Event Timer A033-ET: Current State and Typical Performance Characteristics

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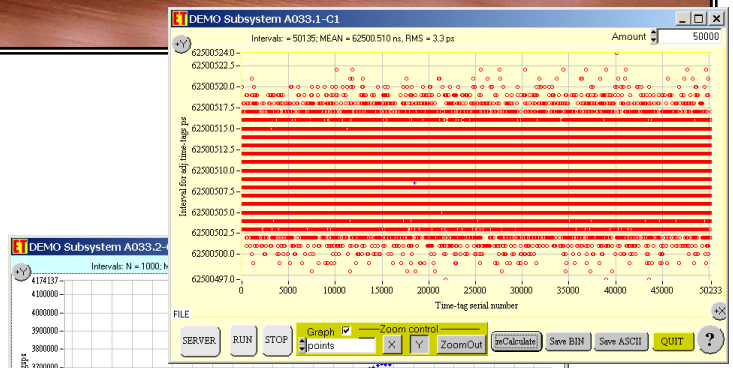
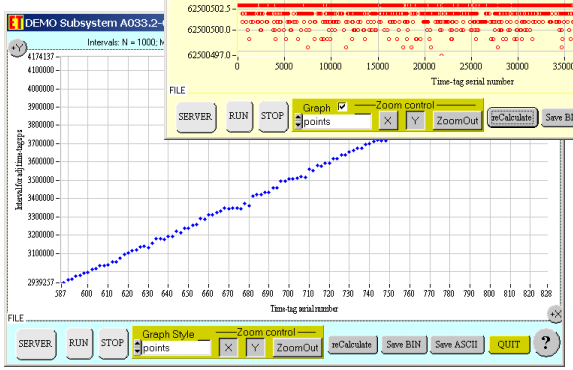
The Event Timer A033-ET has been developed as an advanced version of the model A032-ET that is well known in SLR community.



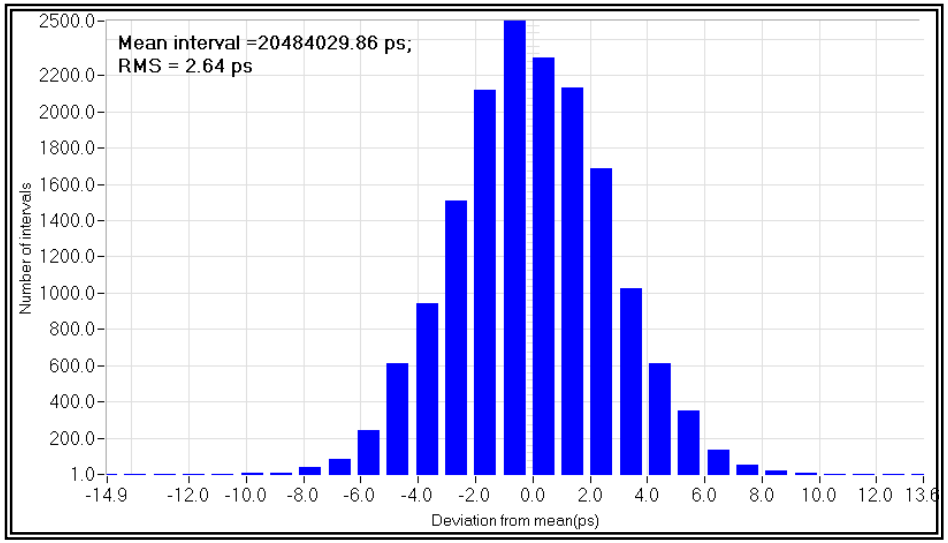


The A033-ET is commercially available from 2010, and up to now 10 units of this device have been manufactured and carefully tested. Consequently, sufficient statistics have been accumulated to reliably specify the A033-ET typical performance characteristics currently available.

A033-ET Performance Characteristics (1)

Single-shot RMS resolution is the main parameter specifying the practicable A033-ET precision. For the A033-ET it is defined as the standard deviation of total error in measurement of time intervals between events.

Typically the A033-ET supports single-shot RMS resolution in the range 2.5-3.0 ps depending on the hardware unique features.



