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BHUTAN INFOCOMM AND MEDIA AUTHORITY

ROYAL GOVERNMENT OF BHUTAN

FREQUENCY CHANNEL PLAN FOR FIXED POINT TO POINT RADIO SYSTEM IN MICROWAVE BAND

NOVEMBER, 2019

FOREWORD

In accordance with the Information, Communications and Media Act of Bhutan 2018 and the National Radio Rules and Regulations, the “**Frequency Channel Plan for Fixed Point to Point Radio System in Microwave band**” is hereby adopted as of 15th November, 2019.



(Chairperson)

BHUTAN INFOCOMM AND MEDIA AUTHORITY

1. BACKGROUND

With the drastic increase in domestic communication traffic, there is need to enhance the backhaul transmission capacity resulting into rise in demand for band above 10 GHz. This band supports short hop high density application for mobile network backbones and urban network application.

The frequency channel plan for point to point radiocommunication in microwave band is to strengthen the proper management and enhance the effective and efficient planning and usage of microwave spectrum by the Service provider. This frequency channel plan prepared as per the ITU-R recommendations and ESTI standards.

2. LEGAL BASIS

This frequency channel plan is prepared as per:

1. Section 165 of the Information, Communications and Media Act of Bhutan 2018, which requires Authority , from time to time, prepare a Frequency Band Plan in respect of any part of radio frequency spectrum;
2. Subsection 1.2(a) of the chapter I of the National Radio Rules which requires the Authority to prepare frequency band plans.

3. ALLOCATIONS, BAND PLANNING AND CHANNEL ARRANGEMENTS

3.1 Frequency Allocation

The frequency allocations for fixed service are specified in the frequency allocation table of Bhutan which is as per the ITU Radio Regulations fixed service allocations for Region 3. However, all of the specified fixed service allocated in microwave band has also been allocated to other services (Mobile, Fixed satellite and etc). Therefore, in order to assign suitable band for fixed service it is very important to choose most suitable band fixed service from the long list of band outlined in frequency table of allocation.

Further, fixed services are generally categorised into fixed point to point and fixed point to multi-point. Therefore it is essential to redistribute the frequency band within the two categories of fixed services in most suitable, equitable and efficient manner as per the international norms and standards like ITU-R resolution, recommendation and ETSI standard.

3.2 Channel arrangement planning for point to point radio system in microwave band:

Fixed service in microwave bands are generally planned to align with well-defined ITU recommendations or other recognised regional standards and to accommodate readily available products. Accordingly, most of the Radio Frequency (RF) Channel Arrangements of Bhutan are closely aligned with the appropriate ITU-R recommendations.

The following table shows the channel arrangement plan for fixed point to point radio system where channel planning is framed based on the ITU-R recommendation on fixed services. The detail information of channel arrangement plan point to point radio system can be retrieved from the appendix 1 of this document.

Table 1 : Channel arrangement plan in microwave band for fixed point to point radio system.

Sl. No	Frequency band	Frequency range	Channel arrangement plan	Remarks
1	Lower 6 GHz (5925-6425 MHz)	5925-6425 MHz	Recommendation ITU-R F.383-9	Recommended for Radio-frequency channel arrangements for medium- and high-capacity digital fixed wireless systems
2	Upper 6 GHz (6425-7125 MHz)	6425-7125 MHz	Recommendation ITU-R F.384-11	Recommended for Radio-frequency channel arrangements for medium- and high-capacity digital fixed wireless systems
3	7 GHz (7110-7900 MHz)	7125-7425 MHz	Recommendation ITU-R F.385-10	Recommended for RF channel arrangement for FWSs at supporting data rates up to 155 Mbit/s, including synchronous digital hierarchy bit rates,
		7425-7725 MHz	Recommendation ITU-R F.385-10	
4	8 GHz (7725-8500 MHz)	7725-8275 MHz	Recommendation ITU-R F.386-9 (annexure 1)	RF channel arrangements for the transmission of various digital signals operating in the 7725-8275 MHz band, with 300 MHz duplex spacing, based on multiples of 2.5 MHz bandwidth
		7725-8275 MHz	Recommendation ITU-R F.386-9(annexure 6)	Recommended for Fixed service with a capacity digital systems up to 140 Mbit/s or synchronous digital hierarchy bit rates operating in the 8 GHz band,
5	13 GHz (12.75-13.25 GHz)	12.75-13.25 GHz	Recommendation ITU-R F.497-7	This Recommendation presents an RF arrangement with a channel separation of 28 MHz in the frequency range 12.75-13.25 GHz. Methodologies are provided for subdividing the main

				28 MHz wide channels into smaller channels of 14, 7 and 3.5 MHz,
6	15 GHz(14.5 - 15.35 GHz)	14.5- 15.35GHz 14.4-15.35 GHz	Recommendation ITU-R F.636-4	This Recommendation presents RF channel arrangements with separations of 3.5, 7, 14, 28 and 56 MHz.
7	18 GHz(17.7-19.7 GHz)	17.7-19.7 GHz	Recommendation ITU-R F.595-10	The channel spacing recommended in the main text are 220, 110, 55 and 27.5 MHz for co-channel arrangements as well as interleaved arrangements for 220 and 110 MHz spacing.
8	22 GHz (21.2-23.6 GHz)	21.2-23.6 GHz	Recommendation ITU-R F.637-4	The main text of this Recommendation presents RF channel arrangements based on the homogeneous patterns with channel separations of 2.5 and 3.5 MHz.
9	32 GHz (31.8 -33.4 GHz)	31.8 -33.4 GHz	Recommendation ITU-R F.1520-3 (Annexure 1).	The RF channels for separations of 3.5 MHz, 7 MHz, 14 MHz, 28 MHz, 56 MHz and 112 MHz shall be derived as follows: fr be the reference frequency of 32599 frequency duplex spacing = 812 MHz.
10	38 GHz (37-39.5 GHz)	37- 39.5 GHz	Recommendation ITU-R F.749-3 (Annexure 1).	The radio-frequency channel arrangement for carrier spacing of 112 MHz, 56 MHz, 28 MHz, 14 MHz, 7 MHz and 3.5 MHz in band of 37.0 - 39.5 GHz.
11	42 GHz (40.5 -43.5 GHz)	40.5-43.5 GHz	Recommendation ITU-R F.2005-4 (Annexure 1).	This Recommendation provides radio-frequency channel arrangements for point-to-point (P-P) fixed wireless systems operating in the 42 GHz (40.5 to 43.5 GHz)

