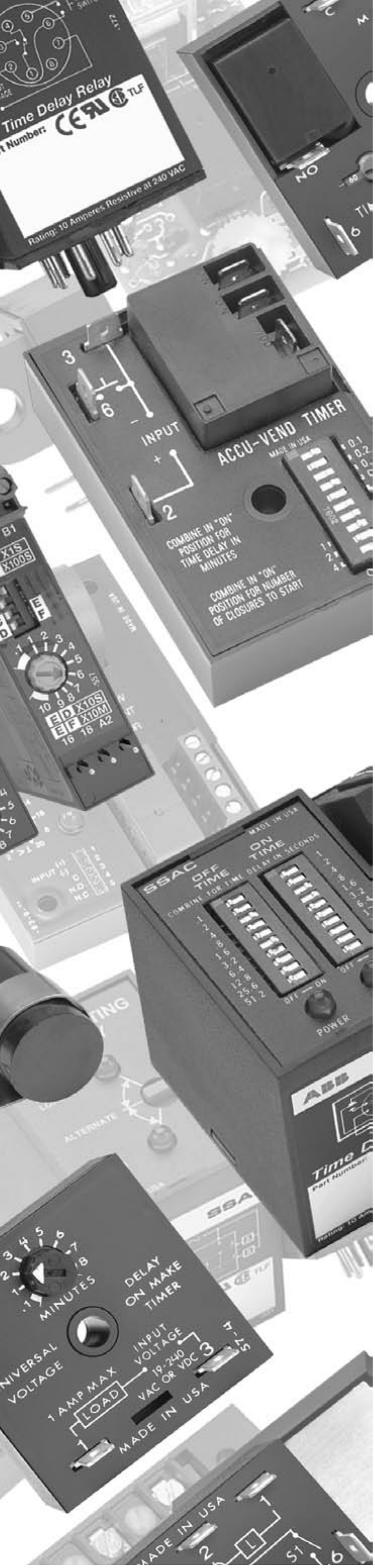


Application Notes & Glossary

The Application Notes that follow are a collection of circuits utilizing products found in this catalog. These circuits illustrate possible uses in a variety of applications. It is strongly recommended that you contact our Technical Assistance Team (see below) before using any of this information.

Application Notes

Alternating & Duplexing Relays

Current Sensors

HVAC Timers

(Continued on next page)

Index, cont.

Liquid Level Controls

Timers

Voltage Monitors

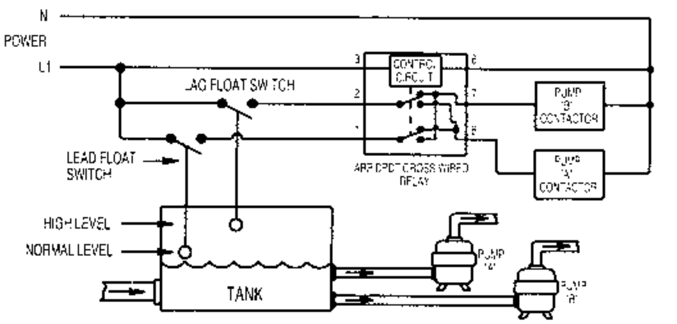
Glossary of Terms

Alternating & Duplexing Relays
Application Notes

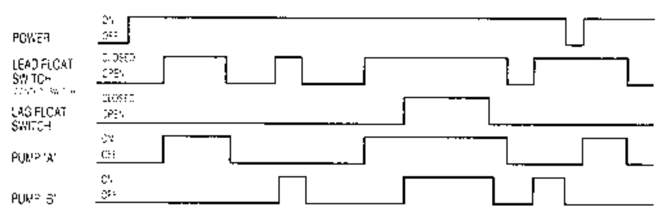
Alternating: Power must be applied at all times. When the level in the tank rises to the normal level, the Lead Float Switch closes. Pump “A” is turned on via Pump “A” contactor, and will remain in this condition until the Lead Float Switch opens. When the Lead Float Switch opens, the ARP relay contacts transfer. When the level in the tank rises again to the normal level, the Lead Float Switch closes, energizing Pump “B” via Pump “B” contactor. Pump “B” will remain energized until the Lead Float Switch opens. The ARP relay contacts then transfer back to their original position. The ARP’s internal relay contacts transfer each time the Lead Float Switch opens. By alternating the lead pump for each successive operation, the total number of operating hours is similar.

Duplexing: When an Alternating Relay is internally cross wired, the normal alternating operation is extended to include duplexing. If the Lead Float Switch cycles as previously explained, normal alternating operation will occur. If the Lead Float Switch and the Lag Float Switch close simultaneously, due to a heavy flow into the tank, both pumps A & B will be energized. The ability to alternate the pumps during normal work loads and then operate both when the load is high is called Duplexing. Duplexing relays can save energy in most systems because only one smaller pump is operating most of the time; yet the system has the capacity to handle twice the load.

Typical Connection Diagram



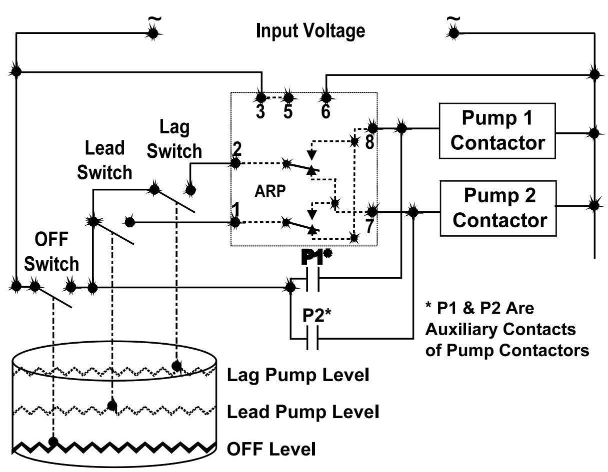
Timing Diagram



Duplex Panel with Latching Pump Down Operation

Many dual pump, duplex pumping applications, require two or more float switches to properly operate the system. The ARP Series of alternating (duplex or cross wired) relays are designed to equalize run time for two loads by automatically changing the “lead pump” and “lag pump” sequence at the end of each cycle. The ARP assures approximately equal wear on both loads, plus the duplexing models allow both pumps to operate simultaneously. This application can be used for water and wastewater pumping; and for circulating and distribution pumping of various liquids.

The diagram depicts a typical drain pumping application. The OFF, Lead and Lag float switches are connected as shown. As the liquid level rises, first the OFF and then the lead float switches close; pump “1” energizes. The liquid is pumped down by pump “1” until the OFF switch opens because of the latching action of the P1 auxiliary contacts on the pumps contactor. As the OFF switch opens, pump “1” turns OFF and the ARP toggles making pump “2” the lead pump. This operation continues with the pumps alternating lead/lag order on each successive cycle. If the flow is too heavy for one pump, the lag float switch eventually closes. Now, both pumps operate until the OFF float switch opens. A benefit of this connection method is the elimination of rapid cycling of the pump motors caused by float switch bounce.



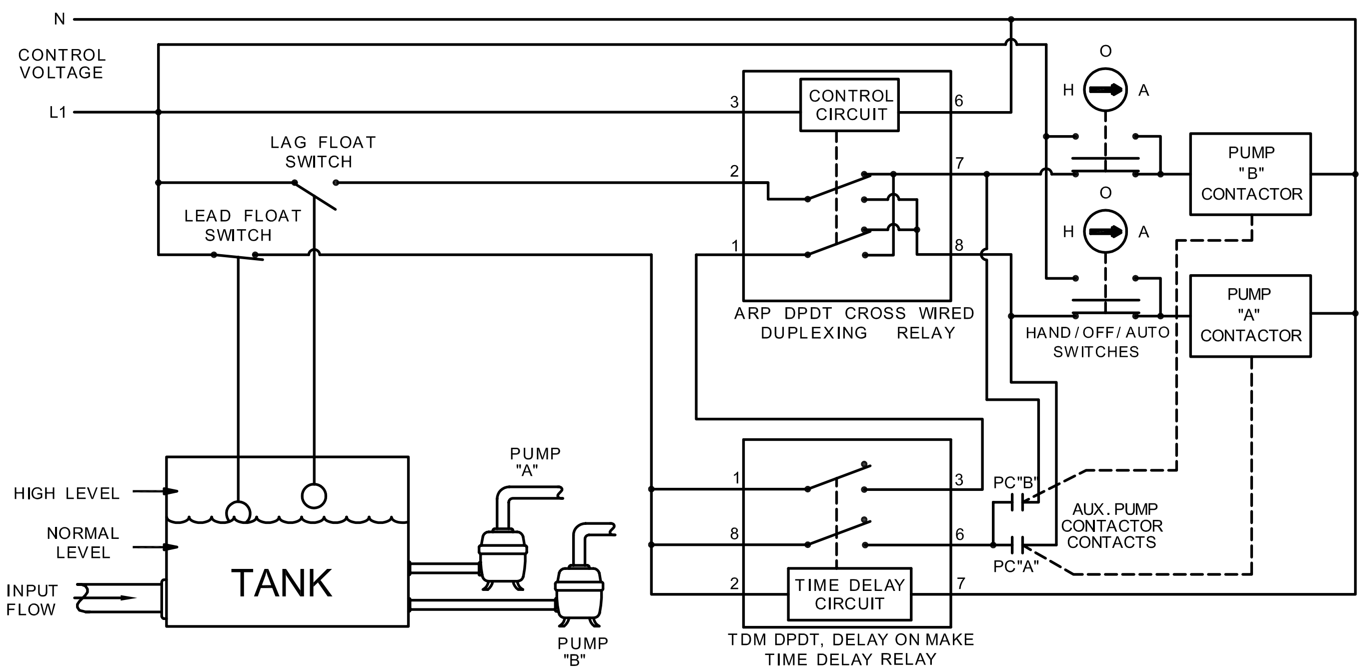
Alternating & Duplexing Relays
Application Notes

Timer Replaces Expensive Float Switch

In this application, a TDM delay on make time delay replaces the OFF float switch. In a duplexing pump controller, an OFF switch is installed at a level below the Lead Float Switch. The lead pump starts when the Lead Float Switch closes, and stops when the OFF switch opens. The difference in the position of the switches produces a time delay that prevents rapid cycling of the pump. Because of the installation and maintenance expense associated with all float switches, this solution replaces the OFF float switch with a no maintenance TDM time delay relay.

In the figure when the input flow exceeds the capacity of a single pump, both pumps operate. Unless the lag pumps contactor is latched ON, the lead pump will operate continuously and the lag pump will cycle ON and OFF as the lag switch opens and recloses. Remember the lag switch only closes when the fill rate exceeds the capacity of the lead pump. As the Lag Float Switch opens, the lag pump is turned OFF. Because of peak flow, the level immediately rises and turns the lag pump back ON; rapid cycling it.

Operation with the time delay installed: The diagram is shown with the Lead Float Switch already closed. Pump A (lead pump) does not start until the TDM delay on make timer energizes. When the TDM energizes, relay contacts 1 to 3 and 8 to 6 close energizing pump A. The TDM remains energized until the Lead Float Switch opens. When the level rises and closes the Lag Float Switch, the lag pump (pump B) energizes immediately. Pump contactor auxiliary contacts, PC A and PC B latch the lag pump on. Both pumps operate until the Lead Float Switch opens; the TDM de-energizes and the contactor's auxiliary contacts open. The ARP duplexing relay transfers to position B, making pump B the lead pump for the next cycle. Typically, the level rises again, re-closing the Lead Float Switch. The lead pump does not restart again until the TDM time delay times out. The TDM prevents rapid cycling of the lead pump by providing the time delay typically created by the OFF and Lead Float Switches; at a fraction of the cost.

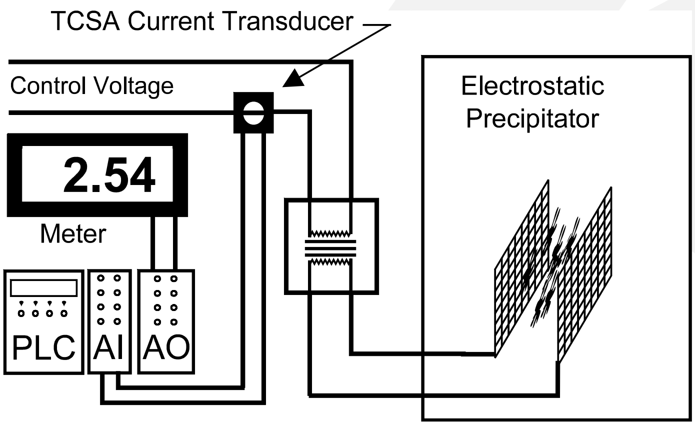


Current Sensor
Application Notes

Measuring Contamination with a Current Sensor

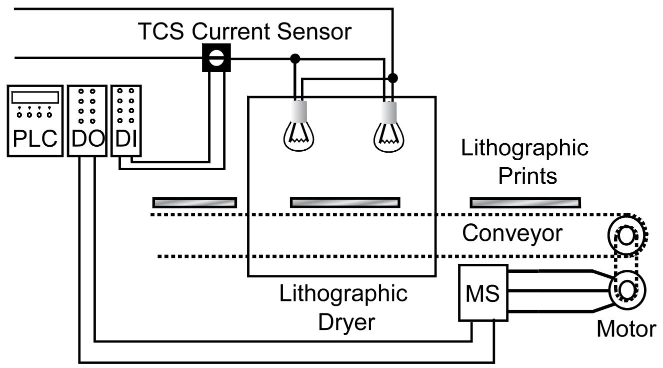
An electrostatic precipitator is placed on an industrial smoke stack to remove particulate pollutants. The filter grids within these precipitators are charged with a known voltage and operate at a specific current level when the grids are clear of conductive materials. As these materials are trapped and absorbed by the grid, the current increases due to leakage between the grids. This increasing current can be detected by a current sensor. For constant monitoring, (as shown) a linear analog output current transducer like the TCSA would be selected. The output of the TCSA is connected to a meter or an analog input module of a PLC.

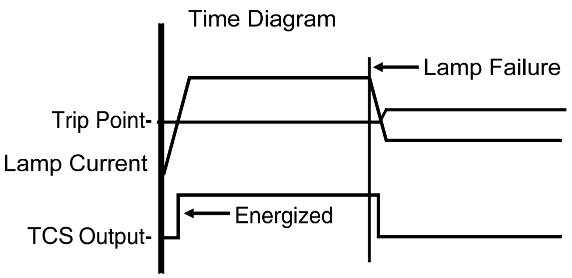
For alarm applications, (not shown) a current sensor with a preset trip level like the ECS Series is used. When the current level reaches a preset level, the ECS Series output relay energizes and an alarm buzzer or lamp is energized.



Using Current Sensing to Detect a Failed Lamp

This application illustrates how current sensing can cost effectively sense the failure of a critical lamp load in a piece of process equipment. A lithograph dryer is used in the production of expensive reproduction prints. The inks used for this medium are cured by ultraviolet lamps. The inks are laid down in stages to achieve the four color reproduction process. The inks are cured by the ultraviolet lamps between stages. A lamp failure or a decrease in lamp intensity can ruin this process. The undercurrent monitor is utilized to detect when the operating current falls below a predetermined level for the number of lamps in use. Any change in current below the preset level is viewed as a fault and the output contacts are used to shut down the process for repair.





Sensing Failed HID Lighting

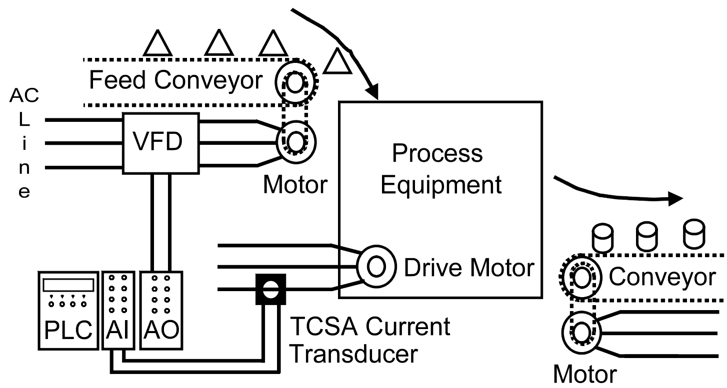
Current sensing can also be used to detect the failure of safety lighting and automatically energize backup lighting. HID lighting was used to provide customer safety in a local banking establishment. If an HID lamp fails to light, the current sensor automatically switches on backup incandescent flood lights. After a momentary power outage, the incandescent lights are on while the HID lamps warm up.

For equipment that uses electromechanical logic or requires a trip delay, the ECS Series is used. For PLC controlled equipment, the TCS series would be selected.

Current Sensor
Application Notes

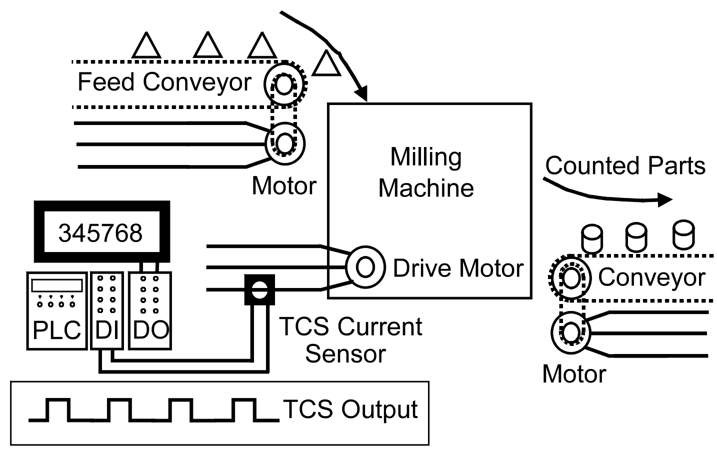
Feed Rate Control Using Current Sensing

The performance of equipment like grinders, sanders, saws, crushers, compactors, milling machines, etc. can be improved by adjusting the speed of the feed conveyor in proportion to the load on the process motor. The feed conveyor slows when the load on the process motor is heavy and increases when the load is lighter. The load on the process motor can be monitored with the TCSA 4 to 20 milliamp output, analog current transducer. The output of the TCSA Series is connected to an analog input module of the process controller. The process controller is connected to the variable speed drive (VFD) that controls the feed conveyor motor. The TCSA current transducer varies the flow of current in the 4 to 20 milliamp loop in direct proportion to the AC current flowing through its isolated current sensor. When the current in the loop increases, the process controller understands that this means the load on the process motor is increasing. It acts to optimize the flow by slowing the feed rate of the feed conveyor. The TCSA improves the operation of the equipment by providing reliable closed loop response to the controllers command that the requested operation is being performed. The low installed cost of the TCSA Series over the competition makes it the product of choice for OEM process equipment designers.



