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TVILIGHT, the Netherlands

Comparison between NEMA and Zhaga Standard for Smart Street Lighting Application

This document presents a technical-commercial comparison between Outdoor Lamp Controller (OLC) based on NEMA receptacle and Zhaga (book 18) socket standards.

It aims to answer a typical question which is faced by many municipalities and city corporation regarding: which type of Lamp Controller is more suitable for Smart Street Lights?

	NEMA (ANSI C136.41 receptacle standard)	ZHAGA (book 18) socket standard
Standard/Region	<p>NEMA standard originates from North America ANSI C136.41¹.</p> <p>ANSI stands for American National Standard for Lighting Systems.</p> <p>It is one of the old conventional standards, mainly used in Anglo-Saxon region, namely US, UK, Australia, New Zealand. And later followed by some countries.</p>	<p>Zhaga (book 18)² is the latest industry standard for street lighting application launched and supported by global Zhaga Consortium.</p> <p>This standard originated in Europe, and now widely adopted as a de facto standard in most countries³.</p> <p>The last remaining country, USA, also adopted this standard as part of their ANSI C136.58 standard⁴ in 2019.</p> <p>Zhaga (book 18) became extremely powerful and popular due to interoperability with DALI D4i standard⁵.</p>

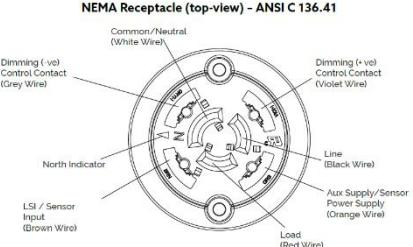
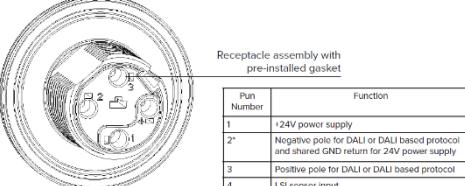
¹ NEMA ANSI C136.41 standard: <https://www.nema.org/standards/view/for-roadway-and-area-lighting-equipment-dimming-control-between-an-external-locking-type-photocontrol-and-ballast-or-driver>

² Zhaga consortium: <https://www.zhagastandard.org/about-us/why-use-zhaga.html>

³ Zhaga D4i a de-facto standard in Europe: [https://twilight.com/zhaga-d4i a-de-facto-standard-for-smart-street-lights/](https://twilight.com/zhaga-d4i-a-de-facto-standard-for-smart-street-lights/)

⁴ ANSI C136.58-2019 standard: <https://webstore.ansi.org/standards/nema/ansic136582019>, DALI alliance: <https://www.dali-alliance.org/news/172/ansi-c1374-2019-standard-aligns-with-d4i-specifications>

⁵ Zhaga D4i Standard by DALI alliance: <https://www.dali-alliance.org/zhaga-d4i/>

Electrical Contacts	 <p>NEMA receptacle (and controller) use 3-pin, 5-pin or 7-pin listed in the drawing above. This includes high-voltage lines (115V/ 230V).</p>	 <table border="1"> <thead> <tr> <th>Pin Number</th> <th>Function</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>+24V power supply</td> </tr> <tr> <td>2*</td> <td>Negative pole for DALI or DALI based protocol and shared GND return for 24V power supply</td> </tr> <tr> <td>3</td> <td>Positive pole for DALI or DALI based protocol</td> </tr> <tr> <td>4</td> <td>LSI sensor input</td> </tr> </tbody> </table> <p>Zhaga (book 18) significantly simplified NEMA 7-pin to Zhaga 4-pin. High-voltage is not used in Zhaga system.</p>	Pin Number	Function	1	+24V power supply	2*	Negative pole for DALI or DALI based protocol and shared GND return for 24V power supply	3	Positive pole for DALI or DALI based protocol	4	LSI sensor input
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Dimming Support	<p>NEMA was originally designed mainly for switching function (3-pin). It evolved into 5-pin to mainly support analogue dimming (0-10V / 1-10V). 7-pin supports external sensor connection (e.g. a motion sensor).</p> <p>NEMA can also be used for DALI communication.</p>	<p>Zhaga has been mainly designed for DALI based communication (including DALI-2, D4i, DT6, DT7, DT8 LED drivers).</p> <p>Zhaga (book 18) socket can also be used for analogue (0-10V / 1-10V) dimming.</p>										
Auxiliary Power	<p>Original NEMA standard was not designed for auxiliary power-supply or sensor connection.</p> <p>Nema ANSI C136.41 and C137.4 standard⁶ started support for auxiliary power from the LED Driver on 7-pin NEMA receptacle (on orange wire).</p>	<p>Zhaga (book 18) standard supports 24V auxiliary power from smart LED driver on Pin 1 by default design.</p> <p>This aligns perfectly with DALI D4i standard.</p>										
Examples	<p>Nema receptacle examples include TE Lumawise⁷ and Amphenol FLA series⁸.</p>	<p>Zhaga (book 18) socket examples include TE 2213858¹¹ and Amphenol FLS¹².</p>										

