FlowScanner™ 6000 Valve Diagnostic System

The FlowScanner 6000 Valve Diagnostic System

The FlowScanner 6000 is a powerful valve diagnostic tool that can help you evaluate the condition and performance of all makes and models of control valves—accurately and efficiently.

As a highly portable, field test instrument, the FlowScanner 6000 is ideally suited for process plant conditions. There's no need to remove or disassemble the valves you want to test. Simply hook up the FlowScanner 6000's sensors, and you're ready to evaluate the valve's operating condition and identify any corrective actions that may be required. You can also take advantage of the FlowScanner 6000's new, remote testing capabilities.

The FlowScanner 6000 is an excellent tool to use for valve commissioning before plant startup. By verifying that valves will function as intended, you can help ensure a smoother process startup. You can also use the FlowScanner 6000 to calibrate the instruments of the valve assembly, while creating an electronic record of the results.

Figure 1. *The FlowScanner 6000 housed in its convenient padded canvas operating bag (left), and analyzing a control valve in a field situation (right).*

Features That Make the FlowScanner 6000 Unique

- **Convenient, flexible PC control—**The FlowScanner 6000 works with most standard Microsoft Windows PCs, including standard laptops, special ruggedized field computers, and tablet PCs. This allows for the use of the latest and fastest computer technology—without having to upgrade the FlowScanner 6000 itself.

- **Remote testing capabilities—**The FlowScanner 6000 communicates with the PC via an Ethernet connection, which allows you to conduct tests from comfortable, remote locations. An optional model, the FlowScanner 6000 WiFi, adds integrated wireless communication.

- **Integrated, accurate pressure scanners—**With the pressure scanners being integral and calibrated as a single unit, a higher degree of accuracy can be achieved. This also eliminates the concern of mixing non-calibrated sensors.

- **State-of-the art data acquisition hardware and dedicated Digital Signal Processor**—The custom acquisition unit provides excellent stability, high accuracy, and resolution over wide input ranges.

- **Multiple input capability—**The FlowScanner 6000 can give you a comprehensive look at a valve's performance. The FlowScanner 6000 can accept eight pneumatic inputs. It also has eight voltage inputs that allow you to measure such things as valve-mounted switches and transmitters, or loop process variables such as flow rate, temperature, and pressure. It also includes two digital travel inputs.

- **Optional Strain Gauge Interface** – An optional interface is available which integrates into the operating case for direct use of stem-mounted strain gauge sensors.

- **Optional Isolation Box –** An air tight, sealed box is available that protects the FlowScanner 6000 and battery pack from contaminated dust while in containment.

- **Easy set up and use—**Housed in its padded canvas operating bag, the FlowScanner 6000 can be carried into and operated in any field situation. Simply hang or place the FlowScanner 6000 near the valve, connect the pressure scanners and travel transducer, and begin testing.

- **Lightweight, compact & rugged—**The FlowScanner 6000's light, 14-pound weight, and compact size make it a highly portable tool that requires little or no work surface. Its rugged aluminum body and sealed keypad and status display also make the unit ideally suited for field use.

- **Extended battery life—**NI - MH (Nickel - Metal Hydrite) batteries and extremely low-power components enhance the FlowScanner 6000's battery life. One battery charge should deliver a full eight hours of use. Batteries charge in just 3 to 4 hours and can be changed quickly.

- **Optional WiFi (Wireless) Model** – The FlowScanner 6000 can be ordered as a WiFi model that adds built in Wireless communication between the data unit and the controlling laptop. This eliminates the Ethernet cable between the units, and allows the operating technician to be located a distance from the valve. Most laptops have built-in WiFi and work with the FlowScanner WiFi. As is typical for WiFi connections, the maximum distance depends on obstructions and interference, but typically exceeds 200 ft. In locations where wireless signals are not allowed the WiFi section can be securely switched off, and an Ethernet cable can be used.