Using Current Sensing for: Improved Part Counting, Counting Motor Starts, and as an Hour Meter Interface

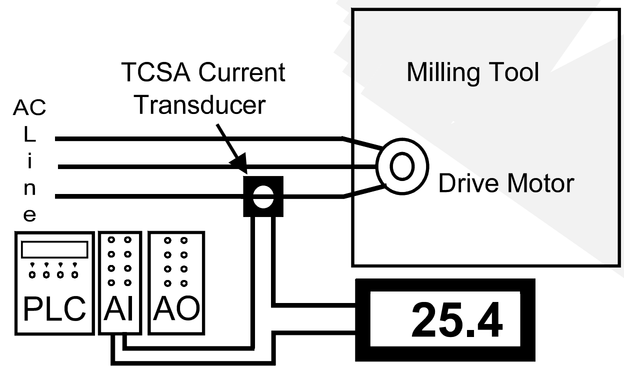
Traditionally, proximity sensors and limit switches are used for part counting. These both have positional limitations that are responsible for part count errors. If a part is constructed with one continuous twisting, stamping, boring, or punching motion, a review of the current used by the drive motor will reveal a distinctive pattern of current peaks. Using a TCS Series selected for overcurrent sensing and an electronic counter can produce a very accurate count of the parts being manufactured. The TCS's trip point is selected so that each operation of the drive motor is viewed as an overcurrent event. The solid state output of the TCS closes causing the counter to advance one count. This same concept can be used to count the number of starts of an electric motor, compressor, or pump so that regular maintenance can be performed. If the counter is replaced with an hour meter, the system will indicate the number of hours in operation.



Current Sensor & Indicator
Application Notes

Dull Tool Detection

During machining and milling operations, it is important to know when a cutting tool is becoming dull. Using a current transducer, like the TCSA Series, provides the information needed to detect a dull tool. As the tool gets dull, the current draw on the drive motor gradually increases. If a tool breaks, there will be a sharp drop in the current draw. The output of the TCSA transducer is connected to an analog input module of a PLC for evaluation, or to a meter to display the drive motor's current draw for the operator to evaluate.



Load Status Indication - Local and Remote

Equipment that processes chemicals, solvents, asphalt, plastics, dyes, textiles, plus dryers and curing ovens use multiple electric heating elements during their operation. Sensing the current flow through the heater element is the only sure way to determine if the heater is operating correctly. A convenient, low cost method of monitoring a bank of heaters is to install current flow indication LEDs. A low cost current indicator like the LCS with the LPM panel mount LED is easy and fast to install, and safe to operate. When the LCS senses between 5 and 50 amps flowing through the monitored conductor, it energizes the LPM indicator. The advantages of this system include: total isolation between the monitored load and the indicator; the sensor can be located 500 ft. from the LED indicator; and connection is accomplished using safe, low cost Class II wiring procedures. Further, the current sensor can be located anywhere along the monitored wire; it could be hundreds of feet or even miles away from the monitored load. The LCS sensor hangs on the monitored conductor and the LPM indicator snaps into a status panel. With the LPM located next to the temperature controller's indicator, the operator can see when a heater fails. If the temperature control's LED is illuminated and the LPM is not, the heater has failed open. By reverse indication, it also shows if the heater's solid state relay has failed in the shorted condition.

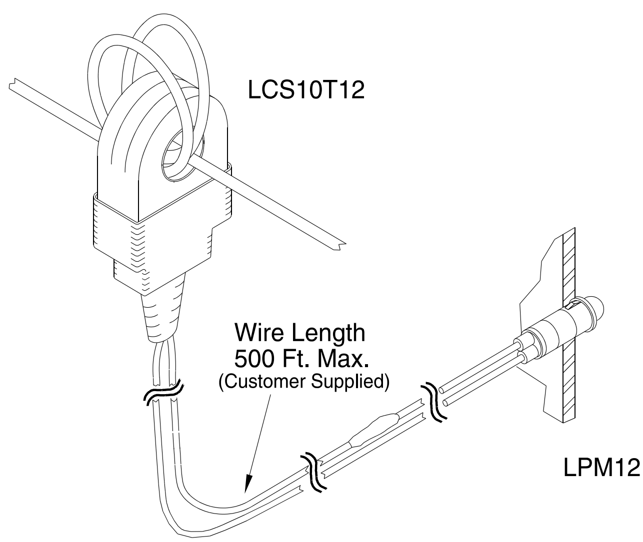


Figure 1

Sensing Operation of Heat Tapes

In the chemical industry, current indicators are used to show the normal cycling of freeze protection heat tapes. Many heat tapes do not include their own indicators. It is difficult to know when they are operating correctly and when they have failed open. Upgrading to the TCS Series of Go No/Go current switches allows the operation of a heat tape to be monitored by a PLC. The output of the TCS can be connected directly to the PLC's digital input module.

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Current Sensor & Failed Heater Detectors
Application Notes

Failed Heater - Fast Visual Indicator Single Phase Heater

A cost effective approach for monitoring the operation or failure of a heater element is to use a Go/No Go current indicator like the LCS10T12 connected to an LPMG12. The current carrying wire is passed through the LCS10T12 toroidal sensor. The current sensor can be placed at any location along the wire, even hundreds of feet away from the monitored load. The wires on the LCS10T12 are connected to the LPMG12 LED indicator (Fig. 1 on previous page). These two components can be up to 500 feet apart.

The LPMG12 is mounted in the control panel next to the heater's temperature control (Fig. 2). The Go/No Go Indicator, along with the
Go-Glow indicator light on the temperature control, displays four events for viewing by the operator. As long as both indicators glow simultaneously, the system is OK (as shown in Fig. 2). If only one glows, the system needs servicing.

System Status	Temperature Control	Current Indicator
System ON	ON	ON
System OFF	OFF	OFF
Failed Heater Or Open Relay	ON	OFF
Shorted Relay	OFF	ON

System indicates four events

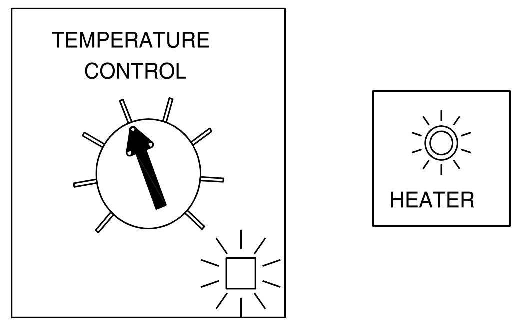
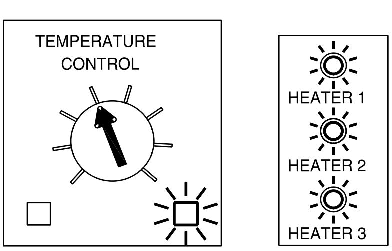


Figure 2

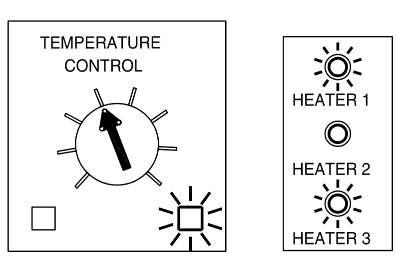
Three Phase Heater

This same approach can be applied to three phase bank heaters. For three phase systems, a Go-Glow Indicator is installed for each phase of the three phase heater. As above, the three Go-Glow Indicators are mounted in the operator's panel next to the temperature control. The operator watches the temperature control and three panel mounted Go-Glow Indicators.

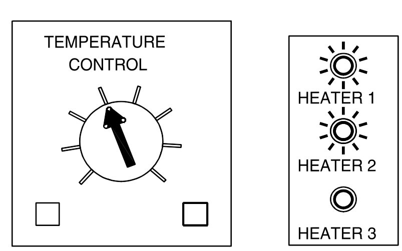
Operation: If all four indicators are ON, the system is OK. If all four are OFF, the system is OK. If the temperature control is ON and one of the Go-Glow Indicators is OFF, that heater or control relay has failed open. If any of the Go-Glow Indicators glow when the temperature control is OFF, a control relay has shorted. Note: If the system has a 3 wire (delta or wye) bank heater, a single shorted control relay cannot be detected. Two must fail short before this condition is displayed.



All Heaters Are Okay



Heater #2 Has Failed



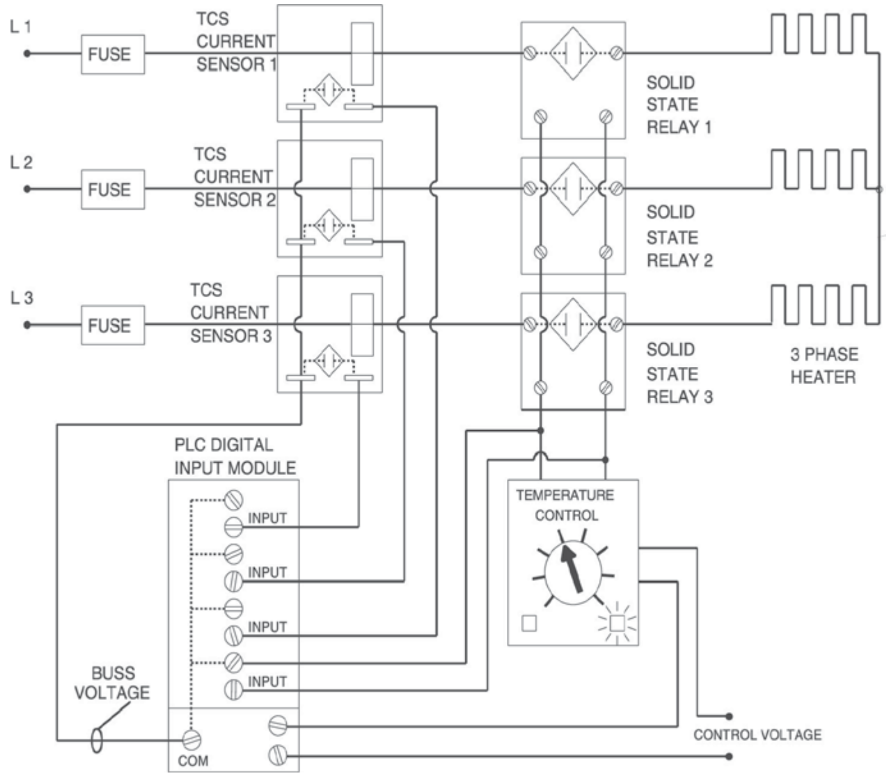
Control Relays #1 & #2 Have Failed

Current Sensor
Application Notes

Three Phase Heater Unsupervised Equipment

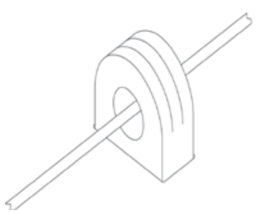
Active heater monitoring can be added to unsupervised machines and equipment. The figure below shows the connection for monitoring a 3 phase bank heater in an unsupervised piece of equipment. The TCS current interface switches are selected to monitor the current flowing to the heaters. When the current flowing exceeds 2 amps, the TCS's solid state output is closed or opened depending on the model selected. The temperature controller can be an analog input in the PLC or a separate controller. In the diagram, the output of a separate temperature control and each of the three TCS's are connected to four digital input modules of the PLC. Each time the temperature control energizes the solid state control relays, the PLC is notified through the temperature control input. The PLC then checks each of the inputs connected to the TCS's to see if all heaters are operating. When the temperature control de-energizes the solid state control relays, the inputs are checked to see if the solid state control relays have turned OFF or have failed short.

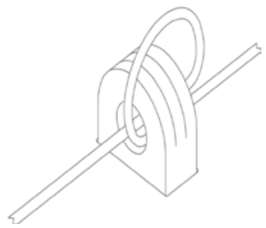
When appropriate, the PLC sends an alarm signal to the main control hub. The operator can evaluate the situation and schedule repairs.



Multiple Turns to Increase Sensitivity

The sensitivity of a current sensor may be increased by passing the current carrying wire through the toroid two or more times. The sensing range becomes the standard range divided by the number of wire passes through the toroid. For example, an ECS with a 0.5 to 5 amp trip range would sense 0.25 to 2.5 amps with two wire passes through the toroid. For four wire passes, the range would be 0.125 to 1.25 amps. The burden increases each time the wire is passed through the sensor. If the burden was 0.5VA for one pass, it would be 1 for two passes, and 2 for four passes.





Wire Passes	Minimum Current	Maximum Current	Maximum Inrush	Maximum Wire Diagram
1	5 Amps	50 Amps	120 Amps	.355”
2	2.5 Amps	25 Amps	60 Amps	.187”
4	1.3 Amps	12.5 Amps	30 Amps	.125”

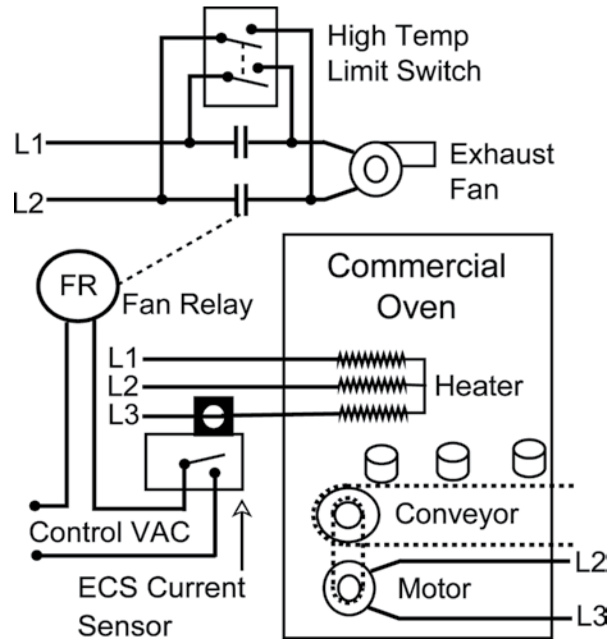
Current Sensor
Application Notes

The Operation of One Load Starts Another Load Operating

The current sensor provides complete isolation between the sensed load and the current sensor's output. This makes it a cost effective switching interface between two loads that operate on different voltages or different phases.

Commercial Oven Starts Exhaust Fan: In the example shown, the equipment is an electric conveyor oven installed in an institutional kitchen. For safe operation, an exhaust fan must run whenever the oven is on. The fan is connected to a completely different power supply box, but must be switched ON whenever the oven is operating. An ECS Series sensing overcurrent is selected for the application. The trip point of the ECS is set below the normal operating current of the oven's heater coils. When the oven coils are energized, the ECS senses the current flow and its output energizes. The output contacts of the ECS are then used to energize the exhaust fan. The high temperature limit switch is a safety backup control that only operates if the fan relay fails to energize.

Laundry Dryer Starts Exhaust Fan: In a high rise building, any one of many laundry dryers can be in operation at any time. The ECS Series sensing overcurrent is used to provide isolation so that any one of the dryers will energize an exhaust fan. Current sensors are used for similar solutions in industrial applications.

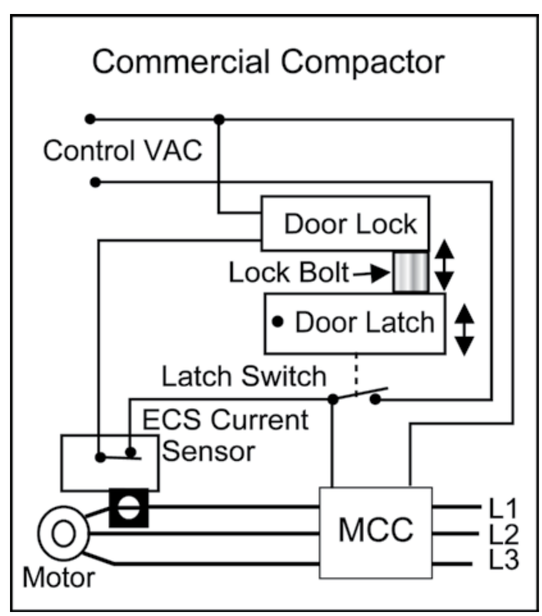


Interlock Two Loads Using Current Sensing

In industrial applications, an interlock can improve the operation and reliability of the equipment. Current sensors can help ensure that the required load devices are operating and start in the proper sequence. Until the first load is operating (drawing current) the second cannot be energized. Compactors, centrifuges, choppers, grinders, saws, and machine tools might all use this to ensure that protective doors and guards are closed and latched before the equipment is operated.

In a commercial compactor, an electric door lock is energized whenever the drive motor is operating. After the door is properly closed, the latch switch enables the motor control circuitry. Then the motor control center (MCC) energizes the drive motor starting a compaction cycle. The ECS Series is set for overcurrent sensing. As soon as the motor starts operating, the ECS senses the current and closes its output contacts. These contacts energize the backup door lock. The latched and locked door cannot be opened during the operation of the compactor. A limit switch allows the door to be unlocked at the end of a complete cycle.

