QUICKWAVE 2013

SOFTWARE FOR ELECTROMAGNETIC DESIGN AND SIMULATIONS

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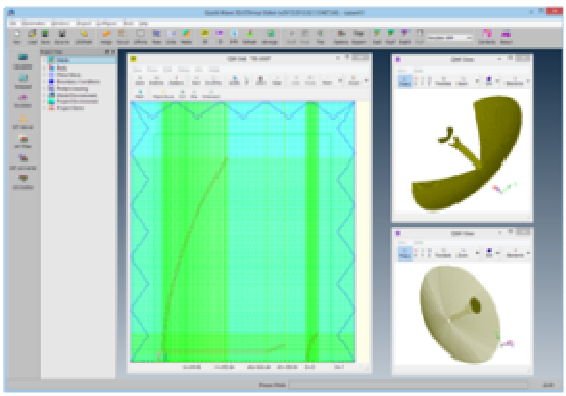
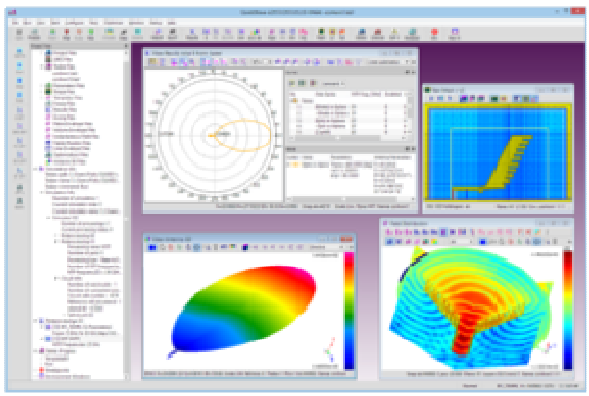
QWED has continued efforts on extending functionality of the QuickWave software for electromagnetic design as well as the scope of its applications. With the introduction of QuickWave 2013 we expand the possibilities with fast and easy project design, fast and accurate simulation and more flexible user interface.

The major requirements of microwave engineers during the design are to have a convenient way to import geometrical data from mechanical CAD software, setting a few simulation parameters and obtaining the results in a reliable time. QWED adjust the development of the QuickWave electromagnetic software to fulfil these needs. An improved *QW-AddIn for Autodesk® Inventor®* Software, very popular and wide-spread mechanical tool, allows defining complete electromagnetic simulation directly in the mechanical data environment.

The speed of simulation is an important issue. Multiprocessor/Multicore and GPU versions of *QW-Simulator* allow very fast simulations of large real-life problems with very high accuracy of the simulation results.

In QuickWave 2013 version we also focused on the comfort using the software introducing a lot of options for user interface adjustments.





