



Recommendation SFCG 7-1R5

**TRANSPONDER TURNAROUND FREQUENCY RATIOS AND RADIO
FREQUENCY CHANNEL PLANS FOR SPACE RESEARCH,
CATEGORY B ⁽¹⁾⁽²⁾**

The SFCG,

CONSIDERING

- a) that accurate frequency references are required on many space missions to obtain Doppler frequency and range information;
- b) that standardized turnaround ratios are especially necessary for those missions which require support of earth stations operated by two or more member agencies;
- c) that care should be exercised in the selection of the numerical factors which make up the turnaround frequency ratios;
- d) that full coverage of the 32 and 34 GHz bands, while maximizing coherency with the 7 and 8 GHz bands, requires the use of multiple ratios;
- e) that certain turnaround frequency ratios have been used extensively and successfully in certain band combinations;
- f) that the SFCG has agreed to adopt and utilize the 2, 7, 8, 32, and 34 GHz Deep Space Network channel plans when selecting frequencies for the deep space missions;

¹⁾ Category B missions are deep space missions. Deep space is defined by the RR as distances from the Earth equal to or greater than $2 \cdot 10^6$ km.

²⁾ CCSDS has adopted a similar Recommendation.

RECOMMENDS

1. that SFCG member agencies use the transponder turnaround frequency ratios listed in Table I below;
2. that SFCG member agencies utilize the Deep Space Network channel plans, Table II below, when selecting frequencies for Category B (deep-space) missions;

TABLE I - Frequency ratios and associated bands for Category B missions

Frequency ratio	Allocated band (MHz)	Available ⁽¹⁾ coherent band (MHz)	Allocated band (MHz)	Available ⁽¹⁾ coherent band (MHz)
<u><i>E-S/S-E</i></u>	<u><i>E - S</i></u>	<u><i>E - S</i></u>	<u><i>S - E</i></u>	<u><i>S - E</i></u>
221/240	2110 - 2120	2110 - 2118	2290 - 2300	2291 - 2300
221/880	2110 - 2120	2110 - 2120	8400 - 8450	8402 - 8442
221/3344	2110 - 2120	2110 - 2120	31.8 - 32.3 (GHz)	31.93 - 32.08 (GHz)
749/240	7145 - 7190	7147 - 7178	2290 - 2300	2290 - 2300
749/880	7145 - 7190	7150 - 7190	8400 - 8450	8400 - 8448
749/3328	7145 - 7190	7156 - 7190	31.8 - 32.3 (GHz)	31.80 - 31.95 (GHz)
749/3344	7145 - 7190	7145 - 7190	31.8 - 32.3 (GHz)	31.90 - 32.10 (GHz)
749/3360	7145 - 7190	7145 - 7190	31.8 - 32.3 (GHz)	32.05 - 32.25 (GHz)
3599/3344	34.2 - 34.7 (GHz)	34.22 - 34.7 (GHz)	31.8 - 32.3 (GHz)	31.91 - 32.24 (GHz)
3599/3360	34.2 - 34.7 (GHz)	34.2 - 34.6 (GHz)	31.8 - 32.3 (GHz)	31.92 - 32.3 (GHz)
<u><i>E-S/E-S</i></u>	<u><i>E - S</i></u>	<u><i>E - S</i></u>	<u><i>E - S</i></u>	<u><i>E - S</i></u>
221/749	2110 - 2120	2110 - 2120	7145 - 7190	7151 - 7185
221/3599	2110 - 2120	2110 - 2120	34.2 - 34.7 (GHz)	34.37 - 34.52 (GHz)
749/3599	7145 - 7190	7145 - 7190	34.2 - 34.7 (GHz)	34.34 - 34.54 (GHz)
<u><i>S-E/S-E</i></u>	<u><i>S - E</i></u>	<u><i>S - E</i></u>	<u><i>S - E</i></u>	<u><i>S - E</i></u>
240/880	2290 - 2300	2291 - 2300	8400 - 8450	8400 - 8433
240/3344	2290 - 2300	2290 - 2300	31.8 - 32.3 (GHz)	31.91 - 32.05 (GHz)
880/3328	8400 - 8450	8408 - 8450	31.8 - 32.3 (GHz)	31.8 - 31.96 (GHz)
880/3344	8400 - 8450	8400 - 8450	31.8 - 32.3 (GHz)	31.92 - 32.11 (GHz)
880/3360	8400 - 8450	8400 - 8450	31.8 - 32.3 (GHz)	32.07 - 32.26 (GHz)

