



- Earthquake Monitoring
- Micro-seismic studies
- Structural Analysis
- Blast Monitoring
- Surveillance

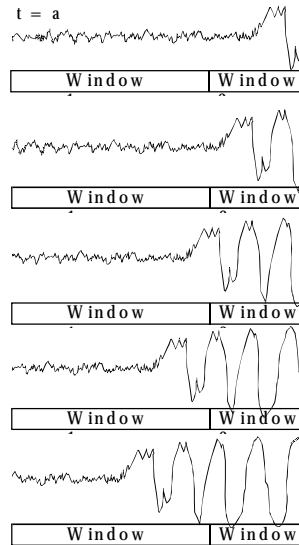
Overview

Typical exploration seismographs can be triggered only by a discrete pulse from an external device such as a hammer switch, blaster, vibrator or some other form of contact closure. Because Geometrics seismographs record continuously, a real time analysis of incoming data on all channels can be performed and the systems triggered automatically based on user-defined criteria. This can be useful for a variety of applications – earthquake monitoring, micro-seismic studies, vibration and blast monitoring – even surveillance.

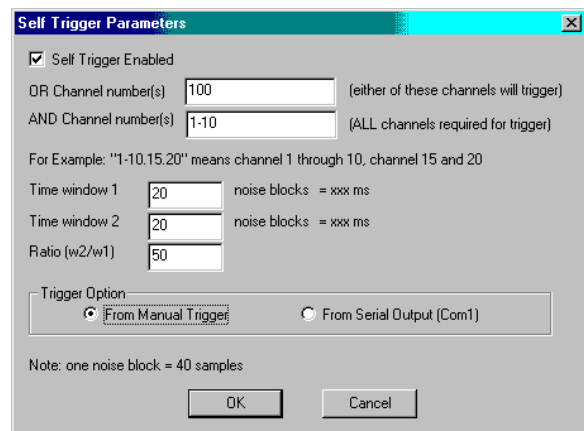
Operation

Geometrics seismic monitoring software allows you to monitor one or more channels for a seismic event. If an event meeting your criteria occurs on any (or all) of the designated channels, the seismograph will trigger and record the data.

The event detection algorithm works as follows: on each designated monitoring channel, noise samples are gathered from the data stream. Average RMS values of the noise are calculated for two contiguous time windows. If the ratio of the average energy in Window 2 divided by the average energy of Window 1 is more than a certain threshold, an "event" is detected by that particular channel.



The lengths of Window 1 and Window 2 are selected by the user, as is the threshold ratio required for an event. Window 2 covers the most recently acquired data. Window 1 covers data prior to that. The windows do not overlap. A more detailed description of how an event is identified is given later.



Checking the *Self Trigger Enabled* box will enable event detection triggering. The system can be configured to trigger if a **single** channel receives an event, or if **all** of a set of channels receive an event simultaneously.

StrataVisor/Geode Self-Trigger Monitoring Software

The *OR Channel numbers* will set the channels for which, if an event is detected in **any one** of the specified channels, the StrataVisor will trigger.

The *AND Channel numbers* sets the system such that an event must be detected on **all** of the monitoring channels in order for the StrataVisor™ to trigger.

If some *OR channels* and some *AND channels* are specified, the system triggers if **any one** of the OR channels are detected, or if **all** of the AND channels are detected.

Time window 1 specifies the length of the first (earlier) time window. The unit of time length is *Noise Blocks*, which is 40 times the sample interval. The string to the right of the entry ("=xxx ms", in the above picture) will tell you how long this is in milliseconds when a value is entered.

Time window 2 specifies the length of the second (most recent) time window.

The *Ratio* is the threshold value for the average RMS noise in Window 2 divided by that in Window 1 required for an event. The larger the ratio, the larger the event must be in order to cause a trigger.

