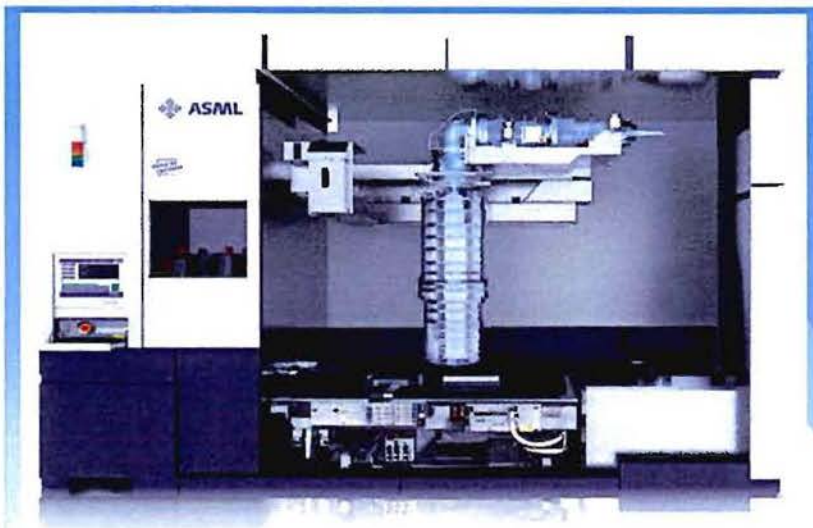

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ASML supply voltage requirement/ impact

G.J. van Herwaarden

Dec 2013

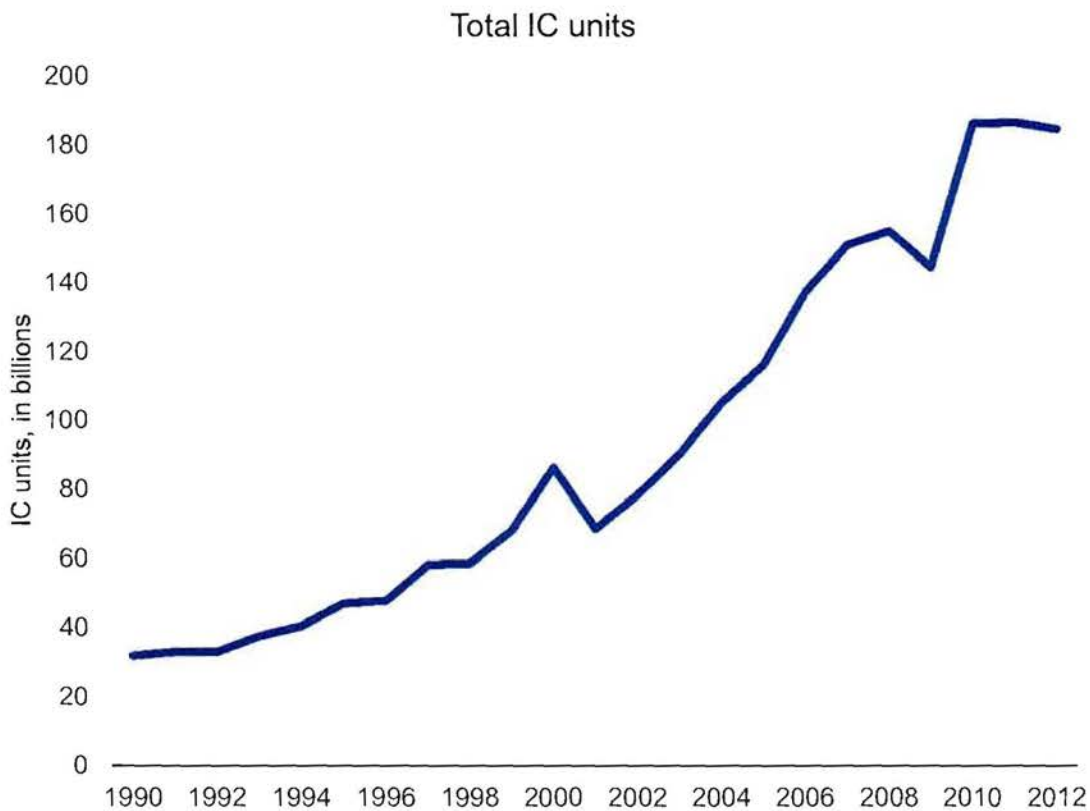
Outline

- ASML Background
- IEC / EU standards
- ASML power electrical system requirements & design
- Hardware: Mains Distribution Cabinet & UPS
- Consequences of not meeting Installation Requirement Manual (IRM) requirements

