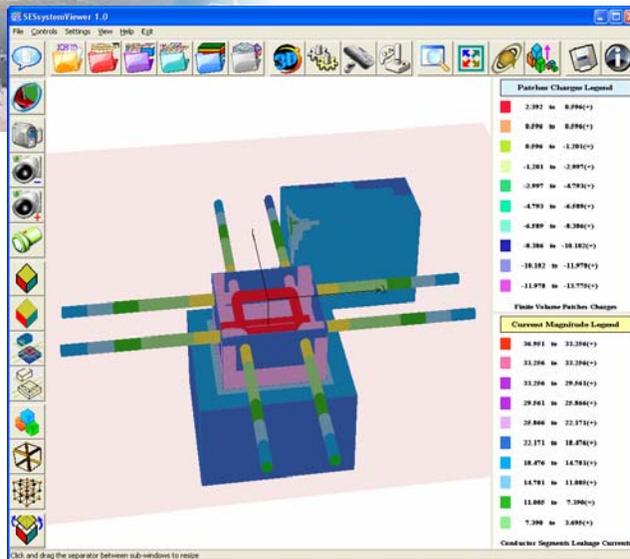


# CDEGS

**Soil Resistivity Measurements Interpretation**  
**Grounding / Earthing Analysis**  
**Line and Cable Parameter Computations**  
**Fault Current Split & Distribution Analysis**



**Electric Environmental Impact Assessment**  
**(Corona, Audible and Radio Noise)**

**EMI & EMC Analysis and Mitigation (Inductive, Capacitive & Conductive Interference)**

**Electromagnetic Fields Analysis**

**Lightning Shielding Analysis**

**Lightning & Surge Transients Analysis**



*Validated since 1974 by scientists from all continents, it is trusted and used by leading professionals around the world*



*A Complete Solution Package ...*

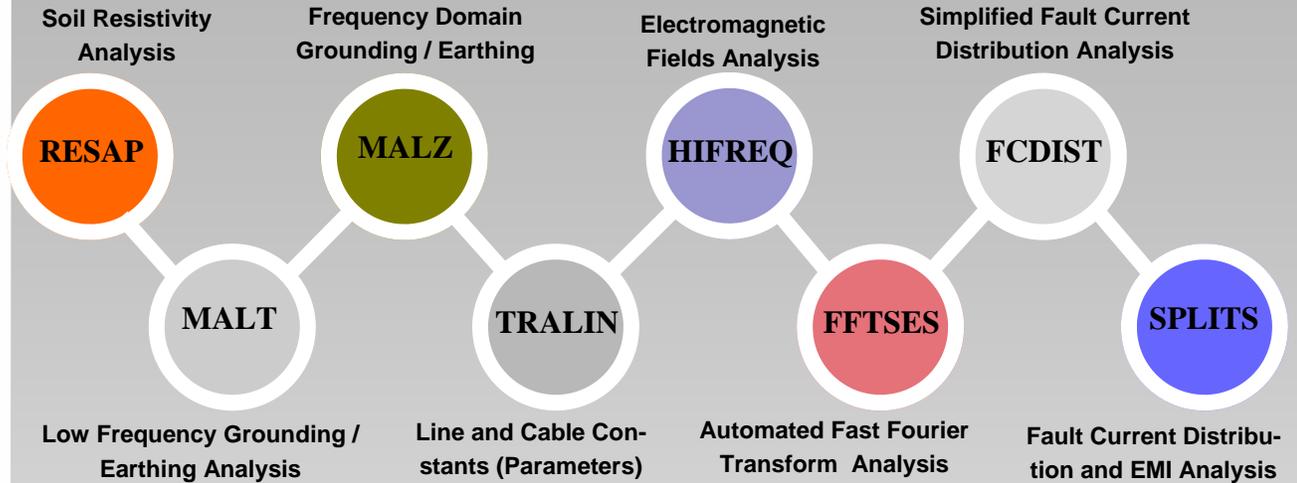
**The Ultimate Grounding / Earthing and EMI Software Package**



World Leader in Grounding & EMI

[www.sestech.com](http://www.sestech.com)

The CDEGS software package (Current Distribution, Electromagnetic Fields, Grounding and Soil Structure Analysis) is dedicated 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. CDEGS software suite of packages consists of eight powerful and accurate computation engines (modules) and several software automation and utility tools that bind the various components together. The computation modules are:



CDEGS consists of eleven software packages and four specialized packages that are dedicated to solving classical as well as challenging problems. They are shown below. More detailed information is given in the individual brochures of each package.

