

# Chapter 5: Basic Waveform Analysis

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## Sweeping and Analysis

There are a few places in the program when a new data acquisition is made to acquire a new wave automatically, but for the most part it is left for you to do. The reason is because getting a new wave is time consuming, and you may wish to make several changes before acquiring a new wave.

To get a new wave all you need to do is press the *sweep button* with the mouse. The program then sends all current settings to the TDR, and asks for a new waveform with these settings. This waveform is then drawn to the screen. It is always good practice to sweep before making an analysis to see if the wave appears how you intended.

### To start a simple analysis:

- Sweep the screen by pressing the **sweep** button.
- Get an *ideal trace*. (see chapter 4 for more information)
- Press the **Analyze** button with the mouse. You can *set the peak* position by **Double Clicking** or **Dragging** the peak position in the screen before clicking analyze if you desire, otherwise WinTDR will attempt to find it for you.
- View the output values that are placed in the **Analysis Output Window**.  
(Note: The algorithms used for analysis are described in Chapter 11. We will cover briefly in this chapter how it is accomplished.)

Because the analysis methods are the heart of WinTDR, there are many important features to aid the user to get an accurate analysis of a waveform. They include having WinTDR automatically analyze a waveform (Auto Analysis), let the user specify peak and 2<sup>nd</sup> reflection for analysis (Manual Analysis), and features to change how the previous two options are accomplished.

## Auto Analysis

Auto Analysis attempts to find the Peak and 2<sup>nd</sup> Reflection points without help from the user. Afterwards, it will calculate Water Content (Wct), Bulk Dielectric (Kb), and possibly Electrical Conductivity (EC) if the option was set under “Analysis Options”. Auto Analysis uses the following steps to accomplish this:

1. Pre-process: Program applies a moving average to the wave and finds the first and second derivatives of the wave.
2. Algorithm finds location of the **First Peak**.
3. Algorithm finds location of the **Second Reflection**.
4. Algorithm **uses the distance between** these two points to calculate the bulk dielectric constant ( $\epsilon_b$ ).
5. Algorithm uses Topp’s equation to calculate the **soil water content**.

6. Algorithm uses a wave to calculate soil electrical conductivity. (as necessary)  
 These steps are described in detail in Chapter 11.

## Manual Analysis

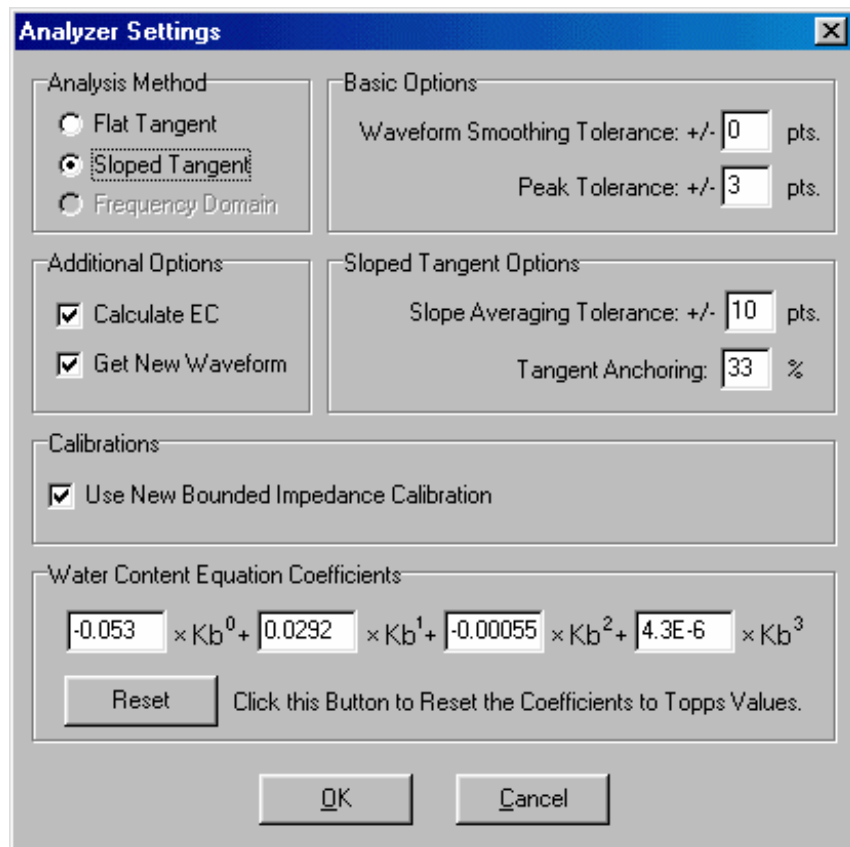
Manual Analysis is similar to Auto Analysis in that it will attempt to find the Peak position and evaluate Water Content, Bulk Dielectric, and EC. It will not however find the 2<sup>nd</sup> Reflection position, it is up to the user to specify its position before analysis. Manual Analysis can only be done once the waveform has been automatically analyzed at least once. If the waveform has not been previously analyzed, Manual analysis will actually perform the same function as Auto Analysis.

