AVO

REG'D TRADE MARK

UNIVERSAL BRIDGE

WORKING INSTRUCTIONS

THE AUTOMATIC COIL WINDER &
ELECTRICAL EQUIPMENT CO. LTD.
LONDON, S.W.1. ENGLAND.

FOREWORD

For more than a quarter of a century we have been engaged in the design and manufacture of " AVO " Electrical Measuring Instruments. Throughout that time we have consistently pioneered the design of modern multi-range instruments and have kept abreast of and catered for the requirements of the epoch-making developments in the fields of radio and electronics.

The success of our steadfast policy of maintaining high standards of performance in instruments of unexcelled accuracy, and making such instruments available at reasonable cost, is reflected in the great respect and genuine goodwill which " AVO " products enjoy in every part of the world.

It has been gratifying to note the very large number of instances where the satisfaction obtained from the performance of one of our instruments has led to the automatic choice of other instruments from the " AVO " range. This process, having continued over a long period of years, has resulted in virtual standardisation on our products by numerous Public Bodies, the Services, Railway Systems, and Post Office and Telegraph Undertakings throughout the world.

Our designers have thereby been encouraged to ensure that new instruments or accessories for inclusion in the " AVO " range fit in with existing " AVO " apparatus and serve to extend the usefulness of instruments already in use. Thus, the user who standardises on " AVO " products will seldom find himself short of essential measuring equipment, for, by means of suitable accessories, his existing equipment can often be adapted to most unusual demands.

It is with pleasure that we acknowledge that the unique position attained by " AVO " is due in no small measure to the co-operation of so many users who stimulate our Research and Development staffs from time to time with suggestions, criticisms, and even requests for the production of entirely new instruments or accessories. It is our desire to encourage and preserve this relationship between those who use " AVO " instruments and those who are responsible for their design and manufacture, and correspondence is therefore welcomed whilst suggestions will receive prompt and sympathetic consideration.

THE "AVO" UNIVERSAL BRIDGE

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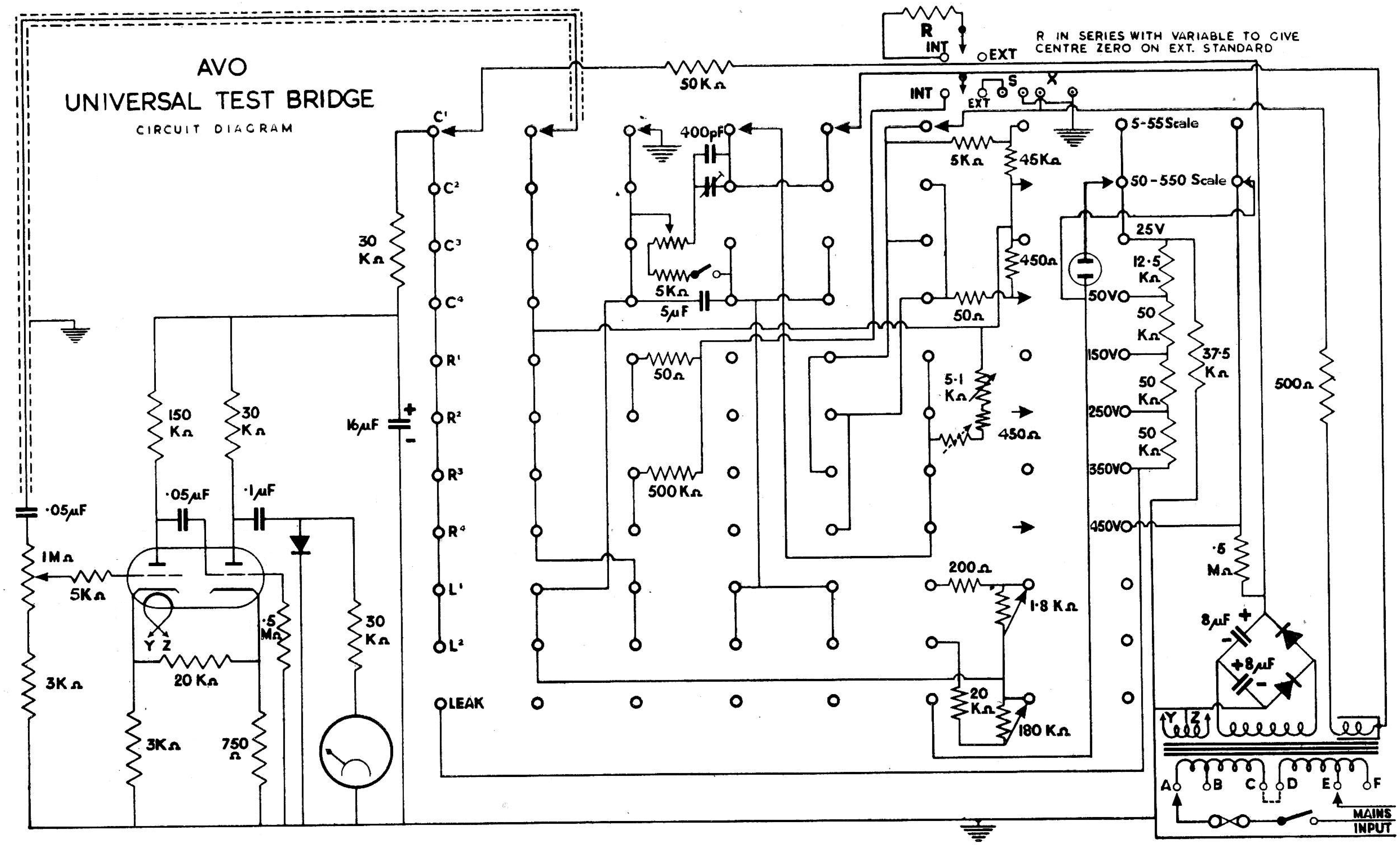
AVO
UNIVERSAL TEST BRIDGE
CIRCUIT DIAGRAM



