

# Transmitter Calibration with the Fluke 700 Series Documenting Process Calibrator

The precision sourcing and measurement capabilities of the rugged Fluke Documenting Process Calibrator (DPC) make it an ideal choice for the calibration of process instrumentation. The following examples show how to address transmitter calibrations quickly and effectively using the Fluke 701, 702, 741 or 743 Documenting Process Calibrator.

## Calibrating a 2 Wire Thermocouple Transmitter with the Fluke 700 Series Documenting Process Calibrators

The transmitter in this example is a 2 wire transmitter (needs loop power). The input stimulus for this device is from a type K thermocouple with an input range of 100 °C to 300 °C at 0 % and 100 %. The output drawn against loop power is 4-20 mA at 0 % and 100 % with a tolerance of 0.25 %. The steps below show how to: 1) perform a three point ascending (3↑) As Found (pre-adjustment) test at 0-50-100 %, and Tag the results, 2) adjust the zero and span (span = 100 %) of the transmitter, then 3) perform a three point ascending As Left (post-adjustment) test at 0-50-100 %, Tag those results and review them in memory.

1. Connect a type K mini-connector into the "TC" input of the DPC and connect to the thermocouple input of the transmitter (Figure 1). It is necessary that you use the correct type of mini-connector for this connection to the DPC.
2. Connect the center two terminals of the DPC to the connections on the transmitter where loop power is applied (Figure 1).

## Application Note

**Note:** If you prefer to use house loop power rather than supplying loop power from the DPC, connect these two leads in series with the loop supply to the transmitter.

3. Once your connections are made, starting from the DPC power up state (or measure screen), select the "mA" button to measure milliamps (Figure 2).

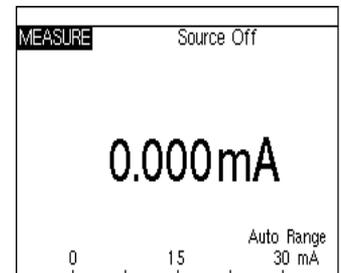


Figure 2

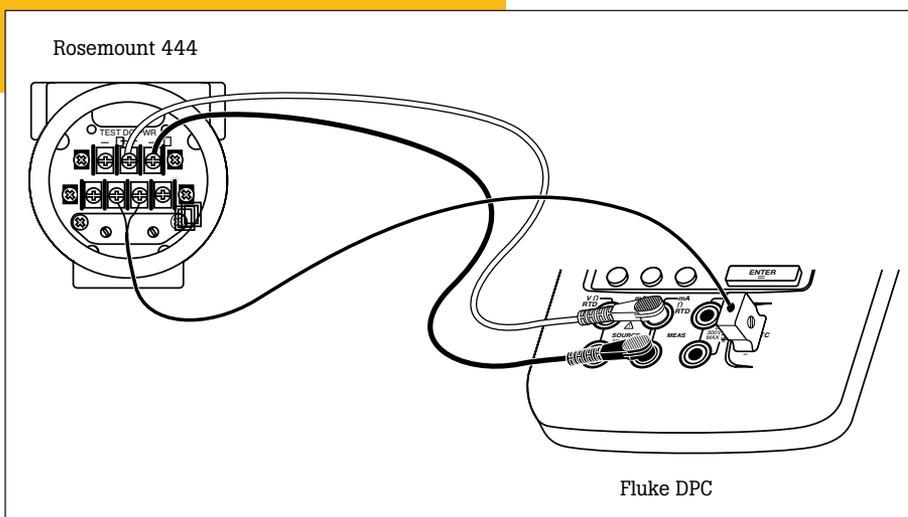


Figure 1

4. Next depress the "MEAS/SOURCE" button; now you are in the source screen. Since you want to source a thermocouple, press "TC/RTD" once. Use the down arrow to move the cursor to "K" and then press "ENTER." (On a 741 or 743, select "Linear T" and press ENTER.) The DPC will respond with "?????" asking for a temperature to source. Depress "100" and "ENTER" (Figure 3).

