TOSHIBA
Leading Innovation

**TOSHIBA INTERNATIONAL CORPORATION**
CORPORATE OFFICE
13131 WEST LITTLE YORK ROAD HOUSTON, TX 77041
PHONE: (713) 466-0277 (800) 231-1412
FACSIMILE: (713) 896-5212

# TOSHIBA G8000MM

## 100/150/225/300/375/500/625/750 kVA

## GUIDE SPECIFICATION
## THREE PHASE UNINTERRUPTIBLE POWER SUPPLY

April 2009

# Table of Contents

**1 GENERAL ..... 5**

1.1 SCOPE ..... 5
1.2 STANDARDS ..... 5
1.3 SUBMITTALS ..... 5
1.4 QUALITY ASSURANCE ..... 6
1.5 ENVIRONMENTAL RATINGS ..... 6
1.6 WARRANTY ..... 7

**2 PRODUCTS ..... 7**

2.1 FABRICATION ..... 7
2.2 GENERAL SYSTEM DESCRIPTION ..... 8
2.3 MULTI-MODULE UNIT SPECIFICATION ..... 10
2.4 INVERTER OPERATION ..... 13
2.5 INVERTER BYPASS OPERATION ..... 14
2.6 MAINTENANCE BYPASS PANEL BOARD OR SWITCHBOARD ..... 15
2.7 TOSHIBA TIE CABINET (TTC) ..... 15
2.8 COMPONENT SPECIFICATION ..... 16
2.9 PROTECTION CRITERIA ..... 16
2.10 DISPLAY AND CONTROLS ..... 18
2.11 LOGIC ..... 19
2.12 SELF-DIAGNOSTICS ..... 21
2.13 LOAD SYNCHRONIZATION (LS) ..... 22

**3 EXECUTION ..... 23**

3.1 FIELD QUALITY CONTROL ..... 23
3.2 UNIT START-UP ..... 23
3.3 MANUFACTURER'S FIELD SERVICE ..... 24
3.4 TRAINING ..... 25
3.5 MAINTENANCE CONTRACTS ..... 25

This page intentionally left blank.

# SPECIFICATION CSI SECTION 26 33 53
# 100-750kVA MULTI-MODULE UPS

## 1 General

### 1.1 Scope

This specification shall cover the requirements for an Uninterruptible Power System (UPS) system. The scope of this specification shall consist of the configuration of one or more UPS module units designed to operate individually or with paralleled outputs. The UPS shall be designed to maintain power to critical load without interruption during failure of normal power source. This specification shall cover the manufacturer's design and materials to ensure complete compatibility with the electrical system and space conditions at the site. The manufacturer shall be responsible to design a UPS system that operates with the existing AC power distribution system to provide conditioned power to the critical load during normal operation and backup power during an AC power failure.

### 1.2 Standards

The UPS and all associated equipment and components shall be manufactured in accordance with the following applicable standards:

- cUL 22.2, No. 107.1
- IEEE 587, Category B (ANSI C62.41)
- National Electrical Code (NFPA 70)
- OSHA
- UL Standard 1778 Listed

The UPS shall be listed per UL Standard 1778 Uninterruptible Power Supplies, and shall be CSA certified. The UL Label shall be attached to the UPS module.

The Quality System for the engineering and manufacturing facility shall be certified to conform to Quality System Standard ISO 9001 for the design and manufacture of power protection systems for computers and other sensitive electronics. In addition to the ISO Quality Control System the Manufacture shall have an additional Quality Control Program and shall be outline in the manufacturer's proposal.

### 1.3 Submittals

#### 1.3.1 Proposal Submittal

Submittals with the proposal shall include:

1. System configuration with single-line diagrams.
2. Functional relationship of equipment including weights, dimensions, and heat dissipation.
3. Descriptions of equipment to be furnished, including exceptions and clarifications to these specifications.
4. Size and weight of shipping units.

5. Detailed layouts of customer power and control connections.

1.3.2 Thirty (30) Day Submittal shall include:

Submittals thirty (30) days prior to UPS delivery shall include:

1. Detailed installation drawings including all terminal locations.
2. Interconnect wiring diagrams with terminal numbers for each wire.

1.3.3 UPS Delivery Submittal

Submittals upon UPS delivery shall include:

1. A complete set of submittal drawings.
2. Two (2) sets of instruction manuals. Manuals shall include a functional description of the equipment, safety precautions, instructions, step-by-step operating procedures and routine maintenance guidelines, including illustrations.

1.4 Quality Assurance

1.4.1 Manufacturer Qualifications

A minimum of ten years' experience in the design, manufacture, and testing of solid-state UPS systems is required.

