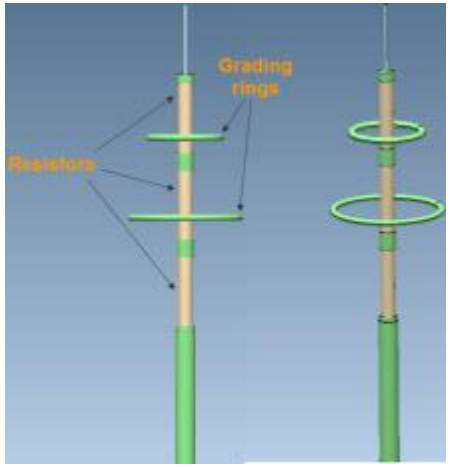
SIEMENS
Ingenuity for life

Minimizing Electric Field Stress in Surge Arresters

Unrestricted © Siemens AG 2018

Minimizing Electric Field Stress in Surge Arresters

SIEMENS
Ingenuity for life



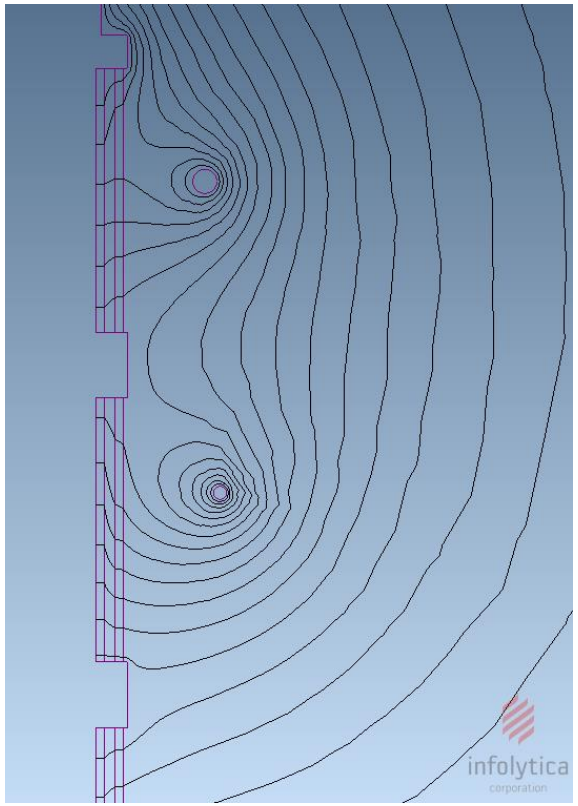
The voltage distribution along the resistors in a surge arrester is uneven due to stray capacitances. It is possible to reduce the maximum electric field stress by a careful choice of position for the grading rings.

In this example, Simcenter MAGNET Design Optimizer is used with Simcenter MAGNET Electric Field to find where the rings should be placed, and what their dimensions should be, in order to minimize the total electric field stress in the resistors.

Unrestricted © Siemens AG 2018

RESISTORS ELECTRIC FIELD EQUIPOTENTIAL LINES

SIEMENS
Ingenuity for life

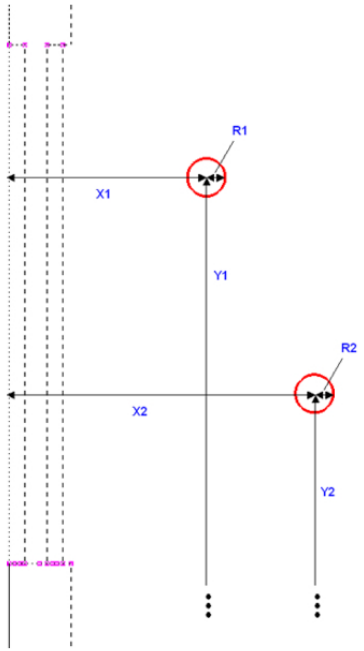


The electric field for the surge arrester is obtained using Simcenter MAGNET Electric Field. This figure displays the equipotential lines in the resistors and surrounding air.

