Load Cell System – Engineering a Low-Cost Plug & Play Solution

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The Field Engineers' Challenges
Field service engineers require a variety of load cells spanning the different ranges needed to calibrate their customers' systems. They may also require the assortment to conduct a wide range of force measurements for a particular testing application. The challenge begins when the engineer needs to change the load cell that is connected to his instrument before he can continue. When the new load cell is connected to the instrument, the appropriate calibration factors need to be installed in the instrument.

Avoiding user-error is a major challenge with manual data entry or with requiring the engineer to select from a database of stored calibration parameters. Loading the wrong parameters for a load cell, or even worse, corrupting the existing calibration data, can lead to erroneous results and costly recalibration expenses. Instrumentation that automatically identifies the load cell being attached to it and self-installing the proper calibration data is optimal.

What is Transducer Electronic Datasheet?
A Transducer Electronic Data Sheet (TEDS) stores transducer identification, calibration and correction data, and manufacturer-related information in a uniform manner. The IEEE Instrumentation and Measurement Society's Sensor Technology Technical Committee developed the formats which include common, network-independent communication interfaces for connecting transducers to microprocessors, instrumentation systems and control/field networks.

With TEDS technology, data can be stored inside of a memory chip that is installed inside of a TEDS-compliant load cell. The TEDS standard is complicated. It specifies a huge number of detailed electronic data templates with some degree of standardization. Even when using the data templates, it is not guaranteed that different vendors of TEDS-compliant systems will interpret what data goes into the electronic templates in the same way. More importantly, it is not apparent that the calibration data that is needed in your application will be supported by a particular vendor's TEDS unit. You must also be sure that you have a way to write the TEDS data into the TEDS-compatible load cell, either through a TEDS-compatible instrument that has both TEDS-write and TEDS-read capabilities, or through the use of some other, likely computer based, TEDS data writing system.

For precision applications, such as calibration systems, it should also be noted that the load cell calibration data that is stored in the load cell is the same no matter what instrument is connected to the load cell. Additional compensation for the instrument itself is not included. Matched load cell - multi instrument systems, where a field service calibration group might be attaching different load cells to different instruments can present a problem.

The TEDS-Tag Engineered Solution
Electro Standards Laboratories (ESL) has developed the TEDS-Tag auto identification system which retains the attractive feature of self identification found in the TEDS standard but can be implemented simply on any load cell and, when connected to the ESL Model 4215 smart indicator or CellMite intelligent digital signal conditioner, becomes transparent to the user. Multi load cell - multi instrument matched pair calibrations are also supported. This can be a critical advantage in precision applications such as field calibration services.

With the TEDS-Tag system, a small and inexpensive electronic identification chip is placed in the cable that extends from the load cell or it can be mounted within the load cell housing. This chip contains a unique electronic serial number that can be read by the ESL Model 4215 or CellMite to identify the load cell. The load cell is then connected to the unit and a standard calibration procedure is performed. The instrument automatically stores the calibration data inside the unit

itself along with the unique load cell identification number from the microchip. Whenever that load cell is reconnected to the instrument, it automatically recognizes the load cell and self-installs the appropriate calibration data. True plug-and-play operation is achieved. With this system the calibration data can automatically include compensation for the particular instrument so that high precision matched systems can be realized. Moreover, if the load cell is moved to another instrument, that instrument will recall the calibration data that it has stored internally for that load cell. The ESL instruments can store multiple load cell calibration entries. In this way, multiple load cells can form a matched calibration set with multiple instruments.

Building the TEDS-Tag Load Cell
Any load cell can be easily made into a TEDS-Tag load cell. The electronic identification chip, Dallas Semiconductor part number DS2401, is readily available from distributors or from ESL. The chip is very small, making it easy to fit into a cable hood or load cell housing.

Both the ESL Model 4215 smart load cell indicator and the CellMite intelligent digital signal conditioner are connected to load cells via a DB9 connector with identical pin outs. The electronic identification chip does not interfere with the load cell signals. Pin 3 of the DS2401 is not used and can be cut off if desired. Simply connecting pins 1 and 2 from the DS2401 to pins 8 and 7, respectively, of the ESL DB9 connector will enable plug-and-play operation.

When using off the shelf load cells, it is often convenient to locate the DS2401 in the hood of the cable. The load cell comes with a permanently mounted cable that protrudes from the load cell housing. At the end of the cable, strip back the insulation from the individual wires and solder the wires into the DB9 connector. The DS2401 is soldered across DB9 pins 7 and 8, and fits within the connector's hood. For a few dollars in parts and a simple cable termination procedure, you have taken a standard load cell and transformed it into a TEDS-Tag plug-and-play load cell.

For applications in which access to the load cell and access to the load cell cable is restricted, an in-line tag identification module can be simply constructed. A straight through in-line cable adaptor can incorporate the DS2401 electronic tag chip. In this application, the cable adapter is actually placed in series with the load cell cable before it is plugged into the ESL instrument. It is also possible to use this technique in applications where different calibrations might be required on the same load cell. The user may have a single load cell and instrument, but can change which calibration is auto-selected by simply changing the in-line cable adaptor. Since each cable adaptor has a different tag identification chip, the ESL instrument will associate a different calibration data set with each in-line adaptor. This might be useful, for example, if a precision 6-point linearization of the load cell is required in two different operating ranges of the same load cell.

