REPORT ITU-R F.2108

Fixed service system parameters for different frequency bands

(2007)

1 Introduction

There is a large variety of fixed-wireless systems in operation or being developed to meet future requirements. This Report provides details of the key radio system characteristics and parameters for systems in the fixed service (FS).

2 Transmitter characterization

The basic transmitter parameters are:

– carrier frequency;
– spectral characteristics;
– equivalent isotropically radiated power (e.i.r.p.);
– antenna radiation pattern.

Operating frequencies normally correspond to radio-frequency channel arrangements specified in ITU-R Recommendations. The modulation type and system capacity will give a guide to the spectral characteristics of the emissions. The e.i.r.p. of the transmitter is calculated from the transmitter power, feeder/multiplexer losses and antenna gain. A maximum e.i.r.p. value would correspond to maximum antenna gain, minimum feeder/multiplexer losses and maximum transmitter output power.

In cases where measured patterns are not available, the reference radiation patterns addressed in the following Recommendations should be used:

– Recommendations ITU-R F.699 – Reference radiation patterns for fixed wireless system antennas for use in coordination studies and interference assessment in the frequency range from 100 MHz to about 70 GHz.
– Recommendation ITU-R F.1245 – Mathematical model of average radiation patterns for line-of-sight point-to-point radio-relay system antennas for use in certain coordination studies and interference assessment in the frequency range from 1 GHz to about 70 GHz.
– Recommendation ITU-R F.1336 – Reference radiation patterns of omnidirectional, sectoral and other antennas in point-to-multipoint systems for use in sharing studies in the frequency range from 1 GHz to about 70 GHz.

3 Receiver characterization

Assessment of the effects of interference into the FS from other services requires knowledge of the performance characteristics of the radio receiver. The following receiver parameters are important for frequency sharing studies:

– noise figure;
– IF bandwidth;
– receiver thermal noise;

– received signal power for 1×10^{-3}, 1×10^{-6}, 1×10^{-10} BER (post-error-correction for digital systems);

– nominal receiver input level.

The received signal levels and interference levels could be referenced to the low noise amplifier (LNA)/mixer input of the receiver, so that they would be independent of receive antenna gain and feeder/multiplexer losses (assuming this to be the same for both transmitter/receiver).

The required signal levels for given BERs could be combined with the calculated receiver thermal noise level to obtain the required carrier-to-thermal noise ratio, *C*/*N*, for a given BER.

4 Tables of system parameters

Tables 1 to 38 show selected examples of digital FS systems parameters that are in use in some of the bands in which the FS systems are operating. Similar information on analogue systems can be found in Tables 39 to 46. The various radio system types are identified in the Tables by modulation type and system capacity.

The nominal long-term interference criteria specified in the Tables provide some guidance to the results that would be obtained from detailed calculations and can be used for information for the time being. For detailed sharing studies accurate criteria must be derived in accordance with the principles in Recommendation ITU-R F.758, and these may differ slightly, in some cases, from those in the Table.

It is most important that the following Notes be taken into account when considering the example Tables.

NOTE 1 – Typically, the carrier level corresponding to 1×10^{-6} BER is around 4 dB higher than that for 1×10^{-3} BER; the carrier level difference between the 1×10^{-6} and 1×10^{-10} BER points is also about 4 dB. For radio equipment using forward error correction (FEC), the carrier level corresponding to 1×10^{-6} BER is 1 to 2 dB higher than that for 1×10^{-3} BER; the carrier difference between 1×10^{-6} and 1×10^{-10} is also 1 to 2 dB.

NOTE 2 – In the example Tables a straightforward, but conservative, approach to specifying maximum permitted long-term external interference is used. This was done because the characteristics and spatial distribution of the interference sources are undefined, and it is also impractical to attempt detailed performance and availability predictions for such a large number of systems.

By referencing interference to the receiver thermal noise level the problem is greatly simplified, since the permitted interference PSD so derived will be dependent solely on receiver noise figure and independent of the modulation scheme of the victim system. It may be shown that, independent of the normal received carrier level, the degradation in fade margin with interference set to a given level relative to receiver thermal noise level is as follows:

Interference level relative to receiver thermal noise (dB)	**Resultant degradation in fade margin (dB)**
–6	1
–10	0.5

Within the Tables, the choice of an interference to thermal noise *I*/*N* value of –6 dB or –10 dB is selected to match the typical requirements of individual systems. For detailed sharing analyses, the interference criteria must be derived in accordance with the principles in Recommendation ITU-R F.758, to match the individual, specific, sharing scenario under consideration, and will need to be agreed between the parties concerned.

Another approach stated in Note(3) in some of the later Tables can be applied, conforming to the method given in 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.

NOTE 3 – Short-term interference criteria have not been included in the example Tables. This information must be derived in accordance with the principles derived in Annex 1 to Recommendation ITU-R F.758. The Tables may be updated when this information becomes available, as a result of future detailed studies of sharing with specific services.

NOTE 4 – In Tables 1 to 46, the antenna gain is expressed only in terms of maximum gain. However, in certain frequency sharing scenarios, the minimum gain or other parameters (such as side-lobe and back-lobe gain) of the antenna may be more relevant. Annex 2 to this Report gives information about typical minimum antenna gains.

TABLE 1

Digital P-P FS system parameters in the frequency bands below 1 GHz

Frequency band (MHz)	340-470			406.1-450						610-960
Modulation	GMSK	GMSK	GMSK	DQPSK	DQPSK	16-QAM	16-QAM	32-QAM	32-QAM	2-FSK and others
Capacity (Mbit/s)	5 × 32 kbit/s	5 × 32 kbit/s	5 × 32 kbit/s	0.32	4	2	8	0.768	8	1.024; 30 channels (it can use lower data rates).
Channel spacing (MHz)	0.6	0.6	0.6	0.25	3.5	1.75	3.5	0.20	1.75	0.75
	Base station	Base station	Out station							
Antenna gain (maximum) (dBi)	7	12	6	25	25	25	25	25	25	16
Feeder/multiplexer loss (minimum) (dB)	4.4	4.4	2.2	2	2	2	2	2	2	1
Antenna type	Omni	Sectoral	Panel	Yagi	Yagi	Yagi	Yagi	Yagi	Yagi	Square reflector
Maximum Tx output power (dBW)	6	6	6	7	7	10	10	0	0	7 dBW (typical: 0 dBW)
e.i.r.p. (maximum) (dBW)	8.6	13.6	9.8	30	30	33	33	23	23	22 dBW (typical: 15 dBW)
Receiver IF bandwidth (MHz)	0.6	0.6	0.6	0.3	3.14	3.5	3.5	0.15	1.67	0.75
Receiver noise figure (dB)	4	4	4	5	5	3	3	3.5	3.5	7
Receiver thermal noise (dBW)	–146.5	–146.5	–146.5	–144	–134	–143	–137	–148.7	–138.3	–138
Nominal Rx input level (dBW)	–100	–100	–100							–100
Rx input level for 1×10^{-3} BER (dBW)	–117	–117	–117	–131	–121	–122	–116	–127	–117	–124
Nominal long-term interference (dBW)	–152.5	–152.5	–152.5	–154	–144	–153	–147	–157	–147	
Equivalent power (dB(W/4 kHz))	–174.3	–174.3	–174.3	–173	–173	–175	–175	–173	–173	
Spectral density (dB(W/MHz))	–150.3	–150.3	–150.3	–149	–149	–151	–151	–149	–149	
Refer to Notes										

DQPSK: Differentially coherent quaternary phase shift keying

GMSK: Gaussian minimum shift keying

TABLE 2

Digital P-P FS system parameters in the FS frequency bands below 1 GHz

Frequency band (GHz)	0.81-0.96					
Modulation	7-FSK	4-QAM	16-QAM	7-FSK	4-QAM	16-QAM
Capacity (Mbit/s)	64 kbit/s	64 kbit/s	128 kbit/s	256 kbit/s	256 kbit/s	512 kbit/s
Channel spacing (kHz)	50	50	50	200	200	200
Antenna gain (maximum) (dBi)	24	24	24	24	24	24
Feeder/multiplexer loss (minimum) (dB)	3	3	3	3	3	3
Antenna type	Grid	Grid	Grid	Grid	Grid	Grid
Maximum Tx output power (dBW)	7	7	7	7	7	7
e.i.r.p. (maximum) (dBW)	31	31	31	31	31	31
Receiver IF bandwidth (kHz)	50	50	50	200	200	200
Receiver noise figure (dB)	5	5	5	5	5	5
Receiver thermal noise (dBW)	–152	–152	–152	–146	–146	–146
Nominal Rx input level (dBW)	–90	–90	–90	–90	–90	–90
Rx input level for 1×10^{-3} BER (dBW)	–123	–135	–130	–117	–129	–124
Nominal long-term interference (dBW)	–153	–165	–160	–147	–159	–154
Equivalent power (dB(W/4 kHz))	–164	–176	–171	–164	–176	–171
Spectral density (dB(W/MHz))	–140	–152	–147	–140	–152	–147
Refer to Notes						

TABLE 3

Digital P-P FS system parameters in the FS frequency bands below 1 GHz

Frequency band (GHz)	0.81-0.96		
Modulation	PSK	4 PSK	FSK
Capacity	1 channel	2	Data
Channel spacing	25 kHz	2	12.5 kHz
Antenna gain (maximum) (dBi)	10	8-26	10
Feeder/multiplexer loss (minimum) (dB)	0	5	0
Antenna type	Yagi	Yagi/ Dish	Yagi
Maximum Tx output power (dBW)	7	0	7
e.i.r.p. (maximum) (dBW)	17	21	17
Receiver IF bandwidth (kHz)	25	1.5	12.5
Receiver noise figure (dB)	5	7	5
Receiver thermal noise (dBW)	–155	–135	–158
Nominal Rx input level (dBW)	–	–79	–
Rx input level for $1 \times 10–3$ BER (dBW)	–	–119	–
Nominal long-term interference (dBW)	–	–	–
Equivalent power (dB(W/4 kHz))	–	–	–
Spectral density (dB(W/MHz))	–	–	–
Refer to Notes	–	–	–

TABLE 4

Digital P-P FS system parameters in the FS frequency bands between 1 and 3 GHz

Frequency band (GHz)	1.4	1.45-1.53										
Modulation	4 PSK	PSK 4-PSK	4-PSK	4-PSK	16-QAM	4-PSK	PCM	MSK	4-PSK	4-PSK	4-PSK	4-PSK
Capacity	2	704 kbit/s 2 Mbit/s	9.6 kbit/s	64 kbit/s	64 kbit/s	144 kbit/s	–	2 Mbit/s	2 × 2 Mbit/s	2 × 2 Mbit/s	4 × 2 Mbit/s	2 × 2 Mbit/s
Channel spacing (MHz)	2	1	0.025	0.075	0.0375	0.225	0.5	2	2	3.5	7	4
Antenna gain (maximum) (dBi)	8-26	33	33	33	33	33	33	16	16	28	28	16
Feeder/multiplexer loss (minimum) (dB)	5	1	1	1	1	1	1	5	3	T:3/R:6	T:3/R:6	5
Antenna type	Yagi/ Dish	Dish	Yagi/ dish	Yagi/ dish	Yagi/ dish	Yagi/ dish	Yagi/ dish		Yagi	Dish	Dish	Yagi
Maximum Tx output power (dBW)	0	7	7	7	7	7	10	7	7	6	6	7
e.i.r.p. (maximum) (dBW)	21	39	39	39	39	39	42	20	20	31	31	20
Receiver IF bandwidth (MHz)	1.5	0.7	0.005	0.032	0.016	0.072	0.35	1.2	1.2	3.5	7	3
Receiver noise figure (dB)	7	4.5	4	4	4	4	8	4	4	4	4	4
Receiver thermal noise (dBW)	–135	–141	–163	–155	–158	–151	–141	–139	–139	–135	–132	–135
Nominal Rx input level (dBW)	–79	–90	–118	–112	–103.5	–106	–90	–86	–84	–136	–133	–83
Rx input level for 1 × 10–3 BER (dBW)	–119	–120	–143	–137	–128.5	–131	–	–126	–124	–124.3	–121.3	–123
Nominal long-term interference (dBW)		–151	–173	–167	–168	–161	–151	–145	–145	–146	–143	–141
Equivalent power (dB(W/4 kHz))		–	–	–	–	–	–			–173.6	–179.4	
Spectral density (dB(W/MHz))		–149	–150	–152	–150	–150	–146	–146	–146	–149.7	–155.4	–146
Refer to Notes		(2), (4)	(2), (4)	(2), (4)	(2), (4)	(2), (4)	(2), (4)		(1), (4)			(1), (4)

(1) Specified interference will reduce system *C*/*N* by 1 dB (interference 6 dB below receiver thermal noise floor).

(2) Specified interference will reduce system *C*/*N* by 0.5 dB (interference 10 dB below receiver thermal noise floor).

(3) Specified interference will have a relative contribution of no more than 10% of total noise (Recommendation ITU-R F.1094).

(4) The specified interference level is total power within the receiver bandwidth.

TABLE 5

Digital P-P FS system parameters in the FS frequency bands between 1 and 3 GHz

Frequency band (GHz)	1.7-1.9		1.7-2.45 (refer also to Table 6)									
Modulation	4-PSK	4-PSK	4-PSK tropos.	4-PSK	4-PSK	4-PSK	4-PSK	4-PSK	9-QPR	O-QPSK	4-PSK	4-PSK
Capacity	2 × 2 Mbit/s	4 × 2 Mbit/s	2 Mbit/s	34 Mbit/s	8 Mbit/s	48 channels	12.6 Mbit/s	2 × 8 Mbit/s	4 × 1.54 Mbit/s	45 Mbit/s	8 Mbit/s	2 × 8 Mbit/s
Channel spacing (MHz)	14	14	Special	29	14	2.5	28	14	3.5	29	7	14
Antenna gain (maximum) (dBi)	28	28	45	31	30	29	30	28	32	33	28	28
Feeder/multiplexer loss (minimum) (dB)	T:3/R:6	T:3/R:6	2	1	3	6	3.5	4	3	3	5	5
Antenna type	2.4 m dish	2.4 m dish	9 m dish	1.8 m dish	1.2 m dish	Dish	Dish	2.4 m dish	3 m dish	3 m dish	1.8 m dish	1.8 m dish
Maximum Tx output power (dBW)	0	0	30	3	0	–9	–10	3	6	7	7	–3
e.i.r.p. (maximum) (dBW)	25	25	73	34	30	14	16.5	29	38	40	20	23
Receiver IF bandwidth (MHz)	3.5	7	1	20	4	1.5	6.5	8	3.5	29	3	4.6
Receiver noise figure (dB)	4	4	4	4	5	6	9	4	5	4	4	4
Receiver thermal noise (dBW)	–136	–133	–140	–127	–133	–	–	–131	–133	–125	–135	–133
Nominal Rx input level (dBW)			–	–73	–78	–78	–88.3		–70	–75	–83	–83
Rx input level for 1 × 10–3 BER (dBW)	–124.3	–121.3	–131	–113	–118	–	–		–117	–112	–123	–123
Nominal long-term interference (dBW)	–146	–143	–146	–137	–143			–137	–139	–135	–141	–139
Equivalent power (dB(W/4 kHz))	–173.6	–179.4	–	–	–			–170	–168	–174	–	–
Spectral density (dB(W/MHz))	–149.7	–155.4	–146	–150	–149	–		–146			–146	–146
Refer to Notes			(1), (4)	(2), (4)	(2), (4)	(3), (4)	(3), (4)	(1), (4)	(1)	(1)	(1)	(1)

(1) Specified interference will reduce system *C*/*N* by 1 dB (interference 6 dB below receiver thermal noise floor).

(2) Specified interference will reduce system *C*/*N* by 0.5 dB (interference 10 dB below receiver thermal noise floor).

(3) Specified interference will have a relative contribution of no more than 10% of total noise.

(4) The specified interference level is total power within the receiver bandwidth.

