Technical Note 175

Energy metering within drives

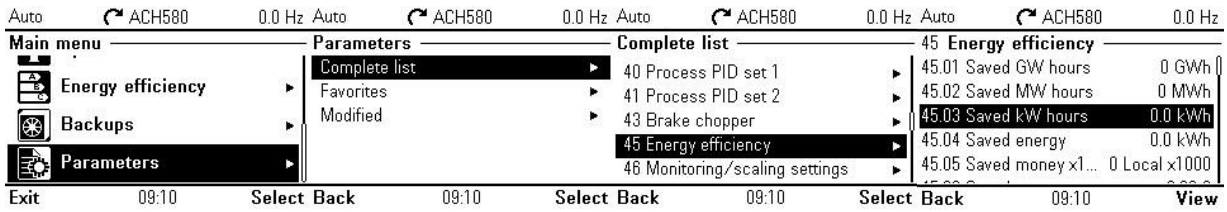
Counters and calculators

Energy efficiency is a crucial component of sustainable development, helping to meet energy needs while minimizing environmental impact and maximizing economic and social benefits. Using variable speed drives (VSDs) in centrifugal applications such as fans & pumps can provide users and owners increased energy efficiency and lower energy consumption compared to applications using mechanical control with direct-on-line starters. This document is to explain the features and parameters in HVACR drives like the ABB ACH series, that can assist the user to save energy for their application with counters for tracking usage/operation along with calculators to understand how much energy has been saved.

Group 45 Energy efficiency

The parameters within group 45 include calculated values being compared to a direct-on-line motor along with some resettable counters. We will review the differences in information provided by each along with the examples where they would be used.

Energy savings calculators



Menu > Parameters > Complete list > 45 Energy efficiency

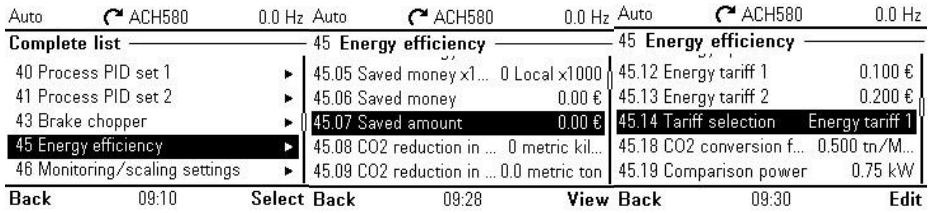
Parameter **45.04 Saved energy** displays the energy saved in kWh compared to a direct-on-line motor connection. This will continuously count kWh and display the number in this parameter.

The following counters are incremental and only apply when the previous one rolls over.

- **45.03 Saved kW hours** displays saved kWh up until it reaches 999.9 kWh.
- Once **45.03** reaches limit of 999.9 kWh then **45.02 Saved MW hours** is incremented and displays saved MWh until it reaches 999 MWh.
- Once **45.02** reaches limit of 999 MWh then **45.01 Saved GW hours** is incremented and displays saved GWh.

It is important to note that the accuracy of these savings calculations is dependent on the accuracy of the reference motor power given in parameter **45.19 Comparison power**. This value is the actual power that the motor absorbs when connected direct-on-line and operating the application. If you do not enter a value in 45.19, the motor nominal power is used by the application which may inflate the savings figures reported as most motors do not absorb their full nameplate power.

Monetary savings calculators

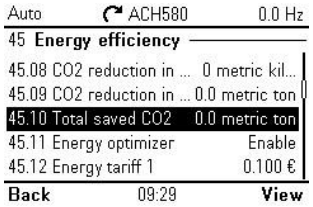


Parameter **45.07 Saved amount** displays monetary savings compared to a direct-on-line motor connection. This value is calculated by multiplying the saved energy in kWh by the active energy tariff selected in the drive parameter **45.14 Tariff selection.** The value for the tariff used in **45.14** for this is entered in parameter **45.12 Energy tariff 1.** Tariffs will be covered in more detail later in this paper.

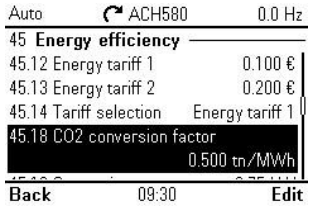
Like the **45.07 Saved amount** parameter, **45.06 Saved money** displays monetary savings compared to direct-on-line motor connection. This value is calculated by multiplying the saved energy in kWh by the active energy tariff selected in the drive parameter **45.14 Tariff selection**.

