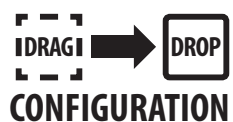




PROGNOST®-SILver

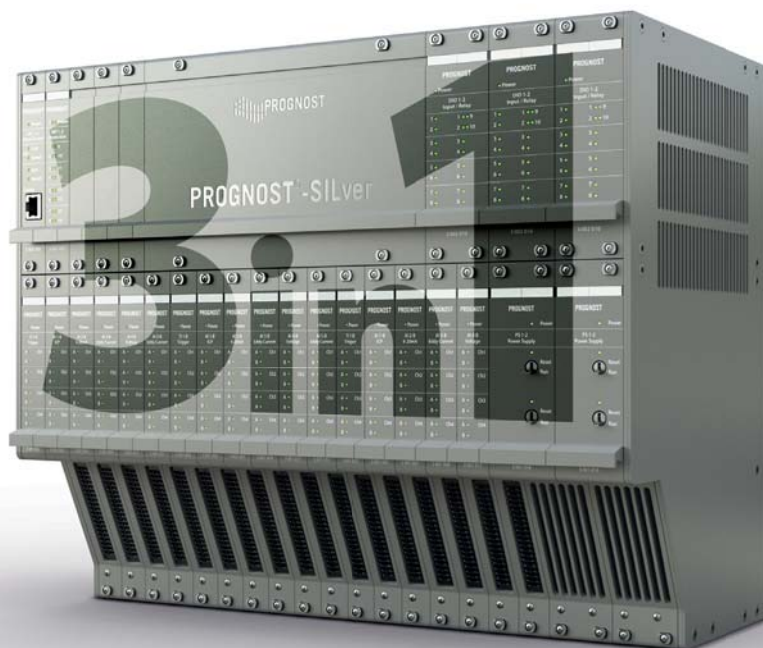
SIL 3 Machine Protection for Rotating Equipment



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Condition Monitoring, Machine Protection, and ESD



Meets your needs – for all machinery

PROGNOST®-SILver is a flexible and fast platform for integrated asset protection. It offers everything operators and instrumentation professionals call for:

- condition monitoring
- machine protection
- diagnostic based SIL 3 certified emergency shutdown device

All this in one rack. This system is designed to provide machinery protection while maximizing production uptime.

This hardware incorporates a smart modular concept that enables you to gradually replace or expand your existing system for additional protection tasks. It also allows users of previous PROGNOST®-SILver racks to re-use their existing PROGNOST® input cards.

Focus on reciprocating equipment

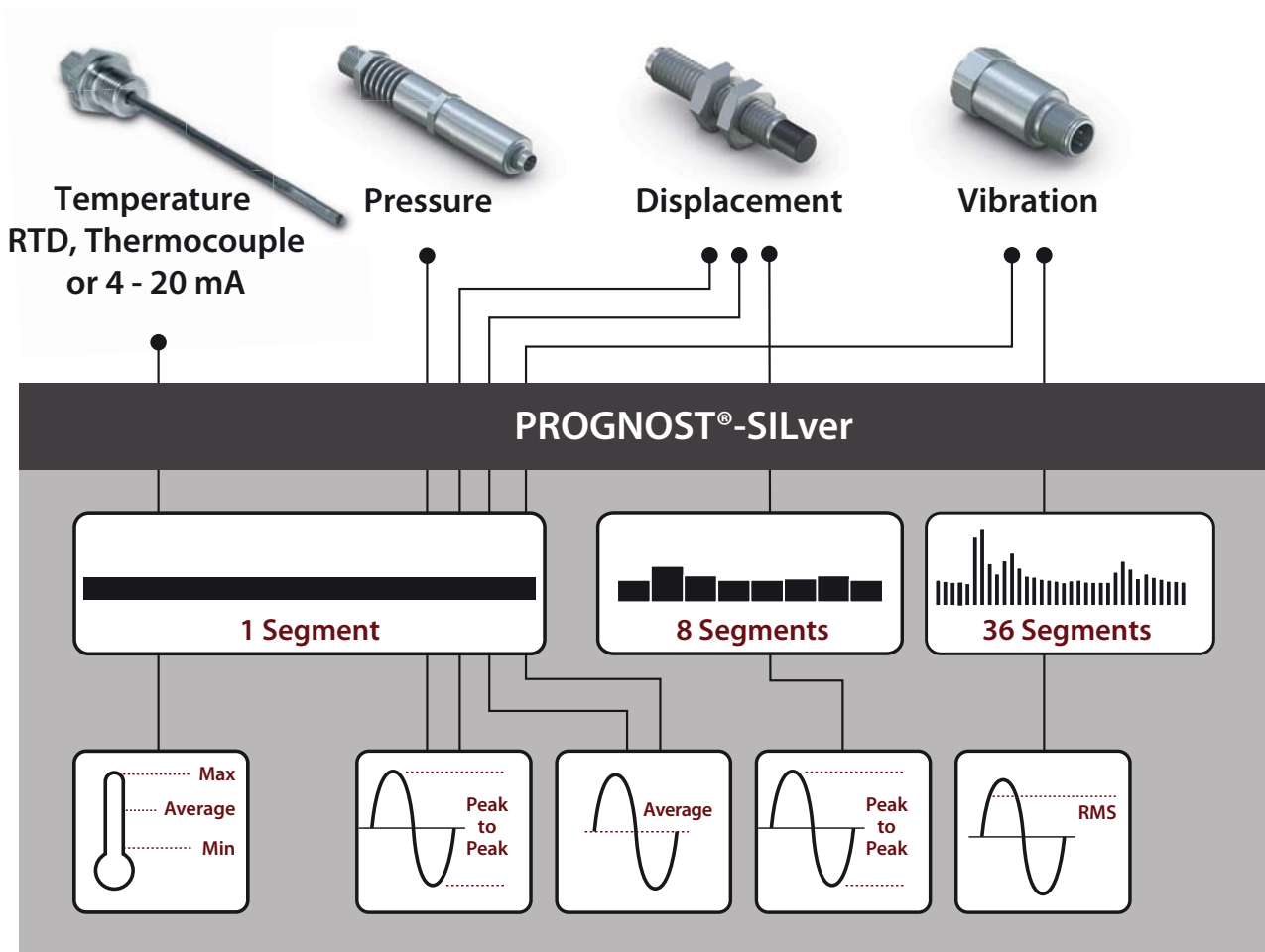
Reliable monitoring of reciprocating machinery bears a list of challenges. PROGNOST Systems started to create dedicated solutions 25 years ago with the invention of the, still today, industry standard of segmented signal analyses. PROGNOST®-SILver comes with the DNA of millions of monitored operating hours of reciprocating compressors based on specialized

