EMFLOW

PS-PR Technical Manual

The Best Flow
for your application.

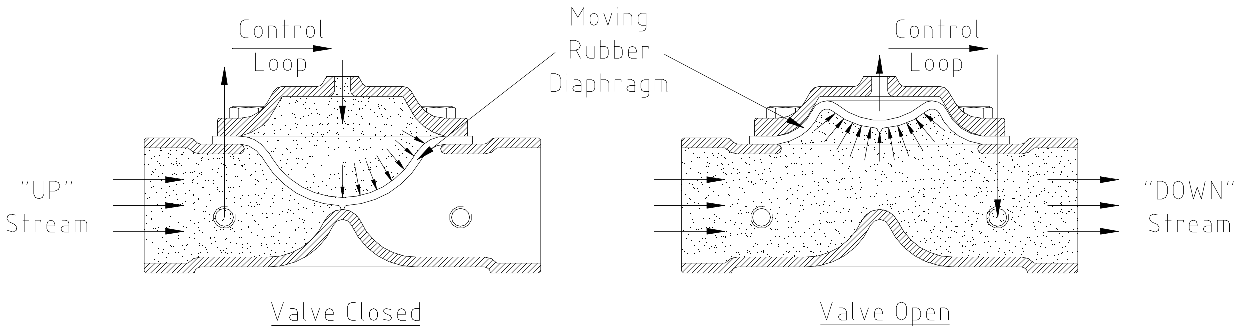
Emflow Valves, PMB 51 Mannum, South Australia 5238 Phone 1300 136 918. www.emflow.com

Technical Manual for ~

Pressure Sustaining & Reducing Valves

Basic valve operation

The design of the Emflow Valve is based on the Saunders or “Diaphragm” style valve. This is where a single flexible rubber diaphragm is caused to move to open and close the valve as required. When the valve is closed it is essentially like putting the plug into your bath outlet …



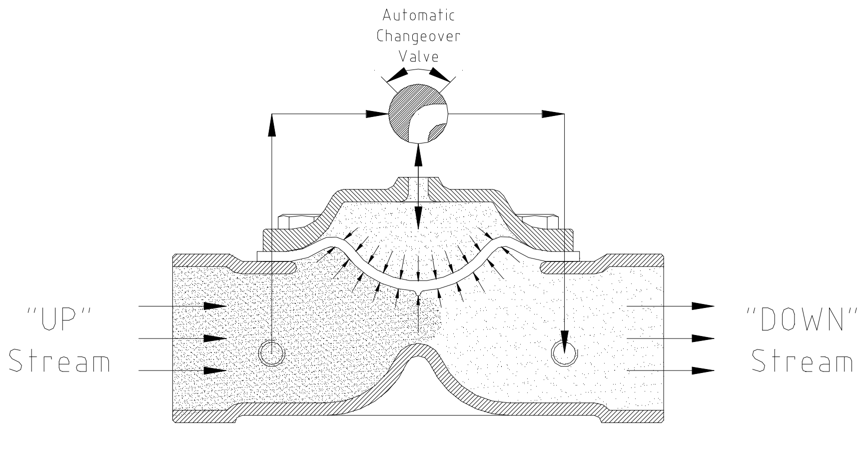
As it can be seen it is the porting of the water from Upstream to fill the diaphragm chamber or venting Downstream from the chamber that causes the valve to Close and Open.

The “Control Loop” that causes the valve control, can dynamically change to fill or vent the diaphragm chamber as needed. This will then cause the diaphragm to sit at any position between the fully open or fully closed extremes, effecting a throttling action on the water going through the valve.

Basic ***Valve*** control methods

Currently there are basically 2 control methods used to achieve valve diaphragm positional control. They are the “3 Way” and “2 Way” control methods.

“3 Way” control :-

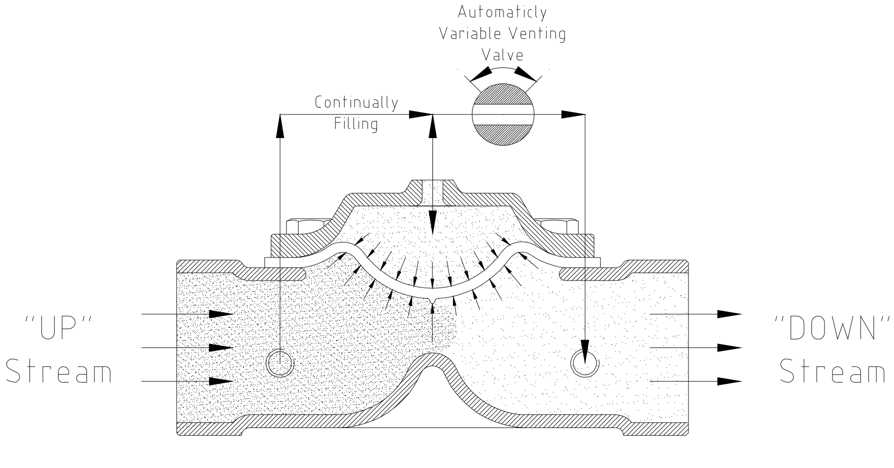


"3" Way Control

This is where an Automatic Changeover Valve (called a “Pilot”) which automatically fills from upstream <u>or</u> vents to downstream the diaphragm chamber as needed, to achieve the diaphragm position control as desired.

The main advantage of the “3 Way” control circuit is that it will control the valve even when there is almost no pressure difference between the upstream side and the downstream sides of the valve. The main disadvantage is that for the pilot to switch between filling the diaphragm chamber to venting the diaphragm chamber takes time causing pressure fluctuations and inaccuracy in system control.

"2 Way" control :-



"2" Way Control

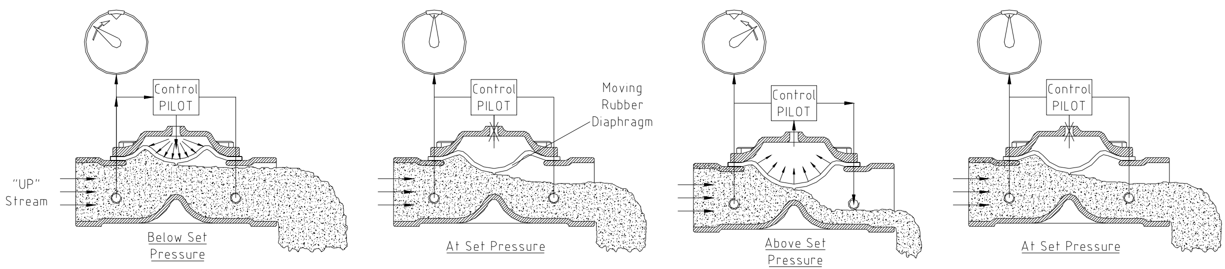
This is where fluid is continually trying to fill the diaphragm chamber from upstream but there is a controlled "leak" (Pilot) that allows fluid to escape downstream thus venting the diaphragm chamber giving control over the valve diaphragm position.

The main advantage of the "2 Way" control circuit is that is gives far greater precision in valve control due to the instantaneously variable balancing act that is maintained in the control circuit. It's main disadvantage is that there has to be a difference in pressure between upstream and downstream of the valve to cause water to flow through the control circuit, so it can't be used in systems where a low pressure differential exists across the valve (difference between upstream and downstream pressures).

Basic ***System*** control methods

There are 2 basic system control methods, Pressure Sustaining and Pressure Reducing. They both control system pressure, but the difference is whether the pressure is controlled ***before*** or ***after*** the Emflow Valve.

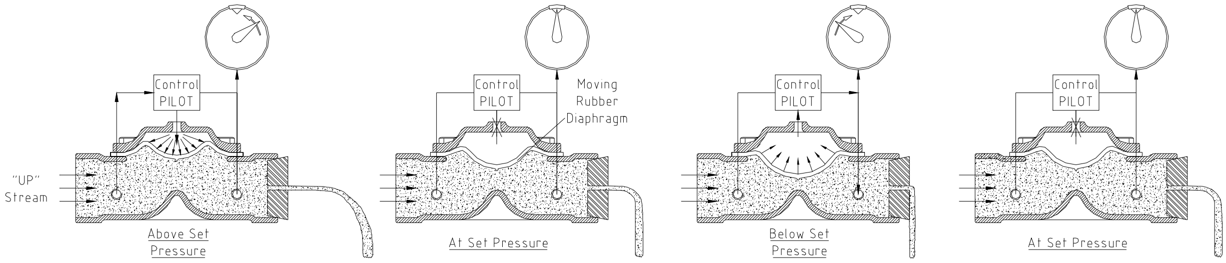
The ***Pressure Sustaining*** control method regulates the water flow through the Emflow Valve such that a preset pressure is achieved and maintained in the piping ***before*** the valve.



As you can see, to start off with, the diaphragm is too far open and too much water is being allowed to escape downstream of the valve causing the pressure upstream of the valve to be too low. The control pilot responds by opening the port from upstream into the diaphragm chamber causing the diaphragm to start to close as in image 1. Then the diaphragm reaches the correct position to allow the correct amount of water to escape through the valve giving the correct pressure upstream as shown in image 2. But if the diaphragm was to go too far in correction then the flow of water escaping through the valve would be restricted too much causing a pressure buildup upstream of the valve as indicated in image 3. As you can see in that image though the Control Pilot is responding by opening a port to let water out of the diaphragm chamber downstream causing the flow of water escaping through the valve to increase and the pressure upstream to go back to the set pressure required as shown in image 4. Therefore the pressure *before* the valve is *sustained* at a preset level, giving rise to the term ***Pressure Sustaining***.

As an example, one of the main uses for this type of control method is where an Emflow Valve is installed at the outlet of a main supply pump. This is to ensure that some back pressure is felt on the pump as it is filling the attached empty pipe lines at startup. In this situation the pump could possibly over-speed and over-heat itself or cause cavitation damage in the pump housing or associated pipe work. Additionally the pump can be made to work in a better position on the pump curve improving pumping efficiencies.

The ***Pressure Reducing*** control method regulates the water flow through the Emflow Valve such that a preset pressure is achieved and maintained in the piping ***after*** the valve.



As can be seen in diagram 1 the diaphragm is again too far open allowing too much water to flow through the valve casing the pressure downstream of the valve to be too high. The Control Pilot senses this and fights back by opening a port that allows water to flow into the diaphragm chamber from upstream causing it to close and reduce the flow of water through the valve, to arrive at diagram 2. Where there is a balance achieved of water flowing through the valve and that escaping downstream. The pressure is stable and at the setpoint required. Now if the diaphragm was actually to move too far then the flow of water through the valve would be restricted too much causing a starvation of water required to go downstream as can be pictured in diagram 3. which would be sensed by the Control Pilot again that opens another port releasing diaphragm pressure downstream causing the diaphragm to open and increase water flow through the valve again balancing the demand downstream and arriving at a stable condition again as can be seen in diagram 4. Therefore the pressure *after* the valve is controlled or "*reduced"* to a preset level below that of the upstream supply, giving rise to the term ***Pressure Reducing***.

