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ACTIVITY/PROJECT SPECIFIC PROCEDURE

SP 12-4
SIXNET DAS CALIBRATION
Revision 3

Effective Date: April 2, 2020

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	(printed name)	(signature)	(date)

1.0 Purpose and Scope

Revision 0 of this procedure was titled, "WIPP Hydrology DAS Calibration and Maintenance", but was modified to the current title so that other systems utilizing Sixnet DAS equipment could be calibrated following this procedure. This procedure prescribes the Sandia National Laboratories (SNL) Waste Isolation Pilot Plant (WIPP) process for the calibration and maintenance of the Sixnet product line of industrial controllers and analog input modules installed as part of a data acquisition system.

This procedure is only applicable to the SIXNET series of industrial controllers when connected with Sixnet supplied analog input modules. This combination of hardware will be referred to as the Sixnet DAS throughout the procedure. The calibration of the Sixnet DAS will require the use of a SIXNET supplied utility software called Sixnet I/O Tool Kit. A calibrated signal generator, such as the Martel Model 1200, will supply the analog signal source used to calibrate the inputs.

This document is not meant to substitute for the manufacturer's instruction manuals for the Sixnet hardware and software. The user is responsible for reading and understanding the appropriate manuals.

Acronyms and definitions for terms used in this procedure may be found in the Glossary located at the Sandia National Laboratories (SNL) WIPP Online Documents web site.

2.0 Implementation Actions

2.1 Safety

The calibration of the Sixnet DAS will require the use of low voltage signals supplied by a signal generator. Make sure the signal generator output is de-energized when connecting the signal source to the DAS.

The activities described in this SP shall conform to SNL Environmental Safety and Health programs (ES&H). All activities described in this SP are also subject to ES&H requirements governed by the WIPP Industrial Safety Program and the WIPP Industrial Hygiene Program IF performed within the WIPP land withdrawal boundary.

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All work around energized circuits will be evaluated using the Energized Work Decision Tool. https://info-ng.sandia.gov/esh/ewd_tool/dev.html.

2.2 Responsibilities

The Principal Investigator (PI), Hydrology Lead (HL) or designee, whose activities warrant the use of this procedure, is responsible for implementing the requirements of this procedure.

The Technical Staff, or designee, is responsible for performing the calibrations and measurements following the requirements of this procedure, documenting the calibrations, and assuring that the latest revision of this document is followed.

If this procedure cannot be worked as written, the user has the responsibility to stop work and resolve all concerns with the PI, safety or QA, as appropriate, prior to proceeding with the work.

2.3 Standards

Sixnet DAS will be verified using a Martel Model 1200, or equivalent, signal generator. The Martel standard is calibrated and traceable to NIST through the Sandia Primary Standards Laboratory in Albuquerque, NM. The serial number and expiration dates of the Martel standard will be recorded in the applicable Scientific Notebook (SN) or Scientific Notebook Supplement (SNS). The Martel signal generator shall not be used for the calibration of measurement equipment past its expiration date.

2.4 Frequency

The Sixnet Controller and connected analog modules will be calibrated semi-annually (six month intervals). The results of the calibration will be documented on the applicable SN or SNS. The PI can elect to length or shorten the calibration interval based on the results of previous calibrations and the stability of the equipment. Any deviations from the calibration interval will be justified and noted in the applicable scientific notebook or SNS.

2.5 Acceptance Criteria

The accuracy is calculated by determining the difference between the applied value and the measured value, dividing this number by the applied value and multiplying by 100 to get percent error. For most Sixnet DAS Current and Voltage analog module channels the error should be within ±0.05% of full scale. The error can be either increased or decreased as determined acceptable by the PI, HL or designee.

For the Sixnet DAS RTD analog modules the error should be ±0.5 degrees C of the applied value or as determined by the PI, HL or designee.

2.6 Trouble Shooting Tips

Sixnet DAS performance is evaluated through a series of calibration steps in which known inputs are applied to the Sixnet DAS and then compared to outputs logged or displayed by the Sixnet DAS Sixnet I/O Tool Kit software. The differences between the known inputs and logged outputs are treated as the system errors that are subsequently compared to the established acceptance criteria (tolerances).

