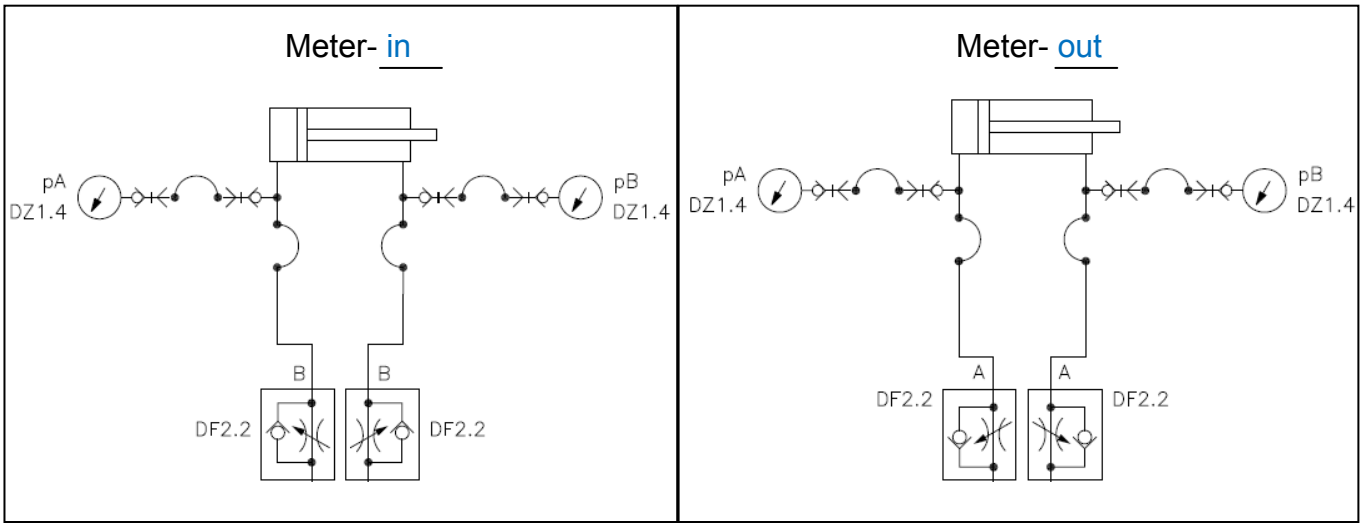
Meter-in vs meter-out flow control

Description of experiment

In order to have adjustment of a cylinder speed in both directions it is necessary to install a throttling valve in the line supplying each end of the hydraulic cylinder. The throttle valves can be installed such that they control the oil flow going into the actuator (meter-in) or they control the oil flow coming out of the actuator (meter-out). The application and type of load determine the selection of meter-in vs. meter-out orientation.

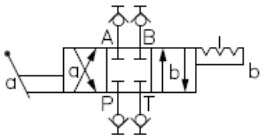
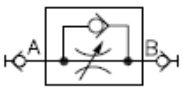
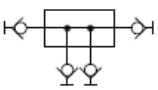
Description of exercise

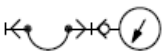
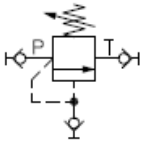
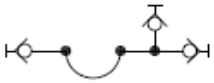
In the following schematics a double acting single rod cylinder connected to a 4/3-directional control valve. In one circuit the throttle valves in the cylinder lines are oriented in a meter-out configuration and in the other the throttle valves in the cylinder lines are oriented in a meter-in configuration.



