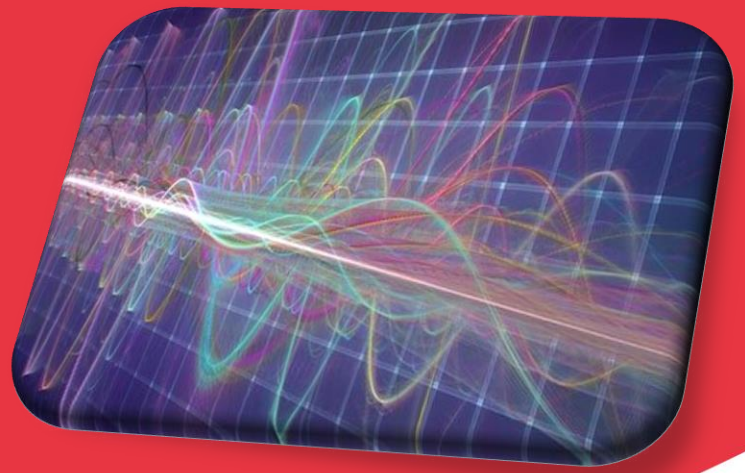
Session Five: Energy Conservation and Efficiency

Utilization of Power Quality Meters in NEDC Networks



17/9/2024

Eng: Hilal Said Al Hadi
Distribution Network Modernization Manger

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IEEE PowerTalks
Oman's Power and Energy Event

Content

- Introduction
- Power Quality Meters
- Mitigation of Power Quality Effects
- Potential Uses of Power Quality Meters
- Case Study
- Conclusions

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Introduction

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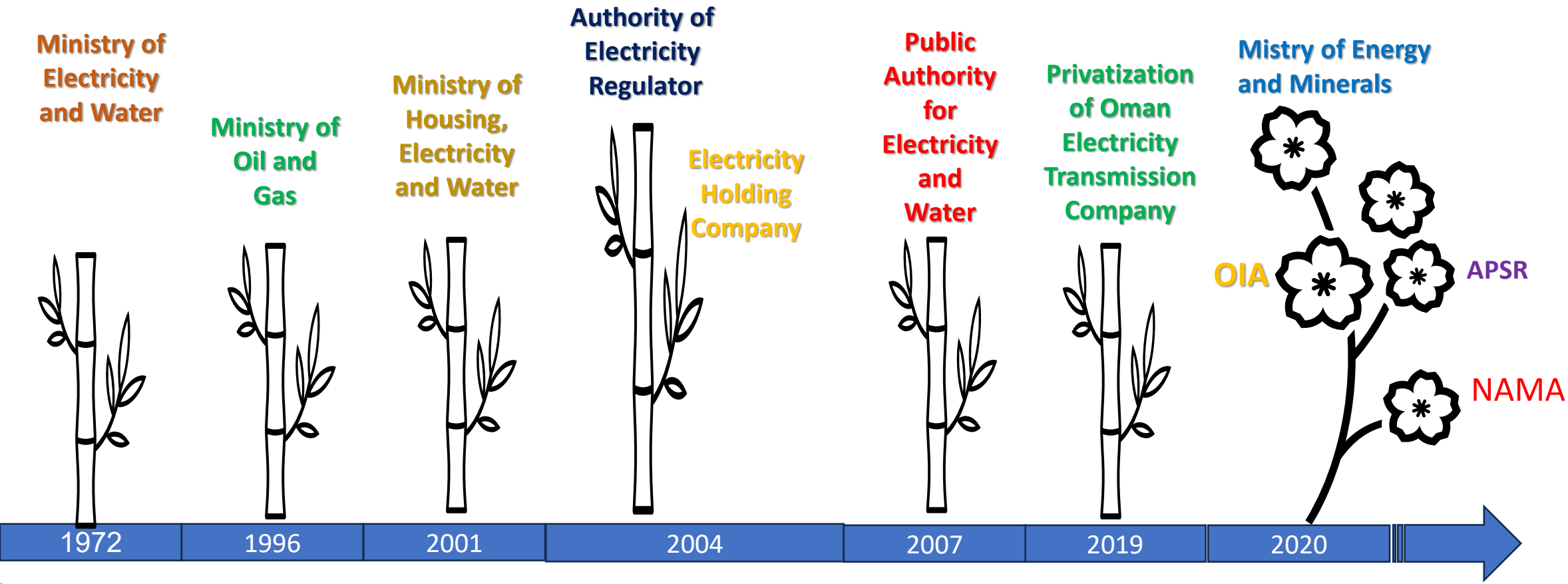
History of the Energy Sector in the Sultanate of Oman



