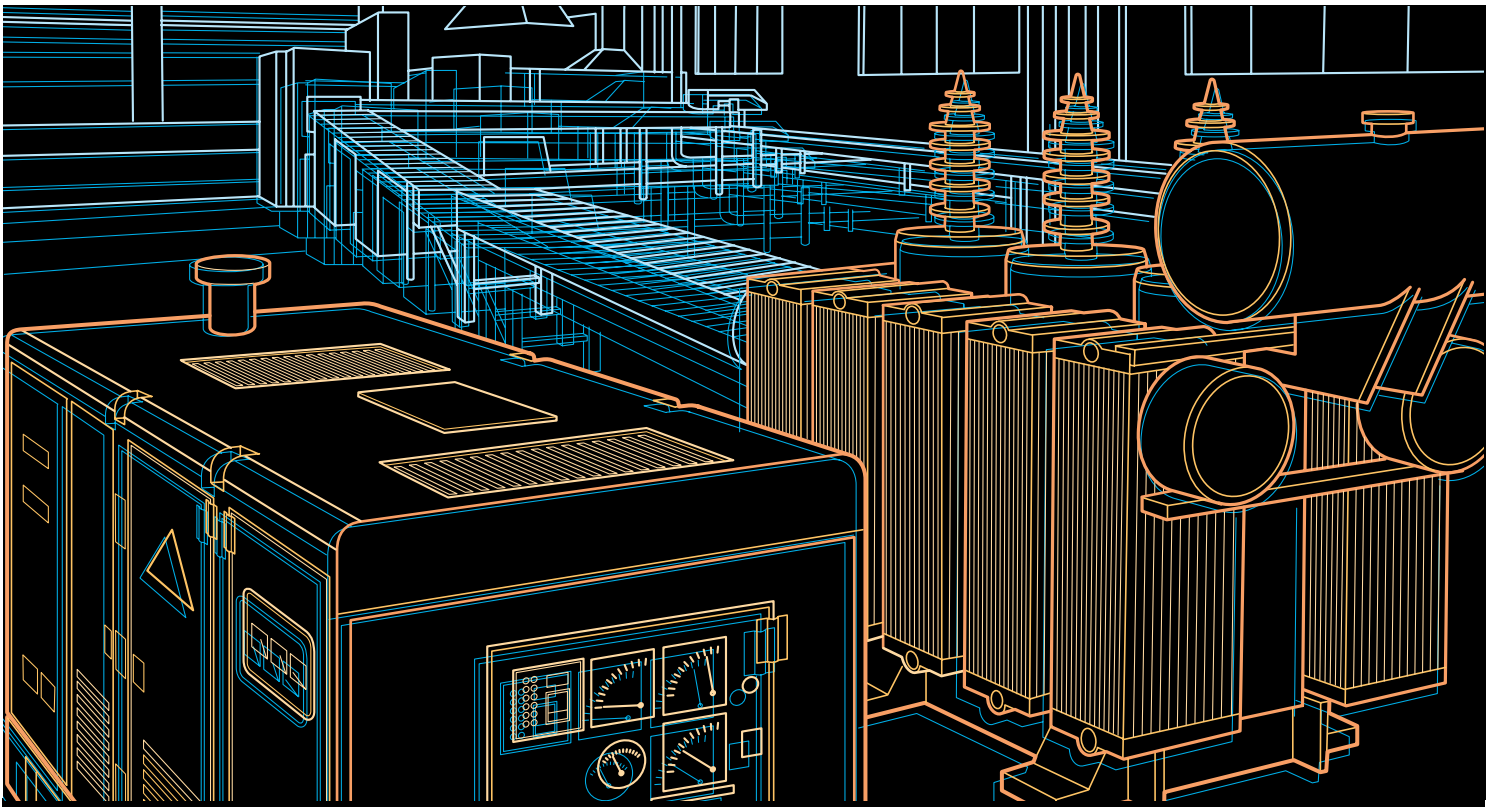




White Paper - July 2012

ATS021-ATS022

Automatic transfer switching

ATS021-ATS022

Automatic transfer switching

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1. Introduction

Over the past few years, service continuity in low voltage electrical installations has played an increasingly leading role. In actual fact, this requirement is a fundamental characteristic if economically and functionally efficient installations are to be created. A system able to switch the supply from the main line to an emergency line reduces problems caused by faulty conditions in the public network to the minimum.

These operations, commonly known as “automatic switching”, comprise sequences that automatically control the installation components (the circuit-breakers play a fundamental role) without interventions from the operator. To guarantee that power is supplied to the loads, a fundamental requirement in an installation is to have a redundancy in supply sources type N+1, usually consisting of a transformer + emergency generator (or, as an alternative, a second transformer).

An installation with an automatic switching system:

- prevents the industrial production process from being stopped
- provides a power supply with high quality voltage if the main network is out of service
- reduces the effects caused by network faults on parts of the installation (voltage reduction leads to loss of stability in the rotating machines, a higher voltage drop, faults in the equipment, etc...)

- achieves a good compromise amongst reliability, simplicity and cost-effectiveness
- provides the maintenance staff and managing system with a power source able to supply the installation or part of it when the transformer is being serviced.

To achieve automatic transfer switching, the installation can be fitted with an Automatic Transfer Switch ATS (available in versions 021 and 022) featuring microprocessor-based technology. If the main line is lost, this device can control generator start-up and can handle switching from one network to another by means of the commands transmitted to the circuit-breakers. This solution has been developed in order to ensure a much higher degree of reliability than the “traditional” solutions using wired logic (with time delay relays, contactors, voltage sensors, etc.), which are often complicated to make and depend on several devices being integrated.

This White Paper deals with the concept of automatic switching in plant engineering and then continues with a practical analysis so as to explain how the ATS units integrate with all the devices involved in the switching process.



2. Description of ATS

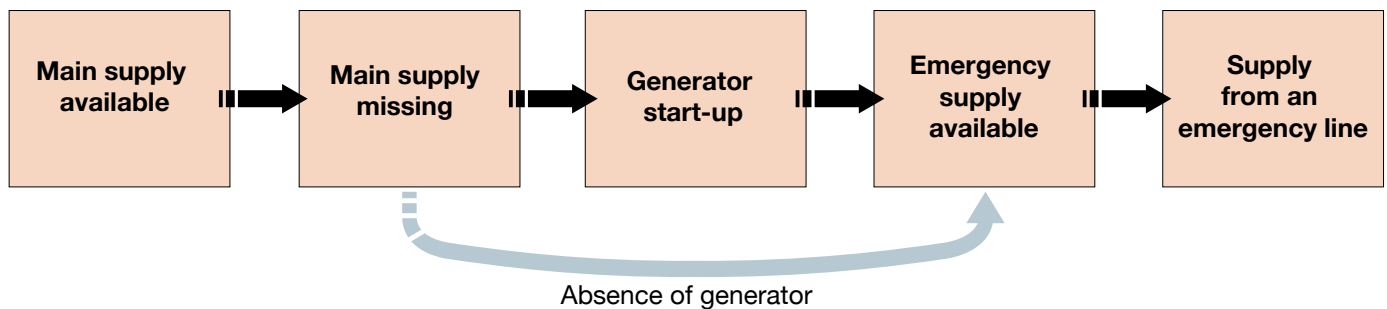
As mentioned previously, to achieve automatic switching, the installation can be provided with an Automatic Transfer Switch ATS (available in versions 021 and 022) with microprocessor-based technology. This solution has been designed to ensure a high degree of reliability thanks to the intrinsic safety systems linked to the operation of the software and hardware. The switching logic is inhibited and an alarm is activated if the state of a circuit-breaker (or a switch-disconnector) operating as the actuator of the system fails to match the command transmitted by the ATS. Moreover, use of the mechanical interlock prevents any parallel between the main and the emergency line from occurring.

The ATS unit continuously monitors the voltage value of the system and automatically switches to the generator or transformer, after a preset delay. This delay allows the activation time of the procedure in case of faults to be regulated, thus preventing unwanted switching due to voltage variations accepted by the installation *.

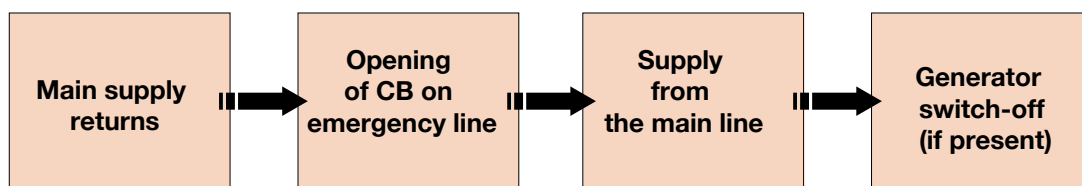
When the main voltage returns within acceptable limits, the ATS transmits a signal to activate back-switching so as to return to the initial conditions**.

These phases can be summarized as follows:

SWITCHING:



BACK-SWITCHING:

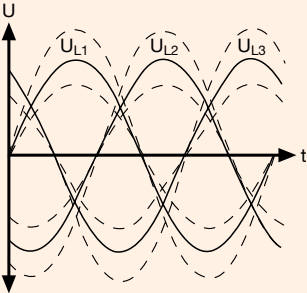
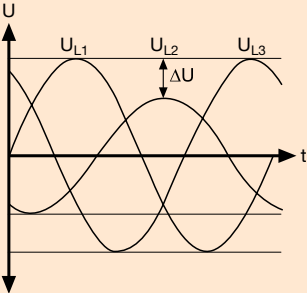
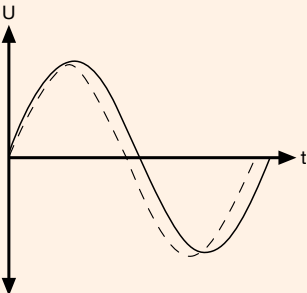
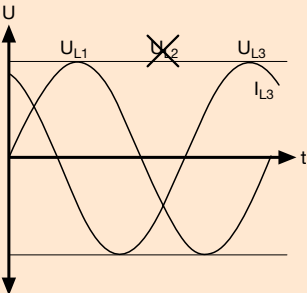


* this analysis must be performed according to the type of load and the type of installation considered

** in the case of ATS022, you can decide whether to remain on the switched emergency line once the initial conditions have been restored by activating the dedicated function ("no priority line" set to "on").

2. Description of ATS

ATS (021 or 022) activates the switching procedure when one of the following faults occurs by means of its internal sensors:

	Settings
Maximum and minimum voltage control 	With ATS021: MIN/MAX: +/-10%, +/-15%, +/-20%, +/-30% With ATS022: MIN: -30%...-5% di Un, MAX: +5% ... +30% Un with step $\pm 1\%$ Un
Voltage imbalance 	No adjustment required
Maximum and minimum frequency control 	With ATS021: MIN/MAX: $0.9f_n > f > 1.1f_n$ With ATS022: MIN: -10% ... -1% di fn MAX: +1% ... +10% di fn with step $\pm 1\%$
Phase loss 	No adjustment required

These faults can cause irreparable damage in an electrical installation. Just think of electrical/electronic devices supplied by voltages that are lower or higher than the rated operating voltage, or faults that affect electrical machines:

- thermal stress
- internal temperature rise
- variations in speed or rotation that also affect the connected devices
- interference when starting-up

Electrical networks that can be managed by the ATS

The characteristics of the networks controlled must be accurately entered to allow the ATS to function correctly in the plant in which it is installed. ATS units can manage three-phase systems, three-phase systems without neutral or single-phase systems. The ATS also functions in the absence of auxiliary supply, since it can draw voltage directly from the network (as shown in the table, with ATS021 the shunted power supply must be connected to the relative terminals).

With ATS022, the auxiliary supply is only required in the following cases:

- use of Modbus RS485 communication
 - use in systems with 16 2/3Hz rated frequency
 - use in single-phase systems with Un 57.5 to 109Vac
- A 24Vdc to 110Vdc (-10%, +15%) emergency power supply can be used.

The maximum operating voltage for both ATS021 and ATS022 is 480Vac. Transformers must be used at higher voltage values. Consult technical manuals CODE: 1SDH000759R0001 (for ATS021) and 1SDH000760R0001 for (ATS022) for the correct settings

The following table shows the connections to the power supply source for both the main and emergency lines.

		ATS021	ATS022
Three-phase system with neutral conductor	Connections		External AUX power supply only if: - Modbus communication is required - 16 2/3 Hz rated frequency - use in single-phase systems with $U_n=57.5\ldots109V_{ac}$
	Settings		
Three-phase system with neutral conductor	Connections		External AUX power supply only if: - Modbus communication is required - 16 2/3 Hz rated frequency - use in single-phase systems with $U_n=57.5\ldots109V_{ac}$
	Settings		
Single-phase system	Connections		External AUX power supply only if: - Modbus communication is required - 16 2/3 Hz rated frequency - use in single-phase systems with $U_n=57.5\ldots109V_{ac}$
	Settings		

* The characteristics of the external transformer for sole supply of ATS021 are:

- transformer (from network voltage to phase voltage)
- isolation transformer or insulator
- the S_n of the transformer must be 40VA.

NOTE: ATS022 allows the main and emergency networks to be set as two different types of network (e.g. main line 3P+N and emergency line PN).

2. Description of ATS

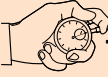
Switching logics

Since the ATS can control different plant engineering configurations, the following pages describe the sequences of operations carried out by this unit. Special attention is given to the most common plant engineering configurations that the ATS can manage. These configurations are:

- a transformer for the main line and a generator for the emergency line

- a transformer for the main line and another transformer for the emergency line
- use of a bus-tie to exclude non-priority loads (with ATS022 only)
- use of a bus-tie to manage two independent supply lines (with ATS022 only).

