ADLINK
LEADING EDGE COMPUTING

IoT Deployed Semiconductor Vacuum Pump Monitoring with ADLINK Edge DAQ



ADLINK MCM-204 standalone edge DAQ solution helps pump providers integrate Ethernet-based vibration monitoring into vacuum pumps for modern semiconductor fabs

Solution Brief

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Semiconductors Embrace Vibration Monitoring

Increased capacity demands on semiconductor manufacturers combined with the predictive maintenance advantages of vibration monitoring and migration to network-connected machine monitoring solutions are opening up an opportunity for vacuum pump manufacturers to integrate these capabilities into their pumps, providing an all-in-one measurement solution that streamlines pump monitoring and maintenance and creates an opportunity for ongoing value-added support offerings.

Chips are in demand. Fabs are expanding. And the expansion in industries such as self-driving cars, AI, high-performance computing, and 5G is outpacing the current chip supply capacity. Semiconductor manufacturers have been quick to pounce on this opportunity, with forecasts predicting 29 new high-capacity fabs coming online in 2022 to fill the gap. For these manufacturers, this rapid pace of growth highlights the necessity of streamlining the management of existing and future operations.

Predictive maintenance programs have become a staple to improve uptime and reduce unplanned downtime. Amongst these measures, vibration monitoring has shown itself to be a highly effective method of measuring machine performance and predicting impending breakdowns. Vibration analysis monitors vacuum pumps, an important piece of equipment for creating the vacuum environment needed to ensure the quality and electrical performance of the wafer, and alerts to machine abnormalities. The difficulty is that the tangles of cables needed for machine monitoring have become a stumbling block in the race to expand operations.

Semiconductor manufacturers have already begun tackling these wiring challenges by retrofitting existing equipment with network-based machine monitoring solutions that allow remote monitoring of critical machine resources. Now that the effectiveness of vibration monitoring and networked machine monitoring is clear, manufacturers need a better and quicker way to implement these functions into their fabs. They are looking to vacuum pump providers for the answer.



Vacuum pumps are critical for many of the major semiconductor manufacturing processes, yet despite regular overhauls and maintenance, these costly pieces of equipment still suffer from unexpected downtime.

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Integrating Edge DAQ Vibration Monitoring Into Vacuum Pumps

Customer Application

Semiconductor manufacturers want pump providers to offer pumps with integrated Ethernet-based vibration monitoring already built in. By integrating these functions directly into the vacuum pump, the semiconductor can speed up the process of getting the vacuum pump up and running by drastically reducing the setup time, eliminating the extra wires needed for measurement devices, and leveraging a complete system already optimized by the pump provider.

Vacuum pumps are an essential part of semiconductor processes that require low-pressure environments in the reaction chamber around the wafer surface. The wafer environment must also contain only gas species needed for the process, and any other reactive species will degrade process and material quality. Therefore, it is essential to evacuate all atmospheric gas components before introducing the gas species needed for the process. Semiconductor manufacturing utilizes various pump types, but the subpar performance of any one can impact product quality and yield.

Pump manufacturers are acutely aware of the importance of their product in the overall production process, and the potential downside for their semiconductor customers if the equipment does not operate correctly. In addition to regular maintenance to ensure their continued stable operation, many pumps currently available already include vibration monitoring and other measurement data.

Integrated vacuum pump vibration monitoring is the all-in-one solution, building this functionality into the machine and allowing semiconductors to begin monitoring production equipment without the requirement for any additions. By tapping into this data, vacuum pump suppliers can also benefit from offering maintenance services better aligned with real-world conditions. In fact, this migration becomes a net positive for the pump provider who now has access to detailed pump data, allowing for more detailed analysis and diagnosis, and also allows the fab to roll out new equipment and hook it up with their existing network in a fraction of the time it would take to use alternative wiring strategies.

The upside is clear, but the implementation poses some technical challenges.

Challenges

New services require new skills. Adding edge DAQ requires pump equipment manufacturers to extend their current resources to take advantage of these new opportunities. There are several areas in which technology advances are bringing change and improvement. However, each of these has its own obstacles for pump manufacturers whose expertise is not primarily in computer hardware and software.

