Low-Noise Frequency Synthesis for High Accuracy Picosecond Satellite Laser Ranging Timing Systems

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Abstract

The developed Frequency Multiplier from 10 MHz to 200 MHz is fully compatible to the Thales Multiplier and can be directly interfaced to the Thales Event Timing Modules by "plug and play". The new Multiplier designed at Deggendorf University of Applied Sciences shows high sub-harmonic attenuation in the frequency domain of greater than 110 dB.

Whereas, in the time domain the 200 fs rms cycle-to-cycle jitter specification is observed when measuring the output signal with a high-bandwidth sampling oscilloscope. Measurements in the time domain and frequency domain of the new multipliers show better specifications to existing frequency synthesizers.

The 10 MHz to 80 MHz Frequency Multiplier is in continuous operation at Mount Stromlo SLR Station and in various Keystone SLR Stations in Japan. Modules are available through our partner company MPF Optics Ltd.

Introduction

Tests carried out at SLR station Lustbühel, Graz:
Graz E.T. / Dassault Modules:
Comparison between Dassault Clock and Deggendorf-Clock

- DeggendorfClock is mechanically / electrical connections identical to Dassault Clock;

- Measurements in Graz were made using both clock modules alternatively;

- Measurement description:

    -   Standard Laser Firing pulse (TTL), Power Splitter 50 Ohm;

    -   1 Pulse direct into E.T. Start;

    -   Splitted pulse delayed with cable, into E.T.Stop;

    -   Standard Calibration Program used, Single Time Intervals stored;

    -   Results checked with Program DRAW, 2.2 Sigma Iteration;

- For ease of tests: Clock module 200 MHz outputs (both clocks) connected via standard RG58 Cables / SMA connectors into Start / Stop Modules (instead of Dassault Semi-Rigid Cables). All Tests performed in this configuration.

- At each change of Setup: E.T. switched off; new sync / new offsets after each switch on.

Results (in ps) / No Sigma iteration

Cal_1: 9215.94 ± 3.87 [ps]	Dassault Clock	Semi-Rigid Cables (Graz Original Setup)
Cal_2: 9216.04 ± 3.34 [ps]	Dassault Clock	RG 58 cable
Cal_3: 9217.14 ± 3.58 [ps]	Deggendorf clock	RG 58 cable
Cal_4: 9214.83 ± 3.34 [ps]	Dassault Clock	RG 58 cable
Cal_5: 9216.45 ± 3.32 [ps]	Deggendorf clock	RG 58 cable

Results (in ps) / 2.2 Sigma iteration:

Cal_1: 9215.94 ± 2.84 [ps]	Dassault Clock	Semi-Rigid Cables (Graz Original Setup)
Cal_2: 9216.12 ± 2.79 [ps]	Dassault Clock	RG 58 cable
Cal_3: 9217.00 ± 2.82 [ps]	Deggendorf clock	RG 58 cable
Cal_4: 9214.73 ± 3.07 [ps]	Dassault Clock	RG 58 cable
Cal_5: 9216.45 ± 2.57 [ps]	Deggendorf clock	RG 58 cable

Remarks

- Variation in absolute values (1-2 ps): Due to new offsets between start/stop modules after switch ON.

- Several other calibration runs were made, with different cable length etc.; all giving similar results.

- The Deggendorf clock module seems to have at least the same specs than the Dassault; no difference visible.

Editor's Note

The technical data specification for the frequency multiplier unit can be found on the accompanying CD.