

Acuity LS[™]

OPERATING MANUAL

ACUITY CORROSION TECHNOLOGY

#OMA20241022 acuitycorrosion.com



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1. OVERVIEW

This document provides an overview of the Acuity LS corrosion monitoring system hardware and interface software. An Acuity LS device provides long-term, autonomous measurements of environmental and corrosion parameters, including air temperature, relative humidity, conductance, galvanic corrosion, and free corrosion. The Acuity LS device is batterypowered, small, and lightweight, and it may be directly mounted onto structures in harsh environments. The Acuity interface software enables users to operate a device.

2. ACUITY LS HARDWARE AND SOFTWARE COMPONENTS

The Acuity LS device consists of a base and a lid-sensing panel (LSP). The base contains the microcontroller electronics, battery, and interface connector. The base includes a sensor to measure the temperature of the surface to which it is attached. The LSP contains a combined relative humidity and air temperature sensor, a gold interdigitated electrode (IDE) to measure solution or coating conductance, a single material IDE to measure free corrosion current, and an IDE with dissimilar materials to measure galvanic corrosion current (Figure 1).



Figure 1. Acuity LS sensing elements and other features.

Operating Acuity LS requires a personal computer (PC) with the Acuity interface software installed and a specific interface cable to connect the device to the PC (Figure 2). The interface software allows users to configure their devices, start and stop data logging, and download collected measurements from the device. The latest interface software installation files are distributed with the devices on CD and USB thumb drive and are available via a download link upon request. Acuity LS accessories and parts including replacement LSP, batteries, and interface cables can be purchased separately from Acuity Corrosion Technology (sales@acuitycorrosion.com).





Acuity LS Base with Lid Sensor Panel (LSP)

* Items sold separately

Figure 2. Acuity LS components.

For any technical support needs, including software installation and device troubleshooting, please contact support@acuitycorrosion.com.



3. INTERFACE SOFTWARE AND DRIVER INSTALLATION

This section provides instructions for installing the interface software that allows users to configure their Acuity LS devices and download stored data. Software version 5.0 is designed to work with the entire family of Acuity products, provided that the devices have compatible firmware installed, as indicated below.

- Interface software version: 5.0
- Acuity LS (standard) firmware compatibility: 2.1.012 or newer (2.1.022 is current)
- Acuity LS (addressable) firmware compatibility: 2.4.015 or newer (2.4.015 is current)

Software System Requirements

The Acuity interface software requires Windows 10 or newer 64-bit operating system, 800 MB of free disk space, and one available USB port. There are no processor or memory requirements.

Interface Software and USB Driver Installation

CAUTION: Do not plug the Acuity interface cable into the computer until software installation is complete. This will prevent Windows from automatically installing an incorrect driver.

- 1. Make sure that you have administrator privileges on the computer.
- 2. Insert the CD or USB flash drive provided with the product shipment. If unavailable, please contact Acuity Corrosion Technology for another copy or a download link.
- 3. Open Windows File Explorer (shortcut: "Windows" key + "E" key).
- 4. Within File Explorer, open the CD, USB drive, or downloaded file and locate "INSTALLER Acuity Interface X.X.zip", where "X.X" will be the current software version.
- 5. Right click on this file and select "Extract All".
- 6. Select a temporary folder on the computer for the extracted files and click "Extract".
- 7. Go to the folder with the extracted files and click "INSTALLER Acuity Interface X.X.exe".
- 8. Select the default values for all prompts. The Acuity interface software installation will take several minutes to complete.
- 9. Once the Interface software is installed, the USB driver installer will automatically start. Select default values for all prompts. Software and drivers are now installed.

The Acuity interface software and supporting drivers are now installed. Shortcuts are available on the desktop and the Windows start menu.



4. INTERFACE SOFTWARE OPERATION

This section provides instructions for connecting an Acuity LS device to a computer and using the Acuity interface software.

Establishing Connection

To establish connection between an Acuity LS device and the computer:

- 1. Plug the Acuity LS interface cable (Figure 2) into any of the PC's available USB ports. The cable's red/green LEDs will blink, indicating Windows has recognized it.
- 2. Remove the protective cap from the Acuity LS interface connector and securely connect the other end of the interface cable.
- 3. Open the Acuity interface software using the desktop icon or the Windows start menu.
- 4. When the Connect to Device window appears (Figure 3, left), click "Connect to Device". The software will find any Acuity device connected to the PC and connect to it automatically (Figure 3, right).



