

High Performance Current Sensing for Automation Applications



- AC/DC Current Switches
- AC/DC Current Transducers
- AC/DC Voltage Transducers
- Ground Fault Sensors
- Current Transformers
- Power Transducers
- Power Monitors
- Current Indicators
- Accessories



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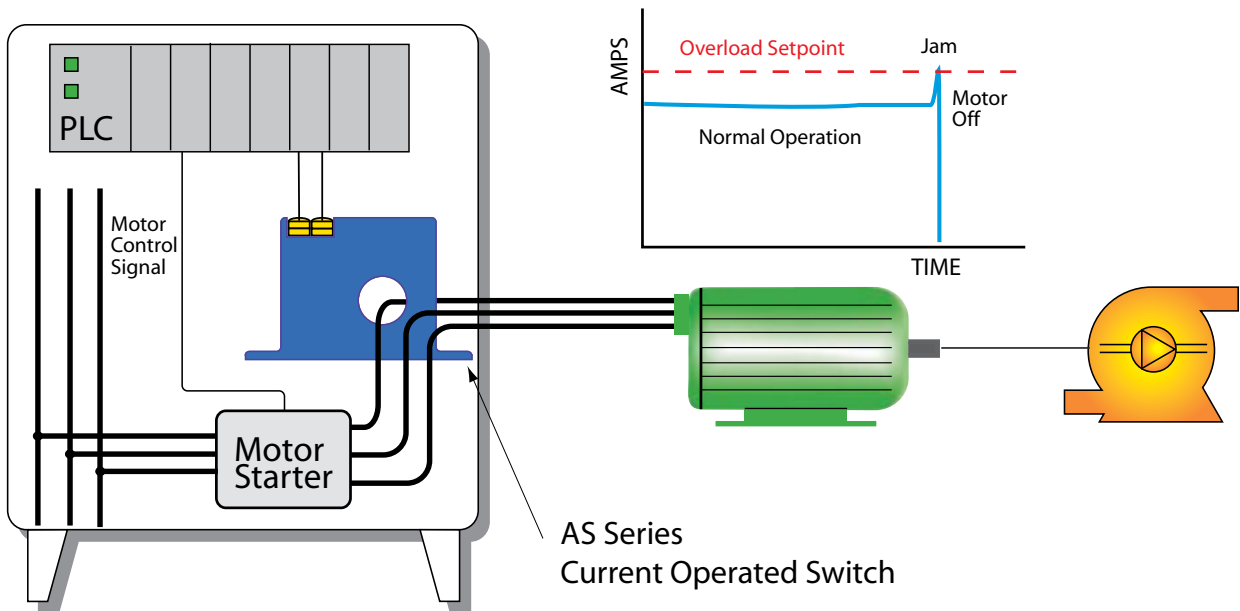
### Electric Motors

are found extensively in both the manufacturing and processing industries. Both AC and DC powered motors are used to drive pumps, fans, conveyors and a broad range of specialized equipment. There are many types of motors designed for many different applications, however all require electrical current in order to generate the magnetic fields that are necessary to create rotation. By measuring this current, useful information can be made available regarding the status of the motor and the equipment that is connected to it. This may be as basic as independently verifying the run status of the motor or in conjunction with a PLC, for example, to protect a pump against dry run. Thus current measurement may be used to both monitor and protect motors and motor-driven equipment. Here are just a sample of some of the extensive applications where NK Technologies' Industrial Current sensors are used to protect electric motors.

### Pump Jam & Suction Loss Protection

Pumps can become jammed due to foreign matter and cause damage to both the pump and the motor before thermal overloads are tripped. Additionally a blockage in the suction line of the pump can cause the pump to run dry, overheat and break a seal.

By simply installing a self-powered **Current Operated Switch** over one leg of the motor, overload (pump jam), underload (suction loss), or underload & overload can be detected quickly before damage occurs.



## Fan Status: Independent Verification of Operation

Good engineering practice suggests that every control output should have a status input for verification. **Current Operated Switches** or self-powered **Current Transducers** can be installed on each motor leg to monitor the on/off status or fan speed.

NK Technologies' **Current Operated Switches** will close or open when the motor turns on and open or close when the motor turns off. Additionally a **Current Transducer** can be used to not only monitor on/off status but to monitor fan status based on current draw. This reliable solution can eliminate the need for the costly installation of a differential pressure switch.



## Conveyor Jam Protection

When conveyors jam and the drive motor continues to run, expensive mechanical damage to the drive components often occurs. By installing a **Current Operated Switch**, an overload condition detected by higher than normal running current, can be used to switch off power to the motor before mechanical damage results. The switch setting can be adjusted so it is not affected by normal changes in conveyor load. Current operated switches are the modern day equivalent of less reliable electromechanical jam relays that have been in use for many decades.



In situations where there may be large variations in load, a **Current Transducer** may be used to feed motor current measurement to the conveyor control system, commonly a PLC. The PLC may be programmed to accommodate different setpoints for different mechanical loads so that jam protection is provided from light to heavy loads. In situations where the conveyor is not able to accept analog signals NK Technologies has developed a patented transducer with a frequency output suitable for the digital inputs of most PLCs.

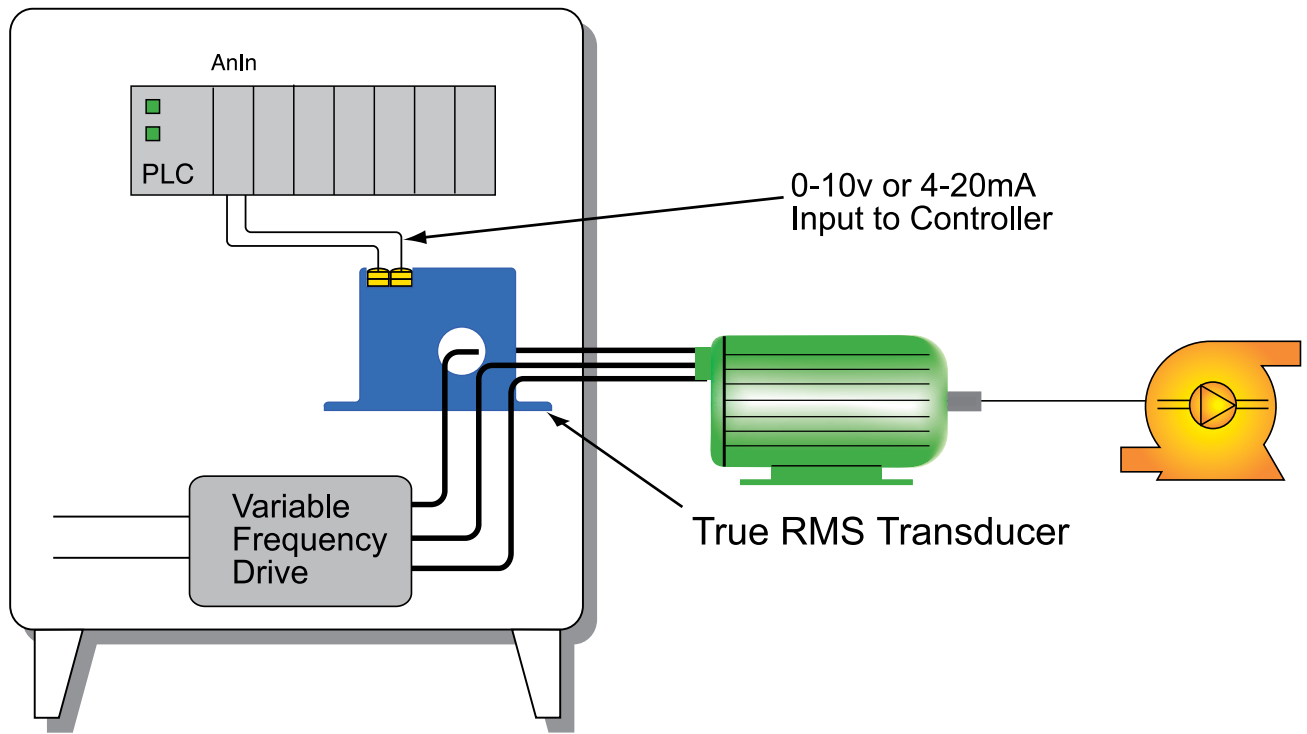


## Pump Load Monitoring

NK Technologies' **Current Transducers** are used to monitor motor current and therefore motor load. The output from the transducer may be fed to an analog or digital indicator or a Programmable Logic Controller (PLC) for more sophisticated monitoring and precise measurement of the watts used.