1.4.2 Factory Testing

1. Before shipment, the manufacturer shall fully and completely test the system to ensure compliance with the specification.
2. These tests shall include operational discharge and recharge tests to ensure guaranteed rated performance.

1.5 Environmental Ratings

The UPS shall be able to withstand the following environmental conditions without damage or degradation of operating characteristics.

1.5.1 Operating Ambient Temperature

1. Ambient operating temperature for the UPS shall be 32° F to 104° F (0° C to 40° C) without de-rating.
2. Battery base line temperature shall be 77° F (25° C).

1.5.2 Storage/Transport Ambient Temperature shall be -20°F to 158°F (-20° C to 70°C).

1.5.3 Relative Humidity shall be 5 to 95%, non-condensing.

1.5.4 Altitude

1. Operation - To 9,000 ft. above Mean Sea Level without de-rating.
2. Storage/Transport - To 40,000 ft. above Mean Sea Level.

1.5.5 Audible noise generated under any typical condition shall not exceed:

1. 64 dBA @ 3.28 Feet (100, 150, 225 KVA UPS Module)
2. 75 dBA @ 3.28 Feet (300, 375, 500, 625, 750 KVA UPS Module)

1.6 Warranty

1.6.1 UPS Warranty

The UPS manufacturer shall warrant the unit against defects in workmanship and materials for one year (12 months) after startup or eighteen (18) months after shipment, whichever comes first.

1.6.2 Battery Warranty

The battery manufacturer's standard warranty shall be passed through to the end user.

# 2 Products

2.1 Fabrication

2.1.1 Materials

A. All materials of the UPS shall be new, of current manufacture, high grade and shall not have been in prior service except as required during factory testing.

B. All active electronic devices shall be solid-state.

C. All power semi-conductors shall be hermetically sealed.

D. Control logic and fuses shall be physically isolated from power train components to ensure operator safety and protection from heat.

E. All electronic components shall be accessible from the front for service access.

2.1.2 Wiring

A. Wiring practices, materials and coding shall be in accordance with the requirements of the National Electrical Code, OSHA, applicable local codes and standards.

B. All bolted connections of bus bars, lugs, and cables shall be in accordance with requirements of the National Electric Code and other applicable standards.

C. All electrical power connections shall be torqued to the required value and marked with a visual indicator.

D. Provisions shall be made in the cabinets to permit installation of input, output, and external control cabling, using raceway or conduit.

E. Provision shall be made for top access for all UPS Systems over 225 KVA, bottom and side access for all modules 225 KVA and under.

F. In conformance with NEC, connection cabinets shall provide for adequate wire bend radius.

G. All copper customer connection points shall be provided.

2.1.3 Construction and Mounting

A. The UPS shall be in NEMA Type 1 enclosures, designed for floor mounting.

B. The UPS shall be structurally adequate and have provisions for hoisting, jacking, and forklift handling. Eye hooks (removable) shall be mounted on each corner.

C. Maximum cabinet height shall be 79.7 inches.

2.1.4 Seismic

The UPS modules and battery cabinets shall be seismic zone 4 designed.

2.1.5 Cooling

A. Adequate ventilation shall be provided to ensure that all components are operated well within temperature ratings.

B. The top-mounted blowers shall be long lasting type.

C. Temperature sensors shall be provided to monitor UPS internal temperature.

D. Upon detection of temperatures in excess of manufacturer's recommendations, the sensors shall cause audible and visual alarms to be sounded on the UPS control panel.

E. Optional air filters shall be located at knee level, front of UPS module, to prevent introduction of ground debris.

2.2 General System Description

2.2.1 Design Requirements

A. For non-redundant operation (applicable, not applicable), the UPS shall be sized to provide a minimum of _____kVA and a minimum of _____kW output with _____ number of UPS modules.

B. For redundant operation (applicable, not applicable), the UPS shall be sized to provide a minimum of _____kVA and a minimum of _____kW output with one UPS module out of service with a total of ____ number of UPS modules.

C. Load voltage and bypass line voltage will be _____VAC, three phase _____ (3 or 4) wire. Input voltage will be _____VAC, three phase, and _____ (3 or 4) wire. The battery shall have a capacity of _____kW for at least _____ minutes at 25°C.

D. The system shall be expandable in the future. YES / NO (pick one option).

### 2.2.2 System Output Configuration

The system shall be configured as an on-line, reverse-transfer power conditioning UPS.

### 2.2.3 System Protection

The UPS shall have built-in protection against surges, sags, and over-current from the AC source, over voltage and voltage surges from output terminals of paralleled sources, and load switching and contactor/circuit breaker(s) operation in the distribution system.

