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Vortex-ME4™

Multi-Element Silicon Drift Detector X-Ray Spectrometer

User's Manual

Rev. 4.0 May 30, 2007

This manual and the data herein are subject to change at any time without notification.

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1. General Instructions

- The detector arrives with an external battery connected to the DB-15 connector of the silicon drift detector (SDD) package. This external battery should be disconnected after arriving at the final location and the SDD package should be connected to the power line through the external +12 V DC wall transformer. **The SDD package should be connected to the power line at all times. However, if necessary, it is acceptable to disconnect it from the power line for up to 100 hours.**

- The beryllium window in the front of the detector, at the end of the probe, is only 12.5 μm thick, thus great care must be taken to ensure that nothing comes in contact with it. Cover the Be window at the end of the probe with the protective plastic cover when not in use.

- The SDD package must be mounted with the snout in the horizontal position, or tilted slightly so that the detector end of the snout is facing *down*. **Do not mount the SDD package into a position such that the detector end of the snout is tilted up.**

- The system can be stored at room temperature without any special care, but it is recommended that it be stored in a location with low humidity.

- List of items delivered:
  - SDD package
  - Digital Pulse Processor and/or Power Supply
  - Main biasing cable
  - +12 V DC wall transformer
  - User's Manual CD

2. Safety and Precautions

2.1 Thin Beryllium (Be) window

- The Be window at the front of the detector probe is extremely thin and fragile. Never touch, shake, or subject the detector window to thermal shock. Cover the Be window with the protective cap when detector is not in use.

- Do not allow any object to come in contact with the window.

- If breakage of the window does occur, return the product to SNTUS for repair.

2.2 Detector biases

Be sure that the detector biases are correctly set (see bias specifications pertaining to individual units that are supplied with the unit). Excessively high bias might damage the detector crystal and/or the field effect transistor (FET). The detector is supplied with a power

supply electronics box, in which the biases were set appropriately at SNTUS and they should not be altered. However, measure the biases to ensure that the correct values have been maintained during shipping. Contact SNTUS if the bias values do not match the data sheet.

2.3 Mechanical shock

The system is a relatively rugged device. However, traumatic handling or droppting it onto the floor, can definitely cause damage. If it is not attached to a table or other equipment, keep the detector in a safe place to prevent accidental mistreatment.

2.4 Turning the system ON/OFF

Do not turn the system ON immediately after turning it OFF! As with most electronic systems, there is a momentary recharging process that takes place after rebooting the system. It is therefore important to wait ~3 minutes before turning the system back ON.

Unless it is absolutely necessary, avoid turning the detector OFF for at least 3 minutes after it has been turned ON and after it has reached its stable operating temperature.

Never turn OFF the external +12 V DC wall transformer!

2.5 Operation in Noisy Environments

The Vortex® instruments are specifically designed to be extremely sensitive to very low signal levels. Thus, if the Vortex® is operating in an electrically "noisy" environment, or if it is subjected to abnormal electro-magnetic interference, it may not operate properly. These conditions are extremely rare, and would not be expected to be encountered under normal operating conditions in a laboratory environment. However, if you suspect you are observing electro-magnetic interference effects, please contact technical support at SNTUS to determine the solution.

3. System Description

The system is comprised of three main parts, as shown in Figure 1: the SDD package, the power supply (PS) box and cable.

Figure 1. The Vortex-ME™ multi-element detector system. Left to right: PS box, cable, SDD package.

3.1 SDD package

The SDD package includes the vacuum chamber and the preamplifier box. The vacuum chamber is sealed with a Be window and includes four SDD detectors, each with a first amplification stage field effect transistor (FET) and thermoelectric cooler (TEC). The preamplifier box includes four preamplifiers, the temperature controller circuit, an ion pump with the ion pump power supply, the ion pump power supply back-up battery and the electrical connections. The SDD package weighs 3.8 kg. The SDD package is shown in Figures 2 and 3, with external dimensions shown in Figure 4.

The preamplifier box back panel includes the DB-15, four BNC and Power Jack connectors, two test points and one LED, as shown in Figure 3. The DB-15 connector is for the detector power supply and the BNC connectors are for the signal output. The test point "T" is for the SDD temperature testing. The power jack is for the external +12 V DC wall transformer that supplies the ion pump power. The test point IP is for measuring the current of the ion pump. The LED is lit when power is supplied to the ion pump from the external +12 V DC wall transformer.

