Series TSP
Flow Switch Controller
Owner’s Manual

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The general purpose flow switch package provides reliable no or low-flow detection of relatively clean non-coating media with a 16A SPDT compact flow controller for pump or process protection. Liquid examples include water and sulfuric acid. The optional flash alarm brings attention to low-flow alarm conditions. Available in Polypropylene-Ryton® or Polyvinylidene Fluoride (PVDF), the short flow sensor is used in pipe from ½” to 1-1/2”, and the long configuration is used in 2” and up. The flow switch set point may be adjusted from 0.04 fps to 3 fps in liquids for low-flow control. The flow sensor is best applied in applications with relatively constant temperature.

Features
- Rugged Polypropylene-Ryton® or Polyvinylidene Fluoride sensor for corrosive liquids and gases.
- Fail-Safe relay control of pumps, valves or alarms with a 0.15 to 60 second delay
- Optional flashing alarm brings immediate attention to level alarm conditions.
- Polypropylene enclosure rated NEMA 4X with swivel base for conduit alignment.
- Invert switch changes relay state from NO to NC without rewiring.
- AC powered

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Set point range: 0.04 to 3 fps (0.012 to .91 mps)
Factory set point: .2 fps (.06 mps)
Viscosity range: 1 to 200 centipoise
Repeatability: ±.5% of set point @ fixed temp.
Response time: 1 to 10 seconds
Set point adjust.: Potentiometer
LED indication: Power, relay and sensor status
Supply voltage: 120/240 VAC @ 50-60 Hz.
Consumption: 0.25A maximum
Contact type: (1) SPDT Relay
Contact rating: 250 VAC @ 16A, ½ Hp
Contact output: Selectable NO or NC
Contact delay: 0.15 - 60 seconds
Process temp.: F: 32° to 140° / C: 0° to 60°
Ambient temp.: F: -40° to 140° / C: -40° to 70°
Pressure: 150 psi (10bar) @ 25 °C, derated @ 1.667 psi (0.113 bar) per °C above 25 °C.
Enclosure rating: NEMA 4X (IP65)
Enclosure material: PP (U.L. 94 VO)
W/ flash alarm: PP (U.L. 94 VO & PC)
Conduit entrance: Single, 1/2” NPT
Wetted material: TSP1_ _: PP-Ryton®
TSP2_ _: PVDF
Enclosure mount.: 3/4” NPT
Enclosure rotation: 300° swivel base
Classification: General purpose
Certificate number: LR 79326-3
CE compliance: EN 61326 EMC
EN 61010-1 Safety

Flash Alarm
Flash type: Xenon tube
Flash frequency: 1 per second
Strobe life: 10M cycles
Supply voltage: 120 VAC, 50-60 Hz.
Consumption: 3 Watts max.
Material: Polycarbonate
Enclosure rating: NEMA 4X (IP65)
Color: Amber
About the Liquid Flow Controller: Dwyer Instrument’s TSP series is a single-point mounting system for installing one flow sensor within a pipe or fume. The compact relay controller features a 120/240 VAC controller with a 250 VAC, 16A, 1/2Hp SPDT relay contract.

<table>
<thead>
<tr>
<th>Part Number</th>
<th>CE</th>
<th>Thread</th>
<th>Flash Alarm</th>
<th>Sensor Material</th>
<th>Sensor Length</th>
<th>Application Media</th>
</tr>
</thead>
<tbody>
<tr>
<td>TSP110</td>
<td>Yes</td>
<td>3/4&quot; NPT</td>
<td>No</td>
<td>PP &amp; Ryton®</td>
<td>Short</td>
<td>Liquid</td>
</tr>
<tr>
<td>TSP120</td>
<td>Yes</td>
<td>3/4&quot; NPT</td>
<td>Yes</td>
<td>PVDF</td>
<td>Short</td>
<td></td>
</tr>
<tr>
<td>TSP210</td>
<td>No</td>
<td>3/4&quot; NPT</td>
<td>Yes</td>
<td>PP &amp; Ryton®</td>
<td>Long</td>
<td></td>
</tr>
<tr>
<td>TSP220</td>
<td>No</td>
<td>3/4&quot; NPT</td>
<td>No</td>
<td>PVDF</td>
<td>Long</td>
<td></td>
</tr>
<tr>
<td>TSP110S</td>
<td>No</td>
<td>3/4&quot; NPT</td>
<td>No</td>
<td>PP &amp; Ryton®</td>
<td>Long</td>
<td></td>
</tr>
<tr>
<td>TSP120S</td>
<td>No</td>
<td>3/4&quot; NPT</td>
<td>No</td>
<td>PVDF</td>
<td>Long</td>
<td></td>
</tr>
<tr>
<td>TSP210S</td>
<td>No</td>
<td>3/4&quot; NPT</td>
<td>No</td>
<td>PVDF</td>
<td>Long</td>
<td></td>
</tr>
<tr>
<td>TSP220S</td>
<td>No</td>
<td>3/4&quot; NPT</td>
<td>No</td>
<td>PVDF</td>
<td>Long</td>
<td></td>
</tr>
</tbody>
</table>

