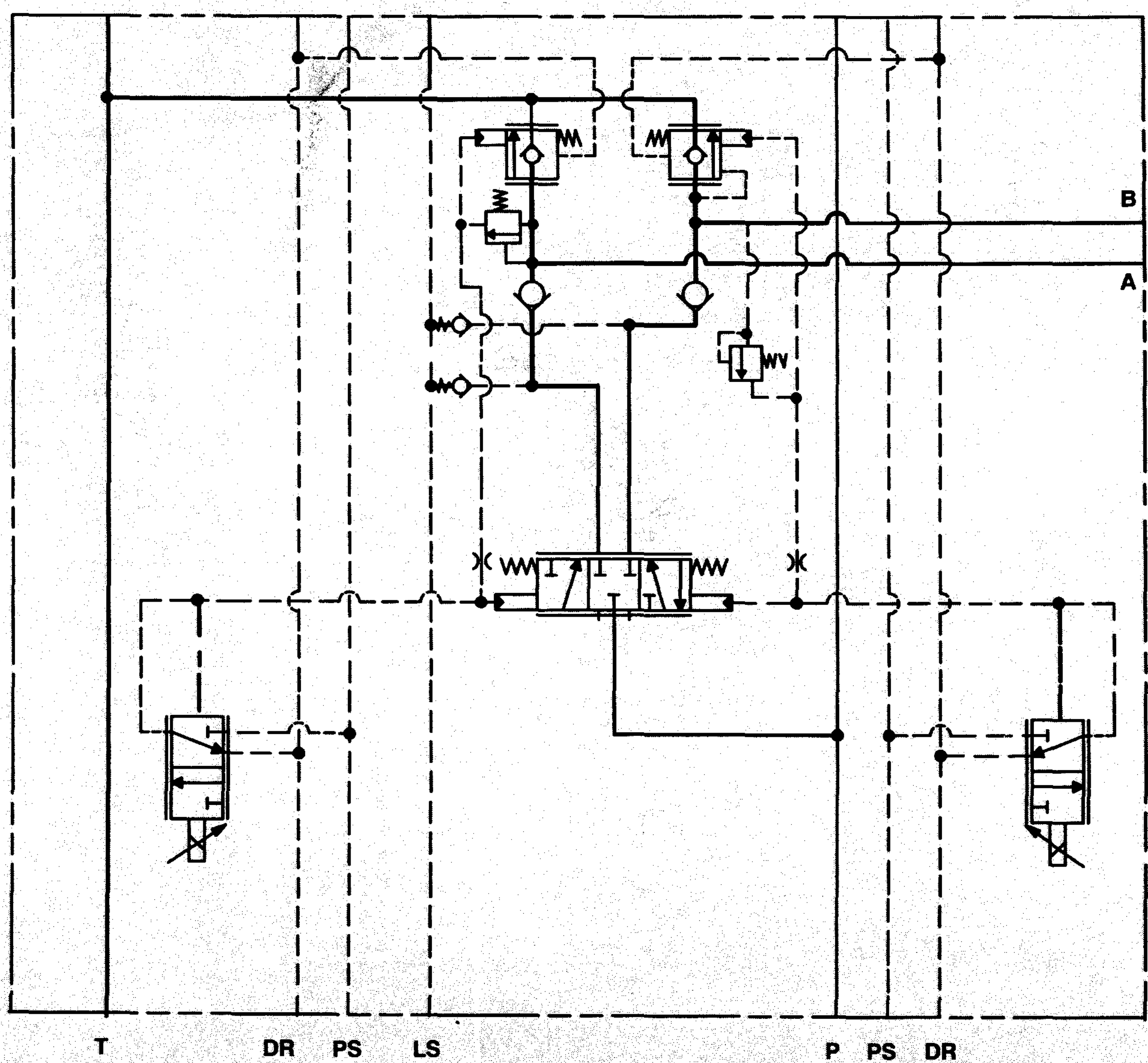
VICKERS

CMX System Start–Up & Trouble Shooting Guide



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Contents

Listing Of Publications Referenced In The Text:

I–1221–S	Preparation Of Pipes, Tubes and Fittings Before Installation In A Hydraulic System
I–3988–S	General Hydraulic Hints
536	CMX Sectional Controls Applications Guide
559	Fluid Analysis Service
559A	How To Take A Fluid Sample
561	Guide To Systemic Contamination Control
562	How To Take A Fluid Test Sample With The Vickers Vacuum Pump

Introduction

One of the significant strengths of CMX series valves is the flexibility of their design and performance through the simple interchange of non–select fit parts. This permits the easy and rapid change out of meter–in and/or meter–out elements to tailor the performance characteristics of the valve to precisely match the application requirements of any specific vehicle/machine hydraulic systems. This is particularly advantageous during prototype vehicle/machine start–ups where, on numerous occasions, the CMX has successfully demonstrated its ability to reduce start–up times from 6 to 18 months down to 1 or 2 weeks. This provides your customers with the opportunity for significant savings, not only in time, but in engineering costs and making manpower available for new projects. Another strength of the CMX valve is that it is a valve subsystem that performs a number of precision control functions and not a single function valve. This affords your customers opportunities for additional cost savings through the elimination of hose, fittings and installation time to connect a series of single function valves into an equivalent valve subsystem. As the market continues to understand and appreciate these benefits our field population is growing.

