Amateur Radio Emergency Communications and ALE (Automatic Link Establishment)

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Automatic Link Establishment (ALE) were first developed in the late 1970's and early 1980's to allow automatic link connections between high frequency radios at different locations. ALE systems act like a telephone switchboard, initiating signals on defined frequencies indicating which station they need to link, and trying different bands until the two stations connect. When not initiating a connection, ALE equipment scans those defined frequencies continuously on multiple HF bands -- a way to circumvent the difficulties of changing ionospheric conditions.

ALE systems allow inexperienced HF operators to far more easily make connections to distant stations. They avoid the need for a standing "net" of operators who are tied down to staying on frequency or relaying messages for stations who can't hear each other.

While the early ALE systems were not very compatible between different vendors, in 1986 a 2nd generation ALE became a mil-standard (MIL-STD-188-141A). Radios built to that standard were expensive, but by the late 1990's most government installations were ALE-compatible. Internationally, other governments jumped on the bandwagon, and prices began to decline. By 2000, enough non-governmental organizations had also adopted ALE in the interest of being able to reach government agencies, that ALE had become a world-wide standard for military and government HF connectivity.

A third generation ALE standard become available in MIL-STD-188-141B but retained backwards compatibility with the 2nd Generation system. Installation of the 3rd generation systems was slower due to their increased cost.

Wikipedia notes the advantages of this HF standard:

> "ALE is a critical path toward increased interoperability between organizations. By enabling a station to participate nearly simultaneously in many different HF networks, ALE allows for convenient cross-organization message passing and monitoring without requiring dedicated separate equipment and operators for each partner organization. This dramatically reduces staffing and equipment considerations, while enabling small mobile or portable stations to participate in multiple networks and sub networks. The result is increased resilience, decreased fragility, increased ability to communicate information effectively, and the ability to rapidly add to or replace communication points as the situation demands.
>
> When combined with Near Vertical Incidence Skywave (NVIS) techniques and sufficient channels spread across the spectrum, an ALE node can provide greater than 95% success linking on the first call, nearly on par with SATCOM systems. This is significantly more reliable than cellphone infrastructure during disasters or wars yet is

mostly immune to such considerations itself." (Ref: https://en.wikipedia.org/wiki/Automatic_link_establishment)

Current ALE Equipment:

Note: *Hardware ALE-equipped radios tend to be in the $10,000+ price category.... which is why the development of PC software that could work with an ordinary SSB transceiver is so significant.*

- Rockwell Collins URGENT LINK – marketed as a way to do disaster communications. https://www.rockwellcollins.com/Products-and-Services/Critical-Infrastructure/ARINC-UrgentLink.aspx

Rockwell Collins customer radio – works like a telephone!
(ref: https://www.rockwellcollins.com/Products-and-Services/Critical-Infrastructure/ARINC-UrgentLink.aspx)

- Vertex Standard ALE Plug In (ref: http://www.rfswireless.com/vx-1700-en-2/vertex-standard-ale-1-automatic-link-establishment-unit/)

- Micom-3F ALE HF SSB Transceiver (https://www.magnumelectronics.com/Micom-3F-p/M90AMN0KV5-K.htm?

gclid=CjwKCAiA5qTfBRAoEiwAwQy-6f0SgJGGNtH_B7nPdct_eBjRIh-cDKLGBz5EC3mmwaIFlD2CFMDsixoCTp0QAvD_BwE)

- ICOM F8101 HF ALE SSB Transceiver (http://www.icomamerica.com/en/products/landmobile/datahf/f8101/default.aspx)

Military installation news
In 2016, General Dynamics received a $7 million contract to upgrade Navy ships with the software to have this technology. https://www.militaryaerospace.com/articles/print/volume-27/issue-7/rf-microwave/gd-upgrading-navy-shipboard-radio-with-hf-automatic-link-establishment.html

The Underlying Radio Protocol

ALE uses eight different audio tone frequencies between 750 Hz and 2500 Hz -- so it can easily be transmitted by a single sideband transceiver. This is frequency shift keying, and in particular it is 8FSK because of the 8 different frequencies used; it is sometimes called multi-frequency shift keying (MFSK). Each tone on one of the frequencies is transmitted for 8 milliseconds, giving a symbol rate of 125 baud (125 symbols per second), but because there are 8 different possibilities for which frequency could have been chosen, the single tone communicates 3 bits of information ($2^3 = 8$) so the rate of information transfer is three times greater than the symbol rate, and is 375 bits per second (0.275 kbit per second).

