TECHNICAL SPECIFICATION
STATIC SWITCH EXCHANGE

INDEX

APPLICABLE REGULATIONS

The STS units of the “EXCHANGE ” series are CE marked and as such they comply with the relevant product regulations; more specifically:

Standard

EN62310-1:2005 “Static Transfer System (STS) Part 1: General and safety requirement”

IEC62040-2:2006 “Static Transfer System (STS) Part 2: Electromagnetic compatibility (EMC) Requirement”

Siel STS's are also conforms to the following directives:
2014/30/UE “EMC- ElectromagneticCompatibility”
2014/35/UE “Low Voltage”

SIEL is certified for ISO 9001 (Security), ISO 14001 (Environment) and OHSAS 18001 (Health and Safety) management systems.

INTRODUCTIONS

The static transfer switch (hereinafter referred to as STS) designated the EXCHANGE is a system that enables the transfer, either manually or automatically, one or more electrical loads from a three-phase power source (circuit 1) to an alternative three-phase power source (circuit 2) and vice versa. In the event of a failure in the source supplying the loads, the transfer to the second source is made automatically.
If the Exchange is 4P type the neutral conductor is switched, so that the neutral conductors of mains 1 and mains 2 are switched on load; if the Exchange is 3P type the neutral conductor is not switched, so that the neutral conductors of load, mains 1 and mains 2 are always connected together.

The system responds effectively to the following requirements:

- A complete separation of the two sources and the system of distribution between them.
- Redundancy in an existing plant.

- Subdivision of uses in order to prevent reciprocal interference (different voltage tolerances), or to observe the terms of current standards as to connection to the public mains system.

Block diagram

Figure 1 contains a schematic diagram of the static switch.
The power blocks that make up the equipment are as follows:
Isolating switches for mains 1 and mains 2 inputs, Q1 and Q2 respectively
Fuses for mains 1 and mains 2 input, F1 and F2 respectively
Static switches for mains 1 and mains 2, SS1 and SS2 respectively
Isolating switch for output of static switches Q3
Fuses for output F3
By-pass switch Q4

Transfer between two sources

The STS consists of two 4 Poles. static switches, each connected to a three-phase mains . One of these is selected as the Priority source and the other the Reserve source.
The common output of the static switches is connected to the output of the system to the critical load. In the event of a power loss, the system will carry out an automatic transfer of the supply from the source that is out of tolerance to the other source in less than a quarter of a cycle (5 ms). In the Exchange 4P the neutral conductors are switched, with a small overlap (~ 10 msec). In the Exchange 3P the neutral conductor is not switched, so that the neutral conductors of load, mains 1 and mains 2 are always connected together.

Symmetry of operations for the selection of the Priority and Reserve circuits

The architecture and operation of the system is totally symmetrical. That means that the selection of source 1 as Priority (with Source 2 = Reserve) or alternatively as Reserve (with Source 2 = Priority) can take place as required and can be modified at any time by the operator from the control panel.

Reversing the transfer process

Depending upon the current operating conditions of the plant, the System will allow the automatic transfer process to be reversed (with the transfer taking place from the Reserve Source to the Priority Source) under the same conditions.

Independence between the sources

The System can be used with various types of sources (mains network, UPS power systems or, generating sets for example). For the correct operation of the power supply system (input supply, system, load) , it is essential that the voltage levels are correctly calibrated, synchronized and in phase either naturally or by means of a special synchronizing device .

Switching technology

Each static switch is constructed of three pairs of thyristors connected back to back which are capable of supplying the nominal load and of withstanding any transient overload as detailed within the technical characteritics.
The switching technology used is “Break Before Make” type. This technique allows, the thyristors of the static switch turning off to be disconnected before connecting those of the static switch turning on. This ensures a non-parallel transfer between the power sources.
This means that the System can be used for transfers between sources at different impedances with different levels of voltage and frequency and different phases without any failure thus preventing any failures spreading from the one source to the other. On the front panel, a synoptic diagram displays the operating mode and system status.

Manual by-pass

To enable repair and maintenance work to be undertaken, the system incorporates 3 isolators for the static switch and one mechanical commutation switch to enable the system to be manually by-passed and isolated from the load. These isolating switches are accessible from the front of the control panel.

DESCRIPTION OF EQUIPMENT

The Exchange is represented by the electrical diagrams attached to this document.
Figure 2 shows the external view of the static switch with the frontal panel door closed.

N.B. This door must only be opened by persons who are suitably qualified and have been fully instructed in the use of the apparatus.

Behind the main enclosure door, the front section is divided into two further compartments each accessible via individual access doors.
The upper section, separates all the power and control equipment for the electronics system in the machine; mounted on the lower section access door are the isolating switches and the manual by-pass for the system.

Opening the lower panel is possible to access of the isolating switches, the terminals of which serve as input power cables connections.
To access these power ratings, the operating handles of the isolating devices must be set in the OFF position and the panel must be removed. **This operation should only be carried out by suitably qualified personnel. Because access to live components is involved, the use of a special tool is necessary.**

Opening the upper panel is possible to access to power modules and power electronic cards; from the top down the following items are visible: the group of static switches with the fuses in series for the mains 1 and 2.

To access the power electronics system must be removed the screws on the panel: access to which should be restricted to suitably qualified and trained personnel.
Ventilation is provided for the system by drawing in fresh air both at the top and bottom and exhausting the heated air through the panel at the back.

Description of the control panel, measurements and signals

The control panel, measurements and signalling, install to the frontal door, for greater detail, is provided in Figure 5 (this panel is referred to below as “Signalling”).
The panel comprises an 80 character liquid crystal display and respective control keys.
During the normal operation of the Exchange, various messages are scrolled cyclically indicating the functional status of the machine.
Some of these signals are repeated in the synoptic diagram by activating the corresponding control key, thus generating an instantaneous reading of the operation of the various sub-assemblies which make up the system.
The activation of one or more alarms has the effect of activating the acoustic alarm. In these conditions, the individual alarms are displayed.

If the acoustic alarm is muted by operation of the appropriate key, the system will display both the alarms and signal the operating status levels of the STS.
The various functions are detailed as follows:

a) Cyclic view of the STS status: every 4 seconds, the signalling panel displays the messages relating to the operating status of all the principal subassemblies of the system.
If, in the meantime, any alarm is triggered, the control logic will raise an audible alarm (continuous) and filter and display the alarm messages in such a way that the operator can observe only those relating to the exsisting alarm signals.
Furthermore, if the operator mutes the audible alarm, the Signalling will display all status messages of the STS alongside the other alarms present. The latter will no longer be visible once the Signalling control logic stops supplying them.

b) Piloted view of the status of the STS: the Signalling can be interrupted by the operator during its normal operation in order to provide an overview of all messages relating to status levels and/or alarms.
In this respect, please consult the Exchange management (fig. 6-7)

The list of possible services are:
- SHOW THRESHOLD SETTINGS: it shows threshold settings Vmin ref, Vmax ref, preferred Vmin and preferred Vmax;
- EXCHANGE CONFIGURATION: it shows the definition of the Exchanger (Maximum Power with relative Voltage)
- SERIAL PORT CONFIGURATION: it allows to see and set the communication way by which it's possible to be connected to the STS.
  - STS can communicate in two different protocols: OCS3 or Modbus.
  - To communicate, the STS must have an address higher than zero, so from 1 to 16.
  - Use arrows to configure the ports then press <SHIFT> + <MENU> to store the information.
- TIME SETTING: it allows to see or set the STS time. It's possible to modify the value using Up and Down Arrows then press <SHIFT> + <MENU> to Store new value.
- DATE SETTING: it allows to see or set the STS date. It's possible to modify the value using Up and Down Arrows then press <SHIFT> + <MENU> to Store new value.
- LANGUAGE CHOISE: It allows to select the preferred language. The two possibility are Italian or English. It's possible to modify the value using Up and Down Arrows then press <SHIFT> + <MENU> to Store new value.
- ALARMS HISTORY: It shows Alarm History. For more details see next paragraph.
- SERVICE PARAMETER: It allows to erase all the History data. To Erase it there is the need of a Password made of 5 keys. The Password is <SHIFT> + < ⇑ >, <SHIFT> + < ⇑ >, <SHIFT> + <MENU>, <SHIFT> + <STAR>, <SHIFT> + <STAR>.

From any position press STAR to come back to the previous level.

c) The following voltage/current real time values are provided via the LCD: (keys 2, 3 and 4 in Fig. 5)

Output Voltage	(VRSo, VSTo, VTRo, VRNo, VSNo, VTNo)
Input circuit 1 voltage	(VRSi, VSTi, VTRi, VRNi, VSNi, VTNi)
Input circuit 2 voltage	(VRSs, VSTs, VTRs, VRNs, VSNs, VTNs)
Output current	(IRout, ISout, Itout)
Output power	(kW)
Mains 1 frequency	(Hz)
Mains 2 frequency	(Hz)

This is described in more detail in the Exchange flow chart measurements menu (fig 7).

