# Using “Black Box” to Measure NOvA APD Arrays (NOVA-DOC-6699)

Mathew Muether

March 11, 2013

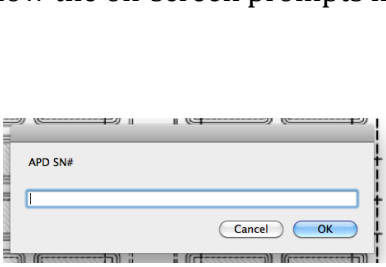
ABSTRACT: This procedure was established to identify APDs on the bench that are grossly malfunctioning (drawing microamperes of current on any given part of the array). This procedure is meant as a final checkout prior at the installation site prior to mounting. This technique DOES NOT in anyway supplement the electrical characterization testing done by Hamamatsu or QA measurements performed at Caltech. APDs that demonstrate gross errors on this tester or data read back issues invisible to these measurements are sent to Caltech for a full evaluation.

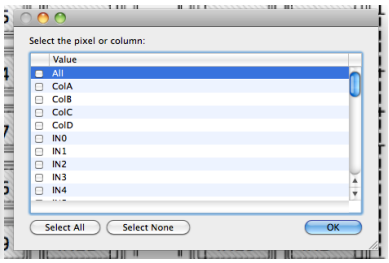
TESTING A CONNECTED APD

1) Remove the black box lid, place APD over posts and seat the ribbon cable into the ribbon connector. Replace black box cover.
2) Power on the Keithly Electrometer. It should boot up as shown below.

2) From the Desktop of the control machine launch either the “APD IV” (Voltage ramp to 375, 20 sec total test time) or “APD Soak” (Voltage hold and current monitor) from the icon.

3) Follow the on-screen prompts like those shown below.

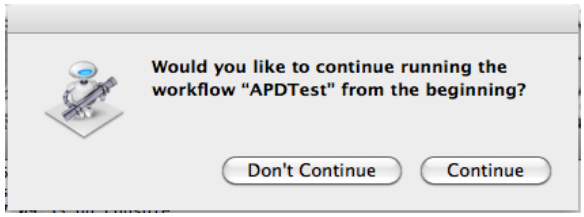



A terminal will launch and look like the following for “APD IV”

```
Terminal — bash — 86×48
~/gpib/IVcurve2.exe 0 375 75 1 ~/Desktop/APD/Data/APD_test_ColA_November_8_2011_37299.
dat ~/Desktop/APD/Reports/APD_test_ColA_Report_November_8_2011_37299.txt
Last login: Mon Nov  7 17:09:53 on console
ppd-116670m:~ muether$ ~/gpib/IVcurve2.exe 0 375 75 1 ~/Desktop/APD/Data/APD_test_ColA
_November_8_2011_37299.dat ~/Desktop/APD/Reports/APD_test_ColA_Report_November_8_2011_
37299.txt
The following parameters are used for this test
  Vstart = 0 V
  Vstop  = 375 V
  Vstep  = 75 V
  Tdelay = 1 s

  Data Filename = /Users/muether/Desktop/APD/Data/APD_test_ColA_November_8_2011_37299.
dat

  Data Filename = /Users/muether/Desktop/APD/Reports/APD_test_ColA_Report_November_8_2
011_37299.txt

  Total of 6 readings

KEITHLEY INSTRUMENTS INC.,MODEL 6517A,1104474,C05  /A02

Beginning Data Collection:

C  Bias(V)    Current (A)
  +0000.000   +002.2709E-09
  +0075.000   +005.4224E-09
  +0150.000   +007.1562E-06
  +0225.000   +0068.359E-06
Current Limit Exceeded...stopping sequence.
  +0300.000   +0138.939E-06
C


Conversion Complete
Take device offline
exit program
ppd-116670m:~ muether$
```

The user can rerun the test with a new APD by clicking the “Continue” button on the dialog box shown below

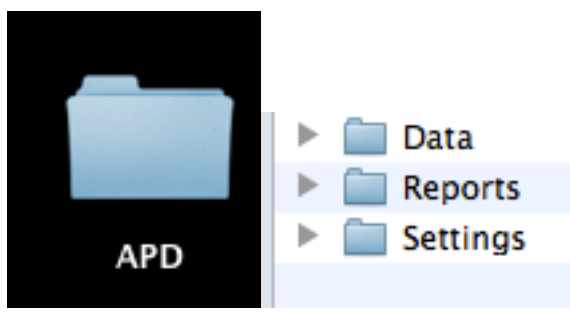


The “APD soak” test looks like:

```
ppd-116670m:~ muether$ ~/gpib/IMonitor2.exe 375 2 ~/Desktop/APD/Data/APD_test_All
_November_8_2011_41272_SOAK.dat
The following parameters are used for this test
  Vset = 375 V
  Tdelay = 2 s

  Data Filename = /Users/muether/Desktop/APD/Data/APD_test_All_November_8_2011_41
272_SOAK.dat

KEITHLEY INSTRUMENTS INC.,MODEL 6517A,1104474,C05  /A02

Beginning Data Collection:

C  Bias(V)     Current (A)   Temp (C)  Time(s)
  +0375.000   +00.52140E-06  +9999.9           0
  +0375.000   +00.52184E-06  +9999.9           2
  +0375.000   +00.52871E-06  +9999.9           4
  +0375.000   +01.32529E-06  +9999.9           6
  +0375.000   +007.4169E-06  +9999.9           8
^Cctrl-c entered
What do you want to do: (0 = stop, 1 = continue):
```

Use Crtl-C to pause the soak.

