Sensata
Technologies

SENSATA EXPERIENCE – PQ SERVICE

The World Depends on Sensors and Controls

Sensata Technologies

Overview

- **SENSATA at a glance**
- Background
- Study by PQ solution provider
- Solutions
- Results

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Sensata Technologies Malaysia

Total employee = 1500

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Sensata-At-A-Glance

Attleboro, MA Business Center

- Sensata makes approximately 20,000 different products that are highly–engineered and application-specific.
- We ship about 1 billion devices a year.
- Business Centers, Product Development Centers and manufacturing sites in nine countries.
- We have about 11,000 employees worldwide.
- Typical household uses 30 or more Sensata components (home and car)
- Most airplanes use more than 1,500 Sensata circuit breakers and switches

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Sensata Technologies Worldwide

Cambridge
Massachusetts, Engineering

Cambridge
Maryland, Engineering

ALMELO
The Netherlands

BAOYING
China

CHANGZHOU
China

SHANGHAI
China(sales & marketing)

SHANGHAI
Sales & Marketing, China

SHANGHAI
China

ATTLEBORO
Massachusetts HQ

FREISING
Sales, Germany

SEOUL
Sales & Marketing, Korea

NOVI
Michigan, Sales

FREE PORT
Illinois

SOFIA
Bulgaria

BOTEVGRAD
Bulgaria

JINCHEON
Korea

AGUASCALIENTES
Mexico

Oyama
Japan

Standish
Maine, Engineering

TOKYO
Sales & Marketing, Japan

HAINA
Dominican Republic

SUBANG JAYA
Malaysia

CAMPINAS
Sales, Brazil

FARNBOROUGH
Engineering, UK

Sales & Engineering	Business & Technology Center	Production Site

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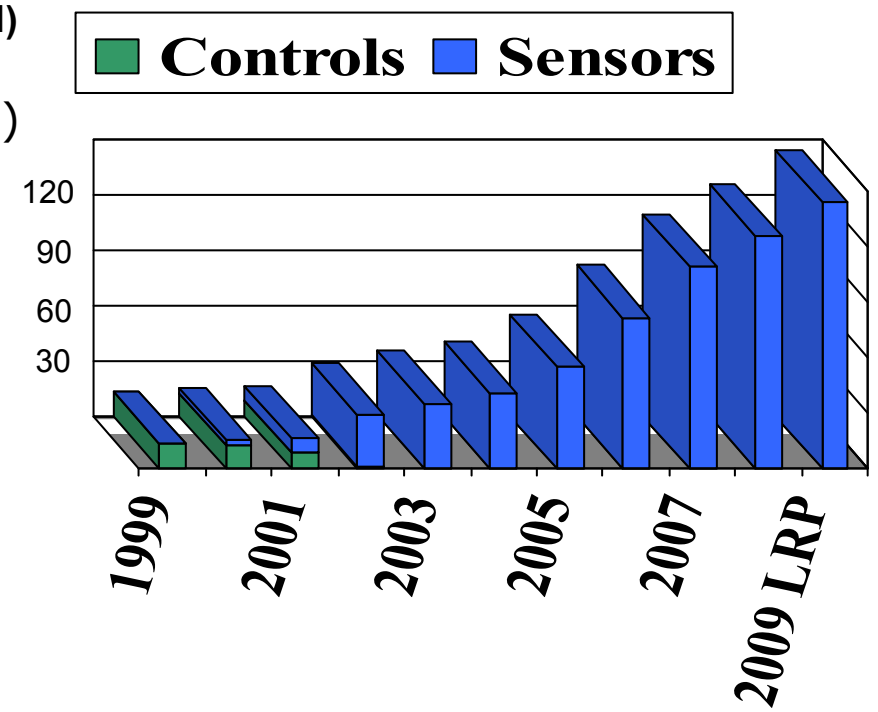
Sensata Malaysia – Products and Growth

MSG (Microfused Silicon Strain Gage)


OWS (Occupant Weight Sensor)


DPS (Differential Pressure Sensor)

RPS (Relative Pressure Sensor)



