CLARK TRANSMISSION MODULATION MANUAL

PUBLICATION NO. 3284

THEORY OF OPERATION and TROUBLESHOOTING GUIDE
TRANSMISSION MODULATOR VALVE OPERATIONAL DESCRIPTION

Both directional clutch assemblies are controlled by individual modulator valves. The pressure rise at side "A" of the regulator spool is the same as that applying the clutch piston. Supply flow to the clutch and modulator is limited by a flow limiting orifice. From this limited flow the regulator spool drains flow to the vent port. The regulator spool restricts flow through the vent port to build clutch pressure at a predetermined rate. Once the vent flow is shut off, only minimal flow passes through the flow limiting orifice to make up for normal spool and clutch leakages. Pressure on either side of the orifice is virtually identical and full regulated system pressure is applied at the clutch piston.

When forward direction is selected the oil under pressure enters the port on the "A" side of the regulator spool. This passes through the dampening orifice. The pressure force on the spool area shifts the spool to the right exposing the vent port. The time required to shift the regulator spool over to expose the vent port shows up as a pressure spike at the beginning of the pressure versus time chart.

The movement of the regulator spool is opposed by the regulator and accumulator springs. This provides an initial low pressure head of approximately 20 psi [137.9 Kpa] on the "A" side of the spool. This 20 psi [137.9 Kpa] is represented as a horizontal line on the pressure versus time chart immediately following the spike. Oil flows through the regulator spool orifice due to a pressure imbalance. Pressure at side "A" is constantly 10 psi [68.9 Kpa] higher than side "B" as a result of the added force of the side "B" spring.

The 10 psi [68.9 Kpa] supply through the regulator spool orifice gives a controlled flow rate. This controlled flow establishes the time it takes to fill the accumulated cavity.

As the accumulator cavity is filled, the accumulator spool is forced against the accumulator springs. As the springs compress their force increases causing the hydraulic pressure in the accumulator cavity and "B" side of the regulator spool to increase. Pressure on the "A" side of the regulator spool increases with the opposing force on the "B" side.

This causes the rising slope in the clutch pressure versus time chart. The rate of this rise is controlled by the accumulator spring force. Once the accumulator spool is stroked to its limit, pressure on "A" and "B" side of the regulator spool is balanced since no flow passes through the regulator spool orifice. The regulator spool spring pushes the regulator spool to the left shutting off the vent flow. The clutch and modulator pressure rapidly rise to the system regulated clutch supply pressure setting. This is the vertical line on the clutch pressure versus time chart.

The entire modulator sequence of events occurs in less than two seconds. The steady rise of clutch pressure increases the clutch driving torque which results in a smooth clutch application.

When forward direction is selected the reverse clutch and modulator are vented through the control valve to the transmission sump. The reverse accumulator cavity is vented back through the regulator spool orifice. To hasten the reset time of the accumulator, immediately preparing the transmission for a directional shift, full system regulated clutch supply pressure from the forward control valve is directed to the spring cavity of the reverse accumulator.

When reverse direction is selected the reverse clutch and modulator function through the same sequence of events as the forward clutch and modulator. This same sequence of events also applies to the lock-up modulators. (See last page for the modulated lock-up plumbing diagram).
FORWARD

28000 SERIES MODULATION

This pressure spike is time required for spools to react. The spike pressure is used to quickly fill the clutch pressure supply passages with oil.
Trouble Shooting Guide — Modulated Transmissions

I Introduction
Standard Clark Service manual pressure and flow check procedures are not adequate for modulated transmission assemblies. However, relatively simple procedures may be employed to assist in trouble shooting these transmissions. These procedures are written to assist in leakage checks and to enable isolation of problem areas.

II Modulated Transmission Design

A. Modulated Transmission Concepts
1. A complete modulation circuit is provided for each clutch being modulated. Included are a differential pressure regulator and a spring loaded accumulator. Such a valve circuit is shown schematically by Figure 1.
2. All modulator circuits are in hydraulic parallel to clutch supply lines. They do not interrupt the circuit at any time. A flow limiting orifice is designed into each modulation valve assembly. Consequently conventional regulated pressure ports, often noted as clutch pressure ports no longer indicate actual clutch pressure for forward and reverse clutches.
3. With the exception of the 18000 transmission all current modulated transmission directional clutch pistons employ a fixed bleed orifice. Due to the combination of clutch leakage, piston bleed orifice flow rate, and flow limiting orifices, directional clutch pressure will be slightly lower than regulated pressure.