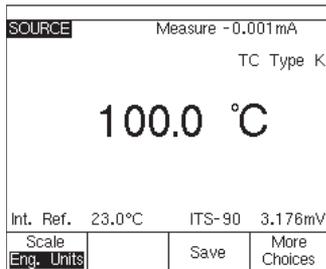


Figure 3

5. Next press the "MEAS/SOURCE" button once and you will be in the split screen mode (Figure 4).

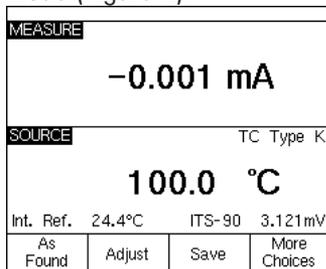


Figure 4

**Note:** Skip to step 7 if you are measuring current in series using the house loop power source mentioned in step (2).

6. Next, depress the "SETUP" button on the DPC. The cursor should begin on loop power. Depress "ENTER," down arrow until the DPC cursor is on Enable 24V and depress "ENTER." Next depress the "Done" softkey (Figure 5).

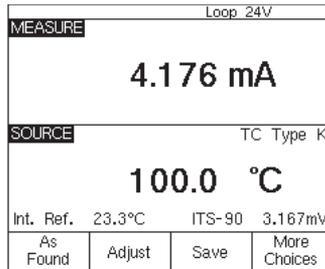


Figure 5

7. At this point depress "As Found" and fill in the template as follows (Figure 6). (On a 741 or 743, select "Instrument" and press "ENTER," then fill in the template. In place of "User-Entered Value= Disabled," use the default "Delay=0 seconds.")

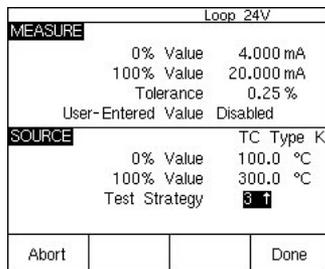


Figure 6

Depress "DONE." You should now see the split screen and are presented with soft key choices of "Abort," "Auto Test," and "Manual Test" (Figure 7).

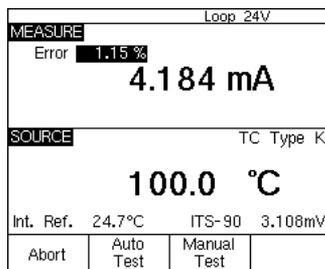


Figure 7

8. Select "Auto Test," and watch the DPC take 0 %, 50 % and 100 % measurements of current (4, 12 and 20 mA nominal) while sourcing 100 °C, 200 °C and 300 °C.

9. Once the DPC has completed this evaluation, it will display the post test summary screen with the SOURCE, MEASURE and ERROR columns. Failures in the error column will be in reverse video (Figure 8). Depress "Done."

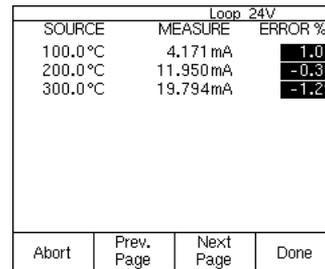


Figure 8

10. Now you are presented with the Tag entry screen (Figure 9).

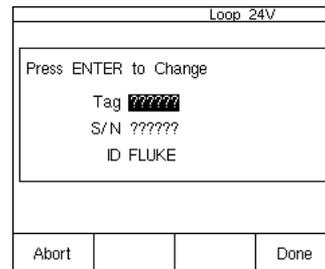


Figure 9

Press the "ENTER" key to edit the entries. Depress "Done" when complete until the split screen reappears with the soft key options of "As Left," "Adjust," "Save" and "More Choices" on the display of the DPC.

11. At this point, select "Adjust" and the DPC will source 0 % and measure for 4 mA to 0.25 %. As long as the error exceeds .25 % the error window in the measure half of the screen will be in reverse video. Adjust the zero on the transmitter until the error is less than 0.25 %. Next, select "Go to 100 %" and adjust the transmitter span in the same way. You may also "Go to 50 %" to check linearity at mid-span.

12. After adjustment is complete, select "As Left," "Done" and "Autotest." Watch the 0-50-100 % evaluations. If the adjustment was successful, all the errors in the post run summary should be in normal video (or less than .25 %) (Figure 10).

