Overview:

A customer reported that their 400 Watt (maximum power) rated laser printer was causing an overload condition on a SSW-1000-12 inverter. Along with this specific issue and a general issue of laser printers and surge protectors and UPS’ there have been overloads and failures of inverter models relating to laser printer applications.

Laser printers surge when the units are powered up and the fuser warms up.

To characterize this fuser heater element surge this document records the current wave forms on a typical laser printer with several models of inverters and the grid.

Equipment and Test setup

Inverters used in testing were:
SAM-2000-12
SSW-2000-12
SSW-1000-12
SA-1500-112
PST-150S-12
SB-2000-12
**Laser printer used in test:**
Brother HL4020 with a maximum rating of 450 Watts.

All measurements were taken with the following equipment and settings unless otherwise noted:

- Tektronics TDS 2012 dual trace oscilloscope, probes with 1x setting.
- Tektronics A622 AC/DC current probe: 10 mV/Amp.
- Tektronics P5200 High Voltage Differential Voltage probe 1/500 setting.

**Settings:**

- The center line of the oscilloscope screen is 0 Volts.
- Volts per division on screen captures are typically 200 or 100mV/division.
  - 100mV/div with differential Voltage probe = 50 V per division
  - 200mV/div with differential Voltage probe = 100 V per division
- Current per division scope setting is typically 100mV/division.
  - 100 mV/div with the current probe = 10 Amps per division

**Channel 1:** AC output Voltage of the inverter (Yellow waveforms)
- External Tektronix Differential Voltage Probe Model P5200; Attenuation setting: 500 X (1/500)
- Oscilloscope probe attenuation: 1X (No attenuation)
  - E.g. Volts per Division shown in the screen shots @ 100 mV
  - **Effective Volts per Division:** 50 V (100 mV X 500 magnification = 50 V)

**Channel 2:** AC output current (Blue wave form)
- External Tektronix AC/DC Current Probe Model A622 set at 10 mV per Amp
- Oscilloscope probe attenuation: 1X (No attenuation)
  - E.g. AC Amps per Division shown on the screen shots @ 100 mV
  - **Effective Amps per Division:** 10 A (100 mV/division@10mV/Amp=10)

- For Ipk to RMS conversion Ipk * 0.707 = Irms.
- For Watts Irms * 120 VAC was used.
Performance Review:
The following photographs were recorded for the grid and inverters.

Photo 1: Grid with cold start.
Channel 1: VAC (Yellow):
Effective Volts per Division= 100 VAC
Channel 2 (Blue): Effective Amps per Division= 20 Amps
Horizontal Scale 1 second
Ipk=~55A
Irms=38.9
Watt surge=4668

Photo 2: Grid with warm start.
Channel 2 (Blue): Effective Amps per Division= 10 Amps
Horizontal Scale 1 second
Ipk=~34A
Irms=24
Watt surge=2880

Note: If printer cycled on and off a couple of times Ipk would lower to ~30 amps as element was warmed.
Photo 3: SAM-2000-12 start-up

Channel 1 VAC (Yellow): Effective Volts per Division= 100 VAC
Channel 2 (Blue): Effective Amps per Division= 20 Amps
Horizontal Scale 1/4 second
Ipk=~55A
Irms=38.9
Watt surge=4668

Note: The SAM is a modified sine inverter which is not recommended for laser printers. warmed.

Photo 4: SSW-2000-12 start-up

Channel 1 VAC (Yellow): Effective Volts per Division= 100 VAC
Channel 2 (Blue): Effective Amps per Division= 10 Amps
Horizontal Scale 1/4 second
Ipk=~40A
Irms=28.28
Watt surge=3394

Duration of highest surge is ~50 msec.
Photo 5: SSW-1000-12 NO-start-up

Channel 1 VAC (Yellow): Effective Volts per Division = 100 VAC
Channel 2 (Blue): Effective Amps per Division = 10 Amps
Horizontal Scale 1/2 second

Unit went into overload condition.

Photo 6: SA-1500-112 start-up

Channel 1 VAC (Yellow): Effective Volts per Division = 100 VAC
Channel 2 (Blue): Effective Amps per Division = 10 Amps
Horizontal Scale 1 second
Ipk = ~30A
Irms = 21.2
Watt surge = 2545

Second surge noted 4.5 seconds after first start-up is the printer’s motor initializing. Peak Watts = 1700
Photo 7: PST-150S-12 start-up

Channel 2 (Blue): Effective Amps per Division= 10 Amps
Horizontal Scale 1/2 second
Ipk=~31A
Irms=21.9
Watt surge=2628

PST inverter did emit a brief alarm on the printer’s start-up.

Photo 8: PST-150S-12 start-up, extended time

Channel 2 (Blue): Effective Amps per Division= 10 Amps
Horizontal Scale 2.5 second
Ipk=~34A
Irms=24
Watt surge=2884

Longer surge noted ~4 seconds after first surge is the printer’s motor initializing. Watts are = 1000 for the duration of < 4 seconds.
Summary

It was noted on one blog that “some laser manufactures do include a current limiter and/or thermistor in the fuser unit heater to keep the inrush current from being so high, but this method does slow down the heating up to operating temperature” but we could find no model with limiting shown in the specifications and the printer tested likely did not have this “feature”.

It has been show that several of the 1500 Watt printers tested will start this particular “maximum 450 Watt” laser printer successfully.

Some of the inverters tested do provide some current limiting for the printers short duration surge as can be seen with the PST and SA in photo’s # 6, 7, and 8, whether this current limiting is sufficient to prevent premature aging of the components has not been determined. Therefore at this time if the characteristics of either device have not been tested it would be recommended that the inverter be sized for the maximum possible surge based on the printer’s grid characteristics in photo # 1.

In the case above for the HL4020 printer the inverters surge rating should be able to handle 6.5 times the maximum power of the printer, -surge rating of >4000 Watts.

Photo 9: SB-2000-12 start-up

Channel 2 (Blue): Effective Amps per Division = 20 Amps
Horizontal Scale 1/4 second
Ipk=~=48A
Irms=34
Watt surge=4080