Issue #75 - Spring 2016

Technical News

Industrial Electrical and Automation Products, Systems and Solutions

Automatic Transfer Switches in Low Voltage Applications

Common methods and design considerations in Australia and New Zealand

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This Technical News discusses a number of common methods and design considerations for Automatic Transfer Switches (ATS) used in low voltage power distribution systems. Within this Technical News low voltage refers to power distribution systems with voltages up to 1000VAC.

It is common for larger electrical systems to have a backup electrical power supply, whether the application is industrial, commercial or agricultural. Depending on the load requirements, the implementation of a reliable back up supply of electrical power can be critical to the electrical design of an installation.

The different forms of power supply can include; street-mains supplies, diesel generators, battery systems, Uninterruptable Power Supplies (UPSs) and Flywheel Energy Storage (FES) devices. The majority of back up applications usually feature the use of a mains (street) supply with a backup diesel generator, and therefore many points discussed in this document directly relate to this application.

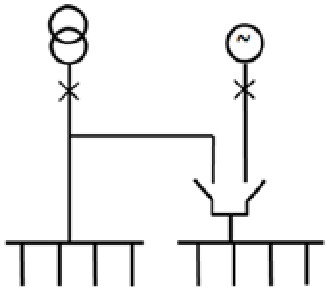
An ATS is used to automatically change between supplies in a power distribution system. The term is generic for any arrangement which can carry out the task. In this document we will cover a number of the current solutions in the market and discuss strengths and weaknesses of each solution.

The standards covering transfer switch equipment are IEC 60947.6.1: 2013, AS/NZS 60947.6.1: 2015, AS/NZS 3000: 2007 with 2012 revisions, and AS/NZS 3010: 2005. AS/NZ 60947.6.1:2015 is now identical to IEC 60947.6.1: 2013.

As with any design, a set of goals need to be outlined. The design goals for an ATS are listed in a general order of importance:

1. Safe and reliable automatic transfer of power between supplies
2. Decide which transfer operation suits the lead type (open/closed tranisition etc.).
3. Ensure the electrical protection offered by switchgear is optimal for the installation
4. Offer safe and straightforward emergency operation
5. Cost effective solution with minimal maintenance

Each ATS solution needs to be measured against these goals to measure how effective it is.



ARCHITECTURES

CIRCUIT BREAKER BASED ATS

The most common ATS solution in the Australian and New Zealand market today uses Moulded Case Circuit Breaker or Air Circuit Breakers with the addition of motor operators or open/close coils to assist with automated remote operation. This solution has been available for decades with all major manufacturers or distributors offering components for customer assembly or pre-built ATS assemblies.

The continuing popularity of this type of ATS is mainly due to the fact that the circuit breakers need be in place for all incoming supplies. Conveniently, these circuit breakers can be built up to form an ATS with accessories such as:

❶ A changeover controller; either electronic based, or a relay timer logic panel to evaluate the health of incoming supplies and control the circuit breakers

❷ Motor operators or open/close coils controlled by the changeover controller

❸ Mechanical interlocking mechanisms between circuit breakers to ensure the load is supplied by only one source at any time

❹ Auxiliary switches and alarms to electrically indicate the circuit breaker status to the logic controller

❺ Interconnecting wiring looms

- An intermediate panel which includes fuses for the protection of the voltage sensing circuit
- Common load side busbars/connections

The above solution is usually cost effective and the electrical industry in general is comfortable and experienced in the operation and troubleshooting of these ATS systems. The above approach has a proven track record, however, it can also introduce some technical issues into the power distribution system.

Difficulty to optimise the protection

The requirement of mechanical interlocking usually means that the two circuit breakers must be alike – either both ACBs or both MCCBs, and both the same brand. This may have an effect on electrical protection as it will restrict the designer to a certain range of protection options, rather than the best given option for the installation. This also rules out the use of fuses.

Another common occurrence, is where an undersized backup generator is used compared to the mains supply. For example, a 1600A mains supply with a 500A backup generator. The mechanical interlocking requirement would usually require an ACB/ACB or MCCB/MCCB, where the best protection solution may be an ACB/MCCB combination. This step away from the optimum protection may lead to an increase of risk to operators and reduced protection features for the installation. A common solution is to use common frame interlocked MCCBs with different trip units, or cable interlocked pairs using different size ACBs or MCCBs, placed physically apart.

Downgrading Cascade or Selectivity protection

A basic design consideration for designers is to avoid placing two identical circuit breakers in series in the same circuit. As discussed by IEC 60947.2 :2015 Appendix A1, the performance of two identical Short Circuit Protection Device in series may differ when compared to their individual performance. An example of this is where a supply will have one main breaker, and then an ATS installed using the same size breaker. Doing so has two main consequences:

- The circuit breaker curves for energy and peak current limitation may not be valid in that configuration, and the installation designer cannot back-up the installation Icw computation by referring to manufacturers data, as selectivity or cascade backup cannot be achieved with two same size breakers in series.
- The result is more energy is dissipated by the busbar system during a fault, as the two circuit breakers will tend to limit the other from tripping as quickly as possible.

