Laser Printer Start-up Surge

Contents

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

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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.

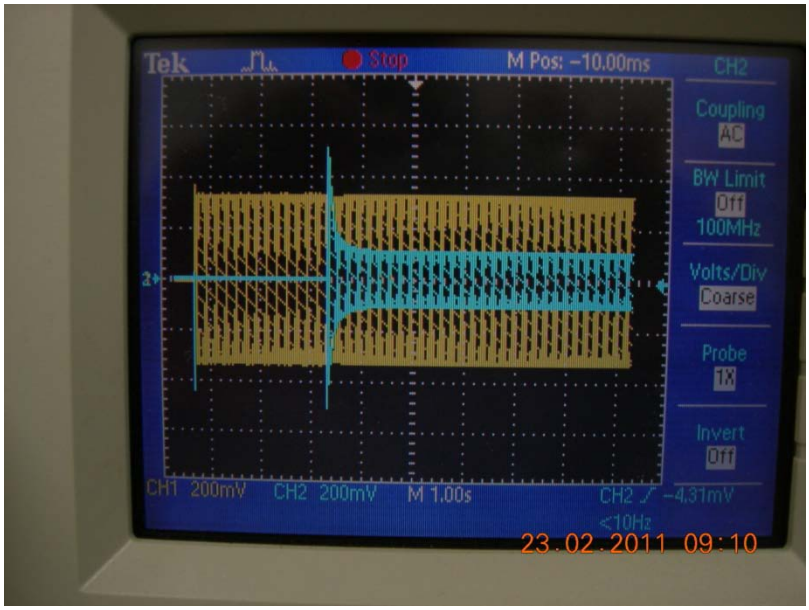

Photo 1: Grid with cold start.

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

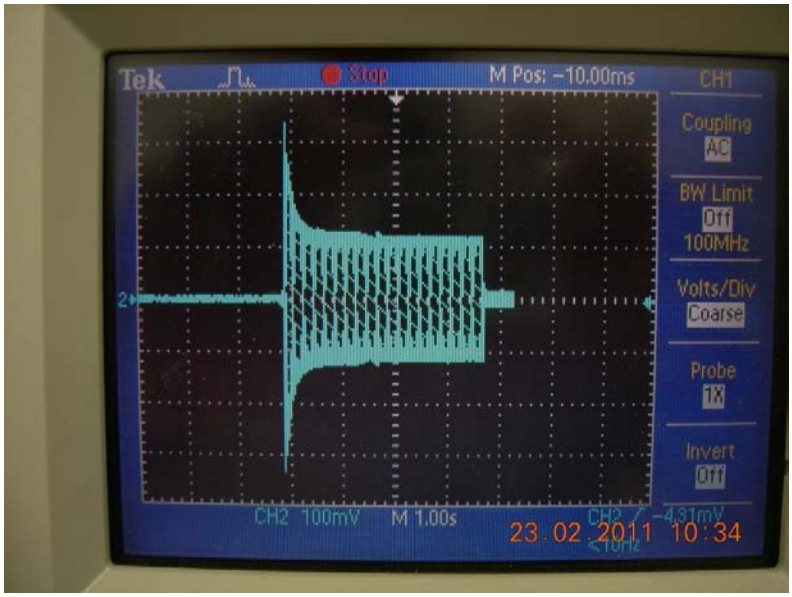

Photo 2: Grid with warm start.

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.