analyses. Signal plausibility checks, proven reliable monitoring and protection analyses guarantee no false trips and no missed detects.

Features at a glance

- Powerful and proven reliable signal analyses
- 3 in 1: Condition monitoring, machine protection and emergency shutdown device
- For all machinery with focus on reciprocating equipment
- IEC61508 (2010) SIL 3 certificate by design
- 68 input channels, 30 relay outputs onboard, 24 digital inputs and up to 272 temperature channels
- Monitors up to 32 machines in parallel
- User-friendly PROGNOST®-Admin software for drag and drop configuration of:
 - Cards and channels
 - Sensors and DCS inputs and outputs
 - International channel naming
 - Voting logic, Exception Ranges, Trip Multiplier and much more
- Installation in hazardous areas
- Hot swappable cards
- Redundant power supply
- Easy upgrade of existing PROGNOST®-SILver racks

PROGNOST®-SILver protection analyses



Segmented vibration analyses for reciprocating compressors

PROGNOST Systems invented segmented vibration analysis and determined that the best approach is to subdivide the 360° of one revolution into 36 segments of 10° crank angle each. This is the most accurate proportion of an average impact width related to one revolution.

Crosshead slide: RMS vibration in 36 segments

Crosshead slide vibrations provide information about machine integrity. Reciprocating machinery has specific vibration characteristics that need to be factored in to avoid false alarms. Vibration signals must be evaluated using the most accurate analysis. For reciprocating machinery, only RMS (Root Mean Square) analysis has proven reliable because it considers not only amplitude, but also the energy content of an impact.

