Weibel Scientific

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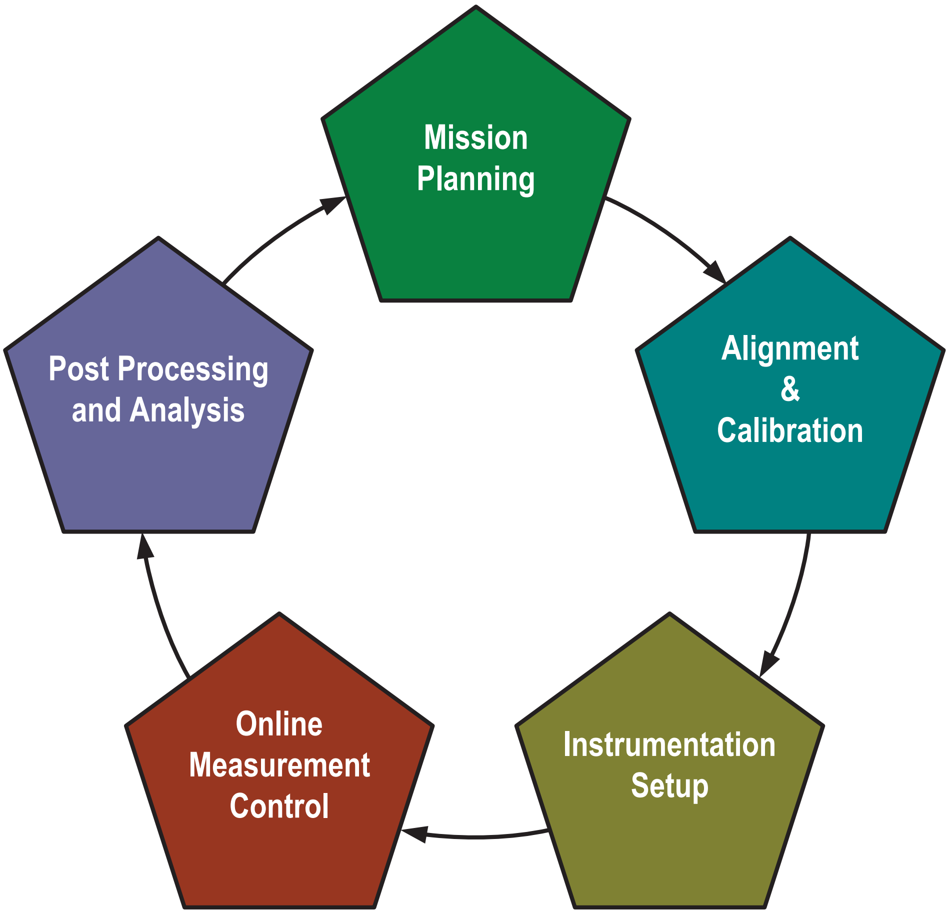
Users Guide

WinDopp



UG-2624 1.47

DISCLAIMER

Contents

1 Introduction

1.1 Change History

Version	Date	By	Comment
0.20	2004-04-28	JJN	Diagnostics not yet included.
0.25	2004-04-30	JJN	.
0.40	2004-09-28	JJN	Added spin analysis
0.50	2004-11-18	BJ	Added burst processing
1.20	2005-03-16	JJN	Added FFT segments
1.21	2006-02-10	JJN	Minor
1.22	2006-06-13	JJN	Editorial changes
1.23	2006-06-23	JJN	Minor
1.24	2007-07-22	JJN	Minor
1.25	2007-08-21	JJN	Added Customize Session View and Calculator.
1.26	2007-08-28	JJN	Added Save/Load button in the Meas. Setup dialog.
1.27	2009-01-23	LR	Accuracy graphs, tracking modes, UTC time.
1.28	2009-11-10	LR	Added menu option to session manager.
1.29	2009-12-22	LR	Updated measurement setup
1.30	2010-03-03	LR	File name options
1.31	2010-05-25	LR	Custom Session Fields & Calculator functions. Belkin.
1.33	2010-09-07	LR	Irig synchronization.
1.34	2010-10-25	JJN	Screen shots updated.
1.35	2011-03-16	JJN	Added Ballistic Coefficient
1.36	2011-05-18	JJN	Editorial changes
1.37	2012-01-11	LR	Added Multi Device functionality
1.38	2012-01-25	LR	Added Inbore Analysis
1.39	2012-03-05	LR	Updated

Version	Date	By	Comment
1.40	2012-04-02	JJN	Editorial changes
1.41	2012-05-02	LR	Added diagnostics and self verification
1.42	2012-06-18	LR	Status bar description
1.43	2012-08-02	JJN	Improved Height, Offset & Setback description
1.44	2012-09-12	MKB	Specific Self-Verification test information
1.45	2012-12-07	JJN	Added advanced MOT parameter description
1.46	2013-08-22	JJN	Updated dialog screenshots
1.47	2014-08-27	AJS	Added calculate muzzle velocity section

1.2 Disclaimer

WinDopp is limited to operating fixed head antennas only and to process data without measured angular information (single channel). DAT or WRK files containing data from a radar system capable of measuring azimuth or elevation angles are not supported.

Any description or example in this document showing angular information or parameters derived from angular information does not imply that WinDopp is capable of processing or generating such information.

1.3 References

[1] “IS-3129: WinDopp External Control Interface”. Weibel Scientific A/S.

1.4 WinDopp Background

WinDopp is a Windows program, running on the Instrumentation Controller, IC-700. It replaces the RemDopp program. It provides a wide range of tools supporting the complete muzzle velocity radar measurement process: mission planning, alignment and calibration, instrumentation setup, online measurement control and post processing & analysis. An overview of these tools is found in the following sections.

WinDopp is intended for fixed head antenna operation only and does not support the data files originating from a tracking radar system, see Disclaimer (page 2). Processing of data files containing angular information requires WinTrack.

While most radar systems are equipped with a local user terminal, the full operator and control interface is only available through WinDopp. The instrumentation setup and online control provides full access to the features of the radar connected.

The system uses TCP/IP, USB, or serial link for the interface between the MVR and the Instrumentation Controller, see Set-up Communications (page 7).

The WinDopp program displays the results on a graphical display during the measurement, and can, in post processing generate several graphs to a connected printer.

The program is activated from the Windows desktop, click on the WinDopp icon to start the program.

1.4.1 Mission Planning

WinDopp provides a number of tools that support the mission planning and preparation process:

WinDopp Tool	Task
Work with Coordinate Systems (page 31)	Find a good location for the radar and configure approximate positions of the radar and the launcher.
Work with Coordinate Systems (page 31)	Identify suitable reference points and prepare coordinate settings.
Predict the Trajectory (page 23)	Check the line of sight to the target throughout the measurement.
Predict the Trajectory (page 23)	Check that the signal to noise ratio is sufficient for the measurement.
Import Meteorological Data (page 26)	Predict the effects of the local meteorological conditions.
Radar and Processing Parameters Overview (page 49)	Configure the radar and how data is saved after each measurement.

1.4.2 Alignment & Calibration

The following WinDopp tools support the radar alignment and calibration process:

WinDopp Tool	Task
Work with Coordinate Systems (page 31)	Configure the actual positions of the radar and the launcher.

1.4.3 Instrumentation Setup

The following WinDopp tools configure the communications and the radar connected:

WinDopp Tool	Task
Set-up Communications (page 7)	Configure link types and baud rates.
Customize File Locations (page 13)	Prepare directories for measurement data.
Radar and Processing Parameters Overview (page 49)	Configure the radar and WinDopp for making measurements.

1.4.4 Online Measurement Control

Muzzle velocity measurements are controlled through the Measurement Control panel, see the Measurement Control Overview (page 63) section for further information.

1.4.5 Post Processing & Analysis

The following WinDopp tools perform post mission data processing on DAT files and analysis on work files and assist the measurement report generation:

WinDopp Tool	Task
Draw a QDTI/DTI Plot (page 103)	View the Doppler-Time-Intensity plot.
Draw an ST Plot (page 110)	View the Signal versus Time plot.
Detect Single/Multi Object Tracks (page 112)	Perform the object tracking algorithm to identify potential target tracks in the signal.
Open a WRK File (page 163)	Process the potential tracks and perform further analysis.

1.5 Install and Run WinDopp

1.5.1 Minimum System Requirements

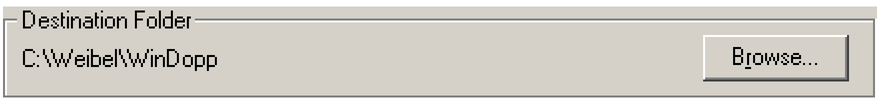
The computer to run WinDopp shall as a minimum meet the following requirements:

- ► Operating system: Windows XP 32-bit, Windows XP 64-bit, Windows 7 32-bit, Windows 7 64-bit.
- ► Memory: 2Gbyte or more
- ► CPU: 1GHz or more
- ► Disk space: 100Gbyte or more

1.5.2 Install WinDopp

To install the application:

1. Locate the file WinDoppSetup.exe and double click it.
2. Change the destination folder if needed or use the default directory:



3. Follow the instructions given by the installation program.

1.5.3 Insert the Dongle

Insert the WinDopp license dongle in the computer where WinDopp is installed and used.

1.5.4 Start the Application

To start the application, locate the WinDopp icon on the desk top and double click it:

1.6 WinDopp Navigation

1.6.1 Menu Bar

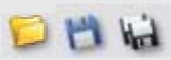
The Menu Bar provides access to most functions available in WinDopp. Some of the functions require that an external device is attached.

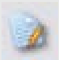
The following menus are available through the Menu Bar.

Menu Item	Function
File	Perform various file operations, including load and save work and command files.
Session	Various functions related to the current session and the Session Manager.
Tools	Various application tools i.e. the single command panel and Terminal window, used when checking or modifying parameters not included in the windows interface.
Options	System control options i.e. Communication port setup.
Measurement	Various functions related to the measurement process.
Window	Control the Graph Area layout.
Help	Activate the on-line Help or see the version number.

1.6.2 Tool Bar

The Tool Bar provides quick access to the most frequently used functions.

Menu Item	Function
	Open and save various files e.g. parameter settings or analysis results.
	Arrange the windows: - Cascade all windows. - Tile all windows Horizontal. - Tile all windows Vertical. - Close all windows.
	Command terminal.

Menu Item	Function
	Main parameter control function.
	Open Session Manager.
	Show measurement control panel

Notes

- ► The Command terminal icon is only shown when the radar is connected.

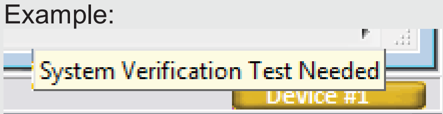
1.6.3 Graph Area

The Graph Area is where data is presented to the operator as curves or plots. It is also used for editing the data set, e.g. removing data points from the analysis or adding data points to a track.

To use the graph area when post processing data, see Work File Tools and Windows (page 164).

1.6.4 Status Bar

The Status Bar provides an overview of the status of the external units.

Status bar Item	Function
	Current work directory.
	Device status. In case a warning or error has been detected this indicator will change color. Hoover mouse on top of the device status indicator for more information. Example: 

Green = OK, red = error, yellow = warning, grey = not available/not used.

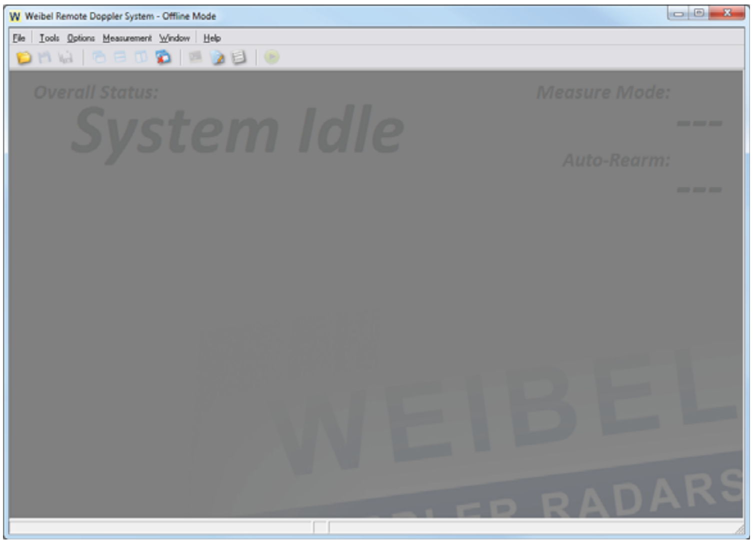
Notes

- ► The green color indicates that no errors have been detected in the main system components.
- ► The status will turn yellow if a warning is detected.
- ► The status will turn red if an error is detected.

◄ End of Chapter ►

2 Initial Setup & Configuration

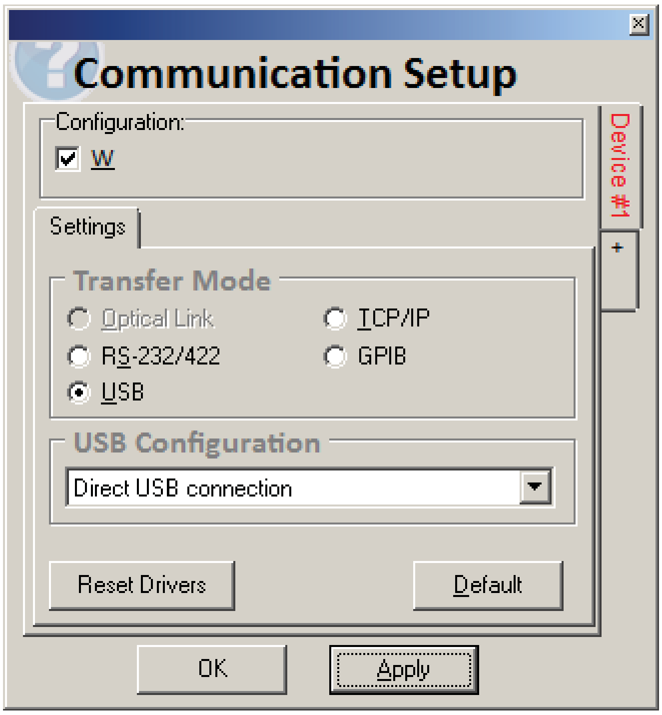
2.1 Set-up Communications



To configure the WinDopp communications interfaces:

1. On the **Options** menu, click **Communications Setup**.
2. Enable the **W** box.
3. Select the **Transfer Mode**:
   RS-232/422: Serial link
   USB: Universal Serial Bus.
   TCP/IP: Ethernet
   GPIB: General Purpose Interface Bus
4. Use the **Default** settings for the serial interface or enter your own settings.
5. Use the **Reset Drivers** button in case of communication problems, see notes below.
6. Click **Apply** to use the configuration.
7. Optionally, add more devices by clicking on the "+" tab.

See below for further information.



The following **USB Configurations** are available:

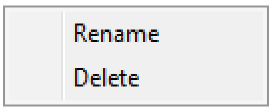
Use	If you want to
Direct USB connection	Connect directly to a W-700 that has a built-in USB interface.
Link - USB adaptor (W1000/W1000i)	Connect to a W-1000/W-1000i through an IO-1000 Link-USB adaptor.
Link - USB adaptor (W700)	Connect to a W-700 through an IO-1000 Link-USB adaptor.

2.1.1 Setup Multiple devices

Click on the “+” tab on the right side to add more devices, if required.

Each device has its own communication settings. Switch between the devices by clicking on the individually device tabs.

Right-click on a device tab to rename or delete a device:



Notes:

- Click on the **Apply** button to check the communication to the unit.
  Click **OK** when satisfied to store and use the selected communication port.

- When using an SL-xxxxPC or SL-xxxxPBC antenna (containing a Belkin Network USB Hub) it is important that the Belkin ControlCenter application is running (and connected) prior to WinDopp.

  The Belkin Software Installation can be found in the WinDopp driver folder.

  The default IP address for the antenna is 192.168.0.92 – so make sure the notebook/workstation (running WinDopp and the Belkin ControlCenter application) uses another IP address than this, eg. 192.168.0.94.

  Be advised that changing the IP address or other system configurations might need a full restart of the system (including the antenna and notebook/workstation).

  For Windows 7 operating systems the Windows User Account Control setting (Control Panel → User Accounts → Change User Account Control settings) needs to be set to minimum.

- When using the Weibel IO-1000 Link - USB adaptor one of the last two USB configurations must be selected in accordance with the type of analyzer (W-700 or W-1000).
- RS-232 baud rates: 1200, 2400, 4800, 9600, 19200, 38400, 57600.
- RS-422 baud rates: 100000, 115200, 125000, 230400, 250000, 500000.
- When using a USB COMI device uncheck the “Set baud rate in device” and make sure to select the same baud rate both in WinDopp and in the Analyzer.

  Use the following settings when using USB COMI:
  RS232/422 on
  COMPORT: (see Windows Device Manager)
  Baud Rate (RS422 baud rates)
  …
  Adaptor Type to Standard
  Uncheck ‘Set baud rate in device’

- Click on the **Reset Drivers** button in case of communication problems. For instance if using a USB connection and the unit gets rebooted while WinDopp is still connected some Windows drivers might hang. Use this button to reset the drivers.

2.2 Set-up IRIG synchronization

WinDopp supports a manual IRIG time synchronization feature (based on an external IRIG unit) for antennas without a built-in IRIG/GPS.

To configure the WinDopp IRIG synchronization:

1. Make sure that the IRIG device is turned on and all necessary drivers are installed.
2. On the **Tools** menu, click **Customize** and choose the **Measurement** tab.
3. Select the “**Enable IRIG synchronization**” option.

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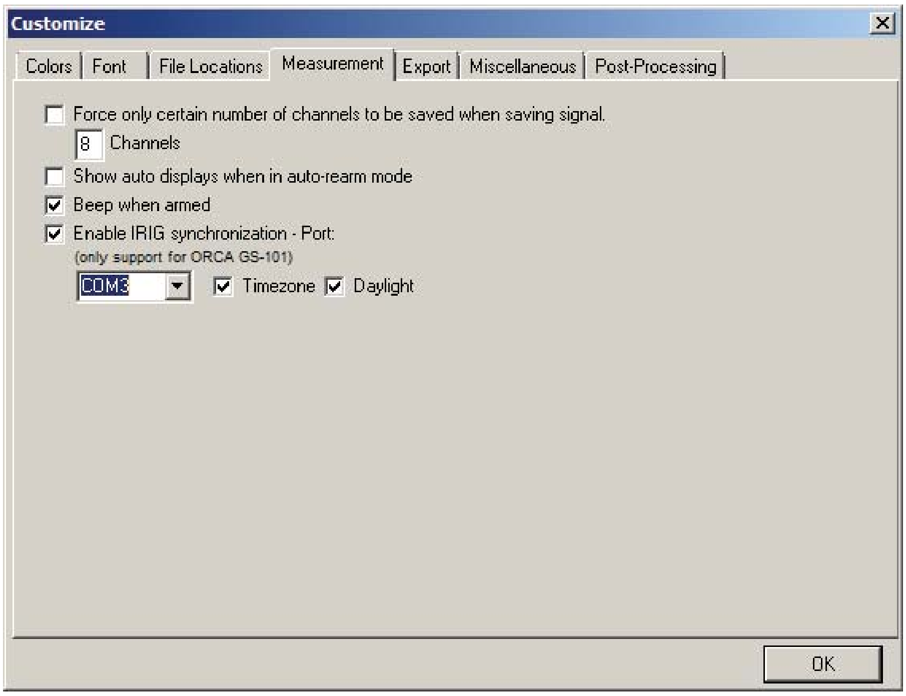
4. Select the proper COM port. See note below.
5. Click **OK** to use the configuration.



Notes:

- ► This is not needed for antennas/analyzers which support IRIG synchronization (e.g built-in GPS receiver).
- ► Only support for ORCA GS-101
- ► To find the proper COM port look in the Windows Device Manager (Control Panel). The device will normally be shown as a “USB Serial Port” in the “Ports (COM & LPT)” list group.
- ► Enable the **Timezone** option for compensate for local time zone.
- ► Enable the **Daylight** option for compensate for local daylight (summer/winter time).

2.3 Customize the User Interface

A number of items in the user interface are configurable:

Group	Function
Colors	Background, graph components and text. See Customize Colors (page 11).
Font	All text output. See Customize Font (page 12).

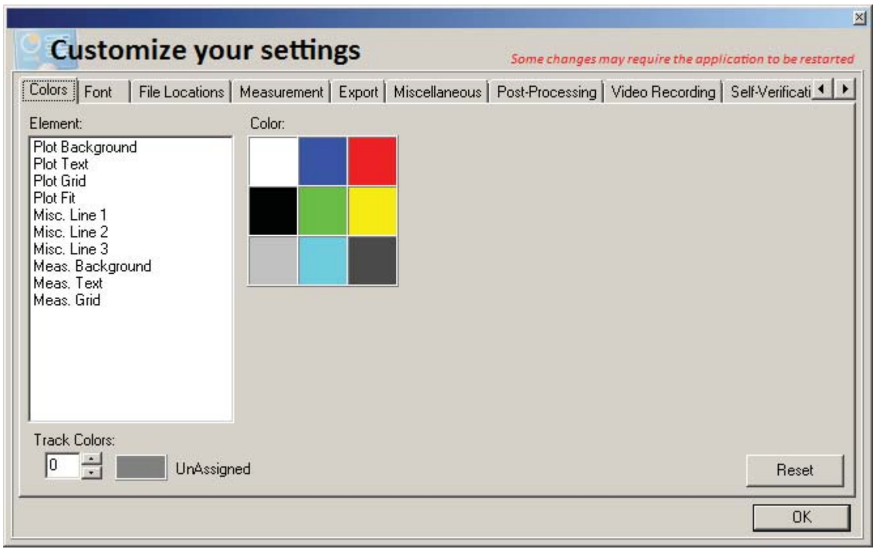
Group	Function
File Location	Default location for work/data files and command/configuration files. See Customize File Locations (page 13).
Export	Default formats for graphics output to file or printer. See Customize Graphics Export (page 14).
Miscellaneous	Status bar, camera control, beep, auto open, logging. See Customize Miscellaneous (page 15).
Post-Processing	Additional post-processing options. See Customize Post-Processing (page 16).
Group	**Function**
Measurement	Measurement settings: Channel saving settings, IRIG synchronization settings. See Customize Measurements (page 13).
Self-Verification	Self-verification settings. See Customize Self-Verification (page 19).
External Control Interface	Enable/Disable the External Control Interface.

2.3.1 Customize Colors

To customize the colors in the user interface:

1. On the **Tools** menu, click **Customize**.
2. Click the **Colors** tab.
3. Select the graphical/textual **Element** to change.
4. Choose a new **Color**.
5. Click **OK**.

The following window appears:



Note

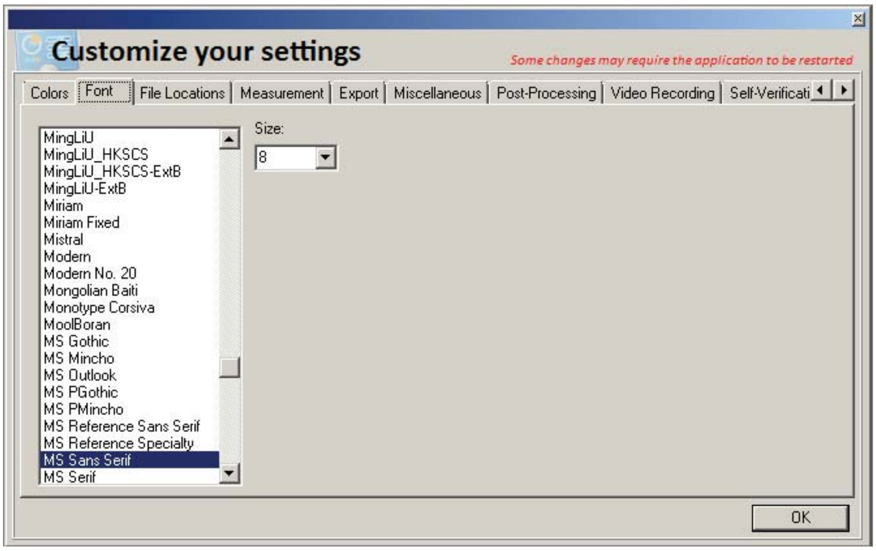
- ► The default color of tracks (shown in the work file view) can also be specified.
- ► Use the **Reset** button to set all colors to default.

2.3.2 Customize Font

To customize the font used for text output:

1. On the **Tools** menu, click **Customize**.
2. Click the **Font** tab.
3. Select the font from the list.
4. Click **OK**.

The following window appears:

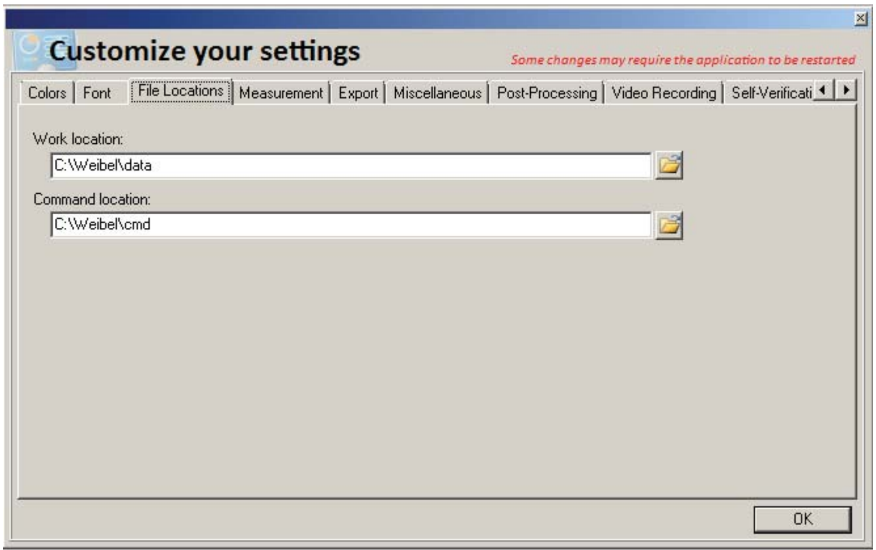


2.3.3 Customize File Locations

To customize the default file locations:

1. On the **Tools** menu, click **Customize**.
2. Click the **File Locations** tab.
3. Type the default **Work Location** or browse the directory.
4. Type the default **Command Location** or browse the directory.
5. Click **OK**.

The following window appears:



Notes

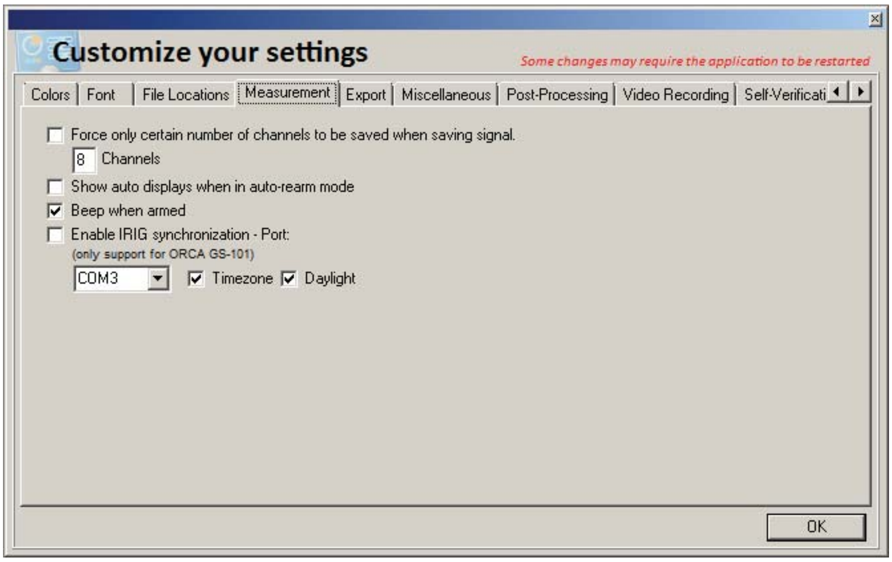
- ► The Work Location is where the following files are stored or loaded from: DAT, WRK, and TRK.
- ► The Command Location is where the following files are stored or loaded from: CMD, PRM.

2.3.4 Customize Measurements

To customize the measurements setup:

1. On the **Tools** menu, click **Customize**.
2. Click the **Measurements** tab.
3. Enable the optional measurement features you want.
4. Click **OK**.

The following window appears:

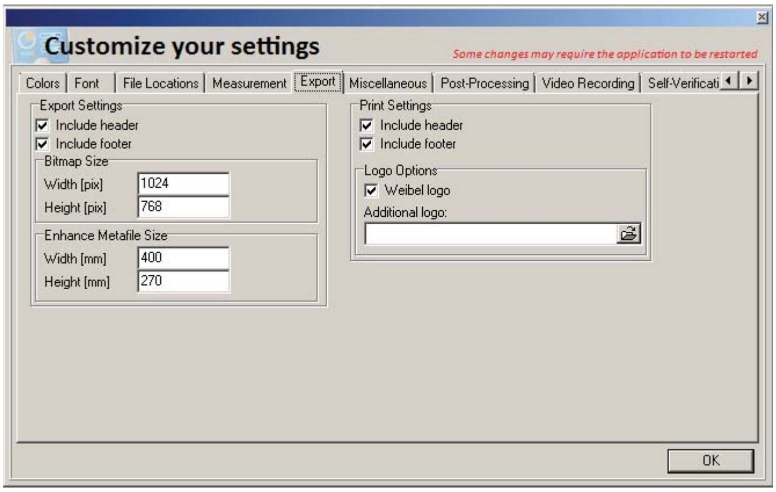


Enable	If you want to
Force only certain number of channels…	Force the system only to save a specific number of channels, starting from channel 1.
Channels	Number of channels to save in case the above option has been checked, starting from channel 1.
Show auto displays when in auto-rearm mode	Show the auto displays after each measurement when in auto-rearm mode.
Beep when armed	Beep shortly when armed
Enable IRIG Synchronization	Enables the system to use IRIG synchronization. See Set-up IRIG synchronization (page 9) for more information.
Port	The COM port used for IRIG synchronization. See Set-up IRIG synchronization (page 9) for more information.
Timezone	Time zone compensation used for IRIG synchronization. See Set-up IRIG synchronization (page 9) for more information.
Daylight	Daylight compensation used for IRIG synchronization. See Set-up IRIG synchronization (page 9) for more information.

2.3.5 Customize Graphics Export

To customize the default print and graphics export settings:

1. On the **Tools** menu, click **Customize**.
2. Click the **Export** tab:



3. Change the graphics and print options/parameters.

Notes

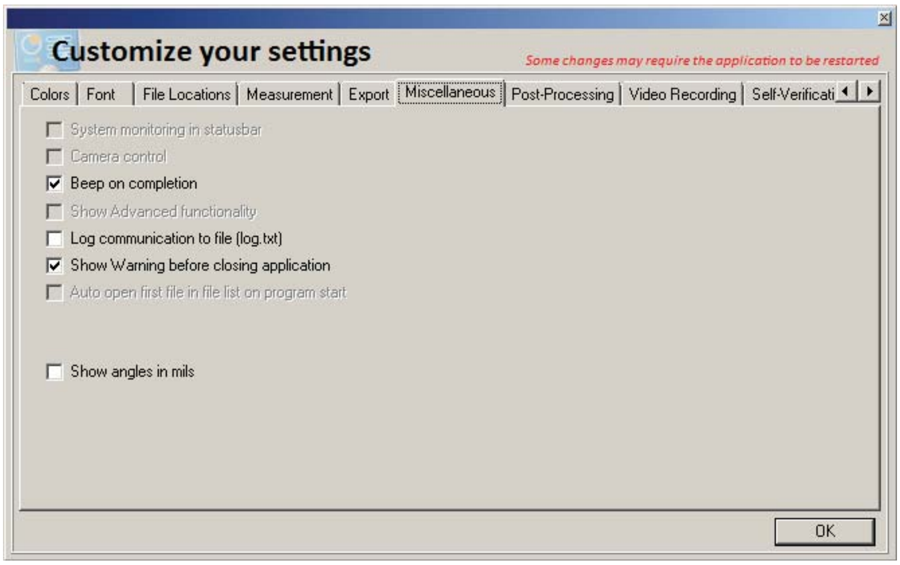
- The **Export** tab is only for exporting pictures and not for exporting data.
- The **Bitmap Size** applies when exporting to the BMP or PNG file format.
- The **Enhance Metafile Size** applies when exporting to the EMF format.
- These settings affect the plots produced using the Print or Export Track Graphics (page 172) feature.

2.3.6 Customize Miscellaneous

To customize miscellaneous setup parameters:

1. On the **Tools** menu, click **Customize**.
2. Click the **Miscellaneous** tab.
3. Enable the miscellaneous features you want.
4. Click **OK**.

The following window appears:



Enable	If you want to
Beep on completion	Hear a sound whenever a task is completed.
Log communications to file (log.txt)	Save all communications to a file. Only for debugging purposes.
Show Warning before closing application	Confirm that the application is closed.
Show angles in mils	Choose to show angles in mil instead of degrees. This is only supported in certain dialogs/windows.

Notes

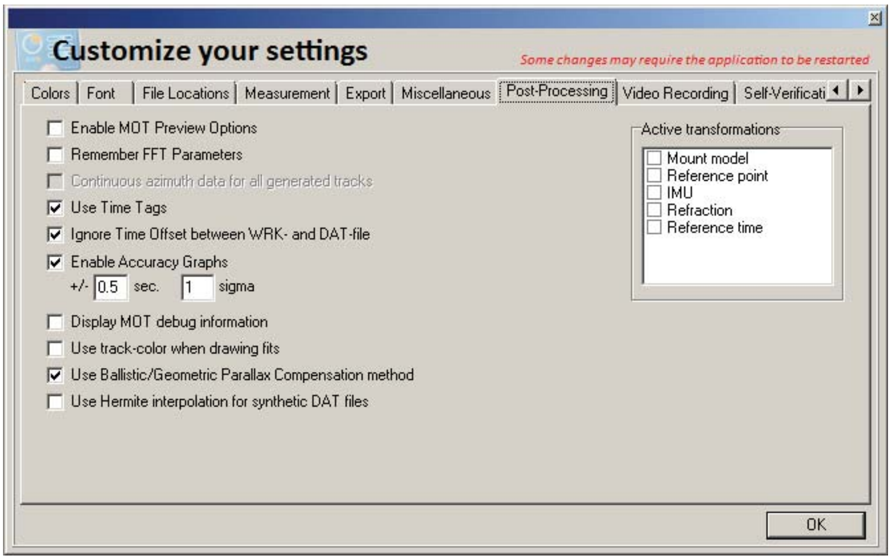
► Options shown in grey are not available in the current application.

2.3.7 Customize Post-Processing

To customize post-processing setup parameters:

1. On the **Tools** menu, click **Customize**.
2. Click the **Post-Processing** tab.
3. Enable the post-processing features you want.
4. Click **OK**.

The following window appears:



Enable	If you want to
Enable MOT Preview Options	Visualize additional information when previewing results from the Track Control Window (see Use the Track Control Window (page 114)).
Remember FFT Parameters	Make the Process Setup form remember the FFT Parameters of the last processing (see Configure the FFT Parameters (page 98)).
Continuous azimuth data for all generated tracks	All tracks generated from dat files using the SOT/MOT processing functions get continuous azimuth angles.
Use Time Tags	Synchronize all post-processing operations on a DAT-file with the time tags stored in the file.
Ignore Time Offset between WRK- and DAT- file	Ignore the possible differences between the MEASTIME information of the WRK-file's ONLINE_INFO entry and that of the DAT-file header. Always recommended if the system is known to be synchronizing via a hardware trigger signal.
Enable Accuracy Graphs	Enable the feature of showing accuracy graphs using the specified time interval and the sigma value. See Accuracy of a Data Point versus Time (page 18) or Accuracy of a Data Point versus another Data Point (page 19) for further information.
Display MOT debug information	Display debug information during MOT processing.
Use track color when drawing fits	Use the same color as the track points for the fit line.
Use Hermite interpolation for synthetic DAT files	Use 5th order Hermite interpolation to interpolate the trajectory data when generating synthetic data files.

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Enable	If you want to
Use Ballistic/Geometric parallax compensation method	Use alternative method for fitting in the launcher coordinate system, see Select Fitting Mode (page 181).

Notes

- Please close any open DAT file and re-open it for the parameter changes to take effect in the following processing. Please refer to Open a DAT File (page 91).
- Activating a transformation in **Active Transformations** will not override any status previously saved. It only applies to newly created groups.

2.3.7.1 Accuracy of a Data Point versus Time

In this case we look at a measured parameter versus time, x(t). This may be radial velocity or a number of other parameters.

To estimate the accuracy of a specific measured data point, x(tm), the following is done:

1. For each data point, x(t), in the time interval [tm-T, tm+T], where T is defined by the user (see Customize Post-Processing (page 16)), do the following:
   a. Calculate the difference between the measured and the fitted value.
   b. Square this value and multiply it by w(t)=(1+cos(pi*(t-tm)/T))
2. Calculate the sum of the values from step 1 and divide by the sum of the w(t) values to get the weighted average.
3. Calculate the square root of the value from step 2 to get the estimated standard deviation, sx(tm).

To estimate the accuracy of a specific fitted data point, xf(Tm), the following is done:

1. For each of the N measured data points, x(t), in the time interval [tm-Tobs/2, tm+Tobs/2]:
   a. Calculate the square of the estimated standard deviation, sx(t).

   Tobs is the fitting observation time, see Change the Fit Parameters (page 187).
2. Calculate the average of the values from step 1 and divide by N.
3. Calculate the square root of the value from step 2 to get the estimated standard deviation of the fitted data point, sf(tm).

Notes

- It is recommended that the value of T is chosen to match the dynamics of the signal strength variations as seen by a close inspection of the SNR plot.

  Look for the fastest change in SNR and note how long it takes to rise/fall 3dB and set T equal to this value. If T is chosen too large, the fastest variation in SNR will not be shown in the accuracy estimate. If T is chosen too small the accuracy estimate is going to be very noisy (unreliable) itself.
- This method is based on both the polynomial fit (see About Polynomial Fitting (page 192)) and the data points surrounding the data point of interest. It is assumed that the polynomial fit does not have substantial bias errors in the time interval. This means that the polynomial order and Tobs match the dynamics of the parameter measured.
- When the accuracy is plotted it is shown relative to the fitted value, which is our best estimate for the average value for that point in time.

- Increasing the FFT length and thereby the observation time, Tobs, improves the accuracy of the measured data points. The fit however has fewer measured data points when we keep the fit time and the FFT overlap constant. This is because the time distance between measurement points increases. Therefore the accuracy of the fitted result does not generally improve with an increased Tobs.

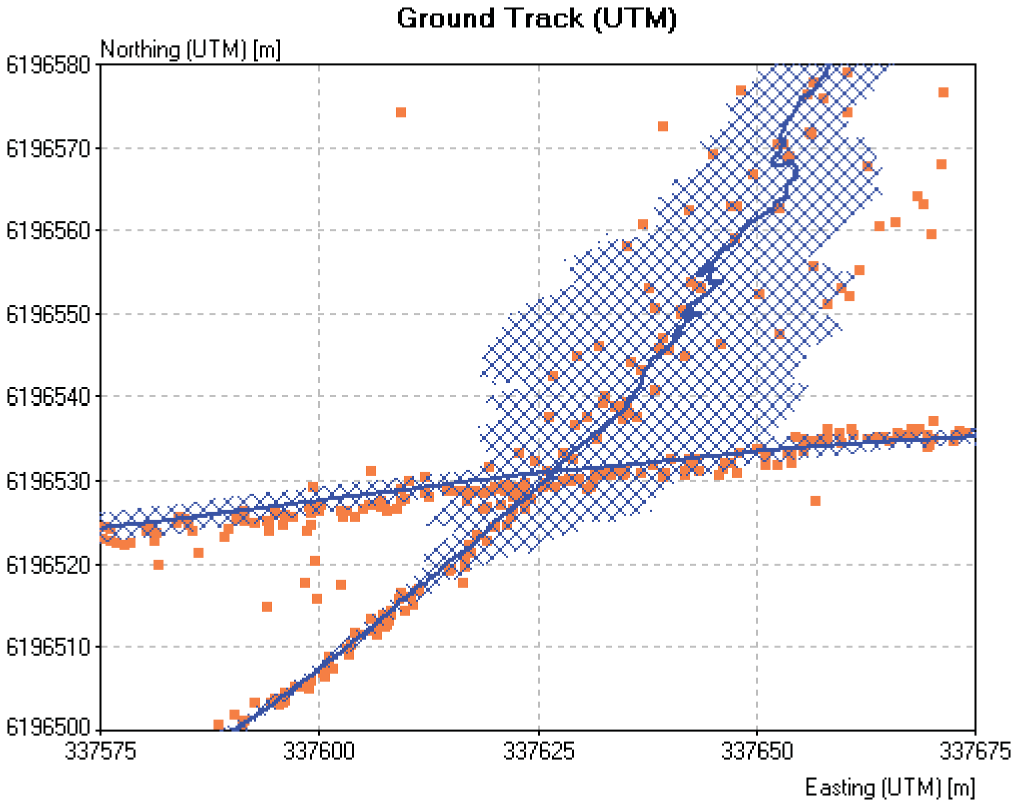
  Increasing the overlap beyond 50% yields more measured data points, but as the noise contribution is strongly correlated the averaging gain is limited.

2.3.7.2 *Accuracy of a Data Point versus another Data Point*

Other plots show a measured parameter versus another measured parameter which are both functions of time, (x(t), y(t)), for example the ground track of the target. Instead of an accuracy interval we get an accuracy area indicating the uncertainty of the measurement.

To estimate the accuracy area of a specific measured data point, (x(tm), y(tm)), we find the accuracy of x(tm) and y(tm) independently, see Accuracy of a Data Point versus Time (page 18). The 1 sigma accuracy area is defined by the ellipse with major axis (sx(tm), sy(tm)).

To illustrate the accuracy of such a plot we show a hatched area which is the unification of the accuracy areas associated with each of the data points in the plot.



Notes

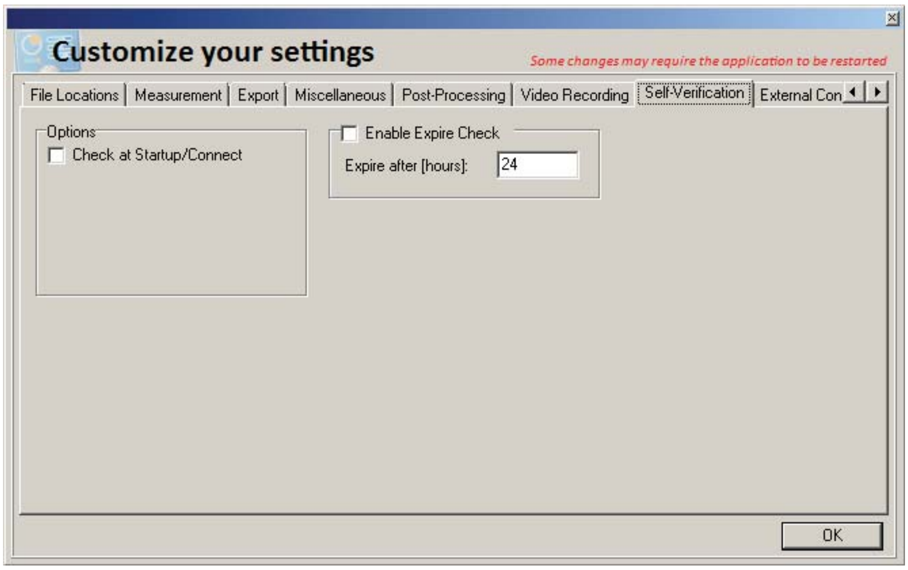
- When the accuracy ellipse is plotted it is shown relative to the corresponding fitted (x,y) value, which is our best estimate for the average value for that point in time.

2.3.8 Customize Self-Verification

To customize the Self-Verification parameters:

1. On the **Tools** menu, click **Customize**.
2. Click the **Self-Verification** tab.
3. Setup the options you want.
4. Click **OK**.

The following options will appear on the **Self-Verification** tab:



Options:

Option	Description
Check at Startup/Connect	Allows the system to check (at startup and connect) if a new self-verification test is needed. See Automated Self-Verification Test (page 89).

Expire options:

Option	Desciption
Enable Expire Check	Enables self-verification tests to expire after a certain time.
Expire after (hours)	Specify after how many hours a self-verification test will expire.

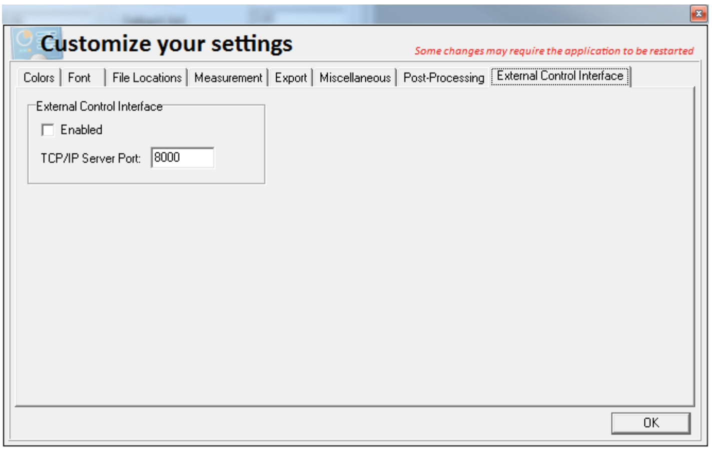
Notes

► For more information regarding Self-Verification tests, please refer to section Perform a Self-Verification Test (page 87) and Automated Self-Verification Test (page 89).

2.3.9 Customize External Control Interface

To customize the External Control Interface:

1. On the **Tools** menu, click **Customize**.
2. Click the **External Control Interface** tab:



3. Change the options/parameters.

Please refer to [1], IS-3129 WinDopp External Control Interface document, for further information.

Notes

► The External Control Interface enables third-party applications to communicate with WinDopp for controlling and setting up system parameters.

◄ End of Chapter ►

3 Mission Planning

3.1 Predict the Trajectory

In order to prepare the radar system before the first measurement you need a rough estimate of the trajectory you are going to measure or at least a few key parameters. The trajectory prediction tool provides the information needed to set up the radar system.

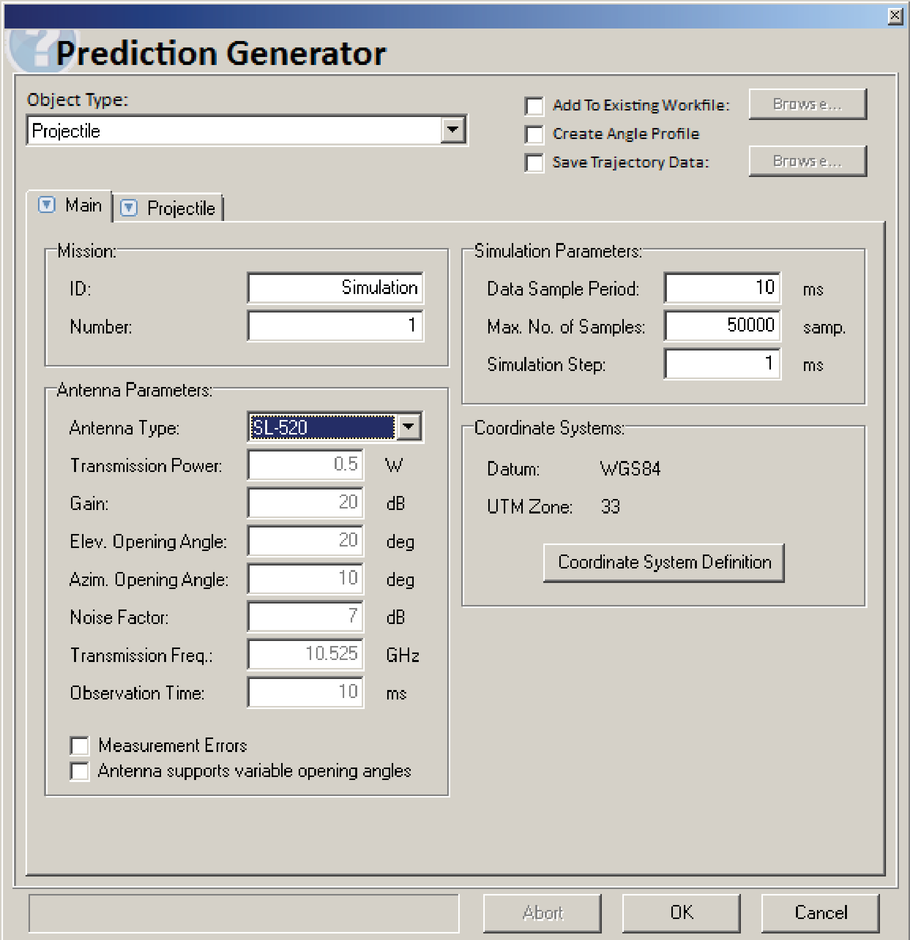
It also gives you an indication of the signal quality you can expect from the measurement taking the antenna system and position, the estimated radar cross section of the object, and the range into account. The graphics also illustrates how the target enters the radar beam.

The prediction results are stored in a WRK file, and can be viewed in the normal graphical outputs; here you can find the required initial delays and intercept angles to ensure safe acquisition.

Based on the simulated data, the optimum location of the radar relative to the launcher and the test objectives can be found.

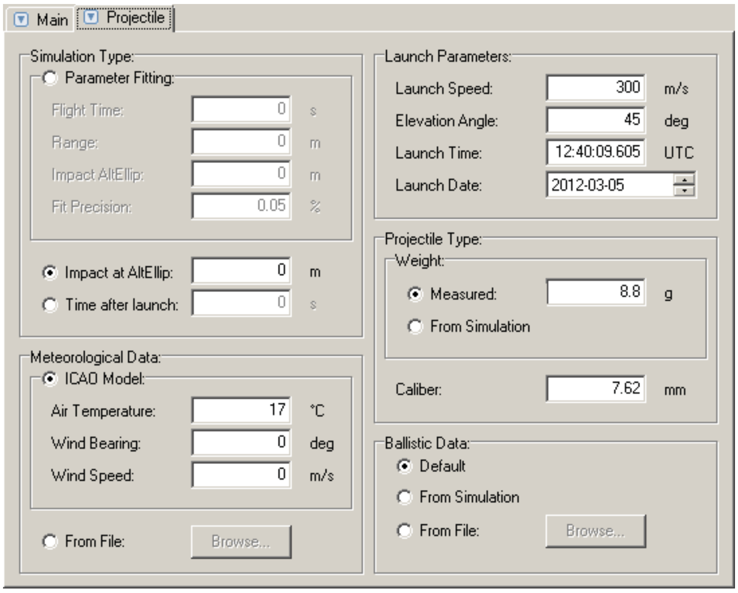
To predict a trajectory:

1. On the **Measurement** menu, click **Prediction**.
2. Enter simulation parameters in the prediction form.
3. Click **OK** to calculate the trajectory and optionally save the results.

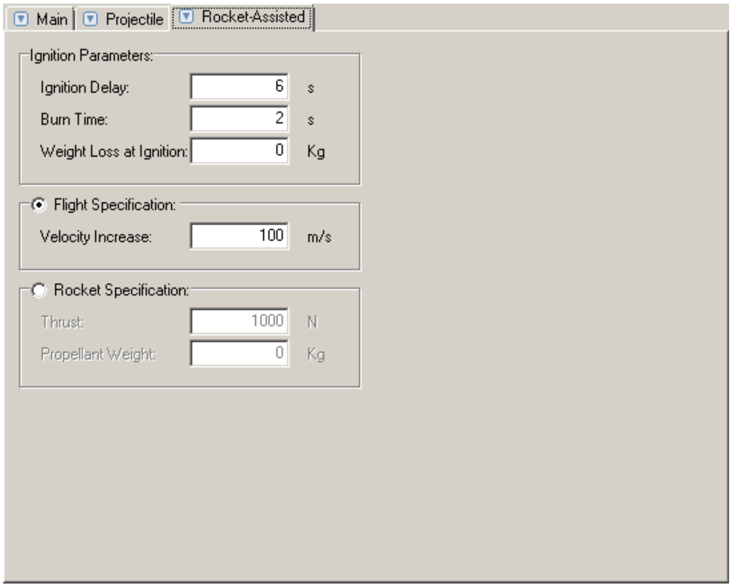


Notes

► The prediction form supports projectiles, rocket assisted projectiles The Projectile tab is always visible.



The **Rocket-Assisted** tab appears when the **Rocket-Assisted Projectile** is selected from the **Object Type** drop down box.



- The predicted radial velocity is useful when configuring the sampling rate of the Analyzer.
- The result is always saved to a work file called prediction.wrk, which is automatically loaded into the Work File Viewer for inspection and further processing.
- The Prediction Generator calculates the maximum radial velocity as seen from the radar. This value is multiplied by 1.20 (20% is added) to get the recommended sampling rate.

  It also calculates the flying time of the projectile and this value is multiplied by 1.10 (10% is added) to get the recommended measurement time.

  The extra sample rate and measurement time ensure that all track data is captured even if the muzzle velocity or trajectory is a little different from the expected.

On the **Main** tab:

Configure the	If you want to
Object Type	Use a specific model for the object.
Add To Existing Workfile	Add the predicted track to an existing workfile.
Create Angle Profile	Create a preprogrammed elevation and azimuth angle profile. This profile can be sent to the antenna pedestal to ensure safe data acquisition.
Save Trajectory Data	Save trajectory data to a TRJ file.
Mission	Specify mission information, which is saved in the WRK file. This information is shown on plots and provides easy identification of the data.
Simulation Parameters	Specify the simulation time step, duration and output sampling rate. See Define Simulation Parameters (page 26) for more information.

Configure the	If you want to
Antenna Parameters	Select a pre-defined antenna type from the drop down list to fill in the antenna parameters. Alternatively enter the parameters in the text boxes manually. It is not possible to save your manually created list of parameters.
Coordinate Systems	Define the position of the radar, the launcher and other fixed points. Define the orientation of various coordinate systems.

On the **Projectile** tab:

Configure the	If you want to
Simulation Type	Specify the fit parameters and the impact condition.
Meteorological Data	Specify the weather conditions according to the ICAO model or Import Meteorological Data (page 26) from a file.
Launch Parameters	Specify launch speed, elevation angle, and time.
Projectile type	Specify the weight and caliber.
Ballistic Data	Select the ballistic modeling data to be used in the simulation. The “Point Mass” model is recommended.

On the **Rocket-Assisted** tab:

Configure the	If you want to
Ignition Parameters	Specify when the rocket is ignited, how long it burns and the total weight loss at ignition.
Flight Specification	Specify how much the velocity is increased during the burn time.
Rocket Specification	Specify how much thrust the rocket delivers and the propellant weight.

3.1.1 Define Simulation Parameters

The **Simulation step** is directly related to the accuracy of the prediction. The optimum step size depends on the details of the system and should always be assessed for any unknown system. The preferred method is to gradually decrease the step size until no further improvement is observed. For many ballistic systems the optimum step size will be in the range from 0.1 to 0.01 ms. It is noted that decreasing the step size may increase the computation time considerably. If the step size is chosen too low it may compromise accuracy because of rounding errors.

3.2 Import Meteorological Data

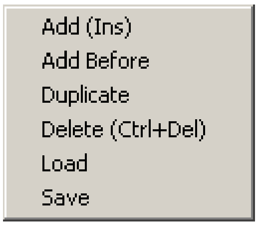
The software can import a meteorological data file and compensate the calculated Drag (Cd) for the actual meteorological conditions. Meteorological Data can also manually be entered.

To import a meteorological data file to be used for Trajectory prediction (see Predict the Trajectory (page 23)):

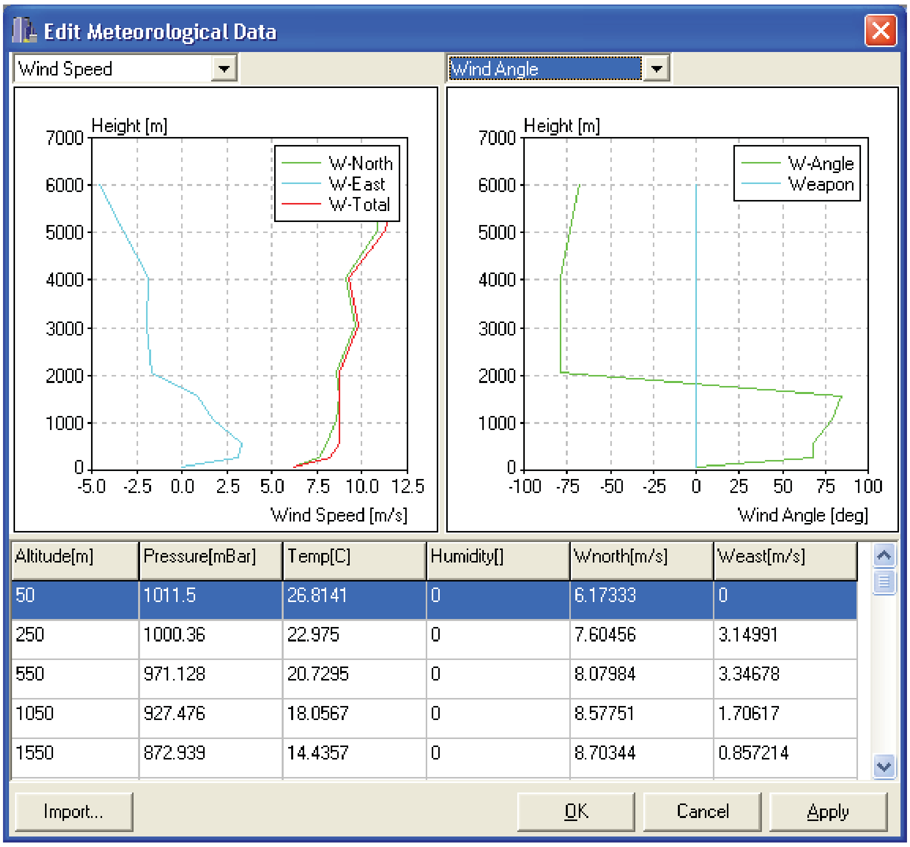
1. In the **Meteorological Data** section of the **Projectile** tab, select the **From File** radio button and click **Browse...**.
2. Use the **Import Meteorological Data** file browser to locate and open the meteorological data file.

To import a meteorological data file to be used when working with work files (see WRK File Processing (page 163)):

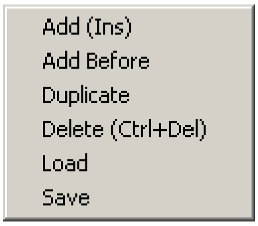
1. From the **Ballistic** menu, select the **Meteorological Info** menu option
2. Manually enter the values, or right click on the table listing to Load a meteorological data file.



These above options open the **Edit Meteorological Data** dialog:



1. Use the graphs to inspect the meteorological data and perform optional adjustments using the table.
2. Edit the values by double-click on values in the table listing – or right click on the table listing to bring up this menu:



3. Do the adjustments and click the **Apply** button to update the graphs with new changes to the data.
4. Click **Cancel** to abort the import or **OK** to import the data to the current work file.

The system can import a variety of Meteorological data formats, and automatically detect the data format from the file. The following formats are supported:

Input File Format	Extension	Description
Weibel ATM	.atm	from Weibel
NATO METCM		NATO STANAG No. 4082
NATO METB		NATO STANAG No. 4061
NATO METTA		NATO STANAG No. 4140
XonTech MET		from XonTech
Vaisala EDT	.edt	from Vaisala
Vaisala SPF	.spf	from Vaisala
Vaisala Text Format		from Vaisala
JDA MET		from the Japanese Defense Agency

ATM, EDT, and SPF files are recognized on their file extension. The other file formats are recognized by their content. If the system cannot determine the file format, the file format needs to be manually selected from a list.

The **Edit Meteorological Data** dialog contains two graphs where meteorological parameters can be displayed. In the combo boxes above the graphs:

Select	To see
Pressure	To the pressure as function of height.
Temperature	To see temperature as function of height.
Humidity	To see humidity as function of height.
Wind Speed	To see the total wind speed together with the wind speed components from the northern and eastern directions as function of height.
Wind Direction	To see the wind direction (where the wind comes from) as a function of height.

Notes

► To load a different meteorological data file, while in the **Edit Meteorological Data** dialog, click **Import...**

► The same six columns are always used in the table in the **Edit Meteorological Data** dialog. If some of these data are not available in the data file, these values will be estimated from the available information and the ICAO meteorological model.

3.3 Use the Command Terminal

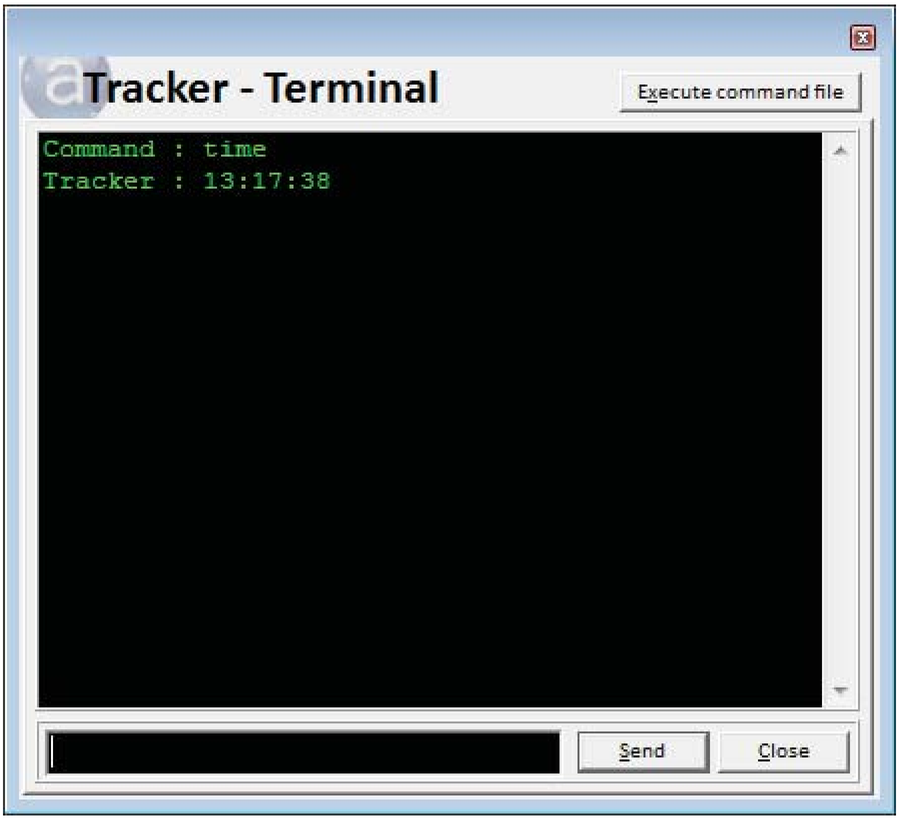
The **Command Terminal** provides a simple text based command/response user interface to the radar whether it is a Range Processor, a Tracking Controller, an Analyzer or an MVR.

The Command Terminal is intended for debugging and low-level configuration, which is outside the scope of this manual.

The command terminal allows you to enter commands.

To start the **Command Terminal**:

1. On the **Tools** menu, click **Terminal**.
2. Enter your command/request on the command line and click **Send**.
3. View the command and the response in the window above.
4. Click **Close** to exit the **Command Terminal**.



In this example, the command "Time" was sent.

The answer was: "13:17:38" reflecting the actual time in the radar.

Notes

► The terminal has a command stack for the most recently used commands; use the cursor keys [↑] and [↓] to scroll through the stack.

◄ End of Chapter ►

4 System Alignment & Calibration

4.1 Work with Coordinate Systems

WinDopp helps you manage the coordinate systems used throughout the measurement and in the post processing of the data. While the raw measurement captured by the radar is referred to the physical radar or pedestal, this is rarely a useful reference. WinDopp converts the results from raw radar measurements to practically any coordinate system needed.

Although the coordinate system setup should be done accurately in advance of the measurements, WinDopp allows you to change the coordinate system definitions after the mission is completed, if e.g. the accuracy of the survey is improved at a later stage.

Coordinate systems and positions of reference points are used in various contexts:

- ► Mission planning. Enter survey data. Calculate look angles and distance to the target. Predict radial velocity, SNR and determine good range waveforms and target acquisition method.
- ► Calibration. Point the radar at a test target with a known position and verify the orientation and calibration values of the radar.
- ► Save measurement data. Save the Radar, Local and Launcher positions and coordinate azimuth turn with the measurement data for post processing purposes.
- ► Edit measurement data. Change the position of the radar in the measurement data, e.g. if the originally used position turns out to be wrong. See View and Edit Positions in a WRK File (page 38).

To configure the coordinate systems follow this step-by-step procedure:

1. Define survey points as user defined absolute positions. See Define an Absolute Position (page 37).
2. Define the Radar, Local and Launcher positions relative to (or equal to) one of the survey points. See Define a Relative Position (page 38).

The Radar position can be defined as an absolute position as well. Often the radar position is actually established by measuring the position of a survey point followed by an offset measurement of the radar reference point relative to the survey point. In this case let Position Definitions Dialog add the two pieces of information.

To view a sample configuration, see Coordinate System Example (page 45). For additional information on the coordinate systems, see Coordinate System Conventions (page 39).

Notes:

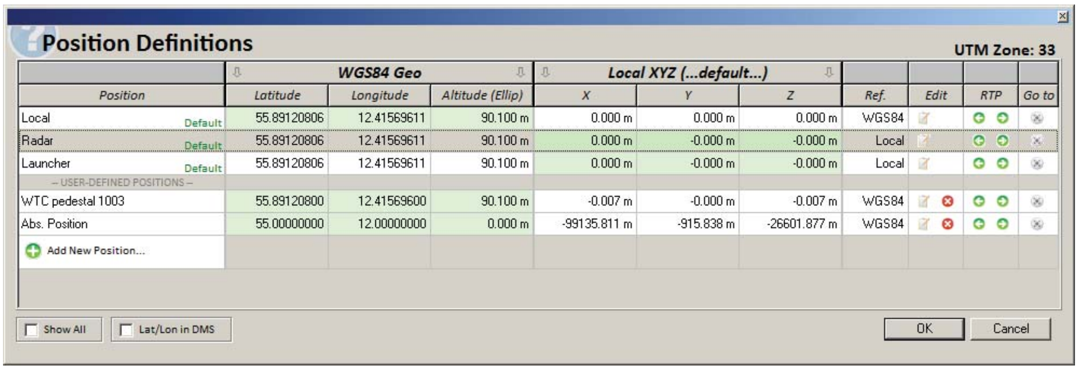
- Due to the curvature of the Earth, the y-axis (pointing up) for the Local, Radar and Launcher coordinate systems are not 100% parallel.
- To save the coordinate definitions in the WRK file after each measurement click the **Set as Default** button.

4.1.1 Use the Position Definitions Dialog

The **Position Definitions** dialog shows a list of positions in a format chosen by the user. The list of positions is the starting point for any update, change or inspection of the positions and the coordinate systems.

To open the dialog from WinTrack:

1. On the **Measurement** menu, click **Position Definitions**.



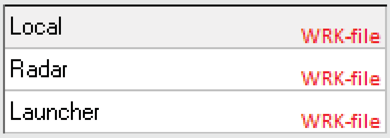
The main part of the dialog is shown as a table where each line describes key information about a position.

The columns are:

<table>
<tr><th>Column</th><th>Contents</th></tr>
<tr><td>Position</td><td>The name of the Position.

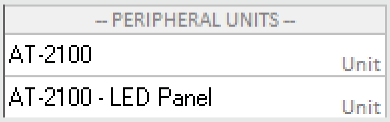
First segment: The three positions, marked as Default, have fixed names and cannot be deleted: Radar, Launcher and Local. These three positions are converted to WGS84 and saved with future measurement data.

If the position dialog is opened from the Work file view then three additional positions, marked as WRK-file, will appear: Radar, Launcher and Local. These shows the positions saved in the Work file as part of the measurement.



If the position dialog is opened from the Prediction dialog then three additional positions, marked as Prediction, will appear: Radar, Launcher and Local. These shows the positions used for the prediction.

Second segment: the Peripheral Units shows the positions for the peripheral units, defined by the user (if any).



Third segment: the Fixed Positions shows a list of fixed positions saved in the radar (if any). These positions can be used in the position dialog AND by keypads and other external devices.

Fourth segment: the User Defined Positions shows the positions defined by the user (if any). These positions can ONLY be used in the position dialog.</td></tr>
<tr><td>WGS84 Geo
Radar Polar
etc.</td><td>These columns show groups of coordinate values as chosen by the user. In the above example two different coordinate sets are shown for each position. To configure this part of the dialog see: Define the Coordinate View (page 34).</td></tr>
<tr><td>Ref.</td><td>For an absolute position the reference system (datum). For a Relative Position the name of the referred position is shown.</td></tr>
<tr><td>Edit</td><td>Double click:
to edit the position, see Use the Position Edit Dialog (page 35)
to delete the position from the list.</td></tr>
</table>

Column	Contents
RTP	Only for tracking systems.
Goto	Only for tracking systems.

To configure other parameters:

Click	To
UTM Zone: 31	Change the UTM zone used to view and define UTM coordinates. See UTM Zones (page 44).
☐ Show All	Show all positions in the list (disregard the individual **Show** flag)
☐ Lat/Lon in DMS	Show geographic coordinates in the Degree, Minute, Second format.

Notes:

► An UTM zone is designed to cover a strip of 6 degrees in Longitude. If the position is more than one UTM zone away from the selected zone then the UTM coordinates of that position is not shown.

► Updates to the position definitions are stored in the default.pos file when the dialog is closed with **Ok**. Click **Cancel** to discard the changes.

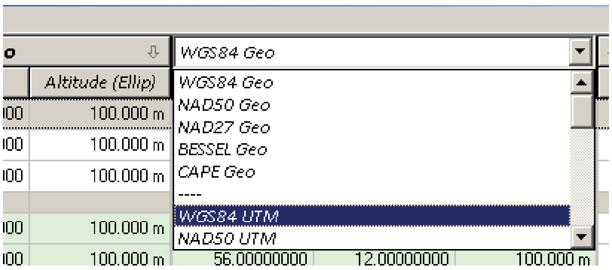
4.1.1.1 *Define the Coordinate View*

The coordinate view is located in the Position Definitions dialog.