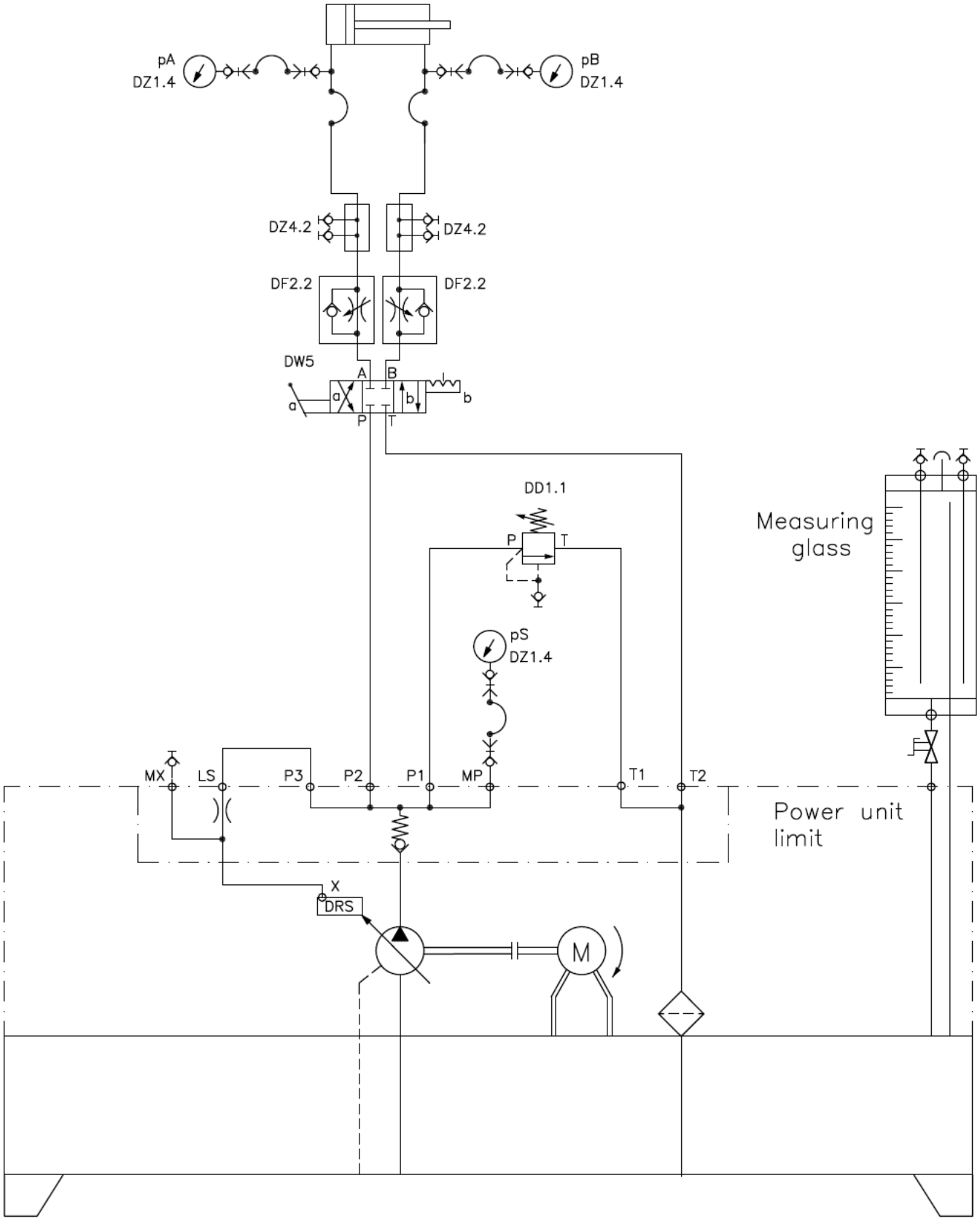
Components:

You will require the following components:

	Hose assembly	
1x	Directional control valve DW5 (part II)	
1X	Throttle check valve DF2.2	
2X	Connection piece DZ4.2	

3x	Pressure gauge DZ1.4	
1X	Pressure relief valve DD1.1	
2X	Pressure hose with gauge connection	