### Grounding / Earthing Analysis

- ◆ AutoGroundDesign
- ◆ AutoGridPro
- ◆ AutoGround
- ◆ MultiGround, MultiGround+
- ◆ MultiGroundZ, MultiGroundZ+

### Electromagnetic Interference Analysis

- ◆ MultiFields, MultiFields+
- ◆ MultiLines+
- ◆ Right-of-Way
- ◆ SESTLC+

### Electrical Environmental Impact Assessment

- ◆ SESEnviro
- ◆ MultiGround+
- ◆ MultiGroundZ+
- ◆ Right-of-Way
- ◆ MultiLines, MultiLines+
- ◆ MultiFields+

### Switching and Lightning Surge Transient Analysis

- ◆ MultiLines+
- ◆ MultiFields+

### Line & Cable Parameter Computations

- ◆ MultiLines, MultiLines+
- ◆ Right-of-Way
- ◆ MultiGround+
- ◆ SESTLC, SESTLC+

### Lightning Shielding

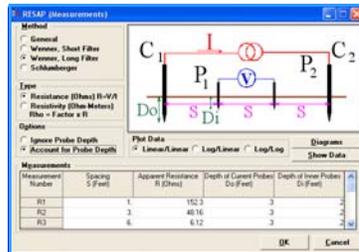
- ◆ SES-Shield

CDEGS computes conductor currents and electromagnetic fields generated by an arbitrary network of energized conductors anywhere above or below ground for normal, fault, lightning and transient conditions. CDEGS models simple and multi-component conductors, including bare, coated pipes and pipe-enclosed cable systems buried in complex soil structures. CDEGS coupled with toll-free support from the world's leading R&D design team, provide you with an array of cost-effective learning aids for areas ranging from simple grounding grid design to the behavior of complex networks of aboveground and buried conductors energized by lightning or other transients. By providing you with a powerful drawing tool and allowing you to exchange graphical data with CAD software supporting DXF, CDEGS makes data entry efficient. Flexible data reporting and graphing utilities allow you to collect and illustrate any important aspect of the results.

MultiGround+, MultiGround and AutoGround are three powerful and easy to use software packages dedicated to grounding / earthing and conductive coupling analyses. All three packages offer a flexible and accurate design tool for the most complex grounding systems. The RESAP, MALT and FCDIST computation engines (modules) make up the core of these software packages.

## MultiGround Capabilities

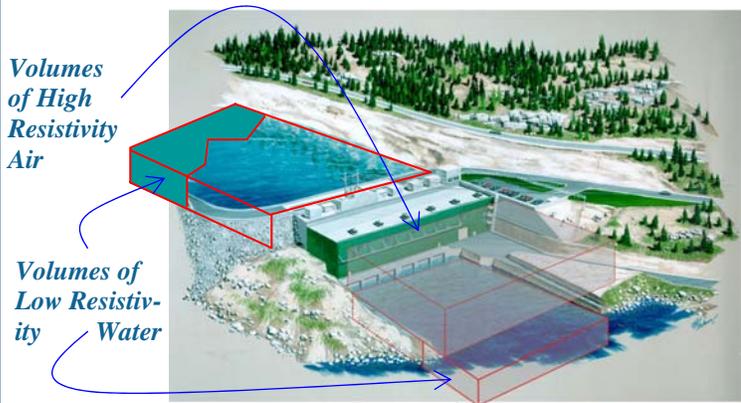
- ◆ Carry out and interpret resistivity measurements using Wenner, Schlumberger, or Dipole-Dipole techniques... or select your own arbitrary electrode spacing configuration. Select horizontal, vertical or exponential multilayered soil structures.
- ◆ Analyze complex power system ground networks composed of arbitrarily oriented conductors located in multilayered soils (vertical, horizontal, spherical or cylindrical) or in soils with finite volumes with other resistivities, such as water upstream and downstream of a dam!
- ◆ Use SESSystemViewer to visualize every aspect of the problem by displaying input data and computation results right on a 3D representation of the complete system!
- ◆ Model any number of complex three-dimensional grounding systems consisting of arbitrarily oriented conductors. You can even model metallic plates accurately.



