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GE VERNOVA

GENQEC model benchmark 2023

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Saturation in GENQEC Model

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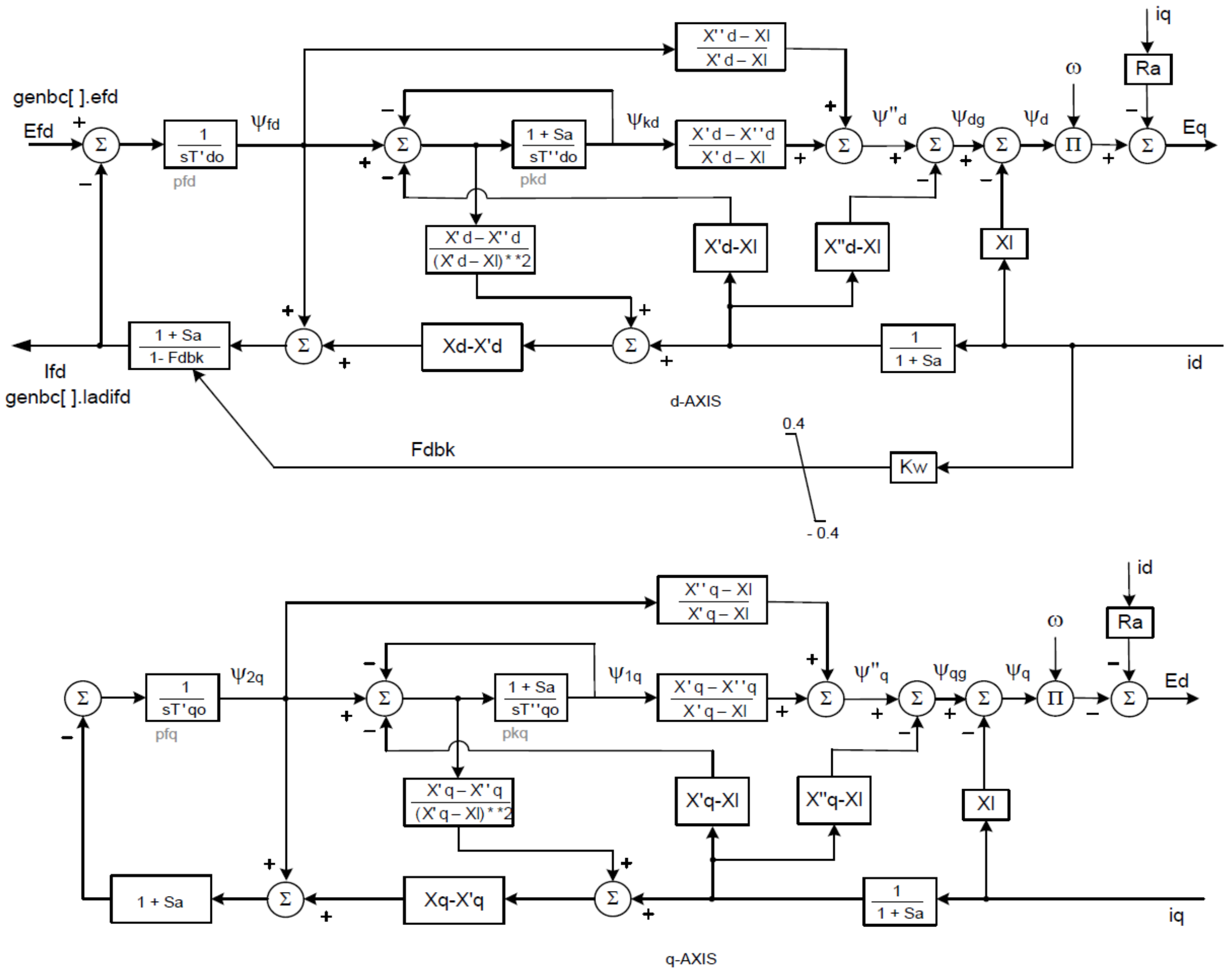
- Saturation:

$$V_{rag} = V_{rterm} + I_{rterm}Ra - X_l I_{iterm}$$
$$V_{irag} = V_{iterm} + I_{iterm}Ra + X_l I_{rterm}$$
$$\psi_{ag} = \frac{\sqrt{V_{rag}^2 + V_{iag}^2}}{\omega}$$