With this growth there has been the natural increase in requirements for assistance in system start up. Due to the compound nature of the CMX valve this has generated several problems where this was either a first time installation or there was limited background and experience in the application and use of CMX valves. To minimize future problems of this nature we have drawn upon our experiences and knowledge gained in both The Americas and European markets to prepare this Start–up And Trouble Shooting Guide. We believe this will not only assist first time users, but also those who are applying CMX valves in new application areas.

Support Equipment

Minimum Recommended Support Equipment For System Start–up & Trouble Shooting

As a minimum, the following items should be available for vehicle/machine hydraulic system start–up and for any possible trouble shooting:

- Pressure gages: 2 – High pressure gages 0–5000 psi (0–350 bar)
  3 – Low pressure gages 0–600 psi (0–45 bar)
- Digital Multi–meter suitable to read voltage, current and frequency. Should be similar to Fluke Model 87 or equivalent. Our field experience indicates Model 87 is used extensively throughout the industry. Note: Electrical measurements should include the solenoid coil as the load.
- Hand pump suitable for 100–500 psi (7–35 bar)

Measuring Equipment That Would Be Helpful In Addition To The Above Minimum Recommended Equipment:

- Transient pressure transducer
- Full 4 – 6 channel portable recorder, DC operated, minimum 100 Hz and at least 300 Hz response

In addition, for those instances where this is the initial start up of a newly designed system, advantage should be taken of the "user friendly" flexibility and versatility of the CMX valve. There are no select fit parts used in the CMX series valves. This permits easy and rapid change out, as may be required, of meter–in and meter–out elements in order to fine tune the CMX valve to the system during the prototype start up phase. Changes to different flow or pressure control meter–in spools, pressure feedback options, meter–in cracking pressure, meter–out function including gain and ΔP can be made in a matter of minutes. To take advantage of this, we suggest an assortment of both meter–in and meter–out elements be available as part of any system start up support material.

For prototype applications using HRC controls, it is suggested adjustable HRC spring capsule stops be used. These will permit maximizing flow and determining the required spring capsule range for production units.

Start–Up Procedure & Check List

The following steps have been designed as a guide in starting up hydraulic systems in which one or more banks of CMX valves are used. It is to be used as a step by step sequential check list to ensure trouble free operation of the hydraulic system prior to shipment.

1. Ensure all lines, fittings and the reservoir have been properly cleaned prior to their installation on the vehicle/machine. Reference Service Drawings I–1221–S and I–3998–S.
2. Ensure the cases of all piston pumps and motors are filled with oil.
3. Install pressure gages at critical test points. Normally 5 gages – 2 high pressure (0 to 5000 psi/0 to 350 bar) and 3 low pressure (0 to 600 psi/0 to 45 bar) – are the minimum number required to enable satisfactory measurement of the various pressure line, pilot line, load sensing line and drain line pressure levels during system operation.
4. Fill and check the reservoir to ensure proper oil level and that there are no visible leaks or sources of unwanted air entry.
5. Start engine/motor and bring up to idle speed.
6. Flush the system. This can be done by short circuiting one high flow demand actuator with a filter containing "V03" filter media to meet the cleanliness level of 15/13/11 for CMX systems. Refer to Publication 561 for guidelines on establishing cleanliness levels and filtration recommendations. Operate that function for a minimum of 20–30 minutes to ensure a minimum of 10 passes of total system oil volume through the filter. Remove the flushing filter and allow the system to warm up to approximately 120°F (50°C).
7. Extend all cylinders, one at a time, bleeding air as required.
8. During Step 7, recheck reservoir level to ensure it is at the proper level; observe the oil condition to ensure their is no sign of air or other undesirable characteristics; and, to ensure there are no signs of vortexing in the reservoir.
9. Retract all cylinders, one at a time.
10. During Step 9, repeat Step 8.
11. Bring the engine up to half throttle and the oil temperature to 120°F (50°C).
12. Operate all functions to get any remaining air out of the system. It may take several cycles to remove all of the air. During this step care must be taken to ensure these operations are performed at a "no load" condition. As required, bleed any remaining air out of the system by cracking a fitting at the highest point in the vehicle.
13. Recheck reservoir level and oil condition to ensure there is no evidence of air or other undesirable characteristics.
14. Bring the engine up to full throttle and the oil temperature to anticipated operating temperature to ensure proper functioning of the load sensing signals at system operating conditions. Note, it may be difficult to bring the unloaded system up to this temperature as it is a load sensing system. However, our experience has proven that it is important to bring the start up system operating temperature as close as possible to normal operating temperature to ensure proper functioning of the load sensing function.
15. Continue operation of all functions while observing for smoothness of operation, jerky motions, noise and any other undesirable characteristics that will need to be addressed.
16. Continue operation of all functions to check functioning of pump controls.
17. Shut down the engine/motor.
18. Change all filter elements and install new elements with a minimum media rating of "V03".
19. Restart the engine and let the oil circulate through the system at engine idle speed.
20. Shut down the engine and take an oil sample to ensure proper cleanliness level based on the highest system operating pressure level and the recommended cleanliness level of 15/13/11 for CMX systems. Reference Publication 561 for background on establishing cleanliness levels and filtration recommendations. See Publications 562, 559 and 559A for guidance in taking oil samples and obtaining a written analysis of the oil sample.