B. Pressure Gage Ports
1. Refer to figures 2, 3 and 4 for locations of directional clutch pressure check ports.
2. Note that the control valve forward and reverse check ports of 18000 and 28000 transmissions cannot be used to check actual clutch pressures of modulated units.
3. The 4000, 5000, 8000 and 16000 transmission control valve ports can be used to check directional clutch pressure.

C. Pre-Test Study
1. Proper transmission identification is required prior to test. For example the 28000 transmission check out procedures are different for an R model and HR model. Modulated 28000 transmissions are available with standard length directional clutches (6 friction discs) and extended directional clutch (12 friction disc) assemblies.
2. Modulated transmission pump size should be determined prior to test. Higher capacity pumps are used for 28000, 4000, 5000, 8000 and 16000 modulated transmissions.

III Transmission Leakage Studies

A. Clutch Pressure Study (Technique #1)
1. Locate gage ports for regulated, forward clutch, and reverse clutch pressures. A 400 PSI [2758,0 Kpa] gage is recommended for use at these ports.
2. Warm system up to operating temperature (180 to 200°F [82.2-93.3°C] at converter outlet). Always use parking brake when making pressure checks.
3. At idle (assumed to be 650-800 RPM) measure and record directional clutch pressures in forward and reverse (use 3rd or 4th range). At idle, with the direction control in neutral, measure and record system regulated clutch pressure, in all ranges, 1, 2, 3, 4.

4. Use following table to evaluate data. Note that data indicates 2nd clutch repair is required.

**Example (Extended Clutch R28423)**

<table>
<thead>
<tr>
<th>Clutch</th>
<th>System Regulated Clutch Pressure</th>
<th>Mod. Clutch Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PSI</td>
<td>Kpa</td>
</tr>
<tr>
<td>Fwd. - 4th</td>
<td>255</td>
<td>[1758,1]</td>
</tr>
<tr>
<td>Rev. - 4th</td>
<td>255</td>
<td>[1758,1]</td>
</tr>
<tr>
<td>Neut. - 1</td>
<td>255</td>
<td>[1758,1]</td>
</tr>
<tr>
<td>Neut. - 2</td>
<td>235</td>
<td>[1620,2]</td>
</tr>
<tr>
<td>Neut. - 3</td>
<td>255</td>
<td>[1758,1]</td>
</tr>
<tr>
<td>Neut. - 4</td>
<td>255</td>
<td>[1758,1]</td>
</tr>
</tbody>
</table>

**Table No. 1**
Clutch Pressure Study at Idle

Due to the combination of clutch leakage, piston bleed orifice flow rate, and flow limiting orifices, directional (fwd. and rev.) clutch pressure will be up to 20 psi [137,9 Kpa], lower than the system regulated clutch pressure.

<table>
<thead>
<tr>
<th>Trans. Model</th>
<th>Direction Clutch Configuration</th>
<th>Conv. GPM</th>
<th>Aux. GPM</th>
<th>System Regulated Clutch Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>18000</td>
<td>Std-8 disc</td>
<td>16</td>
<td></td>
<td>180 - 220 [1241,1 - 1916,8] 5 [34,4]</td>
</tr>
<tr>
<td>HR28000</td>
<td>Std-6 disc</td>
<td>20</td>
<td>[79,4]</td>
<td>240 - 280 [1654,7 - 1930,5] 5 [34,4]</td>
</tr>
<tr>
<td>HR28000</td>
<td>Ext-12 disc</td>
<td>20</td>
<td>[79,4]</td>
<td>240 - 280 [1654,7 - 1930,5] 5 [34,4]</td>
</tr>
<tr>
<td>4000</td>
<td>Ext-10 disc</td>
<td>40</td>
<td>[151,4]</td>
<td>240 - 280 [1654,7 - 1930,5] 5 [34,4]</td>
</tr>
<tr>
<td>5000</td>
<td>Ext-16 disc</td>
<td>50</td>
<td>[189,2]</td>
<td>180 - 220 [1241,1 - 1916,8] 5 [34,4]</td>
</tr>
<tr>
<td>8000</td>
<td>Ext-16 disc</td>
<td>65</td>
<td>[246,0]</td>
<td>180 - 220 [1241,1 - 1916,8] 5 [34,4]</td>
</tr>
<tr>
<td>16000</td>
<td>Ext-16 disc</td>
<td>80</td>
<td>[302,8]</td>
<td>180 - 220 [1241,1 - 1916,8] 5 [34,4]</td>
</tr>
</tbody>
</table>

* Some 28000 units are set up with auxiliary lube pump.