Benefits You Will Enjoy with the FlowScanner 6000

- **Improved Process Efficiency**—With the FlowScanner 6000 diagnostics system you can analyze a valve's dynamic response, and then make any physical modifications to the valve and/or air supply needed to better match the valve's response to the process requirements. You can monitor control valve performance under process conditions to see the effect of the total valve characteristic on process gain.

- **Reduced Downtime**—Using the FlowScanner 6000 system will help improve your set-up and operation, reducing on-line problems. You can trend valve performance, which enables you to implement predictive or condition-based maintenance techniques, minimizing any future problems.

- **Reduced Maintenance Expense**—The FlowScanner 6000 valve diagnostic system can identify valves that need repair—and isolate the individual valve components that require service. This level of diagnostic detail helps service technicians get to the heart of the problem with little wasted time or effort.

Detailed Information

System Test Capability

The FlowScanner 6000's six standard test options help give you a comprehensive view of a control valve's performance.

- Dynamic Scan
- Static Point Scan
- Step Change
- Stepped Ramp
- Step Study
- Sine

The FlowScanner 6000 also offers a convenient **Monitor** mode. By engaging this mode, you can use the FlowScanner 6000 to record data while the valve is controlled by the control system.

Figure 2. *The FlowScanner 6000 set up to test and diagnose a sliding stem valve (left) and a rotary valve (below).*

FlowScanner 6000 Testing Details

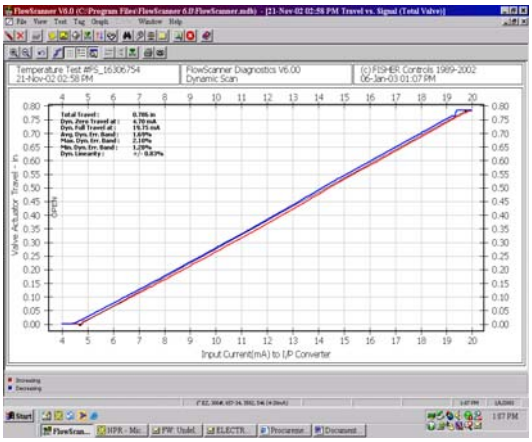
Dynamic Scan Test

Dynamic scan is a valuable test that can help you set up a valve and monitor its performance. On new or reconditioned valve assemblies, the dynamic scan test can establish a performance benchmark that subsequent tests can be compared to. Any change can reveal problems such as wear or damage to the valve and/or its instruments.

Dynamic scan testing checks critical performance operation indicators such as:

- Calibration of the total construction as well as the I/P and positioner.
- Valve perimeters, including:
  - Bench Set
  - Seat Load
  - Valve Travel
  - Friction/Torque
  - Spring Rate
- Dynamic Error Band of the total construction as well as on the positioner and I/P individually. Dynamic error band is the combination of hysteresis and deadband plus “slewing” error (lag). Dynamic error band is a measurement of the valve/instrument’s response.
- Linearity of the total construction as well as on the positioner and I/P individually.

The dynamic scan test varies the control signal at a controlled rate between two defined input levels, typically 4 to 20 mA. Data is recorded during the up-stroke and down-stroke and may be analyzed for dynamic valve operation (figure 3).



TOTAL VALVE **VALVE SIGNATURE**

***Figure 3**. Dynamic Scan Tests*

Static Point Scan Test

The static point scan analysis (figure 4) gives the hysteresis and deadband of each component and their additive effects on the total construction. This test steps the control signal, then pauses and records the valve travel. Data is recorded for both the up and down stroke. This test duplicates a traditional laboratory deviation cycle test for hysteresis plus deadband.

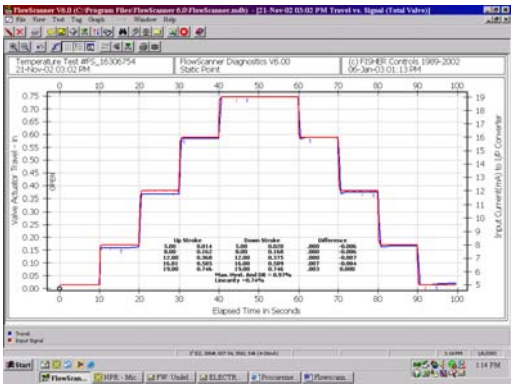


Figure 4. *Static Point Test (illustrating the static control of the valve)*

Step Change Test

The step change test is used to check stroking speed and valve dynamic response (figure 5). This test records data that shows the valve response to a step change in control signal.