The calibration process includes the following general steps: (1) supplying known signals over the measurement range using a calibrator or standard; (2) logging and converting the analog signals using

the 16-bit analog-to-digital converter modules of the DAS; (3) calculating the errors between the input and converted signals, (4) comparing the errors to the established acceptance criteria (tolerances); (5) if necessary, linearize the DAS analog conversion hardware. This calibration process and DAS tools utilized in the process are described below in greater detail.

Note: *Modules that have been used for data collection should first undergo an as-found calibration to determine their condition.*

If the Sixnet DAS cannot be brought into tolerance (as defined by the PI, HL or designee) during the performance of this procedure or if the equipment becomes damaged, the faulty component shall be tagged and taken out of service until repaired. Record this information in the applicable scientific notebook or SNS.

The analog input channels in the Sixnet DAS are individually fused. If a channel fails to measure any signal level when applied, check the channel fuse following the directions in the maintenance manual.

If the analog module's communication light is flashing, then the analog module is not communicating with the Sixnet IPM industrial controller. Perform the linking activity identified in the Sixnet I/O Tool Kit software to re-establish communications with the module. If this fails, attempt a total system power down and reboot. If the problem is not corrected, replace the module and return the defective analog module to the supplier for repair/troubleshooting.

2.7 As-Found Calibration/Verification

Note: Do not linearize and apply new calibration factors to any of the channels if the DAS has been used to collect data prior to the calibration. First determine the channel measurement accuracy by using the Martel unit to apply five current or voltages across the measurement range of the channel.

2.7.1 Connect the Martel signal generator to the first channel to be verified, be sure to disconnect the sensor that may be wired to the channel.

2.7.2 Select the analog module being calibrated. From the ***Operations*** Menu of the Sixnet I/O Tool Kit software, select the ***Test I/O*** function. The system will display the measured feedback signal for all channels on the analog module selected.

2.7.3 Set the Martel unit to the first setpoint for the channel being verified. Record the value displayed in the *Test I/O* window in the applicable scientific notebook or SNS. For analog current and voltage signals, the value recorded will be a 16-bit binary equivalent number covering the range of the applied signal (i.e., 20 mA, 10 VDC, 5 VDC, etc.). For the RTDs, the value will be in degrees C or F, as measured by the system.

2.7.4 Repeat step 2.7.3 for all setpoints to be applied to the channel being calibrated.

2.7.5 Repeat steps 2.7.1 through 2.7.4 for all channels requiring verification.

2.7.6 The verification of all channels must meet the acceptance criteria detailed in section 2.5. If a channel fails to meet the acceptance criteria, proceed to the next section to determine if the accuracy can be improved by re-linearizing the channel.

Note: The PI, HL or designee may accept an As-Found calibration that exceeds the stated acceptance criteria. The PI, HL or designee will need to document this decision and any impact on data collected with this channel(s) in the scientific notebook or SNS.

2.8 Linearizing the Analog Channels Using The Sixnet I/O Tool Kit Software Calibration Wizard

Note: The calibration/linearization process is a feature of the Sixnet I/O Tool Kit software package.

2.8.1 From the DAS system computer start the Sixnet I/O Tool Kit software application by either double clicking the applicable icon on the computer desktop or selecting the program from the START menu.

2.8.2 The technician will need to open the Sixnet I/O Tool Kit configuration file that matches the file being used by the Sixnet DAS. This configuration file determines the type of signal an analog input is configured to measure. Specific details on configuring a project are contained in the Sixnet I/O Tool Kit Users Manual.

2.8.3 Select the analog module to calibrate by using the right mouse button to click on the module located in the left Tree View window as displayed in figure 1.

2.8.4 From the popup menu that appears, select the CALIBRATE menu item to initiate the ***Calibration Wizard***. The Calibration Wizard will step the technician through the calibration/linearization of the individual channels.

