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AMETEK®
COMPLIANCE TEST SOLUTIONS

AMETEK CTS
RIPPLE NX

High power ripple testing made easy

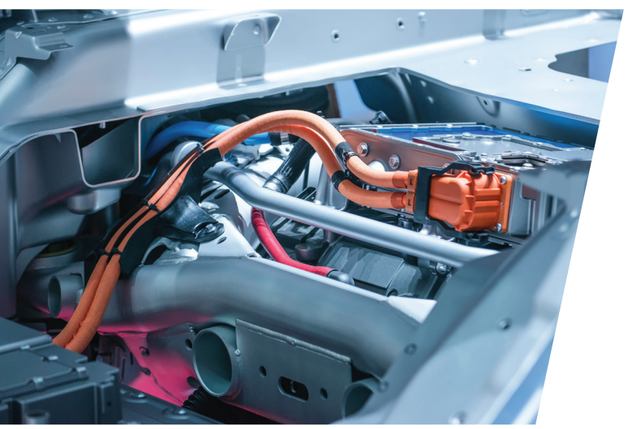
emtest
AMETEK

Introducing the high-performance ripple test solution for high voltage Electric Vehicle components

Ripple NX is a cutting-edge solution designed to meet the needs of the electric vehicle industry. The solution offers customizable ripple tests that comply with industry standards such as ISO 21498-2, ISO 7637-4, LV123, MBN 11123, VW 80300 and others. The system allows testing of devices with voltage up to 1000 V and current up to 1000 A and generates powerful ripple disturbance signals of up to 160 Vpp and 1000 App.

The fully integrated hardware ensures easy and quick setup, while the hardware-based regulation ensures efficient testing without the need for external software. The built-in coupling transformers ensure highest level of safety combined with efficient coupling of the ripple on the DC lines. The built-in 10 mFcapacitor with pre-and discharge circuits guarantees good decoupling of the DC source.

The Ripple NX is a state of the art, high performance ripple generator. It makes ripple testing easy and fulfils the highest safety requirements. The solution can be easily integrated with existing test benches for automation via CAN/Ethernet/Optolink/GPIB. The convenient web interface (LXI) and control & reporting software, with pre-programmed tests, provide maximum flexibility and ease of use, and the comprehensive test library ensures that all your testing needs are met.



Ripple NX at a glance

- High-performance testing solution for EV components with customizable ripple tests
- Highest level of safety with two independent safety circuits and isolation through transformer
- Compliance with industry standards such as ISO 21498-2, ISO 7637-4, LV123, and similar. Supports components with a voltage up to 1000 V and current up to 1000 A
- Generates powerful ripple disturbance signals of up to 160 Vpp and 1000 App
- Easy and quick setup with fully integrated hardware
- Efficient testing with hardware-based regulation, no external software needed
- Integration with existing test benches for automation via CAN/Ethernet/Optolink/GPIB
- Convenient web interface (LXI) and control & reporting software with pre-programmed tests
- Comprehensive test library for maximum flexibility and ease of use

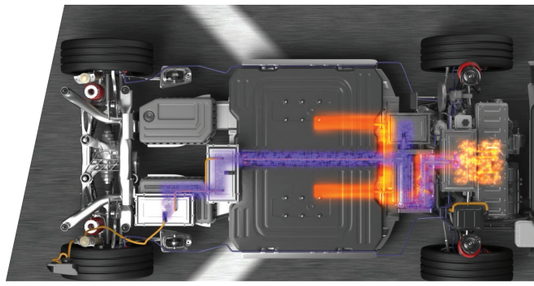
WATCH THE VIDEO
Ripple testing on EV components

What is ripple and where does it come from?

Ripple refers to a disturbance in the power supply line caused by switching of power electronics components, such as MOSFETs or IGBTs. In electric vehicles, the largest source of ripple is the inverter in the electric propulsion system.