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Relay Controller: The flow switch is pre-wired before shipment to the 3-pole terminal strip [Input 1 (+), (-) & (S)]. The technology used to indicate flow is Thermal Dispersion. The Liquid Flow Controller provides a 1/2” Conduit connection and 6 poles for wire termination of power and relay contact. Use the AC, AC and GND terminals for providing power. Use the NC, NC and COM terminals for interfacing to the relay contact.
SAFETY PRECAUTIONS

About This Manual:  PLEASE READ THE ENTIRE MANUAL PRIOR TO INSTALLING OR USING THIS PRODUCT. This manual includes information on the Liquid Flow Controller from Dwyer Instruments: TSP Series. The units are identical except for the material of construction and size of the sensor.

User’s Responsibility for Safety: Dwyer Instruments manufactures a wide range of liquid sensors, controllers, and mounting systems. It is the user’s responsibility to select components that are appropriate for the application, install them properly, perform tests of the installed system, and maintain all components. The failure to do so could result in property damage or serious injury.

Proper Installation and Handling: Use a proper sealant with all installations. Never over-tighten the components. Always check for leaks prior to system start-up.

Material Compatibility:
- **Polypropylene** (PP, a polyolefin): Sensor, Junction Box.
- **Ryton®**: Sensor (TSP1__ only).
- **Polyvinylidene Fluoride** (PVDF): Sensor (TSP2__ only).
- Make sure that the application liquids are compatible with the materials that will be wetted. To determine the chemical compatibility between the components and its application liquids, refer to a chemical compatibility guide.

Temperature and Pressure: TSP series is designed for use in application temperatures up to 50° C (140° F). The assembly is also designed for pressurized applications up to 150 psi (10 bar).

Electrical Shock Hazard: It is possible to contact components on the controller that carry high voltage, causing serious injury or death. All power to the controller and the relay circuit(s) it controls should be turned OFF prior to working on the controller. If it is necessary to make adjustments during powered operation, use extreme caution and use only insulated tools. Making adjustments to powered controllers is not recommended. Wiring should be performed by qualified personnel in accordance with all applicable national, state and local electrical codes.

Flammable or Explosive Applications: The Liquid Flow Controller, TSP series, should not be used within classified hazardous environments.

Install In a Dry Location: The controller housing is liquid-resistant and made of Polypropylene (PP). When installed properly, the controller is not designed to be immersed. It should be mounted in such a way that it does not normally come into contact with fluid. Refer to an industry reference to ensure that compounds that may splash onto the controller housing will not damage it. Such damage is not covered by the warranty.
**SAFETY PRECAUTIONS (cont.)**

**Step Three**

**Make a Fail-Safe System:** Design a fail-safe system that accommodates the possibility of relay or power failure. If power is cut off to the controller, it will de-energize the relay. Make sure that the de-energized state of the relay is the safe state in your process. For example, if controller power is lost, a chemical feed pump will turn off if it is connected to the Normally Open side of the relay.

While the internal relay is reliable, over the course of time relay failure is possible in two modes: under a heavy load the contacts may be “welded” or stuck into the energized position, or corrosion may buildup on a contact so that it will not complete the circuit when it should. In critical applications, redundant backup systems and alarms must be used in addition to the primary system. Such backup systems should use different sensor technologies where possible.

While this manual offers some examples and suggestions to help explain the operation of products from Dwyer Instruments, such examples are for information only and are not intended as a complete guide to installing any specific system.

**Relay Contact Rating:** The relay is rated for a 16 amp resistive load. Many loads (such as a motor during start-up or incandescent lights) are reactive and may have an inrush current characteristic that may be 10 to 20 times their steady-state load rating. The use of a contact protection circuit may be necessary for your installation if the 16 amp rating does not provide an ample margin for such inrush currents.

