts allow the user to easily execute every test and identify problems quickly. Default parameters are set for every test and an integrated help window explains test steps and gives guidance on how to interpret results. On the other hand, experts have access to all test parameters and result details than enable them to extract even more information.

Flat User Interface - configuration and measurement information on one screen. Same concept and layout for all measurements.



The VQT provides a consistent task oriented user interface across all measurements. A taskbar allows users to execute all measurements in the correct order and to switch easily between measurements. All measurements provide configuration and result information on the same screen. Results are represented graphical and as text at the same time. User definable thresholds can be set to identify easily the pass or fail.

All measurement results are logged for later detailed analysis. Remote controllability allows the user to operate the test remotely.

# Clarity - Measuring The Human Perception

Clarity refers to the clearness of speech and the fidelity of voice reproduction. Clarity can be negatively impacted by several factors, including analog/digital conversion, voice encoding/decoding, silence suppression, packet loss, packet delay jitter, echo cancelers, signal attenuation, and noise. The combined effects of these factors are not linear or additive, so measuring just a single factor is not sufficient. Determining end-to-end clarity is necessary to determine the combined, non-linear impacts of these influencing factors.

Measuring clarity is very complicated and requires new perceptual-based measurement systems. Traditional metrics, long used on the PSTN, are no longer sufficient due to the non-linear and time-variant nature of voice-over-packet networks. New perceptual techniques can measure clarity from a human perspective, taking into account human perception factors such as the ability to compensate for some distortions.

The VQT offers three innovative and widely accepted methods for measuring clarity: PESQ, PSQM+, and PAMS.

### PESO.

The Perceptual Evaluation of Speech Quality (PESQ) is the newest ITU standard, and is described in recommendation P.862. PESQ combines the merits of both PSQM+ and PAMS to provide a robust and reliable technique for measuring clarity.

The VQT provides a robust and reliable implementation of PESQ that goes beyond giving just an average score. The VQT provides detailed PESQ scoring analysis that exposes the impairments to voice quality.

To perform PESQ testing, the VQT transmits actual human speech across a network from a source port, and records the received signal on a destination port. The PESQ measurement compares the received signal with the original transmitted signal, and measures any audible distortion. The measurement is based on human perception factors, such as frequency sensitivities, loudness sensitivities, and compensation abilities. The result is a single score on a scale of 1-5 that reflects the human perceptual quality of the received voice signal.

In addition to reporting the PESQ score for a test, the VQT displays graphs of asymmetrical and symmetrical disturbances correlated with the transmitted and received signal graphs, to identify transient impairments. It also displays the two-dimensional error surface to identify added and subtractive distortion in the time-frequency domain.

With the VQT's distributed testing capabilities, one-way PESQ measurements can be made between distant sites on a network. PESQ measurements can also be made in single, repetitive, and continuous modes. The VQT offers over 150 different voice samples in 9 different languages to allow you to test for different end users.

#### PSQM+

The Perceptual Speech Quality Measurement (PSQM) is based on the ITU P.861 standard. PSQM was designed to measure the distortion of voice across voice compression codecs, as perceived by humans. An improved version, known as PSQM+, was developed to account for the severe distortions, such as that due to packet loss, that occur on voice-over-packet networks.

The PSQM+ measurement is actually performed with real human speech by comparing the reference and received signals. The VQT offers 150 different voice samples in 9 different languages to allow you to test for different end users. The VQT also provides the equivalent Mean Opinion Score (MOS) for every PSQM measurement.

In addition to presenting the maximum, minimum and average PSQM score the VQT also provides a graphical representation of the PSQM scores over time during the entire speech sample, and reports the standard deviation. This allows the user to identify network effects that influence the speech quality such as packet loss. To compensate for network delay, the received signal is time aligned with the reference signal to allow an accurate PSQM measurement.

With the addition of the Distributed VQT clients and servers, there now exist the ability to make one-way PSQM+ measurements between servers. This can be done locally on the VQT or the VQT undercradle, or remotely via client applications.



