SineTamer

*"we ARE the standard"*

# Surge Protection for Variable Frequency Drives / PLC's / UPS's


**John Mitchell**

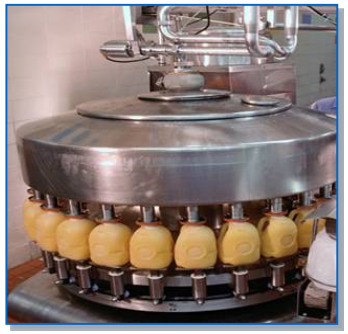
**Global Sales Manager**


CPA

KNOWLEDGE IS POWER!

# Example Industry Sectors

- Paper / Steel
- Food / Beverage
- Cranes & Elevators
- Mines / Quarry
- CNC Machines
- Wind / Solar power plants
- Oil / Gas
- Mesh / Spot welding
- Smart Grid / Regeneration
- Rubber / Extruders
- Water / Pumps
- Data centers / UPS
- Waste / Bio Fuels

# Core Products

1. Dynamic Braking (Resistors) / Regenerative Braking (Regen Units)
2. SPD's / Transient protection
3. RFI/EMC Filters / Inductive Devices (Line/Motor Chokes, dUdT/Sine Filters
4. Harmonic Filters / PFC – Power Quality
5. Motors All types – Wireless Crane Controls

# Anything connected to the drive from us is universal.

**Active Harmonic Filter**

DB Resistor

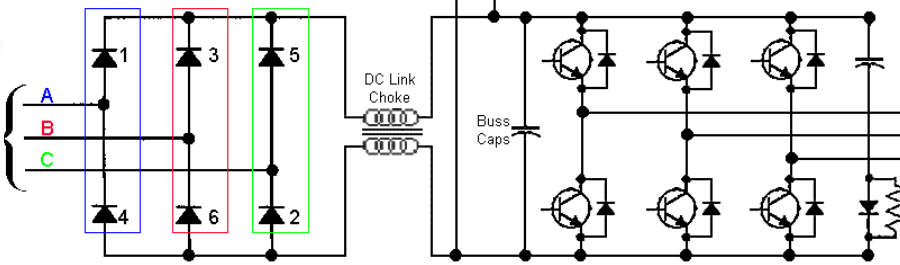
REGEN UNIT

DB Chopper

Line Reactor

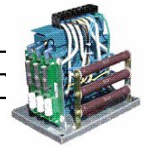
Passive Harmonic Filter

RFI Filter

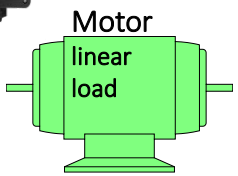



DC Link Choke

Load Reactor

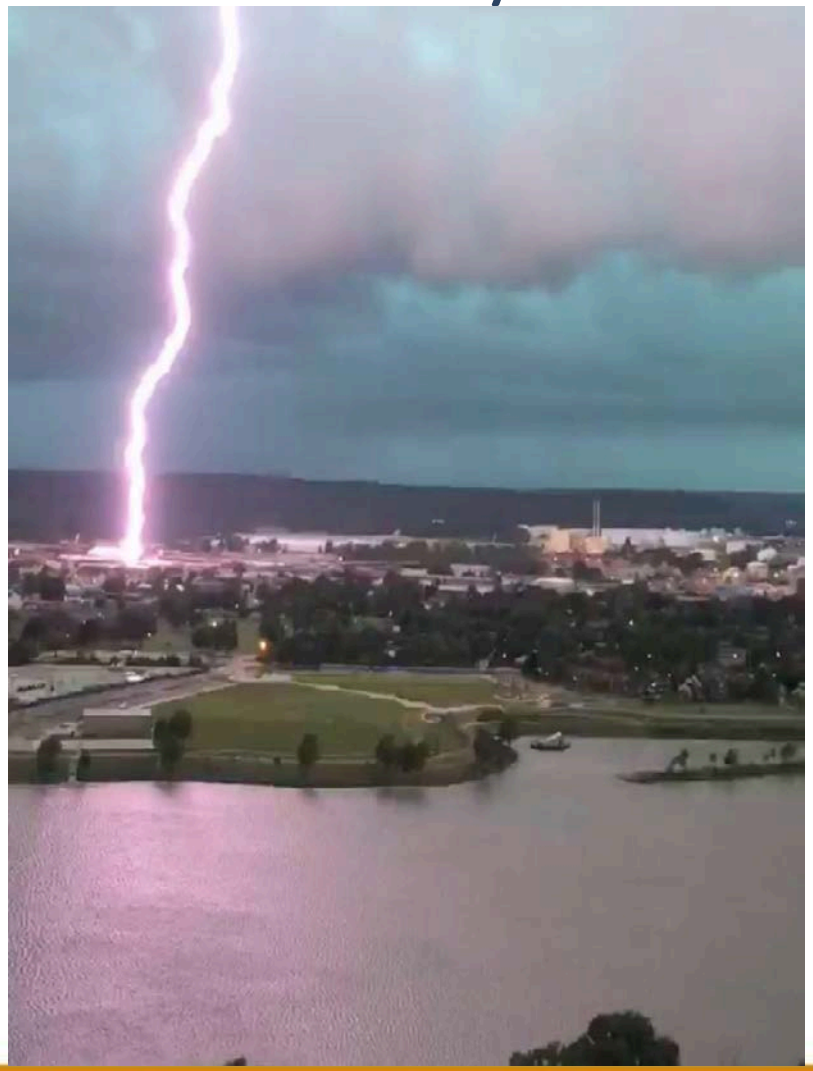


dVdt Filter




Sinewave Filter

# Are You Ready for This?



# Industry Terms and References

# TVSS / SPD

- TVSS – Transient Voltage Surge Suppressor
  - **SPD – Surge Protective Device**

*(SPD is the current prevailing term)*

# A "Transient" is:

***"A subcycle disturbance in the ac waveform that is evidenced by a sharp, brief discontinuity of the waveform." ****

High-energy, fast rise time,
*SHORT* duration

- Energy – Thousands of volts and thousands of amps
- Time & Duration – Nanoseconds to microseconds

***Nanosecond – One billionth of a second***
***Microsecond – One millionth of a second***

* IEEE Std 1100-2005, Emerald Book, Definitions

# Let-Through Voltage (LTV)

The amount of electrical surge that gets past the suppressor and into the protected equipment.

The lower the let-through, the better protection for the equipment being protected.

***<u>This is the most critical measure of SPD performance!</u>***

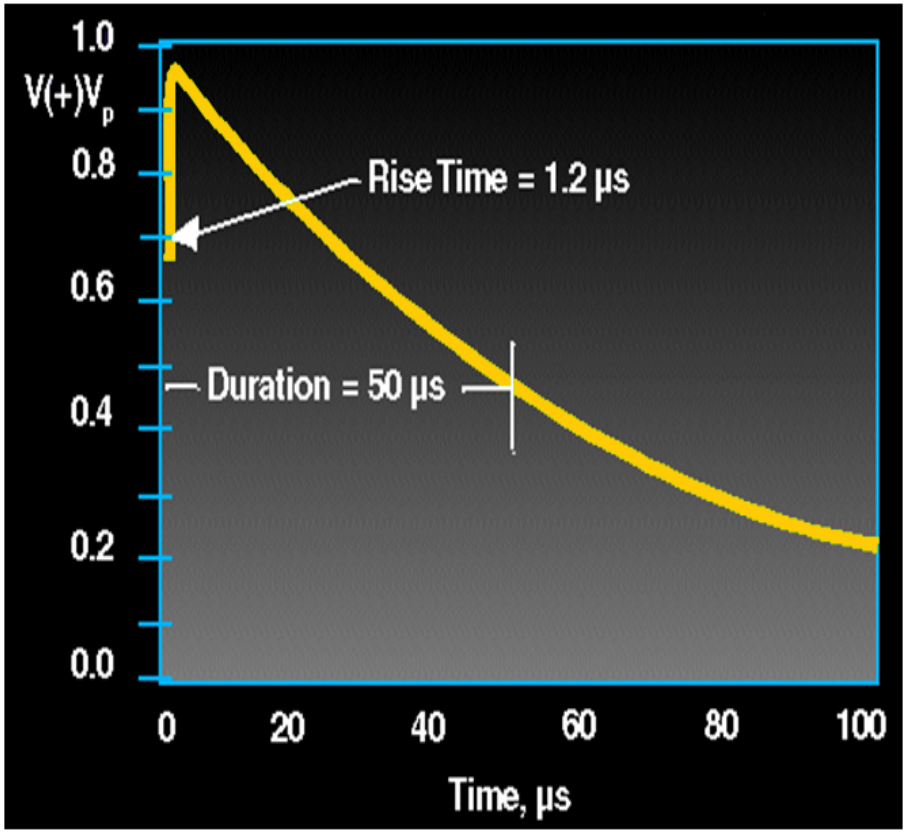
However, it is not the only important factor.

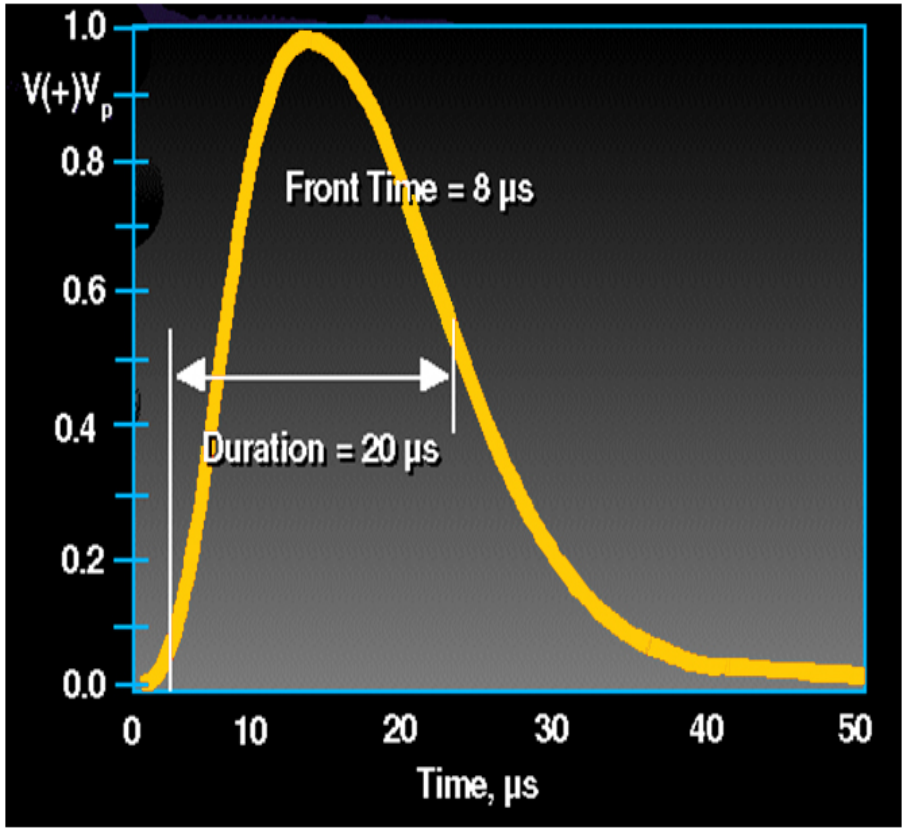
# Two Basic Types of Surge:
# Combination Wave
# Impulse

***and***

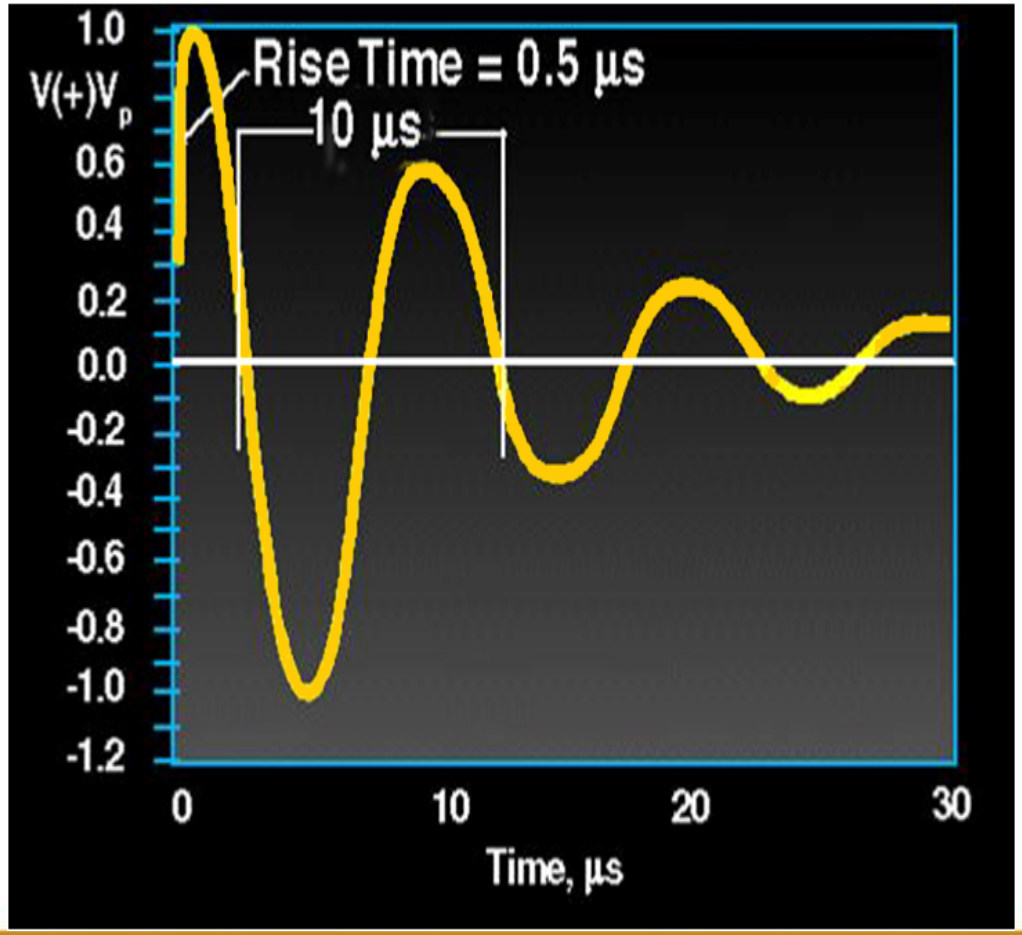
# Oscillatory Ring Wave

# Combination Wave Impulse



# Oscillatory Ring Wave



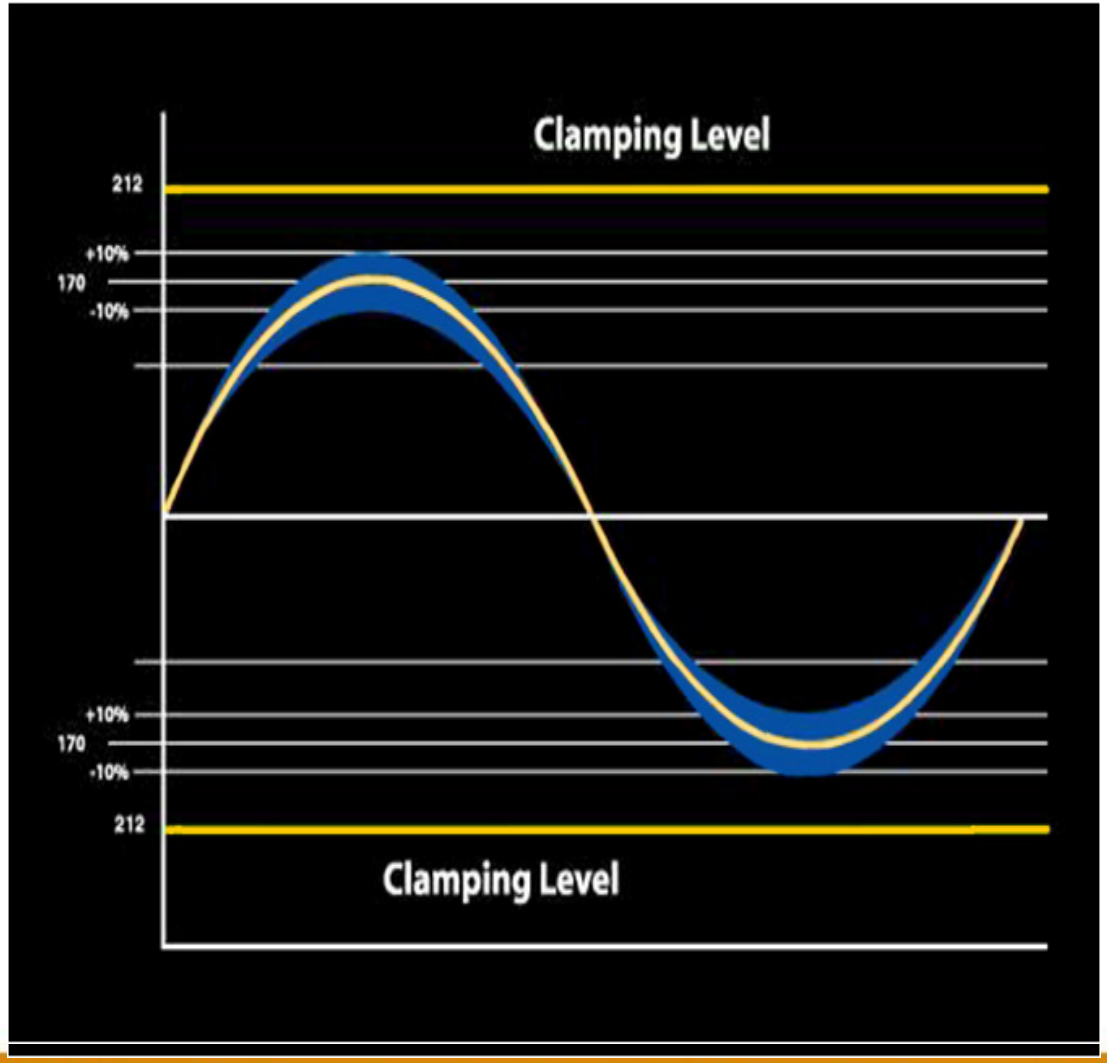
# Two Basic Types of SPD: Voltage Responsive Circuitry

*(Threshold, Standard or Fixed Clamping)*

***and***

Frequency Attenuation Circuitry

# Voltage Responsive Circuitry

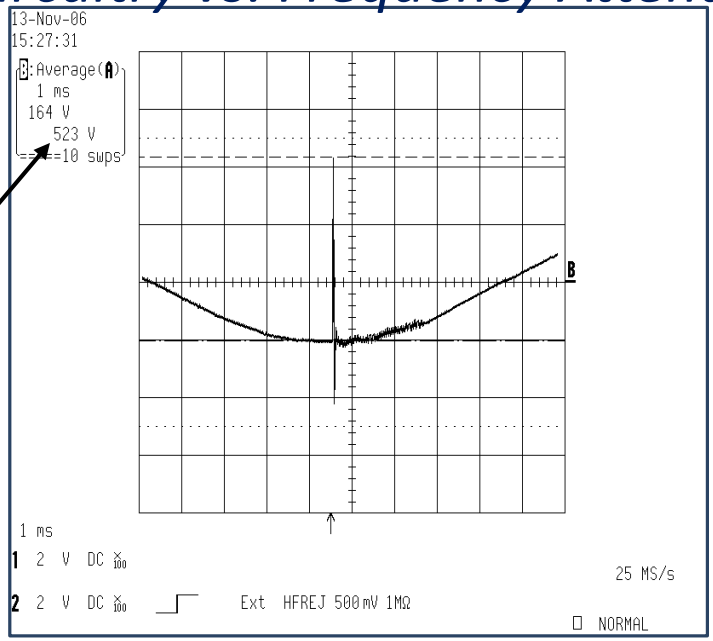


# Frequency Attenuation Circuitry

- Designed to address ring wave surges as they deviate from the power frequency sine wave without interaction with the applied power voltage sine wave.
- Unlike the *Voltage Responsive Circuitry*, “headroom” is not required for this type of circuitry to operate.
- **Reacts to a change in frequency** created by the surge.
- Operates independent of the voltage.

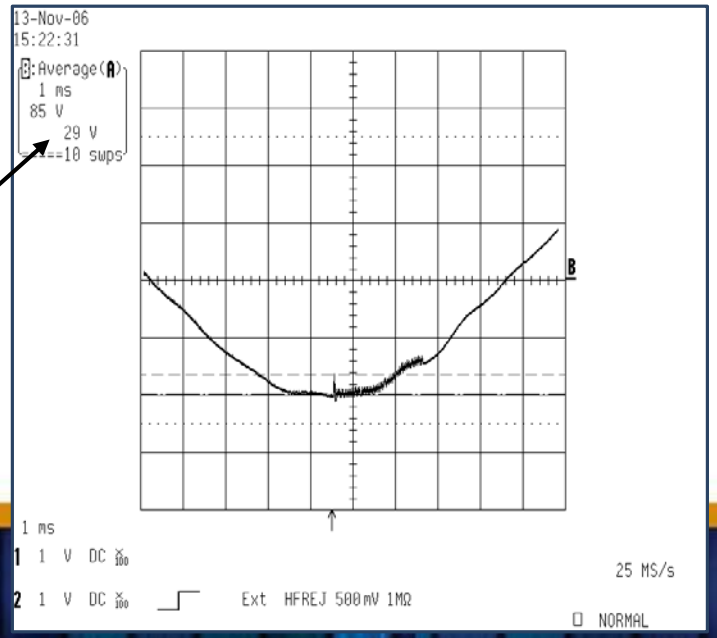
# *Voltage Responsive Circuitry vs. Frequency Attenuation Network*

Let-Through Voltage:
**523 volts**

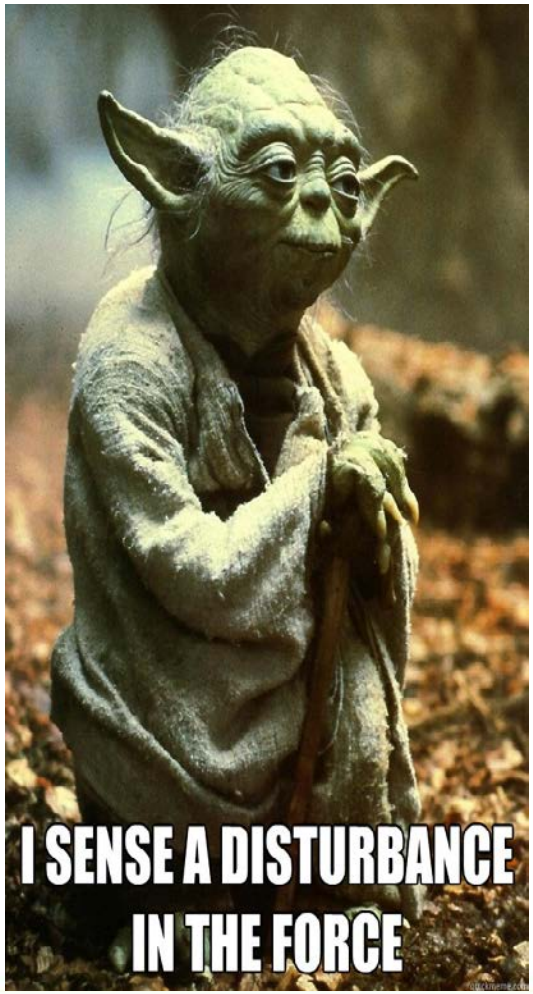



**2,000 Volt "Category A" Ring Wave (Part of the IEEE C62.41.2 Standard) Inserted at a 270⁰ phase angle for both examples**

Let-Through Voltage:
***29 volts!***

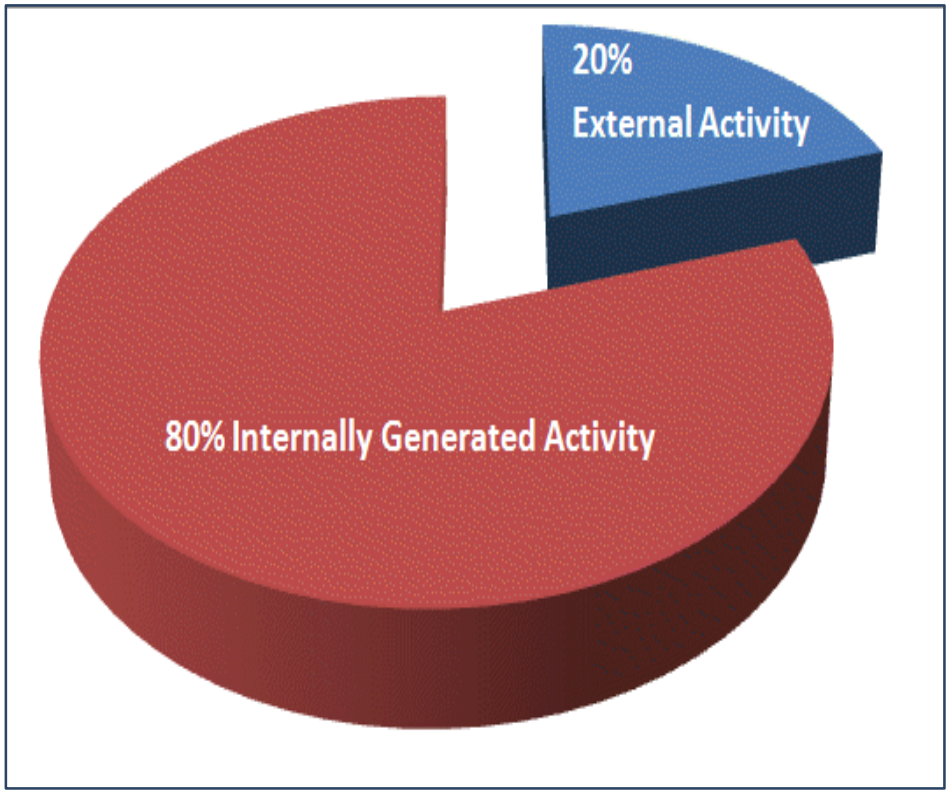


# Transient/Surge Origins



# Transient Events

(Approximately)




Source: General Electric "Current Scene," a bulletin of circuit protection technology

Figures based on nationwide averages

# External Sources:

**Lightning**

**Utility Switching**

**Power Outages**

**Utility Relay Operation**

**External Capacitor Banks**

These external events are both planned and unplanned. Others are spontaneous and uncontrolled.

