RECOMMENDATION ITU-R M.1842-1

Characteristics of VHF radio systems and equipment for the exchange of data and electronic mail in the maritime mobile service RR Appendix 18 channels

(2008-2009)

Scope

This Recommendation describes characteristics of VHF radio systems and equipment used for the exchange of data and electronic mail in the maritime mobile service RR Appendix 18 channels. It also provides a guideline on the use of digital technologies by VHF systems of different bandwidth in the maritime mobile service.

The ITU Radiocommunication Assembly,

considering

a) that Resolution 342 (Rev.WRC-2000) of the World Radiocommunication Conference *invites ITU-R* to finalize studies currently ongoing, *inter alia*:

– identify the future requirements of the maritime mobile service;

– identify suitable technical characteristics of the system or interoperable systems;

– identify necessary modifications to the table of frequencies contained in Appendix 18;

b) that IMO has stated that the maritime industry has a need for radiocommunications for business and safety. At IMO the future need for harmonization of systems using maritime VHF channels was considered, and ITU-R has been informed of the possible future need for worldwide systems for the exchange of data and electronic mail on maritime VHF channels,

recognizing

that in accordance with RR Appendix 18 channels used for VHF data shall not cause harmful interference to and shall not claim protection from other stations operating in accordance with RR Article 5. This includes SOLAS applications such as GMDSS on channel 70 and AIS 1 and AIS 2,

recommends

1 that the characteristics for VHF data described in the Annexes to this Recommendation should be considered as examples of such systems;

2 this Recommendation should be used as a guideline for future digital technologies in the maritime mobile service VHF bands;

3 that new VHF data systems introduced should provide characteristics that are compatible with the existing voice and data system, particularly the AIS.

Annex 1

VHF data system example 1

The following characteristics should be indicative of a VHF radio system for the exchange of data and electronic mail in the maritime mobile service.

1 General characteristics

1.1 The class of emission should be 16K0F1DDN.

1.2 The necessary band should cater for the channels in RR Appendix 18 designated with footnote *o)*, each with 25 kHz bandwidth.

1.3 The modulation may be either π/4 DQPSK at 28.8 kbit/s or π/8 D8-PSK at 43.2 kbit/s, depending on required station-station radio range and channel signal fidelity.

1.4 The access method may be carrier sense time division multiple access (CSTDMA).

1.5 The following area coverage techniques may be used:

– cellular channel reuse;

– time sharing transmission.

1.6 The following handover techniques may be utilized:

– uninterrupted handover (channel and base station);

– uninterrupted file transfer.

1.7 The equipment should be designed so that frequency changes between assigned channels can be carried out in less than 100 ms.

1.8 Switching between reception and transmission should not take more than 2 ms.

1.9 The serial communication channels (SCC) on a single radio modem may be:

– Ethernet;

– RS232 (NMEA).

1.10 The radio equipment should meet the following norms:

– radio parameters: ETSI EN 300 113-1;

– EMC: ETSI EN 301 489-5.

2 Transmitters

2.1 The frequency tolerance for coast station transmitters should not exceed 5 parts in 10^6, and that for ship station transmitters should not exceed 10 parts in 10^6.

2.2 Spurious emissions should be in accordance with the provisions of RR Appendix 3.

2.3 The carrier power for coast station transmitters should not exceed 50 W.

2.4 The carrier power for ship station transmitters should not exceed 25 W.

2.5 The cabinet radiated power should not exceed 25 µW.

2.6 The adjacent channel power ratio (ACPR) should be at least 70 dB (see Fig. 3).

3 Receivers

3.1 The receiver sensitivity for bit error rate (BER) 10^{-3} should be better than –107 dBm.

3.2 The adjacent channel selectivity should be at least 70 dB.

3.3 The spurious response rejection ratio should be at least 70 dB.

3.4 The radio frequency intermodulation rejection ratio should be at least 70 dB.

3.5 The power of any conducted spurious emission at the antenna terminals should not exceed 2.0 nW.

4 Sample emissions spectrum based on variations of ETSI TETRA standard modulation

This proposal refers to the work of RTCM Special Committee 123 (RTCM SC123) which evaluated the ETSI TETRA modulation schemes for use in RR Appendix 18.