The following table shows the time settings required to implement the switching logics described in the following pages:

Time delays	Description	Setting range		Remarks
		ATS021	ATS022	
 TS	Time delay before the start of the switching procedure. In the absence of a generator, this time corresponds to the opening delay of the circuit-breaker on the main line. If a generator is installed, this time corresponds to the generator start-up delay.	0...30s		The delay, which lasts a few seconds, prevents the switching procedure from starting due to transient voltage dips.
ATS021  TF ATS022  TCE	Time delay before the circuit-breaker on the generator side or transformer side closes.	3.5s o fixed	0..60s	It is advisable to select a short delay to reduce the break in power supply to the loads.
 TBS	Time delay before the circuit-breaker on the generator side or transformer side opens (start of back-switching procedure).	0...30s o 300s	0...59s 1,2,3... 30min	The time delay before the circuit-breaker on the emergency side opens, after the main voltage returns, must be as long as possible to ensure complete stabilization of the main voltage.
ATS021  TF ATS022  TCN	Time delay before the circuit-breaker on the main line closes.	3.5s fixed	0..60s	The time delay before the circuit-breaker on the main line closes, after the circuit-breaker on the emergency side has opened, must be as short as possible so as to reduce the time in which the loads are not supplied to the minimum.
 TC	Time delay before the bus-tie closes (if installed).	ATS 022 only: 0...60s		Time TC must only be set for management of two independent supply lines separated by a bus-tie – for further information refer to page 20.
 TGoff	Generator switch-off time (if installed).	0...30s o 300s	0...59s 1,2,3... 30min	The time delay before the generator (if installed) switches off should be long enough to ensure that it is still running should a further power failure occur in the main network.

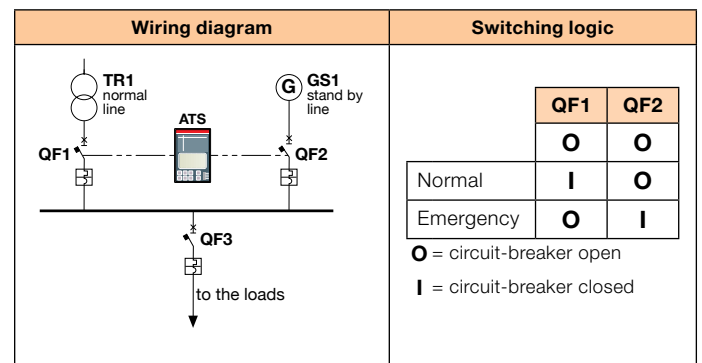
The following table gives examples of time delay settings (with ATS022) for a network with a transformer for the main line and a generator for the emergency line:

Time delays	Description	Setting range	Setting examples
 TS	Time delay before the switching procedure starts with generator start-up.	0...30s	5s
 TCE	Time delay before the circuit-breaker on the generator side closes.	0...60s	1s
 TBS	Time delay before the circuit-breaker on the generator side opens (start of back-switching procedure).	0...59s, 1,2,3...30min	45s
 TCN	Time delay before the circuit-breaker on the main line side closes.	0...60s	1s
 TGoff	Generator switch-off time.	0...59s, 1,2,3...30min	5 min

As can be seen, from the moment a fault occurs in the main network, assuming that the generator starts in 10 seconds, the supply for priority loads is provided in about 16 seconds (TS+10s+TCE).

Transformer for the main line and generator for the emergency line

According to the operating logic, under standard operating conditions, the network is powered by transformer TR1 and, if a failure occurs, the loads are supplied by the emergency line through the GS1 (generator able to deliver the same current as the transformer).



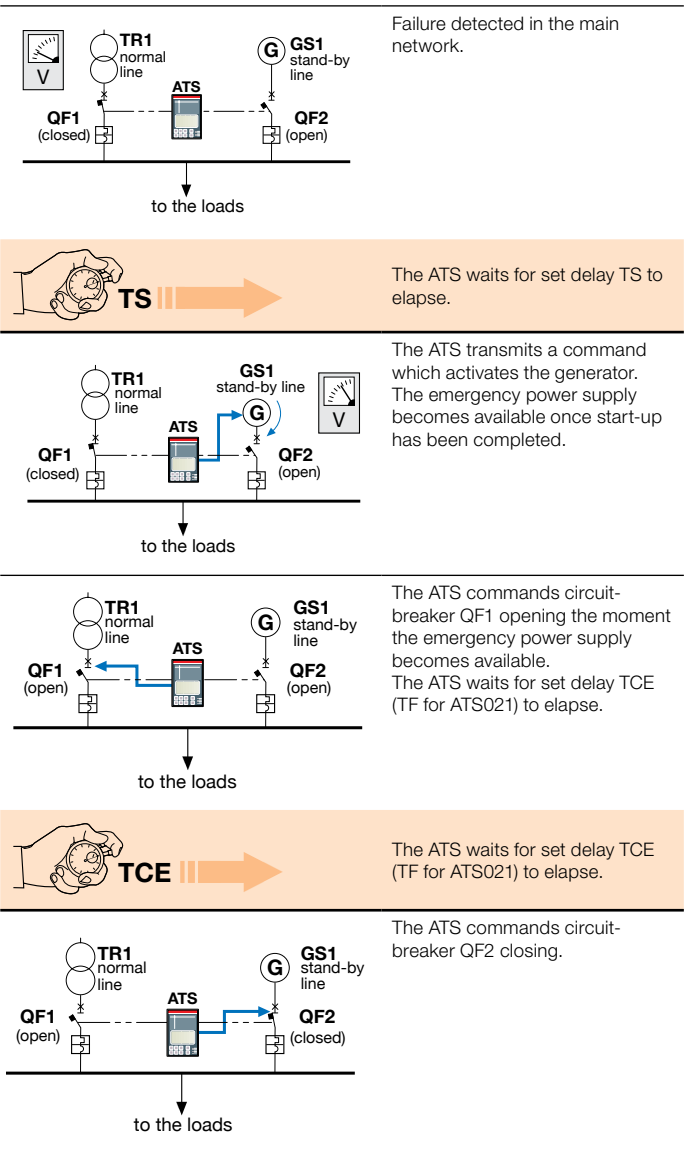
Under normal operating conditions, the ATS monitors the main network and, if a fault occurs, transmits a signal to start the generator after a time TS. When the emergency line becomes available, the ATS activates line circuit-breaker opening and emergency line circuit-breaker closing after a time TCE (TF for ATS021). From that moment on, the network is supplied by the generator and QF2 becomes the main circuit-breaker of the installation.

When the electrical parameters of the main line return within acceptable limits (depending on the setting) and once time delay TBS has elapsed, the ATS activates the back-switching procedures by opening circuit-breaker QF2 on the emergency line and subsequently closing circuit-breaker QF1 on the main line after the set delay TCN (TF for ATS021) has elapsed. The moment in which the installation is supplied by the main network, the ATS commands generator switch-off after time TGoff has elapsed.

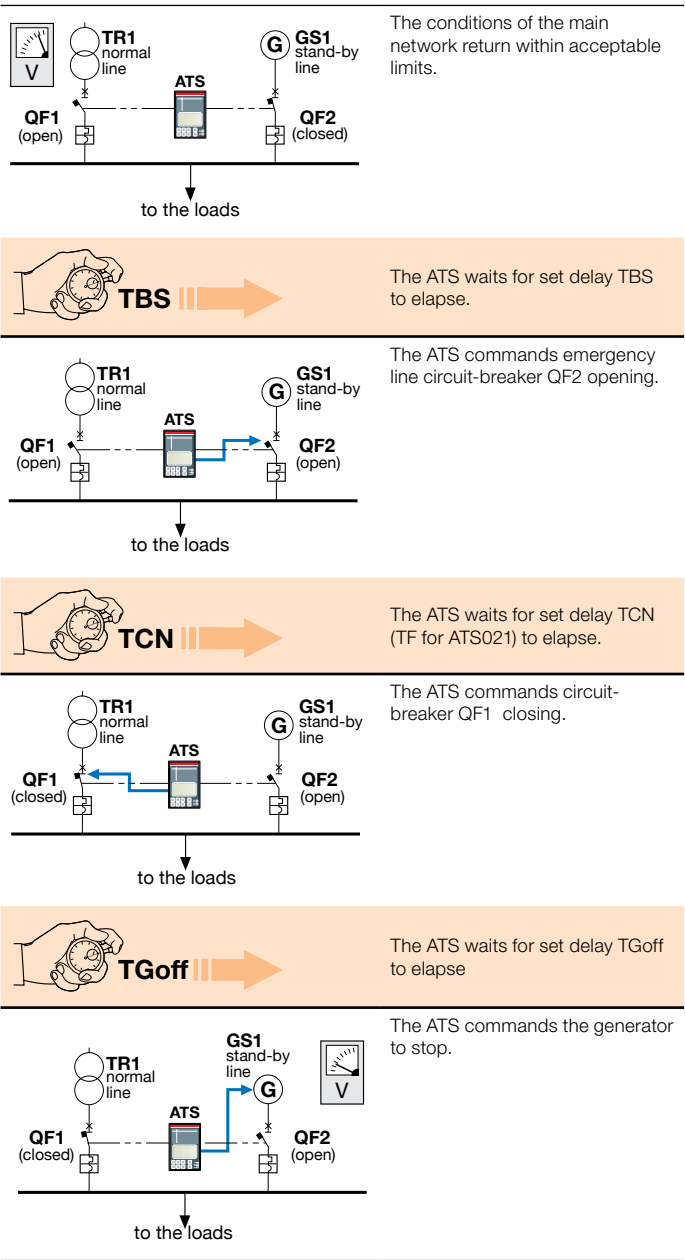
2. Description of ATS

The following table illustrates the operating sequences and the various commands performed by the ATS:

Switching – from TR1 to GS1



Back switching – from GS1 to TR1



From an operational point of view

To implement the switching logic, in addition to the ATS021-022 units, the circuit-breakers must be equipped with the following accessories (for each circuit-breaker):

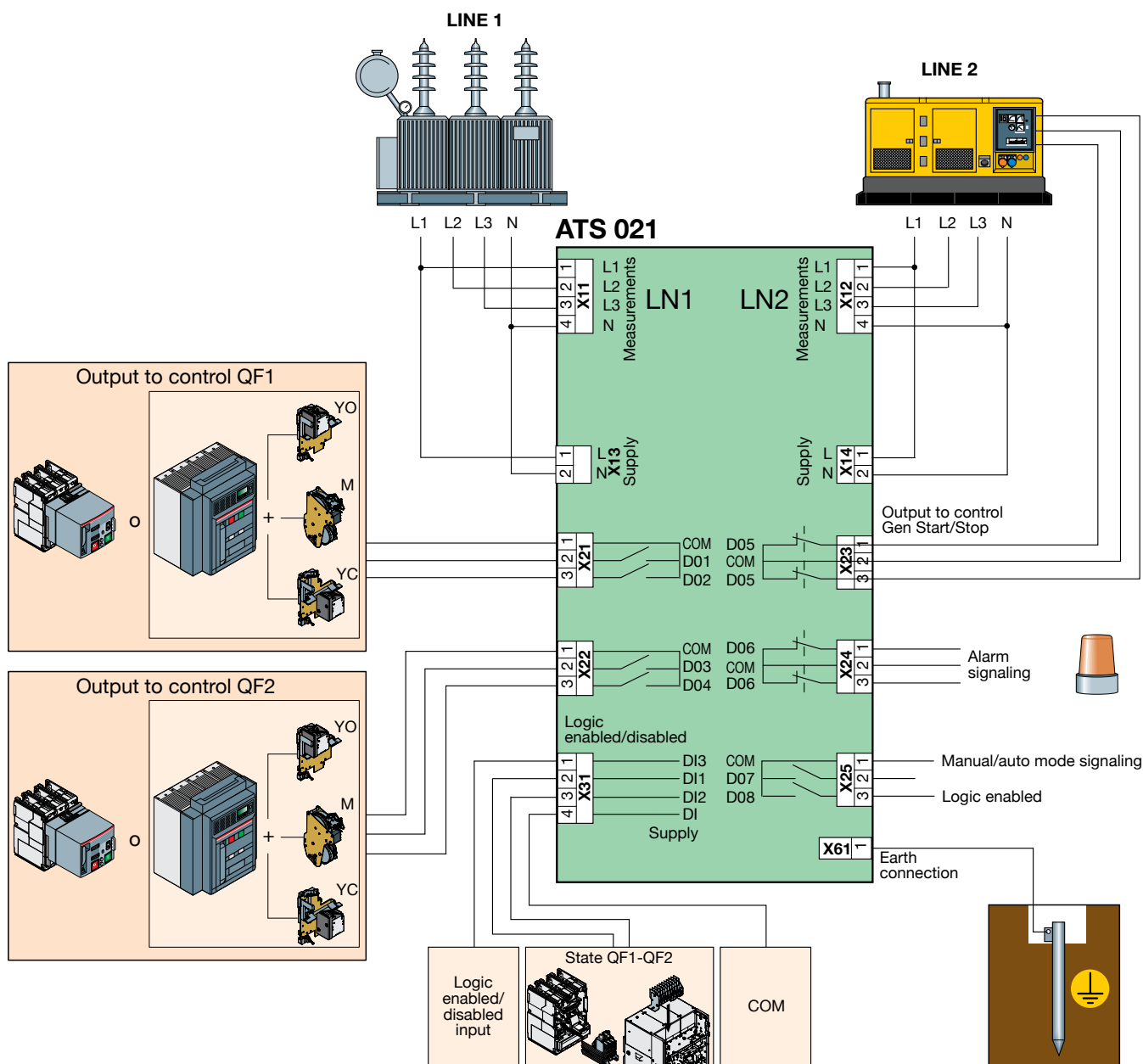
- a motor operator with key lock against manual operation
- an open/closed contact and a "trip unit tripped" contact or, alternatively, an S51 contact if available
- in case of withdrawable circuit-breakers, a CB racked-in/out contact
- a mechanical interlock.