# Internal Sources:

**Motors Switching "On" & "Off"**

**Production Machines**

**Welders**

**Copier Machines**

**Fluorescent Lighting**

**AC Chillers**

**Robotics**

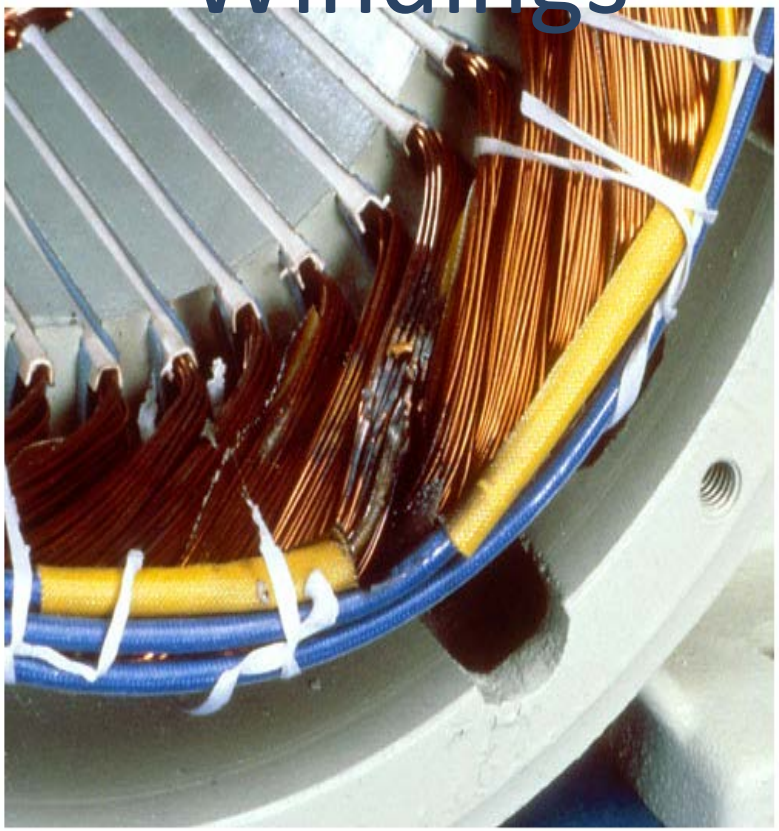
**Capacitor Banks**

**Laser Printers**

**Variable Frequency Drives**

Everyday operation of typical equipment inside your facility creates electrical surge activity that causes cumulative damage!

# Typical Causes of Winding Failures in Three-Phase Stator Windings

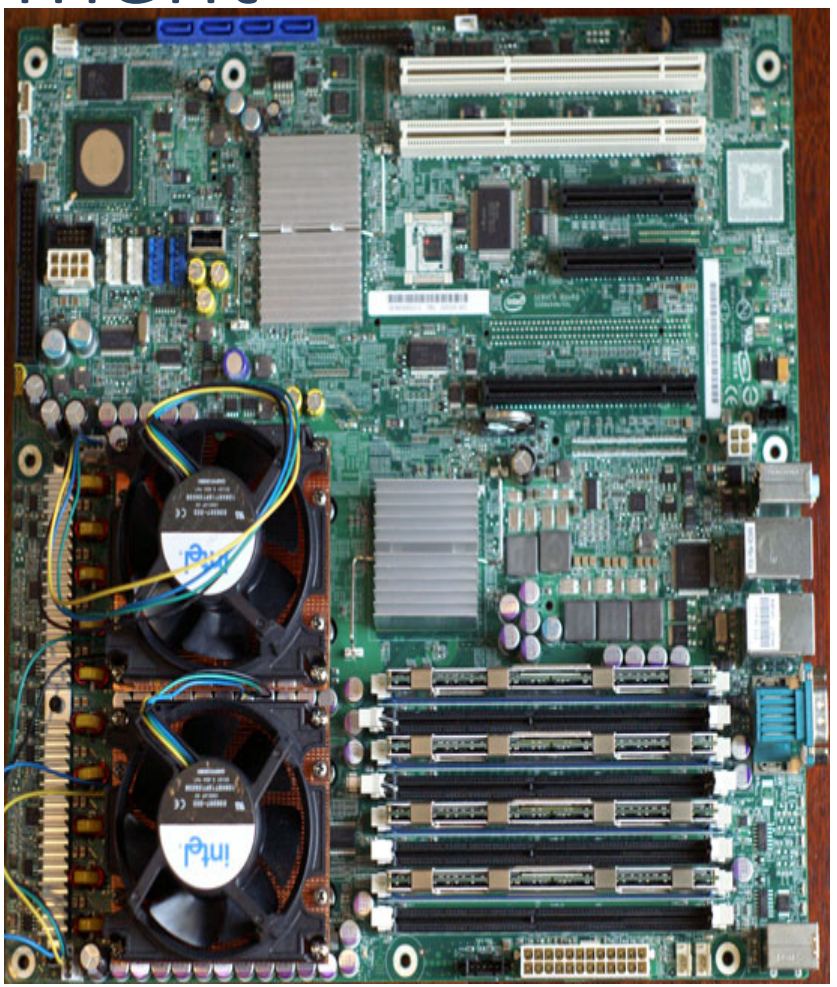


Winding Damaged by Voltage Surge

# Effects Of Transients On Electronic Equipment

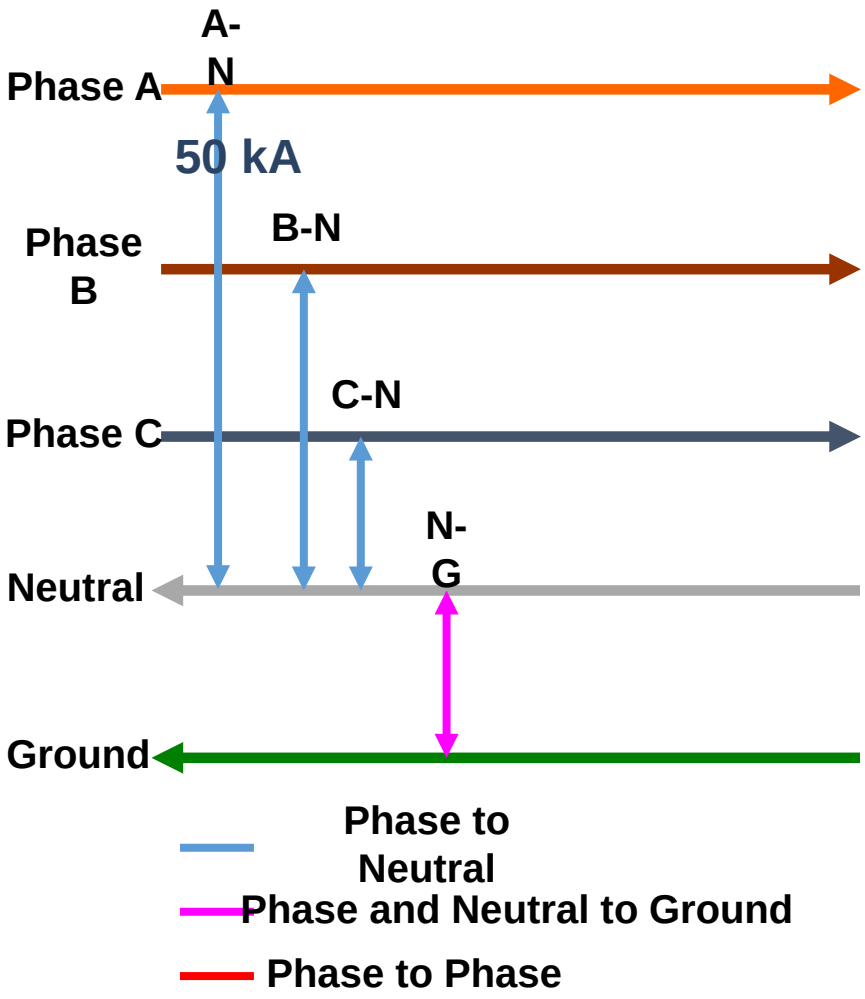
PC boards contain hundreds or even thousands of circuits

Processors can have billions of circuits on a single chip

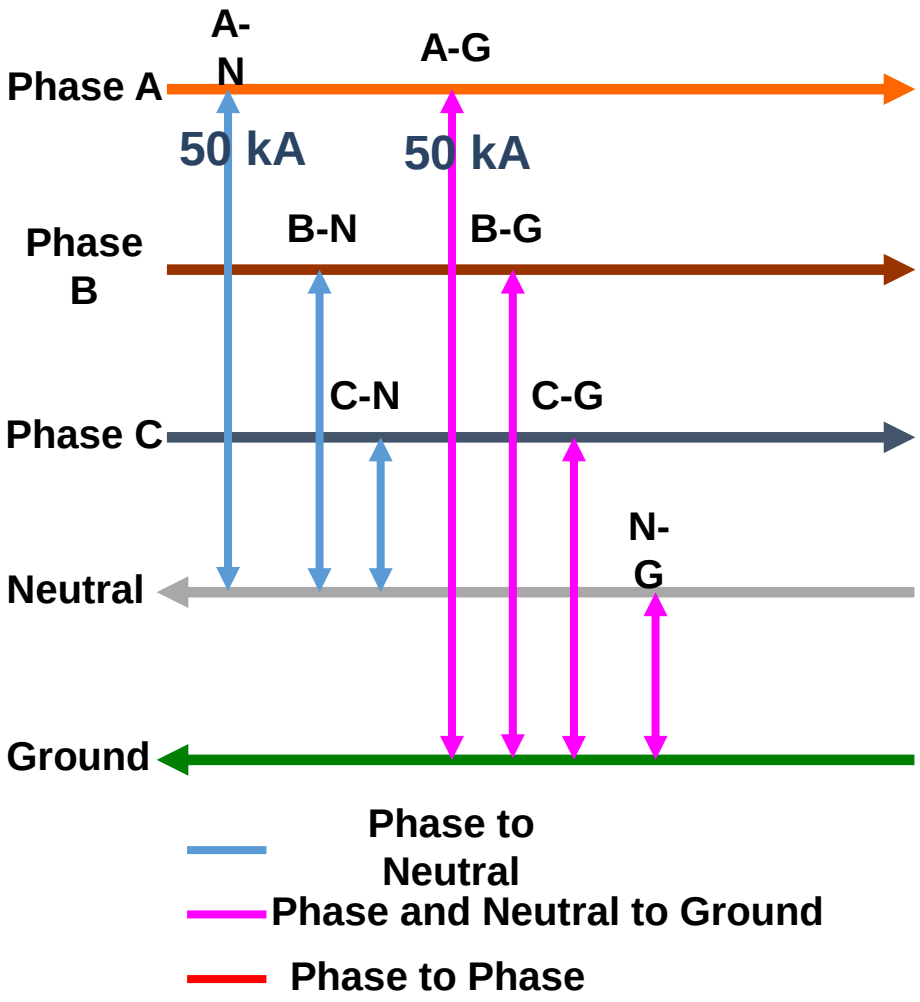


# Modes of Protection

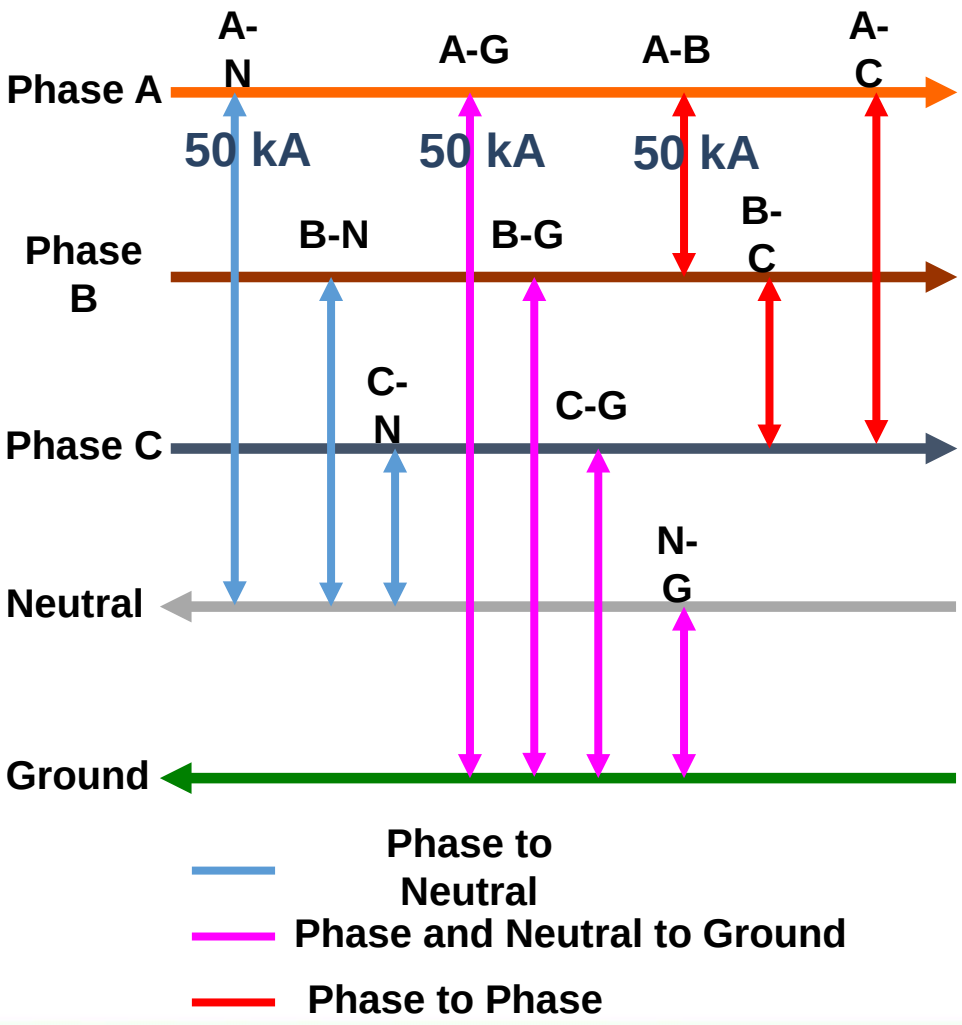
# 4-Mode Protection



# 7-Mode Protection



# 10-Mode Protection





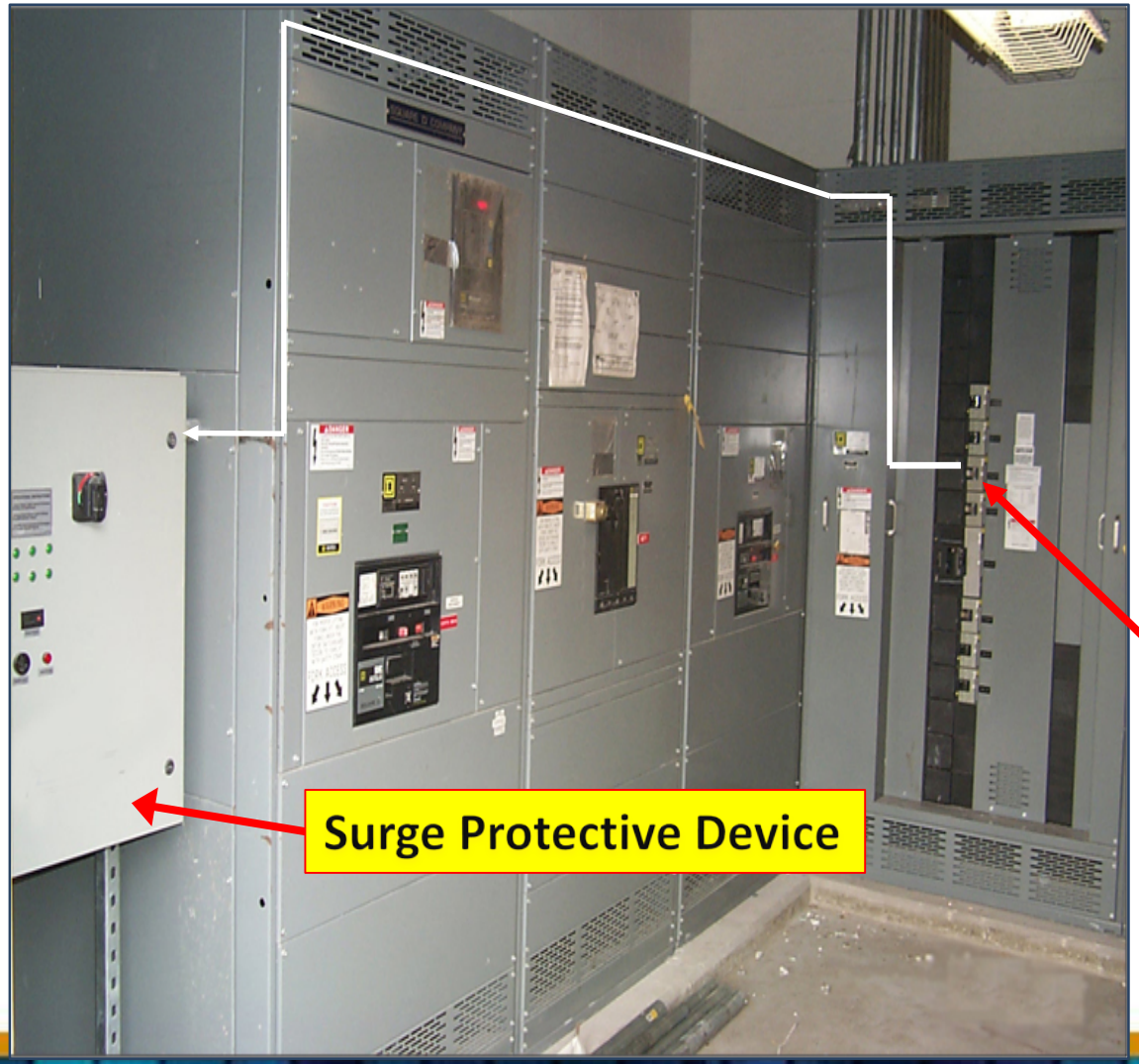
# SineTamer Models

# Lead Length

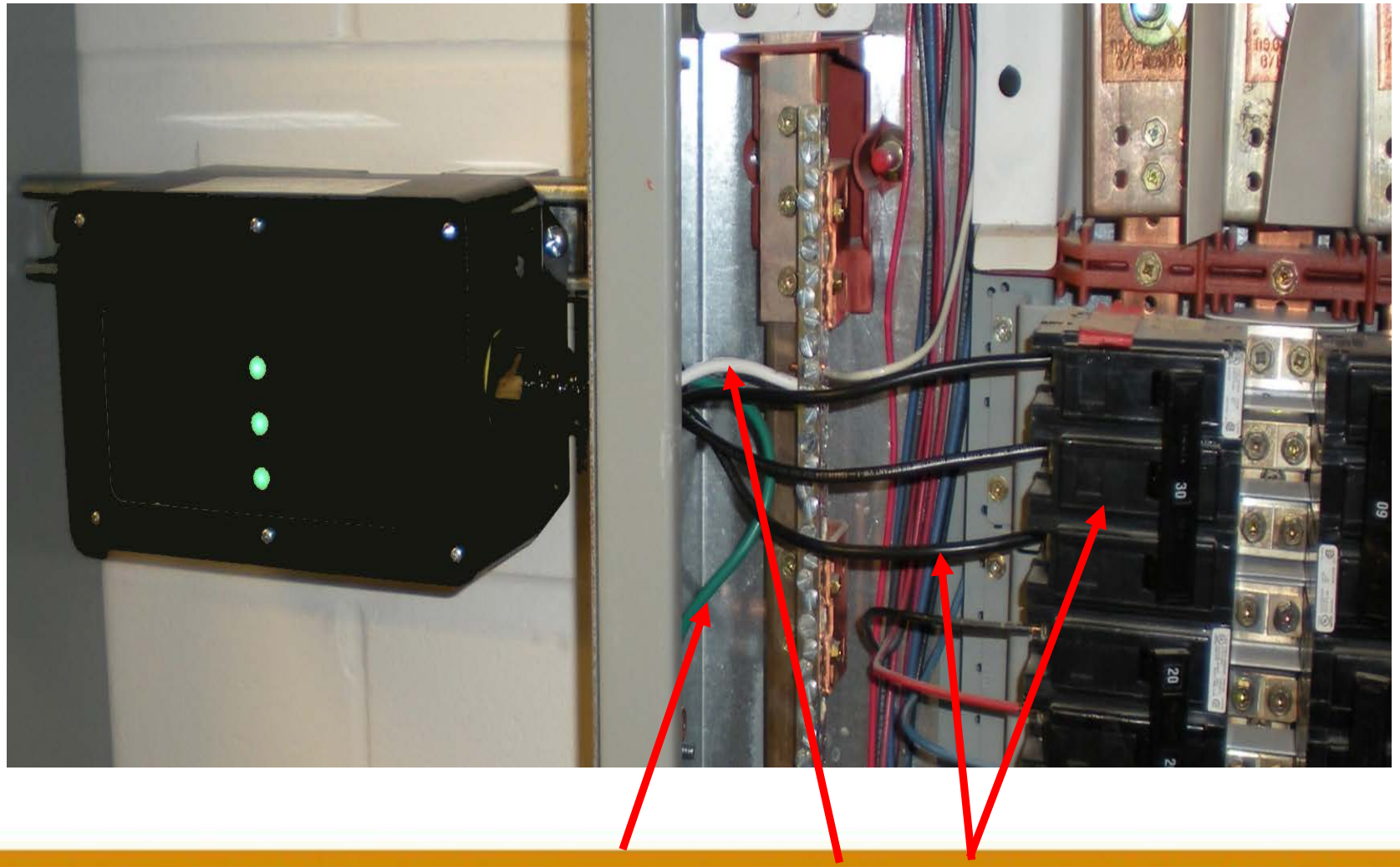
- The amount of external wire required to connect the SPD to the electrical system or equipment
- **NEC Section 285.12 requires** all wire leads to be as short and straight as possible
- Avoid sharp bends in the conductors
- Short leads result in optimum performance; better equipment protection; AND lower let-through voltages

