Insight — Application Note 2.26

Reducing Noise in Dielectric Sensors

Introduction

Lambient Technologies conducted several tests to measure noise with a Mini-Varicon sensor when used with the LT-451 Dielectric Cure Monitor, and demonstrated that electrical interference may be reduced effectively with grounded shields around the sensor.

Noise tests

Dielectric sensors can pick up electrical noise from power lines or ungrounded metal surfaces, which can easily overwhelm the tiny signal from a sensor. To establish a baseline, a Mini-Varicon sensor coated with cured epoxy was placed on an ungrounded, conductive carbon fiber board. The sensor response with epoxy represents the lowest level typically encountered during cure monitoring. Figure 1 shows the baseline noise on measurements of the Mini-Varicon sensor.

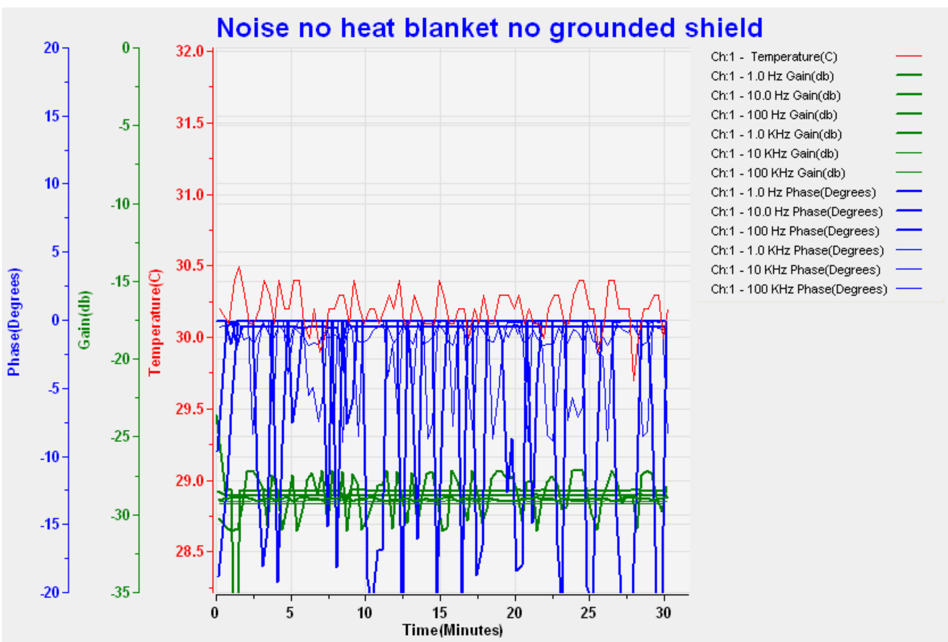

Figure 1
Noise on Mini-Varicon sensor
(Sensor on carbon fiber board, no ground plane, no heat blanket)

Raw measurements from the LT-451 Dielectric Cure Monitor are the attenuation and phase shift of the response compared to the excitation. The attenuation is expressed logarithmically as *gain* and is less sensitive to noise than phase. Phase measurements are very sensitive to noise and are good for determining the level of interference.

Based on phase measurements, the noise of Figure 1 was considerable. The ungrounded carbon fiber board acted as an antenna that picked up interference from nearby power lines. Note that the plot shows gain and phase for frequencies from 1 Hz to 100 kHz, and that noise was greatest at 10 Hz, 100 Hz and 1 kHz.

Figure 2 shows two common ways to reduce noise:

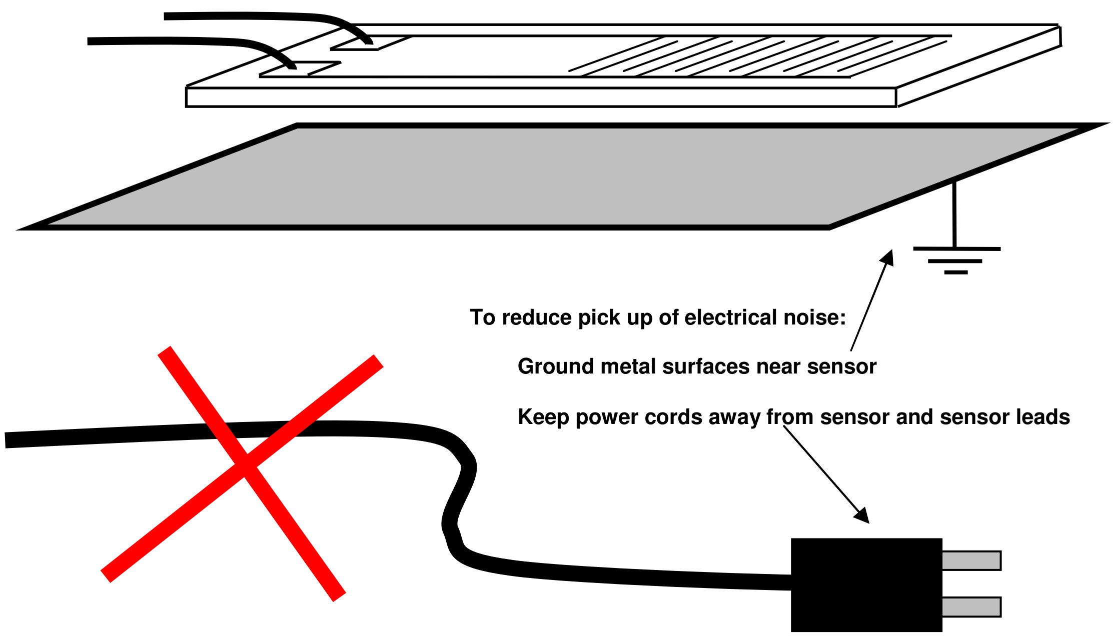

Figure 2
Methods to reduce pick up of electrical noise

Typical methods to reduce noise are:

- Placing a ground plane between the sensor and noise source
- Placing power lines away from sensors and their leads
- Shielding long leads

For the second test, the same Mini-Varicon sensor was placed on a grounded copper foil, as shown in Figure 3. This second test was also conducted without a heat blanket. Figure 4 shows that the noise was greatly reduced compared to Figure 1.