- ◆ Determine the fault current distribution between grounding systems and overhead ground wires, skywires, counterpoises, and other metallic paths.
- ◆ Automatically generate safety tables of touch and step voltages determined according to national, international or your own specific standards, as well as plots of grid "hotspots," to help you quickly refine your grounding designs.
- ◆ You can very easily focus on dangerous zones and identify over-designed regions to optimize your final design.

## AutoGround Capabilities

AutoGround is identical to MultiGround, except that it handles uniform and horizontal two-layer soil grounding analyses only.



- ◆ Hybrid energization by current or voltage can be applied to different conductor groups in the same simulation.
- ◆ Investigate transferred potentials and currents diverted to uncoated pipelines or other metallic structures due to energized ground conductor networks.
- ◆ Simulate complex anode beds and examine cathodic protection problems involving uncoated buried pipelines (use MultiFields for coated pipes).
- ◆ Interpret ground resistance measurements made using the Fall-of-Potential method and other techniques.

## MultiGround+ Capabilities

MultiGround+ includes MultiGround as well as the MultiLines+ package, thereby adding the TRALIN and SPLITS engineering modules. The additional capabilities are:

- ◆ Determines inductive and capacitive interference between energized and non energized conductors or metallic paths sharing the same right-of-way.
- ◆ Computes conductor and cable constants (parameters) and capacitive and electromagnetic induction effects.
- ◆ Develops detailed circuit models to calculate load and short-circuit current distributions in every section of a multi-conductor, multi-phase power network, whether balanced or not.
- ◆ Analyzes complex, multi-phase, multi-winding transformers in full detail. Built-in single-phase and 3-phase multi-winding transformer models, including autotransformers, are also available.

MultiLines is the ideal tool for calculating the line constants of any complex arrangement of conductors, including cables, pipes and pipe-enclosed cables, whether buried or aboveground. It also computes capacitive and electromagnetic induction effects on ungrounded conductors and electric fields generated by energized conductors in air. Moreover it can be used to determine fault current distributions between a central grounding system and all conductor paths including neutrals, shield wires, metallic sheaths and counterpoises. Furthermore, detailed inductive interference analyses involving grounded or ungrounded conductors can be conducted accurately using MultiLines+.

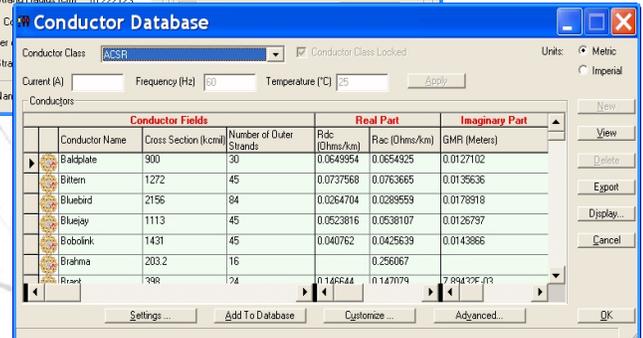
## MultiLines

MultiLines consists of the TRALIN and FCDIST modules. MultiLines features the following capabilities:



- ◆ Accommodates any arrangement of multi-phase conductors: pipe-enclosed cables, pipelines, solid, hollow, stranded and composite conductors, insulated and bare conductors, overhead and buried conductors, and irregular phase configurations. All cable conductors can have a core, sheath, armor, and arbitrary insulations.
- ◆ Computes Maxwell potential coefficients, shunt capacitances, self and mutual impedances, and admittances for all conductors on a per-conductor basis or a per-phase basis, with skywires or static wires being eliminated or treated as distinct conductors, at your option. Get phase or symmetrical sequence domain components.
- ◆ For regular overhead conductor arrangements, conductor characteristics can be specified on a per-circuit basis and the phase bundle configuration is specified to reduce data entry time.
- ◆ For overhead conductor arrangements with little regularity, conductors can be specified one at a time and may be completely different from one another.
- ◆ For systems which include buried conductors such as pipelines and pipe-enclosed cables, conductors are specified individually or as a group.
- ◆ An extensive conductor database is available to ease input operations.
- ◆ Frequency, skin effects, and earth characteristics are accurately accounted for. The thickness, resistivity, permeability and permittivity of up to three horizontal soil layers can be specified.
- ◆ Computes the magnetically induced voltages resulting in ungrounded conductors based on the currents you specify for the other conductors. Also, computes the electrostatic potential induced in one conductor due to the potentials you specify on the other conductors.

- ◆ Determines electric fields generated by overhead conductors at any set of points on conductor surfaces and elsewhere.
- ◆ Analyzes simple circuit models to calculate residual and short-circuit current distributions in every span of the neutrals (and other metallic return paths) of a multi-terminal power network.



## MultiLines+

MultiLines+ consists of the TRALIN, FCDIST and SPLITS engineering modules. The SPLITS module adds the following capabilities to the MultiLines software package:

- ◆ Simulates detailed circuit models to calculate load, residual and short-circuit current distributions in every span of a multi-conductor, multi-phase power network, whether balanced or not.
- ◆ Analyzes electromagnetic interference effects, currents and voltages in every span of a multiconductor, multi-phase power network and in neighboring victim circuits sharing the same corridor.
- ◆ Ground impedances or interconnections to other conductors can be specified for any number of conductors at any number of locations.
- ◆ Analyzes complex, multi-phase, multi-winding transformers in full detail. Built-in single-phase and 3-phase multi-winding transformer models, including autotransformers, are also available.

# MultiFields®

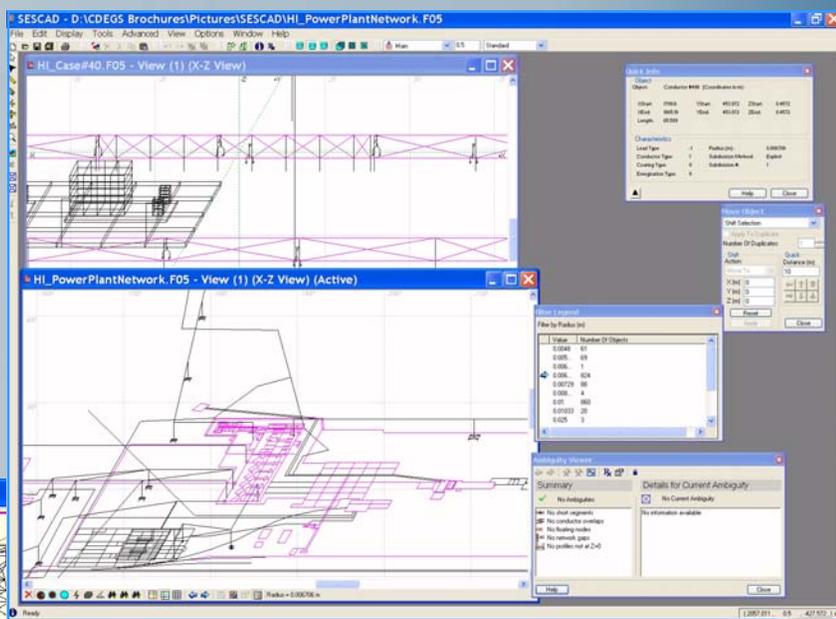
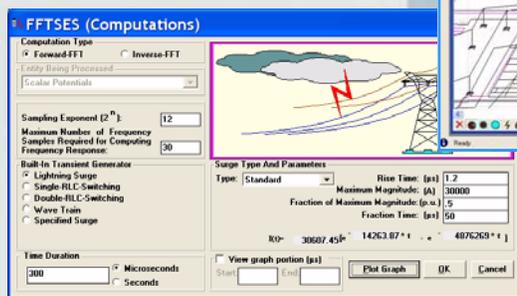
# MultiFields+®