FIGURE 1

36 kbit/s π/4-DQPSK and 54 kbit/s π/8-D8-PSK modulation spectra

RTCM SC123 test results for TETRA-TEDS modulation

Results

Figure 1 presents the spectra for TETRA and TEDS modulations, at their normal 36/54 kbit/s data rates, along with the IEC 61993-2 25 kHz mask for comparison. It is apparent these modulations fail to meet the mask; their power exceeds the –25 dBm limit at a 10 kHz offset from the carrier.

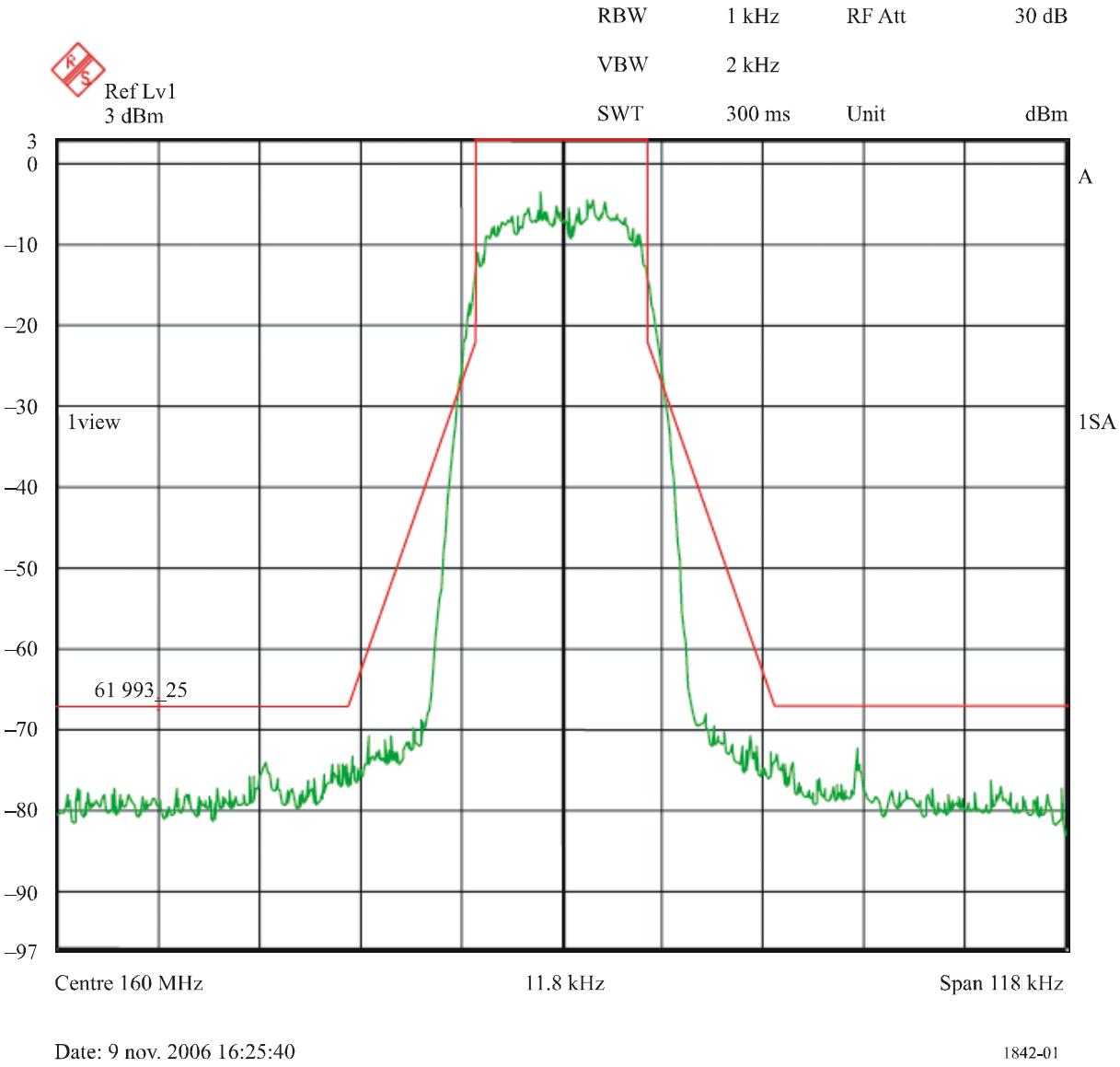


FIGURE 2

Family of spectrum plots for different data rates

RTCM test results for slightly reduced data rates to fit Appendix 18 emissions mask

