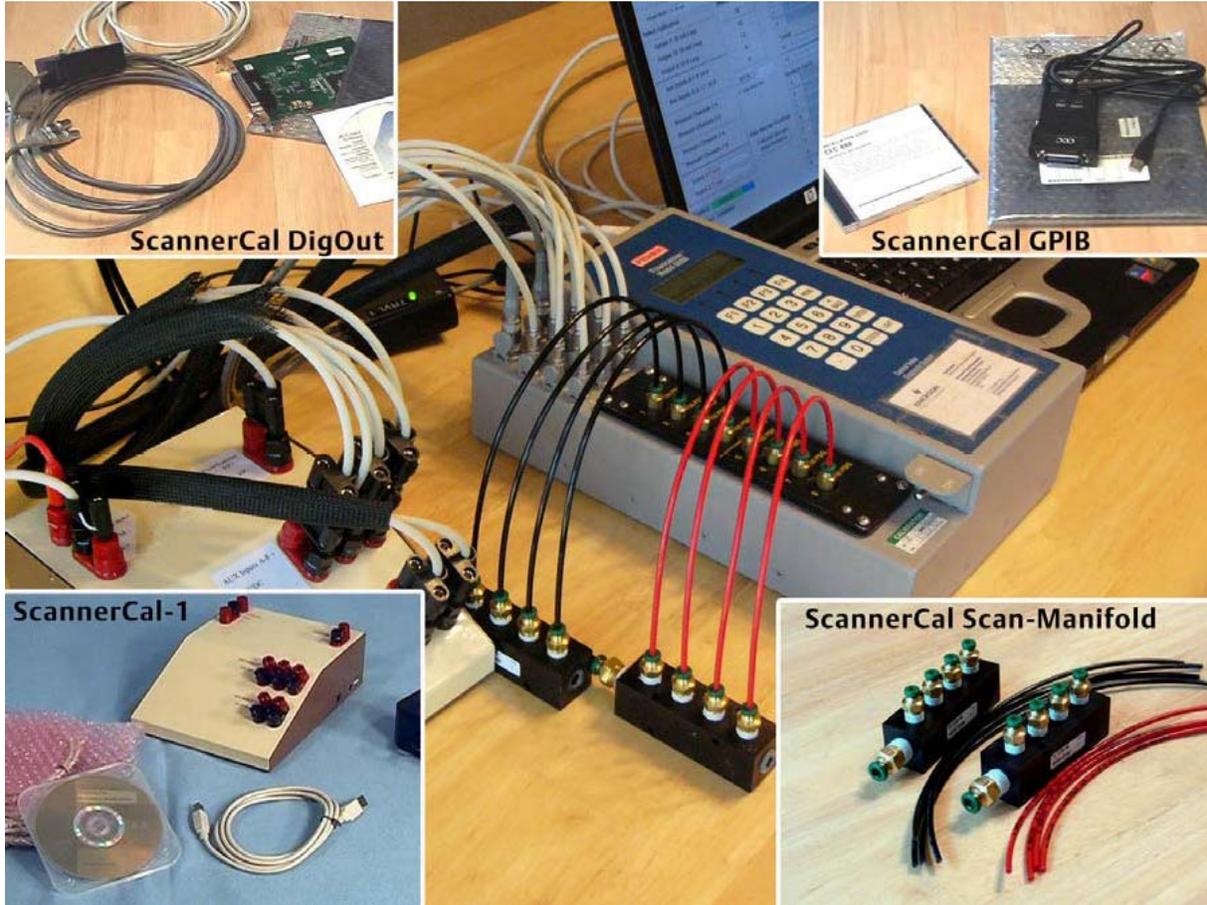


# ScannerCal Accuracy Verification System for the FlowScanner



## ScannerCal Accuracy Verification System

Verify the calibration and accuracy of the FlowScanner™ 6000 with the ScannerCal Accuracy Verification System. ScannerCal uses electrical test signals and compares the FlowScanner 6000 readings with laboratory test instruments. Test results can be automatically copied from the FlowScanner and test instruments to an Excel spreadsheet for complete and accurate record keeping.

ScannerCal does not include the master instruments needed for comparison to FlowScanner readings, as most calibration labs already have similar instruments. Our shops use the Agilent 3458A Multi-meter and Druck DPI 515 pressure calibrator.

ScannerCal provides the needed interconnections between the instruments and FlowScanner, and the software to record readings.

ScannerCal does not perform any adjustment of the calibration. It only documents the accuracy. If the accuracy changes the FlowScanner requires repair, not recalibration.

The ScannerCal Accuracy Verification System consists of the following components:

- Interface Box for testing the electrical analog inputs and output of the FlowScanner.
- Aux Input Cables to connect the interface box to the FlowScanner auxiliary inputs.
- An optional GPIB/USB instrument bus converter to connect laboratory test instruments to the computer.
- Two optional Scan-Manifolds with 1/4" tubing inlets and four 1/8" tubing outlets for connecting the FlowScanner pressure channels to a single pressure line.
- Optional DigOut digital output card and travel simulator cables for testing the two travel inputs on the FlowScanner. The DigOut is available as both a PCI card for desktop computers and a PCMCIA card for laptop computers.

ScannerCal was originally developed for Emerson Instrument & Valve Services internal use for production testing of FlowScanner systems. You get the same hardware and software we use to certify the accurate operation of the FlowScanner.