In addition, many backup generators include their own circuit breaker, and the addition of another circuit breaker in the ATS circuit also infringes on the above design principle – unless one circuit breaker is removed.

If the ATS is in a secondary switchboard, its incoming feeders are usually protected by an upstream circuit breaker of fuses, primarily for cable protection, but here also there may be a protection issue for the same reasons.

Difficulties may occur at the critical time of commissioning or breakdown

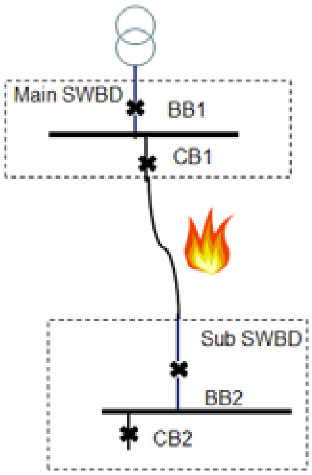
A circuit breaker ATS requires commissioning or maintenance on site when installed. The mix of connected components, wiring and mechanical interlocking, can complicate commissioning as this introduces a number of points of possible ATS failure. During maintenance or for a breakdown, any MCCB, motor operator, wiring or mechanical interlock replacement will require disassembly and re-assembly, and testing.

Difficulties may occur at the critical time of commissioning or breakdown

Another issue arises with manual (by hand) operation of the ATS in an emergency situation, which requires manual operation of the motorised circuit breakers. This may require access to multiple sections of a switchboard and a possible non-obvious procedure if panel or doors need to be accessed, where motor operators are not protruding through a cut-out. A possible safety issue with this is where the human operator closes a circuit breaker onto a fault, which may be hazardous, as the operated circuit breaker could clear a fault, releasing arc gases and a large amount of energy in the vicinity of the operator. For example, in non ATS applications, an MCCB will usually have a door mounted extension handle, but not in the case of a motorised MCCB, unless the motor is protruding through a cut-out, and has a manual operating capability.

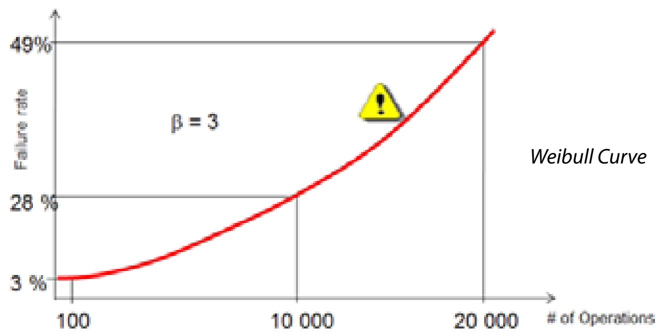
Reduction of reliability of the protection increasing with the number of operations

A circuit breaker used for an ATS function will see its failure rate increasing over time in relation with the number of operations. This occurs with any mechanical device (refer to the Weibull curve seen below). After some years of operation, the result is that the installation may have a failure rate of 20 - 30% instead of the expected 3% compared to a new device. That is the equivalent to having a circuit breaker which has a 1 chance out of 3 of not tripping.



Selectivity or cascade protection

A typical circuit breaker based transfer switch, rated 1250A, with common load busbar assembly



Weibull Curve

LOAD BREAK SWITCH BASED ATS

IEC/AS/NZS standards allow load break switch or circuit breaker based designs. With improving changeover load break switch technology, there has recently been a shift in the electrical industry towards load break switch based ATS systems. These have introduced a number of benefits to the system over traditional circuit breaker based technologies. Load break switch ATS devices are usually comprised of two integrally interlocked load break switches, motor operated or by solenoids, with controllers built into a single housing. This technology emerged some 20 years ago and has a proven track record.

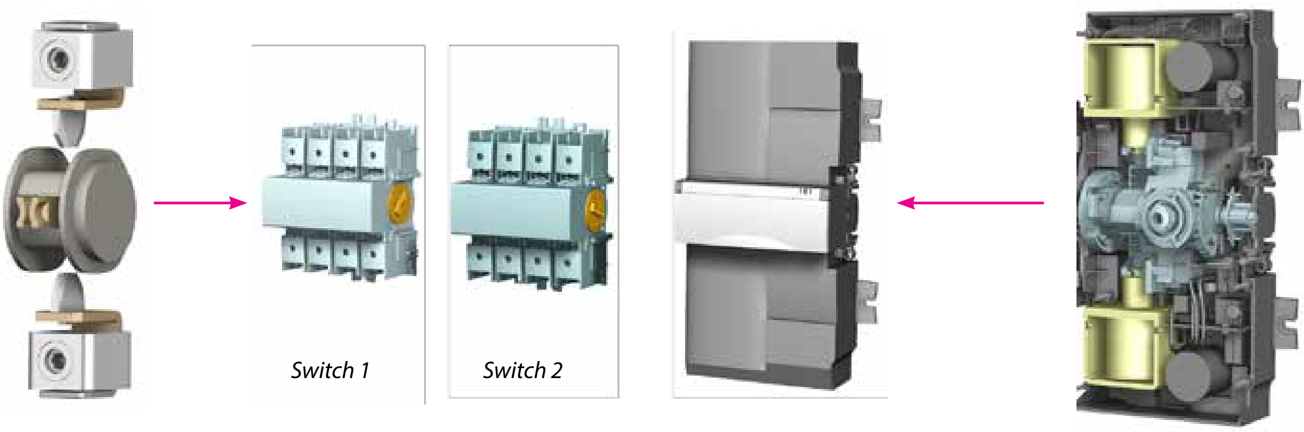
Circuit breakers will still be required in these systems, but will be used for protection only, and therefore would be mounted some distance away from the ATS. As such, there are no restrictions on the type of breaker that can be used, so the best suited products can be used to optimally protect the system. This is since the ATS consists of load break switches only, there is no effect on the system selectivity-grading or cascade-backup.

