TRIAD
MAGNETICS

Understanding Wall Plug-In Power

UNDERSTANDING WALL PLUG-IN POWER

Wall plug-in power supplies have come a long way for us to now be able to plug in and power our computers, appliances, cars, and more. Harvey Hubbell patented the first two-blade electrical plug and socket in 1904, but it wasn't until the 1930s that wall plug receptacles became commonplace across the U.S.

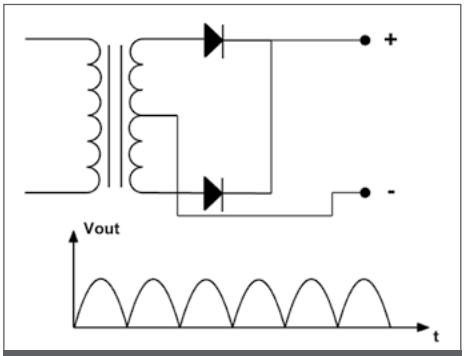
Though you can now find them everywhere, many traditional plug-in power supplies today can be highly inefficient. An estimated 54% of all energy is lost as waste heat. Although most of this loss occurs when converting primary energy to electricity, this statistic highlights the need for energy-efficient devices that minimize energy demand. High-quality, federally compliant wall plug-in power supplies are crucial to making commercial and industrial equipment run safely and more efficiently.

As each new electronic application increases the demand for more wall plug-in power, designing products with efficient and reliable components is vital. This eBook will discuss the basics of wall plug-in power, the efficiency standards they must comply with, and more to help you understand these essential and ubiquitous electronic components.

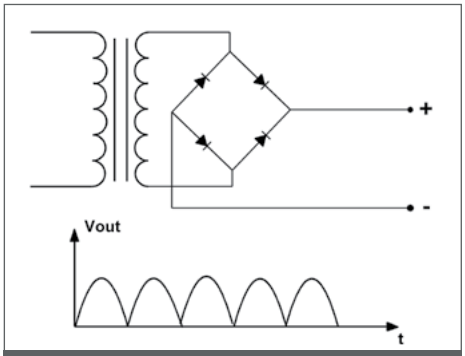
Types of Wall Plug-In Power Supplies

Wall plug-in power supplies are the most widespread sources of low-voltage power. There are two main types of wall plug-in power supplies: AC/AC and AC/DC. An AC/AC wall mount power supply is a basic step-down low-voltage transformer that takes in AC power and outputs AC power. This type of transformer gives a specific voltage at a specific current, with no other passive or active components. The output voltage is proportional to the input voltage.

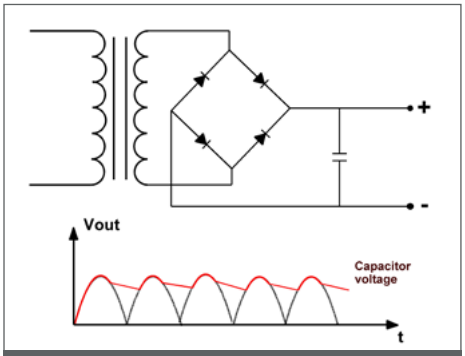
An AC/DC power supply transforms AC power to DC voltage, which is then used to power various electronic devices. The original linear AC/DC wall plug-in power supplies use half-wave silicon rectifiers, with full-wave rectification costing slightly more. Because single-diode, half-wave rectification DC adaptors need larger capacitors to smooth out the 100% ripple than full-wave rectification DC adaptors do, full-wave rectifiers offer the best value.



Half-Wave Rectified



Full-Wave Rectified



Full-Wave with Filter Capacitor

Currently, most AC/DC external power supplies use switching technology to improve efficiency, reduce size, and minimize weight. Unlike traditional linear power supplies that dissipate excess energy as heat, switching power supplies employ silicon semiconductors called Field-Effect Transistors (FETs) to rapidly turn the power source on and off at high frequencies. This enables a more efficient conversion of electrical energy, which is ideal for various electronic devices that need a compact design and energy-efficient operation. The integration of switching technology, with its ability to regulate voltage through rapid switching cycles, has become a standard in modern power supply designs, contributing to advancements in electronics technology.