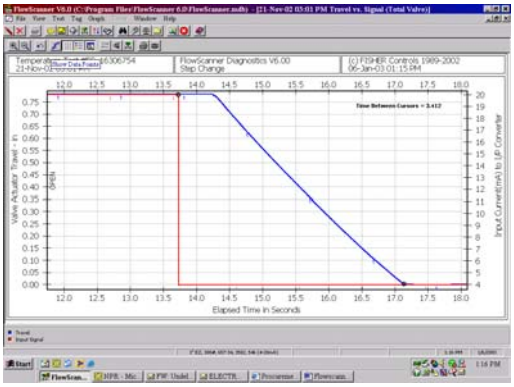


Figure 5. *Step Change (Stroking Speed) Test*

Stepped Ramp Test

The stepped ramp test ramps the valve up and down in a series of small steps (figure 6). Input steps as small as 0.01 mA may be used to test for valve response to process ramps.

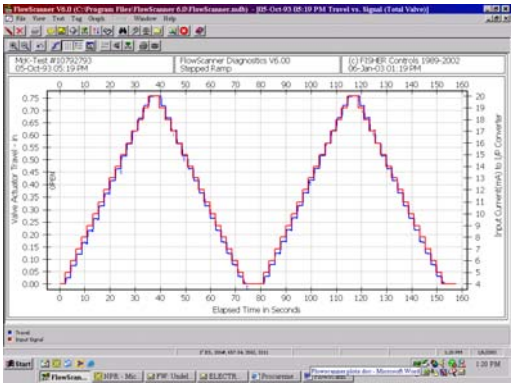


Figure 6. *Stepped Ramp Test*

Step Study Test

The step study test (figure 7) is used to check valve resolution and response, and can quickly show you an approximate deadband for valves. This test also indicates the effects of the total valve characteristic on process gain, especially with the process variable recorded on an auxiliary channel.

A series of increasingly small step sizes are defined (for example, 0.08, 0.16, 0.32, 0.80 mA translates to 0.5%, 1%, 2%, and 5% steps for a 4 to 20 mA loop) to be run at different nominal loop output levels. A pause time is specified for each step (for example, 10 seconds). The normal procedure is to mirror the steps, which is to step up, back, and then down and back from the nominal output level.

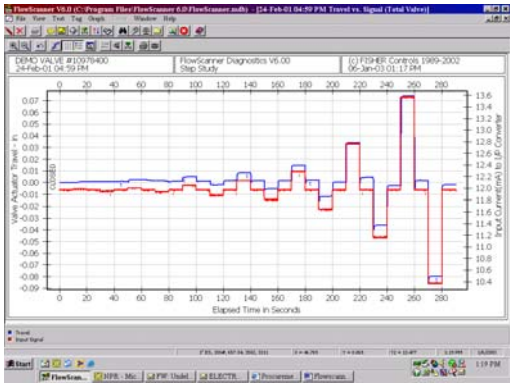


Figure 7. *Step Study Test*

Sine Test

The Sine test allows you to conduct a frequency response analysis. The test utilizes a sinusoidal test signal of constant amplitude at various frequencies (figure 8). In general, any device suitable for frequency response analysis, when subjected to a sinusoidal input, will produce a sinusoidal output of the same frequency. Application of this data must always be made with an awareness of the associated limitations and restrictions.

