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# User's Guide

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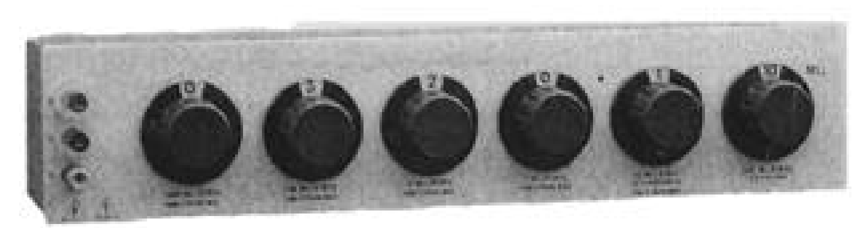

# DBX, DBQ, DBA, DBB

## High-Accuracy Decade Box

# Contents



# Figures

# WARNING

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

ELECTRICAL SHOCK HAZARD. DO NOT OPEN CASE.
REFER SERVICING TO QUALIFIED PERSONNEL.

**HIGH VOLTAGE MAY BE PRESENT** WITH **HIGH VOLTAGE OPTIONS.**

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.

REMOVE POWER WHEN HANDLING UNIT.

POST WARNING SIGNS AND KEEP 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.

# Chapter 1

# INTRODUCTION

The **Omega DB** series of resistance decade boxes is a family of instruments providing a very broad choice of high-performance resistance sources. Any number of decades from one to eleven is available in a choice of accuracies.

The **Omega DB decade box** is a precision resistance source with excellent characteristics of stability, temperature coefficient, power coefficient, and frequency response.

The **Omega DB** Series employs very-low-resistance switches with silver alloy contacts. A special design keeps zero resistance to less than 1 mΩ per decade. 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 digital multimeters or other test instruments. Contact resistance is stable and remains low and repeatable.

High-quality gold-plated tellurium-copper binding posts serve to minimize the thermal emf effects which would artificially reflect a change in dc resistance measurements. All other conductors within the instrument, as well as the solder employed, contain no metals or junctions that could contribute to thermal emf problems.

The standard models offer a choice of one through eleven decades. The panels are clearly labeled showing the step size and maximum voltage and current limitations for each decade.

With a resolution as low as 1 mΩ and a maximum available resistance of over 111 MΩ, the **Omega DB** series may be used for exacting precision measurement applications requiring high accuracy, good stability, and low zero-resistance. They can be used as components of dc and ac bridges, for calibration, as transfer standards, and as RTD simulators.

The **Omega DB** Series may be rack-mounted to serve as components in measurement and control systems.

***Figure 1.1. DBX Series High Accuracy Decade Box***

# Chapter 2

# SPECIFICATIONS

For convenience to the user, the pertinent specifications are given in an **OPERATING GUIDE** affixed to the case of the instrument. Figure 2.1 shows a typical example.

## SPECIFICATIONS

| Resistance per Step | Total Decade Resistance | Stability (±ppm/year) | Long Term Stability (±ppm/3 years) | Temperature Coefficient (±ppm/°C) | Max. Power (W/step) | Maximum current (per decade) | Maximum voltage (per step) |
|---|---|---|---|---|---|---|---|
| **1 mΩ** | 10 mΩ | 100 | 700 | 50 | 0.025 | 5 A | 5 mV |
| **10 mΩ** | 100 mΩ | 50 | 350 | 20 | 0.2 | 4 A | 40 mV |
| **100 mΩ** | 1 Ω | 30 | 50 | 20 | 0.25 | 1.6 A | 0.16 V |
| **1 Ω** | 10 Ω | 10 | 25 | 20 | 0.6 | 0.8 A | 0.8 V |
| **10 Ω** | 100 Ω | 10 | 25 | 15 | 0.6 | 0.25 A | 2.5 V |
| **100 Ω** | 1 kΩ | 10 | 25 | 5 | 0.6 | 80 mA | 8 V |
| **1 kΩ** | 10 kΩ | 10 | 25 | 5 | 0.5 | 23 mA | 23 V |
| **10 kΩ** | 100 kΩ | 10 | 25 | 5 | 0.5 | 7 mA | 70 V |
| **100 kΩ** | 1 M Ω | 10 | 25 | 5 | 0.5* | 2.3* mA | 230 V* |
| **1 MΩ** | 10 MΩ | 10 | 25 | 10 | 0.5* | 0.7* mA | 700 V* |
| **10 MΩ** | 100 MΩ | 25 | 40 | 10 | 0.1* | 0.1* mA | 1000 V* |

*Subject to maximum of 2000 V.