A. The UPS shall be protected against sudden changes in output load and short circuits at the output terminals. The UPS shall have built-in protection against permanent damage to itself and the connected load for all predictable types of malfunctions.

B. Fast-acting software and control with a true Digital Signal Processing (DSP) design shall be used with a sample rate of 30 kHz resulting in 500 sample times of each sine wave. Upon detection of a failure or abnormal condition, the DSP software shall gate off the circuit to protect against cascading failure of solid-state devices.

C. Additional devices such as fast acting fuses and contactors shall backup the software to provide maximum protection. The design shall be such that the opening of a fuse, by design, to protect against a fault shall not be allowed.

D. The isolation of a fault shall be by gating its fast acting software. Fuses and or circuit breakers shall only be used as backup information to maintenance personnel regarding the reason for tripping off line.

E. The load shall be automatically transferred to the bypass line uninterrupted for an internal UPS malfunction.

F. The status of protective devices shall be indicated on a graphic display screen on the front of the unit.

### 2.2.4 Modes of Operation

The UPS system shall operate as an on-line reverse transfer system in the following modes:

A. Normal: The critical AC load is continuously powered by the UPS inverter(s). The rectifier/converter(s) derive power from the utility AC source and supplies DC power to the inverter(s), while simultaneously float charging the battery.

B. Emergency: Upon failure of utility AC power, the critical AC load shall be powered by the inverter(s) which obtain power from the battery. There shall be no interruption in power to the critical load upon failure or restoration of the utility AC source.

C. Bypass: If the UPS system must be taken out of service for maintenance or repair, the bypass switch shall transfer the load to the bypass source upon receipt of a manual transfer command from the user interface. Upon detection of an external fault or overload, or an internal failure, the bypass static switch shall automatically transfer the critical load to the bypass source. The transfer process shall cause no interruption in power to the critical AC load.

D. Off-Battery: If the battery only is taken out of service for maintenance, it shall be disconnected from the rectifier/converter(s) and inverter(s) by means of external disconnect breakers. The UPS shall continue to function and meet all of the specified steady-state performance criteria, except for the power outage back-up capability.

### 2.2.5 Performance Requirements

The maximum working voltage, current, temperature, and di/dt of all solid-state power components and electronic devices shall not exceed 75% of the ratings established by their manufacturer. Electrolytic capacitors shall be computer grade and be operated at no more than 95% of their voltage rating at the maximum battery charging voltage.

A. The Mean Time Between Failure (MTBF) for the UPS including the bypass circuitry shall be 3,000,000 hours. The UPS without the bypass circuit shall have an MTBF of 140,000 hours.

B. Module Configuration: Each UPS Module shall be capable of operating as a single UPS module or as an element of a multi-module system without any major modification to the UPS module for current and/or future configurations. Each UPS module shall be constructed with its associated built-in static bypass switch, input and output switchgear.

## 2.3 Multi-Module Unit Specification

### 2.3.1 UPS Module

A. Each UPS module shall consist of a rectifier/converter and three-phase inverter with associated transformers, static transfer switch with bypass switch, synchronizing equipment, protective devices, and accessories as specified. The specified system shall also include a battery disconnect breaker and battery system.

B. Each UPS module shall be designed for use as a stand alone module.

C. Each UPS module shall be capable of operation in parallel with up to seven (7) other UPS modules in a parallel redundant or parallel capacity system.

D. Up to eight (8) UPS modules shall be capable of parallel operation without the use of a System Control Cabinet or system automatic bypass circuit. Summing of the outputs shall be done via a Toshiba Tie Cabinet (TTC). Optionally available shall be an advanced touch screen monitor, communication ports and maintenance bypass.

E. The UPS module shall be designed so that multiple modules may be paralleled up to 4000kVA (5000A maximum, overcurrent protection device limited).

2.3.2 Module Input Specification

A. Voltage Range: +15%, -15% of nominal

B. Frequency Range: ±5%.

C. Inrush Current Limiting: 30% of full rated load max.

D. Power Factor: Minimum 0.98 lagging at full load with nominal input voltage.

E. Rectifier Input Current Limit: The UPS design shall be such that the input current demand will follow the UPS output load, plus the inefficiency of the system and the preset battery current limit. Under no condition shall the design allow the rectifier to go into current limit while charging batteries. Factory set at 110% of nominal rated current