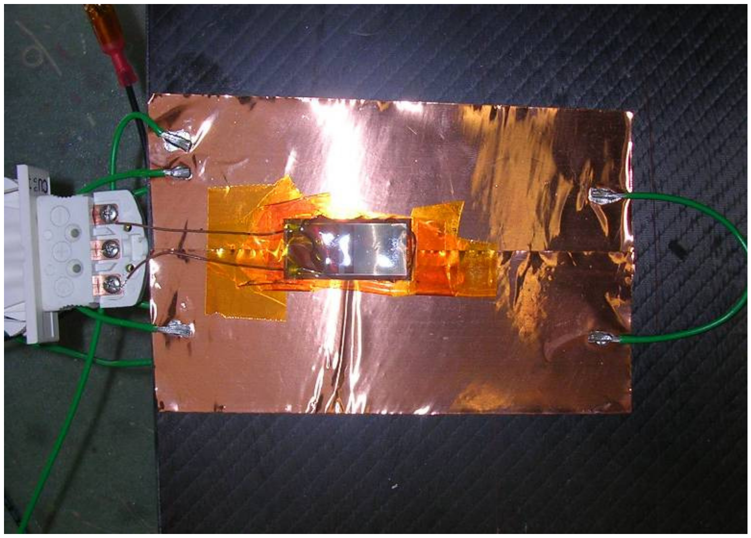

Figure 3
Grounded foil between Mini-Varicon sensor and carbon fiber board

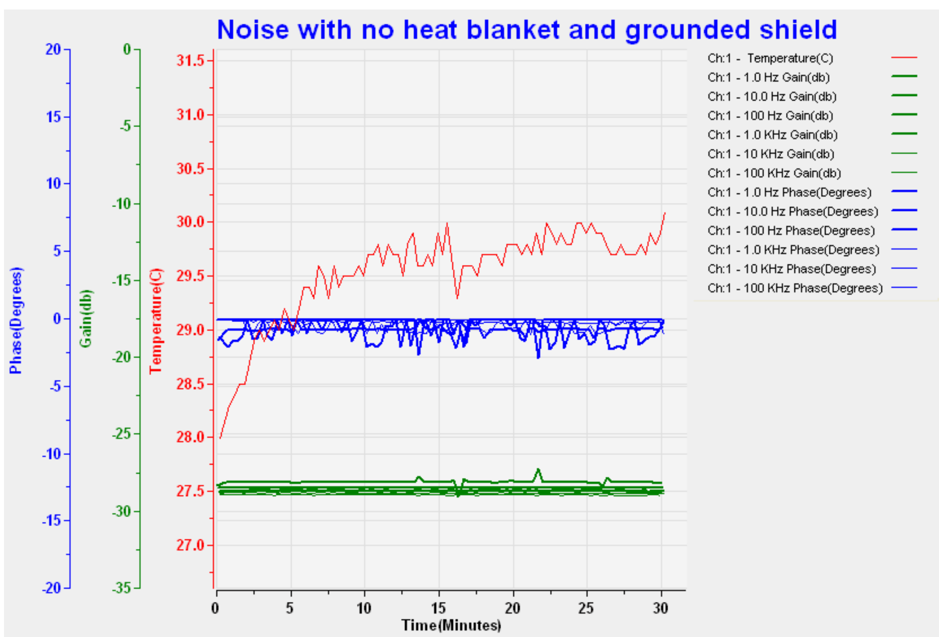

Figure 4
Noise on Mini-Varicon sensor
(Grounded foil between sensor and carbon fiber board, no heat blanket)

Figures 5 a., 5 b. and 5 c. show phase measurements from the second test at 10 Hz, 100 Hz and 1 kHz with and without the grounded foil. The noise for measurements at 100 Hz is greatest because of the 60 Hz AC power in the test area.

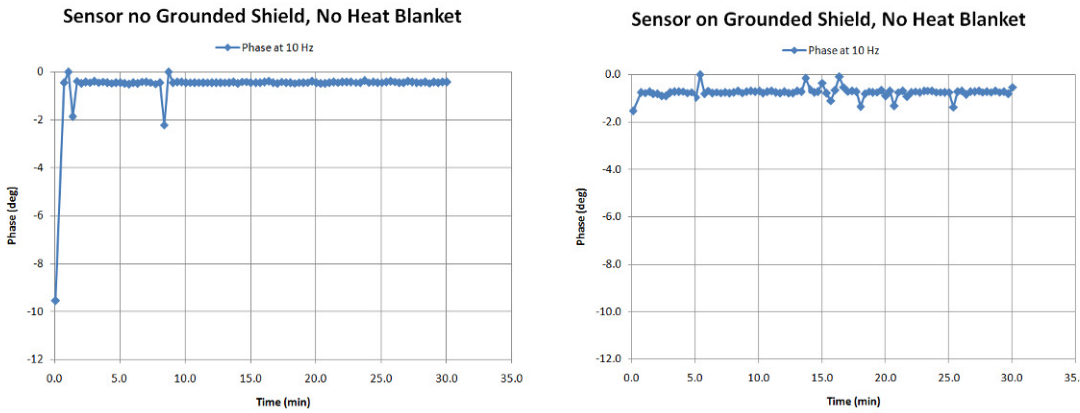

Figure 5 a.

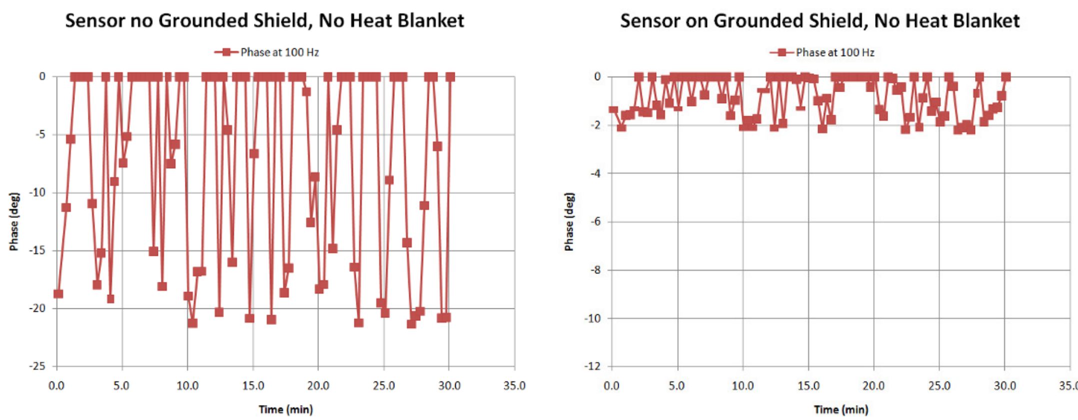

Figure 5 b.
(Note change in scale on left plot)

