

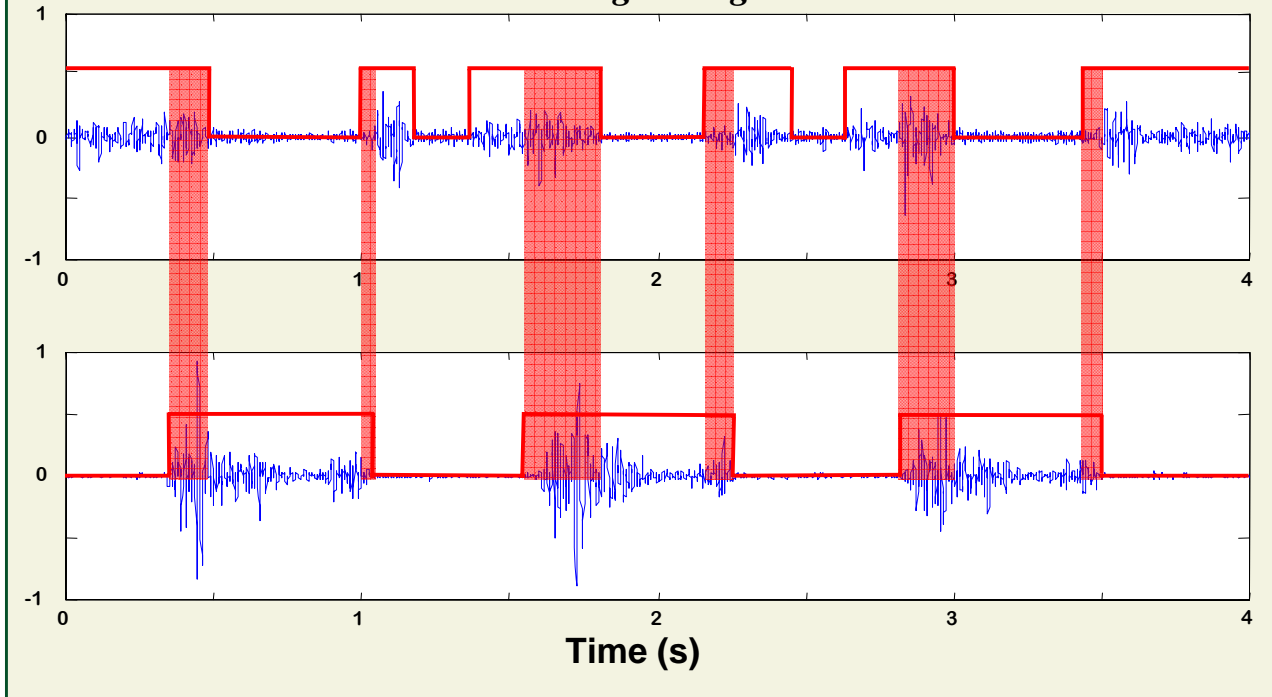


Section 4: *Activation Timing*



66: Activation Timing

Where does the signal begin and end?



Activation Timing:

One of the most common use of the sEMG signal is to determine when the muscle contraction begins and ends. That information establishes when muscles are acting as synergists and/or antagonists. In the example above, the top trace has a red line that indicates when the contraction begins and ends. The red shaded region indicates when the muscle in the top trace is co-activated with the muscle in the bottom trace.

The designation of the begin and end time is made difficult by the presence of noise and cross-talk. Of the two, the more damaging is the cross-talk. The noise is mostly constant, with the exception of the movement artifact, whereas the cross-talk varies in a fashion similar to the sEMG signal of interest.



