R_sample in Terms of the Other Parameters

The SQUID Feedback Servo Loop stabalizes when the flux from the Quick Dipper Bridge circuit, which arrives via the superconducting transformer feeding the Input Coil, is exactly balanced by the Internal Feedback flux, which arrives via the Feedback Signal feeding the Voltage Controlled Current Source which feeds the RF Coil. TTR is the Transformer Turns Ratio. Range is transfer function of the VCCS, i.e. uAmps outout per Volt of Feedback Signal input. Recall that the mutual inductance Input Coil to SQUID is the same as RF Coil to SQUID. Thus the SQUID Feedback Servo Loop settles at a Feedback Signal Voltage such that:

$$I\_det \times TTR = V\_fb \times Range$$

The exactness of this flux balance in the SQUID is at the level of about one part in ten thousand. This is made possible by the high open loop gain of the Internal Feedback servo loop at DC, which is about 100 to 120 dB.

Note that at this point the Quick Dipper Bridge circuit is NOT in exact balance. Rather the bridge must be out of balance just enough so that it provides the current I_det indicated above.

Use this equation for I_det and the equation for I_det from drawing 31 to solve for R_sample in terms of the original parameters:

$$\frac{V\_fb \times Range}{TTR} = \frac{V\_esweeper - V\_efb}{R\_esample + R\_eref}$$

$$R\_sample = \frac{\left(\frac{R\_ref}{R\_fb + R\_ref} \times V\_fb\right) + \left(\frac{R\_fb \times R\_ref}{R\_fb + R\_ref} \times \frac{V\_fb \times Range}{TTR}\right)}{I\_sweeper - \left(\frac{V\_fb \times Range}{TTR}\right)}$$

It is useful to compare this exact equation for R_sample to a simpler equation that assumes that the bridge is in exact balance, i.e. that there are equal voltage drops across R_sample and R_ref in which case:

$$R\_sample = \frac{\left(\frac{R\_ref}{R\_fb + R\_ref} \times V\_fb\right)}{I\_sweeper}$$