ASML Background

It's hard to imagine a world without chips

More than 180 billion chips are made every year



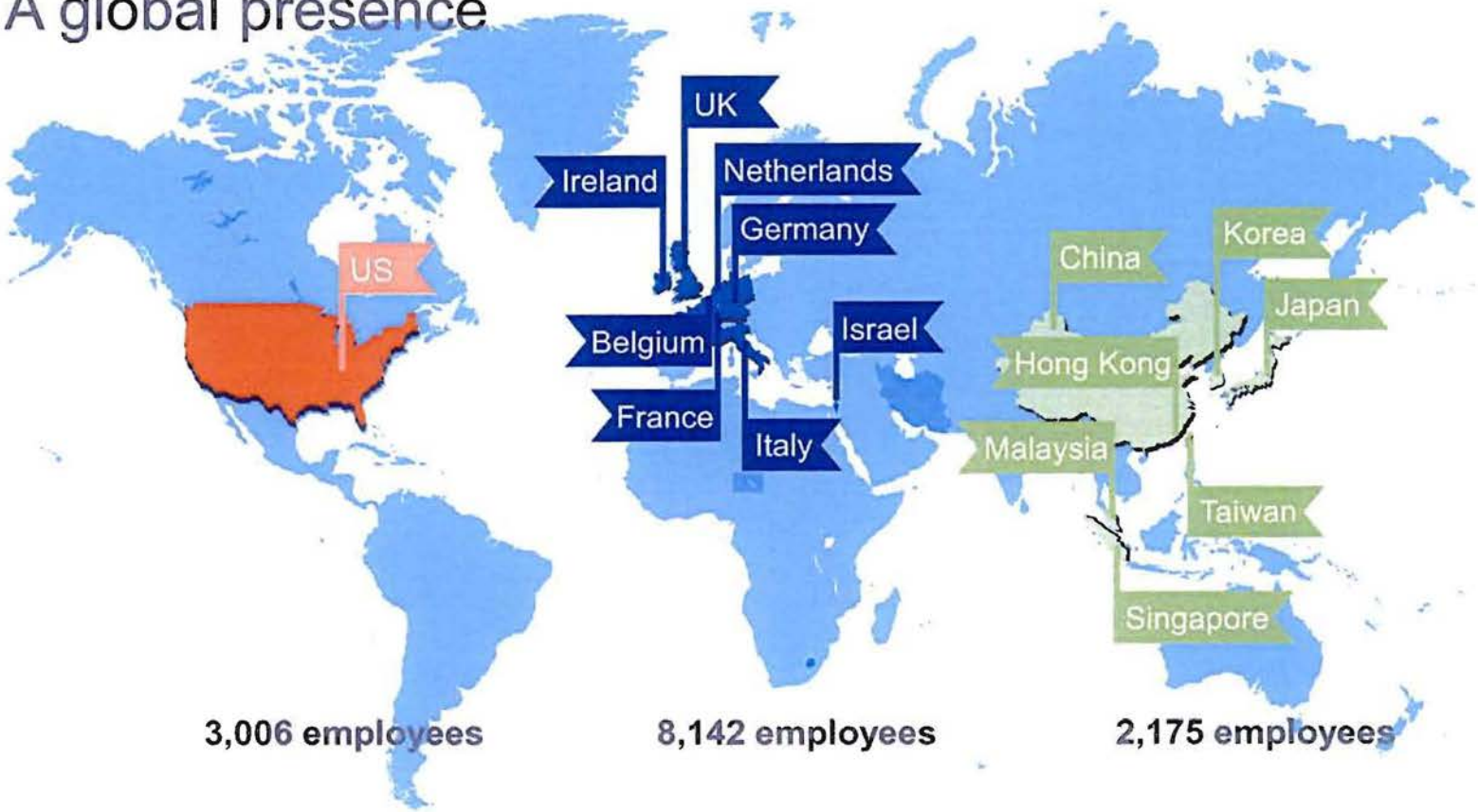
Data: WSTS

In 2012, 185 billion chips were produced — 27 for every man, woman and child on the planet.

This equals total IC sales of $238 billion.

Founded in 1984 as a spin-off from Philips

A global presence



Over 70 sales and service offices located worldwide

Source: ASML/Cymer Q32013

A global presence

Wilton (CT)

Veldhoven

Korea

San Diego (CA)

Taiwan

Tempe (AZ)

