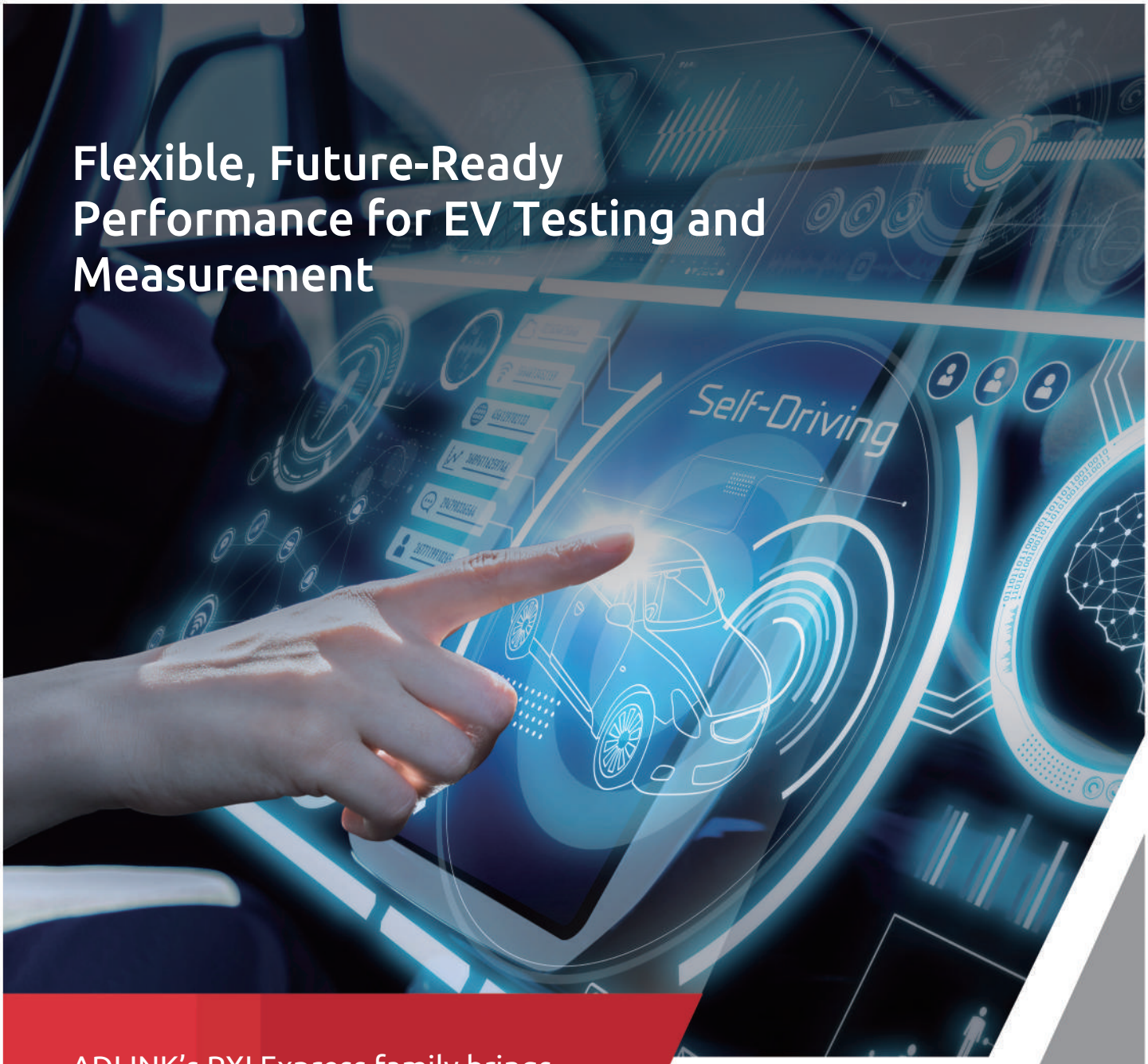
ADLINK
LEADING EDGE COMPUTING

Flexible, Future-Ready Performance for EV Testing and Measurement



ADLINK's PXI Express family brings EV client tremendous breadth of performance and possibilities in instrument applications

