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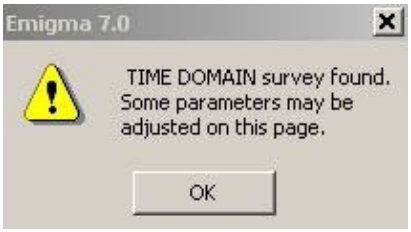
FSEMTRS Manual

FSEMTRS Frequency to Time Domain Transform

In EMIGMA, there are two ways to carry out frequency to time-domain transform. The first is to do it during the forward simulation procedure. It applies when you have changed an already available time-domain model or modeled an actual field dataset and now are going to subject it to forward simulation. In this case, the simulation procedure, which is launched from the **Forward Simulation** dialog, will be preceded by the **Spectral Waveform configuration** dialog offering you to perform the fast transform and adjust the basic transform settings (for more details, see **Forward Simulation As Is**).

The second way is to use the standalone frequency to time domain transform. It applies when you create your survey from scratch or refuse the fast transform during the forward simulation of your new time-domain model and obtain a spectral data set as a result. You can now subject this data set to the standalone transform which allows adjustment of all possible transform settings throughout a number of dialogs to appear.

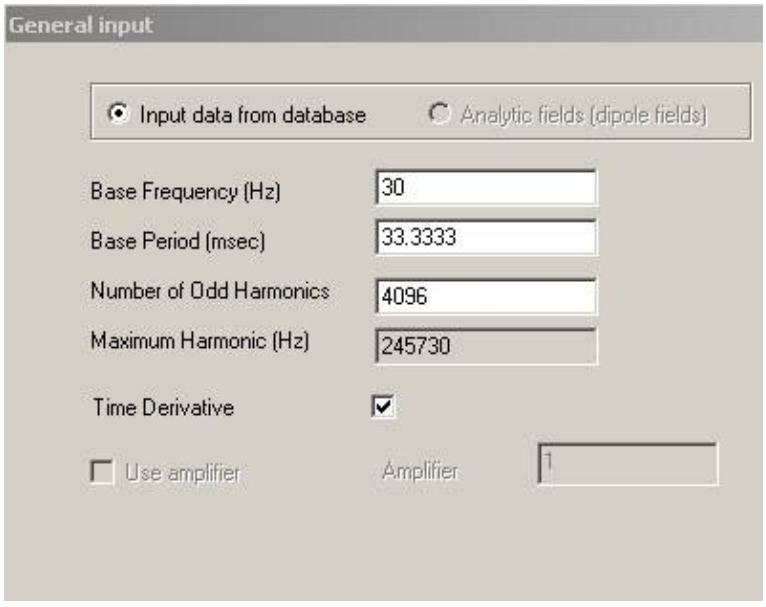
In the **Database** dialog, select a spectral data set to transform and click **FSEMTRS** button  on the EMIGMA toolbar. If your survey is imported and already contains a time-domain data set, the following message will appear:



Click **OK** to proceed to the first dialog of the FSEMTRS wizard. If you created your survey from scratch, you will be taken to the **General Input** dialog automatically.

General Input dialog

In the **General Input** dialog:



The **Input Data from database** button will be turned on, since your data are stored in EMIGMA's database

- Edit base frequency or base period in the respective boxes; if your time-domain data are imported, these two settings will be detected and displayed automatically. If you change the value of one of the settings and click in the box of the other, the latter will update accordingly as well as the value of maximum harmonic in the box below
- Adjust the **Number of Odd Harmonics** value if required. The number 4096 displayed as a reasonable default is not a maximum. If you change it, click in the **Maximum Harmonic** box to update the value in it
- De-select, if necessary, the **Time Derivative** box which is always checked except for the cases when your survey contains electric field data. This would be done, for example, if you wanted to create outputs for the B-field or H-field rather than their time derivatives.