				band, which may be used for high, medium and low capacity systems. The preferred radio-frequency channel arrangements are based on multiples of basic channels of 7 MHz width merged to form higher channel widths up to 112 MHz.
12	52 GHz (51.4-52.6 GHz)	51.4-52.6 GHz	Recommendation ITU-R F.1496-1 annexure 1	This Recommendation specifies radio-frequency channel arrangements for fixed wireless systems with channel separations of 3.5, 7, 14, 28 and 56 MHz in the band 51.4-52.6 GHz, which has been identified for use for high density applications in the fixed service (HDFS).
13	V-band (57-66 GHz)	55- 66 GHz	Recommendation ITU-R F.2006 (Annexure 1 and annexure 3).	This Recommendation specifies radio-frequency channel arrangements for fixed wireless systems (FWS) using TDD (time division duplex) or FDD (frequency division duplex) with channel separations of 3.5, 7, 14, 28, 30, 50 and 56 MHz in the range 55.78-66 GHz.
14	E-band (71-76 GHz and 81-86 GHz)	71-76 GHz and 81-86 GHz	Recommendation ITU-R F.2006 (Annexure 1).	This Recommendation provides radio-frequency channel and block arrangements for fixed wireless systems (FWS) operating in the 71-76/81-86 GHz range, which may be used for broadband applications and other high-speed networks.

4. LICENSING

The Fixed service for point to point radiocommunication in microwave band is generally licensed under radiocommunication Apparatus License under section 2.5 of the National Radio Rules of Bhutan, 2011. Fixed point to point services are also subject to spectrum term and condition prescribed by the Authority.

The frequency being scarce public resource, the use of relevant carrier frequency or frequency block by the company/organization should be subject to the payment of the License fee (application fee and Spectrum access fee) and spectrum utilization fee (SUF) annually.

5. TRANSMIT POWER LIMIT

The transmit power level in fixed service for point to point radiocommunication shall be as per the International Radio Regulation 21.5(3) and ITU-R Recommendation SF.406 "*Maximum Equivalent Isotropic Radiated Power of Radio-Relay System Transmitters Operating in the Frequency Bands Shared with the Fixed-satellite Service*". The power of a transmitter in the fixed service shall not exceed:

- 43 dBm (20 Watts) in the bands between 1 GHz and 10 GHz; and,
- 40 dBm (10 Watts) in the frequency bands above 10 GHz, except in the band of 18.6-18.8 GHz where the limit is +27 dBm (0.5 Watts) in accordance with International Radio Regulation 21.5A.
- in order to protect stations in the Earth exploration-satellite service (passive), the maximum power density delivered by the transmitter to the antenna of a fixed service in band of 55.78-56.26 GHz is limited to -26 dB(W/MHz) which is as per the ITU Radio Regulations.

6. FREQUENCY COORDINATION

Most of the spectrum allocations utilised by microwave fixed services are shared with various other (fixed and non-fixed) types of radiocommunication service. Therefore, it is necessary to consider the frequency coordination mainly with following radiocommunication services:

- Coordination between fixed service with Earth stations;
- Geostationary satellite orbit avoidance: Fixed services operating in the same frequency band/s as satellites in the geostationary orbit are required to ensure that (fixed service); emissions do not cause harmful interference to sensitive satellite receivers;
- Coordination between fixed microwave point to point radio systems with fixed microwave point to multipoint radio system;
- Coordination between fixed services with mobile services.

Appendix 1:

Channel arrangement in fixed point to point radio system in microwave band.

Note:

F_0 = Centre frequency

F= Frequency in MHz for channel in lower half band.

F'=Frequency in MHz for channel in upper half band.

n= channel number.

1. Lower 6 GHz band (frequency range : 5925 MHz-6425 MHz)

Frequency band	RF channel arrangements			Duplex (TX/RX) spacing(MHz)	channel spacing(in MHz)	Remarks
	CH#	F	F'			
5925 -6425 MHz	1	5941	6207	266	28	ITU-R F.383-9 (annexure 2) f0=6172 MHz Recommended RF channel arrangement for fixed wireless System for channel Spacing 28 MHz and 56 MHz
	2	5969	6235			
	3	5997	6263			
	4	6025	6291			
	5	6053	6319			
	6	6081	6347			
	7	6109	6375			
	8	6137	6403			

2. Upper 6 GHz band (Frequency range: 6425 MHz-7125 MHz)

Frequency band	RF channel arrangements			Duplex (TX/RX) spacing (MHz)	Channel spacing(MHz)	Remarks
	CH#	F (MHz)	F' (MHz)			
6425- 7125 MHz	1	6460	6800	340	40	ITU-R F.384-11 centre frequency ($F_0=6770$) radio frequency channel arrangement plan for high capacity fixed service using Channel Spacing of 40 MHz and 80 MHz
	2	6500	6840			
	3	6540	6880			
	4	6580	6920			
	5	6620	6960			
	6	6660	7000			
	7	6700	7040			
	8	6740	7080			