Use Case

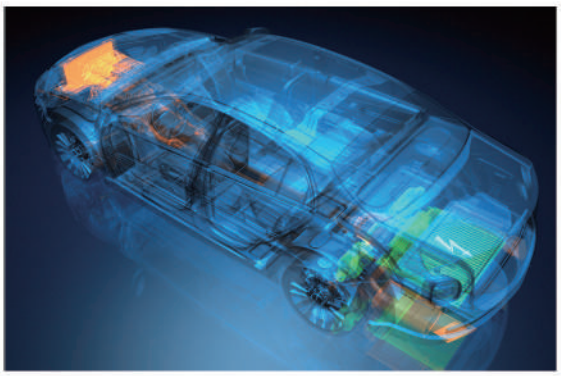
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Flexible, Future-Ready Performance for EV Testing and Measurement

ADLINK's PXI Express family brings EV client tremendous breadth of performance and possibilities in instrument applications

Overview



Electric vehicle (EV) manufacturers and those that service them operate in one of today's most rapidly evolving fields. As such, the testing and measurement processes and equipment for the EV industry often need to evolve at a similar pace. Traditional instrument approaches tend to be fixed. They provide a single set of functionalities in a set way, and if needs around those instruments change, the equipment likely must be replaced. A modular, scalable testing solution with much higher function density could offer tremendous advantages in both the short- and long-term.

Since 1997, the PCI eXtensions for Instrumentation (PXI) standard for industrial testing applications has steadily grown in performance and international adoption. MarketsandMarkets Research predicts 16.5% compounded annual growth for PXI through 2024, driven by increasing R&D in aerospace, automotive, defense, and IT/telecommunications. MarketsandMarkets also notes rising PXI demand for reliability testing in the semiconductor market, where testing demands are prone to exceeding what "traditional approaches" (meaning dedicated-function test equipment) offer for analog, mixed-signal, and RF testing.

Recently, an electric vehicle (EV) vendor approached ADLINK for help in filling its need for R&D and QC testing solutions. PXI technology and specific ADLINK PXI products emerged as clear choices able to satisfy the client's stringent requirements. This case spotlights a broad trend in the automotive space and points toward how companies in similar fields can use PXI to tackle comparable challenges with solutions based on open standards without sacrificing long-term reliability.

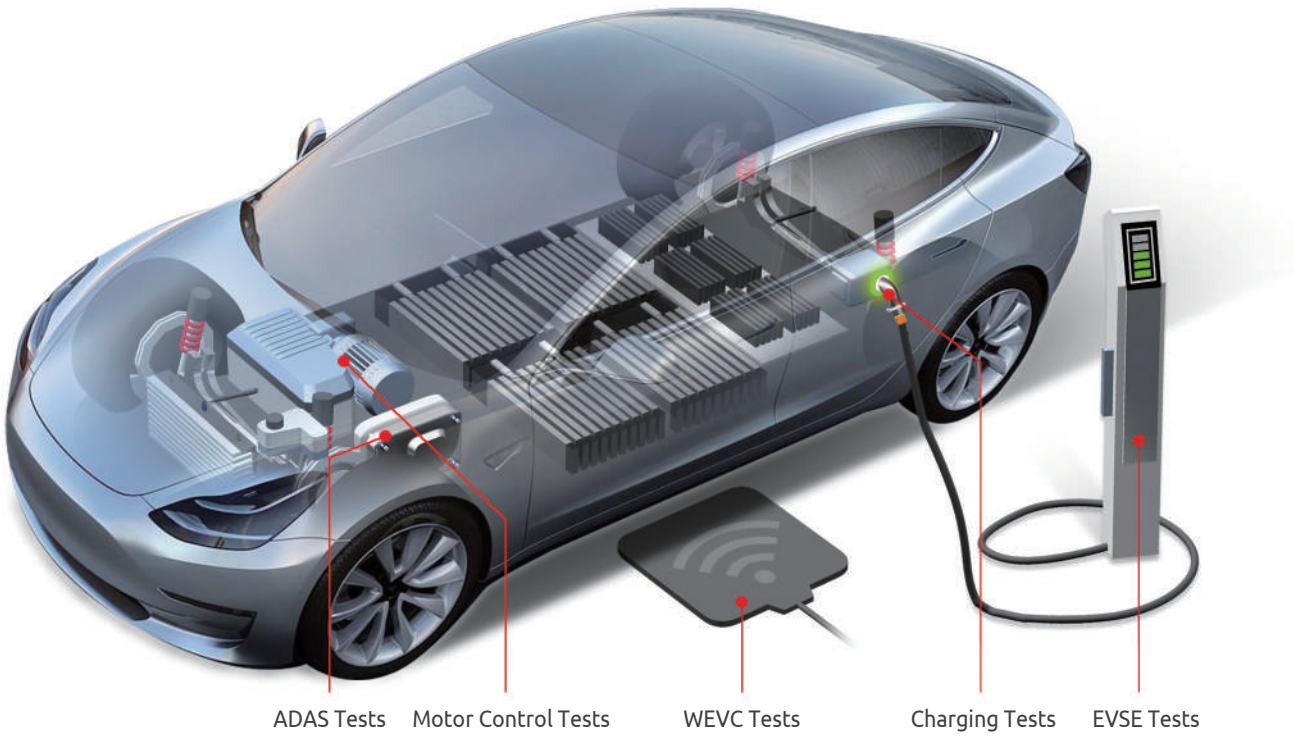
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Customer Application