67: Activation Timing

- **Cross-talk and Noise blur the beginning and end of the EMG activation**

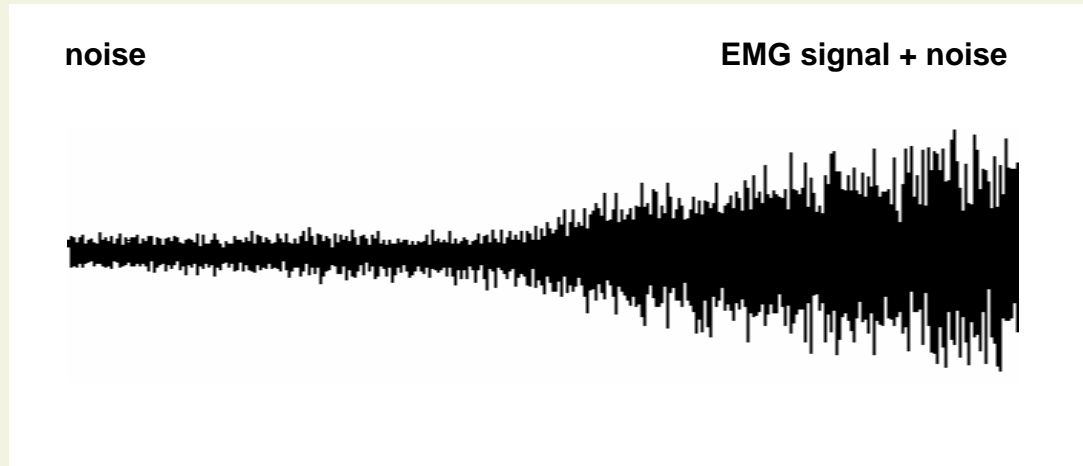
Activation timing:

The presence of cross-talk and noise in the EMG signal contaminates the information concerning the behavior of the muscle being monitored. Some of the noise is inevitable, some can be reduced, and the cross-talk can be reduced or removed.

The following slides will describe procedures for dealing with noise when measuring the activation timing. Note that the example does not deal with cross-talk, which can be even more difficult to deal with, especially if it is not constant as would be the case during force varying contractions. In such cases, the sEMG signal should be recorded with the double differential sensor.



68: Resolution of Activation Timing: Influence of Noise Level: Off-line Method

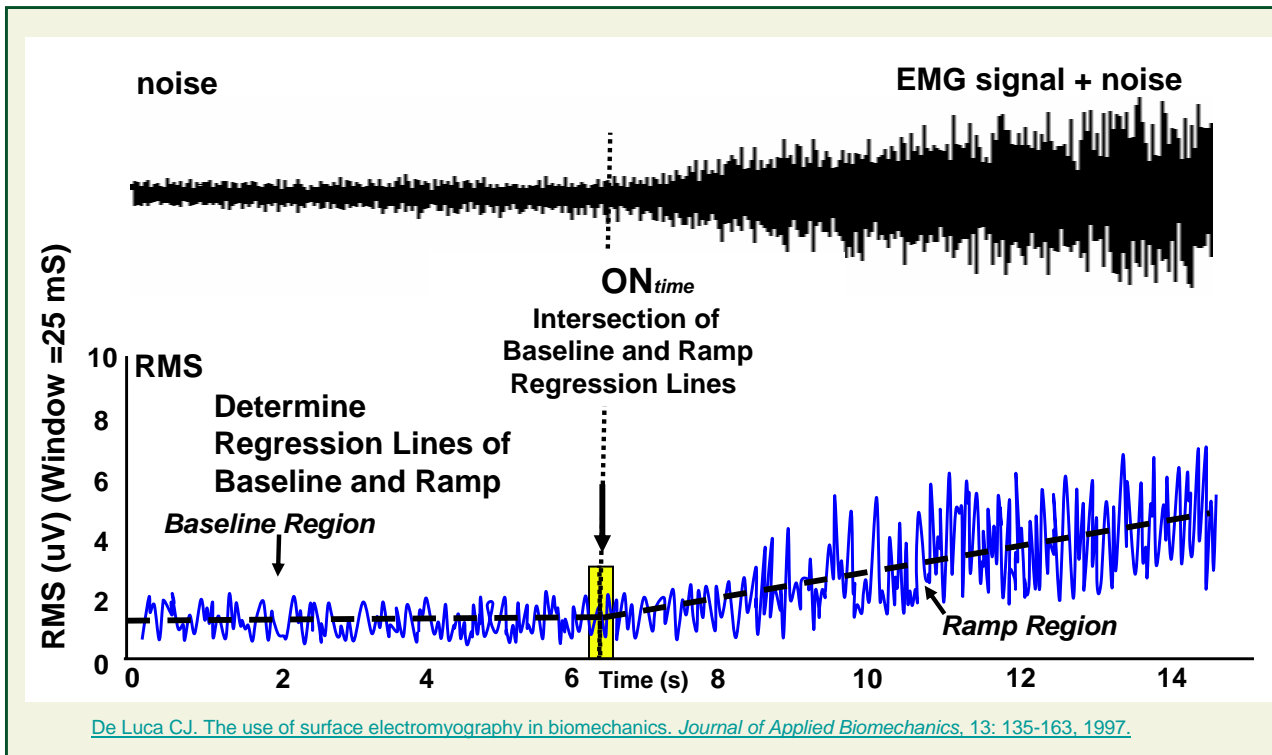


Resolution of activation timing – influence of noise level: off-line method:

