Simple and effective

Speed monitoring of frequency regulated electric motors without signal transducers and rotation speed monitors.

In industry, the operation of electric motors via frequency converters is already well established. However, time and again, there are applications where, on the part of electric drives, the required safety device against excess rotation speed can only be achieved at great expense (with a signal transducer in combination with a rotation speed monitor). This was a problem which a leading manufacturer of machinery for processing solid wood confronted.

With its main office in Tauberbischofsheim, Michael Weinig AG is part of the global Weinig Group. Around the world, the group employs 2,200 members of staff, of which approx. 900 work at the Tauberbischofsheim site. In particular, the company supplies mills that use planing tools and saws, skilled crafts and trade, the furniture industry and window construction involving solid wood. Exports make up around 90 percent of the factory's output. Alone at the main site, around 2,000 machines leave the factory each year. Currently, turnover at Weinig AG is around €120 million.

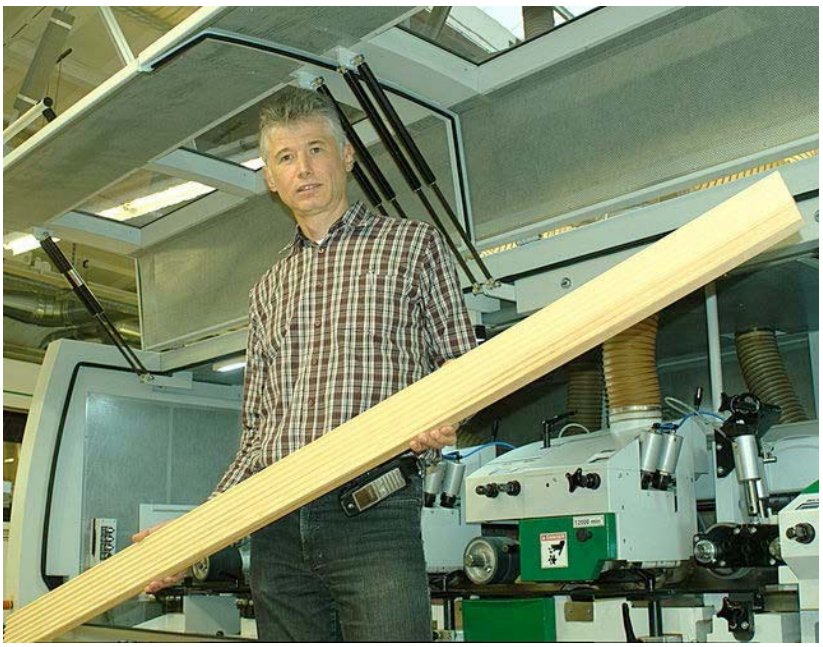

Fig. 1

As Dipl. -Ing. (BA) Rainer Kurz (who is responsible for the technical and electrical aspects of the machinery in the product division of profiling at Weinig AG) states, "We are surely the specialists when it comes down to the development and production of machinery and plant for processing solid wood.

In any event, since 1992 with the acquisition of companies in Germany, Sweden and Switzerland and the foundation of a new company in China, we have successfully positioned the group as an all-round service provider for processing solid wood" (Fig. 1).

Speed monitoring of spindle drives

As Rainer Kurz knows only too well, even now and again specialists confront challenges, that cannot be solved quickly or simply: "Together with our slotting machines for the longitudinal processing of products made of solid wood (among other things) there was a very specific problem with the speed monitoring of the spindle drives which, with regard to EN 12750, affected the safety of the wood processing machines."

Put simply, the standard obliges the manufacturer to ensure that when there is a spindle drive in a machine which is actuated via a frequency converter, it does not exceed ten percent of its maximum speed. Via a frequency converter, this safety function can only be realized with significant additional costs or through the use of new, and costly equipment.
If a converter is defective or damaged, the frequency that it provides to an actuator may increase. This is why the standard requires an additional safeguard, which enables a real measurement of the frequency that is provided.

Magnetic fields interfere with the sensor equipment

As Rainer Kurz adds: "Our first thoughts were based on the fact that according to this, the economic adherence to the standard can only be guaranteed with a separate device."
And at that point in time, there were already solutions in the market which have proven successful up until this day, e.g. the installation of inductive sensors / rotary pulse generators on the actuator and the monitoring of speed via the corresponding evaluation devices.
As a result, this is why even the developer, Rainer Kurz initially preferred such a solution.
"However, very early on, we recognized that the sensors were negatively influenced by the magnetic fields of our rotary current asynchronous motors. Furthermore, the entire process of fitting and installing the equipment was not that easy. In addition to the installation of the sensors, the whole had to be rewired – a very costly process.

In connection with this, it is also necessary to consider the economic efficiency of such a solution. If standard actuators such as rotary current asynchronous motors are modified in any form, i.e. as a result of inductive sensors, then the costs (on the part of the actuator) increase immensely."

