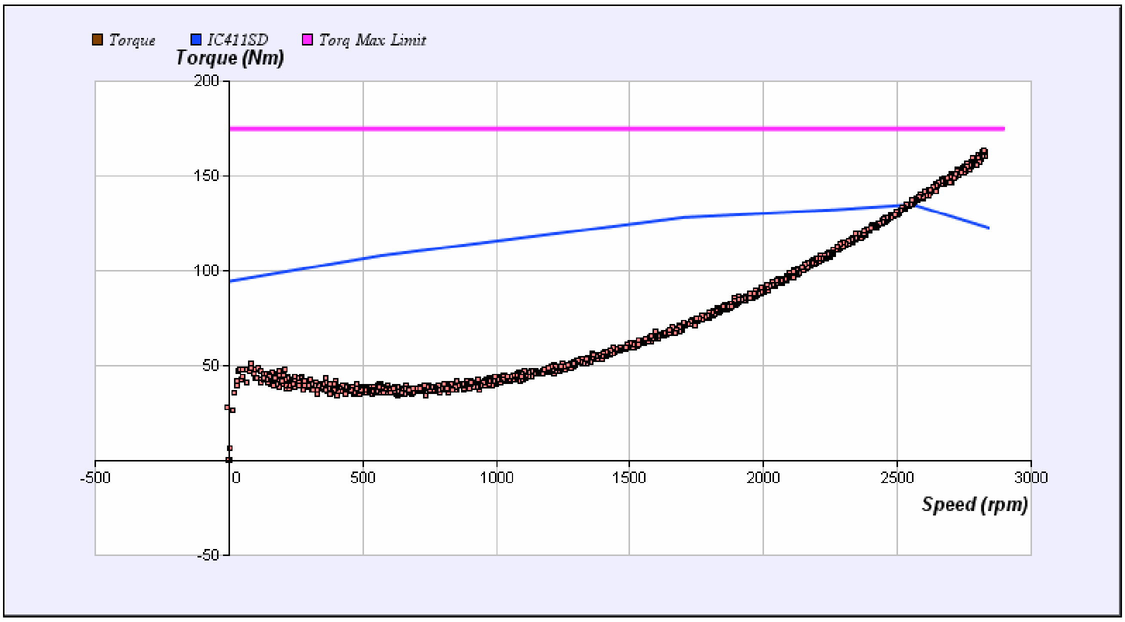
Drive*Ware*®

User Manual
DriveAnalyzer



DriveAnalyzer

User Manual

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Introduction to the manual

Congratulations

You have acquired a new kind and patented SW to analyze how ACS800 /ACS600 frequency converter is running, how the motor is utilized and what is the nature of the mechanical load at motor shaft. Moreover, thanks to the speed control, the energy savings compared to throttling, ON/OFF or hydraulic control can be computed.

DriveAnalyzer is part of Drive*Ware*® *SW* product family.

The energy efficiency is an important part when fighting against climate change and DriveAnalyzer is a tool to analyze the possibilities to improve energy efficiency. Another program in the same category is DrivePump1.2, which is meant to compute the energy savings in pumping applications starting from flow requirements, heads and pumps.

The patent numbers are

In Finland FI 116253,

In USA 7,082,374

In Europe (DE, DK, FR, GB, IT) EP 1 548 925.

ABB is the first to provide users with this kind of SW. ABB is interested to know if other frequency converter manufactures are trying to introduce the same kinds of SW. If so, please send information to this email address: drive.care@fi.abb.com.

Please join the drive users' community and send your proposals to further develop this SW to the same address: drive.care@fi.abb.com. Eventually Drive*Ware*® will have a website for Drive*Ware*® SW users.

Intended audience

The DriveAnalyzer SW is based on statistical theory and users should understand the implications of this.

The first issue is the period of recording. The period of recording shall be selected in such a way that it really represents typical usage of the drives.

When energy measurements are made, the period of recording shall represent the annual behaviour of the drives. If the typical cycle of drive performance is one day, the best measurement should last exactly one day, but maybe another day brings a bit more information. The same rule applies to other typical lengths of measurements: one shift, one day, one week, one month or one year.

The third idea to remember is the possibility of combining results from different periods. Consider doing a one-week measurement in the summertime and another one-week measurement in the wintertime for a drive which is highly affected by seasonal changes.

Finally, the user shall understand the limitations of the statistical approach. The sample time of measurements is one second for recordings shorter than one day, and 0.1 h for longer recordings. The spikes or one time phenomena happening between samples are not caught in PC database. For that purpose ABB drives have data loggers and peak loggers. Also if the duty cycle of the drive happens to be exactly the same as the fixed sample interval and the clocks of the drive and PC don’t drift a bit, then the samples will be biased. This should not be a problem if the recording is somewhat long because the number of samples is anyway high. A one-day recording will collect 86,000 samples. If the cycle of the drive is known to coincide with the sample interval, the measurement period should be extended.

This manual is intended for persons installing the DriveAnalyzer, running the recordings and making the final analysis of the drive and load.

When writing this manual we had an in mind three kind of engineers:

a) OEM (original equipment manufacturers),

b) engineering companies, or

c) engineers of final customers using variable speed drives for their own purposes.

Compatibility

This document describes the DriveAnalyzer1.01 functionality.

Please notice that ABB assumes you to have also a license of DriveWindow2.2 or later revision available and installed. This enable the fibre-optic (DDCS) communication between the PC and the drives,

Reporting requires that Microsoft Excel is installed on the PC.

Safety instructions

DriveAnalyzer PC tool is used for collecting data from ACS800/600 type drives and the user is not provided any direct means of changing the functionality of the drive system itself, hence there are no major safety concerns to others when using the program. DriveAnalyzer will only reset some statistical loggers inside the drive but will not change any control parameters.

Make sure to take care of your personal safety when working close to drives.

Overview of DriveAnalyzer

DriveAnalyzer is PC software for collecting data from one or several drives with the statistical idea. The same or another copy of DriveAnalyzer is then used to analyse the collected data.

DriveAnalyzer has its focus on running or idling drives - it is not a fault diagnostics SW. For that purpose there are other Drive*Ware*® products.

The task of DriveAnalyzer is to make it easy to check how the drive is running - not only with regards to time, but also as a function of speed and frequency. It also checks how well the drive system being tested meets its requirements from a mechanical and electrical dimensioning point of view.

There is a possibility that the motor or other drive system components are too powerful compared to the actual load. In such cases, DriveAnalyzer will give good input for the next investment decision. The knowledge of the exact drive requirements also makes the optimisation of future drive components possible.

On the contrary if the motor or drive is too small, it is alarming information and need to be analysed right away.

The actual load can exceed the thermal characteristics of motor. If this happens together with specified ambient temperature (40C) it means that motor inner temperatures are higher than intended. This will shorten the lifetime of the motor radically. This might be extremely alarming if the motor is in hazardous area having flammable gases or dust.

An undersized drive will, in some control situations, hit its own limits and then it does not fully follow the incoming reference. This is can be just a technical problem but it is possible that the whole process/plant fails to produce its intended output, which is then an economical problem. The incoming reference is perhaps coming from a smart overriding control.

The ability of DriveAnalyzer to connect multiple drives can also be used in the following way: assume the group of drives has common supply components like power lines, transformers, breakers etc, then also assume the drives have different duty cycles, with peak power levels at different time moments. Because DriveAnalyzer is able to draw a so-called duration graph for one or more drives, an engineer will get valuable information on how the supply components can be optimised. The optimal transformer is maybe not the one which is powerful enough to provide the sum of the peak powers of all drives. If the peaks are overlapping in time the power supply components can be reduced.

The duration graphs are commonly used for energy saving calculations.

Getting started

What this chapter contains

This chapter describes how to install the DriveAnalyzer on a PC and how to connect the PC to the drives via fibre-optic DDCS.

Computer requirements

To operate DriveAnalyzer, your computer must meet the following minimum requirements:

Table 1. System requirements

Category	Minimum Requirement
Operating System	Windows 2000 (SP3) or Windows XP
Display	1024x768, 256 colours
System Memory (RAM)	64 MB
Hard Disk Space	80 MB

Delivery check

Package includes DriveAnalyzer CD and registration information.

Connecting drive and PC

DriveAnalyzer uses proprietary ABB DDCS communication media to communicate with the drives.

Installing DriveAnalyzer

Please read carefully the license agreement (License.pdf) before installing DriveAnalyzer. You should quit all Windows applications before starting the installation.

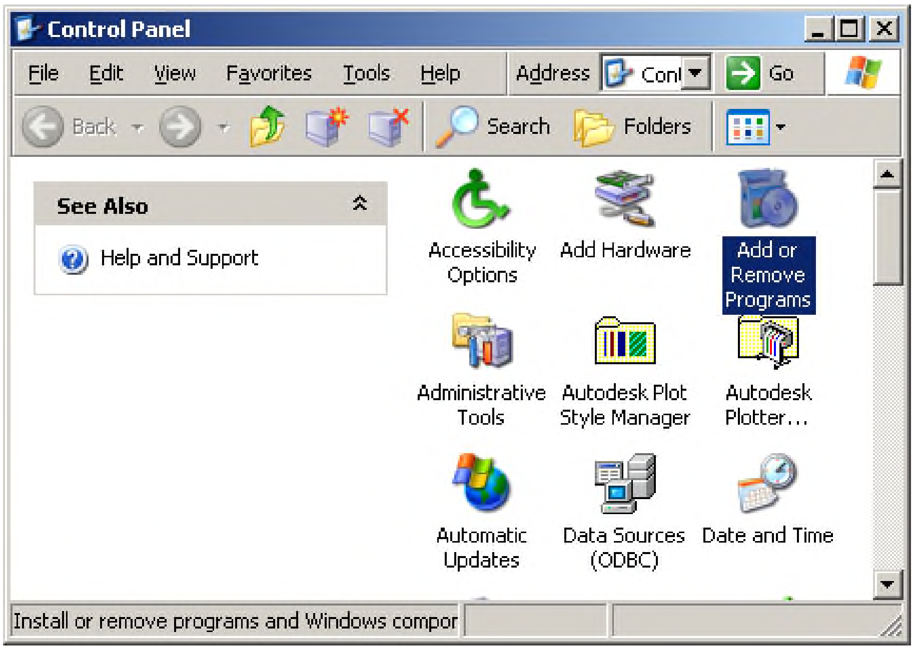
Note! *You must have Administrator privileges to be able to perform the install.*

Your PC may be configured in such a way that when you insert the DriveAnalyzer installation CD into your CD drive, installation starts automatically. Answer the questions and follow the instructions given by the installation program.

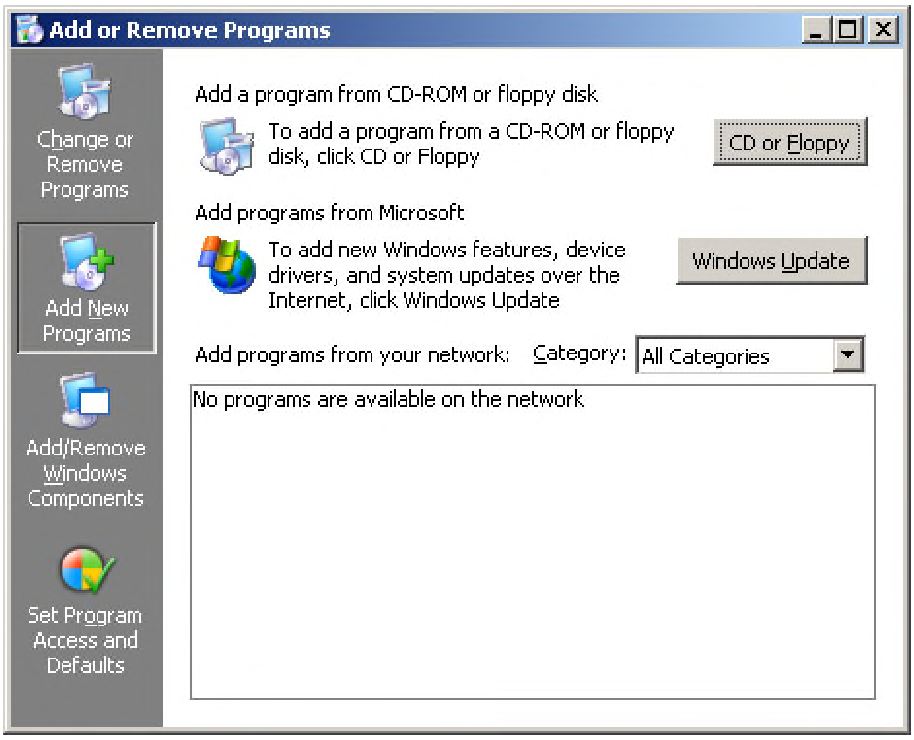
If installation does not start automatically, you can start the SETUP program by double clicking the setup.exe file on DriveAnalyzer CD.

