



YSI 3166 Conductance & Resistance Calibrator Set

For calibration (and verification of calibration) of conductance and resistance meters. Suitable for use with the YSI 32, 34, 35, 3100 and 3200 instruments and with most other laboratory-type meters. Not suitable for use with the YSI 33 S-C-T or 30 meters.

To calibrate conductivity cells and conductance meters together as a system, use YSI 3160-3165 Conductivity Calibrator Solutions.

Resistance	Conductance	Tolerance	Maximum Recommended Frequency	Maximum Working Voltage	Resistor Type
1.000	1000.00 mmho	±0.5%	1 kHz	0.5 V rms	Wirewound
10,000	100.00 mmho	±0.2%	1 kHz	1.5 V rms	Wirewound
100,000	10.0 mmho	±0.1%	1 kHz	5.0 V rms	Metal film
1000.000	1000.00 µmho	±0.1%	1 kHz	15.0 V rms	Metal film
10.00 k	100.00 µmho	±0.1%	1 kHz	25.0 V rms	Metal film
100.00 k	10.0 µmho	±0.1%	1 kHz	25.0 V rms	Metal film
1.000 M	1.000 µmho	±0.1%	100 Hz	25.0 V rms	Metal film

Units of Measure

Resistance = ohms = Conductance = Siemens = s = mho

Conductance = 1/Resistance = Ω^{-1} (The symbol \mathcal{S} is sometimes used for Ω^{-1})

1,000,000 µmho = 1000 mmho = 1 mho 1,000,000 = 1000 k = 1 M

Frequency = Hz = cycles per second = cps rms = root-mean-square average

Solution conductivity = (Conductance) x (Cell Constant) = 1/Resistivity

Directions for Use

Set the conductance or resistance instrument to the desired range. Select the calibrator which would give the mid-scale or full-scale reading for that range. Insert the calibrator into the binding posts of the meter (where the cell would ordinarily be connected) with a slight rocking motion so that there is a gentle scraping action of the calibrator plugs against the contacts of the binding posts. If using with a YSI 3100 or 3200 instrument, use the YSI 3232 cell adaptor. Wait a few seconds until the instrument reading becomes steady. For manual balance instruments, adjust the bridge until the null balance indication is obtained. The conductance or resistance instrument reading should now agree with the nominal value of the calibrator, plus or minus the stated tolerance of the calibration. If there is a disagreement, two modes of correction are possible.

Correction factor mode

This mode can be used with every type of instrument. Observe the apparent conductance or resistance reading which the instrument gives for the calibrator. Calculate a correction factor "F" according to:

$$F = \frac{\text{Nominal value of calibrator}}{\text{Instrument reading for calibrator}}$$

Experimental resistance or conductance readings can then be corrected by multiplying by "F":

$$\text{Correct value} = F \times \text{Instrument reading}$$

Different values of "F" may be obtained on different ranges of the instrument. For instruments which can read either resistance or conductance, use an "F" calculated from resistance readings to correct resistance readings, and use an "F" calculated from conductance readings to correct conductance readings.

Trimming mode

For the YSI 32 and 35 and for other instruments which have an internal scale-factor adjustment for each range, the calibrator readings may be trimmed to agree exactly with the nominal value of the calibrator. With the aid of the Operator's Manual or Service Manual for the instrument, identify the trimmable component for the range in question and adjust according to the manufacturer's directions. Observe the standard electrical safety precautions when operating any electrical device with the protective cover removed.

Calibration is not necessarily permanent. Depending upon the design of the instrument, recalibration may be advisable for operation at extreme ambient temperatures or after exposure to mechanical vibration or corrosive atmospheres, or after the passage of time.

Maximum Accuracy

Optimum performance of the YSI 3166 will be obtained at 25°C at frequencies below the maximum recommended and at working voltages below the maximum.

Storage

To minimize long-term drift, store at room temperatures in a dry place away from acid fumes, chlorine vapors or other corrosive atmospheres.

