1) Introduction:

Individual coils, even if they are made to the same specification, will differ slightly in their mutual inductances. This is not a problem when a coil and integrator are calibrated together as a unit because the integrator can be adjusted to suit the coil but in some cases it is convenient to be able to replace a coil without the need to re-calibrate the whole transducer.

Rocoil has developed an interchangeable coil system where each coil has a calibration resistor which is built into the output cable or the connector. The resistor automatically compensates for the variation in mutual inductance. For this system to work the integrator must be designed appropriately. Effectively this means that the integrator must have a specified input resistance.

Coils which have been calibrated for interchangeability will normally have a resistance value marked on them near the connector (e.g. 2500R, 820R). Compatible integrators will be marked with the same resistance value. Interchangeable coils do not necessarily have to be the same length but for each system there is a maximum length of coil that can be used.

Coils which are provided for a user to use with their own electronics are normally supplied without calibration resistors. In this case we measure the mutual inductance of each coil and this information is supplied with the coils. We can also supply resonance information if needed (see Section 2.1)

2) Choice of Input Resistance.

The choice of input resistance is determined by (i) the self-resonant properties of the coil and (ii) the effect of temperature on the coil output.

2.1 Coil Resonance: Each coil has a resonant frequency which results from the self inductance and self-capacitance of the coil. For flexible coils this frequency is usually in the region 30kHz to 300kHz and depends on the length of the coil and the length of the output lead. Special coils such as the 'Low Output' coil have a higher resonant frequency.

If the coil is used with an integrator having a high input impedance the resonance will distort the output for frequencies near the resonant frequency. For measurements at power frequency and harmonics this is not likely to be a problem because the resonant frequency is much higher than the frequencies that need to be measured. However, to achieve the best flat frequency response it is necessary to use a damping resistor across the coil output. The value of the Critical Damping Resistance depends on the coil and the length of the output lead but it is usually in the region 150-1000 Ohms.

2.2 Temperature Changes: The output of a coil + integrator system depends on the total input resistance to the integrator which is made up of the coil resistance + integrator input impedance. The coil is wound with copper wire and copper has a relatively high temperature coefficient of resistance (= 0.4% /°C). The integrator input resistance has a very low temperature coefficient which is negligible compared with copper.

If the integrator input resistance is large compared with the resistance of the coil the influence of the change in copper resistance will be small giving a low temperature coefficient.

NOTE: Temperature effects in rigid coils follow a different behaviour and are not considered here.

2.3 Interchangeability Systems: The choice of integrator input impedance is a compromise between a low temperature coefficient, which favours a high impedance and flat frequency response which favours a low impedance. The following lists some of the common systems:

2500R System: (2.5kOhms input impedance) Used for situations where the main interest is power frequency and its harmonics. This system has a low temperature coefficient.

820R System: (820 Ohms input impedance) Gives the flattest frequency response for coils with short output leads (up to about 5m) but at the expense of increased temperature coefficient.

430R System: (430 Ohms input impedance) Gives the flattest frequency response for coils with medium length output leads (5 - 30m) but at the expense of higher temperature coefficient.

270R System: (270 Ohms input impedance) Gives the flattest frequency response for coils with long output leads (>30m). The temperature coefficient is higher still. As an example a 1m coil would have a temperature coefficient of 0.05% /°C. The temperature coefficient is proportional to the length of the coil.

Where there is a long distance between the measuring point and the monitoring equipment it is better to have a short coil lead and use a long lead at the output of the integrator. Rocoil have recently introduced a remotely-controlled integrator for this purpose.