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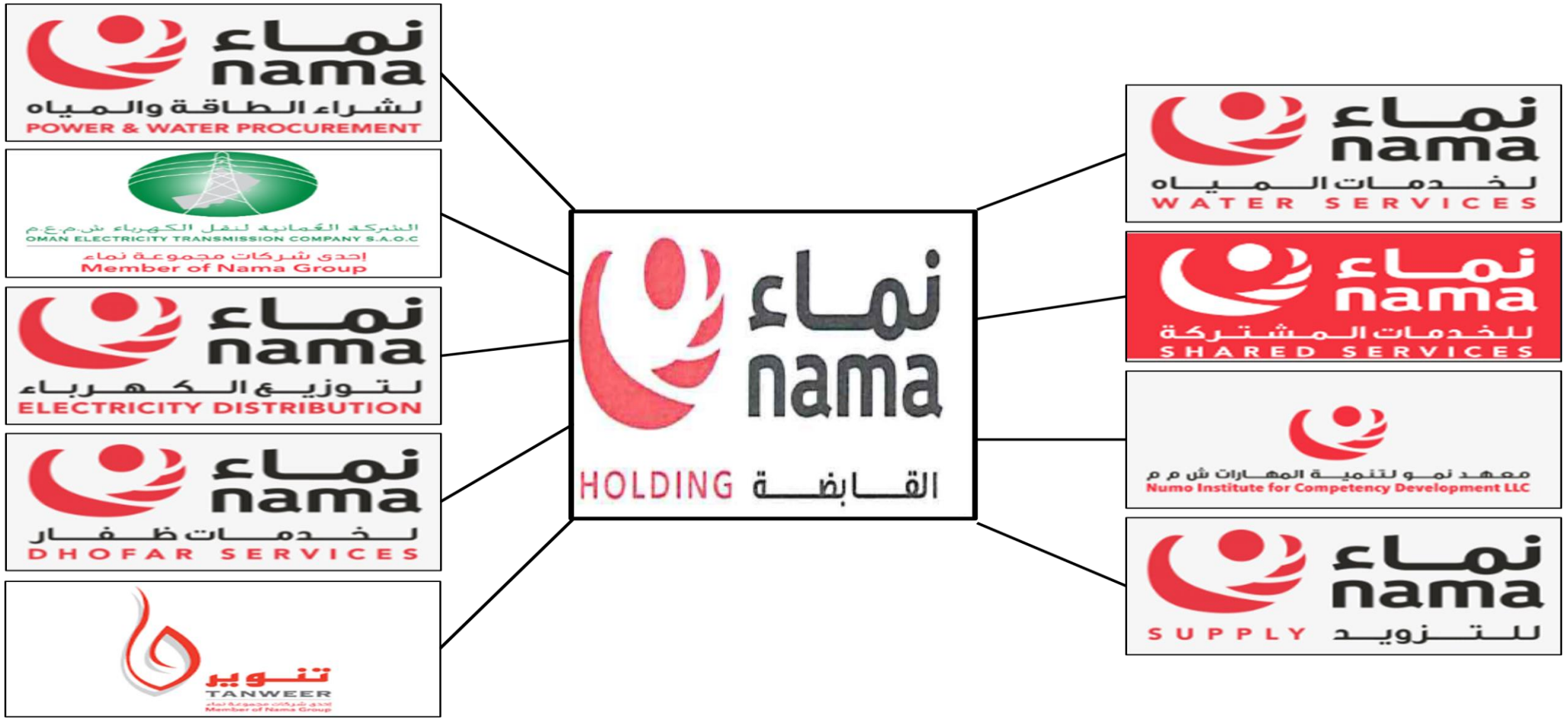
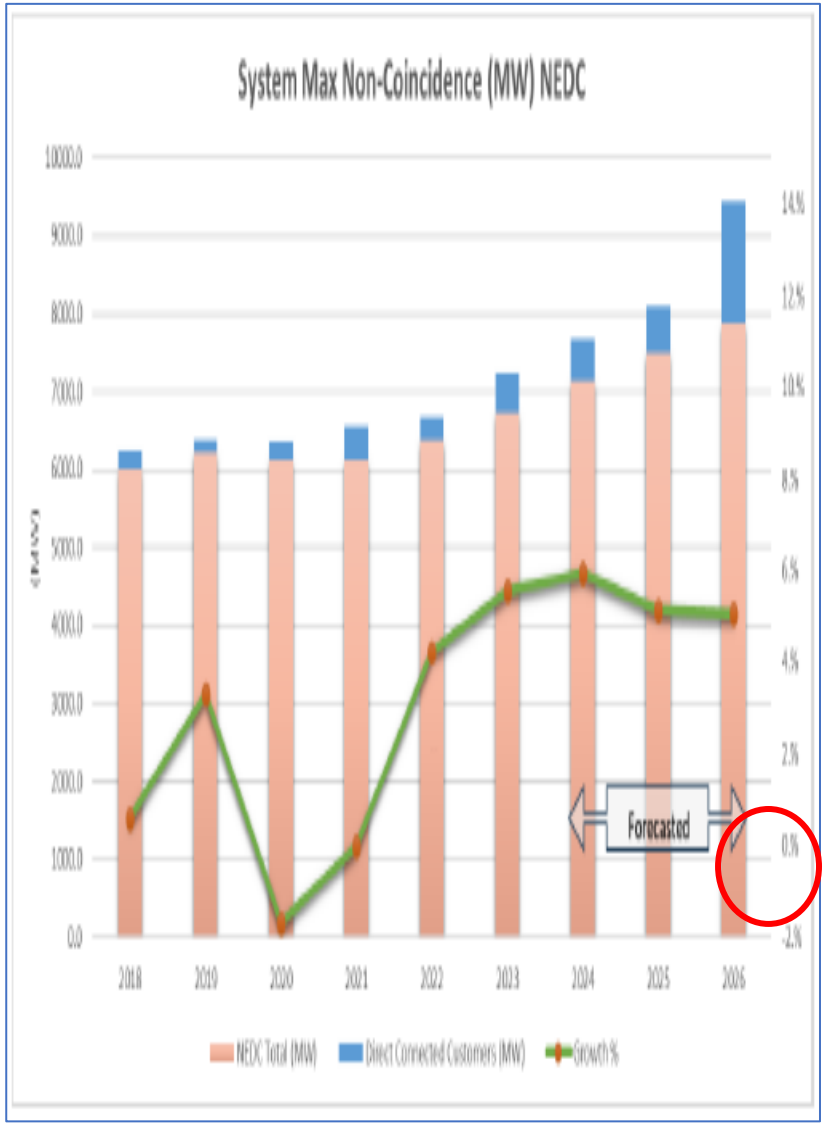
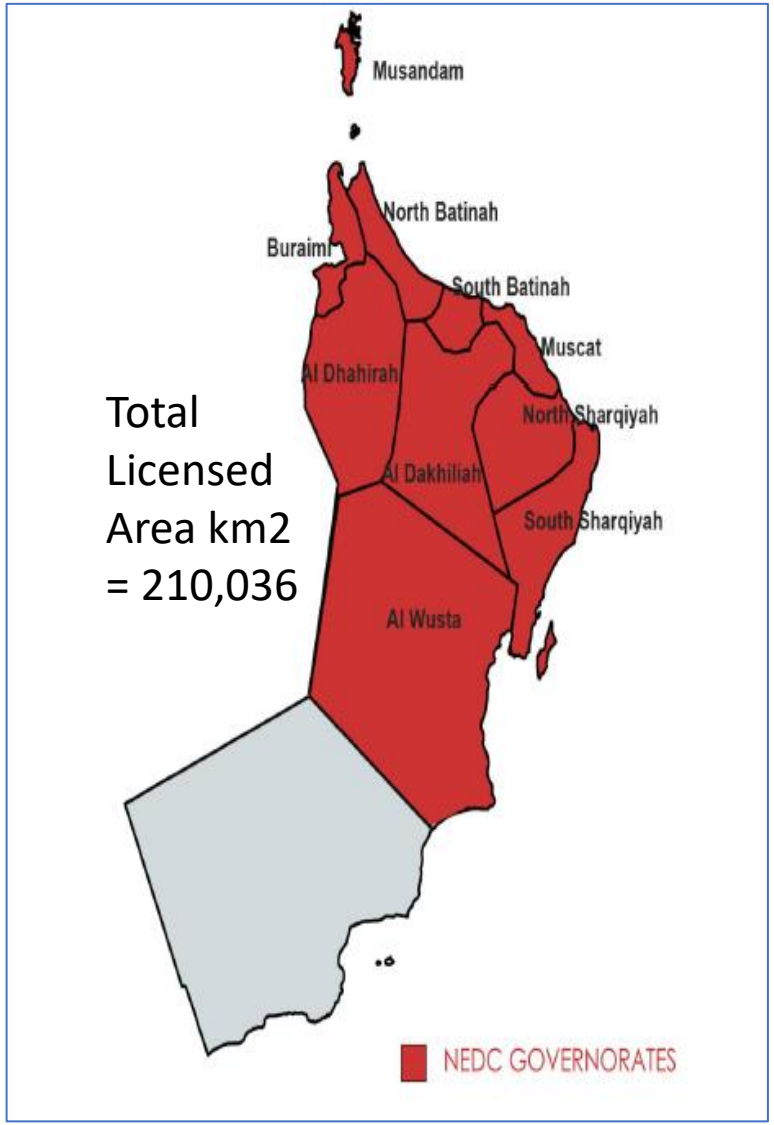
Introduction



Introduction





Total Licensed Area km2 = 210,036

Power Quality Meters

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Power Quality Meters

Introduction

The Power Quality Meter (PQM) is device used for monitoring of the power quality of any electric system at all voltage levels as specified in the IEC 61000-4-30.

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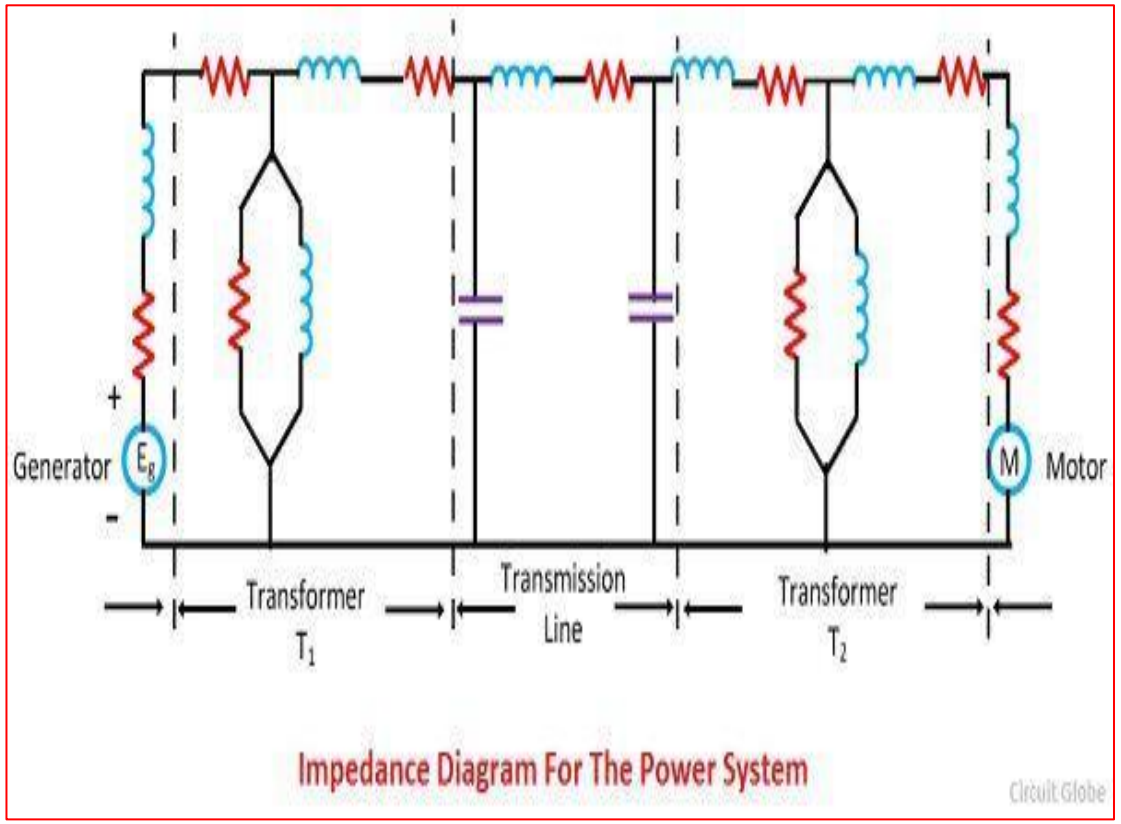
Cont; Introduction to Power Quality Meters

What are the power quality main parameters?