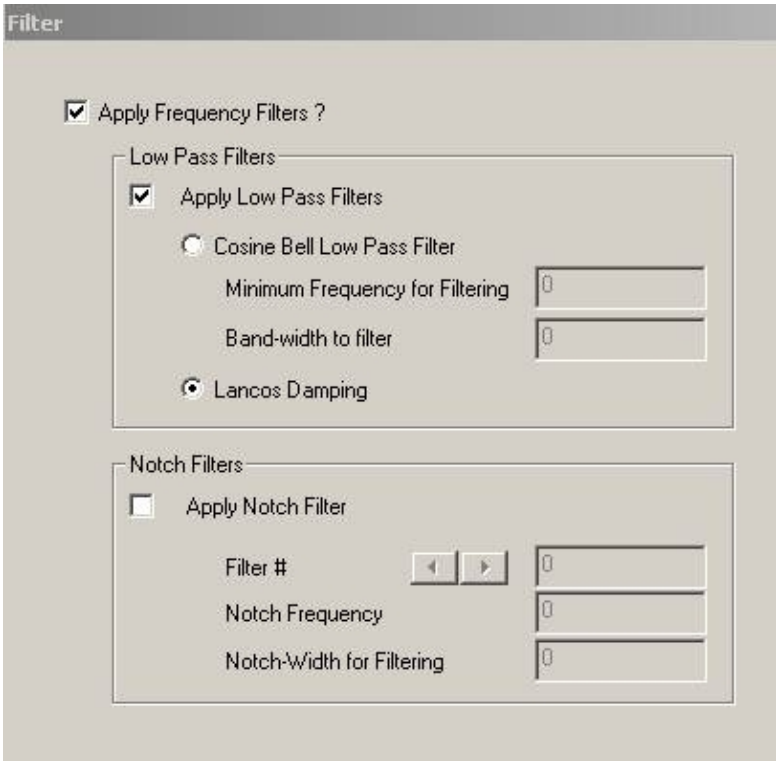
- Click **Next** to proceed to the **Filter** dialog.

Note. The **Analytic fields** button, **Use amplifier** and **Amplifier fields** are for our testing purposes and are not accessible to the user.

Filter dialog

The frequency sampling scheme produced with the Spectral option in EMIGMA results in 9 sets of frequencies, with sequence indices from 1 to 7 and maximum frequency being 17.10 MHz. Time-domain systems are band limited with low frequency filters, usually with a cutoff ranging between 20 to 70 KHz. In other words, when using the sampling scheme and interpolation of FSEMTRS, frequencies up to sequence index 4 (1.7 to 17 kHz) are all that is required to provide a good first approximation to the response. To obtain better accuracy, use up to set # 5. There are no advantages in using higher frequencies, since time-domain systems do not measure this part of the response. The exception is newer systems with air-filled coils that appear to have higher bandwidths.

In the **Filter** dialog:



- If the **Apply Frequency Filter** box is de-selected, check it to activate the available options
- Check the **Apply Low Pass Filter** box to allow selection of one of the two types of low pass filters.

By default, the Lancos filter will be on; this filter dampens higher frequencies much like real systems and provides a simple smooth low pass. To apply a cosine bell filter, select the respective option. In this case, you will be offered to specify the minimum frequency and the bandwidth to filter

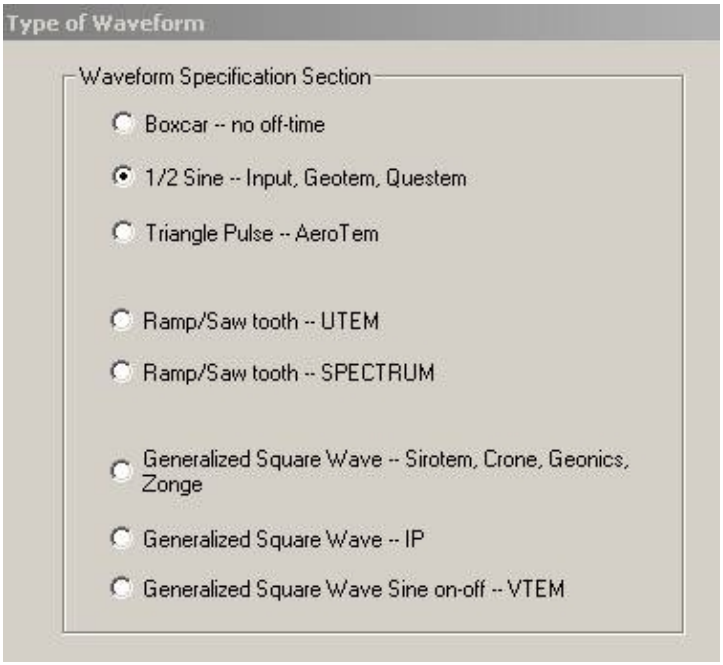
- Check the **Apply Notch Filter** box to allow selection of a notch filter

In the boxes below you are offered to specify the notch frequency (center point) and width to filter. Currently only one notch is allowed

- Click **Next** to proceed to the **Type of Waveform** dialog.