IEEE Std 1100-2005, Emerald Book, Section 8.6.2

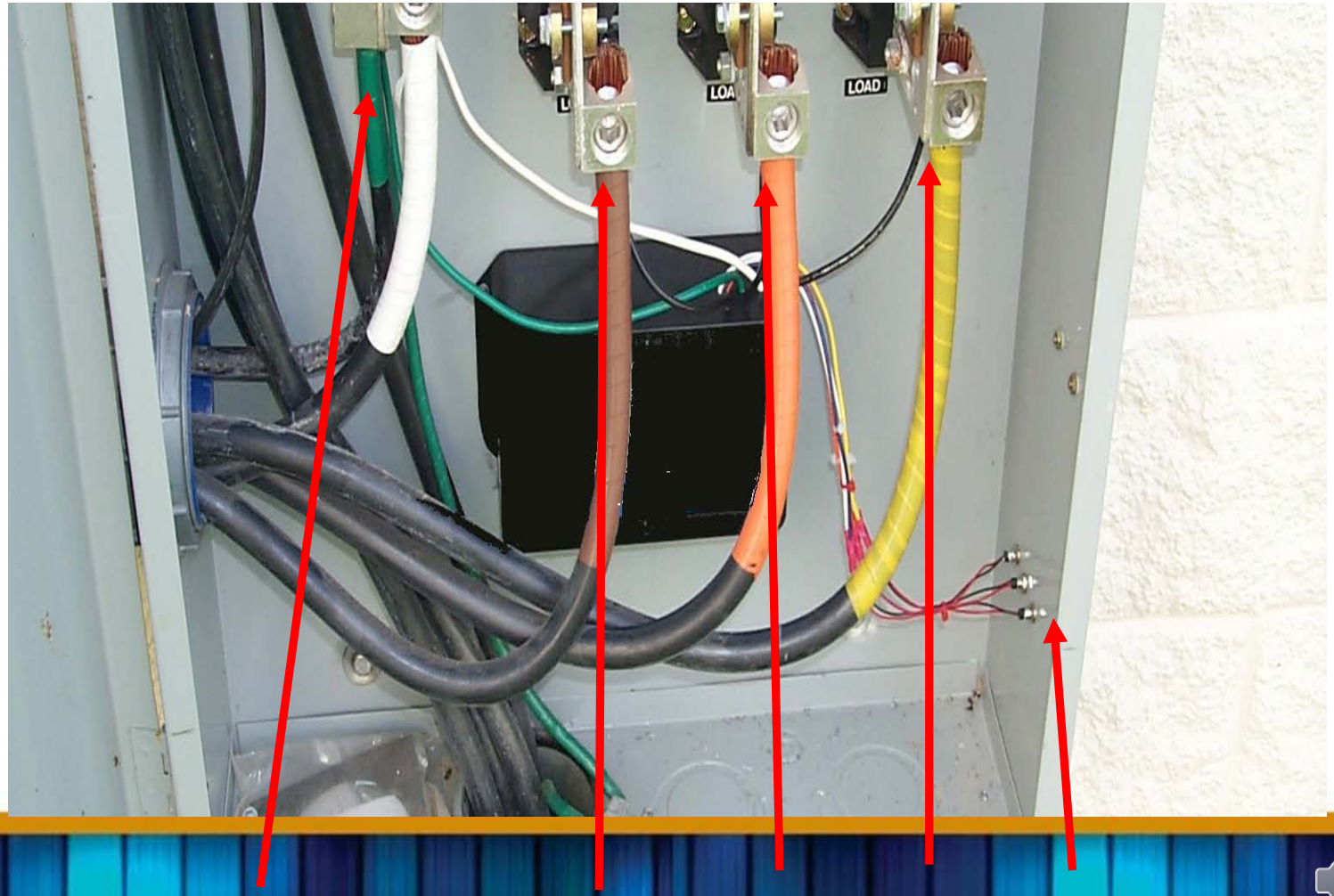
# Improper Installation of SPD



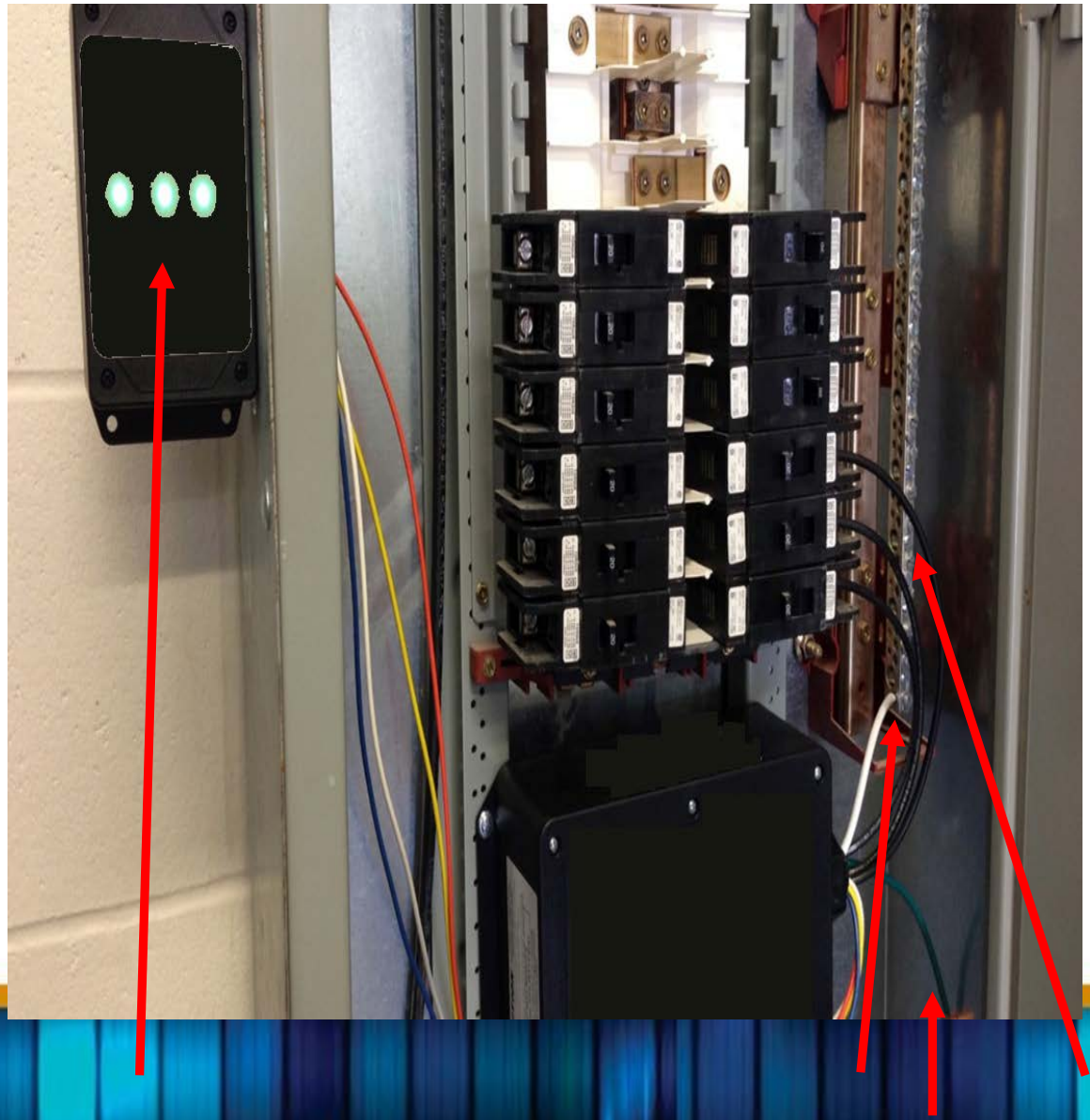
# Almost Perfect Installation of an SPD



# Proper Installation Inside a Fused Disconnect

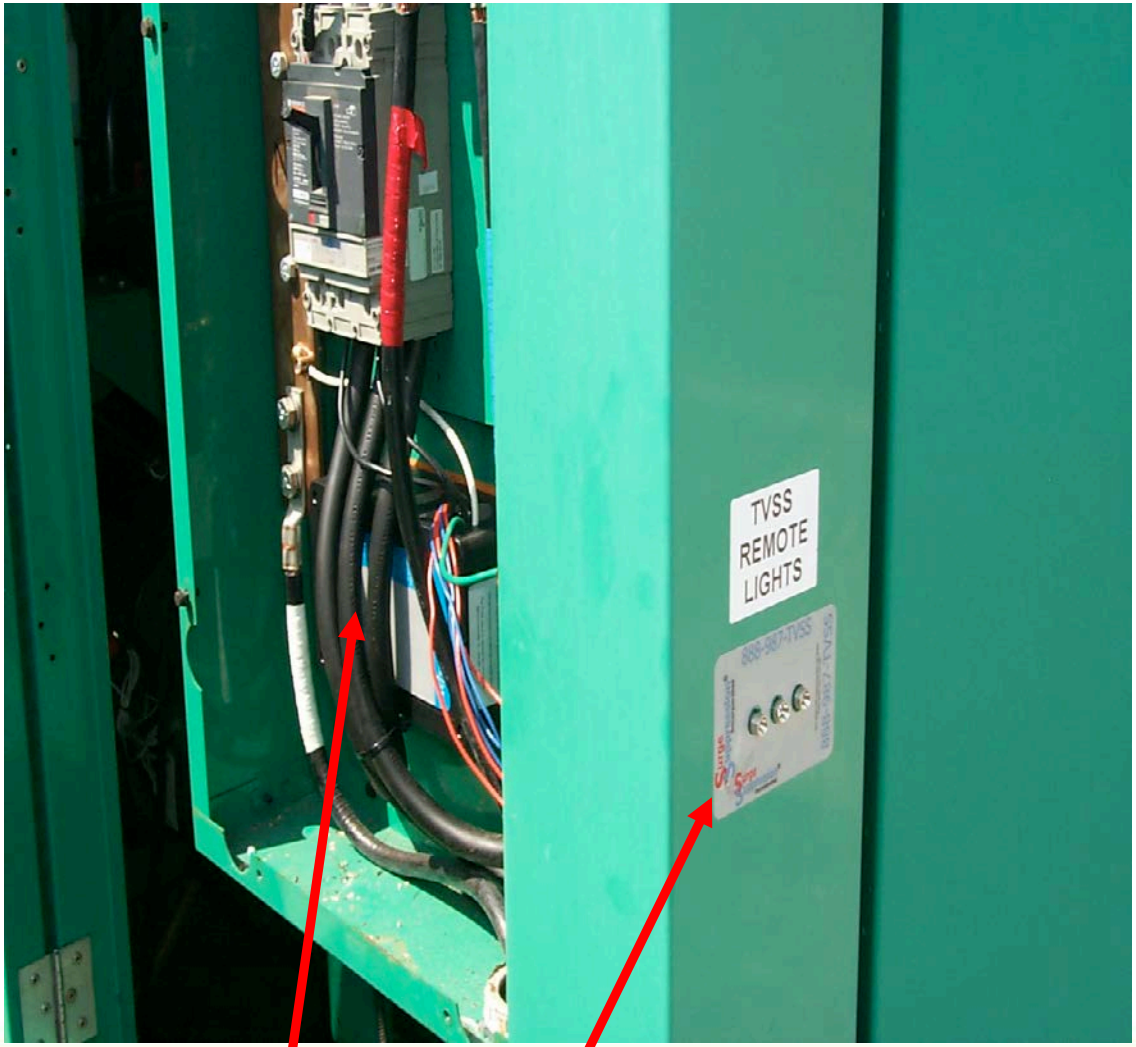


# Proper Installation in a Branch Panel



# Proper Installation SPD in Bucket of MCC

# Proper Installation in a Generator



Transient voltage surges occur every day in every electrical environment, where they ***are*** causing damage. Sometime this damage is ***catastrophic,*** but mostly it is ***cumulative.*** Either way, it is often dismissed as “normal” or just the “cost of doing business!”

Transient voltage surges occur every day in every electrical environment, where they ***are*** causing damage. Sometime this damage is ***catastrophic,*** but mostly it is ***cumulative.*** Either way, it is often dismissed as “normal” or just the “cost of doing business!”

***However, it doesn’t have to be this way!***

# Remember the *"Three R Rule:"*

- **R**ight Product
  - **R**ight Location
    - **R**ight Installation

# The End Results:

- Reduced Maintenance
- Reduced Downtime
- Improved Productivity
- Lower Operating Costs
- Catastrophic Protection
- Peace of Mind!

# *WARRANTY*

With the ***"SineTamer®"*** up to 25 year,

unlimited replacement warranty for any electrical anomaly,

***including lightning***,

**ECS** has the right surge protector

for every application's needs.

# Variable Frequency Drives

A **Variable Frequency Drive** (**VFD**) is a type of motor controller that **drives** an electric motor by varying the **frequency** and voltage supplied to the electric motor. Other names for a **VFD** are **variable** speed **drive**, adjustable speed **drive**, adjustable **frequency drive**, AC **drive**, microdrive, and inverter.

# Variable Frequency Drives

**What do these systems look like?**

**How do we protect them?**

120 Vac, 1 Ø

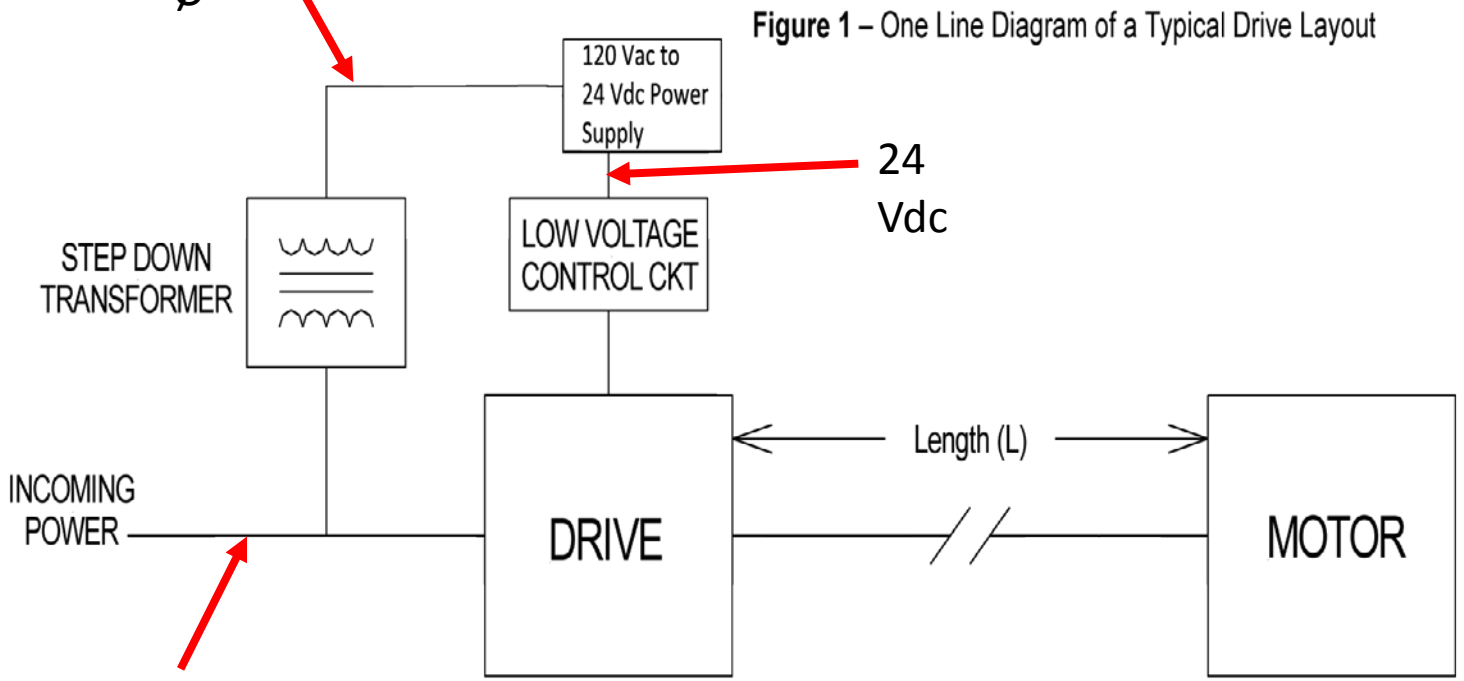



**Figure 1** – One Line Diagram of a Typical Drive Layout

480 Vac, 3 Ø
3 W, Delta

AC to Rectifier to DC
AC to Rectifier to DC Bus
To Inverter to AC

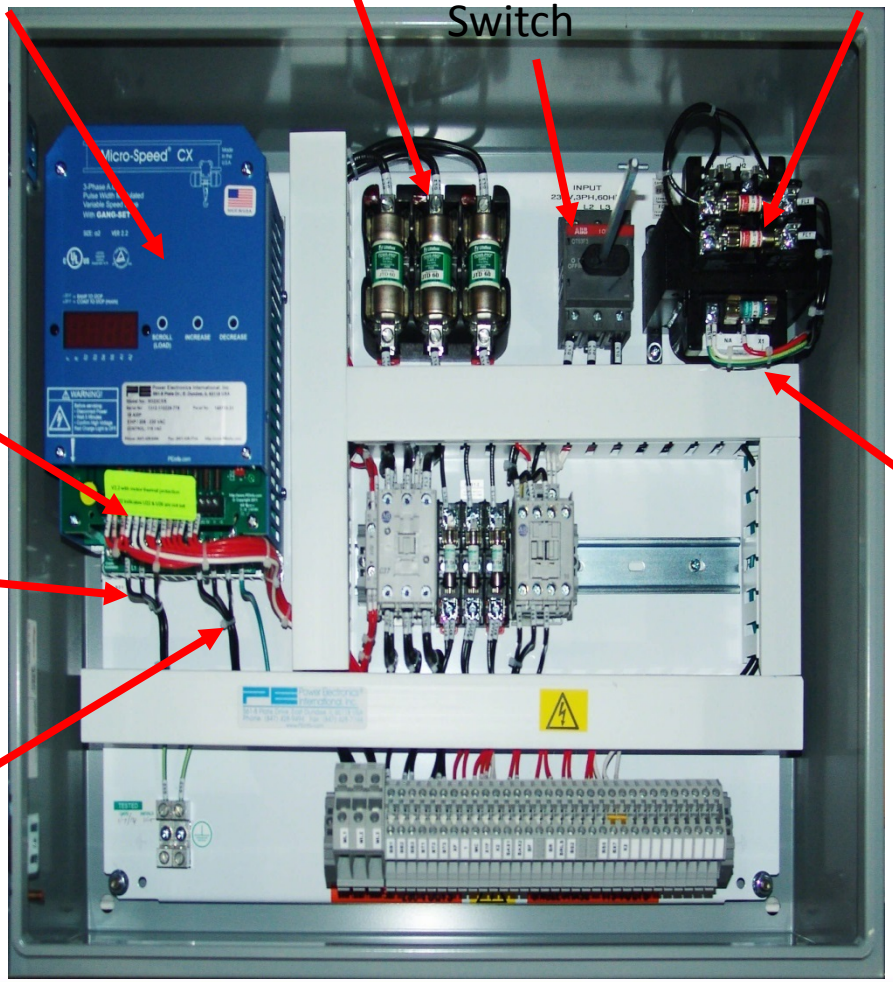
Adjust DC Voltage to control speed of DC motor
Adjust AC Voltage & Frequency to control speed of AC motor

