MITSUBISHI ELECTRIC

2033C-B DDC SERIES

10, 15, 20 KVA

SPECIFICATIONS

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1 SCOPE

This specification describes an on-line, double conversion three-phase, solid-state, uninterruptible power system, hereafter known as the UPS. The UPS shall operate utilizing the existing power distribution system to provide a high quality, reserve source of power to electronic equipment loads. The system shall consist of a converter, system battery, solid-state inverter, automatic static bypass transfer circuit and integral maintenance bypass circuit.

2 SYSTEM DESCRIPTION

2.1 Components

The UPS shall be comprised of the major components listed below:

2.1.1 Insulated Gate Bipolar Transistor (IGBT) Converter Section.

2.1.2 Insulated Gate Bipolar Transistor (IGBT) Inverter Section.

2.1.3 Digital Signal Processor (DSP) using Pulse Width Modulation (PWM) control for Direct Digital Control (DDC) of all UPS control and monitoring functions.

2.1.4 Static bypass switch sized to provide fault clearing.

2.1.5 Standard features:

a) Transistorized PWM IGBT Converter.
b) Transistorized PWM IGBT Inverter.
c) DSP based fault memory and diagnostics.
d) DSP based menu controlled operation.
e) Active mitigation of reflected input harmonics (no passive filters).
f) Active control of output voltage distortion (no passive filters).
g) Automatic input current walk-in.
h) **Automatic** UPS restart and load pick-up (after system battery depleted; AC restored).
i) External customer accessible (A-Type) dry contacts.
j) Internal DC Disconnect and Fuse protection.
k) Remote and Local Emergency Power Off (EPO).

l) Input AC Disconnect and Fuse protection.
m) Static Bypass Disconnect.
n) Internal Maintenance Bypass Switch (MBS)
o) Battery self Test
p) Battery Temperature Compensation

2.1.6 Optional features:

a. Remote monitor panel.
b. Input Isolation Transformer (Standard on **all** 480-208/120. 480-480/277, 600-208/120 and 600-600/347 units).

2.2 Modes of Operation

The UPS shall be designed to operate continuously at rated capacity as an on-line, automatic system in the following modes:

2.2.1 Normal - The inverter continuously supplies AC power to the critical load. The converter converts commercial AC power to regulated DC power which then serves as the inverter input and, simultaneously, as a float charge input to the storage battery.

2.2.2 Emergency - In the event of a commercial AC power failure, the inverter shall derive its input from the system battery, thus providing uninterrupted power to the critical load. This transition shall be accomplished without any switching or coupling, and with no interruption of power to the critical load from either a failure or restoration of the commercial AC power.

2.2.3 Recharge - Subsequent to restoration of commercial AC power, the converter shall automatically reactivate and provide DC power to the inverter, simultaneously recharging the system battery. This occurs automatically and without interruption to the critical load.

2.2.4 Bypass - In the event that the UPS must be taken off line due to an overload condition or UPS failure, the critical load shall be transferred to the bypass source via the static switch without interruption of power to the critical load. The static switch shall only be utilized for automatic emergency transfers. A re-transfer from bypass to inverter shall be performed automatically in overload conditions. A re-transfer shall be inhibited if satisfactory synchronization of the inverter and bypass is not accomplished.

2.2.5 Maintenance Bypass – The UPS system shall be equipped with an internal MBS to allow safe and reliable maintenance of the UPS. The MBS shall be of the Make-Before-Break, "Zero Energy" type to ensure maximum load reliability and personnel safety.

2.3 Applicable Standards

The UPS has been designed in accordance with, and complies to, the following standards:

a) UL 1778 and CSA 22.2 (cUL equivalent).
b) IEC, Semiconductor Converter Standards.
c) ISO 9001 Quality Assurance program.
d) EMI compatibility: FCC Title 47, Part 15, Subpart B
e) IEEE C62. 41-1991
f) This specification

3 PERFORMANCE CHARACTERISTICS

3.1 Power Ratings

The UPS output capacity shall be:

XXX kVA/ **XXX** kW @ .8 pf lagging

3.2 Input (Converter)

3.2.1 Nominal input voltage: 208V, 3 phase, 4 wire (480V, 600V 3 wire).

3.2.2 Input voltage range: +15%, -25%.

3.2.3 Input frequency and range: 60 Hz ± 5%.

3.2.4 Input power factor: .98 lagging minimum at 100% load; 0.95 lagging minimum at 50 % load.

3.2.5 Reflected input current THD: 4% maximum at 100% load. 7% maximum at 50% load.

3.2.6 Converter walk-in time: 20 seconds

3.3 Input (Bypass)

3.3.1 Nominal input voltage: 208V, 3 phase, 4 wire.

3.3.2 Input synchronization voltage range: ± 10% of nominal.

3.3.3 Input frequency tracking range: 60 Hz ± 5% maximum.

3.4 Output

3.4.1 Nominal output voltage: 208, 480, 600 V, 3 phase, 4 wire.

3.4.2 Nominal dynamic voltage regulation: ± 2% for unbalanced loads.

3.4.3 Voltage transient response: Voltage transient response shall not exceed the following, and shall recover to within nominal voltage regulation limits within 16.7 msec:

a. ± 3% for a 100% load step.
b. ± 1% (loss or return of AC input).
c. ± 3% (inverter ⇔ bypass).

3.4.4 Output frequency (inverter synchronous): 60 Hz (tracks frequency of static bypass source).

3.4.5 Output frequency slew rate (inverter synchronized to static bypass)

3.4.6 Free running output frequency (on battery or asynchronous): 60 Hz ± 0.01%.

3.4.7 Output voltage harmonic distortion:

a. **2% THD maximum with 100% linear load**.

b. **Typically 4% THD maximum with 100% non-linear load. Load power factor range of 0.7 lagging to 1.0 within kW rating of UPS. Crest factor 3:1**

3.4.8 Output overload capability:

a. 105% to 150% for 1 minute. (voltage regulation maintained).

3.4.9 Output fault clearing: typically 1000% for 1 cycle (with bypass available).

3.5 Environment

The UPS shall be capable of withstanding any combination of the following external environment conditions without mechanical damage, electrical failure or degradation of operating characteristics.

3.5.1 Efficiency:

a. DC to AC (emergency mode, 100% load): 92 %
b. AC to AC (normal mode, 100% load): 89 %

3.5.2 Ambient operating temperature range: 0 to +40 degrees °C (no derating required).

3.5.3 Recommended operating temperature range: +20 to +30 degrees °C.

3.5.4 Storage temperature (non-operating): -20 to +70 degrees °C.

3.5.5 Relative humidity

a. Maximum operating range: 5% to 95% (non-condensing).
b. Recommended operating range: 30% to 90%.

3.5.6 Heat dissipation (at 100% load).

a. XX kBTU/hr
b. XX kW

3.5.7 Acoustical noise level:

55 dba @ 1 meter

3.5.8 The inverter shall have an output contactor to isolate the inverter from the load and bypass source.

3.6 Reliability

The UPS equipment reliability shall be represented in terms of theoretical Mean-Time-Between-Failures (MTBF). The UPS manufacturer shall, as a minimum, provide the following capability:

3.6.1 Total single module UPS system output (includes reliability of bypass circuit):

3,000,000 MTBF hours.

3.6.2 Single module UPS operation (represents UPS module operation only):

140,000 MTBF hours.

3.7 Maintainability

MTTR of the UPS shall not exceed 1 hour including time to replace components.

3.8 System Battery

The system battery (Included in the UPS) is sized to provide the specified back-up time to the inverter when the UPS is supplying 100% rated load. The external battery (If required) shall be of the VRLA, Flooded Lead Acid or Nickel Cadmium types.
NOTE: Additional battery back-up can be added (Optional).

3.8.1 VRLA Battery System Example (EXAMPLE using 20 kVA UPS)

a. The battery shall be capable of operating in an average ambient temperature of 25 °C, with excursions of 16 °C to 32 °C and shall be sized as follows:

1. float voltage: 407 VDC
(2.25 to 2.27 V/cell)

2. final voltage: 300 VDC
(1.67V/cell)

4 FUNCTIONAL DESCRIPTION

4.1 Converter

4.1.1 General

The Converter shall convert the incoming AC power into regulated DC power to supply the inverter input and system battery. The Converter shall utilize the following technologies:

a. Solid state **PWM controlled IGBT power transistors switching at 16kHz.** Switching shall be defined as IGBT turn on and turn off rate. Doubling of frequency at inverter output shall not be considered as the true switching frequency.
b. **Input Power: Rated kVA at 1:1 ratio.**
c. **DSP based control logic.**

4.1.2 Input Current Limit

The Converter logic shall provide input current limiting by limiting the AC input current. Three (3) line-side current transformers shall be employed as a means of sensing the current amplitude. The Converter shall be capable of supplying 1 line cycle of overload current equal to 125% of its full load rating. It shall also provide sufficient capacity to provide power to a fully loaded inverter while simultaneously recharging the system battery to 90% of full capacity within 10 times the discharge time. The DC output current limit values are as follows:

a. Converter input current (maximum) 110% of nominal

4.1.3 Battery Charge Current Limit

The Converter logic shall provide DC battery current limiting for controlled battery charging. The battery current sensing shall be independent of the Converter DC output current sensing to provide precise battery recharging.

4.1.4 Voltage Regulation

The Converter output voltage shall not deviate by more than ± 1% RMS due to the following conditions:

a. From 0 to 100% loading

b. Converter input variations of voltage and frequency within the limitations set in section 3.2.
c. Environmental condition variations within the limitations set in section 3.5.

4.1.5 Reflected Harmonic Content

The Converter shall not produce more than a maximum of 4% reflected current distortion into the Converter input utility source when nominal voltage and rated load is applied. Typically, the amount of reflected current distortion shall not exceed 7% THD at 50 % load.

4.1.6 Automatic Input Walk-in

The Converter logic shall employ circuitry to allow a delayed and timed ramping of input current. Subsequent to energizing the Converter input, the ramping of current shall be delayed by a maximum of 3 seconds. Upon starting the walk-in process, the ramping of current shall be timed to assume the load gradually within 20 seconds. This function shall be supplied as standard equipment.

4.1.7 Input Overload Protection

An input AC fuse/contactor arrangement shall provide Converter input overload isolation protection. The input AC fuse/contactor shall be standard.

4.1.8 Step load (0-100%) changes

100% step load changes shall use ONLY the converter to supply power to the inverter. The batteries SHALL NOT be cycled at any time during these step load changes.

4.1.9 DC Ripple Voltage

The DC buss rms ripple voltage shall be less than 1% of the UPS' *nominal* DC voltage level at *100% load and with no battery* connected. This shall provide for maximum battery life.

4.1.10 Battery Self Test (DiamondSense)

For a short duration of time, a small power discharge from the battery is automatically carried out. From this small power discharge, the Mitsubishi UPS evaluates the degradation of the battery. The following advantages are therefore achieved:

- The DiamondSense Battery Self-Test Function can be performed even when the load is on the inverter
- Due to the short duration small power discharge there is no effect to the battery life expectancy
- The small power discharge has negligible effect on the overall battery back up time. The small power that is discharged by the battery will quickly be replenished

4.2 Inverter

4.2.1 General

The Inverter shall generate AC power that is derived from DC power supplied from the Converter or the system battery. The Inverter shall be capable of providing rated output as stated in section 3.4 while operating from any DC voltage within the battery operating range. The Inverter shall utilize the following technologies:

a. Solid state **PWM controlled IGBT power transistors switching at 16 kHZ.** Switching shall be defined as IGBT turn on and turn off rate. Doubling of frequency at inverter output shall not be considered as the true switching frequency.
b. **DSP based control logic.**

4.2.2 Voltage Regulation

The Inverter output voltage shall not deviate by more than +/- 1% RMS due to the following steady state conditions:

a. 0 to 100% loading.
b. Inverter DC input varies from maximum to minimum.
c. Environmental condition variations within the limitations set in section 3.5.

4.2.3 Frequency Control

The Inverter output frequency shall be controlled by an oscillator internal to the UPS module logic. It shall be capable of synchronizing to an external reference (e.g.; the bypass source) or operating asynchronously. The oscillator shall maintain synchronization with the external reference within the limitations set in section 3.3.3. A front panel LED alerts the loss of synchronization. Synchronization shall be maintained at 60 Hz ± 0.01% continuously. The Inverter output frequency shall not vary during steady state or transient operation due to the following conditions:

a. 0 to 100% loading.
b. Inverter DC input varies from maximum to minimum.
c. Environmental condition variations within the limitations set in section 3.5.

