## Field Measurement of Specific Conductance and Conductivity

##### Use in conjunction with:

###### FT 1000 General Field Testing and Measurement

###### FQ 1000 Field Quality Control Requirements

* FS 1000 General Sampling

###### FD 1000 Documentation Procedures

##### Introduction: Specific conductance is a useful method to approximate the total amount of inorganic dissolved solids. Conductivity is a measure of the ability of an aqueous solution to carry an electric current. Specific conductance is conductivity temperature-adjusted to 25°C. Specific conductance is generally preferred for environmental monitoring.

##### Conductivity varies with temperature. For example, the conductivity of salt water increases 3% per degree C at 0°C, and only 2% per degree C at 25°C.

##### Record the sample temperature or adjust the temperature of the samples to 25°C prior to measuring specific conductance if the conductivity instrument does not employ automatic temperature compensation and correction of the instrument display value.

##### Specific conductance and conductivity are customarily reported in microsiemens per centimeter (μS/cm) or micromhos per centimeter (μmhos/cm), which are equivalent.

##### Equipment and Supplies

##### Field Instrument: Any self-contained conductivity instrument suitable for field work, accurate and reproducible to 5% or better over the operational range of the instrument, and preferably equipped with temperature-compensation adjustment.

##### Standards: Purchased or laboratory-prepared standard potassium chloride (KCl) solutions with conductivity values that bracket the expected sample range. In the laboratory, prepare standards of appropriate conductivities per method 2510, *Conductivity*, in *Standard Methods for the Examination of Water and Wastewater, 2011* (see Standard Methods Online, http://www.standardmethods.org). Do not reuse standards for initial calibrations.

##### Recordkeeping and Documentation Supplies:

##### Field notebook (w/ waterproof paper is recommended) or forms

##### Indelible pens

##### Calibration and Use

##### General Concerns

##### **Follow the instrument manufacturer's instructions for the details of operating the instrument. Conduct the calibration for specific conductance rather than conductivity if the instrument has automatic temperature compensation.**

##### For instruments without automatic temperature compensation, attempt to adjust the temperature of the samples to 25°C. If the temperature cannot be adjusted, measure the temperature with a calibrated device (see FT 1400), record the temperature, correct for temperature (per section 3.4 below) and report the results corrected to 25°C, if reporting specific conductance.

##### Ensure stable sample and sensor temperature before calibrating or taking sample readings. Drifting sensor or sample temperature may produce erroneous sample measurements, calibrations or verifications.

##### Thoroughly rinse the conductivity sensor with deionized water and fresh standard when calibrating. Rinse the conductivity sensors with deionized water or standard when verifying calibrations. For in-situ measurements, ensure adequate flushing of the sensor with fresh sample water prior to taking measurements. Any residual standard, sample or deionized water remaining on the sensor may affect the measurement of the subsequent standard or sample. This is especially true when samples or low-concentration standards are measured subsequent to measuring high-concentration standards.

##### Drifting readings or an inability to calibrate the sensor may also indicate a fouled electrode. Clean the electrodes per the manufacturer’s instructions.

##### When successful calibration and verification cannot be achieved after ensuring that temperatures have stabilized and the sensor electrodes are clean and free of residual sample or standard from the previous measurement, suspect opened containers of standards, especially after repeated openings, when near the manufacturer’s expiration date or when little standard volume remains in the container. Low-concentration conductivity standards are seldom stable for an extended period after opening.

##### Calibration and Calibration Verification:

##### Follow the calibration activities specified in FT 1000, section 2.2, including requirements for chronological and quantitative bracketing.

##### Initial Calibration: Calibrate the meter prior to use according to the following steps:

##### **Calibrate according to the manufacturer’s recommendations.**

##### When the sample measurements are expected to be 100 μmhos/cm or greater, use two standard potassium chloride solutions that bracket the range of expected sample conductivities. A single standard at 100 μmhos/cm standard potassium chloride solution is acceptable for situations in which all sample measurements are expected to be less than 100 μmhos/cm. See also FT 1000 section 1.3.3.2.

##### Calibrate the instrument with one of the two standards to create an upper or lower boundary for the quantitative bracket.

##### Verify the calibration of the instrument in the “read” or “run” mode with the second standard, quantitatively bracketing the range of expected sample values.

##### If the instrument can be calibrated with more than one standard, choose additional calibration standards within the range of expected sample values. The second standard in section 3.2.2.3 above may be used as an additional calibration standard.

##### Acceptability: Accept the calibration if the meter reads within +/- 5% of the value of any calibration standard used to verify the calibration. For example, the acceptance range for a 100 μmhos/cm standard is 95 to 105 μmhos/cm. If the meter does not read within +/- 5% of each calibration verification standard, determine the cause of the problem and correct before proceeding.

##### Temperature Correction: Most field instruments read specific conductance directly by automatically correcting the temperature of samples to 25°C. If the meter does not automatically correct values to 25°C, calculate correction factors using the procedure in section 3.4 below. Record all readings and calculations in the calibration records.

##### Continuing Calibration Verification: After sample measurement(s), perform a continuing calibration verification (CCV). Perform a CCV at no more than 24-hour intervals from the previous verification, or demonstrated as in FT 1000, sections 2.2.5.1 and 2.2.5.2. Check the meter in the “read” or “run” mode with at least one KCl standard with a value that quantitatively brackets the conductivity or specific conductance measured in environmental samples. The reading for the calibration verification must also be within +/- 5% of the standard value (see 3.2.3 above). Note: If all samples are less than 100 μmhos/cm, only one standard at 100 μmhos/cm standard potassium chloride solution is required and samples do not have to be quantitatively bracketed.

