

Application Notes for the UPS 300Series Multi-Module Systems

Feeder sizing – The input feeder should be sized for maximum input current rather than nominal. This higher value includes current for maximum voltage regulation at low line and simultaneous recharging of the flywheel. Nominal input current is the input current at full load, nominal input voltage and fully charged flywheel. Please see the appropriate table below for maximum input currents for the various Cat UPS models. If the N+1 option is added to the UPS 250, UPS 300 UPS 500 or UPS 600, add 80 amps to the maximum input current.

The output feeder should be sized for rated output current. Please note that nominal input current is less than rated output current. This is not a mistake. Nominal input current is measured at nominal input voltage and rated output. Rated output is specified as 300 kVA, 0.8 power factor load per MMU. The input power factor is between 0.99 and 1.0 at rated load and nominal input voltage. The power factor improvement under these nominal conditions more than offsets efficiency losses of the UPS and results in the nominal input current being lower than the rated output current.

If the dual input option is included, the UPS input should be sized for the maximum input current as stated above and the bypass input should be sized for rated output current. Always be sure to size input and output conductors for any planned capacity expansion of the UPS. The power source for the second input must be from the same source as the UPS (matching phase and rotation).

Currents used for conductor sizing

	UPS 300	UPS 600	UPS 900	UPS 900N+1
Max input Current	440 A	880 A	1320 A	1320 A
Rated Output Current	361 A	722 A	1084 A	1084 A

	UPS 250	UPS 500	UPS 750	UPS 750 N+1
Max input Current	440 A	880 A	1320 A	1320 A
Rated Output Current 380V	380	760	1140	1140
400V	361	722	1084	1084
415V	348	696	1044	1044

Neutral – The standard configuration for 480V systems is 3-wire and ground. An optional 4-wire and ground configuration is available as an SER for 480V systems. The standard configuration for 380V, 400V and 415V is 4 wire and ground, capable of supporting a double sized neutral. If single-phase loads are to be supported directly from the UPS output without an intermediate transformer, then the 4-wire and ground system is required, regardless of system voltage. It is recommended that a 2x neutral be used to connect a 4-wire and ground system.

ATS – Over voltage sensing of the utility and generator (normal and emergency) three-phase voltage is required. Some ATS models do not support this feature, it is available optionally with other models and many models (particularly those using microprocessor control) come with this feature standard. When retrofitting a system into an existing power system with an existing ATS, contact applications engineering.

Wire Terminations – The system connection points are bus bars in the Input/Output cabinet, and can accommodate up to eight cables per phase and neutral. The bus bars are drilled for 1- or 2-hole NEMA lugs with ½” hardware. (This will accommodate lugs for cable sizes up to 1000 MCM.) A ground bus is provided to accommodate multiple 1-hole or 2 hole lugs. Lugs are not supplied. Top and/or bottom cable entry is accommodated by the Input/Output cabinet via removable 12 gauge steel conduit access plates.

External Maintenance bypass – The system is available with an optional 2- or 3-device maintenance bypass circuit installed in the Input/Output cabinet. Some engineers and users may require this function to be accommodated within their existing switchgear instead. The power source for an external bypass must be sized to accommodate full system load and be from the same source as the UPS (matching phase and rotation). Some external bypass schemes may require a signal from the UPS system to indicate the UPS is on bypass. This signal is one of the standard output contacts available on the UPS.

Heat rejection – Cooling should be sized for maximum heat rejection shown on the data sheets. This will ensure adequate cooling for continuous operation under worst-case conditions. When installing an N+1 configuration use the heat rejection of the next larger size. This will add more than enough cooling to cover the additional losses for the redundant unit.

