



**Recommendation ITU-R F.1565**  
**(05/2002)**

**Performance degradation due to interference from other services sharing the same frequency bands on a co-primary basis with real digital fixed wireless systems used in the international and national portions of a 27 500 km hypothetical reference path at or above the primary rate**

**F Series**  
**Fixed service**

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*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 F.1565\*

**Performance degradation due to interference from other services sharing the same frequency bands on a co-primary basis with real digital fixed wireless systems used in the international and national portions of a 27 500 km hypothetical reference path at or above the primary rate**

(2002)

**Scope**

This Recommendation specifies performance degradation due to interference from other services sharing the same frequency bands on a co-primary basis with real digital fixed wireless systems used in the international and national portions of a 27 500 km hypothetical reference path at or above the primary rate. These performance degradations are defined, for each direction of real fixed wireless links, for synchronous digital hierarchy (SDH) systems designed according to ITU-T Recommendation G.828, or for other systems designed according to ITU-T Recommendation G.826.

The ITU-R Radiocommunication Assembly,

*considering*

a) that there is a need to establish the allowable aggregate performance degradation due to interference from other co-primary services sharing the same bands with real fixed wireless systems (FWS) links in the international and national portions of a hypothetical reference path (HRP) defined in ITU-T Recommendations G.826 and G.828,

*noting*

a) that Recommendation ITU-R F.1668, based on ITU-T Recommendations G.826 and G.828, specifies error performance objectives for real digital fixed wireless links which may form part of the international and national portion of a 27 500 km hypothetical reference paths (HRP) and hypothetical reference connections (HRC),

*recommends*

**1** that, in each direction of any real digital FWS link of length  $L_{link}$ , in the international portion of an HRP at or above the primary rate, the allowable degradation in performance resulting from the aggregate of the emissions from systems of other services should not exceed the limits given by means of equation (1) in any month, using the values in Tables 1a and 1b for synchronous digital hierarchy (SDH) systems designed according to ITU-T Recommendation G.828 and values in Tables 2a and 2b for other systems designed according to ITU-T Recommendation G.826 (see Notes 1, 2, 3, 4, 10 and 11);

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\* Study Group 5 made editorial amendments to this Recommendation (on 7-8 December 2009) in accordance with Resolution ITU-R 1.

$$\text{Degradation in EPO due to interference} = B_j \times (L_{link}/L_R) + C_j \quad (1)$$

where:

$j = 1$	for $L_{min} \leq L_{link} \leq 1\,000$ km	(intermediate country)
$j = 2$	for $1\,000$ km $< L_{link}$	(intermediate country)
$j = 3$	for $L_{min} \leq L_{link} \leq 500$ km	(terminating country)
$j = 4$	for $500$ km $< L_{link}$	(terminating country)

EPO (error performance objective) is substituted by the parameters errored second ratio (ESR), severely errored second ratio (SESR) and background block error ratio (BBER) as appropriate.

$L_{min}$ : lower limit of  $L_{link}$ , used to scale the objectives to the real case, provisionally equal to 50 km

$L_R$ : reference length,  $L_R = 2\,500$  km

$B_R$ : block allowance ratio,  $B_R = (0 < B_R \leq 1)$ ;

TABLE 1a

**Parameters for the objectives for degradation of performance due to interference for intermediate countries according to ITU-T Recommendation G.828**

