APC Smart-Ups VT, w/Parallel Operation

GUIDE SPECIFICATIONS FOR
10kVA-30kVA
3x208/208-120 Solution
Uninterruptible Power System

PART 1 - GENERAL

1.1 SUMMARY

A. This specification describes the operation and functionality of a continuous duty, three-phase, solid-state, static Uninterruptible Power System (UPS) hereafter referred to as the UPS. The UPS shall contain a full rated input rectifier / boost converter (hereafter referred to as Input Converter), output inverter, and 10% battery charging circuit. The system shall also contain a continuous duty bypass static switch; internal mechanical bypass, removable hot swap battery plant, and LCD interface display. All of the above system components are housed in a single enclosure.

B. In addition, this specification describes the performance, functionality, and design of the UPS Maintenance Bypass Cabinet, hereafter referred to as the MBC, the extended run (XR) Battery System, connectivity solutions and paralleling operation.

C. The UPS and associated equipment shall operate in conjunction with a primary power supply and an output distribution system to provide quality uninterrupted power for mission critical, electronic equipment load.

D. All programming and miscellaneous components for a fully operational system as described in this specification shall be available as part of the UPS.

1.2 STANDARDS

A. UL 1778 Uninterruptible Power Supply Equipment

B. Where applicable, the UPS shall also be designed in accordance with publications from the following organizations and committees

1. NFPA- National Fire Protection Associations

2. NEMA - National Electrical Manufacturers Association

3. OSHA - Occupational Safety and Health Administration

C. IEEE 519-1992 Standard Practices and Requirements for Harmonic Control in Electrical Power Systems.

D. ISO 9001

E. ISO 14001

1.3 MODES OF OPERATION

A. Normal: The input converter and output inverter shall operate in an on-line manner to continuously regulate power to the critical load. The input and output converters shall be capable of full battery recharge while simultaneously providing regulated power to the load for all line and load conditions within the range of the UPS specifications.

B. Battery: Upon failure of the AC input source, the critical load shall continue being supplied by the output inverter, which shall derive its power from the battery system. There shall be no interruption in power to the critical load during both transfers to battery operation and retransfers from battery to normal operation.

C. Recharge: Upon restoration of the AC input source, the UPS shall simultaneously recharge the battery and provide regulated power to the critical load.

D. Static Bypass: The static bypass shall be used to provide transfer of critical load from the Inverter output to the bypass source. This transfer, along with its retransfer, shall take place with no power interruption to the critical load. In the event of an emergency, this transfer shall be an automatic function. The UPS shall be able to recharge the batteries while supplying full power to the load via the static bypass switch.

E. Internal Mechanical Bypass: As a standard feature, the UPS shall be equipped with an internal, make before break, bypass switch. This switch shall mechanically bypass the UPS for times where maintenance is required.

F. External Maintenance (Wrap-Around) Bypass: As an option for a single UPS unit, the system may be equipped with an external Maintenance Bypass Cabinet (MBC) to electrically isolate the UPS during routine maintenance and service of the UPS. The MBC shall completely isolate both the UPS input and output connections. The MBC shall be used for paralleling of multiple UPS units.

1.4 SUBMITTALS

A. Proposal Submittals:

1. As bid system bill of materials.

2. Product catalog sheets or equipment brochures.

3. Product guide specifications.

4. System single-line operation diagram.

5. Installation information, including weights and dimensions.

6. Information about terminal locations for power and control connections.

7. Drawings for requested optional accessories.

B. Delivery Submittals:

1. Installation manual, which includes instructions for storage, handling, examination, preparation, installation, and start-up of UPS.

2. User manual, which includes operating instructions.

PART 2 – PRODUCT

2.1 DESIGN REQUIREMENTS

A. The UPS shall be sized for _____ kVA and _____ kW load.

B. The UPS battery shall be sized for _____ at a Power Factor of_____ for _____ minutes.

2.2 SYSTEM CHARACTERISTICS

A. System Capacity: The system shall be rated in the following sizes:

1. 10 kVA / 8kW
2. 15kVA /12kW
3. 20kVA /16kW
4. 30kVA /24kW

B. Input:

1. AC Input Nominal Voltage: 3x 208V, 4 wire plus ground, 60 Hz.

2. AC Input Voltage Window: +15%, -20% of nominal (while providing nominal charging to the battery system).

3. Short Circuit Withstand Rating: 30,000 Symmetrical Amperes

4. Maximum Frequency Range: 40-70Hz

5. Input Power Factor:
   a. .98 for loads greater than 50%
   b. .95 for loads greater than 15%

6. Input Current Distortion *with no additional filters*:

   a. < 5% at 100% load

7. Soft-Start: Shall be linear from 0-100% input current and shall not exhibit inrush. This shall take place over a 15 second time period when transferring from battery operation to mains operation

C. UPS Output:

1. AC Output Nominal Output: 3x 208/120V, 4 wire, 60 Hz.

2. AC Output Voltage Regulation: $^{+}$/- 1% For 100 % Linear or Nonlinear Load

3. Voltage Transient Response: $^{+}$/- 5% maximum for 100% linear load step

4. Voltage Transient Recovery within <50 milliseconds

5. Output Voltage Harmonic Distortion:

   a. <2% THD maximum and 1% single harmonic for a 100% linear load
   b. <5% THD maximum for a 100% non-linear load

6. Phase Angle Displacement:

   a. 120 degrees $^{+}$/. 1 degree for balanced load
   b. 120 degrees $^{+}$/. 1 degree for 50% imbalanced load
   c. 120 degrees $^{+}$/. 3 degrees for 100% imbalanced load

7. Overload Rating:

   a. Normal Operation:

      1) 150% 1 minute
      2) 125% 10 minutes
      3) 100% continuous

   b. Bypass Operation:

      1) 110% continuous
      2) 800% for 500 milliseconds

8. System AC-AC Efficiency: >94% for loads higher than 50% of rated system capacity

10. Output Power Factor Rating: .8 at full load.

11. Slew Rate: 1Hz/sec

2.3 ENVIRONMENTAL

A. Storage Ambient Temperature: -58°F to 122°F (-50°C to 50°C).

B. Operating Ambient Temperature: +32°F to 104°F (0°C to 40°C). (77°F is ideal for most battery types).

C. Relative Humidity: 0 to 95% Non-condensing

D. Altitude: Maximum installation with no derating of the UPS output shall be 3280 feet (1000m) above sea level.

E. Audible Noise: The UPS shall not produce audible noise at a distance of 1m (39") in excess of the following:

1. 10-15kVA 54dBA

2. 20-30kVA 58dBA

2.4 INPUT POWER CONVERTER

A. The input power converters of the system shall constantly control the power imported from the mains input of the system, to provide the necessary UPS power for precise regulation of the DC bus voltage, battery charging, and Main Inverter regulated output power.

B. Input Current Total Harmonic Distortion: The input current THD_I shall be held to 5% or less at full system load, while providing conditioned power to the critical load bus, and charging the batteries under steady-state operating conditions. This shall be true while supporting loads of both a linear or non-linear type. This shall be accomplished with no additional filters, magnetic devices, or other components.

C. Soft-Start Operation: As a standard feature, the UPS shall contain soft-start functionality, capable of limiting the input current from 0-100% of the nominal input over a default 15 second period, when returning to the AC utility source from battery operation. The change in current over the change in time shall take place in a linear manner throughout the entire operation. (di/dt= constant)

D. Magnetization Inrush Current: The UPS shall exhibit 0 inrush current as a standard product. If provided with an optional isolation transformer, inrush shall be limited to 6 times the nominal input current of the transformer.

E. Input Current Limit:

1. The system input current limit, shall be designed to provide 100% load while fully charging the batteries at 10% of the system rating. The system shall be capable of this with up to a $^{+}$15%, - 20% variation of the nominal input voltage.

F. Charging:

1. The battery charging shall keep the DC bus float voltage of +/- 220V, +/-1%

2. The battery charging circuit shall contain a temperature compensation circuit, which will regulate the battery charging to optimize battery life.

