REQUESTED N2CKH COMMENTS ON HF RADIO HARDWARE

Many have asked me to write a short opinion paper on the best HF transceivers and sound devices for use with both MARS-ALE and MS-DMT. As I am experienced with HF-ALE transceiver pairing with MS-DMT and MIL-STD hardware data modems, I also get asked about those subjects, as such they are also covered in my comments.

I have been repeatedly asked similar questions by many people where the theme of the top recurring questions are:

1. *"What is the best (new/used) HF SSB transceiver for use with MARS-ALE and MS-DMT?"*
2. *"What is the best (new/used) (low cost) HF-ALE transceiver for use with MS-DMT or a hardware MIL-STD data modem?"*
3. *"What is the best (new/used) MIL-STD data modem (that is not too expensive)?"*
4. *"What is the best sound device to use with MARS-ALE and MS-DMT?"*

NOTE: The one common denominator in these questions is the use of the word "best". The use of "best" is often subjective on the part of the person replying to the question. In addition "best" with few exceptions, usually denotes the most expensive item.

NOTE: Regarding the use of "(new/used)", either or both (as in "new or used", "new and used") have been used at times. The lack of either and the use of "used" are the most common cases. It almost goes without saying that "used", or in the case of Military gear, "surplus", will always cost less up front than "new". However in most cases there will not be any warranty on "used" gear, thus any servicing will be more expensive. The older the gear, the sooner it will require servicing. Then comes the question of who, if anyone, will perform such service, especially when not U.S. made.

NOTE: In Q2 and Q3, the cost factor is often raised as worded or similar. It's obvious to everyone that hardware MIL-STD ALE radio and modem solutions, new or used are expensive, period. In the new market place, COTS hardware is the least expensive and the more readily available to a MARS member verses Military or Paramilitary gear. However not all COTS solutions adhere to MIL-STD or even FED-STD requirements.

JITC CERTIFIED HF HARDWARE

Regarding Q1, in today's world a new Military grade HF transceivers in most cases, especially those used by the U.S. Military, are going to be 2G/3G HF-ALE and MIL-STD/STANAG data modem capable. As such MARS-ALE and MS-DMT use would not be required. However MARS-ALE supports a few such HF-ALE transceivers known to be in MARS member hands. Some older Military radios are not so well equipped (e.g. Harris RT-1446 and RF-5000 models) as standard and are also hardcoded. These make for the "best" HF transceivers for use with MARS-ALE and MS-DMT.

As to Q2 and Q3, a U.S. Military grade HF-ALE transceiver and if required, an external Military data modem. would be the "best" choice. The next best choice would be any transceiver or modem found on the short list of JITC certified equipment for the model and firmware release listed (http://jitc.fhu.disa.mil/projects/hf/index.aspx).

NOTE: The "Green" U.S. Military grade transceivers are very expensive new or used and if under ITAR[2] regulations they are not even obtainable by most. For example, the last price I saw on a non-ITAR[2] RF-5800H-MP 20w manpack was about $25,000USD new. Due to ITAR[2] regulations the U.S. surplus market for U.S. Military grade HF-ALE transceivers are now pretty old. For example the Harris Falcon series, AN/PRC-138 (RT-1694) which was the last to become available is about 20 year old. I had the pleasure of using a 20w PRC-138 manpack on loan some years ago, it still commands about $6,000USD in really good condition. Paramilitary gear like Datron and other brands, as well as COTS equipment are less expensive new and used where some models are on the JITC list.

As to Q3, external "Green" U.S. Military grade modems have disappeared in U.S. Military fielding due to Harris PRC-150C Falcon II and later integrated transceivers. The Rockwell MDM-Q9604, although not "Green", are used in large numbers by the U.S. Air Force and run about $10,000USD new. I consider the MDM-Q9604 (which supports serial 8-bit High Speed ASYNC and TCP/IP) to be the "best" MIL-STD modem based on my personal use. As with HF-ALE transceivers, any JITC[1] listed (http://jitc.fhu.disa.mil/projects/hf/index.aspx) data modem would be the next best.