The inverter serves as a solution to the mismatch between the electrical power stored in the DC battery and the AC 3-phase signal required by the motor. By creating an artificial 3-phase AC source with adjustable voltage and frequency, the inverter allows for control of the motor speed. However, the process of switching in the inverter can result in significant ripple currents and voltage amplitudes in the power supply, potentially affecting other high voltage components connected to the same bus.

WATCH THE VIDEO
What is ripple in electric vehicles?

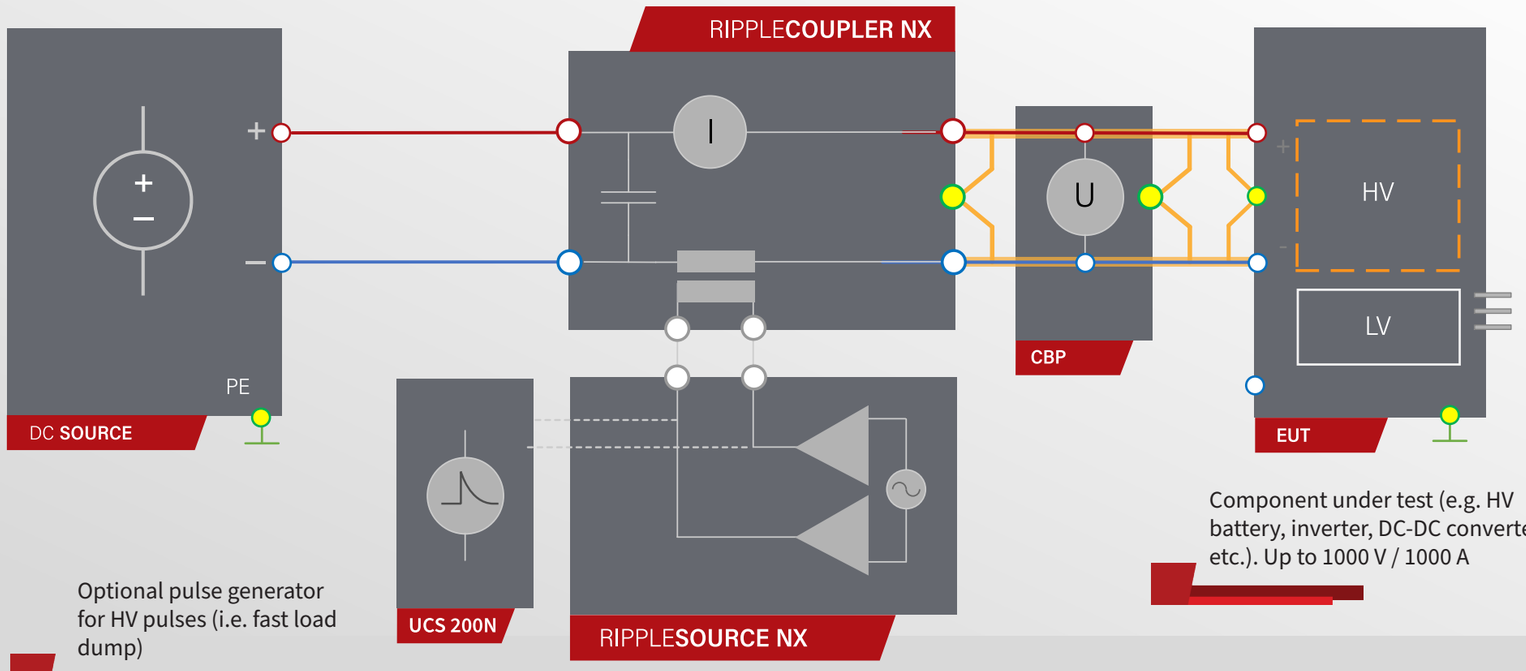


Test setups for batteries and inverters

DC source provides the DC supply (i.e. PowerWave, NetWave)