ALE forms 24 -bit frames of 3 symbols; the signal is recovered by digital signal processing that can reach down or beyond the noise floor. Forward error correction , redundancy and handshaking make it very similar to traditional ARQ techniques (such as PA CTOR, WINMOR, ARDOP).

The User's View

To the user, it looks like a text messaging system. The user selects the station they would like to communicate with, and the system works to establish a LINK. Once the LINK is established, the user can type in a text message of up to 90 characters and have it sent error-free to the other person.

The system includes "groups" so connections can be made to more than one person, just like cell phone text messaging.

The message transmitted may convey all the information needed, or it may be used to set up another communication, such as telling which frequency the pair should move to, in order to have a SSB phone conversation.

The advantage of the ALE system is that it finds the other user on whatever band is useful between the two at that moment – it can measure the "bit error rate" and signal to noise ratio.

Sounding

The system can also be set so that users periodically (typically every hour) send out a "ping" just to let everyone else know they are still there -- and allow measurement of the current signal to noise ratio on various bands to that participant. This allows the system to keep track of the optimum band to use in order to reach the participant.

HAM RADIO ALE

In 2001, Charles Brain G4GUO wrote PC software to allow ham radio operators to utilize ALE. A worldwide small but growing group of hams utilizing this technique developed under the rubric of HFLINK, under the leadership of Bonnie Crystal, KQ6XA (See: http://hflink.com/alehamradio/) An internationally agreed-upon list of scanning frequencies was developed.

While military users typically have hardware radios with internal ALE capabilities by CODAN or other manufacturer, these are very expensive radios; most hams use the PCALE software that has been updated over the years.

GETTING STARTED

With a yahoo account, the ALE software can be downloaded from the yahoo hflink group: http://groups.yahoo.com/group/hflink/files/-PCALE_Download/

There are multiple versions there, and the user is suggested to start with the earliest full release, and then upgrade to the release version 3.2

At the same location, the QRG file (a zipped group of frequency scanning lists for every part of the world) should be downloaded.

Create a directory in the c:\ root that is c:\PCALE and install all the software there. Unpack the QRG file there also.

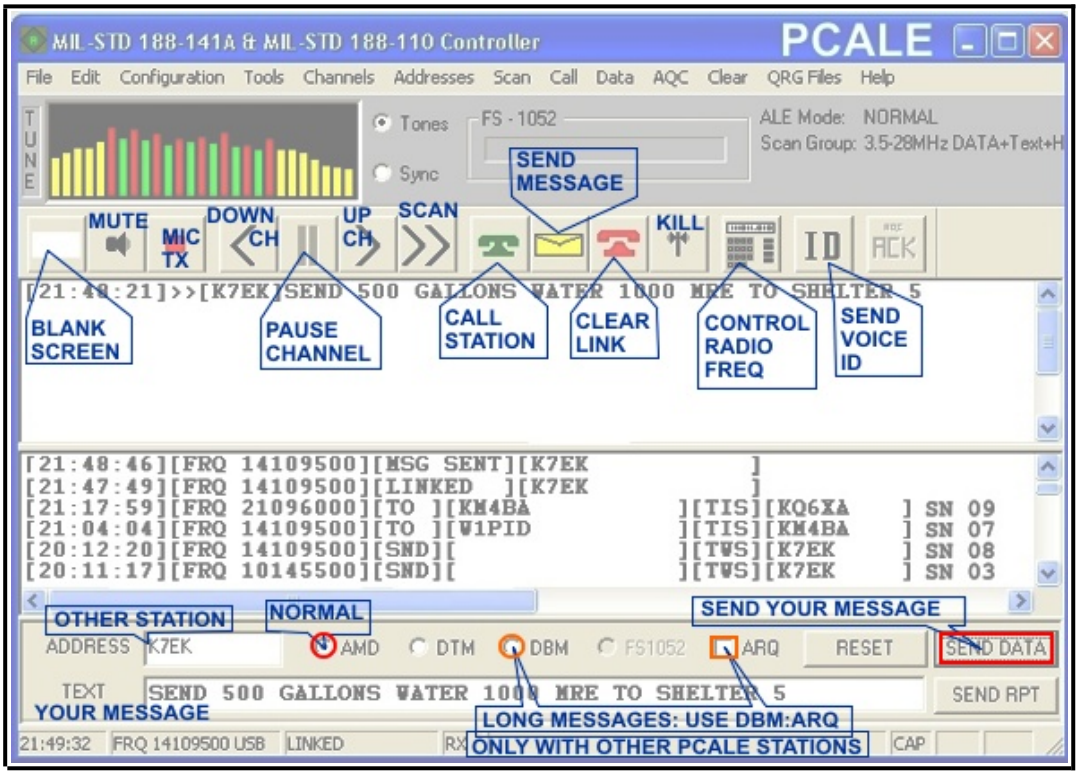
Once the PCALE software is installed, you'll need to follow the following instructions to
a) upload into the application the scanning frequency list
b) insert your OWN call sign as the 0th one in our list of "own" addresses.