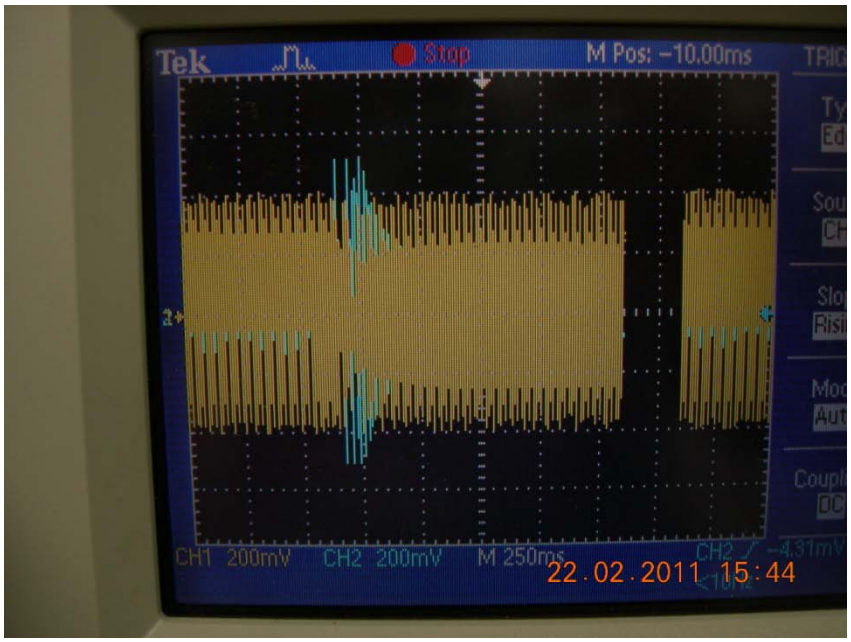

Photo 3: SAM-2000-12 start-up

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.

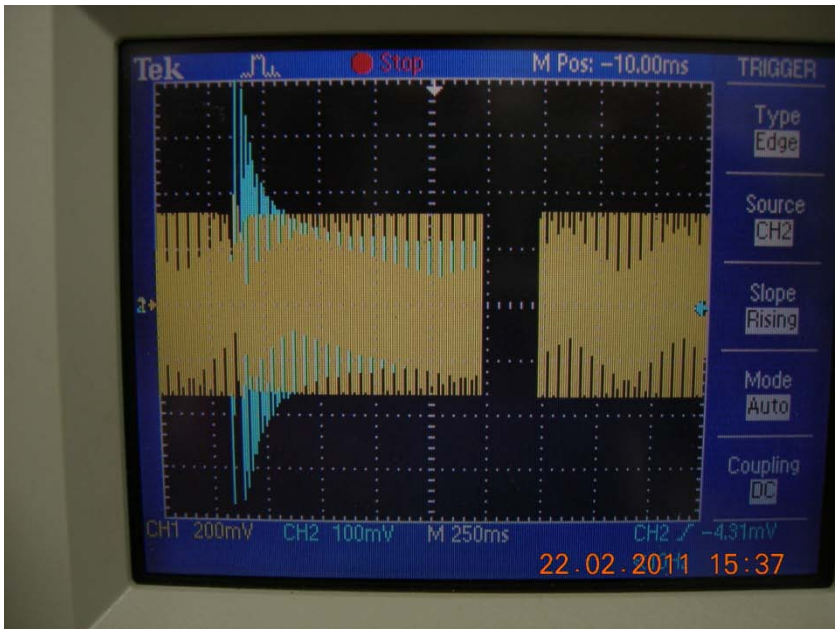

Photo 4: SSW-2000-12 start-up

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.

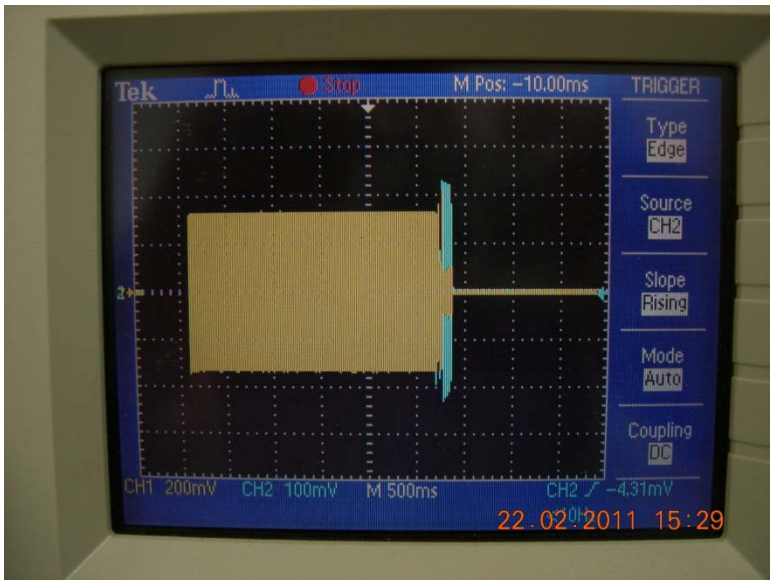

Photo 5: SSW-1000-12 NO-start-up

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.

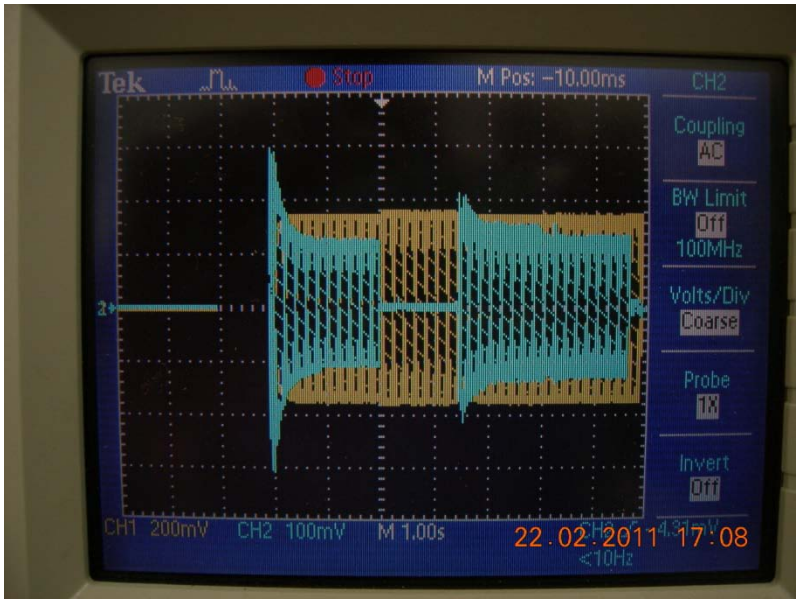

Photo 6: SA-1500-112 start-up

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

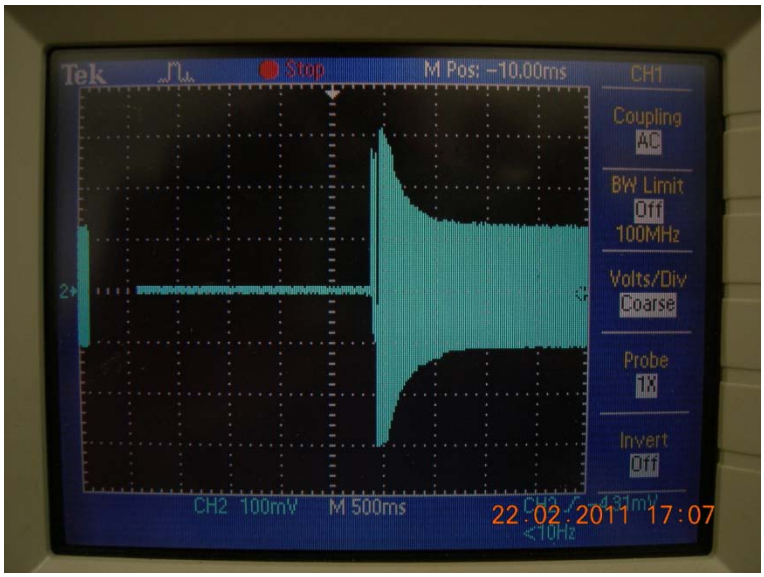

Photo 7: PST-150S-12 start-up

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.

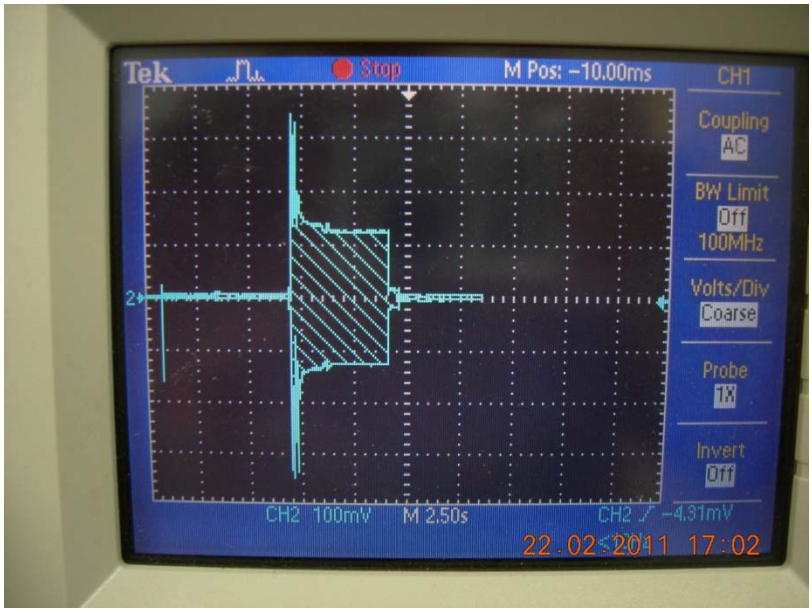

Photo 8: PST-150S-12 start-up, - extended time

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.

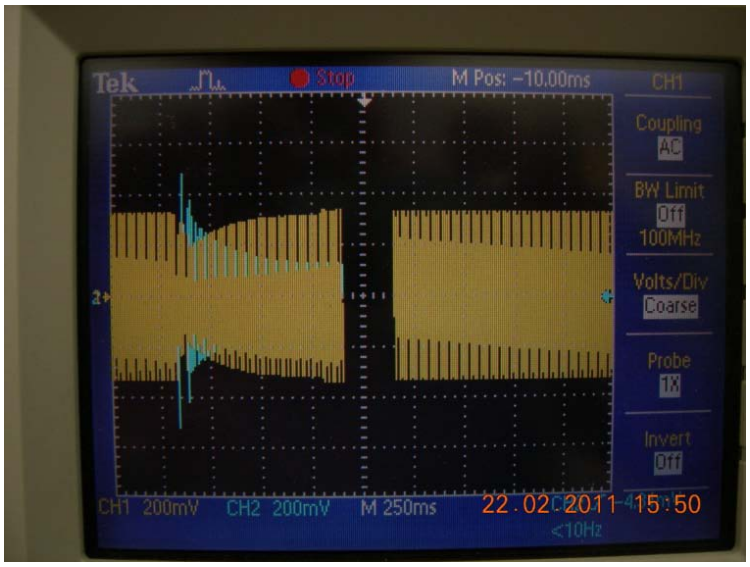

Photo 9: SB-2000-12 start-up

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

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 specfications 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.