## Computer Requirements

ScannerCal software will run on a computer running Microsoft Windows XP or later. The computer will need a CD-ROM reader for installing the software. The computer will also need an Ethernet interface for connecting the FlowScanner, and an available USB port for connecting the interface box and the optional Agilent multimeter and Druck calibration units. ScannerCal does not need to use the same computer that the FlowScanner uses for field work

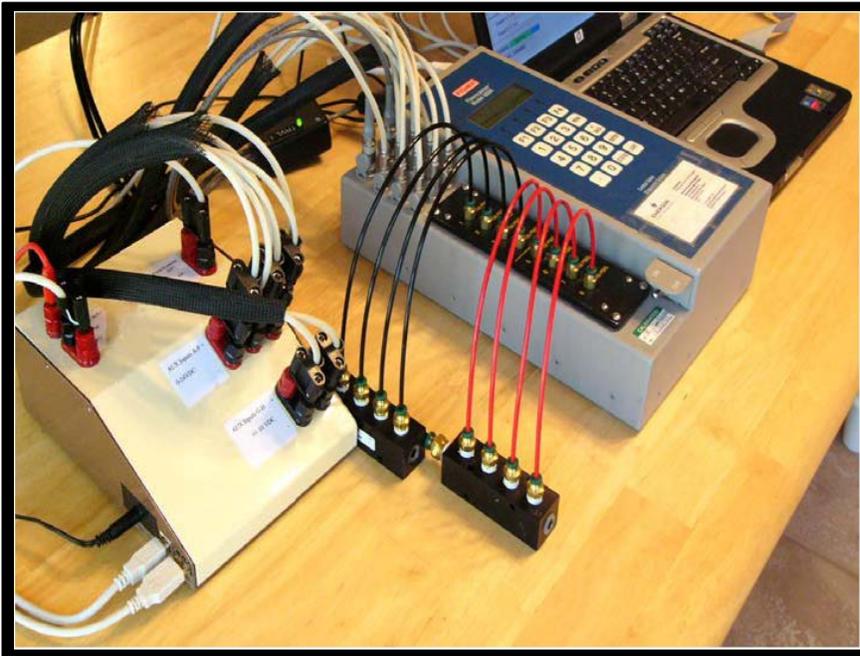
If the DigOut option is used to test the travel inputs, an expansion slot (either PCI or PCMCIA) is also needed.

Because ScannerCal is provided only for licensed users of the FlowScanner 6.X software, it is governed by the terms of the license provided with that software.

## ScannerCal Equipment Installation and Setup

Figure 1 shows the complete ScannerCal Calibration System connected to a computer and a FlowScanner™ 6000.

Figure 1. ScannerCal Calibration System connected to a FlowScanner™ 6000



The software drivers should be installed before connecting the ScannerCal hardware. These programs can be loaded either from the hardware drivers folder on the ScannerCal 6.3 CD, or from the Measurement Computing CD which is included with the ScannerCal system. (The Measurement Computing CD should have the most recent version of the software.) Then the interface box should be connected to the computer and the InstaCal configuration program should be run.

The procedure is as follows:

1. Insert the CD in the PC's CD-ROM drive.
2. Run the "MCCSETUP" program to install the software drivers. When the installation is complete, a dialog box appears advising you that you need to restart the computer. Select "Yes."
3. Connect the power supply to the ScannerCal-1 Interface Box, and plug the power supply into an AC outlet. The interface box will power up as soon as the power supply is connected.
4. Connect a USB cable from the computer to the ScannerCal-1 Interface Box. Windows should find the hardware and run a Wizard to install and configure it. Follow the instructions until Windows reports that the new hardware is ready to use.
5. Select Start/Programs/Management Computing, and run the InstaCal software to configure the interface. This program identifies the USB ScannerCal-1 Interface Box as "USB-ERB08." InstaCal records this configuration information in a file so the ScannerCal software can find it.

Note: You will need to run the InstaCal program again if you install a DigOut card.

## Optional Scan-Manifold Installation

Two manifolds are provided for connecting pressure master sources (0-100 and 0- 150 psig) to the FlowScanner pressure inputs. Each manifold has a ¼-inch input and four 1/8-inch outputs. Two different colored 1/8-inch tubing are provided; black for the 100 psig channels, and red for the 150 psig channels. Using a Dual-Output Druck DPI 515 as the pressure master source, one manifold can be connected to each output, and the software will switch outputs as needed.

1. Connect the ¼-inch tube to the input of each manifold and to a pressure master source (Druck DPI 515 recommended).
2. Connect the four black 1/8-inch tubes to the 0-100 psig manifold, and the other ends to the four 100 psig inputs on the FlowScanner.
3. Connect the four red 1/8-inch tubes to the 0-150 psig manifold and the 150 psig inputs on the FlowScanner.

## Optional GPIB Converter Installation

By installing a GPIB-to-USB converter on the Agilent multi-meter and the Druck DPI 515 pressure master, the ScannerCal software can automatically control these devices and input their readings.

1. Install the software driver that comes with the interface. Follow the manufacturer's directions.
2. Connect the converter to the Agilent multi-meter and/or the Druck DPI 515 test instrument.
3. Connect the USB cable to either the USB port on the ScannerCal-1 Interface Box or to another USB port on the PC.
4. Follow the usual prompts until Windows reports the hardware is ready to use.

Note: ScannerCal will probably work with most GPIB converters; however it has only been tested with the ICS and CEC USB-to-GPIB interfaces.

## Optional DigOut Installation and Configuration

Before installing the DigOut interface card, the software drivers may need to be installed and the InstaCal configuration program should be run. If the drivers were installed for the ScannerCal-1 system, they do not need to be reinstalled for the DigOut card. If they do need to be installed, they can be loaded either from the hardware driver's folder on the ScannerCal 6.3 CD, or from the Measurement Computing CD. (The Measurement Computing CD should have the most recent version of the software.)

1. Insert the CD in the PC's CD-ROM drive.
2. (Skip this step if drivers were installed as part of the ScannerCal-1 installation process.)

Run the "MCCSETUP" program to install the software drivers. When the installation is complete, a dialog box appears advising you that you need to restart the computer. Select "Yes." Leave the CD in place for a future step.

3. If the PCI version is being installed for a desktop computer, shut the computer off, and follow the manufacturer's instructions to open the case and install the card into an available PCI slot. Then restart the computer.
4. If the PCMCIA version is being installed in a laptop computer, it is not necessary to shut the computer off. Simply connect the Travel Simulator cables to the card and insert the card into an available PCMCIA (PC-CARD) slot.
5. Windows will recognize the new card and run the wizard to install it. Follow the prompts until Windows reports the hardware is ready to use.

6. Ensure that power is applied to the ScannerCal Interface Box and that the box is connected to the PC via a USB cable.
7. Select Start/Programs/Management Computing, and run the InstaCal software to configure the interface. This program identifies both the DigOut card and the ScannerCal-1 Interface Box. InstaCal records this configuration information in a file so the ScannerCal software can find it. If the interface card is changed or moved, run InstaCal again to change the configuration information.

