♦ PRECISION INSTRUMENTS FOR TEST AND MEASUREMENT ♦

# 1492 SERIES

# High-Accuracy
# Decade Inductor
# User and Service Manual



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# WARRANTY

We warrant that this product is free from defects in material and workmanship and, when properly used, will perform in accordance with applicable IET specifications. If within one year after original shipment, it is found not to meet this standard, it will be repaired or, at the option of IET, replaced at no charge when returned to IET. Changes in this product not approved by IET or application of voltages or currents greater than those allowed by the specifications shall void this warranty. IET shall not be liable for any indirect, special, or consequential damages, even if notice has been given to the possibility of such damages.

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO, ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE.

## WARNING

OBSERVE ALL SAFETY RULES
WHEN WORKING WITH HIGH VOLTAGES OR LINE VOLTAGES.

**Dangerous voltages may be present inside this instrument. Do not open the case**
**Refer servicing to qualified personnel**

**HIGH VOLTAGES MAY BE PRESENT AT THE TERMINALS OF THIS INSTRUMENT**

WHENEVER HAZARDOUS VOLTAGES (> 45 V) ARE USED, TAKE ALL MEASURES TO AVOID ACCIDENTAL CONTACT WITH ANY LIVE COMPONENTS.

USE MAXIMUM INSULATION AND MINIMIZE THE USE OF BARE CONDUCTORS WHEN USING THIS INSTRUMENT.

**Use extreme caution when working with bare conductors or bus bars.**

WHEN WORKING WITH HIGH VOLTAGES, POST WARNING SIGNS AND KEEP UNREQUIRED PERSONNEL SAFELY AWAY.

## CAUTION

DO NOT APPLY ANY VOLTAGES OR CURRENTS TO THE TERMINALS OF THIS INSTRUMENT IN EXCESS OF THE MAXIMUM LIMITS INDICATED ON THE FRONT PANEL OR THE OPERATING GUIDE LABEL.

# Contents

# Tables and Figures

# Chapter 1
# INTRODUCTION

## 1.1 Product Overview

The **1492** Decade Inductor is a high-performance inductance source. The 1492 has 7 decades from 1 µH to 1 H per step.

The **1492** is a decade inductance source with excellent characteristics of stability, temperature coefficient, power coefficient, and frequency response.

The **1492** Series employs stable, very-low-inductance switches with silver-alloy contacts. A special design keeps zero-inductance to less than 0.75 µH. Self-cleaning keeps the silver contacts from becoming tarnished when unused, or when only low currents are passed through them. This is most often the case when only minute test currents are drawn by LCR multimeters or other test instruments. Contact inductance is stable and remains low and repeatable.

The dials, marked **"0"** to **"10"**, offer smooth rotation from position to position with no stops. Each dial has an overlap **"10"** position for maximum convenience and flexibility in setting and adjusting inductance values. The inductance per step and maximum current of each dial are clearly shown on the front panel. Electrical shielding is provided by an attractive aluminum cabinet and front panel. The inductance elements have no electrical connection to the cabinet and panel; a separate shield terminal is provided.

High-quality gold-plated, tellurium-copper binding posts serve to minimize the thermal emf effects which can introduce errors into dc inductance measurements. All other conductors within the instrument, as well as the solder employed, contain no metals or junctions that contribute to thermal emf problems.

The **1492** series may be used for applications requiring high accuracy, good stability, and low zero-inductance. They can be used as components of ac bridges, for calibration, as transfer standards, and as RTD simulators.

This series is part of a family of inductance substitutters suitable for filling many engineering and testing needs. Consult IET for:

**1491** Precision Decade Inductor
**LS Series** Inductance Decade Boxes for general purpose applications


***Figure 1-1: 1492 Series Decade Inductor***

# Chapter 2

# SPECIFICATIONS

For the convenience of the user, the pertinent specifications are given in an **OPERATING GUIDE** affixed to the case of the instrument.

## Decade Specifications

| Inductance per step | Total decade inductance | dc resistance per step | Representative Q Values | | |
|---|---|---|---|---|---|
| | | | at 100 Hz | at 1 kHz | at 10 kHz |
| **1 µH** | 10 µH | 0.02 Ω | 0.026 | 0.20 | 2.00 |
| **10 µH** | 100 µH | 0.07 Ω | 0.110 | 1.10 | 10.3 |
| **100 µH** | 1 mH | 0.2 Ω | 0.340 | 3.40 | 30.0 |
| **1 mH** | 10 mH | 0.8 Ω | 0.310 | 3.03 | 23.7 |
| **10 mH** | 100 mH | 4 Ω | 2.76 | 18.6 | 70.4 |
| **100 mH** | 1 H | 48 Ω | 1.29 | 12.6 | 90.6 |
| **1 H** | 10 H | 85 Ω | 6.80 | 51.0 | 81.2 |

**Inductor type:**
Toroidal-core inductors for small mutual inductance and minimal effects from external fields

**Range:**
0 to 11.111 11 H in 1 µH steps, controlled by seven in-line readout dials

**Accuracy:**
±(1% + 0.75 µH)
at 1 kHz, 100 mV, 23°C, tested with Model 1689 Digibridge, Series circuit

**Zero inductance:**
< 0.75 µH

**Terminals:**
Two 5-way, gold-plated, tellurium-copper binding posts with low thermal emf and low resistance, plus one binding post connected to case for shielding.

