DC breakers

ASTROL

TYPE APPROVED PRODUCT
DNV·GL
MARITIME

Solid-state, ultra-fast 1.5 kV DC breakers for maritime applications

Designed and certified for onboard electrical power systems in the maritime industry

Protection against short-circuit situations and power overload within µs

- **Ensure safety by preventing arc forming**
- **System-independent and modular design**
- **Cost-efficient and green solution**
- **Marine type approved product**
- **Enabling innovative and SMART DC systems**
- **Technical consultancy and DC experience**

The primary and most important function of the Astrol solid-state DC breaker for marine applications is its ultra-fast interruption of faults, thereby preventing the dramatic consequences of short-circuit situations and over current. Our ultra-fast liquid-cooled DC breakers are available in six sizes with a nominal voltage of 1.5 kV and nominal currents between 0.35 kA and 3 kA. The whole range is DNV and CCS certified.

The Astrol DC breaker is based on the latest, powerful semiconductor technology. It guarantees reliable protection against short-circuit currents in any part of the grid and allows the system integrator to achieve selectivity in the most flexible way. The 1.5 kV version uses 3.3 kV Insulated Gate Bipolar Transistors (IGBT) as well as diode modules.

Features

- Independent solution for integration in any type of DC-grid and drive system
- Autonomous switch-off capability
- Ultra-fast switch off-time within micro seconds
- Modular system
- Suitable for spinning reserve mode
- Switch-off current ≤ 20 kA
- High di/dt capability up to 1000A/us
- Bi-directional current detection
- Liquid cooling (tap- or deionized water)
- Topology optimized for low power loss and maximum lifetime
- Internal self-diagnostics
- Customized interface to overall controller
- Optical (Glass or POF) connections
- Modbus-TCP, PROFINET, WEB based, etc.
- DNV and CCS certification

Main specifications

- Current classes from 0.35 kA to 3 kA
- Voltage class 1.5 kV
- IP Protection ranging from IP20 to IP54
- Ambient temperature range: +5°C … + 60°C

Standard options

- Integrated fan
- Balancing switch

System-independent, compact and modular design

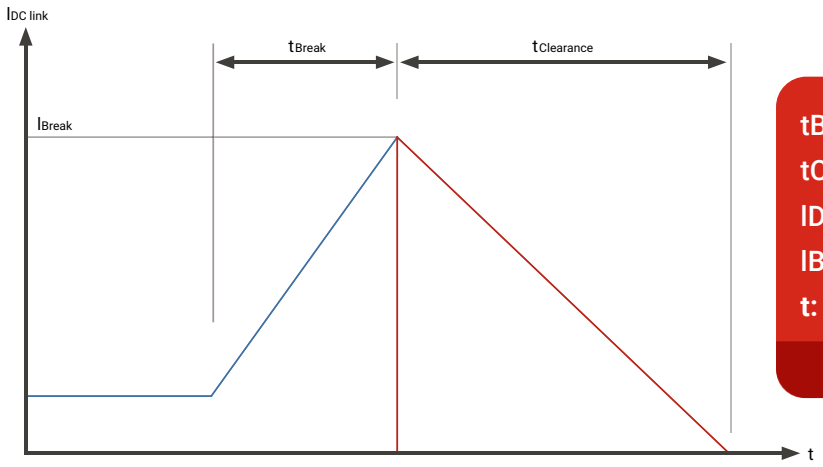
The compact mechanical design supports the control concept of the DC breaker to work as a standalone solution. The power-modules are accessible from the front and the back side. The basic configuration is a modular built DC breaker with integrated sensor communication and control unit.
The table shows the currently available current ratings and dimensions.
Customized versions are available upon request.



Breaker model Model number	***0.35 kA*** AA-10411-111	***0,5 kA*** AA-10411-101	***1.1 kA*** AA-10411-112	***1.5 kA*** AA-10411-122	***2.25 kA*** AA-10411-113	***3 kA*** AA-10411-103
Nominal voltage VDC link	1.5 kV	1.5 kV	1.5 kV	1.5 kV	1.5 kV	1.5 kV
Nominal current IDC link	0.35 kA	0.5 kA	1.1 kA	1.5 kA	2.25 kA	3 kA
Typical Breaking current @1 kV @10uH	1.7 kA	2.5 kA	3.1 kA	3.5 kA	4.25 kA	5.0 kA
Max. breaking current I Break	2.5 kA	5 kA	7.5 kA	10 kA	15 kA	20 kA
Breaking time typical tBreak	8 µs	8 µs	8 µs	8 µs	8 µs	8 µs
Max. breaking time tBreak	10 µs	10 µs	10 µs	10 µs	10 µs	10 µs
Clearance time typical tClearance	7 µs	7 µs	8.3 µs	9.4 µs	11.4 µs	13.4 µs
System inductance Minimum @1 kV	6 µH	2 µH	1 µH	0 µH	0 µH	0 µH
System inductance Typical	6 µH	4 µH	4 µH	4 µH	4 µH	4 µH
System inductance Minimum @1.5 kV	10 µH	4 µH	2 µH	1 µH	0 µH	0 µH
Dimensions Millimeters	507×507×430	507×507×430	507×507×673	507×507×673	507×507×1017	507×507×1017
Weight Kilograms	52 kg	55 kg	93 kg	95 kg	150 kg	154 kg

Short-circuit and overload protection

In case of an event, the breaker interrupts the current within microseconds. With the response time requirement, local fault protection must be performed autonomously by the control system without the need for external control or fault detection. The fast opening time of our solid state breaker limits the fault current and reduces the negative impact on the load to a minimum. The current does not reach damaging energy levels and can be interrupted without forming an arc. In addition to the fast over-current protection, the breaker opens on a configurable time-current profile (I2t) for overload protection.



tBreak:	breaking time
tClearance:	clearance time
IDC link:	DC link current
IBreak:	current interruption
t:	time

Mechanical design

The isolating fiberglass housing allows easy integration in a cabinet, but also the installation without cabinet. With its modular build-up, the focus lies on standardized power modules, which combine to different voltage and current ratings with minimal mechanical changes. The power modules are accessible from the front and backside. All components are UL94 certified and vibration tested according to IEC 60068-2-6.

Maximize system up-time and safety on board while minimizing consequential damages when a short-circuit occurs.

Best in category di/dt capability allowing ultra-fast switch-off

The IGBT technology guarantees ultra-fast switch-off times. Typically short-circuit detection and IGBT switch-off takes less than 8 µs. The DC breaker detects, clears and seperates short-circuits from healthy system parts before they reach dangerous levels. Depending on the rating of the DC breaker and inductance of the system a clearance time of 7 - 13.4 µs is feasible.

Stand-alone solution for integration in any type of DC grid

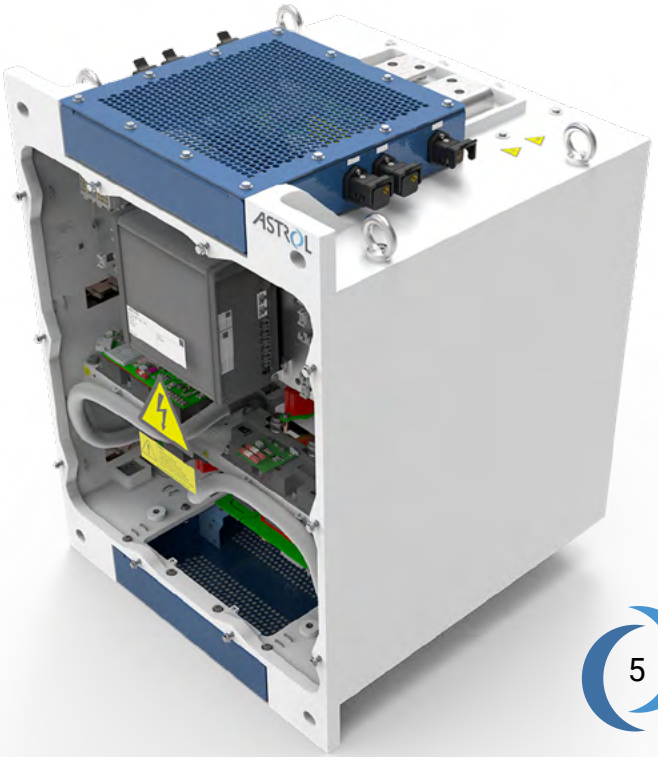
The Astrol DC Breaker is system independent and can be integrated in any type of DC distribution grid. It constantly monitors current and voltage on the DC bus and reacts autonomously according to predefined settings. Protection functions include protection against short-circuits and power overloads. Internal self-diagnostics constantly monitors the health state of the internal breaker functions and reports irregularities to the overall controller.

Maintenance free, robust and reliable solid-state DC breaker

Thanks to sufficient redundancy, the lifetime of our solid-state breakers (which is 15 years) exceeds the lifetime of a typical drive system. No maintenance is needed. The redundancy also leads to a very robust system. This has been proved by the extremely high number of short-circuit and switching-off (fault) conditions without showing any degradation.

Electrical design / topology

An optimized topology reduces the temperature cycles of the semiconductor modules. This leads to a longer lifetime of the IGBT's and contributes to a maintenance free system. Due to the ultrafast detection and switching time, the DC Breaker can safely control low system inductance without adding more inductance to the circuit. With the Astrol DC breaker, the system integrator benefits from maximum design freedom (closed bus and ring systems).



