A Novel FACTS Hybrid Modulated Filter/Capacitor compensator

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Need for Energy Conservation and Loss reduction

- Rising Cost /Depleting resources of fossil fuels
- Unreliable /Unproven Oil/NG Reserves
- Climate change/Global warming and CO2 emissions
- Feeder Congestion and additional Costs of Energy Transmission and need to reduce transmission Losses

What is the solution?

Utilization and Interfacing of Green Energy of Renewable Sources

What is the challenge?

Robust Interface-Decoupling and need to Enhance Power Quality, Energy Utilization and Dynamic Voltage Stability

Our Goal!!

New Flexible AC Transmission System (FACTS) Device-Including Hybrid Modulated Filter-C Type-Capacitor Compensator (MFCCC)

What Does it Include?

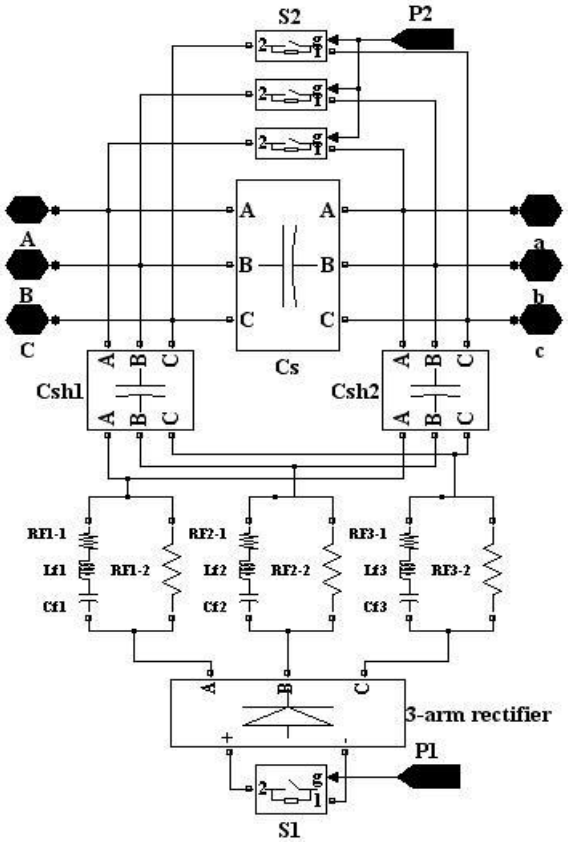
1. Capacitor Banks
2. C Type Filter
3. IGBT/MOSFET Power Electronic Switches

What achievements have been done?

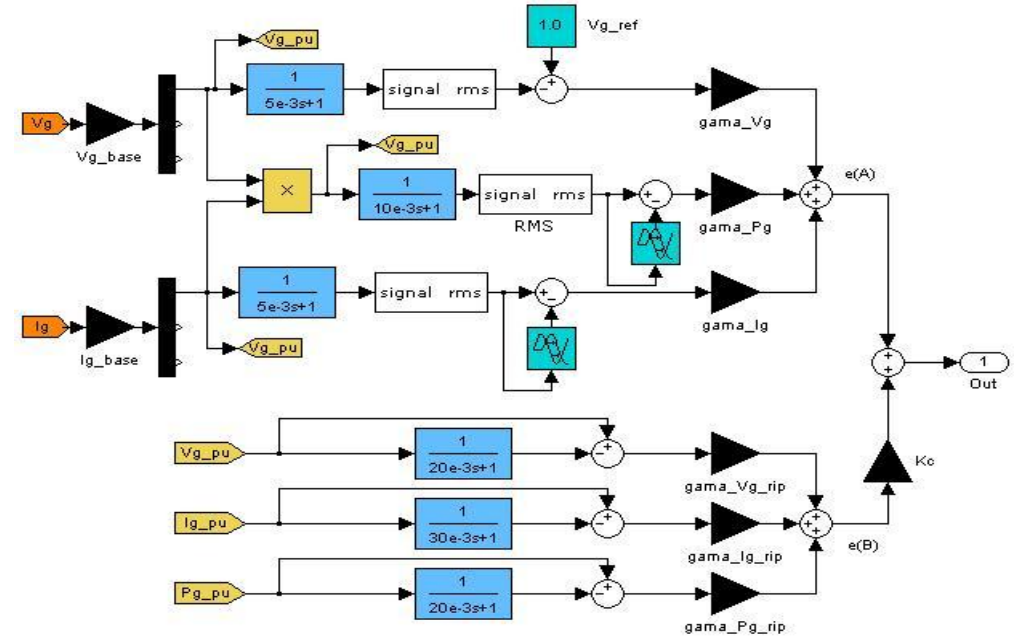
1. Designing Modulated Filter –compensation Schemes
2. Devising A Controller Handling On-Off Sequences in IGBT/MOSFET Switches
3. Testing The Effects of MFCCC in a Grid (by use of MATLAB- Simulink Software Environment)

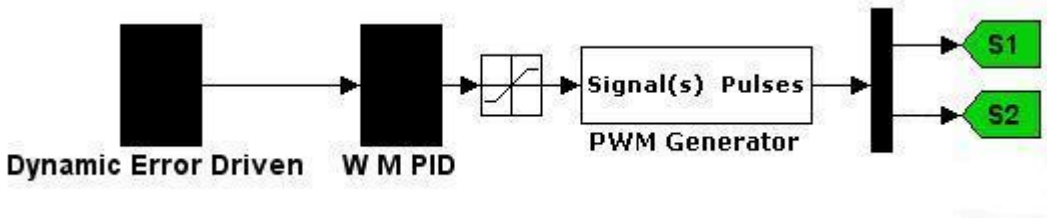
Proposed MFCCC's Structure

- One series and Two shunt 3-phas switched capacitor banks connected in DELTA shape
- C Type Filters following the Delta-Capacitor connection
- Uncontrolled 3-arm rectifier
- IGBT/MOSFET switch S1 on DC side of the rectifier
- S2 in parallel with series capacitor
- NOT LOGIC Command arbitrates between S1 and S2
- S1 controls reactive power, reduces harmonic pollution, and improve power factor
- S2 compensate line impedance and limits fault currents



Multi Loop Dynamic Error-Driven Controller -Overall Scheme





Multi Loop Dynamic Error-Driven Controller- Description

Comprising two blocks whose outputs are indicated by e(A) and e(b):

1. **Dynamic Tracking Regulator**:

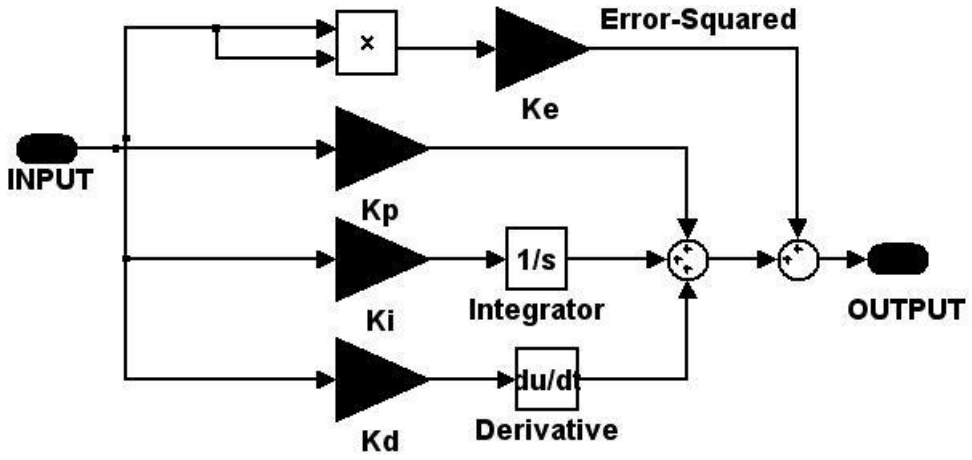
- *Voltage error between instantaneous and reference voltage*
- *Stabilizer current excursion loop*
- *Limiting generator power excursion loop*

2. **Minimal Ripple Regulator**:

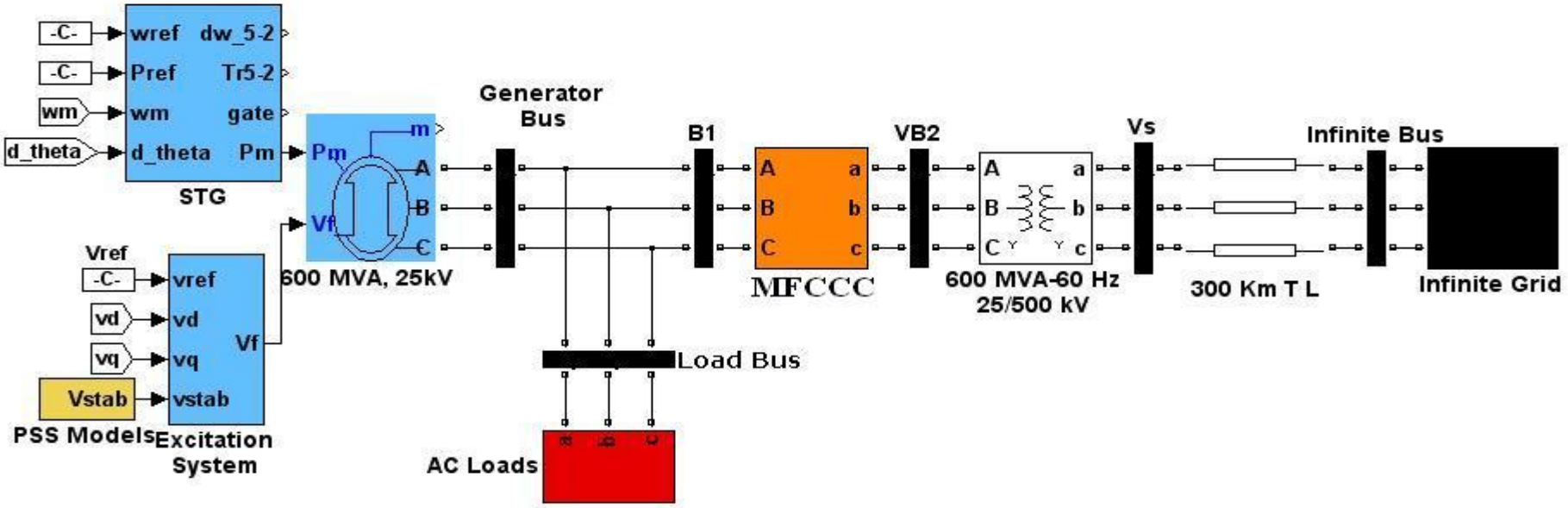
- *Minimizing ripple and abrupt change in generator voltage*
- *Minimizing ripple and abrupt change in generator current*
- *Minimizing ripple and abrupt change in generator power*

What is WM-PID?

