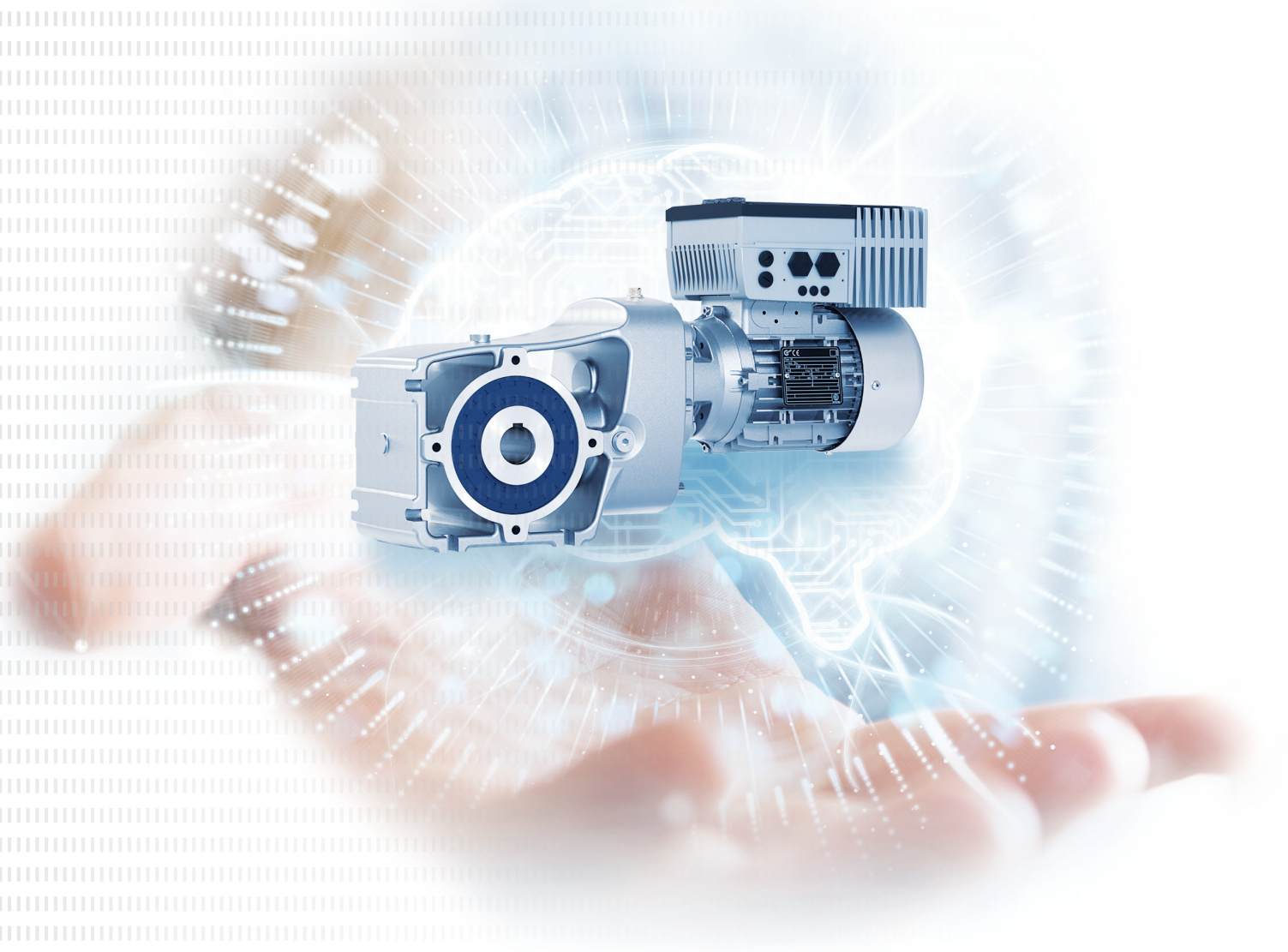
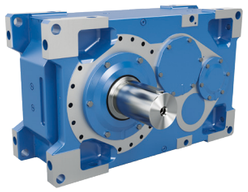