The circuit breakers then are in passive use only, and are less likely to prematurely fail, due to excessive levels of mechanical operation or opening and closing onto higher fault currents, in which case the breaker would usually trip anyway. The use of this type of system also frees up the circuit breakers for maintenance in installations without compromising the operation or installation of the ATS. The breakers typically installed are without a motor operator or interlocking, and are easier to access for testing and/or replacement.

This is a quicker and easier procedure for maintenance teams. Using a load break switch based ATS, mechanical interlocking and electrical wiring is built into the ATS, so there is no setup or ongoing maintenance required for these units, apart from periodic operation being recommended.

Socomec ATyS M: 40A to 160A

Socomec ATyS: 125A to 3200A

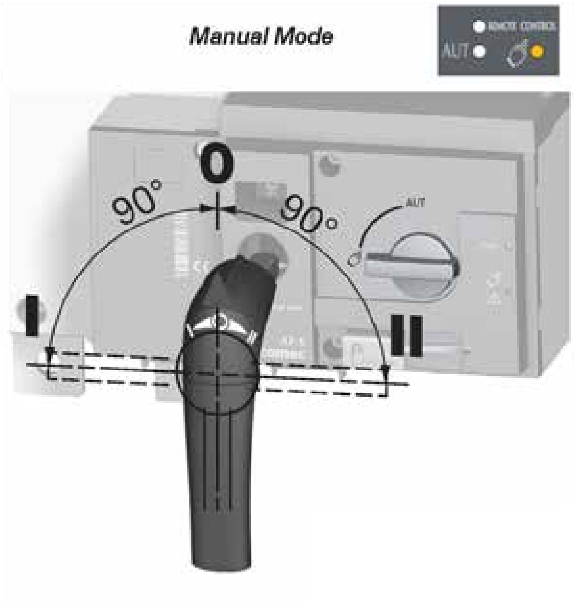


Electrical switching

ATyS M series includes main switching units, controller and switching solenoids in the one housing.

The issue of closing onto a fault is also reduced to a degree. For manual operation of these units, a handle is inserted into the device and then rotated manually. As these are load break switch based, they are designed to close onto a fault and withstand the fault current, while that fault current will be cleared by the upstream circuit breaker or switchfuse - not the switchgear the operator is using and standing in front of. The front control panel of the load break ATS, can be protruding through a cut-out, and this provides a safer access point for manual handle operation without the need to open the panel.

As these devices have no effect on the protection of the electrical system, a power bypass switching system can be installed, which can be used for ATS maintenance purposes. A bypass switch is useful for high reliability systems such as data centres or hospitals where redundancy systems are required. A bypass for the load break switch based ATS would require a make before break bypass changeover switch (BCO), which would provide power to downstream load(s) before cutting power to the ATS, thereby isolating the ATS from the system while providing uninterrupted power to the downstream load. At the same time, the circuit breakers are still protecting the system.



ATyS manual operation lever

ATyS M installed into a panel board

Main Switchboard mounted ATyS

INSTALLATION STANDARDS: AUSTRALIA, NEW ZEALAND AND INTERNATIONAL

- IEC 60947.6.1 and AS/NZS 60947.6.1:2015: are near identical standards specific to transfer switching.
- AS/NZS 3000:2007/2012: Australian/New Zealand general wiring rules, including general transfer switching.
- AS/NZS 3010: 2005 "Electrical Installations – Generating Sets", is specific to ATS using Generators.
- **Service Installation Rules or Electrical Safety Regulations** – These regulations are separate Australian state and NZ based documents that specify general requirements for electrical installations, including for transfer switches. Although these regulations are based on AS/NZS standard requirements, some local differences can occur for similar applications, and are mandatory in those jurisdictions.

NEUTRAL CONNECTION, SWITCHING & EARTHING REQUIREMENTS

A common question that arises with transfer switching applications is the Neutral pole switching requirement. Some determining factors are:

- Determining if 3P+N switching is needed as a part of the ATS assembly.
- Understanding the MEN (Multiple Earth Neutral) system of earthing.
- AS/NZS 3000 and AS/NZS 3010, and local safety/service regulations - requirements for generator sets.

Earthing requirements are straight forward – only 1 earth point is needed.

Neutral connection and switching requirements however, will vary depending where the MEN point is located. For example, a MEN is usually located in a main switchboard, while a remote sub distribution board, or panel board will have no MEN, but will include separate earth and neutral bars, connected separately to the main switchboard MEN. The ATS Neutral switching requirements will vary depending on an ATS being in the main switchboard with a MEN point, or the sub distribution or panel board, with no MEN point.