The bill of materials could also be completed with external devices that are not accessories of the circuit-breakers.

The number and types of components not only depends on whether an emergency power supply source for energizing the motor operators is used or not, but also on the types of circuit-breakers used. Consult the following documents for details about these connections:

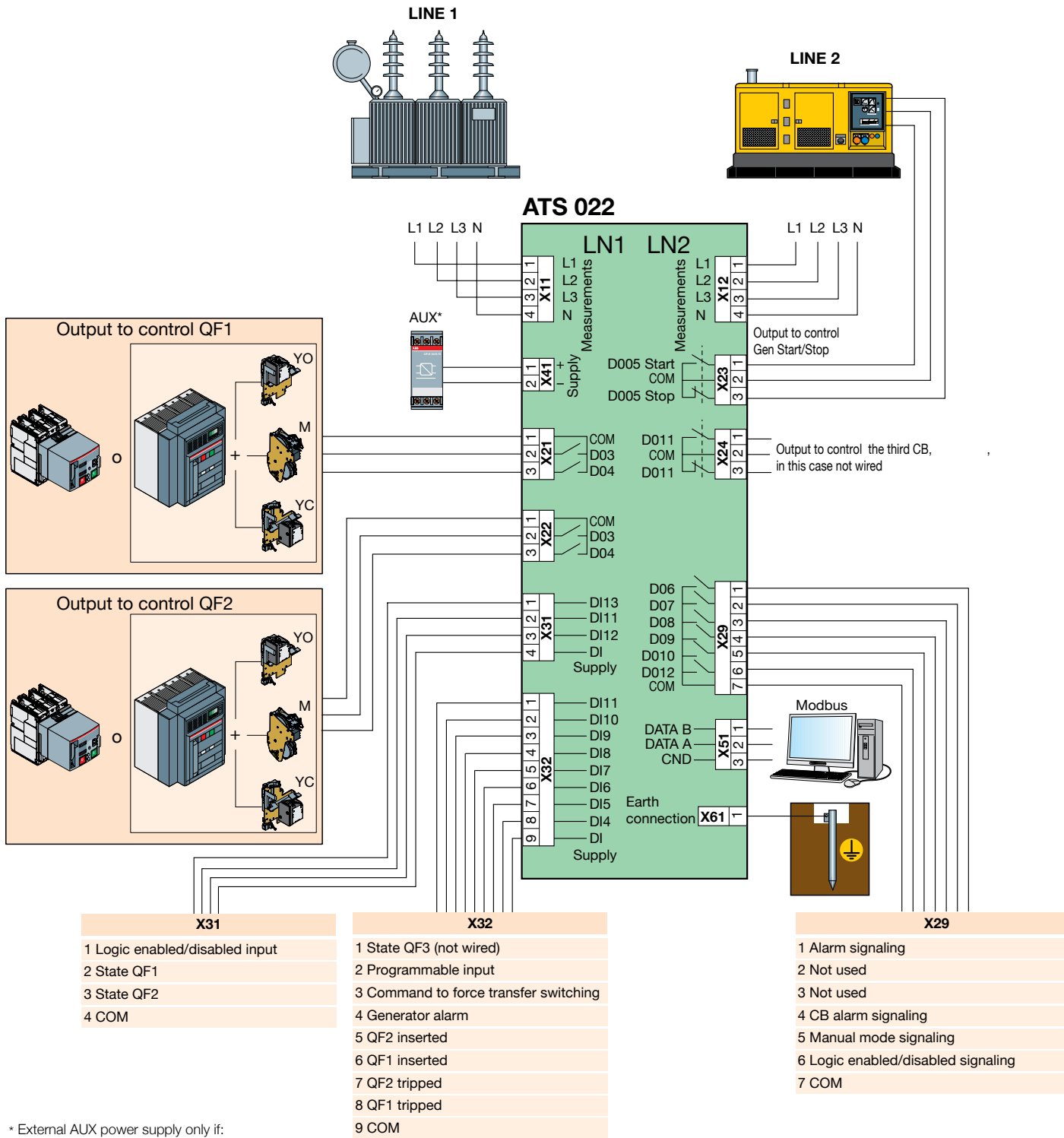
- 1SDH000087R0001 for switching between SACE Tmax XT moulded-case circuit-breakers
- 1SDH000086R0001 for switching between Emax air circuit-breakers, Tmax T circuit-breakers and circuit-breakers T7 and X1.

The following figures give an overall view of the connections between ATS021 and all the components involved in transfer switching (three-phase system + neutral conductor).



2. Description of ATS

The following figures give an overall view of the connections between ATS022 and all the components involved in transfer switching (three-phase system + neutral conductor).



* External AUX power supply only if:
- Modbus communication is required
- 16 2/3 Hz rated frequency
- use in single-phase systems with Un=57.5....109Vac

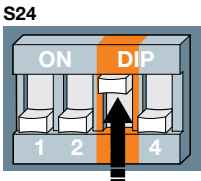
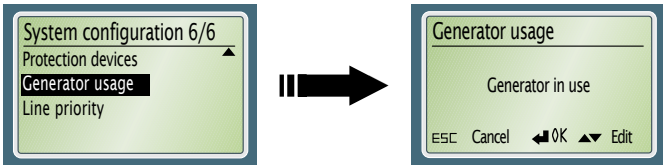
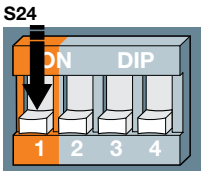
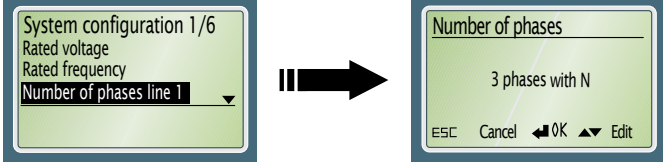
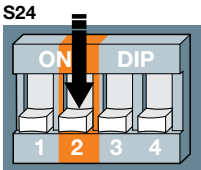
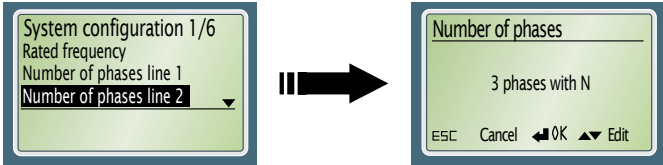
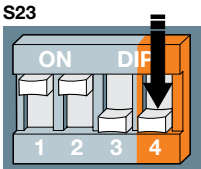
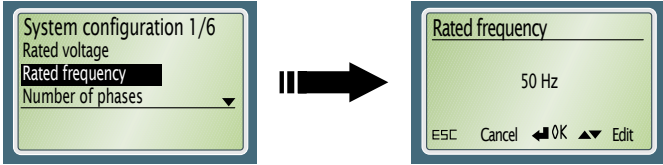
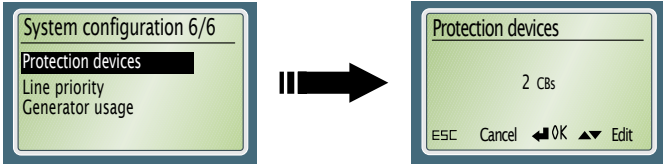
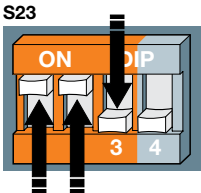
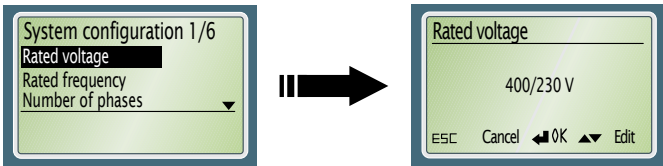
Network settings

Network specification:

transformer line: 400Vac, three-phase+N

generator line: 400Vac, three-phase +N

frequency: 50Hz

	System configuration with ATS021	System configuration with ATS022
Generator in use		
Electrical system 3F+N		
		
Rated frequency 50Hz		
Protection devices	No settings to be carried out	
Network voltage		

2. Description of ATS

Transformer for the main line and transformer for the emergency line

According to the operating logic, under normal operating conditions the network is supplied by the transformer while in case of faults, the loads are supplied by the emergency network. This sort of network consists of a transformer with the same power rating as the main line transformer.

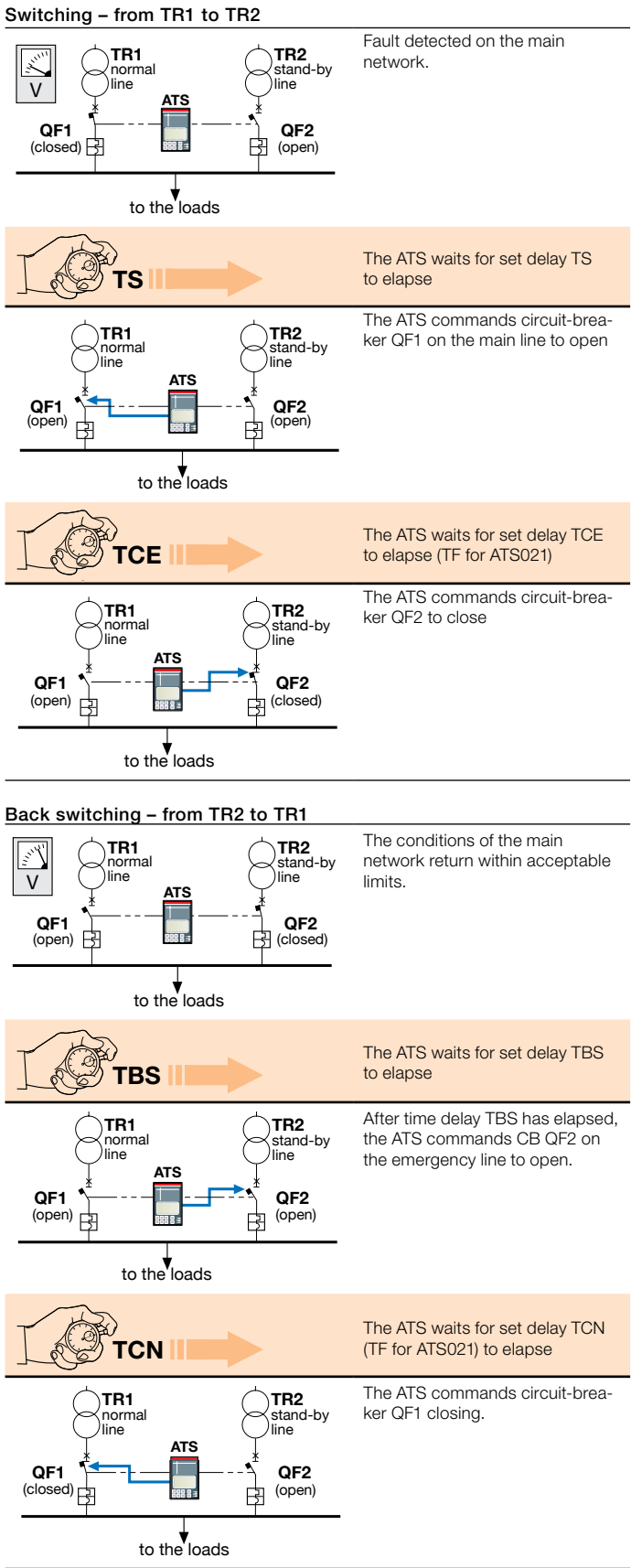
Wiring diagram	Switching logic									
The diagram illustrates a power distribution system. At the top, two transformers are shown: TR1, labeled 'normal line', and TR2, labeled 'stand-by line'. Each transformer is connected to a circuit-breaker, QF1 and QF2 respectively. These two circuit-breakers are connected to a central Automatic Transfer Switch (ATS) unit. The ATS is depicted as a rectangular device with a digital display and several control buttons. Below the ATS, a common busbar is shown, which is connected to a third circuit-breaker, QF3. QF3 is then connected to a line labeled 'to the loads'.	<table><tr><th></th><th>QF1</th><th>QF2</th></tr><tr><td>Normal</td><td>O</td><td>O</td></tr><tr><td>Emergency</td><td>I</td><td>I</td></tr></table> O = circuit-breaker open I = circuit-breaker closed		QF1	QF2	Normal	O	O	Emergency	I	I
	QF1	QF2								
Normal	O	O								
Emergency	I	I								

The ATS monitors the main network and when a fault occurs it waits for set TS time to elapse, after which it transmits an opening command to circuit-breaker QF1 (main circuit-breaker of the main supply). If an emergency power supply is available, once the TCE time setting (TF for ATS021) has elapsed, the ATS transmits a closing command to circuit-breaker (QF2) on the emergency line.

In these conditions, the installation is supplied by transformer TR2 and circuit-breaker QF2 becomes the circuit-breaker on the supply side of all the outgoing feeders.

