APPLICATION NOTES

VALVE CHECKER

G040-123

CONTENTS

DESCRIPTION

1.1 The Moog G040-123 Valve Checker is an instrument capable of checking the flow control function of nearly the complete range of Moog electrical feedback (efb) proportional and servo valves. Mechanical feedback (mfb) and pressure control valves are not catered for by the G040-123.

The feature that makes it so versatile is the way it can test a valve while the valve is still installed in its normal operating plant. This is done at two levels, “in line” and “stand alone”.

1.1.1 Plant (In Line)

As in fig a) the plant and valve operate normally. In fig b) the Valve Checker is connected between the plant electronics and the valve such that all the plant electronics’ signals, to and from the valve, are connected as normal. The Valve Checker monitors the plant electronics’ signals and the signals back from the valve, enabling a check of the valve’s performance.

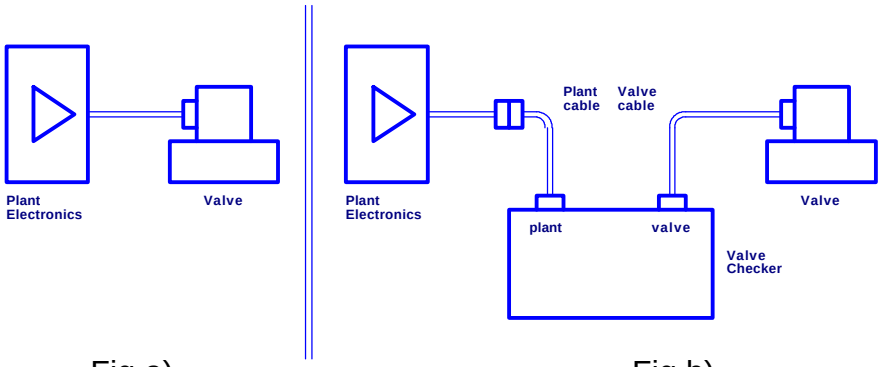


Fig a) Fig b)

1.1.2 Checker (Stand Alone)

In this mode the plant command is switched out while the Valve Checker generates the command to the valve and monitors the signals back from it. The valve remains installed in the plant but the plant command signals are disconnected. Checking while still installed in the plant provides the added benefit of checking the valve by observing the reaction of the plant to the Valve Checker’s commands.

1.2 The Valve Checker is powered by the plant electronics which also continue to supply the valve in both *plant* and *checker* modes of operation. As well, there is a +24V DC power connector on the front panel for 24V DC and ± 15V DC powered valves, without connection to the plant electronics’ power.