Synoptic diagram

The synoptic panel alongside the display, as shown in Figure 5, contains the following (LED) luminous signals, indicating:

STATUS OF THE BY-PASS SWITCH (green indicating closed / extinguished indicating open)
PRESENCE OF A GENERIC FAILURE (red indicating failure / extinguished indicating normal)
PRESENCE OF SOURCE 1 (green indicating circuit present / red indicating a circuit failure)
PRESENCE OF SOURCE 2 (green indicating circuit present / red indicating a circuit failure)
SOURCES IN PHASE (PHASE OK) (green indicating phase OK / red indicating out of phase)
STATUS OF THE ISOLATING SWITCH (Q1) (green closed / yellow open)
STATUS OF THE ISOLATING SWITCH (Q2) (green closed / yellow open)
STATUS OF THE STATIC SWITCH ON MAINS 1 (green closed / extinguished open / yellow ready for manual by-pass)
STATUS OF THE STATIC SWITCH ON MAINS 2 (green closed / extinguished open / yellow ready for manual by-pass)
STATUS OF THE OUTPUT SWITCH (Q3) (green closed / yellow open)
PRESENCE OF THE WORKING VOLTAGE (green voltage present / red no voltage present)

Description of the remote alarm signals

All the signals exchanged with the STS go through a customer interface board (Fig. 8).
The basic version enables the STS to be monitored by the volt free relays.
The basic version performs monitoring of the STS, by reading the potential-free relay contacts. To monitor the conditions of these relays, there are two possibilities:
- one DB9 box-type connector which monitors 4 of them (CN1 in Fig. 8).
- one terminal block which monitors all of them.

The DB9 box-type connector (CN1 in Fig. 8-9) can be used for connection to a PC with the correct software which can monitor the status of the STS and switch it off.
Terminal blocks M1, M2, M3 (Fig. 8) also supply further signals and alarms.

Description of CN1 connector
- CN1 connector is an insulated communication port which provides potential-free contacts: these are usually used by the various software programs specialised in monitoring and controlling the STS (for further information please contact SIEL S.p.A.).
When a contact is closed, the event shown in Fig. 9 occurs. Figure 9 shows the standard connection. Connections to the various pins can be changed by means of the jumpers J1…J6.

Description of M1, M2, M3 terminal blocks.
M1, M2, M3 terminal blocks are equipped with potential-free contacts (both N.O. and N.C.) for the most important signals concerning the STS.
Figure 10 shows relays in idle position while signal indications refer to an energised relay.
The signals coming from relays RL1, RL2, RL3, RL4 (Fig. 8) are fixed, while the ones handled by relays between RL5 and RL10 (firmware has to be modified in advance in accordance with SIEL S.p.A. technical offices) can be customised by using SW1 dip-switches (Fig. 8).

Description of SW1 dip-switches.
This board houses 4 SW1 dip-switches which control the microcontroller assembled on the customer interface board.
They have the following functions:
1 – In 1111 condition (all on) all relays are simultaneously and permanently energised.
2 – In 1110 condition (on, on, on, off) all data for the normal operation of relays are acquired (factory

setting).
3 – All the other conditions permanently de-energise relays.
Therefore, to enable the operation of the terminal block and of the CN1 connector, dip-switches must be set to position 2.

To test the operation of all relays and connections on the terminal block, set the dipswitch to position 1 and 3, alternatively.

This board also includes three optical fibre connectors.
Optical fibres are the ideal data transmission media and ensure data can be carried safely even over long distances in environments with a high level of electrical interference (industrial environments, in proximity to radio transmitters, whenever it is impossible to separate signal and power cables, etc.).

If data must travel further than the maximum distance (approx. 100 m), SIEL S.p.A. can provide special repeaters/amplifiers.
The IC11 connector (in the middle, in Fig. 8) is a dedicated interface with the remote synoptic panel and displays the main EPS parameters in a small console without the need for a PC.

The IC8 and IC9 connectors are used for optical fibre connections with a personal computer where special software (OC-SYSTEM) has been installed; this software displays all signals and measurements sent by the EPS in graphic format, keeps an accurate historical log of all events and controls the EPS from the personal computer.When ordering this software, it is also necessary to purchase its optical fibres and the optical fibre/RS232 converter (available from SIEL S.p.A.) which must be installed in close proximity to the PC.
The connection can be done also with a RS232 DB9 Cable directly to a PC with the special software installed (OCSystem MDB) or it is possible to connect a SNMP Adapter that allows to monitor the STS on line via Ethernet.

Customers wishing to use the signals and measurements from the EPS by using their own software should send a written request to SIEL S.p.A. who will then authorise and supply detailed specifications on their optical fibre communication protocol.
In this case too, customers should remember to order the optical fibre/RS232 converter.
The remote synoptic panel and the PC monitoring software program can also be used simultaneously.
The connection is made by simply inserting the optical fibre's mobile male connector to the female connectors on the board until they click together to show that a proper connection has been made.
The IC9 connector receives commands from the PC, whilst the IC8 connector transmits data to the PC.

The following basic precautions must be taken when connecting and wiring the system:
1 - Always match the colours of the mobile and fixed connectors to avoid confusing the receiver and transmitter with consequent transmission failure.
2 - Do not confuse the remote synoptic panel connector (IC11) with the PC diagnosis connectors (IC8 and IC9).
3 - When laying out the optical fibre cable, avoid bends with a radius of less than 10 cm; too tight a bend will prevent the light from being reflected correctly and this may result in a communication failure.
If no mechanical damage was caused when bending the cable, the connection can be restored simply by making a "gentler" curve.

Although no hazardous voltages are present on this board, the STS must be switched off when making the connections because it is housed in a compartment containing live circuitry.

INSTALLATION

Choosing the installation location

For a successful STS installation, the following rules must be observed:

Although all routine maintenance can be carried out from the front side, it is advisable to leave a space as indicated in figure 3 between the back side of the STS and the wall to provide an adequate circulation of cooling air and eventual operations of unusual maintenance.

The area where the STS is installed must be kept clean and dry to prevent any solid or liquid material from being drawn into the STS.

A free space of about 1 m must be kept in front of the STS to allow all normal and maintenance operations to be carried out (Figure 3).

The top of the STS must have a minimum distance from the ceiling to provide adequate ventilation.

Visual inspection

Prior to delivery, every STS is carefully checked both electrically and mechanically. Always visually check a STS after delivery for any transit damage, and immediately inform Siel S.p.A. if such damage is evident.

Environmental considerations

There are various environmental aspects to take into consideration, the most important being:

<u>Floor capacity</u>

The STS occupies a small area and has a relatively heavy weight (see technical specifications). It is therefore necessary to position it on a floor having suitable capacity.
Cables must be connected from under the floor.

<u>Temperature and humidity</u>

The premises where the STS is to be installed must be able to dispose of the kW dissipated by the machine during operation so as to keep the temperature at between 0°C ÷ 40°C; nevertheless, to achieve utmost reliability and life-span, the temperature of the environment should be around or below 25°C, with a humidity percentage between 0÷90% as shown on the technical specifications table.

Handling

The STS is designed to be lifted from underneath using a fork-lift truck.

Safety Considerations

To reduce accidents, Health and Safety rules must be observed. Walls, ceilings and floors and everything surrounding the STS are best not made of inflammable materials; furthermore, the area around the machine should be kept particularly clean so that metal dusts, iron filings or miscellaneous metals are not sucked up inside the STS as these could cause short circuits.
It is advisable to keep a mobile powder fire extinguisher within easy reach.
Access to the STS room should be restricted to machine service and maintenance personnel; the doors of the premises (equipped with handle and push opening from inside) and of the STS must be kept closed and the keys properly looked after.
All service and maintenance personnel must be trained in emergency procedures.
Periodic tests are advisable to keep technicians trained.
New personnel must be trained before being authorised to operate the STS.

FUNCTIONING STATUS AND ANOMALIES

This section describes the basic aspects of the signals and the alarms that are shown on the display on the front panel of the EXCHANGE cabinet (Figure 5).

DISPLAY MESSAGE	DESCRIPTION	Buzzer
Input Switch Line 1 Open	Switch Q1 open	
Input Switch Line 2 Open	Switch Q2 open	
Output Switch Open	Switch Q3 open	
By-pass Line 1 -> Output	Switch in position mains 1 By-pass activated	
By-pass Line 2 -> Output	Switch in position mains 2 By-pass activated	
Unpowered Load		
Load Fed by Line 1		
Load Fed by Line 2		
Static Switch Failure	Probable SCR lighting failure (anomaly)	X
Preferential Line Not Set	Selected circuit failure as principal circuit	
Preferential Line 1 Set	Source 1 selected as principal source	
Preferential Line 2 Set	Source 2 selected as principal source	
System Forced On Line 1	Status can be controlled only by the operator	
System Forced On Line 2	Status can be controlled only by the operator	
Power Protection Open	Open fuses in the static switch series Catastrophic failure!!	X
Overtemperature	Anomaly in semiconductor ventilation	X
Fan Failure	Failure of ventilator	X
Overload	The output current is too high	X
Line 1 Voltage Over Limit	Maximum voltage source 1	
Line 1 Voltage Under Limit	Minimum voltage source 1	
Line 2 Voltage Over Limit	Maximum voltage source 2	
Line 2 Voltage Under Limit	Minimum voltage source 2	
Wrong Voltage Thresholds	Incorrect setting of minimum and maximum voltage trimmers	X
Wrong by-pass operation	By-pass operation done on the not preferred line	X
Line 1 SCR Section Failure	The static switch in circuit 1 is on but the output voltage is low with mains 1 present	X
Line 2 SCR Section Failure	The static switch in circuit 2 is on but the output voltage is low with mains 2 present	X
Line 1 and 2 SCR Section Failure	Serious anomaly in the control electronics	X
Line 2 Energy Back Flow	Energy back flow to Source 2	X
Line 1 Energy Back Flow	Energy back flow to Source 1	X

OPTIONS

Option 1: Description of the back-feed protection sensor

Each mains input can be monitored by a suitable current back flow relay, that gives an alarm if there is a current flow in the mains that should be open.
This anomaly could be generated by SCR power or control faults.
Connection: this type of sensor must be fitted with a magnetothermal switches, to be supplied by the customer, and connected in series to the mains of the STS.
When a failure, this device enables the release coil of the external switch (230 VAC with enabled alarm), thus protecting personnel working on the system from potential risks. The STS must be connected to the coils of external switches by means of 4 sqm terminals installed next to the power switches. There is additional terminals to connect the signals of the back-feed protection board. Said terminals correspond to a normally closed contact (NC), a common contact (C) and a normally open contact (NO) (the tripping of the sensor causes the relay to be "attracted").
The current back flow relay are placed on the frontal door of the STS.