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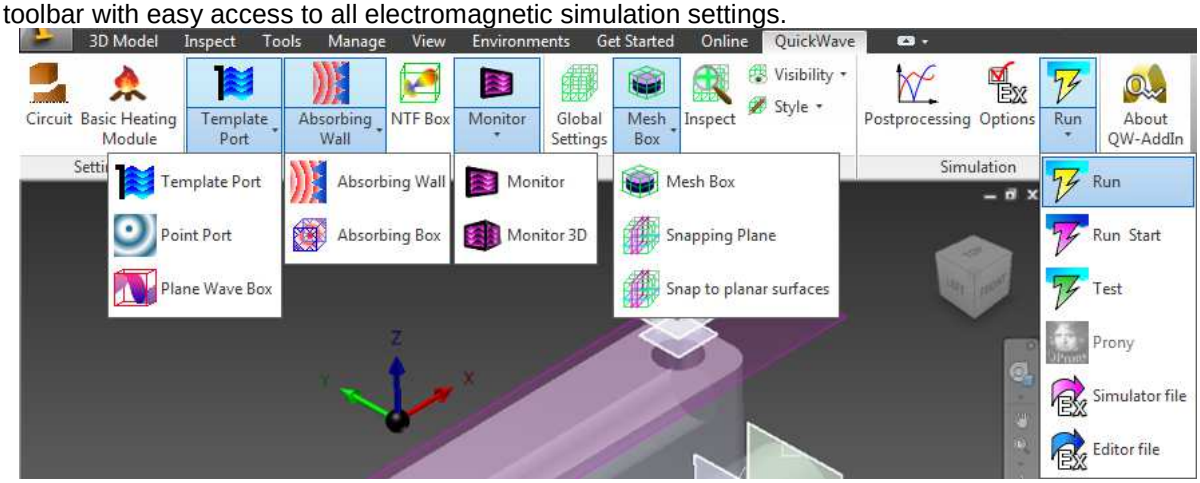
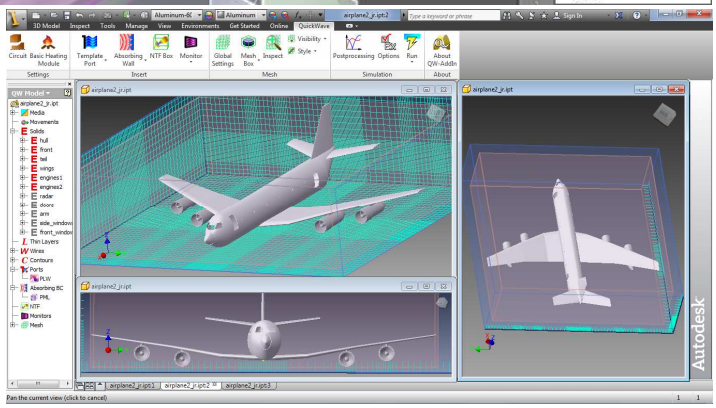
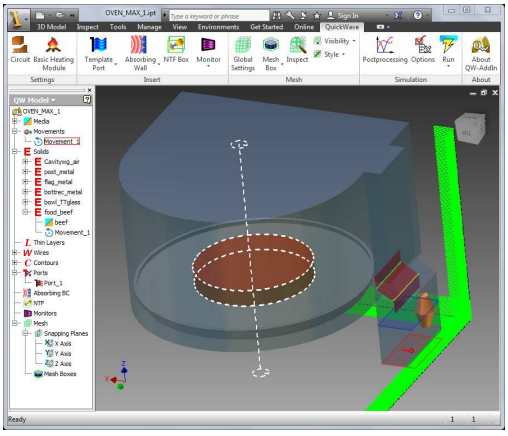
QW-AddIn For Autodesk® Inventor® Software

QW-AddIn for Autodesk® Inventor® Software, a wide-spread mechanical tool, allows defining a complete electromagnetic simulation directly in the popular mechanical data environment. It allows defining a complete electromagnetic simulation directly in the popular mechanical data environment. *QW-AddIn for Autodesk® Inventor® Software* uses a plug-in architecture to bind with CAD environment and allows geometry changes in the CAD model without re-defining electromagnetic parameters. All simulation parameters (boundary conditions, mesh settings, ports, postprocessings) can be set directly in the Autodesk® Inventor® Software using very convenient and well known dialogues from QuickWave interface. QW-BHM module settings as well as the rotation definitions are also possible. Set of self explaining QuickWave-3D like dialogues provides very convenient tool for settings of electromagnetic properties such as assigning the materials, adding ports and boundary conditions, setting excitation parameters and postprocessings etc. After that, just click to start the simulation.
QW-AddIn for Autodesk® Inventor® Software will appear in Autodesk® Inventor® as an additional toolbar with easy access to all electromagnetic simulation settings.





Airplane project in Autodesk® Inventor® with planewave, absorbing boundary and mesh defined.



Commercially available Whirlpool-Max microwave oven project in Autodesk® Inventor® with port, rotation and mesh defined.

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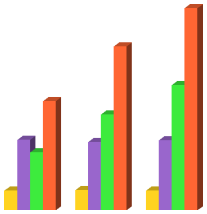
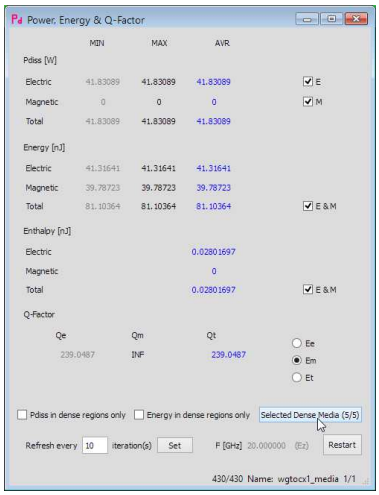
QW-GPU SIMULATOR

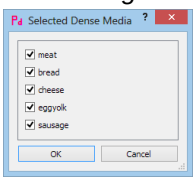


QW-GPU Simulator is an OpenCL language implementation of *QW-Simulator* designated for massive parallel computing hardware, which can be executed on modern graphic cards (GPUs). Acceleration by approximately a factor of 10 for 3D examples and of 20 for V2D examples has been observed, with respect to multithread implementations run on comparably modern CPUs. SMN Multi simulator postprocessing is available in QW-GPU Simulator and more time efficient calculations for Field Monitor 3D postprocessings.

POWER, ENERGY AND Q-FACTOR



Upon the *View-Power&Q* command, the *QW-Simulator* starts searching for time-maximum and time-minimum values of power dissipated and energy stored in the circuit. At each time-step it integrates (over the whole circuit) power and energy. At the iteration when the window is open, it sets the maximum and minimum values of all quantities to their current values. Then at the iteration it re-calculates their maxima and minima, and presents the results in the *Power, Energy&Q-Factor* window. Clicking the *Selected Dense Media* button allows selecting in the *Selected Dense Media* dialogue which dense media will be used in *Pdiss* (if *Pdiss in dense regions only* option is ON) and/or *Energy* (if *Energy in dense regions only* option is ON) calculations.

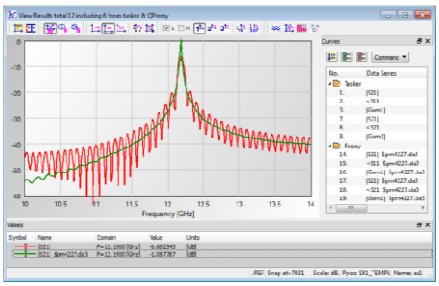


New tasker commands and Breakpoints were added:

Save_Pdiss_Energy_QF_ReIm_Media – power, energy and Q-Factor on real/imaginary grid and specified media will be saved to the text file.

Save_Enthalpy_ReIm_Media – enthalpy on real/imaginary grid and specified media will be saved to the text file.

QPRONY MODULE

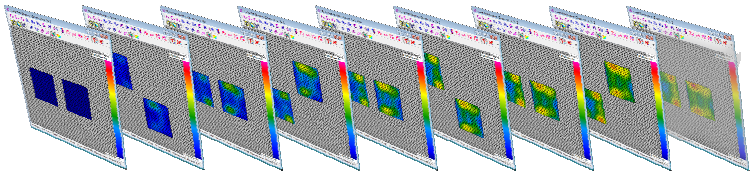


QProny module assists the users of QuickWave-3D in the analysis of high Q structures using very efficient digital signal processing techniques allowing reducing the simulation time. It uses one of the most robust signal processing techniques known as the Generalised Pencil of Function Method (GPOF). New improved 64-bit *QProny* module allows faster and more accurate creating of the simulation results.

BASIC HEATING MODULE

QW-BHM (Basic Heating Module) for QuickWave provides a novel regime of operating the FDTD solver, with modification of media parameters as a function of dissipated energy. It also allows modelling of load rotation, load movement along arbitrary trajectories, facilitates heat flow analysis through the additional *QW-HFM* module, bilaterally coupled to the EM analysis, provides a regime of automatic tuning of the source to the deepest in-band resonance and allows source parameters changing (frequency, amplitude and phase) separately for each source.

Movement was facilitated in the *xy*-plane along a piecewise linear trajectory. Starting from version 2013, movement is available also in *xz*-plane and *yz*-plane.



New *Heat Flow Module* (also in OMP and x64 version) integrated with *QW-Simulator* allows faster heat flow simulations also taking into account divided cells (without boundary conditions).

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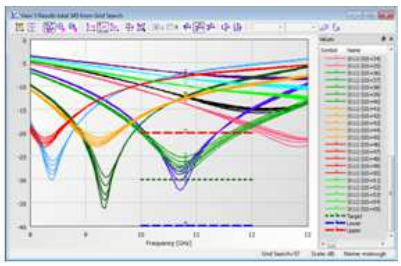
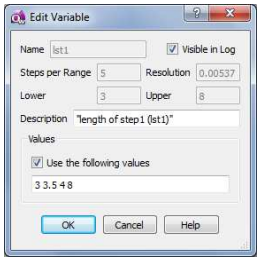
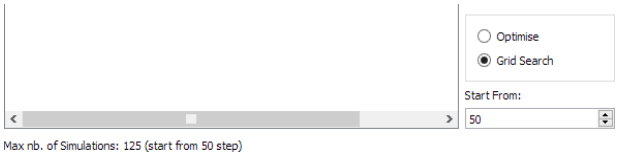