One of the main uses for this type of circuit is to ensure that the supply pressure from the pump has been reduced to an acceptable line pressure that is more suitable for operation of down stream equipment – sprinklers etc.

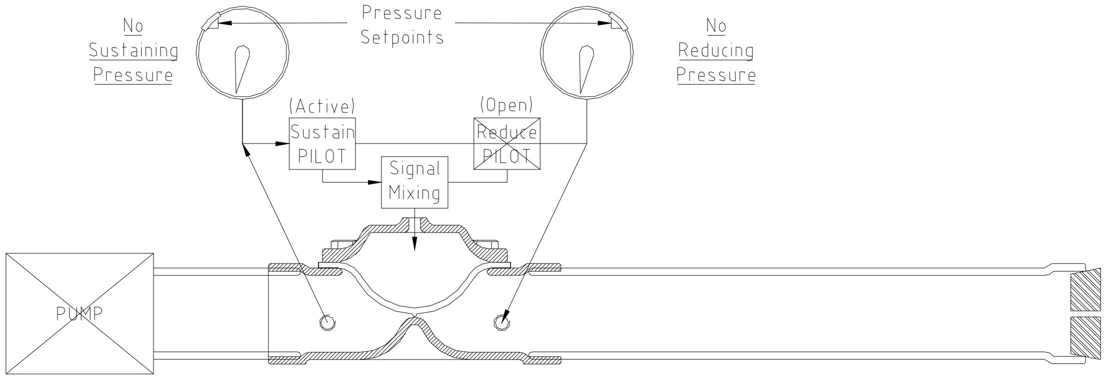
Combined ***System*** control method

The 2 control methods can be combined and installed onto a single Emflow Valve. This valve is called a ***Pressure Sustaining*** & ***Reducing Valve***. This type of control method is used where it is anticipated that a pump will be, at times, pumping against no system back pressure. Such as when a pump is first started up and the associated pipelines are empty of water. This could cause the pump to over-speed drawing excessive current and over heating or the velocity of the water going through the pump and piping may be too great causing cavitation damage. Additionally, when the system is finally full of water and is running under normal conditions, the pump puts out too much pressure and the valve is then used to reduce it to a possibly safer and more usable level.

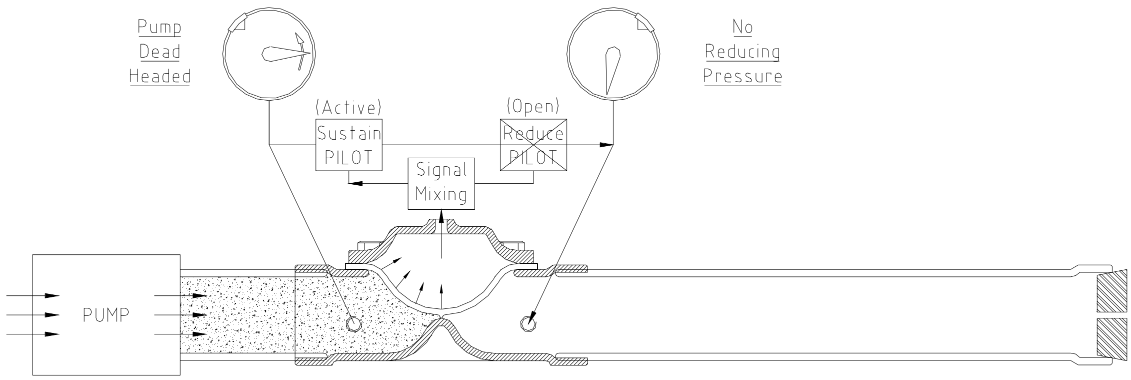
Considering there is only one diaphragm that can control water flow through the valve, it can't do Pressure Sustaining as well as Pressure Reducing ***simultaneously***; the control methods have to be implemented in such a way as to allow an overlap between methods but a segregation and independence of actual control.

The way this is achieved is by setting the Sustaining Pressure Setpoint at a level ***below*** that of the Reducing Pressure Setpoint. That way the Pressure *Sustaining* Pilot is controlling the valve in the lower pressure ranges which transfers to the Pressure *Reducing* Pilot in the upper pressure ranges. Each pilot is then fully open when the other pilot is controlling the valve. This gives opportunity for routing the plumbing such that the fully open pilot is an integral part of the control circuit but not involved in the controlling itself until called to do so by a change in system pressure whereby the roles are reversed and control passes between pilots.

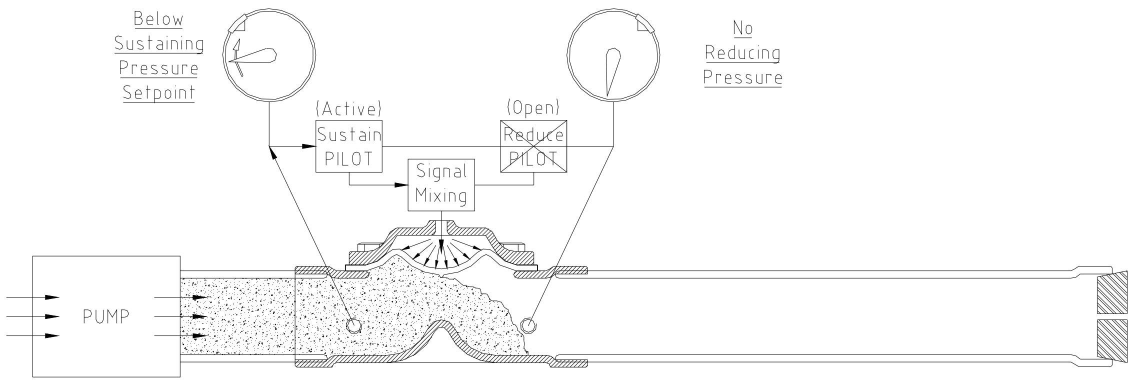
The Pressure Sustaining & Reducing circuit operation and control is described in the following series of diagrams. They show what happens step by step in the sequence of events that occur from pump startup to a fully operational system. The process starts from the assumption that the pump is OFF and there is NO water in the pipelines at all. The Setpoint for the Pressure Sustaining (PS) Pilot is set BELOW that of the Pressure Reducing (PR) Pilot. There is no water pressure in the system anywhere.



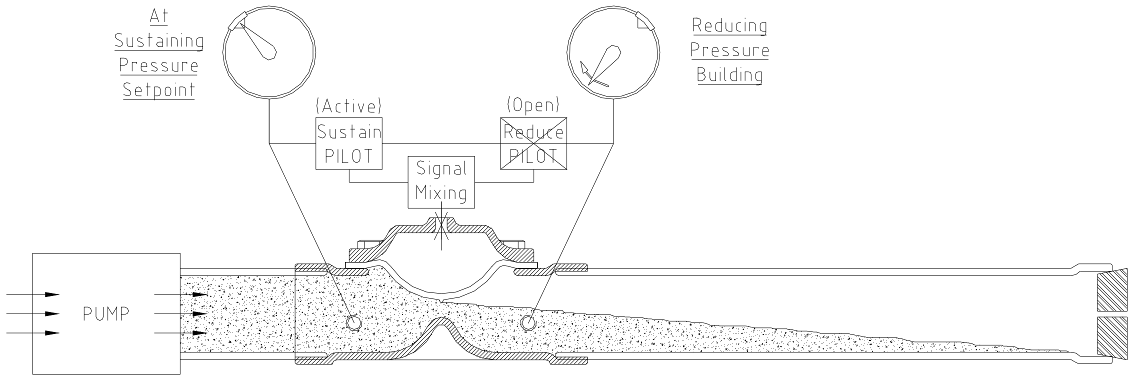
The Pressure Sustaining (PS) Pilot is ready to port water from upstream into the valve diaphragm chamber to try and keep the valve diaphragm closed and bring the upstream pressure up to the required setpoint.
The Pressure Reducing (PR) Pilot is fully open and ready to relieve valve diaphragm chamber pressure downstream to cause the valve diaphragm to open and allow water past bringing the downstream pressure up to the required setpoint.
The Signal Mixing method causes the correct Pilot to have control, either through the way the plumbing is routed or by use of a Shuttle Tee. This will be explained in greater detail later.



At pump startup the water flow will come to bear against the valve diaphragm tending to pressurize it to open. Because the water can not yet go anywhere the pressure will rise on the way to the maximum pressure available from the pump. The PS Pilot will sense this and try to relieve any diaphragm chamber pressure downstream to cause the diaphragm to open and reduce the upstream pressure to that as specified by the setpoint.

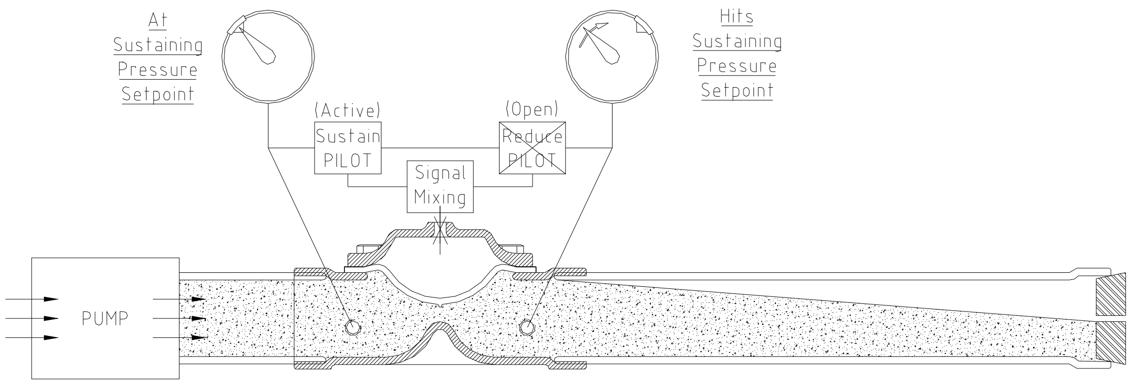


The diaphragm has opened but the pressure is now too low again so the PS Pilot again senses this and causes pressure to be again diverted into the diaphragm chamber to close the diaphragm and increase upstream pressure.

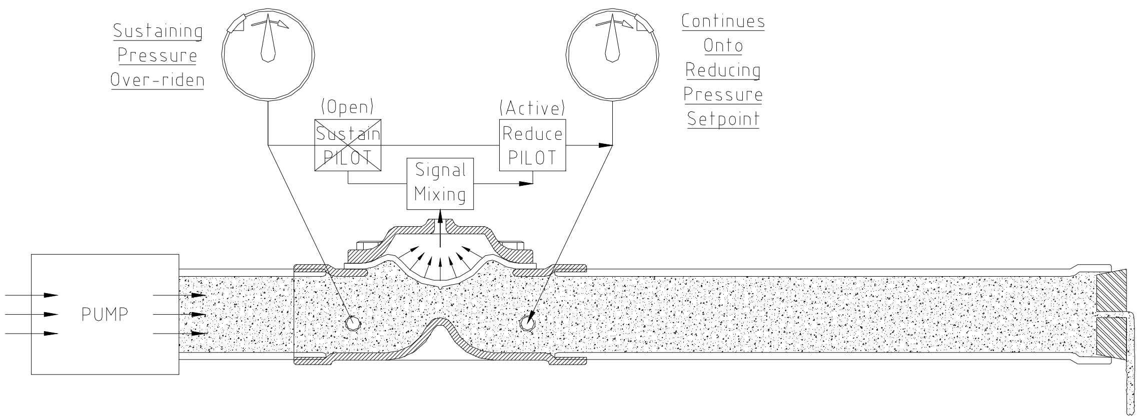


The porting to and from the diaphragm chamber continues to happen all the time getting closer to the setpoint of the PS Pilot at which time the system has stabilized and water continues to flow through to fill the empty pipeline and the Sustaining pressure is also maintained.

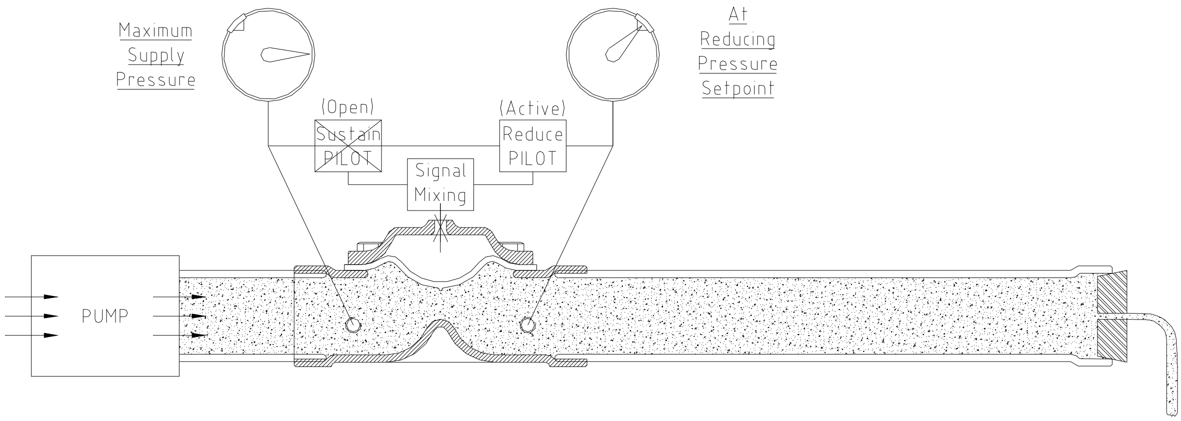
This condition goes on for as long as is required to fill the pipelines. Normally without any valve, the pump would have been starting to over-speed to fill the empty pipelines, causing it damage. But because of the valve, the water flow out of the pump has been restricted and controlled thereby controlling the speed of the pump and eliminating any over-speed problems.
Up to this point the PR Pilot, although it is fully open, has had no effect because the Signal Mixing method has isolated and nullified any interference with the PS Pilot.



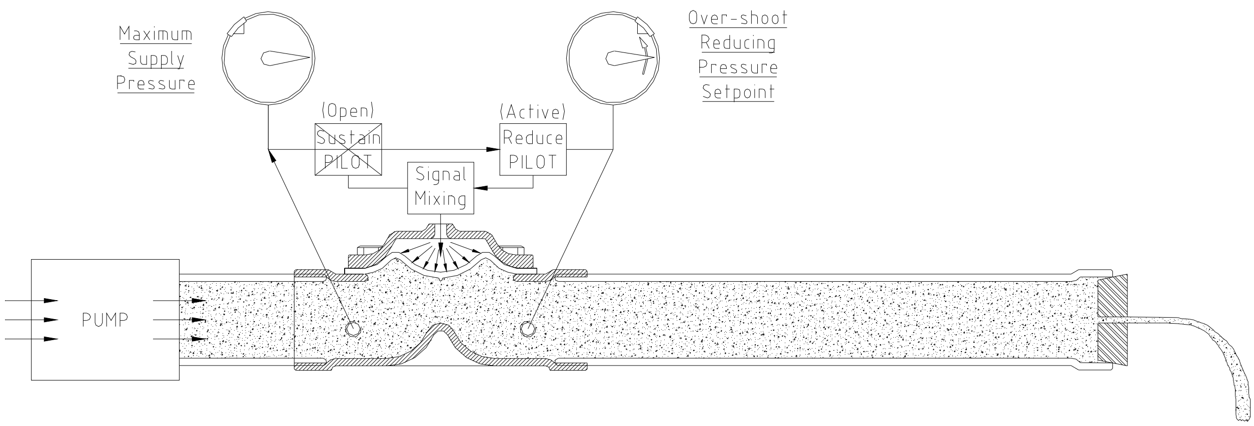
As the pipelines continue to fill, the overall system pressure starts to build up to a point where the downstream pressure equals that of the upstream pressure. This is where system control is essentially transferred between the PS Pilot and the PR Pilot.



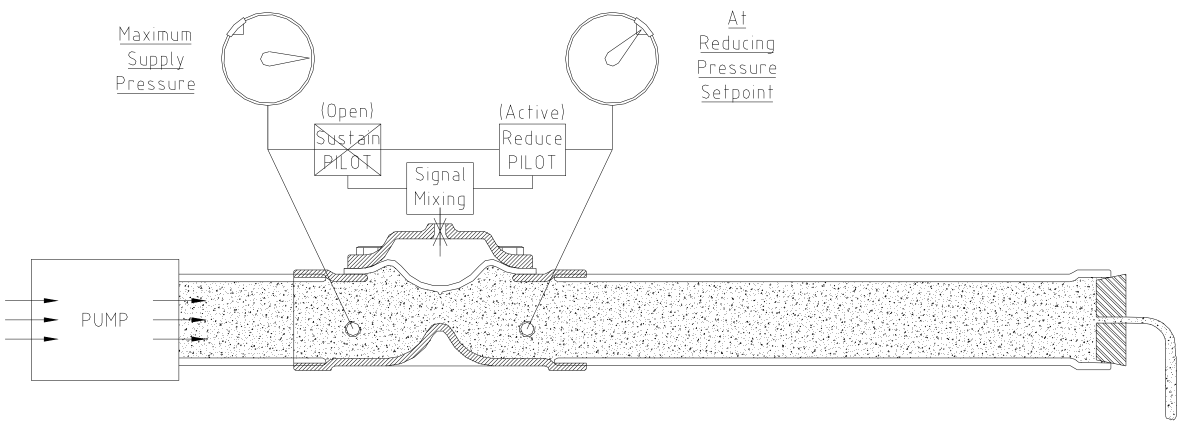
The PS Pilot goes into a perpetually OPEN state of trying to relieve excessive upstream pressure but never being able to do so because the downstream pressure is always the same or greater than the upstream pressure.
The PR Pilot gains full control. It is still OPEN as well because it recognizes that the downstream pressure is still not great enough to reach the PR Pilot Setpoint and continues to port diaphragm pressure out of the diaphragm chamber to achieve the setpoint.



The PR Pilot stays open until the PR Setpoint is reached at which point is closes the downstream port to maintain the diaphragm position. The upstream pressure is high because the water flow out of the pump is contained before the diaphragm which is only letting enough through to ensure the PR Setpoint is maintained downstream.



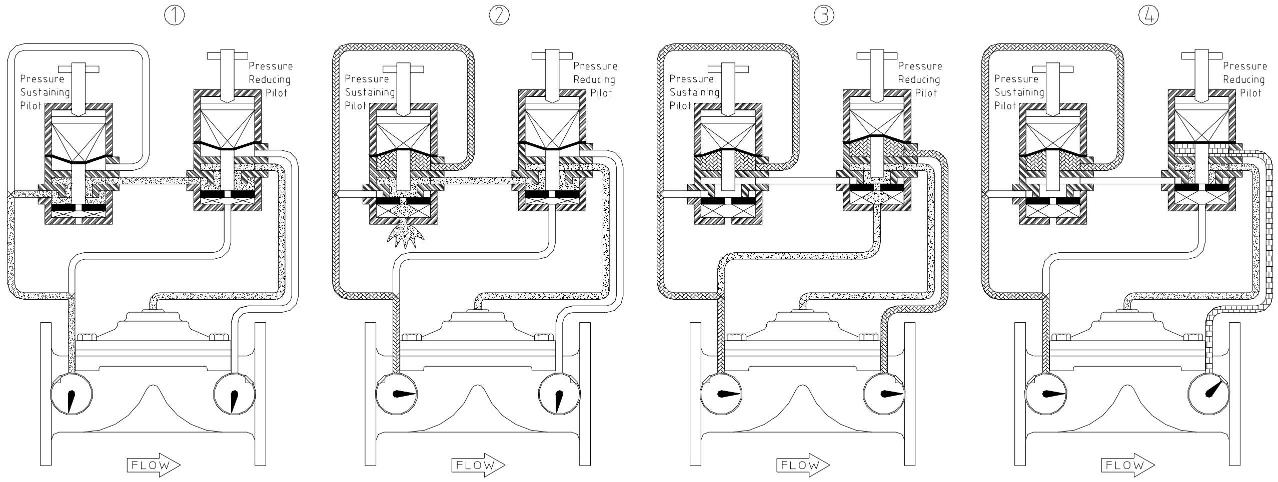
Due to system flow changes there may arrive a condition whereby the downstream pressure goes above that as specified by the PR Pilot setpoint. The PR Pilot would respond by porting fluid from upstream into the diaphragm chamber causing the diaphragm to close marginally reducing water flow into the downstream area to bring that pressure back to that as required by the PR Pilot setpoint.



The final stable condition where the pipelines are full and the pressure downstream is being controlled by the PR Pilot to sit at a pressure as specified by the PR Pilot setpoint. The PS Pilot is over-ridden and stays fully open with no effect upon system pressure control because the system pressure downstream is above the PS Pilot setpoint and there is nowhere for it to relieve to in an attempt to gain control.

The next thing that needs to be explained and understood is how the Signal Mixing occurs. There are 2 ways this is achieved, by the way of **inter-dependence** or that of **in-dependence**. Each has its benefits and its associated detriments.

The way of ***inter-dependence*** is achieved by the routing of the plumbing circuit such that the hydraulic signals go through both PS&PR Pilots.