Operation:
When the STS is operated in ordinary mode, the green "R.E. POWER" LED lights on permanently. As soon as the sensor detects a return of power towards the mains, the red "R.E. ALARM" lights and an acoustic warning is enabled, while the relay on the back-feed protection board releases the external switch upstream from the input mains. To restart the STS in ordinary mode, it is necessary to press "RESET R.E." and reset the switch.

WARNING
Pressing "TEST R.E." is equivalent to simulating a return of current towards the mains, which causes the external switch to be released.

TECHNICAL SPECIFICATIONS

Maximun power of input and output cables: Table 1
Input specifications: Table 2
Output specifications: Table 3
General specifications: Table 4

Warning:
The technical specifications refer to the standard single machine.
The addition of a number of options may significantly change the technical data shown.
For further information, contact Siel S.p.A.

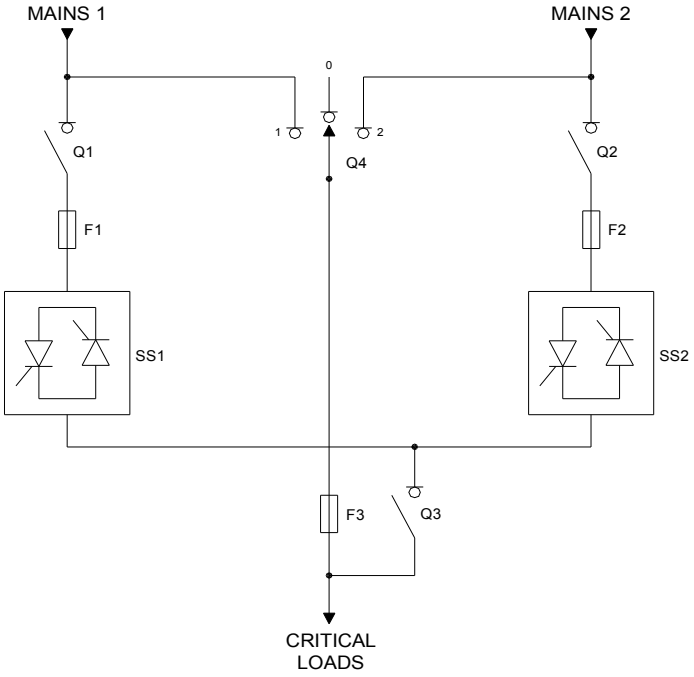


Figure 1A: Block Diagram

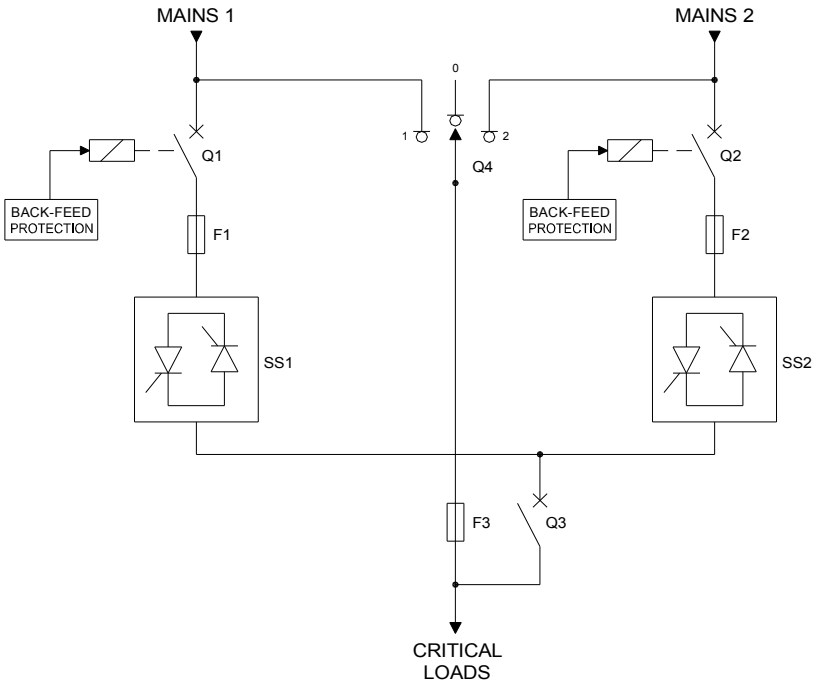
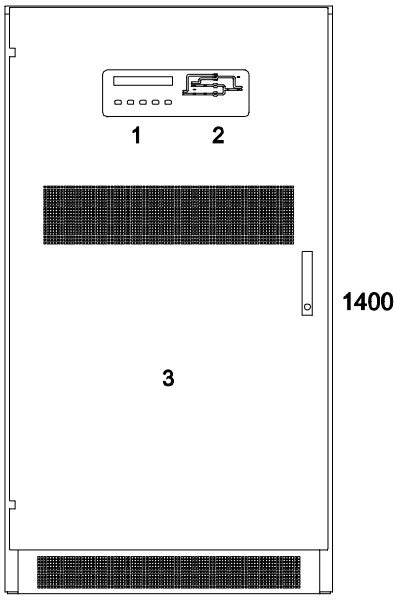


Figure 1B: Block Diagram with N.R.E. and Automatic Switch

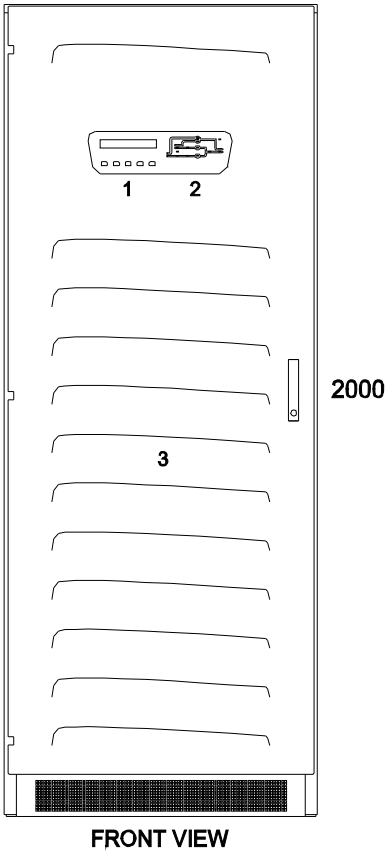
Figure 1: Block diagram



1: Control measurements and signalling panel
2: Functional diagram
3: Input-Output switch door and electronic cubicle