EV testing spans a host of needs, including in power and advanced driver-assistance subsystems. Some examples include:

- **On-board charging** - An EV's OBC converts energy from the power grid to DC power suitable for storing in the car's battery. The EV's battery management system (BMS) manages supplies real-time energy conditions data to the OBC for dynamic adjustment of current or voltage. OBC testing is critical at stages from R&D through production.
- **Advanced driver-assistance subsystems (ADAS)** - Whether for lane tracking, speed control, collision warning, or intervehicle communication, the range of ADAS functions in need of precision measurement is formidable. The amount of data generated can be considerable, and testing groups will need to analyze this data quickly enough to keep product development moving on schedule, which in turn requires a measurement platform with sufficient processing power.
- **Motor control** - An EV relies on constant bi-directional communication between the drive and motor. The drive must be able to adapt instantly if the motor or other subsystems show signs of failure. Testing analyzes this responsiveness.
- **Hardware-in-the-loop (HIL) simulation** - Because in-vehicle testing under real-world conditions can be both time-consuming and very difficult to reproduce exactly, HIL systems enable testing solutions to run in virtual simulation. Often, this involves modeling engine dynamics and can be very compute-intensive. HIL gives testers more control and potentially faster development time.
- **Wireless electric vehicle charging (WEVC)** - The more EVs edge toward autonomous driving, the more WEVC will become a necessity. Even in the luxury consumer market, many EV manufacturers offer limited WEVC options allowing owners to dispense with the hassle and risk of corded charging. The wireless power transfer processes between DC and AC systems requires substantial testing, as does accuracy with foreign metal object detection.
- **Electric vehicle supply equipment (EVSE)** - Despite how much testing goes into EVs, they rely on a surrounding power ecosystem. EVSEs, commonly known as charging stations, also require testing to confirm proper communications and charging exchange with cars. This is a mobile application wherein the testing gear operates from a technician's trunk or van. As such, EVSE testing suits PXI's dense yet performant form factor very well. Some PXI cases, such as ADLINK's PXES-2314T, integrate a carrying handle exactly for such uses.

Conventional measurement and testing solutions designed for the EV market rely on inefficient stacks of single-purpose devices, consuming more space and power at higher cost points. Modern approaches based on ADLINK PXI products can consolidate the functionality of these stacked solutions into far less space, thereby lowering energy use and cost while simultaneously scaling potential application loads due to the flexibility and scalability of ADLINK's high-performance PXI design platform solutions.



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Challenges

EV testing often must address multiple vehicle systems simultaneously. Input and output signals must be perfectly timed, which means testing operations must accommodate both multiple signals and I/O channels as well as synchronization across those channels to within fewer than 100 picoseconds (ps) of variance. When testing across multiple instrument modules are mandatory this synchronization challenge becomes even more difficult, but achieving and maintaining synchronization are mandatory in EV testing.

Clock Sync

To illustrate, consider a test in which a DIO module sends a pulse to the device under test (DUT), waits 10 clock cycles, then a separate data acquisition (DAQ) module measures analog input from the DUT to confirm reaction and/or function. If the DIO and DAQ modules are not in sync, the setup will not return accurate results. If multiple modules don't sync to the same clock, start times or sampling bases will fail to return valid data. Conventional PC-based systems are not made to support this level of I/O timing precision.