In many automated processes, loading and unloading conveyors, exhaust fans, pre-purge blowers, etc. have to be operating before the primary operation begins. An exhaust fan must be operating before grain can be fed to a bag filling machine. The interlock prevents operation of the feed conveyor until the exhaust fan is operating. The interlock must sense the operation of the motor or load before the second is allowed to energize.



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Current Sensor
Application Notes

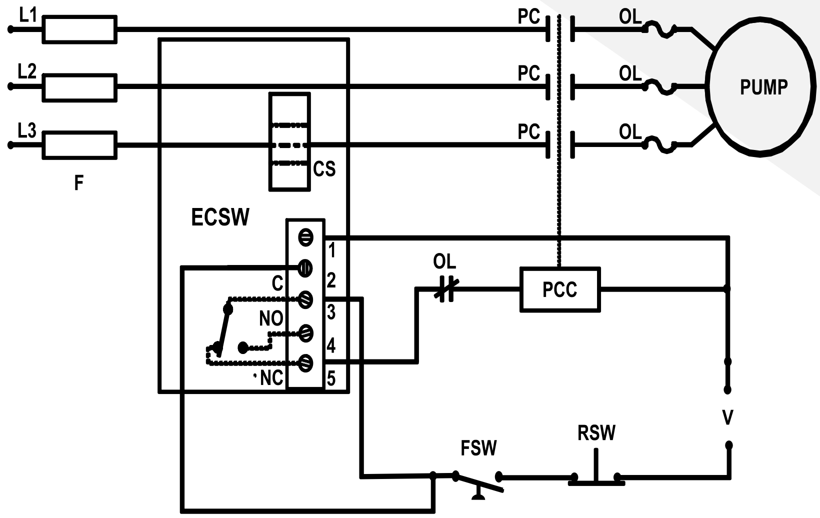
Window Current Sensing For Pump Protection

There are a variety of events that can cause problems in a pumping system. Suction side problems like loss of prime, low reservoir, cavitation, suction leaks or a broken impeller can stop flow even though the motor is still running. Discharge problems like obstructions, broken valves, jammed impellers, or mechanical problems like seized bearings or drive problems can cause the pump motor to slow down or lockup. Most of these events can be detected by monitoring the current flow to the motor. Since suction and discharge problems have the opposite affect on motor's current, a window current sensor is required to provide full pump motor protection.

The ECSW Series of "window" current sensors provides an overcurrent and undercurrent trip point in one unit. The overcurrent set point is adjusted above normal operating current and the undercurrent set point is adjusted slightly below normal operating current. This provides a "window" of normal operating current for the pump motor.

If the pump is unloaded due to suction side problems, the current drops below the undercurrent set point and the ECSW's output relay energizes (or de-energizes).

If the load current increases due to a discharge side restriction or a mechanical problem, the current increases above the overcurrent set point and the output relay responds. With the mode selector switch set for "latched" (manual reset), the ECSW relay will not allow the pump to cycle again after it trips until the control circuit is reset. Resetting the ECSW is far easier than traditional overloads since it can be reset by opening a normally closed reset switch located on the control panel door or in a remote location.

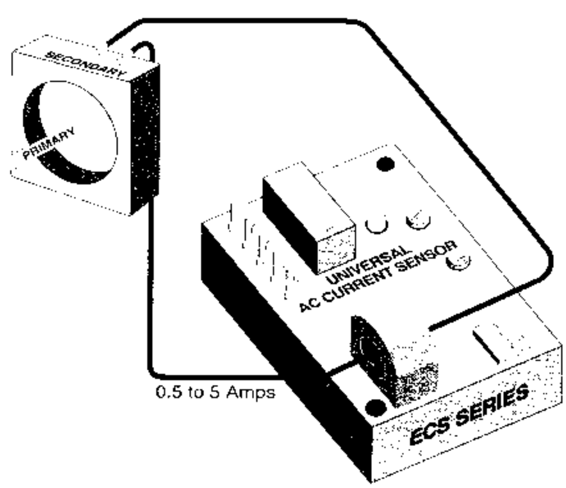


Legend:

F = Fuse
CS = Current Sensor
C = Closed
NO = Normally Open
NC = Normally Closed
PC = Pump Contactor
PCC = Pump Contactor Coil
FSW = Float Switch
RSW = Reset Switch
OL = Overload

External Current Transformer

An external transformer can be used to monitor remote loads or where the steady state load current exceeds 50 amperes. Select a current transformer (CT) that is rated for the load being monitored and an ECS with a trip point range of 0.5 to 5 amperes. The CT secondary should be in the range of 0 to 5 amperes. The burden rating of the secondary should be a minimum of 0.5VA. Pass the current-carrying wire through the hole in the CT. Make one pass of the CT's secondary wire through the toroid on the ECS. When properly connected, the CT's secondary will appear to be shorted. The ECS trip point may now be adjusted.

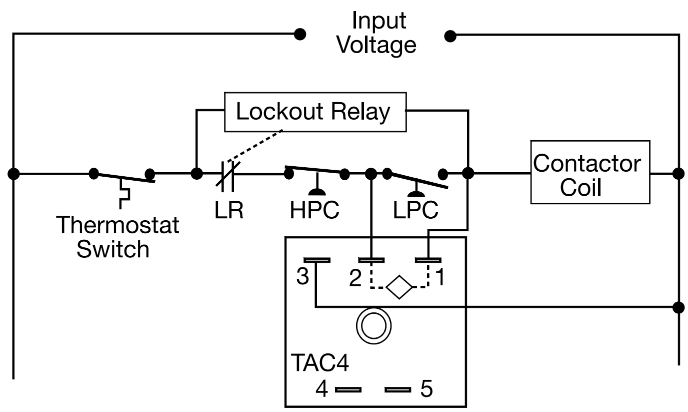


HVAC Timers
Application Notes

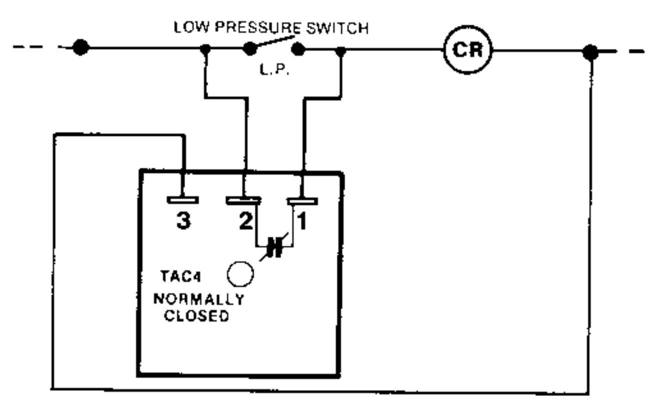
Bypass Timing

Allows Low Temperature Starting of an Air Conditioner:
In some applications, a process variable may be out of range when the equipment is asked to cycle. With a safety limit switch open, automatic equipment cannot be started until the open limit switch is closed or manually bypassed. This application shows how to automatically bypass a process limit switch without damaging the equipment. A bypass time delay momentarily shorts across an open limit switch; allowing the equipment to start and close the open limit switch. If the limit switch opens after the bypass timer times out, the equipment shuts down.

A common example of this situation occurs with air conditioning equipment operating in moderately cold temperature zones. The connection diagram shown represents a typical control circuit from a rooftop air conditioner. It is a chilly fall morning. A southern facing wall of glass has captured enough heat to send the room temperature above normal. The thermostat calls for cooling. Because of the low ambient temperature, the refrigerant pressure is too low and the LPC (low pressure control) is open. Under normal conditions, the LPC protects the compressor from overheating caused by low refrigerant pressure. The addition of a bypass timer allows the system to start and attempts to establish an acceptable refrigerant pressure. The normally closed solid state output of the TAC4 Series is connected across the LPC contacts. The TAC4's output remains closed for one to three minutes each time the thermostat switch closes. It then times out and its output opens for the rest of the cycle. If the LPC opens during a cycle, the compressor shuts down. The bypass delay allows starting when the ambient temperature is low and then returns compressor protection to the low pressure switch. The lockout relay is a fast acting latching circuit. If the LPC or HPC (high pressure control) opens, the lockout relay latches preventing further operation until the lockout relay is reset.



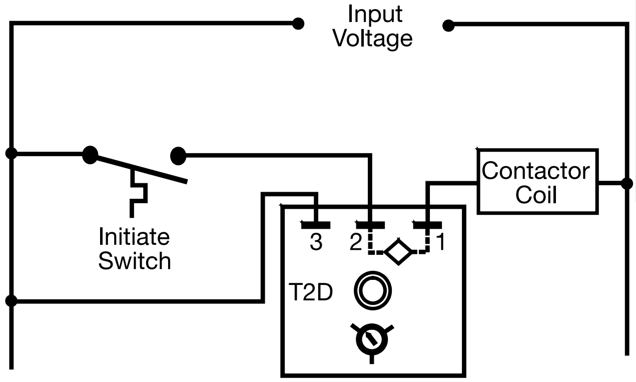
Low Pressure Switch in Compressor Relay Circuit:
The TAC4 is a normally closed all solid state delay on make timer. When power is applied to the compressor relay circuit, the TAC4 will provide a closed circuit across the low pressure switch for a preselected delay to allow pressure to build up and the switch to close.



Anti-Short Cycle and Random Start Protection
A New Dual Timer

Far too many motors are short cycled after a momentary power outage. The utilities reclosing process attempts to re-establish power automatically after a fault has tripped OFF a supply line. The reclosing breaker makes three attempts to re-establish power. Each attempt is a few seconds after the circuit re-trips. Compressors, pumps, machine tools and milling machines that operate with variable loads may not be able to start under peak loading. These motors may be subjected to excessive locked rotor stress after a momentary power outage. A new compact time delay, the T2D Series, doubles the protection provided by traditional anti-short cycle timers. When power is applied, a random start delay begins. The T2D's solid state output is OFF during the random start delay. After timeout, the output energizes and latches ON regardless of the condition of the initiate switch. With traditional random start timers, the time delay doesn't begin until the initiate switch is closed. When the initiate switch opens ending the machine cycle, another anti-short cycle delay called a lockout delay begins. The machine cannot be restarted until this delay is completed. This time delay limits the number of motor starts per hour. This second lockout delay provides further short cycling protection previously not available within a single compact timing module.

T2D Connection - Lockout Plus Random Start Delay

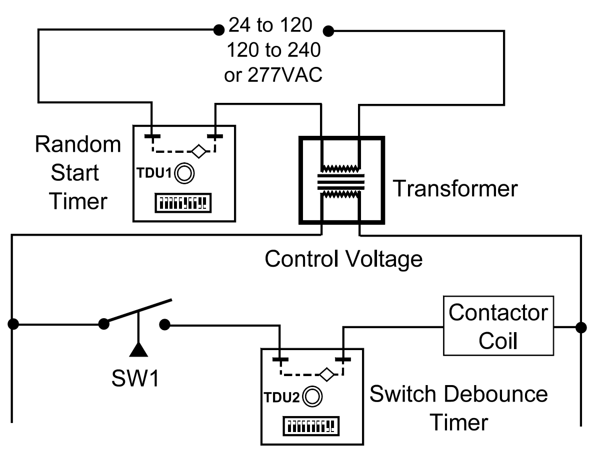


Debouncing - Demand Reduction Timers

Random Start Sequencing:
Random Start Sequencing is a common practice used to prevent overloading of power lines due to peak demand current levels. Peak demand usually occurs after power failures or when night shutdown systems are used.

A low cost random start system includes a delay on make time delay in the control circuitry of the system as shown. Random start timers are placed in each piece of equipment, each timer set for a different time delay period.

The random start delay is connected so that its time delay occurs after loss of power. When power is restored, the normally open solid state output of the TDU1 timer keep the transformer de-energized for a selected time delay. Upon completion of this delay, the solid state output changes state and the transformer is energized.



Debouncing - Preventing Contact Chatter:
Switch bounce can cause unacceptable contact chatter. In this application, the TDU2 timer is used to debounce control switch SW1. Upon closure of SW1, the normally open solid state output of the TDU2 timer keep the contactor coil de-energized during the debounce time delay. Upon completion of the time delay, the contactor is energized. The debounce time delay will be reset to zero if SW1 opens at any time prior to the completion of the TDU2 time delay.

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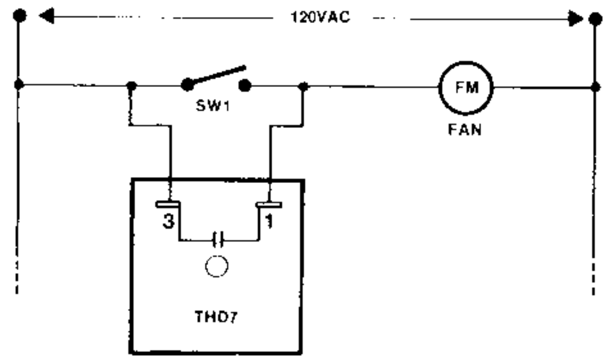
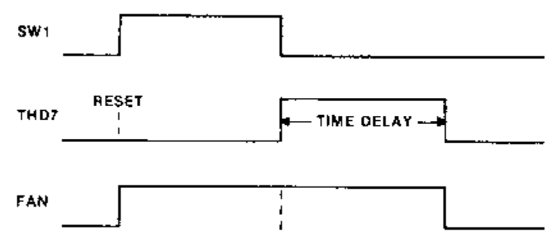
HVAC Timers
Application Notes

Exhaust Fan Delay

In many existing installations a neutral connection (white wire) is not available in the switch box. The two terminal delay on break THD7 is perfect for these installations. SW1, when closed, operates the fan directly and holds THD7 reset. When SW1 opens, THD7 begins timing and holds the fan on until the end of the time delay. The system is reset each time SW1 is closed.



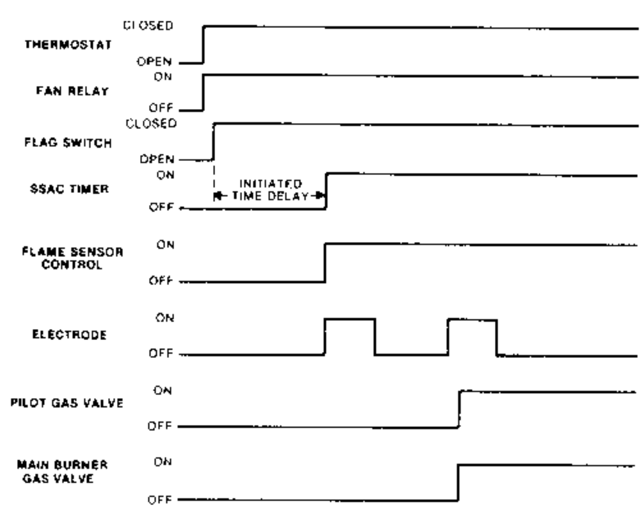
Timing Diagram

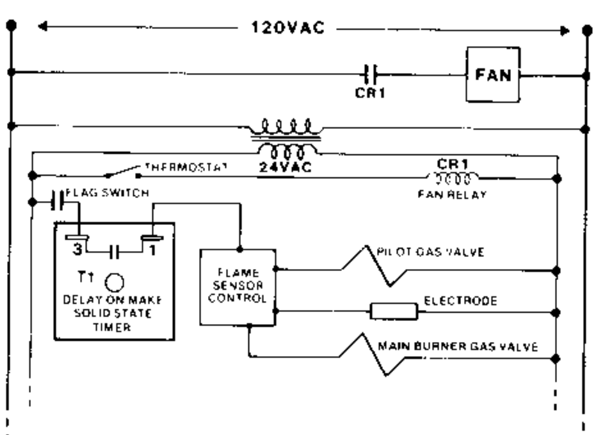


Prepurge

When the thermostat closes, the fan turns on. While purging the combustion chamber, the fan forces the flag switch to close, applying power to the solid state timer. The time delay starts, keeping ignition controls off until gas vapors are removed. The solid state timer then sends power to the flame sensor control section which fires the electrode. If the pilot is lit, the main burner is also lit. If the flame sensor does not see a flame, the electrode is fired one more time. After a second failure, the system goes into lockout and must be manually reset (Lockout circuitry not shown).

Timing Diagram





T1 = TS1, TSD1, TAC1, TSU2000, TMV8000, TDU, KSD1

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Liquid Level Control
Application Notes

Liquid Level Controls (LLC) are designed to detect and control levels of liquids which are electrically conductive. These controls sense the resistance value between the probe(s) and the common point. The conductive liquid completes the electrical path between the probe(s) and the common input. The LLC's then compare this value with a set point value determined by the setting of the adjustment potentiometer. The output of these LLC's can be used to turn on and off pumps, solenoids, or valves to lower, raise, or maintain the liquid level in a containment tank.

Application	Material	Resistance (Ohms)
Agricultural	Ammonium Nitrate	18 K
Dairy Equipment	Milk	1 K
Material Handling	Cement Slurry	5 K
Food & Cooking Equipment	Corn Syrup Cake Batter	45 K 5 K
Pumping Equipment	Fresh Water Salt Water	5 K 2.2K
Vending Equipment	Coffee Fruit Juice	2.2 K 1 K
HVAC/R	Condensate Water	18 K

Single Probe Level Control

In Figure 1, a low cost, open board, single probe LLC1 Series, or 8 pin plug-in LLC4 Series, with the 'A' drain logic, is being used as an AC/R condensate level control. When the conductive condensate (18K typical) touches the probe, the resistance between the probe and common decreases rapidly to a value below the selected trip point. The output remains de-energized until a fixed time delay is completed. Then the LLC's output energizes causing the pump to run. As the reservoir begins to drain, the condensate level drops. Contact between the probe and the condensate is broken causing the resistance to increase to a value above the trip point. Then the output of the LLC transfers and the pump is de-energized; ending the pump down cycle.

