PDSIO™
Pulse Density Signaling I/O

- **Description of PDSIO™ Principles**
- **Outline of the Four Primary PDSIO™ Modes**
- **List of Direct PDSIO™ Benefits**
  - **Eliminate Ammeters**
  - **Eliminate Current Transformers**
  - **Reduce Wiring**
  - **Improve Diagnostics**

Introduction

Many industrial processes have a requirement for fast, accurate exchange of data between two or more pieces of control instrumentation. Often, this data is exchanged as analog voltage or current signals. The obvious problem with this medium is the inherent inaccuracies caused by slight calibration differences between the instruments. Another problem is the limitation of one piece of data per I/O channel.

PDSIO Goals

Pulse Density Signaling Input Output (PDSIO) has been developed as a method of exchanging data between several instruments in a fast accurate manner. A number of design goals have been met by this technique:

- Low cost
- Improved Diagnostics
- Conventional installation methods
- Reduction in installation cost and time
- Reduction in support instrumentation
- Absolute, calibration-free accuracy
- Simple to troubleshoot
- Retrofittable

PDSIO achieves each of these goals.

- Low cost

It is a very low cost interface being based on simple switching of a 24mA signal.

- Improved Diagnostics

Alarm information indicating equipment failure is immediately transmitted to the controller before a process upset occurs. Conventional techniques wait for process upsets before alarms occur.

- Conventional installation methods

It is installed using conventional instrument signal wire, not special cables or connectors.

- Reduction in installation cost and time

Several information signals can be conveyed on the same pair of wires thereby reducing the amount of wiring.

- Reduction in support instrumentation

PDSIO aware instrumentation can convey information that may normally appear on secondary devices such as ammeters or signal lights.

- Absolute, calibration-free accuracy

PDSIO is based on digitally formatted data and is therefore calibration free and absolutely accurate.

- Simple to troubleshoot

The PDSIO signal levels appear as conventional 24mA pulses which are transmitted as either simple time proportioned levels or smoothed to behave like a 4 - 20 mA analog signal.

- Retrofittable

PDSIO output stages can be used to drive conventional devices which are not PDSIO aware. Conventional devices can be used, through appropriate wiring, to convey PDSIO data in a simple manner. Interface devices are available which can modify conventional devices to take advantage of the full set of PDSIO benefits.

PDSIO Modes

PDSIO is available in four modes, three of which are designed for PID controllers driving Solid State Relays or SCR devices firing electric heaters:

Mode 1 - Fault Indicating SSR:

-Controller transmits a simple time proportioned signal to the SSR.
-SSR replies to the controller with a single message indicating a good or bad health situation for the load circuit.

Mode 2 - Current Monitoring SSR:

-Controller transmits a simple time proportioned signal to the SSR.
-SSR replies to the controller with a measurement of ON state load current if the load circuit is healthy. It replies with one of two fault alarms if the load circuit has failed.

Mode 3 - Analog SSR:

-Controller transmits to the SCR device a signal which simulates a simple analog 4 - 20 mA signal .
-SCR device replies to the controller with a measurement of ON state load current if the load circuit is healthy. It replies with one of two fault alarms if the load circuit has failed.

Mode 4 - Setpoint Retransmission:

-Master Controller transmits a setpoint value to the subordinate controller which simulates a

simple 4 - 20 mA analog signal.
-Subordinate controller tracks the setpoint and replies with a holdback request if it cannot stay within a specified tolerance limit.

PDSIO Controller/SSR Modes

A PDSIO aware Solid State Relay (SSR), has the ability to evaluate several failure modes of the load circuit. By monitoring the drive signal to the SSR and the load current, the SSR can deduce:

- Open Heater Burn-out
- Blown Heater Fuse
- Open SSR Device
- Shorted SSR Device
- No Line Voltage
- Broken Controller Signal Wire

This is the real benefit of the PDSIO diagnostics feature. With conventional instrumentation, any of these failures would result in a process upset. The operator would not readily know there was a problem until this process upset began effecting product quality. The PDSIO alarms are instantaneous and therefor avoid production problems.

