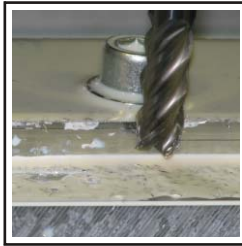


ToolScope

Next Generation

Process Monitoring



Visualize
Monitor
Optimize
Document



Maschine	CHAN1	MDA	SYFB
Kanal unterbrochen			OSTOR
Programm angehalten			Halb M
GE Feed Limit ausgelöst			
WKS	Position	Restweg	
X	10.510 mm	0.000	
Y	-160.525 mm	0.000	
Z	230.879 mm	0.000	
A	0.000 grad	0.000	
C	0.000 grad	0.000	

Essential ToolScope-Properties:

- ✓ Storage oscilloscope, data logger and automatic documentation for machine tools
- ✓ Process monitoring with tolerance bands
- ✓ Process monitoring with statistical process control
- ✓ Self learning tolerance bands
- ✓ Unique breakage detection algorithms for the monitoring of small production batches
- ✓ Adaptive control and optimization of the process time (Unique: this also works parallel to the process monitoring)
- ✓ Wear monitoring
- ✓ Crash monitoring
- ✓ Simple integration into the numeric control unit (NCU)
- ✓ Signal acquisition directly through the NC, no external sensors needed, integration of additional sensors possible
- ✓ Operation by HMI, network and remote maintenance
- ✓ Reduction of scrap parts, reconditioning and secondary damages
- ✓ Higher productivity, process safety and machine availability

Brinkhaus GmbH

More than a solution

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ToolScope Storage Oscilloscope and Data Logger for Machine Tools

Quality Record for Production Processes

- Logging of machine internal and external sensor signals
- Simple generation of quality records due to automatic generation of a process journal
- Complete and deeper insight into production processes
- In case of customer complains processes that happened month ago can easily be investigated

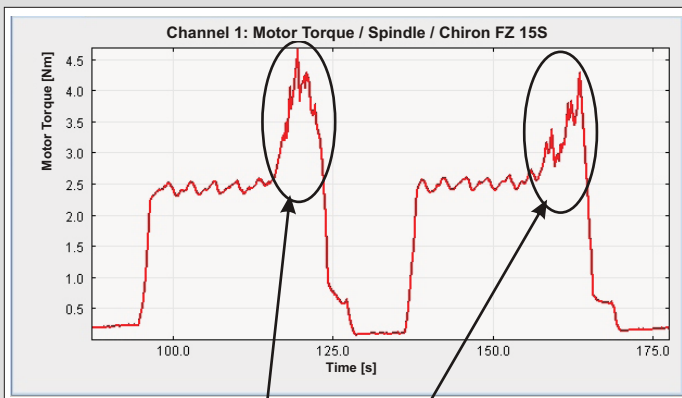


Unique Characteristics of the Data Logger

- In opposition to pure software monitoring solutions:
 - + No impact on the processor load of the machine control
 - + Real time data acquisition of internal and external sensors
- The system can easily be enhanced by activation of additional monitoring functions
- Ready to file process documentation
- Storing capacity for data signals between 2-60 month, depending on sensor acquisition rate



Storage Oscilloscope for Machine Tools

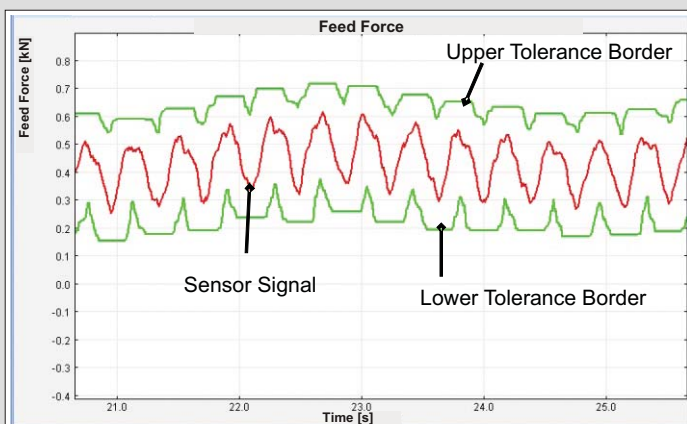


- Irregularities are detected at once (here jammed chips during a drilling process)

Advantages of the Data Logger

- The production processes can directly be verified regarding zero defects on the basis of signal evaluation. Defects like jammed chips during a drilling process (see picture on the left) can be identified very fast.
- By analyzing the sensor signals optimization potential in the NC-program can be revealed.
- Fast qualification of new tools, e.g. optimization of cutting tip geometry.
- Process data is recorded in an Excel readable format to run individual offline analyzation methods.

