



INSTRUCTION MANUAL

SINE CALIBRATOR WEB APP 1.0.5 BETA

This manual explains how to operate the Sine multifunction calibrator web app 1.0.5 Beta at <https://sim.metrologylearning.com>. Student manuals are available beside Tutorial. Desktop and tablet viewing are supported; phone layouts are not optimized.

Training simulator: Measurements, tolerances and uncertainty values are synthetic. Use this environment to practice the workflow; real calibration requires the applicable laboratory procedure and decision rule.

1 HOW THE SIMULATOR IS ORGANIZED

Free Use supports open practice. An S- scenario code retrieves a stored exercise from this installation, including the DUT, permitted assistance, reading count and hidden faults. The DUT sits above the reference source. Use the top menus for the simulator and separate instructor workspaces. A connection to the application server is required.

1.1 MAIN AREAS

Area	Purpose
Source output terminals	Select OUTPUT HI and OUTPUT LO for voltage and resistance. Current uses VI AUX or 30 A with OUTPUT LO as the return. 4-wire Ω also uses SENSE HI and SENSE LO.
Source display	Shows function, entered setpoint, automatic source range, and STANDBY or OPERATE state.
Setpoint keypad	Enter digits, an optional SI prefix, then ENTER. Example: 1, 0, 0, m, ENTER produces 100 mV. V, A or Ω clears the prefix.
DUT display	Shows the simulated multimeter reading, selected manual range, and count capacity.
DUT controls	Bench: function, range and RES – / RES +. Basic handheld: function dial, RANGE, current SHIFT and four input jacks.
Document the results	Source expanded uncertainty and DUT tolerance appear here. Record readings, evaluate tolerance, calculate when required, and submit the range.
Results report	Contains locally submitted results. Save as text, Print, or explicitly Save to server when a scenario is loaded.
Help	Tutorial replays the walkthrough. Source Help opens instructions. Show me what is wrong diagnoses an unsuccessful OPERATE setup.

1.2 RESET AND SAVED PROGRESS

- RESET SOURCE returns the source to 10 V DC in STANDBY.
- RESET DUT returns the DUT to DC V with an appropriate 10 V range, original scenario resolution and quality, and two main leads.
- RESET WORK clears the current reading set and answers while keeping the loaded scenario and submitted results.
- RESET ALL — Return to Free Use, beside the top scenario controls, clears the current scenario and unsaved report after confirmation. Reports already saved to the server remain available.
- Codes identify stored exercises, not fixed readings. Export a report before refreshing, loading another code, or restarting the app. Unsaved browser work and active reading receipts are not durable records.

2 OPERATING THE SOURCE

2.1 SELECT THE SOURCE FUNCTION

Function	Output posts	Source ranges	Setpoint limits
DC V	OUTPUT HI and OUTPUT LO	120 mV, 1.2 V, 12 V, 120 V, 1020 V	0 to 1020 V; negative values allowed
AC V	OUTPUT HI and OUTPUT LO	12 mV through 1020 V	0 to 1020 V RMS; frequency limits apply
DC A	VI AUX or 30 A with OUTPUT LO return	120 μ A through 30.2 A	0 to 30.2 A; negative values allowed
AC A	VI AUX or 30 A with OUTPUT LO return	120 μ A through 30.2 A	0 to 30.2 A RMS; frequency limits apply
Ω	OUTPUT HI and OUTPUT LO; optional SENSE HI/LO	12 Ω through 1200 M Ω	0 to 1200 M Ω ; synthesized resistance

The source range is automatic. Selecting a function changes the default setpoint and unit, and the simulator chooses the source range that contains the setpoint.

2.2 ENTER A VALUE AND UNIT

1. Click the desired source function.
2. Enter the digits on the keypad.
3. Select μ , m, k or M if needed. Unsupported prefixes are disabled; new numeric entries start in the base unit.
4. Use V, A or Ω only to clear a prefix. It keeps the entered number: 100 mV followed by V and ENTER becomes 100 V, not 0.1 V.
5. Press ENTER to accept the setpoint. The source may remain in OPERATE if the new setup is valid. Crossing from below 30 V to 30 V or higher returns it to STANDBY; press OPERATE deliberately to activate that output.
6. If a value was entered incorrectly, use CE to clear the entry or BKSP to remove the last character.