OPTIMISATION AND PARAMETERS SWEEP

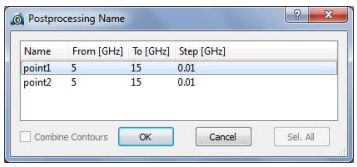
Parameters sweep (grid search) may be a good choice as an indication of good starting point for further use of Optimisation. Instead of setting steps per range for each enabled variable the user defined values can be used. After checking *Use the following values* in the *Edit Variable* dialogue the user can enter new values which will be used in Grid Search.



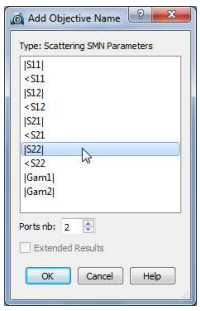
Parameters sweep can be started from specified number of step.



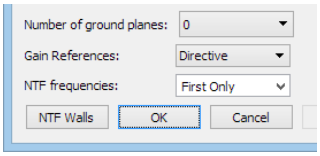
Optimisation or grid search can be performed for selected FD-Probing postprocessing which can be chosen from the postprocessing list. If there is no chosen postprocessing, the optimisation or grid search will be performed for the first one.



Scaterring SMN Parameters objective allows to optimise or parameters sweep for full S-Parameters matrix.



Radiation pattern frequency, at which the antenna characteristics will bee calculated, can be used as a parameter for optimisation or parameters sweep. During *Radiation* Pattern objective configuration, the *First Only* keyword should be introduced in the *NTF frequencies* position in the *Radiation Patterns* dialogue.



Always generate templates option allows controlling template calculations in every simulation during optimization or grid search. If this option is OFF, the template is generated only if the template file *.tpl does not fit the actual size of the port.

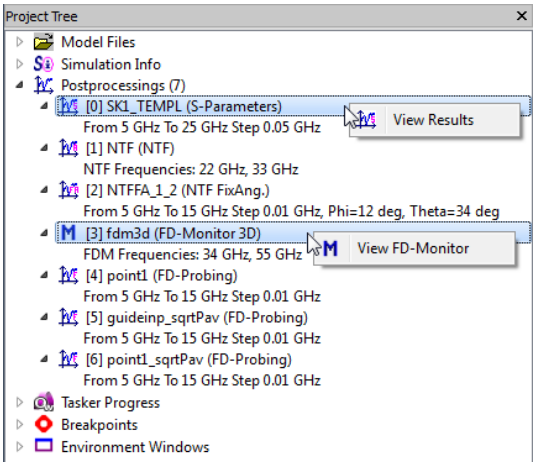
New <*OPTITERATIONS*> variable, which contains the current number of optimisation or parameters sweep iterations, can be used as an indicator for saved results files.

Γ AT REFERENCE PLANES

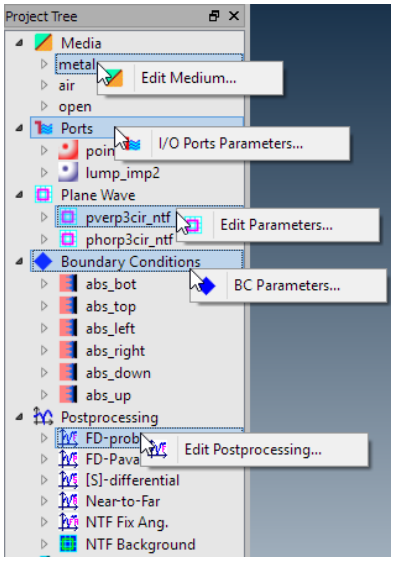
New "*Gamma K at ref. planes*" S-Parameters postprocessing allows computing reflection coefficients **Γ** at several reference planes simultaneously during a single simulation run. It can be applicable when a multi-source network is considered with all the ports operating as sources simultaneously and, consequently, the scattering matrix cannot be computed.

PROJECT TREE

Project Tree in *QW-Simulator* is a dockable window containing information about the current project, simulation and available postprocessings, which displayed in a tree style. Simulation results from the selected postprocessing can be viewed by clicking right mouse button on the selected postprocessing and selecting *View Results* or *View FD-Monitor* from the context menu.



