Integrator and VCCS Page 2

I will skip the details about how the Voltage Controlled Current Source works. It is just another standard OpAmp circuit. If interested lookup "Howland Current Source". It is important to understand what a current source is.

— A Voltage Source says, "you have connected a load to me and told me to make X Volts - so I will make however much output Current is necessary to force X Volts across the load".

— A Current Source says, "you have connected a load to me and told me to make X Amps - so I will make however much output Voltage is necessary to force my X Amps through the load".

In the case of the VCCS there is a control input voltage that tells the VCCS how much output current to make. In our case the output voltage from the Integrator is used to control our VCCS and the output current from our VCCS flows through the RF Coil (assuming "Internal Feedback").

It is OK to just connect this Feedback Current to the RF Coil because it comes from a current source. The flux dither modulation's +– 250 nAmps also effectively comes from a current source (the Meg Ohm resistor R3). These currents will just add algebraically and they are basically independed of any small resistance (e.g. less than a few hundred Ohms) in the RF Coil and its cables and connectors.

The VCCS has a constant of proportionality that controls how many Amps of output current it makes per input Volt of control voltage. This constant of proportionality is controlled by the RANGE Switch on the QD 2010 Analog Control Unit.

The guaranteed linear range of the Integrator output is +– 10 Volts. As controlled by the RANGE Switch the VCCS can make this 10 Volts into either: 10 uA, 100 uA, 1 mA, or 10 mA of Feedback Current. Based on the mutual inductance of our SQUID Coils this corresponds to the Feedback Current being able to balance or cancel out up to: 10, 100, 1000, or 10000 Flux Quanta caused by current flowing in the User's Input Coil. See page 4 of the QD Operating Manual.

Note that the four positions of the RANGE Switch on the ACU are just labeled: 1, 2, 3, 4, i.e. the exponent of 10 of the number of Flux Quanta that can be handled by that Range.

In the "External Feedback" position everything is the same except that the Feedback Current generated by the VCCS is sent out the Trompeter connector labeled "EXT FB" on the SQUID "Amp". The Quick Dipper uses both Internal FB and a special version of Ext FB. The ACU Output (Integrator Output) and the output from the Current Sweeper supply are on opposite sides of a resistor bridge circuit with the User's Input Coil working as the bridge's null detector. In this way the servo loop brings the User's Input Coil Flux close to zero.