

Laser Printer Start-up Surge

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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 I_{pk} to RMS conversion I_{pk} * 0.707 = I_{rms}.
- For Watts I_{rms} * 120 VAC was used.

Performance Review:

The following photographs were recorded for the grid and inverters.

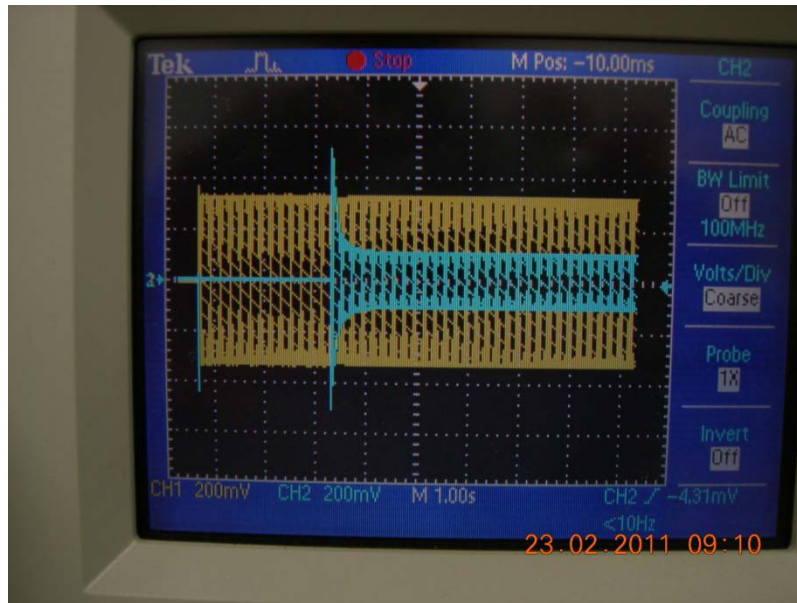


Photo 1: Grid with cold start.

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

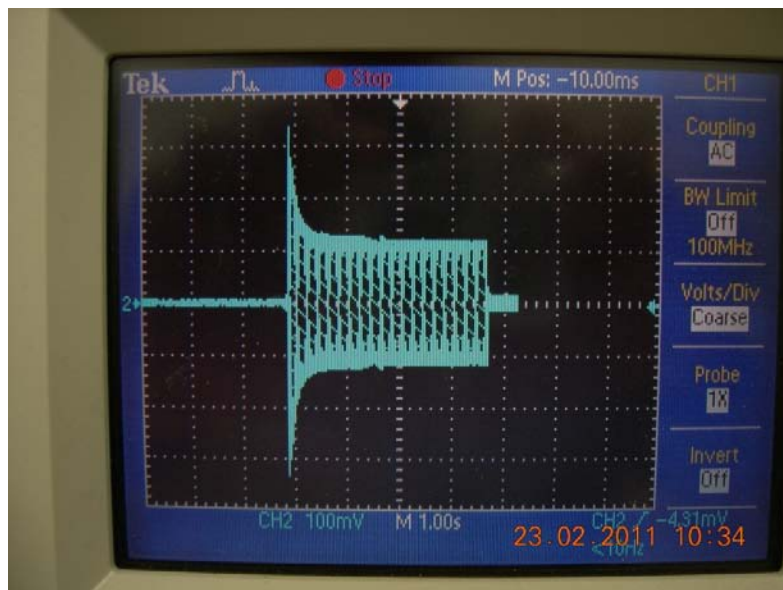


Photo 2: Grid with warm start.

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.

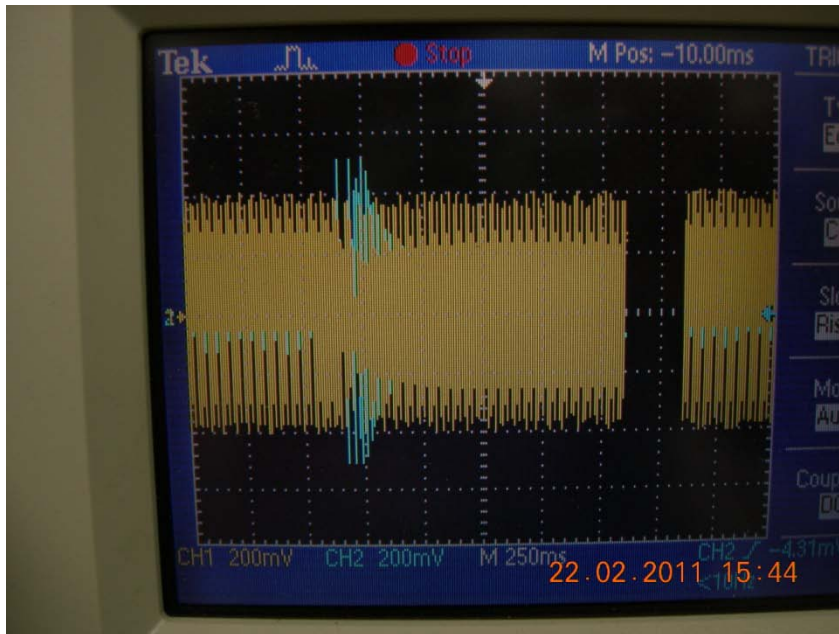


Photo 3: SAM-2000-12 start-up

Channel 1 VAC (Yellow): Effective
Volts per Division= **100 VAC**
Channel 2 (Blue): Effective Amps
per Division= **20 Amps**
Horizontal Scale 1/4 second
I_{pk}~55A
I_{rms}=38.9
Watt surge=4668

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

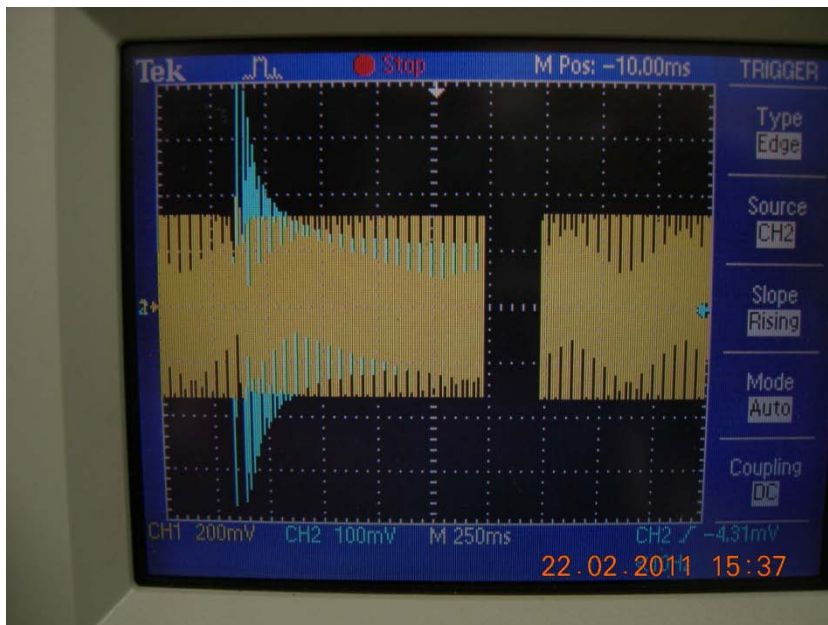


Photo 4: SSW-2000-12 start-up

Channel 1 VAC (Yellow): Effective
Volts per Division= **100 VAC**
Channel 2 (Blue): Effective Amps
per Division= **10 Amps**
Horizontal Scale 1/4 second
I_{pk}~40A
I_{rms}=28.28
Watt surge=3394

Duration of highest surge is ~50
msec.

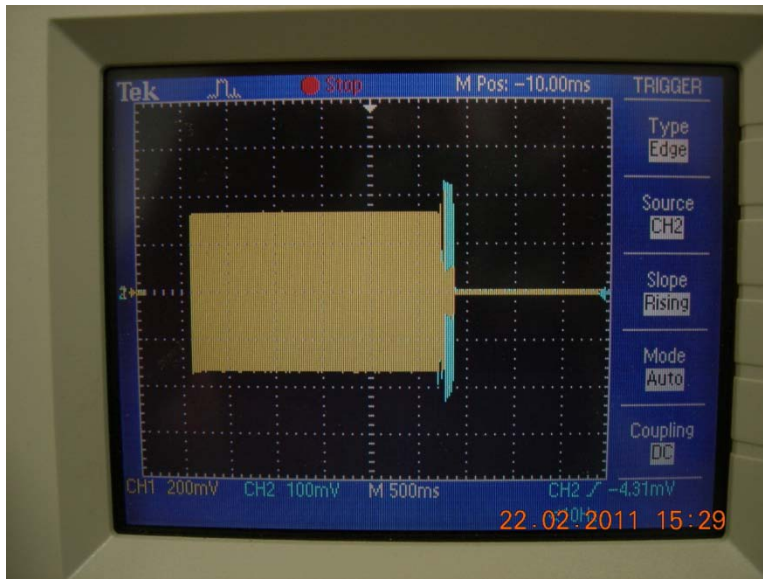


Photo 5: SSW-1000-12 NO-start-up

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.

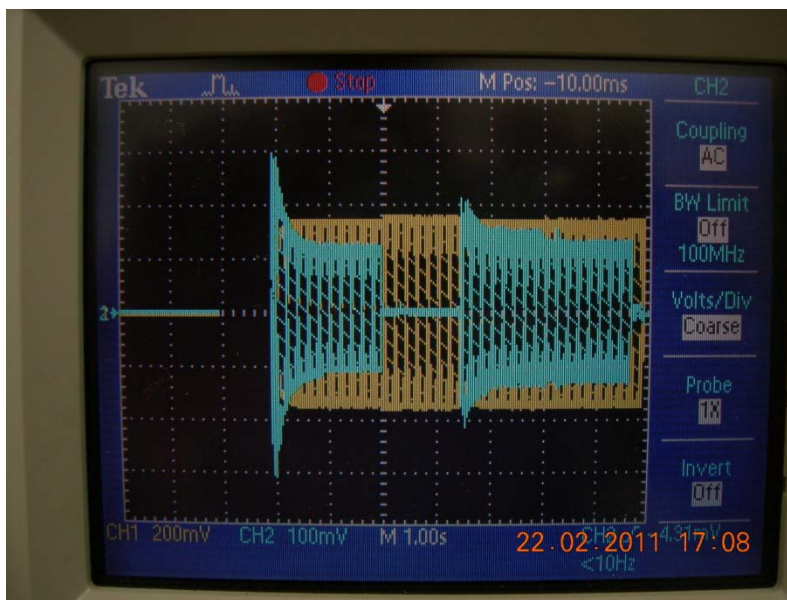


Photo 6: SA-1500-112 start-up

Channel 1 VAC (Yellow): Effective Volts per Division= **100 VAC**
Channel 2 (Blue): Effective Amps per Division= **10 Amps**
Horizontal Scale 1 second
 $I_{pk} \approx 30A$
 $I_{rms} = 21.2$
Watt surge=2545

Second surge noted 4.5 seconds after first start-up is the printer's motor initializing. Peak Watts = 1700

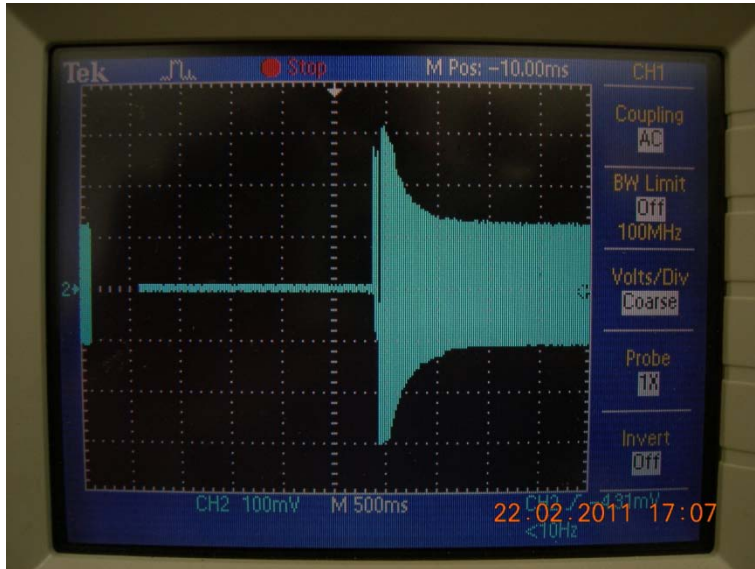


Photo 7: PST-150S-12 start-up

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.

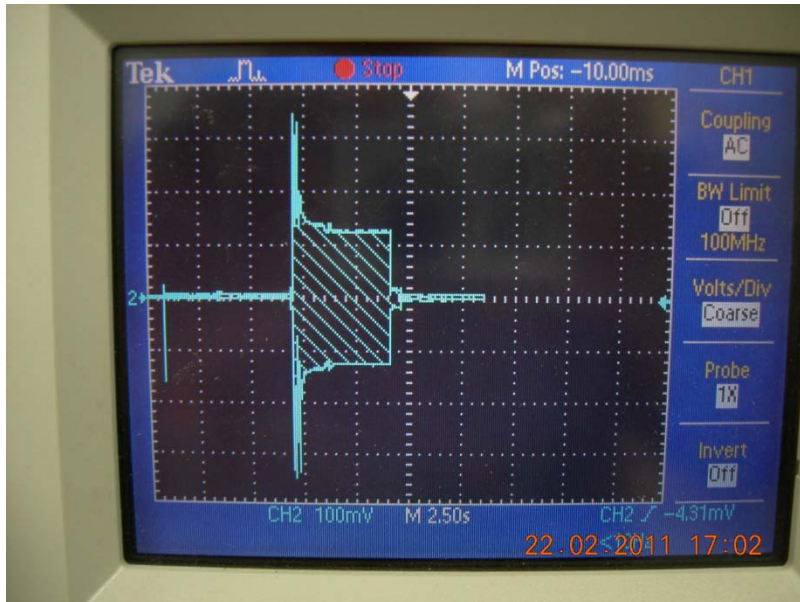


Photo 8: PST-150S-12 start-up, - extended time

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.

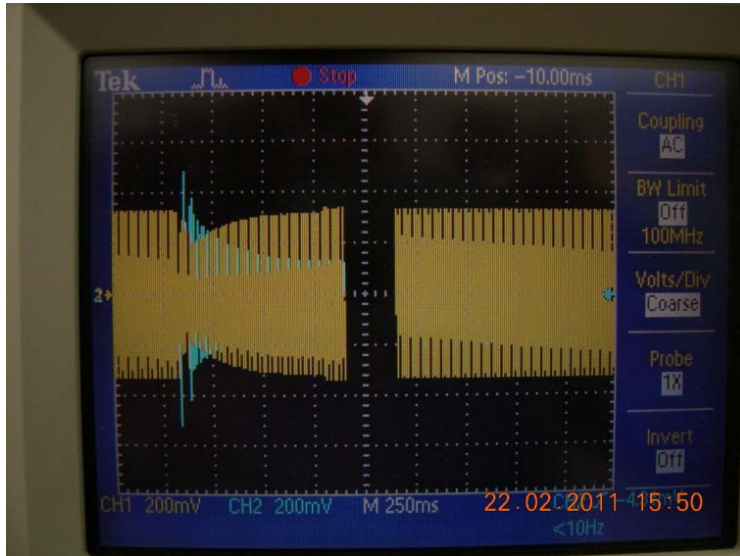


Photo 9: SB-2000-12 start-up

Channel 2 (Blue): Effective Amps
per Division= **20** Amps
Horizontal Scale 1/4 second
I_{pk}=~48A
I_{rms}=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 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.

Brother HL4020 laser printer specification:



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	HD1200 (2400 x 600) / 600 / 300dpi	
	Mac OS® 9.1-9.2, OSX® 10.2.4 or greater Linux	HD1200 (2,400 x 600) / 600 / 300dpi 600 / 300 dpi	
CONTROLLER			
Processor	SPARClike 96MHz		
Memory	8MB		
Interface	Standard	Full-Speed USB2.0, IEEE 1284 Parallel	
Emulation	GDI		
SOFTWARE			
Printer Driver	For Windows® For Macintosh® For Linux	GDI Driver for Windows® 95 / 98 / Me and NT®4.0/2000 / XP / Vista Brother Laser Driver for Mac® 9.1-9.2, Mac OS® X 10.2.4 or greater 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 Output	Paper Tray (Standard)	Up to 250 Sheets* can be stored in the paper tray	
	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 68.9 to 215.9 mm, Length 116 to 406.4 mm	
	Paper Tray	A4, Letter, B5(JIS), B5(ISO), A5, B6, A6, Executive	
PRINTER DRIVER FUNCTIONS			
Page Layout	N in 1 Printing Poster Printing Watermark Printing	Condense 2, 4, 9, 16 or 25 pages into 1 page Enlarge 1 page to print over 4, 9, 16 or 25 pages 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	9x, 98, 98SE	486-66MHz	8MB	16MB	40MB
	NT® 4.0	Pentium 75MHz	16MB	32MB	50MB
	2000 Professional	Pentium 133MHz	64MB	128MB	50MB
	Me	Pentium 100MHz	32MB	64MB	50MB
Macintosh	XP	Pentium 300MHz	128MB	128MB	50MB
	OS 9.1-9.2 OSX 10.2.4 or greater	All base models meet minimum requirements	32MB 128MB	64MB 160MB	50MB 50MB



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