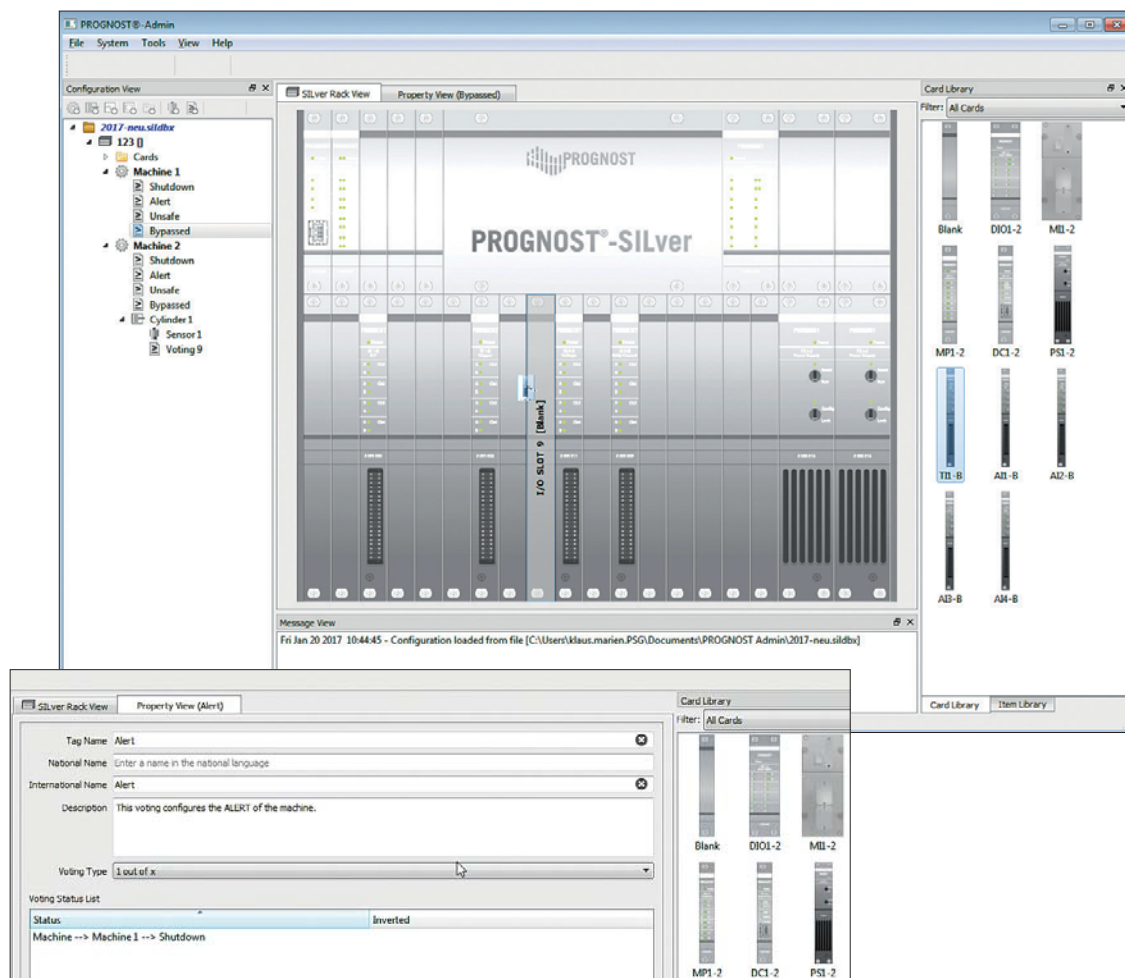
Piston rod position: Peak-to-Peak in 8 segments

The piston rod position is monitored and analyzed in 45° crank angle increments for every revolution to detect critical conditions of the piston rod and packing. A transfer of the average piston rod position to the DCS for rider ring monitoring is also available at the same time.

Further analyses

- Plunger position peak-to-peak
- Gap protection
- Cylinder pressure peak-to-peak (differential pressures)
- Radial shaft vibration peak-to-peak
- Axial shaft position peak and average
- Vibration RMS and peak
- Temperature average

User-friendly rack configuration with PROGNOST®-Admin



Convenient and time-efficient configuration

- User friendly, self-explaining, intuitive usage
- Dedicated configuration rights avoid unauthorized access
- Configuration secured by hardware lock and password
- Communication of the hardware rack with the configuration software via Ethernet protocol

Library for drag and drop selections

An extensive library of pre-defined machine types, machine components, and sensors allows drag and drop configuration of machines, sensors, cards, analyses, voting logic, and much more.

National and international naming

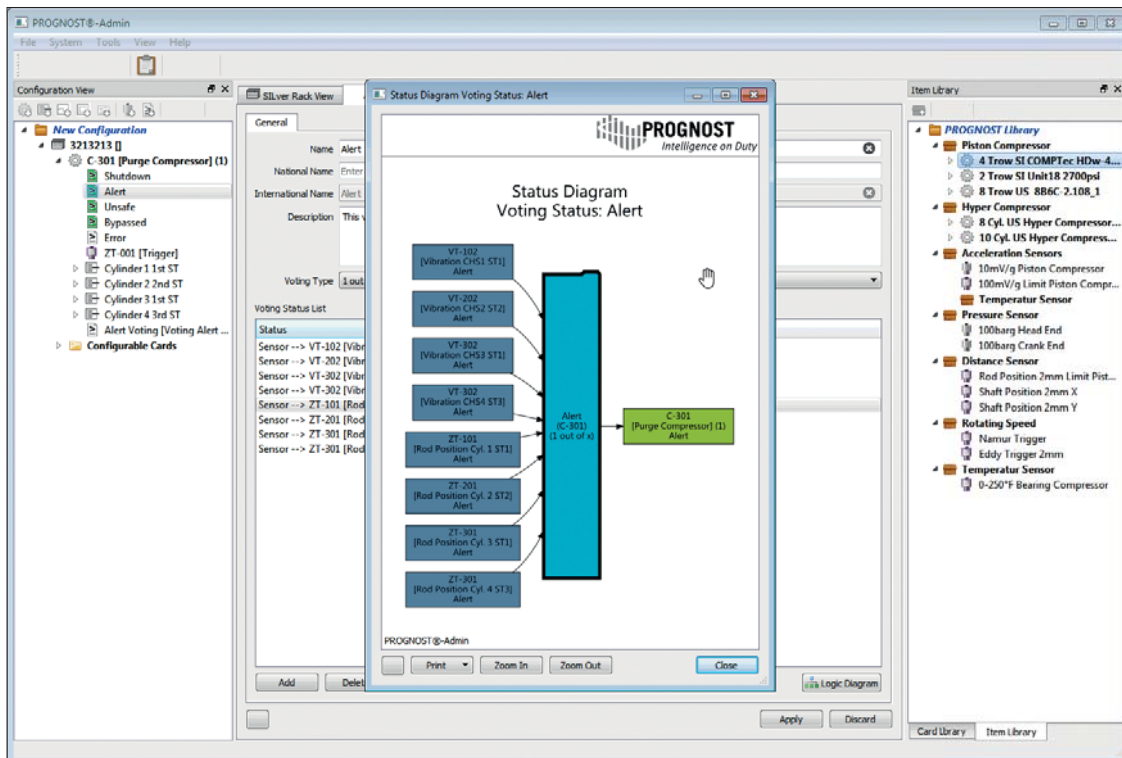
The multilingual approaches of PROGNOST®-SILver, as well as PROGNOST®-Admin, allows the naming of machines, components, TAGs, loops, etc., in almost any language.