Parameter	Bit rate (kbit/s)	$L_{min} \leq L_{link} \leq 1\,000$ km		$1\,000$ km $< L_{link}$	
		$B_1$	$C_1$	$B_2$	$C_2$
ESR	1 664	$5 \times 10^{-5} (1 + B_R)$	0	$5 \times 10^{-5}$	$2 \times 10^{-5} \times B_R$
ESR	2 240	$5 \times 10^{-5} (1 + B_R)$	0	$5 \times 10^{-5}$	$2 \times 10^{-5} \times B_R$
ESR	6 848	$5 \times 10^{-5} (1 + B_R)$	0	$5 \times 10^{-5}$	$2 \times 10^{-5} \times B_R$
ESR	48 960	$1 \times 10^{-4} (1 + B_R)$	0	$1 \times 10^{-4}$	$4 \times 10^{-5} \times B_R$
ESR	150 336	$2 \times 10^{-4} (1 + B_R)$	0	$2 \times 10^{-4}$	$8 \times 10^{-5} \times B_R$
SESR	1 664-150 336	$1 \times 10^{-5} (1 + B_R)$	0	$1 \times 10^{-5}$	$4 \times 10^{-6} \times B_R$
BBER	1 664-48 960	$2.5 \times 10^{-7} (1 + B_R)$	0	$2.5 \times 10^{-7}$	$1 \times 10^{-7} \times B_R$
BBER	150 336	$5 \times 10^{-7} (1 + B_R)$	0	$5 \times 10^{-7}$	$2 \times 10^{-7} \times B_R$

TABLE 1b

**Parameters for the objectives for degradation of performance due to interference for terminating countries according to ITU-T Recommendation G.828**

Parameter	Bit rate (kbit/s)	$L_{min} \leq L_{link} \leq 500$ km		$500$ km $< L_{link}$	
		$B_3$	$C_3$	$B_4$	$C_4$
ESR	1 664	$5 \times 10^{-5} (1 + B_R)$	0	$5 \times 10^{-5}$	$1 \times 10^{-5} \times B_R$
ESR	2 240	$5 \times 10^{-5} (1 + B_R)$	0	$5 \times 10^{-5}$	$1 \times 10^{-5} \times B_R$
ESR	6 848	$5 \times 10^{-5} (1 + B_R)$	0	$5 \times 10^{-5}$	$1 \times 10^{-5} \times B_R$
ESR	48 960	$1 \times 10^{-4} (1 + B_R)$	0	$1 \times 10^{-4}$	$2 \times 10^{-5} \times B_R$
ESR	150 336	$2 \times 10^{-4} (1 + B_R)$	0	$2 \times 10^{-4}$	$4 \times 10^{-5} \times B_R$
SESR	1 664-150 336	$1 \times 10^{-5} (1 + B_R)$	0	$1 \times 10^{-5}$	$2 \times 10^{-6} \times B_R$
BBER	1 664-48 960	$2.5 \times 10^{-7} (1 + B_R)$	0	$2.5 \times 10^{-7}$	$5 \times 10^{-8} \times B_R$
BBER	150 336	$5 \times 10^{-7} (1 + B_R)$	0	$5 \times 10^{-7}$	$1 \times 10^{-7} \times B_R$

TABLE 2a

Parameters for the objectives for degradation of performance due to interference for intermediate countries according to ITU-T Recommendation G.826

Parameter	Bit rate (Mbit/s)	$L_{min} \leq L_{link} \leq 1\ 000$ km		$1\ 000$ km $< L_{link}$	
		$B_1$	$C_1$	$B_2$	$C_2$
ESR	1.5-5	$2 \times 10^{-4} (1 + B_R)$	0	$2 \times 10^{-4}$	$8 \times 10^{-5} \times B_R$
ESR	> 5-15	$2.5 \times 10^{-4} (1 + B_R)$	0	$2.5 \times 10^{-4}$	$1 \times 10^{-4} \times B_R$
ESR	> 15-55	$3.75 \times 10^{-4} (1 + B_R)$	0	$3.75 \times 10^{-4}$	$1.5 \times 10^{-4} \times B_R$
ESR	> 55-160	$8 \times 10^{-4} (1 + B_R)$	0	$8 \times 10^{-4}$	$3.2 \times 10^{-4} \times B_R$
ESR	> 160-3 500	Under study	Under study	Under study	Under study
SESR	1.5-3 500	$1 \times 10^{-5} (1 + B_R)$	0	$1 \times 10^{-5}$	$4 \times 10^{-6} \times B_R$
BBER (see Note 6)	1.5-3 500	$1 \times 10^{-6} (1 + B_R)$	0	$1 \times 10^{-6}$	$4 \times 10^{-7} \times B_R$