Coupling & decoupling unit with integrated measurement channels

Connection box for EUT connection



Optional pulse generator for HV pulses (i.e. fast load dump)

Component under test (e.g. HV battery, inverter, DC-DC converter etc.). Up to 1000 V / 1000 A

Amplifier and signal generation

System overview and main features

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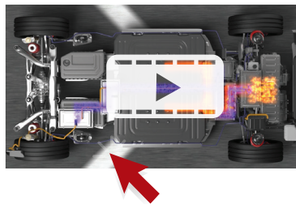


An integrated measurement unit is provided for closed-loop ripple testing. The dual-channel feature enables regulation on two separate outputs for testing batteries and all other HV components. The hardware is specially created and designed for ripple testing, which ensures rapid and dependable measurements, and high noise reduction by frequency selective (narrow band) measurement.

Control unit equipped with a touch panel offers local operation and setup capabilities. It also includes an integrated web server, allowing for testing without the need for additional software. Remote control is available via CAN, Ethernet, Optolink, or GPIB. Additionally, it features various trigger inputs for versatile use.

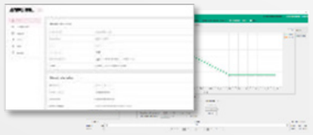
A high quality 10mF decoupling capacitor bank is included for optimal decoupling of the DC source. The unit features integrated, fail-safe pre- and discharge circuits to ensure secure operation. It can also be utilized as a decoupling capacitor for emission measurements with HV-ANs.

The RippleSource NX is a compact, high-performance 4-quadrant amplifier with a power output of 5 or 10 kW and a maximum output voltage and current of 320 Vpp and 160 App, respectively. Its small footprint of only one 19” rack unit conserves valuable laboratory space.

The coupling unit boasts high quality transformers that operate over a broad frequency range (10 Hz to 300 kHz). The transformer ratio can be adjusted for optimal coupling, depending on the EUT impedance. It is durable and can withstand overcurrent or overvoltage caused by abrupt EUT or source shutdowns.

Hardware-based regulation ensures rapid response times and optimizes testing efficiency. With the ability to perform complete ripple tests using hundreds of test points, this feature eliminates the need for external software, streamlining the testing process.

High-grade connection panel with flexible high voltage connection points (up to 1000 A). Adjustable output fuses are included to safeguard the EUT against overcurrent in combination with the programmable current and power limiters.

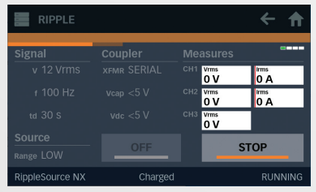


Software & webinterface

The integrated web browser enables remote control via a PC or tablet computer. The Compliance Test Studio software features a vast collection of pre-programmed tests, customizable testing options, test data analysis, and report generation capabilities.

Connection panel

The connection box (included) allows for effortless EUT connection. It is housed in a robust metal box (rated IP 54) that can be positioned inside climate or battery testing chambers.