**Power Transducers** provide load monitoring in more critical applications where the addition of voltage measurement and the comparison of the phase relationship between current and voltage (power factor) provides more control.

**Ground Fault Sensors** keep the pumps safe by measuring ground leakage currents as low as 5 mA. This also provides an alternative to moisture sensors used with submersible pump motors.



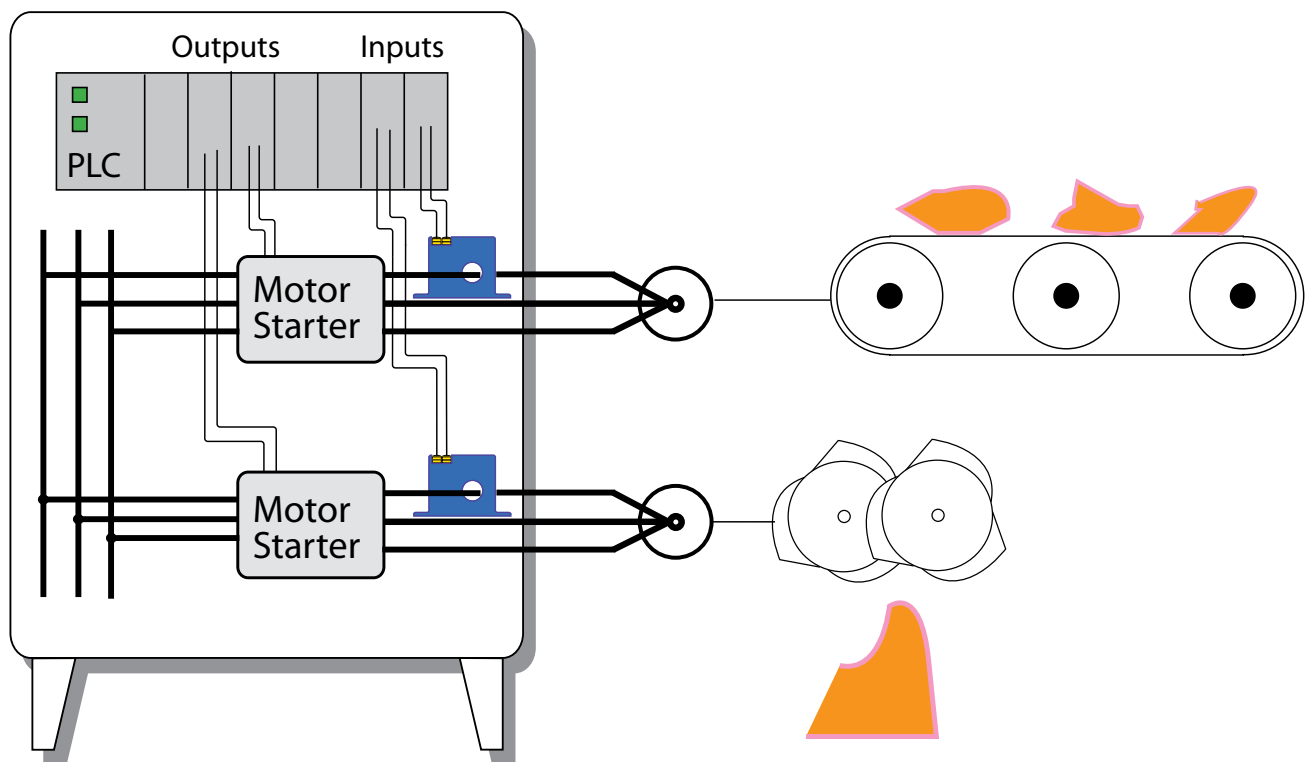
## Crusher/Grinder/Shredder Motor Interlocks

The performance of material reduction equipment like crushers, grinders and shredders can be optimized by not only monitoring the reduction process but also by controlling the in-feed.

By installing **Current Transducers** to monitor the process equipment and the conveyor system feeding the unprocessed material to the system, jams can be detected and the speed of the conveyor can be controlled based on loading. The analog signals can be fed directly into a variable frequency drive.

**Current Operated Switches** can be used in a similar way to monitor for process jams or conveyor under or overloads. A spike in current on the reduction process may reflect a jam. Some current switches and relays offer the option of a time delay to allow the process to clear itself before tripping or reversing. An under-load on the conveyor system may indicate the need for an increase in material flow, where an overload may indicate the need for a slowed material flow to prevent costly equipment damage.

NK Technologies' current sensors come in a variety of configurations for quick and simple installation by the OEM or End-User.



## Saw Load Monitoring

Often a band or circular saw is used to cut logs into rough planks before the planks are processed into finished lumber. Due to inconsistencies in the log (knots, burls and checks), the speed that the log is pulled through the saw must be varied. The operator will often reduce the speed of the cut when smoking occurs or the blade breaks.



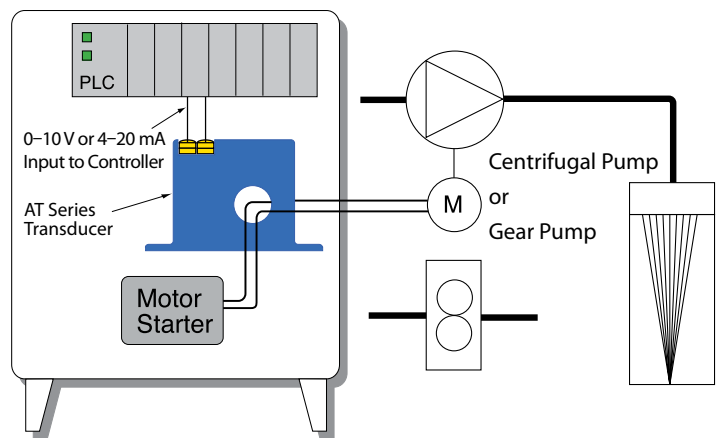
By installing a **Current Transducer** the operator's job is made easier. By watching the log and a display representing the current draw of the band saw, the operator can achieve a higher rate of output with less downtime. A **Current or Power Monitor** can also be used to monitor blade status. As the blade becomes dull, current or power trending increases.

Current measurement is used to automatically adjust the in-feed rate, slower or faster as the conditions require.

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## Spin Pumps

Spin pumps are used in the manufacture of synthetic fibers and yarns. Precise control is required to insure that the product feed rate and the fiber draw rate is matched. It is critical to monitor and protect spin pumps because they are the heart of the system and are required to run continuously.



By installing a **Current Transducer**, the motor current may be monitored providing the control system with key information regarding load. Variations in load may be attributable to a number of factors such as bearing failure, seal failure, suction loss etc. The measurement of load together with other process variables, like pressure and flow, can provide invaluable information regarding the operation of the spin pumps.

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## DC Motor Installations

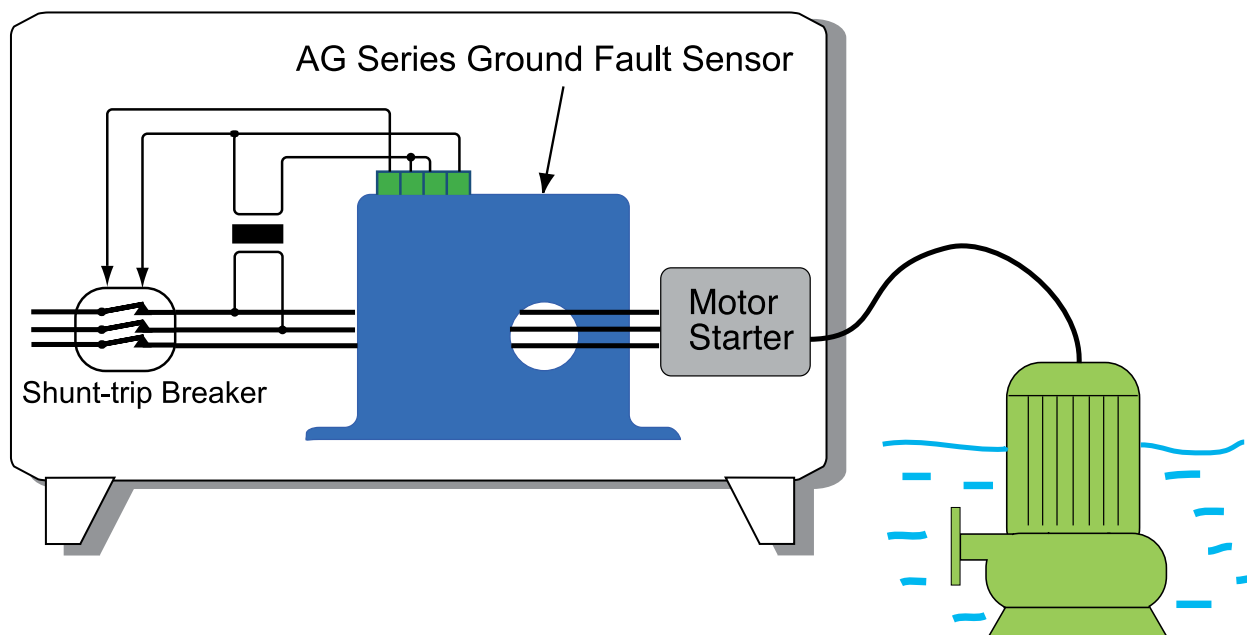
Many applications requiring high torque at low speeds, like bridge cranes and log carriages, use DC shunt wound motors. Since it is relatively easy to control the speed of a DC motor by adjusting the voltage to the field windings, precise regulation is afforded to applications like printing press paper feeds or web control of multiple motors in the paper making process.

