Getting Started with
SES Software Packages

SES

REVISION RECORD

Date	Version Number	Revision Level
September 1996	1	0
October 1996	1	1
December 1997	2	0
December 1998	7	0
January 1999	7	1
January 2000	8	0
September 2000	9	0
November 2002	10	0
May 2004	11	0
February 2007	13	0
June 2009	14	1
July 2011	14	2
January 2012	14	3
August 2017	16	0
February 2019	16	1
December 2019	16	2

SPECIAL NOTE

As SES software is constantly evolving, with frequently created updates, minor discrepancies may appear between this How To manual illustrations of the software interface and the present software version interface. These differences are cosmetic in nature and do not impact the validity of the guidance and procedures provided herein. Furthermore, small differences in the reported and plotted numerical values may exist due to continuous enhancements of the computation algorithms.

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1   Introduction

1.1   Intended Readers

This manual is intended for all users of SES software, i.e., the CDEGS software package and its sub-packages (AutoGround, MultiGround, MultiLines, and MultiFields), and all other fully integrated software packages (Autogrid Pro, AutoGroundDesign, CorrCAD, Right-of-Way, SESEnviroPlus, SESShield-3D, and SESTLC) and associated tools running on Microsoft Windows (Windows 7, 8 and 10). Note that this manual uses the brand name CDEGS to designate all SES's software packages. CDEGS stands for "**C**urrent **D**istribution, **E**lectromagnetic fields, **G**rounding and **S**oil structure analysis."

1.2   Objective of this Manual

The objectives of this manual are threefold:

- Introduce you to SES's software packages and tools.
- Show you how to use SES software in the Windows environment.
- Guide you through the most pertinent documents included in the documentation that comes with SES software.

1.3   Organization of this Manual

This manual is organized as follows:

Introduction:

Chapter 1   Introduces SES software, its structure, available documentation and technical support.

Getting Started:

Chapter 2   Describes the capabilities and features of all software packages, software tools and utilities and describes briefly how to start all SES's software packages.

Using the CDEGS Group of SES Software:

Chapter 3   Describes how to start the CDEGS group of software packages.

Chapter 4   Describes how to use the various input data processors in order to specify and visualize the system data of the CDEGS group of software packages.

Chapter 5   Describes how to process your case in order to carry out the required computations of the CDEGS group of software packages.

Chapter 6   Describes how to report and display the computation results using the various output data processors of the CDEGS group of software packages.

References:

Chapter 7	Refers you to the manuals and guides which include complete tutorials depicting comprehensive and realistic engineering problems.
Chapter 8	Presents the default file naming conventions and default file assignments applicable to the software environment.
Chapter 9	Describes the functions and main features of the computation modules.

1.4   What's in the Professional and Demo Versions

There are no differences between the demo version and the professional licensed version except for the capability of analyzing cases other than those provided in the SES's software distribution media. All the required input and output files generated by the software for all the examples referred to in the "**How To…**" engineering manuals are available and can be explored in detail. This can be carried out easily by following one of these manuals. For example, if you are using the AutoGround or MultiGround software package, the **GROUND.pdf** manual entitled "A Simple Substation Grounding Analysis" should be referred to in order to learn MultiGround and have a complete demonstration of its capabilities.

Therefore, users of the demonstration version can indeed perform all of the steps outlined in the "**How To…**" engineering manuals, including generation of graphs and reports from the pre-run sample cases provided.

1.5   Essential Software Documentation and Support

Using the Documentation Effectively

For installation and general information on the software, etc., please refer to the printed documents that are included in the software box. A PDF copy of all the documents is also included on the SES's software distribution media. For example, for software installation, refer to the **\PDF\Installation_Guide.pdf** file on your SES's software distribution media (a printed copy is provided in the software box).

If you are a first-time user, we recommend that you read the "**How To…**" engineering manuals suggested below for each software package. For example, for the AutoGround or MultiGround software package, refer to the tutorial entitled **"A Simple Substation Grounding Analysis."** This document is available as a PDF file on the SES's software distribution media (**\PDF\HowTo\GROUND.pdf**). If you need help during a session, context-sensitive online help is available to provide you with fully detailed information about specific commands or options. *Just press the F1 key.*

Extended Distribution Media Documentation & Online Help

An extensive online technical help reference is available by default to all SES's software users. In addition, the "**How To…**" engineering manuals are available on the software distribution media in PDF format.

Telephone/Fax/E-Mail Assistance

SES's specialists are available to answer your questions on weekdays from 8:00 A.M. to 7:00 P.M. Eastern Time. Do not hesitate to ask for help in:

- Installing or running the software.
- Understanding the input data or engineering concepts related to each software package or defining appropriate computer models to study your problems.

For more extensive help, SES organizes regular training seminars and can provide training at your site. Call us or send us emailsfor more details.

Toll Free:	(800) 668-3737
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Click this link www.sestech.com/or type it in your browser for an up-to-date list of our international toll-free numbers.

2   Starting SES Software
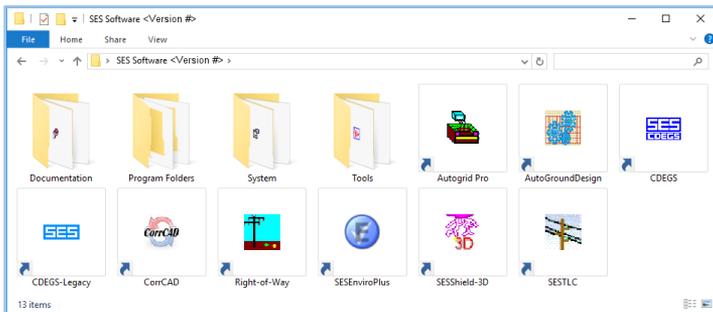
2.1   Introduction

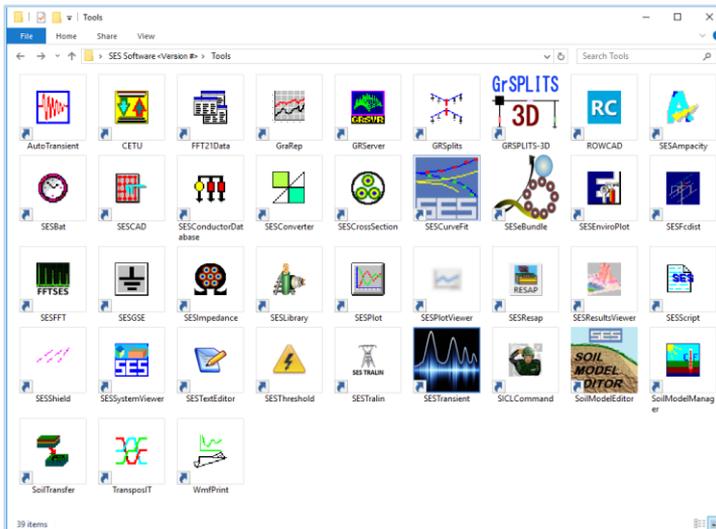This chapter describes how to start a session using the various environments available on a PC.

2.2   Description of the SES's Software Folder Icons

Once the installation is complete, you will be able to find the following SES software folders in the **Start | Programs** menu.

Main Folder:

Subfolder Tools:

In the **SES's software** *<Version#>* group folder, where *<Version#>* is the version number of the software, you should see the icons representing **AutoGrid Pro**, **AutoGroundDesign**, **CDEGS**, **CDEGS-Legacy, CorrCAD, Right-of-Way**, **SESEnviroPlus**, **SESShield-3D**, and **SESTLC** software packages, as well as four folders. The **Documentation** folder contains help documents for various utilities and software packages. The **Program Folders** provide shortcuts to documents, installation and project folders. The **System** folder allows you to conveniently set up software protection (security) USB keys. Various utilities can be found in the **Tools** folder. The main function of each software package and utility is described hereafter.

2.3   Software Packages

➢ **AutoGroundDesign** offers powerful and intelligent functions that help electrical engineers design safe grounding installations quickly and efficiently. The time devoted to design a safe and also cost-effective grounding grid is minimized by the use of fully automated techniques and appropriate databases. This module can help reduce considerably the time needed to complete a grounding design.

➢ **AutoGrid Pro** provides a simple, integrated environment for carrying out detailed grounding studies. This package combines the computational powers of the computation modules RESAP, MALT, and FCDIST with a simple, integrated and largely automated interface.

➢ **Right-of-Way** is a powerful integrated software package for the analysis of electromagnetic interference between electric power lines and adjacent installations such as pipelines and communication lines. It is especially designed to simplify and to automate the modeling of complex Right-of-Way configurations. The Right-of-Way interface runs the TRALIN and SPLITS computation modules and several other related components in the background.

➢ **SESEnviroPlus** is a sophisticated program that evaluates the environmental impact (radio interference, audible noise, corona losses, and electromagnetic fields) of AC, DC or mixed transmission line systems.

➢ **SESShield-3D** is a powerful graphical program for the design and analysis of protective measures against lightning for substations and electrical networks. Its 3D graphical environment can be used to model accurately systems with complex geometries.

➢ **SESTLC** is a simplified analysis tool useful to quickly estimate the inductive and conductive electromagnetic interference levels on metallic utility paths

such as pipelines and railways located close to electric lines (and not necessarily parallel to them). It computes the magnetic and electric fields of arbitrary configurations of parallel transmission and distribution lines. Finally, it can also compute line parameters.

➢ **CorrCAD** tackles a large variety of cathodic protection design tasks and related issues, onshore and offshore, and can also predict the degree of corrosion control provided by a system. A typical application for corrosion control includes Impressed Cathodic Current Protection systems (ICCP) and use of sacrificial anodes in anodic protection systems, where anodic current is impressed on corroding material to enforce passivation. Another application is to estimate the effect of stray currents such as those produced by HVDC electrodes or DC rail traction systems on the corrosion of buried metallic structures. CorrCAD can evaluate the corrosion status of the structure and help optimize the location and characteristics of the corrosion protective system (such as ICCP) to minimize stray current interference effects on protected structures such as pipelines.

➢ **CDEGS** is a powerful set of integrated software tools designed to accurately analyze problems involving grounding, electromagnetic fields, electromagnetic interference including AC/DC interference mitigation studies and various aspects of cathodic protection and anode bed analysis with a global perspective, starting literally from the ground up. It consists of eight computation modules: RESAP, MALT, MALZ, SPLITS, TRALIN, HIFREQ, FCDIST, and FFTSES. This is the primary interface used to enter data, run computations, and examine results for all software packages other than Right-of-Way, AutoGrid Pro, AutoGroundDesign, SESTLC, SESShield-3D, CorrCAD, and SESEnviroPlus. This interface also provides access to the utilities listed below.

CDEGS is accessible via a modern, user-friendly and flexible main interface. A legacy interface, called CDEGS-Legacy, is also available.

2.4   Tools, Utilities and Interfaces

➢ **AutoTransient** automates the process required to carry out a transient analysis with the HIFREQ and FFTSES modules.

➢ **CETU** simplifies the transfer of Right-of-Way and SPLITS output data to MALZ or HIFREQ. A typical application is the calculation of conductive interference levels in an AC interference study. This tool is integrated in the Right-of-Way software package.

➢ **FFT21Data** extracts data directly from FFTSES's computation output database files (file of type .f21) in a spreadsheet-compatible format or in a format recognized by the SESPLOT utility.

➢ **GraRep** is a program that displays and prints graphics or text files. For more information on GraRep see Chapter 6 of the Utilities Manual or invoke the Windows Help item from the menu bar.

➢ **GRServer** is an advanced graphical and input/output processor which displays, plots, prints, and modifies configuration and computation results obtained during previous and current CDEGS sessions.

➢ **GRSplits** displays a static 2D plot of the circuit models entered in SPLITS or FCDIST input and computation database files. This program greatly simplifies the task of manipulating, visualizing and checking the components of a SPLITS or FCDIST circuit.

