Converter-Interfaced Energy Storage Systems – Errata

On page xviii, 6th line, the Laplace transform variable should read s.

On page 106, equations (4.30)–(4.33) should read:

$$\begin{aligned}
T'_{\mathrm{d}o}\frac{\mathrm{d}}{\mathrm{d}t}e'_{r,\mathrm{q}}(t) + \tilde{T}''_{\mathrm{d}o}\frac{\mathrm{d}}{\mathrm{d}t}e''_{r,\mathrm{q}}(t) &= -e'_{r,\mathrm{q}}(t) - (X_{\mathrm{d}} - X'_{\mathrm{d}})\, i_{s,\mathrm{d}}(t) + v_e(t) \\
T'_{\mathrm{q}o}\frac{\mathrm{d}}{\mathrm{d}t}e'_{r,\mathrm{d}}(t) - \tilde{T}''_{\mathrm{q}o}\frac{\mathrm{d}}{\mathrm{d}t}e''_{r,\mathrm{d}}(t) &= -e'_{r,\mathrm{d}}(t) + (X_{\mathrm{q}} - X'_{\mathrm{q}})\, i_{s,\mathrm{q}}(t) \\
T''_{\mathrm{d}o}\frac{\mathrm{d}}{\mathrm{d}t}e''_{r,\mathrm{q}}(t) &= -e''_{r,\mathrm{q}}(t) + e'_{r,\mathrm{q}}(t) - (X'_{\mathrm{d}} - X_\ell)\, i_{s,\mathrm{d}}(t) \\
T''_{\mathrm{q}o}\frac{\mathrm{d}}{\mathrm{d}t}e''_{r,\mathrm{d}}(t) &= -e''_{r,\mathrm{d}}(t) - e'_{r,\mathrm{d}}(t) - (X'_{\mathrm{q}} - X_\ell)\, i_{s,\mathrm{q}}(t)\,,
\end{aligned} \tag{4.30}$$

$$\begin{aligned}
\gamma_{\mathrm{d}1} &= \frac{X''_{\mathrm{d}} - X_\ell}{X'_{\mathrm{d}} - X_\ell}\,, & \gamma_{\mathrm{q}1} &= \frac{X''_{\mathrm{q}} - X_\ell}{X'_{\mathrm{q}} - X_\ell}\,, \\
\gamma_{\mathrm{d}2} &= \frac{X'_{\mathrm{d}} - X''_{\mathrm{d}}}{(X'_{\mathrm{d}} - X_\ell)^2} = \frac{1-\gamma_{\mathrm{d}1}}{X'_{\mathrm{d}} - X_\ell}\,, & \gamma_{\mathrm{q}2} &= \frac{X'_{\mathrm{q}} - X''_{\mathrm{q}}}{(X'_{\mathrm{q}} - X_\ell)^2} = \frac{1-\gamma_{\mathrm{q}1}}{X'_{\mathrm{q}} - X_\ell}\,,
\end{aligned} \tag{4.31}$$

$$\begin{aligned}
\tilde{T}''_{\mathrm{d}o} &= (X_{\mathrm{d}} - X'_{\mathrm{d}})\,\gamma_{\mathrm{d}2}\,T''_{\mathrm{d}o} \\
\tilde{T}''_{\mathrm{q}o} &= (X_{\mathrm{q}} - X'_{\mathrm{q}})\,\gamma_{\mathrm{q}2}\,T''_{\mathrm{q}o}\,,
\end{aligned} \tag{4.32}$$

and

$$\begin{aligned}
0 &= \psi_{s,\mathrm{d}}(t) + X''_{\mathrm{d}}\, i_{s,\mathrm{d}}(t) - \gamma_{\mathrm{d}1}\, e'_{r,\mathrm{q}}(t) - (1-\gamma_{\mathrm{d}1})\, e''_{r,\mathrm{q}}(t) \\
0 &= \psi_{s,\mathrm{q}}(t) + X''_{\mathrm{q}}\, i_{s,\mathrm{q}}(t) + \gamma_{\mathrm{q}1}\, e'_{r,\mathrm{d}}(t) - (1-\gamma_{\mathrm{q}1})\, e''_{r,\mathrm{d}}(t)\,.
\end{aligned} \tag{4.33}$$

On page 106, the last but one line of the page should read: "..., i.e. by assuming $T''_{\mathrm{d}o} \approx T''_{\mathrm{q}o} \approx 0$, ...'

On page 107, the Tables 4.4 and 4.5 should read as indicated below.