						--channel arrangement for multicarrier system can be framed with such channel arrangement
	CH#	F	F'			
	1	6486	6826	340	56	ITU-R F.384-11 centre frequency (F0=6770) radio frequency channel arrangement plan for high capacity fixed service using Channel Spacing of 30 MHz and 60 MHz ---channel arrangement for multicarrier system can be framed with such channel arrangement
	2	6542	6882			
	3	6598	6938			
	4	6654	6994			
	5	6710	7050			
	6	6766	7106			

3. 7 GHz (frequency range: 7110 MHz- 7900 MHz)

Frequency band	RF Channel arrangements			Duplex (TX/RX) spacing (MHz)	Channel spacing (MHz)	Remarks
	CH#	F (MHz)	F' (MHz)			
7125 - 7425 MHz band	1	7128	7289	161	7	Recommendation ITU-R F.385-10 F0=7275 MHz channel arrangement plan for 7125 MHz - 7425 MHz using 7 MHz channel Spacing
	2	7135	7296			
	3	7142	7303			
	4	7149	7310			
	5	7156	7317			
	6	7163	7324			
	7	7170	7331			
	8	7177	7338			
	9	7184	7345			
	10	7191	7352			
	11	7198	7359			
	12	7205	7366			
	13	7212	7373			

14	7219	7380				
15	7226	7387				
16	7233	7394				
17	7240	7401				
18	7247	7408				
19	7254	7415				
20	7261	7422				
CH#	F	F'				
1	7131.5	7292.5	161	14	Recommendation ITU-R F.385- 10 $F_0=7275$ MHz channel arrangement plan for 7125 MHz - 7425 MHz using 14 MHz channel Spacing	
2	7145.5	7306.5				
3	7159.5	7320.5				
4	7173.5	7334.5				
5	7187.5	7348.5				
6	7201.5	7362.5				
7	7215.5	7376.5				
8	7229.5	7390.5				
9	7243.5	7404.5				
10	7257.5	7418.5				
CH#	F	F'				
1	7138.5	7299.5	161	28	Recommendation ITU- R F.385-10 $F_0=7275$ MHz channel arrangement plan for 7125 MHz - 7425 MHz using 28 MHz channel Spacing	
2	7166.5	7327.5				
3	7194.5	7355.5				
4	7222.5	7383.5				
5	7250.5	7411.5				
7425- 7725 MHz	CH#	F	F'			
	1	7428	7589	161	7	Recommendation ITU-R F.385-10 $F_0=7575$ MHz Channel arrangement plan for 7425 MHz - 7725 MHz using 7 MHz channel Spacing
	2	7435	7596			
	3	7442	7603			
	4	7449	7610			
	5	7456	7617			
	6	7463	7624			
	7	7470	7631			
	8	7477	7638			
	9	7484	7645			
	10	7491	7652			
	11	7498	7659			
	12	7505	7666			

	13	7512	7673			
	14	7519	7680			
	15	7526	7687			
	16	7533	7694			
	17	7540	7701			
	18	7547	7708			
	19	7554	7715			
	20	7561	7722			
	CH#	F	F'			
	1	7431.5	7592.5	161	14	Recommendation ITU-R F.385-10 F ₀ =7575 MHz Channel arrangement plan for 7425 MHz - 7725 MHz using 14 MHz channel Spacing
	2	7445.5	7606.5			
	3	7459.5	7620.5			
	4	7473.5	7634.5			
	5	7487.5	7648.5			
	6	7501.5	7662.5			
	7	7515.5	7676.5			
	8	7529.5	7690.5			
	9	7543.5	7704.5			
	10	7557.5	7718.5			
	CH#	F	F'			
	1	7438.5	7599.5	161	28	Recommendation ITU-R F.385-10 Channel arrangement plan for 7425 MHz - 7725 MHz using 28 MHz channel Spacing
	2	7466.5	7627.5			
	3	7494.5	7655.5			
	4	7522.5	7683.5			
	5	7550.5	7711.5			

4. 8 GHz band (frequency range: 7725 MHz- 8500 MHz)

Frequency band	RF channel arrangements			Duplex (TX/RX) spacing (MHz)	Channel spacing(MHz)	Remarks
	CH#	F (MHz)	F' (MHz)			
7725 - 8275 MHz	1	7740	8040	300	30	Recommendation ITU-R F.386-9 (Annexure1) centre frequency (F ₀ =8000) RF channel arrangements for the transmission of various digital signals operating in the 7 725-8 275 MHz band, with 300 MHz duplex spacing, based on multiples of 2.5 MHz bandwidth
	2	7770	8070			
	3	7800	8100			
	4	7830	8130			
	5	7860	8160			
	6	7890	8190			
	7	7920	8220			
	8	7950	8250			
	CH#	F(MHz)	F' (MHz)			
7725- 8275 MHz	1	7747.7	8059.02	311.32	29.65	Recommendation ITU-R F.386-9 (annexure 6) F ₀ =8000 MHz The RF channel arrangement in 7725- 8275 MHz, up to eight go and eight return channels, each accommodating high capacity digital systems up to 140 Mbit/s or synchronous digital hierarchy bit rates operating in the 8 GHz band,
	2	7777.35	8088.67			
	3	7807	8118.32			
	4	7836.65	8147.97			
	5	7866.3	8177.62			
	6	7895.95	8207.27			
	7	7925.6	8236.92			
	8	7955.25	8266.57			
	CH#	F(MHz)	F'(MHz)			
7725 - 8275 MHz	1	7747	8030.5	283.5	28	Recommendation ITU-R F.386-9 (annexure 2) F ₀ =8000 MHz RF channel arrangements for digital FWS
	2	7775	8058.5			
	3	7803	8086.5			
	4	7831	8114.5			
	5	7859	8142.5			
	6	7887	8170.5			