Variable Frequency Drive

Incoming 230 Vac

Main Switch

Step-Down Transformer




Drive Control Voltage

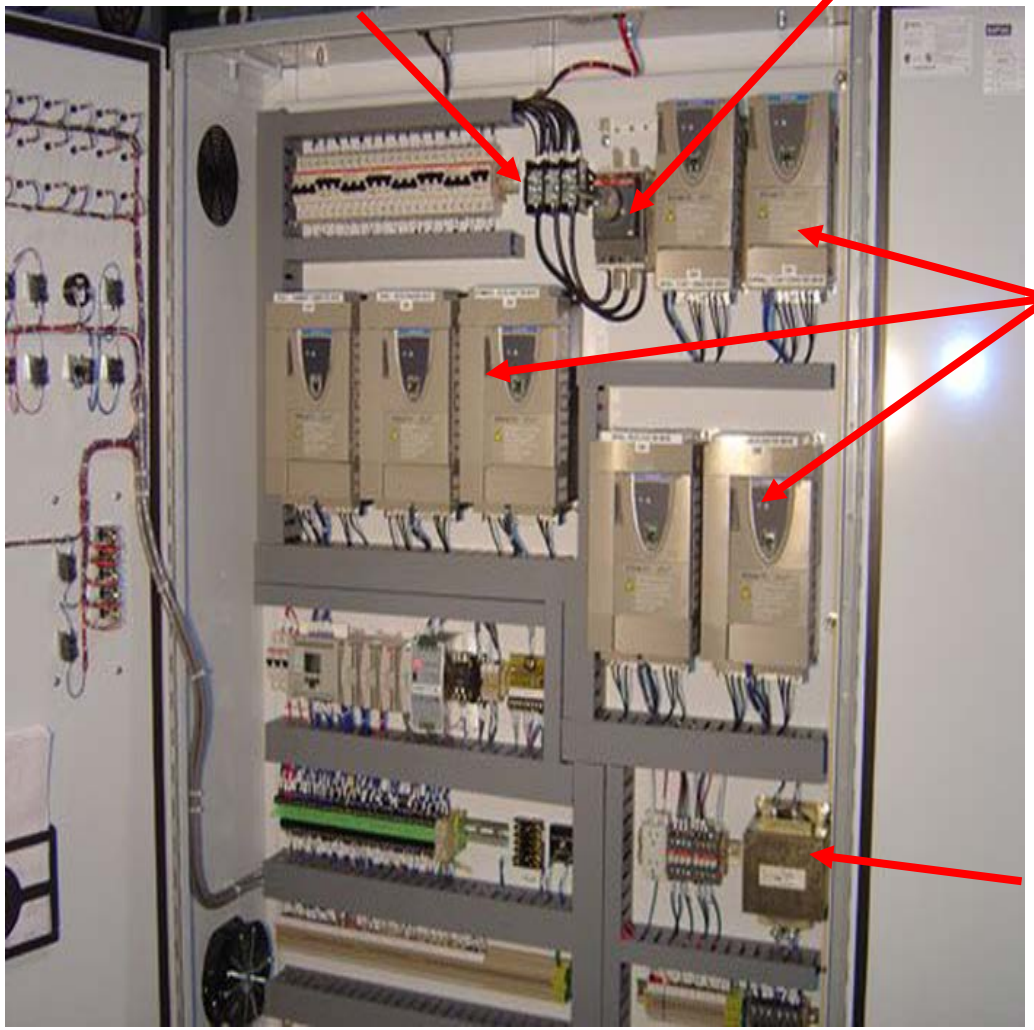
Incoming Drive Power

Outgoing Drive Power

120 Vac Control Voltage

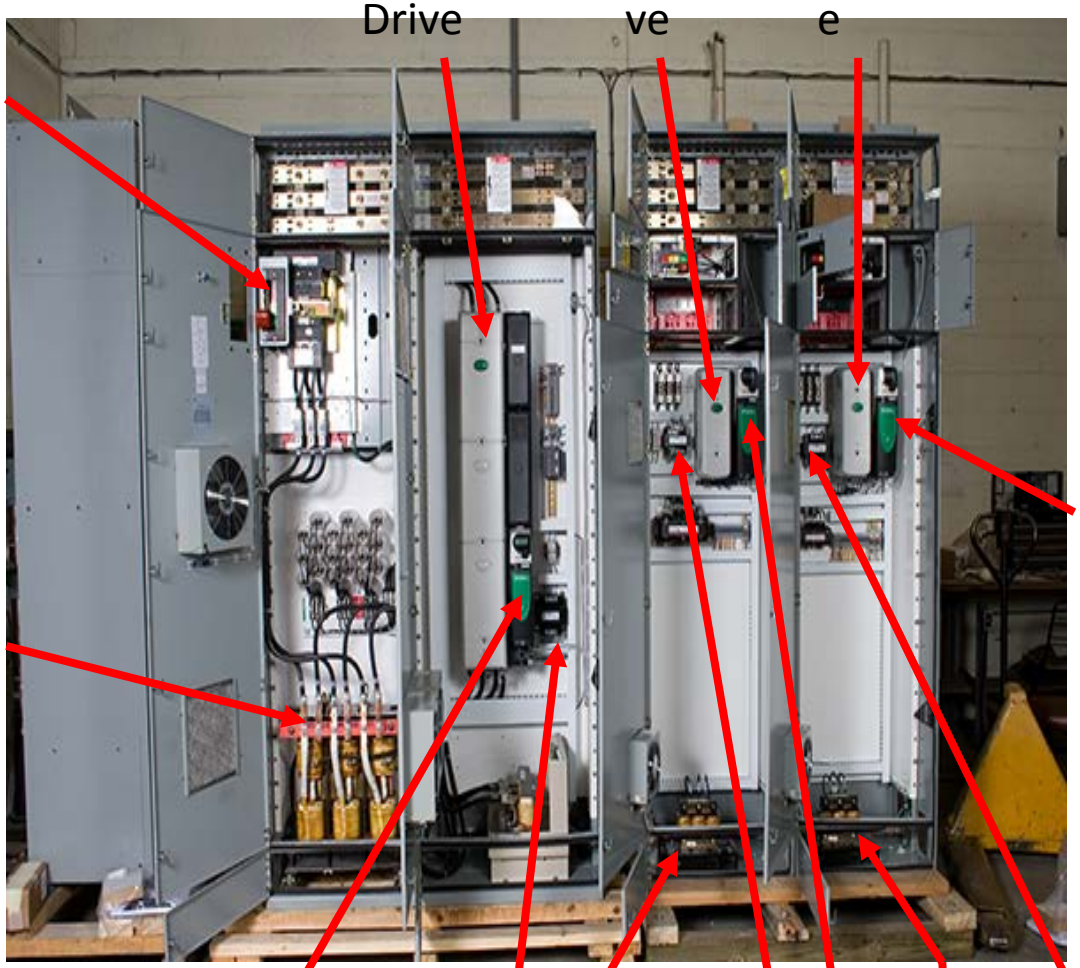
Distribution Block

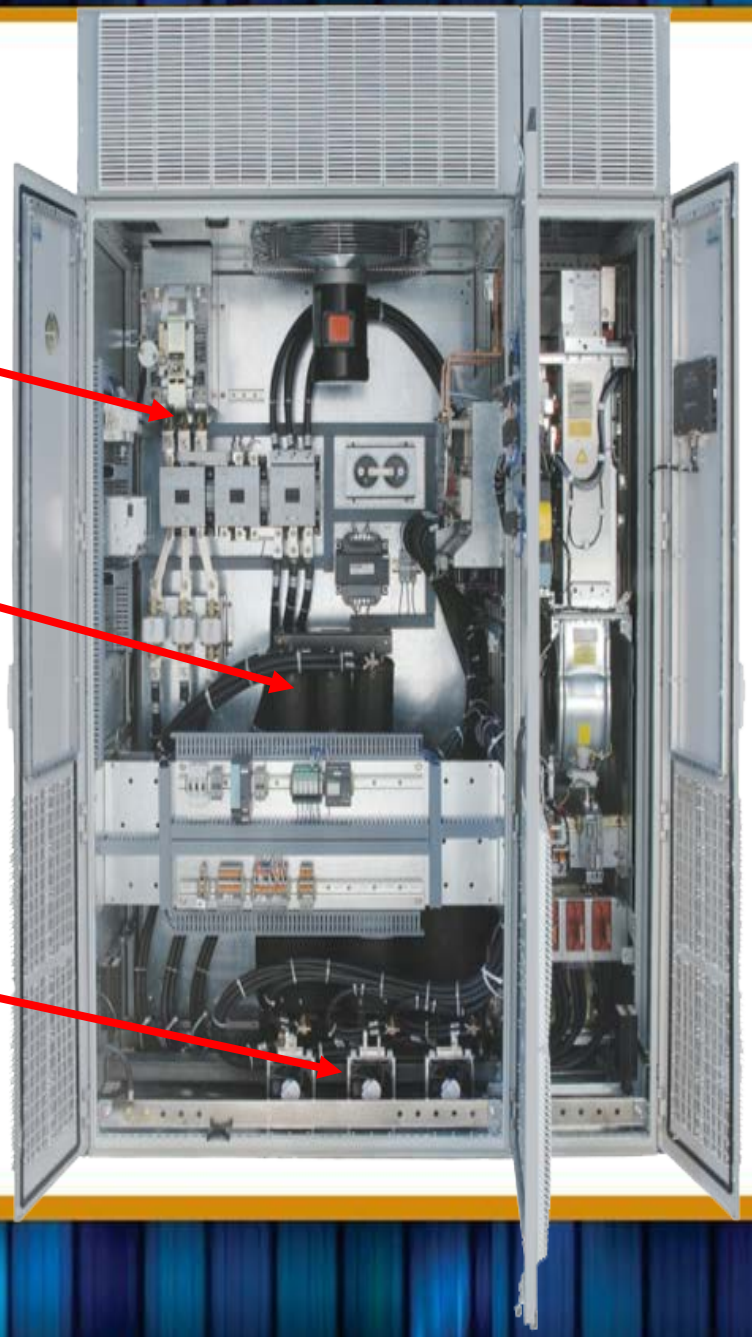
Main Incoming Power 480 Vac 3 Ø



Seven VFDs

480 Vac to 120 Vac Step-down Transformer for Electronic Control Voltage


Incoming 480 Vac, 3 Ø
Main Drive
Drive
Drive
Power Supply
Line Reactor
Power Supply
Step-down transformer
Line Reactor
Step-down transformer
Power Supply
Line Reactor
Step-down transformer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Line
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# Variable Frequency Drives