Types of Waveform

Select the type of waveform to be used by EMIGMA to simulate time-domain response. All of the waveforms are characterized by dual polarity:



See:

BoxCar

1/2 Sine Wave

Triangle Wave

Ramp

Generalized Square Wave

BoxCar

- Select **BoxCar** in the **Type of Waveform** dialog

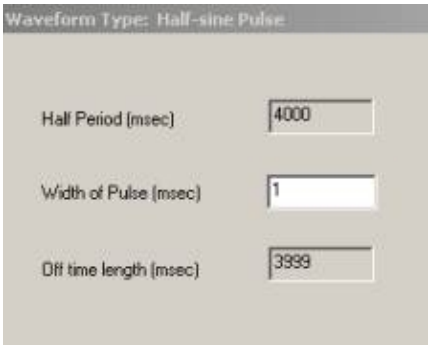
The BoxCar waveform is a positive ON for a half period followed by a negative ON for the other half-period. When the time derivative is taken, it creates an impulse once every half-period. No off-time is allowed for this waveform. No additional waveform characteristics need to be specified

- Click **Next** to directly proceed to the digitizing step of the FSEMTRS procedure.

1/2 Sine wave

The **½ Sine** is an on-pulse which approximates a half period of a sine function followed by an off-time and then a negative repetition to remove any DC offset. It may suit INPUT, new and old GEOTEM or Questem data or merely any waveform of the ½ sine type. This waveform requires further specification:

- In the **Type of Waveform** dialog, select **½ Sine** and click **Next**. The **Waveform Type: Half-Sine Pulse** dialog appears:

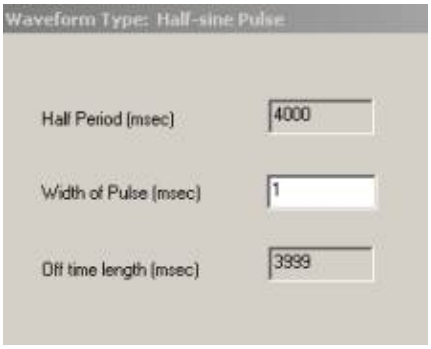


- Change the pulse width in the respective box and click in the **Off time length (msec)** box to update the value in it
- Click **Next** to proceed to the digitizing step of the FSEMTRS procedure.

Triangle wave

The triangle waveform is a kind of a half-sine wave having two linear slopes, one up and one down, equivalent in time and followed by an off-time. This waveform suits AeroTem data. This waveform requires further specification

- Select **Triangle Pulse** in the **Type of Waveform** dialog and click **Next**. The **Waveform Type: Half-Sine Pulse** dialog will open:



- Edit the pulse width as required in the respective box and click in the **Off time length (msec)** box to update the value in it
- Click **Next** to proceed to the digitizing step of the FSEMTRS procedure.

Ramp

The ramp has a linear rise followed by a linear decay, with the slope of the triangle being ±4/T. No off-time is allowed. The two ramp options available are suitable for UTEM and SPECTRUM data, respectively. No additional details need to be specified.

Click **Next** to directly proceed to the digitizing step of the FSEMTRS procedure.

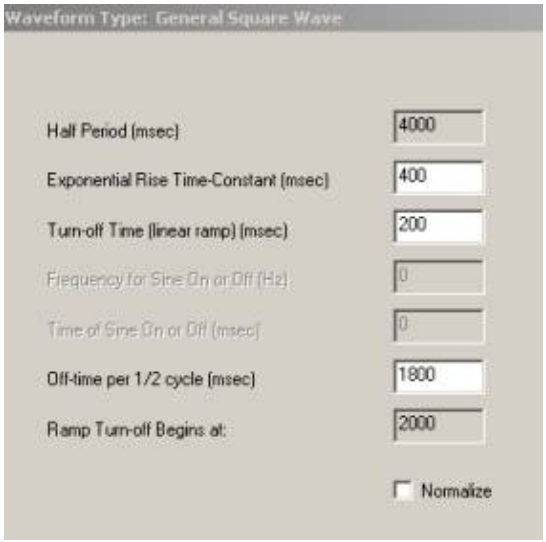
Generalized square wave

The generalized square wave (the first two options) is characterized by an exponential rise, linear ramp and an off-time followed by a negative repetition. The first option can be suited to simulate many commercial waveforms (Sirotem, Crone, Zonge, Geonics), the second, IP option can only be selected for electric field data.