Condition Monitoring for Predictive Maintenance

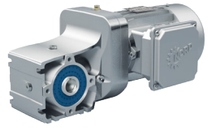
The intelligent drive

NORD DRIVESYSTEMS

NORD DRIVESYSTEMS Group



Industrial gear units



Geared motors

Frequency inverters and motor starters

- Headquarters and technology centre in Bargteheide near Hamburg.
- Innovative drive solutions for more than 100 branches of industry.
- 7 production locations with cutting edge technology produce gear units, motors and drive electronics for complete drive systems from a single source.
- NORD has 51 subsidiaries in 36 countries and further sales partners in more than 50 countries, providing local stocks, assembly centres, technical support and customer service.
- More than 4,000 employees throughout the world create customised solutions.

Headquarters in Bargteheide

Gear unit production

Inverter production

Motor production

Production and assembly

Motor mounting

General

In the context of the NORD DRIVESYSTEMS Group's CONDITION MONITORING for PREDICTIVE MAINTENANCE, dynamically calculated and operating values captured by sensors are evaluated and provided for further processing. The frequency inverter captures and processes operating values independently of an external controller using the frequency inverter in combination with its integrated PLC. The results are continuously provided via the PLC output parameters and can be sent and saved to a local dashboard via Industrial Ethernet (e.g. PROFINET IO) for visualisation. In addition to all internal measuring values, each drive unit can be used to evaluate external sensors such as a temperature sensor (PT1000 in the motor winding) or a vibration transmitter. Processing of measurement values and preparation of output signals is carried out dynamically and individually in each frequency inverter with the aid of its integrated PLC. There is also the option of defining threshold values which trigger an alarm if they are exceeded. All output signals from the frequency inverter's data processing are also provided for further processing via the bus interface and are read out via the dashboard. The dashboard is the data storage unit for all captured operating drive values. Due to the detailed visualisation of each drive, it is also the interactive interface to the operator.

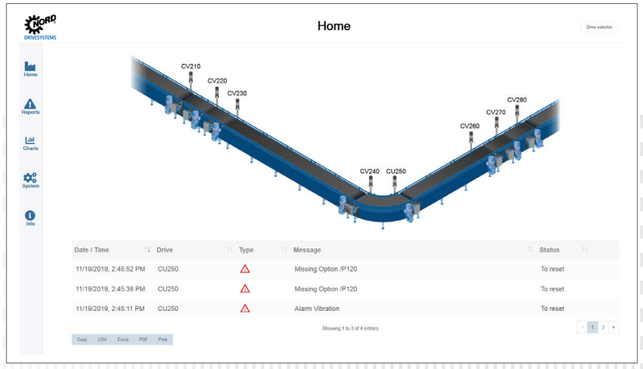
Warning and alarm messages

Each drive can signal its CONDITION MONITORING status, e.g. with an external signal column with the colours green, yellow and red.

- Green: No warnings and errors
- Yellow: At least one of the four measurements has exceeded the warning limit or a warning is present in the frequency inverter
- Red: At least one of the four measurements has exceeded the alarm limit or the frequency inverter has switched to the error state

In parallel, the warning and alarm messages of all drives are visualised on the dashboard.

NORD dashboard: Graphic overview of the application



Condition Monitoring for Predictive Maintenance

For CONDITION MONITORING, drive and status data are recorded periodically or continuously in order to optimise the operational safety and efficiency of machines and plants. CONDITION MONITORING can provide important information for PREDICTIVE MAINTENANCE. The objective is to maintain machines and plants proactively, to reduce downtimes and to increase the efficiency of the entire plant.

