

Switchgear - single busbar or double busbar?

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This article considers the different considerations, advantages and disadvantages for application of single and double busbar medium voltage switchgear systems.

Most switchgear installations used in industry with normal service conditions are based on single busbar arrangements. Compared to

double busbar switchgear, single busbar switchgear is definitely easier to use, readily understood by operators, requires less

space, and the total cost of installation is less (equipment, site procedures, maintenance, spares holding and space). Typical installations consist of basic cubicle types, that can be combined together to form the required switchboard. Fig. 1 shows typical cubicles available from the ABB UniGear ZS1 range.

In a single busbar switchboard the busbar can be split into sections, by means of a bus tie/bus riser (commonly known as a bus section). Although separate busbar sections exist, the switchgear classification will remain a single busbar arrangement, as each circuit (incomer or feeder) is connected to the busbar section where it is placed in the switchgear arrangement.

Fig. 2 shows two incoming circuits with cable voltage transformers, two feeder circuits, and a bus section with voltage transformers on each bus section.

Each circuit contains its required, circuit breaker, instrument transformers (CTs and VTs), earth switch, relay/control equipment. It is seen that this type of arrangement can be easily understood by operators, with little or no reference to any additional documentation.

If for any reason a cable, or cubicle in any busbar section is damaged, the cable can be isolated from the busbar, or the busbar section can be isolated, for repairs if required.

Double busbar switchgear

The use for double busbar may be necessary when some of the following features are required.

- Operation of incoming circuit breakers from non synchronised systems
- Load shedding of feeder circuits with a different level of importance during emergency conditions
- Flexibility during inspection and maintenance procedures without load interruption
- Extension without switchgear shutdown

