# *The Growing Family of Federal Standards for HF Radio Automatic Link Establishment (ALE)*

## Part V: An Amateur's Practical Approach to HF ALE Radio Systems

*ALE is becoming doable for amateurs. Here's one low-cost approach used now.*

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### Introduction

If you have been following this series of articles on Automatic Link Establishment (ALE) technology and those by Adair, Wickwire, and others, you have probably been convinced that this new technology is worth looking at for use by amateurs, but if you are like most hams, you will reserve judgment until you have had the opportunity to get some "hands on" experience with real equipment. Magazine articles can go just so far. Alas, here is the problem. These systems were designed with the requirements of the Federal Government in mind, emergency preparedness agencies and the military services in particular. We all know too well what that means: sticker prices in the $10,000 to $20,000 range which places those technologies out of reach for years, until they begin to appear on the surplus market. There is at least one manufacturer that produces an ALE system for less than $10,000, but that price is still well beyond what most hams could comfortably afford.

The engineers at the National Telecommunications and Information Administration/Institute for Telecommunication Sciences (NTIA/ITS) in Boulder, Colorado, have long been involved in the development of a family of telecommunication standards for federal agencies describing adaptive HF radio systems. Several years ago, ITS developed a need for inexpensive ALE radio systems to support the early testing and evaluation of new concepts. ITS is a very small government agency that receives the majority of its annual operating funds indirectly from other federal agencies, rather than in the form of direct appropriations from Congress. As funds for the purchase of equipment, such as ALE radios, are in a constant state of short supply, some degree of ingenuity was needed to acquire the needed ALE equipment. Hams can now benefit from that ingenuity.

The remainder of this article describes the approach that ITS took to home-brew an ALE radio system using off-the-shelf components. The total cost of this project was under $4,000, and it can be done for even less now. This approach should be of some interest to those hams who may want to experiment with this new technology without spending the family's fortune to do so. This might make a good club project, too.

### System Specifications

An HF ALE radio system is nothing more than an HF SSB transceiver and an associated modem that supports the unique FED-STD-1045 (and MIL-STD-188-141A) protocols. The ALE modem is both a modem in the conventional sense and a controller for the transceiver, causing the radio to scan, transmit, and receive on command. Except for the robust protocols employed by the ALE modem (eg, deep interleaving, triply redundant word transmission and Golay encoding for error detection and correction), it can be considered to be very similar to the AX.25 packet modems (TNCs) familiar to most hams. It seemed logical to ITS that any modern low-cost transceiver developed for the amateur market and capable of

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being controlled by a computer would work as part of a home-brewed ALE system. ITS selected the ICOM IC-725 because we already possessed an ICOM IC-781 transceiver and were familiar with the programming and commands of this series of radios.[1] Since the government operates on frequencies which are, in some cases, far from the ham bands, it was necessary to convert the IC-725 to general coverage on both transmit and receive. This was easily accomplished following instructions obtained from ICOM America, Inc, in Bellevue, Washington. To control the transceiver by computer, it was also necessary to obtain one additional piece of equipment: the ICOM communications interface, CI-V (model CT-17). The CT-17 is a signal-level converter that connects between the transceiver and a computer (or terminal) with an EIA RS-232C communications port.

The final item needed in our build-it-yourself ALE project was the ALE modem. At the time there was only one source for a stand-alone ALE modem: the Model 1045 ALE controller from Frederick Electronics of Frederick, Maryland (with a 1991 price of $3,000). As far as ITS is aware, this is still the case, although we understand that Space Research Technologies, Inc, intends to produce an ALE controller on a card for insertion into a PC, to be sold to the amateur market.[2] The card price is projected to be somewhere in the $700-$800 range and to be available in late 1993.

The Frederick ALE modem is designed to interface with several different radios, as well as external high-speed data modems and terminal devices. Table 1 lists the transceivers with which the Model 1045 has been interfaced. ITS provided Frederick with the ICOM radio command set. These commands were incorporated into the Model 1045 firmware with the radio hex address that was selected (to match those of our other ICOM products).

Interfacing a stand-alone ALE modem/controller to an SSB HF transceiver is no more difficult than interfacing a packet terminal node controller (TNC). One simply provides paths between the two devices for control signals and the FSK audio tones to and from the radio. However, the impedances of the inputs and outputs of the various devices have to be considered.