F. Converter Walk-In time: 0 – 100% rated load in 5 – 30 seconds (selectable in 5 second increments)

G. Current Distortion: Less than 6% THD at full load.

H. Surge Protection: Sustain input surges without damage per criteria listed in ANSI C62.41-1980.

2.3.3 Module Output Specification

A. Load Rating: 100% continuous load rating at 0° C to 40° C for any combination of linear and non-linear loads.

B. Voltage Regulation: ±1% for steady state load.

C. Voltage Adjustment Range: ±5% (manually).

D. Frequency Regulation: +/- 0.05% (in Free-running Mode).

E. Efficiency: Defined as output kW/input kW at rated load and power factor.
Not less than 94.1% for the 750kVA at 09 $PF_{out}$.
Not less than 94.1% for the 625kVA at 09 $PF_{out}$.
Not less than 94.1% for the 500kVA at 09 $PF_{out}$.
Not less than 93.8% for the 375kVA at 09 $PF_{out}$.
Not less than 93.8% for the 300kVA at 09 $PF_{out}$.
Not less than 93.3% for the 225kVA at 08 $PF_{out}$.
Not less than 93.5% for the 150kVA at 08 $PF_{out}$.
Not less than 93.7% for the 100kVA at 08 $PF_{out}$.

F. Phase Imbalance:

| | |
|---|---|
| Balanced loads 120° | ±1° |
| 50% Unbalanced loads 120° | ±3° |

G. Voltage Regulation:

| | |
|---|---|
| 100% Balanced Load | ±1% Regulation |
| 100% Unbalanced Load | ±1% Regulation |

H. Step Load Output Voltage Regulation:

| | |
|---|---|
| 100% Step Load | ±2% |
| Loss of/return to AC input power | ±1% |
| Transfer to/from Bypass | ±5% |

I. Voltage Transient Recovery Time:
± 1% of output voltage within 16.7 milliseconds.

J. Harmonic Content:
Maximum 2% total, maximum for 100% linear load.
Maximum 5% total maximum for 100% non-linear load.

K. Overload Capacity Maintaining Output Voltage Regulation:
100% of full load continuously.
125% of full load for 10 minutes.
150% of full load for 1 minute.

L. Output Current Limit: 150% full load current.

M. Fault Clearing: Sub-cycle current of 500% (300kVA and above) or 1000% (225kVA and below) of normal full load current (when bypass is available).

N. Output Power Factor:
100 kVA - 225 kVA 0.8 lagging
300 kVA - 750 kVA 0.9 lagging

## 2.4 Inverter Operation

A. The inverter shall generate AC power derived from DC power supplied from the rectifier or system battery.

B. The inverter shall be capable of providing rated output as specified while operating from any DC voltage within the battery operating range.

C. The inverter shall utilize the following technology:

1. Solid state Space Vector Modulation controlled IGBT power transistors switching at 6 kHz (average switching frequency).
2. Utilizing the adoption of a low switching frequency (for efficiency improvement) and high-speed response.
3. Switching frequency shall be defined as IGBT turn on and turn off rate. (Apparent doubling of frequency at inverter output due to simultaneous IGBT device activation shall not be considered as the true switching frequency).

D. UPS Module Full Direct Digital Control (DDC)

1. Regulation: Field Programmable Gate Array (FPGA);
2. Control: Digital Signal Processing (DSP) based Control

E. DSP Sampling Frequency shall be 30 kHz, sampling 500 times in 1 cycle of output voltage.

F. Overload Capability: The inverter output shall be capable of providing an overload current while maintaining rated output voltage (and voltage regulation) to:

1. 105% to 125% for 10 minutes.
2. 126% to 150% for 1 minute.

G. The UPS Module Operation/Display panel LCD screen shall illuminate to identify an overload condition. If the time limit associated with the overload condition expires or the overload is in excess of the set current, the load power shall be transferred to the bypass source without interruption via UPS Multi-Module System (MMS) Bypass Operation.

H. Output Frequency: The inverter shall track the bypass continuously providing the bypass source maintains a frequency of 60 Hz ±5%. The UPS module shall maintain a frequency of 60 ±0.05% in asynchronous mode (bypass source unavailable).

I. Output frequency Slew Rate 1 through 10 Hz/second (selectable in 1 Hz/second increments). The inverter frequency drift shall be 0.1 Hz per second maximum.

J. Phase-to-Phase Balance: System logic shall provide individual phase voltage compensation to obtain phase balance ±1% under all conditions including up to 100% load unbalance.

K. Fault Sensing and Isolation:

1. Fault sensing shall be provided to isolate a malfunctioning inverter from the critical load bus to prevent disturbance of the critical load voltage beyond the specified limits.
2. The UPS logic shall automatically gate off the logic and operate the output contactor to isolate a malfunctioning module from the critical load.

L. Output Contactor

1. The inverter shall be provided with a magnetic contactor to isolate the inverter from the critical load bus in addition to the software gating the output power off.
2. This contactor shall be of the correct size and rating to supply full rated load and overload current as specified elsewhere in this document.
3. The contactor shall work in conjunction with the UPS module logic and the logic of the bypass circuit described in Section 2.5 below for both automatic and manual load transfers to and from bypass power.