⁶ NEMA ANSI C137.4-2019 standard: <https://webstore.ansi.org/standards/nema/ansic1372019-2392109>

⁷ TE Nema receptacle: <https://www.te.com/usa-en/product-CAT-ST833-R2435A.html>

⁸ Amphenol Nema dimming receptacle: <https://www.amphenol-cs.com/fla-dimming-receptacle-fla216130.html>

¹¹ TE Zhaga (book 18) socket: <https://www.te.com/global-en/product-2213858-1.html>

¹² Amphenol Zhaga (book 18) FLS series: <https://www.amphenol-cs.com/product-series/zhaga-book-18-compliant-fls.html>

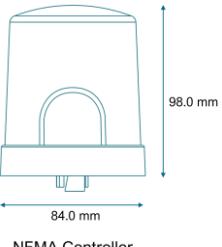
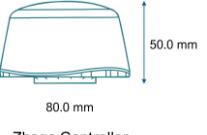
	<p>Nema Controller examples include Tvilight OpenSky Nema IoT⁹ and Tvilight Photocell¹⁰.</p> 	<p>Zhaga street light controller examples include Tvilight OpenSky Zhaga IoT¹³ and SkyLite Prime¹⁴.</p> 
Product Lifetime	<p>Standard NEMA Controller are directly exposed to the AC power-supply (115V/ 230V) from the power-grid.</p> <p>NEMA controller internally converts AC voltage to DC voltage to run its own internal electronics, and forwards the AC power to the LED luminaire.</p> <p>The AC components often fail over a period of time due to voltage fluctuations and surges on the power grid. Secondly, mandatory AC/ DC conversion requires a set of electronic components, which also typically fail over a period of time.</p> <p>Therefore often the NEMA controllers have lower design lifetime when compared to Zhaga controllers.</p>	<p>+ Zhaga Controllers have a significant better lifetime and reliability. They are based on DC input, and does not need an AC/ DC conversion. When using a NEMA device: both the Driver as well as the Controller needs AC/ DC conversion, which increases components and reduces reliability.</p>
Size/ Elegance	<p>Typical NEMA controller requires significantly more components when compared to a Zhaga controller. Therefore, Nema Controllers are often large in size.</p> <p>Many countries (like South Korea) have banned Nema controllers – since their large size spoil streetlight elegance. It is also one of the reasons that many countries in Europe avoid using NEMA controllers.</p>	<p>Zhaga Controller are typically half to one-third size of a typical conventional NEMA Controller.</p> <p>Main reason for this is that Zhaga Controller needs significantly less components. For example, need for AC/ DC conversion and power-metering circuit is completely eliminated.</p> <p>Being a compact design, Zhaga Controller blends to the street lighting fixture design</p>

⁹ Tvilight OpenSky Nema IoT outdoor lamp smart street light controller: https://tvilight.com/products/street-light-controller/nema-iot-street-light-controller-opensky_nema/

¹⁰ Tvilight SkySwitch Nema Photocell: <https://tvilight.com/products/street-light-controller/associated-products/>