**Accuracy:** After subtraction of zero resistance, at 23°C; traceable to NIST.

**DBX**: ±(0.01% + 2 mΩ)

**DBA:** ±(0.05% + 2 mΩ)

**DBQ**: ±(0.02% + 2 mΩ)

**Zero Resistance:** <1 mΩ per decade, at dc; slightly higher for 7-10 decades.

**Maximum Voltage to Case:** 2000 V peak.

**Switch Type:** 11 positions; "0"-"10"; multiple solid silver alloy contacts.

**Switch Capacitance:** <4 pF per switch, low-loss.

**Terminals:** Low-thermal-emf beryllium-copper binding posts with standard 3/4 inch spacing, plus shield terminal; connections on the rear of the instrument are available ( **RO** option). Single decade units have solder-terminal connections.

**Mechanical:**

| Model | Dimensions | Weight |
|---|---|---|
| **1 decade** | 7.7 cm W x 7.7 cm H x 8.4 cm D (3" x 3" x 3.3") | 0.45 kg (1.0 lb) |
| **2-4 decades** | 37.5 cm W x 8.9 cm H x 10.2 cm D (14.8" x 3.5" x 4") | 1.7 kg (3.8 lb) |
| **5 decades** | | 2.0 kg (4.3 lb) |
| **6 decades** | 43.9 cm W x 8.9 cm H x 10.2 cm D (17.3" x 3.5" x 4") | 2.2 kg (4.8 lb) |
| **7 decades** | | 2.4 kg (5.3 lb) |
| **8 decades** | | 2.6 kg (5.7 lb) |
| **9 decades** | 48.3 cm W x 17.8 cm H x 19.7 cm D (19.0" x 7.0" x 7.8") | 5.1 kg (11.2 lb) |
| **10 decades** | | 5.3 kg (11.7 lb) |

## SINGLE DECADE UNITS

Single-decade units are available with resistance as low as 1 mΩ per step to as high as 10 MΩ per step. These units satisfy many system applications requiring only a single decade while maintaining all the quality features of the **DB** series.

Each decade is enclosed in an aluminum case which can serve as a shield.

It may be panel mounted and integrated with additional units to form potentiometer circuits or other configurations.

Each unit consists of low-inductance resistors in series, with a high-performance solid-silver-alloy-contact switch.

*Single Decade **DBX** Unit*

## ORDERING INFORMATION

| Model* (0.01% Accuracy) | Total Res. (Ω) | No. of Decades | Resolution (Ω) |
|---|---|---|---|
| **DBX-1-0.001** | 0.01 | 1 | 0.001 |
| **DBX-1-0.01** | 0.1 | 1 | 0.01 |
| **DBX-1-0.1** | 1 | 1 | 0.1 |
| **DBX-1-1** | 10 | 1 | 1 |
| **DBX-1-10** | 100 | 1 | 10 |
| **DBX-1-100** | 1 k | 1 | 100 |
| **DBX-1-1K** | 10 k | 1 | 1 k |
| **DBX-1-10K** | 100 k | 1 | 10 k |
| **DBX-1-100K** | 1 M | 1 | 100 k |
| **DBX-1-1M** | 10 M | 1 | 1 M |
| **DBX-1-10M** | 100 M | 1 | 10 M |
| **DBX-2-0.001** | 0.11 | 2 | 0.001 |
| **DBX-2-0.01** | 1.1 | 2 | 0.01 |
| **DBX-2-0.1** | 11 | 2 | 0.1 |
| **DBX-2-1** | 110 | 2 | 1 |
| **DBX-2-10** | 1.1 k | 2 | 10 |
| **DBX-2-100** | 11 k | 2 | 100 |
| **DBX-2-1K** | 110 k | 2 | 1 k |
| **DBX-2-10K** | 1.1 M | 2 | 10 k |
| **DBX-2-100K** | 11 M | 2 | 100 k |
| **DBX-2-1M** | 110 M | 2 | 1 M |
| **DBX-3-0.001** | 1.11 | 3 | 0.001 |
| **DBX-3-0.01** | 11.1 | 3 | 0.01 |
| **DBX-3-0.1** | 111 | 3 | 0.1 |
| **DBX-3-1** | 1.11 k | 3 | 1 |
| **DBX-3-10** | 11.1 k | 3 | 10 |
| **DBX-3-100** | 111 k | 3 | 100 |
| **DBX-3-1K** | 1.11 M | 3 | 1 k |
| **DBX-3-10K** | 11.1 M | 3 | 10 k |
| **DBX-3-100K** | 111 M | 3 | 100 k |
| **DBX-4-0.001** | 11.11 | 4 | 0.001 |
| **DBX-4-0.01** | 111.1 | 4 | 0.01 |
| **DBX-4-0.1** | 1.111 k | 4 | 0.1 |
| **DBX-4-1** | 11.11 k | 4 | 1 |

