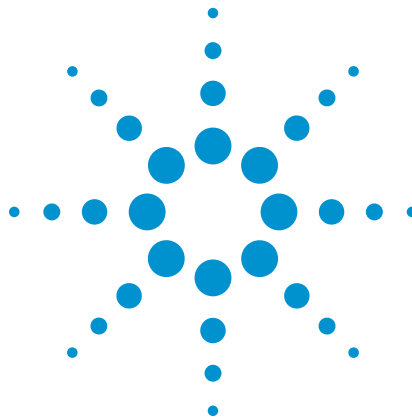# Agilent E3238S/N6820E Signal Survey System

Product Overview

Powerful signal survey and collection system speeds detection of unknown, short-duration wireless signals

- Extremely fast wideband search and high resolution
- Available in four frequency ranges:
    - 100 kHz to 32 MHz
    - 20 MHz to 2.6 GHz
    - 20 MHz to 6 GHz
    - 100 kHz to 26.5 GHz
- Optimized signal detection tools provide data only on signals of interest
    - Multiple search modes – F1-F2, Directed Search, Stare
    - Advanced energy thresholding
        Level, Noise-Riding, Environmental
    - Survey tool simplifies cataloging spectrum survey results
    - Flexible alarms and scheduling to launch numerous tasks
- Re-configure signal detection without programming
- Optional narrowband signal processing using low-cost digital downconverter channels
- Ability to record time and frequency snapshots to memory
- Simultaneous multichannel narrowband recording optional
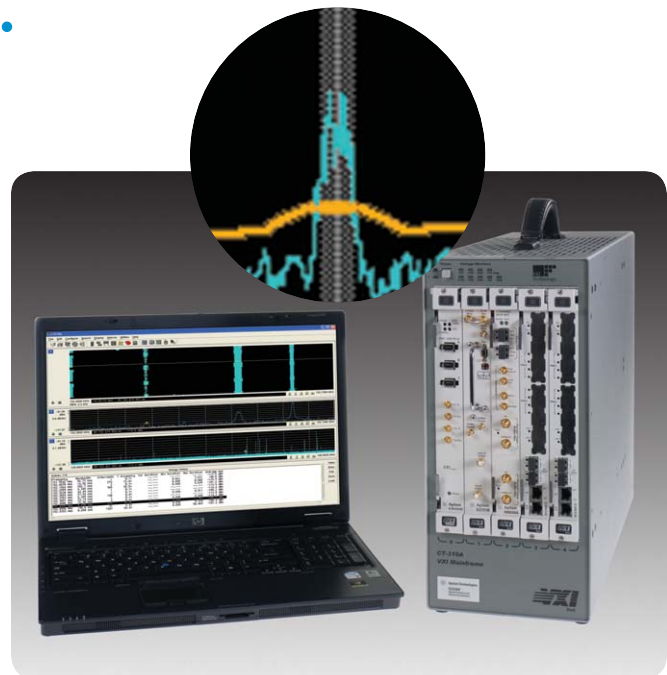
Agilent Technologies

Spectral Search Challenges

Explosive growth in the number and variety of wireless and satellite communications technologies pose an ever-increasing challenge to monitor the RF spectrum. You do not always know the location of the signals of interest; you also don't know when those signals will show up. These signals may be shortduration and/or low power. There may be thousands of irrelevant signals of varying power, duration, and bandwidth that get in the way of identifying your signals of interest.

Ideal RF spectral monitoring systems require extremely high speed RF search and high resolution. The faster a system can monitor a wide spectrum, the more likely you will see short-duration signals.

A system with high resolution can find signals of interest near to other larger signals and low level signals close to the noise floor. Swept spectrum analyzers only provide speed or resolution because of resolution bandwidth (RBW) filter settling time limitations. RF spectral monitoring solutions are optimized by designing a system with good LO Settling time, proper IF and digitizer Bandwidth and embedded signal processing.

A good spectral monitoring solution may have High Speed to find short duration signals along with High Resolution to dig out hidden signals. It will generate hundreds of thousands of data points per second. Only a few of these data points are the signal of interest, whereas a better system will provide some tools to reduce the collected data to information from the few critical transmissions present.

Typically, you do not want the entire spectral data. Signal detection tools are required to reduce the spectral search data to information on the signals of interest. Once the signals are identified, they should be collected and recorded for later analysis. Integration of the signal monitoring system with handoff receivers, direction finding subsystems and antenna switching is a common requirement. The system should allow developers to create their own drivers, customize the user interface, and easily interface with other applications.

RF Sweep Speed vs. Resolution
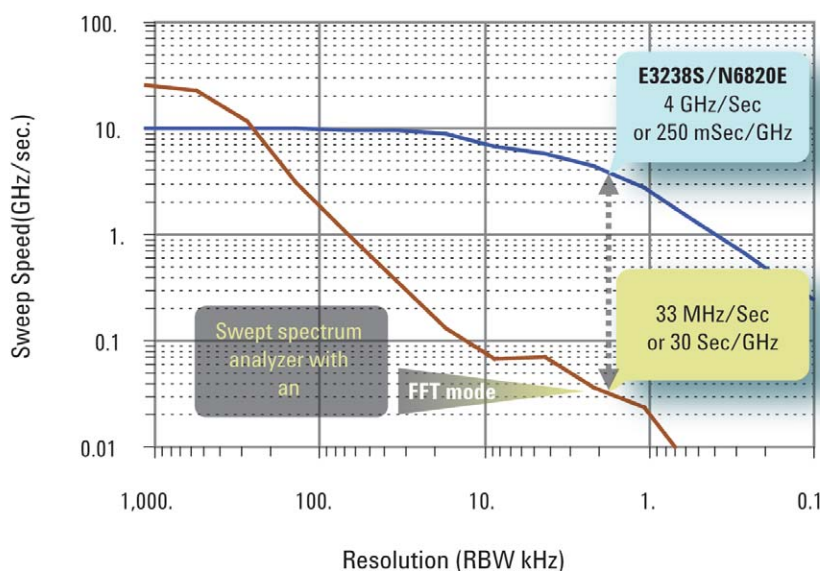
The E3238S/N6820E Signal Survey System provides speed and resolution. It scans the spectrum more than 100 times faster that conventional swept spectrum analyzers at the same resolution bandwidth.

Introducing the E3238S/N6820E Signal Survey System

The E3238S/N6820E Signal Survey System is optimized for very high speed RF spectral search with high resolution. It is orders of magnitude faster than traditional swept spectrum analyzers. As an example, a conventional swept spectrum analyzer would take 5 minutes to make a spectral search of 1 GHz span with 2 kHz RBW. The E3238S/N6820E can scan that spectrum in 250 mS, or more than 100 times faster. Faster sweep/scan times with high resolution will find more intermittent, short-duration signals. For test range managers or frequency spectrum management, this system not only finds many more intermittent offending transmitters than traditional analyzers, it may also discover unexpected energy. In addition, the E3238S/N6820E system can detect subtle changes in EMI emissions without a screen room.

