Minimizing Interference in Simultaneous Operations between GPS and Other Instrumentation Systems

16 May 2012

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• Most airborne vehicles (e.g. missiles, planes, target drones) carry multiple instrumentation systems
  – GPS
  – Telemetry
  – Flight Termination

• Issue with RF interference between these systems
Steps to minimize interference between GPS & TM systems

- Determine GPS minimum sensitivity
  - Minimum input power to not cause interference ($P_{\text{min}}$)
  - GPS Receiver manufacturer specification sheets

$$P_{\text{min}} = \text{Min. acq. level} - \text{Min acq pwr req} - \text{Margin}$$

- Min. acq. level- Minimum RF level needed for acquisition
- Min acq pwr req- Minimum input level needed for acquisition
- Margin- Operational margin (usually 10 dB)
Steps to minimize interference between GPS & TM systems

• Determine items needed to achieve GPS minimum sensitivity
  – Measurement of Transmitter and Antenna properties

\[ P_{\text{min}} = \text{GPS AN} - \text{Antenna Iso} - \text{Filter Attn} \]

\[ (\text{dBm}) \quad (\text{dB}) \quad (\text{dB}) \]

GPS AN - Worse Case GPS Additive Noise from Transmitter
Antenna Iso - Isolation between antenna systems
  (determined by measuring with Network Analyzer)
Filter Attn - Bandstop Filter for GPS spurious emissions from TM transmitter (used as design parameter)
GPS Additive Noise Test Setup

Diagram:
- BERT
- Level Shift
- Power Supply
- Lap Top Control
- Transmitter
- 3 or 20dB Attenuation
- L1 Bandpass Filter
- Spectrum Analyzer
- GPS Amplifier
- Variable Attenuation
- Telemetry
GPS Additive Noise Results (con’t)

![Graph 1: GPS Additive Noise SOQPSK, 12Mbps, 2210.5MHz S/N-2490](image1)

![Graph 2: GPS Additive Noise SOQPSK, 12Mbps, 2210.5MHz S/N-2452](image2)

**UNCLASSIFIED**
GPS Additive Noise Results

GPS Additive Noise
Missile Transmitter S/N-2490

GPS Additive Noise
Missile Transmitter S/N-2452
Example Calculation

- Using the spec for a sample GPS Receiver and a 10 dB margin, we get the following:
  \[ P_{\text{min}} = -137 \text{ dBm} - 35 \text{ dB} - 10 \text{ dB} = -182 \text{ dBm} \]

- Next using the measured data for GPS Additive Noise (-125 dB) and the Coupling between antenna system (25 dB)
  \[ P_{\text{min}} = -125 \text{ dB} - 25 \text{ dB} - \text{Filter Attenuation} \]

Thus the Bandstop Filter on the TM transmitter output needed to filter out the spurious emissions is 32 dB.
Final Configuration

TM Xmitter → GPS Bandstop Filter → TM Antenna

GPS RCVR → Filter/Limiter/Amplifier → GPS Antenna

Antenna coupling

from GPS satellites

to TM Receive Station

* Attenuator may be needed to prevent GPS Receiver from being swamped out by excessive gain of the Low Noise Amplifier.
Filter/Limiter/Amplifier (FLA) Options

- FLA integrated into conformal wraparound antenna
- Low noise amplifier
- External FLA Box
- GPS Bandstop filter
Summary

• All instrumentation system designers should use this process to prevent RF interference between GPS and Telemetry systems

• All that is needed are the following:
  – GPS Receiver specification information
  – Measurement data
    ◦ Transmitter GPS Additive Noise
    ◦ Antenna Coupling between systems

Would like to acknowledge Kip Temple (Edwards AFB) for his support with the GPS Additive Noise Transmitter Testing.