TABLE 2b

Parameters for the objectives for degradation of performance due to interference for terminating countries according to ITU-T Recommendation G.826

Parameter	Bit rate (Mbit/s)	$L_{min} \leq L_{link} \leq 500$ km		$500$ km $< L_{link}$	
		$B_3$	$C_3$	$B_4$	$C_4$
ESR	1.5-5	$2 \times 10^{-4} (1 + B_R)$	0	$2 \times 10^{-4}$	$4 \times 10^{-5} \times B_R$
ESR	> 5-15	$2.5 \times 10^{-4} (1 + B_R)$	0	$2.5 \times 10^{-4}$	$5 \times 10^{-5} \times B_R$
ESR	> 15-55	$3.75 \times 10^{-4} (1 + B_R)$	0	$3.75 \times 10^{-4}$	$7.5 \times 10^{-5} \times B_R$
ESR	> 55-160	$8 \times 10^{-4} (1 + B_R)$	0	$8 \times 10^{-4}$	$1.6 \times 10^{-4} \times B_R$
ESR	> 160-3 500	Under study	Under study	Under study	Under study
SESR	1.5-3 500	$1 \times 10^{-5} (1 + B_R)$	0	$1 \times 10^{-5}$	$2 \times 10^{-6} \times B_R$
BBER (see Note 6)	1.5-3 500	$1 \times 10^{-6} (1 + B_R)$	0	$1 \times 10^{-6}$	$2 \times 10^{-7} \times B_R$

2 that, in each direction of any real digital FWS link of length  $L_{link}$  belonging to the long-haul inter-exchange network section of the national portion of an HRP at or above the primary rate, the allowable degradation in performance resulting from the aggregate of the emissions from systems of other services should not exceed in any month, the provisional limits given in Table 3a for SDH systems designed according to ITU-T Recommendation G.828 and in Table 3b for other systems designed according to ITU-T Recommendation G.826 (see Notes 1, 2, 3, 4, 10 and 11);

TABLE 3a

**Objectives for degradation of performance due to interference for real SDH FWS links belonging to the long-haul inter-exchange network section of the national portion of the HRP according to ITU-T Recommendation G.828**

<b>Rate (Mbit/s)</b>	1.664 (VC-11, TC-11)	2.240 (VC-12, TC-12)	6.848 (VC-2, TC-2)	48.960 (VC-3, TC-3)	150.336 (VC-4, TC-4)
<b>Parameter</b>					
ESR	$0.001 \times A$	$0.001 \times A$	$0.001 \times A$	$0.002 \times A$	$0.004 \times A$
SESR	$0.0002 \times A$				
BBER	$5 \times 10^{-6} \times A$				$1 \times 10^{-5} \times A$

TABLE 3b

**Objectives for degradation of performance due to interference for real FWS links belonging to the long-haul inter-exchange network section of the national portion of the HRP at or above the primary rate according to ITU-T Recommendation G.826**

<b>Rate (Mbit/s)</b>	1.5 to 5	> 5 to 15	> 15 to 55	> 55 to 160	> 160 to 3 500
<b>Parameter</b>					
ESR	$0.004 A$	$0.005 A$	$0.0075 A$	$0.016 A$	For further study
SESR	$0.0002 A$	$0.0002 A$	$0.0002 A$	$0.0002 A$	$0.0002 A$
BBER	$2 A \times 10^{-5}$ (see Note 5)	$2 A \times 10^{-5}$	$2 A \times 10^{-5}$	$2 A \times 10^{-5}$	$1 A \times 10^{-5}$

where:

$$A = (A_1 + 0.002) L_{link}/100 \quad \text{for } 50 \text{ km} \leq L_{link} \leq 100 \text{ km}$$

$$A = A_1 + 2 \times 10^{-5} L_{link} \quad \text{for } 100 \text{ km} < L_{link}$$

$A_1$  has provisionally been agreed to be in the range of 0.01 to 0.02 (1% to 2%) (see Notes 7 and 9);

**3** that, in each direction of any real digital FWS link of length  $L_{link}$  forming all of the short-haul inter-exchange network section of the national portion of HRP, the allowable degradation in performance resulting from the aggregate of the emissions from systems of other services should not exceed in any month, the provisional limits given in Table 4a for SDH systems designed according to ITU-T Recommendation G.828 and in Table 4b for other systems designed according to ITU-T Recommendation G.826 (see Notes 1, 2, 3, 4, 10 and 11).

