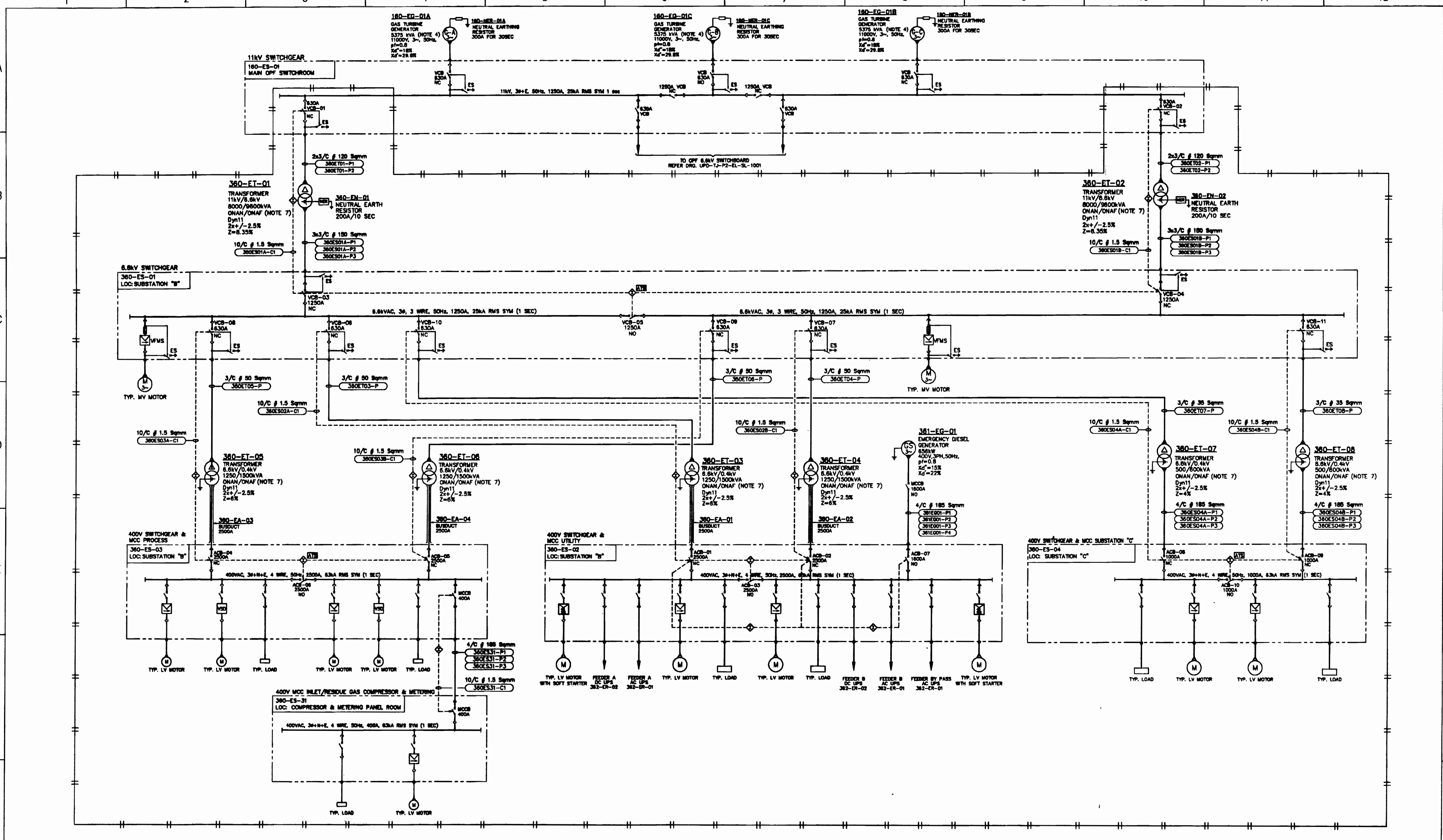

NOTE :

1. TRANSFORMER SIZES, EDG RATING AND SWGR/MCC BUS AMP. RATING REFER TO DOC. ELECTRICAL LOAD CALCULATION.
2. SWGR/MCC RATINGS SHALL BE VERIFIED BY ELECTRICAL SYSTEM STUDY.
3. THE INTERLOCKING & INTERTRIPPING BETWEEN SWITCHGEARS SHALL REFER TO RELATED SWITCHGEAR SINGLE LINE DIAGRAM.
4. A MINIMUM OF 20% SPARE SPACE SHALL BE PROVIDED ON 400V MCC AND DISTRIBUTION BOARD.
5. [symbol] EPC SCOPE OF WORK
6. SITE RATING AT TEMP. RISE B
7. PROVIDE ONLY FUTURE FACILITY FOR ONAF RATING

GENERAL NOTE

REFERENCE DRAWING TITLE	DRAWING NO.
OTF / LPGF 400V SWITCHGEAR & MCC SUBSTATION "C" (360-ES-04) SINGLE LINE DIAGRAM	UPD-TJ-P2-EL-SL-0054
OTF / LPGF 400V MCC INLET/RESIDUE GAS COPRESSOR & METERING (360-ES-31) SINGLE LINE DIAGRAM	UPD-TJ-P2-EL-SL-0053
OTF / LPGF 400V SWITCHGEAR & MCC PROCESS (360-ES-03) SINGLE LINE DIAGRAM	UPD-TJ-P2-EL-SL-0052
OTF / LPGF 400V SWITCHGEAR & MCC UTILITY (360-ES-02) SINGLE LINE DIAGRAM	UPD-TJ-P2-EL-SL-0013
OTF / LPGF 6.6 KV SWITCHGEAR & MCC (360-ES-01) SINGLE LINE DIAGRAM	UPD-TJ-P2-EL-SL-0012
OTF / LPGF INTERLOCK BLOCK DIAGRAM	UPD-TJ-P2-EL-BL-0106
OPF OVERALL SINGLE LINE DIAGRAM	UPD-TJ-P2-EL-SL-1001
ELECTRICAL SYMBOL & LEGEND	UPD-TJ-P2-EL-SL-0101

DISC.	SIGN	DATE
ARCH.		
CONST.		
ELECT.		
INSTR.		
MECH.		
PIPING		
PROCESS		
SAFETY		
STRUC.		

COUNTER SIGN

REV.	DESCRIPTION	DATE	DRAWN	CHKD.	DISC. APP'D	PROJ. APP'D	CLIENT APP'D
10	AS-BUILT	31/03/09	STN	REN	TRS	[signature]	DLS

HESS (INDONESIA - PANGKAH) LIMITED

PT. TRIPATRA
ENGINEERS & CONSTRUCTORS

PROJECT TITLE : **ONSHORE OIL TREATING FACILITIES AND LPG RECOVERY PLANT UJUNG PANGKAH LIQUID DEVELOPMENT PROJECT**

JOB NO.	DWG. SIZE	TITLE :
9490	A1	**OTF/LPGF OVERALL KEY SINGLE LINE DIAGRAM**
	SCALE : N.T.S	

FILE NAME : CAD : UPD-TJ-P2-EL-SL-0102-1

DRAWING NO. UPD-TJ-P2-EL-SL-0102

REV. 10

Synchronous Machine Parameters

Machine			Rating		Positive Sequence Impedance (%)								Zero Seq. Z (%)		
ID	Type	Model	MVA	kV	Ra	Xd"	Xd'	Xd	Xq"	Xq'	Xq	Xl	X/R	R0	X0
160-GTG-01A	Generator	Transient, Round-Rotor	5.375	11.000	0.38		29.80	110.00		15.00	108.00	11.00	48.00	0.25	12.00
160-GTG-01B	Generator	Transient, Round-Rotor	5.375	11.000	0.38		29.80	110.00		15.00	108.00	11.00	48.00	0.25	12.00
160-GTG-01C	Generator	Transient, Round-Rotor	5.375	11.000	0.38		29.80	110.00		15.00	108.00	11.00	48.00	0.25	12.00
161-EG-21	Generator	Subtransient, Round-Rotor	0.814	0.400	0.31	15.00	22.00	110.00	12.00	15.00	108.00	11.00	48.00	0.25	12.00
361-EG-01	Generator	Subtransient, Round-Rotor	0.820	0.400	0.31	15.00	22.00	110.00	12.00	15.00	108.00	11.00	48.00	0.25	12.00