NOTE: Conductive level sensing should not be used with distilled water. Its measured resistance is >450K.

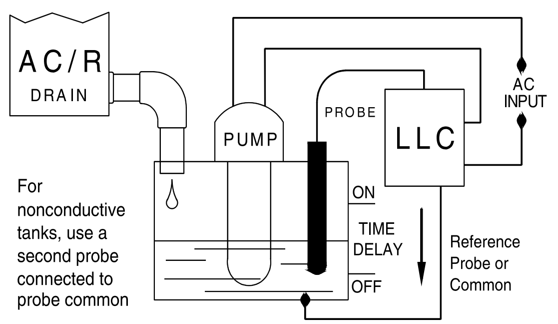


Figure 1

Sensitivity to Ignore Foam

The example in Figures 2A & 2B is taken from an actual application problem that was solved by conductive liquid level control. An OEM wanted to monitor and maintain the level of beer within a holding vessel. The measured resistance of beer is typically 2.2K ohms, which is within the 1K to 100K ohms adjustable sense resistance range of the LLC series. This OEM had tried sonic and optical methods for maintaining the liquid level, but they didn't work correctly. It seems all other methods didn't allow for foam collecting on top of the beer.

Beer foam, with all of the introduced carbonization and air, has a much higher measured resistance than liquid beer. The trip point of the LLC can be adjusted so that it ignores the higher resistance foam and energizes when the lower resistance beer is sensed. This difficult application had a simple and cost effective solution using an LLC Series conductive liquid level control.

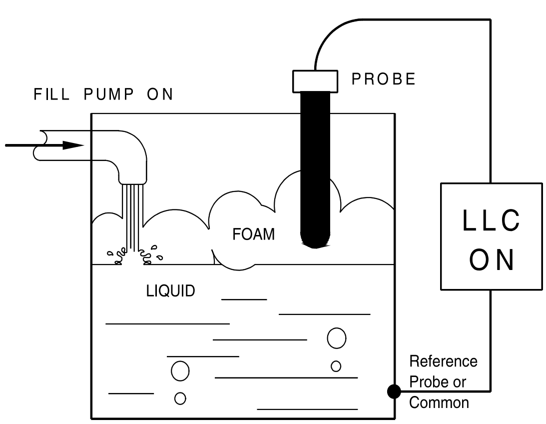


Figure 2A

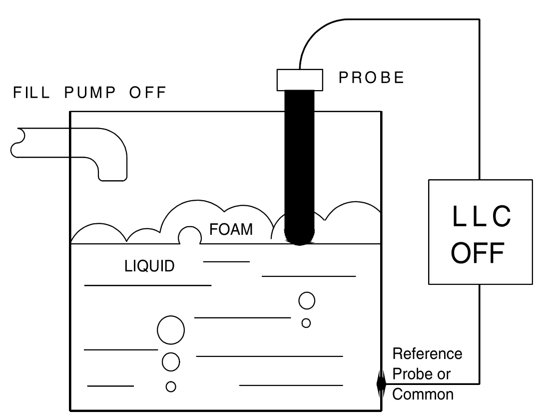


Figure 2B

Liquid Level Control
Application Notes

Dual Probe Level Control

The dual probe input LLC's are designed to maintain the high or low level of a liquid within the containment tank. Figure 3 is an example of a water well reservoir application. Using an LLC2 Series open board design or the LLC5 series 8 pin plug-in (with the 'B' fill logic), we will be able to maintain a precise level within the holding vessel.

As long as the potable water (with a typical resistance of 5K ohms) remains in constant contact with and completes the path between the upper and lower probes, the LLC's output remains de-energized. During usage, the demand pump lowers the water level. When the water level drops below the lower probe, the LLC's output energizes and closes the fill pump control circuit. As the level rises, the pump up circuit will remain closed until the water rises to and touches the upper probe. With the probe depths set accurately, the high level of the tank is maintained and the low level will not drop below the intake of the submersible pump, thus avoiding a loss of prime condition.

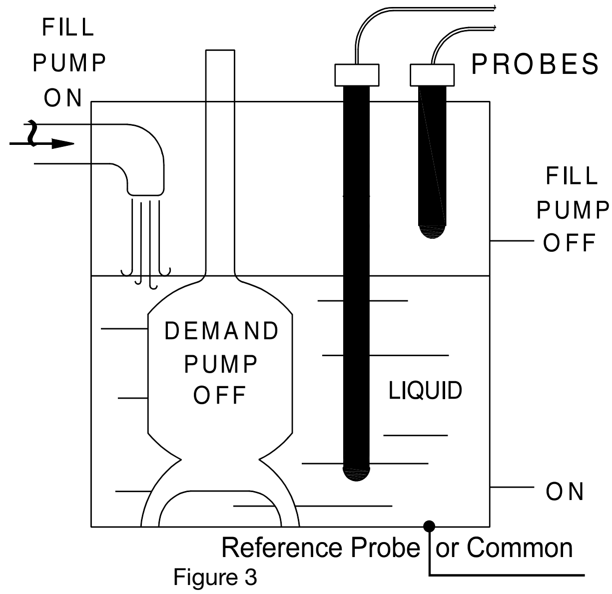


Figure 3

Seal Leak Detection

Another use for a conductive liquid level control is as a seal leak detector. An electrode is placed in contact with the non-conductive oil within a pump/motor casing. If a leak in a watertight seal occurs, the conductive contaminates introduced into the oil lowers its resistance. The LLC senses this change in resistance. The example in Figure 4A & 4B illustrates a typical sewage pump application. The probe is normally inserted through a watertight seal, which isolates the probe from the case (common connection). A separate wire runs from the pump ground (case) to the LLC common to complete the sensing path. Typical sewage has a resistance of 5K ohms. An LLC setting, of approximately 21K ohms, will allow detection of minute levels of sewage in the oil. This means leaks are detected early. Normally the output of the LLC would then be connected to an alarm to signal a leak has occurred allowing routine maintenance to be scheduled to replace the damaged seal.

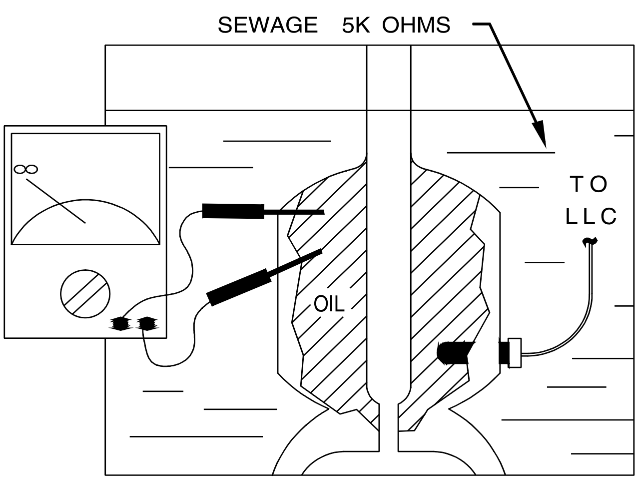


Figure 4A

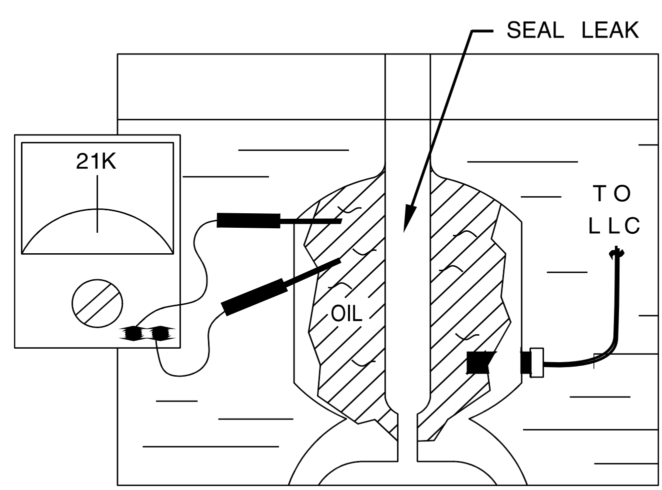


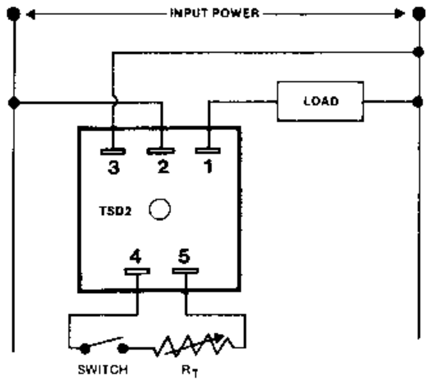
Figure 4B

Timers
Application Notes

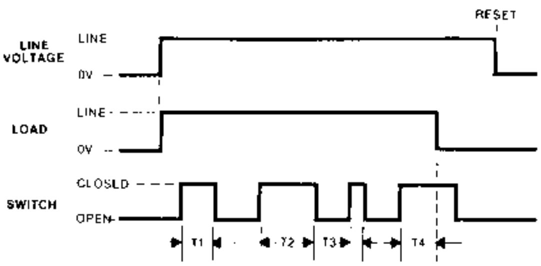
Accumulative Timing

Using digital storage circuitry, a timer can provide a memory. This is true with many digital timing devices. By opening the circuit of the external timing resistor R_T, the time progression will be stopped but will not be lost. When the circuit is reclosed, the timing will again start from where it left off.

The following circuits are several examples of various modes of operation, others are available.



Timing Diagram



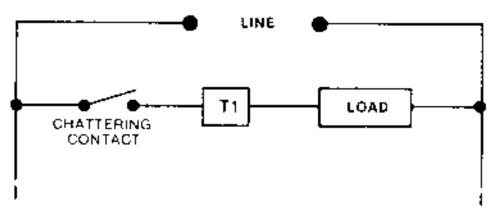
T1 + T2 + T3 + T4 = Total Preset Time Delay (Determined by R_T)

Accumulative Interval Timing

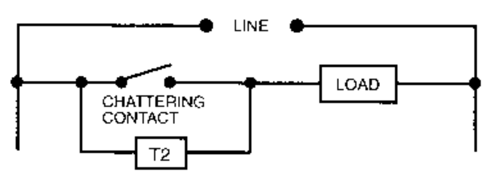
The circuit utilizes a TSD2 Series digital timer. With power applied, the load is energized. The TSD2 will then accumulate and add all switch closures. When the total time of the switch closures equals the time set by R_T, the TSD2 will time out and the load will de-energize.

Single Timing Circuits

Contact Chatter Elimination: Eliminate contact chatter by placing T1 Timer in series or T2 Timer in parallel with the contact. Chatter may occur on closure, or when a contact is being closed or opened. The load will turn ON and OFF during contact chatter. T1 or T2 provide a delay just long enough to eliminate the chatter. T1 prevents the load from energizing during its time delay. T2 energizes the load during its time delay. Use with liquid level controls, thermostats, and limit switches. Note: T2 Timer energizes the load for its time delay when power is applied.



T1 = TSD1, KSD1, TDU, KSDU



T2 = TSD7, THD7

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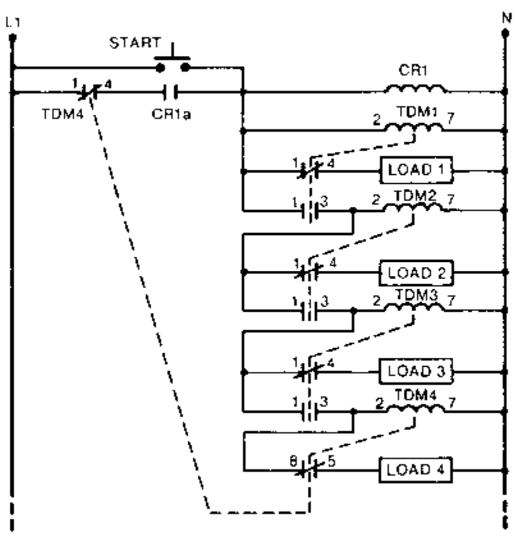
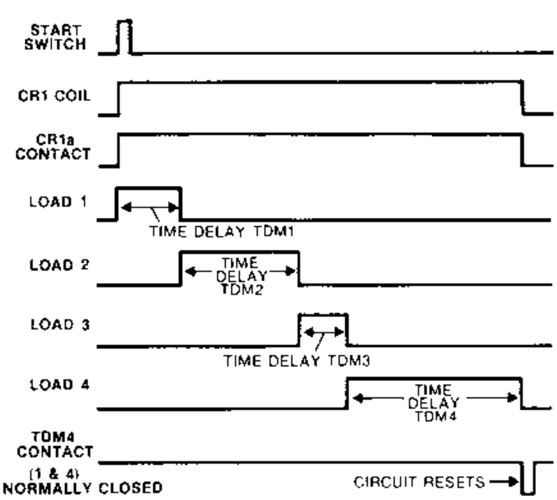
Timers
Application Notes

Sequencing Independent Adjustment Sequence (Single Cycle): Upon momentary closure of start switch, CR1 is energized and latched on through its normally open contact CR1a. This closed contact in turn feeds power to both the TDM1 coil and (through normally closed TDM1 contacts) load 1. When TDM1 time delay is complete, TDM1 normally open contacts (1 and 3) close and its normally closed contacts (1 and 4) open, removing power from load 1. Load 2 is now energized through TDM1 contacts (1 and 3) and through TDM2 normally closed contacts (1 and 4). TDM2 coil is also powered and begins timing. This sequence continues for TDM3 (and load 3) and TDM4 (and load 4) as shown in the Time Diagram until TDM4 completes its time cycle; at which point its normally closed contacts (1 and 4) open and unlatch CR1, resetting the entire circuit. Press start button again to repeat another cycle. (TDM can be replaced by TRM or PRM. Also applicable would be ORM or ERDM; however, pin numbers are different.)

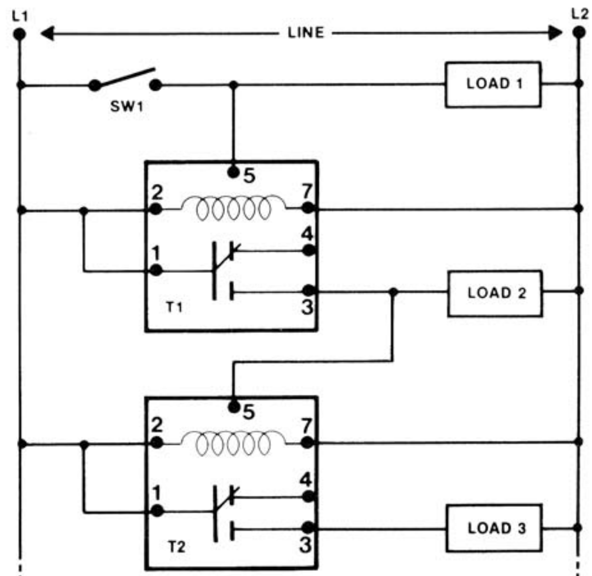


CR1 = Electromechanical Relay

Timing Diagram

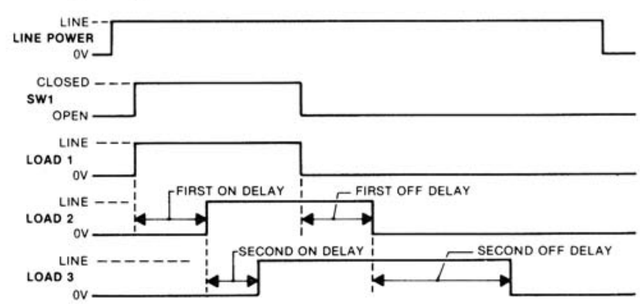


Staging (ON and OFF): On closure of SW1, Load 1 is energized and a time sequencing ON condition is initiated. At the end of the T1 ON delay, Load 2 is energized which in turn initiates the ON delay of timer T2. When the second ON delay is completed, Load 3 is energized. Additional TDMB Time Delay Relays can be connected to operate additional loads. With the opening of SW1, each load in the system is sequenced OFF starting with Load 1 and continuing with Load 2, then Load 3.



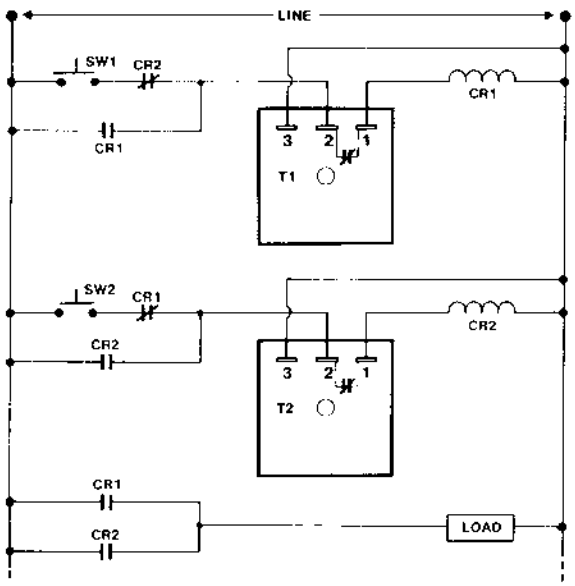
T1, T2 = TDMB

Timing Diagram



Timers
Application Notes

Dual Momentary Timing (With Lockout): Both timing circuits are of the single shot type. Because of the normally closed contacts in series with each push-button, one circuit is disabled when the other is in use.



T1 and T2 = TS2, TS4, TSD2, TSD4,
Also see ORS and ERDI

Using Proximity and Photoelectric Switches with Timers

The Characteristics of Proximity and Photoelectric Switches, also known as solid state electric switches can successfully be used with timers. Typically, a two-wire proximity or photoelectric switch will leak approximately 2.5 milliamperes of current when in its OFF state. The three-wire proximity and photoelectric switches exhibit little, if any, leakage current. The following circuits show the various interfacing of proximity or photoelectric switches (PS) with timers.

