

ITU-R

Radiocommunication Sector of ITU

Recommendation ITU-R BT.1735-3 (02/2015)

Methods for objective reception quality assessment of digital terrestrial television broadcasting signals of System B specified in Recommendation ITU-R BT.1306

BT Series
Broadcasting service
(television)



Foreword

The role of the Radiocommunication Sector is to ensure the rational, equitable, efficient and economical use of the radio-frequency spectrum by all radiocommunication services, including satellite services, and carry out studies without limit of frequency range on the basis of which Recommendations are adopted.

The regulatory and policy functions of the Radiocommunication Sector are performed by World and Regional Radiocommunication Conferences and Radiocommunication Assemblies supported by Study Groups.

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Series of ITU-R Recommendations

(Also available online at <http://www.itu.int/publ/R-REC/en>)

Series	Title
BO	Satellite delivery
BR	Recording for production, archival and play-out; film for television
BS	Broadcasting service (sound)
BT	Broadcasting service (television)
F	Fixed service
M	Mobile, radiodetermination, amateur and related satellite services
P	Radiowave propagation
RA	Radio astronomy
RS	Remote sensing systems
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
V	Vocabulary and related subjects

Note: This ITU-R Recommendation was approved in English under the procedure detailed in Resolution ITU-R 1.

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RECOMMENDATION ITU-R BT.1735-3

Methods for objective reception quality assessment of digital terrestrial television broadcasting signals of System B specified in Recommendation ITU-R BT.1306

(Question ITU-R 100/6)

(2005-2012-2014-2015)

Scope

The purpose of this Recommendation is to make available methods to assist in quality assessment of the reception of digital terrestrial television broadcasting services for digital television broadcasting in System B. This Recommendation takes into account relevant ITU-R Recommendations. For the stated purpose, two methods are available, one for multi-frequency network (MFN) and one for single frequency network (SFN).

The ITU Radiocommunication Assembly,

considering

- a) that Recommendation ITU-R SM.1682 – Methods for measurements on digital broadcasting signals, specifies in § 2.6 the parameters to be measured for coverage evaluation;
- b) that in Recommendation ITU-R BT.1368 planning parameters such as minimum field strength, protection ratio and relation between minimum field strength and receiver voltage input are defined and widely used by administrations;
- c) that in Recommendation ITU-R P.1546 field strength prediction methods and clutter height for field evaluation are indicated and widely used by administrations;
- d) that ITU-R established Recommendation ITU-R BT.500 as a methodology for the subjective assessment of the quality of television pictures;
- e) that, with the introduction of digital television services, it has been observed that subjective assessment of digital television pictures is considered less relevant in quality assessment, as the performance of digital technologies do not provide the tolerances experienced with analogue;
- f) that with the assessment of digital television systems, a critical requirement is that the system is above the threshold;
- g) that subjective analysis of the picture quality cannot be used as a measure of the interference level or required protection ratio of digital systems;
- h) that satisfactory planning of digital systems requires a determination of operation with a sufficient margin above the threshold point of quasi error free (QEF) signal, taking into account time and location variability;
- i) that BER after Viterbi decoding (vBER) is used to determine the threshold of QEF condition;
- j) that the SFP method is used to determine the threshold of visible errors;
- k) that there is a need for in-field methodologies to assist administrations and Sector Members to assess the reception quality of digital terrestrial television broadcasting (DTTB) coverage,

recommends

- 1 that the model to describe the objective reception quality of digital signals based on measured bit error rates (BER) and measured field strength, in accordance with § 3 of Annex 1 should be used;
- 2 that for MFN the quality scale presented in Tables 1 and 2 of § 3.1 of Annex 1 should be used;
- 3 that for SFN the quality scale presented in Table 3 of § 3.2 and Table 2 of § 3.1 of Annex 1 should be used;
- 4 that the methods of measurement described in §§ 5, 6 and 7 of Annex 1 should be used.