On page 163, first paragraph, the occurrences of $i^{\mathrm{ref}}_{\mathrm{ac,q}}$ and $i^{\mathrm{ref}}_{\mathrm{ac,d}}$ should be swapped.

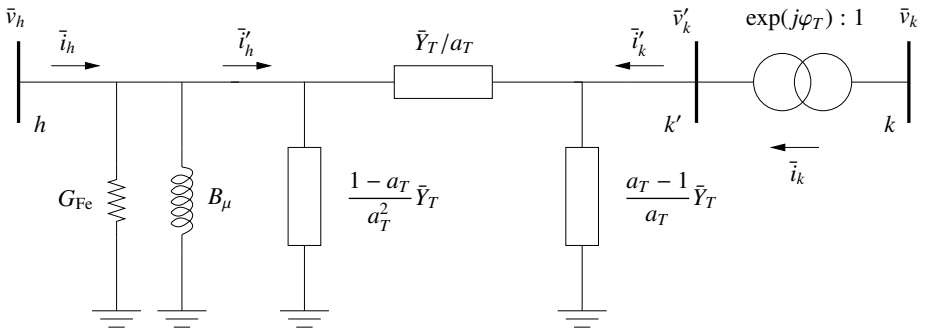
Table 4.4 Variables of the synchronous machine models.

Variable	Description	Unit
$e'_{r,\mathrm{d}}$	Rotor quadrature-axis transient voltage	pu(kV)
$e''_{r,\mathrm{d}}$	Rotor quadrature-axis sub-transient voltage	pu(kV)
$e'_{r,\mathrm{q}}$	Rotor direct-axis transient voltage	pu(kV)
$e''_{r,\mathrm{q}}$	Rotor direct-axis sub-transient voltage	pu(kV)
$i_{s,\mathrm{d}}$	Stator terminal-bus direct-axis current	pu(kA)
$i_{s,\mathrm{q}}$	Stator terminal-bus quadrature-axis current	pu(kA)
v_e	Excitation field voltage	pu(kV)
$v_{s,\mathrm{d}}$	Stator terminal-bus direct-axis voltage	pu(kV)
$v_{s,\mathrm{q}}$	Stator terminal-bus quadrature-axis voltage	pu(kV)
δ_r	Rotor angular position	rad
τ_e	Electromagnetic torque	pu(MNm)
τ_m	Mechanical torque	pu(MNm)
$\psi_{s,\mathrm{d}}$	Stator direct-axis flux	pu(kWb)
$\psi_{s,\mathrm{q}}$	Stator quadrature-axis flux	pu(kWb)
ω_r	Rotor angular speed	pu(Hz)

Table 4.5 Parameters of the synchronous machine models.

Parameter	Description	Unit
D	Damping coefficient	pu(MW)
M	Inertia constant	s pu(MW)
R_a	Armature resistance	pu(Ω)
$T'_{\mathrm{d}o}$	Direct-axis open circuit transient time constant	s
$T''_{\mathrm{d}o}$	Direct-axis open circuit sub-transient time constant	s
$T'_{\mathrm{q}o}$	Quadrature-axis open circuit transient time constant	s
$T''_{\mathrm{q}o}$	Quadrature-axis open circuit sub-transient time constant	s
X_{d}	Direct-axis synchronous reactance	pu(Ω)
X'_{d}	Direct-axis transient reactance	pu(Ω)
X''_{d}	Direct-axis sub-transient reactance	pu(Ω)
X_ℓ	Leakage reactance	pu(Ω)
X_{q}	Quadrature-axis synchronous reactance	pu(Ω)
X'_{q}	Quadrature-axis transient reactance	pu(Ω)
X''_{q}	Quadrature-axis sub-transient reactance	pu(Ω)

Figure 4.2 on page 102 should be corrected as shown below.



Equations (4.46) on page 113 should read:

$$
\begin{aligned}
T_m \frac{\mathrm{d}}{\mathrm{d}t} v_m(t) &= v_h(t) - v_m(t) \\
T_b \frac{\mathrm{d}}{\mathrm{d}t} v_b(t) + \frac{\mathrm{d}}{\mathrm{d}t} v_f(t) &= v^{\mathrm{ref}} - v_m(t) - v_b(t) \\
T_a \frac{\mathrm{d}}{\mathrm{d}t} v_a(t) - K_a T_c \frac{\mathrm{d}}{\mathrm{d}t} v_b(t) &= K_a v_b(t) - v_a(t) \\
T_f \frac{\mathrm{d}}{\mathrm{d}t} v_f(t) &= K_f v_e(t) - v_f(t) \\
T_e \frac{\mathrm{d}}{\mathrm{d}t} v_e(t) &= v_a(t) - \Big(K_e + \mathrm{sat}(t)\Big) v_e(t) \,,
\end{aligned}
\tag{4.46}
$$

Figure 5.12 on page 162 should be corrected as shown below.

