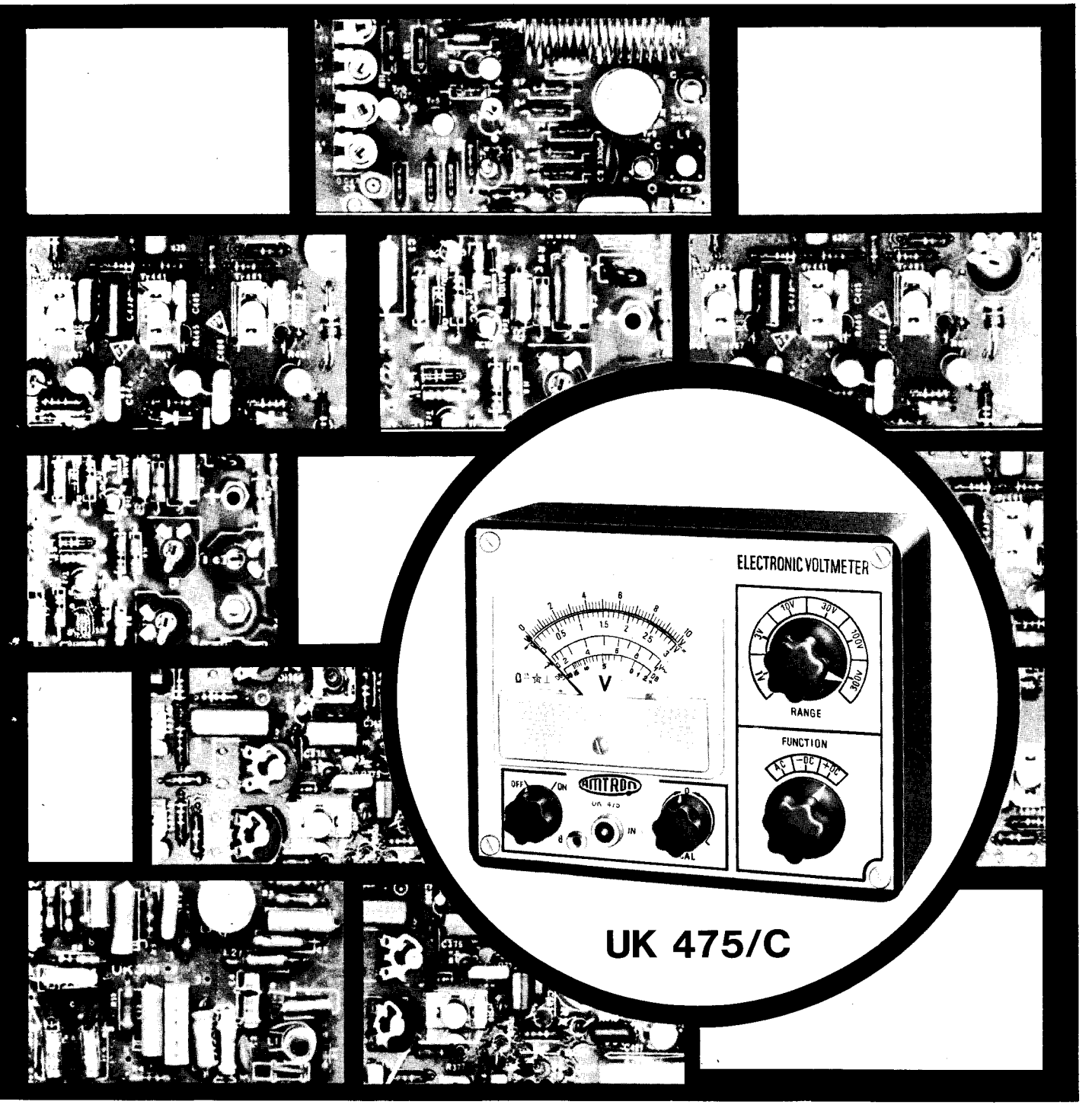
AMTRON®

ELECTRONIC VOLTMETER



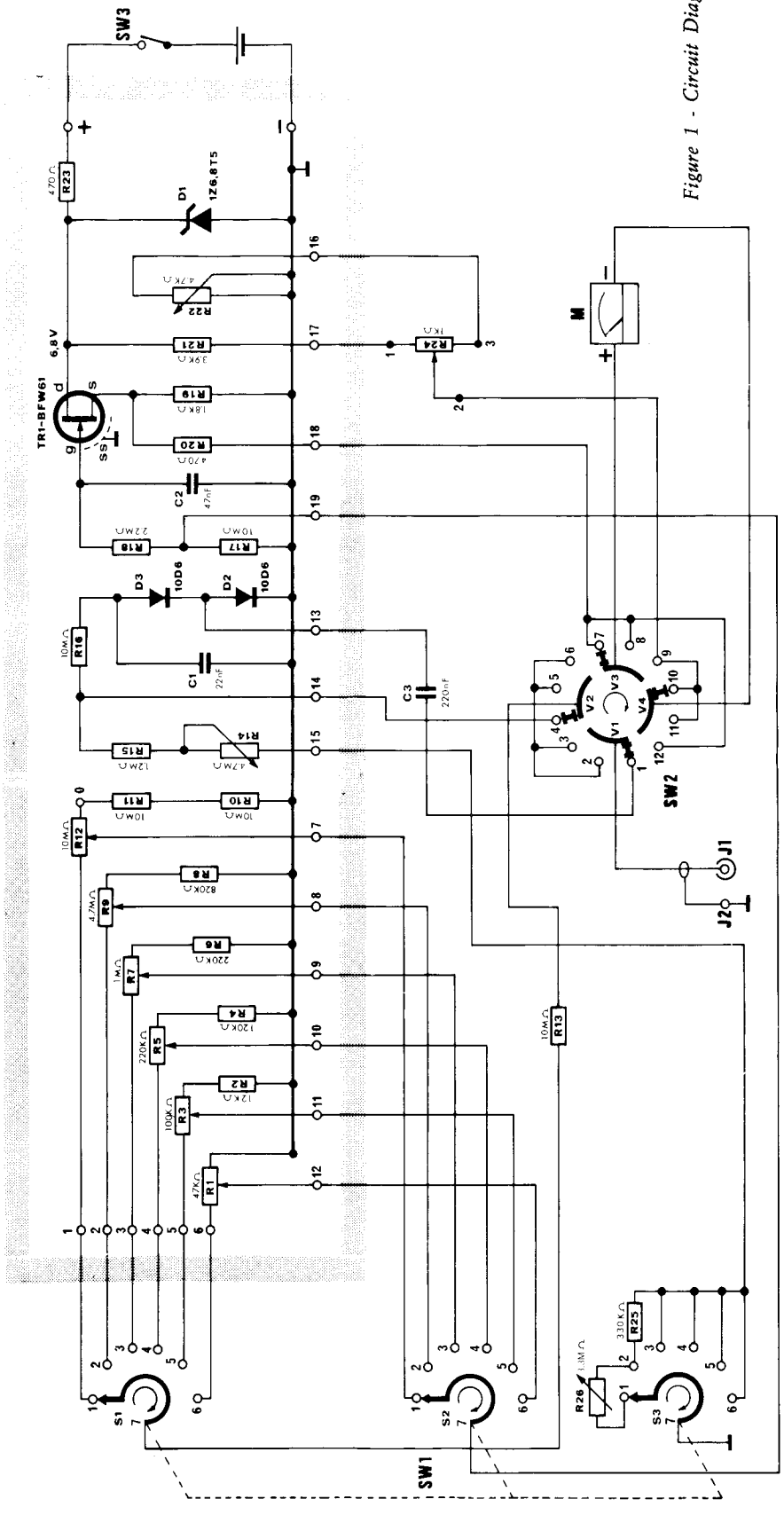


Figure 1 - Circuit Diagram.

The electronic voltmeter is obviously both useful and necessary, since is the only test instrument able to measure voltages in a circuit without greatly altering its characteristics. The electronic voltmeter's accuracy is due to its high input resistance, a quality making it far superior to ordinary voltmeter's for measuring alternating and direct voltage for radio, television and, in general for the entire electronics field. Until recently electronic voltmeter's operated with tube circuits, and were usually based on use of a cathode follower triode bridge circuit with the unbalance current detected by a microammeter.

The UK 475/C is an FET transistor electronic voltmeter which possesses greater stability than the traditional tube voltmeter. The UK 475/C, moreover, is powered by a 9-V battery which makes the UK 475/C independent of the mains and thus eliminates the effects which the later introduces on the stability of an ordinary voltmeter measurement.

The UK 475/C combines all the necessary qualities such as sensitivity, frequency response, high input impedance for optimal testing and maintenance of any electronic apparatus.

TECHNICAL DESCRIPTION

Direct current voltages:
from 20 mV to 300 $V_{D.C.}$ in 6 ranges using the following basic scale values: 1-3-10-30-100-300 V.

Input impedance: 22 MΩ