Why choose a 3 or 4 pole transfer switch?

This is a complex subject, with issues combining earth and neutral connection, safety-redundancy and practicality. Regulatory bodies in various Australian states will often have different preferences in some areas for the same applications.

The Generator Installation Standard AS/NZS 3010 covers all combinations, by showing connection diagrams for 3P/3P, 3P/4P and 4P/4P ATS configurations, used in main or sub-distribution switchboards. However, contractors and specifiers, will still need to refer to individual Australian state or New Zealand electrical regulations which detail mandatory ATS and generator requirements.

Generators connected to a main switchboard with an ATS, with a local MEN point

ATS installed in a main switchboard, with an internal MEN point, mainly use an ATS with 3 poles switch to switch the mains supply. For the generator switching side of the same ATS, some AU states require 3 pole (3 phases), and some 4 pole (3P+N) devices. There are no 4P/4P types included in AS/NZS 3010 for this type of application.

Other points:

- Refer AS/NZS 3010:2005 Figures 2.2 for a wiring example of the above (next page)
- The generator supply neutral is directly connected to main supply MEN neutral when running on backup mode
- For a 3P/4P ATS, the neutral pole does not require overload protection, but only switches the generator neutral

Generators connected to a sub distribution board with an ATS, without a local MEN point.

These installations are for stand-alone generators which are not mains MEN connected, though require neutral switching when running to create a MEN connection. ATS in this case usually use a 4 pole switch or circuit breaker to switch in the generator. This is because the Neutral needs to connect to the Neutral bar or to create a local MEN point, only when the generator is running. Australian states that allow only one MEN point in an installation, require a 4P/4P ATS, because the Neutral connection to the main switchboard MEN will need to disconnected so long as the generator is running, which has its own temporary MEN point. Other Australian states that permit the main switchboard MEN to remain connected, will allow a 3P/4P ATS since the main switchboard MEN Neutral does not need to be disconnected while the generator is running.

Other points:

- Refer AS/NZS 3010:2005 for wiring examples of the above
- Generator Neutral always connected to Earth bar in local switchboard whether Generator active or not
- Generator overcurrent protection: 3P protection for 3P/4P, 3P+N protection for 4P/4P

Awareness of standards requirements

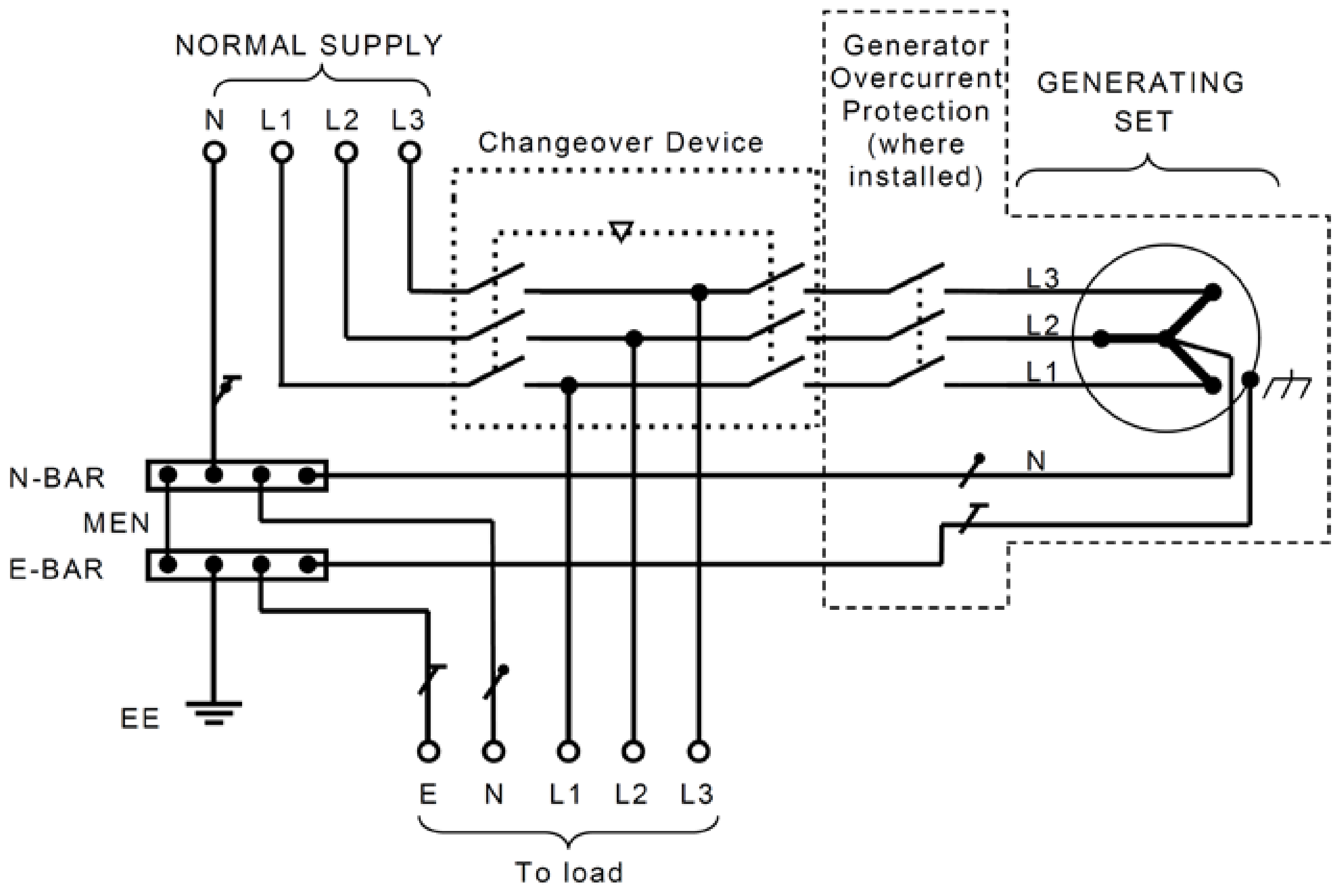
The complex mix of standards and individual state requirements sometimes leads to an unnecessary mix of 4P/4P or 3P/4P ATS being used, where less costly 3P/3P ATS could sometimes be used. It is therefore advisable, that installers and specifiers check service installation rules / safety regulation requirements before commencement of design work.