Once parameter **45.06 Saved money** reaches limit of 999.99 units then **45.05 Saved money x1000** is incremented and displays monetary savings in thousands of units. The difference between **45.06 Saved money** and **45.07 Saved amount** is that **45.06 Saved money** rolls over once it reaches 999 whereas **45.07 Saved amount** counts continuously up to 21,474,830. The use of **45.06 Saved money** is recommended for applications where the **45.07 Saved amount** can exceed the 21,474,830 value.

CO2 reduction calculators

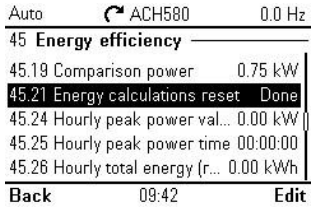


Parameter **45.10 Total saved CO2** displays the reduction in CO_2 emissions in metric tons compared to direct-on-line motor connection. This value is calculated by multiplying the saved energy in MWh by the value of the parameter **45.18 CO2 Conversion factor** (default is 0.5 metric tons/MWh).



The CO_2 emission intensity (kg CO_2/kWh) is determined by dividing the CO_2 emissions from public electricity production (related to electricity and heat production) by the gross electricity production. Countries around the world publish this information periodically or alternatively you can use the default value. This value will be different based on the power source, such as nuclear, coal, solar, wind or gas powered sources.

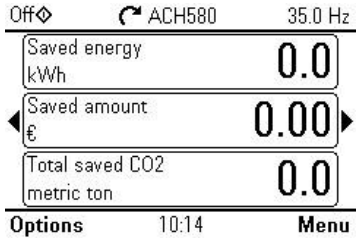
Like the **45.10 Total saved CO2** parameter**, 45.09 CO2 reduction in tons** displays the reduction in CO_2 emissions in metric tons compared to direct-on-line motor connection. This value is calculated by multiplying the saved energy in MWh by the value of the parameter **45.18 CO2 Conversion factor** (default is 0.5 metric tons/MWh). When the value rolls over 999.9 metric tons then 45.08 CO2 reduction in kilotons is incremented. The use of **45.09 CO2 reduction in tons** is recommended for applications where the **45.10 Total saved CO2** can exceed a 214,748,300 value.



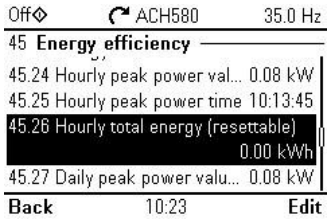
All the above counters can be reset using parameter **45.21 Energy calculations reset**. This resets all parameters from 45.01 – 45.10. If the drive is moved to another application at any point this would need to be reset.

Calculators' summary

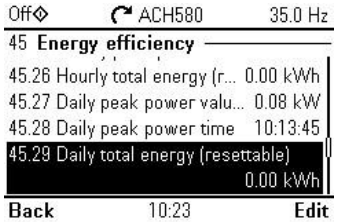
All the previously mentioned calculators are calculating savings compared to a direct-on-line (DOL) motor. When looking at an upgrade or retrofit, these calculators are very useful in illustrating the savings compared to the previous operation. These values can also be read via communications protocols and can be displayed on HMI screens linked to your BMS. These values can also be added to the home screens of the drives to display savings as they accumulate. See the below example of a screen setup that can be used to give a good indicator for all 3 categories of savings compared to DOL operation. Multiple screens can also be used if preferred.



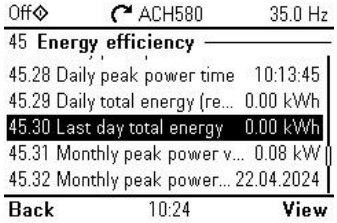
Energy counters



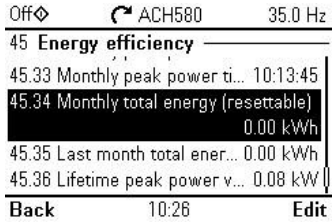
Parameter **45.26 Hourly total energy (resettable)** displays the total energy consumption from the last 60 minutes. This can be reset by setting the value to zero. This is a useful parameter for monitoring energy usage for a small snapshot of time to investigate any potential issue if more energy than expected is being consumed.



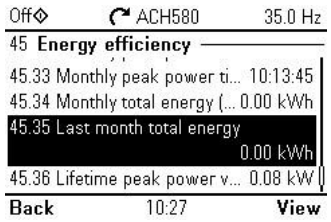
Parameter **45.29 Daily total energy (resettable)** displays the total energy consumption since midnight on the present day. This can be reset by setting the value to zero. This parameter would be useful to monitor energy usage over a slightly longer period to see how an application may be consuming energy during its full process.



Parameter **45.30 Last day total energy** displays the total energy consumption since midnight on the last (previous) day up until midnight on the present day. This parameter is very useful to show a full day energy usage of the previous day to the current day. It could also indicate that maintenance is required if energy usage is rising and trending upwards compared to previous days.



Parameter **45.34 Monthly total energy (resettable)** displays the total energy consumption since the start of the current month. This can be reset by setting the value to zero. This parameter is useful to look at energy usage over a longer period than a day and can be useful for reviewing energy usage for the current month to monitor energy usage following any changes to processes. The parameter being resettable means it can be flexible to use as required for a part month.



Parameter **45.35 Last monthly total energy** displays the total energy consumption since midnight of the first day of the previous month and midnight on the first day of the present month. This parameter is useful to look at energy usage over a longer period than a day and can be useful for reviewing seasonal data for energy managers if used with a BMS to trend this over multiple months.

Group 01 Actual values counters

There are also some parameters contained in group 01 which can be useful for energy consumption tracking. Some of these are very similar to parameters in group 45 but operate differently. It is important to know the differences to accurately use the information available in group 01.

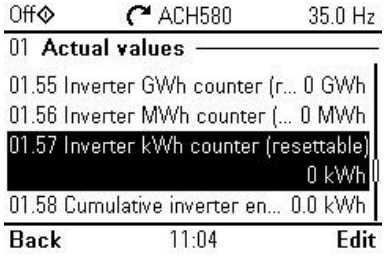
Operation based kWh counters

Parameter **01.50 Current hour kWh** displays the energy consumed in the last 60 minutes of operation. This does not display the energy from the last calendar hour. If the drive is stopped during the hour it will stop counting the time element & resume when it begins running again.

Parameters **01.51 Previous hour kWh**, **01.52 Current day kWh**, and **01.53 Previous day kWh** all operate in a similar manner and are cumulative operation counters rather than a continuous calendar operation. It is important to not confuse cumulative operation counters with continuous calendar operation when tracking energy usage as the figures will not be accurate. For general energy monitoring, typically group 45 or the upcoming **01.58** parameter, and not parameters **01.51** to **01.53**, are used for recording kWh in HVACR applications. However, the cumulative operation counters do provide the flexibility to focus only on the periods when the drive is actively running the motor.

Continuous time kWh counters

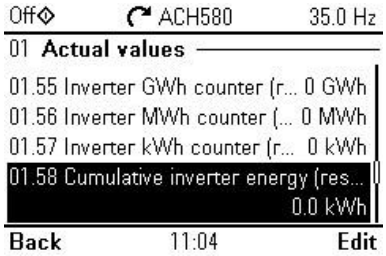
There are some parameters that can be used for energy consumption tracking and are very useful as they can reduce the need to buy extra components, such as energy sub meters, when used in conjunction with a BMS. These parameters operate by displaying values based on continuous time rather than operation only so if the drive ramps down the counters will still continue.



01.57 Inverter kWh counter (resettable) displays amount of energy that has passed through the drive in full kilowatt hours up until it reaches 999.9 kWh.

Once **01.57** reaches limit of 999.9 kWh then **01.56 Inverter MWh counter (resettable**) is incremented and displays amount of energy that has passed through the drive in full megawatt hours until it reaches 999 MWh.

Once **01.56** reaches limit of 999.9 MWh then **01.55 Inverter GWh counter (resettable)** is incremented and displays amount of energy that has passed through the drive in full Gigawatt hours. There are non-resettable values of the kWh, MWh, and GWh found in parameters **01.18** to **01.20**.



The most useful parameter in this section for energy monitoring is **01.58 Cumulative inverter energy (resettable)**. This parameter displays the amount of energy that has passed through the drive in kilowatt hours and just continuously counts until it has been reset. This parameter is useful for displaying the energy consumption as you would generally expect on a simple energy monitoring device. Note that this parameter can count up to a value of 200000000 kWh, so for any large drive size applications where that number could be exceeded, then the **01.55** to **01.57** parameters can be considered.

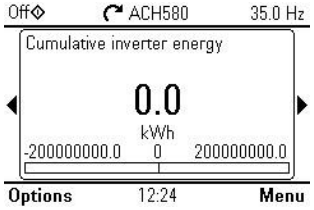
Resetting any of parameters **01.55** to **01.58** resets them all. These can be reset by setting value to zero or pressing reset softkey for 3 seconds.

Counters accuracy

Counter accuracy is typically better than 5% but is not revenue grade so the drive's metering cannot be used for billing purposes. The accuracy is consistent so that makes it useful for baseline comparison as the data will be at the same accuracy level as previous operation. Note that for 6-pulse drives, these measurements are output power, thus add an additional 2% to estimate the equivalent input power consumption by the drive.

Counters summary

The energy counters are useful for providing direct energy usage information. The **01.58 Cumulative inverter energy** can be used to track energy usage from the drive and provide this information to a BMS system to create reporting and tracking energy usage. The daily and monthly data can also be used to populate these reports. Instead of using the daily and monthly data in group 45, some BMS integrations may simply read and trend the **01.58** data and reset that value to 0 kWh each time. The drive was designed to offer multiple ways to provide kWh information to allow flexibility in integration of this data. This can save purchasing extra components to monitor the system because the drive has the ability to provide this data. The drive can also be configured to display these parameters on the control panel as referenced below. Using counters on similar applications can also be very useful for comparing performance and acts as a good indication if there could be an issue if one is changing negatively compared to the other.



Instantaneous power consumption and trending

Parameter **01.14 Output power** is also a useful parameter for seeing and tracking the live power usage of the application. This parameter allows the user to track the output power to see if there is any change in the rate of electricity usage of their application. This can be easily tracked via the BMS to see the change of value over time, BMS integration will be covered later in the paper. Trending this parameter over a period of time would be very useful to see if there are any unexpected changes as this can help indicate if there are any issues with the application and if further investigation is required.

BACnet integration

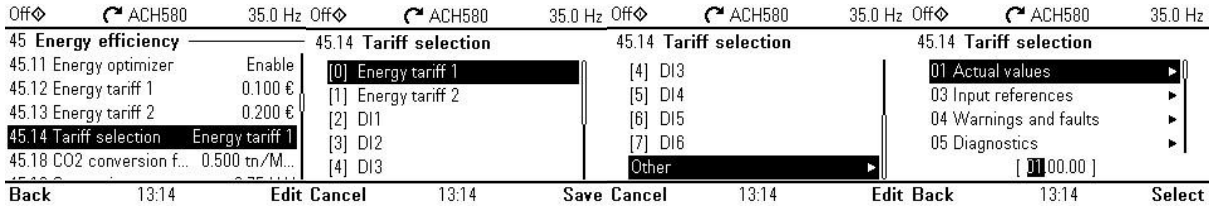
BMS integration has been mentioned throughout this technical note. Trending these points within the BMS will give the user good information on the application energy usage and can be used to compare current operation to previous operation, to identify possible wear and tear on components or reason to investigate further if the values are unusual. Using BACnet as an example, all the points listed below are read only, apart from AV8 which can be used to track energy usage over a custom time period by resetting the value when required.

- AV1 = Output frequency (READ ONLY)
- AV6 = Output power (READ ONLY)
- AV8 = Drive kWh meter-R (WRITEABLE) Can be reset
- AV9 = Drive kWh meter-NR (READ ONLY)
- AV130 = Current hour kWh (READ ONLY)
- AV131 = Previous hour kWh (READ ONLY)
- AV132 = Current day kWh (READ ONLY)
- AV133 = Previous day kWh (READ ONLY)

Tariff selection

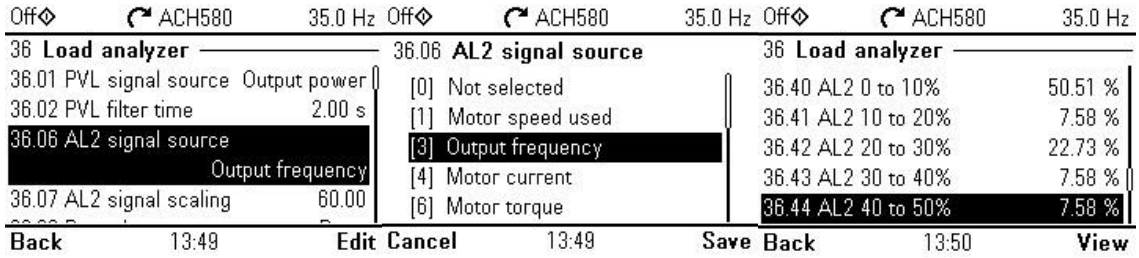
The tariff selection parameters allow the selection of different tariffs for sites where there are split tariffs in place. There are two different rates that can be selected which allow the ability to accurately see the savings across both tariff rates rather than just using an average. For example, a facility may be charged one utility rate during the day (on-peak) and a different rate overnight (off-peak).

