

Application Note 249 Online Averaging Latency Parameters

- This application note describes the procedure to determine a relational curve between specified latencies and the Inter-Stimulus Interval (ISI) when using the online average feature in *AcqKnowledge*.

The Inter-Stimulus Interval (ISI) is the interval between stimulus pulses as generated by the STM100C module under software commands from *AcqKnowledge*. For averaging mode, this stimulus signal triggers a stimulus response that is read in by an MP unit many times for the purposes of reducing noise and smoothing the response. The repetition interval of the stimulus signal (ISI) is a critical factor for some averaging measurements, especially when a subject under test, who may be prone to unpredictable movement, necessitates rapid stimulus/response measurements. Figure 1 shows the components of the repetition interval. For large intervals, the latency factor, as specified in the acquisition/averaging dialog boxes dominates. As that factor decreases, other processing times become increasingly dominant.

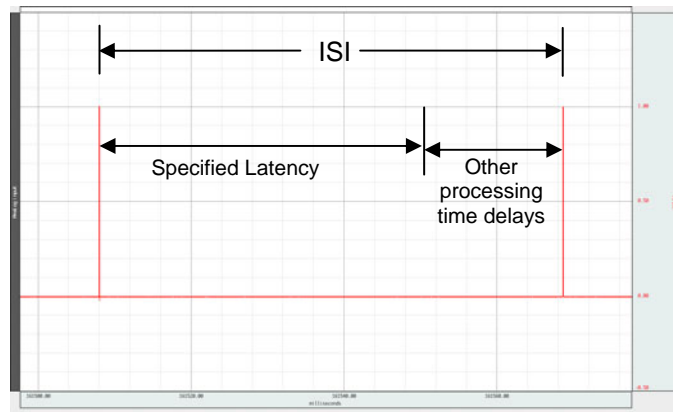


Figure 1: Components in the stimulus interval as pertaining to averaging passes

Using two MP160 or MP150 acquisition units, a profile of the ISI versus latency can be produced for a family of sample rates and acquisition times. Referring to Figure 2, **Computer #1** running *AcqKnowledge*, will generate stimulus pulses through the **MP160/150 #1/STM100C** modules, while **Computer #2**, also running *AcqKnowledge*, will chart the stimulus pulse train through **MP160/150 #2**. Separate UIM100Cs are used to receive the stimulus pulse.

Equipment

Table 1: Equipment necessary to generate and measure ISI

Item	Quantity	Model Number	Purpose
1	2	MP160 or MP150	Acquisition Unit
2	2	UIM100C (for MP150)	Input signal interface unit; 16 analog channels
2a	2	HLT100C (for MP160)	High Level Transfer interface unit; 16 analog channels
3	1	STM100C	Signal generator module
4	3	CBL100 3.5 mm phone jack cables	Signal connection between STM100C and the UIM100C
4a	5	CBL122 3.5 mm-to-RJ11 adapters	Adapter for connecting CBL100 cables (see Item 4) and 3.5 mm Y-splitter to HLT100C units (see Item 5)
5	1	3.5 mm Y-splitter	Split-off the signal from the STM100C to the two UIM100Cs or HLT100Cs

The module connection plan is shown in Figure 2. Note that the two MP units are connected to different computers running separate installations of *AcqKnowledge*.