The ALE lingo ("addresses" instead of call signs) is somewhat foreign to ham radio ears, but you can figure it out.

1. Make a new folder (directory) on the c: drive of your computer named PCALE! c:\PCALE
2. Download and unzip the PCALE software into the PCALE folder! c:\PCALE
3. Download or save the QRG FILE into the PCALE folder.
4. Run PCALE software. INSTALL PCALE in the PCALE FOLDER c:\PCALE
5. In PCALE, *carefully follow* these steps:
6. At the top: "QRG FILES">LOAD QRG FILE>
7. Browse, find, and double-click on the QRG FILE.
8. If you have problems finding the QRG file, please see QRG section of the PCALE Quick Start Guide

LOAD YOUR CALLSIGN:
Follow these steps VERY CAREFULLY to set up your Own Callsign (Own Address).
1. PCALE, at the top: "ADDRESSES">MODIFY>OWN>Select Address>NOCALSIGN>OK
2. Double-click on NOCALSIGN.
3. NOCALSIGN should now be highlighted.
4. *Type your callsign*. Press OK.
5. Main top menu screen: "ADDRESSES">LIST>OWN> view the list, it should have your callsign in the OO line.
6. If Step 5 fails, repeat procedure starting at LOAD YOUR CALLSIGN Step 1.
7. If this succeeds, you are ready for scan group testing and operation.