	7	7915	8198.5			based on multiples of 3.5 MHz(7, 14,28 MHz) 14 MHz channel arrangement The Relationship is given by: lower half of the band: $f_n = f_0 - 274 + 14 n$ MHz upper half of the band: $f_{n'} = f_0 + 9.5 + 14 n$ MHz where: $n = 1, 2, \dots, 17$ or 18.	
	8	7943	8226.5				
	9	7971	8254.5				
	CH#	F	F'				
8275 -8500 MHz	1	8293	8411.5	119	28	Recommendation ITU-R F.386-9 (annexure 2.1) $F_0=8387.5$ MHz Channel arrangement in the frequency band 8 275–8 500 MHz based on28 MHz interleaved channel arrangement with duplex spacing of 119 MHz	
	2	8307	8425.5				
	3	8321	8439.5				
	4	8335	8453.5				
	5	8349	8467.5				
	6	8363	8481.5				
		CH#	F(MHz)	F'(MHz)			
	1	8286	8412	126	14	Recommendation ITU-R F.386-9 (annexure 2.1) $F_0=8387.5$ MHz Channel arrangement in the frequency band 8 275–8 500 MHz based on28 MHz interleaved channel arrangement with duplex spacing of 119 MHz	
	2	8293	8419				
	3	8300	8426				
	4	8307	8433				
	5	8314	8440				
	6	8321	8447				
7	8328	8454					
8	8335	8461					
9	8342	8468					
10	8349	8475					
11	8356	8482					
12	8363	8489					

5. 13 GHz (frequency range: 12.75 GHz- 13.25 GHz)

Frequency band	RF channel arrangements			Duplex (TX/RX) spacing (MHz)	Channel spacing(MHz)	Remarks
	CH#	F (MHz)	F' (MHz)			
12.75-13.25 GHz	1	12765	13031	266	28	Recommendation ITU-R F.497-7 F ₀ = 12996 MHz RF channel arrangement for FWS with a capacity of 34 Mbit/s or higher capacity up to 140 Mbit/s or the synchronous bit-rates, operating in the 13 GHz band,
	2	12793	13059			
	3	12821	13087			
	4	12849	13115			
	5	12877	13143			
	6	12905	13171			
	7	12933	13199			
	8	12961	13227			
12.75-13.25 GHz	1	12758	13024	266	14	Recommendation ITU-R F.497-7 F ₀ = 12 996 MHz
	2	12772	13038			
	3	12786	13052			
	4	12800	13066			
	5	12814	13080			
	6	12828	13094			
	7	12842	13108			
	8	12856	13122			
	9	12870	13136			
	10	12884	13150			
	11	12898	13164			
	12	12912	13178			
	13	12926	13192			
	14	12940	13206			
	15	12954	13220			
	16	12968	13234			
12.75-13.25 GHz	1	12754.5	13020.5	266	7	Recommendation ITU-R F.497-7 F ₀ = 12 996 MHz in cases where smaller capacity radio channels are required, the following channel
	2	12761.5	13027.5			
	3	12768.5	13034.5			
	4	12775.5	13041.5			
	5	12782.5	13048.5			
	6	12789.5	13055.5			

7	12796.5	13062.5
8	12803.5	13069.5
9	12810.5	13076.5
10	12817.5	13083.5
11	12824.5	13090.5
12	12831.5	13097.5
13	12838.5	13104.5
14	12845.5	13111.5
15	12852.5	13118.5
16	12859.5	13125.5
17	12866.5	13132.5
18	12873.5	13139.5
19	12880.5	13146.5
20	12887.5	13153.5
21	12894.5	13160.5
22	12901.5	13167.5
23	12908.5	13174.5
24	12915.5	13181.5
25	12922.5	13188.5
26	12929.5	13195.5
27	12936.5	13202.5
28	12943.5	13209.5
29	12950.5	13216.5
30	12957.5	13223.5
31	12964.5	13230.5
32	12971.5	13237.5

arrangements (which occupy some of the bi-directional radio channels of the basic channel arrangement) should be used (see Note 2):

6. 15 GHz

A. 15 GHz (frequency range: 14.5 GHz-15.35 GHz)

Frequency band	RF channel arrangements			Duplex (TX/RX) spacing (MHz)	Channel spacing(MHz)	Remarks
	CH#	F (MHz)	F' (MHz)			
14.5-15.35 GHz	1	14529	14977	448	56	Recommendation ITU-R F.636-4 preferred radio-frequency channel arrangement for medium-capacity digital fixed wireless systems operating with a 56 MHz channel spacing
	2	14585	15033			
	3	14641	15089			
	4	14697	15145			
	5	14753	15201			
	6	14809	15257			
	7	14865	15313			
	CH#	F(MHz)	F'(MHz)			
14.5-15.35 GHz	1	14515	14935	420	28	Recommendation ITU-R F.636-4 preferred radio-frequency channel arrangement for medium-capacity digital fixed wireless systems operating with a 28 MHz channel spacing
	2	14543	14963			
	3	14571	14991			
	4	14599	15019			
	5	14627	15047			
	6	14655	15075			
	7	14683	15103			
	8	14711	15131			
	9	14739	15159			
	10	14767	15187			
	11	14795	15215			
	12	14823	15243			
	13	14851	15271			
	14	14879	15299			
	15	14907	15327			
	CH#	F(MHz)	F'(MHz)			
14.5-15.35 GHz	1	14515	14935	420	14	Recommendation ITU-R F.636-4 the preferred radio-frequency channel arrangement for digital fixed wireless systems operating with a 14
	2	14529	14949			
	3	14543	14963			
	4	14557	14977			
	5	14571	14991			
	6	14585	15005			
	7	14599	15019			