Mode 1 - Fault Indicating SSR

PDSIO Mode 1 is the simplest method of achieving PDSIO diagnostics benefit from a controller/SSR combination. The controller delivers time proportioned 24mA pulses at the normal output cycling rate. Mode 1 is the only Mode which may be used in retrofit applications to drive existing Solid State Relays.

Being the simplest PDSIO mode, there is limited flexibility with regard to the return signal from the SSR. All failures are just grouped together as a single fault condition. The controller will annunciate a failure as **Ld.F** but cannot differentiate the actual cause.

Mode 2 - Current Monitoring SSR

PDSIO Mode 2 provides a much more sophisticated and useful diagnostics tool than Mode 1. This is principally due to the fact that, in Mode 2, ON state load current is transmitted to the controller for display on the front of the instrument. In addition to this, the faults which are detected are subdivided into two categories: heater circuit faults and SSR faults. Those faults considered as part of the load circuit and annunciated as **Htr.F** include:

- Open Heater Burn-out
- Blown Heater Fuse
- Open SSR Device
- No Line Voltage

The fault considered to be associated with the contactor circuit and annunciated as **SSr.F** is:

- Shorted SSR Device

If the signal wires between the controller and the SSR break, **Ld.F** will be annunciated as with Mode 1.

The intent behind this differentiation is to guide the instrument technician towards the location of the fault. Either he will be led towards troubleshooting the heater and its associated elements such as the fuse, or he will be led towards replacing the Solid State Relay itself. In either event, troubleshooting time is reduced drastically by eliminating half of the possibilities and by presenting the alarm instantaneously.

Except in the case of the broken signal wiring, the SSR will be transmitting the heater current level back to the controller for display. This data will be transmitted even when the SSR is not actually conducting current. If there is a load circuit or SSR fault of some kind as described above, the SSR will indicate this to the controller. Note that if a wire breaks between the controller and the contactor, this will be conveyed to the operator as a total load circuit fault.

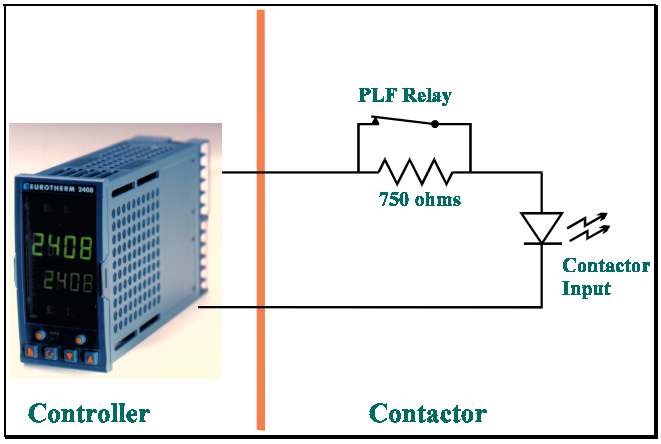

Figure 1: PDSIO Mode 1 Retrofit with PLF

If PDSIO Mode 2 is connected to a conventional Solid State Relay that is not designed with a PDSIO interface, the PDSIO off-state drive current could cause the SSR to remain on continuously. This is not the case, however, because if the controller does not receive PDSIO data, it automatically switches to simple time-proportioning. Once PDSIO data is again recognized, the controller will upgrade itself back to PDSIO Mode 2, thereby self-healing. This will help to prevent any over temperature runaway problems caused by misapplication.

Mode 1 - Retrofit with Eurotherm PLF SSR

In those new or retrofit applications employing non-PDSIO Eurotherm Solid State Relays with the PLF feature, PDSIO Mode 1 may be used to annunciate the load failure. This will not provide load current reading on the front of the controller but the PLF alarm will be presented on the controller and can therefor be incorporated into the alarm scheme.

Figure 1 shows schematically how the PLF relay can be wired in series with the Logic drive signal. When a PLF condition is recognized, the relay will open and the 750 ohm resistor will be placed in the circuit. The controller will recognize this as a PDSIO fault condition and present the alarm to the operator.