Figure 2A: Size 63-100-160A

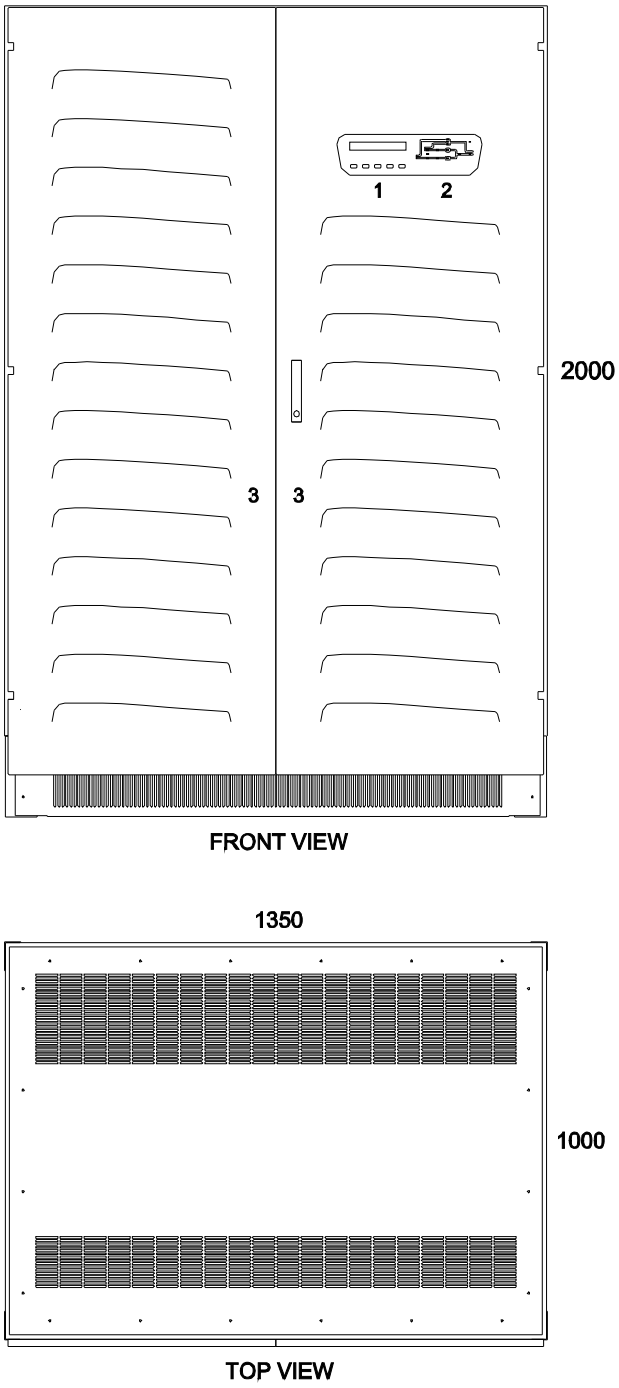
Figure 2: Overall view



1: Control measurements and signalling panel
2: Functional diagram
3: Input-Output switch door and electronic cubicle

Figure 2B: Size 200-300-400A

Figure 2: Overall view



1: Control measurements and signalling panel
2: Functional diagram
3: Input-Output switch door and electronic cubicle

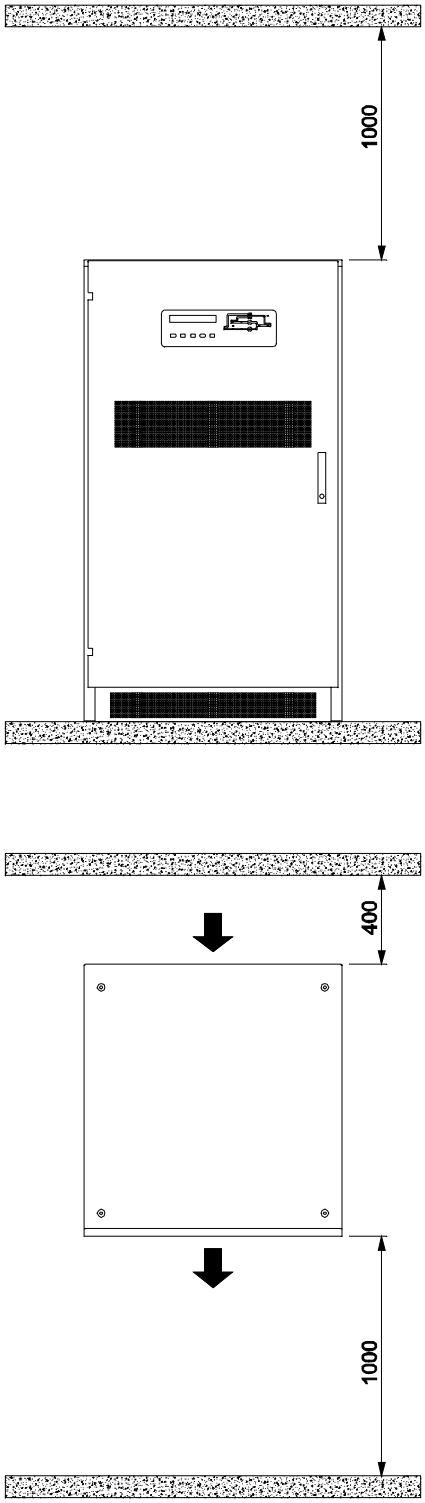
Figure 2C: Size 600-800-1200A

Figure 2: Overall view

1: Control measurements and signalling panel
2: Functional diagram
3: Input-Output switch door and electronic cubicle

Figure 2D: Size 1600A

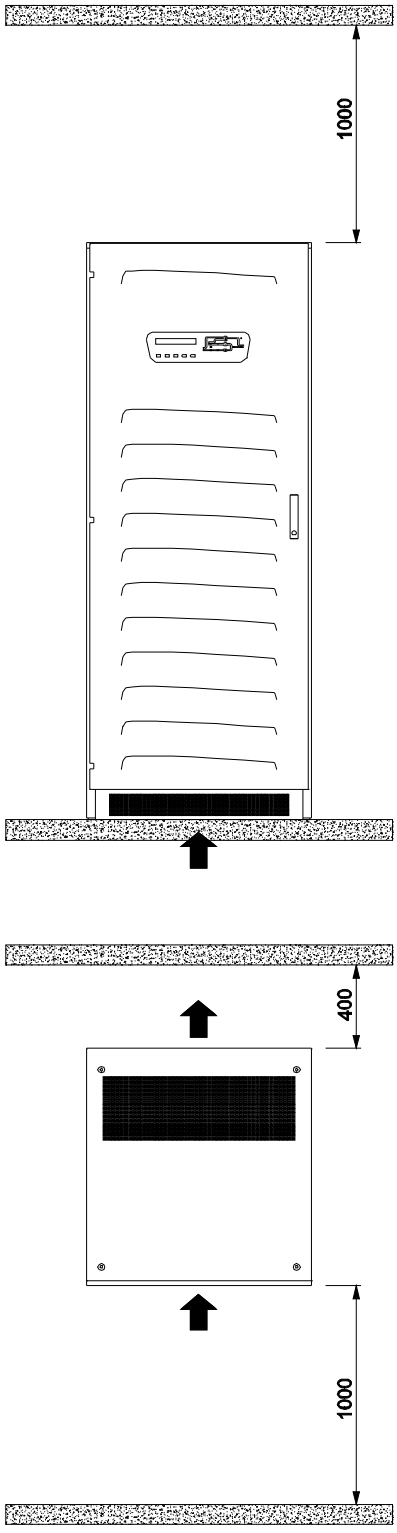
Figure 2: Overall view



The arrows indicated the air flow
The air is sucked from the back and is released on front

Figure 3A: Size 63-100-160A

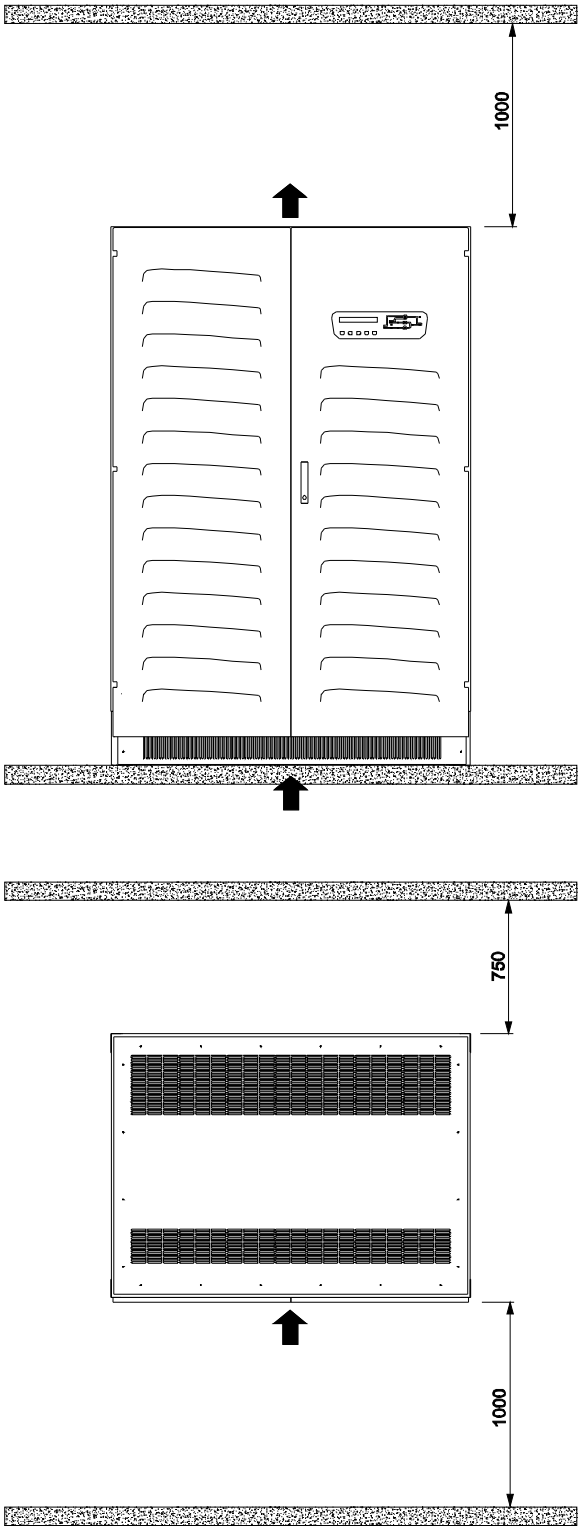
Figure 3: Dimensions to install STS



The arrows indicated the air flow
The air is sucked from the front and bottom and is released on back

