TECHNICAL WHITE PAPER

# STARFLOW QSD AND LIGHTENING SUSCEPTIBILITY

This document is a discussion paper on the susceptibility of instruments, especially the Starflow QSD, to lightning damage.

## LIGHTENING SUSCEPTIBILITY

Lightning is caused by substantial current discharges between earth and "clouds" (or vice versa). It is possible to protect equipment from induced lightning surges, but this requires diverting the lightning away from the protected equipment to a solid ground point. Therefore it would be possible to protect the QSD power supply from lightning coming to/from along the QSD cable, but that will not help the QSD itself if its inherent isolation was breached. Of course, nothing will protect equipment from a direct lightning strike.

Lightning strikes will induce large currents into the water body and surrounding earth. In large water bodies (ocean, river), these currents are rapidly attenuated with distance. However, they will travel hundreds of metres through the water in a narrow stream before slowly dissipating to the ground. These currents can get induced into the QSD and signal cable and can raise the potential difference between the QSD in the water and its cable and power supply. Alternatively, lightning-induced into the external installation (cable or power supply) will create similar potential differences with the QSD in the water. While no ground leakage occurs, everything is fine, but damage occurs as soon as the system insulation is breached.

Inherently, the QSD is well protected from induced lightning damage because it is encapsulated within an epoxy housing of a minimum of 1mm thickness, providing an insulation strength of ~ 20 kV. The QSD cable would be of similar dielectric strength (~20 kV/mm) and, depending on its thickness, might be to the point of the first breakdown.

Without any direct ground connection, the whole QSD installation (QSD, cable & battery system) simply "floats" at an elevated potential above the surrounding water body and earth until its insulation protection (epoxy, cable and power system) is exceeded. Then damaging currents may flow to/from the QSD, and these will affect the performance.

This inherent isolation works well until the insulation is breached. In the REV2 QSD, two potential points have been added:

- The optional pressure depth sensor
- The optional conductivity system

**Pressure Sensor** - The pressure transducer also directly interfaces to the water but is protected by a backfilled RTV silicone barrier with a similar 20-kV/mm dielectric strength. Provided this barrier is not breached, it protects the QSD and does not degrade its isolation.

**Conductivity** - The conductivity electrodes are necessarily in direct contact with the water. They are electrically isolated from the main QSD electronics by a transformer and four capacitors, and the electrodes have ESD surge protection (bi-directional transorbs) between the electrodes and "ground". This "floating" front-end is necessary for the accurate measurement of electrical conductivity, as the water body often contains low-level voltage potentials from power station earth returns and other earth currents.

Whilst this provides protection from static damage and low-level induced voltages in the water (of a couple of hundred Volts), it offers no protection against induced lightning potentials. In fact, it is impossible to protect the directly connected conductivity electrodes and electronics.

Note: The "ground" point for the ESD protection is not really an earth, but just the QSD electrical ground. This is fine for static but does nothing (and may even create problems) for induced potential differences on the electrodes. There could be an argument to move these ESD transorbs to the other side of the isolation capacitors. This may help keep damaging potentials out of the MPU.

## CONCLUSIONS:

The REV1 QSD is inherently protected from induced lighting up to ~ 20 kV.

The REV2 QSD has similar protection, except when the conductivity option is present (when the isolation drops to a couple of hundred Volts).

The pressure transducer does not cause degradation of the QSD protection, provided the RTV barrier remains intact.

In a QSD installation, care should be taken to maintain total system ground isolation to ~ 20 kV.

If system isolation is not possible because external equipment is connected (RS-485 or power sources), then diversion to lightning ground should be added to isolate those external connections.

Suppose the QSD is to be installed into a lightning prone environment (particularly in small streams). In that case, it may be preferable not to have the conductivity option installed OR just accept that the QSD may become damaged if lightning strikes close by.

Further examination of the conductivity front-end using lightning experience from the existing 6536 Four-Electrode, may suggest improvements (e.g. moving the ESD and higher voltage capacitors).

AVAILABLE FROM: **Unidata Pty Ltd** | 40 Ladner Street, O'Connor, 6163 Western Australia | Tel: +61 8 9331 8600 | info@unidata.com.au

**www.unidata.com.au**