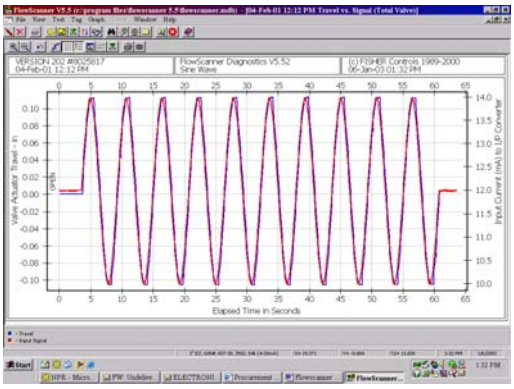


Figure 8. *Sine Test*

Test Connections

To connect the FlowScanner™6000 to a control valve's pneumatic signals (instrument pneumatic pressures), you can either place quick connects into the positioner gauge block or insert pipe tees into the instrument lines. The connectors are supplied in the tool kit or may be ordered with Emerson control valves.

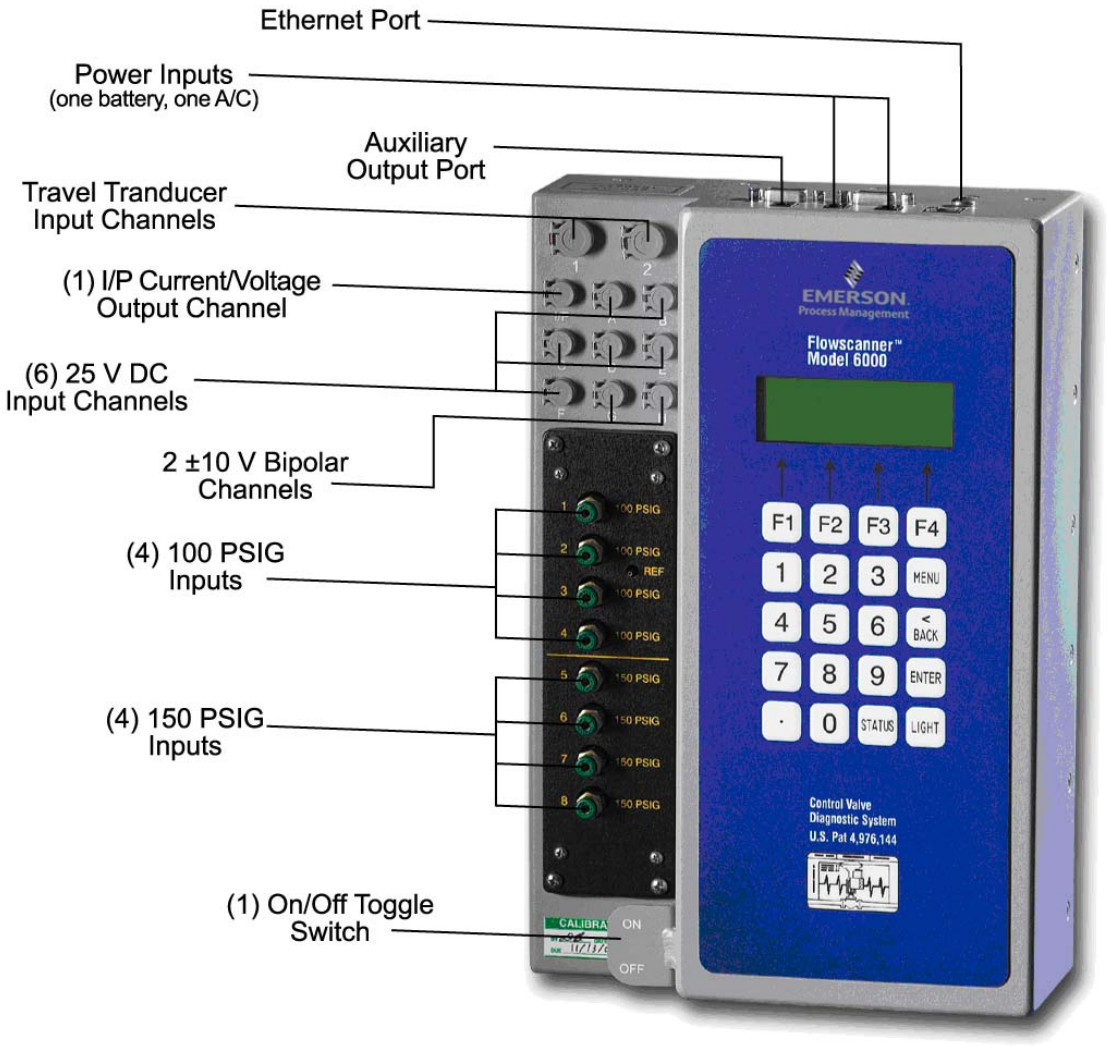


Figure 9. *The FlowScanner 6000's input/output connections.*

The FlowScanner 6000 diagnostic system can monitor the following inputs:

- SUPPLY PRESSURE—Monitoring this pressure verifies that the supply pressure is sufficient to provide full valve stroke and seat load. The operator can also check for pressure decay during the stroke. Decay could indicate an undersized or malfunctioning pressure regulator, a restriction in the supply pressure line, or a leak within the actuator or tubing. Any decay could cause slow or sluggish valve and actuator performance.

- I/P OUTPUT PRESSURE—Comparing this signal to the input signal during valve stroke permits checking the transducer calibration and dynamic performance. This signal also could be used as the input to a pneumatic positioner for checking the positioner calibration and dynamic performance.