A third way to start SETUP is by using the Control Panel as follows.

Start the Control Panel program and double-click the *Add or Remove Programs* icon.



Click the *Add New Programs* button and then the *CD or Floppy* button.

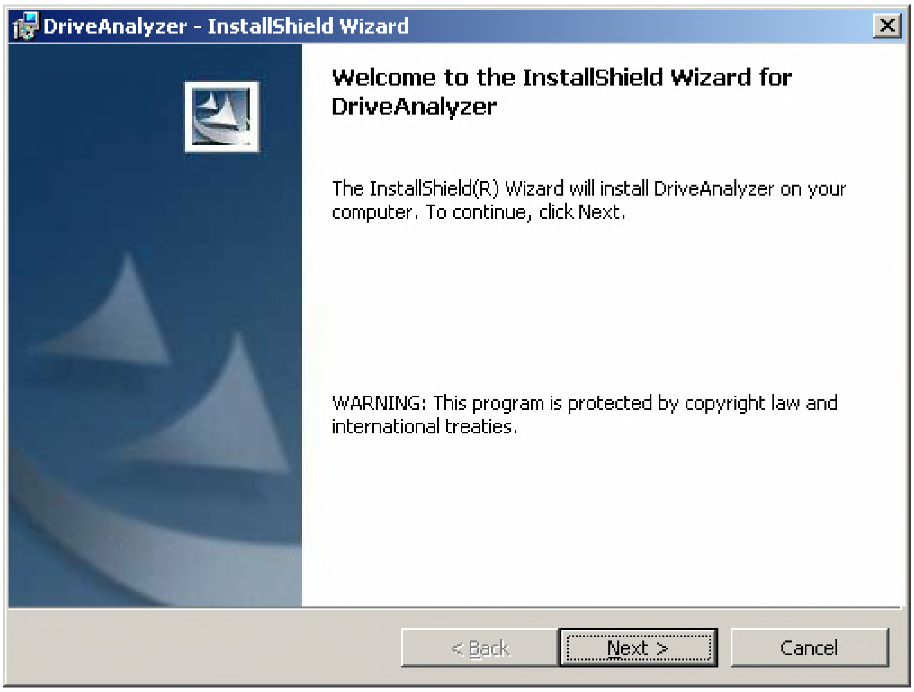


Insert the DriveAnalyzer installation CD into your CD drive and click the *Next >* button.

If the proper SETUP was not found automatically, enter E:\SETUP.EXE into the Command line for installation program (assuming E: is your CD drive), or click the

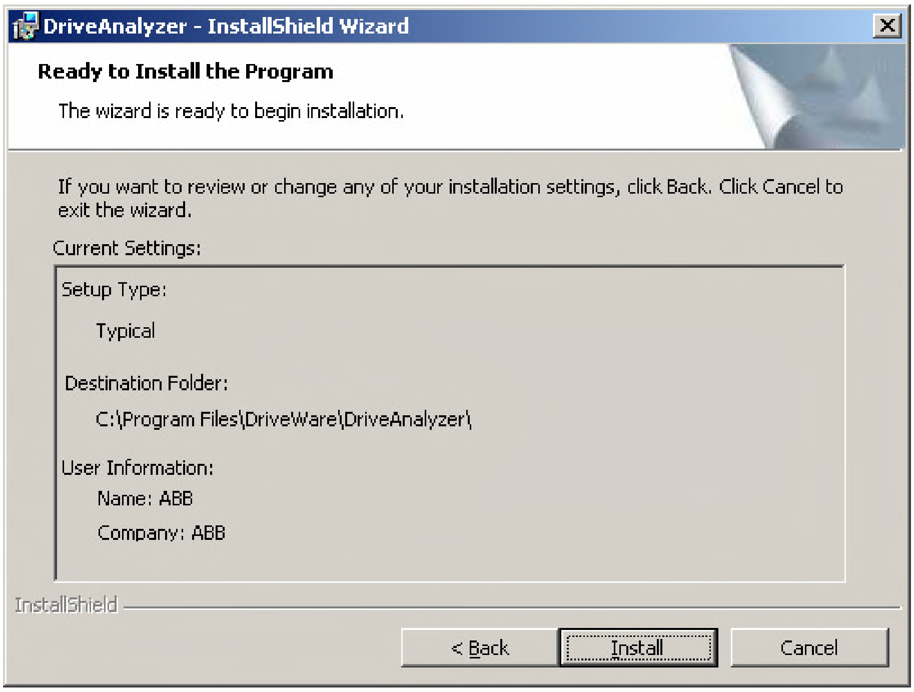
Browse button and select the program by browsing. Finally click the *Finish* button, which starts the SETUP.

When the DriveAnalyzer installation wizard window is shown, click the *Next >* button.

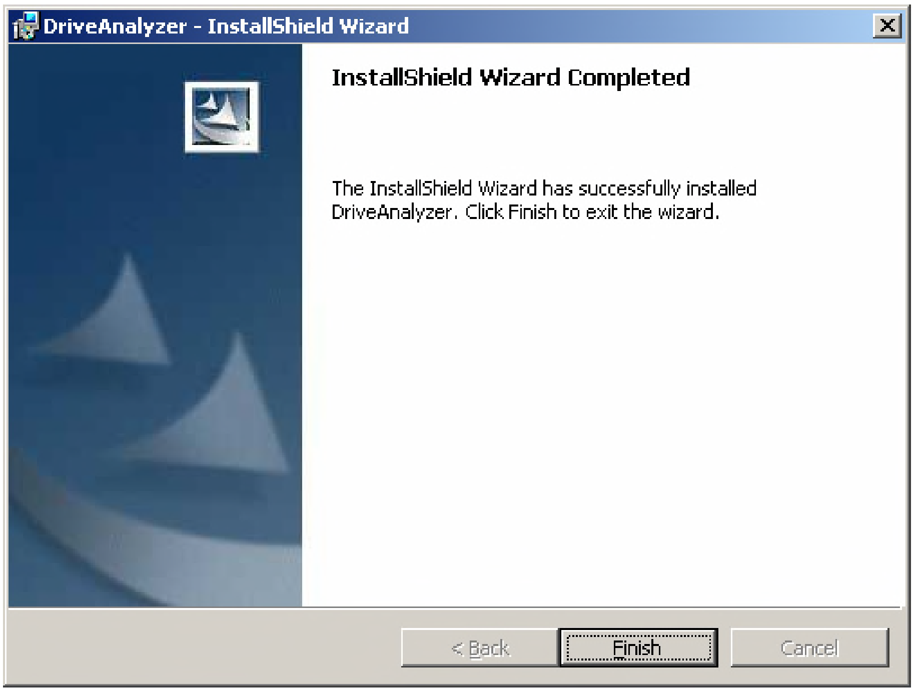


The second screen asks where to install DriveAnalyzer. If the default location is OK, just click the *Next >* button to continue. Otherwise click the *Browse* button to define another location.

A confirmation screen is shown. You can return to a previous screen and change your selections by clicking the *< Back* button. Start the installation by clicking the *Install* button.



After the files are copied to the specified location on your hard disk, click the *Finish* button to end the installation procedure. DriveAnalyzer is now ready for you to use.



Starting DriveAnalyzer

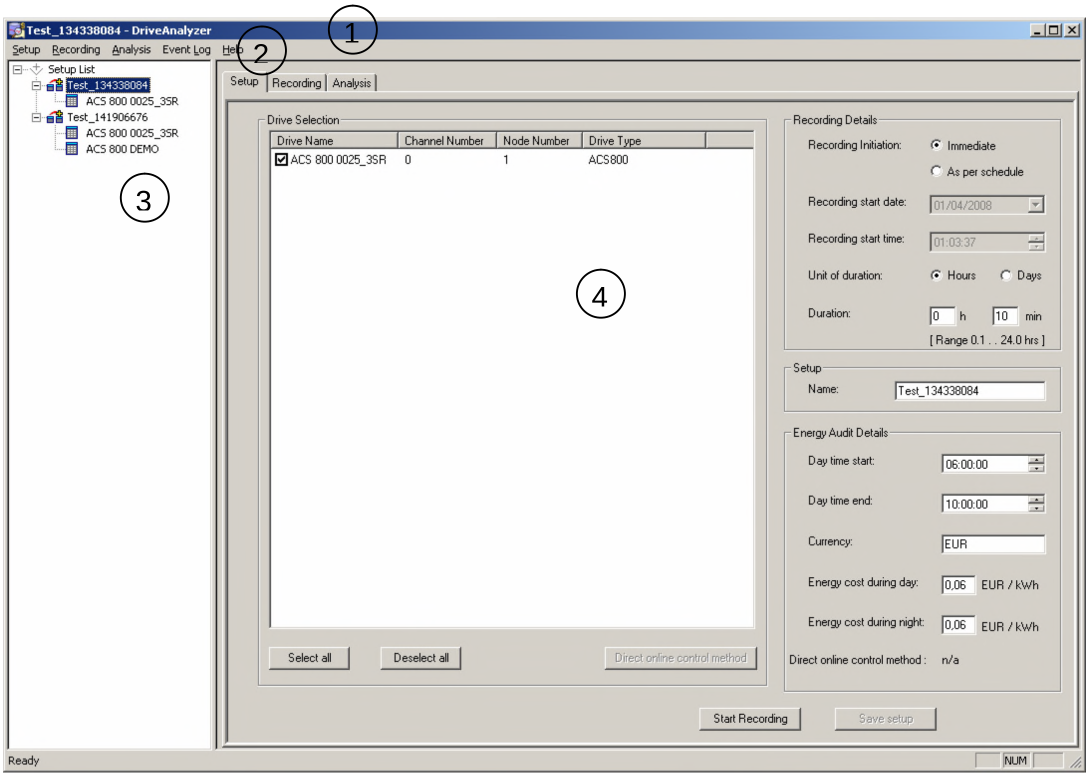
To start DriveAnalyzer, select Start – Programs - DriveWare – DriveAnalyzer

User interface

What this chapter contains

This chapter describes the main user interface of the DriveAnalyzer. It is somewhat "Spartan" because the final report of measurement is assumed to be created in MS Excel and MS Word, where the graphics are passed from DriveAnalyzer.

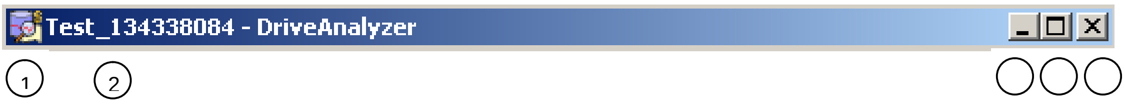
Overview



The user interface consists of the following parts:

1. Title Bar
2. Menu Bar
3. Setup list
4. Setup/Recording/Analysis tab

Title bar



The title bar is located at the top of the main window. It consists of the following parts:

1. System menu button
2. Test setup name

Menu bar

The menu bar is located immediately below the title bar. It always contains the following drop-down main menus:

- Setup
- Recording
- Analysis
- Event Log
- Help

To open a drop-down menu, click its name on the menu bar.

Setup menu

The menu contains the following commands:

- *New* command creates a new setup file for the supported and connected drives. This will be activated when some drives are found on DDCS.
- *Import*… command presents a dialogue to import a previously exported DriveAnalyzer file and appends the data into current database.

- *Export* command presents a dialogue to export recordings from database with filename defined by the user, with DriveAnalyzer structure. Files are in MS Access format.
- *Delete* command deletes the selected setup, including all recordings made under it, from the database.
- *Exit* command ends your DriveAnalyzer session.

