

**APC by Schneider Electric**  
**MGE GALAXY 7000 GFC (Grid Frequency Converter)**

Uninterruptible Power Supply  
**Guide Specifications**  
**500 kVA to 5000 kVA**  
**Parallel UPS system**

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**SECTION [26 33 63] [16611]**

**SOLID STATE FREQUENCY CONVERTER**

**PART 1 - GENERAL**

**1.1 UPS DEFINITIONS**

- A. **Purpose:** The purpose of this specification is to define the design, manufacture and testing characteristics required in view of supplying, putting into operation and maintaining an Uninterruptible Power Supply system (referred to as a UPS in the rest of this document). The UPS system shall be designed to supply dependable electric power to:
- B. **Brief description:**
1. The UPS system shall be made up of [ 1 / 2 / 3 / 4 / 5 / 6 / 7 / 8 / 9 / 10 ] identical, parallel-connected GFC units, all having the same power rating. Each GFC unit shall operate in double-conversion mode and shall be of the VFI-type as per standard IEC 62040-2. The system shall [ not provide redundancy ] [ include 1 / 2 / 3 redundant GFC units among the total ].
  2. Each GFC unit shall have a rating of [ 500] kVA and shall be made up of the following components, described in detail in this specification:
    - a. Rectifier
    - b. Inverter
    - c. User and communications interface
  3. What is more, the UPS system shall include:
    - a. Any and all other devices required for safe operation and maintenance, including circuit breakers, switches, etc.

**1.2 WARRANTY**

- A. The components making up each GFC unit (rectifier, inverter subassemblies) shall be guaranteed (parts and labour on site) for one year following the start-up date.

**PART 2 - PRODUCTS**

## 2.1 OPERATING PRINCIPLES

- A. The UPS system shall operate in double-conversion mode, described in detail in this specification.
- B. **Normal operation** (normal AC source available): The rectifier of each GFC unit shall supply its inverter and charger. Each GFC unit shall continuously contribute, in parallel with the other GFC units via a common bus.
- C. **UPS maintenance:**
  - 1. All power and control electronics of the GFC units making up the UPS system shall be accessible from the front of the UPS.
  - 2. For personnel safety during servicing or testing, this system shall be designed to isolate the UPS system while continuing to supply power to the load from the bypass AC source. The UPS shall also include a device making it possible to isolate the rectifier of each GFC unit from the normal AC source.
  - 3. **(System with redundancy):** In a redundant system, with the above device, it shall be possible to shut down a GFC unit and isolate its inverter for maintenance, with the other inverters in the UPS system continuing to supply the load.

## 2.2 SIZING AND GENERAL CHARACTERISTICS

- A. **Rating:**
  - 1. The UPS system shall be sized to continuously supply a load of \_\_\_\_ kVA, at a power factor (pf) of 0.9.
  - 2. The UPS system shall be made up of [1/ 2 / 3 / 4 / 5 / 6 / 7 / 8 / 9 / 10]... identical, parallel-connected GFC units, each having a power rating of ...[500]... kVA.
  - 3. The total installed power rating shall be \_\_\_\_ kVA. It shall be possible to use ...[1] [2] [3]... GFC units for redundancy.
- B. **Types of loads accepted:**
  - 1. The UPS system shall accept high crest factors (3:1) without derating (kW) to ensure correct operation with computer loads and loads where the leading power factor can reach 0.9.
  - 2. The total harmonic voltage distortion at UPS output (THDU downstream) shall respect the following limits:
    - a. THDU downstream ph/ph  $\leq 2.5\%$  for linear loads.
- C. **PFC sinusoidal-current input rectifiers:**
  - 1. The UPS system shall not draw a level of harmonic currents that could disturb the upstream AC system, i.e. it shall comply with the stipulations of guide IEC 61000-3-4.
  - 2. The PFC input rectifiers of the GFC units, using sinusoidal-current IGBTs, shall have the following performance levels:
    - a. Total harmonic current distortion (THDI) upstream of the rectifier not exceeding 5%
    - b. Input power factor (PF) greater than 0.99 from 30% load upwards.
- D. **Outputs without a transformer:** To reduce losses, dimensions and weight, the output of each UPS unit shall be of the transformer less type and the neutral shall be recreated electronically.
- E. **Efficiency:** Overall efficiency (between the rectifier inputs and the UPS output) shall be greater than or equal to:
  - 1. 93.3% from 50% load to full rated load (In);
  - 2. 94.5% at 50% load (In);
- F. **Noise level:** The noise level, measured as per standard ISO3746, shall be less than ...[75 dBA (for 500 kVA)].

