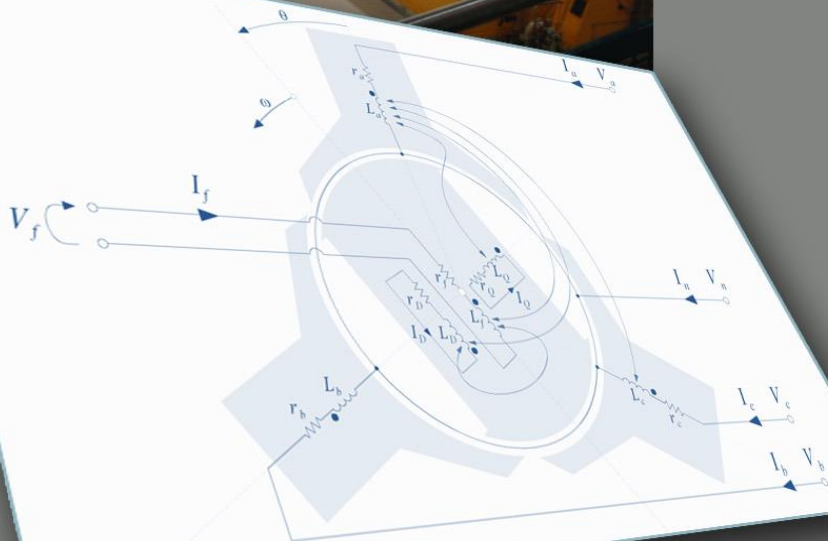


Dynamic State Estimation Based Generator Parameter Identification

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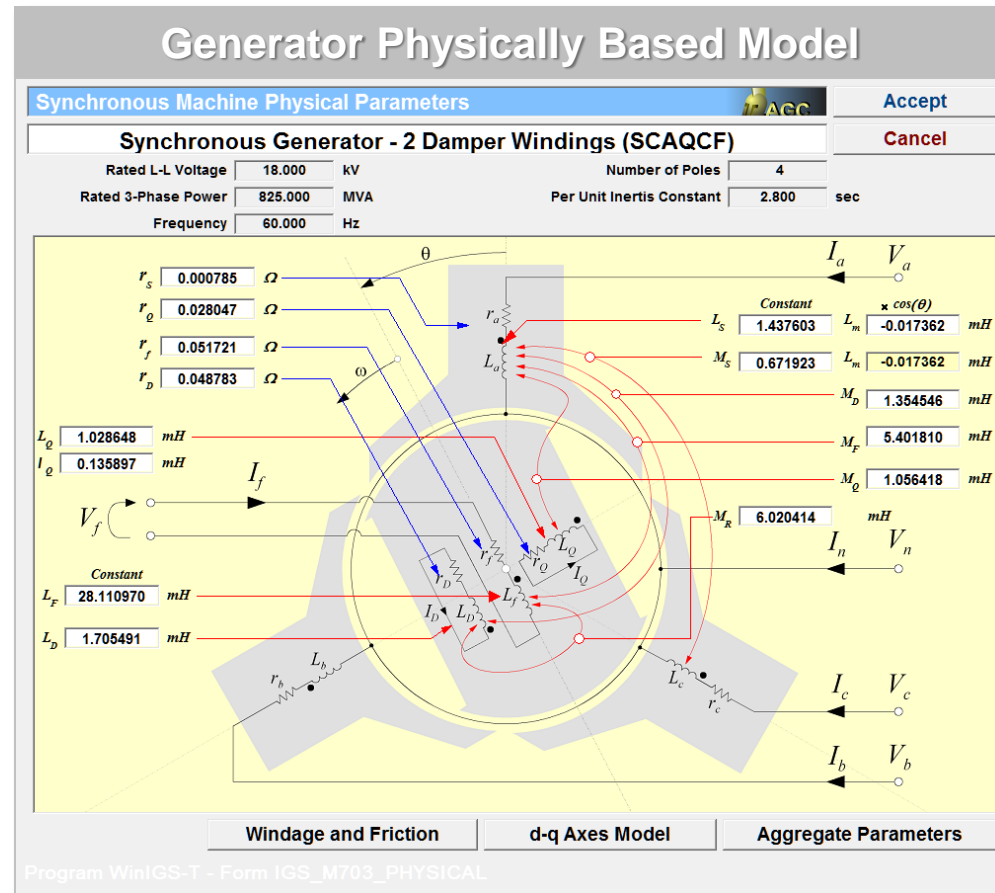
October 18th, 2016
NASPI & NERC SMS Workshop