**What do these systems look like?**

**How do we protect them?**

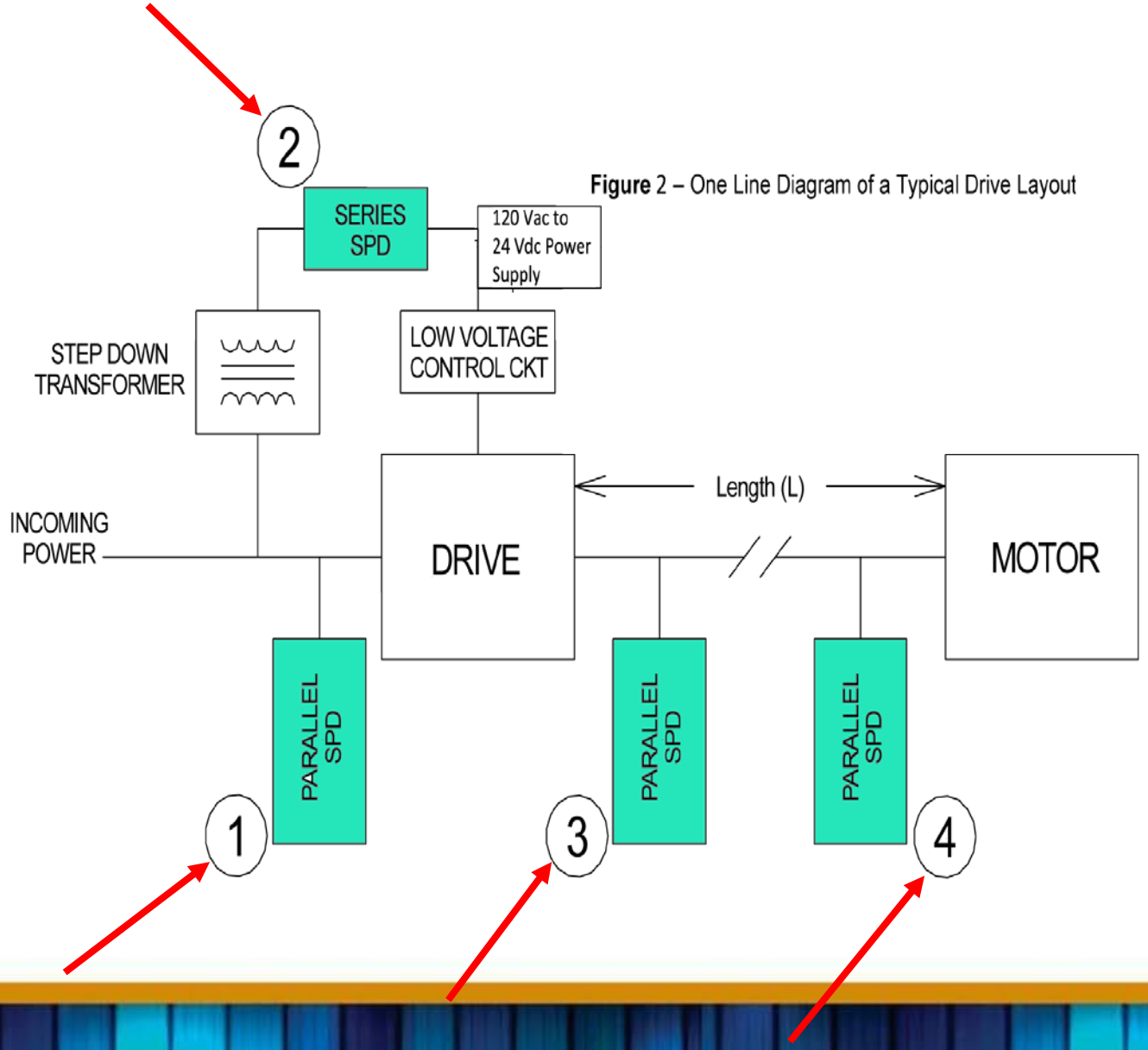



**Figure** 2 – One Line Diagram of a Typical Drive Layout

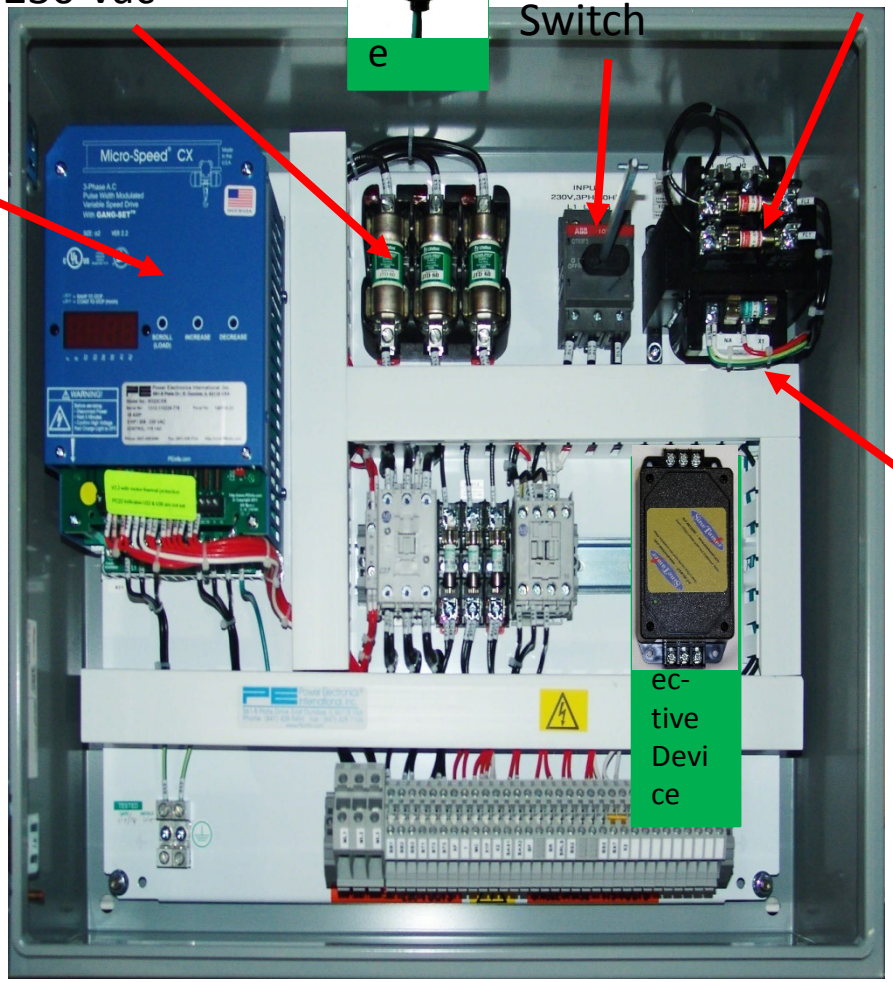
Variable Frequency Drive

Incoming 230 Vac

e

Main Switch

Step-Down Transformer

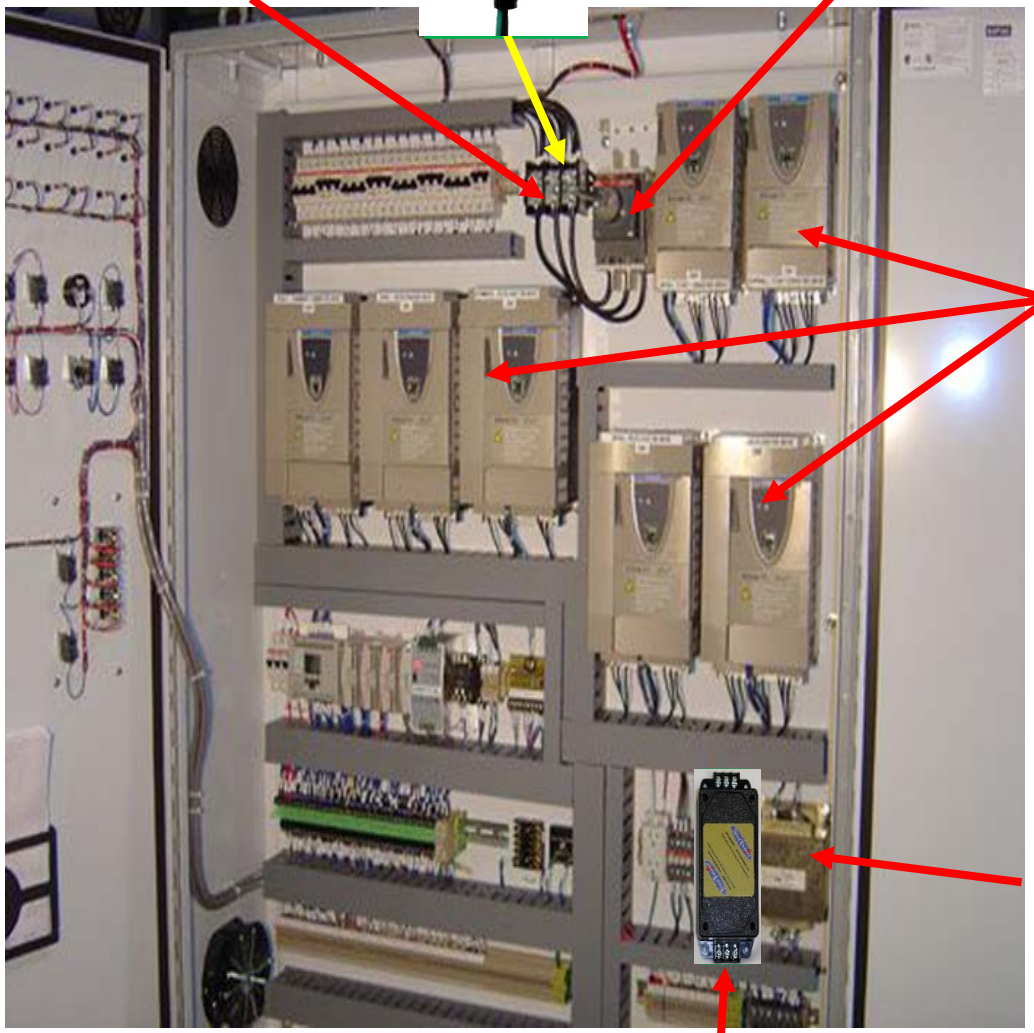



120 Vac Control Voltage

ec-tive Devi ce

Distribution Block

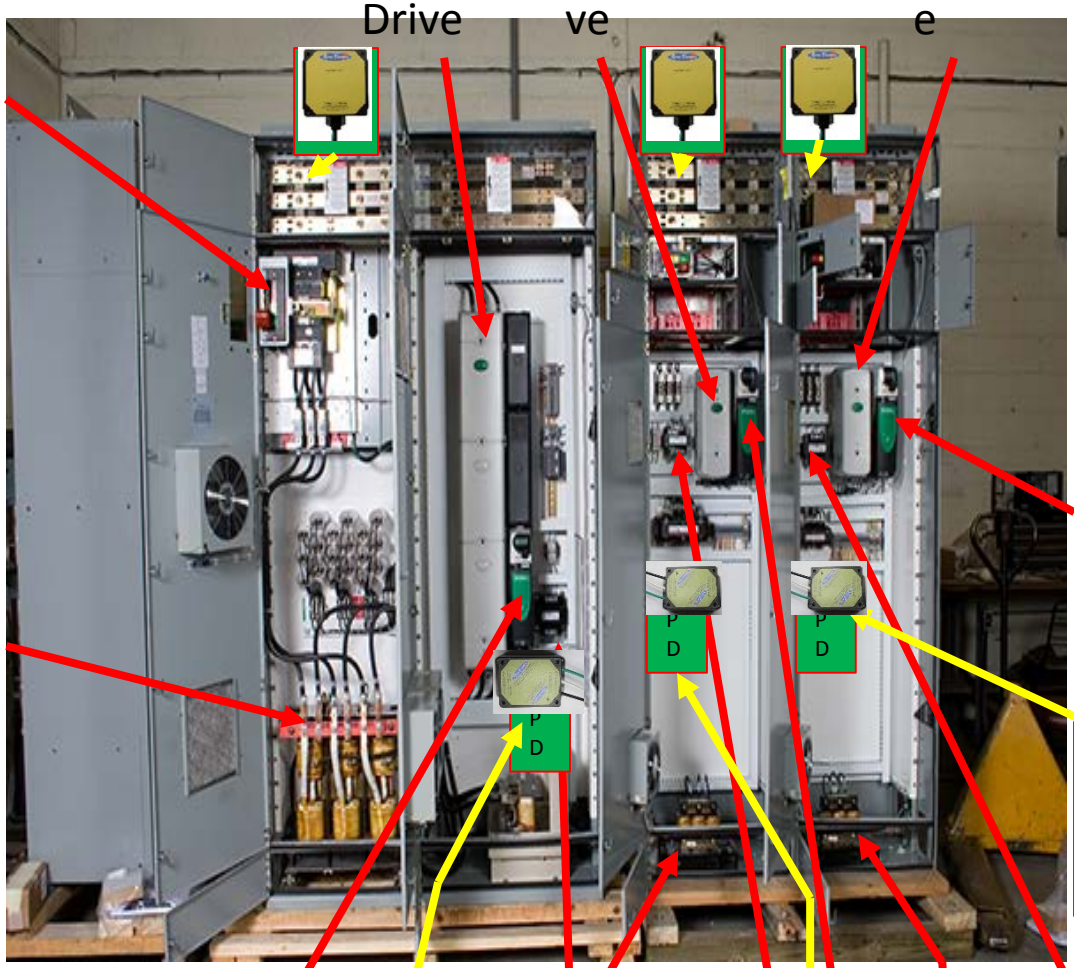

Main Incoming Power 480 Vac 3 Ø

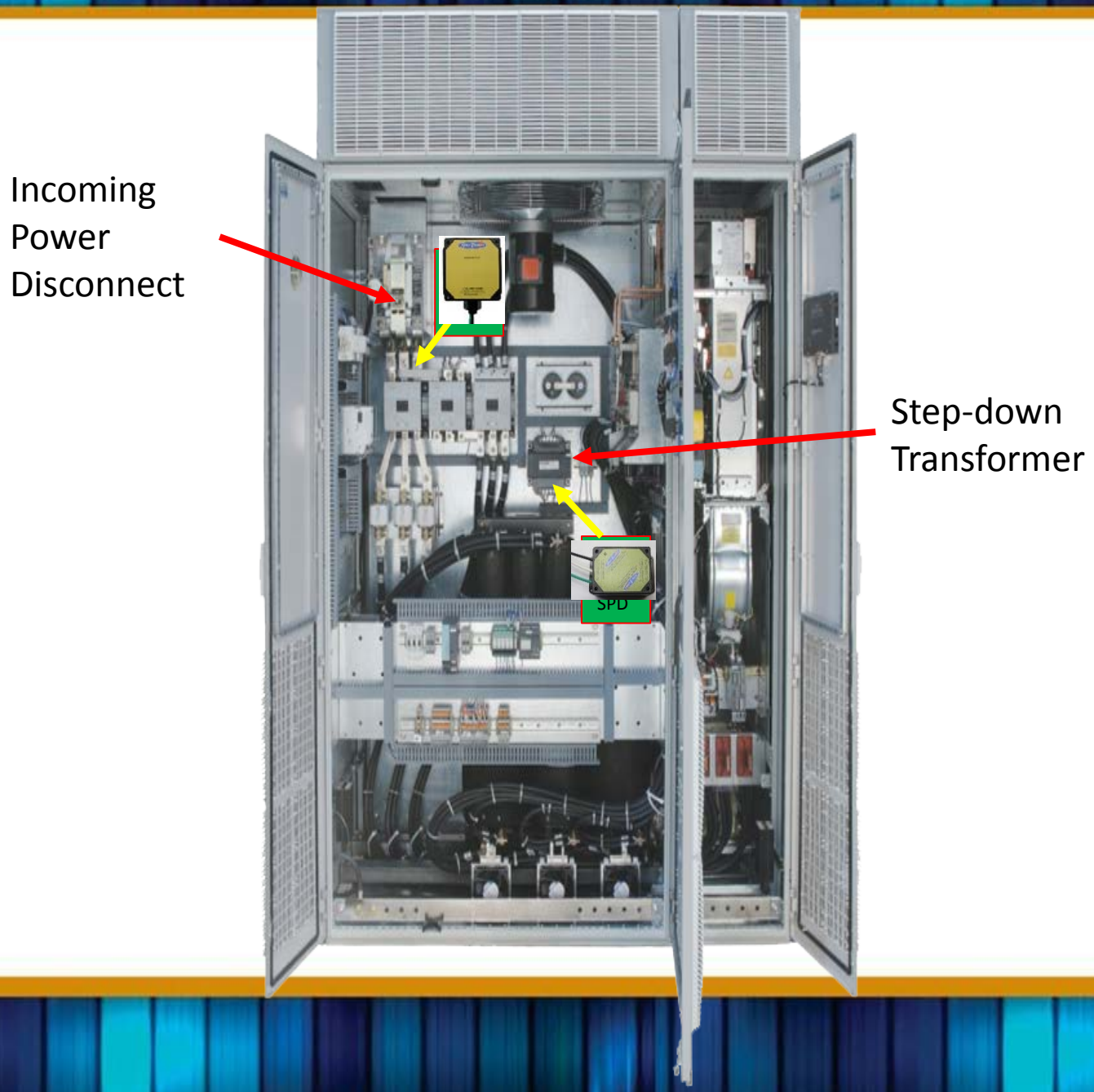


Seven VFDs

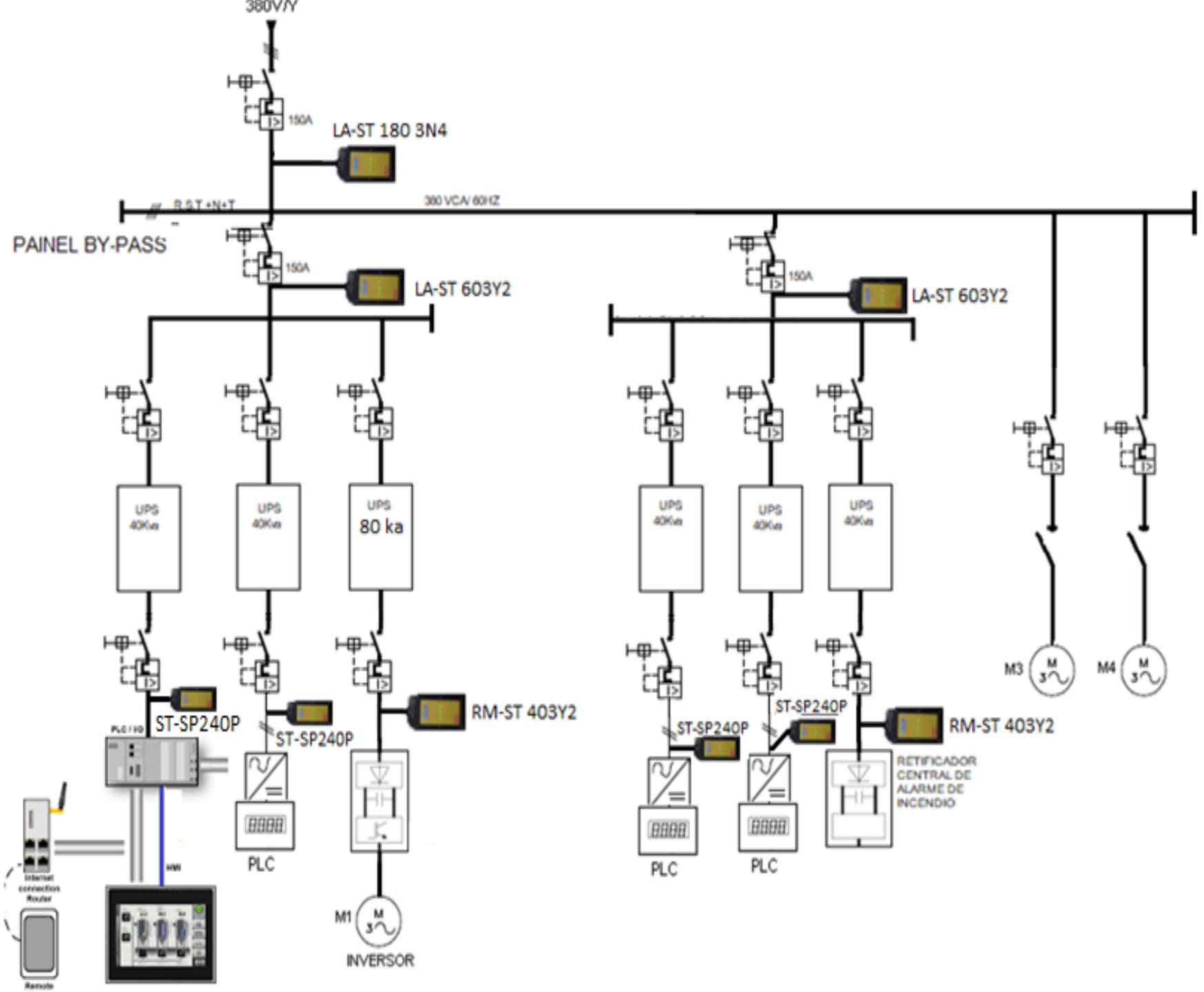
480 Vac to 120 Vac Step-down Transformer for Electronic Control Voltage

Series wired SPD for output of 120 Vac transformer


Main Drive
Drive
Drive
Incoming 480 Vac, 3 Ø
Line Reactor
Power Supply
Step-down transformer
Step-down transformer
Power Supply
Step-down transformer
Line Reactor
Line Reactor
Series SPD
Series SPD
Power Supply
SPD
SPD
SPD


Incoming
Power
Disconnect
Step-down
Transformer
SPD


INDUSTRY
4.0


380V/Y
150A
LA-ST 180 3N4
R S T +N+T
380 VCA/ 60HZ
PAINEL BY-PASS
150A
LA-ST 603Y2
150A
LA-ST 603Y2
UPS 40Kva
UPS 40Kva
UPS 80 ka
UPS 40Kva
UPS 40Kva
UPS 40Kva
ST-SP240P
ST-SP240P
RM-ST 403Y2
ST-SP240P
ST-SP240P
RM-ST 403Y2
RETIFICADOR CENTRAL DE ALARME DE INCENDIO
PLC
PLC
PLC
M1
INVERSOR
M3
M4

# Industry 4.0: How the Internet of Things is Revolutionizing Manufacturing

Industry 4.0 might sound like the newest iteration of a SimCity-style tycoon game, but it's really the biggest shift to hit global manufacturing since automation. Centered around advanced robotics and automation, new ways of human-machine interaction (such as augmented reality) and vast troves of data and boosted connectivity, Industry 4.0 is poised to modernize manufacturing and boost western industrial competitiveness.

BUSINESS NEWS DAILY

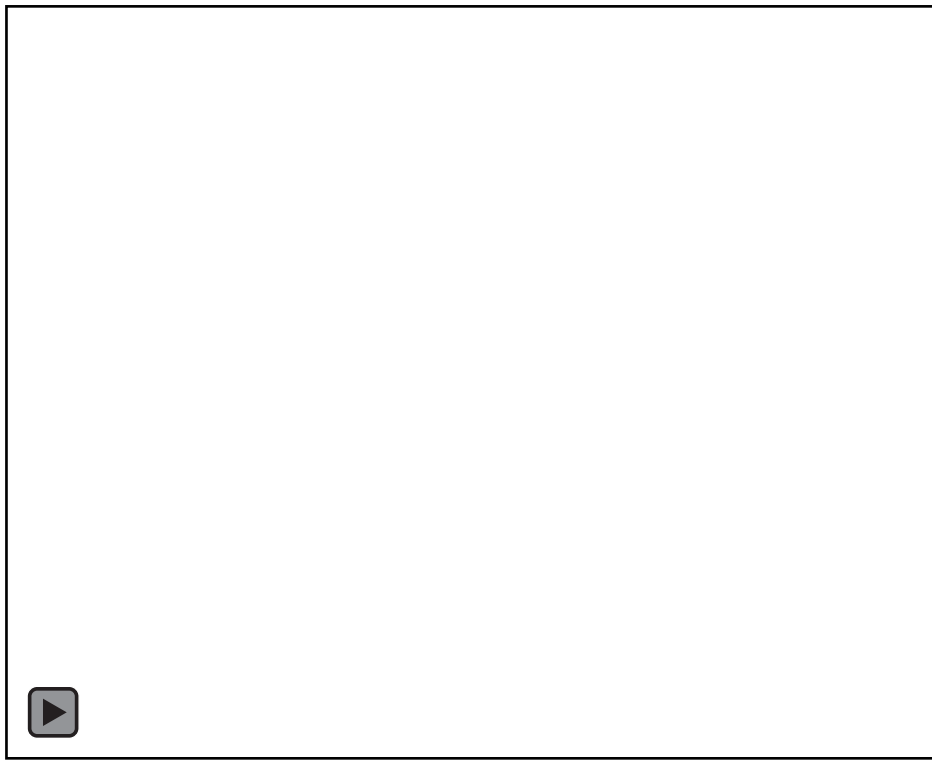
Small Business Solutions & Inspiration


Impossible
Possible

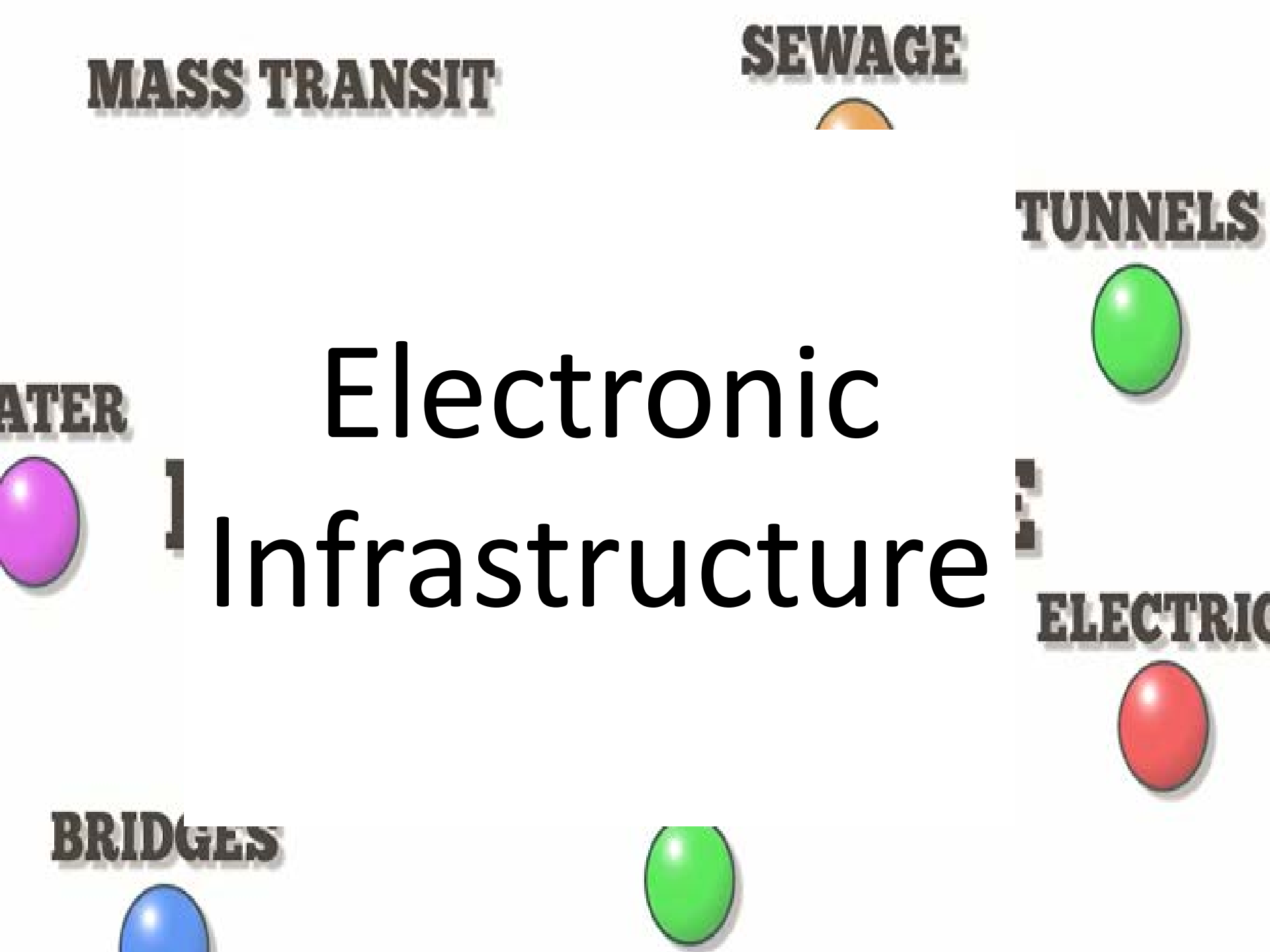
# We are in need of a paradigm shift…

Simply investing in 21st century production, processing, manufacturing equipment is not enough to produce and insure greater profitability.

There is more required!



It is imperative that we do not ignore these trends…

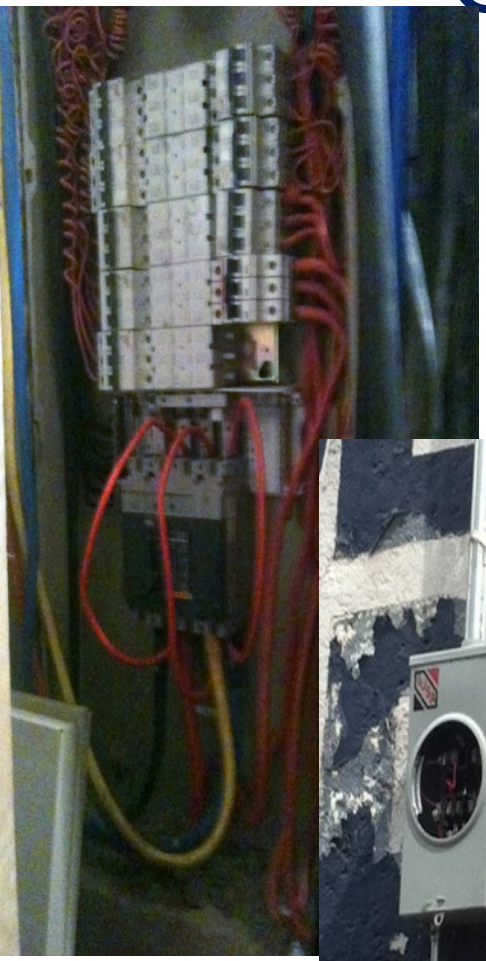



# Electronic Infrastructure

# What comprises electronic infrastructure?

- Facility Grounding
- Lightning Protection
- Surge Protection
- UPS/Generators
- Harmonics
- Power Factor

# Issues with Power Quality?



Leonardo ENERGY

# European Power Quality Survey Report

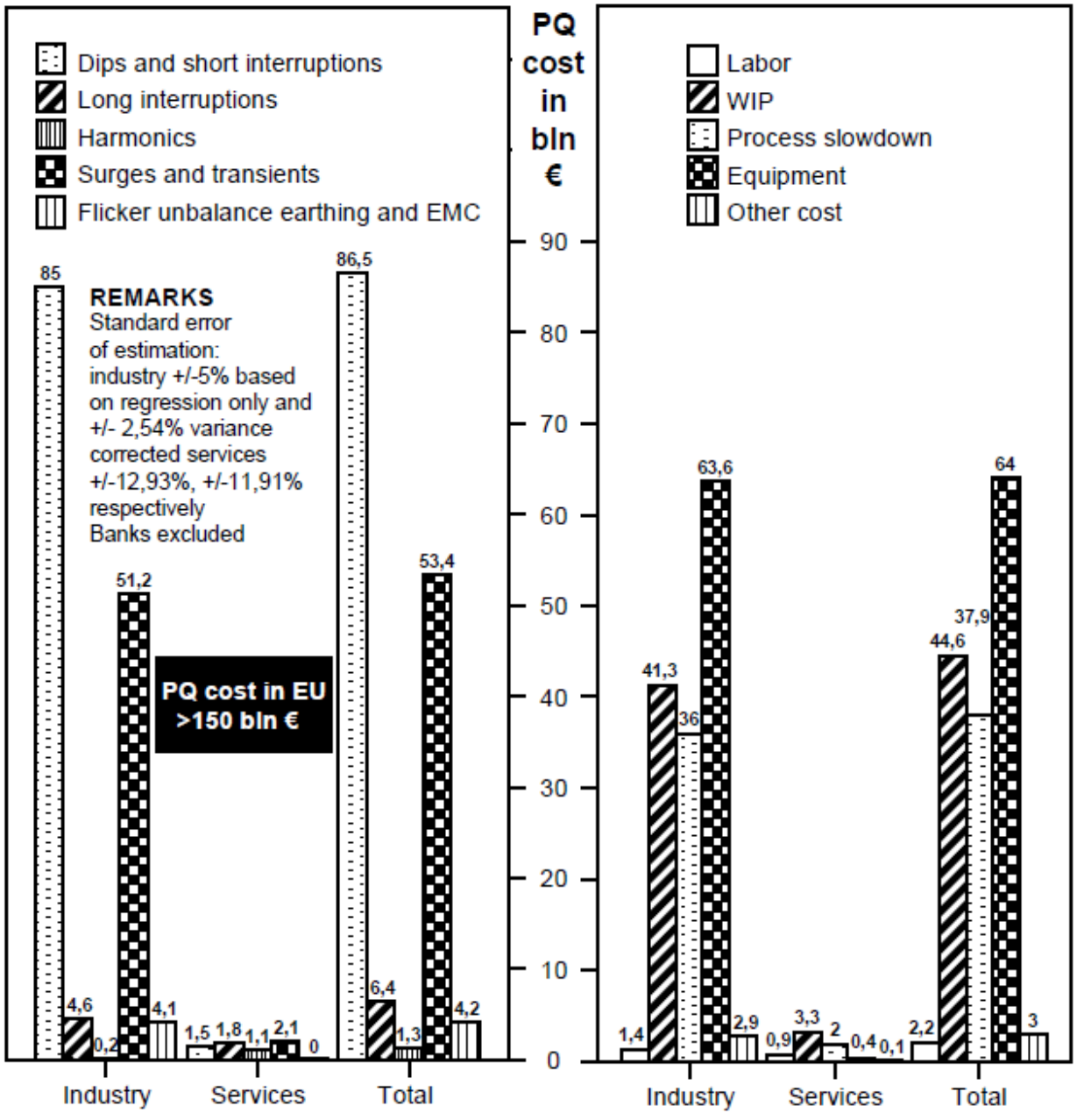
Jonathan Manson &
Roman Targosz

November 2008

Total Spending on power quality issues exceeded €150 billion

The cost of Surges and transients as reported here are in excess of €50 billion!

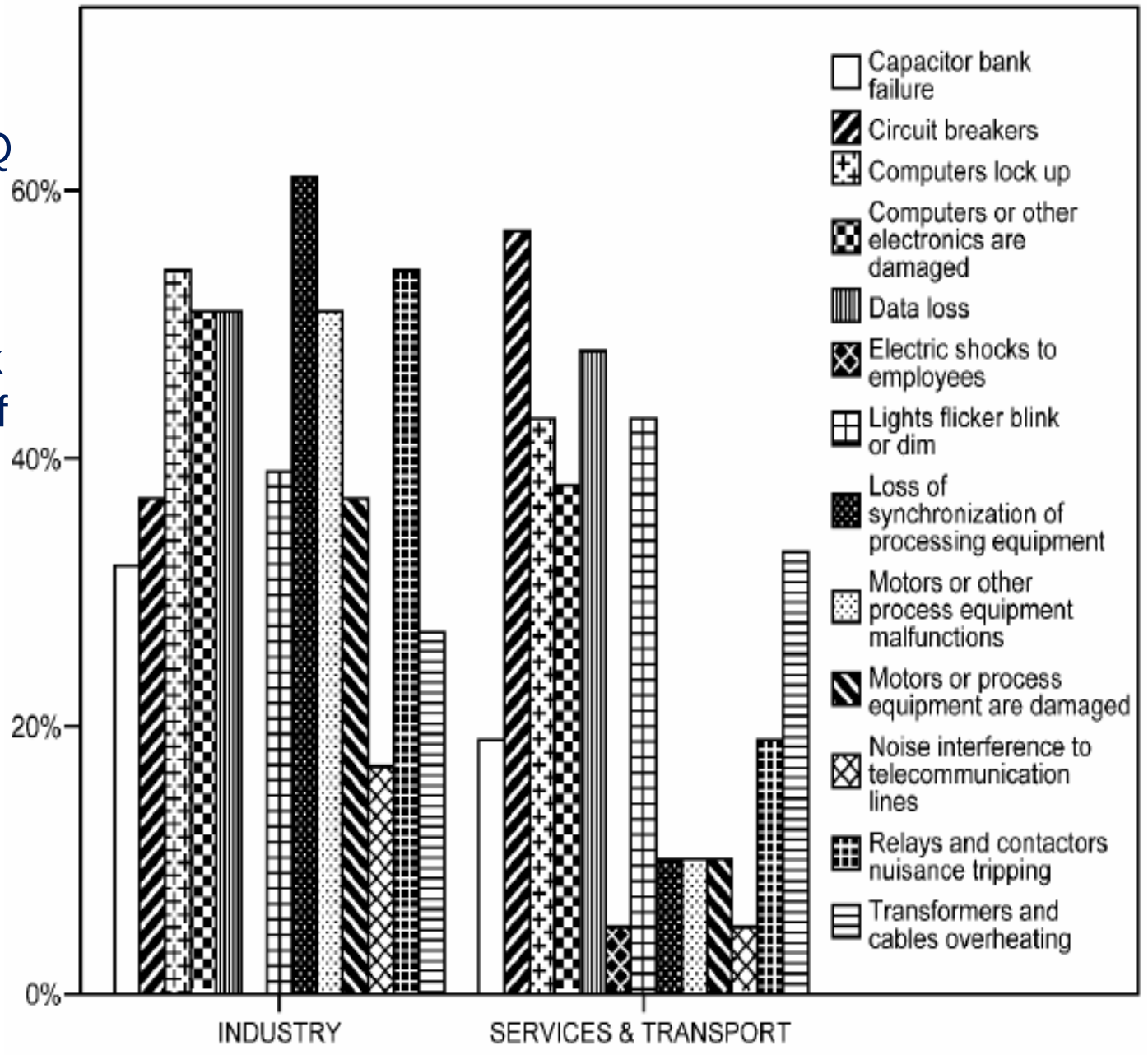
**Figure 1: Extrapolation of PQ cost to EU economy in LPQI surveyed sectors**



The most prevalent issues caused by PQ incidences:
Loss of program in processing equipment, and lock up of and damage of computers, and motors or other processing equipment.

What about all of the surge devices being installed in these countries?