Figure 3B: Size 200-300-400A

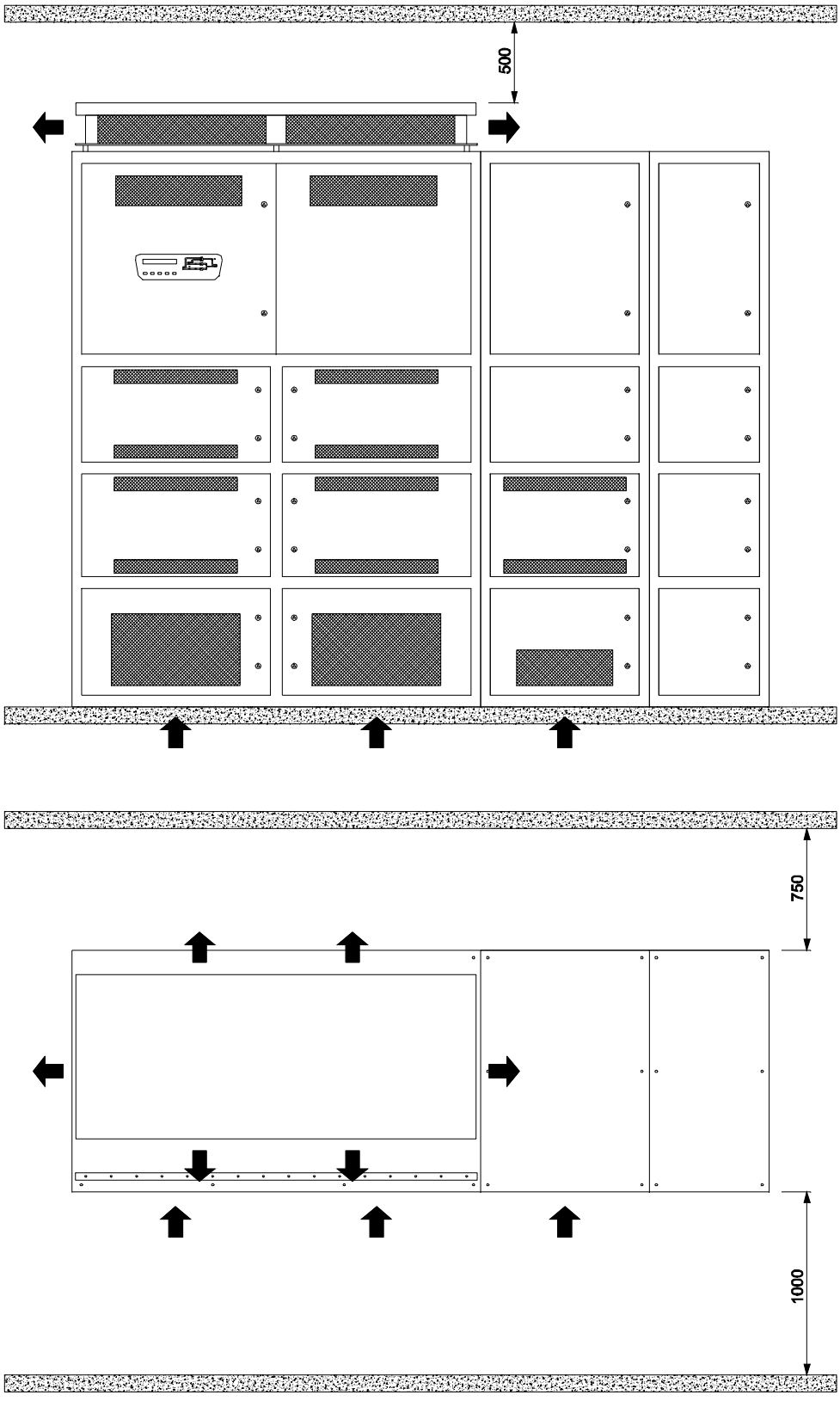
Figure 3: Dimensions to install STS



The arrows indicated the air flow
The air is sucked from the front and bottom and is released on top

Figure 3C: Size 600-800-1200A

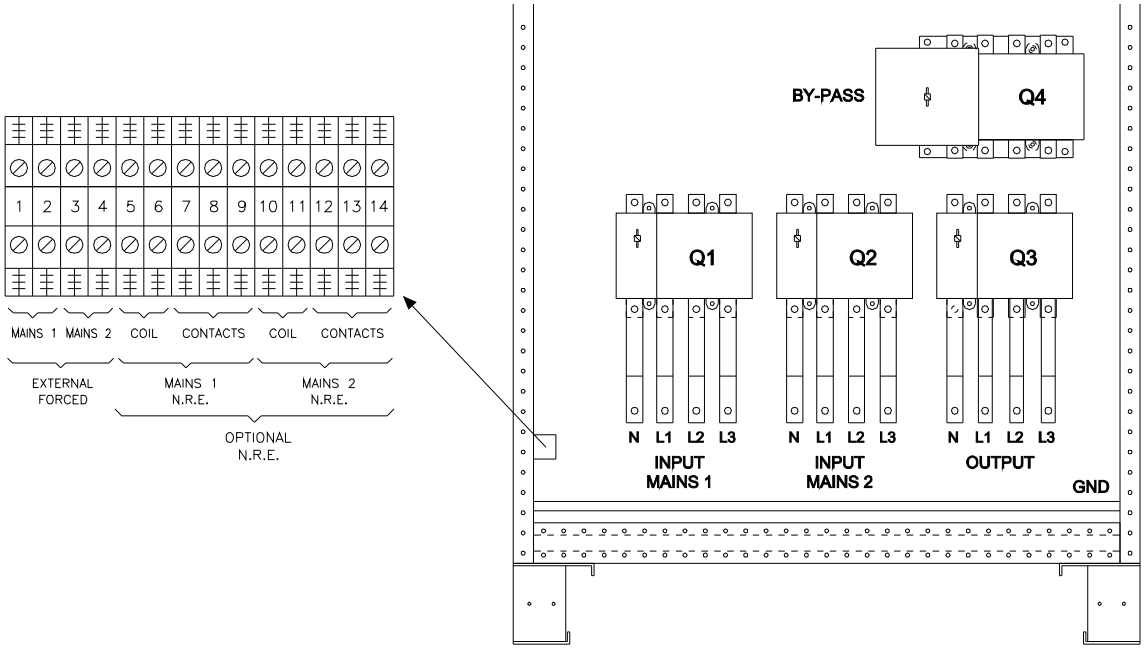
Figure 3: Dimensions to install STS



The arrows indicated the air flow
The air is sucked from the front and bottom and is released on top

Figure 3D: Size 1600A

Figure 3: Dimensions to install STS

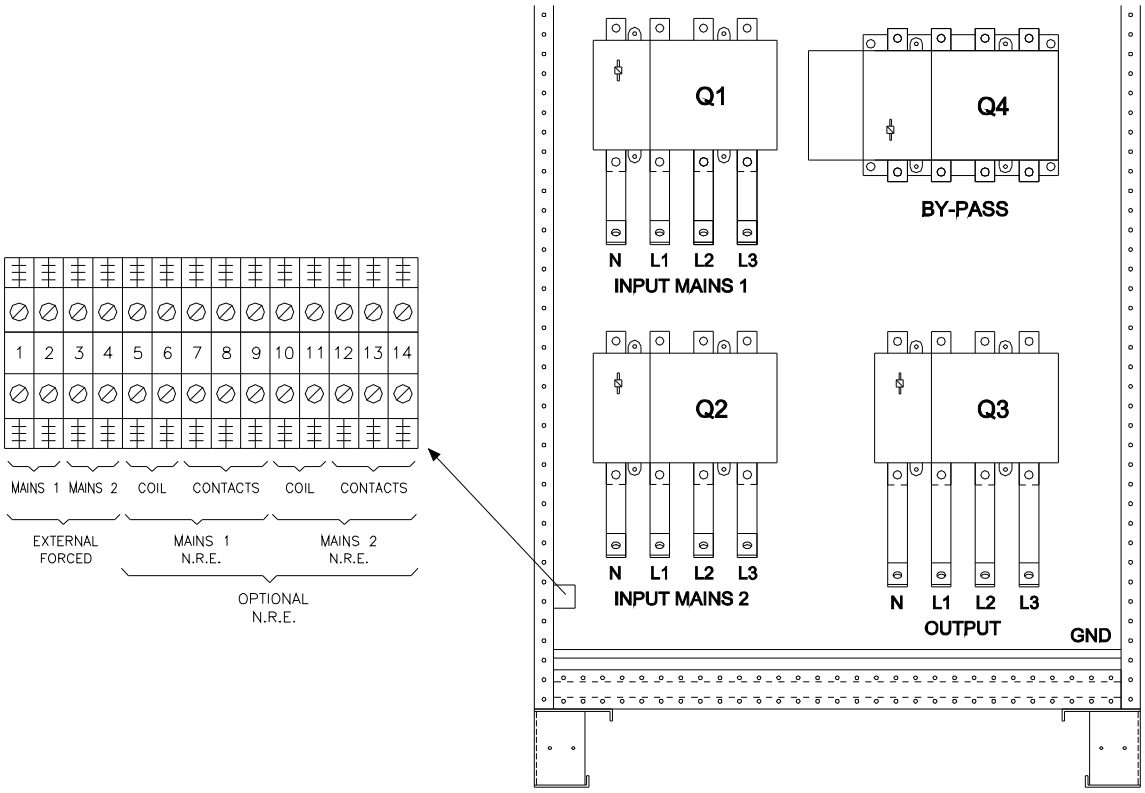


Q1 = Mains 1 input switch
Q2 = Mains 2 input switch
Q3 = Output switch
Q4 = By-pass