➢ **GRSplits-3D** is a powerful interactive 3D graphical environment that allows you to view and edit the circuit data contained in SPLITS input files and to simultaneously visualize the computation results.

➢ **RowCAD** is a graphical user interface for the visualization and specification of the geometrical data of Right-of-Way projects. Its graphical environment can be used to visualize, specify and edit the path data of Right-of-Way, and to define the electrical properties of those paths.

➢ **SESAmpacity** computes the ampacity, the temperature rise or the minimum size of a bare buried conductor during a fault. It also computes the temperature of bare overhead conductors for a given current or the current corresponding to a given temperature, accounting for environmental conditions.

➢ **SESBat** is a utility that allows you to submit several CDEGS computation module runs at once. The programs can be run with different JobIDs and from different Working Directories.

➢ **SESCAD** is a CAD program which allows you to create, modify, and view complex grounding networks and aboveground metallic structures, in realistic 3D and 2D views. It is a graphical utility for the development of conductor networks for the MultiGround, MultiGroundZ，and MultiFields software packages.

➢ **SESCircuitSimulator** is an electrical circuit analysis program for studying the performance of a power system network, taking into account the presence of all neutral conductors, ground metallic networks and earth media under normal, imbalance, or fault conditions. It is the successor to the SPLITS legacy interface.

➢ **SESCombiner** can perform linear superpositions of the computation results stored in several compatible HIFREQ database (F21) files.

➢ **SESConductorDatabase** gives you access to the SES's Conductor Database. It allows you to view the electrical properties of conductors in the database, and to add new conductors to the database or modify their properties. It has been superseded by the SESLibrary tool (see below) and is available here as a legacy tool.

➢ **SESConverter** is a DXF-DWG Converter tool that can be used to import CAD based files to various SES's software package compatible input files or export various SES's software package input command files to CAD files compatible with the DXF or DWG format. The program allows filtering of data to be imported aided by a 2D viewer of selected data, to avoid excessive objects creation in SES's software package compatible files.

➢ **SESCrossSection** provides an interactive interface with direct visual system representation for the specification of conductor characteristics and locations within a conductor path cross-section. The program allows data specification for eventual use in CorrCAD, RowCAD, Right-of-Way, Cable and Conductor modes of SESLibrary, SESeBundle, and finally in Circuit, Group and Single modes of the TRALIN computation module.

➢ **SESCurveFit** is a general curve fitting tool with a special focus on "Polarization curves" used in CorrCAD. It incorporates a curve digitizer utility as well.

➢ **SESeBundle** finds the characteristics of an equivalent single conductor that represents accurately a bundle of conductors, as far as their series impedance is concerned. This utility is particularly useful to simplify models in computation modules, such as HIFREQ, where reducing the number of conductors is important to keep the computational time low.

➢ **SESEnviroPlot** is an intuitive application that dynamically displays computation data produced by the **SESEnviroPlus** software module.

➢ **SESFcdist** is an interactive and visually intuitive interface that supersedes the legacy FCDIST computation module interface. It allows users to prepare input data, compute and view results corresponding to the FCDIST (simplified fault current distribution) computation module.

➢ **SESFFT** is a Fast Fourier Transform computation module intuitive interface that supersedes the legacy FFTSES computation module interface. It helps you automate time domain (lightning and switching surges) analyses based on frequency domain results obtained from CDEGS computation modules such as SPLITS, MALZ, and HIFREQ. The forward and inverse *Fast Fourier* transformations, the sample selection of the frequency spectrum, and related reporting and plotting functions have been automated in SESFFT

➤ **SESGSE** rapidly computes the ground resistances of simple grounding systems, such as ground rods, horizontal wires, plates, rings, etc., in uniform soils. SESGSE also estimates the required size of such grounding systems to achieve a given ground resistance.

➤ **SESImpedance** computes the <u>internal</u> longitudinal impedance per unit length of long conductors of arbitrary geometry and composition, and whose cross-section does not vary over the length of the conductor. The program uses the Finite Element Method (FEM) for calculating the electrical characteristics of conductors and is capable of handling conductors of arbitrary shapes and realistic material properties. The calculations fully account for skin effect, and can be carried out at low or high frequency.

➤ **SESLibrary** allows you to select, inspect and import the properties of a large number of *components* that can be part of models for many SES's software computation modules. Users can create and define their own components as well. It currently includes three comprehensive separate databases containing respectively conductors, power cables and fence posts.

➤ **SESPlot** provides 2D plots from data read from a text or CSV based files. It is used by several SES's Software packages and tools.

➤ **SESPlotViewer** is a tool used by SESEnviroPlus and SESTLC for 2D plot rendering.

➤ **SESResap** is a resistivity analysis computation module interface that supersedes the legacy RESAP computation module interface. It is an interactive and visually intuitive interface that allows users to prepare input data, compute and view results corresponding to the RESAP computation module.

➤ **SESResultsViewer** processes the computation data and results of all computation modules in CDEGS, offering a complete solution for displaying plots and reports in an integrated environment. It presents an appealing layout with intuitive organization of its settings that use sensible defaults that, in turn, allow for a fast configuration of the settings in order to achieve the desired output results. It replaces the legacy Output Toolbox interface.

➤ **SESScript** is a script interpreter that adds programming capabilities to SES's input files. SESScript can systematically generate hundreds of files from a single input file containing a mixture of the SICL command language and scripting code and user-defined parameter ranges and increments.

➤ **SESShield** provides optimum 2D solutions for the protection of transmission lines and substations against direct lightning strikes and optimizes the location and configuration of shield wires and masts in order to prevent the exposure of energized conductors, busses and equipment. It can also perform risk assessment calculations associated with lightning strikes on various structures.

➢ **SESSystemViewer** is a powerful 3D graphics rendition software that allows you to visualize the complete system including the entire network and surrounding soil structure. Furthermore, computation results are displayed right on the system components.

➢ **SESTextEditor** is an enhanced text editor that recognizes the command structure of the SICL (SES Input Command Language) input file associated to the module identified by the file prefix. The program provides syntax highlighting and a command parameter identification tooltip to greatly simplify manual editing of a SICL .f05 input file.

➢ **SESThreshold** is a utility that is used to compute various threshold limits, as recommended by industry standards. It is presently restricted to computing maximum allowable safe touch and step voltages limits. Coupled with an intuitive graphical environment, it allows to specify geometrical zones that represent areas with different threshold limits. The computed threshold and zone boundaries are shown on generated Spot 2D plots which enable safe and unsafe regions to be easily identified. SESThreshold can be used as a standalone application or accessed through SESResultsViewer.

➢ **SESTralin** is an interactive and visually intuitive interface that supersedes the legacy TRALIN computation module interface. It allows users to prepare input data, compute and view results corresponding to the TRALIN computation module.

➢ **SoilModelEditor** is a standalone module with an interactive graphical interface that assists in the creation of soils models for all relevant target SES modules.

➢ **SoilModelManager** is a software tool that automates the selection of soil model structures that apply during various climatic seasons.

➢ **SoilTransfer** is a utility that allows you to transfer the soil model found in several SES files into several MALT, MALZ or HIFREQ input (F05) files.

➢ **TransformerDataEditor** is used by several SES applications to specify the characteristics and locations of single- and three-phase transformers.

➢ **TransposIT** is a tool for the specification and analysis of line transpositions on coupled electric power line circuits. It allows users to determine the optimal number of power line transpositions and their required locations to ensure that voltage unbalance is kept within predefined limits.

➢ **WMFPrint** displays and prints WMF files (Windows Metafiles) generated by CDEGS or any other software.

3 Starting CDEGS in the Windows Environment

As already mentioned in Chapter 2, because of the flexible and intentional partitioned structure of the CDEGS interface, its components are loosely connected. Therefore, it is important to have a good understanding of the interface structure, how the components are related and how to navigate within each component. This chapter and the following Chapters 4, 5 and 6 are devoted to this task. They describe the CDEGS group environment and how to operate a software package within the group. More precisely:

- Chapter 4 describes the Input Data Processor interface, i.e., how to specify the required input data.
- Chapter 5 describes the Computation Modules interface, i.e., how to process and compute the results pertaining to the specified system.
- Chapter 6 describes the Output Data Processor interface, i.e., how to display, view, and plot the computation results.

Start the CDEGS Windows interface by double-clicking on the **CDEGS** icon located in the SES's software group folder. A JobID list appears in the main CDEGS window. At this point, it is worthwhile to describe in greater detail the Working Directory (or project folder location) and JobID (or project scenario) before proceeding further.

3.1 Working Directory and JobID

The JobID string you supply in the Start-up CDEGS window is used to uniquely identify all your input and output files. The interface module will automatically append the JobID string to all file names created during a session according to the following format:
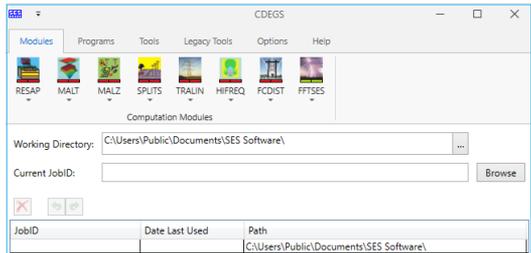
XY_JobID.Fnn

The file prefix XY indicates a two-letter abbreviation used for the name of the computation module associated with the input file which will be created, modified or simply read as input. The abbreviations are RS for RESAP, MT for MALT, MZ for MALZ, HI for HIFREQ, and so on. The two digits "nn" are used to indicate the type of file (e.g., 09 for output, 05 for input and 21 for the computation database files). See Chapter 8 for file naming conventions and default files assignments. In the JobID dialog box, you have the following options:

- You can define the working directory by entering the directory of your choice in the **Working Directory** field. If you specify a directory that

does not exist, it will be created automatically. You can also browse for an existing directory using the **Browse** button.

- You can use a JobID name used previously by highlighting the name of your choice in the JobIDs list.
- You can create a new JobID by typing a new JobID name in the **Current JobID** field. If the JobID field is left blank, the buttons corresponding to the computation modules (programs) will become inactive.
- You can delete a previously used JobID name by highlighting that name in the JobIDs list and by clicking on the Delete ✗ button.
- If you are unsure which files you are looking for, then simply press the **Browse** button and the JobID list box will be replaced by a **Browse** window with different search criteria. The most common search filters are available in the Criteria list (in the **Browse** section) but one can optionally type in a custom search criterion. Once you have found the file you are looking for simply double-click on the file, or select the file and press **Open**, and the working directory and JobID will automatically be deposited in the correct fields and the **Browse** section will close, reverting to the JobID list.
- If you wish to restore the previously deleted JobID entry in the list, click on the **Undo** 🔄 button.

3.2   Start-up CDEGS Window-Modules

The start-up window requires the following inputs:

- Identification of the case (i.e., the JobID and working directory as explained in the previous section).
- Selection of the intended computation module (program) in which the
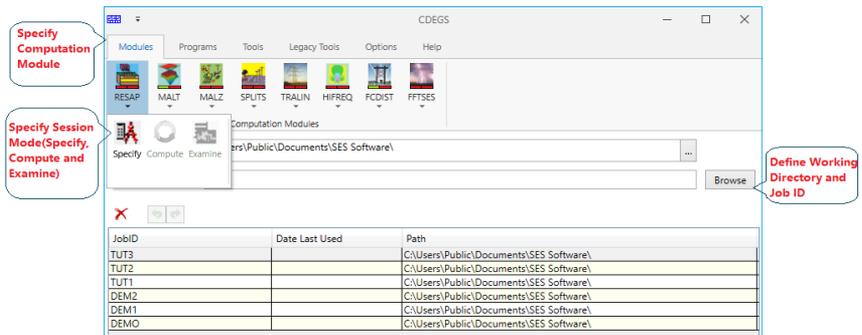
design will be specified, computed, or examined.
- Selection of the session type mode: **Specify**, **Compute** or **Examine**.

3.2.1   Definition of the Case

The case is defined either by selecting the JobID and working directory from the list or by creating a new JobID and/or working directory.

An existing case that is not in the JobID list can be selected by clicking on the **Browse** button and selecting either an input file or output file that belongs to the case.

3.2.2   Selection of the Computation Module

As will be discussed later in Chapter 5, each computation module has a button representing it in the start-up window.

Clicking on the program button will show the available session types for the specified case (i.e., JobID and working directory).

3.2.3   Selection of the Session Type

The session types that are available for each computation module (as shown here in the screen capture to the right) are listed below:

1. **Specify**
    This is the input session which allows you to enter the input specifications for the computer model in the intended software package.

2. **Compute**
    This is the computation session which allows you to execute the computation modules for the input specifications entered in the input session for the intended software package.

3. **Examine**
    This is the output session which allows you to view the results of the computation modules in the form of plots and reports for the intended software package.

Before launching any computation module, note the following about the CDEGS user interface:

- If the computer model has not been created for the selected module, the two status indicators under the module icon are red (▬▬▬▬), as shown below. You can then click on the drop-down arrow ▼ and select **Specify** to build a new model.
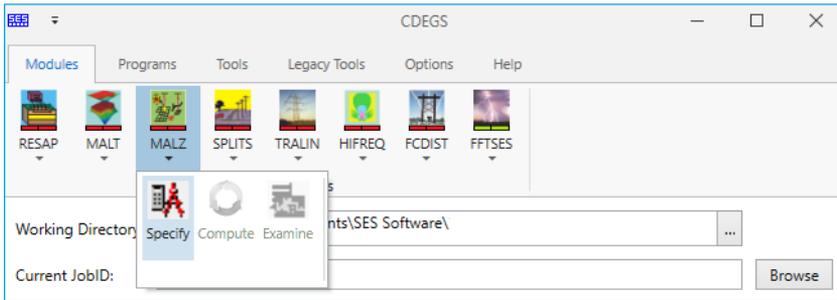
- If the model of the selected module is created but has not been run yet (i.e., a valid *.F05 input file exists, but no output files), the color of the left indicator changes to green (the right one remains red). You can click **Specify** to modify the model or **Compute** to launch the computations, as shown in the following figure. Note that for the modules not included in your license, this **Compute** option is locked.
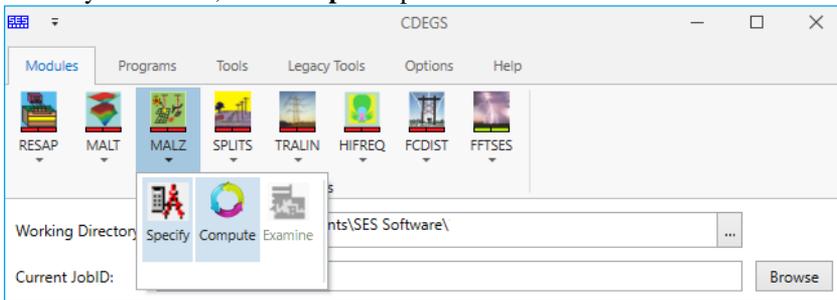
- Once the model for the selected module is computed (i.e., a valid *.F21 computation database file exists), the second status indicator turns to green. You can click **Specify** to modify the model, **Compute** to relaunch the computations or **Examine** to view and plot the results. For the example shown below, the MALZ model is created (F05 file), it has been run (F21 file), and therefore, the results can be viewed. Note that if for any reason, the F21 file is the only one present in the project folder, only the second indicator is turned to green.
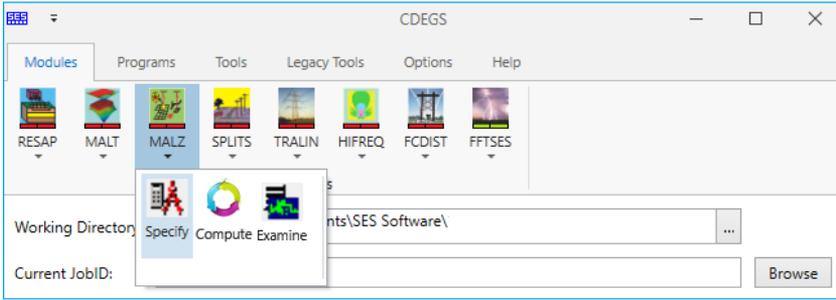
The flow of switching from one session to another is graphically shown below. Note that you can always return to the start-up JobID window from any session.
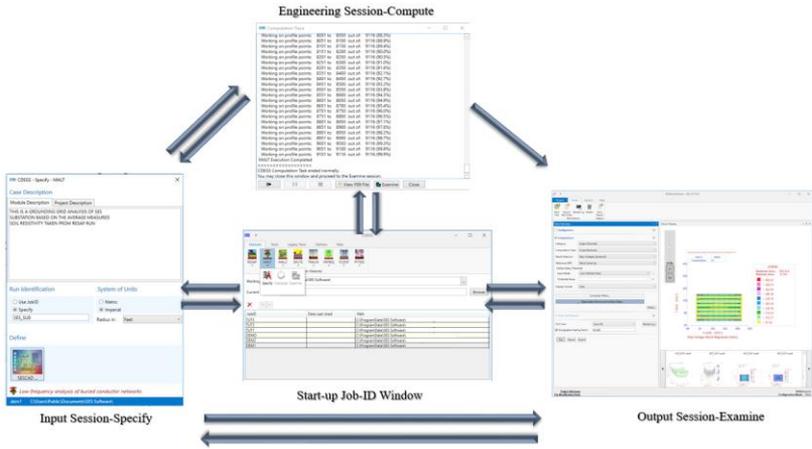
3.3 Tools Tab

The **Tools** tab launches the tools that are part of the CDEGS environment. An advantage to starting the utilities from the CDEGS interface (instead of from Windows Explorer or the SES's software program shortcut folder) is that the JobID and working directory for those utilities are automatically set by whatever is selected in CDEGS.


The Tool items are briefly explained in the same order as shown in the Tools tab. See also Chapter 2 for a more detailed description. Most of the tools are also accessible via the above toolbar buttons.

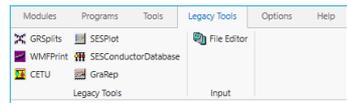| Tools	Description
SESCAD	A graphical utility for the development of conductor networks in the MALT, MALZ, and HIFREQ computation modules.
RowCAD	A graphical user interface for the visualization and specification of the geometrical data of Right-of-Way projects. Its graphical environment can be used to visualize, specify and edit the path data of Right-of-Way, and to define the electrical properties of those paths.
SESBat	The computation modules can be queued in a batch process under different JobIDs and working folders.
SESResultsViewer	Processes the computation data and results of all computation modules in CDEGS, offering a complete solution for displaying the plots and reports in an integrated viewer.
GRServer	An alternative to the SESResultsViewer Output Processor in CDEGS; it can generate advanced plots.
GRSPLITS-3D	A powerful interactive 3D graphical environment to view and edit the circuit data contained in SPLITS input files and to simultaneously visualize the computation results.
SESAmpacity	Computes the minimum size of a conductor for a given current, its ampacity, or its temperature rise during a fault.
SoilModelEditor	A standalone module with an interactive graphical interface that assists in the creation of soil models for all relevant target SES modules.
SESGSE	Quick determination of the type of ground system required to achieve a specified ground resistance value in a uniform soil.
AutoTransient	Automates the process required to carry out a transient analysis with the HIFREQ and FFTSES computation modules.
TransposIT	Automates the analysis of the optimum transposition scenario on a power system network.
SESScript	Generates files for parametric analyses of a combination of parameters in an input file (.F05). It automatically creates the input files for the specified values of the parameters.
FFT21Data	Simplifies the task of plotting results from the computation module database not yet supported by FFTSES.
SoilModelManager	Winter and spring condition equivalent soil model builder.
SESShield	A 2D lightning shielding analysis program.
SESLibrary	Includes three comprehensive separate databases containing respectively conductors, power cables and fence posts.
SESThreshold	An application for computing acceptable threshold limits, as recommended by industry standards, for touch and step voltages.
SESeBundle	Finds the characteristics of an equivalent single conductor representing a bundle of conductors, as far as their series (longitudinal) impedance is concerned.

SESCrossSection	Provides an interactive interface with direct visual system representation for the specification of conductor characteristics and locations within a conductor path cross-section.
SESCurveFit	A general curve fitting tool with a special focus on "Polarization curves" used in CorrCAD.
SESImpedance	Computes the internal impedance per unit length of long conductors of arbitrary geometry and composition, and whose cross-section does not vary over the length of the conductor.
SESPlotViewer	A tool used by SESEnviroPlus and SESTLC for plot rendering.
SESSystemViewer	An interactive 3D viewer of the entire network, surrounding soil structure and computation results.
SoilTransfer	Transfers the soil model found in several SES files into several MALT, MALZ or HIFREQ input (F05) files.

The **Import | Input** and **Export | Output** options available in the **Tools** tab launches SESConverter that can be used to import CAD based files to various SES's software package compatible input files or export various SES's software package input command files to CAD files compatible with the DXF or DWG format. The program allows filtering of data to be imported thanks to a 2D viewer that shows the selected data, to avoid excessive conductor creation in the SES's software package compatible files. Export from computation database files to text files and import from appropriate text files to computation database files are other possible options that can be selected.
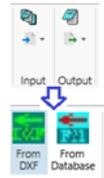
3.4 Legacy Tools Tab

Some of the SES tools are kept under the **Legacy Tools** tab, which are explained briefly below with the same order as shown under the Legacy Tools tab.

| Tools	Description
GRSplits	Draws the circuit modeled in the SPLITS or FCDIST module as a 2D passive plot.
WMFPrint	Displays and prints Windows metafiles.
CETU	Automates the transfer of leakage currents computed by Right-of-Way and SPLITS to conductive analysis software such as MALZ or HIFREQ.
SESPlot	Plotting utility for results computed for 2D or 3D perspective plots.

|	
SESConductor Database	Is a standalone SES conductor database utility.
GraRep	Displays and prints graphics and reports. Saving to metafiles or PDF can be done.

3.5   Options Tab

The **Options** tab provides the tools necessary to customize the overall CDEGS environment and all of its modules. These settings should be set from the start-up JobID window before starting any of the available sessions. The functionality of each option is briefly described here.
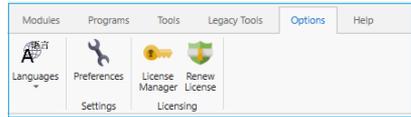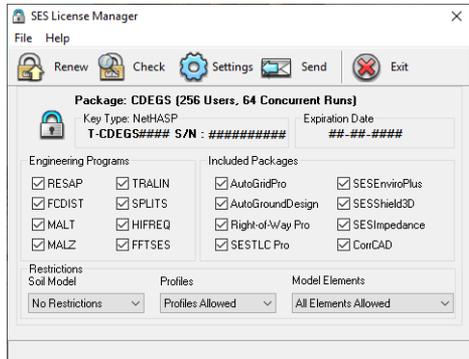
Languages button changes the display language of the program. By clicking on the arrow button, either English, French or Chinese can be selected as the input language.

The **Preference** utility enables the creation of templates for all of the programs in the input session. Also, user defined defaults can be assigned for the **System of Units** and **System Frequency** for all or individual programs.
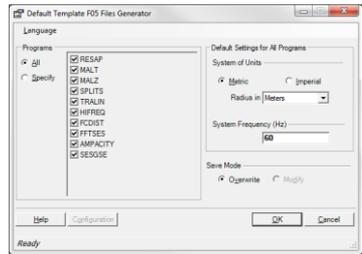
LicenseManager is an important utility monitoring the license for SES software. One item is the computation modules enabled on the hardware protection key or dongle (the active ones will be checked). Another item is the expiration date that reminds you when the key must be reset for those who subscribe to the SES hardware protection key insurance program. Unsupported users and those who have decided to manage their own insurance (following the first automatically supported year) receive a license code that allows them to reset their keys at selectable intervals. In this case, however, the licensee should insure the key against loss or theft.

