RECOMMENDATION ITU-R BT.419-3*

Directivity and polarization discrimination of antennas in the reception of television broadcasting

(1963-1986-1990-1992)

The ITU Radiocommunication Assembly,

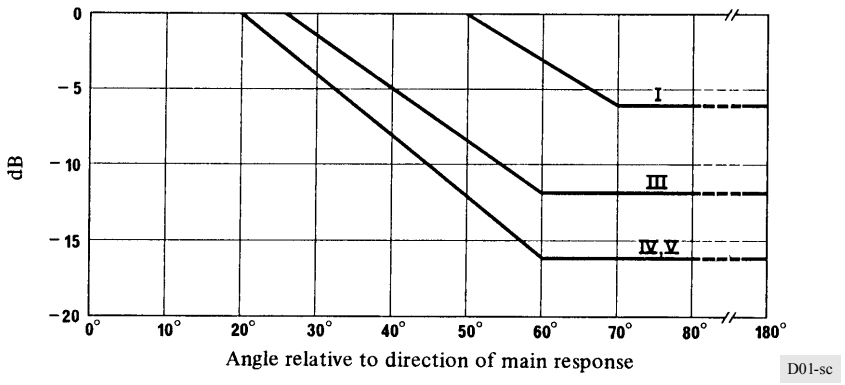
recommends

that the characteristics of directivity of the receiving antennas of Fig. 1 can be used for planning terrestrial television services in broadcasting Bands I, III, IV and V.

FIGURE 1

Discrimination obtained by the use of directional receiving antennas in broadcasting

(The number of the broadcasting band is shown on the curve)



NOTE 1 – It is considered that the discrimination shown will be available at the majority of antenna locations in built-up areas. At clear sites in open country, slightly higher values will be obtained.

NOTE 2 – The curves in Fig. 1 are valid for signals of vertical or horizontal polarization, when both the wanted and the unwanted signals have the same polarization.

NOTE 3 – In the case of orthogonal polarization the combined discrimination provided by directivity and orthogonality cannot be calculated by adding together the separate discrimination values. However, it has been found in practice that a combined discrimination value of 16 dB may be applied for all angles of azimuth in the terrestrial television Bands I to V. This value could be expected to be exceeded at more than 50% of locations (see Annexes 1 and 2).

---

* Radiocommunication Study Group 6 made editorial amendments to this Recommendation in 2002 in accordance with Resolution ITU-R 44.

NOTE 4 – Bands I, III, IV and V are defined in Note 4 of Recommendation ITU-R BT.417.

NOTE 5 – For planning purposes, antenna systems for collective and cable distribution systems will be assumed to have directivity values at least equal to those set out in Fig. 1.

ANNEX 1

Advantages to be gained by using orthogonal wave polarizations in the planning of television broadcasting services in the VHF and UHF bands

Investigations have been conducted in several countries to ascertain the advantages which can be obtained in television broadcasting by using polarization discrimination in reception.

1 Bands I and III (VHF)

In this band of frequencies, between 30 and 300 MHz, the median value of discrimination that can be achieved at domestic receiving sites by the use of orthogonal polarization may be as much as 18 dB, and under these conditions, the values exceeded at 90% and 10% of the receiving sites are about 10 dB and 25 dB respectively.

The values of discrimination are likely to be better in open country and worse in built-up areas or places where the receiving antenna is surrounded by obstacles. For domestic installations in densely populated districts, the median values of 18 dB will usually be realized only at roof level; and this value may be reduced to 13 dB or less at street level.

No significant changes in the polarization of waves at VHF due to transmission through the troposphere have been observed over distances exceeding 200 km. Furthermore, there have been no reports of systematic changes in polarization effects with frequency in the metric band, neither with distance nor with type of terrain.

It must be emphasized, however, that to realize the discrimination ratios mentioned above, certain precautions are necessary at both the transmitting and receiving installations; cases have been reported in which, for a transmitter of horizontally polarized waves, some 7% of the radiated power was vertically polarized. It is clear that if the best discrimination is to be obtained for co-channel operation, the transmitters and antenna systems must be designed and installed so as to radiate as much as possible of the total power on the assigned polarization.