$Sa = Sat(\psi_{ag})$ (Saturation function)

- Saturated impedances:

$$X''_{dsat} = \frac{X''_d - X_l}{1 + S_a} \qquad X''_{qsat} = \frac{X''_q - X_l}{1 + S_a}$$



Initialization of the GENQEC Model

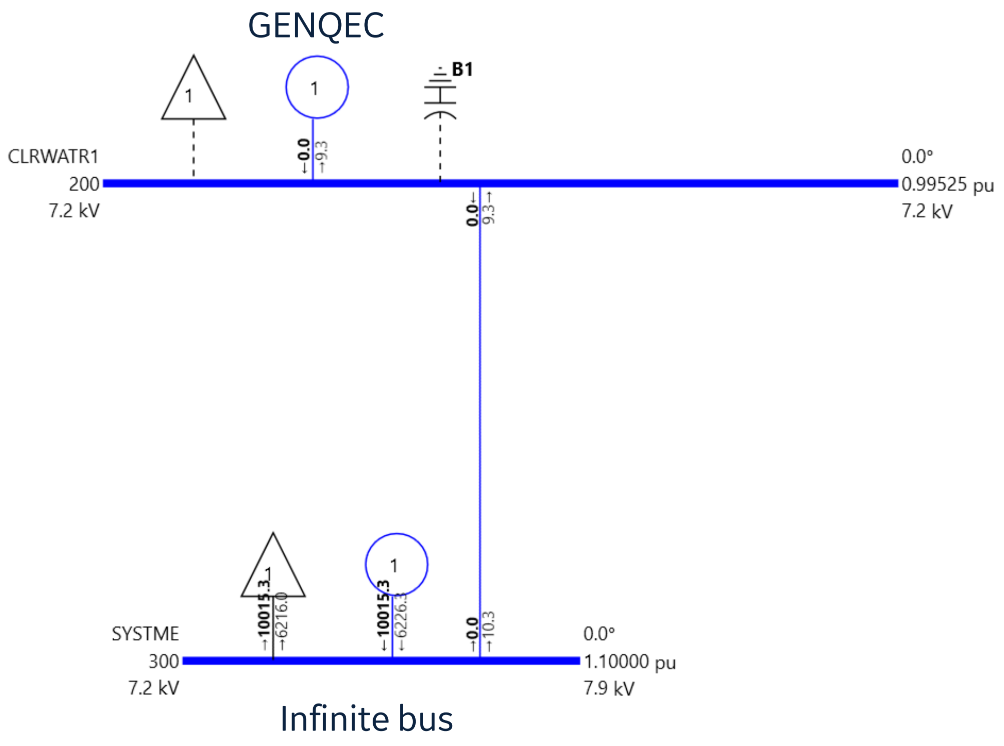
- During initialization, generator impedance is calculated based on Lppd, Lppq, Ll and Ra input by the users, and then fed into the gens table (gens[].zgenr and gens[].zgenx) in PSLF for network solution calculation.
- The resistance and reactance input by users are unsaturated value.
- Gens[].zgenr and gens[].zgenx are unchanged during dynamic simulation even when there is saturation.
  This caused inaccuracy in the PSLF simulation during abnormal operating conditions when saturation exists.
- Fix:
  Adjust the injection current to compensate for the saturated impedances change in genqec model

gens	casepar[0].ngen	Generator Data Record	
t_stamp		time stamp	
ibgen	i	Generator terminal bus index	
id[2]		Generator identifier	
projid		Project Identifier	
st		Generator status	
stn		Normal status	
cont_mode		Voltage control mode	
igreg	i	Index of bus regulated by this generator	
area	e	Area number	
zone	e	Zone number	
mbase		Generator MVA base	MVA
pgen		Actual real power output	MW
qgen		Actual reactive power output	MVAr
qmax		Maximum reactive power limit	MVAr
qmin		Minimum reactive power limit	MVAr
pf		Power factor limit	
qtab		Qtable selector: 1 – use qtable if it exists	
qtabno	e	Qtable number	
qmx		Actual max. Q (from qtable, qmax, or pf)	MVAr
qmn		Actual min. Q (from qtable, qmin, or pf)	MVAr
prf		Real power regulating assignment factor	per unit
qrf		Reactive power regulating assignment factor	per unit
pmax		Maximum power output	MW
pmin		Minimum power output	MW
zgenr		Generator characteristic resistance	per unit
zgenx		Generator characteristic reactance	per unit
		Compensating resistance (+ values looks into system,	
		Compensating reactance - values looks into gen.)	