INSTALLATION STANDARD AS/NZS 3010:2005

3 Pole / 3 Pole ATS in a main switchboard with a MEN link

Main points:

- Main switchboard containing an MEN link, and ATS.
- Mains or generator Neutrals are not switched.
- Mains supply Neutral connected directly to MEN link.
- Generator supply Neutral connected directly to MEN link.
- Generator overcurrent protection: 3 phase protection. No Neutral protection.
- The ATS can be circuit breaker or load break switch based.



AS/NZS 3010:2005 Figure 2.2 3 pole / 3 pole changeover arrangement for a 3 phase generating set installed in a main switchboard with an MEN link.

OPEN/CLOSED TRANSITION ATS

A number of different ATS topologies are available on the market today. A clear differentiator in the market would be 'open transition' and 'closed transition' transfer switches. At least 95% of transfer switches sold in the market in Australia and New Zealand would be "open transition" types.

An open transition transfer switch is designed so that there is a short electrical blackout, or "gap" when transferring between supplies. This is to ensure that supples 1 and 2 are never connected to one another and that a clear break between supplies is provided to inductive loads to ensure the new supply is protected from back EMF, where an explosive result could occur.

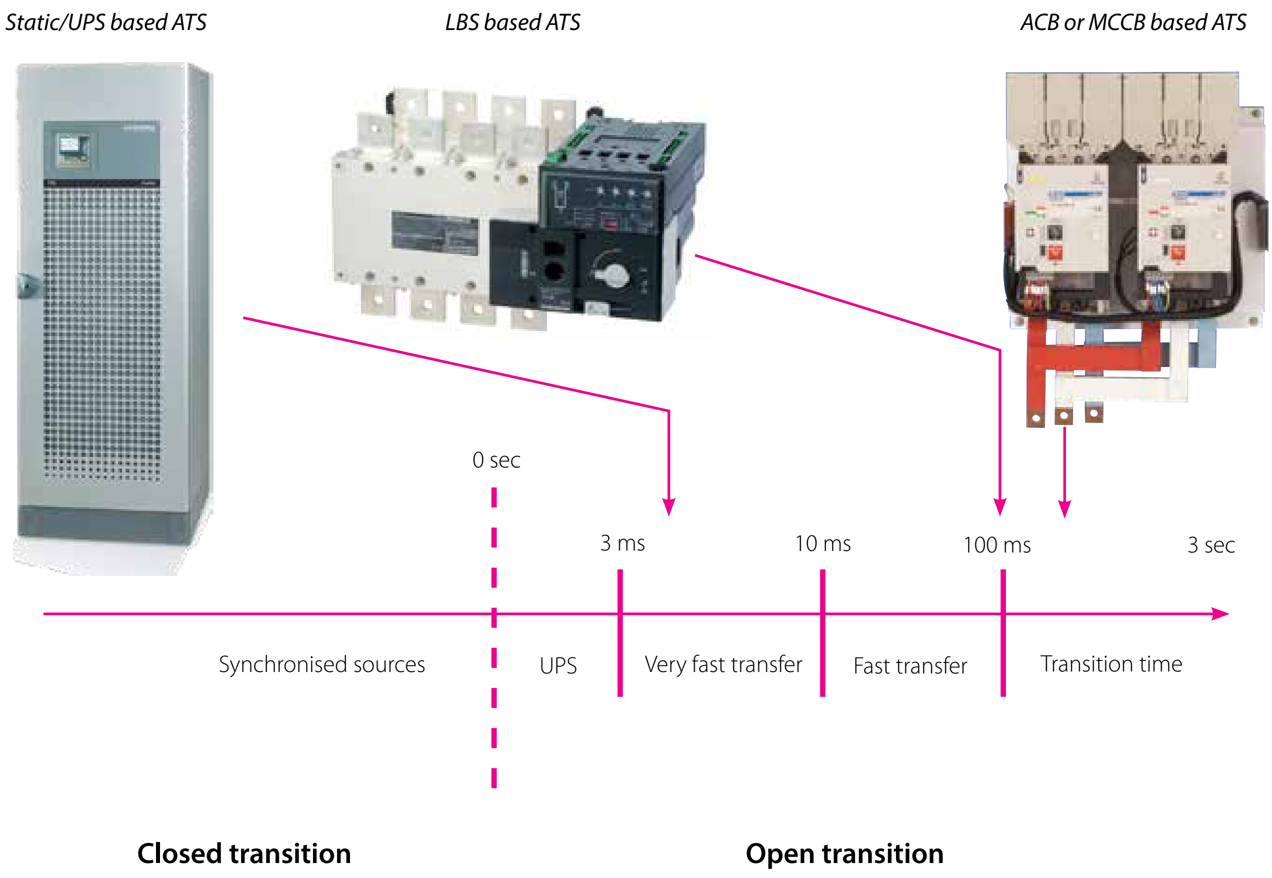
The other smaller component which are closed transition types, can be broken down into two main groups.