The third, **Sine On-Off**, is characterized by a sine rise and fall, with all other conditions being the same, and is suitable for VTEM data.

All the three options require further specification

- Select a required option in the **Type of Waveform** dialog and click **Next**. This will bring up the **Waveform Type: General Square Wave** dialog:



In the case of the first and second options:

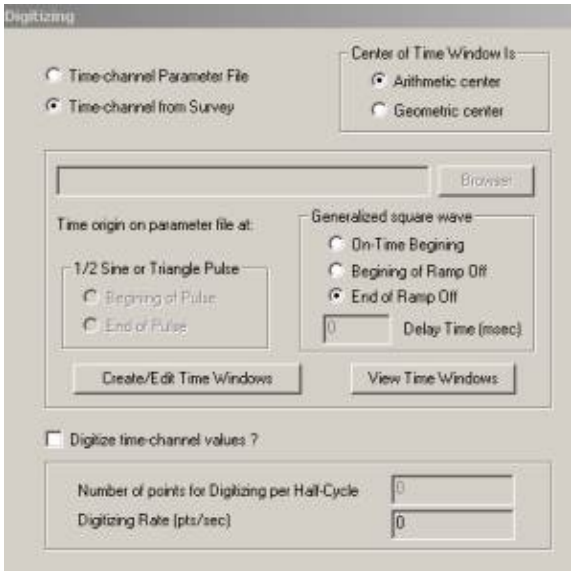
- Specify the exponential rise time-constant and turn-off time (linear ramp) in the respective boxes
- Click in the **Off-time per ½ cycle (msec)** box to update the respective value in it. The latter depends on the ramp time
- To normalize your output, check the **Normalize** box. In the case of IP, this box will be disabled but checked by default

If you selected the third, **Sine On-Off** option:

- Specify the frequency for sine On or Off in the respective box and click in the **Time of Sine On or Off** box to update the value in it
- The **Normalize** box will be inaccessible, since VTEM data are absolute
- Click **Next** to proceed to the digitizing step of the FSEMTRS procedure.

Digitizing

After waveform selection, the **Digitizing** dialog will appear:



In the upper left-hand corner, select between an already available parameter file and a survey to take a desired time-window array from. In both cases you can edit this array and save it as a new parameter file. Or create time windows from scratch.

See

Digitize Actual Measured or Simulated Time-Domain Data

Digitize Data from Scratch Using a Time-Channel Parameter File

Calculate Several Measurements in a Time Window

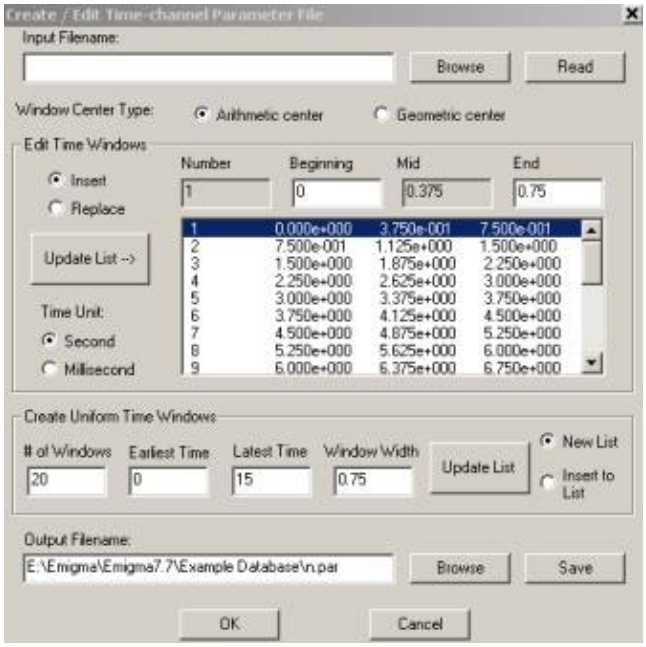
Digitize actual measured or simulated time-domain data