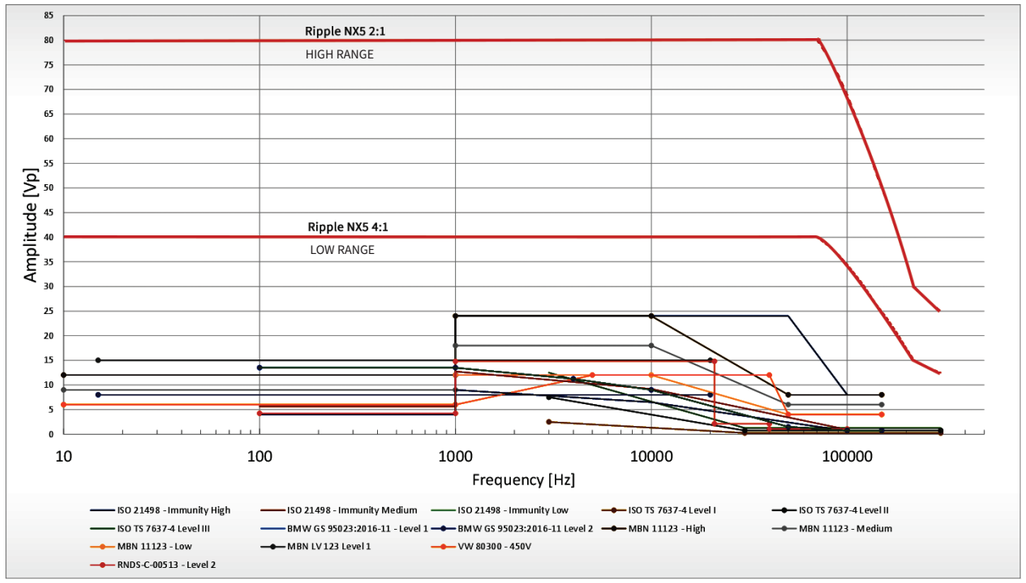
Touchscreen user interface

Remote control interfaces

Robust safety concept that ensures safe testing, with double-secured access to connection panel (door contact, cover) and easy accessible voltage check points.

The system features independent emergency stop and interlock safety circuits that can be integrated into laboratory safety circuits, ensuring the highest level of protection for the operator.

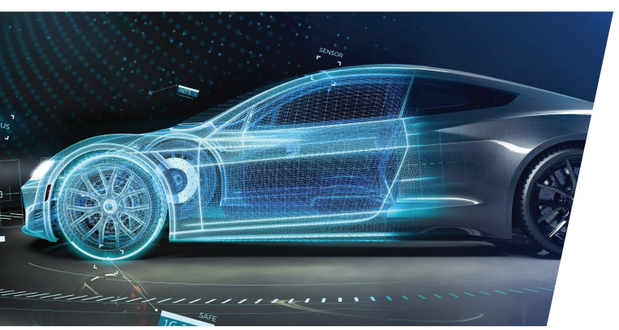
High ripple performance

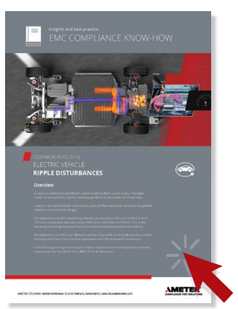


The above graph shows the ripple amplitudes defined by the various standards. The Ripple NX specifications significantly exceed these requirements which provides a wider margin for higher test levels and compensation for voltage drops in connection cables.

When it comes to testing EV components for ripple, one of the biggest challenges is finding the right combination of high test levels and impedance characteristics for items such as batteries and inverters. Ripple currents must be large enough at lower frequencies or resonance points to reach the necessary test levels. Meanwhile, at higher frequencies, a high EUT impedance can lead to significant voltage drops in connection cables, requiring high test voltages to compensate.

Enter Ripple NX. This state-of-the-art technology utilizes a 5 or 10 kW high power amplifier and an adjustable transformer ratio to optimize the system configuration for either high current or high voltage. This unique combination allows for the achievement of the highest test levels per ISO 21498 on even the most demanding HV components, such as large batteries and inverters.





DOWNLOAD TECHNICAL NOTE
Ripple disturbance in electric vehicles

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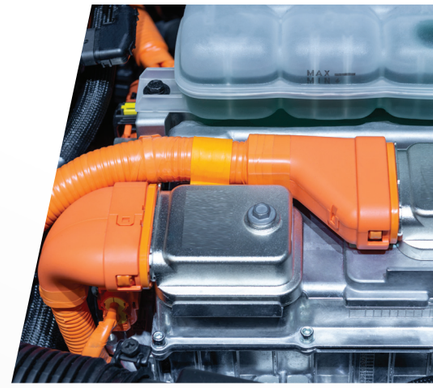
Coupling and decoupling



COUPLING METHOD

Different coupling methods (inductive, capacitive, direct) have pros and cons. Ripple NX uses inductive coupling, where transformers couple the ripple signal (AC) on the EUT's supply lines (DC). Ripple NX's transformers are tailored for the ripple application, covering a broad frequency range and offering high efficiency. We selected transformer coupling for its significant advantages.