Information from a modulated frequency

Consequently, Weinig AG posed the question as to whether it was possible to meet the requirements in a different way. The approach to this lay in a modulated frequency, which provides a converter on the actuator to receive information, which corresponds to the spindle and enables protection against excess motor speed. As Rainer Kurz states, "There was also a supplier that was in the position to realize such a device. However, this solution had the key disadvantage that a wire of the motor feed line had to pass through the device itself. Here, there were problems with the EMC shielding of the line which we normally pick up directly on the frequency converter" and goes on to state: "Here in part, we are talking about 75 kW motors as spindle drives for our high performance machines which have a correspondingly thick cable cross section. As such, the entire handling proved to be exceptionally difficult."

A partner was sought for a new solution

Another problem was the fact that the device and with it, all of the electronics, had to be installed in an area exposed to electromagnetic interference, whereby potential interference was inevitable from the outset. "Apart from this, in the end, the developer of the device only wanted to accompany the transition from the old standard to the new EN 13849-1 to a limited extent." Rainer Kurz: As the technical approach for the solution also seemed too costly for us, we had to find a partner who, with us, developed a new solution together."

Easier monitoring

In the end, Weinig AG found the partner it was looking for in ipf electronic. Together with the company from Tauberbischofsheim, the sensor specialist from Lüdenscheid developed a solution which enabled easier monitoring of frequency regulated electric motors. With the type VY86 monitoring module, the checking of the speed also takes place by establishing the frequency which the frequency converter transfers to the motor. For this, a current transformer (for 50A or 100A) is clipped onto a wire of the motor feed line and connected with the evaluation unit VY86. The module compares the frequency that has been recorded with a maximum frequency that was previously teached-in

If this value is exceeded by a tolerance (1-5%) that is settable with a potentiometer, the device switches an alarm relay, via which, the actuator motor is switched off.

The VY86 can be used for monitoring a frequency of between 10-800Hz, however it only requires 24V DC as a supply current, and with a width of 35.6 mm only a small amount of space on the top hat rail in the switch cabinet. The relay that is used is configured as a change-over contact for 250V AC/1.5A.

As a result of this new method, the current transformer and the evaluation unit remain in the switch cabinet. There is no need on any costly installation of a signal transducer. With the VY86, even the conversion of existing systems is not a problem.

Efficient absorption of electromagnetic interference

As Rainer Kurz explains, “Weinig and ipf electronic have developed the new digital safety device against excess motor speed based on the same principle as our predecessor device. The great advantage however, lies in the fact that now, the actuator phase does not have to go through the device any longer.”

Finally, this very intricate and as a result, problematic concept is replaced by two separate components. On the one hand, there is a toroid coil, through which a motor cable wire is fed. This is located directly underneath the frequency converter and already acts to absorb much of the electromagnetic interference. On the other hand, it can be fixed with the separate evaluation unit VY86, on the top hat rail, at a distance from the frequency converter (Fig.2) that is free from electromagnetic interference.

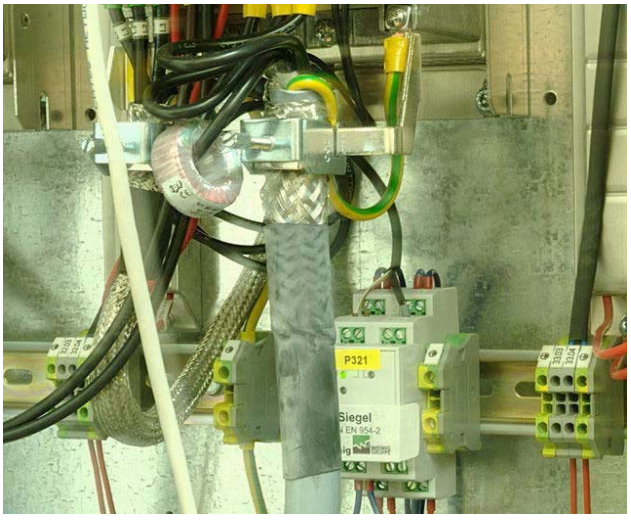

Fig. 2

Compact and standardized

“This way, we are in a position, to bring the shielding very near to the converter and in doing so, decisively minimize the electromagnetic interference. In addition, it is well known that space on the top hat rail is valuable. As such, it is all the more satisfactory that now, we are able to use a solution that is significantly more compact compared to the predecessor device. In addition, the new development conforms fully with the current version of EN 13849-1.”

Expanded safety functions

The EN 13849-1 requirements for an infinitely variable speed monitoring unit for frequency converters demand, among other things, specific safety functions from the devices used here. As such, in accordance with the standard, a sensor used for this purpose has to have an integrated microprocessor, e.g. via a watchdog function. The digital safety device against excess motor speed was therefore equipped by ipf electronic to feature additional monitoring functions based on these types of requirements. As such, the internal memory of the device is checked during the initialization sequence. If this validation fails, the device is not ready for use. The positively driven output relay is also monitored and is not operational in the event of a fault. The signal emitted by the current transformer is processed using two channels, in the device. If a difference is detected between the internal signals the safety device against excess rotation speed is also not operational. In addition to this safety based, sequential testing, the main processor is permanently monitored to make sure it works. If fault-free functioning can no longer be assured, the device is not ready for use and/or the integrated alarm relay does not release the actuator.