(1) The available coherent band refers to the range of frequencies within which a set of channels that are coherent with those in another deep-space allocation may be specified. The band is determined by the frequency ratio and the allocation width. For the 2, 7, and 8 GHz bands, the available coherent band is approximately equal to the allocated band. For the 32 and 34 GHz allocations, the width of the available coherent band for a given frequency ratio is substantially less than the allocation width, and these cases are shown in bold face type.

TABLE II – Channel frequencies (in MHz) for Category B (deep-space) missions

Band:	2 E-S	2 S-E	8 E-S	8 S-E	32 S-E	32 S-E	32 S-E
Factor:	221	240	749	880	3328	3344	3360
Channel	F2DN						
1		2290.185185	7147.286265			31909.913580	32062.592592
2		2290.555556	7148.442132			31915.074083	32067.777787
3		2290.925926	7149.597995	8400.061729		31920.234571	32072.962966
4		2291.296296	7150.753857	8401.419752		31925.395059	32078.148146
5	2110.243056	2291.666667	7151.909724	8402.777780		31930.555562	32083.333340
6	2110.584105	2292.037037	7153.065587	8404.135803		31935.716050	32088.518519
7	2110.925154	2292.407407	7154.221450	8405.493826		31940.876538	32093.703699
8	2111.266204	2292.777778	7155.377316	8406.851853		31946.037042	32098.888893
9	2111.607253	2293.148148	7156.533179	8408.209876		31951.197530	32104.074073
10	2111.948303	2293.518519	7157.689045	8409.567903	31803.456798	31956.358033	32109.259267
11	2112.289352	2293.888889	7158.844908	8410.925927	31808.592595	31961.518521	32114.444447
12	2112.630401	2294.259259	7160.000771	8412.283950	31813.728392	31966.679009	32119.629626
13	2112.971451	2294.629630	7161.156637	8413.641977	31818.864203	31971.839512	32124.814821
14	2113.312500	2295.000000	7162.312500	8415.000000	31824.000000	31977.000000	32130.000000
15	2113.653549	2295.370370	7163.468363	8416.358023	31829.135797	31982.160488	32135.185179
16	2113.994599	2295.740741	7164.624229	8417.716050	31834.271608	31987.320991	32140.370374
17	2114.335648	2296.111111	7165.780092	8419.074073	31839.407405	31992.481479	32145.555553
18	2114.676697	2296.481481	7166.935955	8420.432097	31844.543202	31997.641967	32150.740733
19	2115.017747	2296.851852	7168.091821	8421.790124	31849.679014	32002.802470	32155.925927
20	2115.358796	2297.222222	7169.247684	8423.148147	31854.814810	32007.962958	32161.111107
21	2115.699846	2297.592593	7170.403550	8424.506174	31859.950622	32013.123462	32166.296301
22	2116.040895	2297.962963	7171.559413	8425.864197	31865.086419	32018.283950	32171.481481
23	2116.381944	2298.333333	7172.715276	8427.222220	31870.222216	32023.444438	32176.666660
24	2116.722994	2298.703704	7173.871143	8428.580248	31875.358027	32028.604941	32181.851854
25	2117.064043	2299.074074	7175.027005	8429.938271	31880.493824	32033.765429	32187.037034
26	2117.405092	2299.444444	7176.182868	8431.296294	31885.629621	32038.925917	32192.222213
27	2117.746142	2299.814815	7177.338735	8432.654321	31890.765432	32044.086420	32197.407408
28	2118.087191		7178.494598	8434.012344	31895.901229	32049.246908	32202.592587
29	2118.428241		7179.650464	8435.370371	31901.037041	32054.407411	32207.777782
30	2118.769290		7180.806327	8436.728395	31906.172838	32059.567899	32212.962961
31	2119.110339		7181.962190	8438.086418	31911.308634	32064.728387	32218.148140
32	2119.451389		7183.118056	8439.444445	31916.444446	32069.888891	32223.333335
33	2119.792438		7184.273919	8440.802468	31921.580243	32075.049379	32228.518514
34			7185.429782	8442.160491	31926.716040	32080.209867	32233.703694
35			7186.585648	8443.518518	31931.851851	32085.370370	32238.888888
36			7187.741511	8444.876542	31936.987648	32090.530858	32244.074068
37			7188.897377	8446.234569	31942.123460	32095.691361	32249.259262
38				8447.592592	31947.259256	32100.851849	32254.444442
39				8448.950615	31952.395053	32106.012337	32259.629621
40					31957.530865	32111.172840	32264.814816
41					31962.666662	32116.333328	32269.999995
42					31967.802458	32121.493816	32275.185174

