



Estimated Task Completion: 60  
minutes

**Tools Required:**

N/A

**Supplies:**

N/A

**Parts:**

N/A

**Referenced Documents:**

TP-501, TP-502, TP-503, TP-505,  
TP-506, TP-519

**General Notes:**

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**Introduction**

The automated system for valve testing performs linearity, dead band, hysteresis, and dynamic response tests in accordance with TPs -501, -502, -503 and -505 respectively, using a PC-based data acquisition and control system. These tests are usually specified for new valves as QA requirements by the customer. In addition, it is also programmed for stroke time measurements.

The software for data acquisition programs is Labtech Notebook Pro version 8.04. This provides an icon-based programming environment.

There are three basic data acquisition programs - linearity and hysteresis, dead band, dynamic response tests. Two sets of tests are available: one for valves with increasing signal to open, and the other set for increasing signal to close the valve.

The programs for running through the test cycles are followed by respective data analysis programs. In addition to analysis, these programs generate a test report for Q/A and archive data files with additional information pertaining to the customer, WO etc.

## **Automated System For Valve Testing**

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This system for valve testing was developed with several specific purposes:

- To reduce the time taken for the set-up and for the tests themselves from an estimated eight hours per valve to one hour per valve
- To reduce the potential for operator errors which tend to add to the actual costs incurred in the assembly and testing.
- The automated system gives more accurate and consistent test results.

### **Prerequisite Skills**

- Compatibility of all interfaces
- Competent computer skills - ability to perform basic functions in the Windows Operating System on ( IBM-compatible ) PC platforms.

## Automated System For Valve Testing

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### Hardware Description

Hardware in the automated system for valve testing consists of the following.

IBM compatible PC system (486 DX/100 MHz processor)	
A/D plug-in board (CIO-DAS 1402)	16 single-ended channels or 8 differential channels 12-bit A/D Signal ranges 0-1 V to 0-10 V unipolar and +1V to -+10 V bipolar 50 KHz maximum throughput
D/A plug-in board ( CIO-DAC02 )	2 channels 12-bit D/A
Signal Interface Module	Includes 24 VDC power supply and connections between the data acquisition system and the valve (I/P and LVDT)
RVDT (probe + signal conditioning)	6 in. stroke length nominal 12 in. stroke length nominal
LVDT (probe + signal conditioning)	12 in. stroke length nominal 24 in. stroke length nominal

Two plug-in boards are installed in the PC-bus. The D/A board provides a 4-20 mA signal to control the valve. The system also accepts -2.5 to +2.5 VDC signals, which would be the valve response (position) from an RVDT (or LVDT) connected to the valve stem. A DC power supply is used to power the 4-20 mA loop.

The signal interface module has a built-in DC power supply to power the current loop. It also has built-in ammeter and a voltmeter that displays the mA to I/P and voltage from RVDT (or LVDT). The connections from the PC (a/d and d/a boards) to the interface module are hard wired. This module is only for making the connections from valve to the PC.

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## Operating Instructions

### Icon/Program List

Icons are set up for individual tests. Each icon runs through the test routine, providing a control signal to the valve, monitoring of the valve response, saving the data to a specified data file; in the same manner, the data is reduced, which can be printed for documentation.

#### Program Group TP INCR. SIGNAL TO OPEN

TP-501	Tests for linearity and hysteresis	Increasing signal opens the valve (includes TP-503 procedure)
TP-502	Test for dead band	Increasing signal opens the valve
TP-505	Test for dynamic response	Increasing signal opens the valve
CALIB	Calibration utility	Increasing signal opens the valve
STROKE	Stroke time measurement	Increasing signal opens the valve

#### Program Group TP : INCR. SIGNAL TO CLOSE

TP-501	Tests for linearity and hysteresis	Increasing signal closes the valve (includes TP-503 procedure)
TP-502	Test for dead band	Increasing signal closes the valve
TP-505	Test for dynamic response	Increasing signal closes the valve
CALIB	Calibration utility	Increasing signal closes the valve
STROKE	Stroke time measurement	Increasing signal closes the valve

