Agilent E3238 HF ALE Intercept Solution
(35688E – AL9)

Product Overview

Technical specifications

- 1-32 MHz HF frequency coverage; Stare frequency coverage of 8.0 MHz
- 32 ALE channels with one E9821A DSP module, and 128 with two E9821As
- Channel allocation on a per channel basis, e.g. 27 channels of MIL-STD-188-141 and 5 of other algorithms
- Software socket links to external systems for direction finding and intelligence forwarding
- Excellent portability with 32 through 224 channel solutions in a 5-slot VXI mainframe

ALE product overview

The wideband search and narrowband collection capabilities of the E3238 are perfectly suited to reliably detect and decode MIL-STD-188-141 ALE communications. Stare frequency coverage of 8.0 MHz ensures that short link establishment protocols will not be missed. Wideband filters identify an ALE signal’s eight-level FSK spectral shape and hand them off to multi-channel SSB demodulators. If the signals are determined to be ALE signals, link information from each transmission is automatically entered in a Signal Database where it can be used to generate alarms. Alarms can task the E3238 to record the follow-on messages or task external receivers to decode them. Alarms can also task direction finding systems to geolocate users. Informative displays of link information help operators identify networks of users by identifying patterns of communication. This helps visualize organizational structures. When coupled with direction finding information, searches can be targeted at critical users.
Wideband search

Wideband energy detection
- Auto-threshold shapes the energy detection threshold to the contour of noise floor, maximizing the probability of detecting signals close to the noise floor
- Auto-threshold automatically adjusts to changes in the noise floor caused by changes in the atmospheric conditions
- 8.0 MHz stare bandwidth maximizes POI of short 392 mSec protocols

Energy alarms
- User-adjustable FSK filter tests all wideband energy for FSK spectral shape
- Fast DSP allows multiple tests for FSK shape, even on short 392 mSec protocols
- Only signals that pass a “majority vote” of the FSK tests are passed to demodulators, decreasing false positives and conserving demodulator channels

Narrowband demodulation

Digital downconverters
- Multi-channel digital downconverters independently tune to signal frequencies determined in wideband search

SSB demodulators
- Multi-channel SSB demodulators decode signals and extract link information
- Demodulators are dynamically assigned to increase the availability of resources

Signal database for storing and forwarding

- Database for Protocol Storage
- Contains to/from callsigns and protocol content
- Real-time Protocol Forwarding via sockets

Link information stored in database
- Type of signal (MIL-STD-188-141)
- Frequency and Standard Deviation
- Time of day (time, duration)
- Modulation type (USB, LSB)
- Callsigns (“to” callsign, “from” callsign)
- Demodulated bits
- Two signal quality measures
  1. LQA analysis of “to and from” link
  2. Computed Signal Quality of E3238 to User
- Message Content (AMD, DTM, DBM)
- User Identification Notation
- Raw bits

Alarms

Alarm criteria
- Alarms are based on any link information in the database, or Boolean expressions of the information

Alarm tasks
- Send information to DF systems or handoff receivers via software sockets
- Initiate other E3238-based tasks, such as follow-on recorders

Displays

Signaling statistics
- Time of day (number of frames by hour, frames/hour by hour)
- Duration histogram

Frequency
- All database entries at a frequency
- Single- and double-sided callsigns of links, listed by frequency

Callsign
- Callogram
- Alphabetical
- Frequency list
- Activity
- Links
- Links by frequency
- Network
- LQA
- Receive quality
- Lists

Networks
- All networks
- Frequency lists

Reports
- Activity (by frequency, by callsign)
- Links (by frequency, by callsign)
- Completed links (by frequency, by callsign)
- Protocol (AMD, LQA)

Auto-Threshold shapes to noise floor. The E3238’s “auto-threshold” follows the contours of the noise floor. Signals exceeding the threshold are tested for the MIL-188-141 spectral shape and those that match are marked “true” in the energy history. Energy Alarms pass these signals to SSB demodulators.
Amplitude threshold hugs noise floor

In the E3238, wideband signals that exceed an amplitude threshold have their signal parameters automatically computed and entered into an energy history. Creating a good amplitude threshold function is difficult since the noise floor in the HF band is not flat, and it changes over time. The E3238’s “auto-threshold” is computed from the actual noise floor. It hugs the noise floor, and adapts to changes in the noise floor, because it is recomputed for each sweep. This makes it possible to detect short signals hiding in the noise floor. Finding ALE signals in wideband data, the E3238 looks for ALE signals in wideband search data, and only passes on those signals having the distinctive eight-level FSK spectrum shape to the narrowband SSB demodulators. This avoids wasting critical SSB demodulators on signals that are not ALE signals, minimizing the possibility of missing important communications because all narrowband channels are in use.