Parameter **45.12 Energy tariff 1** allows the user to define the tariff price per kWh for a tariff and the same applies with parameter **45.13 Energy tariff 2**. The parameter used to select which tariff to use or the source that selects which tariff is **45.14 Tariff selection**. **45.14** provides multiple options to select the tariff including setting a single tariff in the parameter itself or using a digital input to toggle between the two tariffs. There is a configurable option *Other* as well which gives you the option to set this tariff via communications protocols or another parameter set such as timed functions. For example, timed functions could be used to set the changeover automatically and the calculated savings will be correct without having to manually execute changes.

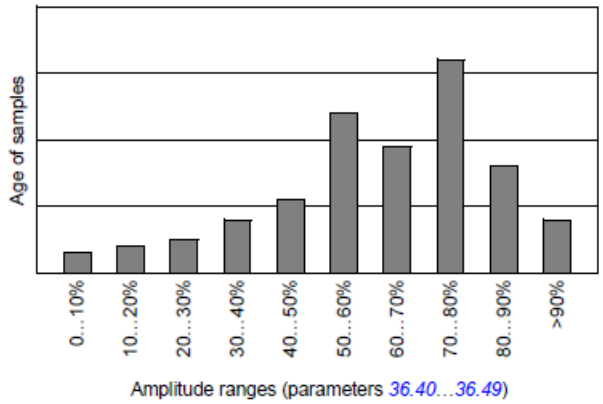


Amplitude logger

The drive also has 2 amplitude loggers which can be used to sample a signal at 200ms intervals. The first amplitude logger is fixed to motor current and cannot be changed or reset. The measured current is logged continuously and the samples are stored in parameters **36.20** through **36.29**. Using amplitude logger 2 (AL2) you can select a signal to be logged such as Output frequency or Output power. This can be particularly useful for monitoring how the drive is operating to see if the distribution of usage across the ranges is as expected. If there is an unusually high portion of readings at the top end of the scale then something may be affecting your application and possibly decreasing its efficiency which results in higher energy costs. Preventative maintenance for the system should be completed to keep the system in optimal condition and at its maximum operating efficiency.



Parameter **36.06 AL2 signal source** allows you to select your desired signal for monitoring. The results from this monitoring are displayed in parameters **36.40** through **36.49**. Each parameter represents a range and shows what portion of the samples fall in that range. You can view this graphically with the control panel or in drives composer PC tool. You can see below an example of the values spread across the range. Parameter **36.07 AL2 Signal scaling** lets you set your signal value that is 100% for your signal range so you can get an accurate spread of results on the logger.



Ultra-low harmonic (ULH) specific drive parameters

If an ABB ACH580-31 or ACH580-34 drive is being used there is another useful parameter available that is worth noting. Parameter **01.112 Grid power** shows the estimated power being transferred through the supply unit. As mentioned earlier in the paper, when a standard 6 pulse drive is used 2% needs to be added to the energy counters to include the drive losses, as these counters are based on the output power value. Using parameter **01.112 Grid power** means there is no need to include the 2% for the drive as it this is included as this measurement is from the input side of the drive.

Summary

The ACH family of drives have parameters to demonstrate ongoing savings using the calculators for retrofit drives. These show savings compared to a direct-on-line motor. Counters in the drives can also monitor energy usage over periods of time which can be used within your building management system or just on the control panel itself. This feature can help reduce the need to purchase external components such as energy meters. Tariff selection function

allows the most accurate savings possible if you are using a split tariff. The amplitude logger in the drives provides the ability to log the usage of the drive by monitoring output frequency or output power to see if your motor is running at the load you would expect. This can help identify if there are any factors affecting efficiency by running at loads outside of the expected range compared to when the drive was commissioned or even if there is an issue affecting operation compared to previous operation. Preventative maintenance is important to ensure any system operates at optimal efficiency over an extended period of time and the amplitude logger can help identify if any of these tasks have been missed.