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MODEL PRS1 - PLUG-IN SPEED SWITCH

- *5 RANGES, FROM 0.1 Hz to 10 KHz*
- *OVER-SPEED, UNDER-SPEED, OR ZERO-SPEED DETECTION*
- *4 OPERATING MODES*
- *REPEATABILITY TO 1/2% OF MAX. RANGE*
- *LED RELAY "ON" INDICATOR*
- *PROGRAMMABLE INPUT CIRCUIT ACCEPTS OUTPUTS FROM A VARIETY OF SENSORS*

DESCRIPTION

The PRS1 is a versatile, reliable and economical solution to most machine speed switching problems. It is not affected by overspeeding and will operate in either direction of rotation.

The heart of the PRS1 is a solid-state CMOS logic circuit, that continuously measures the elapsed time between successive trailing edges *(negative going)* of an incoming pulse train or waveform. It compares this time with an adjustable set-point reference and determines if the period of the waveform is longer *(underspeed)* or shorter *(overspeed)* than the set-point reference.

The internal relay is energized during *"normal"* operation and can be set to de-energize on either under or overspeed by a programming switch. The unit can be connected for simple over or underspeed detection or for latch/trip-off operation in a machine STOP/START circuit.
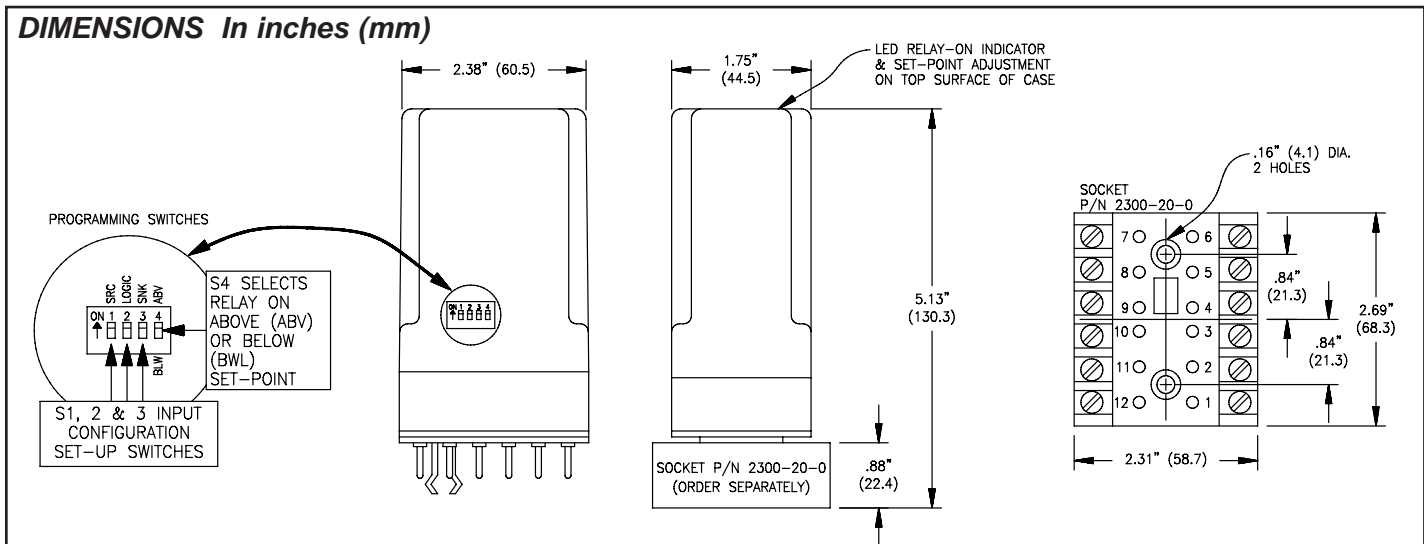
The PRS1 features built-in hysteresis *(differential between pick-up and drop-out)* of 5% of set-point speed. This prevents the output relay from chattering when operating at or near the set-point speed. The set-point control is a 20-turn screwdriver adjustment accessible at the top of the unit with a 10:1 adjustment range. An LED indicates when the relay is energized. A built-in +12 VDC regulated power supply, furnished power for the internal circuit and for external sensor excitation.

The plug-in module mates with a heavy duty, CSA approved base mounting socket with pressure clamp screw terminals that accept stripped wires without lugs. Closed back construction allows mounting directly on metal panel without an insulation barrier.

