Badger® Model 2101 Dual Channel Flow	Multiple Pump Control Using Pressure and Flow	Application Brief

SYSTEM
The pump stations at most golf courses and other medium sized systems utilize multiple pumps sometimes in conjunction with a pressure storage tank. Usually a small "jockey" pump sometimes controlled by a simple pressure switch maintains pressure in the system, and is used to satisfy small demands such as hand watering. When the demands increase a larger "lead" pump is brought on line. In a typical three pump system this would be sized to supply about half of the full capacity, and would supply water for manual or "greens only" schedules. When a full irrigation cycle is started, the third or "lag" pump would also be required to meet full system capacity.

PROBLEM
The designer must find a means of controlling the pumps. The pumps should start and stop at precise repeatable flow rates for best performance. If the main pumps start too soon, stay on too long, or short cycle electrical energy may be wasted. This creates uneven watering and the potential for pipe damaging line surges.

SOLUTION
The dual channel version of the Badger Series 2100 can provide complete control of the station. With a 4-20mA pressure sensor connected to the Series 2100 Analog Input Option Card, and one of the Series 2100 relays programmed as a pressure Set-Point, the jockey pump will be controlled on pressure. Typically Line#1 will be configured to display in "Psi".

As the flow increases beyond the capacity of the jockey pump, the "Lead" pump is brought online based on flow data from a Badger Meter flow sensor installed in the main line, and wired to a second input channel in the Series 2100. The "Lag" pump is started when the flow rate exceeds the capacity of the "Lead".

Optionally, the Series 2100 contains up to four Form C relay contacts that can be set in the field to energize at any flow set-point. These set-points include adjustable on-delays to suppress flow transients, and adjustable dead bands to prevent relay chatter or short pump cycling. The dead band has a wide range of adjustment, up to 50% of the set point, that it can often perform the control functions of two set points. As long as the flow demand is above the set point, the Model 2100 keeps the booster on.

SPECIFIC RECOMMENDATIONS
The following is a description of a typical system. The system can be expanded for control of multiple pump systems.

The jockey pump, usually less than 10% of the system capacity, is controlled entirely by pressure. It is piped directly into the system, not through any pressure regulation valves. An analog pressure transducer, typically 4-20mA, is connected to an analog input card of a Model 2101. The normally open Relay #1 of the Model 2101 is programmed as a "Low Set-Point" so that the jockey starts as soon as the pressure drops, but does not turn off for a few seconds after the pressure recovers. This eliminates any short pump cycles. On some systems, hydro-pneumatic tanks or minimum run-timers are used to lengthen the cycle time.