Weighted Modified PID Controller including an error sequential activation supplementary loop to ensure fast dynamic response in large-load-excursion circumstances

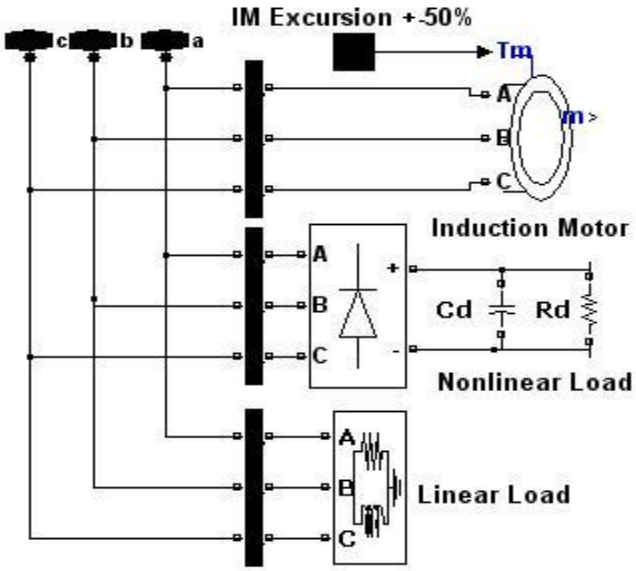


Examination The Performance of SCC



AC grid- Our Case Study

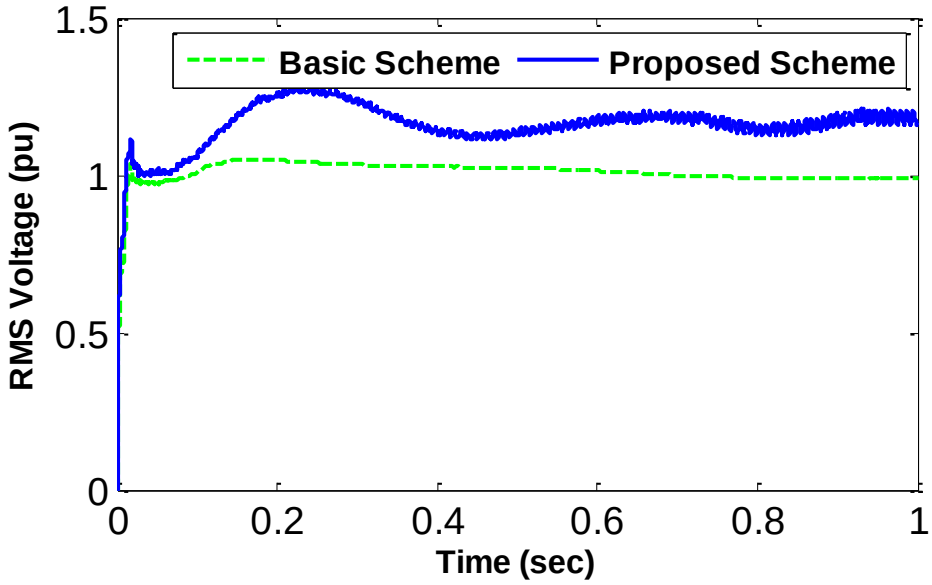
AC load



Simulation Results
(Using MATLAB/SIMULINK)

RMS Voltage- Generator

Normal Conditions



Simulation Results
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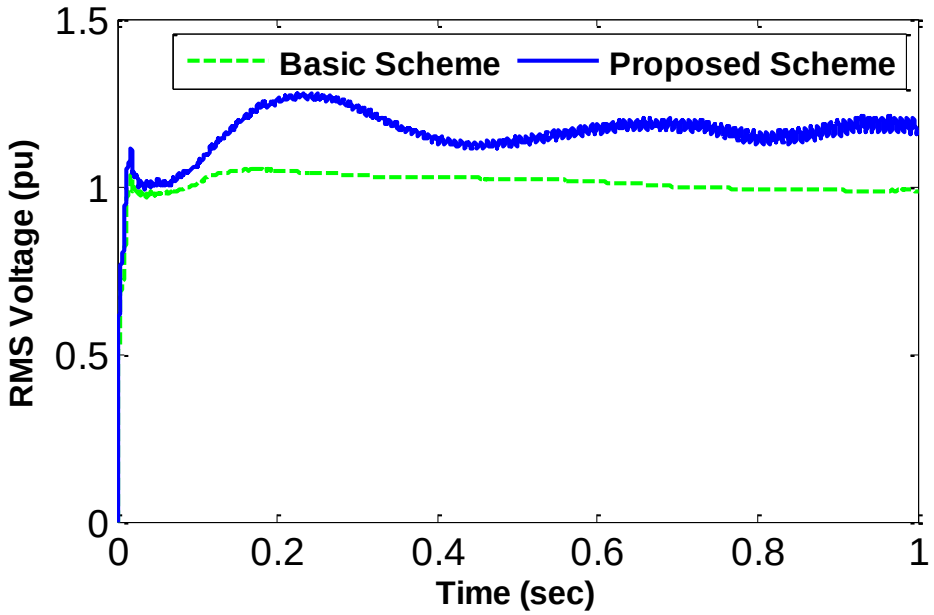
RMS Voltage- Load

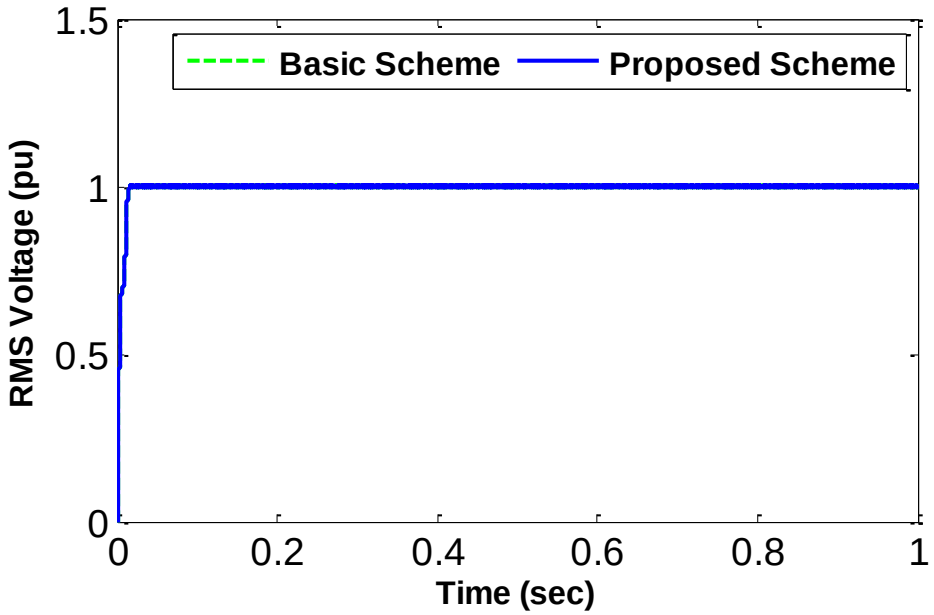
Normal Conditions



Simulation Results
(Using MATLAB/SIMULINK)

RMS Voltage- Infinite Bus

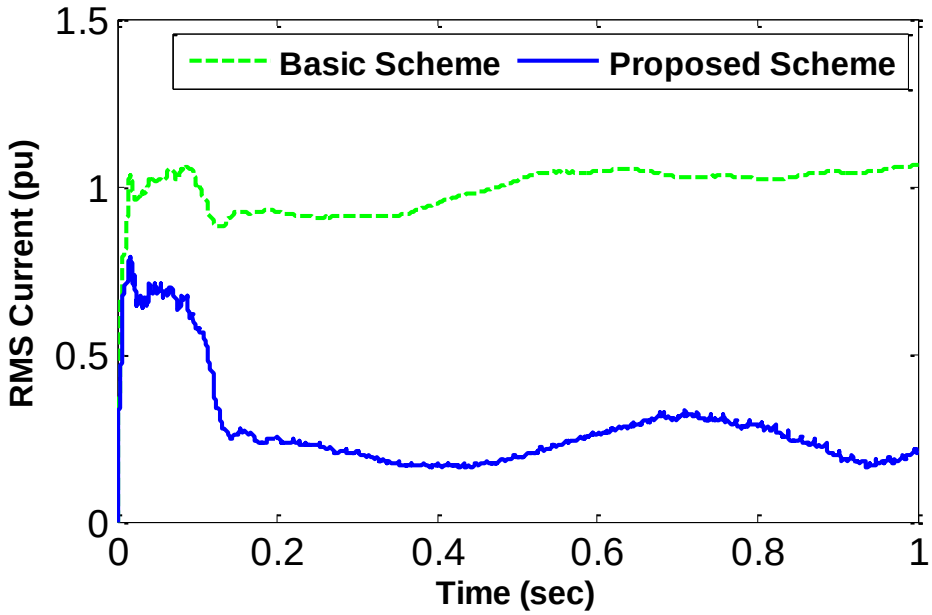
Normal Conditions



Simulation Results
(Using MATLAB/SIMULINK)

