RECOMMENDATION ITU-R F.764-1

MINIMUM REQUIREMENTS FOR HF RADIO SYSTEMS USING A PACKET TRANSMISSION PROTOCOL

(Question ITU-R 158/9)

(1992-1994)

The ITU Radiocommunication Assembly,

considering

a) that there is an increasing demand to provide a virtually error-free digital data service for HF radio systems;

b) that it is desirable to specify the requirements of HF packet radio systems,

recommends

1. that as a minimum requirement for HF packet radio system protocols:

1.1 the HF packet protocols should sustain the highest throughput for a wide range of channel conditions;

1.2 the packet protocols should employ error detection and correction schemes to ensure that the undetected error probability is better than 1×10^{-8} when the channel raw bit error ratio is 1×10^{-2};

1.3 the packet protocols when operated in ARQ mode should utilize selective repeat algorithms. The redundancy of FEC should be transmitted when a repeat of the packet in error is requested. If the repeated packet is received correctly, then the information is recovered and delivered to the message destination. If the repeated packet contains one or more errors, the two versions of the packet related to the same information are put through an FEC procedure and checked for errors. If the processed packet is deemed to be error free, then the information is delivered to the destination. The levels of FEC can be increased from 2 as described for higher performance. Also soft decision values of the received packet signal can be utilized for better FEC performance. Such a system is described in Annex 2;

1.4 the data transmission should be in synchronous mode;

1.5 the packet should contain sufficient preamble for receiver modem bit timing synchronization to take place;

1.6 the packet should have at least 16 bit frame synchronizations in order to reduce false frame detection;

1.7 the packets should contain identification of sending and receiving stations in order to prevent erroneous acceptance of traffic intended for other stations;

1.8 the packet transmitting station should employ some method of carrier detection, packet detection, or synchronization with other stations sharing the same radio channel in order to reduce packet collisions and interference with the packets already in transmission in the channel;

2. that this Recommendation should be updated as new techniques are developed and relevant information is reported. The study of the techniques for optimization of HF packet systems is also recommended;

3. that the following Notes should be considered as part of this Recommendation.

Note 1 – Annex 1 describes a system which employs an HF packet protocol.

Note 2 – Annex 2 describes a system which employs an HF packet radio protocol with selective ARQ and FEC.

Note 3 – Annex 3 lists features of a terminal node controller (TNC) which incorporates the AX.25 packet radio protocol.

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Note 4 – Annex 4 describes a system which employs an HF packet protocol for data transmission, with error correction, detection of uncorrectable errors and repetition of frames not received or not corrected.

ANNEX 1

Transportable HF radiocommunication equipment for transmission of hard-copy messages

1. Introduction

A data terminal is described which can be interfaced with HF radios for the transmission of text messages when the propagation conditions do not permit intelligible voice communications. The system is suitable for use on ships and in remote areas where other means of communication are not available. The important characteristics of the system include:

- real-time channel evaluation and selection;
- interface with the telephone network for remote control;
- economical deployment in remote areas.

2. System configuration

The data terminal is designed to operate with transceivers in a network of up to 128 stations sharing a common set of frequencies.

3. System description

The data terminal is the size of a portable typewriter, consisting of an alphanumeric keyboard, a 20-character light emitting diode (LED) display and a 20-column printer. The package also includes a central processor, modems and a radio interface board (Fig. 1). A message of up to 1 280 characters can be entered into the terminal memory and may be checked on the LED display or printer and edited if required. When the operator is satisfied with the content of the memory, the message can be directed to a particular destination terminal by entering the destination terminal address via the keyboard.

Message transmission takes place under a packet radio protocol which not only identifies the sender and receiver but also allows the receiver to locate portions of the message corrupted by interference or fading. Optional ARQ is activated until the message is correctly received. The protocol is specifically designed to accommodate transceivers which cannot rapidly switch from receive to transmit: single frequency semi-duplex operation is used.

As each packet is received, the terminal stores it and automatically prints out the entire message at the conclusion of the transmission. A confirmation signal is returned to the originating terminal to indicate that the message has been successfully received. An operator is not required at the receiving end.

The system uses in-band frequency diversity to combat selective fading. Two FSK modems using 170 Hz shift operating at 100 bit/s are used to transmit identical data. The data are assembled into an 8-bit byte, including one parity bit. A one-byte cyclic redundancy code is added to form a robust code which allows a character error ratio of only one in 10^8 after ARQ is applied.

Frequency channel selection is under the control of the terminal. When message transmission is initiated, an automatic procedure is activated which causes the stations to search, among the frequencies assigned to the network, for a frequency capable of supporting data transfer. In this way, the reliability of the network is maintained even when experienced operators are not available. If no suitable frequency can be found, a message is printed informing the sender of this fact.