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### Test Setup - Hardware Connections & Calibration

1. Plug-in and turn on computer. Connect air line to I/P if necessary.
2. Check RVDT operation per Module 12.
3. Calibrate Valve per TP-506 and TP-519.
4. If positioner has a pneumatic input signal (3-15 psig), calibrate test I/P for linear output. Check output at 4, 12, and 20 mA.
5. Connect valve positioner to computer. If positioner is electric, wire directly to computer interface module. If it is a pneumatic positioner, use 1/4 in polyflow tubing for test I/P to positioner.
6. Use calibration utility to position valve at mid-stroke.
7. Clamp RVDT to Actuator.
8. Attach temporary take-off arm to stem clamp.
9. Connect RVDT pull wire to temporary take-off arm. Ensure pull wire is plumb with valve stem.
10. Connect RVDT to power supply and interface module and turn power on.
11. Adjust the RVDT output to 0V at 50% (mid-stroke) by raising or lowering. This ensures linearity.
12. Ensure RVDT is securely clamped to Actuator and close valve. Adjust gain on interface module to -2.50V.

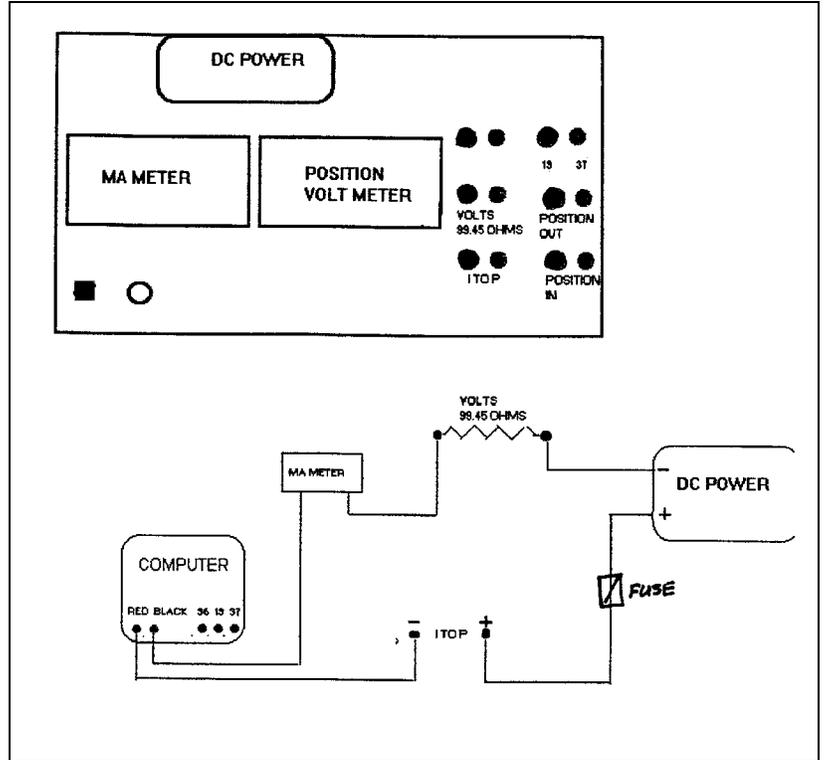
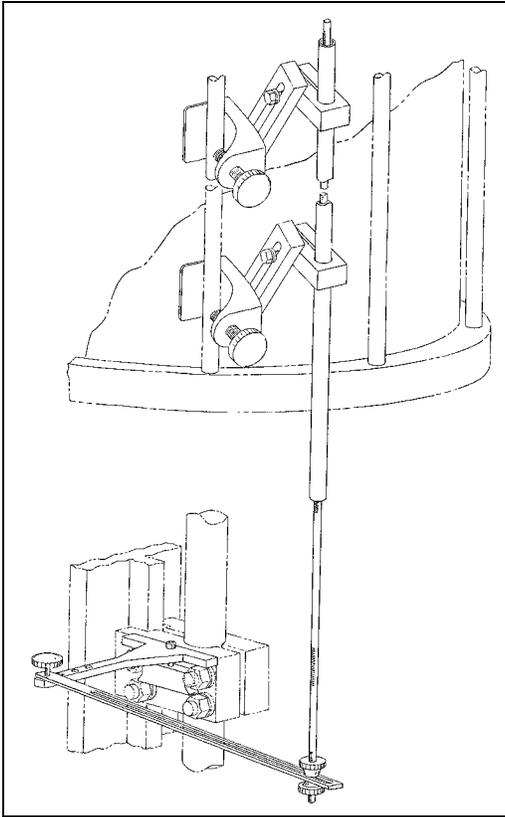
#### Note