The electrical isolation between high and low voltage sides in the Ripple NX offers a crucial safety advantage. It ensures that overvoltage or overcurrent events on the high voltage side do not propagate to user-accessible parts on the low voltage side, thus reducing the risk of electric shock or other hazards. Additionally, this isolation permits the use of smaller amplifier isolation voltage, which can lead to cost and size reductions. The implementation of this isolation feature is a critical engineering decision that serves to enhance safety while improving overall design efficiency.

Utilizing the inductive coupling method in a test system offers significant benefits over direct coupling. The fact that the DC supply current of the component under test does not flow through the amplifier reduces the required amplifier power and the overall size of the system. This is a direct result of the removal of the DC bias from the measurement system. Additionally, this method reduces balancing currents within amplifier configurations, resulting in a more compact and efficient test system. Furthermore, this approach enables the system to operate over a wider frequency range and with reduced power consumption. Overall, inductive coupling offers a superior test solution that is both cost-effective and high-performing.

Comparison system size for a 1000 A / 1000 V configuration with 10 kW ripple power.

Left: Ripple NX with transformer coupling method uses two racks and delivers 10 kW ripple power (up to 160 Vpp and 1000 App)

Right: configuration with direct coupling. Three times the size required because the amplifiers must be dimensioned to carry the full EUT current of 1000 A.

DECOUPLING DC SOURCE

When generating ripple disturbance, it's important to consider that not all of it will go towards the EUT side. High-quality ripple generators utilize a decoupling element to minimize the effects of ripple on the DC source side. If this is not done correctly, a high ripple current can flow through the output capacitors of the DC source, leading to increased degradation of the capacitors. Moreover, the regulation of the DC source can be disturbed, causing distorted DC voltage and unintended switch-off of the source.

To address this issue Ripple NX includes a 10 mF capacitor bank built with high-quality capacitors that have very low internal resistance and losses. This ensures that the available ripple voltage and current are maximized, while safety is guaranteed by the integrated pre-charge and two redundant discharge circuits. With Ripple NX, you can trust that your ripple testing is being conducted effectively and safely, without any risk of harming your DC source.

The engineered solution for ripple testing

Automotive manufacturers no longer need to rely on the limitations of self-engineered ripple generators that are based on commercially available components. It is now possible to experience a fully integrated ripple test system, with the Ripple NX. Developed, manufactured and tested by AMETEK CTS, the Ripple NX offers several advantages over traditional testing solutions.

With optimally adjusted components, maximum system performance and safety are ensured. The Ripple NX allows faster regulation times through its dedicated signal generation, measurement, and control unit compared to software-based regulation, saving you valuable test time. The powerful frequency-selective measurement algorithm suppresses noise generated by the inverter under test, ensuring that the test levels are fulfilled and maintained.

The Ripple NX's inter-wiring is reduced to a minimum, making it easy to set up in different test setups or labs, and allowing less experienced users to do the setup and test. EUT connection is easy and straightforward, with the use of a connection box that can be placed in proximity to the EUT connection points.

Advanced features such as programmable current limiter (per channel), power limiter, and integrated fuses protect the EUT from damage during the test. With our long experience in ripple testing, we have implemented the operating modes that are required to perform ripple tests according to various standards: closed-loop, substitution with calibration, closed-loop with calibration, single and multipoint (list) testing and impedance measurement.

At AMETEK CTS, we have our own hardware, firmware, and software development teams, enabling us to quickly react to customer feedback and implement new features. Trust the Ripple NX for all of your ripple testing needs.