Upon receiving the new Frederick modem it was discovered that the input and output impedances for the FSK tones are 600 Ω balanced, while the ICOM transceiver requires impedances of 10 kΩ unbalanced for input to the radio and 4.7 kΩ unbalanced from the radio. A quick test revealed that the system could correctly receive the ALE tones from another station but could not transmit them successfully without providing a closer impedance match; it was necessary to provide impedance matching between the radio and the ALE modem/controller. A quick look at a recent Radio Shack catalog provided the answer. Radio Shack offered a microphone transformer designed to match an unbalanced high impedance (nominally 10 kΩ) to a 600-Ω balanced line impedance. While not the perfect solution, these transformers provided adequate signal levels for the ALE tones. Fig 1 shows the prototype ITS low-cost ALE system components. Fig 2 is a block diagram of this system showing the major I/O ports on the ALE modem. Fig 3 is a schematic of the "field-expedient" audio impedance transformation unit.

### Equipment Setup

The final step was to interface a video display terminal or personal computer running a communications program that permits the emulation of a Digital Equipment Corp (DEC) VT 100 or VT 220 terminal. ITS chose to use an available laptop computer with *ProComm Plus* communications software. Once the system is assembled and interconnected as shown in Fig 2, power is applied to the radio (via an external power supply) and the system with *Procomm Plus* booted up on the computer. At this point, the computer-to-ALE modem parameters are set up. These are presented in Table 2.

**TABLE 1**

**Transceivers Currently Interfaced to Frederick Model 1045 ALE Modems**

| *Transceiver* | *Models* |
|---|---|
| TransWorld Comm: | TW/RT-100 |
| MacKay Comm: | MSR-8050A |
| ICOM: | IC-781,725,etc |
| Signal One: | MilSpec 1030C |
| Ten-Tec: | 585 Paragon |
| Rohde & Schwarz: | XK-852C1/C2 |
| Skanti: | TRP 82XX |
| SGC: | SG-2000 |
| Hagenuk: | RX 1001 M/L11 |
| | EX 1010 /L11 |

Fig 1—Low-cost HF ALE radio system.

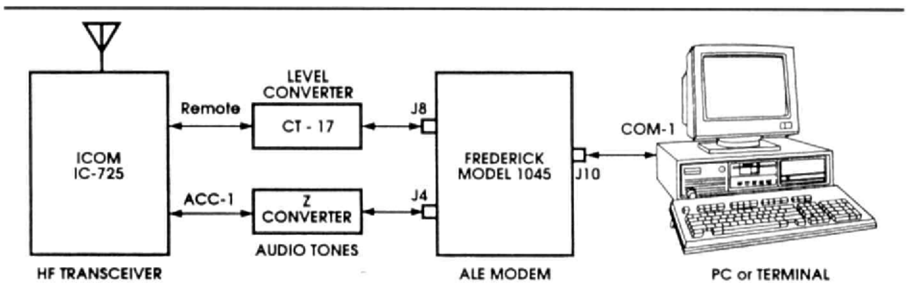


Fig 2—Low-cost ALE system block diagram.

[1]Notes appear on page 12.

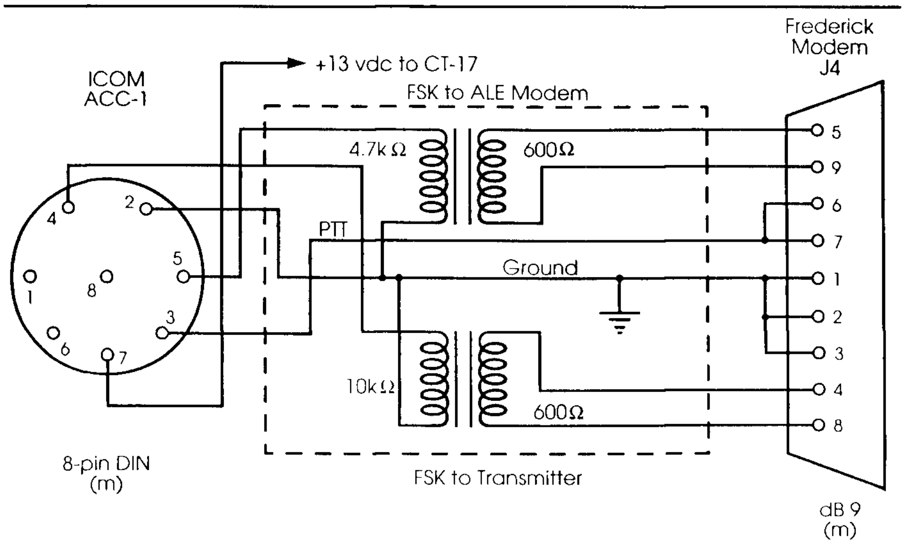


**Fig 3—Audio impedance transformation interface box.**

**Table 2**

**Terminal Communications Parameters**

Display Mode = VT 220 (VT 100)
Data Rate = 9600 Baud
8 data bits, 1 stop bit
No parity, Full duplex