Individual analysis period setting

Different machines require different settings. PROGNOST®-SILver can be configured so that all analyses perfectly match individual machine requirements.

- Speed and phase reference (crank angle)
(Reciprocating compressors)
- Speed and time base (speed range)
(Centrifugal machinery)
- Time base

Voting logic, exception ranges and trip multiplier



SIL 3-certified voting logic

PROGNOST®-SILver offers an unparalleled variety of voting options. PROGNOST®-Admin, the easy-to-use hardware configuration tool included with the system, allows you to use simple drag and drop features to set up highly sophisticated, multi-level voting schemes.

- Voting configuration with pre-defined functional blocks
- Alarm logic up to five logic levels
- Voting options: 1 out of X, 2 out of X, all out of X
Voting results can factor into other voting groups
- Voting logic triggers relay outputs
- Alarm logic can factor in any status value (e.g., exception ranges, sensor, signal, analyses, digital input, voting results)
- Bypass on machine and sensor level

Exception ranges

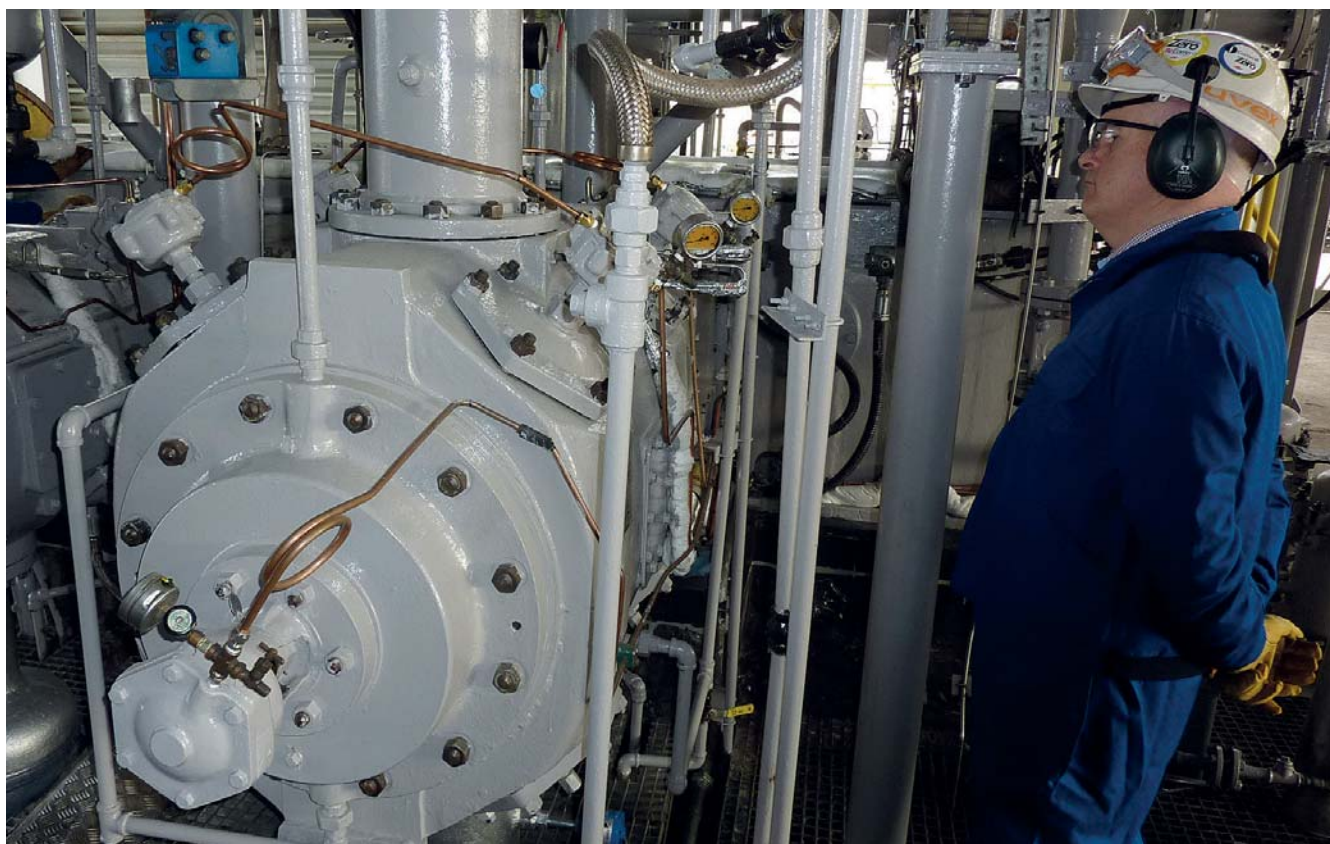
The operation of centrifugal machinery requires flexible protection limit setting during defined operating conditions such as start-up or shutdown to avoid false trips.

