Timing System for the Laser Altimeter for Planetary Exploration Technology Demonstrator

P. Jirousek, I. Prochazka, K. Hamal, M. Fedyszynova, H. Michaelis**
Yang Fumin*, Huang Peicheng*
Czech Technical University in Prague, Czech Republic
** DLR, Germany
* Shanghai Observatory, PLR China

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Czech Technical University in Prague, Czech Republic
General Goals

• Technology demonstrator of a Compact Laser Rangefinder applicable in future space projects:
  • Mercury planet altimetry
  • Lunar altimetry and surface mapping
  • on-board optical transponder(s) for Earth orbiter(s)
  • airborne range finder
  • ground based Satellite Laser Ranging (SLR)

• Desired altimeter parameters:
  • one meter ranging precision (no costly interpolators)
  • multiphoton approach
  • diode pumped laser, ns pulses
  • modular construction
  • existing / available technology
Application

• Technology demonstrator of a Compact Laser Rangefinder
• modular construction
• based existing / available technology
• test bench operation at (any) Satellite Laser Ranging site
• reduced timing resolution (ns- pulse altimetry!)
<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
<th>Responsible Party</th>
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<tbody>
<tr>
<td>July 31st</td>
<td>decision, proposal, quotation</td>
<td>CTU Prague</td>
</tr>
<tr>
<td>August 31st</td>
<td>DLR acceptance, contract</td>
<td>DLR</td>
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<tr>
<td>October 30</td>
<td>first version operational</td>
<td>CTU Prague</td>
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<td>November</td>
<td>on-site testing</td>
<td>CTU / DLR</td>
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<td>November 30</td>
<td>delivery</td>
<td>CTU</td>
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<tr>
<td>December 15</td>
<td>integration at DLR</td>
<td>CTU / DLR</td>
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Altimeter Timing System Characteristics

- **GENERAL**
  universal timing system for laser ranging with sub-ns resolution

- **FUNCTIONS**
  - determining the epoch of laser fire
  - measuring the time-of-flight of the laser pulse
  - generating the range gate pulse for the echo signal detector
  - data acquisition and process control.

- **PROPERTIES**
  - compact, low power (battery operated), low cost
  - based on field-tested components HW & SW
  - simple to integrate into final device
Based on existing P-PET hardware and software concept, the Dassault modules are replaced by integrated TDC chips.

The timing system consists of the range counter module, the epoch timing and range gate generator module, the control processing unit, the input/output circuits and of the power supplies.

The entire control logic hardware, epoch timing, range gate, and input/output board is based on the FPGA (ispGAL) programmable logical arrays.

This ensures the maximum device flexibility and upgradability.
Timing System Technology Demonstrator Block scheme

DC 9..24 V
AC 230 V → Pow.

10 MHz
GPS
optional

10 MHz
1 pps
Start
Stop
Gate

I/O board

Minicounter
start
stop

CPU, I/O

Epoch Timing Range Gate

PC

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Timing System Technology Demonstrator Electronics boards

- Range gate logic PET 2 version
- TDC timing board
- CPU board PET 2 version
- I/O board

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Timing System Technology Demonstrator
Temporal resolution

measured time 1.52 µs
the timing resolution of 0.25 ns
normal data distribution

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Timing System Technology Demonstrator
Long-term temporal stability

Power ON

+ / - 0.1 ns

1 hour
Timing System Technology Demonstrator

Parameters

- universal timing system for laser ranging with sub-ns resolution
- resolution, precision: 0.25 ns, 0.25 ns rms
- non-linearity, stability: < 0.1 ns, < 0.1 ns/hour
- range gate delay, width: 40 ns steps
- repetition rate: 24 Hz max.
- mass: 2.5 kg
- power: DC 9-38 V, 7 VA
  > 3 hr operation on AA cells (8x)
Demonstrator Timing System Technology Summary

- the universal timing system for laser ranging: ground-ground, air-ground and ground-satellite with sub-ns resolution has been developed and tested

- simple to implement: SW package identical to PET devices

- based on tested technology and components development period < 3 months :-)

- In perspective the Altimeter Timing System may be applied in deep space laser transponder experiments