Efficiency and productivity in sorting through the spectrum data to identify signals of interest is done with an impressive set of signal detection tools. The E3238S/N6820E can select and record data for only the signals you have defined with this powerful tool set. First, it limits analysis on signals that exceed an energy threshold. Those signals are stored and updated in the energy history. It can also ignore old signals once you have determined they are no longer of interest. Alarms can be used to further reduce the data to signals of interest or to initiate various tasks.

Capturing data on signals of interest is very flexible with the E3238S/N6820E system allowing real-time actions and post-processing of data. After logging signals of interest in the energy history, files can be recorded as a frequency or time data for further analysis. Signal data can be a snapshot of data or a narrowband recording. The system has low cost narrowband signal processing with multichannel simultaneous time-domain data recording using Digital Downconverter (DDC) hardware. Both the narrowband recording option and audio output option use the DDC hardware for capturing narrowband data on the signals. The audio output software downconverts and plays demodulated audio from a signal of interest. For postanalysis of signal data, two popular standalone signal analysis and playback tools are the N6829A Audio Player Software or 89601A Vector Signal Analysis Software.

With the universal signal detection capability, you re-configure without programming and collect data on the lastest radios. You can pick signals to detect from a library and/or change parameters while the system is running. This flexible and powerful tool easily adapts for detecting and recording future/emerging signals.

The Survey tool for the E3238S/ N6820E Signal Survey System summarizes information into a spectral survey spreadsheet. In contrast to finding one signal of interest, a survey report includes information about all energy detections and all modulation recognition results. The Survey tool accumulates this information from the E3238S/N6820E energy history and signal database.

Since signal survey systems can vary in application and sophistication, the E3238S/N6820E operates standalone and it easily integrates into larger systems. N6820E software supports multiple antennas and numerous handoff receivers. Users can integrate direction finding subsystems into the signal survey system using the open programming environment. To make systems users more productive, the graphical user interface and signal detection tools can be customized with our development software. The N6820E network sockets interface enables other applications to send commands, query settings, and receive data.

The Agilent N6820E software is a component in the E3238S systems and specifically designed for global signal survey tasks. The E3238S/N6820E signal monitoring systems include the hardware components, software, and system integration for a complete signal monitoring solution.

Key system features and benefits are:

High speed search and high resolution maximizes finding unknown transmissions

Superior transformation of spectrum data into signals of interest

Flexible signal capture and analysis

Rapid system integration and customization
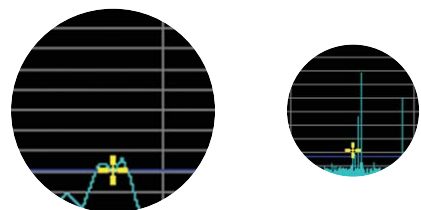
High Speed Search and High Resolution Increases Probability of Intercept

With the E3238S/N6820E, broad expanses of spectrum are covered quickly and frequencies of interest are revisited often to intercept short-duration signals. The system hardware has the combination of resolution bandwidth and sweep speed to dig signals out of noise, isolate small signals hiding next to large ones, and capture signals just fractions of a second long.
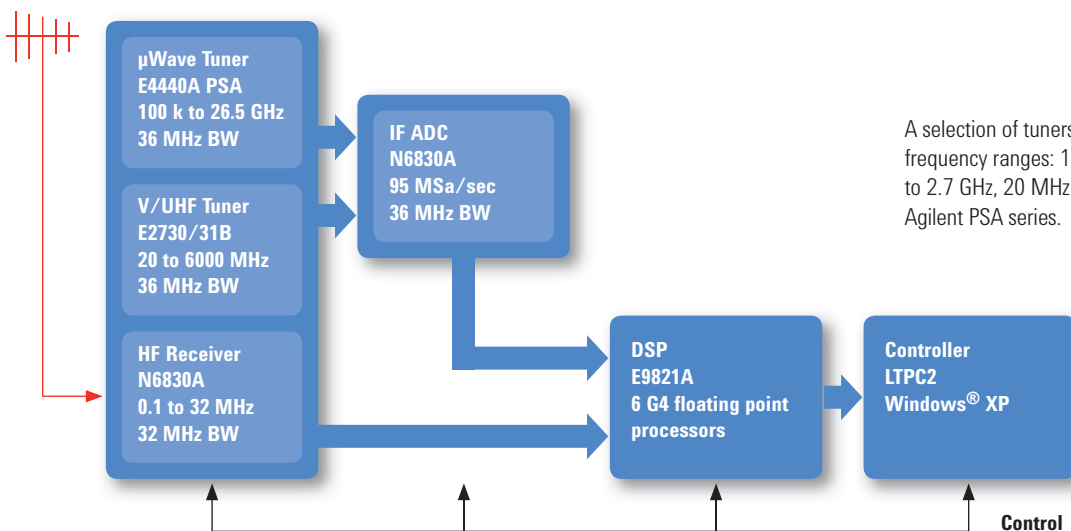
The architecture of the E3238S/N6820E system is ideal for finding unknown, short-duration, intermittent wireless transmitters. It uses a wide-band stepped FFT technique to achieve exceptionally fast spectral survey rates while maintaining high resolution and wide dynamic range. This ideal signal survey system architecture steps through the spectrum of interest rather than sweep in a linear fashion like a conventional spectrum analyzer. At each step many RBW filters are processed in parallel. The signal survey system concatenates several FFTs so you can zoom in closer and still resolve spectral detail.
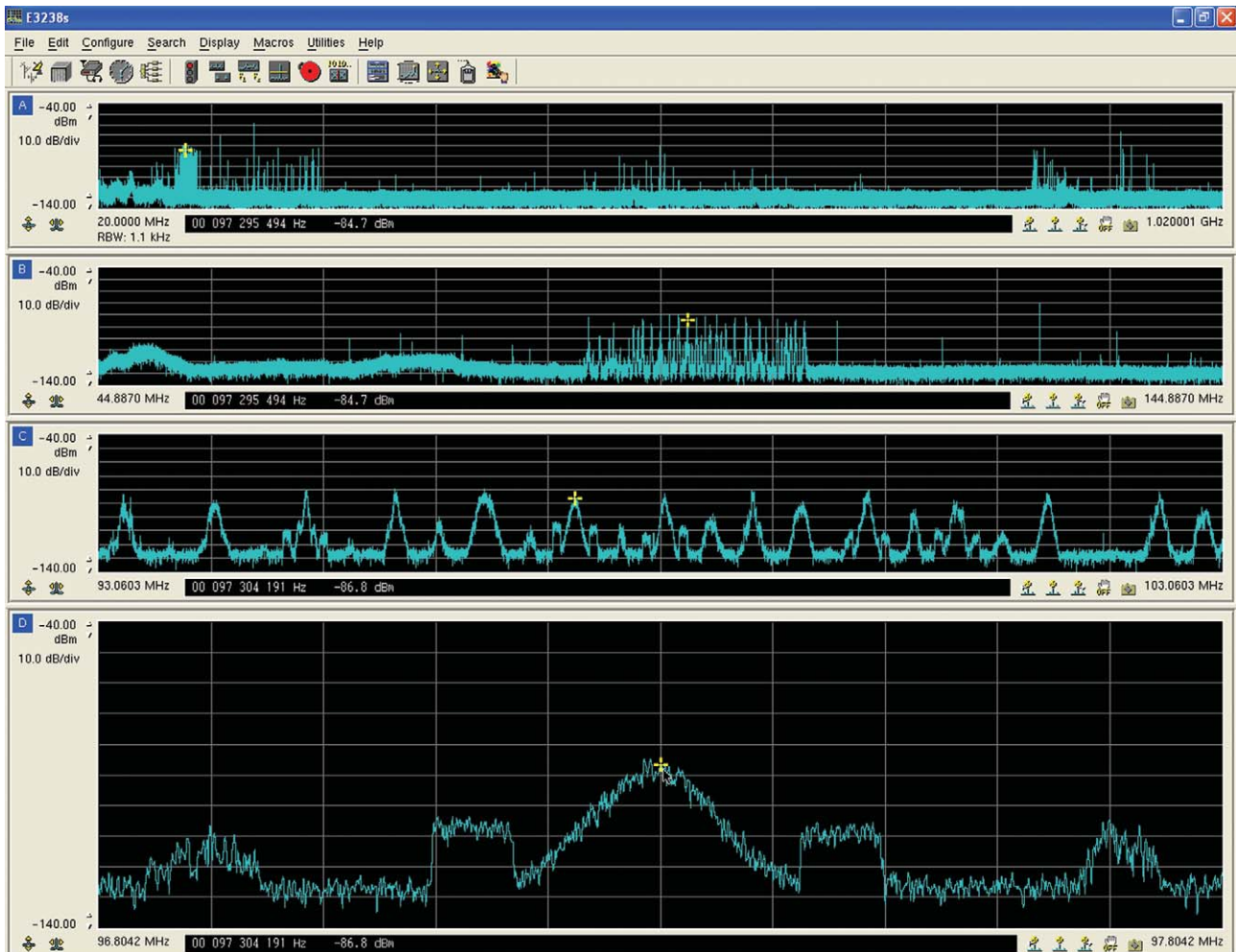
To further optimize the system for high speed survey, fast settling time tuners are matched with a wide bandwidth Analog-to-Digital Converter (ADC). With very quick tuner settling time, you can make faster frequency steps. The tuner has a wide IF bandwidth to reduce the number of steps for the frequency range being monitored. Besides having a matching wide IF bandwidth and fast sample rate to reduce the number of steps, the ADC has a high dynamic range for accurately digitizing multiple signals.