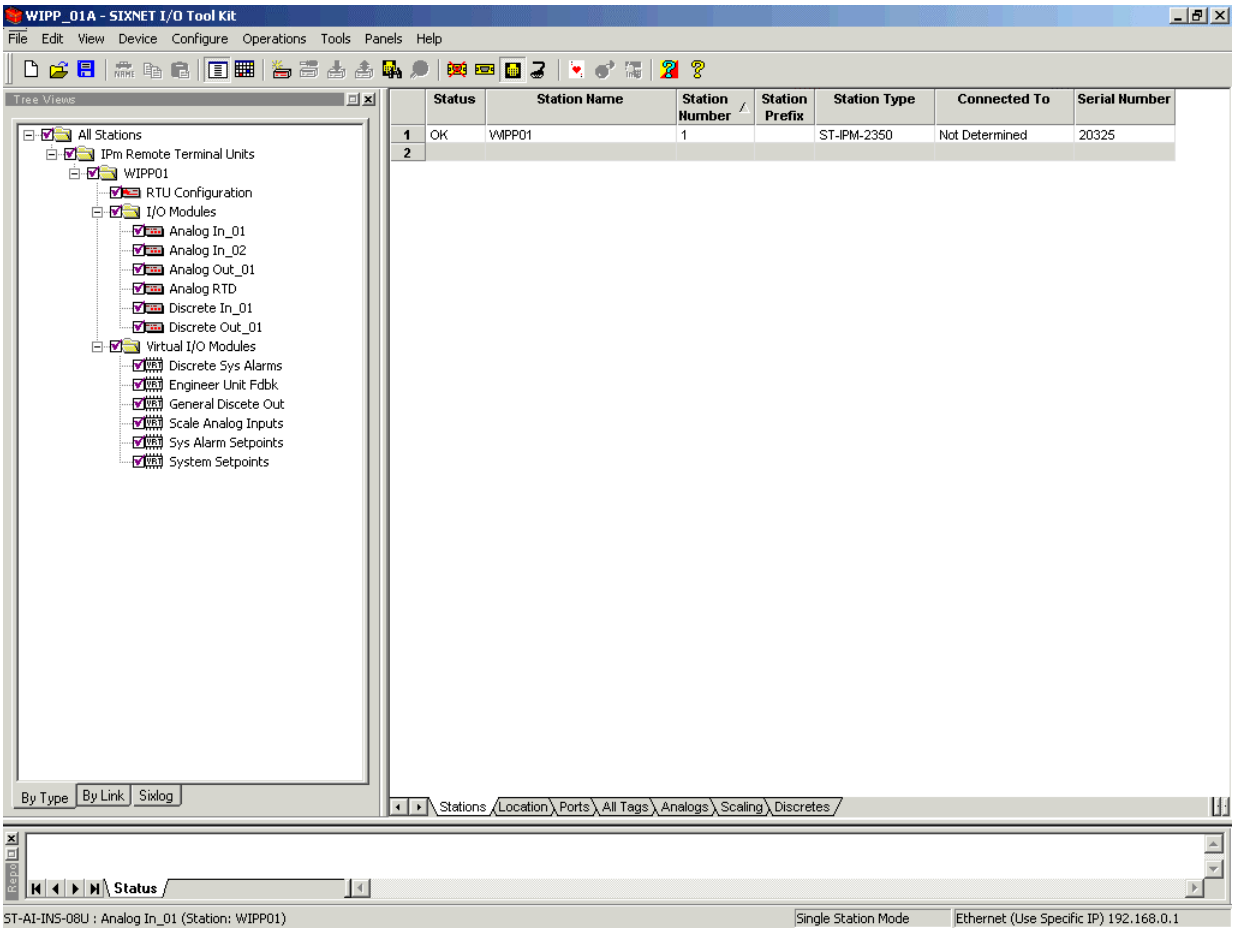

Figure 1. Calibration Wizard Screen

2.9 Channel Selection Screen

2.9.1 When the analog module icon is selected, the *Calibration Wizard* launches the ***Channel Select*** screen (Figure 2). This screen displays module-specific information and the channel to be calibrated. The screen also allows the operator to initiate the linearization of each channel of the analog module. Select the channel to calibrate from this screen then select NEXT.