Trouble Shooting Hydraulic Systems

Systems Containing One Or More CMX Valve Banks

The following charts are arranged by major categories of difficulties which may be encountered with the CMX valve and/or the hydraulic load sensing system. The charts indicate by type of difficulty, the general symptom and actions to eliminate the problem. The information contained in these charts is based upon actual field experiences and the solutions that have been successfully used to identify and resolve system operating problems. A summary of these charts is contained in the Quick Reference Guide shown on the following page.

It should be remembered that pressure and flow rate are factors which are usually dependent upon each other. Adequate measuring equipment and a thorough understanding of the operation of the complete hydraulic system are required to quickly and effectively diagnose improper operation.

Where more than one solution is shown for a particular problem, these are listed in the suggested sequence for action.

Quick Reference Guide

CHART	GENERAL SYMPTOMS	PROBLEM	SOLUTIONS
1 – INSTABILITY	Lurching, hammering, chattering, low frequency hunting, vibration, etc.	1.1 Low frequency hunting	1.1.1 thru 1.1.3
		1.2 Chattering when lowering load against external counterbalance valve	1.2.1 thru 1.2.3
		1.3 Instability with solenoid coil buzzing	1.3.1
		1.4 Engine pulsing at corner horsepower	1.4.1
		1.5 Excessive acceleration	1.5.1
		1.6 Load interference	1.6.1
		1.7 Cavitation	1.7.1
		1.8 Aeration	1.8.1
2 – POOR METERING	Poor control, harsh acceleration/ deceleration and jerky starting	2.1 Poor control while lowering loads	2.1.1 thru 2.1.2
		2.2 Poor controllability in general	2.2.1 thru 2.2.7
		2.3 Harsh acceleration	2.3.1 thru 2.3.3
		2.4 Jerky start	2.4.1 thru 2.4.4
3 – FUNCTION MOVEMENT	Uncommanded movement, no movement, load interference, load drift, instability due to load interference, poor overrunning load velocity control and poor low or high actuator velocity control	3.1 Uncommanded movement	3.1.1 thru 3.1.4
		3.2 Pump at pressure limiting setting and no movement	3.2.1 thru 3.2.3
		3.3 No pressure is generated	3.3.1 thru 3.3.7
		3.4 Function speeds up when function demanding higher pressure is used	3.4.1 thru 3.4.5
		3.5 Function slows down when function demanding lower pressure is used	3.5.1 thru 3.5.4
		3.6 Poor response when 2nd or 3rd function actuated	3.6.1
		3.7 Load drift	3.7.1 thru 3.7.4
		3.8 System instability while accelerating high inertia load	3.8.1
		3.9 Poor overrunning load velocity control	3.9.1 thru 3.9.5
		3.10 Actuator velocity too high or too low	3.10.1 thru 3.10.11
4 – SYSTEM PROBLEMS	System runs hot, exhibits symptoms of cavitation, is noisy or exhibits sluggishness	4.1 System running hot	4.1.1 thru 4.1.7
		4.2 Pump is noisy	4.2.1 thru 4.2.4
		4.3 Actuator deceleration noise and/or spongy stop of the cylinder	4.3.1 thru 4.3.5
		4.4 Aeration noise	4.4.1
		4.5 Solenoid humming or buzzing	4.5.1
		4.6 System response is sluggish	4.6.1 thru 4.6.6

Chart 1 Instability

General Symptoms:

Lurching, hammering, chattering, low frequency hunting, vibration, etc.

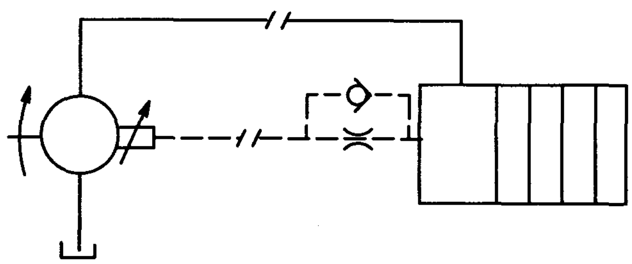
1.1 Problem:

Low frequency (3–6 Hz) hunting of a function. Probable cause is interactions in the load sense line between the pump and CMX valve. This can be verified by the following means:

- Bottom out the unstable function.
- Operate another function that is working properly and bring the pump up to its pressure limiting setting.
- Operate the function that had been hunting. If it stabilizes, then the problem is load sensing related. If not, then the problem relates to something else.