Alternating current voltages:
from 100 mV to 300 $V_{A.C.}$ in 6 ranges using the following basic scale values: 1-3-10-30-100-300 V.

Input impedance: 1.5 MΩ

Band width for alternating measurement current without R-F meter:
from 20 Hz to 1 MHz

Band width for alternating measurement current using RF meter:
from 10 kHz to 250 MHz

Voltage range using RF meter:
from 50 mV to 50 Vp.p.

Level measure: from —20 to +50 dB

FET transistor used: BFW 61

Diodes used: 2 x 10 D6

Zener diode used: 1Z6,8T5

Supply Voltage: 9 V battery

DESCRIPTION OF THE CIRCUIT

The UK 475/C circuit diagram is shown in fig. 1. The alternating or direct, positive or negative voltage to be measured is applied to the input J1 socket by means of the probe and arrives at the track V1 of the a.c./d.c./polarity selector switch SW2. For measuring direct volt-

ages the probe contains an 8,2 MΩ resistor in series, which renders disconnecting the voltmeter from the circuit under test unecessary. The resistance is short-circuited while measuring alternating voltages.

The direct voltage measurement circuit is basically made up of 6 voltage dividers. Of these six, the top of the appropriate one is connected to the input voltage by means of the sector S1 of the range switch SW1.

The voltage at the tap of the same voltage divider, (which is adjustable to allow calibration of each range individually), is connected to the gate circuit of TR1 by means of sector S2 of switch SW1.