PCALE Set Up - Configuration - Information CLICK HERE

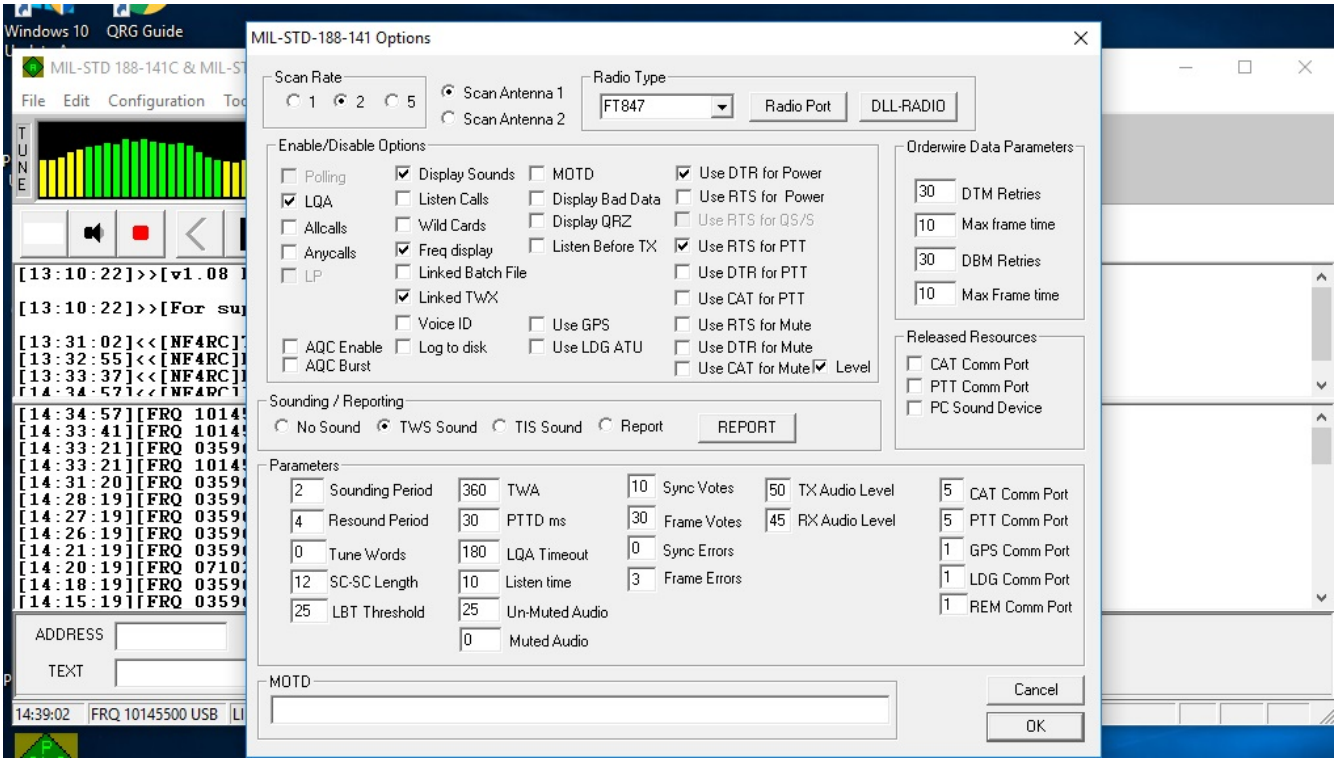


If you reload the QRG file --- you'll need to go through the process to reload your call sign as well!

Along with your installed, you'll find several word processing documents (in pdf) that include many more explanations of the software and its capability. The level of detail can be somewhat overwhelming.

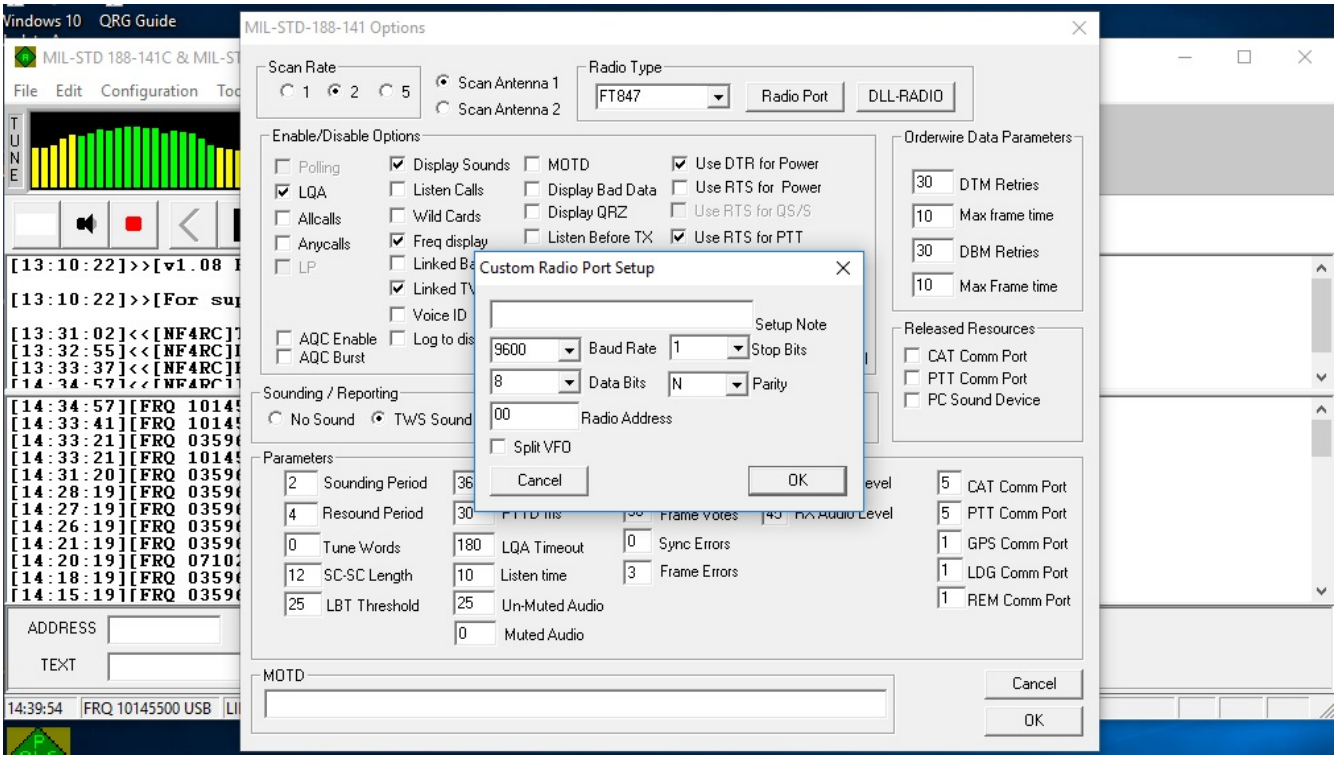
CONFIGURATION:

The ALE military standards include SO MANY adjustable items (to handle slow or fast transceivers, antenna tuners and a host of differences) that configuring the software for your station can be somewhat overwhelming. Here is a screen shot of configuration for a uBitx – pretty reasonable except the Sounding time should be 60 minutes instead of just a very few as were in use during testing:



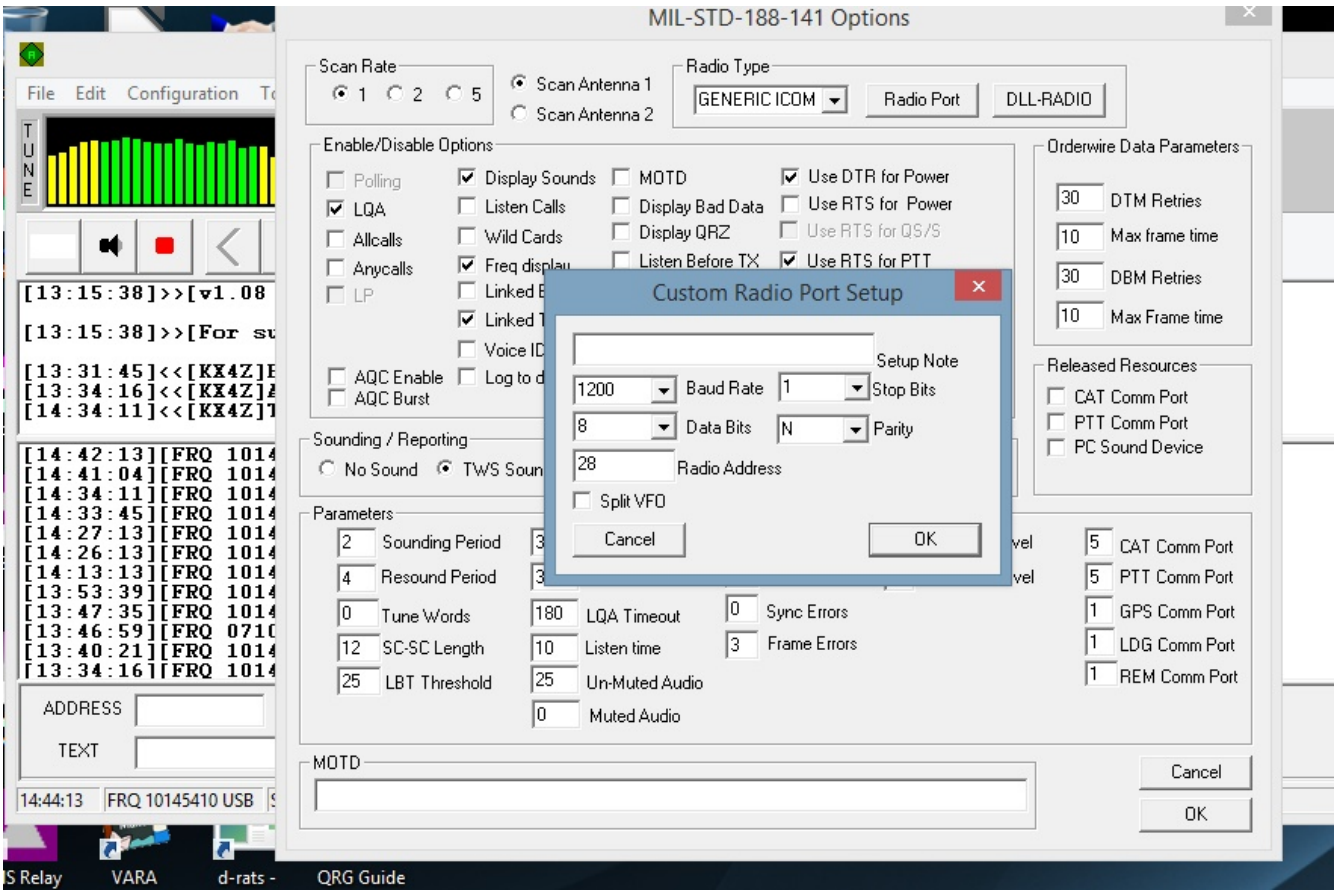
Some items of importance in that configuration:

1. Scanning is set to check 2 frequencies per second.
2. Radio type is set to FT847 (see later configuration of the Radio port)
3. LQA (link quality analysis) is on.
4. Display Sounds means that the system will show on the screen any soundings it hears.
5. The DTR and RTS selections were just what seemed to work. I had to turn OFF "Listen before TX" because it was overly sensitive and NOTHING got transmitted with it was turned on.
6. You will need to use Settings | Control Panel or Device Manager to detect the proper Comm Port to control your radio's frequency (in this illustration it is Port 5). The radio is actually turned on by a Signalink in a VOX-like manner, so the PTT Com Port is probably superfluous
7. 2 Minute Sounding period is only for testing....that would make you very infamous on the real bands.

