A NOVEL DSTATCOM TOPOLOGY AND ITS CONTROL FOR HIGH POWER APPLICATIONS

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Outline Of The Presentation

- Power Quality Issues
- Distribution Static Compensator (DSTATCOM)
- DSTATCOM for High Power Applications
  - Existing Topologies
  - Proposed Topology
- Simulation Results
- Conclusions

POWER QUALITY ISSUES

NON-LINEAR LOADS

- Power converters / Power drives
- Switched mode power supplies and UPS
- Laser printers / Xerox
- Arc lamp / Arc furnace / Welding

POWER QUALITY PROBLEMS

- Current Harmonics
- Poor power factor
- Voltage interruptions
- Voltage sag and swell
- Voltage unbalance

IMPACT OF PQ PROBLEMS ON POWER SYSTEM COMPONENTS

Sl.No.	Item	Impact
1	Rotating machines	Overheating, loss of efficiency, pulsating torque, shaft fatigue, reduced life, acoustic noise emission
2	Transformer	Over heating, reduced life, acoustic noise emission
3	Neutral wire	Overloading
4	Power factor capacitor	Overloading, reduced life, fuse disconnection
5	Fuses and CB	Nuisance tripping, reduced life
6	Cables and conductors	Increased temperature, inability to provide full current rating without overheating, reduced life

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IMPACT OF PQ PROBLEMS ON POWER SYSTEM COMPONENTS

7	Meters	Erroneous reading
8	Residential equipments	Increased acoustic noise emission, loss of life, overheating
9	Electronic equipments	Defective operation, radio interference
10	Power distribution network	Excitation of system resonance, increased level of voltage distortion
11	Telephone network	Increased levels of noise, safety problem
12	Data cable	Interference and noise

MITIGATION: Using Filters

PASSIVE POWER FILTERS

- Use of passive components only (L and C)
- Advantages:
  - Simplicity
  - Low Cost
- Disadvantages:
  - Resonance problems
  - Filter for every frequency
  - Bulky

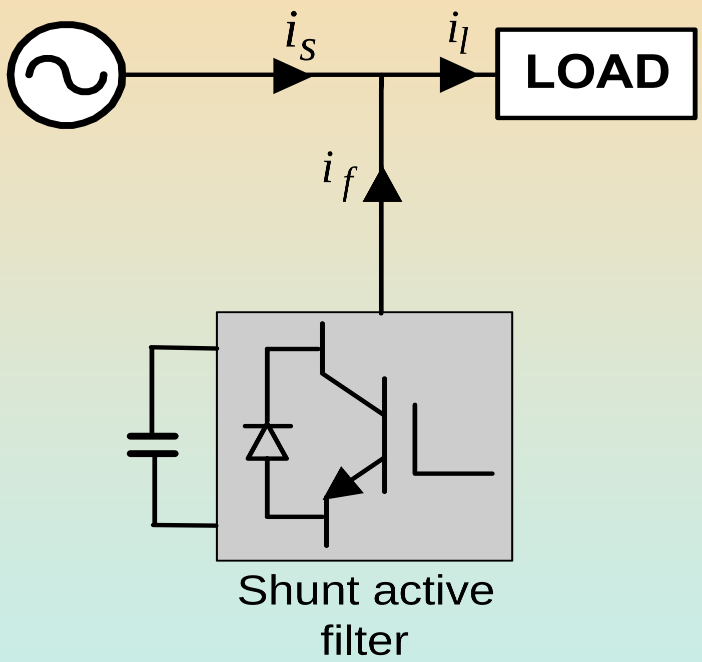
ACTIVE POWER FILTERS

- Power Converter circuit using active components (IGBTs, MOSFETs…) and Energy Storage Device (L or C)
- Advantages:
  - Filtering for a range of frequencies
  - No Resonance Problems
  - Fast Response
- Disadvantages: High Cost

DISTRIBUTION STATIC COMPENSATOR (DSTATCOM)

A Shunt Active Power Filter

- Load balancing
- Power factor correction
- Harmonic elimination



DSTATCOM for High Power Applications

- Literature focuses on the DSTATCOM for low power applications.
- DSTATCOMs available for high voltage or current applications.

High Voltage Appln.

- **Use of Multilevel Inverters**

Demerits

- Complicated in structure and control
- Capacitor balancing issues
- Reduced security

High Current Appln.

