

RECOMMENDATION 791*

CHOICE OF POLARIZATION FOR THE
BROADCASTING-SATELLITE SERVICE**

(Questions 83/11 and 85/11)

(1992)

The CCIR,

considering

- a) that the choice of polarization used in the broadcasting-satellite service (BSS) impacts on system performance, spectrum/orbit utilization, and the level of interference within the BSS and between services sharing the same frequency band;
- b) that misalignment between linearly polarized signals of interfering systems and the misalignment between transmitters and receivers has:
 - no effect on C/N of linearly and circularly polarized systems,
 - no effect on C/I of circularly polarized systems,
 - little effect on co-polar C/I of linearly polarized networks, but
 - has a strong effect on the cross-polar C/I of linearly polarized networks;
- c) that linear polarization can provide significant advantages over circular polarization with respect to atmospheric effects such as rain attenuation and depolarization, particularly at the higher frequency bands (see Annex 1);
- d) that, with linear polarization, accurate alignment between transmitter and receiver would be extremely difficult to achieve for reception by portable receivers and receivers in vehicles;
- e) that for certain frequency bands allocated to the BSS and the associated feeder links there are Plans in the Radio Regulations where circular polarization was adopted and that there are satellite networks, operating or planned, in these bands,

recommends

1. that circular polarization be used where reception is required by portable receivers and receivers in vehicles and for fixed reception except for the situation referred to in § 2;
2. that, for the frequency bands where atmospheric effects are predominant and when maximum frequency re-use from the same orbital location is needed, the advantages of linear polarization should be taken into account. Should linear polarization be employed, it should be fully specified and any additional information required to allow the IFRB to determine the affected administrations should be given;

Note 1 – A summary of the factors affecting the choice of polarization is given in Annex 1.

3. that for bands where Plans exist, the choice of polarization considered in § 2 should take into account the polarization adopted in the Plans.

* *Note from the Director, CCIR* – Reports 814-2, 564-4 and 722-3 were used in preparing this Recommendation.

** This Recommendation should be brought to the attention of Study Groups 4, 5 and 9.

ANNEX 1

1. Introduction

For purposes of planning the BSS in the band 11.7-12.5 GHz in Region 1 and 11.7-12.2 GHz in Region 3, right- and left-hand circular polarization was adopted. Similarly, in Region 2, right- and left-hand circular polarization was selected for the Plan for the broadcasting-satellite service in the band 12.2-12.7 GHz as well as for the associated feeder-link Plan in the band 17.3-17.8 GHz. Furthermore, at the WARC ORB-85 the frequency bands 14.5-14.8 GHz (for countries outside Europe and for Malta) and 17.3-18.1 GHz were selected for the planning of feeder links for the broadcasting-satellite service in Regions 1 and 3. It was assumed that circular polarization would be used for planning. Alternatively linear polarization could be used, subject to the agreement of all administrations sharing the given orbital position.

This Annex presents a summary of the factors that were considered in making a choice, both for the record and for the design of future systems in other bands that are or may be allocated to the broadcasting-satellite service.

2. Comparison between linear and circular polarization

The polarization type has an influence on system and service design. Although the WARC-BS-77, RARC SAT-83 Plans and WARC ORB-88 feeder-link Plan used circular polarization, linear polarization has some distinct advantages with respect to circular polarization. One advantage is that there is a cross-polarization improvement factor which varies with polarization tilt angle and amounts to 15 dB for 0° and 90° local polarization tilt angles. A further advantage of linear polarization is that it is easier to achieve adequate co-polar side-lobe suppression and cross-polar discrimination in the receiving antenna.

The comparative advantages and disadvantages of linear and circular polarization for use in the broadcasting-satellite service are summarized in Table 1. The symbols in the last two columns of the table indicate for each factor which type of polarization, linear (L) or circular (C), is considered to have the advantage. In evaluating these comparative advantages and disadvantages, it must of course be recognized that the different factors are not all of equal practical importance and that their relative importance is also a matter of engineering judgement.

To aid in evaluating the importance of satellite antenna orientation on the choice of polarization (item 3 in Table 1), a short quantitative discussion of the effects of system geometry on linear polarization is given in Appendix 1.

The choice between linear and circular polarization for planning the BSS is governed by two major factors:

- the effect of rain attenuation and depolarization on C/N and C/I ;
- the effect on interference of the misalignment between the reference linear polarization vectors and of the misalignment of earth station and satellite polarizers.

Rain affects both the C/N and C/I of linearly and circularly polarized waves for small percentages of time. On the other hand, the misalignment between linearly polarized signals of interfering networks and the misalignment between transmitters and receivers has:

- no effect on C/N of linearly and circularly polarized networks;
- no effect on C/I of circularly polarized networks;
- little effect on co-polar C/I of linearly polarized networks; but
- has a strong effect on the cross-polar C/I of linearly polarized networks.

This is significant since linear polarization is normally used to improve C/I during rain but, as a consequence of the misalignment, it may decrease C/I far below the maximum possible discrimination capability of the satellite and earth-station antennas.

TABLE 1

Some aspects of linear as compared with circular polarization

Factor	Remarks	Advantage ⁽¹⁾
1. Alignment of receiving antenna	Alignment of the polarization direction is not necessary for circular polarization	C
2. Effect of misalignment on cross-polarization	Misalignment of polarization direction of both transmitting and receiving antennas required with linear polarization, 2 to 4 dB extra cross-polar protection margins in comparison with circular polarization	C
3. Orientation of satellite antenna	With linear polarization, the plane of polarization will not in general correspond to the major or minor axes of a beam with elliptical cross-section; therefore:	C
	a) it may be difficult to produce a good cross-polar response with linear polarization (in particular for elliptical beams);	C
	b) transfer to a spare satellite at a different orbital position would probably be more difficult with linear polarization because of the need to realign the polarization plane	C
4. Sharing with other services	a) If circular polarization is chosen for the broadcasting-satellite service and other services use linear polarization, up to 3 dB protection between these services and the broadcasting-satellite service is assured	C
	b) If both the broadcasting-satellite and other services, e.g. fixed-satellite and terrestrial services, use linear polarization, then in isolated cases, where the dominant interference arrives near the main beam of a receiving antenna, it may be possible to increase the isolation by the use of orthogonal polarization	L
5. Propagation effects	Circular polarization is more affected by atmospheric conditions than linear polarization for high rainfall rates (greater than 12.5 mm/h) and low angles of arrival	L
	For example, the cross-polar attenuation may be 20 dB for 1% of the time with circular polarization according to some measurements in Switzerland at 12 GHz. This disadvantage of circular polarization may not be significant if compared with linear polarization transmission on or near a 45° plane	

(1) C: circular L: linear

It was found that even for high rainfall zones, the effect of rain on co-polar and cross-polar C/I is small for all but 1% of the worst month. For smaller percentages of time, the effect of rain becomes more important and its effect on cross-polar C/I depends on the type of polarization and on the reference vectors for linear polarization.

There are two main reference systems that can be used to define linear polarization:

- *canted linear polarization*: *Vertical polarization* is defined so that the polarization vector is perpendicular to the satellite antenna beam axis and lies in the plane defined by the satellite antenna beam axis and the local vertical. *Horizontal polarization* is defined so that the polarization vector is perpendicular to the satellite antenna beam axis and is contained in the local horizontal plane. These vectors will be in the direction closest to the local horizontal or local vertical at the boresight of the satellite antenna;