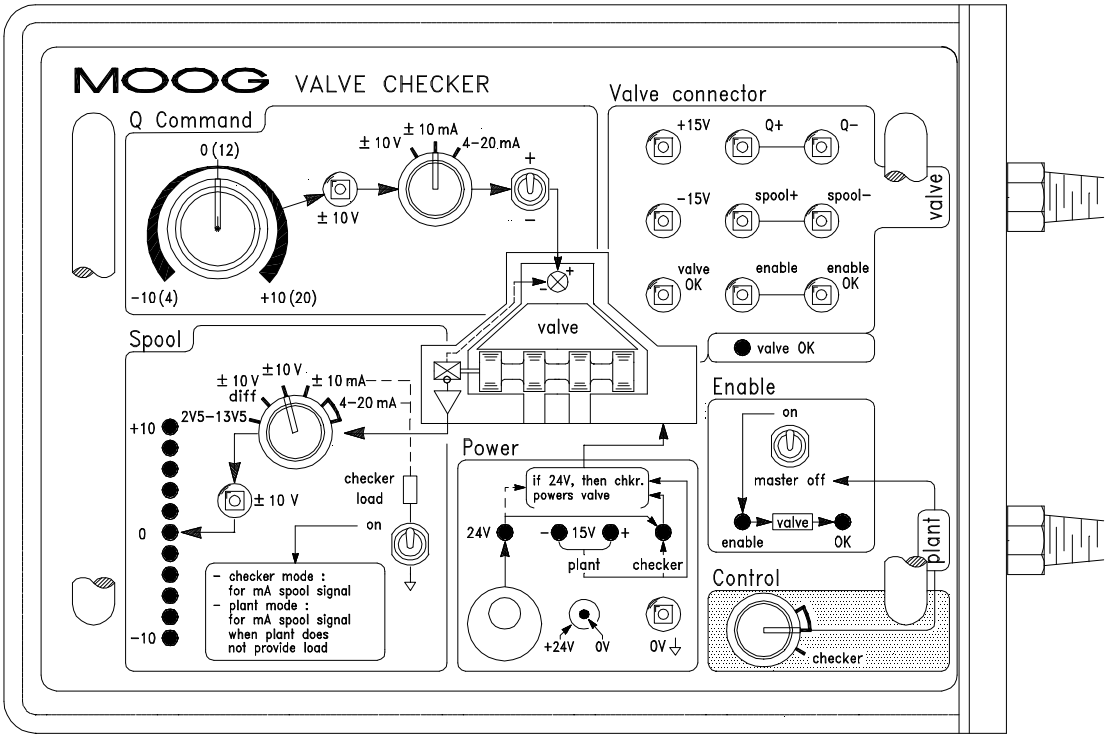
1.3 Two cables connect the Valve Checker to the plant electronics and valve. Each of the Valve Checker models is dedicated to a power supply voltage and connector type. It is necessary to select the model type that has the correct connector and supply voltage. The table below shows the model numbers and their supply/connector types.

Model dash number table:-

Model dash no.	Connector	Supply
-001	6 + PE	24V
-002	11 + PE	24V
-003	12 pin	± 15V
-004	6 + PE	± 15V
-005	6 pin	± 15V

1.4 There are six functional blocks on the front panel.

1. Q Command
2. Spool
3. Power
4. Control
5. Enable
6. Valve Connector



1.4.1 **Q Command**

This block is active only when *checker* mode is selected. The rotary pot adjusts the Q command level.

The grey test point gives a 0 to ±10V signal proportional to the actual voltage or current being delivered to the valve. The rotary selector switch selects the signal type that is connected to the valve.

The +/- *switch* connects the valve *Q command* signal to the non-inverting (+ve gives P→ A) and inverting (+ve gives P→ B) inputs.

1.4.2 **Spool**

The spool position signal from the valve is always available at the *green spool* test point and passed on to the plant electronics regardless of the mode of operation. The *green spool* test point gives a 0 to ±10V signal proportional to the spool signal from the valve. The *LED display* to the left of the test point provides a rudimentary indication of the signal. The centre *blue null LED* will be illuminated when the spool signal is less than ± 10%.

An understanding of the *checker load* switch is important for successful use of the Checker, when the spool signal is a current
(± 10mA or 4-20mA). When the valve has a current output there must be a path through which the current can flow, for the Checker to be able to measure the current. When the plant electronics do no provide this load, or the Checker is not connected to the plant electronics, the *Checker load* switch connects a 100 Ohm load to ground (0V) on the spool signal, enabling a current to flow.

Note that a six position rotary switch is used to select the five feedback signals. The fifth and sixth positions both select 4-20mA signal.

1.4.3 **Power**

1.4.3.1 **24V models**

The *24V LED* illuminates with both plant 24V and the external 24V supply. The external 24V is connected via the large black connector below the LED.

The *checker LED* indicates the internal ±15V supply is healthy. This supply is used to power only the Valve Checker internal electronics.

The valve and internal ±15V regulators are always powered by the external 24V, regardless of the presence of plant 24V. When there is no external supply the plant 24V powers the valve and internal regulators.

1.4.3.2 **±15V models**

The *24V LED* illuminates when the external 24V supply is connected. The plant *±15V LED's* illuminate when the plant ±15V supply is present. The *checker LED* indicates the internal ±15V supply is healthy.

When the checker is powered from the plant ±15V the valve is powered from that supply as well.