- Frequency
- Voltage Quality
- Harmonics
- Power factor



Cont; Introduction to Power Quality Meters

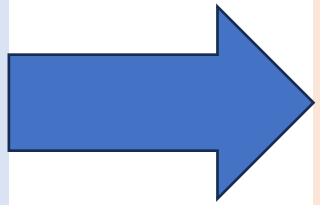
What are the Electrical Components and environment effecting the power quality ?

	Type of the Element	Power Factor	Harmonics	Under Voltage	Over Voltage	Over Frequency	Under Frequency	Flickers	Losses (%)
1	Generator	X	X	X	X	X	X		X
2	Motor	X	X	X			X	X	X
3	Capacitor	X			X				X
4	Reactors	X	X	X	X				X
5	SVC	X	X	X	X				X
6	Type of Lights	X	X	X			X	X	X
7	Wind generator	X	X	X	X	X	X		X
8	Electronic Devices	X	X	X	X	X	X	X	X
9	Over headline accessories	X	X	X	X			X	X
10	Circuit Breaker							X	X
11	Lightening	X	X	X	X	X	X	X	X
12	Solar PV System	X	X	X	X	X	X	X	X
13	EVC	X	X	X			X	X	X
14	Protection devices	X							X
15	Environment	X	X					X	X
16	Cables	X	X		X			X	X

Cont; Introduction to Power Quality Meters

Power Disturbances

- Surge/Transient
- Power Outage
- Power Swell
- Power Sag
- Electrical Noise
- Electromagnetic Interference (EMI)



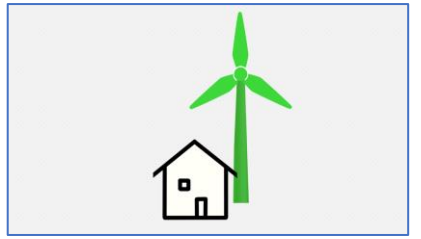
Results/ Effects

- Overheating of machines
- Damage of sensitive equipment like computers
- Increase of system losses
- Electric System over /under sizing

Cont; Introduction to Power Quality Meters

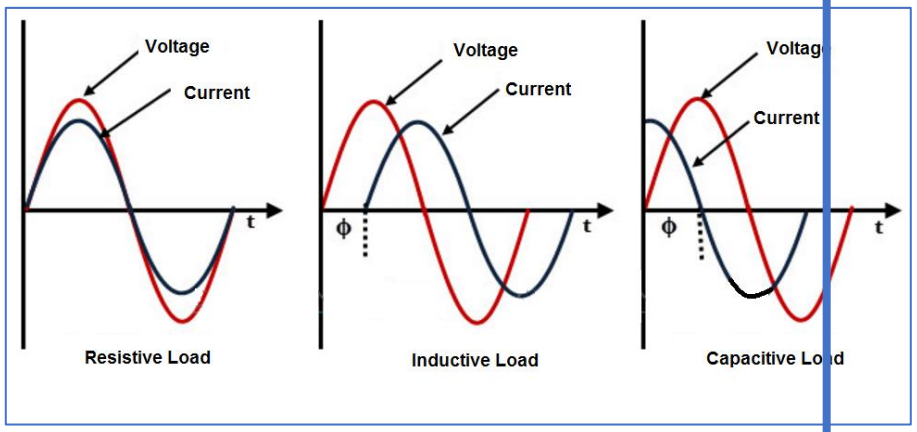
Classifications of the Power Disturbances

80%	20%
Generated internally at the end-user (downstream) system. Due to non-linear loads:	From the Grid (upstream):
Inverters	Type of power source like Solar and Wind.
Welding	Large load connected directly to the grid.
Robots	Power interruption
Large motors	
Electronic equipment	