RMS Current- Generator

Normal Conditions



Simulation Results
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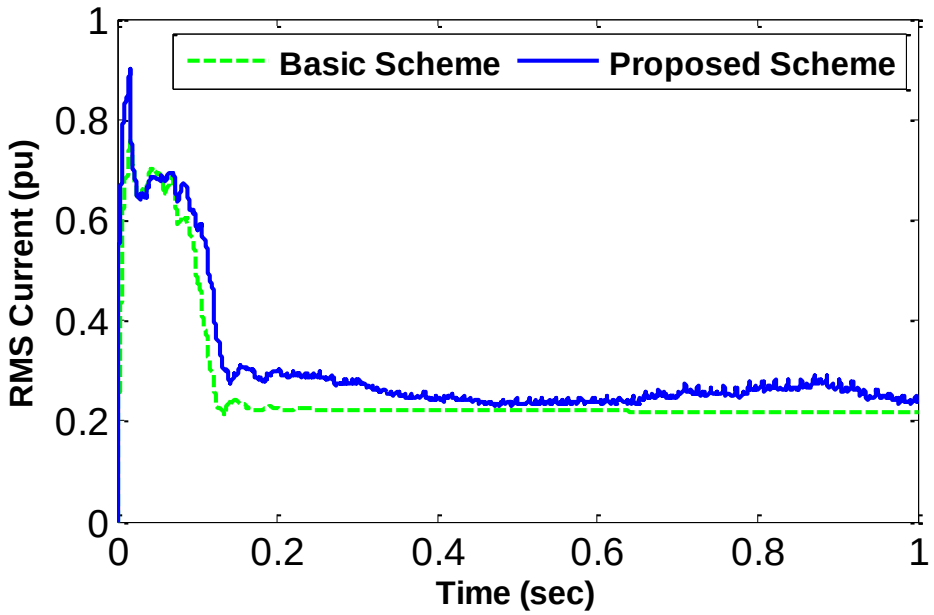
RMS Current- Load

Normal Conditions



Simulation Results
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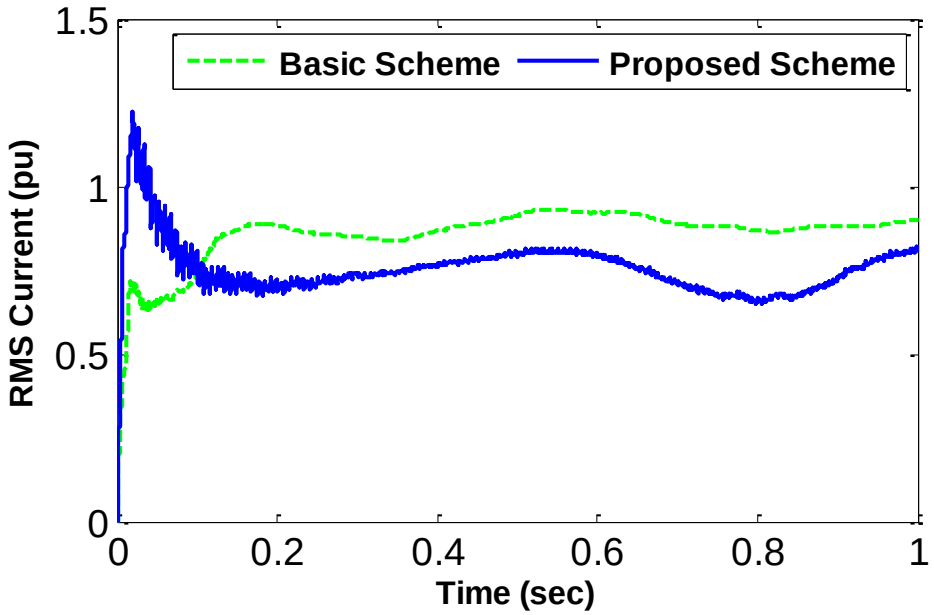
RMS Current- Infinite Bus

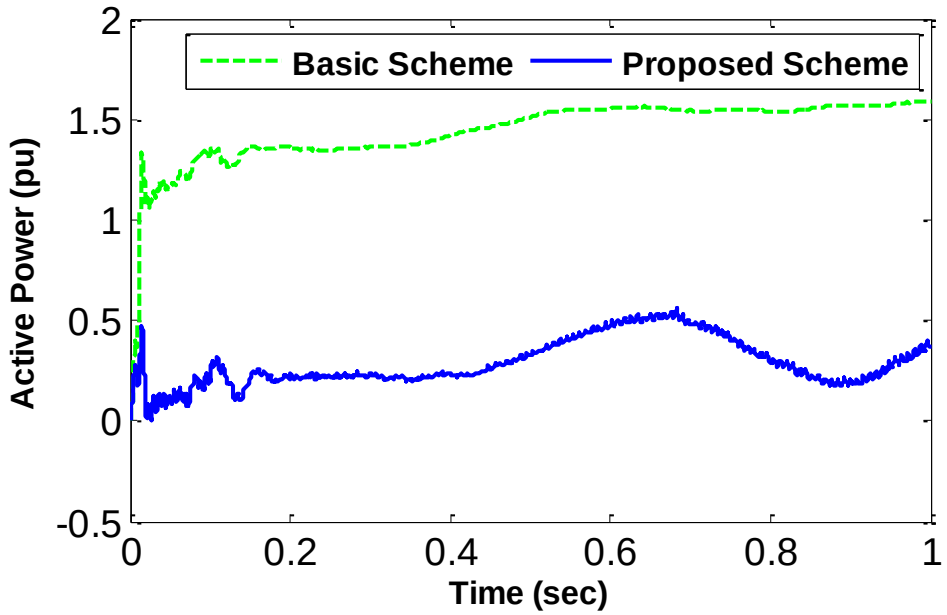
Normal Conditions



Simulation Results
(Using MATLAB/SIMULINK)

Active Power- Generator

Normal Conditions



Simulation Results
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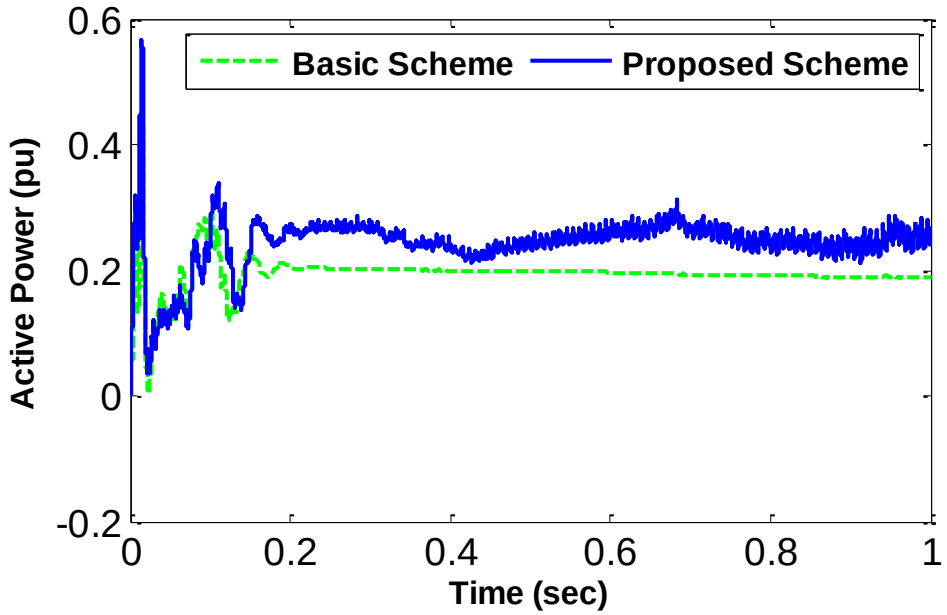
Active Power- Load

Normal Conditions



Simulation Results
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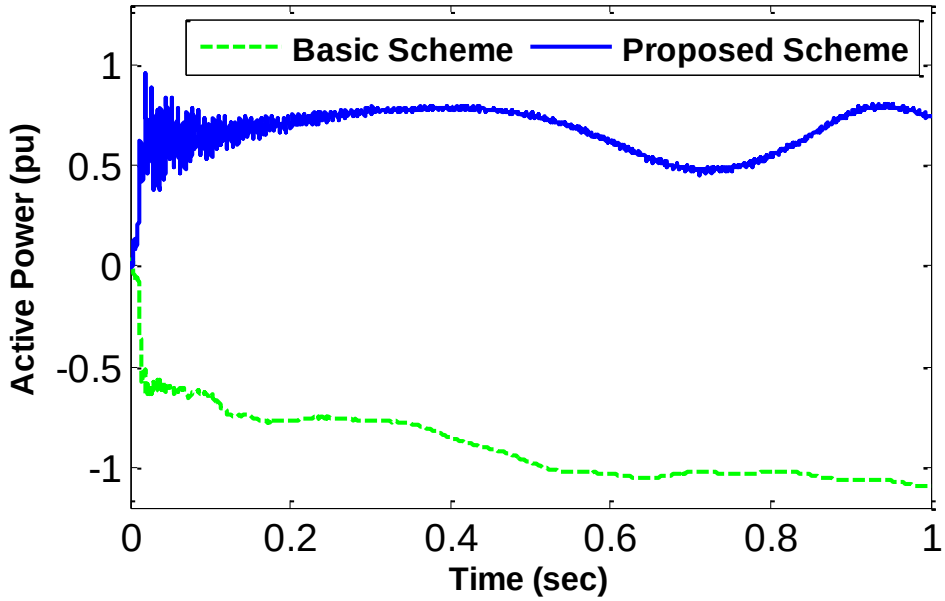
Active Power- Infinite Bus

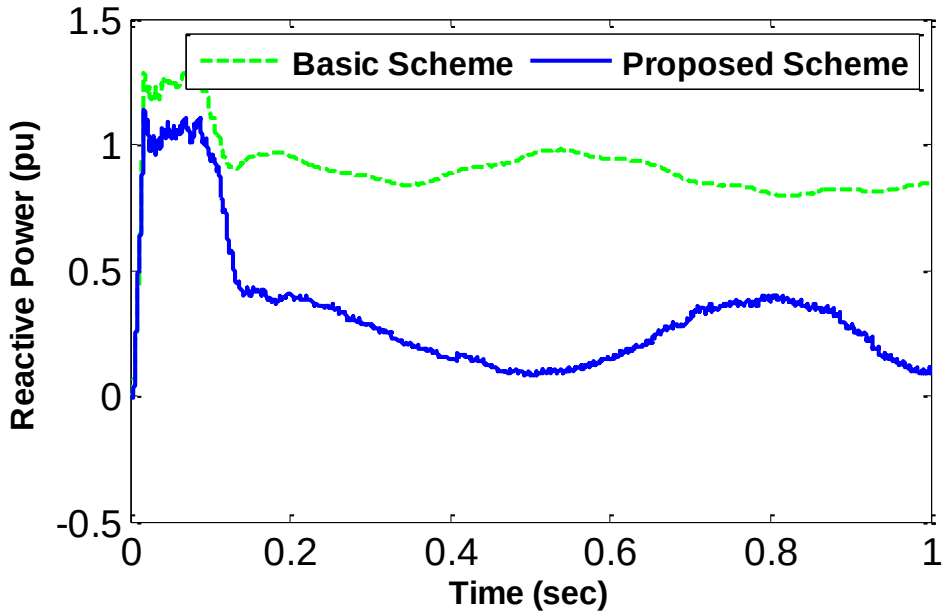
Normal Conditions



Simulation Results
(Using MATLAB/SIMULINK)

Reactive Power- Generator

Normal Conditions



Simulation Results
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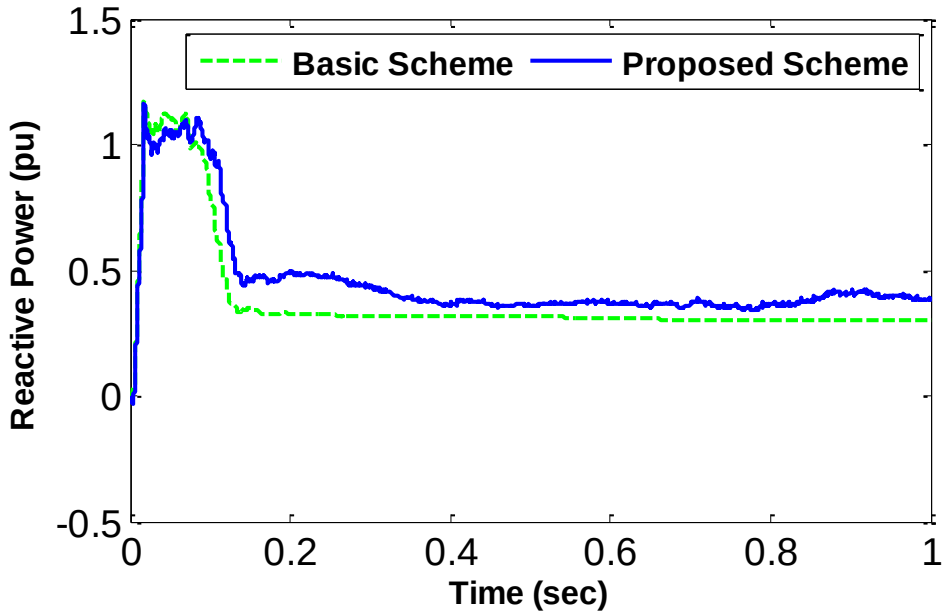
Reactive Power- Load

Normal Conditions



Simulation Results
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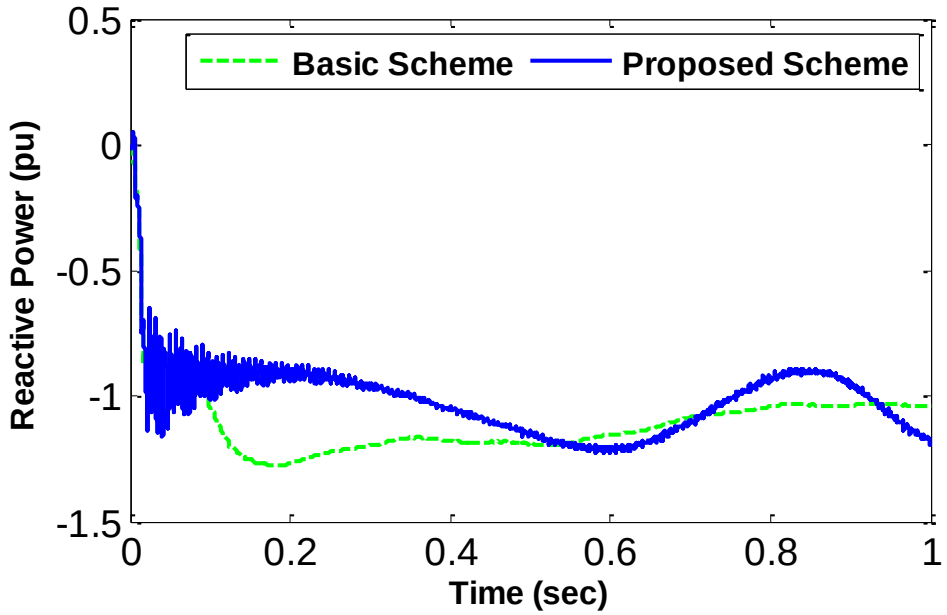
Reactive Power- Infinite Bus

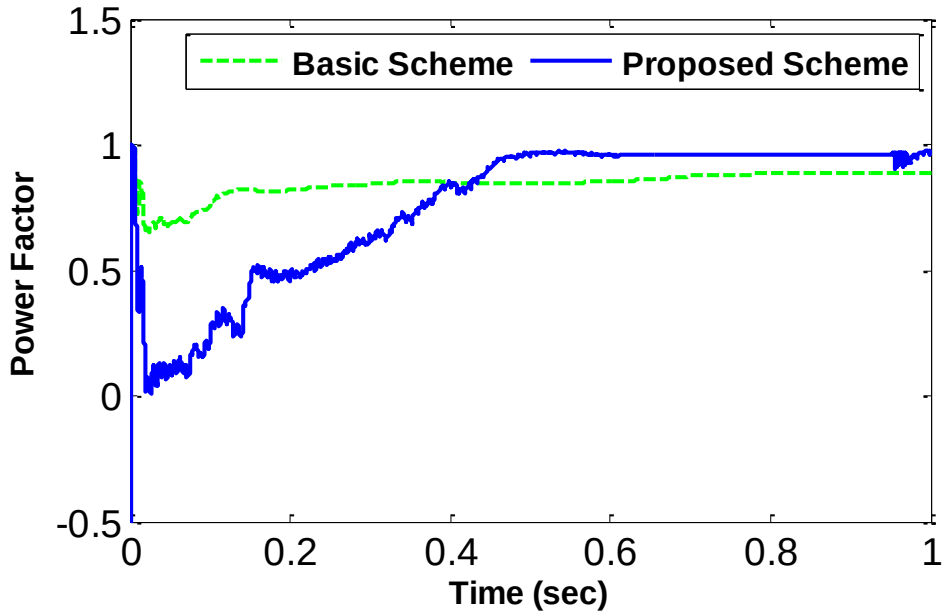
Normal Conditions



Simulation Results
(Using MATLAB/SIMULINK)

Power Factor– Generator

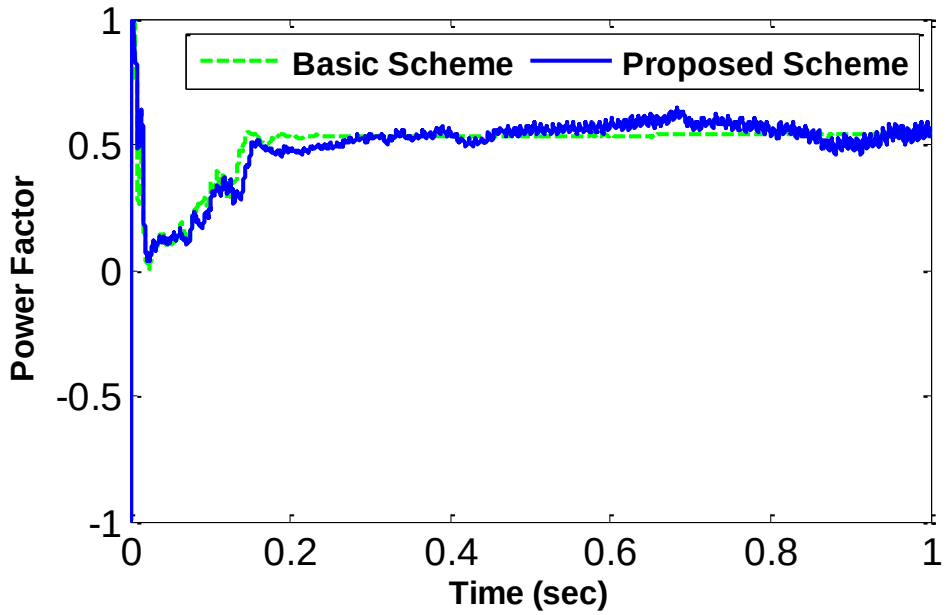
Normal Conditions



Simulation Results
(Using MATLAB/SIMULINK)