Recording menu

The menu contains the following commands:

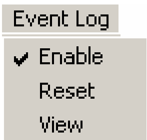
- *Start recording* command removes all data from an active DriveAnalyzer and starts recording with setup settings.
- *Delete recording* removes selected data.

Analysis menu

The menu contains the following commands:

- *View Graph* command opens the Analysis tab.

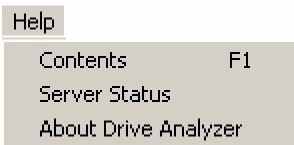
Event Log menu



The menu contains the following commands:

- *Enable* command enables or disables logging to the Log File.
- *Reset* command deletes the contents of the Log File.
- *View* command opens the Log file.

Help menu



The menu contains the following commands:

- *Contents* command brings up the online help window and shows its topics.
- *Server Status* command opens a dialogue showing the OPC server information.
- *About DriveAnalyzer* command brings up a window displaying program information, version number and copyright.

How to set up the recording with DriveAnalyzer

What this chapter contains

This chapter describes the setup process and how to start recording.

How to set up new the recording

Creating a new setup is made easy and minimal input is required from the user. Almost all setup data is taken through DDCS: the drives names, limits, rated motor data, rated drive data, DDCS node numbers, etc. A new setup needs a live connection to the drives with auxiliary power on.

Select New from Setup menu

- Select drives to be measured. Available drives are shown under the Setup tab. You can select or deselect all drives by clicking corresponding buttons under the Setup tab.

Recording Details

- Enter recording details in a group box as in Figure 1

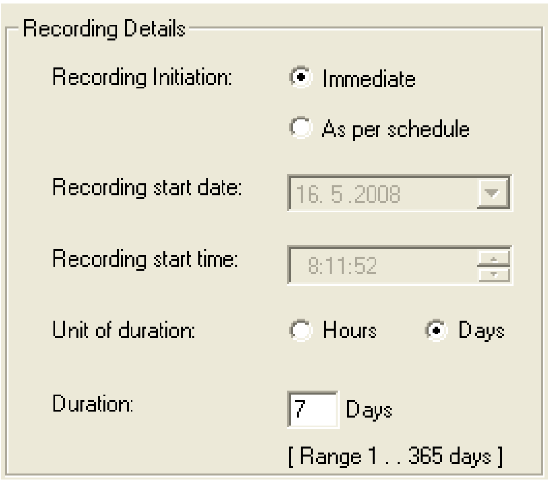


Figure 1. Entering recording details

The recording initiation has two choices:

a) The choice “Immediate” means that recording is started right after you have hit the “Start recording” button.

b) The choice “As per schedule” is more professional, at least with energy measurements. The timing is based on the PC clock. But there is also the possibility of confusing the timings and ending up with no recording in the expected time. Please set the date and time carefully so that the recording really starts at the earliest possible date and moment. Due to time settings this type of setup can not be repeated.

Unit of duration /Duration. Next choose whether the duration of the recording is in hours or in days. This selection will also select the sample interval.

Then enter the duration of the recording. If Unit is in days, enter how many days the recording lasts, or else enter the duration in hours and minutes.

Setup name

You are able to give name for your setups. Please use characteristic unique names like: Pool_pump_winter, paper_unwinder etc.

If necessary, DriveAnalyzer creates a default name based on the time of setup creation; change the name if needed, as in Figure 2.

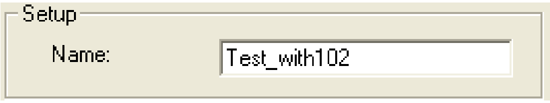


Figure 2. Change setup name

Energy audit details

DriveAnalyzer supports the idea of two energy tariffs, which is becoming more and more common all over. If at some plant the energy cost is the same at day and at night, it is not a problem; simply set the energy cost the same for day and night. The other possibility is to eliminate the night time by setting Day time start = Day time end. In general, the day and night accumulated energies/duration graphs are interesting and tariffs can be distinct.

Without DriveAnalyzer the accumulation of two energy integrals would be awfully cumbersome. Naturally it is possible with DriveWindow and then manipulating data with Excel etc.

To be able to calculate energy audit details, enter day time start and end times, currency, and the energy costs for day and night time, as in Figure 3.

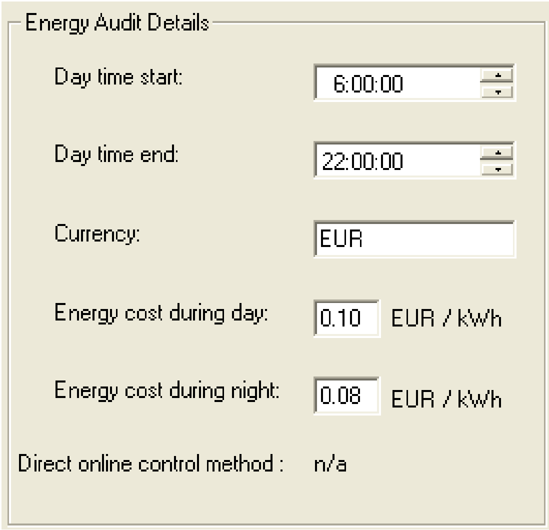


Figure 3. Enter energy audit details

Day time start default is 06:00 morning and **Day time end** default is 22:00 (10:00 PM).

Currency field is for the local currency symbol. You can use single symbols like €, £, $ or just short strings like CHF, EUR etc. DriveAnalyzer does not really have any understanding of currencies but will consistently repeat your input.

Energy cost during day is first of all the energy cost plus possible power cost allocated for the day time. The energy cost is charged based on [kWh]. But if your plant is also obliged to pay for drawn power based on [kW] this should be included. On a case-by-case basis, the fixed cost or part of the fixed cost of energy should also be included. Consult your accounting personnel.

Energy cost during night the principle shall be the same as with day time cost.

DriveAnalyzer can make a comparison of variable speed control to some other control methods, but this needs more information from the user. To select a control method, select first a drive, then click the Direct online control method button under Setup tab.

This presents a dialogue, as in Figure 4.

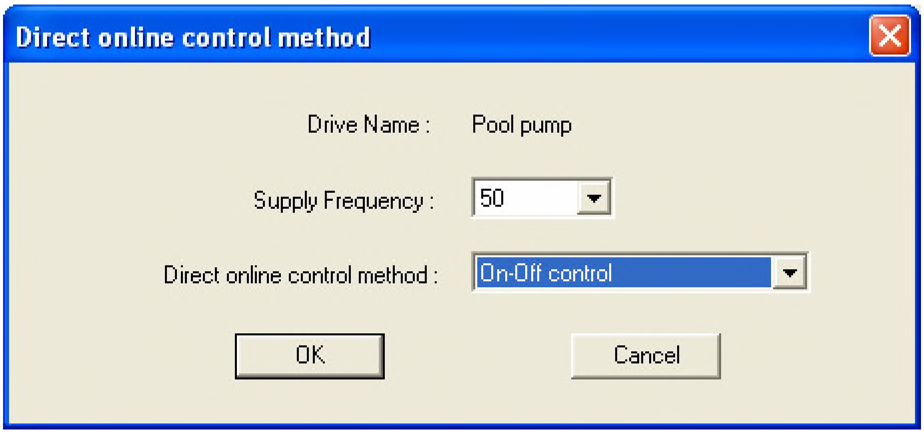


Figure 4. Selecting supply frequency and online control method for a selected drive

Throttle control

Throttle control is such that the motor is running at full speed all the time and the desired flow rate is achieved by throttling. This means a lot of losses.

The measured power levels are basically extrapolated to 50Hz or 60Hz to find out what size of motor would be big enough to direct on-line use. If variable speed drive was running more than 50/60 Hz, the direct on-line motor would require some gearing. DriveAnalyzer will assume ideal gearing – no losses.

ON/OFF control

ON/OFF control always needs a reservoir when we assume the final flow to be controlled. The ON/OFF control will waste energy because it works at full speed and maximum power when it runs and energy is wasted by moving material on max speed unnecessarily. The average speed reflecting the required flow would be much better. The ON/OFF will waste additionally in every DOL start equivalent to the kinetic energy of the moving masses. Additionally, ON/OFF changes will generate pressure waves, causing more need for maintenance. All of these nuisance phenomena are forgiven by DriveAnalyzer.

Hydraulic control

The hydraulic control will have the motor running at full speed all the time. The motor shaft speed is reduced by slip to match the control needs. With the slip, the torque of the load is taken from motor shaft, but some power savings are achieved because the measured active load is typically increasing with speed. The possible slippage at full speed is also forgiven by DriveAnalyzer.

Start a recording

To start a recording, click the Start recording button under the Setup tab, or select Start recording from the recording menu, and the Recording tab is shown for you.

What to do with recording phase screens

During the recording, the PC is normally left to do the recording by itself. If the recording initialisation is selected to be Immediate, it makes sense to check how the recording starts and if the PC really gets some response from the drives.

The response is shown by coloured icons for each drive with different status. The speed, current and torque are listed, as seen in figure 5.

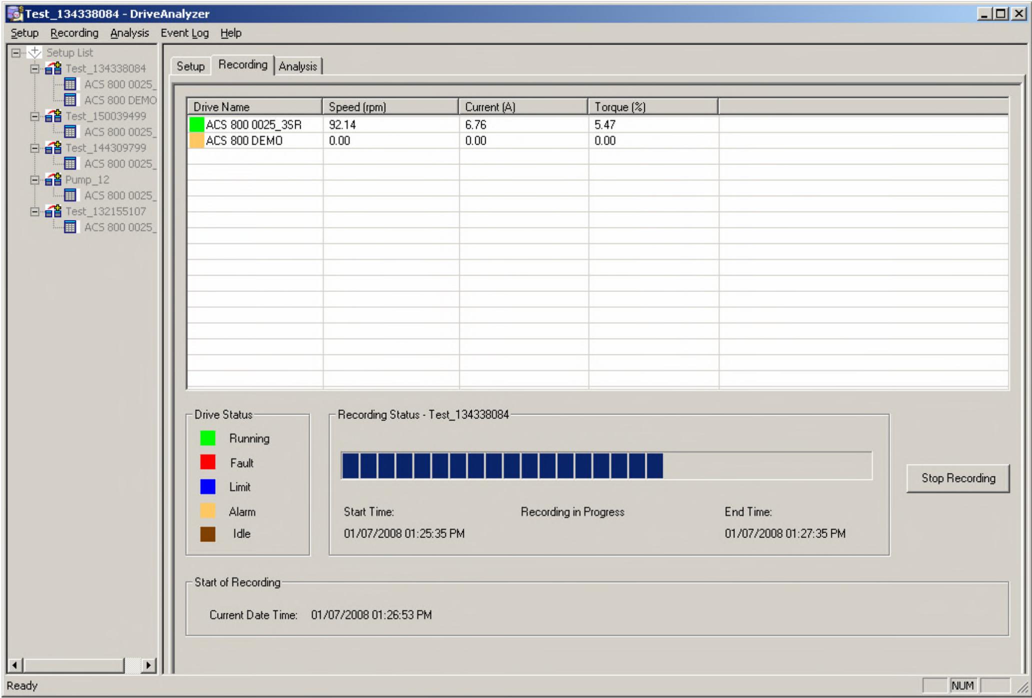


Figure 5. Viewing status and some actual values during recording phase.

Drive Status

Drive status is frequently polled from drives by using status words. The status "Running" means the drive is modulating and producing some output voltage without limits or alarms. "Idle" means that the drive is ready to start any time or the drive is out of auxiliary power.

If the drive is running at some limit it is indicated with "Limit", and if an alarm is on this is indicated with "Alarm". Both status indications are important if they stay on for too long. During fast acceleration/deceleration, it is even possible to have regularly limiting status.

"Fault" is a status which must be reset by plant operators with door panel or from control room.

Recording Status

The recording status has a relative progress bar, where the first blue rectangle will show up within the first 10 minutes and the rest within equal time spans. The **Start Time** is just information but the **End Time** informs you when this recording will finish and the PC can be removed.

Stop Recording button

If you make recordings according to plans, there should be no need to use this button. But there may be cases when you just make test recordings and want to start immediate recording and stop the recordings relatively soon after, and this is when you will use **Stop Recording.** In these cases, please allow the recording to last for at least 10 minutes, otherwise you may draw the wrong conclusions from the test runs.

