On-line control and changing settings of the converter with the software "STARTER"

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Abstract
The variable speed drives (VSD-s) give a number of possibilities for saving energy. The parameterization of VSD-s becomes more and more complicated because the functions of modern active feed-in converters are today much more, than just speed adjustment of the motor. Siemens AG has developed a strategy named Totally Integrated Automation (TIA) which allow on-line control and changing settings of the converter by means of the software "STARTER".
The connection between the variable frequency drive and the software, the calculation of the ramp-up time of the motor, and the checking out the behavior of the drive when it exceeds the temperature maximum value are discussed at this topic. This article demonstrates an example of the diagnostic possibilities of the network component.

Key words: The variable speed drives, Totally Integrated Automation, on-line control.

1. INTRODUCTION
European Commission Regulation No EC/640/2009 establishes ecodesign requirements to the induction motors. Minimum efficiency levels IE2 and IE3 for motors are introduced. According to the regulation, all induction motors in the power range from 7,5 to 375 kW that will be put to the market after First of January 2015, should be at the efficiency level IE3 or as a second choice IE2 when equipped with variable speed drive. From the First of January 2017 the power range is extended from 0,75 kW to 375 kW. The requirements are based on the statistical facts. In the first, the biggest part of the lifetime cost of induction motor is the cost of the electricity needed to run the motor. The second fact is that from all of the motors in the world the biggest amount of them lays in the range from 0,75 to 375 kW[1].
The variable speed drive (VSD) gives a number of possibilities for saving energy. In applications where the output capacity of the pumps or ventilators is regulated by throttle valve, the savings can be even 60%. In the applications, where frequent deceleration is needed, the VSD can regenerate the kinetic energy back to electrical. VSD-s can also be used to adjust the power factor[2].
To facilitate all of the automatization process, Siemens AG has developed a strategy named Totally Integrated Automation (TIA). By this strategy, the automation of the processes in industry is standardized. TIA hardware and software meets each other demands [3].

2. CONTROL ON-LINE

The VSD G120 has about twenty main functions, each of them several parameters. They are used to change the way for how drive reacts in different applications[4]. There are two ways to change the parameters of G120 functions: by operator panel and by special commissioning software "STARTER". The program makes it more intuitive to parameterize a drive (Fig. 1).

At first it is necessary to establish the connection between the variable frequency drive and the software. When the drive is online, it responds to the commands given from the program. “STARTER” can be downloaded free from www.siemens.com/starter.

![Fig.1 STARTER software window: control on-line](image1)

It is possible to switch the motor on and off, change its speed by inserting different frequency values and by moving the slider. The turning torque value of the motors shaft has to be noted up[6].

![Fig.2 Turning torque value](image2)

3. CALCULATION OF THE RAMP-UP TIME OF THE MOTOR

For calculation of the ramp-up time of the motor, the torque equation of the electrical drive and the active torque value has to be used. The inertial moment of the load on the shaft is calculated using the guessed values for the load, angular velocity of the shaft is calculated from the data given in the motor
catalog. The result of the calculation is entered into the program and the motor is started with new ramp-up parameter value.

The parameter value must be applied on the movement of power from core equation [5]:

$$ M - M_c = \sum J \frac{d\omega}{dt}, $$

where $M$ is the torque developed by an electric motor, $M_c$ is a static torque, $\sum J$ reflects all the moment of inertia of the masses, which is mechanically connected with the motor shaft and rotating with it, $\frac{d\omega}{dt}$ is the motor angular acceleration. Angular acceleration of the motor starts, the ability to read even and according to the definition:

$$ \varepsilon = \frac{d\omega}{dt} = \frac{\omega - \omega_0}{t}, $$

where $\omega$ is the final speed of the motor shaft, motor shaft $\omega_0$ is the initial velocity, and $t$ is the time that is needed to accelerate from standstill to the nominal motor speed. Then, the time $t$ is found from the movement of core equation:

$$ t = \frac{\sum J (\omega - \omega_0)}{M - M_c} $$

$$ t = \frac{\sum J \cdot \omega}{T_A} = \frac{0.00042 \cdot 141.3}{0.29} = 0.21 \text{ s}. $$

![Fig.3 Ramp-up time of the motor](image)

4. **WARNING MESSAGE**

With the STARTER software it is possible to check out the behavior of the drive when it exceeds its maximum value. For this, the maximum allowed temperature value is lowered so, that it exceeds the actual motor temperature for five degrees and the drive is switched on. In working state, the actual temperature of the drive arises and it reaches the new entered maximum allowed (Figure 4).
Fig. 4 The actual motor temperature

Then the warning message is given and when temperature exceeds the maximum for 10\%, the fault message is generated and the motor switches off. In off state, the motor cools down again and after acknowledgement of the alarm message, the drive returns the possibility to be started up again (Figure 5).

Fig. 5 Warning message

5. DIAGNOSTICS POSSIBILITIES

The STARTER software is used to demonstrate the diagnostics possibilities of the network component. Into the free port of the network switch the network cable is plugged. Other end of the cable is not connected. As a result of running the test the distance to the rupture of the cable is identified. An example of the diagnostics possibilities of the network component is shown in Figure 6.

Fig. 6 Diagnostics possibilities
6. CONCLUSION

The parameterization of VSD becomes more and more complicated because the functions of modern active feed-in converters are today much more than just speed adjustment of the motor. It is the calculation of the ramp-up time of the motor, the checking out the behavior of the drive when it exceeds the temperature maximum value, and the diagnostic possibilities of the network component.

Based on the eco-design requirements for electric motors changing the control parameters of the converter is possible by means of the "STARTER".

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