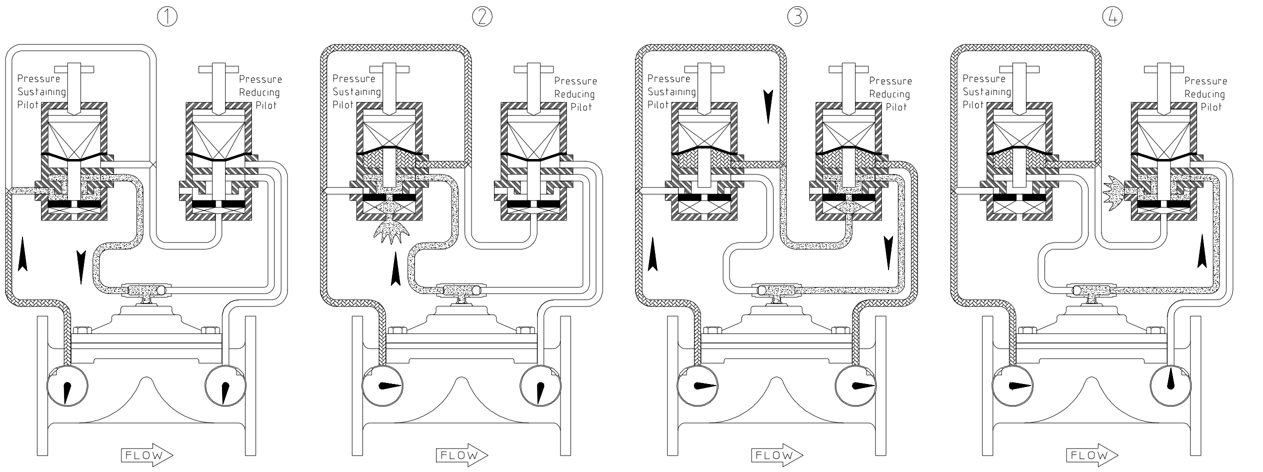


As can be seen in Diagram 1 the upstream port of the valve is in communication with the diaphragm chamber by passing through both pilots. As an over-pressure builds upstream, but downstream has an under-pressure, as in Diagram 2, the diaphragm is relieved of pressure, opening the valve, to reduce that of the upstream. This is the Pressure Sustaining Pilot in action, but it can be seen that even the exhausting action passes through both pilots. As the overall system pressure builds up, the control of the circuit transfers to the Pressure Reducing Pilot, as can be seen in Diagram 3. The PS Pilot is permanently held OPEN by the system pressure and the downstream pressure of the valve is controlled by porting system fluid in and out of the diaphragm chamber by the PR Pilot, as is shown in Diagrams 2 & 3. This continues until a stable downstream pressure is obtained as shown in Diagram 4.

The significant benefit is that the transfer between the PS Pilot to PR Pilot circuit control happens without control interruption as Diagram 2 shows … it is the final condition of the 1 – 2 Pressure Sustaining Control and the starting condition of the 2 – 3 – 4 Pressure Reducing Control; there is no lag.

The detrimental fact is though that it is hard to isolate the 2 control circuits for fault finding, setup and operator instruction upon installation.

The way of ***in-dependence*** is achieved by the routing of the plumbing circuit such that the hydraulic signals of both PS&PR Pilots arrive at the diaphragm chamber independently.



The Pressure Sustaining circuit is shown by Diagrams 1 – 2. The Pressure Reducing circuit is shown by Diagrams 3 – 4. It can be seen in 1 – 2 that the PR Pilot is not activated by any signal from downstream of the valve, allowing the PS Pilot to act. In 3 – 4 it can be seen that system pressure has over-ridden the PS Pilot and it is held fully OPEN to allow the PR Pilot to act. The significant factor is that both circuits are routed through a shuttle tee on the way to the valve diaphragm chamber. Within the shuttle tee there is a ball or shuttle that slides back and forwards under the effects of the differential pressure across it. In so doing it closes the opposing port preventing fluid from going through that port. This is the way the PS & PR circuits are isolated from each other.

The significant benefit is that the 2 circuits are isolated and can operate independently. So for fault finding, setup and operator instruction, one of the lines can be removed from the shuttle tee, to allow either just the PS or PR circuits to operate, without interference of the other circuit.

The detrimental fact is, though, that there is introduced a lag in changeover between the PS & PR circuits. In most situations this will not be a problem, but it can become significant in installations, such as in filter back flushing scenarios, where speed of response to switch back to the sustaining circuit is paramount.

In practice about 14 out of every 15 installations can benefit from using the ***in-dependence*** type of circuit - that uses the shuttle tee. In the rest there is a need, due to extenuating circumstances, to go the ***inter-dependence*** circuit route.

Recommended system control method selection table

The following table is a summary of all the available setup variations and can be used as a selection method to determine which is the most appropriate setup.

Just answer the questions in order 1 – 4. At each question select the most appropriate answer YES or NO and jump down to that column from the previous answer. That way you will arrive at a Circuit Number at the bottom of the table that corresponds to the correct Plumbing Diagram on the following pages.

<table>
<tr><th colspan="18">PS&PR Pilot & Circuit Selection</th></tr>
<tr><td>1</td><td>Is the Valve Bore 100mm or smaller?</td><td colspan="8">YES
(Small Pilots)</td><td colspan="8">NO
(Large Pilots)</td></tr>
<tr><td>2</td><td>Is the water supply Temperature < 40°C and Pressure < 980kPa or is there a special corrosion resistance requirement? (special consideration needed?)</td><td colspan="4">YES
(Plastic Pilots)</td><td colspan="4">NO
(Brass Pilots)</td><td colspan="4">YES
(Plastic Pilots)</td><td colspan="4">NO
(Brass Pilots)</td></tr>
<tr><td>3</td><td>Is the Pressure Drop across the valve expected to be < 200kPa or will the Supply Filter have a mesh size > 100µm?</td><td colspan="2">YES
(3Way Pilots)</td><td colspan="2">NO
(2Way Pilots)</td><td colspan="2">YES
(3Way Pilots)</td><td colspan="2">NO
(2Way Pilots)</td><td colspan="2">YES
(3Way Pilots)</td><td colspan="2">NO
(2Way Pilots)</td><td colspan="2">YES
(3Way Pilots)</td><td colspan="2">NO
(2Way Pilots)</td></tr>
<tr><td>4</td><td>Is installation diagnostics and fault finding deemed more important than the speed of response in switching back from the PR to PS circuit?
(Yes = + Shuttle Tee)
(No = - Shuttle Tee)</td><td>Y</td><td>N</td><td>Y</td><td>N</td><td>Y</td><td>N</td><td>Y</td><td>N</td><td>Y</td><td>N</td><td>Y</td><td>N</td><td>Y</td><td>N</td><td>Y</td><td>N</td></tr>
<tr><td>Step</td><td>Circuit Number</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>11</td><td>12</td><td>13</td><td>14</td><td>15</td><td>16</td></tr>
</table>

Can't implement due to non-removable integral restrictor. (Circuits 3, 4)

Not manufactured. (Circuits 9, 10, 11, 12)

