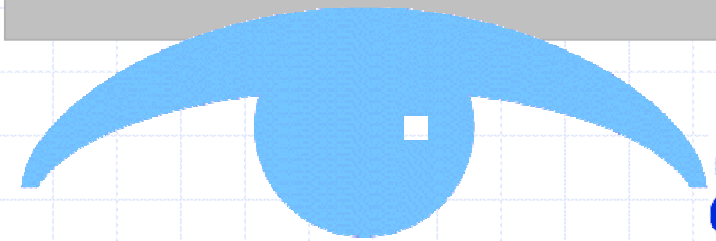


argotech

Sensor capabilities, limitations and practical applications

an overview

Wednesday, 25 April 2007

Introduction

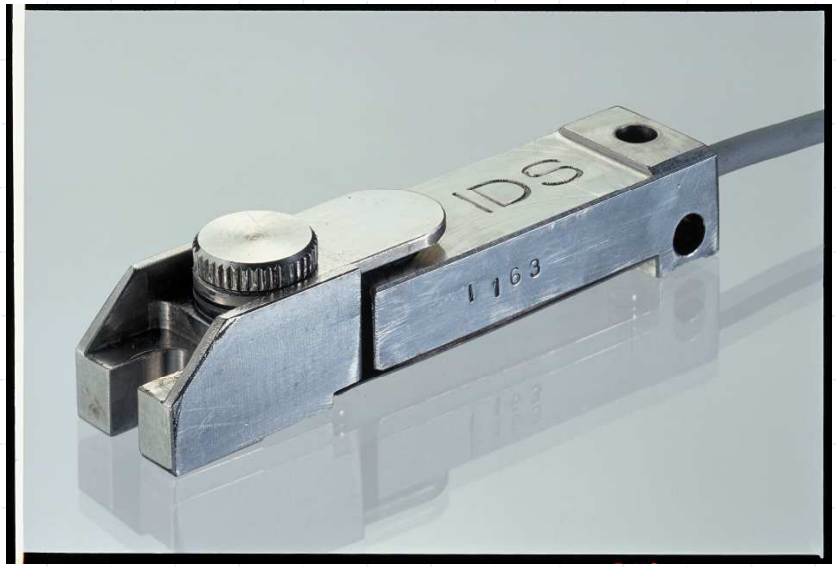
- Vibration sensing is being touted as the sensor that can do it all. This is a simplification of reality. Vibration has many applications, but other sensor types can be much more relevant to detect certain problems and conditions.
- This presentation tried to provide an overview of the pro's and con's of each of the measurement technologies available so that the right decision can be made.
- In life there are however, no guarantees and it is no different with sensors and their applications. The statements made in this document are general in nature. It could well be that certain sensors do not have the performance from that described in this presentation in a specific application.

The right sensor for the right application

IDS Sensor

Technical specification

- Measures amount of deformation in materials
- Resolution 1 µM (x10^{-6} M)
- Output 0 – 10 V
- Does not require amplification, but
- When used with Smart Amp will optimize signal automatically



Typical applications

- Levers in multi-spindle machines
- Can work in stamping applications to measure distances (limited)

IDS Strengths and limitations

Strengths:

- High resolution, can measure very small changes
- No contact sensing
  - easy & quick to install
  - No damage to machine
  - No wear

Weaknesses:

- Sensitivity to machining vibrations to trigger internal resonance
  - Makes measurements invalid
- Dimensions of senor limits placement options

General take-away; good for lever force measurement

stay away from stamping with high force >200,000 kgf

KSS accoustic sensor

Technical Data

- Supply 4mA, const. I
- Output voltage ± 5 V, max.
- Sensitivity 55 dBref1V/(m/s)
- Temperature range 0 to 60 0C
- Ground Isolation > 10 MΩ
- Shock resistance 2500 g (0,5 ms Puls)
- Sensor Protection Type IP 66, resistant to industrial climate, oil and cooling lubricant**M5N8A0,1A0,05min 30 x 20min 6 x 20**
- Amplifier Protection Type IP 68, resistant to industrial climate, oil and cooling lubricant
- Installed in conjunction with MWW1 amplifier

Installation note: Needs flat surface with good contact to machine to work well

Typical applications include:

- Tool breakage (stamp, drill etc.)
- Contact identification for quality measurement

KSS Strengths and limitations

Strengths:

- High resolution, can detect very small changes
- Robust sensor technology, not sensitive to electric interference
  - No false alarms
- Relatively simple installation, one screw to hold sensor in place

Weaknesses:

- Contact to machine required, as close as possible to machining point
- Sensitive to mechanical interference from spanners hitting machine (emulates tool break signature)

General take-away; Good for tool breakage detection, stay away from high speed/force cutting*

*machining processes which require a lot of cooling or which generate a lot of spanners

VIB Low Frequency Vibration sensor

Technical Data

- Power Supply no active operation modeinner ground**VIB**78MWW-39outer groundcore
- Output max. 3 – 4 VSS
- Measure Sensitivity at 5 kHz 26 ±8 mV / g
- Temperature Range -10 to +70 0C
- Ground Isolation > 10 MΩ
- Overload Shock 2500 g (0,5 ms puls)
- Rmin = 15 mm
- Sensor Protection Type IP 66, resistant to industrial climate, oil and cooling lubricant
- Amplifier Protection Type IP 68, resistant to industrial climate, oil and cooling lubricant
- Installed in conjunction with MWW3 amplifier

Typical applications

- Tool breakage, especially with high spanner count
- Tool wear

Because it measures in lower frequency band than KSS sensor, therefore less sensitive to spanner interference

However, more sensitive to interfering bearing noises.