The optimized system design results in large amounts of spectrum data that require ultra-fast digital I/O. To maximize processing speed, the system's DSP receives data from the ADC's via a fiber optic front panel data port.

Processing all the spectral data, e.g. performing the FFT analysis, requires significant computer horsepower. The E3238S/N6820E system uses up to six Motorola G4 processors in one E9821A DSP module to compute FFTs at up to 10 GHz/sec sweep rates. The multiple DSP's work in parallel to compute the spectrum data and preserve the high resolution maximizing the probability of finding signals of interest.

A selection of tuners lets you monitor four unique frequency ranges: 100 kHz to 32 MHz, 20 MHz to 2.7 GHz, 20 MHz to 6 GHz, and > 6 GHz with Agilent PSA series.

Simultaneous Fast Spectral Search and High Resolution

The E3238S/N6820E display shows four simultaneously active measurements with the marker coupled in all four traces. The span on each trace is different to show both the high speed spectral search AND the high resolution.

> Trace A – 1 GHz Span
> Trace B – 100 MHz Span
> Trace C – 10 MHz Span
> Trace D – 1 MHz Span

Trace A shows a wide spectrum scan that is 100's of times faster than traditional spectrum analyzers. In the same measurement scan, Trace D quickly identifies a signal from a new digital broadcast station. The E3238S/N6820E architecture has high speed spectral search for intermittent energy AND high resolution to dig out the signal details.

Superior Transformation of Spectrum Data into Signals of Interest

The E3238S/N6820E Signal Survey System architecture has scalable performance from simple survey solutions to automated survey and record solutions. When the system is connected to an antenna or other energy source, the search hardware measures the signals in the spectrum and converts it into spectrum data. This spectrum data is processed and becomes wideband data and narrowband data.

The wideband search processes all of the signals in the RF environment and uses signal detection tools to filter out all but the signals of interest. Once the signals of interest are identified, only that data should be collected and recorded for later analysis. This filtered RF energy is entered into the energy history with continuously updated statistics. Energy alarms can be triggered to cause one of numerous alarm tasks to be executed.

The narrowband signal processing collects or records the specific signal information. E3238S/N6820E systems can be configured with hundreds of narrowband channels, each with independently programmable center frequencies and bandwidths. The narrowband timedomain data is extracted from the wideband data via the Digital Down Converter (DDC) hardware.

Signal detection consists of energy detection, energy history and alarm conditions. Real-time data of the complete spectrum is first passed through an energy detection threshold function. If the signals exceed a threshold defined by the user, the signal data is logged into the energy history. Thresholds can be set by level, noise, baseline RF environment, automatically by the system, or user-defined. Alarm functions automate the task of finding the specific signal of interest and improve productivity because you do not need to constantly monitor the system.

The E3238S/N6820E Universal Signal Detection option (Option USD) automatically identifies signals of interest by operating on the characteristics of RF transmissions. The universal signal detectors include bandwidth filters, a frequency plan, wideband detectors, and narrow band confirmers. These wideband and narrowband technologies are combined to efficiently sift through the crowded spectrum and significantly increase the probability of intercept. As signals of interest are detected, simultaneous gap-free recordings (or data streams) are easily handled by the multiple digital down converters (DDCs) and parallel DSPs in the E3238S system. When a new threat emerges you can quickly build a detector from a recording of a new signal without programming.