Machine	Connected Bus	Time Constants (Sec.)				H(Sec.), D(MWpu/Hz) & Saturation					Generator or Loading		Grounding		
ID	ID	Tdo"	Tdo'	Tqo"	Tqo'	H	%D	S100	S120	Sbreak	MW	Mvar	Conn.	Type	Amp
160-GTG-01A	Bus1		5.600		3.700	8.740	5.00	1.070	1.180	0.800	0.000	0.000	Wye	Resistor	300.00
160-GTG-01B	Bus2		5.600		3.700	8.740	5.00	1.070	1.180	0.800	0.000	0.000	Wye	Resistor	300.00
160-GTG-01C	Bus3		5.600		3.700	8.740	5.00	1.070	1.180	0.800	0.000	0.000	Wye	Resistor	300.00
161-EG-21	Bus44	0.002	5.600	0.002	3.700	4.900	5.00	1.070	1.180	0.800	0.000	0.000	Wye	Solid	
361-EG-01	Bus60	0.002	5.600	0.002	3.700	4.899	5.00	1.070	1.180	0.800	0.000	0.000	Wye	Resistor	300.00

Machine		Generator/Motor			Coupling			Prime Mover/Load			Equivalent Total		
ID	Type	RPM	WR²	H	RPM	WR²	H	RPM	WR²	H	RPM	WR²	H
160-GTG-01A	Gen.	1500	2652	6.090	1500	192.2	0.441	1500	961.7	2.209	1500	3805.9	8.740
160-GTG-01B	Gen.	1500	2652	6.090	1500	192.2	0.441	1500	961.7	2.209	1500	3805.9	8.740
160-GTG-01C	Gen.	1500	2652	6.090	1500	192.2	0.441	1500	961.7	2.209	1500	3805.9	8.740
161-EG-21	Gen.	1500	59.33	0.900	1500	13.19	0.200	1500	250.5	3.800	1500	323.02	4.900
361-EG-01	Gen.	1500	59.79	0.900	1500	13.29	0.200	1500	252.4	3.799	1500	325.48	4.899

WR²: kg-m² H: MW-Sec/MVA

Machine		Shaft Torsion			
ID	Type	D1	D2	K1	K2

D1, D2: MW(pu)/Speed (pu) K1, K2: MW(pu)/Radiant

2-Winding Transformer Input Data

Transformer	Rating					Z Variation			% Tap Setting		Adjusted	Phase Shift	
ID	MVA	Prim. kV	Sec. kV	% Z	X/R	+ 5%	- 5%	% Tol.	Prim.	Sec.	% Z	Type	Angle
160-ET-01	5.000	11.000	6.600	7.15	12.14	0	0	6.0	0	0	7.5790	Std Pos. Seq.	0.0
160-ET-02	5.000	11.000	6.600	7.15	12.14	0	0	6.0	0	0	7.5790	Std Pos. Seq.	0.0
160-ET-11	3.000	6.600	0.400	6.25	10.67	0	0	0	0	0	6.2500	Std Pos. Seq.	0.0
160-ET-12	3.000	6.600	0.400	6.25	10.67	0	0	0	-5.000	0	6.2500	Std Pos. Seq.	0.0
160-ET-13	0.100	6.600	0.400	4.00	2.47	0	0	0	0	0	4.0000	Std Pos. Seq.	0.0
360-ET-01	8.000	11.000	6.600	8.35	14.23	0	0	8.4	0	0	9.0514	Std Pos. Seq.	0.0
360-ET-02	8.000	11.000	6.600	8.35	14.23	0	0	8.4	0	0	9.0514	Std Pos. Seq.	0.0
360-ET-03	1.250	6.600	0.400	5.00	7.10	0	0	6.0	0	0	5.3000	Std Pos. Seq.	0.0
360-ET-04	1.250	6.600	0.400	5.00	7.10	0	0	6.0	0	0	5.3000	Std Pos. Seq.	0.0
360-ET-05	1.250	6.600	0.400	5.00	7.10	0	0	6.0	0	0	5.3000	Std Pos. Seq.	0.0
360-ET-06	1.250	6.600	0.400	5.00	7.10	0	0	6.0	0	0	5.3000	Std Pos. Seq.	0.0
360-ET-07	0.500	6.600	0.400	5.00	7.10	0	0	4.0	0	0	5.2000	Std Pos. Seq.	0.0
360-ET-08	0.500	6.600	0.400	5.00	7.10	0	0	4.0	0	0	5.2000	Std Pos. Seq.	0.0

2-Winding Transformer Grounding Input Data

Transformer	Rating			Grounding								
				Conn.	Primary				Secondary			
ID	MVA	Prim. kV	Sec. kV	Type	Type	kV	Amp	Ohm	Type	kV	Amp	Ohm
160-ET-01	5.000	11.000	6.600	D/Y					Resistor		200.0	19.05256
160-ET-02	5.000	11.000	6.600	D/Y					Resistor		200.0	19.05256
160-ET-11	3.000	6.600	0.400	D/Y					Solid			
160-ET-12	3.000	6.600	0.400	D/Y					Solid			
160-ET-13	0.100	6.600	0.400	D/Y					Solid			
360-ET-01	8.000	11.000	6.600	D/Y					Resistor		200.0	19.05256
360-ET-02	8.000	11.000	6.600	D/Y					Resistor		200.0	19.05256
360-ET-03	1.250	6.600	0.400	D/Y					Solid			
360-ET-04	1.250	6.600	0.400	D/Y					Solid			
360-ET-05	1.250	6.600	0.400	D/Y					Solid			
360-ET-06	1.250	6.600	0.400	D/Y					Solid			
360-ET-07	0.500	6.600	0.400	D/Y					Solid			
360-ET-08	0.500	6.600	0.400	D/Y					Solid			

Line/Cable Input Data

Line/Cable	Ohms or Siemens per 1000 m per Conductor (Cable) or per Phase (Line)											
			Length									
ID	Library	Size	Adj. (m)	% Tol.	#/Phase	T (°C)	R1	X1	Y1	R0	X0	Y0
135PM30A-P	10NCUS3	25	120.0	0.0	3	90	0.927000	0.117000		1.473900	0.297180	
135PM30B-P	10NCUS3	25	120.0	0.0	3	90	0.927000	0.117000		1.473900	0.297180	
135PM30C-P	10NCUS3	25	120.0	0.0	3	90	0.927000	0.117000		1.473900	0.297180	
139PM01A-P	10NCUS3	25	260.0	0.0	3	90	0.927000	0.117000		1.473900	0.297180	
139PM01B-P	10NCUS3	25	300.0	0.0	3	90	0.927000	0.117000		1.473900	0.297180	
145PM01A-P	10NCUS3	25	230.0	0.0	3	90	0.927000	0.117000		1.473900	0.297180	
145PM01B-P	10NCUS3	25	225.0	0.0	3	90	0.927000	0.117000		1.473900	0.297180	
160ES11A-P	6.6NCUN3	240	25.0	0.0	3	90	0.098000	0.085900		0.155820	0.218190	
160ES11B-P	6.6NCUN3	240	20.0	0.0	3	90	0.098000	0.085900		0.155820	0.218190	
160ES12-P	10NCUS3	70	3600.0	0.0	3	90	0.342000	0.100000		0.543780	0.254000	
160ES21-P	1.0NCUN3	300	30.0	0.0	3	90	0.077796	0.075400		0.124474	0.192270	
160ES22-P	1.0NCUN3	240	300.0	0.0	3	90	0.096459	0.075800		0.154334	0.193290	
160ET01-P	11NCUN1	240	55.0	0.0	3	90	0.098000	0.109000	0.0001445	0.160000	0.280000	
160ET02-P	11NCUN1	240	45.0	0.0	3	90	0.098000	0.109000	0.0001445	0.160000	0.280000	
160ET11-P	6.6NCUN3	240	50.0	0.0	3	90	0.098000	0.085900		0.155820	0.218190	
160ET12-P	6.6NCUN3	240	40.0	0.0	3	90	0.098000	0.085900		0.155820	0.218190	
160GTG01A-P	11NCUN1	240	325.0	0.0	3	90	0.098000	0.109000	0.0001445	0.160000	0.280000	
160GTG01B-P	11NCUN1	240	325.0	0.0	3	90	0.098000	0.109000	0.0001445	0.160000	0.280000	
160GTG01C-P	11NCUN1	240	325.0	0.0	3	90	0.098000	0.109000	0.0001445	0.160000	0.280000	
161EG21-P	1.0NCUN3	300	160.0	0.0	3	90	0.077796	0.075400		0.124474	0.192270	
339CM01A-P	10NCUS3	25	190.0	0.0	3	90	0.927000	0.117000		1.473900	0.297180	
339CM01B-P	10NCUS3	25	190.0	0.0	3	90	0.927000	0.117000		1.473900	0.297180	
360ES01A-P	6.6NCUN3	150	30.0	0.0	3	90	0.159000	0.090800		0.252810	0.230630	
360ES01B-P	6.6NCUN3	150	30.0	0.0	3	90	0.159000	0.090800		0.252810	0.230630	
360ES04A-P	1.0NCUS3	185	15.0	0.0	3	90	0.128000	0.071200		0.203520	0.180850	
360ES04B-P	1.0NCUS3	185	15.0	0.0	3	90	0.128000	0.071200		0.203520	0.180850	
360ET01-P	11NCUN3	120	420.0	0.0	3	90	0.196000	0.118000	0.0001147	0.310000	0.250000	
360ET02-P	11NCUN3	120	420.0	0.0	3	90	0.196000	0.118000	0.0001147	0.310000	0.250000	
360ET03-P	6.6NCUN3	50	65.0	0.0	3	90	0.494000	0.108000		0.785460	0.274320	
360ET04-P	6.6NCUN3	50	65.0	0.0	3	90	0.494000	0.108000		0.785460	0.274320	
360ET05-P	6.6NCUN3	50	75.0	0.0	3	90	0.494000	0.108000		0.785460	0.274320	
360ET06-P	6.6NCUN3	50	75.0	0.0	3	90	0.494000	0.108000		0.785460	0.274320	
360ET07-P	10NCUS3	25	190.0	0.0	3	90	0.927000	0.117000		1.473900	0.297180	
360ET08-P	10NCUS3	25	190.0	0.0	3	90	0.927000	0.117000		1.473900	0.297180	

