International Telecommunication Union

ITU-R

Radiocommunication Sector of ITU

Recommendation ITU-R SM.1840-0

(12/2007)

Test procedure for measuring the sensitivity of radio monitoring receivers using analogue-modulated signals

SM Series

Spectrum management

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S	Fixed-satellite service
SA	Space applications and meteorology
SF	Frequency sharing and coordination between fixed-satellite and fixed service systems
SM	**Spectrum management**
SNG	Satellite news gathering
TF	Time signals and frequency standards emissions
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Note: *This ITU-R Recommendation was approved in English under the procedure detailed in Resolution ITU-R 1.*

Electronic Publication
Geneva, 2009

RECOMMENDATION ITU-R SM.1840-0*

Test procedure for measuring the sensitivity of radio monitoring receivers using analogue-modulated signals

(2007)

Scope

This Recommendation belongs to a set of Recommendations describing the test methods to determine technical parameters of radio monitoring receivers that are important for the users of these receivers. When the described methods are followed by manufacturers, comparing different receivers is made easier. This Recommendation provides the definition of a sensitivity test procedure for receivers. This test procedure definition is recommended to all the manufacturers, with the advantage for the users of such receivers, that an easier and more objective assessment of product quality is possible.

Keywords

Test procedure, sensitivity measurements, radio monitoring receiver, analogue modulated signals

The ITU Radiocommunication Assembly,

considering

a) that ITU-R has published the Typical recommended specifications for analogue and digital monitoring receivers in the ITU Handbook on Spectrum Monitoring (Edition 2011), but that nothing is said about the test procedures behind such specifications;

b) that one of the specifications that most strongly depends on the test procedures applied is the sensitivity;

c) that the sensitivity of a receiver is a measure of its ability to receive weak signals and to produce an output having a usable level and acceptable quality;

d) that the sensitivity level specified in the data sheet of a receiver depends extremely on the test frequencies used, the modulation parameters, the IF filter bandwidth used, the signal-to-interference ratio including noise and distortion (SINAD) value and the ambient temperature prevailing during the tests;

e) that due to the direct correlation with the noise figure the sensitivity characteristic has a direct influence on the suitability of a receiver as a monitoring device;

f) that without a defined test procedure, the sensitivity specifications published by the manufacturers have to be made comparable by some kind of conversion and that this conversion might be complex or even impossible to perform;

g) that a defined test procedure for the sensitivity must be independent of receiver design;

h) that a well-defined test procedure for the sensitivity, if adopted by all the manufacturers of radio monitoring receivers, will have the advantage for the users of such receivers, that an easier and more objective assessment of product quality is possible, avoiding ambiguities;

* Radiocommunication Study Group 1 made editorial amendments to this Recommendation in the years 2010 and 2019 in accordance with Resolution ITU-R 1.

j) that supplementary information about these sensitivity measurements can be found in the Report ITU-R SM.2125 – Parameters of and measurement procedures on H/V/UHF monitoring receivers and stations,

recommends

1 that for cases in which the sensitivity of radio monitoring receivers using analogue-modulated signals is specified by administrations, the measurement method in Annex 1 should be used.

Annex 1

Test procedure for measuring the sensitivity of radio monitoring receivers using analogue-modulated signals

1 General aspects

This Annex provides the definition of a test procedure to determine the sensitivity of a radio monitoring receiver.

The sensitivity depends on:

– the noise figure;
– the modulation type;
– the frequencies used for the test;
– the IF bandwidth used for the test;
– the SINAD value;
– the modulation frequency;
– the modulation index (for AM);
– the frequency deviation (for FM);
– the preamplifier settings;
– the temperature prevailing during the tests.

Furthermore, to correctly assess the sensitivity:

– the measurements have to be done over the whole frequency range of the receiver;
– a worst value of the sensitivity must be specified and published by the manufacturer in the data sheet over the receiver's whole operating range. Since sensitivity values are frequency dependent the manufacturer can choose to additionally specify the sensitivity for selected frequency bands or ranges;
– a *mean value* (the arithmetic mean of a number of test measurements) may also be indicated;
– the published sensitivity values have to be valid over the entire temperature range indicated in the data sheet. Limitations, if any, have to be mentioned in the data sheet.