4.2.4 Output Harmonic Distortion

The Inverter output shall limit the amount of harmonic content to the values stated in section 3.4.7. The use of excessive or additional filtering shall not be required to limit the harmonic content thus maintaining a high level of efficiency, reliability and original equipment footprint.

4.2.5 Output Overload Capability

The Inverter output shall be capable of providing an overload current while maintaining rated output voltage to the values stated in section 3.4.9. An indicating LED located on the control panel shall illuminate to identify this condition. If the time limit associated with the overload condition expires or the overload is in excess of the set current amplitude, the load power shall be transferred to the bypass source without interruption.

4.2.6 Inverter Current Limit

The Inverter output shall also be limited to 150% of rated load current. Two sensing locations shall operate separately and independently thus providing redundancy and, in the event of a failure, prevent unnecessary damage to power transistor components/fuses. Load current above 150% shall cause an immediate transfer of the load to the bypass source for fault clearing.

4.2.7 Inverter Overload Protection

The Inverter AC output shall utilize electronic current limiting for overload conditions. The Inverter shall utilize a contactor to isolate its output from the critical bus.

a. The Inverter DC fuses shall be the fast acting semiconductor type to clear faults on the DC buss..
b. The Inverter output isolation contactor shall be located internal to the UPS module and shall be controlled by the internal UPS module system logic.

4.3 Bypass and Static Switch

4.3.1 General

A bypass circuit shall be provided as an alternate source of power other than the inverter. A high speed SCR switch shall be used to assume the critical load during automatic transfers to the bypass circuit. The static switch shall derive power from an upstream bypass feed contactor internal to the UPS module. The static switch shall be 100% rated thus increasing reliability. The static switch shall be capable of supplying the UPS rated load current and also provide fault clearing current. The UPS system logic shall employ sensing which shall cause the static switch to energize immediately thus providing an uninterrupted transfer to the bypass source when any of the following limitations are exceeded:

a. Inverter output undervoltage or overvoltage.
b. Overloads beyond the capability of the inverter.
c. DC circuit undervoltage or overvoltage.
d. Final voltage of system battery is reached (bypass source present and available).
e. System failure (e.g.: logic fail, fuse blown, etc.).

4.3.2 Automatic Re-transfers

In the event that the critical load must be transferred to the bypass source due to an overload, the UPS system logic shall monitor the overload condition and, upon the overload being cleared, perform an automatic re-transfer back to the inverter output. The UPS system logic shall only allow a re-transfer to occur three times within a one minute period. Re-transfers shall be inhibited on the fourth transfer due to the likely hood of a recurring problem at the UPS load distribution. The re-transfer of load to the inverter shall also be inhibited due to the limitations set in section 3.3. All retransfers will be inhibited if the inverter and static bypass line are not synchronized.

4.3.3 Manual Transfers

The UPS shall be capable of transferring the critical load to/from the bypass source via the front control panel, current to the inverter. Manual transfers will be inhibited if the inverter and static bypass line are not synchronized.

4.3.4 Static Switch

The static switch shall be a high speed transfer device comprised of naturally commutated SCR's.

5 OPERATOR CONTROL PANEL

5.1 Operator Controls

The 2033C (DDC) series Operator controls and indicators are as follows:

On/Off Control Buttons
- a. UPS Start
- b. UPS Stop
- c. Silence
- d. Clear
- e. Emergency Power Off (EPO)

LED Indicators
- a. Bypass Operation
- b. Inverter Operation
- c. Battery Operation
- d. UPS Failure

5.2 Remote Operation

Certain UPS controls shall, as standard equipment, be capable of being operated from a remote location. The remote functions are provided for user convenience and shall be activated via, user supplied, external dry contact switches connected at the user interface panel. The following remote control functions shall be provided as a minimum:

a. Emergency Power Off.

5.3 Mimic Bus Display

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. The following display shall be included:

a. Battery operation.
b. Converter on/off.
c. Inverter on/off.
d. Load on inverter.
e. Load on bypass.