Power Factor– Load

Normal Conditions



Simulation Results
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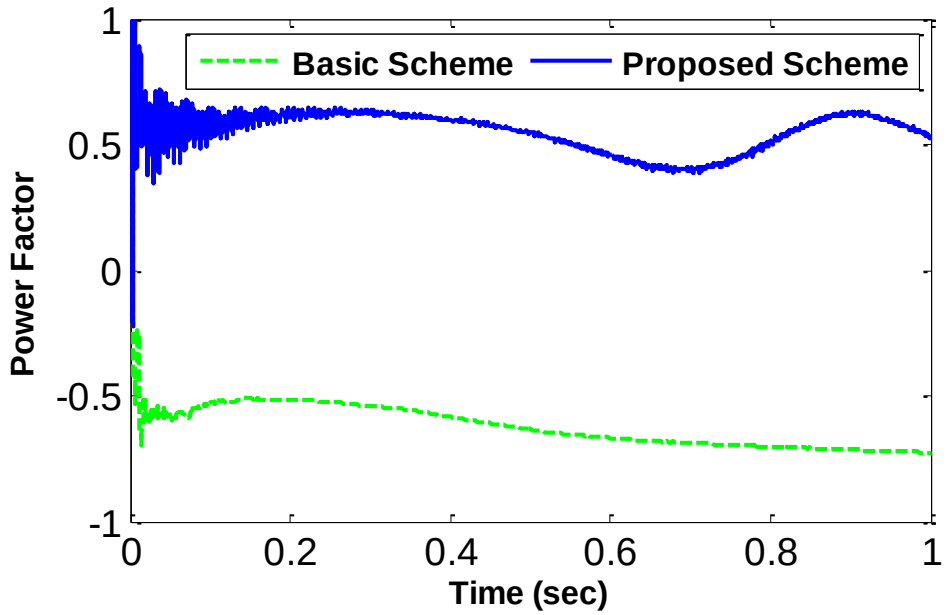
Power Factor– Infinite Bus

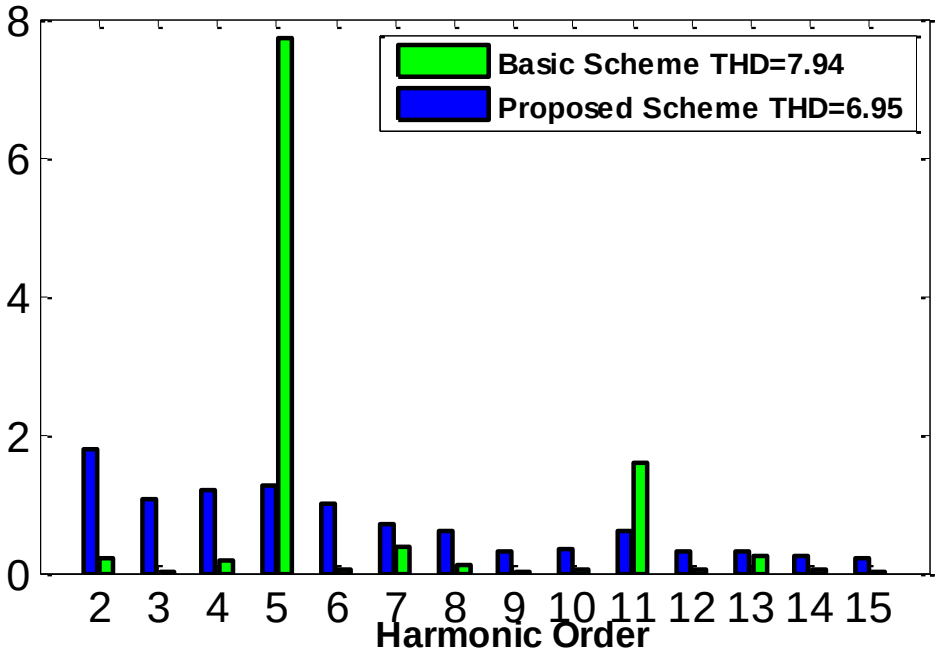
Normal Conditions



Simulation Results
(Using MATLAB/SIMULINK)

THD- Voltage- Generator

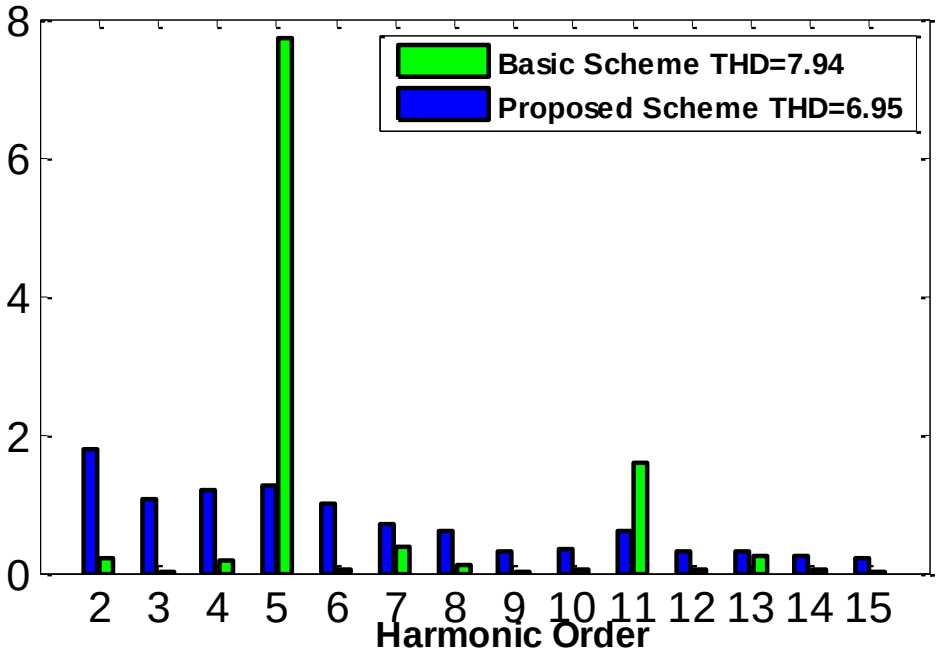
Normal Conditions



Simulation Results
(Using MATLAB/SIMULINK)

THD- Voltage- Load

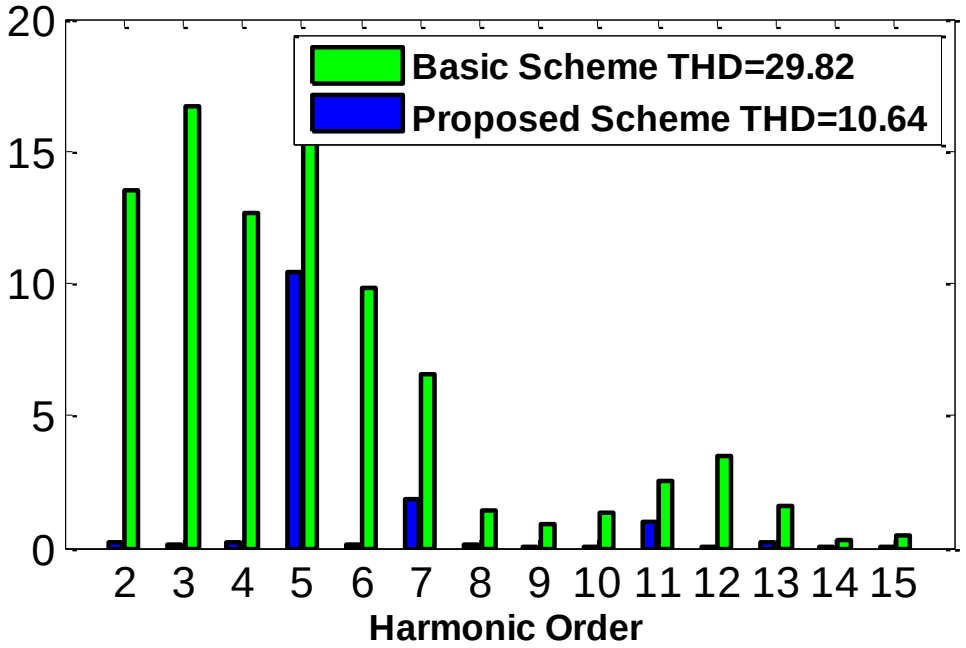
Normal Conditions



Simulation Results
(Using MATLAB/SIMULINK)

THD- Current- Generator

Normal Conditions



Simulation Results
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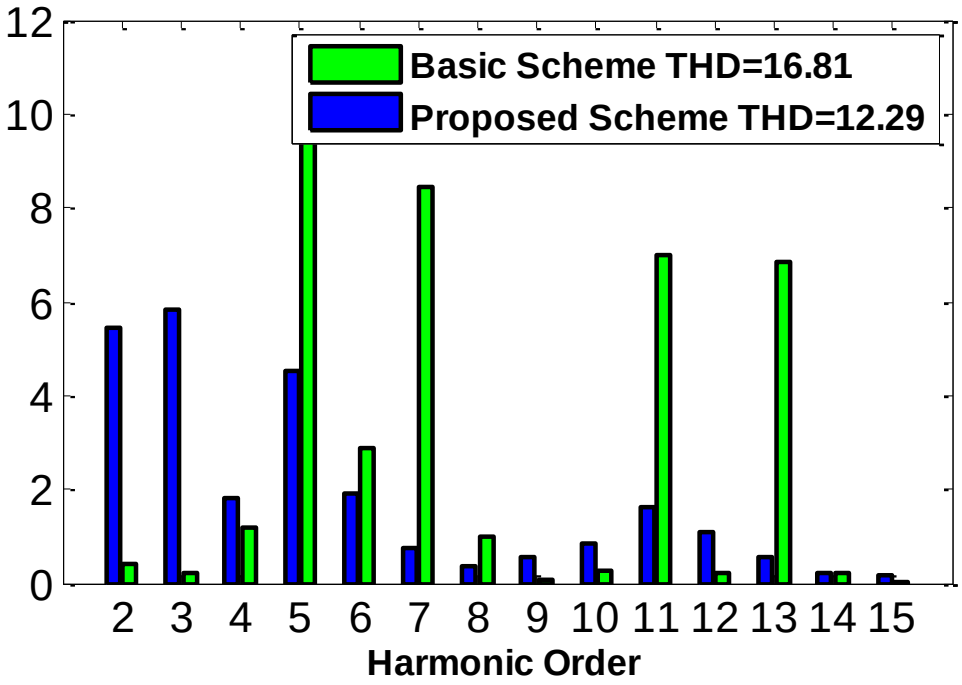
THD- Current- Load