TABLE 6

Digital P-P FS system parameters in the FS frequency bands between 1 and 3 GHz

Frequency band (GHz)	1.7-2.45		2.1-2.2			2.45-2.69		
Modulation	64-QAM	256-QAM	32 TCM	64-QAM	256-QAM	MSK	4-PSK	4-PSK
Capacity	45 Mbit/s	18.5 Mbit/s	3.1 Mbit/s	6.2 Mbit/s	18.5 Mbit/s	2 □ 2 Mbit/s	34 Mbit/s	2.3 Mbit/s
Channel spacing (MHz)	10	3.5	0.8	1.6	3.5	14		
Antenna gain (maximum) (dBi)	33	33	38	38	38	25	35.4	
Feeder/multiplexer loss (minimum) (dB)	2	2	0	0	0	4		
Antenna type	Dish	Dish	Dish	Dish	Dish	1.2 m dish	3 m dish	Yagi
Maximum Tx output power (dBW)	1	–1	+2	+5	+2	5	–2	
e.i.r.p. (maximum) (dBW)	34	32	40	43	40	26	33	
Receiver IF bandwidth (MHz)	10	3.5	0.8	1.6	3.5	3		
Receiver noise figure (dB)	4	4	3	3	3	4		
Receiver thermal noise (dBW)	–130	–134.5	–142	–139	–136	–135		
Nominal Rx input level (dBW)	–65	–65	–60	–60	–60	–		
Rx input level for 1 × 10–3 BER (dBW)	–106	–104.5	–117	–115	–105	–		
Nominal long-term interference (dBW)	–136	–140.5	–152	–149	–146	–141	–111.5	
Equivalent power (dB(W/4 kHz))	–170	–170				–170		
Spectral density (dB(W/MHz))	–146	–146	–151	–151	–151	–162		
Refer to Notes			(2), (4)	(2), (4)	(2), (4)			

(2) Specified interference will reduce system *C*/*N* by 0.5 dB (interference 10 dB below receiver thermal noise floor).

(3) The specified interference level is total power within the receiver bandwidth.

TABLE 7

Digital P-MP FS system parameters in the FS frequency bands below 3 GHz*

System	150, 450, 800 MHz	890 to 960 MHz	1.5, 2.4 and 2.6 GHz		1.5 and 2.4 GHz	1.5 to 2.6 GHz	2 GHz
1 Channel capacity (typical) (kbit/s)	2 × 32 or 4 × 16	64 × 1.2	10 × 64	30 × 64	30 × 64	60 × 64	48 × 64
2 Aggregate bit rate (kbit/s)	26 × 64	240	832	2 304	2 432	4 864	3 088
3 Modulation method	16-DPSK	Offset 4-PSK	2-FSK	4-PSK	4-PSK	Offset 4-PSK	4-PSK
4 Central station (CS) antenna	Omnidirectional: gains up to 10 dBi or Yagi	Omni or wide beam: gain 10 dBi	Omnidirectional: gain 10 dBi Yagi: gain 16-21 dBi Horn: gain 13 dBi		Omni or wide beam: gain 10 dBi	Omni or wide beam: gain 10 dBi	(45°) wide beam: gain: see Fig. 4 of Report 1057 (ex CCIR, Düsseldorf, 1990)
5 Out-station (OS) antenna	Yagi: gain 10 dBi	Loop Yagi: gain 20 dBi	Yagi: gain 16-21 dBi Horn: gain 13 dBi		Yagi: gain 17 dBi at 1.5 GHz Parabolic: gain 22 dBi at 1.5 GHz gain 27 dBi at 2.4 GHz	Conical: gain 17 dBi	Parabolic ($\varphi \geq 1.2$ m)
6 Customer data rates (kbit/s)	Up to 1.2	1.2-64	64	1.2-19.2 64 144 (ISDN)	a) Up to 9.6 b) Standard: 64	2.4-64	64-1 544
7 Customer assignment	Fixed or demand assignment	Fixed assignment	Fixed or demand assignment		Fixed or demand assignment	Fixed or demand assignment	Fixed assignment
8 Operational range (km)	Up to 60	Up to 30	Up to 70		Up to 50	Up to 72	Up to 50
9 Equivalent power (dB(W/4 kHz))							
10 Spectral density (dB(W/MHz))							

* These parameters are from Recommendation ITU-R F.755 for TDMA systems below 3 GHz.

TABLE 8

Digital P-MP FS system parameters in the FS frequency bands below 3 GHz

Frequency band (GHz)	0.81-0.96			1.45-1.53				1.7-2.45		1.427-1.452/1.492-1.517				
Modulation	PSK	QAM	FSK	4-PSK		4-PSK		4-PSK		O-QPSK				
Capacity	24 channels	48 channels	Data			2 Mbit/s				60 × 64 kbit/s				
Channel spacing (MHz)	600 kHz	12.5 kHz	25-200 kHz	3.5		2		3.5		3.5				
	Base station	Base station	Base station	Central station	Out station	Central station	Out station	Central station	Out station	Central station/repeater			Out station	
Antenna gain (maximum) (dBi)	0	0	0	17	27	13	17.5	17	27	13	16	31	23.5	17
Feeder/multiplexer loss (dB)	0	0	0	0	0	4	4	0	0	4.4			2.5	
Antenna type	Omni	Omni	Omni	Omni/ section	Dish/ horn	Omni/ sectoral	Yagi/ horn	Omni/ section	Dish/ horn	Omni	Sectoral 180°	Dish (3 m)	Dish (1.2 m)	Panel
Maximum Tx output power (dBW)	30	30	20	7	7	0	0	7	7	5			5	
e.i.r.p. (maximum) (dBW)	30	30	20	24	34	6	16	24	34	13.6	16.6	31.6	26	19.5
Receiver IF bandwidth (MHz)	600	12.5	25-200	3.5	3.5	1.3	1.3	3.5	3.5	3.5			3.5	
Receiver noise figure (dB)	5	5	5	3.5	3.5	4	4	3.5	3.5					
Receiver thermal noise (dBW)	–158	–141	–155 to –146	–135	–135	–139	–139	–135	–135	–134			–134	
Nominal Rx input level (dBW)								–	–					
Rx input level for 1×10^{-3} BER (dBW)	–	–	–			–124	–124	–	–	–121			–121	
Nominal long-term interference (dBW)	–	–	–	–145	–145	–145	–145	–141	–141	–140			–140	
Equivalent power (dB(W/4 kHz))	–	–	–	–174	–174	–170	–170	–170	–170	–169.4			–169.4	
Spectral density (dB(W/MHz))	–	–	–					–	–	–145.4			–145.4	
Refer to Notes	–	–	–					(1)	(1)					

(1) Specified interference will reduce system *C*/*N* by 1 dB (interference 6 dB below receiver thermal noise floor).

TABLE 9

Digital P-P FS system parameters in the FS frequency bands between 3 and 10 GHz

Frequency band (GHz)	3.4-5.0		3.7-4.2			4.5-5.0			5.850-7.075		7.075-8.500		
Modulation	64-QAM	512-QAM	64-QAM			64-QAM			64-QAM		16-QAM	QPR	64-QAM
Capacity (Mbit/s)	90	311	45	90	135	45	90	135	45	135	45	90	135
Channel spacing (MHz)	20	40	10	20	30	10	20	30	10	30	20	40	30
Antenna gain (maximum) (dBi)	40	40	42	42	42	44	44	44	43	43	44	44	44
Feeder/multiplexer loss (minimum) (dB)	3	3	0	0	0	0	0	0	3	3	3	3	3
Antenna type	Horn/dish	Horn/dish	Dish	Dish	Dish	Dish	Dish	Dish	Dish	Dish	Dish	Dish	Dish
Maximum Tx output power (dBW)	–1	+7[2]	–1	–1	–1	+2	+2	+2	–1	+4	+3	+10	+3
e.i.r.p. (maximum) (dBW)	36	44[2]	41	41	41	46	46	46	39	44	44	51	44
Receiver thermal noise (dBW)	–128	–126	–131	–128	–126	–131	–128	–126	–130	–125	–124	–120	–125
Rx input level for 1×10^{-3} BER (dBW)	–104	–93	–108	–105	–102	–108	–105	–102	–103	–102	–105	–101	–100
Nominal long-term interference (I/N = –13 dB[1]) (dBW)	–141	–139	–141	–138	–136	–141	–138	–136	–143	–138	–137	–133	–138
Spectral density (dB(W/MHz))	–154	–155	–151	–151	–151	–151	–151	–151	–153	–153	–150	–149	–153

QPR: Quadrature partial response.

[1] Objective for FS systems employing space diversity.

[2] –7 dBW transmit power and +30 dBW e.i.r.p. without APC.

TABLE 10

Digital P-P FS system parameters for FS frequency sharing between 3 and 10 GHz

Frequency band (GHz)	3.7-4.2	3.7-4.2	4.4-5.0	4.4-5.0	5.9-6.4			5.925-6.425	5.925-6.425	6.425-7.11	
Modulation	RBQPSK	QPSK	16-QAM	64-QAM	64-QAM			RBQPSK	64-QAM	QPSK	16-QAM
Capacity	140 Mbit/s	34 Mbit/s	140 Mbit/s	155 Mbit/s	45 Mbit/s	90 Mbit/s	135 Mbit/s	140 Mbit/s	140 Mbit/s	34 Mbit/s	140 Mbit/s
Channel spacing (MHz)	90	29	40	40	10	20	30	90	29.65	20	40
Antenna gain (maximum) (dBi)	41	37	42.5	42.5	46	46	46	45	45	45	45
Feeder/multiplexer loss (minimum) (dB)	3	3	2	3.5	0	0	0	4	5.5	5	5
Antenna type	3.7 m dish	2.4 m dish	Dish	Dish	Dish	Dish	Dish	3.7 m dish	3.7 m dish	3.7 m dish	3.7 m dish
Maximum Tx output power (dBW)	6	0	3	3	+3	+3	+3	6	2	0	0
e.i.r.p. (maximum) (dBW)	44	38	43.5	42	49	49	49	47	41.5	40	40
Receiver IF bandwidth (MHz)	56	26			10	20	30	56	29	26	44
Receiver noise figure (dB)	6	4			3	3	3	6	4	4	4
Receiver thermal noise (dBW)	–122	–128	–125.3	–127.5	–131	–128	–126	–122	–127	–128	–126
Nominal Rx input level (dBW)	–65	–68			–60	–60	–60	–65	–63	–68	–65
Rx input level for 1 × 10–3 BER (dBW)	–105	–114.5	–106	–106	–109	–106	–104	–105	–103	–114.5	–105
Nominal long-term interference (dBW)	–132	–138	–138.3	–140.5	–141	–138	–136	–132	–137	–138	–136
Equivalent power (dB(W/4 kHz)	–	–						–	–	–	–
Spectral density (dB(W/MHz))	–149	–152	–154	–155.3	–151	–151	–151	–149	–152	–152	–152
Refer to Notes	(2), (5)	(2), (4)			(2), (4)	(2), (4)	(2), (4)	(2), (5)	(2), (4)	(2), (4)	(2), (4)

(2) Specified interference will reduce system *C*/*N* by 0.5 dB (interference 10 dB below receiver thermal noise floor).

(4) The specified interference level is total power within the receiver bandwidth.

(5) The specified interference level should be divided by the receiver bandwidth to obtain an average spectral density. The interference spectral density, averaged over any 4 kHz within the receiver bandwidth, must not exceed this value.

TABLE 11

Digital P-P FS system parameters in the FS frequency bands between 3 and 10 GHz

Frequency band (GHz)	3.400-3.456	3.6-4.2	4.4-5.0	5.925-6.425	6.4-7.1		6.570-6.870		6.5-6.9			7.425-7.750		7.1-8.5		
Modulation	4-PSK	16-QAM	16-QAM	16-QAM	64-QAM		4-PSK	16-QAM	128-TCM			4-PSK	16-QAM	64-QAM		
Capacity	550 kbit/s	52 Mbit/s	52 Mbit/s	52 Mbit/s	90 Mbit/s	135 Mbit/s	10 Mbit/s	52 Mbit/s	3.1 Mbit/s	12.4 Mbit/s	24.7 Mbit/s	19 Mbit/s	52 Mbit/s	45 Mbit/s	90 Mbit/s	135 Mbit/s
Channel spacing (MHz)	0.5	20	20	20	20	40	20	20	0.8	2.5	5	20	20	10	20	30
Antenna gain (maximum) (dBi)	40	40.7	42.5	45.0	47	47	45	45	47	47	47	46	46	49	49	49
Feeder/multiplexer loss (minimum) (dB)	T:4.0 R:4.0	T:7.0 R:4.0	T:7.0 R:4.0	T:7.0 R:4.0	0	0	T:2.5 R:5.5	T:3.0 R:5.0	0	0	0	T:2.5 R:5.5	T:3.0 R:5.5	0	0	0
Antenna type	Dish	Horn	Horn	Horn	Dish	Dish	Dish	Dish	Dish	Dish	Dish	Dish	Dish	Dish	Dish	Dish
Maximum Tx output power (dBW)	19	–5.2	–7.1	–9.8	+3	+3	3	3	+1	+1	+1	3	3	+3	+3	+3
e.i.r.p. (maximum) (dBW)	55	28.5	28.4	28.2	50	50	45.5	45	48	48	48	46.5	46	52	52	52
Receiver IF bandwidth (MHz)	0.35	16.65	16.65	16.65	20	30	12.5	17.5	0.8	2.5	5	12.5	17.5	10	20	30
Receiver noise figure (dB)	5	4.2	4.2	4.2	3	3	5	5	3	3	3	5	5	3	3	3
Receiver thermal noise (dBW)	–143.6	–128.1	–128.1	–128.1	–128	–125	–128.0	-126.6	–142	–137	–134	–128.0	–126.6	–131	–128	–126
Nominal Rx input level (dBW)	–87	–73	–73	–73	–60	–60	–92.5	–87.5	–60	–60	–60	–92.5	–87.5	–60	–60	–60

TABLE 12

Digital P-P FS system parameters in the FS frequency bands between 3 and 10 GHz

Frequency band (GHz)	6.425-7.11	6.425-7.11	7.425-7.750	7.725-8.275	8.275-8.500	8.275-8.500
Modulation	16-QAM	16-QAM	16-QAM	128-QAM	4-PSK	16-QAM
Capacity (Mbit/s)	34	2×34	34	155	34	34
Channel spacing (MHz)	20	20	14	29.65	28	14
Antenna gain (maximum) (dBi)	45	45	45	45	45	45
Feeder/multiplexer loss (minimum) (dB)	Tx:1.5 Rx:2	Tx:1.5 Rx:2	Tx:1.5 Rx:2	Tx:4.6 Rx:4.8	Tx:3.0 Rx:6.5	Tx:3.0 Rx:6.5
Antenna type	Dish	Dish	Dish	Dish	Dish	Dish
Maximum Tx output power (dBW)	0	0	0	3	0	0
e.i.r.p. (maximum) (dBW)	43.5	43.5	43.5	43.4	42	42
Receiver IF bandwidth (MHz)	24	24	14	28	26	14
Receiver noise figure (dB)	4	4	4	2	4	4
Receiver thermal noise (dBW)	–130	–127	–130	–128	–127	–130
Nominal Rx input level (dBW)						
Rx input level for 1×10^{-3} BER (dBW)	–111.5	–108.5				
Nominal long-term interference (dBW)	–140	–137				
Equivalent power (dB(W/4 kHz))	–173.8	–173.6				
Spectral density (dB(W/MHz))	–149.8	–149.7				
Refer to Notes						

TABLE 13

Digital P-MP FS system parameters for FS frequency sharing between 3 and 10 GHz

Frequency band (GHz)	3.4-3.6 (TDMA)[1]		4 (DS-CDMA)	
Modulation	π/4-DQPSK		QPSK	
RF transmission rate (Mbit/s)	54 channels		2	
Channel spacing (MHz)	0.30	0.30		
System type	Base station	Remote station	Remote station	Base station
Antenna maximum gain (dBi)	10	15	16 (Vertical)	16 (Vertical)
Transmit power (dBW)	–1	–3	2	2
Feeder loss (dB)	1.5	0	18	8
Antenna type				
Maximum e.i.r.p. (dBW)	9	12	0	10
Receiver IF bandwidth (MHz)	0.256	0.256	21	21
Receiver thermal noise (dBW	–145	–145	–117	–117
Receiver threshold (10^{-6} BER) (dBW)	–72.5 (10^{-3})	–72.5 (10^{-3})	–118	–118
Maximum long-term interference power (dB(W/MHz))			–140[2]	–140[2]
Availability target (% time)			99.99	99.99
Typical fade margin (dB)			30	30
Path length (km)			3	3

[1] Time slot length (ms) 0.5; Frame length (ms) 5.0; Time slots per frame 10.