Figure 2. Vortex-ME4™ SDD package.

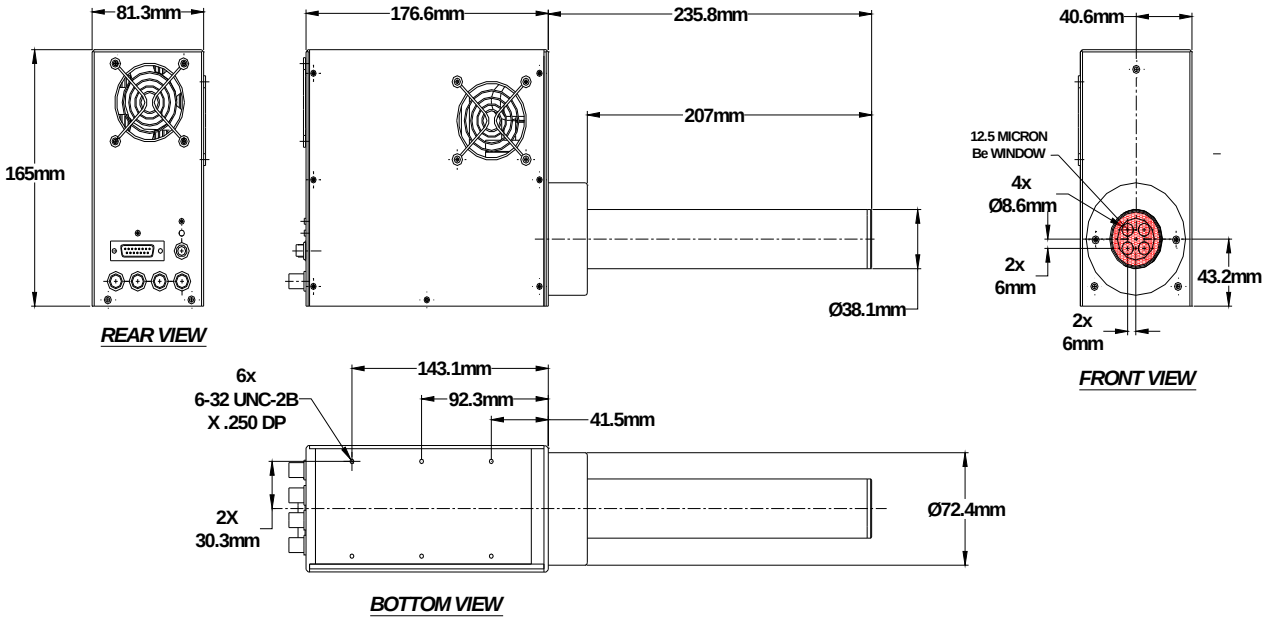

Figure 4. Vortex-ME™ SDD package with external dimensions (in mm).

3.2 Power supply (PS) electronics box

The PS electronics box includes the detector power supply that provides four separate voltages to bias the SDDs, and power supplies that provide power to the TEC and to the rest of the electronics. The front and the back panels of the PS electronics box are shown in Figures 5 and 6, respectively. The PS box has external dimensions of 220.2 x 152.4 x 87.63 mm3 (L x W x H) and the weight is 2.2 kg.

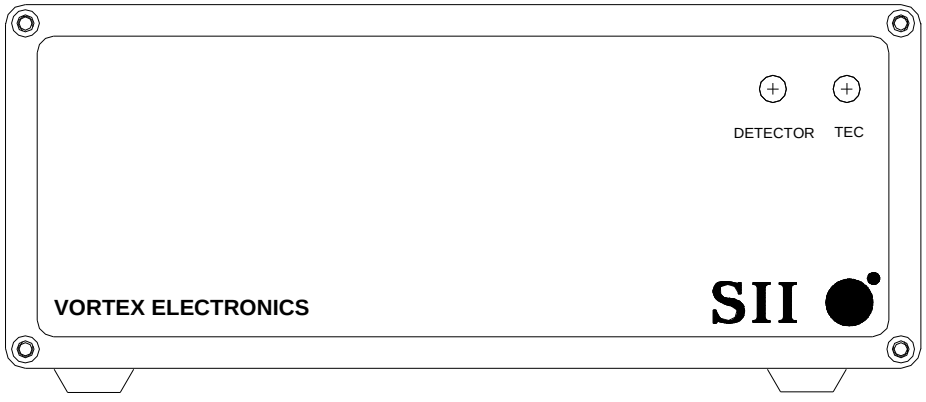

Figure 5. Front panel of PS electronics box.