TABLE 4a

**Objectives for degradation of performance due to interference for real SDH FWS links forming all of the short-haul inter-exchange network section of the national portion of the HRP according to ITU-T Recommendation G.828**

<b>Rate (Mbit/s)</b>	1.664 (VC-11, TC-11)	2.240 (VC-12, TC-12)	6.848 (VC-2, TC-2)	48.960 (VC-3, TC-3)	150.336 (VC-4, TC-4)
<b>Parameter</b>					
ESR	$0.001 \times B$	$0.001 \times B$	$0.001 \times B$	$0.002 \times B$	$0.004 \times B$
SESR	$0.0002 \times B$				
BBER	$5 \times 10^{-6} \times B$				$1 \times 10^{-5} \times B$

TABLE 4b

**Objectives for degradation of performance due to interference for real FWS links forming all of the short-haul inter-exchange network section of the national portion of the HRP at or above the primary rate according to ITU-T Recommendation G.826**

<b>Rate (Mbit/s)</b>	1.5 to 5	> 5 to 15	> 15 to 55	> 55 to 160	> 160 to 3 500
<b>Parameter</b>					
ESR	$0.004 B$	$0.005 B$	$0.0075 B$	$0.016 B$	For further study
SESR	$0.0002 B$	$0.0002 B$	$0.0002 B$	$0.0002 B$	$0.0002 B$
BBER	$2 B \times 10^{-5}$ (see Note 5)	$2 B \times 10^{-5}$	$2 B \times 10^{-5}$	$2 B \times 10^{-5}$	$1 B \times 10^{-5}$

The value of  $B$  has provisionally been agreed to be in the range of 0.075 to 0.085 (7.5% to 8.5%) (see Notes 7, 8 and 9);

4 that, in each direction of any real digital FWS link of length  $L_{link}$  forming all of the access network section of the national portion of HRP, the allowable degradation in performance resulting from the aggregate of the emissions from systems of other services should not exceed in any month, the provisional limits given in Table 5a for SDH systems designed according to ITU-T Recommendation G.828 and in Table 5b for other systems designed according to ITU-T Recommendation G.826 (see Notes 1, 2, 3, 4, 10 and 11).

TABLE 5a

**Objectives for degradation of performance due to interference for real SDH FWS links forming all of the access network section of the national portion of the HRP according to ITU-T Recommendation G.828**

<b>Rate (Mbit/s)</b>	1.664 (VC-11, TC-11)	2.240 (VC-12, TC-12)	6.848 (VC-2, TC-2)	48.960 (VC-3, TC-3)	150.336 (VC-4, TC-4)
<b>Parameter</b>					
ESR	$0.001 \times C$	$0.001 \times C$	$0.001 \times C$	$0.002 \times C$	$0.004 \times C$
SESR	$0.0002 \times C$				
BBER	$5 \times 10^{-6} \times C$				$1 \times 10^{-5} \times C$

TABLE 5b

**Objectives for degradation of performance due to interference for real FWS links forming all of the access network section of the national portion of the HRP at or above the primary rate according to ITU-T Recommendation G.826**

Rate (Mbit/s)	1.5 to 5	> 5 to 15	> 15 to 55	> 55 to 160	> 160 to 3 500
<b>Parameter</b>					
ESR	0.004 <i>C</i>	0.005 <i>C</i>	0.0075 <i>C</i>	0.016 <i>C</i>	For further study
SESR	0.0002 <i>C</i>	0.0002 <i>C</i>	0.0002 <i>C</i>	0.0002 <i>C</i>	0.0002 <i>C</i>
BBER	$2 C \times 10^{-5}$ (see Note 5)	$2 C \times 10^{-5}$	$2 C \times 10^{-5}$	$2 C \times 10^{-5}$	$1 C \times 10^{-5}$

