

TN0003

Calibration of Current and Charge Measuring Devices

Current and charge measurement

All models in the Pyramid I-series devices (charge integrator topology) and F-series devices (I-V converter topology) are designed for high stability and accuracy. Every model includes one or more built-in calibration sources which feed current to the input(s) of the circuit. These are true current sources based on precision bandgap voltage regulators and high precision, high stability resistors. The sources allow the device to be recalibrated at any time, and the linear calibration factors are stored in non-volatile memory in the device. We recommend that you keep a record of the gain and offset parameters reported by the device. A consistent trend may indicate degradation of the device, for example due to radiation damage for products used in radiation environments.

It is usually preferable to remove the signal connections at the device when running the automatic calibration for best accuracy. If there are factors in the measurement arrangement that can affect the reading, such as high capacitive load or offset currents, it is preferable to manage these by using additional application correction factors. An example is “flat-fielding” a multichannel sensor array.

It is important to validate the accuracy of the device against traceable external standards periodically. The frequency of the checks will be determined by how critical absolute accuracy is to the application and by the working practices at the place of use. As an example, an electrometer making current measurements for a medical dosimetry application should have regular calibration checks. A multi-channel electrometer making relative measurements for position sensing may be considered less critical. The procedures at the customer site will provide guidance, but the following guidelines are proposed for external accuracy confirmation against an external source:

Critical dosimetry applications – basic cross check against independent source	Not less than monthly
Critical dosimetry applications – full cross-check against traceable source	Not less than quarterly
Critical dosimetry applications – full recalibration against traceable source	Not less than annually
Other applications	Not less than annually

A full re-calibration service is available from Pyramid. The units must be returned but the work only takes 1-2 days and also includes a full health check, cleaning and upgrades and repairs if needed. Alternatively the customer can use their own traceable current source and follow in-house protocols. The current source must have the necessary dynamic range to cover the measurement range of the Pyramid device. Special adaptor cables may be required to connect the external current source to high-density multichannel devices. Screened low-noise or triaxial cables should be used to eliminate EMI and triboelectric noise. Avoid opening the case of the device unless specifically asked to do so by Pyramid. This would void any warranty and can introduce contamination which produces offset currents and instability.

High voltage supplies

All I- and F-series devices can be fitted with high voltage supplies for biasing detectors. The output voltage is sensed by a voltage divider, independent of the high voltage module. On the I128, I6400 and F3200E products there is a second divider which can sense the voltage returned from the detector via a second cable. The HV supplies and voltage sensing circuits are factory calibrated at time of manufacture. We recommend that the external accuracy of the HV supplies is also checked periodically; the frequency depending on how critical the application is and the risks from incorrect voltage.

The accuracy required from an HV supply depends significantly on the application. Ionization chamber biasing is relatively tolerant of errors in the voltage for example, whereas analog electron multipliers need good accuracy and stability. Electron multipliers can be damaged by overvoltage. For very critical applications an on-line high voltage monitor should be considered as a back-up to the on-board readback.

HV calibration is included in the Pyramid back to base calibration service. If you prefer to do HV calibration checks yourself, you must ensure that the input impedance of the measuring device is high enough to avoid loading the circuit down (at least 5 Mohm), and you must take care to avoid shock hazard or damage to measuring equipment from overvoltage.

Other calibrations

Many Pyramid current and charge measuring devices include analog voltage input and output channels for monitor outputs, process control and general use. These outputs are factory calibrated at time of manufacture using calibrated voltage sources and meters and are checked during the Pyramid back to base calibration service. You should include these inputs and output in your periodic external calibration checks if they are used for important measurements.