One of the latest technology examples of efficient power supply uses GaN, or gallium nitride, as a semiconductor material. GaN wall plug-in chargers provide up to three times faster charging than traditional silicon chargers without consuming as much energy or requiring bulky heat sinks to dissipate heat. These benefits are compounded for higher power density external power supplies, such as those for medical, industrial, and commercial applications.

Wall plug-in transformers are available in a broad range of power levels, voltages, output connectors, and reversed polarities (-R). When plugged into a standard electrical outlet, the power supply provides connected low-voltage electronic devices with adequate protection from the outlet's higher voltages. Wall plug-in power supplies are essential components of power distribution systems and are also known as:

- AC adapters
- Wall adapters
- Power cubes
- Wall warts
- Wall bumps
- External Power Supply (EPS)

Because of their important role, wall plug-ins should be high-quality and meet all necessary compliance standards.

Efficiency Regulations

The U.S. is the world's second-largest electricity consumer and the second-largest producer of greenhouse gas emissions. To reduce the country's environmental impact, the U.S. Department of Energy has established increasingly stringent energy efficiency standards. The most recent standard, Level VI, went into effect in 2016 and outlines the minimum energy efficiency requirements for external power supplies, including wall plug-in transformers and adaptors.

Level VI mandates decrease energy demand, helping to reduce the greenhouse gasses that cause global warming. For example, an 18-watt power supply with Level VI efficiency would be 4.71% more efficient than a Level V device.

Unlike older power supplies, Level VI-compliant power supplies have restrictions on no-load power draws, in the form of internal feedback mechanisms. These mechanisms minimize the amount of power drawn when the connected device is not being used. When the power supply is used with a switched outlet, the mechanisms may manifest as a slight power-on delay before the power supply turns on.

According to the U.S. Environmental Protection Agency (EPA), Level VI requirements and other efficiency regulations implemented over the past 10 years have cut energy consumption by 32 billion kW, reducing carbon emissions by at least 24 million tons and saving $2.5 billion every year. Many OEMs are demanding power supplies with even more stringent efficiency requirements than what is federally mandated, in an effort to distinguish their end products from those of competitors. These innovations will ultimately promote the development of power supply technologies that eliminate no-load power consumption entirely.

Additional compliance certifications have been established to improve quality and efficiency standards, including:

- **ECD 2005/32/EC**, a set of European standards outlining the eco-design requirements for all products that consume energy
- **Energy Independence and Security Act (EISA) 2007**, which aims to strengthen U.S. energy independence and national security by increasing energy efficiency
- **California Energy Commission (CEC) requirements**, which aim to reduce the environmental impacts of energy consumption and the associated costs in California
- **Restriction on Hazardous Substances (RoHS) compliance**, which indicates that a given product has been tested and was found not to exceed the acceptable levels of 10 hazardous substances (cadmium, lead, mercury, hexavalent chromium, etc.)
- **Class B EMI certification**, which offers exceptional noise filtration, power isolation, and common mode signal rejection

To maximize energy efficiency and high quality, any wall plug-in product you choose for your application should be compliant with these standards. Triad Magnetics' wall plug-in power supplies meet or exceed all of these regulatory standards, combining state-of-the-art designs with superior quality and reliability. Triad's innovative, cleaner designs provide both advanced performance and cost savings compared to typical power supplies.

Standard Wall Plug-In Offerings

With seven different product lines, Triad offers a wide selection of readily available wall plug-in transformers and junction boxes that fall into the following categories.

Wall Plug-Ins Switch-Mode Power Supplies - WS Series

Triad's green-friendly WS Series wall plug-in power supplies are manufactured to Class B EMI certification, RoHS compliance, and Level VI efficiency standards, and they meet these efficiency requirements under fully loaded and no-load conditions. This product line is available as the WSU Series and the interchangeable plug WSX Series, both detailed below.

The WS Series features the latest power switching topologies for superior performance and economy. The components are 25% more efficient, 70% lighter, and 50% smaller than traditional power supplies. The WS's compact, tamper-proof surface mount construction with automated assembly delivers higher quality and reliability. The result is a dependable power supply offering longer life at a lower cost of ownership. Other features include:

- Reduced component count
- Superior reliability 105 °C capacitors
- Industry-leading 5-year warranty

Triad WS Series power supplies feature an advanced circuit layout that is cleaner and more efficient, providing excellent performance and reliability compared to typical power supplies. Our wall plug-in power sources allow for smaller and lighter end products by eliminating the need for an internal cooling device in the power supply. The switch-mode power supply keeps heat separated from sensitive circuits, supplying a lower, safer output to the end device.

