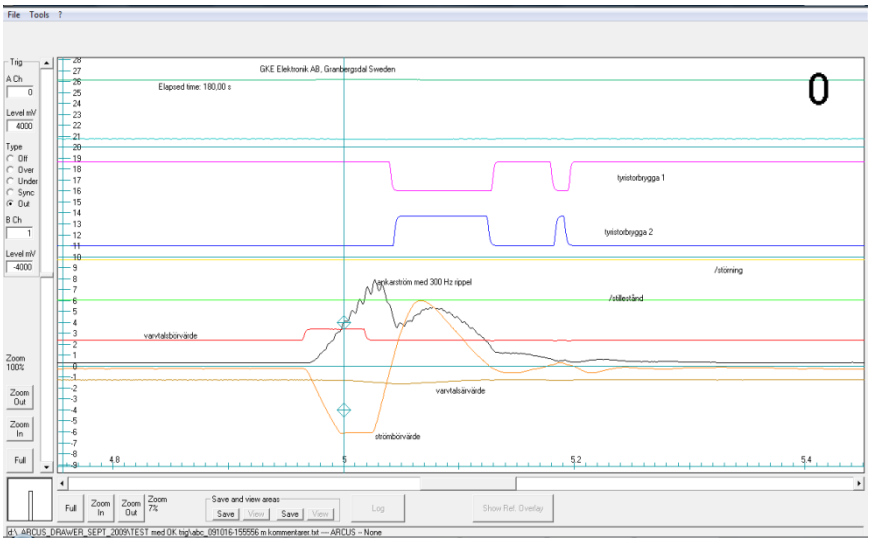
The ARCUS recorder – hard to beat when problems get tough!

GKE Elektronik AB has solved technical problems all over the world for decades. Mostly in critical equipment for paper mills, steel works, power plants, harbor cranes, on-board ships and other 'high-dollar-per-hour' facilities. We used to fly on our missions – and still do – but recent luggage carry-on restrictions, security being more and more suspicious and the queues associated with air transportation has made flying less attractive. Letting the 'luggage morons' handle delicate instrumentation turns every air transport into a gambling – will my gear work on site or will it be DOA?

Analyzing our needs, we soon realized that we needed something that was robust, low cost and simple. And we think that is what you also need – plus:

- USB powered. No more fighting with UK 'claws' or US flat prong receptacles.
- Enough channels for serious fault-finding. There are ten channels available. Ever needed more?
- Enough speed for process signals and fast servo signals. 30 000 samples/second fulfill that need. That equals 3 kSa/s on each of the ten channels. Fast enough for ripple in a DC motor's armature current.
- Enough memory to make concerns about recording time limitations a thing of yesterday. Data are streamed directly to your hard disk. So the limit is in the 100 - 500 GB range – with TB in view.
- Enough functionality in the default settings to allow a complete newbie to connect and start recording after reading a one-page leaflet – or being instructed over the phone. No more waiting for specialists.
- Enough flexibility to allow complex trig settings like, edge, over/under, window out/in, edge qualified by level, OR and AND between trig channels and much more. There is even a mains transient trig!
- Enough time zoom to allow detailed study at milliseconds level also when recording was in the 10 second range. Get the whole picture – plus all the details – in one recording.
- Enough vertical zoom to allow detailed study of signals down to 10 mV also when recording was in the -10 to + 30 V range. Analog signals and PLC signals on same screen – makes fault analysis easier.
- Enough room in the sturdy case to pack all cables and transducers needed. Making travelling a lot easier and 'Grab and Go' a reality at a cost that is a realistic alternative to rental.

The thinking resulted in the ARCUS transient recorder and data logger.



ARCUS sample screen with window out triggering set to -4 V and +4 V (diamond markers along vertical trig line. Zoomed horizontally (7% of range shown). Buttons to save and review zoomed areas and one button to show reference overlay – invaluable when comparing actual data to 'known-good' data.

Write comments directly in the recorder screen and mail to remote system specialists to solve the problem on-site with minimum delays.

Get one and start fighting your toughest problems today! Or contact us for other arrangements – we are open for all variations – from rental to the 'full package' where we visit your plant to solve your problem.