3.6   Help Tab

The **Help** tab provides you with help related functionality. The **Help** section includes the entries: **Browse to Examples, Manuals, Video Tutorials, FAQ** and **Publications**. **Browse to Examples** gives a direct access to **Examples** and **How To** folders. Selecting **Manuals | Interface Help (F1)** from the Help tab will invoke the main CDEGS context sensitive online help as shown below.
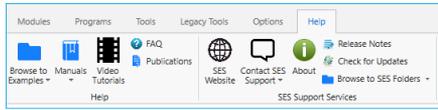
Selecting **Manuals | Command Help** option from the Help tab will bring up the complete reference of the SES Command Language (SICL) as shown to the right and by clicking on **Manuals | How To Manuals** option the complete CDEGS PDF manuals will be accessible.

From the **Help | SES Support Services** section, links and utilities are available to aid in using the support services of SES:

- **SES Web Site** button is a link that will open your Web browser to the home page of SES.

- **Contact SES Support** menu item automates the packaging of deliverables (e.g., input & output files for support) via email to SES for analysis.

- **About** option displays the software version currently installed on your computer. Moreover, the **SES License Information** window can be accessed by selecting the **License** tab from the **About CDEGS** window. The expiration date of the license, the computation modules and included packages and also the soil model type enabled on the protection key or dongle are shown in this window.
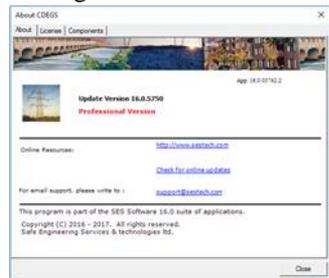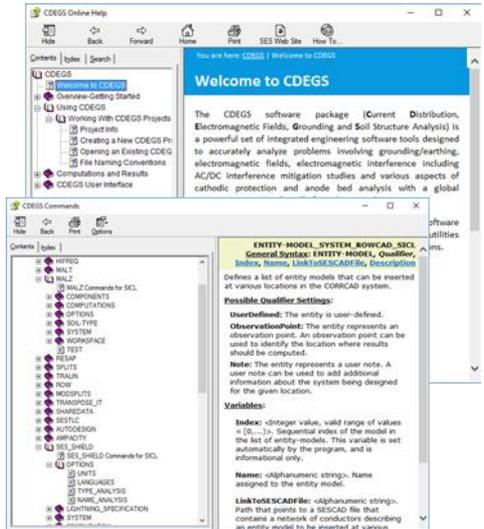
- **Check for Updates** option directs your browser to the SES Web Site **Software Update** page to upgrade your software to the latest version.

- **Browse to SES Folders** option gives a direct access to the installation and command folders.
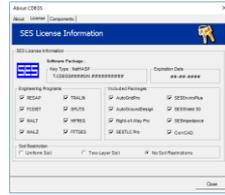
4 CDEGS Input Session – Model Specification

The input session of a CDEGS software package allows you to easily create input data files for the computation modules. It supports all of the features that are available directly from the use of the powerful **S**ES **I**nput **C**ommand **L**anguage (SICL). In addition, it boasts several options and features that are not available in some other input modes and are described later in this chapter.

4.1 Starting an Input Session

The input session in the CDEGS application is used to specify the necessary system data in order to carry out the engineering design or study. After having selected or entered the desired JobID (i.e., scenario) and working directory (i.e.,

project folder), click on the **Specify** item from the drop-down **Module** list to invoke the input session.

The main input windows of some of the computation modules have a similar layout as described in Section 4.4.
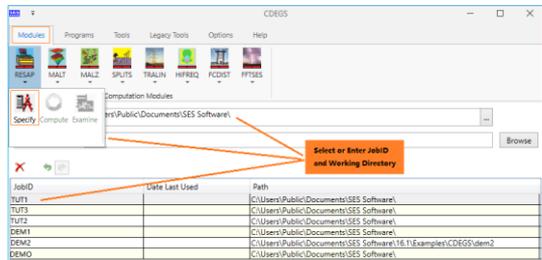
4.2 Field Types

The following describes and explains several convenient field types that will help you to easily determine how to manipulate and enter data.

Radio Buttons System of units ○ Metric ◉ Imperial	Present two or more mutually exclusive choices. You must pick one of the choices by clicking the associated button to highlight it. They are normally displayed in a frame.

Check Boxes 	Enable or Disable a particular command option. The option is enabled when a check mark appears in the check box; it is disabled when the check box is empty.
Table Entries 	Allow you to enter several numeric and alphanumeric entries displayed in a spreadsheet-type grid.
Display Boxes 	Give you a visual representation of your current selection. Some of the representations are static while others are interactive and will display your actual numerical entries in a graphical format.
Scroll Arrows 	Allow you to scroll through a table or a list.
Text Entries 	Allow you to enter text strings. When the cursor is positioned in the field, you can type your entry.
Drop-Down List Boxes 	Give you a list of several options. To select an item that is not displayed, click the arrow button at the right of the list box and select the item by clicking on it.
Inactive Features 	Are grayed and are not accessible to the user.
Numeric Entries 	Are used to enter numeric values. You type in the values.

4.3 Key and Mouse Behavior

In CDEGS windows the following key and mouse behavior are applicable:

Tab Key	Will move the cursor (focus) from the current field to the next logical field.
Alt+*Character*	Will move the cursor (focus) directly to the field identified by that character (i.e. the character that appears underlined).

In text or numeric fields:

Backspace key	Use the backspace key to delete a character to the left of the cursor.
Delete Key	Use the delete key to delete a character to the right of the cursor.
Insert Key	By default, you are in insertion mode. If you need to add text, this allows you to position the cursor where the text is to be entered and just type it. When you hit the insert key, you are in overwrite mode and whatever you type overwrites previously entered text.
Ctrl+X	Will cut highlighted text to the Clipboard.
Ctrl+C	Will copy highlighted text to the Clipboard.
Ctrl+V	Will paste the Clipboard content in the current entry field.
Shift+Arrow Left or Right Keys	Will highlight text.

In table fields:

Commas	Will enter the data in current cell and move the cursor to the next cell in the table.
Arrow keys	Will enter the data in current cell and move the cursor by one cell in the direction of the arrow that was used.
Spacebar	Will enter the data in the current cell and move the cursor to the next cell in the table.
Shift+Arrow Left, Right, Up or Down Keys	Will highlight cells.
Slash (/)	If a series of cells are highlighted, will open a Gradient Fill dialog box. The Gradient Fill is used to automatically increment values in a series of rows or columns.
Delete Key	Will delete the data in the current cell or in a selected block of cells.
Shift+Delete Keys or Ctrl+X	Will delete the data in the current cell or in a selected block of cells and will copy it to the Clipboard.

Ctrl+Insert Keys or Ctrl+C	Will copy the data in the current cell or in a selected block of cells to the Clipboard.
Shift+Insert Keys or Ctrl+V	Will copy the contents of the Clipboard to the table using the current cursor position as its starting point.

In most Interactive Display Boxes (Show Data) fields:

Show Data	Will display the interactive plot.
Top View	Will display the top view of the interactive plot.
Animate	Will rotate the display automatically.
Stop	Will stop the automatic rotation of the display.
Left mouse button	When the mouse cursor is located in the display window, will move the plot to various convenient viewing positions.
Shift Key and Left mouse button	When the mouse cursor is located in the display window, will zoom in or zoom out of the plot. Moving up the mouse will zoom in and moving down the mouse will zoom out.
Ctrl Key and Left mouse button	When the mouse cursor is located in the display window, will modify the view angle as the mouse is moved.

In Drop-Down List boxes fields:

Arrow Keys	Will cycle through the various items available.
Down Arrow at the right of the List Box	When clicked, will display additional list items.

4.4   Common Fields, Buttons & Windows

Many fields, buttons and windows are common to some of the computation modules.

4.4.1 Input Window of MALT, MALZ, and HIFREQ Modules

The input (Project) window of MALT, MALZ, and HIFREQ is an example of common structures found in the computation modules. These main menus customize the input data and provide an entry point or road map to the different categories of data required by the module. The Window shown below corresponds to the MALT module.

The **Case Description** containing **Module Description** and **Project Description** are used to identify and document the project for which the data is prepared.

The **Run-Identification** is used to identify the outputs for the case. This Run-ID appears in all printouts, output and graphics files created by the program. It is automatically set to be identical to the JobID (which is functionally equivalent to a scenario name) unless specified otherwise. This is the recommended choice. It allows a unique identification name for different input data prepared with the same JobID. Note that cases with different Run-ID but with the same JobID will overwrite each other. Note that the **JobID** will also become a synonym of the project **Scenario** name in future versions.

The **System of Units** radio buttons specify the units in which the data will be entered.
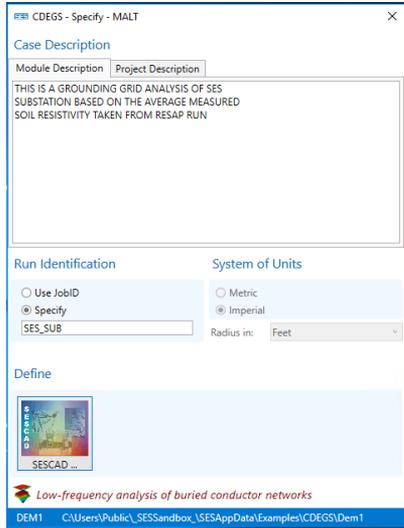
The **Define** button (SESCAD) is the road map for entering data. It simplifies and accelerates the data input process. In MALT, MALZ, and HIFREQ computation modules, the SESCAD is used to build the entire system input data in a graphical interface which greatly simplifies the design of the network.

SESCAD is a complete graphical interface environment that allows you to create, modify, and view complex grounding networks and aboveground metallic structures. In SESCAD, you can specify the conductor configuration, type, energization, and the observation points. You can also define
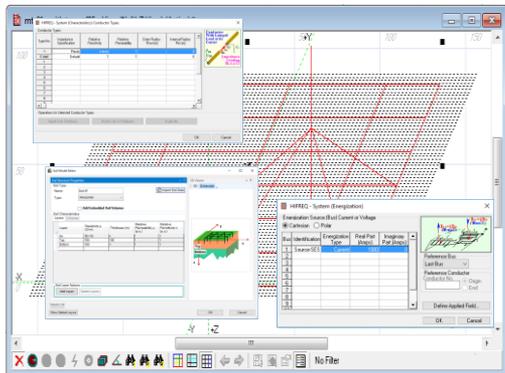
the soil layer characteristics in terms of electrical resistivity, positioning, depth and horizontal thickness.

Depending on the Soil Type selected, the input data required in the Soil Characteristics frame will be displayed. Similarly, the 3D Viewer panel will illustrate the type of soil that is requested and the orientation of the axes relative to the soil.

An added benefit of launching SESCAD here is that it takes the conductors already defined and loads them into the interface. There they can be manipulated as required. Once the modifications are completed, the new configuration is reloaded into the input conductor list. This greatly facilitates the grid design.

4.4.2   Output Window of MALT, MALZ, and HIFREQ Modules

The Examine option from the drop-down menu of the MALT, MALZ, and HIFREQ computation module interfaces will request the **SESResultsViewer** Output Processor which shows again one of the common utilities and windows used by these modules. **SESResultsViewer** utility will be explained in detail in Chapter 6 Section 6.3.1.
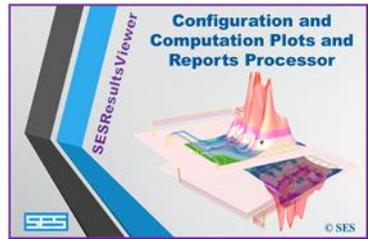
4.5   Other Input Toolbox Features

4.5.1   RESAP Computation Module

In the **Measurements** panel, specify the method used to gather the data. Several popular and advanced resistivity measurement techniques are available. The Plots panel allows you to immediately inspect the results in a linear/linear or log/linear fashion to determine the shape of the curve or the presence of noise in the measurements.