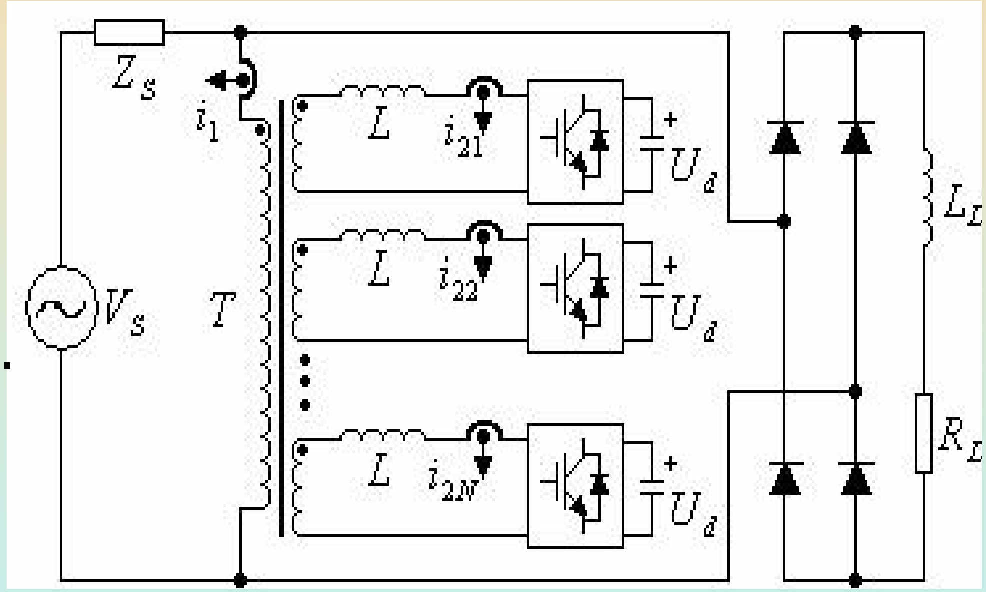
- **Use of paralleled units**

Demerits

- Requires suppression of Zero sequence circulating current. Thus complex control.

High Voltage and Current DSTATCOM

- **Use of Multiple secondary transformer based on magnetic flux compensation technique.**