MultiFields is a unique engineering tool 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. MultiFields is a dream come true for those who have to tackle complex electromagnetic problems involving conductor networks. MultiFields is probably the only software that can provide accurate solutions to transient and steady-state problems in the frequency range of 0 to hundreds of megahertz. The central components of MultiFields are the RESAP, HIFREQ, MALZ, and FFTSES computation engines. Uniform and multilayer soils are supported.

## MultiFields

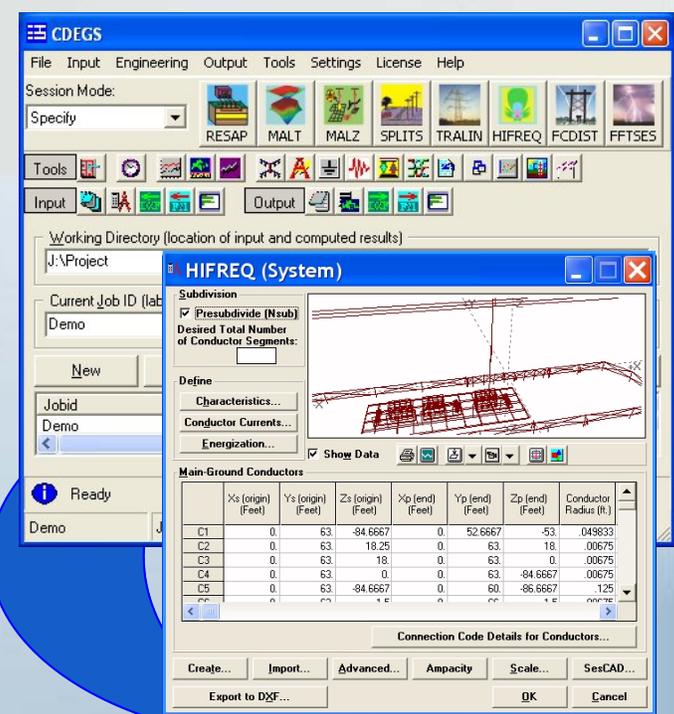
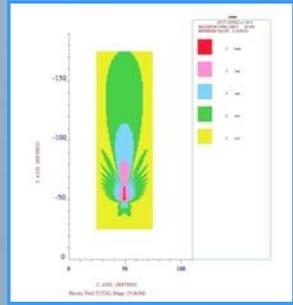
With MultiFields you can:

- ◆ Study transients (such as lightning, switching surges and any conceivable surge problem) and high frequency disturbances on power system networks, structures and grounding systems at frequencies ranging from a few hertz to hundreds of megahertz.
- ◆ Calculate current and potential distributions in all conductors, EMF values in air and soil and voltages along well defined paths due to buried or in-air power system conductors and structures.
- ◆ Calculate electromagnetic interference to pipelines, communication lines, etc., in one single step. Inductive, capacitive and conductive effects are accounted for simultaneously!
- ◆ Use the FFTSES module, a fully integrated and automated Fourier Transform tool, to visualize electromagnetic fields in the time domain.



MultiFields Tackles the Most Challenging Electromagnetic Problems Head-On ...

- ◆ Calculate induction between arbitrary circuits at low and high frequencies and during surge conditions. Determine self and mutual impedances as well as capacitances of these circuits regardless of whether they are located above or below ground!
- ◆ Study re-radiation interference or calculate current distributions in monopole, quarter-wave, and other antenna structures excited at frequencies reaching hundreds of megahertz.
- ◆ Every conductor can be the source of current, voltage or potential energization. Every conductor can be loaded at its center with a lumped impedance (R, L, C). Single phase or multiphase transformers can be inserted anywhere in the conductor network.