Basis of the Method

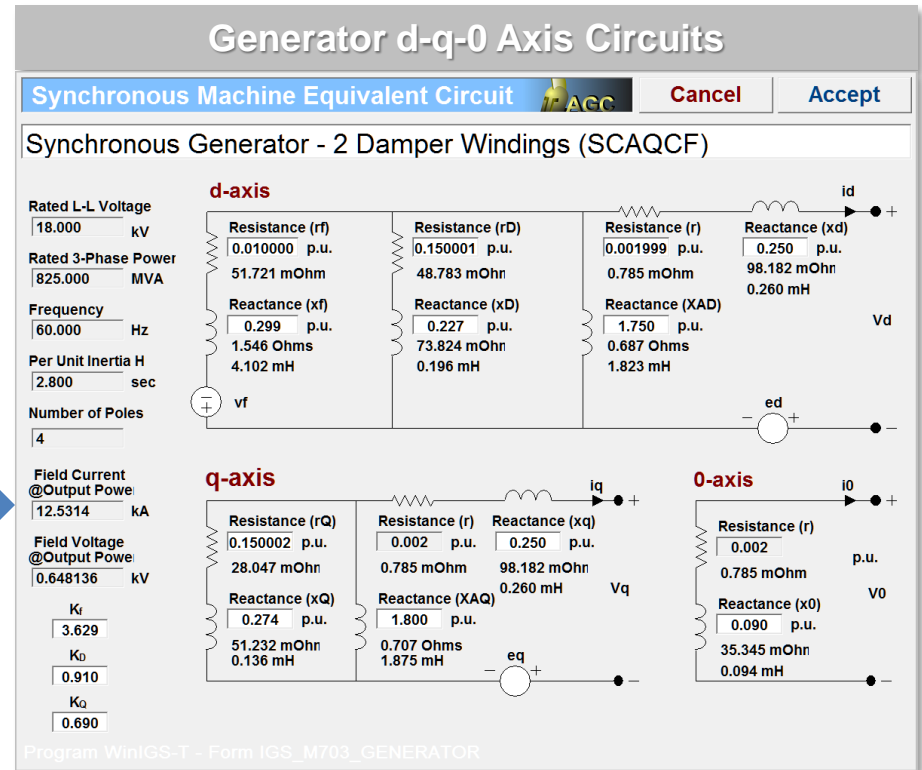
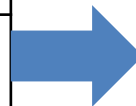
Use dynamic state estimation to identify generator parameters. Measurements are sampled values, typical rate of 4800 s/s. Generator is a two-axes physical-based with damper windings model. State consists of the generator state and the generator **independent** parameters (shown below). Method is capable of identifying the inductance parameters with high confidence level but not resistances (low confidence level). All other generator parameters can be computed from the estimated independent parameters.

Generator Independent Parameters	Description
r_s	Stator resistance
r_f	Field resistance
r_D	D damper resistance
r_Q	Q damper resistance
L_s	Stator self-inductance constant part
L_m	Stator self-inductance varying part
L_f	Field self-inductance
L_D	D damper self-inductance
L_Q	Q damper self-inductance
M_S	Stator mutual inductance
M_F	Field D damper mutual inductance
M_R	Stator field mutual inductance
M_D	Stator D damper mutual inductance
M_Q	Stator Q damper mutual inductance



Generator Independent Parameters → Usual Models

Generator Independent Parameters	Description
r_s	Stator resistance
r_f	Field resistance
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M_R	Stator field mutual inductance
M_D	Stator D damper mutual inductance
M_Q	Stator Q damper mutual inductance