Line/Cable	Ohms or Siemens per 1000 m per Conductor (Cable) or per Phase (Line)											
			Length									
ID	Library	Size	Adj. (m)	% Tol.	#/Phase	T (°C)	R1	X1	Y1	R0	X0	Y0
361EG01-P	1.0NCUS3	185	90.0	0.0	3	90	0.128000	0.071200		0.203520	0.180850	
381PM01A-P	10NCUS3	25	365.0	0.0	3	90	0.927000	0.117000		1.473900	0.297180	
381PM01B-P	10NCUS3	25	365.0	0.0	3	90	0.927000	0.117000		1.473900	0.297180	
381PM01C-P	10NCUS3	25	365.0	0.0	3	90	0.927000	0.117000		1.473900	0.297180	
381PM01D-P	10NCUS3	25	365.0	0.0	3	90	0.927000	0.117000		1.473900	0.297180	

Line / Cable resistances are listed at the specified temperatures.

Bus Input Data

Bus			Initial Voltage		Load							
					Constant kVA		Constant Z		Constant I		Generic	
ID	kV	Sub-sys	% Mag.	Ang.	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar
160-ES-01A	11.000	1	100.0	0.0								
160-ES-01B	11.000	1	100.0	0.0								
160-ES-01C	11.000	1	100.0	0.0								
160-ES-11A	6.600	1	1.0	0.0								
160-ES-11B	6.600	1	1.0	0.0								
160-ES-12	6.600	1	1.0	0.0								
160-ES-13	0.400	1	1.0	0.0	0.005	0.003	0.020	0.013				
160-ES-21A	0.400	1	1.0	0.0	0.323	0.176	0.024	0.013				
160-ES-21B	0.400	1	1.0	0.0	0.481	0.279	0.054	0.031				
161-ES-21	0.400	1	1.0	0.0	0.231	0.143	0.020	0.012				
161-ES-22	0.400	1	1.0	0.0	0.071	0.040	0.002	0.001				
360-ES-01A	6.600	1	1.0	0.0								
360-ES-01B	6.600	1	1.0	0.0								
360-ES-02A	0.400	1	1.0	0.0	0.189	0.120	0.021	0.013				
360-ES-02B	0.400	1	1.0	0.0	0.090	0.056	0.023	0.014				
360-ES-03A	0.400	1	1.0	0.0	0.086	0.057	0.008	0.006				
360-ES-03B	0.400	1	1.0	0.0	0.203	0.155	0.018	0.013				
360-ES-04A	0.400	1	1.0	0.0	0.072	0.038	0.003	0.002				
360-ES-04B	0.400	1	1.0	0.0	0.066	0.034	0.003	0.002				
Bus1	11.000	1	100.0	0.0								
Bus2	11.000	1	100.0	0.0								
Bus3	11.000	1	100.0	0.0								
Bus4	6.600	1	1.0	0.0	0.172	0.078						
Bus5	6.600	1	1.0	0.0								
Bus6	6.600	1	1.0	0.0	0.172	0.078						
Bus7	6.600	1	1.0	0.0								
Bus8	6.600	1	1.0	0.0								
Bus9	6.600	1	1.0	0.0								
Bus10	6.600	1	1.0	0.0								
Bus13	6.600	1	1.0	0.0								
Bus26	6.600	1	1.0	0.0								
Bus27	6.600	1	1.0	0.0								
Bus35	11.000	1	1.0	0.0								
Bus38	11.000	1	1.0	0.0								

Bus			Initial Voltage		Load							
					Constant kVA		Constant Z		Constant I		Generic	
ID	kV	Sub-sys	% Mag.	Ang.	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar
Bus39	11.000	1	1.0	0.0								
Bus40	11.000	1	1.0	0.0								
Bus41	6.600	1	1.0	0.0								
Bus42	6.600	1	1.0	0.0								
Bus43	6.600	1	1.0	0.0								
Bus44	0.400	1	100.0	0.0								
Bus47	6.600	1	1.0	0.0								
Bus48	6.600	1	1.0	0.0								
Bus49	6.600	1	1.0	0.0								
Bus51	6.600	1	1.0	0.0								
Bus52	6.600	1	1.0	0.0								
Bus54	6.600	1	1.0	0.0								
Bus55	6.600	1	1.0	0.0								
Bus56	6.600	1	1.0	0.0								
Bus57	6.600	1	1.0	0.0								
Bus58	6.600	1	1.0	0.0								
Bus59	6.600	1	1.0	0.0								
Bus60	0.400	1	100.0	0.0								
Bus61	0.400	1	1.0	0.0								
Bus62	0.400	1	1.0	0.0								
Bus63	6.600	1	1.0	0.0								
Total Number of Buses: 55					2.163	1.256	0.197	0.120	0.000	0.000	0.000	0.000

Note: Dynamically modeled motor loads are not included in the bus motor load. See machine and motor pages for detail.

Generation Bus				Voltage		Generation			Mvar Limits	
ID	kV	Type	Sub-sys	% Mag.	Angle	MW	Mvar	% PF	Max	Min
Bus1	11.000	Swing	1	100.0	0.0					
Bus2	11.000	Swing	1	100.0	0.0					
Bus3	11.000	Swing	1	100.0	0.0					
Bus44	0.400	Swing	1	100.0	0.0					
Bus60	0.400	Swing	1	100.0	0.0					
						0.000	0.000			

Induction Machine Parameters

Induction Machine		Nameplate						Operating Loading			
ID	Quantity	HP/kW	kV	RPM	FLA	% PF	% Eff	% Slip	kW	kvar	% Load
135-PM-30A	1	160.00	6.600	1500	16.45	91.73	92.78	1.65	172.45	83.78	100.00
135-PM-30B	1	160.00	6.600	1500	16.45	91.73	92.78	1.65	172.45	83.78	100.00
135-PM-30C	1	160.00	6.600	1500	16.45	91.73	92.78	1.65	172.45	83.78	100.00
145-PM-01A	1	185.00	6.600	1500	18.64	91.79	94.59	1.63	195.58	95.10	100.00
145-PM-01B	1	185.00	6.600	1500	18.99	91.79	92.86	0.00	0.00	0.00	100.00
339-CM-03A	1	481.00	6.600	1000	49.85	89.85	93.95	0.00	0.00	0.00	100.00
339-CM-03B	1	481.00	6.600	1000	49.85	89.85	93.95	0.00	0.00	0.00	100.00
381-PM-01A	1	450.00	6.600	1500	46.64	89.85	93.95	0.00	0.00	0.00	100.00
381-PM-01B	1	450.00	6.600	1500	46.64	89.85	93.95	0.00	0.00	0.00	100.00
381-PM-01C	1	450.00	6.600	1500	46.64	89.85	93.95	0.00	0.00	0.00	100.00
381-PM-01D	1	450.00	6.600	1500	46.64	89.85	93.95	0.00	0.00	0.00	100.00