M. Battery Protection

1. The inverter shall be provided with monitoring and control circuits to protect the battery system from damage due to excessive discharge.
2. Inverter shutdown shall be electronically initiated when the battery voltage has reached the end of discharge level.
3. The battery end-of-discharge voltage shall be calculated and automatically adjusted for partial load conditions to allow extended operation without damaging the battery. Automatic shutdown based on discharge time shall not be acceptable.
4. If power has not returned within a four hour period of time the UPS shall trip the battery circuit breaker.

## 2.5 Inverter Bypass Operation

A. Manual Load Transfers:

1. A manual load transfer between the inverter output and the alternate AC source shall be initiated from the control panel.
2. Manually initiated transfers shall be make-before-break utilizing the inverter isolation and bypass contactors.

B. Automatic Load Transfers

1. An automatic load transfer between the inverter output and the alternate AC source shall be initiated if an overload condition is sustained for a time period in excess of the inverter output capability or due to a malfunction that would affect the output voltage.
2. Transfers caused by overloads shall initiate an automatic retransfer of the load back to the inverter only after the load has returned to a level within the rating of the inverter source.
3. The UPS system logic shall allow 0 to 4 retransfers (adjustable) within any five minute period to prevent cyclical transfers caused by overloads.

C. Momentary Overloads

1. In the event of a load current inrush or branch load circuit fault in excess of the inverter rating, the static bypass switch shall connect the alternate AC source to the load and the bypass contactor shall subsequently be closed.
2. Output voltage shall be sustained to the extent the alternate AC source capacity permits.

D. Protection and Back feed Prevention

1. As required by UL1778 and cUL, the static bypass switch shall not back feed UPS power to the bypass distribution system while the UPS is operating on battery during a bypass power outage.
2. The static bypass switch shall be provided with redundant bypass power outage sensing circuits.
3. The back feed prevention system shall operate even if two component failures exist simultaneously.

## 2.6 Maintenance Bypass Panel Board or Switchboard

A. For single module operation of one UPS module a make-before-break maintenance bypass switch (MBS) shall be available as an option in a wall-mounted or floor-standing cabinet.

B. Thermal-magnetic breakers shall be provided for maintenance bypass operation. Two (2) or three (3) circuit breakers shall be specified.

C. Each circuit breaker shall have an interrupting rating of 65 KAIC or at a specified higher rating.

D. An optional key interlock system shall be provided.

## 2.7 Toshiba Tie Cabinet (TTC)

A. The TTC shall consist of two sections, the Power Section and the Monitoring Section.

1. The Power Section shall include the UPS Module output circuit breakers, parallel bus power circuit, optional system maintenance bypass circuit breaker and power circuit, system output circuit breaker and output power circuit, and an optional interlock system.
2. The TTC shall also have an inductor per UPS module to compensate for the mismatch in impedance of the power cable in bypass mode of operation.

B. The Monitoring Section shall be located in a separate enclosure to the Power Section and incorporate a Monitoring System.

1. The Monitoring System shall include a main Toshiba Graphic Interface (TGI).
2. The TGI shall be located on the TTC door exterior.
3. The Monitoring System shall monitor all UPS MMS components and display UPS MMS operational status and information.
4. UPS MMS operation sequences shall be initiated from the Monitoring System.

5. The touch screen shall allow selectable individual UPS module monitoring from the same screen.

C. Construction

1. An electrical interlock shall be used to prevent out of sequence transfer of the bypass circuitry.
2. The bracing of all copper bus shall be 100 kAIC. Bus shall be plated with either tin or silver.
3. Accessing shall be _____ (front/side/back) with vendor stating size of TTC in proposal (dependent upon access requirements).

## 2.8 Component Specification

### 2.8.1 Rectifier/Converter

A. The term rectifier/converter shall denote the solid-state equipment and controls necessary to convert AC to DC for input to the inverter and charging the battery.

B. The design shall use a high power diode bridge rectifier to limit the reflected harmonic currents and increase the MTBF to at least 3,000,000 hours

### 2.8.2 Engine Generator Sizing

The sizing of the engine generator to the UPS shall be 1.1 to 1 for all 480V UPS Systems.

### 2.8.3 Input Contactor

The rectifier shall have an input contactor to prevent backfeed protection per UL 1778.

### 2.8.4 DC Filter

A. The charger shall have an output filter to minimize ripple current into the battery.

B. The AC ripple voltage of the charger DC output shall not exceed 1% RMS of the float voltage.

C. The AC ripple current in the battery during float operation shall not exceed 10% RMS of the inverter full load DC current.

