RECOMMENDATION ITU-R F.1670*

Protection of fixed wireless systems from terrestrial digital video broadcasting systems in the VHF and UHF shared bands

(Question ITU-R 216/9)

(2004)

The ITU Radiocommunication Assembly,

considering

a) that it is important to establish compatibility and sharing criteria between the fixed service (FS) and the broadcasting service in the VHF and UHF bands where appropriate;

b) that the bandwidths of typical fixed wireless systems (FWSs) in this spectrum are narrow in comparison with digital video broadcasting (DVB) signals;

c) that the emission characteristics of terrestrial DVB in these bands may be approximated by white Gaussian noise, in respect to reception by the FWS;

d) that the noise level, N, of the FWS receiver depends on its IF bandwidth;

e) that Recommendation ITU-R F.758 specifies an interference criterion $I/N = -6$ dB, which is equivalent to a 1 dB increase of the FWS receiver noise floor;

f) that the direction of arrival of the terrestrial DVB signal, relative to the FWS main beam, influences the maximum allowable field strength at the receiver,

recommends

1 that the threshold level, P_r, for sharing between terrestrial DVB stations and FWS receiving stations of IF bandwidth B (MHz) may be determined from the following formula:

$$P_r = -114 + 10 \log B \qquad \text{dBm}$$

NOTE 1 – This threshold level does not include the antenna gain and losses of the FWS receive station.

2 that the maximum allowable field strength and the maximum interfering field strength of the DVB signal (dB(µV/m)) may be calculated for terrestrial DVB centre frequencies, F, as follows:

$$\text{Field strength (dB(µV/m))} = -44 + 20 \log F \text{ (MHz)} + 10 \log B$$

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* This Recommendation should be brought to the attention of Radiocommunication Study Groups 1 and 6.

NOTE 1 – Levels have been calculated for an FWS receiver antenna gain of 15 dBi and feeder losses of 8 dB.

NOTE 2 – Actual antenna radiation patterns should be used. If they are not available, Recommendation ITU-R F.699 should be used.

3   that Annex 1 may be referred to for guidance in the derivation of the maximum allowable powers and field strengths, in *recommends* 1 and 2.

Annex 1

Technical considerations

a)   Signals from terrestrial DVB systems operating in the VHF and UHF bands are similar to white noise (see Fig. 1), and can be considered:

–   "homogenous" along the 7-8 MHz TV channel (which is not the case for analogue TV); and

–   wideband relative to signals of FWS operating in the bands 174-230 MHz and 470-862 MHz.

b)   The exact calculations of potential interference require the receiver characteristics of all FWS. It may not be practical to check specific interference and protection ratios, to assess the interference from terrestrial DVB to FWS.

c)   The broadcasting service typically uses field strength in µV/m and dB(µV/m) units; while F-series ITU-R Recommendations refer to power values.

d)   The resulting field strengths differ significantly for the different receiver bandwidths. FWS below 1 GHz usually do not have 7-8 MHz bandwidths, as does the terrestrial DVB. FWS in the VHF bands may have even narrower bandwidths. Recommendation ITU-R SM.1541 provides spectrum masks for the terrestrial DVB.

e)   The allowed interference criterion is used for determining the maximum allowable field strength (similar to nuisance interfering field strength), which equals the minimum usable field strength (see Recommendation ITU-R V.573), minus the protection ratio (see No. 1.170 of the Radio Regulations).

f) The sensitivity of FWS point-to-point (P-P) or point-to-multipoint (P-MP) systems equals the $(k\,T\,B\,F) + C/N$. The maximum allowed interfering signal (and the maximum interfering field strength) equals: Sensitivity – C/I. If $C/N = C/I$, the interfering terrestrial DVB signal equals the equivalent $k\,T\,B\,F$. For equivalent added protection of 6 dB, the interference, I, equals $k\,T\,B$. The $k\,T\,B\,F$ is the value to be protected for a 3 dB sensitivity degradation, and $(k\,T\,B\,F) - 6$ dB for 1 dB degradation. For an equivalent noise figure of 6 dB, the criterion of interference, I, from terrestrial DVB into the input of the FWS receiver equals –144 dB(W/MHz) or –114 dB(m/MHz), independent of frequency. For this case, the interference noise threshold depends only on the IF bandwidth of the FWS receiver, disregarding the modulations of the interfering terrestrial DVB and the interfered-with FWS.

g) In the VHF band, the sensitivity of FWS may be defined not by the $(k\,T\,B\,F) + C/I$, but by man-made noise, that can be higher than the sensitivity defined by the noise floor. In this case, the sensitivity and field strength thresholds are higher (see Recommendation ITU-R P.372 – Radio noise).

h) If the FWS receiver (Rx) filter is not entirely included in the terrestrial DVB power spectrum-density envelope, there is frequency difference Δf between the terrestrial DVB centre channel and the FWS Rx, and it will enable higher terrestrial DVB interfering power.

i) The relationship (numbers, not in dB) between field strength, E, and power, P_r, in free space is given by:

$$P_r = \frac{E^2\,g\lambda^2}{Z_0\,4\pi} = \frac{E^2\,gc^2}{480\,\pi^2 f^2}$$

j) It may be assumed that the FWS antenna gain = 15 dBi and feeder losses up to $L_f = 8$ dB. FWS antennas can be found deployed in V or H polarizations. Any cross-polarization between the horizontal (mainly used) terrestrial DVB and the FWS antenna (both polarizations are used) will enable higher terrestrial DVB interfering power. Any interfering terrestrial DVB signal arriving to the side-lobe of the FWS antenna, the side-lobe gain should be compared to the 15 dBi FWS main antenna gain.

k) It could be appropriate to assume a cross-polarization advantage of 10 to 18 dB, at least for the vertically polarized FWS station. For FWS, the antenna polarization discrimination for horizontally polarized broadcasting emissions may reach 18 dB (see Recommendation ITU-R SM.851). Where mixed polarized broadcasting emissions are used, no antenna polarization discrimination should be taken into account. There might also be attenuation in the elevation antenna pattern, due FWS antenna tilt or terrestrial DVB sites in mountainous areas.

l) Clarifying example: For 7-8 MHz (9 dB relative to 1 MHz) FWS bandwidth, the sensitivity is –105 dBm before the antenna amplification, and –112 dBm input Rx including the antenna gain. This is the value of power signal to be protected. The corresponding field strength thresholds per 7-8 MHz, including 7 dB Rx antenna gain and protection ratios, which may interfere into the FWS, are: 10 dB(µV/m) for 174 MHz; 13 dB(µV/m) for 230 MHz; 19 dB(µV/m) for 470 MHz; 23 dB(µV/m) for 790 MHz and 24 dB(µV/m) for 862 MHz.

m)   Figure 1 depicts an experimental transmitted (wireless) signal, in Channel 29, with centre frequency 538 MHz; 8 MHz separation bandwidth, quaternary phase shift keying (QPSK) (4-QAM), forward error correction (FEC)-1/2 fast Fourier transform (FFT) 8K, guard interval-1/8.

FIGURE 1

Terrestrial DVB signal, in Channel 29, a QPSK (4-QAM), FEC-1/2 FFT 8K, guard interval-1/8

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