Using an NK Technologies' **DC Current Transducer** will provide an analog signal that can be used to keep the motor from over current situations. Using a **DC Current Operated Switch** will ensure if a crane movement jam occurs the motor will not overload to a point of self destruction.



## Moisture Ingress on a Submersible Pump Motor

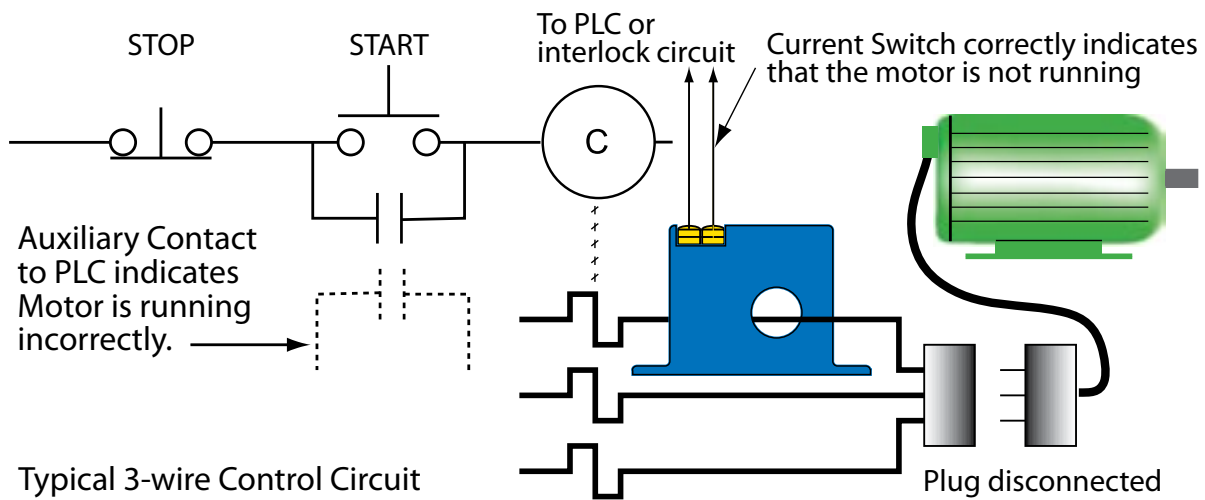
A **Ground Fault Sensor** installed on a submersible pump motor provides an easy-to-install replacement or addition to moisture sensors housed in the motor casing. Unlike moisture sensors that have to be wired back to the motor control center, the ground fault sensor is installed in the motor control center. By detecting the ground fault current resulting from moisture ingress or other potentially dangerous conditions, remedial action can be taken prior to catastrophic failure. Either the pump can be replaced at the next convenient time or switched off and a back-up pump started.



## Status Alarming/Motor Protection

The auxiliary contacts in a motor starter are commonly used to indicate when the motor is running. However auxiliary contacts only indicate the position of the contactor, not the actual load status. If a downstream disconnect is open (for example, for maintenance) or the contact fails (either sticks or due to dirt build-up) there can be serious consequences. When considering total installation cost, **AC Current Operated Switches** can be used as a more cost effective option than the replacement of thermal overloads for motor protection. Total replacement cost, switch and installation, is lower than that of thermal overload replacement.

At a large fish farm, failed aerator pumps resulted in massive stock losses. Because the auxiliary contacts remained closed when the pump failed, the alarm was never activated, the back-up pumps were not switched on and the fish suffocated due to lack of oxygen. Now current operated switches have been installed to provide an alarm signal and a signal to automatically switch over to the back-up aerator pumps.



## Vacuum Pump Monitoring

Vacuum pumps are used in a variety of applications in the semiconductor industry, and in heat treatment, plastics and packaging industries.

By adding a **Current Transducer** over the lead feeding a vacuum pump, it can easily be determined when all the air has been removed from a vessel or envelope. The analog output can signal the vacuum or equipment controller that it is time for the next step in the process. In the case of an automated packaging machine, a drop in current will signal that the package is ready for sealing.

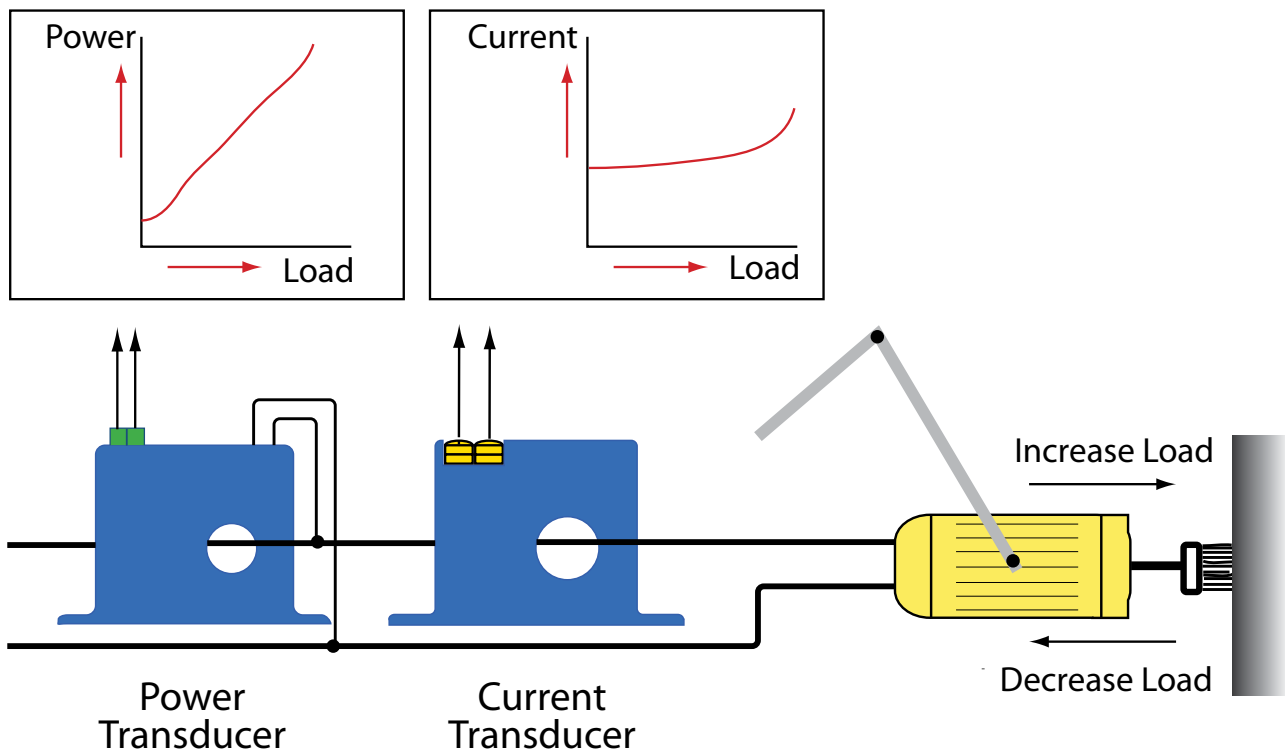
## Closed Loop Control

Normal linear AC induction motors have a current characteristic that increases with load. Thus a measurement of current is proportional to the motor load. NK Technologies' **True RMS Current Transducers (ATR Series)** are designed to work in conjunction with variable frequency drives (VFD) and measure the current in the leg of the motor.