**Safety Cover:** Based upon the part number selected, a safety cover has been placed within the enclosure. Always replace the safety cover after any service.
GETTING STARTED

Step Four

The relay inside the controller is a single pole, double throw type; the controlled device can be connected to either the normally open or normally closed side of the relay. A time delay from 0.15 to 60 seconds can be set before the relay responds to the sensor input.

Guide to Controls: Below is a listing and the location of the different components for the controller:

CE Version

1. Power indicator: This green LED lights when AC power is ON.

2. Relay indicator: This red LED will light whenever the controller energizes the relay, in response to the proper condition at the sensor input and after the time delay.

3. AC Power terminals: Connection of 120 VAC power to the controller. The setting may be changed to 240 VAC if desired. This requires changing internal jumpers; this is covered in the Installation section of the manual. Polarity (neutral and hot) does not matter.

4. Relay terminals (NC, C, NO): Connect the device you wish to control (pump, alarm etc.) to these terminals: supply to the COM terminal, and the device to the NO or NC terminal as required. The switched device should be a non inductive load of not more than 16 amps; for reactive loads the current must be derated or protection circuits used. When the red LED is ON and the relay is in the energized state, the NO terminal will be closed and the NC terminal will be open.

5. Invert switch: This DIP switch reverses the logic of the relay control in response to the sensor(s): conditions that used to energize the relay will make it turn off and vice versa.

6. Time Delay: After the input(s) change(s) state, this control sets a delay from 0.15 to 60 seconds before the relay will respond.

Flash Alarm Version (non-CE)

7. Input 1A indicator: These amber LED will light immediately whenever the appropriate sensor attached to the terminals detects no-flow, and will turn off when it detects flow. This polarity can be reversed by change of the switches polarity.

8. Input terminals: Connect the wiring from the sensors to these terminals: Note the polarity: (+) is a 24 VDC, 100 mA power supply (to be connected to the red wire of a Dwyer Instruments sensor), and (-) is the return path from the sensor (to be connected to the black wire of a Dwyer Instruments sensor). (S) Is the relay signal input to be connected to the white wire? The remaining green wire will return to the (-) terminal. If polarity is reversed, the sensors will not work.
Follow these steps for the electrical portion of this manual:

1. Confirm flow switch is attached to the input terminals.
2. Provide 120/240 VAC power to the sensor.
3. Connect switched device to the relay terminals.
4. Attach flash alarm (if included) to the relay terminals.

1. **Confirm flow switch is attached** (Connecting switches to input terminals):
   The sensor provided is prewired. The flow switch will be wired with the White wire to the (S) terminal (Switch Chan 1) and the Green wire to the (-) terminal (GND). Typically, the Red wire is wired to the (+) terminal (24 VDC) and the Black wire to the (-) terminal. This is a Normally Closed (NC) state. Reversing the Red and Black wires will switch the polarity from Normally Closed to Normally Open (NO).

2. **Provide 120/240 VAC power** (VAC Power Input Wiring):
   Observe the labeling on the controller on whether it is configured as 120 or 240 VAC. **Note**: Polarity does not matter with the AC input terminal.

**Changing from 120 to 240 VAC:**

1. Remove the two screws from the top of the printed circuit board (PCB) and gently slide the PCB from the housing. Use caution when removing the PCB.
2. Located jumpers JWA, JWB and JWC on the PCB.
3. To change to 240 VAC, remove jumpers from JWB and JWC and place a single jumper across JWA.
   To change to 120 VAC, remove jumper JWA and place jumpers across JWB and JWC.
4. Gently return PCB into housing and replace the two screws.
3. Connect switched device to the relay (Relay Input Wiring):
The relay is a dry contact single pole, double throw type rated at 250 VAC, 16A, ½ Hp. The two terminals NO and NC (normally open and normally closed) will be used in different applications with C (common) used regardless of choice between NO or NC. **Note:** the "normal" state is when the relay coil is de-energized (the Red relay LED will be OFF). Regardless of the invert status (ON or OFF), the normal state will always be when the Red LED is OFF.

4. Attach Integral Flash Alarm:
With the integral flash alarm wired NC; it can be used as a high or low level alarm, depending on the setting for the invert switch. The flash alarm can also be wired NO. **Note:** the integral flash alarm shares the relay within the sensor. The flashing alarm can be set to either indicate when the switched device (pump, valve or alarm) is active or not active.
The TSP series flow switch controller must always be in contact with the liquid being measured. The TSP series feature a 3/4” NPT threads which will allow it to be used with various types of fittings. Be sure to check the insertion depth of the flow switch in the fitting after it is installed. See the diagram to the right for the recommended insertion depth.