## 2.3 AC SOURCES

- A. **Normal AC source** (rectifier input): The normal AC source supplying the UPS system shall, under normal operating conditions, have the following characteristics:
1. Rated voltage: 380, 400, 415 or 440 V at full rated load P<sub>n</sub>.
  2. Input voltage range: 250 V (at 30% load) to 470 V.
  2. Number of phases: 3, a neutral is not necessary.
  3. Frequency: \_\_\_\_\_ Hz  $\pm$  10%..

## 2.4 ELECTRICAL CHARACTERISTICS

- A. **Rectifier**
1. **Supply:** The PFC rectifier of each GFC unit, drawing sinusoidal current, shall be supplied by the normal AC source, without a neutral. Each unit is independent in terms of its input module.
  2. **Sequential start:** An adjustable device shall make it possible to stagger start-up of the PFC rectifiers when the normal AC source returns to within tolerances. By ensuring sequential start, this device shall avoid overloading a genset picking up the supply to all the rectifiers.
  3. **Phase sequence:** A device shall check that the phase sequence is correct to protect the power system from the effects of incorrect connections.
  4. **Input power factor:** > 0.99 @ 100% load.
- B. **Inverter:** Each inverter shall be sized to supply a rated load of ...[500]... kVA at 0.9 PF and shall satisfy the specifications listed below.
1. **Output voltage**
    - a. **Rated voltage:** ...[ 380 / 400 / 415 / 440 ]... volts rms, adjustable via the user interface, within tolerances of  $\pm$  3% in order to take into account voltage drops in the cables.
    - b. **Number of phases:** 3 phases + neutral + earth.
    - c. **Steady-state conditions:** Variations in the rated voltage shall be limited to  $\pm$  1% for a balanced load between 0 and 100% of the rated load, whatever the voltage level on the normal AC source and the DC voltage level, within the defined limits.
    - d. **Voltage variations for load step changes:** Output voltage transients shall not exceed  $\pm$  5% of rated voltage for 0 to 100% or 100 to 0% step loads. In all cases, the voltage shall return to within steady-state tolerances in less than 200 milliseconds.
    - e. **Unbalanced conditions:** For a load unbalance between phases, the variation in the output voltage shall be less than 1%.
  2. **Output frequency**
    - a. **Rated frequency:** - 50 or 60 Hz.
    - b. **Variations in the free-running frequency:** -  $\pm$  0.1 %,
  3. **Overload and short-circuit capacity:** The UPS shall be capable of supplying for at least:
    - a. 10 minutes a load representing 125% of the rated load
    - b. 30 second a load representing 150% of the rated load.
    - c. For the specified power rating of [ 500 ]... kVA, the inverter shall be capable of current limiting to a peak capacity of ... [245%] ... for 150 ms to allow highly disturbed transient operating states without transferring the load to the bypass.
    - d. The overload capacity shall be capable of taking into account temperature conditions for more than ten minutes, by allowing a continuous, 10% overload when the temperature is less than or equal to 20°C.
  5. **Higher power ratings for lower temperatures:** It shall be possible to increase the power rating when the temperature is less than 35°C. The rating can be raised by +2,5% for 30°C, +5% for 25°C and +7,5% for 20°C.
- C. **System earthing (grounding) arrangement (SEA):** The preferred arrangement for a GFC (frequency converter) shall be :
1. **Upstream source SEA:** ...[ TNC ]...
  2. **Downstream installation SEA:** ...[TNS ]...

3. If upstream 3ph without N TNS is used, then GFC Output will be in IT. In this configuration, neutral between each GFC output must be connected even if distribution to the load transformer is 3p without neutral.