Unrestricted © Siemens AG 2018

IDENTIFYING THE PARAMETERS

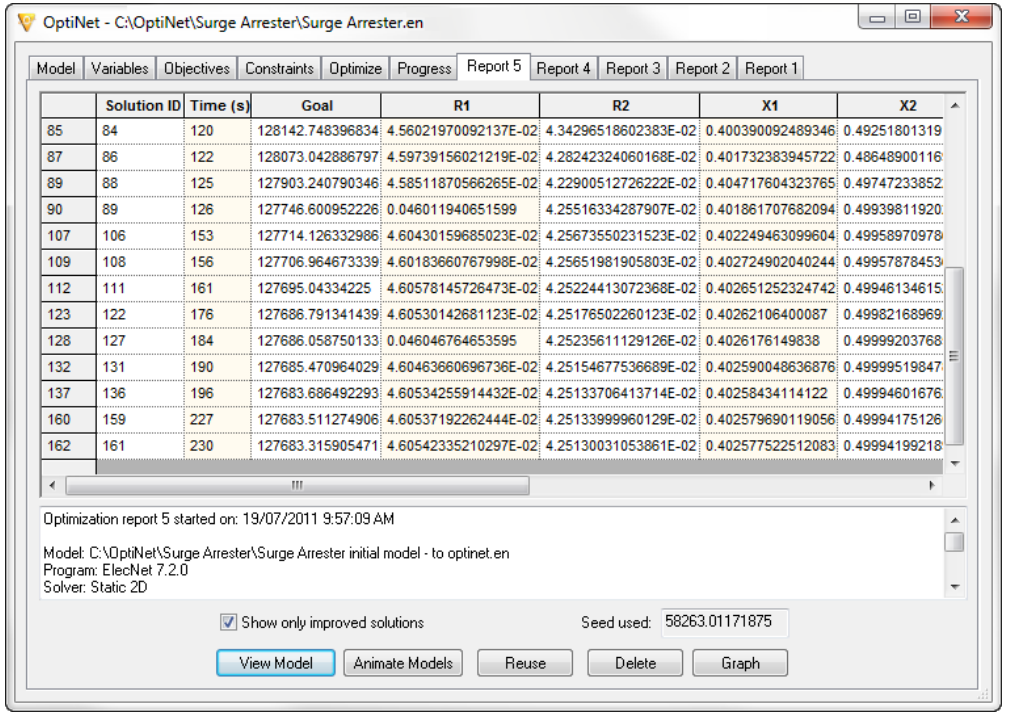
SIEMENS
Ingenuity for life



This figure shows the parameters that control the placing and the size of the grading rings. In Simcenter MAGNET Design Optimizer, the user specifies a minimum and a maximum value for those variables that can change, and Simcenter MAGNET Design Optimizer limits the searches within this range to find the optimum design.