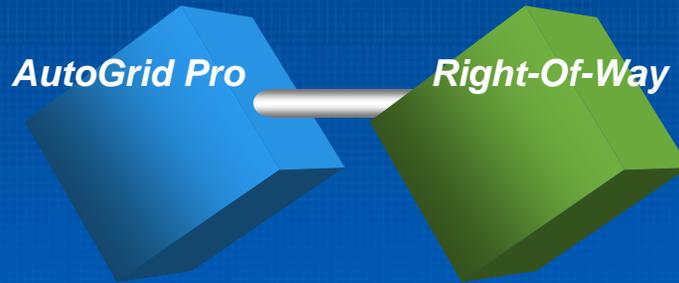
## MultiFields+

MultiFields+ adds the capability to analyze complex right-of-way electromagnetic interference problems using circuit theory. MultiFields+ calculates line constants as well as load and short-circuit current distributions in every span of a multi-conductor, multi-phase power network and induced voltages and currents throughout neighboring circuits sharing the same corridor. The power network may be balanced or not.

# Specialized Software Packages

CDEGS includes several specialized software packages, especially designed to tackle challenging problems, that speed up the input tasks, automate repetitive runs and expedite the output processes. These software packages unleash all their power through an unprecedented level of data input simplicity, which dramatically increases productivity.

A simple, integrated and automated environment for studying grounding systems of any shape and size (including 3D ones) buried in multilayered or arbitrarily defined soil models.



An integrated software package for computing induced voltages and currents caused by electromagnetic interference from electric power lines and cables on pipelines, railways, communication or other victim lines.

**Automated**  
**Accurate**

**Simple**



The only software package that determines automatically the optimal design of rectangular grounding grids buried in layered soil by calculating the maximum mesh size allowed to meet specified safety criteria. Determines the ground resistance of a variety of grounding systems and electrodes or determines the required size that meets this resistance.

An easy-to-use program that quickly estimates line parameters and electro-magnetic fields around transmission lines, as well as the conductive and inductive interference levels caused by transmission lines on adjacent metallic structures.

SESEnviro evaluates the environmental impact of transmission lines with respect to radio interference, acoustical noise, corona loss, and electro-magnetic fields.

A professional's tool for providing optimum solutions for the protection of transmission lines and substations against direct lightning strikes.

For more details, please download the pertinent brochures from SES web site or contact SES

[www.sestech.com](http://www.sestech.com)

SES software package unleashes all of its engineering power through an unprecedented level of data input simplicity and various tools and utilities that help you speed up the input tasks, automate repetitive runs and expedite the output processes while dramatically increasing productivity. Some of these tools are described here. Refer to the individual brochures for more details.

# Tools and Utilities



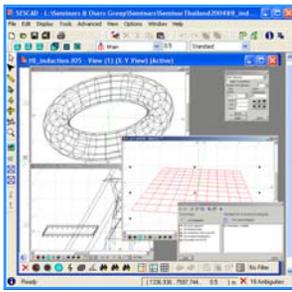
## SESCAD

An Object-Based Graphical Environment for the Specification and Development of Arbitrary Networks of Conductors.

SESCAD is a CAD processor for viewing and editing three-dimensional networks consisting of straight conductor segments.

It uses an object-oriented approach to network development. Elementary objects (conductors and observation profiles) can be created by simply drawing them or by entering data in dialogs boxes.

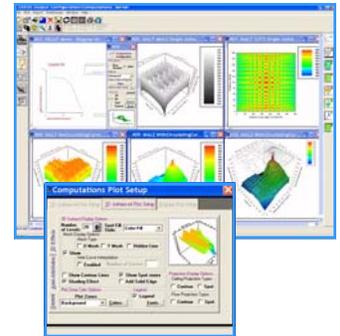
Object databases and smart buttons allow you to easily automate the creation of complicated structures, conductor networks or grounding electrodes.



## GRServer

An advanced graphics and report tool with input processing capabilities. It can display, plot, and print configuration and computation results.

