

# Uninterruptible Power Supply



***SOLA 4000***

**OPERATING MANUAL**

JUE 401263

# SOLA 4000 Operating Manual

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The SOLA 4000 Operating Manual consists of the following documents:

<b>SECTION 0:</b>	<b>JUE 401263</b>	<b>INDEX AND SAFETY INSTRUCTIONS</b>
<b>SECTION 1:</b>	<b>JUE 401264</b>	<b>GENERAL SYSTEM DESCRIPTION</b>
<b>SECTION 2:</b>	<b>JUE 401265</b>	<b>INSTALLATION AND INITIAL START-UP</b>
<b>SECTION 3:</b>	<b>JUE 401266</b>	<b>OPERATION</b>
<b>SECTION 4:</b>	<b>JUE 401267</b>	<b>OPERATING PANEL</b>
<b>SECTION 5:</b>	<b>JUE 401268</b>	<b>PCB DESCRIPTION</b>
<b>SECTION 6:</b>	<b>JUE 401269</b>	<b>TECHNICAL DATA</b>

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Rev.	Description	Date	Created	Revised	Date	Format	Pages	Total
/	ISSUED	04.02.97		M. Porpora	04.02.97	A4	1	3
A	See Rev. Doc. JSE401440	20.06.97	T. Boon					
				T. Boon				

**JUE 401263**

# Safety Instructions

## SAFETY INSTRUCTIONS



The unit must be used as intended. Follow the instructions given in the Operating Manual.



Dangerous voltages are present inside the unit.



Installation and use of this equipment must comply to all national and local regulations and procedures.



To prevent overheating do not obstruct the flow of air for ventilation openings to the unit.



The components inside the unit are not repairable by the user. The user must not open the UPS cabinet or auxiliary cabinets or remove any protective covers from inside the UPS cabinet.



This equipment must be installed and serviced by qualified personnel.



The unit contains Lead-Acid batteries which must be disposed of correctly, in compliance with the local regulations.



To completely isolate the equipment, the switches IRP, IRE, IBY, IUG and IB must be switched off, the input supply and the battery supply must be isolated from the UPS and the output isolated from other modules if the unit is part of a multi-module system. For 10-30kVA units with an internal battery, intermediate links must be removed in order to isolate the battery in sections of a safe working voltage.



**High leakage current:** connect protective earth before power supply cables.

## Safety Instructions

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**Earth leakage protection:** this device has a high leakage current towards protective earthing. The maximum earth leakage current is 300 mA. When setting the threshold of the earth leakage circuit breaker installed upstream from this equipment consider this amount of current and that due to the loads.



All primary power switches installed downstream of the UPS must be labelled as follows: "Isolate UPS (Uninterruptible Power Supply) before working on this circuit.



The unit is provided with the E.P.O. (Emergency Power Off) function. This function is activated by pressing simultaneously the two push buttons on the bottom part of the Front Panel. This function provides UPS disconnection from the load and from the battery. Dangerous voltages will still be present inside the unit, if a shunt-trip of the input supply switch is not provided for.



During electrolysis, batteries release hydrogen gas. There is a risk of an explosion if the amount of hydrogen in the battery room becomes too high. Ensure appropriate ventilation of the battery room according to the standard EN50091-1, to prevent the risk of an explosion.

# SOLA 4000 - General System Description

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	ISSUED	04.02.97		M. Porpora	04.02.97	A4	1 8
A	See Rev. Doc. JSE401440	20.06.97	T. Boon				
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# 1 UPS Assembly

## 1 UPS ASSEMBLY

### 1.1 Features

**CE** This equipment complies to the essential requirements of European Directives 89/336/EEC and 73/23/EEC, and complies to EN50091-2 (1995) and EN50091-1 (1991) standards.

**UPS Function** The uninterruptible power supply (UPS) is connected between the consumer's critical equipment (the load) and supply mains. Its function is to guarantee a continuous and conditioned power supply to the load. Even in the case of a total blackout it will supply the load for a predetermined time (autonomy time). In addition, the UPS provides the following advantages in comparison with conventional supply systems (mains, motor generator sets, etc.):

**Better Output Power Characteristics** The UPS output voltage control of frequency and amplitude guarantees consistent and stabilised output power. Mains voltage fluctuations and frequency changes that are usually present in electricity supply systems do not affect the UPS output voltage.

**Uncoupling from Mains Distortion** By using double energy conversion from ac to dc and back to ac and using an isolation transformer in the inverter output, all mains distortions are filtered out. Therefore, all loads connected to the UPS system are protected against mains disturbances that can be present in industrial electricity supply systems. This is especially important for sensitive electronic devices, e.g. computer systems, control systems, medical equipment.

**Complete Protection against Mains Failures** During long term or short term ac mains supply interruption, the UPS system guarantees continuous supply to the connected loads by means of a battery. The battery is connected to the rectifier output and the inverter input of the UPS system. In normal operation the inverter (which feeds the load) is fed by the rectifier. In case of a mains failure, the connected battery automatically feeds the inverter. Thus the load is supplied without interruption. However, the load can only be supplied by the battery for a certain time (autonomy time, see chapter 1.4 "Battery"). If longer autonomy times are required, we recommend the use of a Diesel Generator Set. In this case the battery autonomy time only has to be sufficient for the time span between mains failure and full operating capacity of the Diesel-Generator-Set.



**This is a class A product.**

**In a domestic environment, this product may cause radio interference, in which case, the user may be required to take additional measures.**

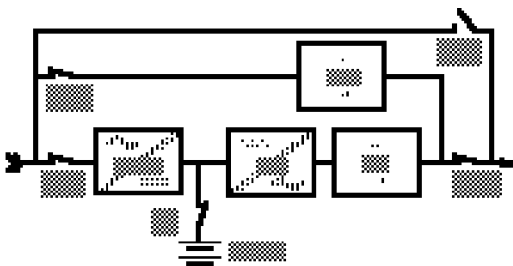
# 1 UPS Assembly

## 1.2 UPS System Structure

The basic SOLA 4000 power supply unit is an ac/dc/ac converter; the block diagram: Figure 1.1 illustrates six essential functional components:

- Rectifier/battery charger (6 pulse) (RECT.)
- Battery (BATT.)
- Inverter (INV.)
- Static inverter switch (SSI)
- Static bypass (SSB)
- Maintenance bypass (IBY)

All components are located in a single housing. They are explained in detail on the following pages. The control electronics of the rectifier, inverter and static bypass sections are completely independent of each other. i.e. a failure in any one section will not cause a failure in another section.



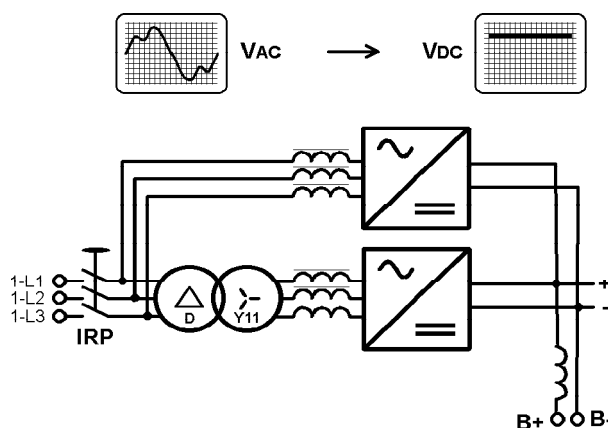
## 1.3 Rectifier/Battery Charger

In the standard configuration the charger is a three phase/6 pulse rectifier that converts ac voltage to dc voltage. No isolation transformer is used and the rectifier is connected to the mains via the commutation chokes which reduce the mains distortion created by the rectifier. The dc output of the rectifier feeds the inverter and the battery. The battery is connected to the rectifier through a saturation choke which reduces ac ripple current to the battery, thus ensuring the maximum battery life-time.

The rectifier is designed to feed both the inverter at maximum load conditions and simultaneously the battery with maximum charging current. Normally, the battery voltage is constantly regulated at 432 V dc (floating charge, maintenance-free lead battery, 2.25 volts per cell). The rectifier's recharge characteristic is of the I/U type. This means that the recharging current limitation is accomplished by reduction of the dc voltage, thus assuring that the batteries will not be damaged by excessive charging currents.

A 12-pulse rectifier is optional and requires the addition of a second rectifier bridge inside the UPS cabinet and a phase shifting transformer in a separate cabinet.

FIG. 1.3 - 12-pulse Rectifier Block-Diagram



# 1 UPS Assembly

## 1.4 Battery (Accumulator)

The battery supplies power in case of a short interruption or a total breakdown of the ac mains supply. In case of a rectifier failure (no dc voltage output), the load will be fed by the battery.



The battery is only capable of feeding the load for a certain time (autonomy time), depending on battery capacity and actual load.

The number of cells within the battery depends on the battery type and may also vary due to specific customer requirements. The standard number is 192 cells for lead-acid batteries and 300 cells for NiCd batteries. The battery capacity (Ah) depends on the UPS output power and the required autonomy time. The battery of 10-30kVA units is installed inside the UPS cabinet as standard. For 40-120kVA units (or 10-30kVA units with extended battery autonomy), batteries are installed in external battery cabinets.

## 1.5 Inverter

The inverter converts dc voltage supplied by the rectifier or battery to ac voltage of a precisely stabilised amplitude and frequency that is suitable for power supply to most sophisticated electrical equipment.

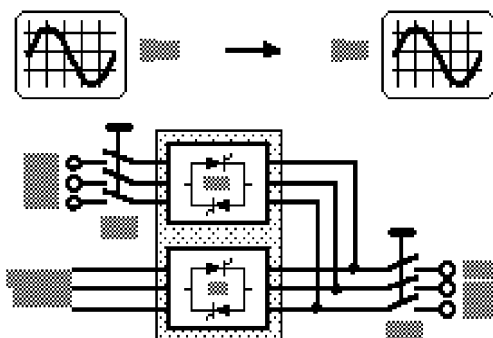
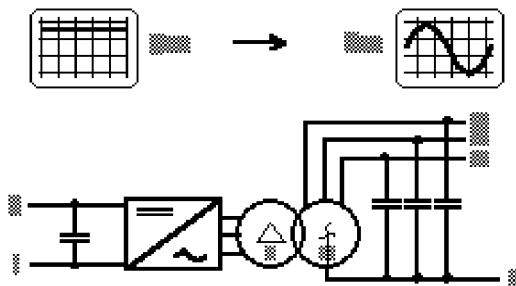
The inverter output voltage is generated by sinusoidal pulse width modulation (PWM). The use of a high carrier frequency for the PWM and a dedicated ac filter circuit consisting of the transformer and capacitors, ensure a very low distortion of the output voltage (THD<1% on linear loads).

Every phase voltage of the inverter output is controlled separately, thus ensuring constant and equal UPS output voltages even with highly unbalanced loads.

The inverter is designed specifically for the application of today's loads i.e. The output harmonic distortion will be maintained at low levels due to a unique adaptive correction technique, even with the application of highly distorted loads.

The inverter control logic restricts the maximum output current to 150% of the nominal current in case of a short circuit. In case of overload (up to 125% of the nominal current), the output voltage is maintained constant. For higher currents the output voltage is reduced, however, this will only occur if the bypass supply is not available. Otherwise the UPS will switch to bypass operation for currents higher than 110% of the nominal current.

The inverter IGBT transistors are fully protected from severe short circuits by means of a desaturation monitor or "electronic fuse".



## 1.6 Static Switches

The block diagram illustrates the two static switch sections that use thyristors as switching elements. During normal UPS operation, SSI is closed and SSB is open, thus connecting the load to the inverter output.



# 1 UPS Assembly

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During overload or inverter failure conditions, SSI is switched off and SSB is switched on, providing power supply from a backup source (mains, output of another UPS system, diesel generator set....). By always actuating both switches together for a short period, an uninterrupted power supply during the switching is ensured. This is an essential condition to reliably meet all power supply requirements for connected sensitive equipment.

The control for each static switch (SSB and SSI) is performed totally independently of each other, thus ensuring that a failure in one static switch does not affect the other.

## Switching Conditions, Inverter - Bypass

The voltage and frequency of the bypass line have to be within set tolerance limits, and the inverters have to be synchronised with the bypass line.

### Under inverter failure conditions:

- (i) the UPS switches to bypass operation, for a **single unit**. (SSB switches on, and SSI off).
- (ii) for **hot-standby units**, the load is commutated to the second inverter, and will switch to bypass only when no inverter is ready to take the load.
- (iii) in **parallel systems**, all units switch to bypass operation together only if the load is more than the rated value for the remaining on-line units.

If the conditions above for the bypass line and synchronisation are not met:

- the inverter will continue to operate with reduced output voltage under overload conditions, or
  - the inverter will stop if an inverter failure occurs.
- In this second case, the system will:
- (i) commutate to a second standby-inverter in the case of a hot-standby system
  - (ii) the remaining inverters will take the load in the case of a parallel-redundant system or,
  - (iii) the UPS will commutate to the bypass supply with a very short interruption of 10msec if the supplies are not synchronised, for the case of a single UPS unit.

**Under overload conditions**, all UPS modules present will switch to the bypass supply, and remain in bypass until the overload is removed.

## Switching Conditions, Bypass - Inverter

- a) The UPS switches automatically back to inverter operation when inverter voltage and frequency are within tolerance limits, the overload has been removed and the inverter is synchronised with the bypass line (SSI switches on and SSB off).
- b) If the UPS unsuccessfully attempts five times within 3 minutes to switch to inverter operation, the UPS remains in bypass operation and signals an alarm. After pressing the reset-button once to reset the audible alarm, it should be pressed a second time to automatically switch back to inverter operation.
- c) If the UPS remains blocked on bypass operation and a mains failure occurs, the UPS will switch automatically to inverter operation if the inverter voltage and frequency are within tolerance and the inverter is synchronised to the mains.

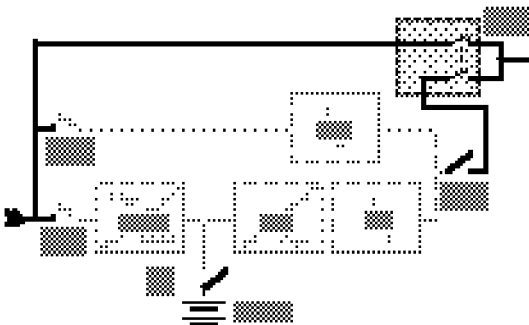
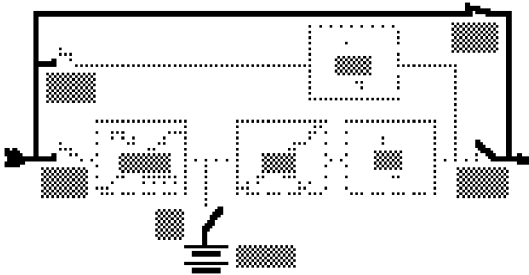
# 1 UPS Assembly

## 1.7 Maintenance Bypass

The maintenance bypass function is to supply power directly to the connected load during UPS maintenance. The bypass consists essentially of one switch IBY.

With SOLA 4000 series UPS systems, switching from different operating modes to maintenance bypass can be performed without interruption. With the maintenance bypass on, the UPS system may be completely switched off, thus permitting maintenance work to be carried out safely ( there will only be voltage at the input and output terminals and their connections to the circuit-breakers).

In order to prevent erroneous switching of the maintenance bypass switch IBY that could possibly cause parallel connection of the bypass line and the inverter line, IBY is electronically interconnected with the static inverter switch SSI. Thus, during actuation of IBY, switch SSB will be closed and switch SSI opened automatically, preventing parallel operation of the maintenance bypass network and the inverter.

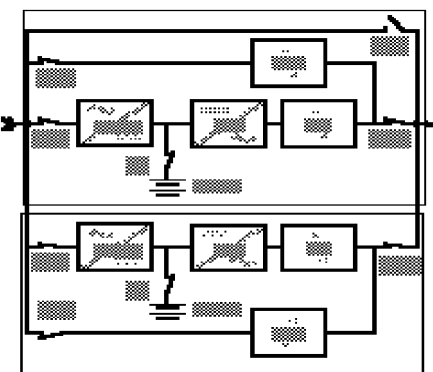


As an option, an external wall-mounted no-break maintenance bypass switch (see FIG. 1.6.1) may be supplied by SOLA. This switch provides simple one-step transfer to maintenance bypass (version 1) without the possibility of erroneous switching and without interruption to the load. For the version 2 type maintenance bypass, an additional position is provided in order to completely isolate the UPS with the one bypass switch. In this way, the UPS may be isolated totally from all supply by switching off the input supply to the UPS.

## 1.8 Hot-Standby Systems

A hot-standby UPS system basically consists of two (or more) single UPS units which operate independently of each other. Any one unit can be feeding the load at any time.

- All units are continuously in operation; but only one is supplying the load, at any one time.
- In case of a failure in the unit currently supplying the load, another unit is ready to takeover the load without an interruption on the output side. i.e. the load is still supplied with conditioned and stabilised power.
- The load is supplied by the static bypass, only if there is no inverter ready in the system to takeover the load.



# 1 UPS Assembly

## 1.9 Parallel-Redundant Systems

A parallel UPS system consists of 2 to 8 single UPS units connected in parallel, sharing the load current equally. Each unit has an individual static bypass, thus ensuring also redundancy of the static bypasses in a redundant system, i.e. if one static bypass should fail, the bypass system will still be available.

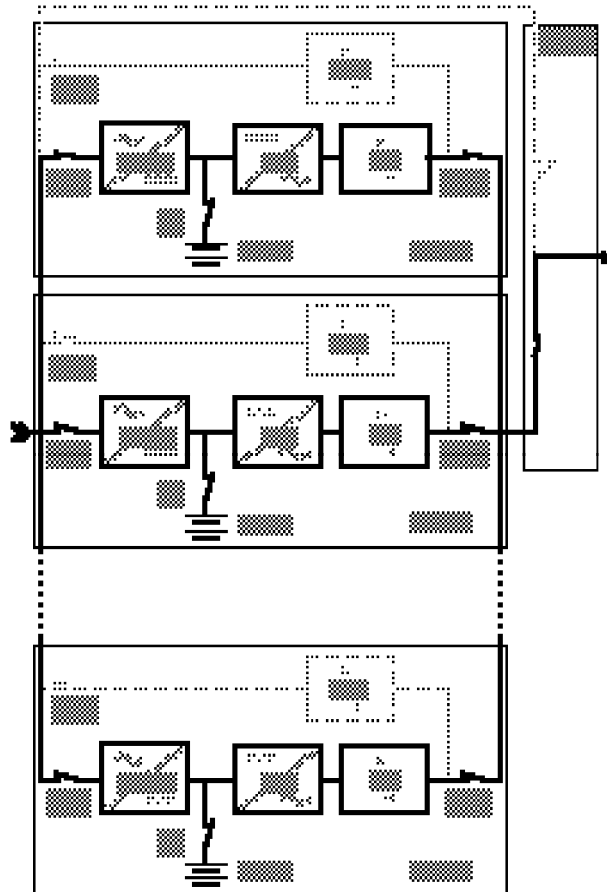
There is no common electronic device for the parallel system. Each unit has its own parallel-operation electronics that controls all of its functions, thus ensuring perfect redundancy.

## 1.10 Parallel Systems

This is identical to the configuration in section 1.9 except that the rated load is normally equal to the rating of the UPS and there is therefore no redundant unit. UPS units of different kVA ratings may be connected in parallel in this configuration, proportionally sharing the load.

Note that the parallel configuration is identical to the parallel-redundant configuration if the load is reduced to a value such that the system minus one (or more) units is capable of supplying the reduced load. Therefore one (or more) units become redundant and the control is identical.

FIG. 1.8 - Parallel Operation - Block Diagram



## 2 Operating Panel

### 2 OPERATING PANEL

#### 2.1 Functional Description

The operating panel is the user-interface of the UPS. It offers the following functions:

- Indication of important data (actual load, battery charging status, battery autonomy during the "BACK UP" phase)
- Protective functions ( Battery Running Down, Battery Test)
- Indication of the UPS operating mode
- Alarm signalling (audible and visual)
- Start push button
- Reset function after retransfer blocked condition
- **Emergency-Power-Off** function

The panel can be subdivided in four functional sections:

1. Block diagram with status LEDs
2. Battery autonomy and charging status
3. Percentage of load supplied
4. E.P.O. push-button

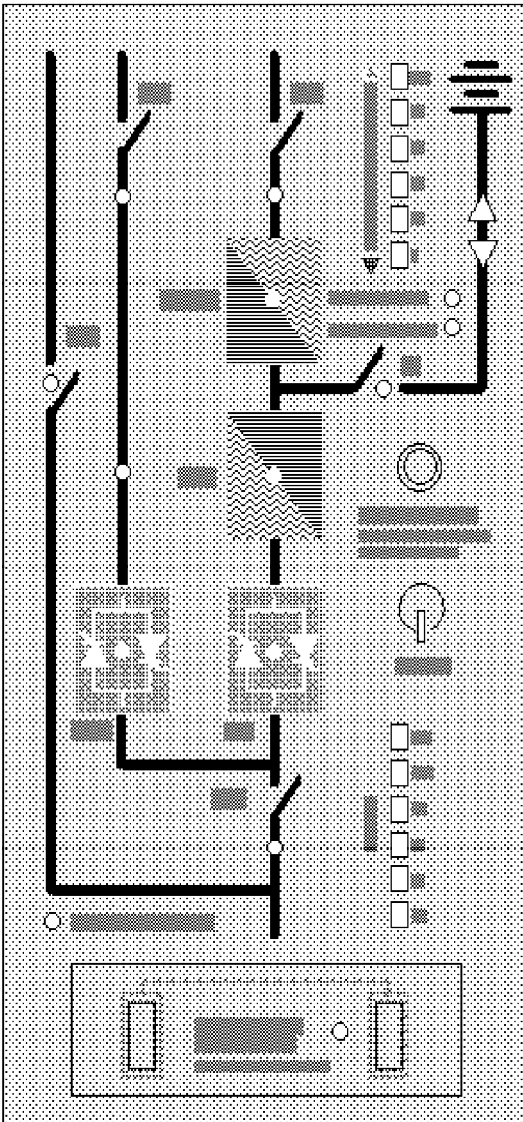
#### 2.2 Remote Monitoring

The operating panel provides an option to communicate with a computer through RS232 and RS485 interfaces. The RS232 serial interface communicates with a PC or mainframe computer, with a SNMP protocol (SEC). With the RS485 interface it is possible to transmit all necessary data up to a distance of 400m or to connect a remote monitoring panel.

#### 2.3 Emergency Power Off

In case of emergency it is possible to switch off the entire UPS system. This is done by simultaneously pressing the "Emergency Power Off" (E.P.O.) push-buttons located on the operating panel. This function provides UPS disconnection from the load and the battery, when a separate shunt-trip battery circuit breaker is installed.

In the case of parallel and hot-standby configurations, activating E.P.O. on one unit, automatically switches OFF the entire system (when IUG is closed on that unit).



# SOLA 4000 - Installation and Initial Start-Up

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Rev.	Description	Date	Checked	Released	Date	Type of doc.	Page n°	Pag. Tot.
	<b>ISSUED</b>	<b>04.02.97</b>		<b>M. Porpora</b>	<b>04.02.97</b>	<b>A4</b>	<b>1</b>	<b>44</b>
<b>B</b>	See Rev. Doc. JSE401479	08.08.97	M. Porpora	Approved	Date	Cod.	<b>JUE 401265</b>	
<b>C</b>	See Rev. Doc. JSE401490	01.09.97	M. Porpora					
<b>D</b>	See Rev. Doc. JSE401547	23.09.97	T. Boon					

# SOLA 4000 - Installation and Initial Start-Up

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# 1 Installation

## 1 INSTALLATION

### 1.1 Mechanical Installation

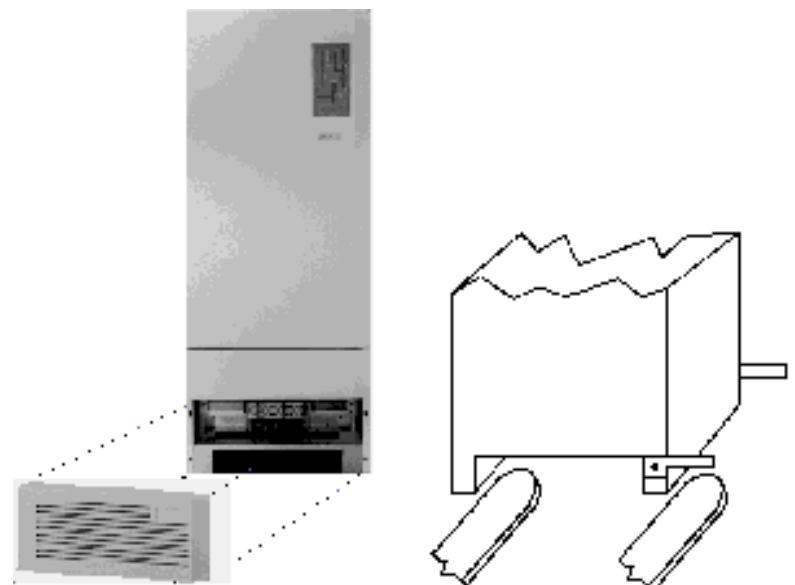
**Equipment Delivery and Storage** After delivery, check equipment for any damage that may have occurred during shipment. The shipper and your SOLA agency must be notified in writing about damages due to shipment, including a detailed description of visual defects. If you do not wish to install the equipment immediately, please observe the following storage recommendations:

- Store equipment in a vertical position in a well conditioned room, protected against humidity. Do not store the equipment in close proximity to frequently used passageways and keep it away from movable parts.
- If the UPS system is already unpacked, please ensure storage in a clean environment protected from dust, away from heat sources.

**Handling the UPS System** The UPS can be simply lifted and moved by means of a lifting truck or a fork lifter for 80-120kVA units. For 10-60kVA units, remove the front side and rear side base sheets and attach two angle irons with 8MA bolts to the right front and rear side of the UPS. The UPS can now be moved with a lifting fork. Remove the angle irons when the UPS is set in the correct position.



**Caution:** Secure equipment against being knocked over



**Setting Up** The UPS system should be installed in a dry, clean and lockable room. Provisions have to be made to remove heat created by the system. Under all installation conditions, the unrestricted flow of cooling air must be assured.

# 1 Installation

## Weight

Type SOLA 4000	Weight without Battery [kg]	Weight with Battery [kg]	Static Load - [kg/m <sup>2</sup> ]
10	310	597	1277(*)
15	310	597	1277(*)
20	335	622	1330(*)
30	350	637	1362(*)
40	480	-	1026
60	520	-	1112
80	810	-	1176
100	840	-	1219
120	870	-	1263

TAB. 1.1.1 UPS weight

## Floor Space Required

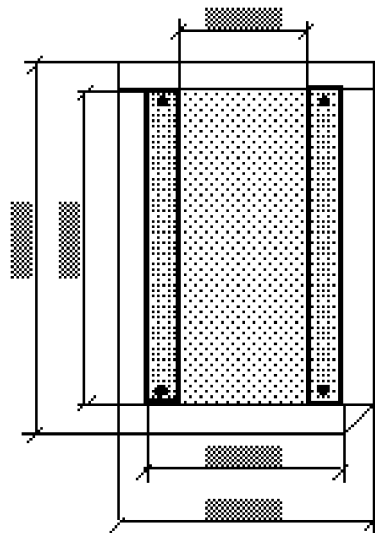


FIG. 1.1.2 10-60kVA UPS floor space

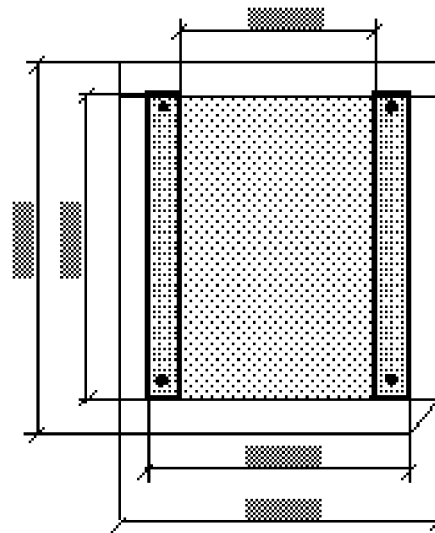
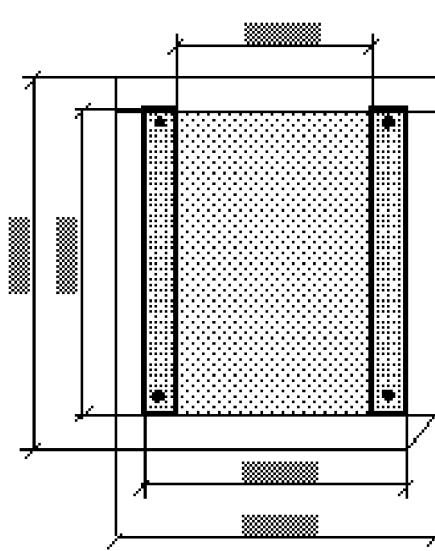
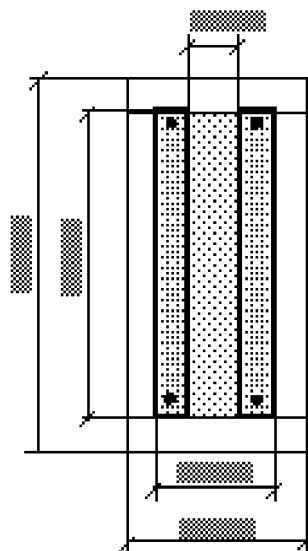


FIG. 1.1.3 80-120kVA UPS floor space





# 1 Installation

## Room Size for 10-60 kVA UPS

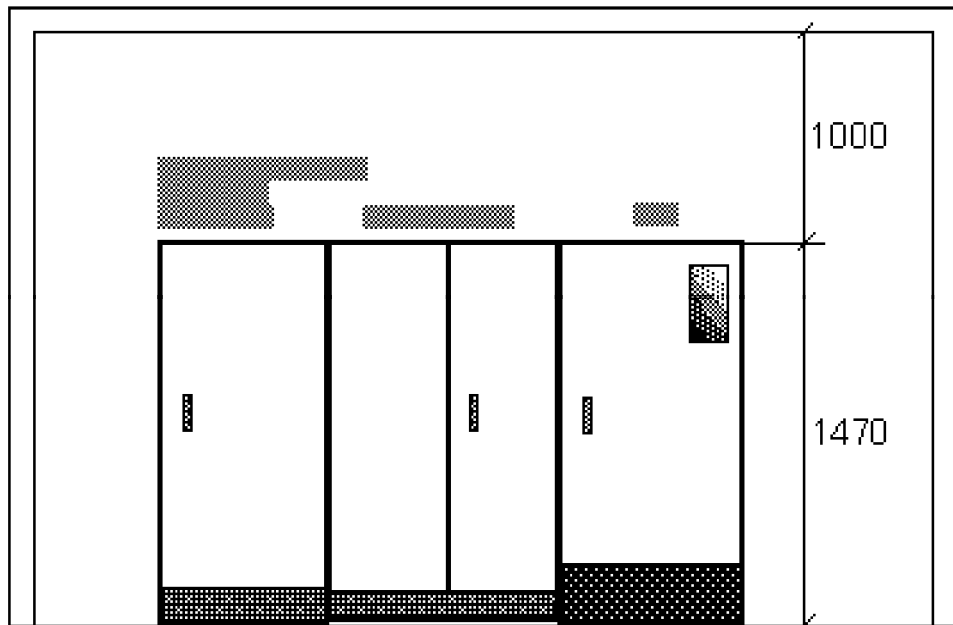
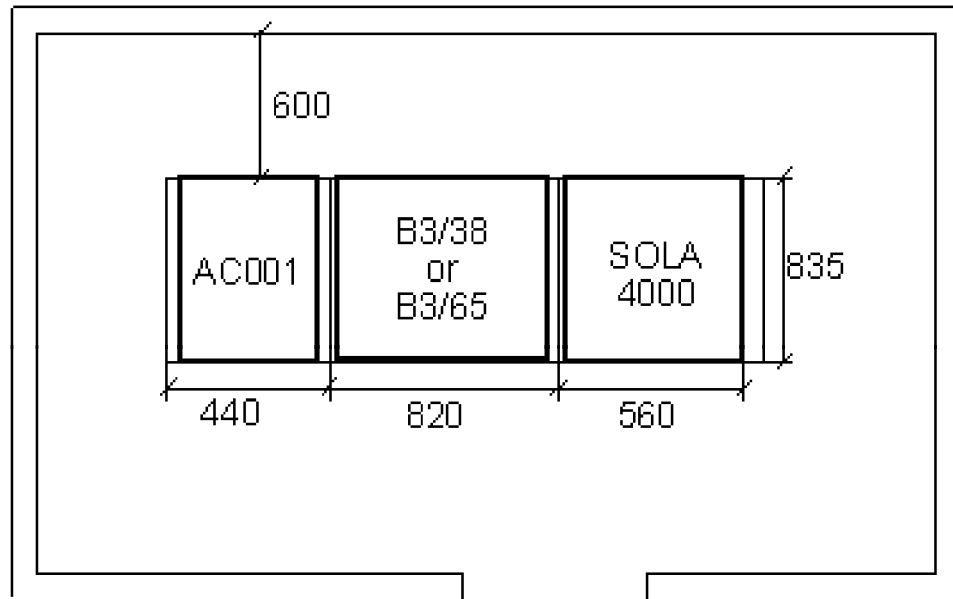


FIG. 1.1.6 UPS 10-60kVA room size

# 1 Installation

## Room Size for 80-120 kVA UPS with auxiliary AC001 cabinet

AC001 cabinets are used for SOLA 4000 units with 12 pulse chargers without galvanic separation and with THD Filters.