Induction Machine		Single-Cage 1 (% & Sec.)				Single-Cage 2 or Double-Cage (%)							Zero Seq. Z(%)	
ID	Model	X/R	X'	Xoc	Td0'	Rs	Xs	Xm	Rr1, fl	Rr2, lr	Xr1, fl	Xr2, lr	R0	X0
135-PM-30A	Single-Cage 2					3.83	10.29	365.20	1.52	1.23	11.67	9.30	0.000	18.46
135-PM-30B	Single-Cage 2					3.83	10.29	365.20	1.52	1.23	11.67	9.30	0.000	18.46
135-PM-30C	Single-Cage 2					3.83	10.29	365.20	1.52	1.23	11.67	9.30	0.000	18.46
145-PM-01A	Single-Cage 2					3.83	10.29	365.20	1.52	1.23	11.67	9.30	0.000	18.46
145-PM-01B	Single-Cage 2					3.83	10.29	365.20	1.52	1.23	11.67	9.30	0.000	18.46
339-CM-03A	Single-Cage 2					3.83	10.29	365.20	1.52	1.23	11.67	9.30	0.000	18.46
339-CM-03B	Single-Cage 2					3.83	10.29	365.20	1.52	1.23	11.67	9.30	0.000	18.46
381-PM-01A	Single-Cage 2					3.83	10.29	365.20	1.52	1.23	11.67	9.30	0.000	18.46
381-PM-01B	Single-Cage 2					3.83	10.29	365.20	1.52	1.23	11.67	9.30	0.000	18.46
381-PM-01C	Single-Cage 2					3.83	10.29	365.20	1.52	1.23	11.67	9.30	0.000	18.46
381-PM-01D	Single-Cage 2					3.83	10.29	365.20	1.52	1.23	11.67	9.30	0.000	18.46

Induction Machine	Motor			Coupling			Load			Equivalent Total		
ID	RPM	WR^2	H	RPM	WR^2	H	RPM	WR^2	H	RPM	WR^2	H
135-PM-30A	1500	14.96	0.982	1500	0	0.000	1500	0	0.000	1500	14.96	0.982
135-PM-30B	1500	14.96	0.982	1500	0	0.000	1500	0	0.000	1500	14.96	0.982
135-PM-30C	1500	14.96	0.982	1500	0	0.000	1500	0	0.000	1500	14.96	0.982
145-PM-01A	1500	2.52	0.146	1500	0	0.000	1500	0	0.000	1500	2.52	0.146
145-PM-01B	1500	35.17	2.000	1500	0	0.000	1500	0	0.000	1500	35.17	2.000
339-CM-03A	1000	20.05	0.193	1500	0	0.000	1500	0	0.000	1000	20.05	0.193

Induction Machine	Motor			Coupling			Load			Equivalent Total		
ID	RPM	WR²	H	RPM	WR²	H	RPM	WR²	H	RPM	WR²	H
339-CM-03B	1000	20.05	0.193	1500	0	0.000	1500	0	0.000	1000	20.05	0.193
381-PM-01A	1500	42.41	0.982	1500	0	0.000	1500	0	0.000	1500	42.41	0.982
381-PM-01B	1500	42.41	0.982	1500	0	0.000	1500	0	0.000	1500	42.41	0.982
381-PM-01C	1500	42.41	0.982	1500	0	0.000	1500	0	0.000	1500	42.41	0.982
381-PM-01D	1500	42.41	0.982	1500	0	0.000	1500	0	0.000	1500	42.41	0.982

WR^2: kg-m²   H: MW-Sec/MVA

Induction Machine	Connected Bus	H	Load Torque (= A0 + A1 ω + A2 ω² + A3 ω³)					Grounding		
ID	ID	(MW-Sec/MVA)	Model ID	A0	A1	A2	A3	Conn.	Type	Amp
135-PM-30A	Bus57	0.982	Pump	10.0	-91.0	321.0	-147.0	Wye	Open	
135-PM-30B	Bus58	0.982	Pump	10.0	-91.0	321.0	-147.0	Wye	Open	
135-PM-30C	Bus59	0.982	Pump	10.0	-91.0	321.0	-147.0	Wye	Open	
145-PM-01A	Bus5	0.146	Pump	10.0	-91.0	321.0	-147.0	Wye	Open	
145-PM-01B	Bus8	2.000	Pump	10.0	-91.0	321.0	-147.0	Wye	Open	
339-CM-03A	Bus52	0.193	Centr. Comp	10.0	-91.0	328.0	-147.0	Wye	Open	
339-CM-03B	Bus54	0.193	Centr. Comp	10.0	-91.0	328.0	-147.0	Wye	Open	
381-PM-01A	Bus49	0.982	Pump	10.0	-91.0	321.0	-147.0	Wye	Open	
381-PM-01B	Bus51	0.982	Pump	10.0	-91.0	321.0	-147.0	Wye	Open	
381-PM-01C	Bus56	0.982	Pump	10.0	-91.0	321.0	-147.0	Wye	Open	
381-PM-01D	Bus55	0.982	Pump	10.0	-91.0	321.0	-147.0	Wye	Open	

Lumped Load Input Data

Conventional Type

ID	kV	kVA	kW	kvar	% PF	Amp	Load % Motor	Load % Static	Ta	Gamma
160ES13	0.400	30	25	16	85	43.2	20	80	0	0
160ES21A	0.400	395	347	189	87.820	570.3	93	7	0	0
160ES21B	0.400	618	535	310	86.520	892.5	90	10	0	0
161ES21	0.400	296	251	156	85	427.0	92	8	0	0
161ES22	0.400	85	74	42	87	122.0	97	3	0	0
360ES02A	0.400	249	210	133	84.480	358.8	90	10	0	0
360ES02B	0.400	133	113	70	85.040	191.8	80	20	0	0
360ES03A	0.400	114	94	63	83.140	163.9	91	9	0	0
360ES03B	0.400	278	221	168	79.610	400.7	92	8	0	0
360ES04A	0.400	84	75	39	88.400	121.6	96	4	0	0
360ES04B	0.400	78	70	36	88.790	113.0	95	5	0	0