To keep a TNS, SEA downstream with a TNS SEA upstream, use,

- a 3ph + n input connection ( N will be connect on output terminal),
- or a galvanic isolation transformer need to be added.

**D. Discrimination and Short Circuit capacity**

3 duration settings for short circuit value (ik3)

- 150 ms – 1255 A rms
- 500 ms – 1332 A rms (default setting)
- 800 ms – 1255 A rms

## **2.5 MECHANICAL CHARACTERISTICS**

A. **Mechanical structure:** The inverter of each GFC unit shall be installed in cabinet(s) with an [ IP 32 ] degree of protection (standard IEC 60529). Access to the subassemblies making up the system shall be exclusively through the front.

B. **Modular design:** The UPS system shall be designed to allow the installed power to be easily increased on site by connection of additional GFC units, either to meet new load requirements or to enhance system availability by introducing or increasing redundancy. This transformation shall be possible directly on site, without returning the equipment to the factory and without causing excessive system downtime.

C. **Dimensions:** The UPS system shall require as little floor space as possible. To gain space, it shall be possible to install the GFC units with the back to the wall or back to back.

**D. Connection:**

1. To facilitate connections, all terminal blocks must be easily accessible from the front when the GFC units are installed with the back to the wall. Entry of upstream and downstream power cables, as well as any auxiliary cables, shall be possible through the bottom without requiring a false floor.
2. The UPS shall be equipped with an earth-circuit connector, in compliance with the listed standards. The cables shall comply with the listed standards and be mounted in compliance with the safety stipulations.

**E. Ventilation:**

1. Cooling of each GFC unit shall be by forced-air ventilation. To facilitate layout of the GFC units (particularly when installed back to the wall), air input shall be through the front and bottom, exit through the top.
2. All power electronics shall be equipped with a redundant ventilation system including fault detection.
3. Possibility to control the fan by external device

## **2.6 ENVIRONMENT CONDITIONS**

**A. UPS (not including battery)**

1. **Operation:** The UPS, not including the batteries, shall be capable of operating under the following environmental conditions without loss of performance:

- a. Ambient temperature range: 0° C to +35° C.
- b. Maximum temperature: 40°C for eight hours
- c. Recommended temperature range: +20° C to + 25° C;
- d. Maximum relative humidity: 95% at 25° C;
- e. Maximum altitude without derating: 1000 meters.

2. **Storage**

- a. **The UPS, not including the battery, shall be designed for storage under the following conditions:** ambient temperature range: -25° C to +45° C.

## 2.7 DISPLAY

- A. **User interface:** UPS system operation shall be facilitated by a user interface, on each of the GFC units, comprising:
1. A graphic display (at least quarter VGA and high resolution are preferable);
  2. ON and OFF control buttons (independent of the display);
  3. Status indications with mimic panel.
- B. **Graphic display:** The mimic diagram shall enable display of installation parameters, configuration, operating status and alarms and indication of operator instructions for switching operations (e.g. bypass). It shall be capable of supervising a given GFC unit or a parallel system (up to eight UPS units with the external bypass).
1. **Display of measurements:** It shall be possible to display the following measurements for any one of the GFC units or for the entire system:
    - a. Inverter output phase-to-phase voltages
    - b. Inverter output currents
    - c. Inverter output frequency
    - d. Voltage across battery terminals
    - e. Rectifier input phase-to-phase voltages
    - f. Rectifier input currents
    - g. Crest factor
    - h. Active and apparent power
    - i. Power factor of the load
  5. **Display of status conditions and events:** It shall be possible to display the following indications:
    - a. Load on UPS
    - b. General alarm
    - c. Additional information shall be provided in view of accelerating servicing of the system.
  6. **Display of operating graphs:** It shall be possible to graphically display the measurements mentioned above on the screen over significant periods.
  7. **Statistics:** Number of overloads, maximum power levels, demand power levels.
  8. **Log of time-stamped events:** This function shall store in memory and make available, for automatic or manually initiated recall, time-stamped logs of all important status changes, faults and malfunctions, complete with an analysis and display of troubleshooting procedures. It shall be possible to time stamp and store at least 2 500 events.
- C. **Controls:** Each GFC unit shall comprise the following controls:
1. **Two ON and OFF buttons:** Located on the front panel of the UPS, they shall control UPS-unit ON/OFF status. It shall be possible to turn OFF the UPS externally via an isolated dry contact.
  2. **EPO terminal block:** The UPS shall be equipped with an emergency power off (EPO) terminal block for complete system shutdown following reception of an external control signal. The EPO command shall result in:
    - a. Shutdown of UPS units;
    - b. Opening of an isolated dry contact on the programmable card.
  3. **Alarm reset button:** This button shall turn off audio alarms (buzzer). If a new alarm is detected after clearing the first, the buzzer sounds again.
- D. **Status indications with mimic panel:** Indication of status conditions shall be distinct of the graphic display.
1. Three LEDs on the control panel on each GFC unit indicate the following status conditions:
    - a. Load protected by the GFC unit;
    - b. Minor fault;
    - c. Major fault.
  2. The mimic panel shall represent the GFC and indicate the status of the load supply using five two-colour (red and green) LEDs:
    - a. Load supplied (LED at UPS output on mimic panel),
    - b. Inverter on (inverter LED on mimic panel),
    - c. PFC rectifier on (rectifier LED on mimic panel).

