



## Ka-Band Transmitter for Small Spacecraft

*Smallsat Conference 2013*

- Phase I Transmitter:
  - Ka-Band EESS Primary Band: 25.5 – 27.0 GHz
  - ½ watt RF Power Output (+27 dBm)
  - 23.0 dBiC Antenna
  - 50.0 dBm (20.0 dBW) EIRP
  - QPSK Modulator
  - Two CODING STEPS Taken from DVB-S2:
    - QPSK; R=1/4; LDPC Concatenated with BCH; Spectral Efficiency = 0.4902 bits/Hz
    - QPSK; R=9/10; LDPC Concatenated with BCH; Spectral Efficiency = 1.7886 bits/Hz
  - Supports 10 Mbps; 2.4 m GS Antenna with 99.5% Avail @ Svalbard; 600 km Orbit; 25 MHz Bandwidth
  - Supports 40 Mbps; 2.4 m GS Antenna under No-Rain Conditions @ Svalbard; 25 Mbps
  - 1.0 to 1.1 U Volume, including antenna
  - 10 watts DC Input Power
  - CCM Mode Only



- Phase II Transmitter:
  - Ka-Band EESS Primary Band: 25.5 – 27.0 GHz
  - ½ watt RF Power Output (+27 dBm)
  - 23.0 dBiC Antenna
  - 50.0 dBm (20.0 dBW) EIRP
  - Full DBV-S2 Modulator
  - Supports ALL Constant Envelope MODCODs from DVB-S2:
    - Supports 10 Mbps; 2.4 m GS Antenna with 99.5% Avail @ Svalbard
  - Supports 40 Mbps; 2.4 m GS Antenna under No-Rain Conditions @ Svalbard
  - 1.0 to 1.1 U Volume, including antenna
  - 15 watts DC Input Power
  - CCM, VCM and ACM are Possible

# DVB-S2 MODCOD Table



## DVB-S2 Quasi-Constant Envelope Modes

This is only to be used to show the DVB-S2 MODCOD table steps (in order of spectral efficiency). It is not to be taken as an optimized system approach. The grey highlighted rows are MODCOD steps that have a MINIMUM amplitude crest factor.

### DVB-S2 STEPS Not Requiring Significant Amplifier Linearity

Specified Bandwidth in MHz (Per Channel) **25.00** Specify Nyquist rolloff **0.2**