Advantages for our customers

- Detection and avoidance of impermissible operating states at an early stage
- Status-oriented maintenance instead of time-based maintenance
- Scheduled machinery and plant downtimes based on real drive and process data
- Reduction of service and material costs
- Longer service life of components and machinery
- Increase in system availability
- Avoidance of unplanned downtimes
- Predictable and cost-optimised repairs

CONDITION MONITORING

The INDUSTRIAL INTERNET of THINGS (IIoT) focuses on use of the internet in industrial processes and procedures. IIoT aims to increase operational efficiency, reduce costs and speed up processes. Sensors and sensor data play a central role to provide the basis for CONDITION MONITORING and PREDICTIVE MAINTENANCE.

- CONDITION MONITORING solutions for PREDICTIVE MAINTENANCE systems integrated into the frequency inverter
- System is IIoT / Industry 4.0 READY!
- Available for decentralised and control cabinet solutions

Sensors

- Interface for digital/analogue sensors
- Virtual sensors – the PLC can calculate information such as the optimal time for oil change

Communication interfaces

- Threshold values or general status information can be communicated externally (via normal Industrial Ethernet dialects)

Integrated PLC

- Local pre-processing of data with the integrated PLC
- Pre-processing of threshold values

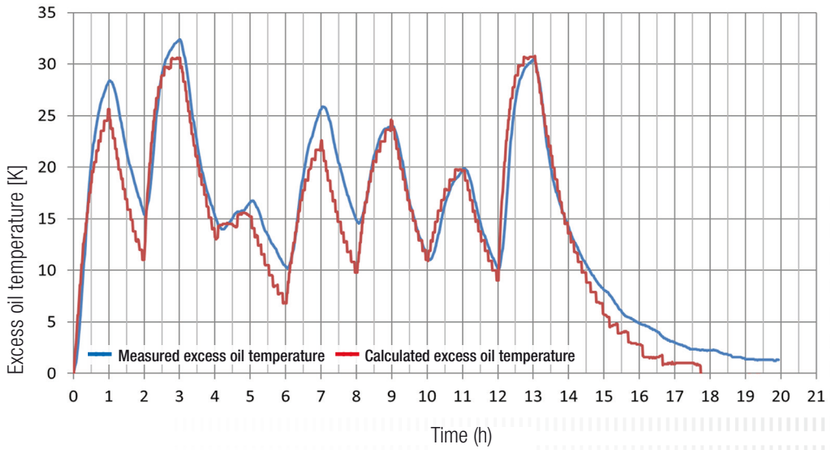
PREDICTIVE MAINTENANCE

Information from CONDITION MONITORING can be transferred to PREDICTIVE MAINTENANCE.

Drive-based approach

- Sensorless determination of the optimum oil change time based on virtual oil temperature
- Pre-processing of drive data in the integrated PLC
- Provision of this data to the customer via all common interfaces

Gear unit oil temperature curve



Optimum oil change time

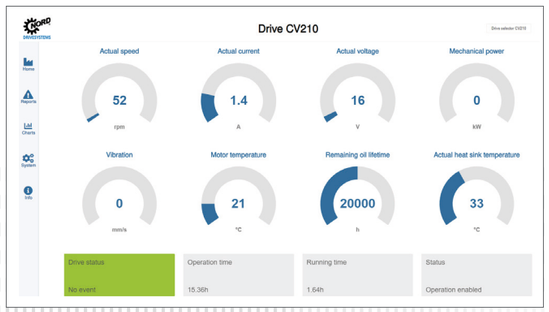
- Gear unit parameters and specific operational parameters make it possible to precisely calculate the oil change time
- The NORD solution is based on the fact that the oil temperature is a key factor for oil ageing in gear units
- A hardware temperature sensor is not needed, because virtual sensors calculate the current oil temperature continuously using drive-specific parameters
- The existing NORD frequency inverter is used for evaluation: The algorithm is executed the internal PLC

Condition Monitoring for Predictive Maintenance

Visualisation of defined drive information parameters

Actual speed	Motor speed	Actual current	FI output current
Actual voltage	Output voltage (FI)	Mechanical power	Mechanical power of the motor
Vibration	Vibration levels	Motor temperature	Motor temperature
Remaining oil lifetime	Remaining useful life of the gear oil	Actual heat sink temperature	Temperature on FI heat sink
Drive status	Drive condition	Operation time	Duration of operation, i.e. FI is switched on
Running time	Enabling time of the FI	State	FI condition

View of the transferred information parameters for a drive



Scope of functions

A series of three function ranges are available for condition monitoring (CM). The NORD SMART OIL CHANGE function (SOC) is available as an option.

