

Product Description

Digital Energy™ SG Series

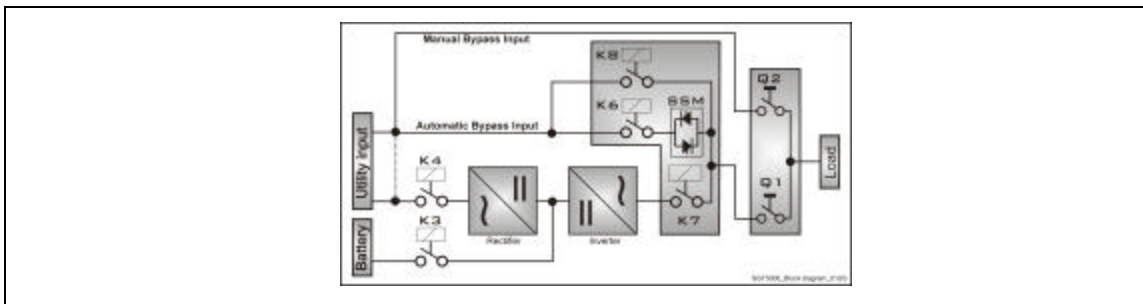
Models: 10-150KVA

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1. INTRODUCTION

The **SG Series** is a family of Uninterruptible Power Supply (UPS) designed to meet highest requirements of reliability and output power quality, even in the most demanding applications. The **SG Series** UPS are based on double conversion technology and are "true On-line" or "continuous operation" UPS with integrated inverter transformer for utility load isolation. **SG Series** are designed to be "VFI" (Voltage & Frequency Independent) where the AC input voltage is first converted to DC voltage and then re-converted to AC voltage to supply the load. The DC voltage is also used to charge the battery. The VFI design and product topology is internationally recognized as providing the optimum level of protection for sensitive loads and critical power applications. Other features inherent to the **SG Series** UPS are high output power quality, excellent behavior and response to non-linear loads, zero-interruption transfer time, excellent over voltage protection and filtering, and high efficiency at various loads. With RPA (Redundant Parallel Architecture) the system power can be expanded by paralleling additional units or the system reliability can be increased by adding redundant units.

The **SG Series** consists of the following main building blocks:



Rectifier/Charger

The rectifier converts the 3-phase utility input voltage into a controlled and regulated DC-voltage. This regulated DC voltage is used to supply the inverter and charge the battery. The standard version employs software control to limit rectifier start-up current and voltage (soft start procedure).

Inverter

Converts the DC-voltage into clean 3-phase alternating voltage with constant amplitude and stable frequency. The **SG Series** uses an IGBT based inverter with SVM (Space Vector Modulation) regulation achieving extremely high efficiency even at partial load conditions. The inverter with accompanying isolation transformer allows the output to remain totally unaffected by utility disturbances or failures while delivering extremely low output distortion when driving non-linear loads.

Static bypass

Consists of a continuous duty static switch and serves to transfer the load automatically and interruption free to utility in the case of overload, inverter fault condition or manual input. During overload, re-transfer is automatically initiated once normal load conditions are restored.

Maintenance bypass

Serves to transfer the load interruption-free to utility for service and maintenance purposes.

Battery

The battery is used to supply the inverter with energy in case of utility failure. It is normally sized to supply the inverter at rated load for the required back-up time.

2. SINGLE UPS

2.1 PRINCIPLES OF OPERATION

To ensure an uninterrupted supply of the load under all operating conditions, the standard **SG Series** UPS employs four different operating modes:

- Normal mode (On-line mode)
- Battery mode
- Static bypass mode
- Maintenance bypass mode

Transfer from one operating mode to another takes place without any interruption of power to the critical load. These multiple redundant modes of operation greatly increase the systems ability to supply power to the load, even during utility or UPS failure conditions

All modes of operation are also available when the SG Series is configured in an RPA (Redundant Parallel Architecture) and will be further emphasized when (RPA) is discussed.