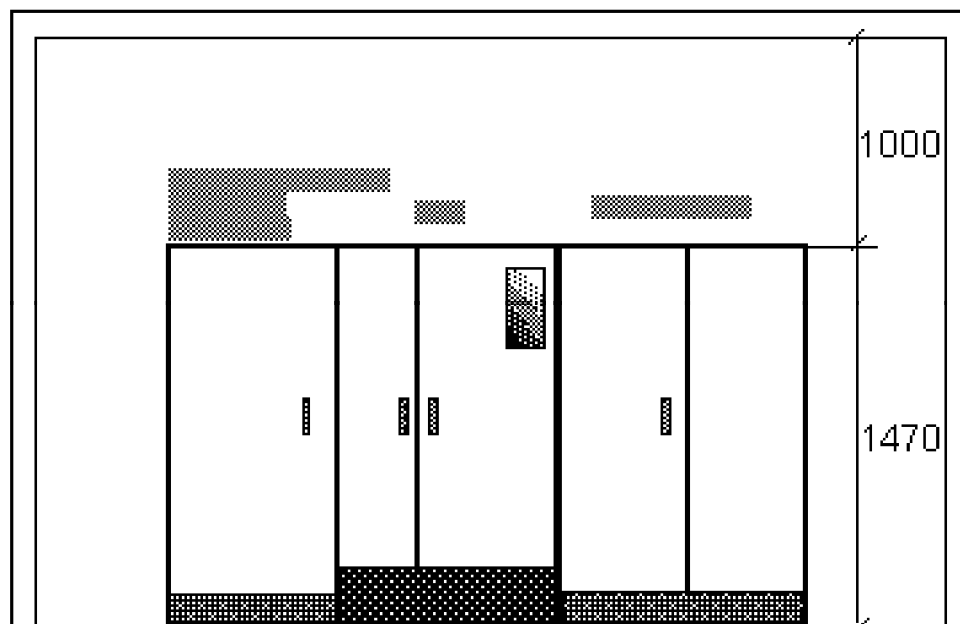
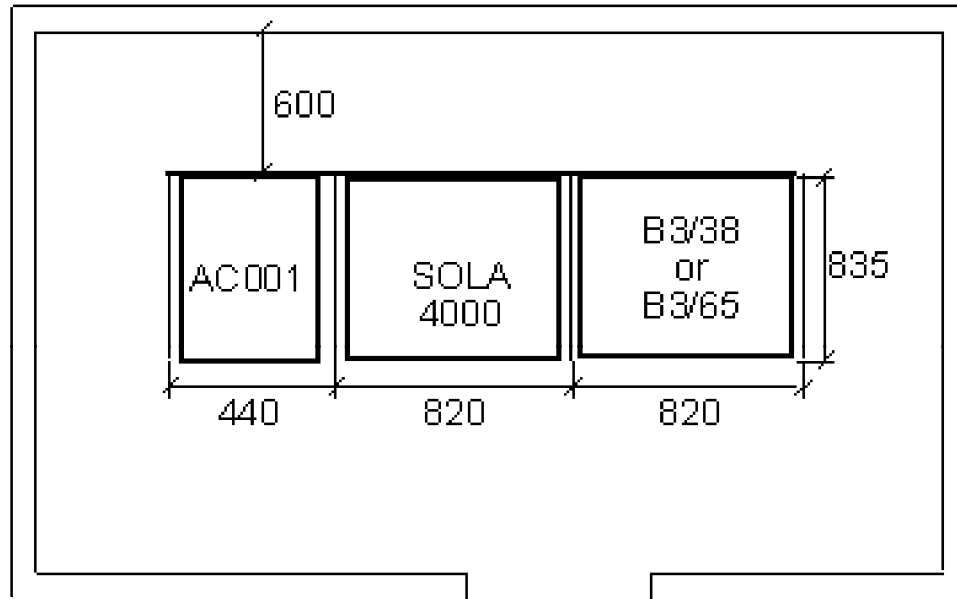


FIG. 1.1.7 UPS 80-120kVA room size

# 1 Installation

## Room Size for 80-120 kVA UPS with auxiliary AC002 cabinet

AC002 cabinets are used for SOLA 4000 units with 12 pulse chargers with galvanic separation and with auxiliary transformers.

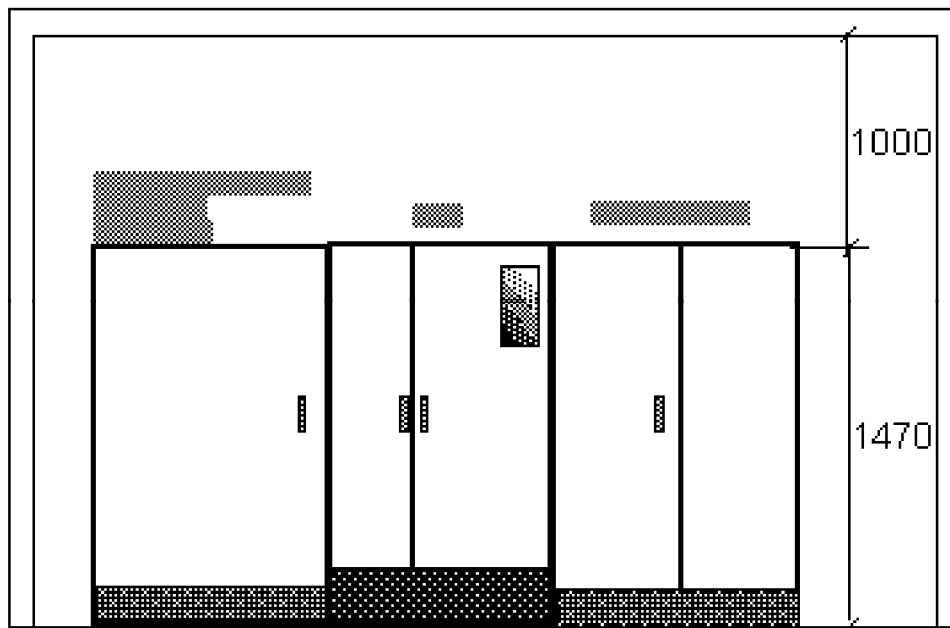
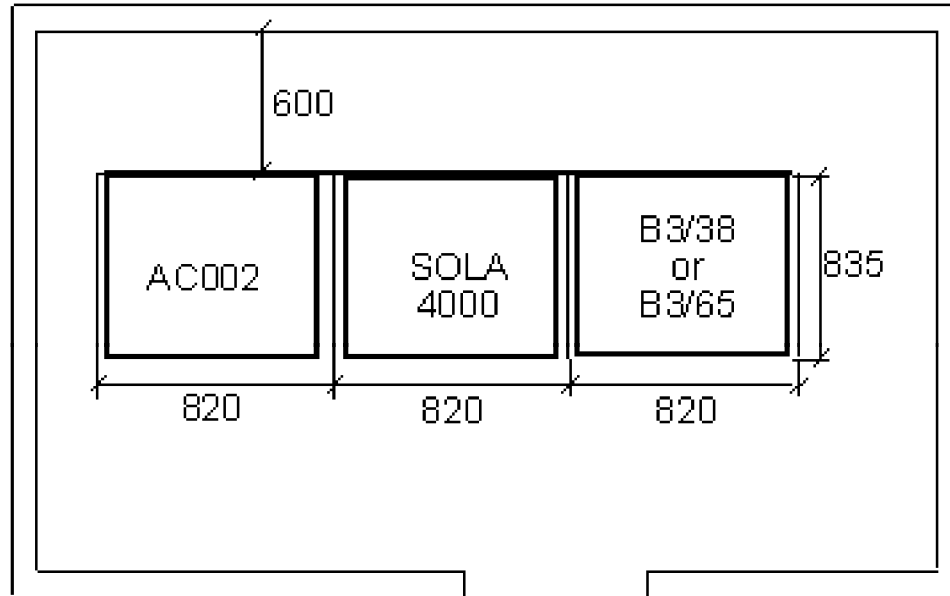


FIG. 1.1.8 UPS 80-120kVA room size

# 1 Installation

## 1.2 Electrical Installation

This equipment must be installed by qualified service personnel.



Switch off IRP, IRE, IB, IUG, IBY circuit breakers to completely isolate the equipment.

**Earth leakage protection:** this device has high leakage current towards protective earthing. Earth leakage circuit breakers shouldn't be installed upstream from this equipment or a correct threshold should be set.



**High leakage current - it is essential to connect the protective earth before connecting the power supply.**



All primary power switches installed remotely from the UPS area must be fitted with the following label: "**Isolate uninterruptible power supply (UPS) before working on this circuit**".

### General

All electrical connections must be made in accordance with local standards and all input terminals (1-L1, 1-L2, 1-L3 and, if existing, 4-L1, 4-L2, 4-L3) must be protected by external fuses. The tables give recommended values for fuse sizes and cable cross-sections. These may vary, depending on local standards. They are valid for voltages 380/220 V, 400/230 V and 415/240 V. Ensure clockwise connection of conductors L1, L2 and L3 at input and output terminals.

If possible, install battery cables separately from other power cables in order to avoid possible RF interference. Before wiring, open all system switches (IRP, IRE, IBY, IUG) plus the battery switch (IB).

# 1 Installation

Version 1 SOLA 4000 with Common Input for Rectifier and Bypass

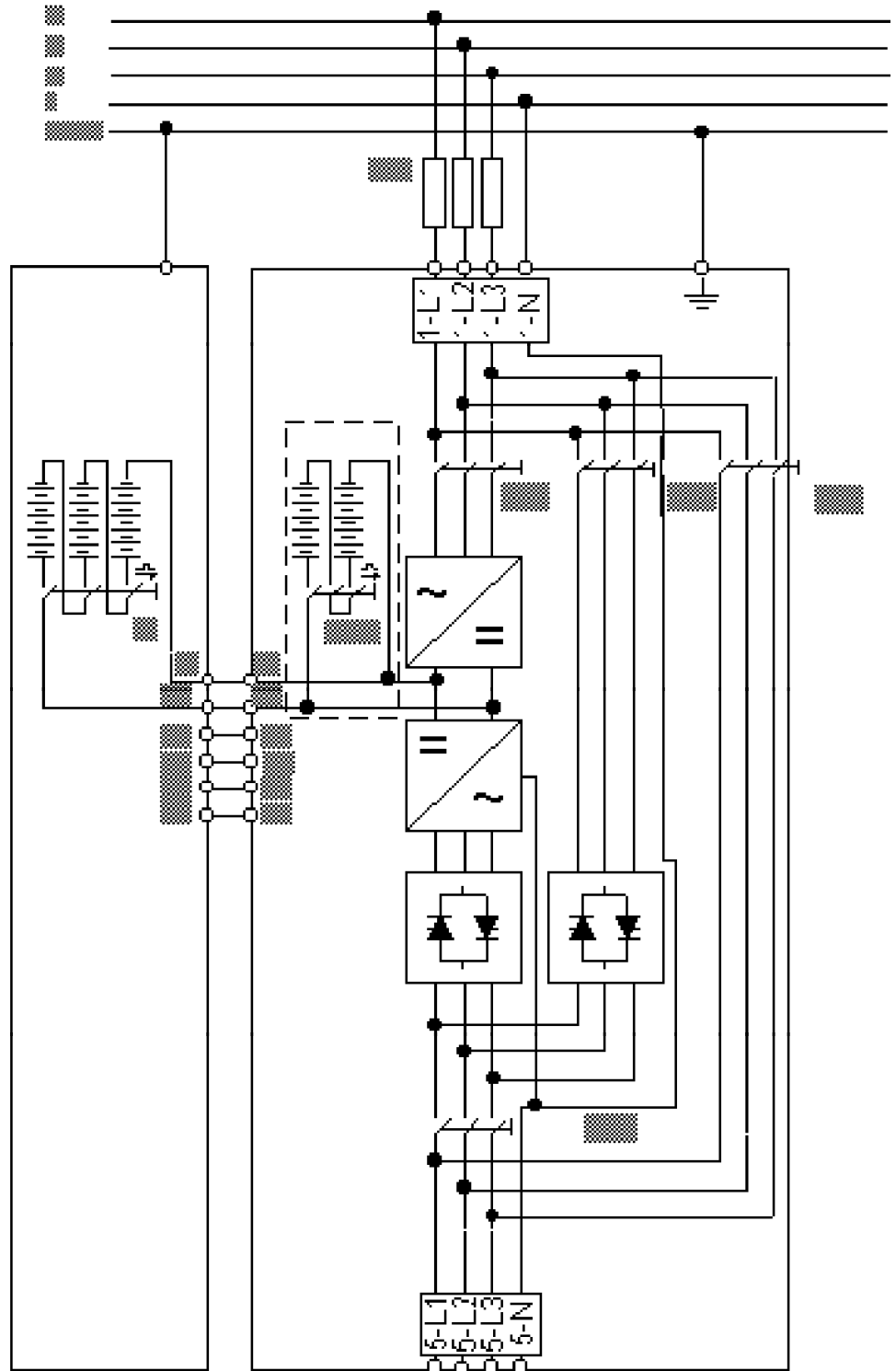


FIG. 1.2.1 UPS connection diagram, version 1

(\*) **Note:** Internal Battery only for 10-30kVA units

(\*\*) **Note:** Customer supplied input fuses - see table 1.2.1

# 1 Installation

## Version 1 SOLA 4000 with Common Input for Rectifier and Bypass

### Input Cables / Fuses

Type SOLA 4000	Input cables [mm <sup>2</sup> ]	Input fuses [A]	earth cable [mm <sup>2</sup> ]
10	4x10	25	16
15	4x10	35	16
20	4x16	50	16
30	4x25	63	25
40	4x35	100	25
60	4x35	125	25
80	4x70	160	50
100	4x70	200	50
120	4x120	250	70

TAB.1.2.1 UPS input cables and fuses, version 1

### Output / Battery Cables and Max. Current Ratings for Battery Overcurr. protection

Type SOLA 4000	Battery cables [mm <sup>2</sup> ]	Output cables [mm <sup>2</sup> ]	Max. inv. input current (V <sub>dc</sub> =320V)
10	2x16	4x10	25
15	2x16	4x10	40
20	2x25	4x16	50
30	2x25	4x35	75
40	2x35	4x25	100
60	2x50	4x35	150
80	2x70	4x50	200
100	2x95	4x70	250
120	2x120	4 x120	300

TAB.1.2.2 UPS output cables and fuses, version 1

# 1 Installation

## Version 2 SOLA 4000 with Separate Inputs for Rectifier and Bypass

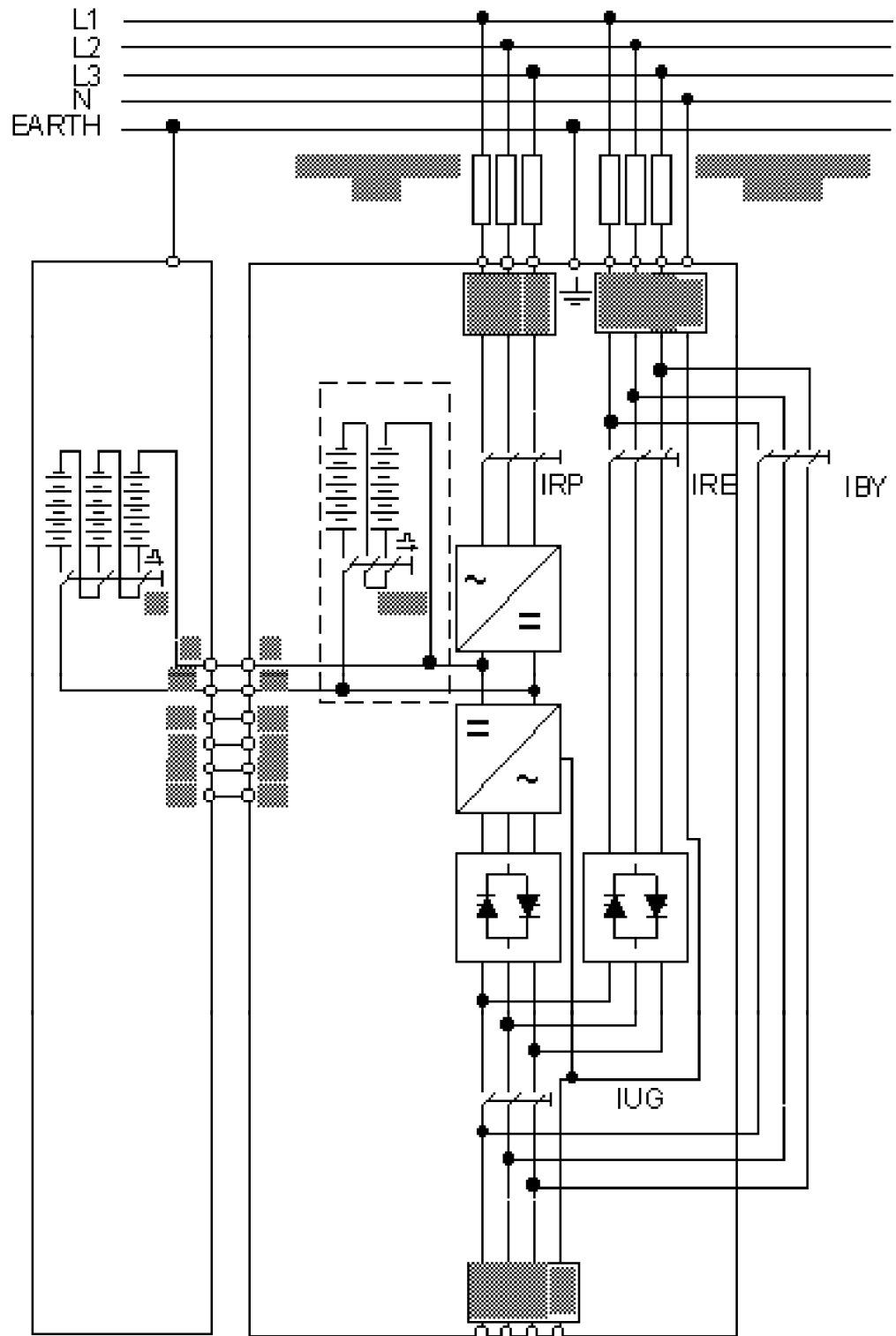


FIG. 1.2.2 UPS connection diagram, version 2

(\*) **Note:** Internal Battery only for 10-30kVA units

(\*\*) **Note:** Customer supplied rectifier input fuses - see table 1.2.5

(\*\*\*) **Note:** Customer supplied bypass input fuses - see table 1.2.5

# 1 Installation

## Version 2 SOLA 4000 with Separate Inputs for Rectifier and Bypass

### Input Cables

Type SOLA 4000	Rect. cables [mm <sup>2</sup> ]	Bypass cables [mm <sup>2</sup> ]	earth cable [mm <sup>2</sup> ]
10	3x10	4x10	16
15	3x10	4x10	16
20	3x16	4x16	16
30	3x25	4x25	25
40	3x25	4x25	25
60	3x35	4x35	25
80	3x50	4x50	50
100	3x70	4x70	50
120	3x120	4x120	70

TAB. 1.2.3 UPS input cables, version 2

### Input Fuses

Type SOLA 4000	Rect. Fuses [A]	Bypass Fuses [A]
10	25	25
15	35	35
20	50	50
30	63	63
40	100	100
60	100	125
80	125	160
100	160	200
120	200	250

TAB. 1.2.4 UPS input fuses, version 2

### Output / Battery Cables

Type SOLA 4000	Battery cables [mm <sup>2</sup> ]	Output cables [mm <sup>2</sup> ]	Max. inv. input current (Vdc=320V)
10	2x16	4x10	25
15	2x16	4x10	40
20	2x25	4x16	50
30	2x25	4x35	75
40	2x35	4x25	100
60	2x50	4x35	150
80	2x70	4x50	200
100	2x95	4x70	250
120	2x120	4 x120	300

TAB. 1.2.5 UPS output cables and fuses, version 2



# 1 Installation

## 1.3 Installation of additional optional cabinets

SOLA 4000 with input and output transformers for voltage adaption

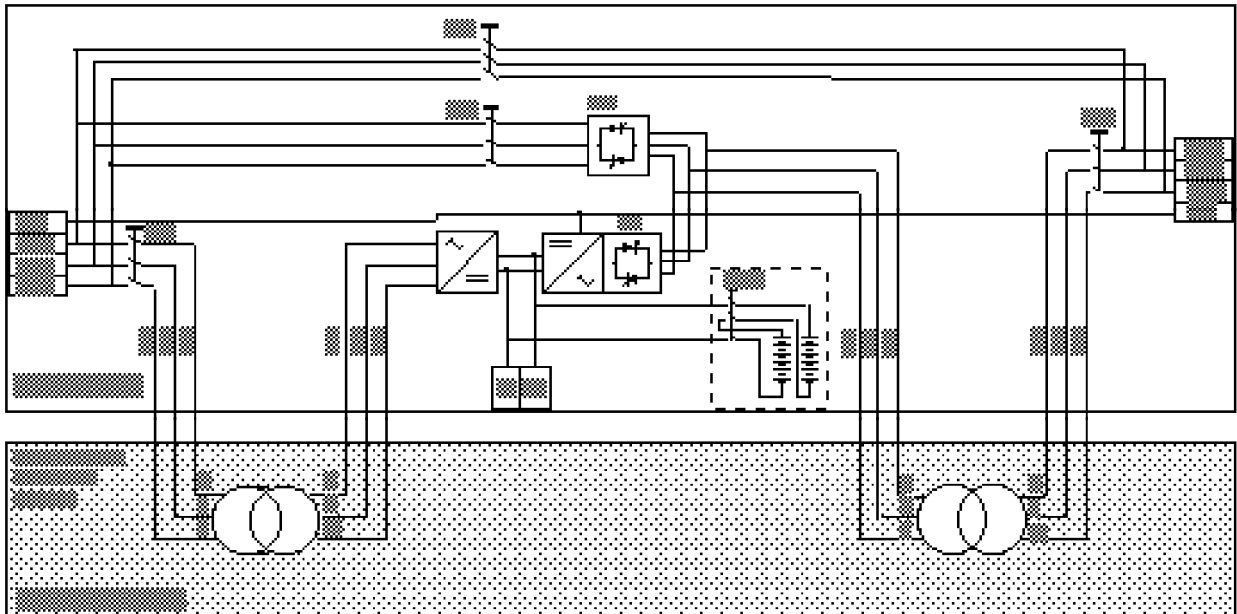


FIG. 1.3.1 UPS connection diagram, with input and output transformers to adapt the UPS to the on-site voltage.

SOLA 4000 with isolation transformer of the bypass supply

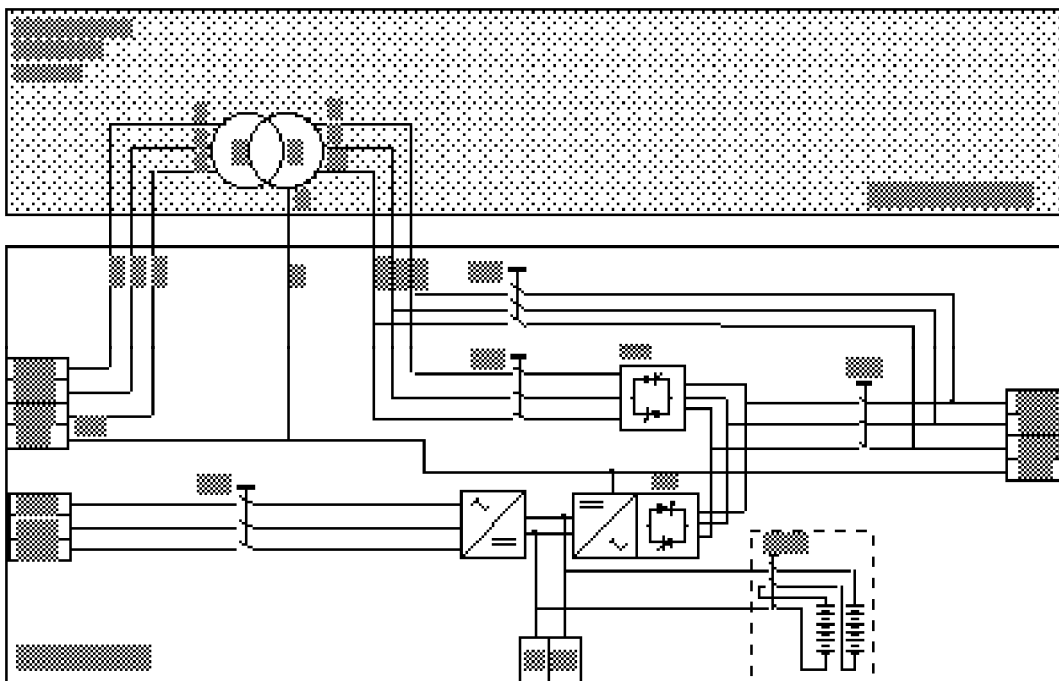


FIG. 1.3.2 UPS connection diagram, with bypass input transformer to isolate the neutral line (\*\* 4-N may be connected to the supply neutral or earth or left disconnected.)

(\*) **Note:** Internal Battery only for 10-30kVA units

# 1 Installation

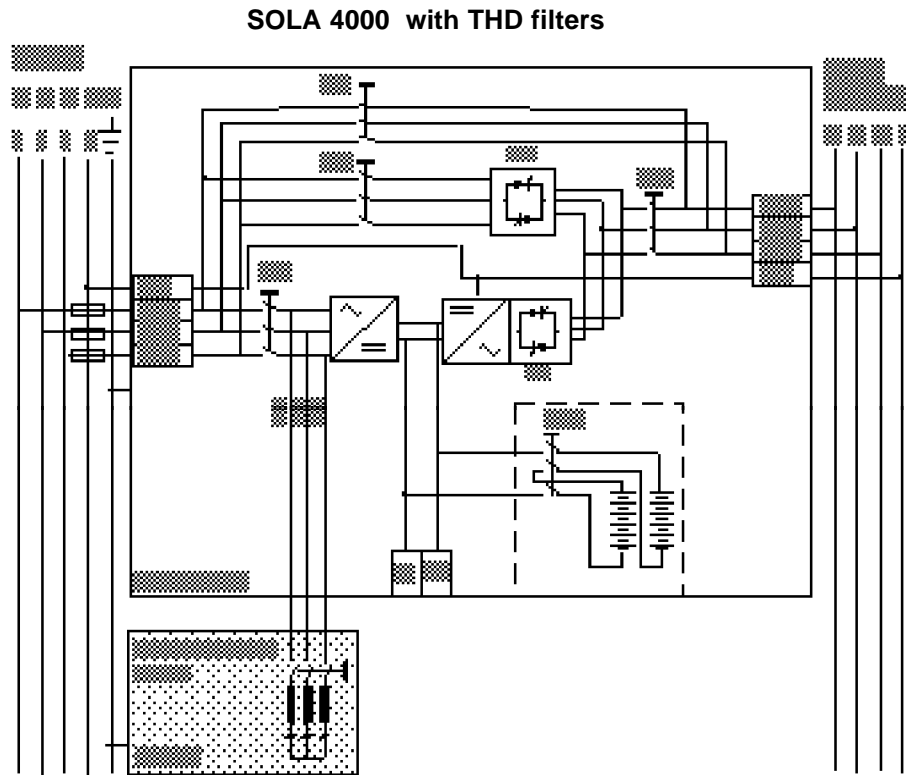


FIG. 1.3.3 UPS connection diagram, with THD filters

(\*) **Note:** Internal Battery only for 10-30kVA units

# 1 Installation

SOLA 4000 with 12-pulse charger / rectifier

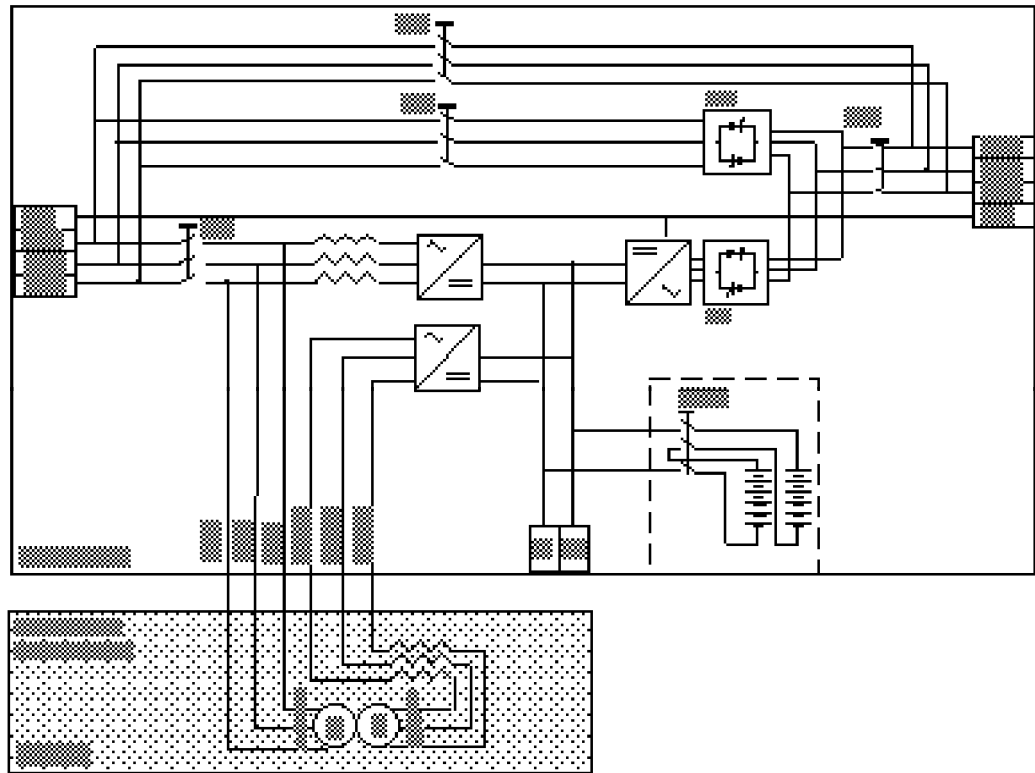


FIG. 1.3.4 Installation of 12-pulse units without galvanic isolation

SOLA 4000 with 12-pulse charger / rectifier and galvanic isolation of the input supply.