Unrestricted © Siemens AG 2018

OBJECTIVE FUNCTION - ELECTRIC FIELD IN THE RESISTORS



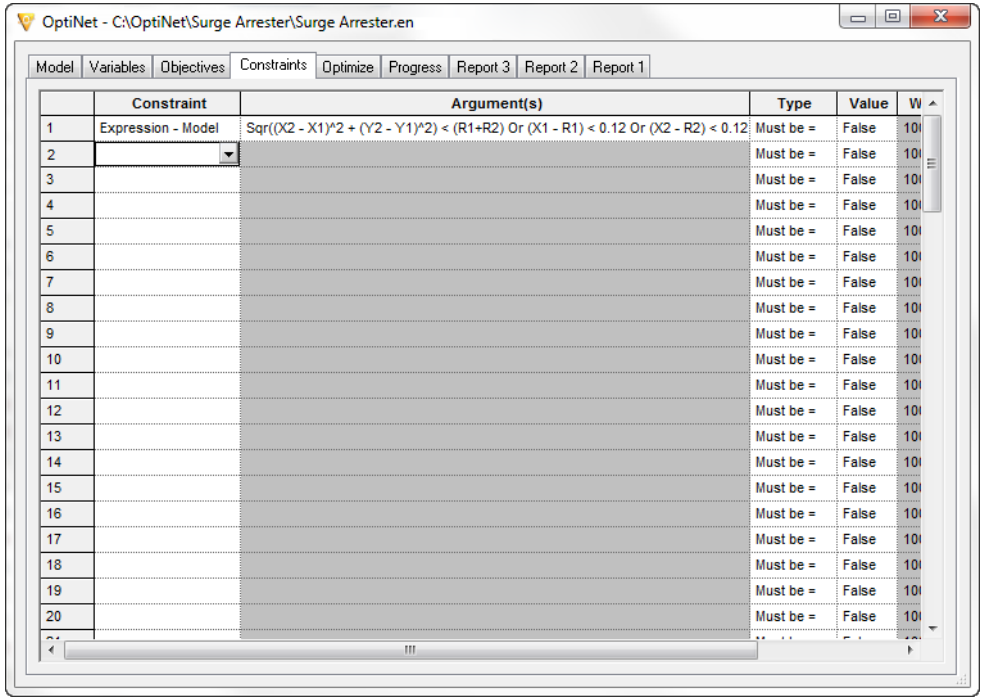
	Solution ID	Time (s)	Goal	R1	R2	X1	X2
85	84	120	128142.748396834	4.56021970092137E-02	4.34296518602383E-02	0.400390092489346	0.49251801319
87	86	122	128073.042886797	4.59739156021219E-02	4.28242324060168E-02	0.401732383945722	0.48648900116
89	88	125	127903.240790346	4.58511870566265E-02	4.22900512726222E-02	0.404717604323765	0.49747233852
90	89	126	127746.600952226	0.046011940651599	4.25516334287907E-02	0.401861707682094	0.49939811920
107	106	153	127714.126332986	4.60430159685023E-02	4.25673550231523E-02	0.402249463099604	0.49958970978
109	108	156	127706.964673339	4.60183660767998E-02	4.25651981905803E-02	0.402724902040244	0.49957878453
112	111	161	127695.04334225	4.60578145726473E-02	4.25224413072368E-02	0.402651252324742	0.49946134615
123	122	176	127686.791341439	4.60530142681123E-02	4.25176502260123E-02	0.40262106400087	0.49982168969
128	127	184	127686.058750133	0.046046764653595	4.25235611129126E-02	0.4026176149838	0.49999203768
132	131	190	127685.470964029	4.60463660696736E-02	4.25154677536689E-02	0.402590048636876	0.49999519847
137	136	196	127683.686492293	4.60534255914432E-02	4.25133706413714E-02	0.40258434114122	0.49994601676
160	159	227	127683.511274906	4.60537192262444E-02	4.25133999960129E-02	0.402579690119056	0.49994175126
162	161	230	127683.315905471	4.60542335210297E-02	4.25130031053861E-02	0.402577522512083	0.49994199218

The goal is to minimize the electric field magnitude in the resistors. In Simcenter MAGNET Design Optimizer, basic quantities, such as the maximum field value in a component, are easily available.

Unrestricted © Siemens AG 2018

SETTING THE CONSTRAINTS

SIEMENS
Ingenuity for life

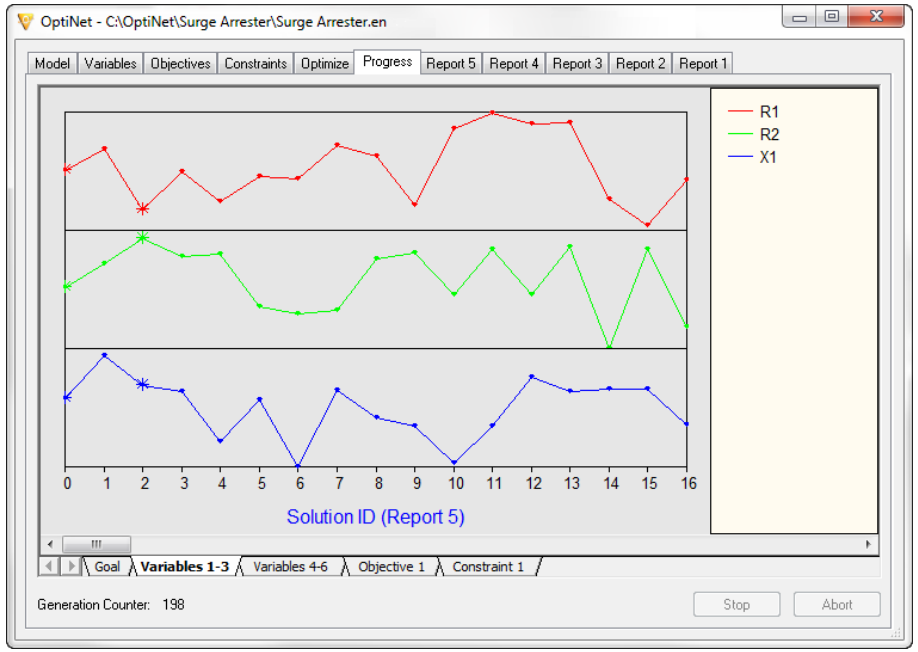


The constraints in this optimization process are pure physical ones: the two ring must not overlap and the rings cannot be less than 5mm from the surge arrester.