- POSITIONER OUTPUT PRESSURE—Comparing this output with the instrument's input (either pressure or current) permits checking the positioner dynamic performance. This pressure also is used as the input signal to any accessory, such as a booster or solenoid, to permit checking the booster dynamic performance. If there is no accessory between the positioner and actuator, this input monitors actuator pressure.

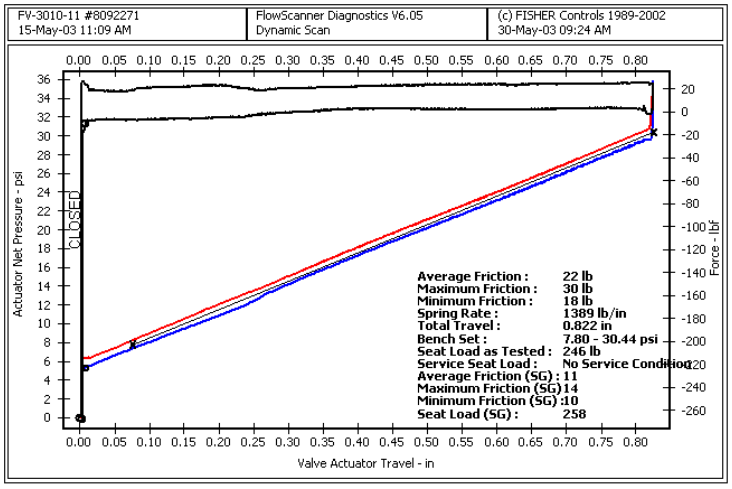
- ACTUATOR PRESSURE—Comparing this key parameter to the valve position verifies the seat load along with bench set, friction, and spring rate. If there is an accessory, such as a booster or solenoid between the positioner and actuator, comparing this pressure to the positioner output pressure permits checking the accessory's performance. On a double-acting piston actuator, both the top and bottom cylinder pressures are monitored.

- INPUT SIGNAL TO I/P—The I/P output connection on the FlowScanner™ 6000 system is used to supply a current or voltage signal to the I/P. Comparing this signal with the I/P output pressure provides the information required to determine the I/P calibration and dynamic performance.

- VALVE POSITION—Valve position is monitored with a travel transducer. The output from the travel transducer is connected to the FlowScanner 6000 system digital TRAVEL input. Monitoring valve position permits verifying travel, seat profile, and positioner performance.