A closed transition transfer switch is designed to switch between two supplies seamlessly, often using make before break switches, and a controller that senses if the supplies are synchronised, before allowing switching. This system allows no loss of power to the load when both supplies are present.

This does provide some advantages:

- Regular testing of the alternate sources on the real load is possible without loss of system power
- No loss of power on return to main supply after a loss of power

Typical transition types:



CLOSED TRANSITION TRANSFER SWITCH ISSUES

Switching, IEC, Australian and New Zealand standards

The operation and user expectation of a Closed Transition ATS needs to be well understood, as this type of ATS is usually suited to very specific applications only, where a seamless change of supply is required, from source 1 to 2, and back again.

Standards such as IEC 60947.6.1 and AS/NZS 60947.6.1 do not distinguish between open or closed transition transfer of supply, though they may in the future. Many Closed Transition ATS assemblies used in A/NZ tend to be built to the North American UL standards, and they do technically comply with IEC 60947.6.1 for transfer switching, though not with IEC 60947.3 which specifies disconnectors suitable for isolation use, often associated with transfer switching.

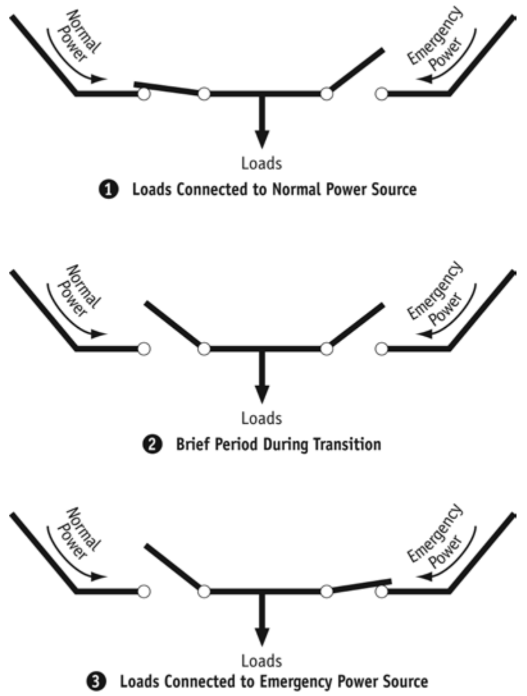
Closed transition ATS designed to UL standards have contact assemblies that do not have fault make load break capability, unlike a load break switch ATS, nor do they have fault interruption capabilities, like a circuit breaker switched ATS. At the same time, the contact assemblies of UL closed transition ATS are very fast switching, though with no OFF position. Because of this switching system, a closed transition ATS cannot have both the mains and generator switching switched OFF, or be padlocked OFF at the same time. For maintenance isolation, an isolating switch, or a bypass system must be installed.

Closed transition types are still "open transition" for unexpected power loss: There is still a loss of power on loss of mains supply with closed transition ATSs, no matter how fast the changeover occurs. This is because the backup generator still needs to be started, and brought up to speed before the backup supply is switched on. This means that a closed transition ATS cannot offer continuous power during an unexpected power loss. Closed transition ATS mainly suit planned supply changeover applications, such as for generator testing or system maintenance, and will in those applications perform a seamless change from one supply to another and back again.

However arguably the biggest issue with the closed transition ATS is the cost: These have been reported to be around 500% higher than the same switch size in an open transition style. The other compulsory additional cost of a closed transition ATS is the synchronisation panel which can be very expensive.

Close Transition transfer switch use is tightly controlled by utility suppliers: A closed transition transfer switch may use a backup generator supply. This generator when changing back to the mains supply, will be connected to the mains supply directly for a period of time as part of the seamless changeover. The generator is therefore classed as an "embedded generator", since it effectively becomes a power generation source feeding into the utility mains supply. Naturally this is not desirable, so energy authorities by design, limit the "overlapping time" that a user's private generator can be connected to the public mains. Groups of utility providers, for example, those covered by the Victorian Service and Installation Rules 2014, specify a short overlapping time ranging from 0.1ms to 10 seconds depending on the system. The generator system will also need a range of protection measures to ensure that the council supply is not negatively affected by the "embedded generator". Complete design details for each system are required by utilities in A/NZ for prior approval.