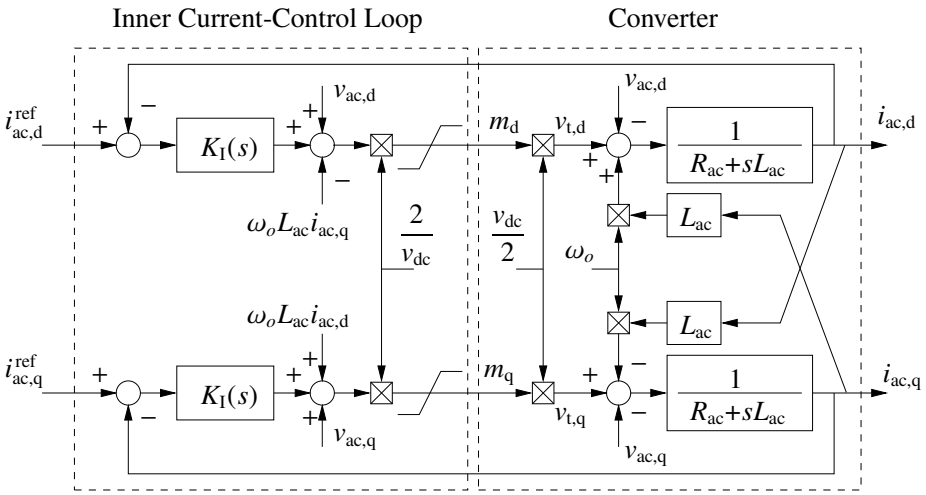


Figure 9.5 on page 279 should be corrected as shown at right.

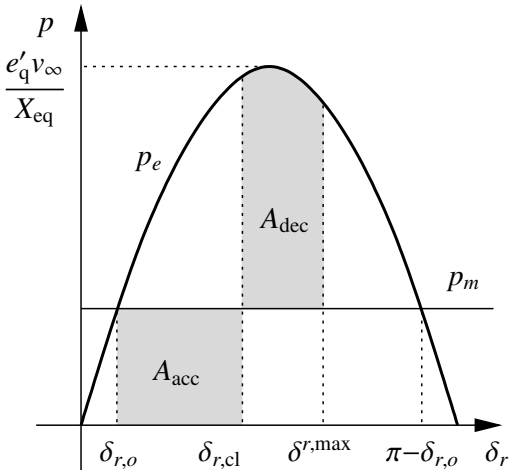
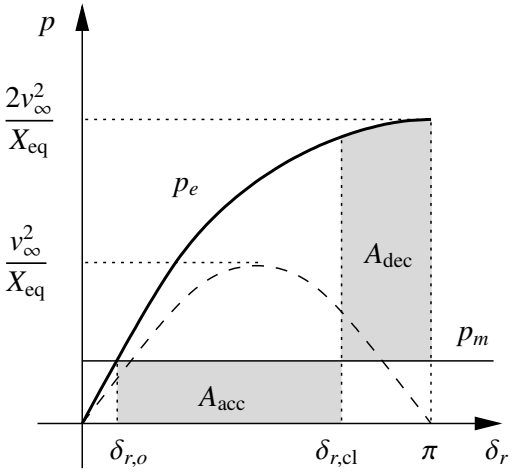


Figure 9.7 on page 280 should be corrected as shown at right.



On page 322, Table D.3 should read as indicated below.

On page 323, Table D.4 should read as indicated below.

On page 330, Table D.14 should read as indicated below.

Table D.3 Base-case power flow solution of the WSCC system.

Bus #	v_n [kV]	v [pu(kV)]	θ [rad]	p_G [pu(MW)]	q_G [pu(MVAr)]	p_D [pu(MW)]	q_D [pu(MVAr)]
1	16.5	1.0400	0	0.7164	0.2705	0	0
2	18.0	1.0250	0.1620	1.6300	0.0665	0	0
3	13.8	1.0250	0.0814	0.8500	−0.1086	0	0
4	230.0	1.0258	−0.0387	0	0	0	0
5	230.0	0.9956	−0.0696	0	0	1.25	0.50
6	230.0	1.0127	−0.0644	0	0	0.90	0.30
7	230.0	1.0258	0.0649	0	0	0	0
8	230.0	1.0159	0.0127	0	0	1.00	0.35
9	230.0	1.0324	0.0343	0	0	0	0

Table D.4 Base-case power flows and losses in transmission lines and transformers of the WSCC system.