If your survey contains actual measured or simulated time-domain data, the **Time-channel from Survey** option in the **Digitizing** dialog will be on by default

- Select between **Arithmetic Center** and **Geometric Center** in the **Center of Time Window Is** section
- Click the **View Time Windows** buttons. The **Time Windows** dialog will open showing the start, end and mean (dependently of the center type selected) values of each of the windows. You can choose the sec or msec representation of the data in this dialog

To edit your time window settings:

- Click the **Create/Edit Time Windows** button to open the respective dialog



The table in the **Edit Time Windows** section of the dialog will display all available time windows.

To edit any of the windows:

- Select a required window from the table and edit the beginning and the end of the window in the respective boxes above. The **Mid** box will show the mean of the two values dependently of the window center type you selected in the **Digitizing** dialog. However, if necessary, you can change the window center type right here, in the respective section on top
- Select **Replace** if you want to replace the former window with the adjusted and **Insert** if you want to add this new window to the existing list of windows
- To delete a time window, select it and press Delete
- Click the **Update List** button and view the results.

The time values can be represented both in seconds and milliseconds. Select the time units in the lower left-hand corner of the section

To create uniform time windows:

- Specify the number of windows you want to create in the **# of Windows** box
- Specify the earliest and latest times to define a required time interval and click in the **Window Width** box to calculate the respective value
- In the left part of the section, select the **New List** option to replace the list in the table above or **Insert** to add your new array of windows to this list
- Click **Update List**
- To save your new list of windows, click **Browse** to the right of the **Output Filename** field and choose the directory to save it in as a parameter (*.par) file
- Click **OK** to return to the **Digitizing** dialog

Digitize data from scratch using a time-channel parameter file

If you created your survey from scratch and want to use an already available time-channel parameter file:

- Select the **Time-Channel Parameter File** option in the **Digitizing** dialog. The filename field below will become active
- Click **Browse** to open the standard Windows-style Open dialog and find the required parameter file

- To view this file, click the **View Time Windows** button in the **Edit Time Windows** section
- Specify the time origin the time gates are to be relative to.

If the waveform selected is ½ sine, the **½ Sine or Triangle Wave** section will be active. Select between the **Beginning of Pulse** and **End of Pulse** options

If the waveform selected is generalized square, the **Generalized Square Wave** section will be active. Select between **On-Time Beginning**, **Beginning of Ramp-Off** and **End of Ramp-Off**

To change the parameter file

- Click the **Create/Edit Time Windows** button. The respective dialog will open, with the **Input Filename** field containing your parameter file

If you decide to use a different parameter file at this point, you can either click the **Browse** button to the right of the **Input Filename** field to browse for another file or type the name of this other file directly in the **Input Filename** field. Click the **Read** button to update the list of time windows in the table below

- Edit your time channels as required, see Digitize Actual Measured and Simulated Time Domain Data. Click **Save** to overwrite the parameter file or **Browse** to save it as a separate filename
- Click **OK** to return to the **Digitizing** dialog

Calculate several measurement in one time window

- In the **Digitizing** dialog, check the **Digitize Time-Channel Values?** box. The section below will become active
- Specify the number of points for digitizing in a half-cycle in the respective box. The digitizing rate below will update accordingly

Normalization

In all cases, where normalization is required, the **Normalization** dialog will open after the **Digitizing** step. Its appearance will vary dependently of the waveform and will be filled out for you if your survey contains measured or simulated time-domain data.

See

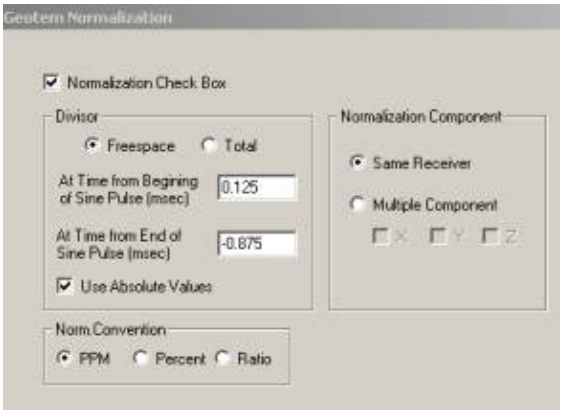
Half-Sine Wave

Ramp (UTEM and Spectrum)

General Square Wave IP

Half-sine wave

In the case of a ½ sine wave, the Digitizing step will be followed by the **Geotem Normalization** dialog:



- Check the **Normalization Check Box** to activate the sections below.