Somewhat lower 32/48 kbit/s and 28.8/43.2 kbit/s data rate combinations were then tested. Figure 2 overlays these results with those of Fig. 1. It is evident 32 kbit/s π/4-DQPSK and 48 kbit/s π/8-D8-PSK modulations just barely fit or violate the mask whereas 28.8 kbit/s π/4-DQPSK and 43.2 kbit/s π/8-D8-PSK modulations comfortably fit the mask.

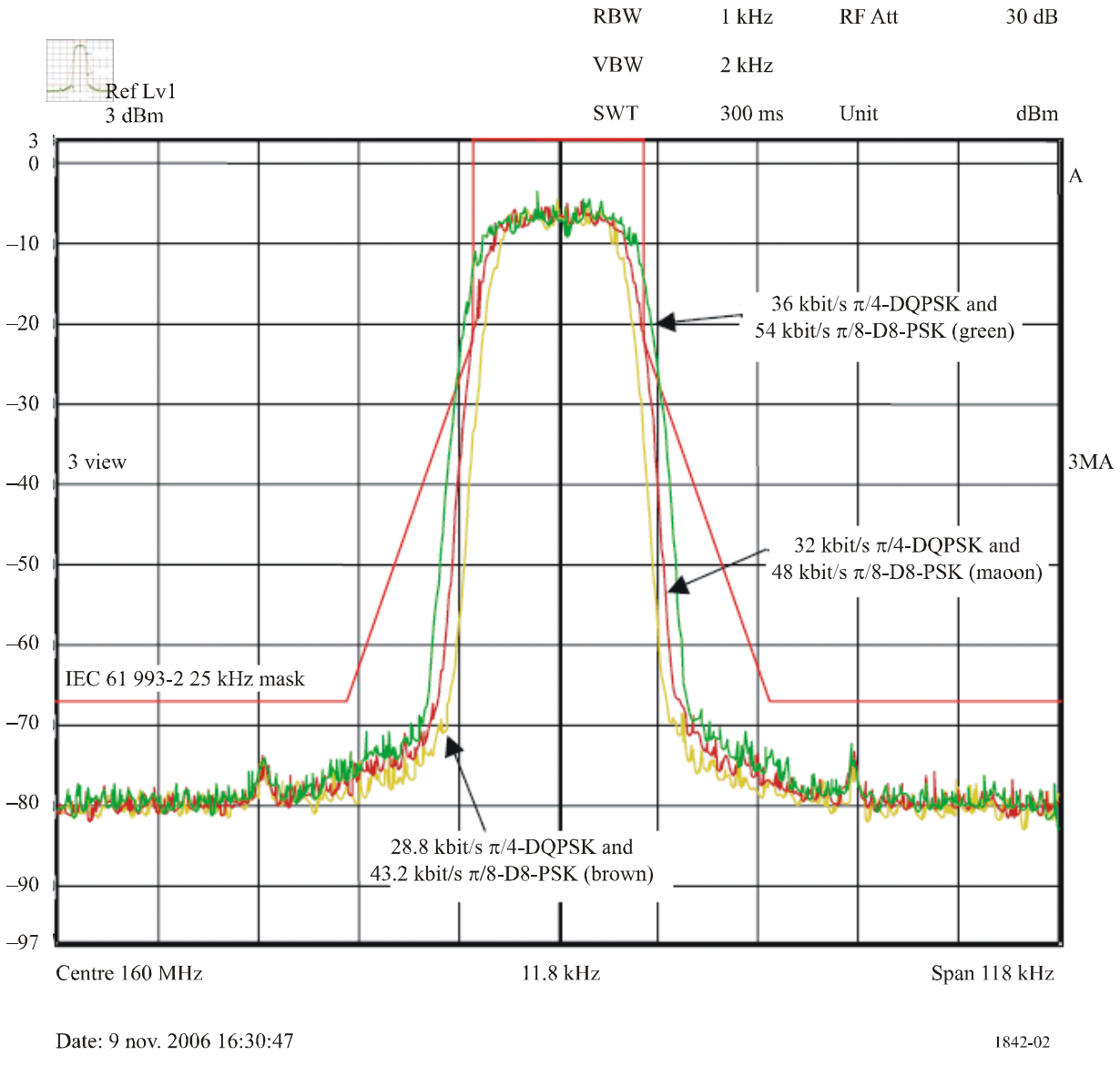
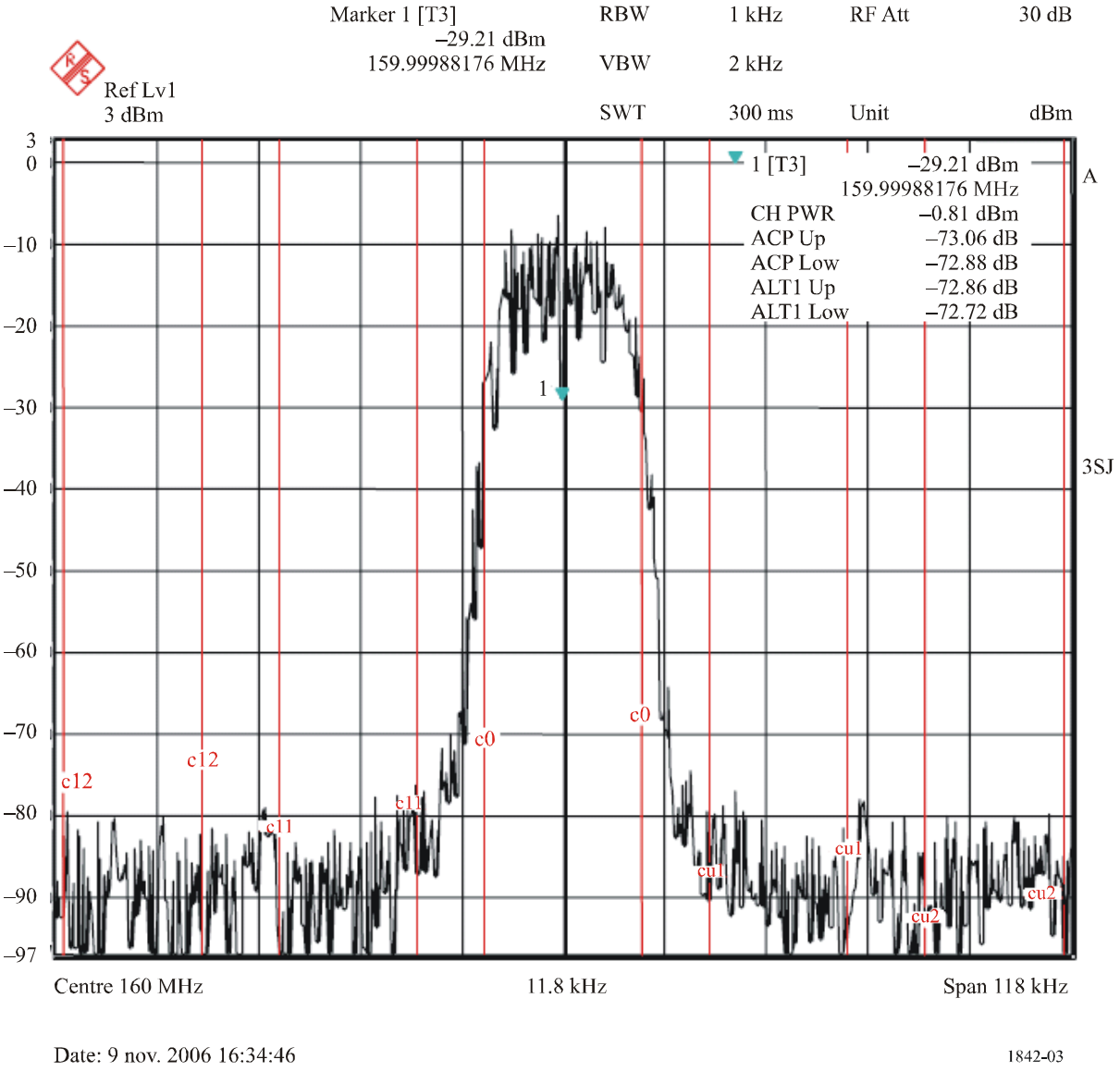