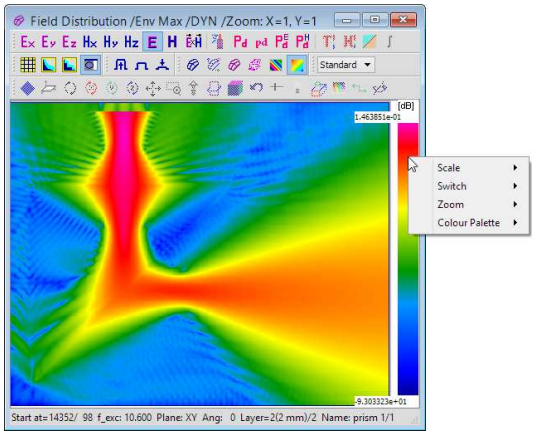
Project Tree in *QW-Editor* is a dockable window containing information about the current project. It includes defined media, ports and lumped impedances, boundary conditions and postprocessings. An appropriate parameters can be changed by clicking right mouse button on the selected property and selecting the command from context menu.



SYSTEM TRAY NOTIFICATIONS

The *QW-Simulator* icon will be visible in the system tray and also errors and some information will be displayed near the system tray for 5 seconds. The tooltip for the icon contains version number of QuickWave and the name of actual project. After clicking right mouse button the context menu will appear. This option is set to ON by default and can be changed in the *Configure->Preferences* dialogue by selecting/unselecting *Use system tray for notifications* option.

VIEW FIELDS AND VIEW MONITOR WINDOW

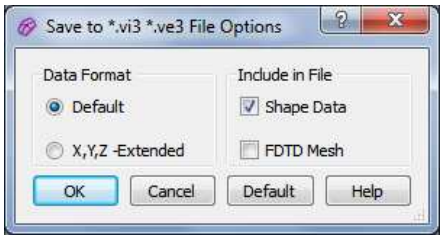


QW-Simulator allows dynamic monitoring of field distributions, on surface, thermal or vector display, during time-domain simulations with any kind of excitation. For such monitoring no special arrangements are needed before launching the simulation. The user can decide at any time of the simulation: which fields are of interest, what kind of displays he prefers and how many windows he wants to open.

Time domain displays are very useful and flexible but they are most informative with a sinusoidal excitation at a particular frequency. Thus one frequency can be thoroughly investigated at a time. *QuickWave* allows also watching the field distributions at selected frequencies from data extracted by Fourier transforming of the results of simulation obtained with pulse excitation. Such a postprocessing is called *FD-Monitoring*.

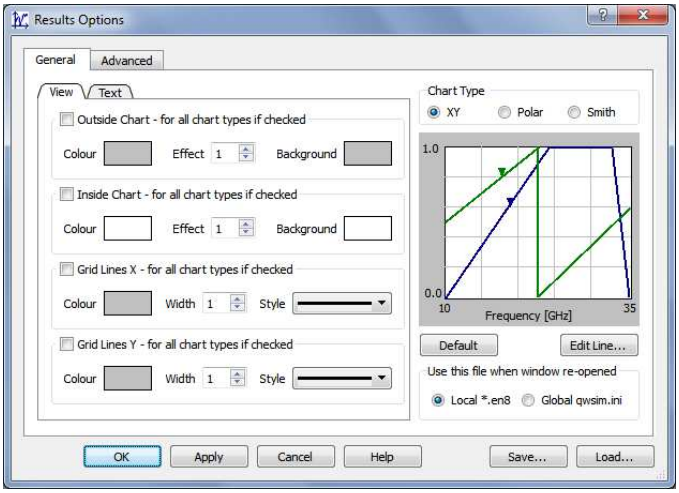
Each type of display has dedicated options which can be easily accessed from context menu after right mouse click on the colour bar. Display can be switched to isotropic view and transparency of the project structure can be set. 3D Monitor fields can be displayed in whole structure or in box limited by the shape of the monitor. Clicking *Save->Save All Components* option or pressing **U** allow saving all components for all monitors and frequencies to separate files in the subdirectory.