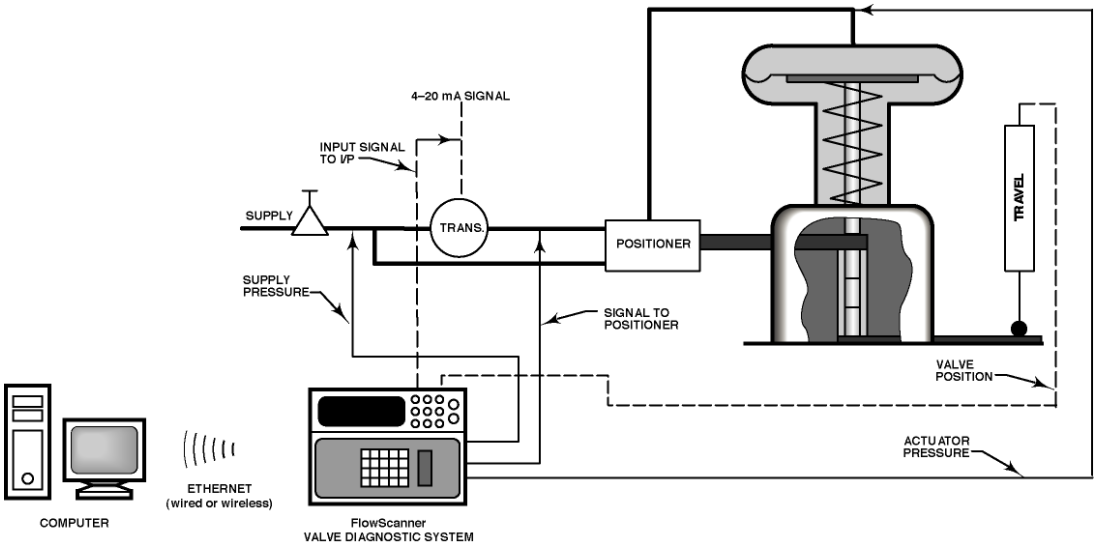
- AUXILIARY SIGNALS—Other signals can be simultaneously recorded for testing accessories and loop operation (including process variables from transmitters, limit switches, and position transmitters), or for monitoring a valve control signal provided by the control room. If the actuator pressures are unable to be measured, strain gauge sensors can be used with the optional Strain Gauge Interface Module to provide direct measurement of forces. Eight auxiliary analog inputs are provided. Six accept inputs from 0 to 24 Vdc, two accept ±10 Vdc for bipolar or strain gauge measurement. All inputs provide full 16-bit data for excellent resolution over the full range, and provide at least 100 KΩ isolation. Accessory signal conditioners can be used to boost low-level signals, such as those received from strain gauges.

- STRAIN GAUGE INTERFACE MODULE – An optional interface can be added to the operating case to accept direct input from stem-mounted strain gauge force-sensors for direct measurement of force to determine valve friction (or torque) and seat load, or to provide qualitative proof of seating contact. The interface fits the case accessory pocket and connects directly to the model 6000 for power and signal, providing an integrated, portable solution operating off the 6000 battery pack.