PROGNOST®-SILver offers four different exception ranges which automatically adjust protection limits during pre-defined machine operating conditions to eliminate the risk of unjustified trips or alarms.

Trip multiplier

PROGNOST®-SILver protection limits can be adjusted with signals from the DCS to multiply the thresholds and avoid alarming when operating conditions change, e.g., load steps, speed, start-up and machine shutdown.

Installation in hazardous areas saves wiring costs



Significantly reduced wiring costs

You can achieve huge savings with the protection rack installed in hazardous areas, i.e. Zone 2. Direct and short wiring from the sensor to the PROGNOST®-SILver input eliminates expensive field wiring, such as lines from the junction box to the rack cabinet. Not only is the cost per loop reduced, but also the cost for housings because PROGNOST®-SILver can operate in Zone 2 without costly Exd- or purged Exp-housings. With Ethernet and fibre optics, a distance of > 1.000 meters from the protection rack (MPS) to the control room (CMS) is possible.

Seamless integration of existing instrumentation

Sensors and wiring are costly components of monitoring system retrofits or expansions. PROGNOST®-SILver is flexible enough to allow you to use existing sensors and save

money. The possibility to mix of Exi and Non-Ex signals, e.g. motor winding temperatures or motor current signals in one protection rack, without the need for barriers, yields the highest cost efficiency.

Broad certification of PROGNOST®-SILver

Meeting the latest and most rigorous industry standards provides neutral, third-party confirmation of our product performance promise. PROGNOST®-SILver holds, besides others, the following certificates: IEC61508:2010 (SIL 3), ATEX, IECEx, US/CSA, KOSHA, GOST-R-Ex. The number of certificates grows steadily; please refer to our website to see the full list.

Three output cards with up to 30-SIL certified relay contacts



30 relay outputs with SIL 3 certification

The sole task of machine protection systems (MPS) is to avoid major secondary damage. In case of demand, the MPS must shut down your machine reliably. To execute alarms, PROGNOST®-SILver can accommodate up to 3 DIO cards with 30 SIL 3 certified relay outputs on board which can be individually assigned to any ALERT, SHUTDOWN, UNSAFE status or voting logic output of the system.

With PROGNOST®-SILver, you do not need an additional ESD or Safety PLC since all relays are on board and certified for operation in Zone 2.

Digital inputs for signal processing from the DCS

PROGNOST®-SILver takes in up to 24 digital inputs from the DCS system. This enables the system to trigger commands such as "Bypass machine" or "Bypass channel", as well as "Reset shutdown inputs" or "Activate exception range". You get maximum flexibility without compromising SIL compliance during all machine operation situations.