Options for choosing data format, include FDTD mesh in a vector form, include shape data while saving volume instantaneous and volume envelope fields allow to include additional information in the *.vi3 and *.ve3 files. For big projects, for instance, and in the case of a lot of *.vi3 or *.ve3 files it is recommended to not include shape data in the file. Instead of the shape data, the path to the common file with shape information will be added. This solution makes fields files much smaller and is used by default with *Save->Save All Components* for 3D Monitors. FDTD mesh information in a suitable vector form can be also included in the file.

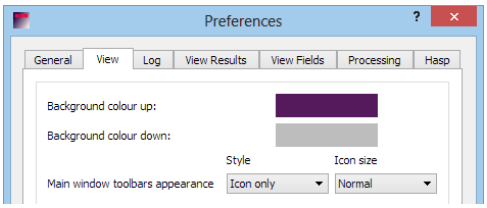


VIEW RESULTS WINDOW

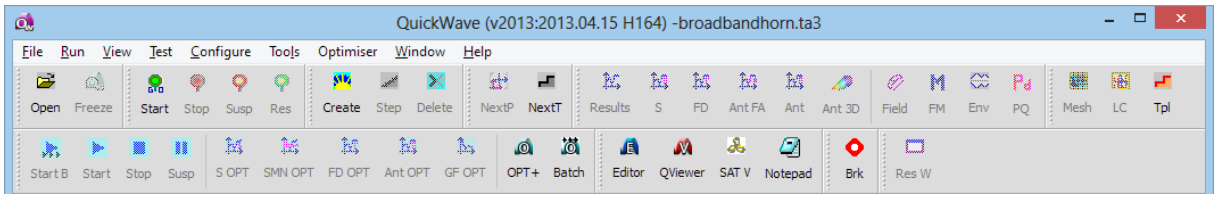
View Results window allows observing frequency or angle dependent characteristics: S-Parameters, FD-Probing, FD-Pavailable, radiation patterns and antenna fixed angle results. Also saved results from file can be viewed or loaded as a reference. Multiple files can be selected for Load Reference and SWR can be calculated for results from file. New reorganized *Preferences* dialogue allows adjusting window appearance (colours, grid lines, turn on/off the chart legend etc.) and saveing/loading the layout to/from the *.lr3 file. Number of decimal places for displaying values and domain can be also set, but values lower that 1E-4 will be displayed with full precision.