In the same way, to achieve the desired discrimination at the home receiving installation, the reception of the undesired orthogonally polarized waves on the antenna feeder and on the receiver itself must be reduced to the minimum practicable value.

It should, however, be noted that the above-mentioned advantage from the use of orthogonal polarizations can only be obtained when, in general, the polarization of the receiving antennas conforms to that of the wanted signal.

Due to problems with multipath reception in hilly and wooded terrain a comparison of vertical and horizontal polarization for VHF TV transmissions was made in Norway. The measurements show, in spite of higher field strengths for vertical polarization, that horizontal polarization in almost every measured site gave a better picture quality.

2 Bands IV and V (UHF)

Investigations have been carried out in the United Kingdom to determine the polarization discrimination in band 9 (UHF) of antennas at typical urban and rural domestic receiving sites. The results showed that for orthogonally polarized signals the median value of discrimination was 18 dB, and under the same conditions, the values exceeded at 90% and 10% of the receiving sites were about 9 dB and 25 dB respectively. There is also some small variation of discrimination with angle relative to the direction of main response. However, for television planning purposes in the United Kingdom, a value of 15 dB is used for all relative bearings.

As at VHF, care is necessary to ensure that the transmitter and receiver respectively do not emit or receive radiation of the undesired polarization. Apart from this, however, experience indicates that at UHF, the use of horizontal polarization offers advantages, because of the greater directivity obtainable at the receiving antennas; this reduces the effect of reflected waves, particularly in town areas. The European Broadcasting Union, therefore, considers that frequency assignments in these bands should be based on the general use of horizontal polarization, though exceptions may be made in cases where orthogonal polarization is necessary to achieve the desired protection.

3 Summary

From the studies described above, it is clear that the use of orthogonal polarization for broadcasting stations operating in the same frequency channel is of material assistance in discriminating against the reception of undesired signals. Worthwhile advantages are obtainable over the whole band of frequencies from 40 to 500 MHz and within the normal broadcasting service ranges. From the uniformity of the discrimination obtained over these frequencies, it is considered to be almost certain that the advantages will extend to the top of the broadcasting band in Band V at nearly 1 000 MHz.

ANNEX 2

Polarization of emission in television broadcasting

1 Linear polarization

Linear polarization of emissions is in almost universal use in television broadcasting. The plane of polarization is usually horizontal but from the viewpoint of planning there is much to be gained from allowing the possibility of also using vertical polarization.

The available evidence suggests that the use of horizontal polarization provides improved picture quality in hilly and wooded terrain compared with vertical polarization, at least for the VHF bands (see Annex 1).

The use of orthogonally polarized transmissions, together with appropriately polarized receiving antennas, offers significant advantages in terms of spectrum utilization. Planning based on the use of receiving antennas not offering polarization discrimination does not give this advantage.

2 Circular or elliptical polarization

There is a lack of information concerning the use of circular or elliptical polarization in planning the television broadcasting services. However, some administrations permit the use of circular or elliptical polarization as an alternative to the more usual horizontal or vertical. It is reported that the reception of circular polarized television emissions by simple portable or indoor antennas is improved because the orientation of these antennas by individual receivers is less critical than for the case of linear polarization.

However, it should be remembered that the use of simple portable or indoor antennas can lead to poor quality reception as a result of multipath propagation and low input signal levels.

Theoretically, the use of circularly polarized transmissions offers the possibility of filtering out most of the first order reflections. However, this advantage can only be achieved by the use of a circularly polarized receiving antenna and at this time such an antenna is not in practical use for individual television reception.

For a given transmitter power, a circularly polarized transmitting antenna will result in a field strength lower by 3 dB in the horizontal or in the vertical plane than that provided using a linearly polarized transmitting antenna, thus effectively giving a reduced coverage area.

3 Summary

From the foregoing it can be concluded that for optimum planning it is necessary to take full advantage of polarization discrimination, and that this can only be done economically and realistically by using horizontal and/or vertical polarizations.