Usual Generator Parameters

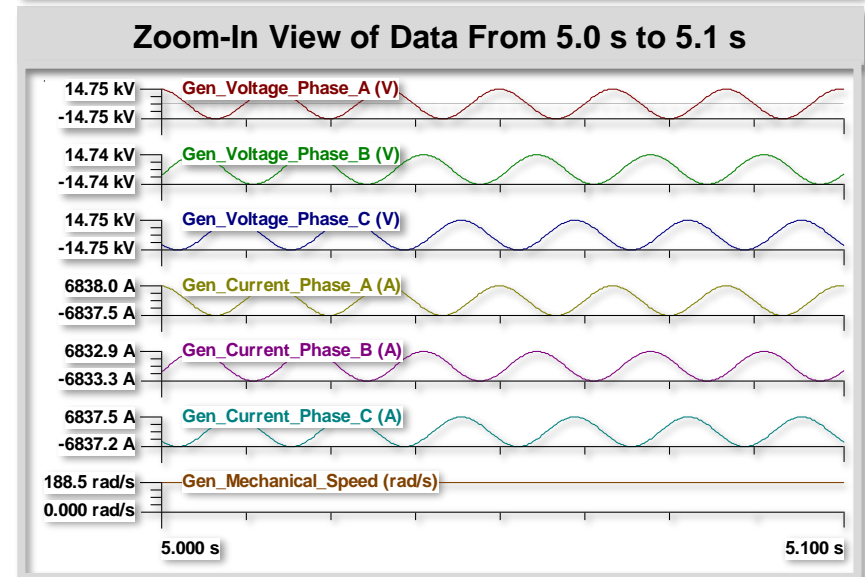
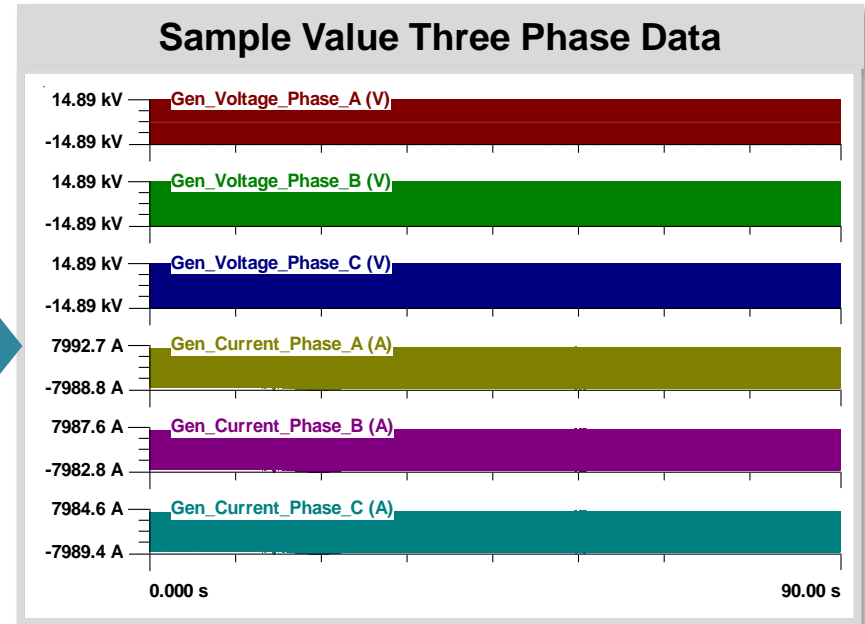
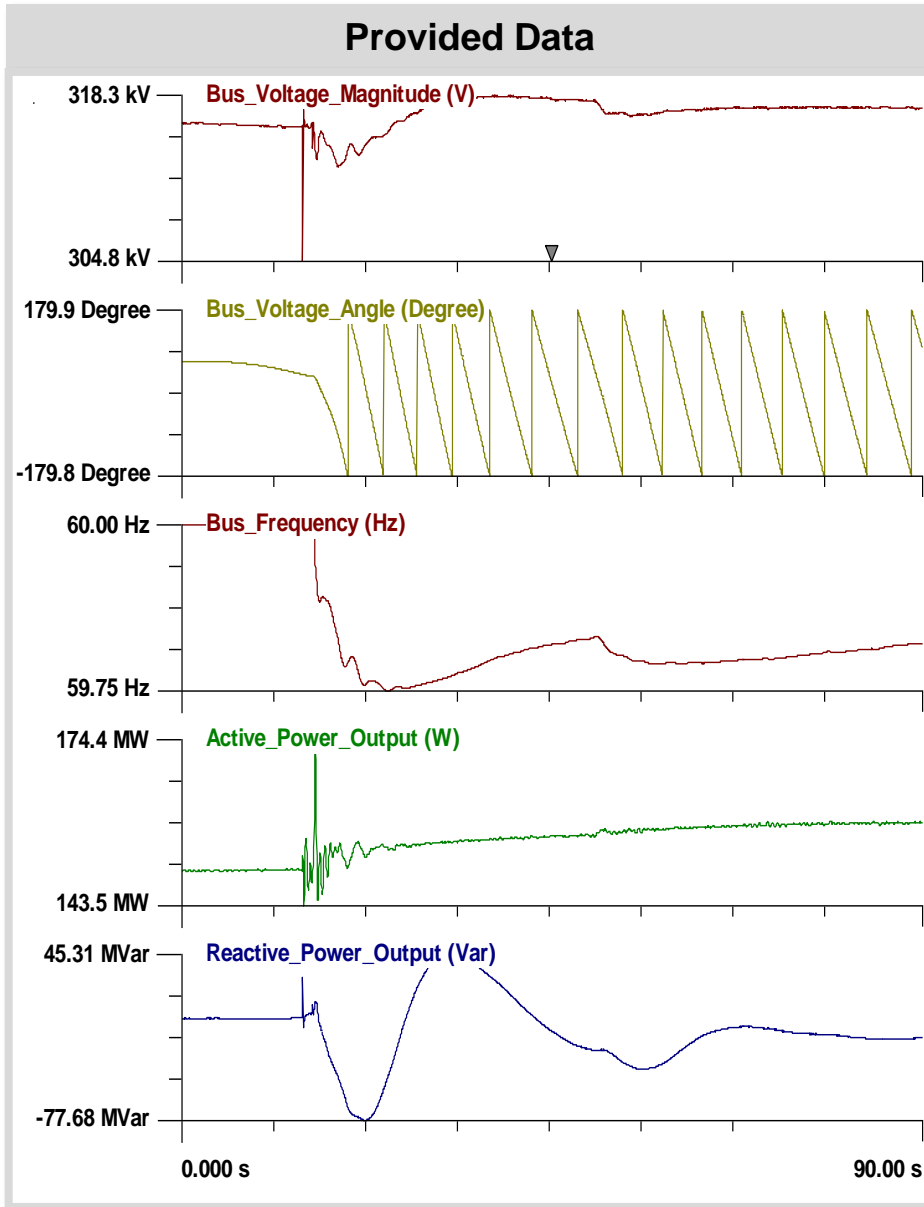
Synchronous Machine Aggregate Parameters **AGC** Cancel Accept