When external 24V is present, the checker internal regulators are powered from that supply, regardless of the presence of the plant supply and the valve in turn is powered form the internal regulators.

1.4.4 **Control**

This switch selects the two operating modes:

- In *Checker* mode valve Q commands and valve enable are generated by the Checker, with the valve generated signals of spool position, enable OK and valve OK, available to be monitored on the Valve Checker test points and passed back to the plant electronics.
- In *Plant* mode valve Q commands and valve enable are generated by the plant electronics, with the valve generated signals monitored in the same way as in *checker* mode.

Note that a three position rotary switch is used to select between *checker* and *plant* modes. The first and second positions both select plant mode.

1.4.5 **Enable**

The *enable LED* illuminates when the enable signal to the valve is positive. The enable signal to the valve comes from the plant electronics when *plant* mode is selected. When *checker* mode is selected it comes from the *enable on* switch. However, the enable to the valve can be turned off by selecting *master off* when either *plant* or *checker* mode is selected.

As well as enabling the valve, the enable signal also enables the Valve Checker output signals derived from either the checker itself, or the plant electronics.

This provides a safety feature that quickly removes all signals in the event of damaging or dangerous process movements. Simply selecting master off turns off all signal lines to the valve.

The *enable OK LED* illuminates when the enable OK signal form the valve is positive.

1.4.6 **Valve Connector**

All the test points in this section are wired directly to the valve connector. This enables the actual voltage on the valve's input pins to be measured, regardless of the mode selected. A knowledge of the valve input impedance is sometimes necessary to gain benefit from this measurement.

This section also contains the *valve OK LED*. The valve OK signal is an output from the valve.

2. SPECIFICATION

Q Command Outputs	± 10V, ±10mA, 4-20mA
Q Command Test Point	0 to ± 10V
Q Command Output swing	±10V, ±20mA
Spool Inputs	2.5 to 13.5V, ±10V differential, ±10V single ended, ± 10mA, 4-20mA.
Spool Feedback Test Point	0 to ±10V
Test point size	2.0mm diameter
Supply	
± **15V DC**	± 9 to ± 18V, ±65 mA at ±15V, excluding valve
24V DC	18 to 36 V, 90mA at 24 V, excluding valve
Weight	1.2kg. includes cables
Dimensions	205 x 138 x 70 high
Cable Length	3.0M
Enable, Enable OK & Valve OK Thresholds	on at 8.5V. off at 6.5V.
EMC	EN 50081-1 EN 50082-2
Protective earth	EN 60204-1 equal-potential

3. QUICK START

3.1 Select the Valve Tester model number

Model dash no.	Connector	Enable	Supply
-001	6 + PE	Internal	24V
-002	11 + PE	Plant	24V
-003	12 pin	Internal	± 15V
-004	6 + PE	Internal	± 15V
-005	6 pin	Internal	± 15V

3.2 Select Operation Mode

Select *plant* mode for in line testing or *checker* mode for stand alone testing.

3.3 External Supply

If using *checker* mode an external 24V power supply is needed. Supply requirements are:-

- 2.1mm diameter connector: 24V outside contact, 0V inside contact.
- 18V to 36V range.
- 90mA at 24V to power the valve checker with no load.

3.4 Connect Cables

First select master off on the *enable switch.* Turn hydraulic pressure and plant electronics off before disconnecting and reconnecting the valve.

CAUTION Be sure that the power down and power up sequence is orderly so no damage can be done to the process.

3.5 Select Signal Types

Select the Q command, if using in *checker* mode, and spool signal switches to match the valve signal types.

3.6 Run Test

Turn on the *enable* switch. The valve will now operate and correct operation can be verified by measuring the Q command and comparing it to the spool signal.

3.6.1 **Plant (in line)**

Measure Q + and Q – test points in the Valve connector section and compare this signal to the *green test point* in the spool section.

3.6.2 **Checker (Stand Alone)**

Measure the *grey test point* in the Q command section and compare this signal to the *green test point* in the spool section.

3.7 **Valve won't respond?**

Check in Valve connector section
- Correct Q+ and Q- signal.
- Correct power supply.
- Correct enable signal, if the valve has an enable.