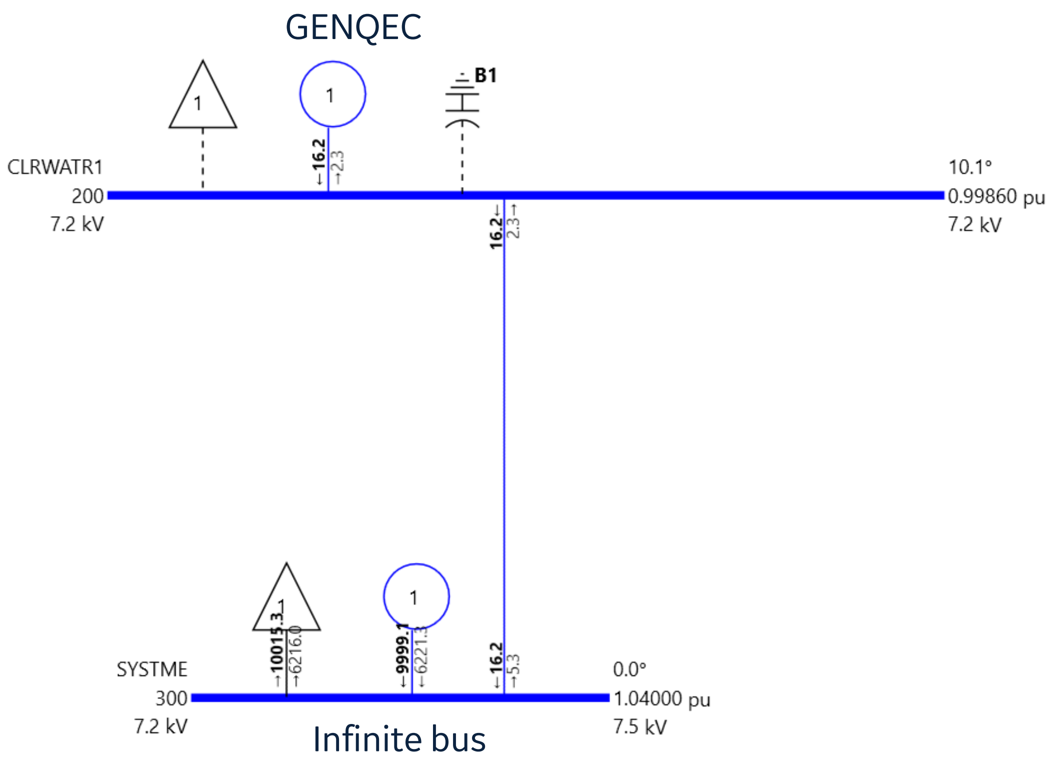
Parameters:

EPCL Variable	*Default Data*	*Description*
Tpdo	7.0	D-axis transient rotor time constant, sec.
Tppdo	0.030	D-axis sub-transient rotor time constant, sec.
Tpqo	0.75	Q-axis transient rotor time constant,sec.
Tppqo	0.05	Q-axis sub-transient rotor time constant, sec.
H	3.0	Inertia constant, sec.
D	0.0	Damping factor, p.u.
Ld	2.1	D-axis synchronous reactance, p.u.
Lq	2.0	Q-axis synchronous reactance, p.u.
Lpd	0.2	D-axis transient reactance, p.u.
Lpq	0.5	Q-axis transient reactance, p.u.
Lppd	0.18	D-axis sub-transient reactance, p.u.
Lppq	0.10	Q-axis sub-transient reactance, p.u.
Ll	0.15	Stator leakage reactance, p.u.
S1	0.05	Saturation factor at 1 p.u. flux
S12	0.3	Saturation factor at 1.2 p.u. flux
Ra	0.0	Stator resistance, p.u.
Rcomp	0.0	Compounding resistance for voltage control, p.u.
Xcomp	0.0	Compounding reactance for voltage control, p.u.
Kw	0.0	Rotor field current compensation factor [1]. $0 \leq Kw < 1$
Satflg	0.0	Saturation type selector.
		Satflg = -1: No saturation (i.e., Sa = 0).

