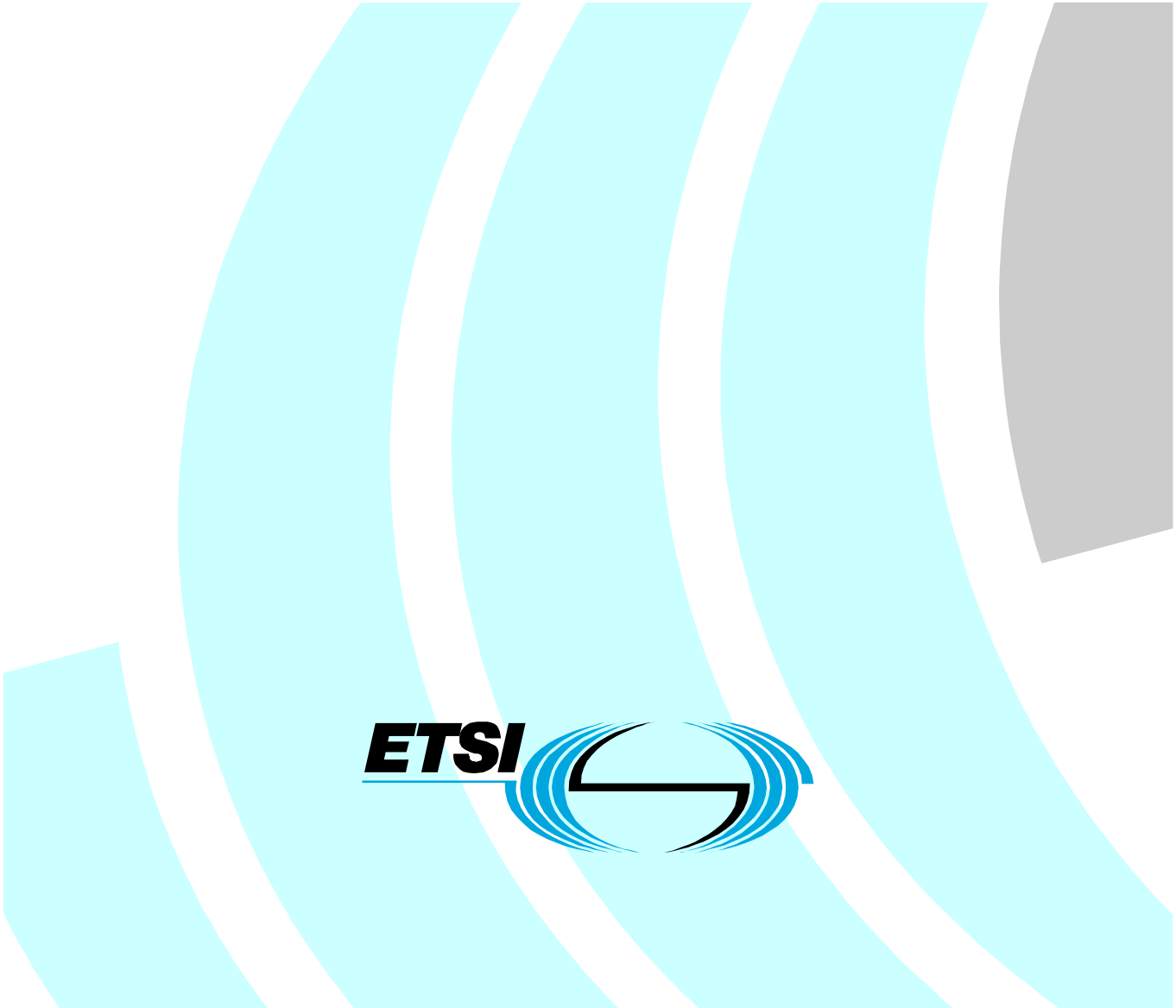
ETSI TR 101 446 V1.1.1 (2002-04)