When the electrical parameters of the main line return within acceptable limits (depending on the setting) and once time delay TBS has elapsed, the ATS activates the back-switching procedures by opening circuit-breaker QF2 on the emergency line and then by closing circuit-breaker QF1 on the main line after set delay TCN (TF for ATS021) has elapsed.

The following table illustrates the operating sequences and the various commands performed by the ATS:



From an operational point of view

To implement the switching logic, in addition to ATS021-022 units, the circuit-breakers must be equipped with the following accessories (for each circuit-breaker):

- a motor operator with key lock against manual operation
- an open/closed contact and a “trip unit tripped” contact or, alternatively, an S51 contact if available
- in case of withdrawable circuit-breakers, a CB racked-in/out contact
- a mechanical interlock.

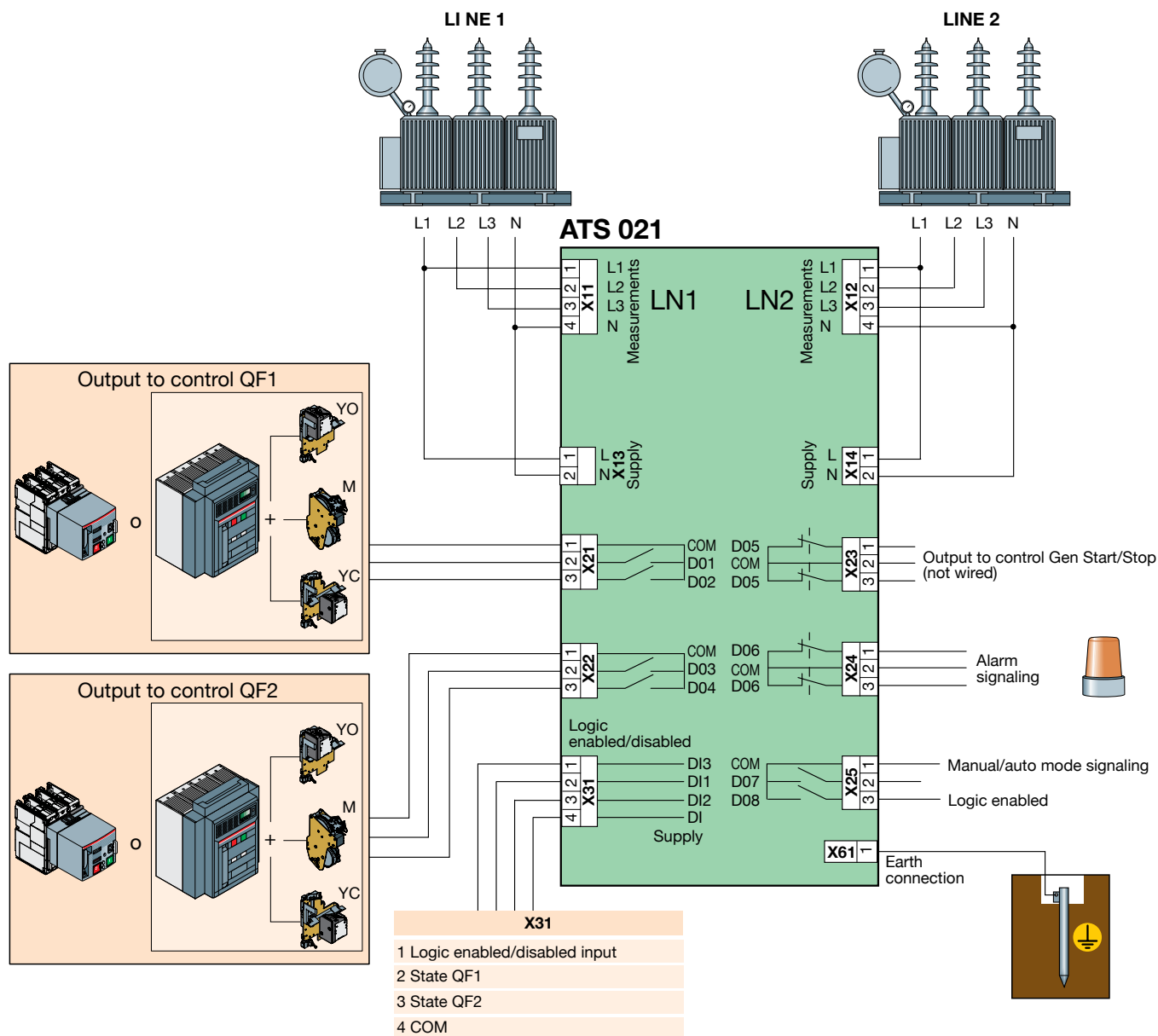
The bill of materials could also be completed with external devices that are not accessories of the circuit-breakers.

The number and type of components not only depends on

whether an emergency power supply source for energizing the motor operators is used or not, but also on the types of circuit-breakers used. Consult the following documents for details about these connections:

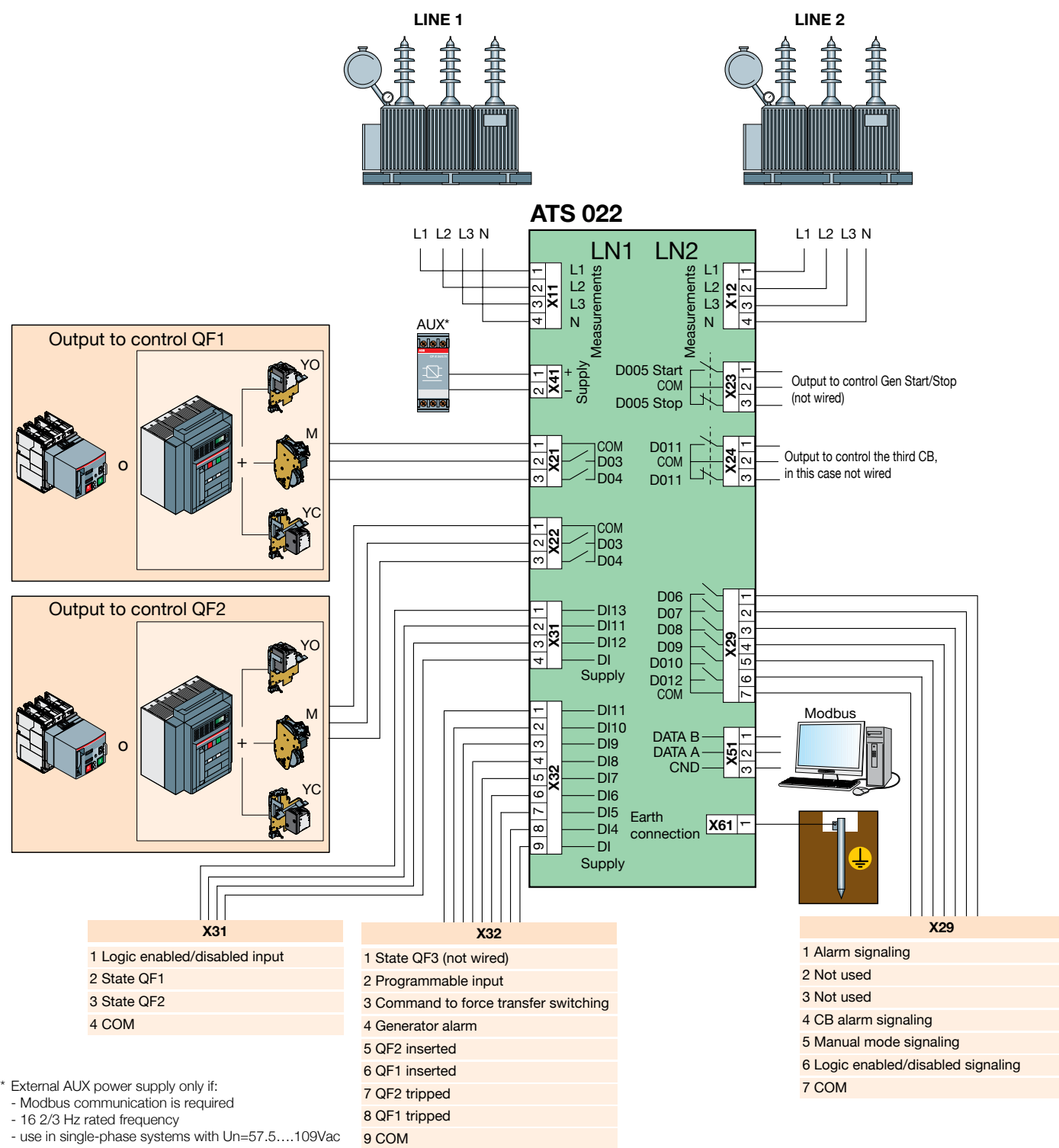
- 1SDH000087R0001 for switching between SACE Tmax XT moulded-case circuit-breakers
- 1SDH000086R0001 for switching between Emax air circuit-breakers, Tmax T circuit-breakers and circuit-breakers T7 and X1.

The following figures give an overall view of the connections between ATS021 and all the components involved in transfer switching.



2. Description of ATS

The following figures give an overall view of the connections between ATS022 and all the components involved in transfer switching.



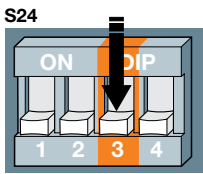
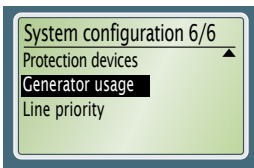
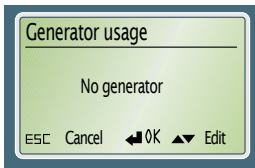
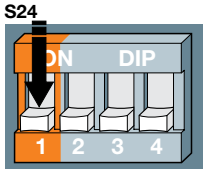
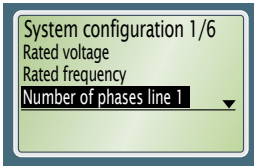
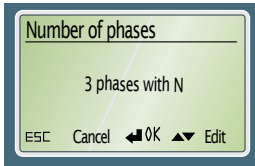
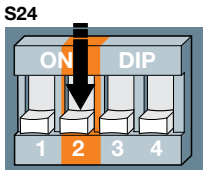
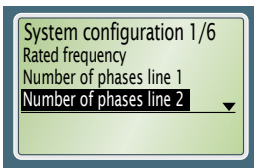
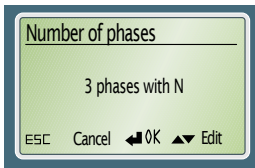
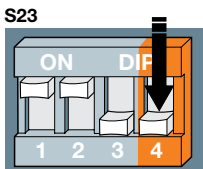
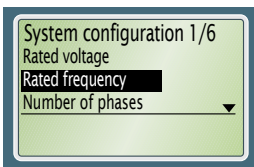
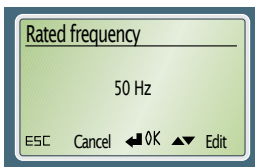
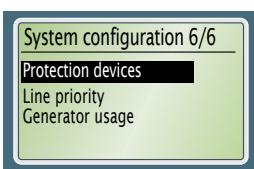
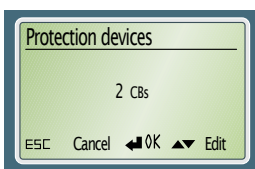
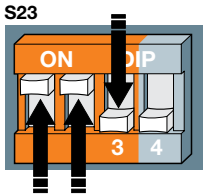
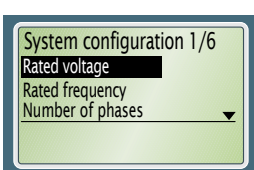
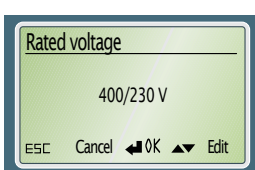
Network settings

Network specification:

transformer line 1: 400Vac, three-phase+N

transformer line 2: 400Vac, three-phase+N

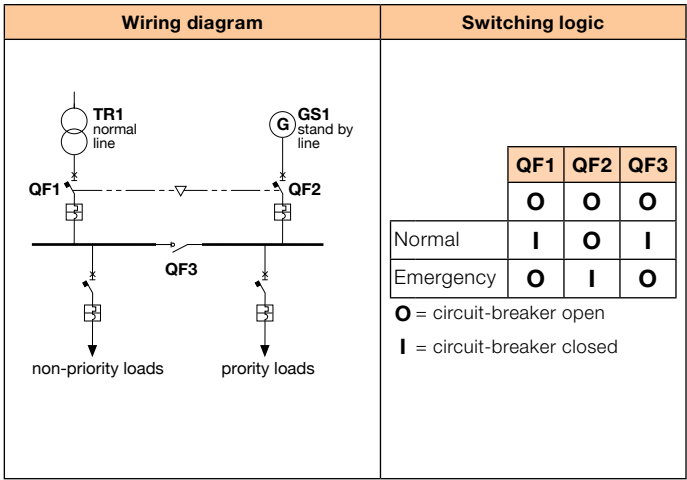
frequency: 50Hz

	System configuration with ATS021	System configuration with ATS022
Generator not in use		 
Electrical system 3F+N		 
		 
Rated frequency 50Hz		 
Protection devices	No settings to be carried out	 
Network voltage		 

2. Description of ATS

Use of a bus-tie for the exclusion of non-priority loads (with ATS022)

According to the operating logic, under normal operation conditions, the network is supplied by the transformer and bus-tie QF3 is closed. If faults occur, the loads are supplied by the emergency network (generator) with the bus-tie open. The generator is sized to continuously supply the priority loads only, thus its power rating is lower than that of the transformer.



The 022 version of the ATS must be used for this type of configuration.

The operating sequences are the same as the previous ones (depending on whether a generator or a transformer are installed).