Brother HL4020 laser printer specification:

HL-2040

Technical Specification

ENGINE		
Technology		Electrophotographic
Print Speed	A4	Up to 20 ppm
First Print Time		Less than 10 sec
Resolution	Windows® 95 / 98 / Me NT4.0/2000 / XP / Vista	HQ1200 (2400 x 600) / 600 / 300dpi
	Mac OS® 9.1-9.2, OSX® 10.2.4 or greater	HQ1200 (2,400 x 600) / 600 / 300dpi
	Linux	600 / 300 dpi
CONTROLLER		
Processor		SPARClite 96MHz
Memory		8MB
Interface	Standard	Full-Speed USB2.0, IEEE 1284 Parallel
Emulation		GDI
SOFTWARE		
Printer Driver	For Windows®	GDI Driver for Windows® 95 / 98 / Me and NT®4.0/2000 / XP / Vista
	For Macintosh®	Brother Laser Driver for Mac® 9.1-9.2, MacOS® X 10.2.4 or greater
	For Linux	GDI Driver for Linux (Download from http://solutions.brother.com)
Utilities	Interactive Help	Instructional movie for the solution when any error message appears on the Status Monitor
CONTROL PANEL		
Display	LED	4 LED (Toner/Drum/Paper/Ready)
Buttons	1 button	Go
PAPER HANDLING		
Paper Input	Manual Feed Slot	1 Sheet
	Paper Tray (Standard)	Up to 250 Sheets* can be stored in the paper tray
Paper Output	Face Down	Up to 100 Sheets* can be stored in the output tray face down
Duplex	Manual Duplex	Yes
MEDIA SPECIFICATIONS		
Media Types	Manual Feed Slot	Plain Paper, Bond Paper, Recycled Paper, Envelopes, Labels, and Transparencies
	Paper Tray	Plain Paper, Bond Paper, Recycled Paper, Transparencies (up to 10 sheets^)
Media Weights	Manual Feed Slot	60 - 161 gsm
	Paper Tray	60 - 105 gsm
Media Sizes	Manual Feed Slot	Width 69.9 to 215.9 mm, Length 116 to 406.4 mm
	Paper Tray	A4, Letter, B5(JIS), B5(ISO), A5, B6, A6, Exe
PRINTER DRIVER FUNCTIONS		
Page Layout	N in 1 Printing	Condense 2, 4, 9, 16 or 25 pages into 1 page
	Poster Printing	Enlarge 1 page to print over 4, 9, 16 or 25 pages
	Watermark Printing	Watermark documents with predefined text or user defined messages
Others	Quick Print Setup	A printer driver function that enables you to change the driver setting without opening the property dialog
	Status Monitor	A function to indicate the printer error on the PC
SUPPLIES		
Toner	TN-2025	Up to 2,500 A4 pages @ 5% coverage
Drum	DR-2025	Up to 12,000 A4 pages (1 page / job)
DIMENSION/WEIGHT		
Dimensions (W x D x H)		371 x 361 x 165.5 mm
Weight		6.5kg
OTHERS		
Power Consumption	Printing	Less than 450W
	Standby	Less than 70W
	Sleep	Less than 5W
Noise Level	Sound Pressure	Printing 51dB(A) or less
		Standby 30dB(A) or less
	Sound Power	Printing 6.2B(A) or less
		Standby 4.3B(A) or less
Ecology	Power Saving	Yes
	Toner Saving	Yes

Brother strongly recommends that our customers use genuine Brother consumable products only. The benefits to you are:
- Better quality prints
- Greater yields per consumable
- You protect your machine from damages
- Achieve optimum performance.

Failure to use only genuine Brother® supplies may damage the machine and such damages may not be covered under warranty.

HL-2040	Operating System Version	Processor Speed	Minimum RAM	Recommended RAM	Available Hard Disk Space
Windows	95, 98, 98SE	486-66MHz	8MB	16MB	40MB
	NT® 4.0	Pentium 75MHz	16MB	32MB	50MB
	2000 Professional	Pentium 133MHz	64MB	128MB	50MB
	Me	Pentium 150MHz	32MB	64MB	50MB
	XP	Pentium 300MHZ	128MB	128MB	50MB
Macintosh	OS 9.1- 9.2	All base models meet minimum requirements	32MB	64MB	50MB
	OSX 10.2.4 or greater		128MB	160MB	50MB

*at 80gsm A4 paper

Contact:

At your side.

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