The alternating voltage measurement circuit (calibrated in V_{eff}) is identical in concept to the d.c. circuit, but it is preceeded by a voltage-doubling rectifier network using diodes D2 and D3 and capacitors C1 and C3.

The FET TR1 circuit is a classic bridge circuit in « cathode follower » configuration.

The potentiometer R24 is used to obtain the balance condition or bridge - zero and is pre-set to block any passage of current on the bridge diagonal. Whenever current voltage is applied at the FET gate G, a current flows proportional to the unbalance and thus to the original input voltage. The Zener diode D1 renders the instrument insensitive to battery voltage fluctuation.

CHASSIS

Mechanically, the electronic voltmeter is made up of the two parts described below:

1) Front-panel holding the meter a.c./d.c./polarity switch SW2, the range switch SW1 the miniature socket J1 the banana socket J2, the on-off switch SW3 and the potentiometer R24 for zero adjustement.

2) Printed circuit upon which the components are mounted, the circuit istelf being directly fixed to the meter.

MECHANICAL AND ELECTRICAL ASSEMBLY

The assembly stages listed below describe completion of the overall assembly as shown in fig. 2.

STAGE I - Assembling components on the printed circuit - fig. 3.

Fig. 3 shows where to place each component on the insulated side, and is reproduced on the P.C. board itself.

• Mount the 20 solder pins indicated with (+) (—) - 0 - 2 - 3 - 4 - 5 - 6 - 8 - 9 - 10 - 11 - 12 - 13 - 14 - 15 - 16 - 17 - 18 - 19, by inserting them in the correct holes, making sure their shoulders firmly contact the insulate side - solder and snip off any length jutting more than 2 mm from the copper base plating.

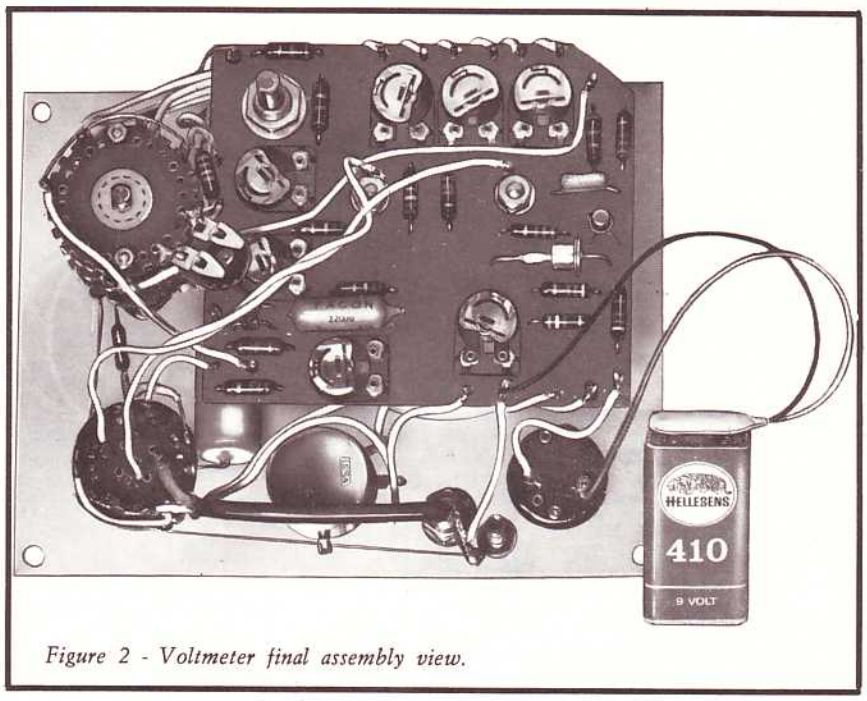


Figure 2 - Voltmeter final assembly view.

• Mount the resistors and capacitors by bending their leads and inserting them in the correct holes, making sure the body of each component rests firmly against the insulated P.C.B. surface - solder and snip off any length jutting more than 2 mm from the copper plating.

• Mount the pre-set potentiometers, inserting their tags in the correct slots - solder and snip off any tags jutting more than 2 mm from the copper base.

• Mount the diodes D2-D3, bending their leads and inserting them in the correct holes making sure their bodies remain about 5 mm from the insulated P.C.B. surface - solder and trim any leads jutting more than 2 mm from the copper surface.