Benchmark Test

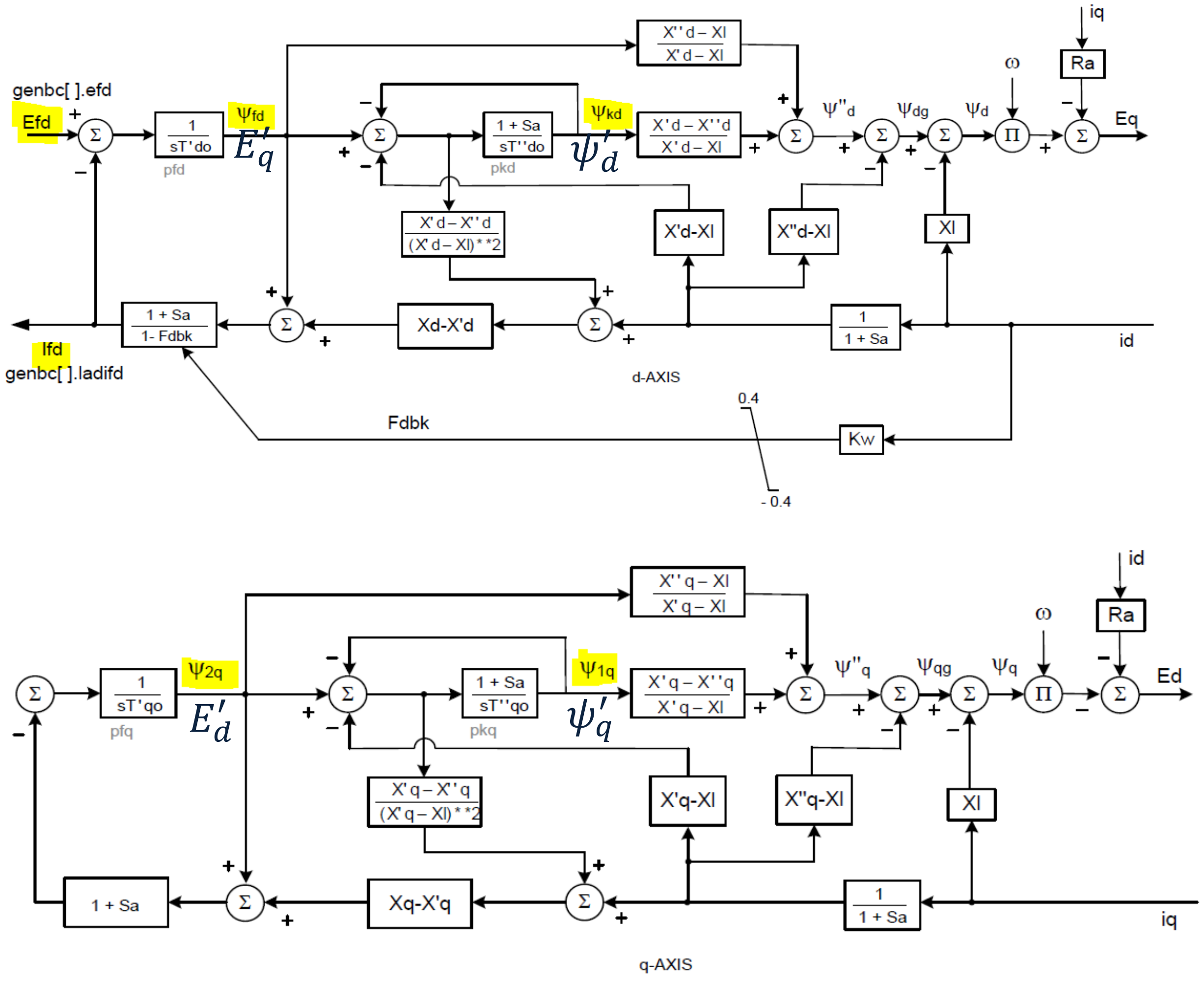


Case 1: pgen = 0



Case 2: pgen = 16

Benchmark Test



- Variable compared between three software (PSSE, PowerWorld, PSLF):

