

How many SD/HD channels can we get from one transponder?

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Everybody who ever studied satellite charts with transponder data knows that the symbol rate of a transponder is one of its most important parameters. And that's not only because you need to know it to set the data in manual channel search in your receiver. Symbol rate directly affects the amount of useful data that can be transmitted via a transponder. The higher it is, the more data can be sent. More data means more TV and radio channels.

But can you exactly tell how many TV channels one can send through a transponder having a given symbol rate? Well, the exact answer is: no, we can not tell it with absolute exactness, but we can estimate the number of channels with reasonable accuracy.

Why is that so? The main reason is: we can not say precisely how many bits per second will be needed for a given channel. Channel bit rate changes depending on how dynamic its content is. Moreover, the DVB standard allows the service providers to choose between different video resolutions and different MPEG compression levels. If you have a good satellite signal analyzer, you can check for yourself that SDTV channel have average bit rates ranging from 1.5 Mb/sec to 6 Mb/sec (peaking even to 7 Mb/sec). Of course, the quality of a channel transmitted with 1.5 or 2

Mb/sec is very poor – the picture is foggy and sometimes you can notice compression artifacts. On the other hand, high quality SD channels like for example ZDF channel on ASTRA 19.2° E, have so good picture quality that when received with a set-top-box with an upscaler, you have the impression it is an HD channel. To achieve this, you need about 6 Mb/sec video bit rate.

The majority of the channels with acceptable quality have 3.5-4 Mb/sec video bit rate. Because audio occupies usually 0.256 Mb/sec, one can assume that on the average 4 Mb/sec is need for a good (but not the best) quality SDTV channel. This is true for MPEG-2 compression which is still in use for the vast majority of SD channels.

But what about HDTV channels? Well, they need much more bits per seconds. One can

assume about 15-20 Mb/sec for a HD channel compressed with classical MPEG-2 but only 10 Mb/sec if more modern H.264 (MPEG-4) is used. More and more HD channels move from MPEG-2 compression to MPEG-4. You know, the bandwidth is costly...

Once that we did the assumption on the required bit rate for an MPEG-2 SD channel and MPEG-4 HD channel (4 and 10 Mb/sec respectively), we can calculate how many channels one can send through a transponder of a given symbol rate. Except for the symbol rate, we need to take into account if it is DVB-S or DVB-S2 and what is the FEC value. The higher the FEC, the more efficient transmission, i.e. the higher usable bit rate for a given symbol rate.

In the three graphs, you can see the relationship between transponder symbol rate, FEC

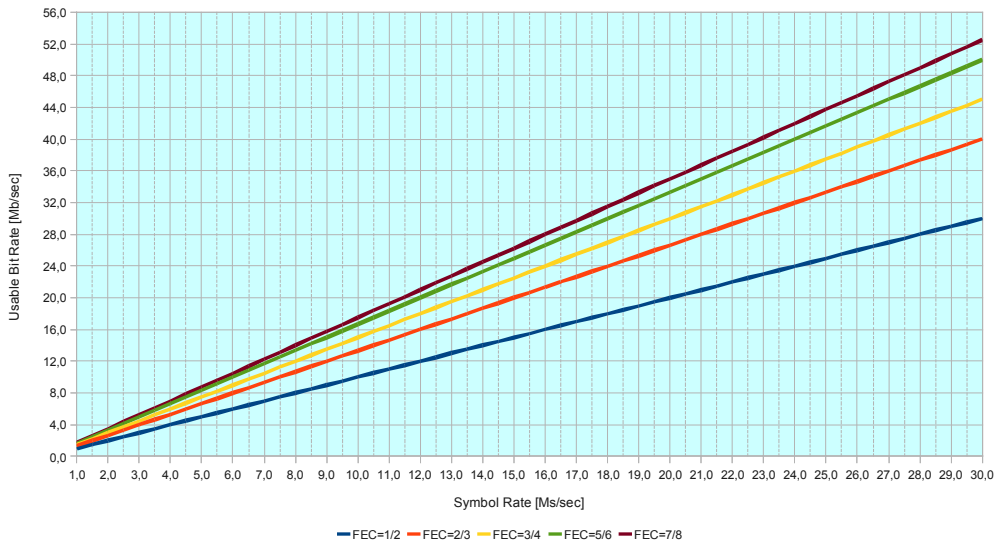
and the bit rate. The Y axis scale has been chosen so that you can easily calculate the number of channels. So the scale has either a unit of 4 Mb/sec or 10 Mb/s.

Use the first graph to find a number of SD MPEG channels transmitted via DVB-S transponder. On X axis find the point equal to the transponder symbol rate and draw a vertical line upwards until it crosses the line corresponding with transponder FEC. From the crossing point, move horizontally towards Y axis to find the value of the bit rate that can be achieved for that symbol rate and FEC. Next count how many 4 Mb/sec steps you can make from zero to the found bit rate. This is the number of good quality SD channels encoded with MPEG-2 you can transmit via the DVB-S transponder. For example if $SR=27.5$ MS/sec and $FEC=3/4$, you will get over 40 Mb/sec what corresponds to 10 good quality SD channels.