To add more coordinates to the view:

1. Right click the header row to get the Insert/Remove dialog

2. Select **Insert** to add a new set of coordinate columns:



3. Select one of the items from the drop down list to define the coordinates to view.

For more information about the coordinate options see Define an Absolute Position (page 37) and Define a Relative Position (page 38).

4.1.1.2 *Activate the Position Definitions Dialog*

To configure the coordinate systems, while connected to a fixed head radar:

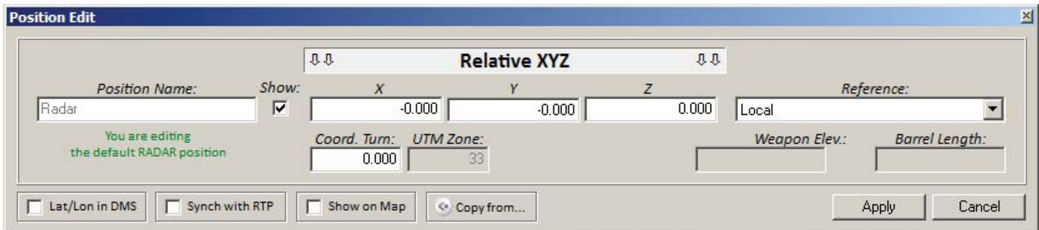
1. On the **Measurement** menu, click **Setup**.
2. Click the **Coordinates** button, located at the bottom of the window.
3. Select the appropriate tab and enter the origo and pointing values.
4. Hit **Ok** to use the new settings.

To configure the coordinate systems, while **post-processing a work file**:

1. On the **Edit** menu, click **Edit Coordinate System**.
2. Select the appropriate tab and enter the origo and pointing values.
3. Hit **Ok** to use the new settings.

4.1.2 Use the Position Edit Dialog

The **Position Edit** dialog handles all types of position definitions. For existing positions it shows the values entered by the user when the position was last edited.



To open the dialog:

► In the **Position Definitions** dialog, click an existing entry to edit it.

► In the **Position Definitions** dialog, click **Add New Position** to create a new position entry in the list.

Enter the information in the appropriate fields and click **Apply** to finish editing the position.

Field	**Comment**
Position Name	Enter a name for the position. Use the name of the location or the survey point ID.
Show	Decide whether the position is shown in the **Position Definitions** list.
Reference	See Define the Reference (page 36).
⇩⇩ Relative XYZ ⇩⇩	Drop down list of available coordinate formats. See Define an Absolute Position (page 37) or Define a Relative Position (page 38).
X, Y, Z	This text depends on the selected coordinate format.
UTM Zone	Select the UTM zone. Only applicable when the UTM coordinate format is selected. See UTM Zones (page 44).

Field	Comment
Lat/Lon in DMS	Use the Degree-Minute-Second format for the latitude longitude angles.
Copy from	Copy the contents of another position to this position.
Coord. Turn	A positive angle indicates that the x-axis or azimuth zero axis is pointing to the right relative to north. Note that the y-axis (up) is not affected by this parameter.
Weapon Elev. Barrel Length	Weapon characteristics. Saved with measurement data for post processing purposes. Applies ONLY to the **Launcher** position.
Synchronize with RTP	Not supported by WinDopp.
Show on Map	Decide whether the position is shown on online Map graphs (RTCD)

4.1.2.1 *Define the Reference*

Select the **Reference** to define in which coordinate frame the position is defined. There are two different types of references:

Reference	Description
Absolute Position	The coordinates are defined with reference to one of the standard ellipsoid models also called Datum, e.g. WGS84.
Relative Position	The coordinates are defined relative to another position. This is identified by the name of the Position. The coordinate system is centered in the referred position and per default the xyz-axes are aligned with North Up East in this point. The position have a parameter, **Coord Turn**, to offset the azimuth angle.

At least one position must be in the **Absolute Position** format. Subsequent positions can be either absolute or relative to another position. It is ok to define a chain of **Relative Positions**, each referring to another, as long as the first element of the chain, the root position, is an **Absolute Position**. Of course a circular reference is not accepted.

Note that if a position is defined relative to a reference position then a change to the reference position affects the referring position as well. Their relative position however remains unchanged.

With a **Coord Turn** of 0 the orientation of the coordinate frame is (x,y,z) = (North, Up, East) as defined by the ellipsoid model in use by the root position. Changing the value of coord turn affects the referring positions.

- ► It is recommended that a survey point is entered as a user defined absolute position.
- ► A position referring to a reference position with a coordinate turn different from zero does not inherit this coordinate turn. The coordinate turn always refers to north.
- ► When the radar or a test target, e.g. MC-100, is set-up above a survey point it is recommended that this position is defined relative to the user defined absolute position of the survey point. E.g. with an offset of (x,y,z) = (0, 1.45, 0) if the MC-100 or the radar is 1.45 m above the survey point.

4.1.2.2 *Define an Absolute Position*

The Coordinate Type defines the format of the coordinate values. The options available depend on selection made in the preceding Define the Reference (page 36) step.

To define an absolute position:

1. From the Positions Definitions dialog double click an entry to open the **Position Edit** dialog.
2. In the **Reference** field select the **Absolute Position** option, see Define the Reference (page 36).
3. Select the appropriate coordinate type from the drop-down box:

   The options are described below.
4. Enter the coordinate values.
5. Click **Apply** to complete the position definition.

The absolute coordinate type is defined by two parameters: the Datum, e.g. **WGS84** and the coordinate format, e.g. **Geo** = geographic.

The following Datum's are supported:

Datum	Description
WGS84	World Geodetic System of 1984. It is the reference frame used by the U.S. Department of Defense (DoD). WGS84 is the default standard datum for coordinates stored in GPS units.
ED50	European Datum. Used in much of Western Europe apart from Great Britain, Ireland, Sweden and Switzerland, which have their own Datums.
NAD27	The North American Datum of 1927 (NAD27) is a datum based on the Clarke Ellipsoid of 1866.
Bessel	The Bessel ellipsoid is the geodetic system e.g. for Germany, for Austria or for Czech Republic. Partly also in the successive states of Yugoslavia and some Asian countries (e.g. Sumatra & Borneo, Belitung) or Okinawa (Japan); in Africa e.g. Eritrea and Namibia.
Cape	Also called the modified Clarke 1880 ellipsoid. Used in R.S.A., Botswana, Zimbabwe.

The following coordinate formats/projections are supported: :

Format/Projection	Description
Geo	The Geographic Coordinates (page 42) consists of three values: Latitude, Longitude and Altitude. They Latitude, Longitude angles define a point on the specified ellipsoid model (datum). The unit is degrees.

Format/Projection	Description
UTM	The Universal Traverse Mercator projection maps the Latitude and Longitude values to two zone dependent UTM Coordinates (page 43): Northing and Easting. The unit is meter. Note that the UTM projection still relies on a user selected ellipsoid (datum).

The altitude is the height above/below the surface of the ellipsoid. The unit is meter.

4.1.2.3 *Define a Relative Position*

To define a relative position:

1. From the Positions Definitions dialog double click an entry to open the **Position Edit** dialog.
2. In the **Reference** field select one of the position names, see Define the Reference (page 36).
3. Select the appropriate coordinate type from the drop-down box:

The options are described below.

4. Enter the coordinate values.
5. Click **Apply** to complete the position definition.

The relative coordinate types are:

Relative Position Types	Description
Relative XYZ	The (x,y,z) Cartesian Coordinates (page 40).
Relative Polar	The (Range, Azimuth, Elevation) Polar Coordinates (page 41).

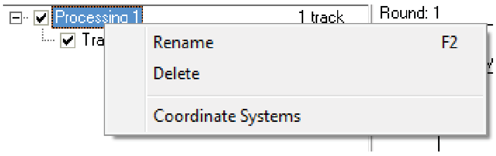
4.1.3 View and Edit Positions in a WRK File

After a measurement the currently defined Radar, Local and Launcher positions are saved in the WRK file. They are saved in the following format:

Position	Coordinate format
Local	Absolute Position, WGS84
Radar	Relative to Local, XYZ
Launcher	Relative to Local, XYZ

To edit a position stored in a WRK file:

1. Open the WRK file.
2. Right click on the track collection group to get this menu:



3. Select **Coordinate Systems** to get:

		WGS84 Geo			Local XYZ (...WRK-file...)			
Position		Latitude	Longitude	Altitude (Ellip)	X	Y	Z	Ref.
Local	WRK-file	43.03127917	6.47077083	174.010 m	0.000 m	0.000 m	0.000 m	WGS84
Radar	WRK-file	43.03226636	6.47089147	176.011 m	110.000 m	2.000 m	5.000 m	Local
Launcher	WRK-file	43.04162566	6.47123195	177.114 m	1150.000 m	3.000 m	-13.000 m	Local

4. Double click any of the three positions to edit the coordinates.

Note that it is not possible to change the Ref. or coordinate format of positions stored in the WRK file.

Although the Radar and Launcher positions are stored in the WRK file relative to the Local position they may be modified using e.g. absolute coordinates. To change the Radar position using a new set of WGS84 coordinates:

1. Define a new position entry in the **Position Definitions** dialog.
2. Enter the new position of the radar in **WGS84**.
3. Open the **Radar WRK-file** entry for editing
4. Click the **Copy from** button and select the entry from step 2
5. Click **OK** to close the dialog
6. Click Save file to save the new radar position in the WRK file

Before saving the updated radar position WinTrack calculates the position relative to the Local position and stores that data set in the WRK file.

Note that the coordinate system for the original online track is not available for editing. To edit the online data coordinate system you need to create a New collection and copy the online track to this collection, see Use the Track List (page 166).

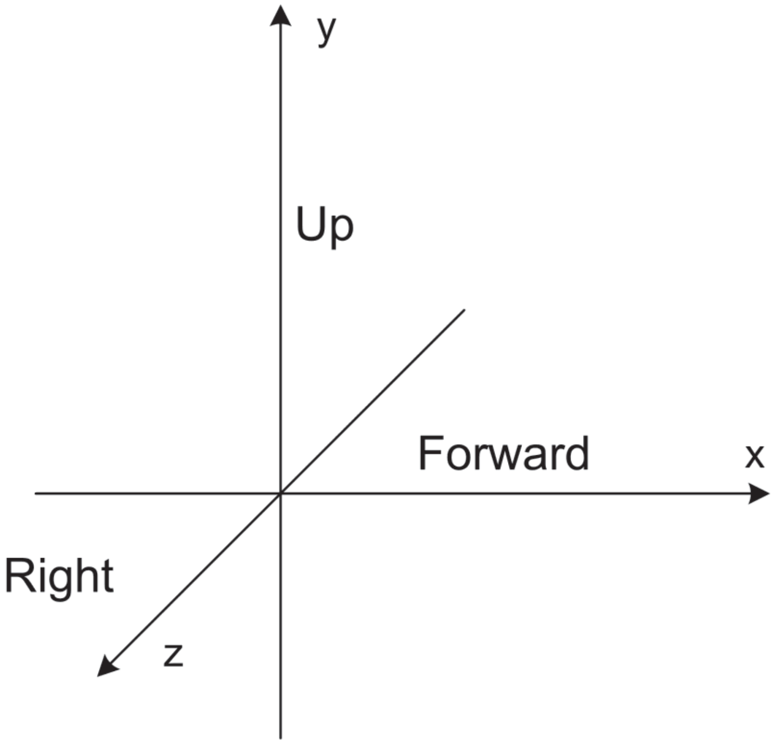
4.2 Coordinate System Conventions

WinTrack/WinDopp handles the most commonly used coordinate systems and converts positions and results from one system to another.

System	Description
Cartesian Coordinates (page 40)	The orthogonal right-hand xyz-coordinate system.
Polar Coordinates (page 41)	The 3-dimensional (spherical) coordinate system using azimuth, elevation and range.
Geographic Coordinates (page 42)	The Longitude, Latitude, Altitude representation of a position relative to the Earth.
UTM Coordinates (page 43)	The Northing, Easting, Altitude representation of a position relative to the Earth.

4.2.1 Cartesian Coordinates

Cartesian 3-dimensional space, also called xyz-space, has three axes that are mutually perpendicular and cross each other in one point called the origin or Origo. In WinTrack/WinDopp positions or coordinates are determined according to the forward/backward (*x*), up/down (*y*), and right/left (*z*) displacements from the origin. The position of the Origo is (0,0,0).



WinTrack/WinDopp internally uses the meter as the unit measure of distance, but most others units are available as well.

Axis	Orientation
x	Forward/Backward. The x-axis is level and pointing forward. It's pointing is often defined relative to North.
y	Up/Down. The y-axis is pointing up, which is exactly opposite the gravitational force (including the effect from the Earth rotation).
z	Right/Left. Consider your self positioned in the origo of the coordinate system, (0,0,0) and your face pointing forward in the direction of the positive x-axis, then the z-axis is level and points to the right.

Notes:

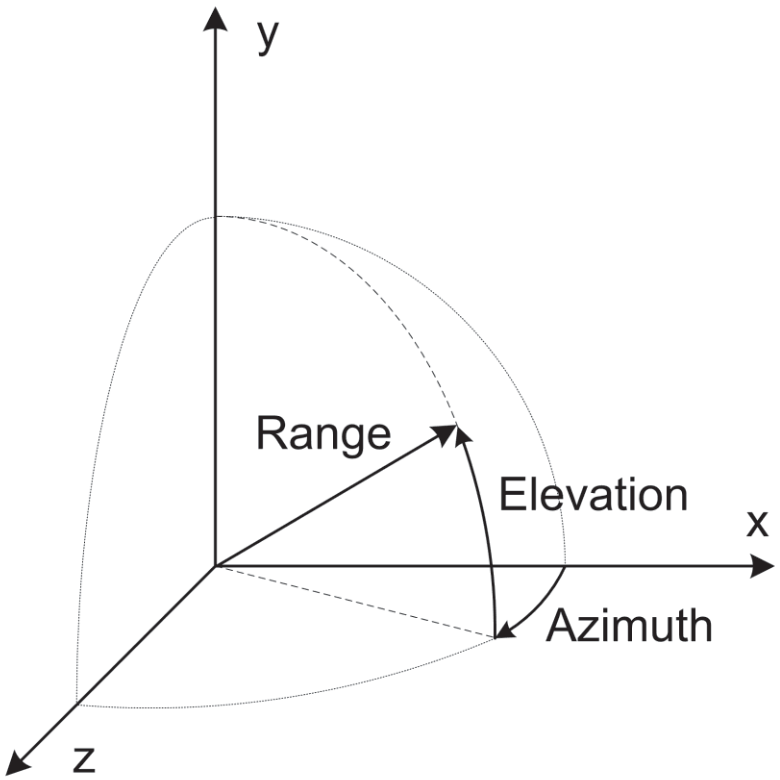
- All Cartesian coordinate systems in WinTrack/WinDopp are right hand and with the y-axis pointing up.
- When the Origo of the coordinate system is the launcher and the x-axis is pointing towards the target, then a position behind the launcher

has a negative x-coordinate. The distance behind the launcher is sometimes called **setback** and this means that **x = -setback**.

- The term **offset** is often used to describe the distance to the right of the launcher. This value is identical to the z-coordinate, **z = offset**. Similarly the height above the launcher is identical to the y-coordinate: **y = height**.
- Polar Coordinates (page 41) are an alternative representation of a position in 3-dimensional space.

4.2.2 Polar Coordinates

The 3-dimensional (spherical) Polar Coordinates are an alternative to the Cartesian Coordinates (page 40). In WinTrack/WinDopp the relation between the Polar Coordinates and the Cartesian Coordinates is depicted in the figure below:



The center of the system is called the Origo. The azimuth is defined relative to the x-axis and the elevation angle is defined relative to the level plane defined by the x-axis and the z-axis.

Parameter	Description
Azimuth	Angle to the right/left of the x-axis.
Elevation	Angle above/below the level plane, defined by the x- and z-axis.
Range	Distance from the Origo (center).

Notes:

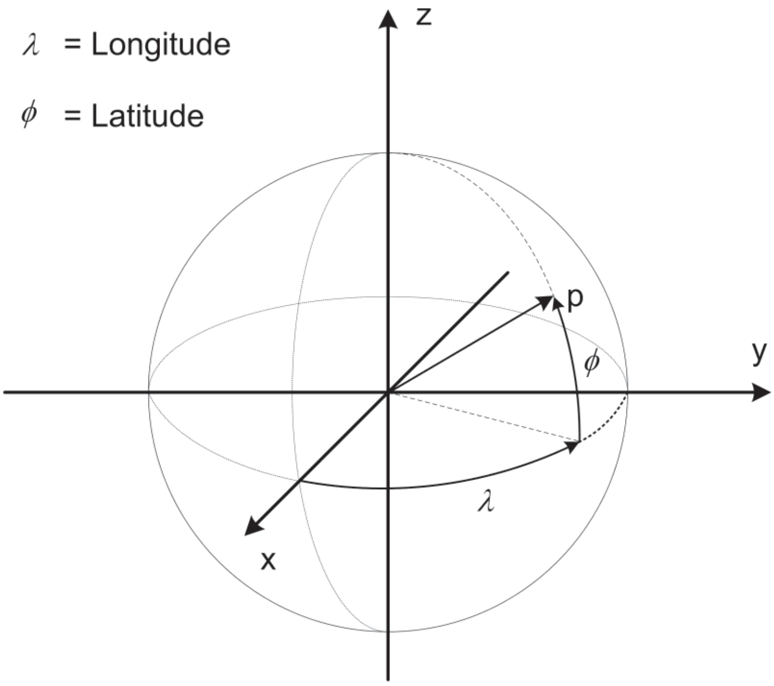
- The polar coordinates are useful during calibration, when the line of sight to known fix points is used or during star calibration.

- While the (x,y,z) coordinates of the Cartesian Coordinates (page 40) are unique for a specific position, many sets of (azimuth, elevation, range) values correspond to the same position.
- The raw encoder and error angle data captured during a measurement is saved in Polar Coordinates.

4.2.3 Geographic Coordinates

The Geographic Coordinates describe the position relative to the rotating Earth. The Latitude describes the North-South position relative to the Equator and the Longitude describes the East-West position relative to the Meridian (typically going through Greenwich, UK).

To simplify the description we assume that the Earth is a perfect rotating ball with a constant radius (note that all transformations in WinTrack/WinDopp use the full ellipsoid model). In the simplified case the Geographic Coordinates correspond to a 3-dimensional Polar coordinate system:



In this figure the z-axis is identical to the Earth rotational axis and the Origo coincides with the Earth center. The x-axis passes through Equator and defines the zero Longitude line. The Altitude is defined as the height above/below the surface of the ball (not shown on the figure).

Because the Earth is slightly flattened by its rotation, an ellipsoid is a better geometric reference surface than a ball. The gravity field is formed as a result of gravitation and rotation and is not pointing towards the Earth center. One of the advantages of the ellipsoid model is that the gravity field is (almost) perpendicular to the surface of the ellipsoid and the height/Altitude is therefore still the distance from the reference surface.

There are many different ellipsoid reference surfaces (also called geodetic reference datum's) in use throughout the world providing references for the charting of particular areas. WinTrack/WinDopp supports the most common including: WGS84, ED50, BESSEL & NAD27.

Notes:

► The latitude and longitude is entered/displayed either in Degrees, Minutes, Seconds (DMS) or in decimal degrees. To enter in the DMS/HMS format just insert a blank (space) between the three numbers:

E.g. enter 8 5 25.490 to get +008°05'25.490".

4.2.4 UTM Coordinates

Military maps and a growing number of civilian maps use the UTM projection to provide coordinates for positions relative to the rotating Earth. The advantage of the UTM, Universal Transversal Mercator, projection is that distances and absolute UTM coordinates are easily read from an UTM map.

While UTM positions are entered directly in WinTrack/WinDopp, using angles relative to the UTM grid is a little trickier, please refer to Use UTM Grid Angles (page 45).

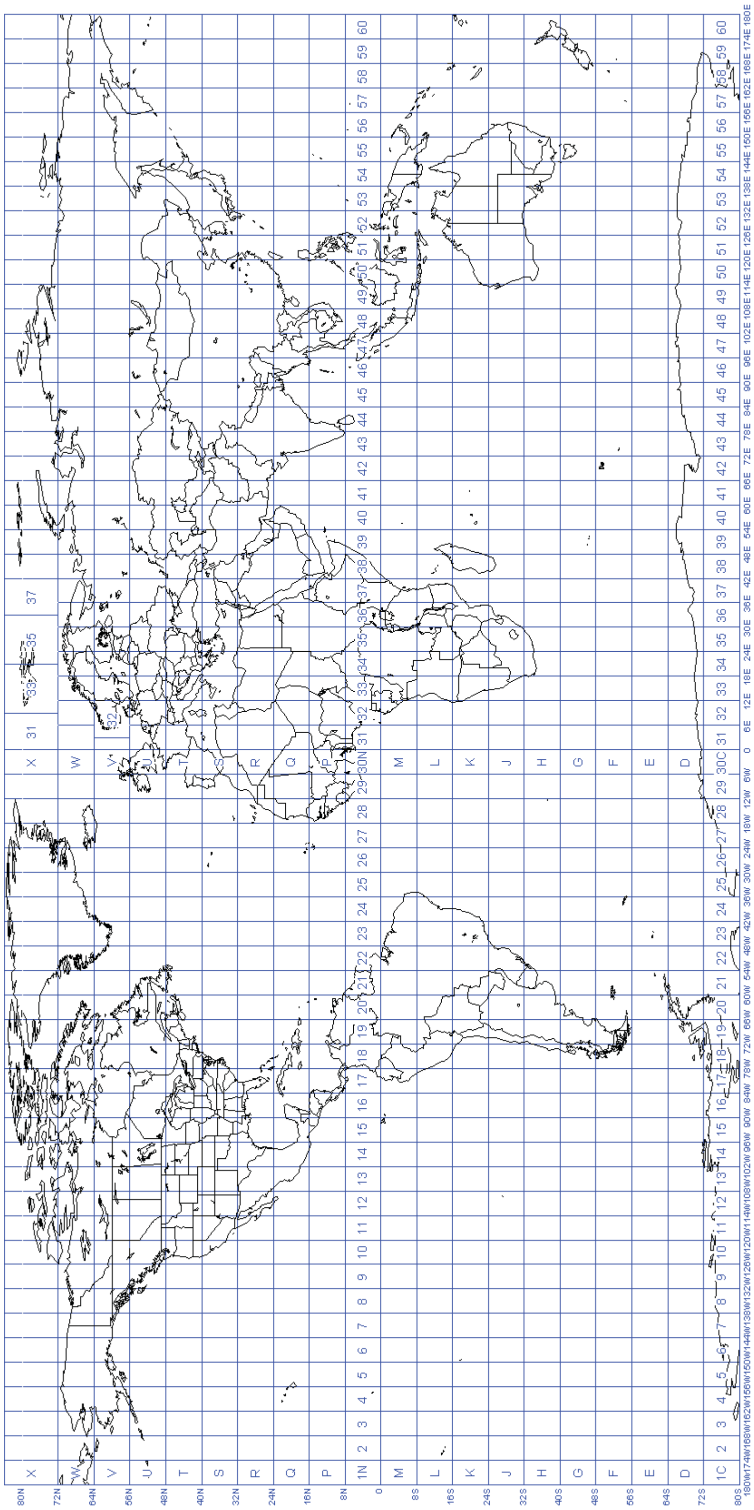
In the UTM system, the world is divided into 60 north-south zones, each covering a strip 6° wide in longitude; see a map of the UTM Zones (page 44). These zones are numbered consecutively beginning with Zone 1, between 180° and 174° west longitude, and progressing eastward to Zone 60, between 174° and 180° east longitude. In each zone, coordinates are measured north and east in meters. (One meter equals 39.37 inches, or slightly more than 1 yard.) The northing values are measured continuously from zero at the Equator, in a northerly direction. To avoid negative numbers for locations south of the Equator, NIMA's cartographers assigned the Equator an arbitrary false northing value of 10,000,000 meters. A central meridian through the middle of each 6° zone is assigned an easting value of 500,000 meters. Grid values to the west of this central meridian are less than 500,000; to the east, more than 500,000.

Notes:

► Do not mix coordinates from one zone with that in another. If you need to cross zone boundaries, use Geographic Coordinates (page 42).

► The vertical UTM grid lines are parallel in terms of distance from the central meridian, but they are **not** pointing towards the geographical North (except for the central meridian).

4.2.4.1 UTM Zones



4.2.5 Use UTM Grid Angles

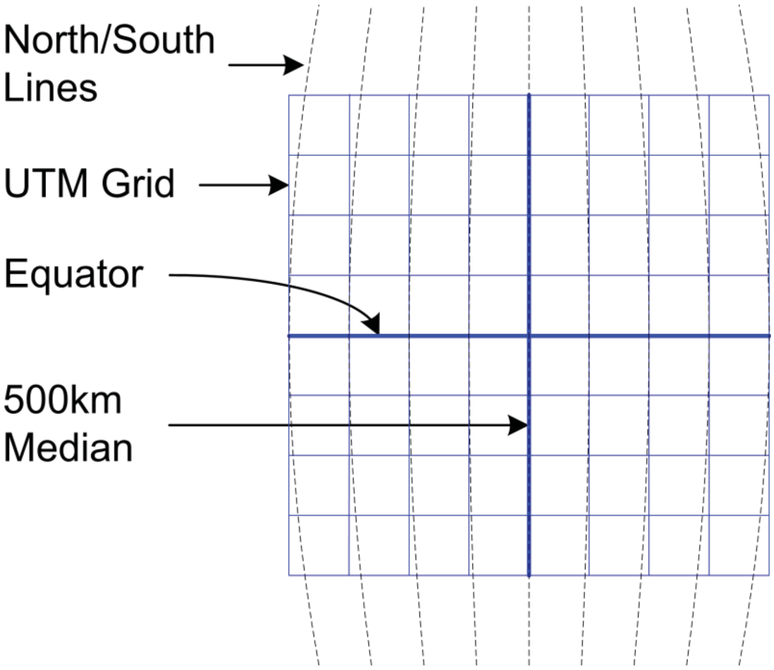
Sometimes the angle of sight from the radar to a suitable reference point is only available as an angle relative to the UTM grid.

An angle relative to the vertical UTM grid must be converted to an angle relative to Geographic North before it can be used by WinTrack/WinDopp because WinTrack/WinDopp defines the orientation of a coordinate system relative to Geographic North.

To convert from UTM grid angle to Geographical North aligned azimuth:

1. Enter the radar position in UTM or Geographical Coordinates, see Define an Absolute Position (page 37).
2. Enter a dummy position with identical UTM Easting and an UTM Northing which is 100m higher. Same method as above.
3. In the **Radar Polar** coordinate view note the value in the **Azim** field. This is the pointing of the UTM grid relative to Geographical North.
4. Add the correction value above to the UTM grid angle to get the correct value.

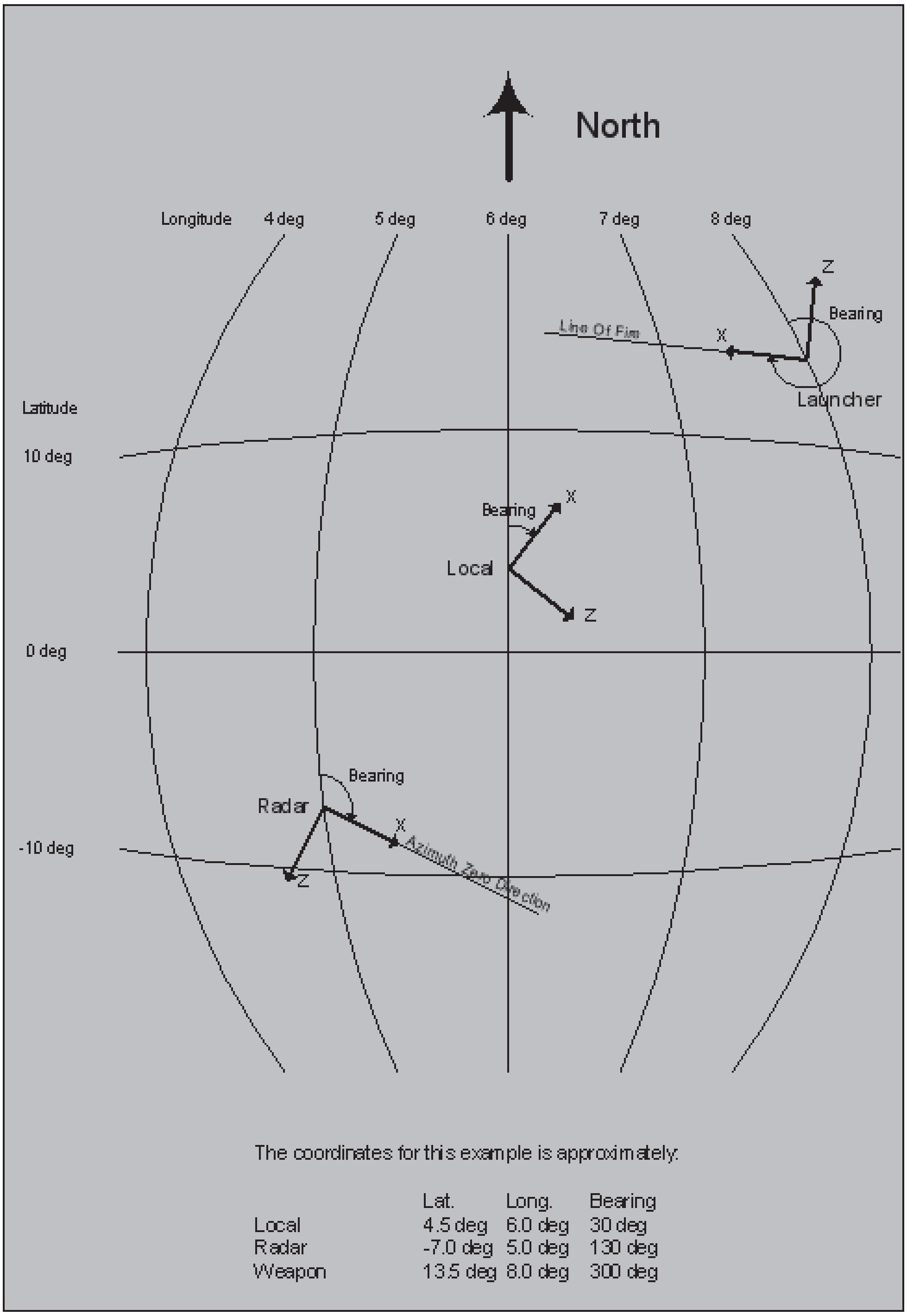
The reason for this work around is that the vertical UTM grid lines (with constant Easting) do not point straight towards Geographic North except for the median line of the UTM grid (the 500km line).



Note that lines west of the median point to the left of North on the Northern hemisphere and to the right of North on the Southern hemisphere.

4.2.6 Coordinate System Example

The figure below shows how the Local, Radar and Launcher coordinate systems are defined with different positions and orientations.



Notes:

- ► The y-axis is always pointing up, opposite the locally defined gravitational force.
- ► Due to the curvature of the Earth the y-axis (pointing up) for the Local, Radar and Launcher coordinate systems are not 100% parallel.
- ► The x-axis orientation is defined relative to the locally defined direction to geographic North.
- ► The three coordinate systems need not be different; e.g. the Local and the Radar coordinate systems may very well be the same.

- ► When positions are recorded in a measurement the Local coordinate system is defined in WGS84 and the Radar and Launcher positions are defined relative to the Local coordinate system

4.3 IRIG Synchronization

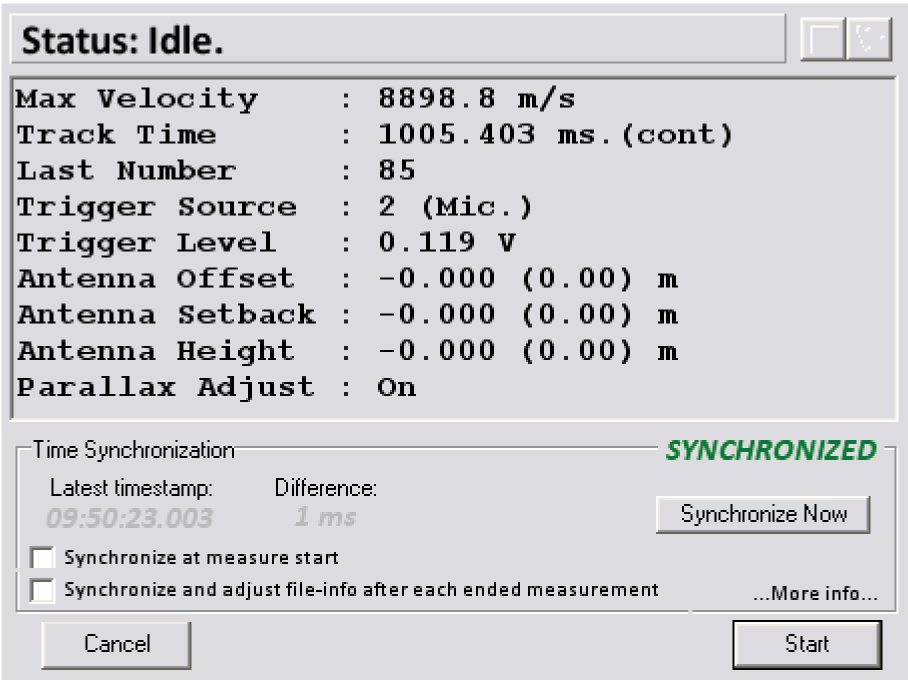
WinDopp allows you to synchronize your measurement time with an external IRIG time signal, in case the antenna doesn't have a built-in IRIG/GPS.

This can be done in various ways:

- ► Manually prior to each measurement
- ► Automatically prior to each measurement
- ► Automatically after each ended measurement

To use this feature you need to enable the option in **Customize**. See Set-up IRIG synchronization (page 9).

Enabling this feature will expand the Measurement dialog with additional information and options.



The additional information is:

Information	Description
Status	Current status – "Synchronized" or "Not Synchronized". Status "Not Synchronized" means that current time difference exceeds 10ms.
Latest timestamp	Latest received IRIG timestamp.
Difference	Current time difference between the IRIG time and the internal time on the device.

The options are:

Option	Description
Synchronize Now	Press this button to manually synchronize the time.
Synchronize at measurement start	Use this option to do automatically time synchronization prior to each measurement.
Synchronize and adjust file-info after each ended measurement	Use this option to do automatically time synchronization after each ended measurement. This option can be a very useful when started measurements don't get trigged before several minutes. Due to internal clock drift in the device, the time may get out-of-synch when the measurement gets trigged – even thou the time was synchronized (manually or automatically) prior to the measurement. All recorded timestamps in the measurement will automatically be adjusted with the time difference – unless the time difference exceeds 500 ms, then the user will be prompted before any changes are made.

Notes:

- ► Supported in W-700i/SL-5xxxP version DOPP 1.51/WOS 2.35 or later.
- ► Only support for ORCA GS-101

◄ End of Chapter ►

5 Measurement and Processing Setup

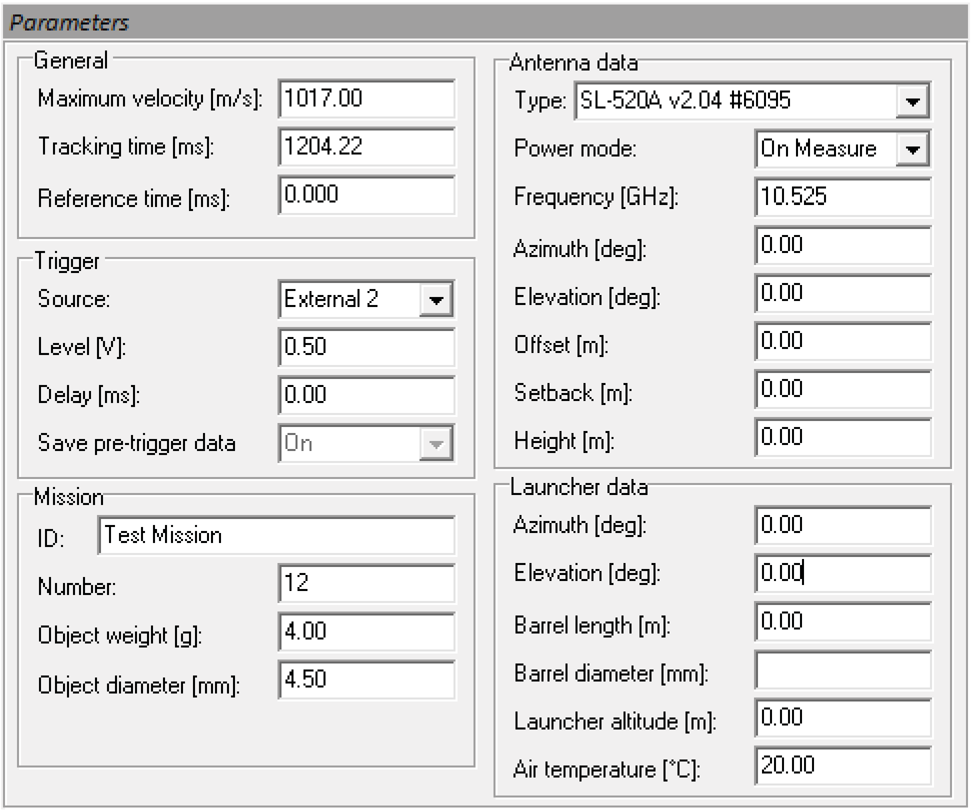
5.1 Radar and Processing Parameters Overview

A large set of parameters controls the behavior of the radar during a measurement. These parameters are configured before the measurement.

The parameters are organized in a number of categories further described below. To set up the measurement parameters:

1. On the **Measurement** menu, click **Setup**.
2. Configure the parameters.
3. Click **Close** to exit the setup dialog box.

The parameters can either be set manually or loaded from a file.



Group	If you want to
Measure Mode	Change the type of measurement or Enable/disable the Auto rearm option, see Configure the Measure Mode (page 51).
Auto Display	Automatically display a DTI draw and/or a Velocity fit after a single file processing is complete, see Enable/Disable Auto Display (page 52).
Output Files	Configure the work directory, the session file, how to name the files and which files to save with every data set. See Configure Output File Names (page 53).
Parameters	Configure the radar parameters, see Configure the Radar Parameters (page 54).
MVR Parameters	Configure the muzzle velocity radar parameters. See Select FFT Processing Parameters (page 59).
Processing	Configure the FFT length and overlap, see Select FFT Processing Parameters (page 59). Configure the V0 (muzzle velocity) processing parameters, see Select V0 Analysis Parameters (page 61).

Click	If you want to
Advanced	Configure an advanced set of parameters. See notes below.
Clear Batt.	Reset parameters in the unit to factory default, it is always recommended to use this function prior to any measurement if you are uncertain of the parameter settings in the unit. See notes below.
Prediction	Use the prediction tool to estimate the trajectory of the target
Coordinates	Configure the coordinate systems.
Save / Load	Either save the current configuration or to restore a previous saved configuration.

Notes

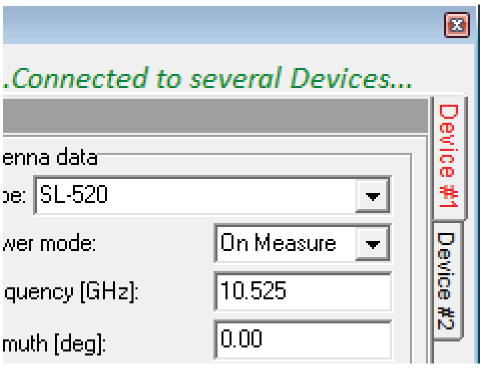
► For multiple connected devices the **Advanced** and **Clear Batt** buttons only affect the currently selected device. See Setup Multiple Devices (page 8).

5.1.1 Multiple Devices

In case of multiple connected devices each device will appear as a tab on the right side of the Measurement Setup dialog. Switch between the tabs to change the parameters for each device.

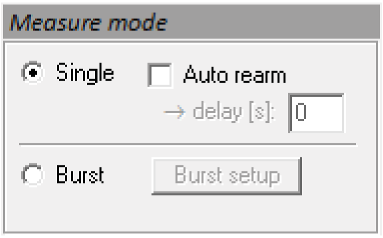
Notes

► Only processing parameters for the first device are used for post-processing. See Select FFT Processing Parameters (page 59) and Select V0 Analysis Parameters (page 61) for more information.



5.2 Configure the Measure Mode

The measure mode controls the type of measurement and whether the radar is rearmed after a measurement has been completed. To configure this group of parameters see Radar and Processing Parameters Overview (page 49).

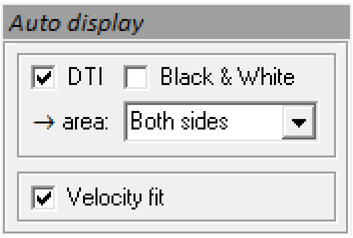


Notes

- ► Select **Single** if there is only one trigger event per measurement.
- ► Select **Burst** if there are several trigger events per measurement. The Burst setup becomes available when burst has been selected. To configure these parameters see Configure the Burst Parameters (page 58).
- ► Use **Auto rearm** to prepare the system for the next trigger when a measurement is complete. Choose a **Delay** between the measurements, if required.

5.3 Enable/Disable Auto Display

Enable the auto display options to display the DTI and/or the Velocity fit automatically after the processing of a single DAT file is completed. To configure this group of parameters see Radar and Processing Parameters Overview (page 49).



Select	If you want to
DTI draw	Automatically draw a DTI plot of the measured signal after the measurement is completed.
Black & White	Choose to show the DTI as Black & White instead of colors.
Area	Choose what area of the DTI to show.
Velocity fit	Automatically calculate the muzzle velocity based on the measured velocities. The algorithm uses a polynomial fit to extrapolate the measured velocity points back to the launch time.

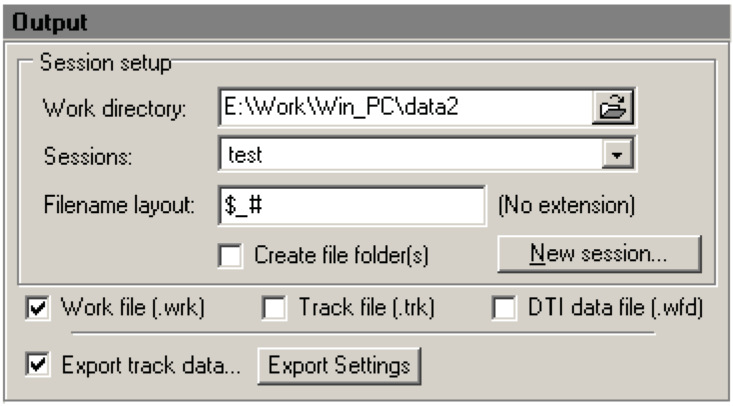
Notes

- ► The DTI plot is an important tool for detecting errors in the measurement set-up.
- ► If Auto rearm has not been selected, see Configure the Measure Mode (page 51), and no valid signal has been found during processing, the DTI plot will automatically be drawn.
- ► The velocity fit algorithm takes the parallax into account; therefore these parameters

must be configured before the first measurement.

5.4 Configure Output File Names

Configure the work directory, the session file, how to name the files and which files to save with every data set. To configure this group of parameters see Radar and Processing Parameters Overview (page 49).



Select/Configure	If you want to
Work directory	Specify which directory to use for the measurement results.
Sessions	Specify the active session.
Filename layout	Configure the filename structure and how it is updated between measurements: $ = The measurement date: YYMMDD. % = The measurement time: HHMMSS. @ = The Julian data: YDDD. # = The four digit measurement number / mission number. £ = The antenna serial no. * = The device index (see note below).
Create file folders	Create a separate folder for each measurement.
Work file (.wrk)	Save the WRK file for each measurement.
Track file (.trk)	Save the TRK file for each measurement.
DTI data file (.wfd)	Save the WFD file for each measurement.
Export track data	Export track data for each measurement. Use the **Export Settings** button to configure the exporting.

Notes

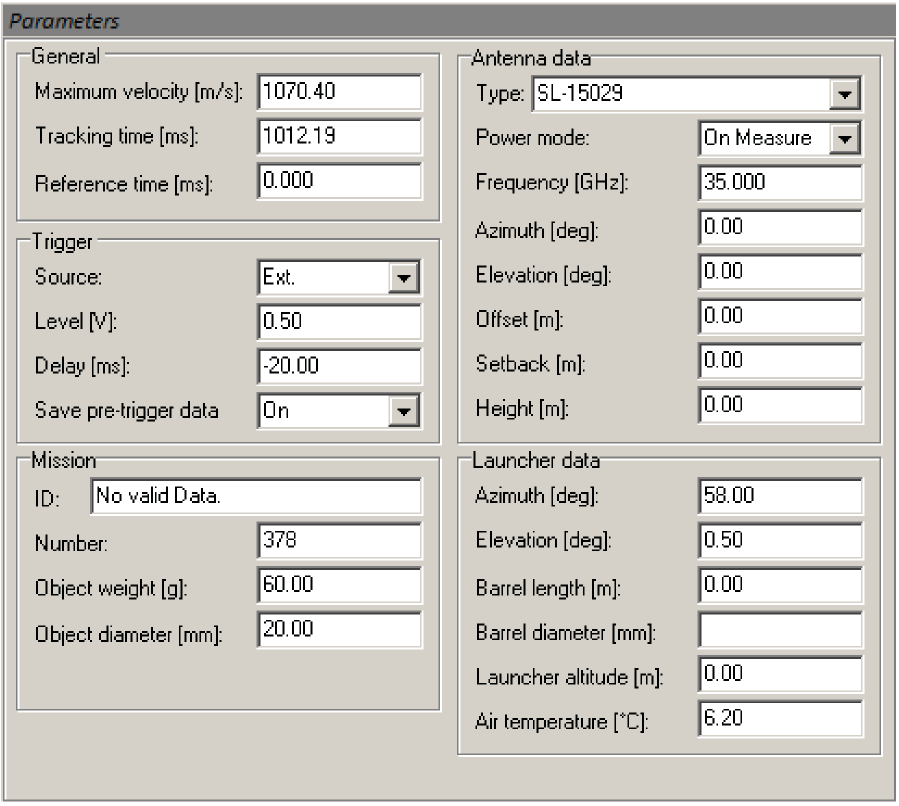
- The session file will always hold the muzzle velocity result as well as a number of other parameters related to the measurement, even if none of the intermediate results files are saved.
- Files saved or generated during a measurement will be placed in the same directory

as the session file. If **Create file folder(s)** has been selected, these will also be placed in this directory. In other words, the session file controls where the data is being stored. This makes it easier to move or store data on another media.

- ► The Device index available in the **Filename layout** defines the index/order in which each device (radar/antenna) has been set up in the Communication Setup dialog (see Set-up Communications (page 7)). 1st device, 2nd device, etc.

5.5 Configure the Radar Parameters

Configure the radar parameters. To configure this group of parameters see Radar and Processing Parameters Overview (page 49).



To configure the **General** parameters:

Select/Configure	If you want to
Maximum velocity	Control the sampling rate used in the radar. The maximum velocity value should exceed any radial velocity observed by the radar throughout the measurement.
Tracking time	Specify the time to measure the velocity.
Reference time	Adjust the time difference between trigger mark and muzzle exit.

To configure the **Trigger** parameters:

Select/Configure	If you want to
Source	Select one of the following options: External: e.g. a flash or optical detector. CH1 (Radar): Doppler signal. Mic. (SL-520M): Internal microphone.
Level	Configure the trigger level.
Delay	Specify the time to start measuring after trigger mark.
Save pre-trigger data	Save data from before trigger mark (only available if 'Delay' are below zero)

To configure the **Antenna data** parameters:

Select/Configure	If you want to
Type	Specify the antenna connected to the analyzer (See note below).
Power mode	Change the antenna power mode (when to turn the antenna power on). Select one of the following options: On Trigger: When accepted a trigger. On Measure: When starting a measurement. Always On: When the system is turned on. (See note below)
Frequency	Specify the transmitting frequency of the antenna.
Azimuth	Specify the antenna beam azimuth angle relative to the launcher azimuth pointing angle.
Elevation	Specify the antenna beam elevation angle, see Height, Offset and Setback (page 57).
Offset	Specify the antenna position to the side of the muzzle. The distance is measured perpendicular from the launcher pointing line. See Height, Offset and Setback (page 57).
Setback	Specify the antenna position from the muzzle or trunnion point. The distance is measured parallel to the launcher pointing line and is positive behind the launcher. See Height, Offset and Setback (page 57).
Height	Specify the antenna position over the muzzle or the trunnion point. See Height, Offset and Setback (page 57).

To configure the **Mission** parameters:

Select/Configure	If you want to
ID	Specify a text that describes the mission in a few words (max. 32 char).
Number	Specify the initial round number for the next measurement. The number will automatically be incremented by one when a measurement has been trigged.
Object weight	Specify the object weight in grams. This value is used for drag calculation.
Object diameter	Specify the object diameter in mm. The value is for drag calculation

To configure the **Launcher data** parameters:

Select/Configure	If you want to
Azimuth	Specify the launcher pointing angle relative to the selected coordinate system. The value is used for drag calculation if wind data is available.
Elevation	Specify the launcher elevation angle. The value is used for drag calculation. Furthermore, it is used by the parallax compensation when this is calculated from the trunnion point (Barrel length > 0), see Height, Offset and Setback (page 57).
Barrel length	Specify the length of the barrel in meter. Used for parallax compensation together with antenna Setback, Offset, Height and launcher Elevation. see Height, Offset and Setback (page 57).
Barrel diameter	Specific the diameter of the barrel.
Launcher altitude	Specify the altitude of the launcher position over sea level.
Air temperature	Specify the air temperature (˚C) at the launcher. Used by the drag calculation.

Notes

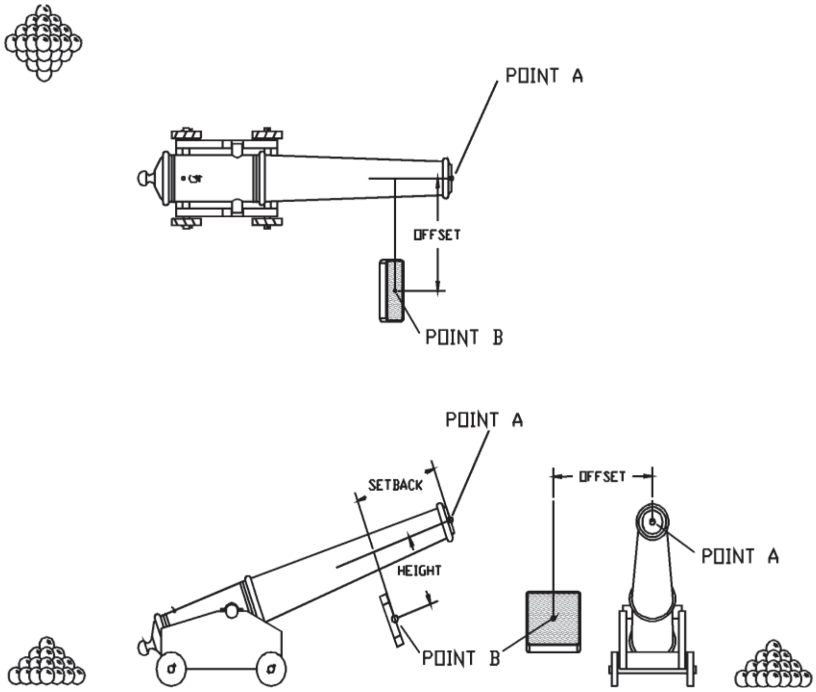
- Specifying a **Maximum velocity** value that's too low leads to loss of data.
- Specifying a **Maximum velocity** value that's too high leads to reduced measuring time or excessive data file size.
- Use the prediction tool to estimate the trajectory of the target including the radial velocity. See Predict the Trajectory (page 23).
- The **Type** of the antenna is usually detected by the analyzer and displayed as antenna model, serial number and software version. For systems with a non-intelligent antenna, the type has to be specified manually using the drop-down box.
- In order to record data when using a negative trigger delay. The **Power mode** should be set to either On Measure or Always On.
- To get the best performance of the system, the **Elevation** of the antenna should have a lower setting than the launcher. This way the object will stay in the beam for a longer period.

► The sign of the antenna **Offset** is only used when adjusting angles. Then, a positive offset means that the antenna is to the right of the muzzle.

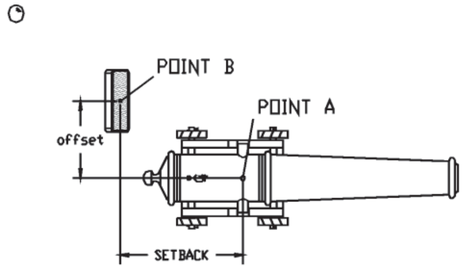
5.5.1 Height, Offset and Setback

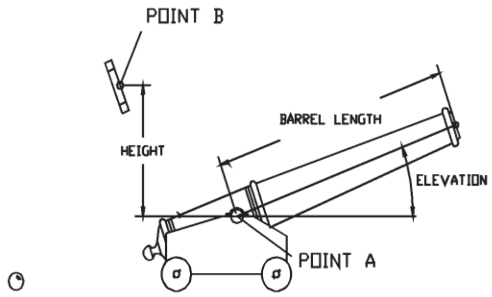
The three antenna data parameters **Height**, **Offset** and **Setback** are used by the parallax compensation routine to compensate for the antenna position. The definition of these parameters depends on the **Barrel length** as described below.

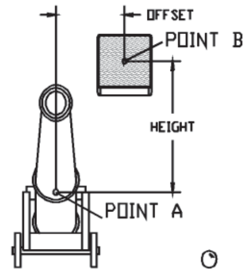
In the first situation the **Barrel length** is set to zero and the position of the radar relative to the muzzle is entered directly in the **Parameters** dialog:



In the second situation the **Barrel length** of the launcher data is set to a positive value. In this case the operator enters the coordinates relative to the trunnion point of the launcher.



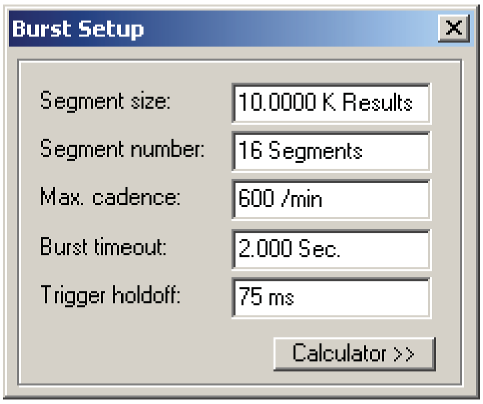




WinDopp then automatically calculates the radar location relative to the muzzle.

5.6 Configure the Burst Parameters

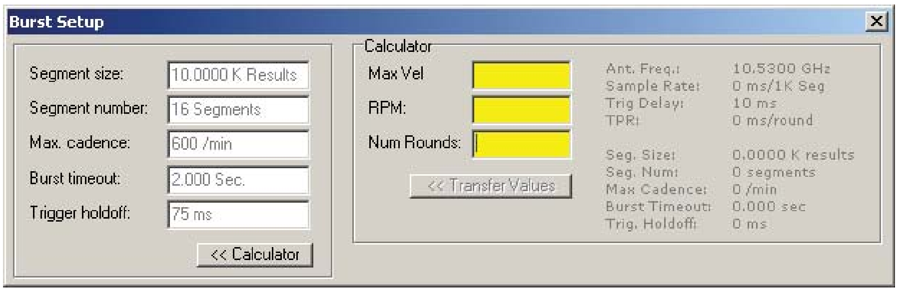
The Burst Parameters located in the Burst Setup dialog defines how the system records a burst measurement. To configure this group of parameters see Radar and Processing Parameters Overview (page 49).



Select/Configure	If you want to
Segment size	Change the size of the data segments. The number specifies how many results/samples each segment will consist of.
Segment number	Change the total number of data segments.
Max cadence	Change the maximum cadence for burst rounds.

Select/Configure	If you want to
Burst timeout	Specify how long time the system should wait for a new trigger (time between rounds). The system automatically stops when the limit has been reached.
Trigger holdoff	Specify the minimum time between trigger events.

Click on the **Calculator** button to show the calculator:



Configure	Description
Max Vel.	Choose the Maximum Velocity
RPM	Choose the RPM (Rounds Per Minute)
Num Rounds	Change the maximum number of rounds

Press the **Transfer Values** button to accept the calculated values.

Notes

- Increasing the **Segment size** decreases the maximum number of segments, since **Segment number** multiplied by Segment size cannot be great than the size of memory the analyzer has available.
- **Trigger holdoff** is used to discard false trigger events. These events could be reflections from the shockwave that trigged the system in the first place.

5.7 Select FFT Processing Parameters

The **Process** parameters define how the Doppler signal is analyzed using FFTs for spectral analysis. To configure this group of parameters see Radar and Processing Parameters Overview (page 49).

Select	If you want to
FFT points	Directly specify the FFT length.
FFT Segments	Define variable FFT size segments. See Define Variable FFT Size Segments (page 99). Use the checkbox to enable or disable. When enabled the **FFT Segment** button will become red.
Parameters	Choose a pre-defined set of parameters. See Select a Predefined Set of MOT Parameters (page 113) for a lists of pre-defined set of parameters.
Overlap [%]	Specify the overlap between two consecutive FFTs. E.g. 50% overlap increases the number of FFTs by a factor of two.
FFT Start [s]	Specify the time of the first sample of the first FFT.
FFT End [s]	Specify the time of the last sample of the last FFT.
Min. Velocity [m/s]	Specify the minimum velocity. Set this to blank to use default.

Notes

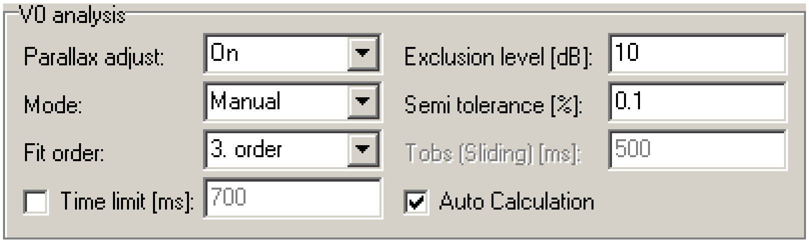
- The **Tobs** parameter is calculated as the number of **FFT points** divided by the sampling rate. The sampling rate is defined by the antenna frequency and the current maximum velocity.
- Increasing the **Overlap** provides better utilization of the data, when using window weighting.

  Exceeding 50% overlap will only result in a marginal improvement and may cost a lot of processing time.
- Choosing a negative overlap means that some of the measurement data is excluded from the processing. This is only done to save processing time. For more information about the relation between overlap and Tobs, please refer to Configure the FFT Parameters (page 98).
- Use FFT Start and FFT End to select the part of the recorded signal to be analyzed. Data outside this interval is not included in any FFT. The time is specified relative to the trigger.
- Only processing parameters defined for the first device will be used for post-processing.

  Processing parameters for all other connected devices will only be used for finalizing new measurements measured on the particular device (and the **Auto Calculation** option has been checked, see Select V0 Analysis Parameters (page 61)).

5.8 Select V0 Analysis Parameters

The **V0 analysis** parameters controls the algorithm responsible for calculating the muzzle velocity based on the measured velocity points. To configure this group of parameters see Radar and Processing Parameters Overview (page 49).



Select	If you want to
Parallax adjust	Correct velocity data according to the offset and setback of the radar relative to the launcher.
Mode	Select one of the modes, see below.
Fit order	Specify the velocity fit order used by the **Manually** and the **Semi auto** V0 analysis **Mode**.
Time limit	Enable and configure **Time limit** to specify the maximum amount (time) of data to base the V0 analysis on (See note below).
Exclusion level	Specify the minimum S/N ratio level for velocity points. The value is used by **Manually** and **Semi auto** V0 analysis **Mode**.
Semi tolerance	Specify the highest tolerance of the velocity fit used by **Semi auto** V0 analysis **Mode**.
Tobs (Sliding)	Specify the length of the sliding fit. Only in use when V0 analysis **Mode** is **Sliding**.
Auto Calculation	Enable or disable **Auto Calculation**. When enabled, the muzzle velocity will automatically be calculated after each measurement.

To configure the V0 mode:

Select	Description
Manual	The S/N ratio of each velocity point is compared to the **Exclusion level**. Points with a too low S/N ratio are excluded. The selected **Fit order** is used for Muzzle calculation.
Semi auto	Executes the manually procedure. The remaining points are excluded one at a time until the tolerance of the total velocity fit meets the tolerance specified by **Semi tolerance**.

Select	Description
Auto	First a 4. order semi auto procedure is executed. All points either with a bad S/N ratio or points far away from the fit are excluded. Secondly, a 2. order velocity fit is made. If the tolerance is worse than the tolerance accomplished by the 4. order semi auto procedure, the measurement base is too long and points are removed from the end until the tolerance is coming close to the tolerance reference. Finally, the procedure checks whether a 1. order fit is more suitable than the 2. order fit. This is done by comparing the tolerances for each fit type. If the tolerance for the 1. order fit is lower or equal to the tolerance for the 2. order fit, the 1. order fit is selected otherwise the 2. order fit is selected (See note below).
Sliding	Executes the manually procedure. Instead of using a total velocity fit for Muzzle calculation, a shorter sliding fit is used. The length of the fit is specified by Tobs (Sliding). Using the sliding fit will result in a more smooth velocity fit which is more suitable for drag calculation.

Notes

- If the **Mode** of the V0 analysis is set to **Auto** and the time of processing is taking several minutes, typically when having seconds of data, it is recommended to enable the **Time limit** processing limitation. Then the V0 analysis does not have to waste time going through data that have no effect on the muzzle result.
- When doing series of measurements with limited amount of time between each round the **Auto Calculation** should be disabled. This will reduce the time used for a measurement-cycle. The disadvantage is that the muzzle result can not continually be confirmed.
- The ‘Tolerance’ is based on a standard Deviation of the point difference between points and fit relative to the average velocity
- Only processing parameters defined for the first device will be used for post-processing.

  Processing parameters for all other connected devices will only be used for finalizing new measurements measured on the particular device (and the **Auto Calculation** option has been checked).

◄ End of Chapter ►

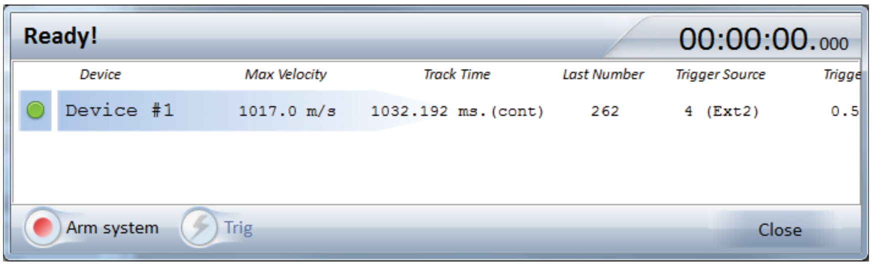
6 Muzzle Velocity Measurement

6.1 Measurement Control Overview

When the radar is ready for measurements, see Radar and Processing Parameters Overview (page 49), next step is to perform the measurement.

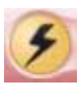
To start a measurement:

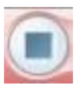
1. On the **Measurement** menu, click **Start Measurement**.
   Alternatively hit **Ctrl+m**. This will open the Measurement Control dialog:

   Double-click on the title bar to minimize the dialog.

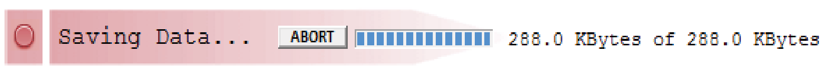
2. Press the **Arm System** to enter the **Wait for trigger** mode. This will arm all connected devices (radar/antennas). The color of the background will change from blue to red, the time in the upper right corner starts to blink and a beep sound will occur every second indicating that the system is armed. The following buttons will be enabled:

   
   Manually trigger the measurement.
   This will trig all connected devise (radar/antennas).

   
   Manually abort the measurement.
   This button will appear as soon as the measurement has been started.

3. When the measurement is triggered and completed the data is automatically transferred and stored in a DAT file at a specified location, see Configure Output File Names (page 53).

   Press **Abort** or **Ctrl+q** to cancel the current transfer.

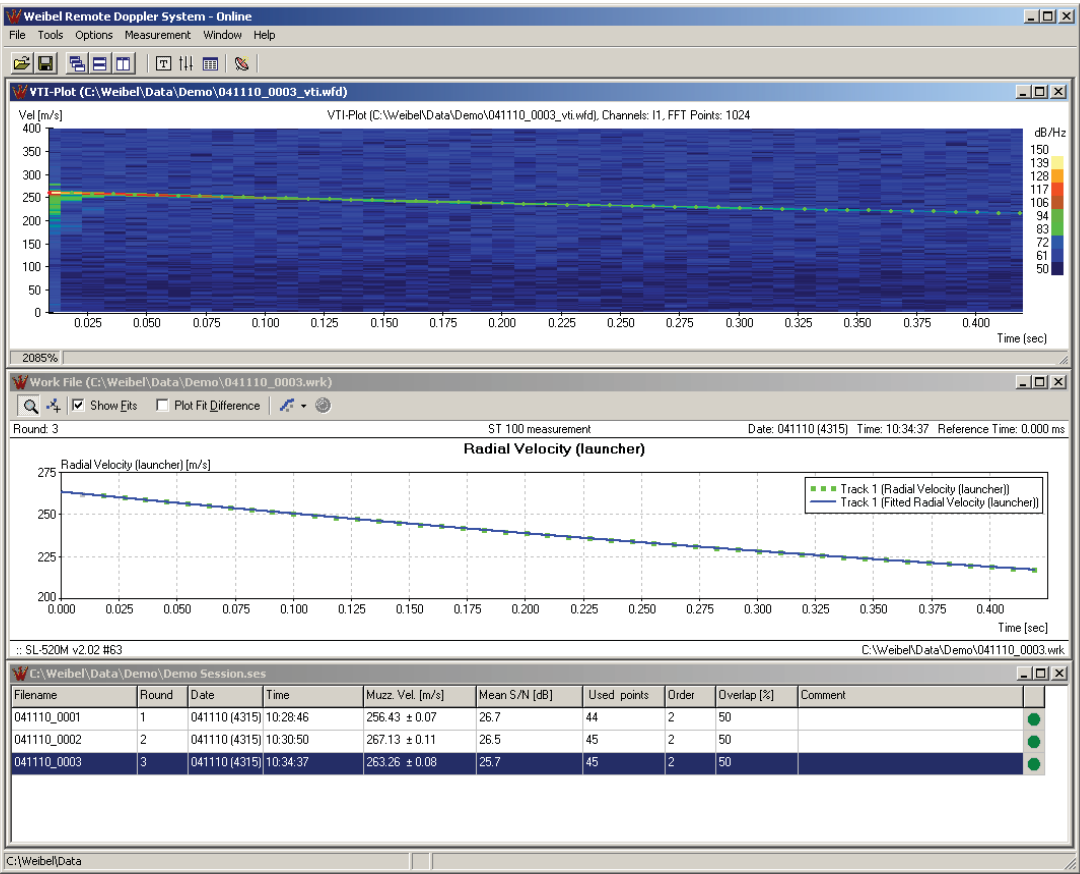
4. Finally the data is analyzed and the results are displayed, see Enable/Disable Auto Display (page 52) and Measurement Results (page 64).

Notes

- The measurement is automatically added to current session.
- Measurements results from multiple connected devices will all be added to the current session.
- If automatic rearm is selected, see Configure the Measure Mode (page 51), the results are added to the session and the system returns to step 2 above and waits for the next trigger. No graphs are displayed between measurements.
- Data will be saved and analyzed as soon as each device has finished its measurement.

6.2 Measurement Results

When the measurement is complete and the automatic display option is enabled, see Enable/Disable Auto Display (page 52), the following screen appears:



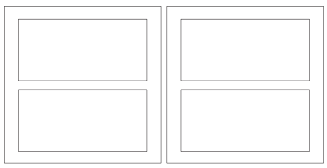
This screen contains three windows:

Window	Description
VTI Plot	The Velocity-Time-Intensity plot is the result of the DAT file processing providing a graphical presentation of the raw FFT output. The result of the MOT processing is showed as green dots on top of the VTI are the result. To configure the VTI graph, see Draw a QDTI/DTI Plot (page 103).
Work File	The work file view presents the radar velocity points (same as in the VTI), the launcher velocity points (parallax compensated), and the polynomial fitted to the launcher velocity points. To configure the work file view or manually edit the data set graphically, see Open a WRK file (page 163).
Session	The session manager shows the final results from the new measurement.

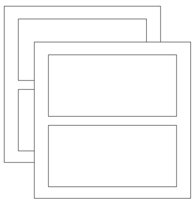
Results from multiple devices will be identified by its filename (depending on the filename layout, see Configure Output File Names (page 53)), and the device name for each result will be shown in the Session Manager (in case the **Show 'Device' field** option has been enabled, see Customize the Session Manager Layout (page 70)).

Notes

- The time axes of the two graph windows may not be aligned.
- To manually control the DAT file processing, see Open a DAT File (page 91) or Use the Session Manager (page 68).
- To manually control the WRK file processing, see Open a WRK File (page 163) or Use the Session Manager (page 68).
- Result windows from multiple devices will be tiled horizontal (or cascaded if there isn't enough screen space available).



Tiled



Cascaded

◄ End of Chapter ►

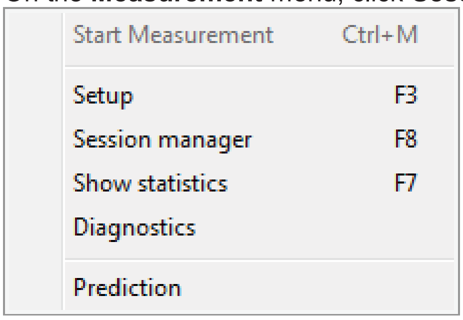
7 Session Management

7.1 Session Manager Overview

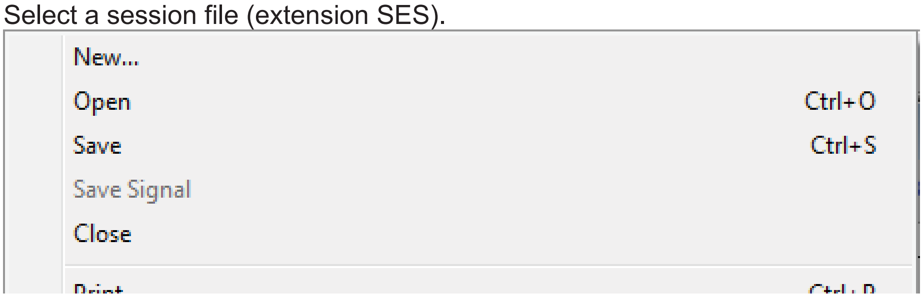
A session is a set of individual measurements organized by the session manager. It is up to the user to decide how measurements are assigned to a session. A typical session comprises a series of consecutive measurements made under identical conditions.

