Fast adaptive data transmission on shortwave at up to 5400 bit/s with HF Modem GM2100

FIG 1 HF Modem GM2100 for shortwave data transmission at up to 5400 bit/s

Photo 42 569

When it was first introduced, shortwave data transmission was limited to 200 bit/s. This was because of the problem of multipath propagation in shortwave communications. Error control methods such as FEC (forward error correction) and ARQ (automatic repeat request) ensure minimal bit error rates. Methods of compensating for multipath effects could however not be developed cost-effectively until powerful signal processors came along. They made it possible to increase the data rate to over 2400 bit/s, which became the standard for most shortwave modems for a period of several years.

In HF Modem GM2100 (FIG 1), Rohde & Schwarz has now pushed the speed limits for data transmission even further. This modem from the XK2000 family of shortwave radio equipment [1] makes data transmission rates up to 5400 bit/s possible. Adaptive methods are used for matching the data transmission rate to the quality of the path: under favourable propagation conditions, transmission is at maximum speed, under less favourable conditions, the number of error control bits is increased. This results in a considerable increase in the effective data throughput for a typical shortwave link.

Data modem GM2100 has **three signal formats for data transmission:**

- a Rohde & Schwarz signal format,
- a signal format to MIL-STD-188-110A (single-tone method),
- a signal format to STANAG 4285.

The **R&S signal format** is compatible with those of data modems GM857C4 [2] and GM2000. For GM2100 it was optimized to give data rates between 900 and 5400 bit/s. FIG 2 shows the structure of a frame with this signal format transmitted by GM2100. If GM2100 is used in conjunction with an ALIS processor [3], the transmission rate is automatically matched to the radio-link quality and to the requirements of the transmission protocol, and optimum utilization of the transmission channel is also ensured. During link setup, the ALIS processor automatically calculates the maximum possible link

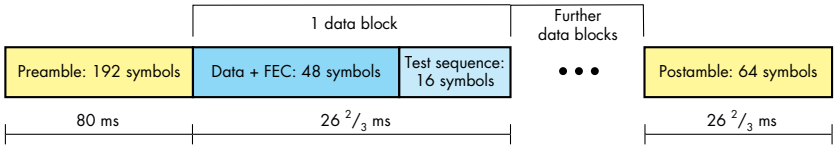

FIG 2 Frame structure of Rohde & Schwarz signal format for HF Modem GM2100

Modulation method	Info bits	Redundancy bits	Code rate	FEC [%]	Net data rate [bit/s]
8PSK	144	0	No FEC	0	5400
8PSK	120	24	$^5/_6$	17	4500
8PSK	96	48	$^2/_3$	33	3600
8PSK	72	72	$^1/_2$	50	2700
4PSK	36	36	$^1/_2$	50	1800
2PSK	18	18	$^1/_2$	50	900

TABLE 1: Possible data rates for Rohde & Schwarz signal format for HF Modem GM2100

	Typical data volume non-compressed	Typical data volume compressed	Data reduction	Transmission time with GM2100
Text	2.5 Kbyte/page	0.9 Kbyte/page	64 %	2.5 s
Fax	30 Kbyte/page	24 Kbyte/page	20 %	63 s
Video	490 Kbyte/page	15 Kbyte/page	97 %	44 s

TABLE 2: Data transmission times for typical shortwave applications

data rate. This gives full compatibility with the Rohde & Schwarz series HF850 and XK2000 HF systems.

The HF modem phase-modulates the HF carrier, using 2PSK, 4PSK and 8PSK. 2PSK is used for a data rate of 900 bit/s and 4PSK for 1800 bit/s. As fewer phase states are used for transmission, 2PSK and 4PSK increase the reliability of data transmission for links of lower quality. 8PSK is used for high-quality HF paths. To further increase the data rate in the latter case, the redundancy of the FEC of a transmitted block can be adjusted. In this way, transmission rates up to 5400 bit/s can be achieved (TABLE 1).

A great advantage of the transmission method employed by GM2100 is automatic detection of the received signal data rate by means of a code received at the start of reception. This means that the receiving data modem need not be told the data rate of the transmitting modem. The ALIS processor makes use of this feature and transmits RSX.25 protocol data at a lower rate. Even though the quantity of these data in relation to the user data is vanishingly small, the protocol data are extremely important for the transmission protocol. This intelligent control function therefore greatly enhances data transmission reliability.

The high transmission speeds achievable, in conjunction with the RSX.25 protocol, give a synchronous data rate of 3600 bit/s at the data terminal interface for high-quality radio links. This corresponds to an asynchronous data rate of 4480 bit/s for an interface setting with eight data bits, one stop bit and no check bit, ie to a practically continuous data stream of 4500 baud. TABLE 2 shows the data transmission times for an HF system with System Processor MERLIN [4], HF Transceiver XK2100, the ALIS processor and HF Modem GM2100.

For transmissions using standardized **signal formats to MIL-STD-188-110A,** 8PSK at a rate of 2400 symbols per second is employed. Asynchronous data rates between 75 and 4800 baud and synchronous data rates between 75 and 4800 bit/s are possible. FEC for error control can be set according to the selected transmission speed. Interleaving of the transmitted data with an interleaver length between 0.6 and 4.8 s can also be selected.

For transmissions using **STANAG 4285 signal format,** similar data rates as with MIL-STD-188-110A can be achieved by means of various modulation methods. Here too, a long or short interleaving time can be selected.

Although MIL-STD and STANAG signal formats do not allow as high a data throughput as the R&S signal format, their availability on GM2100 ensures interoperability with stations using these standards. GM2100 gives maximum transmission rates at low BERs, making shortwave data transmission technically comparable with worldwide satellite transmission or PTT lines.

Günter Wicker; Gerhard Greubel

REFERENCES

[1] Helmke, B.; Wachter, G.: HF Transceiver XK2100 – Digital shortwave for future-proof, long-haul communication. News from Rohde & Schwarz (1994) No. 144, pp 4–7

[2] Hackl, H.: Secure data transmission with 2700 bit/s on shortwave links. News from Rohde & Schwarz (1994) No. 146, pp 29–31

[3] Greiner, G.: Reliable shortwave with ALIS. News from Rohde & Schwarz (1987) No. 116, pp 47–50

[4] Kneidel, T.: System Processor MERLIN GR2000 – Powerful processor stands toughest conditions. In this issue, pp 12–13

Reader service card 152/16