3. The battery charging circuit shall remain active when in Static Bypass and in Normal Operation.

4. Battery Charge Current Limit: The UPS shall be capable of limiting the energy sourced from the mains for purposes of battery charging. As a default setting, the battery charge energy will be set to 100% of its nominal value. When signaled by a dry contact, (such as from an emergency generator) the UPS shall be capable of limiting the battery charge energy taken from the mains. This shall take place in user selectable increments of 75%, 50%, 25%, 10% and 0% of the nominal charge power. The selection shall be made from the UPS front panel display/control unit.

G. Back-feed Protection: The logic controlled input contactor shall provide the back-feed protection required by UL1778.

2.6 OUTPUT INVERTER

A. The UPS output inverter shall constantly recreate the UPS output voltage waveform by converting the DC bus voltage to AC voltage through a set of IGBT driven power converters. In both normal operation and battery operation, the output inverters shall create an output voltage independent of the mains input voltage. Input voltage anomalies such as brown-outs, spikes, surges, sags, and outages shall not affect the amplitude or sinusoidal nature of the recreated output voltage sine wave of the output inverters.

B. Overload Capability: Steady-state overload conditions, of up to 150% of system capacity, shall be sustained by the inverter for 30 seconds in normal and battery operation. Overloads of 125% shall be sustainable by the inverter for up to 60 seconds. Should overloads persist past the outlined time limitation; the critical load will be switched to the automatic static bypass output of the UPS.

C. Output Contactor: The output inverter shall be provided with an output mechanical contactor to provide physical isolation of the inverter from the critical bus. With this feature a failed inverter shall be removed from the critical bus.

D. Battery Protection: The inverter shall be provided with monitoring and control circuits to limit the level of discharge on the battery system.

2.7 STATIC BYPASS

A. As part of the UPS, a system static bypass switch shall be provided. The system static bypass shall provide no break transfer of the critical load from the Inverter output to the static bypass input source during times where maintenance is required, or the inverter can not support the critical bus. Such times may be due to prolonged or severe overloads, or UPS failure.

B. The design of the static switch power path shall consist of Silicon Controlled Rectifiers (SCR) with a continuous duty rating of 110% of the UPS output rating.

C. Automatic Transfers: An automatic transfer of load to static bypass shall take place whenever the load on the critical bus exceeds the overload rating of the UPS. Automatic transfers of the critical load from static bypass back to normal operation shall take place when the overload condition is removed from the critical bus output of the system. Automatic transfers of load to static bypass shall also take place if for any reason the UPS cannot support the critical bus.

D. Manual Transfers: Manually initiated transfers to and from static bypass shall be initiated through the UPS display interface.

E. Overloads: The static bypass shall be rated and capable of handling overloads equal to or less than 110% of the rated system output continuously. For instantaneous overloads caused by inrush current from magnetic devices, or short circuit conditions, the static bypass shall be capable of sustaining overloads of 800% of system capacity for periods of up to 500 milliseconds.

F. System Protection:

As a requirement of UL1778, back-feed protection in the static bypass circuit shall also be incorporated in the system design. To achieve back-feed protection, a mechanical contactor in series with the bypass SCR(s) shall be controlled by the UPS/static switch, to open immediately upon sensing a condition where back-feeding of the static switch by any source connected to the critical output bus of the system is occurring. One such condition could be a result of a shorted SCR.

G. Dual Feed

For purposes of increased reliability, the static bypass shall be capable of being fed from a separate feed from the input power converter.

2.8 INTERNAL MECHANICAL BYPASS

The UPS shall be equipped with an internal make-before-break bypass switch to isolate the UPS during times where maintenance is required.

2.9 DISPLAY AND CONTROLS

A. Display Unit: A microprocessor controlled display unit shall be located on the front of the system. The display shall consist of an alphanumeric display with backlight, an alarm LED, and a keypad consisting of pushbutton switches.

B. Metered Data: The following metered data, shall be available on the alphanumeric display:

1. Year, Month, Day, Hour, Minute, Second of occurring events

2. Source Input Voltage

3. Output AC voltage

4. Output AC current

5. Input Frequency

6. Battery voltage

7. Highest Internal Battery temperature

D. Event log: The display unit shall allow the user to display a time and date stamped log for the 64 most recent status and alarm events.