Current Date & Time shall be compared to the **Stop Time**.

How to analyse the results with DriveAnalyzer

You may enter to analysis phase when recording is done or you have imported data into the DriveAnalyzer database.

Overview of analysis screen

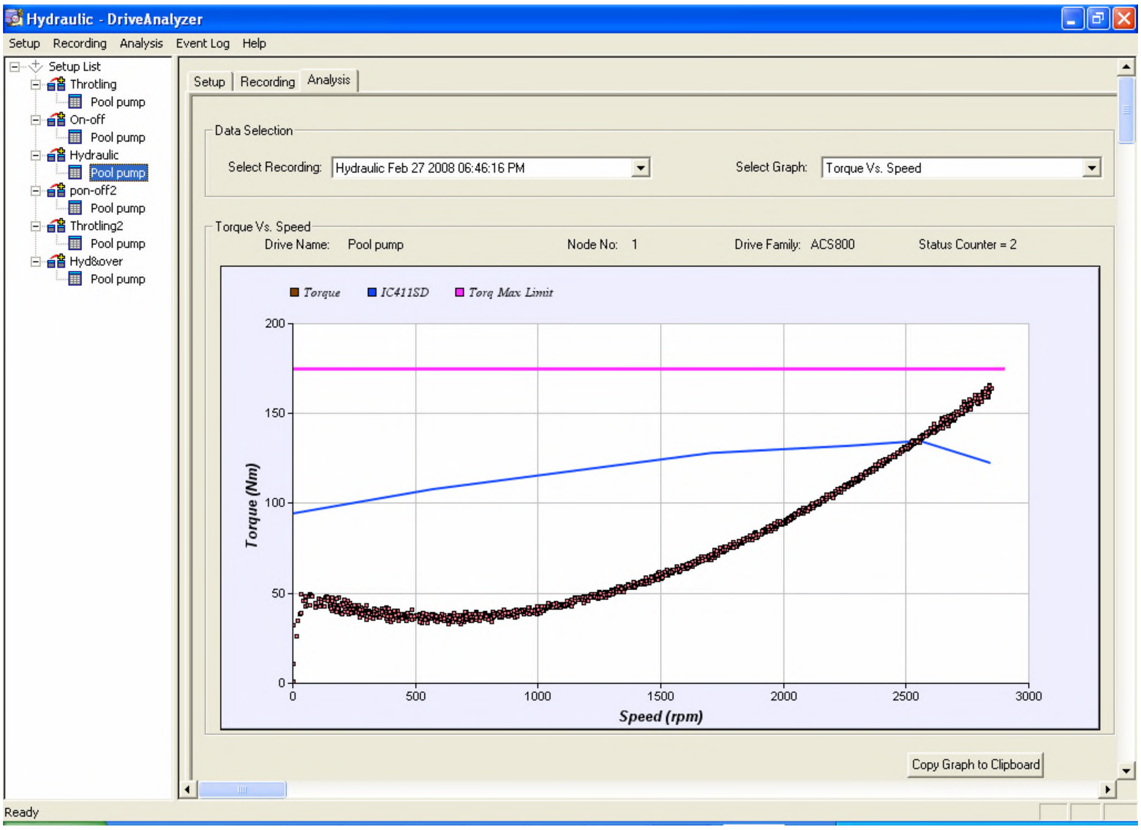


Figure 1. Viewing first analysis graph.

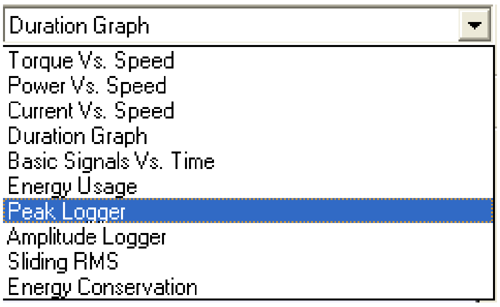
Selecting the measurement

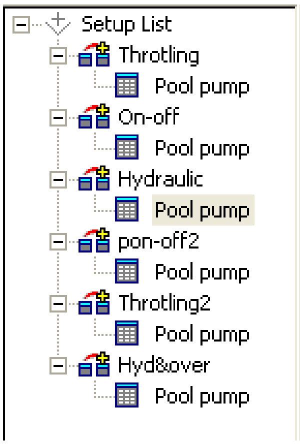
To start with select from Setup List tree the interesting recording and drive and open the Analysis tab, Figure 1.

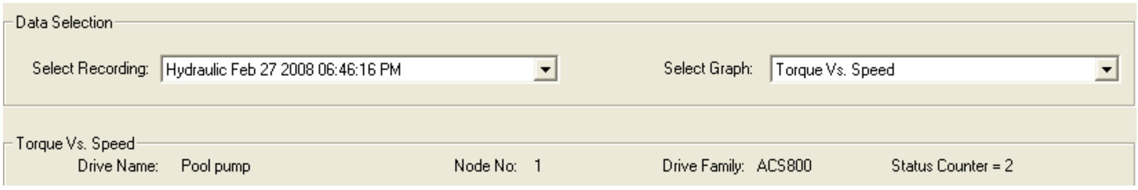
Within the **Data Selection** group, **Select Recording** and **Select Graph** are the main and independent selections. Some screens, like the duration graph, have their own sub-selections.

The idea is that you might want to check the “Torque Vs. Speed” graphs from all recordings. In this case you just keep selecting different recordings from the same setup or even change the setup from the setup tree. The usual way is to select the recording and just select the different graphs one-by-one:

For each setup there might be more than one measurement. See the following clips.







Each measurement is identified with:

Drive Name originates from the drive parameters.

Node No: is determined by the DDCS node.

DriveFamily comes through DriveOPC server, which will identify the drives.

Status Counter is number of different drive status (Run/ Idle etc.) indications.

In the following pages the analysis graphs are explained one-by-one.

Notice: Measured samples are shown in many graphs by dots. With DriveAnalyzer you are able to mark the interesting sample with asterisk with left mouse click. Then you can follow where this sample is located in the other graphs.

Torque Vs. speed

Torque Vs. Speed in its simplest form is like Figure 2.

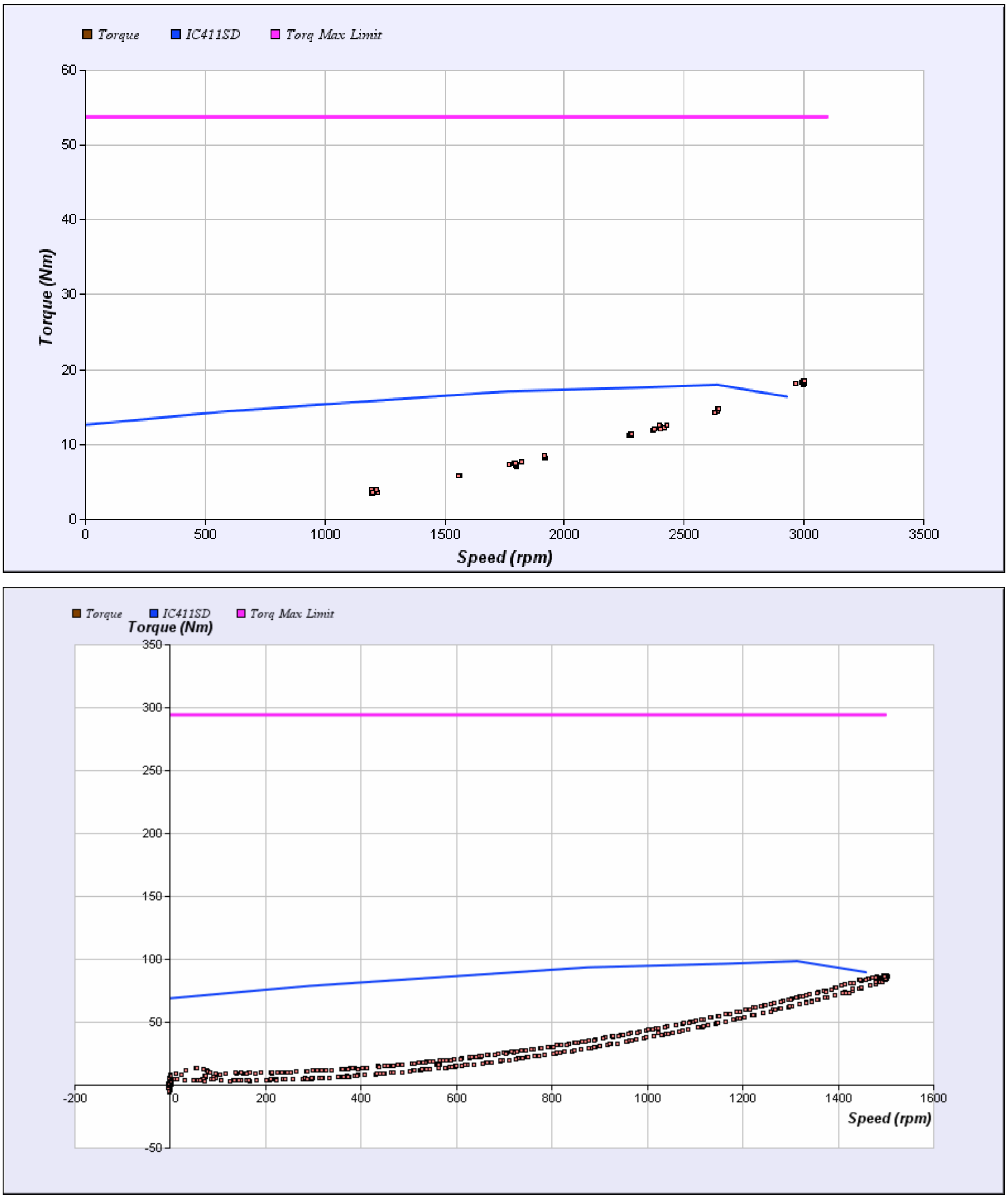


Figure 2. Viewing Torque Vs. Speed in two simple cases.

Each torque sample is shown as a dot. In the upper case the small motor was accelerated fast to its final speed, around 2840 RPM, where torque stayed for a longer period. So from the density of dots one can conclude which torque and speed area was mostly used during measurement. In the lower case a bigger motor was more evenly accelerated and decelerated.

The novelty of DriveAnalyzer in these cases can be seen from blue and purple curves. The blue line represents the thermal capability of a typical AC motor with the IC411 cooling. This curve is drawn based on nominal data of motor which is available from the drive. The correct scale is utilised. The same intelligent method is applied to the red curve and the level of it is the rated torque of motor multiplied by the parameter 20.04 TORQ MAX LIMIT. If negative torques are present, the negative limit is based on 20.15 TORQ MIN LIMIT.

Please notice that the x-axis scale is automatically adjusted to the limit settings of the drive.

You should not be surprised if the sample dots do not form a specific curve, but rather a family of curves. Imagine, for example, that the motor is pumping water to different vertical levels during the measurement. With lower levels, the required torque is systematically less, and torque samples are located higher with higher vertical levels. There are many other reasons, even with pumping, which affect the torque. Please consider the thickness of the liquid and the viscosity of the liquid; even the resistance of the tubing might change during the measurement due to the clogging of filters or opening of valves, etc. Moreover, the pump impeller is subject to damage, wear and tear and this will affect the required torque. This was, of course, just an example and it is your duty as analyser to draw the final conclusions.

If the drive is running in positive and negative directions and if the torque is, at the same time, getting positive and negative values, the graph will be drawn in four quadrants.