## ScannerCal 6.3 Software Installation

The ScannerCal installation program installs the ScannerCal program and two Excel templates that are used to generate reports.

1. Insert the ScannerCal 6.3 CD.
2. Run the “setup” program in the ScannerCal Setup folder.

The setup program will install ScannerCal in directory “C:\Program Files\Emerson Process Management\ScannerCal 6.3.” The Excel templates will be just below this directory in a templates folder. These templates are for the standard FlowScanner Inspection and Test Report (FITR). Templates for both the standard 4&4 pressure and special 6&2 pressure channel configurations are provided. These Templates can be copied or moved to another location if desired.

## Ethernet Connection to FlowScanner™ 6000

The test PC communicates with the FlowScanner via an Ethernet cable. The simplest way to establish this connection is to connect the PC directly to the FlowScanner using an Ethernet crossover cable. If the PC must remain on a LAN, you have two options: 1.) you can change the FlowScanner’s IP address to one that will work on the LAN, or 2.) you can insert a router between the PC and the LAN, and connect the FlowScanner to the router. Whichever method you choose, the IP address of the PC must be in the same subnet range as the FlowScanner’s IP address.

If the computer will connect directly to the FlowScanner with a crossover Ethernet cable, set the address on the PC Ethernet port to work with the FlowScanner. For example: the FlowScanner 6000™ normally has a default IP address of 10.6.0.10, subnet mask 255.255.255.0. The PC could then be set to 10.6.0.101, subnet 255.255.255.0.

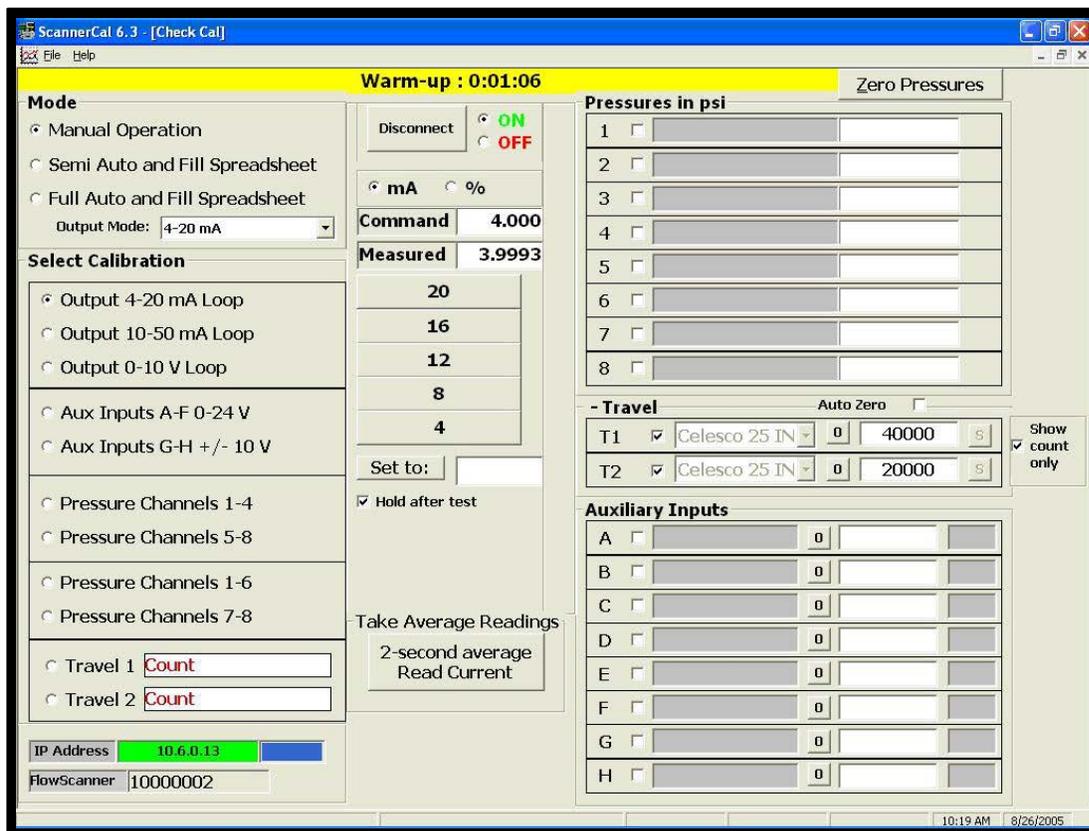
If the PC must remain on a LAN, then one option is to change the IP address of the FlowScanner to a static IP address that will work on the LAN. The PC can then access both the LAN and FlowScanner.

Another option that allows the FlowScanner address to remain at the default setting is to use an inexpensive router to isolate the PC and FlowScanner from the LAN. Routers are available for cable/DSL that includes a DHCP function to automatically assign an IP address to the computer. Set the local DHCP of the router to assign addresses of 10.6.0.100 and higher. This won’t duplicate the FlowScanner address but it will still assign an address that is within its subnet range.

## ScannerCal Software Operation

ScannerCal certifies the accuracy of the FlowScanner by running it through a series of nine tests. If the DigOut option is detected it will run two additional tests on the two travel channels. During each test, the FlowScanner readings are inputted into ScannerCal through the Ethernet connection, and, if a digital multi-meter is connected, the multi-meter readings are also read. Both of these readings are entered into a report spreadsheet.