At an engine block manufacturing facility **Current Transducers (AT Series)** provide the input to a PLC used to position the rotating wire brushes in order to clean away burrs and debris after machining. As the current, and thus the load changes, so the brushes are positioned for optimal clean-up.

Similarly **Power Transducers (APS Series)** are used to control the position of wheel wash brushes in a car wash. Power measurement provides a more linear relationship for motors and other loads with non-linear current characteristics.

**Current Operated Switches** are used to coordinate operations between conveyor, washing and drying systems.



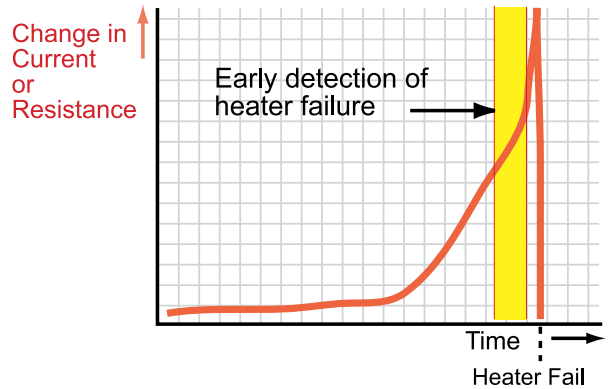
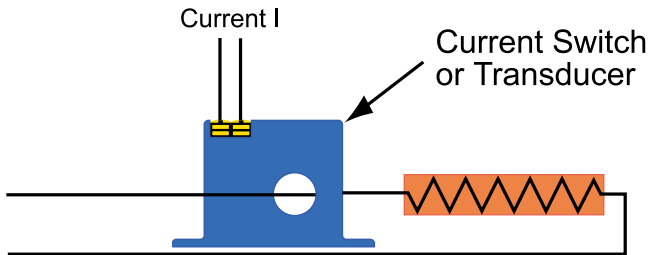
**Electric Heaters** are used in a broad variety of industrial applications. Many chemical reactions require the addition of heat. Trace heating may be used to prevent process pipes from freezing or melt snow on roofs or car parks. Many plastic parts are manufactured using the addition of heat to mold them to the required form. The heat output of an electric heater is directly proportional to the square of the current flowing through it. Therefore measurement of current is useful for both process monitoring and heater status. If a heater fails, poor quality products or scrap material may be produced. NK Technologies' Industrial Current Sensors are used in many heater applications.

### Heater Life Prediction

As an electric heating element ages, its resistance also changes. Many high technology and extreme temperature applications employ exotic and expensive elements. Where the value of the products or materials being heated is high, the failure of a heater or heating element has a financial impact resulting from either reduced quality or scrapped materials.

By measuring the current drawn by the element using an NK Technologies' **AT Series Current Transducer**, the resistance of the element can be determined and compared against a known ageing characteristic. When the element reaches a predetermined state it can be replaced prior to failure i.e. predictive maintenance.

**ATR Series True RMS Current Transducers** are used in conjunction with intelligent PLC systems when phase angle fired SCRs are used to control the heater output.

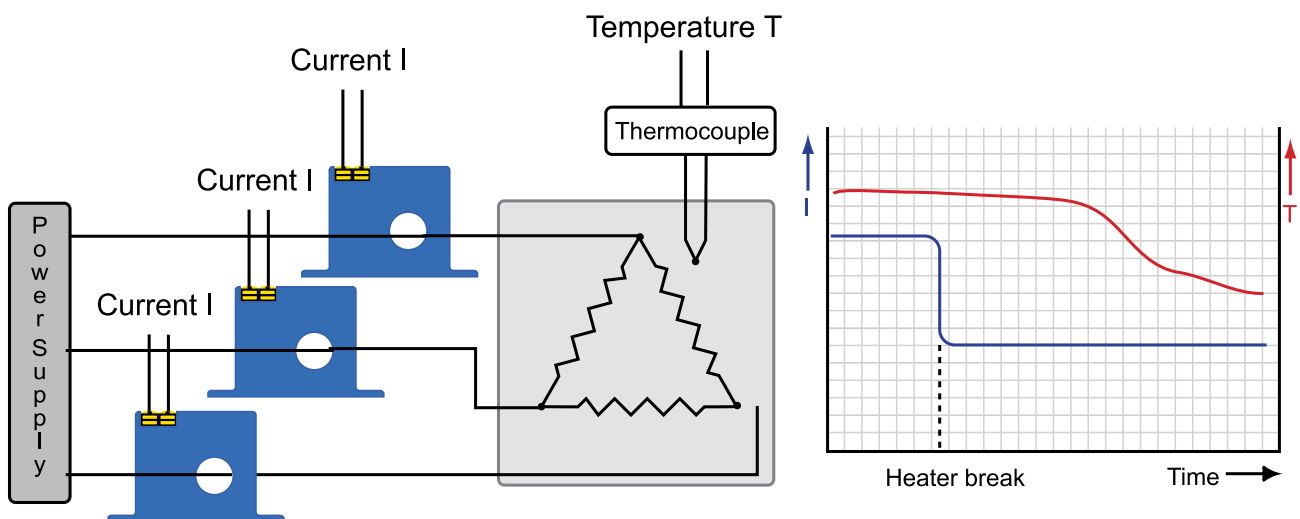


## Heater Failure Detection

The detection of a single phase heater failure by measuring the temperature is like measuring the effect rather than the cause. By installing a **Current Operated Switch**, heater failure can be detected before cooling has had time to occur. The signal from the current sensor can be used to switch on a back-up heater, stop the equipment, alarm the equipment operator or trigger the appropriate action.

The **ACI series** is a low cost, simple to install visual indication confirming current flow. Add an NK Technologies' **ACI "AmpFlasher"** over each leg of a heater circuit, and the ACI will show that there is current flowing in the conductor. The **AS1 Compact Case Series** is a low cost, small size switch option. The AS1 provides a solid-state "contact" which changes state with AC current at or above 0.50 amps.

The AS1 Compact Case Series is a low cost, small size switch option. The AS1 provides a solid state "contact" which changes state with AC current at or above 0.50 amps. For three-phase heaters, installing a **Current Transducer** on each leg of a delta connected heating array is the best way to detect loss of one element. When one of a delta connected heating element fails to open, the current used by the remaining two elements drops by about 15%, while the current in the phase connected to the open element drops by about 50%. There will be a reduction in thermal output, which can take quite some time to detect with temperature sensors like thermocouples. A current transducer will identify the problem in milliseconds. Poor product quality can be prevented and large quantities of raw material can be saved by quick action. The **AT Series Current Transducers** will work well when the heating elements are controlled by simple on/off action by a contactor or switch. The **ATR Series** is recommended for phase angle fired SCR controllers, while the **ATH series** is designed to measure current used by heaters controlled with zero-crossing (burst) fired SCR controls..



## Ground Fault Monitoring on Heat Trace Systems

Heat trace cable is used to keep pipes or their contents from freezing, or to keep the contents at a constant temperature while being transferred from one location to another. The most common type of heat trace cable is the self-regulating type. Self-regulating cable contains two conductors and is usually physically attached to the pipe and therefore subject to mechanical damage.

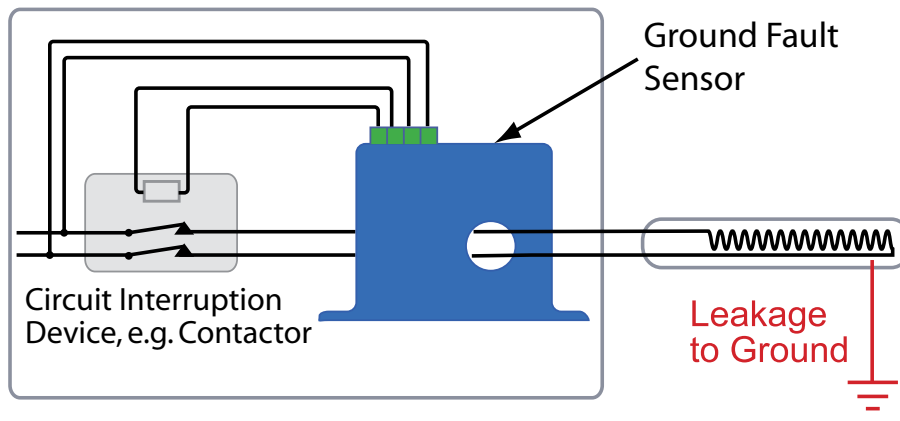


**Ground Fault Sensors** are frequently installed to monitor heat trace circuits and systems. When a ground fault is detected, a circuit interruption device, like a contactor or shunt-trip circuit breaker, is used to automatically disconnect the faulty circuit. In many situations NEC and/or local electrical codes require the installation of ground fault interruption devices. However ground fault sensors are commonly installed, even if not required by code, in order to monitor the condition of the heat trace cable and for installation and to maintain safety. Faulty circuits can be identified and then repaired or replaced at a convenient time.

