PROCESSPOWER®

1-Phase and 3-Phase Product Specification

AMETEK Solidstate Controls

Revision 5

Date Created: October 25, 1999

Date Revised: October 30, 2003

AMETEK®
SOLIDSTATE CONTROLS

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1.0 System Summary

This specification describes both single-phase and three-phase continuous duty on-line, Uninterruptible Power Supplies or UPS Systems between 3KVA and 125KVA. The UPS shall operate in conjunction with the existing building/plant electrical systems to provide high quality power to the critical load. AC power is converted to DC power by a rectifier/charger section, which provides power to operate the Inverter and keep the batteries fully charged. The Inverter then converts the DC power back to clean, conditioned AC power.

1.1 UPS System Modes of Operation

The UPS system shall operate as an on-line, fully automatic system in the following modes:

1.1.1 Normal Mode

The critical load is continuously supplied by the Inverter, with isolated clean AC power. The rectifier/charger derives its power from the commercial AC source and supplies DC power to the Inverter while simultaneously float charging the battery.

1.1.2 Reserve Mode

Upon failure of the commercial AC power, the critical load is supplied by the Inverter without any interruption; the Inverter obtains its power from the external storage battery. There shall be no interruption of power to the critical load upon failure or restoration of the commercial source.

Upon DC disconnect the Inverter shall turn off and the Static Switch will transfer to Bypass regardless of the Bypass status.

1.1.3 Recharge Mode

Upon restoration of the commercial AC power the rectifier/charger shall recharge the batteries and simultaneously supply DC power the Inverter. This will be an automatic function and shall cause no interruption to the critical load.

1.1.4 Static Switch Transfer

During an Inverter malfunction or load fault at the Inverter output, the Static Switch shall automatically transfer the load to commercial power with less than ¼ cycle break.

On clearing an Inverter malfunction, or fault condition, the static transfer switch shall automatically transfer the load from the bypass back to the Inverter output. The re-transfer shall be without interruption (zero-break).

Transfer to the bypass may also be accomplished manually by the Bypass to Load push button without interruption.

1.2 Major Components

- AC Rectifier/Charger
- Static Inverter
- Static Transfer Switch
- 4-Position Manual Bypass Switch

1.3 UPS System KVA Ratings, DC Bus Voltages, Input Voltage and Output Voltage

1.3.1 Single Phase Systems

KVA Rating	DC Bus Voltage (Nominal)	Input Voltage	Output Voltage
3	120	208,380,480	120,220
5	120	208,380,480	120,220
10	120	208,380,480	120,220
15	120	208,380,480	120,220
20	120	208,380,480	120,220
30	120,240	208,380,480	120,220
40	120,240	208,380,480	120,220
50	240	208,380,480	120,220
60	240	208,380,480	120,220
80	240	208,380,480	120,220
100	360	208,380,480	120,220
125	360	208,380,480	120,220

1.3.2 Three Phase Systems

KVA Rating	DC Bus Voltage (Nominal)	Input Voltage	Output Voltage
10	120	208,380,480	120/208,277/480,220/380
15	120	208,380,480	120/208,277/480,220/380
20	120	208,380,480	120/208,277/480,220/380
30	120,240	208,380,480	120/208,277/480,220/380
40	120,240	208,380,480	120/208,277/480,220/380
50	240	208,380,480	120/208,277/480,220/380
60	240	208,380,480	120/208,277/480,220/380
80	240	208,380,480	120/208,277/480,220/380
100	360	208,380,480	120/208,277/480,220/380
125	360	208,380,480	120/208,277/480,220/380

Note: Additional kVA and DC bus voltage ratings are available on a custom design basis.

1.4 Protective Devices

The UPS shall be equipped with the following protective devices, at a minimum:

- AC input circuit breaker
- Battery input breaker
- Current limit circuitry
- Over-voltage protection via RC networks

2.0 UPS Reliability and Maintainability

Power Supplies – Power to control power supplies shall originate from any of the following sources the rectifier/charger input, bypass input and UPS system output. Loss of any of the three power sources shall be displayed on the appropriate menu of the front panel display and be communicated to the operator through the closure of the systems common trouble (summary) alarm, form “C” contact.