  $E'q,\ \psi_d', E_d', \psi_q', E_{fd}, I_{fd},$
  ω (speed), V_t (terminal voltage)

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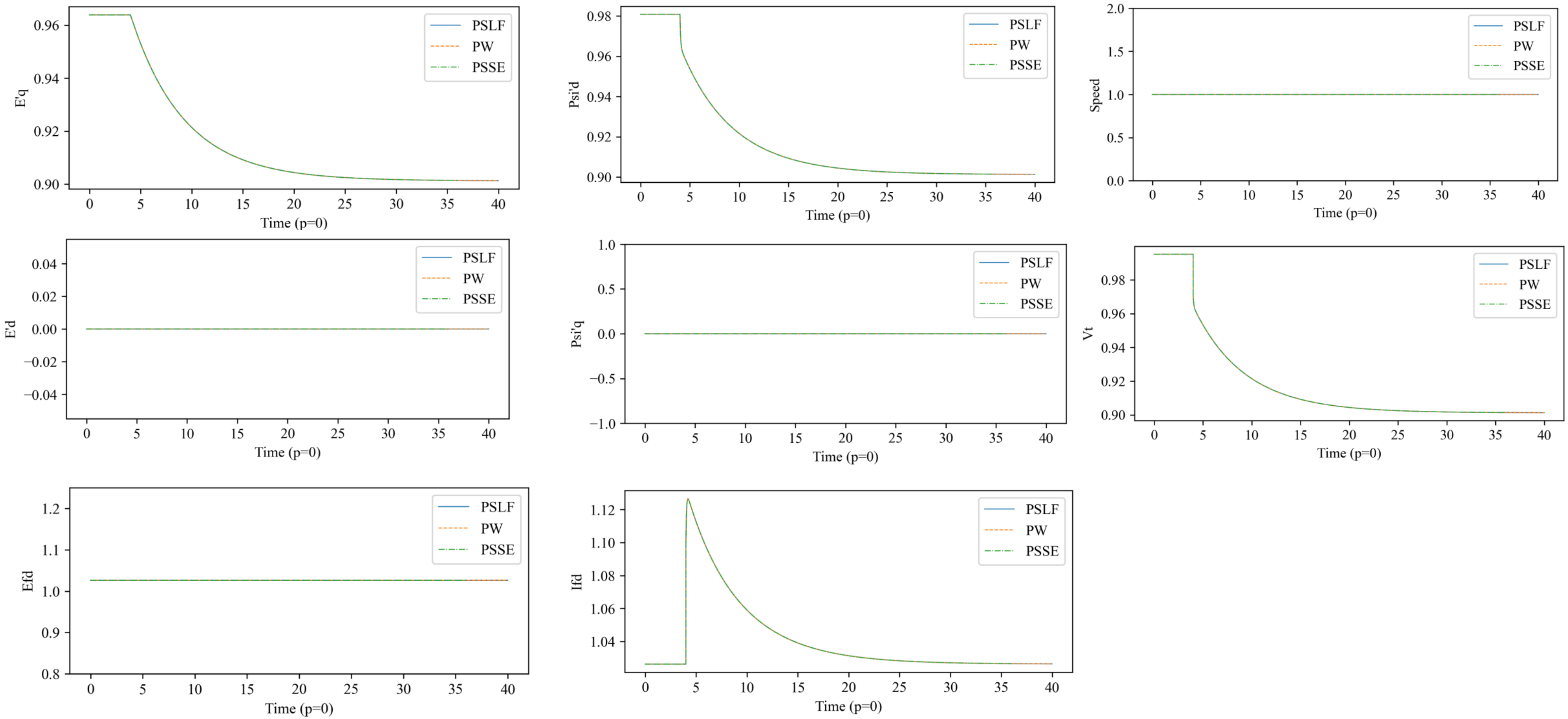
Benchmark Test Results

