Earth Ground Station DSN to GPS Satellites with Long Haul Capability and back

Link Budget Calculation

Project specifications required an Earth to Mars link with a data rate of 1.5 Mbps. The link uses the Deep Space Network 70m dishes on earth to communicate with 4 satellites in Mars orbit that are also GPS satellites. In addition to transmitting the normal navigation messages, these satellites carry transceivers for communication back to earth. All four satellites are in the same constellation and separated by 90 degrees. This ensures that at least one satellite always has a line of sight to earth. These satellites carry a 36 dBi dish antenna which tracks the earth station during communications. BPSK modulation is used due its low required C/N. A ½ turbo code is used to provide a maximum bit error rate of 10^{-8} with the designed minimum C/N of .62 dB.

Received Signal Power		
Transmit Output Power	43.01	dBW
Receive Antenna Gain	75	dB
Transmit Antenna Gain	36	dB
Propagation Loss at 7.170 GHz	-281.62	dB
Miscellaneous Losses	-1	dB
Received Power	-128.61	dBw
Receiver Noise Power		
Boltzmann's constant K	-228.6	dBW/K/Hz
System Noise Temperature 243 K	27.8	dBK
Receiver Noise Bandwidth 6 MHz	67.8	dBHz
Noise Power	-133	dBW

Figure 1.0 Link Budget: Earth to GPS Satellites

Received Signal Power		
Transmit Output Power	27.50	dBW
Receive Antenna Gain	75	dB
Transmit Antenna Gain	36	dB
Propagation Loss at 8.4250 GHz	-283.02	dB
Miscellaneous Losses	-1	dB
Received Power	-145.52	dBw
Receiver Noise Power		
Boltzmann's constant K	-228.6	dBW/K/Hz
System Noise Temperature 243 K	14.6	dBK
Receiver Noise Bandwidth 6 MHz	67.8	dBHz
Noise Power	-146.3	dBW

Figure 2.0 Link Budget: GPS Satellites to Earth