HERMES Equipment List and Recommendations

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Abstract

This document lists the equipment needed to set up a HF station capable of sending and receiving digital data. This document is based on field experience acquired through HF systems deployed in the south of Mexico and in the Amazon region in South America. The software stack for digital telecommunications system is described in another document.

Contents

1 Digital HF station

An HF station capable of transmitting digital data is composed by the following main set of components:

- HF Radio Transceiver
- Antenna
- Mini-Computer
- Power source

Each part has its own dedicated subsection, and also a section with important tools to have in order to properly adjust the HF station is present.

1.1 HF Radio Transceiver

We consider best options for HF radio transceiver the 100W (or more) transceivers which have a USB (Universal Serial Bus) port and internal analog/digital converters, which provide seamless and error-free connection between the HF transceiver and a computer. Taking in consideration the cost of the transceivers, usually the most affordable ones are made for the amateur (ham) radio market. Ham radio transceivers are usually blocked to transmit only in the ham radio allocated bands, and need to be modified to transmit in all the HF bands (See example here: https://radioaficion.com/cms/ic-7100-marscap-modification/).

In order to improve transmitting data rate a passband of at least 2.8kHz is recommended in SSB mode (the mode typically used for data and voice transmissions in HF).

Among this category we list as examples (supported frequency bands between parenthesis):

- ICOM IC-7100 (UHF + VHF + HF)
- ICOM IC-7300 (HF)
- Yaesu FT-991A (HF)

Other HF transceivers can also be used for digital telecommunications, but need an external interface to connect the radio to a computer. Examples of transceivers in the category are:

- ICOM IC-78 (HF)
- ICOM IC-718 (HF)
- Vertex VX-1700 (HF)
- Alinco DX-SR8T (HF)
- Yaesu FT-857D (UHF + VHF + HF)
- Yaesu FT-891 (HF)

If an external interface is needed to connect a transceiver to computer, be aware that an adjust procedure to identify the correct audio levels to correctly drive the transceiver and to optimally receive the audio needs to be done. With some transceivers like the ICOM IC-78 and IC-718 there is a need to set the MIC gain level to 0 when transmitting using its ACC connector. Different transceivers have different quirks and issues, so be aware to always carry tests before taking any equipment to the field.

Examples of external interfaces which support all transceiver models (PC connection between parenthesis):

- Tigertronics Signalink USB (USB)
- DigiMaster MiniProSC (USB)
- West Mountain Radio RIGblaster (USB and Bluetooth)

1.2 Antenna

The antenna is a very special part of the system. If not well tuned or well installed, nothing works. We recommend the use of the appropriate antenna for the desired coverage. For Near Vertical Incidence Skywave (NVIS), which exceeds 600km radius of coverage, we recommend a simple quarter wavelength antenna with a balun for impedance matching. If a portable antenna is needed, the Buddipole antenna is a good option, but with worse performance then a simple 1/4 wavelength dipole (See https://www.buddipole.com/). Frequency bands below 7MHz are recommended for NVIS operation.

1.3 Mini-computer

The mini-computer will host the HF modem application, the network stack and services. In the a minimal setup, the computer will run the HF modem application and a Web server which provides access to the HF telecommunication system services over a WiFi network. A Raspberry Pi 4 has enough processing power and memory for this use case.

In more complex setup, in which the computer will run the HF modem and also control GSM or LTE networks connected to the HF telecommunication facilities, a more capable Intel-based mini-pc is recommended.

1.4 Power source

A common HF transceiver uses a 12V voltage input and at least 1A current in receiving mode, and peaks up to 25A when transmitting. So it is important to have a charge controller which can provide at least 30A, in order to allow some headroom for fluctuations of consumption.

As a example scenario, take a transceiver using 20A when transmitting full power, 1A while listening. Lets assume we want to transmit for 5 minutes every 24 hours and listen all the time when we're not transmitting.

The daily power budget of the system (@12V) is:
HF rx: $1A * 24h = 24Ah$
HF tx: $20A * 5/60h = 100/60 = 1.7Ah$
mini-pc: $0.5A(\ 1.2A@5V) * 24h = 12Ah$

So total daily battery consumption would be $24 + 1.7 + 12 = 37.7Ah$

Let's say we want to discharge our batteries 15% on a normal day, so this load would represent a battery capacity of 100/15 * 37.7 = 251.3Ah.

We'd probably also want some spare capacity, say, an extra day of using the system when there's no sun. (solar panels are really bad at producing output on cloudy days: expect 8%-20% of normal output). So we'll either have to add more batteries or stop listening all day (nearly all our power consumption is for listening, not talking). for the solar panels recharging the battery, it is a good practice to size things at somewhere around 2 times the normal load every day, so that the system recharges in about 1 day after 1 day of operating without sun, plus add around 15%-20% for inefficiencies.

The solar maps for the Amazon region show a yearly average insolation of about $4.0kWh/m^2/d$. Based on this,
$4h * Cpanel(W) = 37.7Ah * 12.5V * 2.2$
$Cpanel(W) = 2.2 * (37.7Ah * 12.5V)/(4h)$
$= 259.2W$

So there is a need for around 250W to 300W of solar panels.

Another good practice would be to double the battery capacity for this scenario to make the system workable for more than 1 sunless day without discharging the batteries too deeply.

Recommended power related parts:

- 250Ah stationary battery
- One 250W or 300W solar panel, or two 250W panels
- Charge controller which can output at least 30A of current. 40A recommended.

In the case of using the HF transceiver connected to power grid, a AC/DC power supply is needed, with 12V or 13.8V output. A couple of options for the AC/DC power supply:

- At least 30A transformer-based power supply at 12V or 13.8V.
- Low cost switched power supply at 12V or 13.8V marked as 50A or more.

1.5 Essential tools

Essential tools to have for basic radio and antenna testing:

- Wattmeter with reflected and forward power readings for HF, which supports at least 100W
- Multimeter
- 50ohm dummy load for at least 100W