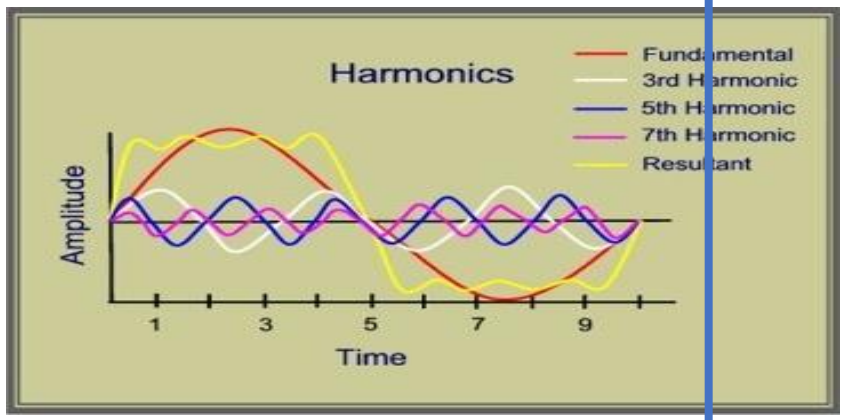


Cont; Introduction to Power Quality Meters

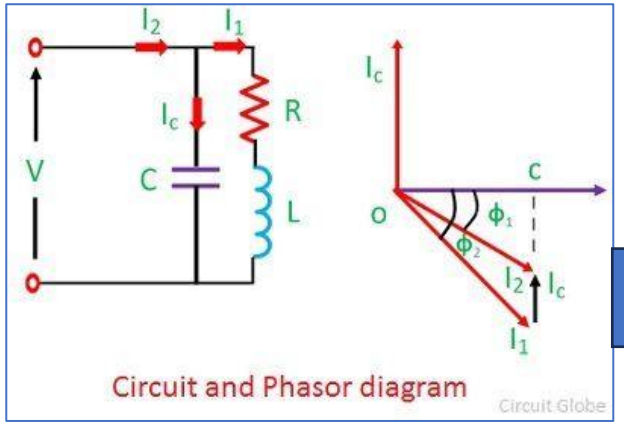
Effect of Power Factor

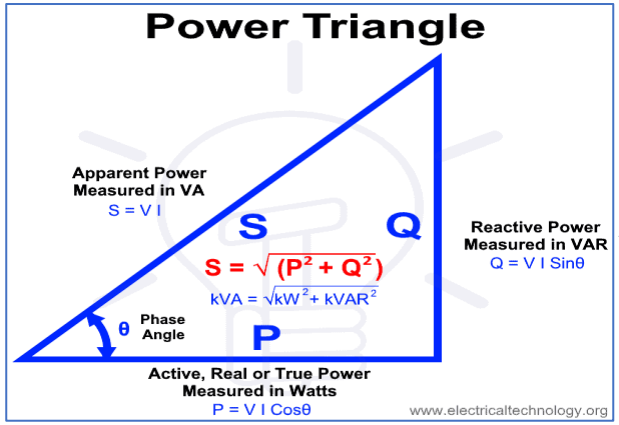


Harmonics



Solution





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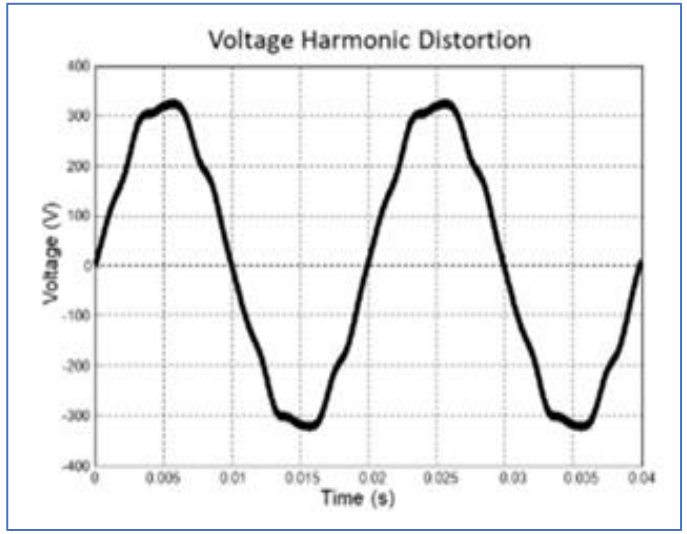
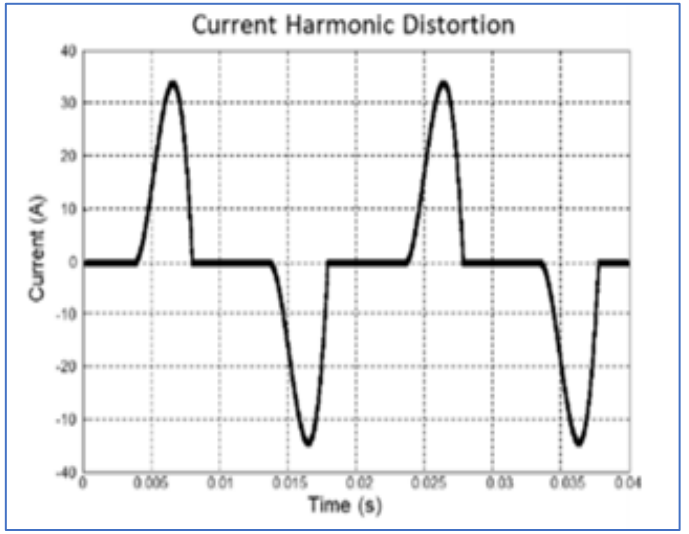
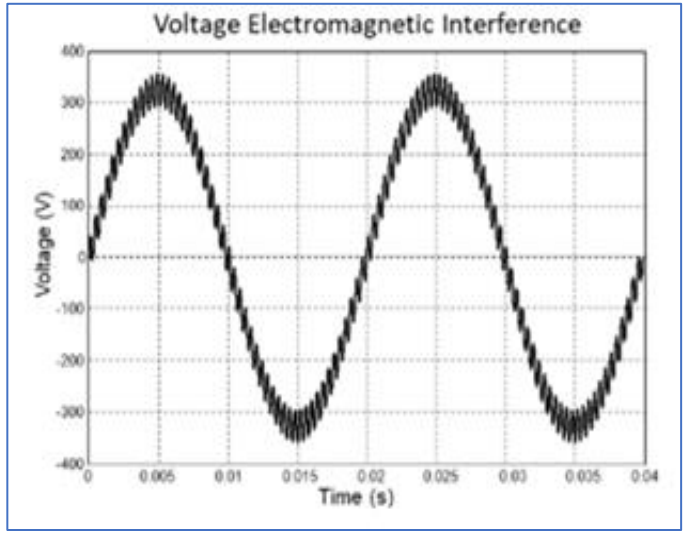
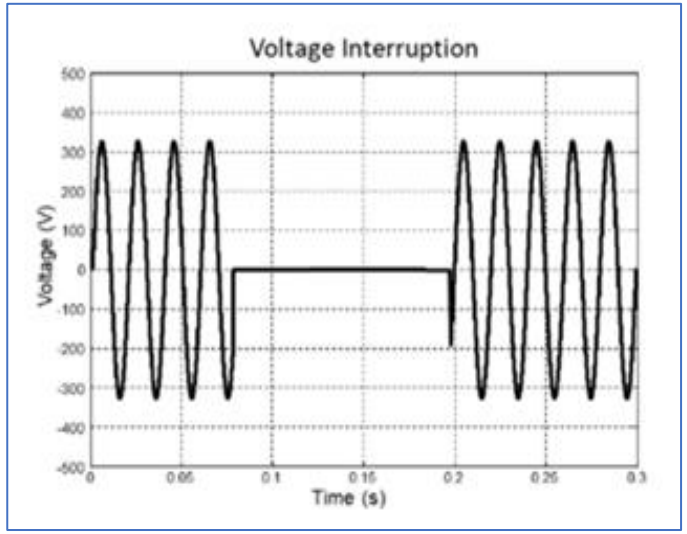
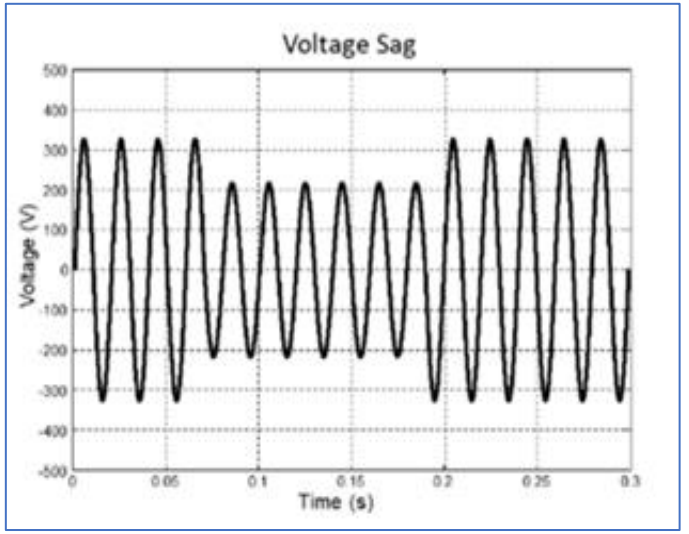
Shape of Wave Disturbances:

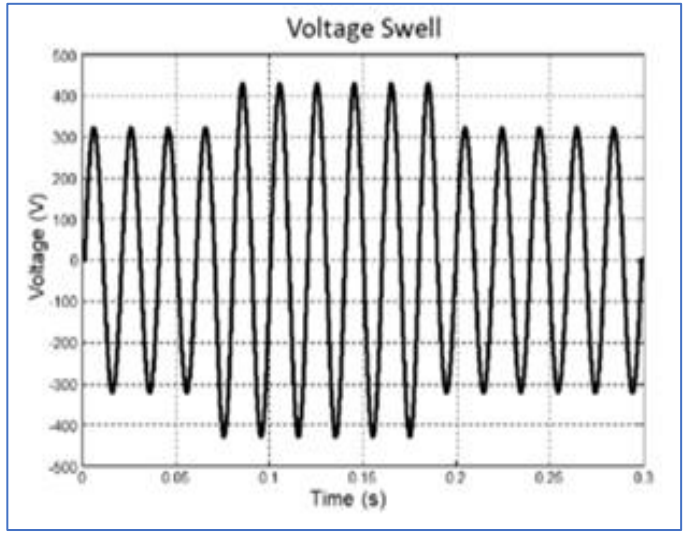












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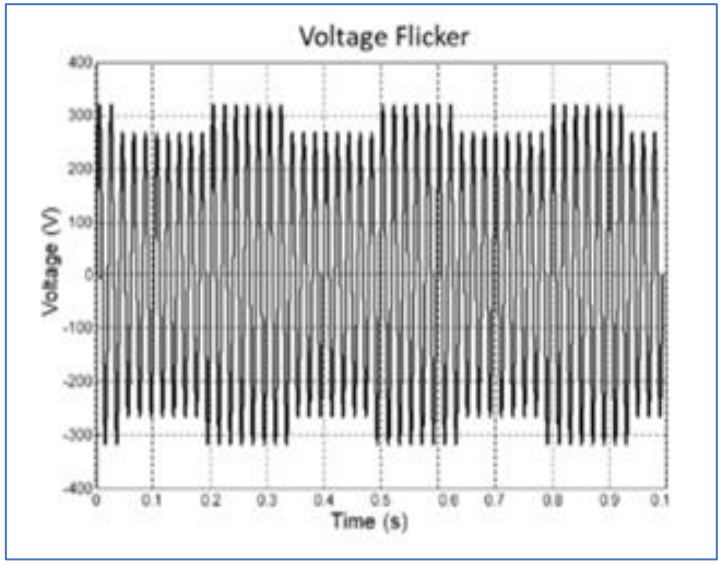
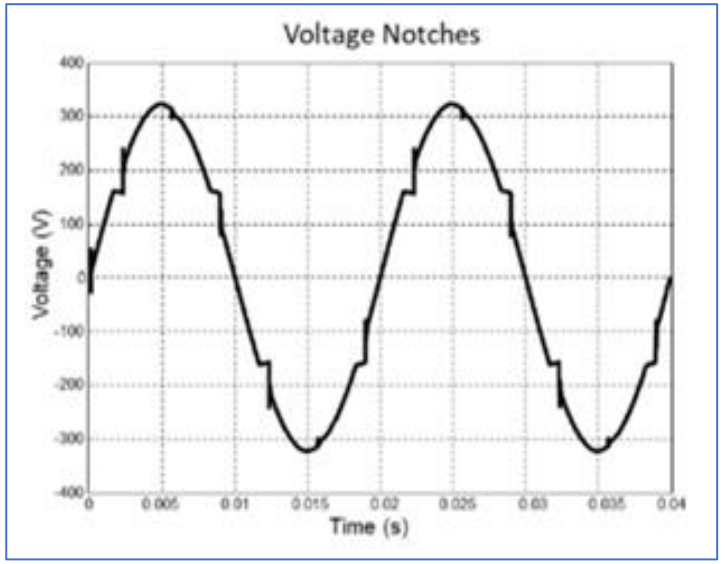
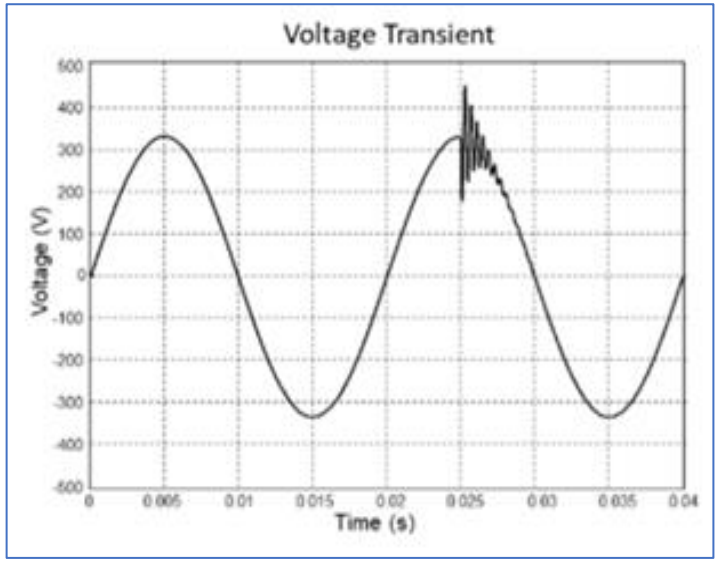
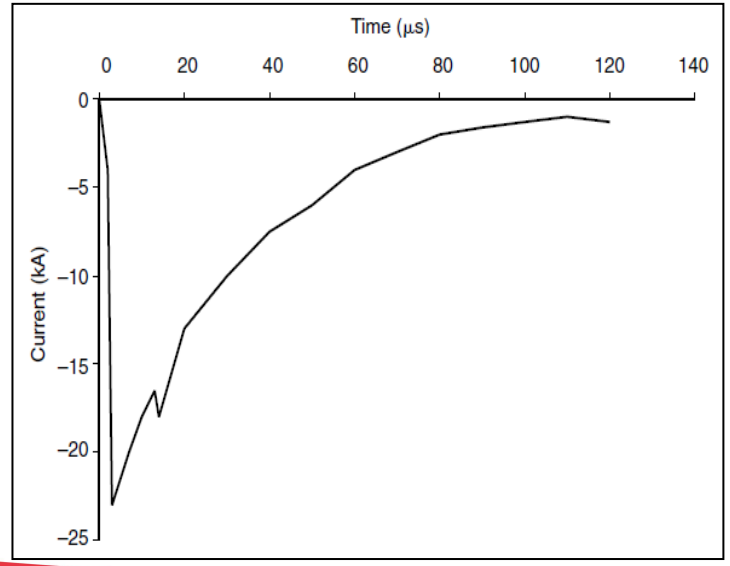
Shape of Wave Disturbances:

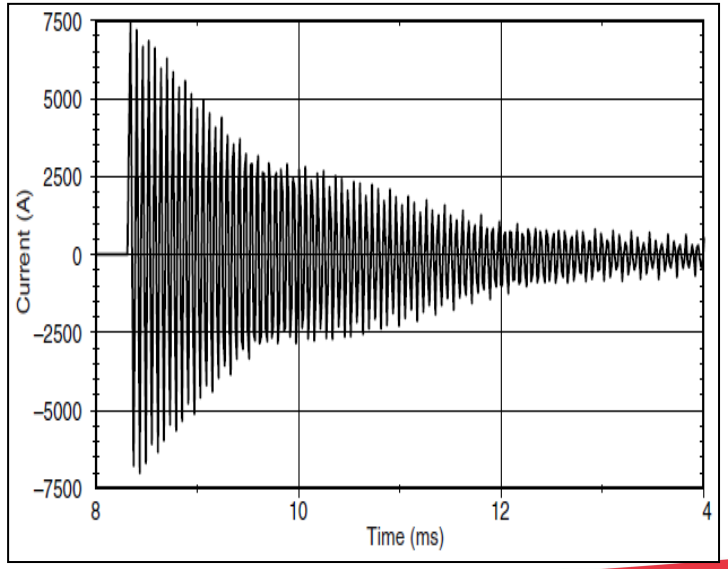






Lightning stroke current impulsive transient.

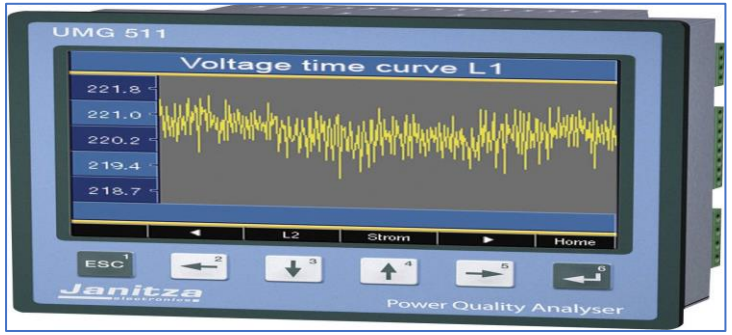




Oscillatory transient current caused by back-to-back capacitor switching

Cont; Introduction to Power Quality Meters

Monitoring of Power Quality

Power and Energy Loggers	Power Quality analyzers and meters	Power Quality recorders and monitors
		
		
		

Mitigation of Power Quality Effects

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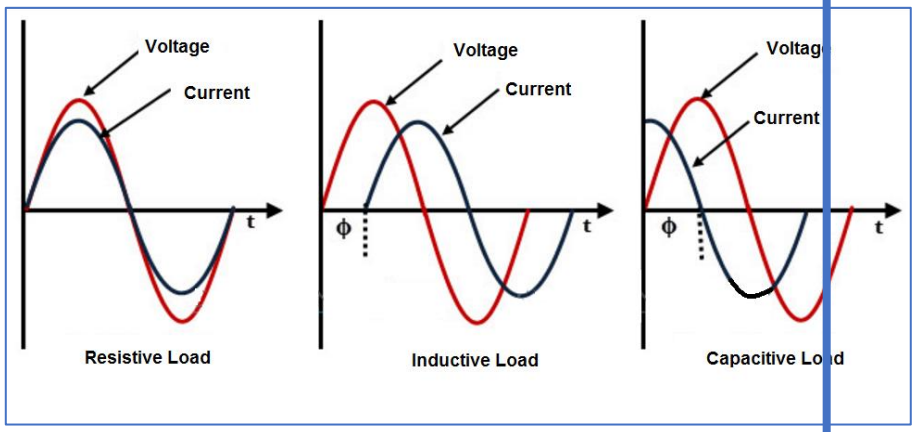
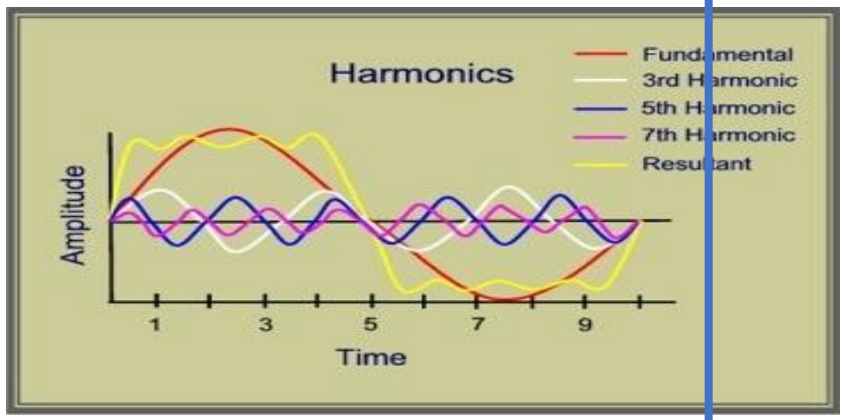
Mitigation of Power Quality Effects