Last but not least, the reliability is affected: One mode of failure of a closed transition transfer switch is where both sources become connected permanently. This is especially not wanted by utility suppliers, who will usually insist on protection against this possibility. Another issue for large installations is that a single synchronising panel must be used, and therefore the synchronising panel becomes a Single Point of Failure.



Typical closed transition transfer switch cabinet

ALTERNATIVE TO A UL CLOSED TRANSITION ATS

Due to the various issues associated with UL types and Closed Transition ATS in general, a solution already used in most applications, and an arguably better and simpler solution, is to have an open transition ATS feeding into a UPS for critical loads. Examples could be: computer servers and systems, control systems, critical process, building lifts and escalators, hospital rooms and operating theatres etc.

Open Transition ATS + UPS:

A UPS with battery back-up, provides power to critical loads at all times, and whenever there is an electrical blackout, the ATS commences to start the back-up generator. As the UPS battery was already being continuously charged from the mains supply, the critical load never sees a loss of power. Once the generator becomes the new main supply, it also provides power to the UPS batteries, so when the changeover back to mains occurs, again, there is no loss of power to critical load. This solution also provides advantages for easy testing and same seamless retransfer as with closed transition switching. This solution is well suited to applications where loss of power at any stage has to be avoided. In addition the switching will have a definite OFF position for both switches, and mechanical interlocking. The UPS paired with the ATS open transition solution also fully complies with AS/NZS 60947.6.1: 2015.

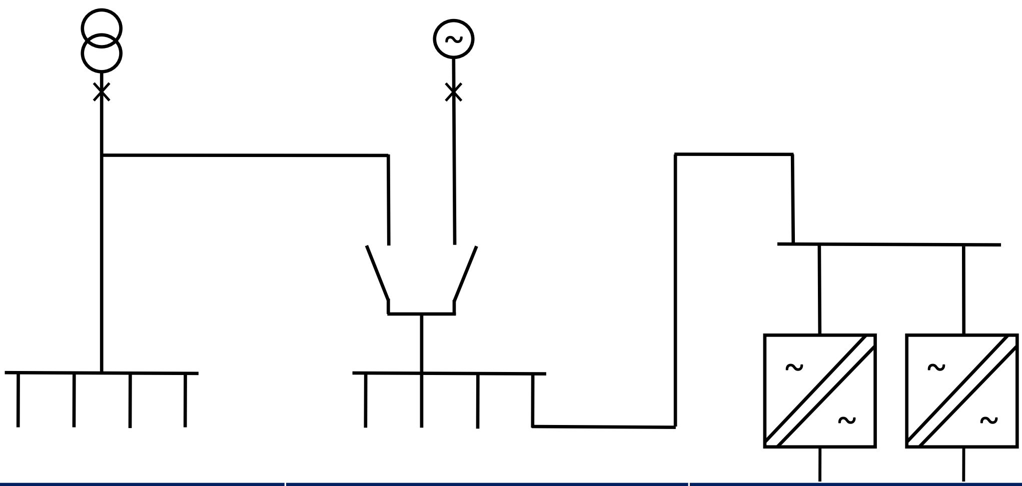
A power loss will create issues for non-essential and more important "essential" loads, which are not backed up by the UPS, but are regularly used by human activity. Examples could be conference rooms, TV's in hotels, air conditioning, refrigeration, test labs in hospitals etc. These areas are more comfort, rather than critical-safety related. In that case, the most obvious solution would involve adding additional local UPS systems.

An additional feature is a "Conditional Return", where the return of the ATS to the mains supply is conditional by certain conditions being met. For example, when a process is in a safe phase that can be interrupted, the ATS only then can switch back to the mains. This solution is particularly useful for certain industrial processes.

Saving costs using a Closed Transition ATS

An example of when the high cost of a closed transition ATS is acceptable, is for a large installation, running 24/7/365, in a location or country with negligible average power outages per year, with an installed power of around 5 MVA, and with a high cost per minute of interruption. In that case, a UPS cost will be high, and will not return its investment. A closed transition ATS is a compromise paid back by the savings made on a return to mains only.

In conclusion, there are a number of alternative solutions to closed transition ATS, which avoid the drawbacks of closed transition ATS.



Application	Non Essential Loads	Essential Loads Diesel Generator	Critical Loads Diesel Generator + UPS
Data centres	Lighting	HVAC (chiller, buffer)	Servers, HVAC (pump)
Hospitals	Secondary utilities	Half lights, HVAC	Lifts, half lights, operating rooms

OTHER TYPES: CLOSED TRANSITION ATS WITH SYNCHRONISED SUPPLIES

There are other areas of the market where alternative types of closed transition transfer switches are used. One of the most common is where a user uses individual motorised switches, which are usually circuit breakers, that are NOT mechanically interlocked, and a synchroniser. These applications would often involve generators only, and as such would be an isolated system, not connected to a utility mains supply. The strict regulations involving the effects of embedded generators and mains supplies would not usually apply.