[2] Measured at antenna port.

TABLE 14

Digital P-P FS system parameters in the FS frequency bands between 10 and 30 GHz

Frequency band (GHz)	10.50-10.68	10.55-10.68		10.6-10.7			10.7-11.7 (refer also to Table 17)			
Modulation	4-PSK	FSK, QPSK	FSK, QPSK	128-TCM			4-PSK	FM-FDM	64-QAM	64-QAM
Capacity	34 Mbit/s	8 Mbit/s	16 Mbit/s	3.1 Mbit/s	12.4 Mbit/s	24.7 Mbit/s	140 Mbit/s	960 channels	90 Mbit/s	135 Mbit/s
Channel spacing (MHz)	14	7	14	0.8	2.5	5	67	40	20	40
Antenna gain (maximum) (dBi)	36-45	49	49	51	51	51	49	47	51	51
Feeder/multiplexer loss (minimum) (dB)	0	0	0	0	0	0	5	5	0	0
Antenna type	Dish	Dish	Dish	Dish	Dish	Dish	3.7 m dish	2.5 m dish	Dish	Dish
Maximum Tx output power (dBW)	–7	–2	–2	–3	–3	–3	10	10	+3	+3
e.i.r.p. (maximum) (dBW)	34	47	47	48	48	48	54	52	54	54
Receiver IF bandwidth (MHz)	20.4	7	14	0.8	2.5	5	68	29	20	30
Receiver noise figure (dB)	8	3	3	4	4	4	7	7	4	4
Receiver thermal noise (dBW)	–123	–135.5	–129.5	–141	–136	–133	–119	–121	–127	–125
Nominal Rx input level (dBW)	–68	–60	–60	–60	–60	–60	–62	–65	–60	–60
Rx input level for 1×10^{-3} BER (dBW)	–108	–117	–114	–110	–104	–101	–104	N/A	–106	–103
Nominal long-term interference (dBW)		–142.5	–139.5	–151	–146	–143	–129	–131	–137	–135
Equivalent power (dB(W/4 kHz))							–	–170		
Spectral density (dB(W/MHz))		–151	–148	–150	–150	–150	–147	–	–150	–150
Refer to Notes				(1), (2)	(1), (2)	(1), (2)	(1), (2)	(1), (3)	(1), (2)	(1), (2)

N/A: Not applicable.

(1) Specified interference will reduce system *C*/*N* by 0.5 dB (interference 10 dB below receiver thermal noise floor).

(2) The specified interference level is total power within the receiver bandwidth.

TABLE 15

Digital P-P FS system parameters in the FS frequency bands between 10 and 30 GHz

Frequency band (GHz)	12.2-12.44		13/14				14.4-15.35 (refer also to Table 17)	
Modulation	4-PSK	16-QAM	4-PSK	4-PSK	4-PSK	4-PSK	64-QAM	8-PSK
Capacity	13.9 Mbit/s	50.4 Mbit/s	2 Mbit/s	8 Mbit/s	16 Mbit/s	34 Mbit/s	140 Mbit/s	156 Mbit/s
Channel spacing (MHz)	20	20	3.5	7	14	28	28	40
Antenna gain (maximum) (dBi)	50	50	49	49	49	49	49	52
Feeder/multiplexer loss (minimum) (dB)	1	1	0	0	0	0	2	5
Antenna type	Dish	Dish	Dish	Dish	Dish	Dish	Dish	Dish
Maximum Tx output power (dBW)	–5	–5	10	10	10	10	5	0
e.i.r.p. (maximum) (dBW)	40	40	45	45	45	45	47	47
Receiver IF bandwidth (MHz)	12.3	17.2	1	2	4	17	40	50
Receiver noise figure (dB)	7	5	10	10	10	10	4	5
Receiver thermal noise (dBW)	–		–134	–131	–128	–122	–124	
Nominal Rx input level (dBW)	–59 + M	–59 + M	–74	–71	–68	–65	–66	–44
Rx input level for 1×10^{-3} BER (dBW)			–116	–113	–111	–109	–101	
Nominal long-term interference (dBW)			–144	–141	–138	–132	–134	
Equivalent power (dB(W/4 kHz))			–	–	–	–	–	
Spectral density (dB(W/MHz))			–144	–144	–144	–144	–150	
Refer to Notes	(3)	(3)	(1), (4)	(1), (4)	(1), (4)	(1), (4)	(1), (4)	

M: Fade margin.

(1) Specified interference will reduce system *C*/*N* by 1 dB (interference 6 dB below receiver thermal noise floor).

(2) Specified interference will reduce system *C*/*N* by 0.5 dB (interference 10 dB below receiver thermal noise floor).

(3) Specified interference will have a relative contribution of no more than 10% of total noise.

(4) The specified interference level is total power within the receiver bandwidth.

TABLE 16

Digital P-P FS system parameters in the FS frequency bands between 10 and 30 GHz

Frequency band (GHz)	17.7-19.7 (refer also to Table 17)														
Modulation	4-PSK	4-QAM	2-PSK	4-PSK	4-PSK	O-QPSK	64-QAM	4-QAM	4-PSK	4-FSK	4-QAM	4-QAM	4-QAM	4-QAM	4-QAM
Capacity (Mbit/s)	140	140	8	34	8	44.7		8	12.6	400	3.1	6.2	12.4	24.7	45
Channel spacing (MHz)	110	55	20	27.5	13.75	40		10	10	300	2.5	5	10	20	40
Antenna gain (maximum) (dBi)	48	48	45	45	49	45	38	32-48	48	48	48	48	48	48	48
Feeder/multiplexer loss (minimum) (dB)	7	7	0	0	1	3	3	0	3	3	0	0	0	0	0
Antenna type	Dish	Dish	Dish	Dish	1.8 m dish	Dish	Dish	Dish	Dish	Dish	Dish	Dish	Dish	Dish	Dish
Maximum Tx output power (dBW)	–10	–4	–9	–8	–5	–9	–7	–5	–7	–8	–5	–5	–5	–5	–5
e.i.r.p. (maximum) (dBW)	31	37	27	37	43	33	31	27-43	38	40	43	43	43	43	43
Receiver IF bandwidth (MHz)	68	68	8	18	25	40	40	4	10	250	2.5	5	10	20	40
Receiver noise figure (dB)	7	8	7	7	9	5	5	7	7	8	6	6	6	6	6
Receiver thermal noise (dBW)	–119	–118	–128	–124	–121	–125	–123	–131	–131		–134	–131	–128	–125	–122
Nominal Rx input level (dBW)	–63	–64	–65	–65	–60	–70	–73	–65	–72		–60	–60	–60	–60	–60
Rx input level for 1 × 10–3 BER (dBW)	–103	–104	–116	–113	–111	–106		–116	–113		–120	–117	–114	–111	–109
Nominal long-term interference (dBW)	–129	–131	–138	–143	–134	–131		–141	–137		–144	–141	–138	–135	–132
Equivalent power (dB(W/4 kHz))	–	–	–			–171			–171						
Spectral density (dB(W/MHz))	–147	–149	–147					–147	–147		–148	–148	–148	–148	–148
Refer to Notes	(2), (3)	(2), (3)	(2), (3)	(2), (3)	(4)	(1)		(2), (3)	(1)		(2), (3)	(2), (3)	(2), (3)	(2), (3)	(2), (3)

(1) Specified interference will reduce system *C*/*N* by 1 dB (interference 6 dB below receiver thermal noise floor).

(2) Specified interference will reduce system *C*/*N* by 0.5 dB (interference 10 dB below receiver thermal noise floor).

(3) The specified interference level is total power within the receiver bandwidth.

(4) Occupied bandwidth = 6 MHz.

TABLE 17

Digital P-P FS system parameters in the FS frequency bands between 10 and 30 GHz

Frequency band (GHz)	10.7-11.7				14.4-15.35		17.7-19.7									
Modulation	64-QAM	32-QAM	16-QAM	64-QAM	4-PSK	4-PSK	4-PSK	4-PSK	16-QAM	4-PSK	16-QAM	4-PSK	16-QAM	32-QAM	32-QAM	128-QAM
Capacity	155 STM-1	155 STM-1	140 Mbit/s	155 Mbit/s	2 × 2 Mbit/s	4 × 2 Mbit/s	2 × 2 Mbit/s	4 × 2 Mbit/s	155 Mbit/s	4 × 2 Mbit/s	5 × 2 Mbit/s or 10 Mbit/s Ethernet	34 Mbit/s	20 × 2 Mbit/s or 40 Mbit/s Ethernet	155 Mbit/s	155 Mbit/s	155 Mbit/s
Channel spacing (MHz)	40	40	40	40	10.5	10.5	5	10	55	7	3.5	27.5	13.75	55	55	27.5
Antenna gain (maximum) (dBi)	49	49	45	45	45	45	45	45	45	48	48	48	48	48	48	48
Feeder/multiplexer loss [3] (minimum) (dB)	3	3	5	4	0	0	0	0	Tx:4.5 Rx:3.5	0	0	0	0	0	0	0
Antenna type	3m dish	3m dish	Dish	Dish	Dish	Dish	Dish	Dish	Dish	Dish	Dish	Dish	Dish	Dish	Dish	Dish
Maximum Tx output power (dBW)	0	–3.5	3	3	–7	–7	–7	–7	–5	–7 ± 2 dB	–13 ± 2 dB	–7 ± 2 dB	–13 ± 2 dB	–12	–12	–15
e.i.r.p. (maximum) (dBW)	46	42.5	43	44	38	38	38	38	35.5	43	37	43	37	36	36	33
Receiver IF bandwidth (MHz)	27	39	50	40	3.5	7	3.5	7	55	7	3.5	27.5	13.75	55	55	27.5
Receiver noise figure (dB)	5	3.5	4	2	4	4	5	5	4.5	5	7.5	5	7.5	5	4.5	4.5
Receiver thermal noise (dBW)	–125	–126	–124	–127	–136	–133	–135	–132	–123	–132.16	–133.48	–126.14	–127.47	–122.80	–123.30	–125.64
Nominal Rx input level (dBW)	–60 80[2]	–60 75[2]														
Rx input level for 1 × 10–3 BER (dBW)	–101	–107	–106	–105.6	–123.5	–120.5	–122.5	–119.5	–105.4	–119.5	–116.5	–113	–110.5	–105.5	–107	–98.5
Nominal long-term interference (dBW)	–138	–140	–134	–137	–146	–143	–145	–142	–133	–142.16	–143.48	–136.14	–137.47	–132.80	–133.30	–135.64
Equivalent power (dB(W/4 kHz))			–173.6	–175.8	–173.8	–173.7	–172.8	–172.7	–173.2	–172.96	–172.16	–172.96	–172.16	–172.96	–173.46	–173.46
Spectral density (dB(W/MHz))	–152	–156	–149.6	–151.8	–149.8	–149.7	–148.8	–148.7	–149.2	–148.98	–148.18	–148.98	–148.18	–148.98	–149.98	–149.98
Refer to Notes	[1], [2]	[1], [2]														

[1] $I/N = -13$ dB.

[2] With automatic transmit power control (ATPC).

[3] For bands above 20 GHz, current FS installations have outdoor applications: indoor applications are possibly found as custom arrangement. Feeder losses, whenever mentioned, are considered as ranging from 0 dB to the value mentioned in the Table.

TABLE 18

Digital P-P FS system parameters in the FS frequency bands between 10 and 30 GHz

Frequency band (GHz)	21.8-23.6				22.0-23.0, 25.25-27.0			
Modulation	4-PSK	4-PSK	4-PSK	16-QAM	4-PSK	4-FSK	16-QAM	16-QAM
Capacity	2 × 2 Mbit/s	4 × 2 Mbit/s	34 Mbit/s	155 Mbit/s	6 Mbit/s	45 Mbit/s	52 Mbit/s	156 Mbit/s
Channel spacing (MHz)	7	10.5	28	56	10	50	20	60
Antenna gain (maximum) (dBi)	47	47	47	45	46	46	46	46
Feeder/multiplexer loss[3] (minimum) (dB)	0	0	0	Tx:6 Rx:4	0	0	0	0
Antenna type	Dish	Dish	Dish	Dish	Dish, plate	Dish, plate	Dish, plate	Dish, plate
Maximum Tx output power (dBW)	–7	–7	0	–10	–3.0	–3.0	–3.0	–3.0
e.i.r.p. (maximum) (dBW)	40	40	47	29	43.0	43.0	43.0	43.0
Receiver IF bandwidth (MHz)	3.5	7	18	56	5.3	33.1	18.6	55.6
Receiver noise figure (dB)	6.5	6.5	7	5	8	8	8	8
Receiver thermal noise (dBW)	–133.5	–130.5	–124	–122.6	–128.9	–121.2	–123.5	–118.7
Nominal Rx input level (dBW)					–112.1 + M	–100.6 + M	–100.0 + M	–95.2 + M
Rx input level for 1 × 10–3 BER (dBW)	–120.5	–117.5	–113	–104.9	–116.2	–108.8	–103.3	–98.5
Nominal long-term interference (dBW)	–143.5	–140.5	–134	–132.6	–138.9	–131.2	–133.5	–128.7
Equivalent power (dB(W/4 kHz))	–171.3	–171.2	–170.8	–172.8	–	–	–	–
Spectral density (dB(W/MHz))	–147.3	–147.2	–146.9	–148.8	–146.0	–146.0	–146.0	–146.0
Refer to Notes					(1), (2)	(1), (2)	(1), (2)	(1), (2)

M: Fade margin.

(1) Specified interference will reduce system *C*/*N* by 0.5 dB (interference 10 dB below receiver thermal noise floor).

(2) Specified interference level is total power within the receiver bandwidth.

(3) For bands above 20 GHz, current FS installations have outdoor applications: indoor applications are possibly found as custom arrangement. Feeder losses, whenever mentioned, are considered as ranging from 0 dB to the value mentioned in the Table.

TABLE 19

Digital P-P FS system parameters in the FS frequency bands between 10 and 30 GHz

Frequency band (GHz)	21.12-23.6									
Modulation	2-FSK	2-FSK	2-FSK	4-PSK	4-PSK	4-PSK	ASK	ASK	2-FSK	64-QAM
Capacity	2 Mbit/s	4 Mbit/s	8 Mbit/s	34 Mbit/s	140 Mbit/s	34 Mbit/s	2 Mbit/s	4 × 2 Mbit/s	2 Mbit/s	140 Mbit/s
Channel spacing (MHz)	7	7	14	28	112	28	28	28	5	40
Antenna gain (maximum) (dBi)	47	47	47	47	47	47	35	50	47	38.5
Feeder/multiplexer loss (minimum) (dB)(5)	0	0	0	0	0	0	4	4	0	3
Antenna type	Dish	Dish	Dish	Dish	Dish	Dish	Dish	Dish	Dish	Dish
Maximum Tx output power (dBW)	0	0	0	0	0	0	–16	–14	–10	– 4
e.i.r.p. (maximum) (dBW)	50	50	50	50	50	47	15	32	37	31.5
Receiver IF bandwidth (MHz)	2	4	8	17	70	18	5	14	2	40
Receiver noise figure (dB)	9	9	9	9	9	12	4	4	11	5
Receiver thermal noise (dBW)	–132	–129	–126	–123	–116	–119	–133	–128		–123
Nominal Rx input level (dBW)	–105 + M	–104 + M	–103 + M	–100 + M	–94 + M	–87	–108 + M	–109 + M	–115	–73
Rx input level for 1×10^{-3} BER (dBW)	–108	–	–106	–103	–97	–103	–112	–113		–96
Nominal long-term interference (dBW)	–142	–139	–136	–133	–126	–129	–139	–136		–131
Equivalent power (dB(W/4 kHz))	–	–170	–	–	–	–	–	–		–171
Spectral density (dB(W/MHz))	–143	–143	–143	–143	–143	–141	–146	–148		–147
Refer to Notes	(1), (4)	(1), (4)	(1), (4)	(1), (4)	(1), (4)	(1), (4)	(1), (4)	(1), (4)	(3), (4)	

M: Fade margin.

N/A: Not applicable.

(1) Specified interference will reduce system *C*/*N* by 1 dB (interference 6 dB below receiver thermal noise floor).

(3) Specified interference will have a relative contribution of no more than 10% of total noise.

(4) The specified interference level is total power within the receiver bandwidth.