N = Neutral
L1 = Phase L1 (R)
L2 = Phase L2 (S)
L3 = Phase L3 (T)
GND = Connecting of earth

Figure 4A: Size 63-100-160A

Figure 4: Connections

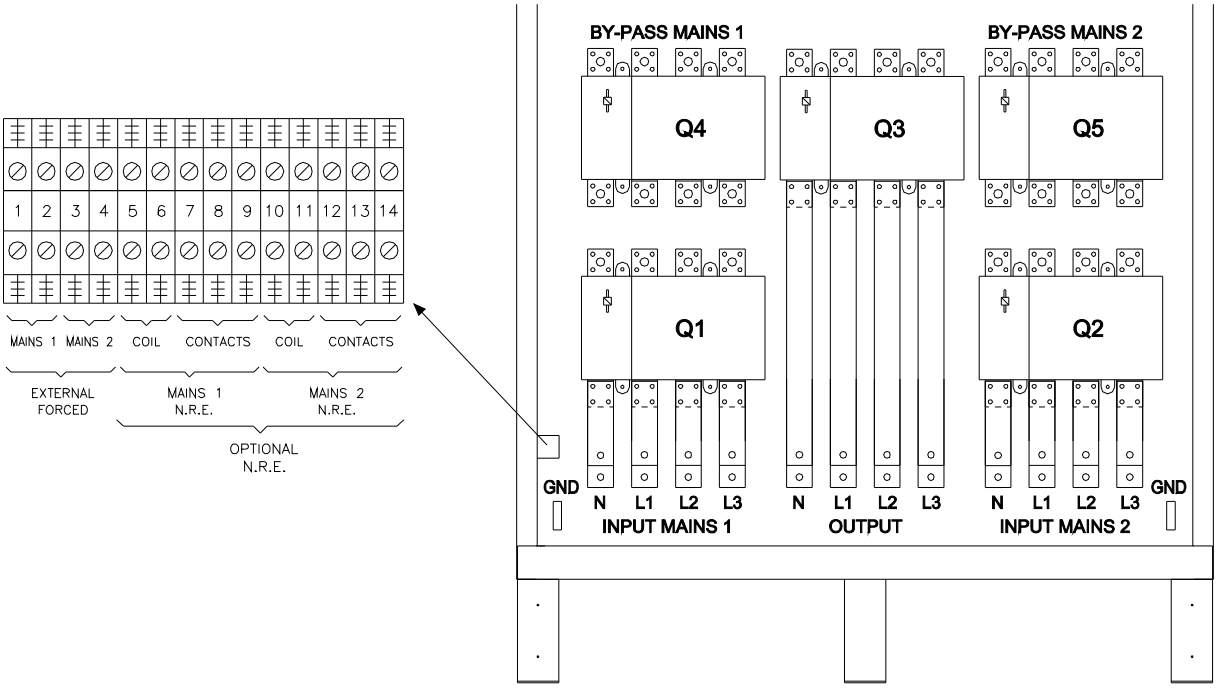


Q1 = Mains 1 input switch
Q2 = Mains 2 input switch
Q3 = Output switch
Q4 = By-pass

N = Neutral
L1 = Phase L1 (R)
L2 = Phase L2 (S)
L3 = Phase L3 (T)
GND = Connecting of earth

Figure 4B: Size 200-300-400A

Figure 4: Connections



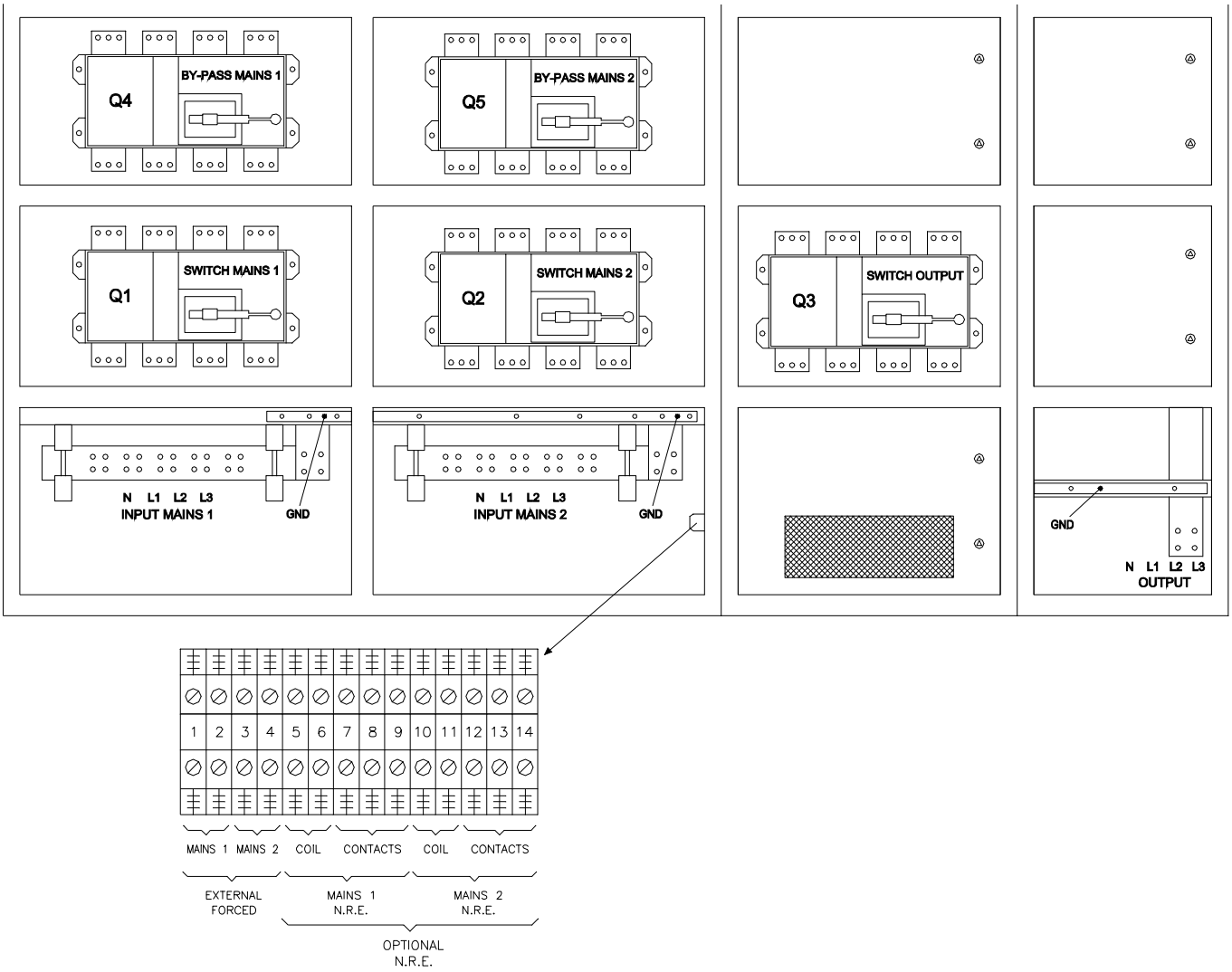
Q1 = Mains 1 input switch
Q2 = Mains 2 input switch
Q3 = Output switch
Q4 = By-pass mains 1
Q5 = By-pass mains 2

N = Neutral
L1 = Phase L1 (R)
L2 = Phase L2 (S)
L3 = Phase L3 (T)
GND = Connecting of earth

The connection bars are doubled to allow the connection of four wire

Figure 4C: Size 600-800-1200A

Figure 4: Connections



Q1 = Mains 1 input switch
Q2 = Mains 2 input switch
Q3 = Output switch
Q4 = By-pass mains 1
Q5 = By-pass mains 2

N = Neutral
L1 = Phase L1 (R)
L2 = Phase L2 (S)
L3 = Phase L3 (T)
GND = Connecting of earth