A market of 12 large ASML customers

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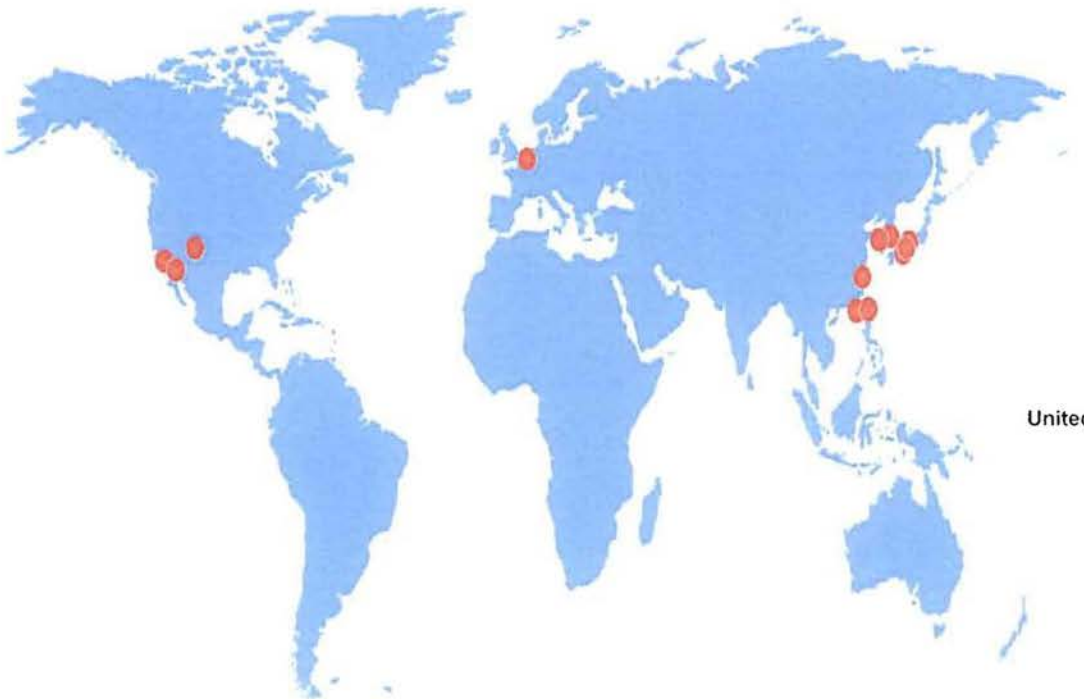
Public

Slide 9

16 October 2013



Company	2013 semi capex (estimate, $M)
Intel	12,700
Samsung	9,500
TSMC Group	9,000
GlobalFoundries	3,000
SK Hynix	2,500
Micron Technology	1,800
United Microelectronics Group	1,500
SanDisk	1,200
Toshiba	1,178
Sony	738
Infineon Technologies	700
SMIC	600

Source: Gartner, Q1 2013

IEC / EU Standards

Electrical standards on power quality

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Grid voltage networks quality standards – worldwide standards

- IEC 61000-2-2 public Low Voltage system
- IEC 61000-2-4 LV + MV industrial installations
- EN 50160 quality of public distribution networks + test methods
- IEEE 519 (recommendation)

Equipment requirements (how to design & manufacture)

- Voltage requirement: IEC60204-1 and NFPA79 chapter 5 identical to IRM
- Voltage Sag Immunity Semi F47-0706
- Current requirement: IEC 61000-3-2 for LV equipment up to 16A
- Current requirement: IEC 61000-3.12 for LV equipment between 16 -75A
- Voltage & Current requirement: IEEE 519 (recommendation)

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ASML power electrical system requirements and design

Installation Supply Requirements – NXT System

Referenced: NXT1970i IRM Table 7.7 - highlighted some typical requirements

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Table 7.7 Power supply requirements for MDRC

Parameter	MDRC requirements
Nominal operating voltage [a][b]	230/400 Vac – Line to Neutral / Line to Line voltage 3-phase, 5 wire star configuration TN-S or T-T with grounded neutral conductor.
Voltage variation range [c]	± 10% of nominal voltage (LN = 207 – 253, Vac; LL = 360 – 440 Vac)
Voltage dips or sags immunity (in compliance with Semi F47 - 0706)	50% V_{nom} for < 200 ms 70% V_{nom} for 200 ms to 500 ms 80% V_{nom} for 500 ms to 1 s
Phase voltage unbalance	3-phase voltage unbalance < 2%
Supply voltage harmonics distortion levels (NFPA79/IEC60204)	< 10% distortion of the sum of 2nd to 5th harmonics < 2% distortion of the sum of 6th to 30th harmonics
Transients voltage level	Over voltage category IEC class II or TS (test level 2.5 kV)
Nominal operating frequency	50 Hz or 60 Hz
Frequency variation range	± 2% of nominal frequency
Phase order [d]	L1/L2/L3 clockwise
Displacement power factor or cos Φ	> 0.8
Maximum current load asymmetry	≤ 10% at full load, ≤ 20 % at partial load condition
Full load power consumption	121 kVA
Full load current = FLC The largest equivalent steady state true RMS value of the symmetrical 3 phase line currents over a process cycle of 1 minute time period, with all motors and other equipment that may be in operation for processing in use, under normal operating conditions.	175 A RMS
Maximum RMS current = (largest 1 second RMS current) Peak RMS current = (largest 1 cycle RMS current at 50 Hz/60 Hz	< 125% FLC < 200% FLC
Processing power consumption: [e] • Maximum • Average • Idle • Service	 TBD TBD TBD TBD
Calculated peak connected load	173 kVA
Peak utilization factor = FLC/OCPD	70%
Maximum current/phase for single largest load	50 A
Amperage Interrupting Capacity (AIC) [f]	35 kA
Short Circuit Current Rating (SCCR) [g]	33 kA RMS sym @ 400 Vac
Over Current Protection Device (OCPD) rating MDRC	250 A
Steady state earth leakage current at 50/60 Hz	NXT: < 300 mA
Max. supply line to line impedance	40 mOhm
Min. available short circuit current	10 kA RMS sym @ 400 V line to line