~ CIRCUIT 1 ~

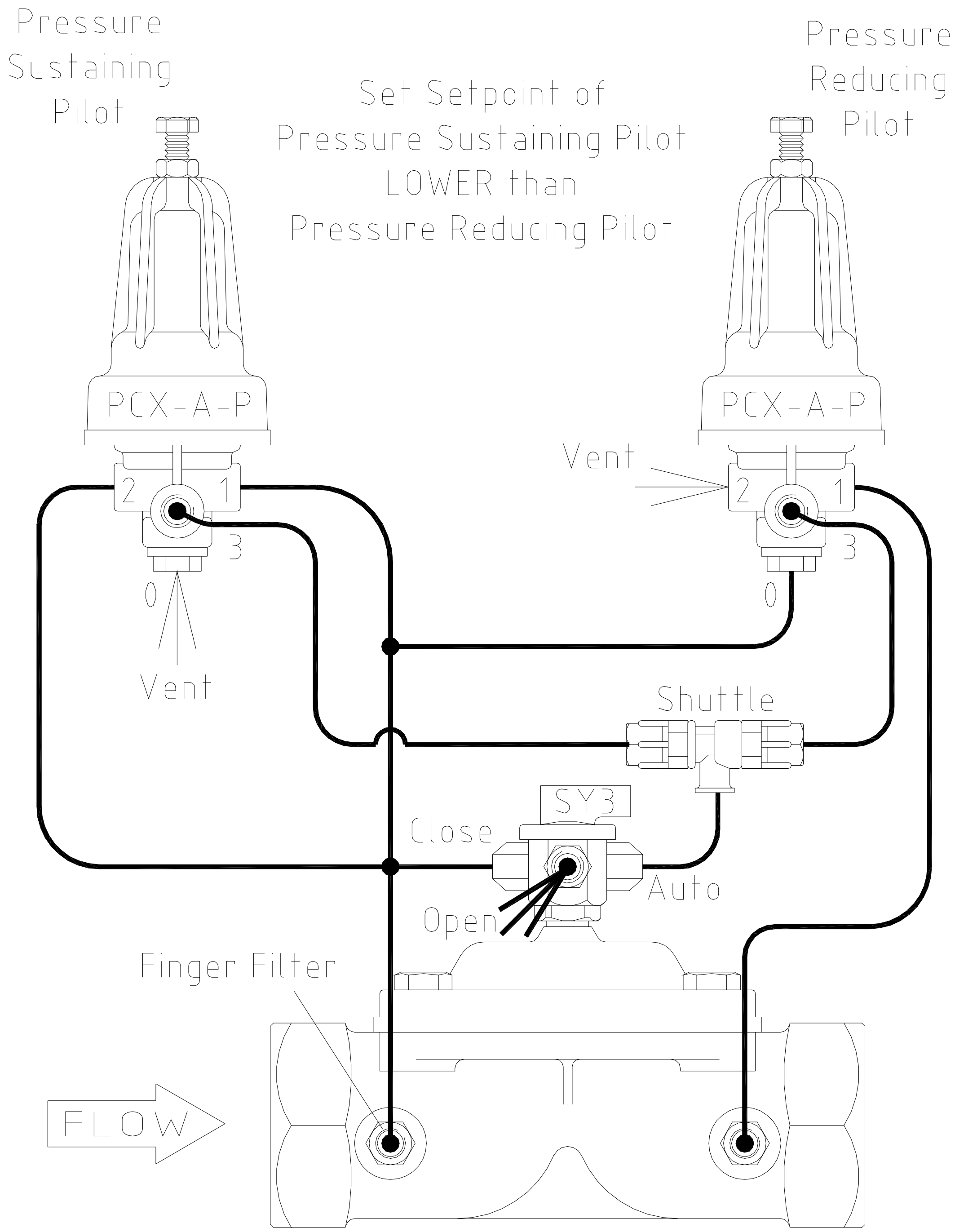
PS&PR01

PMB 51 Mannum
South Australia 5238
ph. (08) 8570 4251
fax. (08) 8570 4180

Manual, Pressure Sustaining & Reducing Valve

Tap ~ SY3

Pilots ~ Bermad, Plastic, 3 Way, PC–X–A–P



~ CIRCUIT 2 ~

EMFLOW

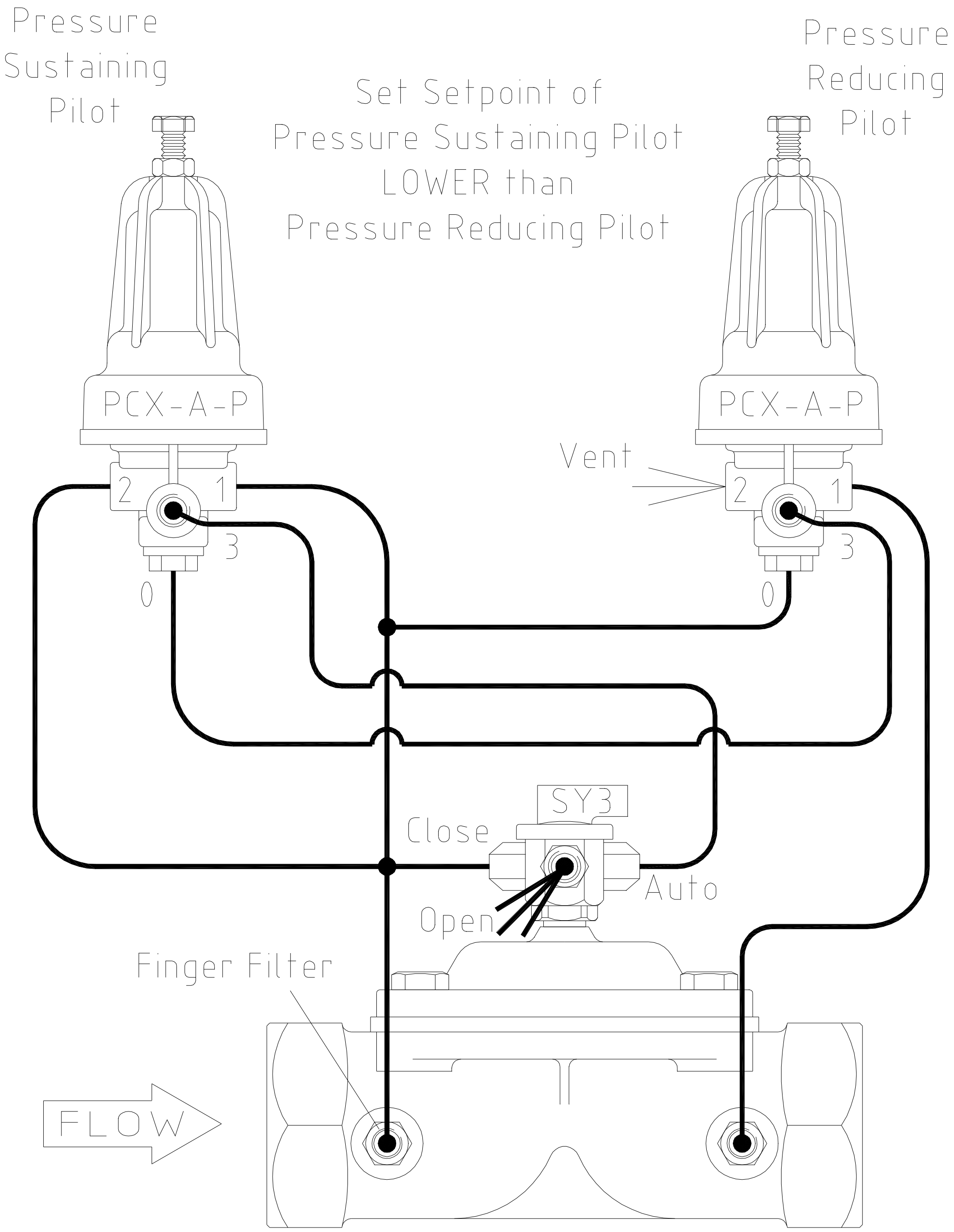
PS&PR02

PMB 51 Mannum
South Australia 5238
ph. (08) 8570 4251
fax. (08) 8570 4180

Manual, Pressure Sustaining & Reducing Valve

Tap ~ SY3

Pilots ~ Bermad, Plastic, 3 Way, PC-X-A-P



~ CIRCUIT 5 ~

EMFLOW

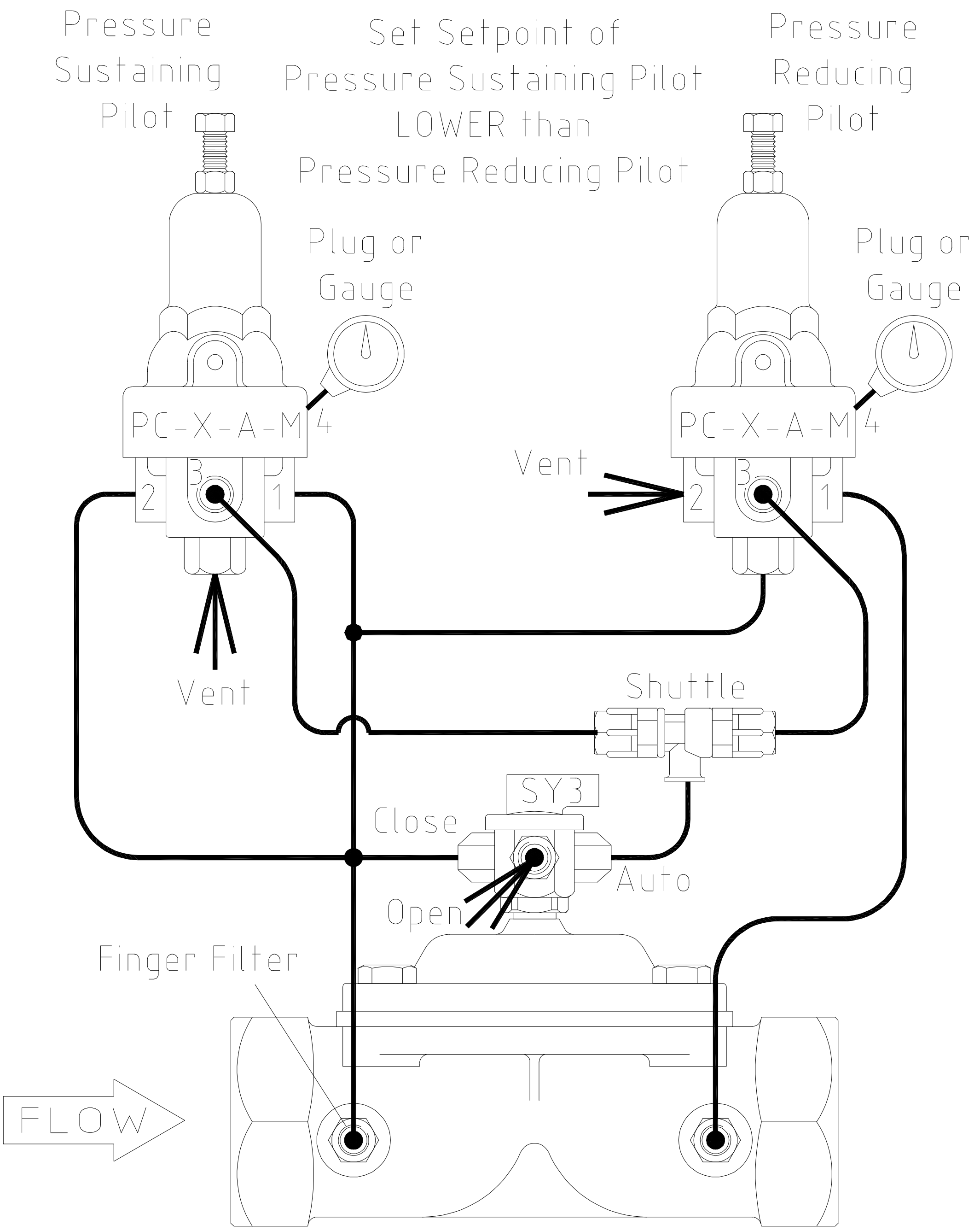
PS&PR05

PMB 51 Mannum
South Australia 5238
ph. (08) 8570 4251
fax. (08) 8570 4180

Manual, Pressure Sustaining & Reducing Valve

Tap ~ SY3

Pilots ~ Bermad, Brass, 3 Way, PC–X–A–M



~ CIRCUIT 6 ~

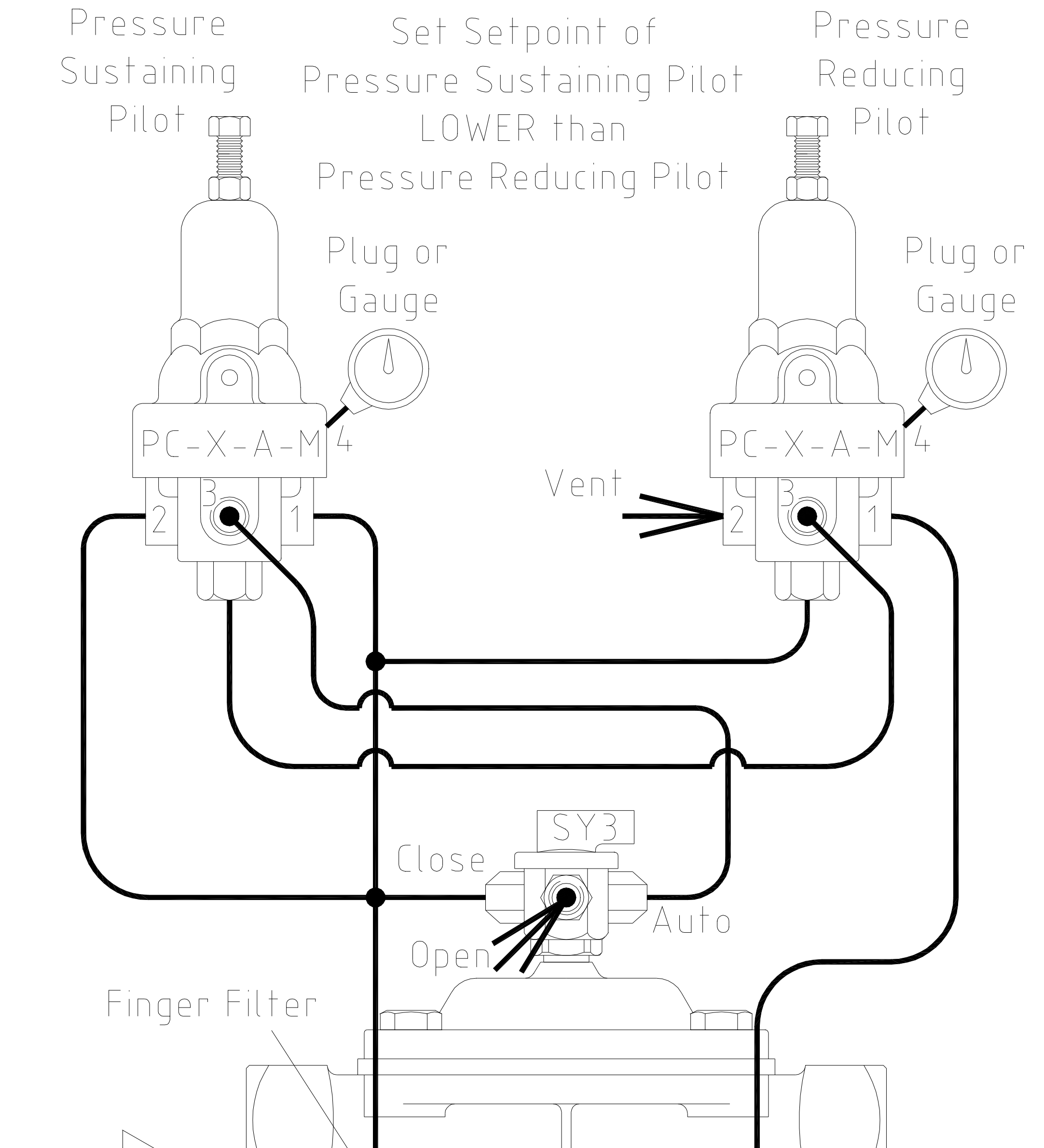
PMB 51 Mannum
South Australia 5238
ph. (08) 8570 4251
fax. (08) 8570 4180