Normal Conditions



Simulation Results
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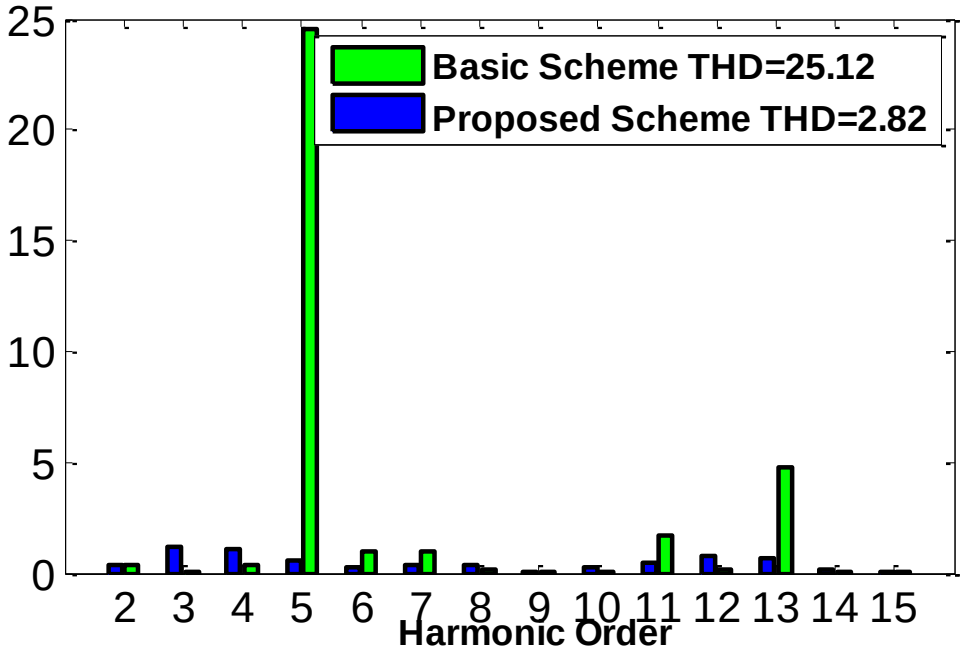
THD- Current- Infinite Bus

Normal Conditions



Simulation Results (Using MATLAB/SIMULINK)

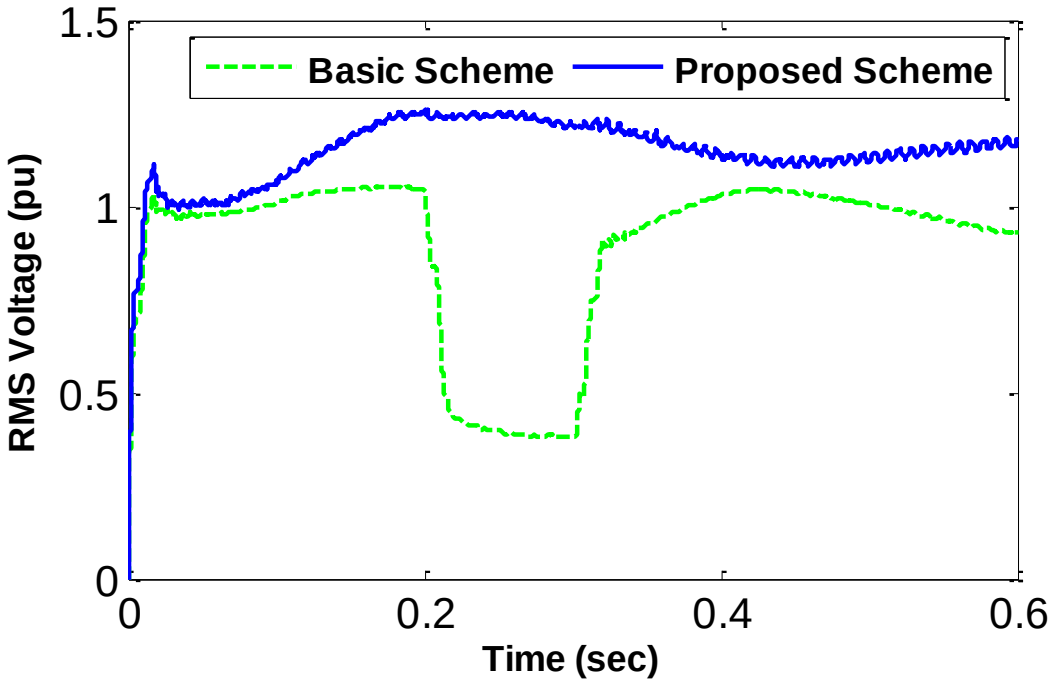
Fault Conditions

- A 3-Phase Short Circuit occurs in VB1 Busbar at 0.2 sec and would be cleared after 0.1 sec

Simulation Results
(Using MATLAB/SIMULINK)

RMS Voltage- Generator

Fault Conditions



Simulation Results
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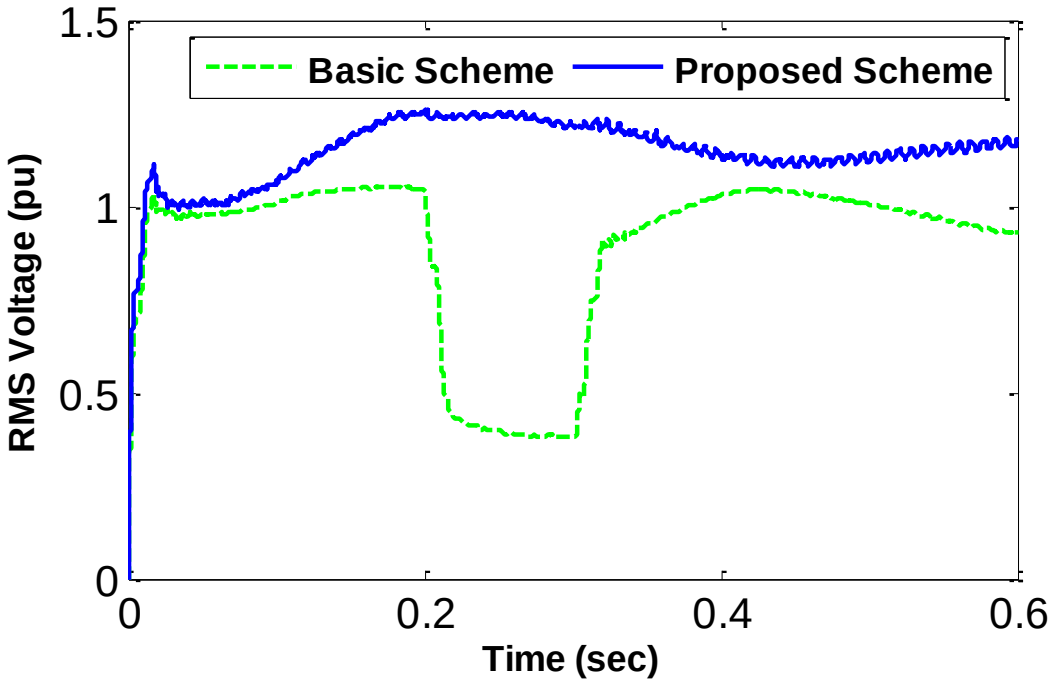
RMS Voltage- Load

Fault Conditions



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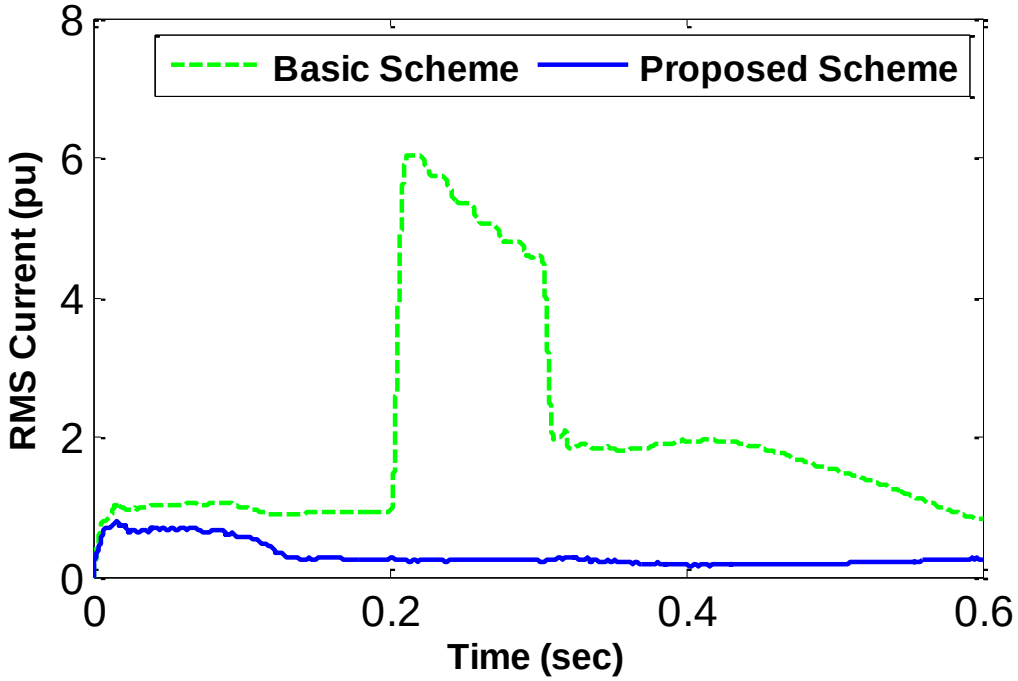
RMS Current- Generator