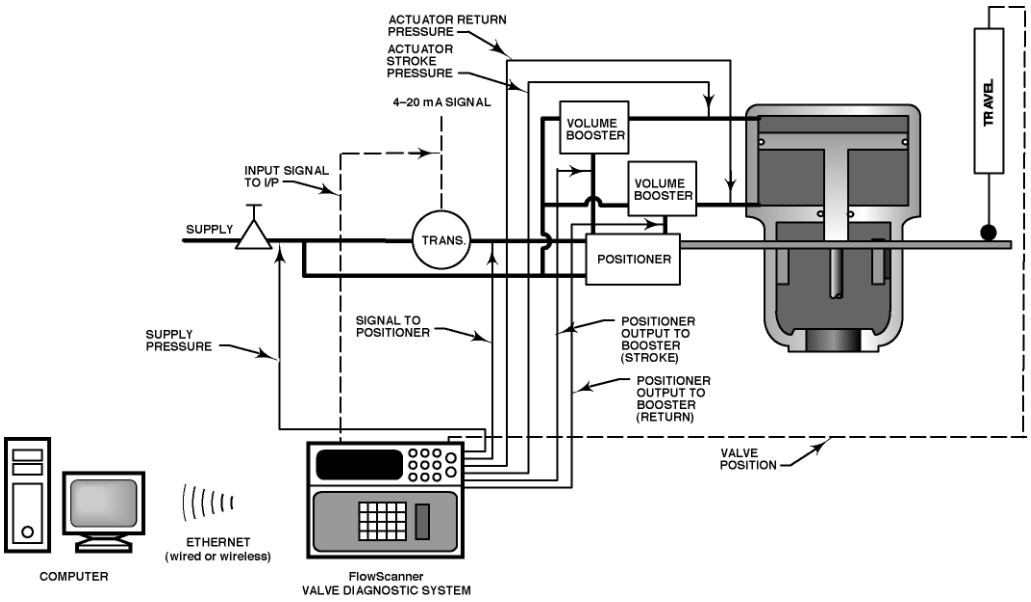


The FlowScanner software provides easy scaling of the strain gauge output to force units, and the resulting data can be plotted and analyzed on its own, or overlaid and compared to the simultaneously measured pressure-based analysis.

Schematic views of a FlowScanner 6000's connections to a control valve



SPRING AND DIAPHRAGM ACTUATOR



PISTON ACTUATOR (WITH BOOSTERS)

Figure 10. *FlowScanner™ 6000 Diagnostic System Test Connection*

Specifications

Power
AC Power: 100 to 240 Vac, 50-60 Hz by external adapter (carried within the operating case). Provides 15Vdc to the FlowScanner 6000.
Battery: 12 Volt pack in case compartment providing 7-8 hours normal operation; recharges by external charger in 3-4 hours. (Unit can operate simultaneously on A/C and battery for UPS function.)
Accessory Power: 12Vdc output is provided for optional accessories. (Battery life is reduced when using self-powered accessories such as the wireless Ethernet adapter or strain gauge interface module.)

Operating Temperature Limits
Operating temperature: -40 to 155º F (-40 to 70º C)
LCD display functional range –4 to 140º F (-20 to 60º C)
Operating humidity checks: 95% non-condensing

Control Signal Output
Current Loop: 0 to 55 mA (at up to 24 V compliance for high-impedance valves)
Voltage Loop: ±10 V

Inputs
- 8 integrated air pressure inputs, 4 ea 0-100 psig, 4 ea 0-150 psig
- 8 auxiliary voltage inputs, isolated by at least 100 KΩ
    - 6 ea (A through F) 0-24 Vdc
    - 2 ea (G,H) ± 10 Vdc
- Current loop readback (on output) ±100 mA
- 2 Travel inputs
    - Linear 0-30 inches
    - Rotary 0-360 degrees
- (Monitoring of battery voltage and internal temperature)

Pressure Connections
Replaceable Parker Prestolock 1/8 NPT x 1/8 inch tubing
Tubing: 1/8 inch OD x 1/16 inch ID (Parker p/n NB2-031)

Data Rate Capability
Variable sample rate, set by software test selection, up to 1,000 samples/second simultaneously on all channels. (Supports “Dynamic Scan” tests down to 5 second stroking times.)

Controls
Status LCD
Configuration keypad
Guarded On/Off toggle switch

Housing
Data unit in welded aluminum case; carried and operated in padded canvas operating case with room for battery pack, AC adapter, cables, and connecting tubing.

Included Accessories:
Canvas operating shoulder bag, padded for protection.
Battery pack
AC adapter
External battery charger
RJ45 Crossover cable for direct PC connection (14 ft or longer)
Accessory power cable (for optional accessories)
Setup and configuration instructions
FlowScanner software on CD-ROM for operating PC (Supplied conforming to 10CFR50 Appendix B requirements for nuclear power customers.)

Approximate Carrying Weight
14 pounds (6.4 kg)

Communication link to PC
Ethernet (Standard unit: RJ45 – 10 Base T cable; Optional FlowScanner 6000 WiFi: 10 Base T cable or by integrated wireless adapter using 802.11g/b WiFi); IP address configurable)
(Sampling and timing are controlled internally by the FlowScanner 6000 data unit, so communication speed and reliability does not affect test data collection. Test data is internally buffered until downloaded after test completion, real time data is also provided for display during testing.)

