Harmonic Modeling and Simulation Task Force

Chair: R. Langella, Second University of Naples, Italy
Vice-Chair: Igor Papič, University of Ljubljana, Slovenia

Boston, July 19 2016
Agenda

• Communications (10:00 – 10:05)
• Progress report on tasks identified in past GMs (10:05-10:45)
• New Business or Proposals (10:45-10:55)
• Adjournment
Communications (1)

- **ISGT Europe 2016**
  - Ljubljana, Slovenia
  - October 9-12
  - [http://sites.ieee.org/isgt-europe-2016/](http://sites.ieee.org/isgt-europe-2016/)
Communications (2)

• ICHQP 2016
  – Oct. 16-19, 2016, Belo Horizonte, Brazil.
  – http://www.ichqp2016.org
Communications (3)

• ICHQP 2018
  – Announcement (13-16 May 2018)
Agenda

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• Adjournment
Panel (Wednesday, July 20, 2016, 3:00 PM - 5:00 PM)
SB - Berkeley

- Modeling and measurement of network and equipment impedance for harmonic studies
- 5 Contributions
Panel (Wednesday, July 20, 2016, 3:00 PM - 5:00 PM)
SB - Berkeley

- Modeling and measurement of network and equipment impedance for harmonic studies
  - Alfredo Testa, Second University of Naples: Statistical and theoretical considerations on network harmonic impedance assessment; Panelists: Alfredo Testa and Roberto Langella.
  - David Mueller; Enernex: Characterizing Transmission System Harmonic Impedances with R-X Loci Plots
Panel (Wednesday, July 20, 2016, 3:00 PM - 5:00 PM)
SB - Berkeley

• Modeling and measurement of network and equipment impedance for harmonic studies
  – Carlos Duque, Universidade Federal de Juiz de Fora: Power System Impedance Estimation Based on Wavelet Current/Voltage Injection; Panelists: Carlos A. Duque and Paulo F. Ribeiro.
  – Xiongfei Wang; AALBORG University: Virtual Impedance Control for Grid-Connected Power Converters; Panelists: Xiongfei Wang and Frede Blaabjerg.
TF PAPERS
Progress report on tasks identified in GM’12 TF Papers

• Roberto:
  • Harmonic Modeling of Grid Converters for Distributed Power Generation Systems led by Xiongfei Wang, Roberto Langella and Frede Blaabjerg.

• Igor:
  • Benchmark network models for comparison of harmonic contribution evaluations with different methods.
  • Presentation by Igor Papic.
Task Force Paper: Harmonic Modeling of Grid Converters

- led by Xiongfei Wang, Roberto Langella, Frede Blaabjerg

• **Paper Title**: Harmonic Modeling and Simulation of Grid Converters for Distributed Power Generation Systems

• **Paper Outline**:

  I. Introduction
  II. Control Architecture for Grid Converters
  III. Sources of Harmonics
  IV. Harmonic Modeling Methods
  V. Implementation Examples
  VI. Future Trends and Challenges
    I. Aggregation
    II. linear loads reduction,
    III. time-varying....
    IV. ...
  VII. Conclusions
Task Force Paper: Harmonic Modeling of Grid Converters

- led by Xiongfei Wang, Roberto Langella, Frede Blaabjerg

**Outline Section II - Control Architecture for Grid Converters**

(Reference based Section)

1) **Switching Control - Modulations and duty cycle calculation**
   1) Pulse Width Modulation (PWM)
      - Continuous PWM, Discontinuous PWM, Random PWM
   2) Hysteresis Control

2) **Converter Control**
   1) AC Current/Voltage Control
   2) Grid Synchronization
   3) DC Voltage/Current (Current-Source Converter) Control

3) **Application Control**
   1) Active Power and Reactive Power Control
   2) Harmonic compensation and resonance damping
Task Force Paper: Harmonic Modeling of Grid Converters
- led by Xiongfei Wang, Roberto Langella, Frede Blaabjerg

• Outline Section III - Sources of Harmonics
  A. High-Frequency Harmonics
  B. Low-Frequency Harmonics
  C. Electrical Resonance
    1) Interactions among multiple grid converters
    2) Interaction between converter and passive components
  D. Inter-harmonics
  E. Effects of output filters
• **Outline Section IV - Harmonic Modeling Methods**

  A. **Steady-State Model**
     1) Switching model (Switching functions)
     2) Harmonic-domain model (Frequency-coupling)

  B. **Dynamic Model**
     1) State-Space Averaging Model
     2) Generalized Averaging Model
     3) Harmonic State-Space Model

  C. **Time-Domain Model**
Task Force Paper: Harmonic Modeling of Grid Converters

- led by Xiongfei Wang, Roberto Langella, Frede Blaabjerg

• Outline Section V - Implementation Examples
  
  A. Large PV
     1) ..... 
     2) .............

  B. Large Wind Turbine
     1) ..... 
     2) .......
Progress report on tasks identified in GM’12

TF Papers

• Roberto:
  • Harmonic Modeling of Grid Converters for Distributed Power Generation Systems led by Xiongfei Wang, Roberto Langella and Frede Blaabjerg.

• Actions
  1. Stalemate!
  2. Individual names on TF papers on TPWRD.
  3. Organize a Panel 2018?
Progress report on tasks identified in GM’12 TF Papers

• Roberto:
  • Harmonic Modeling of Grid Converters for Distributed Power Generation Systems led by Xiongfei Wang, Roberto Langella and Frede Blaabjerg.

• Igor:
  • Benchmark network models for comparison of harmonic contribution evaluations with different methods.
  • Presentation by Igor Papic.
Agenda

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New Business or Proposals (1)

• Panel (slot 2017) – 4h
  – New Challenges and Issues related on Interharmonic modeling and simulation
    1. Alfredo Testa: “Basic concept and theoretical considerations” (confirmed)
    2. Roberto Langella: “Interharmonics produced by Renewables (Wind and PV systems)” (confirmed)
    3. Jiri Drapela: “Interharmonics effects on different Lamp Technologies” (confirmed)
    4. Wilsun Xu: “Interharmonics produced by LCI ASD” (confirmed)
    5. Frede Blaabjerg: “Interharmonics produced by PWM ASD” (waiting for confirmation)
    6. Dave Mueller: “Incident experiences with Wind farms due to interharmonics” (confirmed)
    8. Igor Papic: “Interharmonic propagation related to voltage flicker in HV networks” (confirmed)
New Business or Proposals (1)

- Panel (slot 2018) – Igor co-chair
  - Benchmark network models for comparison of harmonic contribution evaluations with different methods.

- Panel (slot 2019) – Xionfei Wand and Frede Blaabjerg co-chairs
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Boston, July 19 2016
• Progress report on tasks identified in past GMs (10:05-10:45)
  • Panel: Modeling and measurement of network and equipment impedance for harmonic studies
  • TF paper 1: Harmonic Modeling of Grid Converters for Distributed Power Generation Systems led by Xiongfei Wang, Roberto Langella and Frede Blaabjerg.
  • TF paper 2: Benchmark network models for comparison of harmonic contribution evaluations with different methods led by Igor Papic in collaboration with Wilsun Xu.
  • Presentation by Igor Papic.

• New Business or Proposals (10:45-10:55)
  • Panel 2017
New Business or Proposals (1)

• Panel (slot 2017) – 4h
  – New Challenges and Issues related on **Interharmonic** modeling and simulation
    1. Alfredo Testa: “Basic concept and theoretical considerations” (confirmed)
    2. Roberto Langella: “Interharmonics produced by Renewables (Wind and PV systems)” (confirmed)
    3. Jiri Drapela: “Interharmonics effects on different Lamp Technologies” (confirmed)
    4. Wilsun Xu: “Interharmonics produced by LCI ASD” (confirmed)
    5. Frede Blaabjerg: “Interharmonics produced by PWM ASD” (waiting for confirmation)
    6. Dave Mueller: “Incident experiences with Wind farms due to interharmonics” (confirmed)
    7. Gary Chang: “Interharmonics produced by EAF” (Confirmed)
    8. Igor Papic: “Interharmonic propagation related to voltage flicker in HV networks” (confirmed)