In the **Divisor** section:

- Select between the **Freespace** and **Total** response to be used as a divisor
- Specify the time channel to use for normalization: type a required value in one of the boxes, **At Time from the beginning of Sine Pulse** or **At Time from End of Sine Pulse**. Click in the other box to update the value accordingly
- Leave the **Use Absolute Values** box checked to utilize the absolute value of the divisor. Otherwise, de-select this box

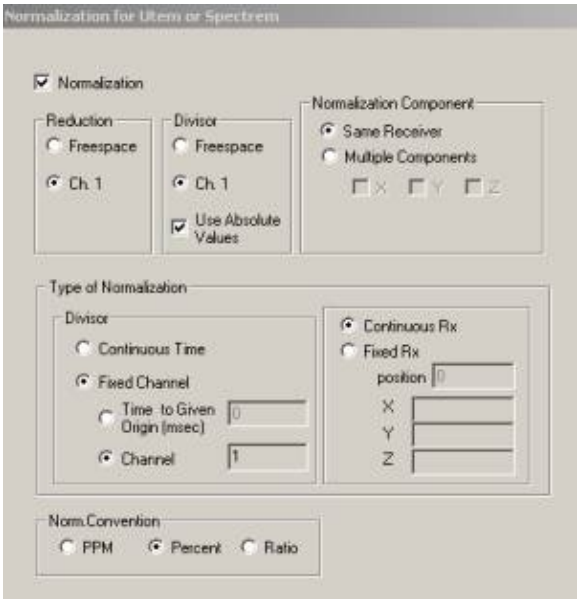
In the **Norm.Convention** section, select between the three output units: ppm, percent and ratio

In the **Normalization Component** section:

- Select **Same Receiver** if you want to normalize your data to the same component as measured
- Select **Multiple Component** to specify one-, two- or three-component normalization. In the latter case, the freespace or total response from all components is used as the normalizing factor
- Click **Next** to proceed to the final **Output** dialog.

Ramp (UTEM or Spectrum)

In the case of UTEM or Spectrum surveys, where ramp waveforms are used, the **Normalization** dialog to open will be as follows:



- Check the **Normalization** box to enable all the sections of the dialog

In the **Reduction** section:

- Select between **Freespace** and **Ch. 1** for UTEM and **Ch N** (last channel) for SPECTRUM to be subtracted from data prior to division

In the **Divisor** section:

- Select **Freespace** or **Ch. 1** (UTEM)/**Ch N** (SPECTRUM) to divide your data by after the reduction
- Check the **Use Absolute Values** box to utilize the absolute value of the divisor

In the **Type of Normalization** section:

- Select between the **Continuous Time** and **Fixed Channel** options

If you selected **Freespace** in the **Divisor** section above, the **Continuous Time** option will be on by default; it means that each time channel will be divided by its own freespace component. If needed, you can change this option to **Fixed Channel** and thus to divide by **Freespace** of only **Ch 1/Ch N** or specify a certain time within this channel in the **Time to Given Origin** box.

If you selected **Ch 1/Ch N** option, the **Fixed Time** button will be on by default; it means that each channel will be divided by **Ch 1/Ch N** or by some concrete time within **Ch 1/Ch N**, if you specify it in the **Time to Given Origin** box.

- Select between continuous and fixed receiver

The **Continuous Rx** option will provide normalization of data for all locations; the **Fixed Rx** option will normalize data only in a certain location. Currently, the latter option is not available.