Figure 4D: Size 1600A

Figure 4: Connections

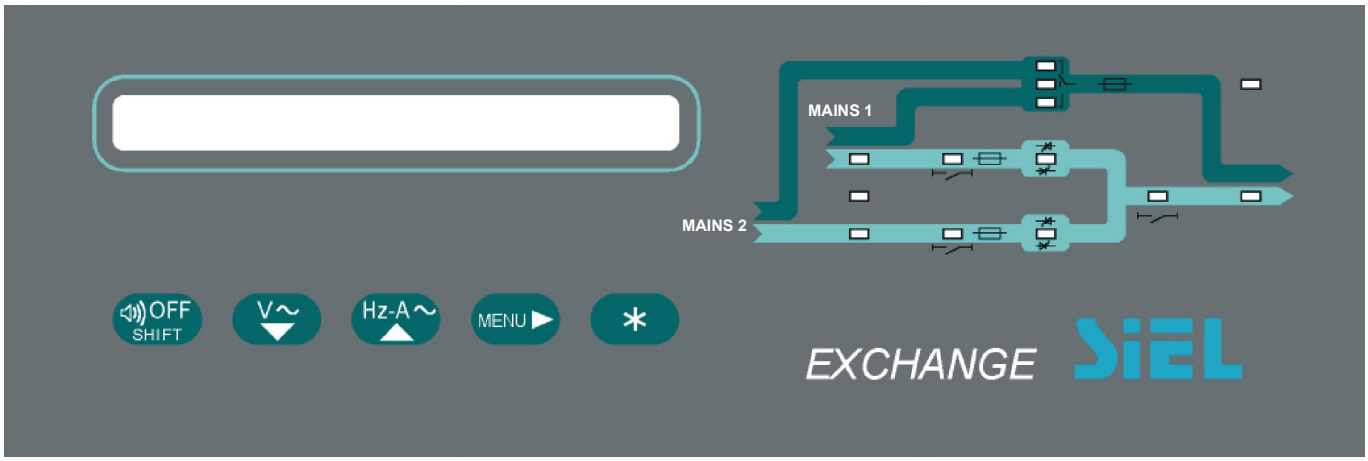


Figure 5: View of Signalling and Synoptic panel

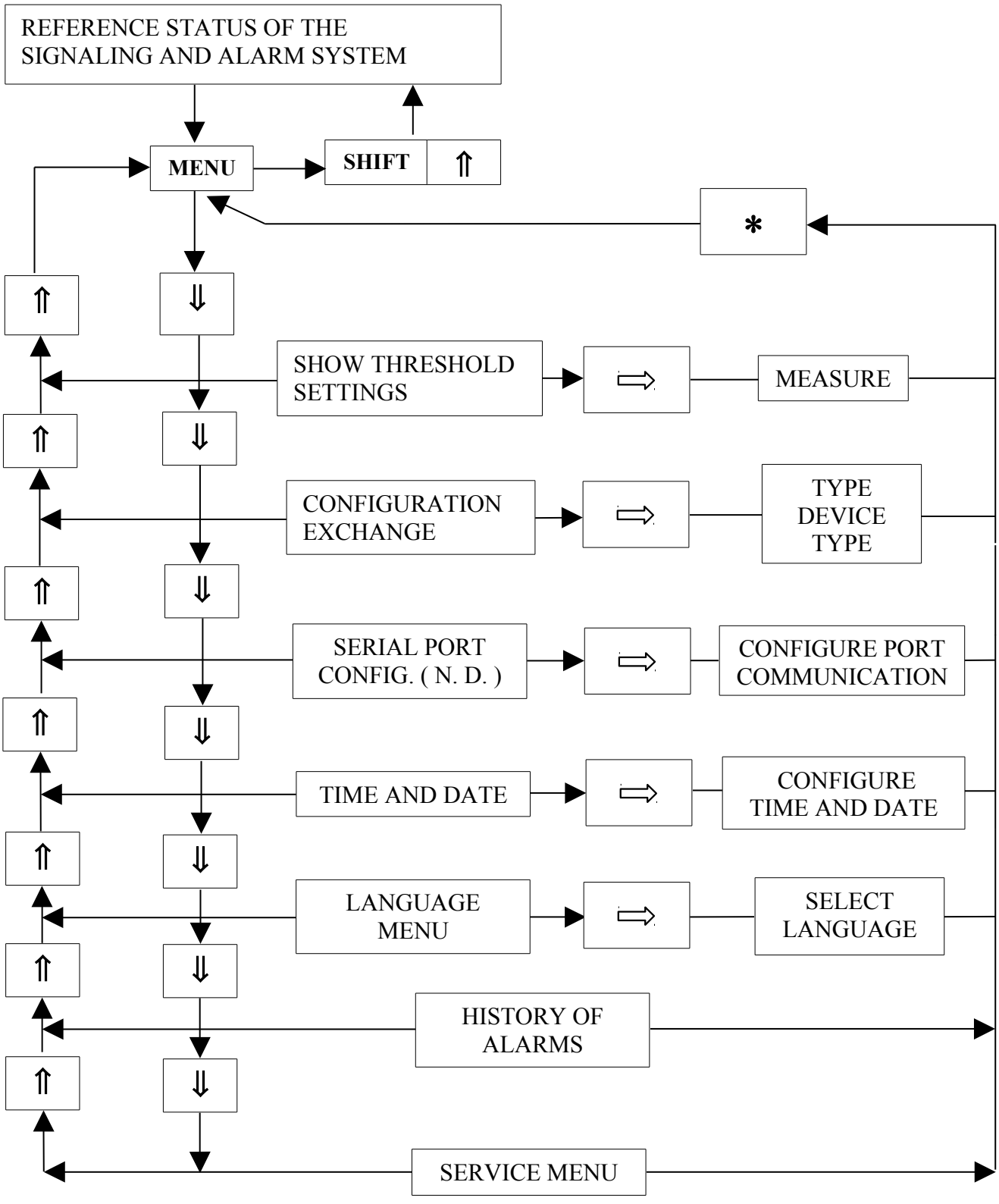


Figure 6: Flow Chart Exchange

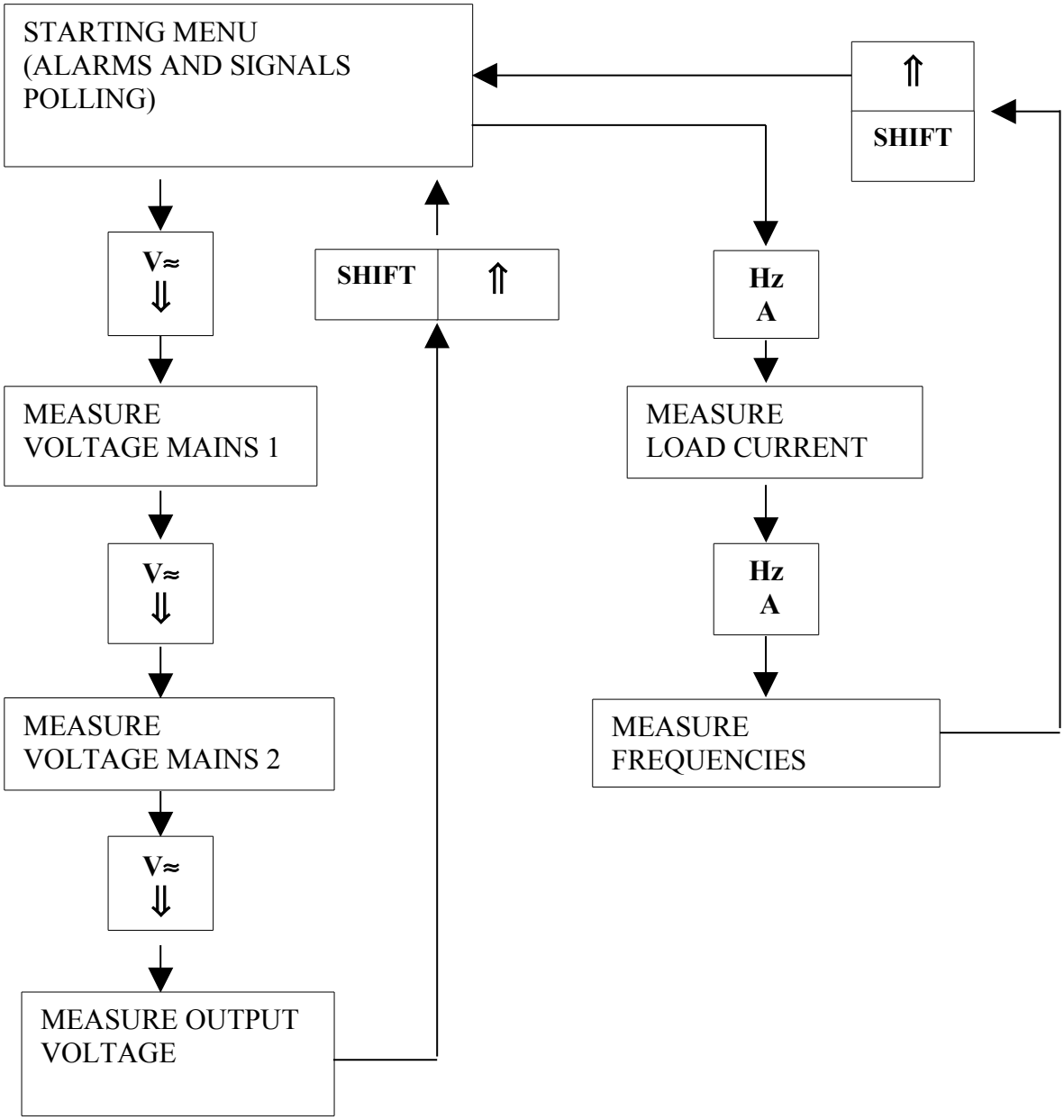


Figure 7: Flow Chart measure Exchange