INTRODUCTION

The instrument consists basically of a bridge network suitable to the measurement to be undertaken, fed from a screened winding of low distributed capacity on the mains transformer, together with an amplifier valve voltmeter of variable sensitivity as a balance indicator.

The bridge has standard arms of resistance for resistance measurements, and capacity for condenser and inductance measurement, a Maxwell network being used in the latter case.

The variable calibrated arm is a linear variable resistance, whilst fixed resistive multipliers, together with the unknown, complete the network. An approximate phase balance is provided by a variable resistance connected either in parallel or in series with the condenser standard, dependent upon the range being used.

THE CONTROLS

THE MAIN CALIBRATED DIAL

The main calibrated dial read against the hair line cursor covers a single decade of measurement and is calibrated from 5—55 and 50—550, the reading chosen being dependent upon the setting of the first two positions of the " D.C. VOLTS " switch. The reading obtained on the appropriate calibrated dial is multiplied by the setting of the range switch. A subsidiary scale for use when the bridge is used for comparison against external standards is marked +50 to —50%, thus giving a percentage comparison range of +50 to —50% of the standard being chosen.

THE RANGE SWITCH

The knob on the right hand side of the instrument (viewed with the meter window at the top) drives the " RANGE " switch, the calibrated drum dial being read in the middle of the rectangular window marked " RANGE." It will be seen that this switch has eleven positions, and its setting automatically combines the switching of the standard and multiplier arms so that the calibrated dial at balance indicates the value of the unknown component. The eleventh position of this switch is marked " LEAK " and, when set thus, the bridge proper is removed from the unknown component and the latter is put into circuit for the indication of condenser leakage by the flashing neon method, at the " D.C." test voltage shown by the control marked " D.C. VOLTS."

THE D.C. VOLTS SWITCH

The left hand drum switch marked " D.C. VOLTS " has two functions. The first two positions marked " scale 5—55 " and " scale 50—550 " determine which of the two scales that has to be read on the calibrated dial.

The other six positions (marked 25, 50, 150, 250, 350 and 450 Volts respectively) are used in conjunction with the " LEAK " setting of the " RANGE " switch and indicate "D.C." voltage applied to the condenser on which the test is being performed.

THE LEAKAGE INDICATOR

The neon lamp visible in the window marked " LEAKAGE " serves to show when the instrument is switched on when the bridge measuring ranges are in use. With the instrument switched for condenser leakage tests however, the neon will not be continuously alight but will flash at a rate indicative of the leakage of the condenser under test, remaining completely extinguished for a condenser having no leakage.