FIGURE 3

Adjacent channel power ratio (ACPR) performance

RTCM test results: 28.8 kbit/s π/4-DQPSK and 43.2 kbit/s π/8-D8-PSK modulation



5 Conclusions on emissions

Emissions spectrum requirements for RR Appendix 18 based on maritime IEC test standards will allow both π/4 DQPSK at 28.8 kbit/s and π/8 D8-PSK at 43.2 kbit/s modulation to be used.

6 System interoperability

6.1 Ship-to-shore

In the ship-to-shore direction interoperability is maintained by the internet service provider (ISP) at the internet protocol (IP) level. Typically, a ship will enter an electronic mail, with or without attachments, in the electronic mail system and then click on the "send" button.

6.2 Shore-to-ship

In this system, there are no interoperability concerns on the part of the shore-side user. The shore-based sender of an electronic mail to a ship can merely:

a) click on the "reply" button, or

b) address the message to Shipname@xxx.com or callsign@xxx.com.

The electronic mail will be delivered via whatever system the ship is using. If there is a system failure, there will be an automatic re-route via an alternate system. These automated decisions are based on the contents of an extensive database. Consequently, the electronic mail may be delivered via HF or an alternate satellite-based system. If there is an overall system failure, addressing problem or non-delivery for any reason, the system support operators will be alerted and take corrective action. This ensures that shore-based users need not be concerned about what system or network the ship is using. They need only address the electronic mail and click on "send".

6.3 Ship-to-ship

The VDL protocol should also provide for direct transmission between ships where possible (within radio propagation range) in the simplex ship-ship mode. The duplex ship-shore-ship mode should be used for extended range (beyond the ship-ship radio propagation range).

6.4 Efficient use of the VHF data link (VDL)

System interoperability should be achieved for all transmission modes, ship-to-shore, shore-to-ship, and ship-to-ship. Spectrum efficiency and data throughput should also be considered. For example, application of the electronic mail internet protocol (IP) at the network level and not on the VDL would result in an efficiency improvement of 3:1.

Annex 2

VHF data system example 2

Introduction

This Annex describes an existing narrowband VHF data system for the exchange of data and electronic mail in the maritime mobile service. The system is currently in use, operating from base stations ashore and on offshore installations.

1 General characteristics

1.1 The system is operating on nine duplex 25 kHz channels in the maritime VHF band.

1.2 The class of emission is 16K0F1DDN.

1.3 The modulation is 4-level GMSK. Transmitted bit rate 21.1 kbit/s.

1.4 The access method is time division multiple access (TDMA).

1.5 The following area coverage techniques are used:

– cellular channel reuse;

– time sharing transmission.

1.6 The following handover techniques are utilized:

– uninterrupted handover (channel and base station);

– uninterrupted file transfer.

1.7 The equipment is designed so that frequency changes between assigned channels can be carried out in less than 100 ms.

1.8 Emissions are vertically polarized at the source.

1.9 Switching between reception and transmission should not take more than 2 ms.

1.10 The serial communication channels (SCC) on a single radio modem should be:

– Ethernet;

– RS232 (NMEA);

– IEC 61162.

1.11 The radio equipment should meet the following norms:

– radio parameters: ETSI EN 300 113-1;

– EMC: ETSI EN 301 489-5 and IEC 60945.

2 Transmitters

2.1 The frequency tolerance for coast station transmitters should not exceed five parts in 10^6, and that for ship station transmitters should not exceed ten parts in 10^6.