## Insulation Breakdown

Industrial electrical heaters are prone to ground leakage due to the breakdown or contamination of insulation. The use of **Ground Fault Sensors** enables early detection of leakage currents as small as 5 mA. The on/off output of the sensor can be used to trigger a circuit interruption device (for example a shunt-trip breaker) or a monitoring device like a PLC to determine the required action.

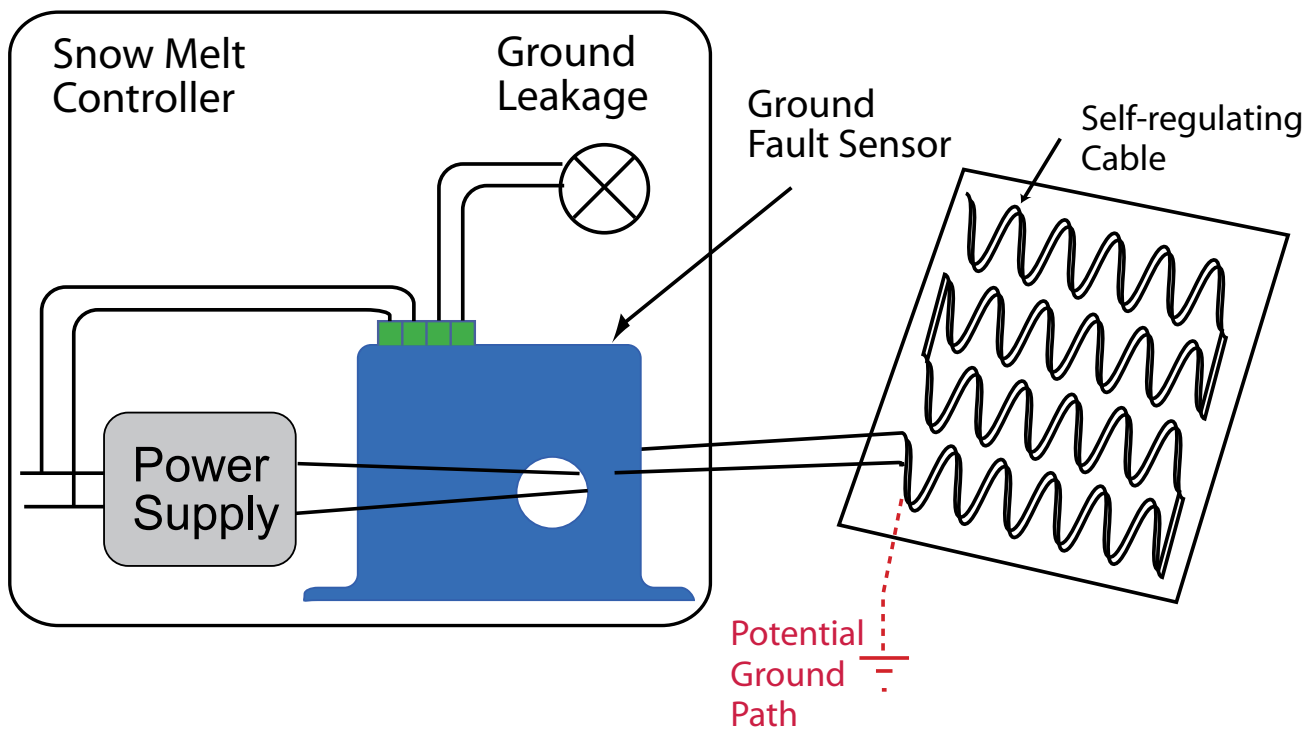
Latching and auto-reset models are available in both normally energized and normally de-energized configurations suitable for most applications. The **AGT Series Ground Fault Transducer** is used to monitor and trend insulation breakdown over time for maintenance and repair purposes.



## Snow Melt Systems

This application is similar to the Heat Trace System application. However there is a wider choice of lower-cost cable, which is often attached directly to roofs and gutters, or imbedded in sidewalks, steps, driveways or car parks. Although this type of installation is sometimes exempt from the code requiring ground fault protection, it is strongly recommended.

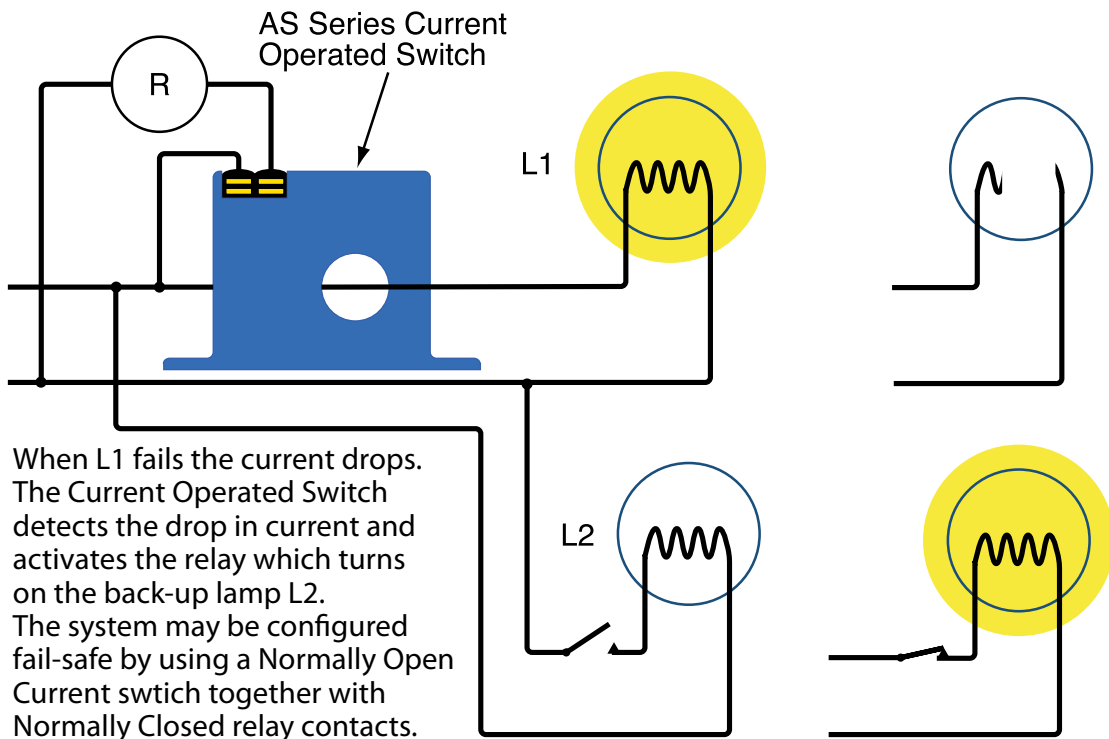
The simple installation of a **Ground Fault Sensor** will provide an early warning of trouble. Inevitably cable insulation deteriorates with age and stresses such as hydraulic action from ground water, resulting in current leakage to ground. This may create a hazardous situation for people or animals in contact with the installation. It will also waste power and cause a significant drop in the heat output and overall efficiency and effectiveness of the system. The circuit may continue to function, but snow and ice could continue to accumulate. If circuit interruption is required, a ground fault sensor should be installed in conjunction with a contactor, shunt trip breaker, or other approved circuit interruption device.



**Industrial Lighting:** Airports, tunnels, and industrial complexes all require reliable lighting systems for safety. The measurement of current provides essential information regarding a lighting system either in conjunction with photo-sensors or on their own. Photo-sensors may be unreliable due to fogging and the affects of ambient lighting. Monitoring current may be used for preventative maintenance on lamps with known life cycle characteristics. Generally NK Technologies' industrial current sensors are used to sense current and provide signals to an intelligent control system like a Programmable Logic Controller (PLC) or a Lighting Controller. The following examples demonstrate just a few possible applications.