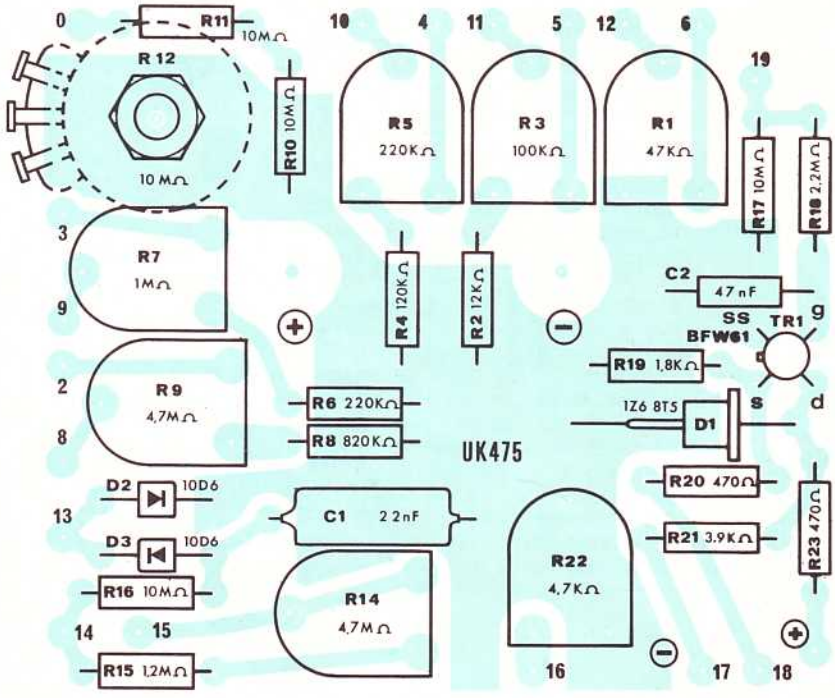


Figure 3 - Layout of components on PC board.

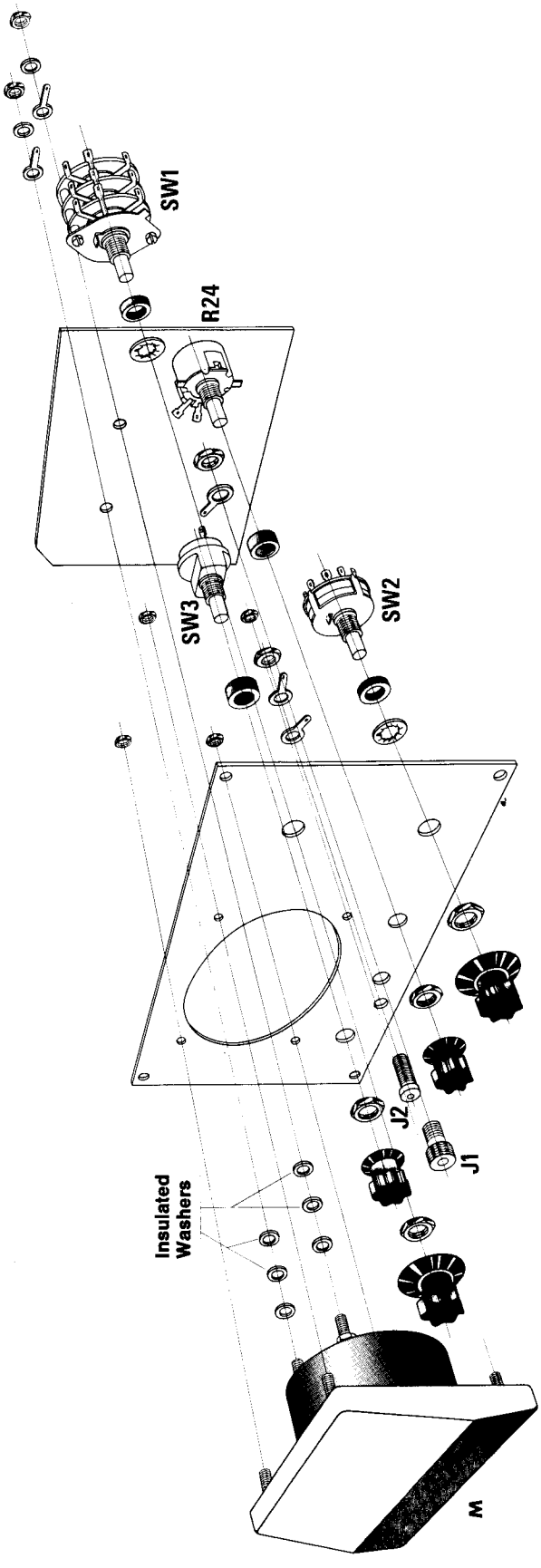


Figure 4 - Exploded view of panel assembly.

• Mount the diode D1, bending the 2 leads inserting them in the correct holes, making sure the component bodies rest firmly against the P.C.B. insulated surface. Solder and snip off any leads jutting more than 2 mm from the P.C.B. copper base plating.

• Mount the potentiometer R12 according to the figure, put the spacing washer in place, insert the central bush in its 10 mm hole and screw the nut down fully.

• Mount the TR1 transistor by setting it according to the figure, insert the leads in the correct holes while making sure the base of the component remains about 5 mm from the P.C.B. insulating surface - solder and snip off any leads jutting more than 2 mm from the P.C.B. copper base plating.

STAGE II - Assembling the front panel
Assembling the separate parts - fig. 4.

• Mount the range swich SW1, setting it according to the figure. Between the switch and the panel, place the 15 x 3 mm dia. spacing washer, the spring washer and screw the nut down.

• Mount the a.c./d.c./polarity switch SW2, setting it according to the figure. Between the switch and the panel, place the 15 x 3 mm washer, the spring washer and screw the nut down.

• Mount the potentiometer R24, setting it according to the figure. Place the 15 x 6 mm spacing washer between the potentiometer and the panel and screw the nut down.

• Mount the miniature socket J1 with its solder tag.

• Mount the banana socket J2, placing a tag under the nut - solder it to the tag of the J1 socket.

• Mount the rotary switch SW3. Place the 15 x 6 mm spacing washer between the switch and the panel and screw the nut down.

• Use a length of stiff bare wire, 0,7 mm dia. and 20 cm long, to connect the earth tags of the sockets J1 and J2, the earth tag of the potentiometer R24 the metallic frames of switches SW1 and SW2 and the 7-S3 terminal of the switch SW1.

• Mount the meter M.

• Mount the printed circuit on the meter. Place a metallic washer and two insulated washer on each terminal post and then pass them through the P.C.B. Place another washer and a solder tag on each screw, on top of the P.C.B. then put on the nuts and tighten them up.

• Rotate the shaft of switch SW3 anticlockwise to the « open » position and mount the knob with the pointer mark against the line marked « off » on the panel.

• Rotate the SW2 switch anticlocwise to the first position. Mount the knob

with the pointer mark against the mark on the panel.

• Rotate the SW1 switch anticlockwise to the first position. Mount the knob with the pointer mark against the mark turned to 1 V marked on the panel. Use a length of stiff bare wire, 0,7 mm dia., to connect the tags 2 - 3 - 5 - 6 of the switch SW2. Similarly connect the tags 9 - 10 - 11 and the tags 7 - 8 - 12.

Connect the tags 3 - 4 - 5 - 6 - S3 of switch SW1. Use a lenght of wire to connect the solder pin 0 of the top tag of potentiometer R12. See fig. 5 for these connections.

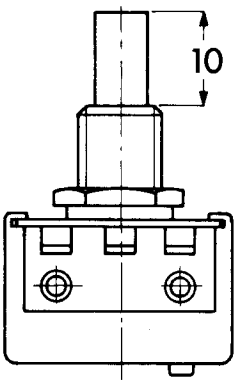
STAGE III - Wiring - fig. 5 - Tab. 1

Connect the black lead of the polarized battery connector to the (—) solder pin of the P.C.B., and the red lead to the remaining tag of SW3.

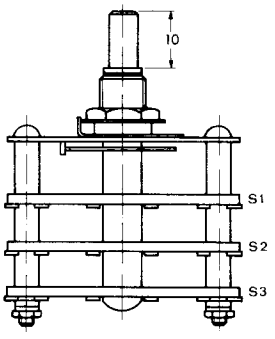
• Connect the miniature socket J1 to the switch SW2, using a length of single cored screened cable, 12 cm long and 4,5 mm dia.

ASSEMBLY HINTS

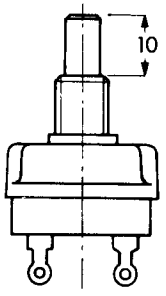
Strip the outermost insulation from the cable for about 2 cm from one end, laying bare the screening without cutting it at all. Push the screening back to open out the mesh and pass the insulated inner lead through the mesh close to the end of the outermost sleeving.



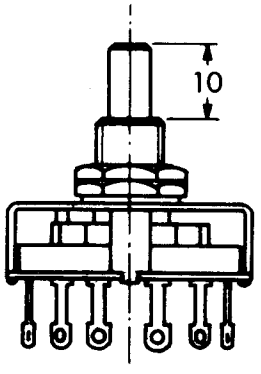
Modification to be made on R24 and R12 potentiometer spindles.



Modification to be made on SW1 switch spindle.



Modification to be made on SW3 rotary switch spindle.



Modification to be made on SW2 switch spindle.

TABLE I

Conductor	Length cm.	Connect.	Components to be connected
Insulated stranded wire	5,5	A	Tag 1S1 of the switch SW1 and tag 1 of the potentiometer R12
Insulated stranded wire	3	B	Tag 2S1 of the switch SW1 and pin 2 of printed circuit
Insulated stranded wire	3	C	Tag 3S1 of the switch SW1 and pin 3 of printed circuit
Insulated stranded wire	9	D	Tag 4S1 of the switch SW1 and pin 4 of printed circuit
Insulated stranded wire	13	E	Tag 5S1 of the switch SW1 and pin 5 of printed circuit
Insulated stranded wire	16	F	Tag 6S1 of the switch SW1 and pin 6 of printed circuit
Insulated stranded wire	7	G	Tag 1S2 of the switch SW1 and pin 7 of the potentiometer R12
Insulated stranded wire	2	H	Tag 2S2 of the switch SW1 and pin 8 of printed circuit
Insulated stranded wire	2	I	Tag 3S2 of the switch SW1 and pin 9 of printed circuit
Insulated stranded wire	9	L	Tag 4S2 of the switch SW1 and pin 10 of printed circuit
Insulated stranded wire	12	M	Tag 5S2 of the switch SW1 and pin 11 of printed circuit
Insulated stranded wire	13	N	Tag 6S2 of the switch SW1 and pin 12 of printed circuit
Insulated stranded wire	3	O	Tag 4 of the switch SW2 and pin 14 of printed circuit
Insulated stranded wire	12	P	Tag 12 of the switch SW2 and pin 18 of printed circuit
Insulated stranded wire	7	Q	Tag 1 of the potentiometer R24 and pin 17 of printed circuit
Insulated stranded wire	10	R	Tag 2 of the potentiometer R24 and tag 11 of the switch SW2
Insulated stranded wire	6	S	Tag 3 of the potentiometer R24 and pin 16 of the printed circuit
Insulated stranded wire	13	T	Tag V4 of the switch SW2 and terminal + of meter M
Insulated stranded wire	15	U	Tag V3 of the switch SW2 and terminal — of meter M
Insulated stranded wire	15	V	Tag 7S2 of the switch SW1 and pin 19 of printed circuit
Insulated stranded wire	7	Z	Tag 6S3 of the switch SW1 and pin 15 of printed circuit
Insulated stranded wire	5	X	Tag — of the Printed circuit and tag of the Sockets J1 and J2
Insulated stranded wire	5	Y	Pin + of the Printed circuit and tag of the Switch SW3

