PROTECTION AND SAFETY

Ekip Link logic-zone discrimination protection system

A modern dynamically positioned (DP) vessel will have a sophisticated electrical power system driving the propulsion that keeps it on station. Logic-zone discrimination using Emax 2 with Ekip Link in DP vessels with closed bus ties ensures the highest reliability and flexibility.

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Any seagoing vessel is subject to forces from wind, waves and currents. Dynamic positioning is the ability to maintain a vessel's position automatically in the face of these forces of nature by using its propulsion system. DP vessels come in many shapes and sizes – rock dumpers, diving or ROV support vessels, pipe layers, crane ships, drill ships, offshore support vessels, etc. →1.

Dynamic positioning is the ability to maintain a vessel's position automatically, using its propulsion system.

What these vessels all have in common is the need for exact stationkeeping: They must maintain their position and heading precisely even in the roughest seas or strongest tides.

DP – components and levels

A DP system has three main elements:

- Power system. Everything that is needed to supply the DP system with electrical power, including generators, switchboards, electrical distribution systems (cabling and cable routing) and power management.
- Thruster system. All components and systems necessary to supply the DP system with thrust force and direction. The thruster system includes thrusters with drive units and electronic and manual thruster controls.
- DP control system. All DP control components and systems (including software) necessary to dynamically position the vessel, consisting of a computer and joystick controller (for manual backup), position reference (using satellites), DP sensor system and operator panels.

Not all DP vessels are the same in terms of redundancy. IMO (International Maritime Organization) rules define three basic redundancy levels for DP vessels:

- Class 1 (DP1). No redundancy required.
- Class 2 (DP2). Redundancy to make the system tolerant to a single fault. Loss of position should not occur from a single fault of an active component nor system such as generators, thrusters, switchboards, remote controlled valves, etc., but may occur after failure of a static component such as cable, pipe, manual valve, etc.

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01 Marine vessels often have to maintain a very exact position and heading.

- Class 3 (DP3). In addition to Class 2 requirements, the redundant systems shall be physically separated. Equipment must withstand fire or flood in any one compartment without the system failing. Loss of position should not occur from any single failure including a completely burnt out fire subdivision or a flooded watertight compartment [1] →2.

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A DP vessel's electrical power system must have the highest reliability and flexibility, which is a challenge given the restricted space, complex power system and hostile environment.

The all-electric DP vessel

Like some other marine vessel classes, there is a strong trend amongst DP vessels toward electrification. For DP vessels, the all-electric ship (AES) approach is the only one that permits, in an easy and efficient way, complete and precise position control under all relevant marine environment conditions.

The performance required from a DP vessel necessitates an electrical power system with the highest availability and flexibility. But the restricted space available, the reliability issues raised by the complex power system and the hostile marine environment make this task challenging. Fault management is, therefore, a critical aspect of DP vessel operation and must effectively do the following:

- Isolate the faulty component or system before the failure propagates from one system to another.
- Guarantee a disconnection strategy for a faulty system based on detection of fault direction.
- Guarantee flexible and redundant power protection systems.
- Provide self-monitoring to limit hidden failures.

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	DP class notation										
IMO equipment class	ABS	BV	CCS	DNV Det Norske Veritas (Norway)		GL	IRS	KR	LR	NK	RINA	RS
	American Bureau of Shipping (USA)	Bureau Veritas (France)	China Classification Society (China)			Germanischer Lloyd (Germany)	Indian Register of Shipping (India)	Korean Register of Shipping (Korea)	Lloyds Register (UK)	Nippon Kaiji Kyokai (Japan)	Registro Italiano Navale (Italy)	Russian Maritime Register of Shipping (Russia)
	DPS-0	DYNAPOS SAM		DYNAPOS AUTS	DPS-0				DP (CM)		DYNAPOS SAM	
Class 1	DPS-1	DYNAPOS AM/AT	DP-1	DYNAPOS AUT	DPS-1	DP 1	DP(1)	DP (1)	DP (AM)	Class A DP	DYNAPOS AM/AT	DYNPOS-1
Class 2	DPS-2	DYNAPOS AM/AT R	DP-2	DYNAPOS AUTR	DPS-2	DP 2	DP(2)	DP (2)	DP (AA)	Class B DP	DYNAPOS AM/AT R	DYNPOS-2
Class 3	DPS-3	DYNAPOS AM/AT RS	DP-3	DYNAPOS AUTO	DPS-3	DP 3	DP(3)	DP (3)	DP (AAA)	Class C DP	DYNAPOS AM/AT RS	DYNPOS-3

