Event Timer A033-ET

OVERVIEW

The Event Timer A033-ET is a computer-based instrument that measures time instants when input events (represented by electrical pulses) occur. Distinguishing feature of the A033-ET is extremely high precision combined with high measurement rate. In particular, single-shot RMS resolution better than 5 ps at measurement rate up to 20 MSPS makes the A033-ET one of a few best event timers currently available. Combining the A033-ET with application-specific software, a number of top-quality and reasonably priced event timer systems can be created. Especially the A033-ET is well suited for applications related to Satellite Laser Ranging (SLR).

The A033-ET offers two inputs (A and B) to measure events on these inputs alternately with 50 ns dead time. Result of every single measurement (epoch time-tag) is represented in digital form with 1 ps LSB resolution. Time-tags appear at the timer's output in order of event measurement. Special mark accompanies each time-tag, indicating the input that provides measured event. There are two basic operation modes for such measurement:

Continuous mode provides for continuous (gapless) measurement of events at high (up to 30 KSPS) average rate, allowing bursts of the rate up to 20 MSPS. This mode is well suitable to measure the overlapped time intervals between Start and Stop events that come at the separate inputs (either A or B) of the A033-ET in arbitrary order. In particular, this is the case of advanced SLR at KHz repetition rate.

Cyclical mode provides for cyclical measurement of events that come at the separate inputs of the Event Recorder in strict order: in every cycle at first the A033-ET measures a single Start-event coming at the input A, and then - a user-defined number of Stop-events (up to 16 000) coming at the input B. The Stop-events are measured under internal online programmable gating. In particular, this mode suits to routine SLR where the measured Start-Stop time intervals do not exceed the repetition period of Start-events.

The A033-ET provides network interface based on TCP/IP communication protocols to interact with any remote application requiring precise event timing. Such interfacing is well suited for designing distributed multi-user event timer systems where user's application software is separated from the specialized software supporting event measurement. In this case the user's software can fully remotely control the A033-ET operation.
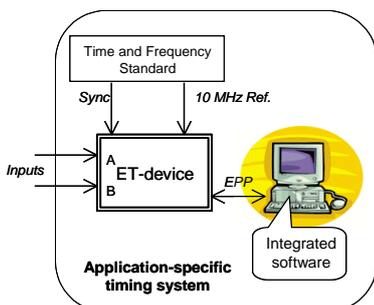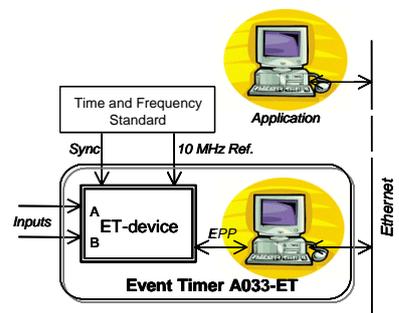
In addition to the A033-ET standard set, Sample program in *C* is being supplied. This program presents all particularities of processing the data that are obtained directly from the A033-ET hardware via PC parallel port. In this case the A033-ET hardware and Sample program together represent a basis for creating various event timer systems specially tailored to the specific user's requirements. So users can create on this basis own event timer systems, integrating the event timer software functions with application-specific functions. In many cases this is also the way to markedly increase the system operation speed.

TYPICAL PERFORMANCE CHARACTERISTICS

A033-ET PRECISION CHARACTERISTICS

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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 of 3-4 ps. In some cases the resolution may be a little better or a little worse depending on the hardware unique features.
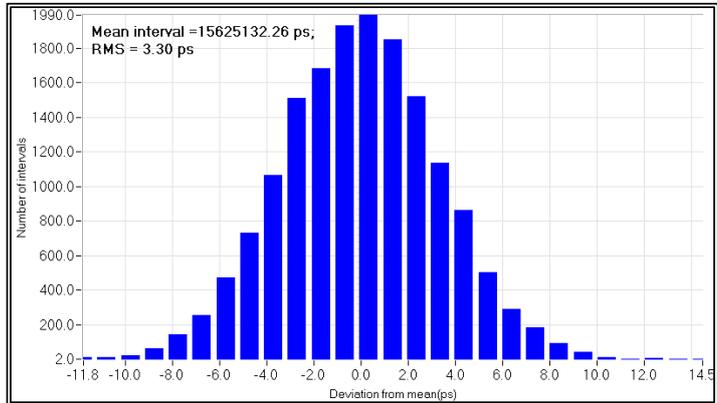

Histogram of errors in measurement of high-stable time intervals

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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.

Typically the A033-ET integral non-linearity RMS error is ranged from 1 to 1.5 ps, and surely less than 2 ps.
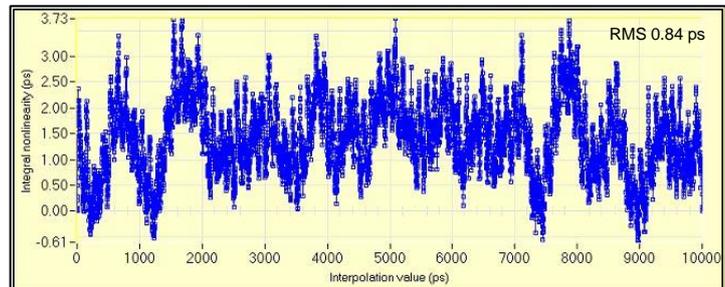
Integral non-linearity error over 10 ns interpolation interval