Cost of disruption

190,000,000 X 3.3 = RM 627,000,000

365 days = 365 x 24 = 8,760 hours

~ RM 70,000/ hour

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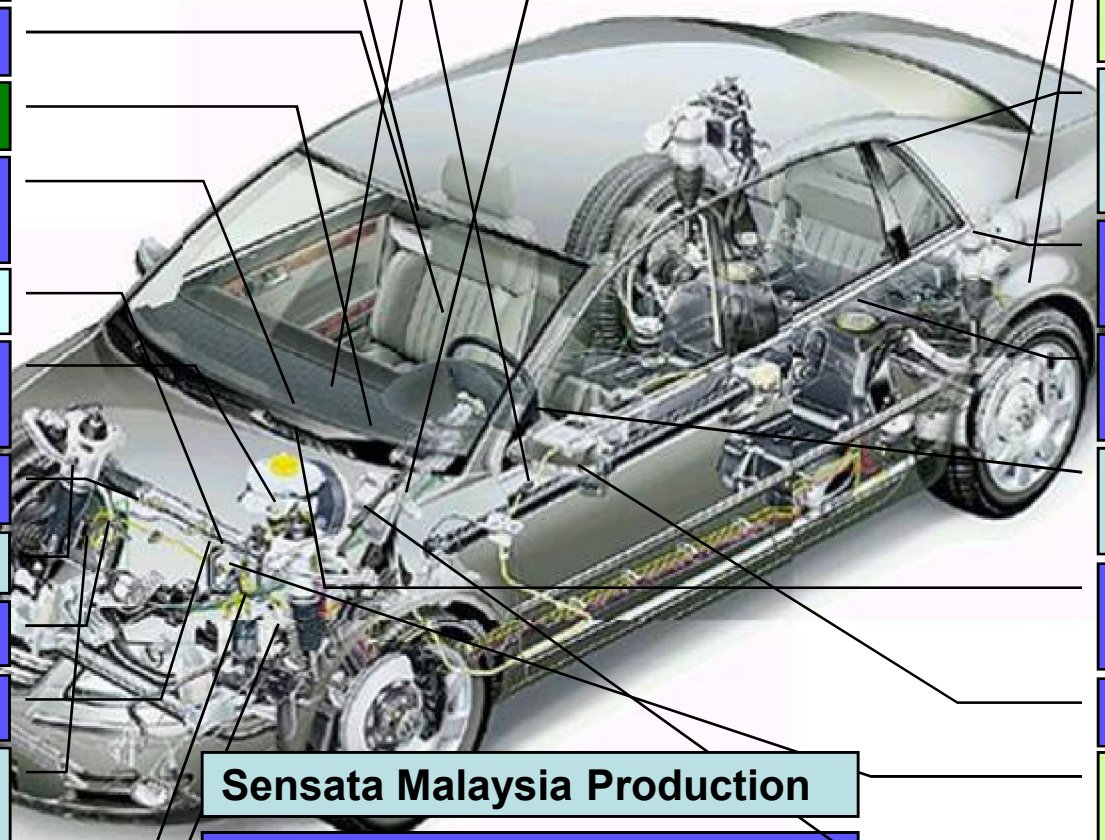
Automotive Sensors

- Vision Sensing
- Acceleration
- MAP sensor
- Belt Alert
- Transmission range
- Cylinder pressure
- Power steering pressure
- Turbo pressure
- Air classification
- Oil pressure
- Coolant level
- Air conditioning pressure
- Fuel rail
- Brake pressure

- Solar / Twilight
- Steering Angle



- Fuel Level
- Battery-less tire pressure
- Particulate filter differential pressure
- Air suspension pressure
- Exhaust gas back pressure
- Occupant Weight Sensor
- Transmission pressure
- Humidity
- Brake boost pressure
- Low Profile Pressure Sensor

- Sensata Malaysia Production
- Global Sensata Production
- Future Production by Sensata
- Research & Development

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Site information

No.	Items	Details
a.	Company name	Sensata Technologies (M) Sdn. Bhd.,
b.	Business Type/Product	Sensor Manufacturer (Automotive)
c.	TNB Branch/Region/State	Subang Jaya, Selangor.
d.	Incoming Voltage	11kV
e.	Source of Supply	PPU Seafield 2 33/11kV, PMU Proton 132/33kV
f.	Tariff	E2: Industrial
g.	Maximum Demand (MW)	2.86MW
h.	Monthly bill (estimated)	RM 680,000
i.	Estimated losses due to PQ events	RM 70,000 / hour (revenue loss)

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PQ disturbance experienced at Sensata

Disturbances experienced by SENSATA (until Oct) are as below:

- 15 Sept
- 5 Oct
- 16 Oct
- 30 Oct

Affected Equipments:

1. Facilities Department
   Chillers - TRANE
   Compressors
2. Production Machines
   Honda 1, Honda 2 and ATS

Domino effect:
Cooling tower, PCW, Production Machines

Voltage Sag data from PMU PROT (33kV) – TNB PQMS

Date	Time	V1(%)	V2(%)	V3(%)	Duration (s)	Min V (%)
5-Oct	10:48AM	84	52	52	0.120	52
30-Oct	4:41:58 PM	16	16	16	0.100	16