Figure 18: LPQI Survey, Frequency of PQ consequences as % of cases




# Low Voltage SPD Survey Results

A market study regarding the use of and experience with SPDs. (2013)

# What type of damage has occurred?

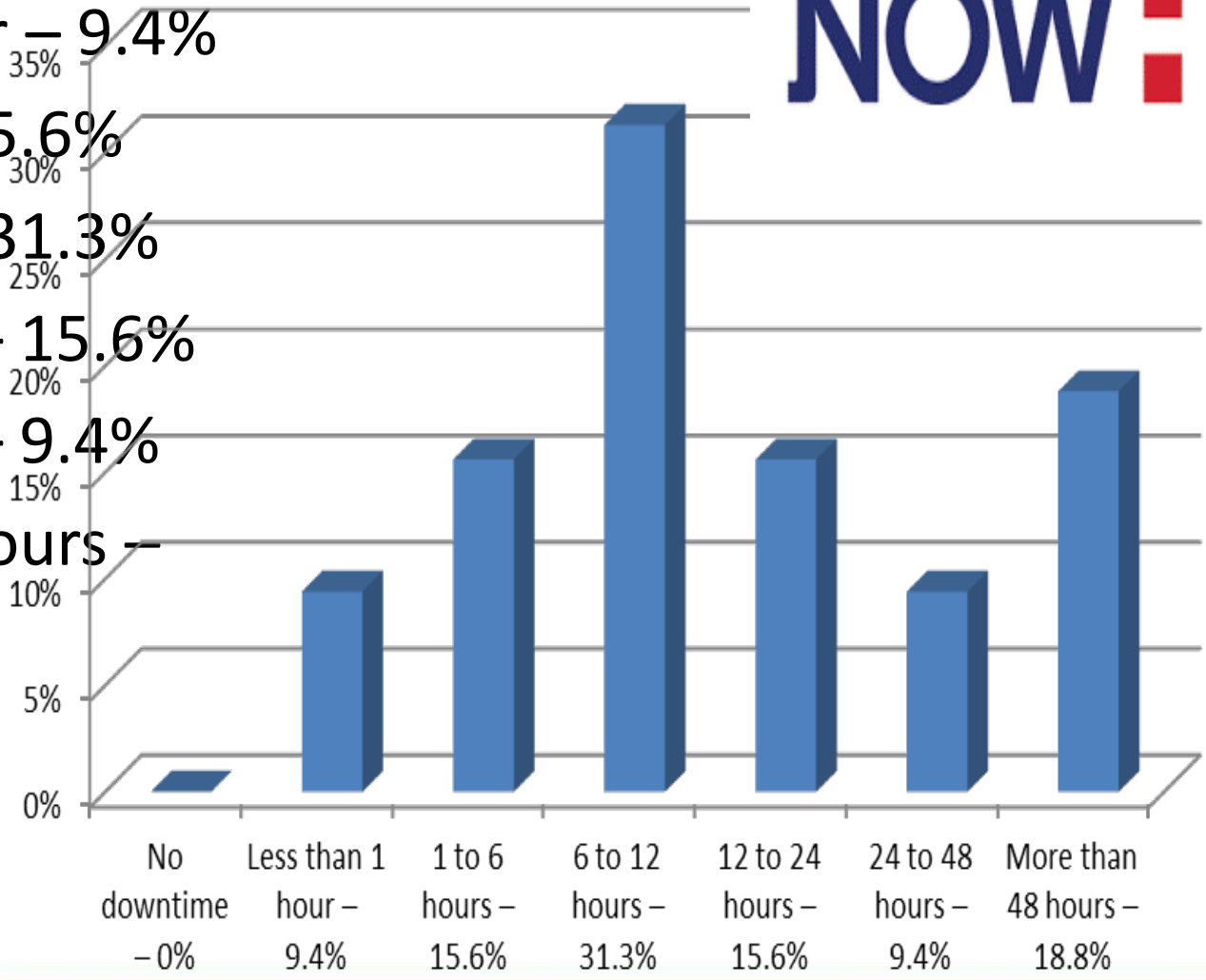
70% of businesses experienced some form of software confusion…

| Answer | Percentage |
|---|---|
| Catastrophic failure or damage of electrical or electronic equipment due to a lightning event or voltage surge | 18.7% |
| Premature failure of electrical or electronic equipment | 26.7% |
| Unexplained process interruption | 46.7% |
| Lock-up of computer or industrial process systems | 24.0% |
| Insulation failure on electric motors or transformers | 10.7% |
| None of the above | 33.3% |

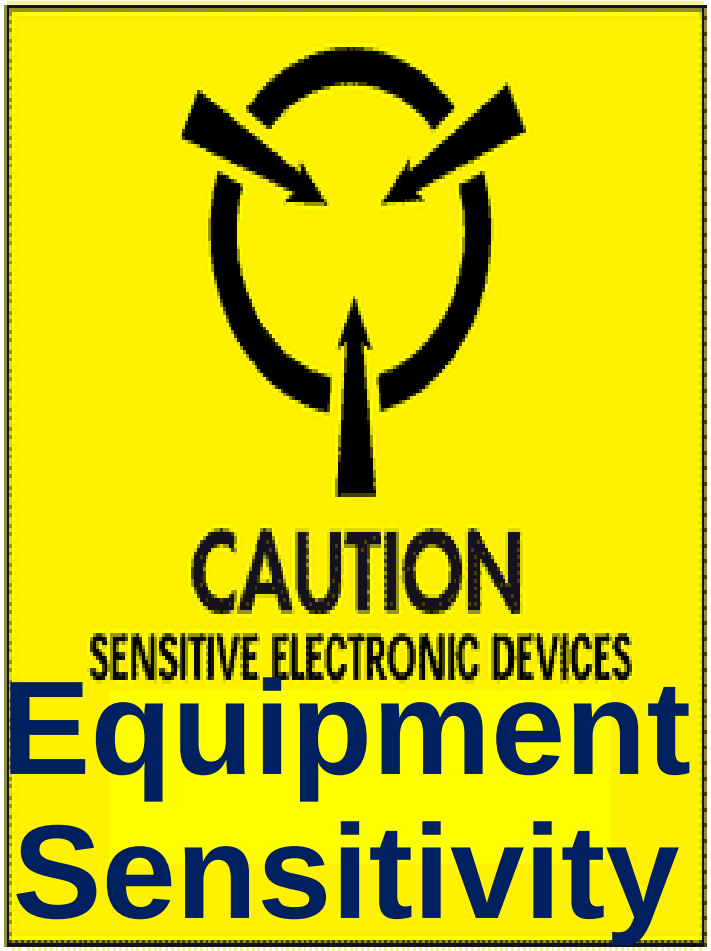
# WHY NOW?

## Total downtime?

- No downtime – 0%
- Less than 1 hour – 9.4%
- 1 to 6 hours – 15.6%
- 6 to 12 hours – 31.3%
- 12 to 24 hours – 15.6%
- 24 to 48 hours – 9.4%
- More than 48 hours – 18.8%




**90% suffered more than one hour of downtime!**




# Equipment Sensitivity

RACE to EMBRACE

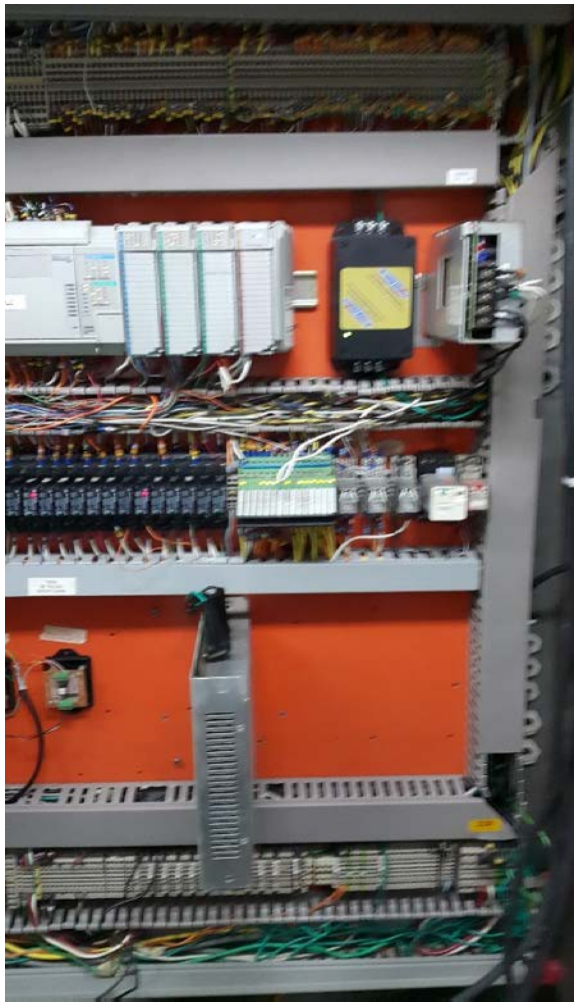
# At Issue


- Unilever – Ecuador in the Surf detergent production and packaging area Line 301. A problem presented itself of PLC programming loss and over-voltage false alarms at a VFD. These issues caused an average of 2 hours in unscheduled stops, and a resulting loss of production value by $8,500 weekly.

- During our visit in 2013 we presented a protection solution by Sinetamer (protection kit), which the engineer applied immediately in this board power of control.

# APPLICATION EMPACADORA DETERGENTE SURF LINE 301


LA-ST60-3N2



ST-SP2N2-P

# The Result

- Investment in Sinetamer Protection Kit : $ 1,900
- Downtime by failures in powder tower control board: $8,500

- ROI: $1,900 / $8,500 = 0.22 * 20 working days = 4.47 days.

- The protection was implemented in July of 2013, and the result has been successful until now (February 2017).

# At Issue


- Envases is a company specializing in the manufacture of all type of containers for different industries. Among them soft drinks, chemical and paints.
- They installed a Kosme SB 8R machine blower/filler to increase production to existing clients.
- They soon began experiencing failure of the heating lamps and controller. In the first 6 months of operation they burned 6 servo's of the 12 and the machine was still under warranty. Each servo controller has a cost of $1873.

# Heater Controllers

# The Result

- **Investment en SPD´s SINETAMER: $7,288.00**
- Profits per day of stoppage: $ 10,289.00
- Replacement of Each Controller : $1,873.00
- Total Replacement Cost of Controllers: $11,238.00
- Stoppage Time,  6 días: $61,734.00
- **Cost Per Loss: $72,972.00**

- ROI: $\frac{\text{Investment in Sinetamer}}{\text{Cost Per Stoppage}} = \frac{(\$7{,}288.00)}{(\$72{,}972.00).}$ **< 3 Hours**

# RESULTS

- After installed them SPD the 11 of March 2016, until the day of 30 of January of the 2017, not have returned to occur damage in those drivers of the lamps heating, nor in panel View or VFD of the machines.
- We were able to remove the damage and constant equipment malfunctions. Obtaining a fully satisfied customer.
- The installation of SineTamer arresters for the protection of equipment with electronic control was a complete success.
- This led the customer to maximize profits, to such an extent that they are convinced of the benefits of SINETAMER and the entire line of Envases Universales, SANTA ANA SPRINGS, customer will be protecting future machines that have experienced failures.

# At Issue:


- ADELCA , Is a company involved in the recycling and re-manufacturing of steel in Ecuador.

  Adelca, over the time has invested considerably in high-tech and globally known equipment such as Siemens , ABB, Telemecanique, among others, so now their production processes are 75% automated , with a trend to grow in the mid and long term.
- It was soon realized that in the 60 ton overhead crane that significant downtime issues were occurring, costing the company over $11,000 per hour of stoppage.
- After exchanging one  brand of VFD's for another it was decided to investigate the power quality and install Sinetamer in a cascaded format as a pilot project.


ABB

# The Results

The cascade protection network with SineTamer eliminated the cause of failures, thus eliminating the VFD graveyards.

VFD's inventories declined significantly in the spare parts warehouses for overhead cranes for those that are already protected SineTamer.

Productive hours were increased in continuous Casting Line.

Return on Investment after the installation of SineTamer units : 20 minutes.
The crane works 20 hours per day carrying $228,000 of materials. One hour of downtime stoppage equates to $11,400. The investment in SineTamer units was $3800. Thus equating to about a 20 minute return on investment.

# Similar results are experience across the world

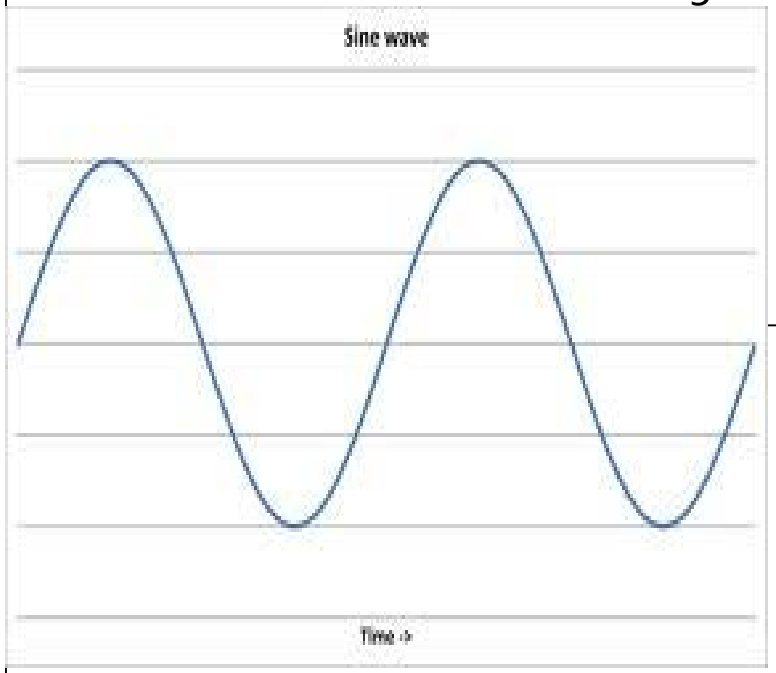
# How can these results be obtained?

# Surge Protection – SPD - TVSS

- “Surge protectors – Aren’t they all the same?”
- “I don’t have any problems.”
- “We don’t have any lightning around here.”
- “We have never lost anything due to a surge.”
- “We don’t have transients.”
- “I have tried them, they don’t work.”

# Electrically… +/- 15%

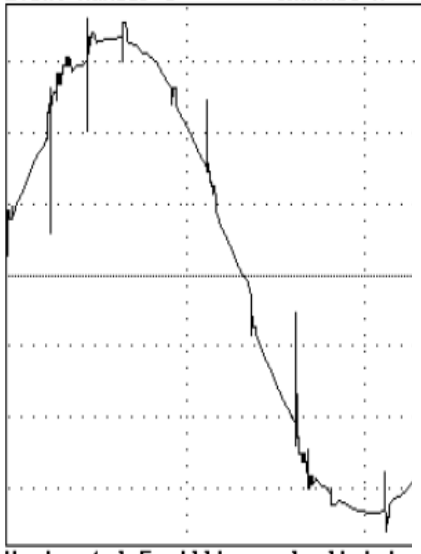
250 V





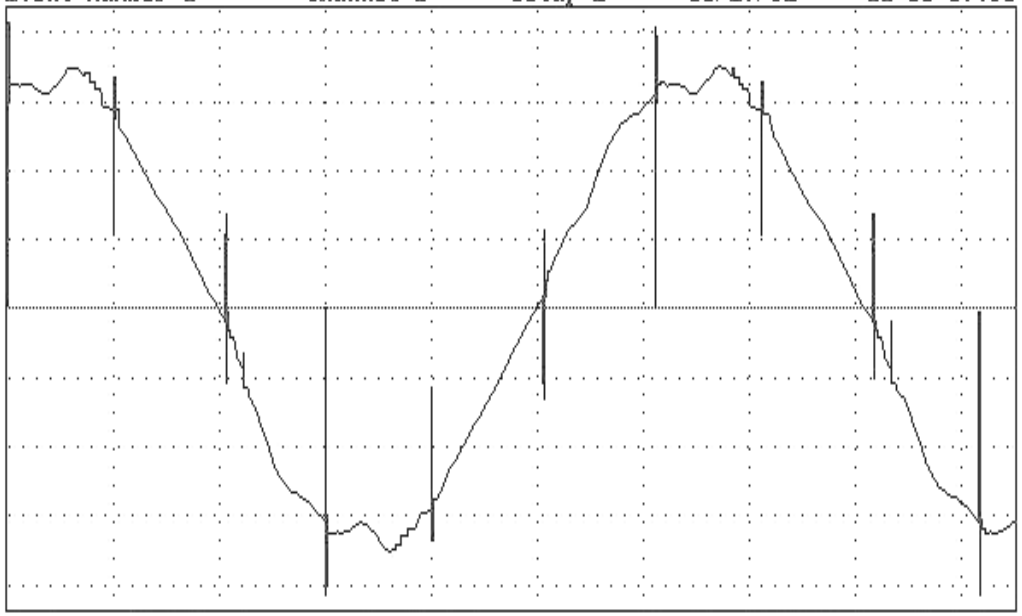
250 V

658 GRAPHICAL & HARMONIC ANALYSIS (c)1988-1992 Dranetz Technologies,Inc.
FEDERAL MOGUL N BLDG RC 15 OP10 IN RUNNG
Event Number 6 Channel A Setup 1 03/21/06 15:09:25.10

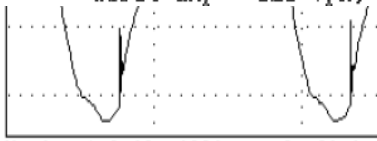


Horizontal 5 milliseconds/divisio
Vrms: Prev=474.8, Min=470.5, Max=

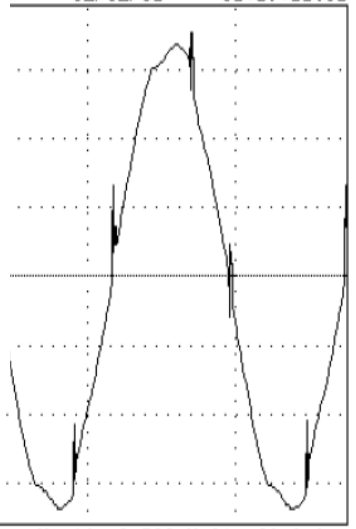
656A GRAPHICAL & HARMONIC ANALYSIS (c)1988,1989 Dranetz Technologies, Inc.
CT FILM RELIANCE DRIVE #3
Event Number 1 Channel B Setup 2 05/27/92 11:33:37.98



Horizontal 2500 microseconds/division Vertical 200 Volts/division
V rms: Prev=0.000, min=487.7, Max=487.7 - Worst Imp= 828 Vpk, 0 deg

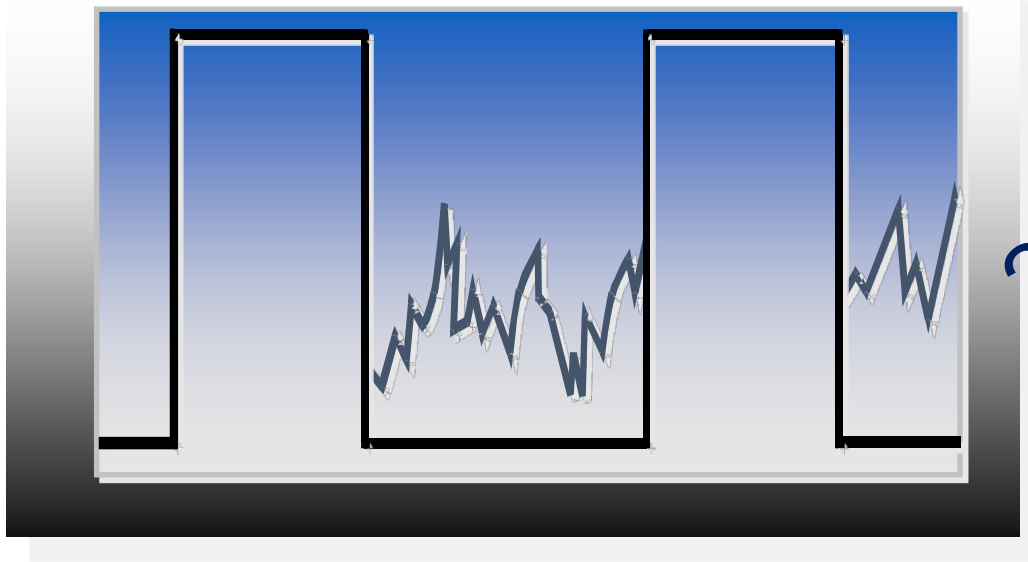


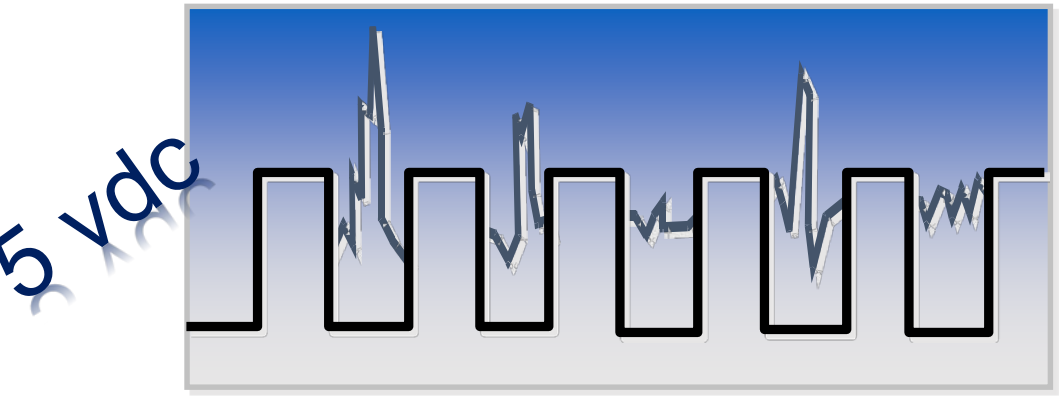
992 Dranetz Technologies,Inc.
02/02/05 08:57:35.08



Horizontal 10 milliseconds/division Vertical 200 Volts/division
Vrms: Prev=475.5, Min=475.5, Max=475.7 - Worst Imp= 308 Vpk, 360 deg

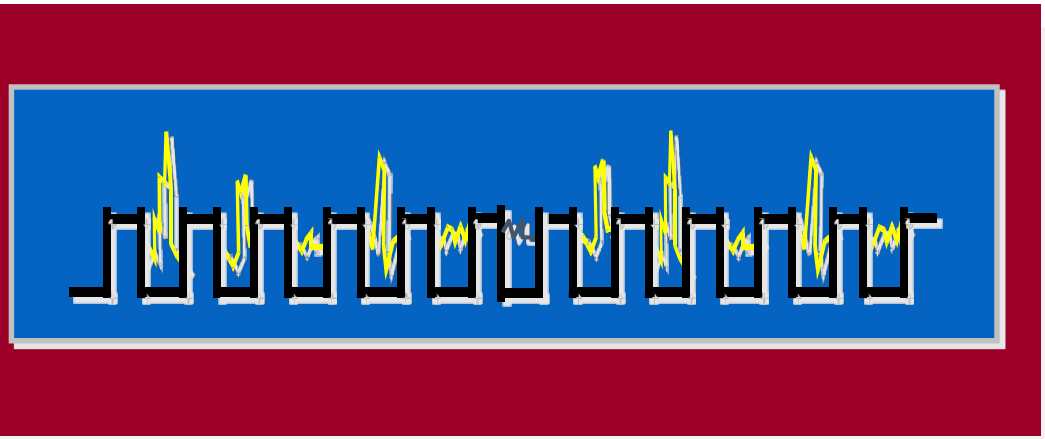
# Logic Signal Voltage & Chip Speed

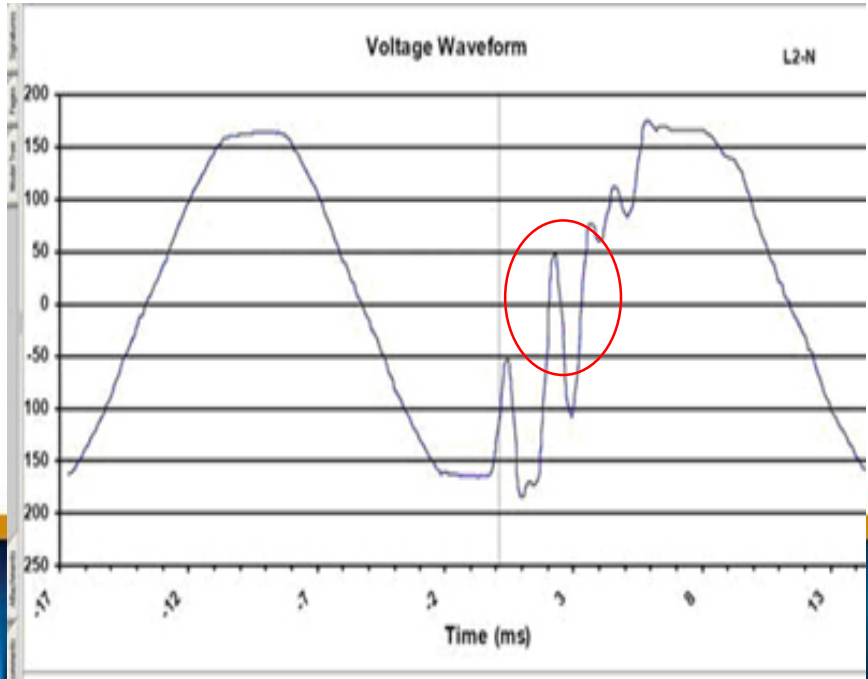


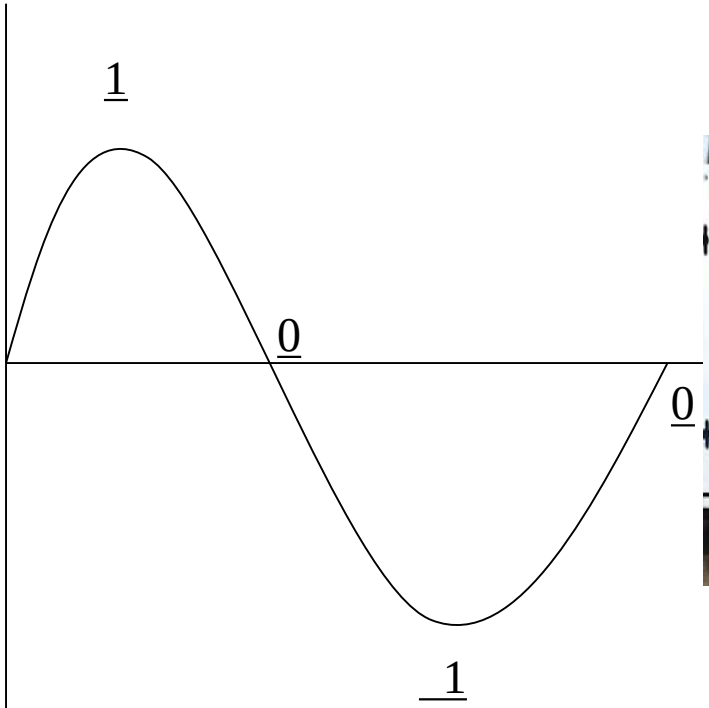

As the chip voltage decreased over time… these same low level transients cause increasingly more noticeable problems.

