

## Effects of Metallic Glass on Donor Unit

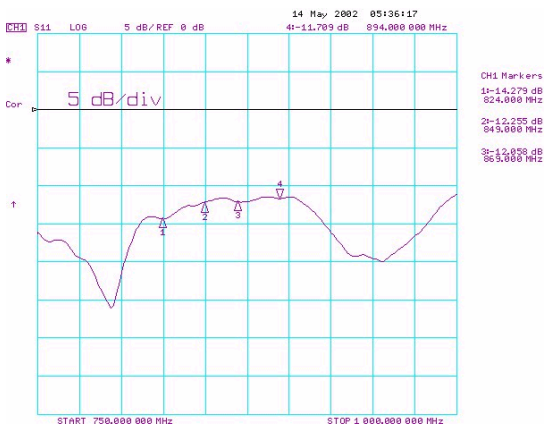
### Overview

The following technical note describes how the performance of the SpotCell Donor Unit (DU) is affected when located close to thermal (metallic) glass.

Included are recommendations on how to mount the DU so that the effects of the metallic glass are minimized.

### Return Loss and Metallic Glass Proximity Effects

Return loss is an antenna parameter that indicates the amount of RF signal that is absorbed by the antenna versus that which is reflected back. Good signal absorption means a greater amount of gain is applied by the antenna to the signal as it is radiated into free space. A good antenna might have a value of 10dB return loss (90% absorbed & 10% reflected). The plot below is the return loss of the DU antenna in free space. The return loss is better than 12 dB in both uplink and downlink.



**Figure 1 - DU antenna return loss in quasi-free space**

### Measurements

The following plots show the effect on antenna return loss when positioning the DU directly in front of a window fitted with a modern double glazed insert.

The glass is apparently metallic, as it has a strong impact on the antenna return loss. At close range (5 to 10 cm) the DU return loss is poor across the band.

At distances up to 60 cm the window noticeably affects the return loss, although at some frequencies the reflected signal also creates local minima in the return loss.

If the antenna is angled towards the window at 45 degrees, the return loss remains similar to free space, even with the closest edge of the ground plane almost touching the window.

The tests were repeated with a commercially available 10dBi panel antenna (Maxrad) with similar results.

An omni antenna was also tested. In this case the return loss was not noticeably affected until the tip of the antenna was actually touching the glass.

Similar tests conducted on a single sheet of glass in the office interior showed that plain glass has a much smaller impact on the DU antenna return loss, and presumably the antenna gain.