Technical details of input and interface cards

Description	Measurement parameters	Input parameters
AI1-B ICP	Vibration (acceleration) Crosshead, cylinder, bearing Frame (crankcase) Vibration (velocity) Casing, bearing, piping	Anti-aliasing filter 16-bit resolution Intrinsically safe inputs 4 channels
AI2-B 4-20 mA	Indicated cylinder pressure Compression chamber Suction/discharge pressures Piping Temperatures Bearing, gas, valve	Bessel low pass filter 8 adjustable cut-off frequencies 16-bit resolution Intrinsically safe inputs 4 channels
AI3-B Eddy Current	Dynamic position (displacement) Piston rod position, plunger position Shaft vibration, axial thrust	Anti-aliasing filter 16-bit resolution Intrinsically safe inputs 4 channels
AI4-B Voltage	Indirect pressure measurement Cylinder tie rod, strain gauge	Input voltage range +/-10, +/-5, +/-2, +/-1 Volt Anti-aliasing filter 16-bit resolution Intrinsically safe inputs 4 channels
AI6-2 Temperature	Temperatures	2-/3-/4-wire PT 100/1000 or thermocouple Intrinsically safe inputs 16 channels
CI1-2 Communication Interface	Interfaces with DCS Modbus RTU, TCP	2x RTU 1x TCP
MI1-2 Monitoring Interface	Interfaces with PROGNOST®-NT	FO-connector LC
TI1-B Trigger	Phase reference	NAMUR input according EN 60947-5-6 Detection of trigger cam or hole Intrinsically safe inputs 4 channels

Intrinsically safe channels in 17 slots

PROGNOST®-SILver is the only protection hardware that offers 68 safe and SIL certified inputs. A single PROGNOST® rack takes in signals from extensive instrumented production assets or from various machines in parallel. In addition, the system can monitor 272 temperature signals in parallel. For you, this means both large capacity and high cost-efficiency.

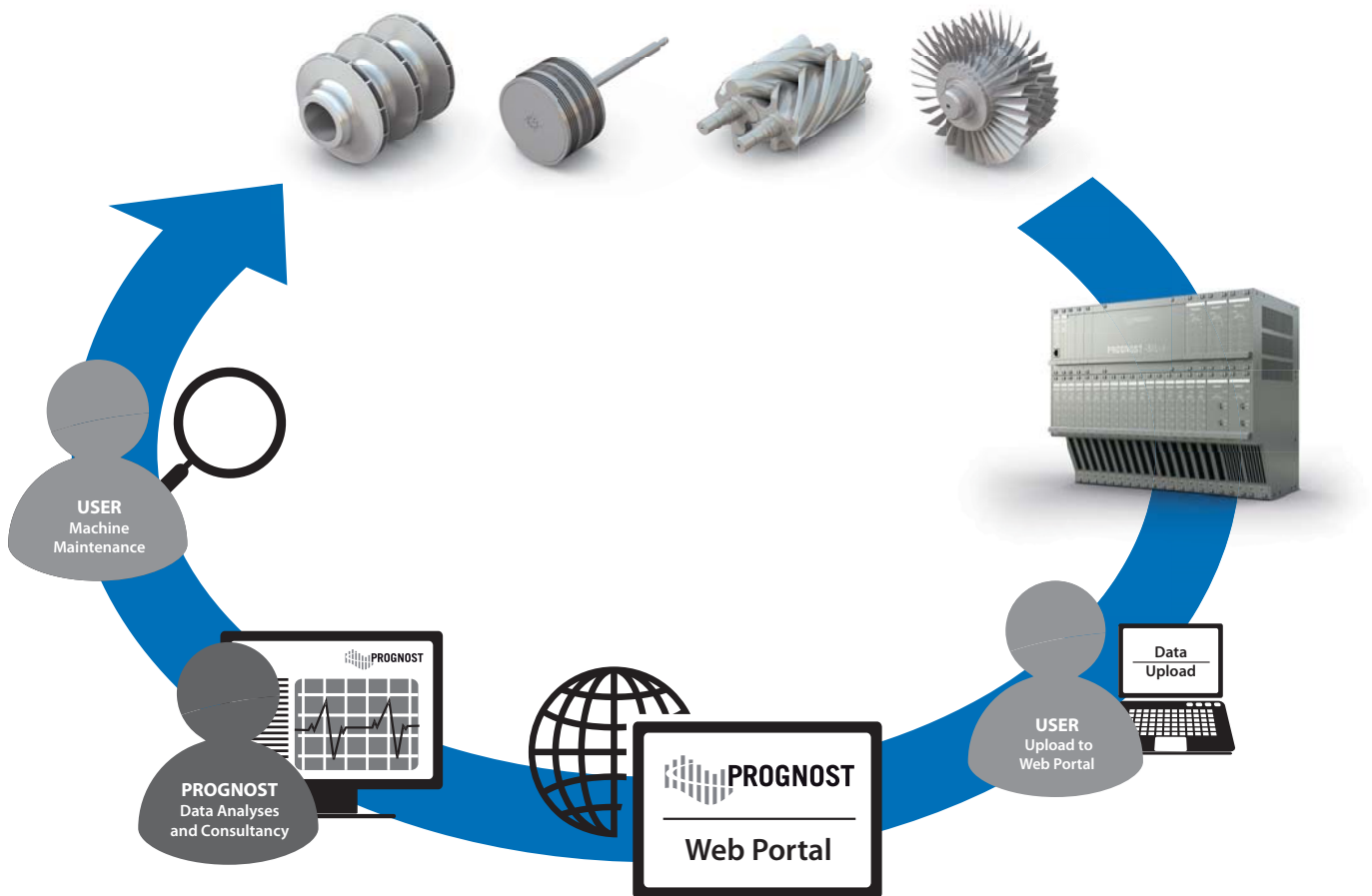
No barriers required

PROGNOST®-SILver has for all channels intrinsically safe Exi inputs on board. The Galvanic isolation per channel provides high interference resistance.