Check in spool section.
- If spool signal is a mA signal turn on checker load in spool section to ensure a path for the mA current.
- Correct spool signal selected.

Check in the power section.
- Checker LED is illuminated.

Check in enable section.
- Enable LED is illuminated.

Check in Q command section.
- Correct command signal selected.
- Try reversing the polarity of the +/- switch.

4. CONNECTING TO VALVE AND PLANT ELECTRONICS

4.1 Disable the process that the valve is controlling by turning off electrical power and hydraulic pressure.

CAUTION: Be sure that the power down sequence is orderly so no damage can be done to the process.

4.2 Remove the plant electronic cable from the valve and mate it with the Valve Checker plant cable.

4.3 Mate the Valve Checker valve cable with the valve.

4.4 Select *master off* on the *enable* switch.
Restore power and hydraulic pressure.

CAUTION: Be sure that the power up sequence is orderly so no damage can be done to the process.

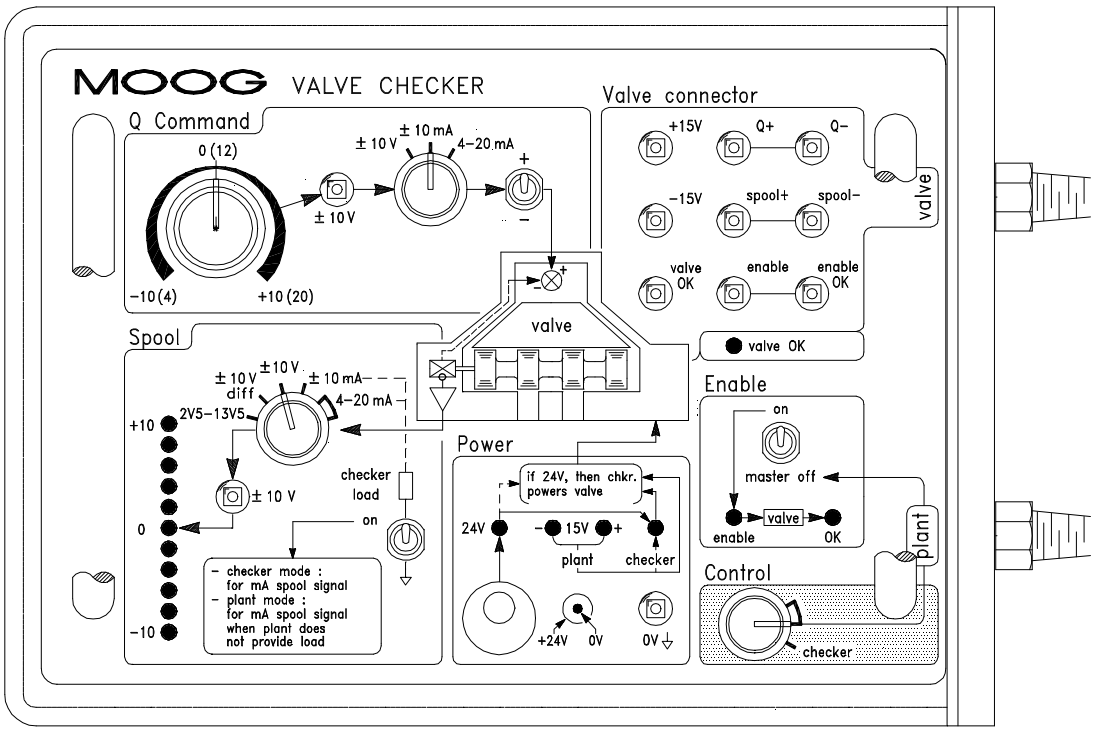
4.5 Verify that the checker power LED is illuminated.

4.5 Select either *plant* (in line) mode or *checker* (stand alone) mode on the control selector switch.
See chapter five for instructions on *plant* mode operation and chapter six for instructions on *checker* mode operation.