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Specifications and sample screens (we are updating from software version 1 to version 2 – there are a few screens from v.1 shown below, they will be replaced with v.2 screen-shots later).

General

The Arcus logger/transient recorder was developed to fill our own needs. Our needs were, as mentioned on page 1: simplicity, ruggedness, low cost, reasonable speed, reasonable number of channels, reasonable accuracy. The use is mainly for fault-finding. Especially for intermittent faults or faults that occur very seldom. It can also be used as a 'flight recorder' aka Black Box to find out what happened if a failure occurs.

The functionality is mainly in the software. The v.2 software is more modular than v.1 and accepts integration of two Bearing Predictors, two Drawers and one Encoder evaluation channel[1]. The new software also includes a data base for reference data, schematics, photographs, notes and reference recordings.

Specifications, v.2

Power	USB	5 V DC, <200 mA
PC interface, data, control	USB	Same connector as power
Number of channels	12 + 4	Analogue + isolated nonpolarized binary
Sampling	30 000 samples/second	3 kSa/s on each channel
Filter, 100, 10, 1 Hz	Single-pole	Individually settable, all channels
Default analogue range	-10 V +30 V, 1 megohm	Process signals and PLC on same screen
Calibration	+/- 0.2 % of range	Field calibration possible w/ DC source and DMM
Operating temperature	0 C +50 C "dry"	Arcus, PC may have narrower range
Vertical zoom	x100	
Horizontal zoom	x1000	
Display modes	YT, data, XY, FFT	XY and FFT only in v.2
Save/recall zoom areas	Two	Used to compare sections of recording
Reference overlay	One	Compare actual recording with OK recording
Recording modes	Continuous, Trigged	Continuous streams data to disk. Trig stores records
Maximum recording length	'Unlimited'	Disk capacity. Utility for Hot Swap available
Trig system:	Software, real time, math	Complex trig available, custom trig possible
Level, Edge	-10 V +30 V	Ch 0 – 9 selectable
Window in/out	-10 V +30 V	Ch 0 – 9 selectable
Logic trig	-10 V +30 V	A: ch0-9 B:ch0-9 (A&B, A+B and variations)
Timed snapshot	1 min – 1 day	Works in all trig modes
Data files	BIN and ASCII	ASCII can be imported to Excel, MatLab etc
Connectors	Two sets	Cage clamp terminal strip and 15-pole D-sub
Outputs	Three isolated binary	Option. Used to sound alarm or activate device
Math functions	"Four-banger"	A+B, A-B, A*B, A/B, Square root
Cursor measurements	Yes	Several modes
Comments (text)	Yes	Directly on screen
Colours	Yes, customer settable	Resistor colour code (0=bk, 1=bn, 2=rd etc)
Save/recall data	Yes, several modes	Data, reference data, binary, ASCII, bitmap
Post-processing	Yes, "Sieve"	Used to find 'the needles in the hay-stack'
Enclosures	Case or wall-mount	Case: 400x300200 mm Wall: 220x190x100 mm

[1] These are GKE devices for Bearing Current measurement, accurate speed and draw measurement on paper machines and one fast encoder evaluation device for measuring a drive's dynamic behaviour.