Note:
F2DN = (N-14)*(10/27) + 2295 MHz, where N is the channel number. The value of F2DN is rounded to the nearest Hz.
Frequencies in the 2 GHz E-S band are then computed and rounded to the nearest Hz. Frequencies in other bands are derived from 2 GHz E-S frequencies by using the corresponding ratio of frequency factors, and then rounding to the nearest Hz.

TABLE II (continued) Channel frequencies (in MHz) for Category B (deep-space) missions

Band: 34 E-S 32 S-E 32 S-E
 Factor: 3599 3344 3360

Channel

L1			31803.333335
L2			31808.518514
L3			31813.703694
L4			31818.888888
L5			31824.074068
L6			31829.259262
L7			31834.444442
L8			31839.629621
L9			31844.814816
L10			31849.999995
L11			31855.185174
L12			31860.370369
L13			31865.555548
L14			31870.740728
L15			31875.925922
L16			31881.111102
L17			31886.296296
L18			31891.481475
L19			31896.666655
L20			31901.851849
L21			31907.037029
L22			31912.222223
L23			31917.407403
L24			31922.592597
L25			31927.777777
L26	34204.385040		31932.962971
L27	34209.939046		31938.148151
L28	34215.493068		31943.333345
L29	34221.047074		31948.518525
L30	34226.601080	31801.543210	31953.703704
L31	34232.155103	31806.703713	31958.888898
L32	34237.709109	31811.864201	31964.074078
L33	34243.263131	31817.024704	31969.259272
L34	34248.817137	31822.185192	31974.444452
L35	34254.371144	31827.345681	31979.629631
L36	34259.925166	31832.506184	31984.814826
L37	34265.479172	31837.666672	31990.000005
L38	34271.033178	31842.827160	31995.185184
L39	34276.587201	31847.987663	32000.370379
L40	34282.141207	31853.148151	32005.555558
L41	34287.695213	31858.308639	32010.740738
L42	34293.249235	31863.469142	32015.925932
L43	34298.803241	31868.629630	32021.111112
L44	34304.357264	31873.790133	32026.296306
L45	34309.911270	31878.950621	32031.481486
L46	34315.465276	31884.111109	32036.666665
L47	34321.019298	31889.271613	32041.851860
L48	34326.573304	31894.432101	32047.037039
L49	34332.127311	31899.592589	32052.222218
L50	34337.681333	31904.753092	32057.407413