Wideband Search to Alarm Tasking
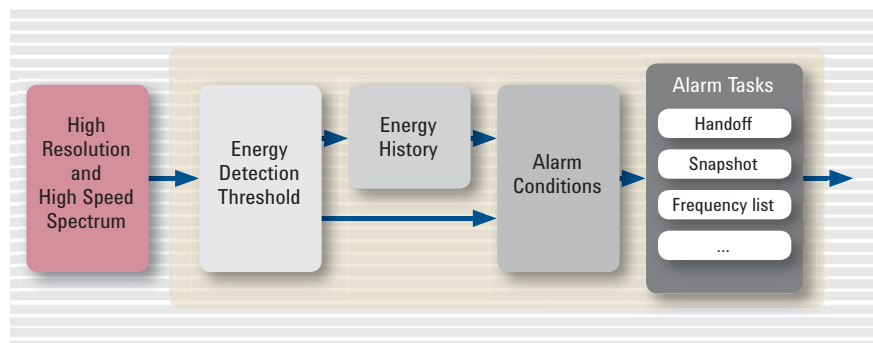
The high speed search system passes along spectral data to the host for further processing. First, energy is detected using energy thresholding. Detected emitters statistics are entered into the Energy History. Alarm conditions and criteria are defined upon energy characteristics, like time of day, percent occupancy, Min, Max, Avg amplitude etc. If the energy matches the criteria then an alarm task may be executed. Many different types of alarm tasks are possible.
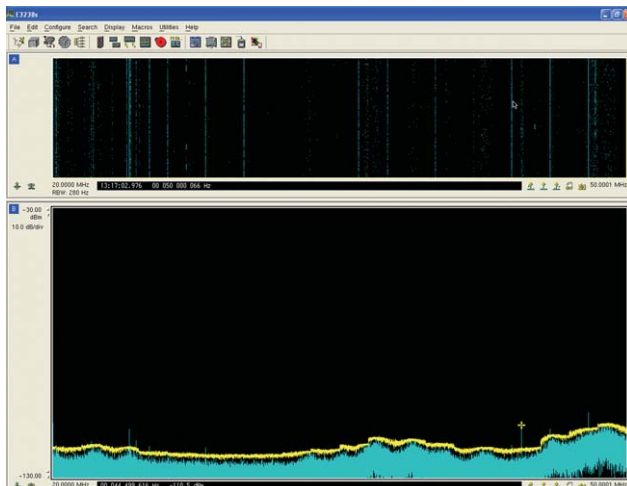
Energy Detection Thresholds
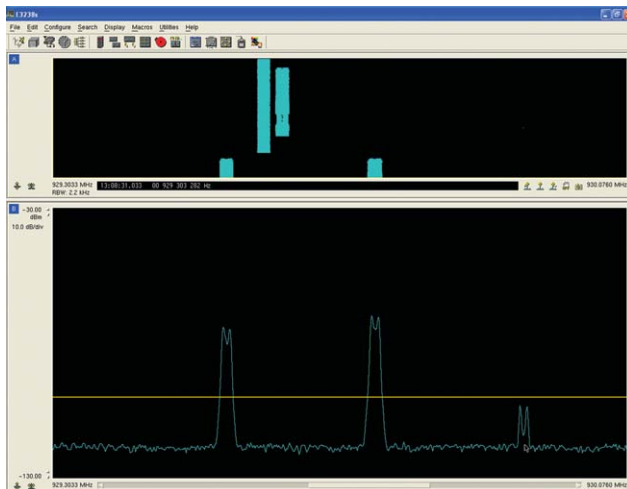
Energy detection occurs when signals exceed thresholds set by the user. The N6820E provides three standard types of thresholds plus a user definable energy threshold.

The level threshold works well when the noise floor is flat and unchanging, as it often is in VHF/UHF and µWave Spectrums.

The Auto-Threshold shapes itself to the noise floor. This is especially important in HF, where the noise floor is not flat, and changes with the time of day and year. Since the auto-threshold is automatically recalculated with each new sweep, it can adapt to changes, which significantly increase the probability of intercepting HF signals.
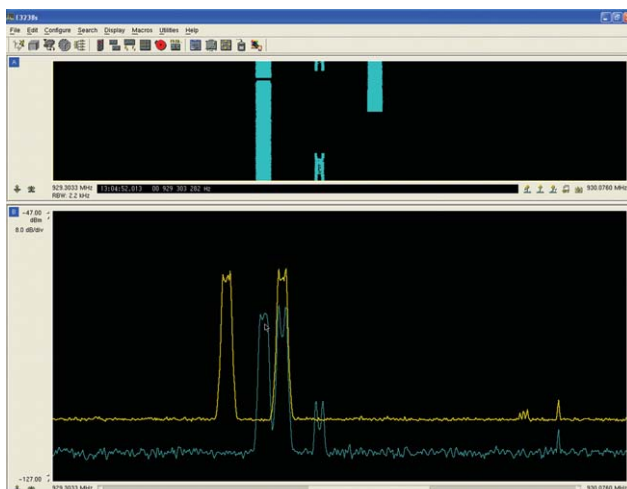
The Environmental-Threshold takes a snapshot of the spectrum and creates a threshold that matches the spectral shape at that time. It can be used at a later time to see if new signals are present. In this case there are three new signals that were not present when the original threshold was created, and two signals are not present now. Notice that only the new signal appears in the spectrogram display.

Energy History

The energy history stores statistical information on each signal that passes through the energy detection algorithm. Frequency, amplitude, bandwidth, duration, time of intercept, number of detections, and percent occupancy are recorded for each signal of interest. This significantly reduces the data that must be further analyzed to gain information on the RF spectrum.

Alarm Conditions

The N6820E software uses alarming algorithms to further reduce data only to signals of interest and automate the signal acquisition process. These alarms are logical equations that are evaluated during every spectrum sweep. Alarms can use logic on frequency lists set by the user. Triggering sweeps can be set by alarms along with scheduling the system to gather spectral data with a time of day alarm. The N6820E alarm capability can launch tasks such as initiating a handoff receiver or capturing a time/frequency snapshot. Alarm tasks can include visual or audible notification to an operator, external processing, or internal narrowband processing.

Multiple signal events can be combined into a single alarm. The alarms function can automatically identify energy of interest in the energy history and take action. The alarm criteria can be set based on the external characteristics or features of the signal such as:
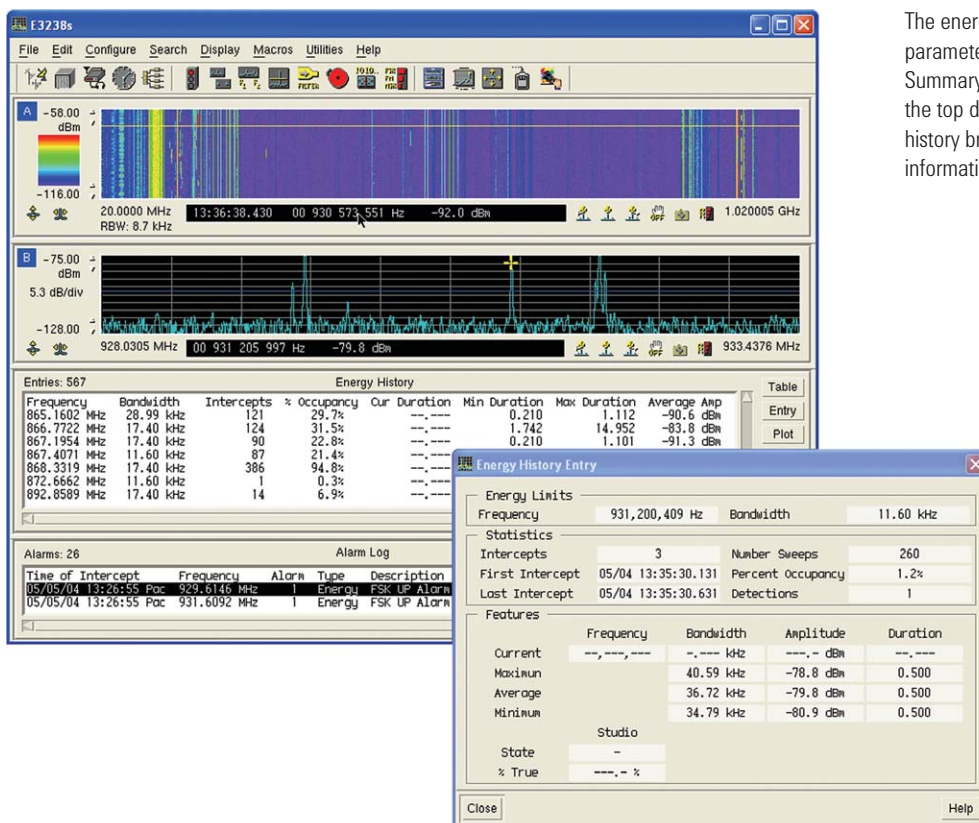
Signal parameters