EMI Suppression - Electromagnetic effects shall be minimized to ensure that computer systems, or other similar electronic systems are not adversely affected by the system.

Transformers - All power transformers or chokes shall be designed using copper windings for reliability and efficiency. The insulation type shall have a temperature rating of at least 200 C (UL 1446, Class N). An epoxy based insulating varnish shall be applied with a V P I (Vacuum Pressure Impregnation) system to insure a low temperature rise over the 10-15 year design life of the transformer.

3.0 Applicable Standards

Unless noted otherwise, the design, fabrication, testing, and performance of the system shall be in accordance with the standards and codes, where applicable, of the following agencies:

National Electrical Manufacturers Association (NEMA)
American National Standards Institute (ANSI)
National Electric Code (ANSI/NFPA 70-1993)
Institute of Electrical and Electronic Engineers (IEEE)
International Electrotechnical Commission (IEC)

4.0 RECTIFIER/CHARGER

Incoming AC power shall be converted to regulated DC output by the rectifier/charger. The rectifier/charger shall be a constant potential, phase-controlled, 6-pulse, solid-state type with constant voltage and current control circuitry. The components within the rectifier shall be capable of operating independently from the remaining system.

4.1 Capacity

The rectifier/charger shall have sufficient capacity to support the total connected load and to recharge a dedicated battery at equalize conditions to 90% of its full capacity within eight-ten times the discharge rate.

4.2 Input Power Factor/THD

The input power factor shall be a minimum power factor of 0.75 at nominal input voltage, frequency, and at full-rated load. The input current distortion will be 25-35% THD.

4.3 Rectifier/Charger Output Voltage and Efficiency

DC bus Voltage	Number of Cells	Nominal Float Voltage	Nominal Equalize Voltage	AC to DC Efficiency
120	60	135	140	92%
240	120	270	280	92%
360	180	405	419	92%

Note: The float and equalize voltages shown above are for Lead Calcium batteries. Float and equalize voltage values may vary depending upon the battery type and battery manufacture.

Float and Equalize voltages are adjustable +/-5%.

4.4 Voltage Regulation

The charger output steady state voltage shall not change more than +/-0.5% at the Battery output terminals from no-load to full-load, with input voltage variation of +/-10% and input frequency variation of +/-5%. The charger shall be capable supplying the Inverter load with an input deviation of –15% without discharging batteries.

4.5 Output Ripple

The output ripple shall be less than 2% RMS when connected to a battery bank having an eight hour, ampere hour rating of at least four (4) times the full load ampere rating of the battery charger.

4.6 Current Limit

The charger shall be capable of supplying 100% rated full load current at float voltage and -10% input. This shall not cause damage to the charger/rectifier, tripping of circuit breakers, or blown fuses.

4.7 Float Adjustment

Float level adjustment shall be made via potentiometer located on the Charger control board inside the UPS enclosure

4.8 Equalize Adjustment

Equalize level adjustment shall be made via potentiometer located on the Charger control board inside the UPS enclosure.

4.9 Float/Equalize Modes of Operation

Under normal operating conditions the rectifier/charger shall operate in float mode. Equalize mode operation shall only occur under the following conditions:

1. Return of AC Power – After a power outage (i.e. loss of incoming AC power to the rectifier/charger), the UPS system will automatically go into equalize mode operation. The Charger will monitor the battery current to when it is approximately 5% below the current available to the batteries, at that point it will automatically return to float mode operation.

2. Manual Initiation – By pushing the “Float/Equalize” push button on the alphanumeric keypad the rectifier/charger will change states, i.e. if the rectifier/charger is in float mode operation then it will transfer to equalize mode operation.

   An 0-100 Hour electronic timer shall be used to keep the charger into a high voltage equalize mode for a specific amount of time and then automatically return it to its normal float mode when the time has elapsed. Note, if the batteries current has not returned to approximately 5% below the current available to the batteries, then the charger will remain in equalize mode until the this parameter is met.

4.10 Input Isolation Transformer

A dry type isolation transformer shall be supplied on the input to the rectifier with surge/transient protection on the secondary side.

5.0 STATIC INVERTER

5.1 General

The static Inverter shall be a pulse-width-modulated (PWM) type, which generates single-phase AC power. The Inverter provides continuous and uninterruptible AC power while operating from any DC source within the operating input range.