CM1

CM1 includes transfer of selected information parameters from the frequency inverter to a database in a local IPC. The integrated PLC of the frequency inverter is not used. An Ethernet interface in the frequency inverter is necessary to transfer the data to the local IPC.

CM2

CM2 additionally uses the integrated PLC of the frequency inverter for threshold-based evaluation of external sensors (vibration sensor and motor temperature) or drive information parameters,
The NORD SMART OIL CHANGE function is available as an option.

CM3

CM3 provides visualisation of the data for each drive in a proprietary NORD dashboard.

SOC

The optional SOC function enables determination of the optimum oil change time on the basis of the virtual oil temperature. The algorithm runs in the integrated PLC. At present this function is available for 2-stage bevel gear units.

The data are updated in real time in the charts. Via a calendar function it is also possible to view data from the past.

Detailed chart, available for all of the values shown above

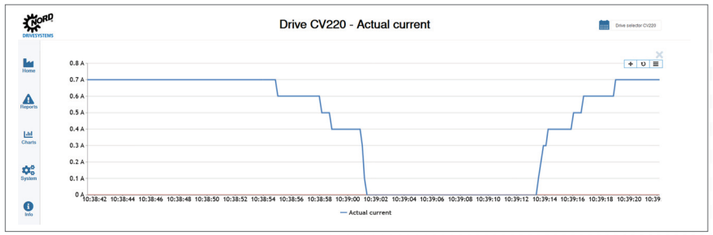
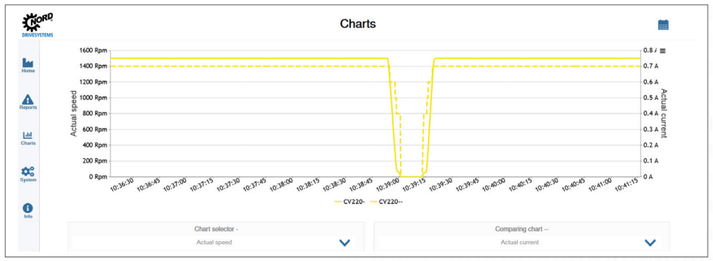
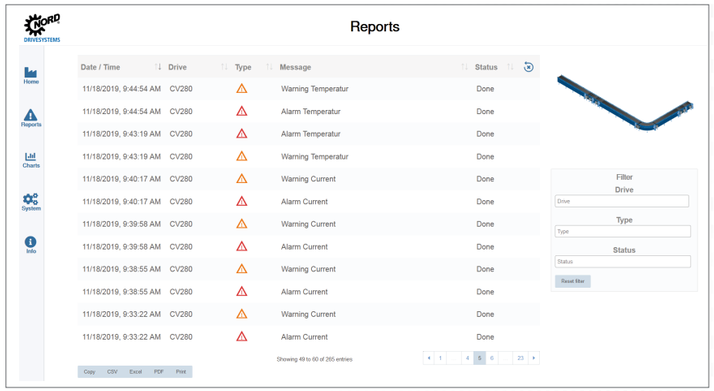


