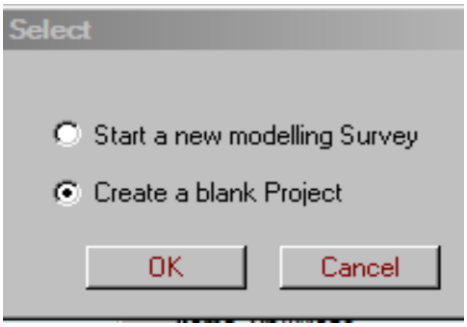
EMIGMA Modelling of TDEM Data

Case 1. Without Use of Imported Field Data:

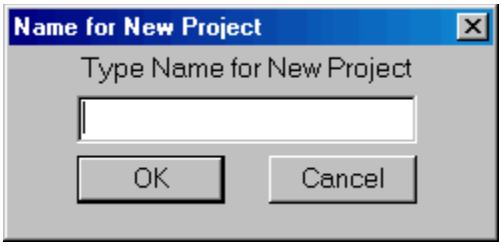
Forward Simulation - i.e. **Building your model**

Of course it is always easier to open a previously-created TEM dataset and adjust the model parameters. You will find several examples in the sample databases available on the downloads page of our website(www.petroseikon.com).

- If you do not already have a project in which you wish to work, Click the **Create Project** button in the bottom left-hand section of the **Database** window. In the **Select** dialog to appear, select the **Start a New Modeling Survey** button:

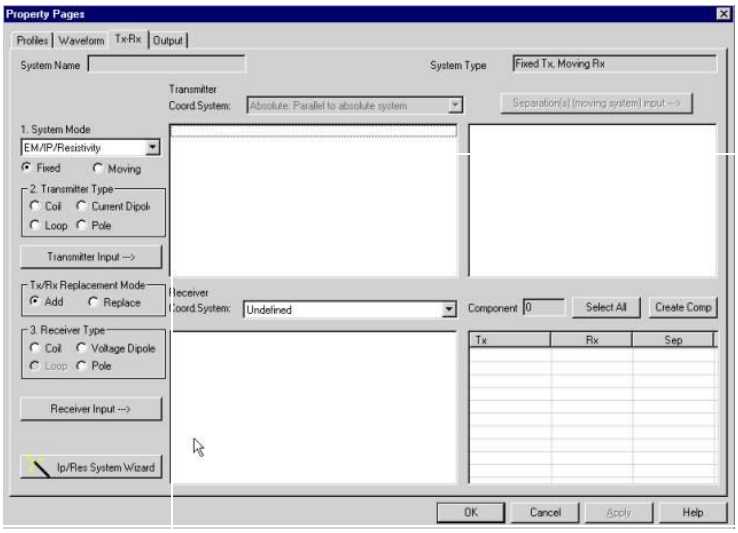


- In the **Name for New Project** dialog to appear, type in the name of your project and click **OK:**



The **Property Pages** window to open contains four tabs allowing you to specify your system geometry, waveform, profile information and output.

TX-RX Page:



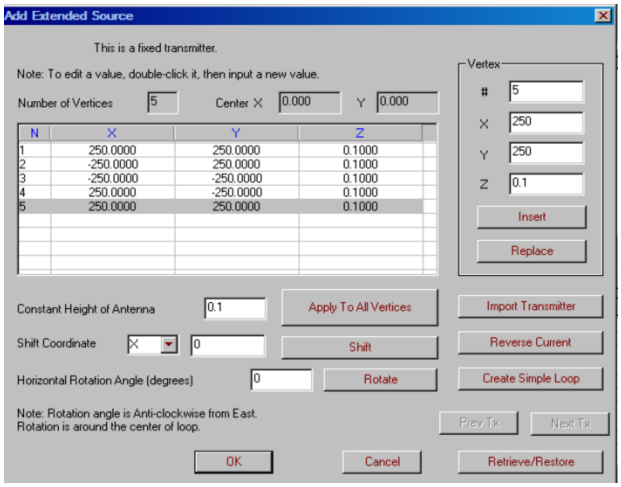
This page encapsulates the capabilities of EMIGMA for a wide variety of geophysical systems. This example will illustrate one such system.

1. Transmitter Mode - select “Fixed” for fixed loop survey

2. Transmitter Type - select Loop

3. Click on “Transmitter input ->”.and set the approximate loop size. And the **Add Extended Source** window appears, Loop coordinates may be edited

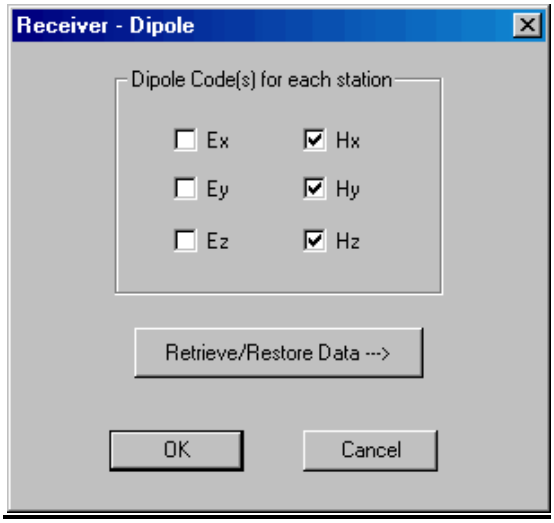
Set **Height of Antenna** to 0.01 in the following window and click **OK**.