SPECIFICATIONS

1. **PRIMARY SUPPLY VOLTAGE:** Available for 115 or 230 VAC ±10%, 50/60 Hz; 2.5 VA *(See Ordering Information)*.
2. **SENSOR OUTPUT POWER:** +12 VDC ±5% regulated, 60 mA max.
3. **SIGNAL INPUT CHARACTERISTICS:** See *"PRS1 Input Circuits, Sensor Connections & Configuration Switch Set-ups"* section.
4. **FREQUENCY RANGES AVAILABLE:** Available in 5 ranges, each range providing a relay pick-up or drop-out adjustment span of 10:1. *(See Ordering Information)*
5. **RELAY CONTACT OUTPUT:** FORM *"C" (SPDT)* contacts max. rating 5 amps @ 120/240 VAC or 28 VDC *(resistive load)*, 1/8 H.P. @ 120 VAC *(inductive load)*. The operate time is 5 msec nominal and the release time is 3 msec nominal.
6. **RELAY LIFE EXPECTANCY:** 100,000 cycles at max. rating. *(As load level decreases, life expectancy increases.)*
7. **RESPONSE TIME:** Response time is equivalent to the period of set-point frequency, plus 5 msec for relay pickup or plus 3 msec for relay dropout.
8. **OPERATING TEMPERATURE RANGE:** 0 to 60°C.
9. **WEIGHT:** PRS1 PLUG-IN MODULE - 8 oz (226.8 g).

WARNING: SPEED SWITCHES MUST NEVER BE USED AS PRIMARY PROTECTION AGAINST HAZARDOUS OPERATING CONDITIONS. Machinery must first be made safe by inherent design, or the installation of guards, shields, or other devices to protect personnel in the event of a hazardous machine speed condition. Then a speed switch may be installed to help prevent the machine from entering the unsafe speed condition.

DIMENSIONS In inches (mm)

PRS1 APPLICATIONS

The following guidelines and considerations will help to assure the best performance when applying the PRS1 Speed Switch.

1. SENSOR AND FREQUENCY RANGE SELECTION
(See "PRS1 Sensor & Frequency Range Selection" section.)

2. RESPONSE TIME
The PRS1 has an internal adjustable timer whose *"time-out"* period is determined by the set-point adjustment. In operation, this timer is reset *(retriggered)* at the start of each signal cycle and the internal logic circuitry monitors whether the signal cycle concludes before time-out occurs *(overspeed)* or if time-out occurs before conclusion of the signal cycle *(underspeed)*. This operating scheme results in an inherent delay in output switching response which is insignificant at moderate and higher frequencies, but can be appreciable at low frequencies. For example, with the PRS10011 *(Range 0.1 to 1 Hz)* set to the minimum range, underspeed output will not occur until 10 sec after the initiation of the last signal cycle. Overspeed response is directly related to the period of the signal frequency and will be faster, depending on the amount of overspeed.

The inherent delay at low frequencies can be an advantage when the PRS1 is applied as a zero-speed switch. However, for fast response, a higher frequency unit with an appropriate sensor arrangement should be used. This can often be accomplished simply by moving the sensor to a higher speed shaft, or by going directly to the drive motor shaft with an ARCJ Ring Sensor Kit. *(See Sensor Section of the RLC Catalog.)*

3. ERRATIC OR IRREGULAR SHAFT MOTION
Since the PRS1 operates by timing each successive signal cycle, relay chatter can be experienced when the set-point speed is adjusted close to the running speed and the motion of the sensor shaft is irregular. For example, if a sensor detects teeth of the driven sprocket in a chain drive with a good deal of chain slack, the period between adjacent signal cycles can vary as much as 2:1 as the driven sprocket alternately overhauls and takes up slack. This does not present a problem if the set-point is adjusted at 5 or 10% of running speed, but if the set-point is to be 90% of running speed, the PRS1 output will chatter as the chain picks up and gives out slack. Again, the solution to this problem is to locate the sensor at a point in the drive train where the motion is smooth.
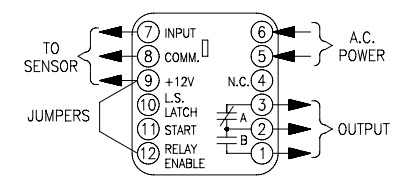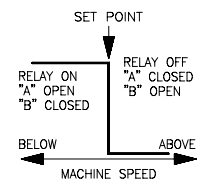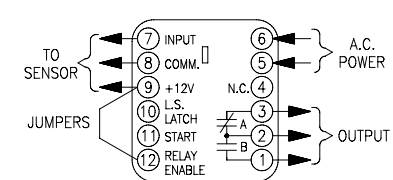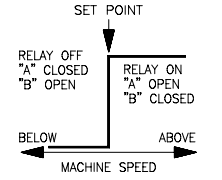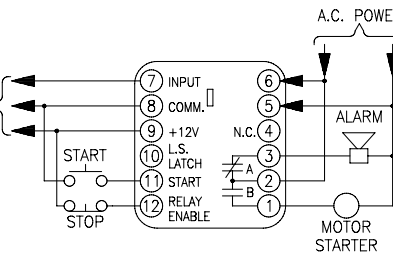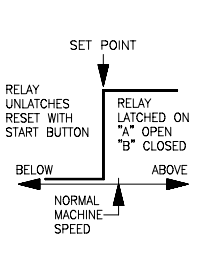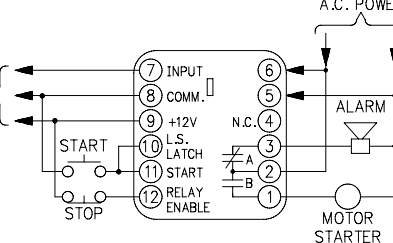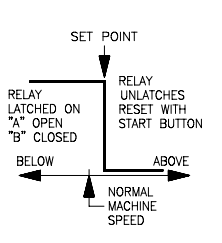
Note: The PRS1 has built-in hysteresis of 5% of set-point speed, i.e. underspeed output occurs at 95% of the overspeed set-point. This allows a set-point near running speed provided shaft motion is reasonably smooth.