Figure 3. (left) Connect to Device window.

"Advanced Settings" allow the user to manually select the device communication port, but this typically reserved only for diagnostic purposes.

5. If multiple devices are detected, a selection window will appear showing the device type and ID number (Figure 4). The software can recognize different Acuity products (LS, CR, ES) connected at the same time, so please ensure you are selecting the correct device. Select the device and click "Connect".





Figure 4. Selection window when multiple devices are found.

6. If no devices are found, a window offering basic troubleshooting guidance will appear (Figure 5). If none of these remedies are successful, please contact Acuity support.

No Acuity devices found.		
Possible reasons and remedies include:		
a. Cable not connected properly -> Check physical connection and click RETRY		
b. Scheduled measurement was in progress -> Wait 30 seconds and click RETRY		
c. Battery depleted -> install new battery and click RETRY (Acuity LS and ES only)		
d. Incorrect port settings -> Use Advanced Settings to select a specific port		
e. Device is busy streaming data from a previous record download attempt -> Wait several minutes and click RETRY.		
If no device is found after troubleshooting, please contact Acuity support.		
RETRY Return to Menu		

Figure 5. Troubleshooting window when no devices are found.

7. When the software successfully connects to a device, the Acuity interface main window will appear, showing the device type and ID number at the top left (Figure 6).



Operating the Acuity interface Software

The Acuity interface software main window is a combination of status indications and buttons to perform various commands (Figure 6). This section describes the meaning of each indicator and the details of each command. To help guide a new user through the specific steps of configuring a device and downloading records from it, please see Section 5.

Acuity Interface	- 🗆 X
	Interface 5.0
Acuity LS 00627 Not Logging Data Sampling Int. 5 minutes Stored Records 5435 [4% used]	Device status checked
Battery Counter 5436 [13% used] Firmware Ver. 2.1.022 Configuration Single Galvanic	Synchronize ClockDevice (UTC)23 Jul 2024 05:11:28 PMHost (UTC)23 Jul 2024 05:12:51 PMDifference1.4 minutes
Change Setup Start Logging Stop Logging Download Records Summary Clear Records	Take Measurement Relative Humidity Air Temp. Surface Temp. Conductance LF Conductance HF Galvanic Corrosion Free Corrosion Battery Voltage
Connect to a Different Device	EXIT

Figure 6. Acuity interface main window.

The Acuity Interface provides the following information:

- Device Type and ID This number should match the label on the device base.
- **Logging Status** Indicates whether the device is currently logging data or not logging data (green = logging, red = not logging).
- **Sampling Int.** Interval between automated, timed measurements when the device is logging data (minutes).
- **Stored Records** Number of records stored in device memory and percentage of total memory used.



• **Battery Counter** – Number of measurements taken since the last battery change and percentage of total memory used.

NOTE: The "% used" is based on a nominal battery lifetime of approximately 40,000 measurements. The expected lifetime can be reduced by operating for extended periods in cold climates.

The device resets this counter to zero whenever power is removed and reapplied. Normally, this would only happen when changing an old battery for a new one. However, if the user removes and reinstalls the same battery the counter will still reset to zero even though the battery may not be new.

- Firmware Ver. Firmware version installed on the device.
- **Configuration** Indicates whether the Acuity LS device is configured to measure one galvanic and one free corrosion sensor (Single Galvanic) or two galvanic sensors (Dual Galvanic).
- **Device (UTC)** Displays device's current time (UTC+0).
- **PC (UTC)** Displays computer's current time (UTC+0).
- **Difference** PC time minus the device time given in minutes, as a quick reference.