3. A buzzer shall warn the user of faults, malfunctions .

## 2.8 COMMUNICATION

- A. **Standard communication:** It shall be possible to remote the following controls, indications and measurements. To that end, each GFC unit shall have as standard equipment:
  1. A programmable card with four inputs and six outputs (**see page 7 & 8 operating manual**)
- B. Communications embedded: The GFC system shall be designed to enable the extension of communications, without system shutdown, to the following types of cards that may be installed on each GFC unit:
  1. Multi-standard communications card with two outputs: One standard only available to be chosen on between
    - a. An RS485 serial-link implementing the JBus/ModBus protocol for connection to a building management system (BMS)
  2. Remote Monitoring Service card.

## PART 3 – EXECUTION

### 3.1 PROTECTION

- A. **UPS:** Each GFC unit in the UPS system shall include protection against AC-source overvoltages (as per standard IEC 60146), excessive external or internal temperature rise and vibrations and impacts during transport.
- B. **Rectifier :**
  1. Each rectifier shall accept external orders provoking automatic shutdown in the following cases:
    - a. EPO (emergency power off), in which the battery circuit breaker also opens
    - b. If the temperature exceeds the specified limits..
- C. **Inverter:**
  1. The load shall be protected against overvoltages resulting from a loss of voltage regulation at the output of the inverters.
  3. In the event of an overload exceeding system capacity (AC bypass absent), each inverter shall be equipped with an automatic shutdown system to protect its power circuits. A load short-circuit shall provoke the static shutdown of each inverter without fuse destruction.

### 3.2 MAINTAINABILITY

- A. **Local and remote diagnostics and monitoring - E. Services:** The UPS shall be equipped with a self-test system to check operation of the system as a whole each time it is started. To that end, the supply control/monitoring electronics shall offer:
  1. Auto-compensation of component drift;
  2. Acquisition of information vital for computer-aided diagnostics or monitoring (local or remote);
  3. Overall readiness for remote supervision services provided by the manufacturer.

### 3.3 STANDARD AND TESTS

- A. **Standards**
  1. All equipment shall be designed and built in accordance with accepted engineering practice and applicable international standards, in particular the standards listed below.
    - a. IEC 60140-4: UPS - Performance.
    - b. IEC 62040-1 and EN 62040-1: UPS - Safety.
    - c. IEC 62040-2 and EN 62040-2: UPS - Electromagnetic compatibility (EMC), level B.
    - d. IEC 62040-3 and EN 62040-3: UPS - Performance.