Setting energy threshold parameters (top left). Having a good energy threshold is critical to detecting new energy when it appears. Auto-Threshold allows users to set parameters to determine how tightly the threshold tracks the noise floor. The complexity of the threshold is adjustable, and visual feedback helps set the level. If filters such as MIL-STD-188-141 are available, they are enabled in this dialog box. Clicking Setup opens the dialog box at the right, where the FSK spectral shape is specified.

Setting FSK filter parameters (top right). A FSK filter template simplifies setting the parameters of the FSK filter shape. In addition to defining the filter’s shape, the user can also set Ignore Frequency Lists of frequencies that are known to not be of interest. The Target Frequency List identifies frequencies of known ALE transmitters and assigns narrowband assets immediately upon detection, rather than waiting for wideband detection.

Energy alarms pass signals to SSB demodulators (below). Users define the criteria for handing off signals for narrowband demodulation.
Narrowband Demodulation and Databasing

Signal Database integrated into E3238 interface. This display shows one possible configuration of the E3238 user interface. The Signal Database is visible, arranged by the time-of-day of each communication. Important link information for each is shown, but clicking a particular message will show all the link information and provide quick access to numerous displays designed to provide insight into networks of users. (See additional examples of displays later in this document).

Narrowband SSB demodulation

Signals that pass the wideband test for MIL-188-141 spectral characteristics are passed to demodulators, consisting of multi-channel digital downconverters linked to G4-based digital signal processing that implements SSB demodulation and decoding. A minimal system might have 32 independent channels of SSB demodulation implemented in the same E9821A DSP module that performs wideband search. If more channels are required, an additional E9821A can add up to 96 channels of DDCs, each DDC with its own SSB demodulator. Larger systems can be built by adding more E9821As. Signal Database Demodulated signals that are determined to be MIL-188-141 have their link information automatically entered in a Signals Database, which is viewable in the E3238 user interface (see graphic). The Signal Database is the fundamental source of information for generating alarms, creating visual displays, and generating reports. For each detected communication, the database includes time of day, frequency, duration, modulation type, “to” and “from” call signs, and message content information, such as Link Quality Analysis (LOA) or AMD messages.

Signal alarms

The information in the Signal Database, or Boolean combinations of it, can generate alarms to task other systems to perform direction finding, message recording, or real-time message processing. System response time is fast so that external systems can be tasked while signals are still up, increasing the chance of intercepting critical information.
SSB demodulator display. This display shows a system with 32 channels of ALE demodulation. Channel activity is shown graphically on the left side and in the table on the right side. Channels seven and ten, shown in red, have detected ALE signals, while channels three, four, and five are processing channels that are not ALE signals. Clicking a red button, channel seven in this case, shows the message content “This was: TST.” The eye diagram shows the slice point with eight distinct levels, signifying good demodulation of the signal.

Signal Database entry. The complete content of a database entry can be displayed, showing the time of day, callsign, and message information. This information can be used to create Signal Alarms that cause Alarm Tasks to execute when specific criteria are met. Automated operation is critical given the complex signal environment. The buttons at the bottom give you quick access to overall signal statistics for these callsigns.
Uncovering networks of users

The “to” and “from” callsigns in the Signal Database contain the information required to uncover networks of users who are communicating with each other. Displaying the interconnections graphically helps visualize the networks of users and their usage patterns.

Get insight from many points of view

The displays available in the E3238 have been optimized for quickly looking at the link information from different points of view. It can be displayed by callsign, frequency, and time of day. The graphical displays at the left depict networks of users, while other displays show individual users and their communication patterns. By looking at the information from many points of view, insight is gained into the structure of the users. When coupled with direction information from external systems, specific users and networks can be targeted for extracting message content.

Locating the network for a specific callsign.

Entering a particular callsign can call up a diagram of any network connected with it.
Frequency Development

Focusing on individual users

Knowing when and where communications are likely to occur helps utilize critical resources efficiently and protects against missing critical communications. Displaying link information by frequency and time reveals the patterns of usage required to assign resources efficiently to capture follow-on messages.