# Today…




Voltage Waveform
L2-N
200
150
100
50
0
-50
100
150
200
250
Time (ms)

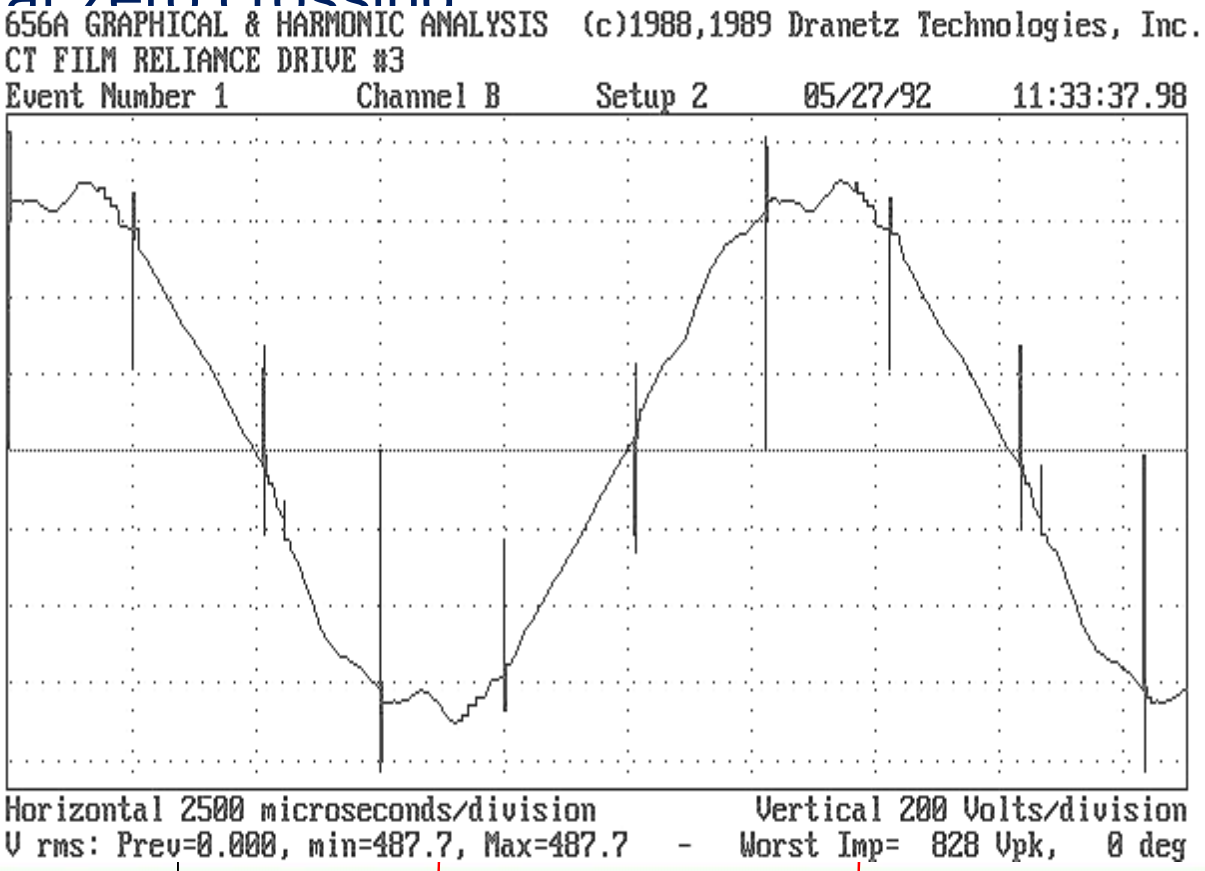
A sinewave can be viewed as a series of 1’s and 0’s, just as binary computer language. If the 1’s and 0’s are in order then the AC to DC “translations” functions normally.



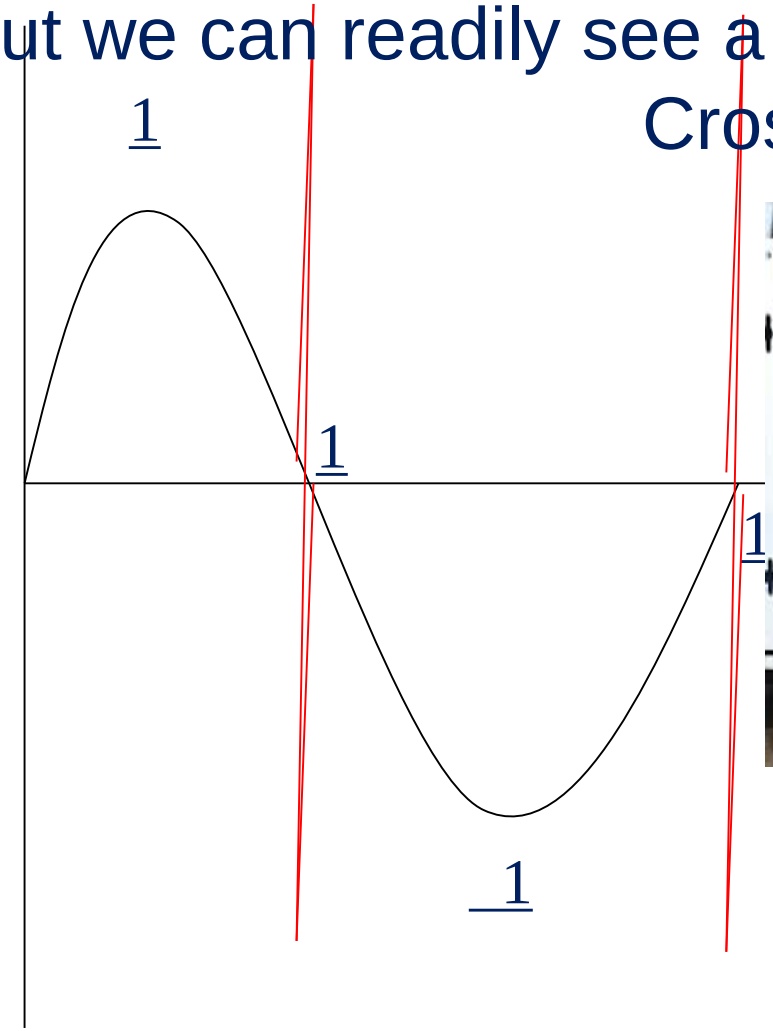


01010111 01101001 01101011
01101001 01110000 01100101
01100100 01101001 01100001

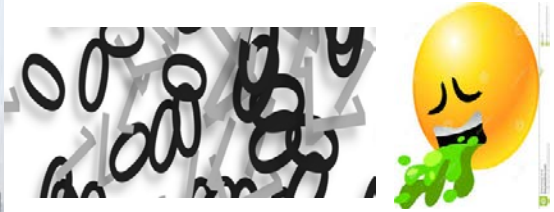
However, due internal switching transients caused by inductive loads and variable frequency drives… we find multiple cases of transients, many of which can and do occur at zero crossing



No longer do we retain the 1 – 0 – 1 - 0….
But we can readily see a 1 -1 – 1 – 1 or False Zero Crossing

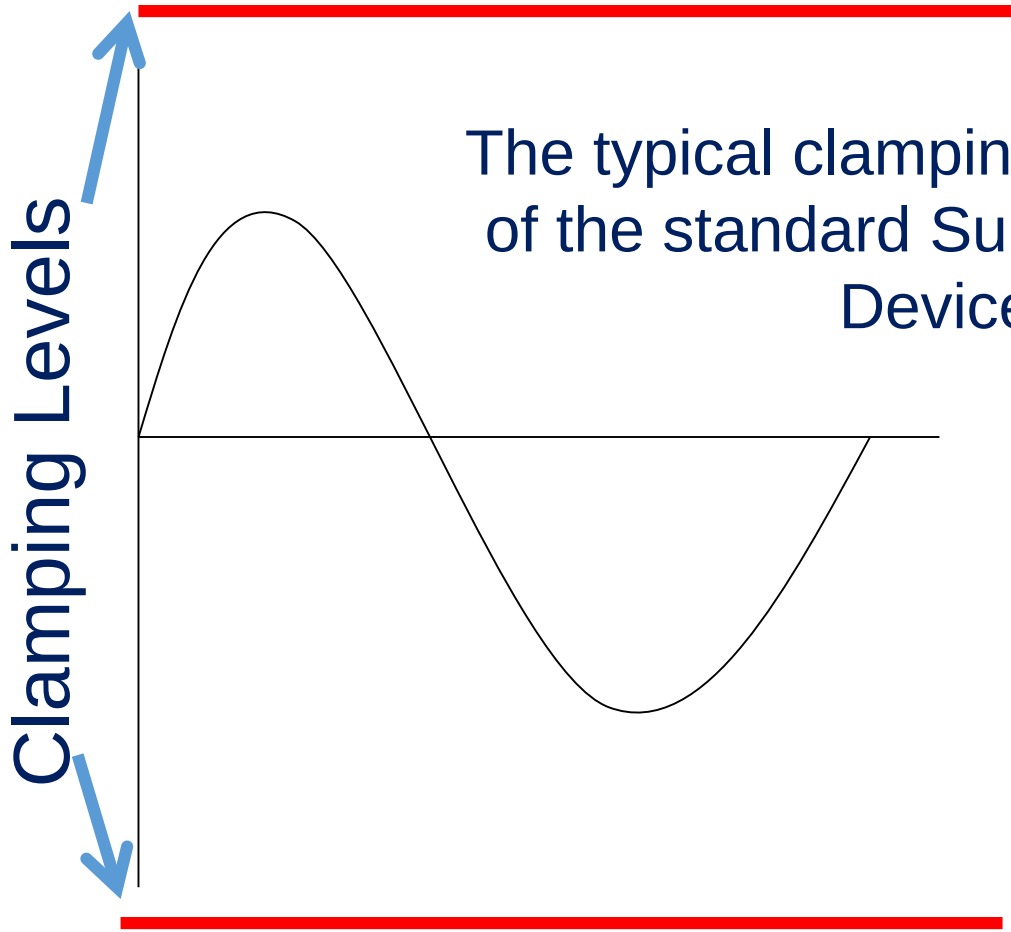




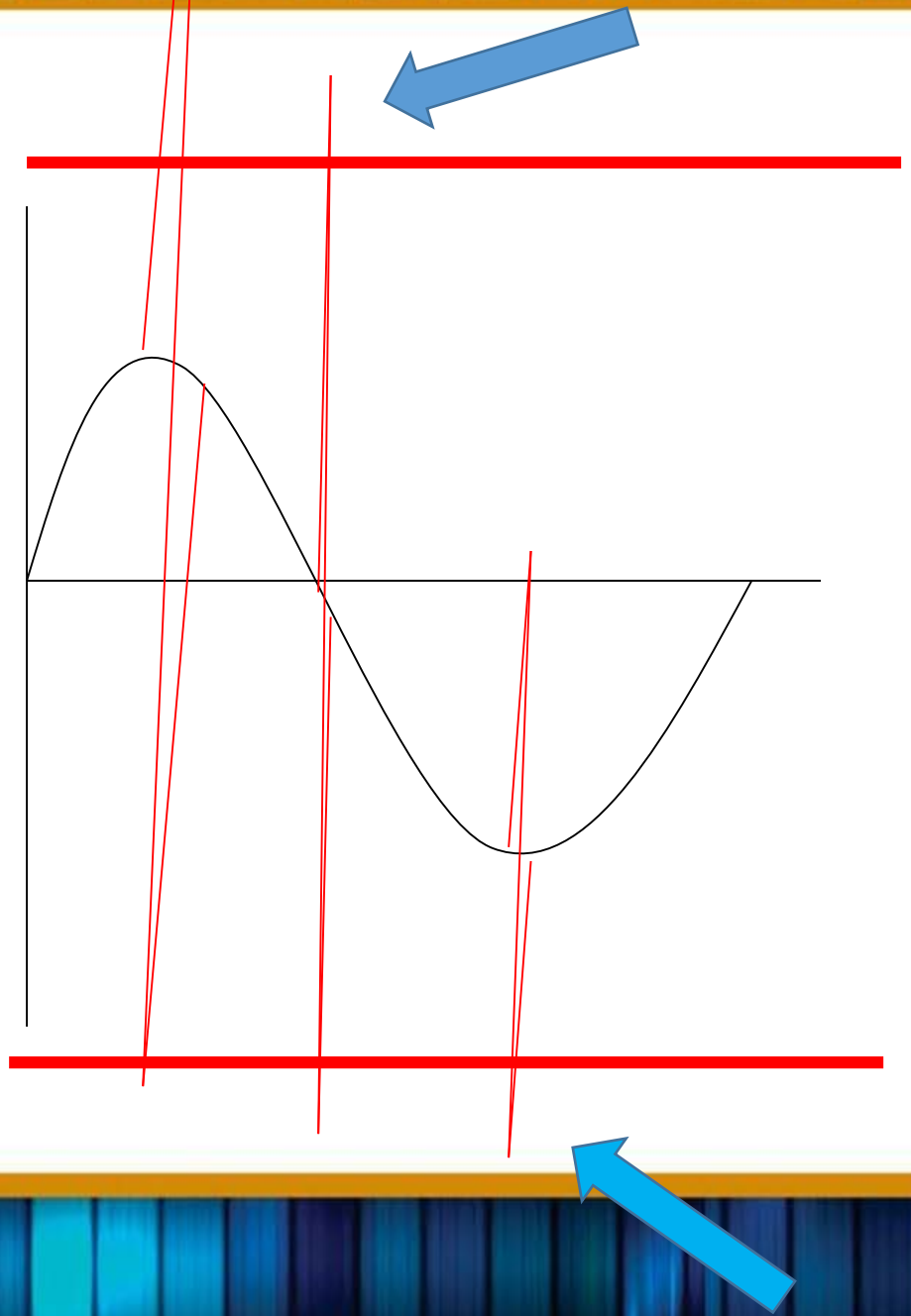


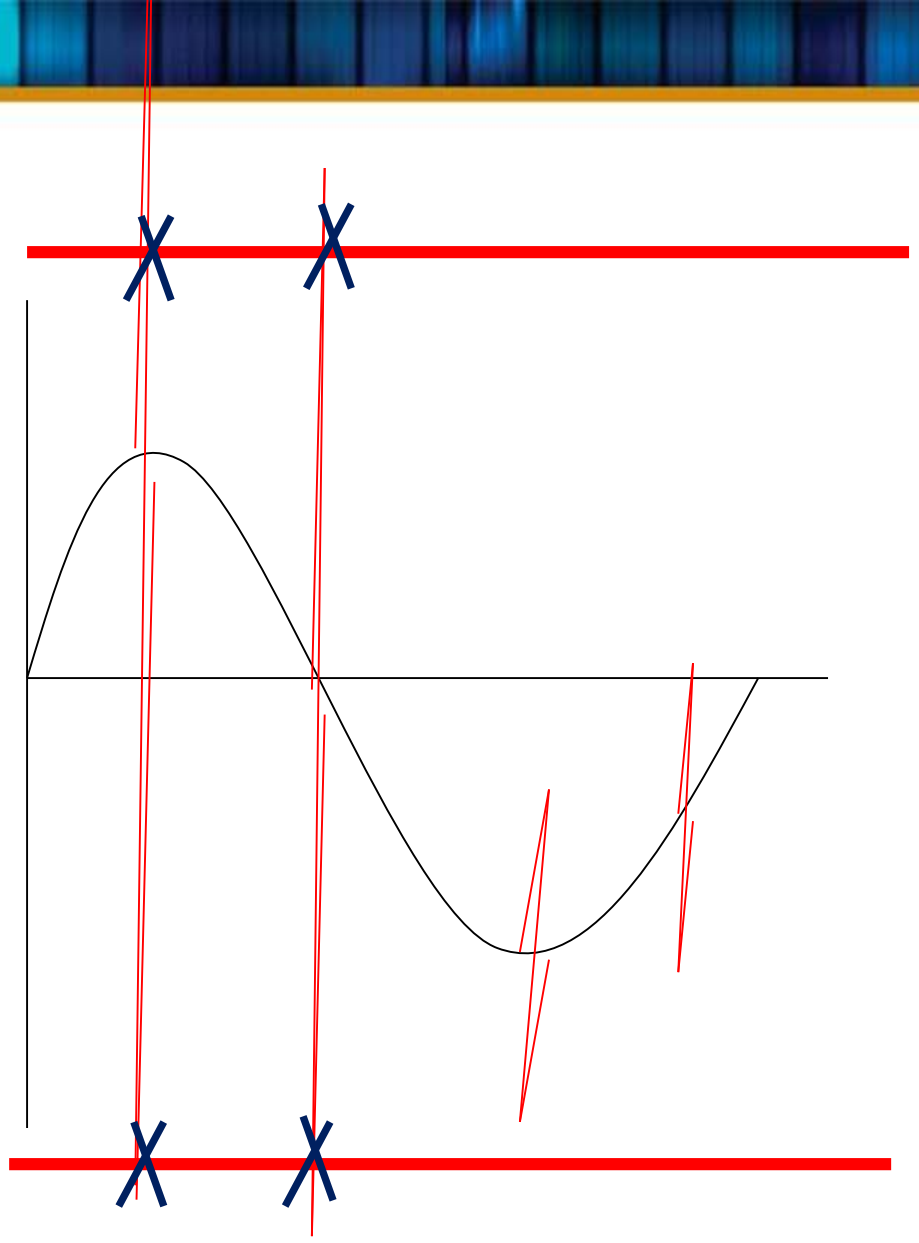
Software Confusion

# 3rd Generation Surge protection

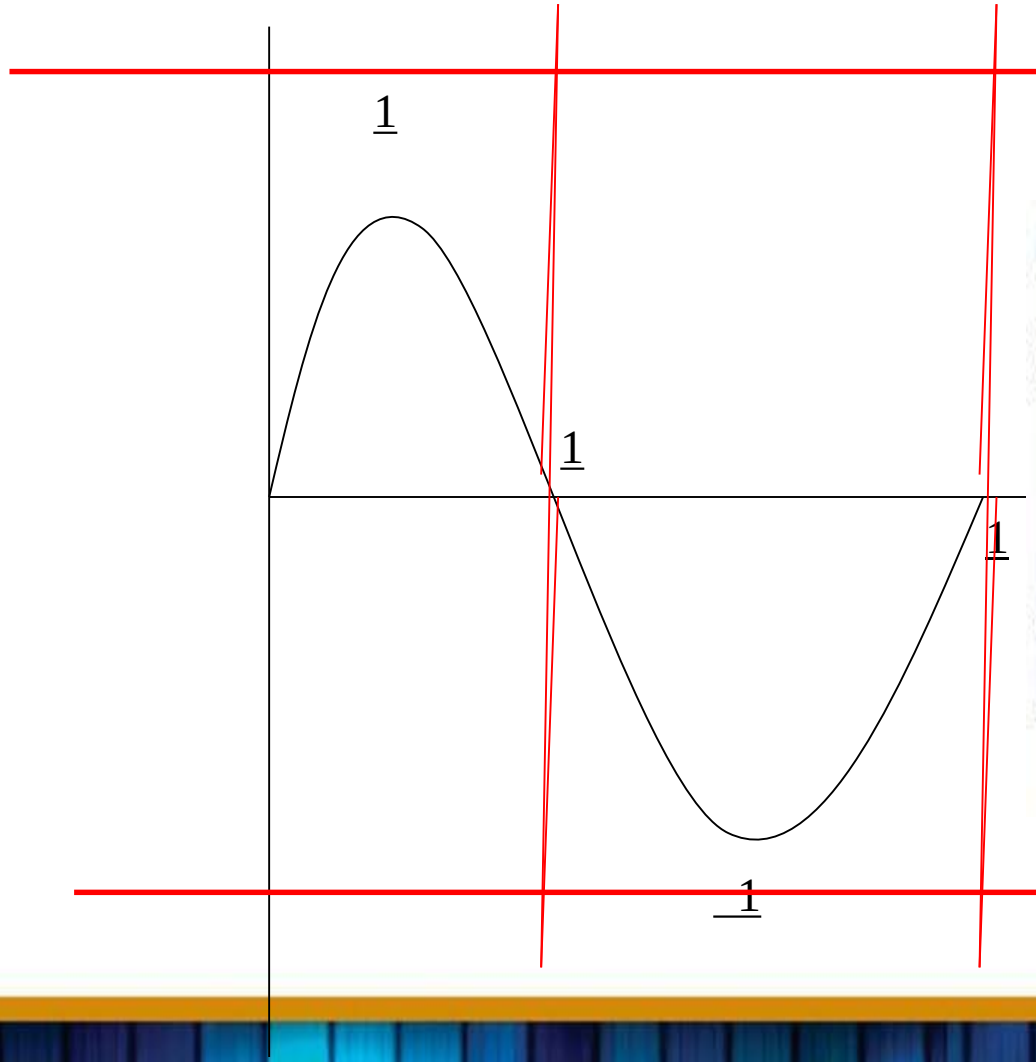



The typical clamping performance of the standard Surge Protection Device.