The **Measurement** menu selects the **Wenner Method** and the **Account for electrode depth** option by default. The measurement data are entered in the **Traverse parameters** option. The results are automatically plotted in the Plots panel.
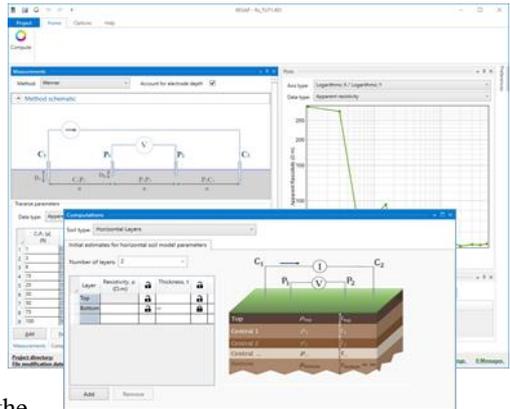
The **Computations** panel is used to access a screen where you can define the type of soil model you wish to use as well as the initial (estimated) values of the soil characteristics you wish to compare to the real soil structure. The **Number of Soil Layers** field allows you to explicitly request the number of layers for a horizontally layered soil type (**User-Defined**). If the resistivity and thickness under **Initial estimates for horizontal soil model parameters** are left as blank (default setting), the program will determine suitable initial values for the requested soil characteristics.

The **Advanced Options** screen helps you define computation settings for the optimization process or generate different filters. By default, RESAP chooses Automatic filter, which is sufficient for most practical cases. The High Precision filter is sometimes needed when extreme soil conditions are encountered (for example, very large

soil resistivity contrast ratios) and it will greatly increase the computation time. Generating new filters is seldom needed unless RESAP encounters a missing or corrupted filter database file.
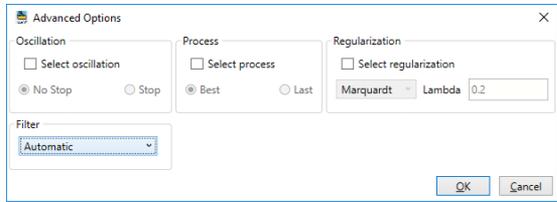
4.5.2 TRALIN Computation Module

TRALIN performs line parameter calculation of conductors and cables. There are three modes to enter conductors in the transmission line system, which can be identified in the **Cross Section Specification Options** (in the Project info); **Single Mode**, **Circuit Mode**, and the **Group Mode.** The **Single Mode** is used for systems consisting entirely of above-ground, uninsulated conductors. The conductors are described one at a time.
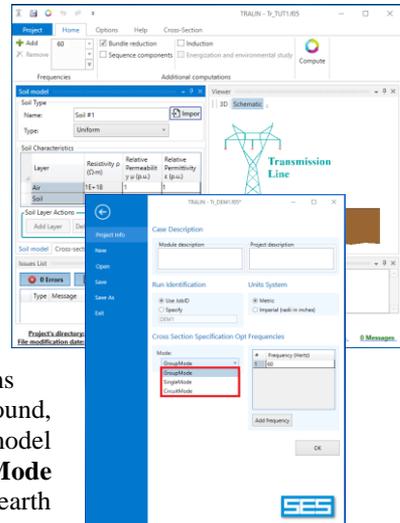
The **Circuit Mode** is used for systems consisting entirely of above-ground, uninsulated bundled conductors. The soil model used in both **Single Mode** and **Circuit Mode** allows the specification of up to three earth layers in addition to the air layer. The **Group Mode** is used for both overhead transmission lines and aboveground and buried cables. It should be used if the system contains underground, insulated, pipe-enclosed or cable-type conductors.

The location, size, and characteristics of conductors are entered by clicking on the **Cross-section** tab. The data in the Phase/Line Number field specifies the phase number of the conductor. The phase number is used to indicate which conductors share the same energization sources (points) and are to be reduced to an equivalent single conductor when the Bundle Reduction option (in the Home tab) is in effect.

The characteristics of the conductors are defined by clicking on the **Component Type | Create New | From Database** which invokes the **SESLibrary** tool. The **Conductor Database** window from SESLibrary offers a comprehensive list of conductor specifications based on various countries and international commonly used conductors and cables. When the screen on the right appears, select from the desired category from the Conductor Class list. Scroll down the screen to find the desired conductor, select it and click the Import button.

4.5.3 SPLITS Computation Module

The SPLITS module is a powerful circuit solver that has a flexible **Import Data** feature in the **System (Terminal)** window. This feature allows the import of self and mutual impedances of transmission line conductors computed by **TRALIN** (Line Parameters) for the various transmission line sections (spans). It is used along the GRSplits-3D tool to visualize, edit and display computation results of the defined circuit network.

The SPLITS module interface has not been replaced yet by the new interface mainly because it will be combined and integrated with the GRSplits-3D tool and will be a component of the Right-of-Way software package.
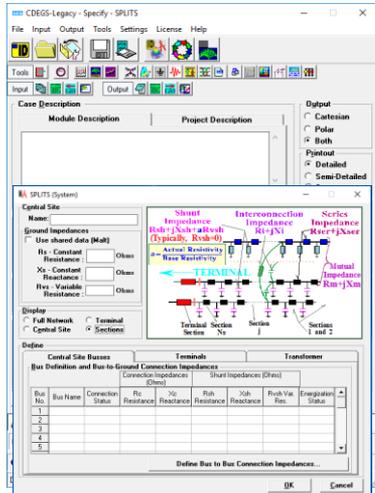
4.5.4 FCDIST Computation Module

FCDIST is a line parameter and fault current distribution module that provides a simpler equivalent to the combination of TRALIN and SPLITS computation modules. The conductor characteristics can be obtained from the same database in SESLibrary described above.
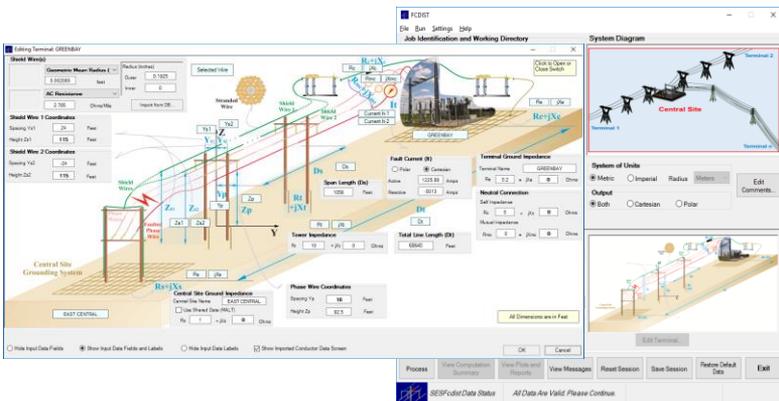
4.5.5   FFTSES Computation Module

FFTSES is an efficient and flexible Fast Fourier Transform computation module aimed at providing time-domain computation capabilities to SES software frequency based computation modules such as SPLITS, MALZ, and HIFREQ.

FFTSES offers several standard and classical time domain surge functions, as well as a user-specified arbitrary surge that can be imported from measured data or from other computation sources.
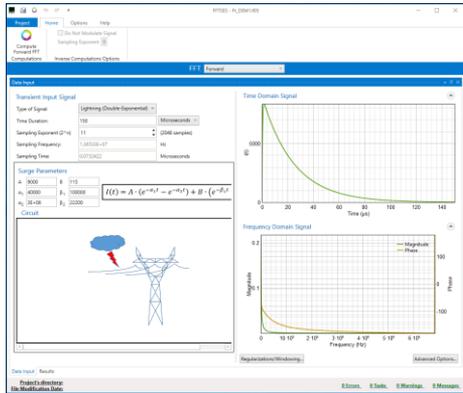
5   Software Computation Module Interface

5.1   Introduction

As you begin to use one of CDEGS software packages, keep in mind that your engineering solving capabilities will continually increase as your familiarity with the software and your understanding of the related engineering concepts increase. CDEGS software packages yield the greatest rewards to those who persistently explore their analytical capabilities. Furthermore, CDEGS software packages allow you to study complex engineering problems with an exceptional level of detail and accuracy. Consequently, significant reductions in your design and construction costs will result from your ability to build accurate and realistic computer models. You will no longer have to make frustrating and unnecessary conservative assumptions or be subject to the uncertainty of simplified models and assumptions.

While CDEGS can be applied to a very wide variety of engineering problems, it is most often used for the following types of studies.

- Soil resistivity measurement interpretation (RESAP module).
- Grounding studies (MALT, MALZ, HIFREQ, and FFTSES modules).
- Line and cable parameter calculations (TRALIN, FCDIST, and HIFREQ).
- Determination of fault current distribution in power systems (FCDIST, SPLITS, and HIFREQ).
- Inductive interference studies involving power systems, pipelines, communications cables, etc. (TRALIN, SPLITS, HIFREQ, and FFTSES modules).
- Cathodic protection studies (MALZ and HIFREQ).
- EMF and transient studies (MALZ, HIFREQ, and FFTSES).
- Analysis of arbitrary 3D conductor networks using accurate Maxwell electromagnetic field theory. Solutions range from line parameter calculations to lightning studies to antenna performance analysis (HIFREQ).

5.2   Invoking the Computation Modules

The computations are performed by the software Computation Modules RESAP, MALT, MALZ, TRALIN, SPLITS, FCDIST, HIFREQ, and FFTSES. Each of these modules (sometimes called programs) reads the data it requires from a structured command input file generated by one of the input processors. For illustrative purposes, assume that a RESAP input file was already prepared. From the Windows CDEGS Main Menu, proceed as follows:

To invoke the RESAP computation session, select the **Soil Resistivity Analysis (RESAP)** menu item from the **Modules** menu and then select the **Compute** item from the drop-down menu that appears once you select the down arrow ▼.

Note that if the **Compute** item for RESAP is disabled (i.e., grayed out), then this is a visual indicator that the program was unable to locate the input file. In this case, make sure that the specified working directory and the JobID point to the input file that has been selected. It could also be that there is, indeed, no input file available yet. Below are possible windows or messages that you may encounter in the computation session.
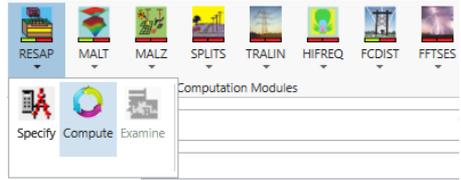
The **Overwrite Files** message window indicates that the RESAP computation module was previously launched using an input file of the same name. Consequently, the output files associated with the previous run would be replaced by the results of the new computation run if the **Yes** button is clicked. Clicking on the **No** button will abort the engineering run since the computations cannot begin without overwriting the existing output files.
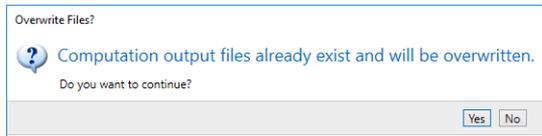
The engineering session window to the right indicates a proper completion of the engineering application since the "RESAP Execution Completed" message is displayed.
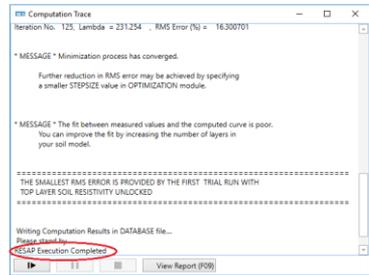
If the program cannot communicate with the software license security key during the computations, the execution will be aborted, displaying "*No CDEGS Protection key detected.*" Further details can be found in the Web site link that is provided along with the error message. In this specific instance, for example, the protection key might have been removed or not seated properly in the physical port. If the computation module has completed normally, the following output files will be generated:

- A printout listing input data, user-selected options, some computation results and error or warning messages (*.F09).