The value of *C* has provisionally been agreed to be in the range of 0.075 to 0.085 (7.5% to 8.5%) (see Notes 7, 8 and 9);

**5** that for the error performance objectives evaluation in *recommends* 1 to 4, the error performance parameters for any real link are defined as follows:

- ESR is the ratio of errored second (ES) events to total seconds in the available time during a fixed measurement interval;
- SESR is the ratio of severely errored second (SES) events to total seconds in the available time during a fixed measurement interval;
- BBER is the ratio of background block error (BBE) events to total blocks in the available time during a fixed measurement interval. The count of total blocks excludes all blocks during SESs;

**6** that Annex 1 be used as guidance in the application of this Recommendation.

NOTE 1 – The SES, BBE and ES events and the block structure for SDH multiplex and regenerator sections are defined in ITU-T Recommendation G.829; the SES, BBE and ES events and the block structure for paths are defined in ITU-T Recommendations G.826 and G.828.

NOTE 2 – A real link is defined as a portion of a path coming from partitioning and it is characterized by its real length,  $L_{link}$ .

NOTE 3 – The error performance objectives apply only when the link is considered to be available. The entry and exit criteria into and from the unavailable state are defined in ITU-T Recommendations G.826 and G.828.

NOTE 4 – According to ITU-T Recommendations G.826 and G.828 the suggested evaluation period is one month for any parameter. In FWS links these objectives should be respected for any month (see Recommendation ITU-R P.581).

NOTE 5 – For systems installed based on designs prior to 1996, the BBER interference objective is  $3 \times 10^{-5} \times A$  (or *B* or *C* accordingly).

NOTE 6 – For systems with bit rates of 1.5 to 5 Mbit/s designed prior to 1996, the BBER values in Tables 2a and 2b should be multiplied by a factor of 1.5.



NOTE 7 – The sum of the percentages  $A_1\% + B\% + C\%$  shall not exceed 17.5%, in accordance with the allocations to the national portion of an international constant bit rate path given in ITU-T Recommendations G.826 and G.828.

NOTE 8 – The provisional values agreed for  $B\% + C\%$  are in the range 15.5% to 16.5%.

NOTE 9 – Depending on national network configurations administrations may reallocate the  $A\%$ ,  $B\%$  and  $C\%$  block allowances among the sections of the national portion of a radio path.

NOTE 10 – In the case of multihop links the objectives derived according to this Recommendation apply to the overall links (irrespective of the date when each hop was brought into service and of the number of independent operators involved); the allocation of the objectives to each hop is under the responsibility of the network operators.

NOTE 11 – The limits on allowable interference from space services apply to the aggregate effect of emissions from space stations, direct long-term emissions from earth stations and interference due to the anomalous propagation of emissions from earth stations.

## Annex 1

### Application examples

This Annex shows some examples of the application of this Recommendation to real links, in order to derive the objectives.

The calculations in the first two examples are made for ESR, SESR and BBER for a link in the international portion of a HRP with length,  $L_{link}$ , of 105 km.

Furthermore:

- An intermediate country is assumed.
- $B_R$  is assumed to be equal to 1.
- The evaluation time is one month (30 days).

*Example 1:*

Bit rate: 150 336 kbit/s (VC-4, TC-4), i.e. objectives according to ITU-T Recommendation G.828.

Number of blocks/s: 8 000

The objectives are calculated from equation (1) and with  $B_1$  and  $C_1$  from Table 1a.

$ESR = 2 \times 10^{-4} (1 + 1) \times 105/2\,500 + 0 = 168 \times 10^{-7}$	Number of ES/month = 44
$SESR = 1 \times 10^{-5} (1 + 1) \times 105/2\,500 + 0 = 84 \times 10^{-8}$	Number of SES/month = 3
$BBER = 5 \times 10^{-7} (1 + 1) \times 105/2\,500 + 0 = 4.2 \times 10^{-8}$	Number of BBE/month = 871

*Example 2:*

Bit rate: 140 Mbit/s, i.e. objectives according to ITU-T Recommendation G.826.

