APPLICATION NOTE

Calculating temperature rise when mounting wireless LAN access points into Oberon's NEMA and Ceiling Enclosures

Introduction to Thermal Considerations

When mounting active (powered) equipment such as wireless LAN access points and DAS access units inside enclosures, the temperature within the enclosure increases over the ambient temperature external to the enclosure, due to the heat dissipation of the equipment inside the enclosure.

The heat flow due to power dissipation can be modeled by analogy to a linear electrical circuit, where heat flow is represented by current, temperatures are represented by voltages, heat sources are represented by constant current sources, and thermal resistances are represented by resistors.

In this case, the thermal resistance of the enclosure, in units of °C/Watt, multiplied by the wattage dissipated inside the enclosure, results in the temperature rise inside the enclosure, in degrees C.

Indoor/Outdoor NEMA Enclosures

Oberon engineers have measured the thermal resistance of four Oberon indoor/outdoor NEMA enclosures, the Model 1020-00, the Model 1024-00, and the model 1026-16148. The thermal resistance will vary as a function of the size and construction of the enclosure, with smaller enclosures having a higher thermal resistance, all other factors being constant. A brief description of each enclosure follows.

The Model 1020-00 is an outdoor NEMA rated enclosure. It is constructed of UL94-V0 rated PC plastic. The size is 10.8” x 9” x 3.7”, equating to a volume of 360 in^3. The dome maximum dimension is 4”, but a 3.7” size is used in these calculations to factor in the dome shape.

The Model 1024-00 is an outdoor NEMA rated enclosure. It is constructed of UL94V-0 Polycarbonate/PBT blended plastic. The size is 14.75” x 10.9” by 4.5”, equating to a volume of 723 in^3.

The Model 1026-16148 is an outdoor NEMA rated enclosure. It is constructed of UL94-5VA polycarbonate. The size is 16” x 14” x 8”, equating to a volume of 1792 in^3.

Indoor Ceiling/Wall Mount Enclosures

We will also measure the thermal resistance of five popular Oberon ceiling and wall mount enclosures, the Model 1015-00, the Model 1052-00, the Model 1030-00, the Model 1059-00, and the model 1074-04-ANT7. The thermal resistance will vary as a function of the size and construction of the enclosure, with smaller enclosures having a higher thermal resistance, all other factors being constant. A brief description of each enclosure follows.

The Model 1015-00 is a Hard-Lid ceiling or wall mount enclosure. It is constructed of UL94-HB ABS. The interior size is 11.1” x 11.1” x 3.9”, equating to a volume of 480 in^3. The dome maximum dimension is 4.4”, but a 3.9” size is used in these calculations to factor in the dome shape.

The Model 1052-00 is a ceiling mount enclosure. It is constructed of 16 gauge steel for the back box. The interior size is 12.5” x 12.5” x 4.5”, equating to a volume of 703 in^3.

The Model 1030-00 is a ceiling or wall mounted enclosure. It is constructed of 16 gauge steel for the back box, and UL94-5VA rated dome. The interior back box size is 17” x 17” x 1.75”, equating to a volume of 506 in^3, and the interior dome size is 12” x 12” x 2”, equating to a volume of 288 in^3, resulting in a total interior volume of 794 in^3.

The Model 1059-00 is a ceiling mount enclosure. It is constructed of 16 gauge steel for the back box, and UL94-5VA rated dome. The interior back box size is 18” x 18” x 2.6”, equating to a volume of 842 in^3, and the interior dome size is 14” x 14” x 4”, equating to a volume of 784 in^3, resulting in a total interior volume of 1626 in^3.

The Model 1074-04-ANT7 is a ceiling mount enclosure. It is constructed of 16 gauge aluminum for the back box. The interior size is 22.7” x 22.7” x 4.4”, equating to a volume of 2267 in^3.

Thermal Measurement Overview

For each of the four enclosures above, the enclosure was placed on a table, with the side normally mounted against a wall or floor placed face down on the table to simulate the normal mounting environment, from a thermal standpoint.