- The two tip of the sensor are to be perpendicular to the flow (as seen to the right). Never mount the tips with one in front of the other.

When using any type of fitting, the orientation as well as the insertion depth of the flow switch in the pipe is critical. See the diagram to the right for the recommended orientation.

**Warning**

⚠️ The flow switch tips have a thin plastic wall which may be damaged if dropped or installed improperly.

⚠️ The TSP series is designed for use in liquid. For best results, avoid installing the sensor where bubbles are present or where the tips of the switch may be out of the liquid.

The two temperature probes (tips) must always be perpendicular to the flow (see the flow at the same time).
**FLOW SWITCH CALIBRATION**

**Step Seven**

**Set Points:** If the preset factory calibration is not adequate for your application, follow the calibration steps listed below. **Note:** the switch's internal LED will be on when the switch detects no-flow and will off when the switch detects flow.

1. Install the fitting and flow switch as described in the Installation section of this manual. Turn the flow switch and controller power on and adjust the flow rate to the application setting. If the medium to be sensed is likely to be subject to high temperature variations, the flow switch should be set at the highest normal temperature likely to be encountered.

2. Locate the potentiometer knob at the top of the flow switch. The red LED is visible through the potentiometer. (If the LED is on, slowly adjust the potentiometer counterclockwise, with a small flat head screwdriver until the LED turns off.) The adjustment is a single turn 270° potentiometer. The initial response time of the flow switch after adjustment is 1 to 10 seconds. Adjust the potentiometer in slow increments and wait for the response. If the LED is off, slowly adjust the potentiometer clockwise until the light turns on. Then turn the potentiometer counterclockwise to bring the LED off at a reliable setting. Remember, adjust the potentiometer in slow increments and wait for the response.

3. Verify that the new calibration is correct by lowering the system flow rate below the set point and check to see that the red LED turns on. Then increase the flow rate above the set point and verify that the red LED turns off accordingly.

**Accessing the Adjustment Potentiometer:** Remove the two screws from the top of the printed circuit board (PCB). Then gently slide the PCB from the housing. Use caution when removing the PCB. You will now be able to see the potentiometer through the housing. Make any necessary adjustment. **Note:** Electrical wiring of any liquid level control system should be performed in accordance with all applicable national, state, and local codes. When completed, gently return PCB into housing and replace the two screws.
**APPLICATION EXAMPLES**  

**Step Eight**

**Low Flow Alarm:** The goal is to indicate when the flow rate falls below a certain point. If it does, an alarm is supposed to sound, alerting the operator of a low flow condition.

If power is accidentally cut to the controller, the sensor's ability to notify the operator of a low flow condition could be lost. The system must alert the operator not only to low flow, but to controller power loss.

To do this, connect the hot lead of the alarm to the NC side of the relay terminal of the controller. If power is lost, the relay will be de-energized, and the alarm will sound (if there is still power to the alarm circuit itself). The alarm circuit should have a noninterruptible power supply or some other indicator or backup alarm to warn of a power failure in the alarm circuit.

In this application, the normal status is when the sensor is in the flow condition, and the relay will be energized holding the alarm circuit open. Please note that the flow switch can be wired either normally closed or normally open (Step ???). When the switch is wired NC, the input LED will be off and the relay LED will be on. So for this application, Invert should be set to the On position. When the switch is wired NO, the input LED and the relay LED will be on simultaneously. So for this application, Invert should be set to the Off position.
Controller Logic: Please use the following guide to understand the operation of the controllers.

1. **Power LED:** Make sure the Green power LED is ON when power is supplied to the controller.

2. **Input LED:** For NC switch wiring, the input LED on the controller will be Amber when the switch reads no-flow and OFF when the switch reads flow.

3. **Invert Operation:** When the input LED turn Off and On, the relay LED will also switch. With invert Off, the relay LED will be On when the input LED is On and Off when the input LED is Off. With invert On, the relay LED will be Off when the input LED is On and On when the input LED is Off.

4. **Relay Operation:** The relay may be wired either NO or NC. The normal state of the relay is when its LED is Off. With the LED On, the relay is in the energized mode and all terminal connections are reversed.