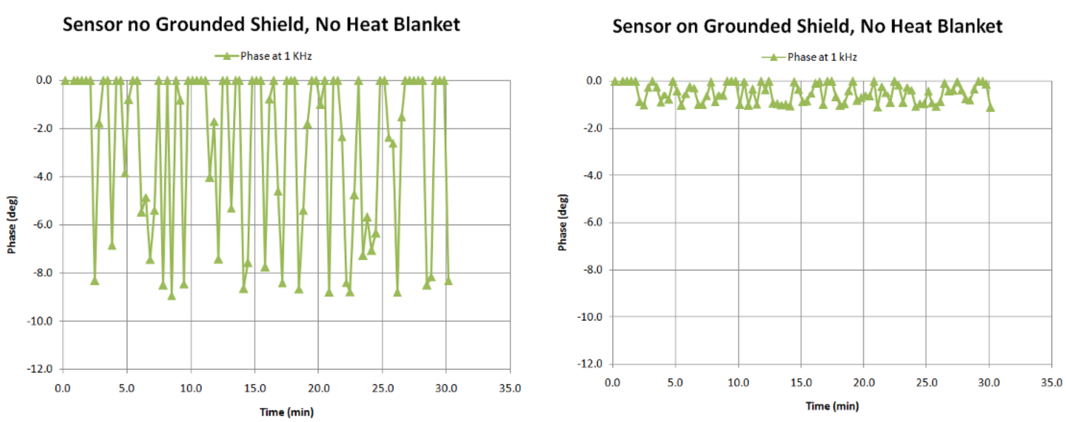

Figure 5 c.

A third test was conducted with the Mini-Varicon sensor and a heat blanket connected to AC power. A grounded foil was placed between the sensor and carbon fiber board ("board shield") and the heat blanket was placed directly on top of the sensor with no additional shield. Figure 6 shows the configuration of this test.

A fourth test was conducted under the same conditions with a grounded foil between the sensor and the heat blanket ("blanket shield") and between the sensor and the carbon fiber board ("board shield"). Figures 7 a., 7 b. and 7 c. compare the phase measurements at 10, 100 Hz and 1 kHz for the third and fourth tests.

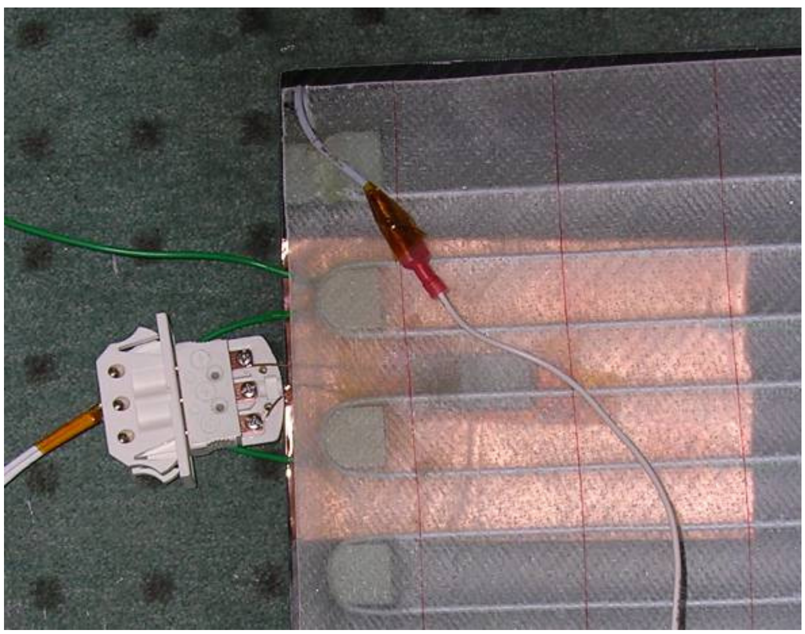

Figure 6
Mini-Varicon sensor on grounded board shield with heat blanket on sensor

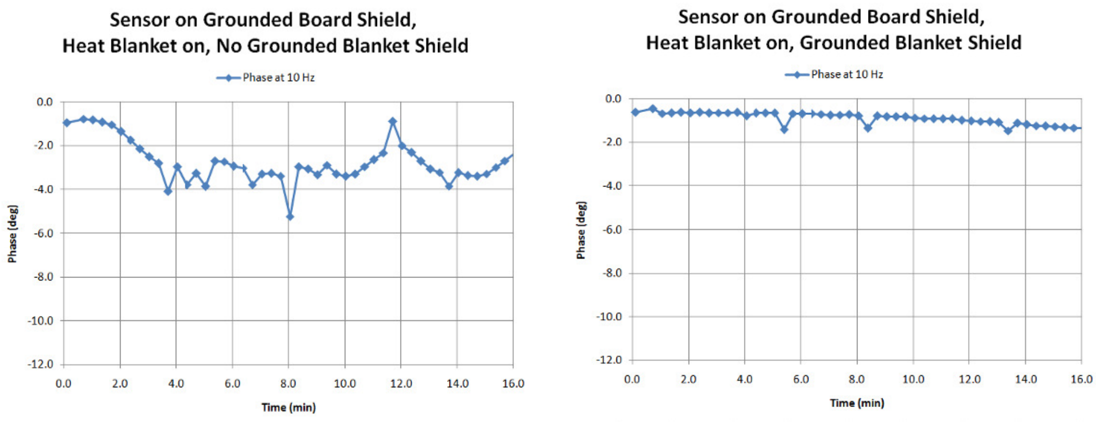

Figure 7 a.