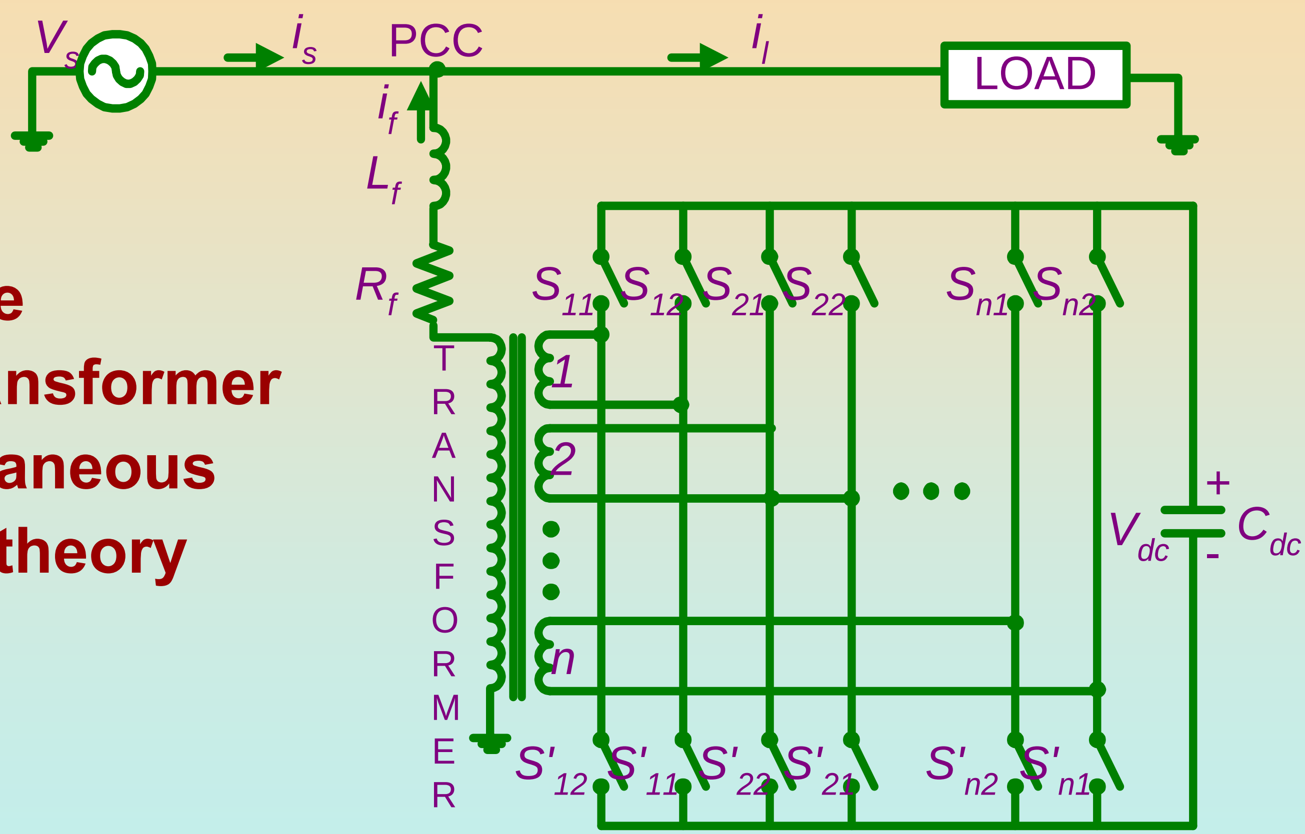


Demerits

- Possibility of improper compensation.
- Cannot compensate dc load.
- No proper control over pf.

Thus the need for High Power DSTATCOMs.

A Novel DSTATCOM Topology for High Power Applications



- **Use of Multiple secondary transformer**
- **Use of instantaneous symmetrical theory**

Theory of Instantaneous Symmetrical Components

$$i_{fa}^{*} = i_{la} - \frac{v_{sa} + \beta(v_{sb} - v_{sc})}{v_{sa}^{2} + v_{sb}^{2} + v_{sc}^{2}}.(P_{lav} + P_{loss})$$

$$i_{fb}^{*} = i_{lb} - \frac{v_{sb} + \beta(v_{sc} - v_{sa})}{v_{sa}^{2} + v_{sb}^{2} + v_{sc}^{2}}.(P_{lav} + P_{loss})$$

$$i_{fc}^{*} = i_{lc} - \frac{v_{sc} + \beta(v_{sa} - v_{sb})}{v_{sa}^{2} + v_{sb}^{2} + v_{sc}^{2}}.(P_{lav} + P_{loss})$$

where $\beta = \tan\varphi/\sqrt{3}$ and φ is the desired power factor angle.