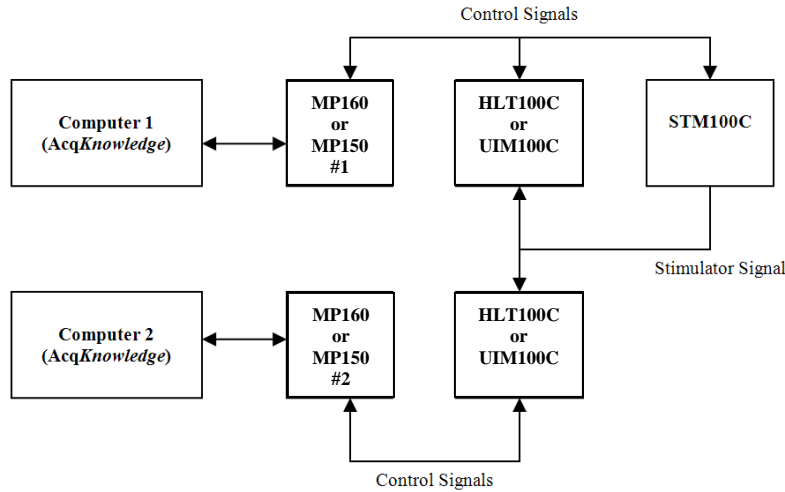


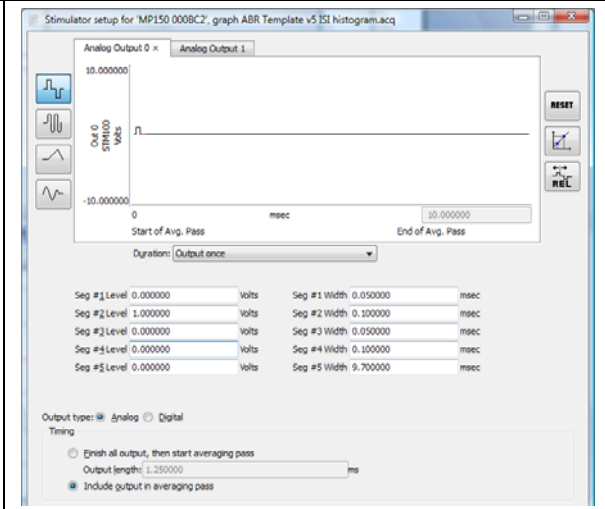
Figure 2: Module connection

Signal Generation and Processing

Table 2 delineates the acquisition, averaging, and signal generation parameters for the two MP units and the Stimulator module.

Table 2: Module and signal parameter set up

Module	Process	Parameter Set Up
MP160/150 #1	<p>Acquisition: basic Acquisition values and modes. Here set sample rates and acquisition lengths to the following:</p> <ul style="list-style-type: none"> - 40 K, 10 ms - 20 K, 10 ms - 40 K, 5 ms - 20 K, 5 ms <p>For each rate/time pairing, varying the latency time.</p>	
MP160/150 #1	<p>Averaging: Number of averages, channel enabling, no artifact rejection, int. triggering. Here set the number of averages to 2000 and vary the latency with each run of the rate/time pairings.</p> <p>Latencies values are in msec: 25, 30, 40, 50, 60, 70, 80, 90, 100, 200, 300, 400, 500</p>	
MP160/150 #2	<p>Acquisition: basic Acquisition values and modes. Here set sample rate to 100 K and acquisition length to 900 s max.</p>	

<p>STM100C (through MP160/150 #1)</p>	<p>Pulse generation: Here a PW of 100 μs is specified. Include the pulse in the averaging sweeps.</p>	
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Measurements

When the parameters are set for the 3 modules, the user should enable MP160/150 #2 signal acquisition through Computer #2, then enable MP160/150 #1 for signal generation and averaging through Computer #1. What will be displayed on the graph window of Computer #2 (Figure 3) is a plot of the stimulus pulse train with each pulse generated at the start of an averaging pass. On the graph window for Computer #1 (Figure 4) is the stimulus pulse undergoing averaging; the pulse remains stationary.

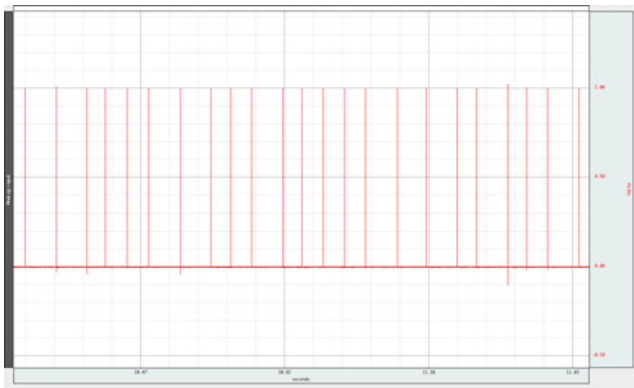


Figure 3: Stimulus pulse train as captured in AcqKnowledge on Computer #2



Figure 4: Stimulus pulse undergoing averaging in AcqKnowledge as displayed on Computer #1

After the pulses are generated and captured to a graph file in Computer #2, the train of pulses will undergo further processing, using Analysis > Find Rate (or Transform > Find Rate in older versions of AcqKnowledge).

The parameters for Find Rate are listed in Figure 5. For the ranges of Latency: 25 ms to 500 ms, the Min/Max settings should be 0/1 and the Output tab Function should be set to Interval.

Using the Find Rate settings, the resulting Find Rate output should appear as in Figure 6. The top waveform is the pulse train, whereas the bottom waveform shows the ISI.