Improve Service Levels

Semiconductor manufacturers want increasingly high service levels. The challenge for pump providers is improving their service offering when they already have scheduled maintenance programs to keep vacuum pumps operating at optimum capacity. Even with regular maintenance, pump problems ranging from abnormal operation to complete failure still occur. These events interrupt fab production and can lead to sub-quality products or the loss of an entire wafer batch. There is a great incentive for preemptive and predictive maintenance to improve service levels when service contracts are on the line. The challenge is implementation.

Enable Large-Scale IoT Expansion

The expansion of IoT is a noticeable trend that pump providers can no longer afford to ignore. Existing semiconductor manufacturers are quickly replacing their legacy systems with IoT to reduce the overhead and maximize their existing production capacity. New fabs will likely introduce IoT from the start. Pump providers have to up their game to keep pace. With their expertise firmly in the provision of hyper-reliable pumps, the difficulty is developing the equipment and resources necessary to integrate IoT into their pumps. They need to find a plug-and-play solution to make this integration easier and allow them to implement ongoing subscription-based monitoring services.

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ADLINK's Solution

ADLINK provides a complete edge condition monitoring system ready for deployment with minimal setup and development time. As a full solution for factory digital transformation, it provides the hardware and software functionality to collect, process, analyze, and transmit data from any standard sensor, including IEPE accelerometers needed for vibration monitoring. The system includes the ADLINK MCM-204 edge DAQ and the backend software system.



ADLINK's edge DAQ solutions accelerate time to market and simplify integration by combining sensor connectors, edge data acquisition, and monitoring software into a single device.

ADLINK Edge DAQ MCM-204

The MCM-204 is a standalone Ethernet DAQ edge computing platform. Unlike traditional measurement systems, the MCM-204 does not require an additional host computer, and includes dual RJ-45 ports for Ethernet data connection to the backend server and daisy-chaining with multiple other devices. Other features include:

ARM Cortex-A9 CPU

Powerful and low-power integrated ARM processor ideal for edge computing and DAQ measurement needs, providing powerful data processing in a compact package. The embedded processor eliminates the need for an external host computer typically required for measurement devices, allowing all functions to be packed into a single device that simultaneously does away with the usual compatibility issues between different devices.

Custom Algorithms

For pump manufacturers, measurement needs vary according to the pump and its particular application. The core set of algorithms provides a starting point for measurement without expensive outlays on custom development. Pump providers can update these algorithms as needed.

Industrial Reliability

The level of precision necessary for semiconductor manufacturing requires everything within the production facility to meet stringent reliability requirements. The MCM-204's compliance with CE and FCC regulations -20 to 70 temperature support ensures that radio frequency interference and electrostatic discharge will not adversely affect measurements.

Rich Data and DAQ

Measurement resolution of 24-bit 128KS/s supports the 4-channel analog input for an IEPE sensor and additional 4-channel digital I/O. Semiconductor firms use a variety of different protocols to access data gathered by the MCM-204. RESTful API, TCP socket, Modbus TCP, and Wi-Fi support ensure compatibility with the maximum number of systems.

Built-in Web Console

Initial setup of the MCM-204 happens through a network connection, and the IP address and hostname are both customizable during or after initial setup. Once setup is complete, every device is available over the network for complete remote access, including updating algorithms, setting up data storage rules, and configuring measurement parameters. Customers can make all updates and firmware upgrades through this interface.

Monitoring Software

ADLINK includes the RM-IOT-NET software package for central monitoring of sensor measurements on the factory network. This software base provides an all-in-one software solution that pump vendors can use off-the-shelf, eliminating the long development times typically needed for complex software solutions. There are options to select the type of monitoring motor, define the monitoring devices and points, select the ISO vibration standard, and see an overview of all the motors or pumps in the fab.

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Conclusion

ADLINK Edge DAQ helps pump equipment providers integrate Ethernet-based machine condition monitoring into their pumps. Integration simplifies their customers' operations and provides the technology to improve their service quality and leverage the benefits of ongoing subscription-based monitoring services. With both hardware and software included, providers can rollout value-added services without the cost and time investment needed to develop their own.

Individual equipment with embedded machine condition monitoring, including hardware and software for streamlined development, provides fault alerts in real-time for an improved condition-based maintenance strategy. IoT lets each machine transmit its own operational data specific to its function, reporting on its operational health and integrating seamlessly into the end customer's manufacturing environment.