Parameter:	Voltage dips or sags immunity (Semi F47 - 0706)
Requirement:	50% Vnom for < 200 ms 70% Vnom for 200 ms to 500 ms 80% Vnom for 500 ms to 1 s

Parameter:	Supply voltage harmonics distortion levels (NFPA79/IEC60204)
Requirement:	10% distortion of the sum of 2nd to 5th harmonics < 2% distortion of the sum of 6th to 30th harmonics

Parameter:	Full load power consumption
Requirement:	121 kVA (Scanner only)

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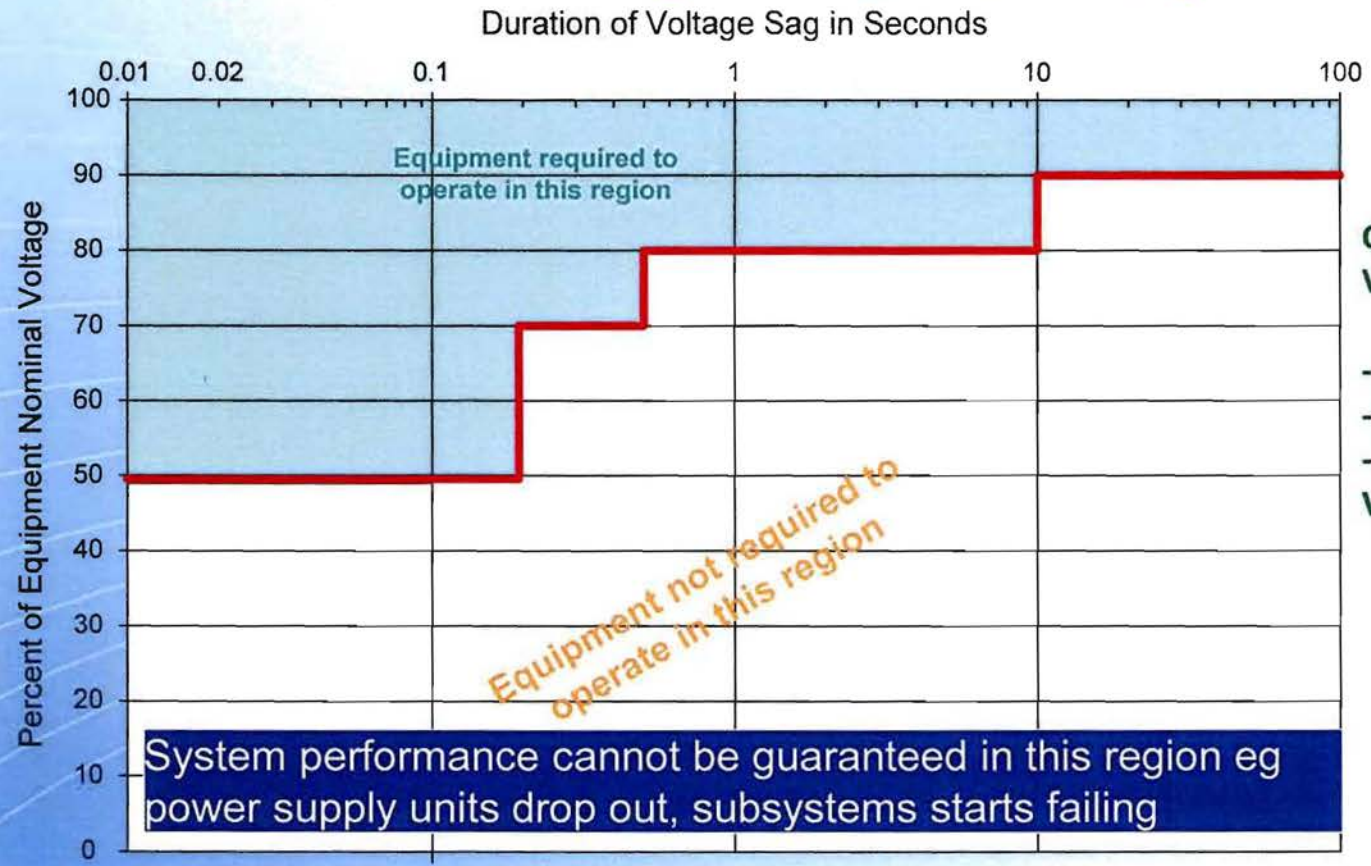
Semi F47 Voltage Sag Immunity



