



NEXT-GENERATION CONDITION-BASED MONITORING

Technologies and Solutions for Industry 4.0



Status: Online

Good decisions require good information.

Predicting and diagnosing a machine's health before it becomes problematic requires insights that can only come from having accurate and reliable data. Analog Devices' focus on condition-based monitoring leverages next-generation technologies that enable effective and efficient monitoring of factory equipment, delivering high performance solutions that can lead to improvements in uptime, productivity, and quality.

Overview

Analog Devices, Inc. (ADI) is focused on delivering next-generation condition monitoring solutions that enable real-time monitoring of factory equipment. ADI's commitment to enabling condition monitoring and Industry 4.0 leverages decades of experience in MEMS sensor development, signal processing, and packaging techniques by helping our customers solve the most challenging problems. Deep signal chain and system design insights enable our customers to extract more value out of their system and improve their customers' processes.

Vibration, current, and temperature all provide key insights into the health of equipment ranging from motors and pumps to bearings and encoders.

Measuring vibration provides additional insights into machine health by further isolating mechanical noise from electrical noise, improving machine diagnostics.



Bearings

Initial signs of wear typically create high frequency noise that can only be detected with wide bandwidth, low noise vibration sensors or accelerometers. Wide bandwidths enable earlier detection of initial bearing wear caused by impacts created by small fragments of metal.



Misalignments and Imbalances

Small changes in shaft alignment or motor frame imbalances require low noise, stable accelerometers that detect subtle mechanical shifts that can impact motor performance.



Machine Tools

Increased vibration levels during high speed activities such as production milling or cutting can damage critical materials and reduce precision. Wide bandwidth, low noise sensors that sense irregularities can provide real-time data for feedback and machine control.





Features

- Wide Bandwidth
- ► Wide Measurement Range
- Low Noise
- Stability Over Temperature and Life
- Multiaxis
- Small Form Factor



Wired Signal Chain Example for Machine Tools

Critical applications that require higher bandwidth data for vibration monitoring, real-time feedback, and control require a robust, wired solution suitable for industrial environments. Reduced sensor size and overall form factors allow sensors to be placed closer to the vibration source, enabling more reliable measurements, which result in improved diagnostics and real-time machine control.



Wireless Signal Chain Example for Motor Monitoring

Monitoring of factory equipment in difficult to access locations requires wireless solutions that eliminate the need for extra cables while providing critical information over a robust wireless link. Low power components coupled with high performance sensors in compact form factors create new condition monitoring opportunities for a wide variety of factory applications, while minimizing the complexities of integrating into existing and new factory equipment.

Recommended Products

Integrated Vibration Monitoring Modules

Integrated modules combine ADI's high performance MEMS sensors with an optimized signal chain and embedded signal processing into a mechanically optimized package, enabling predictive maintenance solutions.

 On-board pre- processing User conf operating 			Jser configu operating m	rable odes	
Part Number	Axis	Range (g)	Resonance (kHz)	Nois <u>e</u> (µ <i>g</i> /√Hz)	Temp Range (°C)
ADcmXL3021*	3	50	21	25	-40 to +105
* Digital Output					

Sensors

ADXL1001

High performance sensors provide precision, stability,

► MEMS accelerometers

Part Number	Axis	Range (g)	Resonance (kHz)	Nois <u>e</u> (µ <i>g</i> /√Hz)	Temp Range (°C)
ADXL1001	1	100	21	30	-40 to +125
ADXL1002	1	50	21	25	-40 to +125
ADXL1003	1	200	28	45	-40 to +125
ADXL1004	1	500	45	125	-40 to +125
ADXL1005	1	100	42	75	-40 to +125
ADXL356	3	40	5.5	80	-40 to +125
ADXL357*	3	40	5.5	80	-40 to +125

* Digital Output

Wireless Radio

Enabling wireless industrial applications requires a robust, low power wireless interface. SmartMesh technology supports operation in harsh environments and simplifies network accessibility.

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Robust Stable Small footprints

Upstream Data Throughput (Max Packets/sec) Part Number Band (GHz) Temp Range (°C) LTP5902 2.4 24 -40 to +125

High performance sensors c	emand precision	
measurement. ADI's amplifie	rs and converters	
are optimized for sensor me	asurement.	
 High resolution 	 Simultaneous samp 	oling

High resolution

Amplifiers and Converters

Low noise

Part Number	Channel	Bits	Sample Rate (kHz)	Power (mW)	Temp Range (°C)
AD4008	1	16	500	2.5	-40 to +125
LTC2344	4	16 to 18	400	81	-40 to +125
ADAQ7980	1	16	1000	21	-40 to +125
AD7768-1	1	24	204	<37	-40 to +125

Processors

DEVICES	
ADuCM3027	
ALL AND	

ANALOG

AD4000

Converting information into insights requires powerful processors that enable efficient processing at the node, reducing wireless bandwidth requirements.

► Ultra low power Flexibility

Part Number	Core	Max Speed (MHz)	Flash/SRAM (Max kB)	Hibernate Current (nA)	Temp Range (°C)
ADuCM3027	M3	26	128/64	750	-40 to +85
ADuCM3029	M3	26	256/64	750	-40 to +85
ADuCM4050	M4F	52	512/128	680	-40 to +85

Isolated Digital Interface

Harsh industrial environments require robust, isolated signals to drive long cable lengths and minimize interference.