| Model* (0.01% Accuracy) | Total Res. (Ω) | No. of Decades | Resolution (Ω) |
|---|---|---|---|
| **DBX-4-10** | 111.1 k | 4 | 10 |
| **DBX-4-100** | 1.111 M | 4 | 100 |
| **DBX-4-1K** | 11.11 M | 4 | 1 k |
| **DBX-4-10K** | 111.1 M | 4 | 10 k |
| **DBX-5-0.001** | 111.11 | 5 | 0.001 |
| **DBX-5-0.01** | 1.1111 k | 5 | 0.01 |
| **DBX-5-0.1** | 11.111 k | 5 | 0.1 |
| **DBX-5-1** | 111.11 k | 5 | 1 |
| **DBX-5-10** | 1.1111 M | 5 | 10 |
| **DBX-5-100** | 11.111 M | 5 | 100 |
| **DBX-5-1K** | 111.11 M | 5 | 1 k |
| **DBX-6-0.001** | 1.111 11 k | 6 | 0.001 |
| **DBX-6-0.01** | 11.1111 k | 6 | 0.01 |
| **DBX-6-0.1** | 111.111 k | 6 | 0.1 |
| **DBX-6-1** | 1.111 11 M | 6 | 1 |
| **DBX-6-10** | 11.1111 M | 6 | 10 |
| **DBX-6-100** | 111.111 M | 6 | 100 |
| **DBX-7-0.001** | 11.111 11 k | 7 | 0.001 |
| **DBX-7-0.01** | 111.1111 k | 7 | 0.01 |
| **DBX-7-0.1** | 1.111 111 M | 7 | 0.1 |
| **DBX-7-1** | 11.111 11 M | 7 | 1 |
| **DBX-7-10** | 111.1111 M | 7 | 10 |
| **DBX-8-0.001** | 111.111 11 k | 8 | 0.001 |
| **DBX-8-0.01** | 1.111 111 1 M | 8 | 0.01 |
| **DBX-8-0.1** | 11.111 111 M | 8 | 0.1 |
| **DBX-8-1** | 111.111 11 M | 8 | 1 |
| **DBX-9-0.001** | 1.111 111 11 M | 9 | 0.001 |
| **DBX-9-0.01** | 11.111 111 1 M | 9 | 0.01 |
| **DBX-9-0.1** | 111.111 111 M | 9 | 0.1 |
| **DBX-10-0.001** | 11.111 111 11 M | 10 | 0.001 |
| **DBX-10-0.01** | 111.111 111 1 M | 10 | 0.01 |
| **DBX-11-0.001** | 111.111 111 11 M | 11 | 0.001 |

* For less exacting applications, more economical tolerances are available:
- For 0.02% accuracy substitute **DBQ** in part number in lieu of **DBX**
- For 0.05% accuracy substitute **DBA** in part number in lieu of **DBX**
- For 0.1% accuracy substitute **DBB** in part number in lieu of **DBX**

**OPTIONS**

- **RM** Rack mountable case for standard 19" rack
- **K** Kelvin type 4-terminal binding posts
- **RO** Rear output binding posts

## DBX SERIES HIGH ACCURACY DECADE BOX

CONSULT INSTRUCTION MANUAL FOR PROPER INSTRUMENT OPERATION

**Resistor Type:** Resistance wire for 0.1 Ω steps and under; wirewound, noninductive for 1 Ω through 1 MΩ steps; resistance film for 10 MΩ steps.

**Accuracy:** ±(0.01% + 2 mΩ) after subtraction of zero resistance, at 23°C; traceable to NIST.

**Zero Resistance:** ≤1 mΩ per decade, typical at dc.

**Power per Step:** 25 mW for 1 mΩ steps;
0.2 W for 10 mΩ steps;
0.25 W for 100 mΩ steps;
0.6 W for 1 Ω through 100 Ω steps;
0.5 W for 1 kΩ through 1 MΩ steps;
0.1 W for 10 MΩ steps;
subject to a maximum of 2000 V.

**Temperature Coefficient:** <±50 ppm/°C for 1 mΩ steps;
<±20 ppm/°C for 10 mΩ through 1 Ω steps;
<±15 ppm/°C for 10 Ω steps;
<±5 ppm/°C for 100 Ω through 100 kΩ steps;
<±10 ppm/°C for 1 MΩ and 10 MΩ steps.

**Switch Type:** Multiple solid silver alloy contacts.

**Switch Capacitance:** Less than 4 pF per switch, low loss.

**Operation:** If switches have not been operated for an extended period, they should be rotated a few times to restore contact resistance to specifications.

**MODEL:** **DBX-7-0.1** **SN:** **C1-02191540**

## WARNING

Observe all safety rules when working with high voltages or line voltages. Connect the (G) terminal 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. Typical 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 **DBX** Series Decade unit provides three terminals labeled **H** (high), **L** (low), and **G** (ground). The **H** and **L** terminals are connected to the ends of the resistance being set; 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 either 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 one of the two **DBX** terminals. That would either be the **DBX** terminal that is shorted to the case, or the **LOW DBX** terminal whenever neither is connected to the case.

### 3.2.2 Electrical Considerations

In order to make proper use of the full performance capabilities of the **DBX** unit, especially if low resistance or low-resistance increments are important, care must be taken in connecting to the terminals of the decade box.

In particular, in order to keep contact resistance to a minimum, the most substantial and secure connection to the binding posts should be made. 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.

These considerations may be relaxed whenever single milliohms are considered significant for the task being performed.

### 3.2.3 Four-Wire Kelvin Lead Connections

Whenever possible, 4-wire Kelvin leads, the ideal connection, should be employed. Such a connection minimizes the effects of contact resistance 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. If the four terminals are available separately, the optimal connection is shown in Figure 3.1, where the current leads are introduced into the top of the binding posts, and the voltage leads at the necks.

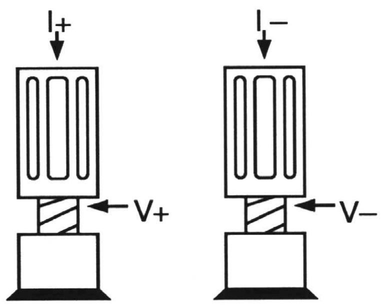


***Figure 3.1 Optimal 4-Wire Kelvin Lead Connection***

### 3.2.4 Thermal emf Considerations

The highest-quality low-ernf components are used in the **DBX** Series. There nevertheless may be some minute thermal emf generated at the test leads where they contact the gold banana jacks.

This emf will not reflect itself if an ac measurement instrument is employed. It will also be eliminated if a meter with so called “True Ohm” capability is used. Otherwise it may represent itself as a false component of the dc resistance measurement.

### 3.3 Dial Setting

Whenever the dials are used in positions 0-9, the resulting resistance is simply read directly. Both 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 resistance.

To determine the resistance 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 Ω 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 Ω 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** |

### 3.4 Environmental Conditions

For optimal accuracy, the decade box should be used in an environment of 23°C. It should be allowed to stabilize at that temperature after any significant temperature variation.

Humidity should be maintained at laboratory conditions. This is especially important if high resistances are involved.

# Chapter 4

# MAINTENANCE

## 4.1 Verification of Performance

### 4.1.1 Calibration Interval

The **DB** Series instruments should be verified for performance at a calibration interval of twelve (12) months. This procedure may be carried out by the user if a calibration capability is available, by Omega, or by a certified calibration laboratory.

If the user should choose to perform this procedure, then the considerations below should be observed.