Compliance with Semi F47 - 0706: Voltage sags immunity

- **50% Vnom for < 200 ms**
- **70% Vnom for 200 ms to 500 ms**
- **80% Vnom for 500 ms to 1 s**

Vnom → Voltage nominal

Hardware: Mains Distribution Cabinet & UPS

ASML Scanner, Subfab Facilities Equipment and Mains Distribution Cabinet (MDRC)NXT 2 & 3 Design, layout

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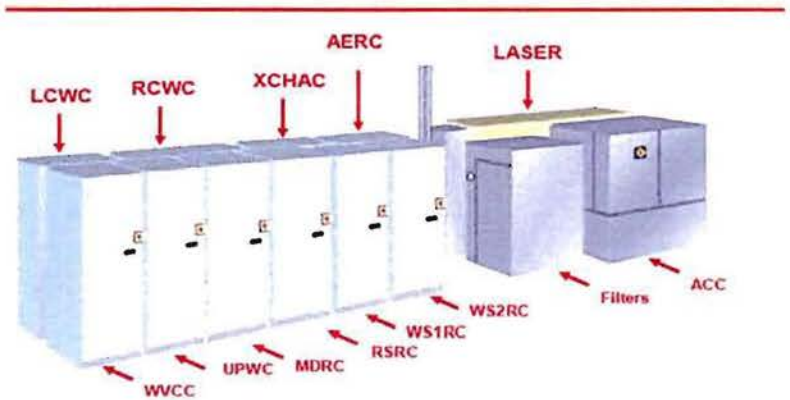
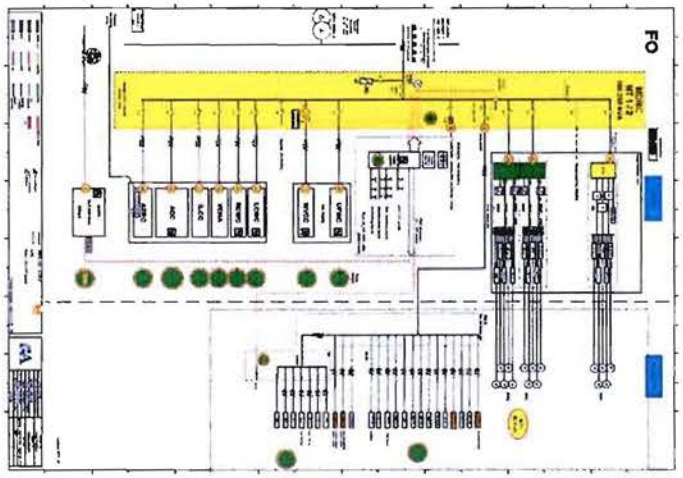


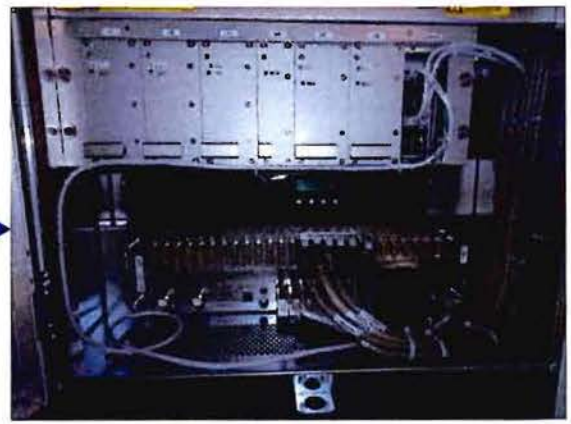


UPS system within ASML Semi equipment

Uninterruptable Power Supply (UPS)

Internal 2-3kVA UPS battery backup system:

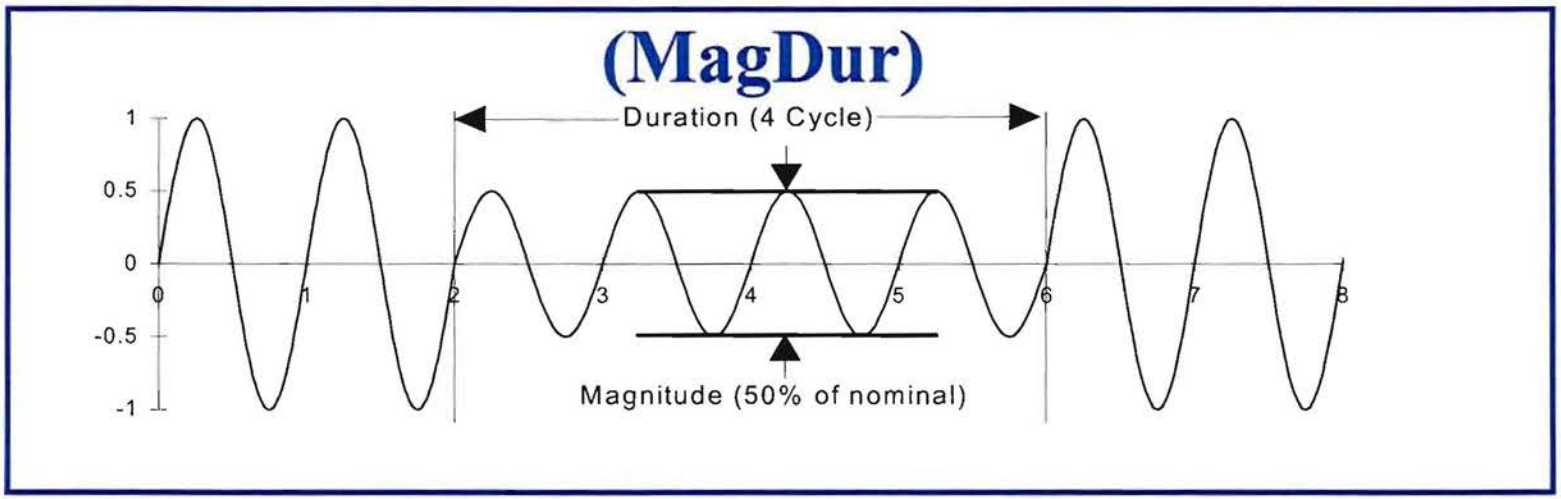
- System SUN/Datahost computer systems.
- Controller safety PLC and Reticle Handler.
- Data logging and error recovery.



Purpose: Safely bring the system to an idle state in a controlled way; not protecting/keep-up the whole system

Consequences of not meeting IRM requirements on sagging

Most Frequent PQ Problem: The Voltage Sag



- Lights may or may not flicker
- Machine tool shutdown or malfunction
- Can result in production downtime an/or product loss

Typical Costs of Voltage Sag Related Shutdowns Per Industry (ca 3-4 yrs old data)

No.	Process	Reported Cost	Service Voltage	Load
1	Semiconductor	$1,500,000	69 kV	25 MW
2	Semiconductor	$1,400,000	161 kV	30 MW
3	Semiconductor	$ 700,000	12.5 kV	10 MW
4	Metal Casting	$ 200,000	13.8 kV	16 MW
5	Chemical Plant	$ 160,000	12.5 kV	5 MW
6	Pulp and Paper Mill	$ 110,000	161kV	100 MW
7	Aerospace Engine Machining	$ 100,000	13.8kV	10 MW
8	Food and Beverage	$ 87,000	12.5 kV	5 MW
9	Chemical Plant	$ 75,000	66kV	3 MW
10	Chemical Plant	$ 75,000	66kV	5 MW
11	Electronic Components	$ 75,000	12.5 kV	5 MW
12	Crystal Growth	$ 60,000	12.5 kV	1 MW
13	Chemical Plant	$ 46,175	66kV	30 MW
14	Wiring Manufacturing	$ 34,000	12.5 kV	2 MW
15	Chemical Plant	$ 18,000	12.5 kV	2 MW
16	Fibers Plant	$ 15,000	12.5 kV	1 MW
17	Paper and Packaging	$ 10,000	12.5 kV	4 MW
18	Plastic Bag Manufacturing	$ 10,000	480V	4 MW
19	Plastics	$ 7,500	12.5 kV	4 MW
20	Stainless Steel Manufacturing	$ 5,500	12.5 kV	2 MW

Source: Technical and Economic Considerations for Power Quality Improvements, EPRI TR-1005910