- Frequency
- Amplitude
- Bandwidth

Signal state

- New signal
- Any signal
- Signal no longer there

Signal activity

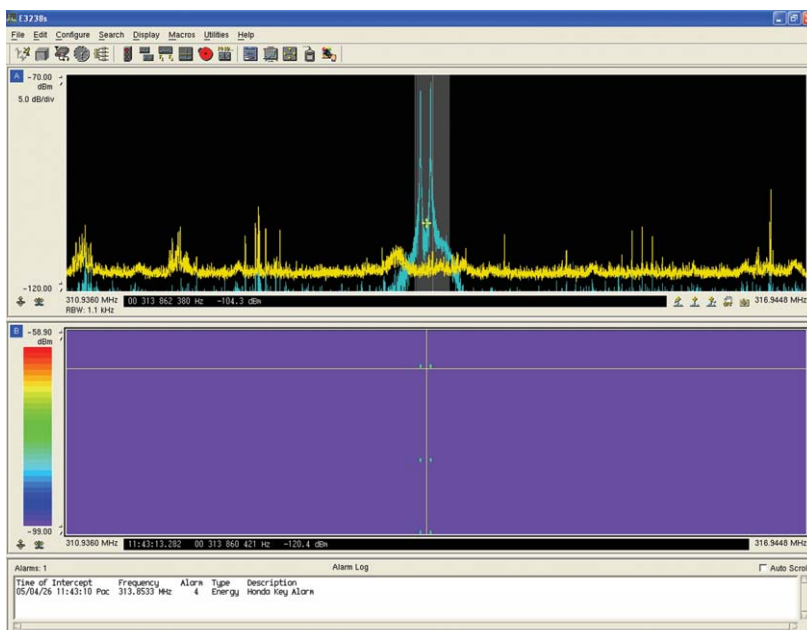- Duration
- Intercept time
- Occupancy

The energy history automatically stores the parameters of all energy above the threshold. Summary tables and standard plots are shown in the top display. Querying an entry in the energy history brings up a second dialog box with all information for the energy at that frequency.

Alarm Tasks

The N6820E signal survey software automates common tasks so system operators gain productivity. The key to efficiently surveying and collecting data on unknown emitters is the integrated suite of tools for controlling the system. Once the flexible alarm scheme is set up, the system will operate totally unattended and in remote locations. The system also allows highly skilled operators to set automated states for other less skilled operators.

The E3238S/N6820E can quickly be set up for a few high speed scans to capture an environmental threshold (yellow). An alarm is set to catch a short duration signal from an automotive key fob. The system captures the wireless transmission of the "unlock signals." Using alarms automates the task of finding the specific signal of interest thereby improving productivity.

Setting up alarms with multiple signal events records only the signals of interest and automates the entire process. Alarms can be scheduled by time, energy, signal characteristics, and other events.

Flexible Signal Capture and Analysis

The E3238S/N6820E system captures signals as time or frequency data. Recording snapshots of this information on signals of interest is very efficient. Complex time-domain data comes directly from the ADC and is stored as a file. Capturing time data allows further processing such as demodulation. The system captures frequency snapshots on a portion of the spectrum as a file. Snapshots can be initiated as alarm tasks or manually.

Signal File Playback and Analysis Software

Time snapshots can be analyzed by using numerous tools. The N6829A is a completely separate software tool

that can playback back files saved by the E3238S/N6820E system. Multiple operators using PCs on a system LAN can independently demodulate and listen to voice channel files saved from E3238S/N6820E systems. E6829A software provides AM, FM, uppersideband, and lower-sideband demodulation, gain, squelch and other audio processing controls. Using arrow keys to toggle through saved files makes it quick and easy to manage.

The 89601A vector signal analysis software has compatible file formats with the N6820E, so it can also analyze time snapshots. This software's powerful demodulation features makes it most useful for digital signals.

### Narrowband Signal Capture and Analysis

Another method for capturing signal data is the narrowband DDC functionality in the system. The narrowband recorder function, N6820E-NBR, allows multichannel recording of narrowband signals up to 350 kHz bandwidth per channel. It records the time data from the DDC's output to the system disk. The center frequency and bandwidth of the recording can be passed from alarms. The recorded narrowband time data can be analyzed at a later time.

Audio output, option AU1, uses the narrowband digital downconverter channels as a virtual hand-off receiver, so you can listen to voice signals directly. Besides demodulating AM/FM signals, option AU1 lets you listen to single-side band and CW signals with the left and/or right audio output channels.
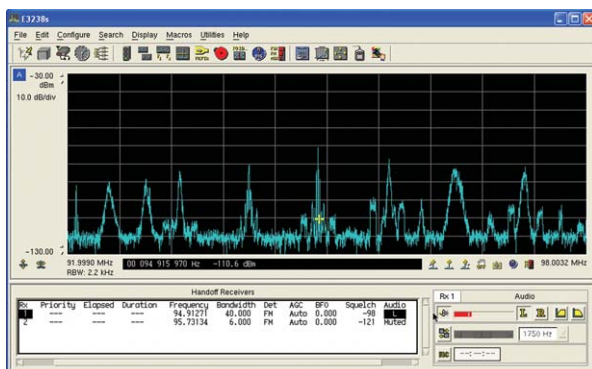

Two narrowband channels and option AU1 will demodulate the signals so you can listen to audio in realtime.