Note: The Solid State Relay input circuit must not have any resistance in series with the Opto-coupler. This will be the case for model AS-1 contactors ordered with the LCS input option. Also, model 425 contactors may be wired in such a way that there is no series resistance.

Mode 1 - Applied to a Conventional Solid State Relay

In applications where a conventional Solid State Relay is used for switching heater current, PDSIO Mode 1 can be used to alarm a blown load fuse. By wiring a small relay from the bottom of the fuse to Neutral and placing a 750 ohm resistor across the normally open contacts as shown in Figure 2, PDSIO Mode 1 signaling can be accomplished. When the fuse clears, the relay will drop out. This will place the 750 ohm resistor in series with the Logic drive signal thereby signaling the fault condition to the controller. As in the situation with the PLF relay, heater current will not be transmitted to the controller but the fuse fail condition will be displayed.

Note: Certain Solid State Relays are supplied with resistance in series with the opto-coupler. It is important that there be no series resistance when used with PDSIO Mode 1.

Mode 4: PDSIO Setpoint Transmission

Since PDSIO has the benefit of absolute digital accuracy and resolution, it is ideal for transmitting analog data from one instrument to another. The real benefit is that, by using PDSIO, there is no calibration difference between the two instruments as there would be when using analog signals. The two dominant benefits are:

- Absolute digital accuracy and resolution
- Inherent broadcast of data from the master to all subordinate units at the same time.

The most common application is PDSIO Mode 4 which transmits an analog value such as Process Setpoint from a master controller to a number of subordinate controllers. This is often used in multi-zone furnaces or hot presses. The master controller or controller/programmer will transmit its setpoint as a PDSIO signal to the subordinate controllers. These subordinate controllers will read the PDSIO signal in engineering units and then add a local trim or offset value as desired. In addition, these subordinate controllers can use the return path to signal a problem back to the master. In the example of a setpoint programmed system where many zones are ramped simultaneously, the master controller can command the setpoint ramp. If any of the subordinate controllers have a control problem and cannot keep up with the ramp, they can signal this back to the master. The master can pause until the problem unit comes out of holdback.

Much like PDSIO Mode 3, Mode 4 simulates a 4 - 20mA signal so troubleshooting can be with conventional tools.

Conclusion: PDSIO Benefits

Whether used for power control of electrically fired heaters or setpoint transmission between ganged controllers, PDSIO has real benefit in terms of performance and cost.

- The interface itself is very low cost, about the same as a standard logic interface circuit.

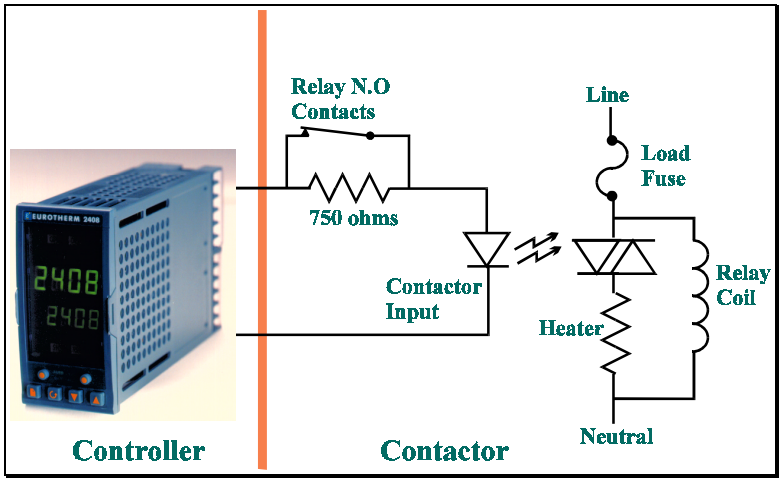

Figure 2: Mode 1 Used with a Conventional SSR

- Accuracy is absolute and calibration free so all devices on the PDSIO link will respond to exactly the same data.
- PDSIO is not based on a communications standard but is more of a logic signaling scheme, so it is very easy to install and maintain.
- All PDSIO Modes are designed to save money in terms of installation costs as well as associated equipment such as ammeters and current transformers.
- PDSIO is easy to retrofit and can give benefit even when interfaced with older equipment.

Comments: