



Technical
information

 **wieland**
www.wieland-electric.com

Stop everything!
Standstill monitors add sensorless safety
features to motor-driven machinery
SVM4001 Series standstill monitor



Back EMF technology enables motion detection for safe motor operation.

WHITE PAPER



A simple, sensorless solution to increase machine safety

Machinery applications involving high-inertia motor-driven rollers or spindles present unique challenges for machine safety engineers who are tasked with minimizing the risks to machine operators and maintenance technicians. Although operator safety “best practices” are a part of any machine safety program, they must be coupled with robust mechanical means of detecting motor rotation, preventing access to dangerous areas, and otherwise ensuring operator safety.



The problem:

In many machine applications, safety scanners or light barriers are not a practical solution, especially when one considers that the barrier must be located at a distance approximately 1600mm (more than 5 feet) away for every second that the machine takes to come to a complete stop.

Conventional practice has usually required the installation of physical guards, paired with a locking solenoid interlock to ensure operator safety. This type of interlock often relies on a standstill

monitoring system that counts pulses generated on the machine’s rotating parts. This is typically done via sensors detecting tabs on a shaft, teeth on a gear, or encoder pulses from an encoder mounted to moving parts of the machine.

For the retrofit of existing machines, the addition of such pulse generation requires mechanical modification of the machine, which has the potential to create problems for the machine safety engineer, including:

- Warranty issues with the machine manufacturer, due to the non-factory modification.
- The cumbersome installation of new sensors when the machine lacks a convenient place to mount them, or when the environment does not lend itself to available sensor technology.
- Sensor alignment issues once the device is in service
- Addition of more cabling to the machine, requiring more cable entries, and thus new points of possible failure.
- Sensors may have short lifetimes when installed in hostile environments.
- Sensors may generate low voltage, high frequency signals susceptible to EMC interference issues.
- Safety devices often operate on 24Vdc. For encoders, this means 24Vdc HTL (high threshold logic) outputs, which are not always readily available.



Wieland's SVM4001 Series standstill monitor

magnetic feedback – more commonly referred to as back EMF – which is generated when a conductor (such as a rotor) is moved through a magnetic field (such as the one from a stator). Consequently, virtually any rotating motor or generator will generate back EMF, thus enabling the standstill monitor to detect motion for several types of rotating machines, including:

- Generators with permanent magnet
- Permanent magnet motors (such as stepper, servo motors)
- DC motors with permanent magnets
- DC motors without permanent magnets on the rotor.
- AC induction motors.

The solution:

An alternative approach to monitoring machine motion provides a simple and elegant technology solution that eliminates many of the drawbacks listed above. By specifying a safety-rated sensorless device, such as Wieland's SVM4001 Series standstill monitor, this important safety function can be added to various types of high inertia motor-driven machinery. The standstill monitor operates on the principle of electro-