CAUTION: Do not spill oil on the Valve Checker. Oil can enter the housing and damage the internal electronic circuit.

Do not subject the Valve Checker to severe shock or vibration. Damage to the internal electronic circuit may result.

5. PLANT MODE OPERATION



±15V model (see Pg 15 for +24V model illustration)

5.1 Connection

Having successfully connected the Valve Checker as per chapter three, select *plant* mode on the control selector switch.

CAUTION: Ensure the *enable* switch is in the *master off* position and leave it in this position until all switch selections are made and the test is ready to proceed.

5.2 Plant Mode

In *plant* mode the Q command section is inoperative. The Q and enable commands come from the plant electronics.

5.3 Spool

In the spool section select the appropriate spool signal. When selecting either 10mA or 4-20mA, check if the plant electronics provides a load that enables a current signal to flow. If there is no return signal path to ground (0V) turn on the *checker load* switch.

5.4 Enable

Begin the test by turning on the *enable* switch to enable the valve. The *enable LED* should illuminate confirming that the valve and Valve Checker are enabled. The *enable* signal is also used in the valve checker to enable it to operate. On valves that do not have an “enable signal input” the Valve Checker generates an internal enable signal.

5.5 Valve OK and Enable OK

Enable OK indicates a valid enable signal has been received by the valve. *Valve OK* indicates that the valve closed loop is operating within a certain error band.

Be aware that not all valves have these output signals. If the Valve Checker being used does not have the two OK test points the signals are not wired to the Valve Checker and the two OK LED’s will not illuminate.

5.6 Spool Signals

Measure the actual spool signal on the green test point. The voltage on this test point is standardised to 0 to ± 10V, regardless of the actual signal type.

5.7 Valve Connector Test Points

The plant electronics' command, directly on the valve input pins, can be measured on the grey valve connector section test points. A knowledge of the valve input impedance is required to calculate the current level when the command is a mA signal.

Example

A D66X valve with a ± 10mA Q command, an input impedance of 400 Ohm and the Q- pin grounded will give a Q+ voltage of ±4V. However, if you measure approximately +13V it is likely there is no current flowing. If you measure approximately 0V it is likely the command from the plant is not connected. These test points are useful if a test shows a fault and you want to be sure that it is the valve and not the Valve Checker causing it.

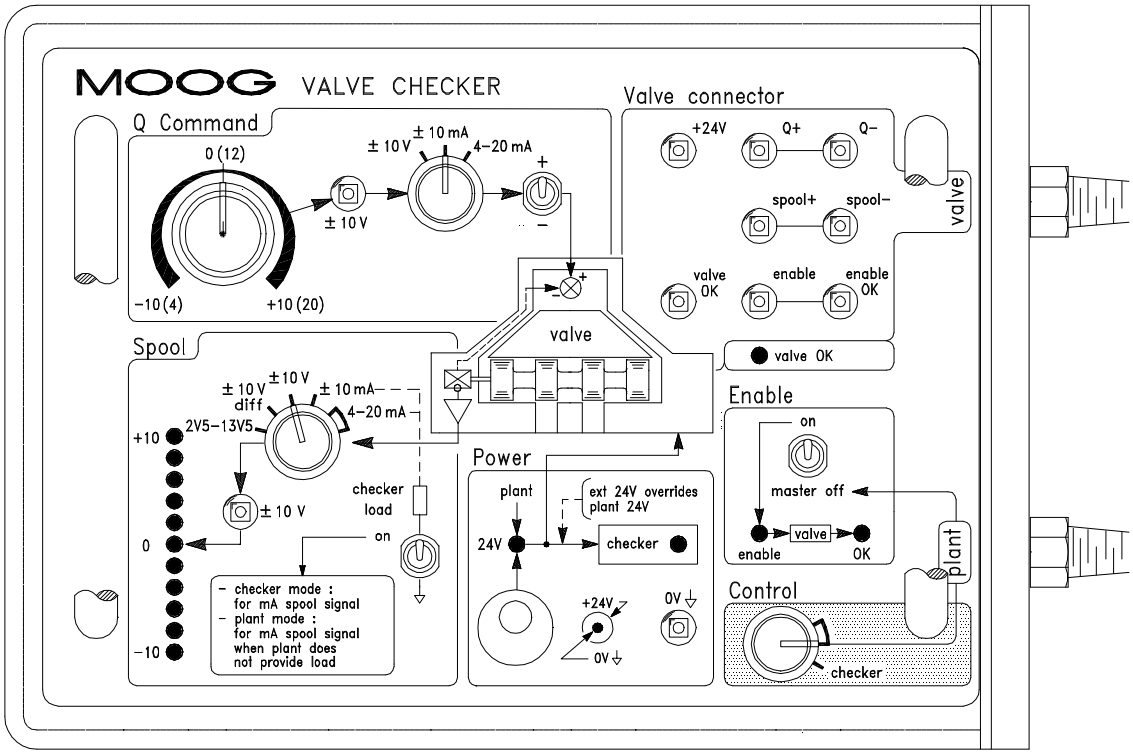
Q+ and Q- valve pin numbers:

Valve	Q+ pin	Q- pin
D66X 12 pin	D	E
D66X 11 + PE	4	5
D66X 6 + PE	D	E
D64X 6 pin	D	E
D633/4 6 pin	D	E
D633/4 6+ PE	D	E

5.8 LED Display

The *LED display* in the spool section shows the amplitude of the signal selected by the spool signal rotary *switch*. This *display* provides a rudimentary check of the spool signal. The centre *blue null* LED is illuminated when the spool position is within ± 10% of null.

6. CHECKER MODE OPERATION



+24V model (see Pg 12 for ±15V model illustration)

6.1 Checker Mode

Having successfully connected the Valve Checker as per chapter three, select *checker* mode on the *control* selector switch.

CAUTION: Ensure the *enable* switch is in the *master off* position and leave it in this position until all switch selections are made and the test is ready to proceed.

6.2 Q command pot, initial setting and polarity

Set the *Q command pot* to its centre zero position and select the signal type appropriate to the valve being tested. Set the ± *polarity* switch as required.

If you are uncertain of the polarity, it is recommended to use + as a starting point and check the direction of actuator travel in the process plant, when testing begins.

6.3 Spool

In the spool section select the appropriate spool signal. If selecting either 10mA or 4-20mA check if the plant electronics provides a load that enables the current signal to flow. If there is no load, turn on the *checker load switch*.

6.4 Enable

Begin the test by turning on the *enable* switch to enable the valve. The *enable LED* should illuminate confirming that the valve is enabled. The *enable* signal is also used in the valve checker to enable it to operate. On valves that do not have an “enable signal input”, the Valve Checker generates an internal enable signal.

6.5 Q Command

Adjust the *Q command pot.* Measure the command value, standardised to 0 to ±10V on the *grey* test point. Compare this value to the actual valve spool output on the *green* test point. For correct function they should be the same; within accuracy limits.

6.6 Checker Accuracy Limits

The accuracy limit of the Valve Checker is ± 0.2V for all signals. This means that if you read a command of 5.6V the feedback signal could be between 5.4 and 5.8V and the valve will be functioning correctly.

See pg. 10 for a table of Q+ and Q- valve pin numbers.

6.7 Valve Connector test points

The valve connector section test points enable a measurement directly on the valve input pins. This is useful if a test shows a fault and you want to be sure it is the valve and not the Valve Checker causing it. A knowledge of the input impedance of the valve is necessary to calculate the current level when the command is a mA signal.

6.8 LED Display

The *LED display* shows the amplitude of the spool signal. This *display* provides a rudimentary check of the signal. The centre *blue null LED* is illuminated when the spool position is within ±10% of null.

7. EXTERNAL 24V SUPPLY

7.1 The Valve Checker can be powered from the plant electronics via the plant connector or from the front panel 24V connector. When the external 24V is supplied to this front panel connector three things happen:

- The Valve Checker internal power is derived from this supply.
- The 24V supply to valves powered by 24V comes from this supply.
- The ±15V supply to valves powered by ±15V comes from the Valve Checker internal regulators, which in turn are powered by the external 24V.