Fault Conditions



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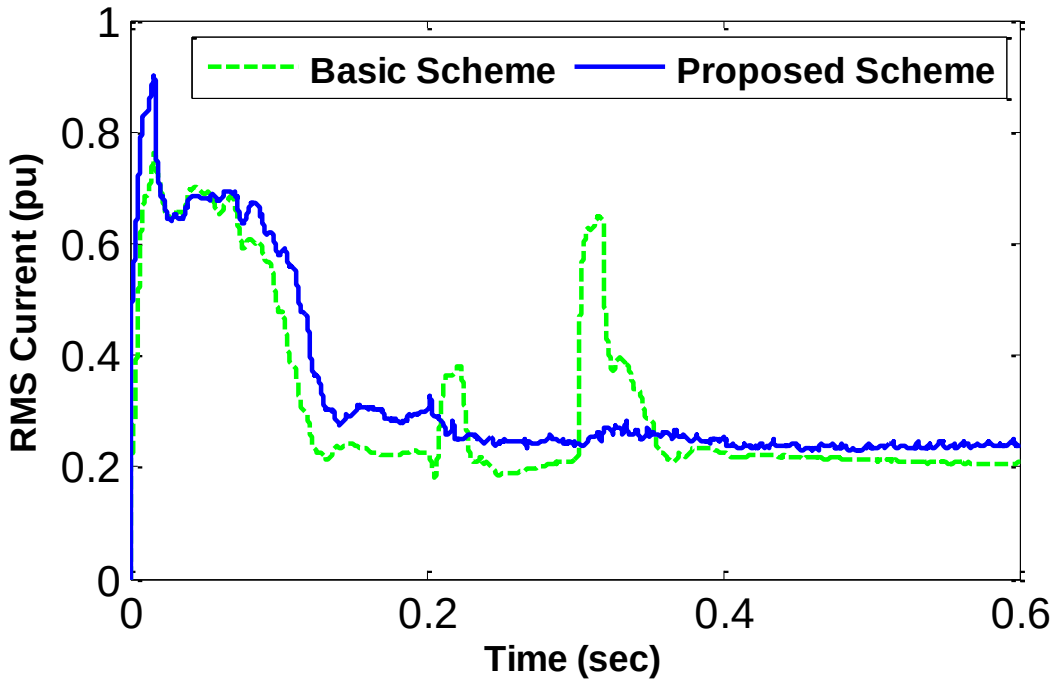
RMS Current- Load

Fault Conditions



Simulation Results
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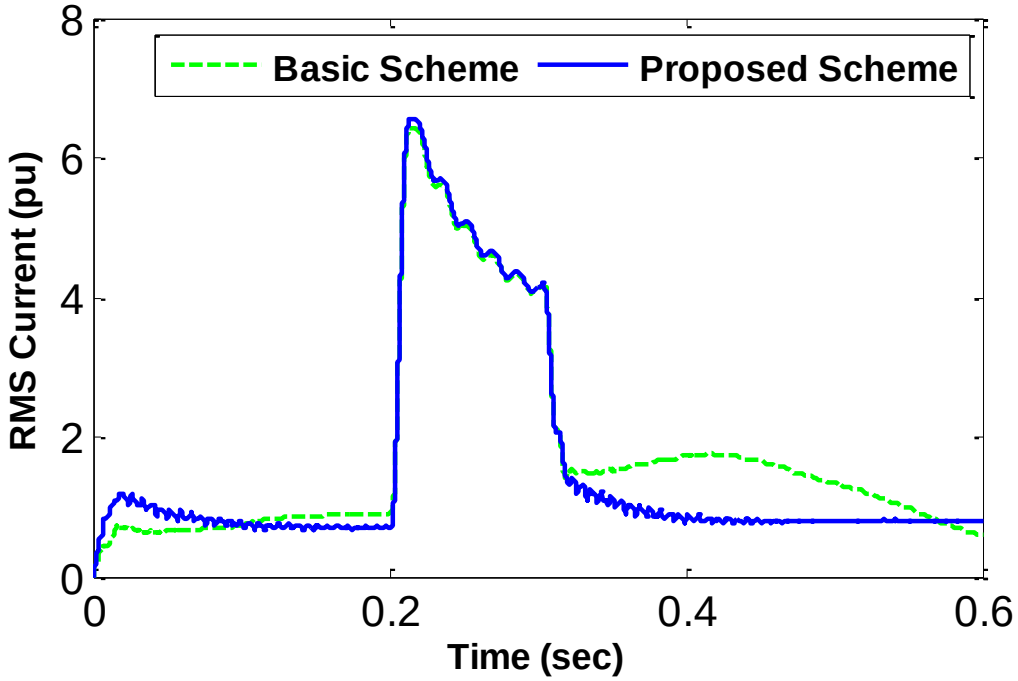
RMS Current- Infinite Bus

Fault Conditions



Simulation Results (Using MATLAB/SIMULINK)

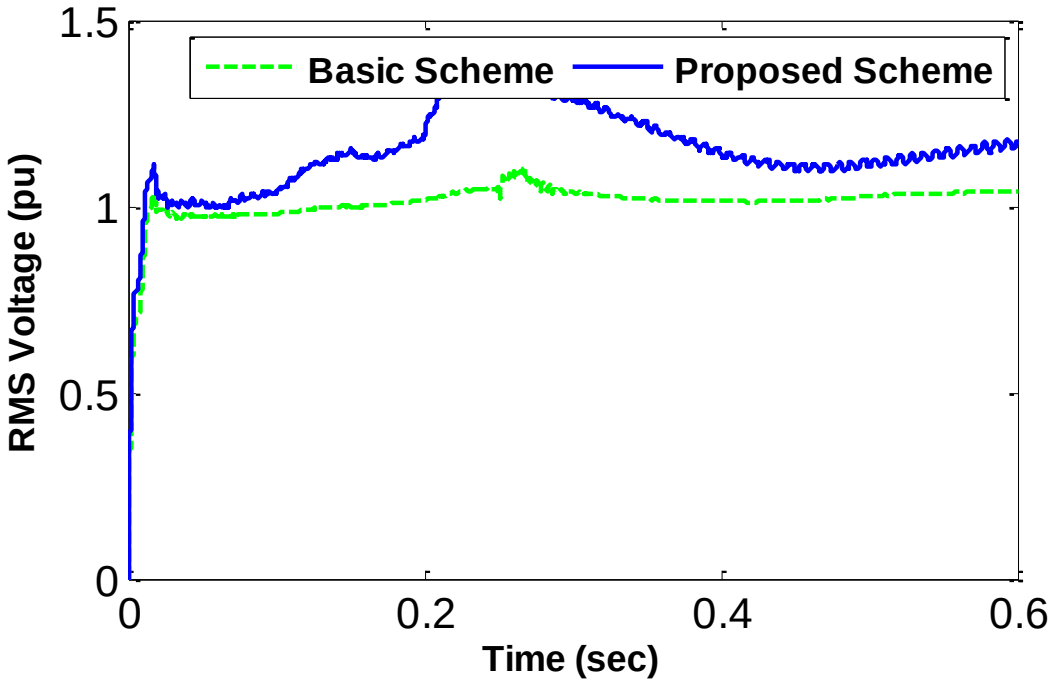
Hybrid-Load Excursion Conditions

- At 0.1 sec, linear load is disconnected and reconnected after 0.05 sec.
- At 0.2 sec, nonlinear load is disconnected and reconnected after 0.05 sec.
- At 0.3 sec, load motor torque is decreased by 50% for duration of 0.05 sec.
- At 0.4 sec, load motor torque is increased by 50% for duration of 0.05 sec.

Simulation Results
(Using MATLAB/SIMULINK)

RMS Voltage- Generator

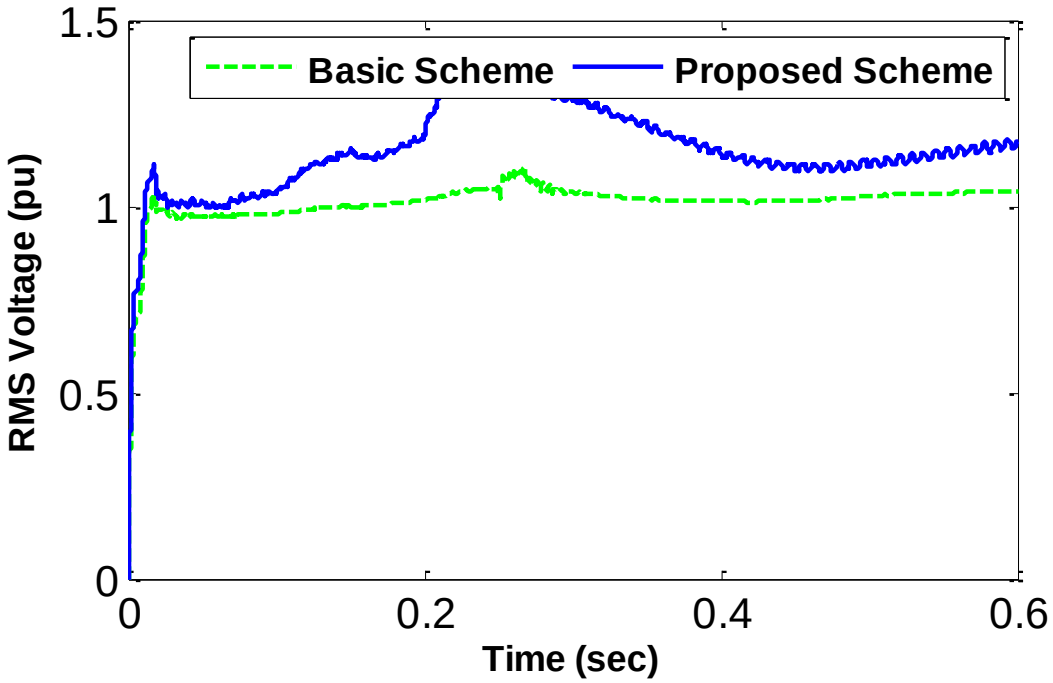
Load Excursion- Conditions



Simulation Results
(Using MATLAB/SIMULINK)

