An Inexpensive, Do-It-Yourself, Load Cell System, Accurate and Easy-To-Use

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Abstract: It is advantageous to have an efficient instrument that can automatically identify the load cell that is being attached to it and self-install the proper calibration data. When a new load cell is connected to the instrument, the appropriate calibration factors need to be installed in the instrument. Manual data entry or selecting from a database of stored calibration parameters introduces the possibility of user error. Loading the wrong parameters for a load cell, or corrupting the existing calibration data can lead to erroneous results and costly re-calibration expenses. An easy way to make a plug-and-play load cell system is presented in this paper.

Keywords: load cell, force measurements, TEDS, Transducer Electronic Datasheet, calibration

1. A Synopsis of the Problem

This is the problem. You're out on the road and you're carrying a variety of load cells that span different ranges that might be needed to calibrate a customer's system, or perhaps you need to conduct a wide range of force measurements for a particular testing application. You need to change the load cell that is connected to your instrument before you can continue. When the load cell is connected to the instrument, the appropriate calibration factors need to be installed in the instrument. Manual data entry, or requiring the operator to select from a database of stored calibration parameters, introduces the possibility of user error. Loading the wrong parameters for a load cell, or even worse, corrupting the existing calibration data, can lead to erroneous results and costly re-calibration expenses. It would be much more efficient if the instrument could automatically identify the load cell that is being attached to it and self-install the proper calibration data.

2. Difficulty Implementing TEDS – Transducer Electronic Data Sheet

You've heard of the Transducer Electronic Datasheet, referred to as TEDS technology, where data can be stored inside of a memory chip that is installed inside of a TEDS-compliant load cell. You've investigated the TEDS standard but it seems complicated. And it is. In an effort to be flexible, the TEDS standard specifies a huge number of detailed electronic data templates with some degree of standardization, but they've traded off simplicity for flexibility. 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.

It doesn't need to be this complicated.

3. The TEDS-Tag® Auto-Identification System

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 ESL Model 4325B CellMite® 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.

4. Do-It-Yourself TEDS-Tag® Load Cell

Any load cell can be easily made into a TEDS-Tag® load cell. The electronic identification chip is a Dallas Semiconductor part, number DS2401. As shown in Figure 1, the chip is inexpensive, small and easy to fit into a cable hood or load cell housing.

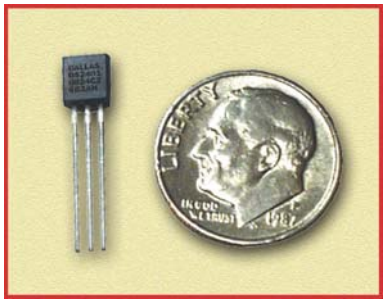

Fig. 1 *Electronic identification chip.*

Both the ESL Model 4215 and CellMite® 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. Figure 2 shows the interconnection of the DS2401 tag identification chip with the DB9 sensor connector on the rear of the ESL instruments. 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.

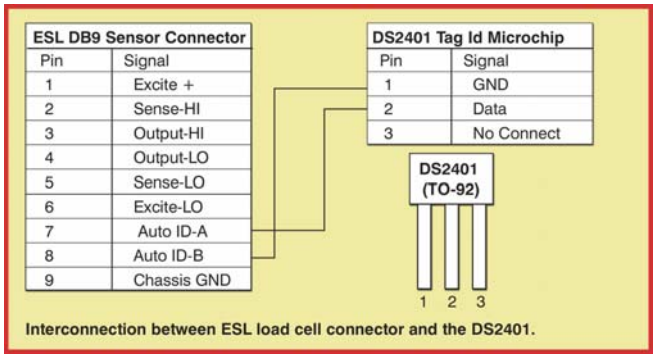

Fig. 2 *Interconnection of the DS2401 tag identification chip with the DB9 Sensor connector on the rear of the ESL instruments.*

When using off-the-shelf load cells, it is often convenient to locate the DS2401 in the hood of the cable. Figure 3 shows a typical integration of the DS2401 with a commonly available S-type load cell. The cable hood is pulled back to view the DS2401. The load cell comes with a permanently mounted cable that protrudes from the load cell housing. At the end of the cable, the individual wires have their insulation stripped back and they are soldered into the DB9 connector per the pinout in Figure 2. 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.

Fig. 3 *Standard S type load cell shown with an electronic tag chip mounted in the hood of the cable.*

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. Figure 4 shows how a straight through in-line cable adaptor can incorporate the DS2401 electronic tag chip. The protective hood has been removed for clarity. 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.

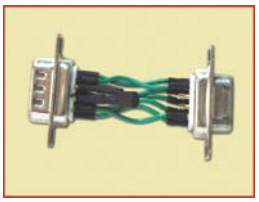

Fig. 4 *Illustration of a straight through in-line cable adapter with DS2401 Electronic tag chip.*

5. A Load Cell System as Simple as 1, 2, 3

Now that the load cell has been converted to a TEDS-Tag® load cell, it can be connected to the ESL Model 4215 or CellMite®. 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.

Figure 5 shows the front panel of a dual-channel ESL Model 4215 Intelligent Indicator that has two TEDS-Tag® load cells attached to it. The load cells on both channels are independently and automatically identified and the appropriate calibration data is self-installed on each channel. The numerical data shown with the Auto ID label is a cell serial number that was input by the user during the initial calibration process.

Fig. 5 *ESL Model 4215 Intelligent Indicator shown displaying load cell auto identification message.*

The ESL Model 4215 is a calibration-quality unit that has internal nonvolatile storage for the calibration data of 25 load cells. This unit with TEDS-Tag® auto load cell identification is ideal for field calibration services.

For embedded applications or for applications that require direct digital communications with a PC and do not require a display, the ESL CellMite® unit can be used. The CellMite® is shown in Figure 6. It has internal nonvolatile storage for the calibration data of 3 load cells. This unit outputs analog voltages as well as direct-to-PC digital readings. It can be used with Graphical User Interface (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.

Fig 6 *ESL CellMite® digital signal conditioner with TEDS-Tag® auto load cell identification capabilities.*

Author Information

Dr. Raymond B. Sepe, Jr., is a graduate of Massachusetts Institute of Technology and is a Vice President and principal of ESL, an engineering and manufacturing company located in Cranston, RI, USA. ESL's measurement and data acquisition product line includes strain gage and LVDT smart indicators and CellMite® force and LVDT intelligent digital signal conditioners. Its communication product line includes copper and fiber optic network switches, cable assemblies and interface converters. ESL offers contract engineering services specializing in motor control and data acquisition systems.