**B. Lube Pressure Study (Technique #2)**

1. Locate lube pressure port. (Refer to Figures 2 and 3). Install pressure gage. (100 PSI [689,4 Kpa] max. range). **Always use parking brake when making pressure checks.**

2. Warm transmission to operating temperature (180-200° F). [82-93,3 ° C].

3. Stall converter at full throttle, taking care not to overheat converter by extended stall.

4. Place directional control in neutral at full throttle. Measure and record lube pressure in all ranges.

**Example (Extended Clutch R28423)**

<table>
<thead>
<tr>
<th>Dir. — Range</th>
<th>Lube Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fwd. — 4th</td>
<td>42 [289,5]</td>
</tr>
<tr>
<td>Rev. — 4th</td>
<td>41 [282,6]</td>
</tr>
<tr>
<td>Neut. — 1</td>
<td>43 [296,4]</td>
</tr>
<tr>
<td>Neut. — 2</td>
<td>30 [206,8]</td>
</tr>
<tr>
<td>Neut. — 3</td>
<td>42 [289,5]</td>
</tr>
<tr>
<td>Neut. — 4</td>
<td>42 [289,5]</td>
</tr>
</tbody>
</table>

**Note:** Example data indicates leaking in 2nd clutch.
5. Refer to table 2 and evaluate data.

Table No. 2
*Full Throttle Lube Pressure Study

<table>
<thead>
<tr>
<th>Trans. Model</th>
<th>Direction Clutch Configuration</th>
<th>Charge Pump Assembly</th>
<th>Minimum Lube Pressure</th>
<th>Maximum Diff. In Lube Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Conv. GPM</td>
<td>Aux. GPM</td>
<td>liters</td>
</tr>
<tr>
<td>18000 Std-8 disc</td>
<td>16 [60.5]</td>
<td>15</td>
<td>103,4</td>
<td>8 [55.1]</td>
</tr>
<tr>
<td>R28000 Std-6 disc</td>
<td>21 [79.4]</td>
<td>12</td>
<td>82,7</td>
<td>5 [34.4]</td>
</tr>
<tr>
<td>HR28000 Std-6 disc</td>
<td>20 [75.7]</td>
<td>20</td>
<td>137,9</td>
<td>5 [34.4]</td>
</tr>
<tr>
<td>R28000 Ext-12 disc</td>
<td>21 [79.4]</td>
<td>18</td>
<td>68,1</td>
<td>35</td>
</tr>
<tr>
<td>HR28000 Ext-12 disc</td>
<td>20 [75.7]</td>
<td>21</td>
<td>79,4</td>
<td>50</td>
</tr>
<tr>
<td>R28000 Ext-12 disc</td>
<td>21 [79.4]</td>
<td>15</td>
<td>56,7</td>
<td>35</td>
</tr>
<tr>
<td>HR28000 Ext-12 disc</td>
<td>20 [75.7]</td>
<td>15</td>
<td>56,7</td>
<td>45</td>
</tr>
<tr>
<td>4000 Ext.10 disc</td>
<td>40 [151.4]</td>
<td>16</td>
<td>110,3</td>
<td>5 [34.4]</td>
</tr>
<tr>
<td>5000 Ext-16 disc</td>
<td>50 [189.2]</td>
<td>14</td>
<td>96,5</td>
<td>5 [34.4]</td>
</tr>
<tr>
<td>8000 Ext-16 disc</td>
<td>65 [246.0]</td>
<td>24</td>
<td>165,4</td>
<td>5 [34.4]</td>
</tr>
<tr>
<td>16000 Ext-16 disc</td>
<td>80 [302.8]</td>
<td>20</td>
<td>137,9</td>
<td>5 [34.4]</td>
</tr>
</tbody>
</table>

*Full throttle range applicable (2200-2800 RPM)

IV Techniques for Problem Isolation

A. Transmission Malfunctions

1. Low Pressure (Clutch & Lube)

A typical failure would be a lack of propulsion due to little or no pressure in forward or reverse clutches.

The lack of acceptable directional clutch pressure may be due to clutch leakage or due to modulator malfunction. To isolate proceed as follows.

a. Install .375 dia. x 1.125 [9,525 x 28,575 mm] pin inside modulator regulator spool. This blocks valve shut.

b. If pressure at clutch increases to acceptable level, assume clutch is good. Assume modulator malfunction.

c. If pressure remains low, assume clutch is leaking.