- A computation database file (*.F21) in binary format (i.e., you cannot read the information in this file using a text editor) containing the computation results for subsequent use by the output processor or by the output Binary/ASCII converter.

- Plots, if requested by the user.

The validity of the license protection key is queried at several checkpoints during the execution of any CDEGS program. In particular, CDEGS verifies whether the key has expired as soon as it loads. The following message should appear if it finds that the key has expired.
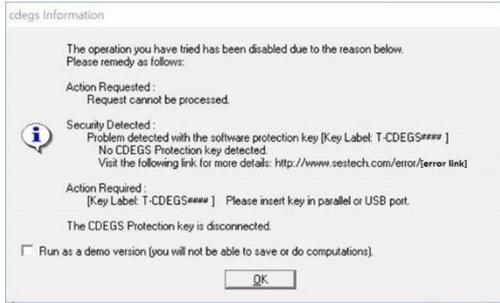
Moreover, you will be warned up to 14 days in advance that the key is about to expire. The message, "*** WARNING * Hardware Key limit will expire in _x_ day(s). Please renew using the Renew License menu item**" (where _x_ represents the number of days left before the key expires) will be displayed in the status bar of the CDEGS program. This message remains until the hardware security key has been renewed with a new expiration date. Please keep in mind that the protection key that comes with CDEGS is of the reset type. What this means is that it must be periodically reset in order for the CDEGS program to function. The reason for this security method is

twofold. First, the key is shipped with a limited period of time during which CDEGS can function. Should the package get lost or stolen, the key will function for only a very short period of time. Secondly, once the key has been installed into the host system, this protects the user of CDEGS from theft should the key get stolen; the key again will function for a short time.

For such safety reasons, the owner of CDEGS can control the allowable period of time during which the software can function only over a period of one year. For example, even though the license agreement normally extends over 50 years, the protection key has a maximum allowable time of one year. In such a case, the owner of CDEGS can download his or her license file using the **SESLicenseManager** utility to reset the expiration date of the key date (_valid only for those who subscribed to SES hardware security key theft or loss insurance program_).
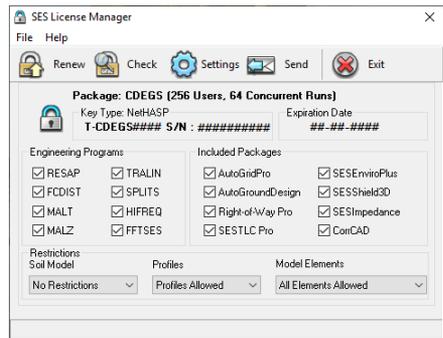
5.3   RESAP Computation Module

To use the RESAP computation module to its fullest capability, read the following documents:

- The "**How To...**" engineering manuals: see[1] GROUND, GISGRND, SUBURBAN, INTERF, URBAN, AutoGrid Pro, and AutoGroundDesign.
- The RESAP engineering application manual.
- The Seminar Reference binder (if you attended an SES seminar).

5.4   MALT Computation Module

To use to its fullest capability the MALT computation module, read the following documents:

- The "**How To...**" engineering manuals: see[1] GROUND, GISGRND, INTERF, AutoGrid Pro, and AutoGroundDesign.
- The MALT engineering application manual.
- The Seminar Reference binder (if you attended an SES seminar).

5.5   MALZ Computation Module

To use the MALZ computation module to its fullest capability, read the following documents:

- The "**How To...**" engineering manuals: see[1] SUBURBAN and URBAN.
- The MALZ engineering application manual.
- The Seminar Reference binder (if you attended an SES seminar).

5.6   SPLITS Computation Module

To use the SPLITS computation module to its fullest capability, read the following documents:

- The "**How To...**" engineering manuals: see[1] SUBURBAN, INTERF, ROWInterf, and ACTotalInterferenceStudy.
- The SPLITS engineering application manual.
- The Seminar Reference binder (if you attended an SES seminar).

5.7   FCDIST Computation Module

To use the FCDIST computation module to its fullest capability, read the following documents:

- The "**How To...**" engineering manuals: see[1] GROUND, GISGRND, AutoGrid Pro, and AutoGroundDesign.
- The FCDIST engineering application manual.

5.8   TRALIN Computation Module

To use the TRALIN computation module to its fullest capability, read the following documents:

- The "**How To...**" engineering manuals: see[1] SUBURBAN, INTERF, URBAN, ROWInterf, and ACTotalInterferenceStudy.
- The TRALIN engineering application manual.
- The Seminar Reference binder (if you attended an SES seminar).

5.9   HIFREQ Computation Module

To use the HIFREQ computation module to its fullest capability, read the following documents:

- The "**How To...**" engineering manuals: see[1] RLC, TOWER, LIGHTN, FENCE, CAPIND, and ACTotalInterferenceStudy.
- The HIFREQ engineering application manual.
- The Seminar Reference binder (if you attended an SES seminar).

5.10   FFTSES Computation Module

To use the FFTSES computation module to its fullest capability, read the following documents:

- The "**How To...**" engineering manuals: see[1] RLC and LIGHTN.
- The FFTSES engineering application manual.
- The Seminar Reference binder (if you attended an SES seminar).

[1]**Note**: The abbreviations used to name the "**How To…**" engineering manuals are as follows:

ABBREV.+extension	TITLE
AutoGroundDesign.pdf	Automated Grounding System Design Using AutoGroundDesign
AutoGrid Pro.pdf	A Simple Substation Grounding Grid Analysis Using AutoGrid Pro
GROUND.pdf	A Simple Substation Grounding Analysis
GISGRND.pdf	NCC-SES Gas Insulated Substation Grounding Analysis
SUBURBAN.pdf	Large Suburban Substation Grounding System Analysis: Measurements & Computer Modeling
URBAN.pdf	Urban Area Substation Analysis

CAPIND.pdf	Computation of Capacitance and Inductance of Conductor Networks
RLC.pdf	Computation of Transient Currents in RLC Circuits
SESEnviroPlus.pdf	Electromagnetic Environment Study using SESEnviroPlus
SESTLC.pdf	Electromagnetic Fields and AC Interference Study using SESTLC
TOWER.pdf	Electromagnetic Fields Near a Transmission Line Tower...
FENCE.pdf	Electromagnetic Fields Under a Transmission Line and Induced Currents on a Fence
LIGHTN.pdf	Lightning Transient Study of a Communication Tower
INTERF.pdf	Analysis of AC Interference Between Transmission Lines and Pipelines
ROWInterf.pdf	AC Mitigation on a Gas Pipeline Near an Electric Network. Part I: Inductive Study
ACTotalInterferenceStudy.pdf	A Simple AC Total Interference Mitigation Study Using SES software
Importing DXF Drawing Into SESShield-3D	Two main ways to generate SESShield-3D models from DXF drawing of picture
Quick Start Guide CorrCAD	Cathodic Protection System Design and Corrosion Evaluation
Quick Start Guide ROW	Quick start guide for Right-of-Way
Quick Start Guide ROWCAD	Quick start guide to the user interface to input the data of Right-of-Way
Quick Start Guide SESShield-3D	Quick start guide for lightning shielding protection system
SESShield-3D-Direct Lightning Stroke Shielding of a Substation	Lighting protection analysis of a simple substation using SESShield-3D

Note that the above manuals can be read onscreen using Acrobat Reader and similar software supporting the PDF convention. To open a manual, locate the file name in the **\PDF\HowTo** folder of the distribution media.

6   Output Data Processor

6.1   Introduction

Once a particular computation module has ended its task, you can start examining the computed results using the **Examine** button of the module drop-down menu or you can view the output (F09) file and examine the results, by clicking the **View F09 file** or **Examine** which are available in the **Computation Trace** window once the computation is finished.

Examination of the output results can only be done if the computation module has been run for the case (i.e., a computation database exists for the case). The state indicator of the program buttons act as visual indicators to help you decide which program to examine. As mentioned earlier in Section 3, the module (program) buttons will be shown in either of its two states: green or red. Once the model for the selected module is computed (i.e., a valid F21 file exists), both status indicators turn to green.

6.2   Viewing, Printing, Plotting and Exporting Computation Results

You can examine or print the computation output files (*.F09) by either selecting the **Examine** button from the drop-down menu of the module or from the **Tools | Output | File Viewer** item .

You can export conductor network data to DXF-compatible CAD systems by selecting the **Tools | Output | Export | To DXF** menu item (see the context sensitive online help for more details). Finally, you can convert computation database files (*.F21) to ASCII format for subsequent processing by non-SES graphics or report packages or simply for transferring to other non-Intel PC-compatible computer platforms (see the context sensitive online help for more details).

6.3   Plotting and Reporting Results Using SES Output Processors

You can use the following three different tools to report and view your computation results.

- SESResultsViewer
- GRServer
- SESSystemViewer

Note that you still have access to the legacy Output Toolbox, if desired or necessary.

6.3.1 SESResultsViewer Configuration and Computation Plots and Reports Processor

SESResultsViewer 🦋 in the **Tools** folder processes the computation data and results of all computation modules in CDEGS, offering a complete solution for displaying the plots and reports in an integrated viewer. It presents a light layout with intuitive organization of its settings that use sensible defaults that, in turn, allow for a fast configuration of the settings in order to achieve the desired output results. This tool replaces the legacy Output Toolbox.
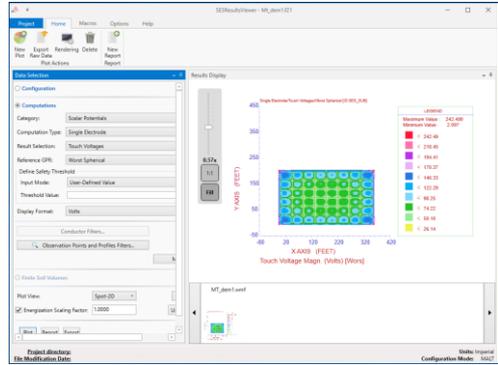
Data selection falls under the following general modules:

- **Configuration** option (found in MALT, MALZ, and HIFREQ modules, for plotting conductors and their currents or GPR, etc.).

- **Computation** option (found in all modules, for plotting computed earth currents, voltages, resistances, etc.).

Clicking on the **Plot** bottom will plot the desired data and clicking the **Report** button, will display the computation results in character-based format. You can select to plot 3D, side and top views of your systems and focus on the area of interest with the zoom ribbon on the left of the plot. You can also direct plots and reports to your screen or to a file.

There is also a **Define Safety Threshold** in the Computations tab with three drop-down options; **User-Defined Value**, **Default/Actual Threshold Stored Value** and **Specify in Threshold Module**. Choosing **Specify in Threshold Module** from the drop-down menu and clicking on the right side button 🔲 brings up the Safety window where you can define the safety criteria on which your safety assessment of the conductor network should be based. In other words, this feature provides you with the safe touch and step voltage thresholds as well as the safe body current reference value.
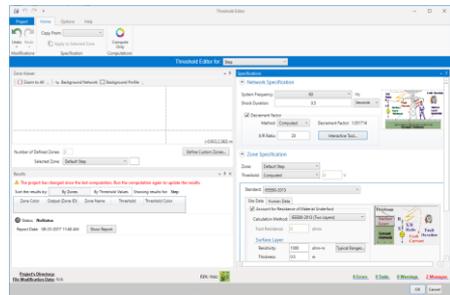
You will note that various standards as well as your own guidelines or rules can be selected using various options displayed as drop-down selection lists or in the write-in numerical fields in the **Zone Specification**.

Upon clicking the **Show Results** button from the Results section on the left side of the window, a safety report is generated for a single fault clearing time.

If one or more parameters are not specified by the user, then the touch and step voltage limits are computed based on the following default parameter values:

• Body Resistance = 1000 ohms
• Surface Resistivity = 1000 ohm-m
• Foot Resistance Calculation = IEEE Exact
• Fault Duration = 0.5 s
• Surface Layer = 6 inches (15.2 cm) of crushed rock

For detailed online help, hit the **F1** key after selecting an input field in the window.