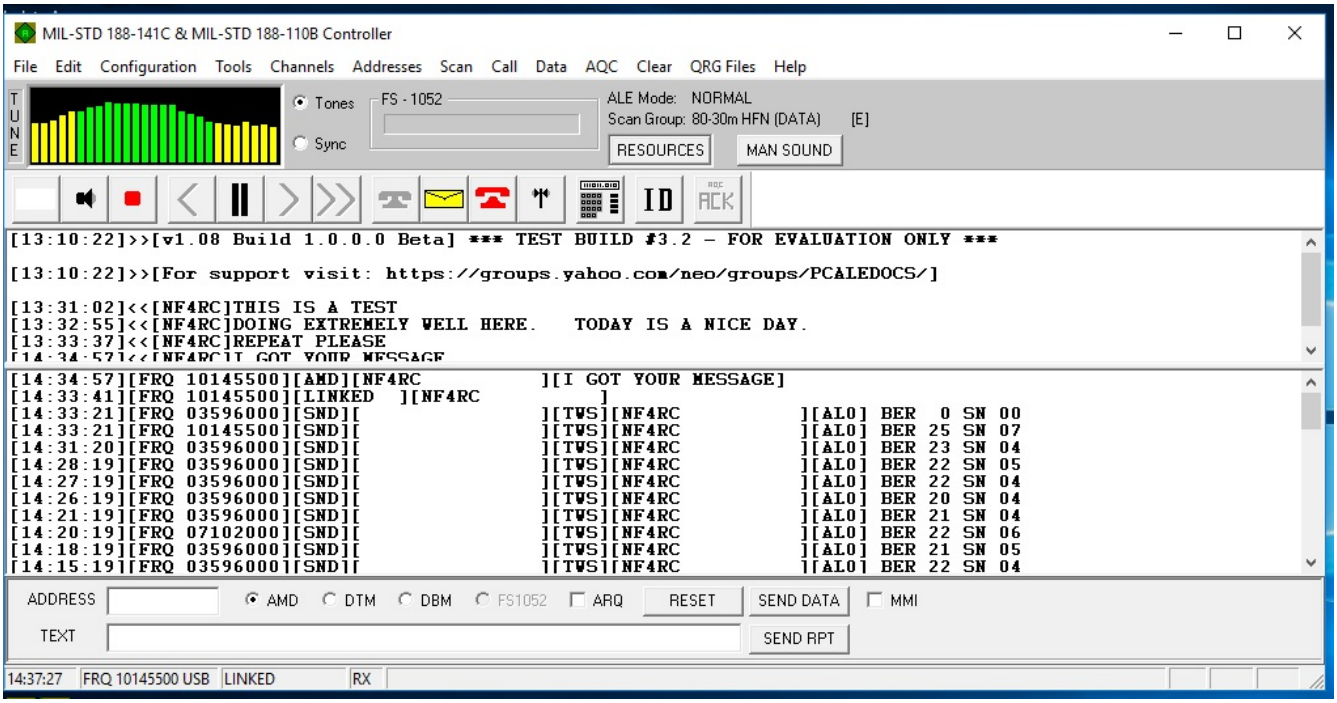


In the Radio Port setup for the uBitx, the port is set to 9600 baud, 8N1

For the ICOM 725, the configuration is similar, but "generic" ICOM worked much better than selecting the ICOM725 specifically – remember to put in the correct ICOM 'address' number.



For the ICOM725, the comm port is 1200 8n1 and the radio address is 28.



Here you see multiple SOUNDINGS that have been received from NF4RC; and each includes the frequency, the stylized "bit error rate" and an indication of the signal to noise ratio.

CONNECTION:

Once linked, the system shows two important items:

- red telephone button can be clicked to "hang up" the connection
- yellow envelope can be clicked to send a text messages

Several text messages have been transferred already and are visible in the dialog window.

Visual Display of Real Time ALE Connections

http://www.hflink.net/