Installation note: Needs flat surface with good contact to machine to work well

Strengths and limitations

Strengths:

- Can be mounted farther from machining process, as low frequency waves transmit further
- Insensitive to electrical interference
- Not as sensitive to installation variations

Weaknesses:

- Sensitive to mechanical interference from bearings
  - Can be filtered out by hand with MWW3 amplifier
- Can influence it's own measurement through own mass and resonance

General take-away; Good for high spanner count machining processes with quiet bearings, stay away from loose bearing applications

KS-3 Force Sensor

Technical data

- Measuring Sensitivity: 250 pC / µε
- Temperature Range: 0 to 60 0C
- Isolation Resistance > 1011 Ω
- Overload 2500 g (0,5 ms impulse)
- Sensor Protection Degree IP 66, resistant to industrial climate, oil and cooling lubricant
- Length of cable (standard) 3 m
- Installed with smart-AMP amplifier

Typical applications

- Force measurement inside machine to detect variety of problems:
  - Tool wear, breakage
  - Production quality problems such as double material

Installation note: Don't install on fast moving parts on stamping/punching machine, as cable will wear out.

KS-3 Applications and limitations

Strengths:

- Can detect variety of problems in stamping/punching
- High sensitivity, can detect relatively small changes
- Small, can fit in relatively small spaces

Weaknesses:

- Signal sensitive to placement of sensor. To overcome, detailed knowledge of the machine is required, or high number of sensors.
- Requires one-time calibration at start-up

General take-away; Good for detecting a variety of issues in stamping & punching, stay away from applications with varying force directions

LW1 – Power consumption sensor

Technical data

- Power Supply ± 15 V DC ± 5 %, Ripple: max 100 mVss, ± 100 mA
- Output± 10 V DC lin, 0 – 10 V log
- Dissolution > 60 dB
- Temperature Range 0 to 50 °C
- Amplifier Protection Type IP 20, suitable for installation in switch cabinet
- Dimensions (L x W x H) 73,2 x 75 x 78,2 (mm)

Typical applications

- Tool wear, breakage in drilling and milling applications

LW-1 Applications and limitations

Strengths:

- Simple installation, stay away from machining chamber
- Can detect tool wear better than any other technology

Weaknesses:

- Can't measure all applications. Dependent on ratio of motor strength and cutting tool size and material. I.e. with standard 3.5 bhp motor, can't measure below 0.5 mm drill. Power consumption does not change enough.

General take-away; Good for detecting tool breakage / wear in turning and milling, not suitable for stamping and punching applications

Summary Overview

0 = can work
✓ = good fit
✓✓ = best fit

		Sensors type				
		Electrical Power	Acoustic Emission	Vibration	Force	Strain
Machining Processes	Turning	✓✓	✓✓	0	✓✓	✓
	Grinding	0	✓✓	✓	✓	✓
	Drilling	✓✓	✓✓	0	0	0
	Stamping		✓		✓✓	✓✓
	Die-casting		✓✓	✓✓	✓	✓
	Rotary–cycle machine	✓	✓✓	✓	0	0
	Multi-spindle lathe		✓✓	✓	✓✓	✓✓
	Machining center	✓	✓	0	✓	0
Detection capability	Missing tool	✓✓	✓✓	✓✓	✓✓	✓✓
	Tool fracture	✓	✓✓	✓	✓✓	✓✓
	Tool wear	✓✓	✓	✓	✓✓	✓
	Chatter	0	✓✓	0	0	0
	Collision	✓	✓✓	✓✓	✓	✓
	Contact	0	✓✓	✓✓	✓	✓
Optimisation	Tool life	✓✓	✓	0	✓	✓
	Quality	✓	✓	0	✓	0
	Process	✓	0	✓	✓	✓
	Reduction of air grinding	0	✓✓	✓✓	0	0

Notes:

Electrical Power: Electrical power sensors use the clear relationship that exists between the power load requirement and amount of metal machining that is taking place to monitor the process. Reduction gears can influence the clarity of the signal level.

Acoustic Emission: The measurement is more sensitive the closer the sensor is installed to the processing point. Joining areas (such as screw connections) between the processing point and the sensor reduce the acoustic signals.

Vibration: Comparable to acoustic emissions (low frequency range)

Force / Strain: Forces and strain within machine components are dependent on the structure of the machine and should be interpreted separately in each case.