2.2 In order to prevent harmful interference to other users of the maritime VHF band, spurious emissions should be in accordance with the provisions of RR Appendix 3.

2.3 The carrier power for coast station transmitters should not exceed 50 W.

2.4 The carrier power for ship station transmitters should not exceed 25 W.

2.5 The cabinet radiated power should not exceed 25 µW.

2.6 Adjacent channel power ratio (ACPR) should be at least 70 dB.

3 Receivers

3.1 The receiver sensitivity for bit-error rate (BER) 10^{-3} should be better than –107 dBm.

3.2 The adjacent channel selectivity should be at least 70 dB.

3.3 The spurious response rejection ratio should be at least 70 dB.

3.4 The radio frequency intermodulation rejection ratio should be at least 70 dB.

3.5 The power of any conducted spurious emission at the antenna terminals should not exceed 2.0 nW.

4 Possibilities and advantages

4.1 *Coverage and stability*

The VHF band has very good qualities regarding range and stability. Typical range from a land-based station is up to 70 NM.

4.2 *IP – Ethernet*

The common used Ethernet protocol that makes connection to local data networks and other data services easy.

4.3 *Fixed IP address at the radio on board the ship*

This makes it possible to send data to the ship without anyone being needed to activate the link. The ship may also have ten local IP addresses.

4.4 *Always connected*

There is no connection time. This makes the system very effective for real-time applications, e.g. banking terminals.

4.5 *Several services in parallel from one radio on the ship*

The system is based on packets all the way. From one radio on the ship one may carry out several different services at the same time. The system is therefore frequency efficient.

4.6 *Automatic reconnection after disruption*

The system will automatically reconnect and continue the tasks again at the right point. This happens both after short breaks as well as long breaks, e.g. outside radio coverage area.

4.7 *Integrated data router*

The radio is delivered with an integrated router. It means that tasks may be programmed directly into the radio and may be carried out without the use of a PC. For example, the fishing boat positioning and moving report system is programmed into the radio/router. In addition, the router has very large capacity to carry out several tasks, among other things compression and decompression of electronic mail, web applications and weather maps.

4.8 *Several inputs to the radio*

Ethernet cable may be plugged directly into the radio or the router, enabling easy establishment of a local net on board the ship. Other digital or analogue inputs may be used for GNSS, measuring instruments, etc.

4.9 *Connection to local WLAN*

The system may be combined with local wireless networks on board the ship.

4.10 *External communication carriers*

The system may be delivered with possibilities for seamless connection to external networks, e.g. wireless LANs in harbour areas or to satellite communication.

5 Applications

Some current and possible future applications of VHF data are listed below:

- safe SeaNet reporting (ISPS);
- fishery catch reporting;
- fishing boat position and movement reporting;
- weather maps;
- general electronic mail;
- messages to the ship's agent, the pilot or harbour authorities;
- banking terminals, especially on passenger ships;
- safety-related information;
- telemetry information;
- updating of electronic maps.

6 System interoperability

6.1 *Ship-to-shore*

In the ship-to-shore direction interoperability is maintained by the Internet service provider (ISP) at the internet protocol (IP) level. Typically, a ship will enter an electronic mail, with or without attachments, in the electronic mail system and then click on the "send" button.

6.2 *Shore-to-ship*

In this system, there are no interoperability concerns on the part of the shore-side user. The shore-based sender of an electronic mail to a ship can merely:

a) click on the "reply" button, or

b) address the message to Shipname@xxx.com or callsign@xxx.com.

The electronic mail will be delivered via whatever system the ship is using. If there is a system failure, there will be an automatic re-route via an alternate system. These automated decisions are based on the contents of an extensive database. Consequently, the electronic mail may be delivered via HF or an alternate satellite-based system. If there is an overall system failure, addressing problem or non-delivery for any reason, the system support operators will be alerted and take corrective action. This ensures that shore- based users need not be concerned about what system or network the ship is using. They need only address the electronic mail and click on "send".

Annex 3

VHF data system 50 kHz wideband example

The following characteristics should be indicative of a VHF radio system for the exchange of data and electronic mail in the maritime mobile service.