SG Series offers all the following operating modes as a standard:

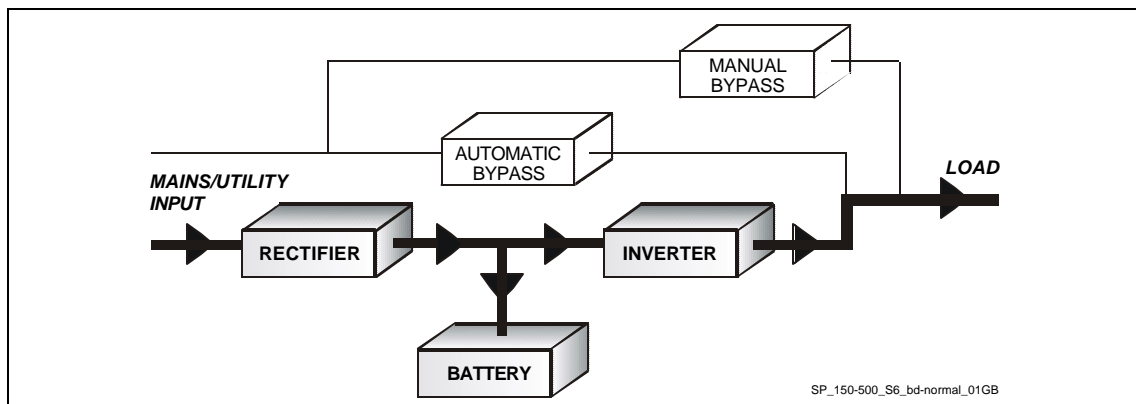
2.2 ON-LINE MODE (NORMAL OPERATION)

During normal operation, the rectifier converts input AC power to DC.

The DC power provides input power for the inverter and charging power for the battery.

The inverter converts the DC power to continuous and precisely regulated AC power, which supplies the critical load.

The control panel reports the battery charge status and the expected backup time with the actual load.



2.3 BATTERY MODE (UTILITY FAILURE)

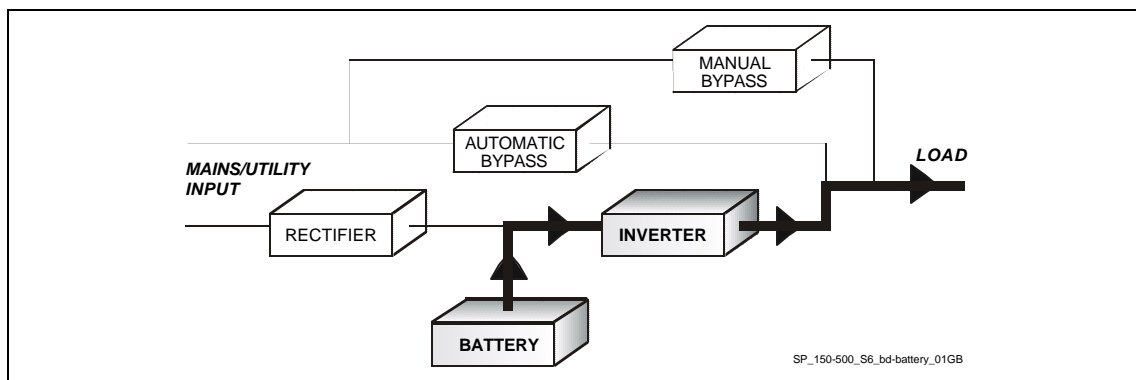
In the event of a utility failure, the DC power to the inverter will automatically be provided by the battery. The battery is sized to enable the inverter to support the critical load for the specified time (or longer at a reduced load).

The inverter will continue to discharge the battery until the battery voltage reaches the battery discharge limit.

During the discharge, the LCD screen displays the estimated time the battery can support the critical load.

Prior to the battery being completely discharged, the alarm **“stop operation”** (load shutdown imminent) warns the operator that the battery is almost discharged and the UPS is about to shut down.

“Stop Operation” activation time is adjustable.