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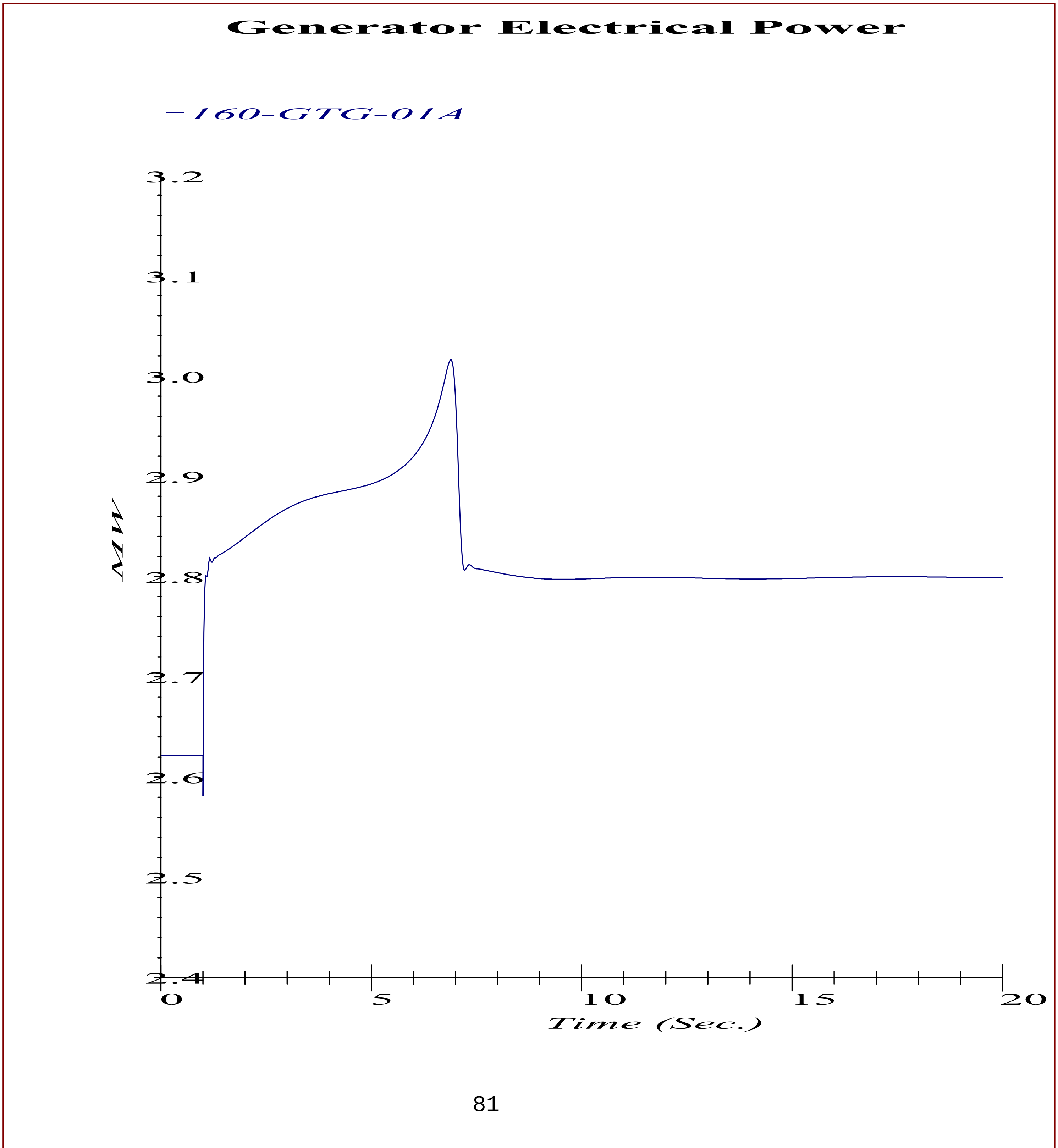

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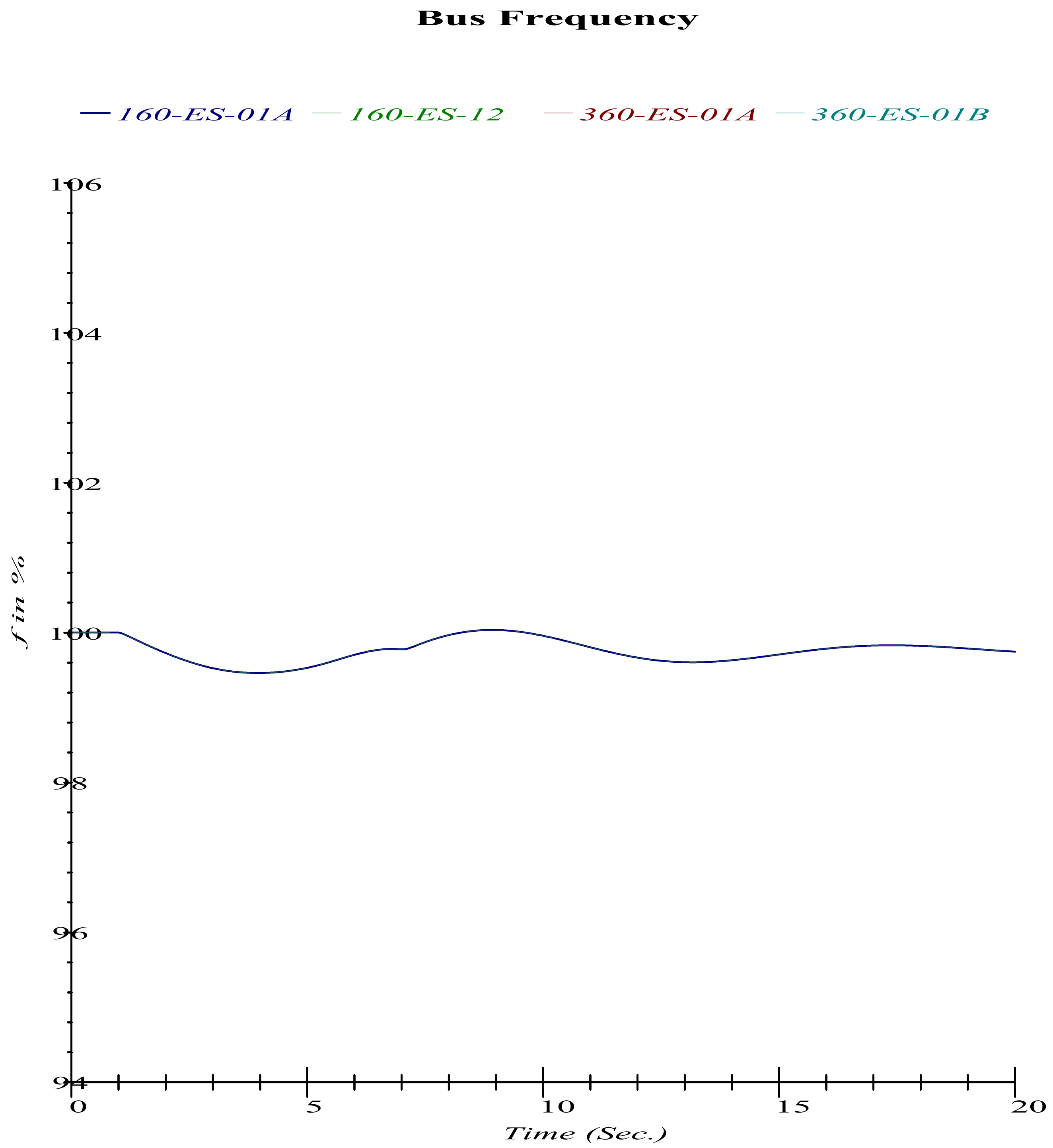

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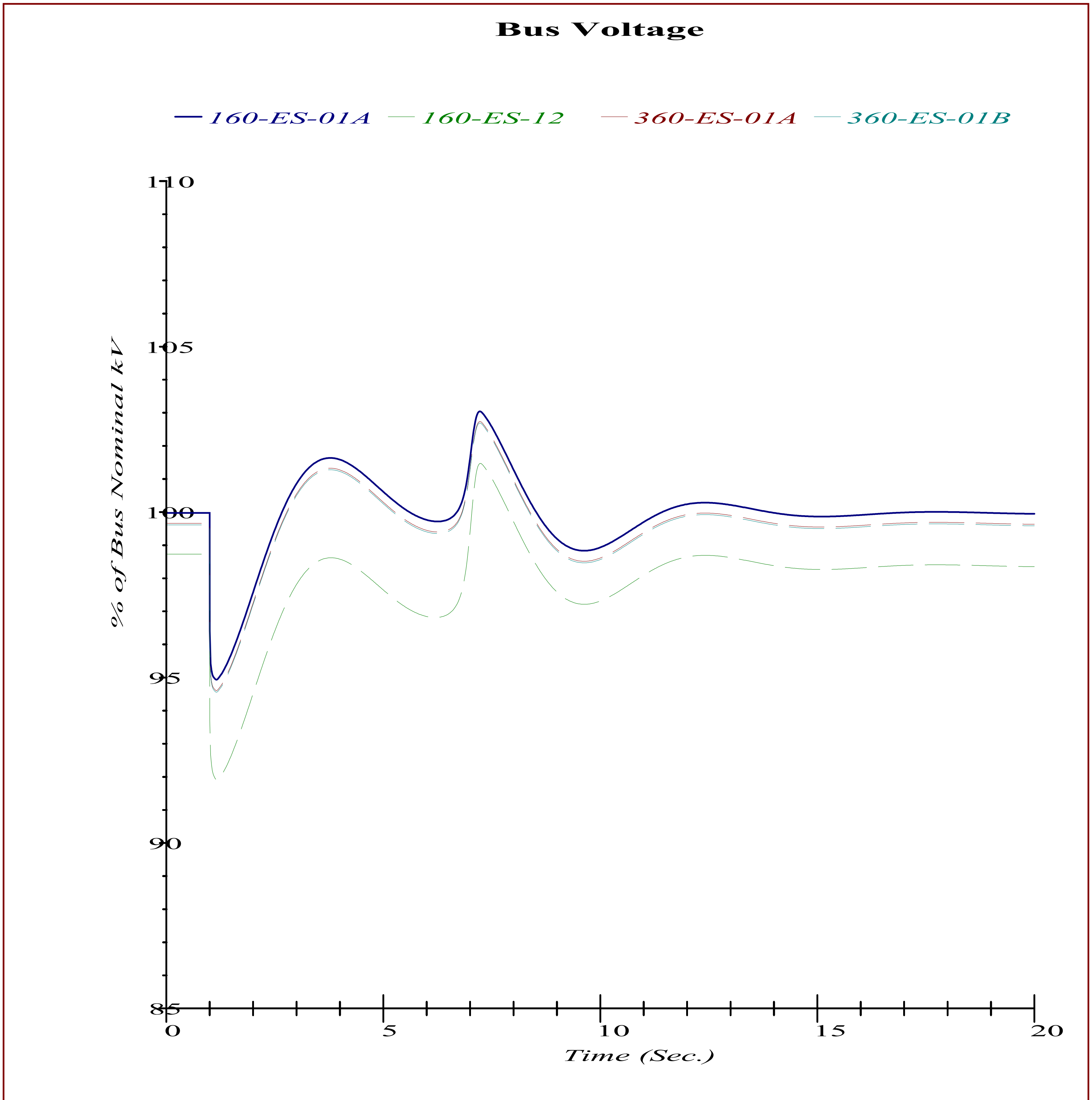