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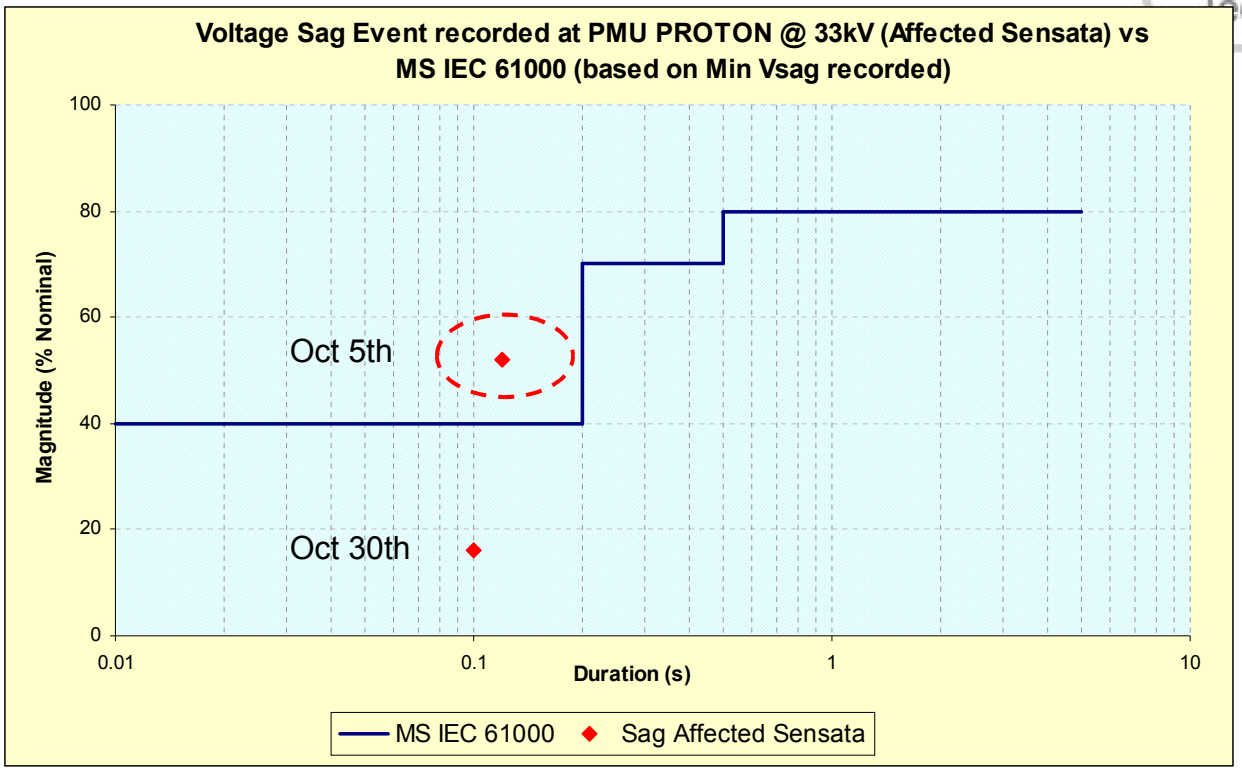
PQ disturbance analysis



Observation & moving forward

✓ It is evident that the some of the affected equipments are too sensitive to voltage sag.
✓ To perform MS IEC 61000 Compatibility test thru voltage variations immunity tests or Ride Through Test (RTT) to the affected equipments
✓ Determine the best fit mitigation plan

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Affected chillers (No 3 is new chiller)

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PQ services activities

Task 1 (Preliminary Study):

- PQ Briefing, preliminary discussion & site visit
- Arrangement with OEM, operation side

Task 2 (RTT):

- Chiller (TRANE). No 1,2 and 3
- One unit after another

Task 3 (PQ Solution):

- Recommendation & PQ optimum mitigation solution based on RTT result, production loss etc.
- Commission and verify results