THE SENSITIVITY CONTROL

The control on the right hand side of the meter window is marked " SENSITIVITY " and as its name implies, it enables the sensitivity of a valve volt meter to be set in relation to the out-of-balance voltage applied from the bridge.

THE POWER FACTOR CONTROL

The control marked " % P.F." is a phase balance control to enable a sharper indication of balance to be obtained on condensers and chokes which have an appreciable resistive component. It is calibrated 0—50% and thus reads directly in percentage power factor at 50 c/s, for condensers above .05μF. For condensers of capacity below this figure (measured on ranges x 1 pf. and x 100 pf.) the range of this control is approximately divided by 5, the 50% calibration representing 10% and *pro rata.*

In the case of inductance, the 0—50% power factor calibration still holds, but since " Q " is the factor usually required, the " Q " of the coil at 50 c/s can be gained by dividing 100 by the power factor rate obtained. Thus a power factor of 25% represents a " Q " of 4 whilst a power factor of 2% represents a " Q " of 50. Note that the calibration of this control is for power factor at 50 c/s, but since such a calibration is necessarily only approximate no serious error will be experienced if the bridge is used over the range 50—60 c/s.

THE BALANCE INDICATOR

The meter visible immediately above the main calibrated dial is the balance indicator. The scale plate marking is purely arbitrary and is intended to assist the indication of small movements of the pointer when approaching zero (see left hand end of the scale plate) so that balance points can be clearly determined. The movement is of logarithmic nature having a high sensitivity at low deflection where balance indications are usually obtained, whilst at the other end of the scale the decreased sensitivity prevents damage to the pointer at extreme unbalance.

THE INTERNAL AND EXTERNAL SWITCH

The switch on the sub-panel has two positions. For normal working of the bridge with the unknown in terminal sockets marked " X " the switch is in position " INT " whilst in position " EXT " the comparison scale should be used, the unknown being connected to terminal sockets " X " and the comparison standard at " S."

GENERAL PROCEDURE FOR MAKING MEASUREMENTS

CONNECTION OF INSTRUMENT TO MAINS SUPPLY

The instrument normally leaves the factory, unless otherwise indicated, set for operation on 220/240 50-60 c/s A.C. mains. To operate the instrument upon A.C. supply voltages as set out in the table below, turn the instrument upon its face, remove four main fixing screws from the back of the instrument, and then remove four small screws from the terminal panel upon the side of the unit, thus releasing the rear half of the metal casing. The transformer and tap changing board will then be exposed to view, together with the fuse holder (one Belling Lee L562/1 1A fuse).

Operating Voltage	Connect G to:	Connect H to:	Link
100—110V.	B & D	C & E	—
110—130V.	A & D	C & F	—
200—220V.	B	E	C & D
220—240V.	A	E	C & D
240—260V.	A	F	C & D

It is essential that this instrument is correctly connected to the mains, in so far as phase and neutral are concerned, and to this end, the mains wire is colour-coded according to the standard convention, the yellow or green lead being earthed or connected to the earth socket of the mains plug. Users should ensure that they affix the mains plug so that correct connections are maintained at their output plug. The effect of transfer capacity in the transformer is to give a minimum capacity reading (approximately 12/15 p.F.) on the lowest range (see capacity testing). A reversal of the mains connections may cause this figure to be considerably increased.

SWITCHING ON

Switch the instrument on by the " ON/OFF " switch. Provided that both " RANGE " and " D.C. VOLTS " switches are correctly set for C.L. or R. measurement, the neon light will show continuously in the aperture marked " LEAKAGE." After allowing a few minutes for the instrument to warm up, the balance indicator needle will in all probability assume a position towards the right hand end of the scale.

MEASUREMENT OF CAPACITY

To measure the capacity of an unknown condenser connect the component in question to terminals " X " set the rotary switch on the sub-panel to " INT." In the case of an air condenser or other component with one side connected to frame or can, the frame terminal should be connected to the Earthy " X " socket. When testing electrolytic condensers the negative side of the condenser should be connected to the earthy socket and in the case of condensers that have lain unused for some period, it is desirable that they shall be given a leakage test at or near their working voltage before carrying out capacity measurements, as this serves to polarise them.