This shows the AU1 realtime audio output tool in action. The bottom right shows the controls for the audio processing.
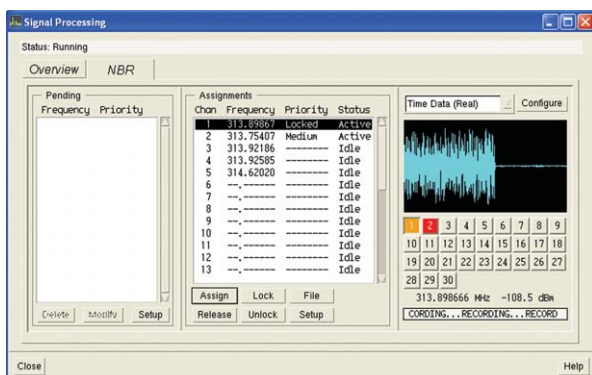
Using the narrowband channels as multiple low-cost hand-off receivers with Option NBR, you can record time data on multiple signals of interest. Each E9821A DSP handles up to three modules each with 32 narrowband channels.
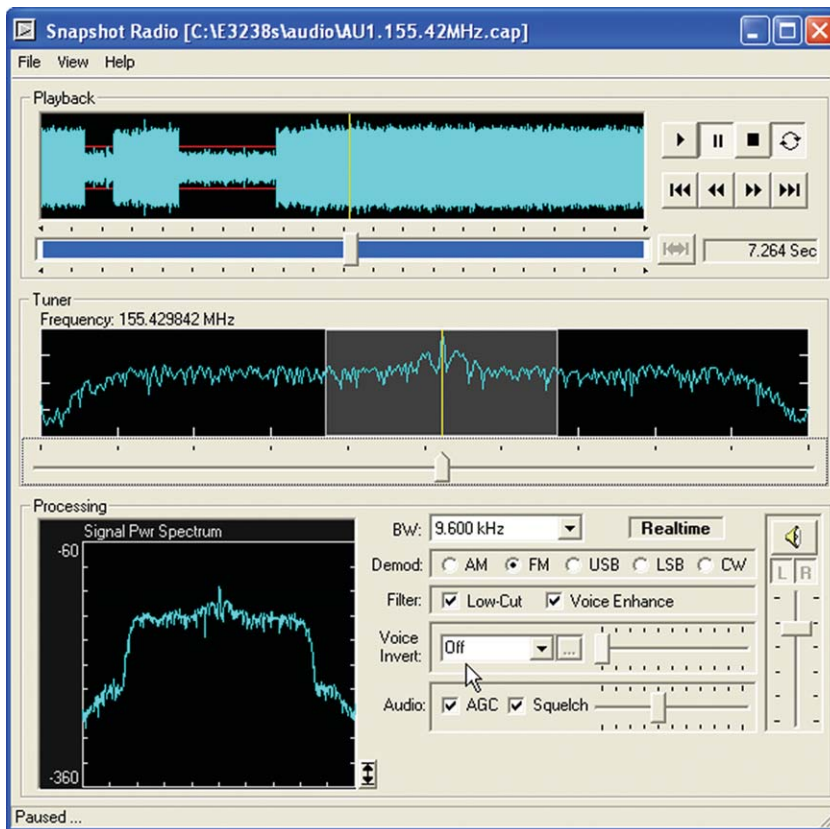
The N6829A software is a standalone software tool for listening to files captured by the E3238S/N6820E system. It has radio functions for demodulating and processing the audio recordings.
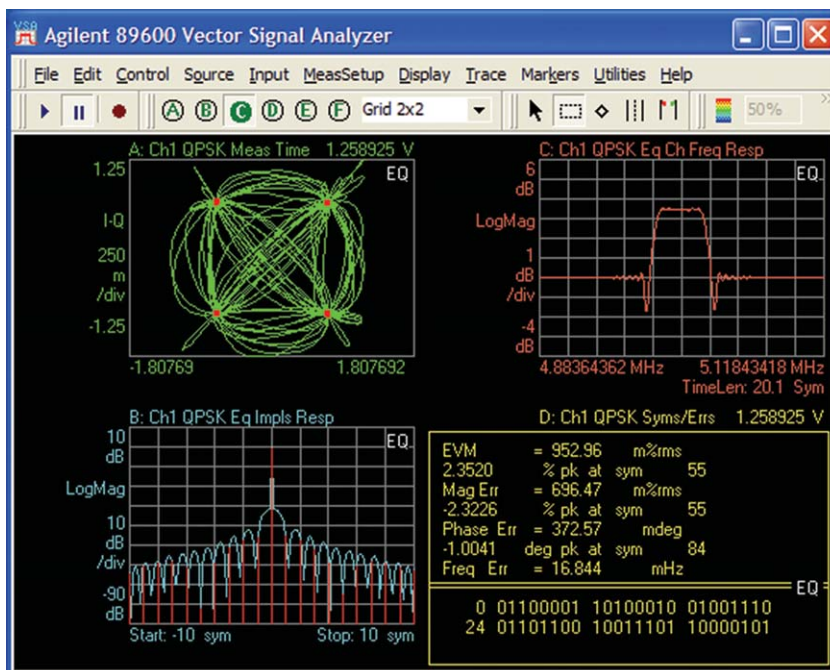

The Agilent 89601 VSA software has powerful analysis for post-processing of the signal information recorded by the E3238S/N6820E system. File formats are compatible for quicker analysis.

Universal Signal Detection (Option USD)