Figure 2. ScannerCal main display - The nine tests are listed on the left along with the two travel channel test

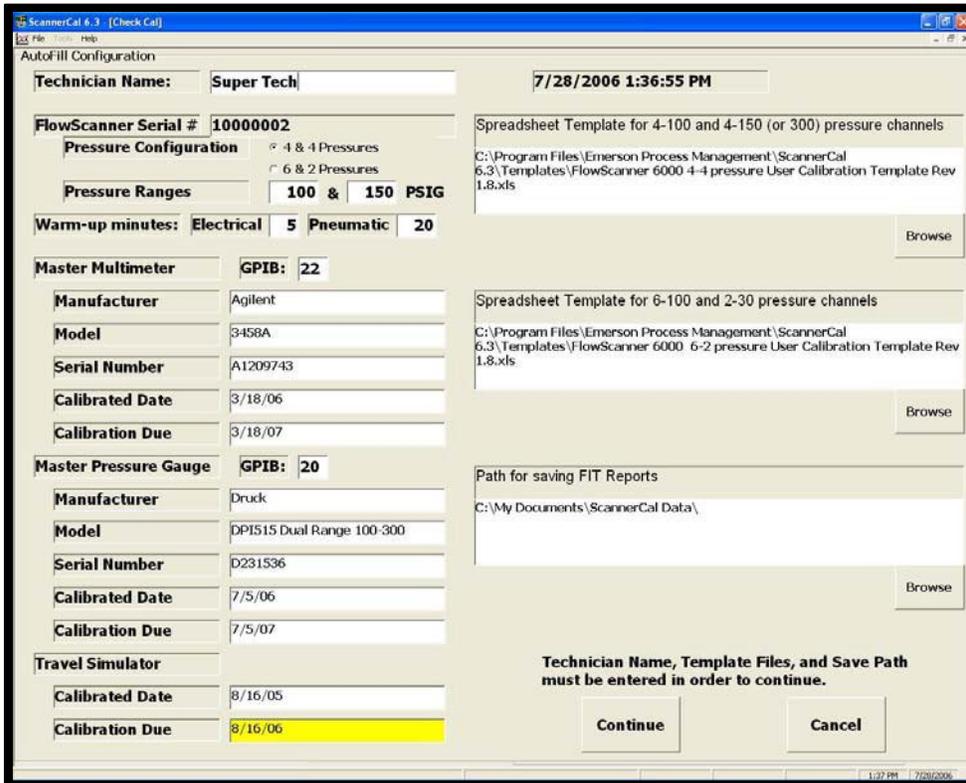


### Configure the Instrument Details and File locations

The first time you run the ScannerCal software, you must input details about the test instruments, indicate where to find the spreadsheet templates, and indicate where to save the report files.

1. Ensure the ScannerCal Interface Box is connected and powered on, and any GPIB connected instruments are powered on. Then start ScannerCal 6.3.
2. Open the Tools/Configure/File Options menu.

Figure 3. ScannerCal File Options display showing the test instrument details and the paths to the spreadsheet directories



3. Enter the information for the master multi-meter. If the instrument is connected to the computer by a GPIB bus for automatic reading, enter the GPIB address. Then enter the manufacturer, model, serial number, and calibration dates as indicated. The software will compare the calibration due date to the current date, and warn when the due date is approaching or past by changing the field background color.
4. Enter the master pressure instrument information the same way.
5. If a DigOut Travel Simulator is used, record the calibration date and the due date.
6. Select the Browse button and select the spreadsheet template. (Normally in the Templates folder).
7. Select the Browse button to select the folder for the final report. You can select any drive/folder location to store the reports. If any unit fails the tolerance evaluation, ScannerCal will create a "FlowScanner Failed Calibration" folder within this specified folder and put the report there.
8. When all information is correct, click the Save button and a configuration file will be created. These details can be edited later if desired.
9. End the ScannerCal software.

## Connecting a FlowScanner™ 6000 to the ScannerCal System

Connect the FlowScanner 6000 to be tested to the ScannerCal system before starting the ScannerCal software. The procedure is as follows:

1. Connect the FlowScanner power supply and Ethernet cable.
2. Connect the single 3-foot cable to the I/P connector on the interface box. A small tab on the banana plug indicates the negative terminal. Plug this negative terminal into the black post. Connect the other end to the I/P connector on the FlowScanner.
3. Connect the six 3-foot cables to the three posts for channels A through F on the interface box. Two banana plugs should be installed on each post. Connect the other ends of these six cables to AUX Inputs A through F on the FlowScanner
4. Connect the two 3-foot cables to the posts for channels G and H.
5. Connect the 4-foot dual-banana cable, and the single banana lead to the DVM posts. Connect the other end to the Agilent multi-meter. The single lead is used for the current input.
6. Connect the eight 1/8-inch tubes from the pressure manifolds to the FlowScanner.
7. If the DigOut option is used, connect the two Travel Simulator cables to travel inputs 1 and 2 on the FlowScanner.
8. Power on the FlowScanner and all test instruments.
9. Start the ScannerCal software.

Figure 4. The tab on banana plug indicates the negative side



## ScannerCal Connect Operation

Unlike the FlowScanner program, ScannerCal will not attempt to find the FlowScanner until the “Connect” button is clicked. The IP address bar starts by showing the IP address that is entered in the Tools/Configuration menu and the red background shows it has not found the unit.

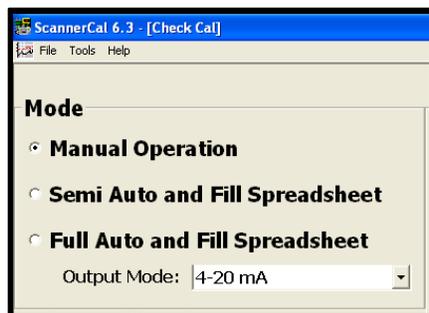
If the FlowScanner LCD shows that it has a different IP address than that shown by ScannerCal, open the ScannerCal Tools/Configuration menu and change the IP address that ScannerCal will use to look for the FlowScanner. Then close and restart ScannerCal to use the new address.

1. Click the Connect button. If the IP address is found, the background of the bar turns green, and the serial number of the FlowScanner is shown under the IP address bar. This serial number is read automatically from the unit and will be entered into the calibration reports. This is the same serial number that is recorded in the test data files when valves are tested. In this way you can verify that the tests were performed with a certified FlowScanner.
2. Select the ON radio button to turn on the FlowScanner data acquisition. This activates the electronics in the FlowScanner. The ScannerCal screen will now track the Warm-Up time in the status bar at the top of the screen. If a test is selected before the recommended warm-up time for that function, the status bar will turn yellow. If an automatic test sequence is selected, tests will not run until the warm-up time is correct. These warm-up times can be specified when configuring an automated sequence.