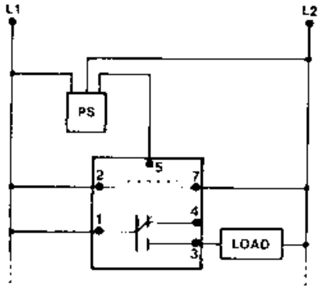


Figure 1A
TRS, TDS, TRB, TDB

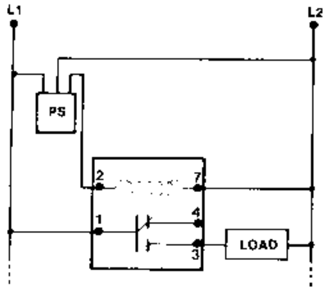


Figure 1B
TRM, TDM, TDI, TDR

Plug-in Timers: The three-wire PS will operate with all plug-in timers as shown in Figures 1A and 1B.

Two-wire proximity devices have minimum load requirements. The load resistor Rd shown in Figure 2 & 3 is necessary for proper operation of the proximity device. See proximity data sheets for correct load values.

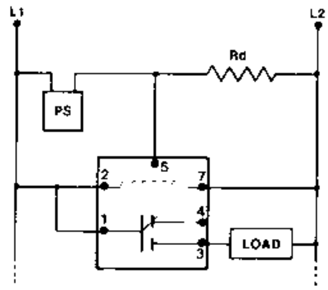


Figure 2
TDB, TRB, TDS, TRS

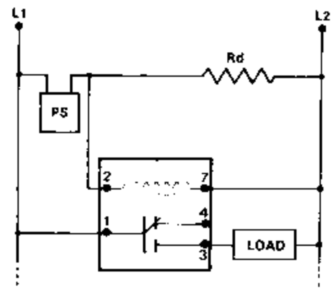


Figure 3
TDM, TRM, TDR, TDI

Pulse Shaping: (Fig. 3) For pulse shaping applications, the timer coil is wired in series with the PS. Resistor Rd may be required for proper operation of the PS.

Solid State Timers: The three-wire PS can be wired directly to most solid state timers as shown in Figures 4A through 4D.

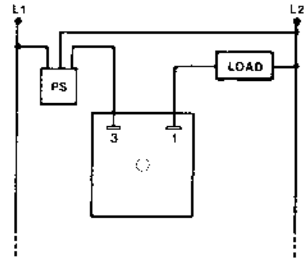


Figure 4A
TS1, TSD1, TDU, KSDI,
TSU2000, TMV8000

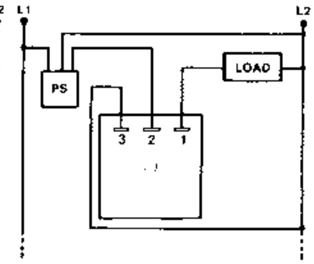


Figure 4B
TS2, TSD2, TSDR, TSD3,
KSD2, KSDR

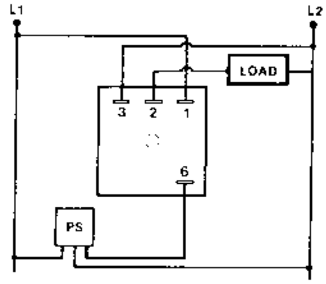


Figure 4C
TSDS, TSDB

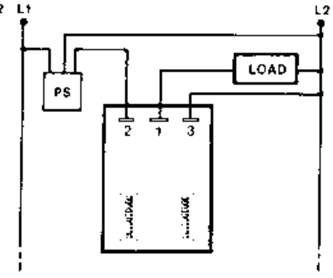


Figure 4D
RS Series

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Timers
Application Notes

Solid State Timers (continued from previous page): In some applications, an interfacing device may be required as shown in Figure 5. A simple relay interface would provide the dry closure required by this series of timers. Note: This same principle can be used with the two-wire PS.

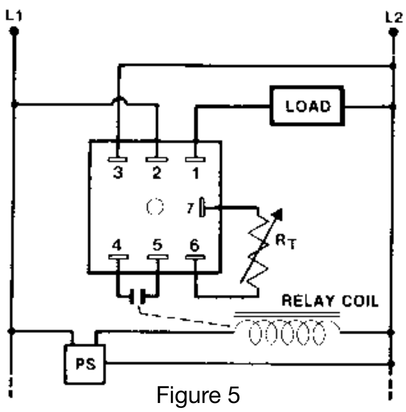


Figure 5
TSB, TSS

Timers TS2 and the TSDR Series do not require a shunt resistor and can be operated efficiently with two-wire PS as shown in Fig. 8. Be aware that the application of a two-wire PS with solid state timers is varied. If you do not find your application in these notes, contact our Technical Assistance Department about your specific requirements.

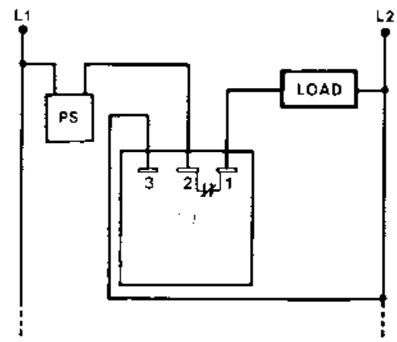
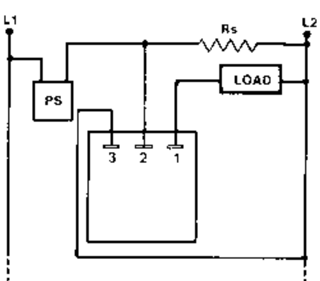


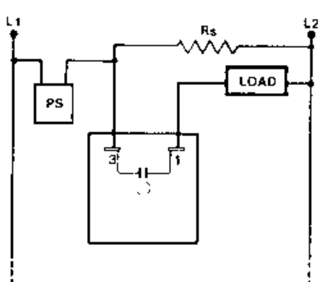
Figure 8
TS2, TSDR

Leakage Current: (Control of) Solid state switches have an ON resistance of about 5 to 10 ohms and an OFF resistance of a few hundred thousand ohms causing a certain amount of leakage through the solid state switch during the OFF state. This leakage can present problems. The leakage current of the two-wire type PS may result in premature timing of the two-terminal solid state timers. This leakage current can be redirected by using a shunt resistor Rs as shown in Figures 6 and 7.



Rs = 10K, 2W at 120VAC

Figure 6
TSD2, TSD3



Rs = 2.5K, 10W at 120VAC

Figure 7
TS1, TSD1, TDU,
TMV8000, TSU2000

Possible Shunt Resistor Values (Rs)

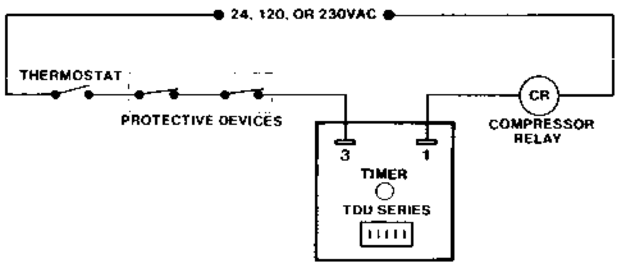
Voltage	Value in Ohms	Power in Watts
24VAC	100	7
24VAC	270	3
24VAC	470	2
120VAC	2,500	10
120VAC	5,000	5
120VAC	10,000	2
240VAC	6,000	10
240VAC	10,000	7
240VAC	27,000	3

NOTE: Due to a number of variables, we urge you to consult our Technical Assistance group or that of the switch manufacturer.

Timers
Application Notes

Random Start: Random start timing is a common practice used to prevent overloading of power lines and the reducing of peak demand levels. In industrial and commercial locations where numbers of compressors are used for air conditioning, heating, refrigeration, compressed air, and electric heating elements are used to heat air, water, or in process equipment, it is important that all of this equipment not start at the same time. This can happen in the case of a power failure or with night shutoff systems. If simultaneous starting is allowed, damage can occur due to low voltage starts.

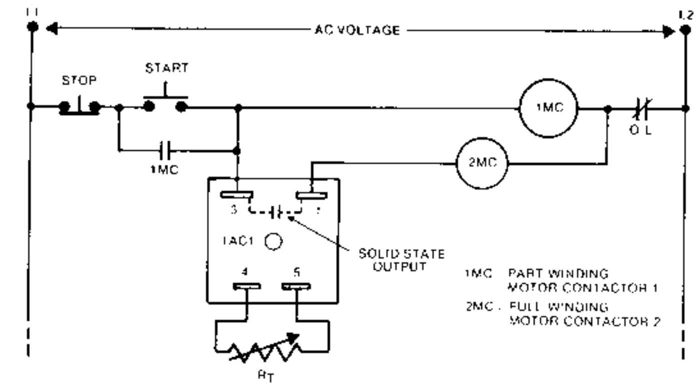
One way to correct this situation is to provide a Random Start system. This is accomplished by placing a timer in each piece of equipment to delay start. These timers are set at different times so that a staggered or random start situation is achieved.



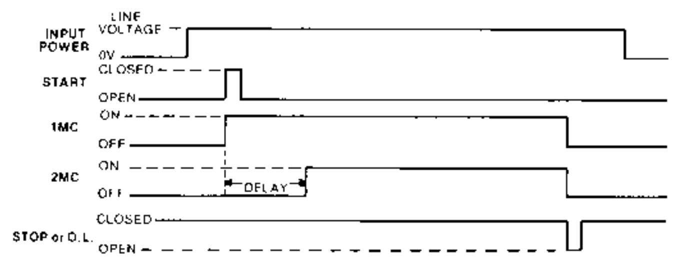
NOTE: Also see TMV8000 and TSU2000

Part Winding Start: The following is a typical wiring diagram for reduced torque starting of a 2 winding, 3 phase motor.

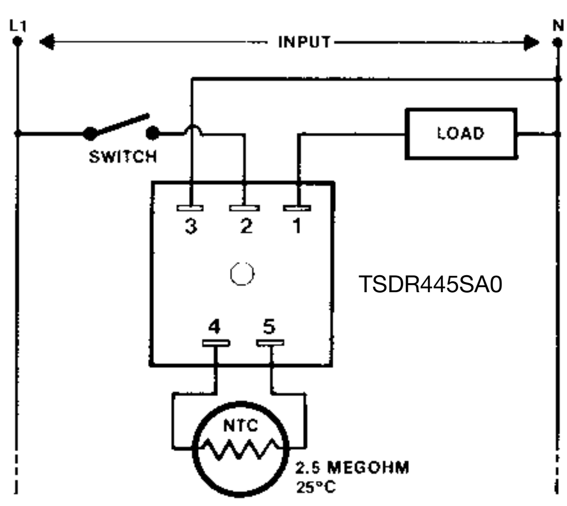
Upon closure of the Start button, 1MC is energized and TAC1 begins its time delay. At the end of TAC1's time delay, 2MC is energized. The circuit is reset upon opening of Stop button or O.L. contact.



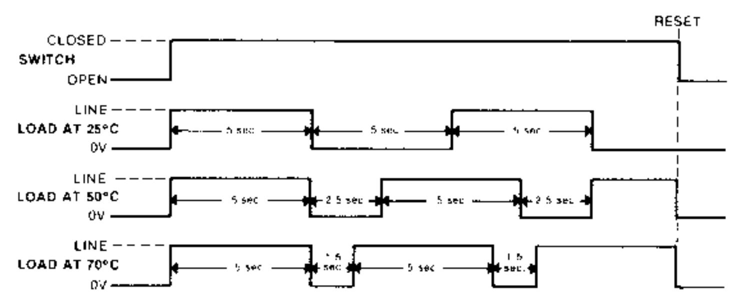
Timing Diagram

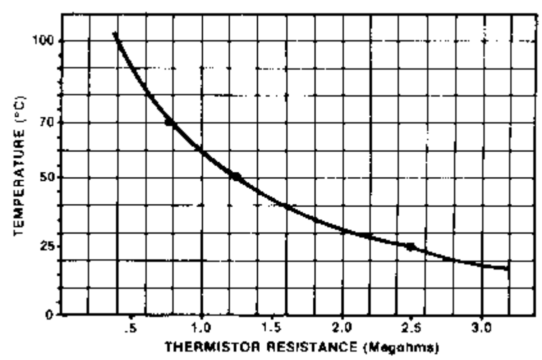


Thermistor Controlled Timer: This application utilizes a negative temperature coefficient (NTC) thermistor to change the time delay as a function of temperature. NTC thermistors decrease in resistance as temperature increases. In this case, the OFF time is being varied. As the temperature increases, the cycles per minute increase as a result of a shorter OFF time.



Timing Diagram





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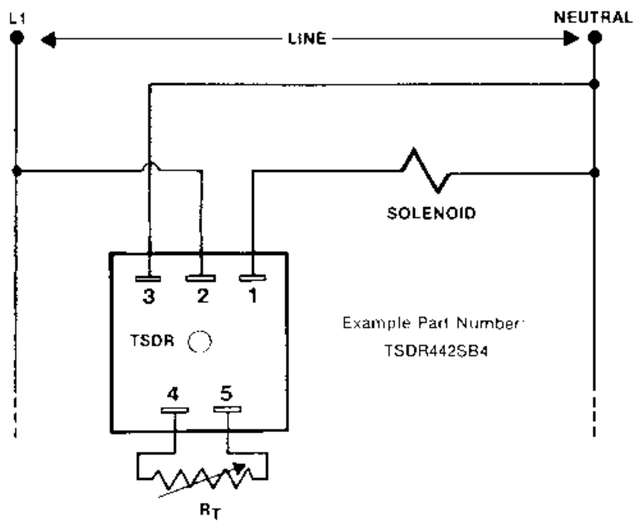
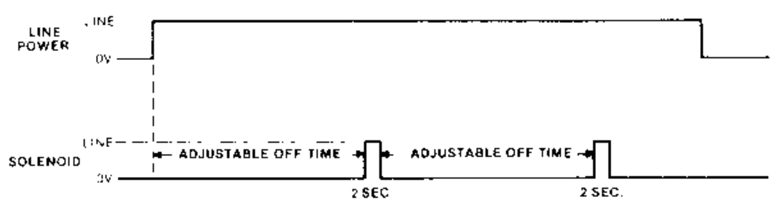
Timers
Application Notes

Air Compressor Drain, Automatic Operation: Upon application of power, the external adjustable 1 to 100 minutes OFF time delay begins. At the end of the OFF period, a fixed ON time of 2 seconds is initiated which energizes the solenoid, and drains the condensation commonly built up in a compressor. OFF/ON recycling continues until the input power is removed. The KSPD and ESDR Series are also available featuring onboard or remotely adjustable ON and OFF time delay control.



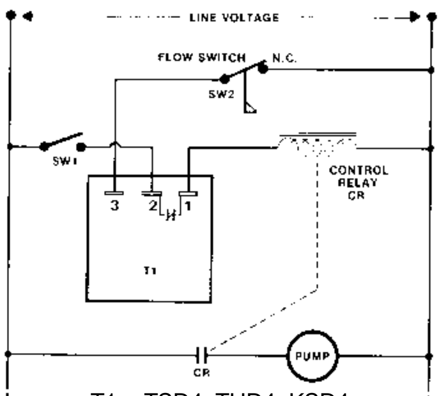
Timing Diagram



Timers
Application Notes

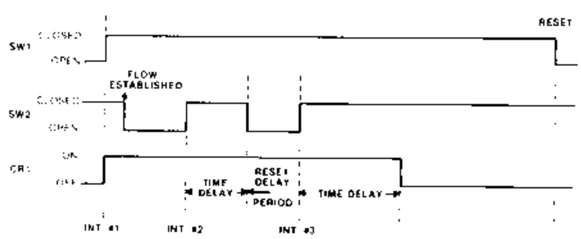
Flow Monitor (Delay on Make Normally Closed): Flow monitoring is used in industrial applications where a continual flow of product is necessary, and can terminate the operation if the flow is not detected. Upon closure of SW1, T1 time delay is initiated and relay CR is energized. When the normally open contacts of relay CR close, energizing the pump, the resulting flow (Int. #1) opens flow switch SW2. Each time SW2 opens, T1 time delay is set to zero. (Int. #2) As long as SW2 remains open, timing will not progress.

Should the SW2 flow switch close and re-open before the end of the T1 time delay, the pump will stay energized. When the flow switch SW2 closes and remains closed for a period longer than the T1 time delay (Int. #3), T1 de-energizes the control relay and disconnects the pump. To reset, open SW1.

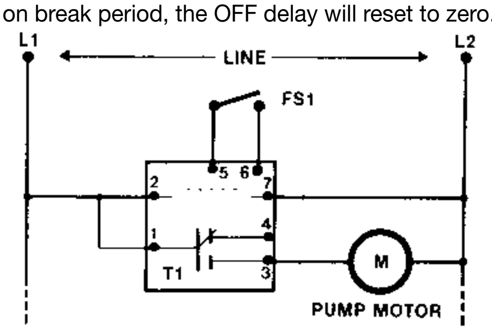


T1 = TSD4, THD4, KSD4

Timing Diagram



Pump Control: Upon closure of float switch, FS1, the delay on make time delay is initiated. This time delay will be reset if the float switch does not stay closed for the duration of the ON delay. At the end of the ON time delay, the pump motor is energized and will remain in this condition if no further action is taken. When the float switch opens, the motor stays running for the length of the delay on break time delay, then shuts off. Should the FS1 be reclosed during the delay on break period, the OFF delay will reset to zero.