To activate the session manager do one of the following:

- On the **Measurement** menu, click **Session Manager**

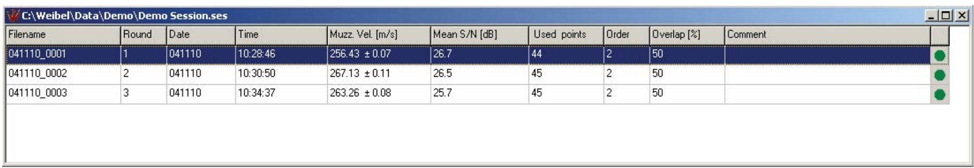


- On the **File** menu, click **Open**.
  Select a session file (extension SES).



- Hit **F8**.
- Perform a measurement.

The following window appears.



Each row represents one of the measurements assigned to this session. To perform an action on one or more of the items, see Use the Session Manager (page 68).

The columns display information for each measurement. The default layout has the following fields:

Field	Description
Filename	The filename associated with the measurement. All files generated for this measurement will be using this filename but with various extensions. See Configure Output File Names (page 53) for files generated when measuring/re-processing. See Export / Print Data (page 74) for files generated when exporting data. If the **Show 'Device' field** option is enabled (see Customize the Session Manager Layout (page 70)) the name of the device used for the measurement will be appended the filename.
Round	This is the measurement number (Mission number) generated by the analyzer at the time the measurement was trigged. See Configure the Radar Parameters (page 54) for setting this parameter.
Date	The date when the measurement was made, format: YYMMDD
Time	The time of the day when the measurement was made, format: HH:MM:SS. For burst rounds the format is extended to display milliseconds.
Muzz. Vel. (m/s)	Calculated muzzle velocity and accuracy.
Mean S/N	The mean S/N ratio based on the velocity points used for the muzzle velocity calculation.
Used points	The number of points the muzzle velocity was based on.
Order	The order of the velocity fit the muzzle velocity was based on. The order is an output of the V0 analysis, see Select V0 Analysis Parameters (page 61).
Overlap (%)	The overlap used for FFT processing, See Select FFT Processing Parameters (page 59).
Comment	Comment line of the measurement. It is possible to write notes for each measurement as a single line of text, see Use the Session Manager (page 68). If the velocity processing fails, the text "Velocity processing failed" will automatically be shown. When adding DAT files to the session these will be commented "not processed". In this case the text "Not processed" will be shown.
Statistics	The right most column of the Session manager is used for statistics. A green dot indicates that a specific measurement is included in the statistics, see Statistics Overview (page 71).

When the Burst layout has been selected the following fields will be displayed in combination with most of the fields from the default layout.

Field	Description
Result time	The time since the first trigger event.
Time diff	Time difference between each round.
Cadence	The calculated cadence. Naturally this is not calculated for the first round in a burst measurement.

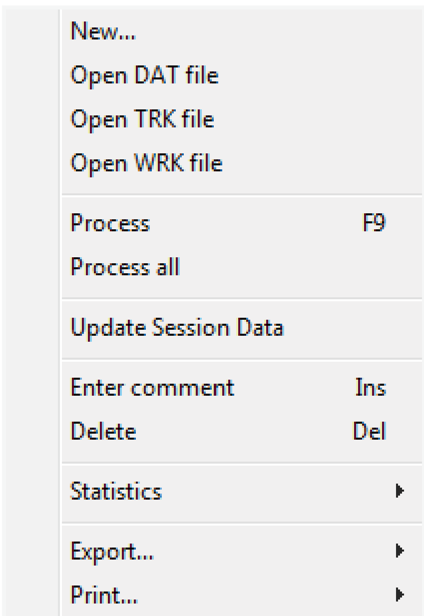
Notes

► Measurements from multiple connected devices will all be added to the same session.

7.1.1 Use the Session Manager

To process one or more measurements:

1. Open the session, see Session Manager Overview (page 66).
2. Select one or more items from the list.
3. Select the **Session** menu item or Right click the Session Manager to get the following menu:



4. Select the menu item, see below.

Use	If you want to
New…	Make a new session. To add to the session see Add or Remove Measurements from a Session (page 69).
Open DAT file	Load the DAT file associated with the selected measurement and activate the DAT file process window. See Open a DAT file (page 91).
Open TRK file	Load the TRK file associated with the selected measurement.
Open WRK file	Load the WRK file associated with the selected measurement and activate the WRK file process window. See Open a WRK file (page 163).
Process	Process the selected measurements.
Process all	Process all measurements in the session.
Update Session Data	Update session data without having to reprocess selected measurements.
Enter comment	Change the comment line of the measurement.
Delete	Delete the selected measurements from the session. The measurement files are not deleted, only the entry in the session file.
Statistics	See Configure Statistics (page 72).
Export	Export data to file. See Export / Print Data (page 74).
Print	Print data. See Export / Print Data (page 74).

Notes

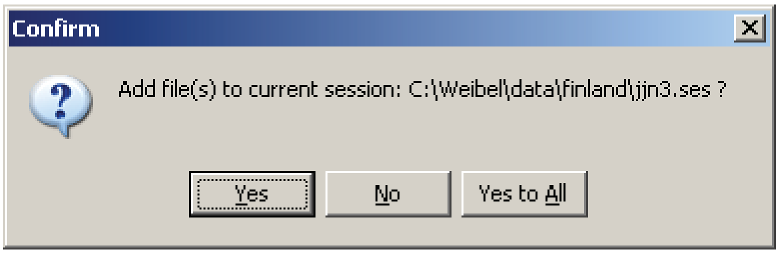
► When processing the settings from the current Radar and Processing Setup window is used, see Radar and Processing Parameters Overview (page 49).

7.1.2 Add or Remove Measurements from a Session

When a measurement is complete it is assigned to the session selected in the **Measurement Setup** window, see Radar and Processing Parameters Overview (page 49).

To add measurements to a session:

1. Open the session, see Session Manager Overview (page 66).
2. On the **File** menu, click **Open**.
3. On the **Files of type** pull-down menu select DAT files.
4. Select one or more file from the directory.
5. Click **Open** to get the following window:

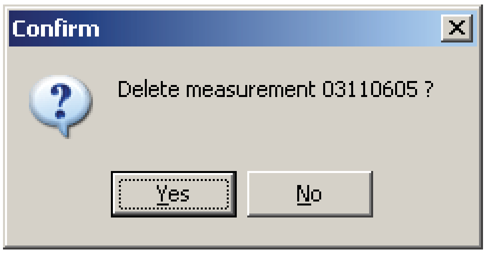


6. Click **Yes** to add one file at a time or **Yes to All** to add all selected files to the session.

Note that all new measurements have the comment Not Processed. To process the measurements see Use the Session Manager (page 68).

To remove one or more measurements from a session:

1. Open the session, see Session Manager Overview (page 66).
2. Select one or more items from the list.
3. Hit **Delete** to delete the items from the list.



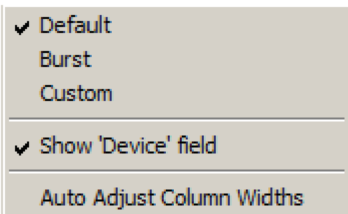
4. Click **Yes** to confirm.

7.2 Customize the Session Manager Layout

The Session Manager allows the user to customize the layout. Only one custom-layout can be saved.

To change the layout:

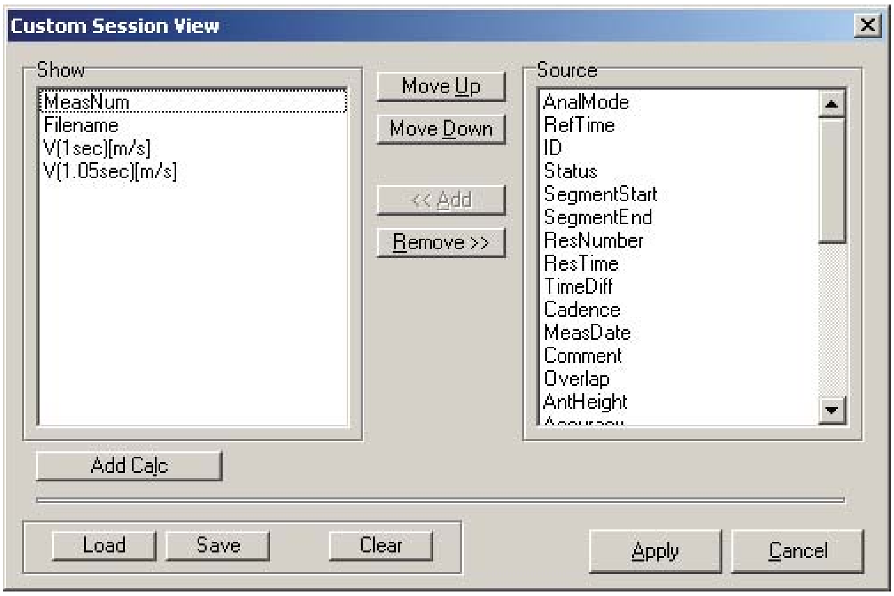
1. Open the Session Manager, see Session Manager Overview (page 66).
2. Either select the **Session** menu item and locate the **Layout** submenu or Right click the column header in the Session Manager to get the following menu:



3. Select **Auto Adjust Column Widths** to reset all columns to fit the width of the Session Manager window.
4. Toggle the **Show 'Device' field** to show or hide the device name in the **Filename** field. This option is only enabled for **Default** and **Burst** layout.
5. Select the menu item in accordance with the type of results the Session Manager should display for each round. **Default** and **Burst** are predefined

layouts.

6. Select **Custom** to define your own layout:

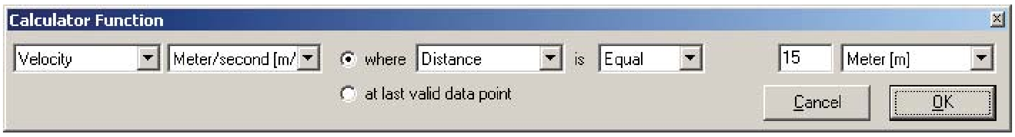


7. **Add** or **remove** results from the left pane to customize the layout. Select predefined results in the right pane or create your own type of results.
8. Click **Add Calc** to Define a New Type of Results (page 71).

The results presented in a customized layout can be exported to a text file, see Export / Print Data (page 74).

7.2.1 Define a New Type of Results

Use the **Calculator Function** to customize the results presented in the session manager. To activate the calculator function see Customize the Session Manager Layout (page 70).



The new type of result is defined by a parameter type, e.g. **Velocity,** and a trajectory condition, e.g. that the target is at a **Distance** of **15** m.

Choose the “at last valid data point” option to extract results from the time of the last valid data point.

Click **OK** to add the new type of result to the session view.

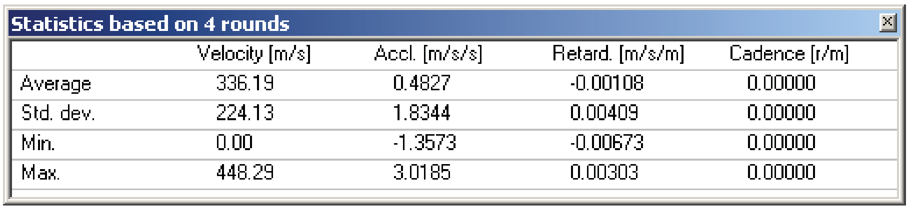
7.3 Statistics Overview

WinDopp calculates statistics on the measurements as they are made or when the results are reviewed at a later stage. This feature is useful when a first view of the results is wanted during the measurement.

To show statistics:

1. On the **Measurement** menu, click **Show statistics**.

   The following window appears:



Statistics based on 4 rounds

	Velocity [m/s]	Accl. [m/s/s]	Retard. [m/s/m]	Cadence [r/m]
Average	336.19	0.4827	-0.00108	0.00000
Std. dev.	224.13	1.8344	0.00409	0.00000
Min.	0.00	-1.3573	-0.00673	0.00000
Max.	448.29	3.0185	0.00303	0.00000

The window stays visible until closed.

Notes

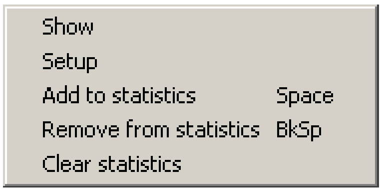
► A green dot in the right most column of the Session manager indicates that a specific measurement is included in the statistics.

7.3.1 Configure Statistics

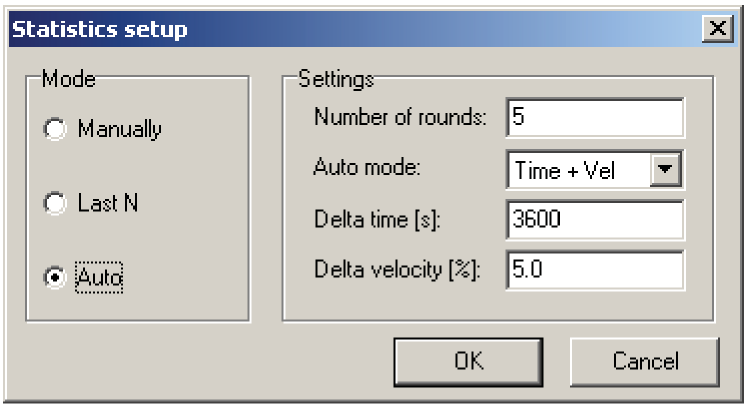
The statistics feature performs both manual and automatic selection of the measurements to be included.

To configure statistics:

1. Open the session, see Session Manager Overview (page 66).
2. Select one or more items from the list.
3. Right click to get the main options menu.
4. Select the **Statistics** item to get the following options:



5. Select Setup to get the following window:



Configure	If you want to
Mode	Control how measurements are included in the statistics, see below.

Configure	If you want to
Number of rounds	Set the maximum number of measurements to be included in the statistics.
Auto mode	Select one of the auto modes, see Select Statistics Mode (page 73).
Delta time (s)	Configure a parameter used in the **Auto mode**, see Select Statistics Mode (page 73).
Delta velocity (%)	Configure a parameter used in the **Auto mode**, see Select Statistics Mode (page 73).

7.3.2 Select Statistics Mode

To select the statistics mode, see **Configure Statistics**.

The **Mode** controls how measurements are included/excluded from the statistics:

Select Mode	If you want to
Manually	Add/remove measurements manually.
Last N	Include the last N measurements, where N is specified as the **Number of Rounds**.
Auto	Use the automatic selection mode, see below.

The **Auto mode** controls how measurements are automatically included/excluded from the statistics.

Use Auto Mode	If you want to
Time	Include measurements that were recorded less than **Delta time** after the last measurement.
Vel	Include measurements that deviate less than **Delta Velocity** from the current average.
Time+Vel	Include measurements that meet both of the above criteria.

Notes

► When the **Last N** or the **Auto** mode is selected, the Add and Remove options are disabled from the session manager.

7.3.3 Add or Remove Measurements from the Statistics

When the Manually mode is selected, see Configure Statistics (page 72), the user chooses which measurements are included/excluded from the statistics.

To include or remove measurements:

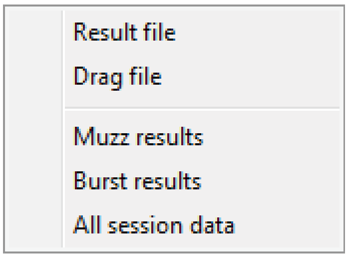
Use	If you want to
Spacebar	Include the selected measurements in the statistics.
Backspace	Remove the selected measurements from the statistics.

7.4 Export / Print Data

Specific measurement data or summary data covering a complete session is easily exported to a text file or sent to a printer, made for ASCII reading.

To export data:

1. Open the session, see Session Manager Overview (page 66).
2. Select one or more items from the list.
3. Right click to get the main options menu.
4. Select the **Export** or **Print** item to get the following options:



5. Select the item from the list.

While the first two items generate separate files/printouts for each measurement the last three items generate one summary file/printout for the complete session.

Generate	If you want to
Result file	This contains all velocity points for the measurement. Each point is described by: Point number, time, velocity, distance, acceleration, retardation, S/N ratio and a mark showing if the point was used for calculating the muzzle result.
Drag file	This contains all drag results for the measurement. Each point is described by: Point number, time, velocity [m/s], velocity [mach], elevation angle, aspect angle, X-distance, Y-height, slant range, drag coefficient, S/N ratio and a mark showing if the point was used for calculating the muzzle result.
Muzz. results	This contains all muzzle velocity results for the session. Each round is described by: round number, date, time, velocity, acceleration, retardation, number of points used, fit order, FFT process overlap, accuracy of the muzzle, mean S/N ratio.

Generate	If you want to
Burst results	This contains all burst results for the session. Each round is described by: round number, result time, time difference, cadence, muzzle velocity, accuracy of the muzzle, mean S/N ratio.
All session data	Thiscontains all data available for each measurement. The file has the same structure as the **Muzz result** file but more data has been added.

Notes

► The results added to a custom session manager layout are included in **Muzz. results**, **Burst results** and **All session data**.

► All types of export will include statistics from the measurement.

◄ End of Chapter ►

8 Diagnostics

8.1 Diagnostics Overview

The Diagnostics Window provides information about the current status of the radar system, modules and subsystems.

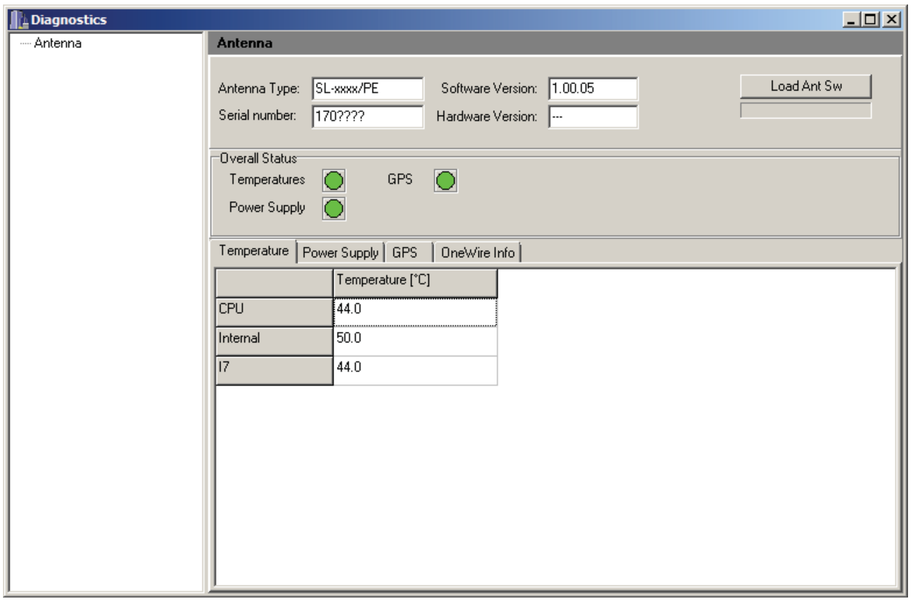
The information is organized in a hierarchical structure to facilitate easy access to both high level "system readiness" information as well as detailed information about the operation of a particular subsystem.

To start working with diagnostics see Enter the Diagnostics Screen (page 77).

8.2 Enter the Diagnostics Screen

To enter the diagnostics screen:

1. On the **Measurement** menu, click **Diagnostics** to bring up the **Diagnostics** Summary window:



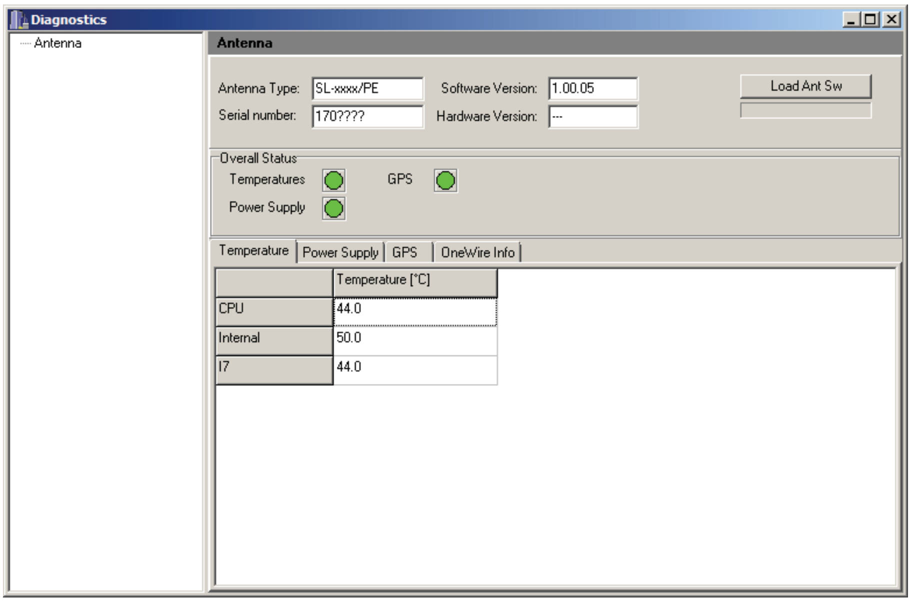
The left side of the window provides access to the diagnostics information for each connected device. The right side of the window shows the Antenna Diagnostics (page 78) overview.

Notes

► Pressing F7 will also open the Diagnostics window.

8.3 Antenna Diagnostics

The Antenna diagnostics section, give the user a quick overall status of the antenna. Various red and green "lights" indicates if there are problems in some of the antenna sub systems.



The Antenna diagnostics is divided into the following sections:

Section	Description
Antenna Properties (page 79)	Detailed information about the antenna and push buttons to load software and configuration files to the antenna microcontrollers.
Overall Status (page 79)	Overall antenna status display.
Temperature	Detailed temperature status display. See Temperature Diagnostics (page 79).
Power Supply	Detailed voltage status display. See Power Supply Diagnostics (page 80).
Amplifiers	Detailed amplifier status display. See Amplifier Diagnostics (page 81).
GPS	Detailed GPS status display. See GPS Diagnostics (page 81).
OneWire Info	Detailed OneWire information. See OneWire Diagnostics (page 82).

Notes

► Depending on the antenna type some of the sections might not be shown.

8.3.1 Antenna Properties

The following options are available when configuring the antenna:

Click/Enable	If you want to
Load Ant Sw	Load software to the main antenna controller

The antenna properties are stored internally in the antenna. When WinDopp is connected this information is read and displayed in the following fields:

Field	Content
Antenna Type	Name of the antenna
Serial Number	Serial number of the antenna
Software version	Version of the main antenna controller software
Hardware version	Version of the main antenna controller hardware

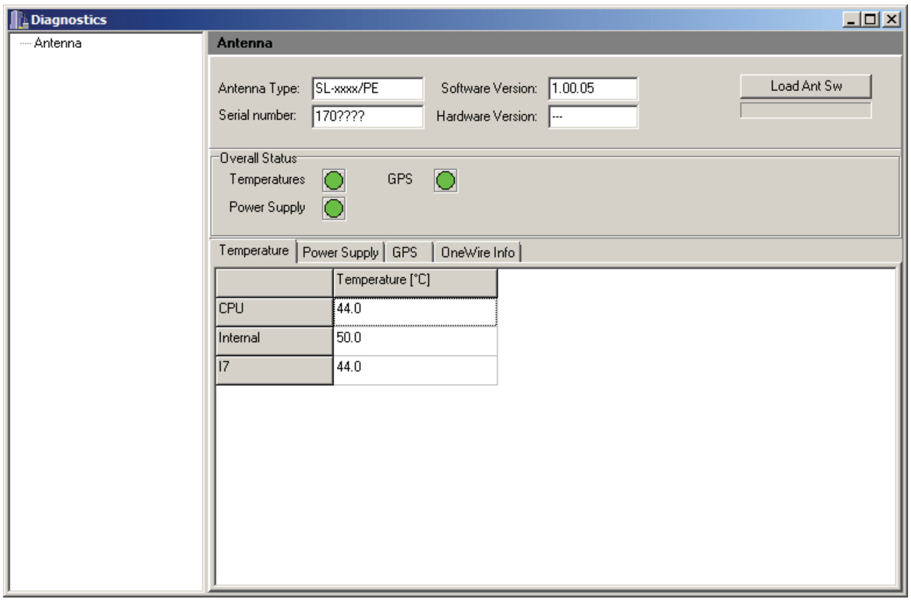
8.3.2 Overall Status

The overall status display shows the overall status as red or green lights.

Indicator	Content
Temperature	Green: If all temperatures are within the allowed limits and reports status OK. Red: If one or more temperature reports status different from OK (see Temperature Diagnostics (page 79))
Power Supply	Green: If all voltages are within the allowed limits and reports status OK. Red: If one or more voltages reports status different from OK (see Power Supply Diagnostics (page 80))
GPS	Green: If GPS reports status OK. Red: If GPS reports status different from OK (see GPS Diagnostics (page 81))

8.4 Temperature Diagnostics

The temperature panel contains a list of temperature sensors inside the antenna.

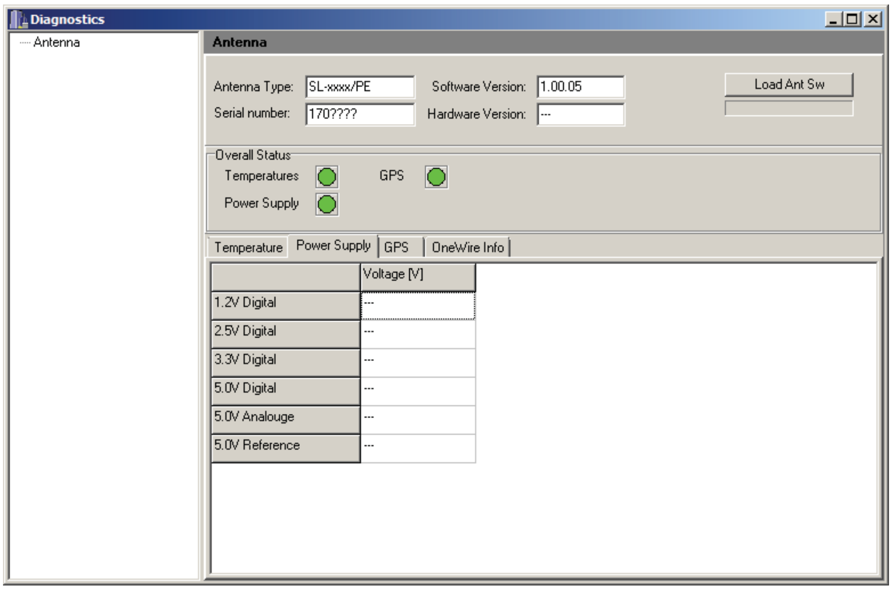


Notes

► Number of sensors depends on the antenna type.

8.5 Power Supply Diagnostics

The power supply panel contains a list of voltage sensors inside the antenna.

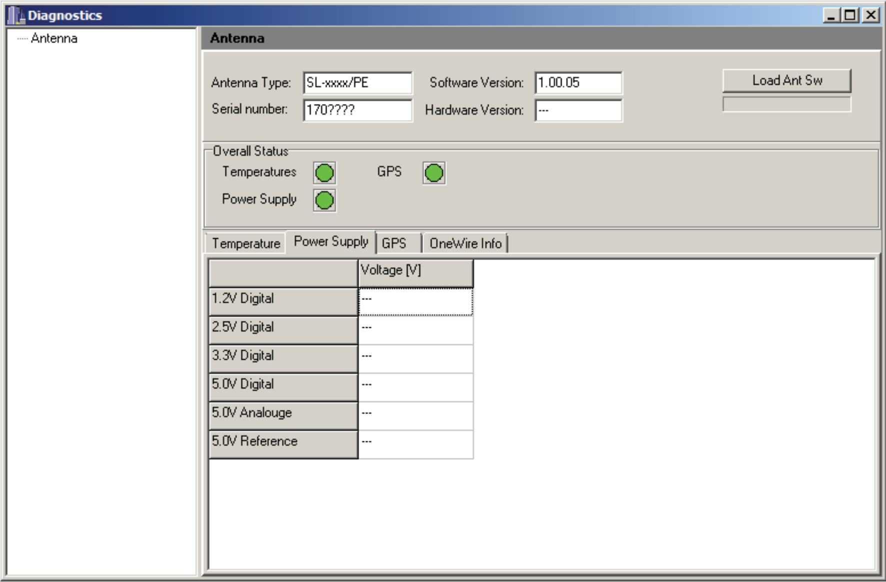


Notes

► Number of sensors depends on the antenna type.

8.6 Amplifier Diagnostics

The amplifiers panel contains a list of amplifiers inside the antenna and their current status.

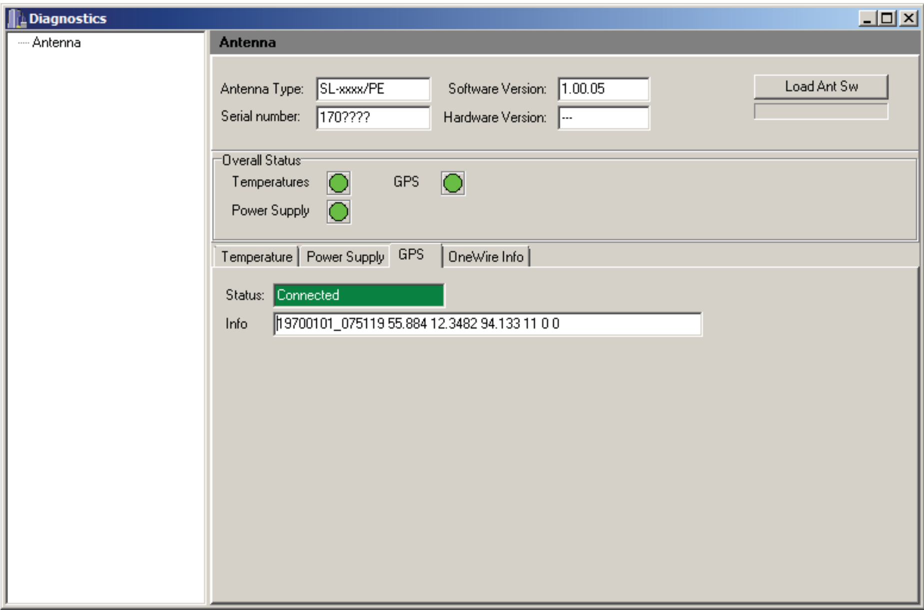


Notes

► Number of amplifiers depends on the antenna type.

8.7 GPS Diagnostics

The GPS panel contains the current GPS status and time information received by the GPS.



The following information is available

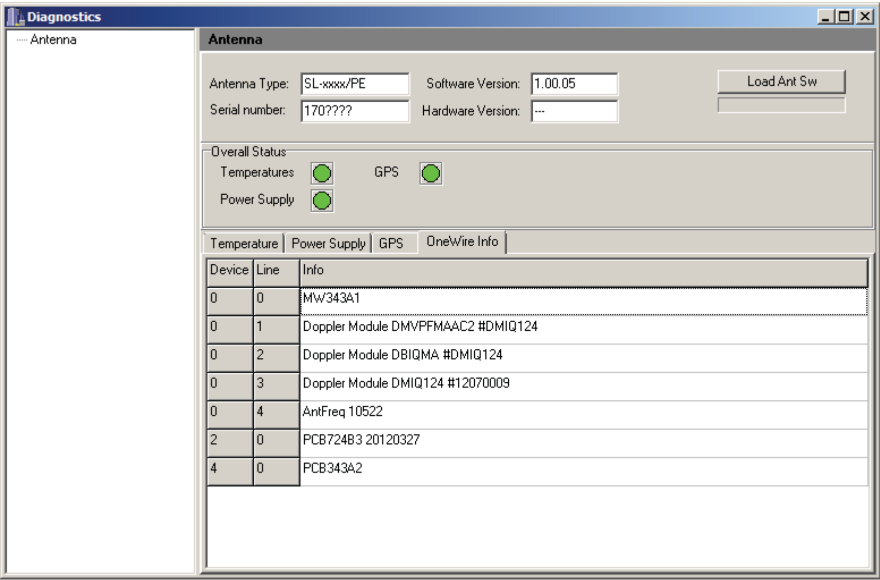
Field	Content
Status	Current GPS status. See below for further information.
Info	Current GPS time information.

The Status field can have one of the following statuses:

Status	Description
Connected	GPS is connected and locked to satellite signals.
Disconnected	GPS is disconnected and isn't properly locked to satellite signals.
Error	GPS reports an internal error.
Idle	GPS is disabled.

8.8 OneWire Diagnostics

The OneWire diagnostic panel contains a list of available OneWire information.



Notes

► Number of information depends on the antenna type.

◄ **End of Chapter** ►

9 Self-Verification

9.1 Self-Verification Overview

The WinDopp application provides features for performing self-verification tests. These tests will perform a series of hardware and software tests to verify that the system is fully operational without any errors.

The self-verification test can be started manually through menus - or by enabling an automated startup/connect check that will warn the user if a new self-verification test is needed.

To start working with self-verification tests see Perform a Self-Verification Test (page 87).

For more information regarding automated startup/connect check see Automated Self-Verification Test (page 89).

9.2 Self-Verification Tests

The self-verification test performs the following tests:

Test	Scope	What is checked	Pass criteria
Communication	Tests the general antenna communication.	The replies from several commands send to the antenna.	Expected replies.
Amplifier	Tests that all amplifiers is working.	Each amplifier is checked while the antenna shortly transmits.	All amplifiers transmit and report no error.
Voltage	Tests the antenna internal power supply voltages.	Voltage levels supplied from the antenna internal power supply	That all voltages are within the allowed limits
Temperature	Tests the antenna internal temperatures	Temperatures from ADC, IO and CPU boards	That the temperatures are within the allowed limits
Oscillator	Tests the oscillator is working	That the oscillator frequency is locked	The oscillator reports correct lock status

Test	Scope	What is checked	Pass criteria
Antenna Gain	Tests the antenna gain.	Antenna gain is changed during a short measurement.	At least 20 dB in difference.

9.2.1 Communication Test

The communication test verifies that the general communication to the antenna is fully functional.

This is achieved by sending commands to the antenna that have known expected replies.

An error in the communication test will result in the following statement:

Error Statement	Error Details	Possible Cause
Can't communicate with device	The antenna has return a non-valid response to the commands sent from the IC-700	A disconnection between antenna and IC-700 may have occurred. Verify all cables are still connected. Verify that PS-200 is still on

9.2.2 Amplifier Test

The amplifier test verifies that all antenna amplifiers are functioning.

This is achieved by turning on each amplifier and having them report no errors to the antenna.

Possible errors reported from the amplifier test in the self-verification test are:

Error Statement	Error Details	Possible Cause & Solution
Amplifier #xxx reports and error! (status: yyy). **xxx: amplifier id** **yyy: return value**	Upon startup one of the amplifier has return an error code (return value) instead of an OK signal.	

9.2.3 Voltage Test

The voltage test verifies that all internal antenna voltages are within the allowed limits for normal antenna operation.

This is achieved by verifying that the measured voltages on the internal antenna boards are within the allowed limits.

Possible errors reported from the voltage test in the self-verification test are:

Error Statement	Error Details	Possible Cause & Solution
1.2V is out of limits **(1.14-1.26) : x.xx**	The measured voltage is outside of allowable limit. x.xx is measured voltage	Issue is most likely hardware related. If system is running check the voltages that can be viewed in the diagnostics part of WinDopp Contact Weibel and report any voltages that are outside of the specified limits.
1.5V is out of limits **(1.40-1.60) : x.xx**	As above	As above
1.8V is out of limits **(1.70-1.90) : x.xx**	As above	As above
2.5V is out of limits **(2.38-2.62) : x.xx**	As above	As above
3.3V is out of limits **(3.14-3.45) : x.xx**	As above	As above
5.0V is out of limits **(4.50-5.50) : x.xx**	As above	As above

9.2.4 Temperature Test

The temperature test verifies that all internal antenna temperatures are within the allowed limits for normal antenna operation.

This is achieved by verifying that the measured temperatures on the internal antenna boards are within the allowed limits.

Possible errors reported from the temperature test in the self-verification test are:

Error Statement	Error Details	Possible Cause & Solution
ADC Temperature is out of limits **(-40 - +80): x.xx**	The measured temperature is outside of allowable limit. x.xx is measured temperature	If the system is running within the operational temperatures; issue is most likely hardware related. If system is running check the temperatures that can be viewed in the diagnostics part of WinDopp Contact Weibel and report any temperatures that are outside of the specified limits
IO Temperature is out of limits **(-40 - +80): x.xx**	As above	As above

Error Statement	Error Details	Possible Cause & Solution
CPU1 Temperature is out of limits **(-40 - +80): x.xx**	As above	As above
CPU2 Temperature is out of limits **(-40 - +80): x.xx**	As above	As above
CPU3 Temperature is out of limits **(-40 - +80): x.xx**	As above	As above

9.2.5 Oscillator Test

The oscillator test verifies that the internal antenna oscillator is locked to its targeted frequency.

Possible errors reported from the oscillator test in the self-verification test are:

Error Statement	Error Details	Possible Cause &Solution
Oscillator not locked	Oscillator has failed to report a successful lock status to the IC-700	The antenna will still be functional with the oscillator out of lock.

9.2.6 Antenna Gain Test

The antenna gain test verifies that the gain for the internal antenna amplifiers is within the allowed limits for normal antenna operation.

This is achieved by verifying that the difference in noise background with the amplifiers on and off is greater than allowed limit for normal antenna operation.

Possible errors reported from the amplifier gain test in the self-verification test are:

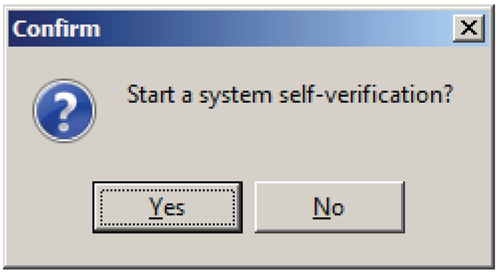
Error Statement	Error Details	Possible Cause & Solution
No valid measurement was recorded	No data was available in the antenna memory	Firmware or antenna hardware related Verify that the antenna can perform a normal measurement
Can't save measurement data from device	Data could not be transferred from antenna to IC-700	Antenna did not send data although it was available IC-700 is out of hard-drive space Verify that the antenna can perform a normal measurement

Error Statement	Error Details	Possible Cause & Solution
Can't process the measurement file	Data sent from the antenna is invalid	Data transfer was faulty Redo the self-verification test and verify the error is persistent Verify that the antenna can perform a normal measurement
Can't calculate average spectrum	Data is valid but average spectrum calculation was not possible	Perform a normal measurement and open the DAT file menu Make a diagnostic – noise spectrum processing Verify that this processing is possible.
Too low dB difference: XX dB (min: YY dB)	Average gain difference between amplifier states XX: Gain difference YY: Required gain limit	Pay attention to any sources of RF noise in the vicinity of the Radar and also any sources of reflection that could cause the background noise to increase.
Too low dB difference: XX dB (min: YY dB) for channel #1 **(I channel)**	Average gain difference (I-Channel only) between amplifier states XX: Gain difference YY: Required gain limit	As above
Too low dB difference: XX dB (min: YY dB) for channel #2 **(Q channel)**	Average gain difference (Q-Channel only) between amplifier states XX: Gain difference YY: Required gain limit	As above

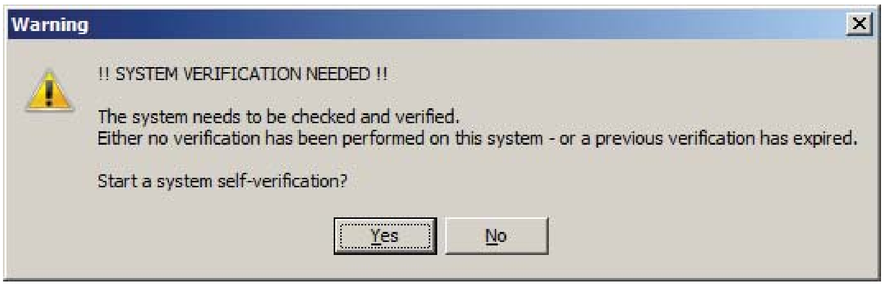
9.3 Perform a Self-Verification Test

To perform a self-verification test do one of the following:

1. On the **Measurement** menu, click **Self-Verification** to bring up this confirmation window:



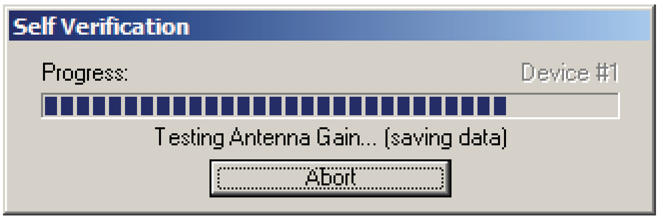
2. Or by accepting to start a new self-verification test due to a previous expired self-verification test, or due to newly connected devices. See Automated Self-Verification Test (page 89).



Be advised, a self-verification test will turn on the antenna power periodically during the tests. Make sure no one is near the antenna during the tests!

Starting a self-verification will warn the user with the following dialog:

Press **OK** to start the test. This will bring up the self-verification dialog showing the current progress:

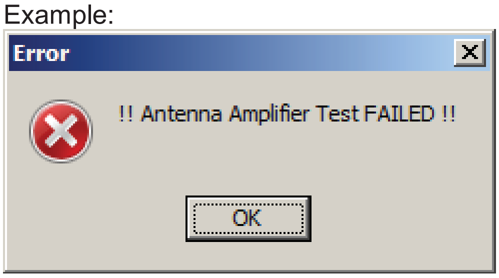


Press **Abort** to abort the self-verification tests.

When all tests are done the user will be informed.

In case of any errors found during the test, the self-verification will stop any further tests and will inform the user with a short message describing the error.

Example:



In the above example, one of the amplifiers in the antenna has failed the test.

To get a more detailed diagnose regarding the actual problem use WinDopp's Diagnostic tool, see Enter the Diagnostics Screen (page 77).

Notes

► All windows in WinDopp will be closed during the self-verification test.

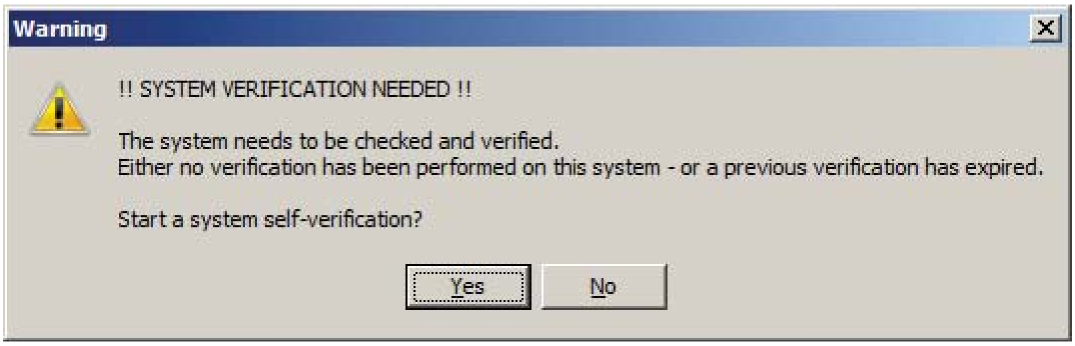
► When connected to multiple devices the self-verification will test each device individually.

9.4 Automated Self-Verification Test

A self-verification check can be enabled to be performed at WinDopp startup and when WinDopp connects to one or more devices.

To enable this check, see Customize Self-Verification (page 19).

The self-verification check will check the validity of the previous performed self-verification test, if any. In case it detects it's no longer valid the user will be prompted to perform a new self-verification test.



The following scenarios will cause the self-verification check to warn the user:

1. No previous self-verification tests have been performed.
2. Previous self-verification test has expired.
3. WinDopp have been connected to new devices.

Press **Yes** to start a new self-verification test. See Perform a Self-Verification Test (page 87) for more information.

Notes

► To setup the expire time for a self-verification test, see Customize Self-Verification (page 19).

◄ End of Chapter ►

10 DAT File Processing

10.1 Introduction

The Doppler data from the measurement is saved in the DAT file and WinTrack/WinDopp provides a number of tools for viewing and further processing of the raw measurement data.

DAT file processing finds the frequency components of the received signal and provides the operator with various graphical presentations of the signal. These are important tools for checking the quality of the signal before extracting the track information.

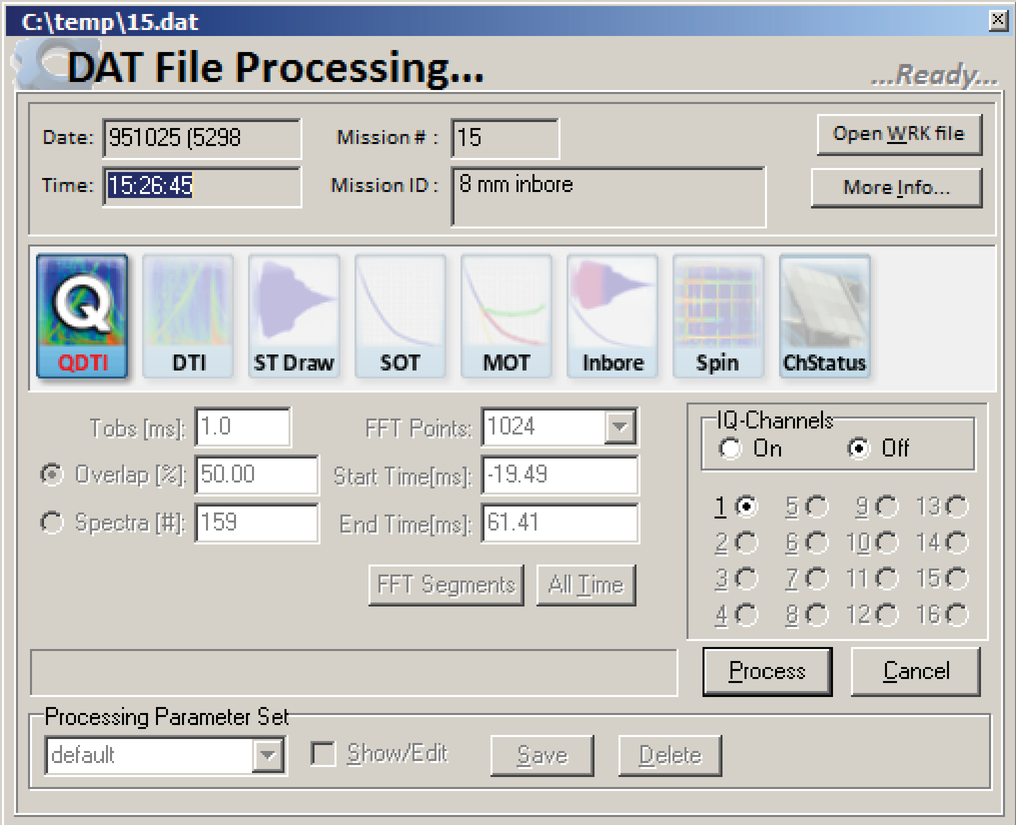
The SOT or the MOT processing finds the tracks in the signal and stores them in a WRK file for further processing. Each track consists of a number of measurement points, that are available for further processing, see Open a WRK File (page 163).

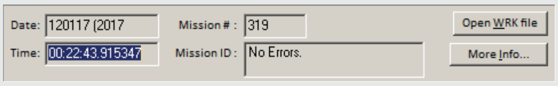
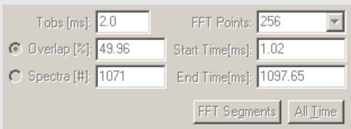
10.2 Open a DAT File

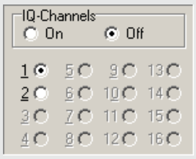
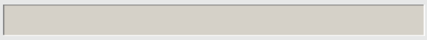
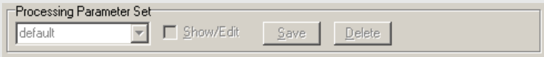
To open a DAT file:

1. On the **File** menu, click **Open**
2. From the file select window choose the DAT file
3. Click **Open**.

The following window appears:



Sub Window	Description
DAT file	 Provides the date, time, mission # and ID recorded in the DAT file. Click **Open WRK** to access the associated work file. Click **More Info** to Access the DAT Info (page 93).
Processing Options	 Click one of the icons to Select the Processing Algorithm (page 97).
FFT Setup	 View or edit the values to Configure the FFT Parameters (page 98).

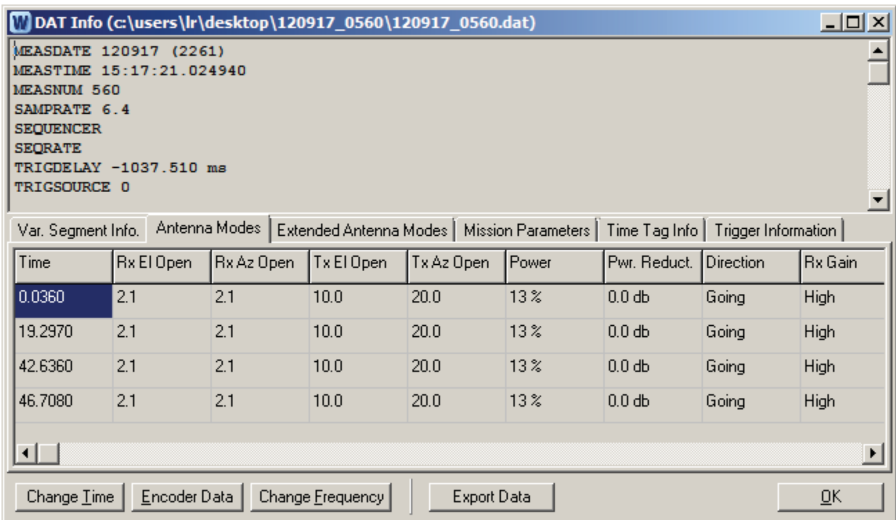
Sub Window	Description
IQ-Channels	 Choose between the real/complex channel modes and select the channels to be processed.
Progress bar	 Shows the progress of the current processing.
Process/Cancel	 Click **Process** to start the processing. Click **Cancel** to stop it before it has completed.
Processing Parameter Set	 Allows to load, edit, save and delete pre-defined parameter sets to be used with the selected processing option.

Notes

► A DAT file can also be opened by double-clicking on the file in Windows Explorer or dragging the file from Windows Explorer to the WinTrack window or icon.

10.2.1 Access the DAT Info

To activate this window Open a DAT File (page 91), and click the **More Info** button.



Several tabs with information are available. The number of visible tabs depends on the information saved in the file:

Tab	Description
Var. Segment Info.	List of data segments saved in the file. In case of burst measurements several segments may be saved. **Time (Sec)** is the start time of the segment (relative to trigger) **Segsize** is the size of the segment. **Samp Rate. (uS)** is the sample rate used. **Bitmode (Bits)** is the number of bits per sample. **Dig. Gain.** is the gain of all channels.
Antenna Modes	List of antenna modes saved during measurement (if present in file): **Time** is the time of the antenna mode (relative to trigger time). **El Open** is the elevation opening angle. **Az Open** is the azimuth opening angle. **Power** is the power in %. **Direction** is the direction (going, coming). **Rx Gain** is the receiver gain. **OSC 2** shows the state of the 2^{nd} oscillator. **Rg Set** is the range set number used.
Mission Parameters	Mission parameters saved in the file: **Mission ID** is the Mission ID/description entered prior to measurement. **Launch Date** is the date of the measurement. **Launch Time** is the time of the measurement.

Tab	Description
Time Tag Info	List of time tags (if present in file). Time tags are information stamps recorded during measurement (approx.. 1 per second): **Trig dT** is the time of the stamp relative to trigger. **IRIG dT** is the time of the stamp relative to first sample. **Samp1 dT** and **Samp2 dT** is the time of the stamp calculated based on the sample count and sample rate. **File dT** is the time of the stamp calculated based on the position in the file. **IrigFullSec** is the full part of the IRIG stamp time. **IRIGFracSec** is the fractional part of the IRIG stamp time. **SampCount1** and **SampCount2** is the sample count. **FilePos** is the actual position in the file. **Type** is the stamp type (Start, Normal, End, Packet Lost, Unknown)

Tab	Description
Trigger Information	The DAT file holds information on trigger events generated during a measurement. If the DAT file was created with Burst Processing active, multiple trigger events may have been generated, and this tab provides some statistics on these events: **Event #** is the event count since the start of the measurement. **Trigger info** describes the type of trigger, which can be either hardware or software generated. The numbers in parentheses are the counter for the current event type and the total event counter. **Sample #** is the number of the first sample after the trigger. **Time stamp** is the time stamp of the first sample after the trigger. **Time elapsed** is the time elapsed since the first trigger. **Period** is the the time elapsed since the previous trigger. **Rate (insta.)** is the instantaneous rate of fire. That is, the reciprocal of the pariod. **Rate (mean)** is the rate of fire calculated as the mean of the current and previous triggers. By right-clicking in the data grid, the user has the following options: **Export…** to export the data to a text file. **Show non-trigger events** shows all events instead of only trigger events.

The following options are available:

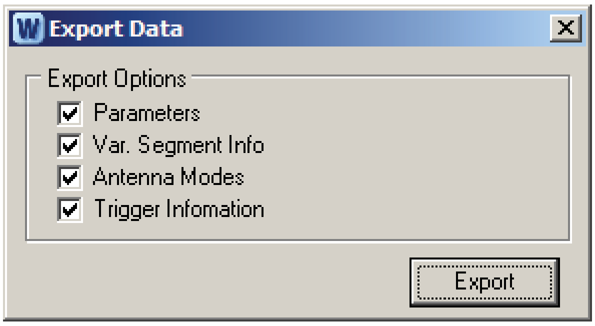
Select the	If you want to
Change Time	Change the date of the measurement.
Encoder Data	View the encoder data saved in the file. This button will be grayed/disabled if no encoder data is present in file.
Change Frequency	Change the antenna frequency in the file.
Export Data	Export DAT Info information, see Export DAT Info (page 97).

Notes

- Several of the above information is primarily for debugging purpose.
- The Burst Processing feature mentioned above is only available in RTP versions higher than (and not including) 1.67.

10.2.1.1 *Export DAT Info*

Export DAT file information by pressing the **Export Data** button on the Access the DAT Info (page 93) dialog. This will bring up the following dialog:



Choose what to export.

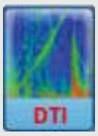
Option	If you want to
Parameters	All parameters and their values.
Var. Segment Info	The variable segment information.
Antenna Modes	Range sets and antenna modes.
Trigger Information	Trigger information.

Press the **Export** button to choose the output file.

10.2.2 Select the Processing Algorithm

To access the **Process Setup** window see Open a DAT File (page 91).

The following processing options are available:

Select the	If you want to
	See a quick Doppler-Time-Intensity draw based on just one channel and a subset of the data available. For more details see Draw a QDTI/DTI Plot (page 103).
	See a full Doppler-Time-Intensity draw based on all the channels selected. For more details see Draw a QDTI/DTI Plot (page 103).
	See the Signal-Time draw. For more details see Draw an ST Plot (page 110).
	Perform the Single Object Tracking algorithm to search for one object trajectory in the data. For more details see Detect Single/Multi Object Tracks (page 112).

Select the	If you want to
	Perform the Multiple Object Tracking algorithm to search for multiple object trajectories in the data. For more details see Detect Single/Multi Object Tracks (page 112).
	Perform Inbore Analysis (page 158) to search for object trajectory in the data.
	Perform Spin Analysis (page 148) to identify the spin modulations accompanying a previously processed object with MOT/SOT.
	Perform analysis on each channel to compare and verify their performance. The analysis to perform is selected under Advanced settings.

The option selected is indicated by a thick blue rectangle, e.g. see the QDTI icon above.

10.2.3 Configure the FFT Parameters

To access the **Process Setup** window see Open a DAT File (page 91).

The following processing options are available:

Set the	If you want to
Tobs [ms]	Configure the FFT length as a time interval. WinTrack/WinDopp finds the smallest FFT length, N, so that N divided by the sample frequency is larger than or equal to your input. The resulting Tobs replaced your entry.
FFT Points	Directly specify the FFT length. See Define Variable FFT Size Segments (page 99) in order to process the file with variable FFT lengths.
# Spectra	Specify the effective number of spectra calculated.
Overlap [%]	Specify the overlap between two consecutive FFTs. E.g. 50% overlap increases the number of FFTs by a factor of two.
Start Time [s]	Specify the time of the first sample of the first FFT.
End Time [s]	Specify the time of the last sample of the last FFT.
FFT Segments	Define Variable FFT Size Segments (page 99). Press the button to enable or disable the use of FFT Segments. When enabled the button become red.
All Time	Click the All Time button to select the maximum number of FFTs.

Set the	If you want to
Times Rel. To Launch	Enable the Times Rel. To Launch checkbox to operate with times given relative to a user defined launch time. The launch time can be.changed from the **DAT Info** form. See Access the DAT Info (page 93)

The relation between the FFT parameters is:

- Fsample is the Doppler data sample rate and Tsample is the time between samples:

  Tsample = 1/Fsample

  Tobs = FFT Points * Tsample

- Tdelta is distance in time between FFT spectra updates:

  Tdelta = Tobs * (1 – Overlap%/100)

- #Spectra = (End time - Start time)/Tdelta

Notes

- To re-use the FFT Parameters of the last processing enable the **Remember FFT Parameters** option at Customize Miscellaneous (page 15).
- Either the **Number of Spectra** or the **Overlap** is specified as one depends on the other.
- The frequency resolution of the FFT is roughly equivalent to 1/Tobs. To convert from frequency to velocity use the approximated relation:

  Velocity = λ/2 * 1/Tobs = 0.014m * 1/Tobs

  Assuming that the radar transmits at 10.5GHz and the speed of light is c = $3*10^8$ m/s.

10.2.4 Define Variable FFT Size Segments

Any processing on a DAT File may be carried out with variable FFT size. This feature is especially interesting when tracking objects whose radial acceleration varies over a wide range of values, since it allows optimizing the FFT size attending to the radial acceleration of the target at each point in the measurement.

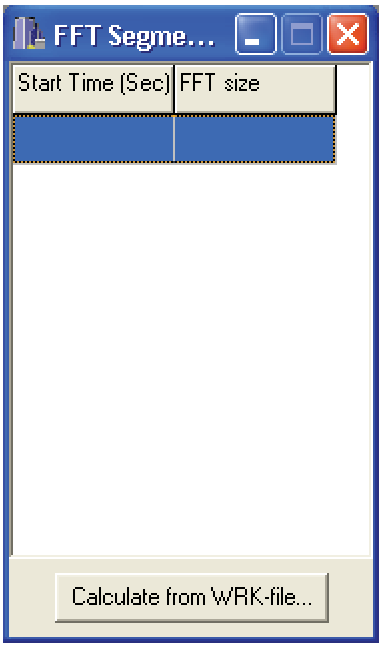
As a general rule, the observation time at any point in the measurement (resulting from multiplying the FFT size by the sampling time at that point) should not exceed sqrt(lambda/2/acc), being sqrt the root square of the expression inside the parentheses, lambda the transmission wavelength (approx. 0.028m) and acc the radial acceleration of the object in m/s^2. E.g. an acceleration of 10g = $100m/s^2$ results in a maximum observation time of approximately 12ms. Using a longer observation time results in smearing of the spectrum. This does not improve the accuracy of the results.

When tracking projectiles launched from a location close to the radar, the acceleration is usually high at the beginning of the measurement, when the distance to the object is low and the signal-to-noise ratio high. The first part of the measurement can then be processed with a short FFT. As the projectile flies downrange, its acceleration diminishes and its signal-to-noise ratio becomes lower because of the increased distance to the radar. In this situation, improved accuracy and higher detection ranges may be obtained by increasing the size of the FFT.

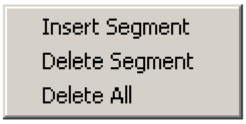
To process with variable FFT size segments:

1. On the **Process Setup** window click on **FFT Segments**.

2. The following form appears:



3. Right click on the white area to show the following pop-down menu.



4. Click on **Insert Segment** in order to define a new FFT size segment. The user is prompted to type the start time of the FFT segment in seconds since trigger and the FFT size to be employed from that time. That FFT size will be used until the beginning of a later segment or the **Stop Time** specified for the processing (see Configure the FFT Parameters (page 98)).
5. In order to delete a given segment, select it with the mouse, right-click to show the pop-down and click on **Delete Segment.**
6. To delete all segments, right-click to show the pop-down menu and click on **Delete All**.

Notes

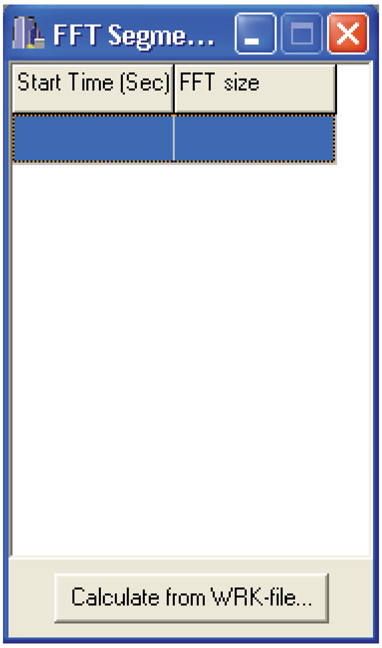
► In case a section of the measurement is not covered by any of the given FFT segment definitions, the size specified by the **FFT Points** parameter (see Configure the FFT Parameters (page 98)) is taken as default.

► Close down the FFT segment window is equivalent to delete all segments.

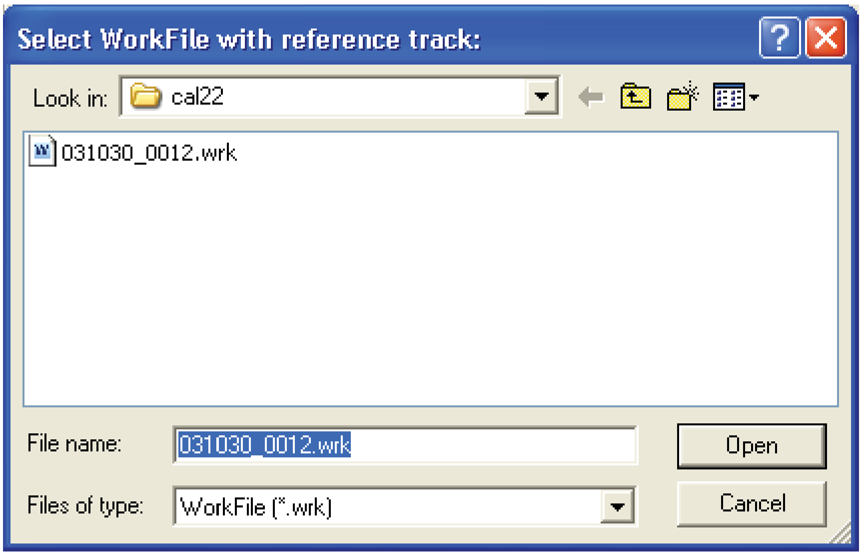
10.2.4.1 *Automatically Define Variable FFT Size Segments*

To optimally define the FFT size segments for a particular measurement:

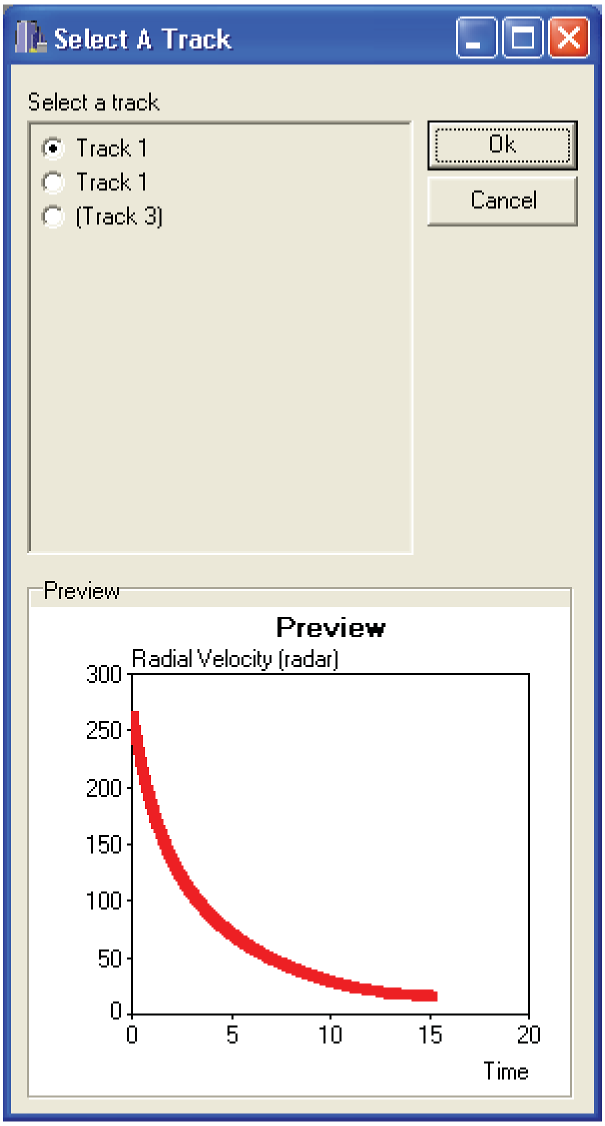
1. On the **Process Setup** window click on **FFT Segments**.
2. The following form appears:



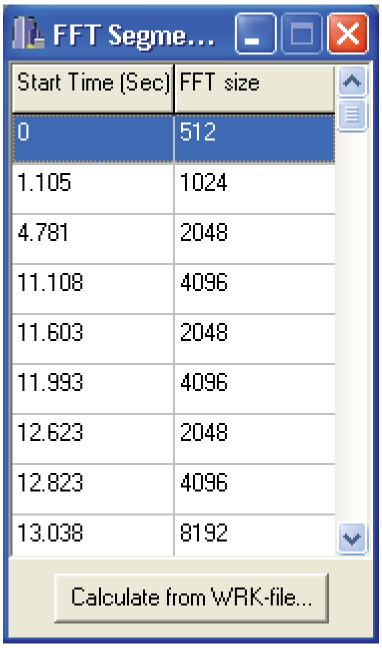
3. Click on **Calculate from WRK-File**.
4. An open file dialog box appears which permits to choose the workfile that contains the trajectory for which the FFT segments will be calculated.



5. A form with the list of available tracks in the file appears. Select the desired track and click **OK**.



6. A new list of FFT size segments is generated.



Please refer to Define Variable FFT Size Segments (page 99) for further details on how the optimum FFT sizes are calculated.

10.3 Draw a QDTI/DTI Plot

To access the **Process Setup** window see Open a DAT File (page 91).

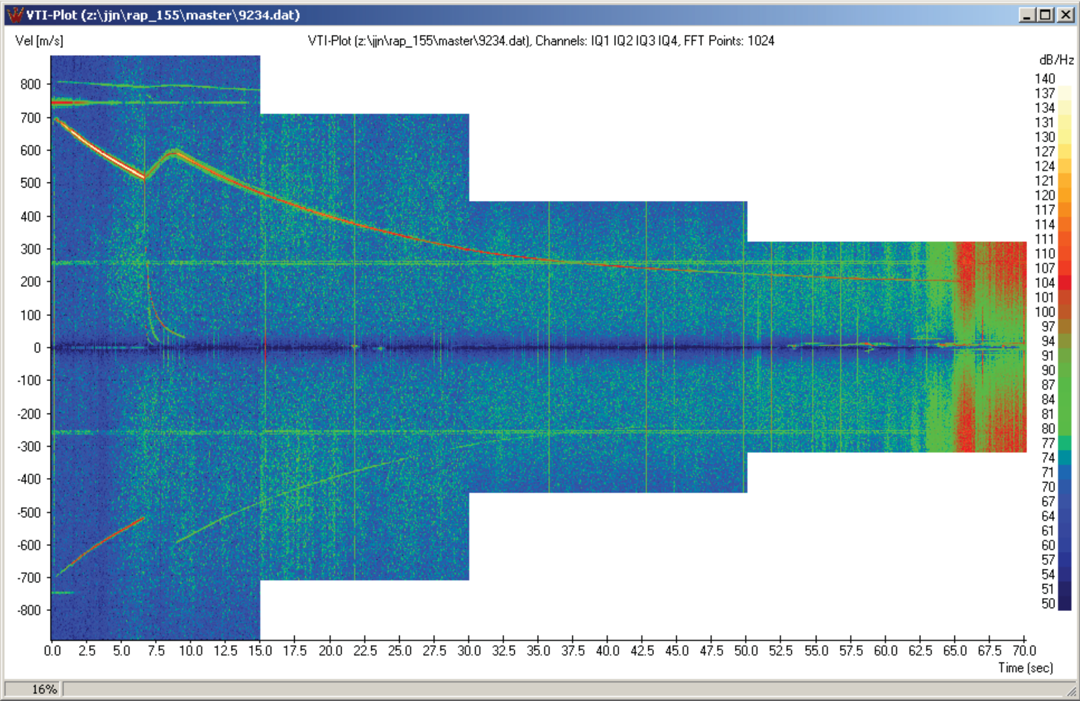
The Doppler Time Intensity (DTI) plot shows the power of the received Doppler signals as a function of time. Because the Doppler frequency is proportional to the velocity the y-axis is often indicating velocity rather than frequency offset. In that case the graph is called a Velocity Time Intensity (VTI) plot.

To draw a DTI or VTI plot:

1. Select the **DTI** processing option.
2. Configure the FFT Parameters (page 98).
3. Select the **IQ Channels** to include in the processing.
4. Click the **Process** button.

To get a quick preview of what the result is going to look like select the **QDTI** option in step 1.