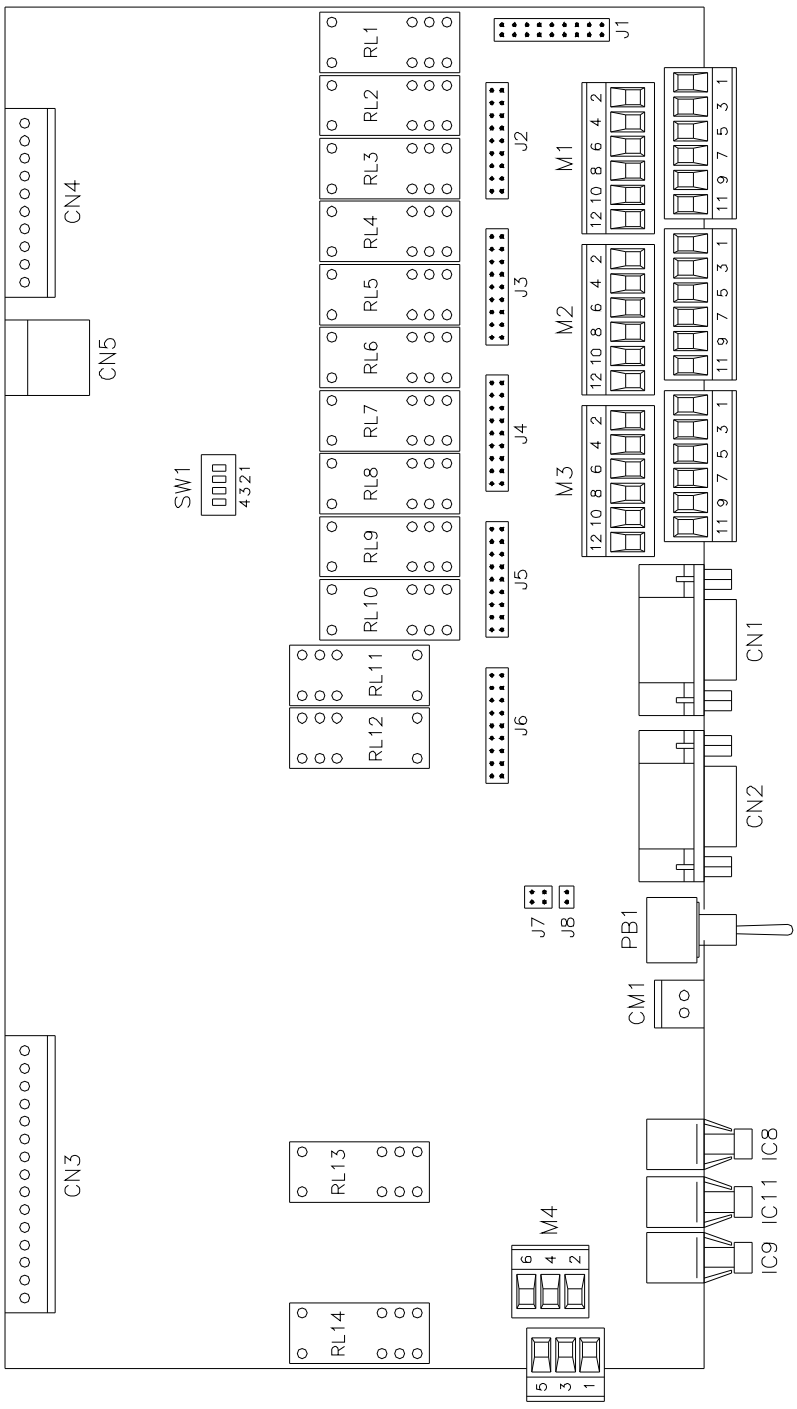


Figure 8: Customer Interface Board

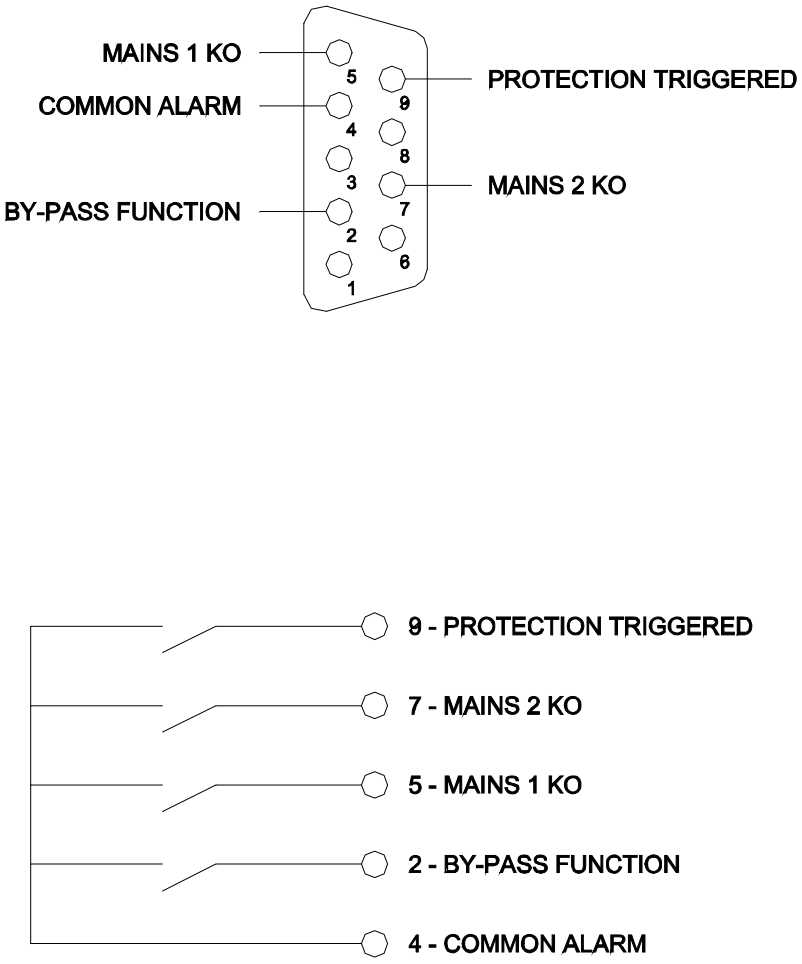


Figure 9: DB9 Contacts

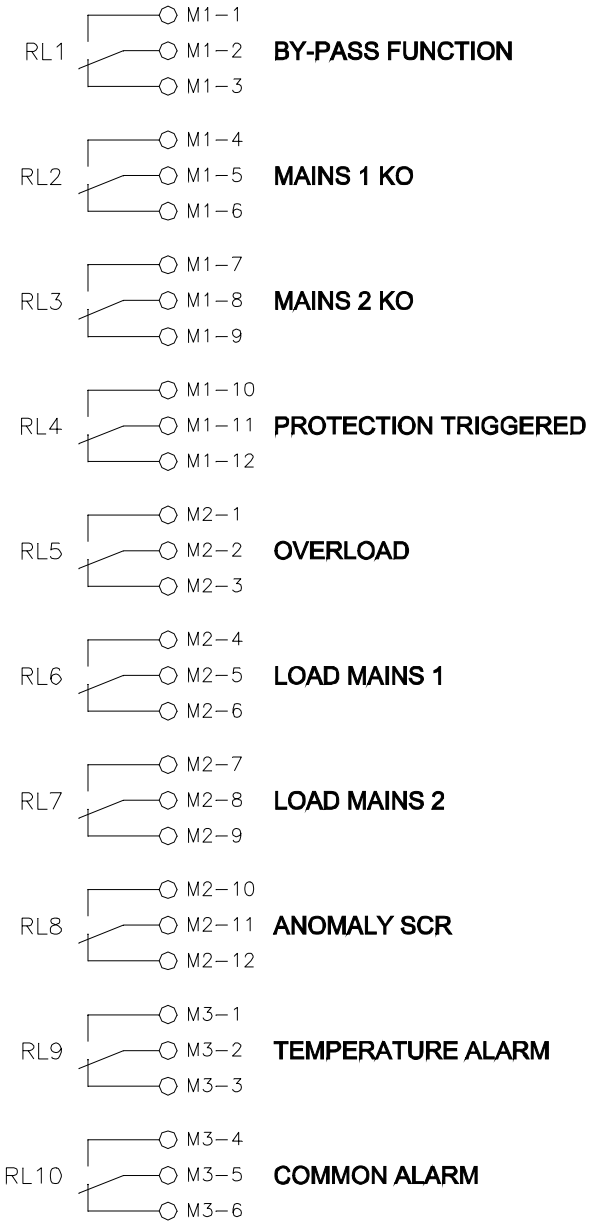
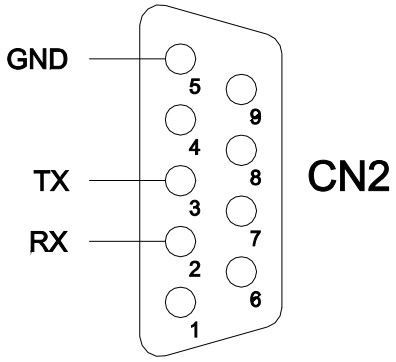


Figure 10: Remote Alarm Signals



2 = Recevier
3 = Trasmitter
5 = Ground

Figure 11: Connector