$$P_{lav} = \frac{1}{T}\int(v_{sa}i_{la} + v_{sb}i_{lb} + v_{sc}i_{lc})dt$$

$$P_{loss} = K_P e + K_I \int e\,dt$$ **where $e = V_{ref} - V_{dccyl}$**

Generation of Switching Commands

Hysteresis band current control method

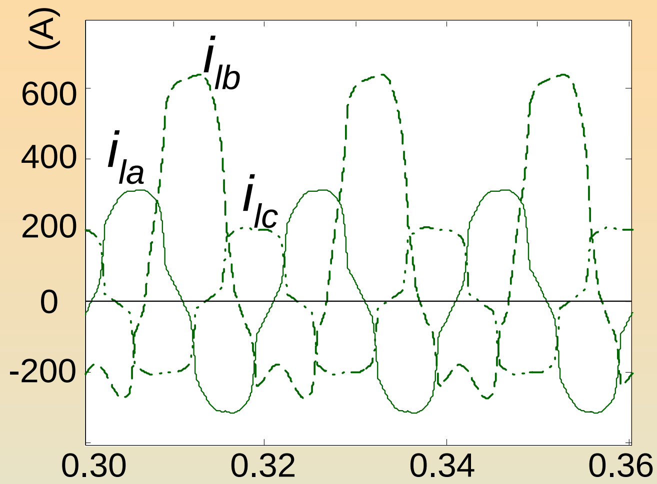
If $i_f \geq i_f^* + h,$

S_{12} and S'_{12} are turned ON whereas S_{11} and S'_{11} are turned OFF

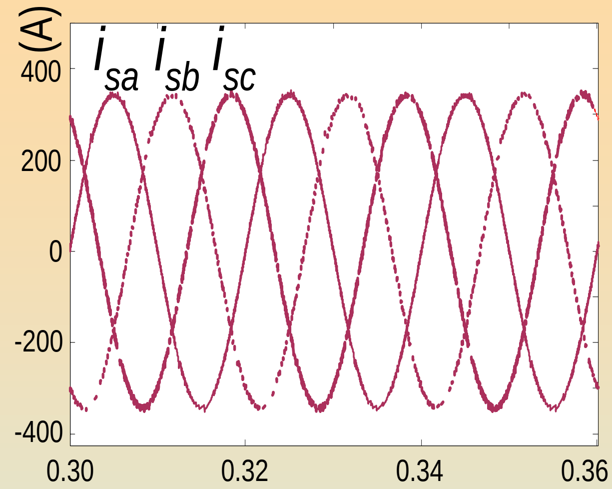
else if $i_f \leq i_f^* - h,$

S_{11} and S'_{11} are turned ON whereas S_{21} and S'_{12} are turned OFF

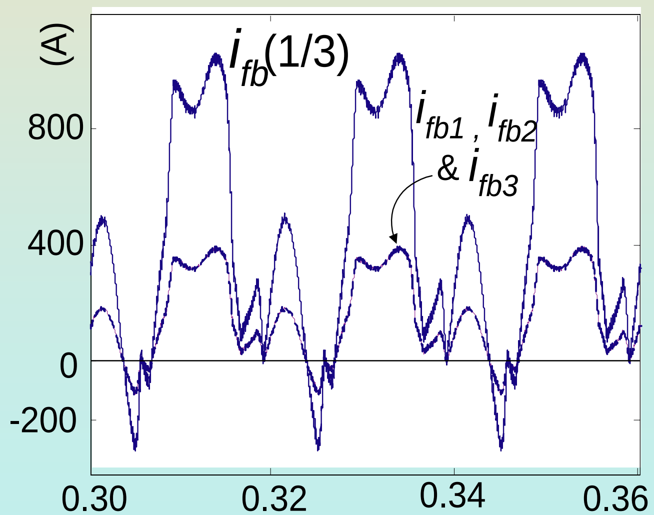
Simulation results



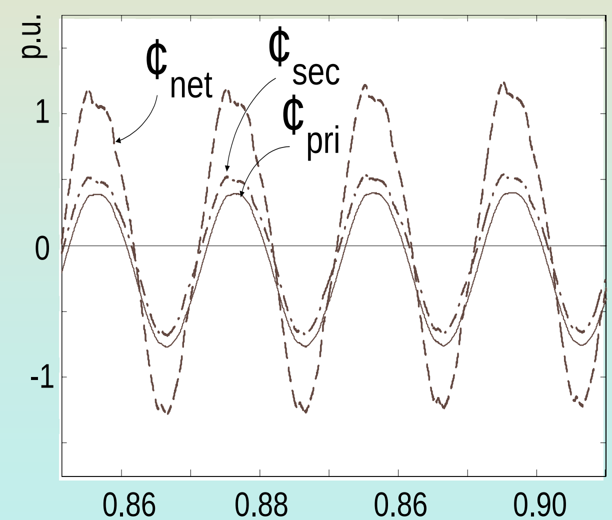
Load currents



Source currents

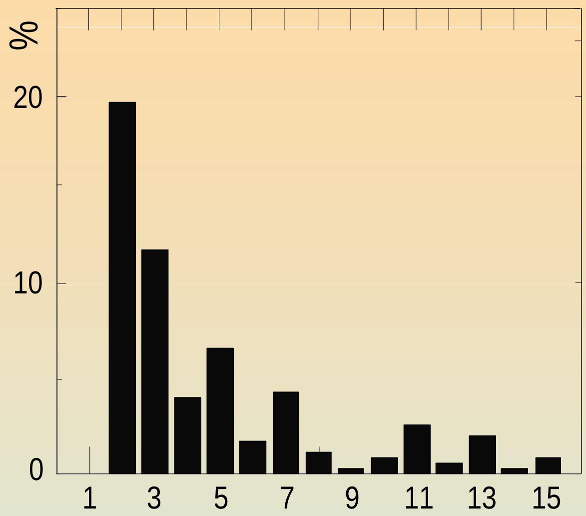


Filter currents

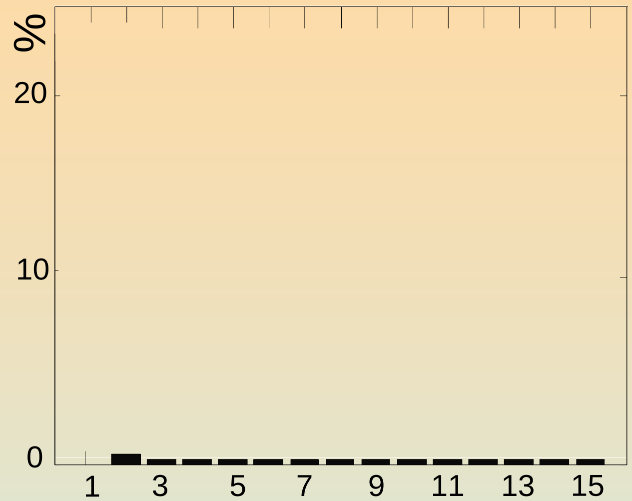


Transformer flux

Harmonic Components



Load current



Source current

%THD	Phase-*a*	Phase-*b*	Phase-*c*
Load currents	12.35	25.01	19.1
Source currents	0.27	0.57	0.22

CONCLUSIONS

A Novel DSTATCOM Topology proposed with

- Instantaneous compensation
- Compensation for dc and triplen harmonic components
- Control over source power factor
- Minimal control complexity
- Single capacitor of lesser voltage rating
- Increased security

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