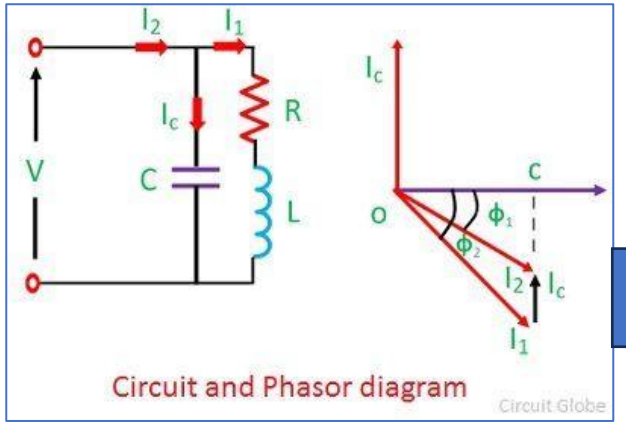
Effect of Power Factor

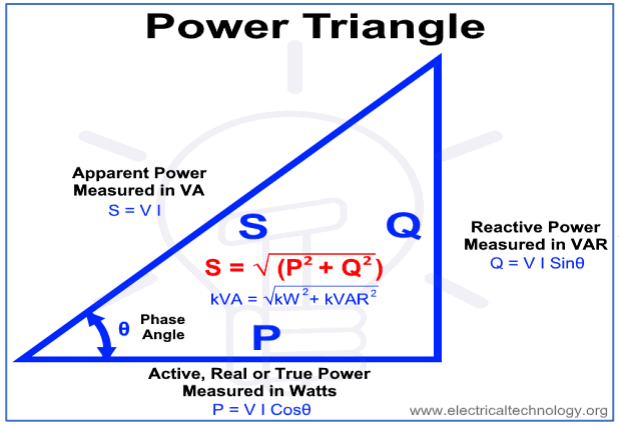


Harmonics



Solution





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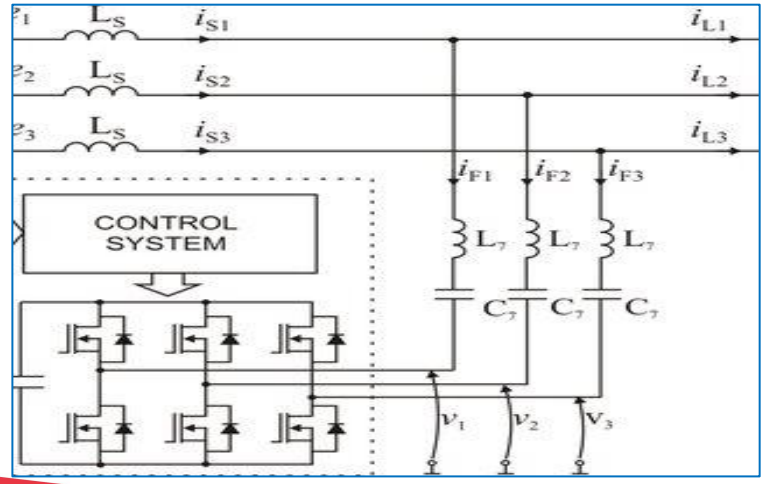
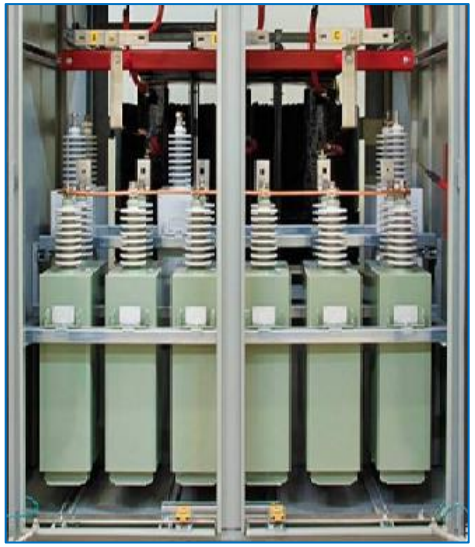
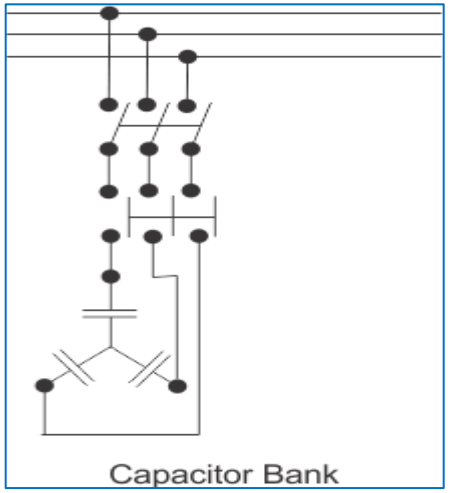
Mitigation of Power Quality Effects

Active Filters / Compensators

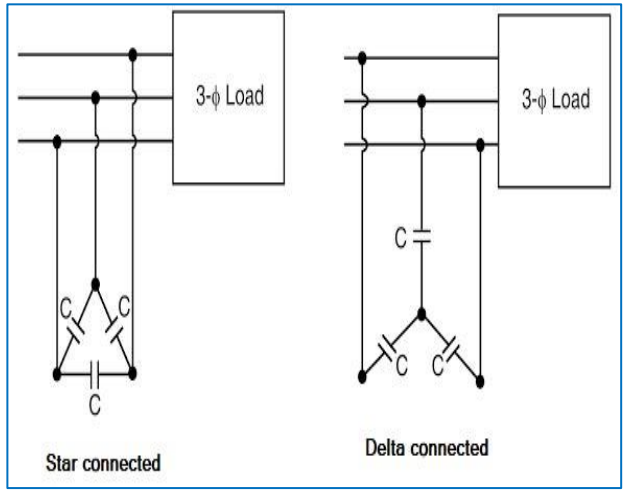


Capacitor Banks





Power Factor Correction Capacitors/Components



Potential Uses of Power Quality Meters

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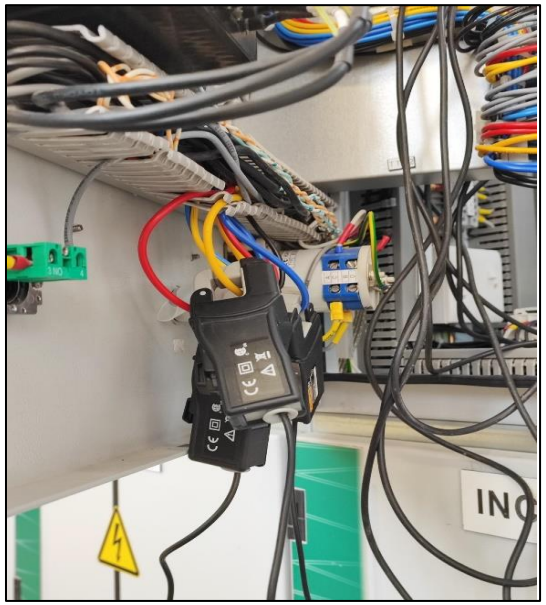
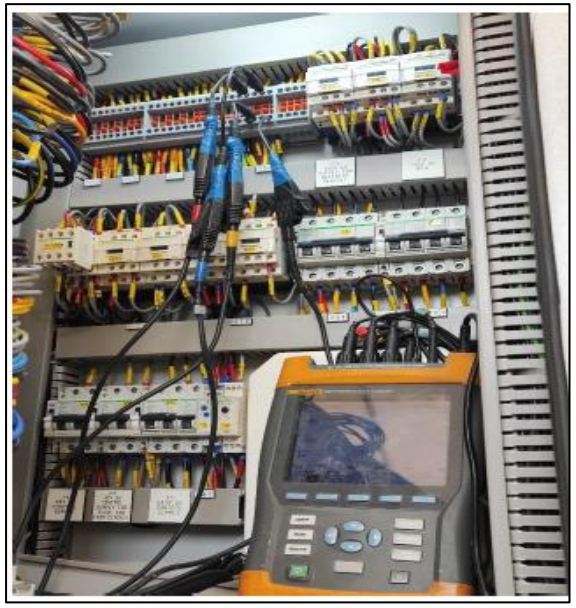
Cont; Potential Uses of Power Quality Meters

Installation of the PQM



At the site as fix type for continues monitoring.



Portable at selected location to monitor any unnormal conditions as required (minimum one week).