Unrestricted © Siemens AG 2018

GRAPH OF VARIABLES

SIEMENS
Ingenuity for life

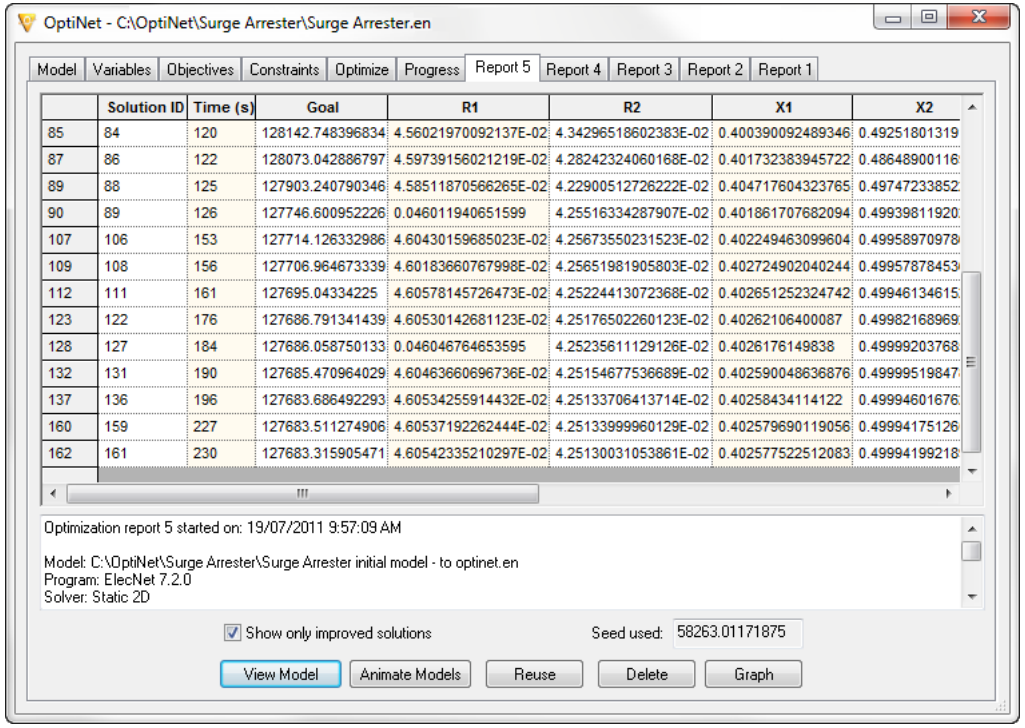


For each iteration of the optimization process, Simcenter MAGNET Design Optimizer updates and displays the changes (in the form of graphs) for the goal, variables, objectives, and constraints -- these graphs are displayed on the Progress page. In this example, each of the six variables' graphs (in groups not exceeding five variables per window) is updated as Simcenter MAGNET Design Optimizer finds a new design.