Troubleshooting:

<table>
<thead>
<tr>
<th>PROBLEM</th>
<th>SOLUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controller is powered, but nothing happens.</td>
<td>First check the Power LED to make sure it is Green. If not, check the wiring, power and make sure the terminal is seated correctly over the 6-pins.</td>
</tr>
<tr>
<td>A Flow or No-Flow condition is met but the relay did not switch.</td>
<td>Check the relay by switching the invert switch. Confirm that relay click on and off as well as the relay LED.</td>
</tr>
<tr>
<td>The Flow or No-Flow is not switching at the correct flow rate.</td>
<td>The flow switch may need to be adjusted. Review the Flow Switch Calibration section on the previous page for instructions on setting the actual flow switch. Note: access to the flow switch adjustment is difficult and requires the removal of the PCB assembly. Use caution when performing this step.</td>
</tr>
<tr>
<td>Trying to start the flow but the controller keeps turning the flow off.</td>
<td>To restart a flow condition, the sensor needs to sense an actual flow condition before changing the relay in the controller. A flow switch over-ride may need to be added across the relay contacts that allows for a true flow to occur before switching back to the controller. The use of a moment switch is recommended for the over-ride switch.</td>
</tr>
<tr>
<td>Relay LED does not match my flow condition.</td>
<td>The relay LED can be switched by either the reversing the wiring of the sensor to the controller or by flipping the invert switch. This means that the relay LED can either be set to turn on during a flow condition or to turn off during a no-flow condition. This is all dependent on the wiring and the invert position.</td>
</tr>
<tr>
<td>Relay LED does not match the sensor’s LED indicator.</td>
<td>The sensor’s LED will always be ON during a No-Flow state and OFF during a Flow state, regardless of the switches wiring. As per above the input LED can be inverted to any condition. In some applications, they will match and in others they will be opposite. This is all dependent on the application parameter/setup.</td>
</tr>
</tbody>
</table>
**General:** The TSP series requires no periodic maintenance except to clean off any deposits or scaling from the sensor tip as necessary. It is the responsibility of the user to determine the appropriate maintenance schedule, based on the specific characteristics of the application liquids.

The TSP Series is not field serviceable and should be returned if repair is needed (field repair should not be attempted and may void warranty).

**Cleaning Procedure:**

1. **Power:** Make sure that all power to the sensor, controller and/or power supply is completely disconnected.
2. **Sensor Removal:** *Make sure that the flow is off and the pressure is down prior to removing the flow switch controller.* Carefully, remove the sensor from the installation. Replace the sensor with a 3/4” NPT plug to insure that liquid does not leak out during this procedure. *Do not re-install the TSP series if the threads are damaged.*
3. **Cleaning the Sensor:** Use a soft bristle brush and mild detergent, carefully wash the TSP series. Do not use harsh abrasives such as steel wool or sandpaper, which might damage the surface sensor. Do not use incompatible solvents which may damage the sensor's PP/Ryton® or PVDF plastic body.
4. **Sensor Installation:** Follow the appropriate steps of installation as outlined in the installation section of this manual.
**Test the Flow Switch:** Use to verify if sensor indicates either a no-flow or flow condition. This test uses all four-wires (Red, Black, White and Green). With Red to Positive and Black to Negative, the Contacts (White and Green) will be Open in a Flow Condition and Closed in a No-Flow Condition. Also, the Red LED in the switch will be OFF for a Flow Condition and ON for a No-Flow Condition.

To simulate a no-flow / flow condition, place the sensor in a cup of water. With the sensor sitting still, the Red LED will turn on indicating a no-flow state. When you swirl the sensor within the cup, the LED will turn OFF indicating a flow condition. The internal relay (across White and Green) will open and close accordingly.

**LED Indication:** Use the LED for the switch input to identify the state of the flow switch (flow or no-flow). The LED is located next to the input terminal. When the switch is wired NC, an Amber LED indicates no-flow and an Off LED indicates flow. Reversing the polarity (Normally Open), an Amber LED indicates flow and an Off LED indicates no-flow.

![Diagram showing wiring and LED indications for Flow Switch](image)

**Note:** The LED inside the flow switch will always be ON for No-Flow and OFF for Flow, regardless of the polarity of the flow switch. In NC wiring, the switch’s LED will match the controller’s LED. In NO wiring, the switch’s LED will be opposite of the controller’s LED.
WARRANTY/RETURN

Refer to “Terms and Conditions of Sale” in our catalog or on our website. Contact customer service to receive a Return Goods Authorization number before shipping your product back for repair. Be sure to include a brief description of the problem plus any relevant application notes.

Dwyer Instruments, Inc.
Attn: Repair Department
102 Highway 212
Michigan City, IN 46360