Set the phase control at " O " (switch " off ") and the range switching to encompass the normal value of the capacity (see table, page 12). With the sensitivity control set fairly low (approaching anti-clockwise), slowly rotate the main dial until the meter needle dips through zero showing that the balance point has been passed. Then gradually increase the sensitivity at the same time making small adjustments to the main calibrated dial until the balance point is clearly and sharply shown. Although this shows a minimum reading on the meter it may be well removed from meter " ZERO." This does not necessarily indicate any fault on the condenser especially if small values are being measured or if the valve volt meter sensitivity is high. It may however point to the fact that the unknown condenser has a bad power factor. This can be checked by switching the phase control on and gradually rotating it in a clockwise direction. Note if this results in any better minimum deflection. Very small variations of the calibrated scale may be made during this operation, and the power factor and capacity setting chosen that gives the lowest reading on the balance indicator.

The main dial should not be moved considerably from its original balance setting during this operation as otherwise it is possible with a large amount of the power factor control in circuit to get a spurious balance point removed from the correct one.

The reading on the main calibrated dial, using the appropriate scale factor as indicated by the " D.C. VOLTS " switch and multiplied by the capacity factor shown in the centre of the range switch window, will then give the capacity of the unknown condenser, its power factor being obtained from the setting of the "P.F." control.

Note that when checking condensers on the lowest capacity range, a balance will be obtained at approximately 12—15 pF. with no condenser connected to the " X " terminals. This is the total stray capacity due to the mains transfer capacity and wiring. This indicated value should be noted and subtracted from the measured value of a condenser, if highly accurate measurements are desired to be obtained. For example, suppose balance is obtained on the lowest capacity range at a reading equivalent to 13 pF. with no condenser connected to the "X" terminals, and when a condenser is connected, balance is obtained at a figure of 70 pF. on the second capacity range, then the actual valueof the condenser is 57 pF.

(70—13 pF.) If the mains connections are reversed from normal, this stray value may be much higher.

CHECKING A CONDENSER FOR LEAKAGE

To measure the leakage of a condenser, connect it to the terminals as for capacity measurements, turn the " D.C. VOLTS " switch to the required test voltage and turn the range switch to " LEAK." The neon indicator lamp will now be normally extinguished except for an initial charging flash with a good condenser. Any leakage in the condenser will cause the neon to flash periodically according to the applied voltage and the time constant of the capacity of the condenser and the value of its leakage resistance. A poor condenser having a low " D.C." resistance will show a continuous or rapidly intermittent glow. In the case of electrolytics which have become deformed, these will often show a continuous glow at first which will change to an intermittent flash as the condenser becomes formed due to the application of the test voltage.

MEASUREMENT OF RESISTANCE

To measure the value of an unknown resistance, connect it to the " X " sockets, set the " RANGE " and " D.C. VOLTS " switches to cover the probable resistance value of the unknown component in accordance with the table upon page 12. With the sensitivity control set at a fairly insensitive condition, rotate the calibrated dial until a minimum is shown on the Valve Volt Meter. Slowly increase the sensitivity control whilst making minor adjustments to the main dial until a clear and sensitive minimum is obtained. The value of the resistance can then be computed by multiplying the reading on the appropriate scale on the main dial by the resistance shown in the " RANGE " switch window. Note that when very high resistances are being measured a somewhat poorer minimum may be obtained than with the normal values, owing to distributed circuit capacity, which may also result in an apparent resistance error on resistances above say 10MΩ. For this reason the capacity of any connections between the unknown resistance and the measuring sockets should be kept to a minimum, and in this instance one should preferably dispense with connecting leads.