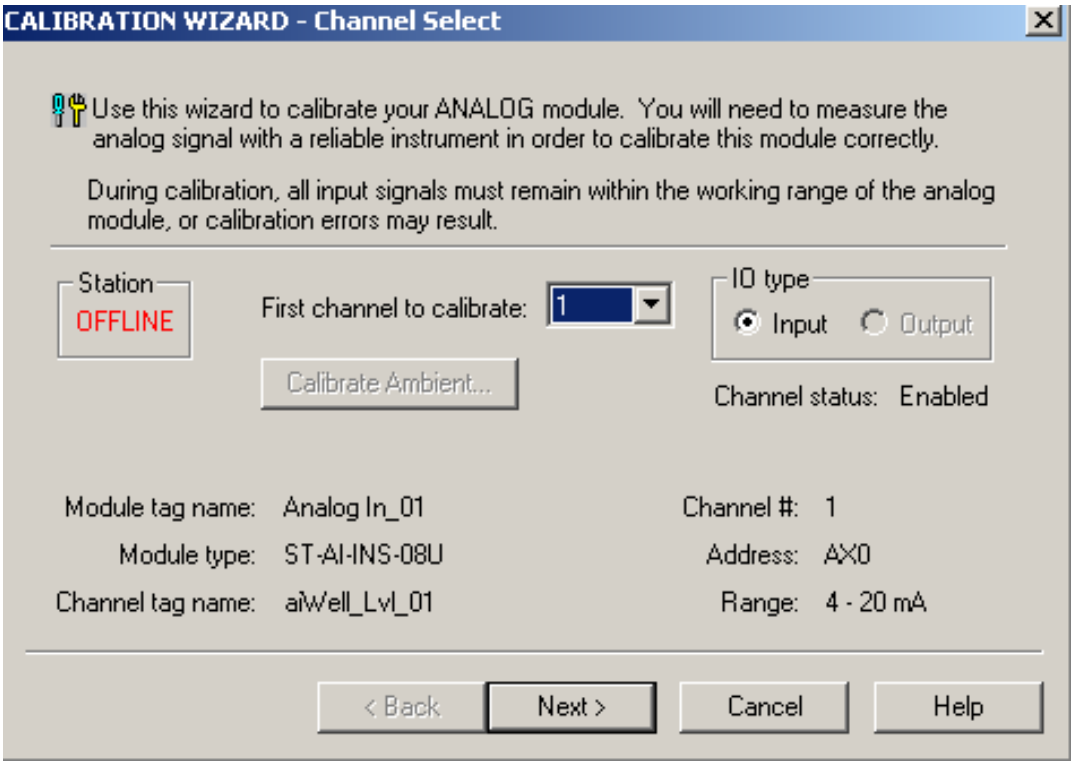

Figure 2. Channel Select Screen

2.10 Calibration Method/Units Select Screen

Note: Selecting *Next* from the previous screen launches the ***Calibration Method/Units Select*** screen (Figure 3). Using pull-down menus, the operator selects the calibration method and the calibration units to be used.

2.10.1 For Sixnet DAS calibrations select a “two point: offset and span” as the Calibration Method (Figure 3).

2.10.2 Select the type of calibration signal to match the configuration of the channel. This will typically be either 4-20 mA, 0-5VDC or 0-10VDC (Figure 3).

2.10.3 For an RTD analog module select degrees C or F as the calibration unit. The calibration range should only encompass the range of expected usage for the RTD. This will improve the linearization over the range that the instrumentation will be operated.

2.10.4 Future configurations may include the selection of other voltages or signal types (i.e. thermocouple inputs). The same process would apply to these signal types; therefore, this procedure would continue to be applicable.