**Switch type:**
Multiple solid silver contacts.
To allow continuous rotation, a blank position is added on all decades.

**Mechanical:**
**Dimensions:** 43.9 cm W x 8.9 cm H x 10.2 cm D (17.3" x 3.5" x 4")
**Weight:** 2.4 kg (5.3 lb)

**Environmental conditions:**
**Operating:** 10°C to 40°C
**Storage:** -40°C to 70°C
**Humidity:** <50% RH

**Supplied with unit:**
Instruction manual
Calibration Certificate

**Ordering Information:**
1492 Precision Decade Inductor

# 1492 DECADE INDUCTANCE SUBSTITUTER

**Type:** Toroidal-core inductor, for small mutual inductance and minimal effects from external fields.

**Range:** 0 to 11.111 11 H in 1 µH steps, in 7 decades.

**Accuracy:** ±(1% + 0.75 µH), traceable to SI.

**Test Condtions:** 1k Hz, 0.1V for 0 to 11.111 11 H, at 23°C; <50% RH.

**MODEL: 1492** **SN: E1-XXXXXXXX**

**WARNING**

Observe all safety rules when working with high voltages or line voltages. Connect the shield to earth ground in order to maintain the case at a safe voltage. Whenever hazardous voltages (>45 V) are used, take all measures to avoid accidental contact with any live components: a) Use maximum insulation and minimize the use of bare conductors. b) Remove power when adjusting switches. c) Post warning signs and keep personnel safely away.

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***Figure 2-1: Sample operating guide affixed to unit***

# Chapter 3
# OPERATION

## 3.1 Initial Inspection and Setup

This instrument was carefully inspected before shipment. It should be in proper electrical and mechanical order upon receipt.

An **OPERATING GUIDE** is attached to the case of the instrument to provide ready reference to specifications.

## 3.2 Connection

### 3.2.1 General Considerations

The **1492** Series Decade unit provides five terminals labeled **H** (high), **L** (low), and **G** (ground). The **H** and **L** terminals are connected to the set inductance; the **G** terminal is connected to the case. The **G** terminal may be used as a guard or shield terminal. It may also be connected (using a shorting link) to the **L** terminal to allow two-terminal as opposed to three-terminal measurements.

In order to make the most stable measurements, determine which is the more sensitive of the two user leads, i.e. the one going into a higher impedance. This lead should be connected to the more *protected* of the two terminals: **H** (high) or **L** (low). That would either be the terminal that is shorted to the case, or the **L** terminal if neither is connected to the **G** (case).

If switches have not been operated for an extended period, they should be rotated a few times to assure that contact inductance is within specifications.

### 3.2.2 Electrical Considerations

In order to make proper use of the full performance capabilities of the **1492** unit, especially if low inductance or low-inductance increments are important, take care when connecting to the terminals. In particular, in order to keep contact inductance to a minimum, make the most substantial and secure connection to the binding posts. They accept banana plugs, telephone tips, spade lugs, alligator clips, and bare wire. The largest or heaviest mating connection should be made, and, where applicable, the binding posts should be securely tightened.

### 3.2.3 Four-Wire Kelvin-Lead Connections

Whenever possible, 4-wire Kelvin leads (the best connection) should be employed. Such a connection minimizes the effects of contact inductance and approaches ideal performance.

If the four terminals are available as clamps similar to alligator clips, they may be connected to the necks of the binding posts on a 3-terminal unit. If the four-wire connections are available separately, the optimal connections are shown in Figure 3-1.

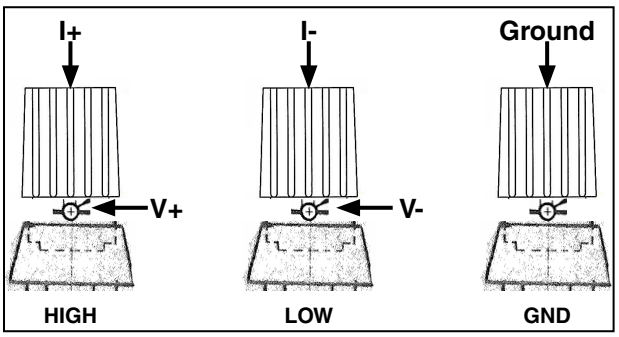


***Figure 3-1: 4-Wire connection to a 3-terminal unit***

## 3.3 Dial Setting

Whenever the dials are used in positions 0-9, the resulting inductance is read directly. The decimal point and the steps are clearly marked on the panel. For additional flexibility and range, each decade provides a "10" position setting. This "10" position on any one decade equals the "1" position on the next higher decade. It adds about 11% to the nominal total decade inductance.