	8	14613	15033			MHz channel spacing	
	9	14627	15047				
	10	14641	15061				
	11	14655	15075				
	12	14669	15089				
	13	14683	15103				
	14	14697	15117				
	15	14711	15131				
	16	14725	15145				
	17	14739	15159				
	18	14753	15173				
	19	14767	15187				
	20	14781	15201				
	21	14795	15215				
	22	14809	15229				
	23	14823	15243				
	24	14837	15257				
	25	14851	15271				
	26	14865	15285				
	27	14879	15299				
	28	14893	15313				
	29	14907	15327				
	30	14921	15341				
	CH#	F(MHz)	F'(MHz)				
14.5-15.35 GHz	1	14504.5	14924.5	420	7		Recommendation ITU-R F.636-4 the preferred radio-frequency channel arrangement for digital fixed wireless systems operating with a 14 MHz channel spacing
	2	14511.5	14931.5				
	3	14518.5	14938.5				
	4	14525.5	14945.5				
	5	14532.5	14952.5				
	6	14539.5	14959.5				
	7	14546.5	14966.5				
	8	14553.5	14973.5				
	9	14560.5	14980.5				
	10	14567.5	14987.5				
	11	14574.5	14994.5				
	12	14581.5	15001.5				
	13	14588.5	15008.5				
	14	14595.5	15015.5				
	15	14602.5	15022.5				
	16	14609.5	15029.5				

17	14616.5	15036.5
18	14623.5	15043.5
19	14630.5	15050.5
20	14637.5	15057.5
21	14644.5	15064.5
22	14651.5	15071.5
23	14658.5	15078.5
24	14665.5	15085.5
25	14672.5	15092.5
26	14679.5	15099.5
27	14686.5	15106.5
28	14693.5	15113.5
29	14700.5	15120.5
30	14707.5	15127.5
31	14714.5	15134.5
32	14721.5	15141.5
33	14728.5	15148.5
34	14735.5	15155.5
35	14742.5	15162.5
36	14749.5	15169.5
37	14756.5	15176.5
38	14763.5	15183.5
39	14770.5	15190.5
40	14777.5	15197.5
41	14784.5	15204.5
42	14791.5	15211.5
43	14798.5	15218.5
44	14805.5	15225.5
45	14812.5	15232.5
46	14819.5	15239.5
47	14826.5	15246.5
48	14833.5	15253.5
49	14840.5	15260.5
50	14847.5	15267.5
51	14854.5	15274.5
52	14861.5	15281.5
53	14868.5	15288.5
54	14875.5	15295.5
55	14882.5	15302.5
56	14889.5	15309.5
57	14896.5	15316.5

58	14903.5	15323.5			
59	14910.5	15330.5			
60	14917.5	15337.5			

B. 15 GHz (frequency range: 14.4 GHz-15.35 GHz)

Frequency band	RF channel arrangements			Duplex (TX/RX) spacing (MHz)	Channel spacing (MHz)	Remarks
	CH#	F (MHz)	F' (MHz)			
14.4-15.35 GHz	1	14431	14921	490	56	Recommendation ITU-R F.636-4 preferred radio-frequency channel arrangement for medium-capacity digital fixed wireless systems operating with a 56 MHz channel spacing
	2	14487	14977			
	3	14543	15033			
	4	14599	15089			
	5	14655	15145			
	6	14711	15201			
	7	14767	15257			
	8	14823	15313			
	CH#	F (MHz)	F' (MHz)	490	28	Recommendation ITU-R F.636-4 preferred radio-frequency channel arrangement for medium-capacity digital fixed wireless systems operating with a 28 MHz channel spacing
	1	14417	14907			
	2	14445	14935			
	3	14473	14963			
	4	14501	14991			
	5	14529	15019			
	6	14557	15047			
	7	14585	15075			
	8	14613	15103			
	9	14641	15131			
	10	14669	15159			
	11	14697	15187			
	12	14725	15215			
	13	14753	15243			
	14	14781	15271			
	15	14809	15299			
	16	14837	15327			

7. 18 GHz (frequency range: 17.7 GHz - 19.7 GHz)

Frequency band	RF channel arrangements			Duplex (TX/RX) spacing (MHz)	Channel spacing(MHz)	Remarks
	CH#	F (MHz)	F' (MHz)			
17.7– 19.7 GHz	1	17920	18930	1010	220	Recommendation ITU-R F.595-10 F ₀ = 18700 MHz For systems with a capacity of the order of 280 Mbit/s:
	2	18140	19150			
	3	18360	19370			
	4	18580	19590			
	CH#	F(MHz)	F'(MHz)			
17.7- 19.7 GHz	1	17755	18765	1010	55	Recommendation ITU-R F.595-10 F ₀ = 18700 MHz For systems with a capacity of the order of 140 Mbit/s or STM-1 with multi-state modulation formats: For 110 channel spacing , there will be 8 channels)
	2	17810	18820			
	3	17865	18875			
	4	17920	18930			
	5	17975	18985			
	6	18030	19040			
	7	18085	19095			
	8	18140	19150			
	9	18195	19205			
	10	18250	19260			
	11	18305	19315			
	12	18360	19370			
	13	18415	19425			
	14	18470	19480			
	15	18525	19535			
	16	18580	19590			
	17	18635	19645			
	CH#	F(MHz)	F'(MHz)			
17.7– 19.7 GHz	1	17727.5	18737.5	1010	27.5	Recommendation ITU-R F.595-10 F ₀ = 18700 MHz For systems with a capacity of the order of 34 Mbit/s: For a channel spacing of 13.75 Co-channel arrangement (): lower half of the band: $f_n = f_0 - 1\ 000$
	2	17755	18765			
	3	17782.5	18792.5			
	4	17810	18820			
	5	17837.5	18847.5			
	6	17865	18875			
	7	17892.5	18902.5			
	8	17920	18930			
	9	17947.5	18957.5			
	10	17975	18985			