For both increasing signal opens and increasing signal closes the RVDT output is -2.50V when fully seated.

13. Fully open valve. RVDT output should be +2.50V. If not, adjust RVDT span POT to move output to +2.50V.
14. Fully close valve. RVDT output should be -2.50V. If not, adjust RVDT zero POT to move output to -2.50V.
15. Repeat the previous two steps as necessary until the output on the interface module reads:
  - 0V at mid-stroke position
  - 2.50V when fully seated
  - +2.50V when fully open

# Automated System For Valve Testing

The connections from the a/d and d/a, which reside in the PC, to the interface module are hard wired. The connection diagram is shown below:



# Automated System For Valve Testing

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## Tests Procedures

### Linearity and Hysterisis Tests ( TP-501 REV. F)

*Run time- 6 minutes*

This test gives data for both linearity (TP-501 Rev. f) and hysteresis (TP-503 Rev. E).

1. Verify hardware connections. See the Test Setup section.
2. Verify that the signal interface module is ON and that the RVDT (or LVDT) is ON.
3. From the Program Manager, open the correct program group TP : INCR. SIGNAL TO OPEN or TP : INCR. SIGNAL TO CLOSE, depending on the valve specifications.
4. Double-click on icon - TP-501.
5. The program strokes the valve through the test cycle in the software. It is based on a 5-point test (data is taken starting at 10, 25, 50, 75 and 90% valve openings (TP-503 Rev. E)). When this test is completed, follow instructions in the next section for dead band test.

#### Note

The data analysis can be done only after the dead band test. Because the test just described gives hysteresis + dead band, therefore the dead band has to be determined to calculate hysteresis.

### Dead Band Test (TP-502 REV. C)

*Run time - 40 minutes*

1. Verify hardware connections. See the Test Setup section.
2. Verify that the signal interface module is ON and that the RVDT (or LVDT) is ON.
3. From the Program Manager, open the correct program group TP : INCR. SIGNAL TO OPEN or TP : INCR. SIGNAL TO CLOSE, depending on the valve specifications.
4. Double-click on icon - TP-502
5. The program strokes the valve through the test cycle in the software. When the test is completed, follow instructions for data analysis and data archival.

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### Dynamic Response Test (TP-505 REV. C)

*Run time - 10 minutes.*

1. Verify hardware connections. See the Test Setup section.
2. Verify that the signal interface module is ON and that the RVDT (or LVDT) is ON.
3. From the Program Manager, open the correct program group TP : INCR. SIGNAL TO OPEN or TP : INCR. SIGNAL TO CLOSE, depending on the valve specifications.
4. Double-click on icon - TP-505
5. The program strokes the valve through the test cycle in the software; when the test is completed, follow instructions for report and data archival.

### Stroke Speed Test (STROKE)

*Run time - Test Varies*

1. Verify hardware connections. See the Test Setup section.
2. Verify that the signal interface module is ON and that the LVDT is ON.
3. From the Program Manager, open the correct program group TP : INCR. SIGNAL TO OPEN or TP : INCR. SIGNAL TO CLOSE, depending on the valve specifications.
4. Double-click on icon - STROKE
5. The program will run the valve through this test in the software. Time for each stroke (up or down) is calculated as the difference of two clock readings - first clock times the instant control signal is changed, and the second clock times the instant that the valve position reaches the desired position within 1%.