The following operations can be performed on the Acuity interface main window:

- **Check Device Status** The red or green indicator at the top left is also a button that will request updated status information from the device when clicked.
- Change Setup Allows users to change the automated measurement sampling interval. Also provides a way for users to store useful information within the device about the current test. For convenience, this information is included in the data file along with the downloaded measurement records.
- **Start Logging** Starts automated measurements at the user-defined sampling interval. Logging only stops when the user selects "Stop Logging".
- **Stop Logging** Stops the automated measurements and places the device in a lowpower sleep state. The device can remain in this sleep state for several years without significantly impacting battery life.
- **Download Records** Saves all records stored on the device to the computer in a user-selectable location. Data downloads may take several minutes, with progress indicated in the top right of the main window.
- **Summary** Provides a summary of the downloaded records. This command becomes active after records are downloaded.
- **Clear Records** Permanently deletes all stored records on the Acuity LS device. Clearing records takes about one minute, with progress indicated in the top right of the main window. This command does not affect other device settings.



• Synchronize Clock – Adjusts Acuity LS device clock to match the PC clock.

NOTE: Please verify accurate local PC time before synchronizing Acuity LS clock.

- **Take Measurement** Immediately takes a measurement, regardless of logging status, and displays the result on window to verify sensor operation. Measurements taken in this manner will be stored to the device memory.
- **Connect to a Different Device** Returns to the "Connect to Device" menu so that the user can connect to a different device without restarting the software.
- **EXIT** Closes the Acuity interface software.

Additional information on these operations is provided below.

Checking Device Status

Device status information is displayed on the interface main window (Figure 7). To ensure that the status is up to date, the software queries the device status after any other software function is completed. The user can force a status update without performing any other function by clicking on the logging indicator (either red or green).

Acuity LS 00627 Not Logging Data	
Sampling Int.	5 minutes
Stored Records	5435 [4% used]
attery Counter	5436 [13% used]
irmware Ver.	2.1.022
Configuration	Single Galvanic

Figure 7. Device status indicators for not logging (left) and logging (right).

Change Setup – Sampling Interval

Clicking "Change Setup" opens a new window with two main areas. The first area allows the user to adjust the sampling interval that the device uses when data logging is active (Figure 8). To change the sampling interval, click into the number field and type the new value. Alternately, use the small arrow buttons. Click "Update Sampling Interval" to send the new value to the device. Changes to the sampling interval are effective immediately and do not require stopping and restarting the data logging.



Figure 8. Sampling Interval portion of the Change Setup window.



If changes are made to the sampling interval or user descriptions, they must be sent to the device with their respective "Update" command before returning to the main menu, otherwise these changes will be lost. The software warns when continuing to the main menu will result in lost changes (Figure 9). If this was not your intent, click "Cancel" and then "Update Sampling Interval" or "Update Description" as appropriate.



Figure 9. Warning message when returning to main menu if changes were made to sampling interval or user descriptions without updating the device.

Change Setup – User Input Descriptions

The second area within the Change Setup window allows the user to input descriptions about the device, where it is located, test details, sensor alloys, and other notes. These values will appear in the same data files as the downloaded records as a convenient way to keep this information together. Adding user input descriptions is not required for Acuity LS operation; but may help document test details and device use. When first opening this window, the text values shown are those currently stored in the device. After entering the desired new values, click "Update Descriptions" to store the changes to the device. Clicking "Clear Descriptions" will clear the user input descriptions from the device.

User Input Desc	criptions	Update Descriptions
Asset	Aircraft ABC	
Asset ID	H1234	
Position on Asset	Tail Section	
Geographic Location	Anytown USA	
Test Type	On-aircraft exposure	
Notes	Installed on vertical w	all
Notes		
Galvanic Alloys	AA7075-T6 / A286 SS	
Free Corrosion Alloy	AA7076-T6	
Notes	Sprayed with CPC	
Notes		
User input sections wil automatically be adjusted to 240 characters maximum. Carraige return, comma, and "\$" characters will be stored as a space.		
Clear Descriptions		Return to Main Menu

Figure 10. User Input Descriptions portion of the Change Setup window.



Memory limitations allow a maximum of 240 characters in each section (e.g., the first seven rows total up to 240 or less, and the same for the last four rows). Carriage return, comma, and dollar sign (\$) characters interfere with storage and retrieval of the descriptions and will be automatically replaced by a space character. The software will notify the user before automated corrections are made to maintain the 240-character limit or allowable character types.

Start Logging

If the device is not logging data, the "Start Logging" button will be active. Click "Start Logging" to start automated measurements at the sampling interval set by the user. A new window will appear asking for confirmation. Clicking "OK" will initiate device data logging. Another window will appear indicating success or failure of this operation. The logging indicator in the main window will turn green.