(5) For bands above 20 GHz, current FS installations have outdoor applications: indoor applications are possibly found as custom arrangement. Feeder losses, whenever mentioned, are considered as ranging from 0 dB to the value mentioned in the Table.

TABLE 20

Digital P-MP FS system parameters for FS frequency sharing between 10 and 30 GHz*

System (GHz)	10.5	19	23	26	26
1 Channel capacity (typical) (kbit/s)	30 × 64	90 × 64 47 × 144 (2B+D)	10 × 64	192 × 64	96 × 64
2 Aggregate bit rate (kbit/s)	2 100	8 192	832	14 300	4 × 2 048
3 Modulation method	QPSK	2-FSK	2-ASK	FSK (CS-RT) DFSK (RT-CS)	2-FSK
4 Central station (CS) antenna	90° or 120° wide beam: gain 13 dBi	90° or 120° wide beam: gain 18 dBi	90° or 120° wide beam: gain 10 to 15 dBi	90° wide beam: gain 20 dBi	90° wide beam: gain 20 dBi
5 Out-station (OS) antenna (dBi)	Parabolic: gain 34	Parabolic: gain 35	Parabolic: gain 35	Cassegrain: gain 35 to 47	Parabolic: gain 30
6 Customer data rates (kbit/s)	64 Others available	12.8 and 64 initially, expandable to include ISDN rates of 80 or 144	64	64 to 6 144	64
7 Customer assignment	Fixed or demand assignment	Fixed or demand assignment	Fixed or demand assignment	Fixed assignment	Demand assignment
8 Operational range (km)	Up to 10	Up to 10	Up to 5	Up to 7	Up to 2

* These parameters are from Recommendation ITU-R F.755.

TABLE 21

Digital P-MP FS system parameters in the FS frequency bands between 10 and 30 GHz

	Type 1 (TDD)			Type 2 (FDD)		
Service type	P-MP			P-MP		
Frequency band (GHz)	25.25-27.0	25.25-27.0	25.25-27.0	25.25-27.0	25.25-27.0	25.25-27.0
Multiple access	TDMA/TDD	TDMA/TDD	TDMA/TDD	TDMA/FDD	TDMA/FDD	TDMA/FDD
Modulation	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK
Capacity (Mbit/s)	50	50	50	52	13	13
Channel spacing (MHz)	40	40	40	40	10	10
	CS-OS	OS-CS	OS-CS	CS-OS	OS-CS	OS-CS
Condition	Clear-air	Clear-air	Rain-faded	Clear-air	Clear-air	Rain-faded
Antenna gain (maximum) (dBi)	12	35	35	15	32	32
Feeder/multiplexer loss (minimum) (dB)[3]	6	0	0	0	0	0
Antenna type	60° sector	Plate	Plate	90° sector	Plate	Plate
Maximum Tx output power (dBW)	–11.3	–21.3	–11.3	–4	–20	–10
Maximum Tx P.S.D. (dB(W/MHz))	–25.3	–35.3	–25.3	–18.1	–28.1	–18.1
e.i.r.p. (maximum) (dBW)	–5.3	13.7	23.7	11	12	22
e.i.r.p spectral density (dB(W/MHz))	–19.3	–0.3	9.7	–3.1	3.9	13.9
Receiver IF bandwidth (MHz)	32.2	32.2	32.2	33.4	8.4	8.4
Receiver noise figure (dB)	7	7	7	6	6	6
Receiver thermal noise (dBW)	–122.9	–122.9	–122.9	–122.8	–128.8	–128.8
Rx input level for 1×10^{-6} BER (dBW)	–108.9	–108.9	–108.9	–106.8	–112.8	–112.8
Rx E_b/N_0 for 1×10^{-6} BER (dB)	7.9	7.9	7.9	13	13	13
Nominal long-term interference (dBW)	–132.9	–132.9	–132.9	–132.8	–138.8	–138.8
Spectral density (dB(W/MHz))	–146.8	–146.8	–146.8	–146.9	–146.9	–146.9
Refer to Notes	(1), (2)	(1), (2)	(1), (2)	(1), (2)	(1), (2)	(1), (2)

OS: Out station (subscriber station).

(1) Specified interference will reduce system C/N by 0.5 dB (interference 10 dB below receiver thermal noise floor).

(2) Specified interference level is total power within the receiver bandwidth.

(3) For bands above 20 GHz, current FS installations have outdoor applications: indoor applications are possibly found as custom arrangement. Feeder losses, whenever mentioned, are considered as ranging from 0 dB to the value mentioned in the Table.

TABLE 22

Digital P-MP FS system parameters in the FS frequency bands between 10 and 30 GHz

Frequency band (GHz)	25.25-27			25.25-27.5, 27.5-28.35, 29.1-29.25, 31.0-31.3					
Service type				2-way asymmetric – FDD		2-way asymmetric – FDD		2-way asymmetric – TDD	
Modulation	FSK	DFSK	FSK	16-QAM	4-PSK	64-QAM	16-QAM	64-QAM	64-QAM
Direction of transmission	Central station	Out station	Central station	Hub to RT	RT to Hub	Hub to RT	RT to Hub	Hub to RT	RT to Hub
Capacity (Mbit/s)	6 Mbit/s		8 Mbit/s	24	11	35	20	180	180
Channel spacing (MHz)	40		20	7	7	7	7	50	50
Antenna gain (dBi)	20	47	47	21	36	21	36	21	36
Antenna diameter (m)				–	0.30	–	0.30	–	0.30
3 dB beamwidth (degrees)				90° sector 2.7° vertical	2.7°	90° sector 2.7° vertical	2.7°	90° sector 2.7° vertical	2.7°
Antenna type	90° section	Dish	Dish	Sector	Dish	Sector	Dish	Sector	Dish
Feeder loss (dB)	0	0	0	0	0	0	0	0	0
Maximum Tx power (dBW)	–8	–10	–10	–3	–13.5	–6	–16.5	–14	–14
e.i.r.p. (maximum) (dBW)	10	37	37	18	22.5	15	19.5	7	22
Receiver IF bandwidth (MHz)	16.4	16.4	16.4						
Receiver noise figure (dB)	10	8	10	7	6.5	7	6.5	7	7
Receiver thermal noise (dBW)				–129	–129	–129	–129	–120	–120
Nominal Rx input level (dBW)	–99 + M	–123 + M	–99 + M						
Nominal long-term interference (dBW)				–139	–139	–139	–139	–130	–130
Equivalent power (dB(W/4 kHz))				–171	–171	–171	–171	–171	–171
Spectral density (dB(W/MHz))				–147	–147	–147	–147	–147	–147
Refer to Notes	(1), (2)		(1), (2)						

M: Fade margin.

(1) Specified interference will have a relative contribution of no more than 10% of total noise.

(2) The specified interference level is total power within the receiver bandwidth.

TABLE 23

Digital P-MP FS system parameters in the FS frequency bands between 10 and 30 GHz

Frequency band (GHz)	25.25-27.5, 27.5-28.35, 29.1-29.25, 31.0-31.3[8, 9]						
Service type	1-way	2-way symmetric			2-way asymmetric – TDMA		
Modulation	4-PSK FDM/TDM	4-PSK FDM/TDM	4-PSK FDM/TDM	4-PSK FDM/TDM	4-PSK FDM/TDM	4-PSK FDM/TDMA	4-PSK FDM/TDMA
Capacity	1 ch/40 MHz BW	20 ch/30 MHz BW	20 ch/30 MHz BW	20 ch/30 MHz BW	1 ch/50 MHz BW	20 ch/50 MHz BW	20 ch/50 MHz BW
Channel spacing (code rate 3/4) (MHz)	40	1.36	1.36	1.36	50	2.5	2.5
Direction of transmission	Hub to RT	Hub to RT	RT to hub	RT to hub	Hub to RT	RT to hub	RT to hub
Condition	Clear-air	Clear-air	Clear-air	Rain-faded	Clear-air	Clear-air	Rain-faded
Antenna Gain (maximum) (dBi)	15	15	36	36	15	36	36
Feeder/multiplexer loss (minimum) (dB)	0	0	0	0	0	0	0
Antenna type (El × Az)	15° × 90° horn	15° × 90° horn	2° × 2° dish	2° × 2° dish	15° × 90° horn	2° × 2° dish	2° × 2° dish
Maximum Tx output power (dBW)	9.0[7]	–5.7[7]	–40.0	–4.2[7]	10.0[7]	–32.7	4.0[7]
Maximum Tx P.S.D. (dB(W/MHz))	–7.0[7]	–7.0[7]	–41.3	–5.5[7]	–7.0[7]	–36.7	0.0[7]
e.i.r.p. (maximum) (dBW)	24.0[7]	9.3[7]	–4.0	31.8[7]	25.0[7]	3.3	40.0[7]
Receiver IF bandwidth (MHz)[6]	40.0	1.36	1.36	1.36	50.0	2.5	2.5
Receiver noise figure (Typ.) (dB)	7.0	7.0	7.5	7.5	7.0	7.5	7.5
Receiver thermal noise (dBW)[5]	–121.0	–135.6	–135.1	–135.1	–120.0	–132.6	–132.6
Rx input level for 1×10^{-3} BER (dBW)							
Nominal Rx input level (dBW) for 1×10^{-6} BER at 5 km	–77.0	–91.7	–126.0	–125.9	–76.0	–118.7	–118.6
Rx E_b/N_0 for 1×10^{-6} BER (dB)	7.2	7.6	8.6	8.6	7.2	14.0	14.0
Nominal long-term interference (dBW)[1, 2]	–130.1	–144.8	–144.3	–144.3	–129.1	–141.6	–141.6
Equivalent power (dB(W/4 kHz))	–170	–170	–170	–170	–170	–170	–170
Spectral density (dB(W/MHz))	–146	–146	–146	–146	–146	–146	–146
Refer to Notes		[4]	[3, 4]	[3, 4]		[3]	[3]

See Notes on the next page.

Notes to Table 23:

Hub: Hub station.

RT: Remote terminal (subscriber station).

TDM: Time division multiplexed (continuous transmission when in service).

FDM: Frequency division multiplexed.

TDMA: Time-division multiple access (burst transmission).

(1) Specified interference will reduce system *C*/*N* by 0.5 dB.

(2) The specified interference level is total power within the receiver bandwidth.

(3) Remote terminal power control (RTPC) is used to transmit the minimum power necessary to meet the hub receiver threshold (E_b/N_0). In order to limit system self-interference to less than 10 dB, an interference mitigation algorithm detects interference and restricts transmit e.i.r.p. escalation.

(4) Code rates typically range from rate 1/2 to rate 7/8.

(5) Receiver thermal noise is based on Nyquist bandwidth of detection process.

(6) Total occupied bandwidth per carrier.

(7) Operating points are typically set to meet fade margin requirements while minimizing self-interference. Systems with these values will typically be operated in locations where fade margins at 5 km are from 20 to 40 dB. Interference studies should take into account fade margin requirements and related operating points for a given location and hub-to-RT separation.

(8) Typical parameters for a point-to-multipoint system operating at 8 dB(W/MHz) hub e.i.r.p. and requiring 37 dB of fade margin at 5 km hub-to-RT separation.

(9) ITU-R is studying sharing in the band 25.25 to 27.5 GHz.

TABLE 24

Digital P-MP FS system parameters in the FS frequency bands between 10 and 30 GHz

Frequency band (GHz)	27.5-28.35, 29.1-29.25, 31.0-31.3[8]						
Service type	1-way	2-way symmetric			2-way asymmetric – TDMA		
Modulation	4-PSK FDM/TDM	4-PSK FDM/TDM	4-PSK FDM/TDM	4-PSK FDM/TDM	4-PSK FDM/TDM	4-PSK FDM/TDMA	4-PSK FDM/TDMA
Capacity	1 ch/40 MHz BW	20 ch/30 MHz BW	20 ch/30 MHz BW	20 ch/30 MHz BW	1 ch/50 MHz BW	20 ch/50 MHz BW	20 ch/50 MHz BW
Channel spacing (code rate ¾) (MHz)	40	1.36	1.36	1.36	50	2.5	2.5
Direction of transmission	Hub to RT	Hub to RT	RT to hub	RT to hub	Hub to RT	RT to hub	RT to hub
Condition	Clear-air	Clear-air	Clear-air	Rain-faded	Clear-air	Clear-air	Rain-faded
Antenna Gain (maximum) (dBi)	24	24	36	36	24	36	36
Feeder/multiplexer loss (minimum) (dB)	0	0	0	0	0	0	0
Antenna type (El × Az)	3° × 45° horn	3° × 45° horn	2° × 2° dish	2° × 2° dish	3° × 45° horn	2° × 2° dish	2° × 2° dish
Maximum Tx output power (dBW)	22.0[7]	7.3[7]	–49.0	7.3[7]	23.0[7]	–41.7	10.0[7]
Maximum Tx P.S.D. (dB(W/MHz))	6.0[7]	6.0[7]	–50.3	6.0[7]	6.0[7]	–45.7	6.0[7]
e.i.r.p. (maximum) (dBW)	46.0[7]	31.3[7]	–13.0	43.3[7]	47.0[7]	–5.7	46.0[7]
Receiver IF bandwidth (MHz)[6]	40.0	1.36	1.36	1.36	50.0	2.5	2.5
Receiver noise figure (Typ.) (dB)	7.0	7.0	7.5	7.5	7.0	7.5	7.5
Receiver thermal noise (dBW)[5]	–121.0	–135.6	–135.1	–135.1	–120.0	–132.5	–132.5
Rx input level for 1 × 10–3 BER (dBW)							
Nominal Rx input level (dBW) for 1 × 10–6 BER at 5 km	–55.0	–69.7	–126.0	–125.9	–54.0	–118.7	–118.6
Rx E_b/N_0 for 1 × 10–6 BER (dB)	7.2	7.6	8.6	8.6	7.2	14.0	14.0
Nominal long-term interference (dBW)[1, 2]	–130.1	–144.8	–144.3	–144.3	–129.1	–141.6	–141.6
Equivalent power (dB(W/4 kHz))	–170	–170	–170	–170	–170	–170	–170
Spectral density (dB(W/MHz))	–146	–146	–146	–146	–146	–146	–146
Refer to Notes		[4]	[3], [4]	[3], [4]		[3]	[3]

See Notes on the next page.

Notes to Table 24:

(1) Specified interference will reduce system C/N by 0.5 dB.

(2) The specified interference level is total power within the receiver bandwidth.

(3) Remote terminal power control (RTPC) is used to transmit the minimum power necessary to meet the hub receiver threshold (E_b/N_0). In order to limit system self-interference to less than 10 dB, an interference mitigation algorithm detects interference and restricts transmit e.i.r.p. escalation.

(4) Code rates typically range from rate 1/2 to rate 7/8.

(5) Receiver thermal noise is based on Nyquist bandwidth of detection process.

(6) Total occupied bandwidth per carrier.

(7) Operating points are typically set to meet fade margin requirements while minimizing self-interference. Systems with these values will typically be operated in locations where fade margins at 5 km are from 40 to 60 dB. Interference studies should take into account fade margin requirements and related operating points for a given location and hub-to-RT separation.

(8) Typical parameters for a point-to-multipoint system operating at 30 dB(W/MHz) hub e.i.r.p., up to 42 dB(W/MHz) RT e.i.r.p., and requiring 57 dB of fade margin at 5 km hub-to-RT separation.