The Inverter will be controlled with a sine-triangle PWM modulation and use Insulated Gate Bipolar Transistors, (IGBT's), to synthesize a clean sinusoidal output. The output is isolated from the DC via a transformer.

5.2 DC to AC Efficiency

The DC to AC efficiency of the inverter shall be as follows:

120 Volts DC Nominal	87%
240 Volts DC Nominal	89%
360 Volts DC Nominal	90%

5.3 Input Voltage

At a minimum the DC input voltage should range from:

Nominal DC Bus Voltage	Valid Range DC Bus Voltage	Battery Cells
120	105 – 140	60
240	210 – 280	120
360	315 – 419	180

5.4 Voltage Regulation

The Inverter steady state output voltage regulation shall not change more than +/-1% under any of the following conditions:

1. 0 to 100% and 100% to 0 load change.
2. Minimum to maximum DC bus voltage
3. Minimum to maximum ambient temperature

5.5 Frequency Regulation

The free-running, steady state output frequency of the Inverter shall not deviate more than +/-0.1% due to the following conditions;

1. 0% to 100% load
2. Minimum to maximum ambient temperature
3. Minimum to maximum DC bus voltage

5.6 Frequency Control

The output frequency of the Inverter shall be controlled by a crystal controlled oscillator, which can be operated as a free-running unit or synchronized with an AC source. The Inverter shall track the AC reference source+/-0.5Hz. Upon failure or frequency deviation greater than +/-0.5Hz from the reference the oscillator shall automatically revert to its free-running mode.

In the free running mode the oscillator will be within 0.1% of the specified frequency.

5.7 Load Power Factor

The Inverter shall be capable of handling linear loads of 0.8 pf and non-linear loads (switch-mode power supplies) with a power factor range of 0.8 to 1.0 while maintaining a +/-1% voltage regulation. The UPS is sized for 0.8 pf loads. For example, a 10 kVA unit will supply 8 kW at unity power factor and 10 kVA at 0.8 pf. The unit's nameplate rating reflects the total power delivered at the worst cast power factor.

5.8 Harmonic Distortion

The Inverter shall limit the total harmonic distortion of the output voltage to less than 3% RMS total with a 100% linear load or less than 5% THD with a 100% switch-mode type load. No single harmonic shall exceed 3% THD.

5.9 Crest Factor

The Inverter shall be capable of supplying non-linear loads exhibiting a crest factor of up to 3.0 at full load without additional filtering or increasing the size of the system.

5.10 Slew Rate

The Inverter frequency rate of change shall not exceed 1 Hz/second when synchronizing to the bypass reference.

5.11 AC Transient Response

The Inverter voltage transient response shall not exceed +5% to -5% due to a 100% step load change. The output voltage, following the step load changes listed above, shall begin to recover immediately. Return to within +/-1% of the steady state output voltage shall occur within 3 cycles.

5.12 Overload Capability

The Inverter shall be capable of supplying loads up to 105% continuously, 125% for 10 minutes and 150% for 10 seconds.

5.13 Output Voltage Adjustment

The Inverter output voltage can be adjusted up to ±5% of its rated output voltage.

5.14 Over Temperature

During an over temperature on the static switch or inverter heat sinks the UPS shall automatically transfer the load to the bypass source. A Manual re-transfer of the load to the inverter shall be permitted when the temperature returns to normal.

5.15 DC Input Transient

The DC input shall include an input filter to suppress externally generated DC transients and to control Inverter switching transients at the battery. Filtering shall be designed to suppress a transient of 4000 volts, with a 10 micro second duration, occurring at the Battery input terminals.

5.16 Inverter Protection

When the Inverter Gate Drive senses a de-saturation on an IGBT, it will automatically turn off its gate drive and all other gate drives. A de-saturation condition occurs when a high over-current (overload) condition develops or there is a power supply failure to the inverter gate drives. The Static Switch will sense this condition and automatically transfer the load to Bypass.

5.17 High/Low DC Voltage

When the DC voltage rises above or drops below a predetermined set point the Inverter drive will shut off protecting the Inverter. The Static Switch will sense this condition and automatically transfer the load to Bypass.