Connect the resistor R13 between V2 of the switch SW2 and the tag 7-S1 of the switch SW1.

Connect the resistor R25 between, the tags 2-3 S3 of the switch SW1 and the variable resistor R26 between the tags 1 & 2.

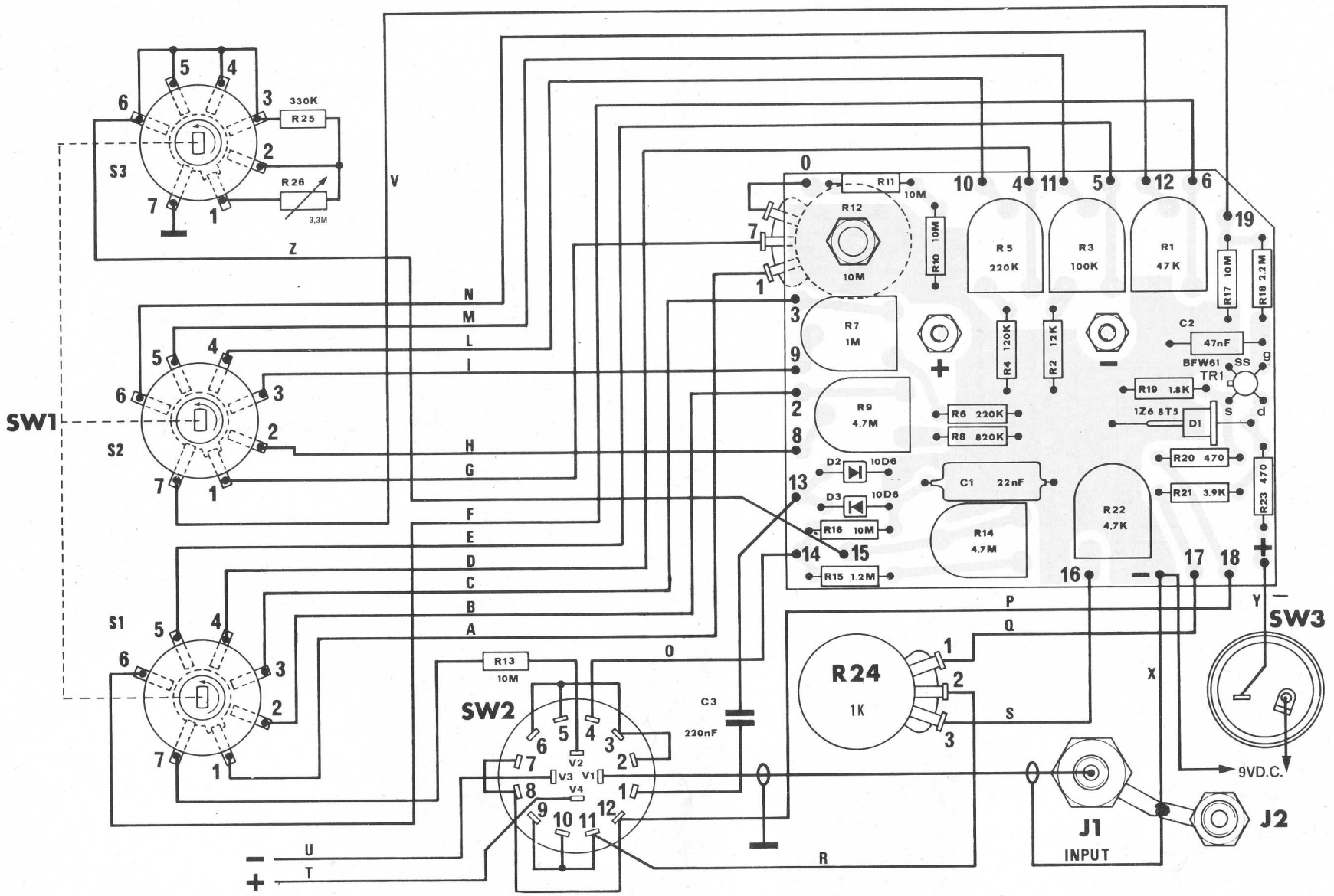


Figure 5 - Connections between printed circuit and outside components.

Strip the end of the inner for about 5 mm. and solder it to the centre contact of the miniature socket J1. Pull the tail of the outer to close the mesh again, and solder it to the earth tag of J1. Prepare the other end of the cable in the same way and solder the inner to the tag V1, and the screening to the frame of switch SW2.