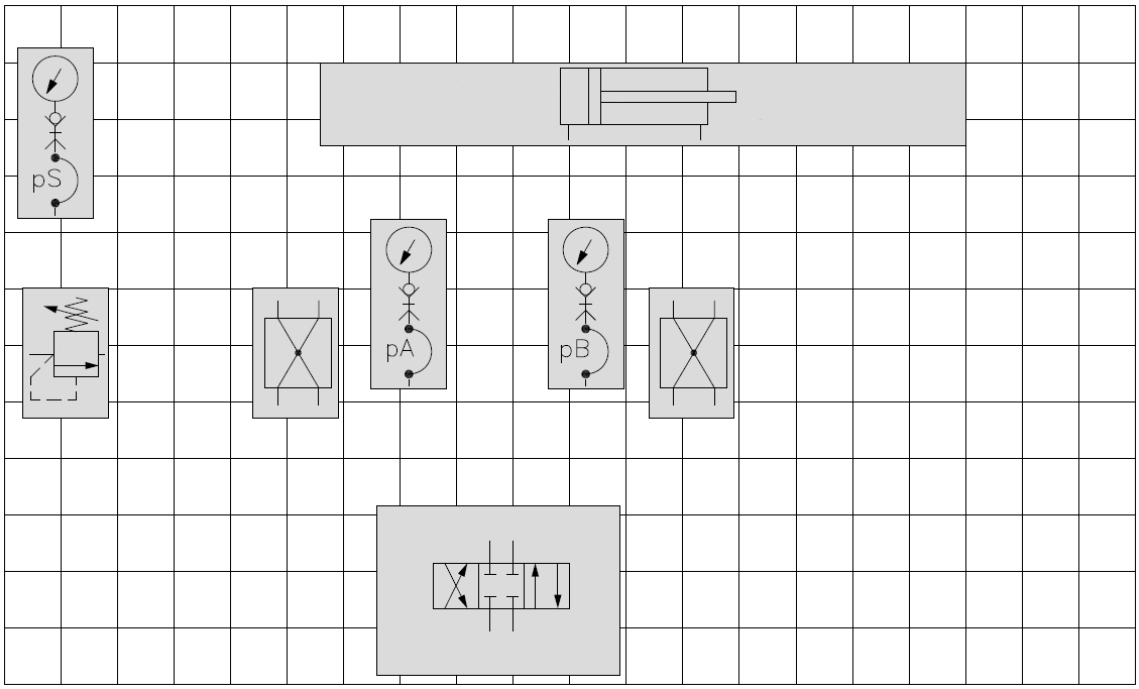
Part I – Meter-in



Before beginning the experiment read the **Rules for hydraulic trainer operation** sheet.

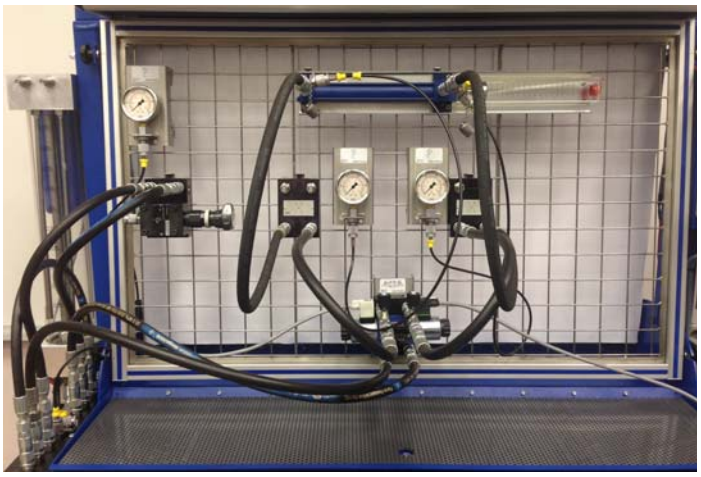
Experiment – Part I meter-in

Experimental Layout



Meter-in

Meter-out



Setting up the experiment

Set up the circuit observing the following points:

1. Make sure the pump is switched off and the hydraulic circuit is not pressurized.
2. Mount the required components on the grid and lock them
3. Connect the separate units with pressure hoses according to the meter-in connection diagram. Take care that the connection hoses are not kinked or under undue stress. Ensure that the pressure gauges pA and pB are located between the cylinder and the throttle valve so that the cylinder pressure can be seen

Experimental procedure

Steps in the experimental procedure:

1. Has your instructor checked the constructed circuit?
2. Check again that all connection hoses are firmly coupled. (pull/turn to test)
3. Back out the setting (CCW) of relief valve DD1.1 until a setting of zero. This will ensure that there is minimum pressure at start-up
4. Ensure the red E-STOP button is not engaged on either of the starters. (rotate the button to reset)
5. Switch on the pump via the green START push button

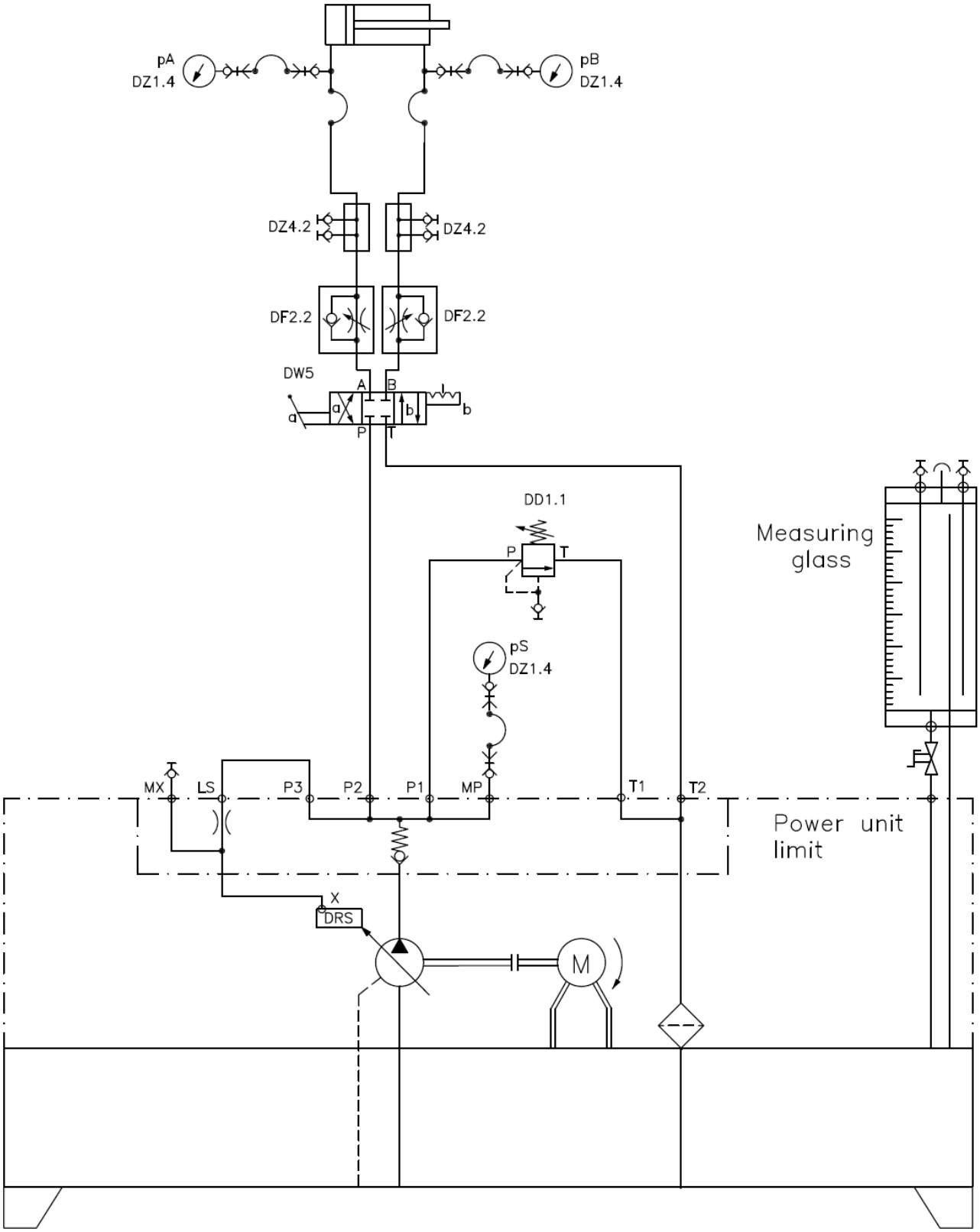
   Exercise a
6. With the 4/3 directional valve in the centre condition (position 0) set the system pressure to 600 psi via the pressure relief valve DD1.1
7. By operating the directional control valve extend and retract the cylinder and adjust the throttle valves to achieve extension in 4 seconds and retraction in 2 seconds
8. Measure the pressure readings at the various gauges while extending and retracting the cylinder and record these in the corresponding table