[1]**JITC (Joint Interoperability Test Command) is the U.D. Department of Defense's Joint Interoperability Certifier and only non-Service Operational Test Agency for Information Technology (IT)/National Security Systems. JITC provides risk based Test, Evaluation & Certification services, tools, and environments to ensure Joint Warfighting IT capabilities are interoperable and support mission needs.**

[2]**ITAR (International Traffic in Arms Regulations) is a United States regulatory regime to restrict and control the export of defense and military related technologies to safeguard U.S. national security and further U.S. foreign policy objectives.**

COMMERCIAL/MARINE/AMATEUR GRADE HF TRANSCEIVERS

Regarding Q1, use of an HF SSB transceiver other than Military grade is best achieved with Commercial or Marine grade HF transceivers. Some Amateur grade HF transceivers that qualify as "rugged" (e.g. ICOM IC-7200) when compared to Commercial and Marine grade are also suitable. It's up to the end user to decide if the transceiver in hand is up to the task "AS IS" or can be economically enhanced or if a new acquisition is required to meet the must have requirements. In addition, meeting the desired requirements would be the best situation.

The must have features of an HF SSB transceiver regarding Q1 are:

- *TCXO (Temperature-Controlled Crystal Oscillator) equipped with an accuracy of at least ±1.0ppm frequency stability*
- *Minimum 2-28Mhz frequency coverage at full power and receiver ratings.*
- *Full 2.8kHz analog filter IF pass band (300-3100hz) or full 3.0kHz (300-3300hz) for DSP IF filtering where the center frequency is 1800hz and variations in attenuation at most are +/-2db and a Group Delay time over 80% of passband must not be more than .5ms per STANAG 4203[3]*
- *AGC time constant must be less than 10ms on de-sensitization and less than 25ms on re-sensitization.*
- *Remote control (CAT) for ALE of Frequency minimum, Mode and PTT preferable (CAT PTT is required for MS-DMT behind MARS-ALE), selection between TX audio ports if required (for ALE and MS-DMT), using RS-232 or other serial interface that can be emulated. A data rate of at least 4800 baud, where 9600 baud or greater is preferably to support 2 ch/sec. and greater 2G ALE scan rates.*

The desired features of an HF SSB transceiver regarding Q1 are:

- *TCXO equipped with an accuracy of at least ±0.5ppm frequency stability is more desirable.*
- *MS110A PSK at 100w output is desired (with full duty cycle being preferable).*
- *Heavy PA heatsink cooling for rated output (preferably without the need of fan cooling).*

NOTE: Military grade transceivers come standard with STANG 4203[3] wide SSB data filters. However most Commercial, Marine and Amateur grade transceivers usually come standard with only narrow SSB filters. Most but not all manufacturers offer factory fitted optional wide filters of 2.7kHz or greater. There are also new 3rd party IF drop-in hardware DSP filter boards for some radios starting to appear, they are less expensive then ceramic or crystal filters, however you will need to request wider BW filters than standard.

Any transceiver must meet the must have features herein. Most Amateur Radio grade HF SSB transceivers are mediocre performers regarding 2G HF-ALE. They have shortcomings when it comes to both ALE scanning and long MS110A PSK data transmissions that will lead to damage over time if not addressed. They are awful for MS110A PSK or newer serial tone waveforms use without a TCXO or wide SSB filtering.

Almost all HF SSB transceivers above a certain RF power level that necessitate spectral purity filter selection use relays (even HF-ALE transceivers) vs. RF PIN diode based switching (e.g. MICOM ALE radios). As such it presents an issue when it comes to ALE scanning when used with MARS-ALE. However Amateur grade radios use lesser quality relays which presents a bigger issue. Few HF transceivers provide remote PA filter relay bypass commands. All manufacturers could implement remote control bypass commands in firmware if enough users demanded it.

