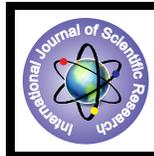


Functioning of Dp Class Drilling Equipments by Integreated Power And Automations Systems



Engineering

KEYWORDS :

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ABSTRACT

With the introduction of IEC 61850 communication standard in marine power systems new opportunities for increasing the operational performance (efficiency and safety) of DP drilling vessels are made possible. The first drilling vessels are now under construction using this communication technology, and new functionalities are gradually being implemented. Firstly the functionality of faster communication between protection systems and control systems make it possible to operate with closed bus in DP2 and DP3 operation. This is achieved by introducing enhanced feature such as, Block based protection functions, Ultra-fast load reduction schemes and Enhanced engine and generator protection functions integrated in the main power switchboards.

1. Introduction

In the last couple of years there has been a growing market demand for operating DP class drilling vessels with closed bus power system, even under the strictest DP requirements. The main motivation for going in this direction is to utilize the full potential of an electric power and propulsion system with respect to fuel efficiency, emissions and flexibility. For other ship types (e.g. cruise vessels and LNG carriers) this operation mode has been a standard ever since the electric propulsion principle was introduced for fuel saving reasons. However also for these vessels, redundancy and blackout prevention are, and have always been, essential requirements. This means that for whatever ship type under discussion using electric propulsion with centralized power plant principle, the power generation and distribution have always been split into minimum two or more sections.

2. Closed bus operation

Today for DP Class 3 drilling vessels the question of closed bus operation is therefore a matter of minimizing this risk to the same level as operating in a split bus mode. Achieving this goal is done by close cooperation between ship-owners, suppliers and classification societies. The requirements have been market driven, and the suppliers have developed new solutions to fulfil these requirements. In parallel the classification societies have published revised rules, additional notations, and guidance notes on how the integrity can be kept at the highest possible level.

It is, however, important to notice that most of the basic technology development, both in component level and system level has been done independent of closed or open bus operation.

2.1 Requirements for closed bus operation

Both DNV and ABS have issued new and revised rules for Dynamic Positioning systems, with requirements for closed bus operation [2], [3]. Together with market driven requirements and the technology development both in more advanced and intelligent devices and system configurations we have summarized the main closed bus operational requirements as follows:

- **Enhanced and robust power plant design;** Implemented zone protection with fast failure detection and discrimination of failed components or system. The zone protection act then as the primary protection function and *the traditional time current selectivity settings will still function as backup protection* in case of severe communication faults (see Figure 1).

- **Resistance to hidden failures;** Protection with backup arrangement as alternative action to isolate faulty system or components, self-diagnostic.

- **Enhanced Generator Protection system;** Protection for over- or under-fuelling and excitation as well as load sharing. These are failures that are normally not covered by the traditional

protection relays, however considered as protection system and should be an integrated part of the overall protection system.

- **Autonomous systems;** Autonomous and decentralized thruster and generator systems to achieve segregation in order to minimize the effect of failures and dependencies.

- **Blackout prevention;** Fast load reduction to avoid overload due stopping of one or more generators in large consumers (mainly thruster and drilling Variable Speed Drives).

- **Fast blackout recovery;** with no manual interaction and full thruster control on DP within 45s, according to [2]

- **Transformer pre-magnetising;** For reduction of large inrush current and related voltage drop (mainly thrusters and drilling supply transformer) especially with one generator out of service.

- **Fault ride through capability;** For essential systems, especially on the low-voltage distribution side. It is important that faults are cleared as quickly as possible so time delay in under voltage devices and other fault tripping delays can be minimized.

2.1 Advanced power system with integrated intelligence

In this section we will concentrate on the main new technology features designed to fulfill above requirements. The basic starting point was the release of ABBs new generation of protection relays, the Relion® series. The new feature with this relay is the possibility to communicate with IEC 61850 standard using GOOSE (Generic Object Oriented System Event) for fast and accurate communication between relays and between switchboard and surrounding control and automation systems.