5.4 Microprocessor Interface/Diagnostics

5.4.1 Microprocessor Controls

The microprocessor shall monitor each step, thus prompting itself to the next step of the instructions. The following instructions shall be available as a minimum:

a. Inverter stop.
b. Inverter start.
c. UPS shutdown.
d. UPS startup.
e. Transfer of load to static bypass.

5.4.2 Microprocessor Controlled Metering

All meters shall be digitally displayed having an accuracy of 1% or better. The following parameters shall be available for display:

a. Converter input voltage (all phases)
b. Converter input current
c. Converter input frequency
d. Input Effective Power (Real, kW)
e. Battery voltage
f. Battery charging/discharging current
g. Output voltage (all phases)
h. Output current in RMS Amps (all phases)
i. Load Effective Power (Real, kW)
j. Output Frequency

5.4.3 Microprocessor Controlled Diagnostics

The UPS shall provide microprocessor controlled diagnostics capable of retaining fault alarms along with metering parameters in the event of a UPS failure. The microprocessor memory data shall be viewed via an LCD display located on the front of the UPS. The following alarm/status information shall be provided as a minimum:

a. Inverter Operation
b. Inverter Start/Stop
c. Battery Operation
d. Battery Low Voltage
e. Output Overload
f. Battery Depleted
g. Battery Temperature Abnormal
h. Converter Operation
i. Converter Supplying DC Power

j. Converter Input out of Range
k. Inverter Stop due to Overload Condition
l. Inverter Running Synchronously
m. Inverter Running Asynchronously
n. UPS on Static Bypass
o. Static Bypass Input out of Range
p. Minor Fault
q. Major Fault
r. Inverter Output Condition (Open or closed)
s. Battery Charge/Discharge Operation

6 CONTROL LOGIC POWER

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

7 UPS STATUS INTERFACING

7.1 Output Contacts

The internal UPS logic shall provide, as standard equipment, a set of six (6) normally open, A-type dry contact outputs to allow user interfacing of the UPS operating status. The following contacts/information is available:

- Load on Inverter
- Load on Bypass
- Battery Operation
- Battery Low Voltage
- Converter Operation
- Output Overload
- Summary Alarm

7.2 RS 232 Communication

The UPS shall have, as standard equipment, an RS 232 smart port allowing the user to interface the UPS status information to a host computer. "DiamondLink" monitoring software, or equivalent, shall be available to support the specified operating system. Field installed, and field tested RS 232 additions shall not be accepted.

7.3 Input Ports

The UPS shall have, as standard equipment the following inputs.

1. Emergency power Off (EPO)
2. Battery temperature High

8 OPTIONAL EQUIPMENT

8.1 Remote Status Alarm Panel (RSAP)

The UPS manufacturer shall offer a Remote Status Alarm Panel which shall not allow any control over the UPS. **The RSAP shall have, as standard equipment, a battery backup feature allowing it to continue monitoring UPS status conditions during power outage situations.** The RSAP shall act only as an annunciation panel providing the following alarms/indications as a minimum:

a) Load on Bypass
b) Load on Inverter
c) Battery Operation
d) Converter Operation
e) Output Overload
f) Summary Alarm

9 MECHANICAL DESIGN

9.1 Enclosure

The UPS shall be equipped with casters and leveling jack provisions to allow ease of movement and installation.

9.2 Ventilation

Forced air cooling shall be provided to allow all components to operate within their rated temperature window.

9.3 Printed Circuit Boards

All printed circuit boards shall be conformally coated to guard against corrosive vapors.

9.4 Busbar

All busbar used for conductivity within the UPS shall be designed with COPPER ONLY
Aluminum not acceptable

10 Factory Test Report

All UPS units shall come equipped (as standard) with one (1) factory test report included in the UPS. The factory test report shall include the following:

a. Series/kVA
b. Serial number
c. Date of test
d. Approved by/Inspected by/Tested by
e. Inspection of construction
f. Grounding of continuity
g. Insulation strength test
h. Control circuit operation
i. Measurement of steady state characteristics (Voltage/Current/Efficiencies)
j. Transient characteristics (0-100% step load test without batteries/voltage fluctuation)
k. Overload testing (150%, for one (1) minute)
l. Transfer switch operation
    (Manual transfer) Inverter to Bypass
    (Manual transfer) Bypass to inverter
    (Automatic transfer) (UPS failure)
    (Manual transfer) Inverter to maintenance bypass