2 Basics of the sensitivity measurements

The sensitivity of a receiver is defined as the minimum signal level (µV, dBµV or dBm) at the input of the receiver for demodulation and audio listening of the received signal. The minimum audible signal with acceptable quality shall be determined by a SINAD measurement.

A modulated test signal, generated by a signal generator, is inserted into the antenna input of the receiver. An audio analyser is connected to the audio output.

The principle of this measurement is to reduce the signal level at the signal generator until the SINAD value is reached. The SINAD value is measured on the audio analyser.

The measurements must be done over the whole frequency range by tuning the signal generator and the receiver to the test signals with the frequencies f_1, f_2, ... f_n.

AM modulation for HF and VHF/UHF band

The sensitivity level is then indicated as:

Sensitivity (AM) ≤ *X* at
(preamp. "on") 6 kHz bandwidth
12 dB SINAD
fmod = 1 kHz
m = 0.5

FM modulation for HF band

The sensitivity level is then indicated as:

Sensitivity (FM) ≤ *X* at
(preamp. "on") 8 kHz bandwidth
20 dB SINAD
fmod = 1 kHz
Δf = 2.4 kHz

FM modulation for VHF/UHF band

The sensitivity level is then indicated as:

Sensitivity (FM) ≤ *X* at
(preamp. "on") 15 kHz bandwidth
20 dB SINAD
fmod = 1 kHz
Δf = 5 kHz

where:

X is the measured sensitivity, indicated in µV (or dBµV or dBm)
the bandwidth used is indicated
the SINAD value is indicated
the modulation frequency is 1 kHz
the modulation index m for AM
the frequency deviation Δf for FM.

The measurements must be done over the whole frequency range by tuning the receiver to the test signals with the frequencies f_1, f_2, ... f_n. Per octave at least two frequencies being evenly distributed over the full frequency range of the receiver have to be chosen.

The receiver must be set up under normal operating conditions. If an input attenuator exists, it must be switched to 0 dB attenuation. The automatic gain control (AGC) must be switched on during the

tests. If a switchable preamplifier exists, the measurements must be done in the condition "preamplifier on". The condition "preamplifier on" may also be expressed as "high sensitivity mode" or "low noise mode".

3 Definition of a test procedure for measuring the sensitivity of radio monitoring receivers using analogue-modulated signals

In addition to the general aspects and basics stated in § 1 and 2 above the following definitions for the measurements apply:

The measurements have to be done for the two main modulations modes AM (A3E) and FM (F3E) at the test frequencies f_1, f_2, ... f_n.

Selection of the test frequencies as stated in item No. 2.

Settings of the signal generator

for AM in the range 9 kHz-3 000 MHz:

Modulation mode	AM
Modulation frequency	1 kHz
Modulation index	0.5

for FM in the range 9 kHz-30 MHz:

Modulation mode	FM
Modulation frequency	1 kHz
Frequency deviation	2.4 kHz

for FM in the range 20-3 000 MHz:

Modulation mode	FM
Modulation frequency	1 kHz
Frequency deviation	5 kHz

Settings of the receiver

for AM:

Modulation mode	AM
IF bandwidth	6 kHz

for FM in the range 9 kHz-30 MHz:

Modulation mode	FM
IF bandwidth	8 kHz

for FM in the range 20-3 000 MHz:

Modulation mode	FM
IF bandwidth	15 kHz

If the recommended IF filter bandwidth is not available in the receiver, the next higher filter bandwidth must be chosen.

The audio filter used for the measurement needs to be specified.

Settings of the audio analyser:

The audio analyser must be set to the measurement mode "SINAD".

The psophometric audio filter (ITU-T Recommendation P.53) in the audio analyser must be switched on.

Measurement procedure

Increase the signal generator level until a stable SINAD value of approx. 30 dB is displayed on the audio analyser.

Reduce the signal level until the SINAD value has reached 12 dB (for AM) or 20 dB (for FM). The corresponding level value read on the signal generator is the sensitivity of the receiver.

4 Units conversions

If the sensitivity value is expressed in µV it must be converted to dBm with:

Value (dBµV) = 20 log value (µV) e.g. for 1µV: 20 log 1(µV) = 0 dBµV

Value (dBm) = Value (dBµV) – 107 e.g. for 0 dBµV: 0 dBµV − 107 = −107 dBm

assuming an input impedance of 50 Ω.