Oberon is pleased to announce new wireless access point enclosures to facilitate the planning and implementation of Wi-Fi in stadiums and auditoriums.

Models 1026-PS, 1021-00, and 1026-00 are compact NEMA-4 enclosures designed for challenging indoor/outdoor environments such as retail centers, college campuses, auditoriums, and stadiums.

The Model 1026-00 is a NEMA Stadium Enclosure for most vendors’ wireless access points with a fully hinged, latchable, padlock-ready lid; UL Listed.

The rugged polycarbonate enclosure protects wireless LAN access points from most vendors in challenging indoor/outdoor environments such as stadiums. It is transparent to wireless signals and protects body integrated or small detachable antennas. Access points attach to an interior universal mounting plate. Opaque or clear covers available.

Oberon’s impact-resistant ABS plastic doors are virtually transparent to wireless signals.

See our full line at oberonwireless.com
The Model 1020-PS is a compact NEMA-4 Stadium Enclosure for Cisco wireless access points. The enclosure is designed to protect Cisco's 1140, 1260, 3500, and 3600 series and other wireless LAN access points in challenging environments. This rugged polycarbonate enclosure protects the access point from weather, dust, and impacts. It is transparent to wireless signals, so access points with body integrated antennas or small detachable antennas may be protected.

The enclosure is designed to protect Cisco's 1140, 1260, 3500, and 3600 series and other wireless LAN access points in "under the seat" stadium and auditorium environments.

Model 1021-00 is a compact NEMA Stadium enclosure for most vendors' wireless access points with screw-on lid and opaque or clear cover. Designed for challenging indoor/outdoor environments such as stadiums, this rugged polycarbonate enclosure protects the access point from weather, dust, and impacts. It is transparent to wireless signals, so access points with body integrated antennas or small detachable antennas may be protected. Access points attach to an interior universal mounting plate. Opaque or clear covers are available.
The proliferation of mobile devices continues to challenge wireless network designers. The limits of macro-cellular 3G and 4G spectrum and bandwidth are being approached in many venues, and the opportunities for "offloading" traffic onto cooperative Wi-Fi networks are being recognized in those venues. In particular, high density wireless environments, such as stadiums and auditoriums may have hundreds and thousands of mobile devices packed in an area much smaller than the geographical coverage of a traditional cellular base station. The device users have become accustomed to being able to connect and expect to do so in the stadium or auditorium. Service providers strive to provide satisfactory service, and venue owners or sponsors can increase revenue through mobility enabled services such as wireless point of sale terminal and advertisement push to mobile devices.

Wi-Fi offers the opportunity to off-load much of the data traffic congesting the 3G and 4G macro-cellular network, due to its ability to provide for high spectral re-use, particularly in the 5 GHz band. By populating the stadium or auditorium with many low power Wi-Fi access points tuned to different frequencies, spectral re-use is much higher than can be achieved with macro-cellular technologies.

The opportunity for high spectral re-use is great, but these venues are vexing for even the seasoned wireless network designer. In these public venues there is no convenient suspended ceiling to which the access point may be attached. In auditoriums it is undesirable to have access points mounted in the high ceiling for every client device in the auditorium to "see" every access point installed. Access points may need to be installed under seats, on risers, or on railings. This "low to the ground" installation restricts radio wave propagation (especially through human bodies), and advantageously increases spectral re-use opportunities, but is a challenge to actively site survey. It is difficult to find thousands off willing participants to sit in an auditorium or stadium, around an access point, while a site survey is being performed. In outdoor stadium environments, the designer has no ceiling to work with at all, and he must be concerned about the effects of temperature and weather on the access points used. Bandwidth wise, there are two fewer 20 MHz channels in the 5 GHz band to work with outdoors, due to the rules established by the FCC.

Installation in these public venues is challenging also. Within the carpeted office environment, access points can be installed in the ceiling, in a temperature controlled, liquid free environment. In the public venue, the access points may be exposed to outdoor temperatures, direct sunlight, rain, running and dripping liquids, wash-down liquids, and physical abuse. None of these public venues have been designed with provisions for the cabling and locations for the wireless access points.

