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REPORT 1028

**3 kHz DUPLEX SEPARATION FOR DSC CHANNELS IN THE BAND 435-526.5 kHz**

(Question 53/8)

(1986)

**1. Introduction**

1.1 The Regional Administrative Radio Conference for the Maritime Mobile Service and the Aeronautical Radionavigation Service in certain parts of the MF band in Region 1 (Geneva, 1985) adopted Recommendation No. 6 which invites the CCIR:

“1. To study the technical problems that may arise from the 3 kHz duplex separation in the digital selective calling channels in the band 435-526.5 kHz.

2. To review the appropriate CCIR Recommendations.”

1.2 This Report considers the probable characteristics of digital selective calling (DSC) receivers for interference rejection, the ratio of transmitted powers likely to be experienced in practice and the effect that they are likely to have if 3 kHz channel spacing is used.

## 2. Possible technical problems

### 2.1 Requirement for acknowledgement delay

2.1.1 After transmission of a DSC calling sequence from a particular station, a time period of at least 3 s is required before the acknowledgement sequence is transmitted from the called station. This is to enable transmit/receive switching to be completed at the calling station and give sufficient "settling time" for AGC etc. in the receiver.

2.1.2 For coast stations transmitting to ship stations there will inevitably be a suitable delay if the ship station responds manually, and if the ship station is automatic then Recommendation 541, Annex II, § 2.1.13.2 defines a delay. However, to cater for any automatic systems at coast stations, a delay should also be defined for the case of ship stations calling coast stations. Recommendation 541, Annex II, § 2.2.6 states that "The coast station should transmit an acknowledgement within 4.5 min". To prevent the problems identified in § 2.1.1 from happening, a minimum time (5 s) as well as a maximum time for acknowledgement has been included.

### 2.2 Single frequency channels

Similar problems arise in the use of narrow-band direct-printing (NBDP) on single frequency channels, which has been reported in Report 1026 under Question 5/8, and therefore these studies may be applicable to the operation of DSC on single frequency channels.

### 2.3 Interference from another station

2.3.1 The second major problem would occur when a ship or coast station was receiving an incoming call or acknowledgement from a ship or coast station some distance from it. If a second station was geographically located close to the receiving ship or coast station, e.g. 5 km away, and was then to start transmitting a call or acknowledgement on the adjacent channel there is a possibility that this would cause interference.

2.3.2 The possibility of this type of problem happening is dependent upon the receiver bandwidth and its adjacent channel rejection characteristic, and also on the relative powers of the wanted receive signal and the unwanted (interfering) signal ( $W/U$  ratio). The  $W/U$  ratio will be a function of the relative powers of the wanted and unwanted stations and of the relative distances between the receiving station and the station sending the wanted signal, and the station sending the unwanted signal.

## 3. Receiver characteristics

3.1 The bandwidth required for DSC signals as given in Appendix 6 of the Radio Regulations is 304 Hz ( $\pm 152$  Hz).

3.2 Taking this value into consideration, the passband and attenuation of the DSC receiver is likely to approximate to:

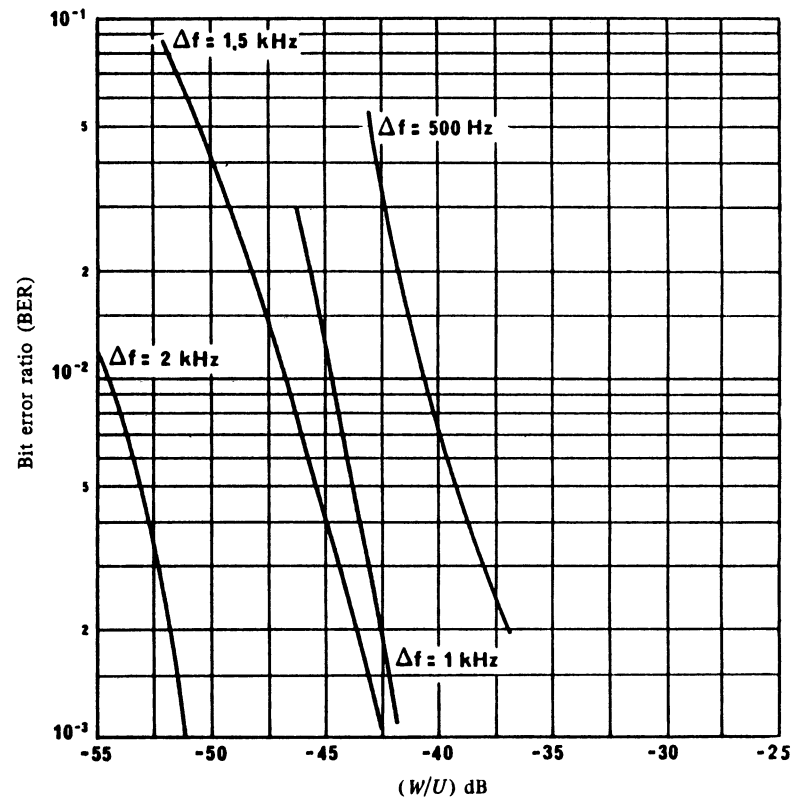
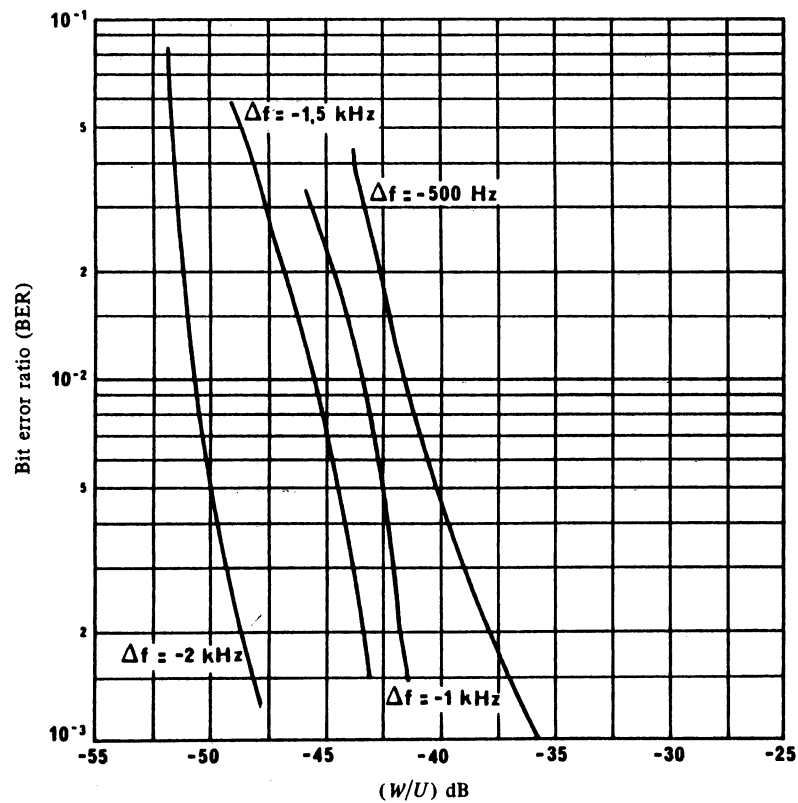
-3 dB at  $\pm 150$  Hz,  
 -6 dB at  $\pm 170$  Hz,  
 -30 dB at  $\pm 260$  Hz,  
 -60 dB at  $> \pm 370$  Hz.

