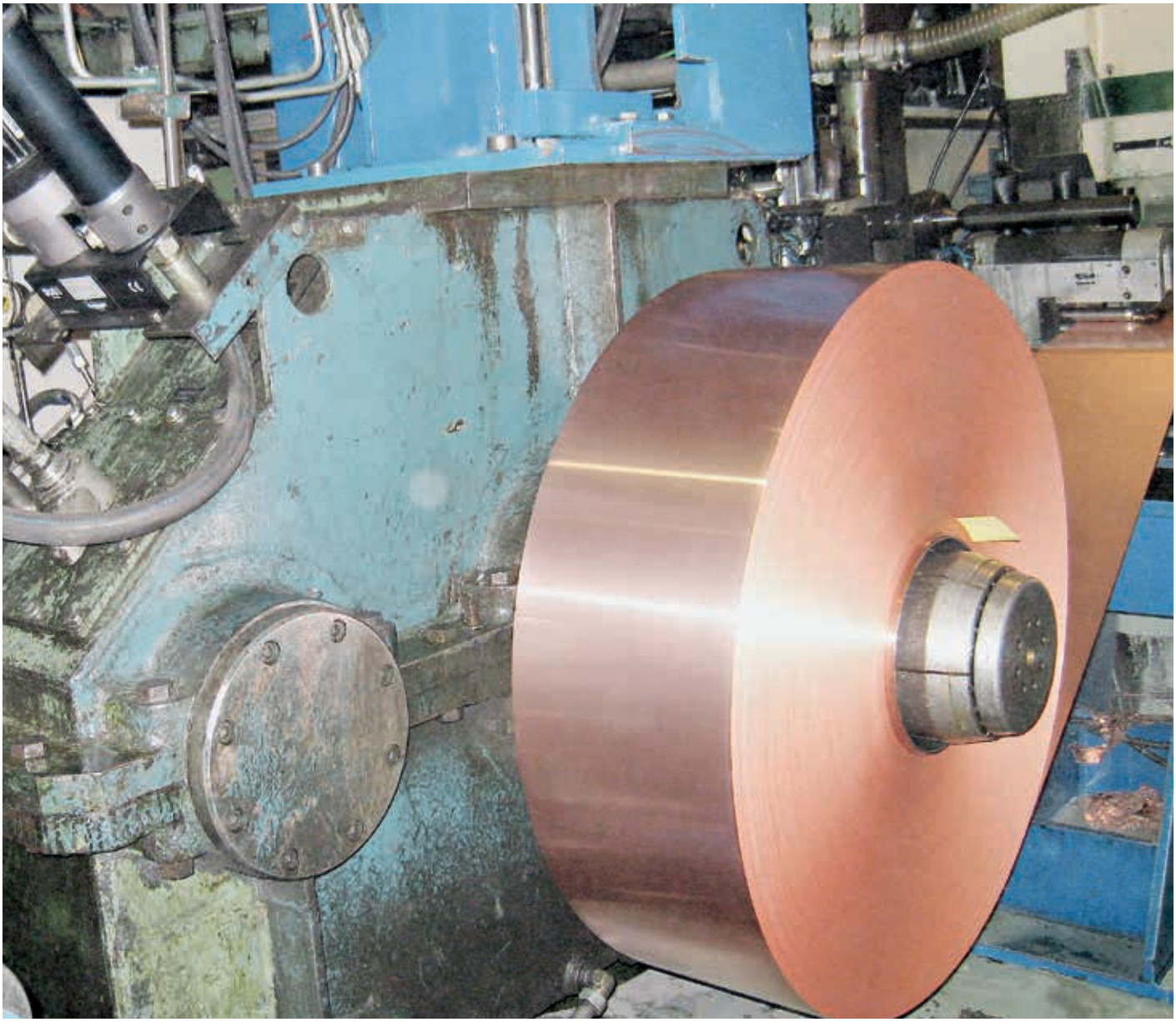
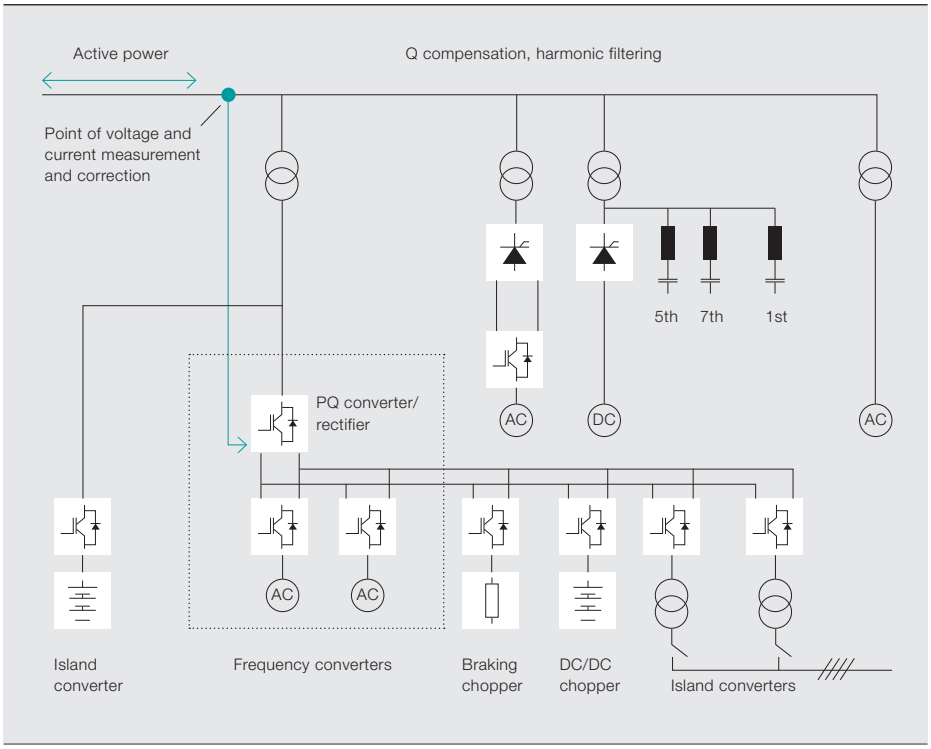


Multitalented

ACS800 power electronics can do more than rotate a motor

REIJO KOMSI – Industrial drives turn, literally, the wheels of commerce. That makes drives and the technology that controls them very important products in the industrial setting. Where several drives form part of a single process, as in a paper machine, say, and the individual drive motors have to be coupled in some way, it makes sense to use one so-called multidrive to manage all of them. ABB's ACS800 multidrive is one such device. The ACS800 contains sophisticated software and power electronics that handle the power flow to the drive. However, with appropriate application software, the power electronics module is capable of far more than just rotating a motor. For instance, it can perform valuable power quality correction and enable the power electronics to support intentional islanding.

1 A standard ACS800 multidrive schematic. Island converters, a braking chopper, a DC/DC chopper and energy storage can also be configured.



The multidrive approach has been very successful throughout industry. Instead of many individual drives being driven separately, products such as ABB's ACS800 multidrive handle multiple drives and allow coupling between them. This is important in processes like papermaking where many drives have to be tightly coupled to ensure good product quality all the way through the production process. These, and less-tightly coupled, applications benefit from the other advantages of the ACS800 multidrive approach too, such as space savings; savings in cabling, installation and maintenance costs; reduced component count and increased reliability; and the implementation of overall safety and control functions made possible by the common supply of the ACS800 multidrive.

The ACS800 multidrive has a rectifier unit and two or more frequency converters connected to a common DC link ➔ 1. The most sophisticated type of rectifier unit is an IGBT (insulated-gate bipolar transistor) supply unit (ISU), which consists of an active power stage similar to that of the frequency converter. This is capable of bidirectional active power flow, which enables regenerative energy from braking to be fed into the grid. In addition, the harmonic distortion of such an active rectifier is much lower than that of a diode or thyristor rectifier.

The fundamental building block of the rectifier – six IGBTs and six freewheeling diodes – can be used for other purposes by implementing appropriate software. This article describes two of these: power quality (PQ) correction and intentional islanding.

Power quality correction

The PQ correction abilities of the unit enable reactive power compensation and active harmonic filtering. Four of the most significant characteristic harmonic currents – the fifth, seventh, eleventh and thirteenth – can be filtered ➔ 2.

PQ correction is available at the same time as the unit is supplying active power for the motor drives. The voltage and current measurement and correction point can be on the low-voltage (LV) or medium-voltage (MV) side – whereby the latter is more beneficial because it takes the reactive power of the transformer(s) into account. A dedicated board performs voltage and current measurement. The analysis, reference generation and control is then performed internally and no communication is needed with the external automation ➔ 1.

The PQ correction can also be used in parallel with passive filters as a kind of hybrid compensator. This requires less total investment, but the performance is still as good as with full active correction.

Compensating reactive power and harmonic currents can reduce MV currents significantly – 45 percent in one reference case. This means lower stress in MV transmission lines and transformers, higher cosphi, lower levels of harmonic distor-

The fundamental building block of the rectifier can be used for other purposes by implementing appropriate software.

Title picture
ABB's ACS800 provides sophisticated control of industrial motors, such as the one shown here. But the ACS800 power electronics can be used for other tasks, too.

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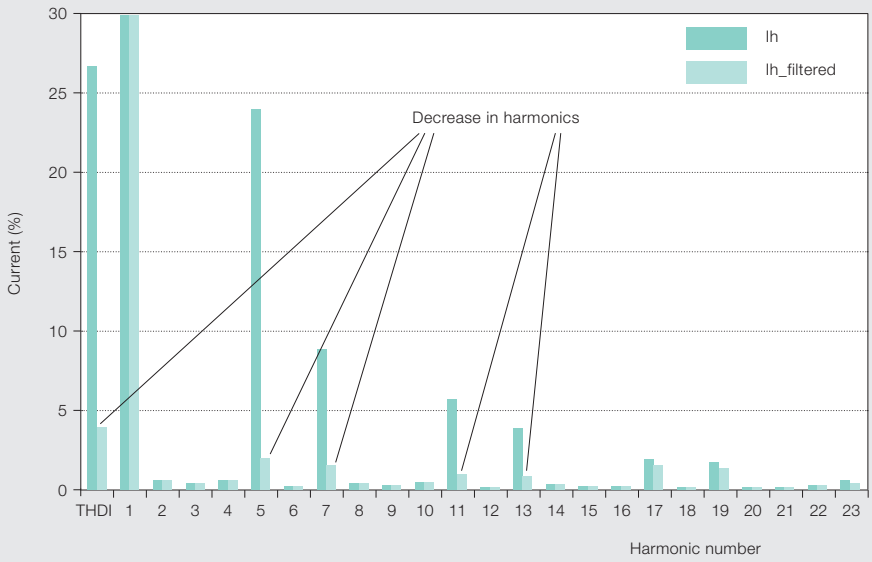
2 Reduced harmonics



tion and an increase in MV line loading capacity. The decrease in reactive power can be directly equated to savings in the electricity bill. In addition, lower reactive power leads to lower voltage variation and, thus, lower flicker index.

Intentional islanding

The other control software discussed here enables the ACS800 power stage to be used as an island converter – ie, to produce robust sinusoidal three-phase voltage, similar to a rotating generator, for the process. Intentional islanding is the deliberate sectionalization of the power system during disturbances to create power "islands" that maintain a continuous supply of power to a critical process.

The energy required for this can come from any DC source: eg, a rectified AC grid, wind turbine, diesel generator, solar cell, fuel cell or battery bank. The battery storage can be connected straight onto the DC link or through a DC/DC chopper. The common DC link makes distribution of power to the process drives straightforward. This same concept can be utilized in smart grid applications where no transmission lines are available but there is a need for electricity to provide power "islands." In smart grid applications, the battery energy storage is essential for balancing the distributed generator production and the island grid consumption → 3.

Usually, emergency power (from batteries) is required to ride through a supply grid fault or to buy time to start diesel backup generators. Energy storage dimensioning depends on the topology used, actual power required and reserve time.

The energy storage can also be used to balance the active power intake from the grid if the industrial process is very dynamic. The benefit of using energy storage in a dynamic process is that a smaller rectifier unit can be used, due to the lower peak power.