D. The filter shall be adequate to ensure that the DC output of the rectifier/converter will meet the input requirements of the inverter without the battery connected.

## 2.9 Protection Criteria

### 2.9.1 Input Current Total Harmonic Distortion

Input current THD shall be less than 6% at full load input current.

### 2.9.2 AC Input Current Limiting

A. AC input current limit shall be factory set at 110% of normal.

B. The rectifier, converter logic and control shall also be capable of providing auxiliary current limiting when initiated by an external dry contact when the UPS is fed from an engine generator.

2.9.3 Fuse Protection

A. Each AC phase shall be individually fused with fast-acting fuses as a backup to the software logic, so that loss of any semiconductor shall not cause cascading failures.

B. Fuses shall be bolted to copper bus bars at both ends to ensure mechanical and electrical integrity.

2.9.4 Over Voltage Protection

There shall be DC over-voltage protection so that if the DC voltage rises to the pre-set limit, the UPS shall shut down automatically and initiate an uninterrupted load transfer to bypass.

2.9.5 Battery Charge Current Limiting

A. The battery charge current limit shall control the recharge current by reducing the rectifier/converter output when the set limit is reached.

B. The minimum limit shall be set a -10% of the battery Ah rate.

C. The battery supplied with the system will have its unique values entered into the UPS Module's data storage at time of startup, by the field service engineer, to ensure proper battery values are used in charge/discharge calculations.

2.9.6 Battery Recharge

A. In addition to supplying power for the load, the rectifier/converter shall be capable of producing battery charging current sufficient to recharge valve regulated batteries to 90% of their rated capacity or flooded batteries to 95% of their rated capacity within ten (10) times the discharge time.

B. After the battery is recharged, the rectifier/converter shall maintain the battery at full charge until the next emergency operation.

C. The rectifier/converter design shall be a Pulse Width Modulation (PWM) type design using Insulated Gate Transistors (IGBT) at a switching frequency of 9 kHz to limit AC ripple into the battery plant.

2.9.7 Battery Temperature Compensation

A. The UPS shall have as standard a battery temperature compensation function allowing the charger voltage to fold-back to a safe value in the event the battery system temperature reaches a pre-determined (dangerous) level.

B. Initiation shall be by dry contact input from a thermocouple sensor (user-supplied) and from the DSP calculations.

2.9.8 Automatic Battery Load Testing

A. For a short duration, a small power discharge from the battery shall be automatically performed while the battery voltage is monitored.

1. The UPS module, from this small power discharge, shall evaluate the degradation of the system battery.

B. The small power discharge shall have negligible effect on the overall battery back up time and shall quickly be replenished.

C. The Battery Self Test shall automatically occur every 720 hour interval.

D. An event alarm shall occur and be displayed if battery abnormalities are detected.

2.9.9 Input Current Walk-In

A. The rectifier/converter logic and control circuit power walk in function shall enable delayed and timed ramping of input current.

B. Converter startup shall be delayed by a maximum of 3600 seconds (every 1 second selectable-default at 1 second).

C. The ramping of current shall be timed to gradually increase the load from 0% to 100% in 5 to 30 seconds (every 1 second selectable - default at 10 seconds).

2.9.10 Automatic Equalize Charge Timer

A. The UPS module logic and control shall provide an electronic equalize charge timer function (0 to 50 hour selectable - default twenty-four (24) hour).

B. Once activated the timer circuit shall provide a high rate equalizing charge voltage to the system battery for the selected time.

C. The function shall be capable of manual activation and de-activation via the UPS Module LCD.

D. The level of equalizing voltage shall be equal to that stated by the battery manufacturer (typically .04 to .08 VDC/cell higher than the specified float level).

E. Upon completion of the timer count, the converter output voltage shall return to the specified float voltage (typically 2.25 to 2.28 VDC/cell).

F. An Auto Equalize charge operation shall also be provided following AC input restoration and subsequent to the power walk in function.

G. This equalizing charge shall occur until the battery target voltage is reached (condition is met to end equalizing charge), after which float voltage shall be applied.

2.10 Display and Controls

2.10.1 UPS Control Panel

A. The operator control panel shall employ the use of a LCD touch screen interface which allows lock-out of all UPS control functions for security (the Emergency Power Off function shall not be locked-out).

B. The operator interface shall provide the following:
1. UPS start-up procedure
2. UPS shutdown procedure
3. Emergency Power Off (EPO)
4. Audible alarm silence
5. System status levels

2.1.2 Microprocessor Controlled Operator Guidance

A. The UPS' microprocessor logic shall, as standard equipment, provide menu-driven operator instructions detailing the operation of the UPS system.

