DATASHEET

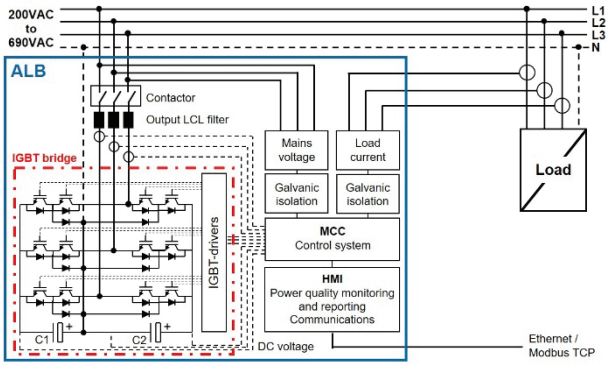
Active load balancers

Active load balancers (ALB) are the ultimate answer to power quality problems in installations caused by unbalanced load conditions for a range of segments and applications. They are a high performance, compact, flexible, modular and cost-effective type of active power filters (APF) that provide an instantaneous and effective response to power quality problems in low or high voltage electric power systems. They enable longer equipment lifetime, higher process reliability, improved power system capacity and stability, and reduced energy losses, complying with most demanding power quality standards and grid codes.

ALB module rated 400V 50/60Hz 100A

Using single-phase loads on a three-phase electric power system (connected phase-to-phase or phase-to-neutral) results in unbalanced load conditions in the system. Unbalanced load currents result in unbalanced voltages and affect other loads connected at the point of common coupling. Unbalanced load conditions also cause excessive neutral current, resulting in overheating motors and transformers, power losses and lower system efficiencies. Load balancing is necessary to improve the power quality and efficiency of the system.

Properly designed and rated ALBs can balance any unbalanced load from the supply system point of view. Any unbalanced load can be converted to a symmetrical three-phase active power load only.



Typical design of an ALB

Highlights

- Full range: Specifications from 50A to 200A (200V-690V) in 3- and 4-wire systems can be covered by a single module. Unlimited amount of ALB modules can be connected in parallel.
- Simple connection to high voltage systems.
- 3-level NPC inverter topology reduces losses, noise, size and extends module's lifetime.
- Overall response time <100 microseconds.
- Excellent load balancing performance for negative and zero sequence components, mitigating also neutral currents and unloading of neutral wires.
- Suitable for networks with harmonic distortion.
- Compact and modular design optimized for installation, commissioning and maintenance.

Typical segments

ALBs can be applied to small, medium or large applications in few specialized segments.

Markets	Segments	Applications
Smart grid	Renewable generation	
	Non-renewable generation	
	Transmission & distribution	
	Microgrids	
Raw material extraction & processing	Mining	
	Oil & gas	
	Minerals & cement	
	Steel & metals	
Manufacturing & infrastructure	Conventional manufacturing	
	Critical process industries	
	Transport	
	Water & wastewater	
Green buildings & smart cities	Healthcare facilities	
	Critical process facilities	
	Industrial & office facilities	
	Retail & leisure facilities	

Applications: Green - primary, yellow - secondary, red - none.

Typical applications

ALBs have few low and high voltage potential applications where their use offers many benefits.

- Arc welding machines: Shielded metal arc, gas tungsten arc, gas metal arc, flux-cored arc, submerged arc and electroslag welding.
- Resistance welding machines: Spot, seam, butt, flash, projection and upset welding.
- Single-phase loads not well distributed in a three-phase system: Computers, printers, lighting, air conditioners, electric vehicles, etc.
- Railway electrification systems: Trains & trams
- Single-phase electric arc furnaces.
- Single-phase generators such as small wind turbines and photovoltaics connected to the distribution network via single-phase power electronic inverters.

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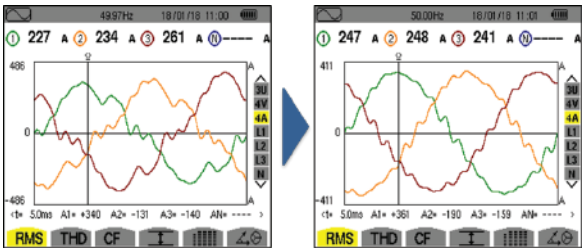
Operating principle

An ALB is a power electronics-based device connected in parallel with the load that requires load balancing. The ALB works as a controlled current source providing any kind of current waveform in real time.

ALBs are using current control to deliver load balancing functionality in 3- and 4-wire systems with their full rated capacity. How this relates to power depends on variables like load power factor. They inject capacitive or inductive negative sequence current that has an opposite phase to the load negative sequence current. As a result, the network sees symmetrical load and phase voltages, and currents are balanced without exchanging active power between the network and the ALB.