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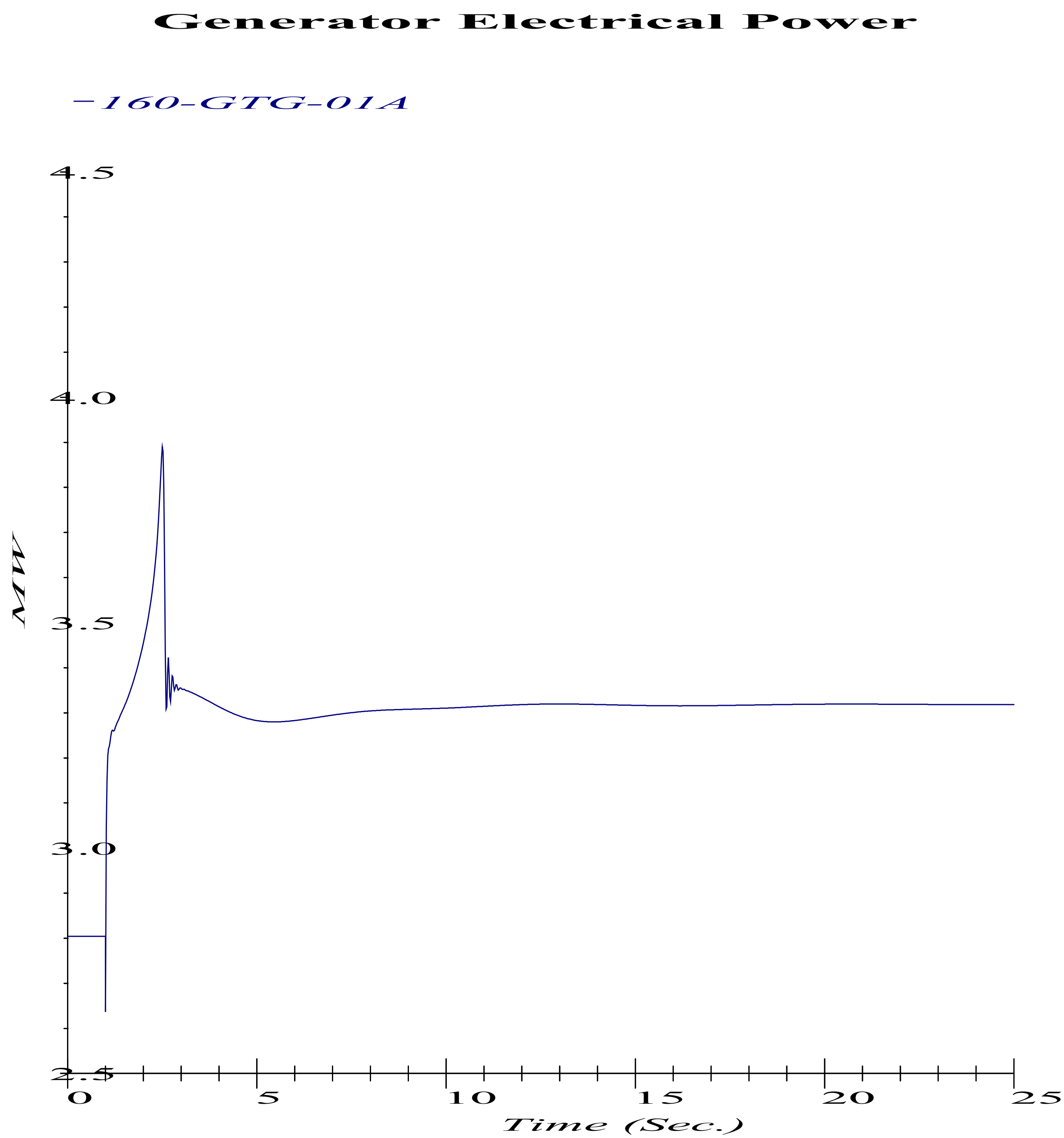

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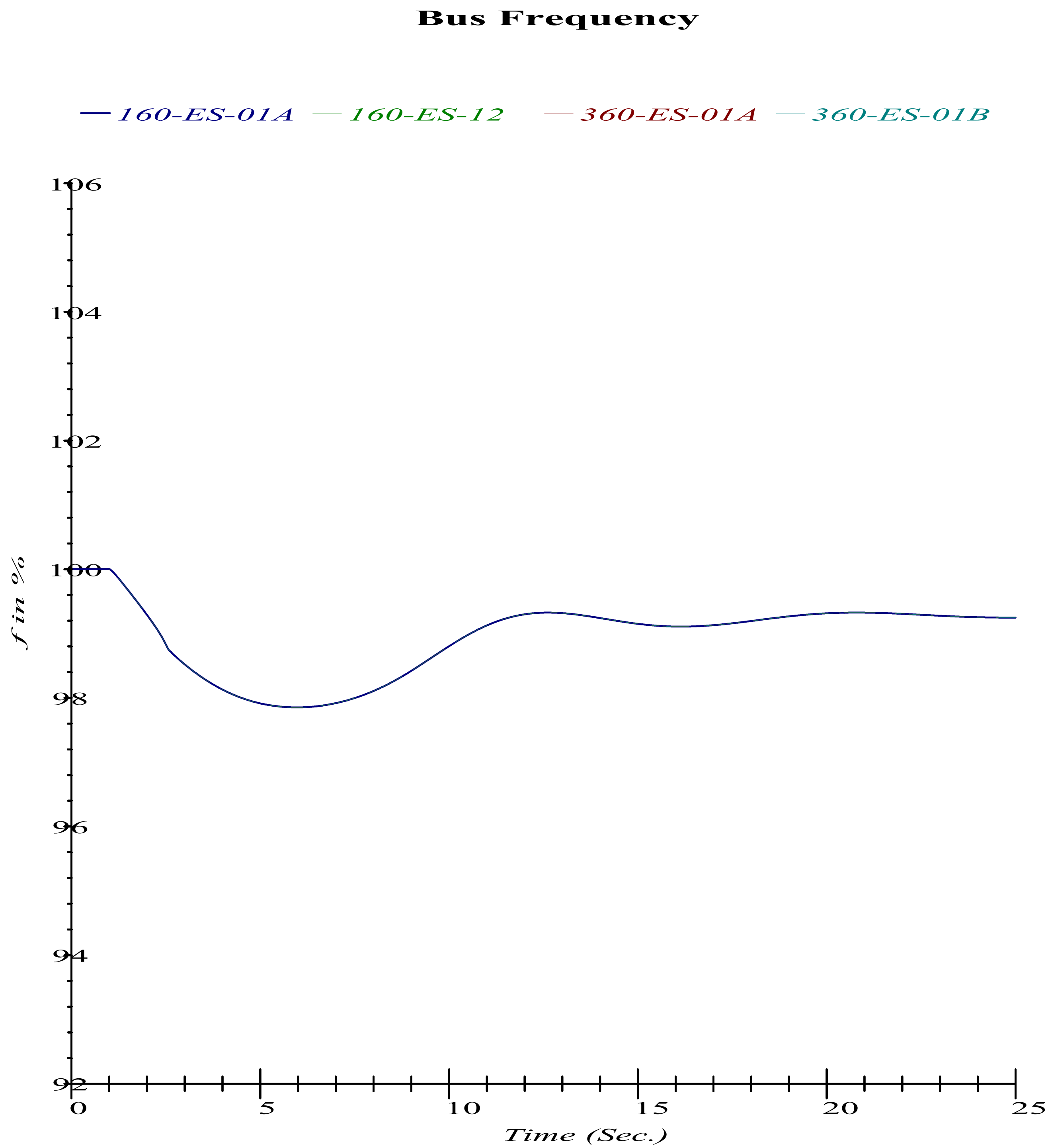