- e. IEC 60950 / EN 60950: Safety of IT equipment, including electrical business equipment.
  - f. IEC 61000-2-2: EMC, levels of compatibility..
  - g. IEC 61000-3-4: Limits for harmonic current emissions (equipment input current > 16 A/ph).
  - h. IEC 61000-4: EMC – Immunity tests.
  - j. IEC 439: Low-voltage switchgear and control gear assemblies.
  - k. IEC 60529: Degrees of protection provided by enclosures (IP Code).
  - l. ISO 3746: Sound power levels.
  - m. CE marking.
2. What is more, the equipment shall comply with eco-design and eco-manufacturing criteria in view of sustainable development and to that end, the manufacturer shall be able to demonstrate:
- a. R&D and production on an ISO 14001 certified site
  - b. Manufacture with over 90% recyclable materials
  - c. Capacity to recover products at the end of their service life and provide proof of destruction by a certified organisation
  - d. The environmental profile of the product, which shall be supplied with the sales offer.
- B. **Certification of conformity:** The manufacturer shall provide, on request, a complete qualification file demonstrating compliance with the above standards. What is more, the indicated levels of performance shall be confirmed by certification from independent laboratories (e.g. TÜV or Veritas).

### 3.4 QUALITY SYSTEM AND TEST PROCEDURES

- A. **Test procedures:**
- 1. The manufacturer shall provide proof of a quality-assurance system. In particular, the main manufacturing steps must be subject to suitable tests such as:
    - a. Inspection of incoming components, tests on discrete subassemblies
    - b. Complete functional checks on termination of manufacture.
  - 2. The equipment shall be subject to burn-in under load conditions prior to shipping.
  - 3. Final checks and adjustments shall be recorded in a report drafted by the quality-inspection department of the supplier.
  - 4. Certification of the industrial facilities in compliance with ISO 9001 or 9002 shall be required.
- B. **Quality system:** The UPS must be designed using an ISO 9001 quality system and a dependability study to ensure maximum reliability.

### 3.5 SERVICES

- A. **Maintenance:** The supplier shall propose contracts covering four levels of maintenance.
- 1. **Level one:** simple checks and settings, procedures accessible without any dismounting and involving no risk.
  - 2. **Level two:** preventive maintenance, checks not inhibiting continuous operation of the system and preparing operators for Manufacturer services.
  - 3. **Level three:** trouble-shooting. Repairs by standard exchange of subassemblies and functional power and control components. Preventive-maintenance operations, both systematic and when indicated by qualified diagnosis.
  - 4. **Level four:** major preventive and corrective maintenance operations or technical upgrades during start-up, operation or renovation of the UPS installation and recycling of equipment or components representing a risk. These operations require the use of devices and means that have been calibrated by certified organisations. Need to include RMS service contract
- B. **Technical competency:**
- 1. **Customer operators:** the supplier shall offer a level 2 training program.
  - 2. **Service personnel:** the supplier shall ensure that service personnel are qualified for level 4.
- C. **Functional components - organisation of supplier services:**

1. Sufficient geographical proximity of the supplier or an authorised agent shall ensure reasonable access times to the customer site in view of reducing the mean time to repair (MTTR). The supplier shall be in a position to offer a contract limiting the response time to four hours.
  2. The supplier's logistics system and the availability 24 hours a day of original replacement parts shall similarly contribute to reducing to the greatest extent possible the mean time to repair (MTTR).
- D. **System start-up:** The system and equipment shall be started up on site by the supplier or its authorised agent. The procedure shall include checks on the characteristics of the upstream and downstream protection devices and on the UPS installation parameters.
- E. **Replacement parts:** The supplier shall undertake to provide certified original replacement parts for at least ten years following the date of delivery.
- F. **Recycling and renovation/substitution:** At the end of the UPS service life, the supplier shall guarantee the continuity of service of the customer's installations if necessary, including dismantling of equipment and replacement of equipment, in compliance with applicable standards on environmental protection.

### 3.6 INSTALLATION SERVICES

- A. **Required services include:**
1. Supply of the UPS and any accessory parts or elements.
  2. Carriage-paid UPS transportation and delivery to the site.
- B. **Options:**
1. UPS handling and installation on the site.
  2. Connections between the UPS.
  3. Connection of the normal AC source to the rectifier.
  5. Connection of the load circuits to the UPS output.

**END OF SECTION**



## CHECK LIST FOR GUIDE SPECIFICATION

To meet the requirements of your project, use this checklist to identify the technical specifications available.