The effect of non linear load on the supply voltage

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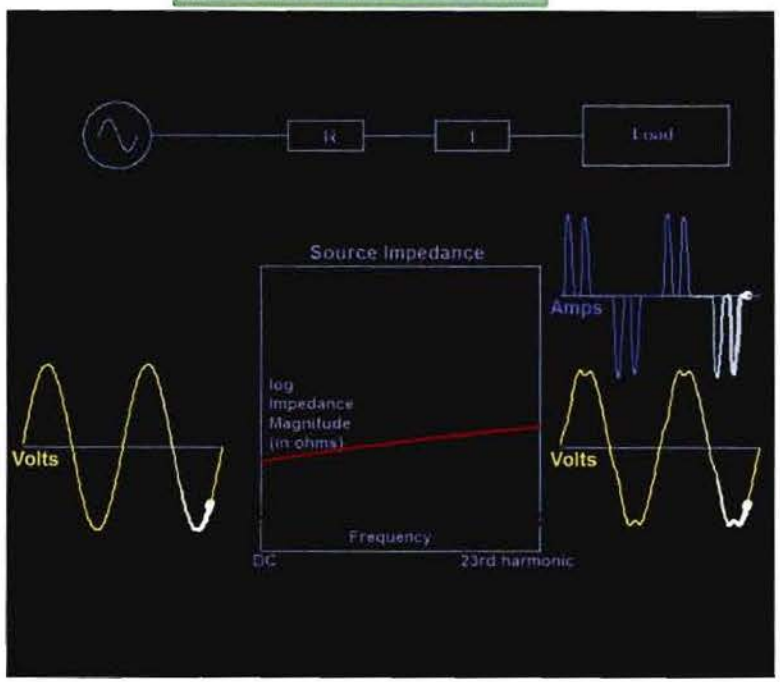
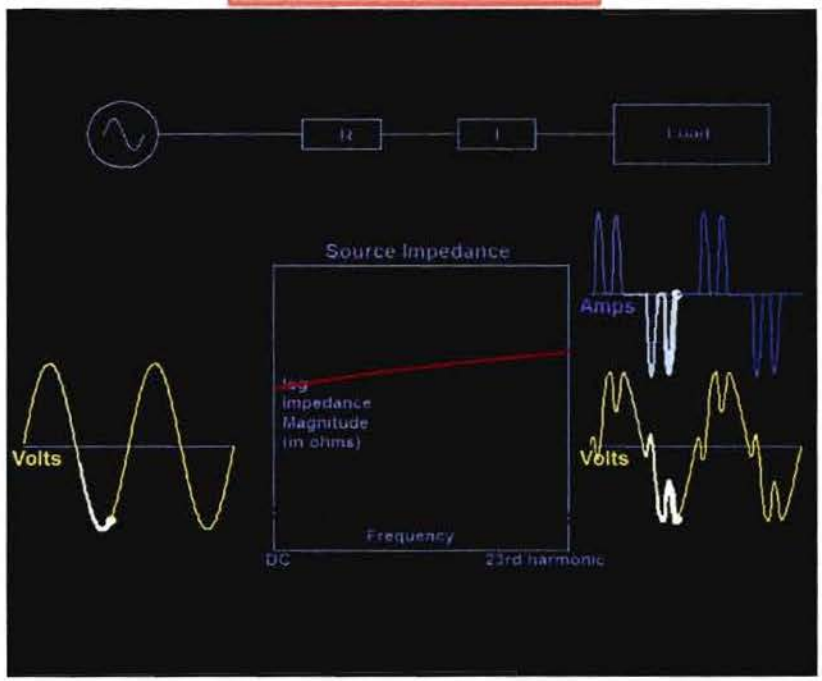
Requirement: strong power grid with small impedance

Deviating from IRM result in distorted voltage

Small impedance grid
Z=10-20 mOhm / 20-40 kA



Large impedance grid
Z= 50-80 mOhm / 5-10 kA



Example: GF Malta NXT system: Grid voltage with high non linear load, on a grid with high impedance

