White Paper

WINLAND™
ELECTRONICS, INC.

ENVIROALERT®

Temperature Variation and Buffering Solutions

Visit www.winland.com, call 800.635.4269 or email techsupport@winland.com to learn more.

424 North Riverfront Drive, Suite 200 • Mankato, MN • 56001 • 800.635.4269 • www.winland.com

WINLAND™
ELECTRONICS, INC.

Introduction

When encountering two temperature devices with varying readings, people will often question the newer reference rather than an existing indicator – regardless of quality or accuracy. Little is understood by the end-user as to why the device readings do not match. This unfortunately can result in product returns only to discover that the replacement unit acts the same.

Why Do Readings Vary?

Many factors can cause two devices to give varying temperature readings. In order to determine whether there is actually a problem, there are several things that must be considered, since they are all legitimate reasons for temperature variation:

- Probe mass (more mass = slower reaction to change)
- Probe placement
- Measurement type (surface, air, liquid)
- Software averaging and sampling mechanism
- Measurement accuracy (tolerance of probe, A/D resolution)

In the two test scenarios to follow, you'll see the dramatic effect of probe mass (using a buffer solution) as well as probe placement. You'll also see that these both are affected by refrigerator cycling, which also widely varies. The two refrigerators used were monitored under normal use, though a couple forced scenarios were used to see the effect of the temperature when the door is opened.

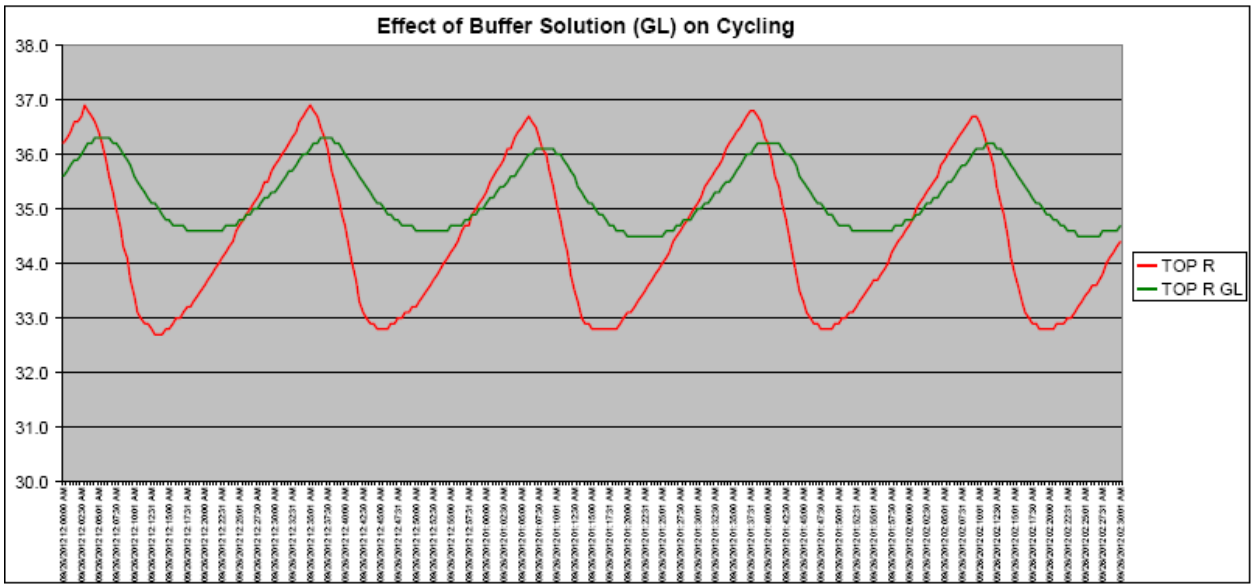
WINLAND™
ELECTRONICS, INC.

