Application Note: AZD014
Grounding effects in the power supply of capacitive sensors & methods for improving sensitivity

A capacitive sensor relies on a closed loop to perform sensing (very much like electrical current requires a closed loop to flow). Having a battery supplied portable unit vs. a well grounded unit, impacts on the sensitivity of the sensor.

In Figure 1, the capacitive loop is formed by the body of the person activating the sensor, then C1, then the electrical path through the electrode and module, then C3 (the coupling of the module with earth) and finally C2 (the body of the person coupling with earth). The ProxSense™ module will detect a change in capacitance relative to a long term steady state value. With no clear reference, it can be seen from Figure 1, that a change in C1, C2 or C3 will cause a change relative to the steady state reference and could be interpreted by the module as a legitimate activation.

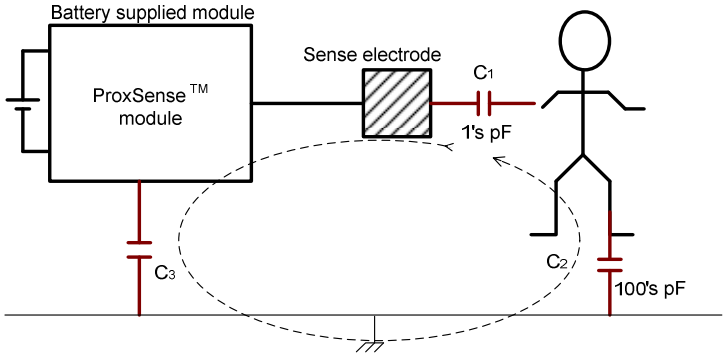

Figure 1. Battery supplied module

In normal circumstances, C2 stays relatively fixed. If a portable unit is not moved, C3 stays relatively fixed too. Therefore, in normal operation as a user approaches the electrode, C1 changes and is detected as an activation. It must be noted that the further the module is removed from earth, the weaker the coupling between the module and earth becomes (yielding a smaller C3 capacitor). Because $C_T \alpha 1/C3$, a small C3 will decrease the effect of C1, and the system will be less sensitive. Another disadvantage of battery applications is that there exists 2 variables (C1 and C3).

Figure 2 depicts a well grounded application. This is a typical application supplied from a wall outlet. No capacitive coupling between the module and earth (C3) is required and that effectively means that you have a better referenced system (and only one variable capacitor: C1). The sensitivity on a well grounded system will be better than a battery supplied unit, since C3 is omitted and C2 has very little impact on the system. This means that small changes in C1 is easily detectable.

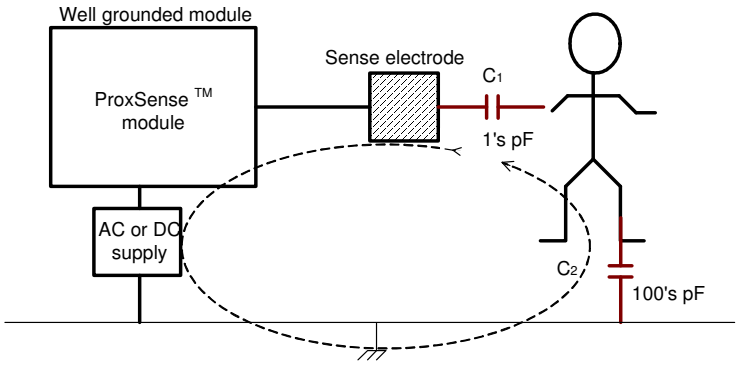

Figure 2. Grounded module

Improving sensitivity in portable units

A number of methods could be used to improve sensitivity in portable units. In general, no special steps need to be taken for devices at a TOUCH sensitivity, but may be required for small battery powered devices requiring PROXIMITY detection.

1. The physical size of the system can be enlarged
2. If possible a large ground plane can be added to the system. The designer should aim not to have the ground planes too close to the electrode on devices without the ATI feature. (Refer to the application note on the Antenna Tuning Implementation (ATI) employed on certain ProxSense™ devices that counters parasitic sources in the vicinity of the electrode). If the system allows, bonding the ground plane (or the module) to physical surfaces like the floor or a wall will improve sensitivity. (A battery supplied unit will have improved PROX sensitivity when bonded to a wall)
3. The module can be connected to other battery supplied equipment (effectively enlarging the ground coupling surface).
4. In some cases, enlarging the sense electrode may improve sensitivity (however care should be taken, as this also increases the area that noise can couple into, increasing noise susceptibility).
5. Using a driven shield improves sensitivity in portable devices. (refer to the application note on the use of driven shields: AZD009)
6. In small portable devices, the closeness of ground planes and components may reduce the sensitivity on the sensor due to parasitic capacitance. Using devices with the ATI feature (e.g. IQS127x) will reduce the effect of parasitic capacitance.
7. When used in a TOUCH application, a more sensitive threshold can be chosen. Even a PROX threshold can be chosen in very in-sensitive systems to detect a TOUCH.
8. Reducing the thickness of the overlay material or using an overlay with better dielectric value will improve sensitivity (glass is better than plastic)
9. Avoid air gaps between the sensor and the overlay material. (Use a spring with a conductive surface pressing against the overlay where big air gaps exist or attach the touch pad directly to an overlay using non-conductive glue / double-sided tape)