Technical data for analog input (AI) cards

- Galvanic separation of each input channel
- 2 A/D converters per channel (redundancy)
- Sampling rate 25 kHz per channel prepared for 100 kHz
- DSP and FPGA technology
- Card self test
- Continuous signal integrity check:
 - Failure detection open circuit
 - Failure detection short circuit
 - Failure detection by redundant signal processing
 - Failure detection voltage supply
- Out of range

Data recording for root cause analyses



Signal analyses after emergency shutdown

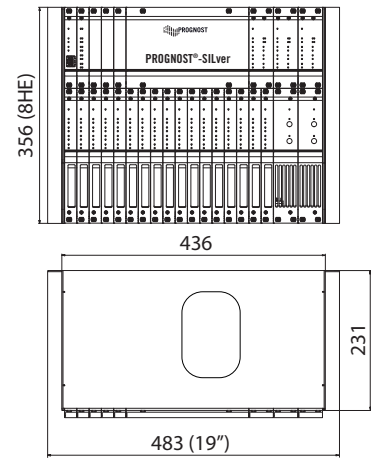
While critical machines usually demand a full condition monitoring system, such as PROGNOST®-NT, less critical machines in many cases only call for a machine protection system. But what happens after the protection device initiated a shutdown? How can you determine the root cause of the problem?

Users of PROGNOST®-SILver get the answers from diagnostic specialists. Support is available on demand in case of an emergency shutdown or any other operation-critical situation. This unique service requires an optionally available

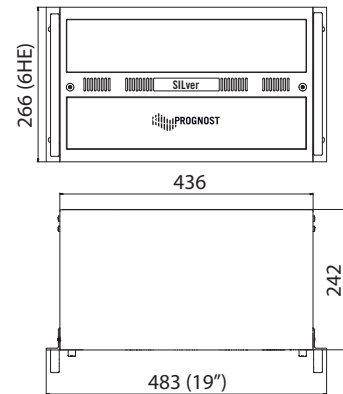
recording function. After retrieving data from the affected machine, the PROGNOST Customer Support team will communicate initial findings and, if requested, followed by a written report with detailed conclusions. This meaningful failure analysis is based on:

- Ring buffer with transient recordings of all online signals before and during the shutdown
- Trends of the monitored parameters, and
- A protocol with all status information such as alarms per machine, per sensor, and per PROGNOST®-SILver card

When imminent demands threaten your MPS



EASY  GRADE



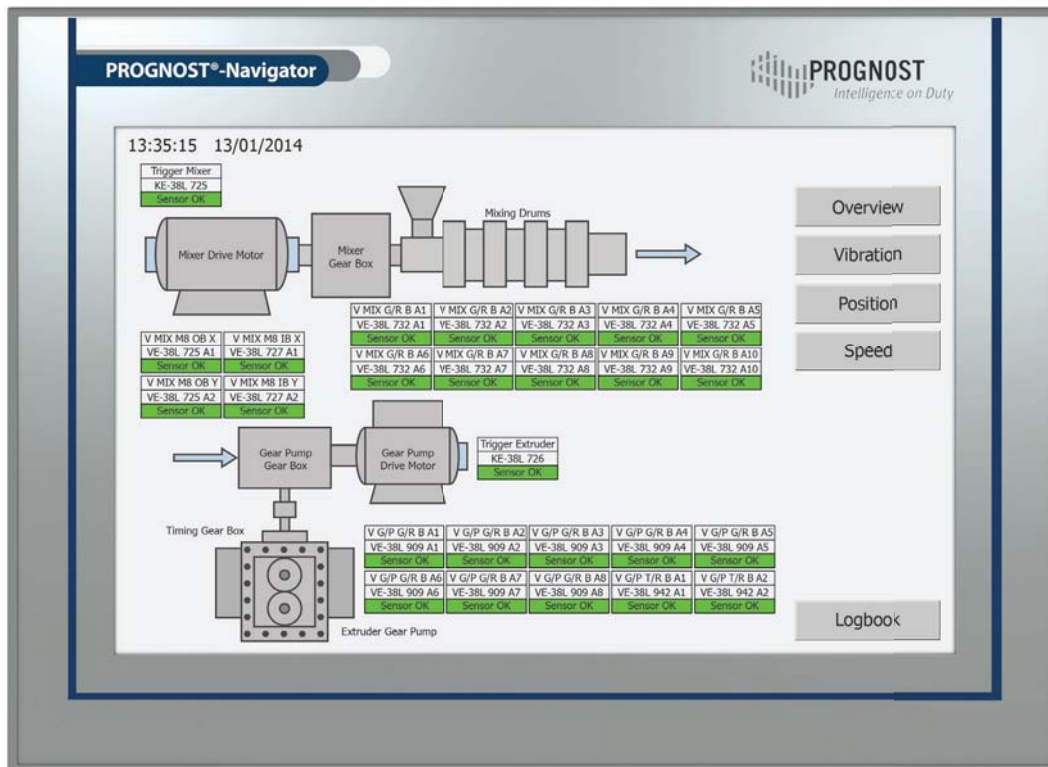
Using existing PROGNOST®-SILver cards saves money