¹³ Tvilight OpenSky Zhaga IoT smart street light controller: https://tvilight.com/products/street-light-controller/zhaga-d4i-iot-street-light-controller-opensky_zhaga/

¹⁴ Tvilight SkyLite Prime Zhaga RF smart street light controller: https://tvilight.com/products/street-light-controller/zhaga-d4i-rf-mesh-street-light-controller-skylite_prime/

	 <p>NEMA Controller</p>	<p>and often remains invisible to the eyes of normal citizens.</p>  <p>Zhaga Controller</p>
Product Cost	<p>NEMA controller often requires much more components when compared to a Zhaga controller.</p> <p>This includes all components related to AC/DC conversion and energy-metering chip.</p> <p>This adds cost to a typical NEMA controller.</p> <p>Secondly, when NEMA receptacle equipped street light luminaire is installed in the field – without a NEMA controller – then it is mandatory to use a Shorting Cap¹⁵. Otherwise, the NEMA fixture will not work. Shorting Cap adds additional cost to the system.</p>	<p>Zhaga Controller does not need AC/DC conversion – since it receives filtered 24V DC power-supply directly from DALI D4i LED Driver.</p> <p>Zhaga Controller also does not need in-built power-metering chip – since all power-metering data is provided at no additional cost by standard D4i Driver.</p> <p>Zhaga (book 18) socket based street light luminaire does not need any shorting cap. Standard Zhaga cap is sufficient. This cap can be removed when a Zhaga Controller is mounted on the streetlight fixture.</p>
Inter-operability	<p>Each NEMA Controller provides a customized set of data to the central management system (CMS). For example, supplier A might provide 20 data-points in a specific format, while supplier B might provide 25 data-points in a different format.</p> <p>In other words, there is no standardization on data. This makes the inter-operability between suppliers very difficult for a municipality.</p>	<p>Zhaga (book 18) and related D4i standard provides a detailed list of data-points, alerts and counters. Each Zhaga Controller must comply to this data standard.</p> <p>In other words, municipality gets the same data and data format from a supplier A as well as supplier B. In turn, this standardization delivers excellent interoperability to municipality. They can replace Controllers from Supplier A to Supplier B without worrying about getting different data.</p>
Smart Data	<p>NEMA ANSI C136.41 does not provide any smart data model or smart data standard. NEMA Controller supplier can choose the data and data-format that they prefer to deliver.</p>	<p>Thanks to D4i Smart Driver standard, Zhaga (book 18) Controller leverages all the standardized Smart Data.</p> <p>Smart Data includes complete Luminaire, and LED Driver information, which can be readout directly from the D4i driver in a standard universally accepted format.</p>

¹⁵ Nema Shorting Cap example: <https://tvilight.com/products/street-light-controller/associated-products/>

		<p>Plus advance grid health monitoring, luminaire health and LED Driver data. This also includes alerts and counters related to fault analysis and maintenance.</p> <p>Over 60 data-points are delivered by Zhaga-D4i standard in a standardized universal format.</p>
Market Adoption	<p>NEMA was the only standard available 20 years ago. Therefore there are many projects use NEMA receptacle and NEMA Controller.</p> <p>However, there is a significant trend moving towards Zhaga (book 18) socket and Zhaga Controllers. US and UK projects are also gradually considering to switch to Zhaga standard.</p>	<p>ZHAGA (book 18) standard is 5 – 6 years old.</p> <p>Due to significant benefits, most new projects are using Zhaga-D4i standard for smart streetlighting application. It is expected that Zhaga-D4i standard will eventually replace the original NEMA standard.</p>

Concluding Remarks

Both NEMA (ANSI C136.41) and ZHAGA (book 18) standard offer multiple benefits as listed below. Municipalities and City Corporate therefore can choose one of the two options.

However, Zhaga (book 18) clearly offers superior advantages, and therefore we see that increasing number of smart street lighting projects are adopting Zhaga D4i standard. We also see that Zhaga D4i standard will eventually replace the traditional NEMA (Ans C136.41) standard over a period of time.

We remain fully available for any questions or feedback.

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