Solutions to load sense line related problems:

1. Install a 0.030 inch (0.75 mm) size orifice in the load sense line between the CMX valve and the pump, located as close to the valve as possible, and as far as possible from the pump. Dependent upon line size and length, a 0.020 inch (0.50 mm) size orifice may be required; and, if so, adequate filtration protection is required. Aeroquip sells separate fittings that incorporate either size orifice.
2. If the problem is not fully resolved, then increase the volume of oil in the load sense line. The easiest way to do this is by changing the line size from 3/8 inch to 3/4 inch. Note: As a general rule of thumb, there should be a minimum of 16 feet of 3/8 inch rubber hose (never use hard tubing) in the load sense line.
3. If the low frequency hunting problem is resolved, but the response is still not satisfactory , then a check valve (spring range 3–15 psi 0.2 - 1.0 bar) should be installed around the 0.030 orifice which is located as close as possible to the valve. This condition is more likely to occur in cold weather than in warm weather conditions. This check valve should be installed to permit free flow from the valve to the pump. Refer to the diagram shown below:



1.2 Problem:

Low or high frequency chattering when lowering a load against an external counterbalance valve.

Solutions:

1. Ensure counterbalance valve is properly adjusted.
2. Try a lower counterbalance ratio ie: 3:1 vs 4:1. Note: This will impact system gain and creates power loss.
3. Replace meter–in spool with a meter–in spool having the pressure control feature for lowering against the counterbalance valve and the flow control feature for lift/velocity control.

1.3 Problem:

Instability accompanied by buzzing in the solenoid coils.

Solution:

Check PWM signal to ensure it is 100 Hz minimum. Note, this may be somewhat controller dependent as the DMX controller developed in Scandinavia for use with CMX valves gives best results with an 85 Hz PWM signal in some systems. Our experience in North America with both the widely used OEM and PQ controllers indicates 100 Hz minimum is required.

1.4 Problem:

Engine pulsing at its corner horsepower point (high load demand condition).

Solution:

Adjust throttle/governor control.

1.5 Problem:

Excessive acceleration (typically in swing circuit) and the function overruns available oil flow.

Solution:

Change meter–in spool from flow control function to pressure control function.

1.6 Problem:

Instability due to load interference.

Solution:

See load interference in Chart 3 – Function Movement.

1.7 Problem:

Instability due to cavitation.

Solution:

See cavitation in Chart 4 – System Problems.

1.8 Problem:

Instability due to aeration.

Solution:

See aeration in Chart 4 – System Problems.

Chart 2 Poor Metering/Feathering

General symptoms:

Poor control, harsh acceleration/deceleration and jerky starting.

2.1 Problem:

Poor control while lowering loads.

Solutions:

1. Change to a meter–out element with a higher ΔP if the higher delta pressure can be accepted. For a CMX100 series valve this could be a change from an "03" to a "14" meter–out element; and, for a CMX160 valve, a change from either an "04" or "07" element to a "14".
2. Change to a lower HRC or ERC gain.

2.2 Problem:

Poor controllability in general.

Solutions:

1. Check tank line of HRC unit to ensure there are no return line surges.
2. Check external drain on CMX tank side to ensure there are no return line surges.
3. Check to ensure the CMX drain line is a separate line to tank and is not plumbed into another return or drain line.
4. If using a pressure control meter–in element, check to ensure the pressure feedback pin moves freely.
5. Check to ensure operator is not inadvertently introducing the condition due to machine vibration. This can happen when the operators seat starts to rock and his hand is not stable. This can be confirmed by taking and holding the operators hand steady and observing if controllability is improved.
6. Check HRC or ERC deadband. Adjust spring capsule rating or threshold current as may be required. Ensure the spring settings or threshold current are providing the correct command signals and load phasing requirements. Refer to the CMX Marketing Kit for additional information on this aspect.
7. If this condition occurs when operating at maximum flow, check to ensure that maximum required flow for the function is achieved just before the end of the lever stroke in order to obtain maximum resolution.

2.3 Problem:

Harsh acceleration.

Solutions:

1. If the valve has a flow control spool, change to a pressure control spool.
2. If the valve already has a pressure control spool, increase size of pressure feedback pin in the pressure control meter–in element. When increasing feedback pin size, attention should be given to the impact on the slope of the pressure vs flow curve and the increased command pressure required to maintain the previous flow/pressure relationship. At low loads actuator speed may be too high and a restrictor may be required in the actuator port.
3. If using an ERC control, adjust the gain for a longer ramp.

2.4 Problem:

Jerky start.

Solutions:

1. Check to see if pilot pressure threshold is set too high (cracking pressure on HRC / threshold current on ERC). If so, reduce initial pilot pressure point. If pilot pressure setting is correct, then check the actuator for cavitation, particularly if the cylinder is oriented with the rod end down and lowering a load.
2. If using a flow control meter–in spool, consider changing to a pressure control meter–in element.
3. Check for mechanical backlash causing the jerky movement. If this is the cause, adjustments must be made to tighten up the machine.
4. Check to ensure the operator is not inadvertently introducing the jerky movement.

Chart 3 Function Movement

General symptoms:

Uncommanded movement, no movement, load interference, load drift, instability due to load interference, poor overrunning load velocity control and poor low or high actuator velocity control.

3.1 Problem:

Movement of any uncommanded function.