Chart selector: Comparison of two parameters between several drives



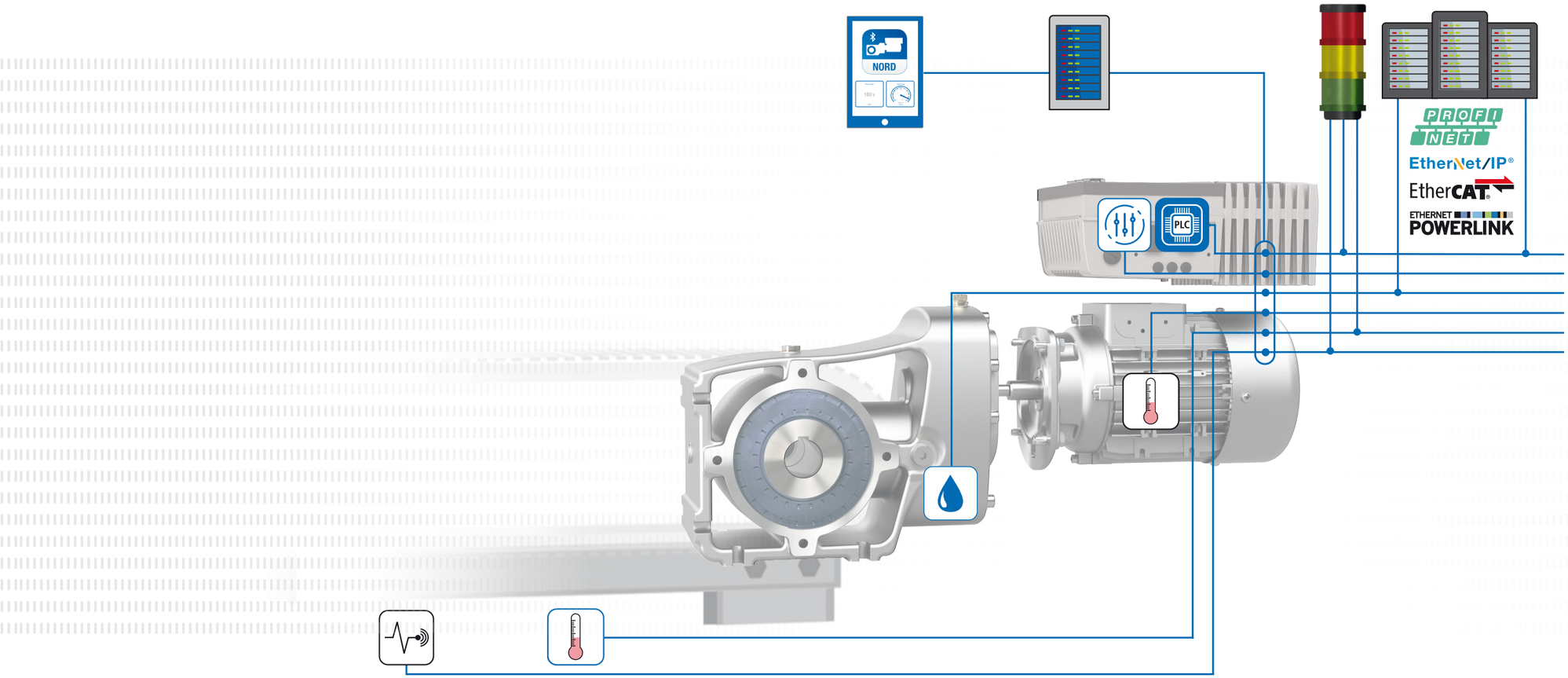
Reports: Display of pending or acknowledged faults and warning messages



Parameterisation on the frequency inverter

In general, these functions are fixed. The user can only adjust the alarm threshold values. The threshold values for warning messages are derived from the alarm threshold values on a percentage basis.