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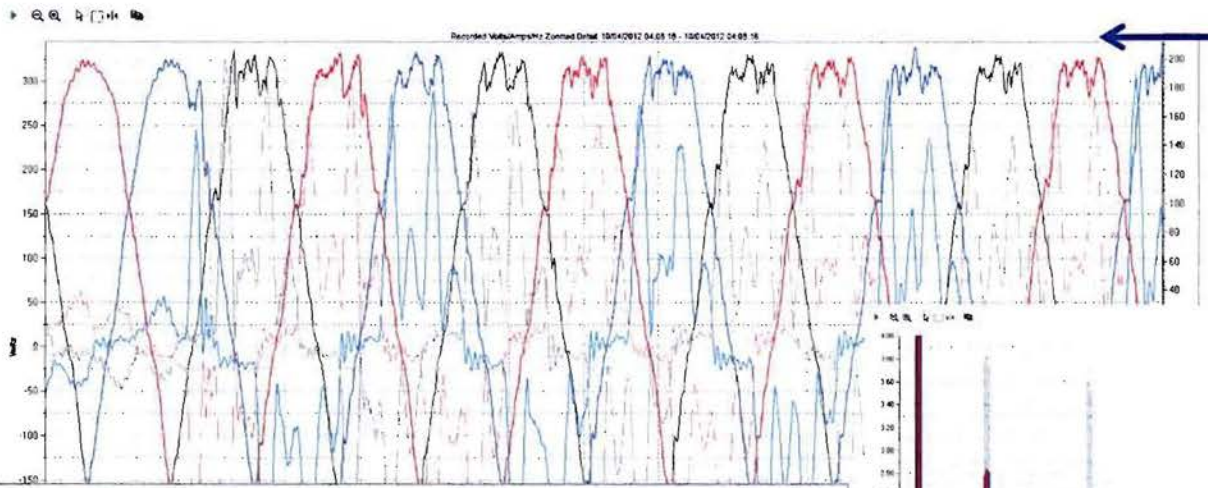
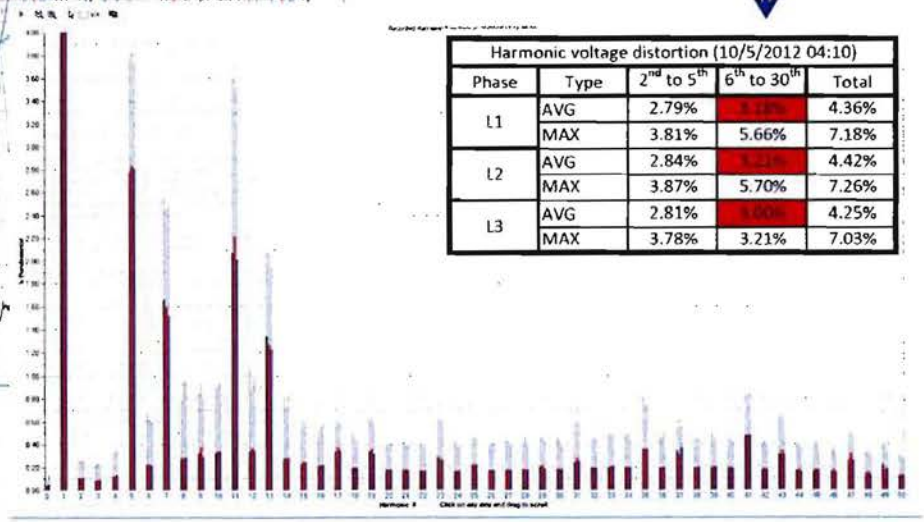


Harmonics outside IRM spec:

6th to 30th > 2%



Harmonic voltage distortion (10/5/2012 04:10)				
Phase	Type	2nd to 5th	6th to 30th	Total
L1	AVG	2.79%	[illegible]	4.36%
	MAX	3.81%	5.66%	7.18%
L2	AVG	2.84%	[illegible]	4.42%
	MAX	3.87%	5.70%	7.26%
L3	AVG	2.81%	[illegible]	4.25%
	MAX	3.78%	3.21%	7.03%

Voltage distortion cause Frequency drives inside ACC to oscillate and trip.

Result: Frequent long system downs; with Diagnostic only shows: "High Voltage"

Resolution: installed power conditioners

Typical impact of PQ issue on ASML system

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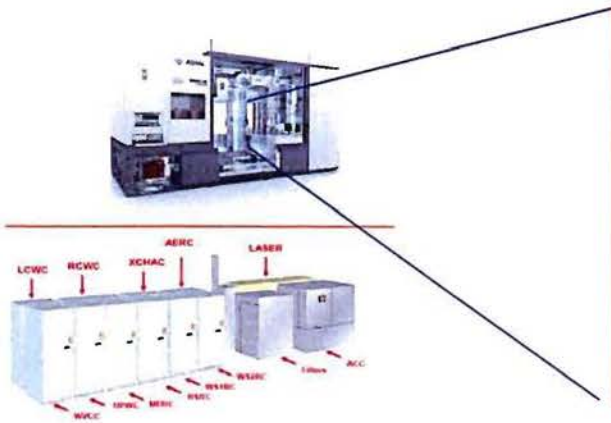
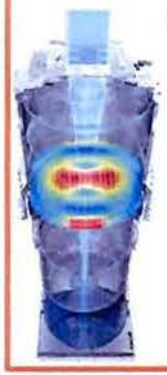
12 December 2013



Exposure Lens



Lens Temperature Stability Requirements in order of mK per minute

Temperature conditioning is critical 24x7.

	Example A			Example B		
		Lost Productivity			Lost Productivity	
		[hrs]	[$]		[hrs]	[$]
Problem:	Temperature Conditioner down < 1hr 'Small' Lens Temperature offset	1	$20,000	Temperature Conditioner down > 4 hrs 'Large' Lens Temperature offset	4	$80,000
Impact	System Recovery/ Stabilization	5	$100,000	System Recovery/ Stabilization	23	$460,000
Total		**6**	**$120,000**		**27**	**$540,000**

*productivity cost calculated using $20,000/hr estimate

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Questions?