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Closed bus tie operation

Marine power systems are typically of the isolated type, with four to eight generators and the overall power system split into two, three or four sections. The power bus of each section is connected to the others by a bus tie, which utilizes a circuit breaker. When closed, this interconnection makes the power system flexible (any generator then being able to provide power to any consumer, eg, thrusters).

An efficient way to handle electrical faults is zone selectivity, which allows rapid fault isolation without users, other than those directly affected, seeing any effect.

Closed bus tie operation allows the vessel to run with a few engines at high power rather than operating all engines at low power. This mode of operation significantly reduces operating costs (eg, fuel consumption is cut by around 3 to 5 percent) and maintenance costs (30 percent lower). Emissions are reduced too. Closed bus tie operation is, therefore, desirable and it is possible to design fault-tolerant systems for closed bus tie and closed ring operation. This approach to fault management is possible thanks to the circuit breaker inside the closed ring system →3.

Emax 2 and Ekip Link modules

Emax 2 is more than a circuit breaker as traditionally defined: Compactness and the high reliability that results from pretesting makes Emax 2 highly suitable for applications in marine vessels. Emax 2 is an innovative all-in-one concept. In fact, it is the first intelligent circuit breaker designed to protect, connect and optimize low-voltage microgrid applications. Accessories (modules) are added to the breaker to achieve all the additional functions needed. One such basic accessory is the electronic trip unit or protection relay. Ekip Hi Touch or Ekip G Hi Touch are examples of such units, in which a dual set of protection settings delivers the flexibility to change the system configuration.

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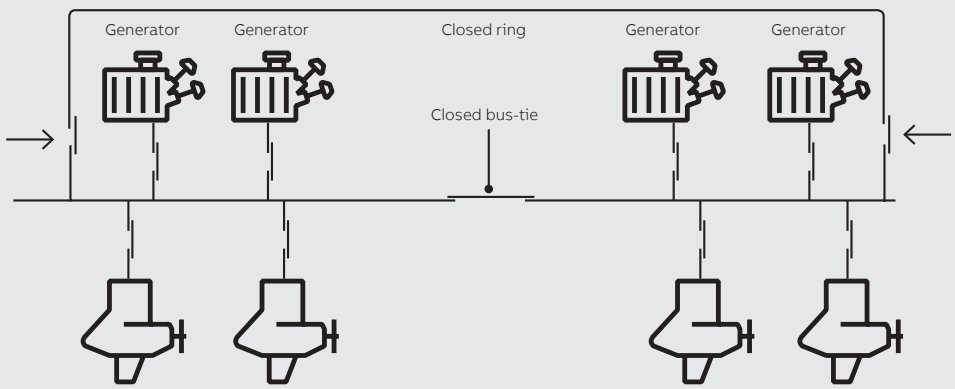

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02 DP classifications have worldwide commonalities.
Note: The equivalent to IMO DP class is approximate because of differences between the various classifications, local exemptions, etc.

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03 Closed bus ties enable more efficient operation.

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04 Ekip Link module.

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DP applications require other signaling and this additional flexibility is achieved through programmable contacts.