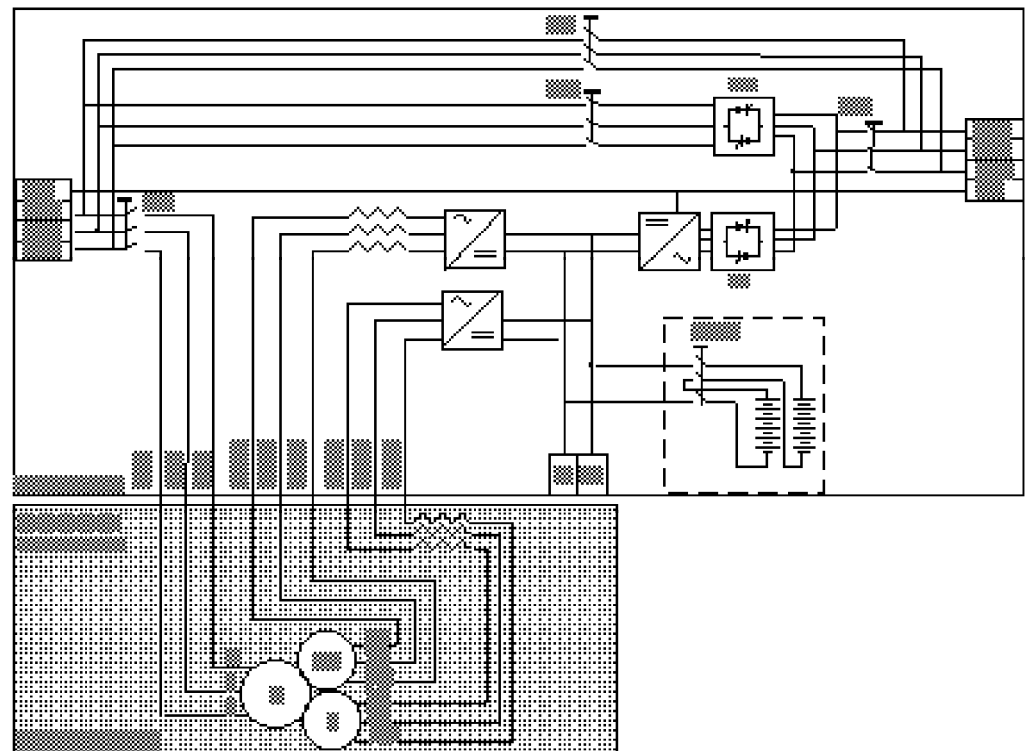


FIG. 1.3.5 Installation of 12-pulse units with galvanic isolation

(\*) **Note:** Internal Battery only for 10-30kVA units

# 1 Installation

## 1.4 Installation of an External Maintenance Bypass

When an external maintenance bypass is installed, a normally open, voltage free contact must be available. This contact must be connected to the connector M4, Pin1 and Pin 2 at the top left hand corner of the mother board for the inverter/bypass electronics (IBYBP-CP see figure 1.10.3).

If the standard SOLA no-break wall-mounted maintenance bypass switch is used (optional) in the MB3 cabinet, a normally open contact is provided. For the version 2 maintenance bypass (3 position), an additional contact is provided which automatically isolates the UPS system (EPO) when switched to the "UPS ISO-LATED" position (see FIG 1.4.2).

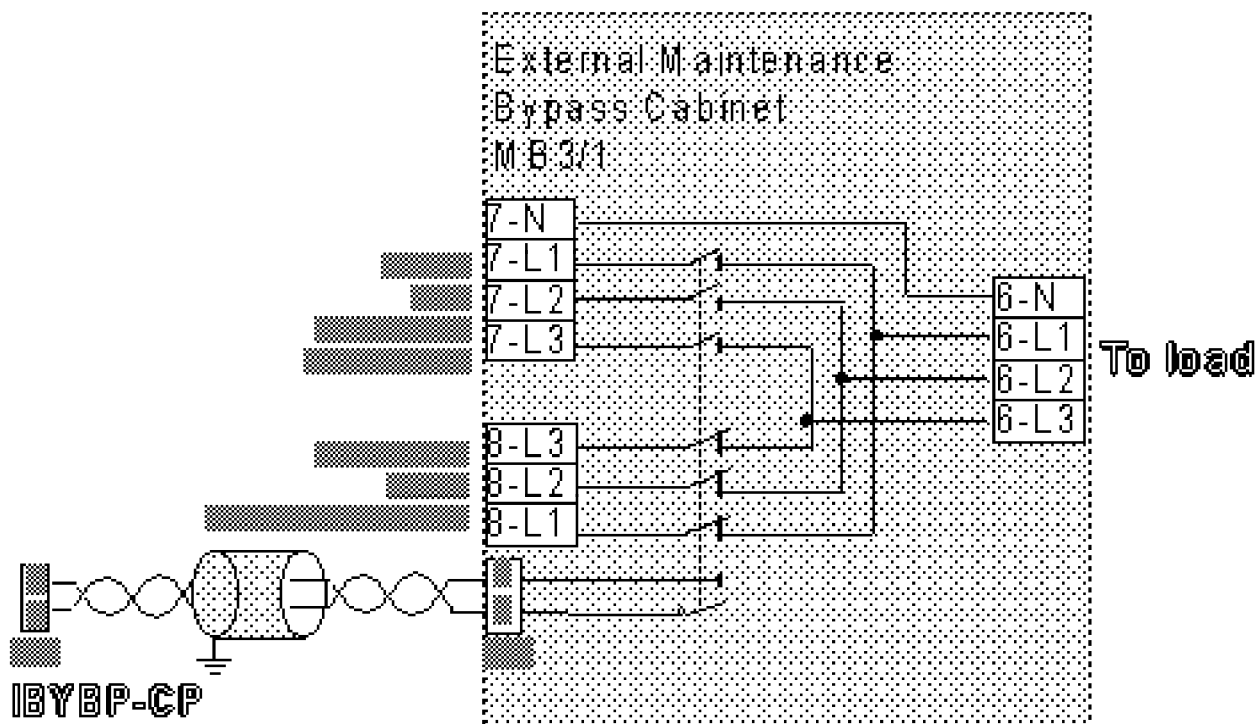


FIG.1.4.1 External Maintenance Bypass Switch Version 1 (2 position)

# 1 Installation

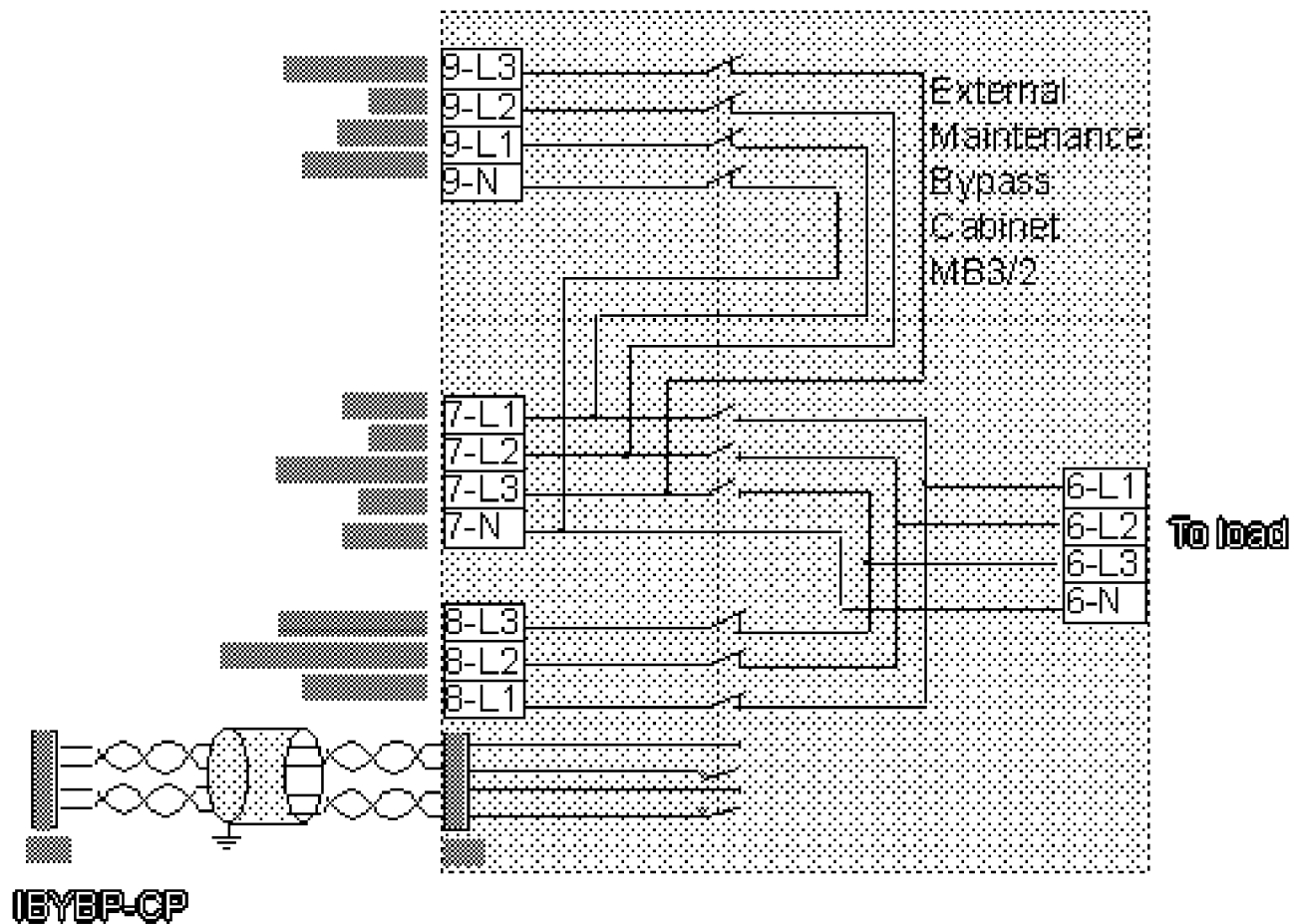


FIG.1.4.2 External Maintenance Bypass Switch Version 2 (3 position)

**Note1:** For Hot-Standby or parallel systems, it is sufficient to feed one contact into one unit only, however they may be connected in parallel at M4 (of IBYBP-CP) Pin1 and Pin 2 for all units. In this case separate terminals may be provided within the MB3 cabinet (see FIG. 1.9.2 and 1.10.2)

**Note2:** The cable used must be twisted pair, with a total shield. This shield must be grounded at one end (the cabinet of the UPS may be used).

# 1 Installation

## 1.5 CPNET Interface Card

The CPNET interface card is used for remote signalling of four standard alarm conditions by means of voltage-free contacts in programmable configurations.

### 1.5.1 Installation

The CPNET interface card is a small pcb that is installed directly underneath the CPU/NCP pcb, inside the front door of the UPS cabinet.

It is connected to the UPS via the connector CN1 on the CPNET pcb to CN10 on the CPU/NCP pcb.

It can be connected to remote devices via two different connectors:

- CN2, a 9 pin sub-D connector for standard computer connection. The following interface cables are available (see also JUE 300 599):
  - IBM AS-400
  - Novell
  - 3-COM
  - Banyan Vines
- M1, a terminal block for individual configurations.

### 1.5.2 Functions

Contacts for the following alarm conditions are available:

Inverter Operation (N)	(CN1, pin 6)
Bypass Operation (B)	(CN1, pin 8)
Mains Failure (MF)	(CN1, pin 5)
Battery Low (BL)	(CN1, pin 7)

By means of the DIP switch SW1, the single relays and output pins can be configured for each requirement.

SW1								INTERFACE
1	2	3	4	5	6	7	8	
0	0	0	1	0	1	1	0	IBM-AS400
0	0	0	0	-	-	0	1	NOVEL
0	0	1	0	-	-	-	-	3-COM
0	0	0	0	-	-	-	-	BANYAN-VINES
0	1	1	0	-	-	0	1	BORRI VIKING
0	0	1	0	-	-	0	1	BORRI SIDEKICK
0	0	1	0	-	-	0	1	AMERICAN POWER

TAB. 1.5.2.1 Programming of the CP-NET pcb

**Note:** Maximum rating of relay contacts: 250Vac, 6A (only when using connector M1)

# 1 Installation

Pin CN2	Pin M1	AS400	NOVEL	3-COM	BANYAN-VINES	BORRI VIKING	BORRI SIDEKICK	AMERICAN POWER
1	1				Not Used			
2	2	N	-	MF*	-	MF*	MF*	MF*
3	3	MF	MF	MF	MF	MF	MF	MF
4	4				Common			
5	5	BL	BL	BL	BL	BL	BL	BL
6	6	B	MOK	-	-	MOK	MOK	MOK
7	7	BOK	BOK	BOK	BOK	BOK	BOK	BOK
8	8	-	-	-	-	BL*	-	-
9	9				0 V			
	10				Not Used			

TAB. 1.5.2.2 Allocation of the pins for the output connectors CN1 and M1 for the various programming configurations of TAB. 1.5.2.1

Key to table 1.5.2.2 (when contact is closed with respect to pin 4).

- N: Inverter Operation
- B: Bypass Operation
- MF: Mains Failure
- BL: Battery Low
- MF\*: 0V when mains failure, -12V when mains OK
- BL\*: -12V when battery low, otherwise +12V
- MOK: Mains OK
- BOK: Battery not low

# 1 Installation

## 1.6 Remote Emergency Power off

A Remote Emergency Power Off may be connected to the system. The connection terminals are M4 Pin 5 and Pin 6, using a normally-open, voltage-free contact as a pushbutton. (See FIG. 1.6.1. and FIG 1.6.2.)

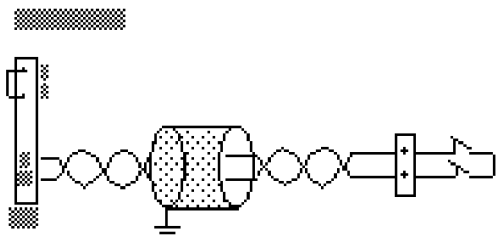


FIG. 1.6.1 Connection of Remote EPO with N.C. contact

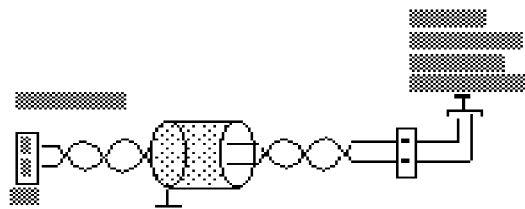


FIG. 1.6.2 Connection of Remote EPO with N.O. contact

**Note 1:** The cable used must be twisted pair, with a total shield. This shield must be grounded at one end (the cabinet of the UPS may be used).

**Note 2:** For Hot-Standby or parallel systems, it is sufficient to feed one contact into one unit only, however they may be connected in parallel at M4 (of IBYBP-CP) Pin5 and Pin 6 for all units (N/O) only or series for (N/C).

**Note 3:** To completely isolate the UPS system from all voltage with the emergency power off (EPO), it is necessary to install trippable circuit breaker on the input supply (to terminals 1-L1, 1-L2, 1-L3 and 4-L1, 4-L2, 4-L3 and 4-N if installed).

The trip coil is then connected to the terminal M1 on the CPU/NCP pcb located inside the front door of the cabinet. A normally open or normally closed voltage-free contact is available.

**Note 4:** The N.C. contact can only be used for IBYBP-CP motherboards in rev. 0A and following.

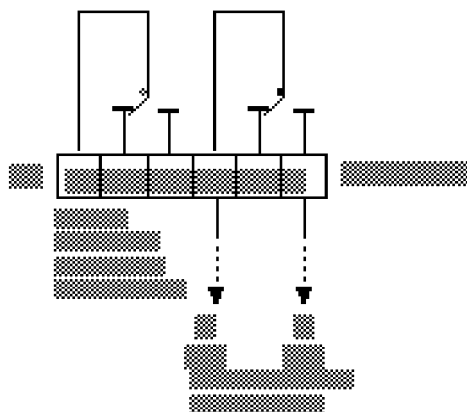


FIG. 1.6.3 Connection of Remote Emergency Power Off - Input and battery circuit breaker trip circuit.

Nominal Rating of Contacts		
125 V $\cong$	0,5 A	60 W
30 V $\cong$	2 A	60 W

TAB. 1.6.1 Nominal Rating of contacts for the input breaker trip circuit.



# 1 Installation

## 1.7 Diesel - Generator Operation

During diesel generator operation, if the frequency of the diesel-generator, with UPS and load connected, is unstable, it is advisable to disconnect the synchronisation of the inverter. This is achieved with a normally-open, voltage-free contact (which closes during diesel-generator operation) and is connected to the connector M4 Pin 7 and Pin 8 as follows:

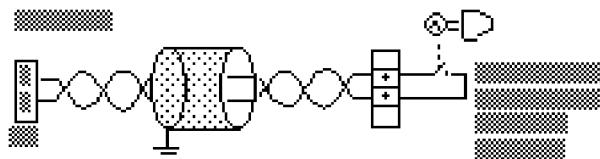


FIG. 1.7.1 Connection for Diesel Generator Operation (connector M4) - synchronisation disable.

**Note1:** For Hot-Standby or parallel systems, it is sufficient to feed one contact into one unit only, however they may be connected in parallel at M4 Pin7 and Pin 8 for all units

If it is necessary to reduce the current supplied by the diesel-generator, then a second voltage-free contact (again normally open) is required and must be connected to the connector M8, Pin 1 and Pin 2 on the rectifier electronic mother board (RBPHC16) see FIG.1.7.2

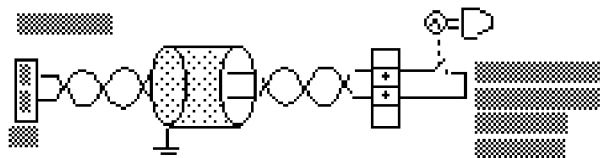


FIG. 1.7.2 Connection for Diesel Generator Operation (connector M8) - second level current limitation.

**Note 1:** The cable used in both cases must be twisted pair, with a total shield. This shield must be grounded at one end (the cabinet of the UPS may be used).

**Note 2:** The cable for current limitation must be connected to all units for parallel or hot-standby units, using separate voltage-free contacts.

# 1 Installation

## 1.8 Common Alarm Contacts

As a standard feature, contacts are provided for a remote common alarm. The connector is located on the control p.c.b for the front operating panel (CPU/NCP), located inside the front door of the UPS.

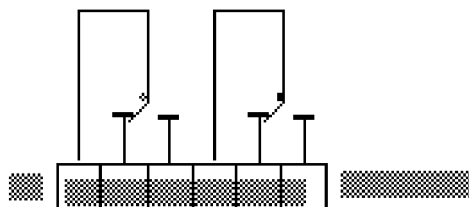


FIG. 1.8.1 Connection of Remote Common Alarm

Nominal Rating of Contacts		
125 V $\cong$	0,5 A	60 W
30 V $\cong$	2 A	60 W

TAB. 1.8.1 Nominal Rating of contacts for the common alarm.

**Note 1:** As an option a pcb CP-NET is available, providing more contacts, compatible with most common configurations (eg AS400, Novell etc.)

A Remote panel may also be purchased with identical functions to the front operating panel.

**Note 2:** To achieve a single common alarm for parallel or hot-standby units, the contacts of each unit may be interconnected in parallel (normally - open) or series (normally - closed).

## 1.9 Remote Reset

The UPS system may be reset remotely with the connection of contacts ( a push-button) to the terminal M4 as shown:

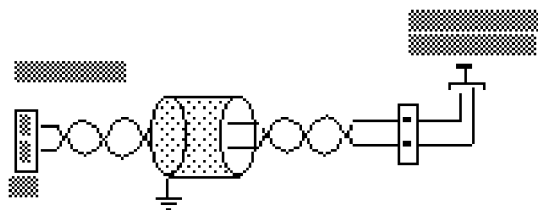


FIG.1.9.1 Connection of Remote Reset

**Note:** The cable used must be twisted pair, with a total shield. This shield must be grounded at one end (the cabinet of the UPS may be used).

# 1 Installation

## 1.10 Installation of Hot-Standby Systems

For hot-standby systems the units must be connected together as shown in the FIG. 1.10.1 or FIG. 1.10.2

**Note:** The installation for each unit must be performed in accordance to the installation of single units as described in the previous sections. Additionally to this, the outputs must be connected in parallel as shown in FIG. 1.10.1 or in FIG.1.10.2

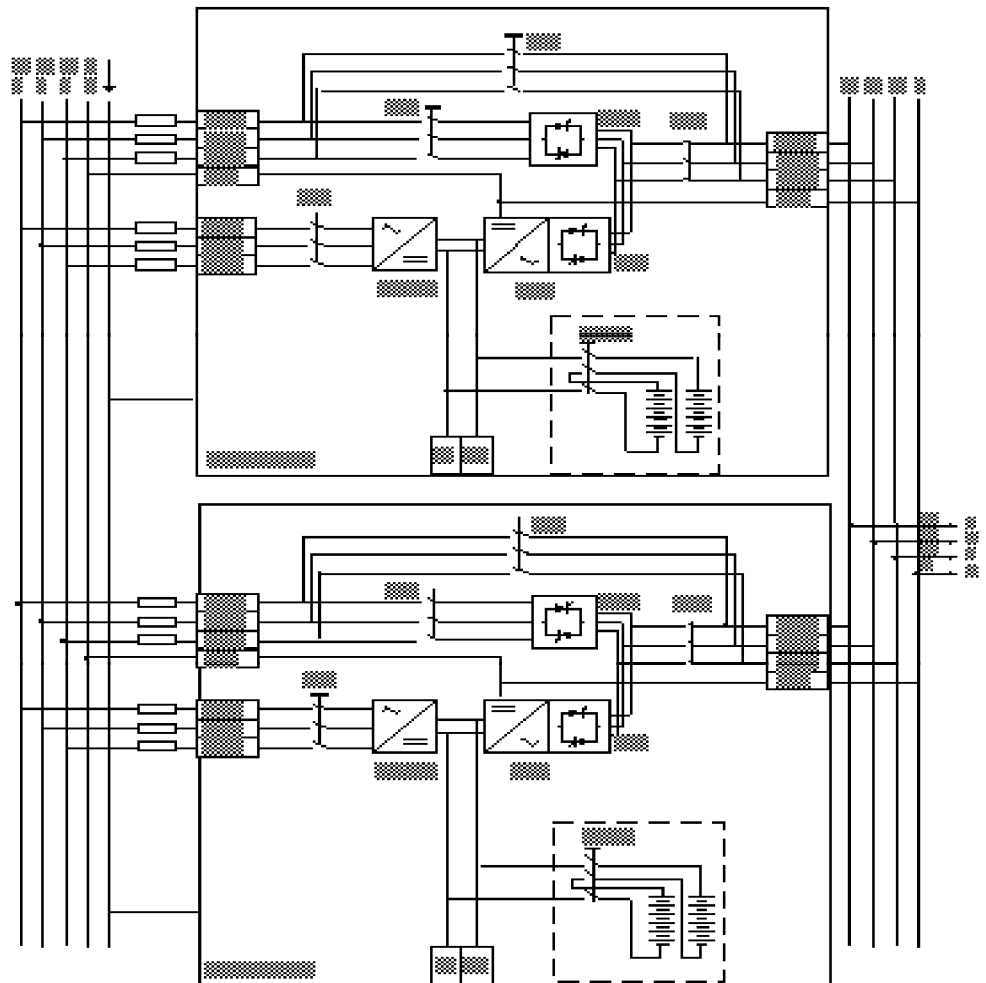


FIG. 1.10.1 Interconnection of hot-standby units with integrated maintenance bypasses and separate bypass terminals.

(\*) **Note:** Internal Battery only for 10-30kVA units

# 1 Installation

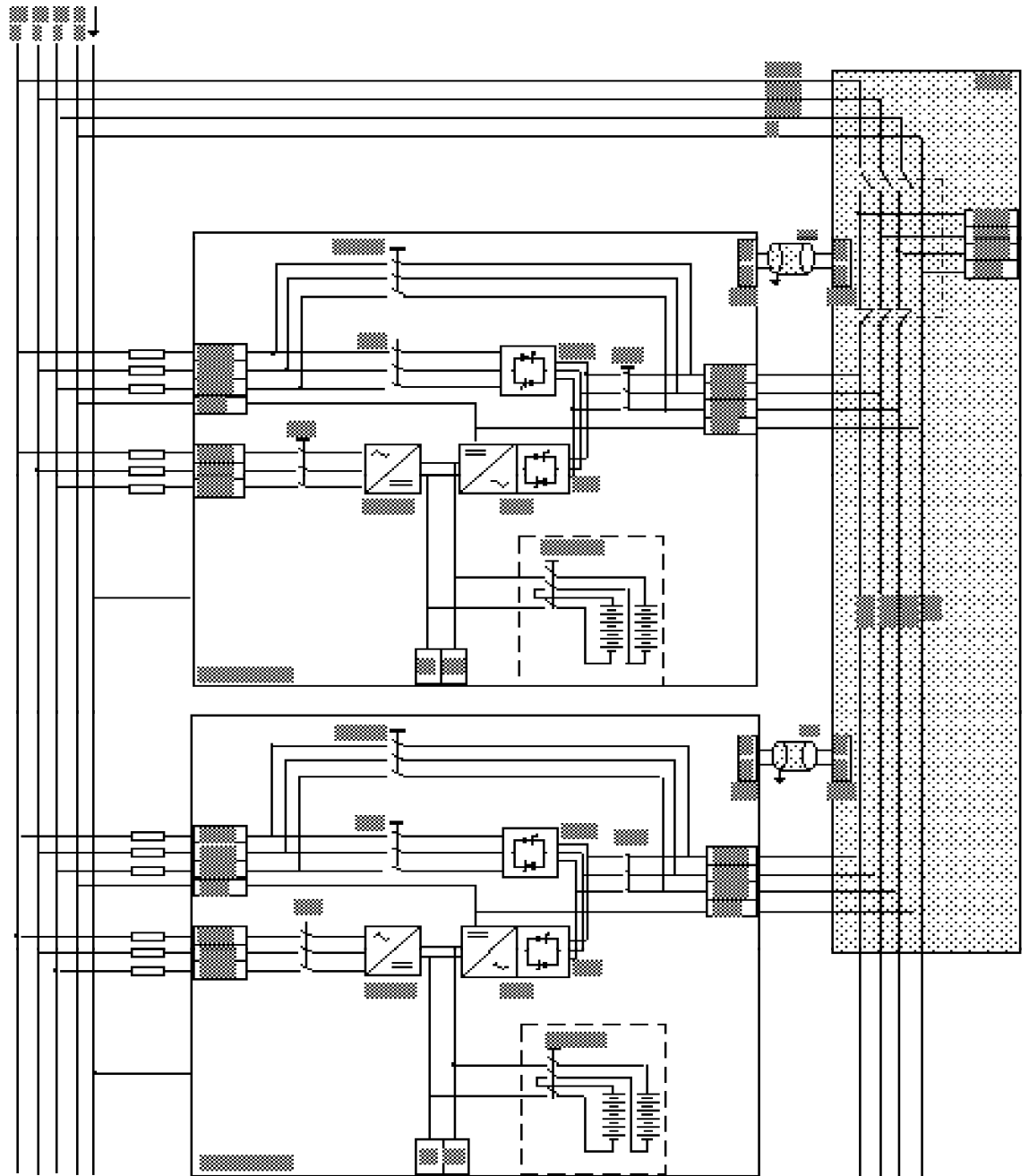


FIG. 1.10.2 Interconnection of hot-standby units with external maintenance bypass and separate bypass terminals.

(\*) **Note:** The internal maintenance bypass (IBY) may or may not be installed in this configuration.

(\*\*) **Note:** This cable must be twisted pair, total shield (refer. to section 1.4)

(\*\*\*) **Note:** Internal Battery only for 10-30kVA units

# 1 Installation

## 1.10.1 Installation of the Interconnection Cable

The supplied cable must be connected between the units within the system. This must be connected at either of the connectors CN12 or CN13 on the mother-board of the Inverter/Bypass electronics (IBYBP-CP) and the other end of the cable is connected to either CN12 or CN13 on the mother-board of the Inverter/Bypass electronics (IBYBP-CP) of the other unit(s).

**Note:** If the unit is to be added to one already installed stand-alone unit which has not been previously tested in a hot-standby configuration, the supports and mounting screws to mount the cable to the p.c.b are supplied with the cable. They must be mounted at both sides of the selected connector in order to fix the cable securely to the connector with the supplied screws.

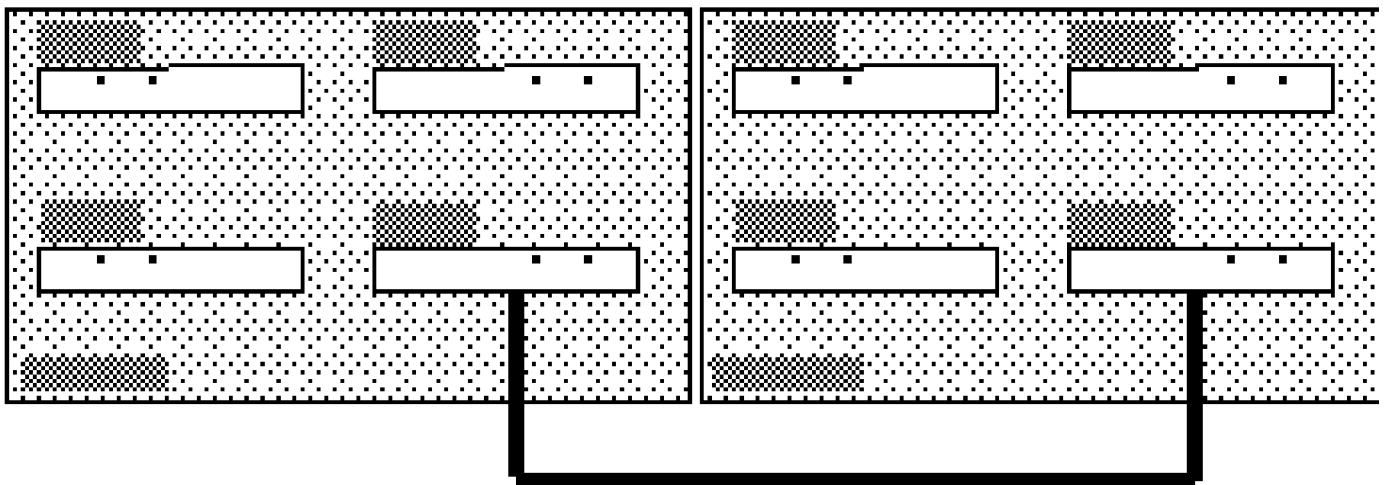


FIG. 1.10.3 Interconnection of control BUS cable for hot-standby units

# 1 Installation

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## 1.11 Installation of Parallel Systems

Up to a total of 8 units may be installed together in the one parallel system.

**Note:** The installation for each unit must be performed in accordance to the installation of single units as described in the previous sections. Additionally to this, the outputs must be connected in parallel as shown in FIG. 1.11.1 or in FIG.1.11.2



Care must be taken with the installation of the bypass line and in particular, that the cables from the point of common coupling of the input supply to the terminals 1-L1, 1-L2, 1-L3 (or 4-L1, 4-L2, 4-L3, 4-N if an optional separate bypass input is installed), are of equal length. Likewise, the output cables from the output terminals (5-L1, 5-L2, 5-L3, 5-N) to the point of common coupling on the load side must be of equal length.

# 1 Installation

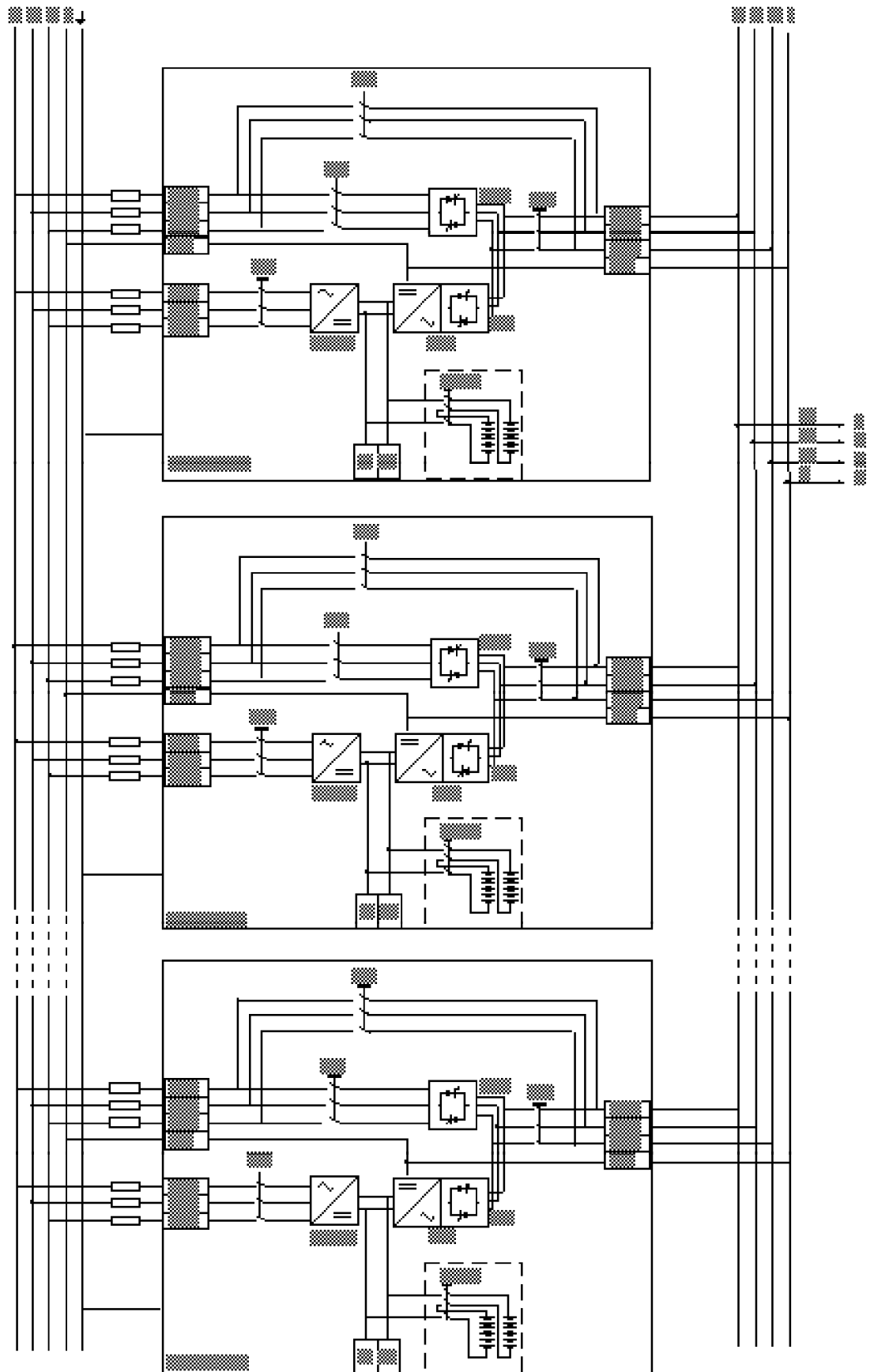


FIG. 1.11.1 Interconnection of parallel units with integrated maintenance bypasses and separate bypass terminals.

(\*) **Note:** Internal Battery only for 10-30kVA units

# 1 Installation

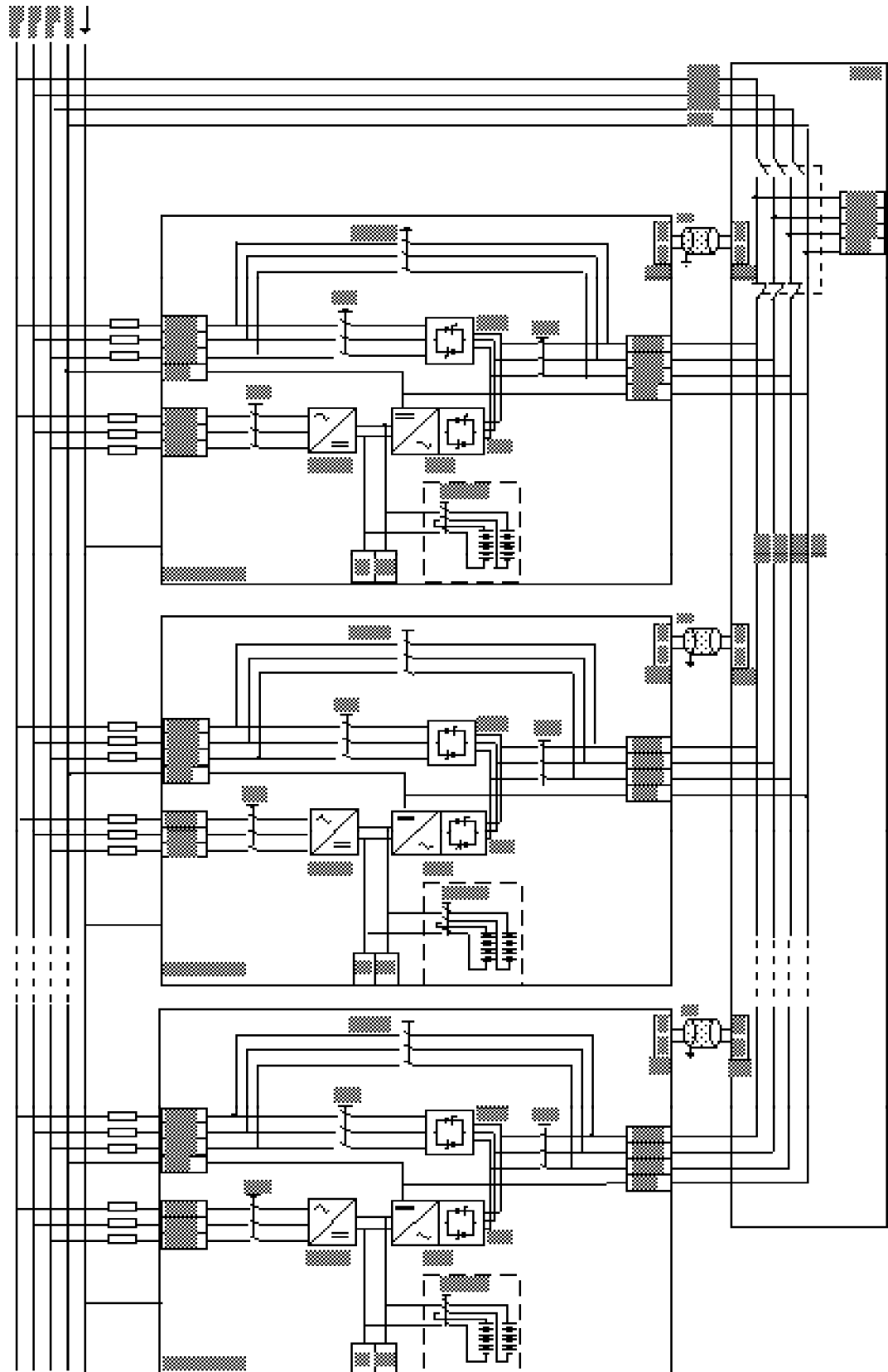


FIG. 1.11.2 Interconnection of parallel units with common maintenance bypass and separate bypass terminals.

(\*) **Note:** The internal maintenance bypass may or may not be installed in this configuration.

(\*\*) **Note:** This cable must be twisted pair, total shield (refer to section 1.4)

(\*\*\*) **Note:** Internal Battery only for 10-30kVA units



# 1 Installation

## 1.11.1 Installation of the Interconnection Cables

There are two interconnection cables supplied with the units for each additional unit to the first unit. These cables must be connected between the units as shown in FIG. 1.11.4 One cable is connected to either CN12 or CN13 (the other end being connected to the corresponding connector of another unit), and the other cable is connected to either of CN10 or CN11, again with the other end connected to the corresponding connector of another unit. In this way, all units will be interconnected by two cables in a BUS-Communication system (Daisy-chain connection).

**Note:** If the unit is to be added to one already installed stand-alone unit which has not been previously tested in a parallel configuration, the supports and mounting screws to mount the cable to the p.c.b are supplied with the cables. They must be mounted at both sides of the selected connectors in order to fix the cables securely to the connectors with the supplied screws.

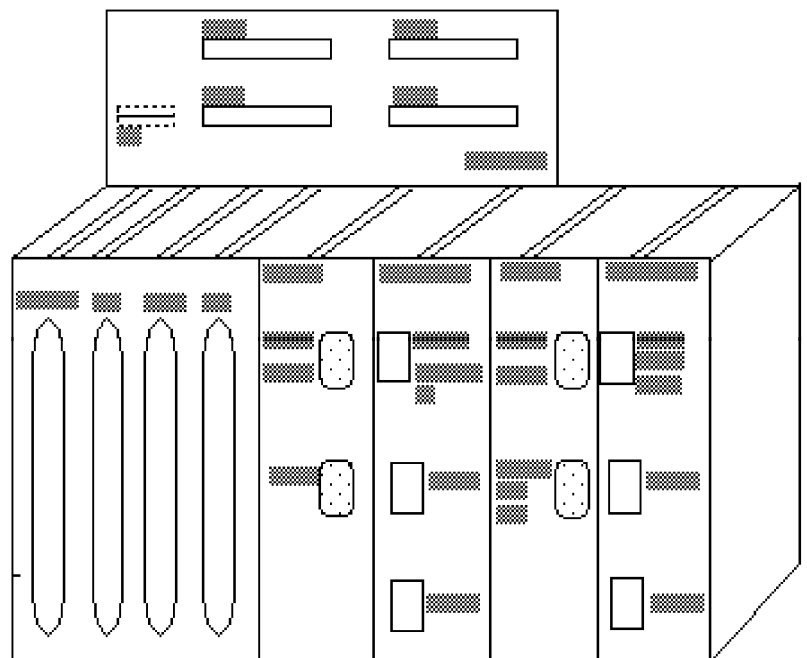


FIG. 1.11.3 Location of connectors on the IBYBP-CP pcb.

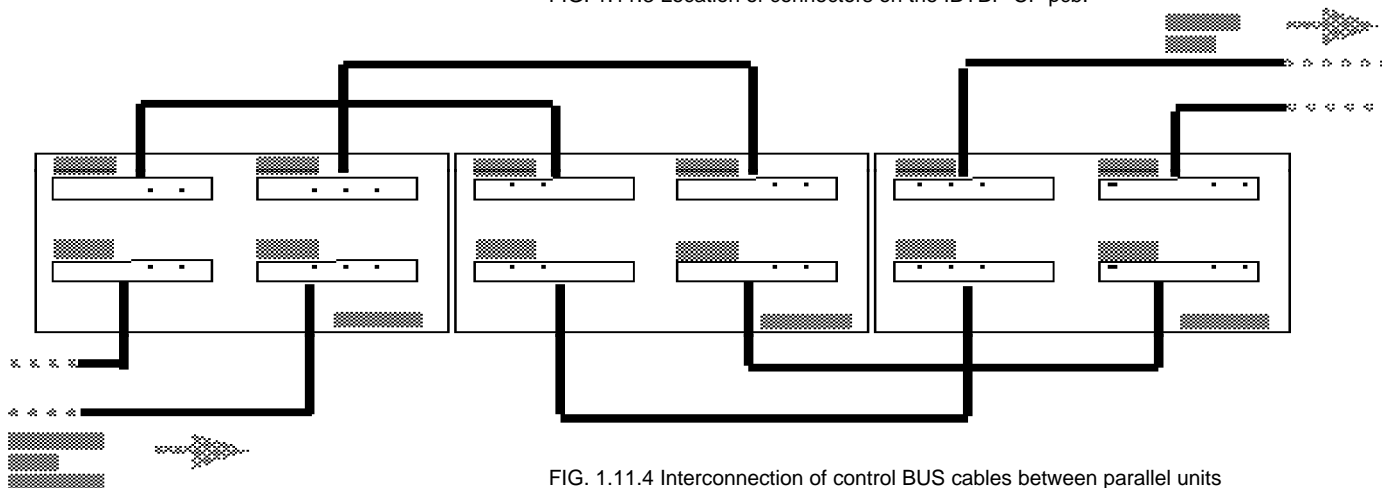


FIG. 1.11.4 Interconnection of control BUS cables between parallel units

# 1 Installation

## 1.12 Battery Installation



**Battery Installation must be in accordance with local safety standards.**

### General

The batteries are charged. The installation should only be made by appropriately qualified personnel. The screw connections between the batteries should be tightened with a torque wrench (max. 7 Nm).

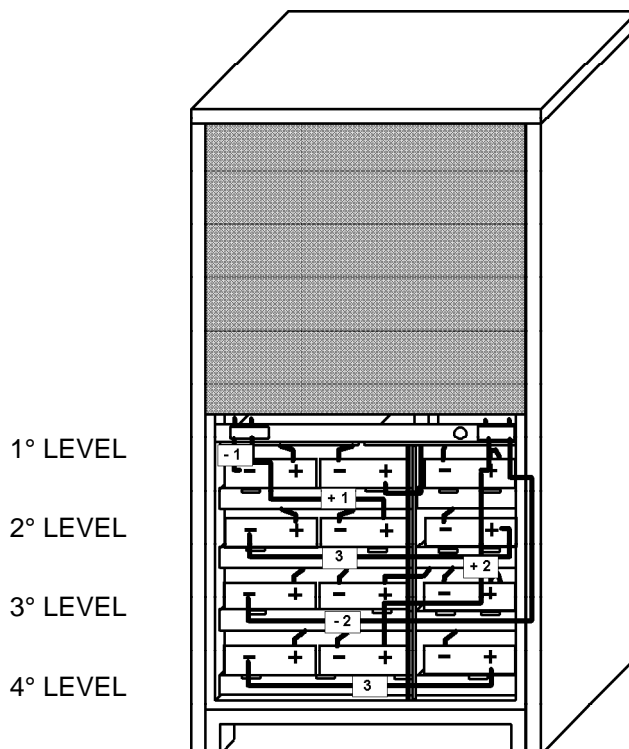
### 1.12.1 Installation of Internal batteries SOLA 4000 (10-30kVA)

#### Internal Battery (24Ah) Installation

- Place five battery blocks on the trays of the first level.
- Place nine battery blocks on the trays of the second, third and fourth level.
- Interconnect the blocks in series (see FIG.1.12.1)



**Warning:** after assembly there is a voltage of 67,5 V on the first level, and 121,5 V on the second, third and fourth levels.



# 1 Installation

## Internal Electrical Connections

Cable (1) n° 3; L = 280 mm; diameter 16 mm<sup>2</sup>

Cable (2) n° 8; L = 420 mm; diameter 16 mm<sup>2</sup>

Cable (3) n° 4; L = 490 mm; diameter 16 mm<sup>2</sup>

Cable (4) n° 2; L = 650 mm; diameter 16 mm<sup>2</sup>

Support (CA1) n° 4; See Fig. CA1

Support (CA2) n° 9; See Fig. CA2

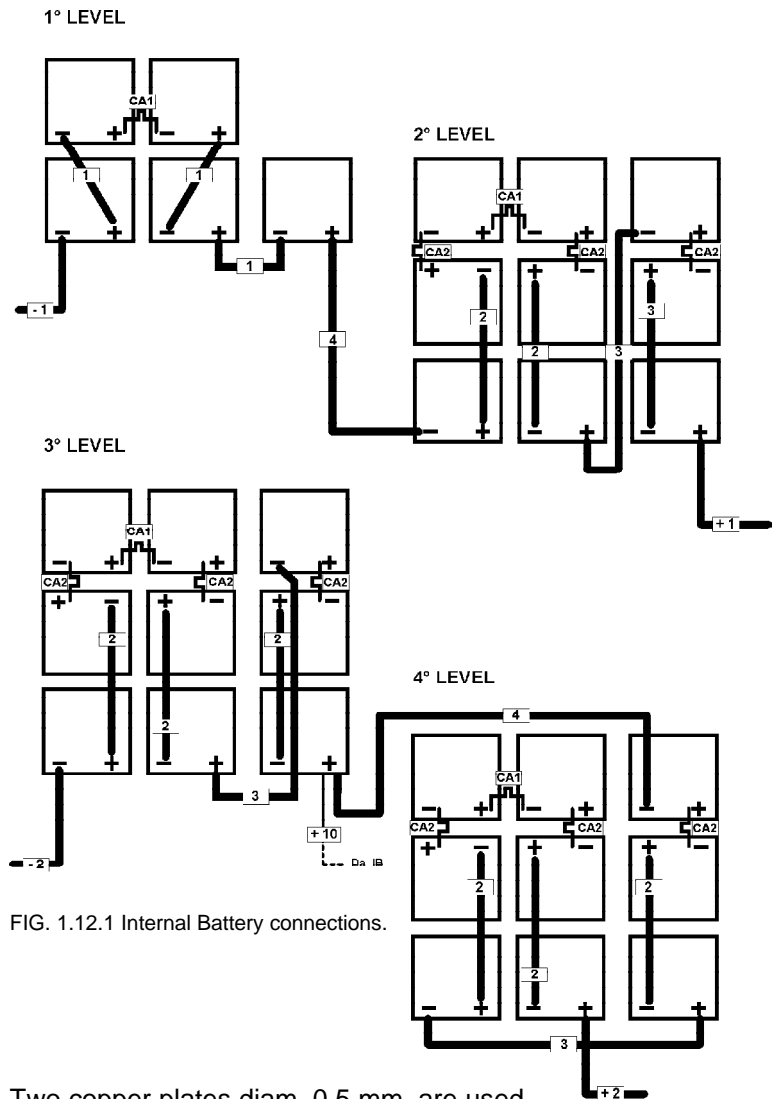
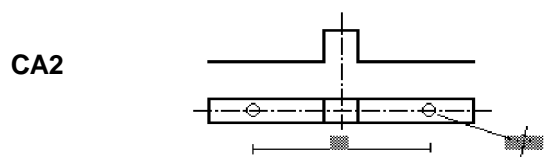
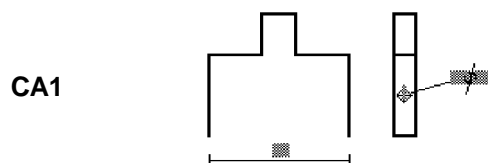


FIG. 1.12.1 Internal Battery connections.

**Copper bars for battery connection** Two copper plates diam. 0,5 mm. are used.



# 1 Installation

## 1.12.2 Installation of External Batteries

### External Battery (38 Ah) Installation

38 Ah external batteries are installed in a B3/38 battery cabinet. To assemble the battery cabinet:

- Place four battery blocks on the trays of the first level (see FIG. 1.12.2).
- Place six battery blocks on the trays of the second and third levels (see FIG. 1.12.3).
- Interconnect the blocks in series (block 1 / negative pole ==> block 2 / positive pole,.....)



**Warning:** after assembly there is a voltage of 48 V on the first level, and 72 V on the second and third levels.

- If necessary secure with strapping (against vibrations).
- Insert the trays into the battery cabinet as shown in FIG. 1.12.4

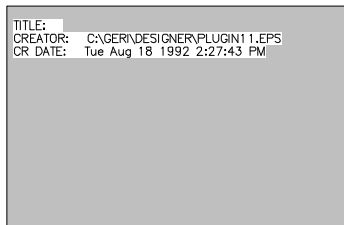
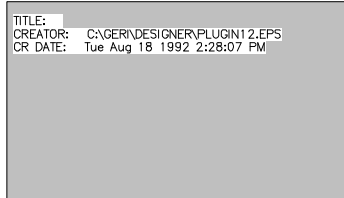


FIG. 1.12.3 B3/38: battery trays in the second and the third level



FIG. 1.12.4 Battery cabinet B3/38

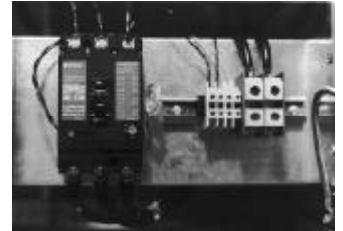
# 1 Installation

---



**Important:** Open battery switch **IB** before connecting the cables.

- Place the trays with the batteries on the corresponding levels in the UPS.
- Connect the battery blocks of the various levels to the battery switch **IB**, and **IB** to the terminals, as shown in FIG. 1.12.5 and FIG. 1.12.6



Ensure appropriate ventilation of the battery room according to the standard EN50091-1, to prevent the risk of an explosion.

# 1 Installation

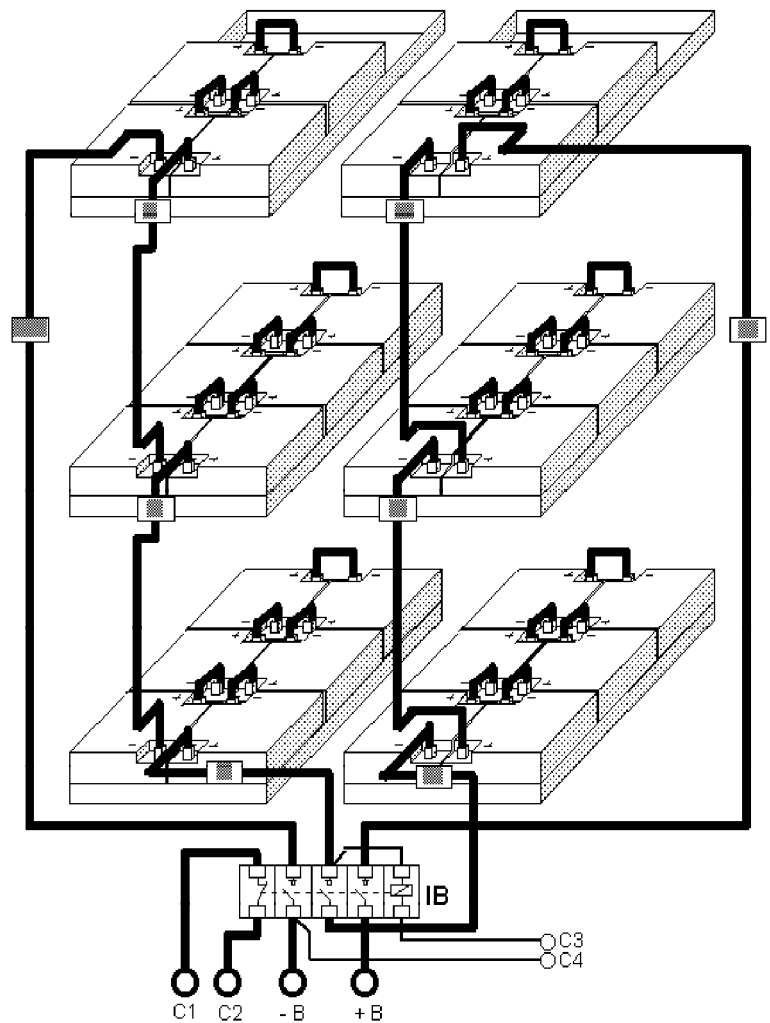


FIG. 1.12.6 B3/38 internal electrical connections

# 1 Installation

**External Battery (65 Ah) Installation** 65 Ah external batteries are installed in a B3/65 battery cabinet. To assemble the battery cabinet:

- Remove the battery switch IB and the terminals.
- Insert the battery blocks from the front and rear sides.



**Warning:** after assembly there is a voltage of 192 V at the front and rear side.

- Remount the battery switch IB and the terminals.



**Important:** Open battery switch **IB** before connecting the cables.

- Connect the battery blocks on the various levels to the battery switch **IB**, and **IB** to the terminals, as shown in FIG. 1.12.8 and FIG. 1.12.9

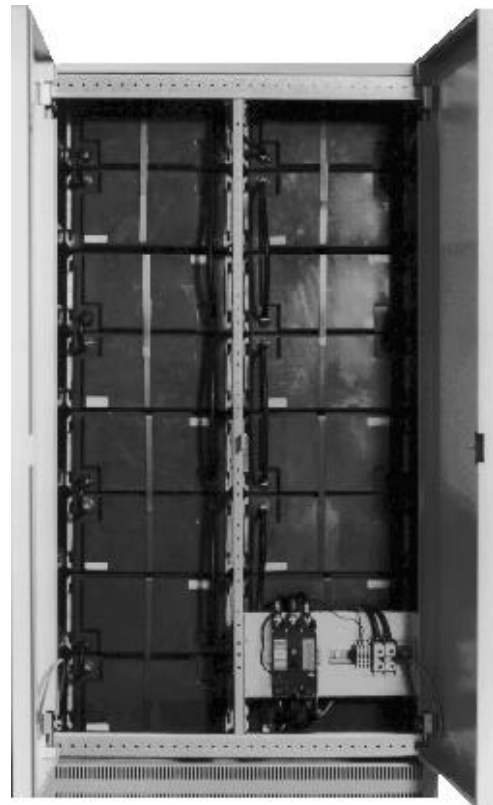


FIG. 1.12.7 Battery cabinet B3/65

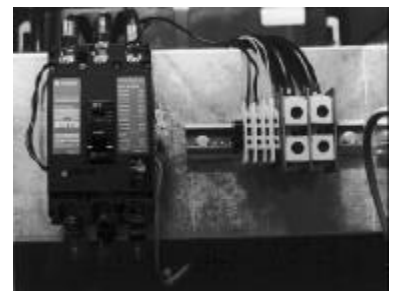


FIG. 1.12.8 B3/65: switch IB and terminals

# 1 Installation

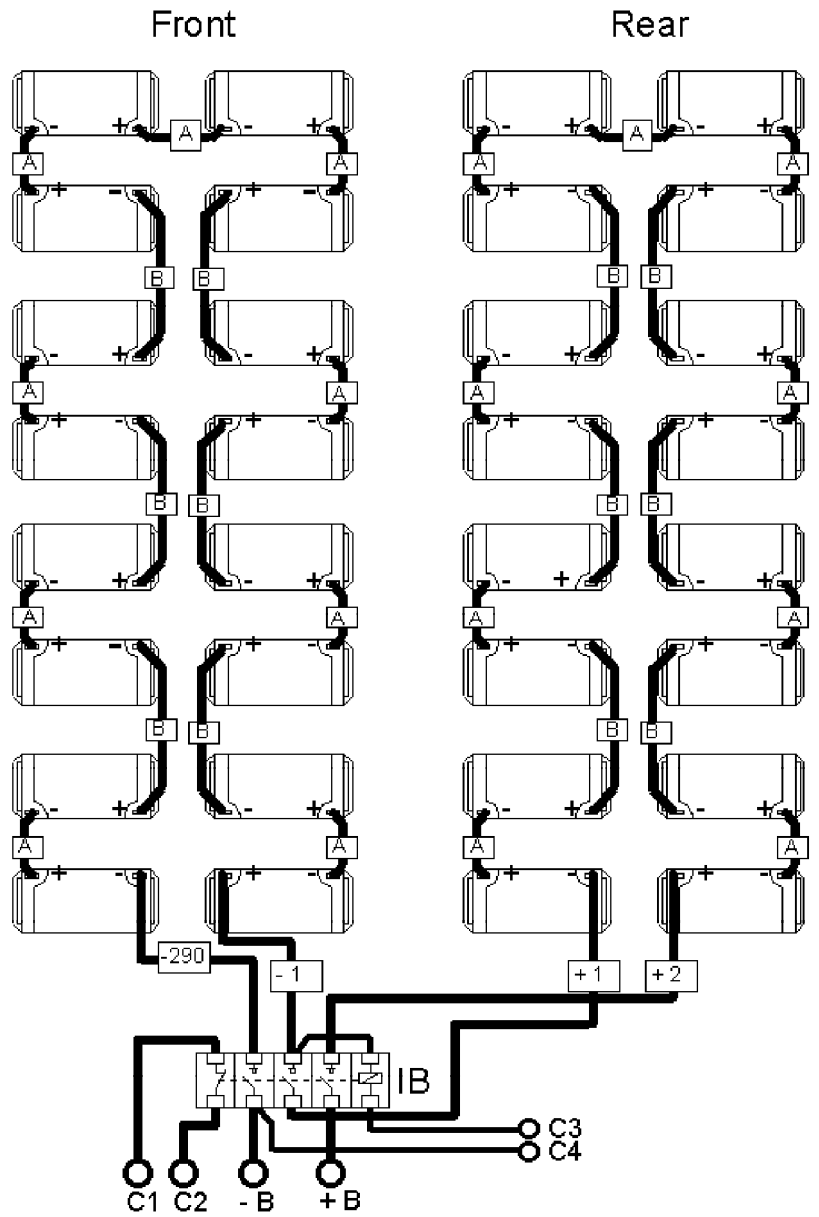


FIG. 1.12.9 B3/65 internal electrical connections



# 1 Installation

## Connection Between UPS and Additional Battery Cabinets



**Important:** Open all battery switches **IB** before connecting the cables. Observe the indicated wiring polarity.

- For UPS systems with external batteries: connect the external batteries as shown in FIG. 1.12.10
- After wiring, check that the external battery is connected with correct polarity.

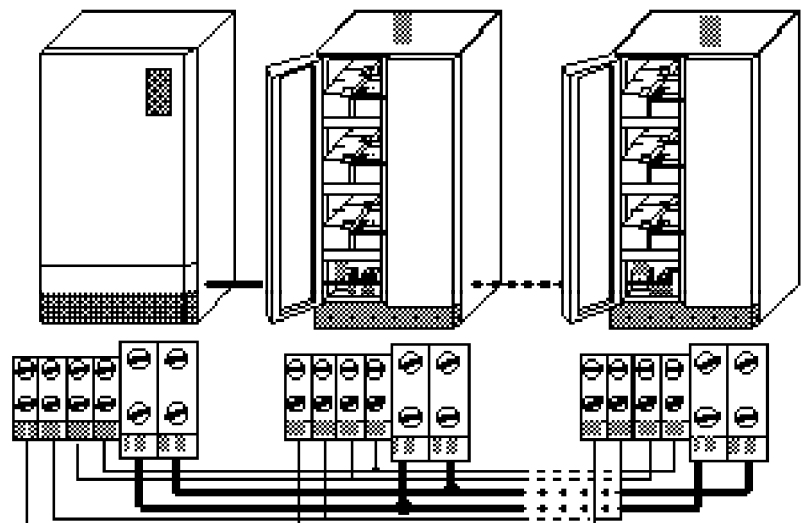


FIG. 1.12.10 UPS with additional battery cabinet

## Connection of Auxiliary Contacts

For the standard battery cabinet, the terminals C1, C2, C3 and C4 are connected to the corresponding terminals in the UPS cabinet as in FIG. 1.12.10.

If a battery is installed without standard cabinet(s), then a voltage-free auxiliary contact (normally closed) should be provided, along with a dc shunt trip circuit, for the battery circuit breaker / fuse switch. The auxiliary contact is connected to the terminals C1 and C2. The shunt trip circuit is connected in series with C3 and C4 and the appropriate number of batteries in order to achieve the rated shunt trip coil voltage.

## 2 Initial Start-Up

### 2 INITIAL START-UP

#### 2.1 Start-Up Procedure

**General** With the Start-Up procedure the correct installation of the UPS according to the previous section is checked. It must be carried out by specialised personnel.



Safety precautions according to the appropriate local safety standards must be applied.

Should problems arise during the Start-Up Procedure, call for service assistance.

**Preparation** For carrying out the Start-Up Procedure you need a 3 1/2 digit voltmeter with 1% accuracy, an AC/DC clip-on ammeter and a small screwdriver for potentiometers (only when necessary). The installation of the UPS must have been carried out according to the previous section.

- Check that the ventilation system of the UPS room is ready to operate.
- Check that all switches IRP, IRE, IUG, IBY, IB are open and the load is off.

#### A: Rectifier Power Supply Check

- Switch on the external mains supply to the UPS.
- Check that the supply voltage at terminals 1-L1, 1-L2, 1-L3 is within  $\pm 10\%$  of the UPS rated voltage.
- Close IRP.

? Does the display on the **CPHC16 -R** pcb for the rectifier give the indication "**P**"?

**yes** The phase rotation at the input is incorrect.

- Open IRP, switch off the external mains supply and exchange any two of the cables at input terminals 1-L1, 1-L2, 1-L3.
- Return to **A**.

**no** The rectifier supply voltage is o.k. and the rectifier will automatically start to operate.

- Wait until the Data Monitor Panel / NCP is illuminated
- Press the START push-button on the front of panel (or the push button PB2 on the top of ICP card) the inverter will start and after approximately 10s the green led L16 will be permanently lit.
- Press the push-button PB3 on the bottom of ICP card: after few seconds the three green leds on SS/FY card will be lit. One led is flashing:
  - green LED 3 flashing: "Battery switch open". Note that when using the external battery cabinet this function is disabled.

**NOTE:** If the battery switch indication is not blinking then the connections to C1 and C2 in the battery cabinet are not correct. Refer to the section "Installation".

## 2 Initial Start-Up

---

### B: Inverter Voltage Adjustment

- On the SS/FY pcb, measure the voltage at the screws Inverter R, Inverter S, Inverter T with respect to the neutral terminal 5-N.

? *Does this voltage correspond to the desired voltage?*

**no**

- Adjust the voltage to the desired value individually for each phase using P3, P4 and P5 on the ICT-2 pcb.  
**NOTE:** If the inverter output voltage is changed, the value at TP1 (adjusted with P1) on the ICP pcb should be checked. (6V corresponds to nominal voltage). Note also that for parallel systems, if the voltage is changed here, the current sharing will also be affected. Therefore, change voltage settings **ONLY IF ABSOLUTELY NECESSARY**. Small variations of the voltage will not affect system performance. The UPS is already pre-calibrated in the factory with nominal load.

**yes**

- Continue with C

### C: Inverter free-run frequency check

- Insert a pin d=2mm in the red test point S1 on the ICP pcb. The red LED LD3 on the ICP pcb must be permanently lit. The inverter frequency is now free-running without the internal oscillator.
- On the SS/FY pcb, measure the inverter frequency on the screws Inverter R, S or T with respect to neutral.
- Check that the frequency is set at the required value (50/60 Hz +/- 0,1 Hz). It can be adjusted with P1 on the ICT-2 pcb. Remove the pin from S1. The inverter now synchronises with the internal oscillator.
- Make sure that the batteries have been installed according to the instructions for installation.

With an external battery cabinet B3/38:

- Measure the battery voltage in the battery cabinet at the battery switch between cables:
  - -290 (-) and -1 (+)
  - +1 (-) and +4 (+)

With an external battery cabinet B3/65:

- Measure the battery voltage in the battery cabinet at the battery switch between cables:
  - -290 (-) and -1 (+)
  - +1 (-) and +2 (+)

? *Does this voltage have positive polarity?*

**no**

- Open **IRP**, **wait for 5-10 minutes**, and then reconnect the battery cables at the terminals which lead to the switch(es) where the wrong polarity was detected.
- Return to **D**.

**yes**

• Check the voltage between the battery terminals B+ and B-. The value of this voltage should be already set according to the amount of batteries installed.

- Close battery switch **IB**.

The alarm "battery switch open" stops.

## 2 Initial Start-Up

- If your unit has separate supplies for the rectifier and bypass (terminals 4-L1, 4-L2, 4-L3, 4-N), switch on the external supply for the bypass. Check that the bypass supply voltage at terminals 4-L1, 4-L2, 4-L3, 4-N is within  $\pm 10\%$  of the nominal input voltage.

If there are no separate input terminals then the bypass input is the same as that checked previously for the rectifier input.

- Close **IUG**.
- Close **IRE**.

? *Does the display on the **CPHC16 -S** pcb for the bypass give the indication "P"?*

- yes**
- Open **IRE** and exchange any two of the cables at the bypass input terminals 4-L1, 4-L2, 4-L3.
  - Return to E.

- no**
- Are the status LEDs (green) 1, 2, 3, 14, 16, 17, 19, 26, on the operating panel continuously on?

**no:** Check that the mains frequency is in tolerance.  
OK?

**yes:** *Is the pcb CPHC16 -S for the bypass correctly functioning? The display should be rotating clockwise.*

**no:** Call for service assistance.

**yes:** Check again the input supply. Check that it is in accordance with the UPS rating label.

**no:** The mains frequency must be within tolerance in order for the bypass to be available

**yes:** Continue with **F**.

### **F: Synchronisation Check**

- Check that the green LED LD1 on the ICT-2 pcb is permanently lit and there is no "S" indication on the bypass electronics.
- On the SS/FY pcb, measure the voltage between the screws Bypass R and Inverter R. Then repeat for the other two phases.

? *Are the voltages < 25Vac?*

- no**
- If the voltage is continuously fluctuating from 0 to 400V there is a synchronisation problem. Switch off IRE and call for service assistance.

If the voltage is slightly higher but relatively constant and the default values have been re-entered using the serial interface on the CPHC16 -S p.c.b., then the synchronisation may need to be re-adjusted. This can be easily confirmed by comparing the two sinewaves for a possible phase difference.

*Are the two waveforms phase-shifted?*

**yes:** The synchronisation must be re-adjusted using the serial interface of the CPHC16 -S pcb and the PSRS232 and a portable computer.

## 2 Initial Start-Up

---

**no:** The difference is probably due to distortion of the mains voltage (the inverter voltage is an almost perfect sinewave)  
Continue with G

**yes:** Continue with G

### G: Static Switch Commutation Check

- **COMMUTATION TO THE BYPASS**

Press the pushbutton on the CPHC16-S pcb for the bypass. The static switch SSB will switch on and SSI will switch off, as indicated on the front panel and on the SS/FY pcb (red LEDs).

- **COMMUTATION TO INVERTER**

Press the pushbutton PB3 at the bottom of the ICP pcb. The static switch SSI will switch on and SSB will switch off, as indicated on the front panel and the SS/FY pcb (green LEDs).

### H: Battery Charging Current Limitation Check

- Connect the load and open **IRP**.

The load is now supplied only by the batteries.

- Discharge the batteries for about 2 minutes at nominal UPS load or longer if the connected load is smaller than nominal UPS load
- Close **IRP** again.
- After 30 seconds, measure the battery voltage.

? *Is the battery voltage lower than the set floating charge voltage?*

**no** The rectifier is not yet in battery current limitation. In order to check the battery current limitation you must discharge the batteries for a longer period.

- Return to **H**.

**yes** The battery current limitation can now be checked according to the battery installed. Standard setting is 10% of the battery capacity.

- Measure the battery recharging current with a dc clip-on ammeter.

? *Is this approximately 10% of the battery Ah capacity?*

**no** Check the settings of the dipswitch S1 on the CPHC16 -R pcb for the rectifier according to JUE400899 programming of PCBs (V2.0 or later). Otherwise, the battery charging current may need to be adjusted using the RS232 connector on the CPHC16-R pcb and a portable computer. This must be performed by first discharging the battery by switching off IRP, connecting the PC and adjusting the charging current. **The battery must remain connected throughout the procedure.**

- Return to **H**.

**yes** **THE START-UP PROCEDURE HAS BEEN SUCCESSFULLY COMPLETED NOW.**

## 3 Additional Start-Up Proced. for Multi-Unit Systems

### 3 ADDITIONAL START-UP PROCED. FOR MULTI-UNIT SYSTEMS

#### 3.1 Start-Up Procedure for Hot -standby Systems

Repeat the procedure of section 2 for the second unit in the system (with the first unit off).



Ensure that the interconnecting BUS cable is connected according to section 1.9.1 and FIG 1.9.3.

- J**
- Switch off the inverter at the second unit with PB2 at the top of the ICP pcb. The unit will transfer to the bypass supply.
  - Switch on IRP of the first unit.
  - Ensure that the switch IUG of this unit is off.
  - Switch on IRE of the first unit.

After approx. 10 seconds the display will flash with a "U" indication and static bypass switch SSB will be closed.

- Measure across the output switch IUG from input to output of each phase.

? *Is this voltage less than 2V a.c for all three phases?*

**no** The output power interconnections are incorrect and must be reconnected correctly. Switch off both units and the mains supply and recheck the connections. Return to **J**

**yes** Continue

- Close IUG of the first unit. The two static bypasses (SSB) are now connected in parallel.
- Close the battery switch of the first unit.
- Start the unit by pressing "START" on the front operating panel. when the inverter is synchronised, the unit will transfer the inverter to the output (SSI closes and both SSB switches switch off).
- Press "START" on the operating panel of the second unit.

The inverter will start and become ready (check that the green LED LD6 on the ICP pcb is illuminated) but the static switch SSI will not close.

- Check the commutation of the inverters by pressing PB2 at the top of the ICP pcb on the unit currently with SSI closed.
- Restart the inverters (with PB2 on ICP or with "START").

THE SYSTEM IS NOW IN NORMAL OPERATION AND THE **HOT-STANDBY** START-UP HAS BEEN SUCCESSFULLY **COMPLETED**.

## 3 Additional Start-Up Proced. for Multi-Unit Systems

### 3.2 Start-Up Procedure for Parallel Systems

Repeat the procedure of section 2 individually for all units in the system, with the the other units off.



Ensure that the interconnecting BUS cables are connected according to section 1.10.1 and FIG 1.10.3.

- Open IRP, IRE, IB and IUG of the last unit checked with the procedure in section 2.

- K**
- Ensure that no load is connected to the system output.
  - Ensure that all IUG switches are open.
  - Switch on the IRE switches of all units. Wait until all units give a flashing "U" indication on the display of the CPHC16-S pcb.
  - Close IUG on one unit only.
  - At each unit in turn:
    - Measure across the output switch IUG from input to output of each phase.

? *Is this voltage less than 2V.a.c for all three phases for every unit?*

**no** The output power interconnections are incorrect and must be reconnected correctly. Switch off all units and the mains supply and recheck the connections.

Return to **K**

**yes** Continue.

- Close the IUG switches on all units. The static bypasses (SSB) will now be connected in parallel for all units.
- Close IRP of all units.
- When the front operating panel is initialised on all units (after 3 beeps), close the battery switches of the respective units.
- Press the "START" pushbutton on any one unit. The inverter will start and when synchronised to the bypass supply, transfer to the system output and all static bypass switches (SSB) will open.
- Press the "START" pushbutton on each successive unit in the system, each time checking that the SSI closes on the unit and that the system operates in parallel operation.
- Commutations to the bypass/inverter supplies may be checked by pressing the pushbutton on the CPH16 -S pcb and PB3 at the bottom of the ICP pcb.
- Apply a load to the UPS system and check for correct sharing of the load currents on each phase. If stand-alone units have been converted for parallel operation, the current sharing needs to be checked and is best performed with a load as close as possible

## 3 Additional Start-Up Proced. for Multi-Unit Systems

---

to the nominal load. Measure the currents at the output of each module on phase T. If this current varies by more than  $\pm 1\%$  for this module, fine adjustment can be made with P1 on the IPR pcb.

Check the currents at the output of each module on phase S. These currents must be balanced to within  $\pm 1\%$  by finely adjusting the inverter voltage of phase S (P4 on ICT-2). i.e. If the module is supplying more current than the system average, the inverter voltage of this module must be reduced slightly.

Repeat for phase R currents by finely adjusting the R phase inverter voltage of this module with P3 on the ICT-2 pcb until the currents on the phase R of all modules are equal to within  $\pm 1\%$ .

- **THE SYSTEM START-UP HAS NOW BEEN SUCCESSFULLY COMPLETED.**



# SOLA 4000 - Operation

## Chapters

<p><b>1 OPERATING MODES</b></p> <p>1.1 General 2</p> <p>1.2 Led Indication 3</p> <hr/> <p><b>2 OPERATING MODES STAND-ALONE UNIT</b></p> <p>2.1 Normal Operation 4</p> <p>2.2 Battery Operation 4</p> <p>2.3 Bypass Operation 5</p> <p>2.4 Maintenance Bypass Operation 5</p> <p>2.5 Standby Operation 5</p> <hr/> <p><b>3 OPERATING MODES HOT-STANDBY OPERATION</b></p> <p>3.1 Normal Operation 6</p> <p>3.2 Operation with an Inverter Failure 6</p> <p>3.3 Battery Operation 6</p> <p>3.4 Bypass Operation 7</p> <p>3.5 Maintenance Bypass Operation 7</p> <hr/> <p><b>4 OPERATING MODES PARALLEL AND PARALLEL/REDUNDANT OPERATION</b></p> <p>4.1 Normal Operation 8</p> <p>4.2 Partial Load Operation 8</p> <p>4.3 Battery Operation 9</p> <p>4.4 Operation with an Inverter Failure 9</p> <p>4.5 Bypass Operation 10</p> <p>4.6 Maintenance Bypass Operation 10</p>	<p><b>5 OPERATING INSTRUCTIONS</b></p> <p>5.1 Switching On the UPS System/from Maintenance Bypass 11</p> <p>5.2 Switching Off the UPS System/to Maintenance Bypass 13</p> <p>5.3 Switching On any one unit within a System (Parallel and Hot-standby Systems) 14</p> <p>5.4 Switching Off any one unit within a System (Parallel and Hot-standby Systems) 15</p> <p>5.5 Emergency Power Off 16</p>
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Rev.	Description	Date	Created	Revised	Date	Rev. Code	Page
	ISSUED	04.02.97		M. Porpora	04.02.97	A4	1 16
A	See Rev. Doc. JSE 401440	20.06.97	T. Boon				
B	See Rev. Doc. JSE 401547	23.09.97	T. Boon				
				T. Boon			JUE 401266

# 1 Operating Modes

## 1 OPERATING MODES

### 1.1 General

There are four different operating modes of the standard stand-alone on-line UPS-system (5 for hot-standby and 6 for parallel systems), ensuring uninterrupted power supply of the load under all conditions. Transitions between these operating modes are performed without interruption of the power supply to the load.

#### Security concept

- In "Normal Operation" any failure, internal or external, will transfer the UPS system either to "battery operation", to "bypass operation" for a stand-alone UPS or to "operation with an inverter failure" for parallel and hot-standby systems.
- In "Battery Operation" or "Bypass Operation", with a stand-alone UPS system, an additional failure may interrupt the power supply to the load, depending on the kind of failure. In both operating modes the UPS signals a failure condition (audible and visual alarm) to indicate that any additional failure bears the risk of interrupting the power supply to the load.
- As additional security, a second UPS unit may be added and connected in parallel with the original unit, in a hot-standby configuration. Therefore, in the case of a failure of one inverter, the second inverter will take over the load. This system requires the occurrence of 3 or 4 simultaneous failures (the bypass can be also redundant) before the load is interrupted. Any number of units can be connected together in this way, the addition of each unit providing the addition of 1 or 2 additional security factors. The interconnection of the SOLA 4000 in this way requires a special cable available from your local distributor.
- Parallel Operation is used to provide redundancy in the same way as for hot-standby units above and / or an increased capacity to supply the load, the parallel units exactly sharing the load requirement.
- "Maintenance Bypass Operation" is used to supply the load directly from mains during maintenance or repair work.



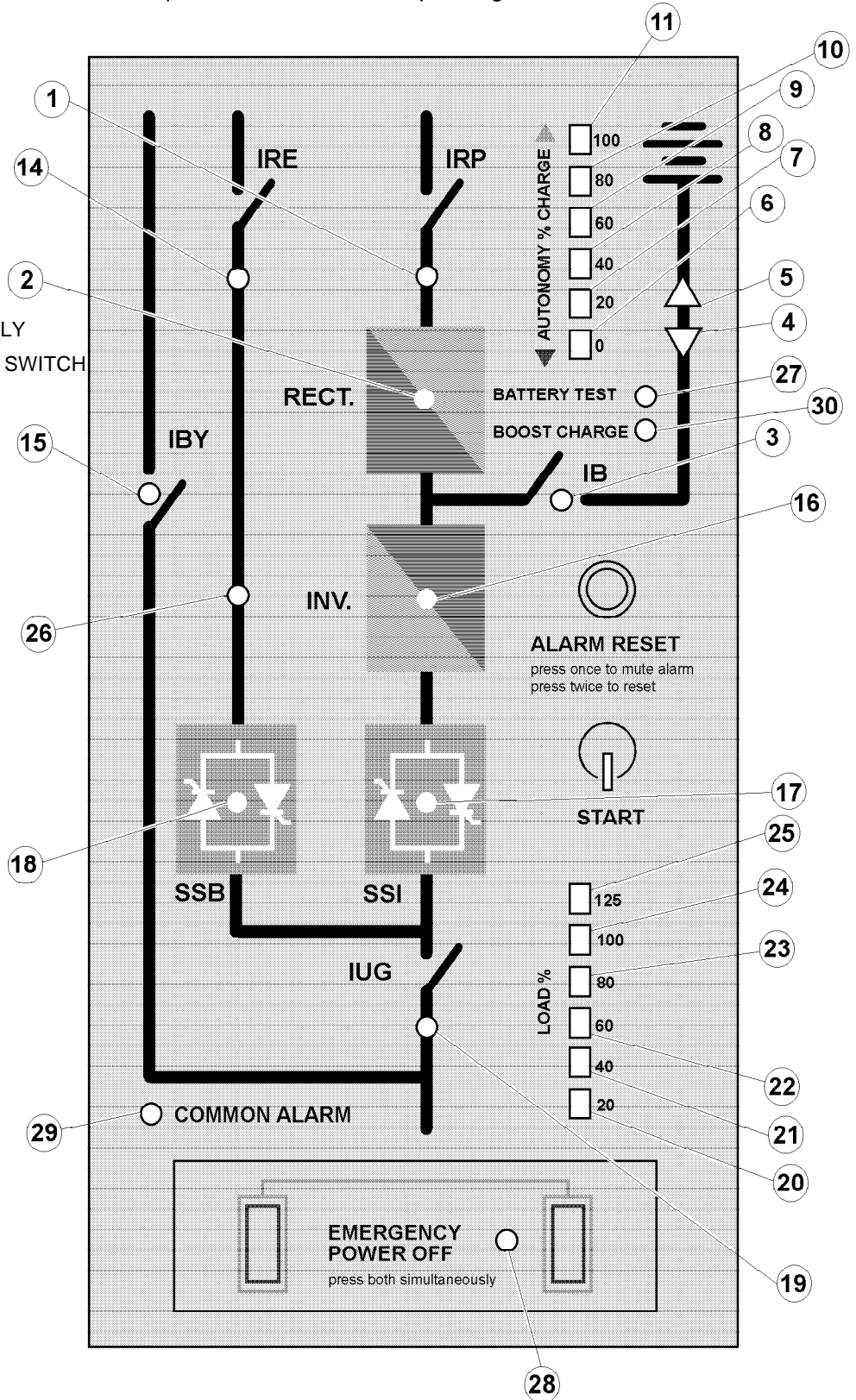
**Warning:** Even in case of a total blackout, the UPS will continue to supply power to the load, therefore all necessary precautions against direct and indirect accidental contact as specified in national and local safety standards must be followed.

# 1 Operating Modes

## 1.2 LED Indication

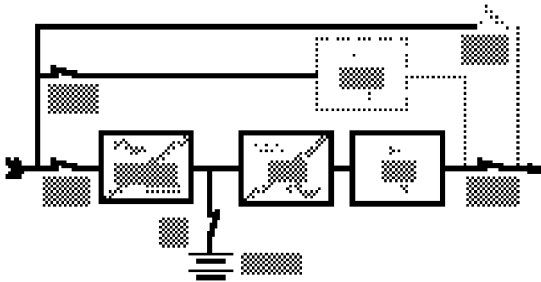
The block diagram of the UPS, with integrated LEDs, allows a quick check of the UPS operating status.

- LED 1 MAINS PRESENT
- LED 2 RECTIFIER
- LED 3 BATTERY SWITCH
- LED 4 BATTERY DISCHARGING
- LED 5 BATTERY CHARGING
- LED 14 BYPASS POWER SUPPLY
- LED 15 MAINTENANCE BYPASS SWITCH
- LED 16 INVERTER
- LED 17 LOAD FED by INVERTER
- LED 18 LOAD FED by BYPASS POWER SUPPLY
- LED 19 LOAD IS SUPPLIED
- LED 27 BATTERY TEST
- LED 28 E.P.O.
- LED 26 BYPASS AVAILABLE
- LED 29 COMMON ALARM
- LED 30 BOOST CHARGE



## 2 Operating Modes Stand-alone Unit

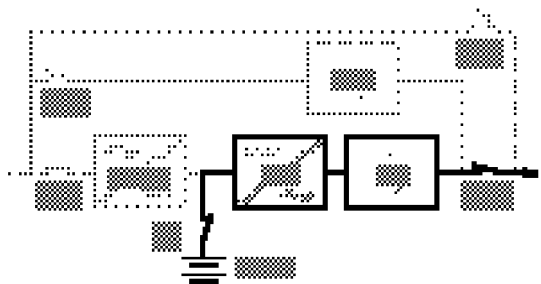
### 2 OPERATING MODES STAND-ALONE UNIT



#### 2.1 Normal Operation

"Normal Operation" is the standard operating mode of the UPS

- Mains power is present.
- The rectifier converts ac power to dc power which charges the batteries and feeds the inverter.
- The inverter converts this dc power to ac power used to feed the connected load.

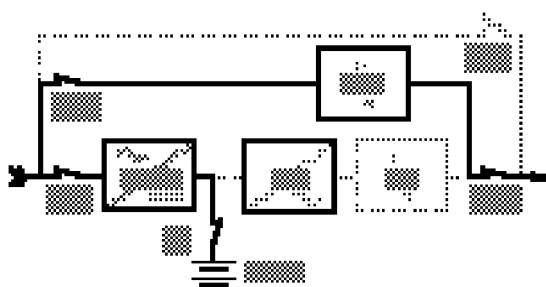


#### 2.2 Battery Operation

The "Battery Operation" mode is activated by a mains failure or rectifier failure

- The rectifier supplies no power.
- The battery supplies the required dc power to the inverter.
- The inverter supplies ac power to the load as described above.
- Power will only be supplied to the load for a certain period of time depending on the battery capacity and the amount of load applied.

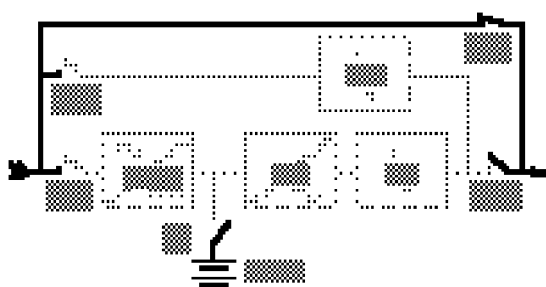
## 2 Operating Modes Stand-alone Unit



### 2.3 Bypass Operation

The "Bypass Operation" mode is activated by an inverter failure or an overload

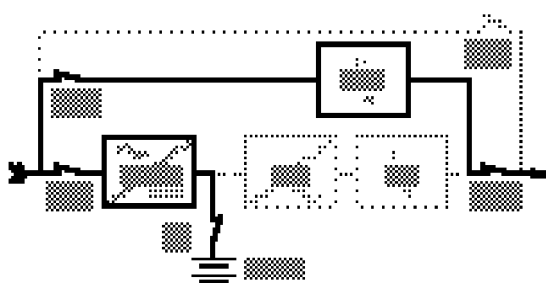
- The rectifier supplies dc power only to the battery.
- The static inverter switch SSI opens automatically after the static bypass switch SSB is closed.
- The load is supplied directly from the mains through the static bypass line.



### 2.4 Maintenance Bypass Operation

The "Maintenance Bypass Operation" mode is used to supply the load directly from the mains during maintenance or repair work.

- In this mode, the individual functional components are completely separated from the load.
- Power for the load is supplied directly from the mains through the switch IBY.



### 2.5 Standby Operation

If an appropriately programmed IPR pcb is inserted in the control electronic of the stand-alone unit, as an option, this mode of operation is possible.

- If the load is completely switched off, the inverter and the inverter static switch SSI, switch off and the UPS commutates to the bypass supply (SSB closes), thus saving power when the UPS is not needed.
- When the load is again switched on, the inverter automatically switches on and the inverter static switch SSI will commutate the load to the protected inverter supply.

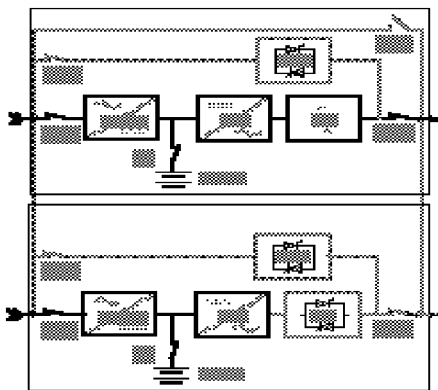
## 3 Operating Modes Hot-Standby Operation

### 3 OPERATING MODES HOT-STANDBY OPERATION

#### 3.1 Normal Operation

"Normal Operation" is the standard operating mode of the hot-standby system.

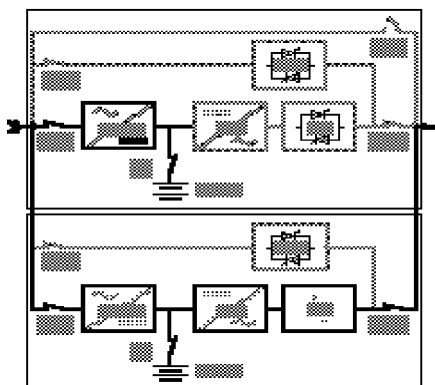
- Mains power is present.
- The rectifiers of all units convert ac power to dc power which charges the batteries and feeds the inverters.
- The inverters convert this dc power to ac power.
- The inverter of one unit feeds the connected load.
- The inverter of the other unit(s) is working in standby mode, ready to takeover the load if there is a failure in the unit supplying the load.
- All units in the system are identical and operate completely independently of each other.



#### 3.2 Operation with an Inverter Failure

"Operation with an Inverter Failure" is the operating mode of the hot-standby system after a failure has occurred in one unit.

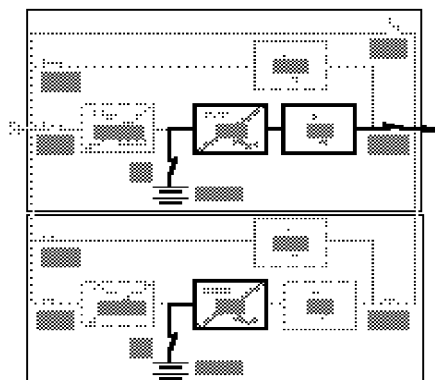
- Mains power is present.
- The static inverter switch of the failed unit opens automatically and the static inverter switch of another unit is closed.
- The rectifier of that unit converts ac power to dc power which charges the battery and feeds the inverter. The inverter then converts this dc power to ac power used to feed the connected load.
- The static bypasses within all units remain ready to supply the load in case of any additional failure(s) or overload.



#### 3.3 Battery Operation

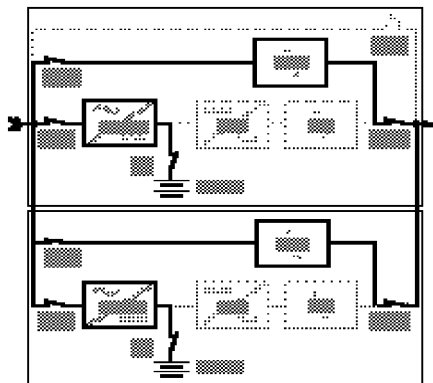
The "Battery Operation" mode is activated by a mains failure or rectifier failure.

- The rectifiers of all units supply no power.
- The batteries of all units supply the required dc power to the inverter of each unit.
- The inverter of one unit continues to supply ac power to the load.
- The inverter(s) of the other unit(s) are operating in standby mode, ready to takeover the load, without interruption.



## 3 Operating Modes Hot-Standby Operation

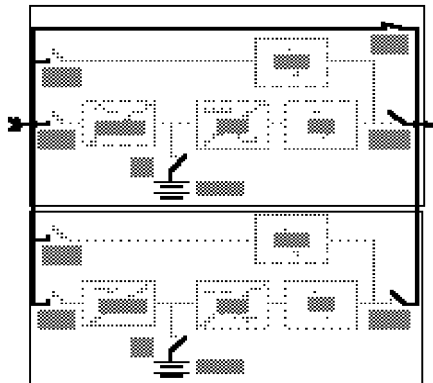
- If an additional failure in the first unit occurs, or when the battery of that unit is exhausted, the inverter of another unit will takeover the load, continuing in battery operation until the mains returns or the second battery is exhausted.



### 3.4 Bypass Operation

The "Bypass Operation" mode is activated by an overload or by inverter failures in all units or by a manual commutation.

- The rectifiers supply dc power only to the batteries.
- The static inverter switch SSI of the unit supplying the load opens automatically after the static bypass switch SSB is closed.
- The load is supplied directly from the mains through the static bypass.
- If the transition to "Bypass Operation" was caused by a temporary overload, the UPS system returns automatically to "Normal Operation", any inverter may takeover the load, when the load returns to within tolerance.



### 3.5 Maintenance Bypass Operation

"Maintenance Bypass Operation" is used to supply the load directly from mains during maintenance or repair work.

- In this mode, the individual functional components of all units are completely separated from the load.
- Power for the load is supplied directly from the mains through the switch IBY.

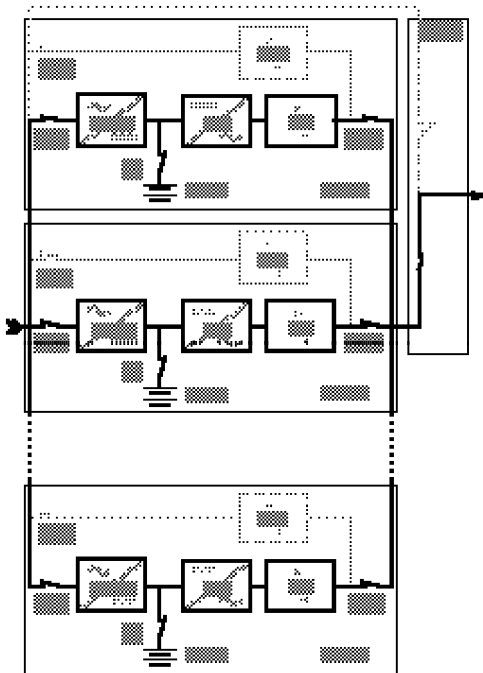
# 4 Operating Modes Parallel and Parallel/Redundant Operation

## 4 OPERATING MODES PARALLEL AND PARALLEL/REDUNDANT OPERATION

### 4.1 Normal Operation

"Normal Operation" is the standard operating mode of the UPS if the system load is at its nominal value or the system is programmed in a way that all units remain on-line. Otherwise see section 4.2.

