

RECOMMENDATION ITU-R F.1113

RADIO SYSTEMS EMPLOYING METEOR-BURST PROPAGATION

(Question ITU-R 157/9)

(1994)

The ITU Radiocommunication Assembly,

considering

- a) that experiments have already shown the practicability of utilizing the frequency band between 30 and 50 MHz for transmission by meteor-burst propagation to distances well beyond the horizon;
- b) that systems using this mode of propagation are already in service for burst data transmission,

recommends

- 1. that Annex 1 be used as guidance for the application of radio systems employing meteor-burst propagation.

ANNEX 1

Radio systems employing meteor-burst propagation**1. Introduction**

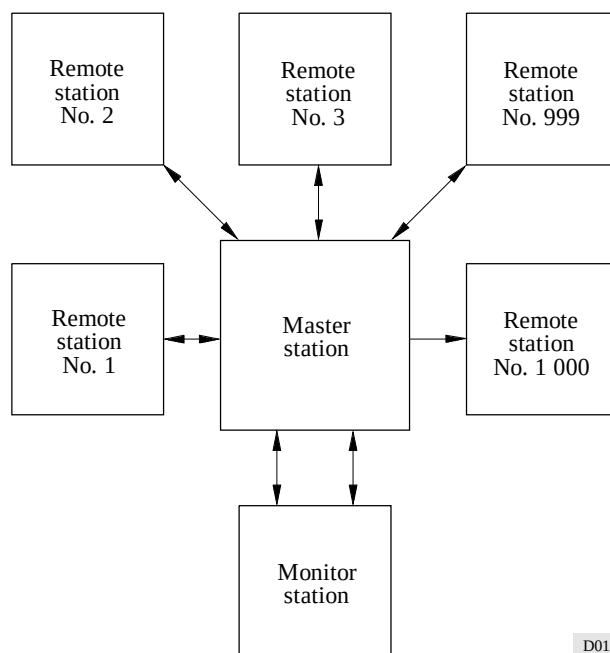
The phenomena of meteor-burst propagation using reflections from ionized meteor trails is described in Recommendation ITU-R P1.843. Recent advances in microprocessors and digital electronics mean that it is now possible to construct a meteor-burst communication system at a realistic commercial cost. This Annex describes two such systems and presents results of tests carried out on these systems.

2. Example meteor-burst system A**2.1 System description**

The system is configured as a star network with a central master station and a capacity of up to 1 000 remote stations within the coverage area of 2 000 km radius (see Fig. 1). The system uses a half-duplex packet protocol with single segment automatic repeat transmissions in the presence of errors. Each of the remote stations is able to communicate with any number of other remote stations via the central master station.

Larger systems may be built using several master stations communicating with each other by full duplex meteor-burst propagation such that all remotes can communicate with each other via combinations of master stations over a series of 25 kHz channels. It is also possible to construct a system without a master station by using point-to-point techniques when the remote stations perform the control functions. This latter system is not flexible and has to be reconfigured for any change in the number of stations.