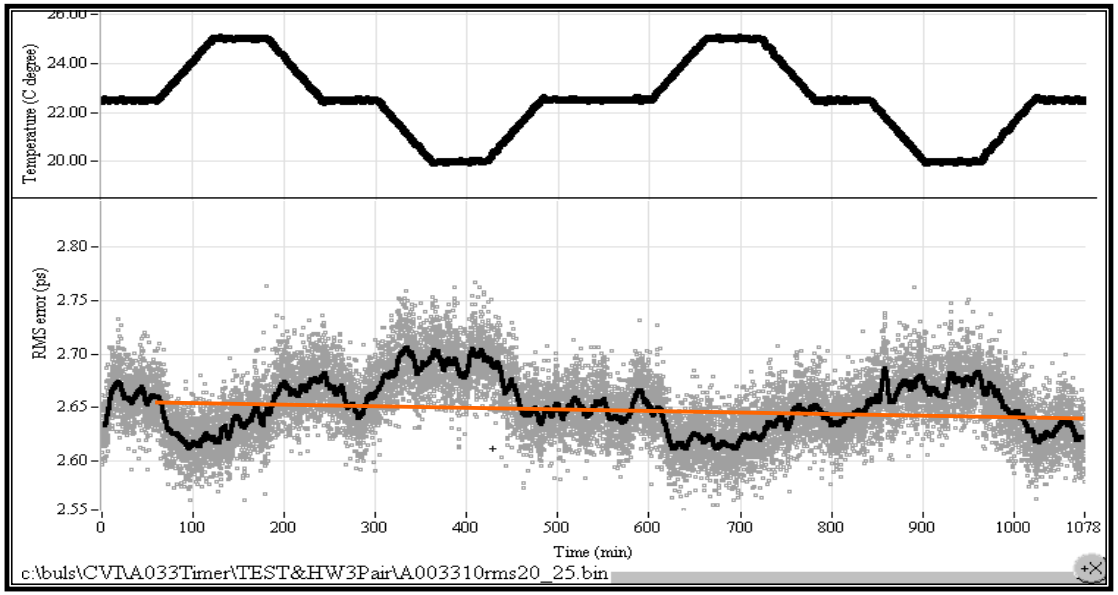
Histogram of errors in single-shot measurement of high-stable time intervals

The A033-ET supports the above resolution at 20 MSPS burst rate for sequences of up to 2 600 events, and 12.5 MSPS burst rate for sequences of up to 16 000 events. The maximum average rate of continuous measurement is 12 KSPS.

A033-ET Performance Characteristics (2)

The A033-ET offers the best single-shot RMS resolution directly after device calibration in steady-state operating conditions.

Thereafter an ambient temperature variation can slightly impair the RMS resolution.



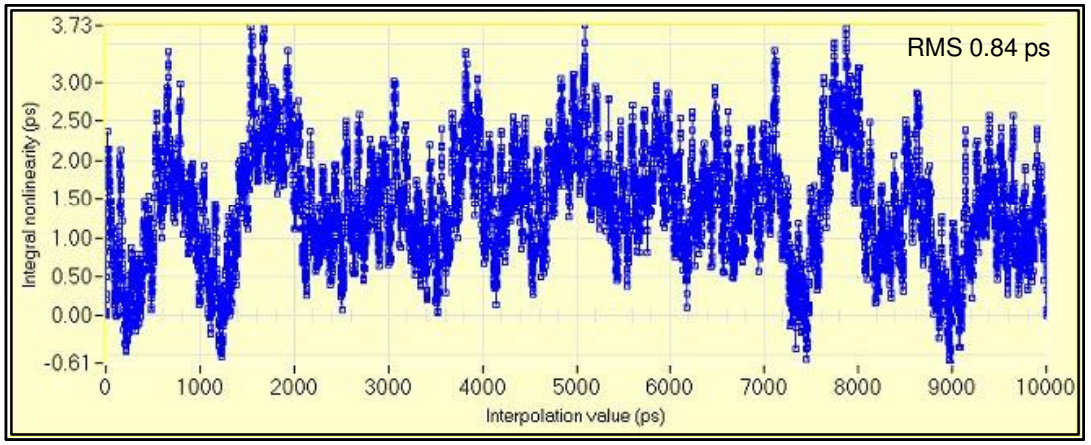
Single-shot RMS resolution vs. time under variation of ambient-temperature in the range ±2.5 ^{0}C. No device re-calibrations during the test.

A033-ET Performance Characteristics (3)

Integral non-linearity error is a systematic error in event measurement that depends on the position of measured event over interpolation interval.

In the average this error is specified by the value of its standard deviation over interpolation interval, representing significant component of single-shot RMS resolution.