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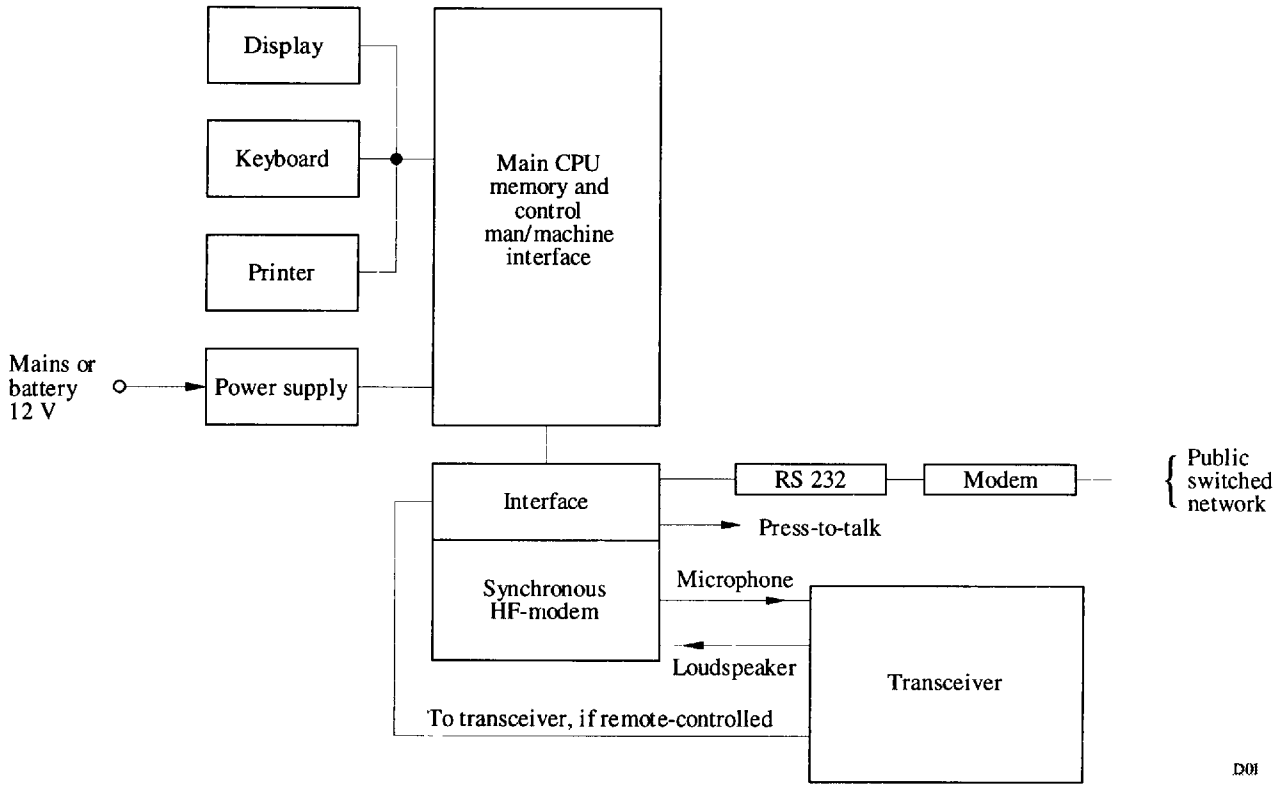
FIGURE 1

The hard-copy message terminal



Under good propagation conditions, a 630 character message may be transmitted in 90 s. When propagation conditions are poor, the data transfer rate is reduced because it is necessary to retransmit corrupted portions of the message. The system will automatically close down when conditions deteriorate to a point where the information throughput falls below an acceptable limit. This feature reduces interference in the radio spectrum. In such cases, printed messages inform the sender that the terminal is unable to carry out the exchange of communication.

4. Test results

Extensive tests have been carried out using both land based and shipboard stations over the period of one year. The path length varied from 50 km to 9 000 km using a variety of transmitters operating between 50 W and 300 W. A number of trans-auroral paths were included in the tests which covered all seasons and all hours of the day. Over one million characters have been successfully received and printed with no undetected errors. This demonstrates the robustness of the error control protocol.

5. Network operation of terminals

Several data terminal-radio combinations can be operated as a network if the traffic volume is low and the traffic is uniformly distributed at the nodes. However, if the traffic at one of the nodes is concentrated in time, blocking can occur. A buffer storage unit should then be incorporated at the busy node to store the messages and perform network control functions to eliminate the blockage. The buffer storage unit has been implemented with a standard desk-top computer connected to the HF terminal through an RS 232 interface. The buffer storage unit is connected to the switched telephone network and permits several users access simultaneously. The messages entered by different users are formed into a queue and are transmitted when the radio channel becomes free. The buffer storage unit permits the terminal to receive a message while a user is entering a message to be transmitted.

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