	UPS 300	UPS600	UPS 900	UPS 900 N+1
Maximum heat rejection	15.3 kW 52,200 btu/hr	30.6 kW 104,500 btu/hr	45.9 kW 156,700 btu/hr	50.9 kW 173,750 btu/hr

	UPS 250	UPS 500	UPS 750	UPS 750 N+1
Maximum heat Rejection	14.1 kW 48,200 btu/hr	28.3 kW 96,400 btu/hr	42.4 kW 144,750 btu/hr	47.4 kW 161,800 btu/hr

High altitude operation – De-rate the ambient operating temperature by 1.2⁰C for each 1,000 feet of altitude above the rated maximum of 3,000 feet.

Ducting ventilation & Ceiling Height – Operation in a small, enclosed space, such as a Power Module, is possible if a minimum unobstructed airflow of 1800 CFM per MMU(power stage) plus 900 CFM per System Cabinet and 900 CFM per Input/Output cabinet is provided. The maximum tolerable backpressure is estimated at 0.05" of H₂O. All units (single and multi module) are designed for installation in locations with 8 ft. (2438 mm) minimum ceiling height.

Anchoring – The anchoring structure for the system must be designed to withstand a shearing force of 7650.9N (1720lbf) and lifting force of 3113.8 N (700 lbf) per Anchor. 5/8 inch anchors must be used The System and I/O cabinets do not have to be anchored in installations that do not require seismic ratings. Minimum distance of the anchors from the edge of slabs or housekeeping pads will vary with the anchor used. See the specification data for the selected anchor for this information. Use the seismic kit for installations that must meet seismic requirements. This kit will allow the MMUs, System Cabinet and I/O Cabinet to be anchored in accordance with seismic zone 4 and California OSPHD requirements.

Dry contact relays – The UPS provides 6 input (relay coil) and 6 output (form C normally open or normally closed) dry contacts with 6 user selectable functions on input and 6 on output. Available input functions are as follows:

- 1 On Generator (allows activation of alternate settings for transient voltage detection, maximum input current and walk-in rate operating parameters)
- 2 Remote switch UPS to Bypass
- 3 Remote switch UPS on-line (inhibited if a Notice or Alarm is active)
- 4 Building Alarm 1 – triggers External Alarm output contact
- 5 Building Alarm 2 – triggers External Alarm output contact
- 6 Building Alarm 3 – triggers External Alarm output contact
- 7 Building Alarm 4 – triggers External Alarm output contact
- 8 Fire Alarm – triggers External Alarm output contact
- 9 Remote Alarm Silence – Silences the buzzer if a Notice or Alarm is Active
- 10 Gen Set Start Breaker Open (i.e., if a circuit breaker is required by code, an auxiliary contact of the breaker initiates display of breaker open/closed status.)
- 11 Room Temperature Abnormal – Indicates excessively high ambient temperature
- 12 User Defined Input 1 Notice Message
- 13 User Defined Input 1 Alarm Message
- 14 User Defined Input 2 Notice Message
- 15 User Defined Input 2 Alarm Message

The 4 building alarms, gen set start breaker open, and room temperature abnormal indications are logged as Notices. User Defined Inputs 1 and 2 are either Notices or Alarms, depending on which functions are selected.

Available output functions are as follows:

- 1 – 100 Flywheel Percent Energy – Available flywheel energy has decreased to the programmed percentage with system on-line
- 101 On-line (normal)
- 102 On Bypass
- 103 Flywheel Discharging
- 104 Notice or Alarm Condition is active
- 105 Alarm Condition is active
- 106 Overload
- 107 Cabinet over temperature
- 108 External Alarm Active – Activated by any one or more of Building Alarm 1-4 or Fire Alarm input contacts
- 109 Aux Generator Set Start unavailable
- 110 Overload Bypass – system is on bypass due to an overload condition
- 111 DC Bus Capacitor Fusible Link Blown
- 112 Fan Failure

TVSS recommended – Although the UPS will protect the load from line surges, and complies with IEEE 587/ANSI 62.41 standards for surge withstand, extreme voltage surges may damage the UPS equipment. Therefore, it is recommended that all installations have appropriately sized Transient Voltage Suppression Systems at building electrical service entrance.