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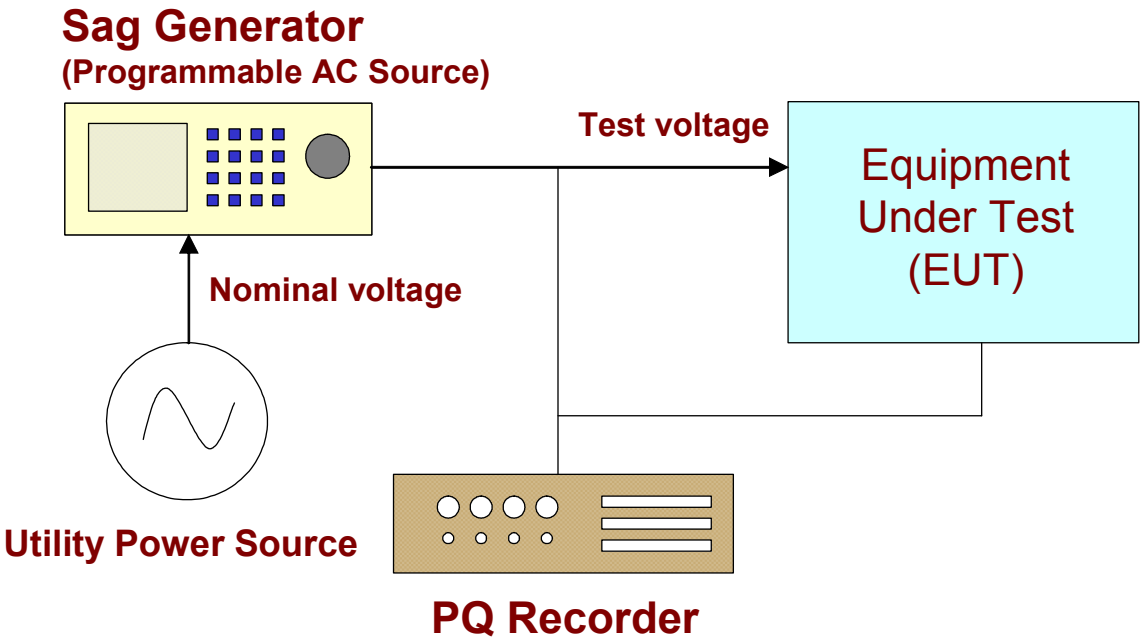
Ride Thru Test

Single Phase RTT using CHROMA (3kVA)



- Existing supply to the Equipment Under Test (EUT) is disconnected and replaced with the CHROMA Sag Generator.
- Simulation of voltage sag of different magnitude and duration were injected to the EUT.
- EUT is observed to determine the ride through against programmed voltage sag.

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Ride Thru Test (findings)

Equipment Under Test	Immunity level	MS IEC 61000-4-11
CHILLER 1 (Trane 400RT) **Control Circuit** **1.110Vac** **2.24Vac**	✓ 75% voltage sag for 100ms & 90% voltage sag for 1 sec ✓ 0% voltage sag for 200ms & 40% voltage sag for 1 sec	Not Comply Comply
CHILLER 2 (Trane 420 RT) **Control Circuit** **1.110Vac** **2.27Vac**	✓40% voltage sag for 200ms & 70% voltage sag for 1 sec ✓0% voltage sag for 200ms & 70% voltage sag for 1 sec	Comply Comply

Recommendation:

- ❑ To install mitigation equipment to improve chiller 1
- ❑ To comply with SEMI F-47 standard or MS IEC 61000

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Objective

- To protect the control circuit (110Vac) of Chiller 1 toward voltage sag and comply with MS IEC61000-4-11 and SEMI F47
- To improve the sensitivity level of the Chillers towards voltage sag

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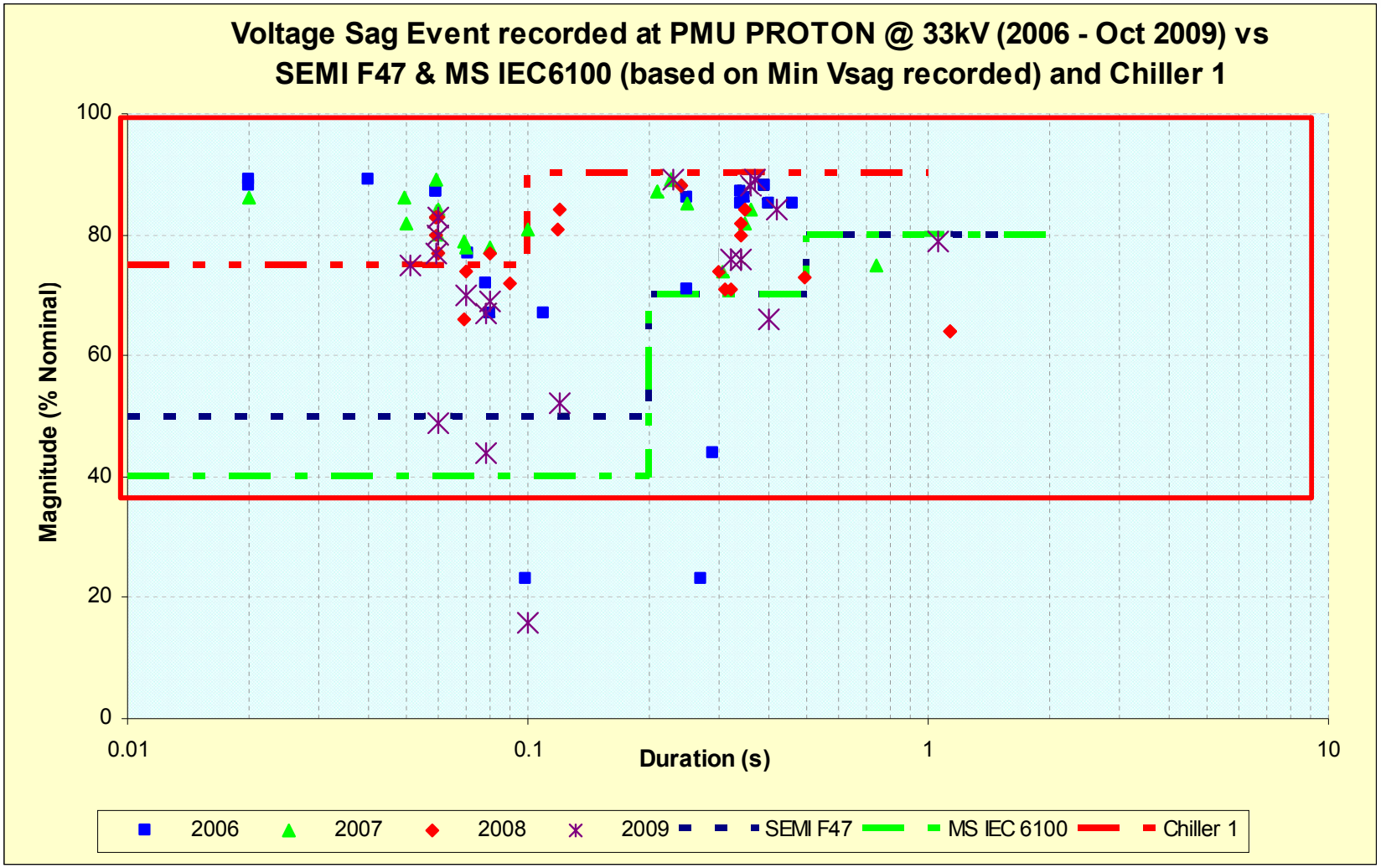
Sensitivity level of Chiller 1



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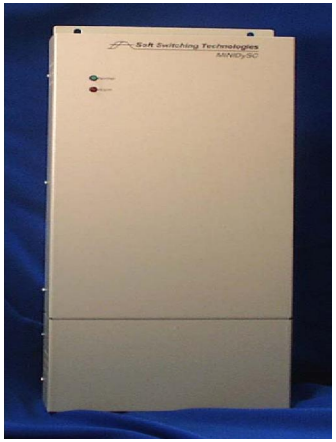
Task 3: PQ solution (options)

➢ The single-phase mitigation equipment was proposed to be installed at the secondary side of isolation transformer 1T2 (110V,1248VA)

PQ Mitigation Equipment	Type of Energy Storage	Output Voltage Waveform	Ride-through Capability
1a. MiniDySC (Dynamic Sag Corrector)	Ultra-capacitor	Sinusoidal	0% voltage for 50ms
1b. MiniDySC (Dynamic Sag Corrector) - Extended	Ultra-capacitor	Sinusoidal	0% voltage for 200ms
2. Dip-Free	Ultra-capacitor	Square	0% voltage for 1 sec
3. Dip-Proofing Inverter (DPI)	Ultra-capacitor	Square	0% for for 3 secs
4. Voltage Dip Compensator (VDC)	Transformer	Sinusoidal	36% voltage for 2.1s
5. On-Line UPS	Battery	Sinusoidal	0% for >1mins



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Task 3: PQ solution

Considering the exposure level for the chiller (tackling ~ 90% of the PQ issues), cost factor, recommendations from OEM

- Single - phase PQME:
  Voltage Dip Compensator (VDC) – 120V, 3kVA.
  Available rating of VDC (208V): 1kVA, 3kVA, 5kVA.