WS series

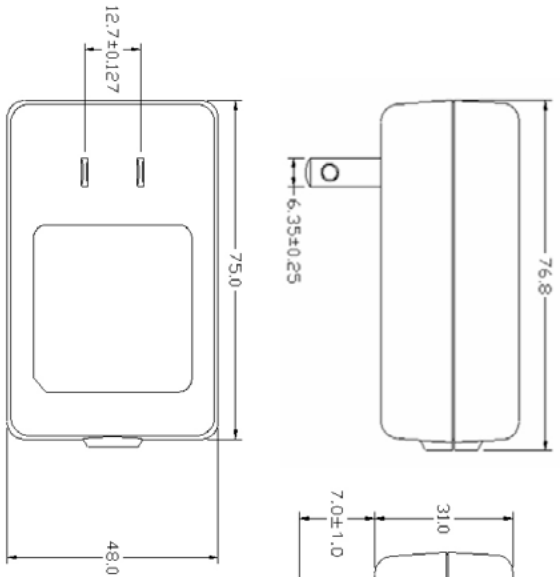
Traditional

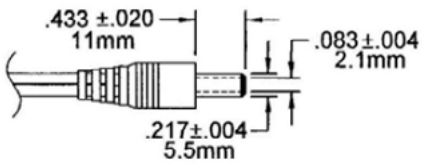
Wall Plug-Ins Switch-Mode Power Supplies - WSU Series

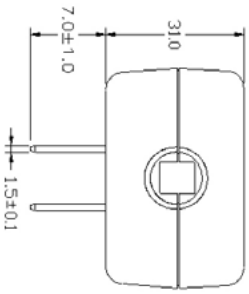
The WSU Series was developed with a robust design for demanding environments. It operates over a wide input voltage range with a variety of output voltages from 4.5 volts DC to 24 volts DC and power levels from 6 to 40 watts. All products have safety approvals from certified and internationally recognized industry standards organizations.

Technical specifications:

- Power Range: 6.75 to 36 W
- Input Range: 100-240 Vac @ 50/60 Hz
- Output Voltage: 4.5 to 24 Vdc
- Dielectric Strength: 4 KVdc for 60 seconds
- Typical six-foot-long cord
- NEMA 1-15P input prongs
- Output barrel connector







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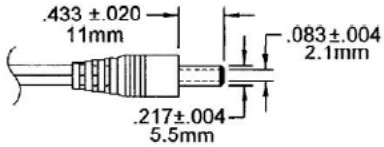
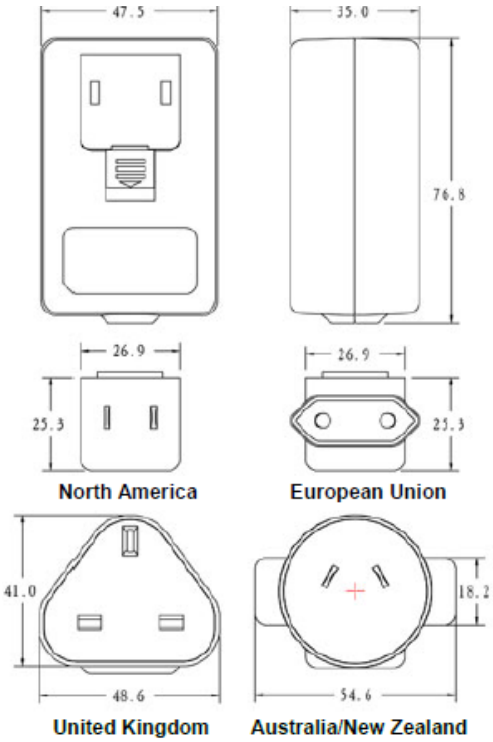
Interchangeable Input Plug Wall Plug-In Switch-Mode Power Supplies - WSX Series

Triad's WS Series now includes the modular WSX configuration, which features four interchangeable input prongs that are designed for easy use around the globe.