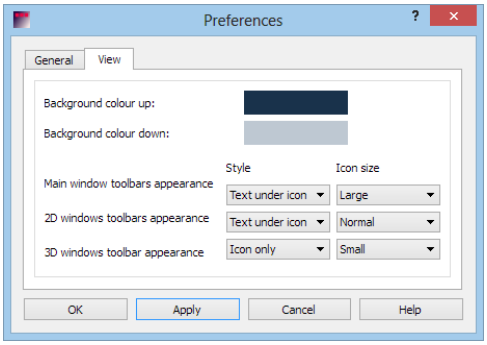


GRAPHICAL USER INTERFACE ADJUSTMENTS

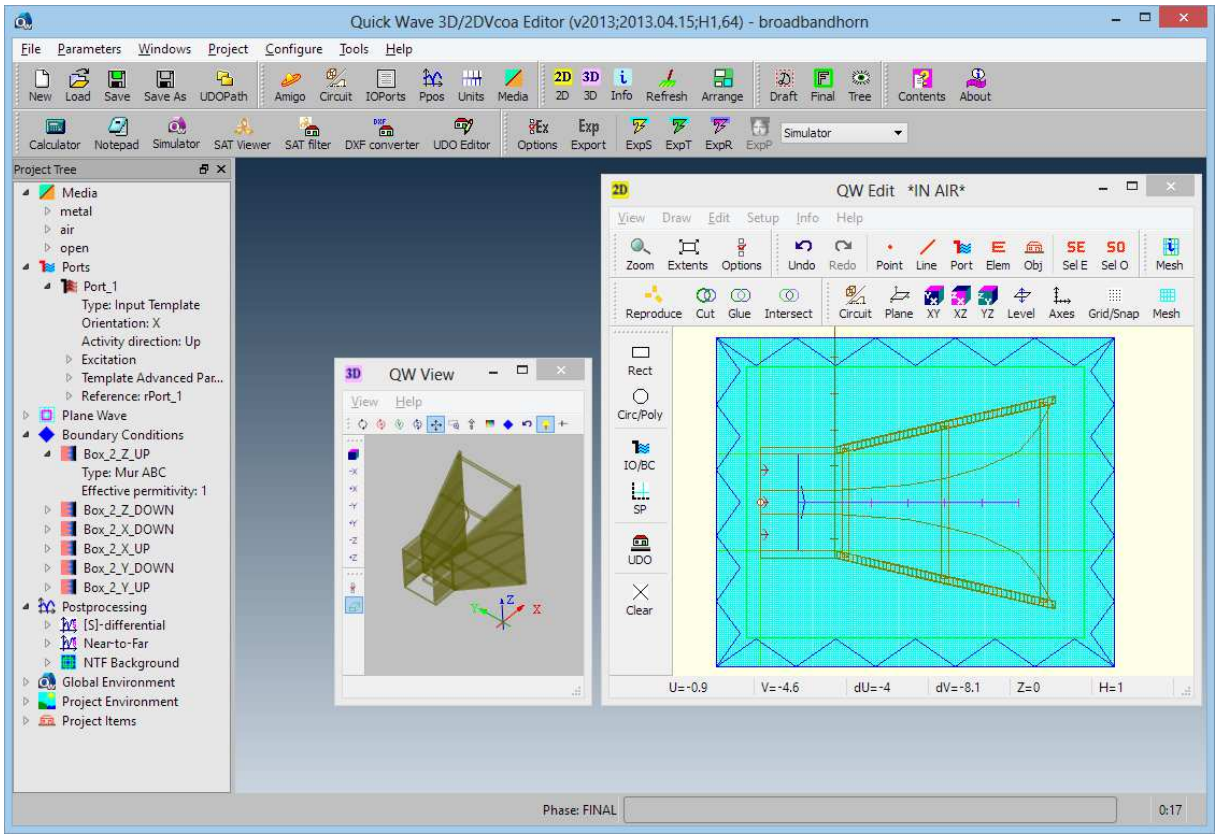


Main window toolbar appearance and background colour (solid or gradient) can be adjusted in the *QW-Simulator*.





The toolbars in 2D and 3D windows as well as main window toolbar appearance and background colour (solid or gradient) can be adjusted in the *QW-Editor*.



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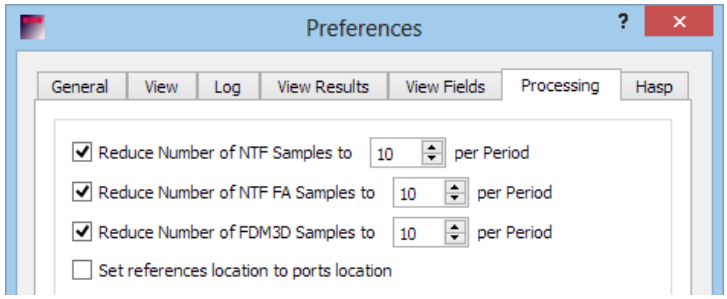
PREFERENCES

In the *Configure->Preferences* dialogue, the user can change the settings for *QW-Simulator* that will be applied in all analyses. Options in the *Processing* section was changed and new *Hasp* section will appear.



The *Processing* section contains settings for *NTF, NTF FA and FDM3D* postprocessings.

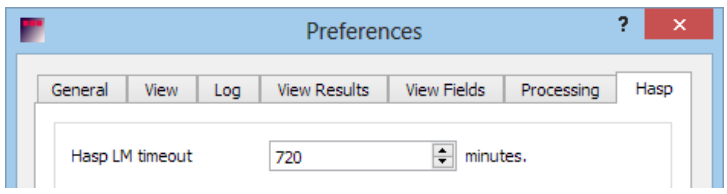
Reduce Number of NTF Samples to N per Period - if this option is OFF, fields at the NTF surface are sampled at every FDTD iteration, and Fourier-transformed with FDTD time step *dt*. If this option is ON, and the number of FDTD iterations per period T_{min} at the highest NTF frequency is equal 2**N* or higher, the sampling rate is reduced. Fields are sampled every *M*th FDTD iteration, where *M*=int(T_{min} / (*N***dt*)), and Fourier-transformed with NTF time step of *M***dt*. This option is ON by default and the default value of N is 10.

