STA/LTA Trigger Guide
TECHNICAL NOTE

INTRODUCTION

The purpose of this document is to explain the process of Configuring and setup of STA/LTA values in xWave series sensors for use in seismic activity detection and structural integrity The 'short-time-average through long-time-average trigger' (STA/LTA) is the most broadly used algorithm in weak-motion seismology. It continuously calculates the average values of the absolute amplitude of a seismic signal in two consecutive moving-time windows. The short time window (STA) is sensitive to seismic events while the long-time window (LTA) provides information about the temporal amplitude of seismic noise at the site. When the ratio of both exceeds a pre-set value, trigger event is 'declared', data starts being recorded in a file, and user is notified.

PURPOSE

The short-time-average/long-time-average STA/LTA trigger is usually used in weak-motion applications that try to record as many seismic events as possible. It is nearly a standard trigger algorithm in portable seismic recorders, as well as in many real time processing software packages of the weak-motion seismic networks.

The (STA/LTA) trigger significantly improves the recording of weak earthquakes in comparison with amplitude threshold trigger algorithms. At the same time, it decreases the number of false records triggered by natural and man-made seismic noise. To some extent it also allows discrimination among different types of earthquakes. The STA/LTA trigger parameter settings are always a tradeoff among several seismological and instrumental considerations. The goal of searching for optimal parameter settings is the highest possible seismic station sensitivity for a given type of seismic signal (which may also include the target 'all earthquakes') at a still tolerable number of false triggers.

The STA/LTA trigger is most beneficial at seismically quiet sites where natural seismic noise (marine noise) is the dominant type of seismic noise. It is also effective in case of changes of 'continuous' man-made seismic noise. Such changes, for example, occur due to day/night variation of human activity nearby or in urban areas. The STA/LTA algorithm is less effective in the presence of irregular, high amplitude man-made seismic noise which is often of burst and/or spike type.

HOW IT WORKS

The STA/LTA algorithm continuously keeps track of the always-present changes in the seismic noise amplitude at the station site and automatically adjusts the seismic station's sensitivity to the actual seismic noise level. As a result, a significantly higher sensitivity of the system during seismically quiet periods is achieved and an excessive number of falsely triggered records is prevented, or at least mitigated, during seismically noisy periods. Calculations are repeatedly performed in real time. This process is usually taking place independently in all seismic channels of a seismic recorder or of a seismic network.

CHOOSING THE RIGHT METHOD

Each xWave sensor supporting STA/LTA mechanism has the following input parameters that need to be set, on the 'Configuration' page in the embedded web server of the sensor, in order to successfully set-up the triggering system:

General Settings:

- Trigger Method: STA/LTA
- LTA Window: value from 2 to 30s
- STA Window: value from 1 to 5s
- TOTAL Trigger weight: cumulative weight (0 to 100)
- Post-event seconds to log: value from 1 to 300s
- Pre-event seconds to log: value from 1 to 300s

Module Setting:

- Trigger Level: required value for this channel to be triggered
- Trigger Weight: participation of this channel in total trigger weight

THE MEANING OF STA/LTA WINDOW PARAMETERS

Depending on the type of seismic event targeted for detection, we need to set the ratio of STA Window and LTA window accordingly. Out of practice, if targets are earthquakes in general, the best recommended values for STA/LTA are: LTA Window = 30 seconds, with STA Window of 5 seconds. We keep the LTA at max in order to smooth-out the system awareness of ambient noise, and we keep STA at max to target longer lasting (e.g.: >2sec) disturbances in amplitude and events like earthquakes. Smaller values of STA will make the system more sensitive to short events.

One thing to have in mind is trigger-algorithm-recovery-time. This means if LTA is bigger (in example: LTA=30 seconds with STA=5 seconds) the system recovery time after a big trigger event is: LTA + ~(STA / 2) seconds. (32,5 seconds in example). This means any after-quake within this time window might be missed by the STA/LTA algorithm. This however, being solvable by setting up longer Post-Event-Seconds-To-Record, might be good trade-off cause with longer LTA the system has bigger resolution of the ambient noise at the site, being more capable of rejecting sudden peaks and thus reducing false-trigger situations.

Smaller values for LTA on the other hand will reduce the post-event-trigger recovery, and should only be used if shorter seismic or structural-integrity events are targeted for triggering.

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HOW TO SETUP THE TRIGGER LEVEL ON CHANNEL

When working in standalone mode, live values of STA over LTA ratio for each channel can be monitored on the 'Live Data' page in the embedded web server of the sensor.
The best practice of setting trigger level is to follow these steps:

- STEP 1 - Turn on the system, and login to the sensor web server. Open the 'Live Data' page.
- STEP 2 - Leave the system to acquire the ambient noise for at least LTA + STA + (15 sec. Boot Time if just powered-up). Make sure no man-made disturbance is applied to the sensor while waiting for this period to pass. If accidental noise happens, we need to wait another such period.
- STEP 3 – Click the 'Reset FFT Buffers' button on the web page. (at this point values for all channels should be
- near 1)
- STEP 4 - Start applying man-made noise that IS NOT targeted for triggering. The values in the 'STA/LTA Max' section should rise accordingly for each channel.
- STEP 5 – Observe that values will settle and are will not continue changing by applying more man-man disturbance of the same intensity.
- STEP 6 – Copy values and mathematically add 5 to 10% of the same value for each channel.
- STEP 7 – Insert the result numbers into the "Trigger level" fields for the corresponding channel, and save the configuration.

The above practice serves as a solution when intentional man-made disturbance is possible to accomplish on site. However, there are cases when this cannot be performed easily. In such cases, instead of quickly applying disturbances installer needs to perform above steps 1, 2 and 3, and then wait for several minutes (depending on the site structural dynamics). Skip step 4, and continue with steps 5, 6 and 7.

NOTE: Like any other triggering method, Trigger Total Weight and channel Trigger Weight need to be set properly in order to gain actual trigger functionality.