The receiver rejection of a signal 3 kHz away will thus be at least 60 dB although there could still be problems from intermodulation products from this signal falling within the passband.

## 4. Variation of frequency separation with $W/U$ for various bit error ratios (BER)

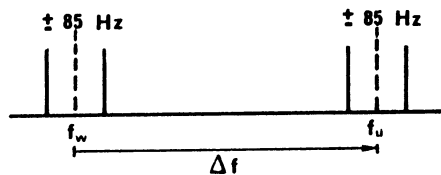
4.1 Figure 1 illustrates the results from a series of experiments conducted within the United Kingdom in 1981 on the variation of BER and wanted/unwanted signal ratios ( $W/U$ ) for different frequency separations of the wanted and unwanted signals.

4.2 It can be seen from the graphs that a  $W/U$  ratio of  $-50$  dB gives a BER of  $10^{-2}$  at a separation of 2 kHz. It can be assumed therefore that at least this figure can be expected with 3 kHz spacing.



USB

FIGURE 1 - Interference to data channel from data channel



Wanted signal  $f_w$ : FSK  $\pm 85 \text{ Hz}$ , FEC (100 bit/s), ITA No. 2 "Fox"  
 Unwanted signal  $f_u$ : FSK  $\pm 85 \text{ Hz}$ , FEC (100 bit/s), ITA No. 2 "Fox"  
 RX IF filter bandwidth 300 Hz  
 Received level of wanted signal 20 dB( $\mu\text{V}$ )  
 $f_w$ : centre frequency of wanted data signal  
 $f_u$ : centre frequency of unwanted data signal

## 5. Distance ratios

5.1 Considering that the transmitter power of ship and coast stations in the 500 kHz band is likely in practice to range between 60 W and 1 kW, the distances between a receive station and the wanted/unwanted transmitting stations can be calculated for varying  $W/U$  protection ratios. These are illustrated in Table I for a power ratio of 12 dB (i.e. 1 kW/60 W).

TABLE I –  $W/U$  ratios: comparison of distances

Wanted signal power: 60 W  
 Unwanted signal power: 1 kW  
 Wanted/unwanted power ratio: 12 dB

Assuming a maximum protection ratio of 50 dB (12 dB power ratio and 38 dB distance ratio) which Fig. 1 indicates as giving good protection from interference (BER =  $10^{-2}$ ) the following distances\* are possible:

Distance from unwanted transmitting station (km)	5	10	25	50
Distance from wanted transmitting station (km)	300	440	600	800

\* From CCIR Recommendation 368, Annex I, Fig. 1 (Ground wave propagation curves over sea water).

5.2 The probability of interference to a wanted DSC signal thus depends significantly on the relative distance between the receiving station and the wanted and unwanted transmitting stations. However from Table I it can be seen that, providing the unwanted station is located at least 5 km from the receiving station, then the wanted signal can be received with no adverse interference from a transmitting station at least 300 km away.

5.3 The probability of interference being caused by simultaneous transmissions on adjacent channels occurring when the unwanted station is closer than 5 km, is considered to be far lower than the probability of two ship stations transmitting simultaneously on the same DSC frequency and can thus be ignored.

## 6. Conclusions

Table I in conjunction with the test figures obtained for the  $W/U$  ratio in Fig. 1 indicate that for normally expected transmitter powers a channel spacing of 3 kHz should not cause loss of calls except in extremely unlikely circumstances.