Note: You are not restricted to four cornered loops.

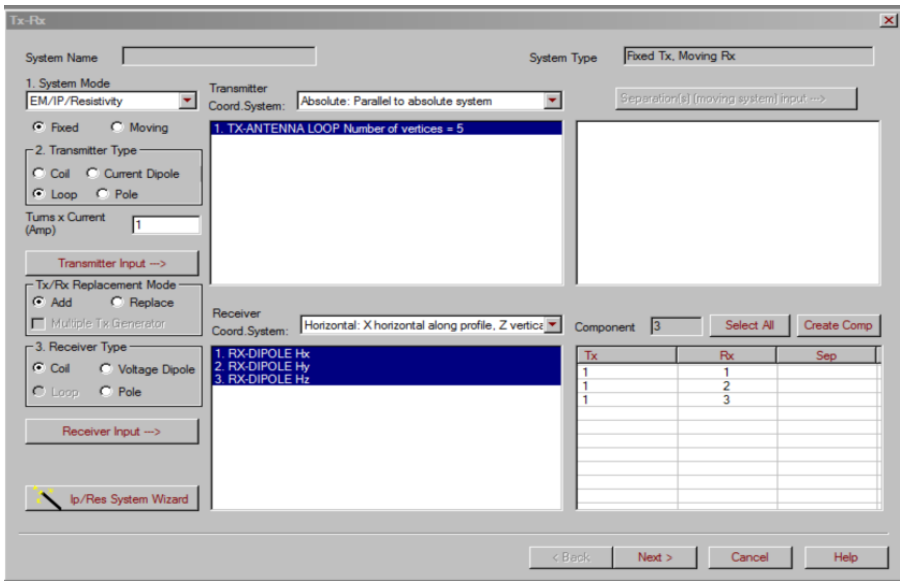
4. Receiver Type – “Dipole”

Receiver Input - Select components you wish to measure, i.e. Hx, Hy and Hz



5. Component

Click **Select All** to create a component for each transmitter receiver combination. To specify an individual component, select a single transmitter and receiver then click **Create Comp**.



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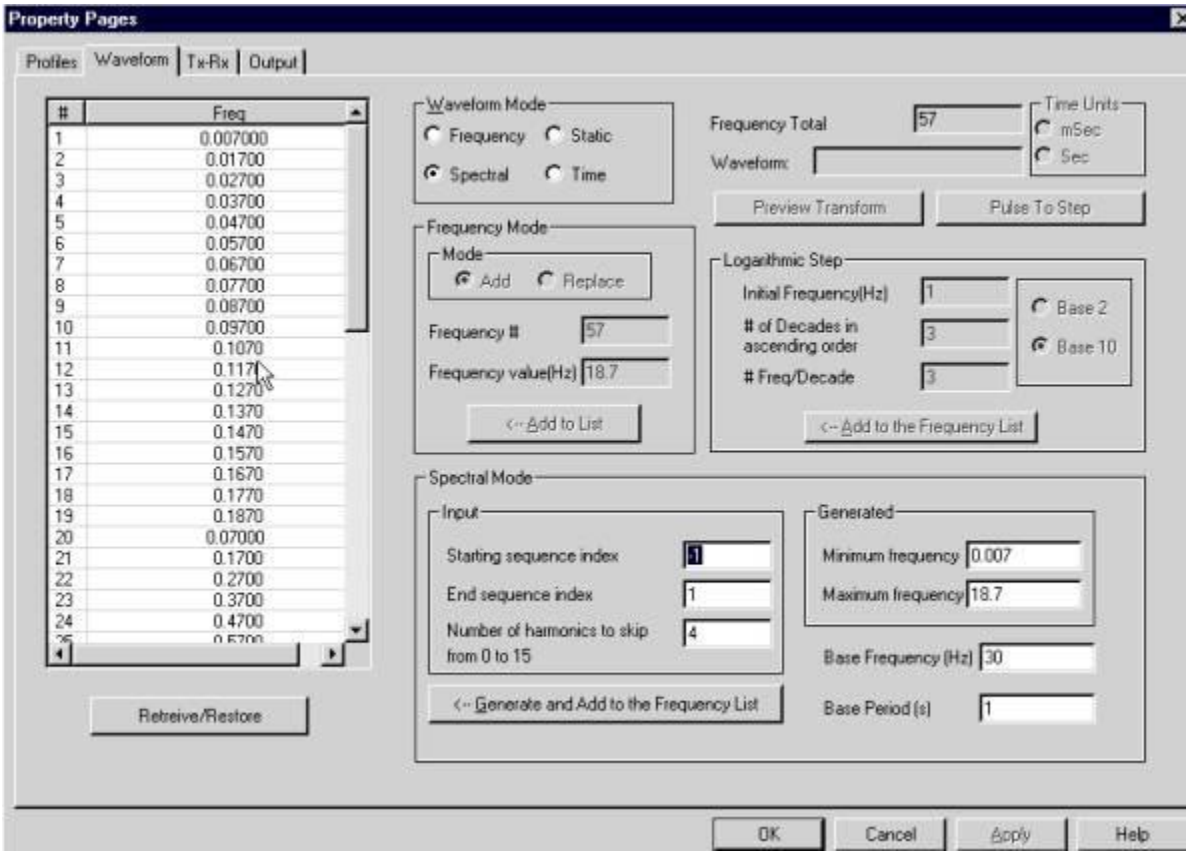
6. Receiver Coord. System

Select “Horizontal” as the coordinate system for surface systems
Select “Uhole” as the coordinate system for borehole systems

Refer to the main EMIGMA manual for details of the different coordinate systems

Waveform Page



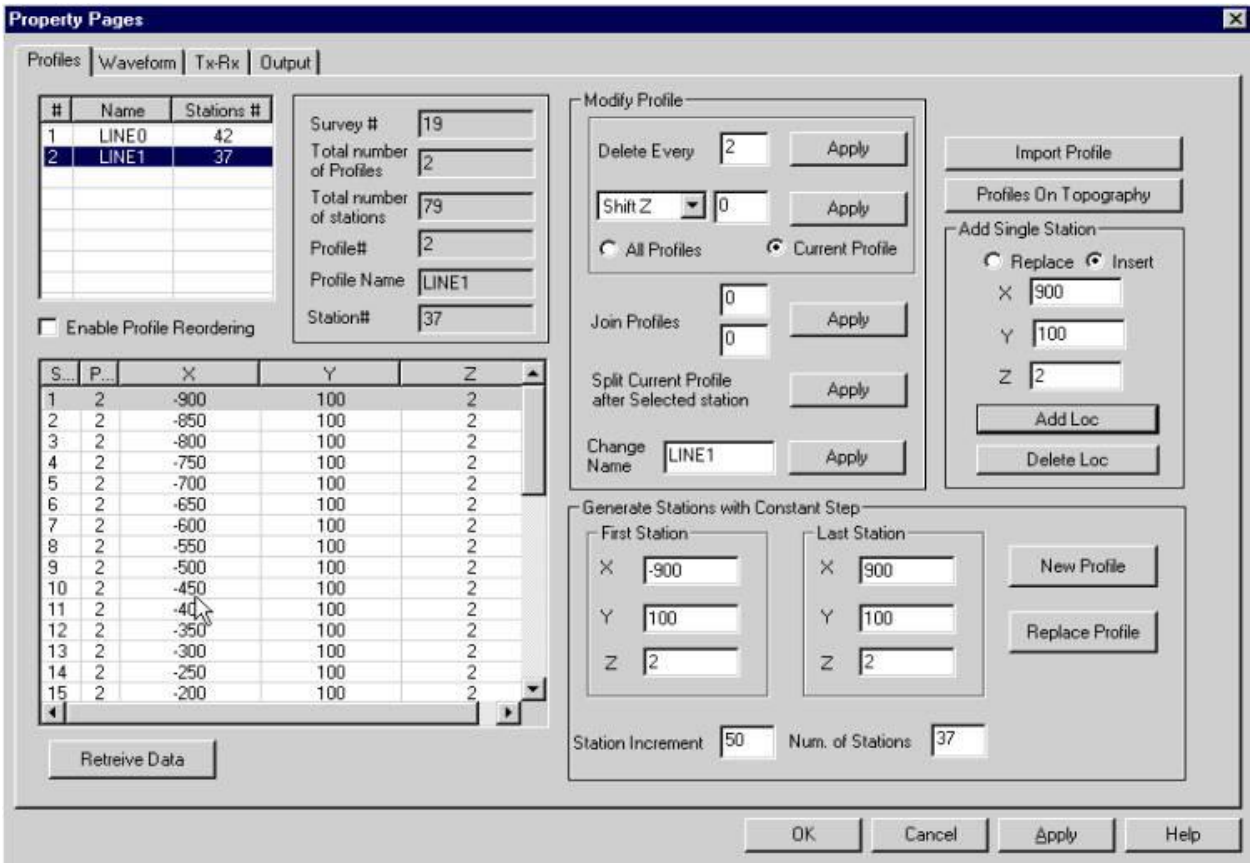
Waveform mode - Select "Spectral", then specify a base frequency to generate a frequency list. To modify the default settings: in the **Spectral Mode** section, input a different starting sequence, end sequence and skip: e.g. 2,4,4

Click the **Generate and add to the frequency list** button.