Technical specifications:

- Power Range: 20 to 24 W
- Input Range: 100-240 Vac @ 50/60 Hz
- Output Voltage: 5 to 24 Vdc
- Dielectric Strength: 4 KVdc for 60 seconds
- Typical six-foot-long cord
- Interchangeable input prongs: NEMA 1-15P, CEE7 (Schuko), AS/NZS 3112 (Australia/New Zealand), BS 1363 (UK/Ireland)





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Medical Wall Plug-In Switch Mode Power Supplies - WM Series

These external wall plug-in adaptors have been specifically designed for medical applications, with additional tamper-prevention features. They keep heat away from sensitive circuits to supply safer, lower output voltages to the end products. These units eliminate the need for internal power supply cooling devices.

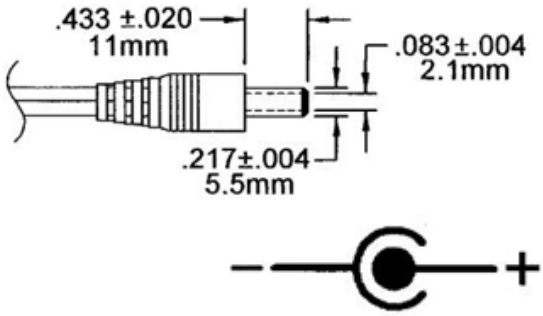
WMX Series plug-ins feature low noise, minimal leakage currents, and superior performance in ambient temperatures up to 40 °C. They also have a low standby power consumption and high power efficiency.

Triad's WMU Series wall plug-ins are similar to the WMX Series power supplies but have fixed NEMA 1-15 plugs specifically designed for the North American market. WMU Series products are available in a range of popular power levels, voltages, and reversed polarity.

Technical specifications:

- 24 and 50 watt versions
- Input Voltage Range: 90-264Vac, 50-60Hz
- DC Output Voltage: 4.5V, 5.0V, 6.0V, 7.5V, 9.0V, 12.0V, 13.5V, 15.0V, 18.0V, 20.0V, 24.0V, 36.0V, and 48.0V
- Regulation (line & load): ±5%
- Ripple & Noise: 120mVpk-pk Max
- Operating Temperature Range: 0 °C to +40 °C
- Leakage Current: < 0.25mA
- Dielectric Strength (Hi-pot): 4242VDC
- Warranty: 5 years
- Safety & EMI:
    - UL Standard: ANSI/AAMI ES60601-1: A1:2012, C1:2009/(R)2012 and A2:2010/(R)2012
    - CSA CAN/CSA-C22.2 NO. 60601-1:14 Class II, 2 Means of Patient Protection (2XMOPP)
    - Classified as Class II equipment requiring no Frame Ground (FG)

- TUV SUD: EN60601-1:2006/A1-2013
- IEC Standard: IEC 60601-1:2005 & IEC 60601-1:2005/AMD1:2012
- RCM: EN 60601-1-2: 2015, IEC 60601-1-2: 2014, CISP 11: 2009 + A1: 2010, EN 61000-3-2: 2019, EN 61000-3-3: 2013 +A1: 2019
- EMC Standard: EN/IEC 60601-1-2:2015 & 2014 and EN61000-3-2 & 3
- EMI Standard: FCC 47 CFR Part 18, ICES-001
- Exceeds efficiency requirements mandated by EU ErP Ecodesign and US DOE (EISA 2007)



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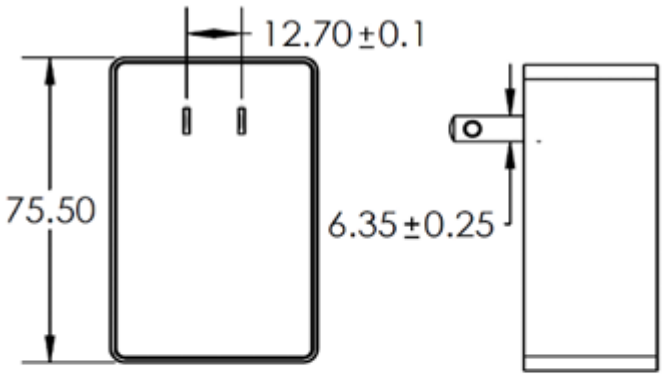
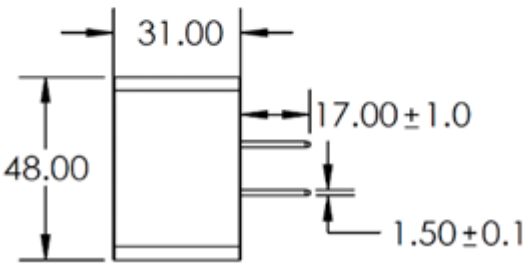