#### ETSI EN 302307 DVB S2 Theoretical Performance for Target ModCOD

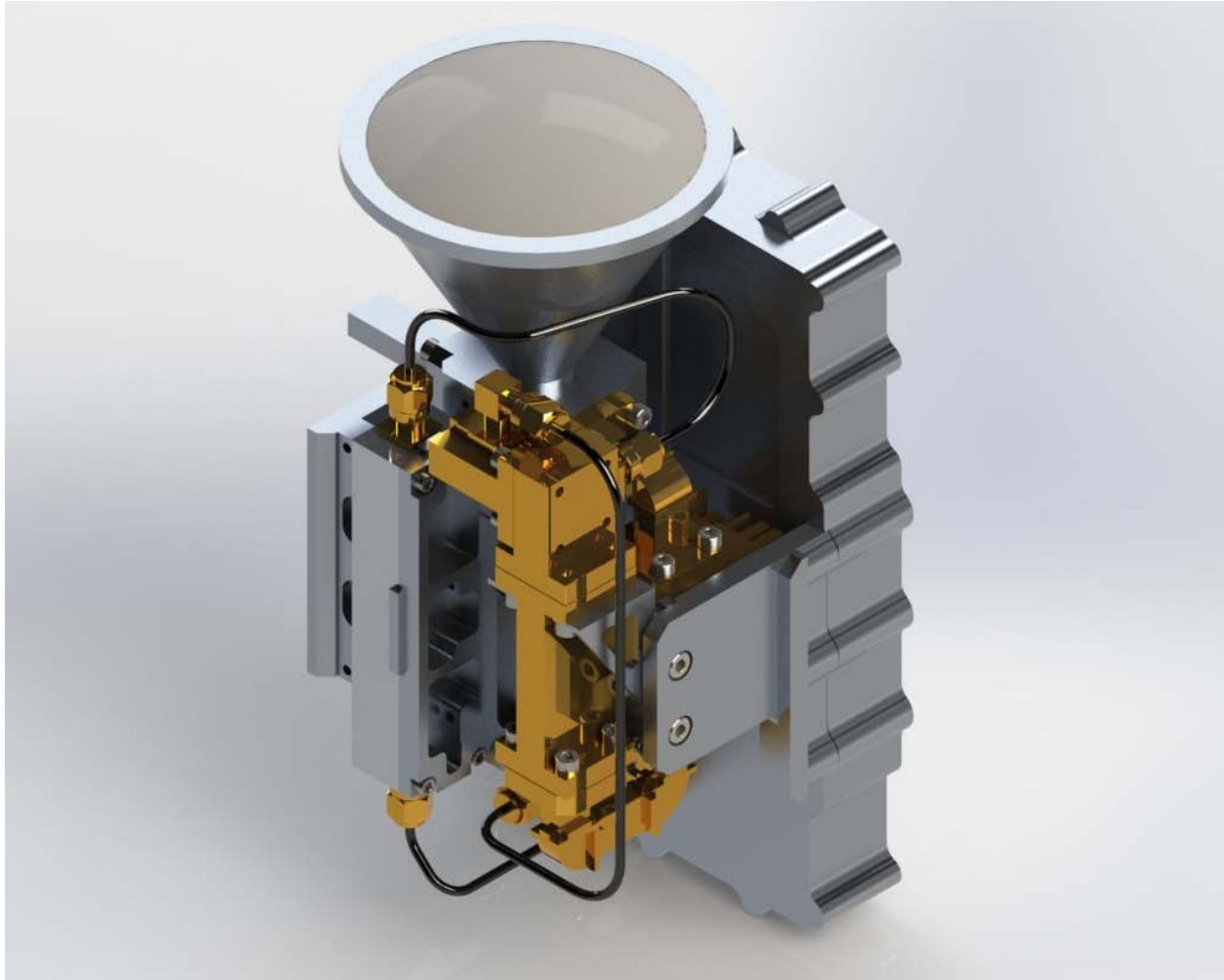
Step Available:	MODULATION	CODING Rate	Es/No	Sym rate	BW (nyq)	C/No	C/N	Spectral Efficiency	Bits/ symbol	Data Rate	Ebi/No	Eb/No	Gross Bit Rate	Info bits	code bits	"overhead"
1	QPSK	1/4	-2.35	20.83	25.00	70.84	-3.14	0.490243	2	10.2134	0.746	-5.360	41.67	10.42	31.25	1.951%
2	QPSK	1/3	-1.24	20.83	25.00	71.95	-2.03	0.656448	2	13.6760	0.588	-4.250	41.67	13.89	27.78	1.533%
3	QPSK	2/5	-0.3	20.83	25.00	72.89	-1.09	0.789412	2	16.4461	0.727	-3.310	41.67	16.67	25.00	1.324%
4	QPSK	1/2	1.00	20.83	25.00	74.19	0.21	0.988858	2	20.6012	1.049	-2.010	41.67	20.83	20.83	1.114%
5	QPSK	3/5	2.23	20.83	25.00	75.42	1.44	1.188304	2	24.7563	1.481	-0.780	41.67	25.00	16.67	0.975%
6	QPSK	2/3	3.10	20.83	25.00	76.29	2.31	1.322253	2	27.5469	1.887	0.090	41.67	27.78	13.89	0.831%
7	QPSK	3/4	4.03	20.83	25.00	77.22	3.24	1.487473	2	30.9890	2.306	1.020	41.67	31.25	10.42	0.835%
8	QPSK	4/5	4.68	20.83	25.00	77.87	3.89	1.587196	2	33.0666	2.674	1.670	41.67	33.33	8.33	0.800%
9	QPSK	5/6	5.18	20.83	25.00	78.37	4.39	1.654663	2	34.4721	2.993	2.170	41.67	34.72	6.94	0.720%
10	8PSK	3/5	5.50	20.83	25.00	78.69	4.71	1.779910	3	37.0815	2.996	0.729	62.50	37.50	25.00	1.116%
11	QPSK	8/9	6.20	20.83	25.00	79.39	5.41	1.766451	2	36.8011	3.729	3.190	41.67	37.04	4.63	0.637%
12	QPSK	9/10	6.42	20.83	25.00	79.61	5.63	1.788612	2	37.2628	3.895	3.410	41.67	37.50	4.17	0.633%
13	8PSK	2/3	6.62	20.83	25.00	79.81	5.83	1.980636	3	41.2633	3.652	1.849	62.50	41.67	20.83	0.968%
14	8PSK	3/4	7.91	20.83	25.00	81.10	7.12	2.228124	3	46.4193	4.431	3.139	62.50	46.88	15.63	0.972%
NO	16APSK	2/3	8.97	20.83	25.00	82.16	8.18	2.637201	4	54.9417	4.759	2.949	83.33	55.56	27.78	1.10%
15	8PSK	5/6	9.35	20.83	25.00	82.54	8.56	2.478562	3	51.6367	5.408	4.579	62.50	52.08	10.42	0.858%