B. The instruction menu shall be accessible via a touch screen display located at the control panel.

C. The microprocessor shall monitor each step, thus prompting itself to the next step of the instructions.

D. The following instructions shall be available as a minimum:

1. Inverter stop
2. Inverter start
3. UPS shutdown
4. UPS startup
5. Transfer of load to static bypass
6. Equalize charge to system battery

2.11 Logic

UPS Module Control and Monitoring shall include:

- Rectifier/converter
- Inverter
- Independent automatic bypass static switch circuit control (working in conjunction with UPS MMS Control.

2.11.1 Metered Values

A. All meters shall be digitally displayed having an accuracy of 1% or better.

B. The following parameters shall be available for display:
1. Converter input voltage
2. Converter input current
3. Converter input frequency
4. Battery voltage
5. Battery charging/discharging current
6. Battery capacity remaining during power failure conditions
7. Number of battery discharges
8. Bypass input voltage
9. Bypass input frequency
10. Output voltage
11. Output current in RMS Amps, % Amps

12. Load Apparent Power (kVA)
13. Load Effective Power (Real, kW)

2.11.2 Mimic Bus Display

A. A mimic bus identifying the internal UPS power circuit, contactors/circuit breakers, operating status and fault conditions shall be provided on the touch screen interface.

B. The following display shall be included:

1. Converter operation.
2. Battery operation.
3. Converter on/off.
4. Inverter on/off.
5. Inverter synchronized with bypass.
6. Load on inverter.
7. Load on bypass.
8. Equalize charge on.

2.11.3 Microprocessor Controlled Diagnostics

A. The UPS shall provide microprocessor controlled diagnostics capable of retaining fault alarms along with metering parameters in the event of a UPS failure.

B. The microprocessor memory data shall be viewed via an LCD display located at the control panel.

C. The following alarm/status information shall be provided as a minimum:

1. Load on Inverter
2. Inverter Operation
3. Inverter Start/Stop
4. Battery Operation
5. Battery Low Voltage
6. Output Overload
7. Overload Level Set
8. Remote Start/Stop Enabled
9. Remote Operation
10. Battery Depleted
11. Battery Temperature Abnormal
12. Converter Operation
13. 72B (DC Breaker) Tripped
14. Converter Supplying DC Power
15. Converter Input out of Range
16. Equalize Charge Activated
17. Inverter Stop due to Overload Condition
18. Inverter Running Synchronously
19. Inverter Running Asynchronously
20. UPS on Static Bypass
21. Static Bypass Input out of Range

2.11.4 Control Logic Power

A. The UPS control logic power supply shall employ a redundant design utilizing the UPS utility input and the system battery as power sources.

B. An additional power source, separate from the redundant power supplies shall supply power to the Static Switch logic.

2.11.5 Emergency Power Off

A. The UPS control panel shall have a local emergency power off pushbutton with protective cover.

B. Pressing the emergency power off shall cause the opening of the input, output contactors, and battery breakers to open, completely isolating the UPS.

C. Provisions shall be available for a remote emergency power off function, which completely removes power from the critical bus when activated.

2.12 Self-Diagnostics

2.12.1 Preset Status Screen

A microprocessor self-diagnostics shall automatically be performed at each start-up of the UPS module and at the beginning of each of the battery self test performed every 720 hours.

2.12.2 Event Log

A. An event log file shall contain information dealing with any of alarms conditions.

B. The log shall contain time and date stamps of each event.

C. Up to five screens (50 events/faults) shall be displayed. An unlimited number of events shall be available via software transfer to the customer data base via the UPS modules standard RS232, 10/100 Base-T, and ports.

2.12.3 Waveform Capture

A. A waveform capture of 4 cycles before and 4 cycles after an event shall be displayed on the UPS modules' touch screen.

B. These traces shall also be downloadable to the customer's PC utilizing the manufacturer's software.

C. Sample rate shall be at 30 kHz allowing for 500 samples in one cycle.

2.12.4 IP Address (Remote Eye II option module)

A. Each UPS module shall be capable of being assigned a unique IP Address

B. Each UPS module shall have the necessary hardware (10/100 Base-T) and software to support this function as standard equipment.

C. . Each UPS module be capable of being remotely monitored via the internet.

2.12.5 Remote Status Alarm Panel (RSAP) (Optional)

A. The remote alarm panel shall have LED alarm lights.

B. An audible alarm shall sound upon any alarm condition.

C. In addition to its AC power supply, the remote panel shall have a two (2) week battery supply, internal to the remote panel.