   Exercise b
9. With the 4/3 directional valve in the centre condition (position 0) set the system pressure to 300 psi via the pressure relief valve DD1.1. **Do no**t change the settings of the throttle valves from exercise a
10. Extend and retract the cylinder and record the new times as well as the pressure values in the corresponding table

	System pressure pS 600 psi		System pressure pS 300 psi	
	Extending	Retracting	Extending	Retracting
Time s (sec)	4 seconds	2 seconds	5.7 seconds	2.8 seconds
System pressure pS (psi)	580	575	300	300
Rod end pressure pB (psi)	30	150	25	125
Cap end pressure pA (psi)	0	10	0	0

Table: Part I – Meter-in

Part II - Meter-out



Part II Meter-out

1. Connect the separate units with pressure hoses according to the meter-out connection diagram. Take care that the connection hoses are not kinked or under undue stress. Ensure that the pressure gauges pA and pB are located between the cylinder and the throttle valve so that the cylinder pressure can be seen

Exercise a

2. With the 4/3 directional valve in the centre condition (position 0) set the system pressure to 600 psi via the pressure relief valve DD1.1
3. By operating the directional control valve extend and retract the cylinder and adjust the throttle valves to achieve extension in 4 seconds and retraction in 2 seconds
4. Measure the pressure readings at the various gauges while extending and retracting the cylinder and record these in the corresponding table

Exercise b

5. With the 4/3 directional valve in the centre condition (position 0) set the system pressure to 300 psi via the pressure relief valve DD1.1. **Do no**t change the settings of the throttle valves from exercise a
6. Extend and retract the cylinder and record the new times as well as the pressure values in the corresponding table

	System pressure pS 600 psi		System pressure pS 300 psi	
	Extending	Retracting	Extending	Retracting
Time s (sec)	4 seconds	2 seconds	8 seconds	3.5 seconds
System pressure pS (psi)	580	580	290	290
Rod end pressure pB (psi)	860	540	420	280
Cap end pressure pA (psi)	520	540	260	130

Table: Part II – Meter-out

Evaluation

What happened to the cylinder speed when the system pressure was lowered from 600 to 300 psi? Why?

