



Recommendation SFCG 7-1R6

**TRANSPONDER TURNAROUND FREQUENCY RATIOS AND RADIO
FREQUENCY CHANNEL PLANS FOR SPACE RESEARCH,
CATEGORY B ⁽⁰⁾⁽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 $2 \cdot 10^7$ 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			31909.913578	32062.592591
2		2290.555556	7148.442131			31915.074080	32067.777784
3		2290.925926	7149.597994	8400.061729		31920.234569	32072.962964
4		2291.296296	7150.753857	8401.419752		31925.395057	32078.148144
5	2110.243056	2291.666667	7151.909723	8402.777779		31930.555559	32083.333337
6	2110.584105	2292.037037	7153.065586	8404.135802		31935.716048	32088.518517
7	2110.925154	2292.407407	7154.221449	8405.493825		31940.876536	32093.703696
8	2111.266204	2292.777778	7155.377316	8406.851853		31946.037042	32098.888894
9	2111.607253	2293.148148	7156.533179	8408.209877		31951.197531	32104.074074
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	31966.679010	32119.629627
13	2112.971451	2294.629630	7161.156637	8413.641977	31818.864203	31971.839512	32124.814820
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	32135.185180
16	2113.994599	2295.740741	7164.624229	8417.716050	31834.271608	31987.320990	32140.370373
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	8421.790123	31849.679012	32002.802469	32155.925926
20	2115.358796	2297.222222	7169.247684	8423.148147	31854.814810	32007.962958	32161.111106
21	2115.699846	2297.592593	7170.403551	8424.506175	31859.950624	32013.123464	32166.296304
22	2116.040895	2297.962963	7171.559414	8425.864198	31865.086422	32018.283952	32171.481483
23	2116.381944	2298.333333	7172.715277	8427.222221	31870.222219	32023.444441	32176.666663
24	2116.722994	2298.703704	7173.871143	8428.580248	31875.358029	32028.604943	32181.851856
25	2117.064043	2299.074074	7175.027006	8429.938271	31880.493826	32033.765431	32187.037036
26	2117.405092	2299.444444	7176.182869	8431.296295	31885.629624	32038.925920	32192.222216
27	2117.746142	2299.814815	7177.338735	8432.654321	31890.765434	32044.086422	32197.407409
28	2118.087191		7178.494598	8434.012345	31895.901231	32049.246910	32202.592589
29	2118.428241		7179.650464	8435.370372	31901.037042	32054.407412	32207.777782
30	2118.769290		7180.806327	8436.728395	31906.172839	32059.567901	32212.962962
31	2119.110339		7181.962190	8438.086418	31911.308636	32064.728389	32218.148142
32	2119.451389		7183.118057	8439.444446	31916.444451	32069.888895	32223.333340
33	2119.792438		7184.273920	8440.802469	31921.580248	32075.049384	32228.518520
34			7185.429783	8442.160493	31926.716045	32080.209872	32233.703699
35			7186.585649	8443.518520	31931.851856	32085.370374	32238.888893
36			7187.741512	8444.876543	31936.987653	32090.530863	32244.074073
37			7188.897378	8446.234570	31942.123463	32095.691365	32249.259266
38				8447.592593	31947.259260	32100.851853	32254.444446
39				8448.950616	31952.395058	32106.012341	32259.629625
40					31957.530868	32111.172843	32264.814819
41					31962.666665	32116.333332	32269.999999
42					31967.802462	32121.493820	32275.185178

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 8 GHz E-S band are then computed and rounded to the nearest Hz. Frequencies in other bands are derived from the 8 GHz E-S frequencies by using the corresponding ratio of frequency factors, and then rounding to the nearest Hz. Due to rounding, ratios of the uplink to downlink frequency may differ by 1 or 2 Hz from the exact turnaround ratio in some cases.