A universal signal detector automatically identifies signals of interest by operating on the characteristics of RF transmissions. Agilent's Universal Signal Detection option includes a bandwidth filter, a frequency plan, wideband detectors, and narrowband confirmers. These wideband and narrowband technologies are combined to create universal signal detectors that efficiently sift through the crowded spectrum and significantly increase the probability of intercept. As signals of interest are detected, simultaneous gapfree recordings (or data streams) are easily handled by the multiple digital down converters (DDC) and parallel DSPs in the E3238S system. When a new threat emerges you can quickly build a detector from a recording of a new signal without programming.
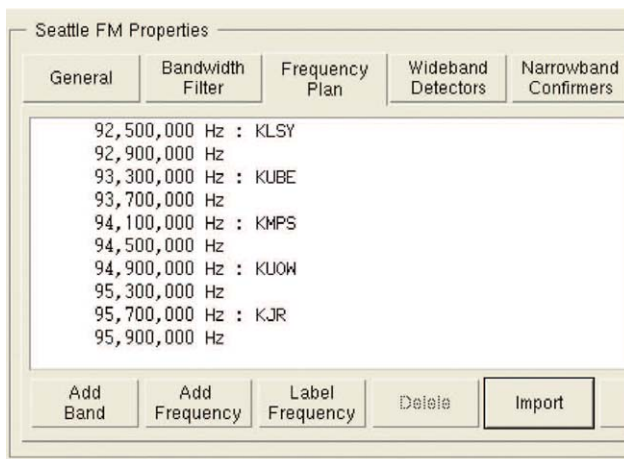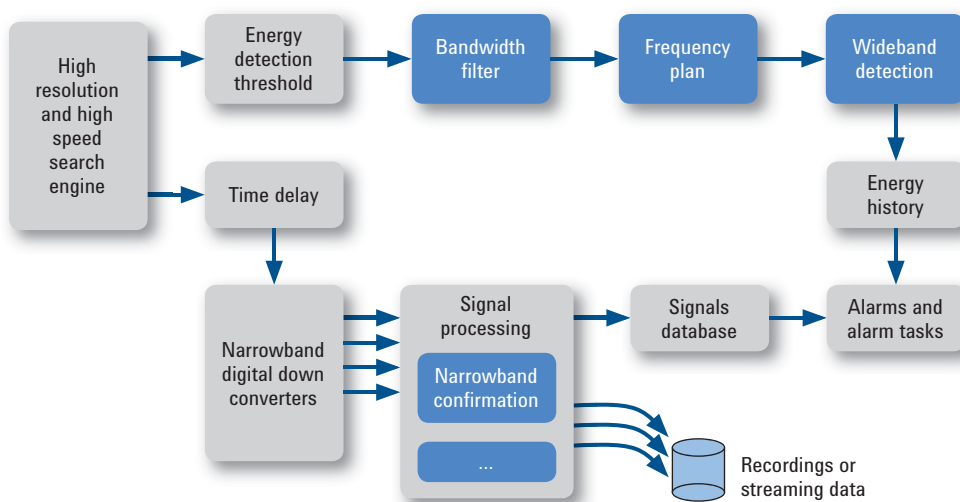
Bandwidth filter and frequency plan. For energy that appears above a threshold, a signal detector's bandwidth filter and frequency plan will remove signals that don't meet the criteria for the signal of interest. The frequency plan can include individual frequencies, bands of frequencies, or the channelized bands.
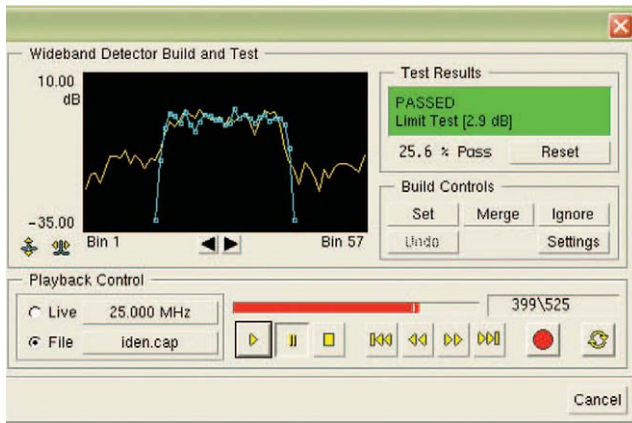
Wideband detection. USD's wideband detection operates on the frequency-domain results of each sweep. When energy is detected in the frequency spectrum, that portion of the frequency spectrum is processed by one or more wideband detectors. The wideband detectors quickly determine if the energy is a potential signal of interest by comparing its magnitude spectrum to the wideband detectors you created. It passes signals programmatically as opposed to a human viewing the spectrum data. The wideband detector techniques that are supported in USD are shape, peaks and limit lines.
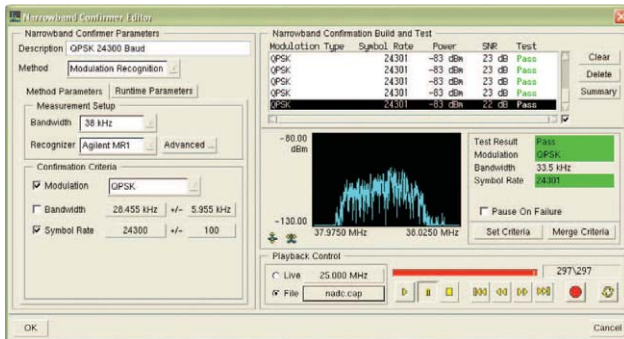
Narrowband confirmation. USD's narrowband confirmation operates on the complex time-domain data from signals that meet the bandwidth, frequency, and spectral shape criteria. When used with Agilent's modulation recognition Option MR1, the modulation format, symbol rate, (and frequency spacing for FSK) are compared to criteria for the signal of interest. Agilent's narrowband confirmation takes full advantage of the E3238S system's DDCs and parallel DSPs.
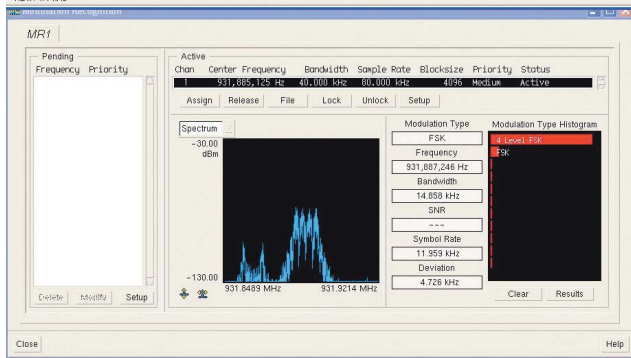
Automated modulation recognition. Modulation recognition (Option MR1) is used to identify modulation types on signals of interest. Option MR1 provides a library of analog and digital modulation recognizers. Option MR1, when coupled with Option USD, allows the modulation recognition application to run on all active narrowband channels at the same time.

Popular modulation types supported with Option MR1:

- Noise
- Unknown digital
- MSK
- FM MSK
- FSK
- 3 level FSK
- 4 level FSK
- 8 level FSK
- BPSK
- QPSK
- PI/4 QPSK
- 8 Level PSK
- 16 Level PSK
- 16 QAM
- 32 QAM
- 64 QAM
- 128 QAM
- 256 QAM
- AM
- AM DSBSC
- LSB
- USB
- Analog FM
- Pure Carrier
- Manual Morse
- Machine Morse
- OOK
- FM OOK
- 4 PAM
- V.29
- Any
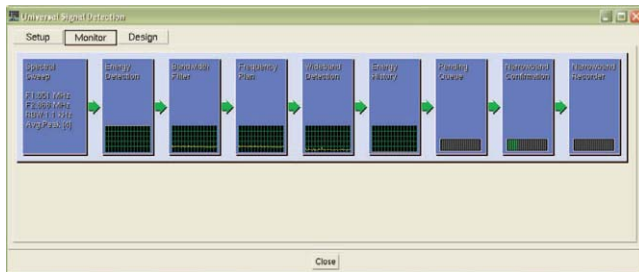
Design, monitor and run universal signal detectors. Universal signal detection has separate development and run modes for maximizing efficiency for the developer and the operator. In the design environment, you create and test signal detectors. Because you make inputs into dialog boxes, pull-down menus, and check boxes, programming is not needed to detect and capture signals of interest. There's a straightforward design flow that helps you create signal detectors. Once the signal detector is designed, it is stored in a library. There is no limit to the number of detectors stored in the library. Up to 23 signal detectors can be running at one time. In run or monitor mode, operators can add signal detectors "on-the-fly" from the library that was previously created. A mission set up can load numerous detectors and automatically begin the search for specific signals.

Rapid System Integration and Customization

Off-the-shelf Standard Products Speed Up Deployment Process

Deploying the E3238S/N6820E system to survey the frequency spectrum for unknown emitters is fast because components are off-the-shelf products. Currently many users tasked with signal survey buy individual pieces of test equipment, including conventional spectrum analyzers. Often, users and developers end up writing custom software and struggling to create databases for their collected signals. The E3238S/N6820E family is based on commercial products and is easy to buy, maintain, and support. The system arrives with everything pre-installed and ready to run. Because the hardware is standardsbased, your investment is protected. As technology ramps, so can your system.