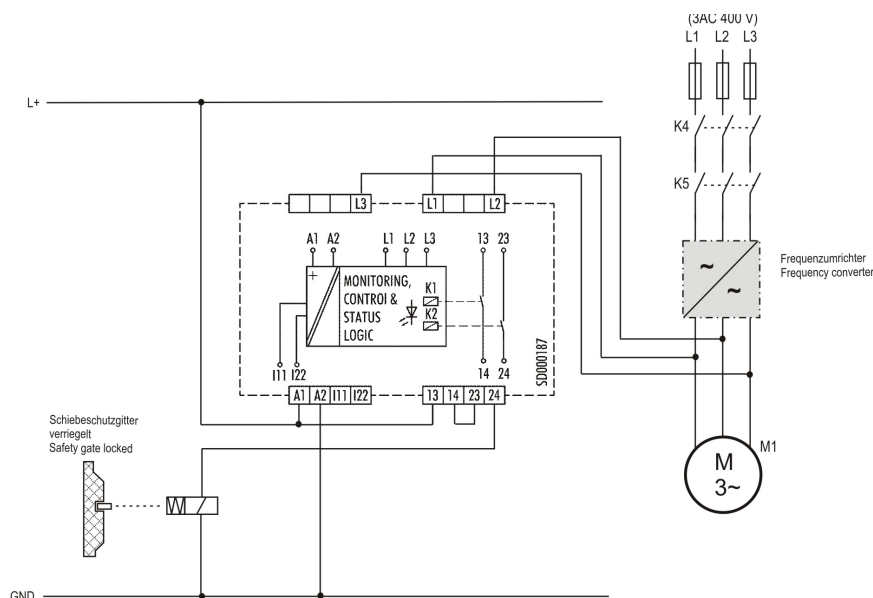


Figure 1. SVM4001 monitoring AC motor with frequency converter

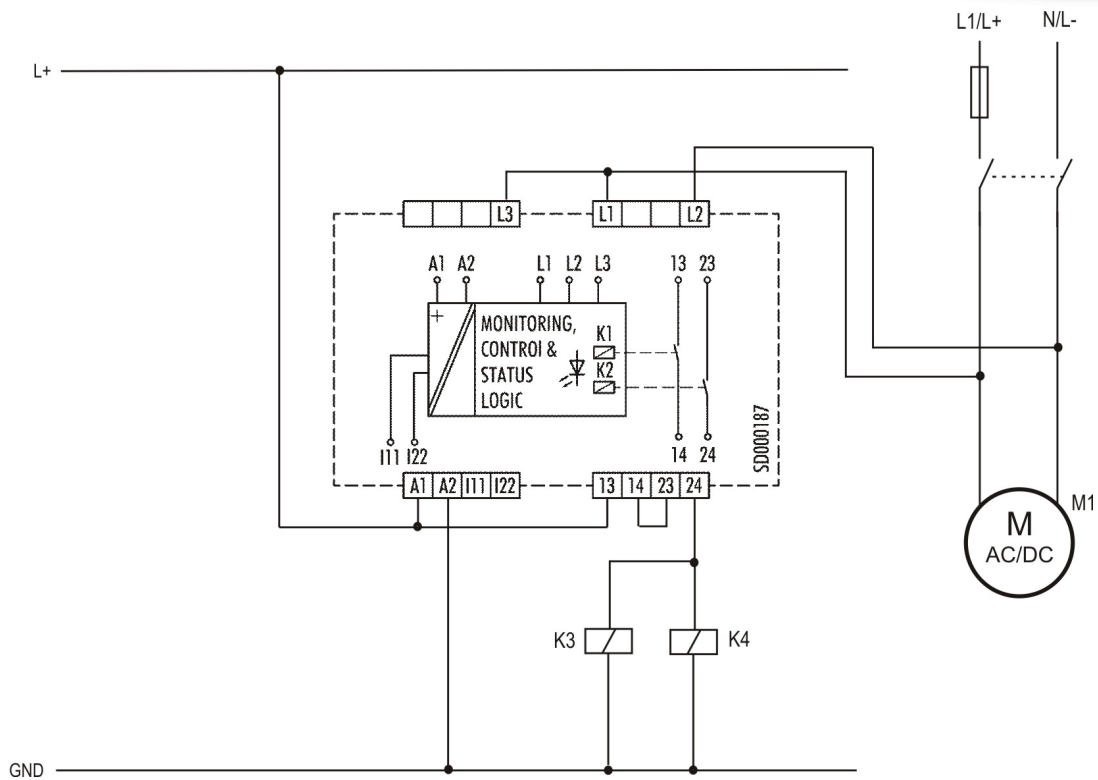


Figure 2. SVM4001 monitoring single phase motor or DC motor

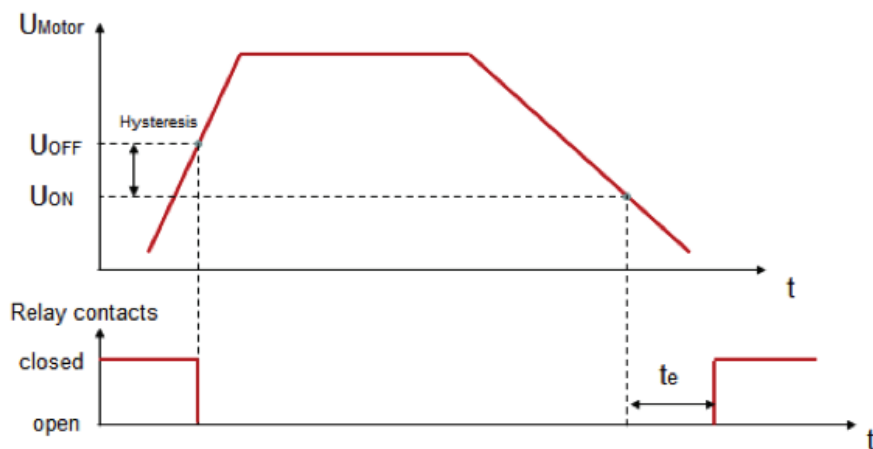


Figure 3. SVM4001 timing diagram



Although these last two motor types theoretically have no permanent magnet on the rotor to generate a magnetic field, in practice the magnetic fields generated during the operation of the motor create a permanent low magnetization of the motor. When power is removed, there are still sufficiently large magnetic fields to generate measurable back EMF voltages.

By measuring the back EMF of these machines, any motion of the motor can be detected. For a safety application, as long as there is a non-slipping mechanical linkage between the motor and the rotating hazards, the machine's motion can be safely monitored. Examples of slipping linkages include Eddy current drives, friction disc transmissions and hydraulic couplings.

The result of implementing back EMF standstill monitoring is a simple, safe and cost-effective solution. It requires only a parallel connection to the motor power leads. Such a solution presents many benefits, including:

- All wiring related to the standstill monitor is done inside the control cabinet.
- Simplified wiring and fewer connection points.
- Eliminates the need for costly, cumbersome mechanical modifications to the machine.
- Fewer points of failure by eliminating the need

for multiple sensors.

- Frequency of the pulse train generated by the machine is not a consideration (this can be a problem with high pulse count encoder feedback).
- No additional cables are required on the machine frame.
- The size of the motor is not a consideration because the monitor is wired in parallel.