The second graph lets you calculate how many HD channels you can send via the same DVB-S transponder. Please mind that now we assume MPEG-4 compression. If this is still MPEG-2, the number of channels will be twice as low. In the same example as

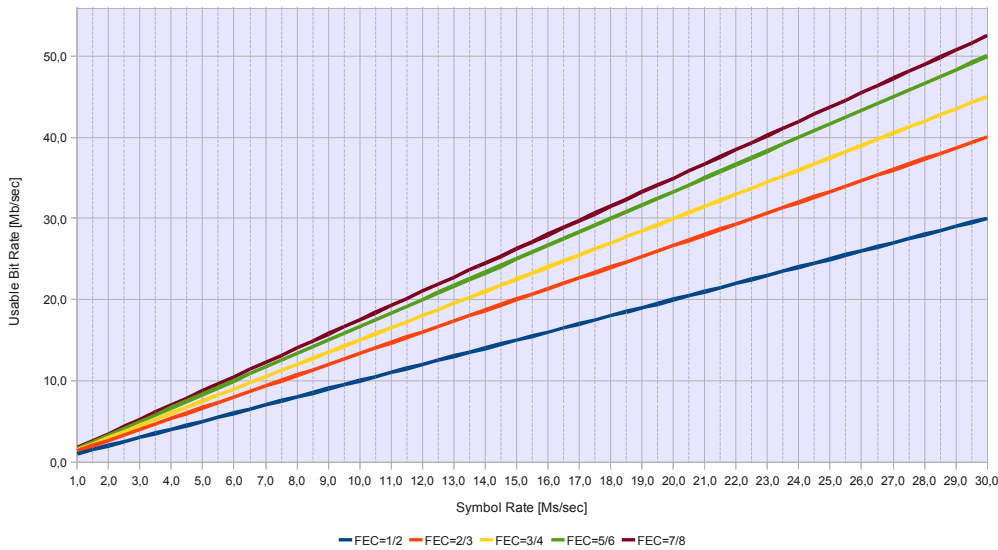
Graph 1. Bitrate vs. Symbol Rate and FEC for DVB-S

Note: 4 Mb/sec = 1 MPEG-2 SD channel of good quality



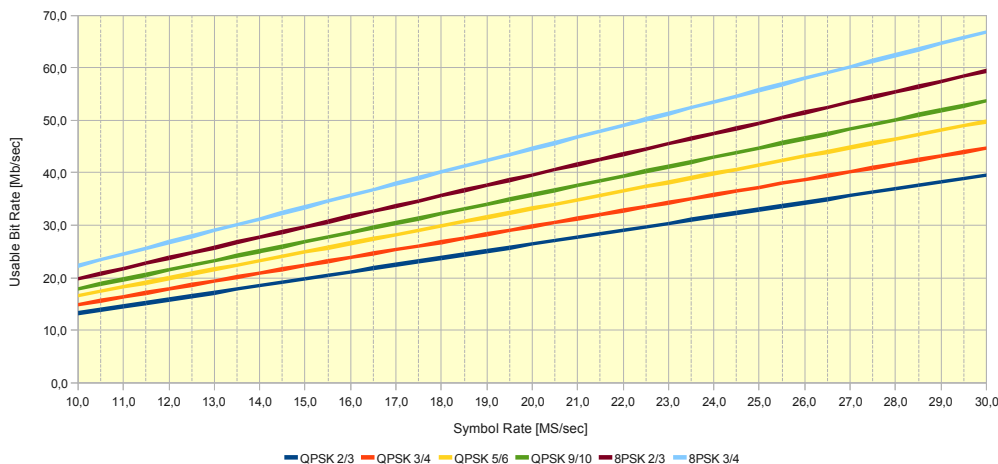
Graph 2. Bitrate vs. Symbol Rate and FEC for DVB-S

Note: 10 Mb/sec = 1 MPEG-4 HD channel



Graph 3. Bit Rate vs. Modulation and FEC for DVB-S2

Note: 10 Mb/sec = 1 MPEG-4 HD channel



above, you will find that 4 HD channels are possible with this transponder.

But what about DVB-S2? It becomes more and more popular. We prepared the third graph, this time only for the HD channels (but you can multiply the result by 2.5 to get the number of MPEG-2 SD channels). We have chosen only the most popular combinations of modulation type (QPSK/8PSK) and FEC values. Drawing all possible combinations would make the graphs completely unreadable. For the same exemplary symbol rate 27.5 Ms/sec, we can use 8PSK modulation and FEC=3/4 in DVB-S2 to get the usable bit rate over 60 Mb/sec what would enable us to transmit even 6 HD channels.

However you should be aware that the 8PSK and high FEC values require higher power to guarantee the same noise margin at the end user reception system. So, only the transponder on a satellite capable of providing enough power from its solar panels can be used in 8PSK mode with high FEC value. That's the physical limitation.

In the old days of analog TV, one could precisely tell how many channels you can transmit in a given bandwidth, but not today. In a real world, you can see quite often a combination of HD/SD channels and TV/radio channels transmitted through the same transponder. Channels differ in bit rates (and in this way in quality), so there is no way to say precisely how many channels we can expect assuming given bandwidth.

However, after reading this article you know what kind of video quality you can expect for example from a transponder filled with 20 channels and having SR=27500 3/4.