Synchronous Generator - 2 Damper Windings (SCAQCF)

d-Axis Subtransient Reactance	X''_d	0.3702	pu	0.1454	Ohms
d-Axis Transient Reactance	X'_d	0.5054	pu	0.1985	Ohms
d-Axis Open Circuit Subtransient Time Constant	τ''_{do}	3.216	pu	0.008530	sec
d-Axis Open Circuit Transient Time Constant	τ'_{do}	204.9	pu	0.5435	sec
q-Axis Subtransient Reactance	X''_q	0.4878	pu	0.1916	Ohms
q-Axis Transient Reactance	X'_q	2.050	pu	0.8051	Ohms
q-Axis Open Circuit Subtransient Time Constant	τ''_{qo}	13.83	pu	0.03668	sec

Program WinIGS-T - Form IGS_M703_AGGRP

Provided Data in Frequency Domain → Sampled Values (TD)



Generator Parameter Estimation Results

Gas Turbine Parameters		
Parameter	Original	Estimated
Xd	1.85	1.75
X'd	0.21	0.21
X''d	0.15	0.15
Xq	1.3	1.70
X'q	0.7	0.60
X''q	0.15	0.20
Xl	0.15	0.15
Ra	0.003	0.003
T'd0	5	9.5
T''d0	0.25	0.12
T'q0	1	1
T''q0	0.05	0.08
S(1.0)	0.12	0.12
S(1.2)	0.48	0.48
H	3.1	3.1
D	0	0
Accel	0.5	0.5

Steam Turbine Parameters		
Parameter	Original	Estimated
Xd	2.3	2.2
X'd	0.3	0.3
X''d	0.3	0.2
Xq	1.5	1.6
X'q	0.53	0.6
X''q	0.3	0.3
Xl	0.25	0.25
Ra	0.004	0.004
T'd0	3.2	5
T''d0	0.15	0.1
T'q0	0.8	0.8
T''q0	0.07	0.07
S(1.0)	0.14	0.14
S(1.2)	0.4	0.4
H	4	4
D	0	0

Hydro Turbine Parameters		
Parameter	Original	Estimated
Xd	0.55	0.6
X'd	0.25	0.3
X''d	0.18	0.2
Xq	0.47	0.41
X'q	0.47	0.41
X''q	0.18	0.15
Xl	0.15	0.15
Ra	0.003	0.003
T'd0	4.3	6
T''d0	0.02	0.02
T'q0	0	0
T''q0	0.02	0.02
S(1.0)	0.63	0.63
S(1.2)	0.65	0.65
H	4	4
D	0	0

Detailed Results in Full Report

Thank you