2.10.5 Connect the Martel signal generator output to the channel selected for calibration.

2.10.6 Select ***Next*** to continue with the calibration.

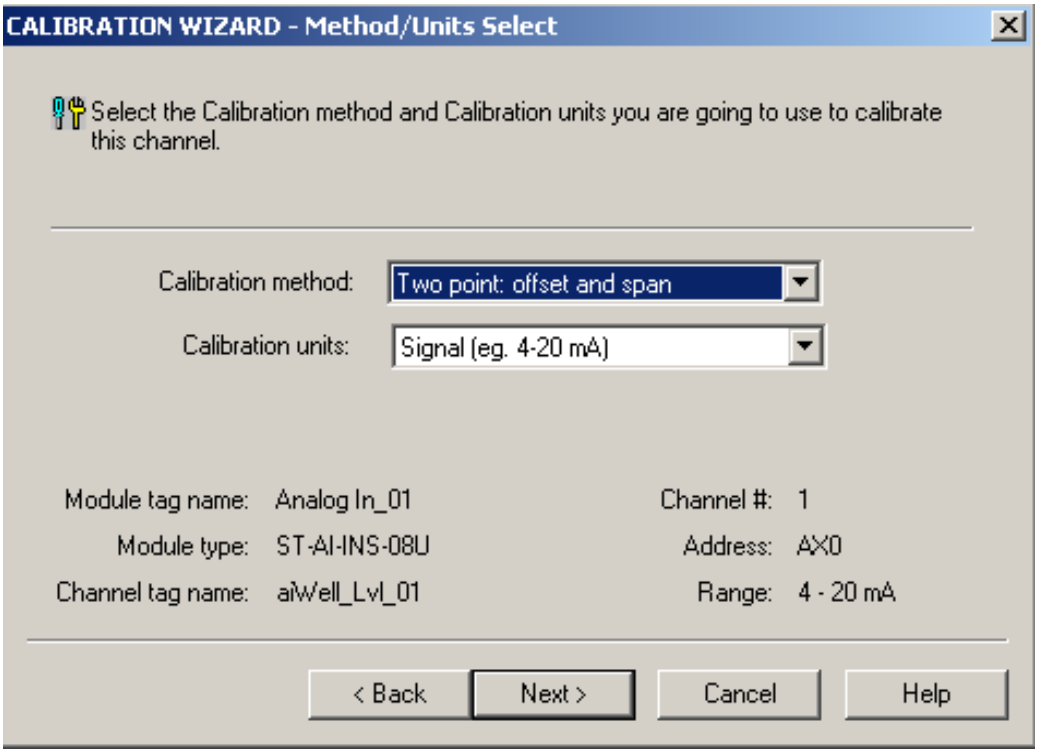

Figure 3. Calibration Method/Units Screen

2.11 Offset Calibration Point Screen

Note: Selecting *Next* from the previous screen launches the ***Calibration Offset*** screen (Figure 4).

2.11.1 Set the Martel signal generator to a value that is approximately in the bottom 10% of the measurement range being calibrated. For example, for a 4-20mA calibration an offset value of 5.0 mA is preferred, and for 0-10VDC an offset value of 1.0 VDC is preferred. For RTDs, a value near the low end of the expected usage range shall be used.

2.11.2 The technician will need to enter the value of the applied signal in the field next to “Enter known signal’s measured value” on the ***Calibration Offset*** screen.

2.11.3 Once the reading has stabilized, select the ***Next*** button to proceed with the calibration. When the ***Next*** button is selected the value is stored by the DAS.

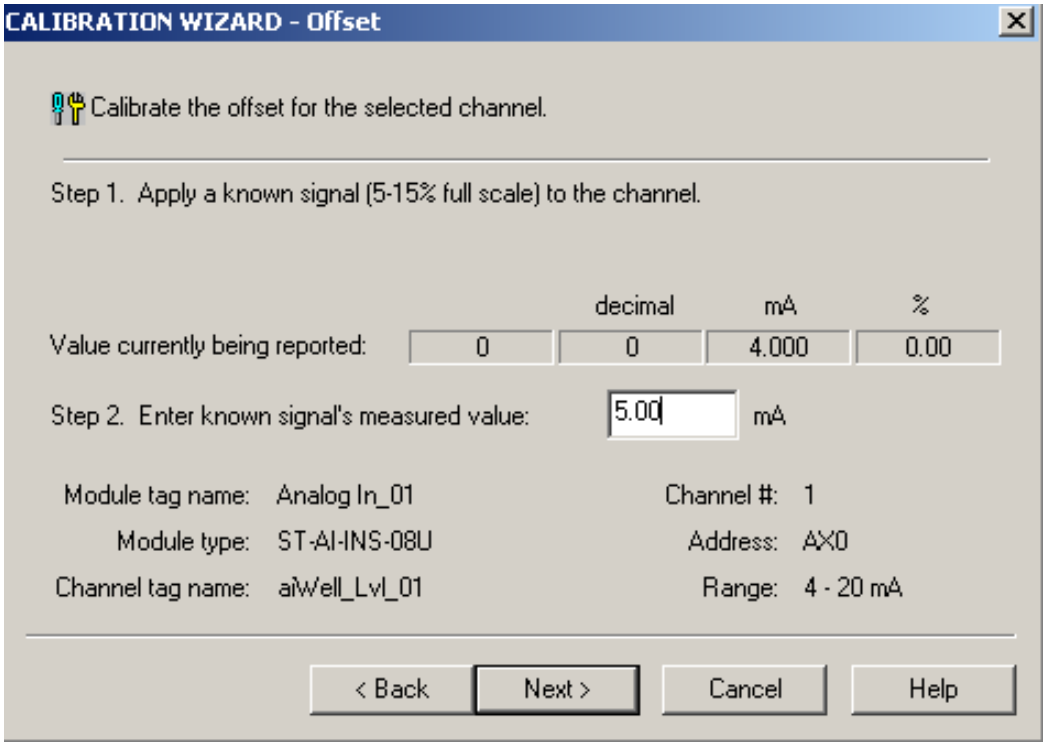

Figure 4. Calibration Offset Screen

2.12 Span Calibration Point Screen

Note: Selecting ***Next*** from the previous screen (Figure 4) launches the ***Calibration Span*** screen (Figure 5). The process from the previous step is repeated except the value entered represents the span value instead of the offset value.