Typically the A033-ET integral non-linearity RMS error is less than 1 ps directly after device calibration. Thereafter an ambient temperature variation can increase this error and impair the RMS resolution as a whole



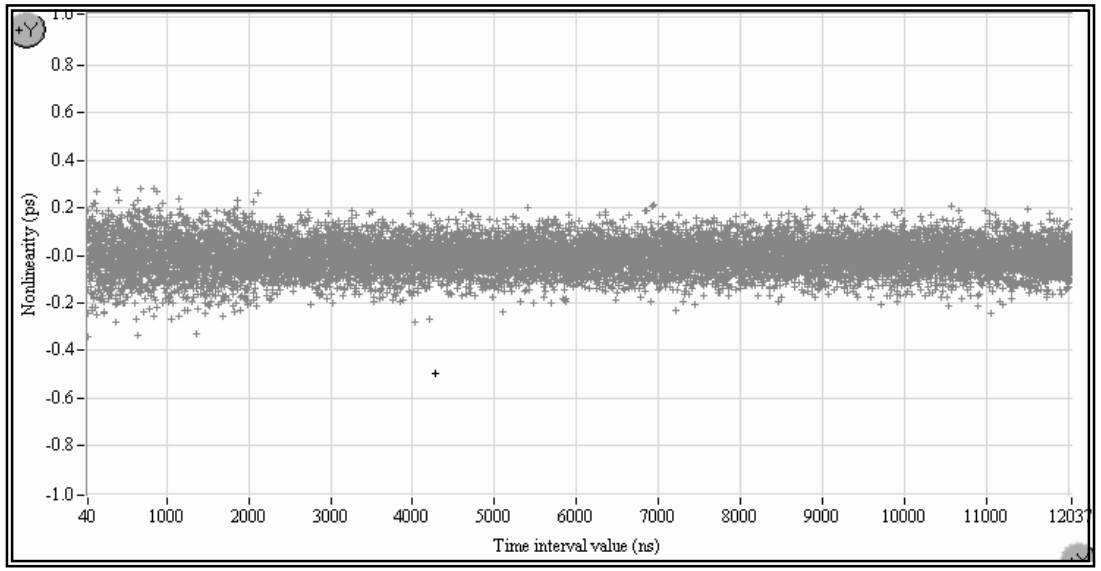
Integral non-linearity error over 10 ns interpolation interval

A033-ET Performance Characteristics (4)

Interval non-linearity error is a systematic error in measurement of time interval between adjacent events that depends on the value of this interval.

Typically the A033-ET interval non-linearity error does not exceed ±0.25 ps for time intervals from 100 to 2000 ns. For smaller time intervals such errors can be a little greater (especially for time intervals that are near to the 50 ns dead time).

For time intervals greater than 2000 ns the interval non-linearity error is actually absent.

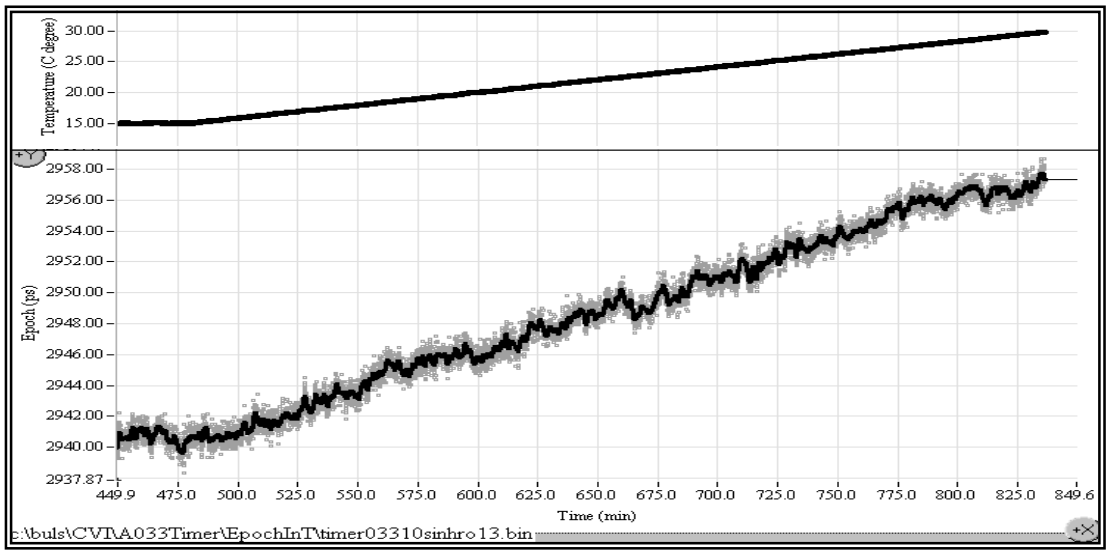


Interval non-linearity error vs. time interval

A033-ET Performance Characteristics (5)

Single-input offset drift is seen as long-term deviation of systematic error in measurement of events coming at the same input of the event timer. Such drift reflects long-term instability of the internal time-base relative to the external 10 MHz reference frequency, depending mainly on the ambient temperature variation.