11	18002.5	19012.5
12	18030	19040
13	18057.5	19067.5
14	18085	19095
15	18112.5	19122.5
16	18140	19150
17	18167.5	19177.5
18	18195	19205
19	18222.5	19232.5
20	18250	19260
21	18277.5	19287.5
22	18305	19315
23	18332.5	19342.5
24	18360	19370
25	18387.5	19397.5
26	18415	19425
27	18442.5	19452.5
28	18470	19480
29	18497.5	19507.5
30	18525	19535
31	18552.5	19562.5
32	18580	19590
33	18607.5	19617.5
34	18635	19645
35	18662.5	19672.5

+ 13.75 n MHz
upper half of the
band: $f_n' = f_0 + 10 +$
13.75 n MHz
where:
 $n = 1, 2, 3, \dots 70.$

8. 22 GHz band (frequency range : 21.2 – 23.6 GHz)

Frequency band	RF channel arrangements			Duplex (TX/RX) spacing (MHz)	Channel spacing(MHz)	Remarks
	CH#	F (MHz)	F' (MHz)			
21.2-23.6 GHz	1	21280	22512	1232	112	Recommendation ITU-R F.637-4 (Annexure 1) . The use of the band 21.2-23.6 GHz is based on a homogeneous 3.5 MHz frequency pattern. Various channel spacings are accommodated as shown in Fig. 1 and interleaved patterns are also used for the various spacings.
	2	21392	22624			
	3	21504	22736			
	4	21616	22848			
	5	21728	22960			
	6	21840	23072			
	7	21952	23184			
	8	22064	23296			
	9	22176	23408			
	10	22288	23520			
21.2-23.6 MHz	CH#	F(MHz)	F'(MHz)	1232	56	Recommendation ITU-R F.637-4 (Annexure 1) . The use of the band 21.2-23.6 GHz is based on a homogeneous 3.5 MHz frequency pattern. Channel spacing of 56 MHz
	1	21252	22484			
	2	21308	22540			
	3	21364	22596			
	4	21420	22652			
	5	21476	22708			
	6	21532	22764			
	7	21588	22820			
	8	21644	22876			
	9	21700	22932			
	10	21756	22988			
	11	21812	23044			
	12	21868	23100			
	13	21924	23156			
	14	21980	23212			
	15	22036	23268			
	16	22092	23324			
	17	22148	23380			
	18	22204	23436			
19	22260	23492				

	20	22316	23548			
	CH#	F(MHz)	F'(MHz)			
21.2-23.6 GHz	1	21238	22470	1232	28	<p>Recommendation ITU-R F.637-4 (Annexure 1) . The use of the band 21.2-23.6 GHz is based on a homogeneous 3.5 MHz frequency pattern. Channel spacing of 28 MHz channel spacings of 14 MHz .7 and 3.5 Mhz can be accomdated as shown in Fig. 1 of annexure 1 of Recommendation ITU-R F.637-4 .</p>
	2	21266	22498			
	3	21294	22526			
	4	21322	22554			
	5	21350	22582			
	6	21378	22610			
	7	21406	22638			
	8	21434	22666			
	9	21462	22694			
	10	21490	22722			
	11	21518	22750			
	12	21546	22778			
	13	21574	22806			
	14	21602	22834			
	15	21630	22862			
	16	21658	22890			
	17	21686	22918			
	18	21714	22946			
	19	21742	22974			
	20	21770	23002			
	21	21798	23030			
	22	21826	23058			
	23	21854	23086			
	24	21882	23114			
	25	21910	23142			
	26	21938	23170			
	27	21966	23198			
	28	21994	23226			
	29	22022	23254			
	30	22050	23282			
	31	22078	23310			
	32	22106	23338			
	33	22134	23366			
	34	22162	23394			
	35	22190	23422			
	36	22218	23450			

37	22246	23478
38	22274	23506
39	22302	23534
40	22330	23562

9. 32 GHz (frequency range : 31.8 GHz-33.4 GHz)

Frequency band	RF channel arrangements			Duplex (TX/RX) spacing (MHz)	Channel spacing(MHz)	Remarks
	CH#	F (MHz)	F' (MHz)			
31.8GHz-33.4GHz	1	31927	32739	812	112	Recommendation ITU-R F.1520-3 (Annexure 1) . The RF channels for separations of 3.5 MHz, 7 MHz, 14 MHz, 28 MHz, 56 MHz and 112 MHz shall be derived as follows: fr be the reference frequency of 32599 frequency duplex spacing = 812 MHz,
	2	32039	32851			
	3	32151	32963			
	4	32263	33075			
	5	32375	33187			
	6	32487	33299			
	CH#	F(MHz)	F'(MHz)			
31.8GHz-33.4GHz	1	31899	32711	812	56	Recommendation ITU-R F.1520-3 (Annexure 1) . The RF channels for separations of 3.5 MHz, 7 MHz, 14 MHz, 28 MHz, 56 MHz and 112 MHz shall be derived as follows: fr be the reference frequency of 32599 frequency duplex spacing = 812 MHz,
	2	31955	32767			
	3	32011	32823			
	4	32067	32879			
	5	32123	32935			
	6	32179	32991			
	7	32235	33047			
	8	32291	33103			
	9	32347	33159			
	10	32403	33215			
	11	32459	33271			
	12	32515	33327			