Condition Monitoring for Predictive Maintenance



System vibration sensor
- NORD qualified sensors
- Connection of customised sensors (analogue / digital)

Temperature sensor
- PT1000-based motor temperature sensor
- Ambient or system temperature

Oil change
- Determination of the optimal time for oil change on the basis of the virtual oil temperature
- The algorithm is executed in the integrated PLC

Drive parameters
- Readout of drive system parameters
- Basis for virtual sensors

Integrated PLC
- Pre-processing of drive-specific parameters and sensors related to the drive
- Evaluation of drive conditions

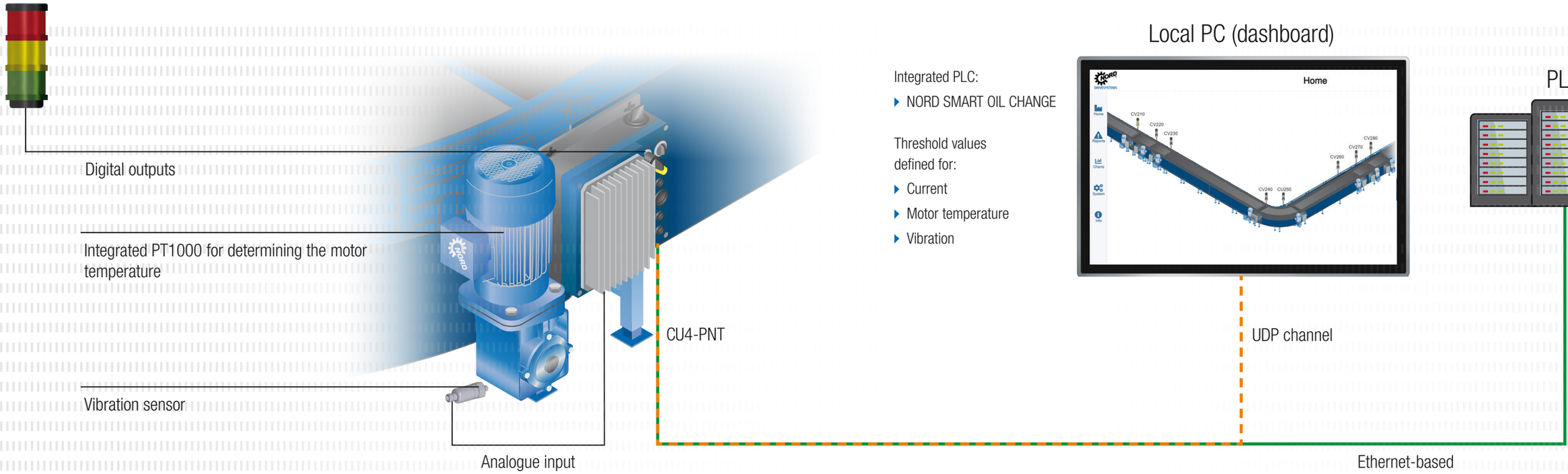
Signal beacon
- Local display of drive conditions
- Scalable display

Local data management
- Processing of drive data for drive and system analysis
- CONDITION MONITORING

Local dashboard
- Display of drive and system data

Higher level PLC
- Processing of CONDITION MONITORING information by the customer
- Combination of collected CONDITION MONITORING data with process data