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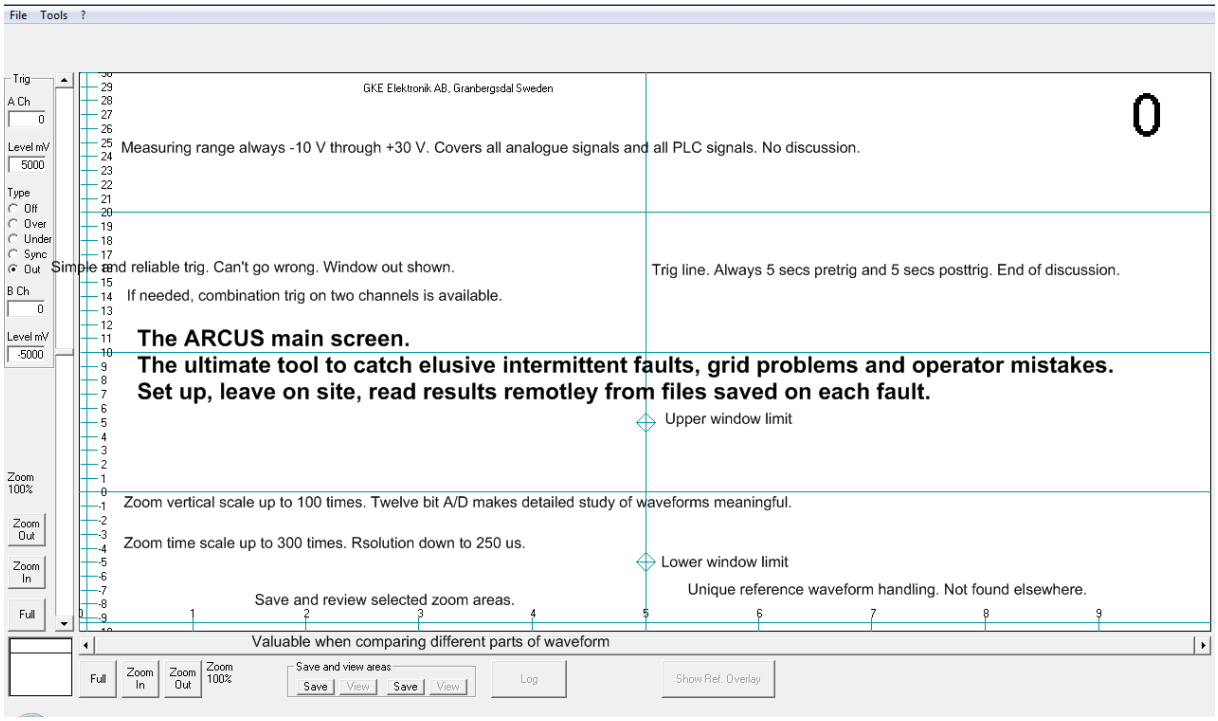
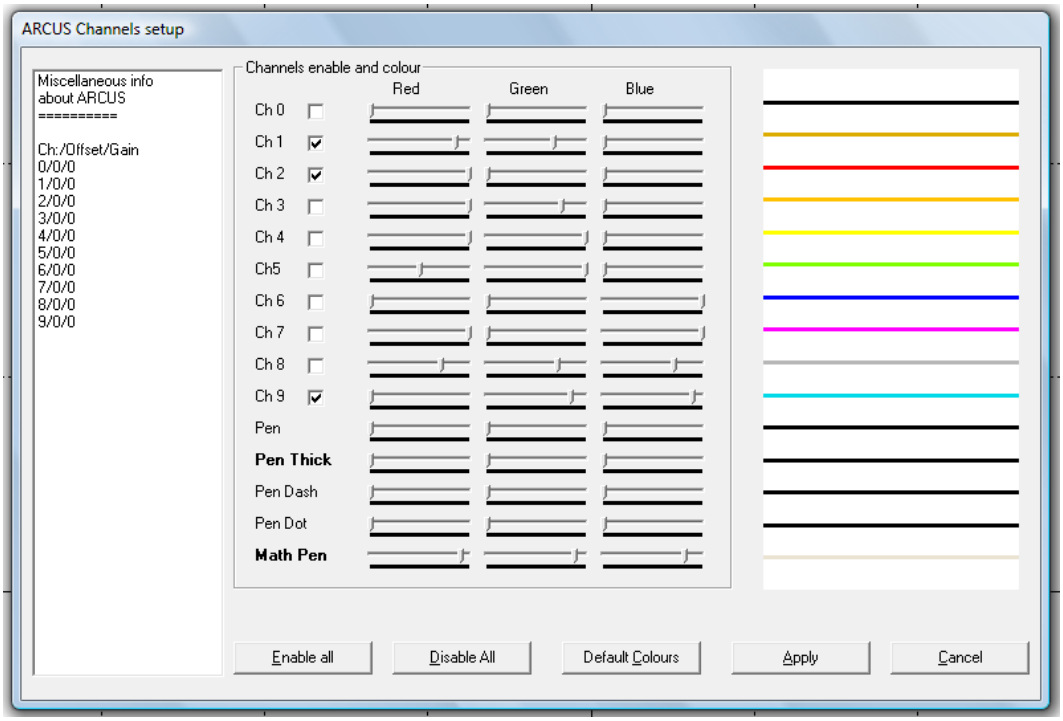
The main screen and its components (‘simple’ screen shown):