6.0 STATIC TRANSFER SWITCH

6.1 General

The Static Switch shall be a high-speed transfer device provided as an integral part of the UPS. The control of the unit shall provide an automatic or manual uninterrupted transfer of the load to the bypass. The Bypass line SCR's shall be naturally commutated and the Inverter devices shall be forced commutated to minimize the harmonics induced due the turn on time of the SCR.

The Static Switch shall use inverse parallel connected 600 volt minimum silicon controlled rectifiers with an ampacity suitable to carry ten times the Inverter's capacity for one cycle on the Bypass line.

6.2 Operation

The Static Switch shall automatically connect the bypass source to the critical load and have the following features.

Uninterrupted Transfer - The Static Switch shall automatically transfer the critical load after the control logic senses one of the following conditions:

Zero-Break Transfer Conditions

1. Distorted Output Wave Form (12%)
2. Inverter Output Over/Under Voltage (±5%)
3. Inverter or Charger heatsink over temperature
4. Manual Transfer via internal push button
5. Manual Bypass Switch transferin from position 1 to position 2

¼ Cycle Break Transfer Conditions

1. Out-of-Sync Condition
2. Inverter Failure

Inhibited Re-Transfer to Inverter - The Static Switch will not allow a transfer from Bypass to the Inverter when one of the following conditions exist:

1. Inverter's Output Wave Form is Distorted (+/-12%)
2. Inverter Output Over/Under Voltage (±5%)
3. Inverter or Charger heat sink over temperature
4. Manual Bypass Switch in position 2, 3 or 4
5. Three transfers to Bypass with Auto retransfer ON

Uninterrupted Automatic Retransfer - If the transfer control switch is set for automatic retransfer, the control circuit shall be capable of re-transferring the critical load to the Inverter output when the Inverter output is within specification.

Uninterrupted Manual Retransfer - If the transfer control switch is set for manual retransfer, upon manual command the critical load shall be transferred to the Inverter.

Transfer Lockout - The transfer logic shall not allow a transfer to the bypass source if one of the following conditions exist (except upon an Inverter failure)

1. Bypass source out of sync with Inverter output.
2. Bypass source not within +/- 10%.
3. Bypass source frequency greater than +/- 0.5Hz from nominal

6.3 Transfer Time

The time required for normal static switch transfers, see "Uninterrupted Transfers" shall be zero, resulting in an uninterrupted flow of power to the system loads.

6.4 Overload Rating

The Static Switch shall carry the following overload rating in the Bypass position:

- 150% for 10 minutes
- 200% for 1 minute
- 400% for 1 second
- 1000% for 50 milliseconds

6.5 Logic Design

The Static Switch shall be designed to transfer over to the bypass source during a control failure.

6.6 Sync Range

The Static Switch will enable the Inverter Phase Locked Loop as long as the Bypass frequency is within +/- 0.5Hz of nominal. The range to indicate synchronism will be +/-5 degrees.

7.0 MANUAL BYPASS SWITCH

7.1 Operation

The UPS shall include a manually operated four (4) position mechanical make-before-break transfer switch to facilitate rectifier/charger, Inverter and Static Switch maintenance and/or repair. The manual bypass switch shall be a mechanical drum type and shall be mounted in the UPS enclosure

The bypass switch positions:

1. Normal – Load Connected to Inverter
2. Static Switch on Bypass – Load on bypass via the Static Switch
3. Load on Bypass – Bypass switch and Static Switch in parallel, load connected to bypass via the Static Switch
4. Isolated Bypass – Load connected directly to bypass; isolated from the Inverter output

7.2 Ratings

The manual bypass switch shall carry the following overload rating:

- 150% for 10 minutes
- 200% for 1 minute
- 400% for 1 second
- 1000% for 50 milliseconds (3 cycles)

8.0 ACCESSORIES

8.1 Controls

The following controls will be accessible from the front of the UPS;

Auto-retransfer

An internal switch shall be provided to defeat the automatic retransfer of the Static Switch after a transfer to the Bypass source. Shipment setting for the unit shall be OFF (i.e. auto-retransfer not activated).

Inverter On/Off Switch

The UPS Inverter shall be equipped with a switch to turn ON and OFF the Inverter.