Condition Monitoring for Predictive Maintenance

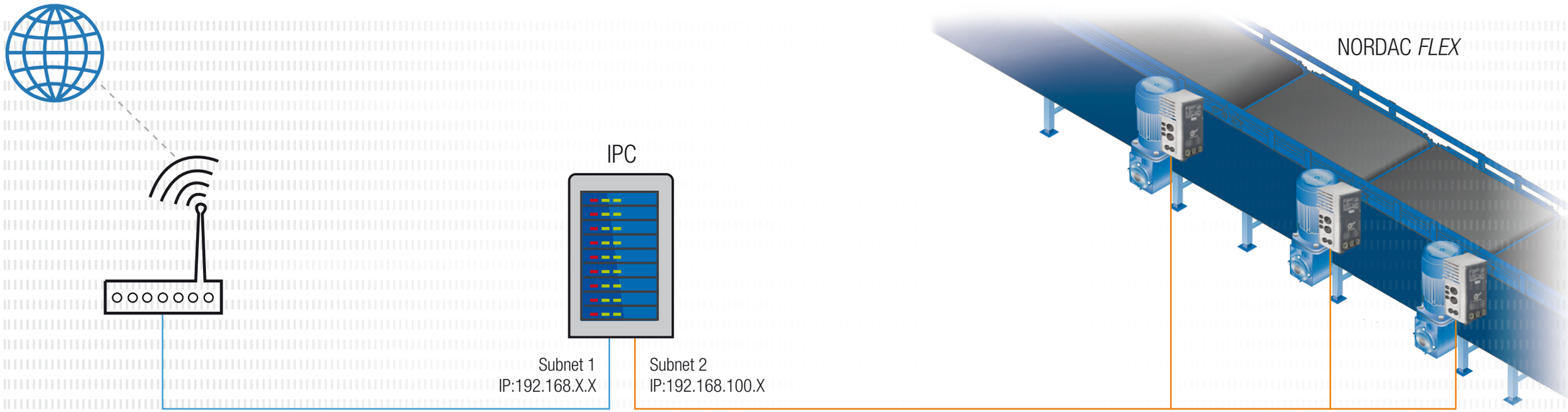


CONDITION MONITORING at an airport

At an international airport, NORD DRIVESYSTEMS has retrofitted a pilot system in order to collect CONDITION MONITORING data from selected drives. These conveyors are equipped with NORD gear units, motors and frequency inverters of the NORDAC *LINK* series.
The motors feature a PT1000 to determine the motor temperature. A vibration sensor is attached to the gear motors that monitors the vibration velocity of the drive. Both sensors are analogue sensors and thus could be connected directly to the analogue inputs of the NORDAC *LINK*.
This solution's special feature is that the NORD frequency inverter's integrated PLC is used to evaluate threshold values for vibration, motor temperature and motor current and generate corresponding warning and alarm messages based on that. In addition, the NORD Smart Oil Change algorithm is running to determine the oil change interval of the 2-stage bevel gear units inside the integrated PLC. This way, the complete logic for the "CONDITION MONITORING for PREDICTIVE MAINTENANCE" solution has been implemented in the frequency inverter's integrated PLC.

A communication interface to the higher level PROFINET IO controller is in use. Via the PROFINET IO interface, several drive info parameters are transferred to a PC. With its touch screen, the PC also serves as NORD's own dashboard on which values that have been stored in a local database can be displayed. Messages on exceeded threshold values as well as general drive information parameters can easily be displayed here. Via a history function, also data from the past can be displayed quickly and easily.
In addition, an external signal light, connected and supplied via the NORDAC *LINK*, visualises the CONDITION MONITORING status. Green – no messages, Orange – warning threshold exceeded, Red – alarm threshold exceeded. Warning or alarm messages that have occurred can also be directly acknowledged via a reset button on the dashboard.
The solution is designed as an additional development step to promote CONDITION MONITORING for PREDICTIVE MAINTENANCE.

Condition Monitoring for Predictive Maintenance



CONDITION MONITORING in a parcel distribution centre

NORD Drivesystems supplied a software solution for a parcel distribution centre to upgrade the existing system with CONDITION MONITORING. With additional hardware, consisting of an IPC, it became possible to collect all drive information parameters and forward it to a customer cloud. The system is equipped with 96 drives, comprising gear units, motors and frequency inverters from the NORDAC *FLEX* series. PROFINET IO is used as communication interface. In addition to participants in the PROFINET network, up to three participants are also connected to an inverter via the system bus. The IPC was subsequently installed in a control cabinet.
In addition to a cybersecurity concept (Windows firewall, Windows security updates, antivirus program), the IPC is equipped with two physically separated network cards. One is the interface to the customer application via which the drive data is collected. The other one provides the interface to the customer cloud. This makes the system optimally secured.
The IPC queries all previously defined parameters from all frequency inverters via the UDP channel of the PROFINET IO telegram. Additionally, the local database is protected by HTTPS, a user name and a password.