Once the waveform has been analyzed, the user can specify a new 2<sup>nd</sup> Reflection position by clicking on the existing 2<sup>nd</sup> Reflection position and while holding the left mouse button down, moving the line to the desired position. Then by click the “Manual Analysis” button, Water Content, Bulk Dielectric, and EC will be calculated with the user specified 2<sup>nd</sup> Reflection position.

## Analysis Options

The Analysis Options window is provided to help the user obtain more accurate analysis of waveforms. It contains: Multiple Analysis Methods and ability to modify those methods, Basic Options, Additional Options, and the ability to change equation coefficients.

**Figure 1** shows what the Analysis Options Window.



**Figure 1:** The Analysis Options Window.

## Analysis Methods

Two methods are available for waveform analysis, Flat and Sloped.

- Flat Tangent will draw a line from the local minimum with a slope of zero. The second reflection is then found using the intersection of this line and the right hand tangent.
- Sloped Tangent will attempt to find a better fit left tangent line for finding the second reflection.

### Calibrations

There are two ways to calculate EC values. The more accurate, Castiglione and Shouse Method, requires a more intensive probe calibration. This check box selects the bounded impedance calibrations so the Castiglione and Shouse method can be used to calculate electrical conductivity. See Chapter 11 *Probe Impedance Calibration Using the Castiglione and Shouse (2003) Method* section for details on calibration.

### Basic Options

These options are always considered every time a waveform is analyzed.

- *Waveform smoothing tolerance*: This value will calculate a new “smoothed” waveform during and for analysis. By taking each point value and averaging it with the values of the other points in this tolerance, excess noise will be eliminated. This value is defaulted to zero because the TDR unit will do most of this smoothing for us if *noise filter* is set to more than 1, and smoothing this waveform again will decrease accuracy.
- *Peak Tolerance*: When finding the first peak, this tolerance looks to both sides (+/- the peak tolerance value) of the user defined peak for a higher waveform value.

### Additional Options

These options modify the speed of analysis and what calculations will be performed when analyzing the waveform.

- *Calculate EC*: The analyzer will calculate the electrical conductivity (EC) of the waveform. This requires a ‘long’ waveform and a extra sweep might be necessary for each analysis with this option on.
- *Get New Waveform*: When checked, WinTDR will retrieve a new waveform from the TDR before analysis. Otherwise, the current waveform for the probe will be analyzed (or re-analyzed).

### Slope Tangent Options

Changing these options will modify how the slope tangent analysis will function.

- *Tangent Anchoring*: The left side tangent of the second reflection will be calculated and anchored to this position. The percentage is the distance from the second reflection to the peak position. Thus 0% will anchor the tangent on the second reflection and 100% will anchor it on the peak position. A value between these two extremes is best. The default is 33% or 1/3<sup>rd</sup> the distance from the second reflection to the peak position.

- *Slope Averaging Tolerance*: Will average the slope of the left side tangent using values +/- this tolerance from the tangent anchor position.

### **Water Content Equation Coefficients**

The user can change the coefficients used in calculating the water content. If you ever want to revert back to Topp's 1980 equation coefficients, you can simply click the reset button.

### **Looking at Past Analyses**

To look at a previous analysis, click on the down arrow located on the right side of the *Analysis Output Window (AOW)*. The last 50 analyses are stored top down in the order they were taken. The other method for looking at past analysis is to open the .wc file for the particular probe.