Example: 100 mV is 1, 0, 0, m, ENTER. For 10 V, enter 1, 0, ENTER. If a prefix is already selected, press V before ENTER. RESET SOURCE restores 10 V DC in STANDBY.

2.3 OPERATE AND STANDBY

1. Verify the source posts, DUT input jacks, DUT function, and DUT range.
2. Press OPERATE. A valid setup produces a live DUT value.
3. Wait for a completed conversion, then record the displayed value. Use Collect remaining readings (accelerated) only when the exercise permits it.
4. Press STANDBY when the measurement activity is complete.

3 CONNECTING THE SIMULATED DUT

Measurement	Source connections	DUT connections	DUT function
DC or AC voltage	OUTPUT HI / OUTPUT LO	INPUT HI / INPUT LO	DC V or AC V
DC or AC current	VI AUX or 30 A / OUTPUT LO	Bench: I / INPUT LO. Basic: A or $\mu\text{A}/\text{mA}$ / COM.	DC A or AC A
2-wire resistance	OUTPUT HI / OUTPUT LO	INPUT HI / INPUT LO	Ω , 2-wire
4-wire resistance	OUTPUT HI / OUTPUT LO plus SENSE HI / SENSE LO	INPUT HI / INPUT LO plus SENSE HI / SENSE LO	Ω , 4-wire

Blue posts have leads connected. For voltage and resistance, connect OUTPUT HI to INPUT HI and OUTPUT LO to INPUT LO. For current, use VI AUX for values up to 3.1 A and 30 A above 3.1 A; current returns through OUTPUT LO. For 4-wire Ω , select COMP 4W and connect both source sense posts to both DUT sense posts.

Click a selected terminal to disconnect it. A lead connected at only one end hangs loose. Missing leads, mismatched functions or wiring, and unsupported frequency/setpoint combinations prevent valid readings. Attempt OPERATE to make setup help available.

Basic handheld: V / Ω is the voltage/resistance jack and COM is the return. The $\mu\text{A}/\text{mA}$ jack has a 600 mA limit; A has a 6 A limit. Exceeding the selected current-jack limit, or applying voltage to a current jack, opens its simulated fuse. Return to STANDBY and use Replace blown fuse(s). Basic supports 2-wire resistance only.

4 DUT RANGE, RESOLUTION, AND QUALITY

4.1 RANGE STYLE AND MANUAL RANGES

DUT function	Bench ranges	Handheld ranges
DC V / AC V	100 mV, 1 V, 10 V, 100 V, 1000 V	600 mV, 6 V, 60 V, 600 V
DC A / AC A	1 mA, 10 mA, 100 mA, 1 A, 10 A	6 mA, 60 mA, 600 mA, 6 A
Ω	100 Ω through 1 G Ω	600 Ω through 600 M Ω

Bench meters use RANGE + and RANGE –; RES – and RES + change display increment. Basic uses the function dial and one RANGE button, with no resolution control. Current starts on the 6 A range: SHIFT selects the $\mu\text{A}/\text{mA}$ range family, then RANGE cycles 6, 60 and 600 mA. Move the red lead to match the selected jack. OL means overrange; choose a range that contains the value. Changing range or resolution starts a new reading set.

4.2 DISPLAY RESOLUTION, QUALITY, AND READING COUNT

- Display resolution: Bench settings provide 11,999, 119,999 or 1,199,999 counts. Precision scenarios may specify an 8.5-style 119,999,999-count display. Scenario locks can prevent changes. Resolution changes the display increment, not accuracy.
- Quality selects Basic, General-purpose or Precision behavior. General timing is inspired by the 34410A; Precision timing by the 8588A. These are teaching models, not reproductions of manufacturer specifications.
- Intermediate and Advanced activities use 5, 10 or 30 readings. Basic activities use one reading and an acceptance response; s and u(mean) are not estimated or graded for one reading.