Inverter to Bypass Push Button

Transfers the load from the Inverter output to the bypass source

Inverter Reset

A push button integral to the keypad will initiate a signal to the Inverter Control board and Gate Drive board to reset the fault circuitry and allow the Inverter to restart.

Static Switch Reset

A push button integral to the keypad will initiate a signal to the Static Switch board to reset the retransfer to Inverter after 3 transfers to Bypass.

UPS Battery Test

A push button integral to the keypad will initiate a one-minute battery discharge test. Pressing the shall cause the battery to pick up the Inverter load. After one minute, the charger shall come back on, and assume the load. If the batteries would fail to pick up the Inverter's load, the static transfer switch will automatically transfer the systems load to the bypass power source via the static transfer switch.

Setup

A push button integral to the keypad will place the LCD software into a setup mode. In this mode the following conditions can be adjusted/changed:

- Current Date and Time via Computer Interface
- Equalize Time Adjustment 1-100 Hours in 30 minute increments

Float/Equalize

A push button integral to the keypad will toggle states between Equalize mode and Float Mode. The mode of operation (float or equalize) is constantly displayed on the LCD display. Equalize time remaining (Hours and minutes) is displayed in the top left-hand corner of the mimic diagram.

Mimic/Escape

A push button integral to the keypad will display a real time online diagram of the UPS. This online represents the current status of the UPS system. The following status are provided on this screen:

- Charger – Available or Not Available
- Float or Equalize Mode of Operation
- Equalize Timer Count Down (When in Equalize Mode)
- Inverter – Available or Not Available
- Bypass – Available or Not Available
- Synchronization Between Bypass Line and Inverter
- Static Switch Position (Inverter or Bypass)
- Manual Bypass Position (Normal or Bypass)

Enter

A push button integral to the keypad is utilized in conjunction with the setup button to establish or change UPS software parameters.

8.2 Audible Alarm

An Audible alarm shall be provided when any alarm occurs as described in Section 7.4. A silence push button on the keypad shall silence the Audible alarm. The Audible alarm shall have re-flash occur after the alarm has been silenced and another alarm occurs

8.3 Alphanumeric Display Panel

The UPS shall be designed with a microprocessor based monitoring system that includes an alphanumeric 4-line (20 characters long) LCD display panel mounted on the front of the unit to monitor system alarms and status.

8.4 Alarms

By pushing this button the UPS software will display a listing of currently active alarm conditions. If no alarms are active then the message “System Normal” is displayed. This screen will automatically display anytime a new alarm is activated. The following alarms are capable of being displayed:

- Rectifier/Charger Failure – Sums the following conditions Power Failure, Improper Phase Rotation and Over-Temperature.
- Bypass Failure
- Battery Discharging
- Low Battery Voltage
- High Battery Voltage
- Inverter Failure
- Inverter Over-Temperature
- Bypass Out Of Frequency
- Retransfer Blocked
- Static Switch Over-Temperature
- Inverter Protection

8.5 System Monitor

The LCD Display will display the following will display the following values when polling the screens:

- Battery Current
- Battery Voltage
- Battery Capacity Remaining (% of Full)
- Rectifier Output Current
- AC Output Voltage
- AC Output Current
- AC Output Frequency

8.6 Alarm Contacts

Interface to the equipment by the client will be made via two form “C” contacts:

Summary Alarm – An alarm contact shall be provided to indicate when any alarm status occurs. The relay shall be normally energized.

Bypass Supplying Load - An alarm contact shall be provided to sense when the Inverter is supplying power to the load. The relay shall be normally energized.

8.7 Remote Communication

The UPS shall be shipped with RS232 communication capability. A interface software package (Windows based) shall be provided to allow for remote (external) user monitoring of all standard system status and outputs.

9.0 MECHANICAL SPECIFICATIONS

9.1 Cable Entry

Cable entry into the UPS enclosure shall be from either the top or bottom.

9.2 Enclosure

The enclosure shall be a NEMA-1(IP-20), free standing, with minimum 14GA framework. Door panels shall be a minimum of 14GA steel and side panels shall be a minimum of 18GA.

The enclosure shall be mounted on channels with a 3-inch lifting base open at the front and back to facilitate moving with a fork lift and to provide an entrance area for air movement through the enclosure.