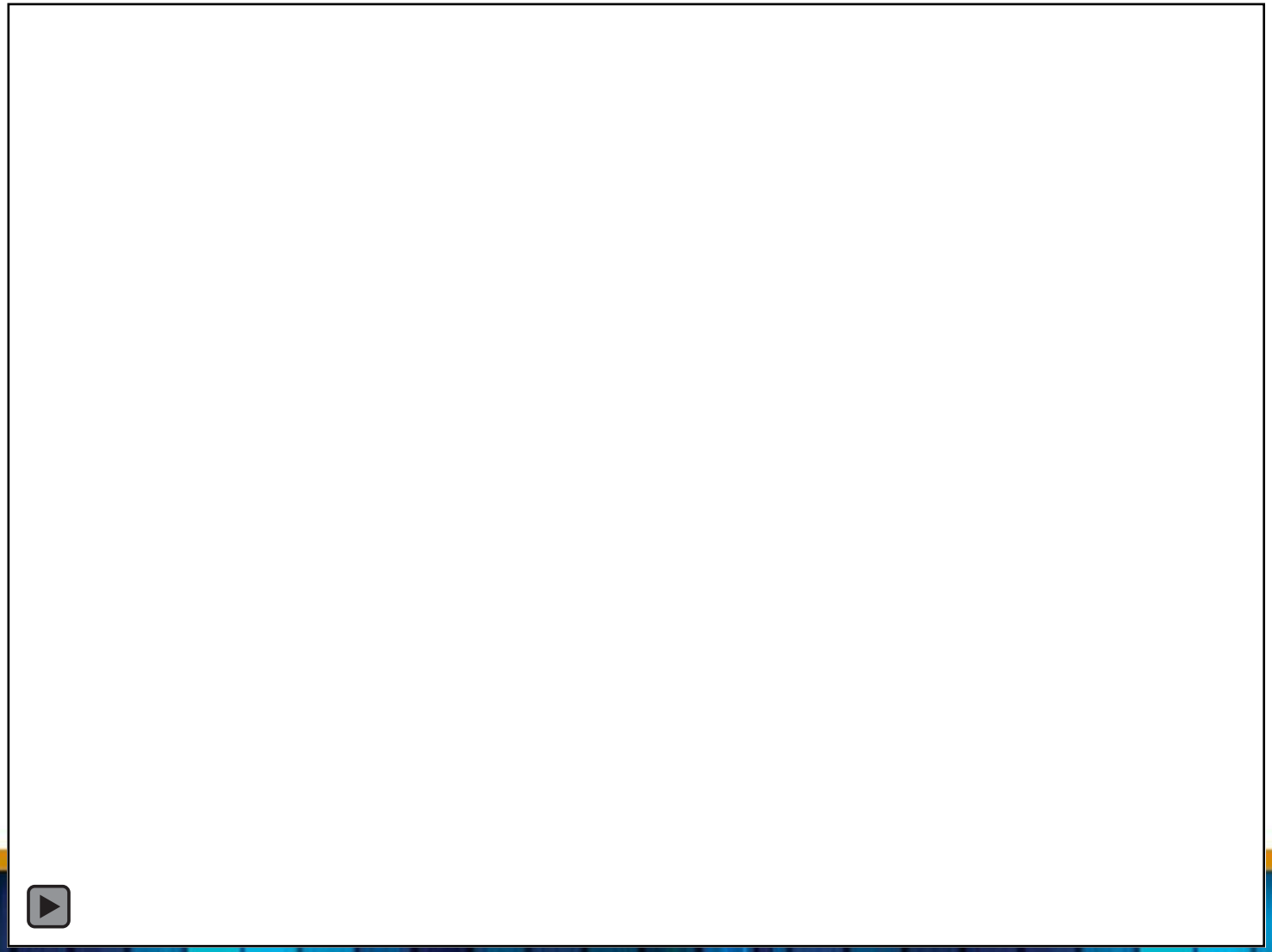


# This type of technology will have zero impact!

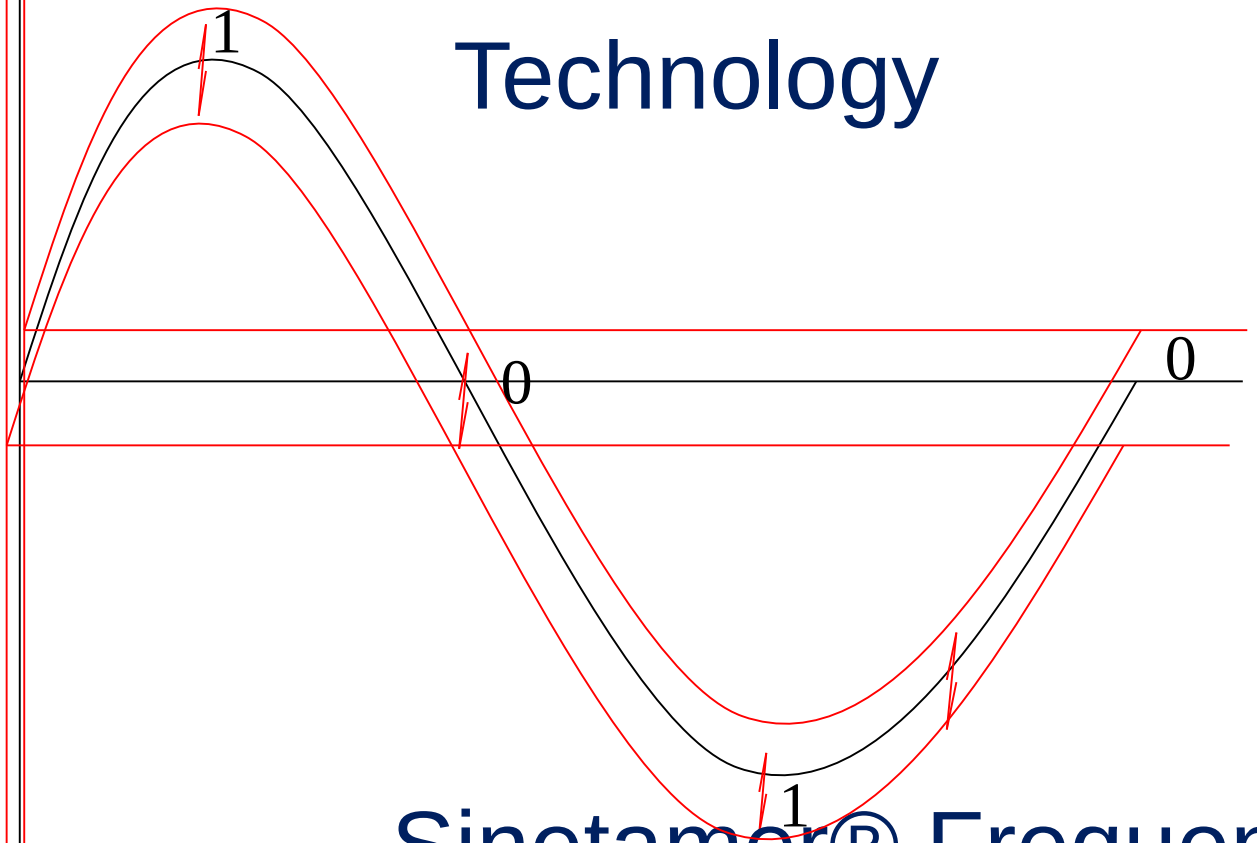




# Software Confusion



# Fourth Generation Technology

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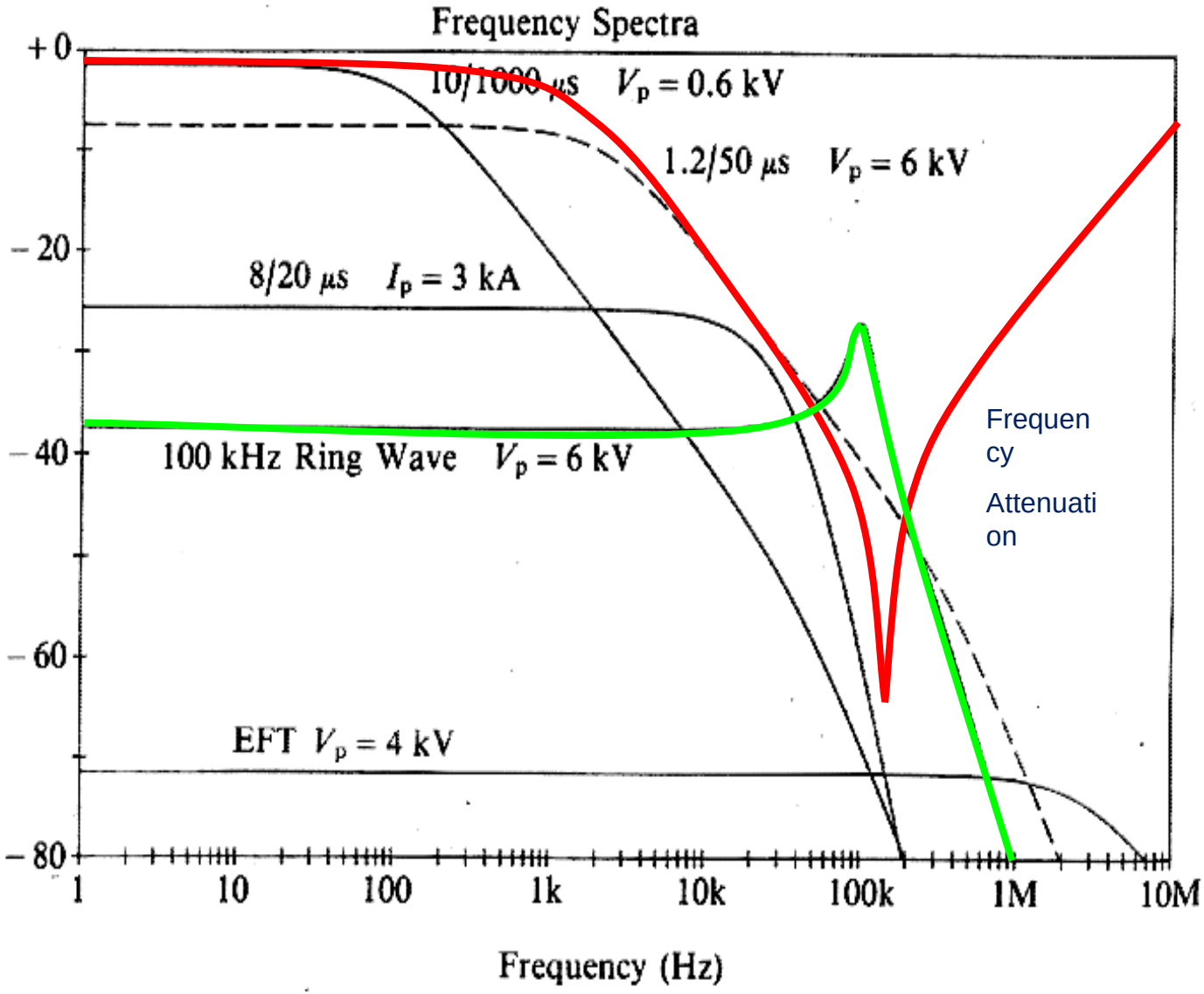
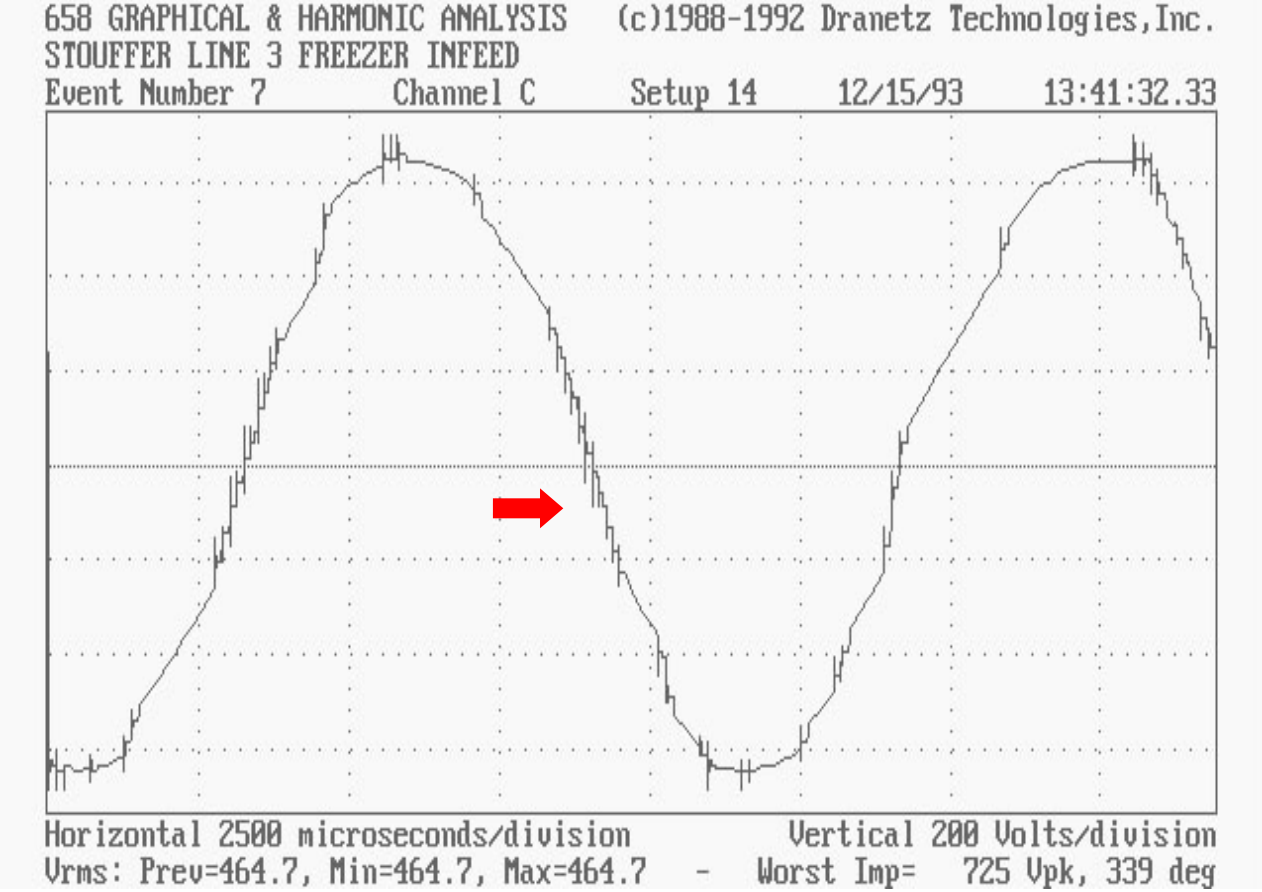
## Sinetamer® Frequency Attenuation

# Frequency Attenuation



# Production Line Freezer Input

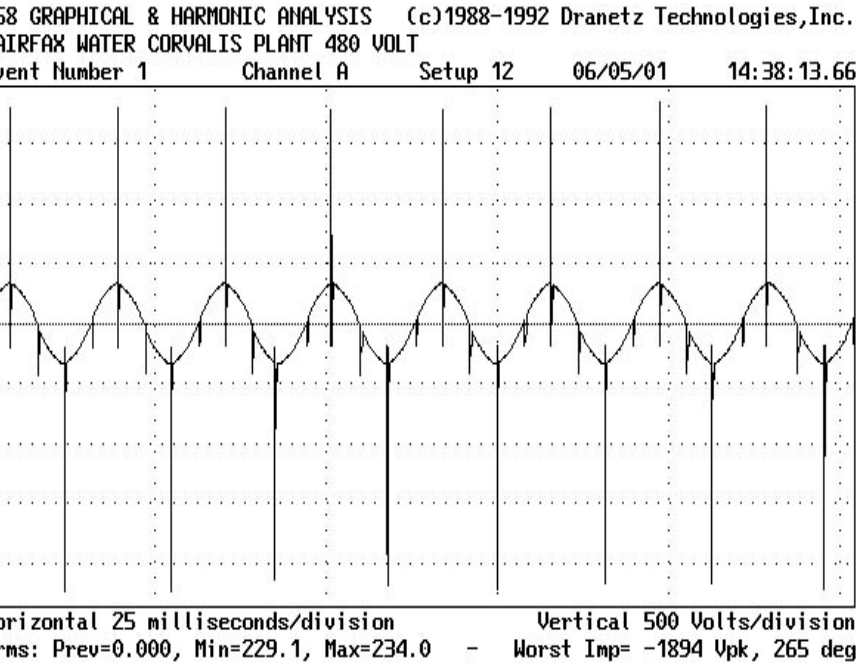



Here we see multiple 700 volt transients, but nothing catastrophic. Noting the red arrow enlarge that point to reveal the following…

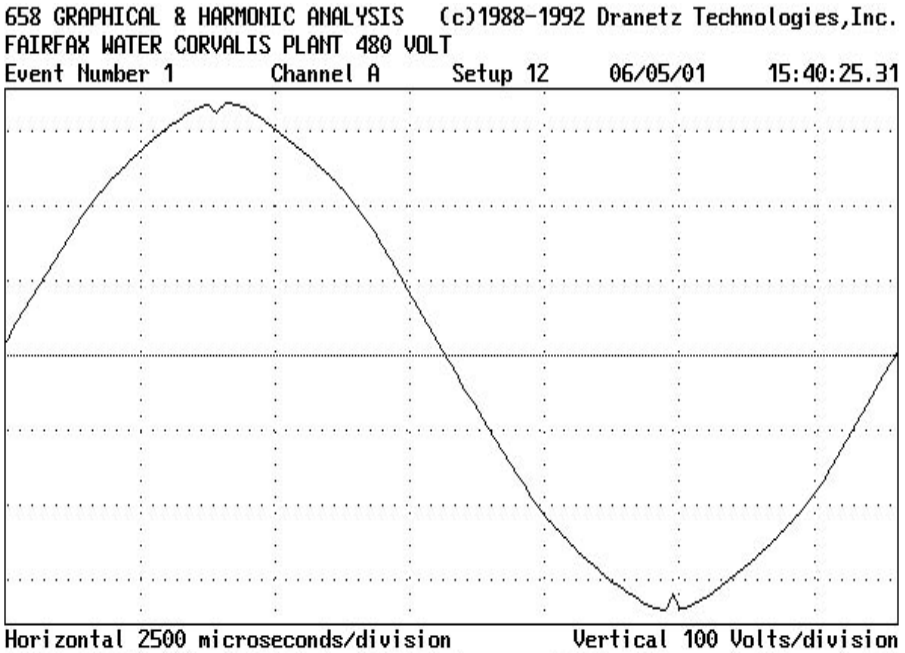

**What was discovered were transients that cross the zero line nine different times, thus disrupting and confusing the programmable controller on this process line.**

# The implementation our Frequency Attenuation Technology brought about the effect seen below.

Before

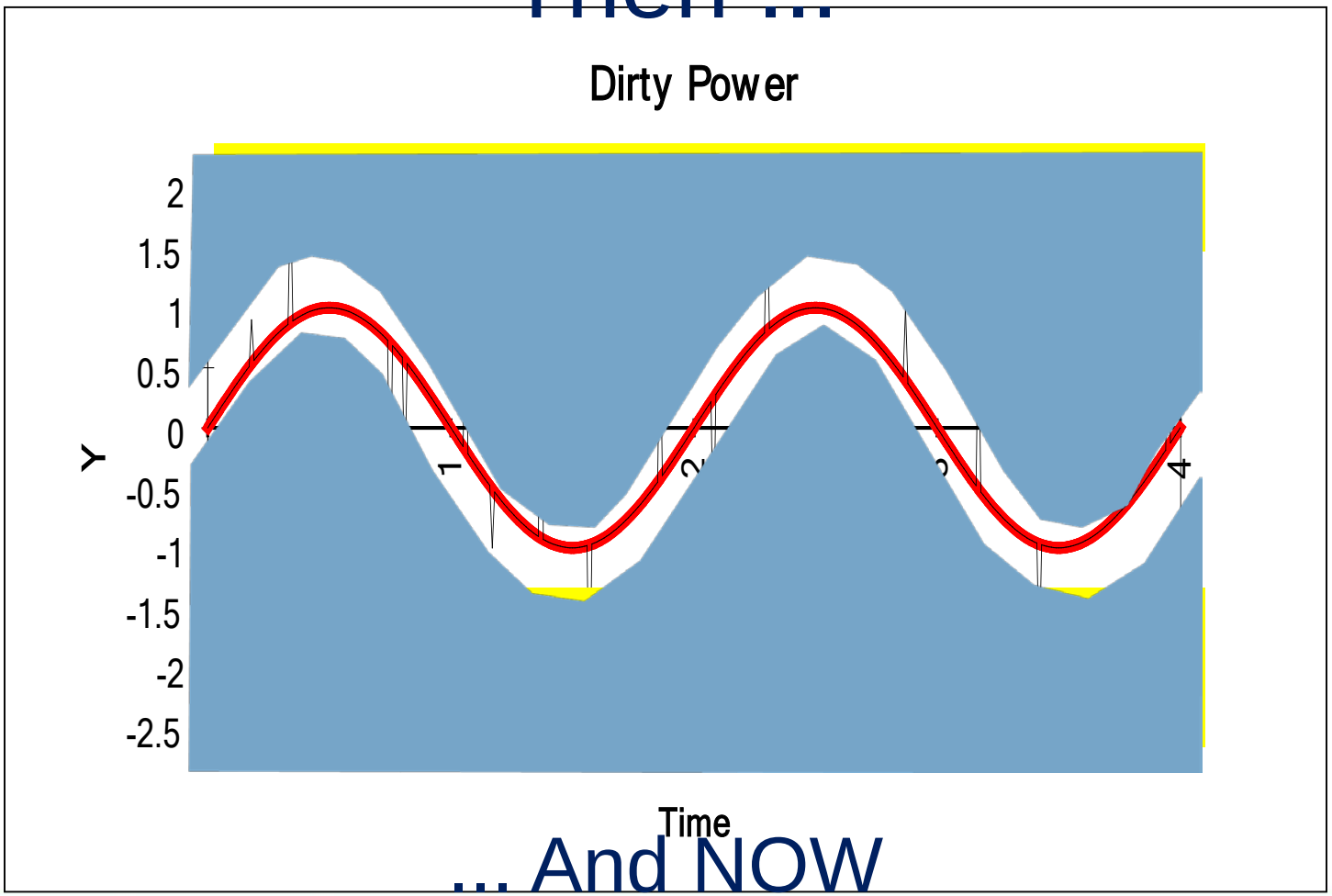



After



# Suppression technology

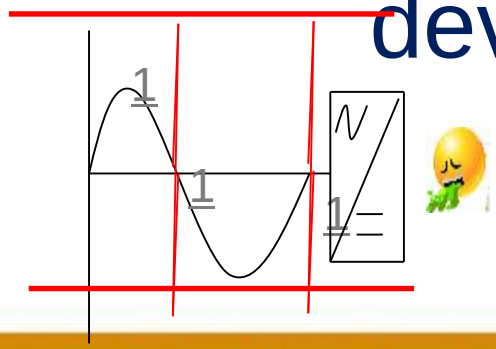
## Then ...

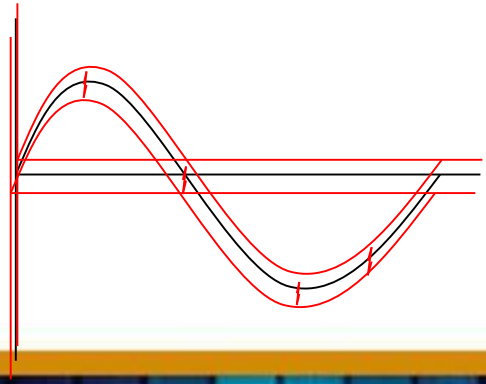



## ... And NOW

# In the same way transportation has evolved…


# So have transient protection devices…





# Sinetamer® Family







# Panel Models

# Data Models


PROTECTED EQUIPMENT (OUTPUT)
Ground
UNPROTECTED LINE (INPUT)


SineTamer
ST-CL24C-2C


INPUT
(Unprotected)
OUTPUT
(Protected)
SineTamer
Model ST-CL2P48A4DIN-B
Serial Number 10-1103-2028

# Telecommunication



# Individual Load Protection Models



# Sinetamer – Technology for the 21st Century

Improving Electronic Infrastructure Reliability Around the World!

SineTamer

*"we ARE the standard"*

**Thank you for your time!**