##### If new environmental samples are encountered outside the range of the initial calibration in 3.2.2 above, verify the instrument calibration with an additional standard that brackets the range of new sample values. If these calibration verifications fail, recalibrate the instrument as in 3.2.2.

##### **More frequent calibration verifications may be required for discharge permit compliance measurements or other regulatory requirements.**

##### Measuring Specific Conductance of Samples:

##### Follow manufacturer’s instructions for sample measurement.

##### Immerse or place the conductivity probe or sensor in situ at a measuring location representative of the sampling source.

##### Allow the conductivity instrument to stabilize.

##### Measure the water temperature (if necessary for manual temperature compensation) and record the temperature. See FT 1400 for temperature measurement procedures.

##### If the meter is equipped with manual temperature compensation, adjust the conductivity meter to the water temperature, following manufacturer’s instructions.

##### If the conductivity meter has a set of positions that multiply the reading by powers of ten in order to measure the full range of potential conductivities, set this dial to the correct range in order to take a reading.

##### Record the sample conductivity or specific conductance measurement after all applicable meter adjustments and temperature measurements have been made and the instrument reading has stabilized. If the sample has been collected into a container for measurement, record the instrument reading within 15 minutes of water sample collection.

##### Follow manufacturer’s instructions for probe storage between use.

##### Calculations for Temperature Compensation

If the meter does not automatically correct for temperature (manual or automatic adjustment), or if a probe with a cell constant other than 1 is used, the following formula must be used to normalize the data to 25°C:

 K = (Km) (C) .

 1 + 0.0191(T-25)

 Where: K = specific conductance (conductivity in μmhos/cm at 25°C)

 Km = measured conductivity in μmhos/cm at T degrees C

 C = cell constant

 T = measured temperature of the sample in degrees C

If the cell constant is 1, the formula for determining conductivity becomes:

 K = (Km) .

 1 + 0.0191(T-25)

Refer to SM2510B if other calculations (*i.e.,* determining cell constant, etc.) are required.

3.5 *In situ* Measurements at Depth or With Flow-through Cells: After calibrating the instrument as outlined in 3.2 above, **follow the manufacturer’s instructions** to measure the conductivity of the sample.

* + 1. For *in situ* measurements immerse the probe at the desired depth and wait for stabilization of the reading and record its value. Follow a similar procedure when using a flow-through cell.
		2. Preferably measure groundwater sample conductivity *in situ* with a downhole probe or in a flow-through system.

##### Preventative Maintenance: Refer to FT 1000, section 3.

#####  Documentation

##### Standard and Reagent Documentation: Document information about standards and reagents used for calibrations, verifications and sample measurements.

##### Note the date of receipt, expiration date and date of first use for all standards and reagents.

##### Document acceptable verification of any standard used after its expiration date.

##### Record the concentration or other value for the standard in the appropriate measurement units.

##### Note vendor catalog number and description for preformulated solutions as well as for neat liquids and powdered standards.

##### Retain vendor assay specifications for standards as part of the calibration record.

##### Record the grade of standard or reagent used.

##### When formulated in-house, document all calculations used to formulate calibration standards. Record the date of preparation for all in house formulations.

##### Describe or cite the procedure(s) used to prepare any standards in-house (DEP SOP or internal SOP).

##### Field Instrument Calibration Documentation: Document acceptable calibration and calibration verification for each instrument unit and field test or analysis, linking this record with affected sample measurements.

##### Retain vendor certifications of all factory-calibrated instrumentation.

##### Designate the identity of specific instrumentation in the documentation with a unique description or code for each instrument unit used. Record manufacturer name, model number, and identifying number such as a serial number for each instrument unit.

##### Record the time and date of all initial calibrations and all calibration verifications.

##### Record result to the level of resolution stated by the conductivity sensor manufacturer (value in appropriate measurement units).

##### Record the name of the analyst(s) performing the calibration.

##### Document the specific standards used to calibrate or verify the instrument or field test with the following information:

##### Type of standard or standard name (e.g., conductivity standard)

##### Value of standard, including correct units (e.g., conductivity = 100 µmhos/cm)

##### Link to information recorded according to section 5.1 above

##### Retain manufacturers’ instrument specifications.

##### Document whether successful initial calibration occurred.

##### Document whether each calibration verification passed or failed.

##### Document any corrective actions taken to correct instrument performance according to records requirements of FD 3000.

##### Document date and time of any corrective action.

##### Note any incidence of discontinuation of use of the instrument due to calibration failure.

##### Describe or cite the specific calibration or verification procedure performed (DEP SOP or internal SOP).

##### Record all field-testing measurement data, to include the following:

###### Project name

###### Date and time of measurement or test (including time zone, if applicable)

###### Source and location of the measurement or test sample (e.g., monitoring well identification number, outfall number, station number or other description)

* + Latitude and longitude of sampling source location (if required)

###### Analyte or parameter measured (specific conductance vs. conductivity)

###### Measurement or test sample value result, recorded to the level of resolution stated by the conductivity sensor manufacturer (value in appropriate measurement units)

###### Reporting units

* + “J” qualifier code and explanatory comment if the sample measurement is not chronologically or quantitatively bracketed by acceptable calibrations and verifications per requirements in FT 1000, section 2.2 (see section 3.2 above for bracketing requirements when all sample values are less than 100 µmhos/cm)
	+ Initials or name of analyst performing the measurement

###### Unique identification of the specific instrument unit(s) used for the test(s)