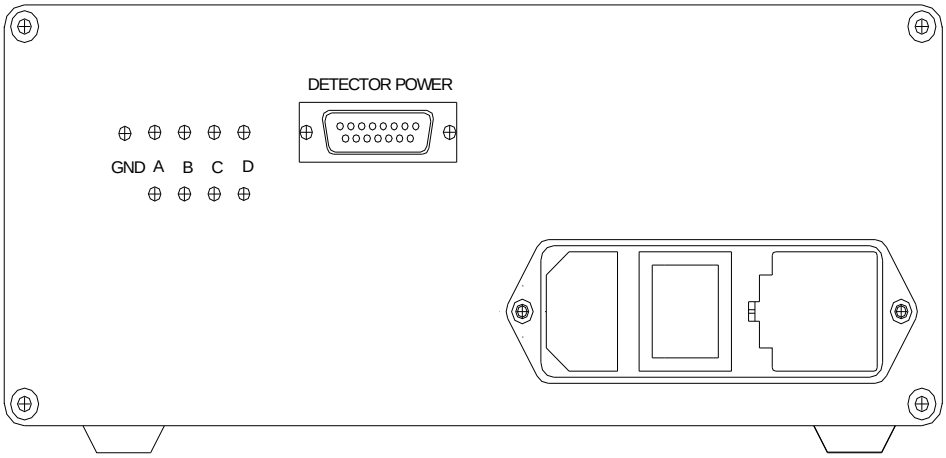

Figure 6. Back panel of PS electronics box.

On the front panel of the PS box (Figure 5) there are the two LEDs indicating the detector voltage and the TEC operation:

- **Detector voltage LED** is lit when the system is ON and the detector is biased normally.
- **TEC LED** is **Red** 2-3 minutes after turning the system ON and indicates that the detector is cooling down.
- **TEC LED** is **Green** when the detector cooling process is complete and the detector is functioning normally.

On the back panel of the PS electronics box (Figure 6) are the ON/OFF switch, the detector power connector and the detector bias regulating points. (Customers should not change the detector bias without first consulting with SNTUS).

3.3 Preamplifiers

There are four preamplifiers, one for each SDD. The preamplifier is a charge-sensitive preamplifier, which is optimized to work with a transistor-reset FET. All four preamplifiers have a common reset to avoid potential crosstalk among the four detectors. Figure 7 shows the oscilloscope traces of the four preamplifier output signals under normal operating conditions. The ramp voltage range is from ~ -2 V to ~ +2 V.