TABLE 25

Digital P-P FS system parameters in the FS frequency bands between 30 and 60 GHz

Frequency band (GHz)	31.8-33.4											
Modulation	4-FSK	4-FSK	4-FSK	16-QAM	16-QAM	32-QAM	128-QAM	4-FSK	O-QPSK	4-FSK	16-QAM	16-QAM
Capacity (Mbit/s)	2 × 2	2 × 8	34	STM-1 155	STM-0 52	STM-0 52	STM-1 155	6.2	45	45	45	155
Channel spacing (MHz)	3.5	14	28	56	28	14	28	5	40	40	20	50
Antenna gain (maximum) (dBi)	46*	46*	46*	46*	46*	46*	46*	43**	43**	43**	43**	43**
Feeder/multiplexer loss (minimum) (dB)	0	0	0	0	0	0	0	0	0	0	0	0
Antenna type	Dish	Dish	Dish	Dish	Dish	Dish	Dish	Dish	Dish	Dish	Dish	Dish
Maximum Tx output power (dBW)	–3	–3	–3	–3	–3	–3	–3	–15	–13	–13	–7	–4
e.i.r.p. (maximum) (dBW)	43	43	43	43	43	43	43	28	30	30	36	39
Receiver IF bandwidth (MHz)	2	8	17	40	15	12	30	5	40	40	20	50
Receiver noise figure (dB)	9	9	9	7	7	7	7	8	8	8	8	8
Receiver thermal noise (dBW)	–132	–126	–123	–121	–125	–126	–123	–129	–120	–120	–122	–119
Nominal Rx input level (dBW)	–113 + M	–107 + M	–104 + M	–100 + M	–99 + M	–96 + M						
Rx input level for 1 × 10–3 BER (dBW)	–116	–110	–107	–103	–107	–104	–95	–118	–113	–109.5	–108.5	–103
Nominal long-term interference (dBW)	–142	–136	–133	–131	–135	–136	–133	–139	–130	–130	–132	–129
Equivalent power (dB(W/4 kHz))												
Spectral density (dB(W/MHz))	–145	–145	–145	–147	–147	–147	–147	–146	–146	–146	–145	–146
Refer to Notes	(1), (2)	(1), (2)	(1), (2)	(1), (2)	(1), (2)	(1), (2)	(1), (2)	(1), (2)	(1), (2)	(1), (2)	(1), (2)	(1), (2)

* 0.9 m dish assumed.

** 0.6 m dish assumed.

(1) Specified interference will reduce system *C*/*N* by 0.5 dB (interference 10 dB below receiver thermal noise floor).

(2) The specified interference level is total power within the receiver bandwidth.

TABLE 26

Digital P-P FS system parameters in the FS frequency bands between 30 and 60 GHz

Frequency band (GHz)	37.0-39.5					38.6-40.0				
Modulation	4-FSK	4-FSK	4-FSK	4-FSK	16-QAM	2-FSK	OQPSK	4-QAM	16-QAM	256-QAM
Capacity (Mbit/s)	2 × 2	8	2 × 8	34	155	1.544	44.736	44.736	90	310
Channel spacing (MHz)	3.5	7	14	28	56	5	40	50	50	50
Antenna gain (maximum) (dBi)	47*	47*	47*	47*	47*	44**	44**	44**	44**	44**
Feeder/multiplexer loss (minimum) (dB)	0	0	0	0	0	0	0	0	0	0
Antenna type	Dish	Dish	Dish	Dish	Dish	Dish	Dish	Dish	Dish	Dish
Maximum Tx output power (dBW)	0	0	0	0	0	–13	–15	–14	–4	–4
e.i.r.p. (maximum) (dBW)	47	47	47	47	47	31	29	30	40	40
Receiver IF bandwidth (MHz)	2	4	8	17	40	2	40	50	50	50
Receiver noise figure (dB)	11	11	11	11	8	11	8	13	5	5
Receiver thermal noise (dBW)	–130	–127	–124	–121	–120	–130	–120	–114	–122	–122
Nominal Rx input level (dBW)	–112 + M	–109 + M	–106 + M	–103 + M	–99 + M	–114 + M	–110 + M	–101 + M	–100 + M	–88 + M
Rx input level for 1 × 10–3 BER (dBW)	–115	–112	–109	–106	–102	–122	–114.5	–105	–106	–94
Nominal long-term interference (dBW)	–140	–137	–134	–131	–130	–140	–130	–124	–132	–132
Equivalent power (dB(W/4 kHz))										
Spectral density (dB(W/MHz))	–143	–143	–143	–143	–146	–143	–146	–141	–149	–149
Refer to Notes	(1), (2)	(1), (2)	(1), (2)	(1), (2)	(1), (2)	(1), (2)	(1), (2)	(1), (2)	(1), (2)	(1), (2)

* 0.9 m dish assumed.

** 0.6 m dish assumed.

(1) Specified interference will reduce system *C*/*N* by 0.5 dB (interference 10 dB below receiver thermal noise floor).

(2) The specified interference level is total power within the receiver bandwidth.

TABLE 27

Digital P-P FS system parameters in the FS frequency bands between 30 and 60 GHz

Frequency band (GHz)	37.0-39.5											
Modulation	4-PSK	4-PSK	4-PSK	CPM	CPM	CPM	4-FSK	4-FSK	4-FSK	C-QPSK	C-QPSK	C-QPSK
Capacity (Mbit/s)	2 × 2	4 × 2	16 × 2	2 × 2	4 × 2	8 × 2	2 × 2	4 × 2	8 × 2	2 × 2	4 × 2	8 × 2
Channel spacing (MHz)	3.5	7	28	3.5	7	14	3.5	7	14	3.5	7	14
Antenna gain (maximum) (dBi)	47	47	47	44.3	44.3	44.3	44.3	44.3	44.3	44	44	44
Feeder/multiplexer loss (minimum) (dB)	0	0	0	1.0	1.0	1.0				0	0	0
Antenna type	Dish	Dish	Dish	Dish	Dish	Dish	Dish	Dish	Dish	Dish	Dish	Dish
Maximum Tx output power (dBW)	–15	–15	–15	–13	–13	–13	–14	–14	–14	–13.7	–13.7	–13.7
e.i.r.p. (maximum) (dBW)	32	32	32	30.34	30.34	30.34	30.3	30.3	30.3	30.5	30.5	30.5
Receiver IF bandwidth (MHz)	3.5	7	28	3.5	7.5	14	3.5	7	14	3.5	7	14
Receiver noise figure (dB)	7.5	7.5	7.5	10	10	10	8	8	8	12	12	12
Receiver thermal noise (dBW)	–132.5	–129.5	–123.5	–133.4	–130.1	–127.4	–130.5	–127.5	–124.5	–128	–125	–122
Nominal Rx input level (dBW)												
Rx input level for 1 × 10–3 BER (dBW)	–119	–116	–110	–117.5	–114.5	–111.5	–112	–110	–106	–115	–112	–109
Nominal long-term interference (dBW)	–142.5	–139.5	–133.5	–143.4	–140.1	–137.4	–140.5	–137.5	–134.5	–138	–135	–132
Equivalent power (dB(W/4 kHz))	–170.3	–170.2	–170.2	–172.8	–172.8	–172.8	–167.5	–167.5	–167.5	–167.4	–167.4	–167.4
Spectral density (dB(W/MHz))	–146.3	–146.2	–146.2	–148.9	–148.9	–148.9	–143.5	–143.5	–143.5	–143.4	–143.4	–143.4
Refer to Notes	(1), (2)	(1), (2)	(1), (2)	(1), (2)	(1), (2)	(1), (2)	(1), (2)	(1), (2)	(1), (2)	(1), (2)	(1), (2)	(1), (2)

CPM: continuous phase modulation.

(1) Specified interference will reduce system *C*/*N* by 0.5 dB (interference 10 dB below receiver thermal noise floor).

(2) The specified interference level is total power within the receiver bandwidth.

TABLE 28

Digital P-P FS system parameters in the FS frequency bands between 30 and 60 GHz

Frequency band (GHz)	37-39.5				38.6-40.0					47.2-50.2				54.25-57.2			
Modulation	2-FSK	2-FSK	4-FSK	4-FSK	2-FSK	OQPSK	4-QAM	16-QAM	256-QAM	2-FSK	4-QAM	16-QAM	256-QAM	2-FSK	2-FSK	4-PSK	4-PSK
Capacity	2 Mbit/s	8 Mbit/s	34 Mbit/s	140 Mbit/s	1.544 Mbit/s	44.736 Mbit/s	44.736 Mbit/s	90 Mbit/s	310 Mbit/s	1.544 Mbit/s	44.736 Mbit/s	90 Mbit/s	310 Mbit/s	2 Mbit/s	8 Mbit/s	34 Mbit/s	140 Mbit/s
Channel spacing (MHz)	7	14	28	140	5	40	50	50	50	5	50	50	50	14	14	28	140
Antenna gain (maximum) (dBi)	47	47	47	47	44	44	44	44	44	46	46	46	46	47	47	47	47
Feeder/multiplexer loss (minimum) (dB)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Antenna type	Dish	Dish	Dish	Dish	Dish	Dish	Dish	Dish	Dish	Dish	Dish	Dish	Dish	Dish	Dish	Dish	Dish
Maximum Tx output power (dBW)	0	0	0	0	–13	–15	–14	–4	–4	–11	–12	–2	–2	–10	–10	–10	–10
e.i.r.p. (maximum) (dBW)	47	47	47	47	31	29	30	40	40	35	34	44	44	37	37	37	37
Receiver IF bandwidth (MHz)	2	8	17	70	2	40	50	50	50	2	50	50	50	2	8	17	70
Receiver noise figure (dB)	11	11	11	11	11	8	13	5	5	11	13	5	5	11	11	11	11
Receiver thermal noise (dBW)	–130	–124	–121	–114	–130	–120	–114	–122	–122	–130	–114	–122	–122	–130	–124	–121	–114
Nominal Rx input level (dBW)	–108 + M	–102 + M	–99 + M	–93 + M	–114 + M	–110 + M	–101 + M	–100 + M	–88 + M	–114 + M	–101 + M	–100 + M	–88 + M	–108 + M	–102 + M	–99 + M	–93 + M
Rx input level for 1 × 10–3 BER (dBW)	–111	–105	–102	–95	–122	–114.5	–105	–106	–94	–122	–105	–106	–94	–111	–105	–102	–95
Nominal long-term interference (dBW)	–140	–134	–131	–124	–140	–130	–124	–132	–132	–140	–124	–132	–132	–140	–134	–131	–124
Equivalent power (dB(W/4 kHz))	–	–	–		–	–	–	–	–	–	–	–	–	–	–	–	
Spectral density (dB(W/MHz))	–143	–143	–143	–143	–143	–146	–141	–149	–149	–143	–141	–149	–149	–143	–143	–143	–143
Refer to Notes	(1), (3)	(1), (3)	(1), (3)		(2), (3)	(2), (3)	(2), (3)	(2), (3)	(2), (3)	(2), (3)	(2), (3)	(2), (3)	(2), (3)	(1), (3)	(1), (3)	(1), (3)	

(1) Specified interference will reduce system *C*/*N* by 1 dB (interference 6 dB below receiver thermal noise floor).

(2) Specified interference will reduce system *C*/*N* by 0.5 dB (interference 10 dB below receiver thermal noise floor).

(3) The specified interference level is total power within the receiver bandwidth.

TABLE 29

Digital P-P FS system parameters in the FS frequency bands between 30 and 60 GHz

Frequency band (GHz)	51.4-52.6									
Modulation	4-FSK	4-FSK	4-FSK	4-FSK	16-QAM	16-QAM	32-QAM	4-FSK	4-FSK	4-FSK
Capacity (Mbit/s)	2 × 2	8	2 × 8	34	STM-0 52	STM-1 155	STM-0 52	1.544	6.2	45
Channel spacing (MHz)	3.5	7	14	28	28	56	14			
Antenna gain (maximum) (dBi)	50	50	50	50	50	50	50	37*	37*	37*
Feeder/multiplexer loss (minimum) (dB)	0	0	0	0	0	0	0	0	0	0
Antenna type	Dish/horn	Dish/horn	Dish/horn	Dish/horn	Dish/horn	Dish/horn	Dish/horn	Dish	Dish	Dish
Maximum Tx output power (dBW)	–20	–20	–20	–20	–20	–20	–20	–10	–10	0
e.i.r.p. (maximum) (dBW)	30	30	30	30	30	30	30	27	27	37
Receiver IF bandwidth (MHz)	2	4	8	17	15	40	12	2.5	5	40
Receiver noise figure (dB)	11	11	11	11	7	8	7	10	10	10
Receiver thermal noise (dBW)	–130	–127	–124	–121	–125	–120	–126	–130	–127	–118
Nominal Rx input level (dBW)	–111 + M	–108 + M	–105 + M	–102 + M	–99 + M	–99 + M	–96 + M			
Rx input level for 1 × 10–3 BER (dBW)	–114	–111	–108	–105	–107	–102	–104	–122	–116	–107.5
Nominal long-term interference (dBW)	–140	–137	–134	–131	–135	–130	–136	–140	–137	–128
Equivalent power (dB(W/4 kHz))										
Spectral density (dB(W/MHz))	–143	–143	–143	–143	–147	–146	–147	–144	–144	–144
Refer to Notes	(1), (2)	(1), (2)	(1), (2)	(1), (2)	(1), (2)	(1), (2)	(1), (2)	(1), (2)	(1), (2)	(1), (2)

* 0.3 m dish assumed.

(1) Specified interference will reduce system *C*/*N* by 0.5 dB (interference 10 dB below receiver thermal noise floor).

(2) The specified interference level is total power within the receiver bandwidth.

TABLE 30

Digital P-P FS system parameters in the FS frequency bands between 30 and 60 GHz

Frequency band (GHz)	55.78-57 (TDD)		55.78-57 (FDD)	57-59 (TDD)		57-59 (FDD)		
Modulation	4-FSK	4-FSK	4-FSK	2-FSK	2-FSK	4-FSK	4-FSK	4-FSK
Capacity (Mbit/s)	2 × 8	4 × 8	45	> 2 × 2	> 8	1.544	6.2	45
Channel spacing (MHz)	14	28	40	50	100	2.5	5	40
Antenna gain (maximum) (dBi)	45*	45*	37**	32	32	37**	37**	37**
Feeder/multiplexer loss (minimum) (dB)	0	0	0	0	0	0	0	0
Antenna type	Dish, horn	Dish, horn	Dish	Flat panel	Flat panel	Dish	Dish	Dish
Maximum Tx output power (dBW)	–10	–10	–10	–20	–20	–10	–10	0
e.i.r.p. (maximum) (dBW)	35	35	27	15	15	27	27	37
Receiver IF bandwidth (MHz)				10	20			
Receiver noise figure (dB)				20	20			
Receiver thermal noise (dBW)				–114	–111			
Nominal Rx input level (dBW)								
Rx input level for 1 × 10–3 BER (dBW)				–100	–97			
Nominal long-term interference (dBW)				–140	–137			
Equivalent power (dB(W/4 kHz))								
Spectral density (dB(W/MHz))				–143	–143			
Refer to Notes	(4)	(4)		(1), (2), (3)	(1), (2), (3)			

* 0.45 m dish assumed.

** 0.3 m dish assumed.

(1) Specified interference will reduce system *C*/*N* by 0.5 dB (interference 10 dB below receiver thermal noise floor).

(2) The specified interference level is total power within the receiver bandwidth.

(3) 57-59 (TDD), channel spacings should be more than twice that of FDD systems (turn over time).

(4) Sum of capacity for both directions.