An HF-ALE transceiver deals with the PA filter relay issue by the ALE modem/controller board BYPASS signaling during scanning. Thus radios like the Kenwood TK-90 and Vertex VX-1700 and others that take optional ALE boards could be interfaced for external MARS-ALE signaling control if anyone takes the time to figure out the required signaling.

NOTE: All transceivers can be modified for PA filter relay bypass during scanning. Manufacturers do not provide such information and few have bothered to develop needed modifications. A few components such as a relay, switching transistor or optocoupler, diodes and wire are all that is needed. A good example are the IC-7200 details: http://hflink.com/icom/ic7200/. You can't purchase just any radio of interest with such modifications along with that MARS frequency modification as resellers are not any more knowledgeable on the subject than we are.

NOTE: Some of the Commercial grade HF transceivers that offer optional ALE boards or firmware update, that are not JTIC[1] certified. In some cases some do not even meet FED-STD-1045A conformance, let alone the required MIL-STD conformance. However most make for excellent HF-ALE transceivers when used with MARS-ALE. A prime example is the Vertex VX-1700 which is an awful implementation of 2G ALE.

[3]**STANAG 4203 C3 (EDITION 3), TECHNICAL STANDARDS FOR SINGLE CHANNEL HF RADIO EQUIPMENT, 27 APRIL 2007, ANNEX B and ANNEX C.**

When it comes to some requirements, a few approaches exist to get more from lesser Amateur grade radios:

- *Use of an external power amplifier can be made with a low power transceiver to address the PA spectral filter relay issue and in achieving the 100w MS110A PSK output.*
- *Additional cooling should be added to all transceivers by either adding more radiating metal heat sinking or heavy fan cooling for long MS110A PSK data transmissions.*
- *T/R operation can be made using an exciter or transceiver for transmit and a receiver for receive to address the PA spectral filter relay issue. This is very common with many Military configurations and supported in more than one manner with MARS-ALE.*
- *In many cases IF SHIFT compensation (best when applied on both RX and TX) can be used with a full analog 2.4kHz (300-2700hz) passband SSB filter will work well for MS110A if the IF shift is set close to 1800hz center. A wider DSP IF filter will be required to attempt IF SHIFT compensation.*

NOTE: I can ONLY recommend specific HF hardware for Q1 (Q2 or Q3) that I own or have owned or had hands on with on loan (which to date are fewer than I own) and found to be good choices. It is only the IC-F8101E, TK90 and IC-7200 (the latter two are both discontinued but currently available while supplies last) that I own which are still being sold new. Thus I recommend the use of my various support groups that provide for general Q&A in asking for comments by others on particular make/model transceivers still being sold new.

As to Q4, I can say with absolute certainty that any computer's on-board AC'97 sound device is the **WORST** choice for use with MARS-ALE and MS-DMT.

The following list of sound device results is achieved when Windows DPC latency is tamed. The devices/approaches outlined are based on hands on results by many users.

1. **BEST RESULTS:** An ASUS Essence STX II or an equivalent professional grade commercial audio device.

2. **BEST RESULTS:** The MS-PCSDM (www.n2ckh.com/MARS_ALE_FORUM/MS-PCSDM_User_Guide.pdf) project is based on use of TI C5535/C5545 DSPs and is the least expensive approach using $10USD or $100USD TI hardware boards. When it comes to an external sound device, which most will be using, taking into account cost, nothing beats this approach. In addition, the TI C5000 DSPs have the potential of future use with new firmware as real embedded modems.

3. **BEST RESULTS:** A Virtual Audio Cable (VAC) with an SDR radio having high quality ADC/DAC devices. However Windows DPC latency is a bigger challenge in this approach.

4. **VERY GOOD RESULTS:** An Amateur Radio grade (e.g. IC-7200) or Commercial grade (e.g. IC-F8101E) HF SSB radio with an internal USB audio codec.

5. **DECENT RESULTS:** The use of an external COTS radio/sound device interface for analog audio will vary from decent results in most cases, down to poor results in other cases.