To determine the inductance obtained when one or more "10" settings are used, simply add "1" to the next higher decade. For example, a setting of 3-6-10-0-10 µH becomes:

| | | | | | |
|---|---|---|---|---|---|
| 3 | 3 | 0 | 0 | 0 | 0 |
| 6 | | 6 | 0 | 0 | 0 |
| 10 | | 1 | 0 | 0 | 0 |
| 0 | | | | 0 | 0 |
| 10 | | | | 1 | 0 |
| **TOT** | **3** | **7** | **0** | **1** | **0** |

and a setting of 10-10-10-l0-10.10 µH becomes:

| | | | | | | |
|---|---|---|---|---|---|---|
| 10 | 1 | 0 | 0 | 0 | 0 | 0.0 |
| 10 | | 1 | 0 | 0 | 0 | 0.0 |
| 10 | | | 1 | 0 | 0 | 0.0 |
| 10 | | | | 1 | 0 | 0.0 |
| 10 | | | | | 1 | 0.0 |
| .10 | | | | | | 1.0 |
| **TOT** | **1** | **1** | **1** | **1** | **1** | **1.0** |

# Chapter 4
# MAINTANENCE

## 4.1 Preventative Maintenance

Keep the unit in a clean environment. This will help prevent possible contamination.

The 1492 is packaged in a closed case, which limits the entry of contaminants and dust to the inside of the instrument. If it is maintained in a clean or air-conditioned environment, cleaning will seldom be required. In a contaminated atmosphere, cleaning may be required.

Should cleaning be needed, do the following:

1. Remove the 4 screws from the sides of the housing, and remove the housing.
2. Remove any dust or debris using optical grade dry compressed air or a clean brush.
3. Should switch contact cleaning or lubrication be required, as may be indicated by an increase in the zero inductance, this may be done be spraying the switch contacts with a conditioning compound such as WD-40 or Deoxit from Caig Laboratories, or Super Lube with PTFE from Synco Chemical Corp.
4. Replace the housing and reinstall the 4 housing screws.

The front panel should be periodically cleaned to eliminate any leakage paths around the binding posts. To do this wipe the front panel clean using alcohol and a lint-free cloth.

## 4.2 Calibration Interval

The recommended calibration interval for **1492** Series decade inductor is twelve (12) months. The calibration procedure may be carried out by the user if a calibration capability is available, by IET Labs, or by a certified calibration laboratory. If the user should choose to perform this procedure, then the considerations below should be observed.

## 4.3 General Considerations

It is important, whenever testing the **1492** Series Decade Units, to be very aware of the capabilities and limitations of the test instruments used. An LCR Meter such as the IET Labs 1689 and 1693 may be employed and there are direct-reading LCR meters available that can verify the accuracy of these units, especially when used in conjunction with standards that can serve to confirm or improve the accuracy of the testing instruments.

Such test instruments must be significantly more accurate than $\pm(1\% + 0.75\ \mu H)$ for all applicable ranges, allowing for a band of uncertainty of the instrument itself. A number of commercial bridges and meters exist that can perform this task; consult IET Labs.

It is important to allow both the testing instrument and the **1492** to stabilize for a number of hours at the nominal operating temperature of 23°C, and at nominal laboratory conditions of humidity <50% RH. There should be no temperature gradients across the unit under test.

Substantial Kelvin-type 4-wire test terminals should be used to obtain accurate low-inductance readings. It is convenient, once the zero inductance has been determined, to subtract it from the remaining measurements. This can be automatically done in many instruments which have an offset subtraction capability.

## 4.4 Calibration Procedure

1. Employ proper metrological practices.
   *Allow a confidence band for the uncertainty of the measuring instrument and setup.*
2. Confirm the zero inductance of the unit.
3. Determine the allowable upper and lower limits for each inductance setting of each decade based on the specified accuracy.
   *For the 1492 series, these limits for any inductance "L" are [L±(0.01 L +* 0.75 µH*)].*
4. Confirm that the inductances fall within these limits after subtraction of the zero inductance.
5. If any inductances fall outside these limits, the associated switch assembly may require trimming or replacement.

## 4.5 Replaceable Parts List

| Model Ref | IET Pt No | Description |
|---|---|---|
| 1 | BP-1000-RD | Binding Post, Red |
| 2 | BP-1000-BK | Binding Post, Black |
| 3 | BP-1000-GN | Binding Post, Green |
| 4 | 1492-4300-KNB | Knob Assembly |
| Not Shown | 1492-3100 | Foot |
| Not Shown | 1492-4000-X-.001m | 1 µH/step Decade Switch Assembly |
| Not Shown | 1492-4000-X-0.01m | 10 µH/step Decade Switch Assembly |
| Not Shown | 1492-4000-X-0.1m | 100 µH/step Decade Switch Assembly |
| Not Shown | 1492-4000-X-1m | 1 mH/step Decade Switch Assembly |
| Not Shown | 1492-4000-X-10m | 10 mH/step Decade Switch Assembly |
| Not Shown | 1492-4000-X-100m | 100 mH/step Decade Switch Assembly |
| Not Shown | 1492-4000-X-1 | 1 H/step Decade Switch Assembly |

***Table 4-1: Replacement List***


***Figure 4-1: 1492 Replaceable Parts***