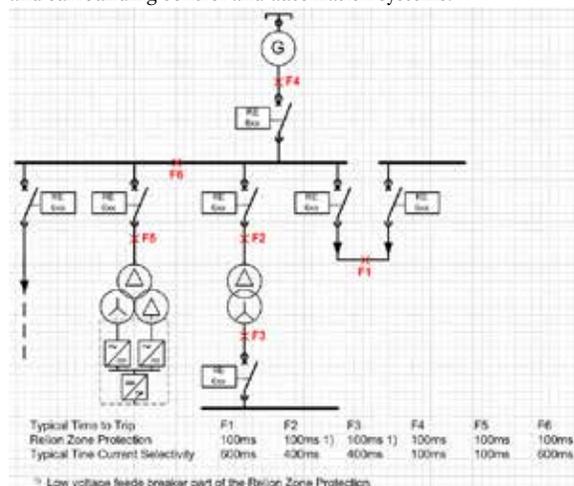


Figure 1. Comparison block based zone protection vs. traditional time-current selectivity

The switchboard configuration reflects the division of systems in redundancy groups throughout the design concept of the vessel. The switchboards are separated where each redundancy group has assigned an independent switchboard. Through switchboard segregation and selective protection functions the worst single failure within the main distribution system is limited to the loss of the switchboard which is exposed to the failure – following the basic design philosophy that any single failure will not cause total blackout. Figure 2 shows the basic zone and redundancy configuration for a four split power plant typically applicable for semi-submersible drilling rigs. As busbar short-circuit zone protection the blocking based principle is used. Basic principle in this protection scheme is that an upstream circuit breaker instantaneous over-current stage selectively is allowed to trip or is blocked depending on location of the fault as detected and identified by the feeder circuit breaker.

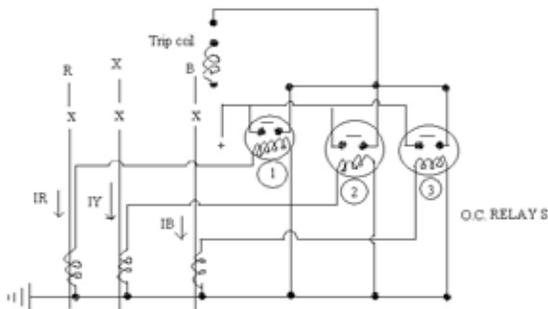


Figure 2. Four split SWBD zone configuration

3. Integrating Power and Automation

3.1 IEC 61850 vertical communication

In section 2 we have discussed the GOOSE communication. GOOSE is one type of communication defined in IEC 61850. IEC 61850 standardizes the set of “Abstract Communication Service Interface services” – ACSI, allowing for compatible exchange of information among components. GOOSE is a publisher-subscriber model distribution of data with analogue and digital multicast which makes it suitable for the high speed demanding applications between devices described above.

For vertical communication from the devices up to the system level a Client/Server type of communication services model is defined for IEC 61850. This type of communication will not fulfill the hard real-time requirements of GOOSE, but is better suited for larger amount of information and other generic communication. This can provide measured and calculated data to the server level for e.g. visualization and debugging, it can provide data for logging etc. Both for operation of a vessel and for asset management issues, IEC 61850 enable valuable extension of the existing communication solutions necessary for a properly integrated power/automation system solution. We look here at solutions for operator interfaces and asset management where IEC 61850 is one of the communication solutions.

3.2 Operational information

The goal for a user interface is to support the safe vessel operation in all situations. Especially, when handling a critical event, fast access to critical information is the best way to ensure correct decisions. For a DP vessel, efficient and correct actions in a situation where there is an incident with the electrical system is essential and this is more likely to be successful if the user interface provides the right information in the right way. In the real case presented in Figure 3, the primary source of the blackout can be identified as under-voltage fault caused by malfunction of the automatic voltage regulator.