# PAMS

The Perceptual Analysis Measurement System (PAMS) is a valuable tool for providing an objective measurement of speech quality. It uses a perceptual model based on human hearing factors, and provides a repeatable, objective means for measuring perceived speech quality. PAMS uses a different signal processing model than the ITU P.861 standard PSQM, and produces different types of scores. It provides a "Listening Quality Score" and a "Listening Effort Score", both which correlate to MOS scores on a 1-5 scale.

In addition to the listening scores, the VQT provides a graphical representation of signal loss and additive distortion over both the time and frequency domains of the test signal. This is known as the error surface. The error surface shows the impacts of a wide range of network-induced distortions, including coding distortion, front-end clipping, muting, noise, and bit or frame errors. The amplitude of errors is related to how audible and annoying they will be.

In addition to single clarity measurements, the VQT also allows trend analysis over a period of time. This provides essential data to understand network performance variations over the course of an hour, a day or more.

With the addition of the Distributed VQT clients and servers, there now exists the ability to make one-way PAMS measurements between servers. This can be done locally on the VQT or the VQT undercradle, or remotely via client applications.

Delay is the time required for a signal to traverse the network. In a telephony context, end-to-end delay is the time required for a signal generated at the talker's mouth to reach the listener's ear.

The VQT provides a very accurate way of measuring delay, via an impulse response measurement using a Maximum Length Sequence (MLS) noise burst. This pseudorandom noise appears like white noise, and allows the user to determine the delay behavior of a network across all frequencies. The impulse response is graphed and the user can visually inspect the delay results. The MLS signal enables highly accurate time-correlation of the transmitted and received signals, allowing the delay for the entire transmission of a signal to be accurately measured. Both end-to-end and round-trip delay measurements can be performed.

In addition to single delay measurement, the VQT also allows to perform multiple delay measurements. It graphs delay over time and also calculates average, minimum and maximum delay.

# Delay - No Longer Just An International Long-Distance Problem



Echo - Go Beyond Simple Detection Echo is a phenomenon introduced by hybrid wire junctions in circuit-switched networks. Echo can have a detrimental effect on voice quality if the delay and signal level are great enough. However, until now, measuring that effect has been elusive.

> The VQT provides two key echo measurements. The Perceived Annoyance Caused by Echo (PACE) measurement detects voice echo and determines the impact that echo has on a speaker's perception of voice quality. The VQT transmits a sample of human voice and measures the return echo. PSQM scoring is applied to the superimposition of the received echo on the originally transmitted voice, using the originally transmitted voice as the reference signal. The VQT presents useful information:

- The signal levels of both the transmitted signal and any received echo are graphed and presented in the time domain
- PSQM scoring is graphed, correlated with the transmitted signal and the echo signal
- Average and maximum PSQM scores are individually reported
- Delay of tail-circuit echo is presented •
- Each duration of echo received during speech, and each duration of echo received during silence, are distinguished and graphed
- The total duration of echo received during speech, and the total duration of echo received during silence, are individually reported in milliseconds
- The percentage of a voice transmission that is echo-free is reported

Tail-end echo can be measured using the VQT's E&M ports, which ensure no originationside echo will be encountered. Origination-side echo, or immediate echo, can be measured using the VQT's FXO ports. In addition, the VQT can simulate echo on its destination port. A network simulator function applied to the destination port can provide varying degrees of delay and return loss to a signal, to simulate echo and exercise the capabilities of echo cancellers.

The second key echo measurement is Echo Doubletalk. This measures the performance of echo cancellers in cancelling the echo of one speaker's voice while passing through another simultaneous speaker's voice unimpaired. The VQT applies the condition of Doubletalk by transmitting simultaneous voice in both directions. It measures the clarity of the voice in one direction, the "Doubletalk" signal. Any impacts due to the uncancelled echo of the other speaker, or impairments on the Doubletalk signal, are detected and measured.