E. Alarms: The display unit shall allow the user to display a log of all active alarms. The following minimum set of alarm conditions shall be available:

1. Static bypass switch on

2. EPO Active

3. Mechanical bypass activated

4. External bypass switch (Q3) activated

5. Battery discharged

6. Return from low battery

7. Low battery

8. Load not powered from UPS

9. UPS in bypass

10. Runtime calibration aborted

11. Runtime calibration started

12. Runtime calibration complete

13. Battery self test aborted

14. Battery self test started

15. Battery self test completed

16. Number of battery modules decreased

17. Number of battery modules increased

18. Fan fault
19. SBS fault
20. System not in sync.
21. Bypass not available, frequency/voltage out of range
22. Mains voltage/frequency out of range
23. Site wiring fault
24. Low battery voltage shut down
25. XR battery breaker or fuse open
26. Defective battery detected
27. Runtime is below alarm threshold
28. Load is above alarm threshold
29. Battery over-voltage warning
30. Battery over-temperature warning
31. Emergency power supply fault
32. Output overloaded

F. Controls: The following controls or programming functions shall be accomplished by use of the display unit. Pushbutton membrane switches shall facilitate these operations.

1. Silence audible Alarm
2. Set the alphanumeric display language
3. Display or set the date and time
4. Enable or disable the automatic restart feature
5. Transfer critical load to and from static bypass
6. Test battery condition on demand
7. Set intervals for automatic battery tests
8. Adjust set points for different alarms
9. Program the parameters for remote shutdown.

G. Front Panel Interface: The following shall make up the UPS front panel user interface.

1. Indicating LED's

a.	Load On	When Green, this LED indicates the load is being supported by the UPS output
b.	On Battery	When Yellow, this LED indicates the UPS is running from Battery power
c.	Bypass	When Yellow, this LED indicates the load is being supported by static bypass/mechanical bypass
d.	Fault	When Red, this LED indicates there is a fault condition present in the UPS.

2. Push Button User Controls

a. Up Arrow
b. Down Arrow
c. Help Key
d. Escape Key
e. Enter Key

H. Potential Free (Dry) Contacts

1. The following potential free contacts shall be available on an optional relay interface board (AP9610 or equivalent). (Note: This may require the use of an external chassis if used in conjunction with web based management or other "smart slot" type devices):

a. Normal Operation
b. Battery Operation
c. Bypass Operation
d. Common Fault
e. Low Battery
f. UPS Off

I. Communication Interface: For purposes of remote communications with the UPS the following shall be available and contained within the UPS on a removable, "hot swappable" "smart slot" interface card:

1. RJ-45 Interface port for remote communications with a network via web browser or SNMP, or APC InfraStruXure Manager.

2. Environmental monitoring feature, capable of locally monitoring temperature and humidity as well as one additional generic set of user determined dry contacts capable of taking an input signal from any APC or third party on/off signal, such as water detection, smoke detection, motion, or fire detection.

2.10 BATTERY

A. The UPS battery shall be of modular construction made up of user replaceable, hot swappable, fused, battery modules. Each battery module shall be monitored to determine the highest battery unit temperature for use by the UPS battery diagnostic, and temperature compensated charger circuitry.

B. The battery jars housed within each removable battery module shall be of the Valve Regulated Lead Acid (VRLA) type.

PART 3 – ACCESSORIES

3.1 EXTENDED RUNTIME (XR) OPTION

A. For purposes of extending the UPS battery runtime, external extended runtime options shall be available. The extended runtime option shall be housed in "line up and match" type enclosures and shall contain necessary hardware and cables to connect to the UPS, or between XR enclosures. Each XR enclosure shall be equipped with removable, hot swappable, battery units housed in draw-out cartridges.

B. The extended runtime system shall have a 250 VDC rated, thermal magnetic trip molded case circuit breaker. Each circuit breaker shall be equipped with shunt trip mechanisms and 1A/1B auxiliary contacts. The circuit breakers are to be equipped as part of a line-up-and-match type battery enclosure.