After assembly and before testing a close check of the overall assembly should be made, especially of the insulation at points with small clearances.

TESTING

1) Set R24 by turning the knob until the pointer is on zero marked on the panel.
2) Switch SW2 to + D.C. position.
3) Switch SW1 on 1 $V_{D.C.}$ range.
4) Rotate R1 - R3 - R5 - R7 - R9 - R12 fully anticlockwise.
5) Set R14 and R22 to their mid-positions.
6) Set the instrument needle at zero at the left end of the graduated scale by means of the adjusting screw.
7) Connect the 9 V battery and turn the apparatus on by means of the switch SW3. Now observe which way the needle moves.

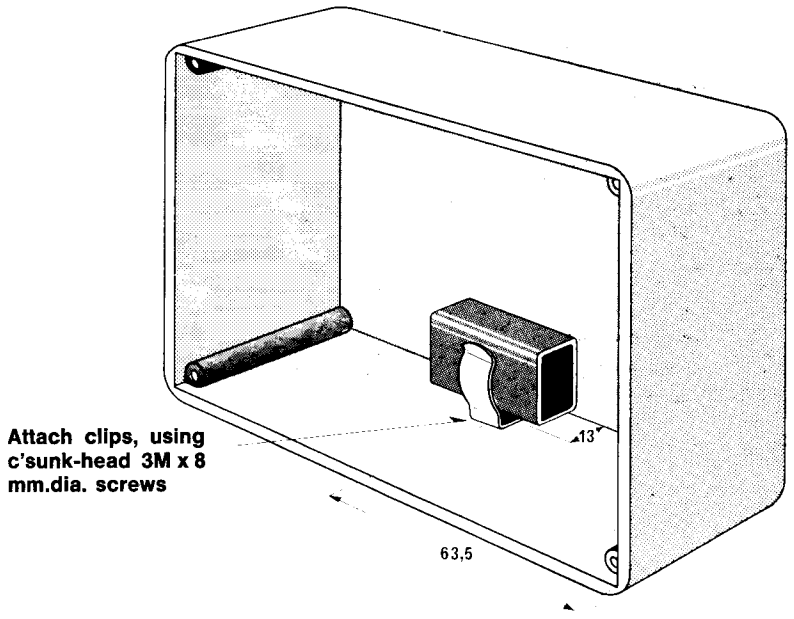


Figure 6 - Wiring for the battery inside the housing.

TABLE II

Operation No.	Check using regular voltmeter sample for the value of	Range switch position	a.d./d.c./polarity switch position	Adjust pre-set potentiometer clockwise	Needle position
I	1 $V_{D.C.}$	1 V	+ DC	R12	1 V
II	3 $V_{D.C.}$	3 V	+ DC	R9	3 V
III	10 $V_{D.C.}$	10 V	+ DC	R7	10 V
IV	30 $V_{D.C.}$	30 V	+ DC	R5	30 V
V	100 $V_{D.C.}$	100 V	+ DC	R3	100 V
VI	300 $V_{D.C.}$	300 V	+ DC	R1	300 V

TABLE III

Operation No.	Check using regular voltmeter	Range switch position	a.d./d.c./polarity switch position	Adjust pre-set potentiometer clockwise	Needle position
VII	300 $V_{A.C.}$	300 V	AC	R14	300 V
VIII	1 $V_{A.C.}$	1 V	AC	R26	1 V

If the needle move rightwards on the scale, adjust R22 clockwise until the needle is at zero (0). If, on the other hand, the needle moves leftwards on the scale, adjust R22 anticlockwise until the needle likewise is at zero (0).

Let the voltmeter function alone for about 30 seconds to stabilize the FET at the proper working temperature. If, during this time, the needle again moves, reset it once more to zero by adjusting R22 as before.

8) Connect the UK 565 A probe to the instrument's miniature socket J1 and the banana socket J2. Ready the probe for measuring direct current voltage so that the 8,2 MΩ R1 is inserted. A source of 300 $V_{D.C.}$ and 300 $V_{A.C}$ is now required and a valve radio receiver may be used to supply this. Connect the ends of a 1 MΩ - 2W potentiometer to the HT and ground rails of the receiver 300 $V_{D.C.}$ supply and connect the tip of the probe to the slider, and the banana socket J2 to the ground of the receiver. Connect an accurate ordinary multi-range voltmeter also between the slider and ground, setting it to a range suitable for 300 V. Adjust the potentiometer slider to give a very low output voltage, and set both the electronic voltmeter UK475/C and the multi-meter to 1 $V_{D.C.}$ f.s.d. range. Adjust the potentiometer until the multimeter reads exactly IV. Then adjust R4 until the UK475/C needle also indicates exactly IV. Then switch both meters to their 3V ranges, and similarly adjust them both to read 3V by adjusting the potentiometer and then R9. Proceed in this way for all the D.C. ranges up to 300 V referring to table II for the pre-set potentiometer to be adjusted.

Use a similar procedure to set-up the 300 $V_{D.C.}$ range, taking the necessary voltage directly from the radio-receiver H.T. transformer, and to set-up the 1 $V_{A.C.}$ range using voltage from a heater winding, referring to Table III. The intermediate ranges will then be correct.

