FILE24 AFS

SPIRE-RAL-NOT-001805

Measurement of Detector Output at QMC

Introduction:

The following gives my impression of Matt Griffin's equipment and techniques for measuring detector output as gathered from our discussions on the 30th of March 1989

The detector:

The detector is photoconductive; infra red radiation increases the conductivity of the detector. A bias voltage (usually about 100mV) is applied to the detector so that a current flows in it. This current is measured by the Integrating Amplifier (the IA).

The Integrating Amplifier:

The IA integrates the current from the detector by letting it charge a 7.5pF capacitor (actually the gate capacitance of the input FET). This FET acts as a "source follower". It gives an output voltage that is about 0.9 of the input voltage but at a lower impedance. The IA is placed inside the cryostat, close to the detector.

To reset the input of the IA to 0V, a high going pulse is applied to the reset transistor. This connects the gate of the input transistor to ground and discharges the 7.5pF capacitor. As a small charge is still left at the gate of the input transistor, a compensating pulse is applied to this gate during reset. The compensating pulse is adjusted until the IA gives zero output when it is reset.

The IA is supplied with +1.5V and -1.5V for power. As it does not work at less than 40K, it also has a heater resistor. The voltage applied to the heater is adjusted (with zero input to the IA) until the leakage current is equal to a value given in the data sheet for the IA. For the IA that Matt is currently using, this zero-input-leakage current is about 13uA. The heater resistance is about 6KOhms and about 160uW is needed (that is a heater current of about 163uA).

The IA is always used in such a way that the voltage at the integrating node (the gate of the input transistor) is small compared to the bias voltage. This means that the charging of the 7.5 pF capacitor is approximately linear so that the output voltage = 0.9*t/(7.5*10^-12) for Matt's JF4 where t is the time since the last reset. The integration time must be limited so that the output voltage is always small compared to the bias voltage.

The Reset Control Unit (RS1):

This is a battery powered circuit purchased from Infra Red Labs (who make the JF4). It provides the reset and compensation pulses for the JF4 when triggered by a +ve going pulse (5V).

The Reset Control Unit also has a *100 preamplifier that is used to amplify the signal from the JF4. This amplifier is an OPA111.

The RS1 Interface:

This is a circuit made at QMC that interfaces the JF4 to the RS1. It provides the power supply for the JF4 and the bias voltage for the detector. It has potentiometers to allow adjustment of the bias voltage and heater current and switches to switch on or off the power supply, heater and bias voltage.

The -1.5V power supply is connected to the JF4 via a 1kOhm resistor for current monitoring.

The power supply to the JF4 (also used for the heater current) is supplied by two 1.5V batteries and the bias voltage for the detector is supplied by a seperate 1.5V battery (to prevent interference from the power supply).

The bias voltage cannot be set to more than 0.5V.

A third switch disconnects the reset and bias pins and connects a test signal the ground pin of the JF4. To check that the JF4 is working, A signal of of about 5mV can then be applied to the "TEST" input of the RS1 interface. The same signal should be seen on the output of the JF4, slightly attenuated.

The RS1 Interface bolts to the side of the cryostat (the IRL cryostat used by Matt has 2 screw holes to accomodate it) so as to have the shortest possible leads from the RS1 box to th JF4. All signal wiring inside the RS1 Interface uses mini coax.

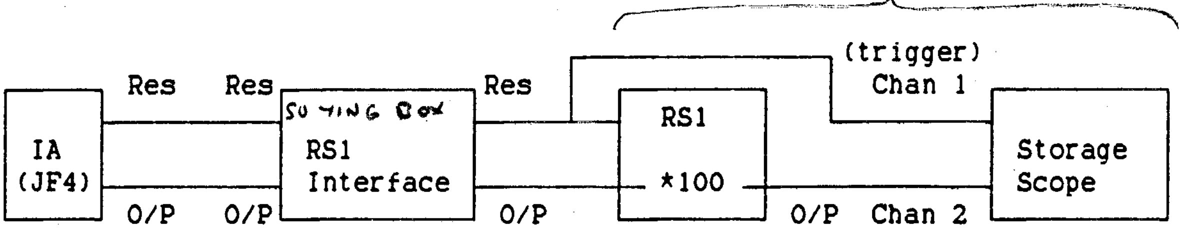
The RS1 reset control box should also be as close to the RS1 Interface as possible

Setting Up and testing the JF4:

These are tests described to us by Matt Griffin that can be done with the JF4 using the following equipment:

1) an RS1 reset control box
2) an RS1 interface circuit
3) a storage oscilloscope (storage scope)
4) a DVM with 0.1mV resolution

Items 1 to 3 were wired as follows:



The Reset pulse from the reset control box was sent, via the RS1 interface to the JF4. It was also connected to channel 1 of the storage oscilloscope. This pulse was used to trigger the storage scope.

The output from the JF4 was connected, via the RS1 interface, to the *100 pre-amplifier in the RS1 box. The output of this amplifier was connected to channel 2 of the storage oscilloscope.

Before Cooling:

Before colling the IA (and detector if present) Matt does the following test:

1) monitor the output of the *100 amplifier using the DVM
2) change the bias voltage using the control on the RS1 interface box
3) check that the output of the *100 amplifier changes accordingly

At room temperature the detector has very low resistance so this test is just amplifying the bias voltage with the JF4. Of course, the JF4 has very different properties at room temperature but the important thing is to check that, when the bias voltage is increased, the output of the JF4 increases too.

Also before cooling, Matt checks the resistance of the JF4 heater (~6 kOhms).

After cooling:

With the heater off, the current for the -1.5V power supply is checked by monitoring the 1k series resistor. This current should be 0 with the heater off.

When the heater is switched on, this current should rise to 13 - 14 uA (for Matt's JF4). When the current reaches this value, it shows that the JF4 is at the right temperature.

Adjusting the Compensation:

Set the storage oscilloscope to trigger on the leading (+ve) edge of the reset pulse.

Send several reset pulses in a short time to clear the JF4 of saturation.

Send a final reset pulse and examine the trace on the oscilloscope. Ideally, the ramp following the reset pulse should begin at the same level as the output during the reset pulse; there should be no discontinuity (sudden change) after the reset pulse.

In practice, there will be a discontinuity after the reset pulse. The compensation control should be adjusted to make this discontinuity as small as possible: