#### How Semiconductor Tools respond to AC Mains Disturbances



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# Problem with old approach to Power Quality:

- 1. Disturbances happen. They cannot be avoided.
- 2. Power company is responsible for power quality.
- 3. Success is technically impossible.



#### What if cars were engineered like this? "Make loads tougher, not power better"



Note: requires road that is +/-10% smooth. Otherwise, wheels may fall off.





Aftermarket roadsmoothers are readily available.



# Basic idea behind new approach to Power Quality

- Power quality is <u>compatibility</u> between source and load, <u>not</u> perfection of source
- There are always two solutions to compatibility
- Either improve the power, <u>or</u> make the loads tougher.
- How to choose?

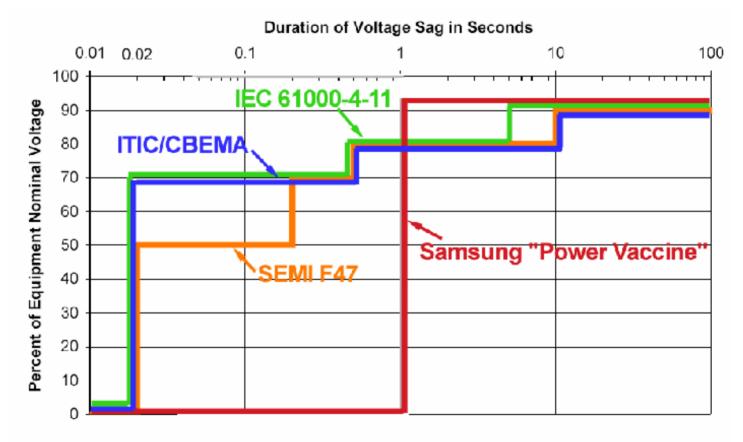


# Consequences of new approach to Power Quality

- Power quality is a <u>shared</u> responsibility:
  - electric company or FAB must deliver some level of quality, but not perfection
  - Customer must buy equipment that tolerates normal disturbances.



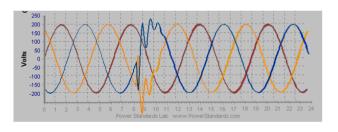
#### New approach: What should be tolerated?



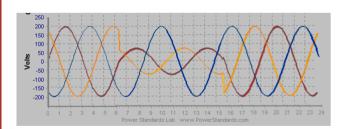
What is "typical" disturbance?



#### What ACMains disturbances?



- •High frequency impulses
- •Voltage swells
- •Flicker

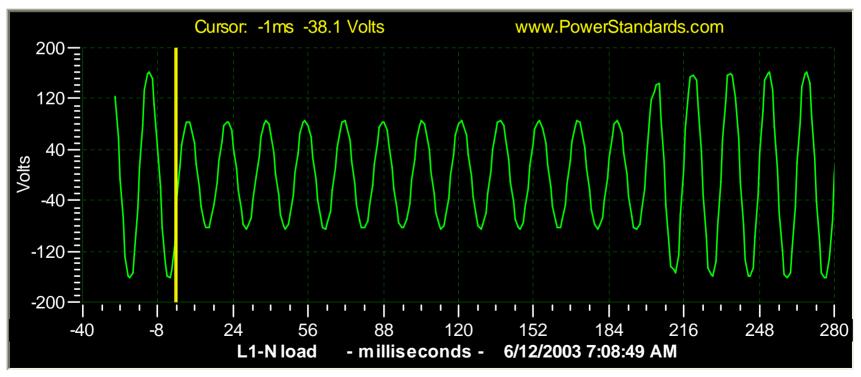


- •Harmonics (Voltage and Current)
- •Capacitor switching transients
- •Voltage dips



#### **Introduction to AC Mains disturbances**

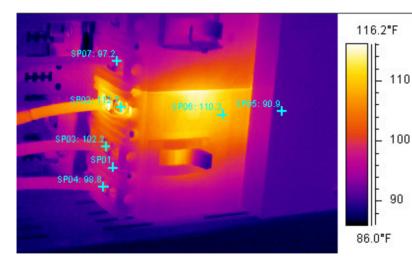
## Voltage sags (or dips – BE) are the most common >90% of all AC mains Disturbances

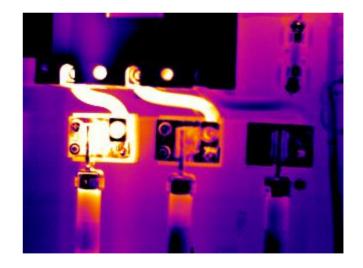




#### **Voltage sag causes in Fabs**

Either increase in source impedance (rare)
 Or increase in current (common).

























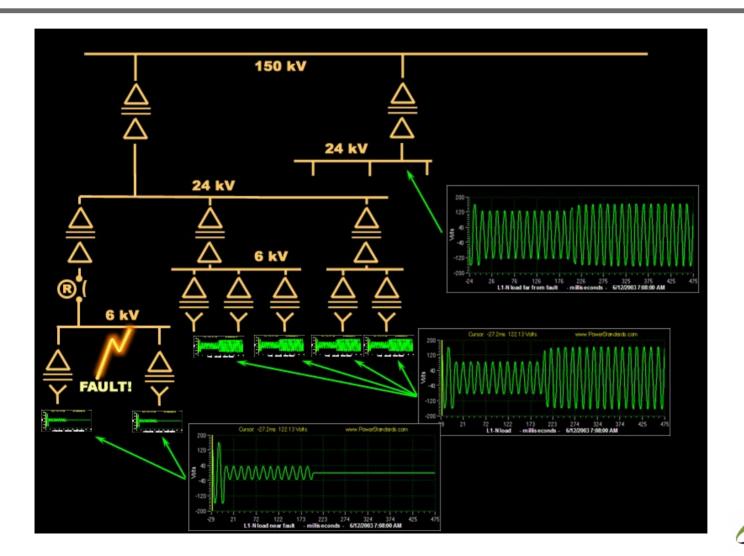


California mudslide - January 2004 - Alex McEachern

AP / Damian Dovarganes



#### **Voltage Sags on Fab level**



semi

## How do semiconductor tools respond to voltage dips?

Remember:

#### The Tool must continue to run the Process Without Operator invention



### How do semiconductor tools respond to voltage dips?



• Extreme #1 – no problem at all

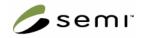
(rare)

 Extreme #2 – explosion, fire, bearing failure (extremely rare)





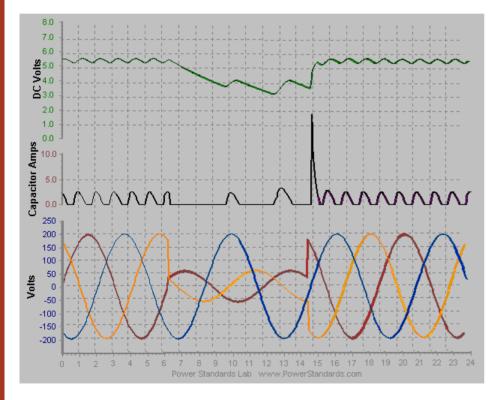
Extreme #3 – graceful restoration
using power quality sensor, for example
(becoming more common)





- Ordinary, common responses
- EMO shutdown
  - Small relay failures
  - Safety relay failures
  - GFI (PE Sense) trip at end of dip





- Unbalance sensor trip
- Power supply fuses fail
- Contactor may drop
- Circuit breakers open due to increased current on phases without dips



	Unit	Alert Name Process may be paused in	B9CM	A4
1	Solvent/T1	Cooling tank DRW lower flow error	BSCM	A4
7	Solvent/T2	Cooling tank DIW lower flow error	MOAU	W4
7	SYS	Fan Filter Unit sw off	MOBB	W4
7	SYS	Local His Unit Malfunction(Communication)	BANK	A4
7	IPA/T6	Chemical-1 flow volume Upper limit	8893	A4
7	Solvent/T2	* Power supply error	B8B4	44
17	Solvent/T2	Heater protection level lower limit error	BBEH	A4
17	Solvent/T2	* Maintenance cover (WTR-side) open error	Banx	44
17		Chemical-1 flow volume Upper limit	8993	A4
17	Salvent/T1	* Power supply error	BSEH	A4
17	Solvent/T1	* Maintenance cover (WTR-side) open error	BSNX	44
17	Solvent/T1	Chemical-1 flow volume Upper limit	Daren	-
800			×	-
		Messenger Service		1
		Message from FCEX3009 to FCEX3009 on 1/2	4/01 10:08AM	
	17 1.1.2	Power trouble!		
		POWS GOLDE	2012	
		OK		
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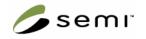
- Sensor faults or errors
- flow, temperature,

RF forward or reverse power,

fan speed, pressure

• Can be sensor error, or

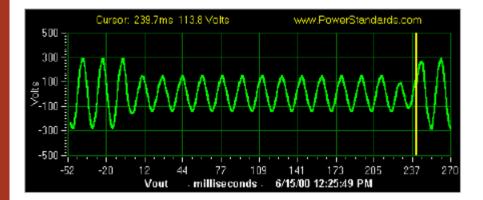
software design error

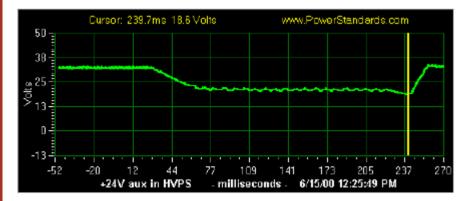




- Interaction between sub-systems during sag
- Communication problems can result tool to misbehave or stop
- Under-voltage sensor at drives, and controllers etc. kicks in







- DC Power Supply faults (surprisingly uncommon)
- Lack-of-energy faults
- Shut-down faults
- Effect of universal input supplies

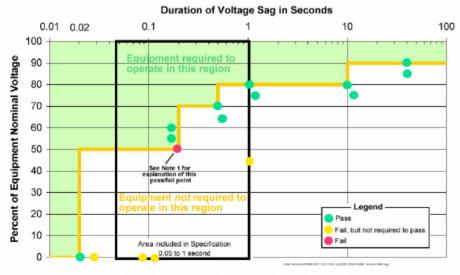




- Robot faults
  - Can destroy wafers
  - Emergency braking
  - Gate closing
  - Transport strategy

(software error)





Voltage Sag Immunity - SEMI F47 Intratech Stepper/Washer, 240V 50 Hz power Model 2200, S/N 99SW4502, 5/00

- ASD shutdown
- Loss of plasma requiring manual re-strike
- Main computer re-boots
- Loss of tool's internal communication network
- Subsystems in tool get out of synchronization



#### New approach to power quality – How to make AC mains disturbances



Using a Voltage Sag Generator in Semiconductor Industry.



## Conclusion: How do semiconductor tools respond to voltage dips?

- No simple answer <u>not just a power supply problem</u>
- Requires testing real tools with real voltage dips
- Requires testing team: power, hardware, software experts
- Solutions rarely require mains power conditioning
  - Minor component value changes
  - Minor software changes
  - More on this topic later!



