**Euler’s Formula:**

**GPS Signal Structures** Signal frequency relationships

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| GPS SV signals |  | Signal modulation at L1 |
| PRN Sequence:   1. 50% are 0, 50% are 1 2. 50% of run lengths are 1, 25% are length 2, … 3. if the sequence is shifted, resulting seq. has equal number of agreements and disagreements as orig. | BPSK (Binary Phase Shift Keying)   * Given carrier: s (t)  Acos( t P) * Its phase modulated version is:   + Scm(t) = Acos(w t + P + O(t)) |  |
| Signal frequency domain representation:   * DTFS and CTFT | Spectral resolution and bandwidth | L1 Signal mathematical rep. |

**CA Code and Signal Power Spectrum**

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| Correlation | Power spectrum’s relation to auto-correlation   * Power: * Auto: | Example with square pulse:  For a sequence of N pulses:   * (same with S) |

**Signal Simulation**

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| CA Code alignment at receiver   * CA=[CASamps(N-n0+2:N) CASamps(1:Ns-n0+1)] * N=samps in code pd., n0=init. code samp index at rcvr, Ns=total samps rcv’d, icp=N-n0+2 | Carrier generation   * ts=1/fs, | Carrier to noise ratio   * C/N spec. by user, Ps rel. to A, Pn env/device |
| Ps and Amplitude relationship   * approximate PSD of at the baseband | Noise power density and amplitude   * ; * ; | Noise generation   * for WGN, normal distrib.: |

**Antenna**

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| Antenna gain |  | Half-wave dipole: |
| Noise Figure   * device’s contribution to thermal noise at output * increase in a device noise power from in- to output * amount of decrease in the SNR * only applies to bandwidth of interest * typical range: 0.5 – 4~8 dB | Polarization | Polarization cont’d |

**RX Front End Circuit**

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| Nominal GPS SNR at a RX   * L1 CA P @ RX: * RX input noise P: * If B=2MHz, 10log(B)=63 dB * Assume kT = -209 dBW = -179 dBm * -116 dBm * Nominal SNR: | RX Front End Amplification | RX Noise Figure Calc.    ;  For cascaded networks:      IF Sampling |
| Mixing and Down Conversion Output | Why use IF samplin to convert to baseband?   * Analog mixing generates I and Q channels   + Channel imbalance   + More complex hardware components   + Sig strength division between 2 ch’s * IF sampling moves ADC to output of IF   + Single channel   + Less hardware   + Signal strength preservation |
| Sampling Frequency and CA Code Chipping Rate   * Fs should not be int multiples of fc   + Choose fs=5MHz (separated from 5fc) * Fc should include Doppler   note: for direct sampling  for IF sampling | Sampling Frequency Selection and Aliasing |  |
| Sampling Frequency Selection Criteria | 1. select n so fo only contains freq. w/in 1 oct. | 1. (no band aliasing) |
| ADC Output Range () and Step Size ()   * N-bit ADC: levels separated by | | Increasing SNR   1. use more bits in ADC 2. higher sampling frequency    1. get more details about signal 3. longer data    1. accumulate more coherent energy |

Signal Acquisition

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| Acquisition Basics for Software RX   * performed using a block of data * performed for each SV in sequence * time elapse between SV acq. & tracking data * fast acquisition is key to real time software rx | General Idea of Acquisition | Good Search Bin Size? |
| Doppler effect on CA code | Acquisition Data Length Selection   * minimum: 1ms to ensure 1 pd CA code included * max: 10 ms to ensure no nav data transition * main constraint: nav data bit transition spread carrier causing SNR loss in acquisition * secondary constraint: Doppler effect on CA code |