4. OVERSPEED OPERATION AND HI-FREQUENCY SENSOR DROPOUT
All ranges of PRS1 units can be operated in the overspeed condition up through 10 KHz without experiencing operational discontinuities. However, when subject to higher input signal frequencies *(12 to 15 KHz)*, signal roll-off will occur in the input circuit and the output will transfer to underspeed as if the signal had dropped to zero frequency.

Sensor signal drop-out at high frequencies will also cause a false underspeed output. Caution is advised when selecting proximity, photo-electric, and other sensors that have limited high frequency ratings, to ensure that their maximum output frequency limit is not exceeded at maximum machine speed.

OPERATING MODES

MODE A:
LOW SPEED OPERATE, OVERSPEED
Internal relay is energized at all speeds below the set-point speed, and de-energizes when speed exceeds the set-point speed. Relay again energizes when speed drops approximately 5% below the set-point speed.

MODE B:
HIGH SPEED OPERATE, UNDERSPEED DROPOUT
Internal relay is de-energized at all speeds below the set-point speed, and energizes when the speed exceeds the set-point. The relay again de-energizes when the speed drops approximately 5% below the set-point.

MODE C:
LATCH, HIGH SPEED OPERATE, UNDERSPEED DROPOUT
Pushing the Start button energizes the internal relay and starts the machine. When operating speed is reached, the relay stays latched with the Start button released. If the machine speed drops below the set-point, the relay unlatches, sounding the alarm and stopping the machine.

MODE D:
LATCH, LOW SPEED OPERATE, OVERSPEED DROPOUT
Pushing the Start button energizes and latches the relay and starts the machine. The relay stays latched as long as machine operates below set-point speed. If the machine exceeds the set-point speed, the relay unlatches, sounding the alarm and stopping the machine.

ORDERING INFORMATION

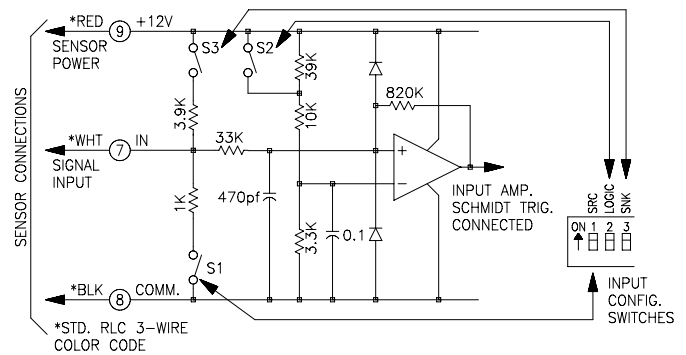| MODEL NO.	DESCRIPTION	A.C. POWER	PART NUMBERS FOR AVAILABLE SUPPLY VOLTAGES				
			0.1-1 Hz	1-10 Hz	10-100 Hz	100-1 KHz	1 K-10 KHz
PRS1	Speed Switch	115 VAC	PRS10011	PRS10101	PRS11011	PRS11021	PRS11031
		230VAC	PRS10012	PRS10102	PRS11012	PRS11022	PRS11032
__	Socket, 12-Pin	2300200					

