More Steps to Make the SQUID Useful

The Phase Sensitive Amplifier improved the S/N ratio of the SQUID as a current meter but it still has a number of problems.
As shown in Figure 12, to use this circuit as a current meter, we depend on the SQUID "waking up" with the net flux through it such that it is at a minimum on the flux vs RF voltage across the RF Coil periodic function. In that case we could measure up to + – 250 nAmps of current in the Input Coil. If more than 250 nAmp every flows in the Input Coil then we will loose track of where we started on the periodic transfer function.

The solution to these problems is to "feedback" a third current through the RF Coil and to use this Feedback Current to exactly cancle any flux caused by current flowing in the Input Coil. The SQUID itself becomes a null detector that tells us when the User's Current in the Input Coil is exactly balanced by the Feedback Current in the RF Coil.

Note that we will need to limit the frequency range of the User's Current in the Input Coil to something like DC to a few kHz. The reason for this is that the response of the Feedback Current is limited at frequencies above 1 kHz or so by the necessarily slow response of the Phase Sensitive Amplifier. At DC a large User's Input Current can be balanced by an approximately equal Feedback Current (recall that the two mutual inductances: RF-SQUID and Input-SQUID are approximately the same). But as we go up in frequency the ability of the Feedback Current to exactly track the User's Input Current is limited. This is what Figure 1-4 on page 8 of the QD Operating Manual is telling you. If the User's Input Current and the Feedback Current ever come out of balance by more than about 100 nAmp then the system will loose track of which minimum in the periodic transfer function it was locked to.

Technical Note: The QD Model 2000 SQUID "Amplifier" provides two paths for the Feedback Current that is used to balance the User's Input Current: Internal Feedback where the Feedback Current flows through the RF Coil and External Feedback where the Feedback Current flows through some other path but is still used to balance or canacle out any flux caused by current in the User's Input Coil.

Most of the following description (and the QD manual) describes the Internal Feedback path. External Feedback really means any Feedback path that does not involve the Fedback Current flowing in the RF Coil. The Quick Dipper uses a combination of Internal and External Feedback to balance or cancle out any change in the flux looping through the SQUID Coil.

This Feedback System is a Servo Loop so all of the design requirements to keep it well behaved must be followed (e.g. non-oscillating and critically damped).

We need two more electronics blocks to implement this Feedback System: an Integrator and a Voltage Controlled Current Source.