Unrestricted © Siemens AG 2018

SIMCENTER MAGNET DESIGN OPTIMIZER'S REPORT GENERATOR

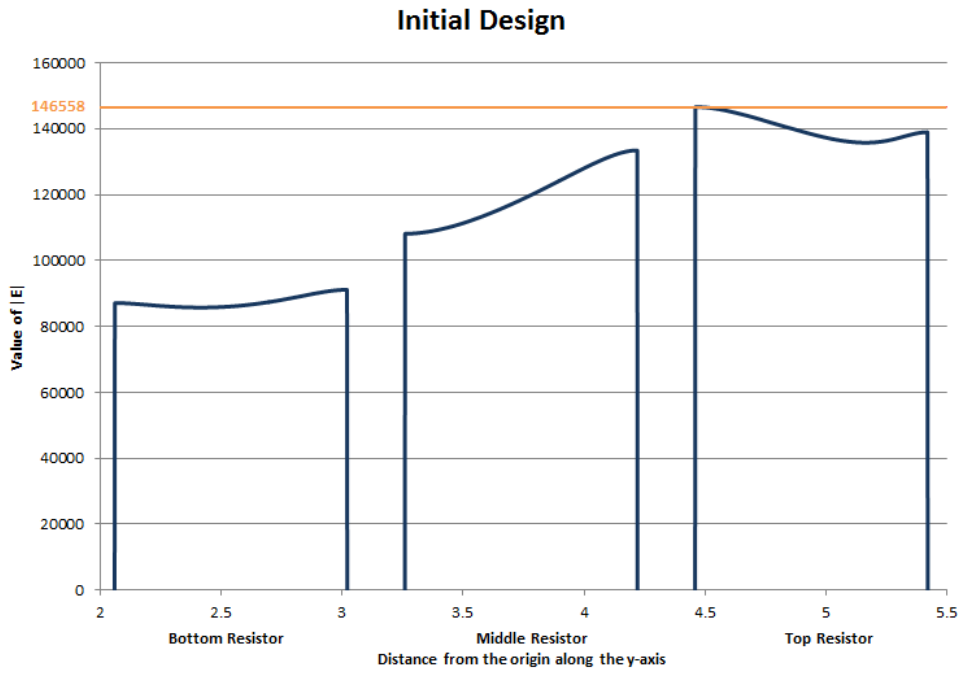
SIEMENS
Ingenuity for life



Simcenter MAGNET Design Optimizer produces a report for each optimization run. In this report, the designs that satisfy the constraints are shown in the order that they are improved. The user can view each design individually. The report also shows the time that it took to arrive at the improved design. The values of all the variables and the optimization function are displayed in this report for each iteration. The values of each parameter can be examined to determine the sensitivity of the design to that particular parameter.

Unrestricted © Siemens AG 2018

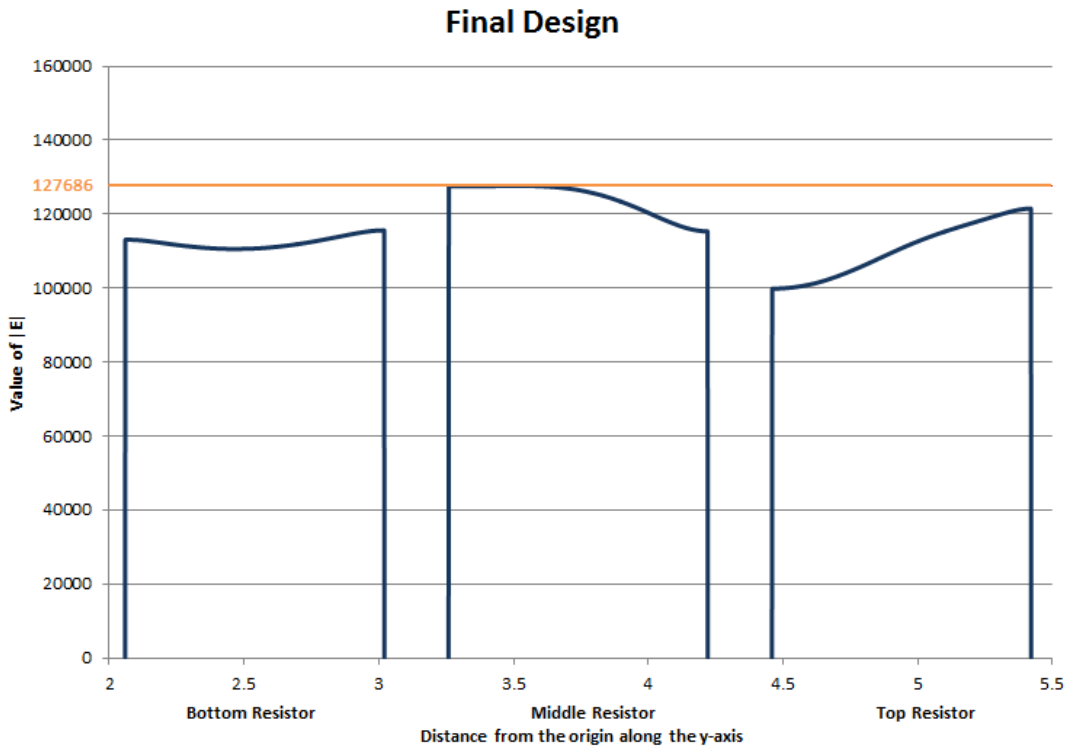
MAXIMUM E FIELD IN THE INITIAL DESIGN



This figure shows the electric field in the three resistors for the initial design that the user supplied to Simcenter MAGNET Design Optimizer, as well as the maximum field magnitude.

Unrestricted © Siemens AG 2018

MAXIMUM E FIELD IN THE FINAL DESIGN



In the optimum design that Simcenter MAGNET Design Optimizer generated, the maximum electric field in the three resistors is lowered from 146558V/m to 127686 V/m, decreasing by almost 13% the maximum electric field.

Unrestricted © Siemens AG 2018