2.4 UTILITY RECOVERY

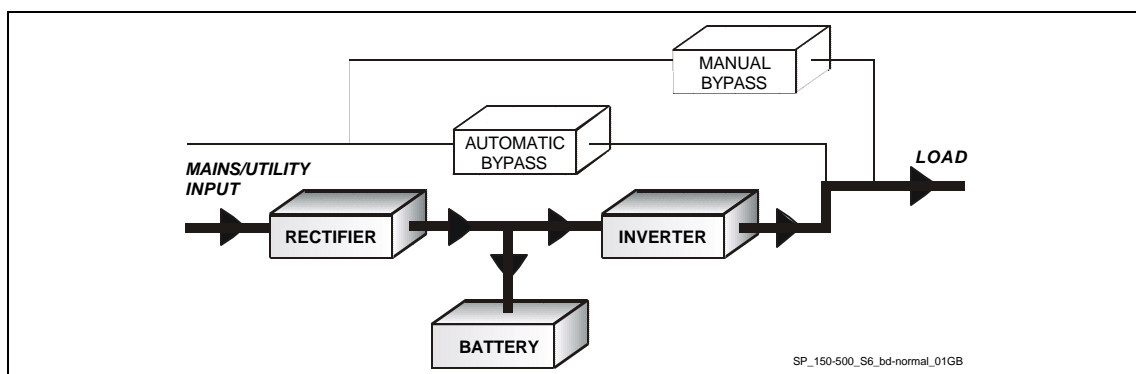
The load is powered from the battery if the utility power does not conform to the specified parameters.

As soon as the AC input power recovers, the rectifier will start up automatically (soft-start) and again supply DC power to the inverter and recharge the battery.

If the inverter was shut down due to total battery discharge, inverter re-start will be delayed for a short period of time. This short delay period is designed to allow the battery to recharge enough to ensure a minimum operation time prior to initiating normal operation.

The inverter will then re-start automatically and the load will be transferred from the static bypass back to the inverter (normal mode).

No additional operations are necessary.



2.5 STATIC BYPASS MODE

In normal operation, the load is supplied by the inverter.

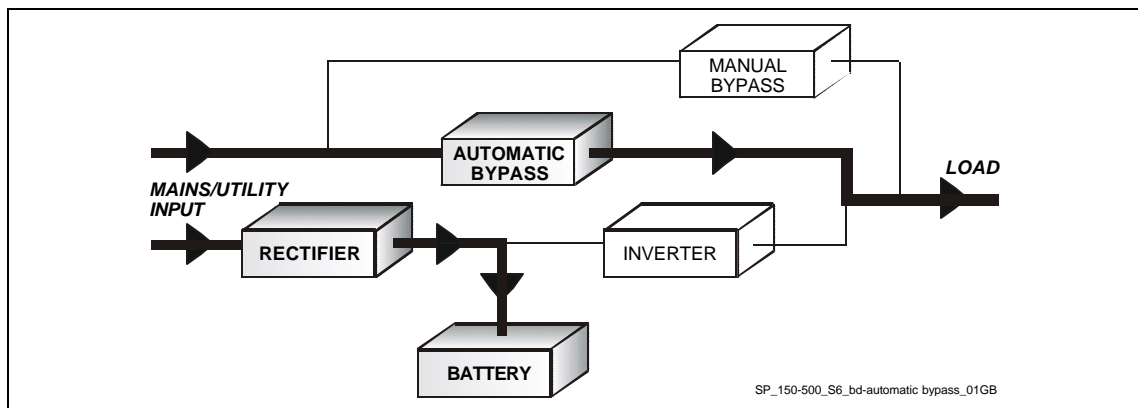
When the control system detects a fault in the inverter, an overload, over temperature or a short-circuit condition, the static bypass switch transfers the critical load to the utility without interruption.

When the inverter recovers, or the overload, over temperature or short-circuit condition is corrected, the load will be transferred automatically back to the inverter interruption-free.

If the UPS is transferred to static bypass manually, the event is logged by the system, but not considered to be an alarm.

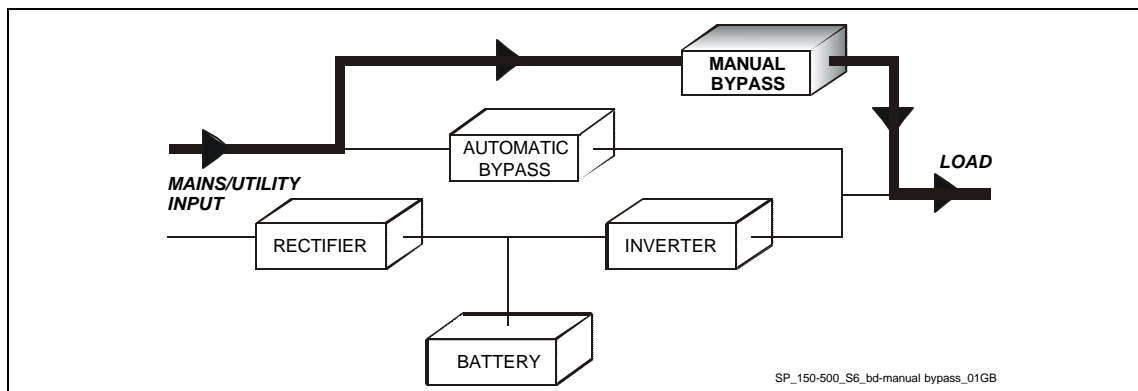
If the UPS is unable to return to normal mode following an automatic transfer to static bypass, an alarm is activated.