### Lamp Failure Detection

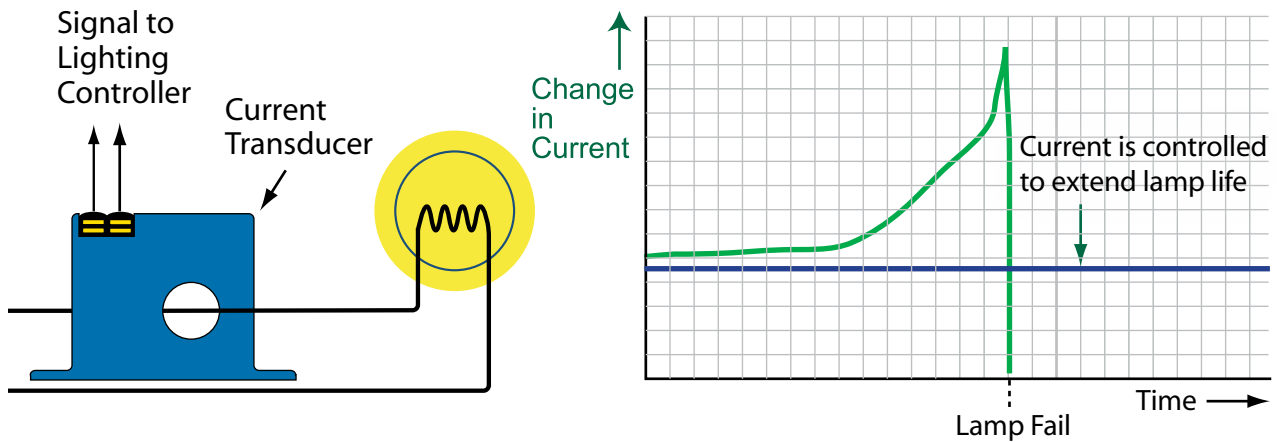
The simple addition of an NK Technologies' **Current Operated Switch** in a lighting circuit provides an isolated on/off signal to either a relay, to automatically switch to a back-up lamp, or to signal a PLC to indicate lamp failure. The split-core model is designed for quick and simple installation for existing installations and the solid-core device provides a compact solution for new installations.





## Preventive Maintenance of Critical Lighting Systems

High technology lamps have been developed for a variety of specialized industrial and commercial applications. These lamps are expensive so their useful life should be maximized. Installing a **Current Transducer** to measure the current draw of a lamp provides the information to determine the lamp's condition by comparison to known characteristics. Intelligent control devices, like PLCs, are programmed to adjust the applied voltage or current to optimize the life of the lamp.



## UV & IR Lamp Status Monitoring

Ultraviolet (UV) lamps are commonly used to disinfect water by killing bacteria. High intensity infrared (IR) lamps are used in a variety of industrial processes to provide heat both for drying and curing. Correct operation is important and can be determined by measuring current draw.

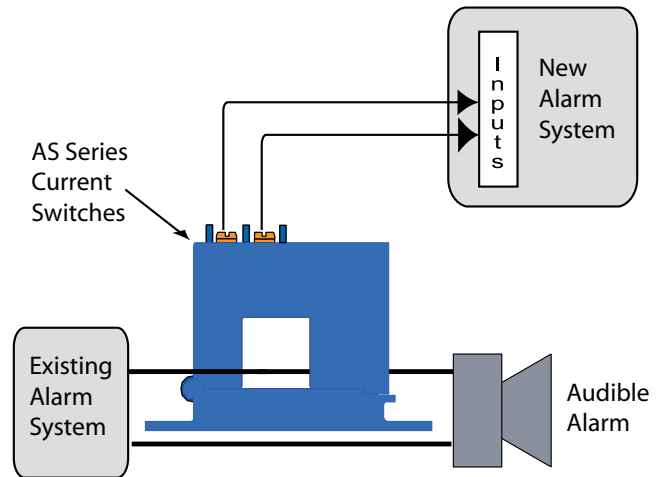
Using a **Current Operated Switch** provides simple and quick verification. The on/off contacts of the switch may be used to simply indicate status to an operator using a lamp or wired to the input of a PLC preprogrammed with the necessary corrective action. Alternatively, **Current Transducers** may be used to provide an accurate measurement of the current draw by a UV, IR or other light source.

**Miscellaneous Applications:** There are other electrical components and systems that use electric power where current measurement will provide useful and important information regarding status or provide protection. Some of those applications are discussed in this section.

### Isolated Alarm System Interfacing

If an alarm or monitoring system is to be installed in addition to another, (for example, a municipal hurricane or tornado warning system) it is desirable to tie into a large distribution automated warning system.

This can be achieved by utilizing a **Current Operated Switch** (models with a split-core design are ideal for this). The switch simply detects current flowing in a conductor feeding the audible or visual alarm providing a fully isolated 'repeater' signal. Switches are available for both AC and DC applications.



### Industrial Batch Mixing

Large mixers can be found in a variety of different industries and processes. From pharmaceuticals to food processing to the manufacture of chemicals, large batch mixers are an integral part of the manufacturing cycle. Quite often it is the viscosity of the mixture that determines the completion of the process.

A **Power Monitor** can be used to equate the viscosity of the mix to the power consumption of the motor driving the process. Single and three-phase designs are available which utilize standard 5 amp or millivolt CTs or flexible split-coil inputs for ease of installation. Simple analog outputs proportional to power or transmission of data through Modbus RTU options are available.

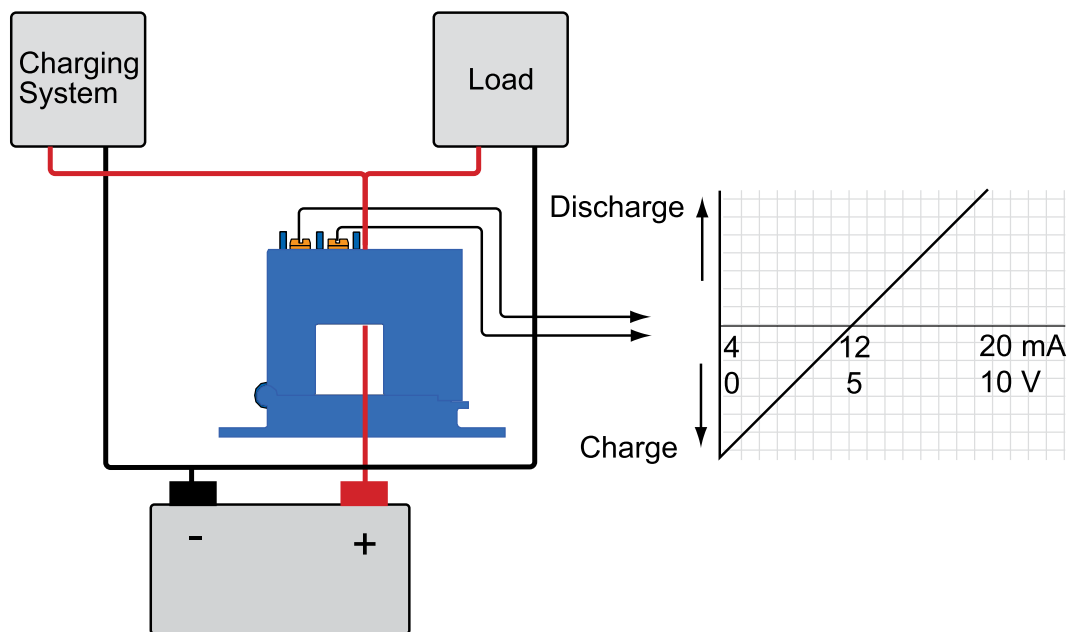


## Battery Charging System

Industrial rechargeable battery systems are used to provide primary power for electric vehicles, backup systems for critical equipment such as cell phone base stations and other communication equipment. Alternative energy storage systems for solar arrays and wind power generation are also prime candidates.

DC current flows in one direction during charging and in the opposite direction during battery operation. Traditional current transformers do not work with DC current so using current shunts has been the solution. The shunt operates by producing a voltage potential across its terminals according to Ohm's law. This has a number of serious disadvantages. Terminals can rise to the potential of the DC circuit. The signal produced is usually 50–100 mV at full rated current and must be isolated and amplified to a higher level signal (typically 4–20 mA) to be of use to an industrial monitoring or control system.

The shunt dissipates power according to the square of the current flowing through it making a shunt less than desirable for an energy consumption point of view. Bipolar and bidirectional options offer analog outputs proportional not only to the magnitude of current flow but also indicates the direction of current flow. Forget the shunt and instead simply pass the current carrying conductor through the aperture of a **DC Current Transducer**. There is no insertion loss and the transducer output signal is fully isolated from both the DC current being measured and the power supply. **Voltage Transducers** offer a convenient method to monitor AC or DC voltage with a proportional analog output.