Having set the terminal communications parameters, we are at the point where power may be applied to the Frederick modem. As the power is applied, you will see the Frederick header screen with its credits and the software version number (currently 2.20). After a few seconds, the screen will change to the working screen with its menus. This screen should look like the one shown in Fig 4. The bottom line, in reversed video, is the *Procomm Plus* status line. Everything else above the status line belongs to the ALE system. The ALE modem has its own status line at the very top of the screen. In the example shown in Fig 4, we see that our ALE system is scanning the frequencies of channel group #1, at a rate of 2 channels per second and listening for a call. We are currently on channel #4 with a transceiver frequency of 10.224 MHz. The indicated time is 08:01:45 (may be either UTC or local, as defined by the operator). The volume/mute indicator has no meaning for our system as this function is not used.

The line of ALE commands just above the *Procomm Plus* status line is the point of operator-machine interface with the ALE system. The example screen in Fig 4 shows the cursor on the "call" function key. After first accessing the system, you must program your station variables into the ALE software. These values include station call sign(s), called self addresses in the ALE vernacular, a set or sets of frequencies to be scanned, the sounding interval, and numerous other technical system parameters. For basic simplex operation, it is only necessary to load a single self address (call sign), the individual addresses (calls) of stations that you might wish to contact, and a set of frequencies that have been mutually agreed upon in the appropriate licensed bands.

```
STATUS   SOUNDS    MODE    GROUP   CHANNEL  RX FREQ    VOLUME  TIME
LISTEN   DISABLED  SCAN 2  -- 1 -- # 04     10.224000  MUTE    08:01:45

FUNCTION   TIME      CH   TO-LQA-FR   'TO' ADDRESS         'FROM' ADDRESS

RX : CALL  07:43:05  03   --  25      NTIA @ @ ----------  ITS ----------
RX : CALL  07:43:10  03   --  26      NTIA @ @ ----------  ITS ----------
   Linked with Station ITS --------

 - Link Terminated via No-Activity timeout.
RX : ALE   07:58:38  05   --  15      MAC -------------    MTR ---------
 -  Station Call - From: NTIA ------- To: ITS ------
 -  Call terminated via user.

CALL   SOUNDS   MODE   GROUPS   CHANNELS   LAST AMD   VOLUME   SET-UP

Alt-Z FOR HELP | ANSI | FDX | 9600 N82 | LOG CLOSED | PRINT OFF | OFF LINE
```

**Fig 4—Sample computer terminal display of ALE data.**

## Summary

This low-cost ALE radio system has been a part of ITS's HF radio Interoperability Test Facility since December 1990 and has been used in numerous ALE performance and interoperability tests since that time. Laboratory personnel find the system easy to learn and very user friendly. The screen of the computer permits much more information to be displayed than does the LCD displays of most ALE equipment.

We recommend this approach to individuals or groups desiring to get into ALE for the lowest possible cost. Amateurs involved in traffic-handling for the NTS or MARS should find the new ALE technology particularly useful.

As expounded upon in previous articles, ALE radios operate quite successfully for linking and slow-speed data traffic at S/N ratios of 0 to 6 dB. These levels are unusable for voice and other modes having no error correction. This means that previously unusable noisy portions of the ham bands are now available for passing data traffic using ALE radios. And they *do not* interfere with existing modes of HF communications. Once again—new technology is exciting and opens a whole new realm of possibilities.

## Acknowledgments

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Institute for Telecommunication Sciences (NTIA/ITS).

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### Notes

[1]Certain commercial equipment and software products are identified in this paper to adequately describe the design of the experiment. In no case does such identification imply recommendation or endorsement by NTIA, nor does it imply that the materials or equipment identified are necessarily the best available for the purpose.

[2]Space Research Technologies, Inc, Attn: Mr Laurence Rennie, 31255 Cedar Valley Dr, Westlake Village, CA 91362, phone (818) 991-0693. □□