Easy Visualization of Process Sequences



Vast Scope of Application

- Next to the standard machining processes like **turning, milling, drilling**, etc. the system can also be used to monitor different other processes like:
 - Broaching (see picture on right)
 - Grinding
 - Punching



Source: Hoffmann Räumtechnik GmbH



Online - Quality and Process Monitoring

Modul QPC

Process Monitoring

- Detection of tool breakage without manual setting of the tolerance borders
- Detection of missing work pieces
- Monitoring of user-defined tolerance bands
- Monitoring of specific values
- Crash detection
- Wear detection
- Condition monitoring



Quality Process Control (QPC)

- QPC is a software module of the ToolScope with which the process quality can be monitored online on the basis of statistical process control (SPC).
- Key elements of this module are statistical methods, which calculate the statistical deviation in comparison to master processes. If the deviation is more than 6 sigma an alarm will be generated.
- These methods take the normal production deviations into account.
- Also the standard monitoring for tool breakage based on fixed tolerance bands is covered.

Focus on Quality Assurance

- Verification if the current process is similar to certified master processes (QPC)
 - + Monitoring with regard to typical aviation standards
 - + Execution of an online SPC parallel to the machine process
- Even in monitoring mode all process data is logged
- Quality assurance and quality control on one system

Advantages of the Statistical Process Control

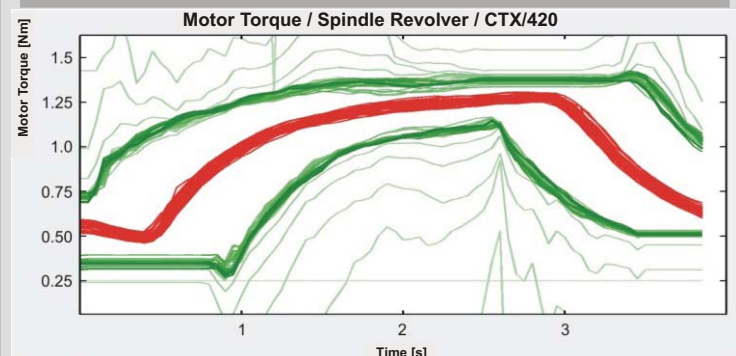
- The SPC is self learning and doesn't need to be configured manually. Though, a manual adaptation is still possible due to a highly configurable system.
- With help of the SPC much smaller tolerance bands can be realized. These bands are automatically adjusted to the production variations.
- Already small production variations or failures in the production process notably prior to a tool breakage, e.g. caused by bubbles, can be detected.
- The SPC can be executed parallel to the adaptive control.

Monitoring Regarding Current Aviation Standards

- E.g. GE-Norm P11TF12
- Automatic generation of calibration protocols
- Automatic configuration of the monitoring setup
- Considerable time savings during process qualification
- System displays are oriented at the needs of the certifying agent



Teach-In and Monitoring



- After just a few monitored master processes the teach-in function of the SPC module has found the optimal tolerance borders.

Process Monitoring for Small Production Quantities

Module Heuristic-Monitoring

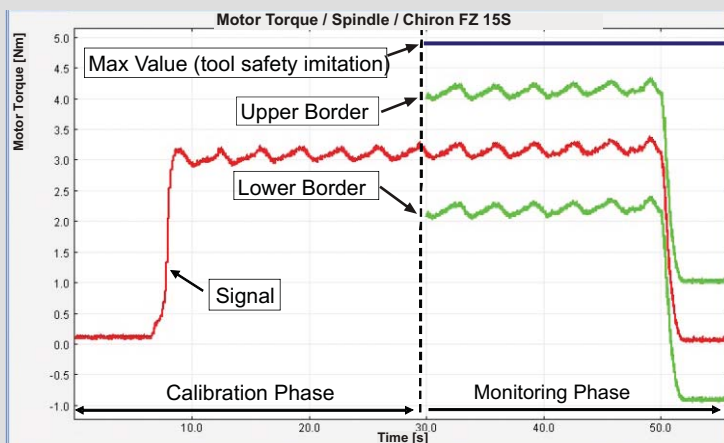
Unique Feature of the Heuristic-Module

- The Heuristic-Monitoring-Module has been designed for monitoring of tool breakage for the production of small quantities where teaching of processes is not possible.
- The monitoring is available without the need of teaching master processes.
- Special algorithms enable the calibration of the tolerance band on the basis of signal characteristics recorded during the first seconds of an ingate.
- No manual setup necessary

Background of the Heuristic-Module

- The Heuristic-Monitoring-Module calculates special characteristic values on basis of the interaction between tool and workpiece/material. The recording of master processes is not necessary.
- With these characteristic values the tolerance borders for each tool are calculated and stored.
- Increasing tool wear is recognized and can be taken into account.

