Optimisation of a contactor dimensions.

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As part of our R&D activity and according to SCHNEIDER ELECTRIC requirement, we have re-dimensioned the active parts of a contactor (figure 1) for which the functioning specifications had been modified.
The air-gap value of the contactor in open position was divided by two and the amplitude of the resisting force, which is applied by the pull-back springs on the moving part according to its position, was modified.
Let us note that the resisting force also varies according to the mass of the moving part to be redefined.

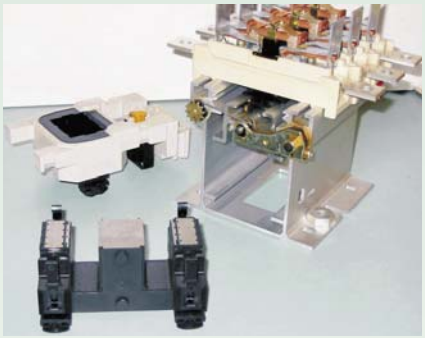

Figure 1: Initial contactor.

For a given voltage supply, the contactor must be shut down with a given response time, by consuming a minimal electrical power in steady state, with both minimal mass of steel and copper.
To guaranty a minimal dissipated energy in steady state, we have adopted the principle of two induction coils: one attraction coil to create the magnetic force useful to the movement when the air-gap is maximal and one holding coil in supplement to be connected in series with the attraction coil once the air-gap is reduced.
Thanks to that, we can reduce the absorbed excitation current and then limit the dissipated energy in steady state.

The parameters to be taken into account, to optimise the design of the contactor, are linked with the design of the induction coils, (kind of copper wire + over-all dimensions of the coils) and with the dimensioning parameters of the magnetic circuit (dimensions of the moving part and of the core of the contactor).

To reach this goal, we used a parametric computation procedure thanks to the E.P.B. (Engineering Process Builder). This tool developed by CEDRAT TECHNOLOGIES allows us to manage the automatic execution of software such as FLUX, EXCEL, MATLAB/SIMULINK and their coupling from a domain applied to a parametric study. In addition, this execution can be guided by an optimisation algorithm.

Description of the operating chain procedure

The first operation consists in choosing the kind of normalized copper wire to be used for both, the attraction coil and the holding coil. Thus, from this first operation we deduct the parameters of two coils (number of turns, resistance, dimensions and masses).
Taking into account the electrical supply source, we know about the absorbed current as well as the ampere-turns injected into the device and such, with one or two induction coils.
We can obtain the definition of the magnetic circuit (geometry + masses). After this stage, we make the model of the whole device into the FLUX environment. The numeric computations are realised for several air-gap values with the magnetostatic module of FLUX 2D (figures 2, 4 and 5).
Then, we realise the analytic resolution of the general mechanical equation by describing the movement of the moving part with EXCEL, in order to determine the response time to shut the contactor down . To do so, we consider the mechanic and magnetic forces, and particularly the action of the springs during the first step of the closing and the second one - the holding phase – (figure 2) and also the inertia effects. Finally a notation on the studied contactor is realised in order to take into account the different evaluation criteria.

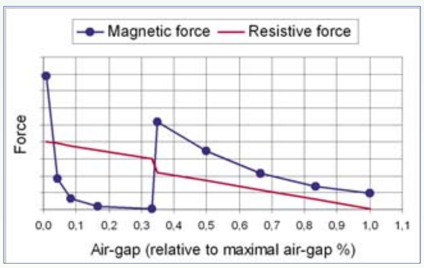

Figure 2: Magnetic and resisting forces versus moving part position (air-gap value).

Criteria and sequence of choices

Each combination of parameters corresponds to a specific conception of contactor.
The availability of all intermediary results (with tools such as FLUX, EXCEL, MATLAB/SIMULINK) in single datafile, enable the user to apply manually or automatically some complex criteria of selection.

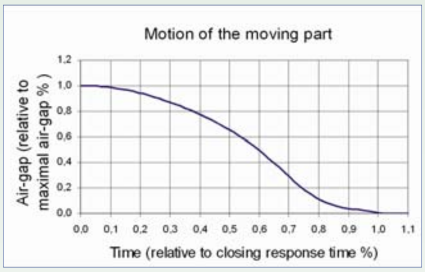

Figure 3: Motion of the moving part versus time - From initial air-gap (maximal value) to contact between moving part and core.

The evaluation of performances of designed contactor has been made from the following criteria:
1- The closing of the contactor must be guaranty and realised within a correct response time (figure 3);
2- The value of the force when the moving part is in contact with the core must be greater than the resisting force applied by the pull-back springs on the moving part;
3- The current density in the conductors as well as the Joule losses dissipated during the holding phase, must be limited to a specific value;

(continued on page 13)

Successful commisioning of the first flight application for C. T. in ESA / ROSETTA mission.