Implementation with stumbling blocks on the way

As Rainer Kurz explains, “Things that sound unproblematic in the description of this project initially turned out to be very different in practice. Basically, this is also not any wonder. Whoever thinks that, in the implementation of a new development, everything will take place without problems, should either doubt such a proposition or at least look at it critically.” The Weinig developer recalls the problems that he initially had with the VY86 to do with the braking action of the spindle drives. For the braking action, a DC voltage was applied to the actuators (DC brake). The induced voltages generated from this were in a frequency range which was ‘misinterpreted’ by the VY86 monitoring module as excess speed.

As a result, this led to the shutting down of the actuator. Although this is by all means required in critical situations, in this case it led to an undesirable outcome, as the actuators could not start up properly due to the fault. As Rainer Kurz points out, “This problem could be fixed by ipf electronic due to the specific way the controller had been programmed. In the event of braking, it suppresses this fault. However, in the light of the outcome that was achieved as a result of the cooperation with ipf electronic, Rainer Kurz was very satisfied: “Our specific ideas regarding the elements of an optimum solution combined with the competency of the sensor specialists were added factors that ideally helped us along the way and ultimately led us to reach our aim.

Simple operation

The actuator is now merely driven by the converter to a maximum speed. If this is reached, the corresponding frequency is teached into the digital safety device against excess motor speed and the maximum permissible frequency deviation is set via a potentiometer. According to Rainer Kurz, the unit has been made much easier to operate. Once the device has been started up, its frontage is fitted with a seal in order to prevent subsequent or inadvertent manipulation (Fig. 3).

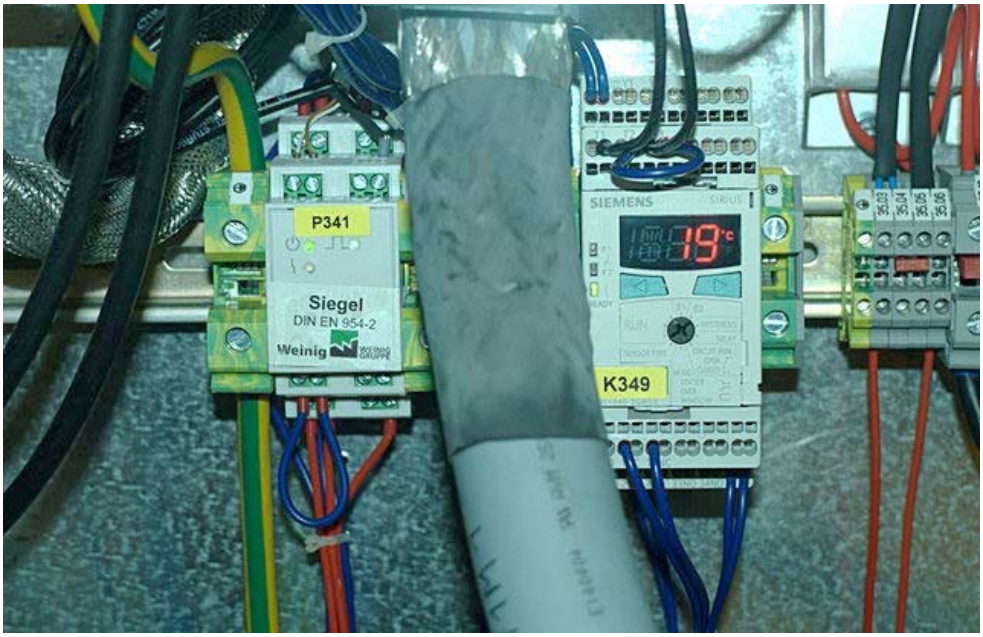

Fig. 3

Three becomes one

A specialist would not be a specialist, were he not to have the aim of optimizing a solution that now ran perfectly, further still. In the eyes of Rainer Kurz, this also applies to Weinig AG: “With regard to the different frequencies which we had to evaluate for the spindle drives of the various machines (i.e. up to 70Hz in our standard machines, up to 300Hz in our high speed aggregates and up to 800Hz in the case of our high speed spindles), we previously had three devices.

At the moment however, we are working in tandem with ipf electronic to introduce a single device for all frequency controlled spindle drives, based on the experience gained up until now and by checking against the current standards.

A lot of potential in open loop applications

With the development of the digital safety device against excess motor speed for frequency converters, it has now become easier to monitor electric motors. The fact that this new development offers potential, especially in the case of open loop applications and in the case of impulsion without speed feedback, is evident from the specific application at Weinig AG.

The safety device against excess motor speed will now also be used in the printing machine industry. More specifically, in the field of the so-called safe feed, in which several publications are synchronized via a cardan shaft (when setting up the machinery in succession).

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Tools for efficient wood processing.