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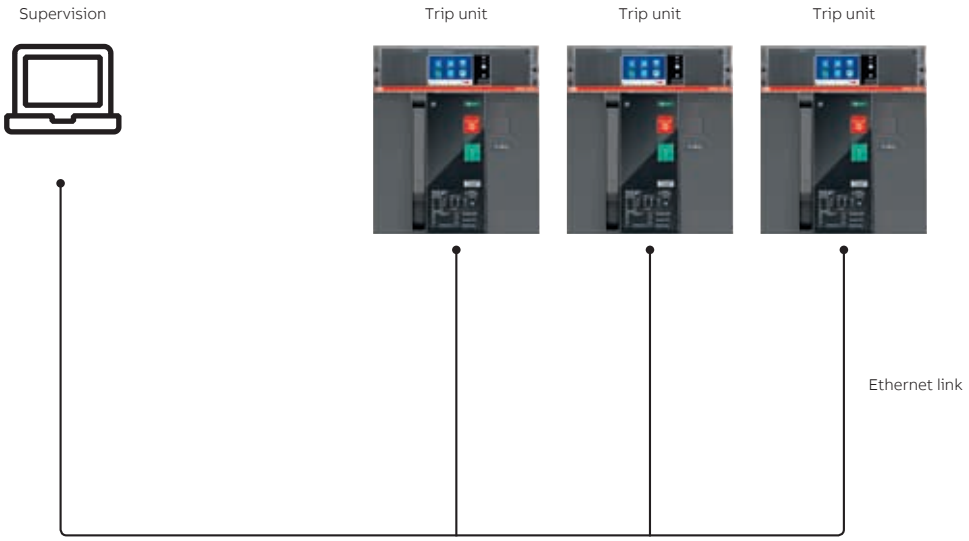
Directional protection is useful in closed ring systems with several generators where it is essential to define the direction of the power flow that supplies the fault.

Ekip Link, the ABB communication module for low-voltage circuit breakers, handles communication between circuit breakers using an internal ABB proprietary bus →4.

All circuit breakers can intercommunicate using only one Ekip Link connected to the main switch via Ethernet. If more than two breakers are involved in the selectivity chain, an Ethernet switch can be used to handle the signals pertaining to the different Ekip Link units →5.

Using the ABB communication protocol, Ekip Link can:

- Create complex logic selectivity without using complex wiring.
- Provide redundancy, using both Ekip Link bus and standard wiring.
- Provide diagnostics (configurable) to test the wiring selectivity.



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Logic-zone discrimination with Emax 2 equipped with Ekip Link
A major element of DP vessel power system design is protection against electrical faults. One very efficient method of handling faults is logic-zone selectivity (or "discrimination"), which allows rapid fault isolation without users – other than those directly involved – seeing any effect.

This approach can accurately isolate the fault branch by quickly opening adjacent circuit breaker(s), and reduce the transitory fault time and electrical stresses.

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Logic-zone discrimination combines zone selectivity and directional protection and is often required in DP2 and DP3 vessels.

Logic-zone selectivity combines zone selectivity and directional protection
In contrast to traditional selectivity methods, which are based on time and/or current, the principle of zone selectivity is that the breaker that should trip for a fault sends a blocking signal to other (upstream) breakers to prevent them from tripping →6. In other words, the principally impacted breaker can block other breakers from tripping, when appropriate.

Behind this scheme lies a logic that defines which breakers should and should not trip in certain situations. With Emax 2, the blocking signal can be realized by traditional hardwiring or by bus communication using Ekip Link. It is also possible to use both in parallel (redundancy).

Directional protection
Directional protection is useful in ring- and grid-type systems with several power sources (generators) where it is essential to define the direction of the power flow that supplies the fault. ABB's Emax 2 is the first low-voltage circuit breaker with fully integrated directional protection and zone-directional selectivity functions.

To use directional protection, the reference direction of current has to be set. Different threshold and delay times for the different directions may also be set.

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05 Every trip unit (protection relay) is connected to an Ekip Link module and thence to a main switch.

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06 The principally impacted breaker can block other breakers from tripping, when appropriate.

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07 Ethernet-based connection eliminates fault-prone twisted-pair cabling.

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Reference
[1] Ian C. Giddings, "IMO Guidelines for Vessels with Dynamic Positioning Systems." Available: http://dynamic-positioning.com/proceedings/dp2013/quality_giddings_pp.pdf

Connecting with Ekip Link
With the Ekip Link connection, all the circuit breakers involved in logic-zone selectivity are connected through an Ethernet-based proprietary bus. This approach eliminates the traditional hardwired twisted-pair cabling that previously made installation, commissioning and testing difficult →7.