5 READING SETS AND CALCULATIONS

1. With a valid setup in OPERATE, read the DUT display.
2. Press Record displayed reading to capture the latest completed conversion. A second click cannot record the same conversion twice; wait for a new value to become available.
3. Repeat until the selected reading count is complete. Collect remaining readings (accelerated) generates new simulated readings without waiting through each integration interval; the report identifies accelerated collection.
4. Press STANDBY when finished.
5. Enter the mean to the DUT display increment. Use Show calculation if you need the sum, division, and rounded result.
6. Enter s and u(mean) to two significant digits when the activity requires learner calculations, or use Calculate s and u(mean) for me when the loaded code allows calculator assistance.
7. Answer the simple tolerance question when it is enabled. Teaching activities may require Submit Results for Range.

Calculate with unrounded intermediate values. The mean uses round-half-to-even at the DUT increment. Enter s and u(mean) to two significant digits in the displayed units. The Type A result represents observed repeatability of the mean only. It is not a complete uncertainty budget, expanded uncertainty, TUR decision, or conformity decision.

Display item	Meaning
Live measured value	The current synthetic value produced by the source and DUT model.
OL	The DUT is overrange. Select a higher DUT range.
LEADS	The source or DUT lead selection is incorrect or incomplete.
FUNC	The source and DUT functions do not match, or 2-wire/4-wire resistance selections do not match.
RANGE	The AC frequency/setpoint combination is outside the simulated source envelope.
ENTER	A new setpoint has been typed but not accepted with ENTER.
STANDBY	The source is not producing an active simulated output.
OPERATE	The simulated source is active and a valid setup can produce readings.

6 HELP AND RECOVERY

Help is intentionally reactive. If OPERATE is pressed with an incorrect setup, the source stays in STANDBY, the relevant error state appears, and the help control becomes available. Press Show me what is wrong to identify the problem and highlight the incorrect and recommended controls.

Symptom	Check first	Typical correction
Source stays in STANDBY	Setpoint entry, leads, function, DUT range	Press ENTER; correct the posts; match DUT function; select a range that contains the value.

Symptom	Check first	Typical correction
LEADS	Source posts, sense posts, DUT inputs	Voltage/resistance: OUTPUT HI/LO and INPUT HI/LO. 4-wire Ω also requires both SENSE pairs. Current uses VI AUX or 30 A and OUTPUT LO.
FUNC	DUT function and resistance wiring	Match the source and DUT functions. For Ω , match COMP OFF/2-wire or COMP 4W/4-wire.
RANGE	AC frequency and setpoint	Select a supported frequency or reduce the setpoint.
OL	DUT range	Press RANGE + until the value fits. A new range clears the current reading set.
Help button disabled	No failed setup detected, or help is locked	Attempt OPERATE to enable permitted setup help. Beginner tests keep help locked.

After correcting a setup, press OPERATE again. When the setup is valid, record the reading. Do not treat the help message as a substitute for understanding the connection and range decision.

7 SCENARIO CODES

The short S- code retrieves a stored scenario. The six beginner surveys are included automatically and receive the guided-practice help policy. Other scenarios retain their assigned assistance settings. Old D9/B3 codes do not load here.

1. Open Simulator from the top menu.
2. Choose a beginner exercise from the dropdown, or paste an S- code into the scenario field. Instructor passwords belong in the instructor sign-in form, not this field.
3. Press Load scenario.
4. Read the exercise introduction and verify its title, DUT, reading count and starting state. Beginner survey packages start at 10 V DC in STANDBY with all leads disconnected.
5. Press OPERATE and complete the exercise procedure.

Loading another code creates a fresh attempt. Download the current report first. Codes can lock quality and resolution, restrict calculators, and control repeat submissions. Normal function, range and connection changes let you complete the assigned survey without discarding its scenario.

The companion beginner survey uses one persistent fault on a selected range per scenario. Values vary between attempts, so follow the displayed tolerance decision rather than expecting an exact answer from the manual.

8 TIMING AND PINNED READOUTS

General and Precision DUTs offer DC/resistance integration through 100 NPLC. Choose 50 or 60 Hz for the simulated line frequency. Lower NPLC produces more variation; higher NPLC reduces variation and lengthens the conversion. Precision also provides 2, 4 and 8 second aperture choices. AC uses separate RMS averaging options of 0.2, 1, 4 or 8 seconds. Basic has a fixed 0.4 second cycle.

