November 14, 2016

To: ConnectedThermostats@energystar.gov

From: Nest Labs
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Certification Programs Manager

RE: Comments on "Energy Star Program Requirements for Connected Thermostat Products" Draft 3 Version 1.0

Nest Labs, Inc. ("Nest") thanks the EPA for the opportunity to comment on the Draft 3 Version 1.0 ENERGY STAR® Connected Thermostats (CTs) specification ("draft specification") which was issued for comment on October 18, 2016. Nest believes that CTs can make a positive contribution to the energy efficiency of American homes and that having an Energy Star designation for them will provide much needed information and validation for consumers as they face decisions in the marketplace. To that end, Nest has been cooperating with EPA in the stakeholder process and is generally very supportive of the draft specification. However, we offer the following additional comments that we believe will make the draft specification even better.

Using the ENERGY STAR Name and Marks

We agree with EPA's comments regarding the important role Energy Star plays in helping consumers to recognize more efficient choices.

As per the draft specification, certification will be dependent upon a 'system' that includes a service and a hardware device (CT) installed in the home. The requirements additionally go on to specify performance and testing of the hardware including energy efficiency, as well as what can and can not be included as part of a product family of devices for certification.

The draft specification has Partner Requirement 7.3 which states:

> "The ENERGY STAR mark may not be physically applied to either the CT Device or CT ENERGY STAR Device packaging."

Just as the EPA notes the energy savings are often driven by the service provider, the 'system' is incomplete without the CT device itself which is required as part of the system

documentation for certification. Hence the CT device is Energy Star by default when used as part of the certified system.

As such, a device manufacturer should have the option to use the Energy Star mark for shelf and/or packaging markings provided:

> Upon initial start-up the device defaults to the Energy Star service for which it has been certified as part of the system. Devices that can work with more than one service must clearly indicate in marking and labeling that the device is only compliant when operated with a compliant service.

Static Temperature Accuracy

The Definitions section of Draft 3 Eligibility Criteria 6 Version 1.0 (Definition 1. M) defines Static Temperature Accuracy as:

> "The deviation in the displayed room temperature from 70°F (21°C); after one hour in a calibrated temperature chamber set to 70°F (21°C)."

Eligibility Criteria Table 1 sets a requirement that static temperature accuracy must be within ±1.0°F.

Although Nest is confident that our thermostats measure the room temperature within ±1.0°F, there are sources of error that can lead to a thermostat failing this standard even when the thermostat actually meets the stated accuracy requirements:

- The reference sensor is required to have an accuracy of ±0.5°F. Given this uncertainty, the thermostat's sensed temperature would need to be within ±0.5°F of the true chamber temperature in order to meet the accuracy standard and account for the allowable reference sensor error.
- The thermostat displays temperature values rounded to the nearest integer. So, a chamber set to 70°F could actually be at 70.4°F and the chamber sensor could read 69.9°F and be within specifications. If the thermostat measured 70.5°F then it would display 71°F and the "error" would be 1.1°F (71 - 69.9 = 1.1), thereby failing the test. But in this case the thermostat's sensed temperature is actually within 0.1°F of the true temperature -- much more accurate than the chamber sensor.

To account for the up to ±0.5°F reference sensor error and the up to ±0.5°F error introduced by rounding the thermostat's displayed temperature, the standard would need

to widen the error bounds to ±2°F to avoid potentially failing devices that actually do comply with the intended ±1°F accuracy.

In addition, it's important that the test conditions not deviate from real-world home environments. Nest's thermostat has multiple temperature sensors and uses an algorithm to accurately estimate the room temperature that accounts for the self-heating caused by the electronics within the device. This algorithm has been optimized for typical thermostat installations -- mounted on an interior wall of a room with typical dimensions. Temperature chambers tend to have different geometries from rooms and often employ fans to mix the air to create a more uniform temperature. These differences from the conditions faced by actual thermostats in people's homes can compromise the accuracy of the temperature adjustment algorithms. So, a thermostat may be accurate in a customer's home yet not appear to be as accurate in the test chamber.

As such, Nest recommends the following details be considered for the test protocol:

- After the chamber achieves a steady 70F temperature, deactivate the fan and wait at least 45 minutes before taking temperature measurements
- Conduct the test with four units located in the middle of the temperature chamber
- Measure the temperature at three distinct points in time (in 15 minute intervals)
- Average the resulting 12 error measurements to obtain the final error

Conclusion

Thank you for the opportunity to share these comments. If you have questions about them, do not hesitate to reach out to:

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