1 General characteristics

1.1 The class of emission should be 50K0F1DDN.

1.2 The necessary band should cater for 50 kHz, two adjacent channels in RR Appendix 18 designated with footnote *o)*, each with 25 kHz bandwidth.

1.3 The system should be comprised of 16 equal-power subcarriers in the 50 kHz bandwidth with a 16-QAM modulation of each subcarrier, as described in ETSI standard EN 300 392-2 v.3.2.1. This provides a data rate (over-the-air) of 153.6 kbit/s.

1.4 The access method should be carrier sense time division multiple access (CSTDMA).

1.5 The following area coverage techniques may be used:

– cellular channel reuse;

– time sharing transmission.

1.6 The following handover techniques may be utilized:

– uninterrupted handover (channel and base station);

– uninterrupted file transfer.

1.7 The equipment should be designed so that frequency changes between assigned channels can be carried out in less than 100 ms.

1.8 Switching between reception and transmission should not take more than 2 ms.

1.9 The serial communication channels (SCC) on a single radio modem may be:

– Ethernet;

– IEC 61162 series.

1.10 The radio equipment should meet the following norms:

– radio parameters: ETSI EN 300 113-1; EN 300 392-2 v.3.2.1;

– EMC: ETSI EN 301 489-5.

2 Transmitters

2.1 The frequency tolerance for coast station transmitters should not exceed 5 parts in 10^6, and for ship station transmitters should not exceed 10 parts in 10^6.

2.2 Spurious emissions should be in accordance with the provisions of RR Appendix 3.

2.3 The carrier power for coast station transmitters should not exceed 50 W.

2.4 The carrier power for ship station transmitters should not exceed 25 W.

2.5 The adjacent channel power (the power in each of the 25 kHz channels immediately above and below the 50 kHz occupied bandwidth) should not exceed −23 dBm.

2.6 The cabinet radiated power should not exceed 25 μW.

3 Receivers

3.1 The receiver sensitivity levels should be better than −106 dBm for shore stations and −103 dBm for ship stations, as described in EN 300 392-2 v.3.2.1 § 6.7.2.4.

3.2 The adjacent channel selectivity should be at least 70 dB.

3.3 The spurious response rejection ratio should be at least 70 dB.

3.4 The radio-frequency intermodulation rejection ratio should be at least 70 dB.

3.5 The power of any conducted spurious emission at the antenna terminals should not exceed 2.0 nW.

4 System interoperability

4.1 Ship-to-shore

In the ship-to-shore direction interoperability is maintained by the Internet service provider (ISP) at the Internet protocol (IP) level. Typically, a ship will enter an electronic mail, with or without attachments, in the electronic mail system and then click on the “send” button.

4.2 Shore-to-ship

In this system, there are no interoperability concerns on the part of the shore-side user. The shore-based sender of an electronic mail to a ship can merely:

a) click on the “reply” button, or

b) address the message to Shipname@xxx.com or callsign@xxx.com.

The electronic mail will be delivered via whatever system the ship is using. If there is a system failure, there will be an automatic re-route via an alternate system. These automated decisions are based on the contents of an extensive database. Consequently, the electronic mail may be delivered via HF or an alternate satellite-based system. If there is an overall system failure, addressing problem or non-delivery for any reason, the system support operators will be alerted and take corrective action. This ensures that shore-based users need not be concerned about what system or network the ship is using. They need only address the electronic mail and click on “send”.

4.3 Ship-to-ship

The VDL protocol should also provide for direct transmission between ships where possible (within radio propagation range) in the simplex ship-ship mode. The duplex ship-shore-ship mode should be used for extended range (beyond the ship-ship radio propagation range).

4.4 Efficient use of the VHF data link (VDL)

System interoperability should be achieved for all transmission modes, ship-to-shore, shore-to-ship, and ship-to-ship. Spectrum efficiency and data throughput should also be considered. For example, application of the electronic mail Internet protocol (IP) at the network level and not on the VDL would result in an efficiency improvement of 3:1.