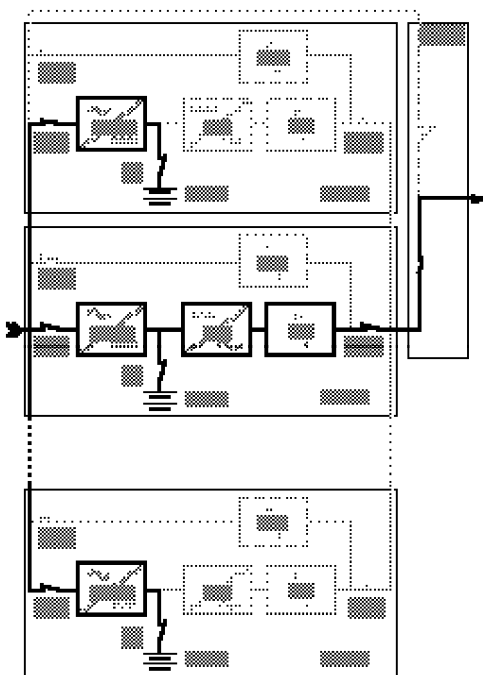
- Mains power is present
- The rectifiers convert a.c. power to d.c. power used to charge the batteries and feed the inverters
- The inverters convert this d.c. power to a.c. power used to feed the connected load
- All units are sharing the load current uniformly. This is accomplished by means of the optional parallel-operation-electronic pcb (IPR).
- All units operate completely independently of each other, each unit supplying its respective share of the load.



### 4.2 Partial Load Operation

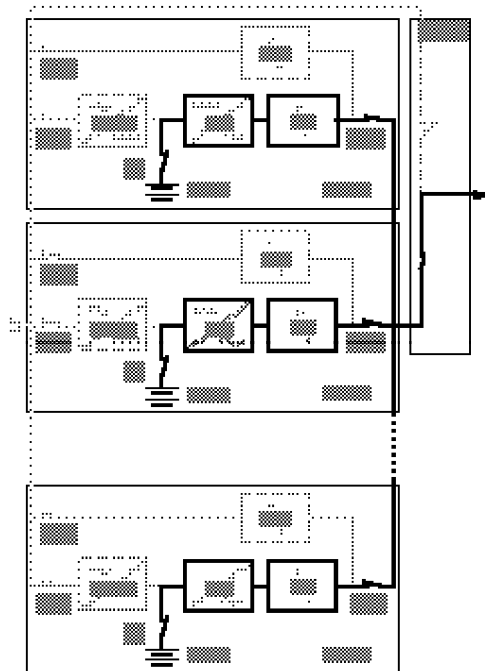
Single inverters that are not needed to supply the load can be switched off automatically, thus saving energy and increasing system efficiency.

- The load is supplied by the remaining inverters
- All rectifiers will continue to operate, charging also the batteries of the units whose inverters have been switched off
- The system can be easily programmed for the minimum number of units which must supply the load at any time.
- When the load is reduced, the units will individually decide which one is to switch off automatically.
- The system may be programmed so that there will always be one redundant unit on-line.
- If the load is again increased, or in the case of an inverter failure, the unit(s) which have been switched off will automatically switch on again to share the load.
- If the mains supply fails, all inverters will switch on and connect to the load in parallel operation in order to maximise the battery autonomy time, (see section 4.3)





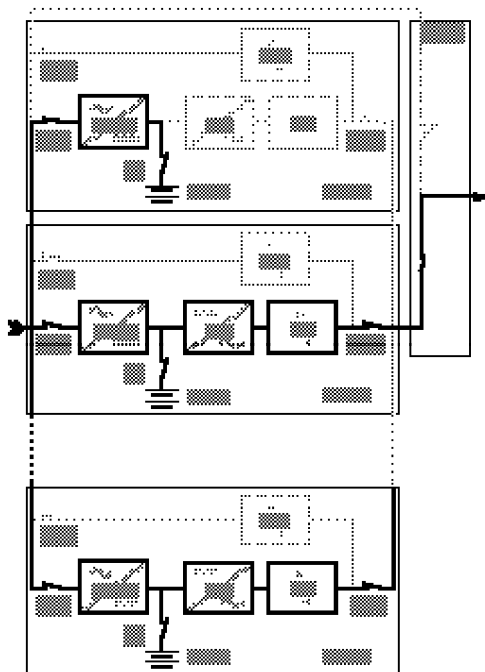
## 4 Operating Modes Parallel and Parallel/Redundant Operation



### 4.3 Battery Operation

The "Battery Operation" mode is activated by a mains failure or rectifier failure

- The rectifiers supply no power
- The batteries supply the required d.c. power to the inverters
- The inverters supply a.c. power to the load as described in 4.1
- Power will only be supplied to the load for a certain period of time depending on the battery capacity
- If there were stand-by units switched off at the time of the mains failure, all units will automatically switch ON in order to extend the battery autonomy time.



### 4.4 Operation with an Inverter Failure

This operating mode is activated by a failure in one or more inverters.

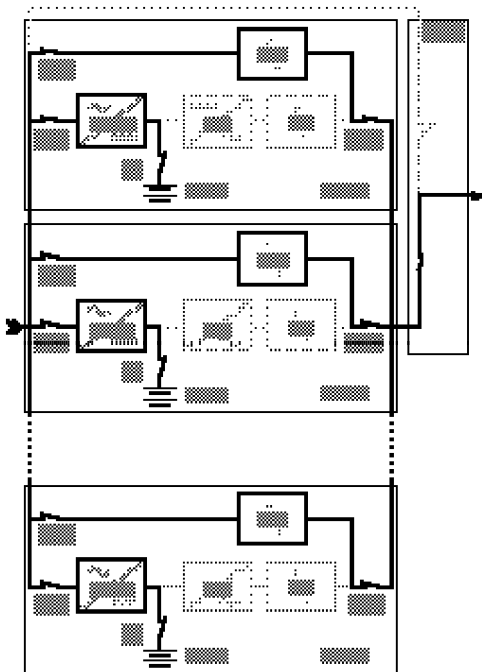
- As long as the load is not too great for the remaining units, the parallel system will stay in UPS (inverter) operation mode, otherwise see 4.5.
- The static inverter-switch(es) (SSI) of the defective unit(s) will open automatically, separating them from the load-busbar
- The rectifier(s) of the defective unit(s) will supply d.c. power to the battery (batteries) only if the respective rectifier is not defective.

## 4 Operating Modes Parallel and Parallel/Redundant Operation

### 4.5 Bypass Operation

The "Bypass Operation" mode is activated by a multiple inverter failure or overload

- If the load is greater than 110% of the load capacity of all available inverters, the static bypasses of all individual units will connect the load with the mains directly
- All inverter output switches (SSI) will open, inverters may continue to operate
- The rectifiers continue to charge the batteries
- If the load is reduced to 100% or less of the load capacity of all available inverters, the system switches automatically back to normal operation
- All bypasses always switch on together.
- If a standby unit was off at the time of the inverter failure/overload, it will automatically switch ON and all units take-over the load. The operation then becomes as in paragraph 4.1 (when there was an overload) or as in paragraph 4.4 (when an inverter failure occurred).

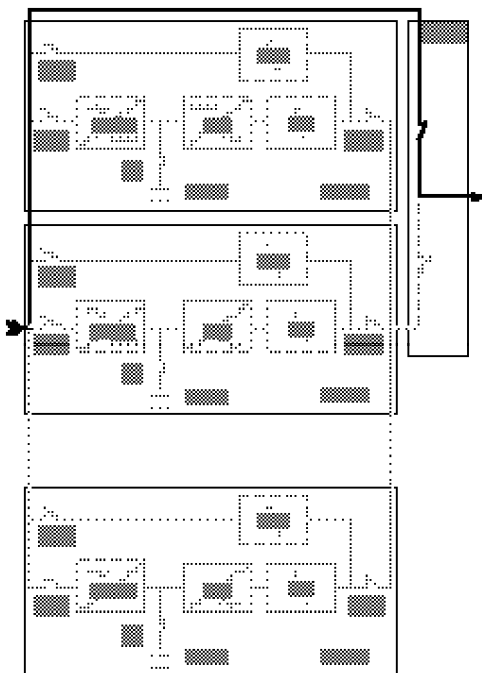


### 4.6 Maintenance Bypass Operation

The "Maintenance Bypass Operation" mode is used to supply the load directly from mains during maintenance or repair work.

- During this mode, the individual functional components are completely separated from the load (e.g. for maintenance work)
- Power for the load will be supplied directly from mains through internal or external power switch(es) (IBY)

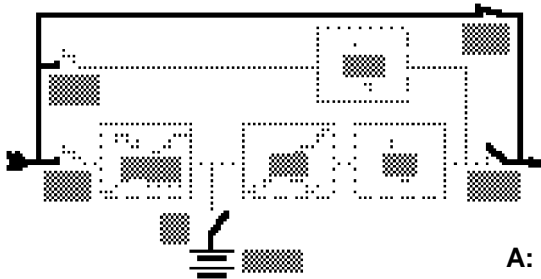
**Note:** If the 3-position maintenance bypass cabinet MB3/2 is installed, the UPS system may be totally isolated from all supply by switching to the 3rd position "UPS ISOLATED". Again the load will be supplied through the maintenance bypass switch.



# 5 Operating Instructions

## 5 OPERATING INSTRUCTIONS

### 5.1 Switching On the UPS System / from Maintenance Bypass



#### Initial UPS Operating Mode:

The UPS is switched off, the load may or may not be supplied by maintenance bypass, **IBY** and all other power switches are open.

#### Operating Steps:

- A:**
- Switch on the external mains supply for the UPS; both the rectifier input and the bypass input when separate supplies are provided.
  - Open the UPS front door or the part necessary to allow access to the switches IRP, IRE, IUG and IBY.

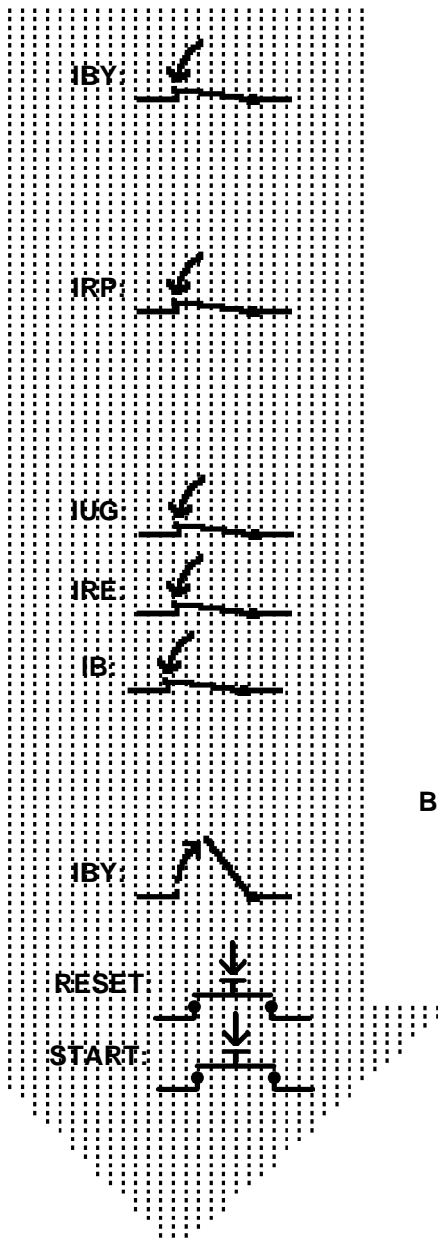
If the bypass switch **IBY**, is not already on, close it now (for parallel systems with internal maintenance bypasses see **Note 1** page 11) The load is now supplied by the maintenance bypass.

- Close the **IRP** switch.  
The rectifier starts and the UPS performs a self-test. The UPS operating panel will beep 3 times and test all the LEDs. The audible alarm may continue beeping and can be muted by pressing "**RESET**" once.
- Close the **IUG** switch.
- Close the **IRE** switch.
- Close the battery switch **IB**.

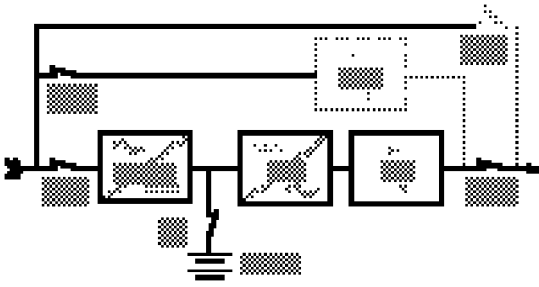
Repeat A above, for all units within the system (Hot-standby and Parallel systems).

- B:**
- Check that the LEDs for the bypass and the output are illuminated.
  - Open the **IBY** switch inside all units (or within the External Maintenance Bypass cabinet if installed).
  - Press the **pushbutton "RESET"** on the operating panel of any unit.
  - Press the **pushbutton "START"** on the operating panel of all units within the system. The inverter(s) will start and will switch over to take the load when ready (SSI closes).

**Note:** The pushbuttons "**START**" and "**RESET**" must be depressed for about 1 sec.



## 5 Operating Instructions



### Final UPS Operating Mode:

The UPS is now in normal operating mode, as described in chapter "2.1. Stand-alone unit", "3.1 Hot standby systems" or "4.1 Parallel systems". The green LEDs (L1, L2, L5, L3, L16, L17, L26, L19) on the operating panel(s) must be illuminated (but not flashing).

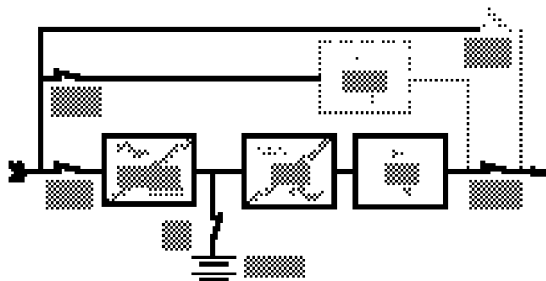
Should a problem arise during the Switching On, please follow the instructions in JUE 401066, Initial Start-up.

### Note 1: For Parallel Systems.

If the bypass is off, the output is not supplied and the system has multiple internal maintenance bypasses and the load is connected, the load may be excessive for one bypass only. In this case, it is better to switch off the load or proceed further without switching on IBY (the static bypasses will only switch on together when enough are ready to take the load.)

# 5 Operating Instructions

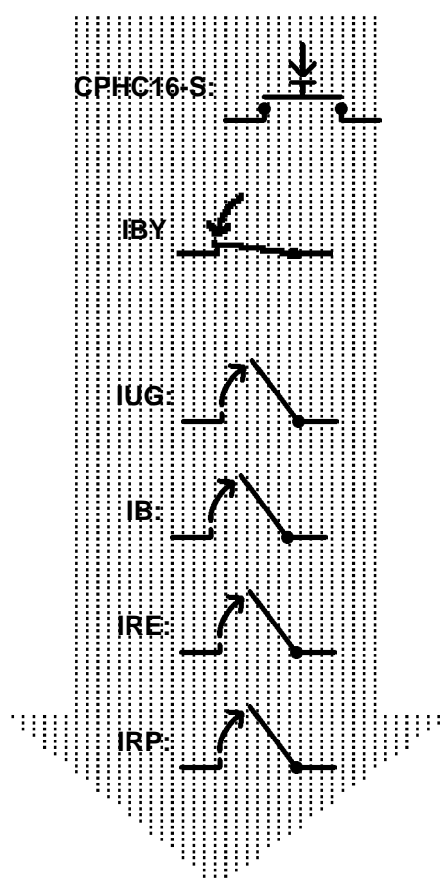
## 5.2 Switching Off the UPS System / to Maintenance Bypass



### Initial UPS Operating Mode:

The UPS is in any operating mode described in the previous sections "Operating Modes" (except maintenance bypass operation). All power switches except IBY are closed, and the load is fed either through the inverter or the static bypass.

### Operating Steps:

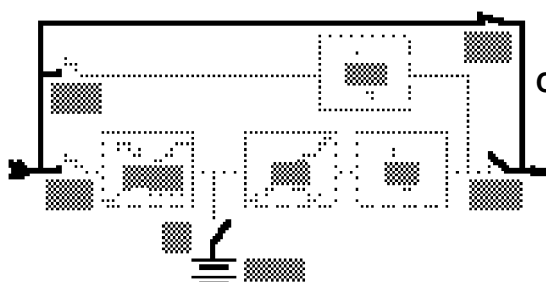


- A:**
- Make sure that the LEDs 14 and 26 "Bypass Power Supply O.K." and "Bypass available" are illuminated and not flashing.
  - Press the pushbutton on the **CPHC16 -S** pcb to commutate to the bypass supply.
- The UPS or all UPS modules (Hot-standby, parallel) switch to "Bypass Operation" mode. The yellow LED 18 lights up.
- After LED 18 is illuminated, close the **IBY** switch.

The load is now supplied by the static bypass and the maintenance bypass in parallel. If more than one IBY switch is present, close **all** switches.

- B:**
- Open the **IUG** switch.
  - Open the battery switch **IB**.
  - Open the **IRE** switch.
  - Open the **IRP** switch.

After opening the IRP switch the display is only powered by the DC capacitors and will fade out within a few minutes.

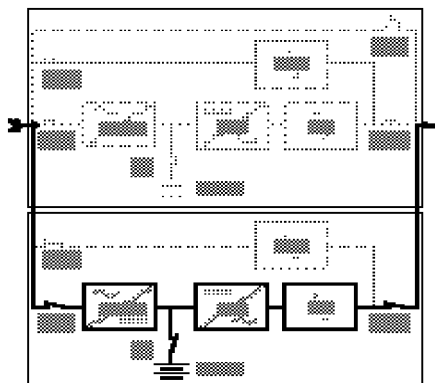


- C:**
- Repeat the steps in B for all units present.

**Note:** If the optional SOLA external maintenance bypass switch (MB3/2 - version 2) is installed, it is not necessary to perform step **B** if the switch is switched directly to position 3 "UPS ISOLATED" in step **A**

# 5 Operating Instructions

## 5.3 Switching On any one unit within a System (Parallel and Hot-standby Systems)



### Initial UPS Operating Mode

The UPS module was switched off using the procedure in section 5.4, all of the power switches in this module are in the off position, the load is supplied by the remaining unit(s) within the system.

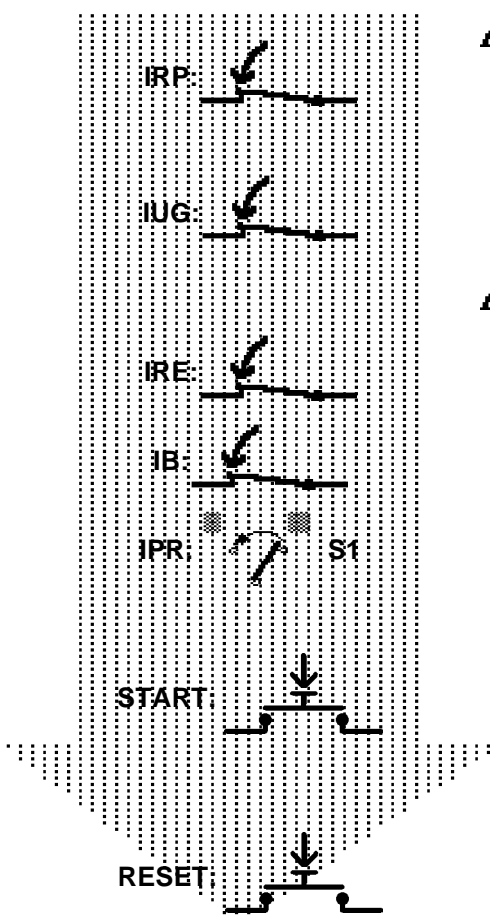
- If this UPS module has an input supply separate to the other units in the system, switch on the external mains supply for this UPS module; both the rectifier input and bypass input when separate supplies are provided.
- Open the UPS front door, or the part necessary to allow access to the switches IRP, IRE, IUG.
- **WARNING: ENSURE THAT THE IUG AND IRE SWITCHES ARE OPEN.**
- Close the **IRP** switch. The rectifier starts and the UPS performs a self test. The UPS Operating Panel will beep 3 times and test all the LEDs. The audible alarm may continue beeping and can be muted by pressing "RESET" once.
- Close the **IUG** switch.



**NOTE: IN ORDER NOT TO AFFECT SYSTEM PERFORMANCE, IT IS IMPORTANT TO CLOSE IUG NOW.**

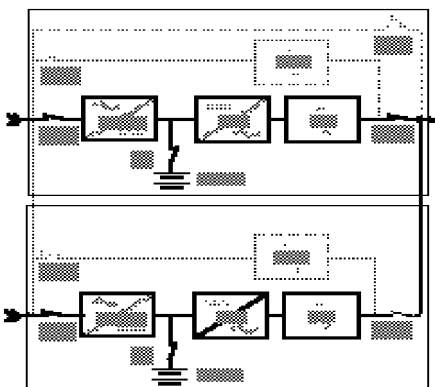


- Close the **IRE** switch.
- Close the battery switch **IB**.
- If present, ensure that the micro switch **S1** at the bottom of the IPR pcb is in the **AUTO** position.

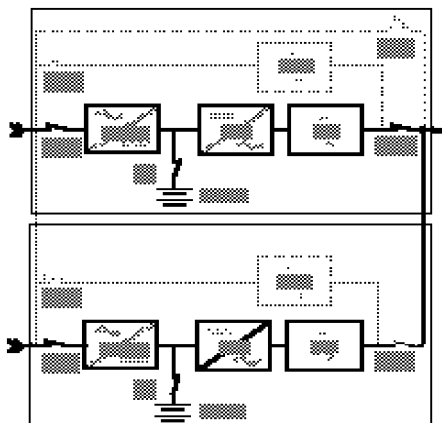


- Press the **pushbutton "START"** on the Operating Panel. The inverter will start. The LED 16 will flash red and 10 seconds later will turn green and be permanently lit.
- Press the **pushbutton "RESET"** on the Operating Panel. If not already on, the green LED 17 will turn on and the LED 29 must switch off.

The UPS module is now in normal operating mode, connected in parallel with the remaining units in the system (parallel systems, section 4.1 or 4.2) or ready to take over the load in the case of an inverter failure (hot-standby systems, section 3.1)



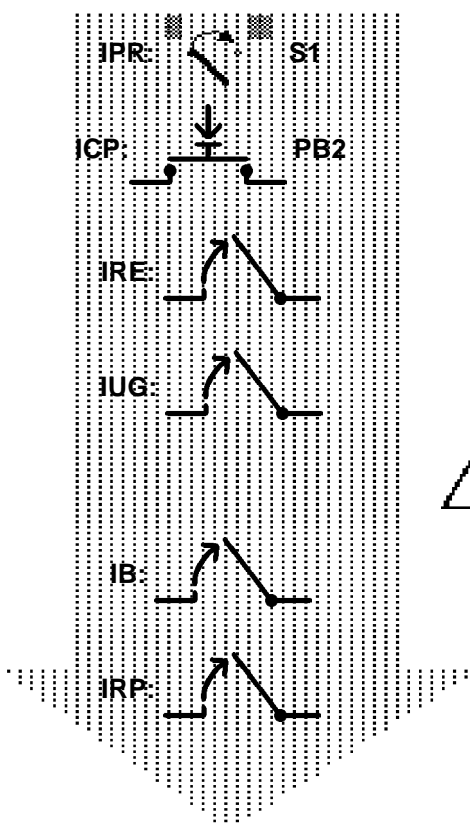
# 5 Operating Instructions



## 5.4 Switching Off / any one Unit within a System (Parallel and Hot-standby Systems)

### Initial UPS Operating Mode:

The UPS is in any operating mode described in the previous sections "Operating Modes". All power switches except IBY are closed, and the load is fed either through the inverter or the static bypass.



- At the bottom of the IPR pcb (if present), switch the microswitch S1 to the manual position.
- At the top of the ICP pcb, press the pushbutton PB2.
- Open the **IRE** switch.
- Open the **IUG** switch.



**NOTE:** IN ORDER NOT TO AFFECT SYSTEM PERFORMANCE, **IUG** MUST BE OPENED AT THIS MOMENT.

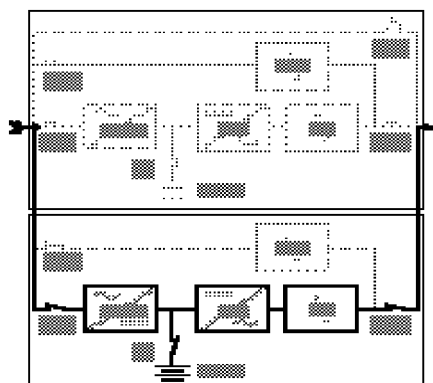
- Open the battery switch **IB**.
- Open the **IRP** switch.

The rectifier voltage will slowly discharge and all the LED(s) on the front panel will switch off. When all the LED(s) on all the internal pcbs are off, the UPS module is free from voltage except at the inputs of IRP, IRE and IBY and at the outputs of IUG and IBY and at the respective terminals.

If this UPS module has an input supply separate to the other units in the system, the input supply switch(es) to this module may now be opened.

### Final UPS Operating Mode:

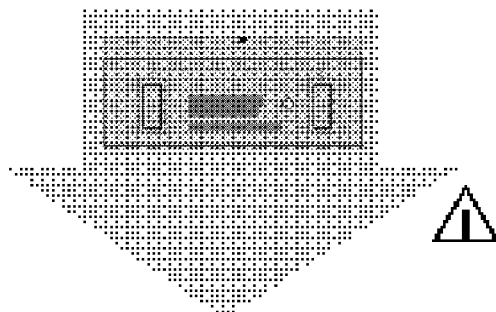
The UPS module is now shut down. The load is supplied by the remaining module(s) within the system.



**Attention!** Even when the input supply to the UPS module is isolated, there will still be voltage present at the output terminals and the output of the switches IUG and IBY (from the remaining modules within the UPS system).

## 5 Operating Instructions

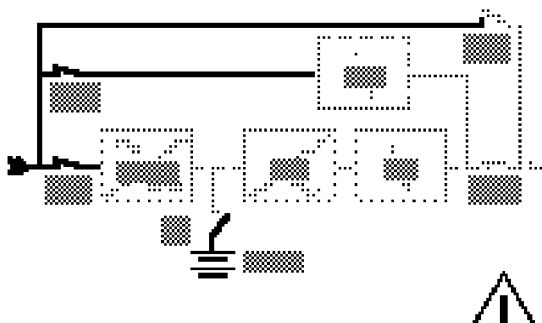
### 5.5 Emergency Power Off



#### Operating Steps:

- To activate the Emergency Power Off, press simultaneously the two pushbuttons in the E.P.O. section of the operating panel (For hot-standby and parallel systems, the operation needs to be performed at one unit only).

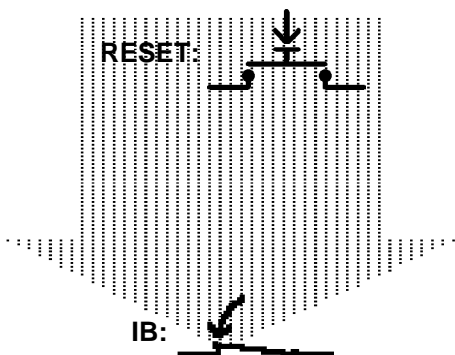
**Attention!** This operation will remove all supply to the load.



#### Emergency Shut Down:

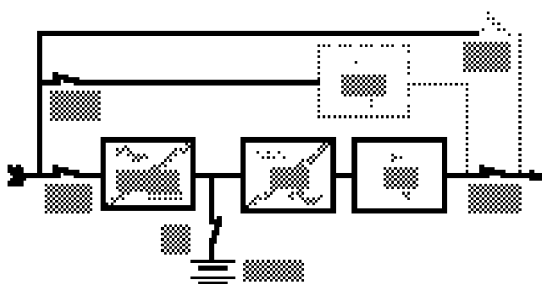
When E.P.O. is activated, all static switches SSI and SSB and the battery switch(es) IB (when connected with a trip circuit) are opened, the rectifier(s) and inverter(s) are switched off. The Data Monitor Panel / NCP will lose supply when the internal DC filter capacitors discharge.

**Attention!** Although the load is no longer supplied by the UPS, the input and output switches are still closed. Voltage is still present in the UPS unless the input circuit breaker(s) have a shunt trip circuit connected with the EPO circuit (see JUE 401066 "Installation and Initial Start-up", section 1.5).



#### Reset after Activating E.P.O.

- To restart the UPS press the RESET push-button **PL2** located on the CPU / NCP pcb inside the front door of the UPS. This releases the EPO circuit and the rectifier will restart.  
Note that if the input switch(es) were automatically tripped, it is sufficient to reclose the switch(es) without the need to press the reset pushbutton above.
- Press the pushbutton at the front of the CPHC16-R pcb at the right side of the UPS control electronic.
- After the front panel is illuminated, close **IB**.
- Repeat for all units in the system.
- Press the "**RESET**" button for one second on the operating panel.
- Press the "**START**" button for one second on the operating panel and repeat for all units in the system (if multiple units are present).



#### Final UPS Operating Mode:

The UPS is returned to normal operation, and all power switches except IBY are closed.



# SOLA 4000 - Operating Panel

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Rev.	Description	Date	Checked	Approved	Date	Format	Page	Total
A	ISSUED	04.02.97		M. Porpora	04.02.97	A4	1	19
B	See Rev. Doc. JSE 401440	20.06.97		T. Boon				
	See Rev. Doc. JSE 401490	01.09.97		M. Porpora				
				T. Boon				

## 1 FUNCTIONS

### 1.1 Indication of Important Data

- Actual Load** The actual load of the UPS is indicated as a percentage of its nominal load capacity.
- Battery Charging Status** While the battery is being charged (green LED 5 on), the actual charging status of the battery is indicated as a percentage of the nominal battery capacity.
- Battery Autonomy** While the battery is being discharged (yellow LED 4 on), the actual battery autonomy is indicated as a percentage of the nominal battery autonomy.

### 1.2 Battery Monitoring

- Low Battery** The Low Battery alarm indicates that only 20% of the battery autonomy is left. The colour of the LEDs for battery autonomy indication changes from green to red. In addition the alarm buzzer beeps.
- Battery Test** The SOLA 4000 UPS automatically performs a battery test every 30 days.  
Whenever the test shows that the battery is damaged or its capacity is reduced, the red LED "BATTERY TEST", located on the operating panel is illuminated and the buzzer beeps.  
This test is of vital importance, since it monitors the battery, warning of possible failures caused by reduced battery autonomy due to defective batteries.  
However this function can be deactivated with DSW2 - 3 on the CPU/NCP pcb inside the UPS front door. In this case the LED "BATTERY TEST" is off.

# 1 Functions

---

## 1.3 UPS Operating Mode Indication

On the operating panel a block diagram of the UPS is shown. The operating mode of the UPS is indicated with LEDs integrated into the block diagram.

<b>LED Off</b>	If a LED is not illuminated at all, the corresponding section is not active.
<b>LED On, Green</b>	If a LED is continually illuminated (green), the corresponding section is o.k.
<b>LED Flashing, Green</b>	If a LED is flashing (green), the corresponding section is not o.k., but the power supply to the load is not currently endangered.
<b>LED On, Yellow</b>	The corresponding section is OK, but it is not the nominal working condition of UPS.
<b>LED Flashing, Red</b>	If a LED is flashing (red), the corresponding section is not o.k., and the power supply to the load is endangered.

## 1.4 Alarm signalling

**By the UPS** Alarms are signalled by the UPS using LEDs and an audible alarm:

- Status LEDs signal an alarm by flashing.
- The integrated buzzer signals an alarm by beeping.
- The buzzer can be muted by pressing "Alarm Reset" at the operating Panel. The LEDs continue flashing when the alarm condition is still active.

There are two different types of alarm signals:

- The flashing LED is green and the buzzer beeps slowly if the power supply to the load is not currently endangered (common alarm flashing - yellow).
- The flashing LED is red and the buzzer beeps fast if the power supply to the load is endangered (common alarm is flashing red).

## 1.5 Remote Monitoring

The operating panel provides an option to communicate with a computer through RS232 and RS485 interfaces. The RS232 serial interface communicates with a PC or mainframe computer, with a SNMP protocol (SEC). With the RS485 interface it is possible to transmit all necessary data up to a distance of 400m or to connect a remote monitoring panel.

# 1 Functions

---

## 1.6 Emergency Power Off

In case of emergency it is possible to switch off the complete UPS system. This is done by simultaneously pressing the "EMERGENCY POWER OFF" (E.P.O.) push-buttons located on the operating panel. This function provides UPS disconnection from the load and galvanically isolates the UPS from the battery.

In the case of parallel and hot-standby configurations, activating EPO on one unit automatically switches OFF the entire system (when IUG is closed on that unit).



When E.P.O. is activated, dangerous voltages will still be present within the UPS cabinet unless the input supply circuit breaker(s) have a shunt trip circuit connected with the EPO circuit (see JUE 401066 section 1.5).

# 2 LED Indication

## 2 LED INDICATION

The block diagram of the UPS, with integrated LEDs, allows a quick check of the UPS operating status.

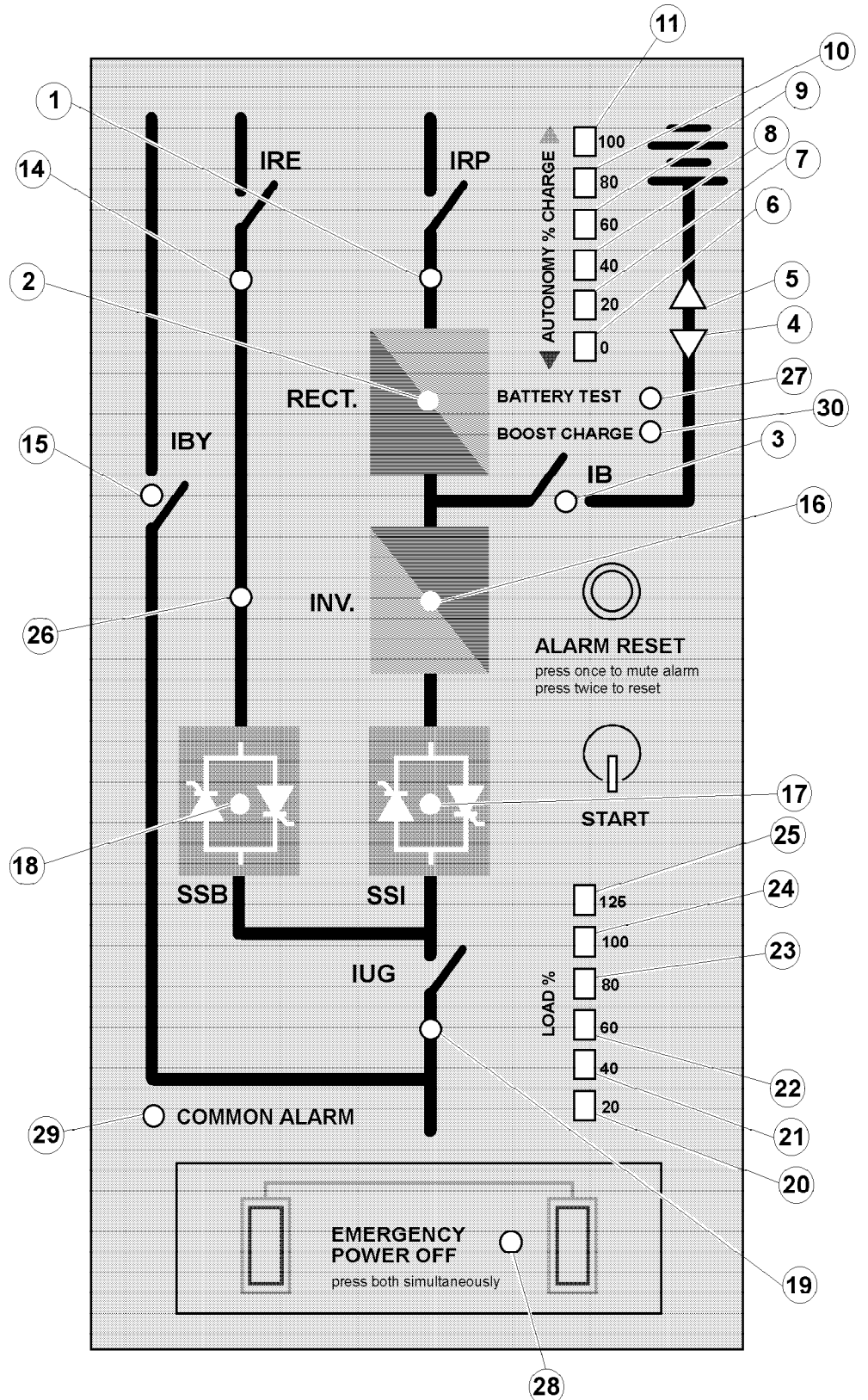


FIG. 2.1 - LED Indication

JUE 401267

## 2 LED Indication

---

**LED 1 MAINS PRESENT**

- Green LED is continually illuminated = Mains O.K.(rectifier).
- Green LED flashing slowly + BUZZER beeping slowly (approx. every 2 sec.) = Mains is not O.K.

**LED 2 RECTIFIER**

- LED off = Rectifier is not supplied
- Green LED is continually illuminated = Mains and rectifier O.K.
- Red LED flashing fast + BUZZER beeping fast (every sec.) = Rectifier failure

**LED 3 BATTERY SWITCH**

- Green LED is continually illuminated = Battery switch closed
- Green LED flashing fast + BUZZER beeping fast (every sec.) = Battery switch open

**LED 4 BATTERY DISCHARGING**

- Yellow LED is continually illuminated = Battery feeding inverter
- Otherwise LED is off.

**LED 5 BATTERY CHARGING**

- Green LED is continually illuminated = Battery charging
- Otherwise LED is off.

**LED 14 BYPASS POWER SUPPLY**

- Green LED is continually illuminated = Mains O.K.(Bypass supply).
- Green LED flashing slowly + BUZZER beeping slowly = Mains out of order or not present, or IRE open.

**LED 15 MAINTENANCE BYPASS SWITCH**

- Red LED is continually illuminated = Maintenance bypass switch closed
- **Note:** For parallel and hot-standby systems, it may be any maintenance bypass within the system that is closed.
- Otherwise LED is off.

**LED 16 INVERTER**

- Green LED is continually illuminated = Inverter O.K.
- Red LED flashing fast + BUZZER beeping fast = Inverter failure
- LED is off = inverter is switched off.

**LED 17 LOAD FED BY INVERTER**

- Green LED is continually illuminated = Load fed by inverter
- Red LED flashing and can be reset with the "RESET" pushbutton; buzzer beeping = Retransfer blocked
- Otherwise LED is off.

## 2 LED Indication

---

### LED 18 LOAD FED BY BYPASS POWER SUPPLY

- Yellow LED is continually illuminated = Load fed by static bypass
- Otherwise LED is off.

### LED 19 LOAD IS SUPPLIED

- Green LED is continually illuminated = Load fed either by inverter or by static bypass and IUG is closed
- Otherwise LED is off.

### LED 27 BATTERY TEST

This test is only performed if the batteries are fully charged. Otherwise the test is skipped and performed in the following month.

- LED off = BATTERY TEST function not active
- Green LED is continually illuminated = BATTERY TEST function activated, but UPS is not performing the test
- Green LED flashing slowly = BATTERY TEST running
- Red LED flashing fast + BUZZER beeping fast = BATTERY TEST failed. Test battery capacity.

### LED 28 E.P.O.

- Red LED is continually illuminated = E.P.O. has been activated  
**Note:** For parallel and hot-standby systems, EPO may have been activated at any unit.

### LED 26 STATIC SWITCH

- Green LED continually illuminated = Bypass available
- Green LED flashing = Bypass not synchronised but the mains is OK
- LED off = Mains not OK

### LEDs BATTERY INDICATOR

a) During the charging phase (green LED L5 ON)

- Green LEDs continuously illuminated indicate the actual battery autonomy as a percentage of the nominal battery autonomy, depending on the actual load and battery charging status.

b) During the discharging phase (yellow LED 4 ON)

- If, during the discharging phase, the actual battery autonomy goes below 20% autonomy, the system signals the alarm "Low Battery".
  - The BUZZER beeps continually.
  - The colour of the "battery indicator" LEDs changes from green to red.
- The actual autonomy is signalled by the flashing of the corresponding LED.
- When the LED corresponding to 0% autonomy starts flashing:
  - The buzzer beeps continually and cannot be muted.
  - The inverter will cease to operate soon.

## 2 LED Indication

### LOAD PERCENTAGE

The actual load is indicated by LEDs as a percentage of the nominal load.

- All LEDs off => Actual load = 0 - 10%
- Green LED 20% cont. illumin. => Actual load = 10 - 30%
- Green LED 40% cont. illumin. => Actual load = 30 - 50%
- Green LED 60% cont. illumin. => Actual load = 50 - 70%
- Green LED 80% cont. illumin. => Actual load = 70 - 90%
- Green LED 100% cont. illumin. => Actual load = 90 - 100%
- Red LED 125% cont. illumin. => Actual load = 100 - 125%
  - The UPS is in an overload condition.
  - The buzzer is beeping continually and cannot be muted.

### LED 29 COMMON ALARM

- Red LED continually illuminated and BUZZER beeping fast = any of the following conditions:
  - Inverter Failure
  - Battery Switch Open
  - Low Battery
  - Rectifier Failure
  - Paralleling Fault
  - Inverter not synchronised (with the bypass supply or internal oscillator)
  - Retransfer blocked
  - Overtemperature
  - Battery Test Failed
  - Inverter not Feeding and bypass off (not active for hot-standby)
  - Bypass system not available (but bypass of this unit is available when more than one bypass is installed)
- Yellow LED continually illuminated and BUZZER beeping slowly = any of the following conditions:
  - Mains Failure (rectifier)
  - Mains Failure (bypass)
  - Battery Discharging
  - Bypass not available
  - Overload
  - Load on Bypass (SSB closed)
  - Inverter not synchronised (with the bypass supply)
  - Auxiliary Alarm
- Otherwise the LED is off

### LED 30 BOOST CHARGE

- Green LED on = Boost charge active
- Otherwise LED is off.



## 3 Communication with a PC

### 3 COMMUNICATION WITH A PC

#### 3.1 Connection to PC

The UPS is connected to the PC via the RS232 interface. The respective connector is the female 9-pin sub-D connector on the CPU/ NCP pcb on the inside of the UPS front door. At the PC a serial port is used which can either be a male 9-pin sub-D connector or a male 25-pin sub-D connector.

**Cable Specification** For connecting the PC and UPS use twisted pair, 24 AWG shielded cable. Connect the shield to ground at the PC and at the UPS.

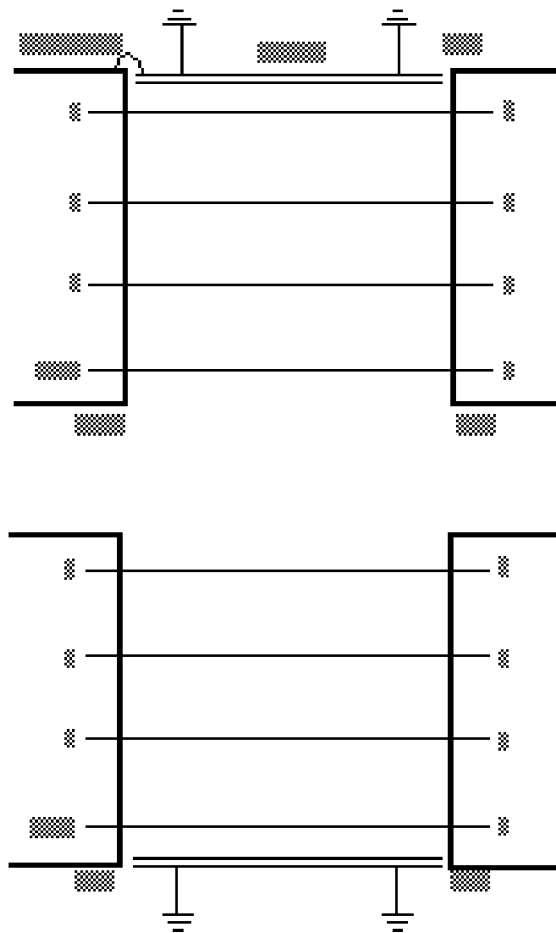


FIG. 3.1 - RS232 connection Cable

## 3 Communication with a PC

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### 3.2 SNMP MODE

With DIP7 of SW2 in the ON position, the UPS can be monitored and controlled from a remote location by a PC through a SNMP protocol converter. In this mode, software packages such as SMARTMON<sup>®</sup> from Systems Enhancement Corporation may be directly applied using a P.C.

The software runs on PCs with the following Operating systems:

MICROSOFT WINDOWS  
MICROSOFT WINDOWS FOR WORKGROUPS  
MICROSOFT WINDOWS 95  
MICROSOFT WINDOWS NT  
IBM OS/2

The software allows:

- UPS monitoring
- Event logging
- Broadcasting
- Paging
- E - Mail (only for Windows 95)

The use of a modem for remote monitoring is also possible.

The UPS can be connected to a LAN and monitored through an SNMP protocol.

An external Hardware interface is required to perform the protocol conversion from SEC protocol to SNMP protocol.

### 3.3 Service Mode

This mode is intended as a test mode and is used during testing / maintenance of all units. It is activated by setting DIP 7 of SW2 in the OFF position.

#### PC Requirements

- A program is available for testing / service purposes.
- The communication parameters must be set as follows:

BAUD	=	1200
PARITY	=	OFF
BITs	=	8
STOP BITs	=	1

## 3 Communication with a PC

---

### 3.4 Alarms

With a connected PC, the following alarms are realised (SNMP and service modes):

<b>Rectifier Failure</b>	The Rectifier mains is in order but a failure is present within the rectifier.
<b>Inverter Failure</b>	The inverter is ON but the inverter voltage or inverter conditions are not in order.
<b>Battery Switch OFF</b>	The battery switch is OFF
<b>Retransfer blocked</b>	The inverter has attempted unsuccessfully to take over the load at least 5 times within 3 minutes. To reset, press the "RESET" pushbutton a second time after muting the alarm.
<b>Overtemperature</b>	The inverter/rectifier components are operating at an excessive temperature. This can be due to extreme environmental conditions or a failure within the inverter or rectifier sections. If the bypass is available the UPS transfers immediately to the bypass supply (in the case of a hot-standby system, the second unit takes over the load, in the case of a parallel system the remaining inverters take over the load). If the bypass or another inverter is not available then the UPS will continue to supply the load for a further 10 minutes before shutting down.
<b>Mains Failure</b>	The mains is not present or not within the specified voltage and frequency tolerances.
<b>Inverter not Feeding</b>	The inverter is not feeding the load and the bypass static switch, SSI is OFF.
<b>Battery Discharging</b>	The mains or rectifier has failed and the batteries are discharging. This alarm is activated at a battery voltage of approx. 360Vdc.
<b>Low Battery</b>	The remaining battery capacity during discharge has been calculated to be less than 20% of the nominal capacity.
<b>Battery Test Failed</b>	The routine battery test has detected a decrease in capacity of the battery. The battery must be checked.
<b>Paralleling Fault</b>	The inverter has failed to regulate correctly in parallel operation with another inverter (parallel systems only).
<b>Bypass not Available</b>	The bypass mains supply is OK but the bypass is not available to take the load if the inverter fails (the inverter is not synchronised or is blocked externally).

## 3 Communication with a PC

---

For systems with multiple static bypasses (hot-standby and parallel/redundant), if the bypass of this unit is available, but the bypass system is not available, the UPS system cannot transfer to the bypass supply, due to the fact that there may be insufficient bypasses available within the system.

- Overload** The UPS is overloaded by more than the nominal output load current
- Load on Bypass** The UPS system load is being supplied by the bypass supply.
- Inverter not synchronised** The inverter is not synchronised to the bypass supply.
- Auxiliary Alarm** This alarm consists of a series of system alarms and includes the following:
- **Oscillator failure**  
A failure has occurred in the oscillator circuit or a loss of synchronism with another oscillator of another unit within the system.
  - **IUG monitoring failure**  
An error has occurred within the monitoring circuit of the output switch (disabled for single units).
  - **Static switch failure (SSI)**  
A failure has occurred within the monitoring circuit of the inverter output static switch.
  - **Static switch failure (SSB)**  
A failure has occurred within the monitoring circuit of the bypass static switch.
  - **Missing or incorrect bypass trip signal** (parallel and hot-standby systems)  
An indifference has occurred within the bypass trip logic of this unit and the remainder of the system.
  - **System not redundant** (parallel /redundant systems)  
If the inverter of the unit signalling this alarm fails, the system must transfer to the bypass supply.
  - **SSI-ON generator failure** (parallel/redundant systems)  
A failure or loss of synchronism has occurred with the SSI ON pulse generator on IPR pcb and may occur during start-up of a unit in a parallel system. To reset press "START" and then "RESET".

To determine which of the alarm(s) are present refer to the section "PCB Description" JUE 401069.

## 3 Communication with a PC

---

### 3.5 UPS status

Additionally to the above alarms, the following status conditions are realised:

<b>Boost Charge</b>	The rectifier is re-charging the battery with a boost charge (according to DIN 41773).
<b>Output Switch OFF</b>	The output switch (IUG) is OFF and the load is not supplied by this unit.
<b>Service Bypass ON</b>	The load is supplied by any of the maintenance bypass(es).

### 3.6 Metering

With a connected PC, the following measurements can be realised (SNMP and service modes):

<b>Vout(R)</b>	(UPS output voltage phase R)
<b>Vout(S)</b>	(UPS output voltage phase S)
<b>Vout(T)</b>	(UPS output voltage phase T)
<b>Vinv</b>	(Inverter output voltage - average of the three phases).
<b>I(R)</b>	(UPS output current phase R)
<b>I(S)</b>	(UPS output current phase S)
<b>I(T)</b>	(UPS output current phase T)
<b>Pout%</b>	(UPS output kVA in % of nom. kVA)
<b>Aut%</b>	(Battery autonomy in % of nom. autonomy)

## 4 Panel Settings

### 4 PANEL SETTINGS

#### 4.1 DIP Switch Settings

With the DIP switches SW1 and SW2 on the CPU/NCP pcb inside the front door , the operating parameters can be set according to actual conditions.

**Note:** The following settings apply only with the software V2.0 or later.

DIP Switch SW1				
Dip 1	Dip 2	Dip 3	Dip 4	UPS RATING (KVA)
OFF	OFF	OFF	OFF	10
ON	OFF	OFF	OFF	15
OFF	ON	OFF	OFF	20
ON	ON	OFF	OFF	30
OFF	OFF	ON	OFF	40
ON	OFF	ON	OFF	60
OFF	ON	ON	OFF	80
ON	ON	ON	OFF	100
OFF	OFF	OFF	ON	120

TAB. 4.1 - Setting of SW1 - UPS rating

DIP Switch SW1	
DIP 5	CONFIGURATION
OFF	Not Hot-standby
ON	Hot-Standby
DIP 6	BYPASS - LINE
OFF	Installed
ON	Not installed

TAB. 4.2 - Setting of SW1

DIP Switch SW1 Nominal Voltage		
DIP 7	DIP 8	Vnom
OFF	OFF	120
ON	OFF	220
OFF	ON	230
ON	ON	240

TAB. 4.3 - Setting of SW1  
Nominal Voltage

## 4 Panel Settings

---

DIP Switch SW2	
<b>Dip 1</b>	<b>AUDIBLE ALARM</b>
<b>OFF</b>	Audible alarm ENABLED
<b>ON</b>	Audible alarm DISABLED
<b>Dip 2</b>	<b>AUTONOMY ALARM</b>
<b>OFF</b>	Autonomy alarm ENABLED
<b>ON</b>	Autonomy alarm DISABLED
<b>Dip 3</b>	<b>BATTERY TEST</b>
<b>OFF</b>	Battery test DISABLED
<b>ON</b>	Battery test ENABLED
<b>DIP 4</b>	<b>TIME CONSTANT</b>
<b>OFF</b>	FAST
<b>ON</b>	NORMAL
<b>DIP 5</b>	
<b>OFF</b>	
<b>ON</b>	
<b>DIP 6</b>	<b>FREQUENCY</b>
<b>OFF</b>	60 Hz
<b>ON</b>	50 Hz
<b>DIP 7</b>	<b>REMOTE ACCESS</b>
<b>OFF</b>	Service mode
<b>ON</b>	SNMP mode
<b>DIP 8</b>	<b>Forced Battery Test (If DIP3=ON)</b>
<b>OFF</b>	Forced batt. test OFF
<b>ON</b>	Forced batt. test ON

TAB 4.4 Setting of SW2

# 4 Panel Settings

## 4.2 Location of DIP-switches and pushbuttons on the CPU/NCP pcb

The CPU/NCP pcb is located inside the front door at the UPS cubicle.

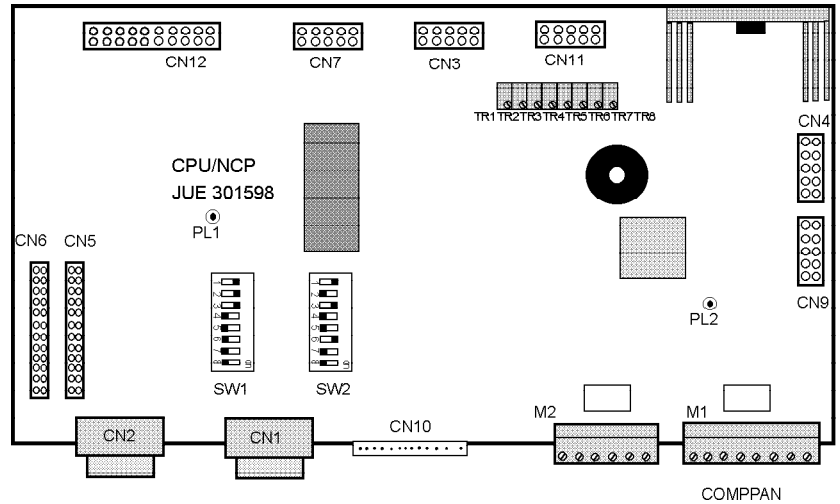


FIG. 4.3 Layout of the CPU/NCP pcb

- PL1**      Microprocessor RESET
- PL2**      Emergency Power Off (E.P.O.) RESET



## 5 Remote Panel

### 5 REMOTE PANEL

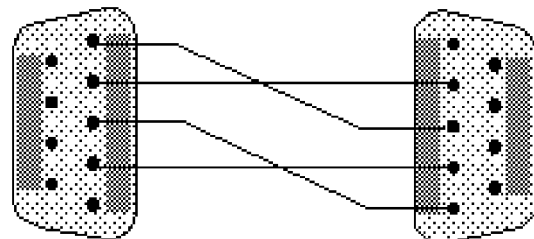
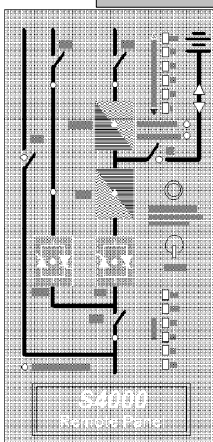
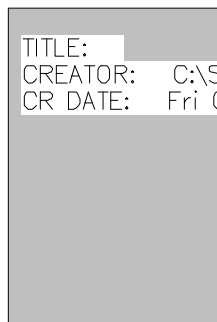
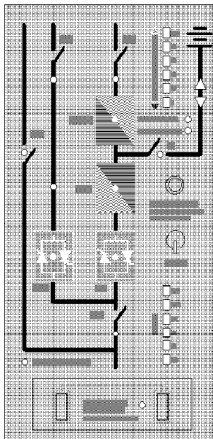
#### 5.1 General

The Remote Panel is used for remote monitoring of SOLA 4000 systems for distances of up to 400m. It is connected by cable via a RS485 interface. It can be installed in a control room and provides the same user interface as the local operating panel.

Only the E.P.O. function is not implemented.

#### 5.2 Installation

The Remote Panel is connected to the UPS by a shielded cable 4x0.5mm of max. 400m length with 9-pole sub-D connectors.



9-pole male sub-D connector, fits in the remote panel

9-pole male sub-D connector, fits in the UPS local panel

The Remote Panel is mounted in a box (270x160x80mm).

The Remote Panel is supplied by an external power supply 220/230/240 V<sub>ac</sub>, 50 Hz (which must be connected to the output of the UPS).

The connection between the UPS and the Remote Panel is provided by a Keyboard 5-Wire Jack.

For the Remote Panel housing the same colour is used as for the SOLA 4000 cabinets.

## 5 Remote Panel

### 5.3 Functions

**General** The Remote Panel provides the same LED indications as the SOLA 4000 operating panel. Alarms are indicated by flashing LEDs and an integrated buzzer. The alarms can be muted directly at the Remote Panel by pressing the "Alarm Reset" push-button.

The buzzer can be deactivated by setting switch 2 of DIP1 to the Off position. The inverter can be switched on from the remote panel but cannot be switched off.

**Automatic alarm phone calls** The Remote Panel can be connected to an external modem through the RS232 DB9 connector, in order to perform an automatic phone call to one or two programmed phone numbers (corresponding to Computers in host Mode), in case of one of the below listed alarm conditions:

- RETRANSFER BLOCKED
- BATTERY TEST FAILURE
- INVERTER FAILURE
- LOAD ON BYPASS
- RECTIFIER FAILURE

The automatic call feature is enabled by setting switch 3 of DIP1 to the ON position.

One computer can receive alarm messages from 8 different Remote Panels. The Remote Panels (and hence the connected UPS) can be identified by a number from 1 to 8 which is binarily programmed by setting the switches 6,7 and 8 of DIP1.

In case of an alarm at a certain UPS the corresponding Remote Panel calls the computer and transmits a two line alarm message (ASCII characters) with the following structure:

**UPS x**                      x =1...8 identifies the UPS

**Alarm condition**    One or more of the above listed alarms

**Programming of phone numbers** In case of an alarm one or two phone numbers may be called automatically, i.e. the UPS status may be monitored by one computer only or by two different computers. With switch 4 of DIP1 the number of computers to be called can be set.

To program the phone numbers to be called connect a PC with a serial interface to the RS232 DB9 connector on the rear side of the Remote Panel and run a terminal program.

Type

*P1XXXXX...X[CR]*    to program the first phone number (XXXXX...X)

*P2YYYYY...Y[CR]*    to program the second phone number (YYYYY...Y)

Each phone number may contain up to 20 digits.

To read programmed phone numbers from the panel type

*N1[CR]*                      The Remote Panel responds with the first number:

*N1=XXXXX...X*

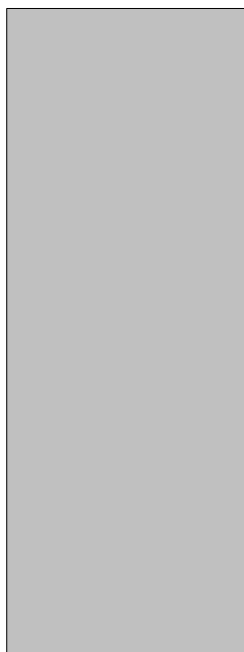
*N2[CR]*                      The Remote Panel responds with the second number:

*N2=YYYYY...Y*

The programmed numbers are stored in an EEPROM and are thus protected against power failures and CPU resets.

## 5 Remote Panel

### Communication timing



When an alarm condition occurs, the Remote Panel calls the first programmed number.

If the line is busy and only one number is to be called, the Remote Panel waits for 5 minutes and, if the alarm condition is still present, it tries to call the number again. This procedure will be repeated until the connection has been established or the alarm condition ends.

If the line is busy and two numbers are to be called, the second number will be called. If this line is also busy the first number will be tried again and so on.

After a successful connection the Remote Panel will normally hold the line for five minutes. Any additional alarm messages that are activated during that time will be displayed automatically at the computer display and one minute will be added to the remaining connection time. The maximum connection time is, however, limited to ten minutes.

If during the connection all alarms are deactivated, the Remote Panel sends the following messages:

**UPSx** followed by:

**UPS OK**

and the remaining connection time is set to one minute.



### 5.4 DIP-switch settings

DIP Switch DIP1			
switch 1		Not used	
ON			
OFF			
switch 2		Local buzzer	
ON		active	
OFF		not active	
switch 3		Automatic call	
ON		active	
OFF		not active	
switch 4		Phone numbers	
ON		two phone numbers	
OFF		one phone number	
switch 5		Not used	
ON		-	
OFF		-	
sw. 6	sw. 7	sw. 8	UPS number for identification
ON	ON	ON	1
OFF	ON	ON	2
ON	OFF	ON	3
OFF	OFF	ON	4
ON	ON	OFF	5
OFF	ON	OFF	6
ON	OFF	OFF	7
OFF	OFF	OFF	8

FIG. 5.1 - Setting of DIP1

# SOLA 4000 - PCB Description

## Chapters

## Figures

<b>1</b>	<b>UPS CONTROL LOGIC</b>	<b>2</b>		
1.0	UPS Control Logic	2	FIG. 1.1 - IF/PS - R front view	3
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1.2	Rectifier	3	FIG. 1.3 - ICP front view	6
1.3	Inverter	5	FIG. 1.4 - ICT-2 front view	7
1.4	Bypass	10	FIG. 1.5 - IPS-500 front view	8
			FIG. 1.6 - IPR front view	9
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Rev.	Description	Date	Checked	By	Date	Sheet	Total
	ISSUED	04.02.97		M.Porpora	04.02.97	A4	1 12
A	See Rev. Doc. JSE 401440	20.06.97	T. Boon				
B	See Rev. Doc. JSE 401547	23.09.97	T. Boon	T. Boon			

# 1 UPS Control Logic







## 1 UPS CONTROL LOGIC

### 1.0 UPS Control Logic

The UPS Control logic is situated in the centre of the front part of the UPS. It consists of one rack with 7-8 PCBs (depending on the system configuration). On the covers of the rack, the various potentiometers, test points and LEDs are briefly labelled.

A more detailed explanation is given in this chapter.

### 1.1 Legend of symbols used

	<b>LED (light emitting diode)</b>	<ul style="list-style-type: none"> <li>- GREEN: normal condition</li> <li>- RED: alarm condition.</li> <li>- YELLOW: warning</li> </ul>
	<b>Potentiometer</b>	<ul style="list-style-type: none"> <li>- For adjustment (only for qualified personnel)</li> </ul>
	<b>Test Point</b>	<ul style="list-style-type: none"> <li>- Requires a pin 2mm for measurement.</li> </ul>
	<b>Test point/switch</b>	<ul style="list-style-type: none"> <li>- Insertion of a 2mm Pin disables the described function</li> </ul>
	<b>Pushbutton</b>	<ul style="list-style-type: none"> <li>- Performs a reset or switching operation</li> </ul>
	<b>Micro switch</b>	<ul style="list-style-type: none"> <li>- Switch from manual to auto matic mode</li> </ul>

# 1 UPS Control Logic

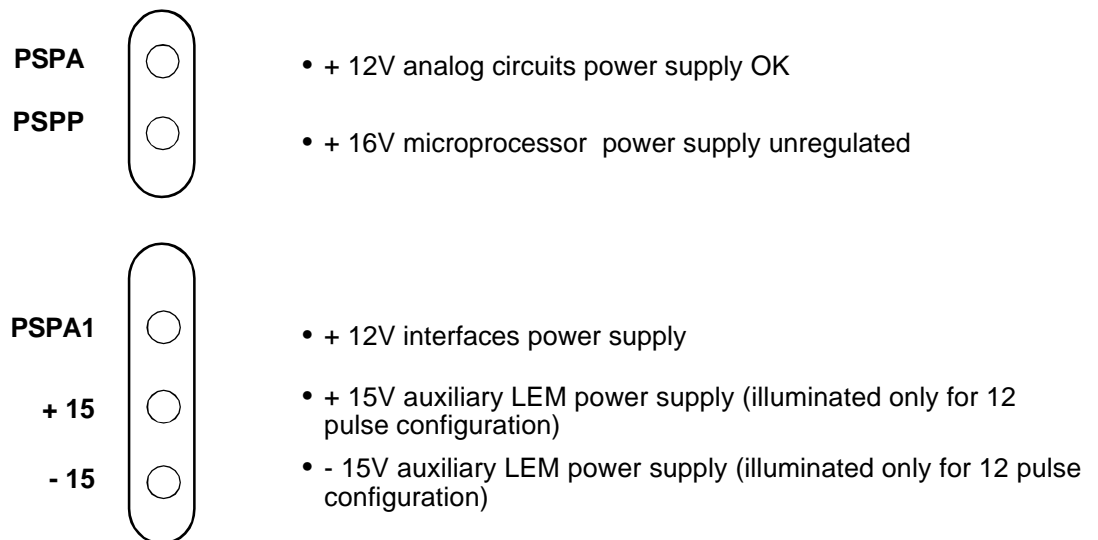
## 1.2 Rectifier

The rectifier control logic consists of two PCBs.