Small Form for Mobile Deployments

This signal survey system is a transportable solution for unknown wireless emitter identification. The system provides an extremely powerful, high-speed portable signal survey and database collection and creation tool. It speeds results by supplying all the necessary measurement acquisition hardware and automated signalprocessing tools in one complete transportable solution. You get a signal search and narrowband processing solution for slightly more than the cost of a traditional swept spectrum analyzer and its associated laptop and software tools.

Integrate Subsystems for Complete Solution

Since the N6820E software is defined with socket protocols, connection and integration with non-Agilent subsystems makes the signal survey system into a control center for unknown emitter identification. After integration of a direction finding (DF) system, the E3238S/N6820E system can "tip off" the DF system as to the presence of energy, then receive back the line of bearing and other geolocation parameters for entry into the signal database.

The Signal Survey System can easily hand-off signals to traditional single channel handoff receivers or transfer them to the N6820E-AU1 software-based AM/FM handoff receiver. Software drivers are provided for hand-off receivers from companies including Cubic Communications, ICOM and others.

Customize with User Programming

Option ASD enables users and system integrators to dynamically link new functions and capabilities into the E3238S/N6820E system. For automated custom energy classification functions, users can create energy history entries computed from parameters already in the energy history. User-created pre- and post-filtering functions can limit the size of the energy history and speeds up energy detection. Custom prefilters prevent signals from being included in the energy history. User-created postfiltering allows signals to be automatically removed from the energy history.

Option ASD enables creation and inclusion of new hand-off receivers into the system. These new hand-off receiver drivers must use VXI, LAN or RS-232C interfaces.

With option ASD, users can add their own tasks to the alarm function task list. Now, the system can automatically execute the user-defined task when energy meets the alarm criteria. The user interface can also be modified with custom pull-down menus and display panes to increase operator efficiency and productivity.

Agilent Technologies has application experts for signal processing and analysis. Our Application Engineers provide consulting, training and project management on E3238S/N6820E systems and applications.
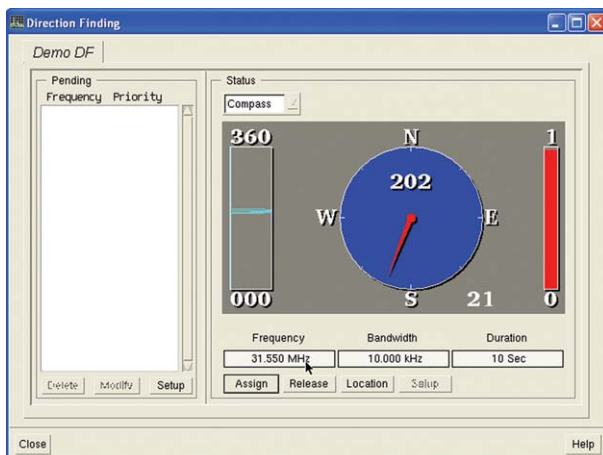
Direction finding subsystems can be integrated into the E3238S/N6820E systems using the advanced programming tools.

E3238S/N6820E Signal Survey System
Feature Summary

The E3238S/N6820E system has the ideal architecture for identifying unknown, short-duration signals in a crowded RF spectrum. The integrated hardware and software system significantly increases productivity in finding signals of interest when compared to other techniques.

Key system features:

- Frequency coverage

  - 100 kHz to 32 MHz with N6830A

  - 20 MHz to 2.7 GHz with E2730B

  - 20 MHz to 6 GHz with E2731B

  - 100 kHz to 26.5 GHz with E4440A PSA

- Up to 36 MHz instantaneous bandwidth

- Fast, high resolution spectral search

- Multiple search modes – F1-F2, Directed, Stare

- Advanced energy thresholding – Level, Noise Riding, Environmental

- Survey tool simplifies cataloging spectrum survey results

- Automated energy alarms based upon energy history parameters

- Re-configure signal detection without programming

- Control of external handoff receivers

- Data compatible with 89601 Vector Signal Analysis software

The N6820E's easy-to-use graphical user interface is designed to speed signal detection in dense signal environments. Simple toolbars configure the system hardware, setup and control the search and collection subsystem, and present user displays and visuals. Multiple displays with high update rates can reveal broad and close-up views of signals simultaneously.
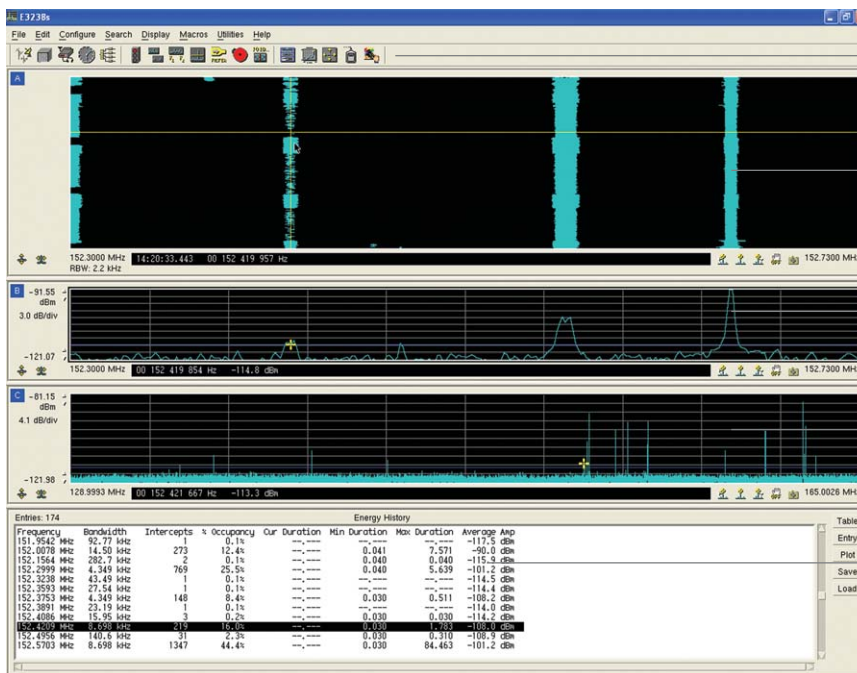
1 Control of all systems assets from antennas to digital receivers via the system icon bar

2 A variety of signal visualization tools speed analysis

3 Operators eyes never leave the signal of interest while they interact directly with trace data to control assets

4 Automated alarms, thresholding and alerts automate the task of keeping track of incoming signals

5 Energy History automatically logs all signals of interest for historical use

Configuration and Ordering Information

Configuring and ordering a complete E3238S/N6820E system is discussed in detail in the 5989-2837EN Configuration, Performance and Reference Guide. Listed below are the N6820E software options.

N6820E   Signal Survey Software

N6820E-103   Standard software for Windows

N6820E-1RU   One-year software update service

N6820E-NBR   Narrowband recorder

N6820E-AU1   Audio output

N6820E-USD   Universal Signal Detection

N6820E-MR1   Standard modulation recognition application

N6820E-ASD   Host user programming libraries and documentation

N6829A   Audio Player Software

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