## Three Modes of Operation

ScannerCal can run certification tests in manual, semi-automatic, or full-automatic sequences. The manual sequence allows the technician to select each test from the list on the left of the screen. If the ScannerCal Interface box is detected, the software will switch the circuits to connect the required inputs and outputs. If it is not detected it will prompt the technician to switch the manual switches on the older ScannerCal Interface box.

Figure 5. ScannerCal's three modes of operation



ScannerCal also checks to see if the DigOut card for testing the travel inputs is detected, and checks to see if it is connected to the Agilent digital multi-meter and Druck pressure calibrator. It will offer appropriate semi-automatic and full-automatic sequences for the instruments detected. If the multi-meter is detected, but not the Druck, it will allow automatic sequence of the electrical I/O tests, and then semi-automatic sequence for the pressure calibration.

### Manual Mode

You should use the manual mode if you will be using your own report format and not one of the spreadsheet templates. Manual mode does not fill in the spreadsheet with the data readings, but it provides buttons that allow the user to easily copy- and-paste readings into any other PC program. You can manually select any plateau/test to run.

Note: If the spreadsheet templates are used for reports, Semi-Automatic or Full- Automatic modes are recommended.

### Semi-Automatic Mode

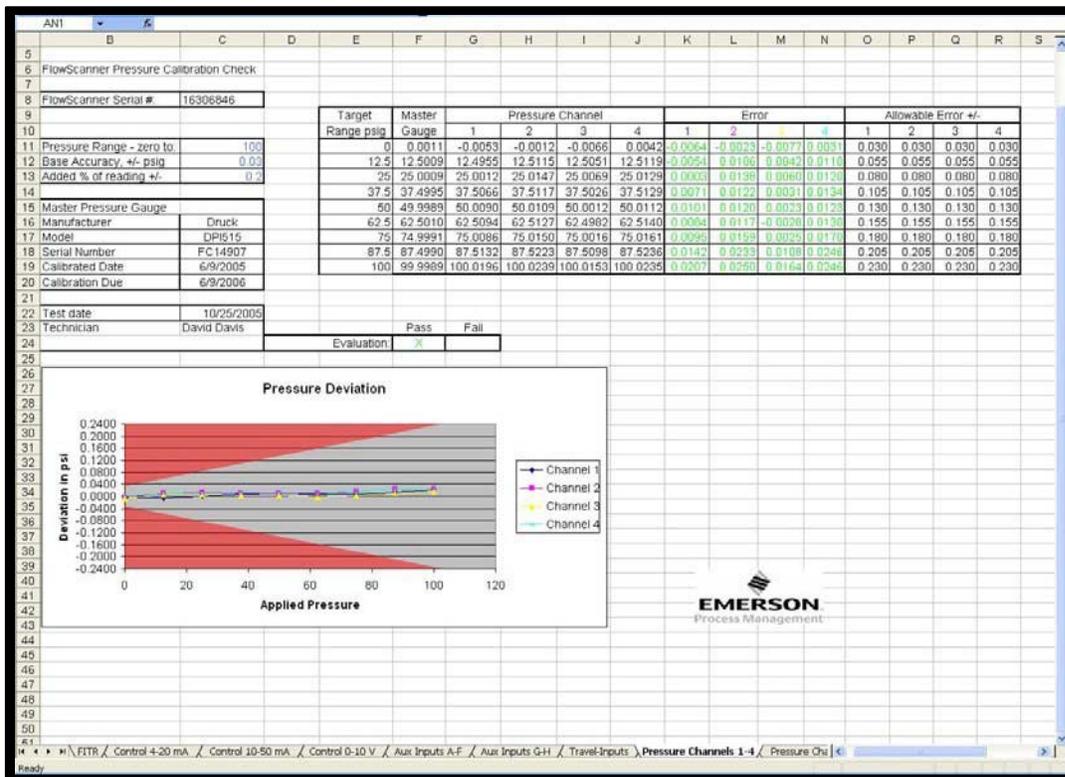
The Semi-Automatic mode runs the standard sequence of tests in the normal order and enters the data on one of the spreadsheet templates. It sequences through the pre-set plateaus for each input and output, and automatically sets the voltage or current required. Readings are taken on the FlowScanner™ 6000 channels when the average reading button is clicked. If the GPIB converter is used with an Agilent DMM or Druck controller, the master readings are also read. If a GPIB converter is not used, the master instrument readings can be manually entered when the software prompts.

The user can control when to advance to the next plateau and when to advance to the next test. The user can also re-read both the FlowScanner™ 6000 channels and master instrument as desired. The user can review each plateau results on the spreadsheet before continuing to the next test.

### Full-Automatic Mode

This mode is only offered if both the ScannerCal-1 Interface Box and a compatible GPIB multi-meter are detected by the software. If a Druck pressure controller is found, the pressure test will run automatically; otherwise the pressure sequence will revert to semi-automatic mode after running the electrical tests. The specified warm-up times are automatically applied to both the analog electrical tests and the pressure tests.

Figure 6. Spreadsheet created by ScannerCal to hold test results



All data is automatically entered in a spreadsheet file that is appropriately named with the FlowScanner serial number and a suffix to avoid over-writing tests. At the conclusion of the test sequence the spreadsheet can be evaluated to see if all tests passed. Units that do not pass, whether from bad readings or incomplete tests, are stored in a “Failed FlowScanner Calibration” folder in the specified file location.

## Starting Automatic Sequences

Clicking the option button for either of the automatic sequences opens the configuration form to verify the settings and identify the test technician. The test sequence can not continue until the Technician fills in his name. The default locations for the template and report folder may be used, or new locations may be specified at this time.

The test instrument details are also recorded and saved, and are transferred to the spreadsheet reports during the test sequence. Each time ScannerCal opens this screen it checks the calibration due dates for the instruments and begins alerting the user 30 days before the dates come due by changing the background field for the date entry.

For each FlowScanner check, the user should verify the pressure channel configuration of the FlowScanner. Either the normal 4 & 4 pressure or alternate 6 & 2 pressure (for early retrofitted units) configuration is used. The pressure ranges are transferred to the spreadsheets and are used for determining the plateau levels and for controlling a Druck pressure calibrator.