Applications for this type, can be industrial processes, mines, or even outdoor entertainment events where generators are bought online and dropped offline as required to supply a variable power requirement. In order to do this, each generator supply will be added or deleted at different times, and these must be correctly synchronised before they are bought online. As each breaker switches in and out, they will overlap for a short period of time as determined by the synchroniser. This sort of arrangement and application is obviously quite different to the UL based devices previously discussed.

Synchronised changeover - critical conditions to be met:

Condition 1 - the 2 sources must have the same voltage

Condition 2 - the 2 sources must have the same frequency

Condition 3 - the 2 sources must be synchronised prior to switching

Typical closed transition synchroniser controller

ATS RELIABILITY

An important consideration in the design of a transfer switch and selection of components is system reliability.

While applications in hospitals and data centres are among the most sensitive to any decrease in the reliability of an ATS, low end application users also expect high reliability of an installed ATS.

A common measure for failures is Mean Time Between Failure (MTBF). This is the average amount of time between failures of the system as a whole, via the addition of the component's MTBF in the system. These components do not only include the switchgear itself, but also the interconnecting components such as wiring, interlocking cables and accessories.

The ability to maintain the assembly is also important in the breakdown time of the ATS. The best offering for an ATS is for the end user being able to quickly and easily replace motor operators, solenoid components, controller units or breakers. Being able to manually operate an ATS increases the availability of the system, until critical parts can be replaced.

The availability of the ATS system can be increased by adding redundancy. For the switched based ATS, this can be as straight forward as a bypass switch being put in place to bypass the ATS easily without effecting the electrical protection of the system. However, bypassing an ATS consisting of circuit breakers can lead to a failure in the selectivity of the system and potential danger to downstream equipment and operators. In this case additional breakers would need to be installed in the alternative current path, or none in the case of a load break based ATS.

The transfer of power is the main function of the ATS, however this must be done in a safe manner. This does not only refer to switching mechanisms or ratings, but also indirect factors. A common oversight is the effect on the selectivity and cascading of the power distribution system, which is directly affected by the switchgear used in a system. As reliability is a major factor in the performance of an ATS, the application also defines exactly how important the reliability aspect becomes. For example, a data centre or hospital would require the highest reliability levels compared to a regular office or workshop.

The reliability of a system is also related to the capability AND willingness of users to maintain and test the system to ensure ongoing service; and therefore, maintenance programs are important to the system. For example in Australia, hospitals, defence forces and some other organisations have government mandated testing procedures for transfer systems, while for most other users this is determined by industry practice. A fair comment would be that although MTBF is an important measure to many industries, regular system testing is the most absolute way to ensure the availability of the system.

The cost of an ATS is a large factor in most power distribution systems, and ensuring the appropriate ATS solution is chosen therefore important. As an ATS is usually central to many electrical installations, taking into account the cost of the ATS by itself is one factor, but beyond this, the cost of being able to achieve easy maintenance is another, and this can be achieved via appropriate switchboard design, or by integrating the use of bypass options, UPS integration etc. This is usually determined by the user application, and the degree to which ensuring supply is non-essential or essential (critical).

FEATURES MATRIX FOR TRANSFER SWITCH TYPES:

Goal	Circuit Breaker ATS	Load Break Switch ATS	Closed Transition ATS
To safely Automatically Transfer between incoming supplies	Yes – proven track record	Yes – specifically designed for this application. Proven track record	Yes – specifically designed for this application. Proven track record
To ensure isolation of supplies from one another	Reliant on functioning external mechanical and electrical Interlocking	Yes - Interlocking internal to device with fail-safe cog.	No – specifically designed to connect source to one another without an OFF position
To maintain electrical protection offered by switchgear in the installation	Yes. Can possibly restrict choice of Circuit Breaker, example an ACB instead of MCCB.	Switch only, no effect on selectivity. Upstream Circuit Breakers can be selected to offer best protection.	Switch only, no effect on selectivity. Upstream CBs can be selected to offer best protection. Maintenance of contacts required.
To be capable of safe and straightforward manual operation by operators in emergency / shutdown situations	Yes - Reliant on operator having knowledge of the ATS system in place. Operator could be in front of the fault clearing device, though effect can be reduced by having motors through escutcheon	Yes – Selector switch on front for manual operation. Simple handle for manual operation - Single point of operation	No – Manual operation in off load condition only. Therefore procedure needs to be followed carefully.
To provide end user cost effective solution with minimal maintenance	Cost effective Adds an extra level of maintenance to the installation – testing operation of system is advisable, motor operators, wiring, etc.	Cost effective. Minimal Maintenance, though testing operation of system is advisable. Maintenance free contacts. Circuit Breaker maintenance program for passive use only.	Expensive option Regular maintenance required for contacts and arc chutes. Regular system testing advisable.

WOULD YOU LIKE TO KNOW MORE ?

If you would like any more information or application advice regarding Automatic Transfer Switches in Low Voltage Applications, please contact NHP's Technical Support Team on 1300 NHP NHP (AUS) or 0800 NHP NHP (NZ)

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