The zero at upper right corner is the trig indicator. Shows how many files that have been saved (=number of trig events). Goes bold when trigged (attention catcher) – beep also available.



Select channel pen colours to suit your application. Default is the international resistor colour code.



Channel 9 is not white (resistor code for 9 is white) for obvious reasons. Turquoise selected here.

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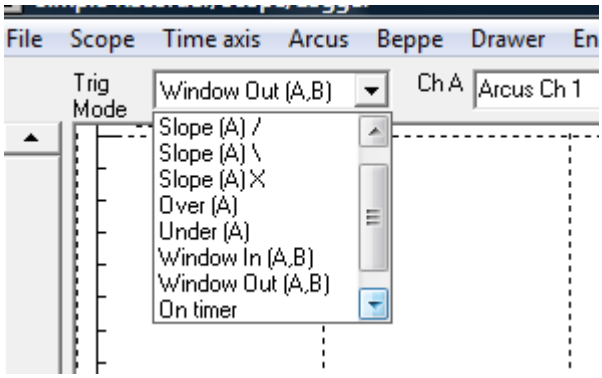
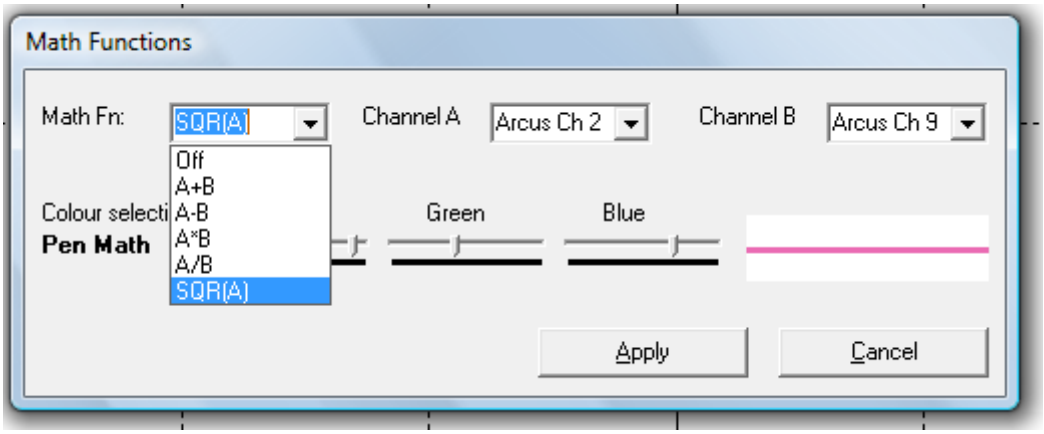
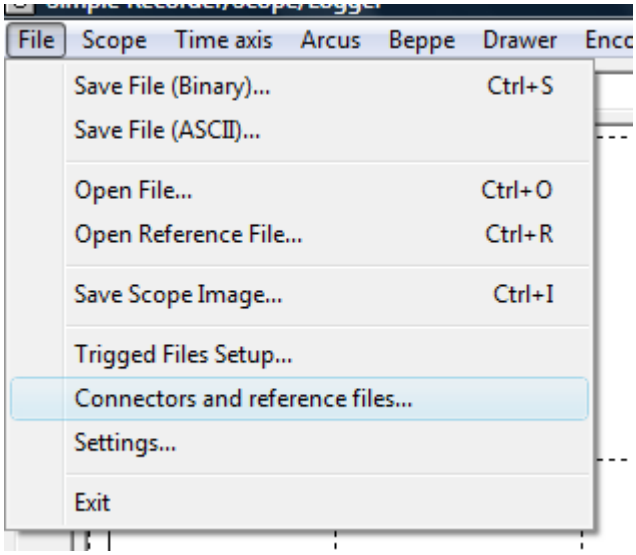


Trig setup drop down menu.