	CH#	F(MHz)	F'(MHz)			
31.8GHz-33.4GHz	1	31829	32641	812	28	<p>Recommendation ITU-R F.1520-3 (Annexure 1) . The RF channels for separations of 3.5 MHz, 7 MHz, 14 MHz, 28 MHz, 56 MHz and 112 MHz shall be derived as follows: fr be the reference frequency of 32599 frequency duplex spacing = 812 MHz,</p>
	2	31857	32669			
	3	31885	32697			
	4	31913	32725			
	5	31941	32753			
	6	31969	32781			
	7	31997	32809			
	8	32025	32837			
	9	32053	32865			
	10	32081	32893			
	11	32109	32921			
	12	32137	32949			
	13	32165	32977			
	14	32193	33005			
	15	32221	33033			
	16	32249	33061			
	17	32277	33089			
	18	32305	33117			
	19	32333	33145			
	20	32361	33173			
	21	32389	33201			
	22	32417	33229			
	23	32445	33257			
	24	32473	33285			
	25	32501	33313			
	26	32529	33341			
	27	32557	33369			

10. 38 GHz (frequency range: 37 GHz- 39.5 GHz)

Frequency band	RF channel arrangements			Duplex (TX/RX) spacing (MHz)	Channel spacing(MHz)	Remarks
	CH#	F (MHz)	F' (MHz)			
37 -39.5GHz	1	37114	38374	1260	112	Recommendation ITU-R F.749-3 (Annexure 1) . The radio-frequency channel arrangement for carrier spacings of 112 MHz, 56 MHz, 28 MHz, 14 MHz, 7 MHz and 3.5 MHz in band of 37.0 - 39.5 GHz
	2	37226	38486			
	3	37338	38598			
	4	37450	38710			
	5	37562	38822			
	6	37674	38934			
	7	37786	39046			
	8	37898	39158			
	9	38010	39270			
	10	38122	39382			
	CH#	F(MHz)	F'(MHz)			
37 -39.5GHz	1	37086	38346	1260	56	Recommendation ITU-R F.749-3 (Annexure 1) . The radio-frequency channel arrangement for carrier spacings of 112 MHz, 56 MHz, 28 MHz, 14 MHz, 7 MHz and 3.5 MHz in band of 37.0 - 39.5 GHz for systems with a carrier spacing of 28 MHz: lower half of band: $F_n = F_0 - 1204 + 28n$ MHz upper half of band: $F'_n = F_0 + 56 + 28n$ MHz where: n = 1, 2, 3, . . . 40. $F_0=38248$ MHz
	2	37142	38402			
	3	37198	38458			
	4	37254	38514			
	5	37310	38570			
	6	37366	38626			
	7	37422	38682			
	8	37478	38738			
	9	37534	38794			
	10	37590	38850			
	11	37646	38906			
	12	37702	38962			
	13	37758	39018			
	14	37814	39074			
	15	37870	39130			
	16	37926	39186			
	17	37982	39242			
	18	38038	39298			
	19	38094	39354			
	20	38150	39410			

11. 42 GHz (frequency range: 40.5 GHz -43.5 GHz)

Frequency band	RF channel arrangements			Duplex (TX/RX) spacing (MHz)	Channel spacing(MHz)	Remarks
	CH#	F (MHz)	F' (MHz)			
40.5 -43.5GHz	1	40606	42106	1500	112	<p>Recommendation ITU-R F.2005-4 (Annexure 1) . This Recommendation provides radio-frequency channel arrangements for point-to-point (P-P) fixed wireless systems operating in the 42 GHz (40.5 to 43.5 GHz) band, which may be used for high, medium and low capacity systems. The preferred radio-frequency channel arrangements are based on multiples of basic channels of 7 MHz width merged to form higher channel widths up to 112 MHz.</p>
	2	40718	42218			
	3	40830	42330			
	4	40942	42442			
	5	41054	42554			
	6	41166	42666			
	7	41278	42778			
	8	41390	42890			
	9	41502	43002			
	10	41614	43114			
	11	41726	43226			
	12	41838	43338			
40.5 -43.5GHz	1	40578	42078	1500	56	<p>Recommendation ITU-R F.2005-4 (Annexure 1) . This Recommendation provides radio-frequency channel arrangements for point-to-point (P-P) fixed wireless systems operating in the 42 GHz (40.5 to 43.5 GHz) band, which may be used for high, medium and low capacity systems. The</p>
	2	40634	42134			
	3	40690	42190			
	4	40746	42246			
	5	40802	42302			
	6	40858	42358			
	7	40914	42414			
	8	40970	42470			
	9	41026	42526			
	10	41082	42582			
	11	41138	42638			
	12	41194	42694			
	13	41250	42750			
	14	41306	42806			

	15	41362	42862		<p>preferred radio-frequency channel arrangements are based on multiples of 7 MHz width merged to form higher channel widths up to 112 MHz.</p> <p>For systems with a carrier spacing of 28 MHz:</p> <p>lower half of band: $F_n = F_o - 1464 + 28 n$ MHz</p> <p>upper half of band: $F'_n = F_o + 36 + 28 n$ MHz</p> <p>where: $n = 1, 2, 3, \dots, 50$ $F_o = 42,000$</p>
	16	41418	42918		
	17	41474	42974		
	18	41530	43030		
	19	41586	43086		
	20	41642	43142		
	21	41698	43198		
	22	41754	43254		
	23	41810	43310		
	24	41866	43366		
	25	41922	43422		