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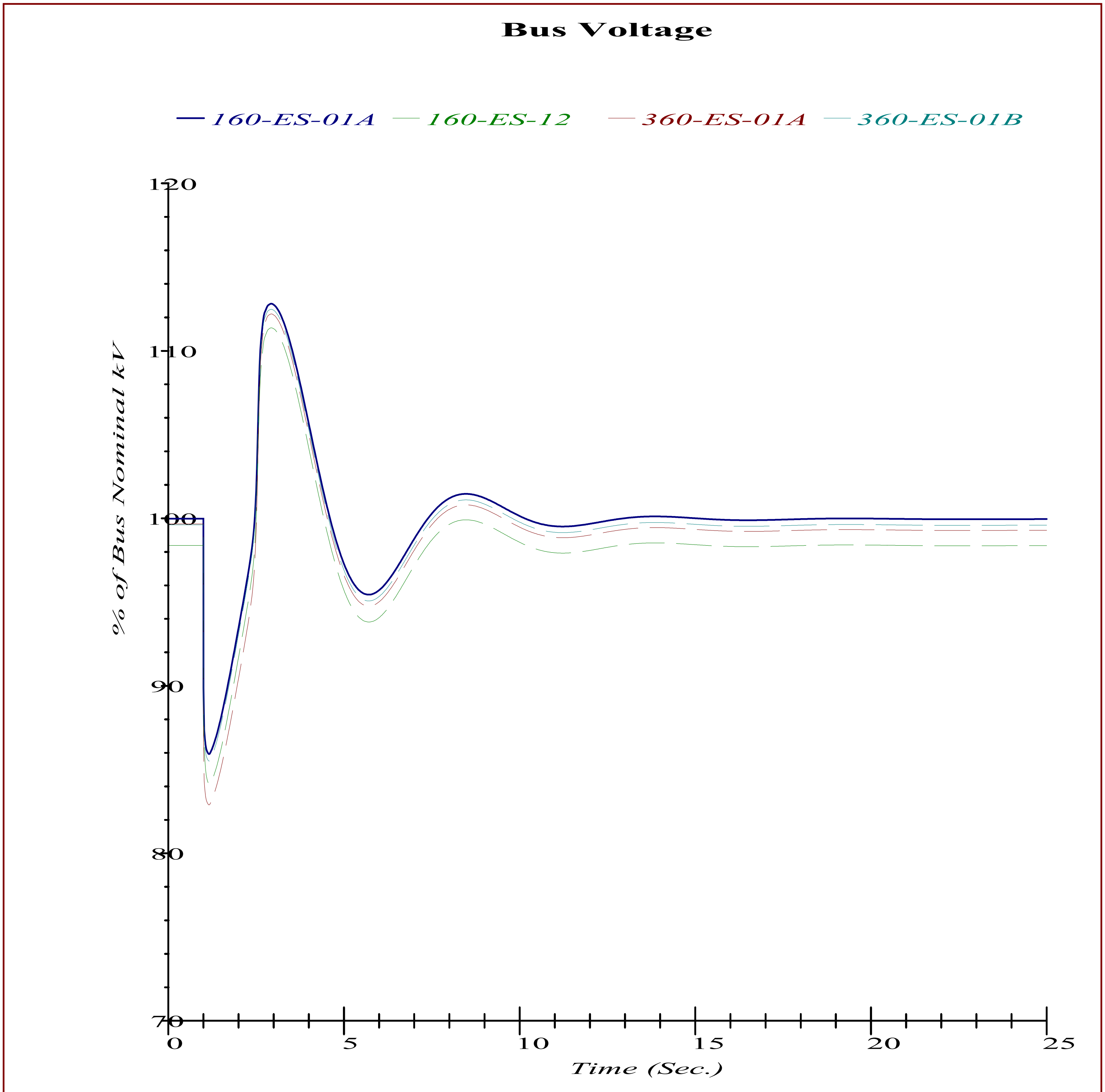

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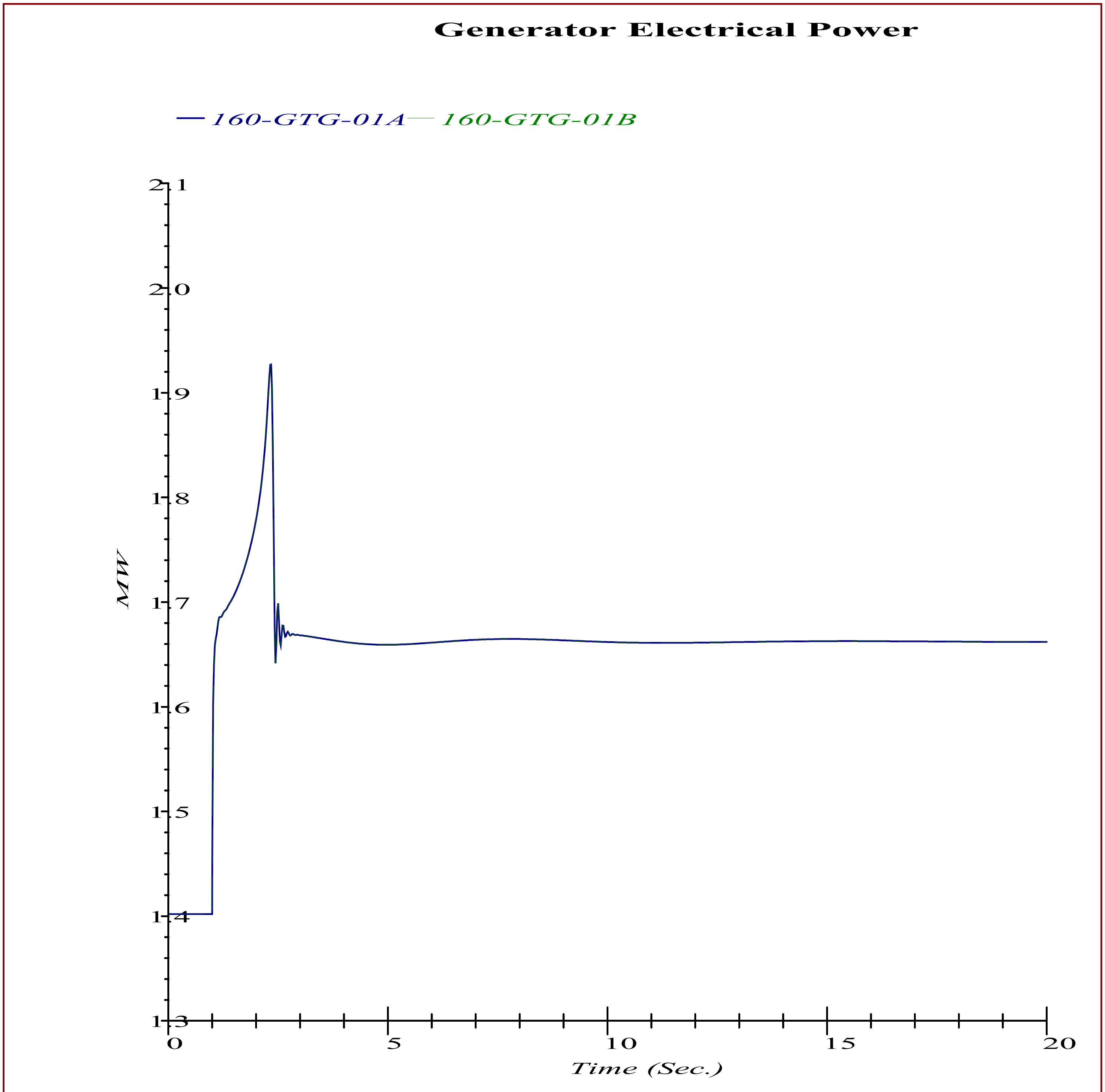