T1 = TDMB

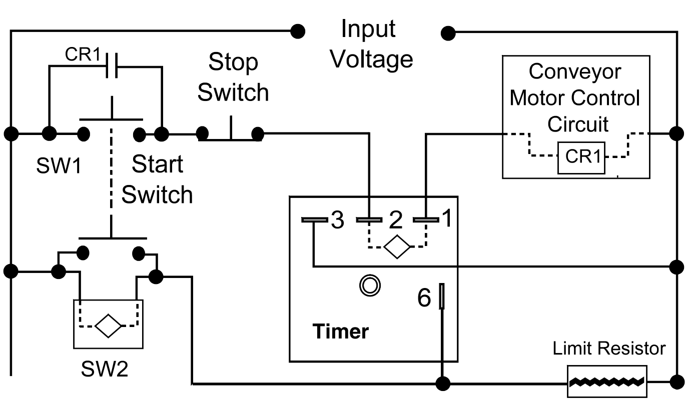
Motion Detectors, Zero Speed Switch a Low Cost Approach

Many conveyor systems use a logic control module as an interface between the proximity or photoelectric switch and its associated load. The KRD9, KRPS, KSPS, NHPS, HRD9, TRDU, and TRU series of low cost Timers/Controls (retriggerable single shot function) are designed to detect motion and/or zero speed by monitoring the pulses from an external photoelectric or proximity switch. These pulses continuously reset the control's timing circuit, preventing it from completing its selected time delay. If a pulse is missing, the control completes its time delay and the output changes state.

To operate correctly, 2-wire proximity and photoelectric switches require a "leakage" or "residual" current flow during their OFF state. See Application Notes: Leakage Current (Control of) for possible (shunt) limit resistor values table.

In the diagram shown, the conveyor motor (CR1) starts when SW1 start switch closes. The conveyor establishes the pulse train which is sensed by SW2, a two wire photo switch. Each time an object is sensed by SW2, it resets the timing circuit of the timer and the conveyor continues to run. If SW2 stops sensing moving objects, (the pulses are interrupted), the timer completes its time delay and de-energizes the conveyor contactor coil (CR1). The N.C. stop switch immediately turns OFF the conveyor when it opens.

Our line of Motion Detectors/Zero Speed Switches/Retriggerable Single Shot Timers are designed for use in conveyor, elevator, escalator, and process control applications. They are available in encapsulated or un-encapsulated versions, and with solid state or relay outputs.



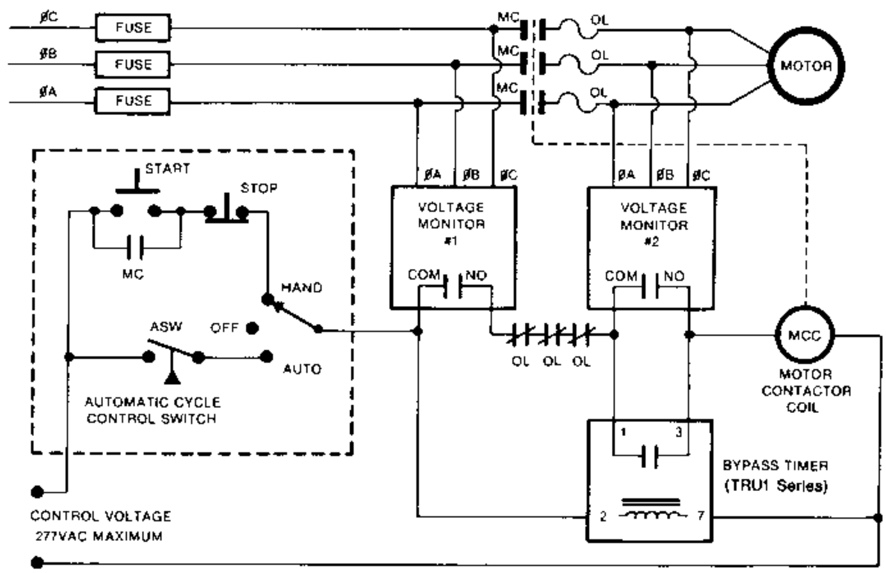
Voltage Monitor
Application Notes

Motor Protection Applications

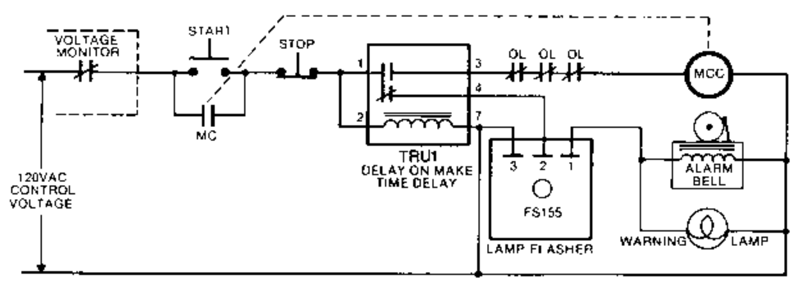
Load Side Monitoring: Broken contact springs, worn and pitted contacts, or loose and corroded wire connections are common causes of unbalanced voltages. Voltage monitor #1 in the diagram cannot protect the motor from these contactor related fault conditions. For complete protection, a voltage monitor should be connected to the motor (see voltage monitor #2).

Voltage monitor #1 protects the motor control panel from faults associated with main power supply. It detects phase reversal, phase loss, low voltage, and unbalanced voltage faults before motor startups. Without voltage monitor #1 in the system, dangerous reverse rotation or locked rotor starts could occur during the bypass time delay (of voltage monitor #2).

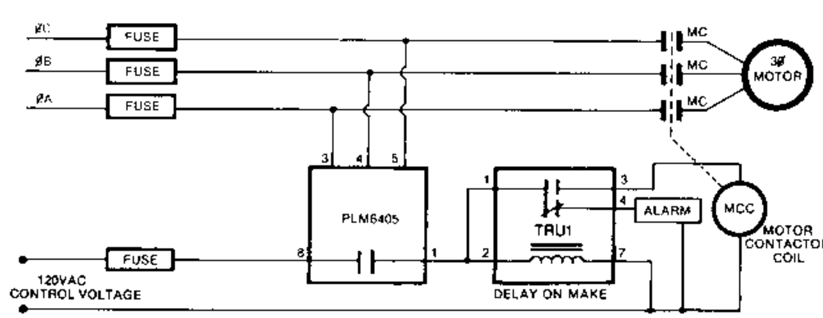
Since voltage monitor #2's contacts open each time the motor contactor opens, a bypass timer is required to restart the motor. The bypass time delay should be kept as short as possible (1-2 seconds maximum). A short bypass delay allows restarting but returns control to voltage monitor #2 as rapidly as possible since phase loss protection is temporarily lost. Some electricians install voltage monitor #1 in the main motor supply panel. This approach ensures prestart protection for all motor control panels. Then voltage monitors and bypass timers are installed in each motor control panel and connected like voltage monitor #2 in the diagram. The RLM, TVM and TVW series are good choices for the load side monitor because of their superior protection from the high voltages caused when the contactor disconnects the rotating motor.



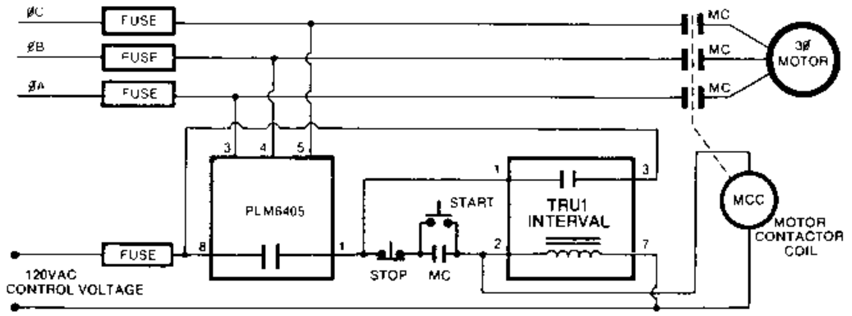
Restart Alarm Buzzer/Flasher: The alarm sounds when the operator pushes the start switch. The alarm bell and warning lamp indicate a pending restart. The start switch must be maintained until the TRU1's delay on make time delay is completed, and its internal contacts transfer. Then the alarm is extinguished and the motor contactor coil (MCC) is energized. Pressing the stop switch resets the system without sounding an alarm.



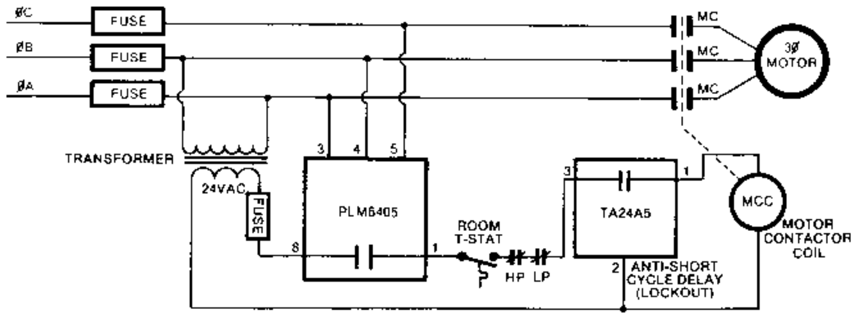
Delayed Restart: When line conditions return to normal, the relay contacts in the PLM voltage monitor close. The TRU'S restart time delay begins. The alarm sounds, warning operators of pending restart. At the end of the delay, the contacts in the TRU transfer, starting the motor and extinguishing the alarm.



Restart Bypass Delay: When line conditions return to normal, the relay contacts in the PLM voltage monitor close. After the operator presses the start switch, the motor contactor is energized, latching supply power to itself and the TRU time delay. The TRU is programmed in INTERVAL mode; therefore, its contacts are closed during timing. If low voltage during start up causes the PLM's contacts to open, the TRU's contacts will hold in the motor contactor for the bypass time delay. At the end of the bypass delay, the TRU's contacts open, returning control to the PLM voltage monitor.



Compressor Anti-Short Cycle Lockout Delay: The anti-short cycle time delay prevents locked rotor starts by locking off the compressor contactor until internal pressures have equalized. Should the PLM voltage monitor sense a line fault, its open contacts will start a lockout delay. The compressor cannot restart until the line fault is corrected and a five minute delay is completed.



Voltage Monitor
Application Notes

Protection & Control

Understanding Voltage Faults - Voltage Unbalance

When 3 phase line voltages are not equal in magnitude, they are unbalanced (also referred to as Phase Unbalance, or Voltage Imbalance). A voltage unbalance condition can be detrimental to the operation and life of a polyphase induction motor. It can cause unbalanced currents resulting in overheating of the motor's stator windings and rotor bars, shorter insulation life, and wasted energy in heat. Voltage unbalance is often completely undetected. It causes numerous motor failures that are incorrectly blamed on other causes like single phasing. Unlike overloading, single phasing, low voltage, poor ventilation and high ambient temperatures, the affect it has on polyphase motors is not well understood. NEMA specification MG1 14:35 indicates that motors must be derated when the voltage unbalance exceeds 1% and that motors should not be operated when the voltage unbalance exceeds 5%. Field testing indicates that the level of voltage unbalance measured on rotating motors during single phasing may not exceed 8 to 9%. This is because of the regenerated voltages produced by the unpowered windings.

The voltage unbalance is calculated as follows:

$$V_u = \frac{V_d}{V_a} \times 100$$

V_u = Percent voltage unbalance
V_d= Maximum voltage deviation from the voltage average
V_a= Average voltage

Example: Assume a supply voltage of 480, 435, and 445 would have an average voltage of 453. The maximum deviation from the average voltage is 480 - 453 = 27. Therefore:

$$V_u = \frac{27}{453} = .059 \times 100 = 5.9\%$$

Unbalanced voltages cause unbalanced currents at 6 to 10 times the level of the voltage unbalance. Unbalanced currents in a loaded motor cause excessive heat. Unbalance coupled with low average voltages and/or slight overloading can cause internal temperatures to increase dramatically.

Calculating percent overheating: In the phase with the greatest unbalance, the percentage increase in temperature will be approximately two times the square of the percentage voltage unbalance. Using the 5.9% voltage unbalance from the above example, the resulting overheating percentage would be: 5.9 x 5.9 x 2, or almost 70%! (See chart Fig. 1)

Simply operating a 1.0 service factor motor at a continuous 2.9% voltage unbalance (resulting in almost 17% overheating) can cut a class B motor's insulation life in half. (See chart Fig. 2)

The most important formula to remember is this:
VOLTAGE UNBALANCE = EXCESSIVE MOTOR HEAT!

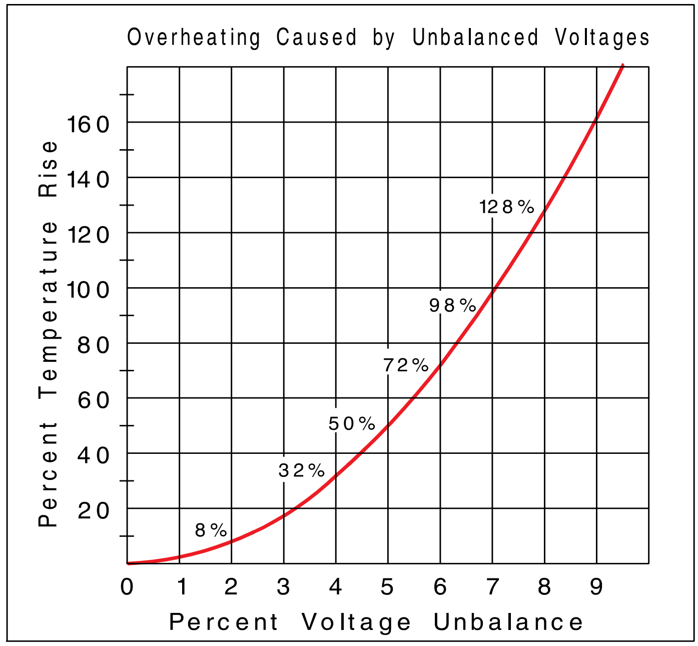


Figure 1

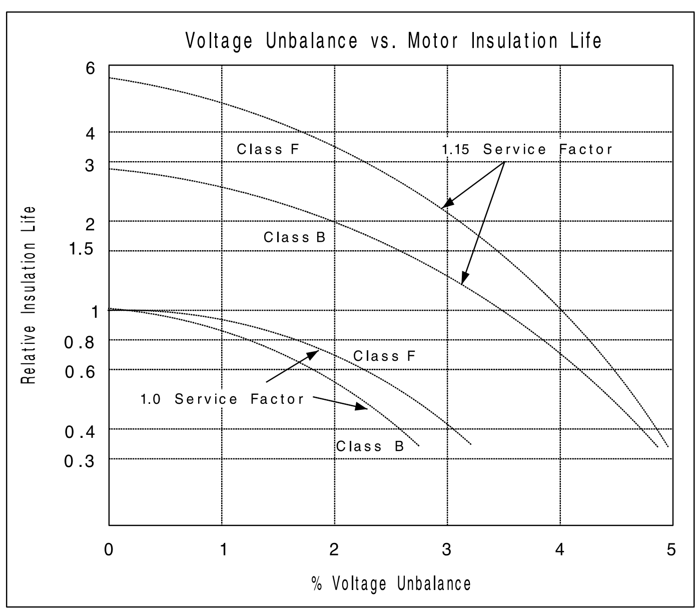
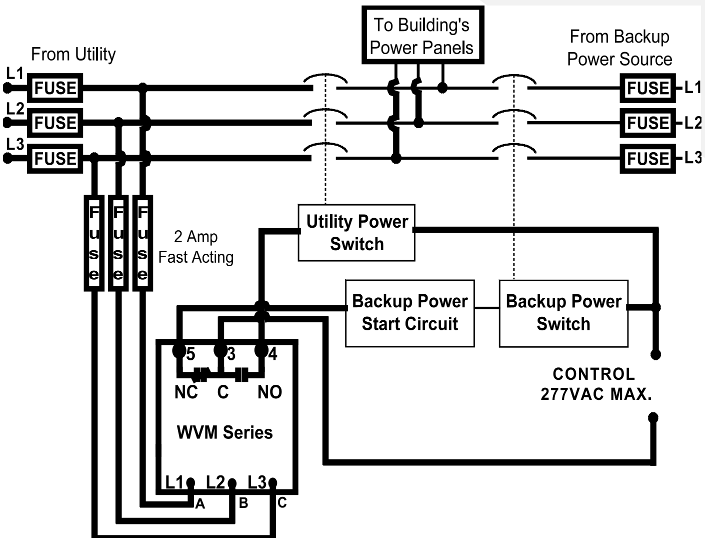


Figure 2

Three Phase Voltage Monitor

Universal Voltage Monitor Controls Switching of a Transfer Panel

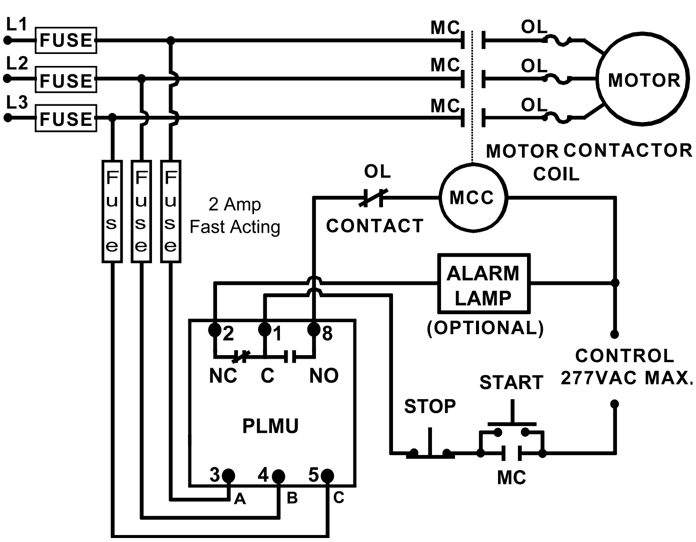
A three phase voltage monitor constantly reads the voltages on the three phase lines. When a power interruption, low voltage, phase unbalance or phase loss event occurs, the voltage monitor can switch the supply voltage to a backup source. In the drawing, the Utility Power Switch is held closed by the WVM Series whenever the three phase voltages are within acceptable limits. The trip delay in the WVM Series allows it to ignore momentary glitches in the utility's power. If a voltage fault occurs, the WVM's contacts revert to the state shown in the diagram. The Utility Power Switch is disconnected and the backup power start circuitry is energized. When backup power is established the backup power switch is energized and power is re-established in the building. The WVM Series is an excellent choice for this application because it includes a restart delay that allows the backup power supply to continue to operate until the utilities power has been re-established for an acceptable period of time. At the end of the delay, the WVM's internal contacts transfer returning the building to utility power. The WVM also includes a 10 fault memory that remembers and displays the last 10 fault events on an LED status panel.