In the **Normalization Component** section:

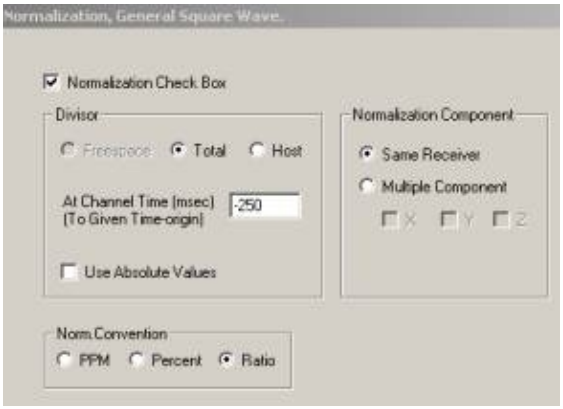
- Select **Same Receiver** if you want to normalize your data to the same component as measured
- Select Multiple **Component** to specify one-, two- or three-component normalization. In the latter case, the freespace or Ch 1/Ch N from all components is used as the normalizing factor

In the **Norm.Convention** section, select between the three output units available: ppm, percent and ratio

Click **Next** to proceed to the final **Output** dialog.

General square wave IP

In the case of the General Square Wave IP, the **Normalization** dialog will be as follows:



- Check the **Normalization Check Box** to activate the sections below.

In the **Divisor** section:

- Select between the three options (**Freespace**, **Total** and **Host**) for your data to be normalized to
- Set the time to use for normalization. The default is an **On-Time** relative to the time origin selected in the previous dialog (**Digitizing**). Change it, if necessary in the **At Channel Time (msec)** box
- Check the **Use Absolute Values** box to utilize the absolute value of the divisor

In the **Normalization Component** section:

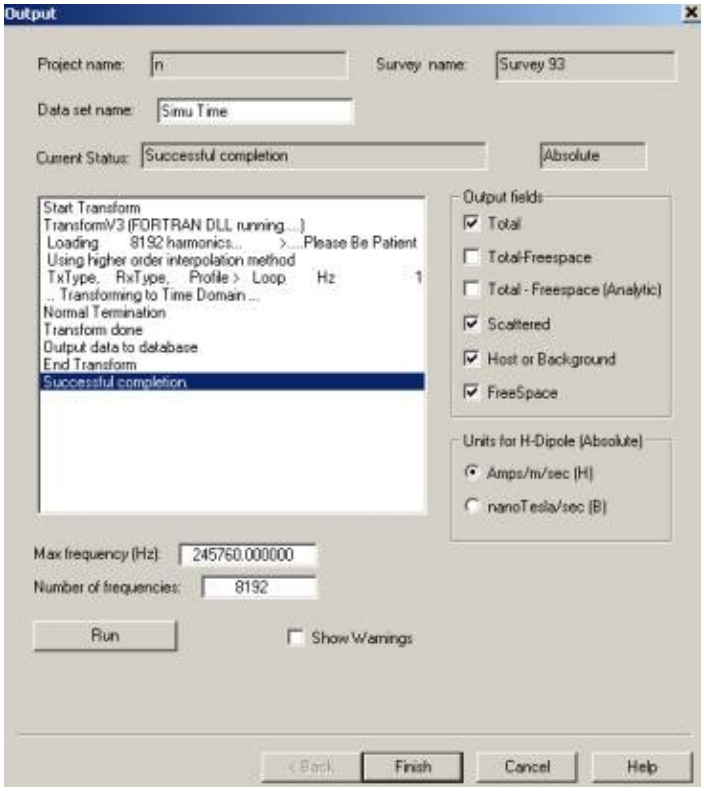
- Select **Same Receiver** if you want to normalize your data to the same component as measured
- Select **Multiple Component** to specify one-, two- or three-component normalization. In the latter case, the freespace, total or host response from all components is used as the normalizing factor

In the **Norm.Convention** section, select between the three output units available: ppm, percent and ratio

Click **Next** to proceed to the final **Output** dialog

Output

The **Output** dialog is the final step of the frequency to time domain transform wizard. From this dialog the transform is launched, with the results to be stored in the database:



In the upper part of this dialog, you will see the name of the project and the survey number. The name of the data set to be created is generated automatically in the respective box. The **Output Fields** section will show the available measured/simulated and calculated responses. The gray box above the **Output Fields** section indicates whether or not normalization is applied

- In the **Units for H-Dipole (Absolute)**, select between the two options offered Amp/m and nanotesla/sec. In the case of normalized data, this section will be disabled
- Click **Run** to start the transform. You will be able to follow the main stages in the central field, whereas the **Current Status** box above will be updated accordingly

Note. *Before running the transform, you can check the* ***Show Warnings*** *box to have a better control over each step of the operation.*

The transform complete, the output file is written to the database. Select **Finish** to close the application.