7.2 Supply requirements are:

- 2.1mm diameter connector: 24V outside contact, 0V inside contact.
- 18V to 36V input range.
- 90 mA at 24V to power the Valve Checker with no valve load.

7.3 Typical 24V maximum supply requirements for some 24V powered valves are:

- D633 – 1.2A
- D634 – 2.2A
- D66X – 300mA

7.4 Typical 24V maximum supply requirements for some ±15V powered valves are:

- D66X – 400mA (300mA @ ±15V)

CAUTION: When the external 24V supply is connected, the plant supply is always automatically disconnected and the valve is then powered, directly or indirectly, from the external 24V supply. It is therefore essential that the external supply you connect has adequate current capacity to power the valve you are checking.

8. VALVE PERFORMANCE CHECKS

The Checker can be used to test null, threshold, step response and hysteresis. Because threshold and hysteresis on electrical feedback (efb) valves are very low, it can be difficult to get an accurate figure if the valve is operating within specification. Testing threshold and hysteresis is only of value if the valve is well out of specification; and then only to confirm incorrect operation, rather than accurately quantifying it.

8.1 Null

The Spool null position of a flow control (Q) valve is generally the point at which there is no flow from either port. This is the case with axis cut spools. However, valves can have overlapped, under-lapped and combinations of the three types that can make checking null a little tricky.
An accurate understanding of the specified null characteristic of a valve is essential before any sense can be made of null measurement results.

8.1.1 To check the null of an axis cut, or quasi axis cut spool (3% overlap), set the Q Command so the actuator controlled by the valve is stationary. Measure the command. This measurement is the null offset, or null error, of the valve. It will be difficult to get the actuator to stop for both types of axis cut spool. A slight creep one way or another is acceptable.

8.1.2 Checking the null on an overlapped vale is a little more difficult. Find a Q Command that holds the actuator stationary, or near stationary. A small amount of actuator creep is normal. Increase the Q Command until a definite actuator velocity is observed. Record this value.
Decrease the Q Command until an equal reverse actuator velocity is observed. Record this value. The two readings should be equal in magnitude but opposite in sign. The difference in the magnitude of the two readings is the null offset.

8.2 Threshold

8.2.1 Threshold on all types of valves is so low that it is difficult to use the Valve Checker to get an accurate figure. However the procedure outlined below will enable you to determine if the valve being checked is faulty, assuming the actuator has low threshold.

- Bring the actuator to a stop with the Q Command.
- Place your finger at the junction of the rod and gland and slowly move the Q Command back and forth around null. Limit the valve drive to less than ± 10%.
- Using your finger, monitor the motion of the rod as its direction reverses. The motion should be smooth and free of jerks.

8.2.2 On efb valves with spool position feedback, the same test can be done while monitoring the spool feedback signal with an oscilloscope or chart recorder. As the Q Command is smoothly reversed about null, the spool signal should show no discontinuity.

8.3 Step Response

Set the Q Command to a small value, say 10%. Switch the command on and off with the enable switch and observe the spool position feedback signal on an oscilloscope. A alternative method is to set a 10% Q Command and reverse the command to the valve by switching the ± switch.

CAUTION: This test may be detrimental to the process or machine, so it should only be done with care.

8.4 Hysteresis

8.4.1 To check hysteresis on an efb valve i.e. a valve with spool position feedback, start with the Q Command fully negative. Monitor the spool signal while changing the Q command towards null over several seconds. Stop when the spool signal reaches null. During this procedure do not reverse the direction while changing the Q Command. Measure the command signal that was required to null the spool signal.

8.4.2 Slowly over a period of several seconds increase the Q Command to the maximum positive value and then reverse it back towards null. It is important that the spool signal comes to null while decreasing the command. The measurements will be invalid if the command is reversed at any time. Now measure the command signal at null.

8.4.3 The difference between the two null measurements, above, is the hysteresis.

8. BLOCK DIAGRAM