The re-transfer delay time after an automatic transfer to bypass is adjustable.



2.6 MAINTENANCE BYPASS MODE

The **maintenance bypass circuit** consist of two manual Switches, which enable the load to be transferred to the unconditioned AC power without interruption.



3. REDUNDANT PARALLEL ARCHITECTURE (RPA)

SG Series UPS may be applied to Mission Critical Applications where a greater level of redundancy is required or greater output power capacity is needed.

GE Industrial Systems meets this requirement with an exclusive redundant-parallel system known as RPA (Redundant Parallel Architecture), available only on GE Industrial Systems **SG Series** UPS or other select single phase systems.

To achieve highest levels of reliability, two or more **SG Series** UPS are linked in a peer-to-peer configuration, concurrently supplying the load.

Due to the total modularity of RPA, the system can be easily expanded to higher power or higher redundancy levels, at any time, under full working conditions.

3.1 PRINCIPLES OF A RPA BASED REDUNDANT-PARALLEL SYSTEM

RPA (Redundant Parallel Architecture) is a unique system designed to provide the highest possible power reliability. This is achieved by providing true “redundancy”, as defined by the relevant industries for mission critical applications.

Fundamental elements to the term “redundancy” are:

- No single failure point
- Fault tolerance - this means the system can accept at least one failure of each type without affecting the system’s ability to support the critical function.
In UPS applications, this means the UPS system must be able to accept any event from a simple fuse failure to the failure of an entire inverter without any influence to the load.
- Error masking – error isolation and error removal under active load conditions.
- Error recovery - restore normal operating conditions without bypass operation for the critical load.

To comply with term “redundancy”, a UPS system must be designed with the following features:

- Decentralized bypass.
- Decentralized control electronics.
- Redundant (n+1) operation and control for critical functions as “Synchronization” and “Bypass operation”.
- Redundant communication link between individual units.

Note: not every parallel UPS is a redundant UPS; some UPS manufacturers honestly disclose this difference, some promote parallel UPS as “redundant”, without respecting the above rules!

3.2 REDUNDANT CONTROL ELECTRONICS

Each individual unit in the RPA system has its own operation controller (Microprocessor). Each active controller continuously intercommunicates with all other controllers in order to manage the entire system in a democratic way. No master-slave relationship exists in the system.

Example:

A typical RPA system consists of 3 UPS units - “A”, “B”, “C”. If unit “A” detects a utility failure and “B” and “C” cannot “see” this failure, “A” will be isolated and it’s functions will be managed by the two remaining units.

3.3 LOAD SHARING

Each RPA operation controller continuously monitors the load to verify the equal load distribution on each unit. This is accomplished by continuously regulating the power exchange between each unit in the RPA system. This power exchange is maintained as near as possible to zero. To achieve this, the RPA operation controllers engage in the continuous calculation of an index value, defined by the sum of the measured values of all active units, divided by the number of active units in the system. This index value is then passed to the individual units as a reference parameter for the regulation of the inverter.

3.4 SYNCHRONIZATION

The most important task in RPA operation is to ensure the synchronization of the entire system-on one hand between all RPA UPS units, and on the other hand between the RPA system and the bypass utility source. With advanced signal processing and enhanced high precision tracking, RPA reaches the highest precision in synchronization in the industry -0.05 milliseconds between units. This enable RPA to implement high speed, voltage based load sharing. All this is achieved without the addition of control circuitry or additional synchronization equipment.

3.5 REDUNDANCY TO THE MAX!

With RPA technology, all UPS internal sub-systems (rectifier, inverter, static bypass, controllers and communications) are redundant.

There are no single failure points, centralized elements or Master-Slave situations.

3.6 FAILURE HANDLING

RPA is able to isolate any unit in the system that is experiencing a problem, and prevent disturbances in the output power supplied to the critical load.

The operation controller of the affected unit will communicate the problem to the RPA system.

If necessary, RPA will automatically “isolate” the affected unit until the problem is solved.

The level of isolation employed by RPA in response to a given problem is dependant on the type and severity of the problem. The goal of RPA is to keep the load protected for as long as possible. As a consequence, an affected unit may be managed by the system and continue to work in RPA or it may be totally excluded from the process.

As long as the output of the remaining units is enough to supply the load, RPA will remain active and feed the load from the inverters. If the remaining inverters are no longer able to provide redundancy, RPA acts as a non-redundant parallel system. If the available inverter power is insufficient to support the load due to system problems or an overload condition, RPA will switch all units to ‘Static Bypass Mode’.

3.7 RPA SUMMARY

Redundant Inverters: RPA sustains the load as long as possible via the paralleled inverters of the true on-line individual units. RPA only switches to ‘Static Bypass Mode’ when the total power of all available inverters is no longer sufficient to sustain the load.

Decentralized Bypass and redundant control: Even at full load, the static bypass of a single unit can fail without jeopardizing the supply of power to the critical load.

Redundant Microprocessors: There is no common failure point, due to multiple redundancy and shared tasks.

4. RPA OPERATING MODE

To ensure an uninterrupted supply of power under all operating conditions, the RPA system operates in the following modes:

On-line Mode

Battery Mode

Inverter Disturbance Mode

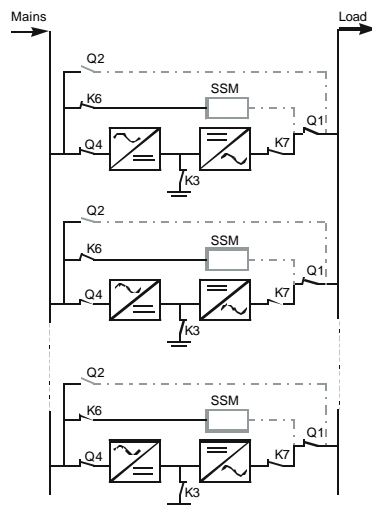
IEM Mode

Static Bypass Mode

Maintenance Bypass Mode

Transfer from one operating mode to another takes place without interruption of power continuity to the load.

4.1 ON-LINE MODE

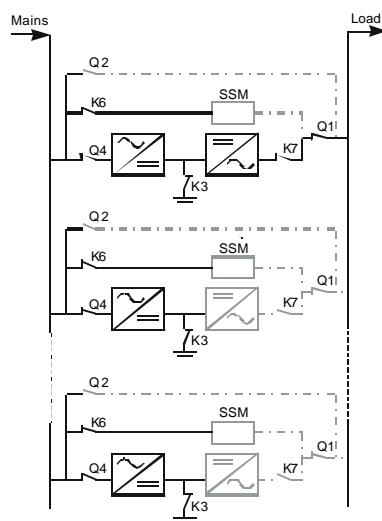


When the system is in On-line Mode, all the rectifiers as well as all the inverters of the system are operating.

The utility supplies the parallel-connected rectifiers. Each rectifier supplies both battery and inverter by converting the utility AC voltage into a DC voltage.

The load is equally shared by all the inverters.

4.2 IEM MODE (INTELLIGENT ENERGY MANAGEMENT)



IEM is an award winning software package, which allows RPA systems to save energy during low load conditions.

Individual inverters, which are not required to support the load, can **automatically** be switched off to save energy.

Depending on load level, inverters are switched off **cyclically**, so that each UPS has the same amount of operating hours over a period of time.

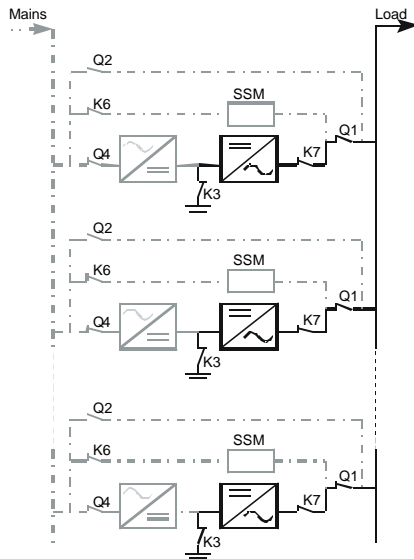
Furthermore, the customer can define if the rectifiers remain operational to charge the batteries on those units that have their inverters switched off, or if the rectifiers are switched off.