- ► *i*Coupler[®] technology reduces board space requirements
- Industrial operating temperature ranges
- Support long cable lengths

Part Number	Channel	Data Rate (Max Mbps)	Insulation Rating (kV rms)	Temp Range (°C)
ADM2486	1	20	2.5	-40 to +85
ADuM4150	6	40	5	-40 to +125
ADN4651	2	600	5	-40 to +125





Maintaining system performance is only as good as the power supplies that support the system. Power by Linear™ provides efficient and flexible solutions to support a wide breadth of applications.

Low noise		 Stable 	e	Small footprints		
Part Number	Туре	V _{iN} Range (V)	V _{out} (V)	Max Out Current (mA)	Temp Range (°C)	
LTC1928	Doubler	2.7 to 4.4	5	30	-40 to +85	
ADP5300	Switch	2.15 to 6.5	0.8 to 5	500	-40 to +125	
LTC3499	Switch	1.8 to 5.5	2 to 6	750	-40 to +85	
ADP7118	LDO	2.7 to 20	1.8 to 5	200	-40 to +125	

New Release ADcmXL3021: Wide Bandwidth, Low Noise, Triaxial Vibration Sensor

The ADcmXL3021 is a complete vibration sensing system that combines high performance vibration sensing (using micro-electromechanical systems (MEMS) accelerometers) with a variety of signal processing functions to simplify the development of smart sensor nodes in condition-based monitoring (CBM) systems. The typical ultralow noise density (26 μ g/ \sqrt{Hz}) in the MEMS accelerometers supports excellent resolution. The wide bandwidth (dc to 10 kHz within 3 dB flatness) enables tracking of key vibration signatures on many machine platforms.

The signal processing includes high speed data sampling (220 kSPS), 4096 time sample record lengths, filtering, windowing, fast Fourier transform (FFT), user configurable spectral or time statistic alarms, and error flags. The serial peripheral interface (SPI) provides access to a register structure that contains the vibration data and a wide range of user configurable functions.

The ADcmXL3021 is available in a 23.7 mm \times 27.0 mm \times 12.4 mm aluminum package with four mounting flanges to support installation with standard machine screws. This package provides consistent mechanical coupling to the core sensors over a broad frequency range. The electrical interface is through a 14-pin connector on a 36 mm flexible cable, which enables a wide range of location and orientation options for system mating connectors.

The ADcmXL3021 requires only a single, 3.3 V power supply and supports an operating temperature range of -40 °C to +105 °C.

Evaluation Kit: EVAL-ADCM

TThe EVAL-ADCM is a simple to use kit that allows quick performance evaluation of Analog Devices 3-axis, digital output MEMS vibration sensing module. The ADcmXL3021 module consists of 3 single axis, ultra low noise, high bandwidth ADXL1002 accelerometers, a fully implemented signal chain and MCU to incorporate configurable digital FIR filters, spectral analysis through internal FFT, configurable alarm monitoring, and time domain capture and statistical analysis. The EVAL-ADCM is ideal for evaluation of the ADcmXL3021 vibration sensing module since the kit readily provides full spectrum experience of all features of the module.



Key Features

- ► Triaxial, digital output MEMS vibration sensing module
- ► ±50 g measurement range
- Ultralow output noise density, 26 μg/√Hz (MTC mode)
- Wide bandwidth: dc to 10 kHz within 3 dB flatness (RTS mode)
- ► Embedded fast data sampling: 220 kSPS per axis
- 6 digital FIR filters, 32 taps (coefficients), default options:
 - High-pass filter cutoff frequencies: 1 kHz, 5 kHz, 10 kHz
- Low-pass filter cutoff frequencies: 1 kHz, 5 kHz, 10 kHz
- User configurable digital filter option (32 coefficients)



Features and Benefits

- ▶ The EVAL-ADCM kit includes one ADcmXL3021 module
- ► Easily connects to PC for full features evaluation
- > Evaluation software for effortless configuration of the module, register setup, data display, and data logging
- ▶ High-speed SPI to USB adaptor for high data rate Real Time Streaming (RTS)



Authorised Analog Devices Distributor and Highly Qualified Test and Programming House



- ► Programming
- ► Marking (Lasers, labels, colour-coding)
- ► Taping





- Logistic requirements
- ► Consignment warehouse
- Just in TimeKanban
- Ship to stock
 - Semitron Test House Services
 - Optical / visual inspections
 - Authentication
 - Component testing
 - Selections
 - Heat treatment
 - Component analysis
 - ► Component programming
 - Mechanical processing
 - ► Tape & reel service
 - Scanning and straightening of component connection pins
 - Dry packing



- Data sheet checks
- Selection
- Thermal tests
- Fully-automated handling



Taping Options

- ► Axial components (DIN IEC-286-1), diodes, resistors, capacitors
- ▶ Radial components (DIN IEC-286-2), ELKOs, LEDs, transistors, etc.
- ▶ SMD taping (EIA-481-1A), SOIC, PLCC, TSOP, SSOP, QFP, etc.





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