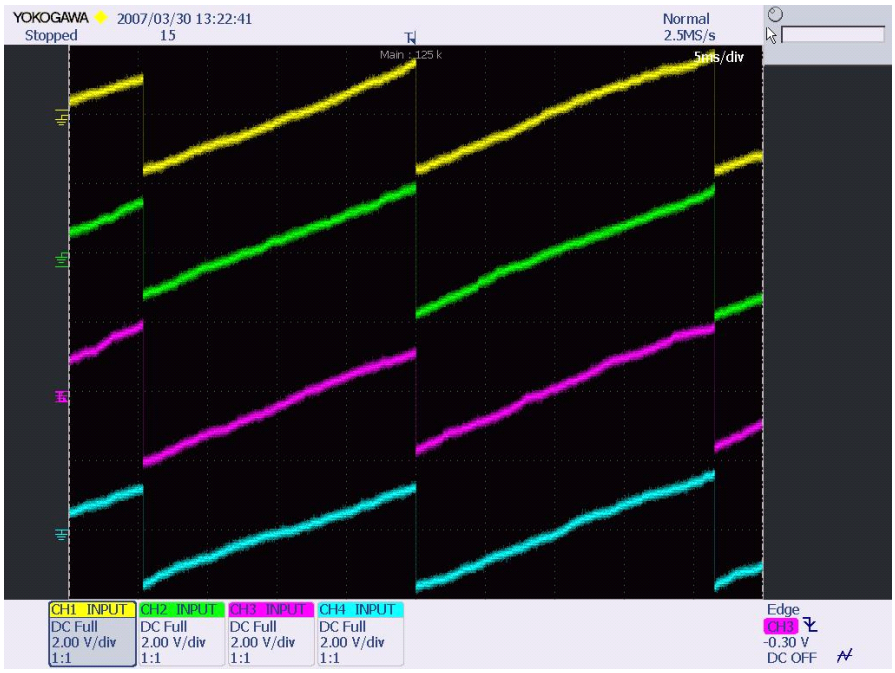

Figure 7. Oscilloscope traces of the four preamplifier output signals when the detector is detecting an x-ray signal.

The output signal from the preamplifier is a step wave function with its height proportional to the energy of the incident photon (~1.5 mV per 1 keV photon energy), as is shown in Figure 8. The mV/keV ratio can be modified per the customer's request, if required. With an x-ray source applied, the preamplifier output signal consists of positive steps superimposed on an irregularly spaced ramp of positive slope, as is shown in Figure 8. The negative reset duration is about 1 μs.

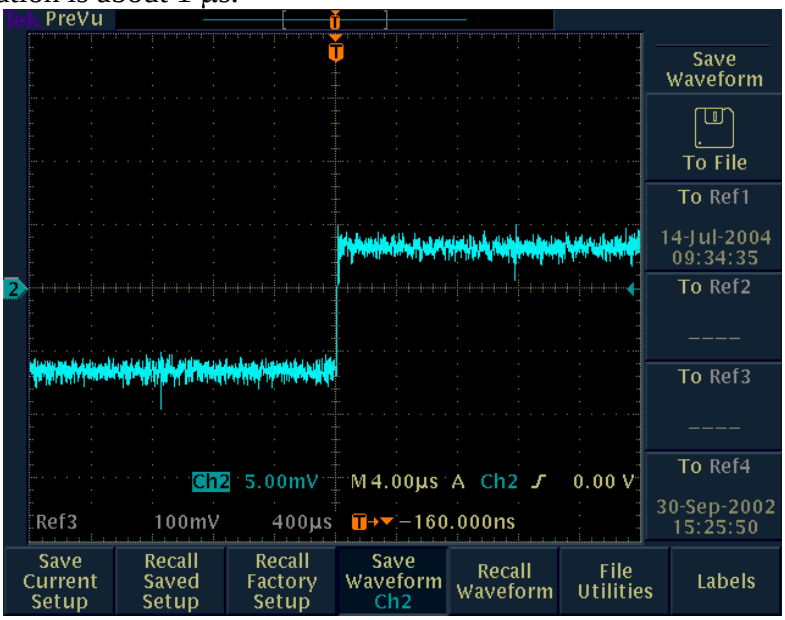

Figure 8. Oscilloscope trace of preamplifier output step pulse, including noise. The height of the step is proportional to the x-ray energy.

4. Operation

Make sure that the external +12 V DC wall transformer is connected to the power line and the LED on the detector back panel is lit all the time. Check that the voltage at the ion pump IP test point does not exceed -3 V. Usually the IP test point voltage is less than -0.3 V.

4.1 Setting up for operation

- Connect the appropriate ends of the cables to the preamplifier box back panel connectors shown in Figure 9.

Figure 9. Vortex-ME4™ SDD package and PS electronics box.

- Main biasing cable connects to the D-Sub 15 pin connector including: Detector Bias, TEC and preamplifier power.
- Output cables to Preamps Out.

- Connect the other end of the cables to:

  - D-Sub 15 pin connector to Detector Power connector of the PS electronics box.

- Output cables to an input connectors of a pulse processor to be used with the detector.

- Turn the PS electronics box ON/OFF switch to ON and wait 2-3 minutes until the TEC LED is lit green.

4.2 Powering down the system

Turn the PS electronics box switch to OFF to power down the system. (The detector can be turned back ON after ~ 3 minutes).