With baseline noise and the often erratic appearance of the EMG signal, finding the beginning of the signal, or activation timing, is not a trivial matter. Here we will see one method which is independent of the noise level. This is a sample of baseline noise and an sEMG signal at the beginning of a weak contraction, for which we will find the activation timing.



69: Resolution of Activation Timing: Influence of Noise Level: Off-line Method



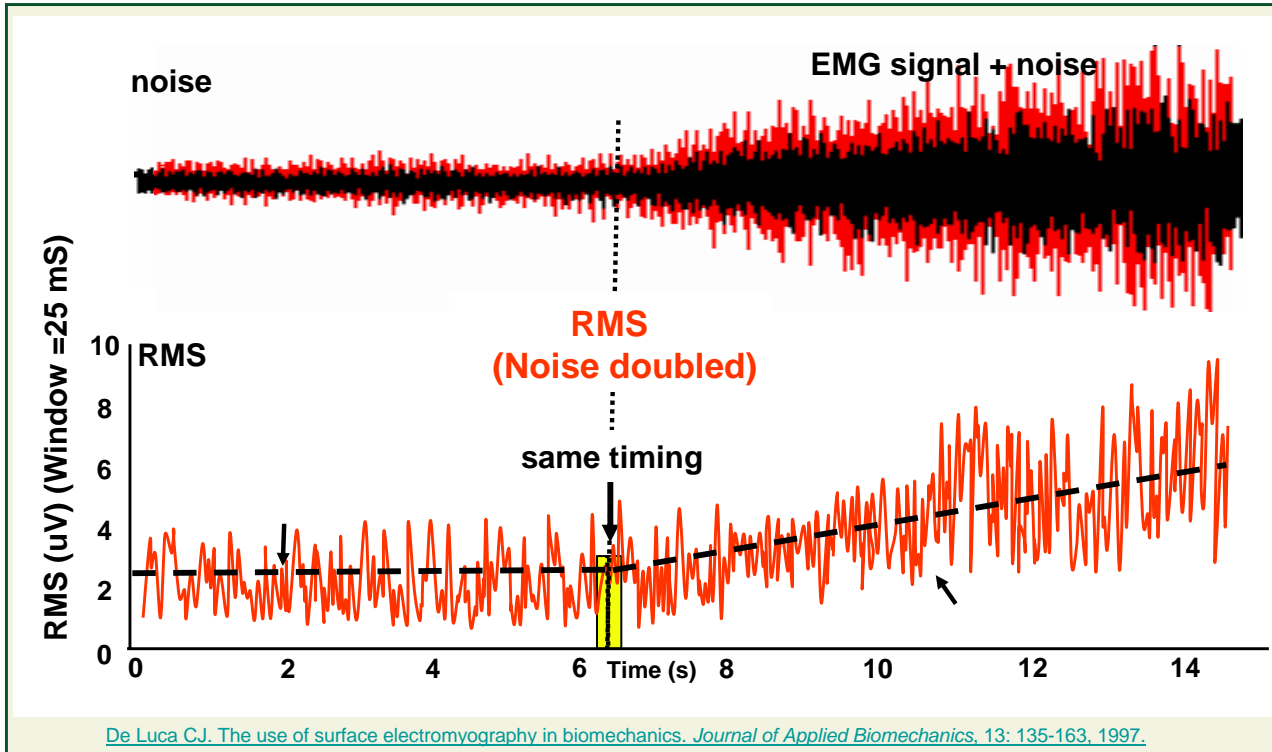
Resolution of activation timing – influence of noise level: off-line method:

This method of determining where the sEMG signal begins is as follows:

- Find a segment of the signal that has a constant lowest level value.
- Calculate the RMS value with a window of 50 ms or less.
- Calculate the regression line for this segment.
- Follow the signal until it begins to increase, and calculate the regression for the segment with the increased signal.
- The point where the regression lines meet is the ON time.
- Perform reverse calculation for finding the OFF time.



**70: Resolution of Activation Timing:
Influence of Noise Level: Off-line Method**



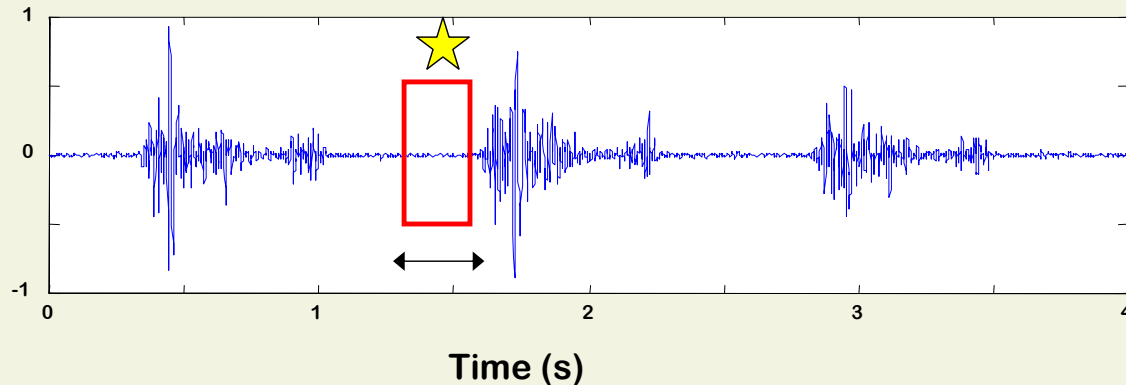
De Luca CJ. The use of surface electromyography in biomechanics. *Journal of Applied Biomechanics*, 13: 135-163, 1997.

Resolution of activation timing – influence of noise level: off-line method:

The procedure described in the previous slide is independent of the noise amplitude, as long as it is lower than that of the sEMG signal. This can be seen in this slide, where the noise level is doubled, but the activation timing found is the same.



71: Detection of ON - OFF: Where Does the EMG Signal Begin and End?



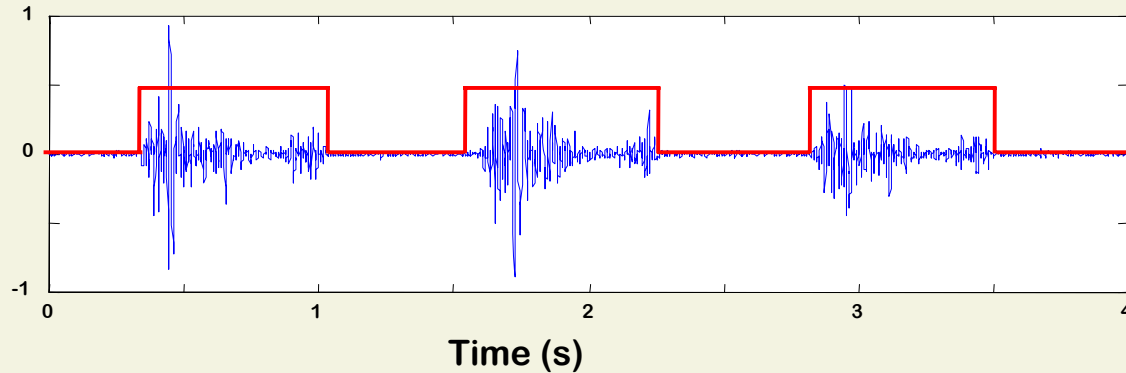
1. Sweep the time file with a window.
2. Calculate RMS value in window.
3. Set lowest value to noise level.

Detection of ON – OFF: where does the EMG signal begin and end?:

This is an alternative method of resolving baseline noise from the signal of interest. Begin with a window size of 50 ms. Gradually expand the window size as necessary to obtain consistent and realistic results. The lowest value of RMS calculated in the window is set to the noise level. The advantage of this method is that it does not require regression calculations and in some cases may be performed in real time.



72: Detection of ON - OFF: Where Does the EMG Signal Begin and End?



- 1. Sweep the time file with a window.**
- 2. Calculate RMS value in window.**
- 3. Set lowest value to noise level.**

Detection of ON – OFF: where does the EMG signal begin and end?:

Anything with an RMS greater than that of the noise is considered to be part of the signal of interest, shown on this slide in the raised red rectangles.