Temperature Monitoring Test Results: Dorm Fridge

Probe Cycling Spans (Undisturbed Cooling)

Top Left	Top Left (Buffered)	Bottom Left	Bottom Left (Buffered)	Top Right	Top Right (Buffered)	Bottom Right	Bottom Right (Buffered)
1.2°F	0.9°F	0.9°F	0.6°F	4.2°F	1.8°F	3.3°F	1.3°F

In all of the above examples, it's clear that the buffer solution reduces the cycling effect. In the case of this particular refrigerator with the coil at top right, it makes sense that you'd see less effect of the cycling in the opposite corner and that the effect would be most pronounced nearest the coil.

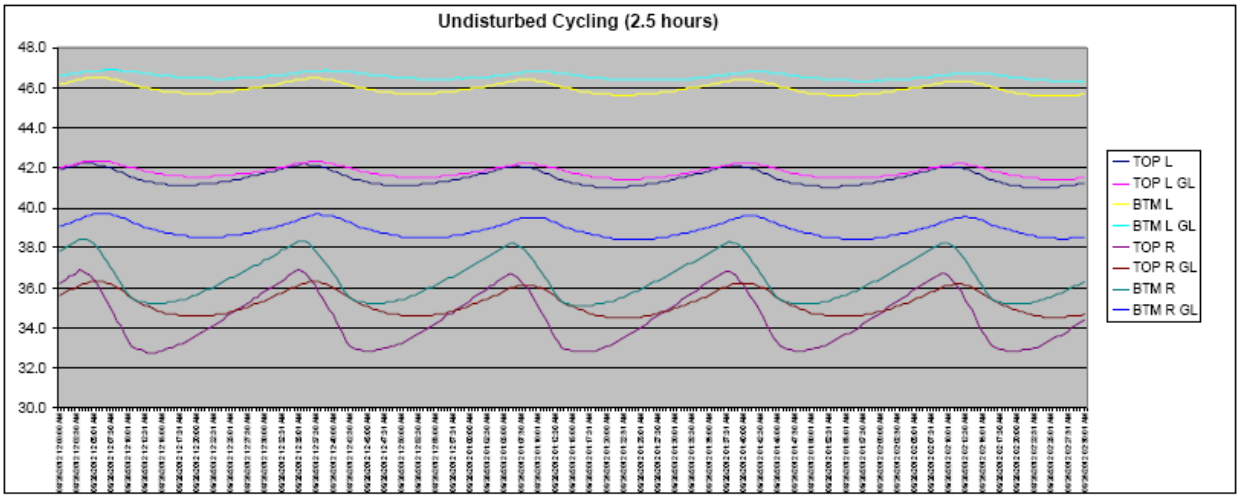


WINLAND™
ELECTRONICS, INC.

Long-Term Averages (Undisturbed Cooling)

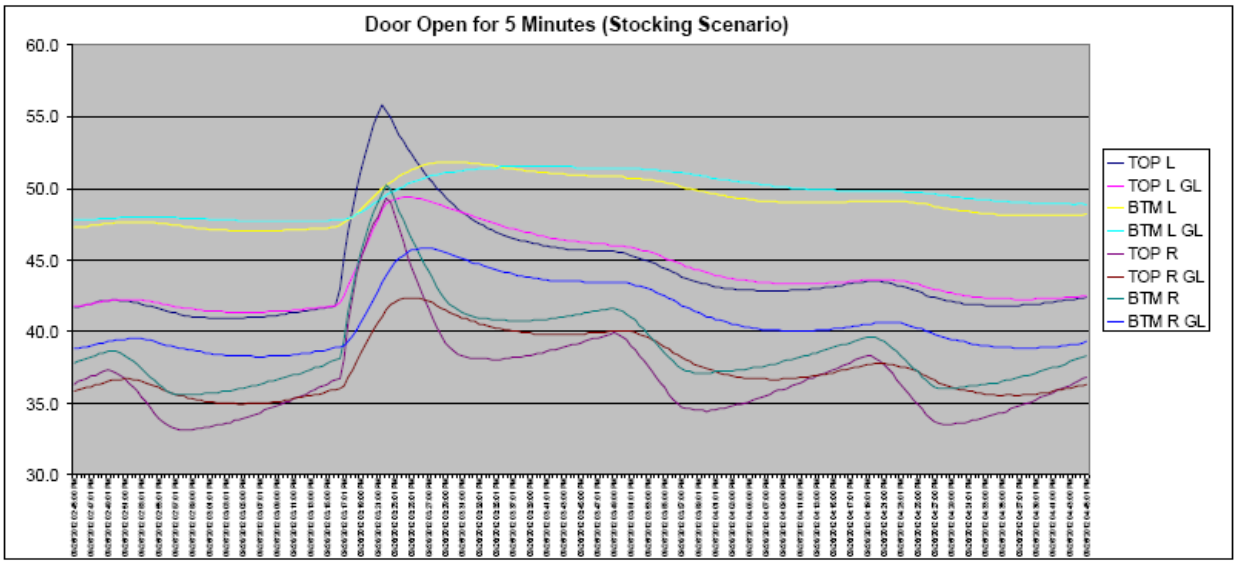
Top Left	Top Left (Buffered)	Bottom Left	Bottom Left (Buffered)	Top Right	Top Right (Buffered)	Bottom Right	Bottom Right (Buffered)
41.5°F	41.8°F	46.0°F	46.6°F	34.5°F	35.2°F	36.4°F	38.9°F