Customer set-up will define after how long, or at what battery voltage level the rectifier will be switched on again.

The IEM mode can be freely programmed and the customer defines the degree of redundancy (i.e. security) required in a given situation.

The reaction of the system in case of problems can also be selected (what must the system do in case of utility failure?).

4.3 BATTERY MODE



A utility failure will trigger Battery Mode.

The rectifiers are shutdown, and the batteries supply the inverters with the required energy.

The inverters supply the load as described under On-line Mode.

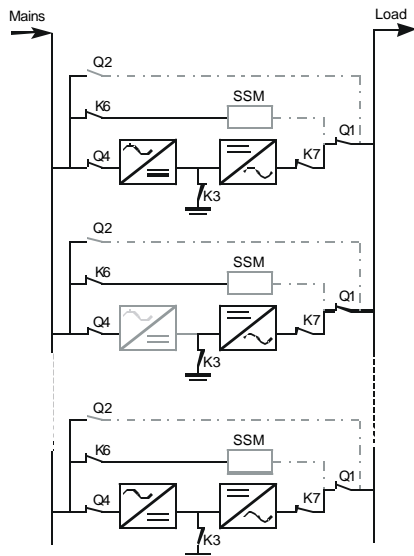
If the utility does not recover and the batteries are used up, the load will be cut off.

When the utility recovers after low battery shutdown, the load will be supplied by the bypass source.

For security and safety, the inverters will need to be restarted manually.

RPA is compatible with both separate and centralized batteries.

4.4 RECTIFIER DISTURBANCE MODE



Rectifier Disturbance Mode is recognized by a disturbance in one or more rectifiers.

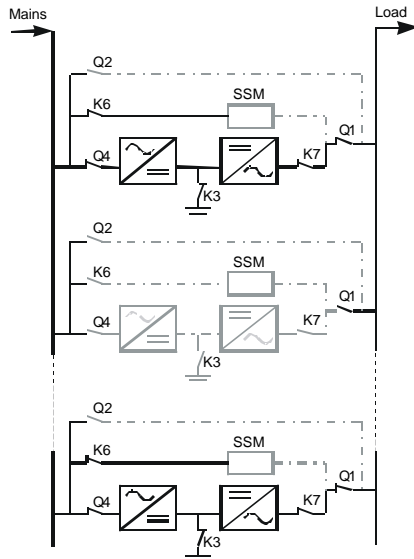
The disturbed rectifier(s) do not supply any energy.

Depending on the set-up defined by the end user, the inverters of those units having rectifier problems will draw their energy from the battery, or RPA will immediately isolate the unit.

The other units continue in On-line Mode.

The load is supported by the inverters of all operational units, as described under On-line Mode.

4.5 INVERTER DISTURBANCE MODE



Inverter Disturbance Mode is triggered by a problem in one or more inverters.

RPA remains in On-line Mode as long as the output of the remaining inverters is sufficient to support the load.

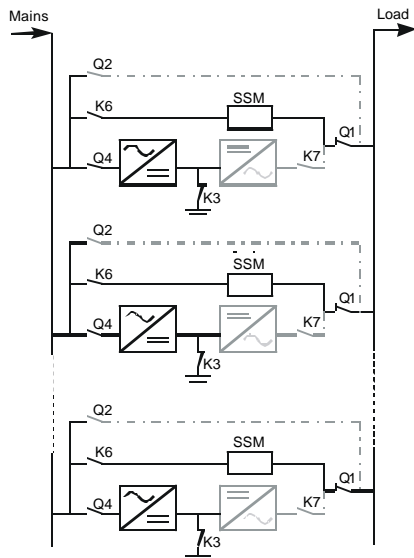
The system may lose redundancy and become a parallel UPS system.

The inverter output Contactor (K7) of the disturbed unit opens automatically to isolate the unit from the load.

The rectifiers of the disturbed units, depending on the nature of the disturbance and the IEM setup, may continue to charge the batteries.

The disturbed units can be completely separated from the utility and from the load, as illustrated, to enable repair work to be carried out.