Universal Voltage Monitor in a Motor Starter

The PLMU11 voltage monitor shown below is connected in a typical motor starter. It constantly monitors the three phase voltages and disconnects the motor if a sustained voltage fault occurs. If a fault, like single phasing, is sensed between cycles, the motor cannot be started until the problem is corrected. After maintenance on the supply lines, the motor cannot be started until all phases are balanced and the phase sequence is correct. The optional alarm sounds if the operator attempts to start the motor while the PLMU11 is tripped.

The PLMU11 offers many advantages for OEM's and contractors. Its wide operating voltage range allows it to be used in all machines designed for domestic and international facilities. In addition, its industry standard octal plug-in base makes servicing quick and easy. The PLMU11 is also backed by a 10 year warranty. For contractors and service professionals, the wide operating voltage range allows it to serve as a universal replacement for most plug-in voltage monitors. The PLMU11 has the potential to replace almost 100 individual voltage monitors on the market from nearly 20 separate manufacturers! Keep the PLMU11 at hand and you're ready for anything. If you want to save money, reduce inventories, and improve your voltage monitoring protection, it makes sense to have the PLMU11 on the shelf.



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Glossary of Terms

A

AC (Alternating Current) An alternating sinusoidal current rated at a given frequency.

Actuate current The point at which an output device will respond to a preset (or predetermined) current level.

Alternating flasher A control which provides voltage first to one load and then to another load. This cycle repeats normally at a fixed rate per minute.

Ambient temperature Temperature of the surrounding air.

Ampere A unit of measurement for electric current. The abbreviation is amp.

Anticipator An adjustable resistor connected in series with a heating thermostat to reduce hysteresis.

Anti-Short Cycle Timer A control which inhibits the rapid cycling of a device by means of locking out the load for a delay period.

B

Block diagram A system of showing circuits in an electrical system. Blocks are used and identified for the various functions of circuits. Lines are drawn between the blocks to show how the functions of the circuits are related.

Break The point at which two contacts open to disconnect (interrupt) a circuit.

Burden The power drawn from the circuit that connects the secondary terminals of an instrument transformer, expressed in volt-amperes.

C

Chaser A repeat cycle flasher with three or more outputs each operating in sequence to the other. Normally used on signs or displays to create a moving effect.

Circuit The path for electric current in an electrical system. All parts which carry current are a part of the circuit.

Closure The point at which two contacts meet to complete a circuit.

Closed circuit principle The output is energized during normal operation.

Compensator A fixed resistor connected in parallel to a cooling thermostat to reduce hysteresis.

Conformal coating A protective finish applied to an open circuit board and components.

Contact chatter Often referred to as contact bounce. Occurs on closure of two contacts. When a mechanical contact closes, the contacts make and break several times before a stable closed condition is established. Bounce or chatter can also be caused by external vibration or shock on a closed contact.

Contacts Elements used to mechanically make or break an electric circuit.

Continuous duty Refers to the ability of a device or a control to operate continuously with no off or rest periods.

Counting circuit This is a digital type of circuit which counts and stores numbers of events. Products that utilize this approach achieve high degrees of accuracy.

CSA Canadian Standards Association. (Testing agency for products sold in Canada).

Current unbalance One or more of the three current levels in a polyphase system are not equal.

D

DC (Direct Current) A current that flows only in one direction through a circuit. May or may not have an AC ripple component. DC sources that are unfiltered should be referred to as full-wave or half-wave rectified AC.

De-energize The removal of power.

Definite purpose A component designed for a specific use, rather than for a wide range of possible applications. For example, a contactor may be designed to switch a 40 AMP compressor, but may not handle a 40 AMP saw motor.

Dielectric breakdown This is a voltage level at which a nonconductor will conduct current. Measured in volts.

Dielectric strength The voltage a dielectric can withstand continuously without deteriorating.

DIN Abbreviation for Deutsche Industries Normenausschuss. A German association that sets standards for the manufacture and performance of electrical and electronic equipment, as well as other devices.

Distortion (In electronics), the term refers to change in wave shape of voltage and/or current between the input and output of a component or circuit.

DPDT(Double pole double throw), A term used to describe a switch or relay output contact form. (2 form C) Two separate switches operating simultaneously, each with a normally open and normally closed contact and a common connection.

Dummy load An electrical component or device whose principle function is to increase the amount of current flow through a ny given switch or control. Usually to satisfy the minimum load requirement associated with solid state switches and controls.

Duty cycle The ratio of the ON to OFF time of an operation. Usually related to a load. May be expressed as a percentage.

E

Encapsulant A material used to encase and seal all components in an electronic circuit.

External adjustment A device, outside the control, used to alter or change the controlled parameter. Example: An external potentiometer with a time delay control.

F

Factory calibration The tuning or altering of a control circuit by the manufacturer to bring the circuit into specification. Normally stated as a percent deviation.

Factory fixed Where the adjustment is made by the manufacturer and not accessible to the user.

First shot effect A term used relative to solid state (electronic) timers using a resistor/capacitor (RC) single time constant circuit. Due to the forming effect found in electrolytic capacitors when stored, the first and sometimes second and third operations have longer time delays. The repeat accuracy specification does not include this condition. Digital type circuits do not exhibit this condition.

FLA (full load amperes) Abbreviation for

Flasher A control where the output to the load (normally a lamp) is turned ON and OFF repeatedly at a given rate of operation/flashes per minute (FPM).

Flash rate Normally specified in flashes per minute (FPM) and denotes the repetitive operation of a flasher, (See Flasher).

G

Guaranteed Range Refers to a range of adjustment or range of operation whereby the control must at least operate or cover the guaranteed range.

Glossary of Terms

H

Half-wave Half-wave or half-wave rectified refers to the passing or the use of only one half of the AC sine wave. The result is half-wave rectified AC, or unfiltered half-wave DC.

Heat dissipation All solid state switches generate heat when carrying a current, with currents of 3 amperes or more this heat must be dissipated. Heat is usually radiated into the surrounding air by means of a heat sink.

Heat sink A method used to transfer temperature. A metal plate or fin-shaped object with good heat transfer efficiency that helps dissipate heat into the surrounding air, or into a larger mass.

Heat sink compound A silicon compound filled with alumina or other heat conductive oxide. Used to fill voids and irregularities in surfaces between two mating objects to permit optimum heat transfer.

Hertz The international unit of frequency, equal to one cycle per second. Named after the German physicist Heinrich Rudolph Hertz, 1857-94.

Holding current (Minimum) A specification used to relate a minimum load operating current of a solid state switch. Normally stated in milliamperes.

Horsepower Unit of ability to do work. Equivalent to 745.7 watts.

HP = VAPf Where HP=horsepower, V=volts, A=amperes, Pf=powerfactor.

Hysteresis A lagging in values of resulting magnetization in a magnetic material (as iron) due to a changing magnetizing force.

I

Impedance The opposition in an electric circuit to the flow of an alternating current (AC). Impedance consists of ohmic resistance (R), inductive reactance (X_L), and capacitive reactance (X_c).

Incandescent lamp An electric lighting and signaling device operating on the principle of heating a fine metal wire filament to a white heat by passage of an electric current through it. The filament wire has a positive temperature coefficient, which results in high inrush currents (up to 10 times the steady state current).

Inductive load Electrical devices made of wire, wound or coiled to create a magnetic field to produce mechanical work when energized. Components such as motors, solenoids, relay coils, contactor coils, and valves are all inductive loads by nature. An inductive load can exhibit an inrush or lock-rotor current of up to 5 times its normal running or steady state current when energized. When de-energized the magnetic field collapses, generating a high voltage transient which can cause arcing across contacts or a malfunction, and/or damage to electronic circuits. When transients are present, they should be suppressed.

Initiate time The time required to activate (initiate) a control function, such as a switch closure time.

Input impedance The impedance of a device as seen from the output terminals.

Input voltage The designed power source requirement needed by the control or by the equipment in order to properly operate.

Inrush The initial surge of current through a load when power is first applied. Lamp loads, inductive motors, solenoids, contactors, valves, and capacitive load types all have inrush or surge currents higher than the normal running or steady state currents. Resistive loads, such as heater elements, have no inrush.

Isolation No electrical connection between two or more circuits.

Insulation resistance Electrical separation between any two or more materials that prevent the flow of current. Insulation resistance is measured in ohms.

Integrated circuit A component manufactured by the semiconductor producers. The same manufacturing techniques are used as those for a single transistor. When thousands of transistors and diodes are produced on a single substrate and interconnected to provide a complete circuit, it is an integrated circuit. The circuit is usually protected in a ceramic or plastic package.

Interference suppression If you have electrical interference that this product is capable of suppressing.

L

Ladder diagram An electrical diagram having two parallel lines or rails representing the power lines with all of the input, outputs, controls and load drawn between the two rails in a ladder arrangement. A ladder diagram is usually easier to understand than a wiring diagram.

Latch The sealing in of a circuit by means of a holding contact. Used in relay logic when a momentary initiation is required. There are also mechanical and magnetic latch arrangements.

Leakage current A small amount of current that passes through a semiconductor when it is in an OFF state.

LED (Light emitting diode.) A semiconductor which emits light when a current is passed through it. Used for visual indication or for signal coupling when complete circuit isolation is desired.

Linear characteristic A straight line curve.

Load rating A control specification outlining the type of load, the minimum (min.) and the maximum (max.) currents, and the voltage.

Locked rotor current The steady state current taken from a line with the rotor locked and the rated voltage or frequency applied to the motor.

Lockout Timer Same as Anti-Short Cycle Timer.

Loop powered A standardized method of supplying power to a transducer from a remote process control system. In this case, the transducer output becomes an element in the process loop allowing 4 to 20 mA to flow according to the value of measured variable.

LRA (Locked Rotor Amperes) Abbreviation for

M

Magnal plug An eleven pin male connector with a locating key for proper orientation.

Maintained initiation A constant closure of a contact to start and complete the control function.

Make The action of closing a switch.

Maximum rating The absolute maximum condition at which a control is designed to operate. Voltage, frequency, current, temperature, humidity, shock, and other parameters can be specified as maximum.

Metal oxide varistor (MOV) A device whose impedance changes appreciably in response to applied voltage. Used to limit maximum voltage across output device, and protect vulnerable circuit components against transients by clamping circuit to a safe level.

Milliamperes One-one thousandth of an ampere (0.001 or 10^{-3} amperes).

Millisecond One-one thousandth of a second (0.001 or 10^{-3} seconds).

Minimum load current See Holding current.

Mode of operation The input to output relationship of a control.

Glossary of Terms

Momentary initiation An initiate signal that is shorter than the control function. A momentary switch closure such as a push button.

Momentary loss of power A short interruption of power to the total equipment.

MOV Metal oxide varistor.

N

Negative switching This refers to the position of an output device in a DC circuit. In this case, the output device opens or closes the negative side of the DC voltage in relationship to its load.

Neutral monitoring Product monitors whether the neutral is connected to a fixed reference or floating.

Nominal voltage Average source voltage.

Normally closed, N.C. The condition or position of a contact prior to initiation or energization. In this case a closed condition.

Normally open, N.O. The condition or position of a contact prior to initiation or energization. In this case an open condition.

O

Octal plug An eight pin male connector with a locating key for proper orientation.

ON/OFF ratio The ration of ON time to OFF time specified as a percentage or as a fraction.

Open circuit principle The output is de-energized during normal operation.

Operating temperature A temperature range over which a control will perform within its specified design tolerances. May be stated in Fahrenheit (°F) or Celsius (°C)

Operating voltage A nominal voltage with a specified tolerance applied. The design voltage range to remain within the operating tolerances. Example: 120 volts AC ±10% of nominal. The 120 volts is the nominal voltage. The design voltage range is 108 to 132 volts AC.

Optical isolation Using a photo coupled device to achieve isolation between circuits. An electrical signal is converted into light that is projected through an insulating surface and reconverted to an electrical signal.

Output The section of a control which energizes and/or de-energizes a load.

P

Phase angle control A method of regulating the effective output voltage, of alternating current, by using a solid state switching device (thyristor) and an adjustable resistor/capacitor timing circuit. This system is capable of delaying the turn-on point for each half-cycle of the AC supply. As the resistance adjustment increases, the delay period increases, thereby decreasing the effective power (voltage) to the load. Household lamp dimmers are examples of low cost phase angle controls.

Phase loss (also known as single phasing) The loss of one phase in a three phase system, effectively producing a single phase.

Phase reversal/sequence A condition whereby any two phase connections of a three phase motor are interchanged. Forward rotation of a three phase motor is accomplished by an ABC phase sequence. By changing the phase connections to an ACB sequence, the motor will rotate in the reverse direction.

Pilot duty The rating assigned to a relay or switch that controls the coil of another relay or switch.

Polarity The positive and negative orientation of a signal, or power source.

Positive switching This refers to the position of an output device in a DC circuit. In this case, the output device opens or closes the positive side of the DC voltage in relationship to its load.

Potentiometer (Pot.) Variable resistor.

Printed circuit A circuit path of copper, usually on an insulating board, eliminating the need for assembling wires between components. Frequently used for electronic circuits requiring low currents. The term printed does not describe the process used to make the circuit boards now, but comes from the printing method originally used.

Q

Quick connect terminals A common type of termination used on many controls. A solderless, easy to use, female/male push-on type of terminal that comes in various sizes. Widely used in automotive, appliance, and other OEM equipment.

R

Random starting The act of connecting power to electrical equipment so that none are activated at the same time. Random starting helps prevent overloading of the power supply.

Rapid cycling (also referred to as short cycling). The repeated act of turning a device on and off in a short duration of time. Rapid cycling is often caused by contact chatter (bounce), vibration or momentary loss and reapplication of power.

RC Resistor/capacitor network. (See also Snubber Network.)

Recycle time The time needed to reset and re-initiate the timing function and remain within the specified timing tolerances. Recycle time is generally specified during timing and after timing.

Regenerative voltage A resulting voltage created by a rotating three-phase electric motor when one phase is lost. This voltage may be almost equal to the other two remaining phases.

Repeat accuracy The maximum deviation from one timing operation to the next. For RC types of timers the specification of repeat accuracy is under fixed conditions, e.g., fixed recycle time, fixed voltage and temperature, and does not include the timers first operation.

Reset time The time required to return the output to its original unenergized condition.

Resolution The degree of setability.

Reverse polarity protected Applies to DC controls where, if the polarity of the input were reversed, there would be no damage.

R_T The symbol used to signify a resistor value in ohms that determines the time period of a solid state time delay.

S

Sensor A device which creates a useful control signal when subjected to changes in temperatures, pressure, humidity or light (transducer).

Set point The value on the controller scale at which the controller indicator is set.

Setting accuracy The ability to set a knob, switch, or other adjustment at the desired time delay, speed, light, sound, or other. Normally specified in percent of maximum or at set point.

Sequencing (also referred to as “Staging”). The act of connecting power to an electrical circuit so as to create a purposeful pattern of on and/or off cycles for two or more devices.

Short cycling see Rapid cycling

Snubber network A form of suppression network, which consists of a series connected resistor and capacitor connected in parallel with

Glossary of Terms

the output device. Helps to limit the maximum rate of rise of a voltage. Used to help prevent false turn-on of solid state outputs.

Solid state device Any element that can control current without moving parts, heated filaments or vacuum gaps. All semiconductors are solid state devices, but not all solid state devices are semiconductors.

SPDT (Single pole double throw) A term used to describe the formation of a switch or relay contacts. For example, a 1 Form C is a normally open and normally closed contact with a common connection.

Steady state A term used to specify the current through a load or electric circuit after the inrush current is complete. A stable run condition.

Storage temperature The maximum temperature that any one material in a system can withstand without sustaining damage. A nonworking condition.

System leakage capacitances Means the capacitance of a complete voltage supply or system measured against earth ground as a reference.

T

Thermistor A semiconductor with electrical resistance which varies with change in temperature. It may have either a negative or positive coefficient. With a negative coefficient, resistance decreases with an increase in temperature.

Three-phase system A polyphase AC system in which three currents or voltages are 120 degrees out of phase with each other.

Threshold value The selected value when the relay should trip (also referred to as the trip point). The measured value rises above or falls below this set point the output relay trips or resets.

Time diagram A drawing used to illustrate the input and output relationship as a function of time.

Tolerance Normally stated as a percentage, and is the maximum allowable deviation of a control's electrical, environmental, or dimensional parameters.

Toroid A toroid is a coil wound on a doughnut shaped ferromagnetic core. The toroid is used as a current transformer in the AC Current Sensor Controls & Indicators shown in this catalog.

Transducer A device for converting an electrical signal into a usable current or voltage for measurement purposes.

Transient voltage Several parameters apply to a transient:

a. The peak voltage
b. The rate of rise
c. The duration of the transient.