Type of PQME installed	Immunity level (Ride Through Capability)	Resultant Exposure level (Estimated per year)
VDC	36% voltage for 2s	(3/46)*12 = 0.78

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Task 3: PQ solution (Summary)

No	Description	Without PQME [A]	With PQME [B]
1.	Number of event per year	~14	~1
2.	Estimated Production Loss per year*:		
	a. Maximum: RM50,000/event	700,000	50,000
	b. Minimum: RM20,000/event	280,000	20,000
3.	Savings: [A – B]		
	a. Maximum	450,000	
	b. Minimum	180,000	
4.	Cost of Solution (excl. installation):	25,000 (2 units)	
5.	Payback Period: [4 / 3] year		
	a. Maximum	25,000/180,000 = 0.13	
	b. Minimum	25,000/450,000 = 0.05	

- Install mitigation equipment for Chiller 1 control circuit – ROI < 2 months

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Installation details

Date of Installation & Commissioning	:	7 March 2011
Equipment to protect	:	Control circuit (110Vac) of Chiller 1
Detail of VDC installed	:	**Chiller 1** Model: VDCL6T3K120 Capacity: 120Vac, 3kVA, 24A Serial #: 11-0001 Date Manufactured: 01/28/11 F/W Ver:1.7 Support setting: **90%** (support threshold) and **2.0 sec** (support duration)
Accessories	:	Housed Bypass Switch 25Amps x 2 units Model: BPSW25A

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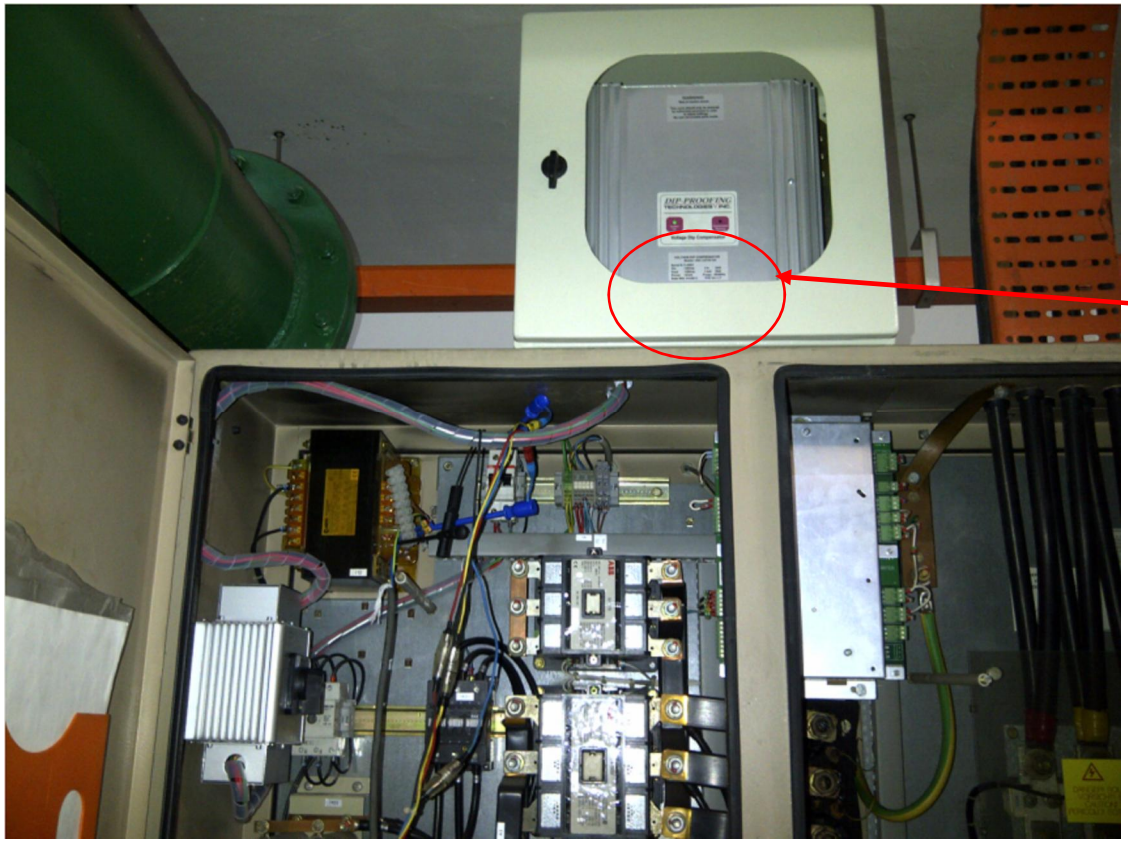
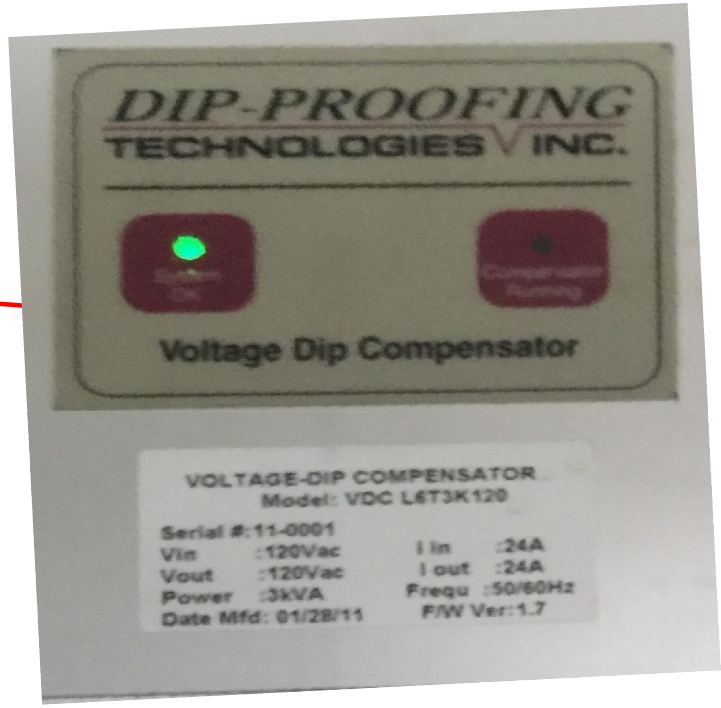
Actual installation