#### Note

This test requires you to press the On/Off switch on the screen to stroke the valve. The switch is toggled by clicking the switch.

With each stroke, the time for stroking appears. At the end of the fourth cycle, the switch is turned Off and the average of the three readings are calculated.

#### Note

The average function is activated only at the end of the test. Therefore the reading acquired before the test may look like an error.

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5. When test is complete, print the screen showing the stroke speed data for documentation (press ALT-F, then P).
6. Exit the data display screen, by pressing ALT-F then X. Answer Y to the prompt.

### Calibration Utility

1. Verify hardware connections. See the Test Setup section.
2. Verify that the signal interface module is ON and that the RVDT (or LVDT) is ON.
3. From the Program Manager, open the correct program group TP : INCR. SIGNAL TO OPEN or TP : INCR. SIGNAL TO CLOSE, depending on the valve specifications.
4. Double-click on icon - CALIB

**Note**

30 minutes after the start, this program is set to automatically turn off.

The display screen shows two knobs - one for coarse control signal and the other for fine control signal to the valve. Two digital readouts show the values of the control signal and position feedback readings; these readings are moving averages with averaging time of 4 seconds.

5. Exit the data display screen, press ALT-F then X. Answer Y to the prompt.
6. To exit the program, press ALT-F then X.

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### Data Analysis, Report Generation and Data Archival

#### Linearity, Hysterisis and Dead Band Tests

1. Double-click on icon DATA ANALYSIS & REPORT. This starts a program that prompts for the customer name , valve S/N etc.
2. Type data as prompted. Press Enter when complete.

This program performs the following functions:

Print a test report and archive data files and test reports in subdirectory C:\NBP\_WIN\(\serial no.)\(\line item)\(\tag no),

**Where:** *serial no.* is the valve S/N

*line item* is the line item

*tag no.* is the tag number specified for the valve tested.

#### Dynamic Response Test

1. To reformat the data collected, double-click on the icon REFORMAT TP-505. This reformats the data and also archives similar to the previous test shown above.
2. To replay the data, double-click the icon RE-TP-505. When data is displayed (usually takes 1 minute), print the screen showing dynamic response data for documentation (press ALT-F, then P).
3. Exit the data display screen, press ALT-F then X. Answer Y to the prompt.
4. To exit the software, press ALT-F then X.

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## Appendix A - Logic and Listing of Data Analysis Programs

These programs have one or both of the following components : one, to write data collected in data files that are directly associated with the WO number and to write the relevant customer information in it; second, to analyze the data to calculate the desired parameters.

### 1. Linearity, Hysterisis and Dead Band Test

The main actions of this program are :

- Accept input from user on the output file names, and data pertaining to the test conducted (WO, customer etc.);
- Drop the data points at 0 and 100 % opening - these are not used in dead band, hysteresis or linearity estimation;
- Calculate dead band at each position (10, 25-, 50-, 75- and 90 % opening)
- Calculate hysteresis + dead band at each position (10, 25-, 50-, 75- and 90% opening) and determine hysteresis at each position by subtracting the corresponding dead band;
- Determine the maximum hysteresis and maximum dead band;
- Calculate the average calibration curve;
- Fit the calibration curve with a straight line using least-squares method;
- Compute the maximum deviation from linearity; and,
- Write data to an output file for report.

### 2. Dynamic Response Test

The main actions of this program are:

- accept input from user on the output file names, and data pertaining to the test conducted (WO, customer etc.)
- rewrite the data so it can easily be plotted in X-Y form by another program in Labtech Notebook Pro environment.

### 3. Stroke Speed Test

There is no data stored or analyzed.

### 4. Calibration Utility

There is no data stored or analyzed.