Typically the A033-ET single input offset drift does not exceed 2 ps/^{0}C. It is specified without regard for long-term instability of the reference frequency.

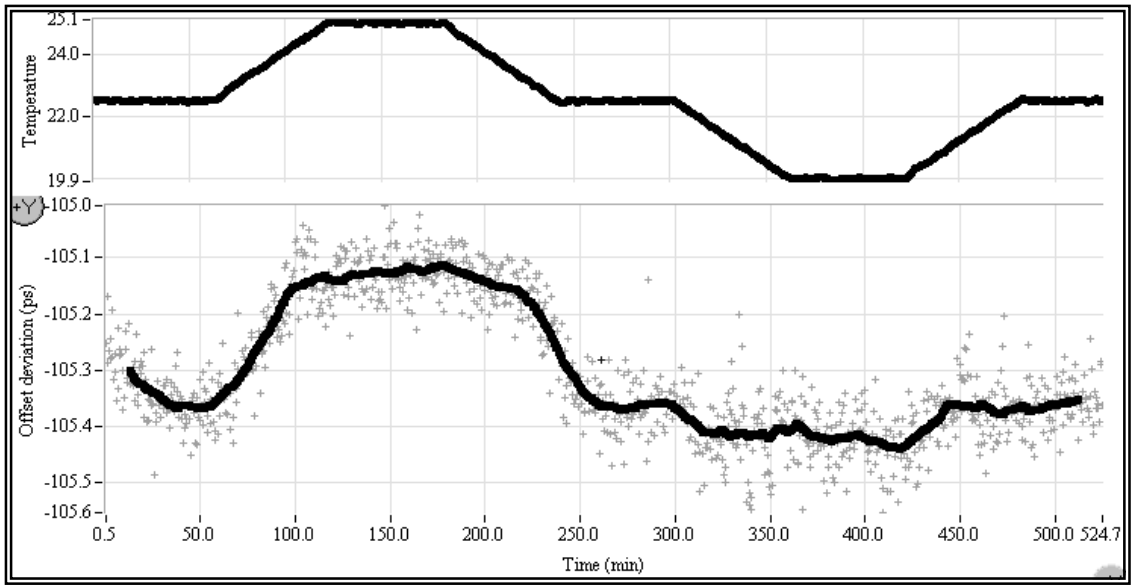


Single-input offset drift in line with slow linear changing of ambient temperature from 15 to 30 ^{0}C

A033-ET Performance Characteristics (6)

Input-to-input offset drift is seen as long-term deviation of systematic error in time interval measurement between Start and Stop events coming at the different inputs A and B of the event timer respectively.

The A033-ET input-to-input offset drift typically is about of 0.1 ps/^{0}C. It is specified without regard for long-term instability of the reference frequency.



Input-to-input offset drift in line with slow linear changing of ambient temperature from 20 to 25 ^{0}C

Performance Comparison

Model	**A032-ET**	**A033-ET**
Single-shot RMS resolution	7 – 8 ps	2.5 – 3 ps
Temperature stability of RMS resolution	<1.5 ps/°C	<0.5 ps/°C
Integral NLE	<2ps	~1 ps
Interval NLE	<1 ps	<0.5 ps
Single-input offset drift	--	<2 ps/°C
Input-to-input drift	~0.4 ps/°C	~0.1 ps/°C
FIFO depth (events)	12000 events	16000 events
Maximum burst rate	16 MSPS	20 MSPS
Maximum average rate	10 KSPS	12 KSPS*

* Increasing up to 30 KSPS is possible by special agreement

In terms of functionality the A033-ET and A032-ET are closely related instruments

Special Notes

1. Generally the Riga Event Timers have been conceived as commercially available instruments that are distinguished by an attractive price/ performance ratio. In this case we have come to the conclusion that single-shot RMS resolution of them should be limited by 3 ps approx. to achieve relatively simple and inexpensive technical solution. In principle the better resolution is possible but its achievement leads to much higher production cost.

2. It seems that the currently offered resolution and measurement speed of the A033-ET are quite enough for the most of ground-based SLR stations that provide both routine and KHz SLR. Taking that into account, currently we focus our research activity on advancing of other important performance characteristics of Riga Event Timers, such as their reliability, friendliness and hardware simplicity.

THANK YOU!