Trig channel A and B separately selected. Trig functions available in v.1 shown. Trig on math result (ratio between two signals, for instance) is available in real time.



Math function window. Math pen is thicker than channel pens and colour selectable.



File drop down menu.

Binary is fast and compact, ASCII is for export to Excel, MatLab etcetera.

Open File to look at recordings and open Reference File to compare actual recording to reference recording.

Scope Image is saved as a bitmap.

Trigged files are autosaved under specified name and autonumbered with date and clock time.

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Connection to process signals

The default input signal range is -10 to +30 V. That range includes standard analogue process signals and also PLC control signals. The input impedance is >1 megohm, which means that loading of the measured signal and its associated circuit is minimal.

Ground referenced higher voltages can be measured using a simple voltage divider or a voltage transformer. A 'field kit' with selectable voltage division ratios is available as a separate unit and connects to the Arcus via ribbon cable and 15-pole D-sub connector. The kit has a terminal strip for connection to process signals.

Process signals 4-20 mA (or 0-20 mA) are usually floating on top of an unknown voltage in the 0 – 30 V range and indicators and receivers are connected in series so that all receive the same current. The voltage drop across a receiver is usually in the 2-10 V range, meaning that the receiver's impedance is 100-500 ohms.
It is then an easy matter to connect the receiver's terminals to two Arcus channels and use the Math function to calculate the difference between the channels so that a voltage difference in the 2-10 V range can be recorded.
If no receiver available, a 500 ohms resistor can be used to produce the necessary voltage drop. Make sure you do not disturb the process when inserting the resistor.
A loop powered 4-20 mA/10 V converter is often the best solution. It is small and standardized and provides full insulation.

Thermocouples and RTDs cannot be connected directly to the Arcus. Use standard signal conditioners.

Physical connection
There are two connectors available for process signals, one cage clamp terminal strip and one 15-pole D-sub connector. All channels are available on both connectors.

The terminal strip connector is used in all temporary installations and also in some permanent installations. It is easy and intuitive with channel numbers clearly indicated. Not much to go wrong.

The D-sub connector is used in applications where many different signals need to be checked. Say, for instance in a paper machine with many different drives. By wiring D-sub sockets to the different drives and giving them unique names, you can quickly and safely connect the Arcus to any signal in the machine. Connect to the central data base and enter the connector's number to get access to reference recordings, schematics for the drive, the drive's 'diary', photographs and other information relevant to that specific drive. Doing this will also set up Arcus with the same parameters that were used to make the reference recording, including channel identification and names.

Calibration
Calibration can be done on site. A utility program and a simple arrangement where all channels are first switched to 0.000 V and then a positive voltage in the 10 – 25 V range is used.
The program asks the user to switch to zero volts and waits for confirmation. It then tells the user to switch to a positive voltage between 10 and 25 V and waits for the exact voltage (either known or measured with a good DMM) to be entered.
When that has been done, the program calculates internal scale factors and offsets and stores them in the hardware's flash memory. The calibration results in better than 0.1 %[2] of range accuracy and +/-0.2 percent is maintained over time and operating temperature.

[2] Provided, of course, that the calibration source has zero error.