After all of the information is entered the Continue button is clicked. ScannerCal then finds and loads the spreadsheet template into Microsoft Excel, and saves it in a “Temp” folder during the test process with a filename based on the FlowScanner serial number. At the end of the sequence it will be transferred to the specified report file directory.

## **⚠ WARNING**

**Do not close the Excel spreadsheet until ScannerCal finishes with all tests and ends the ScannerCal program. Doing so will crash ScannerCal.**

ScannerCal then prompts the user to be sure all cables and tubing are connected to the FlowScanner unit, and then proceeds with the sequence.

If the DigOut Travel Simulator card is detected, ScannerCal first tests the travel inputs. It sends sequences of 20,000 counts (approximately 2 inches of simulated travel) to each of the FlowScanner travel inputs, reads the response from the FlowScanner and displays the count total as well as the total counts commanded by ScannerCal. It repeats this up to 80,000 counts on both channels, then counts down in steps of 20,000 back to zero. The results of each step are transferred to the open spreadsheet as the test is run.

The automatic sequences then proceed through the remaining tests:

- 4-20 mA output
- 10-50 mA output
- 0-10 V output
- 0-24V AUX inputs A-F
- +/- 10V AUX inputs G-H
- Pressure channels 1-4
- Pressure channels 5-8

When running in full-automatic mode, ScannerCal will wait until all warm up times are met. It will take about 28 minutes for ScannerCal to run all tests in full-automatic mode.

After the test sequence ScannerCal exits, but leaves the spreadsheet reports open for review and for adding any additional information about the lab and work order. Each section of the FlowScanner is reported on a separate page of the workbook, so the Excel "Print Entire Workbook" command can be used to print all the worksheets.

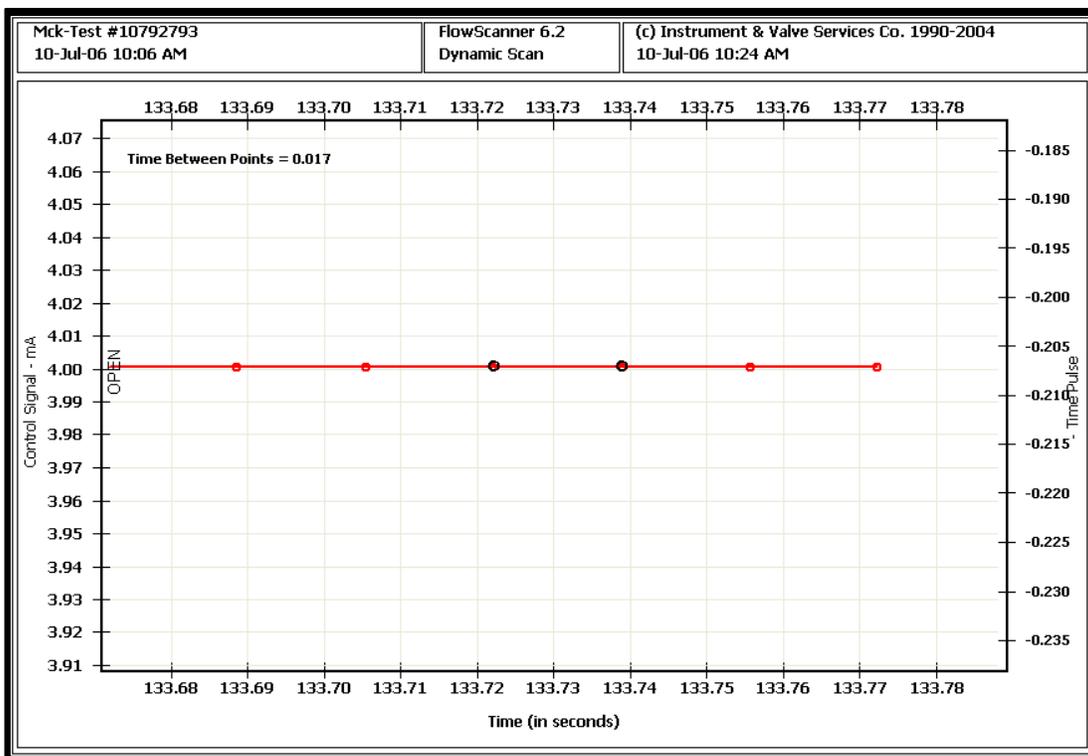
## **Checking FlowScanner Timing Accuracy Using ScannerCal – DigOut and Timing Checker Software**

### **Overview**

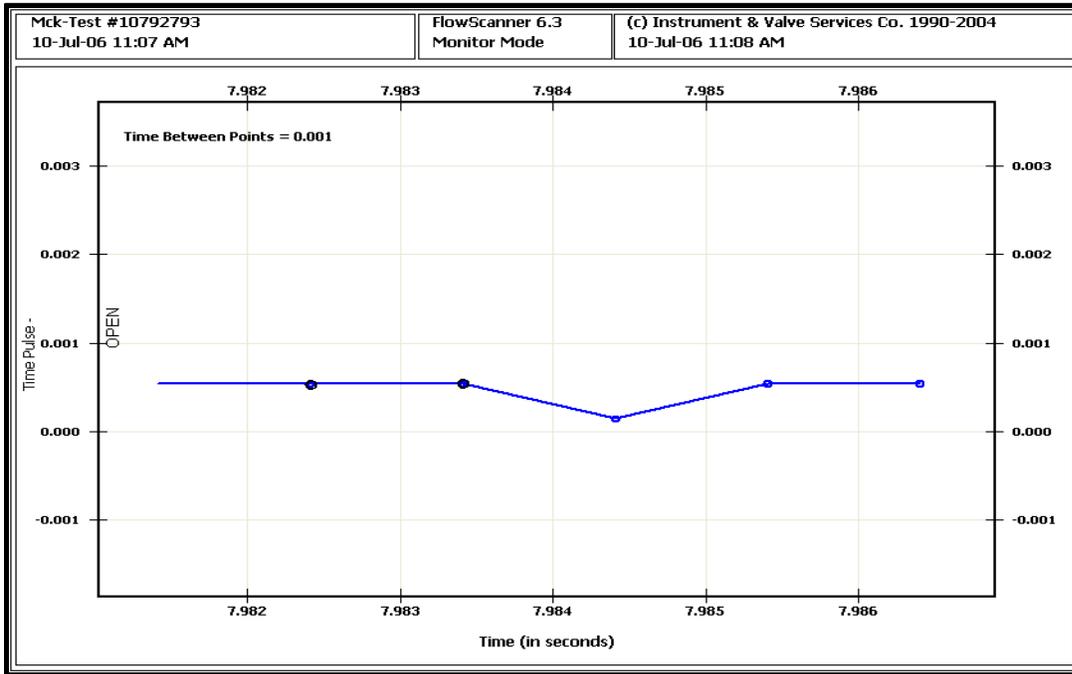
The FlowScanner is sometimes used to check the timing of valve events, such as the closing time of a valve with a specified requirement. Sometimes these requirements can be for a very short period, 250 ms or less. Some users have requested a means to test the timing accuracy of the FlowScanner system when running these tests. The ScannerCal DigOut option (also used for testing the travel inputs on the FlowScanner) provides a signal cable to connect to one of the AUX voltage inputs on the FlowScanner, and the Timing Checker application (installed with the ScannerCal software) can control this voltage signal to provide a square-wave timing pulse that can be recorded during a FlowScanner test, and then graphed to determine the overall timing accuracy of the FlowScanner system, as configured to run a specific test.