Cont; Potential Uses of Power Quality Meters

- ❑ Forecasting Incipient Faults.
- ❑ Pinpointing Fault Locations and Root Cause.
- ❑ Avoid Analyzing Power Instabilities:
  - By reading continues voltage and current.
  - Predicting load demand.
- ❑ Predictive Maintenance with Power Quality Meters.
- ❑ Estimate the inertia contribution from renewable sources.
- ❑ Avoid Human Errors and Achieving Energy Savings:
  - Can analyses the errors of load demands.
  - Avoid unbalances .
  - Reduce the losses.

Cont; Potential Uses of Power Quality Meters

Power Quality Requirements According to Distribution Code

Parameter	Nominal Value	Limit
High Voltage(kV)	33/11	-6% to +6%
Low Voltage(kV)	0.415/0.240	-6% to +6%
Frequency (Hz)	50	49.95 1-Iz to 50.05 Hz
Frequency deviation(Hz)	50	49.9 1-Iz to 50.1 Hz
Frequency Under Disturbed Condition(Hz)	50	48 1-Iz to 51.5 Hz
Individual Harmonic(%)		Not exceed 1.5
THD(%)		Not exceed 2.0
THD at Distortion(%)		Not exceed 2.5
Negative Phase Sequence(%)		Not exceed 1.0
Maximum Unbalance(%)		Not exceed 2.0

DCC.4.1 Voltage regulation.
DCC.4.2 Frequency deviations
DCC.4.3 Voltage waveform quality.
DCC.4.4 Voltage Fluctuations.
DCC.7.8 Power Quality Requirements.

Power Quality Requirements

DCC.4.1 Voltage regulation

Under normal operating conditions, during each period of one week 95% of the 10 minute mean RMS values of the supply voltage at the Users' Connection Points to the Distribution System shall be within the range:

DCC.4.2 Frequency deviations

- 49.95 Hz to 50.05 Hz during 95% of each week
- 49.90 Hz to 50.10 Hz during 99% of each week
- Frequency could rise transiently to 51.50 Hz or fall to 47.50 Hz.

DCC.4.3 Voltage waveform quality:

95% of the 10 minute RMS values of each individual harmonic voltage shall be less than or equal to 3% and the THD of the supply voltage shall be less than 5%. for LV systems, these values shall be 5% for individual harmonics and 8% for THD of the supply voltage.

Under normal operating conditions, during each period of one week, 95% of the 10 minute mean RMS values of the negative phase sequence component (fundamental) of the supply voltage shall be less than 2% of the positive phase sequence component (fundamental).

DCC.4.4 Voltage Fluctuations

Under normal operating conditions, during each period of one week the long-term flicker severity Plt caused by voltage fluctuations should be less than or equal to the following values for 95% of the time on the Distribution System:

DCC.7.8 Power Quality Requirements

- The Users' facility is required to have a tolerance for sustained operation between 49.50 Hz and 50.50 Hz.

- Under normal operating conditions at the point of connection to the Distribution Licensee's network, during each period of one week, 95% of 10 min RMS values of the Total Rated-current Distortion (TRD) caused by the User's facility shall be less than or equal to 5% and the individual harmonic currents shall be less than or equal to the values in the following tables:

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Used PQM in NEDC Network

Fixed Type

Make	Zone-1	Zone-2	Zone-3	Zone-4	Total
UniPower	67	68	527		662
Janitza	50	31	0		81
Qualitral	0	0	23	0	23
KoCus	66				66
Siemens	40				40
Schneider	17				17
Elcom		1			1
Total	240	100	550		**890**
Portable Type					**10**

Case Study

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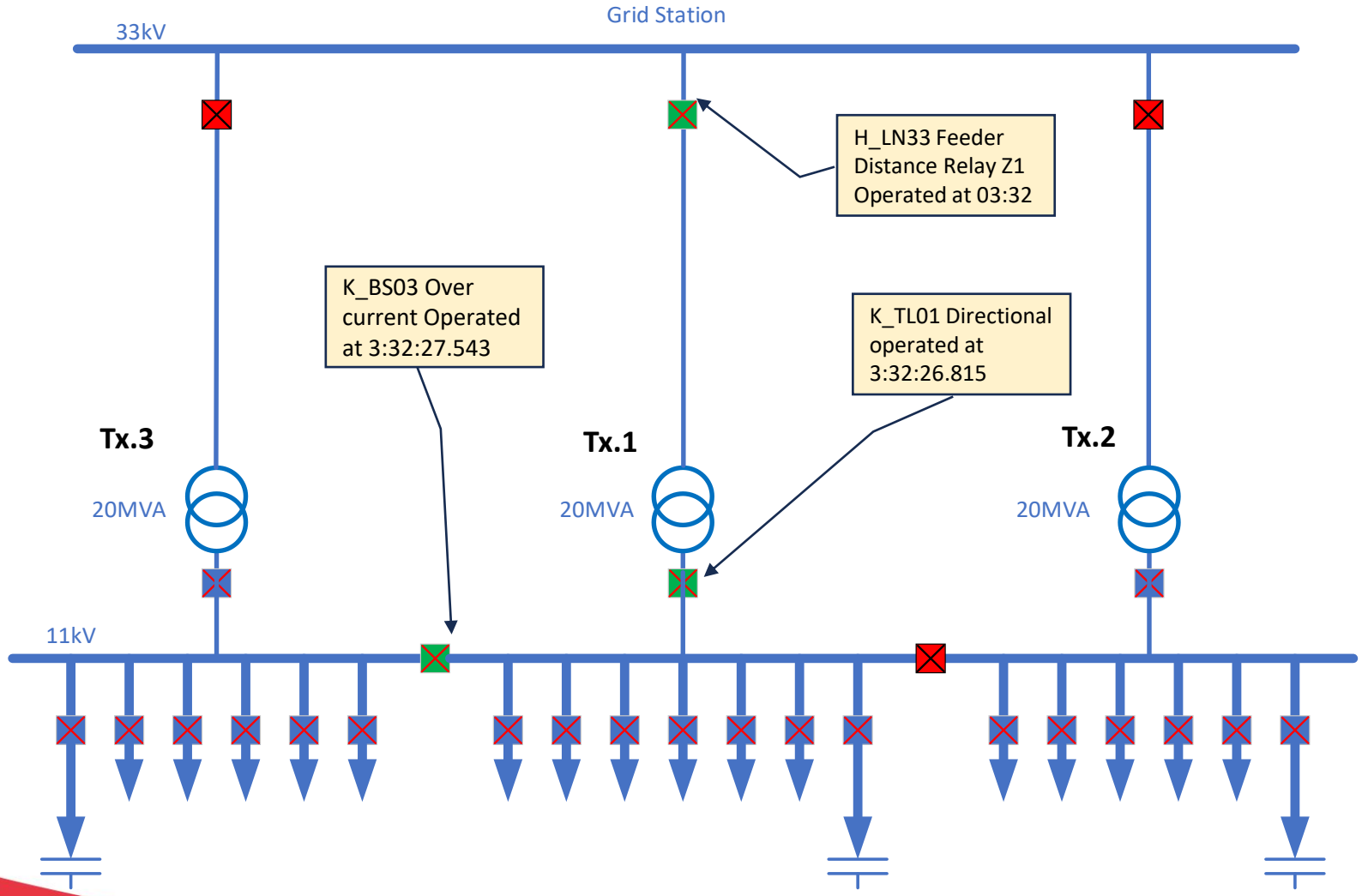
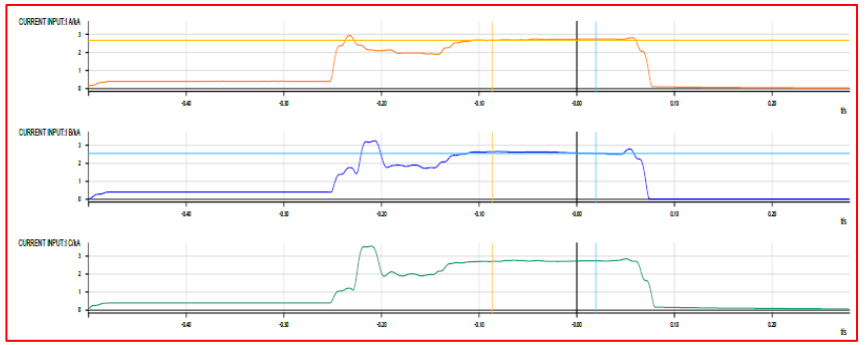
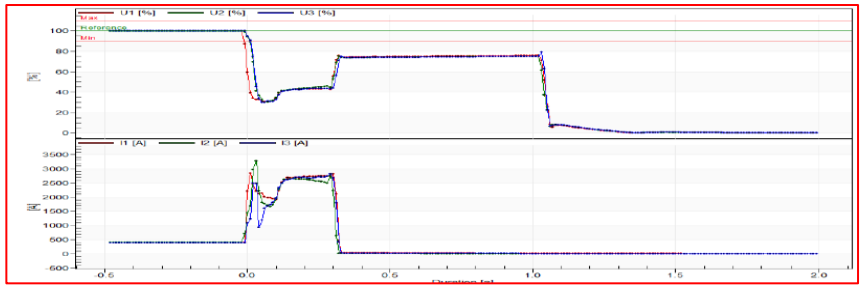
Case Study (8 Jul 2022 – Sohar Area)