Technical Report

Electromagnetic compatibility and Radio spectrum Matters (ERM); Meteorological AIDS devices System reference document on disposable Meteorological Sonde operating in the 400,15 MHz to 406 MHz frequency range



Reference
DTR/ERM-RM-014

Keywords
radio, short range, system, testing

ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - NAF 742 C
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° 7803/88

Contents

Intellectual Property Rights

IPRs essential or potentially essential to the present document may have been declared to ETSI. The information pertaining to these essential IPRs, if any, is publicly available for **ETSI members and non-members**, and can be found in ETSI SR 000 314: *"Intellectual Property Rights (IPRs); Essential, or potentially Essential, IPRs notified to ETSI in respect of ETSI standards"*, which is available from the ETSI Secretariat. Latest updates are available on the ETSI Web server (http://webapp.etsi.org/IPR/home.asp).

Pursuant to the ETSI IPR Policy, no investigation, including IPR searches, has been carried out by ETSI. No guarantee can be given as to the existence of other IPRs not referenced in ETSI SR 000 314 (or the updates on the ETSI Web server) which are, or may be, or may become, essential to the present document.

Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Electromagnetic compatibility and Radio spectrum Matters (ERM).

The present document may be used for regulatory purposes in non-EU countries.

1 Scope

The present document applies to disposable Radiosonde transmitters in Meteorological Aids Systems operating on the 400,15 MHz to 406 MHz band. Essential properties; spectrum mask, power level, and centre frequency drift are specified.

Further, the present document discuss Radiosonde to Radiosonde interference giving guidelines for frequency management.

2 References

For the purposes of this Technical Report (TR) the following references apply:

[1] ITU-R Recommendation SA 1165-1: "Technical characteristics and performance criteria for radiosonde systems in the meteorological aids service".

[2] ITU-R Recommendation SA 1262: "Sharing and coordination criteria for meteorological aids in the 400.15-406 MHz and 1 668.4-1 700 MHz bands".

[3] ITU-R Recommendation SA 1263: "Interference criteria for meteorological aids operated in the 400.15-406 MHz and 1 668.4-1 700 MHz bands".

[4] Directive 1999/5/EC of the European Parliament and of the Council of 9 March 1999 on radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity (R&TTE Directive).

[5] WMO-No.49, World Meteorological Organization: "Volume I - General meteorological standards and recommended practices".

[6] Doc 7488/2, International Civil Aviation Organisation: "Manual of the ICAO standard atmosphere: extended to 32 kilometres (105,000 feet)".

[7] ETSI EN 300 220 (all parts): "ElectroMagnetic Compatibility and Radio Spectrum Matters (ERM); Short Range Devices (SRD); Radio equipment to be used in the 25 MHz to 1 000 MHz frequency range with power levels ranging up to 500 mW".

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

assigned frequency band: frequency band within which the device is authorized to operate

dropsonde: disposable sonde released with a parachute from an airborne launch platform to perform measurements

fixed station: sounding station in a fixed location

floatsonde: disposable sonde performing measurements while floating on the sea surface

harmful interference: interference that prevents the system to perform the intended task

launch site: location where a Meteorological Aids sonde is deployed for use

measurement: single act to provide instant information of e.g. temperature, humidity or pressure

mobile station: sounding station intended for use in varying locations depending on the needs

observation: number of consecutive measurements composing a useful data set

radiosonde: disposable sonde carried up to the altitudes by a balloon to perform measurements of the atmosphere

receiving station: generic name for Meteorological Aids receiving equipment

rocketsonde: disposable dropsonde carried to the altitudes by a rocket and released at the apogee

sonde: generic name for a Meteorological Aids device to perform measurements

sounding station: generic name for a location or platform releasing sondes and receiving signals

3.2 Symbols

For the purposes of the present document, the following symbols apply:

P	Pressure, units in hPa
T	Temperature, units in°C or in°K
U or H	relative Humidity of the air, units in % RH