Loop 24V		
SOURCE	MEASURE	ERROR %
100.0 °C	4.011 mA	0.07
200.0 °C	11.985 mA	-0.09
300.0 °C	20.022 mA	0.14

Abort	Prev. Page	Next Page	Done
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Figure 10

13. Select "Done," "Done," and "Done" again and you are done!

**To review your results**

in memory, select the "More Choices" soft key, the "Review Memory" soft key and move your cursor to the applicable result. (On a 741 or 743, select "As Found" or "As Left," then "ENTER.") Press "ENTER" and review the setup for the test, select "Next Page" for the results, and press "Tag" for its associated label. Select "Done" and "Done" and you should be back at the results screen. Next, move your cursor to the applicable "As Left" result and press "ENTER" and review the setup for the test. Select "Next Page" for the results, and press "Tag" for its associated label. When you are finished reviewing results, press "Done" until right-most soft key label changes to "More Choices."

**3 and 4 Wire RTD Sourcing for the Fluke 700 Series Documenting Process Calibrators**

One of the most frequently asked application questions pertaining to the 700 Series Documenting Process Calibrators is, "How do I hook up the test leads to the DPC to source 3 and 4 wire RTDs?" For 3 and 4 wire RTD **measurement**, the DPC has embedded hookup diagrams that easily show you how to connect the DPC. However, for 3 and 4 wire RTD **source**, the DPC does not offer that assistance.

The example shown below (Figure 11) depicts the hookup for a 3 and 4 wire Rosemount 444 RTD Transmitter. You will need an additional pair of TL22 test leads and AC20 industrial test clips to complete all the connections necessary for this application. In order to double the available connections to the source terminals on the DPC, you also will need to utilize the short black jumpers supplied with the Documenting Process Calibrator.

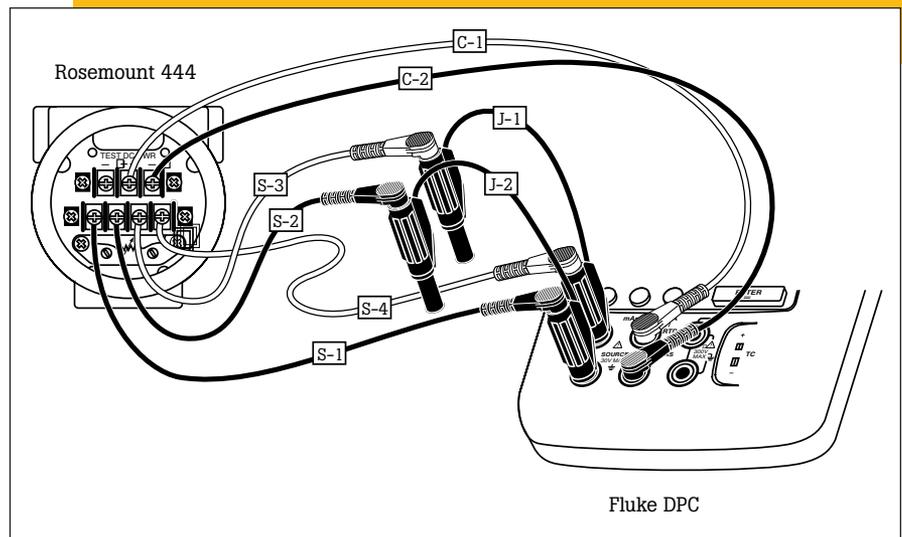


Figure 11

1. First insert the black jumpers, J1 and J2 into the process calibrator's RTD source terminals.
2. Then make the RTD source connections, S1, S2, S3 and S4 (omit S4 for 3 wire RTDs; it is only needed for 4 wire RTD sourcing).
3. Next, connect the loop power and current measurement connections, C1 and C2.
4. Once the connections are made as per the diagram in Figure 11, enable the loop 24 volt power from the setup screen, source the pertinent RTD for the specific transmitter being evaluated, and set the measure mode to mA.
5. At this point, enter the split screen mode of the DPC and perform the As Found, Adjust and As Left tests as you did in the previous thermocouple transmitter example.

## Calibration of an I to P (Current to Pressure) with the Fluke 700 Series Documenting Process Calibrators

A common device in the Fluke DPC workload is the I to P. The I to P device is used to convert electrical loop analog control of 4-20 mA to pneumatic analog loop control of 3-15 PSI. The device in this example is an I to P with current input values of 4-20 mA for 0 % and 100 % with output range of 3-15 PSI for 0 % and 100 %, +/- 2 %. This step-by-step example describes how to: 1) perform a three point ascending (3↑) As Found (pre-adjustment) test at 0-50-100 %, Tag the results, 2) Adjust the zero and span (span = 100 %) of the I to P, then 3) perform a three point ascending As Left (post-adjustment) test at 0-50-100 %, Tag those results and review them in memory.