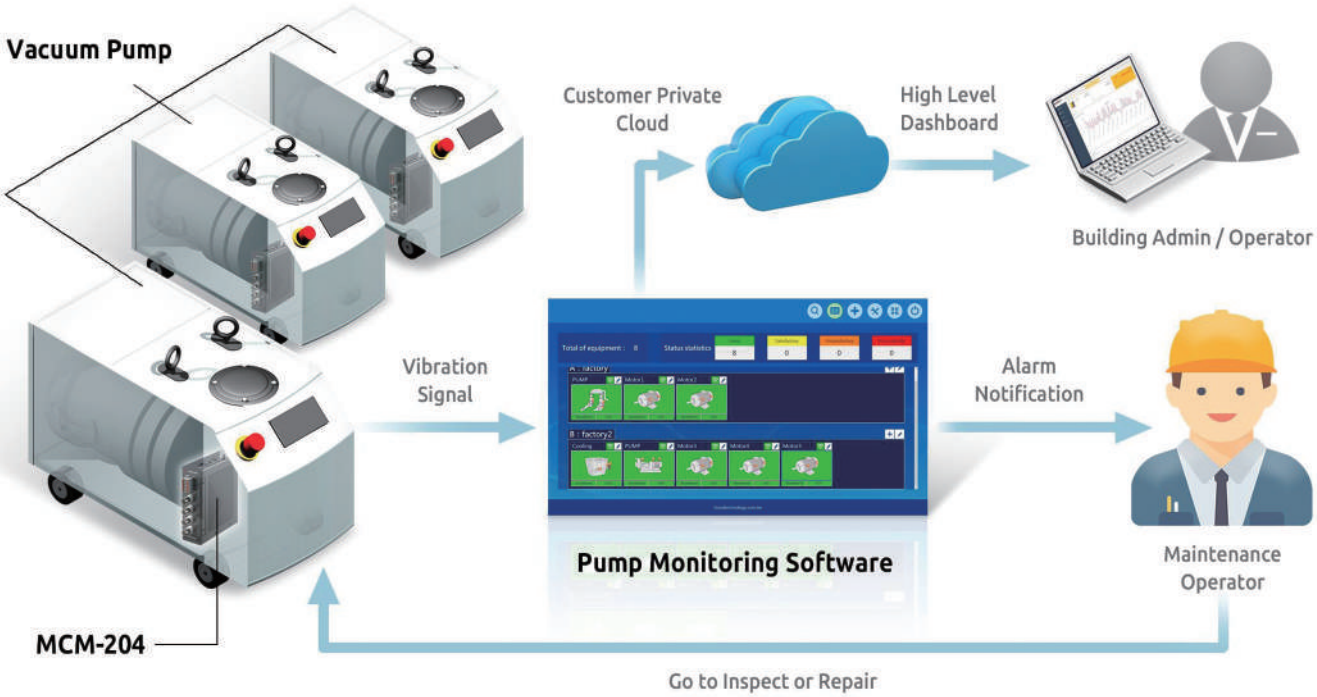
Now, pump equipment makers can realize instant competitive advantage by offering ready-to-go "IoT-deployed" products that the smart factory market is looking for to boost their market share and revenue. This cost-effective and reliable solution offers pump equipment makers an opportunity to build IoT deployed pump equipment that costs less to develop, deploy, and maintain.

Deployment is simpler because ADLINK's out-the-box Ethernet-enabled solution can be adapted into any pump equipment and achieve whole factory pump monitoring powered by pump monitoring software. The one-stop condition monitoring IoT solution includes all sensor hardware and software for sensor and Ethernet connection and the central management software to update and monitor all pump equipment in the factory remotely.

For pain-free IoT-enabled machine condition monitoring, the ADLINK MCM-204 is the obvious choice.



ADLINK edge DAQ devices combine sensors, measurement software, and Ethernet connectivity in a single compact package.



ADLINK MCM-204 measures data from vibration sensors near the vacuum pump to alert personnel to potential problems ahead of time and transmits that collected data via Ethernet to the cloud for further analysis by managers in a unified management page.

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Head Office

ADLINK Technology, Inc.

No. 66, Huaya 1st Rd., Guishan Dist.,
Taoyuan City 333411, Taiwan
Tel : +886-3-216-5088
Fax: +886-3-328-5706

www.adlinktech.com

Worldwide Offices

Ampro ADLINK Technology, Inc.