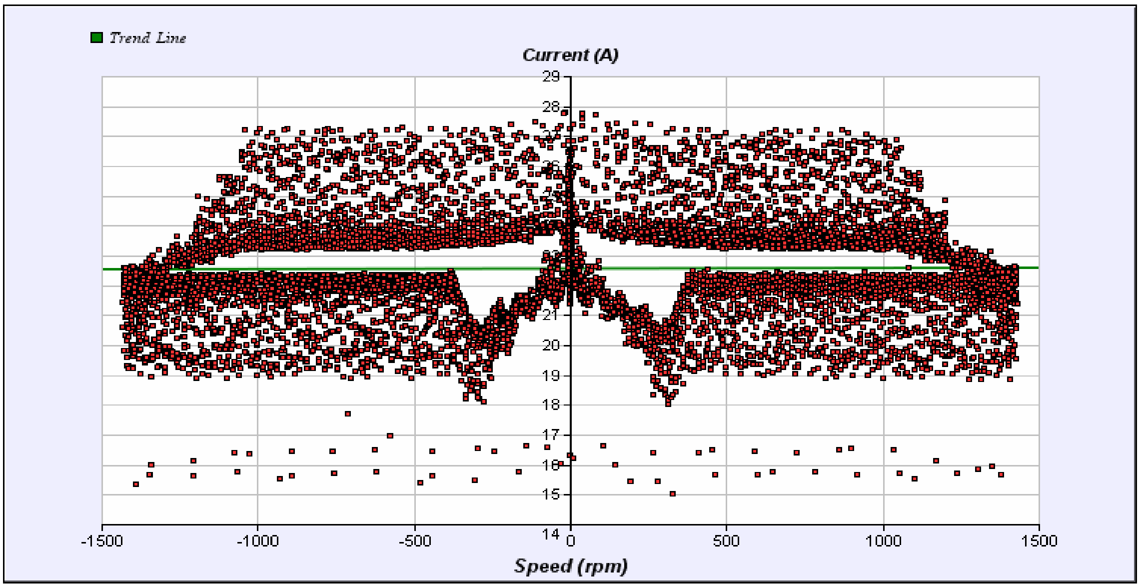
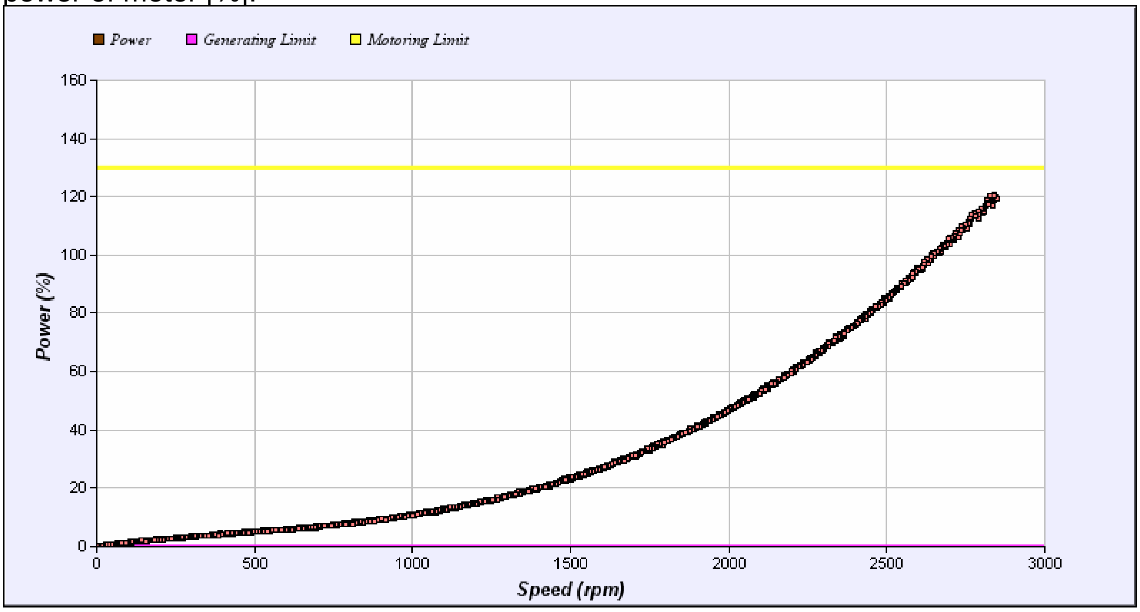


Figure 3. Four quadrant case and an example of Current Vs. speed graph of it.

It is important (but not obvious) to notice that Torque is a mechanical quantity, which the converter has computed based of motor flux and currents. It has basically an accuracy of +/- 3%. The accuracy of rotational speed is much higher at +/- 0.5%.

Power Vs. Speed

Power Vs. Speed is one of the basic analysis graphs, see Figure 4. Please notice that a somewhat similar graph would be electrical power vs. frequency. But Power Vs. Speed is anyway mechanical power vs. rotational speed compared to rated power of motor [%].



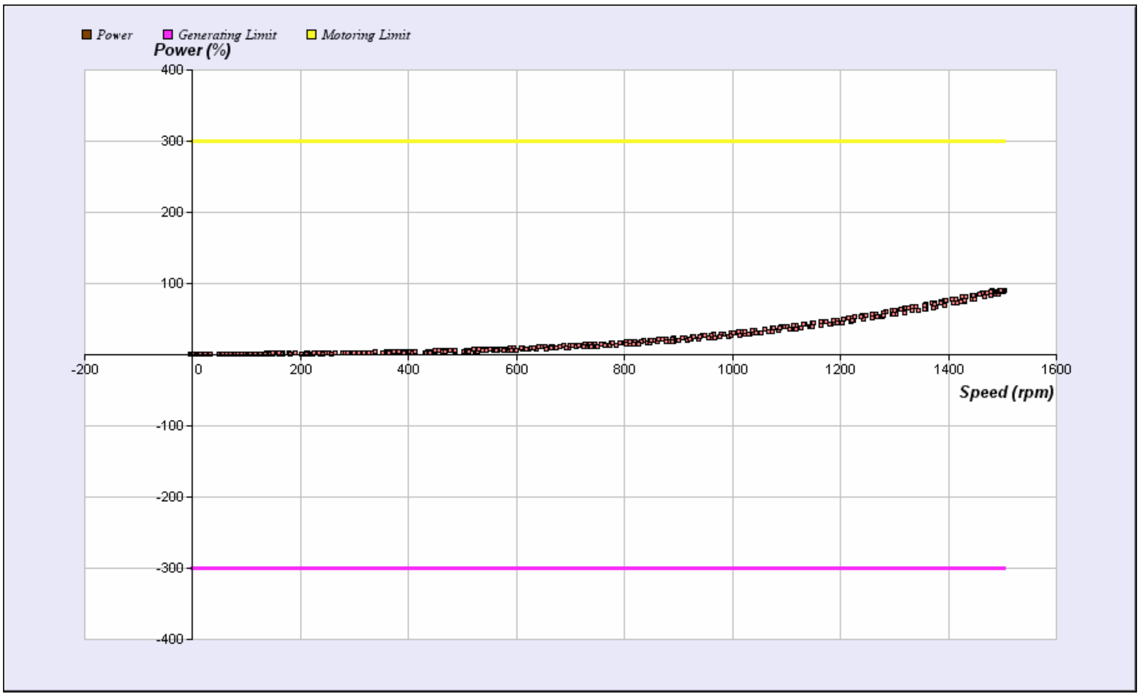


Figure 4. Viewing Power Vs. Speed in a pump case. In upper case the negative power limit is zero and in lower case drive is ready to run with negative inverter power too.

Please compare this graph to Torque Vs. speed. The both graphs have a distinct purpose. The power limits are distinct from torque limits and the **Motoring limit** is a drive parameter, 20.11 P MOTORING LIMIT. Its task is to prevent the power from exceeding the rated motor power only by a given percentage.

In a similar way the 20.12 P GENERATING LIMIT will prevent the power value from reaching high values in a negative direction. ACS800 drives which are equipped with regenerative supply bridges can regenerate a lot of power back to the network. Drives with braking resistors are also able to brake a lot, but for much shorter times. Typically, the drives with diode bridges can only perform a little electrical braking, and the Generating Limit is zero or slightly negative.

Please notice that in upper part of Figure 4 the motor is heavily overloaded and there is real danger that the lifetime of the motor will be radically reduced.

The Power Vs. Speed graph is especially important with so-called constant power cases. Then there might be a wide speed area where the idea is to have flat power levels.

Like in Torque Vs. Speed, the x-axis scale is automatically adjusted to the limit settings of the drive.

The typical accuracy of mechanical power is around +/- 3.3%. The accuracy of rotational speed is much higher +/- 0.5%.

Current Vs. speed

The motor current is derived from the measured AC currents in all three phases of motor. It is not the peak value but RMS (root mean square) value. This is the same current a normal A-meter would show for motors running from sinusoidal supplies. You can consider this as the length of current phasor in a very traditional phasor diagram. This also explains why the current is never negative. When the motor is producing positive torque, the power factor between voltage and current is positive and in the reverse situation, mechanical power is provided externally into the shaft and the power factor is negative. If the motor is just running with no load, the power factor is close to zero and the current is mostly inductive current to magnetize the motor.

Each converter rating is designed for some nominal current, which is shown in the graph with 100% level. The possible overloads of the converter are limited to safe values by Max Current = parameter 20.03 MAXIMUM CURRENT.

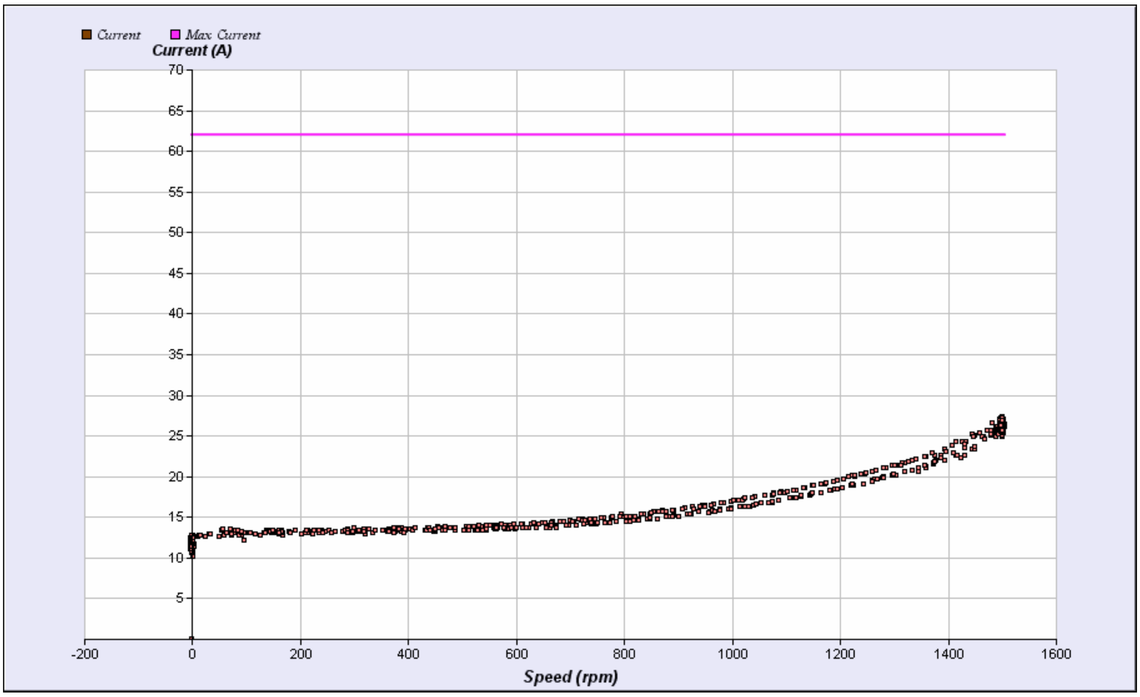


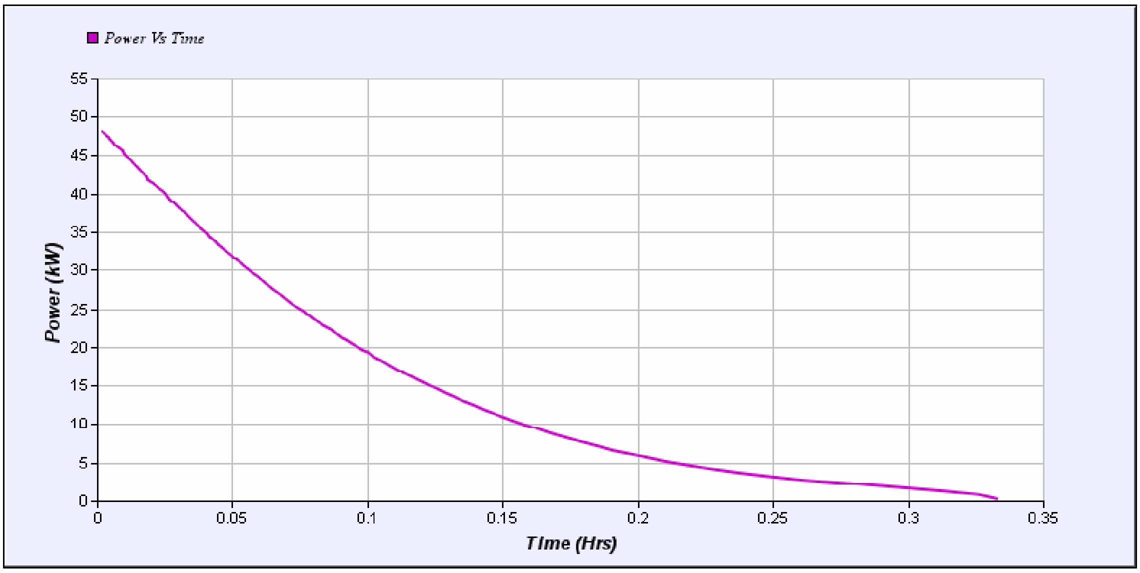
Figure 5. Viewing Current Vs. Speed in a pump case.

In case of figure 5, the 13A current at zero speed means that the motor is automatically magnetised but does not consume much power.

The current curves can have two quadrants if, during the measurement, the speed were both positive and negative.

Duration graph

Duration graphs are a powerful tool to describe the distribution of power levels. They help you to conclude many facts and even the shape of curve can tell you a lot. Let's explain the graph with first example. By using Figure 6 we can see that in this case the power was more than 45 kW only 0.01 hours and more than 10 kW 0.16 hours, etc.



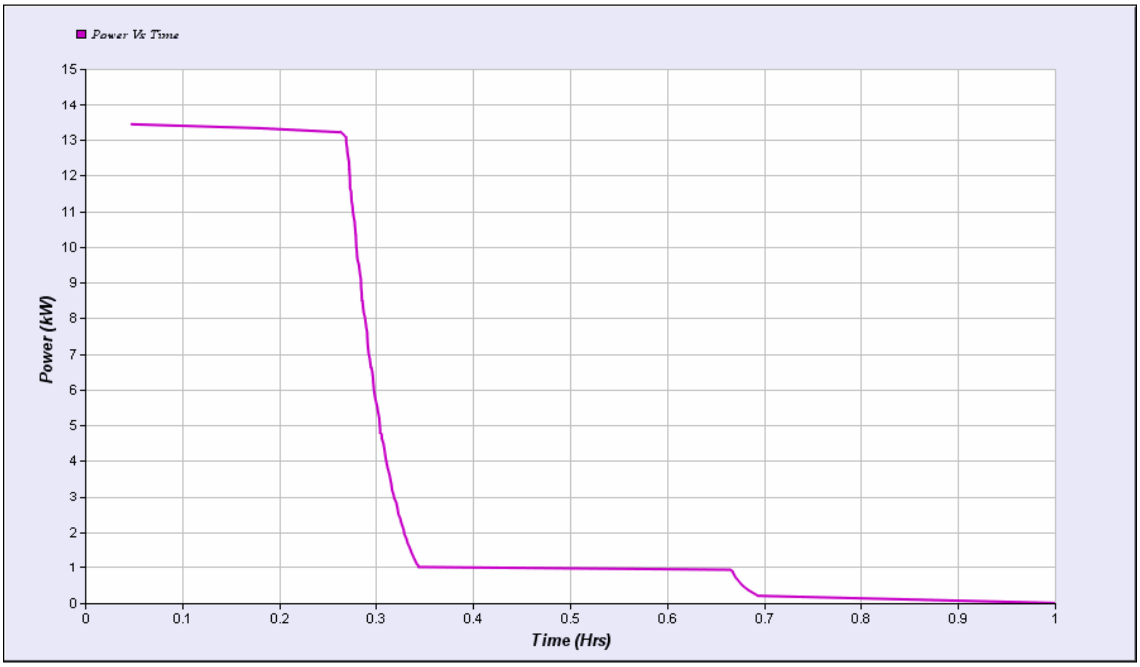


Figure 6. Different duration graph examples.

The duration graphs are computed for you from day period, from night period and from day and night together. Another aspect of duration graphs is that this is done for group of drives. Integral of duration graph has also the unit of energy [kWh].

Basic signals Vs. Time

This basic graph could be the first in the list but it is considered less important in DriveAnalyzer. The best tool to draw this kind of graphs is DriveWindow.

Basic signals Vs. Time will give an overview of how the drive in the process was running during the measurement. You will see if the drive was idling or if there were accelerations and decelerations. You will see if the drive behaved smoothly or if there was lot of action during the measurements. The symptoms of such activity are shown in Torque, Power and Current graphs.

Basic signals Vs. Time is typically a long graph and has a horizontal scroll bar.

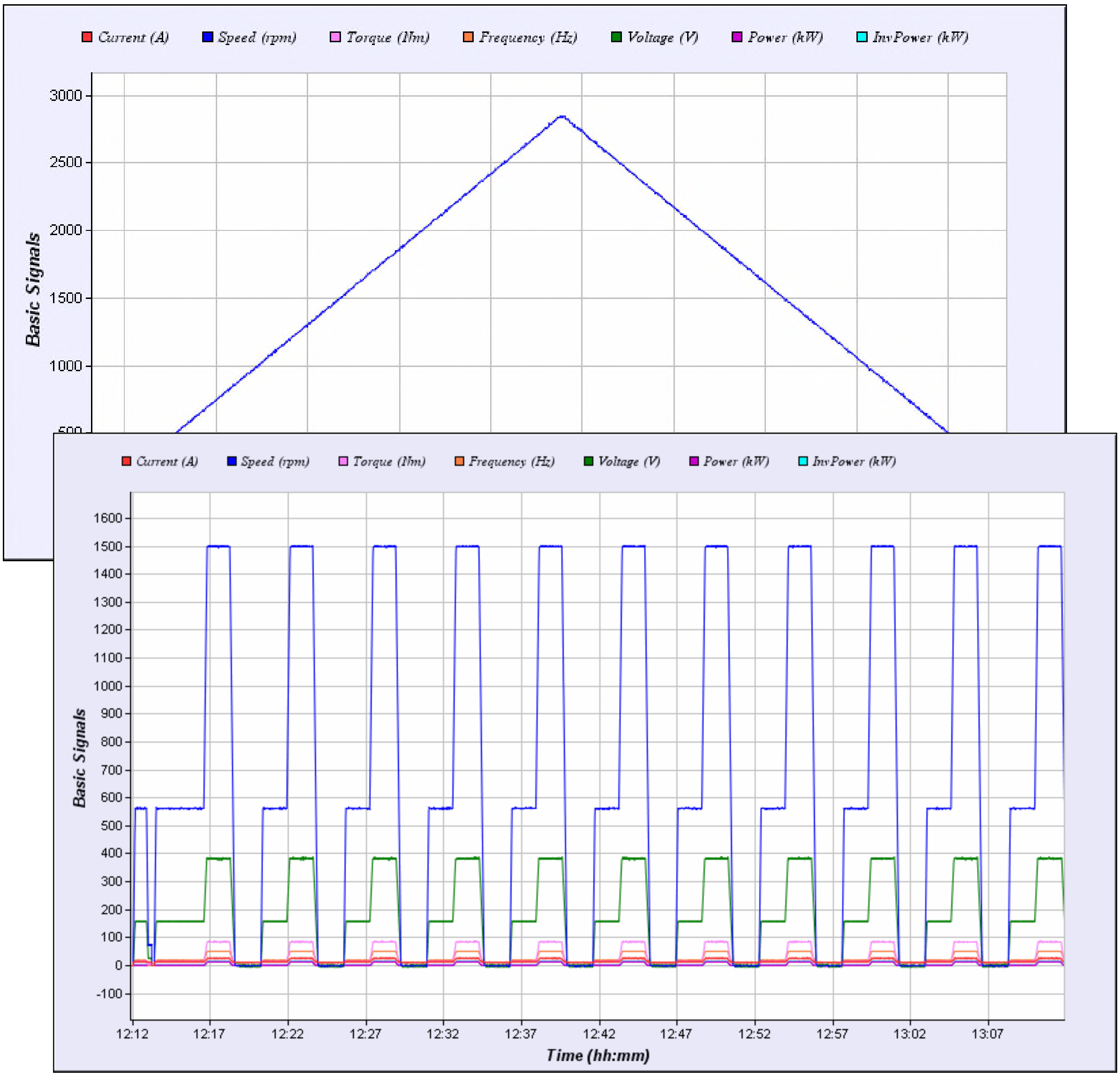


Figure 7. Basic signal graphs.

Energy Usage

Energy Usage is a numerical report which utilises the kWh meters inside the drives. The numbers reflect the energy consumed by the drive. It is also based on signals available to all users; please see the drive manuals. The value is accurate and it is recorded at start, on every day-night change, on every night-day change and in the end.

Inside DriveAnalyzer there is also another type of energy measurement. The other one is based on the recorded samples and by definition it is less accurate due to its statistical nature.

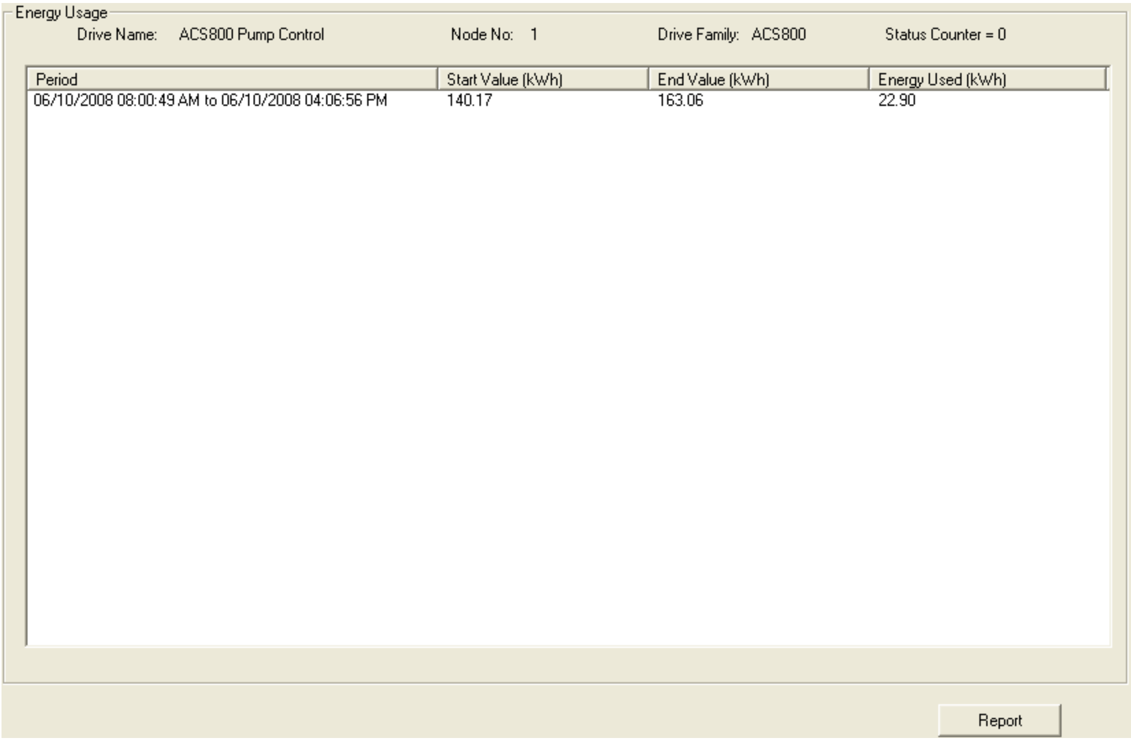


Figure 8. Pool pump measurement was a short measurement and energy used during the day time was 22.9 kWh.

The Excel format report is generated from the measurements, and has the format shown in figure 9. In this figure the day and night energy costs are shown as separate lines.