There are two methods of triggering the seismograph when an event is detected. If you choose *From Manual Trigger*, the seismograph will be triggered as if you chose **Manual Trigger** from the **System** menu. However, you should be aware that the manual trigger function triggers the system via software, one acquisition board at a time. The result is that there is a slight time-delay between each 12-channel block. In a 12-channel system it will not matter, but in a larger system it may, depending on the goals of the survey. The manual trigger function was designed mainly for taking noise records, where slight timing differences are of little import. If it is important that all channels are triggered simultaneously, or if you are using multiple systems, you should choose *From*

Serial Output. In this case, when an event is detected, a character will be sent to the serial port on the seismograph[s]. This can in turn be fed to the trigger input on the seismograph[s], causing all boards on all seismograph[s] to be triggered simultaneously. You will need to obtain from Geometrics or make a special cable to connect the RS-232 output from the computer to the 3-pin Bendix trigger input on the nearest Geode on the line.

Note: in the self-trigger mode, you are using the event you are interested in recording to trigger the seismograph. Therefore, whether you are using one or more seismographs, it is generally advisable to use a negative trigger delay (pretrigger memory) in order to ensure that the onset of the event is recorded. Otherwise you risk missing some of the desired data. Also, in most monitoring applications, AutoSave should be enabled and the Stack Limit should be set to 1.

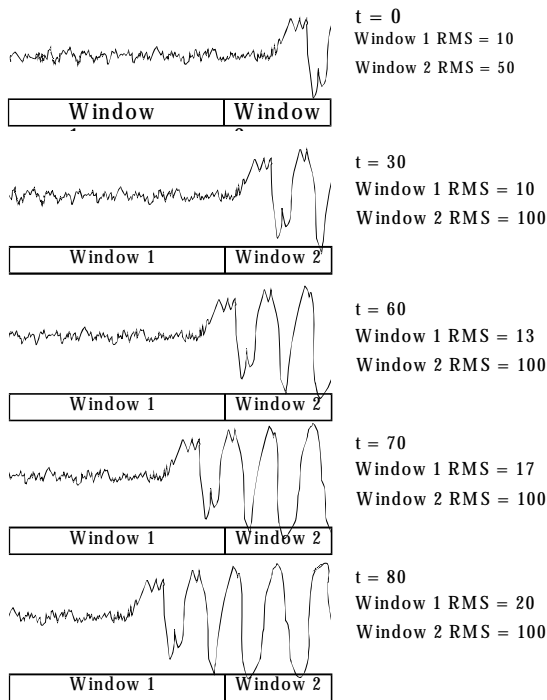
Self-trigger Algorithm - Detailed Description

The RMS calculation for each time window takes place after every 41 noise samples arrive (one "noise block"). The system calculates the ratios of the RMS values for the two time windows for each channel specified in the dialog box. It then loops through these values, considering whether the ratios are greater than the threshold or not. If **any one** of the OR channels have a larger ratio than the threshold, the system triggers. In addition, the system will trigger if **all** of the AND channels have a greater ratio than the threshold at that moment.

The system does not have a direct setting for considering how long to hold in memory the fact that an AND channel was triggered. Some memory is required, however, since it is unlikely that an event will be exactly simultaneous on each of the AND channels. However, the fact that the event slides through the time windows means that a particular event will be detected by a

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particular channel for certain length of time. Thus, the system does allow for delay between the channels by adjusting the length of the time windows. The following discussion provides further explanation of this time slippage. The sequence of sketches below indicates the arrival of an event. As time progresses, the values stored in memory shift accordingly, as the sketches show:



If the threshold is set at 5, then this channel will detect the event at $t=0$. The event will remain detected at $t=30$, $t=60$, $t=70$, and $t=80$. After that, the ratio will drop below the threshold, and the event will no longer be detected.

If several channels are to be ANDed to determine whether to trigger the seismograph, this sliding of the event past the time windows provides the memory required so that even when the event arrives at different channels at different times, at some time all of the channels will still be in a triggered state, and the system will trigger. The length of time over which this will occur is determined by the lengths of the time windows.

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