Number of blocks/s: 8 000

The objectives are calculated from equation (1) and with  $B_1$  and  $C_1$  from Table 2a.

$$\text{ESR} = 8 \times 10^{-4} (1 + 1) \times 105/2\,500 + 0 = 672 \times 10^{-7}$$

$$\text{Number of ES/month} = 175$$

$$\text{SESR} = 1 \times 10^{-5} (1 + 1) \times 105/2\,500 + 0 = 84 \times 10^{-8}$$

$$\text{Number of SES/month} = 3$$

$$\text{BBER} = 1 \times 10^{-6} (1 + 1) \times 105/2\,500 + 0 = 8.4 \times 10^{-8}$$

$$\text{Number of BBE/month} = 1\,742$$

The calculations in the next two examples are made for ESR, SESR and BBER for links in the national portion of an HRP (objectives according to ITU-T Recommendation G.826).

*Example 3:*

The access portion of the network is 20 km long and it is formed by a single link:

Link  $L_3 = 20$  km

Capacity: 2 Mbit/s

Number of blocks/s: 2 000

In this case the objectives are length independent; if  $C = 0.075$  is assumed (see *recommends 4*) we have:

$$\text{ESR} = 0.004 C = 3 \times 10^{-4} \text{ (equivalent to 778 ES/month)}$$

$$\text{SESR} = 0.0002 C = 1.5 \times 10^{-5} \text{ (equivalent to 39 SES/month)}$$

$$\text{BBER} = 2 \times 10^{-5} \times C = 1.5 \times 10^{-6} \text{ (equivalent to 7776 EB/month)}$$

EB: errored block.

*Example 4:*

The short haul portion of the network is 80 km long and it is formed by a single link:

Link  $L_4 = 80$  km

Capacity: 34 Mbit/s

Number of blocks/s: 8 000

In this case the objectives are length independent; if  $B = 0.075$  is assumed (see *recommends 3*) we have:

$$\text{ESR} = 0.0075 B = 5.625 \times 10^{-4} \text{ (equivalent to 1 458 ES/month)}$$

$$\text{SESR} = 0.0002 B = 1.5 \times 10^{-5} \text{ (equivalent to 39 SES/month)}$$

$$\text{BBER} = 2 \times 10^{-5} \times B = 1.5 \times 10^{-6} \text{ (equivalent to 31 104 EB/month)}$$

*Example 5:*

Real link in long-haul portion of the network, designed according to ITU-T Recommendation G.828:

Link  $L_5 = 75$  km

SDH transmission rate: VC-4 (150.336 Mbit/s)

Number of blocks/s: 8 000

$$ESR = 0.004 A = 0.004 (A_1 + 0.002) \times 75/100$$

$$SESR = 2 \times 10^{-4} \times A = 2 \times 10^{-4} \times (A_1 + 0.002) \times 75/100$$

$$BBER = 1 \times 10^{-5} \times A = 1 \times 10^{-5} \times (A_1 + 0.002) \times 75/100$$

In this case the objectives are length dependent; in Table 6 the minimum and the maximum limits ( $A_1 = 0.01$  and  $A_1 = 0.02$ ) are shown:

TABLE 6  
Values for the objectives

$A_1$ value	ESR	SESR	BBER
0.01	$36 \times 10^{-6}$ (= 94 ES/month)	$18 \times 10^{-7}$ (= 5 SES/month)	$9 \times 10^{-8}$ (= 1 867 EB/month)
0.02	$66 \times 10^{-6}$ (= 171 ES/month)	$33 \times 10^{-7}$ (= 9 SES/month)	$165 \times 10^{-8}$ (= 3 422 EB/month)

NOTE 1 – Rounding to immediately superior integer has been used for fractional results.

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