Single-line diagram of the typical units

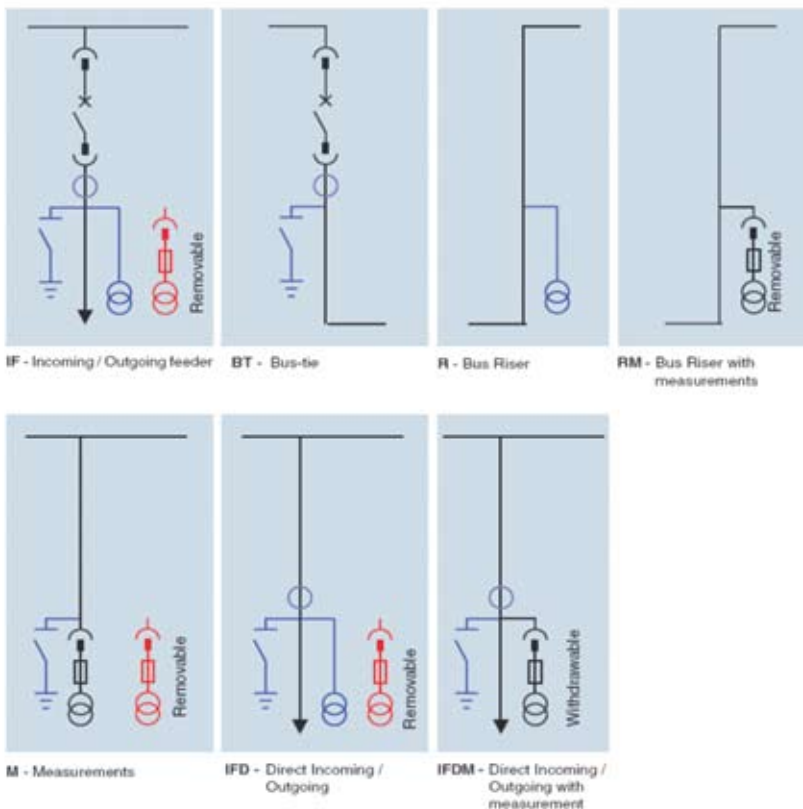


Fig. 1: Typical single busbar cubicles available from the ABB UniGear ZS1 range

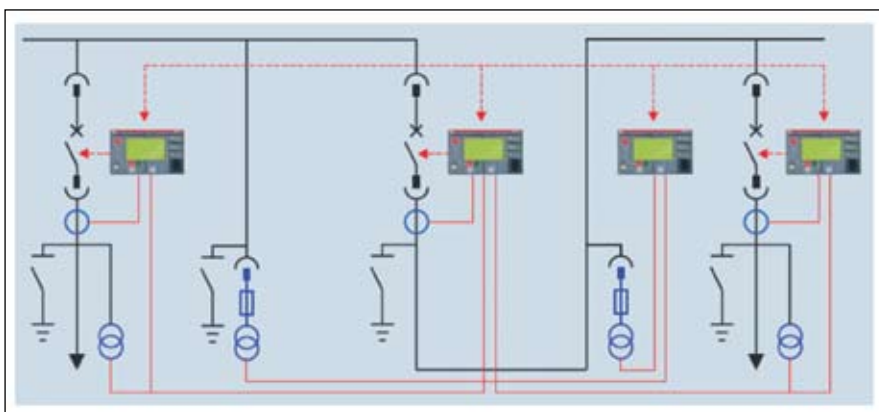


Fig 2: Typical single busbar switchgear.

Table 1 shows the advantages and disadvantages of single busbar switchgear.

Table 2 shows the advantages and disadvantages of double busbar switchgear.

Which double busbar system?

Double busbar systems are based on various different schemes, below are some examples of double busbar arrangements with a short description of the arrangements, and the basic features of these systems:

- Two busbar systems connected to two separate circuit breaker compartments,

each fitted with a circuit breaker. This system is achieved using single busbar switchgear connected in a back to back/front to front arrangement, with a common cable connection for the incoming/feeder cable. Although a very stable system, that provides full redundancy, the cost of this system can be prohibitive.

- Two busbar systems connected to two separate circuit breaker compartments, using a single circuit breaker. This arrangement is achieved using the same principles as described above, so the cost of this design can be quite high, however the cost of duplicating common

equipment such as circuit breakers can be omitted. This system can provide on-load transfer between busbars if a spare circuit breaker is available. However if no spare/transfer circuit breaker is available this system may not provide the option of on-load transfer.

- Two busbar systems connected to two separate circuit breaker compartments, using either a single or two circuit breakers, in a double tier arrangement. This arrangement has the same functionality as described above, and is generally more cost effective, than separate single busbar switchgear connected back to back
- Two busbar systems, connected to a common circuit breaker compartment, via disconnecting switches. This system is achieved using disconnecting switches to connect the different busbars to a common circuit breaker. The cost of this system is less prohibitive than that above, while providing the same level of redundancy for the busbars, and the opportunity to switch between busbars without load interruption.
- Two busbar systems, connected to a common circuit breaker compartment, by changing the position of the circuit breaker or the circuit breaker connections to connect to the different busbars. This system may be the most cost effective solution; however for this system it is not possible to transfer the load between busbars without interrupting the supply.

All busbar systems described above provide for full busbar redundancy, i.e. physical isolation between source busbar systems. The first four systems above have a distinct advantage over the fifth system, in that the incoming or feeder cubicles can be transferred between busbars without load interruption. Fig. 3 shows the relationship between cost, redundancy and functionality. It can be seen that the higher the cost of the switchgear the higher the redundancy, it can also be seen that below a certain cost the option of load transfer is also lost. Users should therefore consider the level of redundancy required, with the operating procedures when making the choice of which solution is most appropriate.

Considerations

The main consideration is the level of redundancy required, followed by the operating philosophy. For full redundancy, with on-load transfer, then a back-to-back solution with all the equipment duplicated would suffice. If the reason for a double busbar solution is around fault levels, load shedding and/or connection of different systems, then it would stand to reason that the need for full redundancy is reduced and

| Advantages | Disadvantages |
|--|---|
| Cost of equipment is less | Flexibility of operations is reduced |
| Ease of use | Load shedding is more complex |
| Requires less space | Extension of the switchgear without de-energising is not possible |
| Cost of installation is less | Non-synchronised systems may present a problem |
| Cost of maintenance and spares holding is less | |

