GPS Satellite to GPS Receiver

Link Budget Calculation

The link budget is specified below in Figure 1.0. The important figure is that a total transmit power of 13.25 dBw is required. The receive antenna gain is the value measured from the antenna range. The transmit antenna is assumed to be an electrically small antenna pointing towards Mars and hence estimated to be 3 dB. The surface temperature of Mars is an average 243 Kelvins and is used as the device temperature for the receiver.

Received Signal Power		
Transmit Output Power	13.25	dBW
Receive Antenna Gain	9.23	dB
Transmit Antenna Gain	3	dB
Propagation Loss at 1.875 GHz	-182.4	dB
Miscellaneous Losses	-1	dB
Received Power	-113	dBw
Receiver Noise Power		
Boltzmann's constant K	-228.6	dBW/K/Hz
System Noise Temperature 243 K	23.8	dBK
Receiver Noise Bandwidth 24 MHz	73.8	dBHz
Noise Power	-114	dBW

Figure 1.0 Link Budget: GPS Satellite to GPS Receiver

Full GPS Precision Calculation

The GPS precision calculations were made based on a BPSK signal with a 24 MHz final RF bandwidth. This gives a chip rate of 24 Mbit/s. The C/N despread was carried over from the link budget with a processing gain of 43 dB. Finally, using the bit period as the integration period gives a final precision of 3.53 meters. The acquisition time for a C/A packet of 1500 bits is 0.62 seconds using a bit rate of 2405 bits/s.

$$\sigma = \sqrt{\frac{Nsat\ Tbit}{\left(\frac{C}{N}\right) despread\ Tint} Tchip\ C}$$

GPS Precision		
Number of Satellites Visible	8	Satellites
Bit Period	0.000831359	s
Chip Period	4.16667E-08	s
Integration Period	1.66E-03	s
C/N despread	50.11872336	
Final Precision	3.52	m
Course Acquisition Time		
Packet Size	1500	bits
Data Rate	2405	bits/s
Acquisition Time	0.62	s

Figure 2.0 GPS Precision