The only difference is that if the “CB+NPL Bus Tie” function is enabled via the display and there is a line voltage failure, besides transmitting the opening command to the main circuit-breaker, the ATS also transmits an opening command to the bus-tie (after time delay TC has elapsed).

When the network conditions return within the rated parameters, the ATS starts the back-switching procedures to allow the installation to return to its initial conditions (main circuit-breaker and bus-tie closed).

From an operational point of view

- To implement the switching logic, in addition to the ATS022 unit, the circuit-breakers must be equipped with the following accessories (for each circuit-breaker):
- a motor operator with key lock against manual operation
 - an open/closed contact and a “trip unit tripped” contact or, alternatively, an S51 contact if available
 - in case of withdrawable circuit-breakers, a CB racked-in/out contact
 - a mechanical interlock (interlocking circuit-breakers 1 and 2).

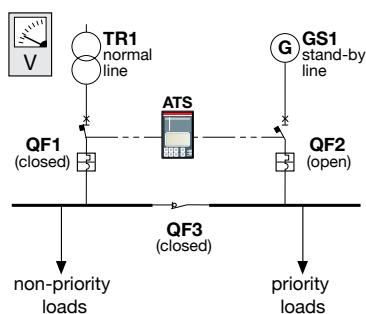
The bill of materials could also be completed with external devices that are not accessories of the circuit-breakers.

The number and type of components not only depends on whether an emergency power supply source for energizing the motor operators is used or not, but also on the types of circuit-breakers used. Consult the following documents for details about these conditions:

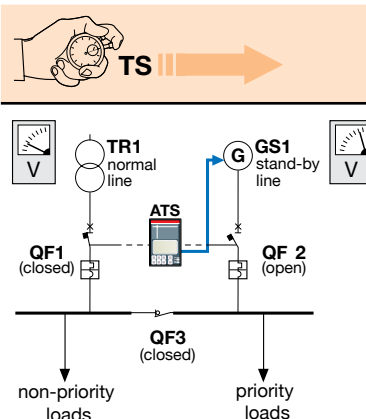
- 1SDH000087R0001 for switching between SACE Tmax XT moulded-case circuit-breakers
- 1SDH000086R0001 for switching between Emax air circuit-breakers, Tmax T circuit-breakers and circuit-breakers T7 and X1.

Since the third device, used as a bus-tie, must also be controlled, an additional connection must be made to include time delay relays and contactors. Consult document 1SD-M000088R0001).

Switching – from TR1 to GS1

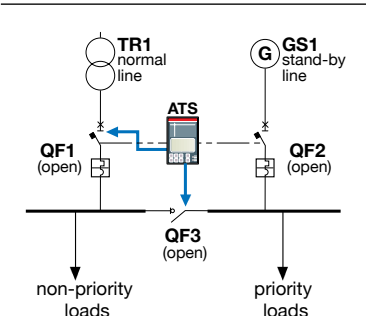


Fault detected in the main network.

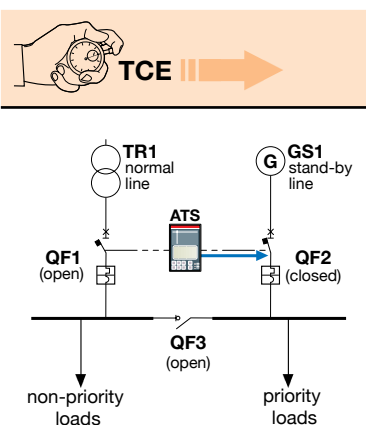


The ATS waits for set delay TS to elapse.

The ATS transmits a command that starts the generator. The emergency power supply becomes available once start-up has been completed.



The moment in which the emergency power supply becomes available, the ATS commands circuit-breakers QF1 and QF3 to open.

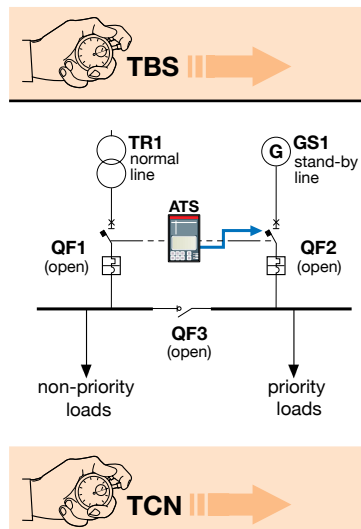


The ATS waits for set delay TCE (TF for ATS021) to elapse.

The ATS commands circuit-breaker QF2 closing.

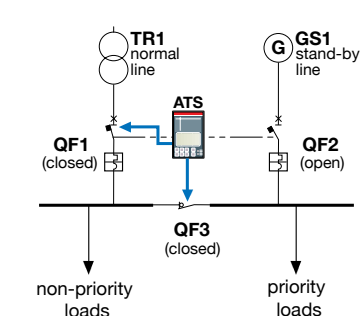
The diagram illustrates a three-phase Automatic Transfer Switch (ATS) system. It features a central ATS unit with three breakers labeled QF1 (open), QF2 (closed), and QF3 (open). QF1 is connected to a 'normal line' (TR1) and a 'stand-by line' (GS1). QF2 is connected to the 'stand-by line' (GS1). QF3 is connected to a 'priority line'. The system is designed to transfer loads from the normal line to the stand-by line in the event of a fault. The loads are categorized into 'non-priority loads' and 'priority loads'.

The conditions of the main network return within acceptable limits.

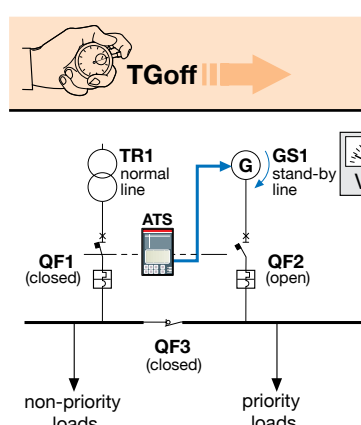


The ATS waits for set delay TBS to elapse

The ATS commands circuit-breaker QF2 on the emergency line to open.



The ATS commands circuit-breaker QF1 and QF3 to close.

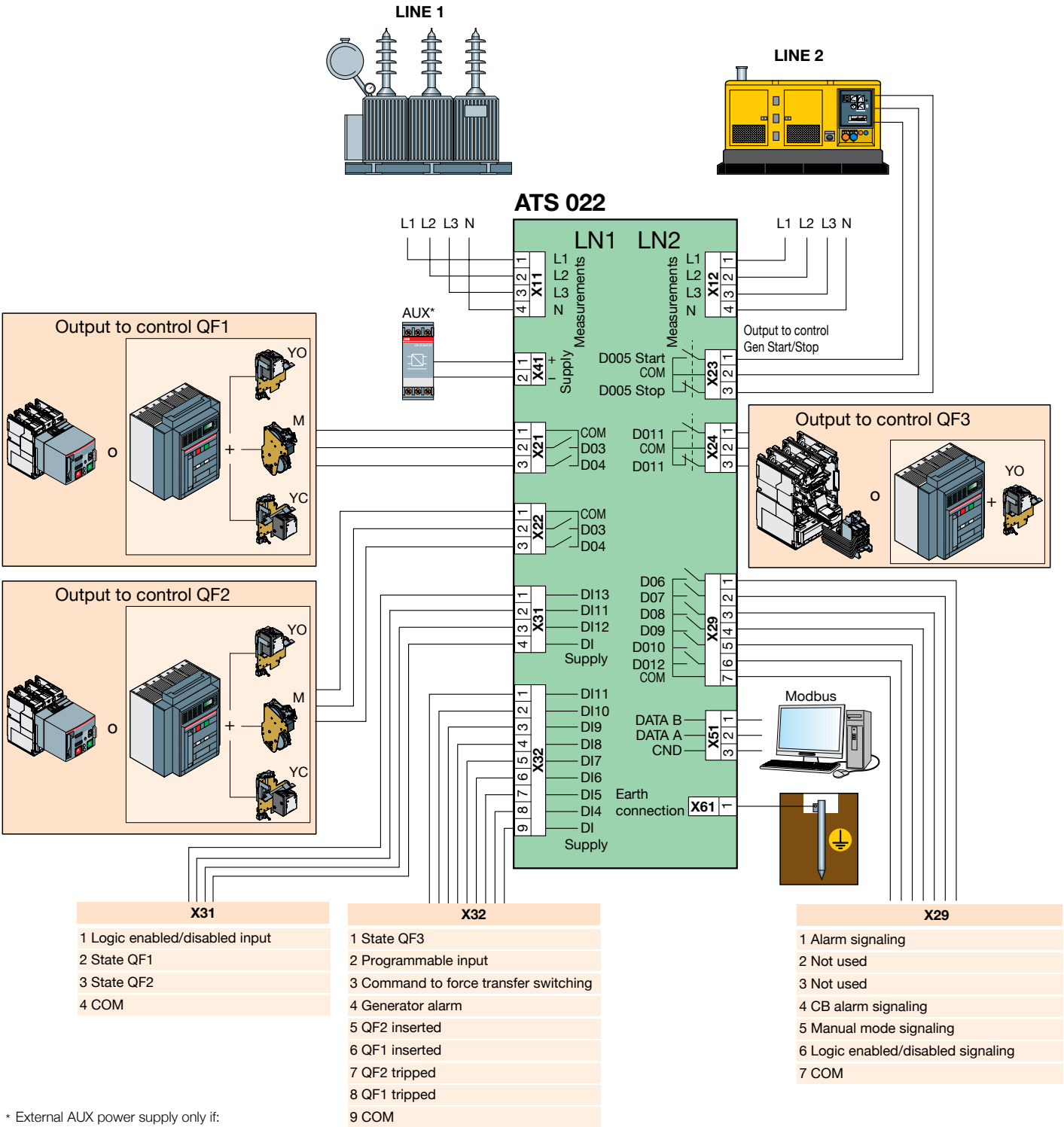


The ATS waits for time delay
TGoff to elapse.

The ATS stops the generator

2. Description of ATS

The following figures give an overall view of the connections between ATS022 and all the components involved in transfer switching.



* External AUX power supply only if:
- Modbus communication is required
- 16 2/3 Hz rated frequency
- use in single-phase systems with $U_n=57.5 \dots 109V_{ac}$

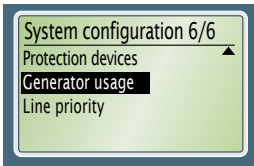
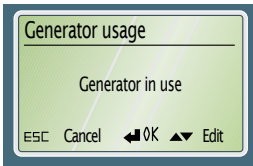
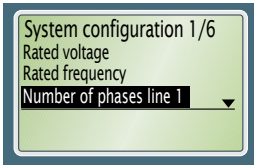
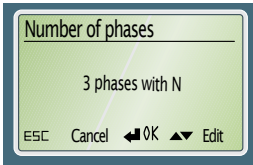
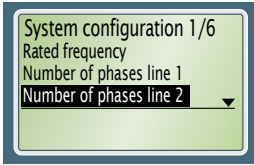
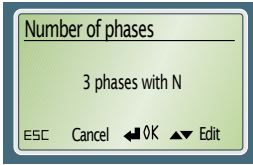
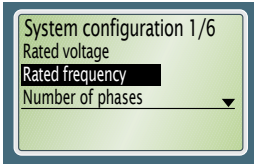
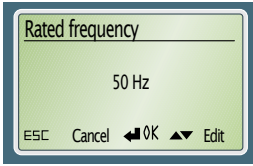
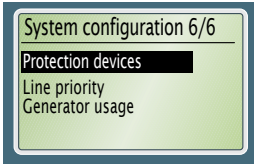
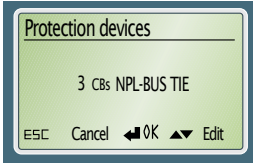
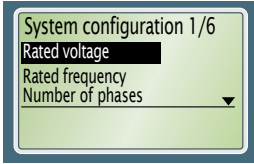
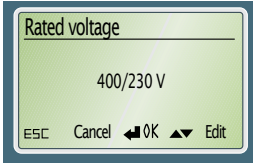
Network settings

Network specification:

transformer line 1: 400Vac, three-phase+N

generator line 2: 400Vac, three-phase+N

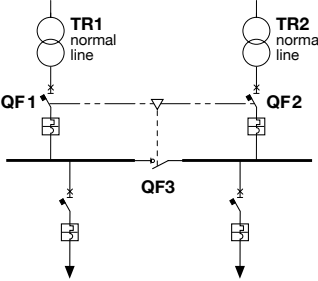
frequency: 50Hz

	System configuration with ATS022	
Generator in use	  	
Electrical system 3F+N	  	
	  	
Rated frequency 50Hz	  	
Protection devices	  	
Network voltage	  	

2. Description of ATS

Use of a bus-tie to manage two independent supply lines (with ATS022)

According to the operating logic, under normal operating conditions, the half-bus bars are supplied by the relative upstream transformers (bus-tie open). If faults occur in one of the two lines and since both transformers are sized for the total power absorbed by the installation, the bus-tie will be closed and the power supply will be provided by the transformer that is not affected by the fault.