2.12.1 Set the Martel signal generator for an output value in the upper 90% of the range of the channel being calibrated. For example, for a 4-20mA calibration a span value of 19.0 mA is preferred and for 0-10VDC a span value of 9.0 VDC is preferred. For RTDs, a value near the high end of the expected usage range shall be used.

2.12.2 The technician will need to enter the value of the applied signal in the field next to “Enter known signal’s measured value” space on the ***Calibration Span*** screen.

2.12.3 Once the reading has stabilized, select the ***Next*** button to proceed with the calibration. When the ***Next*** button is selected the value is stored by the DAS.

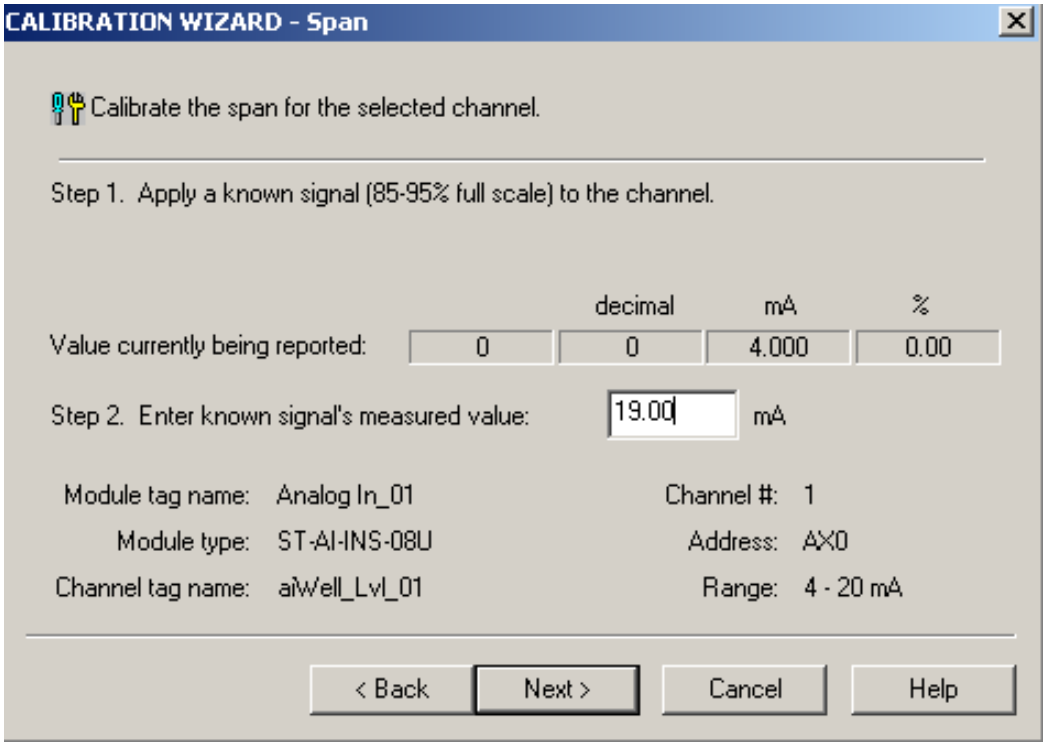

Figure 5. Calibration Span Screen

2.13 Completion of Linearization

Note: Selecting ***Next*** from the previous screen launches the ***Calibration Finish*** screen (Figure 6). This screen displays the current and new calibration factors for the calibrated channel.

2.13.1 Record the current and new calibration factors (offset and span) in the applicable scientific notebook or SNS.

2.13.2 If the results of the linearization are acceptable, save the new calibration factors for this channel by selecting the ***Apply Calibration*** button. This function saves the new calibration factors as the current calibration factors.