ALB operating principle

Benefits

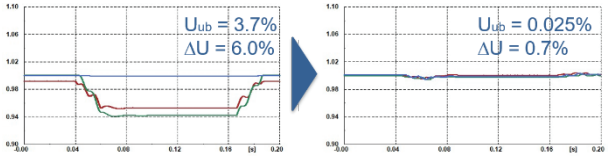
Main benefits of ALBs can be summarized as:

- Improve voltage unbalance on the phases and reduce neutral current which increases the safety of the installation and allows sensitive loads to operate.
- Avoid transformers' saturation & overloading.
- Reduce power losses and voltage drop in neutral conductors.
- Reduce the oscillating torque in the rotating machines that appears because of load variations in the system.
- Avoid electrical equipment overheating and efficiency loss that causes premature failures.

Application examples

Welding machines

Single-phase welding machines (normally 50kVA to 150kVA) are usually supplied through two phases in a three-phase electric power system. The current taken by these welding machines is not continuous and it lasts only for few power cycles (typically 12-15). The machines are usually manually operated and there is no synchronism, so the distribution transformer invariably sees, momentary, yet large unbalance within the phase currents.

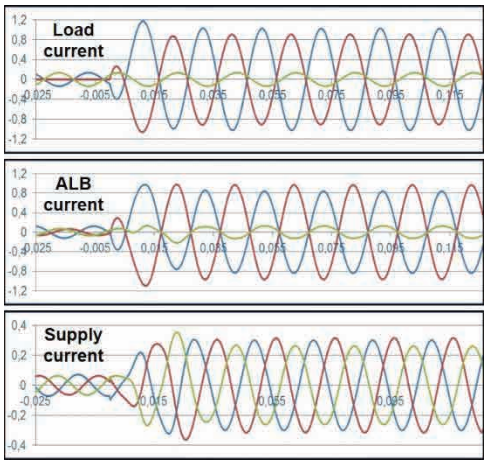


ALB in welding machine application

Unbalanced buildings

System designers and electricians usually try to balance loads across a three-phase system during installation. In practice, three-phase systems are rarely perfectly balanced at installation phase. The situation becomes more critical over the years if different loads have been added to the system without carefully planning.

ALBs can balance the whole system in real time. Alternatives like rewiring all the loads of the site are more costly and time-consuming.



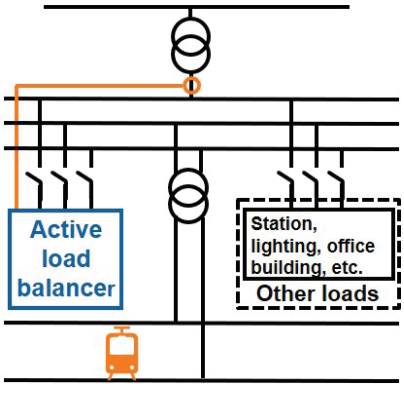
ALB in unbalanced building

Railway electrification systems

ALBs can be used for dynamically balancing the asymmetry between phases caused by the feeding of railways (usually taking the power between two phases in a three-phase system). They can balance in an efficient and cost-effective way the heavy and strongly time-varying single-phase loads ensuring that the conditions set out in the local grid code about power quality at the point of connection to the grid of the traction feeder are fulfilled.

ALBs can also filter (if needed) in real time the harmonics generated by thyristor and diode locomotives up to the 50th harmonic order (including the triplen harmonics) avoiding the need for passive harmonic filters.

Alternatives like building new overhead lines are more costly and time-consuming plus not optimal from the environmental point of view.



ALB in railway electrification system

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Technical specifications – 200-480VAC devices

LOOSE MODULES	A2-50	A2-60	A2-75	A2-100	A2-120	A2-150	A2-200
Electrical ratings							
Rated voltage	200-480VAC +/-10% (auto sensing). Connection to higher voltages through suitable step-up transformer.						
Rated frequency	50/60Hz (auto sensing).						
Phase RMS current output	50A	60A	75A	100A	120A	150A	200A
Neutral RMS current output	150A	180A	225A	300A	360A	450A	600A
Electrical features							
Reaction / response time	Reaction time <50 microseconds / Overall response time <100 microseconds (1 network cycle if working in selectable mode).						
Electrical system compatibility	3-phase 3-wire and 3-phase 4-wire.						
Inverter features	3-level NPC inverter topology (IGBT). Switching frequency 20kHz.						
Controller / redundancy	Each module has an independent controller. In parallel operation of several modules, if any module fails, the rest will continue in operation.						
Load balancing	Negative sequence current injected to balance fundamental current on the system (inherently corrects displacement power factor). Load balancing degree can be set from 0% to 100% of the output current of the module.						
Protection functions	Overcurrent, overvoltage, undervoltage, overtemperature and ripple circuit overload.						
Stand-by & AutoStart	Stand-by stops the IGBTs if required compensation current is below a certain limit. AutoStart allows automatic start after a network failure.						
Remote discrete control	Remote run/stop.						
Connections							
Digital inputs	3 potential free inputs 15-48VDC or up to 277VAC. Any input can be programmed as trigger for stand-by, trip or alarm.						
Digital outputs	6 potential free outputs DC or up to 277VAC. 4 can be programmed for trip, alarm, running & force, or all can be used for capacitor bank steps.						
Current transformers (CT)	Any primary ratio with 1A or 5A secondary (5A preferred). Class 1 accuracy or better.						
CT location	Open loop (current transformers in the load side) and closed loop (current transformers in the supply side) connections possible.						
CT polarity	If one or more CTs are connected with inversed polarity, it is possible to change the load current polarity from normal to inversed in the HMI.						
Number of CTs required	Open loop connection: 3 CTs. Closed loop connection of 1 module: 3 CTs. Closed loop connection of several modules in parallel: 6 CTs.						
Connection of parallel modules	Unlimited scalability. Parallel operation of any rating combinations up to 7 modules per one HMI. Unlimited amount of HMIs.						
Interfaces							
HMI / display	7" touch screen multilingual graphical HMI (new languages can be added on request).						
Monitoring and reporting	On-site and remote monitoring capabilities. Reports data of power quality events up to 30 days.						
Communication capability	Ethernet and Modbus TCP.						
Software update	Via Ethernet or USB drive.						
Mechanical features							
Mounting arrangement	Loose module ready for cubicle or wall installation.						
Enclosure features	Compact IP20 galvanized steel enclosure in black colour.						
Cooling method	Forced air by easy to service automatically controlled DC cooling fans adjusted by module temperature via PWM.						
Losses	<2.3%						
Noise level (ISO 3746)	60dB	60dB	64dB	64dB	65dB	67dB	68dB
Dimensions WxHxD	225x850x500mm	225x850x500mm	225x850x500mm	225x850x500mm	225x850x500mm	225x1150x500mm	225x1150x500mm
Weight	70kg	70kg	70kg	70kg	70kg	110kg	110kg
Installation and operation							
Temperature (without derating)	+5°C to +40°C.				+5°C to +30°C.	+5°C to +40°C.	
Humidity	Maximum 85% RH, non-condensing.						
Altitude (without derating)	Up to 1000m.						
Needed airflow for the module	350 m³/h	350 m³/h	400 m³/h	450 m³/h	500 m³/h	750 m³/h	1000 m³/h
Ventilation requirements	300mm free space below and above the module required for air ventilation.						
Main circuit fuses	NH00 gL/gG 63A	NH00 gL/gG 80A	NH00 gL/gG 100A	NH00 gL/gG 125A	NH00 gL/gG 160A	NH00 gL/gG 200A	NH00 gL/gG 250A
Cable entry	Top or bottom.						
Standards and certifications							
Electrical safety	EN 50178						
Electromagnetic compatibility	Emissions: EN/IEC 61000-6-4. Immunity: EN/IEC 61000-6-2.						
Third party approvals	CE, UL.						
ASSEMBLED MODULES	**Modules installed in cubicles**						
Electrical ratings							
Rated voltage	200-480VAC +/-10% (auto sensing). Connection to higher voltages through suitable step-up transformer.						
RMS current output	Any output is possible. Unlimited parallel operation of any rating combination of modules.						
Electrical features (cubicle)							
Power frequency voltage test	2.5kV/1min						
Impulse withstand voltage	6kV						
Short-circuit current	65kA rms (3 seconds) / 143kA peak.						
Power circuit protection	MCCB or fuse-switch. General design rule is to select the protection level 1.3 times the nominal current of the device.						
Earthing	According to local regulations, 16mm² Cu conductor is the minimum recommended.						
Mechanical features (cubicle)							
Mounting arrangement	Free-standing cubicle.						
Enclosure IP class	IP20 to IP42 for indoor installation (other classes or outdoor installation cubicles on request).						
Enclosure material and colour	Galvanized steel, light grey RAL7035 (other materials or colours on request).						
Panel thickness and treatment	2mm. Epoxy powder coating.						
Cooling method	Forced air or heat exchanger.						
Cable entry	Top or bottom.						
Door locking system	Handle without lock, lock with key, electrical lock or special safety lock.						

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Technical specifications – 500-690VAC devices

LOOSE MODULES	A2-50-E	A2-60-E	A2-75-E	A2-100-E	A2-120-E
Electrical ratings					
Rated voltage	500-690VAC +/-10% (auto sensing). Connection to higher voltages through suitable step-up transformer.				
Rated frequency	50/60Hz (auto sensing).				
Phase RMS current output	50A	60A	75A	100A	120A
Neutral RMS current output	150A	180A	225A	300A	360A
Electrical features					
Reaction / response time	Reaction time <50 microseconds / Overall response time <100 microseconds (1 network cycle if working in selectable mode).				
Electrical system compatibility	3-phase 3-wire (500-690VAC modules) and 3-phase 4-wire (500-525VAC modules).				
Inverter features	3-level NPC inverter topology (IGBT). Switching frequency 20kHz.				
Controller / redundancy	Each module has an independent controller. In parallel operation of several modules, if any module fails, the rest will continue in operation.				
Load balancing	Negative sequence current injected to balance fundamental current on the system (inherently corrects displacement power factor). Load balancing degree can be set from 0% to 100% of the output current of the module.				
Protection functions	Overcurrent, overvoltage, undervoltage, overtemperature and ripple circuit overload.				
Stand-by & AutoStart	Stand-by stops the IGBTs if required compensation current is below a certain limit. AutoStart allows automatic start after a network failure.				
Remote discrete control	Remote run/stop.				
Connections					
Digital inputs	3 potential free inputs 15-48VDC or up to 277VAC. Any input can be programmed as trigger for stand-by, trip or alarm.				
Digital outputs	5 potential free outputs DC or up to 277VAC. 4 can be programmed for trip, alarm, running & force, or all can be used for capacitor bank steps.				
Current transformers (CT)	Any primary ratio with 1A or 5A secondary (5A preferred). Class 1 accuracy or better.				
CT location	Open loop (current transformers in the load side) and closed loop (current transformers in the supply side) connections possible.				
CT polarity	If one or more CTs are connected with inversed polarity, it is possible to change the load current polarity from normal to inversed in the HMI.				
Number of CTs required	Open loop connection: 3 CTs. Closed loop connection of 1 module: 3 CTs. Closed loop connection of several modules in parallel: 6 CTs.				
Connection of parallel modules	Unlimited scalability. Parallel operation of any rating combinations up to 7 modules per one HMI. Unlimited amount of HMIs.				
Interfaces					
HMI / display	7" touch screen multilingual graphical HMI (new languages can be added on request).				
Monitoring and reporting	On-site and remote monitoring capabilities. Reports data of power quality events up to 30 days.				
Communication capability	Ethernet and Modbus TCP.				
Software update	Via Ethernet or USB drive.				
Mechanical features					
Mounting arrangement	Loose module ready for cubicle or wall installation.				
Enclosure features	Compact IP20 galvanized steel enclosure in black colour.				
Cooling method	Forced air by easy to service automatically controlled DC cooling fans adjusted by module temperature via PWM.				
Losses	<2.8%				
Noise level (ISO 3746)	67dB	67dB	67dB	67dB	68dB
Dimensions WxHxD	225x1150x500mm	225x1150x500mm	225x1150x500mm	225x1150x500mm	225x1150x500mm
Weight	120kg	120kg	120kg	120kg	120kg
Installation and operation					
Temperature (without derating)	+5°C to +40°C.				
Humidity	Maximum 85% RH, non-condensing.				
Altitude (without derating)	Up to 1000m.				
Needed airflow for the module	350 m³/h	350 m³/h	400 m³/h	450 m³/h	500 m³/h
Ventilation requirements	300mm free space below and above the module required for air ventilation.				
Main circuit fuses	NH00 gL/gG 63A	NH00 gL/gG 80A	NH00 gL/gG 100A	NH00 gL/gG 125A	NH00 gL/gG 160A
Cable entry	Top or bottom.				
Standards and certifications					
Electrical safety	EN 50178				
Electromagnetic compatibility	Emissions: EN/IEC 61000-6-4. Immunity: EN/IEC 61000-6-2.				
Third party approvals	CE, UL.				
ASSEMBLED MODULES	**Modules installed in cubicles**				
Electrical ratings					
Rated voltage	500-690VAC +/-10% (auto sensing). Connection to higher voltages through suitable step-up transformer.				
RMS current output	Any output is possible. Unlimited parallel operation of any rating combination of modules.				
Electrical features (cubicle)					
Power frequency voltage test	2.5kV/1min				
Impulse withstand voltage	6kV				
Short-circuit current	65kA rms (3 seconds) / 143kA peak.				
Power circuit protection	MCCB or fuse-switch. General design rule is to select the protection level 1.3 times the nominal current of the device.				
Earthing	According to local regulations, 16mm² Cu conductor is the minimum recommended.				
Mechanical features (cubicle)					
Mounting arrangement	Free-standing cubicle.				
Enclosure IP class	IP20 to IP42 for indoor installation (other classes or outdoor installation cubicles on request).				
Enclosure material and colour	Galvanized steel, light grey RAL7035 (other materials or colours on request).				
Panel thickness and treatment	2mm. Epoxy powder coating.				
Cooling method	Forced air or heat exchanger.				
Cable entry	Top or bottom.				
Door locking system	Handle without lock, lock with key, electrical lock or special safety lock.				

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