MEASUREMENT OF INDUCTANCE

To measure the value of an inductance above 50 millihenries connect it to the terminals marked " X," set the " RANGE " switch and determine the scale factor to accommodate the probable value of the unknown as shown in the table upon page 12. Proceed as for the measurement of capacity, starting with the power factor control at " ZERO " and with the sensitivity control at a low sensitivity setting to determine the approximate balance point. Proceed with successive adjustments of power factor and sensitivity control, together with minor variations of the main calibrated scale until a reasonably sharp balance has been obtained. The higher the value of inductance and the lower the " D.C." resistance of the unknown (higher Q), the sharper the Zero indication will become. Note that ordinary air cored chokes of the order of 50—100mH usually have a " D.C." resistance high in comparison with their reactance at 50 c/s and in consequence their " Q " is so low that a good inductance balance is almost impossible to obtain. The value of the inductance will then be the reading on the appropriate scale multiplied by the factor on the " RANGE " switch. The appropriate " Q " reading of the coil (at 50 c/s) will be 100 divided by the percentage reading on the power factor dial.

COMPARISON OF A COMPONENT AGAINST AN EXTERNAL STANDARD

When it is required to use the instrument for the comparison of a number of samples against a standard value, the rotary switch on the sub-panel should be turned to " EXT." Set the " RANGE " switch to " x 1000Ω" and the " D.C. VOLTS " switch to 50—550. With the standard component connected across terminals " S " connect unknowns in succession across terminals " X," in each case rotating the main calibrated dial for balance. The sensitivity control should be set at a suitable position by trial on the first few components of a batch. The respective percentage variation of the samples from the standard can then be read off the calibrated percentage scale on the main dial. It should be remembered that although the dial gives direct reading in plus and minus values for resistance and inductance, since condenser reactance is inversally proportional to capacity, plus and minus values should be reversed when comparing condensers.

When this method is used for the comparison of large condensers, *e.g.*, electrolytics, of widely varying and large power factor, or inductances where the " Q " is liable to vary widely, then a subsidiary power factor balance may be introduced by connecting the low potential sides of the standard and the unknown, to the ends of a potentiometer of suitable value, the slider of which goes to one Earthy terminal, instead of connecting them to the Earthy terminals " X " and " S." The potentiometer should, of course, have a value to suit the likely power factor and reactance of the components under test. As an example a value of say 200 ohms might suit the average smoothing choke and electrolytic condensers, whilst a value of 1000/2000 ohms would be best for condensers of a fraction of a μF.

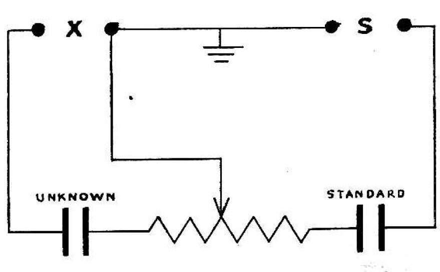


TABLE OF RANGES

Range of Measurement	*Setting of Range Switch*	*Scale factor as shown by DC Volts Switch*
·5 Ω ... ... 5·5 Ω	X 0·1 Ω	5 55
5 Ω ... ... 55 Ω	X 0·1 Ω	50 550
50 Ω ... ... 550 Ω	X 10 Ω	5 55
500 Ω ... ... 5,500 Ω	X 10 Ω	50 550
5,000 Ω ... ... 55,000 Ω	X 1,000 Ω	5 55
50,000 Ω ... 550,000 Ω	X 1,000 Ω	50 550
·5M Ω ... ... 5·5M Ω	X ·1M Ω	5 55
5M Ω ... ... 55M Ω	X ·1M Ω	50 550
5pF 55pF	X 1pF	5 55
50pF 550pF	X 1pF	50 550
500pF 5,500pF	X 100pF	5 55
·005μF ... ... ·055μF	X 100pF	50 550
·005μF ... ... ·055μF	X ·001μF	5 55
·05μF ... ... ·55μF	X ·001μF	50 550
·5μF ... ... 5·5μF	X 0·1μF	5 55
5μF 55μF	X 0·1μF	50 550
50mH 550mH	X 10mH	5 55
·5H ... ... 5·5H	X 10mH	50 550
5H 55H	X 1H	5 55
50H 550H	X 1H	50 550

When using all ranges above, set rotary switch on sub-panel to " INT " and connect unknown component to terminals " X."

Percentage comparison	X 1,000 Ω	50 550

When employing this test, set the rotary switch on the sub-panel to " EXT," connect the component under test to the terminals marked " X " and the standard component to the terminals marked "S."

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