PS&PR06

Manual, Pressure Sustaining & Reducing Valve

Tap ~ SY3

Pilots ~ Bermad, Brass, 3 Way, PC-X-A-M



~ CIRCUIT 7 ~

EMFLOW

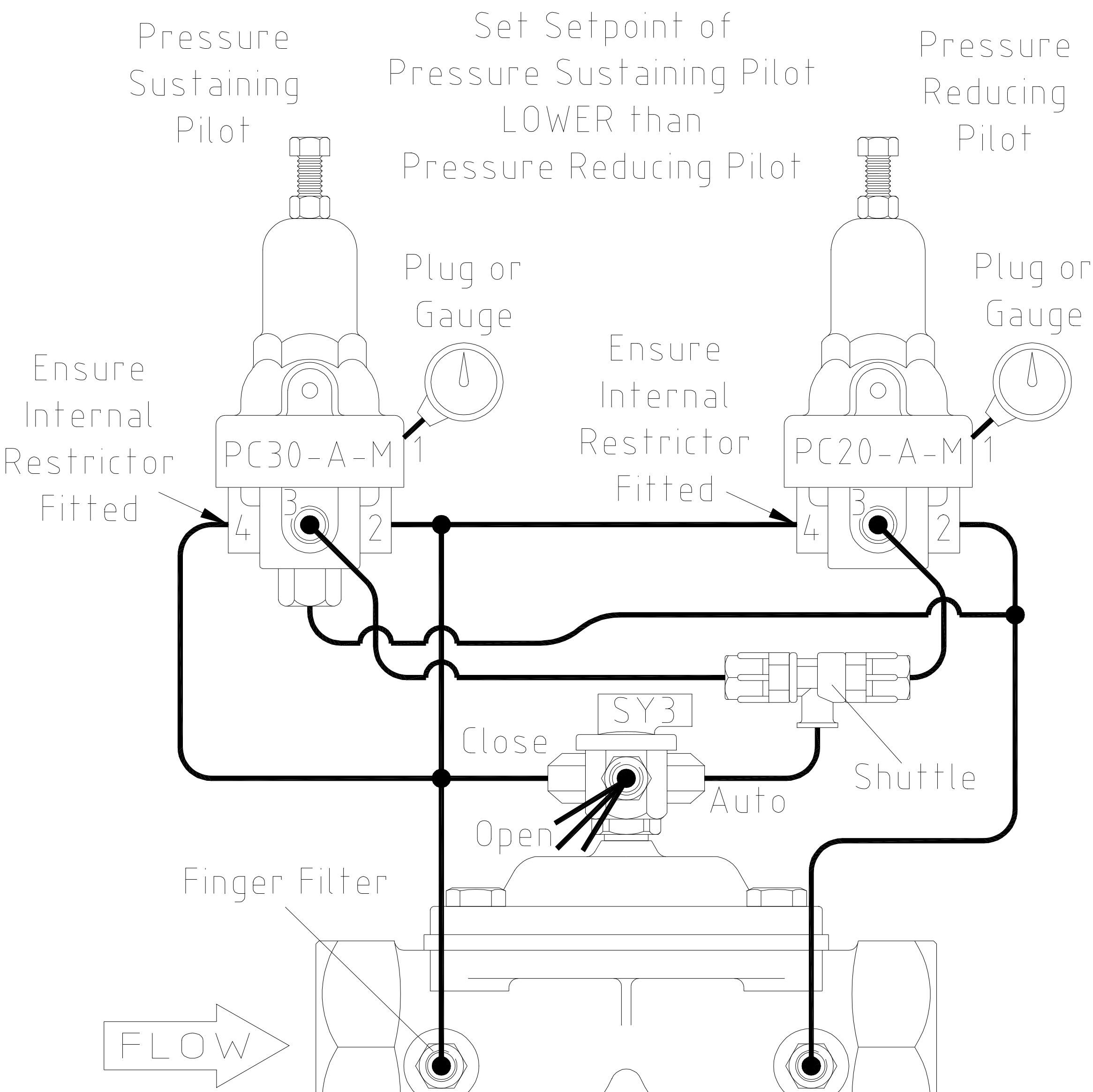
PS&PR07

PMB 51 Mannum
South Australia 5238
ph. (08) 8570 4251
fax. (08) 8570 4180

Manual, Pressure Sustaining & Reducing Valve

Tap ~ SY3

Pilots ~ Brass, 2 Way, PC–30–A–M & PC–20–A–M



~ CIRCUIT 8 ~

EMFLOW

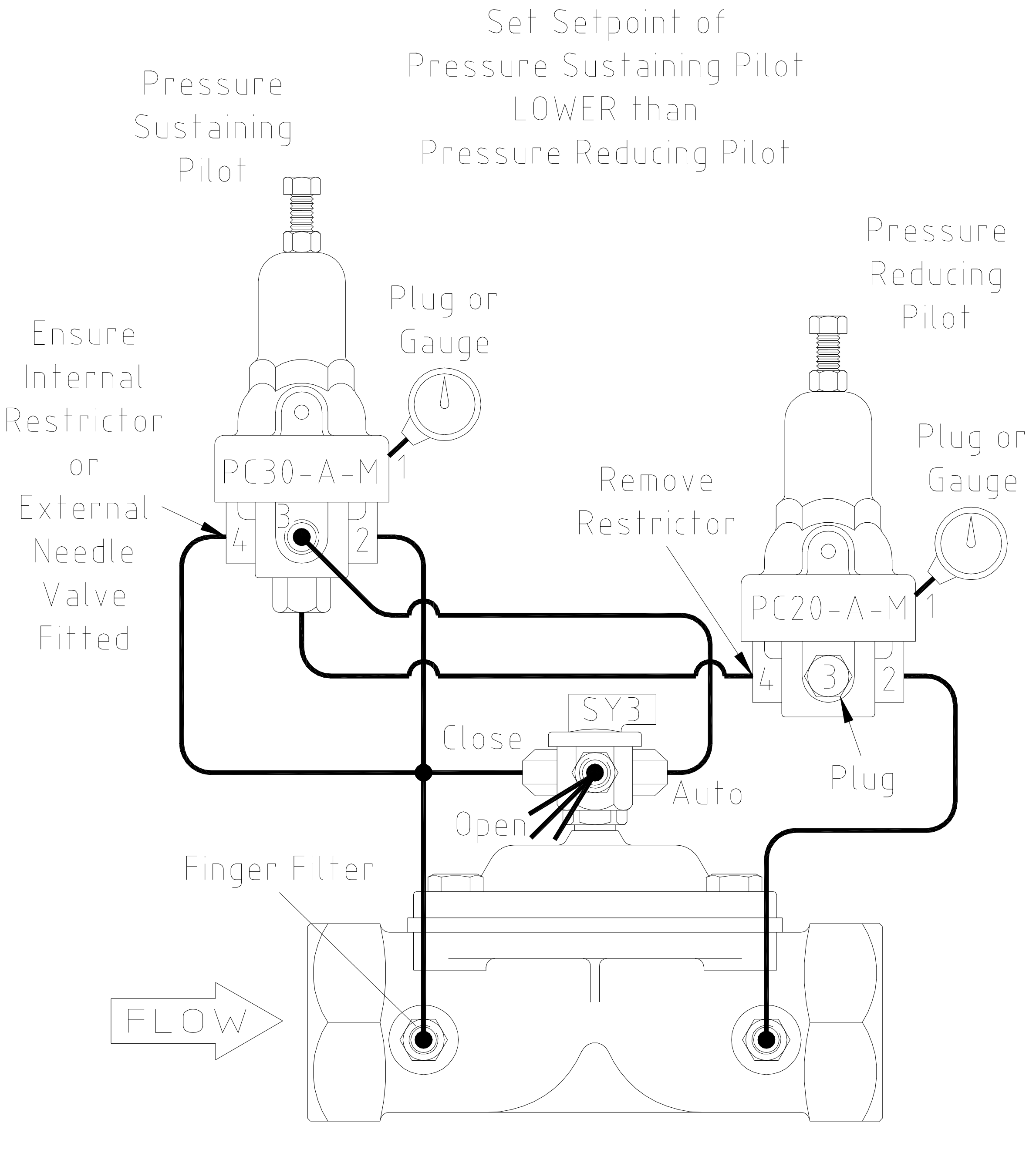
PS&PR08

PMB 51 Mannum
South Australia 5238
ph. (08) 8570 4251
fax. (08) 8570 4180

Manual, Pressure Sustaining & Reducing Valve

Tap ~ SY3

Pilots ~ Brass, 2 Way, PC–20–A–M & PC–30–A–M



~ CIRCUIT 13 ~

EMFLOW

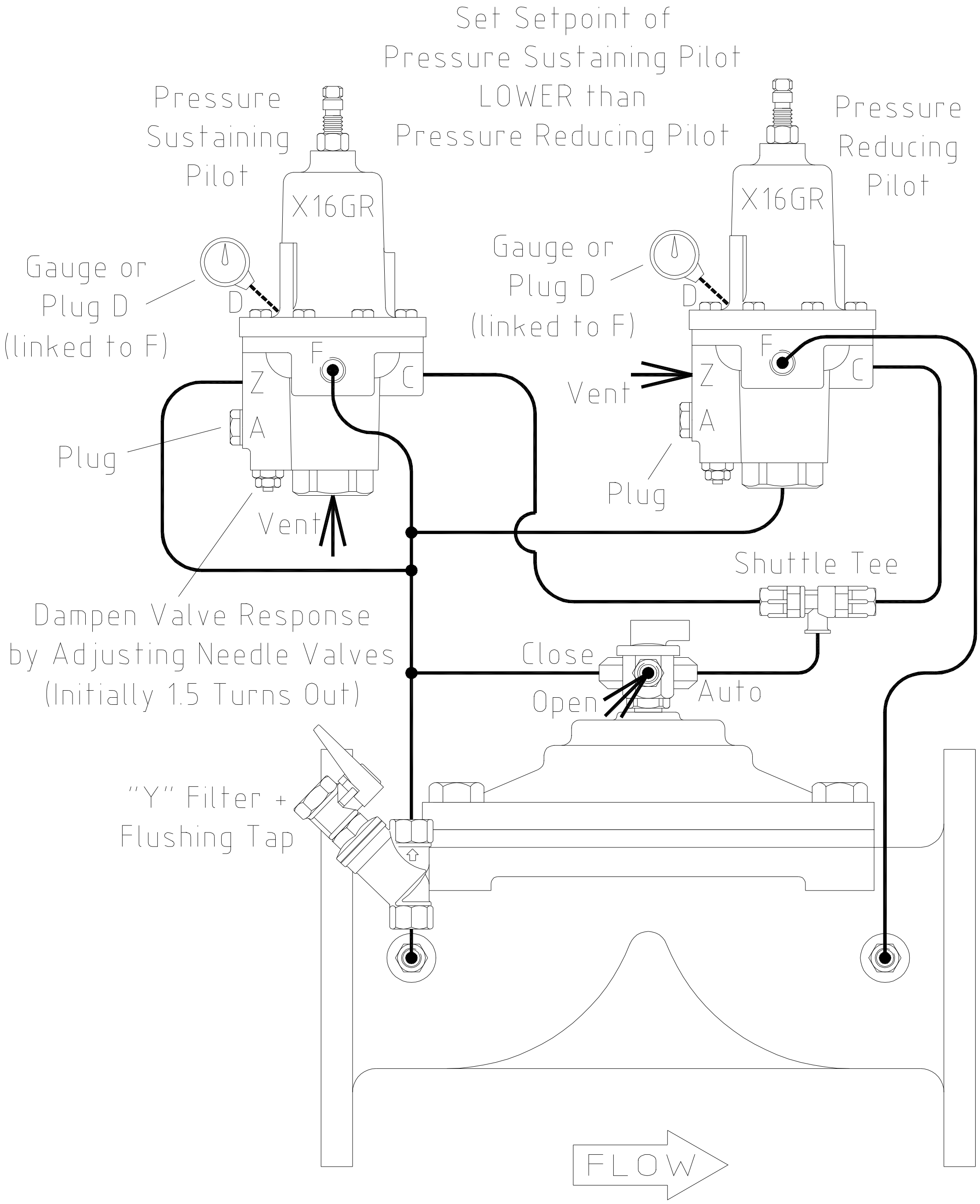
PS&PR13

PMB 51 Mannum
South Australia 5238
ph. (08) 8570 4251
fax. (08) 8570 4180