Performance/Operation

Voltage regulation and power factor improvement – Using reactive current circulating from the input source through the line inductor and the inverter, output voltage is regulated to +/-2% for +/-10% input voltage at rated load. For input voltages outside the +/-10% range, regulation corrects the voltage by 8% (i.e., -15% input voltage will result in voltage regulation of -7% on the output at full load). At reduced load levels the UPS can regulate the output to 2% over wider input voltage ranges. This same current interchange allows improved input power factor, which will be 0.99 with nominal input voltage. If the voltage is significantly below nominal, the input power factor becomes somewhat leading to help boost the input

voltage. If the input voltage is significantly above nominal the input power factor becomes lagging to help reduce input voltage. The change of input power factor with high or low voltage is load dependent – it changes more at reduced loads than at the same voltage level and rated load. (This occurs because the amount of reactive current (kVAR) is determined strictly by the voltage difference between input and output while the real current is determined by load kW. Lower kW for the same kVAR gives a lower power factor.

Harmonic cancellation – high-speed IGBT inverter switches can provide non-sinusoidal current to non-linear loads, without distorting the output voltage, ensuring that clean, precise power is supplied to all other sensitive loads.

Voltage and Frequency window – In normal operation the utility power passes through the surge protection, static switch, and inductors of the system, is regulated to the specified tolerance value, and passed to the protected load. If the power deviates beyond a selectable range of frequency and voltage (password protected and configured at startup), the on-line inverter will draw power from the flywheel to support the load.

Default settings without flywheel intervention:

Voltage: $\pm 10\%$

Frequency: $\pm 5\%$

Typical switching power supplies for computer systems can tolerate higher levels of voltage and frequency variance without any degradation in performance. Therefore, it is possible to adjust to a wider voltage and frequency window for such applications to preserve flywheel energy if deviations greater than the default settings occur regularly.

Walk-in – After input power returns to the system (gen set or utility) and the output is synchronized to the input (at a maximum slew rate of 1 Hz per second), the flywheel voltage phase angle is varied so that it slightly leads the input voltage. The flywheel voltage is moved from slightly leading the input voltage to slightly lagging the voltage to produce the desired load current walk-in rate that is selected for the input source.

Overload while in flywheel discharge mode – In normal operation, the Cat UPS System has up to 10x-overload capability for up to 10 milliseconds. The system will immediately transfer to bypass whenever the overload is 200% or greater and utility is within specified tolerances. This assures maximum fault clearing capacity. While on flywheel power (when utility power is not available), the overload rating is 175% for 10 cycles. Larger loads will cause the system to transfer to bypass if bypass is available and synchronized. The likelihood and profile of motor starting currents should be considered prior to adding them to critical load on the UPS output.

Overload Capability

Line Mode		Flywheel Mode		Bypass Mode	
125%	10 min			125%	Continuous
200%	30 sec	125%	10 secs	200%	1 min
500%	1 sec	150%	1 sec	500%	1 sec
1000%	10 ms	175%	10 cycles	1000%	10 ms

Harmonic current distortion – When operating with primarily linear loads the input current harmonic distortion is less than 3% of full load input current. With loads having common harmonic current content levels the input current distortion will be less than 5%. Under unusual circumstances with large loads having very high harmonic current content, the input current harmonics will still be less than 10%

Load power factor – The Cat UPS System is configured to maintain specified performance for loads with 0.8 lagging to 0.8 leading power factor. The UPS will continue to operate at full load with load power factors as low as 0.65 lagging. However, the output voltage regulation will not be as good at high load levels. If applying system to loads outside of this range, consult a Cat UPS System sales rep.

Running out of flywheel energy – The default action when running out of flywheel energy prior to the standby gen set or utility power becoming available is to transfer to internal bypass if the bypass is available. One can optionally elect to have the system shutdown, turning off power to the load.

Return of utility power – Default setting is automatic restart of the Cat UPS System and powering of protected load. Manual restart is also an option, when operator intervention is desired before re-starting.