D. The panel shall be mounted in a NEMA 1 type enclosed panel shall indicate:

1. Converter on
2. Load on Inverter
3. Load on Bypass
4. UPS Failure
5. Output Overload
6. UPS in battery back-up mode
7. Low battery while in back-up mode

2.13 Load Synchronization (LS)

A. Each UPS shall provide synchronous operation with up to eight (8) UPS modules without the requirement of extra external controls or optional features.

B. All controls shall be housed in each UPS module.

C. The Load Synchronization circuits shall ensure synchronous operation of two or more UPS systems during all steady state operating conditions.

D. The Load Synchronization circuits shall ensure synchronous operation when the UPS is operating on battery, independent generators and situations when the bypass inputs are out of phase or synchronization.

E. Functionality of the load synchronization system:

1. Continuously sense the phase relationship between the outputs of the two UPS's that make up the system.
2. Synchronize the Designated Secondary System (DSS) to the Designated Primary System (DPS) any time separate synchronization results in non-synchronous operation for a designated period of time.
3. Continuously monitor the quality and synchronism of the bypass input voltage to both systems. Once quality and sync between the two have been re-established, the LS shall revert to separate synchronization for both systems, each to its own bypass.
4. Failure of any part of the LS controls shall not cause system failure.
5. Failure of an interconnection cable between UPS systems shall not cause loss of synchronism as the connection is bi-directional.

# 3 Execution

## 3.1 Field Quality Control

The following inspections and test procedures shall be performed by factory-trained field service personnel during the UPS start-up.

### 3.1.1 Visual Inspection

A. Inspect equipment for signs of damage.

B. Verify installation per drawings.

C. Inspect cabinets for foreign objects.

D. Verify neutral and ground conductors are properly sized and configured.

E. Inspect electrolyte level in cells (flooded cells only).

F. Inspect all cell cases.

G. Inspect each cell for proper polarity.

H. Verify all printed circuit boards are configured properly.

### 3.1.2 Mechanical Inspection

A. Check all control wiring connections for tightness.

B. Check all power wiring connections for tightness.

C. Check all terminal screws, nuts, and/or spade lugs for tightness.

### 3.1.3 Electrical Inspection

A. Check all fuses for continuity.

B. Confirm input and bypass voltage and phase rotation is correct.

C. Verify control transformer connections are correct for voltages being used.

D. Assure connection and voltage of the battery string(s).

## 3.2 Unit Start-Up

A. Energize control power.

B. Perform control/logic checks

C. Verify DC float and equalize voltage levels.

D. Verify DC voltage clamp and over voltage shutdown levels.

E. Verify battery discharge, low battery warning and low battery shutdown levels.

F. Verify fuse monitor alarms and system shutdown.

G. Verify inverter voltages and regulation circuits.

H. Verify inverter/bypass sync circuits and set overlap time.

I. Perform manual transfers and returns.

J. Simulate utility outage.

K. Verify proper recharge.

## 3.3 Manufacturer's Field Service

### 3.3.1 Service Personnel

- The UPS manufacturer shall utilize a nationwide service organization, consisting of Toshiba factory-trained field service personnel dedicated to the start-up and maintenance of UPS and power equipment.
- The manufacturer shall provide a national dispatch center to coordinate field service personnel schedules.
- One toll-free number shall reach a qualified support person 24 hours/day, 7 days/week, 365 days/year.

### 3.3.2 Automated Site Monitoring

The UPS manufacturer shall provide as a standard feature communications either from a RS232 or 10/100 Base-T Ethernet connection to monitor the UPS via the customer PC, Server or Internet.

### 3.3.3 Replacement Parts Stocking

- Parts shall be available through an extensive network to ensure around-the-clock parts availability throughout the country.
- Recommended spare parts shall be fully stocked by local field service personnel with back-up available from Toshiba International Corporation.
- Toshiba Customer Support Department shall be on-call 24 hours a day, 7 days a week, and 365 days a year for immediate parts availability.
- Parts from Toshiba International Corporation shall be shipped within 4 hours on the next available flight out and delivered to the customer's site within 24 hours.

## 3.4 Training

- Maintenance training courses for customer employees shall be available by the UPS manufacturer.
- This training shall be in addition to the basic operator training conducted as a part of the system start-up.
- The training course shall cover UPS theory, location of subassemblies, safety, battery considerations and UPS operational procedures.
- The course shall include AC-to-DC conversion and DC-to-AC inversion techniques as well as control, metering, and feedback circuits to the Printed Circuit Board (PCB) level.
- Troubleshooting and fault isolation using alarm information and internal self-diagnostics shall be stressed.

## 3.5 Maintenance Contracts

A complete offering of preventive and full-service maintenance contracts for both the UPS system and battery system shall be available. Contact the Toshiba Service Department for details regarding extended warranties and service plan options.