6450 Via Del Oro, San Jose, CA 95119-1208, USA
Tel: +1-408-360-0200
Toll Free: +1-800-966-5200 (USA only)
Fax: +1-408-360-0222
Email: info@adlinktech.com

ADLINK Technology (China) Co., Ltd.

上海市浦东新区张江高科技园区芳春路300号 (201203)
300 Fang Chun Rd., Zhangjiang Hi-Tech Park
Pudong New Area, Shanghai, 201203 China
Tel: +86-21-5132-8988
Fax: +86-21-5192-3588
Email: market@adlinktech.com

ADLINK Technology Beijing

北京市海淀区上地东路1号盈创动力大厦E座801室
(100085)
Rm. 801, Power Creative E, No. 1 Shang Di East Rd.
Beijing, 100085 China
Tel: +86-10-5885-8666
Fax: +86-10-5885-8626
Email: market@adlinktech.com

ADLINK Technology Shenzhen

深圳市南山区科技园南区高新南七道数字技术园
A1栋2楼C区(518057)
2F, C Block, Bldg. A1, Cyber-Tech Zone, Gao Xin
Ave. Sec. 7 High-Tech Industrial Park S.,
Shenzhen, 518054 China
Tel: +86-755-2643-4858
Fax: +86-755-2664-6353
Email: market@adlinktech.com

ADLINK Technology Singapore Pte. Ltd.

84 Genting Lane #07-02A, Axxel Innovation
Centre, Singapore 349584
Tel: +65-6844-2261
Fax: +65-6844-2263
Email: singapore@adlinktech.com

ADLINK Technology Singapore Pte Ltd. (Indian Liaison Office)

#50-56, First Floor, Spearhead Towers
Margosa Main Road (between 16th/17th Cross)
Malleswaram, Bangalore - 560 055, India
Tel: +91-80-42246107, +91-80-23464606
Fax: +91-80-23464606
Email: india@adlinktech.com

ADLINK Technology Japan Corporation

〒101-0045 東京都千代田区神田鍛冶町3-7-4
ユニゾ神田鍛冶町三丁目ビル4F
Unizo Kanda Kaji-cho 3 Chome Bldg. 4F,
3-7-4 Kanda Kajicho, Chiyoda-ku,
Tokyo 101-0045, Japan
Tel: +81-3-4455-3722
Fax: +81-3-5209-6013
Email: japan@adlinktech.com

ADLINK Technology Korea Ltd.

경기도 용인시 수지구 신수로 767 A동 1503호
(동천동, 분당수지유타워) (우) 16827
A-1503, U-TOWER, 767 Sinsu-ro, Suji-gu,
Yongin-si, Gyeonggi-do, Republic of Korea, 16827
Toll Free:+82-80-800-0585
Tel: +82-31-786-0585
Fax: +82-31-786-0583
Email: korea@adlinktech.com

ADLINK Technology, Inc. (Israel Liaison Office)

SPACES OXYGEN, 62 Medinat, Ha-yehudim st
4673300, Herzliya, Israel, P.O.Box – 12960
Tel: +972-54-632-5251
Fax: +972-77-208-0230
Email: israel@adlinktech.com

ADLINK Technology GmbH

Hans-Thoma-Straße 11
D-68163 Mannheim, Germany
Tel: +49 621 43214-0
Fax: +49 621 43214-30
Email: germany@adlinktech.com

Ulrichsbergerstraße 17
D-94469 Deggendorf, Germany
Tel: +49 991 290 94–10
Fax: +49 991 290 94–29
Email: germany@adlinktech.com

ADLINK Technology, Inc. (French Liaison Office)

Bâtiment Thalès - Parc des Algorithmes,
Route de l'Orme des Merisiers,
91190 SAINT AUBIN, France
Tel: +33 (0) 1 60 12 35 66
Fax: +33 (0) 1 60 12 35 66
Email: france@adlinktech.com

ADLINK Technology, Inc. (UK Liaison Office)

First Floor West Exeter House,
Chichester fields Business Park Tangmere,
West Sussex, PO20 2FU, United Kingdom
Tel:+44-1243-859677
Email: uk@adlinktech.com

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