- Case 1



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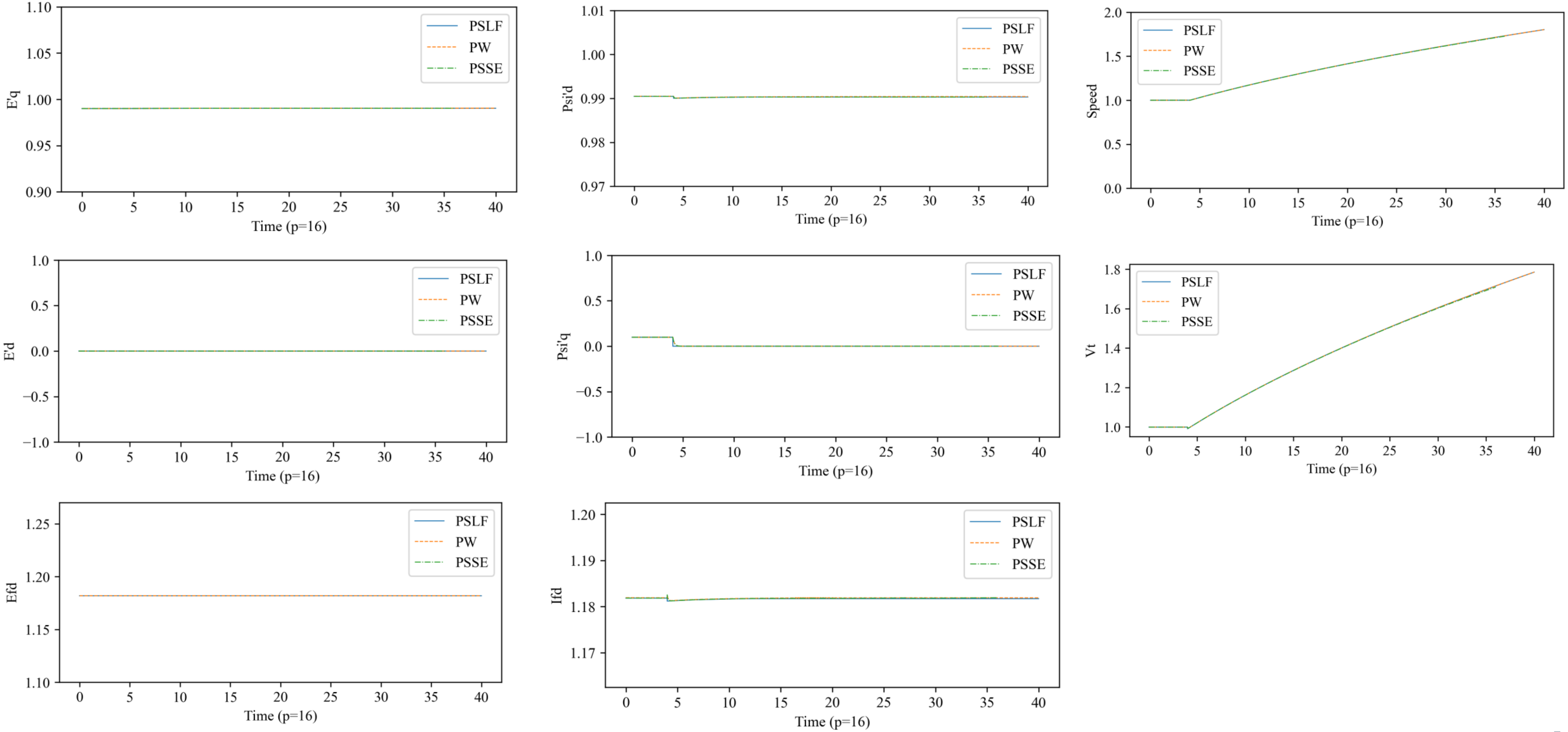
Benchmark Test Results

- Case 2



Fixed Version

- This issue was fixed in GE PSLF version 23.2.7 released December 2023.
- Thanks a lot for your support!