Notes: the second frequency must be below the base frequency. Use a spectral sequence of 2 to 4 for crone surface data (base frequency of 30 Hz). Use a spectral sequence of 1-4 for borehole data (base frequency of 15 Hz). You may want to go as high as an end spectral range of 5. A skip rate of 4 is usually sufficient. Refer to your transform manual for more information on setting spectral ranges.

This step is only required once. After the first model and the transformation to time domain, all the settings are automatic.

Building a Profile



On the profile page, Input the starting and ending X, Y and Z positions of the profile as well as the number of data points. Then click the **New Profile** button. This may be done for several profiles if so desired.
Note: For surface data, the profile must be placed above the surface interface e.g. at 0.01m

Enter the number of positions you would like to measure along the profile in the box labelled **Num. of stations.**
For a profile 1000 m long with sampling positions every 25 m you will need 41 positions.

[Sampling stations= length of profile/sampling spacing + 1]

Output Page

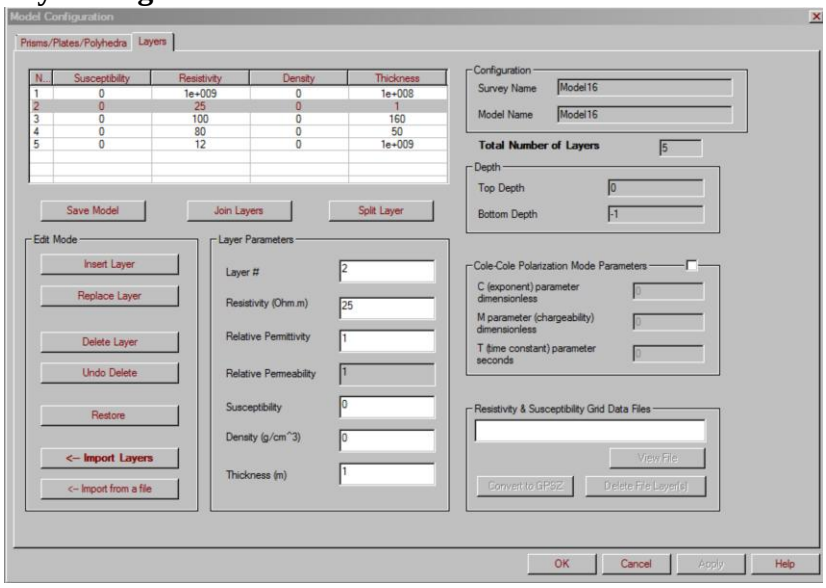
Normalization Convention should be set to Absolute for Time domain calculations
For Time Domain all normalizations are performed in the Transform module.
Now the data channels must be selected. For time-domain data select:

Fields: Scattered
Host
Freespace

The modules to be used later will be able to calculate the Total and Total-Freespace from the above.

Click **Apply** to specify the model properties.

Layers Page*:*



The first layer is set to air for you.
Air need not always be the first layer but must be included if part of the desired physical model.

Set the resistivity and thickness of your first layer ensuring that the insert mode is selected and "Add into the layer list".

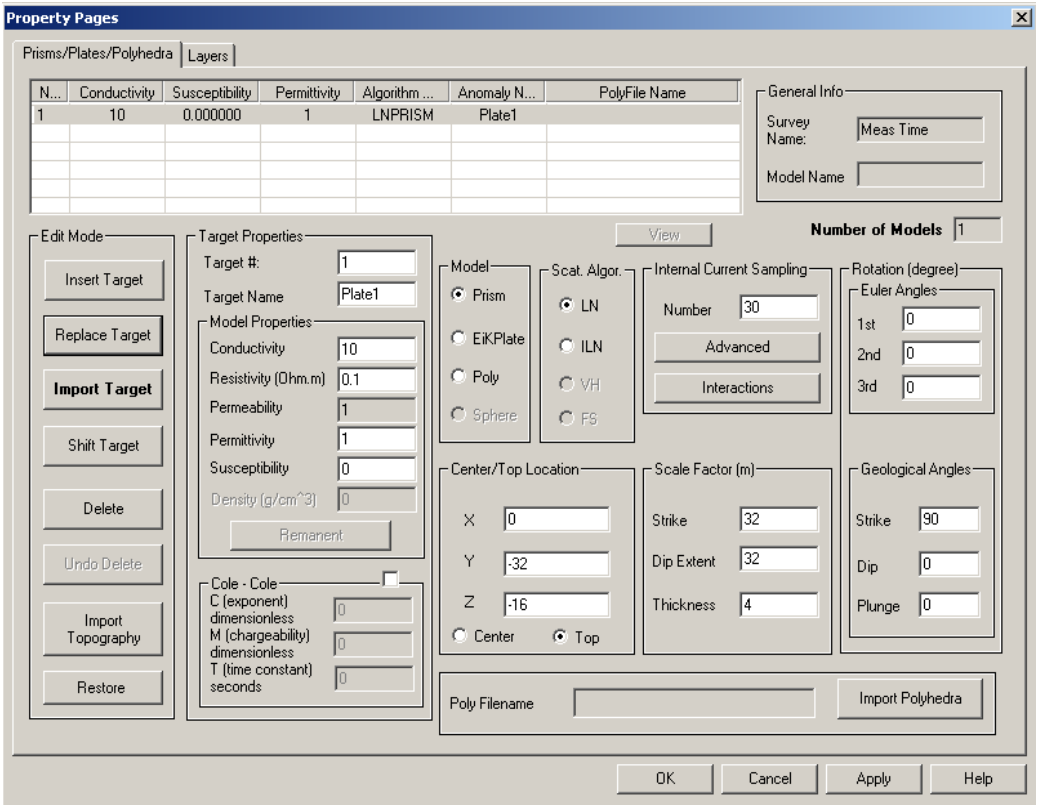
Continue adding layers until you have a representation of your host rock.
Set the thickness of the basement to something large, i.e. 1e8.