2.13.3 If additional channels require linearization, select the ***Next*** button and repeat steps 2.8 through 2.13. If all channels have been linearized continue to step 2.14, *As-Left Calibration Verification*.

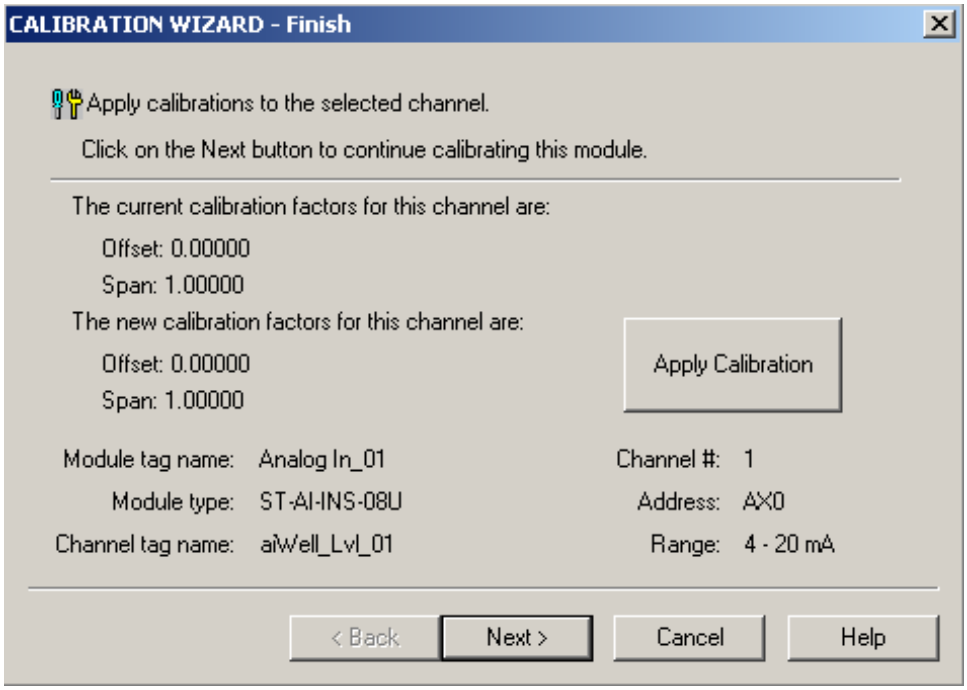

Figure 6. Calibration Complete Screen

2.14 As-Left Calibration Verification

Note: After all channels have been linearized and new calibration factors determined, channel measurement accuracy needs to be verified by applying input signals across the measurement range of the channel being tested.

2.14.1 Connect the Martel signal generator to the first channel to be verified.

2.14.2 Select the analog module being calibrated. From the ***Operations*** Menu of the Sixnet I/O Tool Kit software, select the ***Test I/O*** function. The system will display the measured feedback signal for all channels on the analog module selected.

2.14.3 Set the Martel unit to the first value of the calibration setpoint for the channel being verified. Record the value displayed in the *Test I/O* window in the applicable scientific notebook or SNS. For analog current and voltage signals, the value recorded will be a 16-bit binary equivalent number covering the range of the applied signal.

2.14.4 Repeat step 2.14.3 for all setpoints to be applied to the channel being calibrated.

2.14.5 Repeat steps 2.14.1 through 2.14.4 for all channels requiring verification.

2.14.6 The verification of all channels must meet the acceptance criteria detailed in section 2.5. If a channel fails to meet the acceptance criteria, repeat the Linearization steps to determine if the accuracy can be improved by re-linearizing the channel.

2.14.7 If after repeating the linearization the channel fails to meet the acceptance criteria, remove the analog module from service. The PI, HL or designee may accept a calibration that exceeds the stated acceptance criteria. The PI, HL or designee will need to document this decision in the scientific notebook and in the applicable scientific notebook or SNS. The Sixnet DAS should be tagged indicating its de-rated accuracy.

2.15 References

Sixnet I/O Tool Kit Software Users Manual, version 3.1 or newer, effective at or after 8/07.

3.0 Records

The following records, generated through implementation of this procedure, shall be prepared and submitted to the WIPP Records Center in accordance with NP 17-1 (Records):

QA Record

- Applicable Scientific Notebook or Scientific Notebook Supplement

4.0 Appendices

Not Applicable.

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