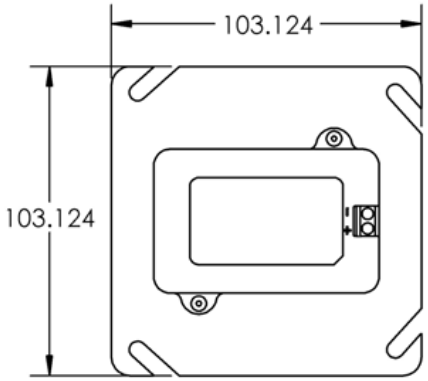


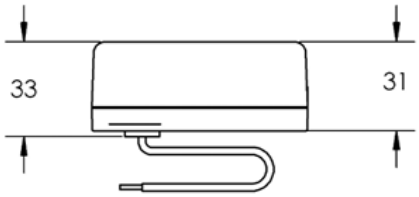
Hardwire Junction Box Power Supply - JSU Series

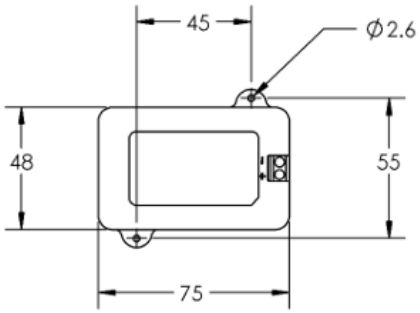
Many operators opt to hardwire stationary electronic equipment to a power supply junction box, preventing the hassle of tangled cords and accidental disconnection. This product line comes in 12VDC/1.5A and 24VDC/0.75A configurations.

Technical specifications:

- Mounts directly to standard 4 by 4 junction box
- Simple two-wire screw connection terminal
- Operating Temperature Range: 0 °C to 40 °C
- Regulation of Line and Load: ±5%
- Ripple & Noise: 150 mV peak-to-peak maximum
- Leakage Current: < 25 mA
- No Load Standby Power: 100 mW







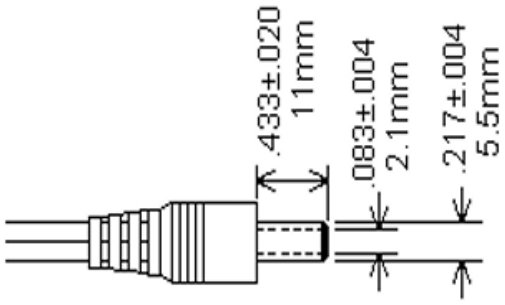
Wall Plug-Ins AC Power Supplies Level VI - WAU Series

This line of AC power supplies consumes 25% less power than previous 60 Hz AC power supplies, making them some of the first plug-ins to meet the Level VI efficiency standard of the U.S. Department of Energy.

Technical specifications of the WAU Series include:

- Input Voltage (AC): 120 V
- Input Power: 4 – 52.2 W
- Output Voltage (AC): 12 – 24 V
- Output Current (AC): 0.20 – 2.5 A
- Secondary rating of 6VAC-24VAC, 2000mA-500mA
- Temperature rise of 30 °C (86 °F) max at rated load
- No-Load Power (Stand By): ≤ 0.21 W
- UL-listed

WAU 12VA is a recently designed series that is the only AC/AC wall mount transformer, available with screw terminals or a traditional output cord, that truly meets DOE Level VI efficiency standards. Added design options include a third pin ground with a secondary ground connection and a mounting tab for enhanced mechanical security. Applications include battery backup equipment, HVAC systems, camera controls, security system locks, and more.