Annex 4

VHF data system 100 kHz "wideband" example

The following characteristics should be indicative of a VHF radio system for the exchange of data and electronic mail in the maritime mobile service.

1 General characteristics

1.1 The class of emission should be 100K0F1DDN.

1.2 The necessary band should cater for 100 kHz, four adjacent channels in RR Appendix 18 designated with footnote *o)*, each with 25 kHz bandwidth.

1.3 The system should be comprised of 32 equal-power subcarriers in the 100 kHz bandwidth with a 16-QAM modulation of each subcarrier, as described in ETSI standard EN 300 392-2 v.3.2.1 (2007-09). This provides a data rate (over-the-air) of 307.2 kbit/s.

1.4 The access method should be carrier sense time division multiple access (CSTDMA).

1.5 The following area coverage techniques may be used:

– cellular channel reuse;

– time sharing transmission.

1.6 The following handover techniques may be utilized:

– uninterrupted handover (channel and base station);

– uninterrupted file transfer.

1.7 The equipment should be designed so that frequency changes between assigned channels can be carried out in less than 100 ms.

1.8 Switching between reception and transmission should not take more than 2 ms.

1.9 The serial communication channels (SCC) on a single radio modem may be:

– Ethernet;

– IEC 61162 series.

1.10 The radio equipment should meet the following norms:

– radio parameters: ETSI EN 300 113-1; EN 300 392-2 v.3.2.1;

– EMC: ETSI EN 301 489-5.

2 Transmitters

2.1 The frequency tolerance for coast station transmitters should not exceed 5 parts in 10^6, and for ship station transmitters should not exceed 10 parts in 10^6.

2.2 Spurious emissions should be in accordance with the provisions of RR Appendix 3.

2.3 The carrier power for coast station transmitters should not exceed 50 W.

2.4 The carrier power for ship station transmitters should not exceed 25 W.

2.5 The adjacent channel power (the power in each of the 25 kHz channels immediately above and below the 100 kHz occupied bandwidth) should not exceed –23 dBm.

2.6 The cabinet radiated power should not exceed 25 μW.

3 Receivers

3.1 The receiver sensitivity levels should be better than –103 dBm for shore stations and −98 dBm for ship stations, as described in EN 300 392-2 v.3.2.1 § 6.7.2.4.

3.2 The adjacent channel selectivity should be at least 70 dB.

3.3 The spurious response rejection ratio should be at least 70 dB.

3.4 The radio-frequency intermodulation rejection ratio should be at least 70 dB.

3.5 The power of any conducted spurious emission at the antenna terminals should not exceed 2.0 nW.

4 System interoperability

4.1 Ship-to-shore

In the ship-to-shore direction interoperability is maintained by the Internet service provider (ISP) at the Internet protocol (IP) level. Typically, a ship will enter an electronic mail, with or without attachments, in the electronic mail system and then click on the “send” button.

4.2 Shore-to-ship

In this system, there are no interoperability concerns on the part of the shore-side user. The shore-based sender of an electronic mail to a ship can merely:

a) click on the “reply” button, or

b) address the message to Shipname@xxx.com or callsign@xxx.com.

The electronic mail will be delivered via whatever system the ship is using. If there is a system failure, there will be an automatic re-route via an alternate system. These automated decisions are based on the contents of an extensive database. Consequently, the electronic mail may be delivered via HF or an alternate satellite-based system. If there is an overall system failure, addressing problem or non-delivery for any reason, the system support operators will be alerted and take corrective action. This ensures that shore-based users need not be concerned about what system or network the ship is using. They need only address the electronic mail and click on “send”.

4.3 Ship-to-ship

The VDL protocol should also provide for direct transmission between ships where possible (within radio propagation range) in the simplex ship-ship mode. The duplex ship-shore-ship mode should be used for extended range (beyond the ship-ship radio propagation range).

4.4 Efficient use of the VHF data link (VDL)

System interoperability should be achieved for all transmission modes, ship-to-shore, shore-to-ship, and ship-to-ship. Spectrum efficiency and data throughput should also be considered. For example, application of the electronic mail Internet protocol (IP) at the network level and not on the VDL would result in an efficiency improvement of 3:1.