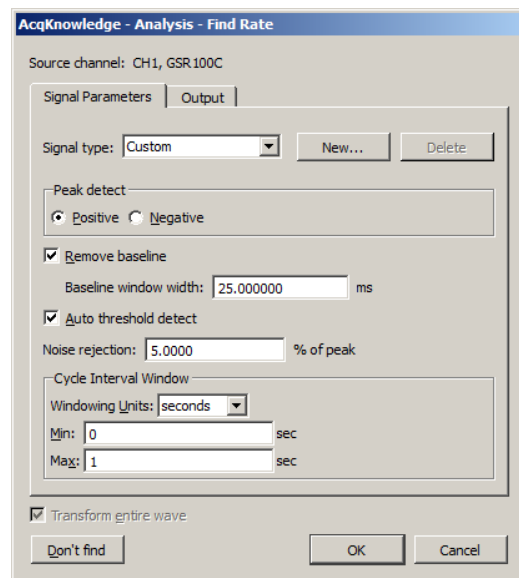


Figure 5: Find Rate dialog with recommended parameter settings

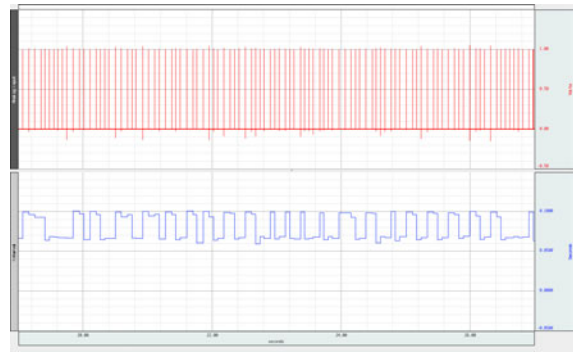


Figure 6: Top waveform is stimulus pulse train and bottom waveform is Interval value as calculated using *Analysis > Find Rate*

Select the ISI waveform (bottom waveform shown in Figure 6) and set two Measurement boxes in the graph window to Mean and Standard Deviation. Select that portion of the waveform that is non-zero and encompasses the pulse train time span. Note the value of the Mean and Standard Deviation reflect the ISI mean and ISI standard deviation within the selected portion of the waveform.

For each pairing of sampling rate and acquisition length for MP160/150 #1, the above process can be repeated to derive parametric curves of ISI versus latency.

Figure 7 shows parametric curves of mean ISI.

- Figure 7 displays a near linear relation between ISI and latency. The relation is valid down to latency values of 90 ms. Below 90 ms, the ISI values "bottom-out" at around 75 ms. The standard deviation values hover around 5 ms for latency values > 100 ms; below 100 ms, the standard deviation can increase by a factor of 3.

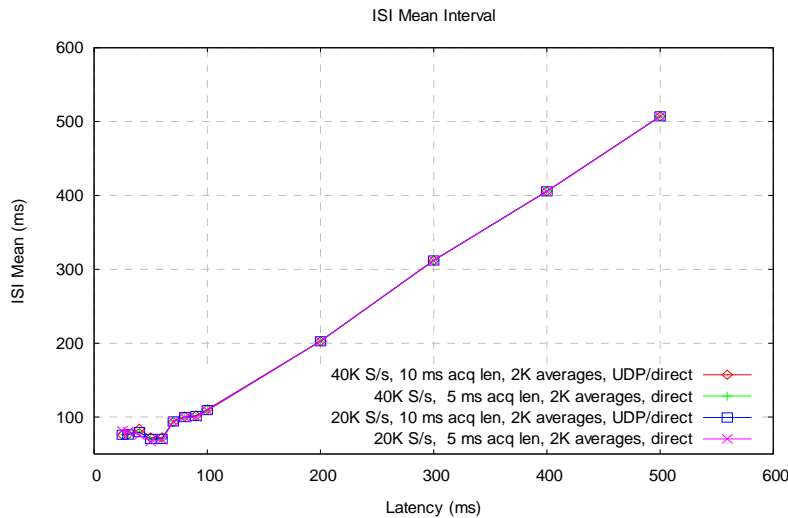


Figure 7: Mean ISI versus latency for a family of sample rates and acquisition times

Figure 8 shows parametric curves of ISI standard deviations from the mean.

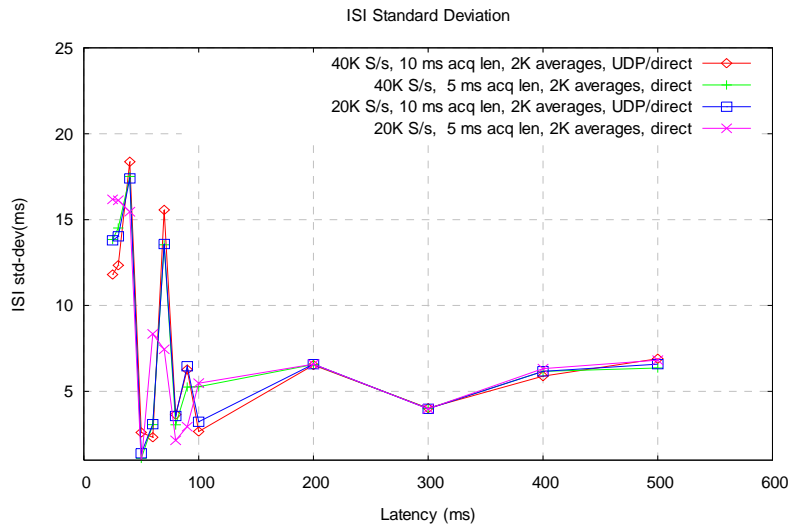


Figure 8: ISI standard deviation versus latency for a family of sample rates and acquisition times.