### 4.1.2 General Considerations

It is important, whenever testing the **DBX** Series Decade Units, to be very aware of the capabilities and limitations of the test instruments used. A resistance bridge may be employed, and there are direct-reading resistance meters or digital multimeters 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 instrument

Such test instruments must be significantly more accurate than ±(l00ppm+2 mΩ) 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 Omega.

It is important to allow both the testing instrument and the **DBX** Substituter to stabilize for a number of hours at the nominal operating temperature of 23$^{O}$C, and at nominal laboratory conditions of humidity. 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-resistance readings. It is convenient, once the zero resistance has been determined, to subtract it from the remaining measurements. This can be automatically done in many instruments which have an offset subtraction capability.

### 4.1.3 Procedure

1. Confirm the zero resistance of the unit.
2. Determine the allowable upper and lower limits for each resistance setting of each decade following the specified accuracy. For the **DBX** series, these limits for any resistance "R" are [R±(0.0001 R + 2 mΩ)]. For the A, B, or Q series, see specifications.

3. Confirm that the resistances fall within these limits after subtraction of the zero resistance.

4. If any resistances fall outside these limits, the associated switch assembly may require replacement.

## 4.2 Schematic

Refer to Figure 4.1 for a schematic of the **DB** decade unit.

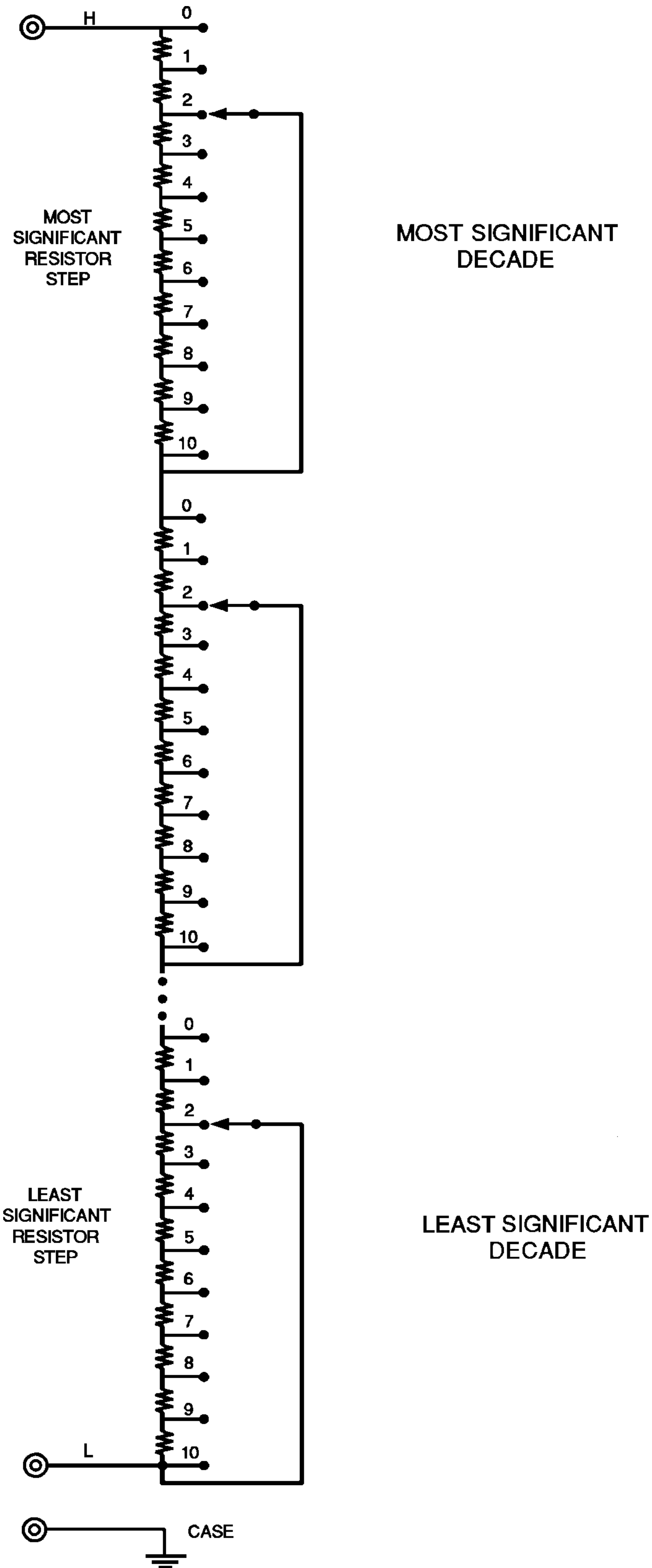


*Figure 4.1. DB Series Schematic Diagram*

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TEL: +33 (0)130 621 400 FAX: +33 (0)130 699 120
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MADE IN USA

