Joule and Watt Meter

Introduction
This instrument is designed for the direct measurement of the electrical energy or instantaneous power supplied to a load. It eliminates the need to calculate results obtained from readings gained using a voltmeter, ammeter and stopclock.

Operation
In use, the Input voltage should be connected to the pair of sockets on the front panel marked 'SUPPLY' and the load should be connected to the pair of sockets marked 'LOAD'.

The input voltage may be d.c. (of either polarity) or a.c. In all cases, peak values should be no more than 20V. Thus, when using an a.c. input voltage, the r.m.s. value should be limited to 14V.

The polarity of the output voltage to the load depends on the polarity of the input voltage (the red sockets are connected together). The connections to the supply and the load are not referenced to earth. i.e. None of the front panel sockets are internally connected to earth potential.

When measuring energy or power in the millijoule or milliwatt range, the range switch on the front panel (marked mJ/mW - J/W) should be set to the 'mJ/mW' position. For energy or power in the joule or watt range the switch should be set to the 'J/W' position.

When measuring energy the function switch on the front panel (marked RESET - J - W) should be set to the 'J' position. At any time the switch can be set to the 'W' position to give a reading of instantaneous power supplied to the load. Momentarily moving the switch to the 'RESET' position causes the display to be reset to 0000.

When using the instrument on the mJ/mW range the maximum permissible current that can be allowed to flow is 10mA. So with a maximum input voltage of 20V, the load should be a minimum of 2kΩ. Similarly, on the J/W range the maximum permissible current that can be allowed to flow is 10A. So with a maximum input voltage of 20V, the load in this case should be a minimum of 2Ω. Care should be taken to limit the current to these maximum values. Failure to do so will result in inaccurate readings and possible damage to the instrument.

Suggested Experiments

Determining the energy stored in a capacitor by discharging it into a resistor
1. Set the Joule & Watt Meter range to mJ/mW, and the mode to J.
2. Connect a large value capacitor (i.e. capacitance greater than 2000μF) to a suitable d.c. voltage source. Wait a few seconds to allow the capacitor to become fully charged.
3. Connect a suitable resistance to the LOAD sockets. Care should be taken in selecting the charging voltage and load resistance to ensure that the maximum discharge current is less than the maximum permissible current that can flow in the Joule & Watt Meter. The maximum current flows at the moment the capacitor begins to discharge. For measurements taken in the mJ range this maximum current (V/R) should be less than 10mA. So choosing V as 12V and R as 10kΩ gives a maximum current of 1.2mA which is safely below the 10mA maximum.
4. Ensuring the display is reset to 00.00, connect the charged capacitor to the SUPPLY sockets. Observe the Joule & Watt Meter displaying the cumulative amount of energy transformed from the capacitor to the resistor. With the values for C and R stated, the capacitor will be fully discharged in approximately 1 minute.
5. By varying the charging voltage (V) and recording the corresponding amount of energy stored in the capacitor (E), a graph of E against V^2 can be plotted. Since energy = $\frac{1}{2}CV^2$, the gradient of the graph is then an estimate of the actual capacitance of the capacitor.

Power supplied by a d.c. source to a resistive load
1. Set the Joule & Watt Meter range to J/W and the mode to W.
2. Connect a power supply capable of supplying 4A d.c. at up to 14V in series with an ammeter and in parallel with a voltmeter, to the SUPPLY sockets.
3. Connect a suitable load to the LOAD sockets ensuring that the maximum current that will flow will be less than 10A. (With the power supply set to 14V, a 4Ω load will draw a maximum current of 3.5A).
4. Vary the supply voltage and in each case note and record the readings for voltage (V) and current (I) and the corresponding power (P) displayed on the Joule and Watt Meter.
5. By plotting a graph of P against I^2 it is possible to show that P is proportional to I^2 and by calculating the gradient, an estimate of the load resistance can be obtained.