### Type of UPS

Total rated power (kVA) at PF 0.9		kVA			kW
Manufacturer					
Range of products					
Operating mode (IEC 62040-3)	double conversion VFI	Yes		No	
Parallel connection of up to 10 GFC units	kVA max	Yes		No	
Up to three redundant units (n+3)		Yes		No	
Alarm signalling loss of redundancy within the UPS system		Yes		No	

### Rectifier

Input voltage range	250-470 V	Yes		No	
3-phase input voltage	Without neutral	Yes		No	
Phase sequence	Wrong phase sequence is signaled by alarm	Yes		No	
Sinusoidal input current	THDI upstream $\leq 4\%$ with PFC rectifier	Yes		No	
Input power factor	PF $> 0.99$ with IGBT rectifier (from 50% load)	Yes		No	
No inrush or start-up current		Yes		No	
Voltage regulation	$\pm 1\%$	Yes		No	
Independent regulation/monitoring systems for the charger		Yes		No	

### Inverter

Three-phase output voltage with neutral		Volts	Yes		No	
Steady-state conditions	$\pm 1\%$		Yes		No	
Voltage transients	$\pm 2\%$ (load from 0 to 100% or 100 to 0 %)		Yes		No	
Output voltage distortion at Pn	THDU $< 3\%$		Yes		No	
Unbalanced conditions	Voltage variation $< 1\%$		Yes		No	
Output frequency		Hz	Yes		No	
Variation in output frequency	$\pm 0.5$ Hz		Yes		No	
Adjustable from	- 0.25 Hz to + 4 Hz		Yes		No	
Frequency synchronisation with an external source	$\pm 0.5\%$ to $\pm 8\%$ of rated frequency		Yes		No	
Overload capacity	125% In for 10 minutes		Yes		No	
	150% In for 30 seconds		Yes		No	
Current limiting	300% In for 150 milliseconds		Yes		No	
Crest factor	Up to 3:1		Yes		No	

## Efficiency

Overall efficiency of UPS system	> 94.5% from 50 % load	Yes		No	
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## User interface

Graphic display in 2 languages		selection of operating language	Yes		No	
	Customisation menu	with password	Yes		No	
	Display	measurements, status, events, graphs	Yes		No	
	Event log	2500 time-stamped events	Yes		No	
	Bargraphs	Power levels, backup time	Yes		No	
	Statistics	% time on battery power, number of transfers to battery power, average percent load, etc.	Yes		No	
Controls		Separated ON/OFF buttons	Yes		No	
Redundant interface with separated mimic panel		Not included on display	Yes		No	
Status indications		Audio alarm, LEDs	Yes		No	

## Communication

Programmable relay card			Yes		No	
EPO terminal block			Yes		No	
Embedded	Card	JBus/ModBus RS485	Yes		No	
	Card with 2 outputs	Same as the card + a modem	Yes		No	
	Supervision software		Yes		No	
	Remote monitoring service		Yes		No	

## Certification

Certified standards and tests	See list in section 12.1	Yes		No	
Performance certification	LCIE	Yes		No	
Quality certification	ISO 9001 / 9002	Yes		No	
Eco-design and manufacturing	ISO 14001 site	Yes		No	

## Installation

Cabinet height	1900 mm maximum	Yes		No	
UPS cabinet weight (without batteries)	1500 kg maximum	Yes		No	
Installation against a wall		Yes		No	
Access to cable or bus bar connection through front		Yes		No	

## Services

Technical competency of supplier	Level 4 NFX 060-010	Yes		No	
Diagnostics and monitoring	Remote	Yes		No	
Technical Support	International	Yes		No	

## Operation/Maintainability

Safe maintenance	Built-in input, output and bypass switches	Yes		No	
Access to power components through front		Yes		No	
Access to communication through front	hot-swap cards	Yes		No	

## Availability

Worldwide availability if original replacement parts		Yes		No	
Response time of Service teams		t<4h	4<t<8	8<t<24 h	t>24 h
Maintenance Programs	Preventive	Yes		No	
	Predictive	Yes		No	
Emergency services		Yes		No	
Renovation/substitution programs		Yes		No	