GPS Clock

MECH 6621 Final Project

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INTRODUCTION
GPS OVERVIEW
Space segment

- 31 satellites
  - 24 at 6 orbital planes
  - 7 are orbited as spares
- Orbital radius is 26,600 km (20,200 km altitude)
- 2 complete orbits each 24 hours (the same ground track each day)
- from 5 to 8 satellites above horizon from any point on the Earth
Control segment

consists of:

- Master control station (Colorado Springs, USA)
- Alternate master control station
- Four dedicated ground antennas
- Six dedicated monitor stations

The main role is observing the ephemeris and clock of each satellite and correction of the orbit and clock errors.
User segment

- U.S. military users of the secure GPS Precise Positioning Service
- Civil, commercial and scientific users of the Standard Positioning Service
Principle of work

The GPS receiver receives the following information from each satellite:

- The almanac data about the approximate position of satellite
- The ephemeris data about the exact position of satellite
- Message containing the time of transmission

The receiver measures the time of arrival of the satellite signals

\[ \Delta t = t_{\text{Arrival}} - t_{\text{Transmission}} \]

Distance = Propagation Rate (speed of light) * Time

User position can be computed using satellite positions and the distance to them
GPS satellite clocks

GPS time is accurate to about 14ns. To achieve such accuracy each satellite is equipped with 2 cesium and 2 rubidium clocks ($100,000 - $500,000 each).
Moreover these clocks are continually adjusted with atomic clock by Master Control Station.
Hardware

- Microcontroller as the main processing and controlling unit
- GPS module as data provider
- An alphanumeric LCD as display
- RS232 standard peripherals for communication purpose

PIC18f4431

PMB-648

LMB162ABC

MAX232
Hardware
Hardware

- PMB-648 GPS Module
- MAX232
- LCD Module LMB162ABC
- PIC18F4431
- Oscillator 8MHz
Software

- High level programming language, Proton Basic employed
- Proton IDE used to develop and compile code
Software

- One-shot HSerln instruction of Proton Basic used with necessary arguments to place each data in its own associated variable

<table>
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<th>RMC standard</th>
<th>NMEA Standard</th>
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</table>

- Valid example of RMC data:
  $GPRMC,161250.487,A,3723.2475,N,15030.3416,W,0.13,309.62,120511
Code Sections:

- Initialization
- Reading GPS module data
- Date calculation
- Time calculation
- Time zone calculation from longitude
- Time and date variables updating
- Data printing subroutines.

- Main core of this code is TIMER0 overflow interrupt
- Occurs exactly every 1 second.
Modeling & Simulation

- Proteus ISIS Professional advanced simulation software employed for design verification of this system

Model Components:
- PIC18F4431 microcontroller
- Standard LM016L 2×16 LCD model
- Virtual terminal to illustrate data flow in serial data line
- HDL (Hardware description language) code to define a virtual model for the GPS module.
Practical Testing
Practical Testing
Conclusion and practical application
Thank you for your attention