Branch #	From (i) #	To (j) #	p_{ij} [pu(MW)]	q_{ij} [pu(MVAr)]	p_{loss} [pu(MW)]	q_{loss} [pu(MVAr)]
1	6	4	−0.3054	−0.1654	0.0017	−0.1551
2	5	4	−0.4068	−0.3869	0.0026	−0.1579
3	7	5	0.8662	−0.0838	0.0230	−0.1969
4	9	6	0.6082	−0.1807	0.0135	−0.3153
5	7	8	0.7638	−0.0080	0.0048	−0.1150
6	9	8	0.2418	0.0312	0.0009	−0.2118
7	1	4	0.7164	0.2705	0	0.0312
8	2	7	1.6300	0.0665	0	0.1583
9	3	9	0.8500	−0.1086	0	0.0410

Table D.14 Base-case power flows and losses in the branches of the New England system.

Branch #	From (i) #	To (j) #	p_{ij} [pu(MW)]	q_{ij} [pu(MVAr)]	p_{loss} [pu(MW)]	q_{loss} [pu(MVAr)]
1	1	2	−1.2434	−0.2831	0.0050	−0.7092
2	1	39	1.2434	0.2831	0.0018	−0.7630
3	2	3	3.6426	0.9226	0.0170	−0.0802
4	2	25	−2.3909	0.8268	0.0416	−0.1108
5	2	30	−2.5000	−1.3234	0.0000	0.1383
6	3	4	0.9289	1.1058	0.0029	−0.1817
7	3	18	−0.5233	−0.1269	0.0003	−0.2236
8	4	5	−1.3699	−0.0838	0.0015	−0.1116
9	4	14	−2.7041	−0.4687	0.0059	−0.0447
10	5	8	3.1729	0.5873	0.0083	−0.0314
11	6	5	4.5484	0.5695	0.0041	0.0099
12	6	7	4.2062	0.9157	0.0110	0.0553
13	6	11	−3.6385	−0.3244	0.0092	−0.0343
14	7	8	1.8572	0.0204	0.0014	−0.0615
15	8	9	−0.1996	−1.0594	0.0019	−0.3606
16	9	39	−0.2015	−0.6988	0.0000	−1.2698
17	10	11	3.6524	0.7036	0.0054	−0.0174
18	10	13	2.8476	0.3867	0.0032	−0.0408
19	10	32	−6.5000	−1.0902	0.0000	0.9614
20	12	11	0.0009	−0.4230	0.0003	0.0079
21	12	13	−0.0759	−0.4570	0.0003	0.0094
22	13	14	2.7682	−0.0390	0.0067	−0.1016
23	14	15	0.0514	−0.3614	0.0001	−0.3753
24	15	16	−3.1487	−1.5161	0.0104	−0.0702
25	16	17	2.3003	−0.4367	0.0036	−0.0978
26	16	19	−5.0267	−0.4814	0.0381	0.1354
27	16	21	−3.2960	0.1300	0.0082	−0.1326
28	16	24	−0.4268	−0.9809	0.0003	−0.0668
29	17	18	2.1065	0.0971	0.0029	−0.1063
30	17	27	0.1902	−0.4360	0.0001	−0.3432
31	19	33	−6.2910	−0.5118	0.0290	0.5876
32	19	20	1.2262	−0.1049	0.0011	0.0213
33	20	34	−5.0549	−1.1562	0.0251	0.5016
34	21	22	−6.0442	−0.8874	0.0279	0.2100
35	22	23	0.4279	0.4198	0.0002	−0.1985
36	22	35	−6.5000	−1.5173	0.0000	0.6074
37	23	24	3.5384	0.0056	0.0253	0.0115
38	23	36	−5.5857	−0.2333	0.0143	0.7788
39	25	26	0.7109	−0.1703	0.0015	−0.5558
40	25	37	−5.3834	0.6359	0.0166	0.6404
41	26	27	2.6295	0.6869	0.0096	−0.1609
42	26	28	−1.4082	−0.2170	0.0079	−0.7751
43	26	29	−1.9018	−0.2544	0.0191	−0.9268
44	28	29	−3.4761	0.2821	0.0156	−0.1067
45	29	38	−8.2477	0.7921	0.0523	1.0207
46	6	31	−5.1161	−1.1608	0.0000	0.7758