To edit layers once added, simply click on the layer in the top white box to select, make your correction to the resistivity and or thickness, then click Replace Layer.

To delete a layer click on the layer and click Delete Layer or use the delete key on your keyboard.

Prisms/Plates/Polyhedra Page:

This page allows access to the variety of simulation algorithms and interactions available in EMIGMA. In general, there are 3 basic modelling primitives - prisms, plates and polyhedra. These objects may have contrasts in either conductivity and/or permittivity from that of the background for EM applications and additionally contrasts in permeability (susceptibility) for Magnetics modelling. Multiple primitives may be considered by use of the "Prism Interactions".



Model

Select Prism, EiKPlate or Poly

Scattering Algorithm

select LN for current channelling responses of prisms
select ILN for current channelling and weak induction of prisms
select VH for channelling and induction of a thin sheet
select FS for induction of a thin sheet

If you are not sure whether the response is dominantly currently channelling or induction, or whether both are important in the response, you can run different algorithms to determine this. For example, if VH and FS give similar results, then the response is dominantly induction. Please refer to the main EMIGMA manual for a description of the different scattering algorithms.

Scale Factor:

Input the width (X), length (Y) and height (Z) of the body

These may be considered as the Strike, Dip Extent and Thickness of the object. Refer to the main

EMIGMA manual under VHPLATE for help in this respect.

Centre/Top Location

Input the centre of mass or top position of the body:

Rotation (Prism/Plate)

Input the rotation/prisms (Euler Angles)

Refer to insert in the main manual on Euler Angles for instructions on rotation your body

For a Plate use strike and dip angles. *Refer to main manual*

Target Properties

Input the conductivity (or resistivity) of the body.

For VHPLATE, the conductance = the conductivity times the thickness of the target (Nominally 0.01m), thus for a plate with a conductance of 20S/m, use a conductivity of 2000S.

One may also indicate here a variation in permittivity.

For Magnetics modelling indicate either the permeability (here this is relative permeability) or the susceptibility

Note: The user is able to use variations in all material properties.

Internal Current Sampling

Input the number of sampling points you would like to calculate

VHPLATE defaults the number of sampling points to 441. You cannot change this.

LNPRISM defaults the number of sampling points to 100. Up to 600 may be used per prism

ILNPrism calculates 7 positions in a cluster around each sampling position. The default is set to 40 sampling points. Normally 20 sample points is sufficient. At this time, the maximum sample points is 85.

Cole-Cole Parameters:

At any time, whether for IP or EM, the user may specify the Cole-Cole parameters m,c,tau for any of the scattering objects.

Inserting an Anomaly:

Click **Insert Target**. Repeat process to add multiple bodies. Note that you can use more than one algorithm in the same model and that you do not need to use the same sampling points for each body.

Prism Interactions - Available to clients who are licensed:
To model the response over multiple bodies, you can now choose the type of interaction. The default is set to near field (assumes electrical contact between the bodies). If you would like to change it to either far field (interaction of bodies not in contact) or superposition (simply addition of the response of two non interacting bodies) you can click on **Interactions** and select one of these.