- Optimally adjusted components ensure maximum system performance and safety
- Dedicated signal generation, measurement, and control unit allows for faster regulation times
- Frequency-selective measurement algorithm suppresses noise generated by the inverter under test
- Inter-wiring is reduced to a minimum, making setup easy in different test setups
- EUT connection is easy and straightforward with the use of a connection box

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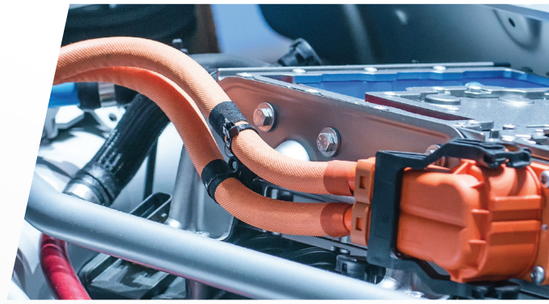


Safety first

Safety is critical when it comes to testing high voltage components, and the Ripple NX is specifically designed with this in mind. Here are some of the safety features that make the Ripple NX the perfect choice for your testing needs:

- Two separate and redundant safety circuits (emergency stop and interlock) ensure safe operation and EUT protection with the Ripple NX.
- The Ripple NX can be easily integrated into laboratory or test bench safety circuits via control and auxiliary contacts and CAN bus.
- All high voltage carrying parts are touch protected with two-step safety measures, such as a door interlock and a protective cover for the connection panel, ensuring safe access to test points.
- Developed with safety standards in mind, the Ripple NX provides a safe and reliable solution for high voltage testing, as opposed to other systems that include components built for low voltage testing only.
- The Ripple NX comes with a sophisticated pre-charge circuit for the 10 mF decoupling capacitor, and redundant discharge circuits ensure user safety in all circumstances.

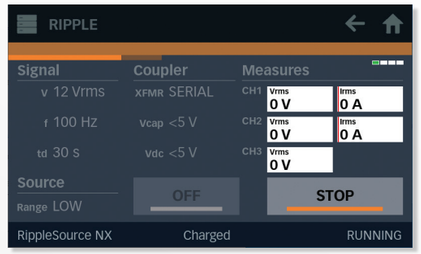
With the Ripple NX, you can be sure that your high voltage testing is performed safely and with peace of mind.

WATCH THE VIDEO
Ripple testing on EV components

User and control interfaces

Whether you are performing ripple tests during development, compliance testing in a laboratory, or extensive testing on a test bench, Ripple NX has a selection of interface options. With advanced features including remote control and a user-friendly touch panel, the Ripple NX allows for quick and efficient testing.

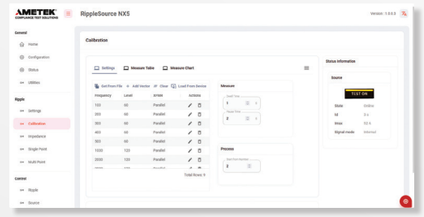
Starting up the Ripple NX for the first time is simple with the easy-to-use touch panel, you can quickly check a specific test point or debug with ease. All the relevant test information is displayed on the Ripple NX's display during remote control, making it the perfect tool for any testing scenario.

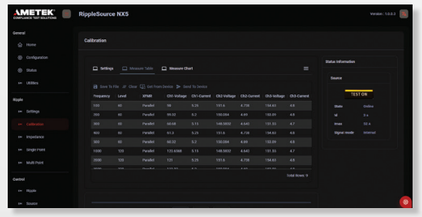


WEB INTERFACE

With Ripple NX, running tests has never been easier. This innovative technology includes a webserver that allows you to perform tests without the need for external software. All you need to do is connect your computer to the Ripple NX through the Ethernet interface and use your web browser to access the system's status, program and run a multi-point test, or perform an impedance measurement. The test results are conveniently shown in both tables and graphics, making it easy to analyze and interpret your data.