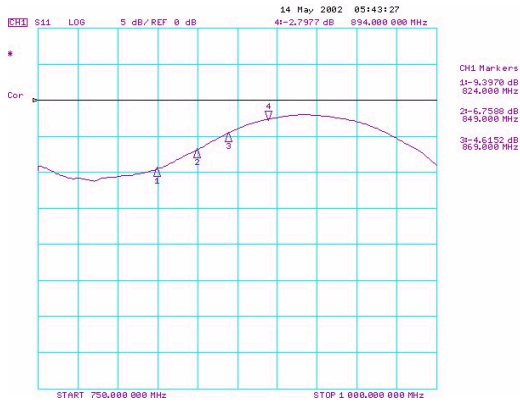


Figure 2 - DU ground-plane 5 cm from glass

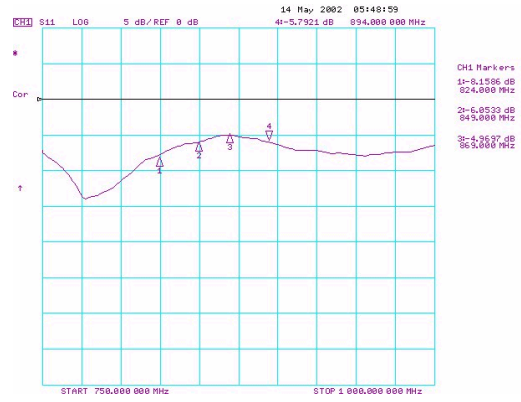


Figure 5 - DU ground-plane 30 cm from glass

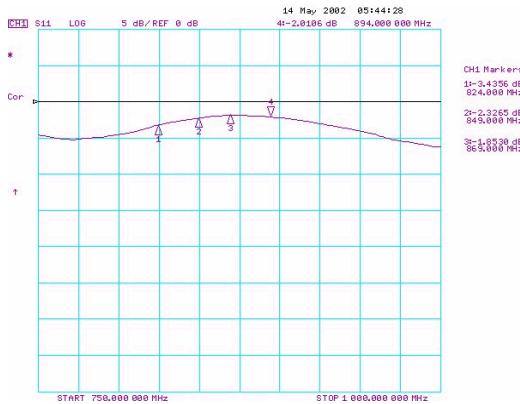


Figure 3 - DU ground-plane 10 cm from glass

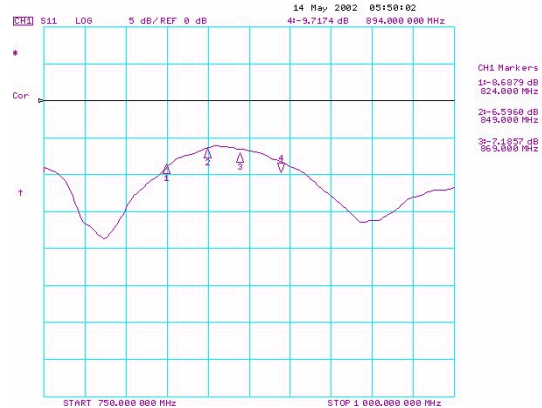


Figure 6 - DU ground-plane 60 cm from glass



Figure 4 - DU ground-plane 20 cm from glass

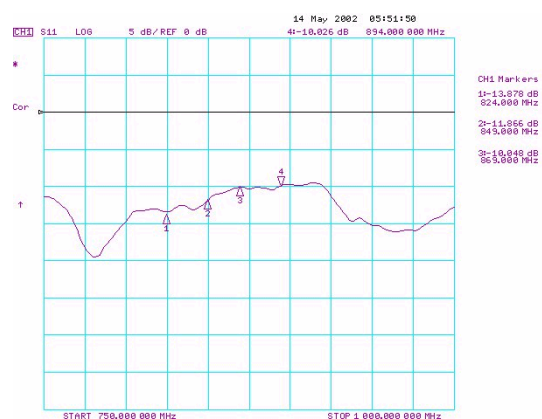


Figure 7 - DU rotated at 45 degrees from glass. Closest ground-plane 5 cm from glass

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## Conclusions

DU antenna return loss can be significantly degraded when placed in close proximity to a sheet of glass that has a thermal (metallic) coating. This is because the conductive surface couples strongly to the main beam of the antenna. The effect of this de-tuning is to significantly reduce the antenna forward gain, reducing the level of a BS signal received through the glass. When de-tuned in this way, the signal radiated into the coverage area also appears to be reduced.

An omni antenna does not couple as strongly to the metallic coating, and so does not de-tune or lose gain in the same way. Therefore the SpotCell system will report a lower signal level when held up against a window constructed with metallic glass than a cell phone (a difference of up to 20 dB appears possible).

If the DU antenna is separated from the glass by a distance of 2 feet or more, the return loss is closer to the free space loss, but the signal reflected back from the conductive surface still creates peaks and dips in the return loss as a function of frequency and separation. The reflected signal may also reduce the available isolation (adding to the multipath signals directed back into the building).

If the antenna is placed at an angle towards the glass, the reflected signal does not return directly to it, and so the antenna return loss and gain are not affected. Isolation is not likely to be degraded either in this configuration.

## Summary

Caution must be exercised when locating the DU in an exterior window constructed with thermal glass. The DU should not be placed in close proximity (2 ft or less) to the glass unless it can be angled away from it by at least 30 degrees. Unless these precautions are taken, the signal received (and transmitted) by the DU may be up to 20dB lower than that reported by a cell phone at that location. The available isolation may also be adversely affected.

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