VTEM: Determining Waveform settings

Input

The user should load a waveform file (text format). There is only one column in the waveform file which is dB/dt in volts. Typically several cycles are included, but for determining the waveform settings, only the one half-cycle needs to be used.

The sampling rate is also required. Sometimes this is included in the header, but not always, so the user should be able to enter it. (A typical sampling rate is 50 kHz, or 0.02 ms sampling interval.) Thus, two inputs are required from the user: the appropriate waveform file and the corresponding sampling rate.

Given the sampling rate, the time of each reading can be determined by multiplying the sample number (*n*) by the sampling interval (*x*).

Parameters

The following waveform parameters must be determined:

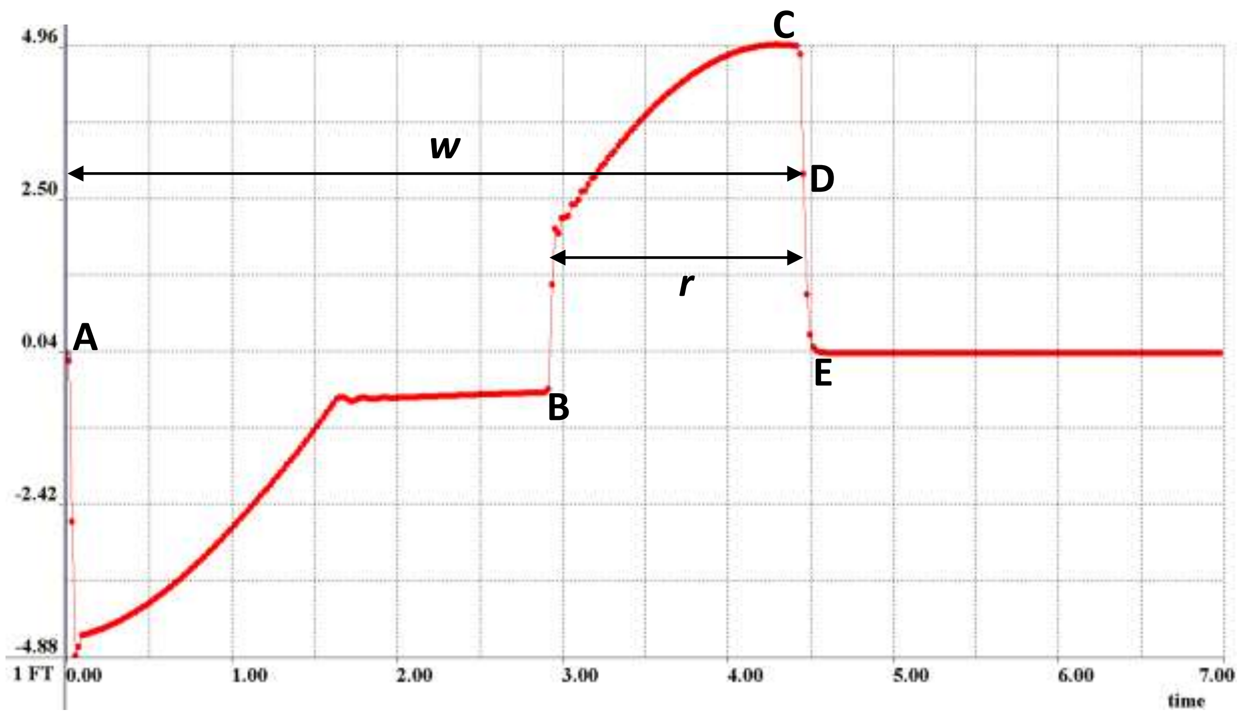
- *w* – pulse width
- *r* – length of turn-off
- τ – time constant for the exponential turn-on
- *f* – frequency of turn-off

These parameters should be output, and then the user can edit if desired. To determine these parameters, the times of five points are required. The timing of each of these points is defined below, and steps for determining them are described later. The times of each of these points should be the times of the closest sample – no need for interpolation. Times are in seconds.

- A – The last sample with essentially zero response before a full half- cycle. This is the beginning of the pulse.
- B – The beginning of turn-off. If there are no pulses during the turn-on, this is the last sample after A whose response has the same sign as A.
- C – The sample at which the peak voltage is reached during the turn-off.
- D – The end of the turn-off, which is when dB/dt is 50% of its peak value.
- E – The first sample after the pulse at which there is essentially zero response.
- F – This is 10 samples after E.

Other parameters used for determining these times:

- *h* – This is the threshold to be considered a non-zero response. Set as 0.05 for now.
- *v* – This is the peak voltage (ie, the response at time C).
- *s* – This is the sign during turn-on.
- *p* – The response of $(1-e^{-t/t})$ at the beginning of turn-off. Set as 0.999 for now.
- I – The peak current, as determined from the integral.



Determining A-E

1) First find A. This is the last sample with close to zero response (ie, |response| < *h*) before the pulse. Note that the waveform file might actually begin during a pulse, but we only want to examine a full pulse. Thus, it may be best to require that A be preceded by at least 10 samples of essentially zero response to ensure that it is at the beginning of a pulse. The sign of the response after A may be either positive or negative, and this sign is *s*.

2) Find E. This is the next sample after A with essentially zero response (ie, |response|<*h*) that is also followed by at least 10 samples of essentially zero response.

3) Find C. If *s* is negative, then C is the sample at which the maximum is reached on (A,E). If *s* is positive, then C is the sample at which the minimum is reached on (A,E). The response at C is the peak voltage, *v*.

4) Find B. This is the sample closest to C with sign *s*.

5) Find D. This is the sample on (C, E) at which the response is closest to 0.5*v* (either just less than or just greater than 0.5*v*).

6) Find F. This is the sample 10 samples after E.

Determining pulse width and turn-off

Having found times A-E, the pulse width and turn-off time can simply be determined as follows:

w=D-A

r =D-B

Determining the time constant

Solve for τ in the following equation. Set p=0.999 for now.

$$p = 1\text{-}e^{-(w-r)/\tau}$$

Determining the frequency of turn-off

I think it is best to determine the frequency of turn-off from the integral of the response between A and F. After integrating the data, shift the integral such that the response at E-F is essentially zero. (ie, find the average value of the integral between E and F. Then shift all of the integrated values by the negative of the average value). The peak current (I) is the result at B.

The goal is to find f such that the following equation fits the (shifted) integrated response between B and D:

$$g(t)=z\sin[2\pi f(t\text{-}D)]$$

where:

$$z=I/\sin[2\pi f(-r)]$$

From my experience,

$$f \approx 0.75/(4r)$$

so it may be best to start with that value of f and adjust as needed.

For waveform file 324, a frequency of 125 Hz is a good fit.