Manual, Pressure Sustaining & Reducing Valve

Tap ~ SY6

Pilots ~ Bermad, Brass, 3 Way, #X-16-G-R



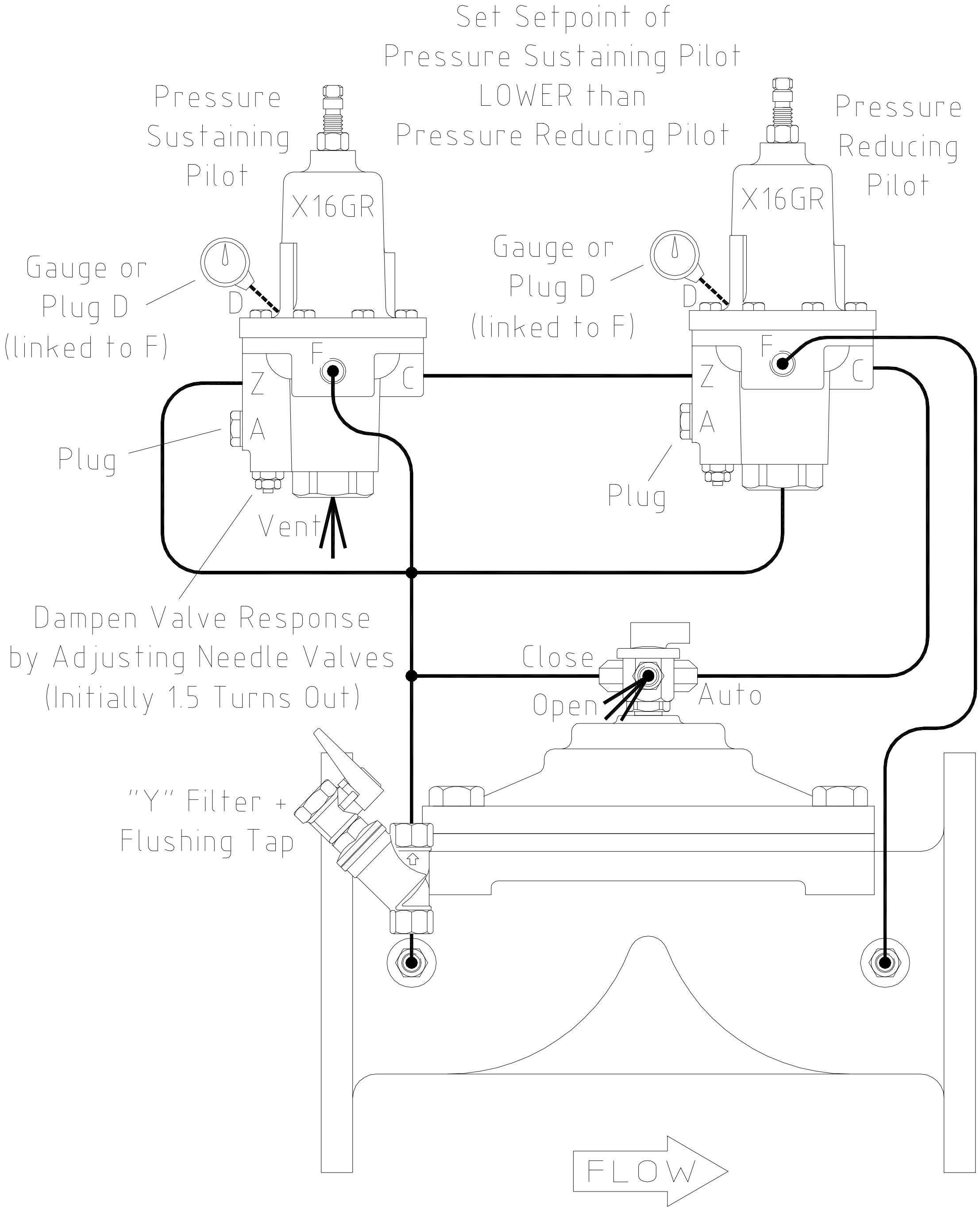
~ CIRCUIT 14 ~

EMFLOW

PS&PR14

PMB 51 Mannum
South Australia 5238
ph. (08) 8570 4251
fax. (08) 8570 4180

Manual, Pressure Sustaining & Reducing Valve
Tap ~ SY6
Pilots ~ Bermad, Brass, 3 Way, #X-16-G-R



~ CIRCUIT 15 ~

EMFLOW

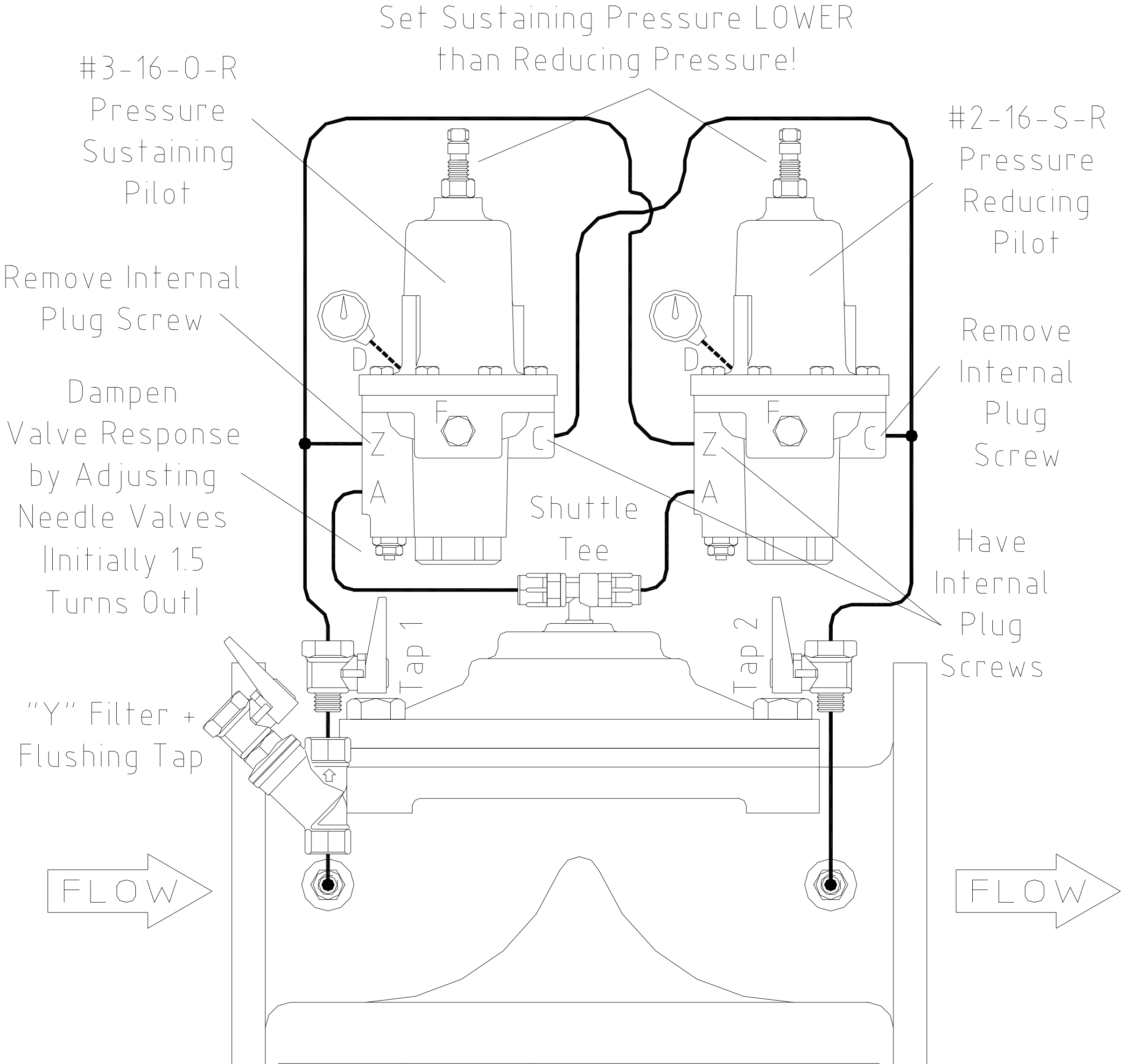
PS&PR15

PMB 51 Mannum
South Australia 5238
ph. (08) 8570 4251
fax. (08) 8570 4180

Manual, Pressure Sustaining & Reducing Valve

Tap ~ 2 x Sagiv

Pilots ~ Brass, 2 Way, #3–16–O–R & #2–16–S–R



Tap 1	Tap 2	Result
Open	Open	Control Circuit ACTIVE
Open	Closed	Valve Fully CLOSED
Closed	Open	Valve Fully OPEN
Closed	Closed	Control Circuit FROZEN