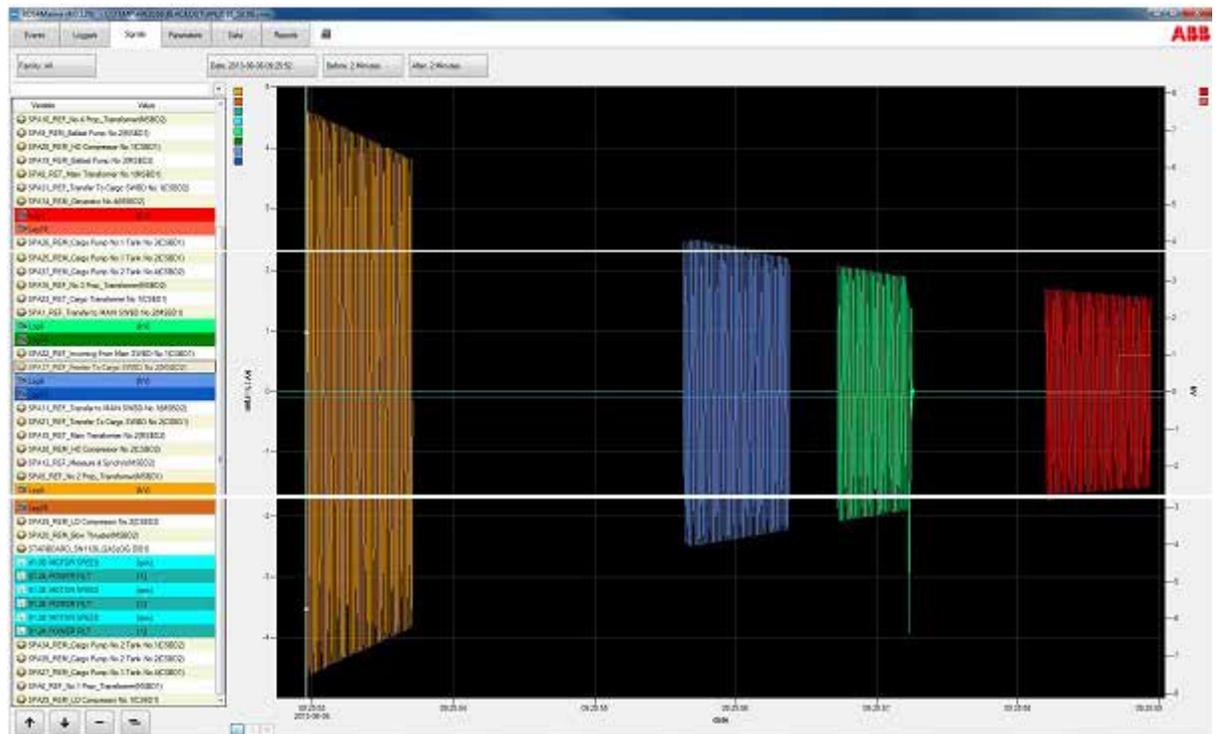


Figure 3 Blackout analysis

Finding root cause of the failure and solving the problem in shortest possible time obviously brings a lot of added value for system operators. But the same high quality information collected by diagnostic system for troubleshooting purposes can be effectively used for preventive maintenance by introducing techniques that can elaborate a condition of the device. One of the very good examples is an advanced monitoring of rotating equipment, such as generators, propulsion or thruster motors. These components also belong to the power and drive train, and in order to get the best possible quality of condition assessment a combination of different techniques and physical measurements is applied.

4. Concluding Remarks

Introduction of intelligent electronic devices (IEDs) and protocols based on the IEC61850 communication standard makes it possible to implement autonomous control systems that address novel class requirements such as closed bus operation and blackout prevention and fast recovery. In addition, as an added value it opens almost unlimited possibilities for acquiring and processing data from various sub systems with the specific purpose those system are designed for. This article gives an overview on how the same type of low level measurements derived from both power and automation systems can be equally efficiently used for protection and control purposes as well as with additional processing by dedicated diagnostic system, in order to provide comprehensive information about the root cause of the fault or actual condition of the asset. In addition, through smart integration with high level, integrated automation systems we create an overview of all assets condition and facilitate inventory management by automatic order generation sent to Computerized Maintenance and Management Systems.

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