Band: 34 E-S 32 S-E 32 S-E
 Factor: 3599 3344 3360

Channel

1	34343.235339	31909.913580	32062.592592
2	34348.789362	31915.074083	32067.777787
3	34354.343368	31920.234571	32072.962966
4	34359.897374	31925.395059	32078.148146
5	34365.451396	31930.555562	32083.333340
6	34371.005402	31935.716050	32088.518519
7	34376.559408	31940.876538	32093.703699
8	34382.113431	31946.037042	32098.888893
9	34387.667437	31951.197530	32104.074073
10	34393.221459	31956.358033	32109.259267
11	34398.775465	31961.518521	32114.444447
12	34404.329471	31966.679009	32119.629626
13	34409.883494	31971.839512	32124.814821
14	34415.437500	31977.000000	32130.000000
15	34420.991506	31982.160488	32135.185179
16	34426.545529	31987.320991	32140.370374
17	34432.099535	31992.481479	32145.555553
18	34437.653541	31997.641967	32150.740733
19	34443.207563	32002.802470	32155.925927
20	34448.761569	32007.962958	32161.111107
21	34454.315592	32013.123462	32166.296301
22	34459.869598	32018.283950	32171.481481
23	34465.423604	32023.444438	32176.666660
24	34470.977626	32028.604941	32181.851854
25	34476.531632	32033.765429	32187.037034
26	34482.085638	32038.925917	32192.222213
27	34487.639661	32044.086420	32197.407408
28	34493.193667	32049.246908	32202.592587
29	34498.747689	32054.407411	32207.777782
30	34504.301696	32059.567899	32212.962961
31	34509.855702	32064.728387	32218.148140
32	34515.409724	32069.888891	32223.333335
33	34520.963730	32075.049379	32228.518514
34	34526.517736	32080.209867	32233.703694
35	34532.071759	32085.370370	32238.888888
36	34537.625765	32090.530858	32244.074068
37	34543.179787	32095.691361	32249.259262
38	34548.733793	32100.851849	32254.444442
39	34554.287799	32106.012337	32259.629621
40	34559.841822	32111.172840	32264.814816
41	34565.395828	32116.333328	32269.999995
42	34570.949834	32121.493816	32275.185174

Band: 34 E-S 32 S-E 32 S-E
 Factor: 3599 3344 3360

Channel

H1	34576.503856	32126.654319	32280.370369
H2	34582.057863	32131.814808	32285.555548
H3	34587.611869	32136.975296	32290.740728
H4	34593.165891	32142.135799	32295.925922
H5	34598.719897	32147.296287	
H6	34604.273920	32152.456790	
H7	34609.827926	32157.617278	
H8	34615.381932	32162.777766	
H9	34620.935954	32167.938269	
H10	34626.489960	32173.098757	
H11	34632.043983	32178.259260	
H12	34637.597989	32183.419748	
H13	34643.152011	32188.580252	
H14	34648.706017	32193.740740	
H15	34654.260040	32198.901243	
H16	34659.814046	32204.061731	
H17	34665.368068	32209.222234	
H18	34670.922074	32214.382722	
H19	34676.476080	32219.543210	
H20	34682.030103	32224.703713	
H21	34687.584109	32229.864201	
H22	34693.138131	32235.024704	
H23	34698.692137	32240.185192	
H24		32245.345681	
H25		32250.506184	
H26		32255.666672	
H27		32260.827160	
H28		32265.987663	
H29		32271.148151	
H30		32276.308639	
H31		32281.469142	
H32		32286.629630	
H33		32291.790133	
H34		32296.950621	

Note:
 F2DN = (N-14)*(10/27) + 2295 MHz, where N is the channel number. The value of F2DN is rounded to the nearest Hz. Frequencies in the 2 GHz E-S band are then computed and rounded to the nearest Hz. Frequencies in other bands are derived from 2 GHz E-S frequencies by using the corresponding ratio of frequency factors, and then rounding to the nearest Hz.