Callsign frequency lists. Knowing the frequencies used by specific callsigns helps target that callsign’s activities.

Activity by frequency. This display shows all activity on a particular frequency, identifying which callsigns use that frequency, and when they use it.
Callsign Development

Callsign frequency list. This display shows the frequencies utilized by two users who are in communication with each other. These frequencies can then be passed to external systems to extract additional message information.

Transmission information listed by callsign. Once callsigns of interest are identified, several displays show information connected with that callsign. In this case, activity is displayed, including whether messages were included in the transmissions.

Link quality by callsign. In this example, the link quality (LQA) is displayed between ALE users, or for single-sided transmissions where there is no response. Link quality can also be displayed between the user and the E3238 system, to evaluate its ability to reliably receive and decode the ALE transmissions.

Callsigns are the key

Users are identified by their callsigns, though an individual user may have more than one callsign. By extracting the “to” and “from” callsigns from the ALE communications, the E3238 gets at the fundamental information required to identify users and networks of users.

Displays based on callsigns

Displaying the frequency and time link information by callsign shows the patterns of usage required to target resources where needed. Also, the usage patterns help identify a single user using many callsigns.

Link quality

Link quality is important to reliably sending and receiving messages between ALE users. It is also critical for the E3238 system to intercept and accurately demodulate and decode the transmissions. The Link Quality Analysis (LQA) of transmissions can be displayed for both the ALE transmissions and the E3238 receptions of the those transmissions. This supplies critical information about the frequencies that are likely be used for future ALE transmissions, and the likelihood that the E3238 will be effective in intercepting it.
Callogram Usage

**Visualize patterns of communication**

The Callogram display is an efficient way to look at the ALE signal activity in general and highlight the activity of a specific callsign. The legend in the display denotes one-sided and two-sided communications, as well as communications with messages. Selecting a callsign in the list highlights its activity in yellow, and a cursor can show the “to” and “from” callsigns. Seeing the patterns of activity can help focus resources on the times and frequencies most likely to produce results.

**Estimated Intercept Quality.** The normal Link Quality Analysis (LQA) reported with Mil-188-141 radios describes the send/receive link quality between the two intended radios. In cases when your system is in a bystander position relative to the transmit and receive radios, the AL9 software allows the Callsign Quality report to interpret the intercept quality of your intercept solution from the bystander position. This new report helps users determine optimal locations for standoff receivers for Mil-188-141 transmissions.

**Using the cursor to display information.** In this example, the cursor is over a specific transmission from a callsign selected in the list. The yellow dots show the times and frequencies of transmission, and the cursor callout shows the time of day, exact frequency, and “to” and “from” callsign of a specific transmission.
Reports

Documenting results is simplified by numerous displays of the information in the Signal Database. It contains not only the information about a single transmission, but information derived from links between the transmissions in the database. By organizing and displaying the information from several points of view, documentation is simplified.

Reporting information by frequency and callsign. Activity and link information organized by frequency and callsign, two critical attributes.

Displaying completed links and link quality. Displays of completed links contain the “to” and “from” information required for identifying networks.
32-Channel ALE System

Measurement hardware
Mainframe
• MFRAME1 5-slot VXI mainframe
• E1421B 6-slot VXI mainframe
• E1421B-80921 RFI shields
• E1421B-xxx power cord
• E1401-80918 RFI shields
• E8403A-xxx power cord

• E8404A 13-slot VXI mainframe
• E1401-80918 RFI shields
• E8404A-xxx power cord

ADC
• N6830A HF Receiver

DSP
• 1 - E9821A - Signal Processor Module
• 3 - E9821A-101 Add dual G4 processor card with extended RAM
• 1 - E9821A-200 Add 32-channel DDC

Controller and interface
• LTPC2 Microsoft® Windows® laptop controller
• E8491B VXI Firewire interface

Measurement software
• 35688E - Intercept and Collection software
• 35688E-AL9 - Automatic link establishment MIL-STD-188-141 application

Physical Characteristics

32-Channel HF ALE System in a 5-Slot Mainframe

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>inch</th>
<th>mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Width</td>
<td>6.96</td>
<td>176.78</td>
</tr>
<tr>
<td>Height</td>
<td>15</td>
<td>381</td>
</tr>
<tr>
<td>Depth</td>
<td>21.3</td>
<td>540</td>
</tr>
<tr>
<td>Weight</td>
<td>40.2</td>
<td>18.28</td>
</tr>
</tbody>
</table>