These advantages cumulatively result in lower installed costs and lower operating/maintenance costs for the machine when compared to conventional means of standstill monitoring using sensors. Moreover, it reduces the probability of downtime, which can far outweigh any savings (if any) afforded by implementing conventional hardware solutions.

The use of modern standstill monitors also offers additional benefits. For example, the SVM4001 offers a bypass function. Using terminals I11 and I22, the monitoring of the motor windings can be suspended. This can be useful in maintenance or setup situations where jogging of the machine is required while safeguards are removed. Another added benefit of the SVM4001 is that it offers an adjustable time delay for relay closure after a standstill condition has been detected. This can be useful for machines that stop briefly in normal operation or where residual motion may be present for some time after the motor has stopped moving.



Typical use of SVM4001 in safety guard locking control application

Key:

- 1) emergency stop
- 2) machine
- 3) safety cover
- 4) cover open/closed
- 5) tool
- 6) drive power supply
- 7) motor
- 8) EMF-sensor wire
- 9) safety cover switch
- 10) safety switch unlocking solenoid

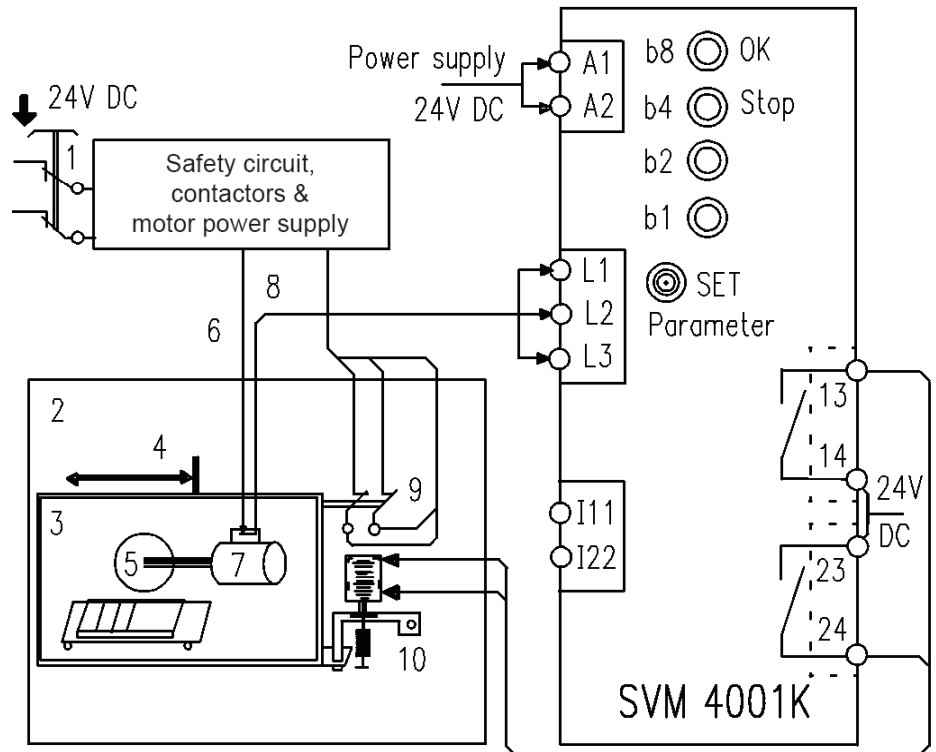


Figure 4: In this application, the speed of the motor is continuously monitored. Unlocking of the door lock is only possible if the motor is at a standstill.

Other design considerations:

In considering whether to specify a back EMF standstill monitor, machine safety engineers should be aware of some historical limitations in their implementation:

- Many standstill monitors cannot be used on motors operating with variable frequency drives (VFD) or (servo) drives due to their high voltage spikes. Wiand’s SVM4001 Series can indeed be

utilized with VFD motors. There are nevertheless a few performance limitations to be considered. Because the monitor requires that the motor’s back EMF voltage be below a certain threshold in order to recognize a standstill condition, in some VFD positioning applications the monitor will interpret the presence of voltage present on the motor windings as “motion,” (even though the VFD system is using the voltage to “hold” a motor’s position). To detect a “true” standstill condition with back EMF, all voltage must be



removed from the motor leads.

- Many sensorless standstill monitors have historically been limited to 500V ratings and category 3 applications. Wieland's SVM4001K Series standstill monitor is rated to 690V and can be used in category 4, PLe applications.

Product datasheets, specifications and other technical information for the SVM4001K Series standstill monitor can be downloaded from the Wieland website at: www.wieland-safety.com/

SVM4001

About Wieland

Wieland Electric Inc., founded in 1910, is a leading global manufacturer of electrical interconnect technology products. Headquartered in Germany with a North American Operations Center and subsidiaries throughout the world, Wieland Electric has 2200 employees in more than 70 countries to service worldwide customers. Wieland provides solutions to the industrial & building automation, wind, solar, HVAC, and power generation markets. Local inventory, value-added services and technical resources at the North American Operations Center support a national sales and distribution channel. Wieland is ISO 9001 certified.

For more information about Wieland Electric's comprehensive offering of machine safety products: call 1-800-WIELAND (1-800-943-5263), or visit: www.wieland-safety.com