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Installed at unit no 1 and no 2

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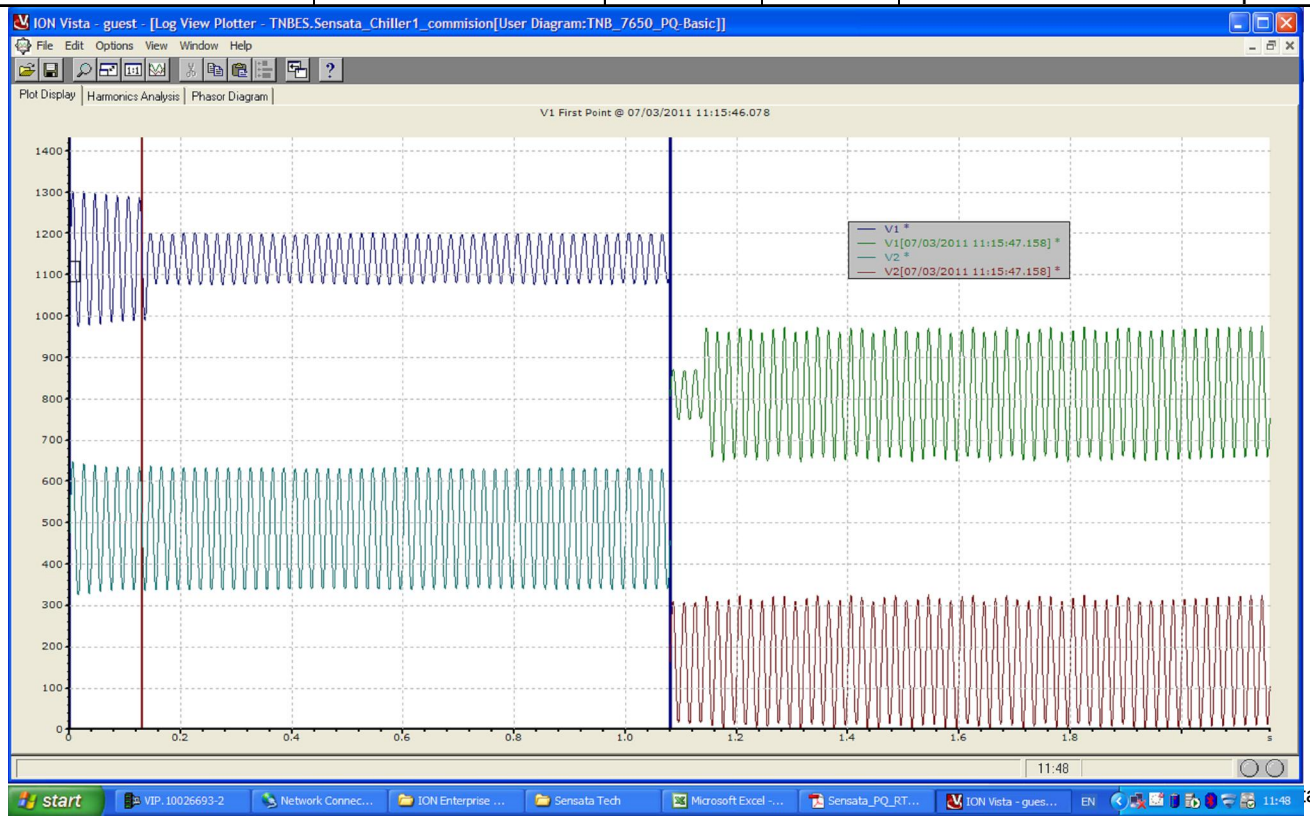
Actual commissioning (Chiller 1 & 2)