224-Channel HF ALE System in a 5-Slot Mainframe

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>inch</th>
<th>mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Width</td>
<td>6.96</td>
<td>176.78</td>
</tr>
<tr>
<td>Height</td>
<td>15</td>
<td>381</td>
</tr>
<tr>
<td>Depth</td>
<td>21.3</td>
<td>540</td>
</tr>
<tr>
<td>Weight</td>
<td>49.2</td>
<td>22.38</td>
</tr>
</tbody>
</table>

Search and collection in a single DSP module.
The processing capabilities of the G4 processor, coupled with the 32-channel DDC, allow 32 channels of HF ALE signals to be processed in the same E9821A DSP module that is running the search application. For larger systems, E9821A modules can be added to provide additional HF ALE narrowband channels. Each additional E9821A module can provide up to 96 additional HF ALE narrowband channels. You can have up to 224 HF ALE narrowband channels in a 5-slot VXI mainframe.
**Custom Solutions**

Agilent Technologies creates standard and custom solutions for signal intercept requirements. If what you have read in this document is similar but not exactly what you require, please talk to your local Agilent Sales Representative about creating a custom solution to fit your exact scenario.

**Agilent Email Updates**

[www.agilent.com/find/emailupdates](http://www.agilent.com/find/emailupdates)

Get the latest information on the products and applications you select.

**Agilent Direct**

[www.agilent.com/find/agilentdirect](http://www.agilent.com/find/agilentdirect)

Quickly choose and use your test equipment solutions with confidence.

**Agilent Open**

[www.agilent.com/find/open](http://www.agilent.com/find/open)

Agilent Open simplifies the process of connecting and programming test systems to help engineers design, validate and manufacture electronic products. Agilent offers open connectivity for a broad range of system-ready instruments, open industry software, PC-standard I/O and global support, which are combined to more easily integrate test system development.

**LXI**

[www.lxistandard.org](http://www.lxistandard.org)

LXI is the LAN-based successor to GPIB, providing faster, more efficient connectivity. Agilent is a founding member of the LXI consortium.

---

**Remove all doubt**

Our repair and calibration services will get your equipment back to you, performing like new, when promised. You will get full value out of your Agilent equipment throughout its lifetime. Your equipment will be serviced by Agilent-trained technicians using the latest factory calibration procedures, automated repair diagnostics and genuine parts. You will always have the utmost confidence in your measurements.

Agilent offers a wide range of additional expert test and measurement services for your equipment, including initial start-up assistance, onsite education and training, as well as design, system integration, and project management.

For more information on repair and calibration services, go to:

[www.agilent.com/find/removealldoubt](http://www.agilent.com/find/removealldoubt)

---

**LXI**

Microsoft and Windows are U.S. registered trademarks of Microsoft Corporation.

---

**For more information on Agilent Technologies’ products, applications or services, please contact your local Agilent office. The complete list is available at:**

[www.agilent.com/find/contactus](http://www.agilent.com/find/contactus)

**Americas**

- Canada (877) 894-4414
- Latin America 305 269 7500
- United States (800) 829-4444

**Asia Pacific**

- Australia 1 800 629 485
- China 800 810 0189
- Hong Kong 800 938 693
- India 1 800 112 929
- Japan 0120 (421) 345
- Korea 080 769 0800
- Malaysia 1 800 888 848
- Singapore 1 800 375 8100
- Taiwan 0800 047 866
- Thailand 1 800 226 008

**Europe & Middle East**

- Austria 01 36027 71571
- Belgium 32 (0) 2 404 93 40
- Denmark 45 70 13 15 15
- Finland 358 (0) 10 855 2100
- France 0825 010 700* 0.125 €/minute
- Germany 07031 464 6333 **0.14 €/minute
- Ireland 1890 924 204
- Israel 972-3-9288-504/544
- Italy 39 02 92 60 8484
- Netherlands 31 (0) 20 547 2111
- Spain 34 (91) 631 3300
- Sweden 0200-88 22 55
- Switzerland 0800 80 53 53
- United Kingdom 44 (0) 118 9276201
- Other European countries: [www.agilent.com/find/contactus](http://www.agilent.com/find/contactus)

Revised: July 17, 2008

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

Printed in USA, August 26, 2008
5989-1794EN