The status bar shows the progress of the processing and when complete the plot is shown:

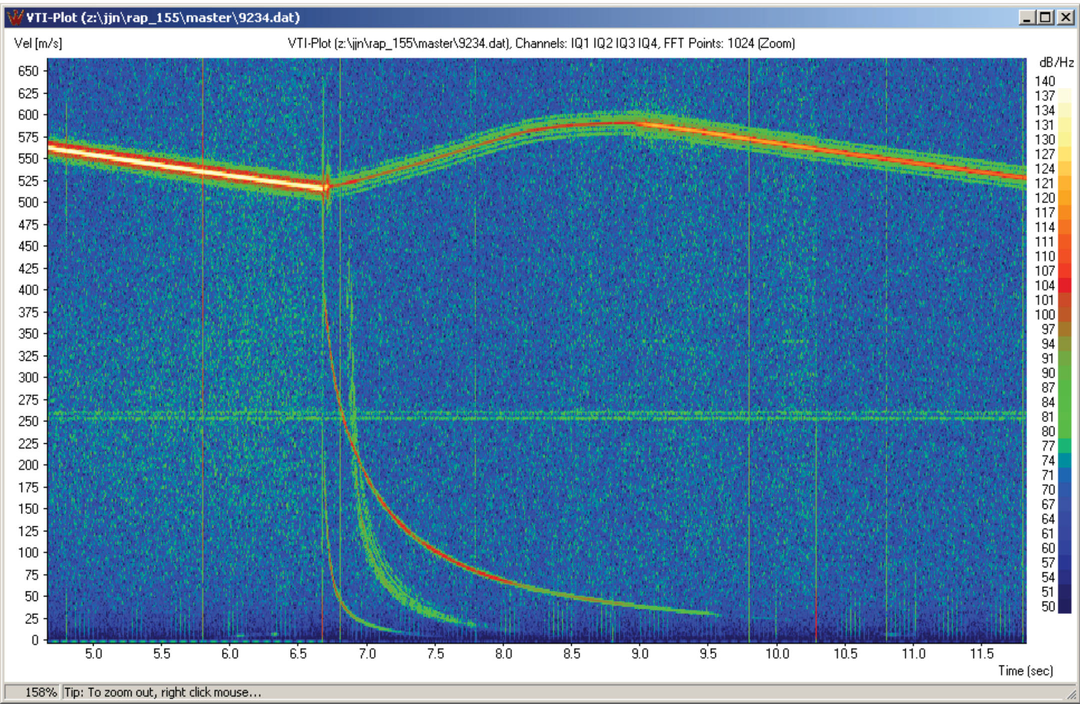


This VTI plot shows a 155mm RAP measured with a radar close to the launcher. The signal is recorded with a W-2100 using variable sampling rate to increase the effective measurement time.

The color coding of the power density is shown to the right.

10.3.1 View Details of the DTI

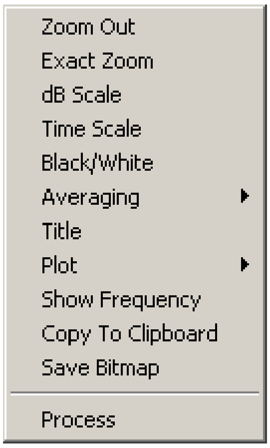
To use the zoom function just select an area of interest with the mouse pointer. The new plot is drawn when the left mouse button is released:



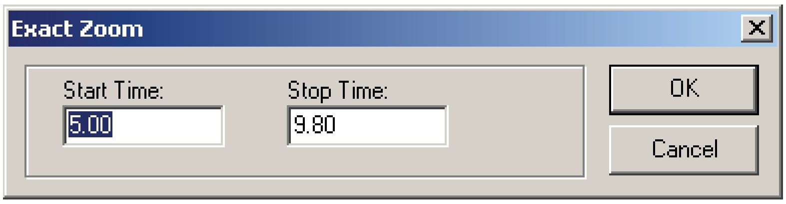
This plot shows the 155mm RAP boost phase. While the projectile gains velocity during the boost phase the objects falling off the projectile quickly loose velocity.

To specify an exact zoom window:

1. Right click on the DTI plot to get this menu:



2. Select **Exact Zoom** to enter the time interval of the zoom window.



Notes

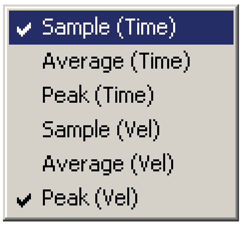
- ► Right click on the DTI plot and select **Zoom Out** to return to the full size plot.
- ► Use **Copy To Clipboard** if you want to copy the DTI plot directly into another application.
- ► Use **Save Bitmap** if you want to save the DTI plot in a separate file.

10.3.2 Configure the DTI Plot Parameters

A number of parameters control how the FFT output is converted to a DTI plot. To configure e.g. the DTI Plot averaging:

1. Right click on the DTI plot to get this menu:

2. Select **Averaging** to get this menu:



3. Change the **Time** or the **Vel** averaging mode.

To change one of the other parameters settings repeat step 1.

Configure	If you want to
dB Scale	Increase of decrease the sensitivity and offset of the color coding.
Black/White	View the DTI plot in black and white.
Averaging	Control how the color is chosen, when there is more than one FFT result per pixel. See below.
Title	Manually set the title of plot.
Show Frequency	Toggle between frequency and velocity units on the y-axis.

When the plot is drawn each colored area or pixel is associated with a specific time and velocity. Each of the FFT output values is associated with the pixel that is closest in time and velocity. That way each pixel represents one or more FFT output values.

When the number of FFTs is higher than the number of pixels on the x-axis (time) a suitable method for reducing the data must be selected. The same applies when the FFT length, and thereby the number of output values from a single FFT, is larger than the number of pixels on the y-axis (vel).

The **Time** and the **Vel** modes for combining the FFT output values are controlled independently. The following **Averaging** options are available:

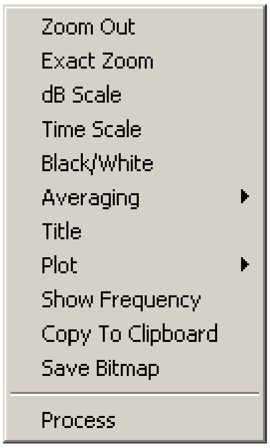
Use	If you want to
Sample	Choose the value closest to the time or the velocity of the pixel.
Average	Average the FFT output values over the time or velocity interval covered by the pixel.

Use	If you want to
Peak	Use the largest value in the time or velocity interval covered by the pixel.

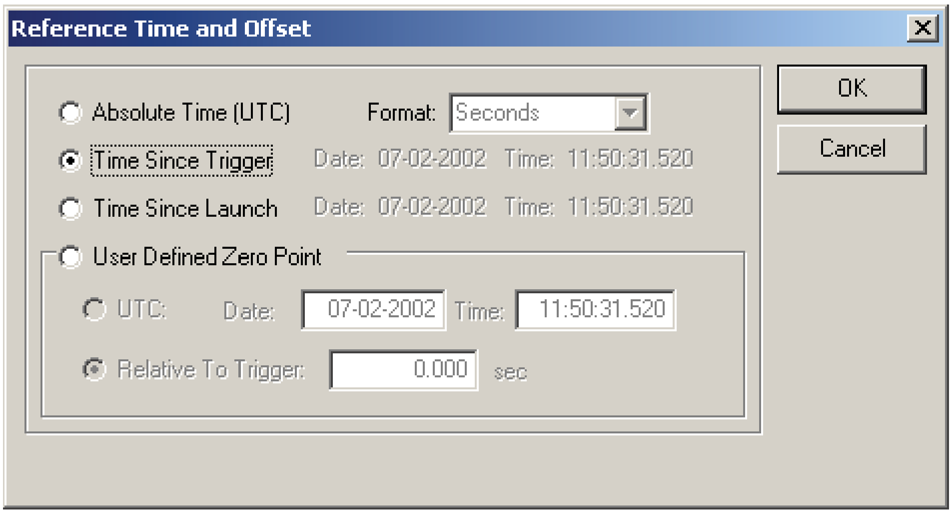
10.3.3 Time Scale

To change the timing of data or to display the data using another time scale do the following:

1. Right click on the DTI plot to get this menu:



2. Select the **Time Scale** option to get this window:



3. To display data using another time scale, select one of the first three options. For old .trk files, the **Time Since Launch** options is not available.
4. The last option can be used to define a new **User Defined Zero Point** and when operating from the **Track File View**, this will modify the parameter REFERENCE in accordance with the new **User Defined Zero Point**.

Notes

- The time and date of Launch can be modified from by clicking the **More Info** button on the Process Setup dialog.
- The **Absolute Time (UTC)** has different formats to choose between.

10.3.4 Draw the Spectrum Plot

To change the timing of data or to display the data using another time scale do the To get a more detailed graphical representation of the frequency components and their relative strength the power spectrum plot is very useful. It plots the power versus frequency/velocity.

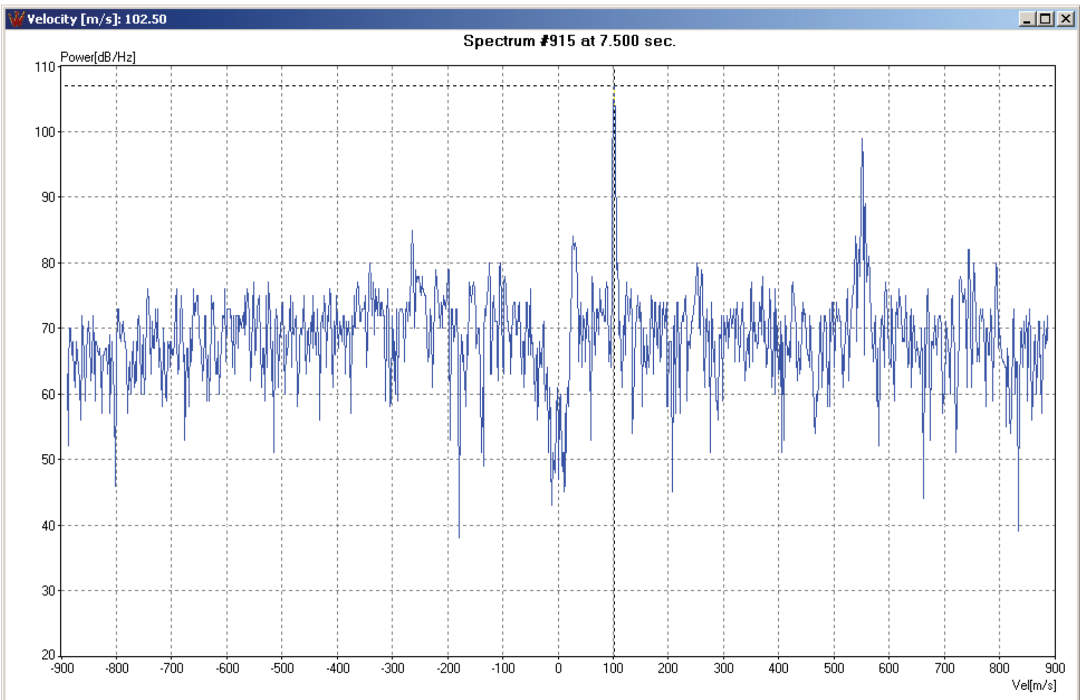
To view the spectrum plot:

1. Right click on the DTI plot to get this menu:

2. Select the **Plot** option to get this menu:

3. Select the spectrum plot option to draw the spectrum.

The following spectrum plot is from the 155mm RAP projectile.



This plot shows the FFT output 7.5 seconds from start and the cross hair is located at the largest peak, which is at 102.5 m/s. The peak at 570 m/s is the projectile, while the largest peak is an object that fell off the projectile when the rocket was started.

Use	If you want to
Selected Spectrum	Plot a single FFT output. The FFT is selected by cross hair on the DTI plot. Moving the cross hair with the arrow keys updates the spectrum plot.
Average of Shown Spectra	Plot an average of the FFTs selected by the DTI zoom window, see View Details of the DTI (page 104).

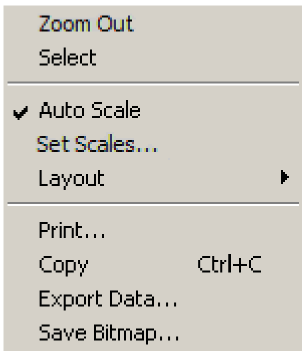
Notes

- ► To use the zoom function, just select an area of interest with the mouse pointer. The new plot is drawn when the left mouse button is released.
- ► The averaging mode is extremely powerful when checking the system for spurious noise components: point the antenna up into the sky and record a couple of seconds of signal with and without the transmitter turned on. Ideally both signals have an identical and spurious free averaged power spectrum.

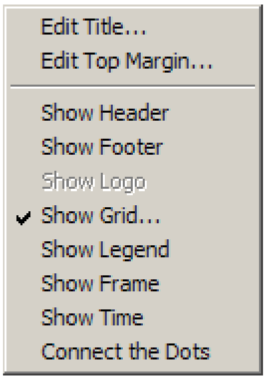
10.3.5 Configure the Spectrum Plot

Before you configure the spectrum plot you need to Draw the Spectrum Plot (page 108). A number of parameters control how the spectrum plot is drawn. To configure e.g. the **Layout** parameters:

1. Right click on the spectrum plot to get this menu:



2. Select **Layout** to get this menu:



3. Change the parameter and click **OK**.

The options available in the first menu are:

Use	If you want to
Zoom Out	Return to the full size spectrum plot.
Select	Not applicable.
Auto Scale	Scale the axes based on the power and velocity values.
Set Scales	Manually specify the power and velocity intervals displayed.
Layout	Use the sub menu, see below.
Print	Print the spectrum plot.
Export Data	Save the spectrum plot as ASCII text file (TXT).
Save Bitmap	Save the spectrum plot as an Enhanced Metafile (EMF), a bitmap file (BMP) or as a compressed bitmap file (PNG)
Copy	Transfer the plot to the clipboard.

The options available in the **Layout** menu are:

Use/enable	If you want to
Title	Change the title of the plot.
Edit Top Margin	Add/remove margin to the top of the graph.
Show Header	Not applicable.
Show Footer	Not applicable.
Show Logo	Not applicable.
Show Grid	Toggle grid on/off.
Show Legend	Add legend text to the graph.
Show Frame	Toggle an outside border frame on/off.
Show Time	Not applicable.
Connect the Dots	Not applicable.

10.4 Draw an ST Plot

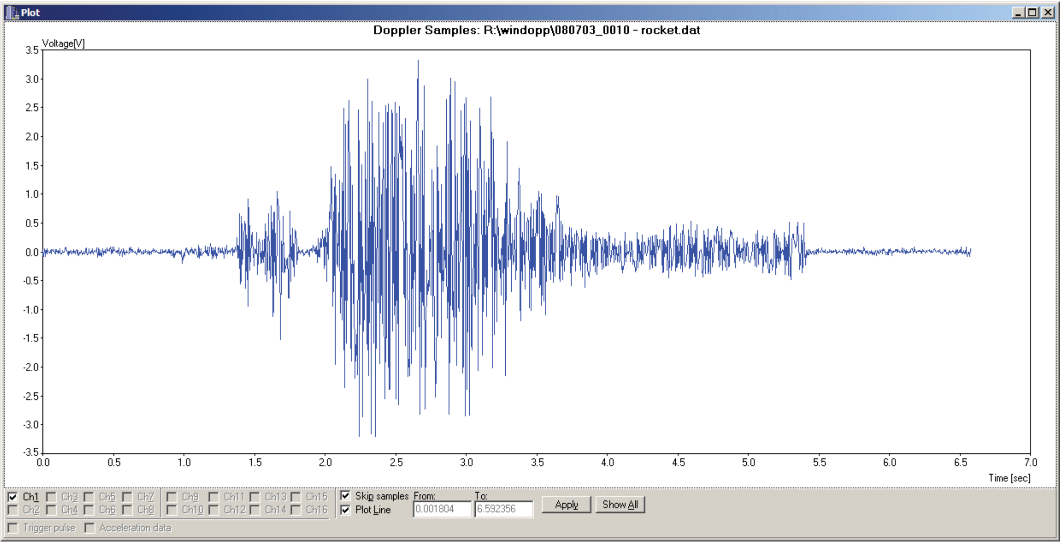
To access the **Process Setup** window see Open a DAT File (page 91).

The Signal Time plot (ST Plot) shows the received Doppler signals versus time.

To draw an ST plot:

1. Select the **ST** processing option.
2. Click the **Process** button.

This displays a quick view of the signal versus time showing only a subset of the samples from channel 1:



This ST plot shows a rocket launched close to the radar.

To take a further look at the signal versus time:

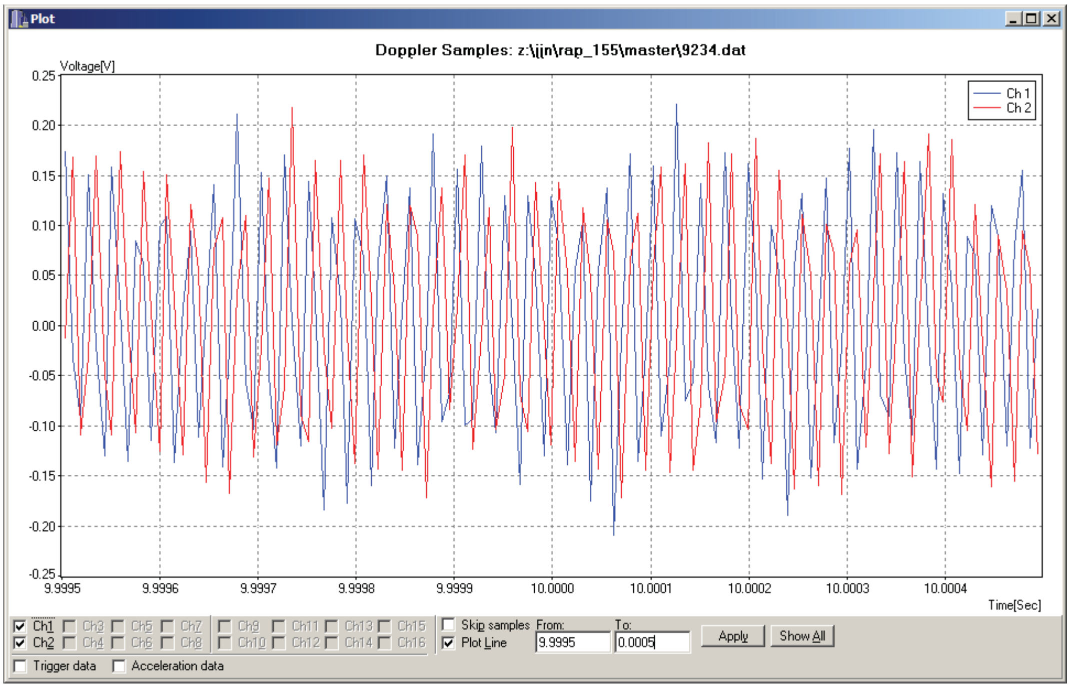
Use/enable	If you want to
Ch1 to Ch16	Draw the selected channels on the same plot.
Trigger pulse	Draw the trigger pulse on the same plot.
Acceleration data	Draw the acceleration on the same plot.
Skip Samples	Draw only a subset of the samples. Uncheck this option to view all samples.
Plot Line	Draw a line between samples from the same channel. Uncheck this option to view samples as points only.
From/To	Specify the start and end time of the plot.
Apply	Redraw the plot with the current settings.
Show All	Enable **Skip Samples** and set the **From/To** variables to the start and end of the measurement. You may need to Zoom out in order to see the full plot.

Notes

- To use the zoom function just select an area of interest with the mouse pointer. The new plot is drawn when the left mouse button is released. See also View Details of the ST Plot (page 112).
- Right click on the plot to configure a set of parameters and options that control the plot drawing. This is where the **Zoom out** option is.
- Use the ST plot to verify that the radar receiver is operating at a reasonable signal level. Select a time interval with a high signal, uncheck the **Skip Samples** option and check the signal for saturation effects (clipping).
- Double click to the right of the **Show All** button to invert the channel selection. This is a fast way of selecting all channels.

10.4.1 View Details of the ST Plot

To use the zoom function just select an area of interest with the mouse pointer. The new plot is drawn when the left mouse button is released:



This plot shows channels 1 and 2 around t = 10 seconds with all samples shown with lines between them. These are the signals from the first IQ mixer. They are offset by approximately 90º corresponding to a dominating single frequency signal.

10.5 Detect Single/Multi Object Tracks

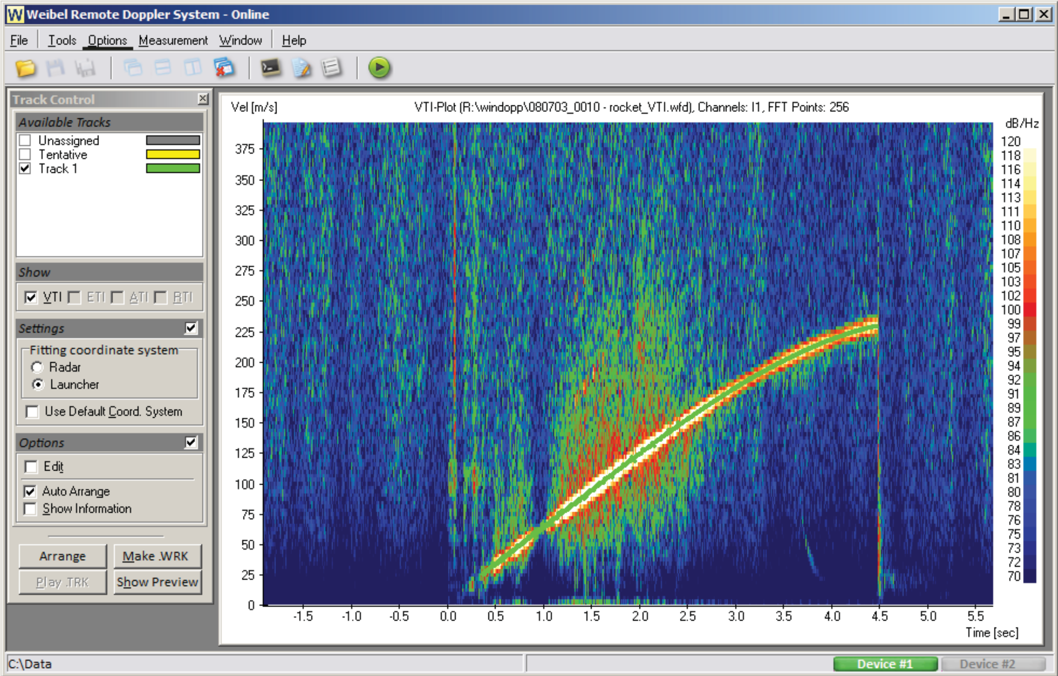
To access the **Process Setup** window see Open a DAT File (page 91).

The SOT/MOT processing function permits to identify the objects present in a DAT file recording and group their measured velocity and position along time into tracks which later can be incorporated into a WRK file for further post-processing and data visualization. The SOT (Single-Object processing) identifies only the most prominent object in the recording and generates a single track record for it. The MOT (Multi-Object processing) generates as many track records as signals potentially corresponding to targets are found in the recording.

To activate the SOT/MOT processing:

1. Select the **SOT/MOT** processing option.
2. Configure the FFT Parameters (page 98).
3. Select a predefined set of MOT Parameters (page 113).
4. Select the **IQ Channels** to include in the processing.
5. Click the **Process** button.

The status bar shows the progress of the processing. When complete the following windows are shown:



The two sub windows in this figure are:

- The Track Control window listing all the detected tracks and their unique color, see Use the Track Control Window (page 114).
- The VTI Plot window with each of the detected tracks shown with a unique color, see Add or Delete Points from a Track (page 118).

10.5.1 Select a Predefined Set of MOT Parameters

To access the **Process Setup** window see Open a DAT File (page 91). The **Processing Parameter Set** area is located at the bottom of the **Process Setup** form. The drop-down list at the right allows selecting the parameter set to be used in the next processing.

In WinDopp only the **Default** set of parameters are available.

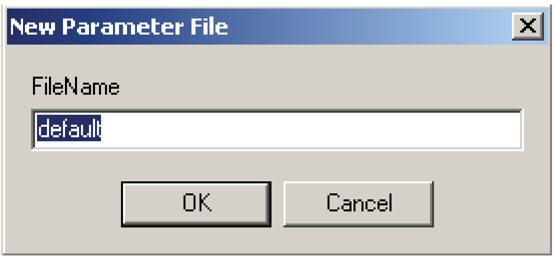
Pre-defined Parameter sets for the MOT:

Use	If you want to
default	Track a generic target. This is the recommended set for ballistic projectiles and rocket-assisted projectiles.
spin_search	Parameter set used by the Spin Analysis function.

To create a new parameter set or modify an existing one:

1. Enable the **Show/Edit** checkbox to view parameter values associated to the current parameter set. This requires the **Enable advanced process settings** to be enabled on the Customize Miscellaneous (page 15) tab.

2. Edit the values of the parameters as required
3. Click **Save** to store the new parameters. At this point it is possible to decide whether the new parameters must be stored under the same name or a new one.

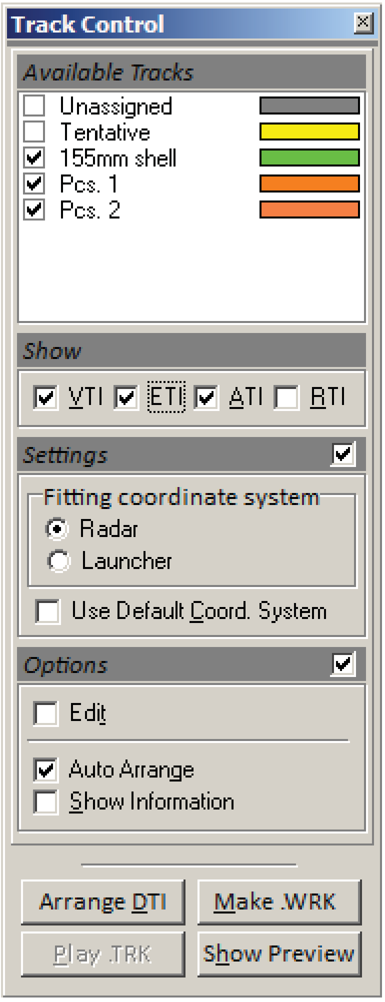


To delete an existing parameter set:

1. Enable the **Show/Edit** checkbox and select the parameter set to be deleted from the drop-down list.
2. Click **Delete**.

10.5.2 Use the Track Control Window

When the MOT processing is complete the result is presented on the screen, see Detect Single/Multi Object Tracks (page 112). The **Track Control** window provides tools for inspecting and manually editing the tracks identified by the MOT before the result is converted into a WRK file for further processing.



A track is associated with a number of measurement points and furthermore has a set of configurable properties, e.g. a name and a color; see Change the Properties of a Track (page 116).

Show or hide a section use the section-checkmark:

The **Track Control** window contains the following options:

Enable/Use	If you want to
Available Tracks	Show specific active tracks found by the MOT algorithm. Right click a track to Change the Properties of a Track (page 116), e.g. name and color.
Show VTI/ETI/ATI/RTI	Control which plots to display: VTI, ETI, ATI and RTI.
Fitting Coordinate System:	Select the coordinate system used for the fitting of data.
Use Def. Coord. System	Override the coordinate system recorded in the measurement file and assign the current default coordinate system to the results generated by the "Make WRK" function.

Enable/Use	If you want to
Edit	Manually Add or Delete Points from a Track (page 118).
Auto Arrange	Resize the selected plots and redraw them every time a change has been made.
Arrange DTI	Resize the selected plots and redraw them.
Make WRK	Convert the result to a WRK file for further processing.
Show Preview	Quick view of the track results in the form of graphs with Velocity, Azimuth, Elevation, Range and Altitude vs. Time and Ground Track relative to the radar location.

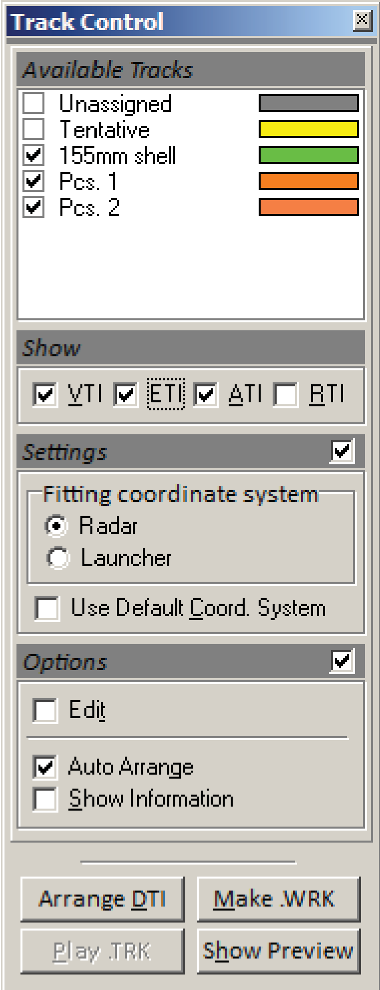
Notes

- The first two items on the **Tracks** list have a special function: The **Unassigned** item holds the single points which did not qualify for tentative track. The **Tentative** item holds the points that were assigned to a tentative track without reaching the confirmation level required to become a real track.
- The operator may want to assign points of an unassigned or tentative track to one of the real tracks manually, see Add or Delete Points from a Track (page 118).
- For Inbore Analysis the Track Control window contains an additional section called “Inbore Processing”. See Perform Inbore Analysis (page 158) for further information.

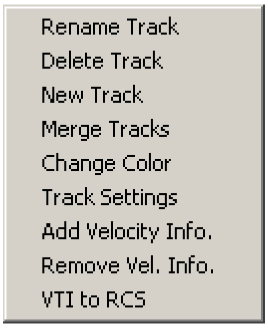
10.5.3 Change the Properties of a Track

To change the properties of a track:

1. Click the track in the **Track Control** window to select it.



2. Right click to view the options window.



3. Select the property to change from the list.
4. Change the property and click **OK**.

Use	If you want to
Rename Track	Assign another name to the track.
Delete Track	Remove the track from the track list and assign its points assigned to the **Tentative** item.

Use	If you want to
New Track	Add a new track to the track list. You can assign points to the track using the Add or Delete Points from a Track (page 118) feature.
Merge Tracks	Merge all points assigned to a track into another track. The “donor” track is deleted from the list when the merge is complete. Those points from the “donor” track which occupy the same time slice as points in the receiving track are moved to the **Unassigned** item.
Change Color	Change the color of the track when drawn upon one of the plots.
Track Settings	Change the Track Settings (page 121).
Add Velocity Info.	Associate to a track resulting from an FMCW waveform the velocity CW measurements from another track (see notes).
Remove Velocity Info.	Remove the velocity CW measurements from a track resulting from an FMCW waveform (see notes).

Notes

► In general, due to the inherent range-velocity coupling in the raw FMCW measurements, no validated range measurements will be provided by an FMCW track unless it has received at least one velocity measurement from the CW channel. In case no (or wrong) associations were automatically found during processing, the “Remove Velocity Info.” and “Add Velocity Info.” tools allow to first remove wrong velocity information from an FMCW track and then assign the correct one from a CW track (which also can be manually created by the user)

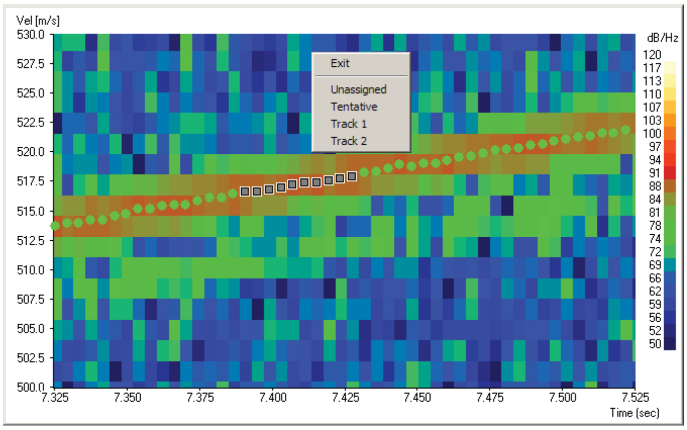
10.5.4 Add or Delete Points from a Track

To move (or re-assign) points from one track to another track:

1. Enable the relevant tracks from the Tracks list, e.g. the **Unassigned** and **Track 1** and **Track 2**.
2. Zoom in on the part of the track you want to edit.
3. Click the **Edit** check box in the **Track Control** window.

   Note that the window turns white.
4. Select the points to be added to the track with the mouse pointer. The selected points are shown with a square box around them.
5. Right click and select the target track from the list.



The points are given the color of the track they are assigned to.

6. Uncheck the **Edit** check box in the **Track Control** window to switch back to zoom control.

In this example the unassigned points (grey) are selected and then assigned to track 1.

Notes

► To remove points from a track use the same procedure. In step 5 assign the points to the **Unassigned** track to remove them from the original track. You can also hit **Delete** to remove the points from track without reassigning them to another track.

► You may enable/disable tracks after zooming in on a detail.

► Select Exit from the selection list in step 5 to return to zoom mode. Same effect as step 6.

10.5.5 Manually Add New Points to a Track

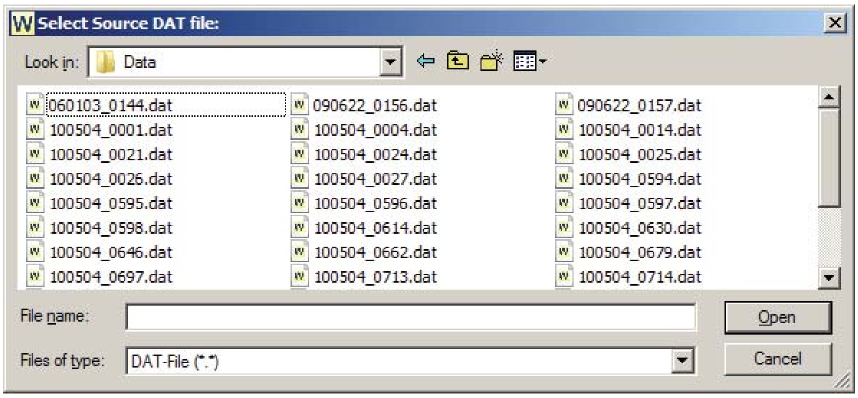
It is possible to add new points to a track directly in the VTI plot. Because this selection does not convey any phase information, it is only possible to use these points for speed estimation, not position.

To add a new point to and existing track:

1. In the **Track Control** window select the track to add points to, by clicking on the track name.
2. In the VTI plot, zoom in on the part of the track you want to edit.
3. Click the **Edit** check box in the **Track Control** window.

   Note that the window turns white.
4. Press and hold the Insert key. This enables manual adding of new points.
5. In the VTI plot, click one or more times to add new points. Every new click makes the application process the DAT-file from which the TRK-file was generated at the location required by the user.

   If the application cannot automatically find the DAT-file from which the TRK-file was generated, a dialog window will pop up allowing the user to manually define the current location of the DAT-file.



6. Release the **Insert** key to return to normal edit mode.
7. Uncheck the **Edit** check box in the **Track Control** window to switch back to zoom control.

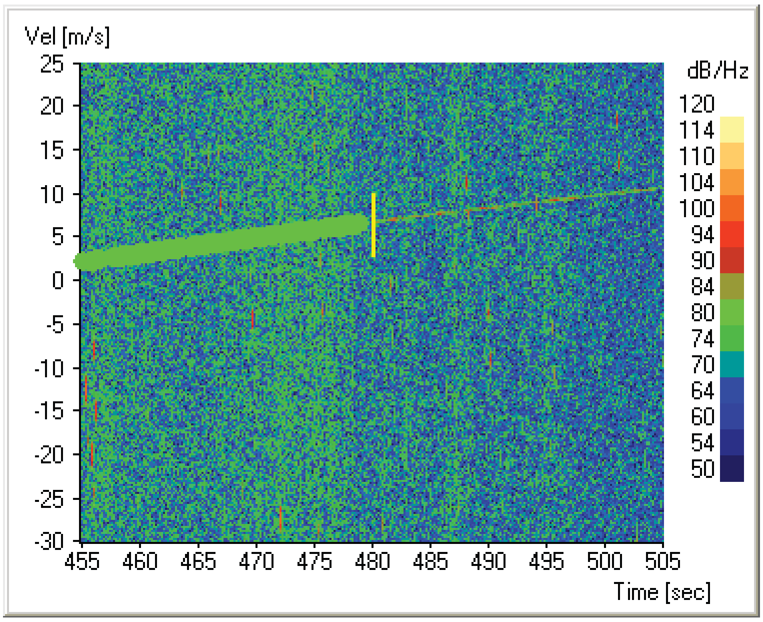
Notes

► To remove (undo) points from the track during the add procedure, release the **Insert** button, click on the unwanted point and press **Delete**. Then, press **Insert** to continue the add procedure.

10.5.6 Manually Track Objects

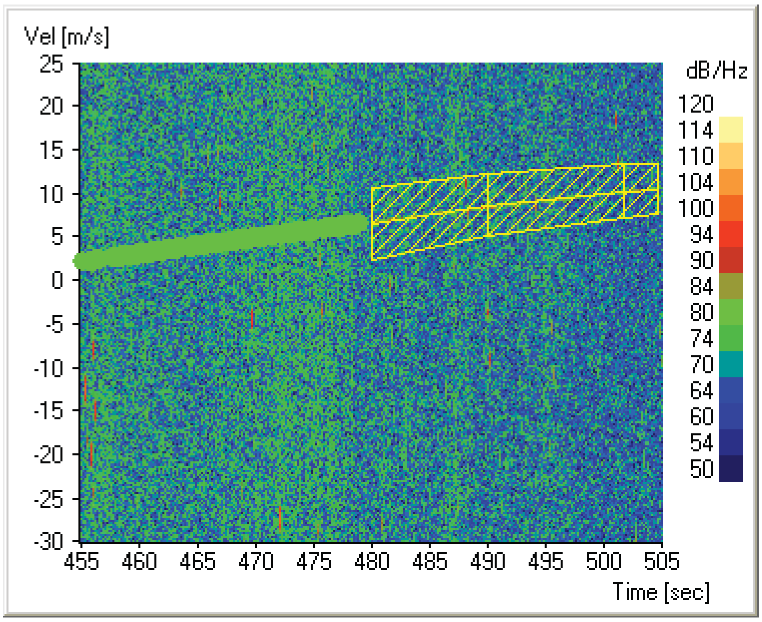
If for some reason a part of a track has not been detected during the DAT-file processing it is possible to manually point out the specific region in the VTI plot and redo the SOT/MOT processing with higher detection sensitivity:

1. Zoom in on the part of the signal you want to track on.
2. Press and hold the **Insert** button on the keyboard.
3. In the VTI view, click on the start of the signal you want to track. While holding down the left mouse button, drag the mouse up and down to adjust the vertical interval to search in and then release the mouse button:



4. Continue to click and drag intervals along the signal, to form a polygonal area

containing the signal:



5. Release the **Insert** button. This will trigger the SOT/MOT process searching for a track in the marked region.

   If the application cannot automatically find the DAT-file from which the TRK-file was generated, a dialog window will pop up allowing the user to manually define the current location of the DAT-file.

Notes

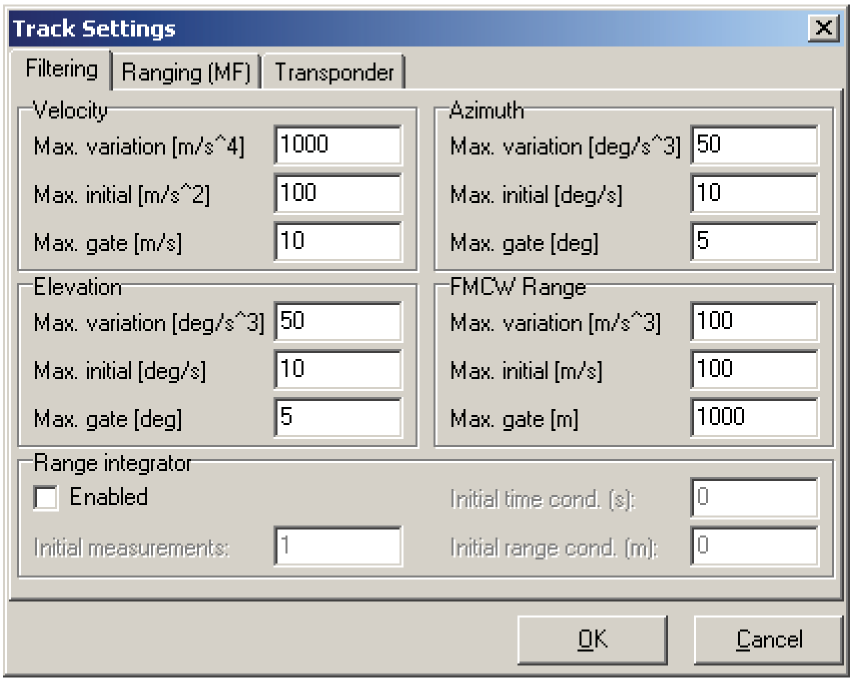
- ► While holding the **Insert** button, the most recently created interval can be undone by right clicking the mouse.
- ► After SOT/MOT processing the result is added as a new track. To append the result to an existing track, use **Merge Tracks** as described above.

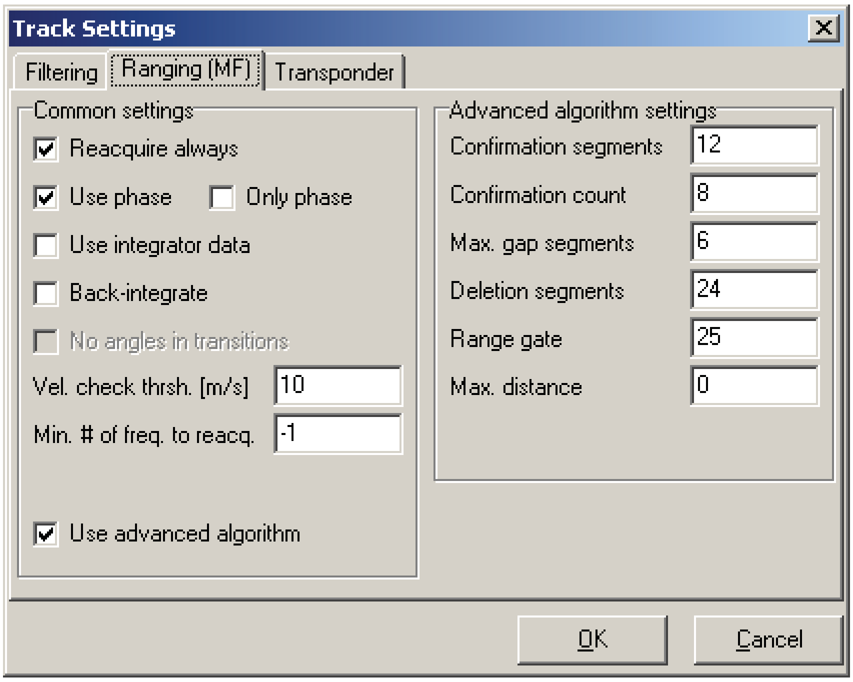
10.5.7 Change the Track Settings

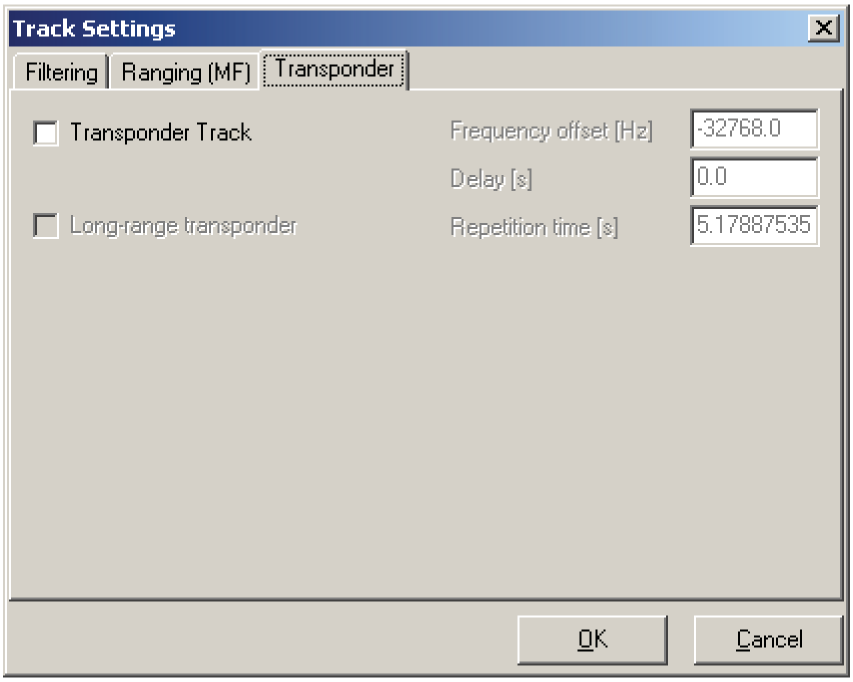
To reprocess the information contained in the points assigned to a track to yield the final measurements, and modify the way in which this is done.

The parameters in the form that appears when the option is selected are a sub set of the full set. They have the same meaning, except for the fact that their effect is restricted to the selected track.

The parameters do not change which points are assigned to the track but only how the new velocity and range measurements are calculated. Following is a list of the most common operations.


Track Settings
Filtering
Ranging (MF)
Transponder
Velocity
Max. variation [m/s^4] 1000
Max. initial [m/s^2] 100
Max. gate [m/s] 10
Azimuth
Max. variation [deg/s^3] 50
Max. initial [deg/s] 10
Max. gate [deg] 5
Elevation
Max. variation [deg/s^3] 50
Max. initial [deg/s] 10
Max. gate [deg] 5
FMCW Range
Max. variation [m/s^3] 100
Max. initial [m/s] 100
Max. gate [m] 1000
Range integrator
Enabled
Initial time cond. [s]: 0
Initial measurements: 1
Initial range cond. [m]: 0
OK
Cancel


Track Settings
Filtering
Ranging (MF)
Transponder
Common settings
Reacquire always
Use phase
Only phase
Use integrator data
Back-integrate
No angles in transitions
Vel. check thrsh. [m/s] 10
Min. # of freq. to reacq. -1
Use advanced algorithm
Advanced algorithm settings
Confirmation segments 12
Confirmation count 8
Max. gap segments 6
Deletion segments 24
Range gate 25
Max. distance 0
OK
Cancel



Use	If you want to
Range Integrator	Calculate range from the integrated velocity of track when no other information is available. Use the parameters under the checkbox to set the initial conditions of the integration process. The results from the range integrator can be used as a "seed" for range calculations with MFCW waveforms (see below).
Transponder	Declare the track as being generated by a transponder. The offset frequency of the transponder can be set in the "Transponder Offset" field.

10.5.8 Load a Set of MOT Results

When data has been processed with the MOT algorithm, the results are stored on the disk in the **Work Location**, where the DAT file holding the Doppler data is stored, see Customize File Locations (page 13).

To reload the MOT results:

1. On the **File** menu, click **Open**
2. From the file select window choose the TRK file
3. Click **Open**.

Notes

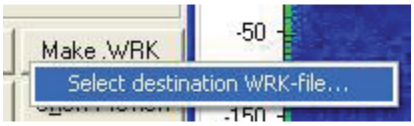
► The **Diff**. results in the first information box are the differences between two consecutively selected (Time, Vel) coordinates.

10.5.9 Generate Work File Results

The tracks generated by a MOT/SOT processing must be incorporated to a Work File for further processing (trajectory smoothing, drag coefficient calculation, event identification, data export, etc). To achieve this:

1. On the **Track Control** window select those tracks that must be incorporated to a Work File.
2. Click on **Make WRK** to select as destination **Work File** for the results, the one with the same root name as the **Track File.** If no Work File with that name exists, a new one will be created.

   Should another Work File name be selected, right-click on **Make WRK**, and then click on **Select destination WRK-file** on the pop-up menu.

   A dialog window will then allow to specify the name of an existing (or to be created) Work File where the results will be stored.
3. The selected tracks are added to the selected destination Work File and shown ready for additional processing. For further details see WRK File Processing (page 163).

10.5.10 Print Results

A single DTI plot can be printed by right-clicking on the plot and select **Print**. Two or more of the VTI, ETI, ATI, or RTI plots can be printed on the same page. To achieve this:

1. In the **Track Control** window select (display) those tracks that should be included in the print.
2. Select **Print** from the **File** menu.

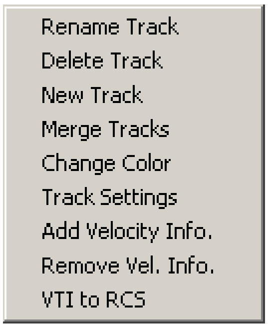
Notes

► The print out reflects the current shown DTI settings (color, B/W, scale, etc.).

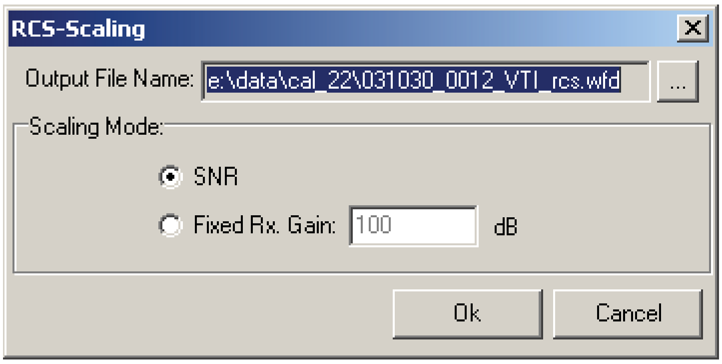
10.5.11 Generate an RCS-scaled DTI

The VTI plot linked to a given TRK file may be scaled to show the apparent radar cross sections of the signals present in it. The scaling is carried out on the basis of the measured slant range to only one of tracks, being all other signals scaled attending to their relative amplitude with respect to that of the reference track. The resulting RCS-scaled VTI will depict blank spectra in those cases where no range data is available from the reference track. To generate an RCS-scaled DTI:

1. In the **Track Control** window select the track whose range will be used to create the new RCS-scaled DTI.
2. Right click and select the “VTI to RCS” option of the pop-down menu.



3. The following form appears, which permits to configure how the scaling will be performed:



4. In the “Output File Name” box a name for the final DTI is proposed. The file name may be changed by clicking on the button to the right of the box.
5. The scaling method is chosen by clicking on the “SNR” or the “Fixed Rx. Gain” buttons.

   In the SNR-based scaling mode, the nominal system noise figure is assumed to originate the observed noise background of the spectra and the input signal power levels calculated on the basis of the measured signal-to-noise ratio of the previously selected track. This is the recommended scaling method for most situations, since it also accounts for the presence of the Automatic Control Gain in the receiver chain.

   In the Fixed Receiver Gain scaling mode, a given gain is assumed for the receiver gain, which can be edited, and the input signal levels derived from the amplitude of the signals. This mode is intended to be used when the data was acquired with the receiver set in a fixed gain mode.

10.6 Configure Advanced MOT Parameters

The MOT algorithm is controlled by a large set of parameters offering extensive flexibility. It is recommended that less experienced users Select a Predefined Set of MOT Parameters (page 113) that best fit their measurement task.

To activate this window Open a DAT File (page 91), click the MOT/SOT icon and enable the **Show/Edit** checkbox in the **Processing Parameter Set** area. A number of tab sheets appear below the process window.

Any changes to the settings take effect when the **Process** button is activated.

10.6.1 The MOT Process Step by Step

The MOT process is repeated whenever a new Doppler spectrum is available. The time between these updates is defined by user selected parameters and for the real-time MOT also the capacity of the processing units (DSPs and CPU) of the RTP.

In each time slot the Multi Object Tracking process performs the following steps:

1. **Analyze the Doppler spectrum**

   Perform windowed FFT and estimate the signal to noise ratio (SNR) for each peak in the spectrum and extract those with a SNR above the set threshold.

   The output from this step is a raw set of spectrum peaks, each corresponding to a potential target.

   For more details see Define Extractor MOT Parameters (page 134).

2. **Cancel peaks that are likely to be "false" targets**

   For example spin modulation, harmonics or a mirror image due to mixer imperfections.

   The output of from this step is a cleaned up set of spectrum peaks also called detections.

   For more details see Cancellers (page 136).

3. **Assign detections to existing tracks**

   For each existing track an updated set of Kalman filters predict the most likely "next observation" in terms of velocity, elevation and azimuth and intervals of likely observation values, also called gates. The detection that is within the gates and is closest to the predicted value is assigned to the track.

   If no detection is found within the gate(s) then the track has no update in this time slot. Note that the size of the gate depends both on the expected dynamics of the target as defined by e.g. the variation value and on the observed measurement noise.

   The output of this step is a set of updated tracks, a set of tracks with no update and a set of unassigned detections.

   For more details see Define Filtering MOT Parameters (page 139).

4. **Promote or delete tracks**

   The decision is based on the events in step 3:

   - Promote a tentative track with sufficient updates to "confirmed"
   - Delete a tentative track with insufficient updates
   - Delete a confirmed track with insufficient updates

   A good threshold for promoting or deleting tracks takes the dynamics of the targets observed by the radar into account and has a fair trade-off between false detections and late detections.

   The output of this step is a set of updated tracks.

   For more details see Confirming the Track (page 142) and About the Track Life Cycle (page 145).

5. **Create new tentative tracks**

   This step takes both the previous and the current set of unassigned detections into consideration.

   The output of this step is a set of tentative tracks and a set of remaining unassigned detections, which in the next time slot is considered as the previous set of unassigned detections.

For more details see Define Management MOT Parameters (page 141).

6. **Update the range value of each track**

   This step depends on the range mode of the radar.

Notes

- If you see the target in the DTI but not as a track then enable the list of Unassigned detections.

  If detections coincide with the trace seen in the DTI then the Kalman filter gates may be too narrow to accept the detections as valid track extensions.

  If no or very sparse detections are seen then the SNR criteria may be too high.

- If the track appears much later than the trace seen in the DTI then the Confirmation Time may be set too high.

10.6.2 About the MOT/SOT Parameters

What's really important about MOT/SOT parameters?

Here is a list, in descending order of importance, of the most significant MOT/SOT parameters. In general, given a set of parameter values, the same type of results should be obtained either for MOT or SOT, except for the fact that SOT keeps, after a regular MOT processing, the most significant tracks attending to the criteria selected in the "Management / SOT Post-Processing" section.

Max. variation [m/s^4], see Define Filtering MOT Parameters (page 139).

This parameter controls how quickly the velocity tracking filter adapts to sudden variations in the radial velocity (more rigorously, in the radial acceleration) of the tracked target. Augmenting the value of this parameter amounts to reducing the number of previous velocity measurements that are used to predict the next measurement (this is, the center of the association gate), and increasing the rate at which the association gates of the track will expand when measurements are missing for several periods. It is the first candidate for a modification if late track confirmation problems (such as at the beginning of ballistic trajectories near muzzle velocity or separation point). Modifications of several orders of magnitude are not unusual for very quick scenarios. For slow scenarios, appropriate reductions of this parameter can provide significant improvements when tracking close or crossing targets in Doppler.

There are similar maneuver parameters for the elevation and azimuth tracking filters. They have no effect for the moment in the overall tracking performance as gating is done by default only in velocity (all gating selection checkboxes in the "Management" section disabled except for the one labeled "Doppler gating"). Modifying their value will only affect the apparent smoothness of the filtered angle trajectories when gating information is depicted in the debug graphs.

Confirmation Time, see Define Management MOT Parameters (page 141).

This parameter determines how long a target must be tracked before declaring the track as confirmed or rejected (based on its apparent quality). The quality of the track is quantified by measuring its observed probability detection, and the quality threshold is determined by the “Management -> Confirmation %” parameter. Its value corresponds to the minimum required percentage of the confirmation time along which the track received updates. For more information see Confirming the Track (page 142).

Scenarios with low sampling rates can benefit in general from longer confirmation times and higher confirmation thresholds, as this will keep at a minimum the number of spurious tracks in the results. For scenarios with fast sampling rates or short duration tracks it will be necessary to reduce the extent of the confirmation time down to values comparable to the duration of the expected tracks in the recording. This is usually the case when many tentative tracks are seen in the results but none of them confirmed.

An intermediate possibility lies in activating the “Management -> Range Confirmation” checkbox. This option adds an additional constraint to the track confirmation decision by requiring a certain correlation between the measured radial velocity and the range rate extracted from the MF range channels (according to the settings in the “MF Range” section). For this option to work the confirmation time must be at least longer than the frequency step used in the system (typically 0.3 seconds) and the final speed of confirmation will be highly dependent on the quality of the range information.

Discard Unassg./Discard. Tentat., see Define Management MOT Parameters (page 141).

If checked, no unassigned plots or tentative tracks are stored in the results file. Very effective to reduce the extent of the track files and to improve the quickness of response of the track GUI if no further edition is to be carried out.

Deletion Time, see Define Management MOT Parameters (page 141).

This parameter quantifies when the tracks will be regarded as finished. This will occur when a track doesn’t receive any confirmation for a time longer than the one specified by the parameter. Given the low probability of avoiding the association of incorrect detections to a track when prolonged target fading takes place, its main utility is avoiding that additional spurious information is added to the track once it is effectively finished (by reducing the extent of the deletion time). A similar result can be obtained by controlling the maximum extent of the association gate with the “Filtering -> Max. Vel. Gate (m/s)” parameter, which in clean and slow scenarios can provided better results.

Minimum Velocity, see Define Extractor MOT Parameters (page 134).

This parameter controls the minimum absolute radial velocity required for a detection to be considered as a candidate for MOT/SOT processing. This is an effective method to get rid of spurious tracks originating from low velocity clutter targets, such as clouds and birds. Extreme care must be taken to ensure that the actual target velocity is above this threshold. Otherwise the target detections are also cancelled. If targets must be track down to very low velocities it is preferable leaving the rejection of spurious clutter signals to the confirmation logic.

Minimum SNR, see Define Extractor MOT Parameters (page 134).

This parameter represents the detection threshold used by the MOT/SOT extractor. Starting from the noise level estimated from the cells surrounding the target, a noise margin of that many dB is added to obtain the final detection threshold. The correspondence between apparent target signal strength and detection expected performance is thus clear. The default setting guarantees a probability of false alarm of 10^{-6} in thermal noise with the default reference size. Any reduction will result in improved detection of weak targets but increased false alarms. To be handled with care. A 2 or 3 dB variation makes a lot of a difference in terms of false alarm rate.

Max. ini. [m/s^2], see Define Filtering MOT Parameters (page 139).

It determines the maximum radial acceleration that any target will be allowed to have to initiate a track on it. Its main purpose is to avoid the creation of targets on false alarms caused by thermal noise. If the false alarm probability is raised (for example by reducing the value of the previous parameter) it might be necessary to lower it to reduce the generation of spurious tracks. The default value (1200, this is 12G) should be enough to initiate a track on almost any kind of object.

There are versions of this parameter for the azimuth and elevation filters. Same comment applies as before: their value is irrelevant as long as only the Doppler gating option is active (which for the moment is the most robust configuration).

Peak Search Thrs, see Define Extractor MOT Parameters (page 134).

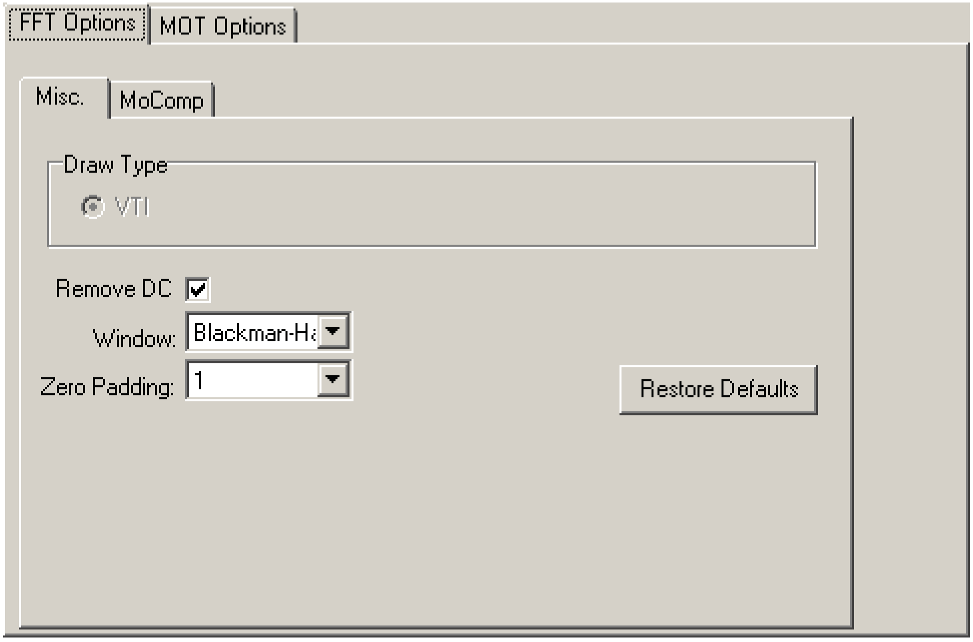
This parameter sets the peak detection sensitivity of the extractor. In brief, the peak of an area of detections is declared when at some point the signal level goes through a variation with respect to highest point found so far higher than the number of dB specified by the value of the parameter. It may be interesting to modify its value either, to gain some in-peak resolution by reducing its value (of doubtful utility in most cases), or to achieve the grouping of several near peaks into one single dominant. This may be interesting in situations where the presence of several near targets leads to erratic track maintenance or unsuccessful track confirmation.

Modulation Canceller, see Define Extractor MOT Parameters (page 134).

The modulation canceller prevents spurious signals generated by spin, jet engine, and rotor blade modulation from being declared as valid signals and subject to give rise to new tracks, this false even leading to the loss of the main track. As general rule, it is recommended to leave all cancellers activated when processing a DAT-file, since this will yield the most consistent results. However in some situations the canceller may originate non-intuitive track terminations, such as when a bigger object part separates from a smaller one, which happens to be the piece of interest. This effect has been observed tracking 155 mm RAP, and the predefined parameter set “rap155” addresses the problems caused by this phenomenon when running a SOT processing, by deactivating this canceller. Running the MOT process with this canceller deactivated may lead to generation of undesired tracks if the projectile presents heavy spin modulation.

10.6.3 Define Miscellaneous MOT Parameters

To activate this window Open a DAT File (page 91), click the MOT/SOT icon and enable **Advanced Settings**. On the **FFT Options** tab the **Misc.** parameters provide additional control over the way FFTs and phase difference calculations are performed.



The following processing options are available:

Use	If you want to
Restore Defaults	Recover the settings of the factory "default" Pre-Defined parameter set.
Remove DC	Eliminate residual DC levels in the signal (must be deactivated when processing Motion-Compensated files)
Window	Change the weighting function employed by the FFT processor. It determines the minimum amplitude and frequency difference between signals that the processor can resolve (see notes).
Zero Padding	Multiply the size of each FFT by the given factor by padding the signal samples with zeros

Notes

- The available FFT window functions are listed next with their associated highest side lobe level and equivalent noise width:

  Hanning: -32 dB ; 1.5 bin

  Rectangle: -13 dB ; 1 bin

  Blackman-Harris: -92 dB ; 2 bin

  Hanning-Poison: - ; 2 bin

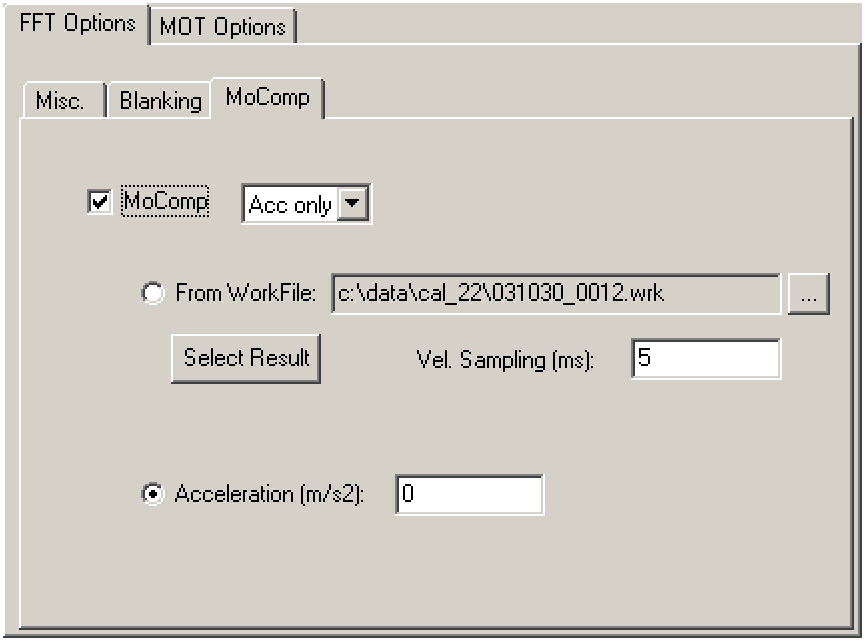
  Hamming: -43 dB ; 1.36 bin

- Care must be taken when changing the window function to also modify the "Avrg. cells per side" parameter (see Define Extractor MOT Parameters (page 134)) correspondingly (to be set to 3 if a Blackman-Harris window is used).

  This is also true when using the Zero Padding feature, see Calculate the Signal to Noise Ratio (page 138).

10.6.4 Define Motion Compensation MOT Parameters

To activate this window Open a DAT File (page 91), click the MOT icon and enable **Advanced Settings**. The controls on the **MoComp** tab sheet permit to compensate for the acceleration of the target of interest and therefore increase the FFT size to achieve higher processing gain and sensitivity.



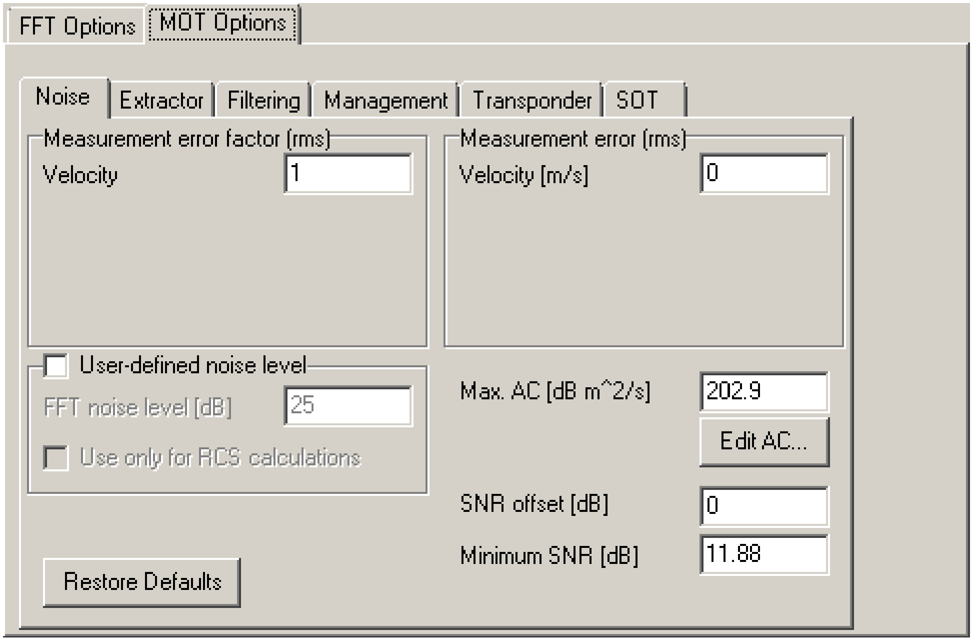
The following processing options are available:

Use	If you want to
MoComp	Compensate for the acceleration of the object of interest inside each FFT to achieve higher sensitivity. Select in the accompanying box “V and R” if you want to obtain a DTI with the signal translated to zero (reduces the effect of sidelobes) or “Acc only” if you want to leave the signals at their original positions.
From WorkFile	Employ at each point the instantaneous acceleration of the target as determined by a measurement result entry (either synthesized or from a previous processing) in the Work File whose name and location are shown in the edit box aside. By clicking on the button to the right it is possible to change the Work File from which the motion compensation information must be extracted.
Select Result	Choose the result entry in the above determined Work File that will be used for instantaneous acceleration compensation.

Use	If you want to
Acceleration	Manually introduce a constant acceleration for the target which will be used throughout the measurement (no information extracted from a Work File).

10.6.5 Define Noise MOT Parameters

To activate this window Open a DAT File (page 91), click the MOT icon and enable **Advanced Settings**. The set of parameters on the **Noise** tab sheet allow controlling the size of the track association gates.



The following processing options are available:

Use	If you want to
Measurement error factor	Multiply the measurement noise estimate by a given factor. This will result in a widening of the point-to-track association gate by the same factor. (See note.)
Measurement error	Add a given value to the measurement noise estimate. This will result in a widening of the point-to-track association gate by the same amount. (See note.)
Max. AC	Shows the maximum antenna loop gain achievable by the antenna used during the measurement.

Use	If you want to
Edit AC…	Activates tool to manually re-define the applicable antenna loop gain parameters. See Define Antenna Loop Gain (page 133).
SNR offset	Introduce a manual offset to be added the signal SNR values estimated by the processor.
User-defined noise level	Disable the automatic receiver noise level estimation and instead provide a known fixed noise receiver level.
FFT noise level	Specify a fixed receiver noise level in the same dB units as shown on WinTrack's DTI plots (see notes).
Use only for RCS calculations	Use the given fixed receiver noise level only for the SNR calculations from which the RCS is estimated, while leaving the detection of targets still based on the adaptive noise level estimation (this prevents the declaration of unnecessary false alarms in case the overall noise level in the receiver increases occasionally due to external factors).

Use	If you want to
Minimum SNR	Set the minimum signal detection threshold. Measurement points with signal/noise ratios below this value will be discarded.