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

EESS	Earth Exploring Satellite System
FM	Frequency Modulation
FSK	Frequency Shift Key
GFSK	Gaussian Frequency Shift Keying
GPS	Global Positioning System
GTS	Global Telecommunication System for meteorological data
ICAO	International Civil Aviation Organization
IPR	Intellectual Property Rights
ITU	International Telecommunications Union
Loran-C	Long range navigational system - version C
Met Sat	Meteorological Satellite
MSS	Mobile Satellite Service
RF	Radio Frequency
S/I	Signal to Interference ratio
S/N	Signal to Noise ratio
SRD	Short Range Device
VCO	Voltage Controlled Oscillator
WMO	World Meteorological Organisation

4 Executive summary

Short Background information:

The Meteorological Aids allocation is 400,15 MHz to 406 MHz. The sub band 400,15 MHz to 401 MHz is shared, with MSS (Mobile Satellite Service), and the sub band 401 MHz to 403 MHz, with Met Sat (Meteorological Satellite) and EESS (Earth Exploration Satellite Service). In addition, in Europe, the Ultra Low Power Active Medical Implants have a secondary allocation in the sub band 402 MHz to 405 MHz.

Radiosondes, the main Meteorological Aids devices, are released in all European Union and adjacent countries on daily basis. This operation is performed based on agreements within the WMO (World Meteorological Organisation). In addition there are national or regional use of sondes in many countries. Because the Radiosondes are carried aloft with free flying balloons they drift with wind, and may cross borders entering into the legislation area of neighbouring countries. In order to avoid cross border harmful interference an European frequency plan and assignment may be needed to ensure proper performance of observations.

The majority of the currently used sondes use free oscillating transmitters and analogue FM modulation. The free oscillating transmitters tend to drift due to the wide ambient temperature variation and decreasing battery voltage.

The present document presents a spectrum mask for transmission encouraging the use of digital modulation, and frequency drift control electronics in disposable sondes.

The present document covers Radiosondes. The other Meteorological Aids applications on the same frequency band shall meet the present document when applicable. The other applications are e.g. Dropsondes, Rocketosondes and Floatsondes.

The present document meets the requirements of efficient use of the spectrum stated in the R&TTE Directive [4] taking into account the sonde specific issues.

System operation, applications and rationale:

The Radiosondes are used for weather forecasting and meteorological and environmental research. The international agreements within the WMO suggest at least two, but encourage four, daily observations at each site (fixed land and mobile ship stations). Observation data are distributed to all WMO member countries through the Global Telecommunication System (GTS). The number of sondes used for international weather data exchange within WMO agreement is about a half of the sondes totally used. In other applications the sondes are used more sporadic, but their use can be intensive during measurement campaigns or other special situations.

Currently the majority of Radiosonde transmissions are full analogue FM modulation or combined with FSK modulated data. The transmitter is typically a free oscillating one, which tends to drift due to the wide temperature variation and fading power source (battery). This causes usually about ±150 kHz drift (±800 kHz defined by ITU-R Recommendation SA 1165-1 [1]) from the pre-set frequency.

For the analogue FM transmitters ITU-R Recommendation SA 1165-1 [1] defines -43 dBc as the limit for spurious (out of band) transmissions. The present document proposes limits corresponding to -60 dBc level and better, and limits the transmission power to 200 mW.

The Radiosonde specific issues, compared with other, e.g. typical SRD applications, are:

a) The wide ambient operating temperature range: +55ºC … -66,5ºC (10ºC less than ICAO standard atmosphere minimum).

b) The high dynamic range of the reception: in the beginning of the observation the Radiosonde is close to the deployment and reception site, and by the end of it, the range may be about 300 km.

c) The economy: Radiosonde is disposed after one time use.

The present document gives a spectral mask for sonde transmission.

Market Briefing:

Radiosondes have been in the use for about 60 years. The use of the 400,15 MHz to 406 MHz band has increased during the past two decades, and about half of the sondes in the world use this band. There are some plans to deploy Dropsondes from high altitude platforms close to European coastal area. In addition ship-borne systems have proven to provide useful data for medium range weather forecast.