NOTE: It is good practice to synchronize the device and PC clocks prior to starting a new data log to ensure that the initial timestamp is accurate.

Stop Logging

If the device is logging data, the "Stop Logging" button will be active. Click "Stop Logging" to stop automated measurements and enter low-power sleep mode. A new window will appear asking for confirmation. Clicking "OK" will stop device data logging. Another window will appear indicating success or failure of this operation. The logging indicator in the main window will turn red.

Download Records

Clicking "Download Records" retrieves all records stored on the device and saves them to the computer in a user-selectable location. The software suggests a default filename that includes product type, ID number, and PC's system date and time of the download (*Figure 11*). Either accept the default filename or provide a custom filename, then click "OK". Download progress will be indicated in the top right of the main window and may take several minutes to complete for large downloads.

Please refer to Section 6 for details about the file types and their contents.

File <u>n</u> ame:	Acuity LS 00627 D20240920 T151605.csv ~
Save as <u>t</u> ype:	CSV (Comma delimited) (*.csv) \sim
∧ Hide Folders	OK Cancel

Figure 11. File save window with default file name. User may change the name and folder as desired.



After the download is complete, the Download Summary window displays information about the device and the downloaded records (Figure 12). The purpose of this information is to quickly determine if download operation was completed successfully.

Acuity LS 00627 Download Summary		
Records Downloaded	5435 of 5435 [100%]	
First Record Time (UTC)	31 May 2024 03:15:00 PM	
Last Record Time (UTC)	19 Jun 2024 12:12:00 PM	
Irregular Time Intervals	0	
Record Write Faults	0	
42.5- 40- 37.5- 5 35- 32.5- 27.5- 25- 22.5-		
Record Number		
Air Temp 📉 Surf Ten	np 🔼	

Figure 12. Download Summary window.

- **Records Downloaded** Number of downloaded records compared to the number of records in memory. If the numbers do not match, it may be because the download was interrupted. In that case, the download Operation should be repeated.
- First Record Time and Last Record Time (UTC) Date and time of the first and last data record. These values should meet the user's expectations for the test period.
- Irregular Time intervals Indicates how many times the timestamp changed more than 24 hours between adjacent records. The intent is to recognize when the device internal clock is unintentionally reset during operation (most likely due to a weak battery). In that case the clock reverts to the year 2000 and time intervals will be very large. Unexpected time intervals also adversely affect the cumulative corrosion calculations stored in the .csv file.
- **Record Write Faults** Under weak battery conditions, there may not be enough electrical energy available for the Acuity LS internal memory to successfully complete a record storage operation following a measurement. Normally, the device recognizes this weak battery condition and will skip the record storage operation to avoid a fault, but in certain cases it may still attempt a write that cannot be successfully completed. Record Write Faults indicates the number of times the devices unsuccessfully tried to store records to memory. These values will usually show up as very large values or "FFFF" in the data file.



- **Temperature Graph** Displays the downloaded values for surface temperature and air temperature. There are three main conclusions to draw from this chart:
 - Surface temperature and air temperature are usually well correlated and should be within the range of operation:
 - Data transferred successfully during download.
 - Air temperature within the expected temperature range but surface temperature is reading more than 10 °C higher, near the end of the data file:
 - Data transferred successfully during download.
 - Battery nearing end of life and should be replaced (low voltage causes surface temperature to read high).
 - Surface temperature and air temperature show out-of-range and highly irregular values:
 - Data not transferred successfully during download. Retry download.

Clear Records

Clicking "Clear Records" will erase all stored measurement records from the device's internal memory. It does not affect any other stored information such as user input descriptions. After clicking the command, the software provides two separate windows for the user to confirm their choice before it finally sends the command to the device. This additional command layer is provided to avoid inadvertent, permanent loss of data.

The record erase operation takes 50-60 seconds with progress indicated in the top right of the main window. Following a successful erase operation, the software will provide a confirmation message "Records cleared successfully".

If the operation fails, the software will provide a warning and additional instructions (Figure 13). A weak battery is the most likely cause of an erase operation failure, so the first troubleshooting step should be to replace the battery and retry the clear records command.