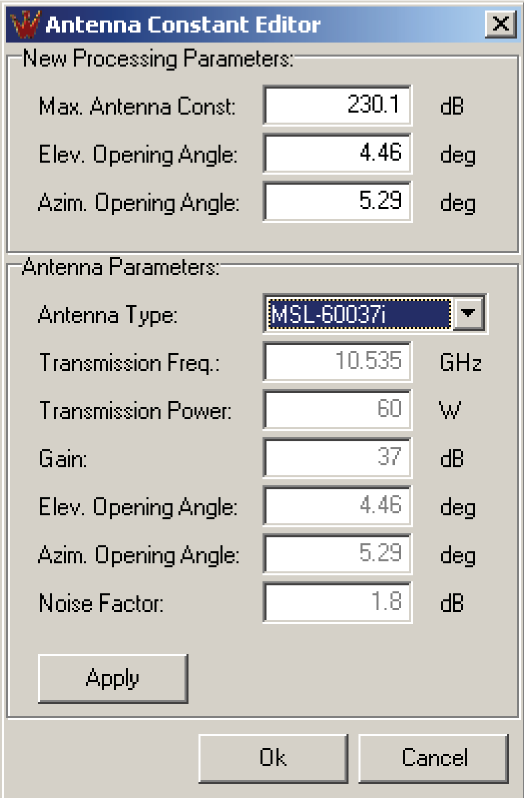
Notes

- The noise level shown on WinTrack's DTI plots is normalized such that for a given gain and noise factor in the receiver the average noise level is kept constant independent of the number channels processed, the FFT size and the sampling rate of the measurement.
- The gate correction factors (either multiplicative of additive) are applied to the gate sizes determined from the SNR of the signals. When both a multiplicative and an additive correction can be defined for a gate, the multiplicative factor will be first applied to the gate size determined from the SNR of the signal, followed by the additive factor.
- The additive correction factor for the velocity gate ("Vel. modul.", and also "Rng. modul" for FMCW modes) is probably the most useful of all gate corrections since it allows widening the velocity association gate to account for target-induced modulations which may jeopardize tracking of certain targets, such as certain classes of rocket-assisted projectiles.

10.6.6 Define Antenna Loop Gain

To redefine the antenna loop gain parameters used to process the measurement:

1. Click the "Edit AC…" button on the "Noise" tab of the "MOT Options". The following form appears:

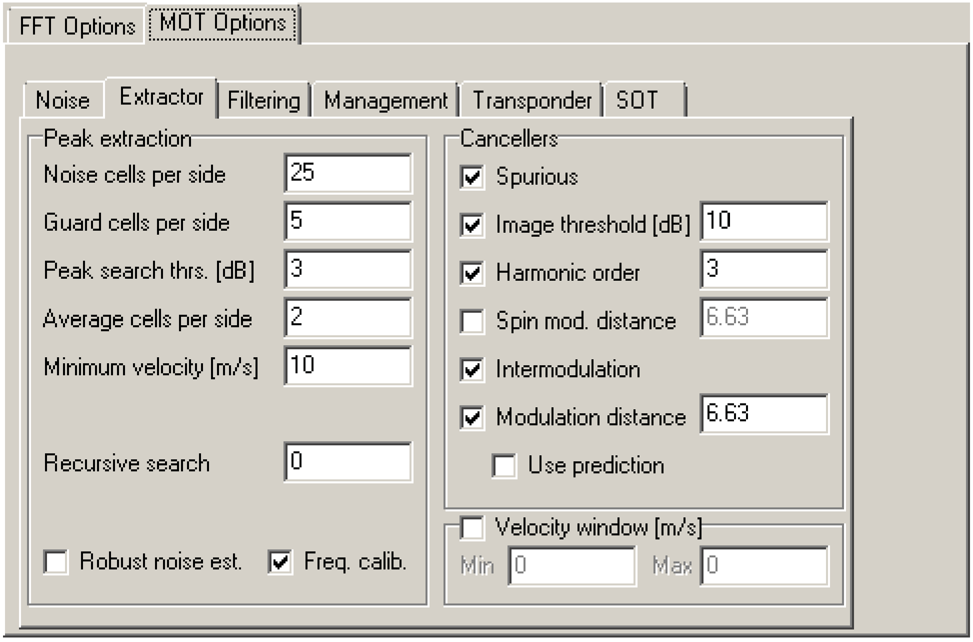


2. If known, the desired maximum antenna loop gain and minimum azimuth and elevation opening angles achievable by the antenna can be typed in directly in the “Max. Antenna Const”, “Elev. Opening Angle” and “Azim. Opening Angle” edit boxes.

3. In case it is preferred to use the standard parameters of a known antenna model, choose the name of the desired model in the “Antenna Type” box and click “Apply”. By selecting the “User defined” antenna type it is possible to define a new set of antenna parameters and from them the resulting maximum antenna constant to be used for processing by clicking “Apply”.

10.6.7 Define Extractor MOT Parameters

To activate this window Open a DAT File (page 91), click the MOT icon and enable **Advanced Settings**. The parameters on the **Extractor** tab sheet determine the way signals are detected and classified.



The settings are divided into three sections: Peak extraction, Cancellers and Velocity window. The settings are described in the following.

10.6.7.1 Peak Extraction

These settings control how the peaks in the FFT spectra are detected and extracted.

Use	If you want to
Noise cells per side	Set the number of noise FFT bins to each side of a detected signal from which the receiver noise level is estimated. See Calculate the Signal to Noise Ratio (page 138).
Guard cells per side	Set the number of FFT bins left (not used for noise level estimation) between a detected signal and the noise cells.
Average cells per side	Set the number of FFT bins to each side of a detected signal which are used to estimate its velocity or range centroid.
Peak search thrs.	Define the peak detection sensitivity of the extractor. This setting affects where (in frequency) one peak ends and another one is allowed to begin. The peak ends on each side where its height gets this much lower than its maximum value. Increasing this value means a larger span from peak maximum to the base of the peak, and thus it may also mean a wider peak. The consequence of this is that weak signals may be masked out by stronger signals, decreasing the total number of detections. This may help increase track stability in certain situations.

Use	If you want to
Recursive search	Define how many recursions of the peak detection procedure that are allowed. More recursions will enable the detection of weaker signals, but will be more time consuming. Enter 0 (zero) to allow repeat until no more detections are found.
Robust noise estimation	Avoid possible numerical errors when estimating the receiver noise level (more time consuming).
Freq. calib.	Apply (or ignore) the frequency calibration coefficients contained in the measurement files.
Minimum velocity	Set the minimum absolute radial velocity required for a signal detected in the CW channel to be considered. Measurements that don't meet this criterion are declared as clutter.

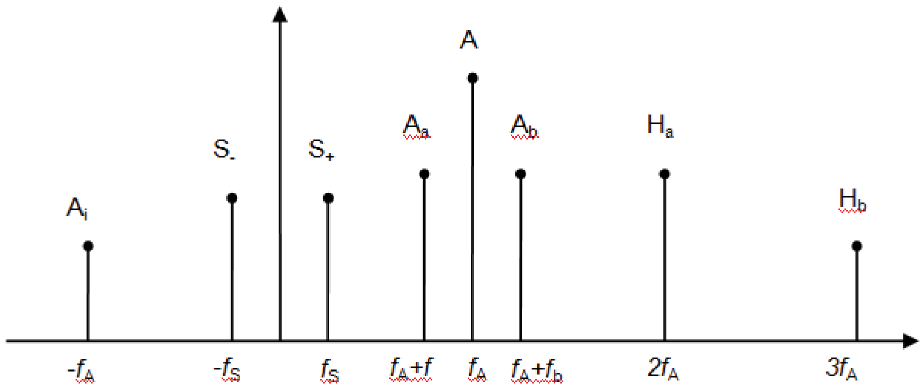
10.6.7.2 Cancellers

The cancellers are used to filter the extracted peaks based on certain criteria described below. The parameters are shown in the order in which they are applied in practice.

Use	If you want to
Spurious	Activate the test to reject spurious signals generated by interference or receiver saturation. A spurious signal consists of a pair of components with the same absolute frequency but with opposite signs. The difference between their amplitudes must be less than the **Image threshold** described below. If two such signals are found, both are declared as spurious.
Image threshold	Activate the image canceller, which rejects spurious signals generated by non-ideal image rejection in the receiver, and specify the minimum image signal rejection ratio. If two components have the same absolute frequency with opposite signs (as described above), but their amplitudes differ by more than the **Image threshold**, the one with the lowest amplitude is declared as an image and rejected. Raising the **Image threshold** will result in more pairs of spurious components and a lower overall number of symmetrical components getting declared as valid.

Use	If you want to
Harmonic	Activate the test to reject harmonic spurious signals originated by receiver saturation. Starting with the peak with the highest amplitude and frequency *f*, it will look for components with lower amplitudes and frequencies 2*f*, 3*f*, …, *nf*, for *n* up the order number entered in the text box.
Spin mod. distance	Activate the spin modulation canceller, which looks for a center component and pairs of symmetrical components around it. To be declared as spin, a measurement point must be coupled with another point, these two points being symmetrical in velocity and amplitude around a third point. The entered distance is a measure of how much the expected velocity and amplitude of a measurement point may differ from its actual value in order to be classified as spin. Raising the distance value will cause more points to be declared as spin modulations, at the cost of more wrong detections.
Modulation distance	Activate the modulation canceller. Modulations are detected by looking for points which coincide in elevation and azimuth. The measurement point with the highest amplitude is determined to be the true target, i.e. the originator of the modulations, and the others are declared as modulations. The entered distance is a measure of how much the angles of a potential modulation may differ from its originator in order to be declared as a modulation. Raising the distance value will cause more points to be declared as modulations.
Intermodulation	Activate the test to reject spurious signals resulting from second and third order intermodulation products in the receiver.

The following figure illustrates the difference between the different kinds of spurious signals encountered.



A The frequency originating from the main object.

A_a A_b Modulation frequencies. They may originate from spin or jet-engine modulations. These frequencies normally lie on both sides of the main frequency, and they may or may not be symmetrical around the main frequency. If they are symmetrical in frequency and magnitude around the main frequency (normal for spin modulations), the spin-modulation canceller may be appropriate. If they are not, the normal modulation canceller is recommended.

Only two modulation frequencies are shown. There may be more.

S_- S_+ Spurious frequencies. These frequencies are symmetrical in frequency and magnitude (within a margin given by *Image threshold*) around zero.

A_i Image frequency. This frequency lies directly opposite of A, but its magnitude is more than *Image threshold* smaller than A.

H_a H_b Harmonic frequencies originating from A. It is seen that their frequencies are integer multiples of f_A. The harmonic canceller will reject the first *N* of these frequencies.

10.6.7.3 Velocity Window

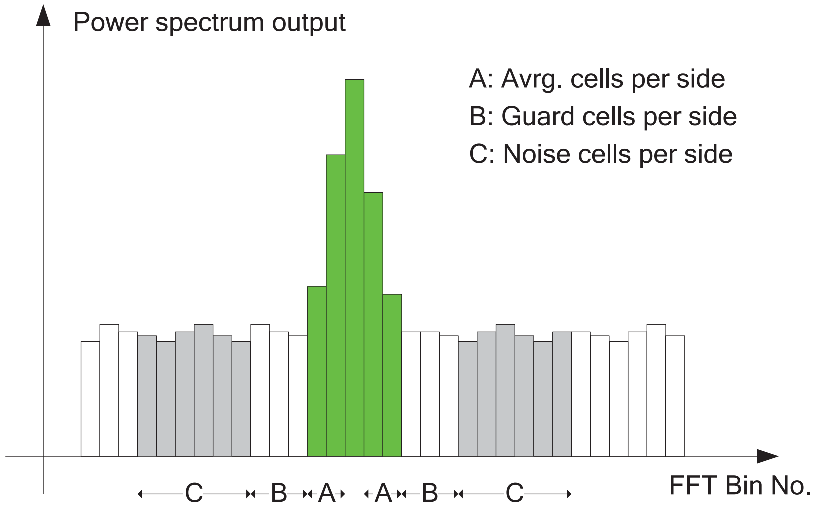
Process only those signals located in the velocity range defined by the following two parameters. Plots that fall outside of the defined interval are rejected as clutter.

This parameter is set correspondingly by zooming into a QDTI/DTI and requesting a processing.

Upper limit	Specifies the upper limit of the velocity window.
Lower limit	Specifies the lower limit of the velocity window.

10.6.7.4 Calculate the Signal to Noise Ratio

The signal to noise ratio (SNR) is defined as the power of the detected signal (received from the target) divided by the noise power in one FFT bin.



To calculate the SNR we average the noise power across a number of FFT bins and we estimate the signal power using the peak FFT bin and some of its neighbours:

P(noise per cell) = Average of the grey power spectrum bins.

P(signal+noise) = Sum of the green power spectrum bins.

Note that the P(signal+noise) value has a contribution from the noise which is proportional to the number of bins used in the sum. We want to correct for this effect by subtracting the estimated contribution from the noise.

P(signal) = P(signal+noise) – (1+2*nAvgCellsPerSide)*P(noise per cell)

SNR = P(signal) / P(noise per cell)

When plotting the power spectrum versus frequency the unit dB/Hz is often used. In this case each spectrum value is divided by the distance between FFT bins in Hz before the dB value is calculated.

Notes

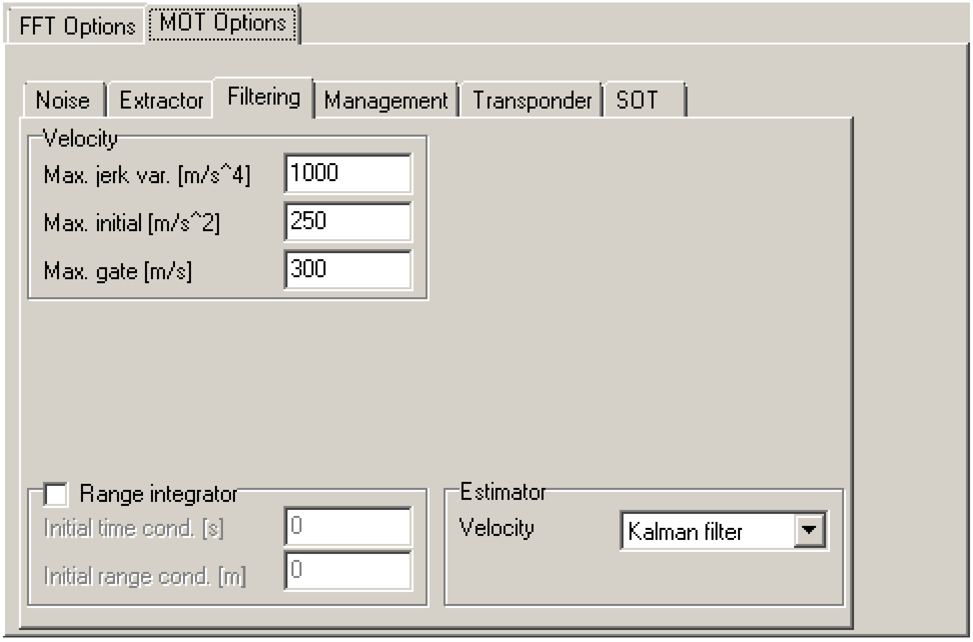
- Doubling the FFT size (and thereby the observation time) improves the SNR by 3dB provided that the signal is a fixed frequency.
- The estimated SNR value depends on the window function used. To compensate for this effect use the **SNR Offset** parameter to manually set the offset value, see Define Noise MOT Parameters (page 132).

  In case the default Hanning window is used leave the SNR Offset = 0.
- If **Zero Padding** is used, see Define Miscellaneous MOT Parameters (page 129), the number of averaging cells, guard cells and noise cells per side should be multiplied by the zero padding factor.

  Doubling the Zero Padding factor increases the SNR value by 3dB. The RCS value remains unchanged.

10.6.8 Define Filtering MOT Parameters

To activate this window Open a DAT File (page 91), click the MOT icon and enable **Advanced Settings**. The parameters on the **Filtering** tab sheet determine the sensitivity of the tracking algorithms to maneuvers performed by the tracked objects. It also contains parameters to define the operation of the velocity integrator for non-ranging systems.



The following processing options are available for velocity, elevation, azimuth and FMCW range:

Use	If you want to
Max. jerk var.	Change how quickly the tracking filter adapts to sudden variations in the acceleration of the tracked target. Higher values lead to a more dynamic filter, which is able to adapt to more abrupt rate changes, but it will also cause the filter to be diverted more easily in cases of small holes in the track or other tracks crossing. Lower values will make the filter less dynamic and more inclined to stay on track, but the filter's ability to adapt to sudden rate changes will be reduced.
Max. initial	Modify the maximum rate of the target at the beginning of a track.
Max. gate	Limit the size of the point-to-track association gate.

Notes

- Wrong filter parameters – especially **Max. variation** – can seriously degrade tracking performance, so care should be taken in choosing the right values.

  Post-processing similar measurement beforehand to determine a good set of parameters is a good idea.

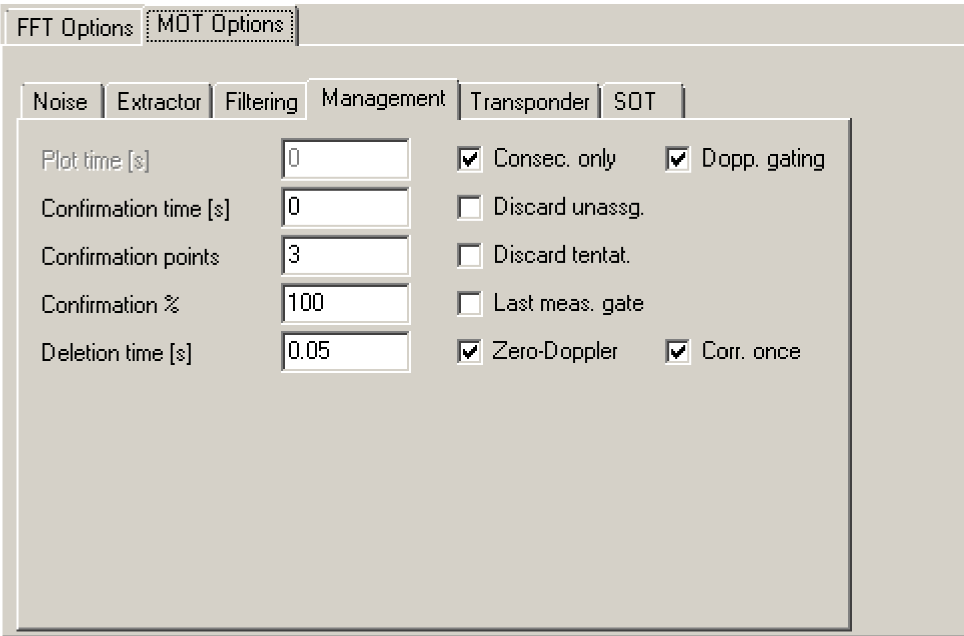
- The parameters and thus performance of a given tracking filter is only relevant if gating is performed on that particular filter.

Other parameters:

Use	If you want to
Range Integrator	For non-ranging systems, activate range calculation based on radial velocity integration. For MF-ranging systems, introduce range initial conditions for elimination of ambiguities.
Initial Range Cond.	Specify the range of the target at a known time.
Initial Time Cond.	Specify the time to which the range given at “Initial Range Cond.” is referred.
Estimator	Select what kind of estimator to use for the velocity tracking filter. The options are: - *Single KF*: Order 2 Kalman filter. - *IMM2 (2, 1)*: IMM estimator with 2 interacting Kalman filters. - *IMM3(2, 1, 2)*: IMM estimator with 3 interacting Kalman filters. See the section **CW Channel** in the chapter **Doppler Track Control** in the RTP-2100 manual for a description of the options.

10.6.9 Define Management MOT Parameters

To activate this window Open a DAT File (page 91), click the MOT icon and enable **Advanced Settings**. The parameters on the **Management** define how tracks are confirmed, maintained and associated to other tracks.



The following processing options are available:

WEIBEL DOPPLER RADARS

Use	If you want to
Plot time	Change the maximum time separation between two plots for a tentative track to be initiated on them. Without effect if “Consec. Only” is active.
Confirmation Time	Set the minimum time from the first detection and until the tentative track is evaluated and confirmed (or rejected). See Confirming the Track (page 142).
Confirmation Points	Set the minimum number of algorithm cycles (FFT’s) to be performed before a tentative track is evaluated and confirmed (or rejected). See Confirming the Track (page 142).
Confirmation %	Set the minimum percentage of track detections within the evaluation time. This value defines the confirmation threshold. See Confirming the Track (page 142).
Consec. only	Only allow plots appearing on consecutive FFTs to give rise to a new tentative track.
Discard unassg.	Remove unassigned plots from the final track file.
Discard. tentat.	Remove tentative tracks from the final track file.
Last meas. gate	Set the size of the association gates according to the estimated accuracy of the last measurement received by a track.
Doppler gating	Discard new measurements being added to a track if their Doppler velocities do not correlate with the predicted Doppler velocity for the track. (see note)
Correlate once	If active, an FMCW is only correlated with CW tracks until a match is found and its velocity ambiguity is resolved. If inactive, an FMCW track will be correlated with CW tracks periodically.
Zero-Doppler	If active, FMCW tracks may be created even on targets with zero velocity.

Notes

- The predicted measurement gates and their size are determined by the values of the parameters on the **Noise** (see Define Noise MOT Parameters (page 132)) and **Filtering** (see Define Filtering MOT Parameters (page 139)) tab sheets.

10.6.9.1 *Confirming the Track*

A tentative track is evaluated when it has reached a certain age. The age is defined as a number of potential detections, Nconf, since and including the first detection; see below for more details.

The evaluation process counts the number of track detections and compares that to the number of potential detections. If the detection rate is equal to or higher than the **confirmation percentage** the track is promoted to a confirmed track.

The number of potential detections, Nconf, takes two user defined parameters into account: **confirmation time** and **confirmation points**.

The **confirmation time** criterion means that the track stays tentative from the first detection and until this time has expired. The number of potential detections within this time window is Nct :

- ► Nct = confirmation time * FFT rate
- ► FFT rate = 1 / Tobs / (1 – overlap)

If we use Tobs = 10ms, overlap = 50% and confirmation time = 200ms we get:Nct = 40.

The **confirmation points** criterion means that at least the specified number of potential detections, Ncp, are evaluated (including the first detection).

The actual number of potential detections (FFTs) evaluated is:

- ► Nconf = max {confirmation points, confirmation time * FFT rate}

Note that setting any of the two parameters, **confirmation time** or **confirmation points** to zero means that the other parameter defines Nconf.

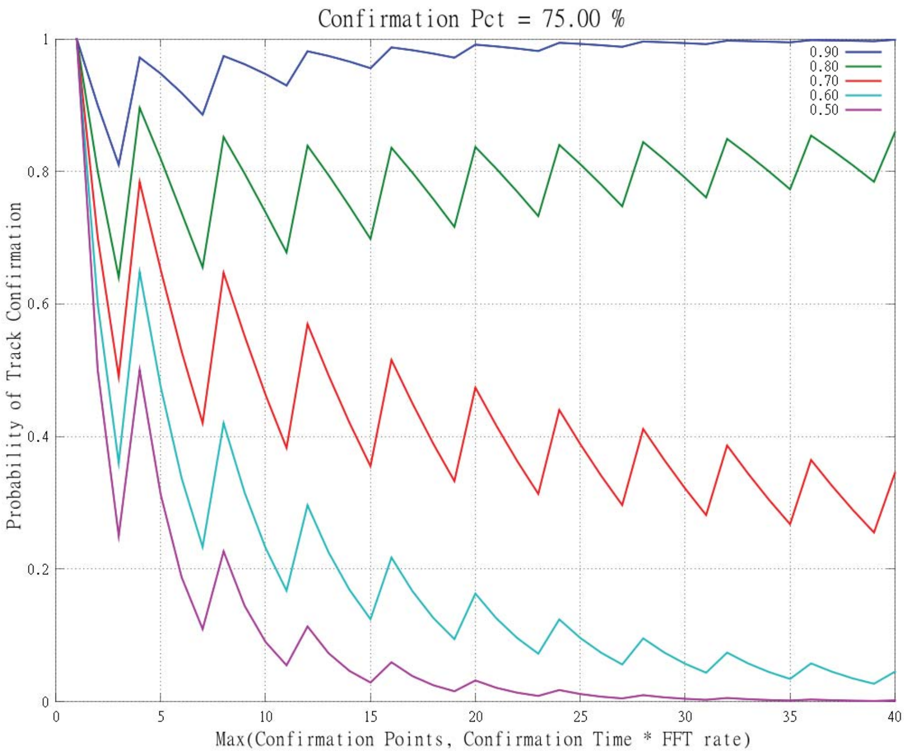
When Nconf potential detections have been collected the tentative track is evaluated by counting the number of track detections Ndet. The track is confirmed if:

- ► Ndet >= Nconf * **confirmation percentage** / 100

If the tentative track fails to meet this criterion it is discarded. As a consequence all detections associated with the tentative track are discarded as well. Note that this is different from a sliding window approach.

As an example we consider the situation where the target we want to track has a probability of detection in each FFT of Pd1 = 0.9. At the same time we need to take into account that other targets are present in the beam and we don’t want to track them. They have a probability of detection of Pd2 = 0.6 in each FFT.

The following figure shows the probability of track confirmation when a tentative track is established as a function of the number of FFT’s considered when evaluating the **confirmation percentage** = 0.75 criterion. Each of the graphs corresponds to a specific probability of detection in a single FFT, Pd.

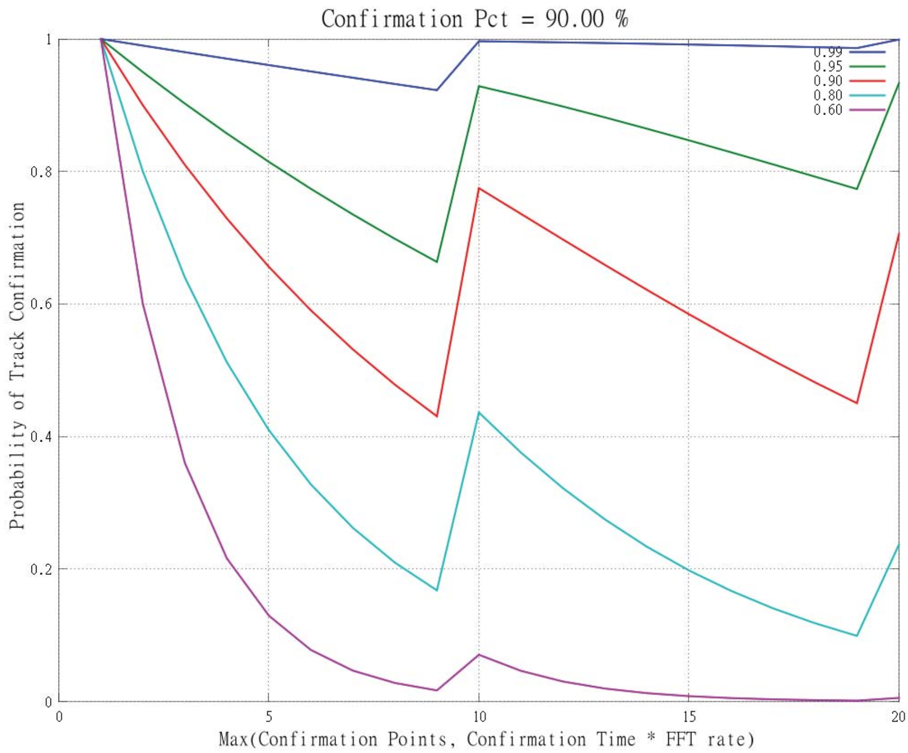


We note that at Nconf = 10 there is a 0.95 chance of confirming the right track and a 0.23 chance of confirming the wrong track. In most cases this is unacceptable because tracking the wrong target may compromise the mission.

At Nconf = 35 there is a 0.995 chance of confirming the right track and a 0.034 chance of confirming the wrong track. So we get a much better probability of locking onto the right target at the cost of a longer time to confirm the track.

Note that the graphs are not smooth, whenever (Nconf * **confirmation percentage**) is an integer the probability of track detection jumps to a higher value. That is because we get an extra FFT output to evaluate, but the number of required detections does not increase compared to (Nconf – 1).

If the time to confirm the track must be much shorter due to the nature of the mission, then we need to reduce Nconf. When the wanted target detection probability is high, then we may choose to increase the **confirmation percentage** e.g. to 90%.



At Nconf = 10 and Pd1 = 0.95 there is a 0.93 chance of confirming the right track and a 0.07 chance of confirming the wrong track. So even with a higher detection probability the shorter time to confirmation reduces the probability of getting the right track confirmed and increases the probability of confirming the wrong track.

10.6.9.2 About the Track Life Cycle

To create a new **confirmed** track the MOT algorithm performs the following:

1. When two unassigned detections appear within certain limits in Doppler velocity and time then a **tentative** track is opened. See Define Management MOT Parameters (page 141) and Define Filtering MOT Parameters (page 139).
2. The track will stay **tentative** until **confirmation time** seconds has elapsed AND at least **confirmation points** MOT iterations have been performed.
3. The track is promoted to a **confirmed** track if the following is true:
   - The track has received measurements (that lie inside it's gate) for at least **confirmation percentage** % of its life time, see Confirming the Track (page 142).
   - It is NOT an acceleration modulation (if "Modulation acceleration canceller" is active),

The tentative track is closed if the conditions in step 3 are not met. Note that a tentative track is always alive for at least **confirmation time** seconds.

To delete a **confirmed** track the MOT algorithm performs the following:

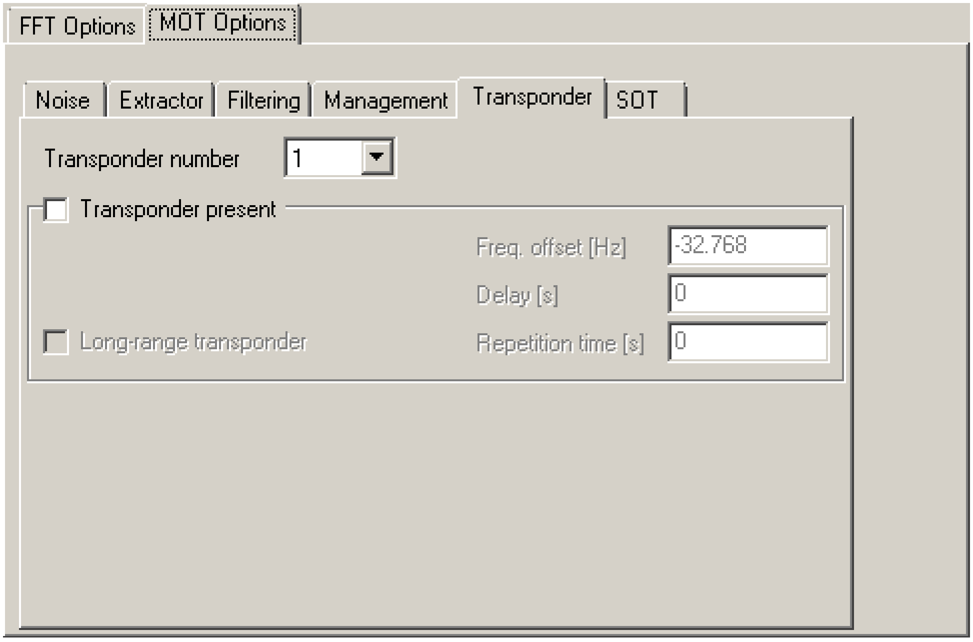
1. Every time an FFT is performed the MOT looks for possible extensions of the track. The detection is assigned to the track if the following is true:
   - It is within the specified gates of the track
   - It is the most likely track extension to have happened.

If one or more detections fall within the gates of two or more tracks THEN the detections are assigned to the tracks on a maximum likelihood basis.

2. The track is deleted without further notice if **deletion time** seconds has elapsed since the last track point was assigned to the track. Otherwise it stays **confirmed**.

10.6.10 Define Transponder MOT Parameters

To activate this window Open a DAT File (page 91), click the MOT icon and enable **Advanced Settings**. The parameters on the **Transponder** tab sheet allow activate the transponder processing functionality.



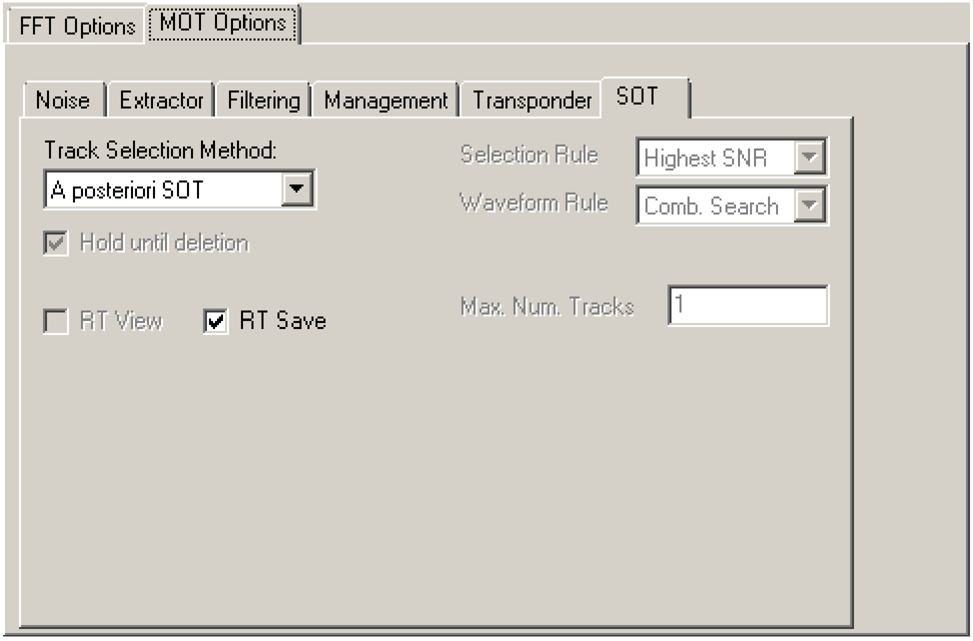
It is possible to keep track of up to 7 transponders (LRT-2100 and/or MC-100). The following processing options are available for each of these:

Use	If you want to
Transponder present	Indicate that the transponder was active when the measurement data was recorded.
Transponder offset	Enter the frequency offset introduced by the transponder.
Delay	Enter the delay introduced in the signal by the transponder. This delay is converted into a range offset, which is subtracted from the calculated range. This parameter works both for long-range (LRT-2100) and normal (MC-100) transponders.
Long-range transponder	Select whether this transponder is a long-range transponder (LRT-2100).
Repetition time	The repetition time of the long-range transponder.

If the measurement file was generated with the transponder option activated, these parameters are automatically set to the values that were used during the measurement.

10.6.11 Define SOT Parameters

To activate this window Open a DAT File (page 91), click the MOT icon and enable **Advanced Settings**. The parameters on the **SOT** tab sheet control how the most prominent track is selected during or after processing.



The following processing options are available in the **Track Selection Method** list:

Use	If you want to
Real-Time SOT	The most relevant signal at any time being declared as the target of interest and its measurements placed into the same track record. Selecting this option is identical to selecting the **SOT** processing option under Select the Processing Algorithm (page 97).
A posteriori SOT	After a MOT has been performed, only the most relevant tracks according to the previous selection criterion will be kept.
MOT	Selecting this option is identical to selecting the **MOT** processing option under Select the Processing Algorithm (page 97).

The following processing options are available:

Use	If you want to
Hold until deletion	A new most relevant signal will be selected only when the current one has been terminated.
Selection Rule	Define the criterion according to which a new most relevant signal will be selected.
Waveform Rule	Constrain the search of the most relevant signal only to the CW or the FMCW channel.

Use	If you want to
Max. Num. Tracks	Define how many tracks will kept when the **A posteriori SOT** option is selected. If **RT View** is selected, it also determines the maximum number of tracks that will be shown on the display simultaneously.

10.7 Perform Spin Analysis

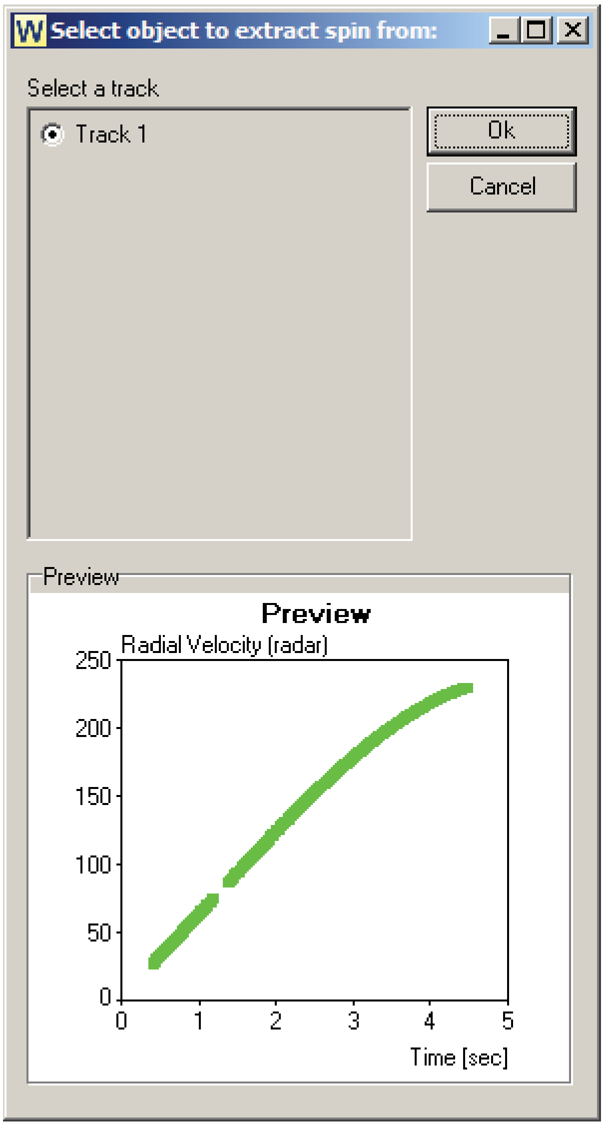
To access the **Process Setup** window see Open a DAT File (page 91).

The **Spin Analysis** function carries out a MOT process on a motion compensated signal so that separate tracks are generated for the object signal (frequency translated to DC after the motion compensation) and the spin modulation signals located inside a predefined frequency range around the target signal.

A prerequisite to initiate a Spin Analysis is having completed a MOT/SOT process of the object for which a Spin Analysis is required (see Detect Single/Multi Object Tracks (page 112) for further details) and generated a result in a Work File with the trajectory of the object (see Generate Work File Results (page 124)).

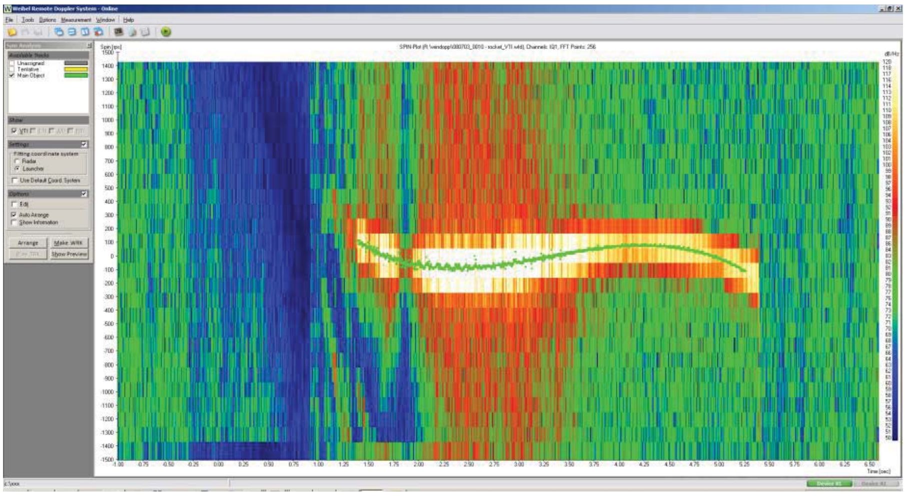
To perform the Spin Analysis:

1. Select the **Spin Analysis** processing option.
2. Configure Spin Analysis Options (page 150).
3. Click the **Process** button.
4. In the form that appears select the trajectory in the selected Work File that contains the data for which the spin analysis is performed and click **Ok**.



5. A **Track Control** window for the Spin Analysis results appears which allows to fine edit the results of the algorithm. Besides the **Unassigned** and **Tentative** entries the Spin Analysis results consist of a track corresponding to the object itself (**Main Object** track), which cannot be deleted but whose points may be moved from and to another track, and a series of **Spin** tracks which represent the found spin signals. See Use the Track Control Window (page 114) for further details on track editing.

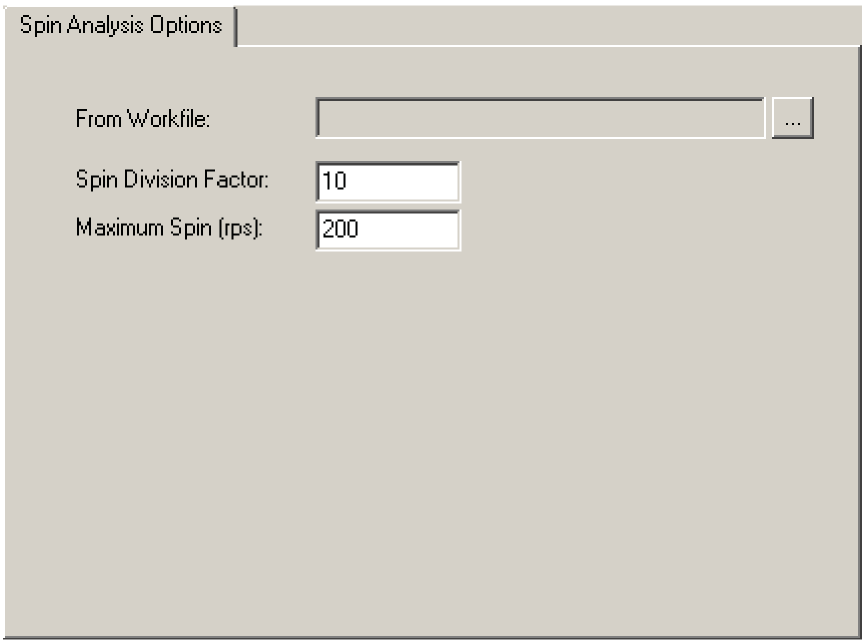
   In general the spin track with the lowest offset from the **Main Object** track is the one that contains the desired spin information. Typically this spin track has an image with which it can be merged (see Change the Properties of a Track (page 116)) to maximize the time for which a spin measurement is available.



6. To create a Work File result with the **Main Object** track plus the desired spin information, select only one spin track on **Track Control** window (in general one which can be the result of merging several initial spin tracks) and click **Make WRK**.

10.7.1 Configure Spin Analysis Options

To activate this window Open a DAT File (page 91), click the **Spin Analysis** icon and enable **Advanced Settings**.



The following options are available:

Use	If you want to
From Workfile	Modify the Work File from which the object trajectory must be read. Click on the button to right to open the file open dialog box.

Use	If you want to
Spin Division Factor	Set the factor that relates the frequency of the found spin modulations and the actual object's spin rate. This factor is a function of the characteristics of the object. As a rule of thumb, this factor must be set to the number of fins of the projectile if this is an even number and twice this value if the projectile has an odd number of fins.
Maximum Spin (rps)	Limit the maximum spin rate that the algorithm tries to identify.

10.8 Perform Channel Verification

To access the **Process Setup** window see Open a DAT File (page 91).

Channel Verification is a set of plots that share the property that there is a graph for each processed channel plus a graph for the summation of the channels. The plots are used to verify or diagnose the overall performance of each channel in the antenna that was used to record the DAT file.

To activate the Channel Verification:

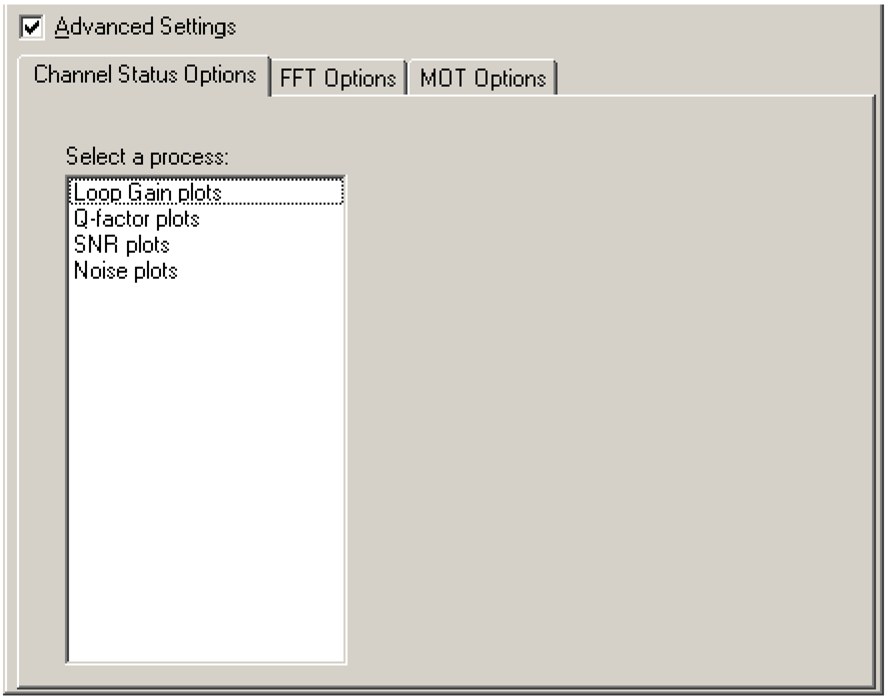
1. Select the **ChStatus** processing option.
2. Configure the FFT Parameters (page 98).
3. Select a predefined set of MOT Parameters (page 113).
4. Select the **IQ Channels** to include in the processing.
5. Select Channel Verification Output (page 151).
6. Click the **Process** button.

The status bar shows the progress of the processing for each channel. When complete the output plot is shown.

The processing is performed by running a SOT on the data for each channel and then calculating the desired output on the result of the SOT processing. Therefore the output is dependent on the SOT parameters.

10.8.1 Select Channel Verification Output

To activate this window Open a DAT File (page 91), click the **ChStatus** icon and enable **Advanced Settings**. On the **Channel Status Options** tab sheet you the output you want.

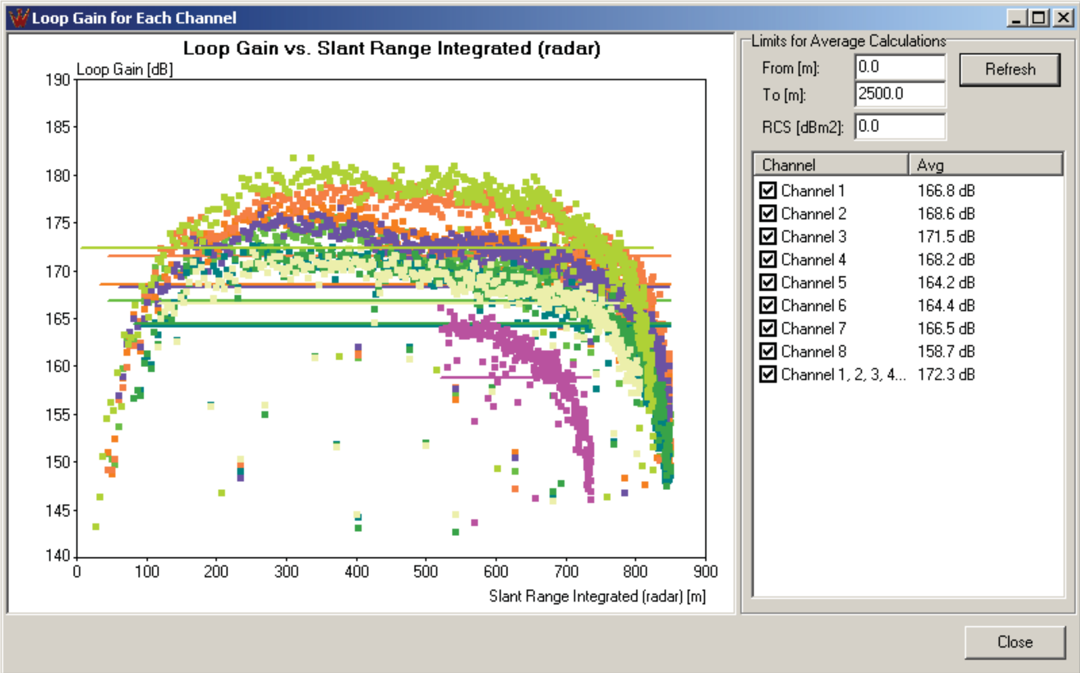


The following processing options are available:

Use	If you want to
Loop Gain plots (page 152)	When you have a measurement of an object where the actual radar cross section is known and you want to evaluate the performance of each channel.
Q-factor plots (page 154)	When you have a measurement of an object where the actual radar cross section is unknown and you want to evaluate the performance of each channel.
SNR plots (page 155)	When you have a measurement of an object and you want to evaluate the signal to noise ratio of each channel.
Noise plots (page 157)	When you have a measurement of thin air (elevation > 80 deg) and you want to evaluate the noise levels of each channel in the antenna.

10.8.2 Loop Gain Plots

The Loop Gain plot is divided in two sections: A graph to the left and a list to the right.



The graph displays the measured loop gain as dots and the average loop gain as a horizontal line.

The list contains the channels that have been processed and the average loop gain for each channel. You can uncheck a channel to remove it from the graph.

The parameters for the calculation of the loop gain can be modified:

Use	If you want to
From	Change the range interval to include in the calculation of average loop gain for each channel.
To	
RCS	Change the radar cross section of the measured object. The calculation of the loop gain uses this value.
Refresh	Recalculate the loop gain of each channel with the entered limits and RCS.

Print Loop Gain Plot

There are two ways to print a loop gain plot.

To print a loop gain graph alone:

1. Right click the graph and select **Print…**
2. Adjust the print options.
3. Click **Print**.

To print a loop gain plot including the list of average values:

1. On the **File** menu, select **Print…**
2. Adjust the print options.
3. Click **Print**.

Export Loop Gain Plot

There are two ways to export a loop gain plot.

To export a loop gain graph alone:

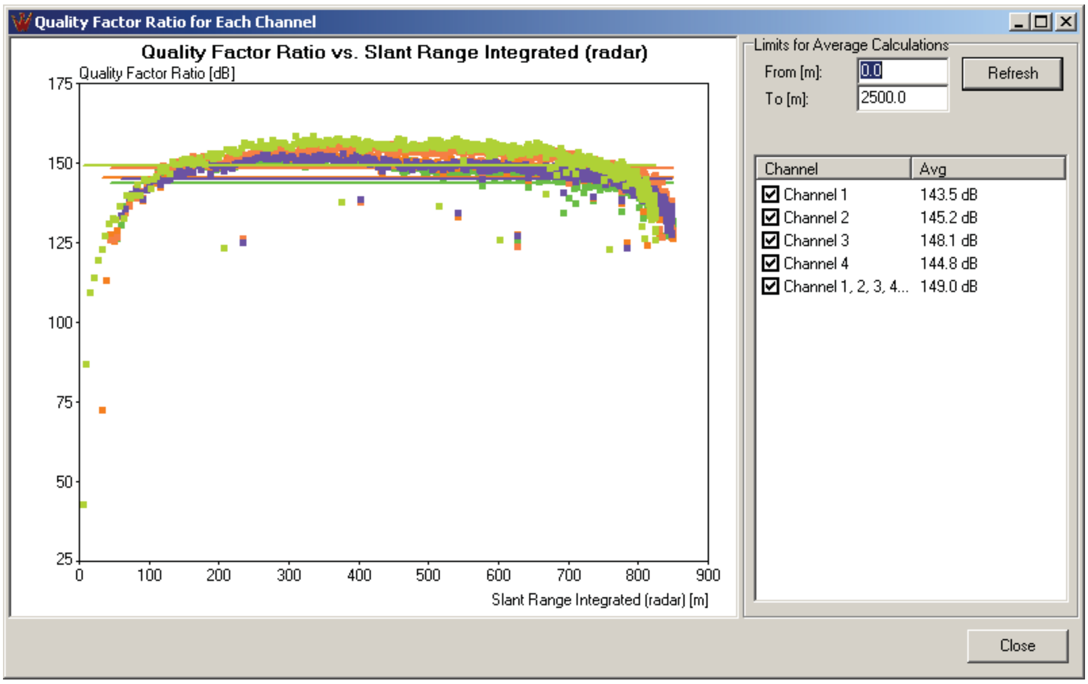
1. Right click the graph and select **Save Bitmap…** or **Export Data…**
2. Enter a file name.
3. Select a file type.
4. Click **Save**.

To export a loop gain plot including the list of average values:

1. On the **File** menu, select **Save Bitmap** or **Export Data**
2. Enter a file name.
3. Select a file type.
4. Click **Save**.

10.8.3 Q-factor Plots

The q-factor plot is divided in two sections: A graph to the left and a list to the right.



The graph displays the measured q-factor as dots and the average q-factor as a horizontal line.

The list contains the channels that have been processed and the average q-factor for each channel. You can uncheck a channel to remove it from the graph.

The parameters for the calculation of the q-factor can be modified:

Use	If you want to
From	Change the range interval to include in the calculation of average q-factor for each channel.
To	

Use	If you want to
Refresh	Recalculate the q-factor of each channel with the entered range limit.

Print Q-factor Plot

There are two ways to print a q-factor plot.

To print a q-factor graph alone:

1. Right click the graph and select **Print…**
2. Adjust the print options.
3. Click **Print**.

To print a q-factor plot including the list of average values:

1. On the **File** menu, select **Print…**
2. Adjust the print options.
3. Click **Print**.

Export Q-factor Plot

There are two ways to export a q-factor plot.

To export a q-factor graph alone:

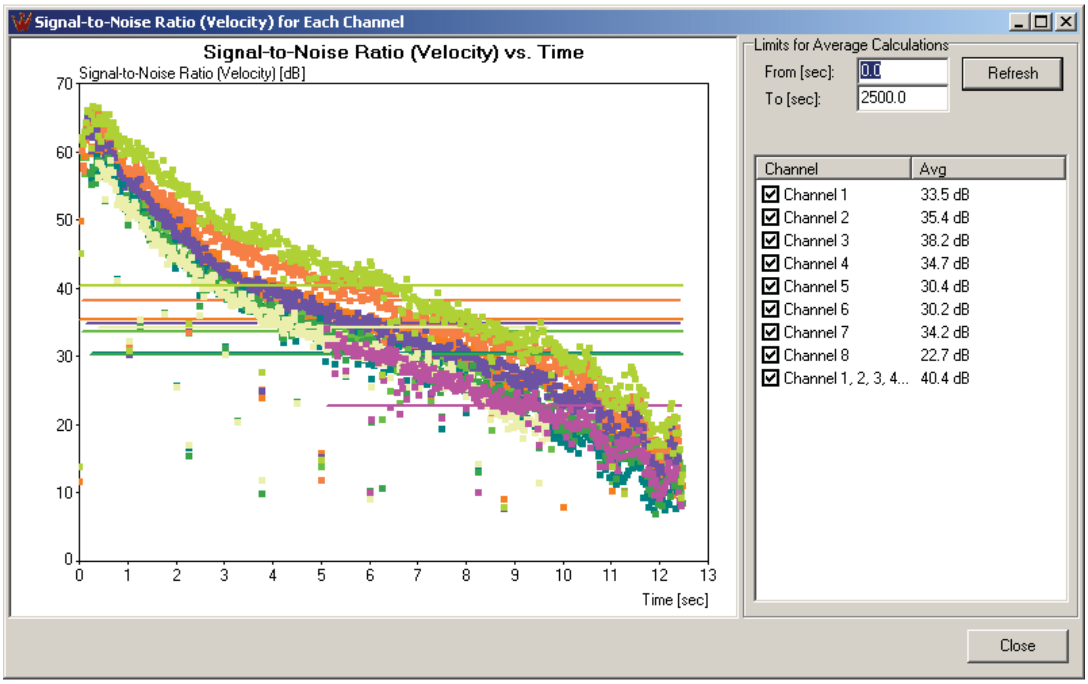
1. Right click the graph and select **Save Bitmap** or **Export Data**
2. Enter a file name.
3. Select a file type.
4. Click **Save**.

To export a q-factor plot including the list of average values:

1. On the **File** menu, select **Save Bitmap** or **Export Data**
2. Enter a file name.
3. Select a file type.
4. Click **Save**.

10.8.4 SNR Plots

The signal to noise ration (SNR) plot is divided in two sections: A graph to the left and a list to the right.



The graph displays the measured SNR as dots and the average SNR as a horizontal line.

The list contains the channels that have been processed and the average SNR for each channel. You can uncheck a channel to remove it from the graph.

The parameters for the calculation of the SNR can be modified:

Use	If you want to
From To	Change the time interval included in the calculation of average SNR for each channel.
Refresh	Recalculate the SNR of each channel with the entered time interval.

Print SNR Plot

There are two ways to print a SNR plot.

To print a SNR graph alone:

1. Right click the graph and select **Print…**
2. Adjust the print options.
3. Click **Print**.

To print a SNR plot including the list of average values:

1. On the **File** menu, select **Print…**
2. Adjust the print options.
3. Click **Print**.

Export SNR Plot

There are two ways to export a SNR plot.

To export a SNR graph alone:

1. Right click the graph and select **Save Bitmap** or **Export Data**

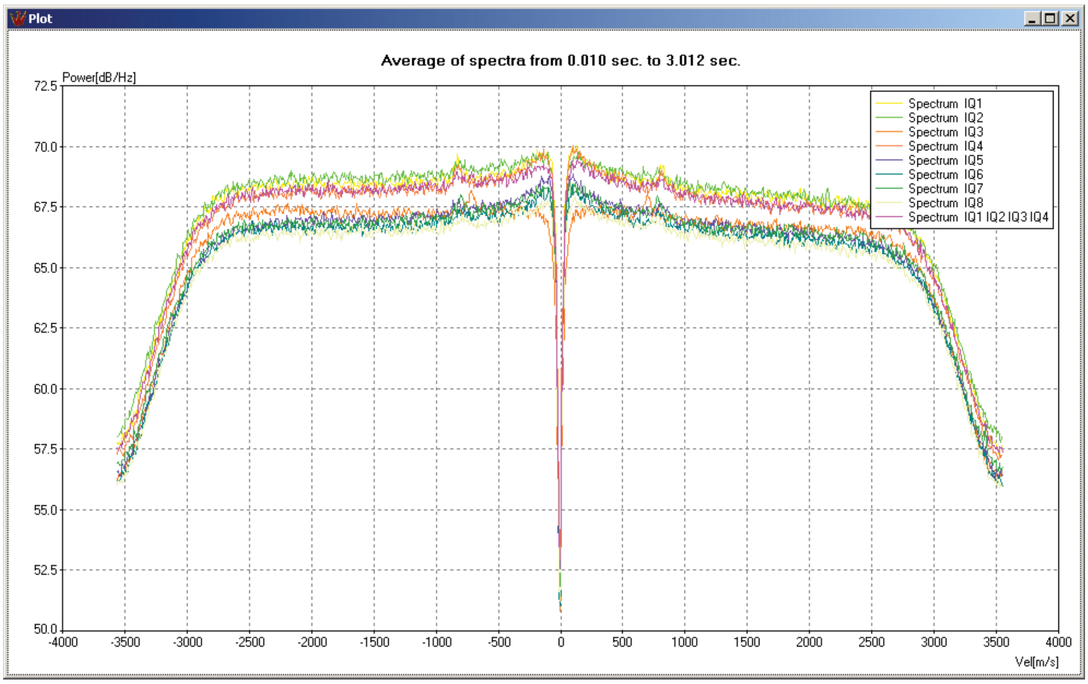
2. Enter a file name.
3. Select a file type.
4. Click **Save**.

To export a SNR plot including the list of average values:

1. On the **File** menu, select **Save Bitmap** or **Export Data**
2. Enter a file name.
3. Select a file type.
4. Click **Save**.

10.8.5 Noise Plots

As the noise plots are calculated several VTI plots will flick up on the screen. The final noise plot looks like below.



The graph can be zoomed by dragging the mouse in the graph.

To print a noise plot:

1. Right click the graph and select **Print…**
2. Adjust the print options.
3. Click **Print**.

To export a noise plot:

1. Right click the graph and select **Save Bitmap** or **Export Data**
2. Enter a file name.
3. Select a file type.
4. Click **Save**.

10.9 Perform Inbore Analysis

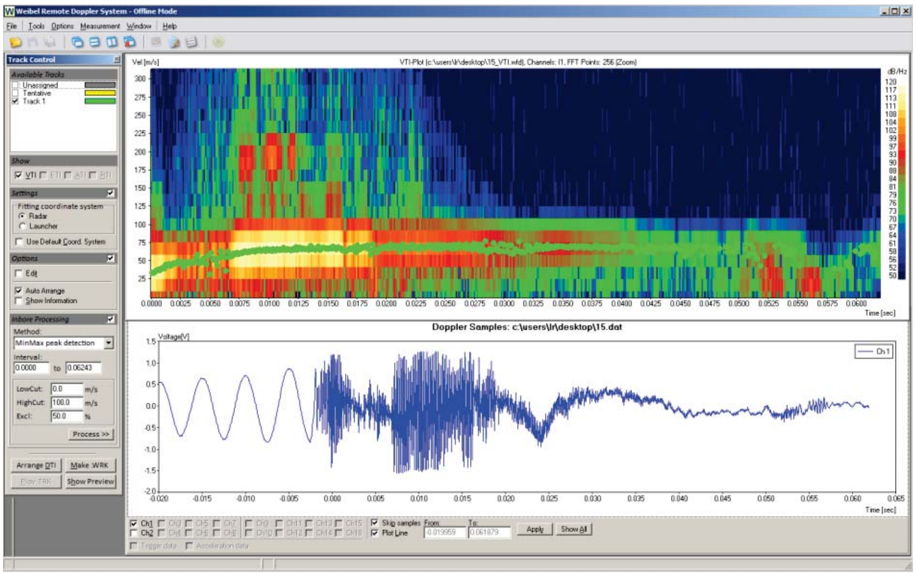
To access the **Process Setup** window see Open a DAT File (page 91).

The **Inbore Analysis** function carries out an inbore velocity search to detect high accelerating objects measured within the barrel.

To perform the Inbore Analysis:

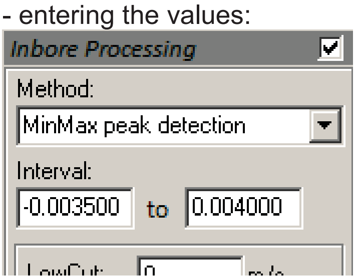
1. Select the **Inbore Analysis** processing option.
2. Configure Inbore Analysis Options (page 159).
3. Click the **Process** button.
4. A **Track Control** window for the Inbore Analysis results appears which allows to fine edit the results of the algorithm. The **Inbore Object** track represents the found inbore signal. See Use the Track Control Window (page 114) for further details on track editing.

   If the **Perform SOT** option were selected (see Configure Inbore Analysis Options (page 159)) the Inbore Analysis results also consists of **Unassigned** and **Tentative** entries, and a track representing the found SOT result.

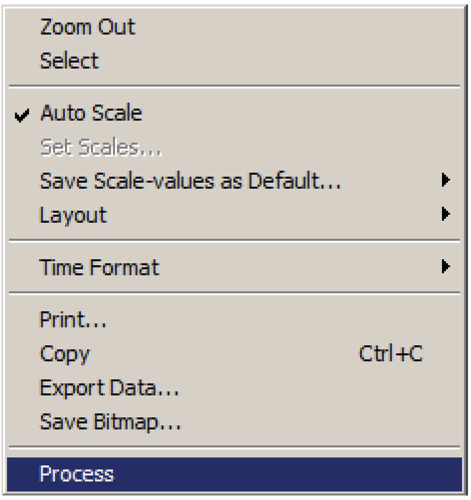
   

5. Set the Min/Max time for the Inbore processing, either by:

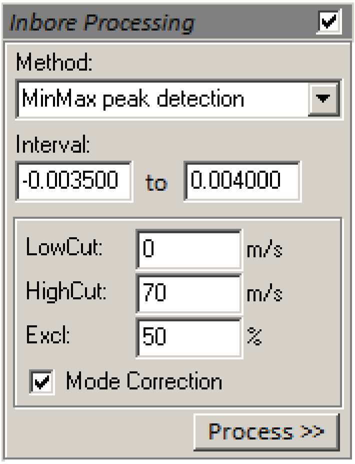
   - entering the values:

   - or zoom in on the STDraw, right-click and choose the **Process** menu option.



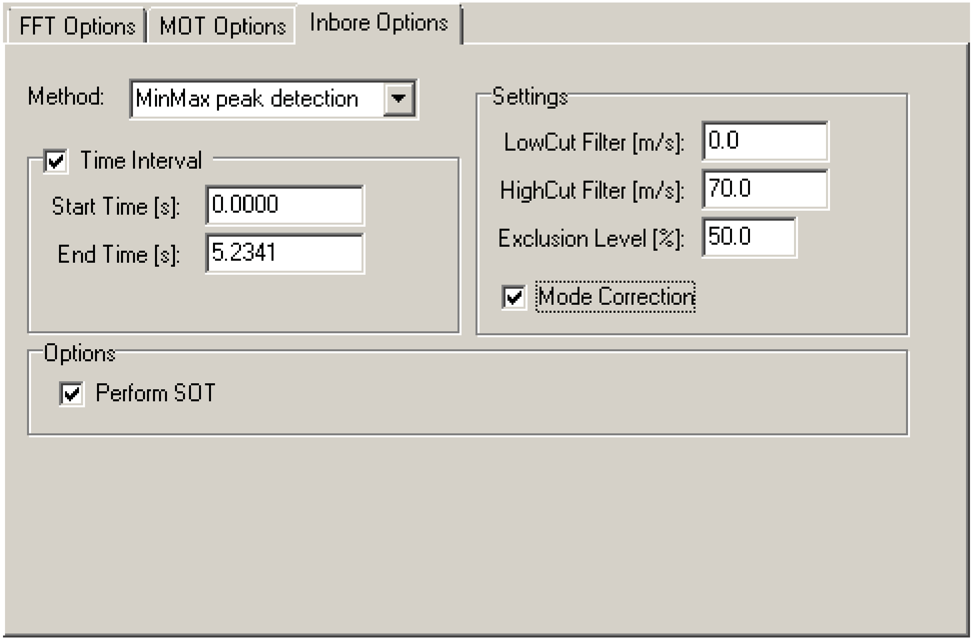
6. Fine adjust the Inbore processing parameters, and press **Process** to reprocess the inbore result. See Configure Inbore Analysis Options (page 159) for additional information.



7. If needed, locate the time for first movement and place the First Movement marker. See Place First Movement Marker (page 161).
8. To create a Work File result with the **Inbore Object** track click **Make WRK**.

10.9.1 Configure Inbore Analysis Options

To activate this window Open a DAT File (page 91), click the **Inbore Analysis** icon and enable **Advanced Settings**.



The following options are available:

Use	If you want to
Method	Inbore Analysis method. See below for further information.
Time Interval	Enable a specific time interval. If disabled the entire track time will be analyzed.
Start Time	Specific start time. Leave blank to use the track's original start time.
End Time	Specific end time. Leave blank to use the track's original end time.
LowCut Filter	Velocity points below this limit will be discarded. Leave blank for no LowCut-filtering.
HighCut Filter	Velocity points above this limit will be discarded. Leave blank for no HighCut-filtering.
Exclusion Level	The exclusion level is a procentage of the maximum peak-peak level in the search window.
Mode Correction	Apply inbore mode correction.
Perform SOT	Combine the Inbore results with the results from a SOT processing. For more details see Detect Single/Multi Object Tracks (page 112).

The following Inbore Analysis methods are available:

Method	Description
MinMax peak detection	Zero-crossing and Min/Max detection that returns a velocity point after each 'zero-crossing' of the signal in combination with the Min/Max detection.

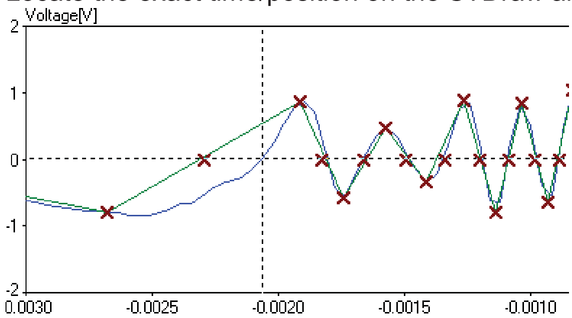
Method	Description
Sinus Curvefitting (half-period)	Using a half-period sinus curve fitting to find the frequency of the signal. This method returns a velocity point every half-period.
Hilbert transformation	Using the phase information from the IQ-signal to calculate the frequency. For non-IQ antennas this method is used to generate the IQ signals. The result is velocity points for every sample – but to increase the accuracy the results is typically averaged over 20-50 samples.

10.9.2 Place First Movement Marker

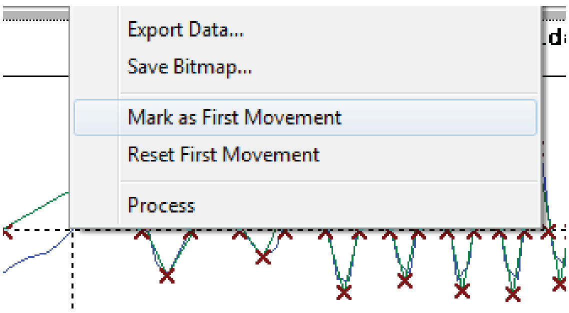
The First Movement marker is an optional marker that can be manually placed to mark the exact time for when the object starts to move.

To place a First Movement marker:

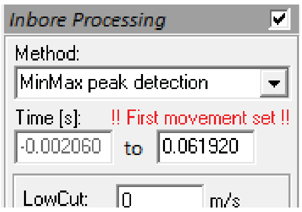
1. Locate the exact time/position on the STDraw and place the normal marker.



2. Right-click on the position and choose the **Mark as First Movement** option.

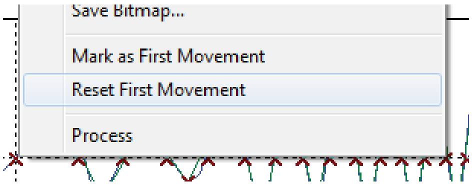


3. The Inbore processing will now be forced to start at this point. A red warning text will appear and the start time will be locked to this specific time.