TABLE 31

Digital P-MP FS system parameters in the FS frequency bands between 30 and 60 GHz

Frequency band (GHz)	30-40 GHz							
System No.	Hub No. 1	Remote No. 1	Hub No. 2	Remote No. 2	Hub No. 3	Remote No. 3	Hub No. 4	Remote No. 4
Capacity/data rate (Mbit/s)	DS-3 45	DS-3 45	OC-3 155	OC-3 155	250	250	OC-6 310	OC-6 310
Modulation type	OQPSK	OQPSK	16-QAM	16-QAM	64-QAM	64-QAM	256-QAM	256-QAM
Necessary bandwidth (MHz)	50	50	50	50	50	50	50	50
Tx power (dBW)	0	–13	5	–10	7	7	7	–4
Antenna gain (dBi)	16	29	18	33	9 to 23	39 to 48	28	39
Transmit e.i.r.p. (dBW)	16	16	23	23	16 to 30	46 to 55	35	35
Antenna beamwidth (degrees)	45 or 90	1.9	45 or 90	1.7	15 to 120	0.5 to 1	45 or 90	1.7
Antenna polarization	H/V	H/V	H/V	H/V	H/V	H/V	H/V	H/V
Rx noise figure (dB)	7	7	5	6	5	5	5	5
Rx noise temperature (K)	1 740	1 740	1 160	1 450	1 160	1 160	1 160	1 160
Rx sensitivity, (1×10^{-6} BER) (dBW)	–110	–110	–102	–101	–102.9	–102.9	–90	–90
Maximum interference (dB(W/MHz))	–146.2	–146.2	–148.0	–147.0	–148.8	–148.8	–148.0	–148.0

TABLE 32

Digital P-MP FS system parameters in the FS frequency bands between 30 and 60 GHz

Frequency band (GHz)	31.8-33.4											
Multiple access method	TDMA						FDMA					
Modulation	2-level		4-level		16-level		4-level		8-level		16-level	
Station type	CS	TS	CS	TS	CS	TS	CS	TS	CS	TS	CS	TS
Capacity/transmission rate (Mbit/s)/per sector	8 × 2 or equivalent	8 × 2 or equivalent	16 × 2 or equivalent	16 × 2 or equivalent	32 × 2 or equivalent	32 × 2 or equivalent	32	2	48	2	64	2
Channel spacing (MHz)	28	28	28	28	28	28	28	28	28	28	28	28
Tx necessary bandwidth (MHz)	28	28	28	28	28	28	28	1.5	28	1.1	28	0.8
Antenna gain (maximum) (dBi) Terminal dish/planar 90°/45°/15° sector planar	14/17/20	41/28	14/17/20	41/28	14/17/20	41/28	14/17/20	41/28	14/17/20	41/28	14/17/20	41/28
Feeder/multiplexer loss (minimum) (dB)	0	0	0	0	0	0	0	0	0	0	0	0
Antenna type	Sector	Dish	Sector	Dish	Sector	Dish	Sector	Dish	Sector	Dish	Sector	Dish
Antenna polarization	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H
Antenna beamwidth (3 dB) azimuth/elevation (degrees)	> 15	1.2/1.2	1 > 15	1.2/1.2	> 15	1.2/1.2	> 15	1.2/1.2	1 > 15	1.2/1.2	> 15	1.2/1.2
Maximum Tx output power (dBW)	–5	–10	–5	–10	–5	–10	–5	–20	–5	–20	–5	–20
e.i.r.p (maximum with/without ATPC) (dBW)	15	31/18	15	31/18	15	31/18	15	21/8	15	21/8	15	21/8
ATPC – range (dB)	10	□ 20	10	□ 20	10	□ 20	15	15	15	15	15	15
Receiver IF bandwidth (MHz)	28	28	28	28	28	28	28/1.3	1.3	28/1.3	1.1	28/0.75	0.75
Receiver noise figure (dB)	7	7	7	7	7	7	7	7	7	7	7	7
Receiver thermal noise (dBW)	–122.5	–122.5	–122.5	–122.5	–122.5	–122.5	–135	–135	–137	–137	–138	–138
Nominal Rx input level (dBW)												
Rx input level for 1×10^{-3} BER (dBW)	–116.5	–116.5	–114.5	–114.5	–105.5	–105.5	–127	–127	–126	–126	–121	–121
Range of cell radius (km)	7	7	5	5	2-3	2-3	5-6	5-6	4	4	2-3	2-3
Typical fade margin (dB)							23	23	20	20	18	18
Availability target (% time)	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
Nominal long-term interference[3], [4] (dBW)	–132.5	–132.5	–132.5	–132.5	–132.5	–132.5	–147	–147	–147	–147	–147	–147
Equivalent power (dB(W/4 kHz))												
Spectral density (dB(W/MHz))							–137	–137	–137	–137	–137	–137
Refer to Notes							(1), (2)	(1), (2)	(1), (2)	(1), (2)	(1), (2)	(1), (2)

TS: Terminal station

(1) For a 2 Mbit/s signal, maximum Tx. Output CS refers to total output.

(2) Code rate 3/4.

(3) Specified interference will reduce system *C*/*N* by 0.5 dB (interference 10 dB below receiver thermal noise floor).

(4) The specified interference level is total power within the receiver bandwidth.

TABLE 33

Digital P-MP FS system parameters in the FS frequency bands between 30 and 60 GHz

Frequency band (GHz)	37.0-40.0											
Multiple access method	TDMA						FDMA					
Modulation	2-level		4-level		16-level		4-level		8-level		16-level	
Station type	CS	TS	CS	TS	CS	TS	CS	TS	CS	TS	CS	TS
Capacity/transmission rate (Mbit/s)/ per sector	8 × 2 or equivalent	8 × 2 or equivalent	16 × 2 or equivalent	16 × 2 or equivalent	32 × 2 or equivalent	32 × 2 or equivalent	32	2	48	2	64	2
Channel spacing (MHz)	28	28	28	28	28	28	28	28	28	28	28	28
Tx necessary bandwidth (MHz)	28	28	28	28	28	28	28	1.5	28	1.1	28	0.8
Antenna gain (maximum) (dBi) Terminal dish/planar 90°/45°/15° sector planar	14/17/20	41/28	14/17/20	41/28	14/17/20	41/28	14/17/20	41/28	14/17/20	41/28	14/17/20	41/28
Feeder/multiplexer loss (minimum) (dB)	0	0	0	0	0	0	0	0	0	0	0	0
Antenna type	Sector	Dish	Sector	Dish	Sector	Dish	Sector	Dish	Sector	Dish	Sector	Dish
Antenna polarization	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H
Antenna beamwidth (3 dB) azimuth/elevation (degrees)	> 15	1.2/1.2	1 > 15	1.2/1.2	> 15	1.2/1.2	> 15	1.2/1.2	1 > 15	1.2/1.2	> 15	1.2/1.2
Maximum Tx output power (dBW)	–5	–10	–5	–10	–5	–10	–5	–20	–5	–20	–5	–20
e.i.r.p (maximum with/without ATPC) (dBW)	15	31/18	15	31/18	15	31/18	15	21/8	15	21/8	15	21/8
ATPC – range (dB)	10	> 20	10	> 20	10	> 20	15	15	15	15	15	15
Receiver IF bandwidth (MHz)	28	28	28	28	28	28	28/1.3	1.3	28/1.3	1.1	28/0.75	0.75
Receiver noise figure (dB)	8	8	8	8	8	8	7	7	7	7	7	7
Receiver thermal noise (dBW)	–121.5	–121.5	–121.5	–121.5	–121.5	–121.5	–135	–135	–137	–137	–138	–138
Nominal Rx input level (dBW)												
Rx input level for 1×10^{-3} BER (dBW)	–115.5	–115.5	–113.5	–113.5	–104.5	–104.5	–127	–127	–126	–126	–121	–121
Range of cell radius (km)	5-6	5-6	4	4	2	2	4	4	3	3	1-2	1-2
Typical fade margin (dB)							23	23	20	20	18	18
Availability target (% time)	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
Nominal long-term interference[3], [4] (dBW)	–131.5	–131.5	–131.5	–131.5	–131.5	–131.5	–147	–147	–147	–147	–147	–147
Equivalent power (dB(W/4 kHz))												
Spectral density (dB(W/MHz))							–137	–137	–137	–137	–137	–137
Refer to Notes							[1], [2]	[1], [2]	[1], [2]	[1], [2]	[1], [2]	[1], [2]

[1] For a 2 Mbit/s signal, maximum Tx. Output CS refers to total output.

[2] Code rate 3/4.

[3] Specified interference will reduce system *C*/*N* by 0.5 dB (interference 10 dB below receiver thermal noise floor).

[4] The specified interference level is total power within the receiver bandwidth.

TABLE 34

Digital P-P FS system parameters in the FS frequency bands above 60 GHz

Frequency band (GHz)	64-66 (FDD)					64-66 (TDD)				64-66 (FDD)		
Modulation	4-FSK	4-FSK	4-FSK	4-FSK	16-QAM	4-FSK	4-FSK	4-FSK	4-FSK	4-FSK	4-FSK	4-FSK
Capacity (Mbit/s)	2 × 2	8	2 × 8	34	155	2 × 2(x)	4 × 2(x)	2 × 8(x)	4 × 8(x)	1.544	6.2	45
Channel spacing (MHz)	3.5	7	14	28	56	3.5	7	14	28	2.5	5	40
Antenna gain (maximum) (dBi)	46*	46*	46*	46*	46*	46*	46*	46*	46*	37**	37**	37**
Feeder/multiplexer loss (minimum) (dB)	0	0	0	0	0	0	0	0	0	0	0	0
Antenna type	Dish, horn	Dish, horn	Dish, horn	Dish, horn	Dish, horn	Dish, horn	Dish, horn	Dish, horn	Dish, horn	Dish, horn	Dish	Dish
Maximum Tx output power (dBW)	–20	–20	–20	–20	–20	–20	–20	–20	–20	–10	–10	0
e.i.r.p. (maximum) (dBW)	25	25	25	25	25	25	25	25	25	27	27	37
Receiver IF bandwidth (MHz)	2	4	8	17	40					2.5	5	40
Receiver noise figure (dB)	12	12	12	12	9					10	10	10
Receiver thermal noise (dBW)	–129	–126	–123	–120	–119					–130	–127	–118
Nominal Rx input level (dBW)	–109 + M	–106 + M	–103 + M	–100 + M	–98 + M							
Rx input level for 1×10^{-3} BER (dBW)	–112	–109	–106	–103	–101					–122	–116	–107.5
Nominal long-term interference (dBW)	–139	–136	–133	–130	–129					–140	–137	–128
Equivalent power (dB(W/4 kHz))												
Spectral density (dB(W/MHz))	–142	–142	–142	–142	–145					–144	–144	–144
Refer to Notes	(1), (2)	(1), (2)	(1), (2)	(1), (2)	(1), (2)					(1), (2)	(1), (2)	(1), (2)

(x) Sum of capacity for both directions.

* 0.45 m dish assumed.

** 0.3 m dish assumed.

(1) Specified interference will reduce system *C*/*N* by 0.5 dB (interference 10 dB below receiver thermal noise floor).

(2) The specified interference level is total power within the receiver bandwidth.

TABLE 35

Digital P-MP FS system parameters in the FS frequency bands between 30 and 60 GHz

Frequency band (GHz)	51.4-52.6											
Multiple access method	TDMA						FDMA					
Modulation	2-level		4-level		16-level		4-level		8-level		16-level	
Station type	CS	TS	CS	TS	CS	TS	CS	TS	CS	TS	CS	TS
Capacity/transmission rate (Mbit/s)/ per sector	8 × 2 or equivalent	8 × 2 or equivalent	16 × 2 or equivalent	16 × 2 or equivalent	32 × 2 or equivalent	32 × 2 or equivalent	32	2	48	2	64	2
Channel spacing (MHz)	28	28	28	28	28	28	28	28	28	28	28	28
Tx necessary bandwidth (MHz)	28	28	28	28	28	28	28	1.5	28	1.1	28	0.8
Antenna gain (maximum) (dBi) Terminal dish/planar 90°/45°/15° sector planar	14/17/20	41/28	14/17/20	41/28	14/17/20	41/28	14/17/20	41/28	14/17/20	41/28	14/17/20	41/28
Feeder/multiplexer loss (minimum) (dB)	0	0	0	0	0	0	0	0	0	0	0	0
Antenna type	Sector	Dish	Sector	Dish	Sector	Dish	Sector	Dish	Sector	Dish	Sector	Dish
Antenna polarization	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H	V/H
Antenna beamwidth (3 dB) azimuth/elevation (degrees)	> 15	1.2/1.2	1 > 15	1.2/1.2	> 15	1.2/1.2	> 15	1.2/1.2	> 15	1.2/1.2	> 15	1.2/1.2
Maximum Tx output power (dBW)	–10	–15	–10	–15	–10	–15	–5	–20	–5	–20	–5	–20
e.i.r.p (maximum with/without ATPC) (dBW)	10	26/13	10	26/13	10	26/13	15	21/8	15	21/8	15	21/8
ATPC – range (dB)	10	> 15	10	> 15	10	> 15	15	15	15	15	15	15
Receiver IF bandwidth (MHz)	28	28	28	28	28	28	28/1.3	1.3	28/1.3	1.1	28/0.75	0.75
Receiver noise figure (dB)	10	10	10	10	10	10	7	7	7	7	7	7
Receiver thermal noise (dBW)	–119.5	–119.5	–119.5	–119.5	–119.5	–119.5	–135	–135	–137	–137	–138	–138
Nominal Rx input level (dBW)												
Rx input level for 1×10^{-3} BER (dBW)	–113.5	–113.5	–111.5	–111.5	–102.5	–102.5	–127	–127	–126	–126	–121	–121
Range of cell radius (km)	4	4	2-3	2-3	< 1	< 1	2-3	2-3	1-2	1-2	< 1	< 1
Typical fade margin (dB)							23	23	15–20	15–20	15–20	15–20
Availability target (% time)	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
Nominal long-term interference (dBW)[3, 4]	–129.5	–129.5	–129.5	–129.5	–129.5	–129.5	–147	–147	–147	–147	–147	–147
Equivalent power (dB(W/4 kHz))												
Spectral density (dB(W/MHz))							–137	–137	–137	–137	–137	–137
Refer to Notes							[1], [2]	[1], [2]	[1], [2]	[1], [2]	[1], [2]	[1], [2]

[1] For a 2 Mbit/s signal, maximum Tx. Output CS refers to total output.

[2] Code rate 3/4.

[3] Specified interference will reduce system *C*/*N* by 0.5 dB (interference 10 dB below receiver thermal noise floor).

[4] The specified interference level is total power within the receiver bandwidth.

TABLE 36

Examples and representative characteristics of multimedia wireless systems in the range 40.5 to 43.5 GHz

Parameter	Uplink/downlink
Frequency band (GHz)	40.5-43.5
System type	Mesh
RF Tx rate (Mbit/s)(1)	100 maximum
Modulation scheme(2)	QPSK
Tx power (dBW)	–10
Antenna polarization(3)	Circular
Antenna gain (dBi)	22-35
Feeder/antenna system loss (dB)(4)	2-6
Max e.i.r.p. (dBW)	6-23
Rx bandwidth (MHz)(5)	10-75
Rx thermal noise (dBW)(6)	–120
Rx threshold (dBW)	–107
Maximum interference (dB(W/MHz))(7)	–149
Availability targets (%)(8)	99.9-99.999
Fade margin (dB)	10-30
Path length (km)	1-5
User capacity	64 kbit/s-40 Mbit/s, full duplex

(1) Could be lower depending on the traffic requirements.

(2) Higher order schemes are under study.

(3) Vertical under study.

(4) For bands above 20 GHz, current FS installations have outdoor applications; indoor applications are possibly found as custom arrangement. Feeder losses, whenever mentioned, are considered as ranging from 0 dB to the value mentioned in the Table.

(5) Dependant on the delivered bit rate.

(6) For a 75 MHz bandwidth.

(7) At the receiver input and based on a 0.5 dB degradation in C/N. Therefore the maximum interferer is assumed to be 10 dB below receiver thermal noise ($I/N = -10$ dB).

(8) Dependant on the market sector addressed.

TABLE 37

Representative characteristics of microwave video distribution systems (MVDS) and associated multi-user access systems operating in the range 40.5-43.5 GHz

System type	Digital MVDS	Multi-access (downlink)	Multi-access (uplink)
Data rate (Mbit/s)	34	≤ 11 (adaptive)	≤ 11 (adaptive)
Modulation type	QPSK	Multi-symbol QPSK	Multi-symbol QPSK
Channel width (MHz)	39	19.5	19.5
Transmit power (dBW)	–3	–6	–12
Transmit antenna gain (dBi)	15	15	38
Transmit e.i.r.p. (dBW)	12	9	26
Transmit antenna azimuth beamwidth (degrees)	64	64	2
Antenna polarization	H/V	H/V	H/V
Receive antenna gain (dBi)	32	38	15
Receiver noise figure (dB)	7	8	7
Receiver noise temperature (K)	1 163	1 540	1 163
Receiver sensitivity for 1×10^{-6} BER (dBW)	–109	–114	–115
Maximum interference (dB(W/MHz))	–148	–147	–148

NOTE 1 – The data for the representative digital MVDS system conforms to that used in some national standards.

NOTE 2 – Channel width indicates the bandwidth that needs to be allocated for transmissions of the stated type; the effective receiver bandwidth will be adaptive and appropriate to the delivered bit rate.

NOTE 3 – Receive antenna gain is the peak value (with no derating for pointing inaccuracy); this is the relevant figure for assessing the effect of external interference.

NOTE 4 – The maximum interference level has been set for a maximum $I/N = -10$ dB where N is the receiver thermal noise floor.

TABLE 38

Representative characteristics of a 42 GHz interactive MVDS system

	Hub	Remote
Modulation	QPSK/16-QAM	D-QPSK
Bandwidth (MHz)	8/36	2/10
Tx power maximum (dBW)	0	–10
Antenna gain[(1)] (dBi)	15	34
Antenna beamwidth[(1)] (degrees)	64	2
Polarization	H/V	H/V
Rx noise figure (dB)	5	6
Rx sensitivity (BER 1×10^{-6})	–118	–124
Maximum interference (dB(W/MHz))	–150.5	–149

(1) Omnidirectional antennas or further sectorization may also be used.