Wiring diagram	Switching logic																
	<table><tr><th></th><th>QF1</th><th>QF2</th><th>QF3</th></tr><tr><td>Normal</td><td>I</td><td>I</td><td>O</td></tr><tr><td>Failure TR1</td><td>O</td><td>I</td><td>I</td></tr><tr><td>Failure TR2</td><td>I</td><td>O</td><td>I</td></tr></table> O = circuit-breaker open I = circuit-breaker closed		QF1	QF2	QF3	Normal	I	I	O	Failure TR1	O	I	I	Failure TR2	I	O	I
	QF1	QF2	QF3														
Normal	I	I	O														
Failure TR1	O	I	I														
Failure TR2	I	O	I														

The ATS monitors the networks (both TR1 and TR2) and, if a fault occurs in one of the two transformers, the ATS022 starts to time according to set delay TS, after which it transmits an opening command to the circuit-breaker on the secondary of the transformer affected by the fault. After time delay TC has elapsed, the ATS closes bus-tie QF3. Thus, all the loads are supplied by the line (transformer) without faults.

When the electrical parameters of the faulty line return within acceptable limits (according to the settings made) and once time delay TBS has elapsed, the ATS starts the back-switching procedure. It opens bus-tie QF3 and then, after time delay TCN has elapsed, commands the circuit-breaker on the secondary of the faulty line to close.

From an operational point of view

To implement the switching logic, in addition to the ATS021-022 units, the circuit-breakers must be equipped with the following accessories (for each circuit-breaker):

- a motor operator with key lock against manual operation
- an open/closed contact and a “trip unit tripped” contact or, alternatively, an S51 contact if available
- in case of withdrawable circuit-breakers, a CB racked-in contact
- a mechanical interlock type C.

The bill of materials could also be completed with external devices that are not accessories of the circuit-breakers.

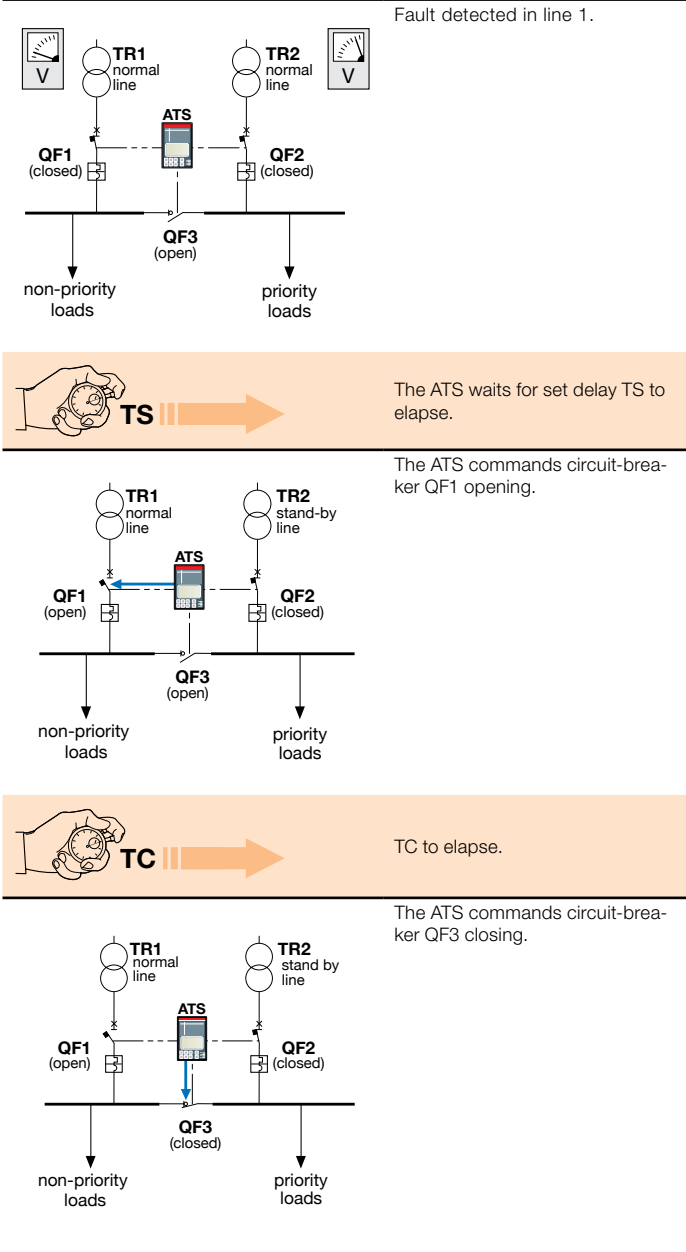
The number and type of components not only depends on whether an emergency power supply source for energizing the motor operators is used or not, but also on the types of circuit-breakers used. Consult the following document for details about these connections:

- 1SDM000086R0001 for the switching between Emax air circuit-breakers, Tmax T circuit-breakers and circuit-breakers T7 and X1.

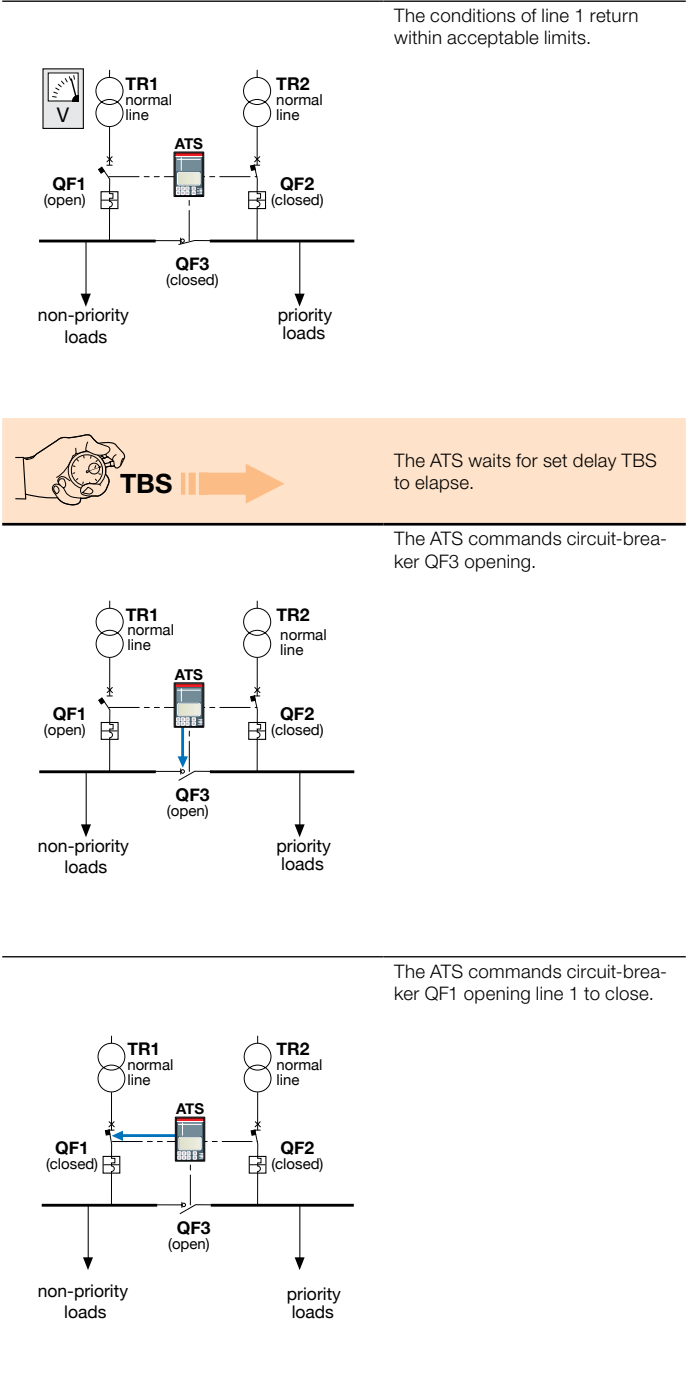
Since the third device, used as a bus-tie (QF3), must also be controlled, an additional connection must be made to include time delay relays and contactors. Consult document 1SDM000088R0001).

The following table shows the operating sequences and the various commands transmitted by the ATS (in the example, line 1 is the faulty line):

Switching - from TR1 to TR2



Back Switching – from TR2 to TR1

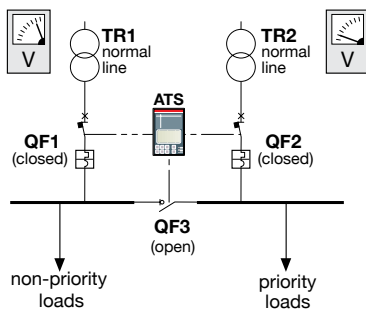


2. Description of ATS

Fault in line 2

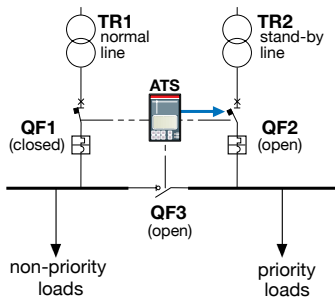
Switching - from TR1 to TR2

Fault detected in line 2.



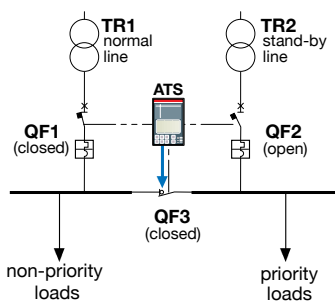
TS

The ATS waits for set delay TS to elapse.



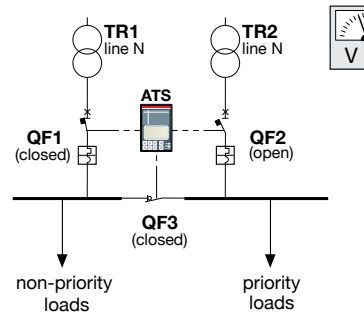
TC

The ATS waits for set delay TC to elapse.



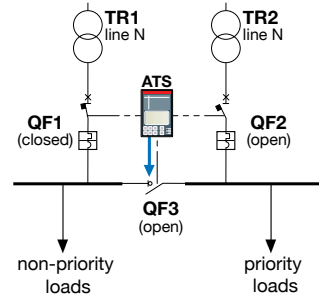
Back Switching – from TR2 to TR1

The conditions of line 2 return within acceptable limits.



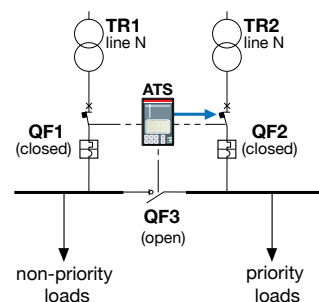
TBS

The ATS waits for set delay TBS to elapse.

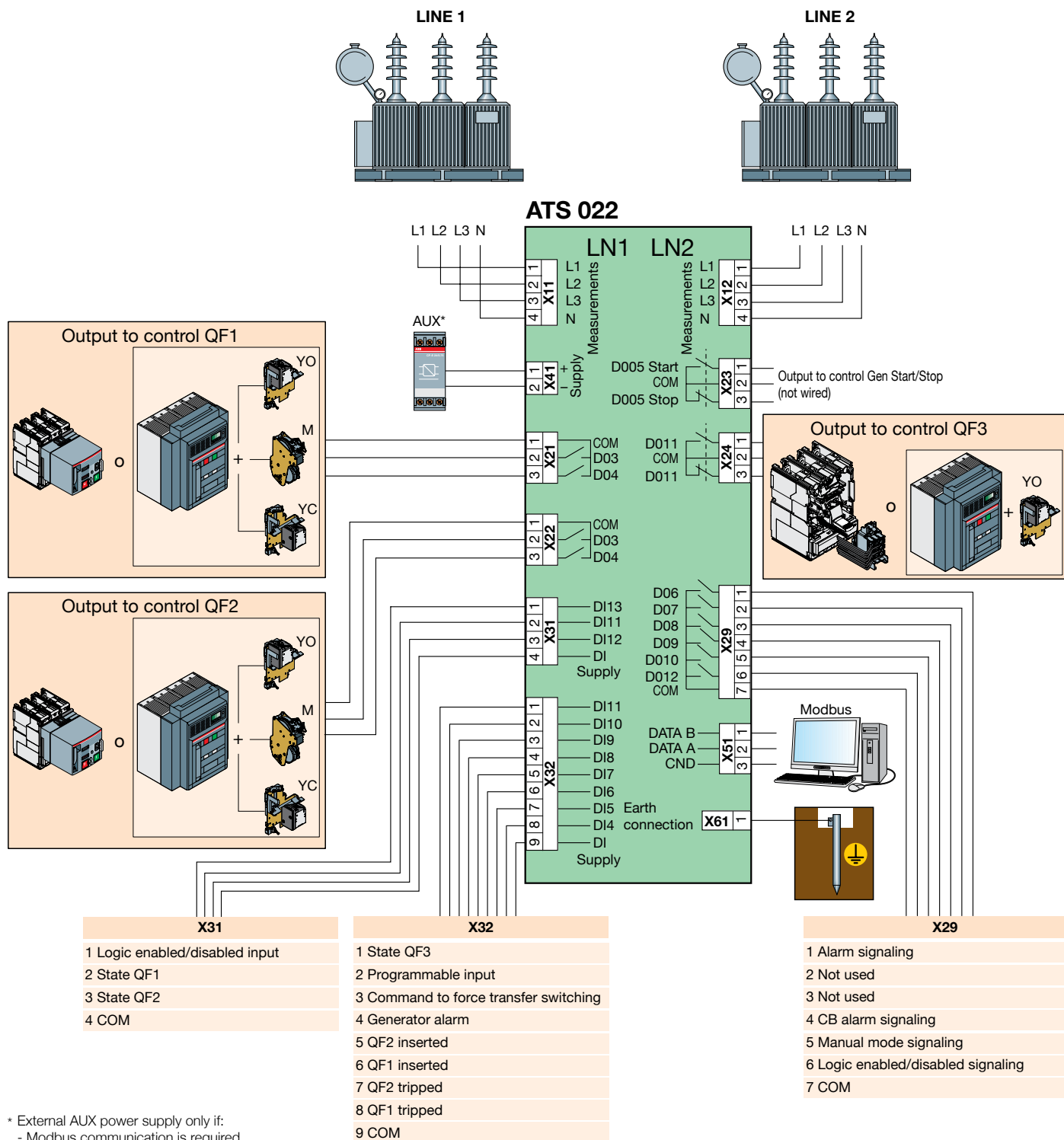


TCE

The ATS waits for set delay TCE to elapse.



