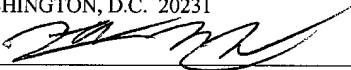


**PATENT**  
**5150-59500**

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Patent # 5150-59500

Measurement System with Modular Measurement Modules  
That Convey Interface Information

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**Title:** Measurement System with Modular Measurement Modules That Convey Interface Information

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### Field of the Invention

10 The present invention relates to measurement, data acquisition, and control, and particularly to measurement devices with adaptive interfaces and modular signal conditioning and conversion devices which convey interface information.

### Description of the Related Art

15 Scientists and engineers often use measurement or instrumentation systems to perform a variety of functions, including laboratory research, process monitoring and control, data logging, analytical chemistry, test and analysis of physical phenomena, and control of mechanical or electrical machinery, to name a few examples. An instrumentation system typically includes transducers and other detecting means for  
20 providing "field" electrical signals representing a process, physical phenomena, equipment being monitored or measured, etc. For example, detectors and/or sensors are used to sense the on/off state of power circuits, proximity switches, pushbutton switches, thermostats, relays or even the presence of positive or negative digital logic-level signals. The instrumentation system typically also includes interface hardware for receiving the  
25 measured field signals and providing them to a processing system, such as a personal computer. The processing system typically performs data analysis and presentation for appropriately analyzing and displaying the measured data.

Often, the field signals may be coupled to high common-mode voltages, ground loops, or voltage spikes that often occur in industrial or research environments which  
30 could damage the computer system. In that case, the instrumentation system typically includes isolation circuitry such as opto-couplers for eliminating ground-loop problems and isolating the computer from potentially damaging voltages. Input modules are

typically provided for conditioning the raw field voltage signals by amplifying, isolating, filtering or otherwise converting the signals to the appropriate digital signals for the computer system. As one example, the digital signals are then provided to a plug-in data acquisition (DAQ) input/output (I/O) board, or a computer-based instrument which is plugged into one of the I/O slots of a computer system. Generally, the computer system has an I/O bus and connectors or slots for receiving I/O boards. Various computer systems and I/O buses may be used to implement a processing system.

Typical DAQ, measurement, and control modules include circuitry or components to provide a standard interface to external systems, such as PCI or PXI boards. The inclusion of these standard interface components on each module may be expensive, and may also substantially increase the size of a given module. Additionally, when multiple modules are used in a single system, such as a PXI based system fielding multiple sensors, the inclusion of PXI interface circuitry on each sensor is redundant and inefficient. Finally, if multiple communication interfaces are desired for the modules, the expense and size of the modules may increase dramatically with the inclusion of each additional interface card.

Therefore, improved measurement systems are desired which reduce cost and enhance efficiency.

**Summary**

Various embodiments of a system and method for measurement, DAQ, and control operations are described. The system may use small form-factor measurement modules in conjunction with a re-configurable carrier unit, sensors and a computer system to provide modular, efficient, cost-effective measurement solutions. In one embodiment, the measurement module is operable to communicate interface information to the carrier, which in turn informs the computer system how to program the carrier to implement the communicated interface, i.e., how to “talk” to the measurement module. This “adaptive interface” approach allows the measurement module to include only components necessary for providing the required functionality, i.e., the measurement module does not have to include hardware and software implementing standard interfaces for communication with external systems. Said another way, much of the interface responsibilities of the measurement module are assumed by the carrier, which itself is programmed by the computer system, thus the measurement module may be smaller and cheaper than typical functional modules. In the preferred embodiment, the measurement module has a small form factor. For example, in one embodiment, the measurement module may have dimensions less than or equal to approximately 1 inch by 2 inches by 3 inches. In one embodiment, the measurement module may have dimensions of approximately .2 inches by 1 inch by 1 inch or more. Thus, in a preferred embodiment, the measurement module has a compact form factor which may enable deployment in a variety of devices or carriers with minimal space requirements.

A typical measurement system using this approach includes a computer system coupled to a measurement or data acquisition (DAQ) device, which may include a carrier and one or more measurement modules. As used herein, the term “measurement device” is intended to include any of various types of devices that are operable to acquire and/or store data, and which may optionally be further operable to analyze or process the acquired or stored data. Examples of a measurement device include various types of instruments, such as oscilloscopes, multimeters a data acquisition device or card, a device external to a computer that operates similarly to a data acquisition card, a smart sensor, one or more DAQ

or measurement modules in a chassis, and other similar types of devices. The computer system may couple to the measurement device through a serial bus, such as a USB (Universal Serial Bus), or any other medium including Ethernet, wireless media such as IEEE 802.11 (Wireless Ethernet) Bluetooth, a network, such as a Control Area Network (CAN) or the Internet, serial or parallel buses, or any other transmission means.

The host computer may comprise a CPU, a display screen, memory, and one or more input devices such as a mouse or keyboard, and may operate with the measurement device to analyze or measure data from the sensor/measurement device or to control the sensor and/or device. Alternatively, the computer may be used only to configure or program the measurement device, i.e., the carrier, as described below.

In one embodiment, the measurement module may include measurement circuitry which is operable to perform signal conditioning and/or signal conversion, e.g., a signal conditioner and/or a signal converter, such as an analog to digital converter (ADC) or a digital to analog converter. The measurement module may also include interface circuitry which is operable to provide an interface for the measurement circuitry, and which may also be operable to communicate an interface protocol to the carrier unit describing the interface, as mentioned above. The measurement module may also include additional transmission lines and/or buses for operation, e.g., a trigger line coupled to the ADC which may receive trigger signals from an external source, such as the computer system, and a power line for supplying power to the measurement module.

The measurement module may be further operable to couple to a sensor or actuator. The sensor may receive signals from a device or unit under test (UUT) and may send sensor signals to the measurement module for one or more of signal conditioning and signal conversion. For example, the sensor may measure a phenomenon, such as temperature, pressure, voltage, current, or any other phenomenon, and send signals to the measurement module. The signal conditioner comprised in the measurement module may then perform signal conditioning on the signals, where signal conditioning may include one or more of protection, isolation, filtering, amplification, and excitation, or other signal conditioning operations. The conditioned signals may then be processed by

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