TABLE 39

Analogue P-P FS system parameters in the FS frequency bands below 1 GHz

Frequency band (GHz)	0.81-0.96			
Modulation	FM-FDM	FM-FDM	FM	FM-FDM
Capacity	52	52	Prog	1 channel
Channel spacing	25-200 kHz	500 kHz	25 kHz	2 MHz
Antenna gain (maximum) (dBi)	27	27	18	27
Feeder/multiplexer loss (minimum) (dB)	0	0	0	0
Antenna type	Dish	Dish	Dish	Dish
Maximum Tx output power (dBW)	13	13	10	13
e.i.r.p. (maximum) (dBW)	40	40	38	40
Receiver IF bandwidth (kHz)	25-200	500	25	2 MHz
Receiver noise figure (dB)	5	5	5	5
Receiver thermal noise (dBW)	–155 to –146	–142	–155	–136
Nominal Rx input level (dBW)	–	–	–	–
Rx input level for 1×10^{-3} BER (dBW)	–	–	–	–
Nominal long-term interference (dBW)	–	–	–	–
Equivalent power (dB(W/4 kHz))	–	–	–	–
Spectral density (dB(W/MHz))	–	–	–	–
Refer to Notes	–	–	–	–

TABLE 40

Analogue P-P FS system parameters in the FS frequency bands between 1 and 3 GHz

Frequency band (GHz)	1.45-1.53			1.67-1.69
Modulation	FDM-FM	FDM-FM	FDM-FM	FDM-FM
Capacity	36 channels	8 channels	2 channels	2 channels
Channel spacing (MHz)	0.5	0.2	0.05	0.05
Antenna gain (maximum) (dBi)	33	33	33	33
Feeder/multiplexer loss (minimum) (dB)	1	1	1	1
Antenna type	Dish	Yagi	Yagi	Yagi
Maximum Tx output power (dBW)	7	7	10	10
e.i.r.p. (maximum) (dBW)	39	39	42	42
Receiver IF bandwidth (MHz)	0.4	0.3	0.04	0.04
Receiver noise figure (dB)	8	8	8	8
Receiver thermal noise (dBW)	–140	–141	–149	
Nominal Rx input level (dBW)	–80	–93	–105	
Rx input level for 1×10^{-3} BER (dBW)	N/A	N/A	N/A	
Nominal long-term interference (dBW)	–150	–151	–158	–159
Equivalent power (dB(W/4 kHz))	–170	–170	–169	
Spectral density (dB(W/MHz))	–	–	–	–169
Refer to Notes	(1), (2)	(1), (2)	(1), (2)	(1), (2)

N/A: Not applicable.

(1) Specified interference will reduce system *C*/*N* by 0.5 dB (interference 10 dB below receiver thermal noise floor).

(2) The specified interference level should be divided by the receiver bandwidth to obtain an average spectral density. The interference spectral density, averaged over any 4 kHz within the receiver bandwidth, must not exceed this value.

TABLE 41

Analogue P-P FS system parameters in the FS frequency bands between 1 and 3 GHz

Frequency band (GHz)	1.7-2.45									
Modulation	FM-TVOB	FM-FDM	FM-MLT-PT		FM-TV	FM-FDM	FM-FDM tropos.	FM-FDM	FM-FDM	FM-QAM
Capacity	625-line PAL	60-132 channels	94 channels		625-line PAL	960 channels	72-312 channels	1-6 channels	600 channels	1 TV . 2 Mbit/s
Channel spacing (MHz)	Variable	14/1	3.5		29	29	Special	0.4	28	3.5
			CS	OS						
Antenna gain (maximum) (dBi)	25	31	10	19	34	34	49	25	35.7	32
Feeder/multiplexer loss (minimum) (dB)	0	5	3	3	5	3	2	3	3.5	6
Antenna type	1.2 m dish	2.4 m dish	Omni	Horn	3.7 m dish	3.7 m dish	12 m dish	Yagi	Dish	3 m dish
Maximum Tx output power (dBW)	7	7	4	4	10	7	28	10	–5.2	5
e.i.r.p. (maximum) (dBW)	32	33	13	22	39	38	75	32	27	37
Receiver IF bandwidth (MHz)	30	2.8	2	2	40	40	6	0.15	20	3
Receiver noise figure (dB)	8	7	9	9	10	10	2	4	10	4
Receiver thermal noise (dBW)	–121	–133	–132	–132	–118	–118	–132	–148	–	–135
Nominal Rx input level (dBW)	–65	–79	–97	–97	–68	–64	–	–78	–78	
Rx input level for 1×10^{-3} BER (dBW)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Nominal long-term interference (dBW)	–127	–143	–142	–142	–128	–129	–138	–158		–141
Equivalent power (dB(W/4 kHz))	–	–172	–169	–169	–	–169	–172	–174		–170
Spectral density (dB(W/MHz))	–142	–	–	–	–144	–	–	–		–
Refer to Notes	(1), (4)	(2), (5)	(2), (5)	(2), (3)	(2), (4)	(2), (3)	(1), (3)	(2), (3)	(3), (5)	

TVOB: Temporary TV outside broadcast (ENG) link.

CS: Central station.

OS: Out station.

N/A: Not applicable.

(1) Specified interference will reduce system *C*/*N* by 1 dB (interference 6 dB below receiver thermal noise floor).

(2) Specified interference will reduce system *C*/*N* by 0.5 dB (interference 10 dB below receiver thermal noise floor).

(3) Specified interference will have a relative contribution of no more than 10% of total noise.

(4) The specified interference level is total power within the receiver bandwidth.

(5) The specified interference level should be divided by the receiver bandwidth to obtain an average spectral density. The interference spectral density, averaged over any 4 kHz within the receiver bandwidth, must not exceed this value.

TABLE 42

Analogue P-P FS system parameters in the FS frequency bands between 1 and 3 GHz

Frequency band (GHz)	2.1-2.2			2.45-2.69	
Modulation	FDM-FM	FDM-FM	FDM-FM	FM-FDM tropos	FM-TVOB
Capacity	48 channels	96 channels	252 channels	17-312 channels	625-line PAL
Channel spacing (MHz)	0.8	1.6	3.5	Special	Variable
Antenna gain (maximum) (dBi)	38	38	38	49	18
Feeder/multiplexer loss (minimum) (dB)	0	0	0	2	1
Antenna type	Dish	Dish	Dish	12 m dish	Dish
Maximum Tx output power (dBW)	+8	+8	+8	28	7
e.i.r.p. (maximum) (dBW)	46	46	46	75	32
Receiver IF bandwidth (MHz)	2.5	6.0	12.0	6	30
Receiver noise figure (dB)	5	5	5	2	6
Receiver thermal noise (dBW)	–140	–137	–134	–132	–123
Nominal Rx input level (dBW)	–60	–60	–60	–65	–55
Rx input level for 1×10^{-3} BER (dBW)	–121	–118	–114	N/A	N/A
Nominal long-term interference (dBW)	–150	–147	–144	–138	–123
Equivalent power (dB(W/4 kHz))	–173	–173	–173	–172	–
Spectral density (dB(W/MHz))				–	–129
Refer to Notes	(2), (3), (4)	(2), (3), (4)	(2), (3), (4)	(1), (4)	

CS: Central station. N/A: Not applicable.

OS: Out station. TVOB: Temporary TV outside broadcast (ENG) link.

(1) Specified interference will reduce system *C*/*N* by 1 dB (interference 6 dB below receiver thermal noise floor).

(2) Specified interference will reduce system *C*/*N* by 0.5 dB (interference 10 dB below receiver thermal noise floor).

(3) The specified interference level is total power within the receiver bandwidth.

(4) The specified interference level should be divided by the receiver bandwidth to obtain an average spectral density. The interference spectral density, averaged over any 4 kHz within the receiver bandwidth, must not exceed this value.

TABLE 43

Analogue P-P FS system parameters in the FS frequency bands between 3 and 10 GHz

Frequency band (GHz)	3.6-4.2	5.85-6.425	6.425-7.11
Modulation	FM/FDM	FM-FDM	FM
Capacity	1 800 channels	1 800 channels	TV
Channel spacing (MHz)	29	29.65	20
Antenna gain (maximum) (dBi)	41	45	45
Feeder/multiplexer loss (minimum) (dB)	3	4	5
Antenna type	3.7 m dish	3.7 m dish	3.7 m dish
Maximum Tx output power (dBW)	13	13	10
e.i.r.p. (maximum) (dBW)	51	55	50
Receiver IF bandwidth (MHz)	46	40	28
Receiver noise figure (dB)	8.5	8	8.5
Receiver thermal noise (dBW)	–119	–121	–122
Nominal Rx input level (dBW)	– 47	–60	–60.5
Rx input level for 1×10^{-3} BER (dBW)	N/A	N/A	N/A
Nominal long-term interference (dBW)	–129	–131	–132
Equivalent power (dB(W/4 kHz)	–170	–171	–170
Spectral density (dB(W/MHz))	–	–	–
Refer to Notes	(1), (2)	(1), (2)	(1), (3)

N/A: Not applicable.

(1) Specified interference will reduce system *C*/*N* by 0.5 dB (interference 10 dB below receiver thermal noise floor).

(2) The specified interference level is total power within the receiver bandwidth.

(3) The specified interference level should be divided by the receiver bandwidth to obtain an average spectral density. The interference spectral density, averaged over any 4 kHz within the receiver bandwidth, must not exceed this value.

TABLE 44

Analogue P-P FS system parameters in the FS frequency bands between 3 and 10 GHz

Frequency band (GHz)	3.4-3.6	5.850-5.925	6.425-6.570	6.570-6.870	6.5-6.9		6.870-7.125	7.425-7.750
Modulation	AM	FM	FM	FM	FDM-FM		FM	FM
Capacity	TV	TV	TV	600 channels	300 channels	600 channels	TV	960 channels
Channel spacing (MHz)	6	18	18	10	5	10	25	20
Antenna gain (maximum) (dBi)	40	40	40	45	47	47	40	46
Feeder/multiplexer loss (minimum) (dB)	T:4.0 R:4.0	T:4.0 R:4.0	T:4.0 R:4.0	T:2.0 R:4.5	0	0	T:4.0 R:4.0	T:2.0 R:5.0
Antenna type	Dish	Dish	Dish	Dish	Dish	Dish	Dish	Dish
Maximum Tx output power (dBW)	17.6	17.6	17.6	10	+3	+3	17.6	10
e.i.r.p. (maximum) (dBW)	55	55	55	53	50	50	55	54
Receiver IF bandwidth (MHz)	5.0	17.0	17.0	20.0	15	28	25.0	27.0
Receiver noise figure (dB)	6	6	6	7	5	5	6	7
Receiver thermal noise (dBW)	–132.0	–130.4	–130.4	–124.0	–127	–125	–129.1	–122.7
Nominal Rx input level (dBW)	–70	–70	–70	–75	–60	–60	–70	–70

TABLE 45

Analogue P-P FS system parameters in the FS frequency bands between 10 and 30 GHz

Frequency band (GHz)	10.7-11.7		13/14	14.4-15.35	21.12-23.6
Modulation	FM-FDM	FM-TV	FM	FM-FDM	FM
Capacity	960 channels	625-line PAL	1 video	2 700 channels	1 video
Channel spacing (MHz)	40	40	28	40	28
Antenna gain (maximum) (dBi)	47	47	49	52	47
Feeder/multiplexer loss (minimum) (dB)	5	5	0	5	0
Antenna type	2.5 m dish	2.5m dish	Dish	Dish	Dish
Maximum Tx output power (dBW)	10	10	10	3	0
e.i.r.p. (maximum) (dBW)	52	52	45	50	50
Receiver IF bandwidth (MHz)	29	29	24	56	24
Receiver noise figure (dB)	7	8	10	10	9
Receiver thermal noise (dBW)	–121	–121	–120		–121
Nominal Rx input level (dBW)	–65	–65	–65	–48	–84 + M
Rx input level for 1×10^{-3} BER (dBW)	N/A	N/A	N/A		N/A
Nominal long-term interference (dBW)	–131	–131	–130		–131
Equivalent power (dB(W/4 kHz))	–170	–	–		–
Spectral density (dB(W/MHz))	–	–146	–144		–143
Refer to Notes	(2), (5)	(2), (4)	(1), (4)		(1), (4)

M: Fade margin.

N/A: Not applicable.

(1) Specified interference will reduce system *C*/*N* by 1 dB (interference 6 dB below receiver thermal noise floor).

(2) Specified interference will reduce system *C*/*N* by 0.5 dB (interference 10 dB below receiver thermal noise floor).

(3) Specified interference will have a relative contribution of no more than 10% of total noise.

(4) The specified interference level is total power within the receiver bandwidth.

(5) The specified interference level should be divided by the receiver bandwidth to obtain an average spectral density. The interference spectral density, averaged over any 4 kHz within the receiver bandwidth, must not exceed this value.

TABLE 46

Analogue P-P FS system parameters in the FS frequency bands between 30 and 60 GHz

Frequency band (GHz)	37-39.5		54.25-57.2	
Modulation	FM	FM	FM	FM
Capacity	1 video	1 video	1 video	1 video
Channel spacing (MHz)	28	56	28	56
Antenna gain (maximum) (dBi)	47	47	47	47
Feeder/multiplexer loss (minimum) (dB)	0	0	0	0
Antenna type	Dish	Dish	Dish	Dish
Maximum Tx output power (dBW)	0	0	–10	–10
e.i.r.p. (maximum) (dBW)	47	47	37	37
Receiver IF bandwidth (MHz)	16	40	16	40
Receiver noise figure (dB)	12	12	12	12
Receiver thermal noise (dBW)	–120	–116	–120	–116
Nominal Rx input level (dBW)	–98 + M	–85 + M	–98 + M	–85 + M
Rx input level for 1×10^{-3} BER (dBW)	N/A	N/A	N/A	N/A
Nominal long-term interference (dBW)	–130	–126	–130	–126
Equivalent power (dB(W/4 kHz))	–	–	–	–
Spectral density (dB(W/MHz))	–142	–142	–142	–142
Refer to Notes	(1), (2)	(1), (2)	(1), (2)	(1), (2)

(1) Specified interference will reduce system *C*/*N* by 1 dB (interference 6 dB below receiver thermal noise floor).

(2) The specified interference level is total power within the receiver bandwidth.

Annex 1

Additional technical characteristics of some FS systems in the 1-3 GHz band

1 Introduction

This Annex provides the characteristics of FS systems, operating in the 1-3 GHz band. Where applicable both typical and the most sensitive parameters are detailed:

– § 3 – Characteristics of digital point-to-point systems;

– § 4 – Characteristics of analogue point-to-point systems;

– § 5 – Characteristics of P-MP systems.

2 Use of ATPC (automatic transmit power control) in digital systems

ATPC has been implemented to facilitate intra-service sharing and coordination based on lower transmit power. During fade conditions the power level is increased for a short duration to overcome the loss of the desired signal. There are two problems associated with the use of ATPC to overcome interference. First, because the transmitter operates at the lower power levels for almost all of the time, the receiver is more sensitive to short-term interference events. The other is that the receiver may be more sensitive to the effects of long-term interference (see Recommendation ITU-R F.1495). The high power levels that would be used for short time periods during fading may impact sharing with other services receiving interference from FS transmitters.

Although there are indirect methods for sensing the potential performance degradations due to interference, the implementation of these techniques may not be considered appropriate in responding to interference as the increased transmitter power levels may make both intra- and inter-service sharing more difficult.

3 Characteristics of digital point-to-point systems

3.1 Typical characteristics

Three different digital systems are described in Table 47 as they represent three different uses of FS systems:

– 64 kbit/s capacity used for example for outside-plant (individual subscriber connection);

– 2 Mbit/s capacity used for example for professional subscriber connection or local part of the inside-plant;

– 45 Mbit/s capacity used for example for trunk network.

These interference values (for long-term interference) correspond to a degradation in the receiver threshold of 1 dB or less.