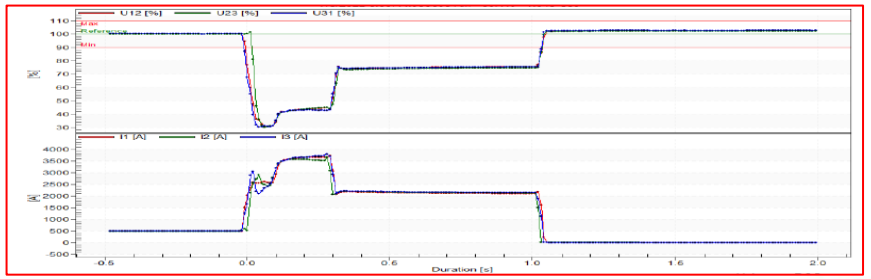
Tx.1 Directional Relay Tripping



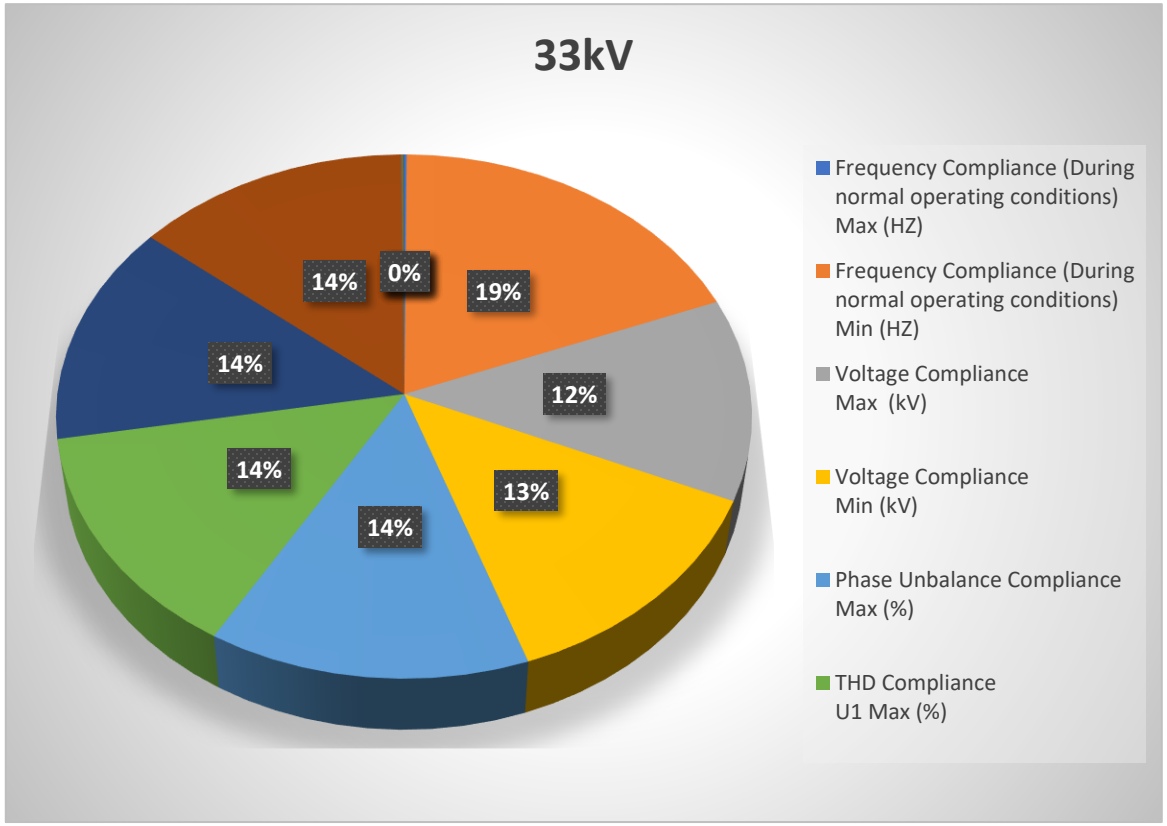
Tx.1 Directional relay tripping record from PQ Meter

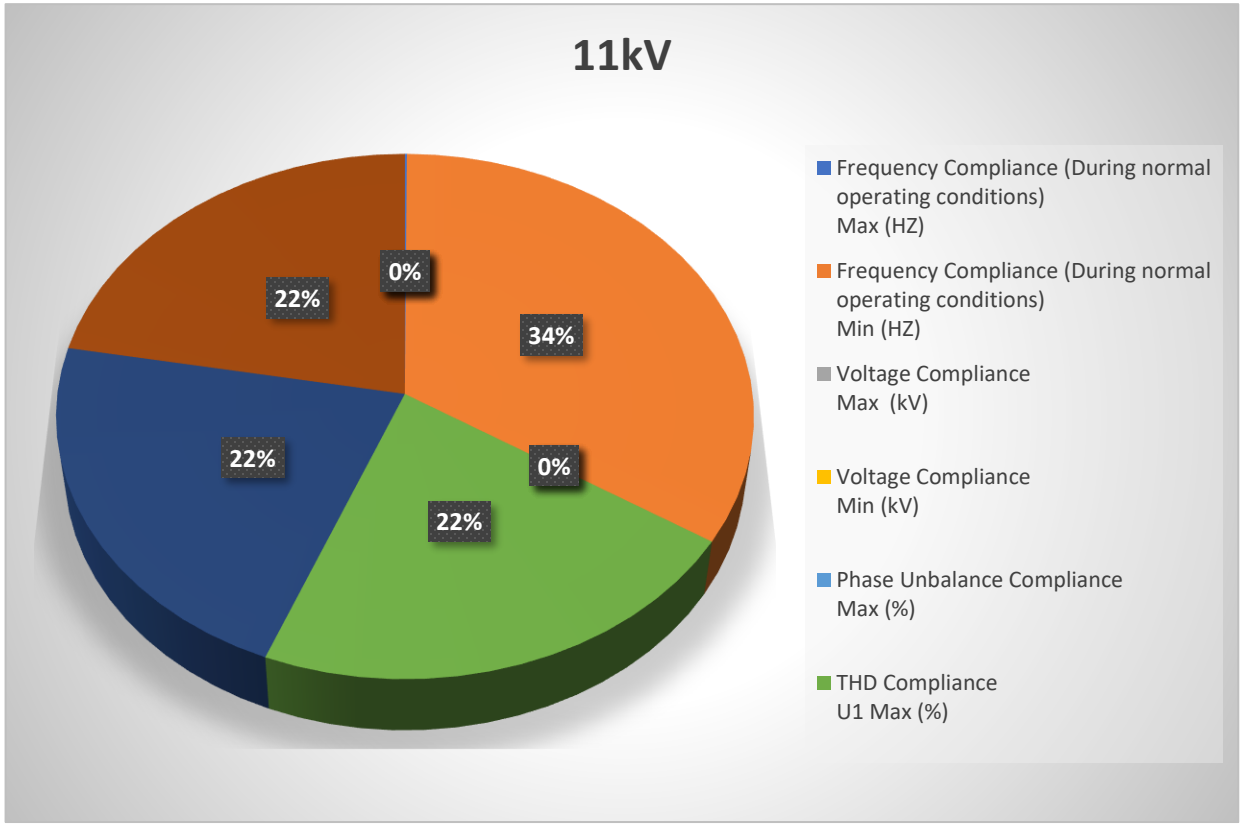


Tx.3 PQ Meter record during the time of Incident



Compliance Statical Collected Sample Data





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Thank You

Utilization of Power Quality Meters in NEDC Networks

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Distribution Network Modernization Manger

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