4.3 Turning the system ON/OFF when not in use

It is recommended to turn the system OFF when it is not in use, to prevent damage to the detector due to a potential power failure or mechanical shock, but do not unplug the external +12 V DC wall transformer from the wall outlet. The LED on the detector back panel should be lit all the time.

Do not turn the system ON immediately after turning it OFF! As with most electronic systems, there is a momentary recharging process that takes place after rebooting the system. It is therefore important to wait ~3 minutes before turning the system back ON.

Note: Unless it is absolutely necessary, avoid turning the detector OFF after turning it ON for at least 3 minutes past reaching its stable operating temperature.

5. Trouble shooting

5.1 The spectrum cannot be acquired

Connect the system to an oscilloscope as shown in Figure 10. Use the electronics box for supplying the biases, and disconnect the input cable (BNC) from the box and connect it to an analog amplifier, as is shown in Figure 10. Turn on the system as described in Section 4.1. Monitor the output of the preamplifier with the oscilloscope. Continue according to the instructions in the following sections.

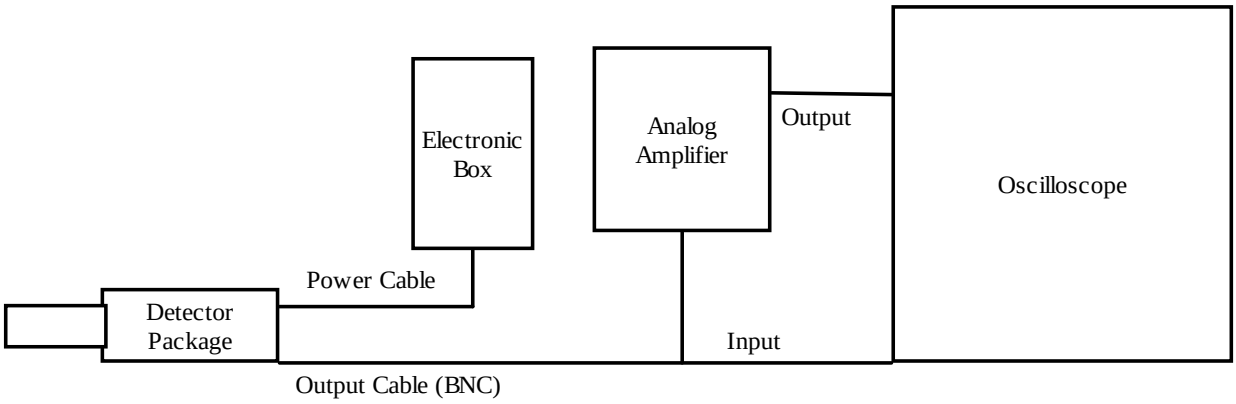

Figure 10. Schematic of detector connections for trouble-shooting.

5.1.1 Preamplifier does not ramp up in voltage

If the preamplifier does not ramp up (as shown in Figure 8), but stays at ~ 0 V or < 0 V, check the electronics box cable connections to the preamplifiers. If the cable is connected properly, but still the preamplifier does not ramp up in voltage, then the FET or preamplifier may be defective. If this is the case, contact SNTUS to return the system for repair.

5.1.2 Preamplifier output is always positive

Make sure the window is covered and not exposed to light! If the preamplifier output is still positive, and is not resetting, as shown in Figure 8, check all the cable connections to ensure proper connection and proper bias conditions. If the cables are connected properly, but still the preamplifier output stays positive, then the detector or FET, and/or the preamplifier, may be defective. If this is the case, contact SNTS to return the system for repair.

5.2 Poor energy resolution and/or noisy

If the energy resolution is poor, or the spectrum is otherwise noisy, ensure that all the cables are properly and tightly connected. If the cables are connected properly, but the energy resolution does not improve, the detector may not be cold enough. Check the temperature test point at the back panel of the preamp. If the temperature test point measures < 1.5 V, the detector is not cold enough. If this is the case, contact SNTUS to return the system for repair.

Poor energy resolution may also occur if the correct biases are not being supplied to the detector, in which case you should also contact SNTUS.

6. Technical Support

Please contact SII NanoTechnology USA Inc. (SNTUS) for technical support or additional information: (818)-280-0745

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