1. Connect the pressure module to the DPC. Connect the output of the I to P to the input of the pressure module. If you are using a differential pressure module, make sure (for this example) that it is a 15 PSI module and connect to the input labeled "H" (Figure 12).
2. Connect from the center two banana type connections of the DPC to the input of the I to P where control current is supplied (Figure 12).
3. Once your connections are made, assuming you are in the power up state (or measure screen), select the "Pressure" button (directly above the "Range" button) (Figure 13).
4. Next depress the "MEAS/SOURCE" button; now you are in the source screen (Figure 14).

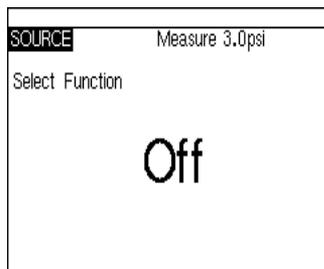


Figure 14

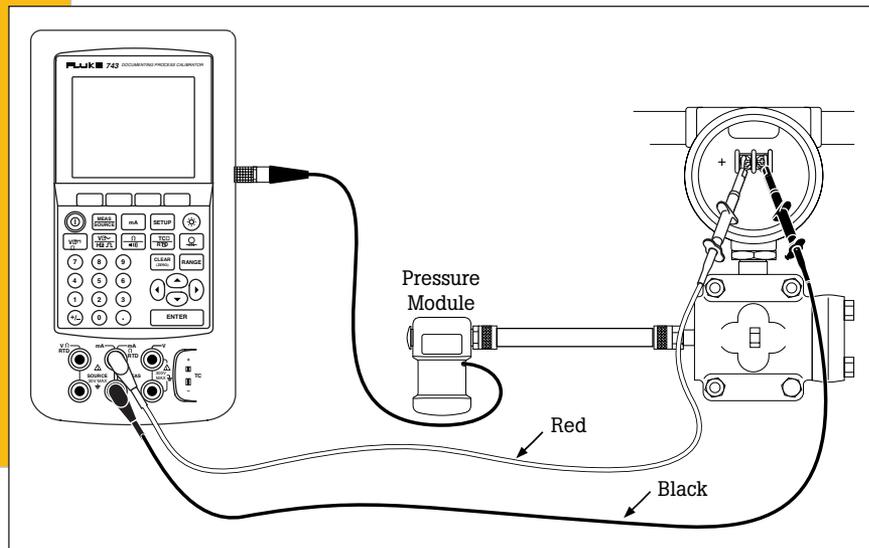


Figure 12

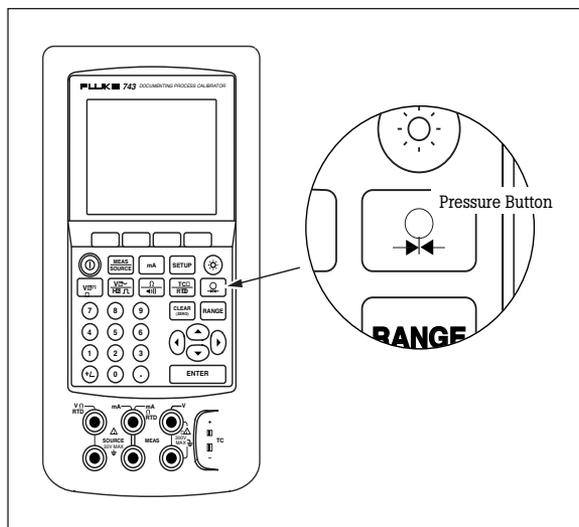


Figure 13

Since you want to source a current, depress "mA." Depress "ENTER" which chooses "Source mA" when given the choice of "Source mA" or "Simulate Transmitter." When the DPC responds with "?????" asking for a current to source, depress "0" and "ENTER."

5. Next depress the "MEAS/SOURCE" button once and you should be in the split screen mode (Figure 15).

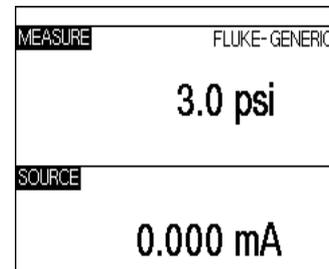


Figure 15

- At this point depress "As Found" and fill in the template as follows (Figure 16). (On a 741 or 743, select "Instrument" and press "ENTER," then fill in the template. In place of "User-Entered Value=Disabled," use the default "Delay=0 seconds.")