Electricity usage report

Long_inverter		
Measurement started	June 10 2008 08:00:49 AM	
Measurement ended	June 10 2008 04:06:56 PM	
Total length of measurement	08 hr 06 min 07 sec	
Drives included:		
ACS800 Pump Control		
Electrical cost:		
Day Time	0.06	EUR/kWh
Night Time	0.06	EUR/kWh
ACS800 Pump Control		
Energy usage at day time	22.9	kWh
Energy usage at night time	0	kWh
Total Energy used	22.9	kWh
Energy fees at day time	1.3738	EUR
Energy fees at night time	0	EUR
Energy fees Total	**1.3738**	**EUR**

Figure 9. Energy usage report. This would be much longer if there were more drives.

Peak Logger

The purpose of internal peak and amplitude loggers is to provide statistical tools to analyse the driven process and dimensioning of the inverter and motor. This is done with two separate parts: “Amplitude loggers” and a “Peak Value logger”. These reside inside drive.

The peak value logger (PVL) records the peak values of a selected signal. When the new peak value is detected, it and some actual signals indicating the situation in which the peak has occurred are saved to the non-volatile memory of drive.

By default, the embedded Peak logger will monitor motor current, but basically the monitored signal is selectable for RMS current [%], torque [%], power [kW], frequency [Hz], DC voltage [V] or temperature [°C]. This selection is done typically by experts with DriveWindow tool.

The input signal is filtered typically with 20 ms time constant.

Peak value logger is able to find both positive and/or negative peak values.

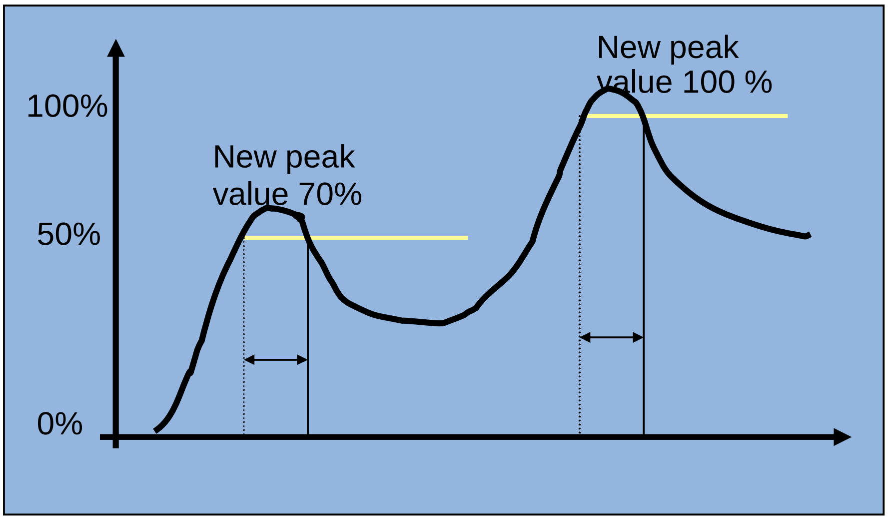
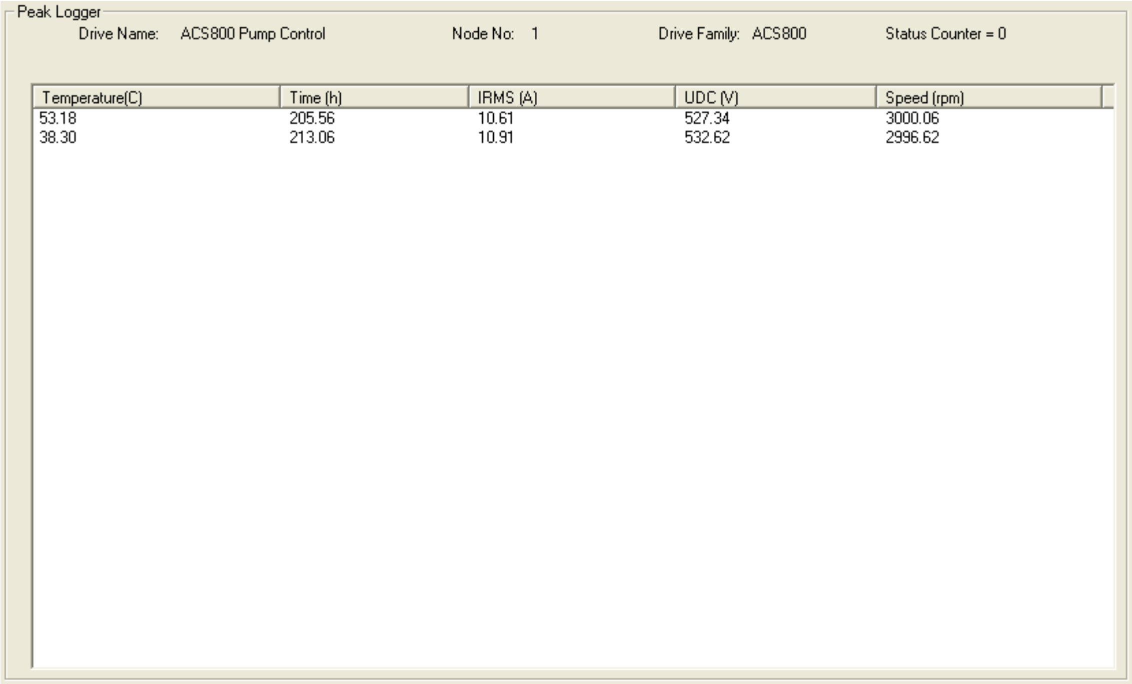


Figure 10. Idea of peak logger.

The peak Logger screen is based on embedded Peak Logger feature the inside drive. See figure 11.



Temperature(C)	Time (h)	IRMS (A)	UDC (V)	Speed (rpm)
53.18	205.56	10.61	527.34	3000.06
38.30	213.06	10.91	532.62	2996.62

Figure 11. Peak logger report.

Amplitude Logger

The purpose of internal peak and amplitude loggers is to provide statistical tools to analyse the driven process and dimensioning of the inverter and motor. This is done with two separate parts: “Amplitude loggers” and a “Peak Value logger”. These reside inside drive.

The amplitude logger (AL) forms an amplitude distribution of a signal. Samples of the averaged signal are discerned in 10 groups according to the amplitude level. Amplitude distribution is formed from the averaged RMS current. Calculated moving averages of two seconds time interval are sampled and the values are divided into ten groups according to their amplitude level. Groups are defined in steps of 10% in the range 0...100% of maximum current I_{MAX}. There are two identical amplitude loggers, AL1 and AL2. AL1 holds the data, which is gathered throughout the whole history of the drive, while AL2 is reset by DriveAnalyzer.

To make it easy for the user, the RMS current will be scaled as a percentage of the I_{MAX} in both PVL and ALs. It must be noted that in this context I_{MAX} is the maximum allowed overload current. The counters are implemented with 48 bits which is enough for the whole lifetime of drive.

Every 2 seconds after the average value is sampled, it is tested to discern into which category the value belongs and the counters of this category, as well as used to increment the total number of the samples by one. After that, the amplitude distribution is formed. The portion of the samples in each category is calculated by dividing the counter values of the categories by the total number of the samples. The counter values of the categories are saved into non-volatile memory of drive at power down.

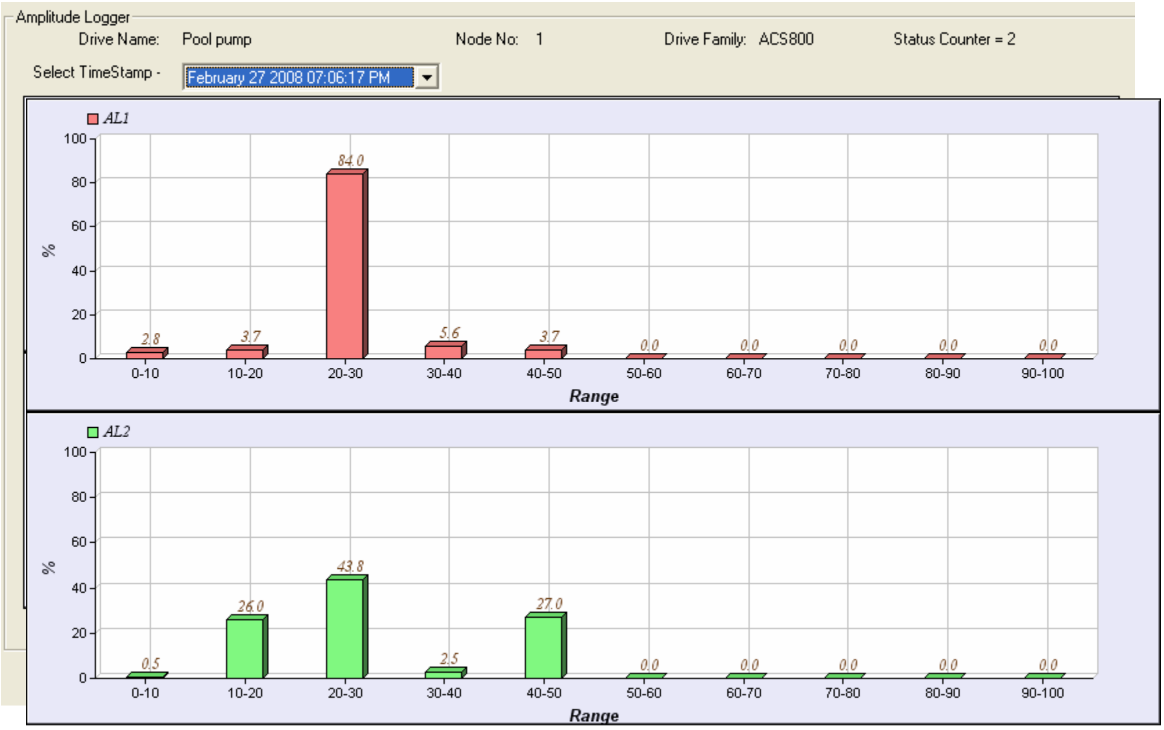


Figure 12. Amplitude logger screen showing both of the amplitude logger distributions.

With the **Select Time Stamp** you are able to select the interesting time moment where the amplitude logger information is shown. DriveAnalyzer will reset AL2 at start and day/night shifts.

Sliding RMS

A very traditional way to select a proper motor for variable load is to find out the RMS value of the required torque. This method has been successfully applied to fixed-speed motors and also DC motors in a constant field area, where the ratio of armature current and torque is roughly constant. The armature reaction naturally distorts this illusion. RMS torque can also be used with force-cooled induction motors in a constant torque area, and can be used with standard IC411 motors, although in this case some human rationalisation should be involved.

DriveAnalyzer will provide three kinds of RMS curves with time constants: 12, 60, 120 minutes. The 60 minutes is considered to be valid for 4- and 6-pole 150 kW std induction motors. You may find out the thermal time constant of the process motor from the motor manufacturer. The potential new motor has to be able to handle the RMS torque thermally. One straightforward way is to compare the top value of RMS torque of load to the rated torque of the motor, which should be bigger. ABB provides a nice tool to select motor and drive to mechanical load; it is called DriveSize and is available on ABB and other public websites.

While DriveAnalyzer computes the RMS torque, it also computes the RMS current for the installed motor. This can be retrospectively compared to the nominal current of the motor on duty. The top value of the RMS current should be lower than the nominal current of the motor if the cooling is nominal and if the normal lifetime of motor is desired.