Rising Bandwidth

An increasing number of EV testing and measurement applications involve higher data loads. The average data bandwidth required when PXI arrived in the 1990s is far lower than that required today, as systems have grown more complex, sampling rates have tended higher and data resolution more dense. This should not imply that all EV applications demand the most performant platforms available. Still, bandwidth demands continue to increase overall, and converging more instrument modules in a given chassis will inherently place more load strain on the system. This is why the PXI standard embraced PCI Express backplane technology in 2005 (dubbed PXI Express), lifting total system bandwidth from 133/266 MB/s (PCI bus) to 24 GB/s (PCI Express Gen 3). Concurrently, PXI also embraced hybrid slots able to support both PXI and PXI Express modules.

Power and Cooling

Not least of all, with high-speed components, high I/O port counts, and high-bandwidth platforms comes another challenge: power and cooling. In this regard, legacy solutions appear to have an advantage. Their half- and full-height rackmount implementations have plenty of room for large power supplies and ventilation. But how should designers condense this into a 3U or 4U form factor without sacrificing power availability and overall system reliability, especially in demanding industrial settings?

The ADLINK PXI Solution

ADLINK continues to innovate its PXI and PXI Express product families with both off-the-shelf chassis and modules as well as the ability to modify those products to fit individual client needs. For example, the EV client that approached ADLINK needed flexibility and functionality in one chassis, so it selected ADLINK's PXES-2785 enclosure. With 18 slots in a 3U form factor, the PXES-2785 features 24 GB/s of PCI Express 3.0 bandwidth and 1170W of total power, enabling up to 82W per PXI Express slot. ADLINK's chassis supports the PXITM-5 PXI Express specification, which delivers advanced timing and synchronization features, while also enabling users to monitor and manage the enclosure's status data remotely. The EV client foresees multiple future scenarios in which the PXES-2785's backplane bandwidth — 24 GB/s for a PXIe controller and 8 GB/s for a PXIe module — could prove very beneficial to expanding testing and measurement needs.

The EV client also anticipated facing the sort of speed and bandwidth challenges described above. As a result, they favored ADLINK's PXIe-3988 PXI Express embedded controller. Based on the 9th Gen Intel® Xeon® E-2276E processor, the PXIe-3988 is optimal for hybrid PXI Express-based testing systems. With six cores (12 threads), the processor offers ample performance for EV testing applications that need high computation power for parallel data processing and short response time. The PXIe-3988 features an auto configure PCIe switch and either four x4 or two x8 PCI Express links, supplying up to 16 GB/s of PCI Express 3.0 bandwidth. The controller features a host of I/O ports, including dual Gigabit Ethernet for simultaneous LAN connection and LXI instrument control and a Micro-D GPIB connector for GPIB instrument connections.

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One of the exceptional benefits of PXI, and of ADLINK's strict adherence to industry standards, is that the PXIe-3988 is entirely compatible with all PCI Express and PXI modules available in the market for functions based on test conditions and requirements. The EV client can deploy modules for digital I/O, serial port connectivity, LAN, DAQ, digitizer, vector analyzer, oscilloscope, and many other applications, all within one chassis and all configurable under a single programming environment. Applied specifically to the EV space, PXI modules can and do provide widespread functionality, including:

- **16-channel analog output of common wave forms at high voltages, with sensor emulation for scenarios such as detecting wheel speed in transmission control unit testing.**
- **32-port multiplexing with eight acquisition channels for fast parallel voltage level measurements.**
- **Digital stimulus/response with RF chipset emulation, complete with 192-channel support and software-based import of patterns from automatic testing programs.**
- **14-bit digitizing for real-time sequencing and multi-module synchronization, accelerated by an onboard field-programmable gate array (FPGA) processor.**
- **PXI or cPCI modules for LIN, CAN, FlexRay, and MOST bus communication with EV peripheral devices.**



Conclusion/Customer Benefits

Convergence, the consolidation of many larger devices into fewer smaller devices, has been at the heart of computing's advances for decades. PXI brings that same principle to testing and measurement. ADLINK now combines PXI's advantages for the automotive market with its own expertise in developing dependable, rugged computing platforms for industrial settings.

Naturally, not every testing and measurement instrument needs to be PXI. ADLINK's EV client is integrating a broad set of solutions, of which PXI is only one notable technology. However, the company selected PXI to fill certain application needs because it was the best technology for its automatic testing needs. PXI will allow the firm to reuse and reconfigure its testing and measurement equipment for related applications years into the future as standards evolve.

In short, the PXI platform solutions implemented and optimized by ADLINK will provide the EV client with the highest levels of flexibility, total cost value, and effectiveness — all benefits that will contribute to the company's competitive edge in one of today's most exciting and important fields.

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