Solutions:

1. Check to ensure there is no pressure build–up in the meter–in chamber. If this is the case, use of a vented meter–in spool will drain the chamber and prevent pressure build–up.
2. Check to ensure all load sense check valves are properly seating. This is done by plugging the 0.020 inch (0.50 mm) load sensing bleed orifice in the end cover and using a hand pump to pressurize the load sense chamber. Depending upon the capability of the hand pump, pressurization should be at least 100 psi (7 bar); and preferably 500 psi (35 bar). There should be no problem maintaining this pressurization for a minimum of 2 seconds. This will permit identifying if one or more of the load sense check valves is not properly seating.
3. Check to ensure there are no high pressure transients in the tank line. If any are identified, then ensure the external CMX drain is used in order to prevent function interaction. Refer to page 48 of Bulletin 536 (CMX Applications Guide).
4. For installations using HRC controls, ensure the HRC drain line pressure can not go higher than the CMX pilot drain line pressure. If this should be the case, then both meter–out elements will be open. This condition is corrected by reducing the back pressure which is accomplished by plumbing the HRC tank return line directly to the reservoir; ie: do not tie into any other return lines.

3.2 Problem:

Pump goes to pressure limiting setting and there is no movement.

Solutions:

1. Check to ensure that neither of the meter–out poppets are sticking or not opening.
2. If movement is in one direction only, check the pilot command signal.
3. Ensure the external drain line is connected directly to tank.

3.3 Problem:

No pressure is generated (no reaction at either the pump or valve).

Solutions:

1. Check the pilot pressure to ensure it is correct.
2. Check the load sense line to ensure there are no problems.
3. Check to ensure the load sense orifice is not plugged.
4. If using an ERC, ensure the command current signal is correct.
5. Check to see there are no open or improperly seated load sense check valves. Refer to Solution 2, Problem 3.1 above.
6. If an external load sense stabilizing orifice is used, check to ensure it is not plugged.
7. Check to ensure the meter–out poppet in the driving actuator port is closed.

3.4 Problem:

Function speeds up when function demanding higher pressure is used.

Solutions:

1. Change meter–in spool from a flow control spool to a pressure control spool.
2. If a pressure control spool is already being used, then go to a larger feedback pin. Note: going to a larger size pin will reduce the available port pressure for the function. If the pilot pressure has to be increased to maintain the port pressure, speed may become too high at low loads, and a restrictor may be required in the actuator port.
3. If the largest feedback pin is already being used, then install a flow limiting orifice in the cylinder line. See note above.
4. Increase the load sense P above 300 psi (20 bar) in order to shift valve operation to a flatter portion of the pressure compensation curve, particularly if the problem is at low flows. Reference Pages 14, 15 and 16 of the CMX Applications Guide.
5. If none of the above solve the problem, then modify the circuit to redistribute or separate the functions being affected when operated simultaneously.

3.5 Problem:

Function slows down when function demanding lower pressure is used.

Solutions:

1. Modify circuit to redistribute valve functions to eliminate the interference when these functions are operated simultaneously.
2. If possible, change from the existing pump to either a larger pump or to a multiple pump system.
3. Modify circuit to incorporate an anti–saturation device. If the system is already using electrical actuation, this can easily be accommodated in the controller. If the system is using hydraulic actuation, and, it is not feasible to change to electrical actuation, then change the meter–in spool to a pressure control meter–in spool.
4. If the above does not resolve the problem, then a hydrostat (compensator element) will be required to limit flow in the cylinder line.

3.6 Problem:

Poor response when 2nd or 3rd function is actuated.

Solution:

This indicates insufficient pilot flow. The problem is resolved by either going to a larger pilot pump or by using an accumulator in the pilot flow circuit. A general rule of thumb, there should be a minimum of 4 gpm (15 lpm) pilot flow, depending upon the number of functions.

3.7 Problem:

Load drift.

Solutions:

1. Reconfirm port relief is set at the correct pressure setting. The maximum load pressure should not exceed 80% of port relief valve setting.
2. Check to ensure meter–out element has not stuck in the open position.
3. Check to ensure the load drop check valve is properly seating.
4. Check to ensure the HRC drain pressure is not higher than the required CMX pilot drain line pressure. If this is the situation, then the valve will effectively be in the float position and will not hold the load. This condition is corrected by reducing the back pressure which is accomplished by plumbing the HRC tank return line directly to the reservoir.

3.8 Problem:

System instability while accelerating a high inertia load such as a swing function.

Solution:

This condition can occur when the load overruns the flow available from the meter–in flow control spool. It is resolved by changing to a pressure control spool.

3.9 Problem:

Poor overrunning load velocity control.

Solutions:

1. Ensure the correct meter–out element is being used and/or is not sticking.
2. If the valve is hydraulically controlled, ensure the pilot pressure is at the correct setting. Or...if the valve is electrically controlled, ensure the threshold current signal is correct.
3. Change to a lower gain meter–out poppet if the resulting increased pressure drop can be accepted.
4. If this occurs in a high flow condition, check to ensure that maximum required flow is achieved just before the end of the lever stroke in order to obtain maximum resolution.
5. Consider use of a counterbalance valve at the actuator.

3.10 Problem:

Actuator velocity is either too high or too low.

Solutions:

1. Confirm that the pilot command signal and meter–in spring are properly matched.
2. Check engine speed.
3. Check pump output flow.
4. Confirm the valve has received the proper command signal.
5. Confirm the meter–in spool is correct.
6. Confirm the meter–in spring has the correct setting.
7. Confirm the meter–out element gain is correct.
8. Confirm the pressure drop across the meter–out element does not exceed rated conditions.
9. Confirm the port relief valve setting is correct.
10. Confirm that the load sense bleed orifice is not too large compared to the load sensing dampening orifice and thus prevents the true load pressure from being fed back to the pump.
11. Confirm the lines are not undersized and causing low velocity at the actuator. This can occur with long line runs.