Adaptors

If using the YSI 3166 with a YSI 3100 or 3200 instrument, the YSI 3232 adaptor is required. Other instruments which will not accept banana plugs on 0.75 inch centers require adaptors for use with the YSI 3166 calibrators. Included in the YSI 3166 is a pair of banana jacks soldered to lengths of tinned copper wire, which will adapt the calibrators to screw terminals, lug binding posts, or "5-way" binding posts on centers other than 0.75 inches. Use of these adaptors will increase the resistance of the calibrator by approximately 0.002 Ω and the capacitance of the calibrator by approximately 0.6 pf. This could cause the 1.000 Ω (1000 mmho) calibrator to read high in resistance or low in conductance by as much as 0.2% in addition to the stated tolerance. Errors from these adaptors should be negligible with the other calibrators.

Adaptors from 0.75 inch center banana plugs to various other connector types are commercially available from Pomona Electronics, H.H. Smith, Inc. and other manufacturers. Consult their literature for further information. Some examples of connector types are given below and the catalog numbers of the Pomona adaptor which will adapt that connector to the banana plugs of the YSI 3166 calibrators.

Connector Type	Pomona Adaptor
UHF	1699
BNC	1296
Pin jack	2978
RCA phone jack	4729
WE309 phone jack	3365
WE310 phone jack	2112
2 conductor 0.25" phone jack	1285

YSI cannot guarantee the performance of the products that it neither manufactures nor distributes. Use of these adaptors may cause significant loss of accuracy. Series resistances are commonly on the order of 0.10 Ω and may be as much as 0.090 Ω for the phone jack types, which could cause the 1000 mmho and 100.0 mmho calibrators to read low in conductance by more than the stated tolerance. Shunt capacitance is typically 8 pf or less, except for phone jack types, which may be 25 pf or more. Depending on the design of the instrument, this may cause the 1.000 µmho and 10.00 µmho calibrators to read high in conductance by more than the stated tolerance.

Sources of Error

Contact resistance

The contact resistance of a newly-manufactured calibrator is approximately 0.001 Ω for each plug and is included in the stated value and tolerance. Corrosion of the contacts can produce much higher resistance, causing serious errors in the 1.000 (1000 mmho) range. Examine the plugs before each use and remove any corrosion, dirt or grease in the contact area.

Temperature extremes and self heating

The nominal temperature coefficients of the calibrators are 20 ppm/ $^{\circ}\text{C}$ for the wirewound types and 10 ppm/ $^{\circ}\text{C}$ for the metal film types, so readings at the temperature extremes may be expected to differ from 25 $^{\circ}\text{C}$ readings by as much as $\pm 0.050\%$. Calibrators at or below the nominal temperature coefficients will remain within stated tolerance at least over the temperature range 0 to 50 $^{\circ}\text{C}$. While the actual temperature coefficients of the calibrators are typically smaller than the nominal values, they are statistically distributed and a small percentage may slightly exceed the nominal value. There is thus a remote possibility that tolerance stackup may cause 50 $^{\circ}\text{C}$ readings to be outside stated tolerance by $\pm 0.01\%$. Power will also be dissipated within the calibrator in proportion to the square of the working voltage, raising the internal temperature above ambient. Operating simultaneously at maximum ambient temperature and maximum working voltage should be avoided, as it increases the risk of exceeding stated tolerance.