In addition the web interface also allows for convenient firmware updates and remote access, making support and service a breeze.

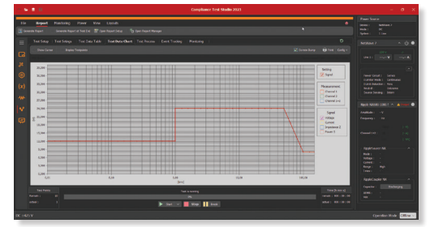


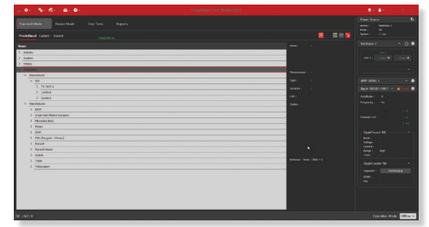


COMPLIANCE TEST STUDIO 23

The Compliance Test Studio (CTS 23) is a software solution that offers far more than just remote control of the Ripple NX. With a vast library of pre-programmed tests, programming time is significantly reduced, as well as the need to read and implement test standards. Individual test plans can be configured and executed with ease, and test results can be analyzed and exported, while test reports can be generated with minimal effort.

The software also features test setup graphics that help to quickly and accurately set up tests, reducing errors in the setup process. With regular updates available, including new features and an updated test library, you can be sure that your testing will always be up-to-date with the latest standards and technologies.

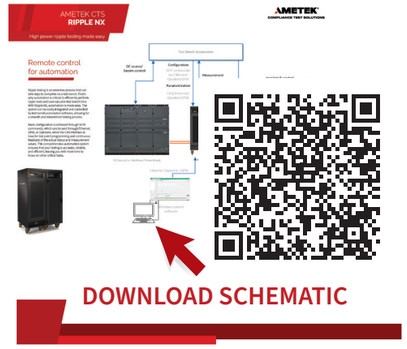




REMOTE CONTROL FOR AUTOMATION

Ripple testing is an extensive process that can take days to complete on a test bench. That's why automation is critical to efficiently perform ripple tests and save valuable test bench time. With Ripple NX, automation is made easy. The system can be easily integrated and controlled by test bench automation software, allowing for a smooth and streamlined testing process.

Basic configuration is achieved through SCPI commands, which can be sent through Ethernet, GPIB, or OptoLink, while the CAN interface allows for test point programming and continuous feedback of the actual status and measurement values. This comprehensive automation system ensures that your testing is accurate, reliable, and efficient, leaving you with more time to focus on other critical tasks.