Innovative and SMART DC systems

Our technology enables efficient topologies such as closed bus tie and ring systems.
These projects are just some references of green vessels with efficient onboard DC power grids.

Svelvik, electric ferry

System integrator
Elkon (Turkey)

DC circuit protection
Astrol 0.5 kA DC breaker

NOMARS, aut. shipping

System integrator
Serco Inc. (USA)

DC circuit protection
Astrol 3 kA DC breaker

ZEETUG, electric tugboat

System integrator
BMA Technology (Turkey)

DC circuit protection
Astrol 1.25 kA DC breaker

Scan the QR code to open our project webpage.

Control interface

For switching actions controlled by the overall system controller, the DC breakers provide different communication interfaces:

- Optical (Glass or POF)
- Modbus-TCP, Profinet, WEB based
- Wire Bus System with CAN and RS485
- 24V power supply with internal filter module

The controller of the breaker and the direct optical link between several breakers, in case of a multi DC Breaker topology, manage shortcircuit protection of healthy zones without protocol overhead.

Parametrization and customization

Typical items for customization are:

- Communication to overall controller
- Internal or external cooling
- Quick coupling connectors in the water cooling circuit
- External fan control with PWM
- Balancing switch
- Integrated fan
- Higher voltage ratings are possible

The DC Breaker provides application specific parametrization. Short-circuit and over current detection can be adjusted according to customer specific requirements. Different parameter settings do not require recertification. A customized DC breaker can either be an adapted standard of a certified version or a completely new version.

Certification

All versions have been marine product type approved by DNV and CCS.

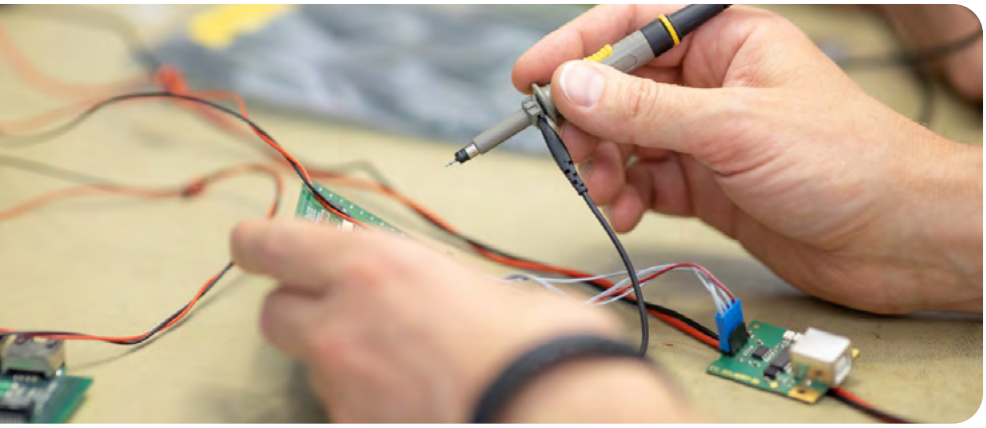
Balancing switch

When the bus tie breaker is open, the capacitors on each side of the breaker can be charged to different voltage levels. The closing of the bus tie will cause an inrush current, which will immediately trigger the short circuit detection of the DC Breaker. To solve this problem, the Balancing Switch option is available for every Astrol DC breaker. The Balancing Switch is an IGBT controlled pre-charge device, which assures voltage balancing within the circuit and smooth closing of the DC breaker.

Spinning reserve mode

Our DC breakers are suitable for spinning reserve mode. This means that the breaker can handle an overcurrent of 20% for a period of 30 minutes for a maximum of 25 times a year. This mode is enabled when grid failure occurs. The ESS supplies power to maintain network continuity while the back-up generator is started and brought online.

About Astrol



Technology leader in pulsed power switches and solid-state circuit breakers

Astrol is a Switzerland based innovator and manufacturer of state-of-the-art power control and switching solutions. We design and produce electronic parts for technical high demanding industries such as medical, energy distribution and pulsed power applications since 1996. In our 25-year history we have developed from a designer of custom-built electronics to a technology leader in pulsed power switches and solid-state circuit breakers with a wide range of products and a world-wide customer base consisting of operating companies and research institutes.

Our main focus lies on power switching in the medium voltage range, from optimized gate drive units to fully integrated solutions of up to 100kV. Our products are designed, manufactured and tested in our production location and high voltage test laboratory in Othmarsingen and therefore are able to withstand harsh environments, extended temperatures and have a long lifetime.

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