An adapter card allows current PROGNOST®-SILver users to use their input cards in the new PROGNOST®-SILver platform.

This saves money and is a convenient and efficient upgrade to the latest PROGNOST® protection technology. Additionally you can use the new powerful and easy-to-use PROGNOST®-Admin software to configure existing input cards.



PROGNOST®-Navigator field display in Zone 2



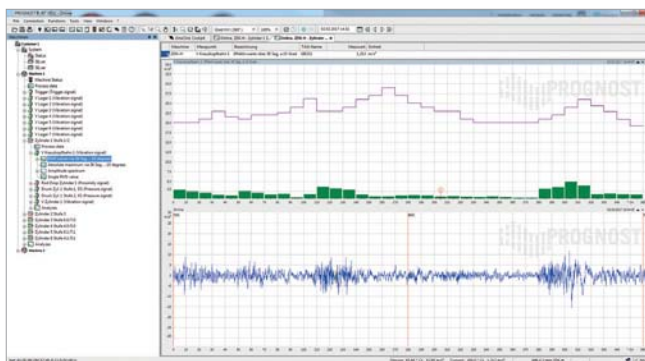
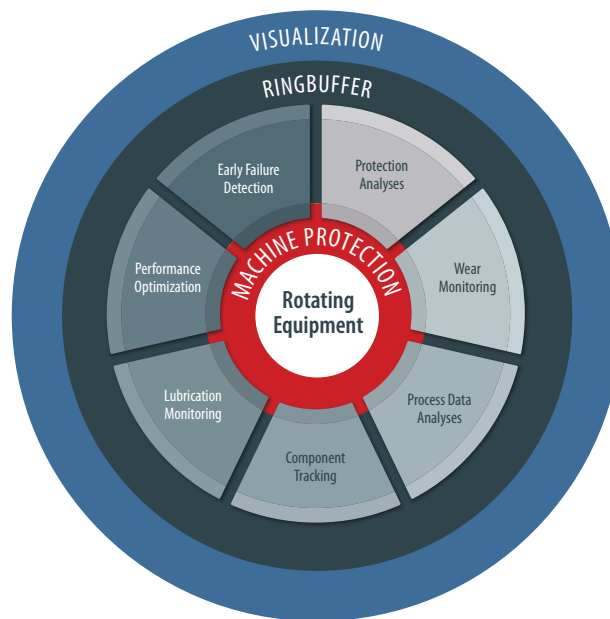
PROGNOST®-Navigator field display (HMI)

- Machinery status information near the machine; especially useful during machinery start-up
- Basic trend data
- Individual sensor and loop status information (ALERT, SHUTDOWN, UNSAFE)
- Intuitive information drill-down
- Easy access to PROGNOST®-SILver status information
- Health & configuration status of PROGNOST®-SILver
- Certificates:
 - ATEX Zones 2 and 22
 - FM Class / Div 2
 - cULus Class / Zone 2
 - 12" display

Available screens:

- Monitoring information of up to 32 machines
- PROGNOST®-SILver system status
- Service logbook

Online diagnostics with PROGNOST®-NT



Online diagnostics with PROGNOST®-NT

PROGNOST®-NT is the perfect solution for critical and non-critical machines. Users who want to extend their MTBM by early failure detection rely on at least some of the PROGNOST®-NT capabilities. The PROGNOST®-NT software modules can be customized depending on your monitoring strategy and/or the failure history of your machines.

Automated machinery diagnostic system incorporating PROGNOST®-SILver safety protection and online condition monitoring

PROGNOST®-NT not only reveals problems, but also provides an accurate diagnosis with specific component identification, location and indication of the extent of damage. Equipped with this information, you can make well-in-

formed decisions about the type and timing of maintenance procedures you need.




Automatic detection of operating conditions

PROGNOST®-NT recognizes changing machine operating conditions and automatically switches to corresponding, pre-defined threshold settings to avoid false warnings caused by changing load conditions.




Pattern recognition with fully integrated diagnostic database

All major failure modes are integrated within a failure pattern database and can be diagnosed automatically, providing clear text messages including failure type and location of the failing component.

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