The following drive information parameters are collected:

- Operating time
- Running time
- Actual speed
- Actual current
- Actual voltage
- Mechanical power
- Heat sink temperature of the frequency inverter

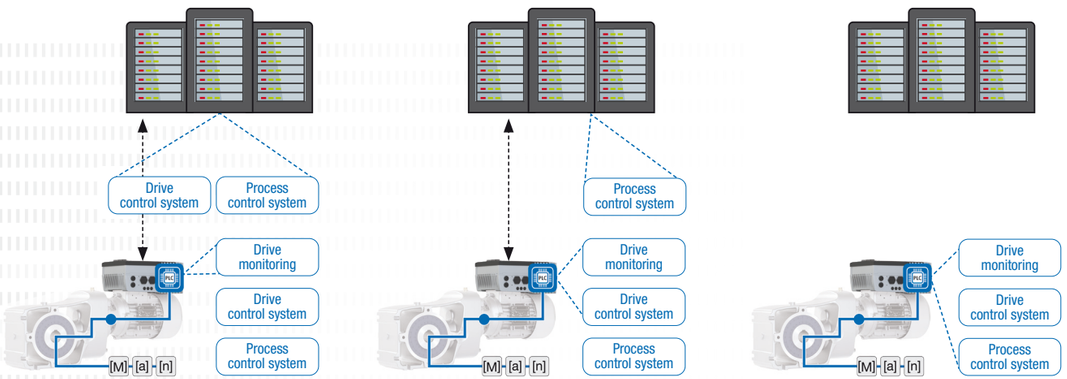
The data is stored in the database on the local IPC. After this, a push function enables the data to be directly transferred into a customer cloud. The solution from NORD enables the customer to also integrate CONDITION MONITORING for PREDICTIVE MAINTENANCE in existing systems.

Condition Monitoring for Predictive Maintenance

Integrated PLC

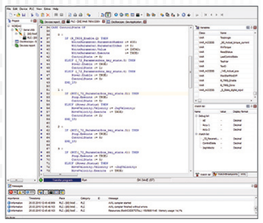
- Available for all NORD frequency inverters and motor starters
- Performs drive-related functions
- Integrates drive-related actuators and sensors
- Parameter access
- Access to Industrial Ethernet or field bus data
- Implementation of application-specific functions

The right PLC software architecture for your solution



NORDCON *APP*

- Dashboard based visualisation for drive monitoring and fault diagnosis
- Parameterisation with help function and rapid access to parameters
- Oscilloscope function



NORDCON software

- User-friendly parameterisation and programming of several drives
- PLC editor according to IEC 61131-3, supporting Structured Text (ST), Instruction List (IL) and PLCopen Motion Control library
- Multi-axis access via Ethernet tunnelling

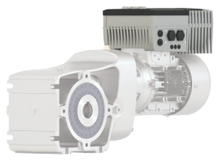
NORDAC *PRO* - Control cabinet inverters

- The next generation of control cabinet inverters
- Compact size, innovative and extremely flexible communication and interface concept, functional expansion with optional modules
- Power range up to 160 kW
- Control cabinet installation
- IP20

NORDAC *LINK* - Decentralised frequency inverter

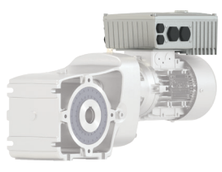
- The field distributor for flexible, decentralised installation. Flexible configuration, functions and application
- Fast commissioning through high level of plug-in capability, system servicing through integrated maintenance switch and local manual control facility
- Power range up to 7.5 kW
- Field installation
- IP55 / IP66

NORDAC *FLEX* - Decentralised frequency inverter



- Decentralised drive unit with versatile installation options
- Simple commissioning and maintenance through extensive plug-in capability and simple parameter transfer via EEPROM
- Power range up to 2.2 kW
- Wall or motor mounting
- IP55 / IP66

NORDAC *BASE* Decentralised frequency inverter



- The economical decentralised version for simple drive applications
- Low installation costs as well as robust design for simple installation outside the control cabinet
- Power range up to 2.2 kW
- Wall or motor mounting
- IP55 / IP66 / IP69K

ENGINEERED & MADE in GERMANY

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