Shunt capacitance and series inductance

All real resistances and conductances have some associated capacitance and inductance which cause current to be somewhat out of phase with voltage. Instrument errors from such reactance typically increase with increasing frequency and with increasing magnitude of the capacitance or inductance. It is not possible to give a general statement of the values which will produce a significant conductance meter error because they depend strongly on the nature of the signal-processing circuitry within the meter; that is, different makes and models will give different errors. The reactance of the YSI 3166 calibrators is sufficiently small to give good results with the YSI conductance instruments, provided that the 1.000 M (1.000 μmho) calibrator is used with the YSI 31 only at 60 Hz and not 1000 Hz. With meters of other manufacture, the 0.8 pf (8×10^{-13} farad) typical shunt capacitance of the 1.00 M (1.000 μmho) and 100.0 k (10.00 μmho) calibrators should generally give satisfactory results at least to the maximum recommended frequencies of 100 Hz and 1 kHz, respectively. Since lower resistance values are less susceptible to error from shunt capacitance and since the shunt capacitance of the metal film resistors is typically 1 pf or less, capacitance errors will be negligible for the other calibrators. The inductance of the 1.000 (1000 μmho) calibrator (typically 0.2 μHy) and the 10.00 (100.0 mmho) calibrator (typically 1.2 μHy) is too small to cause out of tolerance errors with all or most makes operating at 1 kHz or below. The inductance of the other calibrators is insignificant. In general, some tolerance derating may be necessary at 2 or 3 kHz, depending on the make and model of the instrument. Above 3 kHz there is a possibility of substantial error. If inductance causes a meter error, it is usually in the direction of too high resistance, too low conductance. If capacitance causes a meter error, it is usually in the direction of too low resistance/too high conductance.

Adaptors and connector leads

If at all possible, the calibrators should plug directly into the meter to be calibrated. Adaptors or long lead wires may introduce significant series resistance on the 1.000 (1000 mmho) range, causing readings to be high in resistance/low in conductance. They may also introduce unacceptable shunt capacitance on the 1.000 M (1.000 μmho) range. The model 3232 cell adapter uses 4-wire measurement to avoid this error source. Errors in the other ranges will be smaller.

Thermal EMF

Several microvolts DC may arise from temperature gradients across the calibrator and from contact with dissimilar metals in the meter binding posts. This is generally of no consequence to AC conductance meters but may affect resistance meter readings taken at millivolt DC signal levels. Operate at 10 mV or above to minimize this effect.

Resistance/Conductance shift

These resistor types are expected to shift typically less than 0.1% in 5 years at room temperature and zero power. However, severe mechanical shock, extremely high storage temperatures, or even brief operation at excessive power levels may shift values this much or more. The greatest risk of accidental excessive power is when the calibrators are used as meter shunts to read currents or a voltmeter. Be very careful in this application.

Warranty and Repair

YSI calibrators are warranted for one year from date of purchase by the end user against defects in materials and workmanship. Within the warranty period, YSI will repair or replace, at its sole discretion, free of charge, any product that YSI determines to be covered by this warranty.

To exercise this warranty, write or call your local YSI representative, or contact YSI Customer Service in Yellow Springs, Ohio. Send the product and proof of purchase, transportation prepaid, to the Authorized Service Center selected by YSI. Repair or replacement will be made and the product returned, transportation prepaid. Repaired or replaced products are warranted for the balance of the original warranty period, or at least 90 days from date of repair or replacement.

Limitation of Warranty

This warranty does not apply to any YSI product damage or failure caused by (i) failure to install, operate or use the product in accordance with YSI's written instructions, (ii) abuse or misuse of the product, (iii) failure to maintain the product in accordance with YSI's written instructions or standard industry procedure, (iv) any improper repairs to the product, (v) use by you of defective or improper components or parts in servicing or repairing the product, or (vi) modification of the product in any way not expressly authorized by YSI.

This warranty is in lieu of all other warranties, expressed or implied, including any warranty of merchantability or fitness for a particular purpose. YSI's liability under this warranty is limited to repair or replacement of the product, and this shall be your sole and exclusive remedy for any defective product covered by this warranty. In no event shall YSI be liable for any special, indirect, incidental or consequential damages resulting from any defective product covered by this warranty.

Certification

This product was calibrated during manufacture using standards whose calibrations are traceable (at DC) to the US National Institute of Standards and Technology. As manufactured, it met or exceeded the specifications on this sheet.

Recertification

Contact YSI Product Service for information about reinspection, recertification or replacement of used calibrators.

You can contact us at

800 765-4974

or 937.767.7241.

Fax 937.767.9353

E-mail: Info@YSI.com

<http://www.YSI.com>



YSI INCORPORATED
Yellow Springs
Ohio 45387
USA