Pin readout on either instrument keeps its live indication visible at the top of the page while you document results. Pin both when useful; press the same button again to unpin.

9 ADVANCED UNCERTAINTY PRACTICE

Advanced extends a completed repeated-reading set into a measurement-point uncertainty budget. It is usable only in an enabled Advanced instructor scenario. Free Use shows a locked preview; Basic and Intermediate scenarios hide it. A free-edition installation does not enable it.

Use the base SI unit shown in the Advanced panel: V, A or Ω . Divide the reference expanded uncertainty by its stated $k = 2$. The display-resolution contribution is $q/\sqrt{12}$, where q is the display increment. Instructor-supplied drift, temperature and lead-effect values are rectangular half-widths; divide each by $\sqrt{3}$. Lead effects apply only to 2-wire resistance. Zero means no contribution was assigned.

This simulator uses $\max[u(\text{mean}), q/\sqrt{12}]$ as its observed-reading contribution, then combines it with the independent reference, drift, temperature and lead contributions by root sum of squares. It does not add Type A and resolution twice. This conservative resolution floor is a stated teaching convention, not a universal uncertainty-budget rule.

Multiply combined standard uncertainty by the entered k to obtain expanded uncertainty. The app accepts k from 1 to 10 and assigns no coverage probability automatically. Check the budget before submitting the range. Calculation assistance is available only when the instructor permits it.

10 REPORTS AND RETURNING LATER

Submit Results for Range adds a range to the current report. It does not automatically add an entry to the instructor Results tab. Save as text or Print for a personal copy. When a scenario is loaded, Save to server stores the report explicitly. Confirm the success message. Repeating an identical save during the same attempt is deduplicated.

Refreshing the page, restarting the server, or starting another attempt can expire live readings and unsaved work. Export first. Previously saved server reports and scenario definitions remain stored. The web app does not yet send grades automatically to an LMS; opening it from a course link does not create a grade connection.

11 TUTORIAL AND INSTRUCTOR WORKSPACES

The walkthrough opens on the first Free Use visit in a browser. Back, Next, Skip and Finish control the tour. Tutorial reopens it later. Bright green pulsing outlines show the target; reduced-motion settings use a steady outline. Clearing site storage can make the first-visit tour appear again.

Device Creator defines a DUT. Scenario Creator defines an exercise and saves a new immutable code. Scenario Library loads, exports and imports scenarios, one package file at a time. Results lists reports explicitly saved to this installation. These instructor workspaces require sign-in. Share the student manuals and codes with learners; keep instructor packages and the answer key private.

IMPORTANT LIMITATIONS

- The source output, DUT behavior, uncertainty values, TUR estimate, range styles, and error models are synthetic teaching choices.
- AC readings are RMS values for a simulated sine wave. Frequency and setpoint affect the simulated source uncertainty and supported output envelope.
- Resistance is synthesized by the simulator; 4-wire operation uses separate source and DUT sense connections.
- The simulator does not replace a validated calibration procedure, traceability chain, uncertainty budget, guard or grounding instructions, safety assessment, or decision rule.
- A successful exercise demonstrates simulator operation only. It does not establish competence on real equipment.

12 WEEKEND RELEASE WORKFLOW

The worksheet uses the full desktop or tablet width: collect readings on the left, then review uncertainty, tolerance and the acceptance question on the right. Mean calculation and repeatability follow below, then any enabled Advanced budget and range submission.

Calculate s and $u(\text{mean})$ for μ is beside the Repeatability and Type A uncertainty heading. It becomes available after a complete repeated-reading set when assistance is allowed. A single observation cannot estimate sample standard deviation or standard uncertainty of the mean.

For a one-reading exercise, the tolerance question is highlighted after recording. After choosing Yes or No, Submit Results for Range is highlighted. Submission adds to the current report; Save to server remains a separate choice.

The Basic handheld permits display values up to 105% of nominal range at unchanged resolution. This is a generic simulator choice, not a manufacturer specification. Applied current above the 600 mA or 6 A jack limit still opens the simulated fuse.

Scenario Answer is available for guided practice and stays visibly locked for tests, with an explanation. The Exercise Manual link in scenario instructions opens a new tab without resetting the bench.