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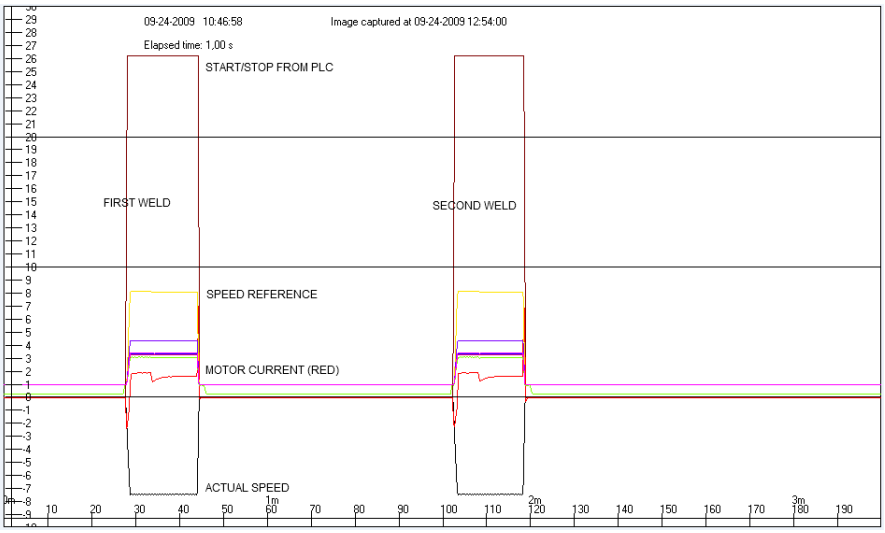
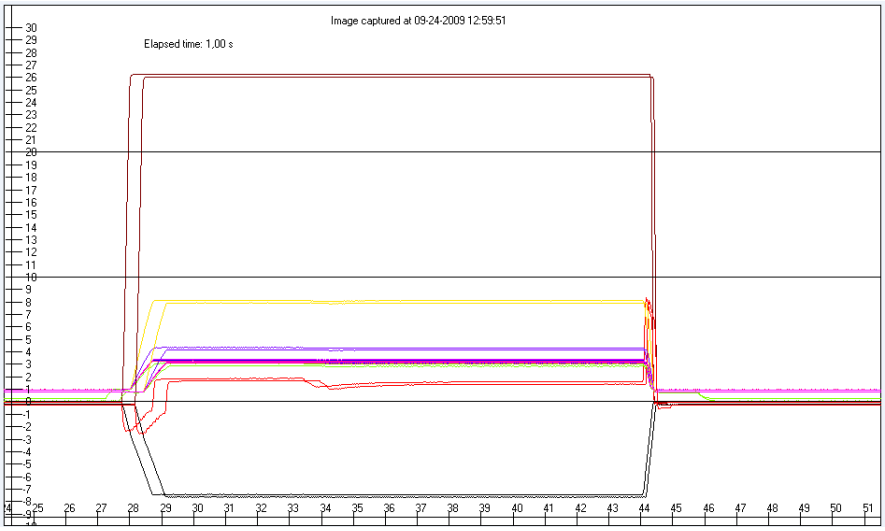
Application examples

Case 1. Friction welder produces faulty pieces – simple when one can see what happens
The friction welding process is a fast and efficient method to butt weld round pieces together. In this case, two universal (cardan) joints were welded to a shaft. Heat is produced by rotating the parts against each other and stopping at an exact angle where the steel solidifies so that a shaft with two joints at exact angles is produced.
The problem: Random angle deviations in the finished shaft. More than 10 percent were rejected.
The equipment used was an analogue thyristor servo drive with a DC motor. The drive was controlled from a PLC. The guy that used to know about the servo drive had quit and the new guy 'did not do analogue technology'. An Arcus was hooked to the system and several recordings taken. A 'good' run was saved as a reference and 'bad' recordings were compared to it. See screenshots below:



Actual run resulting in reject part



Actual run compared to good run. Zoomed.

Studying the details of the two runs revealed that the servo – 'the difficult and unknown monster' – did exactly what it was told to do. The PLC signal is shorter in the good reference run and longer in the bad run. The maintenance guys were well at home with the PLC and now, when they didn't have to worry about the servo drive, they soon found a loose metal flag. Proven innocent is also good.