Table 1: Advantages and disadvantages of single busbar switchgear.

| Advantages | Disadvantages |
|--|--|
| Flexibility of operations is increased | Cost of equipment is more |
| Load shedding is easier to achieve | Operation is more complex |
| Extension of the switchgear without de-energising is possible | Requires more space |
| Non-synchronised systems can be used, to supply outgoing circuits | Cost of installation is more |
| On load transfer is possible with certain double busbar designs, such as the ABB UniGear ZS1 range | Cost of maintenance and spares holding is more |

Table 2: Advantages and disadvantages of double busbar switchgear

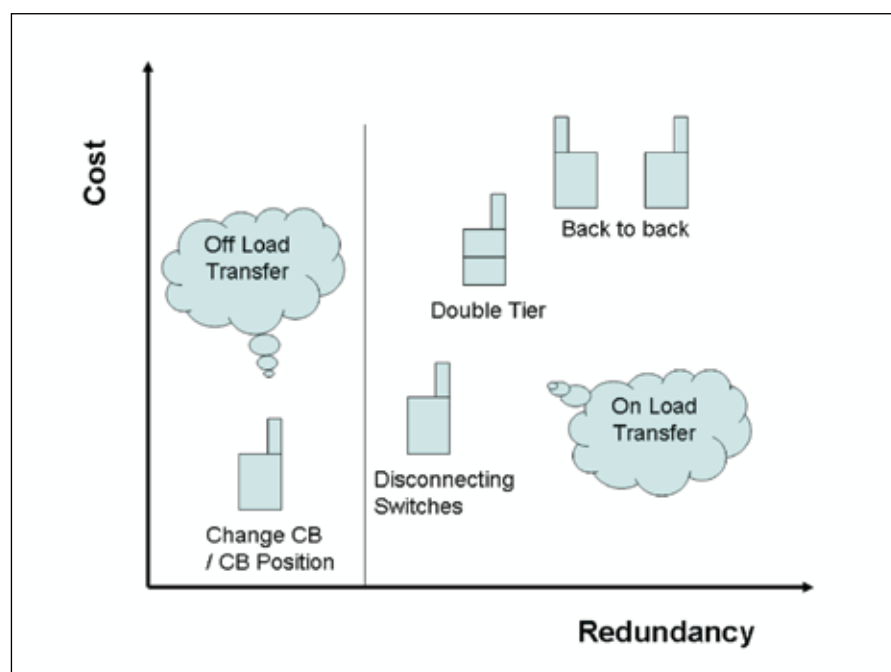


Fig. 3: Relationship between cost, redundancy and load transfer options.

a simpler and more cost effective design can be used. The design selected should then give consideration to the type of switching devices that can be used, the ease of operation, safety, and any requirement to do on load transfer.

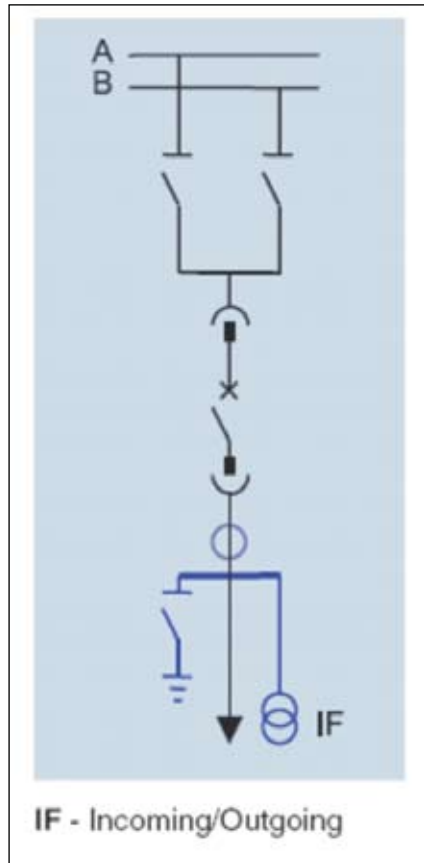


Fig. 4: Typical arrangement for the ABB UniGear ZS1 double busbar switchgear.