With a maximum temperature span of 12.1°F due to probe location, it becomes clear that placement within this type of refrigerator is the key to getting consistent temperatures. In a typical scenario with alarm limits having a 10° span, this would present a major problem.



	Top Left	Top Left (Buffered)	Bottom Left	Bottom left (Buffered)	Top Right	Top Right (Buffered)	Bottom Right	Bottom Right (Buffered)
Average	41.5°F	41.8°F	46.0°F	46.6°F	34.5°F	35.2°F	36.4°F	38.9°F
High Limit	46.5°F	46.8°F	51.0°F	51.6°F	39.5°F	40.2°F	41.4°F	43.9°F
Low Limit	36.5°F	36.8°F	41.0°F	41.6°F	29.5°F	30.2°F	31.4°F	33.9°F
Highest Temp	55.8°F	49.4°F	51.8°F	51.5°F	49.3°F	42.3°F	50.2°F	45.8°F
Degrees Above	9.3°F	2.6°F	0.8°F	N/A	9.8°F	2.1°F	8.8°F	1.9°F
Alarm Time	20 minutes	19.5 minutes	19.5 minutes	N/A	14.5 minutes	14 minutes	15.5 minutes	15 minutes
Recovery Time	17 minutes	19.5 minutes	19.5 minutes	N/A	11.5 minutes	14 minutes	13 minutes	15 minutes

The averages used in this chart are the same as those determined in the test above. The limits here are based on 5° above and 5° below the average in order to represent the span of typical 36- 46° limits. In all cases in this scenario, the effect of the buffer solution has reduced the alarm time – or, in one case – eliminated it altogether. In general, the left side felt the impact of this more than the right side due to the coil location. At the very least, this gives a general indication of a required time delay. Also of note is that the recovery time accounts for most or all of the alarm time. The "recovery time," in this case, is being defined as the time required to clear the high limit after the door has been closed.