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OMEGA ENGINEERING, INC. warrants this unit to be free of defects in materials and workmanship for a period of 25 months from date of purchase. OMEGA's WARRANTY adds an additional one (1) month grace period to the normal two (2) year product warranty to cover handling and shipping time. This ensures that OMEGA's customers receive maximum coverage on each product.

If the unit malfunctions, it must be returned to the factory for evaluation. OMEGA's Customer Service Department will issue an Authorized Return (AR) number immediately upon phone or written request. Upon examination by OMEGA, if the unit is found to be defective, it will be repaired or replaced at no charge. OMEGA's WARRANTY does not apply to defects resulting from any action of the purchaser, including but not limited to mishandling, improper interfacing, operation outside of design limits, improper repair, or unauthorized modification. This WARRANTY is VOID if the unit shows evidence of having been tampered with or shows evidence of having been damaged as a result of excessive corrosion; or current, heat, moisture or vibration; improper specification; misapplication; misuse or other operating conditions outside of OMEGA's control. Components which wear are not warranted, including but not limited to contact points, fuses, and triacs.

OMEGA is pleased to offer suggestions on the use of its various products. However, OMEGA neither assumes responsibility for any omissions or errors nor assumes liability for any damages that result from the use of its products in accordance with information provided by OMEGA, either verbal or written. OMEGA warrants only that the parts manufactured by it will be as specified and free of defects. OMEGA MAKES NO OTHER WARRANTIES OR REPRESENTATIONS OF ANY KIND WHATSOEVER, EXPRESS OR IMPLIED, EXCEPT THAT OF TITLE, AND ALL IMPLIED WARRANTIES INCLUDING ANY WARRANTY OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE HEREBY DISCLAIMED. LIMITATION OF LIABILITY: The remedies of purchaser set forth herein are exclusive, and the total liability of OMEGA with respect to this order, whether based on contract, warranty, negligence, indemnification, strict liability or otherwise, shall not exceed the purchase price of the component upon which liability is based. In no event shall OMEGA be liable for consequential, incidental or special damages.

CONDITIONS: Equipment sold by OMEGA is not intended to be used, nor shall it be used: (1) as a "Basic Component" under 10 CFR 21 (NRC), used in or with any nuclear installation or activity; or (2) in medical applications or used on humans. Should any Product(s) be used in or with any nuclear installation or activity, medical application, used on humans, or misused in any way, OMEGA assumes no responsibility as set forth in our basic WARRANTY/DISCLAIMER language, and, additionally, purchaser will indemnify OMEGA and hold OMEGA harmless from any liability or damage whatsoever arising out of the use of the Product(s) in such a manner.

## RETURN REQUESTS/INQUIRIES

Direct all warranty and repair requests/inquiries to the OMEGA Customer Service Department. BEFORE RETURNING ANY PRODUCT(S) TO OMEGA, PURCHASER MUST OBTAIN AN AUTHORIZED RETURN (AR) NUMBER FROM OMEGA'S CUSTOMER SERVICE DEPARTMENT (IN ORDER TO AVOID PROCESSING DELAYS). The assigned AR number should then be marked on the outside of the return package and on any correspondence.

The purchaser is responsible for shipping charges, freight, insurance and proper packaging to prevent breakage in transit.

FOR WARRANTY RETURNS, please have the following information available BEFORE contacting OMEGA:

1. Purchase Order number under which the product was PURCHASED,
2. Model and serial number of the product under warranty, and
3. Repair instructions and/or specific problems relative to the product.

FOR NON-WARRANTY REPAIRS, consult OMEGA for current repair charges. Have the following information available BEFORE contacting OMEGA:

1. Purchase Order number to cover the COST of the repair,
2. Model and serial number of the product, and
3. Repair instructions and/or specific problems relative to the product.

OMEGA's policy is to make running changes, not model changes, whenever an improvement is possible. This affords our customers the latest in technology and engineering.

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