### Effect of Test Duration on Timing Accuracy

The length of a FlowScanner test determines the sample rate at which readings are recorded, and the sample rate affects the timing accuracy. For example, a “50- Second Dynamic Scan” test allows about 50 seconds to ramp the signal followed by about 16.7 seconds to allow the valve to complete its motion before another 50 second ramp down, and another 16.7 second “dwell” recording for a total of about 133.7 seconds. The FlowScanner records 8,000 readings during this test, so it records a reading about every 0.0167 seconds. Thus when looking at the data you can’t tell if an event occurred exactly when it appears on the graph, or sometime in the 0.0167 interval before the change shows on the graph. A timed event has both a beginning and an end, so the uncertainty due to this sampling rate is twice this interval (once for the start and once for the end events) or 0.0334 seconds, even if the timing accuracy of the hardware is perfect. The FlowScanner timing routines round to the nearest millisecond, so the sample interval on the 50 second Dynamic Scan test looks like this when zoomed in:



On the other hand, an 8-second Monitor Mode test completes 8,000 readings in 8 seconds, for a reading every 0.001 seconds. If the hardware accuracy is perfect, this test would give accuracy for start-finish test of 0.002 seconds. This shows the sample interval on the 8-second monitor mode test:

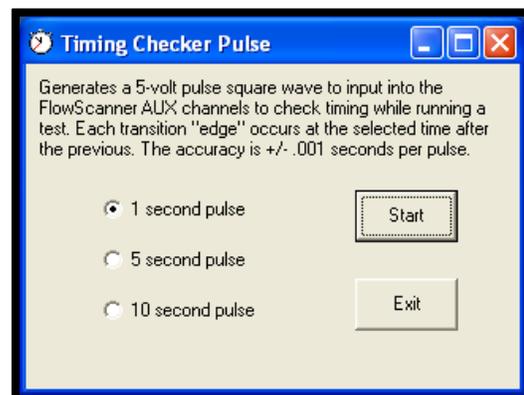


### Effect of number of channels recorded and test duration.

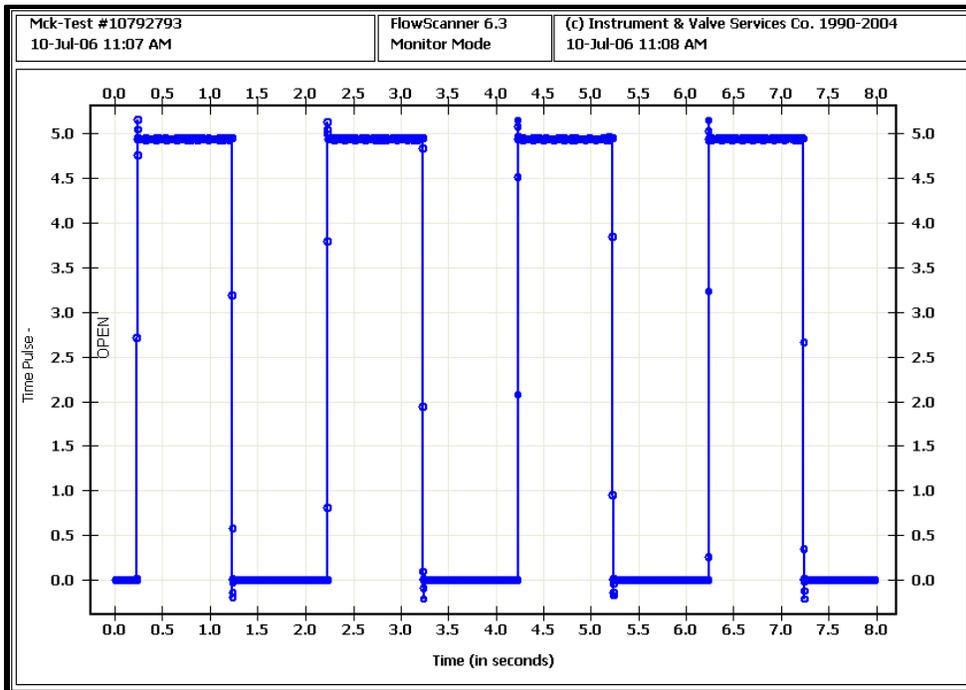
Although the FlowScanner™ 6000 hardware is capable of recording data at 1000 samples/second on all channels, FlowScanner software revisions 6.2 and earlier impose a communication burden that prevents the system from reaching this rate if too many channels are being measured. If a too-short time is selected for the number of channels being recorded, the test will slow down and run in a longer time, but this will not be shown on the graph, which will present the data as if the test ran in the specified time. Thus events will appear to run faster than they actually occurred. Software versions after FlowScanner 6.2 correct this condition, and it can be avoided on earlier versions by limiting the number of channels used on short critical timing tests. Tests on the version after 6.2 show it can collect data accurately at 1000 samples/second on all channels.