The enclosure shall be designed with blank plates on the sides and rear for installation against a wall. The equipment shall be designed to allow replacement or maintenance of all components from the front.

External hinged doors shall be provided in the front with latches that require a tool. Hinged panels, 36" and larger, shall be provided with a 2 point latching system for holding the panels securely. Removable covers shall be attached with machine screws.

9.3 Ventilation

Air inlets and outlets shall be protected by screens or perforated metal guards to prevent the entrance of a rod having a diameter of 0.5 inches or larger except the bottom.

9.4 Power Connections

The connections to the AC output or DC input shall be of the two-hole stud type and shall be sized for full load service per NEC.

Alarm connections shall be sized to allow connection of 12AWG Wire maximum. The alarm terminals shall be compression type and rated for 250 VAC minimum.

9.5 Parts Placement

The system shall be designed to permit front access to PC board, semiconductors, power capacitors, fuses, and assemblies. Parts, test points, and terminals shall be placed so they are accessible for circuit checking, adjustment, and maintenance without removal of any adjacent assembly or component or pose a shock hazard.

9.6 Wire Supports

Permanent wire supports shall be used, no adhesive backed wire supports shall be used.

9.7 Wire Marking

All single point-to-point wires shall be marked with a permanent marking system on both ends of each wire. Individual wires from connector to connectors may not be marked.

9.8 Wiring & Termination

The wiring utilized in the UPS system shall be non-PVC. No more than three wires shall be terminated to a single point. All wiring and bus work shall be copper throughout the system. Except where the mechanical properties of copper do not meet the requirements of the design (i.e. Inverter storage capacitor bus). PVC insulation will not be used, control wiring may use PVC, typically only in ribbon cable. Power wiring shall use SIS insulation.

9.9 Component Marking

All PCB's, indicator lights, meters, controls, semiconductors, and fuses shall be clearly marked with the component designation for ease of serviceability.

9.10 Personnel Safety

High voltage warning labels shall be visible when any of the cabinet doors are opened.

9.11 Painted Surfaces

All external painted surfaces shall be ANSI 61 Gray with a minimum of 1.0 mil thickness and shall be smooth with no runs, sags, or graininess. Internal components may be painted or galvanized.

9.12 Nameplate Markings

The nameplate shall be located so that it is visible when opening the outer door display door and the following minimum information shall be provided on the nameplate:

- Solidstate Controls, Inc., Model # and Serial #
- AC Input Voltage, Phase and Frequency
- Rated AC Input Current
- Bypass AC Input Voltage, Phase and Frequency
- DC Input Voltage and Current
- Rated Output Voltage, Amps, Frequency, Power Factor, KVA and KW.

9.13 Equipment Identification

The equipment shall be marked on the front side of the cabinet with a serial number for ease of identification for service and clients for reference.

9.14 Tagging

All customer, operation and warning tags shall be 1/8-inch high minimum.

9.15 Instruction Manual

At a minimum the Instruction Manual provided with the Equipment shall contain;

- Safety Precautions
- Operation Instructions
- Maintenance Instructions
- Trouble shooting guide

10.0 Environmental Conditions

Acoustical Noise – Noise generated by the UPS under normal operation shall not exceed 60dBA at one meter from any operator surface, measured at 25°C and full load.

Temperature - The system shall operate at rated output without any adverse affects in an ambient temperature of 0°C to 40°C. The semiconductors and magnetic will be designed to meet 50°C

Humidity - The system shall operate at a relative humidity of 5% to 95% non-condensing for a temperature range of 10°C to°40 C.

Altitude - The system shall operate at any altitude from sea level up to 2500m Meters (8,200ft) above sea level without de-rating.

Storage Temperature - 20°C to +70°C. Prolonged storage (>1 Year) will result in capacitor degradation.

PROCESSPOWER® 1-Phase UPS Specification
Revision History

Revision	Date	Description
1	10/25/99	Initial Release
2	10/29/99	Incorporation of Comments
3	10/11/00	Incorporation of Design Changes and Comments
4	08/06/01	Format Change and Addition of 3-Phase
5	10/30/03	Incorporate AMETEK Solidstate Controls company name change