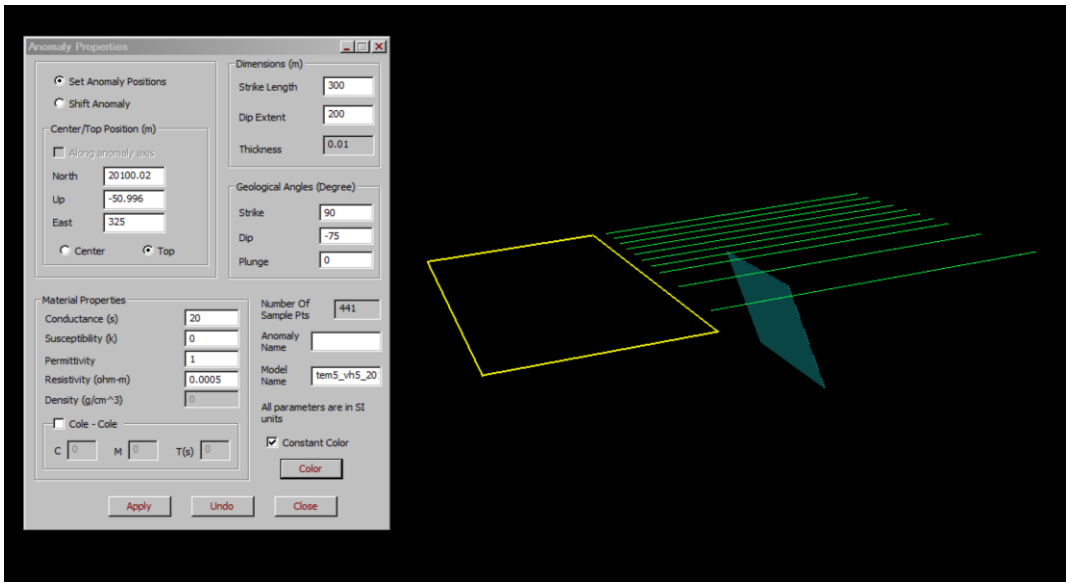
Editing Prisms/Plates

To edit a prism or plate simply double click on the body in the top white box to select, make necessary changes and click the **Replace Target** button. To delete a prism click on the body and click **Delete** or use the delete key on your keyboard.

Click **Apply** to see the new data set in the main EMIGMA database window.

Confirm your model in the Visualizer before Calculations:

It is generally useful to view your model in the Visualizer prior to computing the model. In the visualizer you will be able to make modifications or more accurately specify your model.



With the data set of your model selected, open VisRD with the Viz button on the toolbar.

Using the hand and bottom left dial bars you can manipulate the view of your model in 3D space. The right bottom dial bar and slide bar are zoom controls.

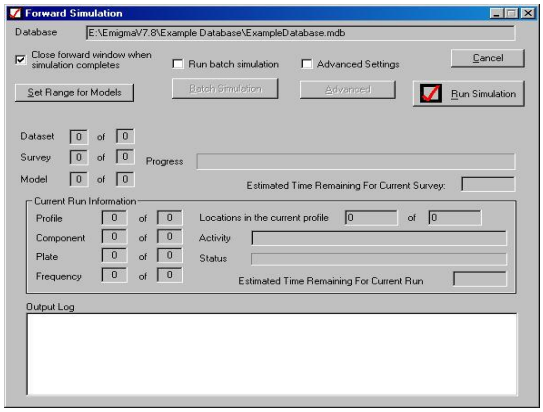
Editing your model

With the arrow, click on your model once, right click, select edit, select properties page. You can now edit your model parameters in the same way as you did before.

If you make changes to your model, click the **Save to Database** button.

Forward Simulation

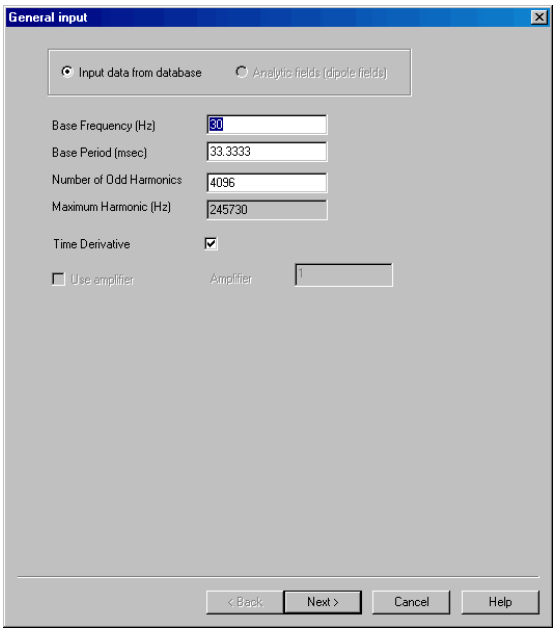
Click the  button on the main EMIGMA toolbar.



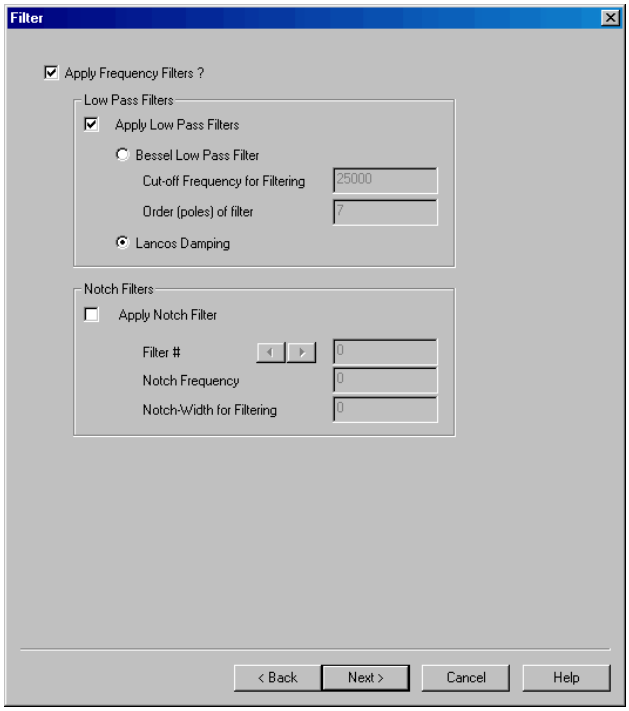
A page is displayed indicating progress through frequencies, components, and profiles.
Click **Run Simulation** to begin

Frequency to Time Domain Transform.