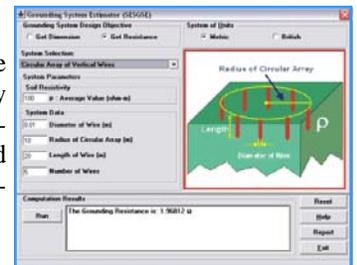
The 3D computations setup window offers a number of different 3D plot options in the General, Axis Attributes and 3D Effects panels. They include options such as displaying floor and ceiling projections of the graph surface, displaying contour lines and spot zones, spot-fill styles, and 3D effects.



## SEGSE

A Grounding System Estimator

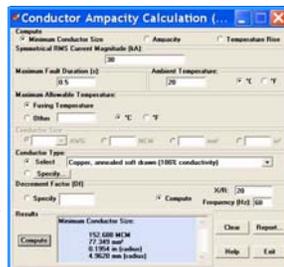
The SEGSE program is a simple tool which allows you to quickly determine the type of grounding system required to achieve a specified grounding resistance value. A uniform soil model is assumed.



## Ampacity

The Ampacity utility computes minimum conductor size, conductor ampacity or conductor temperature rise during a fault. One of the 3 values is computed each time the calculation is launched.

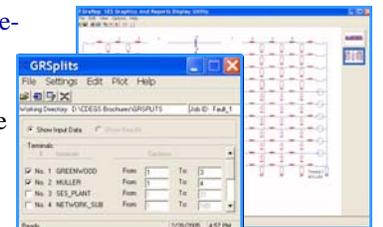
Based on the detailed equation provided in ANSI/IEEE Standard 80 for the calculation of ampacity for symmetrical currents. To account for asymmetrical current characteristics (i.e., dc offset), the symmetrical current is increased in accordance with the decrement factor presented in the same standard.



## GRSplits

To visualize the circuit model represented by a SPLITS or FCDIST input file.

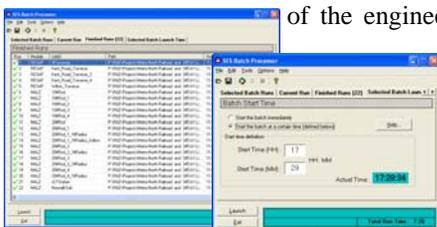
This program greatly simplifies the task of manipulating, visualizing and checking the components of a SPLITS or FCDIST circuit.



## SESBatch

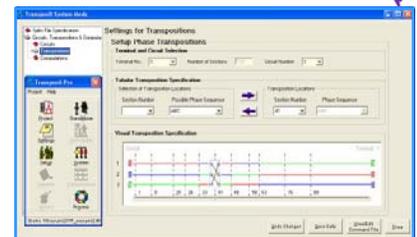
A flexible, powerful batch processor for multiple case analyses

Often it is necessary to examine a large number of scenarios. These cases, which have similar input data, require multiple runs of the engineering modules. It is therefore desirable and efficient to stack all of these runs together and let the computer do the work unattended (batch processing).



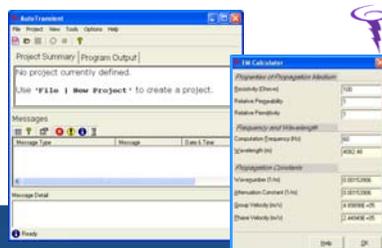
## TransposIT

A utility that automates conductor transposition (phase transpositions, cable sheath cross-bonding, etc.). An excellent tool for the analysis of the optimum transposition scheme of a power system network.



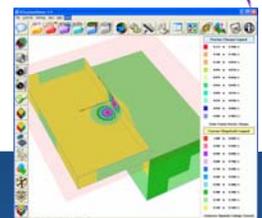
## AutoTransient

Complete automation of FFTSES and HIFREQ for the analysis of transient phenomena in the time domain.



## SESystemViewer

A powerful 3D graphics engine that allows you to visualize the complete network and surrounding soil structure. Computation results are displayed right on the system components.