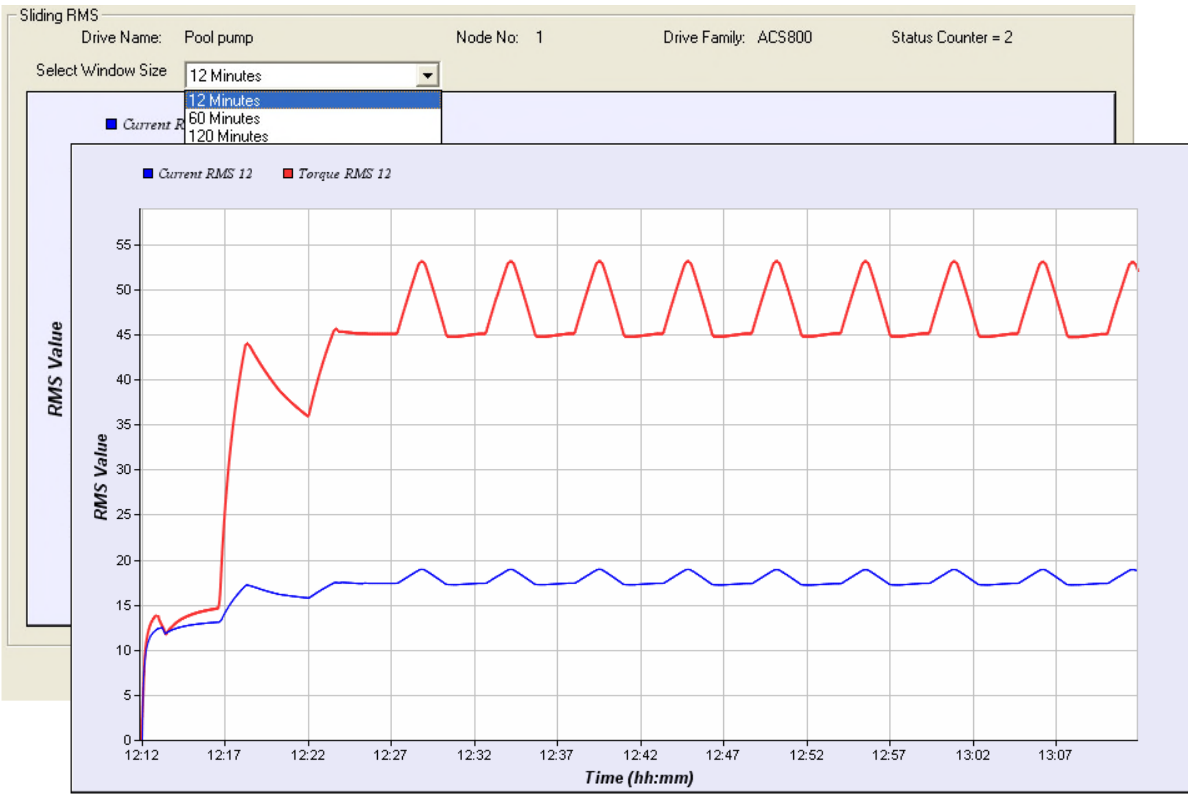


Figure 13. Sliding RMS current and RMS torque graphs.

Energy Conservation

In the following chapter the method and steps to compute the energy savings are described, referring to figure 14.

1) from the samples of measured electrical power an envelope curve is created. This is the blue in curve figure 14. Please notice that this is the power necessary for the motor to run the load. The curve will be of third order polynomial.

2) then the virtual constant speed motor is computed. The rated power of it has to be able to provide the mechanical power required by the load when extrapolated to full mains frequency 50Hz or 60Hz. If the original blue curve extends over 50/60Hz then the max value of the curve determines the power requirements directly. In reality, this would mean a gear ratio between motor and load. The losses of any such gear is forgiven, but the additional VSD motor losses are included. In this version of DriveAnalyzer, both of the motors are assumed to have roughly the same size and characteristics. The consumed power of the virtual motor is called P_{DOL} .

3) The power savings computing depends on compared control technology.

Throttling means that that the power between the red and blue curves is wasted. When weighted with the time distribution, the energy consumption and VSD energy savings are computed.

Hydraulic control means that the torque is according to VSD torque but the control is able to adjust the slippage. Again, when multiplied with timeslots, the consumed power and savings can be computed.

ON/OFF control is most complicated. It is only possible if there is a reservoir in the system, which is partly filled in during the duty period, and during the non-duty period, it is drained off. Naturally, this process itself means losses. The other type of losses happens with an ON/OFF control, namely the kinetic energy loss. Right after the ON command, all the masses have to be accelerated to full speed and then the same amount of energy is wasted as is converted to kinetic energy. Both of these losses are forgiven in the comparison. The ON/OFF control consumes the P_{DOL} but when energy usage is computed, the duty is considered. The duty is computed in such a way that the same output is reached. One simple way to understand this is to consider that the ON/OFF motor will rotate for as many revolutions with 50/60Hz as the VSD motor with lower frequency and 100% duty. Again, when multiplied with timeslots, the consumed power and savings can be computed.

The compared control technology can be selected by button **Direct online control method.**

4) In Figure 14 the column diagram will show the distribution of used frequencies during the measurement. It is divided into eight categories. Distributions are shown for day and night times separately. With this diagram, you may conclude where in the frequency domain the drive was mostly working. This might be useful even if

you are not interested in energy savings. Please note that the following energy saving computing does not use these categorised hours, but the actual measurements to maintain the desired accuracy.

5) Finally, energies are tabulated. **Actual energy** [kWh] is based on measured power values and sample times. Please notice that actual energy [kWh] values might deviate from “Energy Usage” data. The reason is first of all that integration of power is done totally differently. In the drive it is done at a very small time level compared to DriveAnalyzer, which is doing this by samples. The resolution of power value from drive is 0.1 kW, which effect the accuracy when dealing with low power levels (less than 1 kW).

Estimated energy [kWh] is the energy consumed by the alternative control method during the day and night.

The **Energy savings** [kWh] are difference between Actual and Estimated energy values.

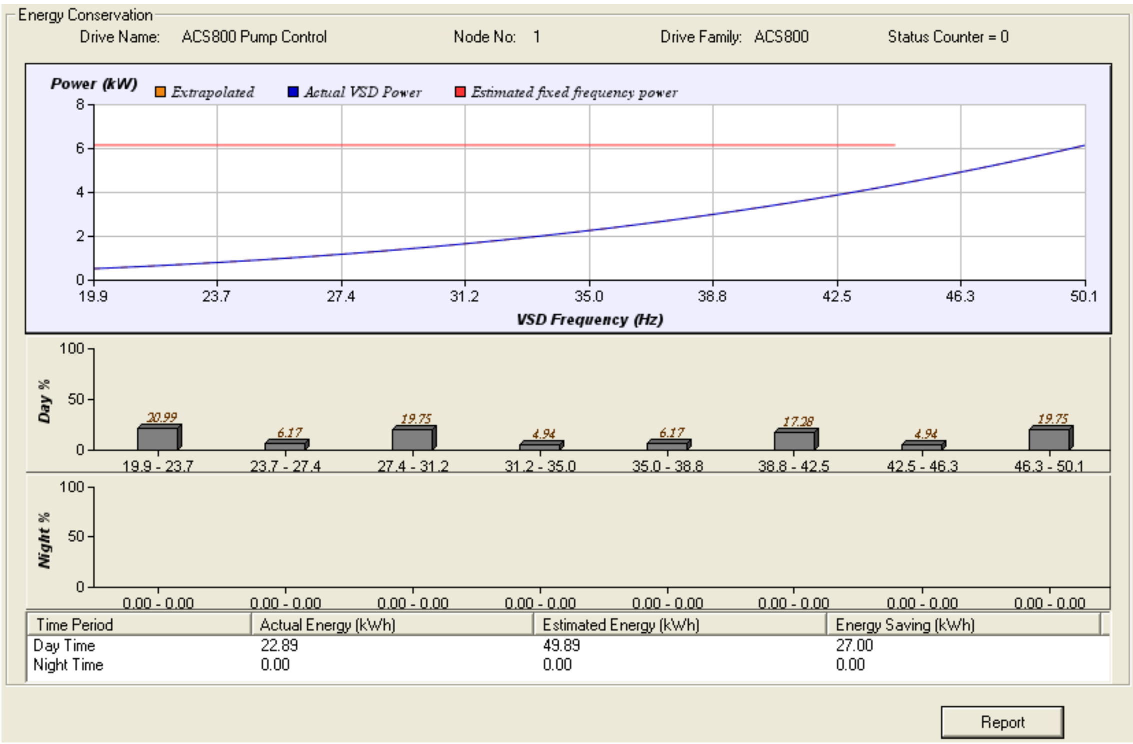


Figure 14. Energy Conservation screen.

An Excel format report is generated from energy conservation having the format of figure 15. In this figure, the day and night energy costs are shown as separate lines.

The savings figures are computed for full year.

Annual energy conservation report

Long_inverter	
Measurement started	June 10 2008 08:0
Measurement ended	June 10 2008 04:0
Total length of measurement	08 hr 06 mi

Drives included:
ACS800 Pump Control

Energy cost:		
Day Time	0.1	EUR/kWh
Night Time	0.06	EUR/kWh

ACS800 Pump Control

Actual Energy Consumed		
Energy consumed at day time	16502.95	kWh
Energy consumed at night time	0	kWh
Energy Total	16502.95	kWh
Energy cost day	1650.23	EUR
Energy cost night	0	EUR
Energy cost total	1650.23	EUR

Estimated Energy Consumed in Throttle control		
Energy consumed at day time	35966.07	kWh
Energy consumed at night time	0	kWh
Energy Total	35966.07	kWh
Energy cost day	3596.61	EUR
Energy cost night	0	EUR
Energy cost total	3596.61	EUR

Savings		
Energy	19463.12	kWh
Energy cost	1946.37	EUR

Figure 15. Energy conservation report. This would be longer if there were more drives in the same measurement.

DriveAnalyzer Databases and log files

DriveAnalyzer database

DriveAnalyzer is using one database and the file name is **DriveAnalyzer.mdb**. It is located, in a typical installation, in directory C:\Program Files\DriveWare\DriveAnalyzer.

It is safe to make a backup copy of the file when DriveAnalyzer is not running. You may also send the file to your collages to be analysed. This can be done through e-mail.

The database is not protected with passwords but you may do that by yourself. Because of the open idea, you are able to view and make queries into data and produce data out of the measurements to your own purposes, using Microsoft Access.

You may copy-paste records to Excel, with the limitation that Excel will only handle 65,000 rows. There are multiple other ways to bring data into Excel.

The most interesting table in the database is the **DriveReading table**.

DriveAnalyzer log file

The DriveAnalyzer log file **DriveAnalyzerLog.txt** from C:\Program Files\DriveWare\DriveAnalyzer might be useful if it is necessary to double check what DriveAnalyzer SW attempted to do and when. The content of it looks like this:

February 27, 2008 [06:46:16 PM] - DriveAnalyzer : Starting Recording.

February 27, 2008 [06:46:17 PM] - DriveAnalyzer : Recording Started.

February 27, 2008 [07:06:17 PM] - DriveAnalyzer : Recording Complete.

February 27, 2008 [07:10:48 PM] - BLManager : No online drives detected.

February 27, 2008 [07:10:48 PM] - DriveAnalyzer : Unable to get Online Drives Info.

February 28, 2008 [04:54:24 PM] - BLManager : No online drives detected.

February 28, 2008 [04:54:24 PM] - DriveAnalyzer : Unable to get Online Drives Info.

February 28, 2008 [05:46:28 PM] - BLManager : FillGraphData() failed.

February 28, 2008 [06:16:39 PM] - BLManager : No online drives detected.

February 28, 2008 [06:16:39 PM] - DriveAnalyzer : Unable to get Online Drives Info.

February 28, 2008 [06:22:11 PM] - BLManager : No online drives detected.

February 29, 2008 [08:44:33 AM] - BLManager : No online drives detected.

February 29, 2008 [08:44:33 AM] - DriveAnalyzer : Unable to get Online Drives Info.

February 29, 2008 [09:16:52 PM] - DriveAnalyzer : Unable to get Online Drives Info.

February 29, 2008 [09:18:44 PM] - DriveAnalyzer : Creating New Setup.

February 29, 2008 [09:18:44 PM] - DriveAnalyzer : New Setup Created.

February 29, 2008 [09:19:29 PM] - DriveAnalyzer : Saving Setup.

February 29, 2008 [09:19:29 PM] - DriveAnalyzer : Setup saved.

February 29, 2008 [09:19:29 PM] - DriveAnalyzer : Starting Recording.

Customising DriveAnalyzer reports

What this chapter contains

This chapter describes how to change the Analyzer file setting and how to change the presentation of numbers shown in the user interface.

How to modify report templates

In a typical installation DriveAnalyzer files are installed into directory C:\Program Files\DriveWare\DriveAnalyzer, and there are two MS Excel template files:

EnergyUsage.XLT

EnergyConservation.XLT

You may change the logos of those reports and also, within some limitations, the layout and formats.

If you decide to change them please make sure to save them in the same place and in the template format.

ABB Oy
AC Drives
P.O.Box 184
FI-00381 HELSINKI
FINLAND
Telephone + 358 10 22 11
Fax + 358 10 22 22681
Internet http://www.abb.com

69000070 EN
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