PRS1 INPUT CIRCUITS, SENSOR CONNECTIONS & CONFIGURATION SWITCH SET-UP

The Model PRS1 Speed Switch uses the circuit shown on the right. The circuit uses a comparator amplifier connected as a Schmidt trigger circuit to convert the input wave form into the pulse form required for proper circuit operation. Three set-up switches are used to configure the input circuit to accept signals from a wide variety of sources, as follows:

S1 - ON: Connects a 1 K pull-down resistor for sensors with sourcing output. *(Maximum sensor output current is 12 mA @ 12 V output.)*

S2 - ON: Sets bias of input to trigger at $V_{IL} = 2.5$ V, $V_{IH} = 3.0$ V; for logic level signals.

OFF: Sets the bias of input to trigger at $V_{IL} = 0.25$ V, $V_{IH} = 0.75$ V; for increased sensitivity when used with magnetic pickups.

S3 - ON: Connects a 3.9 K pull-up resistor for sensors with current sinking output. (Maximum sensor current is 3 mA.)

OTHER CHARACTERISTICS & SPECIFICATIONS

Maximum Operating Frequency: 10 KHz with maximum pulse width ON and OFF times of 50 μsec.

Maximum Input Voltage: Pin 7 *(Input)* may be driven from an external voltage up to ±90 V provided S1 and S3 are "OFF" to disconnect internal load resistors. *(Maximum Input Voltage with S1 "ON" is ±16 V)*

Input Impedance: With S1 and S3 "OFF", the resistive input impedance exceeds 1 Megohm, as long as Pin 7 voltage is greater than zero and less than +12 V.

Paralleling With a Counter and/or Rate Indicator Inputs: The PRS1 can be operated from a common sensor with current sinking output that is also used to drive the input of a Counter or Rate Indicator. Connect Pin 8 to the Common Terminal and Pin 7 to the Input Terminal of the Counter or Rate Indicator; set S1 and S3 "OFF" and S2 "ON". DO NOT PARALLEL CONNECT THE +12V OUTPUTS (Pin 9) OF PRS1 UNITS WITH THE +12V OUTPUTS OF COUNTERS, DITAKS, OR OTHER PRS1 OR PRA2 UNITS. These units have regulated supplies that will not load-share. Multiple inputs cannot be operated from sensing switches, 2-wire proximity sensors, or magnetic pickups.

CONNECTIONS & CONFIGURATION SWITCH SET-UP FOR VARIOUS SENSOR OUTPUTS

MAGNETIC PICKUPS

RECOMMENDED RULES FOR MAGNETIC PICKUP CONNECTIONS
1. *Mount the PRS1 in a relatively "noise-free" environment, away from motor starters, control relays, or other sources of electrical interference.*
2. *Use 2-wire shielded cable for magnetic pickup signal leads.*
3. *Never run signal cable in conduit, troughs, or cable bundles with power carrying conductors.*
4. *Connect the shield to the common Terminal "8" at the input of the PRS1. DO NOT connect the shield at the pickup end, leave it "open" and insulate the exposed shield to prevent electrical contact with the frame or case. (Shielded cable, supplied on some RLC magnetic pickups, has open shield on pickup end.)*

SENSORS WITH CURRENT SINK OUTPUT (NPN O.C.)

RLC SENSOR MODELS:
ASTC, LMPC, PSAC, LSC, RPGC, RPGB, RPGH, RPGQ, HESS, etc.

SENSORS WITH CURRENT SOURCE OUTPUT (PNP O.C.)

2-WIRE PROXIMITY SENSORS

RLC SENSORS WITH -EF OUTPUT

RLC SENSOR MODEL: LMPEC

A.C. INPUTS FROM INVERTERS, A.C. TACHOMETERS GENERATORS, ETC.

R - Resistor to limit input current to 5 mA peak
C - Filter cap required when input A.C. has "ringing" characteristics as with inverters.

A.C. Power sources exceeding 50 V output should be coupled with an isolation transformer.

INPUT FROM CMOS OR TTL

SWITCH CONTACT INPUT

The addition of two external resistors and a capacitor allows the PRS1 to be operated from input signals generated by a switch contact. The external RC network forms a Low-Pass Filter which operates in conjunction with the hysteresis of the input circuit to "De-bounce" the Switch Contact signal.

Use of the Low-Pass RC Filter places a high-speed restriction on the circuit, and it cannot be used at frequencies of more than 200 to 300 cps. However, Switch Contact input is normally limited to low speed operation, so this does not impose a serious restriction.