RMS Voltage- Load

Load Excursion- Conditions



Simulation Results
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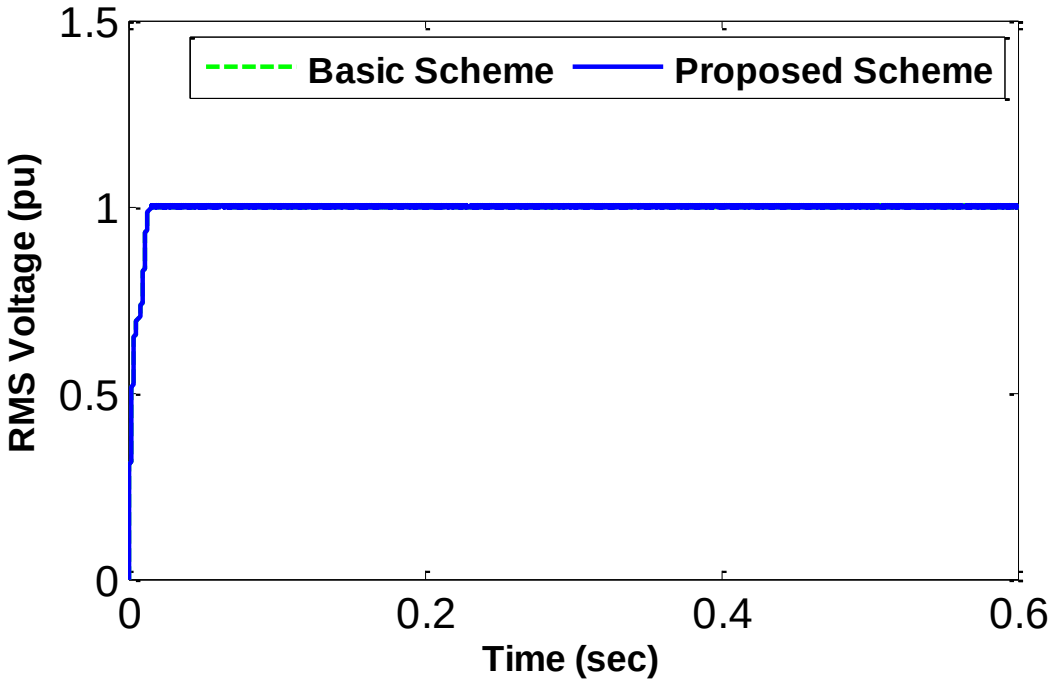
RMS Voltage- Infinite Bus

Load Excursion- Conditions



Simulation Results
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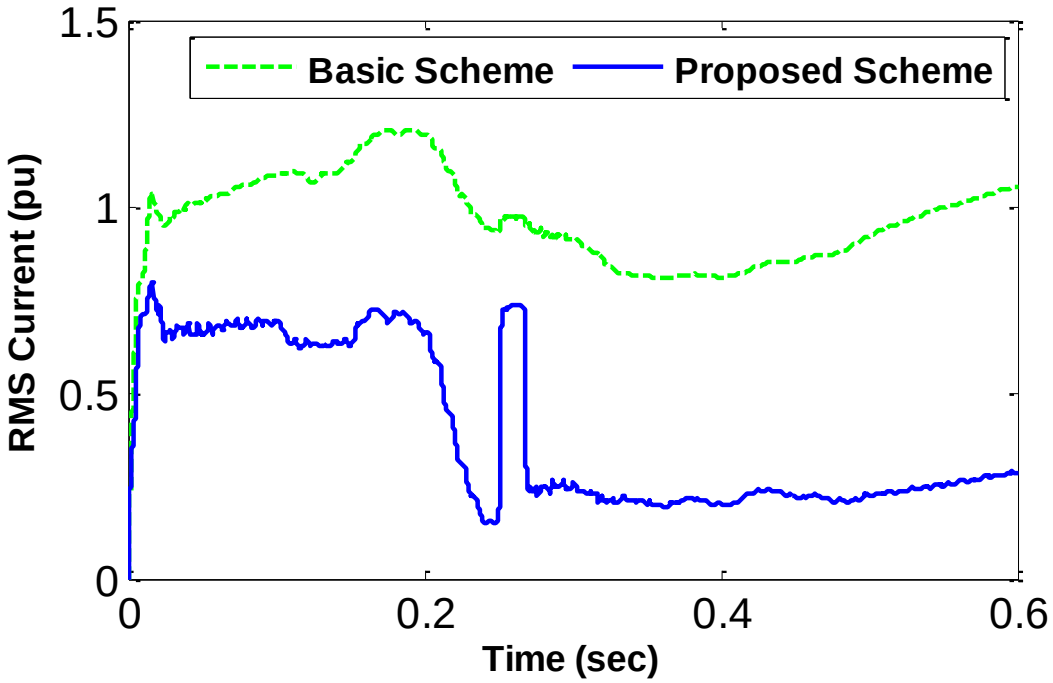
RMS Current- Generator

Load Excursion- Conditions



Simulation Results
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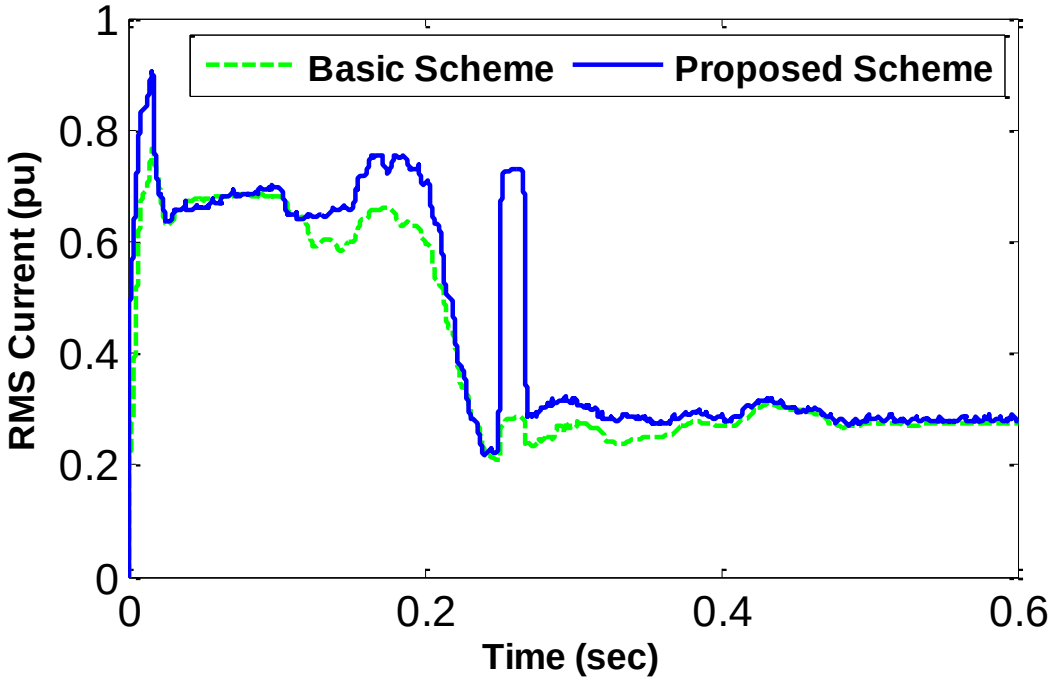
RMS Current- Load

Load Excursion- Conditions



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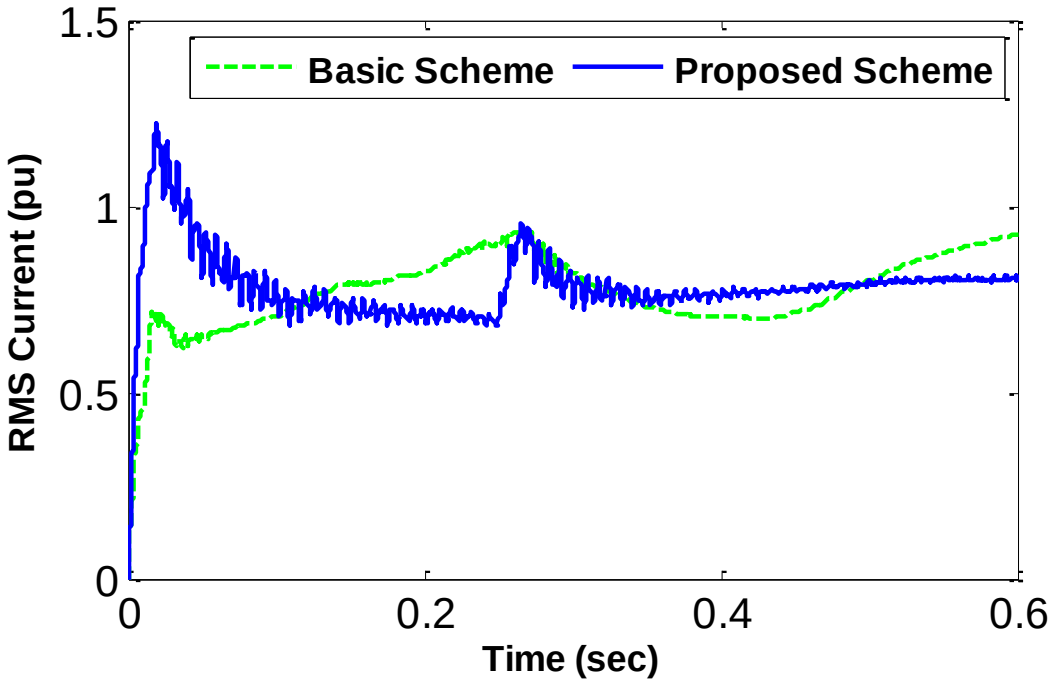
RMS Current- Infinite Bus

Load Excursion- Conditions



Conclusions

- A novel FACTS-based device, Modulated Filter Compensation Scheme
- Dynamic multi-loop error driven controller for effective Pulsing of Solid State switched
- The Switched Filter-Compensation Scheme is effective in Voltage Stabilization, Loss Reduction on Feeder, Efficient Energy Utilization and Power Factor improvement under:
    1. Normal Operation
    2. Fault Conditions
    3. Hybrid- Load Excursions

Appreciate Your Attention

Any Question?