ALWAYS REMOVE PIN AFTER TEST. DO NOT ATTEMPT TO ELIMINATE MODULATION BY BLOCKING REGULATOR SHUT. DIFFERENT CLUTCHES ARE REQUIRED TO ELIMINATE MODULATION SAFELY.
2. Harsh Shift or Excessively Delayed Shift

If modulation is ineffective, problem could be associated with modulator or with clutch. If problem is in modulator, a regulator or accumulator spool may be bound up. Accumulator spring breakage is also possible. To study, observe action of a directional clutch pressure gage. On a modulated clutch you should note a distinct pause in application of pressure. If clutch pressure remains at a low level with the engine at idle and doesn't rise, repair of the modulator valve or clutch pack is indicated.

B. Modulation Valve Service

1. Only the springs should be replaced when servicing modulation valve assemblies. If regulator or accumulator spools are damaged replace the complete valve assembly.

2. The modulation valve assemblies can be cleaned. The regulator spool orifice (approximately .030 [0.76 mm] diameter) should be checked for dirt. Spools should all be free to move in their respective bores.

3. Flow limiting orifices of modulated 4000, 5000 and 8000 modulations are incorporated in the directional valve spools. Consequently special control valve assemblies are required.

MODULATION VALVE SCHEMATIC

FIGURE 1
4000 - 5000 - 8000 - 16000 CHECK PORTS

- Reverse Clutch Pressure Port: ¼" N.P.T.F.
- Forward Clutch Pressure Port: ¼" N.P.T.F.
- Charge Pump Regulated Pressure Port: ¼" N.P.T.F.
- Lube Pressure Port: ¼" N.P.T.F.

NOTE: DO NOT USE 28000 CONTROL VALVE PORTS FOR MODULATED TRANSMISSION DIRECTIONAL CLUTCH PRESSURES

MODULATED 28000 TRANSMISSION

- Forward Clutch Pressure Port: ¼" N.P.T.F.
- Reverse Clutch Pressure Port: ¼" N.P.T.F.

FIGURE 2
18000 MODULATED TRANSMISSION
CHECK PORTS

FORWARD CLUTCH PRESSURE PORT - N.P.T.F.

CHARGE PUMP REGULATOR PORT - N.P.T.F.

REVERSE CLUTCH PRESSURE PORT
SEE MODULATOR BELOW

NOTE: DO NOT USE CONTROL VALVE TEST PORTS FOR DIRECTIONAL CLUTCH PRESSURES

MODULATOR

LUBE PRESSURE PORT

FIGURE 3
TEST PORT LOCATIONS
MODULATED 28000 TRANSMISSIONS

NOTE: LUBE INLET FITTING MAY ALSO BE TAPPED FOR PRESSURE FITTING

FIGURE 4
This pressure spike is time required for spools to react. The spike pressure is used to quickly fill the clutch pressure supply passages with oil.
This pressure spike is time required for spools to react. The spike pressure is used to quickly fill the clutch pressure supply passages with oil.
This pressure spike is time required for spools to react. The spike pressure is used to quickly fill the clutch pressure supply passages with oil.
This pressure spike is time required for spools to react. The spike pressure is used to quickly fill the clutch pressure supply passages with oil.
This pressure spike is time required for spools to react. The spike pressure is used to quickly fill the clutch pressure supply passages with oil.

From Control Valve

Dampening Orifice

Start of Shift

Shift Complete

Charging Pump Flow From Filter

Flow Limiting Orifice

To Clutch

To Modulator Valve

Control Cover

Regulator Spool

Accumulator Spool
4000 and 5000 SERIES MODULATION

4000 AND 5000 SERIES CONTROL COVER

REVERSE REGULATOR

FORWARD ACCUMULATOR

REVERSE ACCUMULATOR

FORWARD REGULATOR
LHR-28000 TRANSMISSION

LOCK-UP SOLENOID VALVE

REMOTE MOUNTED LOCK-UP MODULATOR OPTION

OIL CIRCUIT & PLUMBING DIAGRAM FOR LOCK-UP MODULATOR VALVE
OIL CIRCUIT & PLUMBING DIAGRAM
FOR LOCK-UP MODULATOR VALVE

LOCK-UP SOLENOID VALVE

REMOTE MOUNTED LOCK-UP MODULATOR

CL-270 & CL-8000 TORQUE CONVERTER & R-28000 TRANSMISSION