## Documentation

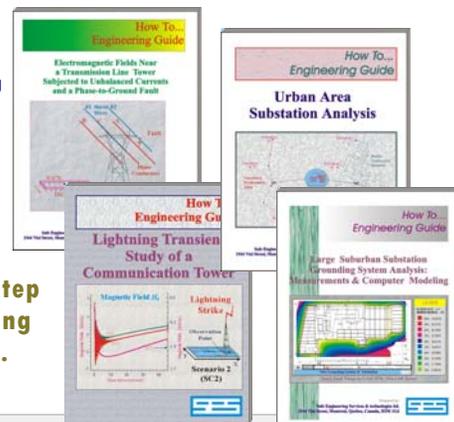
Documentation is a critical item when dealing with engineering software. Potential users should examine thoroughly the documentation in order to properly evaluate a software package.

SES regularly publishes technical papers in Transactions journals and presents papers at various international conferences on engineering topics related to power system grounding (including analysis of transients and lightning), EMF studies and AC interference. SES also undertakes landmark applied R&D studies in these areas. These studies have not ever been undertaken before with the accuracy and detail of which our modern computer-based technology is capable today. This R&D is now being distilled into "How To..."

engineering manuals at a level of detail designed for both novices and advanced users who encounter similar problems and wish to model them with the SES software. These unique, detailed, step-by-step "How To..." engineering manuals guide you through the most complex analysis and design projects (both the engineering concepts, and the use of the software are described).

SES distributes a complete documentation set with its software in electronic form (on CD-ROM) and provides hard copy as well. Furthermore, significant information on new or updated software is made available on the SES web site. The main documentation set supplied with the software package consists of Quick Installa-

tion and System Requirements sheets and booklets, a Getting Started manual, more than ten "How to..." engineering manuals, on-line context sensitive help, Annual Users' Group Meeting Proceedings, Users' Group Newsletters, and an extensive Technical Reference document containing a detailed description of the analytical methods used by the various SES engineering modules.



**Step-by-step  
Engineering  
How-to ...**

## Accuracy and Validation

If there is an item which is of primary importance when dealing with engineering software, it is definitely validation & accuracy. Extensive scientific validation of the software by means of field tests and comparisons with analytical and published research results is documented in hundreds of technical papers published by the most reputed international journals. Each mod-

ule has been tested to insure that it produces the correct results for a large number of cases documented at SES, which include several fundamental cases available to users on CD-ROM. The evolving software is continuously validated over the years using the following three well documented mechanisms (visit our Web site for more detailed information).

- ◆ **Field Tests and Experimental Scale Models**
- ◆ **Comparisons with Scientific Published Results**
- ◆ **Comparisons with Similar Programs Using Completely Different Techniques**

## Technical Support & Software Updates

As part of its ongoing commitment to provide state-of-the-art analysis and design tools, help to use the software as effectively as possible and information on recent R&D advances, SES invests considerable resources in its software development and analytical R&D programs. SES disseminates new technological developments in two ways: by means of engineering applications support and by means of software updates, enhancements and additions.

SES' legendary international toll-free hotlines connect you instantly to SES' software and engineering support team via telephone, fax, and Internet, no matter where you are on this planet. The support covers a wide range of engineering and software topics and is not restricted by

time limits. Telephone access is toll-free for all international users. It's like having the world's foremost experts at your side any time you are ready to tackle your most challenging study or design. SES provides all licensees with support covering installation, updates, and technical support, as well as extended engineering support. SES realizes that veteran software users are becoming overloaded or transferred to other positions as a result of the present economic turmoil and therefore is diligent in providing extensive assistance to new users who must be introduced to the software to share some of the load. Extended technical support is not only on the use of the software but includes also assistance on engineering topics related to the fields encompassed by the software whether or not SES soft-

ware is being used.

The SES software maintenance and update service provides subscribers with new technology in the form of new software (at least two major software releases per year, with instantaneous access to updates and enhancements through FTP downloads or by visiting SES Internet Web Site), along with comprehensive telephone /fax/ Internet support to users requesting assistance in installing or running the software. Extended engineering support is "topics-oriented" and covers help in solving challenging problems that users encounter in their daily work, whether it involves use of the software or not. In addition, SES personnel provide engineering seminars held at various locations, including workshops at customers' sites.



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