Test #	EUT	Chroma 3kVA, 1-phase sag generator			
		Voltage Sag L-N % nominal - (Voltage)	Dur (ms)	Result	Comment/Observation
1	Control Circuit **Chiller 1** (110Vac) (with VDC)	80%	1000	Pass	-
2		50%	1000	Pass	-
3		40%	1000	Pass	-
4		40%	2000	Pass	-
5		30%	1000	Fail	Machine trip



Input to VDC (40% for 1 sec)

Output of VDC (100%)

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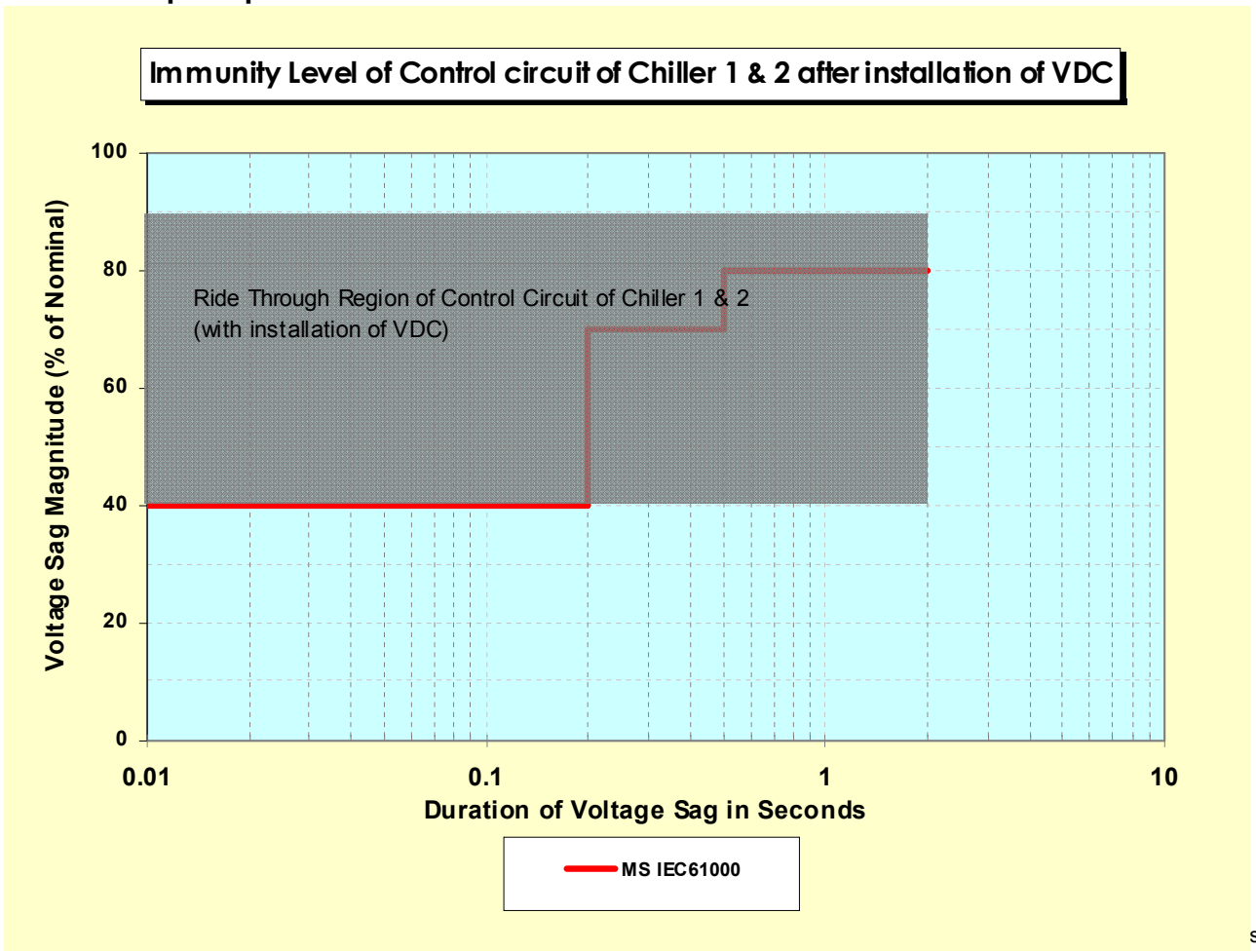
Conclusion

- ✓ Setting for the VDCs are to start support: 90% of nominal voltage, duration 2 sec
- ✓ Immunity level of Chiller 1 and Chiller 2 increased after installation of VDC as below. Comply with MS IEC61000 & SEMI F47
- ✓ Next step – production side sensitive tools



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THANK YOU