Thomas MAILLARD - Cedrat Technologies.

The ROSETTA satellite has been successfully launched the 2nd of March 2004 from Kourou, French Guyana, using an Ariane-5 G+ launcher. The rendezvous with the new targeted comet "Churyumov - Gerasimenko" is expected in November 2014. The spacecraft includes about ten different instruments whose one so called MIDAS. Through MIDAS project, CEDRAT TECHNOLOGIES designed, developed and fully qualified a XYZ piezoelectric stage for the scanning function (see figure 1). The successive integration and test of 4 models (Engineering and Qualification Model, Qualification Model, Flight Model, Spare Flight Model) for the Solar Space Division of ESTEC (Technical centre of ESA in Noordwijk (NL)) took 18 months.

The Scanning Mechanisms for Rosetta/Midas will pilot the first Atomic Force Microscope on a spacecraft in order to analyse the dust of the comet. One month and a half after the mission started, the MIDAS instrument was commissioned by ESA in order to check if no damage occurred during the launching, due to high level of vibrations. The latch mechanism was operated successfully and the piezo-electric stage works fine.

"We made the first 3D XY-scan from the XY-calibration facet in space, this scan is a square of 4,6 µm and the results are very satisfying", confirmed Bart Butler from ESA/ESTEC, definitively relieving the space project team at CEDRAT TECHNOLOGIES.

Rosetta was named after the Rosetta Stone, which enabled linguists to discover the secrets of ancient Egypt by deciphering hieroglyphics for the first time. In a similar way, the Rosetta spacecraft will give vital clues to scientists seeking to discover the secrets of how the planets formed and the origin of life itself.

CEDRAT TECHNOLOGIES is glad to take part in this adventure, never done before: to chase and catch a comet (see figure 2).

Figure 1: The Fligh Model of the Scanning Mechanism for ROSETTA / MIDAS

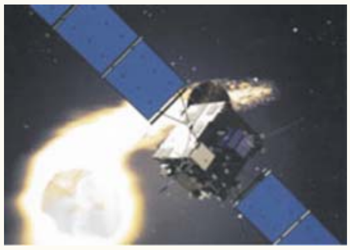

Figure 2: Rosetta approaches a fiery comet's tail (courtesy of ESA)

Last Minute: *APAs hit the slope with Rossignol Skis.* ROSSIGNOL

Using piezo products from Cedrat Technologies (CT) under an ESA technology transfer, ski maker Rossignol hopes to beat the world speed skiing record very soon. Using skis stabilised by an embedded **APA120ML**, originally developed by CT for space applications with CNES (French Space Agency), and controlled with a compact electronics derived from the standard **LA75B** sponsored by ANVAR (French Innovation Agency), the aim is to reach an astonishing 255 km/h down the slopes. More information at : ***http://www.esa.int/esaCP/SEMWJT57ESD_Improving_0.html***

Optimisation of a contactor dimensions. (continued)

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4- We calculate the ratio between the magnetic force once the moving part is in contact with the core, and the product of the total masses of copper and magnetic laminations with the Joule losses (CRD parameter);

5- Once the contactor has been selected according to the criteria 1, 2 and 3, we select the one for which the CRD is the highest.

From the basis of these criteria and considering the simplified models (magnetostatic formulation), we can quickly realise a large quantity of evaluations in order to define the dimensions of the contactor: geometric computations, numeric computations of the magnetic force, dynamic mechanical computations of the moving part.

Thus, by optimising the CRD criteria and by considering 8 parameters, 1361 contactors have been evaluated. As a result, the work enables us to obtain a reduction in both, the masses of copper and of magnetic sheets, in order to realise a new contactor with a limited study cost.

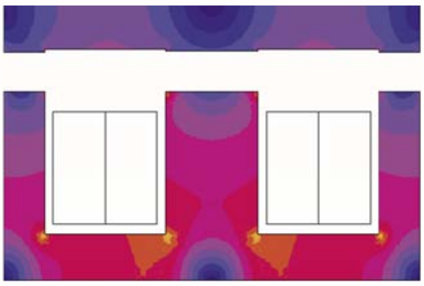

Figure 4: Magnetic induction field – Maximal air-gap – First step of attraction phase.

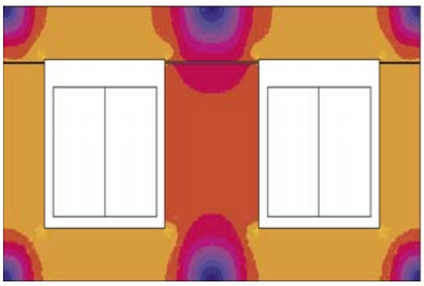

Figure 5: Magnetic induction field – Contact between the moving part and core – Holding phase.