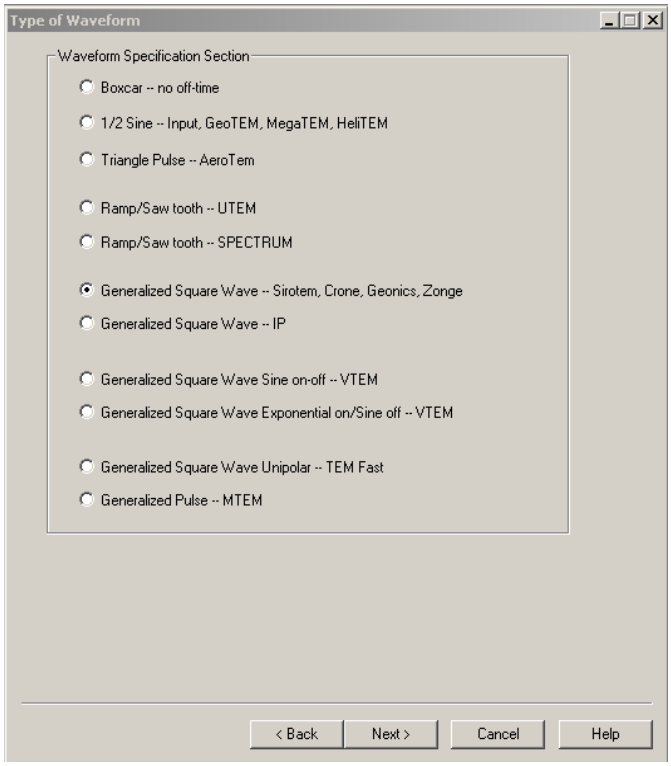
Select the sprectral domain data set and start FSEMTRS with the  button on the main EMIGMA toolbar. The first page in the Wizard appears like this:
Input the base frequency for your system. If you wish dB/dt select Time Derivative. Select **Next**.



Accept the defaults for low pass filters and click **Next**.

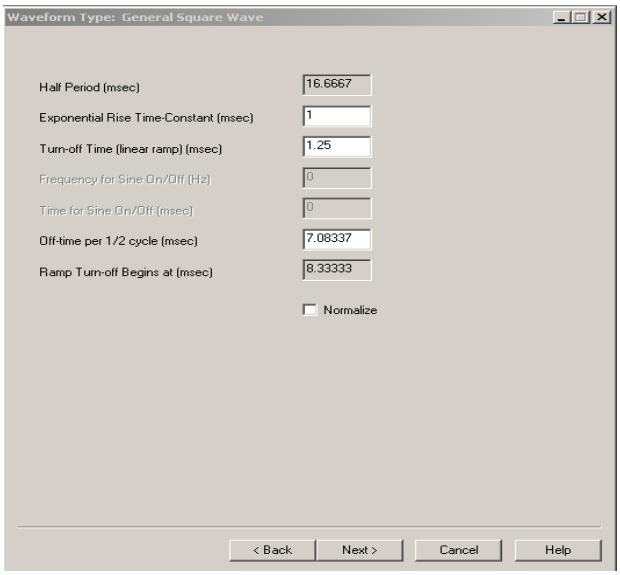


Choose Generalized square waveform for the Crone system and **Next.**

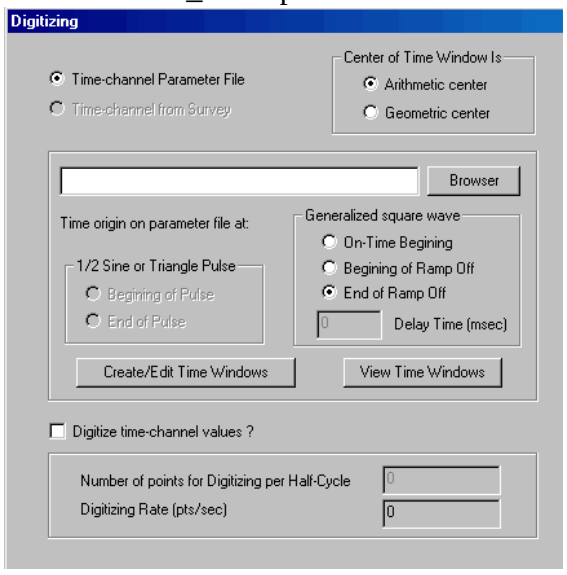


Input the rise time constant (1 msec is used as a rough approximation for many systems).
Input the linear ramp time: (1.25 msec)

Off-time: Off-time is calculated assuming ramp begins at a 1/4 cycle. If this is not correct then input a different Off-time.