WARNING: After a failed erase records operation, the memory is not properly configured to store any new measurement records. It is critical to perform a successful erase records operation before data logging and storing any new records. Contact Acuity support if battery replacement does not remedy the problem.

Starting with Acuity LS firmware version 2.1.022 (standard) and 2.4.015 (addressable), the device has a persistent indicator that warns the software if the memory was not successfully cleared. A successful clear records operation is the only way to remove this indicator (Figure 14).



0	×
Warning: Records were NOT cleared successfully.	
For battery powered devices, a weak battery may not fully support the record clearing operation. Please try again after installing a new battery.	
WARNING: "Stored Records" status indicator may s even when records are NOT cleared successfully.	how zero
You MUST receive the "Records cleared successfully message before storing any new records in memory	,n 7.
Retry Cancel	

Figure 13. Fault message when device records are not cleared.

Firmware Ver. 2.1.022 Device Type Single Galv	Device (UTC) 28 Sep 2023 11:52:11 PM PC (UTC) 28 Sep 2023 11:52:13 PM	
WARNING: Device Memory has NOT been properly cleared. Click for help.		
Start Logging	Take a Measurement	
Deves Lorging	Relative Humidity	

Figure 14. Persistent warning message for a record clear fault.

Synchronize Clock

If the device and PC clocks differ by more than 10 minutes, the date/time indicator will turn red (Figure 15, left). The most common reason for an unsynchronized clock is that the device lost power causing the internal clock to be reset.

Clicking "Synchronize Clock" will bring up a confirmation window reminding the user to verify that the PC time is accurate before continuing. Click "OK" to continue.



Figure 15. Syncing device and PC times. (left) Device is far out of sync due to power loss (right) Device clock successfully synchronized.



Take Measurement

This software feature allows the user to take a measurement at any time and is commonly used to verify that the device is operating as expected. Clicking "Take Measurement" will tell the device to immediately start a new measurement regardless of its logging state. This process will take between 5 and 15 seconds, depending on device configuration, with progress is indicated in the top right of the main screen. The resulting values should align with expectations based on the current operating environment (Figure 16). Refer to Table 4 for the device's measurement limits.

Take Measurement		
Relative Humidity	51.7 %	
Air Temp.	26.4 °C	
Surface Temp.	26.9 °C	
Conductance LF	0.005 μS	
Conductance HF	5.0 μS	
Galvanic Corrosion	0.010 μA	
Free Corrosion	0.005 μA	
Battery Voltage	3.425 V	

Figure 16. Take Measurement results for a clean, dry sensor.

NOTE: The software will indicate "FAULT" for Relative Humidity and Air Temp. values if the device is not able to communicate with the RH / Air Temp sensor built into the LSP. For the battery chemistry used in Acuity LS, battery voltage is not a strong indicator of remaining state of charge. It is provided here for information purposes only.



5. COMMON OPERATIONS

This section covers the recommended steps to perform the most common operations to start a new test and to download records during or at the end of a test. Please refer to the previous section for more information about the functions recommended here.

Start a New Test

- 1. Establish connection to the device (Section 4 Establishing Connection).
- 2. Synchronize clock, if needed.
- 3. If device has any stored records from a previous test, it is recommended to:
 - Ensure that these existing records have been downloaded previously.
 - Clear any existing stored records before beginning a new test so that future downloads will only contain records from the new test.
- 4. Click "Change Setup" to select the measurement interval and add user input description, if desired.
- 5. Click "Take Measurement" and confirm device is operating as expected.
- 6. Click "Start Logging" and confirm that the status button is green.
- 7. If you have another device to set up, click "Connect to a different device", otherwise click "Exit" to leave the application.
- 8. Disconnect the interface cable from the device.
- 9. Replace the interface connector cap.

Acuity LS is now collecting data at set measurement interval.

Download Records

- 1. Establish connection to the device (Section 4 Establishing Connection).
- 2. Click "Download Records".
 - a. Choose the log file download location on the PC and click OK.
 - b. Wait while the records download (may take several minutes).
 - c. Review download summary for any unexpected results.
 - d. Check file location to ensure the .csv and .acu files were stored.
- 3. Synchronize clock, if needed
- 4. Disconnect the communication cable from the device.
- 5. Replace the device cable connector cap.