The following figures give an overall view of the connections between ATS022 and all the components involved in transfer switching.



2. Description of ATS

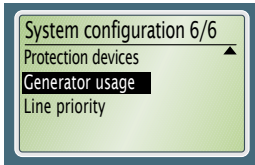
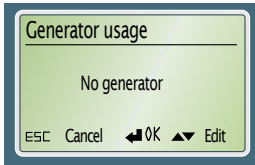
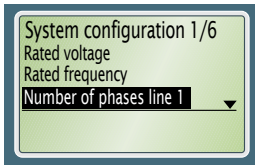
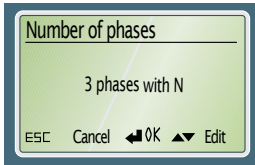
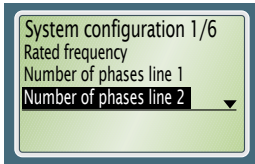
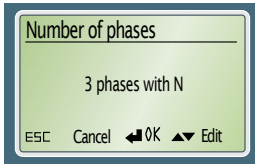
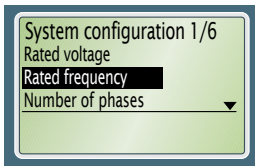
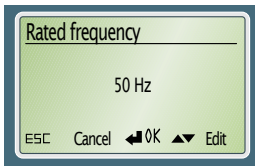
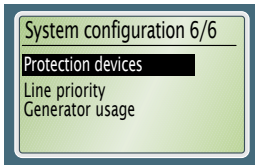
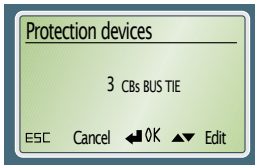
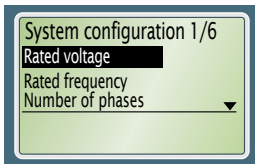
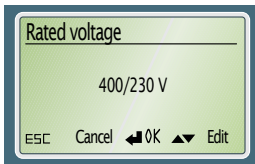
Network settings

Network specification:

transformer line 1: 400Vac, threephase+N

transformer line 2: 400Vac, threephase+N

frequency: 50Hz

	System configuration with ATS022	
Generator not in use	 	
Electrical system 3F+N	 	
	 	
Rated frequency 50Hz	 	
Protection devices	 	
Network voltage	 	

3. Field of application

As already mentioned, an increasing number of industrial electrical installations consist of systems able to perform automatic transfer switching.

The operating characteristics of these systems differ case by case since they depend on the types of load they must supply in an emergency.

For example, it is evident that in an installation where continuity of service is a fundamental aspect, sudden breaks caused by main line outage cannot be permitted.

Therefore, before analyzing how the standards deal with break times (see the following pages) it is advisable to find out how the Standard governing electrical installations (IEC60364) classifies the types of supply that characterize a low voltage electrical system.

In a low voltage installation, the supply can be divided into the following types:

- **safety power supply** – includes all electrical components (sources, circuits and components), the purpose of which is to ensure power is supplied to equipment or parts of installations required for the safety of people
- **stand-by supply** – a type of power supply provided when the purpose for which it is used differs from the safety of people, e.g. the supply of loads allowing production continuity to be achieved.

A generic definition, which includes both the above mentioned types of power supply, is to call any supply source which represents an “alternative” to the main supply and which is used whenever necessary, regardless of the type of load it will power, by the name of “emergency power supply”.

While the safety power supply is classified according to the time within which the supply becomes available for the loads (see the following pages), there are no standards of this type for the stand-by supply since functional performance is usually analyzed and adapted, by mutual agreement between the customer and the plant engineering designer, to suit the importance of the case in question.

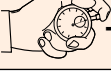
However, there is nothing to prevent these categories from also being used in the case of stand-by supply. In fact, this distinction can be useful for assessing the time delay settings for the ATS with regard to the types of load.

Besides providing indications about the precautions that must be taken to prevent parallel connection of the generator with the network, Standard IEC 60364 also includes a classification which defines 5 types of transfer switching according to the periods of time within which the stand-by supply becomes available for the priority loads. As already mentioned, this distinction refers to the power supply of safety services. In particular, the “automatic” safety power supply can be classified as follows:

- no-break: supply available without a break
- very short break: supply available within 0.15s;
- short break: supply available within the 0.15s to 0.5s time range;
- medium break: supply available after more than 0.5s but within less than 15s;
- long break: supply available after more than 15s.

According to this classification, at least a “medium break supply” can be obtained by setting all the time delays of the ATS to the minimum.

The following table gives an example of this:

Time delays	Description	Setting range	Setting example
 TS	Time delay before the switching procedure starts.	0...30s	1s
 TF ATS022  TCE	Time delay before the circuit-breaker on the generator side closes	0...60s (TF=3.5s)	1s (with TF=3.5s)
		total	2s (4.5s with ATS021)

As it can be seen, the ATS provides stand-by supply to the loads within about 2s (with ATS022) and 4.5s (with ATS021). If there is a generator in the emergency line, the time it requires for providing voltage to the loads must also be considered.

3. Field of application

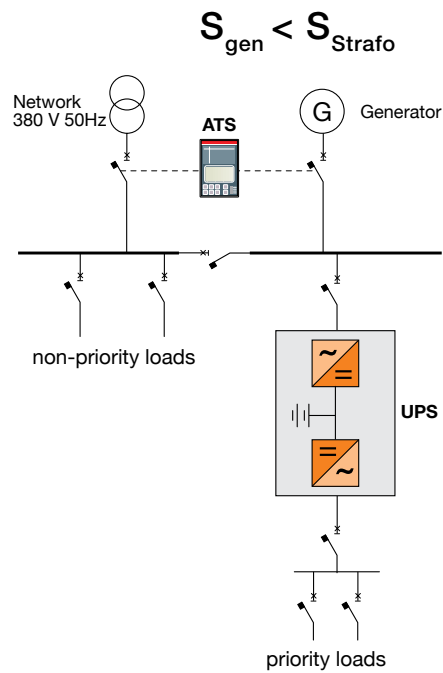
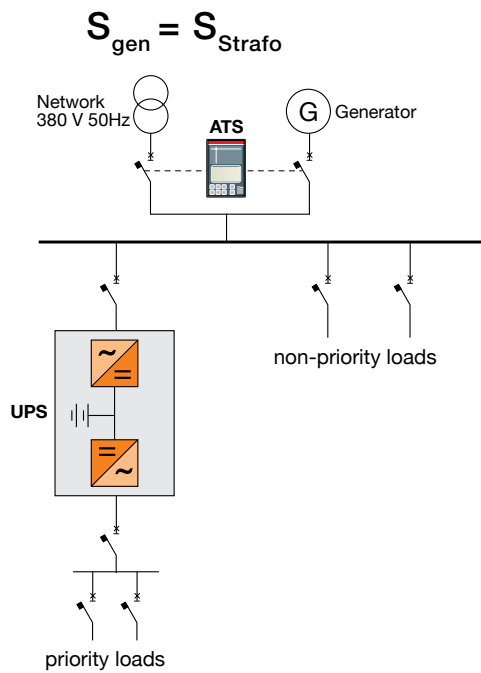
Medium and long break power supply, obtained by using the generator set alone, is a common type in industrial plants and in the services-providing sector, where continuity of service is required but not necessarily within short times.

In fact, when no-break, very short and short break automatic supplies are required, the installation must be provided with devices capable of delivering immediate power by feeding the priority loads with a UPS (Uninterruptible Power Supply) able to guarantee a ready-to-use power source, which may be limited in time, but such as to make up for the time required to start the generator set.

Examples of installations in which continuity of service is essential are:

- hospital applications
- applications in the data processing field (data centers, work stations, servers, etc.)
- telecommunications systems
- industrial applications (process control)
- safety lighting in special environments.

The following figure shows a typical application in which UPS are used to supply priority loads.



4. Application example

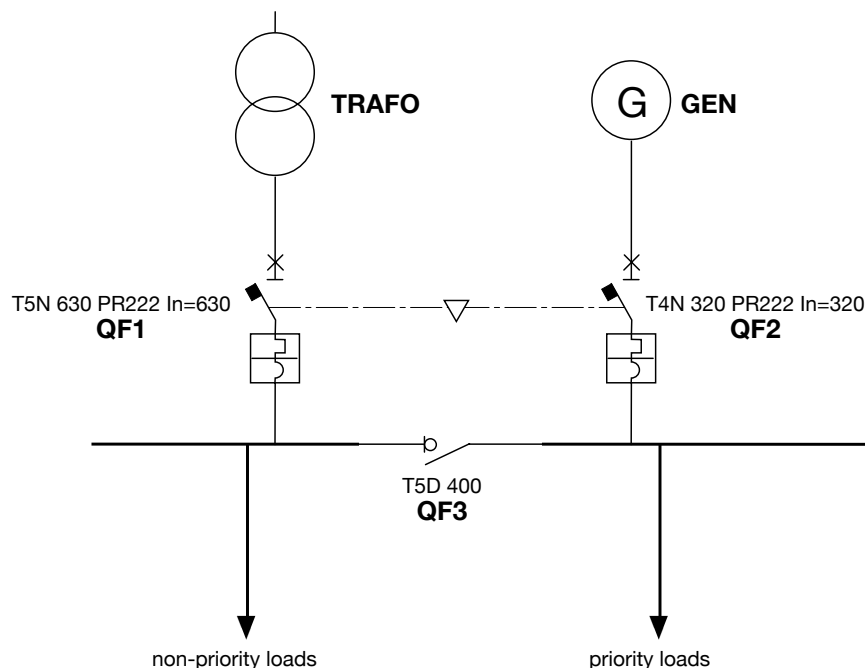
The application example shown on the following pages is given with the intention of explaining and providing further information about the connections between the components involved in switching (auxiliary contacts, motor operator, etc.) and the ATS unit. There are also indications about the time delay settings required for correct switching. This example does not go into detail about how to interact with the display menu of the ATS022 since this is not the subject of this document (this information is given in document 1SDH000760R0001).

In this case, we wish to describe a 400Vac industrial application in a three-phase system with distributed neutral, consisting of a transformer for the main line and a generator for the emergency one. The installation includes non-priority loads

(outdoor lighting, air-conditioning plant, etc.) and priority loads linked to the production cycle.

Use of a bus-tie allows the “load line” to be divided into two half busbars so that in an emergency, only the priority loads are powered by the generator.

The need to manage the third device implies use of the ATS022 since, as already specified in the previous pages, the ATS commands simultaneous opening of both the circuit-breaker on the main line (QF1) and the bus-tie (QF3), as well as their simultaneous re-closing if the initial conditions are restored (see page 16 for the switching operations). The electrical system in question is shown in the simplified diagram below:



4. Application example

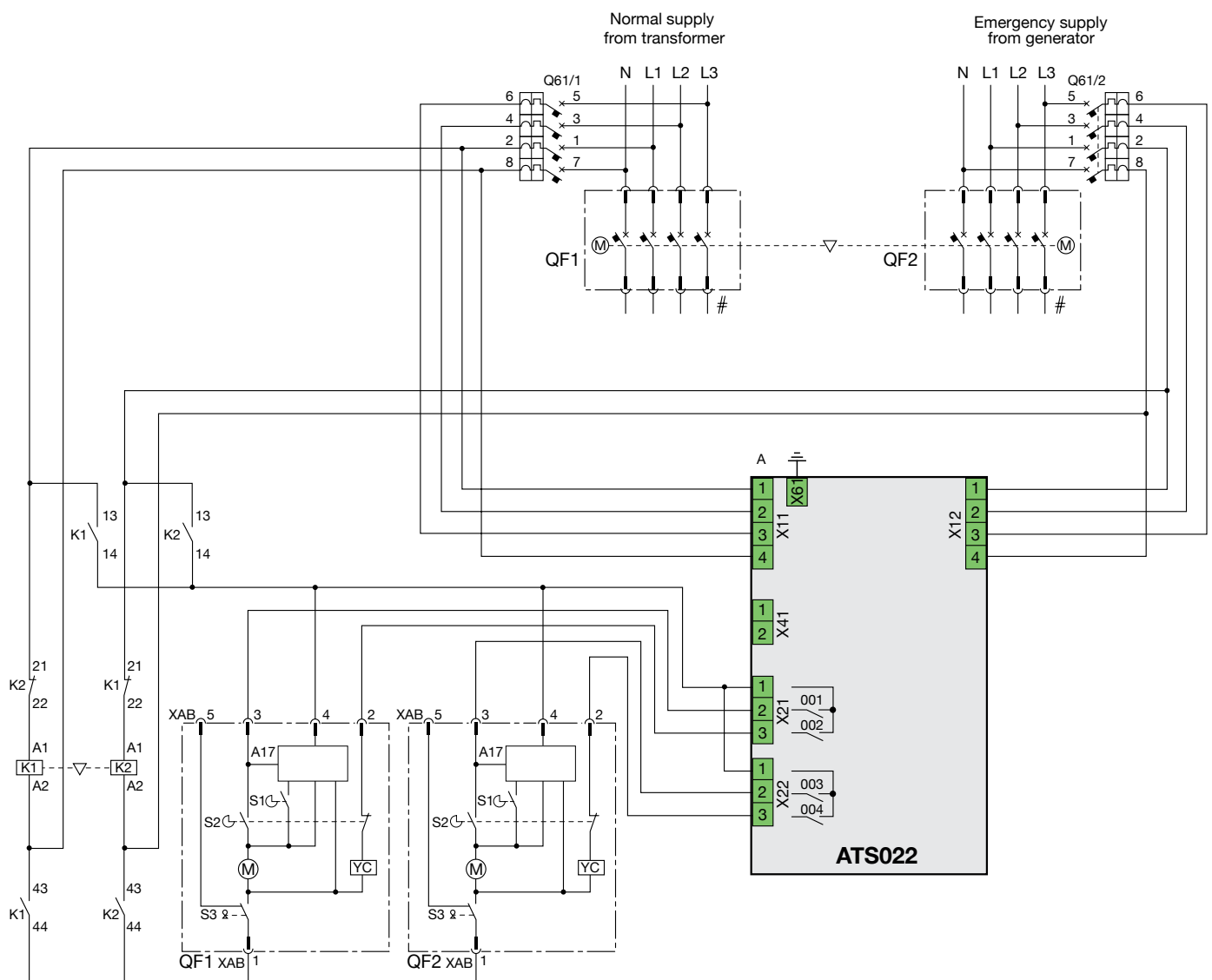
The following table shows the complete bill of materials, considering the choice of withdrawable circuit-breakers and all the components required for connection to the ATS022 (220 Vac supply phase-neutral):