<b>MEASURE</b>		FLUKE-700P06
0% Value		3.00 psi
100% Value		15.00 psi
Tolerance		2.00 %
User-Entered Value		Disabled
<b>SOURCE</b>		
0% Value		4.000 mA
100% Value		20.000 mA
Test Strategy		3.1
Abort		Done

Figure 16

Press "DONE." You should now see the split screen, with soft key choices of "Abort," "Auto Test" and "Manual Test."

- Select "Manual Test," and watch the DPC start at 0 %. Once the reading has settled, depress "accept point." Perform the 50 % and 100 % measurements the same way.
- Once the 701/702 has completed this evaluation, it will display the post test summary screen with the SOURCE, MEASURE and ERROR columns. Failures appear in reverse video in the Error column (Figure 17). Depress "Done."

SOURCE	MEASURE	ERROR %
* 4.000 mA	* 3.368 psi	3.07
12.000 mA	* 9.067 psi	0.58
20.000 mA	* 14.662 psi	-2.62
Abort	Prev. Page	Next Page
		Done

Figure 17

- Now you see the Tag entry screen (Figure 18).

Press ENTER to Change			
Tag	??????		
S/N	??????		
ID	JIM		
Abort			Done

Figure 18

Press the "ENTER" key to edit the entries. Depress "Done" when complete until the split screen reappears with the soft key options of: "As Left," "Adjust," "Save," and "More Choices."

- At this point, select "Adjust" and the DPC will source 0 % (4 mA) and measure for 3 PSI to 2 %. As long as the error exceeds 2 % the Error window in the measure half of the screen will be in reverse video. Adjust the zero on the I to P until the error is less than 2 %. Next select "Go to 100 %" and adjust span in the same way. Select "Go to 50 %" and evaluate linearity.
- After adjustments are complete, select "As Left," "Done" and "Manual Test" and repeat step (8). If the adjustment was successful, all the errors in the post run summary should be in normal video (Figure 19).

SOURCE	MEASURE	ERROR %
4.000 mA	* 3.056 psi	0.47
12.000 mA	* 9.177 psi	1.48
20.000 mA	* 14.632 psi	-1.40
Abort	Prev. Page	Next Page
		Done

Figure 19

- Select "Done," "Done," and "Done" again and you are done!

**To review your results in memory,** select the "More Choices" soft key, then the "Review Memory" soft key. Move your cursor to the applicable result. (On a 741 or 743, select "As Found" or "As Left," then "ENTER.") Press "enter." After reviewing the setup for the test, select "Next Page" for the results, and press "Tag" for its associated label. Select "Done" and "Done" and you should be back at the results screen. Next move your cursor to the applicable "As Left" result and press "enter." Review the setup for the test, select "Next Page" for the results, and press "Tag" for its associated label. When you are finished reviewing results, press "Done" until right-most soft key label changes to "More Choices."

## Calibration of a P to I (Pressure to Current) with the Fluke 700 Series Documenting Process Calibrators

A common device in the Fluke DPC workload is the P to I. The P to I device is used to convert pneumatic analog loop control signals of 3-15 PSI to electrical loop analog control signals of 4-20 mA. The device in this example is a P to I with pressure input values of 3-15 PSI for 0% and 100% with output range (drawn from loop power) of 4-20 mA for 0% and 100%, +/- 2%. In this step-by-step example we will:

- 1) perform a three point ascending (3 ↑) As Found (pre-adjustment) test at 0-50-100%, and Tag the results, 2) adjust the zero and span (100%) of the P to I, then
- 3) perform a three point ascending As Left (post-adjustment) test at 0-50-100%, tag those results and review them in memory.