Specifications

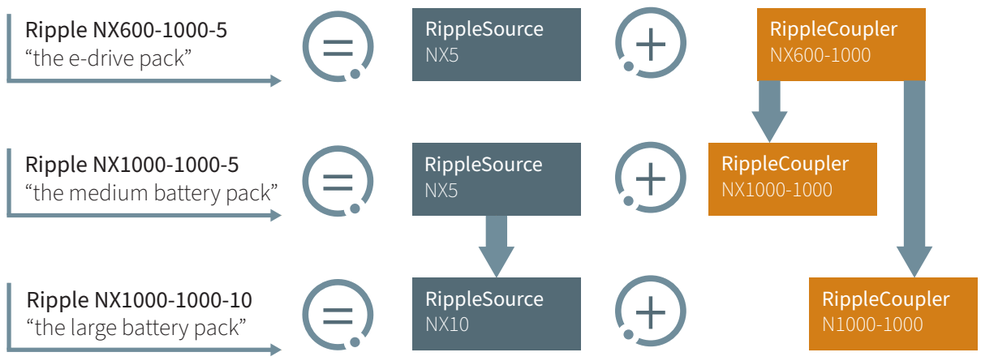
	Ripple NX 200-1000-2.5	Ripple NX 400-1000-2.5	Ripple NX 600-1000-5	Ripple NX 1000-1000-5	Ripple NX 1000-1000-10
Max. EUT supply (from external DC source)	1000 VDC / 200 A *(preliminary data)*	1000 VDC / 400 A *(preliminary data)*	1000 VDC / 600 A	1000 VDC / 1000 A	**1000 VDC / 1000 A**
Ripple (at EUT terminals)	2.5 kVA 10 Hz – 300 kHz (derated <100 Hz) max. 40 Vp (open, 2:1) max. 126 Ap (short, 4:1)		5 kVA (dual range) max. 80 Vp (open, high range, 2:1) max. 504 Ap (short, low range, 4:1)		10 kVA max. 80 Vp (open, 2:1) max. 504 Ap (short, 4:1)
Coupling	Through wide frequency range audio transformers, switchable transformer ratio (2:1 and 4:1), fully isolated high voltage to low voltage				
Outputs and configurations	1 output, single channel		2 individual outputs, single/dual/parallel output configuration, incl. heavy-duty connection box with 3m connection cables		
Dimensions	One 19" Rack, 38 HU		Two 19" Racks, 38 HU		
Decoupling capacitor	included 10mF capacitor bank, low ESR, automatic active pre-charge and discharge circuit, additional passive discharge circuits for safety				
Safety features	Emergency circuit, interlock circuit, external breaker control, warning lamp (optional), high voltage indicator, active and passive discharge circuit (capacitor bank), door interlock, protective covers, access for voltage check on connection points				
Signal Generation	Internal signal generator, 0 – 300 kHz, sine wave (triangle, square, trapezoidal, dual tone on request), arbitrary signals with external signal generator, HV pulses by external pulse generator and coupling through Ripple NX				
Measurement, EUT monitoring and protection	Integrated measurement hardware with dedicated features for ripple testing Voltage and current measurement per output channel, programmable current limiters per channel (I1, I2, I1+I2), programmable power limiter				
Regulation and control	Single and multi-point (list) mode, impedance measurement, calibration mode Voltage and current regulation with operating modes closed-loop, closed-loop with calibration and substitution with calibration				
Control interfaces	Front panel control through touch screen, remote control through webserver (no software installation required), included windows software Compliance Test Studio 23, automation and test bench integration through CAN/Ethernet/OptoLink/GPIB interfaces				

Specifications subject to change without notice. Please check the latest datasheet on www.ametek-cts.com.

Flexible upgrade path

Ripple NX is a flexible and cost-effective testing solution that can keep up with your evolving needs.

Ripple NX has a range of upgrade options, you can start with the NX600-1000-5 and seamlessly transition to the NX1000-1000-10 as your requirements change. And because you only need to invest in the upgrades you need, you'll save time and money in the long run.



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Our commitment to consistent, reliable performance lasts for the lifetime of your AMETEK CTS product. With our support and calibration services, provided by our network of globally recognized laboratories and service centers, you can trust that your instrument will perform at its best for years to come.

Expertise: As the manufacturer AMETEK CTS has the most knowledge and expertise about equipment we have designed.

Access to spare parts: AMETEK CTS has access to original parts for the equipment, which are designed to fit and function correctly, ensuring the longevity of the equipment.

Warranty: Services provided by AMETEK ensures that the equipment warranty is upheld, and repairs are covered under the warranty.

Quality Control: Equipment repairs are always to the original design standards, which can help to prolong the equipment's lifespan and ensure optimal performance.

Cost-effective: Services provided by AMETEK can prove more cost-effective in the long run, as it our processes and product knowledge will help to prolong the equipment's lifespan and minimize the need for repairs.

Overall, servicing by AMETEK CTS will provide additional peace of mind and ensure that the equipment is in optimal working condition, prolonging its lifespan, and minimizing downtime.

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CONTACT US.

Care to learn more about AMETEK CTS?
We look forward to speaking with you!

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