Q.ty	PRODUCT	DESCRIPTION	ABBREVIATION	CODE
1	ATS 022	Automatic switching device	ATS 022	1SDA065524R1
1	T5N 630 PR222 LSiG In=630	Circuit-breaker QF1	QF1	1SDA054403R1
1	T5 630 W FP EF	Fixed part withdrawable circuit-breaker (QF1) (with EF terminals)	-	1SDA054771R1
1	KIT W MP T5 630	Kit for converting a fixed circuit-breaker into the moving part of a withdrawable one (QF1)	-	1SDA054850R1
1	T4N 320 PR222 LSiG In=320	Circuit-breaker QF2	QF2	1SDA054124R1
1	T4 W FP EF 4p	Fixed part withdrawable circuit-breaker (QF2) (with EF terminals)	-	1SDA054746R1
1	KIT W MP T4	Kit for converting a fixed circuit-breaker into the moving part of a withdrawable one (QF2)	-	1SDA054842R1
1	T5D 400	Switch-disconnector QF3	QF3	1SDA054600R1
1	T5 400 W FP EF	Fixed part withdrawable circuit-breaker (QF3) (with EF terminals)	-	1SDA054758R1
1	KIT W MP T5 400	Kit for converting a fixed circuit-breaker CB into the moving part of a withdrawable one (QF3)	-	1SDA054846R1
3	ADP	10-way adapter (left side) for QF1-QF2-QF3	-	1SDA054924R1
1	ADP	12-way adapter (right side) for QF3	-	1SDA054923R1
2	ADP	6-way adapter (right side) for QF1-QF2	-	1SDA054922R1
3	MOE	Stored energy motor operator T4-T5 (for circuit-breakers QF1-QF2 and bus-tie QF3)	-	1SDA054897R1
3	MOL-M	Key lock against manual operation for MOE for T4-T5 (for circuit-breaker QF2 and bus-tie QF3)	-	1SDA054909R1
2	AUX 250V AC/DC	1 open/closed changeover contact + 1 "trip unit tripped" changeover contact (this latter is not used) for QF1-QF2	Q/1	1SDA054910R1
2	AUX SA 250V AC	1 electronic release SA trip contact (for QF1-QF2)	S51	1SDA055050R1
2	AUP-I	Contact signaling circuit-breaker racked-in for plug-in and withdrawable versions (for circuit-breakers QF1 and QF2)	S75I/1	1SDA054918R1
1	AUX 250V AC/DC	3 open/closed changeover contacts + 1 "trip unit tripped" changeover contact (using only 2 changeover contacts) for switch-disconnector QF3	Q/1 Q/2	1SDA054911R1
1	MIR-HB frame unit	Horizontal mechanical interlock (to interlock QF1 with QF2)	-	1SDA054946R1
1	MIR-P plates	Plates for mechanical interlock	-	1SDA054950R1
2	S204P C6	4-pole modular circuit-breakers Q61/1 and Q61/2 (1k single-phase 16kA)	Q61/1 Q61/2	2CDS284001R0064
2	NF22E-13	K1-K2 contactors used for external wiring of ATS	K1 K2	1SBH 137 001 R1322
2	CT-AWE	Timed relays to command switch-disconnector QF3 (suggested time delay range from 200ms to 300ms)	KO3 KC3	1SVR 550 141 R1100

Refer to document 1SDM000086R0001 for the wiring diagram. This document also contains all the diagrams for transfer switching between Emax, Tmax T circuit-breakers and between circuit-breakers T7 and X1. The wiring diagrams in the document have been divided, depending on whether an auxiliary emergency source is used to

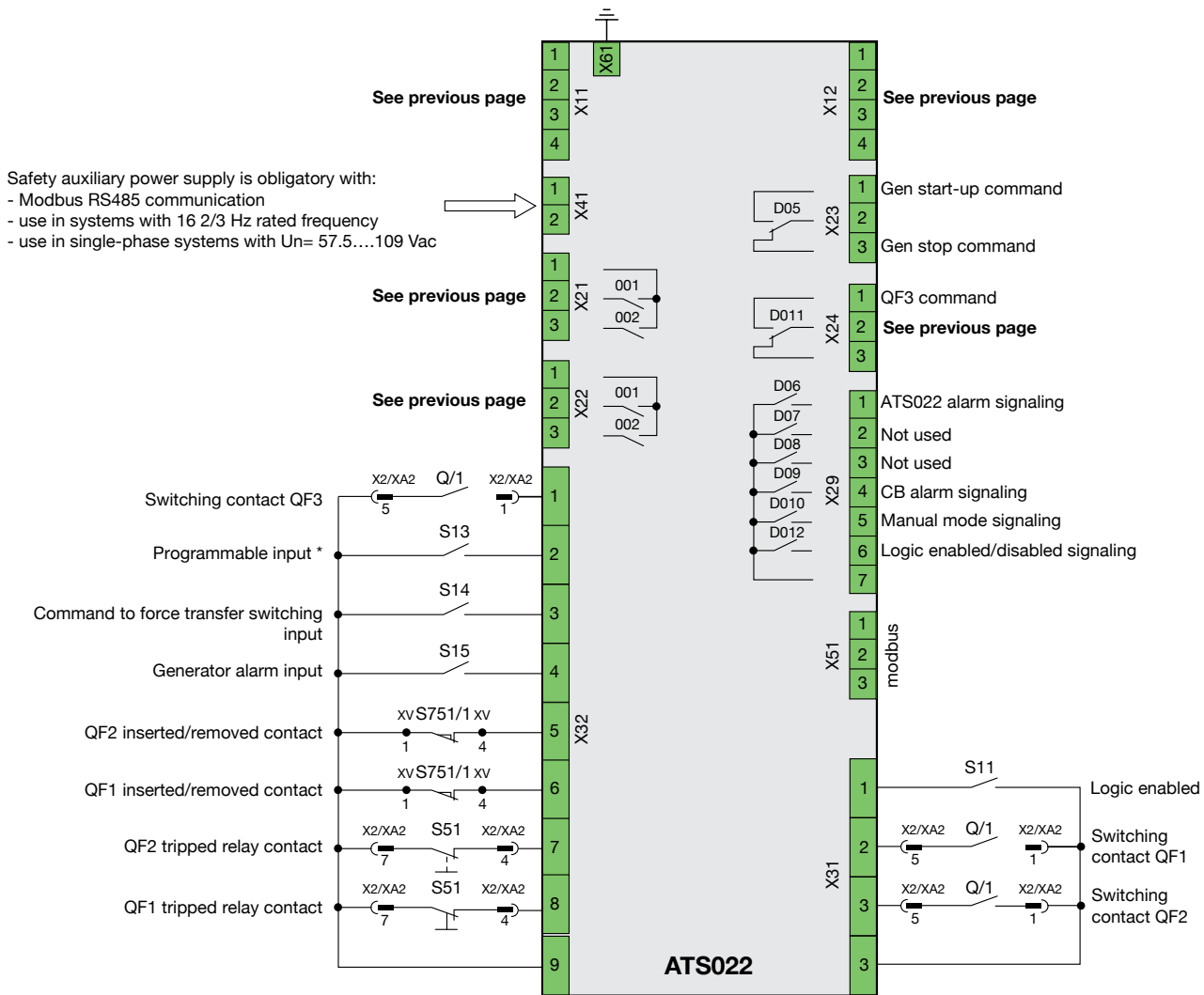
supply the motor operators or not. The connections shown on the following pages must be made in this particular installation, since the auxiliary supply voltage is branched from either the main line or emergency line (there is no auxiliary supply source for feeding the motors).

The following connections concern the measuring and motor operator supply part of the installation:



4. Application example

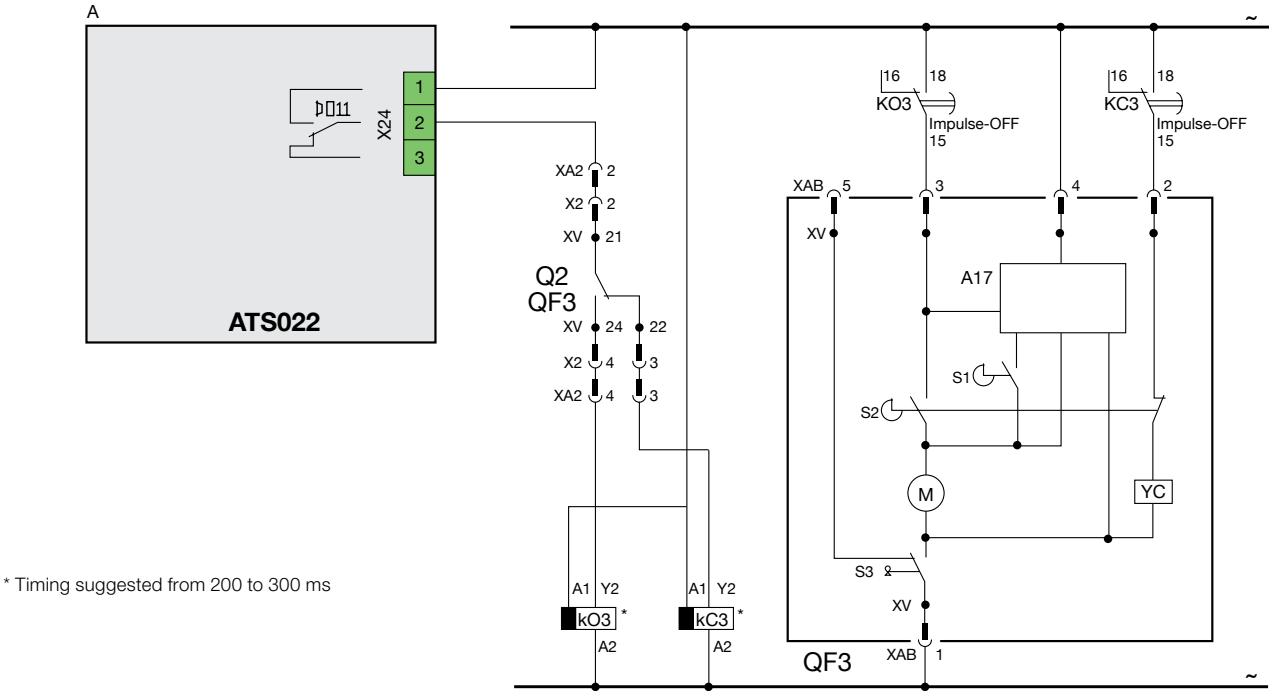
These INPUTs and OUTPUTs of the ATS must also be wired in order to complete the connection.



* the following functions can be associated with this input via the display menu:

- forced generator start-up
- activation of the automatic switching logic
- remote reset
- emergency lock

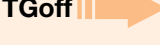
Besides, the ATS must be wired as follows to command the switch-disconnector used as bus-tie:



Once the connections have been made and the ATS has been given the main settings regarding the network (voltage, system, presence of generator, bus-tie, etc.), the time delays settings must be entered accurately in order to ensure correct switching.

Indicative time delays are given in the table below:

As it can be seen, and assuming that the generator starts within 10 seconds from the moment the fault in the main network occurs, the power supply becomes available for the priority loads in about 13 seconds (TS+10s+TCE).

Time delays	Description	Setting range	Setting example
 TS 	Time delay before the beginning of the switching procedure with generator start-up.	0...30s	2s
 TCE 	Time delay before the circuit-breaker on the generator side closes.	0...60s	1s
 TBS 	Time delay before the circuit-breaker on the generator side opens (start of the back-switching procedure).	0...59s 1,2,3... 30 min.	15s
 TCN 	Time delay before the circuit-breaker on the main line side closes.	0...60s	1s
 TGoff 	Time the generator takes to switch off.	0...59s 1,2,3... 30 min.	5min.

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