#### **Silence Suppression Analysis**

Voice activity detectors are implemented in voice gateways and are responsible for silence suppression and comfort noise generation. Silence suppression makes use of the fact that human conversations typically comprise more silence than speech from each speaker. Silence suppression stops digitizing when no voice signal is present. This can realize approximately 50% reduction in bandwidth requirements. During periods of this silence, the listener still expects to hear some background noise to confirm that the connection is still active. A Comfort Noise Generator at the receive-side generates a background noise signal matching the real noise on the line to the listener during these silence periods.



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To identify the appropriate function of these network components the VQT provides a VAD measurement to accurately measure the behavior of the silence suppressor and the comfort noise generator.

The VAD measurement determines the following parameters:

- Front-end clipping the time the VAD needs to detect the speech signal and how much of this signal got cut off. Listeners can be very annoyed by Front-End-Clipping if it makes the first word of each sentence difficult to understand
- Holdover time the time the VAD continues to send data, even after the speaker stopped talking. A conservative/long holdover time will utilize bandwidth unnecessarily sending background noise; an aggressive/short holdover time will potentially stop the voice transmission even in short pauses between words. This can make the front-end-clipping very perceptible and annoy the listener
- The match between the generated "comfort" noise and the "true" background noise. A noticeable difference in sound can be annoying to both speaker and listener

These VAD measurement results are presented graphically as well as in text form.

DTMF stands for Dual-Tone Multi Frequency and is the tone generated by each key of a touch-tone phone. Transmitting DTMF tones through digital networks can be especially difficult with low bit-rate voice codecs, which are tuned to encode speech, a non-sine wave signal. DTMF, however, transmits two distinct sine-wave frequencies per key and low-bit-rate codecs often have difficulty recreating these signals. This can make it impossible to communicate with a voice message or interactive voice response system.



DTMF

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The VQT provides the ability to determine how distorted these DTMF tones are when transmitted across a network. The system determines DTMF twist, the difference between the high frequency and low frequency amplitude. It presents sent and received DTMF frequency to visualize the difference between the two tones. In addition it shows the results in tabular format, including amplitude and difference in peak frequency.

**Signal Loss Measurement** The VQT provides the ability to measure for signal loss across the users network. The VQT allows the user to select from multiple audio types for determining signal loss. These include white noise, wave sample, or a single frequency tone. Both round trip and one-way (source to destination) measurements can be performed. The signal loss results are graphed and the user can visually inspect the results.

**Remote Audio Playback Tool**This feature allows the user to record and playback the audio from a remote server test.
From the client PC the user can select to record the audio from the current measurement
or call setup and either play the recorded file near real time on the client PC or save it for
later review.

Related Literature	Data Sheets VQT Portable Analyzer J1981B VQT Network Server J1987B VQT Phone Adapter J1996A VQT Undercradle J4630A	5988-4041EN 5988-3045EN 5988-3046EN 5980-2091E	
	Application NoteTesting Voice Quality on Next GenerationNetworks using the VQT5988-3036EN		
	<b>Brochure</b> Downtime is not an Option	5988-4329EN	
	<b>Technical Specifications</b> VQT Responder	5988-6474EN	
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# **Agilent Ordering Information**

J1981B J1987B	VQT Portable Analyzer VQT Rackmount Network Server
Module Interfaces 200 201 202 J5479A	VQT dual-port analog FXO and dual-port analog E/M interface VQT dual-port T1 interface for VQT VQT dual-port E1 interface for VQT VQT 10/100 SIP and H.323 interface software license
J4630A	VQT Undercradle for Advisor-Analog FXO/E&M
<b>Software</b> J1979A J1982A J1983A J1997A J5422A	VQT Client software license License to use PAMS voice clarity measurement License to use PSQM voice clarity measurement License to use PESQ voice clarity measurement IP Telephony Reporter
<b>Accessories</b> J1996A J5426A J5480A	VQT phone adapter VQT responder 10/100 cardbus NIC for VQT
<b>Education</b> H7211B-207	Voice over IP Technology and Testing
Warranty and Supp Hardware	<b>port Services</b> 1 year Agilent Instrument Warranty and Service Plans Agilent Instrument Phone Support
Software:	90 day media warranty



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