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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 exceeds ±0.5 ps for time intervals greater than 100 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.
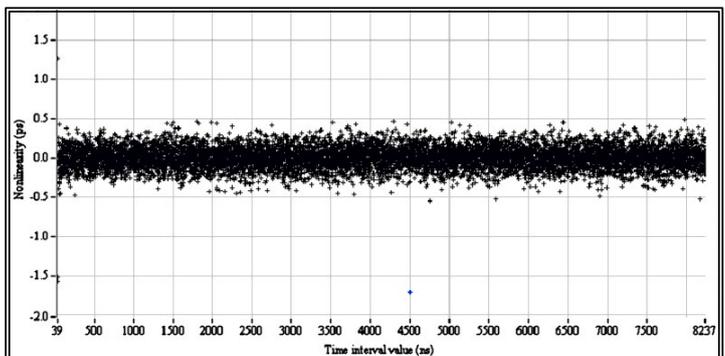
Interval non-linearity error vs. time interval

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 recorder. 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.
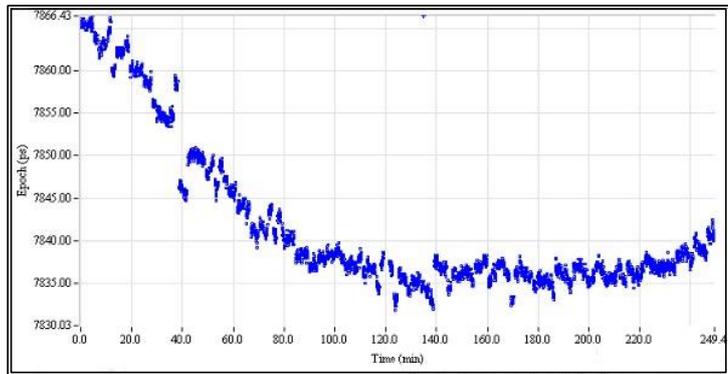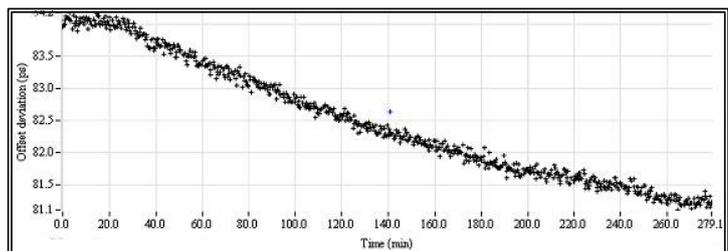

Single-input offset drift in line with slow linear changing of ambient temperature from 40 to 10 ^{0}C

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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 does not exceed 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 40 to 10 ^{0}C

A033-ET OPERATION SPEED

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Maximum burst rate means the maximum measurement rate available for a specified amount of sequential events. It is limited by the duration of single measurement and performance of the hardware buffer memory. The A033-ET supports 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.

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Maximum average rate means the maximum rate of continuous (gapless) event measurement over a long period of time. It is limited by carrying capacity of the timer's hardware interfacing with PC. The A033-ET hardware interacts with the Server PC via parallel port in EPP mode, providing the average rate up to 30 KSPS if such PC port allows reading of 4-byte words. Otherwise the maximum average rate may be reduced down to 12 KSPS.

The A033-ET Server software runs under MS Windows that is widespread but not the best for real-time application. When the A033-ET hardware is applied with a specific user's software based on the Sample program, the maximum average rate can be much higher than the mentioned if an operating system more suitable for real-time operation will be used.

3

SUMMARY OF SPECIFICATIONS

Inputs (BNC, 50 Ω)	
Event input A:	Fast-negative NIM logic pulses (> 4 ns width)*
Event input B:	Fast-negative NIM logic pulses (> 4 ns width)*
External gate:	Fast-negative NIM logic pulses ("1" enables Input B)*
Sync. 1 pps:	Positive TTL/LVTTL pulses
Ref. frequency:	10 MHz (>0.5 V peak-to-peak)
Single-shot RMS resolution:	3 ÷ 4 ps typically, 5 ps maximum
Dead time:	50 ns
Measurement rate	
Maximum burst rate:	20 MSPS for 2 600 sequential events
	12,5 MSPS for 16 000 sequential events
Maximum average rate	12 KSPS**
Integral non-linearity:	<2 ps RMS
Interval non-linearity:	±0.5 ps maximum (for time intervals greater than 100 ns)
Gating of "Input B"	
In Continuous mode:	by external pulses only
In Cyclical mode:	also internal with online programmable delay (10 ns LSD, 50 ns to 167 ms range)
Internal clock:	100 MHz, locked to 10 MHz external reference frequency
Hardware interface:	via PC parallel port supporting EPP mode
Application interface:	over TCP/IP communication protocols
Server software:	MS-Windows based
Accessory software:	Sample program in *C*, DEMO Client software
Hardware dimension, weight:	367x90x265 mm; 2.5 kg
Power supply:	100-240 VAC

* positive LVTTL pulses are possible optionally
** Increasing of the rate up to 30 KSPS is possible by special agreement

Ordering Information

The A033-ET is a custom instrument manufactured in a limited quantity and only on special request. Modifications of the A033-ET that provide certain special user's requirements are possible on agreement basis.
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