12. 52 GHz (frequency range: 51.4 GHz – 52.6 GHz)

Frequency band	RF channel arrangements			Duplex (TX/RX) spacing (MHz)	Channel spacing (MHz)	Remarks
	CH#	F (MHz)	F' (MHz)			
51.4-52.6 GHz	1	51468	52084	616	56	<p>Recommendation ITU-R F.1496-1 annexure 1</p> <p>This Recommendation specifies radio-frequency channel arrangements for fixed wireless systems with channel separations of 3.5, 7, 14, 28 and 56 MHz in the band 51.4-52.6 GHz, which has been identified for use for high density applications in the fixed service (HDFS).</p>
	2	51524	52140			
	3	51580	52196			
	4	51636	52252			
	5	51692	52308			
	6	51748	52364			
	7	51804	52420			
	8	51860	52476			
	9	51916	52532			

	CH#	F(MHz)	F'(MHz)			
51.4-52.6 GHz	1	51454	52070	616	28	Recommendation ITU-R F.1496-1 annexure 1 This Recommendation specifies radio-frequency channel arrangements for fixed wireless systems with channel separations of 3.5, 7, 14, 28 and 56 MHz in the band 51.4-52.6 GHz, which has been identified for use for high density applications in the fixed service (HDFS).
	2	51482	52098			
	3	51510	52126			
	4	51538	52154			
	5	51566	52182			
	6	51594	52210			
	7	51622	52238			
	8	51650	52266			
	9	51678	52294			
	10	51706	52322			
	11	51734	52350			
	12	51762	52378			
	13	51790	52406			
	14	51818	52434			
	15	51846	52462			
	16	51874	52490			
	17	51902	52518			
	18	51930	52546			

13. V-band (frequency range: 57-66 GHz)

Frequency band	RF channel arrangements			Duplex (TX/RX) spacing (MHz)	Channel spacing(MHz)	Remarks
	CH#	F (MHz)	F' (MHz)			
55.78-57 GHz	1	55870	56486	616	56	Recommendation ITU-R F.1497-2 (Annexure 1). This Recommendation specifies radio-frequency channel arrangements for fixed wireless systems (FWS) using TDD (time division duplex) or FDD (frequency division duplex) with channel separations of 3.5, 7, 14, 28, 30, 50 and 56 MHz in the range 55.78-66 GHz, the portions of which have been identified
	2	55926	56542			
	3	55982	56598			
	4	56038	56654			
	5	56094	56710			
	6	56150	56766			
	7	56206	56822			
	8	56262	56878			
	9	56318	56934			

						for use for high-density applications in the fixed service (HDFS).
	CH#	F(MHz)	F'(MHz)			
55.78-57 GHz	1	55856	56472	616	28	Recommendation ITU-R F.1497-2 (Annexure 1) . This Recommendation specifies radio-frequency channel arrangements for fixed wireless systems (FWS) using TDD (time division duplex) or FDD (frequency division duplex) with channel separations of 3.5, 7, 14, 28, 30, 50 and 56 MHz in the range 55.78-66 GHz, the portions of which have been identified for use for high-density applications in the fixed service (HDFS).
	2	55884	56500			
	3	55912	56528			
	4	55940	56556			
	5	55968	56584			
	6	55996	56612			
	7	56024	56640			
	8	56052	56668			
	9	56080	56696			
	10	56108	56724			
	11	56136	56752			
	12	56164	56780			
	13	56192	56808			
	14	56220	56836			
	15	56248	56864			
	16	56276	56892			
	17	56304	56920			
	18	56332	56948			
	CH#	F(MHz)	F'(MHz)			
64- 66 GHz	1	64025	65015	990	30	Recommendation ITU-R F.1497-2 (Annexure 3) . Basic FDD arrangement consisting of 33 paired 30 MHz basic channels, which can be aggregated to form paired FDD channels/blocks consisting of several contiguous 30 MHz basic channels.
	2	64055	65045			
	3	64085	65075			
	4	64115	65105			
	5	64145	65135			
	6	64175	65165			
	7	64205	65195			
	8	64235	65225			
	9	64265	65255			
	10	64295	65285			
	11	64325	65315			
	12	64355	65345			
	13	64385	65375			
	14	64415	65405			
	15	64445	65435			
	16	64475	65465			

17	64505	65495
18	64535	65525
19	64565	65555
20	64595	65585
21	64625	65615
22	64655	65645
23	64685	65675
24	64715	65705
25	64745	65735
26	64775	65765
27	64805	65795
28	64835	65825
29	64865	65855
30	64895	65885
31	64925	65915
32	64955	65945
33	64985	65975

14. E-band (71-76 GHz)& (81-86 GHz)

Frequency band	RF channel arrangement			Duplex(TX/RX) Spacing (MHz)	Channel Spacing	remarks
	CH#	F(MHz)	F'(MHz)			
(71-76GHz)& (81-86 GHz)	1	71250	81250	10000	250	Recommendation ITU-R F.2006 (Annexure I). This Recommendation provides radio-frequency channel and block arrangements for fixed wireless systems (FWS) operating in the 71-76/81-86 GHz range, which may be used for broadband applications and other high-speed networks.
	2	71500	81500			
	3	71750	81750			
	4	72000	82000			
	5	72250	82250			
	6	72500	82500			
	7	72750	82750			
	8	73000	83000			
	9	73250	83250			
	10	73500	83500			
	11	73750	83750			
	12	74000	84000			
	13	74250	84250			
	14	74500	84500			
	15	74750	84750			
	16	75000	85000			
	17	75250	85250			
	18	75500	85500			
	19	75750	85750			