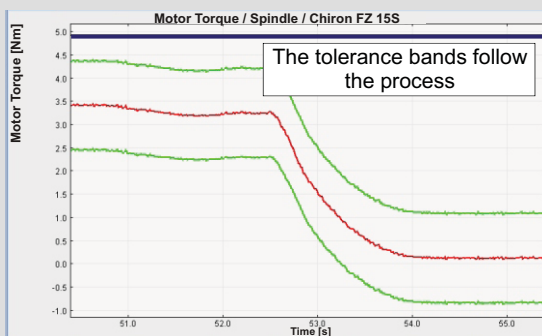
Calibration of the Heuristic-Module



Calibration of the Heuristic-Module

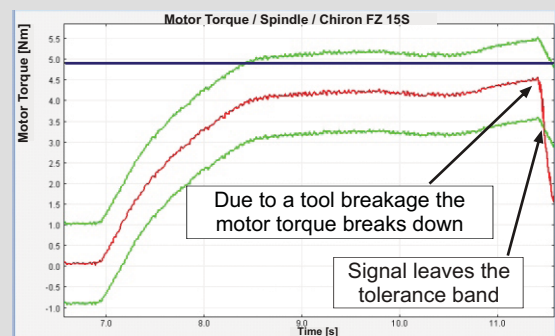
- The calibration of the Heuristic-Monitoring-Module depends on the used tool and workpiece material. The calibration can be done in two ways.
 - Tool calibration in advance: The interaction (best cutting ability of the tool) of tool and material will be taught for different tools and different materials prior to a production process.
 - Tool calibration during the production process: The calibration is done within the first seconds of the process. The calibration time is dependent on the process time. (In the left picture it is 15 seconds).

The Tolerance Bands Follow the Process



- The tolerance bands follow the process on basis of the calculated characteristic values.

Detection of a Tool Breakage



- If a tool breakage occurs the tolerance borders will be breached and an alarm will be generated.



Adaptive control to reduce production time

Module Adaptive Control

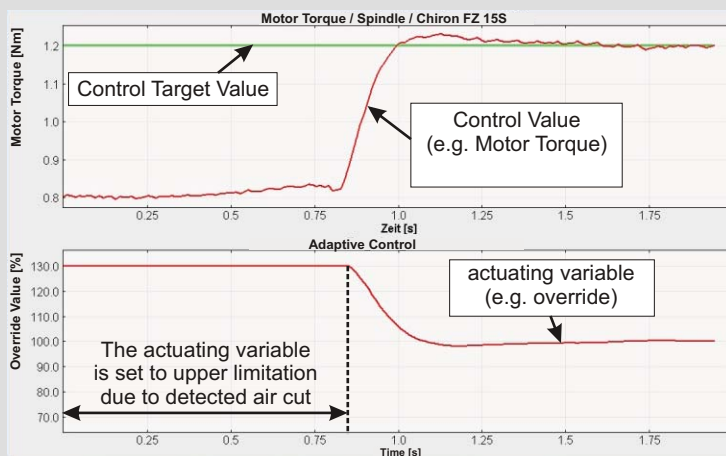
Advantages of Adaptive Control

- The adaptive control e.g. of the motor torque is done by automatically adjusting the override speed with the goal to vary the stock removal volume and thus adjusting the motor torque
- The adaptive control can be specialized on different events:
 - + Recognition of jammed chips (e.g. during a drilling process) and reduction of the feed rate to resolve the jamming.
 - + Process acceleration while detecting an air cut.
- The system is self-learning and can therefore assess the optimal control parameters automatically.
- Manual adaptation for special processes is possible.

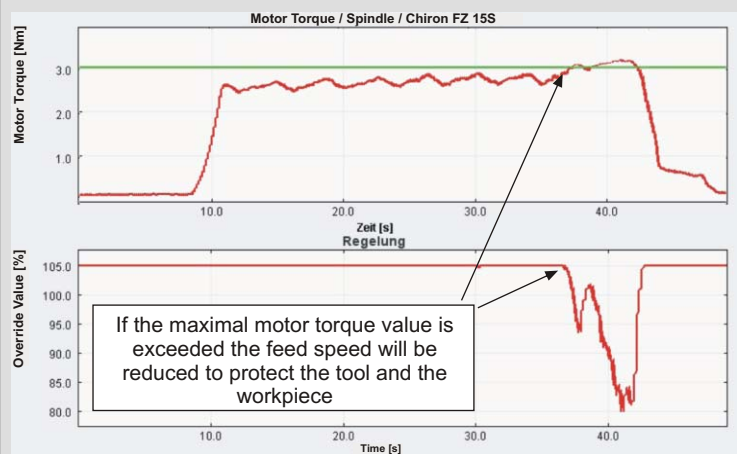
Technical Background

- The output value of the controller is the override value of the feed rate in percentage. This value will be transferred directly to the machine control.
- The generated override value can be limited to a maximal and minimal value (e.g. minimal 80% maximal 120%).
- The parameters of the adaptive control can directly be adjusted according to the current process by certain commands in the NC-Program. Also, the adaptive control can be turned on or off by using M-Commands in the NC-Program.

Reduction of Production Time



Tool Protection



Signal Input and Output

- Prior to calculating the actuating variable, the current sensor signal is passed through different filter stages with widely adjustable filter parameters. This way the system has a broad area of application.
- The signal input can be chosen freely from the available channels of the ToolScope system.
- The setup as well as the variations of the override value is documented continuously.

Adaptive Control During Milling