NO	16APSK	3/4	10.21	20.83	25.00	83.40	9.42	2.966728	4	61.8068	5.487	4.189	83.33	62.50	20.83	1.11%
16	8PSK	8/9	10.69	20.83	25.00	83.88	9.90	2.646012	3	55.1253	6.464	5.919	62.50	55.56	6.94	0.77%
17	8PSK	9/10	10.98	20.83	25.00	84.17	10.19	2.679207	3	55.8168	6.700	6.209	62.50	56.25	6.25	0.77%
NO	16APSK	4/5	11.03	20.83	25.00	84.22	10.24	3.165623	4	65.9505	6.025	5.009	83.33	66.67	16.67	1.07%
NO	16APSK	5/6	11.61	20.83	25.00	84.80	10.82	3.300184	4	68.7538	6.425	5.589	83.33	69.44	13.89	0.99%
NO	32APSK	3/4	12.73	20.83	25.00	85.92	11.94	3.703295	5	77.1520	7.044	5.740	104.17	78.13	26.04	1.25%
NO	16APSK	8/9	12.89	20.83	25.00	86.08	12.10	3.523143	4	73.3988	7.421	6.869	83.33	74.07	9.26	0.91%
NO	16APSK	9/10	13.13	20.83	25.00	86.32	12.34	3.567342	4	74.3196	7.607	7.109	83.33	75.00	8.33	0.91%
NO	32APSK	4/5	13.64	20.83	25.00	86.83	12.85	3.951571	5	82.3244	7.672	6.650	104.17	83.33	20.83	1.21%
NO	32APSK	5/6	14.28	20.83	25.00	87.47	13.49	4.119540	5	85.8238	8.132	7.290	104.17	86.81	17.36	1.13%
NO	32APSK	8/9	15.69	20.83	25.00	88.88	14.90	4.397854	5	91.6220	9.258	8.700	104.17	92.59	11.57	1.05%
NO	32APSK	9/10	16.05	20.83	25.00	89.24	15.26	4.453027	5	92.7714	9.563	9.060	104.17	93.75	10.42	1.04%



- Phase III Transmitter:
  - Ka-Band EESS Primary Band: 25.5 – 27.0 GHz
  - ½ to 1 watt RF Power Output (+27 to +30 dBm)
  - 23.0 dBiC Antenna
  - 50.0 dBm (20.0 dBW) EIRP to +53.0 dBm (23.0 dBW)
  - Full DBV-S2 Modulator
  - Supports ALL Constant Envelope MODCODs from DVB-S2:
  - Supports 125 Mbps Data Rate
  - 1.0 to 1.1 U Volume, including antenna
  - 14 watts DC Input Power
  - CCM, VCM and ACM; ACM Fully Supported

# Progression of Ka-Tx Design

## Phase I Transmitter





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