Reduce Number of NTF FA Samples to N per Period - if this option is OFF, fields at the NTF FA surface are sampled at every FDTD iteration, and Fourier-transformed with FDTD time step *dt*. If this option is ON, and the number of FDTD iterations per period T_{min} at the highest NTF FA frequency is equal 2**N* or higher, the sampling rate is reduced. Fields are sampled every *M*th FDTD iteration, where *M*=int(T_{min} / (*N***dt*)), and Fourier-transformed with NTF FA time step of *M***dt*. This option is OFF by default and the default value of N is 10.

Reduce Number of FDM3D Samples to N per Period - if this option is OFF, fields are sampled at every FDTD iteration, and Fourier-transformed with FDTD time step *dt*. If this option is ON, and the number of FDTD iterations per period T_{min} at the highest FDM3D frequency is equal 2**N* or higher, the sampling rate is reduced. Fields are sampled every *M*th FDTD iteration, where *M*=int(T_{min} / (*N***dt*)), and Fourier-transformed with FDM3D time step of *M***dt*. This option is OFF by default and the default value of N is 10.

Please note that the maximum excitation frequency is also taking into account with the *Reduce Number of NTF Samples to N per Period*, *Reduce Number of NTF FA Samples to N per Period* and *Reduce Number of FDM3D Samples to N per Period* options. If the excitation is delta, step pulse or user pulse excitation these options will be internally off (even if they are ON) and fields will be sampled at every FDTD iteration.

Set references location to port location - if this option is OFF, the S-Parameters results displayed in the View Results window are calculated at original port reference location. If this option is ON, the references are virtually moved to the port location. References location can be virtually changed to any new location via *Reference* command in the *View Results* window.



The *Hasp* section settings contains settings for HASP Licence Manager. *Hasp LM timeout* option allows set the idle-time (in minutes) for HASP Licence Manager. Running *QW-Simulator* during FDTD processing accesses the HASP Net at least every 5 minutes. For other calculations in the *QW-Simulator* it can happen that duration between accesses will be longer than 5 minutes. Default idle-time is set by HASP License Manager and is equal 12 hours. Leaving default idle time (12 hours) can cause blocking of the license for about 12 hours especially after computer unexpected reset etc. so it will be good to set this idle-time shorter. Too short idle-time can cause however that simulator will lose license during normal operation.

FDTD MESH

The conformal FDTD meshing of the circuit is performed in the *QW-Editor* automatically but it is controlled by the user. The user can chose the basic cell size, which determines the accuracy on one hand, and the computer time and memory needed for the simulations on the other hand.
Very useful mechanism for mesh settings is *Mesh Box* introduced in QW-AddIn for Autodesk® Inventor® Software, which allows setting cell size in the selected area. The maximal allowed cell size inside the box can be set and different values can be given for each axis. It is also possible to disable mesh modification along chosen axis.
Automatic mesh settings are performed by *Automatic Meshing Intelligent Generation Option* (*AMIGO*) included in *QW-Editor*. Firstly, it optimises the meshing so as to provide requested wavelength resolution in all media, while avoiding unnecessarily small cells. Secondly, it allows fast setting of frequency ranges for all ports as well as *S-differential*, *FD-Probing*, and *FD-Pavailable* postprocessings. Additionally, it shows useful information about: details of structure definition that cannot be modelled within requested mesh constraints, time step forced by the current mesh, and expected duration of the analysis. It also allows setting automatic stop criteria.

Mesh generation improvements introduced in *QW-Editor* allows faster and more accurate mesh generation for divided cells. New mesh control tools, *Warnings Info* dialogue and possibility of displaying structure view in the Test Mesh window in *QW-Simulator*, allows controlling mesh setting and generation process.

OTHER IMPROVEMENTS

1. Plane wave box allowed in an arbitrary isotropic dielectric medium.
2. Dispersive media allowed in V2D (template ports).
3. Dissipated power density for V2Dcoax examples calculation correction.
4. Speeding-up in redrawing in 2D QW-Edit window.
5. Isotropic view in 3D QW-View window.
6. Icon view in UDO Pane.
7. Postprocessing information is displayed for point source/probe in the *Select Element* dialogue in Status column in *QW-Editor*.
8. Information about lumped impedance (type and component) is displayed in the *Select Element* dialogue in Status column in *QW-Editor*.
9. Layer geometry info in status in *View Fields* window in *QW-Simulator*.
10. More detailed information displayed in *Log* window (postprocessing information, excitation information, circuit type) in *QW-Simulator*.