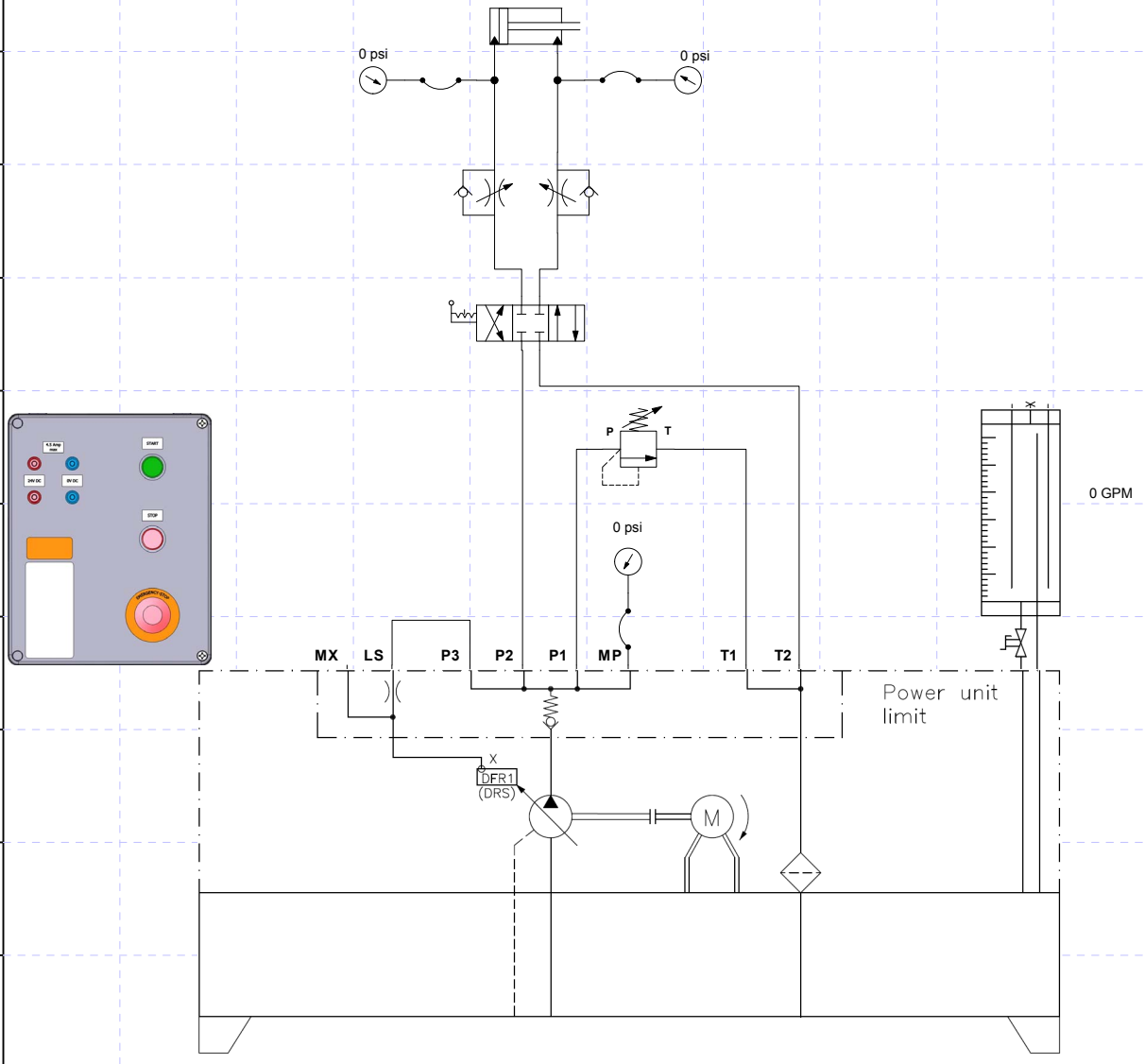
The cylinder slowed down because there is less pressure drop across the throttle valves

Briefly explain why there are such large differences in the pressure readings between the meter-in and meter-out circuits.