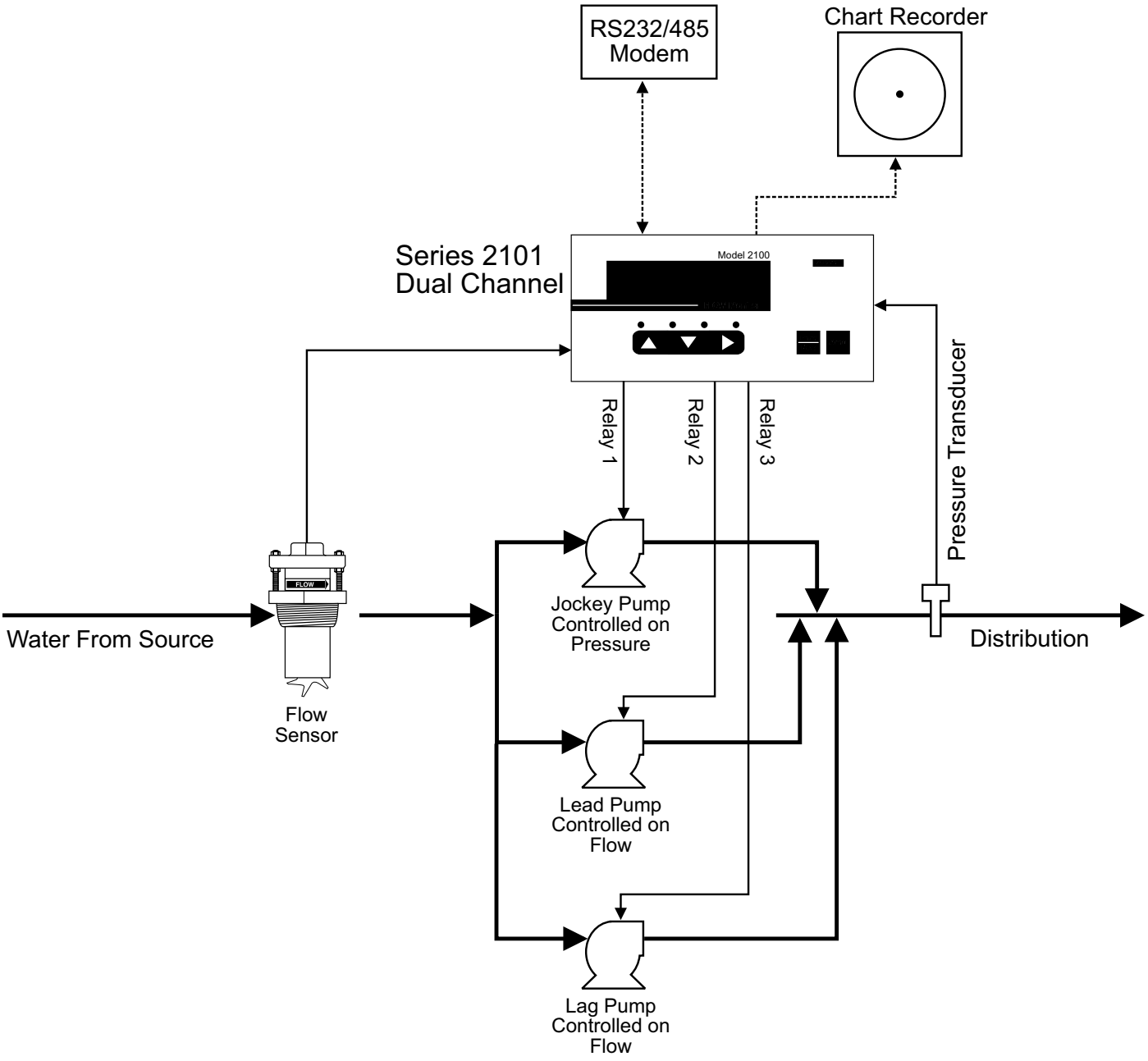
With the jockey pump running and unable to meet the demand the pressure continues to fall. This allows Relay #2, set to 10 psi below the jockey pump pressure setting, to start the lead main pump. It discharges through a pressure regulating valve set at a discharge appropriate for the system, but below the shutoff point of the jockey pump. Once started, the normally open contacts of the Relay #3 wired in parallel with Relay #2 will keep the lead pump ON , as long as the flow remains above the minimum set point, just above the capacity of the jockey pump, the lead pump will remain on.

If the demand of the system exceeds the capacity of the lead pump and the jockey pump, then the "lag" main pump is brought on line with a Relay #4. Time delay and dead-band settings again eliminate pump short cycling, and allows short flow spikes to be ignored as the system stabilizes after a new zone is activated.

Because the relays are easy to program, the actual set-points, time delays, and dead-bands can be fine tuned in the field under actual dynamic flow conditions. Programming the Model 2101 relays is accomplished through a menu and LCD display, which can be backlit for poorly illuminated areas. The "On Delay" may be set from 1-120 second and the hysteresis or dead band can be set from 10% to 50% of the set point.

In smaller systems not using three pumps Relay #4 may be used as a low flow alarm, such as loss of suction, or as a high flow alarm to warn of a leak or pipe break. The relay logic may be reversed, energizing the relay when the flow rate falls below the set point and setting the latch feature to keep off until reset.

SENSOR INSTALLATION
Flow data stability and accuracy will be optimized if the flow sensor is located in a section of pipe with at least ten diameters upstream and five diameters down stream of straight uninterrupted flow. The "IR" series sensor is recommended if the sensor is going to be located outside the station in a pit that might flood.



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Due to continuous research, product improvements and enhancements, Badger Meter reserves the right to change product or system specifications without notice, except to the extent an outstanding contractual obligation exists.

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