Fortunately, leading access point manufacturers are offering access points with the extended temperature range and spectrum management capabilities required in these environments. The extended operating temperature range of these access points, up to -20°C to +55°C (-4°F to +131°F), permit these access points to be reliably used outdoors, in most parts of the world, without active heating or cooling. The elimination of fans, blowers, thermostats and heaters will significantly reduce the cost and complexity of installation, and improve reliability. The access points, however, do need to be protected from liquids, direct sun, accidental disconnect, and abuse.

To facilitate these installations, Oberon has designed a line of NEMA rated, indoor/outdoor polycarbonate enclosures which can assist in most design scenarios, from compact "under the seat installation" to aesthetic club or box seat installations, and mezzanine high density installations with high gain antennas. Because the access point is enclosed, there is a temperature rise within the enclosure as the access point dissipates power. Oberon has developed an application note which can permit the designer to calculate the temperature rise within the enclosure, based on the power dissipated by the access point. In general the temperature rise is in only 5-11°C, permitting access points from many vendors to be installed in enclosures without concerns for actively heating or cooling. Please see Oberon's Application note: calculating the temperature rise with access point in an enclosure.

Oberon's stadium and auditorium enclosure products are made from an impact resistant, UV stabilized polycarbonate material, so that they can be exposed to the elements. This plastic is UL classified for flammability, and is virtually transparent to wireless signals. The enclosures are gasketed and designed to NEMA4X standards to prevent ingress of water and corrosive liquids. Different styles are available with screw on or latch-able, lock ready lids. Internal mounting plates permit access points from most vendors to be easily installed, without drilling into the enclosure itself.
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.

Oberon engineers have measured the thermal resistance of four Oberon indoor/outdoor NEMA enclosures, the Model 1020-PS, the Model 1021-00, the Model 1025-00, 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-PS is an outdoor NEMA rated enclosure. It is constructed of UL94-HB rated PBT/PC blended plastic. The size is 11.5” x 8.8” x 3.1”, equating to a volume of 314 in³.

The Model 1021-00 is an outdoor NEMA rated enclosure. It is constructed of UL94-5VA rated PBT/PC blended plastic. The size is 10” x 12.4” x 4.8”, equating to a volume of 595 in³.

The Model 1025-00 is an outdoor NEMA rated enclosure. It is constructed of 30% fiberglass reinforced polyester plastic. The size is 13” x 15” by 6.5”, equating to a volume of 1268 in³.

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 in³.

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.
Calculating temperature rise when mounting wireless LAN access points into Oberon’s NEMA rated indoor/outdoor enclosures

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

<table>
<thead>
<tr>
<th>Enclosure Model</th>
<th>Enclosure Volume (in³)</th>
<th>Thermal Resistance (C/W)</th>
<th>Internal Temperature Rise @12W</th>
</tr>
</thead>
<tbody>
<tr>
<td>1020-PS</td>
<td>314</td>
<td>0.925</td>
<td>11.1</td>
</tr>
<tr>
<td>1021-00</td>
<td>595</td>
<td>0.783</td>
<td>9.4</td>
</tr>
<tr>
<td>1025-00</td>
<td>1268</td>
<td>0.700</td>
<td>8.4</td>
</tr>
<tr>
<td>1026-16148</td>
<td>1792</td>
<td>0.500</td>
<td>6</td>
</tr>
</tbody>
</table>

As an example, the 1020-PS 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-PS 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 be 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.

<table>
<thead>
<tr>
<th>Enclosure Model</th>
<th>De-rate Maximum Operating Temperature by</th>
</tr>
</thead>
<tbody>
<tr>
<td>1020-PS</td>
<td>11° C</td>
</tr>
<tr>
<td>1021-00</td>
<td>9° C</td>
</tr>
<tr>
<td>1025-00</td>
<td>8° C</td>
</tr>
<tr>
<td>1026-16148</td>
<td>9° C</td>
</tr>
</tbody>
</table>