Fig. 4 shows a typical arrangement available for the ABB UniGear ZS1 double busbar switchgear, described above.

With this design the circuit breaker can be connected to any busbar, and load can be transferred, (provided from the same source), by first closing the disconnecter to the busbar to be connected (both disconnectors closed) and then opening the disconnecter from the busbar to be disconnected.

In the ABB UniGear ZS1 double busbar this feature is built into the disconnecting switch that transfers the load between the busbars. This eliminates the need for a bus coupler switch, or load transfer switch that couples both busbars together when doing on-load change-over.

However as a principle, users may not want to use disconnecting switches alone, and include a buscoupler to connect the busbars together before attempting on load transfer.

The switchgear using disconnecting switch principles, provide a wide range of switching arrangements, at a cost effective price, whilst not compromising on useful features such as on load transfer.

Conclusion

In many instances single busbar switchgear can provide a suitable solution, a high level of security of supply, and a practical solution. Users in process industries and utilities such as power generation where security of supply is most important, opt in many instances for single busbar designs. It is generally realised by users that although

double busbar switchgear, provides for busbar redundancy, achieving full busbar redundancy in a confined environment is not always practical. For example if one busbar on a double busbar system where to fail, although the system can be easily changed over to a reserve or stand by busbar, the switchgear in all likelihood would have to be completely de-energised in order to carry out repairs safely. To provide for full redundancy, and safer conditions for maintenance and repairs, users opt for separate switchboards, connected together with bus sections, or back to back solutions.

In instances with synchronised systems and double busbar systems are needed, then preference is normally given to switchgear where on load transfer is possible. Only in rare circumstances, where on load transfer is not required, do users opt for double busbar systems where on load transfer is not possible.

As a final word users should also take note of the need to ensure that any switchgear, should meet the requirements of the latest revision of the applicable standards. Most manufacturers will test and provide proof of testing to these standards. The standard that should be considered over an above the normal specifications, concerning switchgear, is the IEC62271-200, and any other standard quoted, should be treated with caution, as the standard and related type test certification may be out of date.

Manufacturers should be able to provide test certification for the full fault level of the switchboard, up to 1000 ms, classification AFLR to the IEC62271-200 specification. In short this means that the switchgear can with stand the forces created during an internal arc, at full fault level, for up to 1000 ms, and be accessible to operators from the front, lateral and rear of the switchgear. Users who do not specifically call for certification to the latest IEC 62271-200 specification, may find themselves being presented with switchgear that does comply to these requirements, and thereby open themselves up to litigation claims.

Switchgear is a sizeable investment, so the choice of which switchgear at design stage is critical to ensure that the investment is well made, will safely meet with the life expectancy of the installation, to the latest standards applicable at the time of purchase, and will provide the most appropriate flexibility of operation.

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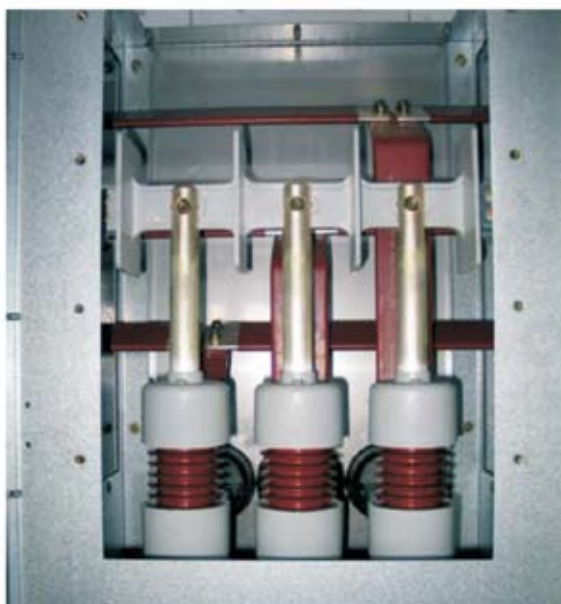


Fig. 5: Example of disconnect switch in UniGear Z21 double busbar switchgear.