PART LIST

No.	Symbol	Description
1	R1	Pre-set potentiometer of 47 kΩ
1	R2	Carbon-film resistor of 12 kΩ - ½ W - 5%
1	R3	Pre-set potentiometer of 100 kΩ
1	R4	Carbon-film resistor of 120 kΩ - ½ W - 5%
1	R5	Pre-set potentiometer of 220 kΩ
1	R6	Carbon-film resistor of 220 kΩ - ½ W - 5%
1	R7	Pre-set potentiometer of 1 MΩ
1	R8	Carbon-film resistor of 820 kΩ - ½ W - 5%
2	R9-R14	Pre-set potentiometers of 4.7 MΩ
5	R10-R11-R13-16-R17	Carbon-film resistor of 10 MΩ - ½ W - 5%
1	R12	Potentiometer of 10 MΩ linear
1	R15	Carbon-film resistor of 1.2 MΩ - ½ W - 5%
1	R18	Carbon-film resistor of 2.2 MΩ - ½ W - 5%
1	R19	Carbon-film resistor of 1.8 kΩ - ½ W - 5%
2	R20-R23	Carbon-film resistor of 470 Ω - ½ W - 5%
1	R21	Carbon-film resistor of 3.9 kΩ - ½ W - 5%
1	R22	Pre-set potentiometer of 4.7 kΩ
1	R24	Potentiometer of 1 kΩ linear

No.	Symbol	Description
1	R25	Carbon-film resistor of 330 kΩ
1	R26	Pre-set potentiometer of 3.3 MΩ
1	C1	Capacitor in polyester of 22 nF
1	C2	Capacitor in polyester of 47 nF
1	C3	Capacitor in polyester of 220 nF
1	D1	Zener diode 1Z6,8T5
2	D2-D3	Diodes 10 D6
1	TR1	Transistor FET BFW 61
1	PN	Front-panel
1	SW1	3-Way 6- position 3 sector switch
1	SW2	4-Way 3- position 1 sector switch
1	SW3	Rotary switch
1	J1	Plug with miniature socket
1	J2	Banana socket
1	—	Tape red plug
4	MI1-MI2 MI3-MI4	Pointer knobs
1	—	Printed circuit
20	—	Solder pins
4	—	Terminals
4	—	Insulated washers
4	—	Spacing washers
1	—	Polarized socket
cm 200	—	Insulated stranded wire
cm 50	—	Tinned copper wire 0.7 mm dia.
cm 10	—	Insulated sleeving 1.5 mm dia.
cm 10	—	Single-core screened cable
1	M	50 μA microammeter
1	—	Case 173x134x59

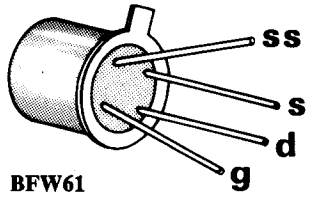
INSTRUCTIONS FOR USE

By observing a few basic rules for proper use of the UK 475/C electronic voltmeter, possible damage to the instrument can be avoided, giving it a long service life.

1) When measuring direct or alternating voltage, always switch the instrument to the high-tension scale first, then to low-tension scale until the unknown value is indicated somewhat beyond the scale center.
2) Check the position of the a.c./d.c./ polarity switch before touching the probes to the circuit to be examined.
3) Check the zero setting during long measuring periods.
4) Leave the instrument switched to the 300-V scale range when not in use.
5) Discharge probes after use in measuring alternating current voltage by touching their points against one another. The voltmeter coupling capacitor becomes charged with any direct current voltage present on an alternating current circuit being tested and can cause shock to any operator who accidently touches either of the circuit probes.

CONCLUSION

Following and adopting the instructions and precautionary measures listed above the assembly, use and testing of the UK475/C, thus allowing even the least expert operator to have an accurate and higly useful instrument to hand at all times.



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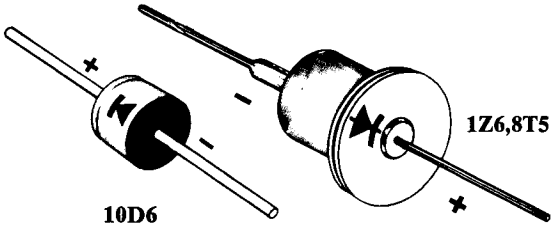

10D6

CHARACTERISTIC DATA

Drain-source voltage	$\pm V_{DES}$	max 25	V
Gate-source voltage (open drain)	$-V_{GSO}$	max 25	V
Total dissipated power (T_A = 25 °C)	P_{tot}	max 300	mW
Drain current	I_{DSS}	2 a 20	mA
Gate-source « cut-off » voltage	$-V_{(P)GS}$	< 8	V
Capacitance push-pull	$-C_{rs}$	< 2.0	pF
Transfer admittance (common source)	(Y_{fs})	> 1.6	$m\Omega^{-1}$

	Voltage maximum			Peak current	
	PRV volt	PTRV volt	Veff volt	Is ampere	I rip ampere
10D6	600	750	420	50	

	Vz a Izt volt	Δ Vz %	IzT mA	ZT a IzT ohm	Izm 25 °C mA	Δ VT %/°C
1Z6,8T5	6.8	5	30	1,6	150	+ 0,05

CRM

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