## Solar Panels

Photovoltaic arrays are used primarily in two ways: (1) to charge batteries that are used to power remote loads where installing a connection to the utility grid would be cost prohibitive, and (2) to energize installations where the DC power is converted to 60 Hz AC power through a solid-state inverter.



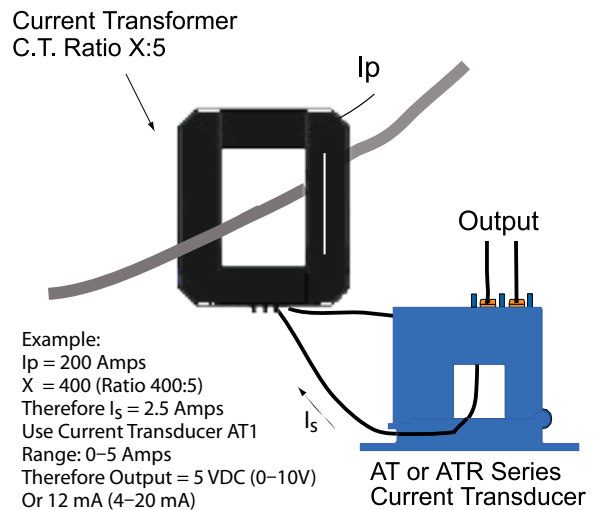
DC Current Transducers can be installed to monitor the output of the arrays. These transducers are available in bipolar and bidirectional versions so that current may be measured during charging or discharging of the batteries. Additionally Voltage Transducers and Power Transducers can be installed to monitor voltage, power and frequency from the inverter.

## Current Transformer Monitoring

Current Transformers (CTs) have been used for many years to measure AC amperage. There are many CTs installed throughout electric utilities, process plants and manufacturing facilities. Typically a CT provides either a 1 Amp, or more commonly, a 5 Amp AC output on the secondary side. In order to use this signal for a modern control system (DCS, PLC or DDC) or data logging system, a signal conversion or conditioner device is required to provide an analog DC signal.

CTs step down current; the secondary has to feed into a very low impedance to maintain accuracy. In the event that the secondary is open-circuited during operation the device operates as a step-up voltage transformer since there is nowhere for the current to flow and voltages of several kV appear on the secondary. Overheating occurs and combustion or explosion often results.

Split-core Current Transducers are simply and safely snapped over the shorted secondary of an a CT to provide a fully isolated analog 4–20 mA DC signal proportional to the current in the secondary, which in turn is proportional to the measured (primary) current. These current transducers are used to safely monitor the secondary of high voltage CTs used in power generation and distribution in the low voltage cubicles. CTs can be used in conjunction with panel meters as a simple and cost effective method to monitor current flow requiring a visual display.



## Generator Installations

The need for back-up power for critical loads is becoming more and more apparent to operating and maintenance personnel. Many existing factories and facilities are also adding generators to assist the grid connection supply during times of excessive consumption, or to help the plant ride through periods of peak usage when the utility charges are at a premium for power.

Monitoring the current demand provided from a generator allows for load shedding of non-critical loads when the generator is nearing its capacity. **Current Operated Switches** close or open when the demand, measured by current, is too high. By connecting to a controller (like a PLC), less critical loads can be disconnected from the system.



## Power Transformer Monitoring



Installing a **Current Transducer** over the conductors on the secondary of a transformer can be used to alarm if the current draw reaches a critical level. Action can then be taken to reduce the load before the transformer overheats.

Most large power transformers utilize auxiliary cooling fans, drawing cooler air from a distance away from the transformer. **Current Transducers** or **Current Operated Switches** are used to

monitor these fans for overload from bearing failure, under loads from drive component breakage or slippage, and to just be sure that the fan is energized and doing its required job.

## OEM Current Operated AC Switch Applications

The NK Technologies' **ASC Series of Current Operated Switches** offer a factory set and calibrated trip point meeting customer specifications with an accuracy of 1%. Because the switch is factory set and calibrated, the customer saves the time and cost associated with field or bench adjustment. From box to installation with no adjustments necessary, the ASC is available in an -FT fixed or -SP split-core design.

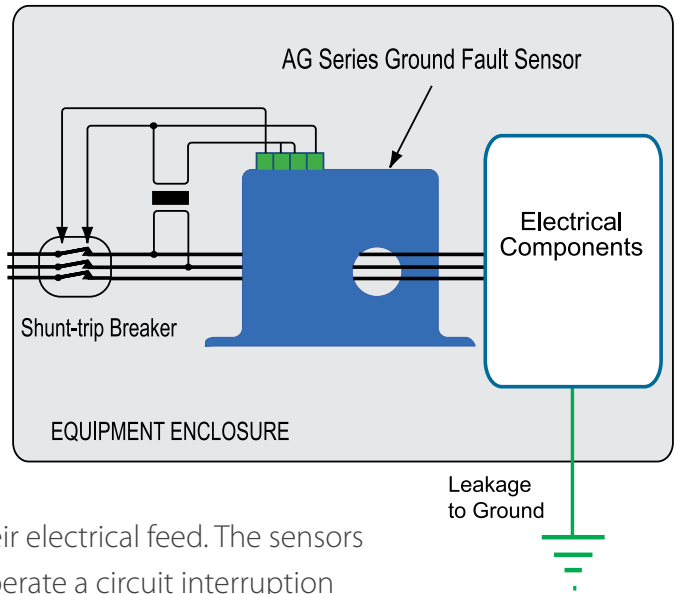




## Equipment Ground Fault Monitoring

As we become more aware of occupational health and safety, the need for protection against ground faults is growing. Industrial electrical equipment is fed via a distribution system which in turn is connected to a main feed. Ground fault protection may be installed, for instance at a main breaker, protecting the branch circuit but not necessarily a valuable or critical piece of equipment.

**Ground Fault Sensors** are designed to be installed in individual pieces of equipment or their electrical feed. The sensors provide an on/off output that may be used to operate a circuit interruption device like a shunt trip breaker or feed into an alarm system.



## Ornamental Fountains & Aerators

Fountains and aerators are often found in private and public ponds and lakes in parks, housing and office complexes, at golf courses, and in amusement parks. These water features all require pumps. In most installations, submersible pumps.

**Current Operated Switches** can monitor for a simple ON/OFF status, clogs (overcurrent) or suction loss (under current). **Ground Fault Sensors** are used to monitor for liquid ingress resulting in a hazardous ground fault condition.

In addition to the water feature portion of these applications it is not uncommon to have a lighting feature installed. **Current Operated Switches** offer a simple and cost effective method to monitor for overall lighting circuit failure or individual bulb failure.



## Industrial Test Equipment

In test stands or burn-in racks an NK Technologies' **Current Operated Switch** can be used to monitor individual products for ON/OFF or PASS/FAIL status or run time. As the current switch is activated an elapsed time counter is activated to track run time or burn-in.

## Welder Tip Dressing

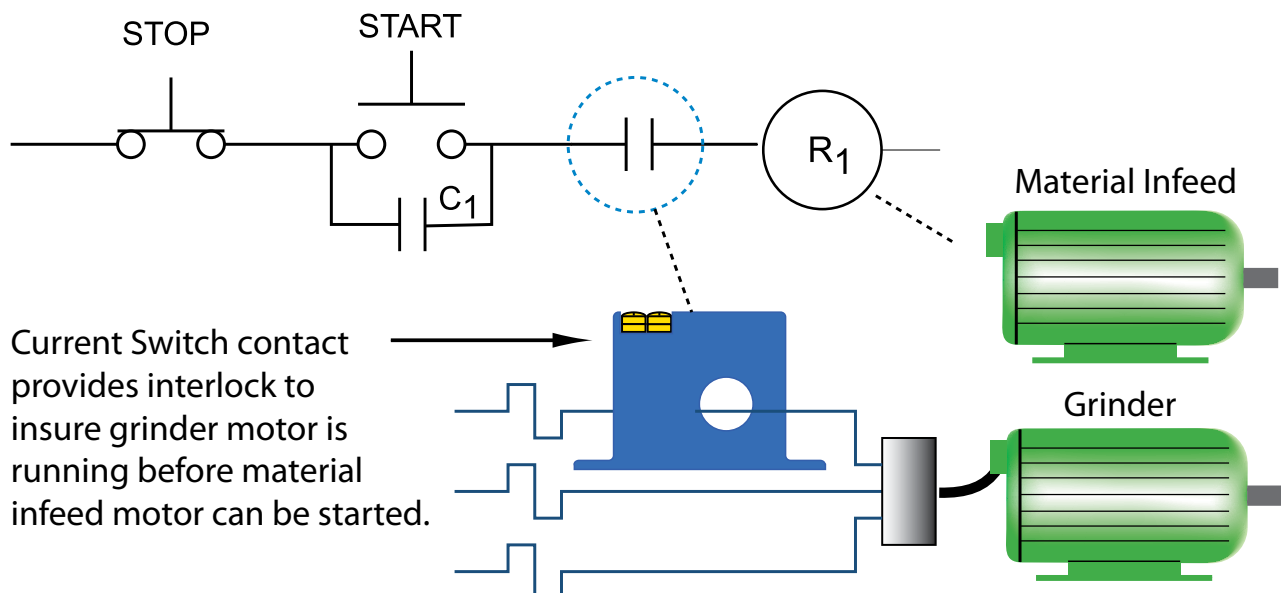
In a manufacturing plant like an automobile body assembly plant, there are machines that are essentially like large pencil sharpeners. These dressers are switched off for regular maintenance. After maintenance the dressers are not always switched back on. When the robotic welder requests tip sharpening, the tips are not dressed and poor quality welds result, this in turn produces poor quality panels.

By installing a **Current Operated Switch** on the tip dresser, the status is signaled and an alarm is generated to warn if the dresser remains un-powered and offline. NK Technologies' unique split-core packaging is ideal for retrofit installation and the compact solid-core unit is well suited for OEM applications.



## Safety Interlocks

**Current Operated Switches** are available in models that will switch at measured currents from just a few milliamps (mA) up to 1600 amps. Detecting current flow is the definitive measurement to determine if equipment or a heater is on or off, if a motor is running or not and other similar applications. NK Technologies' current switch products are installed for interlocking for operational and safety purposes.



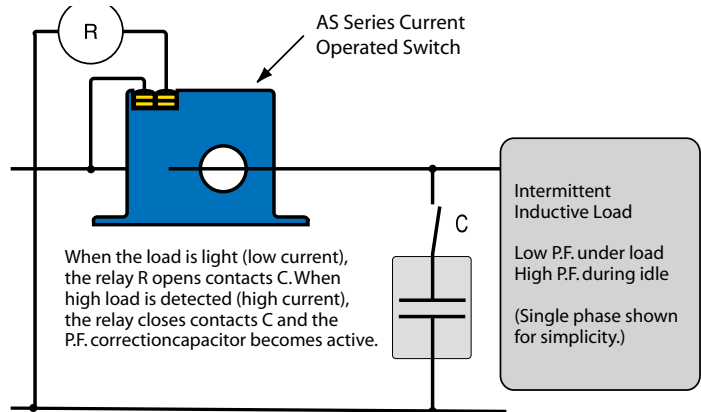
## Power Factor Correction Control

With ever increasing demands for electrical power, the power generating companies are beginning to penalize customers with low Power Factors (PFs). Low PFs can be considered very inefficient use of electrical energy. A low PF can be corrected by the installation of PF correction capacitors.

Although this can be achieved at the main feeder, most facilities, due to multiple varying loads, choose to install PF correction on individual pieces of equipment (like a large motor) or area of plant.

When a load is switched off, unless the PF correction capacitors are removed, undesirable over-correction occurs. Sophisticated automatic control systems are available but are very expensive.

A simple way to switch a PF correction capacitor bank is to use a **Current Operated Switch**. When the load goes down, for example at night when equipment is not used, the PF correction capacitor is switched out. Then when load returns it is switched back in.



## Dairy Farm Equipment

The term stray voltage is applied to certain electrical conditions in the housing of confined livestock. This can have an effect on their behavior, health, and milk production. The source of stray voltage is current entering the earth through power systems, through the electrical equipment used for automated milking, and other applications. These ground faults can result in lower milk production and safety hazards for both the animals and human operators.



A **Ground Fault Sensor** is used to monitor specific equipment for leakage to ground. The **AG Series** can monitor leakage current and, when used in conjunction with circuit interruption devices, provide a contact change when the fault current exceeds a predetermined level.



## Machine Tool Status

Automated drilling machines drill accurate holes quickly, until the drill bit breaks. The last thing a high production furniture manufacturer needed was to produce furniture that was missing a hole that was supposed to be drilled.

**Current Operated Switches** were installed over the current carrying conductor feeding the drill motor. When the amperage drops below a preset level a signal is sent to the controller to stop operation so that the drill bit can be changed.



NK Technologies' range of current transducers are used in a variety of applications on machine tools to detect status or cutting tool condition.

## Signal Conversion

In some applications such as monitoring high current or where space is sometimes at a premium, a two-piece (current transformer and signal converter) solution may be the better choice. When bus bars are used or conductors are packed tightly in a cabinet or in an area difficult to access, installation of a CT may be preferred. Connection to a **CTC Series Signal Conditioner** is simple and allows the use of any ratio 5 amp or millivolt output CT producing an industry standard proportional 4–20 mA output. The CTC series is available in a DIN rail mountable case.

Industrial control systems are often designed to collect data over a network. The **ADC Series of Analog to Digital Converters** accepts up to eight loop-powered, eight externally powered, or a combination of four and four analog inputs. Each input signal can be read on a Modbus RTU network. The ADC accepts an input from any type of sensor which produces an industry standard output.

## Handicapped Transportation Lifts

AC or DC driven handicapped lifts may utilize **Current Operated Switches** to monitor for jams or objects obstructing the path of the lift or the extension of the platform. An over-current or jam situation can damage the drive motor or the mechanics of the lift and possibly endanger the occupant's safety.



## Monitoring Power Consumption

Measuring AC current to determine the power consumption of a load will provide accurate data but only if the power factor, the ratio of the phase angles of the AC current and voltage, remains constant and the voltage stays at one value. Since single phase wattage is calculated by multiplying the current in amperes by the voltage and then by the power factor, if the only variable is current rise and fall the measure of current flowing is directly proportional to wattage consumed. However, inductive or capacitive loads will produce either lagging or leading power factor. Power factor can also change depending on how heavily loaded the inductive or capacitive load becomes.

Electric motors produce relatively constant power factor unless the amount of work done by the motor changes. A fan or pump will run consistently at the same current and power factor unless the pumped product changes in viscosity. A conveyor or material reduction process might cause the motor to run at full horsepower at any given instant while running at a substantially reduced horsepower at other times. A motor which is oversized for the load, whether the load increases periodically or not, would have the lowest power factor.

In any case, the most accurate measurement of wattage is to monitor the current and voltage simultaneously. If the need is to determine how much a machine or process is costing to operate, a comparison based on the rates the utility is charging can be made only by measuring wattage, since the utility bills based on watts per hour. Any other method will be not much better than a guess.

NK Technologies offers several **Power Monitoring Sensors** to measure power consumption. Choices range from small one piece models producing an analog signal to a data acquisition device, a panel meter, or a PLC to models measuring current through standard CTs or flexible coils; at the same time as it measures the line voltage to 600 VAC. This will produce digitally formatted data describing the current in each phase, voltage supplied and power factor.

NK Technologies uses its own power monitors to measure the load supplied to the heating and air conditioning system at its factory. The data provided is used to help improve its energy efficiency in compliance with ISO14000.



Five APN monitors monitoring the AC units at NK Technologies' factory in San Jose, CA..



The LCD display shows the data points sent to a controller via network communication. The LEDs show proper network activity..

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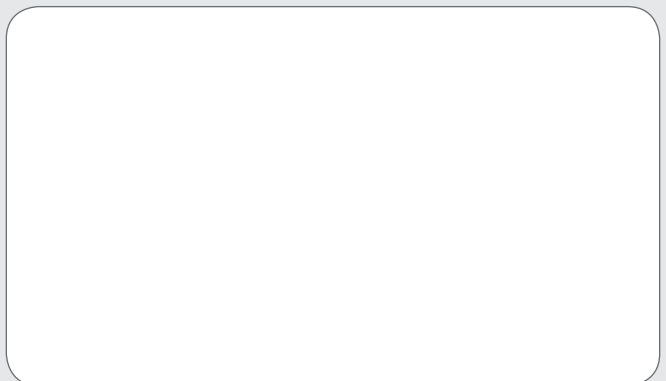
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