Browse for a windows parameter file in EMIGMAVX\TimeChannelFiles
Use wcrone20_15Hz.par for a 15Hz base frequency system. Or create your own windows.*Note: You may view the time channels here using the Retrieve Data button. You may edit the time windows using the Create/Edit button.*



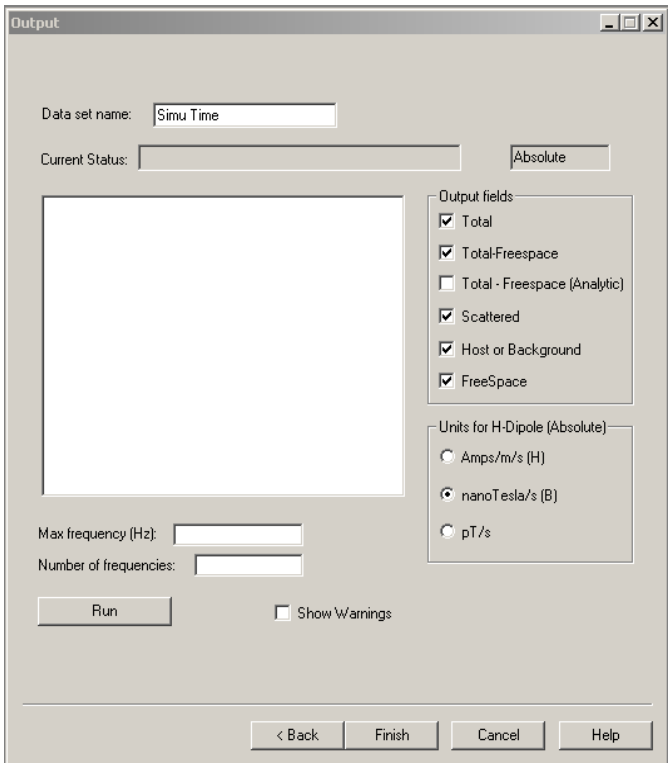
Under Generalized Square Waveform, select end of ramp off as the start time for the channels, the primary pulse will be negative before this all time channels will be positive,

Click **Next.**

Select nanoTesla/sec (B) for the units.

Check the Data set name is as you wish.

Click **Run.**



Upon Successful completion you can click **Finish**.

You may then continue with plotting and displaying the results.

Plotting Measured and Simulated Data -

Start dbPlotter by clicking the button on the main EMIGMA toolbar.

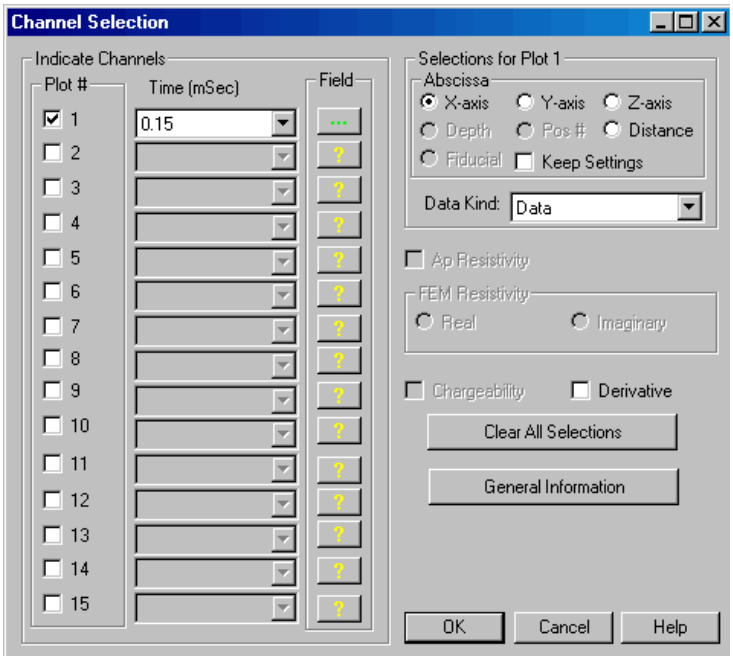
Configuring your plot

Survey - *if you have more then one survey in the file choose the survey you wish to plot*

Profile - *if you have more then one profile in the file choose the profile you wish to plot.*

Use profile name or the Axis which determines the profile line to see which profiles correspond with which numbers. For a profile running North South, the X axis will tell you the start X position of the profile which is usually the line name.

Domain - Use Profile to plot the data as a function of position.
- Use Decay to view the decay of the data as a function of time.



Channel - After channel selection under configuration or using the hot keys -

Click on the first white box under Plot #
- Select the time channel by clicking on the black triangle
- Click on the yellow question mark under field.

Select the fields, component and measured or simulated data. Use fields available to view data contained in the file.

Click **OK**

Additional Tools available in EiKPlot as buttons.

Hold your cursor over the centre of the button to read the tooltips.

Printing:

Printing is available as in any standard Windows application.