6.3.2   GRServer Plotting and Reporting Software Tool

GRServer 🖼 in **Tools** is an Advanced Graphics and report output processor with input processing capabilities. GRServer can display, plot, and print configuration and computation results obtained using any SES's software package. GRServer also has the capability to view the input files, run the computation modules to populate the computation databases and view output files.

The plots which are created in each of the display windows are also created as thumbnails (plot icons) on the sidebar. Its multi-document structure makes it an efficient means to compare results and draw conclusions.

The window menu has six distinct components as shown here. The toolbar provides easy access to the most used features that can also be found in the menu bar. The six program (module)

buttons on the left sidebar are for loading the computation module databases for the programs other than the currently opened one. Clicking on any of these enabled buttons will automatically load the corresponding database. The plot icons (in the right sidebar) are the thumbnails of the plots created in the plot window space. Since the plot icon sidebar is scrollable, there is no limitation on
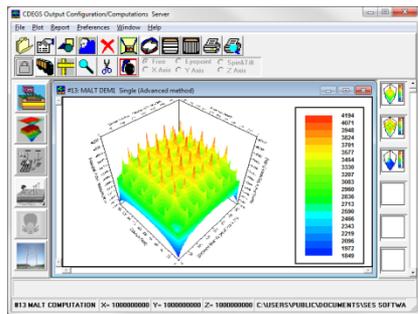
the number of icons it can contain. Clicking on a plot icon activates the plot window associated with the icon. A popup menu shows up when right-clicking on a plot icon. It is used to print, save, and delete the plots.

6.3.3   SESSystemViewer Interactive Plotting Tool

SESSystemViewer 🖼 in **Tools** is a powerful 3D graphics rendition software that allows you to visualize the complete system including the entire network and surrounding soil structure realistically as observed from a moving platform. Furthermore, computation results are displayed right on the system components.

It has the capability to display the system configuration specified by the MultiGround, MultiGroundZ or MultiFields software packages. Furthermore, all computation results pertaining to the system configur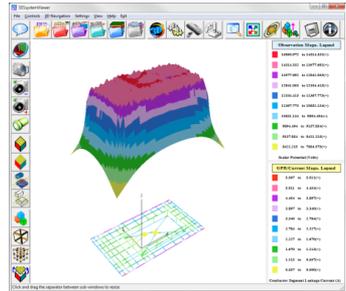ation can be displayed right on the system component itself in vivid spot colors that reflect the intensity of the displayed quantity (such as leakage and longitudinal currents, ground potential rises (GPR), etc.).

The main graphics computation engine of SESSystemViewer is driven by the OpenGL industry standard protocol. It is possible to display the conductor network, soil model structure and observation point computation results alone or simultaneously. Conductor data such as radius, material type, coating type or energization type can be displayed in various colors for easy rendition.

Computation results that can be displayed in various color intensities include the leakage currents, longitudinal currents at the origin or end of a conductor segment, the GPR of its metal, that of its coating or the coating stress voltage.

Plots of computation results carried out at specified observation points can be displayed in 3D or color spot form right on the system configuration model.

6.4   Further Details

The preceding description of the output session in CDEGS is by no means exhaustive. Many useful features are explained in the "**How To…**" engineering manuals and in the context sensitive online help. These documents can be found on the distribution media, under the folder: **\PDF**. The user should refer to these documents for a wealth of information on how to proceed to display useful reports and plots based on the computation results.

7   Tutorials and Getting Started with your Engineering Projects

7.1   Documentation

Now that you are somewhat familiar with the various SES's software packages and associated tools, you are ready to get started with your main concern, i.e., studying a practical engineering project. SES recommends that you proceed as follows:

SES's Software Tools and Utilities Manuals

Read the appropriate manual to become familiar with the various tool and utility programs provided with the software packages. The discussion of these utilities can be found in each utility's online help. An alternative and quite efficient means of becoming familiar with the tool or utility software is to start it and then use the context sensitive online help to learn and understand the software further.

"How To..." Engineering Manuals

If your engineering problem is similar to one of the many "**How To...**" engineering manuals provided with SES software, you should consult it for detailed guidance on how to proceed with your problem. The "**How To...**" engineering manuals provide extensive details on how to complete a typical engineering study using the SES software. These manuals can be found on the distribution media in the files located in the folder: **\PDF\HowTo**.

7.2   Reaching SES via EMAIL

E-mail us at:

info@sestech.com	Product and software brochure requests as well as project engineering requests.
sales@sestech.com	Pricing, sales-related, accounting, and administrative requests.
support@sestech.com	Software and engineering support services for SES's software users (includes demonstration packages to users).

7.3   Accessing the SES Web Site through the Internet

SES Web Site

Visit us on the Internet at www.sestech.com. The SES Web site contains CDEGS program updates, SES corporate profile, upcoming events sponsored by SES's software packages produced by SES, projects that SES has participated in over the years, pertinent peer-reviewed technical papers, various technical guidelines for measurements and project data requests, FAQs, information on SES's training and certification courses and its training facility, etc. If you have a suggestion on what you would like to see added to our Web site, send it to webmaster@sestech.com. The SES Web Site can also be reached by clicking the **Help** item (**Support Services**) of the main CDEGS menu bar.

Downloading Files

If you wish to access directly our software updates download area, visit the following URL: **www.sestech.com/Downloads/ServicePack.aspx** or just click on the SES software Downloads from the Help | Support Services submenu in the CDEGS program.

Note that you will be required to supply your user name and password in order to download software updates. All licensees under current support are given a valid user name and password to be able to download software updates. If you have lost this information, contact us. Once accessed, you will see a web page similar to the one shown here from where to begin downloading the desired updates.

For more information on the maintenance contract, please call SES: (450) 622-5000 or send email to **sales@sestech.com** or **support@sestech.com**.

8   File and Extension Naming Conventions

8.1   Introduction

SES provides a standardized environment for file and extension naming conventions. The standardization is important to easily recognize the different data files.

8.2   File Naming Conventions

The **JobID** is used to label all the files produced during a given CDEGS software package run. It is similar to the use of a scenario name to a given case to be studied. This helps identify the corresponding input, computation, results and plot files. Note that the **JobID** will also become a synonym of the project **Scenario** name in future versions. The CDEGS interface module will automatically insert the **JobID** string in the names of all files (unless manually overridden) created during a session. The default file naming convention is as follows:

XY_JobID.Fnn

Where **XY** is a two-letter abbreviation corresponding to the name of the program which created the file or which will read the file as input. The abbreviations used for the Software Computation Modules are as follows:

Application	Abbreviation		Application	Abbreviation
RESAP	RS		FCDIST	FC
MALT	MT		HIFREQ	HI
MALZ	MZ		FFTSES	FT
TRALIN	TR		SESEnviroPlus	TR
SPLITS	SP		SESShield-3D	SD
SESTLC	TC		ROWCAD	RC
SESShield	LS		SESeBundle	BE
GRSPLITS-3D	SP		CorrCAD	CC
AutoGroundDesign	AD		SESThreshold	TH
SESAmpacity	AP		SESCrossSection	XS
SESImpedance	FM		CSIRPS*	CS

For the input processors, the following abbreviations are used:

Interface Module	Abbreviation
SICL	SC

For the output processor SIRPS, the following abbreviations are used:

Interface Module	Abbreviation
CSIRPS	CS

8.3   Extension Naming Conventions

The default extension naming convention is as follows:

*XY_JobID.F**nn***

Where the **nn** digits are an extension used to indicate the type of file. The main file types are as follows:

FILE TYPE	FILE TYPE
Command input (for Software Computation Modules)	.INP, .F05
Computation results (for Software Computation Modules)	.F09
Computation database results of electromagnetic fields (EMF) produced by SPLITS	.F89
Auxiliary input (command and save files for input and output processors)	.F12
Computation database (for reports and graphic displays)	.F21
Plot files	.EMF, .WMF, .PS and .F30

Unique file types used by specific programs are as follows:

MODULE	FILE TYPE	EXTENSION
MALT	Current Distribution (output)	.F07
MALZ	Current Distribution (output)	.F17
TRALIN	Line Impedance Data (output)	.F27
SPLITS	Summary Computation Results (output)	.F07
HIFREQ	Current Distribution (output)	.F17
FFTSES	Spectrum Storage File	.F07
FFTSES	Recommended Frequency List	.F27
SICL	Session save file (output)	.F08
MALZ	Current distribution recovery file (input and output)	.F33
HIFREQ	Current distribution recovery file (input and output)	.F33
SIRPS	Summary report file (output)	.F17
Share File	Session save file (output)	.F08
AutoGrid Pro	Data Exchange File (share file)	SF_*jobid*.F11

Right-of-Way Software Package

FILE TYPE	EXTENSION
Project file	RW_ProjectName.row
Scenario file	RW_Scenario*.F05
Self and mutual impedances of all phases for all section cuts in a region (output)	TS_Scenario*_T*_R*.out
A SPLITS-compatible file. Where Scenario is the ScenarioName for the project and X is an integer representing the circuit ID for a SPLITS file, typically, 0, 1 …	SP_ScenarioName_X.F05
A SPLITS-compatible file (before modification). Where ScenarioName is the scenario name for the project and ReferenceCircuitModelID is an integer representing the reference ID for a SPLITS file, typically, 0, 1 …	SP_ ScenarioName _ReferenceCircuitModelID.F05
A SPLITS-compatible file (after modification). Where NewCircuitModelID is an integer representing the new ID for SPLITS file, typically, 1, 2…	SP_ ScenarioName _NewCircuitModelID.F05
The command file that records the operations made on a SPLITS file. It can be loaded by this module. X and Y are integers. X is the reference circuit model ID. Y is the new circuit model ID.	MODSP_ ScenarioName _X_Y.F05
Contains the maximum GPR of the exposed line at every section. Here, ScenarioName is the scenario ID for the project and ReferenceCircuitModelID is an integer representing the reference ID for a SPLITS file, typically, 0, 1 …	ExposedlineGPR_ScenarioName_ReferenceCircuitModelID_ExposedlinePhaseNumber.out
Contains the GPR of the exposed line at the fault locations. Here, ScenarioName is the scenario ID for the project and ReferenceCircuitModelID is an integer representing the reference ID for a SPLITS file, typically, 0, 1 …	ExposedlineGPR_FTLCT_ScenarioName_ReferenceCircuitModelID_ExposedlinePhaseNumber.out
Contains the maximum section current of the exposed line at every section. Here, ScenarioName is the scenario ID for the project and ReferenceCircuitModelID is an integer representing the reference ID for a SPLITS file, typically, 0, 1 …	ExposedlineCUR_ScenarioName_ReferenceCircuitModelID_ExposedlinePhaseNumber.out
Contains the section current of the exposed line at the fault locations. Here, ScenarioName is the scenario ID for the project and ReferenceCircuitModelID is an integer representing the reference ID for a SPLITS file, typically, 0, 1 …	ExposedlineCUR_FTLCT_ScenarioName_ReferenceCircuitModelID_ExposedlinePhaseNumber.out
Contains the maximum GPR of the reference line (i.e., tower shunt potential) at every section. Here, ScenarioName is the scenario ID for the project and ReferenceCircuitModelID is an integer representing the reference ID for a SPLITS file, typically, 0, 1 …	REFPOT_ScenarioName_ReferenceCircuitModelID.out

Right-of-Way Software Package (continued)

FILE TYPE	EXTENSION
Contains the maximum shunt current of the reference line (i.e., tower shunt current) at every section. Here, ScenarioName is the scenario ID for the project and ReferenceCircuitModelID is an integer representing the reference ID for a SPLITS file, typically, 0, 1 …	REFCUR_ScenarioName_ReferenceCircuitModelID.out
Contains the section current on the right side of the fault location (i.e., fault current contributed from the right side of the fault location). Here, ScenarioName is the scenario ID for the project and ReferenceCircuitModelID is an integer representing the reference ID for a SPLITS file, typically, 0, 1 …	FAULTCURRIGHT_ScenarioName_ReferenceCircuitModelID.out
Contains the section current on the left side of the fault location (i.e., fault current contributed from the left side of the fault location). Here, ScenarioName is the scenario ID for the project and ReferenceCircuitModelID is an integer representing the reference ID for a SPLITS file, typically, 0, 1 …	FAULTCURLEFT_ScenarioName_ReferenceCircuitModelID.out
Contains the maximum line-to-line voltages of the assigned exposed line (e.g.rail-to-rail voltage) at every section. Here, ScenarioName is the scenario ID for the project and ReferenceCircuitModelID is an integer representing the reference ID for a SPLITS file, typically, 0, 1 …	LTLDIFF_ScenarioName_ReferenceCircuitModelID.out
Contains the maximum GPR differences between the two points along an exposed line. Here, ScenarioName is the scenario ID for the project and ReferenceCircuitModelID is an integer representing the reference ID for a SPLITS file, typically, 0, 1 …	PIPEDIFF_ScenarioName_ReferenceCircuitModelID.out
Contains the maximum total interference GPR. Here, ScenarioName is the scenario ID for the project and ReferenceCircuitModelID is an integer representing the reference ID for a SPLITS file, typically, 0, 1 …	TotMetalGPR_ScenarioName_ReferenceCircuitModelID.out
Contains the maximum total interference coating stress voltage. Here, ScenarioName is the scenario ID for the project and ReferenceCircuitModelID is an integer representing the reference ID for a SPLITS file, typically, 0, 1 …	TotCoatingStressV_ScenarioName_ReferenceCircuitModelID.out

Please note that upon the installation of SES software, not all of the modules may be accessible; the purchased license determines which modules will be fully functional.

8.4   Shared Files for RESAP, MALT, SPLITS, FCDIST, and SIRPS

Some crucial data can be shared between the computation modules RESAP, MALT, SPLITS, FCDIST, and SIRPS. This facilitates data entry in complex studies where the output of one program becomes the input of another.

The RESAP program stores the computed soil model in a shared database file. This soil model is read and used by MALT if no other soil model is specified in its input file.

MALT prints the computed Main Ground resistance to the shared file, which will then be read by SPLITS or FCDIST if the Central Site ground impedance is not entered by the user. SPLITS and FCDIST store the current injected into the Central Site ground in the shared file, which can then be read by MALT (if it is run after SPLITS or FCDIST) if no Main Ground injection current is specified in MALT.

SIRPS reads the SPLITS or FCDIST central site ground current and divides it by the MALT input current (main ground) to obtain a scaling factor which can be applied to all values in SIRPS.

9   Description of SES's Software Computation Modules

9.1   Command Input Mode (SICL)

SICL (**S**ES **I**nteractive **C**ommand **L**anguage) is a flexible, command-driven input processor to the SES's software packages. The user controls operations of the processor by embedding in the input files simple English-like commands that are structured in a logical hierarchy. As a result of the command structure, SICL input files are highly readable (they are backward compatible since the introduction of the SICL command input files) and, therefore, very useful for documentation and reference purposes, especially when the input files are interspersed with pertinent comments.

On-line help provides the syntax and usage of SICL commands as well as discussions on special topics. SICL commands are clustered into groups according to function and thus form a hierarchy. These commands can be entered in ASCII (text) files using the dedicated **SESTextEditor** tool and any text editor including SES's MultiPad editor.

The Software Computation Modules described hereafter read directly the SICL input files in order to gather the required system data and perform the requested computations.

9.2   Software Computation Modules

The calculations are performed by the Software Computation Modules. Each of these modules reads data from a structured command input file and computes various results useful to electrical engineers and scientists as explained hereafter.

RESAP Computation Module

The RESAP computation module interprets measured soil resistivity data and determines equivalent earth structure models. The user enters apparent resistance or resistivity values which have been measured using Wenner, Schlumberger, Dipole-Dipole, Unipolar Wenner or arbitrary electrode arrays and RESAP determines a multilayered or exponential soil structure which most closely matches the measured results.

Soil models generated by RESAP can be used to analyze grounding systems, conduct cathodic protection studies, examine electromagnetic induction (EMI) problems and compute transmission line parameters.

MALT Computation Module

MALT is the oldest and most widely known computation module of the SES's software package. It is a powerful grounding analysis tool, which is useful whenever electrical conduction through earth must be studied; typically, MALT is used to analyze and design ground networks for HVAC and HVDC power stations, substations or transmission towers, or to design anode beds for cathodic protection installations. Other electrical engineering problems can also be accurately solved using MALT program. MALT can analyze complex ground networks of bare or coated conductors buried in vertically, horizontally, spherically, spheroidally, inclined or cylindrically layered soil, or in the air for Perfect soil model (bare or coated plates are also available for horizontally and Perfect soil models). It can also account for the presence of arbitrarily shaped regions of varying resistivities embedded in a uniform or horizontally layered soil.

Generally, MALT is suited to analyze all practical problems where DC or AC power frequency currents are injected into the earth by a ground network or multiple electrodes, so long as the longitudinal impedances of the ground conductors can be neglected. In this situation, the locations of the current injection points within the ground network do not play a significant role. At higher frequencies or increased ground network size or low soil resistivities, the longitudinal impedances of buried conductors cannot be neglected; consequently, MALT results may become inaccurate. For such analyses, it is preferable to use the MALZ or HIFREQ computation modules. HIFREQ is a unique analytical computation software code that can solve any electromagnetic problem involving a network of arbitrarily oriented aboveground and buried conductors energized by any number of current and voltage sources.

MALZ Computation Module

MALZ analyzes the frequency domain performance of networks of buried, current-carrying conductors and computes the following quantities:

- Magnetic field in the air.
- Conductor and earth potentials.
- Current distribution in the conductors.

It is particularly suited to analyzing extensive ground networks which cannot be considered to be equipotential surfaces or which interact with nearby coated pipelines. MALZ is also an excellent tool for analyzing conductor networks energized by currents at frequencies varying from 0 to about 0.5 to 1 MHz or for studying the cathodic protection of coated structures.

MALZ is similar to MALT, with the following main differences:

- MALZ computes magnetic fields, while MALT does not.

- MALZ accounts for attenuation along conductors and computes the potential drop which typically occurs in large conductor systems (e.g., along pipelines or in large plants), while MALT assumes ideal conductors (a valid assumption for power line structure and most small or moderate grounding systems in relatively moderate or high resistivity soils).

- MALZ allows you to specify the injection currents with arbitrary phase angles at multiple locations throughout the grounding system or systems modeled, while MALT allows multiple current or voltage injections of real-valued quantities (positive, zero or negative) on an arbitrary number of equipotential electrodes.

Note that MALZ can accommodate all of the soil structures, except Perfect soils, that can be modeled by MALT.

TRALIN Computation Module

TRALIN analyzes electric line cross sections to determine conductor line parameters, electrostatic and electromagnetic induction effects on ungrounded conductors, and electric fields in the air. TRALIN can be applied to industrial, distribution and transmission lines with any number and type of conductors or phases configured in any arbitrary positions: combinations of cables, pipelines, stranded and composite conductors, insulated and bare conductors, overhead and buried conductors, and irregular phase configurations.

Computations take into account the non-uniform nature of soil structure characteristics. TRALIN can be used to analyze complex Right-of-Way situations containing transmission lines, cables and pipelines just as easily as it can be used for simple power line corridors.

The most usual application of TRALIN is to compute series and shunt impedances of electric line conductors and nearby non-energized conductors such as pipelines and communications cables. These impedances are then used to create a circuit model which can be analyzed by the SPLITS computation module to compute currents flowing in all parts of the system (including metallic return paths) and potentials throughout the system.

SPLITS Computation Module

SPLITS is one of the most versatile computation modules of SES software. It determines the distribution of load and short circuit currents in every section or span of a multi-conductor, multi-phase electric transmission, distribution, or industrial network. It is also used to investigate electromagnetic interference effects caused by such conductors on neighboring facilities such as pipelines, communication lines, rails, fences, etc.

FCDIST Computation Module

FCDIST computes the distribution of fault currents between a grounding system and the overhead ground wires or neutral wires which are connected to it.

FCDIST is a synthesis of the TRALIN and SPLITS programs, which has been simplified in order to permit rapid modeling of a number of electric lines connected to a substation or plant. Only the faulted phase or conductor of each line is modeled and all spans associated with a given line are assumed to be identical. SPLITS and TRALIN should be used instead for more detailed modeling (e.g., modeling of all phases, modeling of networks with different characteristics in each span).

HIFREQ Computation Module

HIFREQ analyzes the performance of networks of buried and above-ground current-carrying conductors (thin metallic plates are also available for Infinite, Uniform and horizontally 2-layer soil models) and cables and computes the following quantities:

- Magnetic field in the air and in the earth.
- Electric field in the air and in the earth.
- Conductor and earth potentials.
- Current distribution in the conductors.
- Self and mutual impedances and capacitances of conductors and arbitrary shaped circuits.

HIFREQ is particularly suited to analyzing extensive conductor networks including grounding systems energized at frequencies ranging from 0 Hz to hundreds of MHz. It can model transformers, GIS, GIL, power cables and pipe-type cables as well. Using appropriate software such as FFTSES, the transient response of any network of conductors is easily determined. Electromagnetic compatibility studies, safety EMF studies involving determination of magnetic and electric field levels, and interference studies are a few of the many possible applications of this powerful computer program.

FFTSES Computation Module

FFTSES performs Forward and Inverse Fast Fourier Transforms on arbitrary transient waveforms to be studied by frequency domain computation modules such as MALZ, HIFREQ, and SPLITS.

Since MALZ, SPLITS, and HIFREQ all operate in the frequency domain, FFTSES is an important complement to these programs for the study of transients

and surges. Of course, FFTSES can be used independently whenever Fast Fourier Transforms on waveforms are to be studied.

9.3   How To… Engineering Manuals

The following table provides a quick reference that will help you locate the appropriate software package "**How To…**" engineering manual.

CDEGS Software Package

Pertinent PDF "HOW …TO" Manual	SES-Shield 3D	SES-EnviroPlus	AutoGroundDesign	AutoGrid Pro	AutoGround	MultiGround	MultiGround +	MultiGroundZ	MultiGroundZ +	MultiLines	MultiFieldsPro	MultiFields	MultiFields +	SESTLC Pro	Right-of-Way Pro	Full CDEGS	CorrCAD
AutoGroundDesign			✓	✓	✓	✓	✓	✓	✓		✓					✓	
AutoGrid Pro				✓	✓	✓	✓	✓	✓		✓					✓	
Ground				✓	✓	✓	✓	✓	✓		✓					✓	
GISGRND								✓	✓		✓	✓	✓			✓	
Suburban								✓	✓		✓	✓	✓			✓	
Urban								✓	✓		✓	✓	✓			✓	
RLC											✓	✓	✓			✓	
Capind											✓	✓	✓			✓	
Fence											✓	✓	✓			✓	
Tower											✓	✓	✓			✓	
Lightn											✓	✓	✓			✓	
Interf									✓				✓		✓	✓	
RowInterf									✓				✓		✓	✓	
ACTotalInterference Study					✓				✓		✓	✓	✓		✓	✓	
SESEnviroPlus		✓				✓		✓	✓		✓				✓	✓	
Quick Start Guide SESShield-3D	✓					✓		✓			✓					✓	
SESTLC EMF and AC Interference						✓		✓				✓		✓	✓	✓	
QuickStartGuide CorrCAD									✓		✓	✓	✓		✓	✓	✓
QuickStartGuide ROW									✓				✓		✓	✓	
QuickStartGuide RowCAD									✓				✓		✓	✓	

SESShield-3D-Direct Lightning Stroke Shielding of a Substation	☑						☑		☑		☑		☑		☑	
Importing DXF Drawing Into SESShield-3D	☑						☑		☑		☑		☑			☑	