In the Europe, the present annual use of Radiosondes, is about 100 000, and there are about 300 receiving systems. About 100 sites (receiving systems) have WMO catalogue number to report observations to the GTS. The other users fall into different categories covering research, atmospheric science and environmental monitoring.

Spectrum requirement and justifications:

The development of technology has made a high measurement rate, compared to Radiosondes used in the past decades, possible. In addition to the actual readings, in order to ensure the measurement quality, Radiosondes need to transmit a number of reference, and housekeeping data to the receiving station for analysis. Further, to ensure error free reception, redundancy, e.g. error detection and correction methods, need to be applied. The spectrum mask allows theoretically high-speed, up to 50 kbit/s, transmission using digital modulation.

The wide variation in the ambient temperature affects on the transmitter frequency stability even if crystals or synthesizers are used, therefore it is feasible to allow drift of the centre frequency during the operation.

The other essential factor in the digital transmission is the property of the local oscillator (VCO). Using an ideal modulation and VCO this spectral mask allows transmission speed of 50 kbit/s. This speed may be sufficient for all foreseen volume Radiosonde applications in future.

The proposed spectrum mask with allowed transmitter drift properties makes 200 kHz channel separation possible. The ITU-R Recommendation SA 1165-1 [1] suggest ±800 kHz drift and 480 kHz spectral mask in worst case for FM-analogy Radiosondes

Current regulations:

In European Countries only in Germany there are specific requirements, which differ from those given in the ITU specification ITU-R Recommendation SA 1165 [1]. In Germany Radiosonde transmission needs to comply with the generic standard for short range devices (EN 300 220) [7].

5 Specifications and recommendations

The essential specifications of the sonde transmitter are given in the following.

1) Effective Radiated Power: maximum 200 mW.

2) Frequency stability: ±20 kHz [= ±50 ppm]
within the ambient temperature range from +55ºC to -66,5ºC, which is 10ºC less than the minimum atmospheric temperature specified by ICAO standard atmosphere.

3) Spectral mask:
Frequency offset is given relative to the nominal carrier frequency. Carrier frequency drift is not included.
Power is given relative to the power in the nominal carrier frequency in 1 kHz band.

Table 1: Spectrum mask

Frequency offset from nominal	Maximum relative power
±50…100 kHz	-34 dBc/1 kHz
±100…200 kHz	-40 dBc/1 kHz
±200…300 kHz	-48 dBc/1 kHz

4) There are no common European channel assignments for Radiosondes in the Meteorological Aids band from 400,15 MHz to 406 MHz. The presented characteristics support use of 200 kHz separation in frequency between Radiosondes operating in the same geographical area.

Annex A:
Detailed application information

A.1 Radiosonde application

A sounding system comprises of disposable radiosonde ascending with a Hydrogen or Helium balloon, and a receiving station. Radiosonde deployed from aircraft and descending with a parachute are called Dropsondes.

In the receiving station the signal transmitted from Radiosonde are converted to quantities and output messages used in meteorology, and then input to Global Telecommunication Network (GTS).

Radiosondes with balloon ascend usually up to about 35 km altitude in about two hours, and Dropsondes released from aircraft cover the range from flight level to the ground. Dropsondes are usually deployed over sea areas, where ground based releases are not practical. The balloon borne Radiosondes drift with wind, and at the end of the flight the maximum distance to the release site may be about 300 km in some weather conditions, but typically much less.

Radiosondes measures typically atmospheric pressure (P), temperature (T), relative humidity (U or H as American abbreviation reads), and wind speed and direction. Special sondes measure Ozone, other substances, and the presence of radioactive particles.

The wind measurement is usually done using Navigational Aid signals from Loran-C or GPS (Global Positioning System). When available the European navigational system Galileo may be applied. The present document does not apply to sondes measuring winds using the Loran-C, and transmitting analogue FM modulated signal.