Using a 6V laboratory power supply and three one ohm power resistors in series, the enclosure was subjected to 12W of continuous heat generation. The internal and external enclosure temperature was monitored, and the testing continued for multiple hours until a steady state temperature difference was obtained between the temperature inside and outside the enclosure.

This 12W power level was chosen to approximate the highest amount of power an access point powered by 802.3af Power over Ethernet (PoE) could reasonably dissipate. Standards compliant PoE switches or injectors can deliver up to 12.95 Watts of power to the access point, but in actual operation, the access point will dissipate much less power than 12W on average.

By simply dividing the temperature rise in degrees C, by the power dissipation in Watts, the thermal resistance is obtained. Note that this is a linear system, and

the relative change in inside temperature is independent of starting ambient temperature, for a given power dissipation.

Thermal Measurement Results

NEMA Enclosure	Enclosure Volume (in^3)	Thermal Resistance (C/W)	Internal Temperature Rise @12W
1020-00	360	0.925	11.1º C
1024-00	723	0.625	7.5º C
1026-16148	1792	0.500	6.0º C

Indoor Enclosure	Interior Volume (in^3)	Thermal Resistance (C/W)	Internal Temperature Rise @12W
1015-00	480	0.583	7.0° C
1052-00	703	0.508	6.1° C
1030-00	794	0.300	3.6° C
1059-00	1626	.292	3.5° C
1074-04-ANT7	2267	.253	3.0° C

As an example, the 1020-00 enclosure with an access point which dissipates 6W of power continuously (a value typical of many access points), the temperature rise inside the enclosure would be 6W * 0.925 C/W, or 5.5 degrees C.

In this case, if the starting ambient temperature was +25C, the internal temperature would be rise to +30.5C. If the starting ambient temperature was only 0C, the internal temperature would rise to +5.5C.

Note that the larger enclosure has a lower thermal resistance. All other factors being equal, a larger enclosure leads to a lower temperature rise. This intuitively makes sense. If you placed an access point in an enclosure the size of a large room, would you be able to even detect a temperature rise caused by the AP?

The power dissipation of the equipment housed in the enclosure can be obtained from the equipment manufacturer, or from measurements conducted by the user. If measurements are made, the access should be actively, wirelessly, transmitting/receiving data traffic to dissipate a realistic power level. Keep in mind that it is the average or long term power dissipation which is used in the thermal calculations, as opposed to short term peak power dissipation.

De-rating the operating temperature range

When placed in enclosures, the access points operating temperature range should be *de-rated* from the operating temperature range specified by the manufacturer by an amount equivalent to the expected temperature rise. As in

the example, using the model 1020-00 enclosure, a temperature rise of 5.5 degrees C is anticipated.

If the access points specified operating temperature range is -20C to +55C, then the upper temperature limit should *de-rated* to +49.5C. This means that if the outside, ambient temperature is higher than +49.5C, the access point inside the enclosure will be at a temperature higher than the manufacturers' specified maximum operating temperature (+55C). On the low temperature side, the AP *may* be warmer inside the enclosure, but not necessarily by 5.5C, depending on data traffic and power dissipation. Caution must be applied when attempting to extend the low side operating temperature of the AP in the enclosure.

Sun loading and other external factors may also de-rate the operating range even further. Access points (whether in an enclosure or not) placed in direct sunlight *may get very hot*. Access points and their enclosure should be protected from direct sun to avoid overheating.

Recommended De-rating

In the absence of measured power dissipation for the access point, Oberon recommends de-rating the access point manufacturer's operating temperature range by the following amounts, for the respective NEMA enclosures (these are essentially worst case, 12 W power dissipation de-ratings). This is for any standards based, PoE powered (or equivalent) wireless access point.

Enclosure Model	De-rate Maximum Operating Temperature by
1020-00	11º C
1024-00	8º C
1026-16148	6º C

Ceiling Enclosure	De-rate Maximum Operating Temperature by
1015-00	7º C
1052-00	6º C
1030-00	4º C
1059-00	4º C
1074-04-ANT7	4º C