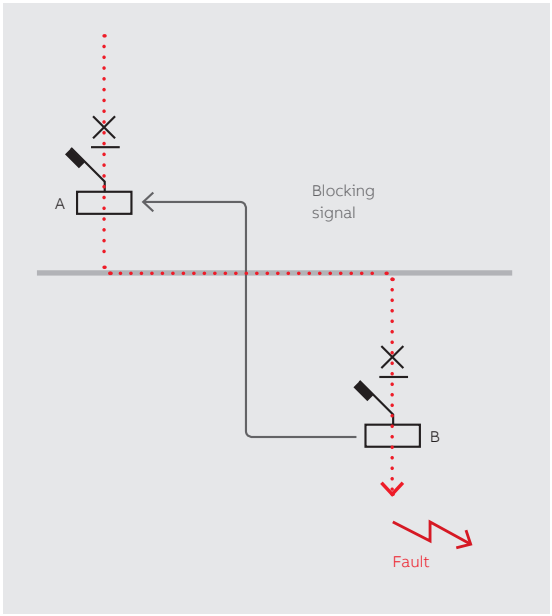
The use of a proprietary bus guarantees very fast and predictable communication that is independent of traffic on other buses.

The Ekip Link modules must be installed in all circuit breakers. During the setup process, ABB's Ekip Connect software is used to configure the trip units' logic-zone selectivity options – ie, define which signals will be received and which will be transmitted to the next circuit breaker; establish the nodes in the system; and determine the IP address of each actor. Here, a node is a defined group of circuit breakers, one of which is nominated as the "unit reference" and in which logic-zone selectivity options are configured using Ekip Connect. The actors are the remaining breakers in the group.

With the Emax 2 and Ekip Link approach, tripping using logic-zone selectivity with high precision and reliability takes 100 ms.

Positioning for the future
The Emax 2 air circuit breaker equipped with Ekip Link forms the basis of a unique solution for low-voltage logic-zone discrimination that has been designed to meet the most demanding requirements of reliability, flexibility and efficiency in DP vessels with closed bus ties. This solution is easy to install, commission and test.

The Emax 2 and Ekip Link techniques described here can also be applied to other microgrid applications or complex power systems – for example, data centers – where zone selectivity can provide major benefits. ●



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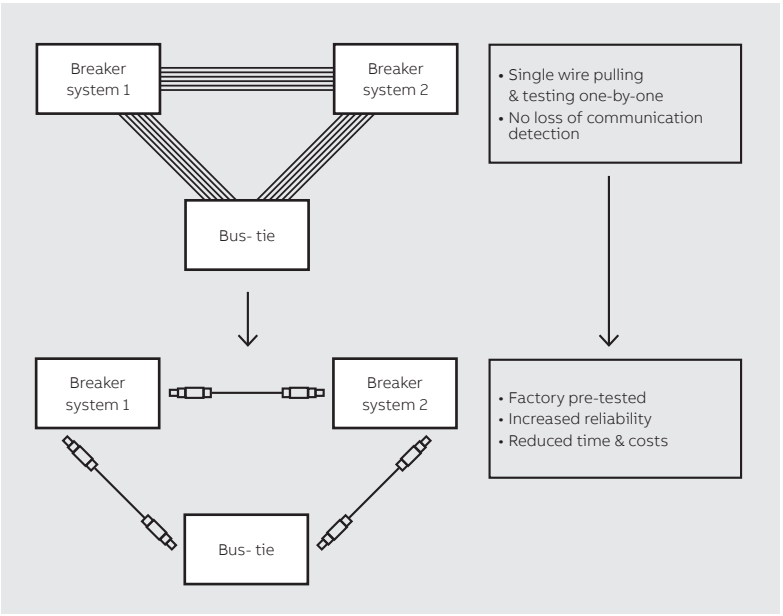

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