As indicated in Note 1 of § 4 in the main part of this Report, it must be noted that in order to simplify the Table, only the interfering carrier level corresponding to the 1×10^{-3} BER is included. Equally important are the 1×10^{-6} and 1×10^{-10} BER objectives, used in the evaluation of permissible degradation. Typically, the carrier level corresponding to 1×10^{-6} BER is around 4 dB higher than that for 1×10^{-3} BER; the carrier level difference between 1×10^{-6} and 1×10^{-10} BER points is also about 4 dB.

TABLE 47

Capacity	64 kbit/s	2 Mbit/s	45 Mbit/s
Modulation	QPSK	8-PSK	64-QAM
Antenna gain (dBi)	33	33	33
Transmit power (dBW)	7	7	1
Feeder/multiplexer loss (dB)	2	2	2
e.i.r.p. (dBW)	38	38	32
Receiver IF bandwidth (MHz)	0.032	0.7	10
Receiver noise figure (dB)	4	4.5	4
Receiver input level for a BER of 1×10^{-3} (dBW)	–137	–120	–106
Maximum long-term interference total power (dBW)	–165	–151	–136
Maximum long-term interference power spectral density (dB(W/4 kHz))	–174	–173	–170

It must be pointed out that when considering maximum power spectral density for a long-term interference, the three values are about the same (only 4 dB difference).

3.2 FS antenna pattern

Recommendations ITU-R F.699, ITU-R F.1245 and ITU-R F.1336 are appropriate.

4 Characteristics of analogue point-to-point radio-relay systems

The types of analogue point-to-point systems operating in the 1-3 GHz bands comprise of telephony, FM-TV and electronic news gathering (ENG) links. A reference set of characteristics has been extracted from Tables 40, 41 and 42 of this Report, Table 1 of Recommendation ITU-R F.759 – The use of frequencies in the band 500 to 3 000 MHz for radio-relay systems and from Recommendation ITU-R SF.358 – Maximum permissible values of power flux-density at the surface of the Earth produced by satellites in the fixed-satellite service using the same frequency bands above 1 GHz as line-of-sight radio-relay systems, which details the analogue hypothetical reference circuit currently used within ITU-R SF-series Recommendations on sharing studies.

4.1 Typical FS analogue characteristics operating in the 1-3 GHz bands

Antenna envelope characteristic: Recommendations ITU-R F.699, ITU-R F.1245 and ITU-R F.1336.

Antenna gain: 33 dBi

e.i.r.p.: 36 dBW

Feeder/multiplexer loss: 3 dB

Receiver noise figure (referred to input of receiver): 8 dB

Long-term interference limit per link (20% of time): –170 dB(W/4 kHz).

4.2 ITU-R analogue hypothetical reference connection (HRC) characteristics

Hop length: 50 km

Number of hops: 50

Antenna gain: 33 dBi

Feeder loss: 3 dB

Receiver noise figure (referred to input of receiver): 8 dB

Total route baseband noise power limit: 1 000 pW0p.

5 Characteristics of P-MP systems

The information presented in Tables 48 and 49 summarizes typical and worst-case basic parameters in the range 1-3 GHz.

TABLE 48

Typical characteristics

Parameter	Central station	Out station
Antenna type	Omni/sector	Dish/horn
Antenna gain (dBi)	10/13	20 (analogue) 27 (digital)
e.i.r.p. (maximum) (dBW): – analogue – digital	 12 24	 21 34
Noise figure (dB)	3.5	3.5
Feeder loss (dB)	2	2
IF bandwidth (MHz)	3.5	3.5
Maximum permissible long-term interference power (20% time): – total (dBW) – (dB(W/4 kHz)) – (dB(W/MHz))	 –142 –170 –147	 –142 –170 –147

TABLE 49

Worst-case characteristics

Parameter	Central station	Out station
Antenna type	Omni/sector	Dish/horn
Antenna gain (dBi)	13/21[(1)]	27/12
e.i.r.p. (maximum) (dBW): – analogue – digital	 23 24	 23 34
IF bandwidth (MHz)	6[(2)]	6[(2)]

(1) A 2 dBi antenna is used in some countries in the band 1 452-1 492 MHz.

(2) 6 MHz bandwidths used by AM-DSB MVDS applications in the United States of America in the frequency bands 2 150-2 162 MHz and 2 500-2 690 MHz.

6 Basic sharing parameters for P-MP systems in the frequency range 1-3 GHz

The characteristics of P-MP systems currently being deployed for local access use by at least one administration are summarized in Table 50. These systems are designed to operate in the 2 025-2 110 MHz and 2 200-2 290 MHz bands.

TABLE 50

Characteristics of an example CDMA local access radio system

Frequency band (GHz)	2	
System type	Fixed P-MP (CDMA)	
RF transmission rate (kbit/s)	2 048	
Modulation	4-PSK	
	Central station	Out station
Transmit power (dBW)	–10.0 (per out station)	–10.0
Antenna polarization	Vertical	Vertical
Antenna maximum gain (dBi)	10	9
Feeder loss (dB)	3.5	0
Maximum e.i.r.p. (dBW)	–3.5 per out station(1)	–1.0(2)
Receiver IF bandwidth (MHz)	3.2	3.2
Receiver thermal noise (dBW)	–134.0	–134.0
Receiver threshold (BER 1×10^{-7})(3) (dBW)	–135.0	–135.0
Maximum long-term interference power (dB(W/MHz))	–150.0	–150.0
Availability target (% of time)	99.99	99.99
Typical fade margin (dB)	< 20	< 20
Path length (km)	1-15	1-15

(1) Maximum e.i.r.p.: 8.5 dBW.

(2) APC is employed, therefore typical powers may be 0-20 dB less.

(3) Typical signal level for a system with 15 out stations.

The characteristics of another example P-MP system are summarized in Table 51 and Fig. 1. These systems are designed to operate in the bands 2 076-2 111 MHz and 2 300-2 400 MHz.

For the central station is appropriate in the absence of further information regarding the out-station antenna pattern, the reference pattern of Recommendations ITU-R F.699, ITU-R F.1245 and ITU-R F.1336 should be assumed.

TABLE 51

Characteristics of an example multipoint distribution system (MDS)

Frequency bands (MHz)		2 076-2 111 and 2 300-2 400	
System type		Fixed P-MP	
Modulation		Not specified – mainly AM-VSB	
Channel bandwidth (MHz)		7	
Emission mask		See Fig. 1	
	Main station	Repeater station	Outstation
e.i.r.p. (maximum) (dBW)(1)	30(1)	< 30(1)	Receive only
Antenna type	Omnidirectional in horizontal plane	Directional	Directional

(1) Transmission power at angles of elevation of 5° or more above the horizontal plane must not exceed the following e.i.r.p. limits:

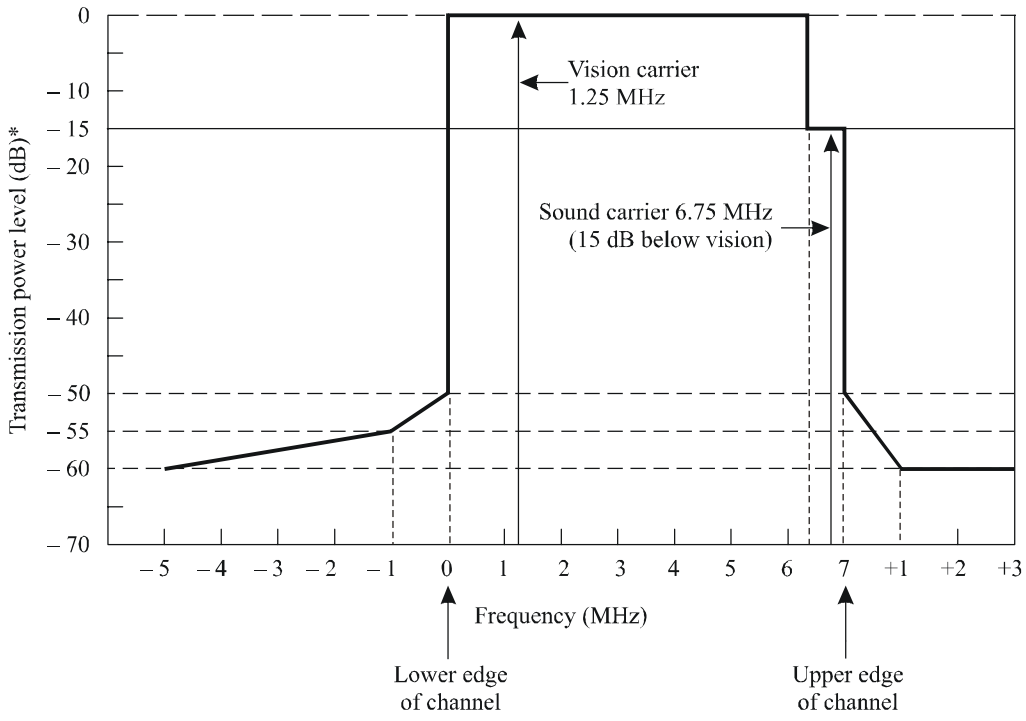
– 100 W at 5°, decreasing linearly to 31.6 W at 10°;
– 31.6 W between 10° and 15°;
– 31.6 W at 15°, decreasing linearly to 10 W at 20°; and
– 10 W between 20° and 90°.

NOTE 1 – Coordination level for protection of MDS receivers anywhere within service area is −146.2 dB(W/(m^2 · 4 kHz)).

Figure 1 shows the emission mask. The location shown for video and sound carriers applies when analogue PAL television signal is transmitted. Other signal formats are permitted, including video and data transmission using digital modulation, if they conform to this emission mask.

FIGURE 1

Transmission mask (emission limits)



* Power level relative to maximum power.

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Annex 2[1]

FS antenna size in sharing studies

1 Interference considerations

Three cases for interference calculations are given below: coordination area around a satellite earth station, interference from GSO satellites and interference from non-GSO satellites. See Fig. 2.

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[1] Annex 2 is a modified Annex 4 of Recommendation ITU-R F.758-4.

2 Earth station coordination

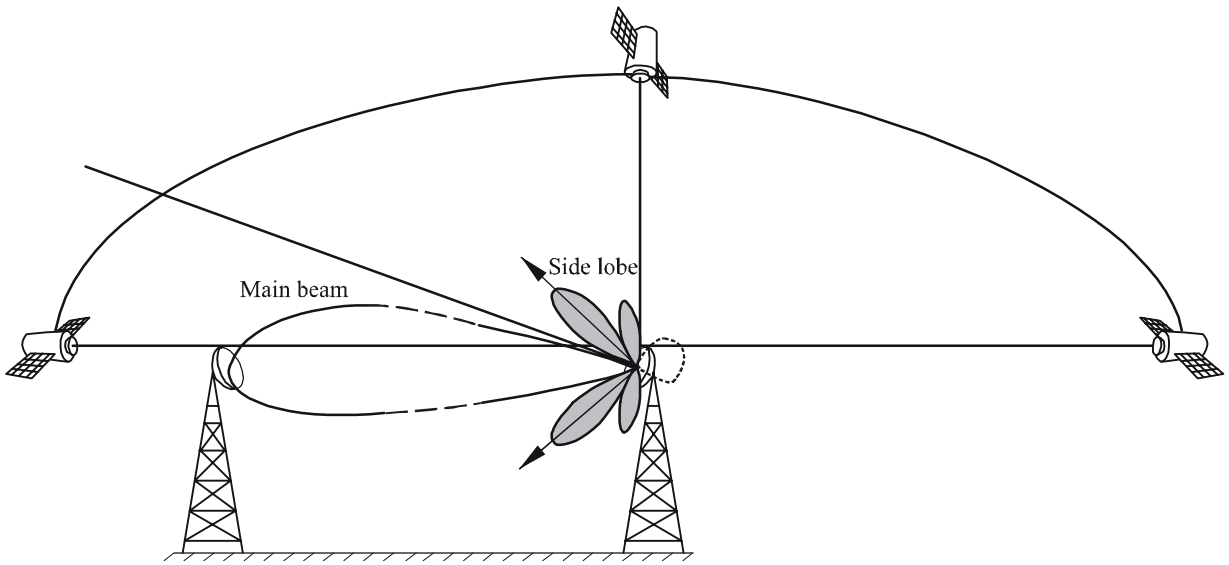
Calculation of the coordination area is done for the worst-case situation, which means that fixed wireless link antenna pointing is taken to be towards the station of the other service. In such cases interference is then through the main beam and for the worst case the highest gain antennas are normally used.

3 GSO satellites

The visible part of the geostationary orbit is mainly several degrees over the horizon and satellites in that part of the orbit are not usually in the main beam of fixed wireless link antennas. Only in the part of the orbit which is near the horizon could that be the case, if the geostationary orbit is not avoided. As the satellite is geostationary, the interference is constant and long term. In most cases the interference from GSO satellites is through the side lobes of the antennas and low-gain antennas may be considered in studies.

FIGURE 2

Main beam and side-lobe interference



4 Non-GSO satellites

Non-GSO satellites are normally visible in large areas of the sky. Therefore satellites of a constellation are, for the main part of the time, at the side-lobe area of a radio-relay link antenna and only for a short time in the main beam of the antenna. If main beam or side-lobe interference is more important in studies, this depends on the satellite e.i.r.p. at low elevation angles compared to the e.i.r.p. at high elevation angles.

Main beam interference may be taken to be short-term interference. Normally there is at least one satellite at high elevation in the side-lobe region; its interference is long-term interference. Criteria for long-term interference level is much lower than for short-term interference and may be the decisive criteria. Both high- and low-gain antennas should be considered in studies.

5 Considering present and FS service antennas

If studies are made using only high-gain antennas and criteria for sharing is based on that, the interference to low-gain antennas may exceed the criterion. That would mean that new systems should be designed to use larger antennas than otherwise would be needed and more robust and more expensive masts have to be used. For existing shorter hops it would mean changing existing antennas to larger ones and probably new masts would be required.

The usage of smaller gain antennas than those in the technical parameter tables reduces the interference margin at antenna side lobes. In addition, the interference criteria is more stringent for long-term interference than for short-term interference. This may cause the long-term interference through the small size antenna side lobe to be decisive in sharing studies between the FS and other services.

6 FS technical parameters and antenna size

Fixed wireless link parameters to be used in interference and sharing studies between the FS and other services are given in Tables 1 to 46. For antenna gain the value is for maximum antenna gain only. That is because the antenna gain is used, e.g. in calculations when determining if coordination is needed. The calculation for that purpose is done for the worst-case situation, which means that fixed wireless link antenna pointing is taken to be towards the earth station of the other service. Interference is then through the main beam and for the worst case the highest gain antenna is used in the calculation.

However, for economical reasons small gain antennas are widely used in practice, especially where hop lengths are short. Because of their wide deployment and the importance of side-lobe interference, small gain antennas should be included in the studies. Table 52 gives typical minimum antenna gains in various frequency bands.

TABLE 52

Typical minimum antenna gains by frequency band

Frequency band (GHz)	Gain (minimum) (dBi)	(1)
1.35-1.53	11.2	P-MP
1.7-2.45	25	FM-FDM
1.7-2.45	13	2-8 Mbit/s
1.7-2.45	9	P-MP
2.45-2.69	10	P-MP
3.4-3.6	27.5	AM-TV
3.6-4.2	16	P-MP
3.6-4.2	30	
3.7-4.2	31	
3.8-4.2	31	
5.925-6.425	36	FM 1 800 channels
6.425-7.11	43	140 Mbit/s
7.125-7.750	31	34-140 Mbit/s
7.425-7.900	37	8-155 Mbit/s, FM
8-8.5	38	
10.15-10.65	32	

TABLE 52 (*end*)

Frequency band (GHz)	Gain (minimum) (dBi)	[1]
10.2-10.68	32	2-8 Mbit/s
10.2-10.68	34	AM-TV
10.5-10.68	34	AM-TV
10.7-11.7	41	34-155 Mbit/s
13-14	29	34 Mbit/s
14.25-14.5	35	2-155 Mbit/s
14.4-15.35	32	8-34 Mbit/s
17.7-19.7	32	4-16 Mbit/s
17.7-19.7	40	AM-TV for CATV
17.7-19.7	32	34 Mbit/s
17.7-19.7	35	140 Mbit/s
21.12-26.5	34	4-34 Mbit/s
21.2-26.5	6	P-MP
30-40	16	P-MP
37-39.5	36	2-34 Mbit/s
37.0-40.5	38	1.544-310 Mbit/s
47.2-50.2	40	1.544-310 Mbit/s

[1] Different capacity or service may use different antennas.