~ CIRCUIT 16 ~

EMFLOW

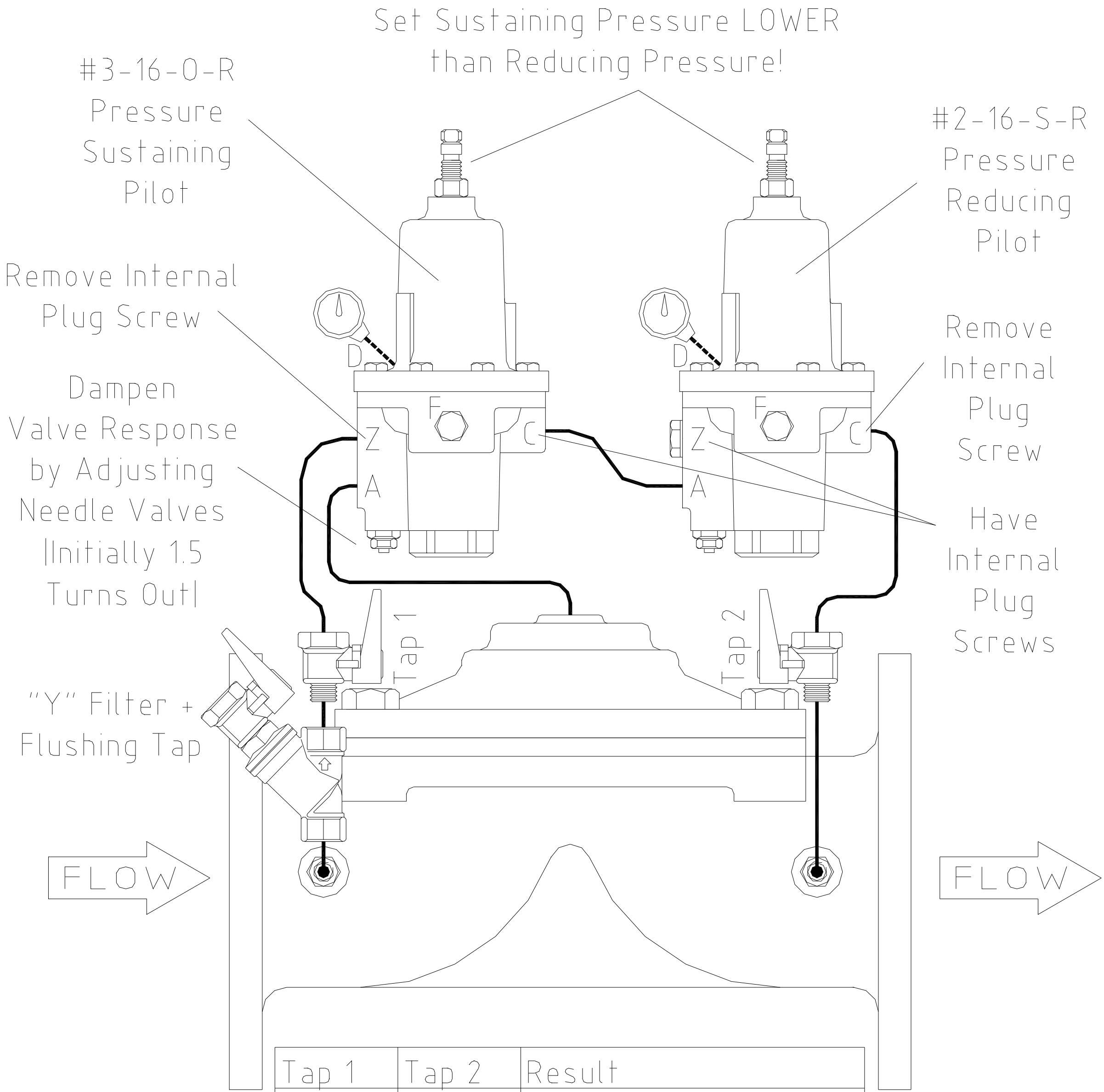
PS&PR16

PMB 51 Mannum
South Australia 5238
ph. (08) 8570 4251
fax. (08) 8570 4180

Manual, Pressure Sustaining & Reducing Valve

Tap ~ 2 x Sagiv

Pilots ~ Brass, 2 Way, #3–16–O–R & #2–16–S–R



Tap 1	Tap 2	Result
Open	Open	Control Circuit ACTIVE
Open	Closed	Valve Fully CLOSED
Closed	Open	Valve Fully OPEN
Closed	Closed	Control Circuit FROZEN

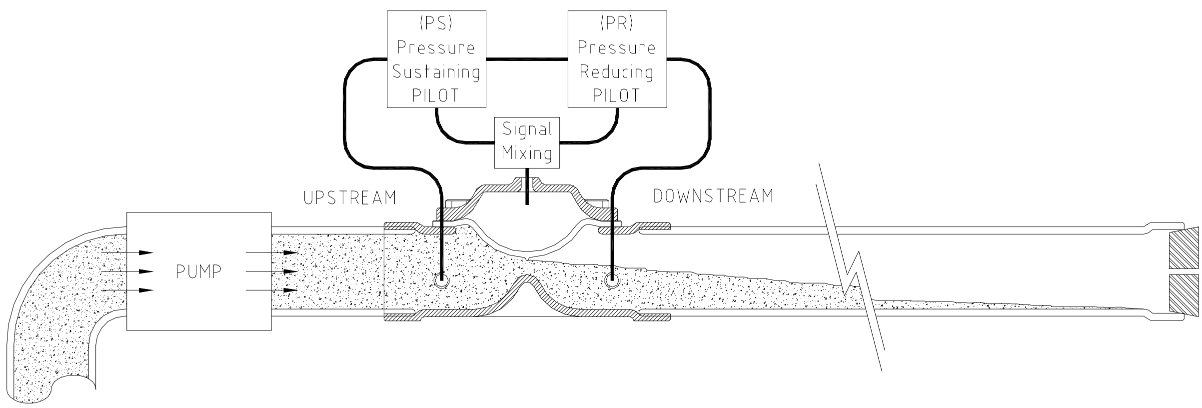
EMFLOW VALVES

PMB 51 Mannum SA 5238
Ph: (08) 8570 4251
Fax: (08) 8570 4180

Setup Instructions for :-
Pressure Sustaining & Reducing Valves
Using Bermad Pilots

These instructions should be paired with one of the range of drawings - PS&PR1 to PS&PR16.

A basic PS&PR circuit –



In this style of installation where the valve is to control the output pressure of the pump and the pressure of that which is going down the pipe …

The main purpose for the **Pressure Sustaining** side of the circuit is to ensure that some pressure is "sustained" between the pump and the valve at all times so that the pump doesn't over-speed in trying to fill empty pipelines and consequently burnout or reduce pump outlet velocity minimizing the possibility of cavitation damage.

The **Pressure Reducing** side of the circuit is to "reduce" the supply pressure from the pump to a line pressure that is more suitable for operation of down stream equipment – sprinklers etc.

The adjustment procedure is as follows :-

1. Look at supplied plumbing diagram to get a feel for the overall system layout.
2. Ensure that your circuit is plumbed the same way.
3. Install 2 pressure gauges, 1 just upstream of the valve and 1 just down stream of the valve. Ideally they should be 10 pipe diameters either side of valve. As a "general" indicator though, the gauges can be attached to the piping that comes from the ports of the valve, or to the pilots ports as indicated on some diagrams.

Adjustment of the Pressure Sustaining Pilot 1st :-

4. Determine the desired Reduction Pressure (RP), downstream of the valve, required for optimal system performance.
5. Calculate 80% of the RP (determined in step 4) to give the maximum Sustaining Pressure (SP) that is desirable, upstream of the valve - it can be less, but no more! Sometimes pump efficiency curves are used to find the most "efficient" SP – ensuring that it remains below the SP calculated.
6. Then calculate 80% of the SP (determined in step 5) and call that the Maximum Filling Pressure (MFP).
7. Ensure that the pipeline downstream of the valve can flow freely and not exceed the MFP. This is important! If this cannot be achieved then it will be impossible to setup the Pressure Sustaining Pilot correctly!

   It is desirable to have NO pressure buildup e.g. as at startup - due to pipeline filling. But, in practice this may be difficult; so it is permissible, for initial setting purposes, to allow a pressure buildup to MFP and then double check the SP the next time the system is started with the pipe empty.

8. Loosen the locknuts of the pressure adjustment bolts located on the top of both pilots.
9. Turn Pressure Adjustment Bolt of the **Pressure Reducing Pilot** all the way **IN**.
10. Turn Pressure Adjustment Bolt of the **Pressure Sustaining Pilot** all the way **OUT**.
11. Start the pump. Do not run the pump for too long in this condition – there will be very little back pressure. Keep an eye on the current draw of the motor and its temperature if possible. Additionally keep an eye on the downstream pressure to make sure it remains below the MFP.
12. Adjust the **Pressure Sustaining Pilot** by screwing its Pressure Adjustment Bolt **IN** to arrive at your pre-determined SP.

Adjustment of the Pressure Reducing Pilot 2nd :-

13. Now the pipelines downstream of the valve will be filling with water. To be able to adjust the Pressure Reducing Pilot it is necessary to wait and ensure that the system is full of water and running under normal conditions e.g. Sprinklers are going etc.

    WARNING - The pressure going to the sprinklers could go VERY HIGH at this point - if care isn't taken (possibly upto the maximum pressure that the pump can supply!).

14. Adjust the **Pressure Reducing Pilot** by screwing its Pressure Adjustment Bolt **OUT** to arrive at your pre-determined RP. It would be advisable to start screwing the bolt out when it is observed that the MFP is reached so that the system pressure will be limited from overshooting the RP too severely and damaging pipelines or associated equipment downstream.
15. Tighten the locknuts on both Pressure Adjustment Bolts to hold settings.
16. Double check the PS level at next system startup - when pipes are empty, to ensure it is set accurately.