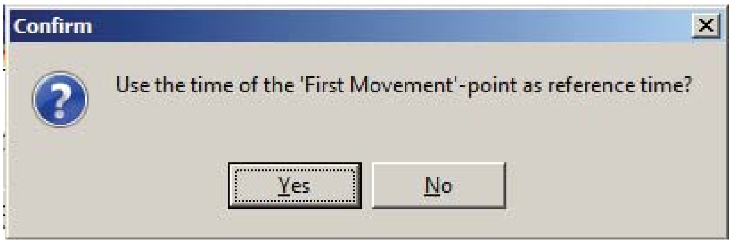


4. Fine adjust the Inbore processing, if needed.
5. To adjust the First Movement time, place the marker at the new time/position and choose the **Mark as First Movement** menu option again.

6. To reset the First Movement marker, right-click anywhere on the STDraw and choose the **Reset First Movement** menu option.



7. To create a Work File result with the **Inbore Object** track click **Make WRK**.
8. If placed, the First Movement marker can be used as reference time and mark where T=0.



◄ End of Chapter ►

11 WRK File Processing

11.1 Introduction

The WRK file holds information about the tracks detected in the signal. Each track is a fragment of the trajectory of an object comprising a number of individual time-space-position measurement points.

The WRK file contains track data obtained during the measurement and track data which is the result of post processing, see DAT File Processing (page 91).

The WRK file processing tool derives a large number of trajectory characteristics like ground track, drag, retardation, tangential velocity and other parameters valuable for ballistics analysis.

Another powerful tool is the fitting or smoothing tool that calculates a set of polynomials that fit the measured data in an optimum way. This way a number of parameters are derived from the measured trajectory even if it is very noisy.

A similar technique is applies to extrapolate the trajectory beyond the measured data and estimate the muzzle velocity or the impact point.

WRK file processing runs entirely on the Instrumentation Controller and uses the stored WRK file from the measurement or from the processed DAT file.

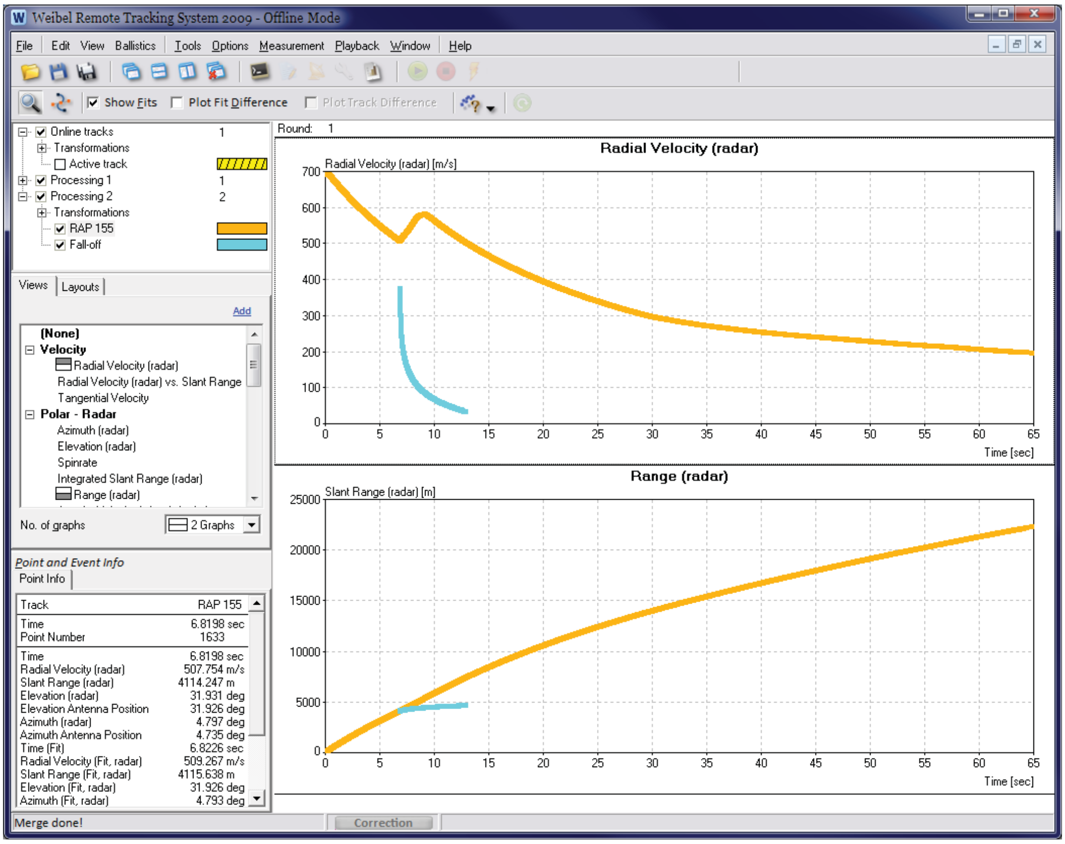
To run the Analysis, you must first load the WRK file stored immediately after the measurement, see Open a WRK File (page 163).

11.2 Open a WRK File

To open and process a WRK file:

1. On the **File** menu, click **Open**
2. From the file select window choose the WRK file
3. Click **Open** and the work file view is displayed, see below.
4. Use the Work File Tools and Windows (page 164).

The following window appears:



The main window to the right is the graph area, where all graphs are drawn. The smaller windows located to the left provide a number of tools for configuring and manipulating the graphs.

Notes

- ► A WRK file can also be opened by double-clicking on the file in Windows Explorer or dragging the file from Windows Explorer to the WinTrack window or icon.

11.3 Work File Tools and Windows

Once a work file is opened a number of tools for displaying and manipulating the work file contents become available, see Open a WRK File (page 163).

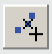
The following actions are supported:

Action	Objective
Use the Work File Tool Bar (page 165)	Access one of the most frequently used functions.
Use the Track List (page 166)	Control which of the tracks present in the WRK file to draw in the graph area. Manipulate tracks or the parameters associated with it.
Configure the Graph Layout (page 167)	Define the number of graphs drawn in the graph area.

Action	Objective
Choose a Graph View (page 167)	Select a view for a specific graph, just drag-and-drop the view on the graph. Define a new view, if the list does not already provide the view you want.
Select a Predefined Layout (page 168)	Select a predefined layout defining the number of graphs in the graph area and their contents.
Use the Info Window (page 169)	View specific points.
Use the Graph Area (page 169)	Configure the graph presentation.
Enable/Disable Points in a Track (page 171)	Make individual points of the graph valid or invalid.
Print or Export Track Graphics (page 172)	Print or export graphs to a file.

11.3.1 Use the Work File Tool Bar

When a work file is opened, see Open a WRK File (page 163), the work file tool bar appears just below the main tool bar. It provides easy access to the most commonly used tools and editing modes for work file processing.

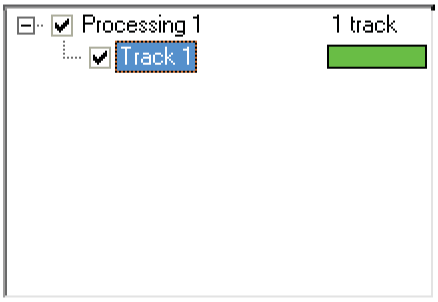
Menu Item	Function
	Switch to the zoom in/out mode in the graph area.
	Switch to the point select mode in the graph area.
Show Fits	Show the polynomial fits on the graph.
Plot Fit Difference	Plot the difference between the fit and the measured data points.
Plot Track Difference	Plot the difference between all visible tracks and the fit of the selected reference track, see Use the Graph Area (page 169).
	Select which points to show.
	Redraw any pending changes.

Notes

- Enable **Plot Track Difference** affects only graphs with a fittable value versus time. These graphs show the text **Track Difference** under the graph.
- Other graphs are shown in normal view.

11.3.2 Use the Track List

The Track List Window shows all the tracks in the work file.



Tracks are collected in groups. The track list shown above contains four tracks, collected into three groups.

There are four types of tracks/groups, and they have slightly different properties:

Track type	Properties
Processing	Processing tracks are tracks that were created by post-processing the measurement data. Each processing will result in one group with all the created tracks. Processing tracks can be manipulated freely, without the restrictions that apply to online tracks. It is possible to select which transformations should be activated when a processing group is opened for the first time. This is done in Customize Post-Processing (page 16).
Ungrouped	This is a collection of tracks that are not assigned to a group. This occurs when opening a work file saved in an older version. Since these tracks may have different origins and may have had different transformations applied, no transformations will be active by default.
Prediction	These are predicted tracks, see Predict the Trajectory (page 23). Since these are not measured tracks, transformations are rarely needed, so no transformations will be active by default.

Track-group assignment is not definite. The tracks can organized by dragging a track while optionally holding down a modifier key, as described below:

Destination	Modifier	Description
Group		Moves the track to the destination group.
Group	Ctrl	Copies the track to the destination group. The result if a processing track, regardless of the source type.
Track		Merges the source track into the destination track, leaving the source track unchanged.

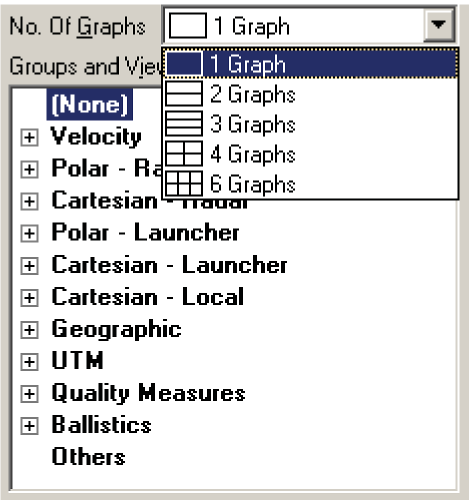
Thus, if the need to work on an online track should arise, it can be done by dragging it to make a working copy and using it instead.

Tracks and groups have check boxes, which are used to show or hide tracks and/or groups of tracks. A track is visible if the track itself and its group are checked.

Right-clicking a track or group brings up a context menu with all possible actions. See Edit and Analyze Tracks (page 173).

11.3.3 Configure the Graph Layout

The graph area is available for 1 to 6 independent graphs. Select the graph layout from the **No. Of Graphs** drop-down box:



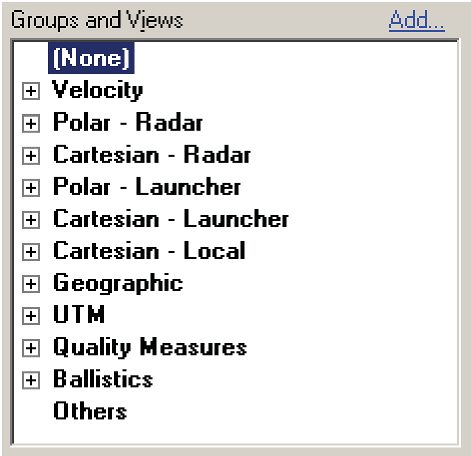
Notes

► Use the mouse to move the boundaries between the graphs.

11.3.4 Choose a Graph View

The graph view defines which track parameters are displayed, either raw measurement data, e.g. radial velocity versus time, or derived track parameters, e.g. drag versus tangential velocity. It furthermore defines which units to use on the axes.

To view the track data and the polynomial fit just select the view from the Groups and Views list and drag-and-drop it on the graph, where you want to see the view.



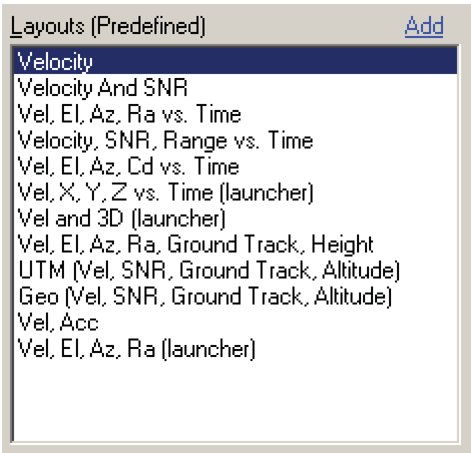
To add a new graph view click the **Add** link in the upper right corner of the **Groups and Views** box, Define or Edit a Graph View (page 195).

Notes

- The views are arranged according to the coordinate system used.
  See Work with Coordinate Systems (page 31).
- It's easy to add more groups, see Define or Edit a Graph View (page 195).

11.3.5 Select a Predefined Layout

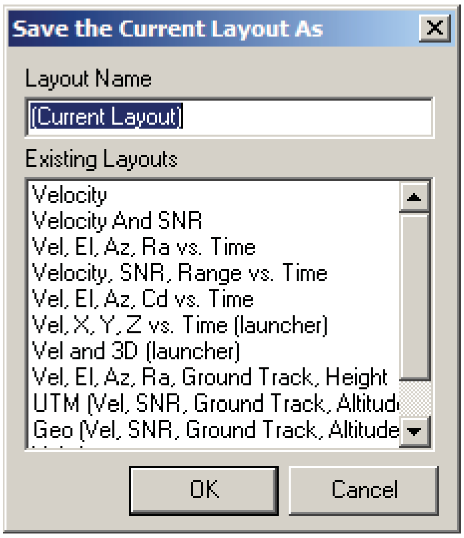
A list of predefined layouts are available in the **Layouts** box, which is part of the WRK file view window, see Open a WRK File (page 163). The layout defines the number of graphs as well as the view displayed in each of the graphs.



Click one of the layouts to use it. The layout is automatically applied to the graph area.

To add a new layout:

1. Manually Configure the Graph Layout (page 167) and Choose a Graph View (page 167) for each of the graphs.
2. Click the **Add** link in the upper right corner of the **Layouts** box to get the following window:



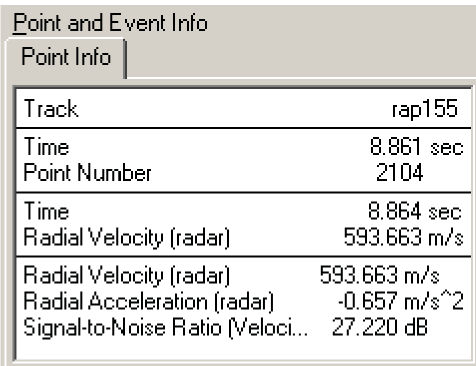
3. Enter the **Layout Name** and click **OK**.

Notes

► Other layout operations like Rename, Delete and Assign Shortcut are available by right clicking a layout name.

11.3.6 Use the Info Window

The info window provides the parameter values for individual points in the track.



Notes

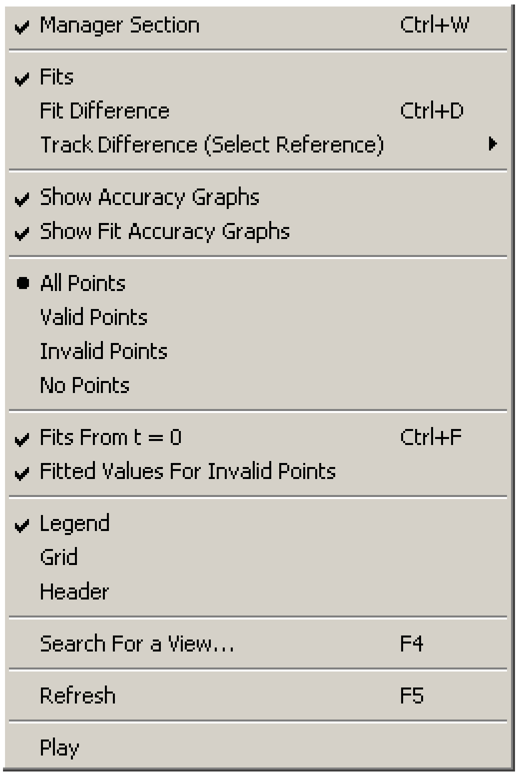
► Click one of the tracks in one of graphs to select the point closest to the cross hair.

► Use the left/right arrow keys to move back and forth in the track.

11.3.7 Use the Graph Area

To define the contents of a specific graph, see Choose a Graph View (page 167). The data is transformed and presented in the graph. To further configure the graph:

1. Select the **View** menu item to get the following options:



2. Select the option from the list.
3. The graph area is automatically updated.

Enable/Select	If you want to
Manager Section	Enable the control windows; see Work File Tools and Windows (page 164).
Fits	Enable fits in the graphs.
Fit Difference	Plot the difference between the fits and the measured data points.
Track Difference (Select Reference)	Plot the difference between the visible tracks and the fit of a selected reference track.
Show Accuracy Graphs	Show the accuracy of the measured values.
Show Fit Accuracy Graphs	Show the accuracy of the fitted values.
… Points	Select which points to include in the plot.
Fits From t = 0	Start the fit in t = 0.
Fitted Values For Invalid Points	Also show fitted values where data points are invalid.
Legend	Enable legend information on each graph.
Grid	Enable vertical and horizontal grids on the graphs.
Header	Enable the header.

Enable/Select	If you want to
Search For a View	Search for a view containing a specified substring in the name.
Refresh	Recalculate the views and refresh the graphs.
Play	Play the on-line information available in the WRK file using the current on line view.

Select	If you want to
All Points	Draw both valid and invalid points in the graphs.
Valid Points	Draw only the valid points in the graphs.
Invalid Points	Draw only the invalid points in the graphs.
No Points	Draw no points; drawing the fits is still possible.

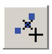
11.3.8 Enable/Disable Points in a Track

The measurement points in a track are shown as colored dots in the graph. To control which points are drawn in the graph see: Use the Graph Area (page 169). They also contribute to the interpolation process depending on their validity status: valid points are taken into account and invalid points are ignored.

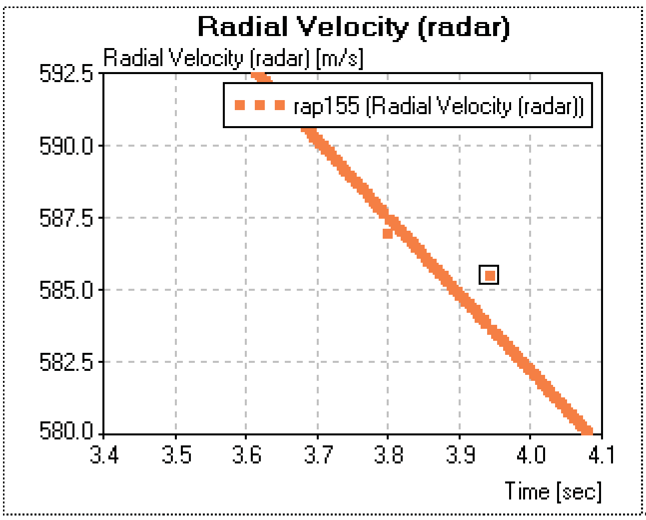
To make points in a track invalid:

1. Enable the relevant tracks, see Use the Track List (page 166).
2. Click the **Zoom mode** icon in the tool bar:

3. Select the area of interest using the mouse pointer to make a zoom.
4. Click the **Edit mode** icon in the tool bar:



5. Click a measurement point to select it or use the mouse pointer to select a group of points:



A square black box is drawn around the point.

6. Hit the **Delete** key to make the data point invalid. Note that it changes color.

In this example a single point from the rap155 track is selected and made invalid.

Notes

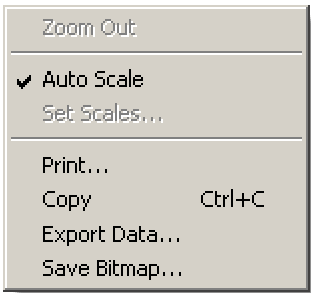
- To make a point valid use the same procedure as above and hit the **Insert** key in step 6.
- To select a sequence of points:
  1. Click on the first point.
  2. Hold Shift down and click on the last point.
- You can select scattered points by holding Ctrl down while clicking on points with the mouse.
- You may enable/disable tracks after zooming in on a detail.
- To move data points from one track to another see Add or Delete Points from a Track (page 118) in the DAT File Processing section.

11.3.9 Print or Export Track Graphics

The graphs shown in the track view can be printed or exported to a graphics file for use in a document or report.

To print or export a single graph:

1. Right click the graph to get the following options:



2. Select **Print** if you want to send the graph to a printer. Select **Save Bitmap** or **Export Data** if your want to save the graph in a graphic file or a text file.

To print or export all graphs in a single plot:

1. On the menu bar select **File**.
2. Select **Print** to send the graphs to a printer. Select **Save Bitmap** if your want to save the graph in a graphic file.

Notes

- To configure the header, footer, height and width of the print-out or graphics file, see Customize Graphics Export (page 14).

11.4 Edit and Analyze Tracks

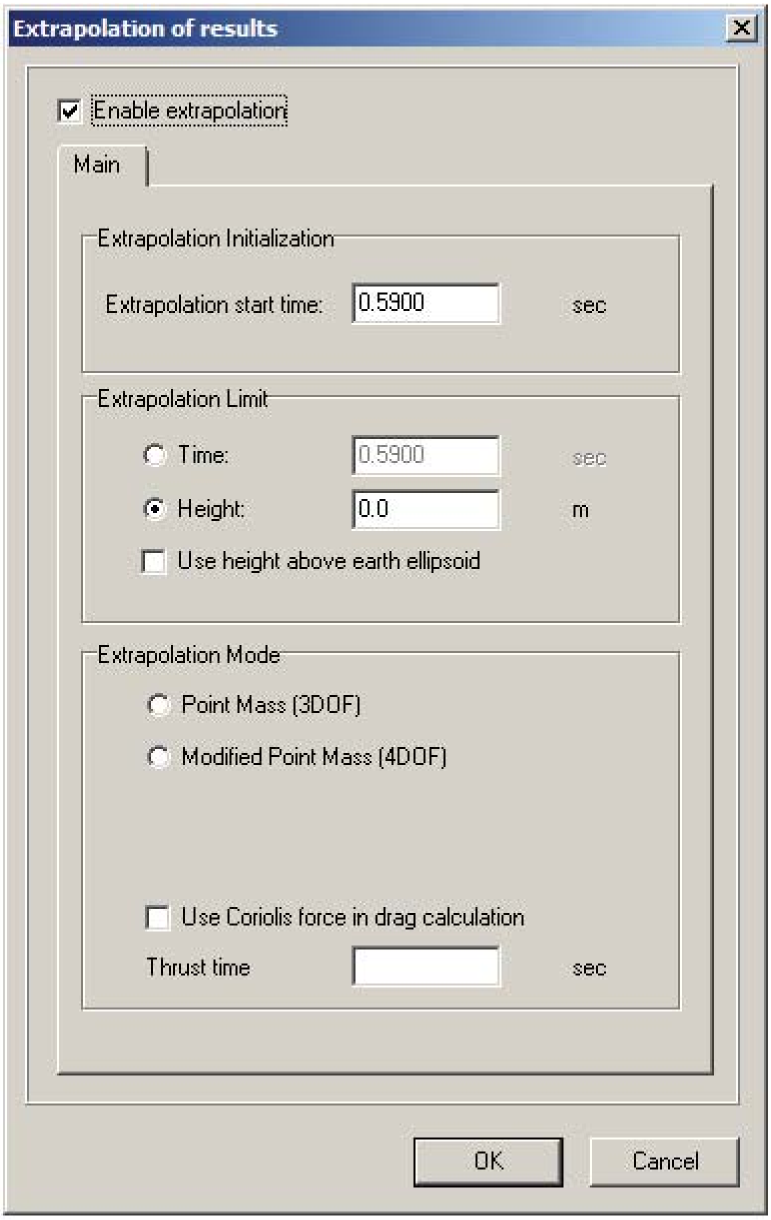
Right-clicking an item will bring up a context menu with available options. The options will depend on the type of item. The table below presents all the options:

Option	Context	Description
Main		
New group	Background	Creates a new track group.
Rename	Group Track	Lets the user rename the item. This option is not available for online tracks and the online track group.
Delete	Group Track	Deletes the item. This option is not available for online tracks and the online track group.
Parameters	Track	Opens the parameter list/editor.
Select Fitting Coordinate System	Track	Select the coordinate frame in which fitting is performed. See Select Fitting Mode (page 181).
Calculate Muzzle Velocity	Track	Select the muzzle velocity calculation method. See Calculate Muzzle Velocity (page 183).
Calculate Impact Point	Track	Extrapolate the track to estimate the point of impact.
Change Color	Track	Change the color of the track.
Edit		
Coordinate Systems	Group	Configure the coordinate systems used. See Work with Coordinate Systems (page 31).
Fit info	Track	Opens the fit editor. See Edit the Fit Information (page 186).
Extrapolation	Track	Opens the extrapolation editor. See Edit the Extrapolation Parameters (page 174).
Export		
Track Data	Track	Lets the user export the track to several different formats, a.o. ASCII format. See Export Track Data (page 176).
Preprogrammed Curve	Track	Generate a pre-programmed curve based on the fits of the selected track. The curve can later be sent to a tracking controller device to ensure safe data acquisition.

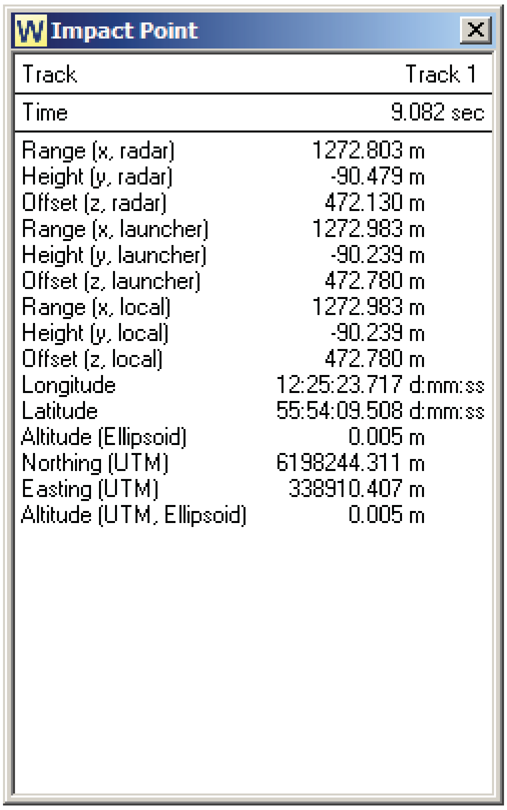
11.4.1 Edit the Extrapolation Parameters

The extrapolation parameters control how the measured data set is used to estimate the impact point of the object. To edit the extrapolation parameters:

1. Open the **Extrapolation** window. See Edit and Analyze tracks (page 173).



2. Make the appropriate changes (if any) and click **OK**.
3. To estimate the impact point using the current setting, repeat steps 1 and 2 above and click **Calculate Impact Point** and view the results window:



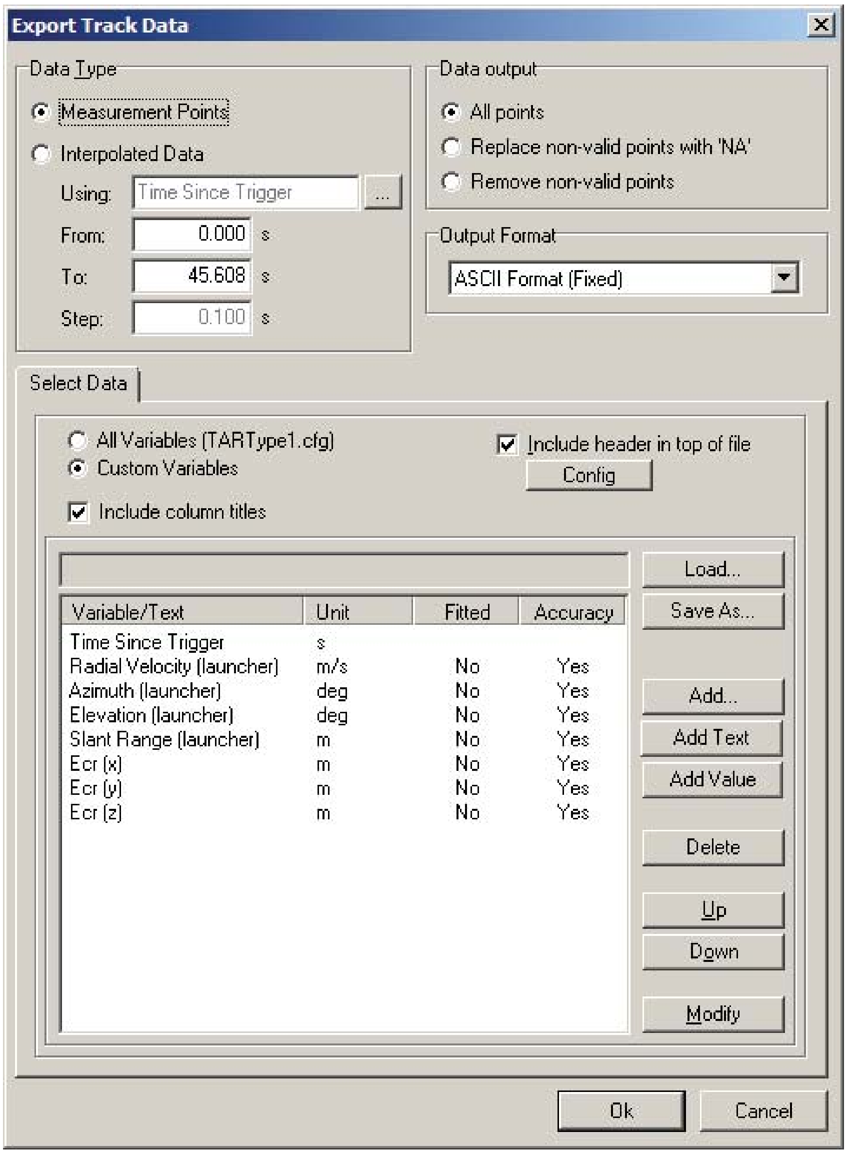
Configure/select	If you want to
Enable extrapolation	Use the built in algorithms for impact estimation.
Start extrapolation at	Specify when the last valid position/velocity point is. Data after this point is not used in the extrapolation.
Time	Use a known impact time to define the impact.
Height	Use the crossing of a certain height above the ellipsoid to define the impact.
Use height above Ellipsoid	Enable the height above ellipsoid parameter.
Point Mass (3DOF)	Use the point mass ballistic model.
Modified Point Mass (4DOF)	Use the modified point mass ballistic model.
Five Degrees of Freedom (5DOF)	Use the five degrees of freedom ballistic model. This feature is only available when using STANAG 4355 ballistic extrapolation.
Use Coriolis force in drag calculation	Take the Coriolis force into account, when the extrapolated points are calculated.
Thrust time	Indicates how long the object is influenced by other than aerodynamic forces. Relevant for objects like rockets.

Notes

- ► The extrapolated part of the fitted curve is drawn in the same color as the grid in the graphs.

11.4.2 Export Track Data

Track data may be exported to an ASCII or binary file for further processing. The **Export Track Data** is opened by right-clicking a track and selecting **Export** → **Track Data**.



Configure/select	If you want to
Measurement Points	Export the measurement points detected in the signal.
Interpolated Data	Export date that is a smooth interpolation of the measurement points.

Configure/select	If you want to
From time	Export interpolated data from this time and forward.
To time	Export interpolated data until this time.
Time Step	Set the distance between interpolated data.
All measured points	Export all valid and non-valid measured points.
Replace non-valid points with ‘NA’	Replace non-valid measured points with ‘NA’ when exporting measurement points.
Remove non-valid points (entire row)	Remove rows with non-valid measured points when exporting measurement points.
Include header in top of file	Include a text header in the beginning of the file. This option only applies to ASCII formatted files. Press the **Config** button to select the header contents, see Configure Export Data Header (page 180).
Include column titles	Include column titles. This option only applies to ASCII formatted files.
All Variable	Include all variables
Custom Variables	Select which parameters to include, see Configure the Export Data List (page 179).
Output Format	Choose the output format – see below

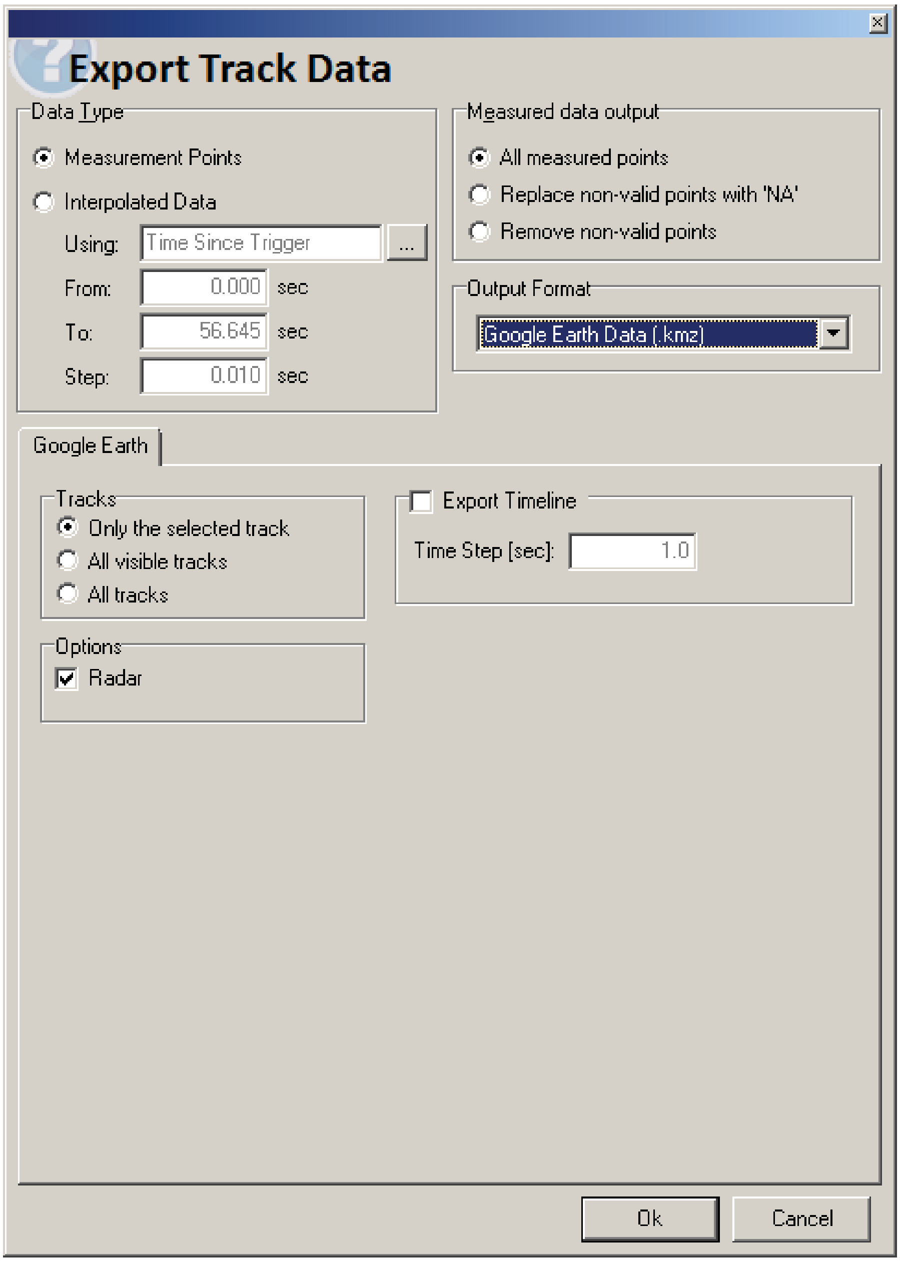
Output formats to choose between:

Format	Output Description
ASCII Format (Scientific)	ASCII text with scientific format (e.g. 1.00e-02)
ASCII Format (Fixed)	ASCII text with fixed format (e.g. 0.010000)
Binary Format	Binary format
Ballistic Modeling Data	Ballistic Data (.drg)
Google Earth Data	Google Earth KMZ data. See Export Track Data for Google Earth (page 177)

11.4.2.1 *Export Track Data for Google Earth*

The Export Track Data (page 176) supports exporting track data to Google Earth as .KMZ files.

By choosing the Google Earth Data format the following options appear:



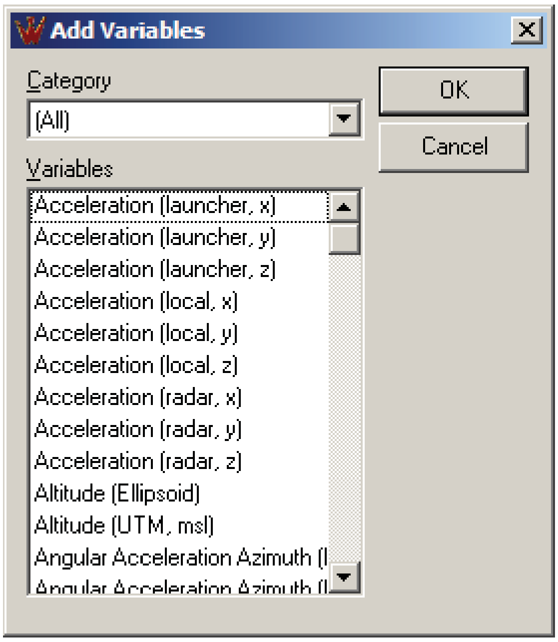
Option	Description
Tracks	Select which track to export
Export Timeline	Enable this option to export time information for track points at specific time steps (see option below). A TimeLine tool will appear in Google Earth. Use this tool to step through time or to make an animation.
Time Step	Choose the time step.
Radar	Select this option to export the radar position. The radar will then be showed as a special marking in Google Earth.

11.4.2.2 Configure the Export Data List

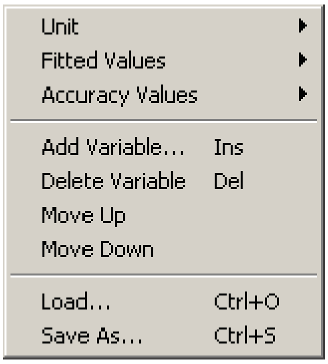
The data export is controlled by the export data list, visible in the Export Track Data (page 176) window. A number of predefined parameter lists are available, click **Load** and select one of the CFG files.

To add and configure a parameter to the export data list:

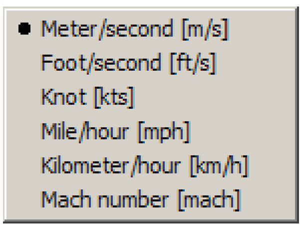
1. In the **Export Data List** window click **Add Variable** to get this window:



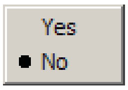
2. Select a variable and click **OK** to add it to the list.
3. Right click the **Parameter** to get this window:



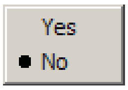
4. Click **Unit** to get this window:



5. Click to select the unit from the list.
6. Repeat step 3. and click **Fitted Values** to get this window:



7. Select **Yes** to use fitted values, **No** to use measured values.
8. Repeat step 3. and click **Accuracy Values** to get this window:

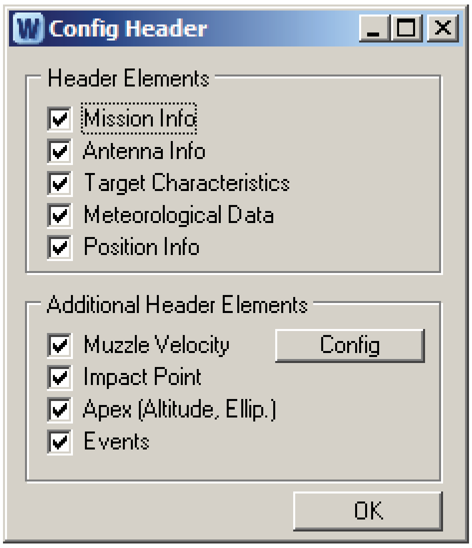


9. Select **Yes** to export accuracy values as an extra column.

   If **Fitted Values** (see step 6) has been set to **Yes** it will export the accuracy for the fitted values instead of the measured value.
10. In the **Export Data List** window click **Add Text** to add a fixed string to the list. This string will be exported as it is.
11. In the **Export Data List** window click **Add Value** to add a fixed value to the list. This value will be exported as it is.

11.4.2.3 *Configure Export Data Header*

Configure the header contents by pressing the **Config** button on the Export Track Data (page 176) dialog. This will show the following dialog.



Choose what to include in the export header.

Option	Description
Mission Info	General mission information
Antenna Info	Antenna type and serial number
Target Characteristics	Target information, like weight and diameter
Meteorological Data	Meteorological data, like temperature.
Position Info	Radar, Launcher and Local position information.

Additional Header information:

Option	Description
Muzzle Velocity	Muzzle velocity and its accuracy. Choose **Config** to configure the muzzle velocity calculation, see Calculate Muzzle Velocity (page 183).
Impact Point	The impact point
Apex (Altitude, Ellip.)	The point of heighest altitude (Ellips)
Events	User-defined events

Notes

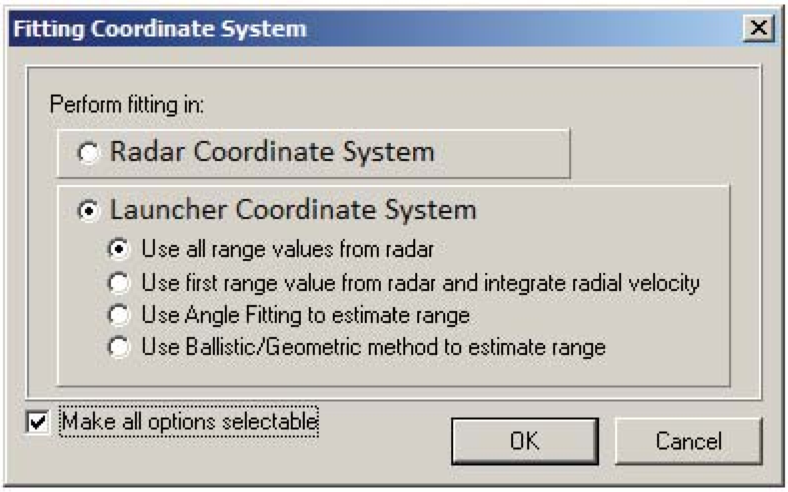
► Be advised, the **Additional Header Elements** options might need to change the current track setting, like enabling extrapolation or changing the fitting coordinate system.

11.4.3 Select Fitting Mode

The fitting process takes a single set of parameters versus time and finds an “optimum” set of polynomials, and uses them for interpolation. When fitting is applied to the polar coordinates, see Edit the Fit Information (page 186), the first radial velocity points as seen from the radar are heavily impacted by the parallax caused by the offset and setback of the radar relative to the launcher, and may thus be difficult to approximate by a polynomial.

Seen from the launcher there is no parallax effect and therefore the measured polar coordinates are smoother. This may lead to a more accurate fit using lower order polynomials.

To configure the fitting coordinate system, right-click a track and select **Select Fitting Coordinate System**. This will bring up the window shown below.



Configure/select	If you want to
Radar Coordinate System	Fit the polar data using the radar coordinate system.
Launcher Coordinate System	Fit the polar data using the launcher coordinate system.

When fitting in the Launcher Coordinate System is selected one or more options in the dialog becomes available, depending on whether range exists or not.

The following options are available:

Configure/select	If you want to	Radar
Use all range values from radar	Use the range found by the radar (range radar only).	Range
Use first range value from radar and integrate radial velocity	Use the first valid range value found by the radar and integrate the radial velocity from that point.	Range
Use Angle Fitting to estimate range	Find the range values that match well with the azimuth/elevation angles and the radial velocity values observed by the radar.	Range Non-range
Use Ballistic/Geometric method to estimate range	Use only the radial velocity values observed by the radar to estimate the range.	Range Non-range

11.4.3.1 *Methods for Parallax Estimation*

To perform the conversion from radar to launcher coordinates we need the exact location of the launcher relative to the radar and for each data point a good range to the target.

For a non-ranging radar we need to estimate the range based on the available information. We offer two options:

Range/Parallax Method	Description
Ballistic/Geometric	Use only the radial velocity values observed by the radar to estimate the range. Assume that the target is following a simple point mass ballistic trajectory based on the location and orientation (elevation and bearing to North) of the launcher as entered by the operator.

Notes

- ► The Ballistic/Geometric method may yield better results when the distance is smaller than 1000m and the location and orientation of the launcher are accurate.

  The values entered during the measurement may be corrected afterwards, see Edit and Analyze Tracks (page 173).

11.4.4 Define Projectile Parameters for Extrapolation

The **Projectile Parameters** groupbox has multiple entries for defining the physical characteristics of the projectile. The entries will be activated/deactivated depending on the ballistic model selected for extrapolation.

The values of angular velocity can be controlled from the **Use measured angular velocity** checkbox. When this is checked the measured angular velocities will be used while the specified angular velocities will be used otherwise. It is noted that only the longitudinal angular velocity can be measured.

The ballistic models used for extrapolation do not include any thrust forces and are applicable only for projectiles without propulsive thrust.

11.4.5 Define Simulation Parameters for Extrapolation

The **Max sample points** define an upper limit on the number of points that will be calculated in the ballistic simulation.

The **Sample period** defines the time difference between two consecutive samples in the ballistic simulation.

The **Step size** is used to control the accuracy of the numerical simulation. The step size depends on the physical characteristics of the system and should always be assessed for any given system. It is recommended that the step size be reduced until the accuracy converges to an acceptable level. It is noted that reducing the step size may result in excessive computation times. If the step size is chosen too low it may compromise accuracy because of rounding errors.

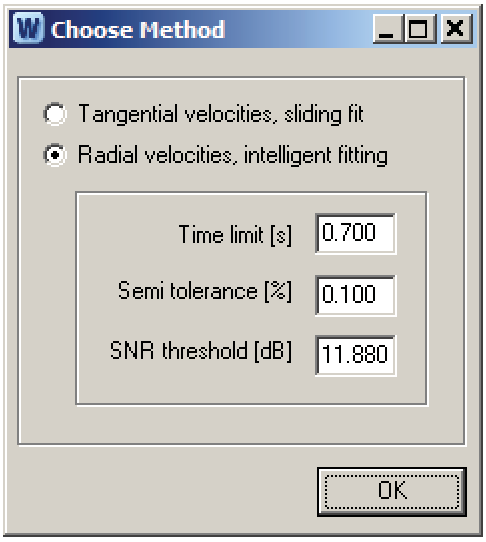
The fitting algorithm used for ballistic extrapolation differs from the algorithm used for ordinary extrapolation. The algorithm is based on polynomial fitting where the **Fitting order** defines the order of the polynomial. Since most ballistic trajectories are similar to a parabola it is recommended that the fitting order be set to two or three. The **Fitting points** define the number of points used for polynomial fitting. The points will be arranged symmetrically around the point to be fitted.

Notes

► The ordinary Fitting Editor cannot be used for setting the fitting parameters for ballistic extrapolation.

11.4.6 Calculate Muzzle Velocity

To calculate the muzzle velocity, right-click a track and select **Calculate Muzzle Velocity**. This will bring up the window shown below.



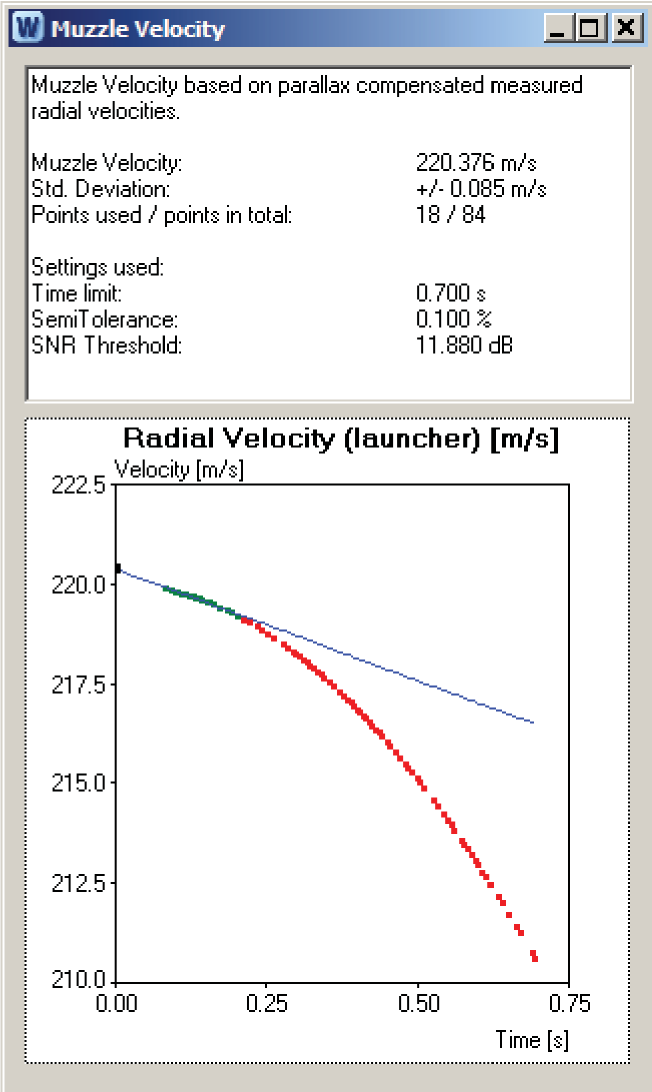
Select	Description
Tangential velocities, sliding fit	Evaluates the interpolated tangential velocities in t = 0. The tangential velocities have been found based on the parallax routine choosed in Select Fitting Mode (page 181) and the fit parameters set in Change the Fit Parameters (page 187).
Radial velocities, intelligent fitting	Data points from t = 0 to t = **Time limit** are used in the calculation. First, the points with a SNR below the **SNR threshold** is excluded, then the raw measured radial velocities are parallax compensated without using angles or range. The velocities are then fitted in the following way where each fit uses every valid data point: A 4th order fit is made, and the data points are excluded one at a time until the tolerance of the total velocity fit meets the tolerance specified by **Semi tolerance** (See note below). When the best 4th order fit has been found, a 2nd order fit is made. If the tolerance of the fit is worse than the tolerance accomplished by the 4th order fit, the measurement base is too long and points are removed from the end until the tolerance is coming close to the tolerance reference. Finally, the procedure checks whether a 1st order fit is more suitable than the 2nd order fit. This is done by choosing the fit with the highest muzzle velocity.

Notes

- The three parameters: **Time limit**, **Semi tolerance** and **SNR threshold** are only used in the intelligent fitting method.

- The limits of the parameters are as follows: **Time limit**: 0 – 10 s, **Semi tolerance**: 0-100 %, **SNR threshold**: positive value.
- The 'Tolerance' is based on a standard Deviation of the point difference between points and fit relative to the average velocity.
- The parallax compensation in the second method is most precise for weapons close (< 10 m) to the antenna and with the first data point before about 200 ms.
- If the radar supports range, use the first method.

Output from the intelligent fitting routine is a table with information and a graph showing the points used in the fitting (green) and the points excluded from the fitting (red):



11.5 Edit the Fit Information

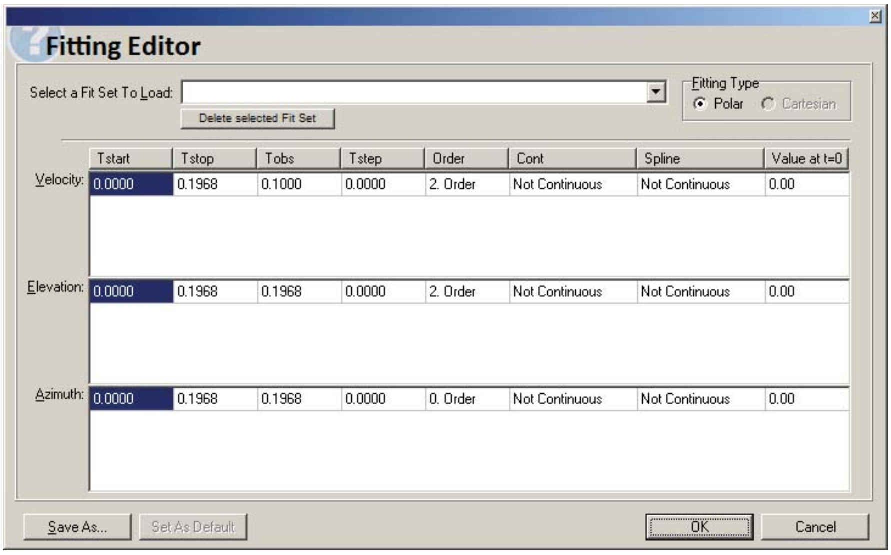
Input to the fitting process is a set of measurement data and the fit information controlling the fitting process. Output from the fitting process is a set of fit data, which is a sampling of the polynomials, fitted to the data.

The fit information determines how to split the trajectory into small time windows and how to fit a polynomial to the measured data in each window. For more information see About Polynomial Fitting (page 192).

To access the fit information editor:

1. Click the track to select it.
2. Right click the track and select the **Edit Fit Info** to activate the editor.

The following window is displayed:



Although the radar does not directly detect angles WinDopp estimates the elevation and azimuth angles based on the initial launcher pointing (entered by the operator) and a simple ballistic model.

In this example the measurement parameters are: **Velocity**, **Elevation**, **Azimuth** and **Range**. The fit information is defined for each of the parameters independently and it contains one or more segments, each holding a set of fit parameters.

Two or more segments are useful if an event during the measurement, e.g. ignition of a rocket motor, has a significant impact on the characteristics of the trajectory. To add more segments to the fit information, see Split a Time Segment (page 188).

Use	If you want to
Select a Fit Set to Load	Load a predefined set of fit parameters.
Fitting Type	Select either polar or cartesian coordinates for the fitting process.
Fitting Editor area	Configure individual fit parameters, see Change the Fit Parameters (page 187).
Save As …	Save the current set of fit parameters for later use.

Use	If you want to
Set As Default	Use the current set of fit parameters every time a new work is generated from a DAT file or a measurement.

Notes

- A polar fit is normally preferred.
- A rectangular fit may give a better result for measurements on objects like airplanes and helicopters. (A rectangular fit requires measured range data i.e. a ranging antenna.)

11.5.1 Change the Fit Parameters

To change any of the fit parameters,

1. Activate the fit editor, see Edit the Fit Information (page 186).
2. Click the numerical value to highlight it.
3. Edit the value (delete characters using Backspace).
4. Repeat steps 2. and 3. as needed.
5. Click **OK** when finished.

Change	If you want to
Tstart	Define when the time segment starts.
Tstop	Define when the time segment ends.
Tobs	Define the size of the time window that one polynomial is based on.
Tstep	Define the size of the step in time taken before calculating the next polynomial.
Order	Set the order of the polynomials.
Cont	Select the boundary condition for the current segment meeting the previous segment, see below
Spline	Select the boundary condition for one polynomial meeting the previous polynomial within the same segment, see below
Value at t=0	Define a start value for the fit.

When configuring either the **Cont** or the **Spline** boundary condition:

Select	If you want to
Not continuous	Optimize the polynomial without taking any boundary condition into account.
Continuous	Force the two bordering polynomials to meet.

Notes

- Setting **Tobs** > **Tstep** means that the polynomial is based on data from a larger interval than the interval where the polynomial is used for interpolation.

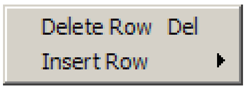
- If **Tstep** = 0 then a new polynomial is calculated for each new measurement point.

11.5.2 Split a Time Segment

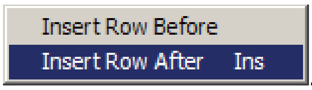
If an event happens at a certain point in the data set, we may want to separate the polynomial fitting before and after the event. In this situation we split the measurement time into two (or more) segments each with their own set of polynomial specifications: **Order**, **Tobs**, **Tstep** etc.

To split a time segment into two segments:

1. Click the row in the edit window that represents the segment you want to split, see Edit the Fit Information (page 186).
2. Right click to get the following options:



3. Select **Insert Row** to get the following options:



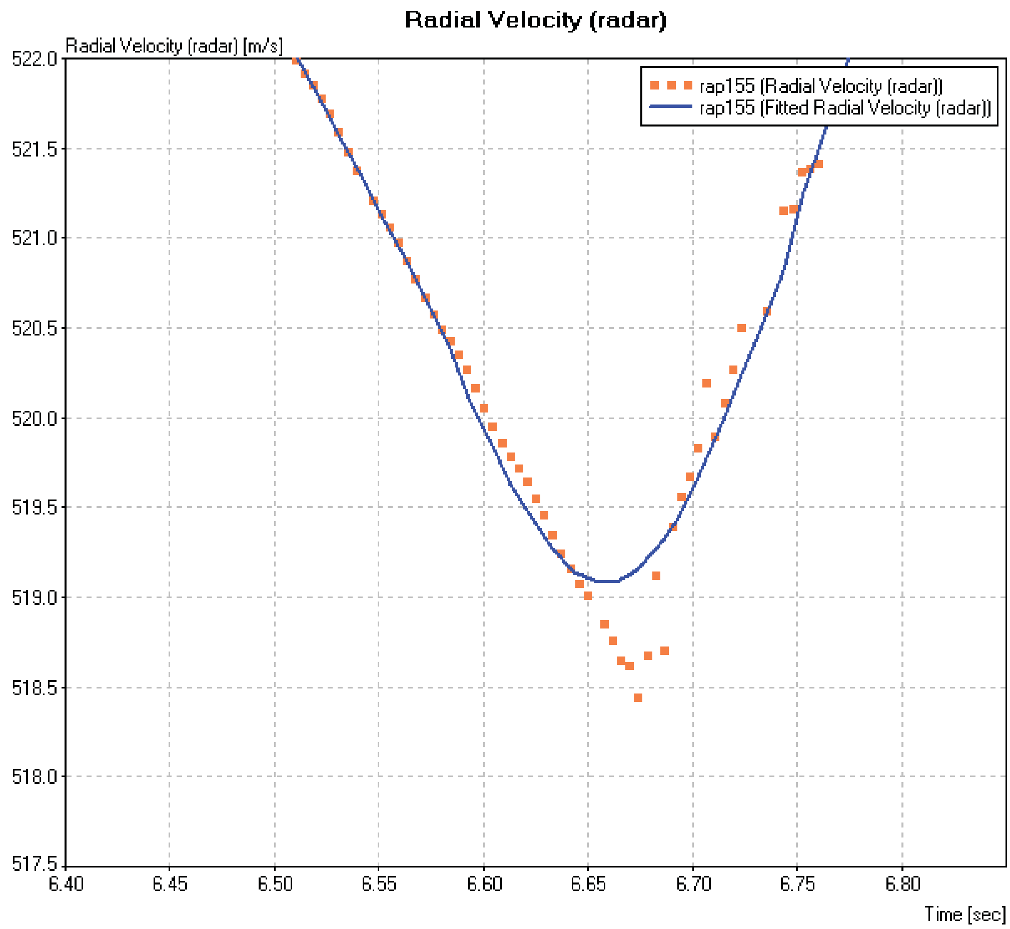
.

4. Select **Insert Row After** and enter the time boundary between the two segments.

11.5.2.1 Using Two Velocity Time Segments

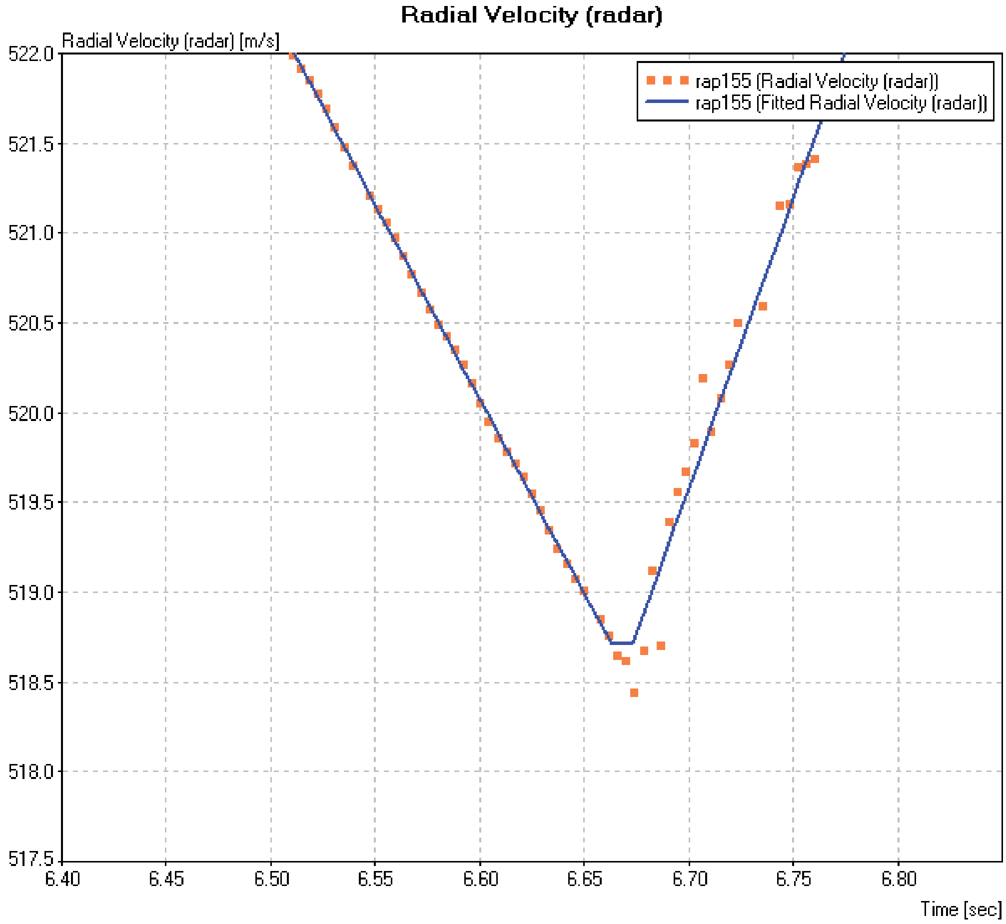
The following figures show the raw and the fitted radial velocity of a 155 mm RAP projectile around the time when the rocket motor starts (approximately 6.67 seconds). Both fits use the following parameters: **Tobs** = 0.2, **Tstep** = 0.0, **Order** = 2, **Cont** = Not continuous, **Spline** = Not continuous.

The first figure shows the result of using only one segment from start to end of the measurement:



A typical "U" shape is seen in the transition area, where **Tobs** overlap both the rocket-off and rocket-on measurement points. This clearly does not depict the real trajectory data.

The second figure shows the result of inserting a segment boundary at t = 6.67 seconds:



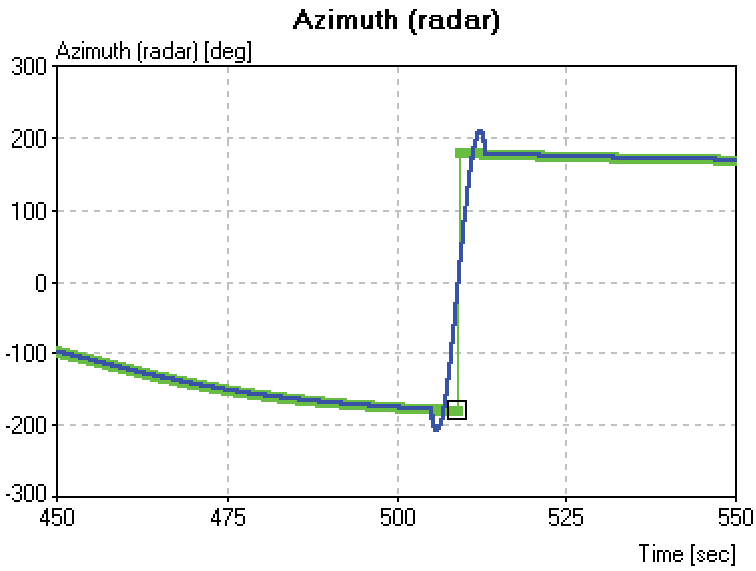
The "V" shape indicates that the polynomial fitting on one side of the segment boundary does not take any measurement points from the other side into account. The result is a more accurate fit.

Notes

- The time boundary entered becomes the new **Tstop** of the original segment and the **Tstart** of the new segment.
- The fitted velocity is plotted by sampling the fit polynomials every 10 ms and then a straight line is drawn between the samples.

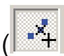
11.5.2.2 *Using Two Azimuth Time Segments*

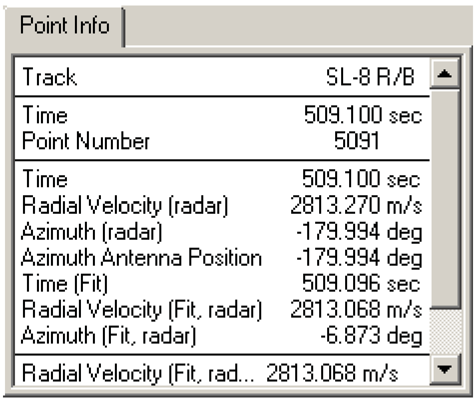
When the trajectory passes through 180 degrees the polynomial fit may look like this:



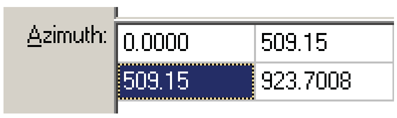
Note the “overshoot” of the fitted values (blue line) which is caused by the polynomial fits trying to bridge the apparent 360 degree jump between the two segments of the data.

A simple work-around to this problem is to split the azimuth time segment somewhere between the last point of the first segment and the first point of the second segment.

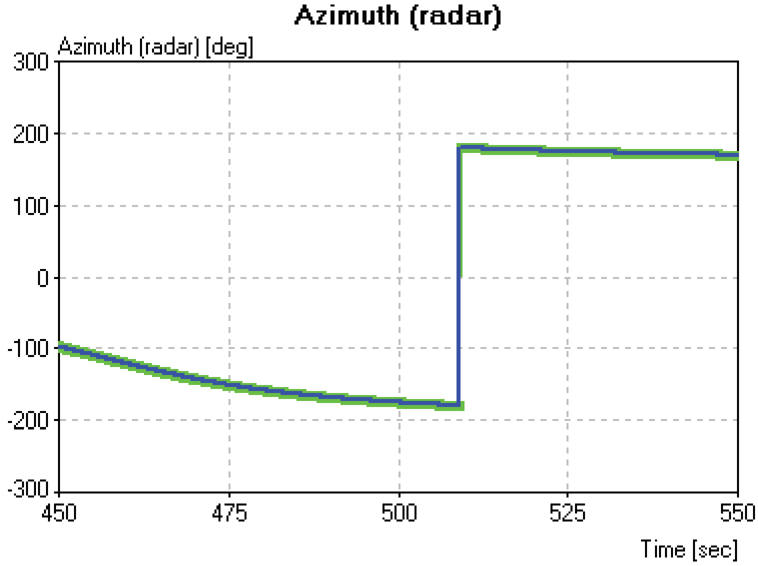
The time can be found by zooming in or by using the “Edit” mode (). Use the right/left arrow keys to move the square box between the two track points on each side of the transition. The “Point Info” box to the left shows the time of the track point:



In this case the time of the two track points are: 509.1 and 509.2. Therefore we decide to split the original segment at t = 509.15 seconds. Open the Fitting Editor and insert the new segment, see Split a Time Segment (page 188). The result looks like this:



Click **Ok** to re-calculate the fit polynomials based on the new set of fit definitions:



This method works because the segmentation prevents data points from one side of the transition to be used for polynomials on the other side of the transition.

11.5.3 About Polynomial Fitting

We use polynomial fitting to approximate a data set of with a polynomial of a specified **Order**. The best fit is defined as the polynomial with the least sum of squared deviations from the data set. Note that the time increment may vary, e.g. if a data point is missing.

Often the complete data set from **Tstart** to **Tstop** is not well approximated by just one polynomial, but the local behavior is still well described by a polynomial. Instead of just one polynomial a set of polynomials is used, each covering an interval of time-values and each optimized for a specific subset of the data set.

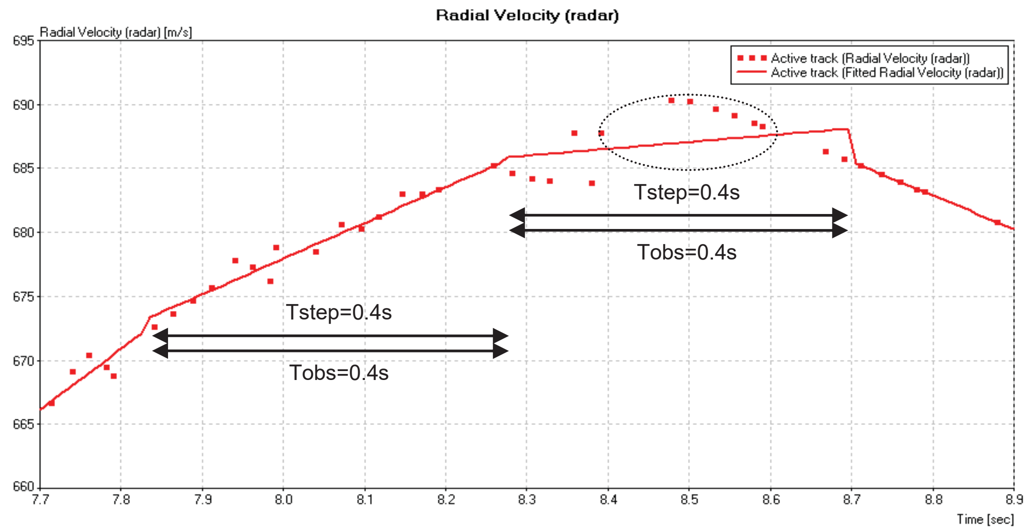
Tstep specifies the distance in time between two polynomials. This means that a new polynomial is calculated for every **Tstep** seconds and that each polynomial is valid (for interpolation, derivatives etc.) in a time interval of length **Tstep**.

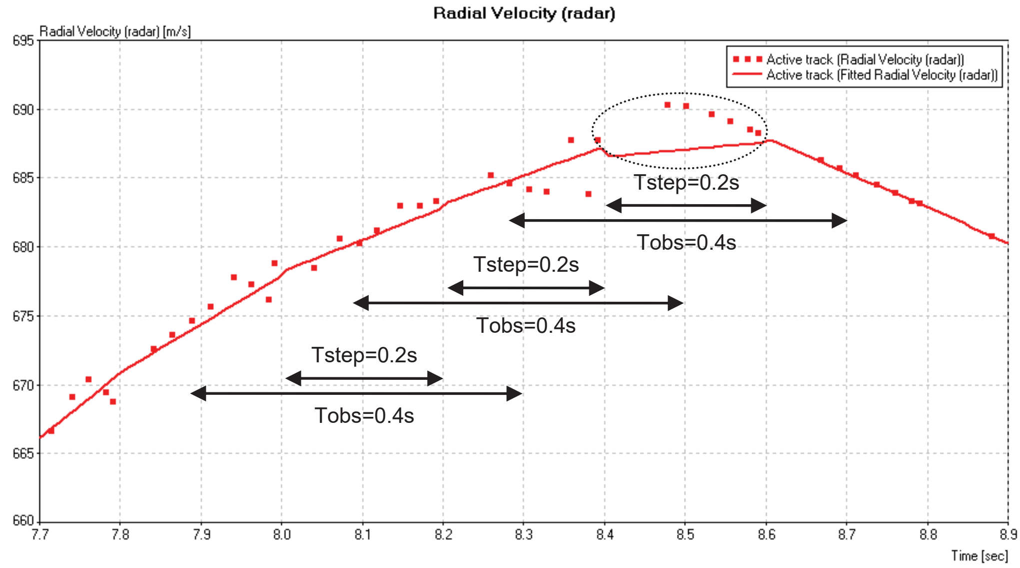
In the extreme case of **Tstep**=0 the fit is re-calculated for every data point and thus **Tstep** effectively becomes equal to the distance between data points.

Tobs is the duration of the observation interval which determines the data points used when the polynomial is fitted to the data. The observation interval is always center aligned with the valid interval.

First Order Fit

The following example shows three variants of a linear (first order) fit to the same set of data points and a second order fit, which is normally recommended as the result is much smoother.





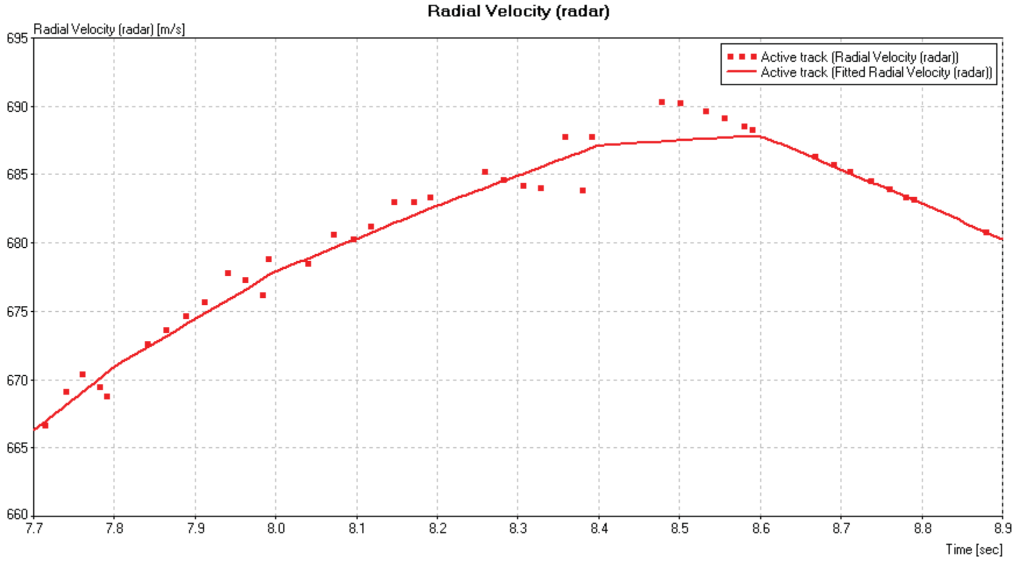
The first graph in the above figure shows a first order fit with an observation time **Tobs**=0.4 seconds which is recalculated every **Tstep**=0.4 seconds. The second graph shows the same data fitted with a first order fit with **Tobs**=0.4 seconds but this time **Tstep**=0.2 seconds. As a result twice as many line segments are calculated.

Note that the two line segments indicated by the dotted circle are identical. This is because they are both first order fits that are based on the same data points (**Tobs** is the same). The only difference is that in the latter case only the middle part of the line is used.

Note that while their **Tobs** intervals overlap, their validity intervals meet without any overlap. With no other restrictions two bordering polynomial fragments are not likely to meet at their border point. The result is a jump or discontinuity in values when going from one polynomial to the next.

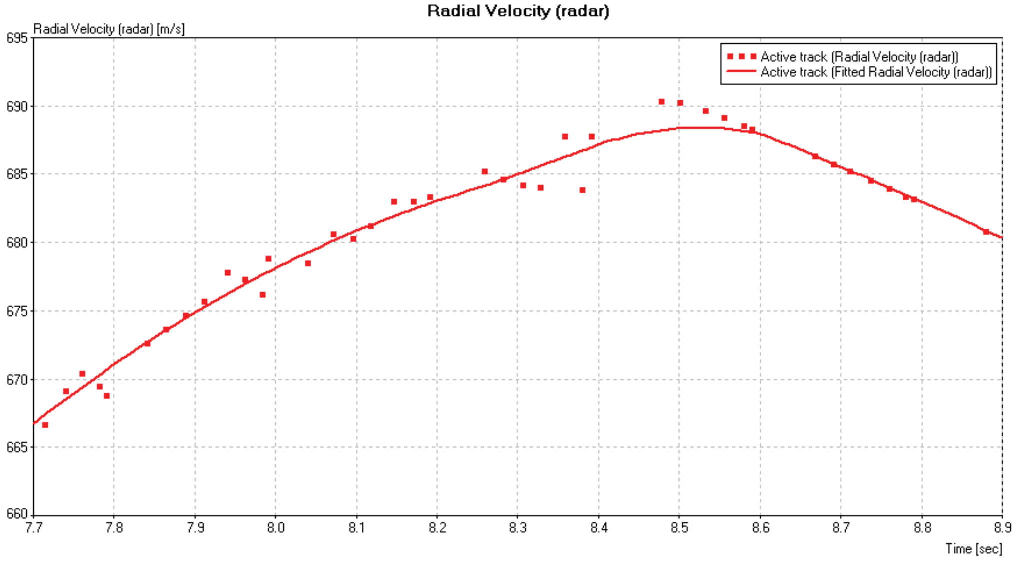
Splining

A technique known as splining solves the discontinuity problem. The idea is that the polynomials are forced to meet each other in their end points and the optimization is done with this restriction. The following figure shows the above data set fitted with the **spline** parameter set to **continuous**.



Higher Order Fits

The splining technique can be generalized to make the 1st, 2nd etc derivative identical at the end points. This however has the disadvantage that a higher polynomial order is needed, which may result in a curve with undesirable high slope values. Below is shown the 2nd order polynomial fit with 0th order splining:

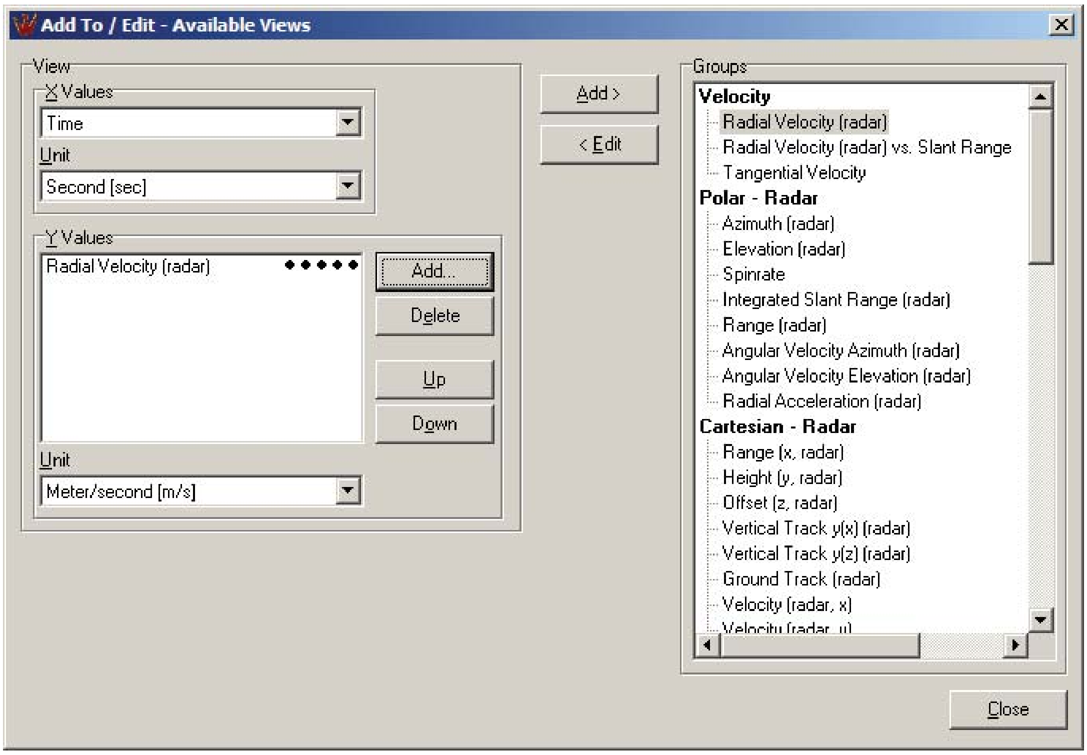


If the number of valid data points within the valid interval defined by **Tobs** is less than the required number of points, then the window is extended symmetrically until the data set has the required number of points. If one of the segment boundaries is reached then the window is extended in the other direction. If both the segment boundaries are reached before the minimum number of valid points have been added then no polynomial fitting is performed.

11.6 Define or Edit a Graph View

To edit or add a new graph view click the **Add** link in the upper right corner of the **Groups and Views** box, see Choose a Graph View (page 167).

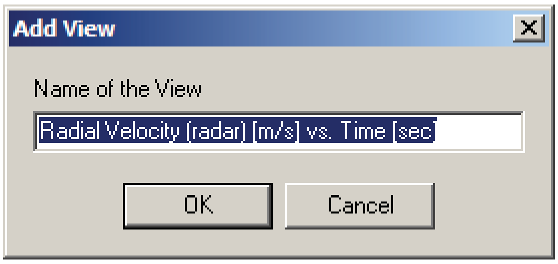
The following window appears:



This window is used both for adding new views to the list and for editing the views already in the list.

To define a graph view:

1. Click the **Add** link in the upper right corner of the **Groups and Views** box to get the **Add To / Edit – Available Views** window, see below.
2. Select the x-axis parameter, e.g. Time, from the **X Values** drop-down box.
3. Select the unit of the chosen x-axis parameter, e.g. [sec] from the **X Unit** drop-down box.
4. Select one or more y-axis parameters, e.g. Radial velocity, from the **Y Values** drop-down box.
5. Select the unit of the chosen y-axis parameter, e.g. [m/s] from the **Y Unit** drop-down box.
6. Optionally repeat steps 4. and 5. to add more y-axis parameters. The selection is now limited to parameters of the same type, e.g. velocity, so that they can share the selected unit.
7. Click **Add** to get the **Add View** window:



8. Change the name if needed and click **OK** to add the view to the **Others** group.

To edit a view:

1. Click the view in the Groups list to high light it.
2. Click **Edit** to copy the view details into the **View** box of the window.
3. Make the changes to the view.
4. Click **Add** to update the view.

Notes

- ► When the first y-axis parameter is selected in step 4, all parameters of the same type stays black. The rest are not available and therefore they are colored grey.
- ► To move the view to another group, see Organize the Views in Groups (page 196).

11.6.1 Organize the Views in Groups

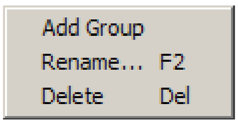
All views are assigned to a group. When one or more new views are defined, see Define or Edit a Graph View (page 195), they are added to the **Others** group.

To move a view from one group to another:

1. Drag and drop the view from one group to another.

To add a new group:

1. Right click one of the existing groups in the **Add To / Edit – Available Views** window to get the following window:



2. Select **Add Group** to add a new group to the end of the **Groups** list:
3. Edit the name of the group and hit **Enter**.
4. Optionally drag and drop the group to a new location in list.

11.7 Use Specific Graph Views

Most views display track parameters in a straight forward and self explanatory way. Others are complex and need more explanation.

11.7.1 Use the Missed Distance Graph

The Missed Distance graph shows the distance between two tracks as a function of time. It is available in the track difference mode; see Use the Work File Tool Bar (page 165).

The graph shown is calculated as follows:

1. Calculate fits to each of the tracks, see Edit the Fit Information (page 186).
2. Calculate Cartesian data points for each track using the fits from step 1.
3. Subtract the reference track from each of the other tracks. This gives the offset vector relative to the reference target.
4. Calculate the Cartesian distance as the length of the offset vector.

11.7.2 Use the Ballistic Coefficient Graph

The Ballistic Coefficient graph is selected from the **Groups and Views** list under **Ballistics**. If another x-axis is preferred then use the Define or Edit a Graph View (page 195) to define your own view.

It is calculated with reference to the G1 or G7 drag functions according to the formula:

$BC = M / (i * d^2)$

$i = C_B/C_G$

Where:

Parameter	Description
M	Mass in kg
d	Diameter in m
C_B	Drag of measured target
C_G	Drag of reference projectile (G1 or G7)

11.8 Modify Meteorological Conditions

The software can import a meteorological data file and compensate the calculated Drag (Cd) for the actual meteorological conditions. To modify the meteorological data:

1. Select **Meteorological Info...** in the **Ballistics** menu.

For further information about the Meteorological Data Dialog see Import Meteorological Data (page 26).

◄ **End of Chapter** ►

12 Glossary of Terms

Acquisition time

The time it takes to measure one (or more) signal parameters used in the tracking process.

ADC

Analog to Digital Converter. Used for sampling the Doppler signal or in some cases the trigger signal. The sampling rate should be high enough to accommodate the maximum velocity of the target.

AGC

Automatic Gain Control. This mechanism automatically adjusts the gain in order to keep a certain output level thus compensating for variations in temperature and input signal level.

Ambiguity

When a parameter value is not fully resolved by the measurement because two or more actual parameter values lead to the same result. A typical situation in radar range or velocity measurements.

Analyzer

A device that records Doppler data during the measurement, e.g. a W-2100.

Antenna

The radiofrequency transmitter or receiver. When looking at a Weibel radar from behind the transmitter is to the right and the receiver is to the left.

AP

Antenna Pedestal: the pedestal holding and pointing the radar antennas. Typically the antenna pedestal receives pointing commands from the RTP.

Apparent range

This is the value that is extracted directly from the FFT spectrum of the FMCW channel. Thus, it does not necessarily reflect the actual range of the target, but rather a combination of its range and Doppler velocity.

ATI

Azimuth Time Intensity. A graphical representation of the Doppler signal showing time on the x-axis and azimuth angle on the y-axis. Each dot in the plot is a color coded signal strength indicator for that specific time and azimuth angle.

Azimuth

The angle from the azimuth reference line to the line of sight projected onto the level plane. Positive to the right. See Polar Coordinates (page 41).

Baud rate

The rate of data transfer on the physical link. The baud rate is equal to the bit rate when transmission is binary (e.g. zeroes and ones).

BNC connector

A type of connector used with coaxial cables. The basic BNC connector is a male type mounted at each end of a cable. This connector has a center pin connected to the center cable conductor and a metal tube connected to the outer cable shield. A rotating ring outside the tube locks the cable to any female connector.

Calibration

The use of an independent reference to adjust the instrument and thereby improve the accuracy of the measurements made with the instrument.

CMD

Command file. An ASCII-file containing a list of different commands.

Coriolis force

The apparent force acting perpendicular to the velocity of an object moving in a rotating coordinate system.

CP-2100

Keypad and joystick in one unit that connects to the Instrumentation Controller running WinTrack.

CW

Continuous Wave: a sine wave with constant amplitude and frequency.

DAT

The DAT file is where the raw Doppler data is saved. Antenna data is also saved in this file, except during on-line save.

Datum

A set of parameters that defines the reference ellipsoid used for absolute coordinates, e.g. WGS-84.

dB

Deci Bell. Ten times the base-10 logarithm of the ratio between two power levels. E.g. 2 Watts is 3 dB higher than 1 Watt.

dBm

Power level measured in dB milli Watts. Ten times the base-10 logarithm of the power level divided by one milli Watt. E.g. 10 Watts is equivalent to 40 dBm.

DC

Direct Current. Usually referring to a fixed offset value.

Doppler

The frequency offset caused by the radial velocity of the reflecting target. An outgoing target has a negative Doppler offset while an incoming target has a positive Doppler offset as seen from the radar.

Drag

The aerodynamic resistance of an object moving through the air.

DTI

Doppler Time Intensity. A graphical representation of the Doppler signal showing time on the x-axis and frequency on the y-axis. Each dot in the plot is a color coded signal strength indicator for that specific time and velocity.

Elevation

The angle between the level plane and the line of sight to the object. See Polar Coordinates (page 41).

Ellipsoid

A 3-dimensional surface generated by an ellipse rotating around one of its major axes. Geographic Coordinates (page 42) refer to a specific ellipsoid definition.

Encoder angle

The angle read from either the azimuth or the elevation encoder in the radar pedestal.

ETI

Elevation Time Intensity. A graphical representation of the Doppler signal showing time on the x-axis and elevation angle on the y-axis. Each dot in the plot is a color coded signal strength indicator for that specific time and elevation angle.

Extrapolating

Estimating the value of a parameter outside the data set defining the parameter. As opposed to interpolating, where the parameter is estimated inside the data set.

False target

An artifact in the received signal that resembles a true reflection from an object.

FFT

The Fast Fourier Transform, a very efficient method for resolving the frequency components of a signal.

FMCW

Frequency Modulated Continuous Wave. This waveform is a linear frequency sweep either repeated or with alternating periods of ramp-up and ramp-down. It is used for range measurement as an alternative to MF.

Frequency segment

In MF range mode, a frequency segment refers to the period in which each MF frequency is transmitted.

Geographic North

The North Pole as defined by the Earths rotational axis.

IC-2100

The Instrumentation Controller type 2100.

IMU

Acronym for Inertial Measurement Unit, a device that can be attached to the radar system in order to measure the changes in position and attitude of the platform on which the radar is located. The WinTrack software allows compensating the radar measurements for these changes and obtaining measurements referred to a fixed reference system.

Inclinometer

An instrument that measures angle relative to gravity.

Instrumentation Controller

An industrial grade PC running Windows controlling the radar instrumentation. The application is e.g. WinTrack.

IO-1000

The IO-1000 is a Link to USB adaptor converting between the Weibel Link port format and the standard USB port format. The IO-1000 is typically used to connect W-700 and W-1000 to off-the-shelf type computers running WinTrack or WinDopp.

IQ mixer

Actually two mixers where one of the mixers are offset by a 90º phase relative to the other. This technique keeps Doppler frequencies above and below the radar frequency separated.

IRIG-B

The Inter-Range Instrumentation Group (IRIG) time code signal.

This signal can be used to precisely synchronize the host computer clock to within a few microseconds.

Launcher

The device launching the object being measured, e.g. a gun or missile launcher.

LNA

Low Noise Amplifier. Keeping the noise contribution at a minimum is critical when amplifying weak signals, e.g. in the receiver.

Lock mode

The state of the tracking algorithm. When "locked" the tracking loop is closed and corrections are based on the measured signal. When "unlocked" the operator may manually override the automatic tracking algorithm.

MC-100

Mono-pulse Calibration target used as an artificial Doppler target generator. It’s effectively a transponder with a fixed frequency offset of 32768 Hz.

MF

Multi Frequency: a technique that allows unambiguous range measurement using two transmitted signals.

Mono-pulse

The phase coherence of a signal hitting two or more receiver antennas. Used to determine the direction to the observed object.

MOT

Multi Object Tracking: the algorithm that detects and tracks one or more objects in the received signal.

Mount Model

The mount model is a description of the mechanical errors or imperfections in the radar pedestal and its alignment. When the parameters of the model are known, these can be used to correct the raw data captured during a measurement yielding a more accurate result.

Muzzle

The tip of the gun barrel.

MVR

Muzzle Velocity Radar: a radar suitable for high accuracy measurement of the muzzle velocity.

Origo

The center of a coordinate system.

Oscillator

A signal generator with a sine wave output.

PCB-302

Antenna sub controller card used in the transmitter and the receiver.

PCB-812

Interface card.

Perpendicular

At an angle of 90 degrees.

PowerPack

Integrated amplifier module providing the transmitter RF output to four antenna sub-elements.

PRM file

Parameter file.

Q-factor

Quality factor. Used as a measure of the sensitivity of a radar. The Q-factor is proportional to the loop gain of the radar.

Radar cross section

The amount of RF power reflected by a specific object when looking at it from a specific aspect angle. The unit is area, e.g. m^2.

Radar Instrumentation

A device used in the radar system, e.g. Tracking Controller, Antenna, Analyzer or Range Processor.

Radial velocity

The velocity component in the direction from/to the observer. The radial velocity is proportional to the Doppler frequency offset.

Radiation hazard

During transmission the radar transmits radio frequency power that may be dangerous to the health.

Range Processor

A device controlling the antenna system. Often used with an optical tracking platform, e.g. RP-2100.

RAP

Rocket Assisted Projectile.

Reference Point

A stationary point on the pedestal used as the zero point for measurements. For most pedestals it is defined as the crossing of the azimuth axis and the upper surface of the pedestal.

Refraction

As light or radio waves passes from one transparent medium to another, it changes speed, and bends. This happens to radar signals passing through the atmosphere as well.

RF

Radio Frequency. The signal as transmitted or received by the radar.

RP-2100

Range Processor: a device controlling the antenna system often used with an optical tracking platform.

RTDS

Real Time Data Storage. An application storing the raw measurement data on a separate computer, usually a PC with a fast disk system. The RTDS has an optical link to a W-2100, providing the Doppler data to be saved on the disk. It is controlled from WinTrack via a TCP/IP connection.

RTI

Range Time Intensity. A graphical representation of the Doppler signal showing time on the x-axis and range on the y-axis. Each dot in the plot is a color coded signal strength indicator for that specific time and range.

RTP

Real Time Processor. The processing unit that captures the Doppler data and the encoder data and sends pointing information to the antenna pedestal (AP). Optionally the RTP sends sampled Doppler data to the RTDS for storage and DTI results to the Real Time Display.

Rx

Acronym for Receive, usually referring to the receiver part of the radar.

S/N Ratio

Signal to noise ratio, se SNR.

Sampling rate

The analog to digital converter (ADC) sampling rate used to capture the Doppler signal.

Slant range

The distance from the observer to the object taking the height into account.

Slave radar

A radar controlled by e.g. another radar (the master radar). Pointing information is sent continuously from the master to the slave radar.

SL-B

A bi-directional RS-422 connection typically used with optical platforms. The protocol handles encoder values and pointing commands between the Range Processor and the platform servo system. The packets are synchronized to the IRIG-B clock.

Sliding fit

A polynomial based smoothing/interpolation of the observed data. Sliding means that a new set of polynomial coefficients are calculated for every time step.

SNR

Signal to Noise Ratio. The ratio between the detected signal power and the noise power density integrated over a fixed bandwidth usually one Hz.

SOT

Single Object Tracking: the algorithm that detects and tracks one object in the received signal. Actually a special version of the MOT with the restriction that only one track is allowed at the time.

Spherical

Like the surface of a ball. The spherical coordinate system is the 3-dimensional equivalent to the polar (2-dimensional) coordinate system.

Spin

Rotation around the main body axis.

SSB mixer

Single Side Band mixer: an equivalent to the IQ Mixer, but with only one output, where either the frequencies above or below the mixer frequency have been suppressed.

Systran

An optical interface board transmitting or receiving Doppler data.

TC

Tracking Controller: the system controlling the pointing of the radar.

Tilt

The deviation of the azimuth rotation axis from gravitational up. The tilt is characterized by the magnitude and the direction of the tilt.

TLE

Two Line Element set. A two line description of a satellite trajectory. TLE’s for all major satellites are available from e.g. http://www.space-track.org.

Tracking Controller

The system controlling the pointing of the radar.

Tracks

Fragments of one or more trajectories observed in the received data.

Trigger

En event that starts the measurement process.

TRJ file

Trajectory file.

TRK file

Track file. This file holds the results from a MOT processing.

Trunnion

A cylindrical projection on each side of a piece, whether gun, mortar, or howitzer, serving to support it on the cheeks of the carriage.

Tx

Acronym for Transmit, usually referring to the transmitter part of the radar.

UART

Universal Asynchronous Receiver / Transmitter, an internal serial port device.

Unambiguous range

The maximum range where the distance to the object is determined without ambiguity.

UTC

Coordinated Universal Time (UTC) is the international time standard. It is the current term for what was commonly referred to as Greenwich Meridian Time (GMT). Zero (0) hours UTC is midnight in Greenwich England, which lies on the zero longitudinal meridian.

UTM

The Universal Transverse Mercator grid system. See UTM Coordinates (page 43).

VTI

Velocity Time Intensity. A graphical representation of the Doppler signal showing time on the x-axis and object velocity on the y-axis. Each dot in the plot is a color coded signal strength indicator for that specific time and velocity.

W-1000

A device that records Doppler data during the measurement, also called an Analyzer.

W-2100

A device that records Doppler data during the measurement, also called an Analyzer.

W-700

A device that records Doppler data during the muzzle velocity measurement, also called an Analyzer. Part of an MVR system.

Work file

A file holding results from processing original Doppler data files and antenna pointing data.

WRK

Same as work file.

[Skolnik 1]

Merril I. Skolnik, "Introduction to Radar Systems, second edition", International Student Edition, McGraw-Hill Book Company, Singapore, 1981.

◄ End of Chapter ►

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3450 Allerød
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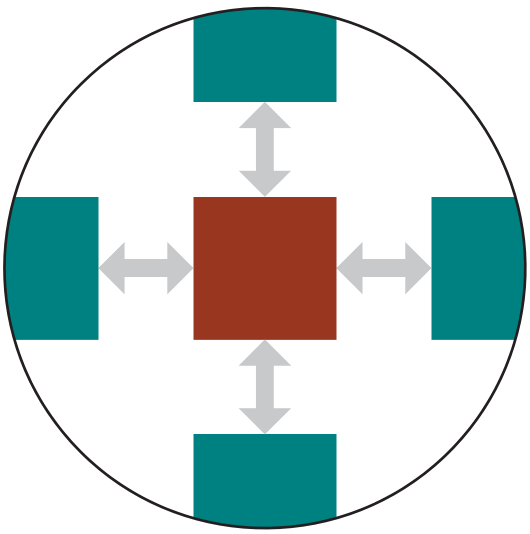
Installation & Maintenance Guide

SL Antennas



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Contents

1 Introduction

1.1 SL Antennas Overview

SL-60034P mounted on a standard Weibel tripod

This manual describes the function of the Weibel Stripline antenna units, hereafter called SL-xxxxxyyy or SL antenna, consisting of one of the antennas, a power supply unit, tripod and other optional equipment. This manual should be read together with the WinDopp User Guide and possibly the specific Weibel power supply manual.

The Weibel SL antennas are portable radar systems based on state of the art radar technology. The transmitting and receiving antenna are microstrip array antennas and all components in the system are entirely solid-state components.

The SL antennas are controlled by pc using a RS232/422, USB or Ethernet connection.

1.2 Change History

Version	Date	By	Comment
1.00	2010-02-16	MA	First release.
1.01	2012-01-15	MKB	Updated to cover all SL antenna types Added sections to chapter regarding installation of the system Added chapter “Inside the antenna” Added section “Physical dimensions”
1.02	2012-03-06	MKB	Corrections made regarding general wording Added section regarding self-calibration Added information regarding safety Added list of acronyms Added block diagrams (system interconnects) Added Pinout of all connectors Added Warning and Caution notes Added additional pictures of PE type antennas
1.03	2012-04-10	MKB	Minor changes
1.04	2012-04-11	MKB	Minor changes
1.05	2012-05-21	MKB	Added notes about storm pegs
1.06	2012-06-27	MKB	Added section regarding firmware installation
1.07	2012-07-13	MKB	Added section regarding time source setup
1.08	2012-09-12	MKB	Added section regarding resetting IP-address
1.09	2013-03-18	MKB	Added information regarding FTP server enabling for Firmware upgrade.
1.10	2015-05-19	MKB	Resetting IP addresses
1.11	2016-04-05	MRN	Added information how to offset time to local time
1.12	2016-05-24	MRN	Ethernet connectivity troubleshooting
1.13	2020-07-01	SJO	Added antenna types SL-528PE and SL-30033PE to section WinDopp Communication Setup

1.3 SL Antenna Variants

The SL antennas are named like the example given below:

SL- **xxx** **xx** **yyy** **Rev. 1.01** *example: SL-30031PBC*

1 **2** **3** **4**

Strip**L**ine **A**ntenna

- Fixed head Doppler radars.

Field	Description
1	This number corresponds to the maximum transmission power in 0.1 W steps. The following options are available: 5, 20, 30, 70, 150, 300, 600. (corresponding to 0.5 Watt to 60 Watt)
2	This two-digit number corresponds to the nominal antenna gain. The following options are available: 20, 25, 28, 31, 33, 34, 36
3	Each of the letters correspond to an added option: M Military version (MIL Speced) for tactical use with W-700M (Only used for SL-520M) P Integrated analyzer electronics (ADC, Sample memory, Control CPU, PSU and System interface) A Analytical version of the M Antenna (Only used for SL-520A) B Low noise oscillator (Poseidon) C Ethernet connector for communications. D Software configurable transmit frequency (+/-3MHz) E Low Noise, Ethernet interface, I/Q mixer (RRRP VR Program)
4	Revision number.

Note: Not all combinations of options and models are available.

1.4 SL-xxxxxyyy Background

The SL-xxxxxyyy Doppler Radar antennas consist of integrated receiving and transmitting modules, ensuring minimal setup time and reliability. They are capable of measuring Doppler velocity and integrated range and are controlled using software running of a standard Windows laptop or a dedicated analyzer unit.

The SL-xxxxxyyy uses single-frequency X-band microwaves for its radar function and interfaces to the controller/analyzer using either Ethernet or RS-232/422 connections. The antenna is typically installed on a tripod, but can also be mounted on custom mechanical setups.

The SL-xxxxxyyy antenna setup has a number of configuration options, which are all discussed in the Install the SL-xxxxxyyy (page 5) chapter. This chapter includes information regarding tripod placement, antenna mounting, cable connections and communication setup.

Since the SL-xxxxxyyy antennas have many different configurations regarding power and gain; the connector configuration differs from model to model. Please consult the Connectors & Indicators (page 25) chapter for more information regarding your models specific configuration.

The SL-xxxxxyyy antenna is operated as the main component of the radar system using the in-house developed software WinDopp. The user needs no technical knowledge of the interface between the computer running WinDopp and the radar itself, but can refer to the WinDopp manual information regarding software control options.

The SL-xxxxxyyy antennas all require maintenance at certain time intervals and may require updates of firmware from time to time. The procedures regarding these topics are covered in the Maintenance (page 45) chapter.

1.5 SL-xxxxxyyy Certification

The SL-xxxxxyyy Doppler Radar antennas follow the below standards in regards to FCC standards and certification.

As per 47 CFR §15.105

Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

As per 47 CFR §15.19

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

As per 47 CFR §15.21

The user's manual or instruction manual for an intentional or unintentional radiator shall caution the user that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment. In cases where the manual is provided only in a form other than paper, such as on a computer disk or over the Internet, the information required by this section may be included in the manual in that alternative form, provided the user can reasonably be expected to have the capability to access information in that form.

1.5.1 RF Exposure warning statements:

This equipment complies with FCC radiation exposure limits set forth for an controlled environment. End users must follow the specific operating instructions for satisfying RF exposure compliance. This transmitter must be at least a distance from the user as indicated in the table below and must not be co-located or operating in conjunction with any other antenna or transmitter. The maximum antenna gian is 28 dBi.

System	SL-520PE	SL-525PE	SL-528PE	SL-2028PE	SL-15028PE	SL-30033PE
Safety Distance	0.8 meters	1.4 meters	1.6 meters	4.8 meters	10.7 meters	21.9 meters

The information in this guide may change without notice. The manufacturer assumes no responsibility for any errors that may appear in this guide.

2 Install the SL-xxxxxyyy

2.1 Installation Overview

Installing the SL-xxxxxyyy involves unpacking, mounting the components, checking the installation, connecting cables to other system components, connecting power and setting up communications options in the user interface.

The SL-xxxxxyyy is preconfigured from the factory when shipped as part of a system. In this case please follow the instructions in the system documentation.

A system consists of the following components:

- SL-xxxxxyyy Antenna
- Power Supply Unit (PS-xxxx)
- Antenna Tripod
- Sighting Scope for the Antenna
- Instrumental Control Unit (IC-xxxx), laptop or pc
- Antenna signal cable
- Antenna power cable
- Mains power supply cable
- Long signal and data cable (typically on drum)

Optional items are:

- External Display Unit
- External Trigger Device
- Warning Device
- IRIG Time Unit
- Display Cable
- Trigger cable
- Warning Device cable
- IRIG Time cable

Notes

- Only the SL-xxxxxyyy Antennas will be covered in detail in this document. For specifications on the other system components please consult the specific unit manual.

- Warning Devices are only available for antennas with a transmission power of 3 Watts or higher

2.2 Un-pack the SL-xxxxxyyy

To unpack the SL-xxxxxyyy:

1. Inspect the shipping boxes for any damage.
2. Carefully open and remove the equipment and the accessories from the shipping boxes.

Notes

- Keep the shipping boxes for future use.
- If any of the boxes were damaged during transportation, check the equipment for any visible signs of damage.

Caution

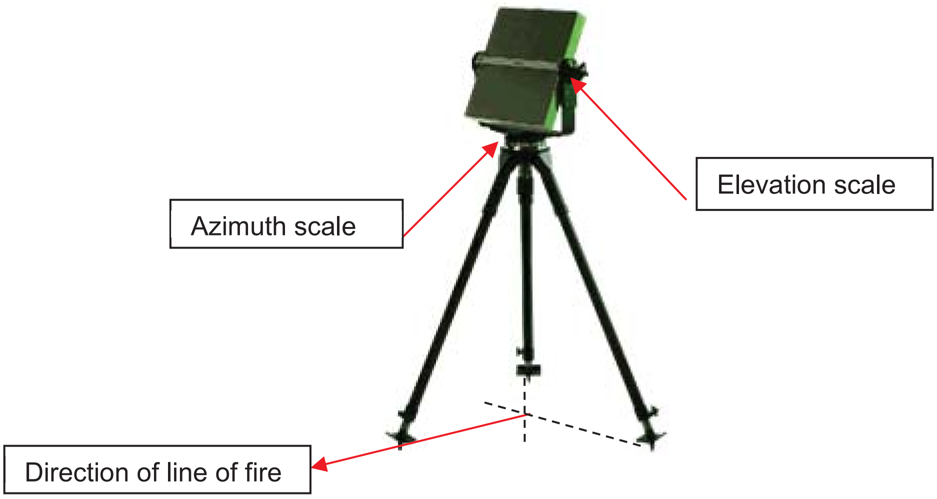
- Make sure not to damage Teflon surface of the antenna elements on the front of the antenna. Any scratches on this surface may result in a degraded performance of the radar.

2.3 Mounting the Antenna on a Tripod

This document only covers use of the SL-xxxxxyyy antennas mounted on a standard tripod. Some antenna variants might be tailored to different uses – in these cases please refer to the documentation that came with the antenna.

2.3.1 Standard tripod

1. First place the system Tripod at the desired Antenna position, with one leg pointing close to the line of fire.
2. Mount the Antenna unit on the top of the tripod and aim the Antenna roughly in the firing direction.
3. Level the Tripod/Antenna assembly using the bubble on the Antenna base.
4. Aim the Antenna carefully to the line of fire using the detachable sighting scope.
5. Raise the antenna to the desired Elevation using the scale on the side of the antenna, if required turn the Antenna Azimuth towards the line of fire using the scale on the Antenna base
6. If required secure the Tripod from the blast with storm pegs, sandbags or similar weighted items to prevent the system from falling over.



SL-30031P on Tripod

7. Confirm that the placement of the antenna does not put it in harm's way; i.e. to close to the blast of the launcher.
8. Confirm that the antenna has a clear line of view for the intended line of fire.

Caution

- ► Confirm that the placement of the antenna does not put it in harm's way; i.e. to close to the blast of the launcher or in the path of possible debris.
- ► Weighting down or securing the tripod with storm pegs is required in the presence of strong winds or other phenomena to prevent it from falling over.

2.4 Cable Connections

Once proper placement of the antenna has been completed the following step is to connect the antenna to the different system components.

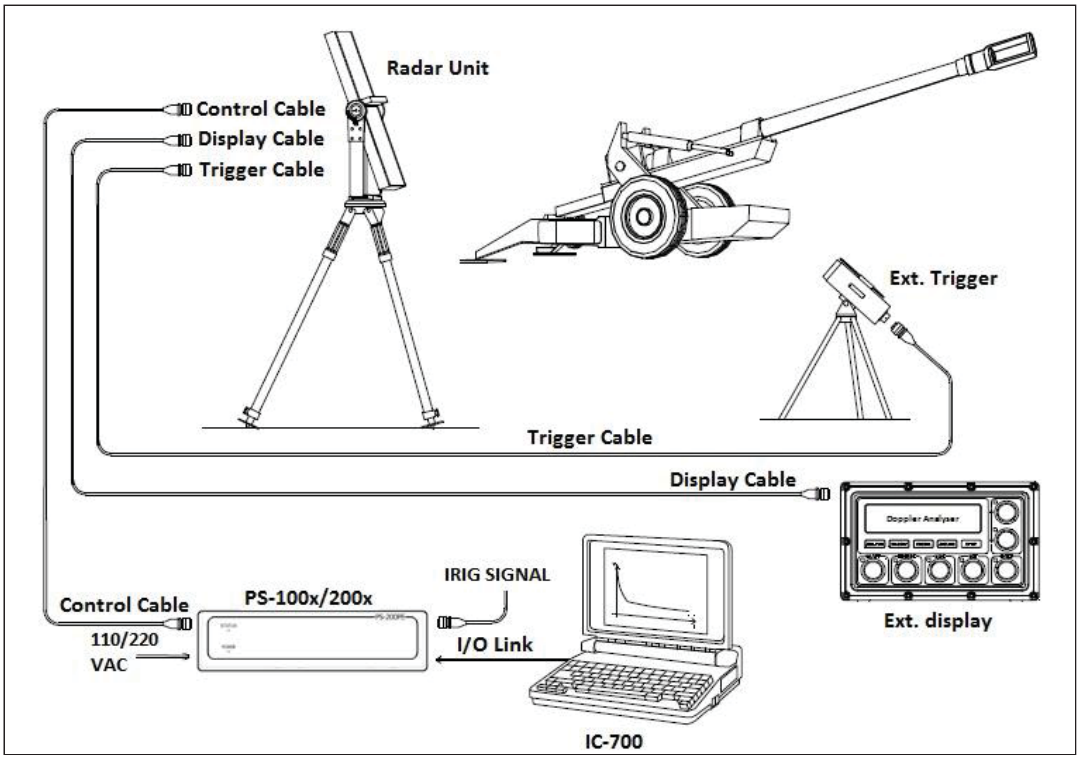
There are three general setups that depend on the specific system components which are based on the type of power supply used for the system. The first one covers systems that used the Weibel PS-100x and PS-200x power supplies. The second system setup are for PS-600x and above. The third setup is for antenna systems that do not include an integrated analyzer and needs an external analyzer. This includes all antennas that either have no letter indication or are of the types M or A (i.e. SL-520, SL-520A or SL-520M).

The following sections show different system setups but keep in mind that these are samples since specific system setups depend on the system components.

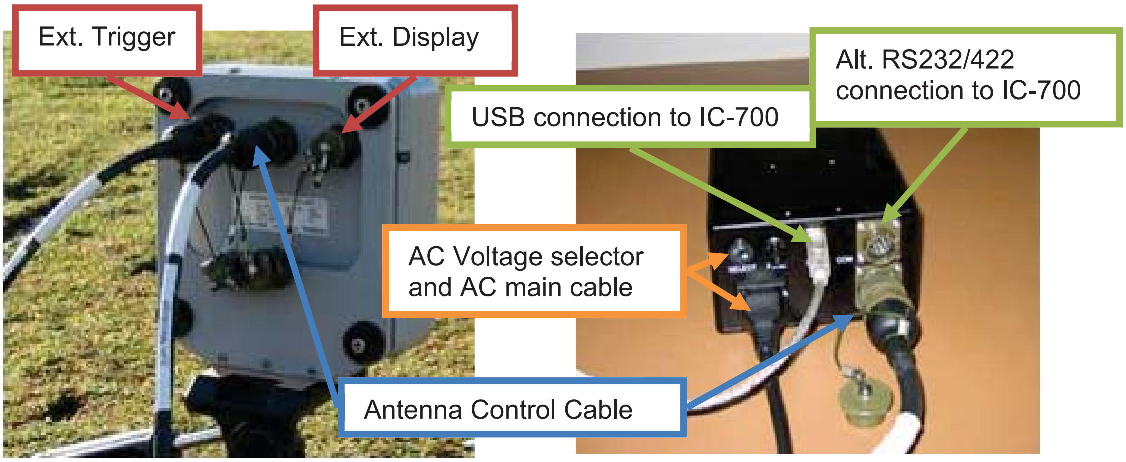
2.4.1 System setup when using PS-100x/200x

To complete the cable connections for this setup follow these steps:

1. Connect the antenna control cable from the antenna to the power supply (see Figure below).
2. Connect optional system components to antenna: External Trigger and Display (see Figure below).
3. Connect optional system components to PS-100x/200x: IRIG signal
4. Ensure that the power supply is set to the correct AC voltage (in case of a voltage selector) and connect the power supply to the AC main (see Figure below).
5. Connect the power supply to the IC-700 using either USB, RS232, RS422 or Ethernet (see Figure below).
6. For details on how to setup communication to the antenna please consult the WinDopp Communication Setup (page 14) section.



SL-xxxxxyyyy system setup when using PS-100x/200x



Setup Example: SL-520P Antenna connected to PS-100U power supply

Warning

- Never walk in front of radiating antenna. Consult Weibel Safety Distance document TR-1032-Safety_Distance for radiation safety distance of the specific antenna.

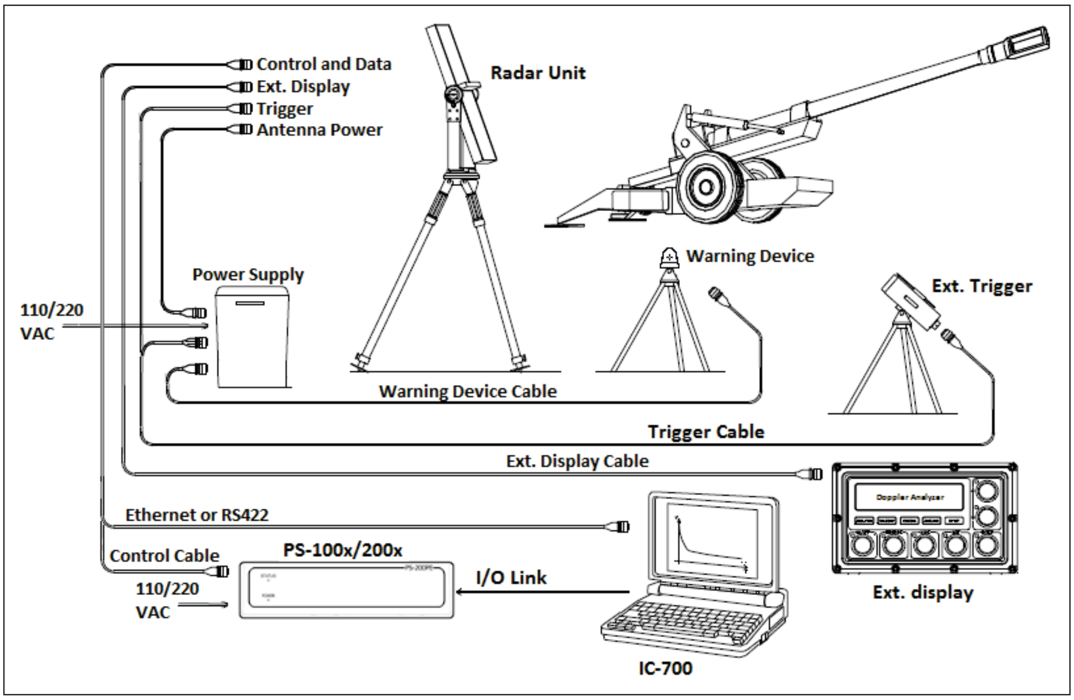
Caution

- Ensure all systems are off before connecting or disconnecting any cables

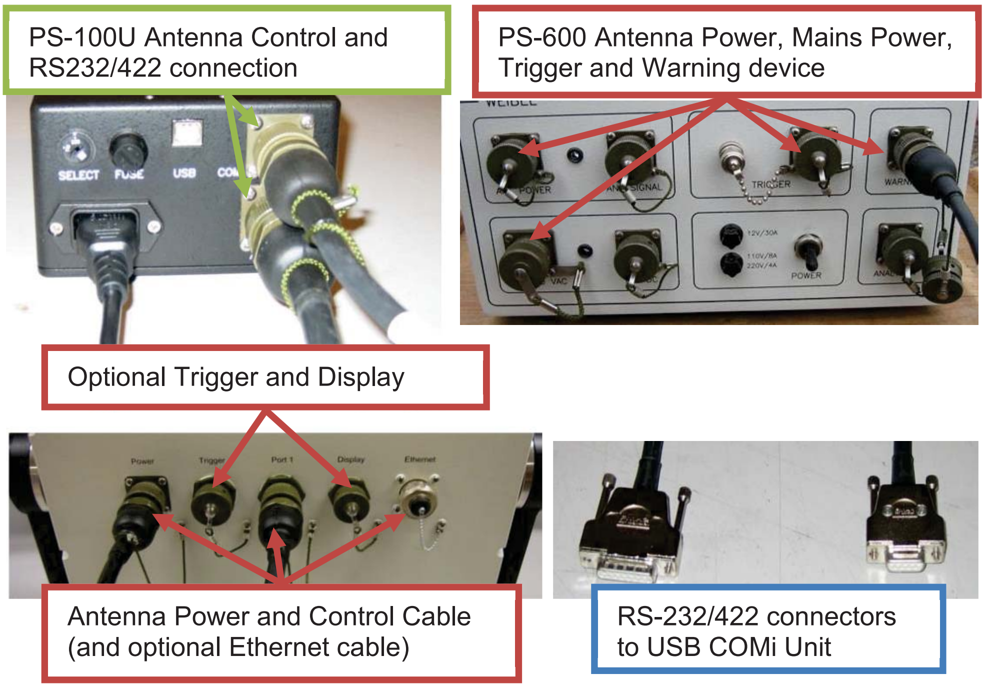
2.4.2 System setup when using PS-600x and higher

To complete the cable connections for this setup follow these steps:

1. Connect the antenna power cable from the antenna to the PS-600x or higher; from here referred to as power supply (see Figure below)
2. Connect the antenna to the IC-700 through one of three options:
    - Connect the antenna control cable to a PS-100/200 (U, C or PE) and using the power supply; connect to the antenna (as described in step 4 of the previous section).
    - Connect the antenna control cable to the IC-700 using a Weibel USB-COMi adapter cable.
    - Connect the antenna Ethernet cable to the IC-700.
3. Connect optional system components to antenna or power supply: External Trigger, Display, and Warning Device (connectors also shown on Figure below)
4. Ensure that the power supply is set to the correct AC voltage (in case of a voltage selector) and connect the power supply to the AC main (see Figure below)
5. For details on how to setup communication to the antenna please consult the WinDopp Communication Setup (page 14) section.



SL-xxxxxyyy system setup when using PS-600x or higher



Setup Example: SL-15028P antenna powered by PS-600 and connected through PS-100U

Warning

- Never walk in front of radiating antenna. Consult Weibel Safety Distance document TR-1032-Safety_Distance for radiation safety distance of the specific antenna.

Caution

► Ensure all systems are off before connecting or disconnecting any cables

2.4.3 System setup when using external analyzer

The following section involves all SL antenna types that do not include an integrated analyzer. Therefor they are not discriminated into groups depending on power supply size; since the general setup is the same for all systems.

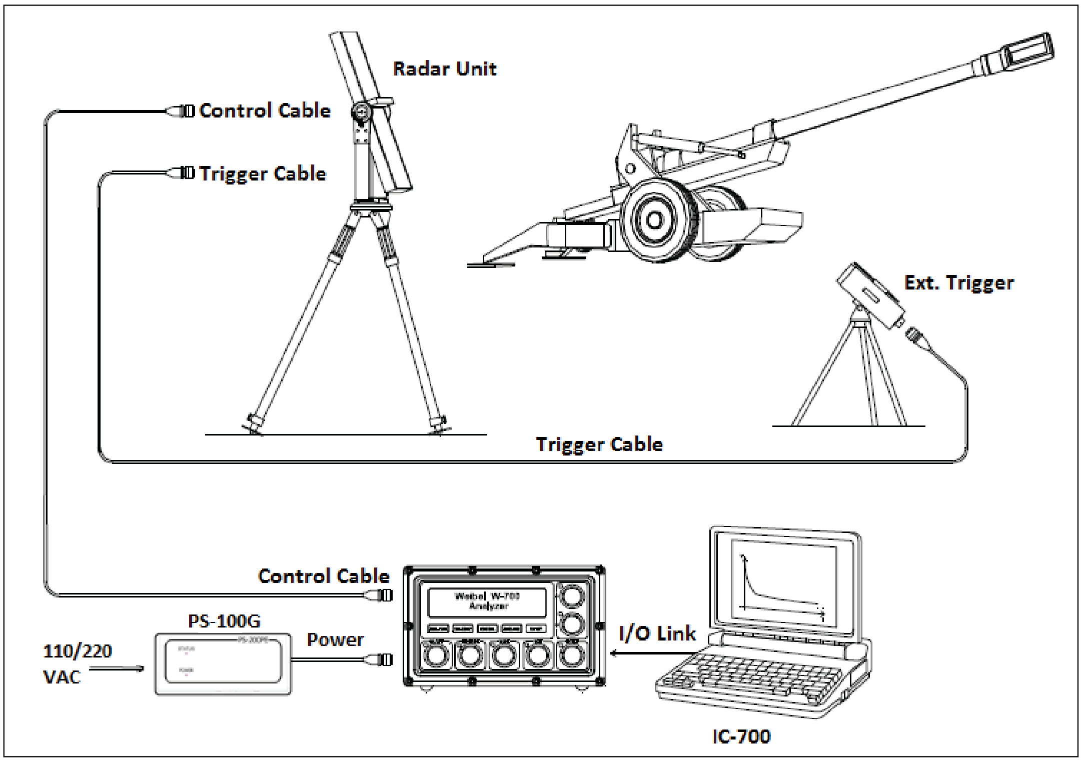
To complete the cable connections for this setup follow these steps:

1. Connect the antenna control cable to the W-700 using one of two options:
    - For small systems connect the antenna control cable directly to the W-700
    - For larger systems connect it to the power supply (PS-600 or higher) and then connect the power supply to the W-700

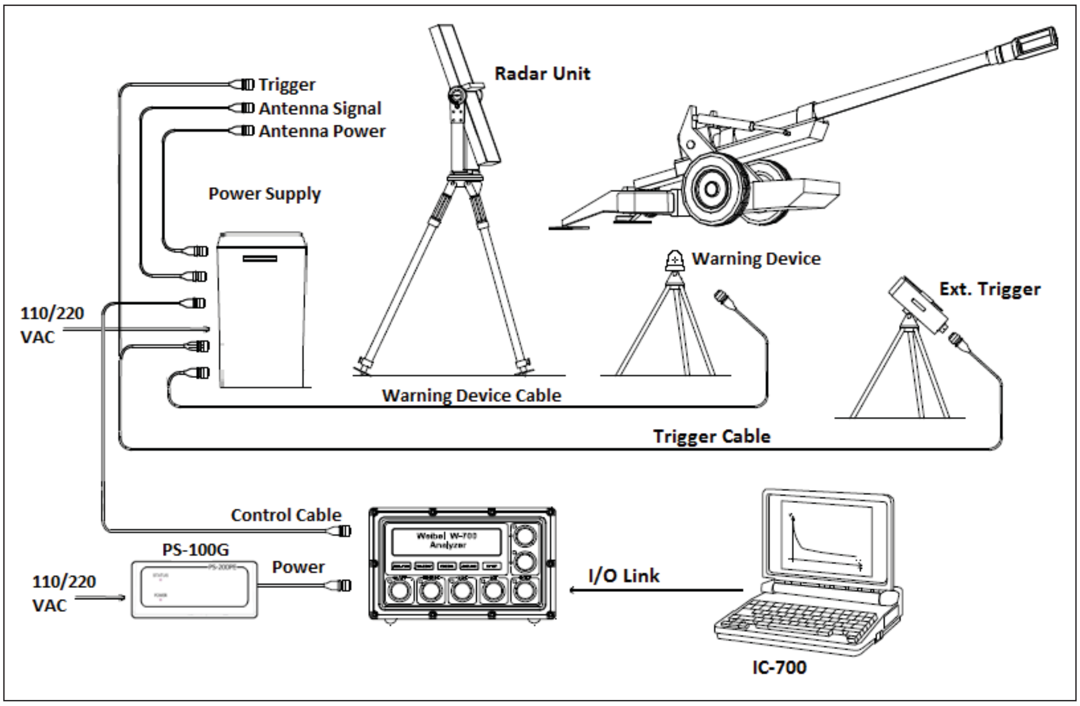
      (see Figures below)
2. For larger systems connect the antenna power cable to the power supply (PS-600 or larger). (see Figures below)
3. Connect optional system components: External Trigger and Warning Device to either antenna or power supply.
4. Ensure that the power supplies and analyzer are set to the correct AC voltage

   Connect W-700 power connector to a PS-100G.

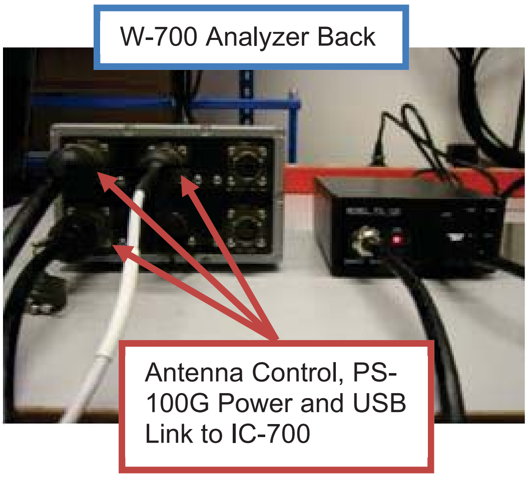
   For systems using PS-600 or larger connect this unit to the AC main.
5. For details on how to setup communication to the antenna please consult the WinDopp Communication Setup (page 14) section.



SL-xxxxxyyy System Setup using W-700 and PS-100G



SL-xxxxxyyy System Setup using W-700 and PS-600 or higher



Setup example: W-700 analyzer connected to antenna, PS-100G and laptop

Warning

- ► Never walk in front of radiating antenna. Consult Weibel Safety Distance document TR-1032-Safety_Distance for radiation safety distance of the specific antenna.

Caution

- ► Ensure all systems are off before connecting or disconnecting any cables

WEIBEL DOPPLER RADARS

2.5 WinDopp Communication Setup

Once all placement and cable connections are completed it is necessary to set up the communication between the IC-700 and the antenna. This is done by using the Weibel software WinDopp. This section will explain how to set up the different types of communication configurations used by the SL-xxxxyyy antennas.

Since there are several different configurations available for the communication and these are depend on the specific antenna model the following table explains what method should be used for each antenna model.

Antenna Type	Link Type	Primary Configuration	Optional Configuration
SL-520A/M SL-525 SL-528 SL-531 SL-3028 SL-7025 SL-1025 SL-15028 /B SL-15034 SL-30031	W-700 Standard	RS232 (page 15)	
	W-700 with Link	Link - USB Adaptor (page 16)	RS232 (page 15)
	W-700 with USB	Direct USB (page 17)	RS232 (page 15)
SL-520P/PD SL-525P SL-528P/PB SL-3028P SL-15028P/PB SL-30031P	PS-100C DOS	RS422D (page 17)	RS232 (page 15)
	PS-100C Windows	RS422W (page 18)	RS232 (page 15)
	PS-100U	RS422W (page 18)	RS232 (page 15)
SL-528PC SL-3028 SL-15028PC/PBC SL-30031PC SL-60034P/PC	Anywhere USB	Anywhere Ethernet (page 19)	RS232 (page 15), RS422W (page 18)
	Belkin USB HUB	Belkin Ethernet (page 19)	RS232 (page 15), RS422W (page 18)
SL-520PE SL-525PE SL-528PE SL-2033PE SL-7036PE SL-15028PE SL-30033PE	Ethernet adaptor	Direct Ethernet (page 20)	RS232 (page 15), RS422W (page 18)

Notes

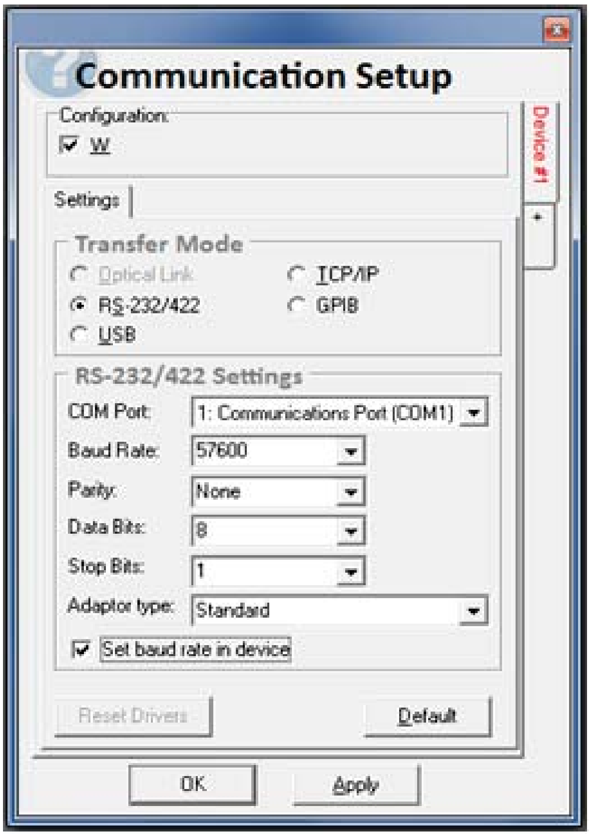
► To change from primary to optional communication configurations it will be required to change the antenna default setup either using an external display or a telnet connection.

2.5.1 RS232

All Weibel antennas have the option of using the RS232 communication option.

To set up the RS232 connection complete the following steps:

1. Start WinDopp and open the Communication Setup menu (F10). (The menu will appear automatically if the current setup is incorrect).
2. Set up the menu as shown on the Figure below with the following corrections:
   - Ensure that the com port selected is the one the RS232 cable is connected to.
   - Selected the appropriate baud rate. A list of available baud rates can be found in the Baud Rate (page 21) section.
   - If the baud rate has to be changed when using a W-700; use the W-700 interface to do so (for details on how to do this please consult the W-700 manual).



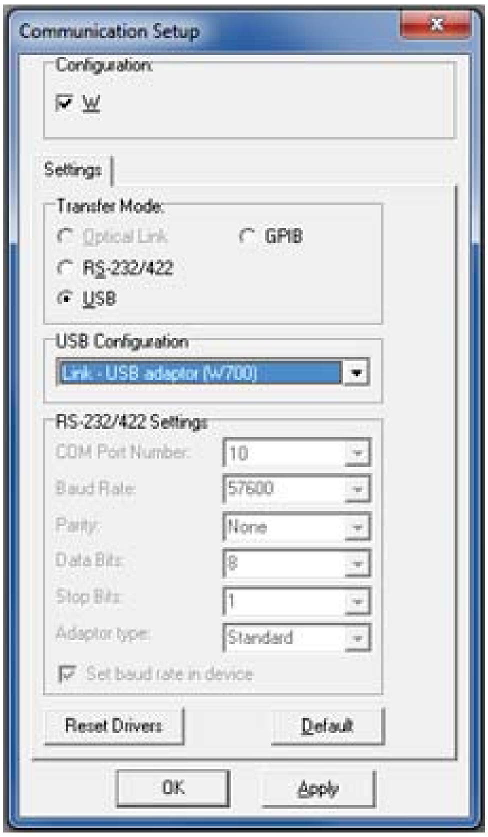
WinDopp RS232 Communication Setup

2.5.2 Link - USB Adaptor

Some of the W-700 analyzer systems uses an IO1000 adapter when using the USB communication configuration.

To set up the Link – USB Adaptor connection complete the following steps:

1. Connect the IO-1000 adaptor to the IC-700 and install the IO-1000 USB Link driver (found on the WinDopp installation CD). Find the nominated COM Port in the Windows Device Manager.
2. Start WinDopp and open the Communication Setup menu (F10). (The menu will appear automatically if the current setup is incorrect).
3. Set up the menu as shown on the Figure below with the following corrections:
    - Ensure that the com port selected is the one the IC-700 sets up for the USB cable.
    - Selected the appropriate baud rate. A list of available baud rates can be found in the Baud Rate (page 21) section.
    - If the baud rate has to be changed this is done using the W-700 interface (for details on how to do this please consult the W-700 manual).



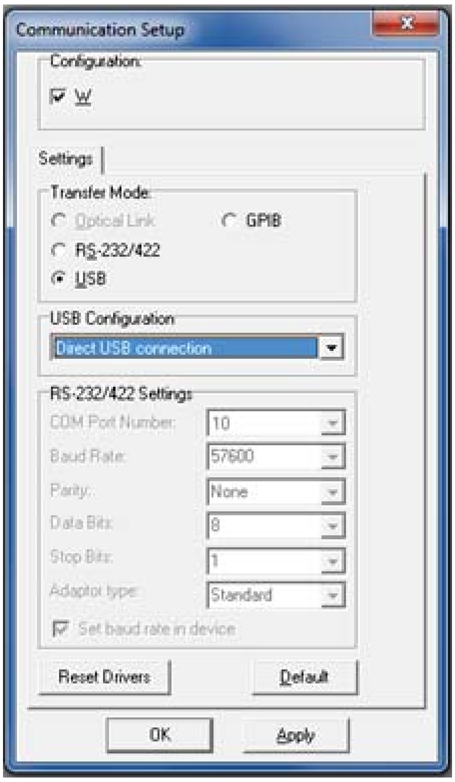
WinDopp Link – USB Adaptor communication setup

2.5.3 Direct USB

Some W-700 analyzer systems uses a direct USB link when using the USB communication configuration.

To set up the Direct USB connection complete the following steps:

1. Connect the W-700 USB cable to the IC-700 and install the W-700 USB driver (found on the WinDopp installation CD).
2. Start WinDopp and open the Communication Setup menu (F10). (The menu will appear automatically if the current setup is incorrect).
3. Set up the menu as shown on the Figure.



WinDopp Direct USB communication setup

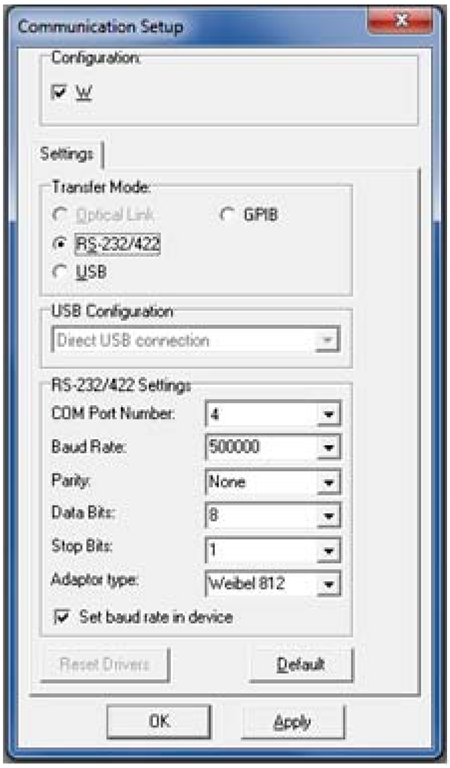
2.5.4 RS422D

Older DOS based IC-700 systems utilize the Weibel 812 link board when using the RS422 communication configuration.

To set up the RS422D connection complete the following steps:

1. Connect the PS-100C to the IC-700 and install the IO-700 RS422 driver (found on the WinDopp installation CD).
2. Start WinDopp and open the Communication Setup menu (F10). (The menu will appear automatically if the current setup is incorrect).
3. Set up the menu as shown on the Figure below with the following corrections:

- Ensure that the com port selected is the one the PS-100C cable is connected to.
- Selected the appropriate baud rate. A list of available baud rates can be found in the Baud Rate (page 21) section.



WinDopp RS422D communication setup

2.5.5 RS422W

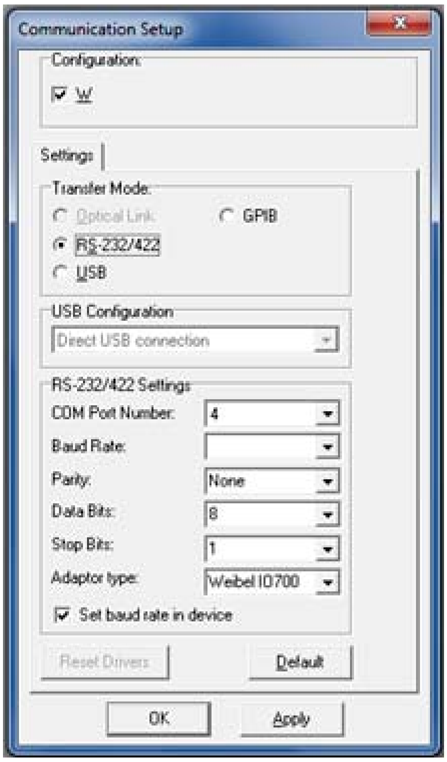
Some Windows based IC-700 systems utilize the Weibel IO700 link board or USB COMi Adaptor (either as separate adaptor or built in for the PS-100U) when using the RS422 communication configuration.

To set up the RS422W connection complete the following steps:

1. If using a PS-100C connect it to the IC-700 and install the IO-700 RS422 driver (found on the WinDopp installation CD).

   If using a USB COMi adaptor connect it to the IC-700 and install the USB COMi driver (found on the WinDopp installation CD).
2. Start WinDopp and open the Communication Setup menu (F10). (The menu will appear automatically if the current setup is incorrect).
3. Set up the menu as shown on the Figure below with the following corrections:
   - Ensure that the com port selected is the one the PS-100C/USB COMi cable is connected to.

- Selected the appropriate baud rate. A list of available baud rates can be found in the Baud Rate (page 21) section.
- Set the adaptor type to either **Weibel IO700** if using the IO700 link or **Standard** if using the USB COMi.



WinDopp RS422W communication setup

2.5.6 Anywhere Ethernet

Antennas with Ethernet capabilities produced before 2009 utilizes an Anywhere USB Ethernet adaptor.

To set up the Ethernet Anywhere connection complete the following steps:

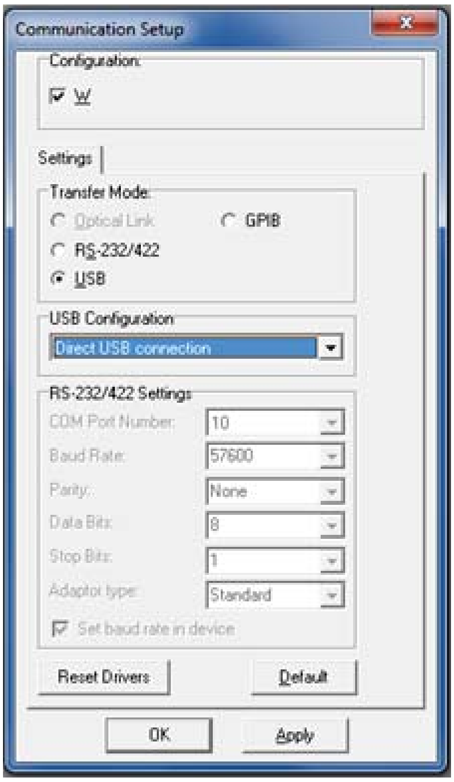
1. Install the Anywhere USB 180 driver (found on the WinDopp installation CD).
2. Connect the Ethernet cable from antenna to IC-700 and install the W-700 USB driver (found on the WinDopp installation CD).
3. Start WinDopp and open the Communication Setup menu (F10). (The menu will appear automatically if the current setup is incorrect).
4. Set up the menu as shown on the Figure below.

2.5.7 Belkin Ethernet

Antennas with Ethernet capabilities produced after 2009 utilizes a Belkin USB Ethernet adaptor.

To set up the Belkin Ethernet connection complete the following steps:

1. Install the Belkin Network USB Hub driver (found on the WinDopp installation CD).
2. Connect the Ethernet cable from antenna to IC-700 and install the W-700 USB driver (found on the WinDopp installation CD).
3. Start WinDopp and open the Communication Setup menu (F10). (The menu will appear automatically if the current setup is incorrect).
4. Set up the menu as shown on the Figure below.



WinDopp Anywhere Ethernet / WinDopp Belkin Ethernet communication setup

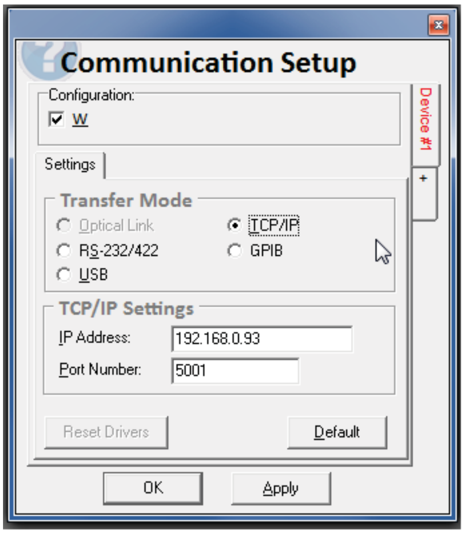
2.5.8 Direct Ethernet

The antennas with the PE letter indication functions as a network device utilizing a pure Ethernet configuration.

To set up the Direct Ethernet connection complete the following steps:

1. Start WinDopp and open the Communication Setup menu (F10). (The menu will appear automatically if the current setup is incorrect).
2. Set up the menu as shown on the Figure below.
3. If using multiple devices as described in the WinDopp manual please ensure that no devices have the same IP address.

   (See Changing the default IP address section for a description on how to setup new IP addresses).



WinDopp Direct Ethernet communication setup

2.5.9 Baud Rate

The following table describes which baud rates are available for the different communication configurations that require a baud rate specified.

Baud Rates	RS232	RS422D	RS422W
9600	√	√	√
19200	√	√	√
38400	√	√	√
57600	√	√	√
100000		√	√
125000		√	√
250000		√	√
500000		√	√

2.5.10 Changing the default IP address

The new line of PE antennas can run a direct Ethernet communication setup which allows the user to add several antennas onto a network and connect and work over this network.

This requires that the antennas each has a specific IP address.

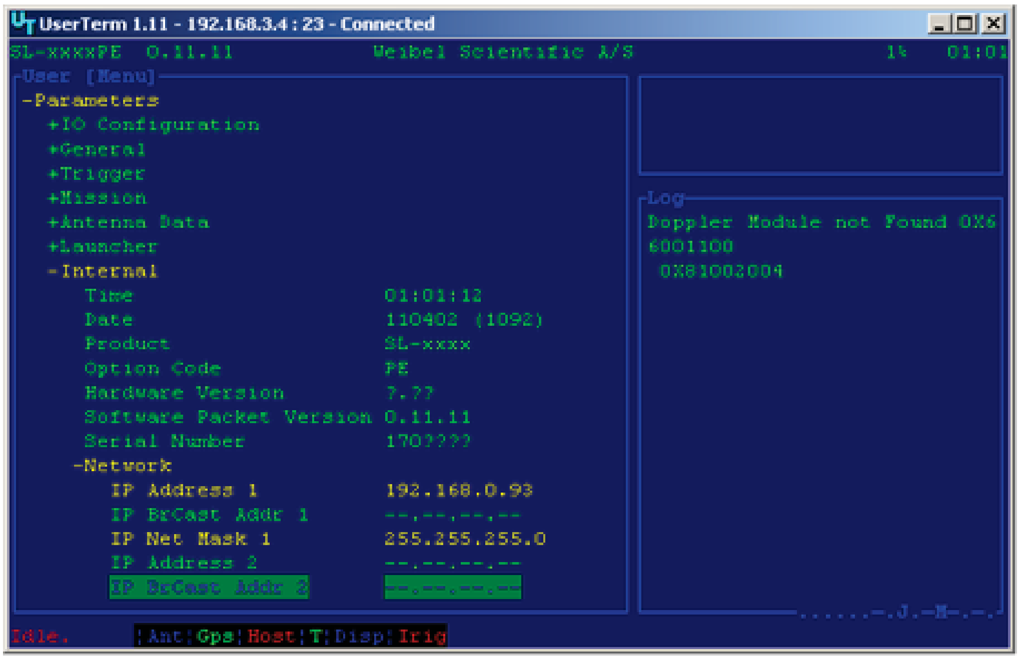
All PE antennas are supplied with one of two default IP address of **192.168.0.93** and **192.168.3.93**; which can be changed by completing the following steps:

1. Connect the Ethernet cable from the PS-200 to a PC that is not connected to a network.
2. From the windows Run field (located in the start bar) type:

   telnet 192.168.0.93 (Or 192.168.3.93)

   and the window seen on the following figure should appear
3. In this new window enter into the parameters menu – Internal – Network and locate IP address 1.

4. Change it to the IP address that will be the units specific address.
5. Note the new IP address along with the Antenna unit serial number to remember which antenna has what address.



SL-xxxxxPE Telnet user terminal window

2.5.11 Resetting to the default IP address

In the case the IP address being forgotten or being mislaid the SL-xxxxxPE antennas has a built in IP address reset feature.

When utilizing this feature the PE antennas will reset its IP address to **192.168.0.93**

The IP address reset function is performed in the following way.

1. Connect the Antenna to the PS-200 and connect the Ethernet cable from the PS-200 to a PC that is not connected to a network.
2. Turn on the system and wait for 2 hours
3. After the two hours the Status Indicator LED will invert its blinking function. Going from stable green with a red blink to a stable red with a green blink.

   Once this state is achieved the antenna has reset it IP address.
4. Change the Subnet mask of the laptop to **255.255.255.0**
5. At this point complete one of the following three actions

5a. Open WinDopp and connect to the default IP address **192.168.0.93**

From WinDopp change the IP address through the advance parameters tab.

5b. Open the User terminal program and input the IP address of 192.168.0.93

From the User terminal program change the IP address.

(See the previous picture for the IP address menu)

5c. Using the telnet command: **telnet 192.168.0.93** connect to the antenna

From the telnet window change the IP address.

(See the previous picture for the IP address menu)

6. Note the new IP address along with the Antenna unit serial number to remember the IP address.

Reboot the antenna to make the new IP address take effect.

7. Reset the Subnet mask of the laptop to **255.255.252.0**

Reconnect to the antenna with the new IP address to verify the change has taken effect

2.6 Time Source Configuration

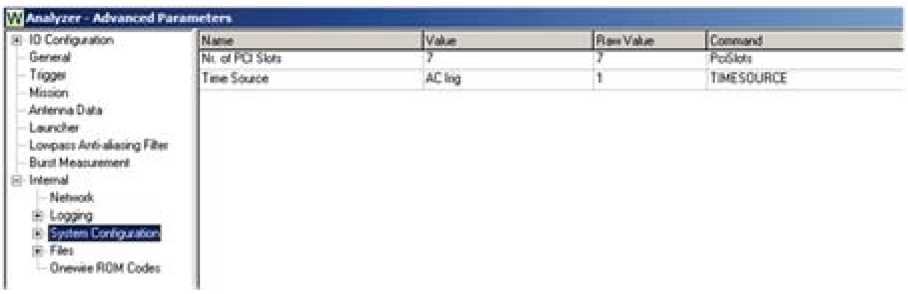
The SL-xxxxxyy antennas can use different time sources to enable time synchronization. For most of the antennas this is done using the IRIG synchronization option that can be set up from the WinDopp User interface and an external IRIG time generator that is plugged into the IC-700 on which the WinDopp is running. For details on how to setup IRIG synchronization from WinDopp consult the WinDopp manual.

The SL-xxxxxPE antennas also has the option of using the internal GPS device (if available) or alternatively having a IRIG device connected directly to the antenna power supply. Setting up the PE antenna time source is explained in the following section

2.6.1 SL-xxxxxPE Time Source Setup

To setup the time source complete the following steps.

1. Connect the antenna to the power supply and IC-700 and possibly the IRIG device if this is the option chosen.
2. Turn on the system, open WinDopp and connect to the antenna
3. Open the parameters screen (F3) and enter the Advanced menu
4. Enter the Internal – System Configuration – Time Source and choose the option used (See following picture).



Options available are: Free Running, GPS, AC IRIG and DC IRIG

5. The Status bar at the bottom of the WinDopp screen should become green once the time signal is present.
6. When using GPS as time source the time is UTC time as default. To offset this to a local time zone, open a terminal (from WinDopp) and type in the

command: **GPSTIMEOFFSET n** where **“n”** is the time zone offset (+/-) from UTC time with unit of seconds, i.e. -1 hour offset equals **n = -3600**.

3 Connectors & Indicators

3.1 Connector Overview

In this section the external connectors and indicators on the SL-xxxxxyyy antennas are described.

3.2 SL-xxxxxyyy Connector Panels

The connector panel located on the antenna provides the communication interface, power supply as well as LED indicators for system status.

Because of the various antenna configurations the connector panels differ from system to system. It is however composed from the same set of connector types each having a specific purpose and pin out. In the following sections a sample of the different connector setups may be found; although keep in mind that minor changes such as the exact connector placement and LED indicators may occur.

To find information about a specific connector on your antenna:

1. Find the appropriate antenna type and connector panel in the following sections.
2. Note the number in the call-out.
3. Find the table entry in the section SL-xxxxxyyy Connector Types (page 31).
4. Look-up the specific connector in one of the sub-sections.

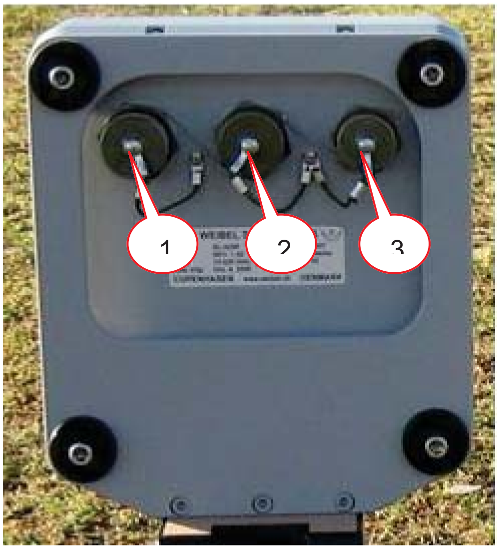
3.2.1 SL-520A, SL520M

For details about a specific connector note the number and refer to the SL-xxxxxyyy Connector Types (page 31) section.

SL-520A

3.2.2 SL-520P, SL-520PD, SL-525P

For details about a specific connector note the number and refer to the SL-xxxxxyyy Connector Types (page 31) section.



SL-520P

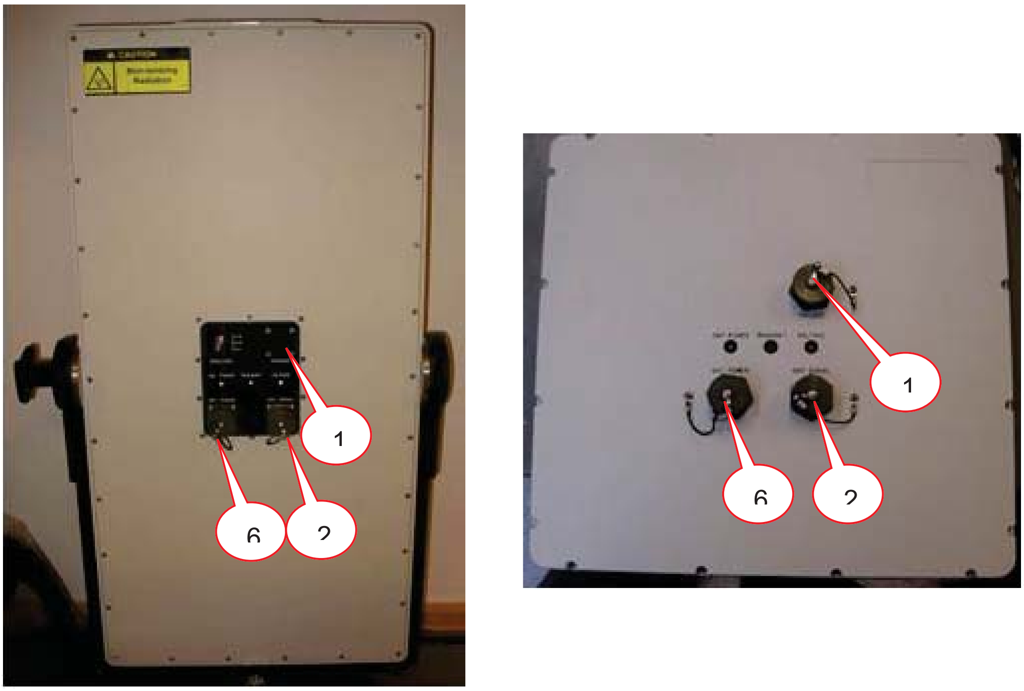
3.2.3 SL-520PE, SL-525PE

For details about a specific connector note the number and refer to the SL-xxxxxyyy Connector Types (page 31) section.

SL-520PE

3.2.4 SL-525, SL-7025, SL-528, SL-3028, SL-15028, SL-531, SL-30031

For details about a specific connector note the number and refer to the SL-xxxxxyyy Connector Types (page 31) section.



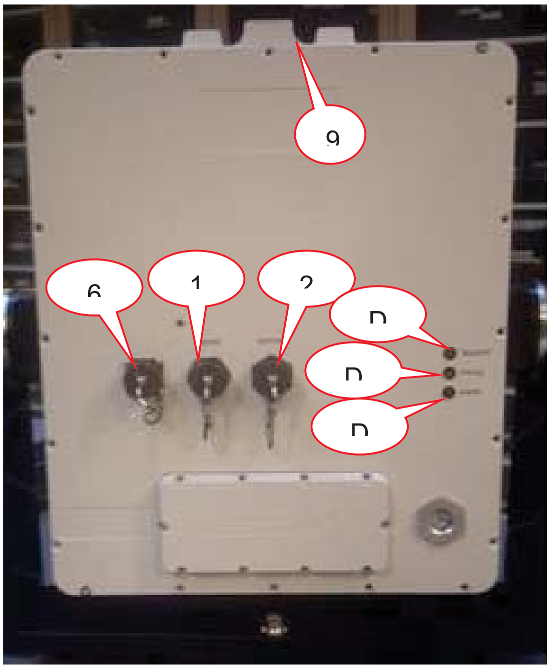
SL-30031 (left) and SL-7025 (right)

3.2.5 SL-528yyy, SL-3028yyy, SL-15028yyy, SL-30031yyy

NOTE: Not all letter configurations (P, PB, PC, PBC, PE) are available; this is specific for certain power and gain configurations.

For details about a specific connector note the number and refer to the SL-xxxxxyyy Connector Types (page 31) section.

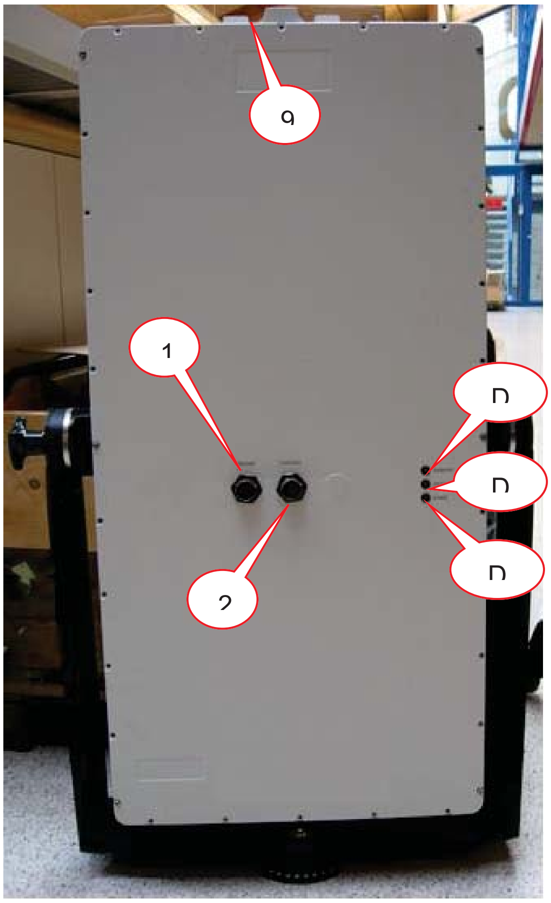
SL-15028PC



SL-15028PE

3.2.6 SL-2033PE

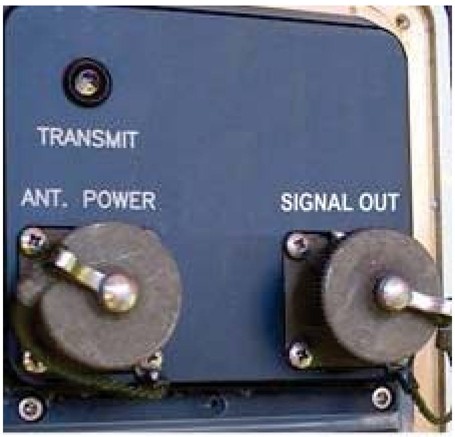
For details about a specific connector note the number and refer to the SL-xxxxxyyy Connector Types (page 31) section.



SL-2033PE

3.2.7 SL-15034

For details about a specific connector note the number and refer to the SL-xxxxxyyy Connector Types (page 31) section.

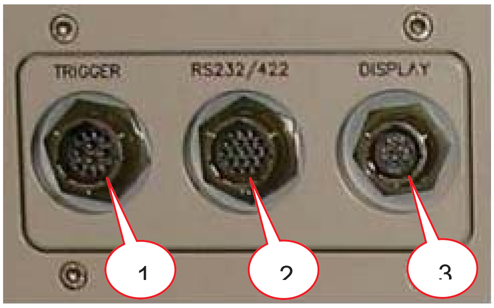


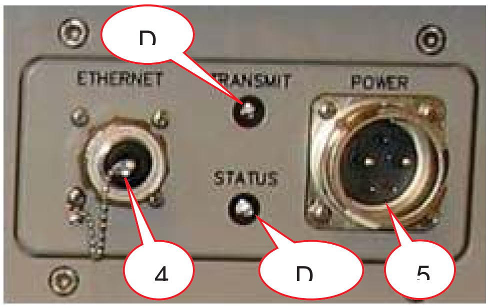
SL-15034

3.2.8 SL-60034P

The SL-60034P antenna type is unique in having separate connectors on the RX and TX parts of the antenna.

For details about a specific connector note the number and refer to the SL-xxxxxyyy Connector Types (page 31) section.

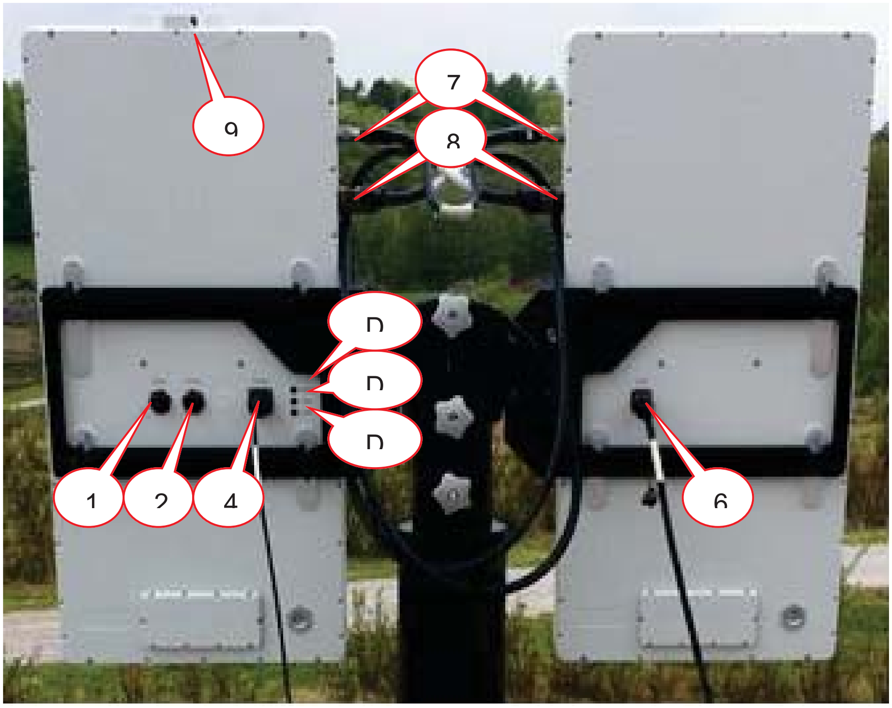




SL-60034 Rx side (left) SL-60034 and Tx side (right)

3.2.9 SL-7036PE

For details about a specific connector note the number and refer to the SL-xxxxxyyy Connector Types (page 31) section.



SL-7036PE

3.3 SL-xxxxxyyy Connector Types

The following connector types are referenced in the SL-xxxxxyyy Connector Panels (page 25) section.

Number	Used for	Type
1	Trigger	Cannon 12P Male size 14 Part Number: KPT02E14-12P Mating Part: KPSE6E14-12S-DZ Connections, see Trigger connector (page 32)
2	Antenna control	Cannon 19P Male size 14 Part Number: KPT2E14-19P-EX Mating Part: KPSE6E14-19S-DZ Connections, see Antenna Control (page 33)
3	Display	Cannon 10P Female size 12 Part Number: KPT7A12-10S-EX Mating Part: KPSE6E12-10P-DZ Connections, see Display connector (page 34)
4	Ethernet connection	MIL-C-28482 RJ45 female Part Number: RJF 2 2 G 00 100BTX Mating Part: Connections, Standard Ethernet pinout *(This connector is replaced by a blanking cap for certain antenna configurations)*
5	+48V Power	2+3-P Male size 22 Part number: CA02COM-E22-12P-B Mating Part: Connections, see 48V Input Power to SL-60034P antenna (page 34)
6	+15V Power	Cannon 5-P Male size 14 Part Number: KPSE2E14-22P Mating Part: KPSE6E14-22S-DZ Connections, see +15V Input power to remaining SL-xxxxxyyy antennas (page 35) *(This connector is replaced by a blanking cap for certain antenna configurations. In this case the antenna receives power through the Antenna Control connector)*
7	Oscillator Connection	Huber & Suhner Female N-Type to SMA Part Number: 37N-SMA50-1/131 Mating Part: Male N-Type Connectors Connections, see Oscillator Connection (page 35)

Number	Used for	Type
8	Antenna Interconnect	Cannon 32-P Male size 18 Part Number: KPT02E18-32P Mating Part: KPSE6E18-32S-DZ Connections, see Antenna Interconnect (page 36)
9	GPS Antenna	Jinchang GPS external Antenna Partnumber: JCA003 Connections, see GPS Antenna (page 37)

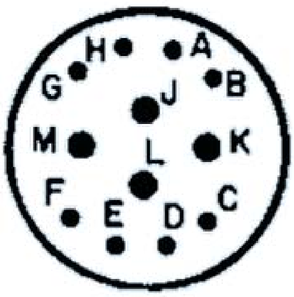
The following table explains the use of the different indicator diodes found on the antennas.

Number	Used for	Type
D1	Transmit diode	LED, see Indicator Diodes (page 37)
D2	Status diode	LED, see Indicator Diodes (page 37)
D3	Antenna Power diode	LED, see Indicator Diodes (page 37)

3.3.1 Trigger Connector

The trigger signal input on the antenna is a 12 core connector for a differential trigger signal. The 12 core connector also provides ±15volt power for a Weibel FOT-2 or microphone trigger device.

The 12 core connector has 100Ω input impedance between the differential input pins and the differential input voltage must not exceed ±10volt. The pin out is listed in the table below.



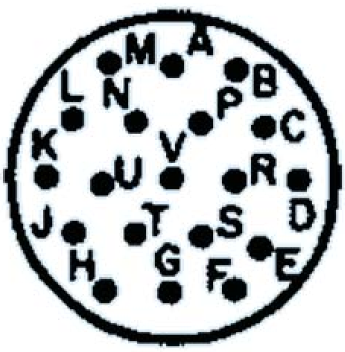
Trigger Connector Pinout

Pin number	Description
A	Differential trigger input +
B	Differential trigger input -
C	Not used
D	Not used
E	Not used

Pin number	Description
F	Not used
G	Not used
H	Not used
J	+15volt power output (max. 500mA)
K	GND, power return
L	-15volt power output (max. 500mA)
M	Not used

3.3.2 Antenna Control

The Antenna Control connector on the antenna is a 19 core connector that is used for data transfer for communication and Doppler signal from the measurement. The connector can also provide the antenna with +24V power which is the only power connection for the smaller antennas. The pin out is listed in the table below.



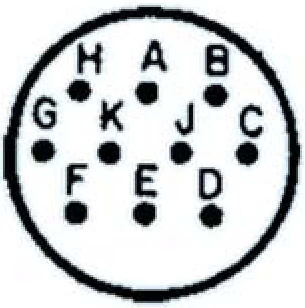
Antenna Control Connector Pinout

Pin number	Description
A	TXD+/ETX1+
B	TXD-/ETX1-
C	RXD+/ERX1+
D	RXD-/ERX1-
E	RTS-/ETX2+
F	RTS+/ETX2-
G	CTS+/ERX2+
H	CTS-/ERX2-
J	SEL
K	0V
L	GND
M	ACIRIG+
N	GND
P	ACIRIG-

Pin number	Description
R	+24V
S	STATUS_LED1
T	STATUS_LED2
U	0V
V	+24V

3.3.3 Display Connector

The Display connector on the antenna is a 10 core connector that is used to connect the optional external display used to control the antenna directly. The pin out is listed in the table below.

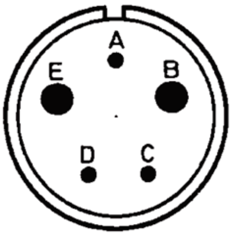


Display Connector Pinout

Pin number	Description
A	DRX-
B	DRX+
C	DTX+
D	D+
E	D+
F	DG
G	DG
H	D-
J	DTX-
K	D-

3.3.4 48V Input Power to SL-60034P Antenna

The 48V Input Power connector located only on the SL-60034 antenna is a 5 core connector used to power the antenna. The pin out is listed in the table below.

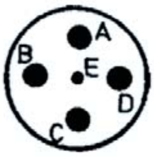


48V Input Power Connector Pinout

Pin number	Description
A	TCREM
B	+48V
C	GND
D	Not Used
E	PGND (0V)

3.3.5 +15V Input Power to Remaining SL-xxxxxyyy Antennas

The +15V Input Power connector located on the SL antennas is used to power the antenna. The pin out is listed in the table below.



+15V Input Power Connector Pinout

Pin number	Description
A	+12V/+15V
B	PGND
C	PGND
D	+12V/+15V
E	TCREM

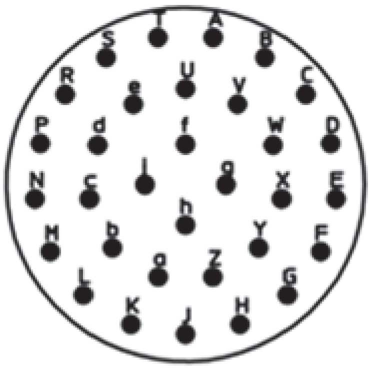
3.3.6 Oscillator Connection

The Oscillator Connection connectors located on the SL antennas that use two antennas; one for receiver and one for transmitter; is used to connect the oscillator signal between the antennas. The pin out is listed in the table below.

Pin number	Description
Center Pin	Oscillator Signal
Shield	PGND

3.3.7 Antenna Interconnect

The Antenna Interconnect connector located on the SL antennas that use two antennas; one for receiver and one for transmitter; is used to transfer power and control signals between the antennas. The pin out is listed in the table below.



Antenna Interconnect Connector Pinout

Pin number	Description
A	TXD+/ETX1+
B	TXD-/ETX1-
C	RXD+/ERX1+
D	RXD-/ERX1-
E	RTS-/ETX2+
F	RTS+/ETX2-
G	CTS+/ERX2+
H	CTS-/ERX2-
J	SEL
K	0V
L	GND
M	ACIRIG+
N	GND
P	ACIRIG-
R	+24V
S	STATUS_LED1
T	STATUS_LED2
U	0V
V	+24V
W	Not Used
X	Not Used
Y	Not Used

Pin number	Description
Z	Not Used
a	CTRL TXD-
b	CTRL TXD+
c	CTRL RXD-
d	CTRL RXD+
e	CTRL CTS+
f	CTRL CTS-
g	CTRL RTS+
h	CTRL RTS-
i	0V

3.3.8 GPS Antenna

The GPS Antenna is an external GPS antenna that is directly mounted onto the antenna and connected internally. The pin out is listed in the table below.

GPS Antenna mounted externally on antenna

Pin number	Description
Center Pin	GPS RF Signal
Shield	PGND

3.3.9 Indicator Diodes

Antenna status	Status LED	Transmit LED	Ant. Power LED
Power up	Red Light	Off	Red Light
System ready	Red/Green Flashing	Off	Green Light
Transmitting	Red/Green Flashing	Green Light	Green Light

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4 Inside the Antenna

4.1 Overview

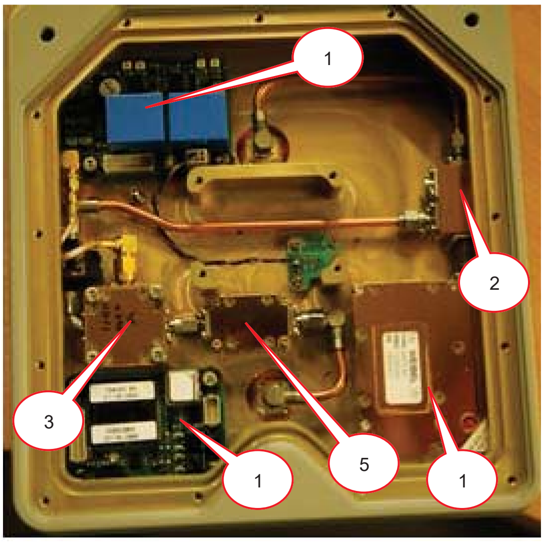
This section describes the internal parts of the SL-xxxxxyyy antennas on a component level and is intended for system component identification.

The antennas are manufactured in a numbers of variants, each having differences in the electronic and mechanical build up, but the main components can be found in all antennas. These components can be found in the section named Main System Components (page 39).

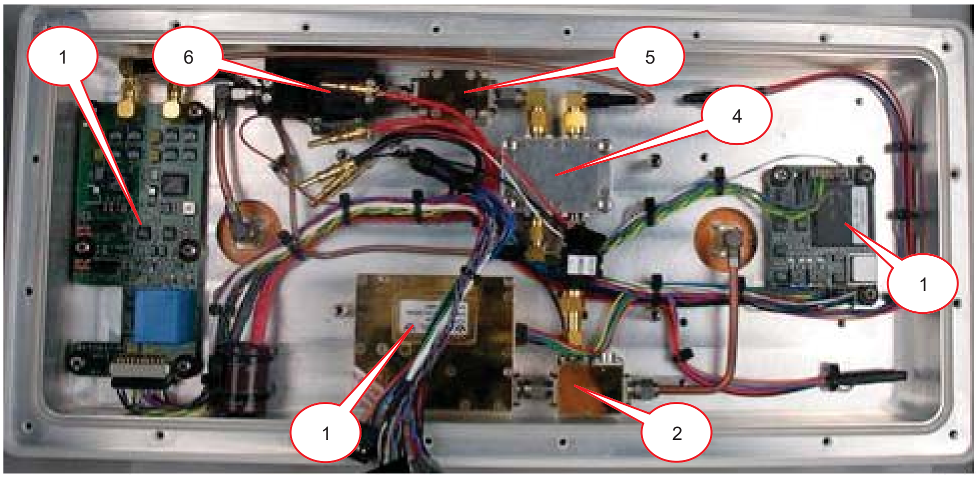
Besides the main system components the antennas that include any of the P, B, C or E options include extra components needed for antenna communication, oscillators and other electrical components. These components are covered in the section named Optional System Components (page 42).

4.2 Main System Components

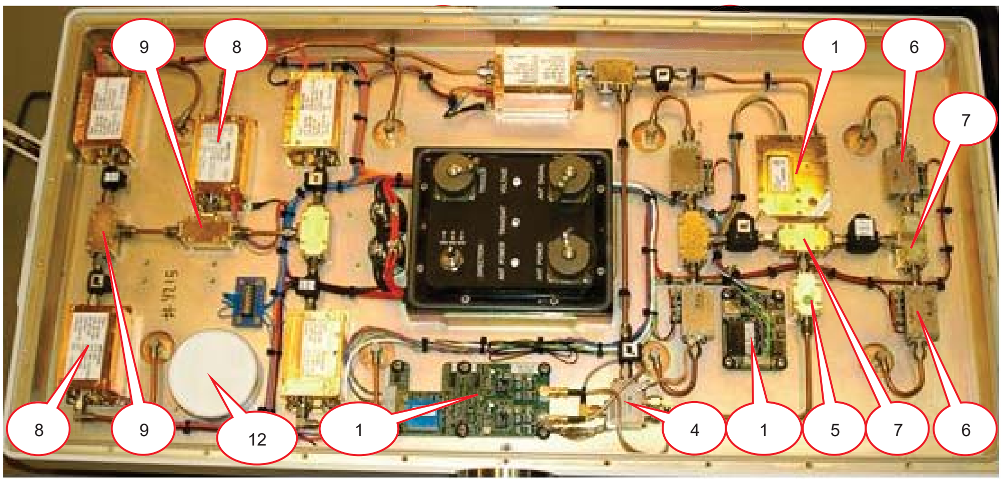
This section describes the most common components found in all SL-xxxxxyyy antennas. Included in this subsection are sample pictures of three different size antennas to give an understanding of the system build-up. Each component is listed below.



SL-520 Antenna



SL-525 Antenna



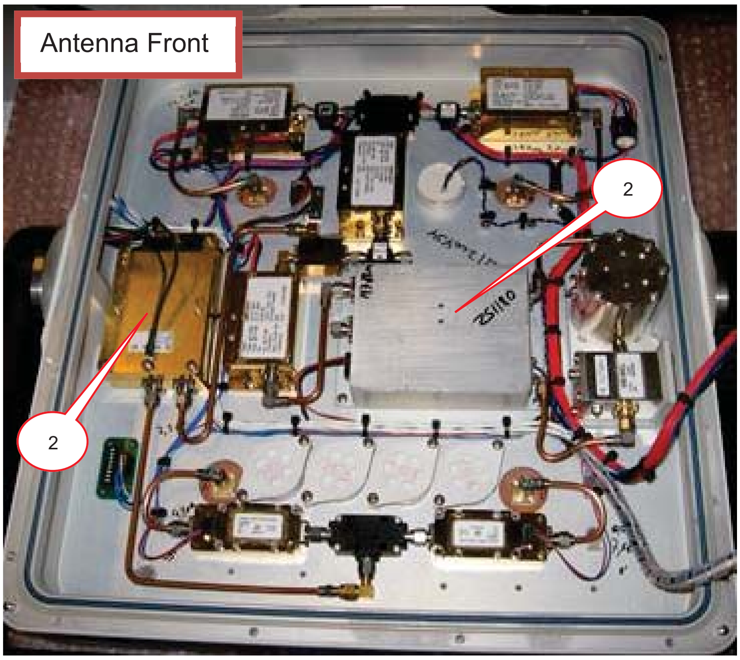
SL-30031 Antenna

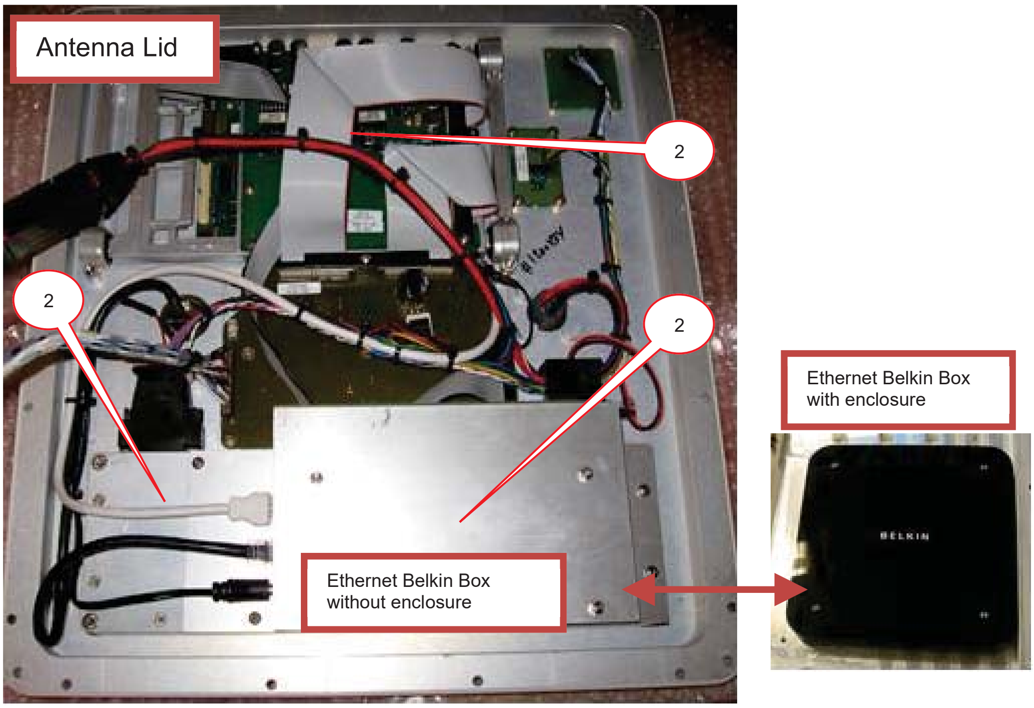
Ref	Description
1	Local Oscillator
2	LO Coupler
3	Double Balanced Mixer
4	Double Balanced IQ Mixer
5	Microwave Filter
6	Low Noise Amplifier
7	Channel Summer
8	LO Amplifier
9	LO splitter
10	IF Amplifier Board

Ref	Description
11	CPU Board
12	Silica gel to keep the antenna dry

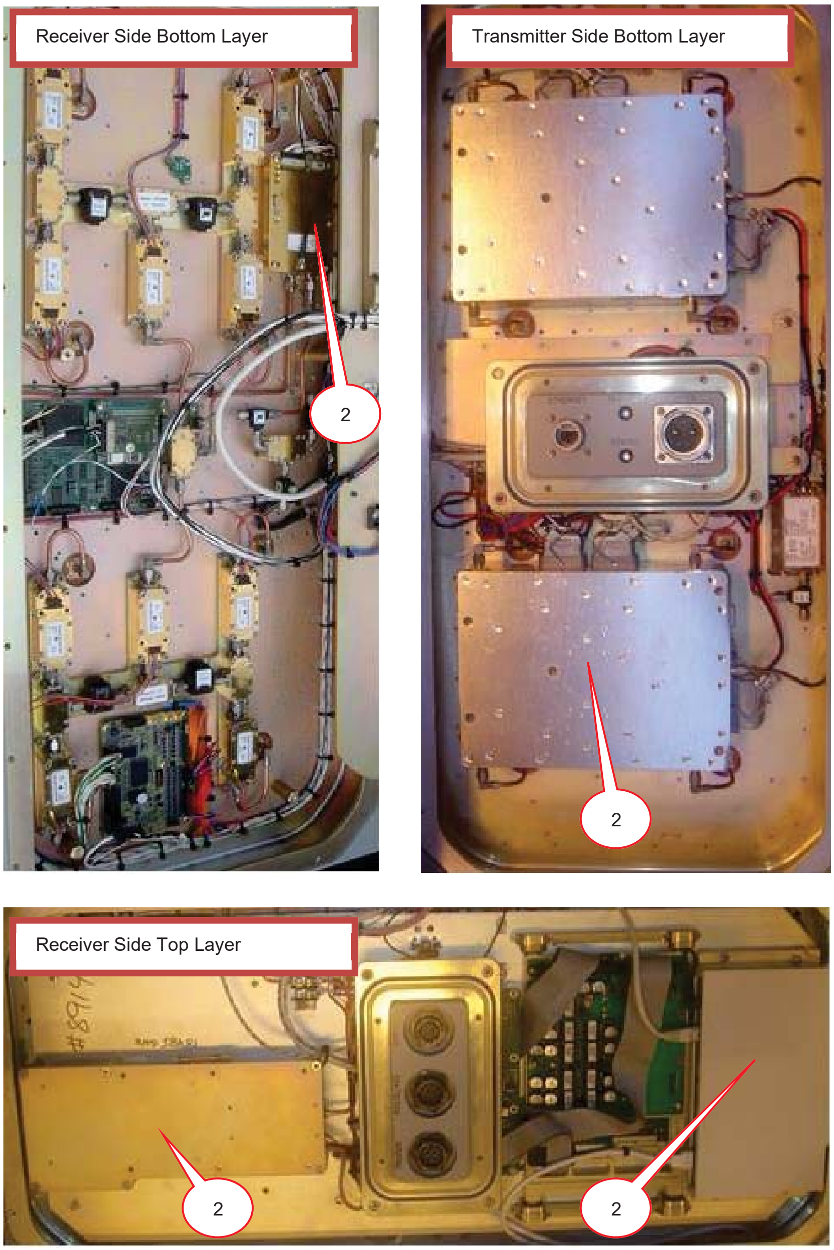
4.3 Optional System Components

This section describes the components associated with the different options P, B, C, and E of the SL-xxxxxyyy antennas. Included in this subsection are sample pictures of two different size antennas to give an understanding of the system build-up. Each component is listed in the table following the pictures.

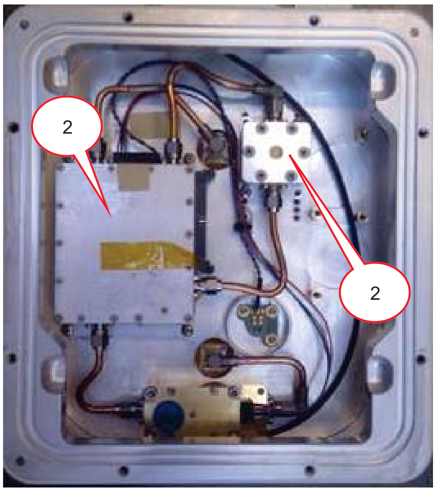




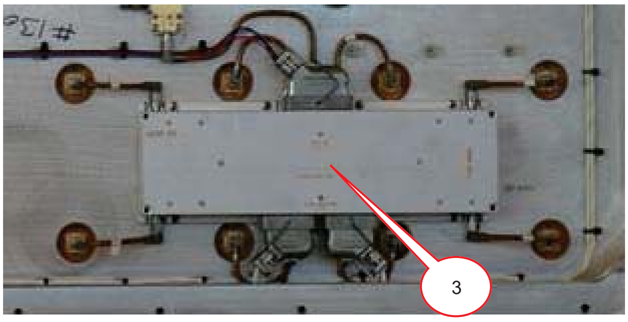
SL-15028PB


Receiver Side Bottom Layer
2
Transmitter Side Bottom Layer
2
Receiver Side Top Layer
2
2

SL-60034PBC



SL-520PE Front



SL-2033PE Front

Ref	Description
21	Low Noise Local Oscillator
22	Double Balanced IQ Mixer and Amplifier Unit
23	Integrated Analyzer with power supply
24	+24V Power Supply Unit
25	Ethernet Belkin Box
26	Ethernet Anywhere USB Converter Unit
27	Power Pack Amplifier Unit
28	Miniaturized Low Noise Local Oscillator
29	Crystal Cavity Resonator
30	LNA Pack (Low Noise Amplifier Pack)

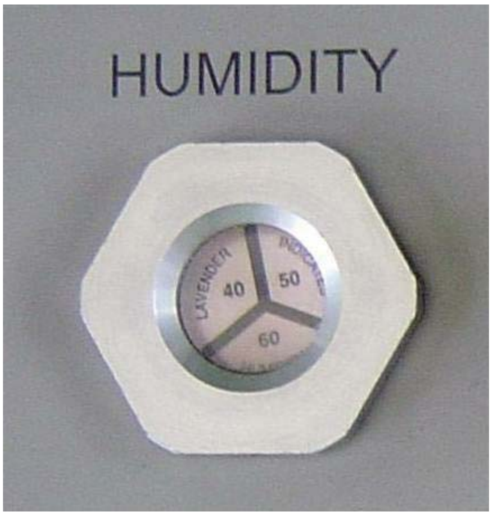
5 Maintenance

5.1 Maintenance Schedule

The recommended maintenance schedule is:

Interval	Maintenance
Every time the radar is used	Check the Humidity Sensors (page 45) Continuous Corrosion Control (page 45)
Every month	Spray Connectors with WD40 (page 46)
Every month	Clean the Antennas with Fresh Water (page 46)

5.1.1 Check the Humidity Sensors



Check the humidity sensors located on the back of the antenna (when available). If the three fields are blue, the antenna is dry. However, if the field is red there is humidity in the antenna. If all fields are red, the antenna must be dried out using silica gel or the silica gel tabs must be replaced.

5.1.2 Continuous Corrosion Control

Tools and materials needed:

- Paint (included in corrosion repair kit, CRK-Cxxx)

- Corrosion protection (included in corrosion repair kit, CRK-Cxxx)
- The specific CRK-Cxxx corrosion repair kit depends on color of antenna. Contact Weibel for specifics.

Damage to Painted surface

If a painted surface is penetrated and the metal is visible, it is important to treat the surface. If paint is available, paint the damage. If paint is not available use corrosion protection until painting is possible. If the surface is corroded, make sure that all corrosion is ground away before painting.

5.1.3 Spray Connectors with WD40

Spray electrical connectors with WD40 (locking mechanism mainly) or other lubrication substance that is rated for use with electrical connectors.

5.1.4 Clean the Antennas with Fresh Water

When the radar is close to the sea, e.g. on a ship or on the pier use a garden hose with clean water (without salt) and clean the antennas on a regular basis. If the antennas are very dirty, use a little Auto shampoo.

Caution

- Make sure not to damage Teflon surface of the antenna elements on the front of the antenna. Any scratches on this surface may result in a degraded performance of the radar.

5.2 Calibration

It is recommended that the SL-xxxxyyy is sent for recalibration at least every second year to ensure correct measurement of velocities.

As an option, the SL-xxxxxyyy radar systems can incorporate a unique self-calibrating technology. With this option, the system does not need any calibration during its entire life cycle, calibrating its transmitting frequencies with the speed of light as a reference.

5.3 Firmware Update

From time to time new features, enhanced capabilities and bug fixes become available via updating the firmware of the SL-xxxxxyyy antenna. Consult the following description to upload new firmware to the antenna.

1. Download or retrieve new firmware from Weibel Scientific A/S

   (A request regarding new firmware can be sent to support@weibel.dk)
2. Connect the antenna to its power supply and IC-700 as described in the installation chapter.
3. Power up the system and ensure a connection.

   Note down the antenna IP address
4. Using the Telnet Connection or WinDopp Advanced parameters enable the FTP server option found under:

   Diagnostics - Internal – Network – FTP Server

5. Enter the folder in which the new firmware was placed, open the install folder and double click the install.exe or (depending on firmware version) the FTPupload.exe file
6. Follow the installation program to the completion

7. Once completed close the installation program and open the UserTerm program supplied by Weibel.
8. In the UserTerm go into the following sub-category and activate the following command:

   – Diagnostics – Internal – Install Software
9. Once the installation is complete, reboot the antenna.
10. The antenna firmware is now updated.

5.4 Troubleshooting

If you experience one of the symptoms indicated below then go through the list of actions to find the cause of the problem and to resolve it. Note that this short guide only covers the most commonly seen symptoms and causes.

If the problem cannot be located and/or the suggested solution does not work then contact Weibel for help on next steps: support@weibel,dk

Please note that from our experience 90% of all errors turn out to be cable/connector or power supply errors:

5.4.1 When Error is Present Always Check Cables

1. Verify that connector pins are not damaged.

   Check that the cables are intact and properly connected.
2. Check that input voltage is within the required range (all power cables) – e.g. using a voltmeter

5.4.2 Cannot Connect with Ethernet (Only Applicable for "E" Variant Antennas)

Cannot connect to the system after boot-up:

1. Wait connecting the Ethernet cable until after boot-up is complete.
    - If error occurs, unplug the Ethernet cable and reboot the system.
    - Wait until fully booted with connecting the cable.
    - Connect to the system to verify connectivity.

5.4.3 Status LED Not flashing Green after Power-up

For more information about the indicator LED's; see Indicator Diodes (page 37).

Status LED is off:

1. Check Antenna control cable, power supplies, fuses
    - Verify all cables are connected; If not connect missing cables.
    - Check that the power supply is on; if not power up the system.
    - Check fuse for the power supply; if fuse is blown contact Weibel for replacement or part type and number.

Status LED is constantly red or green (not flashing):

1. Check the System communication configuration
    - Verify that the correct communication configuration is being used.
    - Verify that the Port configuration and Baud Rate is correct for both IC and Antenna.

5.4.4 Transmit LED not Green during Measurement

Transmit LED does not turn green during measurement:

1. Is Antenna Power Mode set to On Trigger?
    - If so, the antenna is not allowed to transmit before a trigger is received
    - Ensure that the Trigger Source is not set to Channel Trigger
    - Reduce trigger level if using external trigger

5.4.5 Bad Velocity

Velocity NOT OK:

1. Check that the Doppler channel has signal
    - Open DAT file, and use the ChStatus to verify that the signal is present if not check the following:
        - o Cable problem (possible break in Antenna Control cable).
        - o Error in IF amplifier or output driver in antenna.
2. Signal present but velocity is wrong
    - Verify software setup regarding maximum allowed target velocity.

- Check that physical alignment is correct and is setup accordingly in the software.
- Test to see if antenna oscillator frequency is correct
  - Using a ST-xxx or MC-100 verify that the expected velocity is correct (Consult ST-xxx or MC-100 manual for details on this procedure).
  - If not contact Weibel Scientific regarding recalibration of antenna.

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6 Technical data

6.1 Physical Dimensions

The physical height and width dimensions of the antennas are related to the antenna gain and the depth and weight of the antenna is related to the type. The following tables states the size of the different SL antennas that Weibel produce

6.1.1 Thin Frame Antennas

The following table only includes the antennas where either no option has been selected or only the A option.

Gain	Height	Width	Depth	Weight
20	175	175	50	3
25	350	175	50	8
28	350	350	50	12
31	750	350	50	22
34	750	690	50	26

6.1.2 Thick Frame Antennas

The following table only includes the antennas where the selected options are P, B, C, E or any combination of these.

Gain	Height	Width	Depth	Weight
20	175	175	65	4
20 E option	225	190	90	7
25	350	175	65	8
25 E option	410	190	90	10
28	390	355	125	19
31	800	355	125	35
33	900	425	90	25
34	720	820	125	55
36	925	1170	250	65

Notes

- All dimensions are stated in mm.
- Weights are stated in kg.

6.2 DC Power

The SL-xxxxxyyy antennas are made in different internal variants, Depending on the internal components the required power supply is either ±15VDC, +15VDC or +48VDC.

6.2.1 DC Supply Voltages

Supply voltage **from**	**Value**
Antenna Control	±15 volt ±10%
+15V Power Connector	+15 volt +0/-10%
+48V Power Connector	+48 volt ±10%

6.2.2 Power Consumption

Antenna Type	**Supply Connector**	**Nominal** Power Consumption
SL-5XX	Antenna Control	30
SL-20XX	+15V Power Connector	45
SL-30XX	+15V Power Connector	60
SL-70XX	+15V Power Connector	120
SL-150XX	+15V Power Connector	400
SL-300XX	+15V Power Connector	550
SL-600XX	+48V Power Connector	1100

Power consumption is stated in Watts.

6.3 Operating Conditions

All versions of the SL-xxxxxyyy antennas will operate under the following environmental conditions.

Condition	**Value**
Storage temperature	-40ºC - +65ºC
Operating temperature	-20ºC - +55ºC
Relative humidity	0 – 100%

6.4 Safety Considerations

For information regarding radiation safety please consult Weibel Safety Distance document TR-1032-Safety_Distance.

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7 Glossary of Terms

Acquisition time

The time it takes to measure one (or more) signal parameters used in the tracking process.

ADC

Analog to Digital Converter. Used for sampling the Doppler signal or in some cases the trigger signal. The sampling rate should be high enough to accommodate the maximum velocity of the target.

AGC

Automatic Gain Control. This mechanism automatically adjusts the gain in order to keep a certain output level thus compensating for variations in temperature and input signal level.

Ambiguity

When a parameter value is not fully resolved by the measurement because two or more actual parameter values lead to the same result. A typical situation in radar range or velocity measurements.

Analyzer

A device that records Doppler data during the measurement, e.g. a W-2100 or RTP-2100.

Antenna

The radiofrequency transmitter or receiver. When looking at a Weibel radar from behind the transmitter is to the right and the receiver is to the left.

AP

Atenna Pedestal. This the the Weibel term for the radar subsystem responsible for moving the antenna according to the pointing commands received e.g. from the RTP-2100

ATI

Azimuth Time Intensity. A graphical representation of the Doppler signal showing time on the x-axis and azimuth angle on the y-axis. Each dot in the plot is a color coded signal strength indicator for that specific time and azimuth angle.

Azimuth

The angle from the azimuth reference line to the line of sight projected onto the level plane. Positive to the right.

Baud rate

The rate of data transfer on the physical link. The baud rate is equal to the bit rate when transmission is binary (e.g. zeroes and ones).

BNC connector

A type of connector used with coaxial cables. The basic BNC connector is a male type mounted at each end of a cable. This connector has a center pin connected to the center cable conductor and a metal tube connected to the outer cable shield. A rotating ring outside the tube locks the cable to any female connector.

Calibration

The use of an independent reference to adjust the instrument and thereby improve the accuracy of the measurements made with the instrument.

CP-2100

Keypad and joystick in one unit that connects to the Instrumentation Controller running WinTrack.

CW

Continuous Wave: a sine wave with constant amplitude and frequency.

DAT

The DAT file is where the raw Doppler data is saved. Antenna data is also saved in this file, except during on-line save.

Datum

A set of parameters that define the reference ellipsoid used for Geographic Coordinates.

dB

Deci Bell. Ten times the base-10 logarithm of the ratio between two power levels. E.g. 2 Watts is 3 dB higher than 1 Watt.

dBm

Power level measured in dB milli Watts. Ten times the base-10 logarithm of the power level divided by one milli Watt. E.g. 10 Watts is equivalent to 40 dBm.

DC

Direct Current. Usually referring to a fixed offset value.

Doppler

The frequency offset caused by the radial velocity of the reflecting target. An outgoing target has a negative Doppler offset while an incoming target has a positive Doppler offset as seen from the radar.

Drag

The aerodynamic resistance of an object moving through the air.

DTI

Doppler Time Intensity. A graphical representation of the Doppler signal showing time on the x-axis and frequency on the y-axis. Each dot in the plot is a color coded signal strength indicator for that specific time and velocity.

Elevation

The angle between the level plane and the line of sight to the object.

Ellipsoid

A 3-dimensional surface generated by an ellipse rotating around one of its major axes. Geographic Coordinates refer to a specific ellipsoid definition.

Encoder angle

The angle read from either the azimuth or the elevation encoder in the radar pedestal.

ETI

Elevation Time Intensity. A graphical representation of the Doppler signal showing time on the x-axis and elevation angle on the y-axis. Each dot in the plot is a color coded signal strength indicator for that specific time and elevation angle.

Extrapolating

Estimating the value of a parameter outside the data set defining the parameter. As opposed to interpolating, where the parameter is estimated inside the data set.

False target

An artifact in the received signal that resembles a true reflection from an object.

FFT

The Fast Fourier Transform, a very efficient method for resolving the frequency components of a signal.

FMCW

Frequency Modulated Continuous Wave. This waveform is a linear frequency sweep either repeated or with alternating periods of ramp-up and ramp-down. It is used for range measurement as an alternative to MF.

Geographic North

The North Pole as defined by the Earths rotational axis.

GPS

Global Positioning System. The GPS receiver is capable of generating absolute time information with high accuracy.

IC-700

The Instrumentation Controller type 700. This is the computer running WinDopp.

IC-2100

The Instrumentation Controller type 2100. This is the computer running WinTrack.

IF

Abbreviation for Intermediate Frequency. Often used when referring to downconvertion or upconvertion from mixers.

IMU

Acronym for Inertial Measurement Unit, a device that can be attached to the radar system in order to measure the changes in position and attitude of the platform on which the radar is located. The WinTrack software allows compensating the radar measurements for these changes and obtaining measurements referred to a fixed reference system.

Inclinometer

An instrument that measures angle relative to gravity.

Instrumentation Controller

An industrial grade PC running Windows controlling the radar instrumentation. The application is e.g. WinTrack.

IQ mixer

Actually two mixers where one of the mixers are offset by a 90º phase relative to the other. This technique keeps Doppler frequencies above and below the radar frequency separated.

IRIG-B

The Inter-Range Instrumentation Group (IRIG) time code signal.

This signal can be used to precisely synchronize the host computer clock to within a few microseconds.

Launcher

The device launching the object being measured, e.g. a gun or missile launcher.

LNA

Low Noise Amplifier. Keeping the noise contribution at a minimum is critical when amplifying weak signals, e.g. in the receiver.

LO

Abbreviation for Local Oscillator.

Lock mode

The state of the tracking algorithm. When "locked" the tracking loop is closed and corrections are based on the measured signal. When "unlocked" the operator may manually override the automatic tracking algorithm.

Master

The master data is pointing information produced by the radar and output through one of the external interfaces.

MC-100

Mono-pulse Calibration target used as an artificial Doppler target generator. It’s effectively a transponder with a fixed frequency offset of 32768 Hz.

MF

Multi Frequency: a technique that allows unambiguous range measurement using two transmitted signals.

Mis-level

The deviation from level.

Mono-pulse

The phase coherence of a signal hitting two or more receiver antennas. Used to determine the direction to the observed object.

MOT

Multi Object Tracking: the algorithm that detects and tracks one or more objects in the received signal.

Mount Model

The mount model is a description of the mechanical errors or imperfections in the radar pedestal and its alignment. When the parameters of the model are known, these can be used to correct the raw data captured during a measurement yielding a more accurate result.

Muzzle

The tip of the gun barrel.

MVR

Muzzle Velocity Radar: a radar suitable for high accuracy measurement of the muzzle velocity.

Origo

The center of a coordinate system.

Oscillator

A signal generator with a sine wave output.

PCB-302

Antenna sub controller card used in the transmitter and the receiver.

PCB-812

Interface card.

Perpendicular

At an angle of 90 degrees.

PowerPack

Integrated amplifier module providing the transmitter RF output to four antenna sub-elements.

PRM file

Parameter file.

PS-xxxx

Power Supply unit that supplies power and for certain configurations functions as a communication link between IC and Radar system.

Q-factor

Quality factor. Used as a measure of the sensitivity of a radar. The Q-factor is proportional to the loop gain of the radar.

Radar cross section

The amount of RF power reflected by a specific object when looking at it from a specific aspect angle. The unit is area, e.g. m^2.

Radar Instrumentation

A device used in the radar system, e.g. Tracking Controller, Antenna, Analyzer or Range Processor.

Radial velocity

The velocity component in the direction from/to the observer. The radial velocity is proportional to the Doppler frequency offset.

Radiation hazard

During transmission the radar transmits radio frequency power that may be dangerous to the health.

Range Processor

A device controlling the antenna system. Often used with an optical tracking platform, e.g. RP-2100.

RAP

Rocket Assisted Projectile.

Refraction

As light or radio waves passes from one transparent medium to another, it changes speed, and bends. This happens to radar signals passing through the atmosphere as well.

RF

Radio Frequency. The signal as transmitted or received by the radar.

RP-2100

Range Processor: a device controlling the antenna system often used with an optical tracking platform.

RTD

Real Time Display. A stand-alone display unit showing the RTP Doppler spectra real-time.

RTDS

Real Time Data Storage. An application storing the raw measurement data on a separate computer, usually a PC with a fast disk system. The RTDS has an optical link to a W-2100, providing the Doppler data to be saved on the disk. It is controlled from WinTrack via a TCP/IP connection.

RTI

Range Time Intensity. A graphical representation of the Doppler signal showing time on the x-axis and range on the y-axis. Each dot in the plot is a color coded signal strength indicator for that specific time and range.

RTP

Real Time Processor. The processing unit that captures the Doppler data and the encoder data and sends pointing information to the antenna pedestal. Optionally the RTP sends sampled Doppler data to the RTDS for storage and DTI results to the Real Time Display.

Rx

Acronym for Receive, usually referring to the receiver part of the radar.

S/N Ratio

Signal to noise ratio, se SNR.

Sampling rate

The analog to digital converter (ADC) sampling rate used to capture the Doppler signal.

Slant range

The distance from the observer to the object taking the height into account.

Slave

The slave data is used when the radar is in slave mode and refers to pointing information received from an external source.

SL-xxxxxyyy

Strip Line antenna radar system; where the xxxxx denotes power and gain configuration and yyy specific options for the radar system.

SL-B

A bi-directional RS-422 connection typically used with optical platforms. The protocol handles encoder values and pointing commands between the Range Processor and the platform servo system. The packets are synchronized to the IRIG-B clock.

Sliding fit

A polynomial based smoothing/interpolation of the observed data. Sliding means that a new set of polynomial coefficients are calculated for every time step.

SNR

Signal to Noise Ratio. The ratio between the detected signal power and the noise power density integrated over a fixed bandwidth usually one Hz.

SOT

Single Object Tracking: the algorithm that detects and tracks one object in the received signal. Actually a special version of the MOT with the restriction that only one track is allowed at the time.

Spherical

Like the surface of a ball. The spherical coordinate system is the 3-dimensional equivalent to the polar (2-dimensional) coordinate system.

Spin

Rotation around the main body axis.

SSB mixer

Single Side Band mixer: an equivalent to the IQ Mixer, but with only one output, where either the frequencies above or below the mixer frequency have been suppressed.

Systran

An optical interface board transmitting or receiving Doppler data.

TC

Tracking Controller: the system controlling the pointing of the radar.

Tilt

The same as mis-level.

TLE

Two Line Element set. A two line description of a satellite trajectory. TLE’s for all major satellites are available from e.g. http://www.celestrak.com/.

Tracking Controller

The system controlling the pointing of the radar.

Tracks

Fragments of one or more trajectories observed in the received data.

Trigger

En event that starts the measurement process.

TRJ file

Trajectory file.

TRK file

Track file. This file holds the results from a MOT processing.

Trunnion

A cylindrical projection on each side of a piece, whether gun, mortar, or howitzer, serving to support it on the cheeks of the carriage.

Tx

Acronym for Transmit, usually referring to the transmitter part of the radar.

UART

Universal Asynchronous Receiver / Transmitter, an internal serial port device.

Unambiguous range

The maximum range where the distance to the object is determined without ambiguity.

UTC

Coordinated Universal Time (UTC) is the international time standard. It is the current term for what was commonly referred to as Greenwich Meridian Time (GMT). Zero (0) hours UTC is midnight in Greenwich England, which lies on the zero longitudinal meridian.

UTM

The Universal Transverse Mercator grid system.

VTI

Velocity Time Intensity. A graphical representation of the Doppler signal showing time on the x-axis and object velocity on the y-axis. Each dot in the plot is a color coded signal strength indicator for that specific time and velocity.

W-1000

A device that records Doppler data during the measurement, also called an Analyzer.

W-2100

A device that records Doppler data during the measurement, also called an Analyzer.

W-700

A device that records Doppler data during the muzzle velocity measurement, also called an Analyzer. Part of an MVR system.

WDP

Weibel Data Protocol. The protocol is used before and during the measurement for communication between the RTP-2100, the IC-2100 running WinTrack and the AP-2100.

WinDopp

Weibel user software used for controlling the velocity radar system and processing and evaluating measured data.

WinTrack

Weibel user software used for controlling the tracking radar system and processing and evaluating measured data.

Work file

A file holding results from processing original Doppler data files and antenna pointing data.

WRK

Same as work file.

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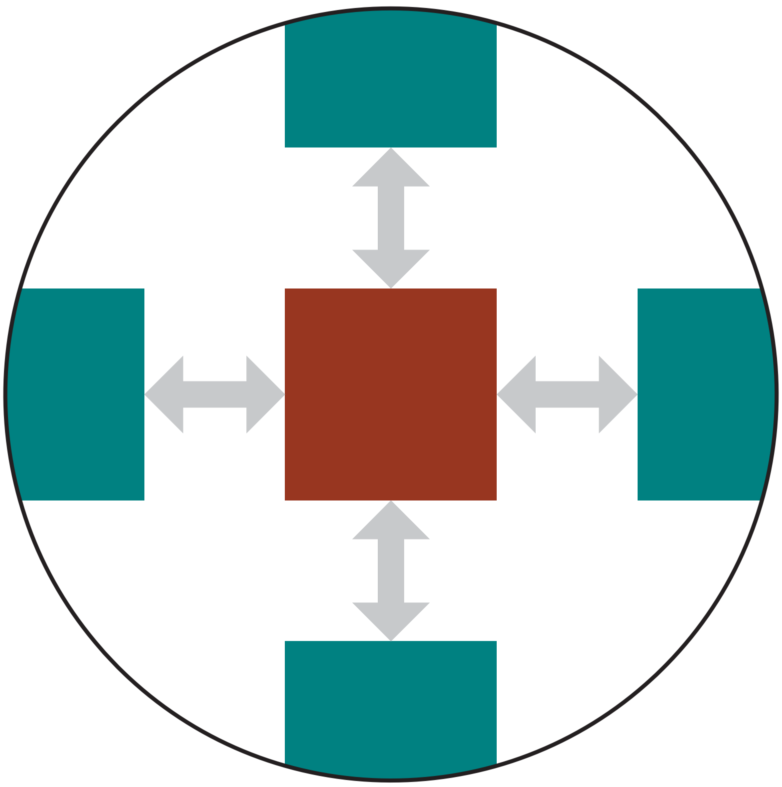
WEIBEL
DOPPLER RADARS

Weibel Scientific

Solvang 30
3450 Allerød
Denmark

Installation & Maintenance Guide

PS-800



UG-3175 1.0

DISCLAIMER

Contents

1 Introduction

1.1 PS-800 Overview

The PS-800 is a 15V power supply used for the MSL range of Doppler Radars. It supplies voltage to a range of antennas for instance the MSL-30031.

1.2 Change History

Version	Date	By	Comment
1.0	2013-07-11	MRN	First release.
1.0	2013-10-15	MRN	New dimensions

1.3 PS-800 Background

The Power supply converts to the correct voltage for the radar and its equipment.

2 Install the Power supply

2.1 Overview

Follow the instructions provided with the equipment to ensure safe and reliable operation.

2.2 Unpack the System

When you receive the tracking system please inspect the shipping boxes for any damage. Carefully open and remove the equipment and the accessories and keep the boxes for future use.

If any of the boxes is damaged during transportation, check the equipment for any visible signs of damage. If any damage is detected, please contact Weibel as soon as possible.

2.3 Mount the Power Supply

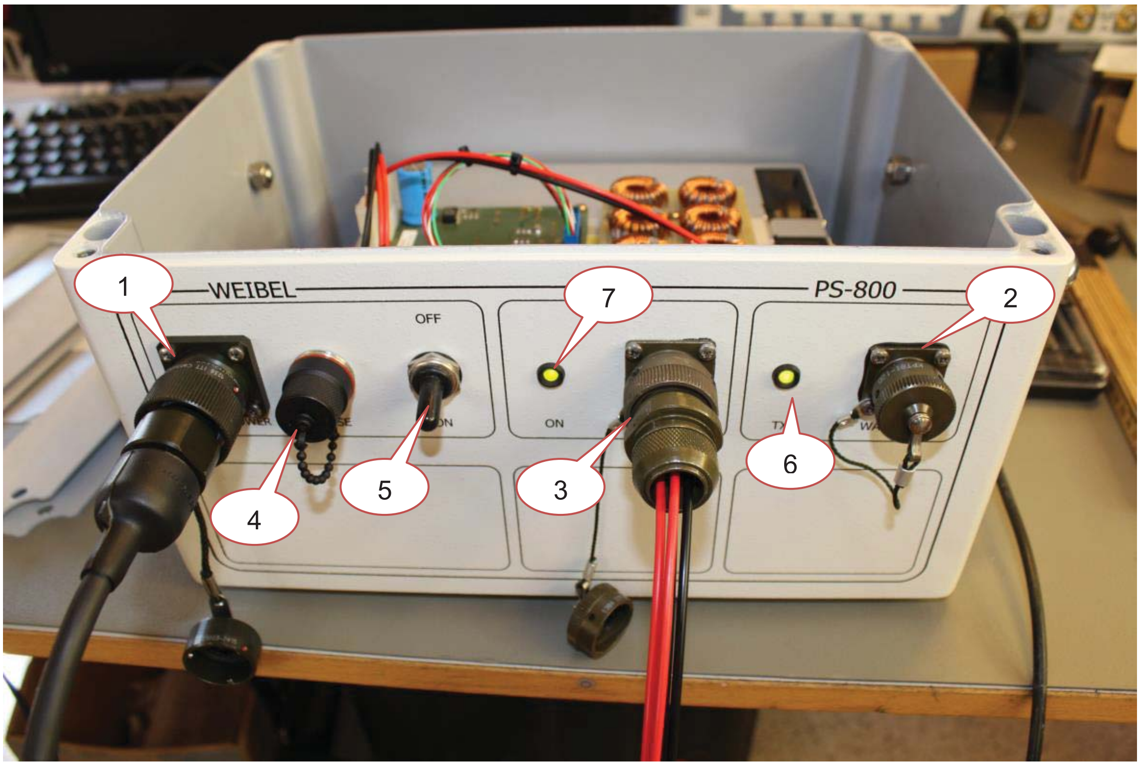
The PS-800 power supply is designed to be placed next to the radar on the ground. It should be protected from direct water exposure.

Make sure that nothing is blocking the free airflow to and from the power supply to avoid overheating.

3 Connectors & Indicators

3.1 Connector Overview

In this section the external connectors and indicators of the PS-800 Power supply are described.



Number	Description
1	Antenna Power (page 6)
2	Warning Device (page 6)
3	External Power line in (page 6)
4	Fuse (page 7)
5	Power Switch (page 7)
6	Ant. Power LED (page 7)
7	PS-800 Power LED (page 7)

The connector pin layouts are described in the tables in the follow parts.

3.1.1 Antenna Power

Type: CANNON14-22F

Pin number	Description
A	+15V
B	GND
C	GND
D	+15V
E	Warning device control

3.1.2 Warning Device

Type: CANNON12-3F

Pin number	Description
A	Not connected
B	+12V
C	GND

3.1.3 External Power line in

Type: CANNON16-3M

Pin number	Description
1	GND
2	Phase
3	Neutral

3.1.4 Fuses

Use 10A or 5A for input voltages of 110VAC or 220VAC, respectively.

3.1.5 Power Switch

Main power input.

Power switch turns ON / OFF the entire power supply for the system.

3.1.6 LEDs

LED	Description
Power	Lights GREEN if Main power ON
Ant. Power LED	Lights GREEN if Antenna power ON (Transmitting)

4 Physical Dimensions

4.1 Overview

This chapter covers the physical dimensions for the Power Supply

4.2 Size and Weight

Type	Dimension (HxDxW)	Weight
PS-800	190mm x 262mm x 358.4mm (Handles in) 190mm x 262mm x 416mm (Handles out)	9 kg

4.3 Power

Type	Input voltage	Output
PS-800	110VAC or 220VAC Max. 1000W	15VDC Max 900W

4.4 Environmental Conditions

All versions of the Power Supply are designed for the following environmental conditions:

Condition	Value
Storage temperature	-40ºC - +65ºC
Operating temperature	-20ºC - +55ºC
Relative humidity	0 – 100%

5 Maintenance

5.1 Maintenance Schedule

Interval	Maintenance
Every month	Spray external electrical connectors.

5.1.1 Clean the Power Supply with Fresh Water

When the Power Supply is close to the sea, e.g. on a ship or on the pier use a garden hose with clean water (Without salt) and clean the Power Supply on a regular basis (remember to tighten the connector caps and have the power disconnected). If the Power Supply is very dirty you can use a little Auto shampoo.

5.1.2 Spray Connectors with WD40

Spray all external electrical connectors with WD40.

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