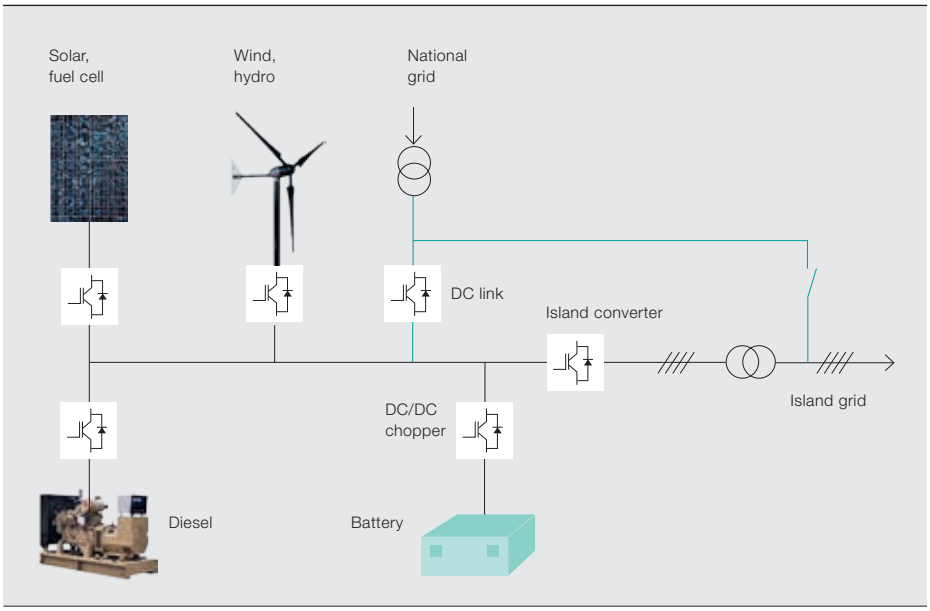
One main criterion in judging the performance quality of the island converter is the fault current capability. Now that the converter is part of the islanded grid, it has to provide the fault current required to clear the fault and protect the equipment and personnel.

The island converter can run in parallel with other island converters and in parallel with the national grid. The number of parallel converters is not limited – from the technical point of view any number can be connected to supply a common island grid. However, at some point, using a rotating generator will be more beneficial than implementing a huge number of parallel converters.

Other applications built on DTC modulation

The control of the two applications presented above is founded on the ACS800 software platform. In each case, the direct torque control (DTC) modulation principle is used. DTC is an AC motor control method developed by ABB in

3 Configurable power provision in smart grid application



Power electronic converters can be used to build an intelligent and highly reliable island grid.

which all switch changes, for every control cycle, are based directly on the electromagnetic state of the motor; there is no separate voltage- and frequency-controlled pulse-width modulator. The first major successful commercial DTC products were developed by ABB in the 1980s for traction applications. DTC relies heavily on digital signal processing and dedicated electronics. The use of DTC allows special converter applications based on ACS800 motor control to be developed. This development work is carried out by a dedicated ABB software team.

Benefits of scale

All the applications mentioned profit from commonality. Each application has its specific software, but the IGBT converter module hardware remains the same. This brings benefits of scale to prices, volumes, reliability, spare parts and global aftersales service.

Size

The modular construction of the ACS800 product series is extremely beneficial and flexible when building complicated converter applications. The smallest reasonable module size in PQ and islanding applications is 150 kVA in an R7i frame and the largest module size is 500 kVA. By paralleling these larger modules, a single converter with a rated power of about 5 MVA can be realized.

The largest PQ converter so far is a 4.5 MVA liquid-cooled ACS800 multidrive supply unit in a test field in Helsinki. It supplies active power to large AC drives. In addition, it compensates the reactive power of the entire test field and filters out the most significant characteristic harmonic currents. When running high-power six-pulse rectifiers in the test field, a reduction of 45 percent in MV current was measured when the PQ converter was enabled. This reduction in reactive power results directly in a savings of several thousand euros per month in the electricity bill.

The biggest island units in operation so far are two (for redundancy) 2.2 MVA liquid-cooled converters operating in parallel on a new Norwegian ship. The ship also has two 0.9 MVA liquid-cooled island converters. These converters are part of multidrive systems.

The applications described above show how ACS800 hardware, coupled with special software, can save energy, increase power quality and provide reliable power in the event of disturbances. Other applications are just a matter of developing the appropriate software. Given the capabilities of the technology, the number and variety of new applications is expected to increase.

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