4.6 STATIC BYPASS MODE



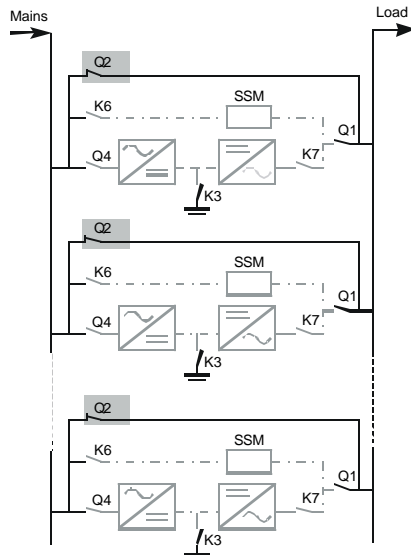
Static Bypass Mode is triggered when all the available inverters are insufficient to support the load, as can happen when several inverters are off-line, or during a severe overload.

If the load demand exceeds 110% of the sum of the rated outputs of all on-line inverters, the load will be transferred directly to the bypass utility source.

All inverter output contactors (K7) are opened automatically and the inverters (depending on the type of disturbance) will continue to operate. The rectifiers will continue to charge the batteries.

When the load level once again returns below 100% of the sum of the outputs of all the available inverters, RPA will close all K7 contactors and automatically switch back to On-line Mode.

4.7 MANUAL BYPASS MODE



Maintenance Bypass Mode is used when all units are switched off.

Q2 is closed in each unit and the system output remains powered to support the load.

The subcomponents of each UPS unit are isolated from power.

The load is not protected during this mode of operation.

5. SUPERIOR BATTERY MANAGEMENT (SBM)

The SG Series UPS has an additional management feature known as **SBM (Superior Battery Management)**. The battery system of a UPS is a critical element which defines system reliability and must be effectively maintained and monitored to ensure optimum reliability and protection of the critical load. **SBM** is a programmable management feature that monitors the battery system for failures by periodically testing the battery system. Within this feature is the ability to calculate true battery autonomy and remaining back up time during a utility outage. **SBM** performs this function by measuring the volts per cell of the battery system and compensating for temperature and load conditions. This means that any shutdown or "stop operation" will be initiated based on measured values and not time. During start up and commissioning of the **SG Series UPS** specific battery information is entered into the **SBM** software such as Amp/Hr ratings and number of cells. This allows the SG Series UPS with **SBM** the flexibility to work with all kinds of battery types (vented, sealed or even Nicad).

The programmable features of **SBM** allow the user to select the frequency and type of battery tests that are to be performed. The frequency can range from once a week to once a year, and the type of test can range from deep cycle to a short three-minute discharge. All tests are performed automatically with the UPS on line. The tests are logged in the UPS events menu and any failure of the battery system is reported to the user with a front panel alarm. **SBM** also gives the user the ability to perform a manual test at any time.

Superior Battery Management can also be accessed and configured remotely using the protection software available for the SG Series UPS; and with the features described above **SBM** will increase over all system reliability and add to the level of security to the critical load.

6. OPTIONS

A wide range of options enables **SG Series** UPS SYSTEMS to fulfill a wide range of needs.

6.1 INPUT/OUTPUT ISOLATION AND VOLTAGE ADAPTION TRANSFORMERS

Used to help isolate the UPS from the source utility or the load, and to transform input and output voltages to meet customer requirements. Available for all kVA sizes and voltages.

6.2 RPA CONFIGURATION KIT

This option allows up to 8 units for parallel operation, and can reconfigure any single module unit.

6.3 INPUT FILTER FOR 5TH HARMONIC CANCELLATION

The 5th harmonic input filter is used for reducing the 5th harmonic generated by the rectifier. This filter reduces the input distortion to less than 7% THD, and increases the input power factor to 0.93. The 5th harmonic input filter is activated when the UPS load reaches 30% (adjustable depending of the customer needs/configuration). This option does not require an additional cabinet. The filter is an internal addition to the UPS thereby minimizing additional footprint.

6.4 BATTERY CABINETS

Matching battery cabinets with integral over current protection and disconnect.

6.5 EXTERNAL MAINTENANCE BYPASS PANELS

Available in two or three breaker configurations, Kirk Key protection also available.

6.6 FCC CLASS A EMI FILTER

Optional internal FCC filter available for applications where FCC Class A compliance is required.

6.7 SNMP CARD

This optional plug in card allows the UPS to be managed remotely with GE's protection software.

6.8 REMOTE STATUS PANEL

Remote Status Panel equipped with: synoptic diagram, alarm reset and lamp test keys. Cable connection to UPS not included.