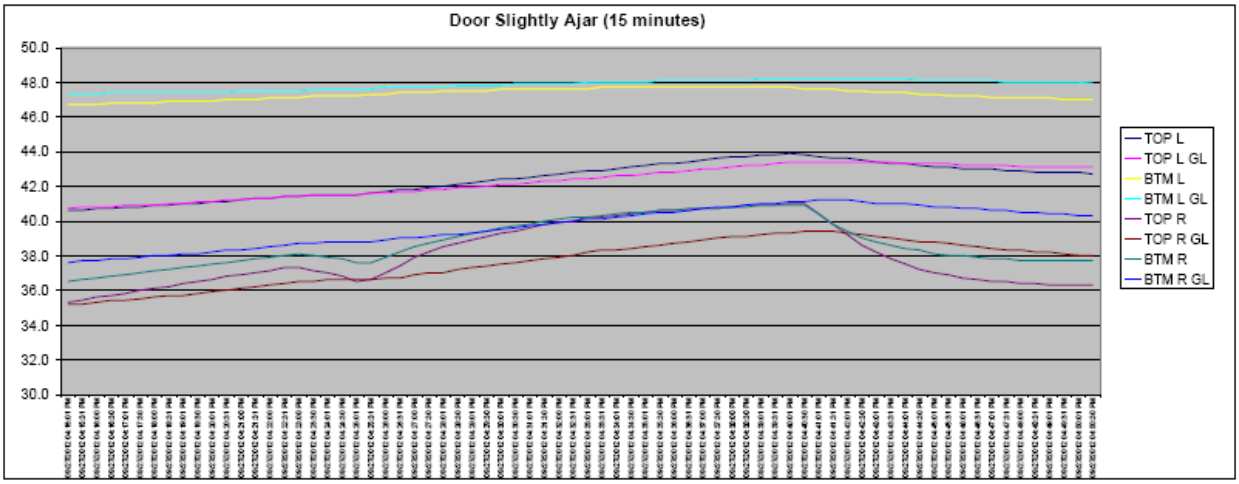


WINLAND™ ELECTRONICS, INC.

Effect of Door Opening (15 Minute Door Ajar Scenario)

	Top Left	Top Left (Buffered)	Bottom Left	Bottom Left (Buffered)	Top Right	Top Right (Buffered)	Bottom Right	Bottom Right (Buffered)
Average	41.5°F	41.8°F	46.0°F	46.6°F	34.5°F	35.2°F	36.4°F	38.9°F
High Limit	46.5°F	46.8°F	51.0°F	51.6°F	39.5°F	40.2°F	41.4°F	43.9°F
Low Limit	36.5°F	36.8°F	41.0°F	41.6°F	29.5°F	30.2°F	31.4°F	33.9°F
Highest Temp	43.9°F	43.4°F	47.7°F	48.2°F	41.0°F	39.4°F	40.9°F	41.2°F
Degrees Above	N/A	N/A	N/A	N/A	1.5°F	N/A	N/A	N/A
Alarm Time	N/A	N/A	N/A	N/A	11 minutes	N/A	N/A	N/A
Recovery Time	N/A	N/A	N/A	N/A	2.5 minutes	N/A	N/A	N/A

In this test, the door was left slightly ajar (approximately one inch). The only probe that resulted in alarm condition was the probe nearest the coil. The highest temperature registered on this probe does not appear to be problematic in this case. However, it clearly demonstrates that this area is the most susceptible to fluctuation and becomes somewhat dependent upon the coil to maintain consistent temperatures.



WINLAND™
ELECTRONICS, INC.

Conclusion

After analyzing the test results herein, several things become clear:

A buffer solution helps to smooth out the cycling effect and more closely represents the temperature of a product with a mass greater than that of the probe itself. Winland thermistor probes are built using a thermally-conductive epoxy potting compound so that they can react quickly to changing temperatures. In some cases, that may be important (e.g.: incubator), but in some cases, it can become a nuisance.

Placement in a dorm fridge is not consistent throughout. According to a study conducted by the National Institute of Standards and Technology (NIST), which was funded by the Centers for Disease Control (CDC), "There is no 'good' vaccine storage area inside a dorm-style unit."[1] NIST also notes that the best storage practice is to "...place vaccines in center fridge space, contained in original packaging, inside designated storage trays positioned 2 to 3 in. from refrigerator walls."[1] If a dorm-style refrigeration unit must be used, it would be wise to keep the probe very near the products being monitored.

During a stocking scenario – even with a buffer solution – it may be necessary to set a time delay on the Winland monitor. If this is not acceptable, stocking should be done as quickly as possible or in phases if alarms are to be avoided.

Reference(s)

1. http://www.nist.gov/pml/div685/grp01/upload/Guidelines-for-Storage-and-Temperature-Monitoring-of-Refrigerated-Vaccines.pdf

Brand: Haier
Model: HSB03-01
Capacity: 2.7 cu. ft.