Companion PC Requirements
The FlowScanner 6000 can only be operated through the Ethernet connection from a companion PC running the FlowScanner 6.0 (or higher) software. A field-hardened, very rugged laptop can be provided as an option, or any PC meeting the following minimum specification can be used.

PC must meet the hardware requirements recommended by Microsoft to run the USA version of Windows XP SP2. A Color display is recommended, and the PC must include 10 Base T Ethernet or WiFi communication (for the FlowScanner 6000 WiFi). CD-ROM reader or network connection is required to install software. Windows XP or newer (Software version 6.3 with Service Pack 1 required for Windows Vista)
(Technical support is not provided for other operating systems.)

FlowScanner™ 6000 Accuracy

Table 1. Control Signal Output Accuracy

Range	Measured Accuracy	Minimum Resolution
0 to 25 mA	±0.02 mA	0.005 mA
0 to 55 mA	±0.03 mA	0.005 mA
±10 V	±0.02 V	0.001 V

Table 2. Travel Input Accuracy

Range	Overall Accuracy**	Resolution
0 to 25 inch	±0.0065 inch	0.0001 inch
0 to 360 degree	±0.25 degree	0.0075 degree

Table 3. Analog Input Channel Accuracy

Input Range	Accuracy *	Minimum Resolution
0 to 100 psig	±0.03 psig + 0.2% of reading	0.015 psi
0 to 150 psig	±0.1 psig + 0.2% of reading	0.025 psi
0 to 24 Vdc	±0.01 V	0.0005 V
±10 Vdc	±0.01 V	0.0005 V

* For units with pressure block marked “Utrastable pressure sensors” accuracy achieved within 30 seconds, for older units accuracy achieved w/10 Minute Warm-Up. Pressure accuracy assumes use within 20 Minutes of Re-Zero.
(Design accuracy verified over full operating temperature range, each production unit calibrated to NIST – traceable standards at room temperature.)
** Travel accuracy and resolution are determined by the model of external encoder used for measurement. The FlowScanner input is a digital quadrature counter that is accurate to +/- 1 count over the entire range.

Related Products

The FlowScanner™ 6000’s modular architecture allows the software to run on a PC or laptop that is communicating with the data unit via an Ethernet connection. While any PC that meets the requirements can be used (see specifications), field-ruggedized models designed for mission-critical field work are available. For situations where no work surface is present, convenient hand-held Tablet PCs can be provided. Contact your representative to learn which current models are available.

Ethernet communication can be either wired (RJ45 connector 10Base-T) or wireless (Ethernet adapter). For direct connection by cable without a network hub, crossover cables are available in different lengths.

The Strain Gauge Interface Module is ordered separately, and can be added to any model 6000 FlowScanner. It is custom designed to integrate with the 6000 in the operating case, and is provided with a standard “QSS” style cable to connect to stem sensors. The QSS sensors are available in a range of sizes to fit nearly all valves. (Note: The interface module fits the same accessory pocket alternately used by the wireless Ethernet adapter. Simultaneous use of the module and wireless adapter is not supported.)

Additional batteries, battery chargers, AC adapters, cables, and tool kits are available.

Ordering Information

To order the FlowScanner 6000, contact your local Emerson representative, or call Emerson Instruments Valve Services in Charlotte, NC, at (704) 598-5660.

As the largest supplier in North America, Emerson's Instrument & Valve Services can help you avoid unplanned costs and unscheduled maintenance through our comprehensive startup, diagnostic, repair, and maintenance services. We are one of the offerings of Emerson Process Management's Asset Optimization Division that combines world-class services with innovative technologies to improve the availability and performance of production assets. Our knowledge of factory design, engineering, and specifications enables us to resolve problems quickly, maximizing your uptime. Put us to work today, and you'll discover that we're your best choice as a services partner.

For more information or to schedule service, please call your local Emerson Process Management sales representative or the North American Response Center at ***1-800-654-7768.***

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