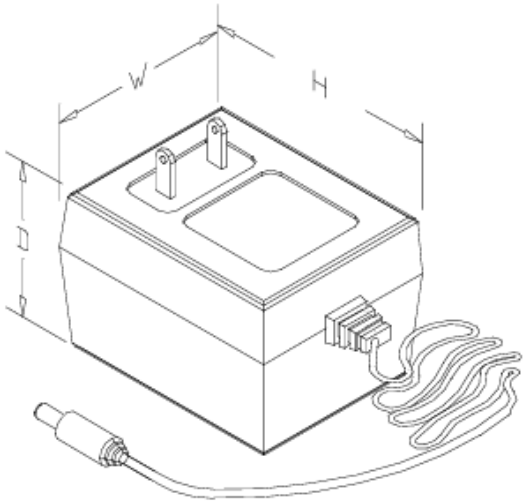
Wall Plug-Ins DC and AC Power Supplies for Industrial and Commercial Use Only - WDU Series

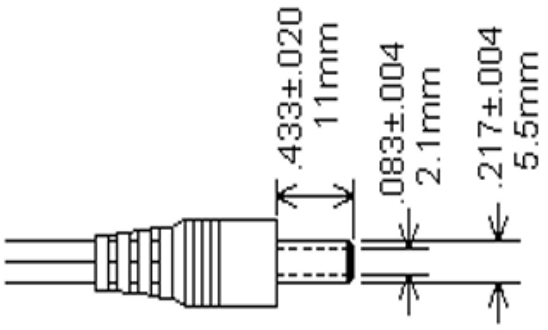
Similar to our core line of wall plug-in transformers, WDU Series AC and DC power supplies are designed for commercial and industrial settings. These products are only available in AC/DC unregulated models at the 60 Hz operating frequency. They feature a tamper-proof thermoplastic molded enclosure and a six-foot cord.

Triad's legacy WAU AC and WDU DC Series power supplies are linear wall plug-in power supplies offering greater reliability, low to zero noise performance, and longer life than switch-mode designs. They are produced exclusively for industrial and commercial use and as such are exempt from Level VI requirements, because they provide power conversion as an auxiliary function and are not distributed in commerce for use with consumer products.

Technical specifications:

- Input Voltage (AC): 120 V
- Output Voltage (DC): 6 – 24 V
- Input Power: 2.3 – 38.0 W
- Output Current (DC): 0.10 – 2.30 A





Custom Capabilities

In addition to a full range of standard wall plug-in transformers, Triad Magnetics has the capabilities to design, build, and manufacture custom solutions to meet the needs of our customers' specific applications.

To provide our valued customers with optimal power supply solutions, our skilled engineering team develops innovative solutions that best fit our customers' unique power supply needs while meeting their system requirements and addressing any challenges. From modifying standard products to delivering ground-up custom designs, we can make a product that meets or exceeds your expectations.

At Triad Magnetics, we can develop custom AC/AC and AC/DC power supplies from 5 watts to 2 kilowatts for commercial, industrial, and medical applications. Our custom power supply development and transformer production capabilities include the following:

- AC/DC charging solutions for mobile and stationary power systems
- High-voltage power supplies for AC/DC systems used in medical and industrial applications
- Ultra-wide operating temperatures for power supplies that range from -40 °C to +80 °C
- Redundant and hot-swappable battery packs

Contact Triad Magnetics to Learn More About Wall Plug-In Power

Given how widespread wall plug-in power supplies are, it's critical to ensure that these components and the devices they power operate as efficiently as possible. Commercial and industrial equipment rely on high-quality wall plug-in power supplies that comply with all applicable regulations for safety and efficiency, such as Level VI efficiency standards.

The experienced team at Triad Magnetics focuses on innovation in our designs and delivering the right power solution to meet your specific needs. Our mission is to understand the requirements of your application and fulfill your expectations with either a standard or custom product. Our products were among the first to meet the U.S. Department of Energy's Level VI efficiency standard, and Triad Magnetics continues to be on the leading edge of power supply and transformer technology.

Contact us to discuss a standard or custom power solution, or view our **product page** to learn more about our broad range of offerings.

ABOUT TRIAD MAGNETICS

At Triad Magnetics, our innovative magnetics technology has powered consumer, commercial, and industrial electronics for over 80 years in the industry. We are extremely proud of this legacy and dedicated to continually building and improving upon it. Our experience makes the difference. Whether a customer needs a standard or custom technology, we can and will deliver an appropriate solution. Our mission for standard products is to be the first choice supplier of power magnetics for electronic component distributors.

Contact Us Today

View Our Wall Plug-In Transformers Product Page

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