A.2 Transmitters

The present document presents specifications for spectral mask of digital modulation. The specification does not impose any methods to stabilize the transmitter or any specific modulation technique. The bit rate 50 kbit/s. is envisioned to be needed for high resolution measurements in the future. The maximum transmission power of 200 mW promotes long range and high bit rate transmission with low bit error rate.

A.3 Requirement to wide spectrum

The number of Radiosondes, which needs to be tracked simultaneously at a site varies, in addition alien Radiosondes usually are within the telemetry range. The situations given here are only for understanding the operation, and other schemes may exist:

a) Fixed or mobile ship stations performing observations according to the WMO recommendations: if the released Radiosonde, using primary frequency, fails but continues to transmit, a new Radiosonde needs to be released using the secondary frequency assigned to the station.

b) Sounding stations locating close to each other's need to have different assignments for primary and secondary frequencies.

c) Mobile (usually research application) sounding stations performing multiple soundings consecutively.

Receiving station tracks at the same time more than one Radiosonde. The earlier released Radiosondes may be far away (e.g. 300 km) from the receiving station while the new one is under preparation in its immediate proximity.

In research applications the need to the channel assignment depends on the (research) program objectives

Annex B:
Technical information

B.1 Technical justifications for spectrum

B.1.1 High dynamic range of reception

The Radiosonde reception range varies during a sounding from deployment, which is usually near to the receiving system, to the end of the sounding, when the range in some conditions may be up to about 300 km.

Table 2: Free space loss of 400 MHz signal

Distance	free space loss
10 m	44,5 dB
100 m	64,5 dB
1 km	84,5 dB
10 km	104,5 dB
30 km	114,3 dB
100 km	124,5 dB
200 km	130,5 dB
300 km	134,0 dB
350 km	135,4 dB

B.1.2 Radiosonde to Radiosonde interference

When a second RF signal is set spectrally near to a desired one, it becomes a harmful interfere under certain conditions. If the power of the side lobe of alien signal is high enough degradation of the system performance will occur.

The Radiosonde to Radiosonde interference occurs if a Radiosonde receiving station is tracking the target far away, and another Radiosonde released from somewhere else would drift to a close distance. This may happen if near-by release sites use frequencies uncoordinated or the assigned frequencies are too close to each other. Assuming that the interfering Radiosonde would be at 30 km, and the sonde to be received at 300 km distance, respectively the free space losses would be 114,3 dB and 134 dB.

The required marginal for successful reception and detection of the GFSK modulated Radiosonde signal, S/N or S/I, is typically about 14 dB with acceptable bit error rate. Consequently at least 33,5 dB is required to separate two adjacent channels. Combining the spectral mask properties, maximum allowed frequency drift given in clause 5, and required receiver band width the channel separation could be 200 kHz.

B.1.3 Frequency drift due to the ambient temperature variation

Radiosonde passes through the atmosphere, and is exposed to all occurring conditions. The operational temperature ranges from +55ºC to -90ºC may occur, pressure from 1 050 hPa to 3 hPa and humidity from dry, about 10 % RH, to condensing 100 % RH. The wide operation environment range tends to cause temperature related drift to the transmitter. With a synthesized frequency, and crystal controlled transmitters the drift can be reduced substantially compared to free oscillating ones, but not eliminated. The allowed drift specified in the present document is substantially less, but allows, however, more temperature related drift for Radiosonde transmitters than is allowed for SRD devices.

B.2 Current of relevant ETSI standards for ensuring the conformity with technical specifications

- ETSI ETS 300 683, (1997): "Radio Equipment and Systems (RES); ElectroMagnetic Compatibility (EMC) standard for Short Range Devices (SRD) operating on frequencies between 9 kHz and 25 GHz ".
- ETSI EN 300 220-1 (V1.3.1): "ElectroMagnetic Compatibility and Radio Spectrum Matters (ERM); Short Range Devices (SRD); Radio equipment to be used in the 25 MHz to 1 000 MHz frequency range with power levels ranging up to 500 mW; Part 1: Technical characteristics and test methods".

History

Document history		
V1.1.1	April 2002	Publication