Annex 1

Standard method for objective reception quality assessment for digital television broadcasting signals for System B

1 Objective quality assessment of reception

The coverage of a specific area, as determined by a prediction method, should be verified by “in-field” measurements in order to assess prediction results. In terms of quality, by means of a prediction method, it is possible to identify the coverage area using “location probability”. In the same way, the “perceived quality” concept, related to the end user, could be evaluated by means of measurement methods. The digital terrestrial television reception system works on the basis of a “threshold” and the perceived quality depends on three factors: the access to the service, the time availability and the location availability.

Signal level assessment and quality assessment are two different processes within the application of this method.

Application of the reception environment is not relevant in the quality assessment process¹. It is assumed that the quality assessment process is based upon the minimum signal level applied for a specific environment within an administration’s DTTB planning regime where the derivation of minimum signal level would take into account the relevant reception environments. It is also assumed that the DTTB planning regime takes into consideration location availability.

If the field strength in a particular reception environment is not achieved according to the planning regime, then the service automatically fails to meet the quality assessment requirement.

¹ The main application is for fixed reception and steady receiving conditions. Caution should be taken for tropospheric propagation when detectable contributions fall closed or outside GI.

For fixed reception and time variable receiving conditions, a statistical method has to be applied. Several samples of field strength and BER have to be taken over a significative period of time and Q values have to be calculated for each sample. A Q value exceeded for more than a specific percentage of time (e.g., 90%) of the samples is the value of the Quality coverage.

2 Parameters to be evaluated

As reported in the current version of Recommendation ITU-R SM.1682 at § 2.6, the parameters to be evaluated are: field strength and bit error ratio (BER) after different decoding stages (here it is suggested to get the BER before and after Viterbi decoding – (cBER and vBER)). The BER after Viterbi decoding (vBER) is used to determine the threshold of quasi error free (QEF) condition. One more parameter should also be recorded during measurement activities. It is the modulation error ratio (MER) at the transmitting site. MER represents a synthetic form of constellation analysis. If the MER value at the transmitting site is lower than an established value, e.g. 36 dB², the measurement activities should be stopped due to possible transmission failure. It has been noted that within some administrations there can be distinct classes of MER performance where there appear to be three distinct classes of MER performance corresponding to *tiers of services* for different types of transmission services as follows:

Type of service	Service performance target (MER)
Primary transmission service which may feed secondary transmission services, requires a reference quality suitable for coverage of urban, suburban and rural areas.	> 35 dB
Secondary re-transmission service which is RF fed from the primary transmitter service and reconstituted or re-modulated for re-transmission on a different output channel to the input.	> 33 dB
Tertiary translator or on channel repeater service which is RF fed off-air from the primary transmitter service and is IF processed only to transmit on either a different channel or the same channel in the case of on-channel repeater (OCR), is intrinsically a lower power service and has a relatively smaller coverage area and may be fed from a secondary re-transmitter service.	> 30 dB

The Modulation Error Ratio (MER) is defined as the sum of the squares of the magnitude of the ideal symbol vectors in a modulation constellation of M points divided by the sum of the squares of the magnitudes of the symbol vectors. The result, expressed as a power ratio in dB, is given by the equation:

$$MER = 10 \log_{10} \left\{ \frac{\sum_{j=1}^N (I_j^2 + Q_j^2)}{\sum_{j=1}^N (\delta I_j^2 + \delta Q_j^2)} \right\} \quad (\text{dB})$$

where N is the total number of received symbol coordinate pairs $(I_j + \delta I_j, Q_j + \delta Q_j)$ and N is significantly larger than the number of modulation constellation points, M .

The ideal symbol coordinate pair is (I_j, Q_j) . For each received symbol the error vector is defined as the distance from the ideal position in the constellation to the actual position of the received symbol. The difference is expressed by the vector $d_j = (\delta I_j, \delta Q_j)$.

Figure 1 illustrates a constellation diagram for a 64-QAM modulation format ($M = 64$). Each of the received symbols at the i^{th} point deviated from the ideal position (I_j, Q_j) by a distance $(\delta I_j, \delta Q_j)$.

² Minimum MER acceptable is contained in the purchase specification for the transmitters.