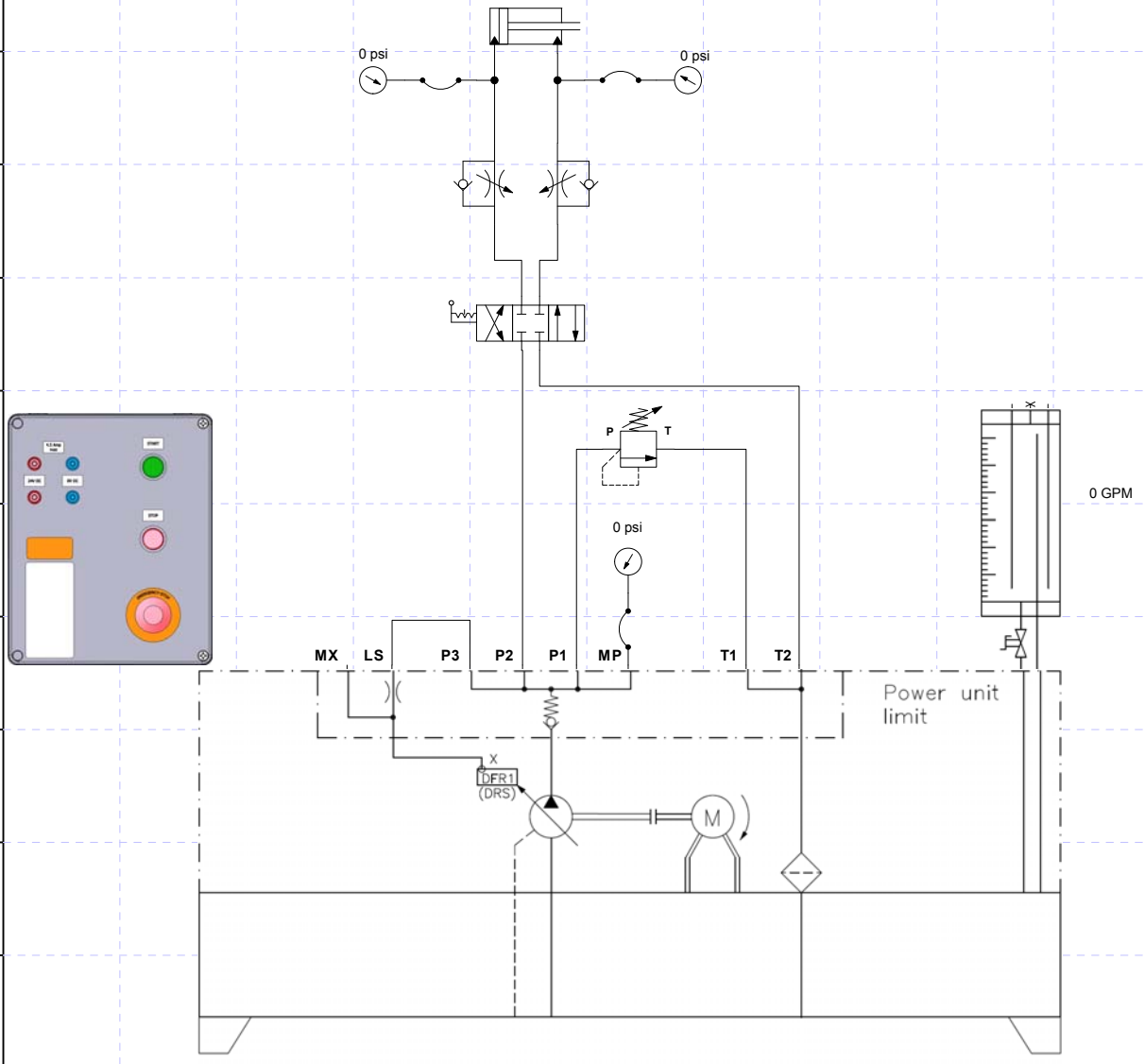
Neither circuit had any load on the cylinder and therefore very low load induced pressure. In the meter out circuit the throttle valves were causing an artificial load (back pressure) on the hydraulic cylinder.

What is causing the high pressure reading at the rod end of the cylinder in the meter-out circuit?

Pressure intensification caused by the meter-out throttle valve is causing the high pressure



Meter-in vs. Meter-out Part I



Meter-in vs. Meter-out Part II