- IF/PS - R** Rectifier electronic power supply
- input voltage sensing
  - rectifier electronics power supply

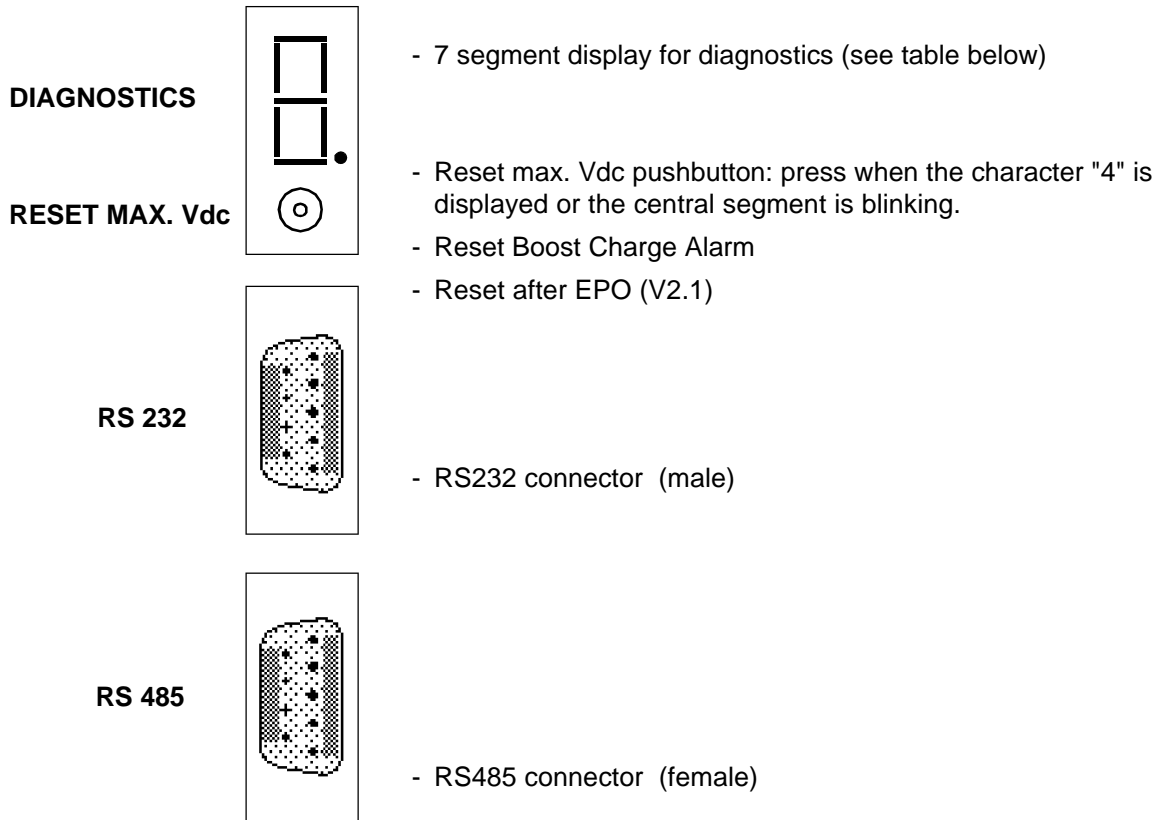
- CPHC16 - R** Rectifier control and regulation
- rectifier output voltage regulation
  - rectifier output current limitation
  - soft-start control
  - battery charging current limitation
  - generation of the thyristor firing pulses
  - input voltage monitoring (phase rotation, mains failure)
  - control for parallel rectifiers (with a common battery)
  - 12-pulse rectifier control
  - Second level current limitation for diesel-generators.
  - Boost charging according to DIN 41773.
  - Thermal compensation.

**IF/PS - R Front View** FIG. 1.1 illustrates the LEDs of the IF/PS - R PCB which are accessible from the front.



# 1 UPS Control Logic

**CPHC16 - R Front View** FIG. 1.2 illustrates the display, switches and connectors of the CPHC16 - R PCB which are accessible from the front.



Priority	Indication	Diagnostics
1	8	E <sup>2</sup> PROM failure
2	2	Fuse blown
3	C	Mains not OK
4	P	Wrong phase rotation
5	3	Overtemperature
6	4	Overvoltage
7	∅	Pulse release missing
8	9	Rectifier failure
9	6	Fan failure
10	L	Overload
	--	Boost charge
	"--"	(when blinking) Has left the boost charge due to a given time limit but the battery was not completely charged. Reset with "RESET max. Vdc" above.

# 1 UPS Control Logic

---

In normal condition the display shows a red segment rotating clockwise. During the starting phase, a blinking central segment "-" is displayed. During parameter acquisition through the serial interface, the character "A" is displayed. If more than one alarm is present, only the one with the higher priority is displayed.

## 1.3 Inverter

The inverter control logic consists of three PCBs (four for parallel systems).

### **ICP** Inverter control

- control for the inverter static switch (SSI)
- temperature monitoring
- inverter monitoring and protection
- hot-standby control
- quartz oscillator
- fan monitoring
- inverter electronic power supply monitor

### **ICT-2** Inverter regulation

- inverter output voltage regulation
- inverter output current limitation
- short-circuit protection
- inverter soft start control
- inverter-bypass synchronisation
- inverter-oscillator synchronisation
- synchronisation monitor:

### **IPS - 500** Inverter electronic power supply

- inverter electronic power supply
- inverter input voltage monitoring
- generation of the battery-discharging alarm



# 1 UPS Control Logic

Inverter control and regulation (parallel configuration)

- parallel regulation of up to 8 inverters
- system control for up to 8 inverters (together with ICP pcb)
- cold-standby control
- load monitoring
- redundancy monitoring

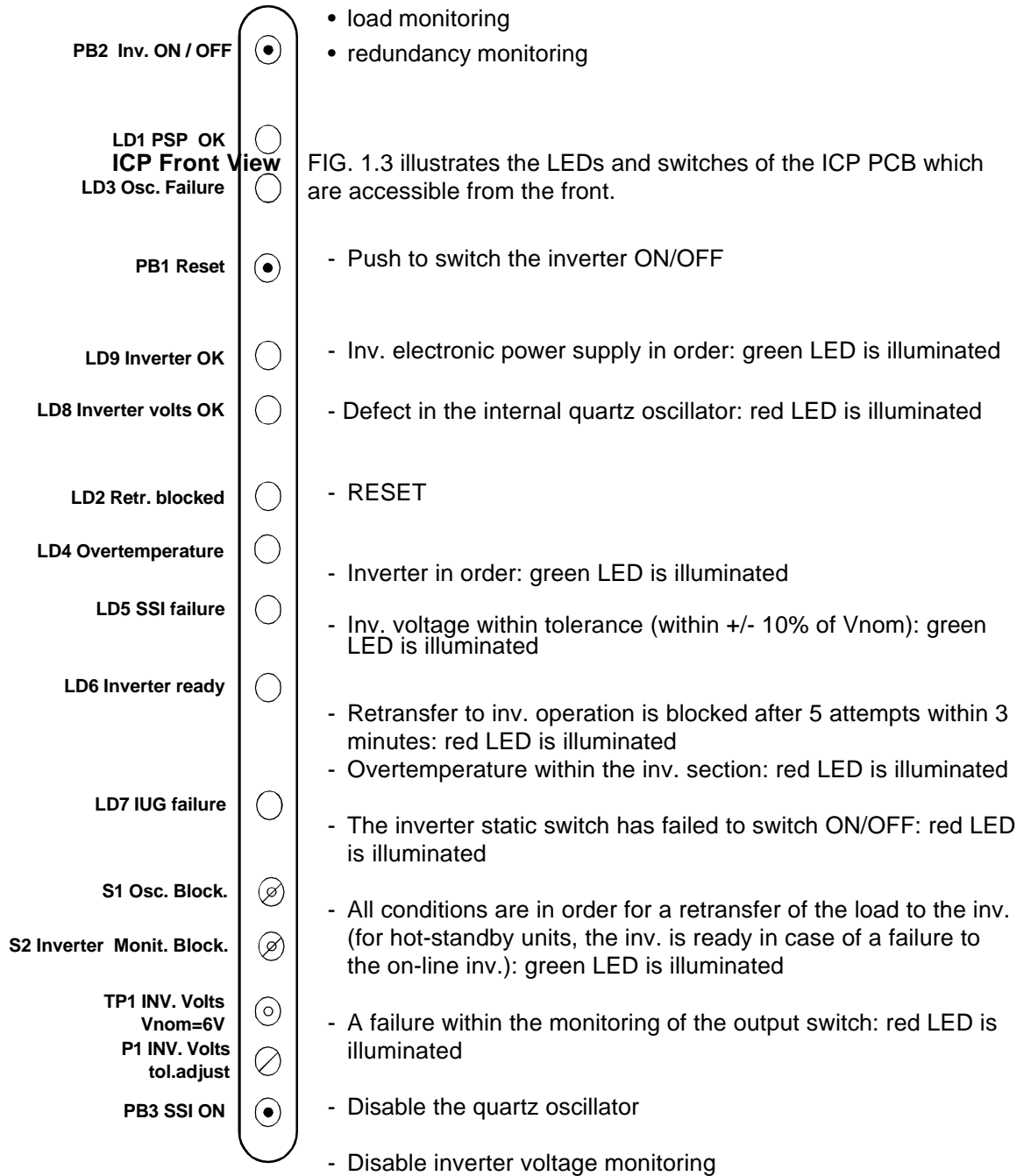
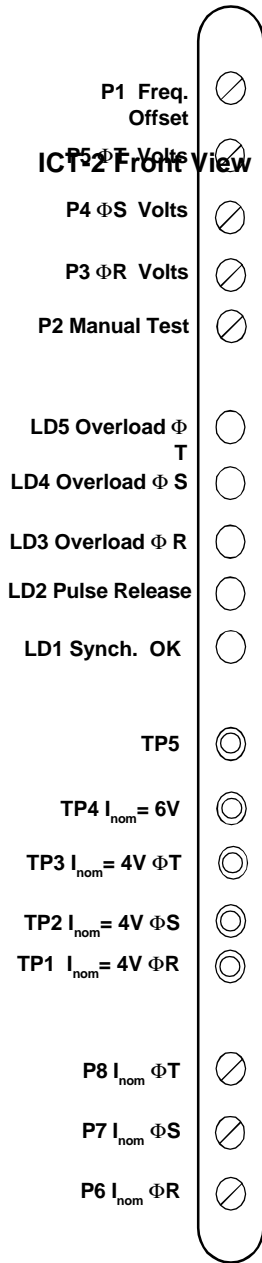


FIG. 1.3 illustrates the LEDs and switches of the ICP PCB which are accessible from the front.

# 1 UPS Control Logic



- Proportional to the inv. voltage. 6V ≡ nominal inverter voltage
- Inv. voltage tolerance adjust for 6V at TP1 with nom. voltage
- Push to switch ON the inverter output static switch (SSI)

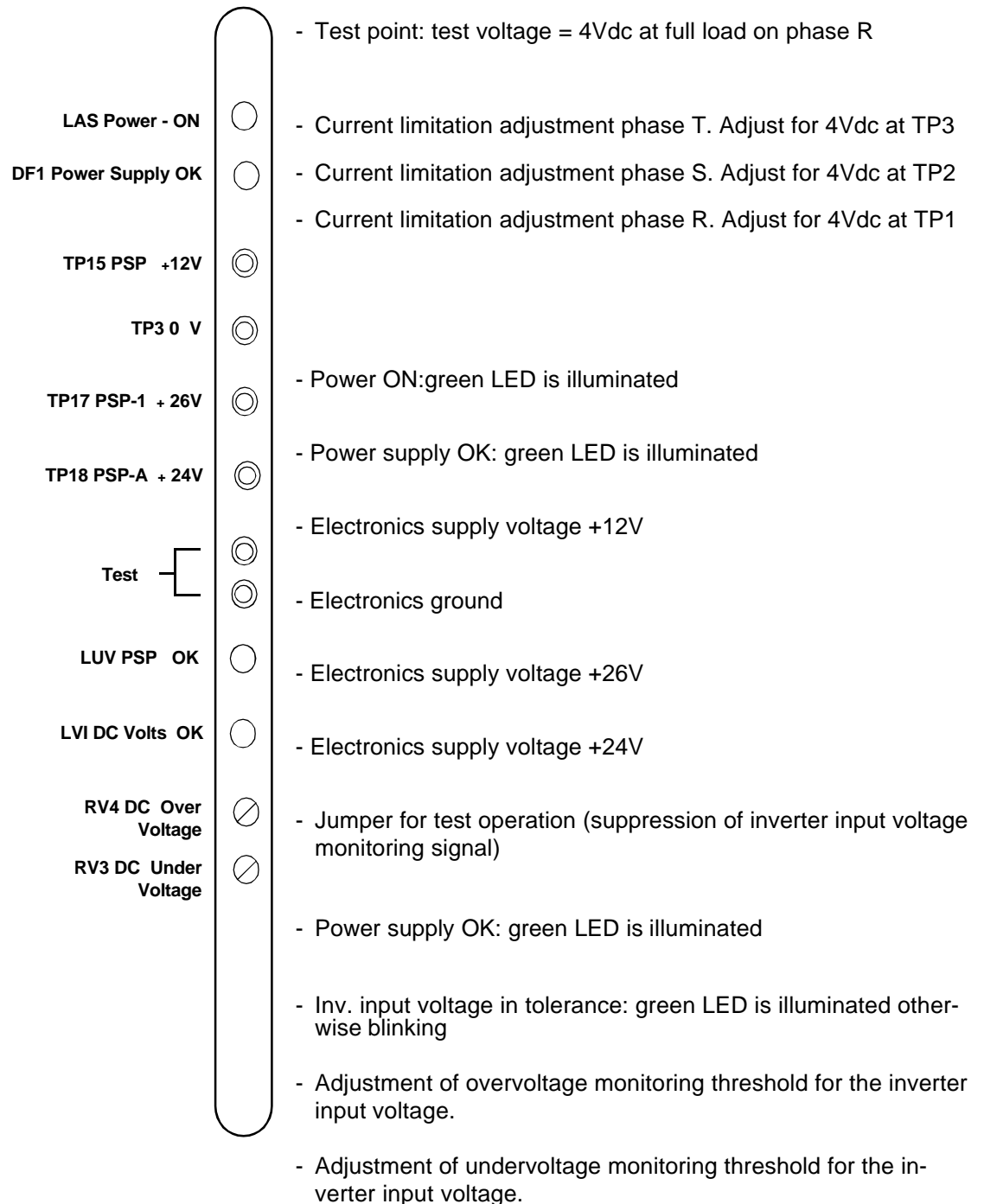
FIG. 1.4 illustrates the potentiometers, LEDs and test points of the ICT-2 PCB which are accessible from the front.

- Frequency offset adjustment (when synchronisation is blocked at TP5)
- Inverter voltage adjustment phase T
- Inverter voltage adjustment phase S
- Inverter voltage adjustment phase R
- Inverter voltage adjustment during test operation (jumpers JP1, JP2, JP3 in position 2,3)
- Overload on phase T: red LED is illuminated
- Overload on phase S: red LED is illuminated
- Overload on phase R: red LED is illuminated
- Pulse release: green LED is illuminated
- Synchronisation OK: green LED is illuminated
- Synchronisation block
- Test point: test voltage = 6Vdc at full load
- Test point: test voltage = 4Vdc at full load on phase T
- Test point: test voltage = 4Vdc at full load on phase S

# 1 UPS Control Logic






















**IPS-500 Front View**

FIG. 1.5 illustrates the potentiometers, LEDs and test points of the IPS-500 which are accessible from the front.



# 1 UPS Control Logic

**IPR front view** FIG. 1.6 illustrates the LEDs, potentiometers, switches and test sleeves of the IPR pcb that are accessible from the front.

<b>LD1 Parall.Operat</b>		- Parallel Operation On: This inverter is connected with another or more inverters to the output in parallel.
<b>LD2 Red not ok</b>		- Redundancy Not OK: Redundant units only. The load has increased or an inverter is off so that if this unit fails, the system must transfer to the bypass supply.
<b>LD3 Parallel Fault</b>		- Parallel Fault: A fault has occurred with the regulation of the inverter in parallel with another inverter.
<b>LD4 Pulse gen. Fail</b>		- SSI pulse generator failure: A failure or loss of synchronism has occurred within the SSI ON pulse generator. To reset press PB3 and then PB1 on the ICP pcb.
<b>TP1 <math>I_{ref} = 6V_{rms}</math></b>		- Reference current for parallel regulation $6V_{rms}$ = nominal current of the system (0.8 p.f.).
<b>TP2 <math>I_{out} = 6V_{rms}</math></b>		- Inverter output current for parallel regulation $6V_{rms}$ = nominal current of this unit (0.8 p.f.).
<b>TP3 <math>I_{error}</math></b>		- Difference current for parallel regulation
<b>TP4 <math>I_{load} = 8V</math></b>		- Output current of this unit. $8V_{dc}$ = nominal load current of this unit (0.8 p.f.)
<b>TP5 <math>I_{syst} = 8V</math></b>		- System output current. $8V_{dc}$ = nominal load current on the system (0.8 p.f.)
<b>TP6 <math>I_{red}</math></b>		- Redundancy current. $8V_{dc}$ = nominal load current on the remainder of the system (without this unit, 0.8 p.f.)
<b>TP7 <math>P_{out} = 6V</math></b>		- Power of this unit. $6V_{dc}$ = nominal load power on this unit
<b>TP8 <math>P_{syst} = 6V</math></b>		- Power of the system. $6V_{dc}$ = nominal load power on the system
<b>TP9</b>		- Output voltage phase T
<b>TP10</b>		- Output voltage phase R-S
<b>P1 <math>I_{ref}</math></b>		- Adjust for $6V_{rms}$ at TP1 with nominal load current (0.8 p.f.)
<b>P2 <math>I_{out}</math></b>		- Adjust for $6V_{rms}$ at TP2 with nominal load current (0.8 p.f.)
<b>P3 <math>I_{load}</math></b>		- Adjust for $8V_{dc}$ at TP4 with nominal load current (0.8 p.f.)
<b>P4 <math>I_{syst}</math></b>		- Adjust for $8V_{dc}$ at TP5 with nominal load current (0.8 p.f.)
<b>P5 <math>P_{out}</math></b>		- Adjust for $6V_{dc}$ at TP7 with nominal load
<b>P6 <math>P_{syst}</math></b>		- Adjust for $6V_{dc}$ at TP8 with nominal load
<b>Manual</b>		- Manual: manual switching on/off of the inverter permitted
<b>S1</b>		- Auto: inverter will automatically switch on/off depending on the load applied and the internal programming of IPR pcb.

# 1 UPS Control Logic

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## 1.4 Bypass

The bypass static switch control logic consists of two PCBs.

**IF/PS - S** Bypass monitoring and power supply

- bypass electronic power supply
- mains voltage sensing

**CPHC16 - S** Bypass control

- switching control of the static bypass switch SSB
- interface with the inverter or multiple inverters
- mains frequency monitoring
- mains voltage and phase rotation monitoring
- generation of synchronisation signal
- interface with multiple static bypasses
- UPS output voltage monitoring
- majority control for multiple static bypasses (parallel and hot standby systems)
- synchronisation monitor: mains - UPS output

# 1 UPS Control Logic

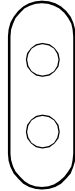
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## IF/PS - S Front View

FIG. 1.7 illustrates the LEDs of the IF/PS - S PCB which are accessible from the front.

PSPA

PSPP



- +12V analog circuits power supply OK: green LED is illuminated

- +16V microprocessor power supply OK: green LED is illuminated

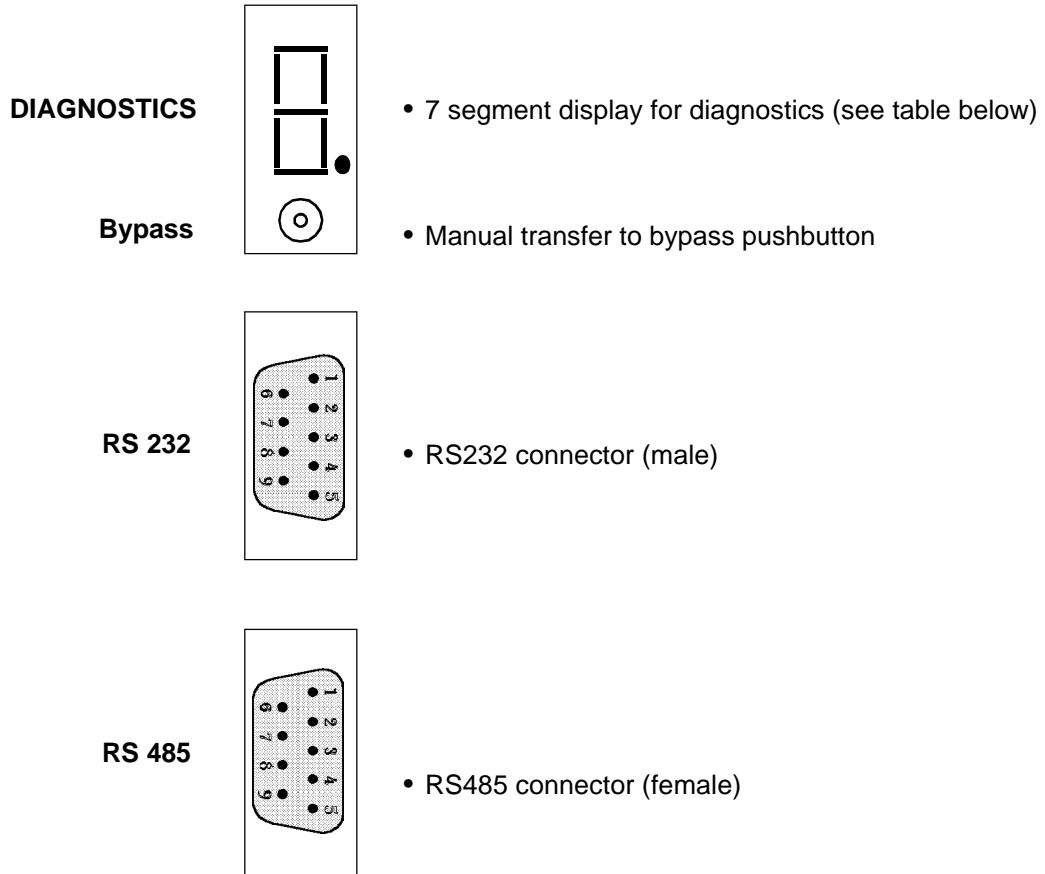
PSPA1



- +12V interfaces power supply OK: green LED is illuminated

# 1 UPS Control Logic

**CPHC16 - S Front View** FIG. 1.8 illustrates the display, switches and connectors of the CPHC16 - S PCB which are accessible from the front.



Priority	Indication	Diagnostics
1	8	E <sup>2</sup> PROM failure
2	F	Bypass Fuses Blown or IRE open
3	C	Phase failure
4	P	Incorrect phase rotation
5	•	Bypass square wave generation error
6	O	Output out of tolerance
7	L	Overload
8	4	Mains frequency out of tolerance
9	H	Mains voltage out of tolerance
10	6	Auxiliary power supply failure on the SS/FY pcb
11	b	Bypass blocked
12	S	Bypass not synchronised
13	d	SSB failure
14	E	Bypass system not available
15	9	Missing or false bypass trip signal
16	7	EPO activated
17	U	IUG open
18	--	SSB on

In normal condition the display shows a red segment rotating clockwise. If more than one alarm is present, only the one with the higher priority is displayed.

# SOLA 4000 - Technical Data

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Rev.	Description	Date	Checked	Revised	Date	Format	Page	Total
/	ISSUED	04.02.97		M. Porpora	04.02.97	A4	1	5
A	See Rev. Doc. JSE 401440	20.06.97	T. Boon					



# 1 System Data

Technical Data / System Data	Type SOLA 4000									
	10	15	20	30	40	60	80	100	120	
System configuration	On-line (double conversion)									
Nominal input voltage	3Ph+N x 380 ÷ 415 V Tolerance: ± 10%									
Nominal input frequency	50 / 60 Hz Tolerance: ± 10%									
Nominal output voltage	380 / 400 / 415 Vac (adjustable)									
Nominal output frequency	50 / 60 Hz									
Output voltage distortion (THD) linear load non linear load at 100% of Pn and C.F. = 3	< 1% < 4%									
Output voltage regulation with load between 0 and 100%	± 1% (balanced or unbalanced)									
Output frequency regulation - synchronisation with mains - free running	± 0,5 / 1 / 2 Hz (selectable with software) ± 0,01 %									
Rated output power, power factor = 0.8 [kVA]	10	15	20	30	40	60	80	100	120	
Rated output power, power factor = 1 [kW]	8	12	16	24	32	48	64	80	96	
Efficiency - 50% load [%] - 100% load [%]	> 88 > 90	> 88 > 90	> 88 > 90	> 88 > 90	> 90 > 91	> 90 > 91	> 90 > 91	> 90 > 91	> 90 > 91	
Losses at nominal load, charged battery ≤ [kW]	0,8	1,2	1,6	2,4	3,2	4,8	6,4	8	9,6	
Overload capacity - Inverter - Static bypass switch (SSB)	125 % 10 minutes, 150 % 1 minute 2000 % 20 msec, 200 % 1 minute, 150 % continuous									
Permissible inverter output voltage variation for bypass switching	± 10%									
Design standards	IEC 146-4, EN50091-1, IEC 950									
Insulation test for 60s	2,0 kV									
Cabinet protection	IP 20 acc. to IEC 529, IEC 944 (excl. air exit)									
Ambient temperature - operating temperature - storage temperature	0 .. 40 °C 0 .. 85 °C (excluding battery)									
Permissible relative humidity	< 95 % UR (non condensing)									
Maximum altitude above sea level at full load	< 2000 m. Higher altitudes require power derating or increased cooling									
RFI suppression	EMC standard satisfied with EN50091-2 (1995) class A - IEC801-2 - IEC801-3 - IEC801-4									
Audible noise level at 1 meter ≤ (dBA)	58	58	58	58	60	60	61	61	62	

FIG. 1.1 - System Data

## 2 Rectifier Data

Technical Data / Rectifier Data	Type SOLA 4000								
	10	15	20	30	40	60	80	100	120
Input voltage Tolerance with reduced output (DC) voltage	refer to system data refer to system data -20 %								
Input frequency Tolerance	refer to system data ± 10 %								
Rated input power with charged battery - [kVA]	10,8	16	21,3	32	42,7	64,1	84,8	106	127,4
Rated input current with charged battery (380 V) [A]	16,4	24,6	32,7	49,2	65	97,5	128,5	160,7	193
Maximum input power - [kVA]	13,5	20	26,9	39,8	53,5	80	105	132	158
Maximum input current, input voltage = 380 V - [A]	20,5	30,8	40,8	61,2	81,5	122	160,5	201	241
Input power factor ( nom. load, input voltage = 380V)	~ 0,83 lag.								
Output control characteristics	I/U characteristic, boost charge possible								
Rated output voltage - Lead-Acid batteries - Ni-Cd batteries	432 V/DC 436 V/DC (depending on number of cells)								
Soft start	~ 10 sec.								
Floating voltage regulation with load between 0 and 100%	1 %								
Output voltage ripple with battery disconnected	RMS 1 %								
Max. batt. recharging current with nom. load - [A]	5	7,5	10	15	20	30	40	50	60
Battery charging current limitation	Complies with battery manufacturer's recommendations, standard setting approximately 10% of rated battery capacity								

IG. 2.1 - Rectifier Data

## 3 Battery Data

Technical Data / Battery Data	Charger input voltage									
	10	15	20	30	40	60	80	100	120	
	Input charging voltage									
	3 x 380 V			3 x 400 V			3 x 415 V			
Number of cells (standard)										
Lead-Acid open	192			192			192			
Lead-Acid maintenance free	192			192			192			
Ni-Cd	300			300			300			
Floating-voltage										
Lead-Acid open      2,25 V/Cell [VDC]	432			432			432			
Lead-Acid mainten. free**      2,25 V/Cell [VDC]	432			432			432			
Ni-Cd      1,42 V/Cell [VDC]	426			426			426			
Boost charge voltage										
Lead-Acid open      2,4 V/Cell [VDC]	462			462			462			
Ni-Cd      1,54 V/Cell*** [VDC]	462			462			462			
Lead-Acid maintenance free (no boost charge)										
Minimum battery voltage										
Lead-Acid      1,69 V/Cell [VDC]	325			325			325			
Recommended charging current (adjustable)	10 % of rated battery capacity									
Protection	<ul style="list-style-type: none"> <li>- Batt. protection disconnecter switch****</li> <li>- Automatic shutdown of the inverter at min. DC voltage</li> </ul>									
Permissible DC voltage range [VDC]	min. 320V . . . . . max. 462V									
Maximum battery discharging current (V <sub>dc</sub> =320V, nominal load)	27	40	54	80	107,5	161,2	212,5	266	319	
Environmental temperature	follow battery manufacturer's instruction									
** At 20° C room temperature *** Maximum voltage/cell **** Battery disconnecter fuse for free standing battery optional										

FIG. 3.1 - Battery Data

## 4 Inverter Data

Technical Data / Inverter Data	Type SOLA 4000									
	10	15	20	30	40	60	80	100	120	
Permissible input DC voltage range	320 - 480 V/DC									
Input power at rated load - [kW]	8,7	13	12,4	26	35,1	52,7	70,3	87,9	105,5	
Inverter input current at 320 Vdc and rated load [A]	27	40	54	80	107,5	161,2	212,5	266	319	
Nominal output current at rated load (380V, cos phi = 0,8) [A]	15,2	22,7	30,3	45,5	60,8	91,3	121,7	152,1	182,1	
Nominal output current (380V, cos phi = 1,0) - [A]	12,1	18,1	24,2	36,4	48,6	73	97,4	122	146	
Efficiency at 80% load - [%]	> 92	> 92	> 92	> 92	> 92	> 93	> 93	> 93	> 93	
Load power factor range - at nominal load - at reduced load	0,7 - 0,8 ind. 0,5 ind. - 0,5 cap.									
Output voltage	refer to system data									
Output voltage distortion (THD)	refer to system data									
Output voltage adjustment range	± 10% of programmable nominal value									
Phase displacement - balanced load - 100 % unbalanced load	120° ± 1% 120° ± 1%									
Voltage tolerances - static, balanced load - static, 100% unbalanced load - dynamic, 50% load step - dynamic, 100% load step	± 1 % ± 1 % ± 4 % ± 5 %									
Voltage transient recovery time	≤ 50 ms within ± 2% of nominal voltage									
Short circuit current	150 % of nominal current									
Max. freq. range for synchr. of the inv. with the mains	± 2,5 Hz									
Max. frequency variation during synchronisation	± 1 Hz/sec.									

FIG. 4.1 - Inverter Data