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

Band:	34 E-S	32 S-E	32 S-E	Band:	34 E-S	32 S-E	32 S-E	Band:	34 E-S	32 S-E	32 S-E
Factor:	3599	3344	3360	Factor:	3599	3344	3360	Factor:	3599	3344	3360
Channel				Channel				Channel			
L1			31803.333340	1	34343.235337	31909.913578	32062.592591	H1	34576.503864	32126.654327	32280.370376
L2			31808.518520	2	34348.789358	31915.074080	32067.777784	H2	34582.057871	32131.814815	32285.555556
L3			31813.703699	3	34354.343365	31920.234569	32072.962964	H3	34587.611877	32136.975304	32290.740736
L4			31818.888893	4	34359.897372	31925.395057	32078.148144	H4	34593.165898	32142.135806	32295.925929
L5			31824.074073	5	34365.451393	31930.555559	32083.333337	H5	34598.719905	32147.296294	
L6			31829.259266	6	34371.005399	31935.716048	32088.518517	H6	34604.273926	32152.456796	
L7			31834.444446	7	34376.559406	31940.876536	32093.703696	H7	34609.827933	32157.617284	
L8			31839.629625	8	34382.113432	31946.037042	32098.888894	H8	34615.381939	32162.777773	
L9			31844.814819	9	34387.667438	31951.197531	32104.074074	H9	34620.935960	32167.938275	
L10			31849.999999	10	34393.221459	31956.358033	32109.259267	H10	34626.489967	32173.098763	
L11			31855.185178	11	34398.775466	31961.518521	32114.444447	H11	34632.043973	32178.259252	
L12			31860.370376	12	34404.329472	31966.679010	32119.629627	H12	34637.597994	32183.419754	
L13			31865.555556	13	34409.883493	31971.839512	32124.814820	H13	34643.152006	32188.580246	
L14			31870.740736	14	34415.437500	31977.000000	32130.000000	H14	34648.706027	32193.740748	
L15			31875.925929	15	34420.991507	31982.160488	32135.185180	H15	34654.260033	32198.901237	
L16			31881.111109	16	34426.545528	31987.320990	32140.370373	H16	34659.814040	32204.061725	
L17			31886.296302	17	34432.099534	31992.481479	32145.555553	H17	34665.368061	32209.222227	
L18			31891.481482	18	34437.653541	31997.641967	32150.740733	H18	34670.922067	32214.382716	
L19			31896.666662	19	34443.207562	32002.802469	32155.925926	H19	34676.476074	32219.543204	
L20			31901.851855	20	34448.761568	32007.962958	32161.111106	H20	34682.030095	32224.703706	
L21			31907.037035	21	34454.315594	32013.123464	32166.296304	H21	34687.584102	32229.864194	
L22			31912.222215	22	34459.869601	32018.283952	32171.481483	H22	34693.138123	32235.024696	
L23			31917.407408	23	34465.423607	32023.444441	32176.666663	H23	34698.692129	32240.185185	
L24			31922.592592	24	34470.977628	32028.604943	32181.851856	H24		32245.345673	
L25			31927.777785	25	34476.531635	32033.765431	32187.037036	H25		32250.506180	
L26	34204.385033		31932.962965	26	34482.085642	32038.925920	32192.222216	H26		32255.666668	
L27	34209.939040		31938.148145	27	34487.639663	32044.086422	32197.407409	H27		32260.827157	
L28	34215.493061		31943.333338	28	34493.193669	32049.246910	32202.592589	H28		32265.987659	
L29	34221.047067		31948.518518	29	34498.747690	32054.407412	32207.777782	H29		32271.148147	
L30	34226.601074	31801.543204	31953.703698	30	34504.301697	32059.567901	32212.962962	H30		32276.308635	
L31	34232.155095	31806.703706	31958.888891	31	34509.855703	32064.728389	32218.148142	H31		32281.469137	
L32	34237.709102	31811.864194	31964.074071	32	34515.409729	32069.888895	32223.333340	H32		32286.629626	
L33	34243.263123	31817.024696	31969.259264	33	34520.963736	32075.049384	32228.518520	H33		32291.790128	
L34	34248.817129	31822.185185	31974.444444	34	34526.517742	32080.209872	32233.703699	H34		32296.950616	
L35	34254.371136	31827.345673	31979.629624	35	34532.071763	32085.370374	32238.888893				
L36	34259.925162	31832.506180	31984.814822	36	34537.625770	32090.530863	32244.074073				
L37	34265.479168	31837.666668	31990.000001	37	34543.179791	32095.691365	32249.259266				
L38	34271.033175	31842.827157	31995.185181	38	34548.733798	32100.851853	32254.444446				
L39	34276.587196	31847.987659	32000.370375	39	34554.287804	32106.012341	32259.629625				
L40	34282.141202	31853.148147	32005.555554	40	34559.841825	32111.172843	32264.814819				
L41	34287.695209	31858.308635	32010.740734	41	34565.395832	32116.333332	32269.999999				
L42	34293.249230	31863.469137	32015.925927	42	34570.949838	32121.493820	32275.185178				
L43	34298.803237	31868.629626	32021.111107								
L44	34304.357258	31873.790128	32026.296301								
L45	34309.911264	31878.950616	32031.481480								
L46	34315.465271	31884.111105	32036.666660								
L47	34321.019297	31889.271611	32041.851858								
L48	34326.573303	31894.432099	32047.037038								
L49	34332.127310	31899.592588	32052.222218								
L50	34337.681331	31904.753090	32057.407411								

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 8 GHz E-S band are then computed and rounded to the nearest Hz. Frequencies in other bands are derived from the 8 GHz E-S frequencies by using the corresponding ratio of frequency factors, and then rounding to the nearest Hz. Due to rounding, ratios of the uplink to downlink frequency may differ by 1 or 2 Hz from the exact turnaround ratio in some cases.