Chart 4 System Problems

General symptoms:

System runs hot, exhibits symptoms of cavitation, is noisy or exhibits general sluggishness.

4.1 Problem:

System is running hot.

Solutions:

1. Check system relief valve and port relief valves to ensure they are a minimum of 300 psi (20 bar) higher than pump compensator or pump pressure limiter setting.
2. Check to ensure there are no obvious leakage points.
3. Check individual components for excessive internal leakage. Replace as necessary.
4. Confirm the pump load sense P is correct. This should be done at 40% or greater displacement.
5. Check to confirm the reservoir oil level is not low.
6. Confirm the hydraulic system cooler is adequately sized, or not bypassed.
7. Ensure the system oil does not have excessive entrained air.

4.2 Problem:

Pump is noisy.

Solutions:

1. Check pump inlet lines and connections for signs of air entry and eliminate any areas of air entry.
2. Check pump inlet lines to assure proper flow conditions to avoid cavitation.
3. Check to confirm the reservoir oil lever is not low.
4. Review reservoir design to insure proper pump inlet conditions exist.

4.3 Problem:

Actuator deceleration noise and/or spongy stop of the cylinder.

Solutions:

1. Increase setting of back pressure relief in the tank line. While the setting required will vary from application/installation to application/installation, a general rule of thumb is that the setting should be at least 65 psi (4.5 bar).
2. In the majority of cases increasing the back pressure setting will not be sufficient to prevent cylinder cavitation and action will be required to install an anti–cavitation module on the CMX valve.
3. Check to ensure oil is available from the tank line when the actuator is cavitating. If the tank line pressure is below the setting of the back pressure valve oil will be missing in the tank line. This can be corrected by installing a pressure reducing valve from the pump outlet line to the tank line before the back pressure valve. The pressure setting of the pressure reducing valve should be just below cracking pressure. This will then add flow from the pump outlet to the tank line whenever tank line pressure is below the setting of the back pressure valve.
4. Confirm reservoir oil level is not low.
5. Review the reservoir design to ensure there are no restrictions to good oil circulation.

4.4 Problem:

Aeration noise.

Solution:

Entrapped air may remain in the system. It will be necessary to bleed the system to purge this air. Refer to "Start–up Procedure" steps 4 thru 15 for guidance.

4.5 Problem:

Solenoid humming or buzzing.

Solution:

Check to ensure the Pulse Width Modulation frequency is 100 Hz minimum. Note, if you are using the DMX controller developed in Scandinavia for use with CMX valves, in some systems the best results are obtained with an 85 Hz PWM signal.

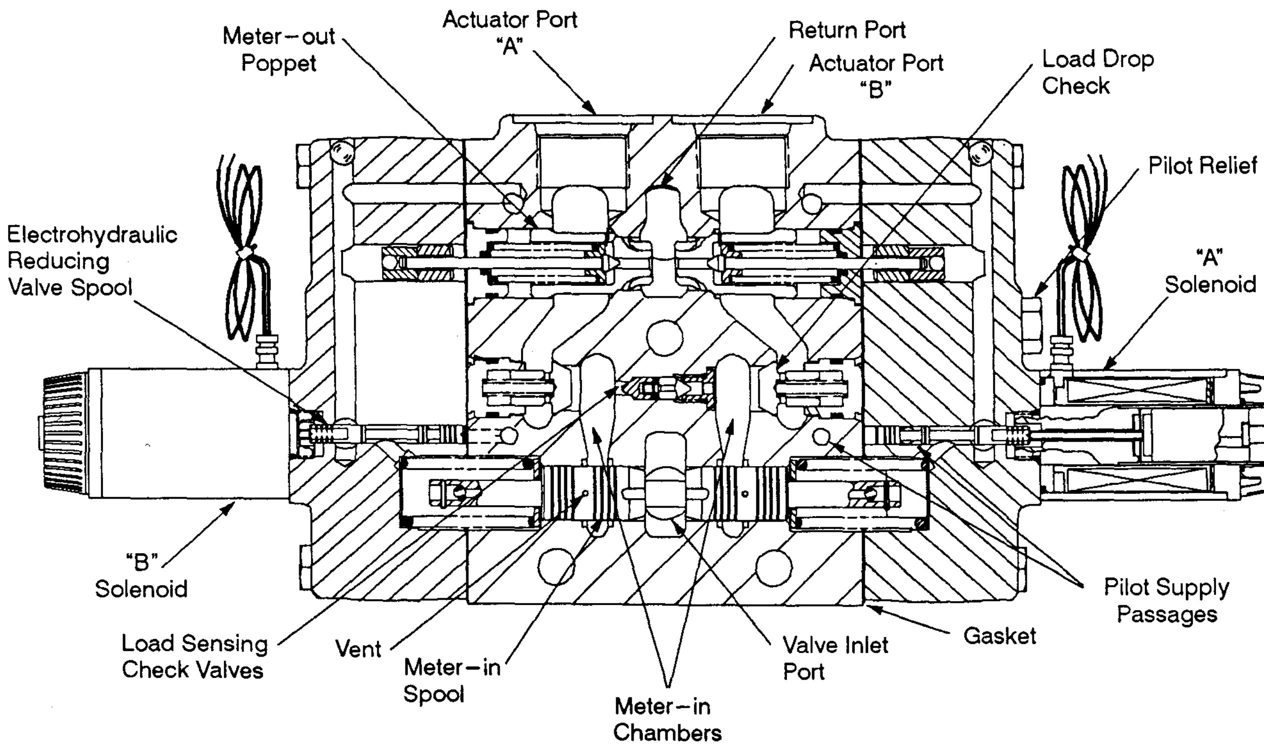
4.6 Problem:

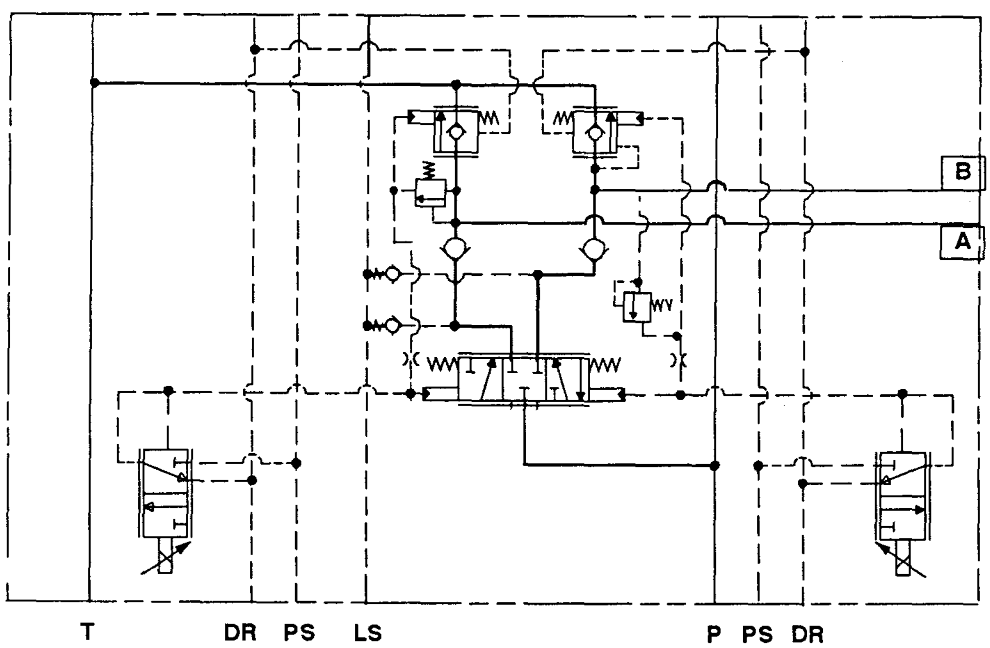
System response is sluggish.

Solutions:

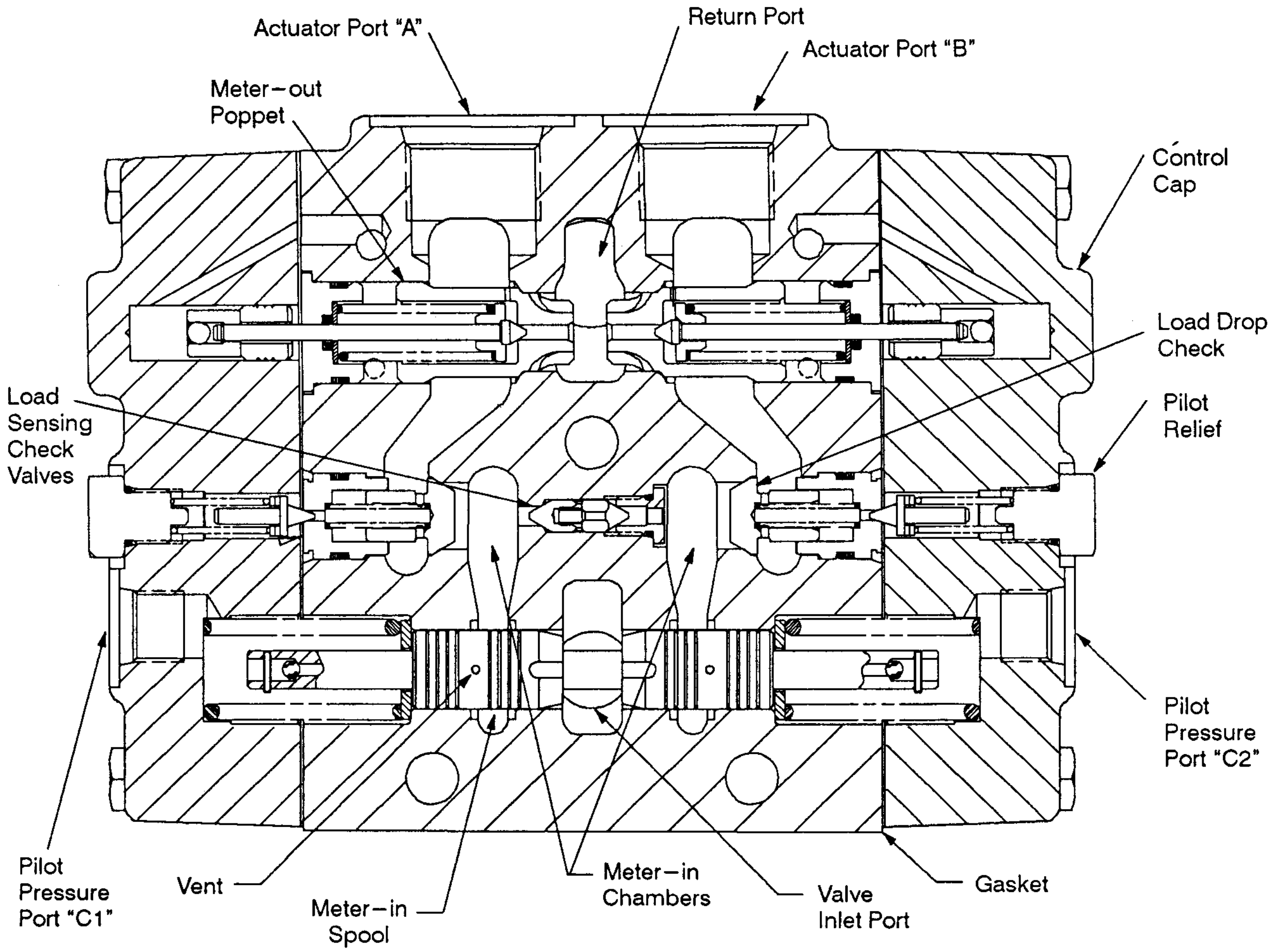
1. Check vehicle start–up procedure to ensure hydraulic system is properly warmed up prior to hydraulic system operation.
2. Check load sensing line to ensure it is not too small. As a minimum, line size should be 3/8 inch rubber hose.
3. Check to confirm the load sense dampening orifice is not blocked or restricted.
4. Check to confirm the piston pump(s) are not operating outside of their viscosity range.
5. Confirm that the load sense bleed orifice is not too large compared to the load sensing dampening orifice and thus prevents the true load pressure from being fed back to the pump.
6. Check to confirm there is no entrapped air. If there is, bleed the system as required, reference "Start–up Procedure" steps 4 through 15 for guidance.

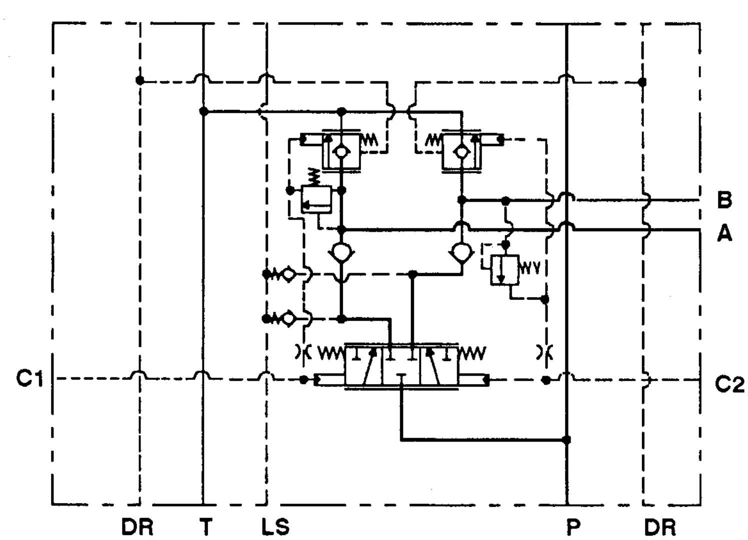
Typical CMX Electrohydraulic Valve Section



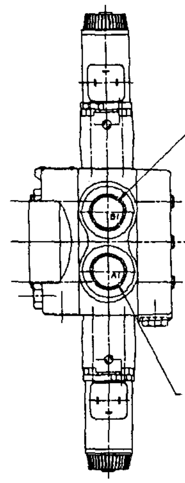


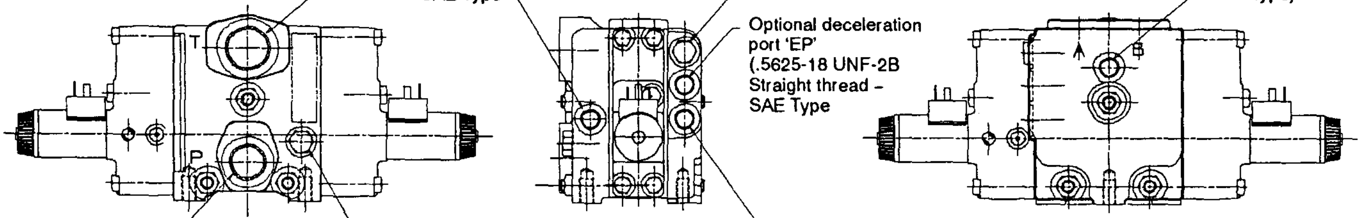
Typical CMX Hydraulic Valve Section





CMX Port Locations





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