Plug & Play Load Cell Instrumentation
Now that the load cell has been converted to a TEDS-Tag load cell, it can be connected to the ESL Model 4215 smart load cell indicator or a CellMite intelligent digital signal conditioner. The very first time it is connected, a standard calibration procedure is performed to initialize the cell's calibration data in the instrument. The ESL instruments support a variety of industry standard calibrations including mV/V, shunt, 2-point, or multi-point calibration. The instrument then automatically detects the presence of the TEDS-Tag load cell and matches it with its calibration data. From this point forward, the system is completely plug-and-play. Typical startup is now:

1. Plug load cell into the ESL instrument.
2. Turn on the power.
3. You're done.

After they've been initially calibrated on the instrument, changing cells is done by simply plugging the new cell into the instrument and turning on the power. That's it.

Model 4215 Smart Load Cell Indicator

The ESL Model 4215 is a calibration quality load cell indicator that has internal nonvolatile storage for the calibration data of 25 load cells. This unit with auto load cell identification is ideal for field calibration services. Model 4215 combines force channels, encoder position channels, print capabilities, and RS-232/485 serial communications into a versatile platform.

The versatile Model 4215 is used with tensile testers, load cells, extensometers, torque transducers, pressure sensors and position encoders. The Model 4215 features a bipolar range +/- 999,999 display, 24-bit resolution, nonlinearity of 0.005%, and auto load cell identification and setup for 25 load cells. Front panel shunt calibration with two selectable resistors is standard.

Menu buttons have alternate functions for setup menus. Programmed operations include peak hold and tracking, programmable math and function channels, programmable limits, the variety of engineering units, position and velocity indication, and user-parameter inputs along with menu scrolling and auto zero. Quad limits output: independent, isolated solid state relays control AC or DC signals. The unit features six user-selectable filters. There is a tri-state limit display of On, Off and Disabled. Model 4215 includes a quadrature encoder channel for position and rate readout.

The Model 4215 is dataView software ready for graphical user interface and connection to a PC. The dataView software features include: full function point-and-click graphical user interface; plug and play operation, full speed data acquisition and plotting; data export into spread sheets; store and recall data files; create and retrieve configuration files; and report generation.

CellMite Intelligent Digital Signal Conditioners
The CellMite is a compact digital signal conditioner that connects directly to a standard strain gauge based load cell, extensometer or pressure sensor and simultaneously generates a serial digital output for connection to a PC as well as a +/-10V analog output. It has internal nonvolatile storage for the calibration data of 3 load cells. It can be used with GUI software or standalone to replace analog load cell signal conditioners. When it identifies a TEDS-Tag load cell, it not only auto-installs the corresponding calibration data needed to take measurements from the cell, it also auto-installs gain and offset factors for its 16-bit scalable analog output. The voltage range and offset of the analog output is automatically changed to match the corresponding load cell. This is a powerful feature. Using the CellMite in this way is like having multiple analog load cell signal conditioners all in one, and having them automatically removed, installed, and matched with a load cell, all without any user intervention.

The CellMite compensates for transducer nonlinearities using its integrated 6-point calibration capability not found in standard signal conditioners. Its multi-drop RS232 serial port, unit addressing capabilities, and simple command set allow for connection of multiple units in a serial network configuration.

CellMite features the ability to select between three transducers, multi-point and mV/V calibration, remote sense excitation, and a 24-bit internal resolution. Functions include tare, peak and valley. The engineering units supported include: in, cm, mm, %, Lb, Kg, N, mV/V and user-defined.

The CellMite operates with either CellView Lite GUI Software, CellView Multi-Unit Display GUI Software or with software drivers. The CellView software features a turnkey data acquisition system. Data, calibration, and sensor test information can be saved and exported to spreadsheets. The software allows the operator to setup a test to start and/or stop automatically with user-selectable trigger events and delayed triggering.

The CellMite is ideally suited for in-situ transducer conditioning and distributed process measurements. CellMites are addressable for a Serial Network. The software guides the user through sensor calibration and through adding and removing networked units. The CellMite force measurement units can be networked along with the CellMite LVDT AC excitation digital signal conditioners.

Electro Standards offers a family of CellMites including single and dual-channel units, encased, DIN rail, and board configurations. Units are available with and without displays. A CellMite is available for wireless communication up to 1500 feet. A CellMite is also available with both LVDT and force measurement capabilities.

Summary

Electro Standards Laboratories has expertise on load cell electronics, digital signal conditioning, data acquisition systems, and related applications. A knowledgeable force of sales engineers is available to assist customers with the standard products offered on the ESL Website and with custom designs for specific applications. The company has been in business for over 30 years designing efficient engineered solutions.

About the Author

Dr. Raymond B. Sepe, Jr., is the Vice President of Research and Development at Electro Standards Laboratories and is a principal in the company. A graduate of Massachusetts Institute of Technology with degrees in Electrical Engineering and Computer Science, Dr. Sepe's expertise includes embedded controls, sensorless motor controls, multi-level inverters, controls modeling and simulation for motor drive systems, energy storage and energy harvesting. The company offers contract engineering services, precision instrumentation products involving strain gauge and LVDT sensors, and communication products including copper and fiber optic network switches, interface converters and cable assemblies.