3.2 MAINTENANCE BYPASS CABINET (MBC)

A. The maintenance bypass cabinet shall provide power to the critical load bus from the bypass source, during times where maintenance or service of the UPS is required. The MBC shall provide a mechanical means of complete isolation of the UPS from the electrical wiring of the installation. The MBC shall be constructed in a free-standing or wall-mounted NEMA 1 enclosure unless otherwise stated in this specification.

B. As a minimum, the MBC shall contain the following features and accessories:

1. Switches of the appropriate size and withstand rating (max. 30 kAIC rating), for the system.

2. Minimum 1A/1B auxiliary contacts for the purpose of relaying status information of the maintenance bypass circuit switch to the UPS.

4. Plated copper bus bar (where applicable), braced for the appropriate withstand rating (max. 30 kAIC rating) of the system.

C. The Maintenance Bypass shall be available in a minimum of two distinct types

1. Wall mount, three or four breaker/switch, NEMA 1 enclosure

2. "Line Up and Match" style enclosure. This option shall come equipped with a 42 pole distribution panel and shall have pre-formed knock-outs for purposes of top or bottom fed distribution.

D. The MBC shall carry a UL 1778 agency listing.

3.3 PARALLEL OPERATION

A. For purposes of load sharing, the UPS shall contain as a standard feature, the ability to parallel up to 4 modules for either increased capacity, redundancy, or both. In this mode of operation the output voltage, output frequency, output phase angle, and output impedance of each module shall operate in uniformity to ensure correct load sharing. This control function shall not require any additional footprint and shall be an integral function of each UPS.

B. Network: Communication between modules shall be connected in a multi-drop bus network comprising of two parallel redundant buses so that the removal of any single cable shall not jeopardize the integrity of the parallel communication bus.

C. Synchronization Bus: One UPS module operates as the master. The master unit transmits a signal directly derived from its own phase lock loop (PLL) circuit as the sync clock reference to the slave units to ensure effective synchronization of modules. In the event that the master unit fails, the first slave unit to receive logic power assumes the role as master

D. Load Sharing: A load sharing circuit shall be incorporated into the parallel control communications to ensure that under no load conditions, no circulating current exists between modules. This feature also allows each UPS to share equal amounts of the total critical load bus. A UPS module's influence over load sharing shall be inhibited in any mode where the UPS inverter is not supporting its output bus. Load sharing communications shall be galvanically isolated for purposes fault tolerance between UPS modules.

3.4 PARALLEL SYSTEM MAINTENANCE BYPASS CABINET (PSMBC)

A. The parallel system maintenance bypass cabinet shall provide power to the critical load bus from the bypass source, during times where maintenance or service of the UPS modules is required. The PSMBC shall provide a mechanical means of complete isolation of the UPS module from the electrical wiring of the installation. The PSMBC shall be constructed in a free-standing or wall-mounted NEMA 1 enclosure unless otherwise stated in this specification.

B. As a minimum, the PSMBC shall contain the following features and accessories:

1. Switches of the appropriate size and withstand rating (max. 30 kAIC rating), for the system and each UPS module.

2. Minimum 1A/1B auxiliary contacts for the purpose of relaying status information of all PSMBC switches to the UPS.

3. Sufficient APC CAN bus PCB's to provide adequate communications of the PSMBC status to the UPS system parallel control system.

4. Plated copper bus bar (where applicable), braced for the appropriate withstand rating (max. 30 kAIC rating) of the system.

C. The Parallel System Maintenance Bypass shall be available in a minimum of two distinct types.

1. Wall mount, breaker/switch, NEMA 1 enclosure.

D. The PSMBC shall carry a UL 1778 agency listing, or other agency listing as appropriate to the design.

3.5 SOFTWARE AND CONNECTIVITY

A. Network Adaptor: The Ethernet Web/SNMP Adaptor shall allow one or more network management systems (NMS) to monitor and manage the UPS in TCP/IP network environments. The management information base (MIB) shall be provided in DOS and UNIX "tar" formats. The SNMP interface adaptor shall be connected to the UPS via the RS232 serial port on the standard communication interface board.

B. Unattended Shutdown

1. The UPS, in conjunction with a network interface card, shall be capable of gracefully shutting down one or more operating systems during when the UPS is on reserve mode.

2. The UPS shall also be capable of using an RS232 port to communicate by means of serial communications to gracefully shut down one or more operating systems during an on battery situation.

3.6 REMOTE UPS MONITORING

A. The following three methods of remote UPS monitoring shall be available:

1. Web Monitoring: Remote monitoring shall be available via a web browser such as Internet Explorer.

2. RS232 Monitoring: Remote UPS monitoring shall be possible via either RS232 or contact closure signals from the UPS.

3. Simple Network Management Protocol (SNMP): Remote UPS Monitoring shall be possible through a standard MIB II compliant platform.

3.7 SOFTWARE COMPATIBILITY

A: The UPS manufacturer shall have available software to support graceful shutdown and or remote monitoring for the following systems:

a. Microsoft Windows 95/98/XP

b. Microsoft Windows NT 4.0 SP6/2000
c. OS/2
d. Netware 3.2 – 5.1
e. MAC OS 9.04, 9.22, 10
g. Digital Unix/True 64
h. SGI 6.0-6.5
j. SCO UNIX
k. SVR4 2.3, 2.41
m. SCO Unix Ware 7.0 - 7.11
n. SUN Solaris 2.6-2.8
o. SUN OS 4.13, 4.14
p. IBM AIX 4.3x-4.33g, 5.1
q. HP-UX 9.x-11.i

Part 4 - EXECUTION

4.1 FACTORY ASSISTED START-UP

If a factory assisted UPS start-up is requested, factory trained service personnel shall perform the following inspections, test procedures, and on-site training:

A. Visual Inspection:

1. Inspect equipment for signs of damage.

2. Verify installation per manufacturer's instructions.

3. Inspect cabinets for foreign objects.

4. Inspect Battery Units.

5. Inspect Power Module(s).

B. Mechanical Inspection:

1. Check all UPS and external maintenance bypass cabinet internal power wiring connections.

2. Check all UPS and external maintenance bypass cabinet terminal screws, nuts, and/or spade lugs for tightness.

C. Electrical Inspection:

1. Verify correct input and bypass voltage.

2. Verify correct phase rotation of all mains connections.

3. Verify correct UPS control wiring and terminations.

4. Verify voltage of all battery modules.

5. Verify neutral and ground conductors are properly landed.

6. Inspect external maintenance bypass switch for proper terminations and phasing.

D. Site Testing:

1. Ensure proper system start-up.

2. Verify proper firmware control functions.

3. Verify proper firmware bypass operation.

4. Verify proper maintenance bypass switch operation.

5. Verify system set points.

6. Verify proper inverter operation and regulation circuits.

7. Simulate utility power failure.

8. Verify proper charger operation.

9. Document, sign, and date all test results.

E. On-Site Operational Training: During the factory assisted start-up, operational training for site personnel shall include key pad operation, LED indicators, start-up and shutdown procedures, maintenance bypass and AC disconnect operation, and alarm information.

4.2 MANUFACTURER FIELD SERVICE

A. Worldwide service: The UPS manufacturer shall have a worldwide service organization Available, consisting of factory trained field service personnel to perform start-up, preventative maintenance, and service of the UPS system and power equipment. The service organization shall offer 24 hours a day, 7 days a week, 365 days a year service support.

B. Replacement parts: Parts shall be available through the worldwide service organization 24 hours a day, 7 days a week, and 365 days a year. The worldwide service organization shall be capable of shipping parts within 4 working hours or on the next available flight, so that the parts may be delivered to the customer site within 24 hours.

4.3 MAINTENANCE CONTRACTS

A complete offering of preventative and full service maintenance contracts for the UPS system and the battery system shall be available. All contract work shall be performed by APC factory trained service personnel.

4.4 TRAINING

UPS service training workshop: A UPS service training workshop shall be available from the UPS manufacturer. The service training workshop shall include a combination of lecture and practical instruction with hands-on laboratory sessions. The service training workshop shall include instruction about safety procedures, UPS operational theory, sub-assembly identification and operation, system controls and adjustment, preventative maintenance, and troubleshooting.