FIGURE 1
System block diagram



D01

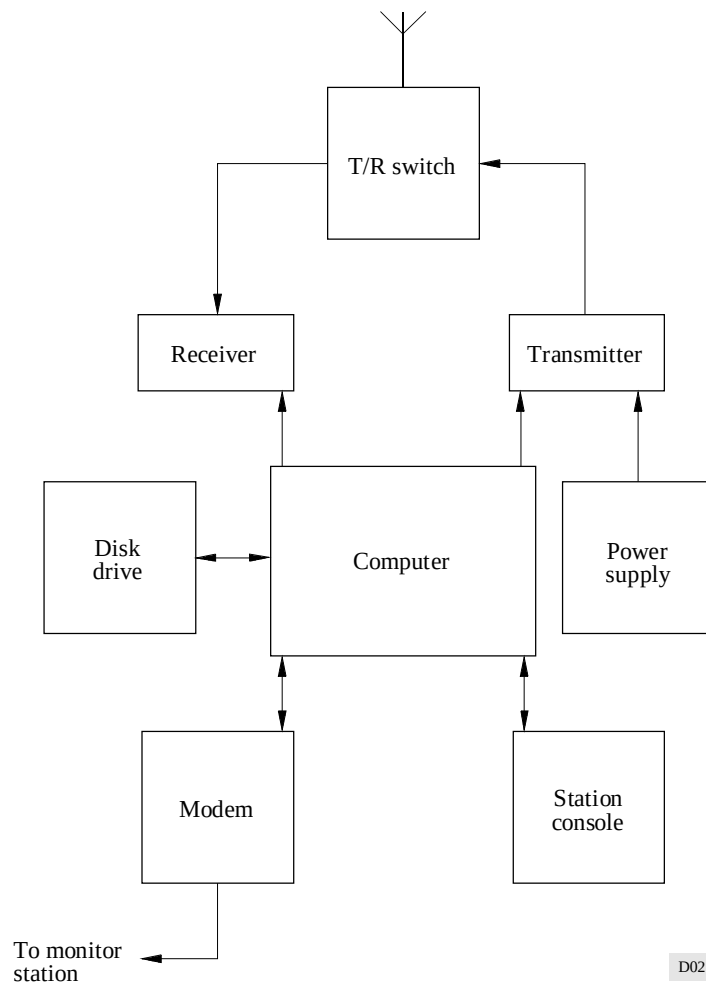
One network system in Europe is designed with the maximum number of system functions concentrated in the master station. This is to minimize the size, cost and power consumption of the remote stations. The master station performs the functions of meteor trail illumination, system synchronization and message routing, but is transparent to the user. It is the only component of the system which needs mains power.

2.1.1 Essential system characteristics

The system described operates in half-duplex mode using two frequencies around 46.9 MHz with a single horizontally polarized antenna at each station. In practice the master station antenna is an array of four “Yagi” antennas connected together for omnidirectional coverage. It would be possible to use vertical polarization if required for operational reasons such as mobile remote stations. The transmitter (see Fig. 2) is rated at 500 W. A transmit/receive switch allows call/listen cycles of approximately 80 ms duration. This alternate 40 ms call, 40 ms listen cycle is used to illuminate the meteor trails and is known as probing. The probe transmissions may be addressed to individual remote stations or may be non-specific depending on system priority. The master station transmitter modulation is binary low index ($\pm 30^\circ$) phase shift keying (PSK) to minimize interference on adjacent channels. Synchronization of remote stations is achieved with Manchester encoding of the clock signal within the data.

Remote stations transmit with high index ($\pm 90^\circ$) PSK modulation for maximum chance of detection by the master station. Two protocols are supported, one for data acquisition and one for communication. In normal operation, the master station sends probe words and checks received signals for valid data segments from a remote station (see Fig. 3). Immediately a valid segment is found, an acknowledgement is sent back to the remote source. At the same time a computer memory check is made for any segments addressed to that remote station and if found, the first segment of the return message is appended to the acknowledgement. If a segment is returned in this way, an acknowledgement from the remote station is sought. In all cases if no acknowledgement is received, the segment is repeated until it is.

FIGURE 2
Master station



The system is controlled by a monitor, connected to the master station by radio or landline. This connection enables the monitor to be at the administration offices while allowing the master station to be remote in an ideal low ambient noise location. The system monitor checks overall performance and stores all the data transmitted so that users can collect from the monitor rather than receiving in real time.

In this system a remote station for data acquisition is optimized for low power consumption and reliable operation in conditions typically from $-30\text{ }^{\circ}\text{C}$ to $+60\text{ }^{\circ}\text{C}$. The 100 W transmitter duty cycle is limited to 1%. The receiver has a sensitivity of -118 dBm and there is a buffer store for packets of data or short text messages (see Fig. 4).

A second type of remote station for communication is optimized for maximum information transfer rate which is related to signal-to-noise ratio. The 300 W transmitter duty cycle is limited to 10%. The receiver has a sensitivity of -121 dBm and there is a buffer store with up to 20 kbytes of memory (see Fig. 5).

The communication protocol makes use of the natural diversity in space and time of the meteor trails to provide automatic polling to a maximum of 1 000 remote stations. When a path is present, the data is sent and acknowledged during the same event. Long data strings require several events and recombination at the receiver. Text is transmitted in a series of segments which are all acknowledged at the end of the message. It is possible to continuously monitor the signal-to-noise ratio and adaptively change the data rate between 2 kbit/s and 64 kbit/s to maximize the throughput.