### ScannerCal Timing Checker Application

The ScannerCal Timing Checker application uses the Windows system internal clock to switch a 5 Volt signal on and off at specified time intervals of 1, 5, or 10 seconds. According to Microsoft the system clock is accurate to 0.001 seconds.



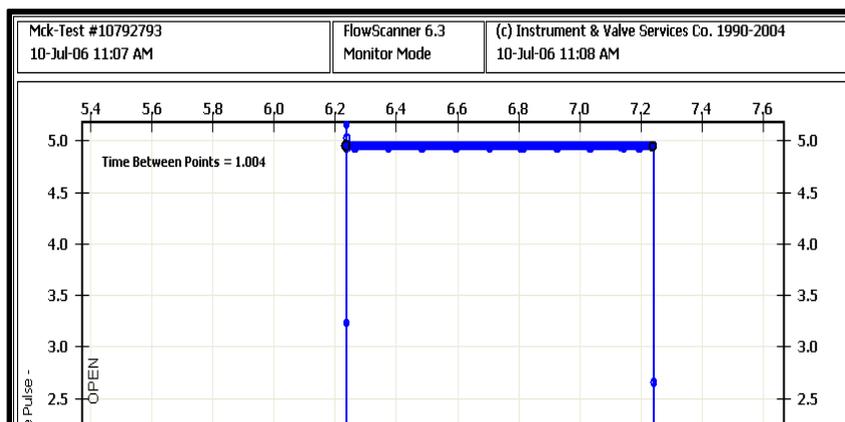
A one-second pulse recorded during an 8-second Monitor test would look like this:



Each switching point has an accuracy of 0.001 seconds, so the time interval represented by a single pulse (one on-off period) would be accurate to 0.002 seconds. A one-second pulse would be accurate to 0.002 seconds, while 10 one-second pulses would be accurate to 0.020 seconds. However, a 10-second single pulse still has a timing accuracy of 0.002 seconds. This allows the user to select a timing pulse interval appropriate to the event in order to verify accuracy to 0.002 seconds.

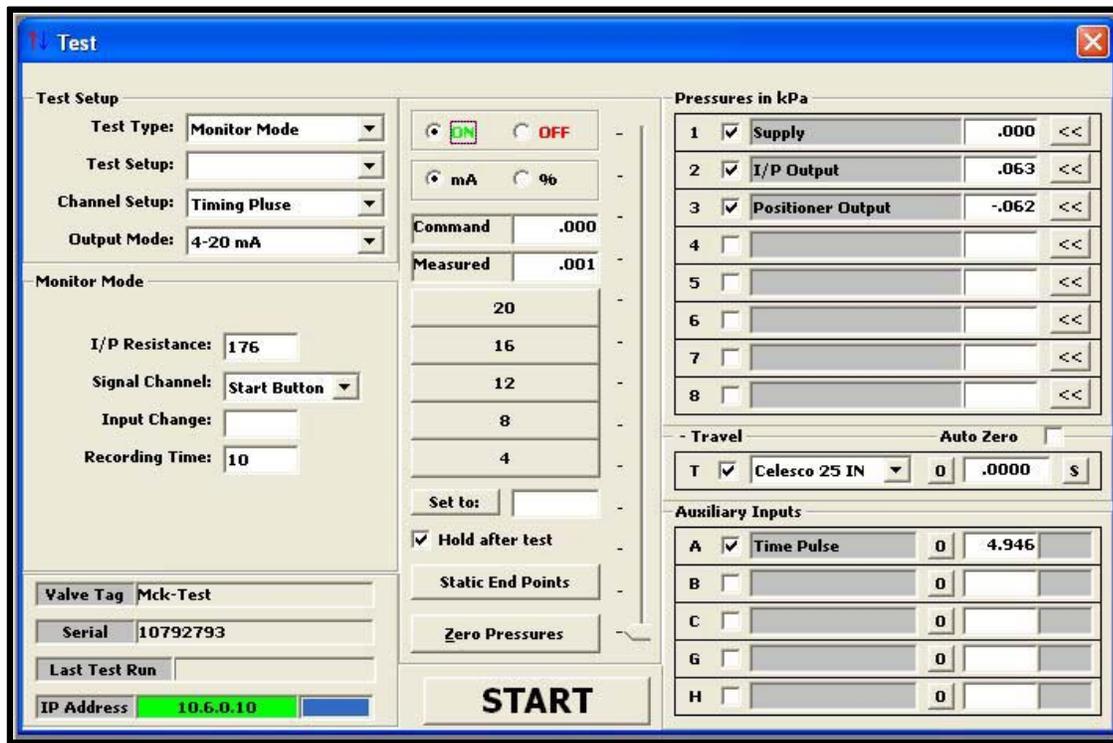
### Combined Accuracy

With the accuracy of a single pulse generated by the Timing Checker program of 0.002 seconds, and the accuracy due to FlowScanner sampling time (8 second test) of 0.002 seconds, the interval reported by the graph timing analysis for a single pulse could be up to 0.004 seconds from the nominal 1-second pulse. Here's the width of a 1-second pulse as recorded and graphed:



### Verifying Timing Accuracy for a specific test setup

First determine the expected duration of the event to be timed, such as the closing time for a valve. Then determine the appropriate test type and length to capture the event, and set up to record data using this setup. Determine the appropriate timing pulse length (1, 5 or 10 seconds) and run the Timing Checker program in the ScannerCal program group selecting that time. Input the DigOut signal cable into an AUX channel, and select that channel to record data in the FlowScanner software. (Both applications can be run on the same or on different computers without affecting the results.) You should be able to see the selected AUX channel switch between 0 and about 5volts on the Test window:



Run a trial test, and select the “vs. Time Plots” graph selection, and graph the AUX channel that records the timing pulse from the timing checker. Zoom in on a single pulse, and use the mouse “right-click” menu to select the start and end points of the pulse. The FlowScanner graph will show the analyzed elapsed time between the two selected points, in the same way the actual event will be recorded and analyzed.

By comparing the analyzed pulse duration with the pulse time selected in Timing Checker you can determine if the FlowScanner accuracy as set up for that test is accurate enough for the event to be tested.

## Product Bulletin

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