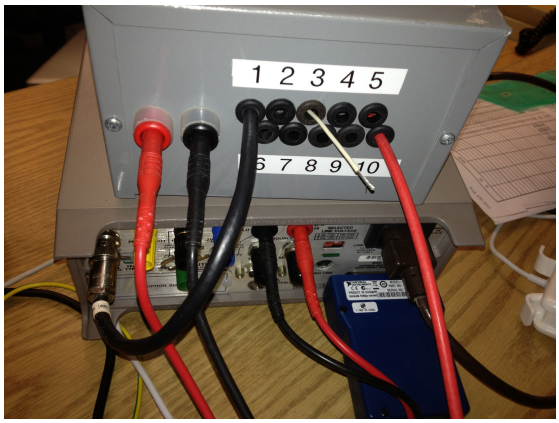
Data from both tests are stored in the Desktop directory “APD” under the Data and Report directory as time stamped files.




TESTING THERMISTOR

1) Remove the black box lid, place APD over posts and seat the ribbon cable into the ribbon connector.
2) With an Ohmmeter connected to the thermistor lemo connector on the black box, measure the resistance.
3) A good thermistor has a resistance of 9-11 kOhms. Quarantine devices out side of this range.

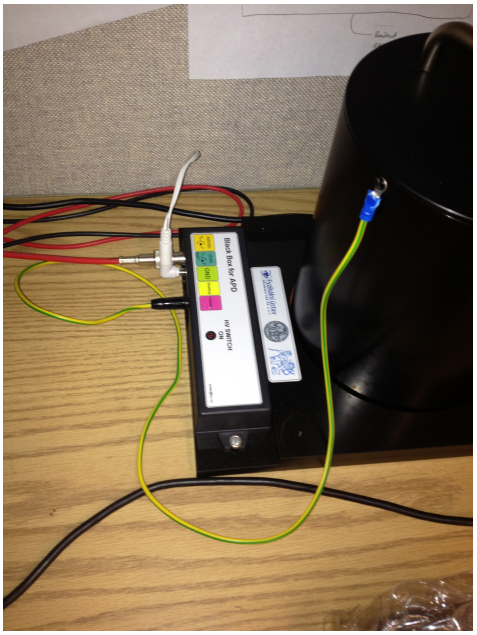
SETTING UP THE ELECTROMETER and BLACK BOX:



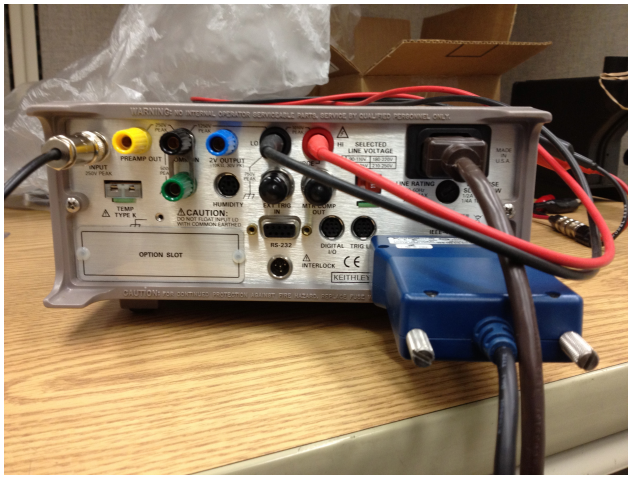

The “black box” tester is connected to the Keithly electrometer through a numbered connection box shown in the photos below.

1)Connect the red and black banana cable connectors on the connection box to the corresponding red (hi) and black (lo) connectors on the electrometer.

2)Connect the black coaxial cable 1 from the connection box to the INPUT coaxial connector on the electrometer.




3) Connect the red High Voltage cable 10 from the connector box to the 400VDC connector on the Black Box.
4) Ground connection 3 on the connector box may optionally be connected to an external ground reference.
5) Plug the brown electrometer power cable into the electrometer and designated wall outlet.
6) Connect the grounding lead from the black box “bell” to the shielding connector on the black box base.
7) Plug the DC power adapter into a standard (120V) wall outlet and connect it to the 120VDC input on the black box base. (The red LED will should light if the bell is seated properly indicating that the box is ready to except HV to the APD. Lifting the bell will break the HV path to the APD connector for personnel safety.)
8) (Optionally) the thermistor and gnd connections on the black box based may be probed with a ohmmeter to test the thermistor.



CONNECTING THE ELECTROMETER TO CONTROL COMPUTER

For connection to a external control laptop connect the NI GPIBtoUSB adapter to the electrometer GPIB port. Connect the USB end to the NI GPIBtoUSB adapter to the control computer with properly installed drivers.

CONNECTING AN APD TO THE BLACK BOX BASE:

1) Remove the "bell" from the black box base. (If an APD is in place disconnect the ribbon and slide off posts)
2) Slide the APD assembly over the post with the

ribbon cable facing toward the ribbon connector on the base.

3)Connect the ribbon the the connector on the base and replace the bell.