Acuity LS measurement records have been downloaded to the PC.



6. DATA FILE CONTENTS

When downloading records, the software generates two files:

- The file ending in ".csv" is the standard file that should be used for all analysis.
- The file ending in ".acu" is a raw data stream from the device and is only used by the Acuity product support team to diagnose device operation.

The ".csv" file uses comma-separated variable (.csv) formatting that is easily imported into analysis tools like Microsoft Excel. The tables below describe the data file contents in more detail.

UNIX Time Conversion

Timestamps are presented in terms of the "UNIX time", or the number of seconds that have elapsed since 12:00 AM, January 1, 1970 (UTC+0). UNIX time may be readily converted to other time and date formats using the methods in Table 1 or visit <u>http://www.unixtimestamp.com</u>.

Package	Conversion Command	
MS Excel	((Unix Time Value)/86400)+25569 NOTE: Format the cell for date/time	
Matlab	datestr(719529 + UnixTimeValue / 86400,'yyyy-mm-dd HH:MM:SS')	
Python	datetime.datetime.fromtimestamp(UnixTimeValue)	

Table 1. Converting UNIX time to other date and time conventions.

File Header

The data files contain information about the device, user input descriptions, and diagnostic information (Table 2).



Item	Description
#GENERAL INFORMATION	
Download Date	Date and Time that the download occurred
Acuity Device Type	Specifies the product type (Acuity LS, ES, or CR)
Device ID	Matches the ID label on the device
Configuration	Single Galvanic: (1) free corrosion, (1) galvanic corrosion sensor Dual Galvanic: (2) galvanic corrosion sensors
Sampling Interval	Time interval between measurements currently set in the device (minutes). <i>NOTE: this may differ from the interval in the downloaded records if it was changed recently.</i>
Logging State	Indicates whether the device was logging or not logging when the download occurred
#USER INPUT DESCRIPTIONS	
Date/Firmware/Software	When the user description was stored to the device and the firmware and software versions installed at that time
Test Description	Information from the first User Input Description block
Panel Description	Information from the second User Input Description block
#DIAGNOSTIC INFORMATION	
Firmware Version	Firmware version currently installed on device
Software Version	Software version used to download records
Stored Records	Number of records on the device when download occurred
Battery Counter	Number of measurements made since the last battery install
Record Write Faults	Number of times a record storage attempt was unsuccessful
Record Erase Faults	Number of unsuccessful record erase attempts since the last successful attempt. Internal safeties require this number to be zero before starting a new data log to avoid corrupt data
Built-In-Test Result	Reserved for future use
Irregular Time Intervals	Number of times that adjacent timestamps have more than 24 hours between them, as would happen if the device clock resetting to its default power due to low battery power

Table 2. Device Information and User Input Descriptions in the downloaded data file.



Downloaded Records

Following the file header, the downloaded records section contains all the useful information from the device, arranged in columns (Table 3).

Column	Measurement (Units)	Description		
А	Unix Time (s)	Number of seconds since midnight Jan 1, 1970 (UTC+0)		
		See "Unix Time Conversion" below for more details		
В	Test Time (h)	Elapsed time since first record was taken		
С	Air Temp (°C)	Temperature of the ambient air		
D	RH (%)	Relative humidity of the ambient air		
E	Surface Temp (°C)	Temperature of the structure		
F	Cond Lo Freq (µS)	Gold IDE conductance @ 20 mV _{pp} , 10 Hz excitation (only useful for coated gold IDE)		
G	Cond Hi Freq (µS)	Gold IDE conductance @ 20 mV _{pp} , 25 kHz excitation		
н	Galv Corr (µA)	Galvanic corrosion current measured by ZRA		
I	Free Corr (µA)	Free corrosion current @ 20 mV _{pp} , 0.5 Hz excitation		
J	Tot Cond Lo Freq (C/V)	Gold IDE time-integral of conductance = total charge passed per unit voltage (only applies to coated gold IDEs)		
к	Tot Cond Hi Freq (C/V)	Gold IDE time-integral of conductance = total charge passed per unit voltage.		
L	Tot Galv Corr (C)	Time-integral of galvanic corrosion current to obtain total charge passed.		
М	Tot Free Corr (C)	Time-integral of free corrosion current to obtain total charge passed.		
N	Battery Voltage (V)	Device battery voltage during the measurement		

Table 3. Data file column measurements and descriptions for Acuity LS devices.

NOTE: The cumulative totals (columns J through M) begin at the first downloaded record. When starting a new test, it is recommended to use "Clear Records" on the interface software to remove any previously measured values so that they do not interfere with the cumulative total calculations for the new test.



7. DEVICE MAINTENANCE

This section describes basic maintenance operations for your Acuity LS device, including preparing an LSP surface for testing, replacing an LSP, and replacing the battery.

LSP Surface Preparation for Testing

For new devices, the LSP is delivered in a clean condition ready for use. For used devices, general contaminants may be removed by rinsing the sensing surfaces with water. Organic contaminants may be removed by wiping the sensing surfaces with a mild solvent (e.g., isopropyl alcohol) using a non-abrasive foam or cotton swab. Highly corroded sensing surfaces may require LSP replacement.

CAUTION: Do not immerse the Acuity LS device or flood the filter cap area that houses the relative humidity and temperature sensor with solvent, as this could affect the temporary operation of these sensors or cause permanent damage.

CAUTION: The contact time of the sensors with solvent should be kept to a minimum. Prolonged contact with solvents may soften and damage the polymer materials.

The Acuity LS device and LSP can be used with coatings, provided specific precautions and procedures are followed. Please contact Acuity support for specific instructions for coating the LSP and using the Acuity LS device to measure coating performance.

LSP Replacement

The following instructions cover removing a used LSP and replacing it with a fresh one.

LSP removal:

- 1. Thoroughly rinse and dry the Acuity LS device to remove corrosive contaminants and salts, especially near the LSP and base interface, to avoid contaminating the device's internals.
- 2. Remove the six screws on the bottom side of the base using a 9/64" hex wrench.
- 3. Do NOT try to pry the LSP from the base with any sharp tools as this could damage the sealing surfaces. Light, even pressure lifting upward on the LSP will normally dislodge it from the base. Another approach is to loosely reinstall the LSP screws and tapping the screw heads down onto a hard surface to break the LSP free.
- 4. Once the LSP is removed, examine the base's spring contacts for any corrosion or mechanical damage. Lightly press on the spring pins with a clean wipe (not bare fingers) and verify that they actuate smoothly and all return to the same position. The spring contacts on the base should have no signs of corrosion or mechanical damage.



LSP installation:

- 1. Using a lint-free wipe with isopropyl alcohol to gently clean the spring-loaded gold contacts in the Acuity LS base and the mating gold contacts on the LSP.
- 2. Ensure that the base and LSP mating surfaces are clean, dry, and free of any contaminants and obstructions that may prevent them from mating together and forming a good seal.
- 3. Orient the LSP so that its two metal pins align with the mating holes in the Acuity LS base (Figure 17).

CAUTION: Misalignment or using the wrong orientation of the LSP could result in bent spring contacts and permanent damage to the Acuity LS base and LSP.

- 4. Hold the LSP onto the base while reinstalling the six socket-head cap screws, applying only light torque until all screws are seated.
- 5. Using a torque-limiting driver, tighten all screws to 15 lbf-in [1.7 N-m].
- 6. Verify the functionality of the new assembly device using the interface software "Take a Measurement" function. Reasonable measurements for air temperature and relative humidity demonstrate good connection between the base and LSP.

NOTE: For stationary (i.e., non-flight) applications where vibration resistance is not required, a torque-limiting driver is not strictly necessary. In that case, tightening the LSP screws until all six screws make solid contact with the base will provide good sealing performance.



LSP installation is now complete.

Figure 17. Gold contacts and alignment features for LSP installation.



Battery Replacement

Acuity LS is designed with low-power circuitry to provide extended run times between battery changes. When the battery is depleted, it may be replaced by the user in the field using the steps outlined below.

NOTE: The standard battery for Acuity LS is the Saft LS17500 Lithium Thionyl Chloride primary cell (non-rechargeable). New batteries should only be sourced from Acuity Corrosion Technology or authorized Saft distributors to avoid counterfeit products.