Transient voltages are generated when inductive loads such as solenoids, contactors, motors, relays, etc., are de-energized. Although the controls in this catalog have excellent protection against these sometimes damaging excursions, when a transient is known to be present, it should be suppressed at the source. (see Metal Oxide Varistors).

Trip delay A period of time between a detected fault and the reaction of an output device. This delay can be inherent to, or purposefully designed into monitoring controls to avoid nuisance tripping.

U

U = V Symbol for supply voltage

UL Underwriter's Laboratories, Inc. Testing agency for products sold in the United States.

V

Voltage A difference of potential measured in volts. The electrical pressure available to cause a flow of current when a circuit is closed.

Voltage balance All three voltage levels in a polyphase AC system are equal.

Voltage drop The voltage existing across each element of a series circuit. Also true of a contact in series with its load where a voltage drop also exists. The voltage present across the load will be the line voltage less the voltage drops across each element in series with the load.

Voltage unbalance (also referred to as Voltage Asymmetry). One or more of the three voltage levels in a polyphase system are unequal. Overheating of three-phase electric motors can result.

W

Watchdog circuitry A form of internal timer that is used to detect a possible malfunction.

Window current sensing A current sensing control whereby lower and upper operating current limits are user preset, creating an optimal system operation "window". If the current level falls outside the optimum current level, the output device of the current sensing control responds accordingly.

Wye circuit (also referred to as a "Star" Circuit). A method of connecting three windings in a three-phase system so that one terminal of each winding is connected to the neutral point. So called because it looks like the letter Y.

Z

Zero voltage switching Only possible with a solid state output, the output is closed only when the AC sine-wave (voltage) is zero or very close to zero. ZVS reduces inrush, RFI, and can increase filament lamp life.

Electronic Timers
Conversion Table

Multifunction timers

Type old	Order code old	Type new / alternative	Order code new / alternative
CT-MFS	1SVR 430 010 R0200	**CT-MFS.21** CT-MVS.21	**1SVR 630 010 R0200** 1SVR 630 020 R0200
CT-MVS	1SVR 430 023 R0200	**CT-MVS.22**	**1SVR 630 020 R3300**
CT-MBS	1SVR 430 010 R1200	**CT-MBS.22** CT-MVS.22	**1SVR 630 010 R3200** 1SVR 630 020 R3300
CT-MBS	1SVR 430 012 R0200	**CT-MBS.22** CT-MVS.22	**1SVR 630 010 R3200** 1SVR 630 020 R3300
CT-MBS	1SVR 430 011 R2200	**CT-MVS.23**	**1SVR 630 021 R2300**
CT-MBS	1SVR 430 010 R1100	**CT-MBS.22** CT-MVS.12	**1SVR 630 010 R3200** 1SVR 630 020 R3100
CT-MBS	1SVR 430 013 R0100	**CT-MBS.22** CT-MVS.12	**1SVR 630 010 R3200** 1SVR 630 020 R3100
CT-MBS	1SVR 430 011 R2100	**CT-MVS.23**	**1SVR 630 021 R2300**

ON-delay timers

Type old	Order code old	Type new / alternative	Order code new / alternative
CT-ERS	1SVR 430 100 R1100	**CT-ERS.21**	**1SVR 630 100 R0300**
CT-ERS	1SVR 430 102 R0100	**CT-ERS.12**	**1SVR 630 100 R3100**
CT-ERS	1SVR 430 101 R2100	**CT-MVS.23**	**1SVR 630 021 R2300**
CT-ERS	1SVR 430 103 R0100	**CT-MFS.21** CT-MVS.21	**1SVR 630 010 R0200** 1SVR 630 020 R0200
CT-ERS	1SVR 430 100 R1200	**CT-ERS.21**	**1SVR 630 100 R0300**
CT-ERS	1SVR 430 103 R0200	**CT-ERS.22**	**1SVR 630 100 R3300**
CT-ERS	1SVR 430 101 R2200	**CT-MVS.23**	**1SVR 630 021 R2300**

OFF-delay timers

Type old	Order code old	Type new / alternative	Order code new / alternative
CT-AHS	1SVR 430 113 R0100	**CT-AHS.22** CT-APS.12	**1SVR 630 110 R3300** 1SVR 630 180 R3100
CT-AHS	1SVR 430 113 R0200	**CT-AHS.22** CT-APS.22	**1SVR 630 110 R3300** 1SVR 630 180 R3300
CT-APS	1SVR 430 183 R0300	**CT-APS.22**	**1SVR 630 180 R3300**
CT-ARS	1SVR 430 120 R0100 *)	**CT-ARS.12**	**1SVR 630 120 R3100**
CT-ARS	1SVR 430 120 R0300 *)	**CT-ARS.22**	**1SVR 630 120 R3300**
CT-VBS	1SVR 430 261 R6000	**CT-VBS.17**	**1SVR 430 261 R6000**
CT-VBS	1SVR 430 261 R5000	**CT-VBS.18**	**1SVR 430 261 R5000**

ON- and OFF-delay timers

Type old	Order code old	Type new / alternative	Order code new / alternative
CT-EAS	1SVR 430 173 R0100	**CT-MXS.22**	**1SVR 630 030 R3300**
CT-EAS	1SVR 430 173 R0200	**CT-MXS.22**	**1SVR 630 030 R3300**
CT-EVS	1SVR 430 193 R0100	**CT-MXS.22**	**1SVR 630 030 R3300**

Impulse-ON timers

Type old	Order code old	Type new / alternative	Order code new / alternative
CT-VWS	1SVR 430 132 R0100	**CT-WBS.22**	**1SVR 630 040 R3300**
CT-VWS	1SVR 430 133 R0200	**CT-WBS.22**	**1SVR 630 040 R3300**

Impulse-OFF timers

Type old	Order code old	Type new / alternative	Order code new / alternative
CT-AWS	1SVR 430 143 R0100	**CT-MVS.12**	**1SVR 630 020 R3100**
CT-AWS	1SVR 430 143 R0200	**CT-MVS.12**	**1SVR 630 020 R3100**

Flasher

Type old	Order code old	Type new / alternative	Order code new / alternative
CT-EBS	1SVR 430 152 R0100	**CT-WBS.22**	**1SVR 630 040 R3300**
CT-EBS	1SVR 430 153 R0200	**CT-WBS.22**	**1SVR 630 040 R3300**

Pulse generators

Type old	Order code old	Type new / alternative	Order code new / alternative
CT-TGS	1SVR 430 163 R0100	**CT-MXS.22**	**1SVR 630 030 R3300**
CT-PGS	1SVR 430 253 R0100	**CT-MXS.22**	**1SVR 630 030 R3300**

Star-delta change-over timer

Type old	Order code old	Type new / alternative	Order code new / alternative
CT-YDAV	1SVR 430 203 R0200	**CT-SDS.22**	**1SVR 630 210 R3300**
CT-YDAV	1SVR 430 201 R2300	**CT-SDS.23**	**1SVR 630 211 R2300**
CT-YDEW	1SVR 430 213 R0200	**CT-SDS.22**	**1SVR 630 210 R3300**

Switching relays

Type old	Order code old	Type new / alternative	Order code new / alternative
CT-IRS	1SVR 430 220 R9100	**CT-IRS.16**	**1SVR 430 220 R9100**
CT-IRS	1SVR 430 220 R8100	**not replaced**	
CT-IRS	1SVR 430 221 R7100	**CT-IRS.14**	**1SVR 430 221 R7100**
CT-IRS	1SVR 430 220 R9300	**CT-IRS.26**	**1SVR 430 220 R9300**
CT-IRS	1SVR 430 220 R8300	**not replaced**	
CT-IRS	1SVR 430 221 R7300	**CT-IRS.24**	**1SVR 430 221 R7300**
CT-IRS	1SVR 430 230 R9300	**CT-IRS.26G**	**1SVR 430 230 R9300**
CT-IRS	1SVR 430 231 R7300	**CT-IRS.24G**	**1SVR 430 231 R7300**
CT-IRS	1SVR 430 220 R9400	**CT-IRS.36**	**1SVR 430 220 R9400**
CT-IRS	1SVR 430 220 R8400	**not replaced**	
CT-IRS	1SVR 430 221 R1400	**CT-IRS.35**	**1SVR 430 221 R1400**

*) still available

Electronic Timers
Conversion Table

Type old	Order code old	Type new	Ordercode new
Current monitoring relays, single-phase			
CM-SRS	1SVR 430 841 R0100	CM-SRS.11	1SVR 430 841 R0200
CM-SRS	1SVR 430 841 R1100	CM-SRS.11	1SVR 430 841 R1200
CM-SRS	1SVR 430 841 R9100	CM-SRS.11	1SVR 430 840 R0200
CM-SRN	1SVR 450 110 R0000	CM-SRS.21	1SVR 430 841 R0400
CM-SRN	1SVR 450 110 R0100	CM-SRS.22	1SVR 430 841 R0500
CM-SRN	1SVR 450 111 R0000	CM-SRS.21	1SVR 430 841 R1400
CM-SRN	1SVR 450 111 R0100	CM-SRS.22	1SVR 430 841 R1500
CM-SRN	1SVR 450 115 R0000	CM-SRS.21	1SVR 430 840 R0400
CM-SRN	1SVR 450 115 R0100	CM-SRS.22	1SVR 430 840 R0500
CM-SRN	1SVR 450 120 R0000	CM-SRS.21	1SVR 430 841 R0400
CM-SRN	1SVR 450 120 R0100	CM-SRS.22	1SVR 430 841 R0500
CM-SRN	1SVR 450 121 R0000	CM-SRS.21	1SVR 430 841 R1400
CM-SRN	1SVR 450 121 R0100	CM-SRS.22	1SVR 430 841 R1500
CM-SRN	1SVR 450 125 R0000	CM-SRS.21	1SVR 430 840 R0400
CM-SRN	1SVR 450 125 R0100	CM-SRS.22	1SVR 430 840 R0500
C551.01	1SAR 411 010 R0001	CM-SRS.11	1SVR 430 840 R0200
C551.01	1SAR 411 010 R0002	CM-SRS.11	1SVR 430 840 R0200
C551.01	1SAR 411 010 R0003	CM-SRS.11	1SVR 430 840 R0200
C551.01	1SAR 411 010 R0004	CM-SRS.11	1SVR 430 841 R0200
C551.01	1SAR 411 010 R0005	CM-SRS.11	1SVR 430 841 R1200
C551.02	1SAR 412 010 R0001	CM-SRS.12	1SVR 430 840 R0300
C551.02	1SAR 412 010 R0002	CM-SRS.12	1SVR 430 840 R0300
C551.02	1SAR 412 010 R0003	CM-SRS.12	1SVR 430 840 R0300
C551.02	1SAR 412 010 R0004	CM-SRS.12	1SVR 430 841 R0300
C551.02	1SAR 412 010 R0005	CM-SRS.12	1SVR 430 841 R1300
Voltage monitoring relays, single-phase			
CM-ESS	1SVR 430 831 R9000	CM-ESS.1	1SVR 430 830 R0300
CM-ESS	1SVR 430 831 R0000	CM-ESS.1	1SVR 430 831 R0300
CM-ESS	1SVR 430 831 R1000	CM-ESS.1	1SVR 430 831 R1300
CM-ESS	1SVR 430 831 R9100	CM-ESS.1	1SVR 430 830 R0300
CM-ESS	1SVR 430 831 R0100	CM-ESS.1	1SVR 430 831 R0300
CM-ESS	1SVR 430 831 R1100	CM-ESS.1	1SVR 430 831 R1300
CM-ESS	1SVR 430 831 R9200	CM-ESS.1	1SVR 430 830 R0300
CM-ESS	1SVR 430 831 R0200	CM-ESS.1	1SVR 430 831 R0300
CM-ESS	1SVR 430 831 R1200	CM-ESS.1	1SVR 430 831 R1300
CM-ESN	1SVR 450 210 R0000	CM-ESS.2	1SVR 430 831 R0400
CM-ESN	1SVR 450 211 R0000	CM-ESS.2	1SVR 430 831 R1400
CM-ESN	1SVR 450 215 R0000	CM-ESS.2	1SVR 430 830 R0400
CM-ESN	1SVR 450 220 R0000	CM-ESS.2	1SVR 430 831 R0400
CM-ESN	1SVR 450 221 R0000	CM-ESS.2	1SVR 430 831 R1400
CM-ESN	1SVR 450 225 R0000	CM-ESS.2	1SVR 430 830 R0400
CM-ESN	1SVR 450 210 R0100	CM-ESS.2	1SVR 430 831 R0400
CM-ESN	1SVR 450 211 R0100	CM-ESS.2	1SVR 430 831 R1400
CM-ESN	1SVR 450 215 R0100	CM-ESS.2	1SVR 430 830 R0400
CM-ESN	1SVR 450 220 R0100	CM-ESS.2	1SVR 430 831 R0400
CM-ESN	1SVR 450 221 R0100	CM-ESS.2	1SVR 430 831 R1400
CM-ESN	1SVR 450 225 R0100	CM-ESS.2	1SVR 430 830 R0400
CM-ESN	1SVR 450 210 R0200	CM-ESS.2	1SVR 430 831 R0400
CM-ESN	1SVR 450 211 R0200	CM-ESS.2	1SVR 430 831 R1400
CM-ESN	1SVR 450 215 R0200	CM-ESS.2	1SVR 430 830 R0400
CM-ESN	1SVR 450 220 R0200	CM-ESS.2	1SVR 430 831 R0400
CM-ESN	1SVR 450 221 R0200	CM-ESS.2	1SVR 430 831 R1400
CM-ESN	1SVR 450 225 R0200	CM-ESS.2	1SVR 430 830 R0400
CM-EFN	1SVR 450 200 R1100	CM-EFS	1SVR 430 750 R0400
CM-EFN	1SVR 450 201 R1200	CM-EFS	1SVR 430 750 R0400

Type old	Order code old	Type new	Ordercode new
C552.01	1SAR 421 010 R0001	CM-ESS.1	1SVR 430 830 R0300
C552.01	1SAR 421 010 R0002	CM-ESS.1	1SVR 430 830 R0300
C552.01	1SAR 421 010 R0004	CM-ESS.1	1SVR 430 831 R0300
C552.01	1SAR 421 010 R0005	CM-ESS.1	1SVR 430 831 R1300
C552.02	1SAR 422 010 R0001	CM-ESS.1	1SVR 430 830 R0300
C552.02	1SAR 422 010 R0002	CM-ESS.1	1SVR 430 830 R0300
C552.02	1SAR 422 010 R0004	CM-ESS.1	1SVR 430 831 R0300
C552.02	1SAR 422 010 R0005	CM-ESS.1	1SVR 430 831 R1300
C553	1SAR 425 010 R0008	CM-EFS	1SVR 430 750 R0400
C553	1SAR 425 010 R0009	CM-EFS	1SVR 430 750 R0400
Three-phase monitors for over- and undervoltage			
CM-PFN	1SVR 450 311 R0400	CM-PSS	1SVR 430 784 R2300
CM-PFN	1SVR 450 312 R0400	CM-PSS	1SVR 430 784 R2300
CM-PFN	1SVR 450 311 R0500	CM-PSS	1SVR 430 784 R3300
CM-PFN	1SVR 450 312 R0500	CM-PSS	1SVR 430 784 R3300
CM-PVN	1SVR 450 300 R1200	CM-PVS	1SVR 430 794 R1300
CM-PVN	1SVR 450 301 R1200	CM-PVS	1SVR 430 794 R1300
CM-PVN	1SVR 450 300 R1500	CM-PVS	1SVR 430 794 R3300
CM-PVN	1SVR 450 301 R1500	CM-PVS	1SVR 430 794 R3300
CM-PVN	1SVR 450 302 R1500	CM-PVS	1SVR 430 794 R3300
CM-PVN	1SVR 450 300 R1700*	-	-
CM-PVN	1SVR 450 302 R1700*	-	-
Three-phase monitors for unbalance			
CM-ASS	1SVR 430 864 R1100	CM-PAS	1SVR 430 774 R1300
CM-ASS	1SVR 430 864 R3100	CM-PAS	1SVR 430 774 R3300
CM-ASS	1SVR 430 865 R1100	CM-PAS	1SVR 430 774 R1300
CM-ASS	1SVR 430 865 R3100	CM-PAS	1SVR 430 774 R3300
CM-ASN	1SVR 450 320 R0200	CM-PAS	1SVR 430 774 R1300
CM-ASN	1SVR 450 321 R0200	CM-PAS	1SVR 430 774 R1300
CM-ASN	1SVR 450 322 R0200	CM-PAS	1SVR 430 774 R1300
CM-ASN	1SVR 450 421 R0200	CM-PAS	1SVR 430 774 R1300
CM-ASN	1SVR 450 320 R0500	CM-PAS	1SVR 430 774 R3300
CM-ASN	1SVR 450 321 R0500	CM-PAS	1SVR 430 774 R3300
CM-ASN	1SVR 450 322 R0500	CM-PAS	1SVR 430 774 R3300
CM-ASN	1SVR 450 422 R0500	CM-PAS	1SVR 430 774 R3300
CM-ASN	1SVR 450 423 R0600	CM-PAS	1SVR 430 774 R3300
CM-ASN	1SVR 450 320 R0700	CM-PAS	1SVR 430 774 R3300
CM-ASN	1SVR 450 321 R0700	CM-PAS	1SVR 430 774 R3300
CM-ASN	1SVR 450 322 R0700	CM-PAS	1SVR 430 774 R3300
CM-ASN	1SVR 450 932 R0100	CM-PAS	1SVR 430 774 R3300
CM-ASN	1SVR 450 424 R0700	CM-PAS	1SVR 430 774 R3300
CM-ASN	1SVR 450 426 R0800*	-	-

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