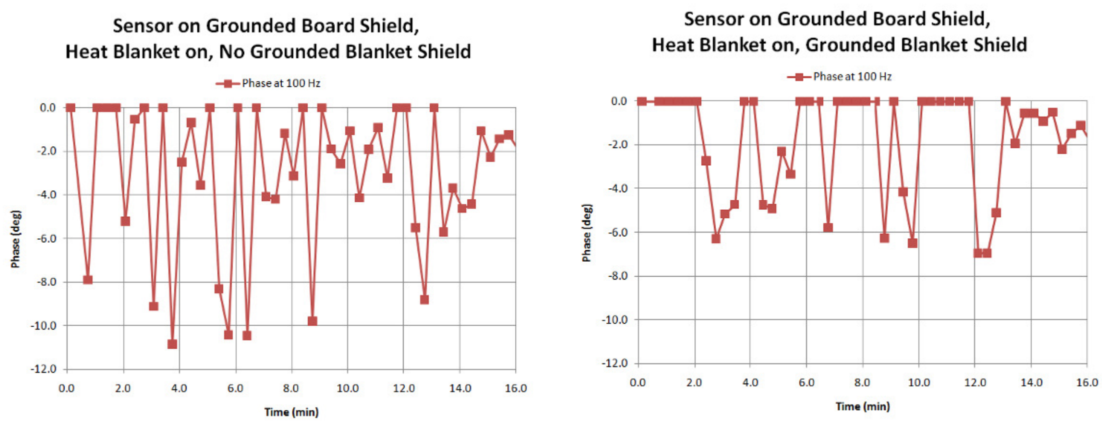

Figure 7 b.

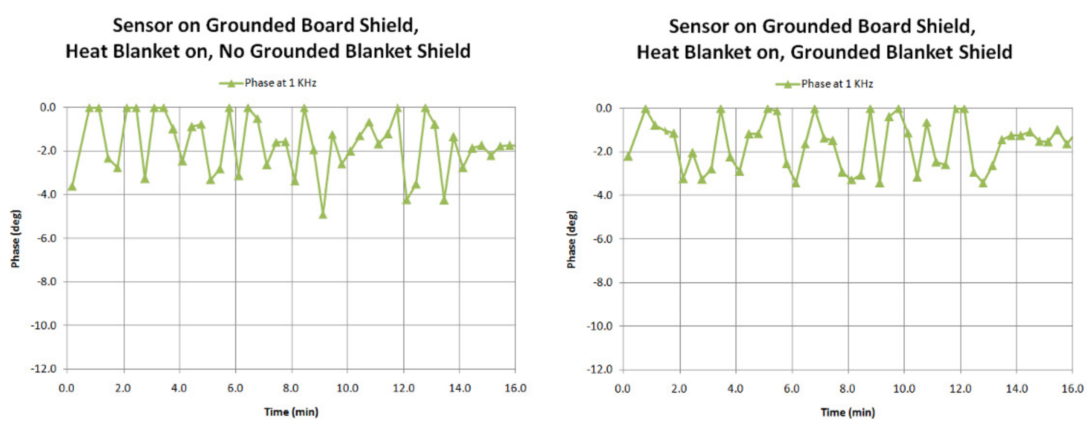

Figure 7 c.

For the third and fourth tests, phase measurements at 10 Hz showed very little noise, even under the worst case condition—the sensor beneath the powered heat blanket without a "blanket shield." Phase measurements at 100 Hz showed the most noise because of the closeness in frequency to the 60 Hz mains frequency. Phase measurements at 1 kHz also showed significant noise.

Conclusion

The use of grounded shields greatly reduces noise in dielectric measurements, especially when the shields are between the sensor and noise source.

Lambient Technologies LLC
649 Massachusetts Avenue, Cambridge, MA 02139
857-242-3963
www.lambient.com
info@lambient.com