NOTE: A small number of Acuity LS devices were delivered with Saft LM17500 cells (purple label). If your device contains an LM17500 cell, it should be replaced with the same type.

WARNING: Substituting any other battery types is prohibited. Device damage and safety hazards may result from using an unauthorized battery.

- 1. Using a 5/8" wrench or socket, remove the battery cap from the base.
- 2. Remove the metal battery tube and the battery. If the device is mounted such that the battery falls back into the device, try pulling the battery contact tube out more quickly to extract the battery. Blowing compressed air into the cavity is another strategy to remove it.
- 3. Install a new battery into the metal tube using the polarity indicated on the tube label (Figure 18).
- 4. Install the battery and tube into the Acuity LS base.
- 5. Inspect the battery cap O-ring seal for damage. Reinstall the battery cap by hand until seated.
- 6. Using a torque-limiting driver, tighten the battery cap to 30 lbf-in [35 kg-cm].
- 7. Following battery replacement, use the interface software to synchronize the device clock and verify expected operation using the "Take Measurement" function.

WARNING: Excessive battery cap tightening can result in fractured threads that may not be immediately obvious.

NOTE: For stationary (i.e., non-flight) applications where vibration resistance is not required, a torque wrench is not strictly necessary. In that case, tightening the battery cap until its flange contacts the housing will provide good sealing performance.





Figure 18. Battery removal and replacement. The positive (+) battery terminal must be oriented to protrude from the metal tube for proper polarity.

Device Power Cycle (Restart)

Although rare, there are situations where a user may wish to power cycle the device. For example, if the device becomes non-responsive even though the battery is known to be good, cycling the power may restore communications with the device.

To perform a system restart of the Acuity LS device, remove the battery, wait ten seconds, then reinstall the battery per the instructions above. Performing a system restart does not affect stored data or device settings. Only the device clock will need to be resynchronized with the PC.



8. GENERAL SPECIFICATIONS

The limits of operation, measurement ranges, and Acuity LS device dimensions are provided below (Table 4 and Figure 18).

Limits of Operation

The Acuity LS device's continuous operating temperature range is from -40 °C to 85 °C.

WARNING: The use of the device outside this temperature range may cause permanent damage to the Acuity LS device. Specifically, temperatures exceeding 100 °C may cause battery fire, explosion, and severe burns.

Limits of Measurements

Acuity LS Measurement	Symbol	Range Min	Range Max	Units	Sensor Excitation
Surface Temperature	Ts	-40	+85	°C	DC current
Air Temperature	Τ _α	-40	+85	°C	-
Relative Humidity	RH	0	100	%	-
Conductance (Low Freq)	G _H	0.005	1	μS	20 mV _{pp} , 10 Hz
Conductance (High Freq)	GL	5	10,000	μS	20 mV _{pp} , 25 kHz
Galvanic Corrosion	lg	0.01	100	μΑ	ZRA
Free Corrosion	lc	0.005	100	μΑ	20 mV _{pp} , 0.5 Hz

Table 4. Acuity LS device measurement limits.

Battery Replacement

Assuming a 60-minute sampling interval between measurements, the battery is expected to last approximately three years for the standard single-galvanic sensor configuration and four years for the optional dual-galvanic sensor configuration. The user can replace the commercially available battery.

LSP Replacement

The Acuity LS Lid Sensor Panel (LSP) is replaceable by the user. Replacement LSP may be purchased from Acuity Corrosion Technology.

Data Storage

The device's internal memory can hold up to 120,000 measurements.



Dimensions



Figure 19. Acuity LS device dimensions, units in inches. Approximate device weight is 0.75 pounds (340 grams)



9. LIST OF ACRONYMS

Acuity LS	Acuity LS Corrosion Monitoring Device
ACU	Diagnostic file extension
CD	Compact Disc
CSV	Comma-Separated Variable file type
ID	Device Identification Number (shown on the device label)
IDE	Interdigitated Electrode
IPA	Isopropyl Alcohol
LSP	Acuity LS Lid Sensor Panel
mV _{pp}	milli-Volts peak-to-peak amplitude
PC	Personal Computer
RH	Relative Humidity
USB	Universal Serial Bus
UTC	Coordinated Universal Time
ZRA	Zero Resistance Ammeter