PRS1 SENSOR & FREQUENCY RANGE SELECTION

The PRS1 Speed-Switch normally operates from a variable frequency signal supplied by a machine mounted sensor. The sensor signal varies in frequency in direct proportion to machine speed, and may be a sinusoidal, triangular, square, or pulse-type waveform. The sensor arrangement can take a variety of forms such as a Magnetic Pickup or Proximity Sensor detecting passing teeth on a sprocket or gear, a Photo-Electric Scanner viewing passing pulley spokes, a Rotary Pulse Generator coupled to a machine shaft, or a Length Sensor driven by a web or ribbon of material passing through the machine. (See Sensor Section of the catalog for more information on sensors.)

Since the PRS1 operates from the frequency content of the incoming signal, the response time of both devices is also related to the signal frequency. This gives rise to the cardinal rule of selecting a sensor arrangement:

WHEN RESPONSE TIME IS IMPORTANT, SELECT A SENSOR ARRANGEMENT & LOCATION THAT WILL PROVIDE A HIGH FREQUENCY OUTPUT AT OPERATING SPEED.

When a PRS1 application is first contemplated, it seems to be natural to think in terms of applying the sensor to the low speed end of the power drive train. In some cases this may be the only practical location for the sensor, and if fast response is needed from the PRS1, a sensor arrangement capable of delivering a high number of cycles or pulses/revolution *(PPR)* will be required. In a great number of applications however, generating a higher frequency sensor signal is simply a matter of locating the sensor on a intermediate or high speed shaft such as directly on the drive motor shaft.

Another advantage of moving the sensor location up toward the high speed end of the drive train is that the shaft rotary motion is usually much smoother and more regular. Slow speed shafts will often rotate irregularly due to gear backlash, "slop" in couplings, or slack in chain drives. This irregular motion can have an adverse effect on the resulting output, especially when using the PRS1 to perform a speed switching function near normal running speed.

SELECTING AN APPROPRIATE SENSOR ARRANGEMENT

There are no exact rules governing the selection of a sensor arrangement since machine geometry and conditions can vary widely from one application to the next. However, the following generalized criteria will prove useful as guidelines toward selecting the best sensor arrangement. *(See Sensor Section of the catalog for more information.)*

ULTRA-LOW SHAFT SPEEDS (10 RPM or less) - Proximity Sensors, Photo-Electric Scanners, or Rotary Pulse Generators, are usually the best selections. In most ultra-low speed applications, it is advisable to provide as many pulses per revolution as possible *(high PPR)* to get acceptable response times.

LOW-SHAFT SPEEDS (10-100 RPM) - LMPC (Super-Sensitive Magnetic Pickup), Proximity Sensors, Photo-Electric Scanners and RPG's can usually be applied in this speed range.

INTERMEDIATE SHAFT SPEEDS (10-1000 RPM) - Magnetic Pickups, the LMPC, RPG's and some Proximity Sensors are appropriate at these speeds.

HIGH-SHAFT SPEEDS (1000 RPM and up) - Magnetic Pickups, the LMPC and RPG's are usually the best choices.

FOR LINEAR SPEEDS ON PAPER WEBS, TEXTILE, RIBBON, STRIP AND WIRE - The LSC Length Sensor may prove desirable.

CAUTION: When selecting a sensor for operation at any speed, make sure the sensor is also capable of delivering an output for the entire speed range up through maximum machine speed.

DETERMINING SENSOR FREQUENCY OUTPUT & SELECTING THE PROPER FREQUENCY RANGE

Machine speeds are normally expressed in revolutions/minute *(RPM)* while the PRS1 has adjustable frequency ranges in cycles/second or Hz. In addition, sensor arrangements usually deliver a number of signal cycles or pulses for each shaft revolution. The following formula provides a convenient way to relate these variables:

$$FRQ \text{ (CPS or Hz)} = \frac{RPM \times PPR}{60}$$

WHERE:

RPM is the speed of the shaft where the sensor is located in revolutions per minute.

PPR is the number of pulses (or cycles) produced by the sensor for one shaft revolution.

EXAMPLE 1

A machine is to be equipped with a PRS1 Speed Switch. A 42-tooth timing belt pulley is available in the power drive train, and an LMPC is to be used to sense passing teeth. The PRS1 set-point is to be adjusted to provide overspeed output when the timing belt pulley reaches 730 RPM. What should the frequency range of the PRS1 be?

$$FRQ \text{ @ set-point} = \frac{730 \text{ RPM} \times 42 \text{ PPR}}{60} = 511 \text{ Hz}$$

SELECT: PRS11021 (or PRS11022 for 230 VAC) which has an adjustable range of 100-1000 Hz.