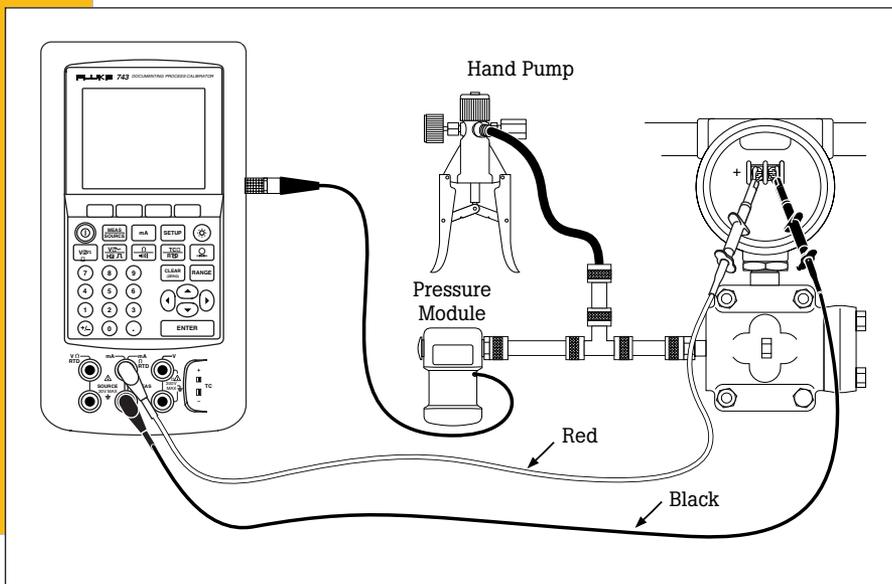


Figure 20

1. Connect the pressure module to the DPC. Connect the input of the P to I and the output of a pressure hand pump to the input of the pressure module using a "T" connector (Figure 20). If you are using a differential pressure module, ensure (for this example) it is a 15 PSI module and connect to input labeled "H."
2. Connect from the center 2 banana type connections of the DPC to the input of the P to I where loop power is supplied (Figure 20).
3. Next, depress the "SETUP" button on the DPC. The cursor should begin on loop power. Depress "ENTER," down arrow until the DPC cursor is on Enable 24V and depress "ENTER." Next depress the "Done" softkey.
4. Once your connections are made, assuming you are in the power up state (or measure screen), select the mA button.

5. Next depress the "MEAS/SOURCE" button; now you are in the source screen (Figure 21).

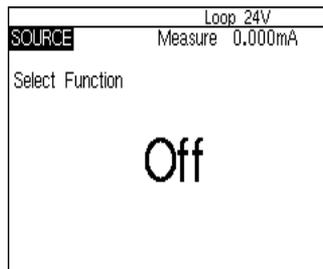


Figure 21

6. Since we wish to source a pressure (using a hand pump) depress the pressure button, (directly above the range button) (Figure 22).

7. Next depress the "MEAS/SOURCE" button once and you should be in the split screen mode (Figure 23).

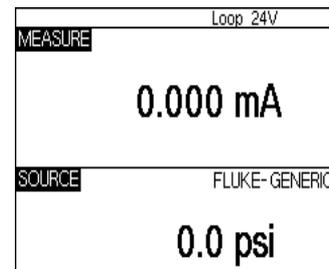


Figure 23

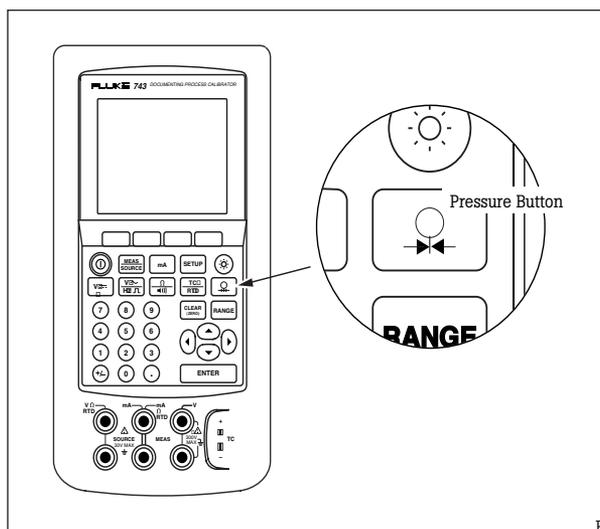


Figure 22

- At this point depress "As Found" and fill in the template as follows (Figure 24). (On a 741 or 743, select "Instrument" and press "ENTER," then fill in the template. In place of "User-Entered Value=Disabled," use the default "Delay=0 seconds.")

Loop 24V	
<b>MEASURE</b>	
0% Value	4.000 mA
100% Value	20.000 mA
Tolerance	2.00 %
User-Entered Value	Disabled
<b>SOURCE</b>	FLUKE-700P04
0% Value	3.000 psi
100% Value	15.000 psi
Test Strategy	5 T
Abort	Done

Figure 24

Depress "DONE." You should now see the split screen and are presented with soft key choices of "Abort," "Auto Test," and "Manual Test."

- Select Manual Test, and watch the DPC for the prompt: "Go to 3 PSI" (Figure 25).

Loop 24V	
<b>MEASURE</b>	
Error	6.25 %
<b>1.000 mA</b>	
<b>SOURCE</b>	FLUKE-700P04
Go To 3.000psi	
<b>0.000 psi</b>	
Abort	Auto Test Manual Test

Figure 25

At that point using the hand pump, pump until the DPC display is reasonably close to 3 PSI and depress "Accept Point." Now the DPC should display "Go to 9 PSI." Again, using the hand pump, pump up reasonably close to 9 PSI and depress "Accept Point." When the DPC responds with "Go to 15 PSI" pump to that value and "Accept Point." It is important to understand a key feature of the DPC at this point. When the error is being calculated on the measured mA by the DPC, it will make the calculation based on the deviation of

the amount of pressure being sourced. What this means is, if you are sourcing 3.120 PSI (1% of span above nominal), the DPC will look for a mA reading of 4.160 mA (also 1% of span above nominal). In order to make a proper evaluation of the device you need only to get reasonably close to the nominal pressure values with the hand pump. The remaining source pressure error is compensated for by the DPC during mA measure calculations.

- Once the DPC has completed this evaluation, it will display the post test summary screen with the SOURCE, MEASURE and ERROR columns (Figure 26). Depress "Done."

Loop 24V		
SOURCE	MEASURE	ERROR %
3.038psi	4.017 mA	-0.21
* 8.953psi	11.489 mA	-2.80
14.949psi	19.201 mA	-4.57
Abort	Prev. Page	Next Page
Done		

Figure 26

- Now you are presented with the Tag entry screen (Figure 27).

Loop 24V	
Press ENTER to Change	
Tag	??????
S/N	??????
ID	JIM
Abort	Done

Figure 27

Press the "ENTER" key to edit the entries, press "Done" when complete until the split screen reappears with the soft key options of: "As Left," "Adjust," "Save," and "More Choices."

- At this point, select "Adjust" and the DPC will source 0%, instruct you to "Go to 3 PSI" and measure for 4 mA to 2%. As long as the error exceeds 2% the Error window in the measure half of the screen will be in reverse video. Adjust the zero on the P to I until the error is less than 2%. Next select "Go to 100%" and adjust span in the same way.
- After adjustment is complete, select "As Left," "Done" and "Manual Test" and repeat step (9). If the adjustment was successful, all the errors in the post run summary should be in normal video (Figure 28).

Loop 24V		
SOURCE	MEASURE	ERROR %
* 3.063psi	4.018 mA	-0.41
8.999psi	12.000 mA	0.01
15.087psi	19.929 mA	-1.17
Abort	Prev. Page	Next Page
Done		

Figure 28

- Select "Done," "Done," and "Done" again and you are done!

**To review your results in memory,** select "More Choices" soft key, "Review Memory" soft key, move your cursor to the applicable result. (On a 741 or 743, select "As Found" or "As Left," then "ENTER.") Press "ENTER" and review the setup for the test, select "Next Page" for the results, depress "Tag" for its associated label. Select "Done" and "Done" and you should be back at the results screen. Next move your cursor to the applicable "As Left" result and depress "ENTER" and review the setup for the test, select "Next Page" for the results, depress "Tag" for its associated label. When you are finished reviewing results, press "Done" until right-most soft key label changes to "More Choices."

**Note on Uploading Results to Your PC**

If you are using a Fluke 702, your results may be uploaded to your PC using Fluke PMLink® Software. If you are using a 702 or a 743, you may choose an instrumentation management software package from this list:

- **Fluke DPC/TRACK™**
  
-  **Cornerstone Cal Station and Base Station**  
The Open Platform for Instrument Management
  
- **beamex** QM6 Quality Manager Calibration Software
  
- **Honeywell Loveland™** InstruMint and DocuMint, Meridium, Intergraph Intools SPI, Prime technologies ProCal

**Additional information is available for download from [www.fluke.com](http://www.fluke.com) on these products**

- Pressure Calibration Application Note
- Custom Units Application Note
- Switch Test Application Note
- HART Calibration Application Note
- Process Tools Accessories

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