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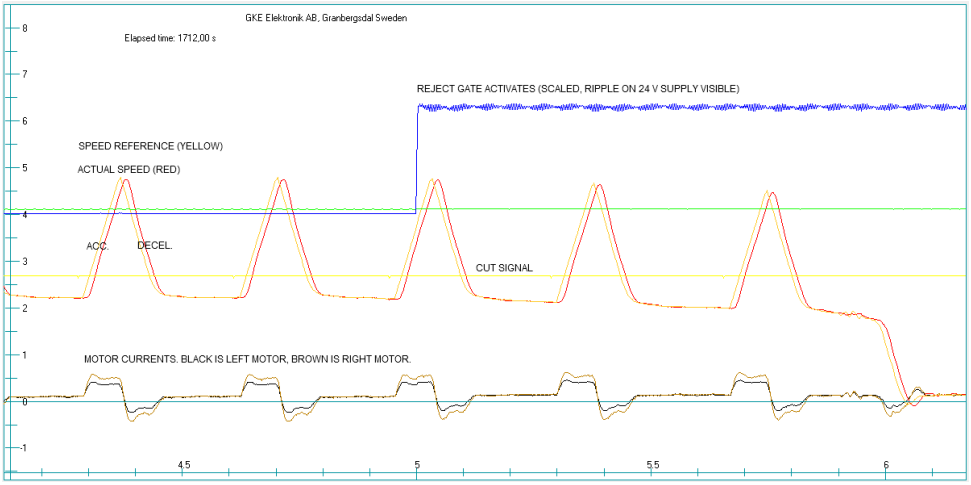
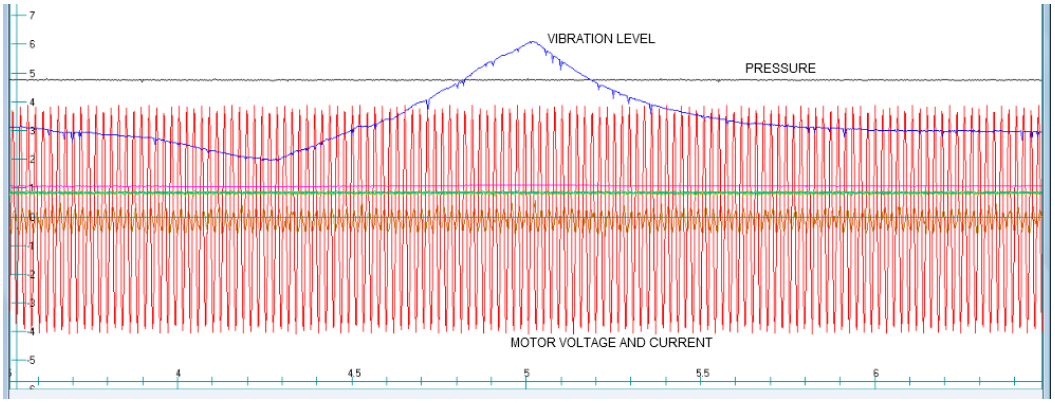
Case 2. Sheet cutter and reject gate

A sheet cutter is working with knife cylinders that are speed controlled so that the exact length of paper is fed forward between cuts. This means that only one length corresponds to constant knife cyinder speed. All other lengths mean that the cylinders must be decelerated and speeded up again (long sheets) for each cut or speeded up and decelerated (short sheets). The dynamics is quite demanding and servo drives are used. In addition, there are motors at each end of the cylinders so that no torque is transferred between the cylinder ends. Such a torque would 'spiral' the cylinders and produce bad cuts. Speed reference, motor actual speed, motor currents (two motors) and the 'cut mark' were recorded. Motor currents are not well balanced and need to be adjusted.



Case 3. Slaughter-house refrigeration compressor. Noisy when no-one there.28 GB to sort through.

A case of long search for the sound that sometimes could be heard from the machine room, but always disappeared before anyone could get there. The compressor was run from a variable frequency drive (VFD) and flow controlled against a set and supposedly constant head. There had been an incident with a bearing and the production manager didn't want it to happen again. The sound was a prime suspect – but where did it come from? In this case, we had the Arcus running in continuous mode for a few weeks and then had to sort through 28 gigabytes of collected data. The 'haystack' was quite big and we were happy to have the 'sieve'[3] so we could sort out the 'needle' we were looking for. And we found it. At 47.2 Hz motor frequency, there was a sharp resonance. The rubber pad feet had been inadvertently mounted metal/metal and caused the resonance. Easy when you have the information.



[3] See Post-processing on page 2.