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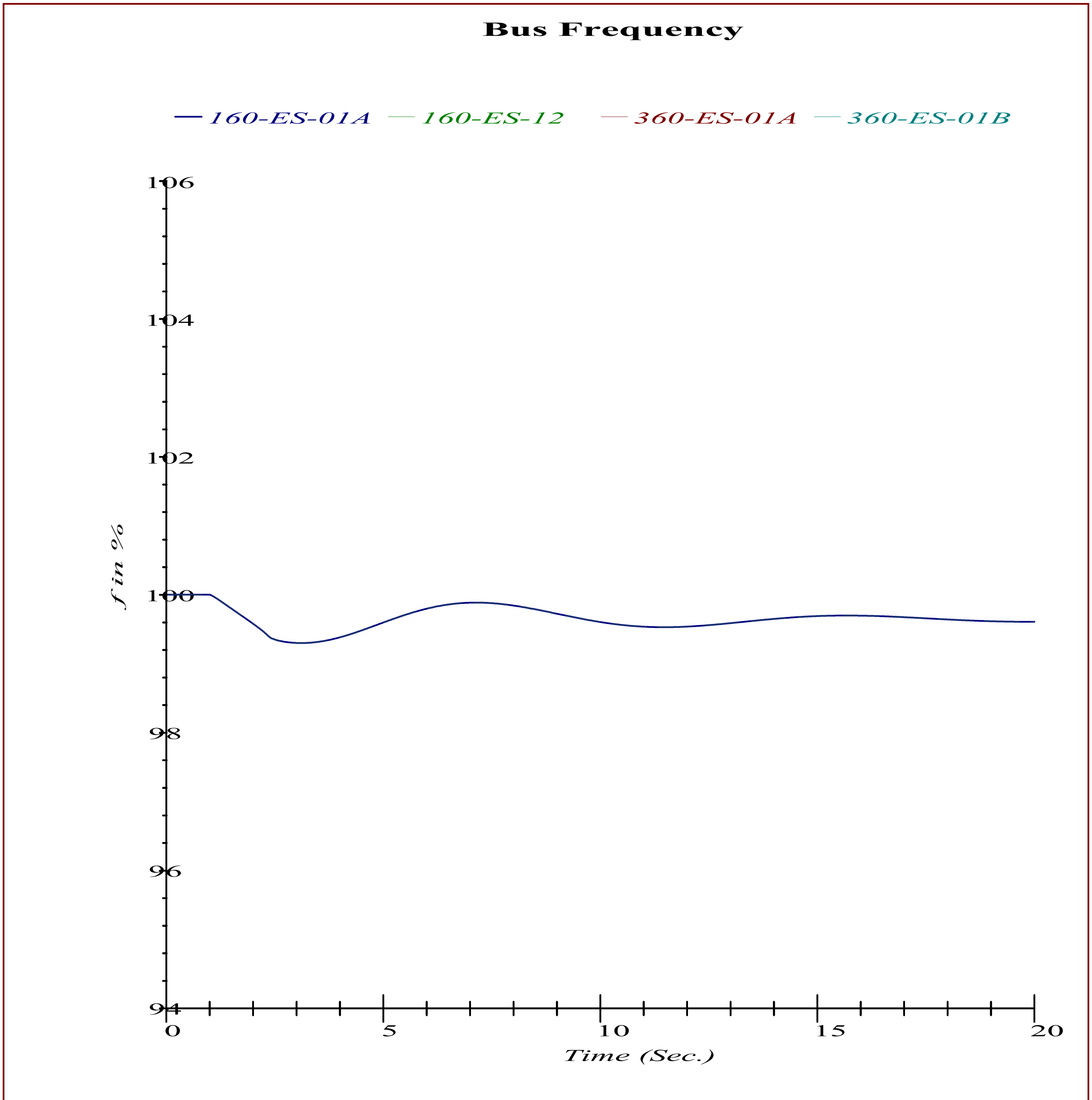

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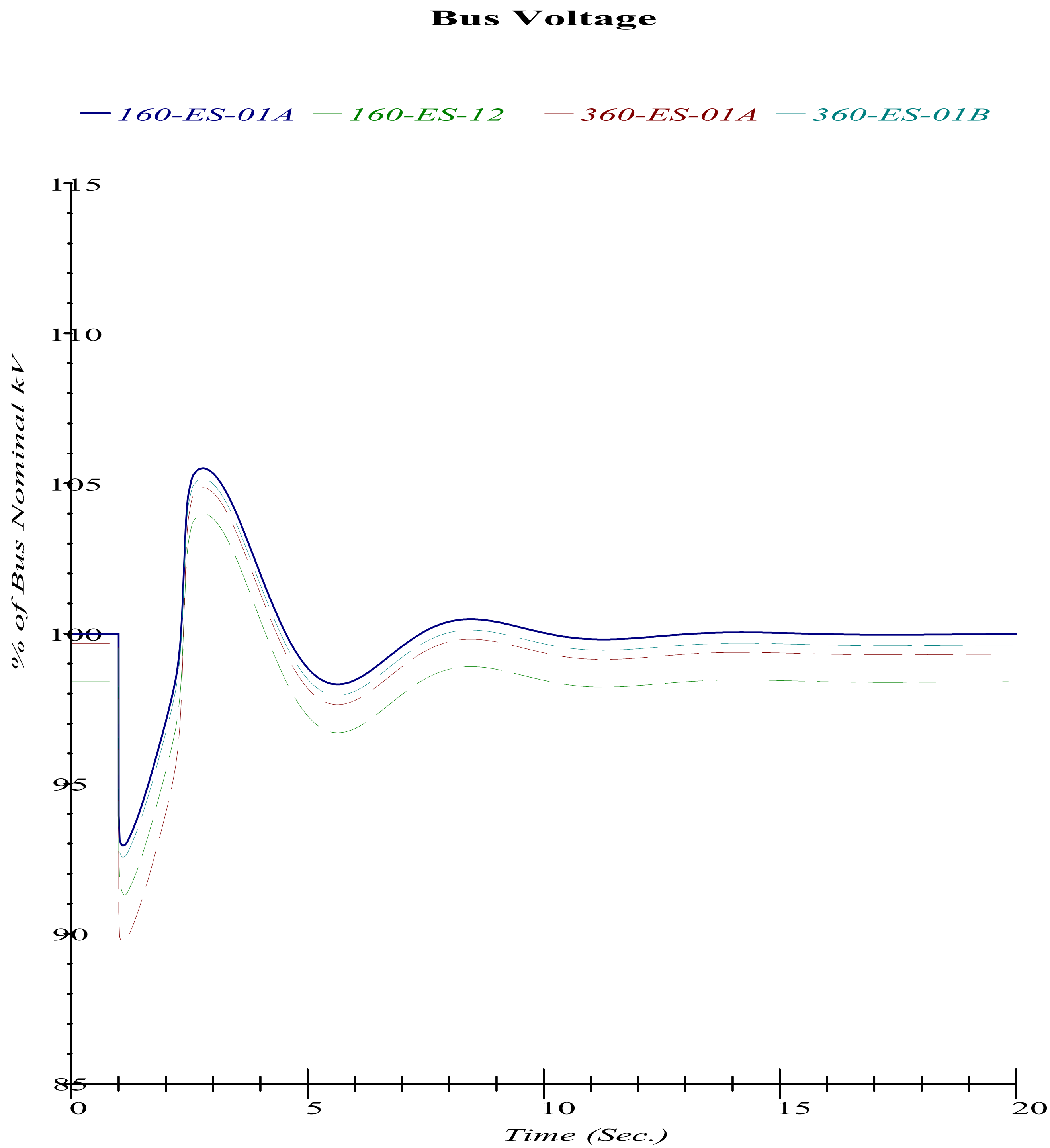

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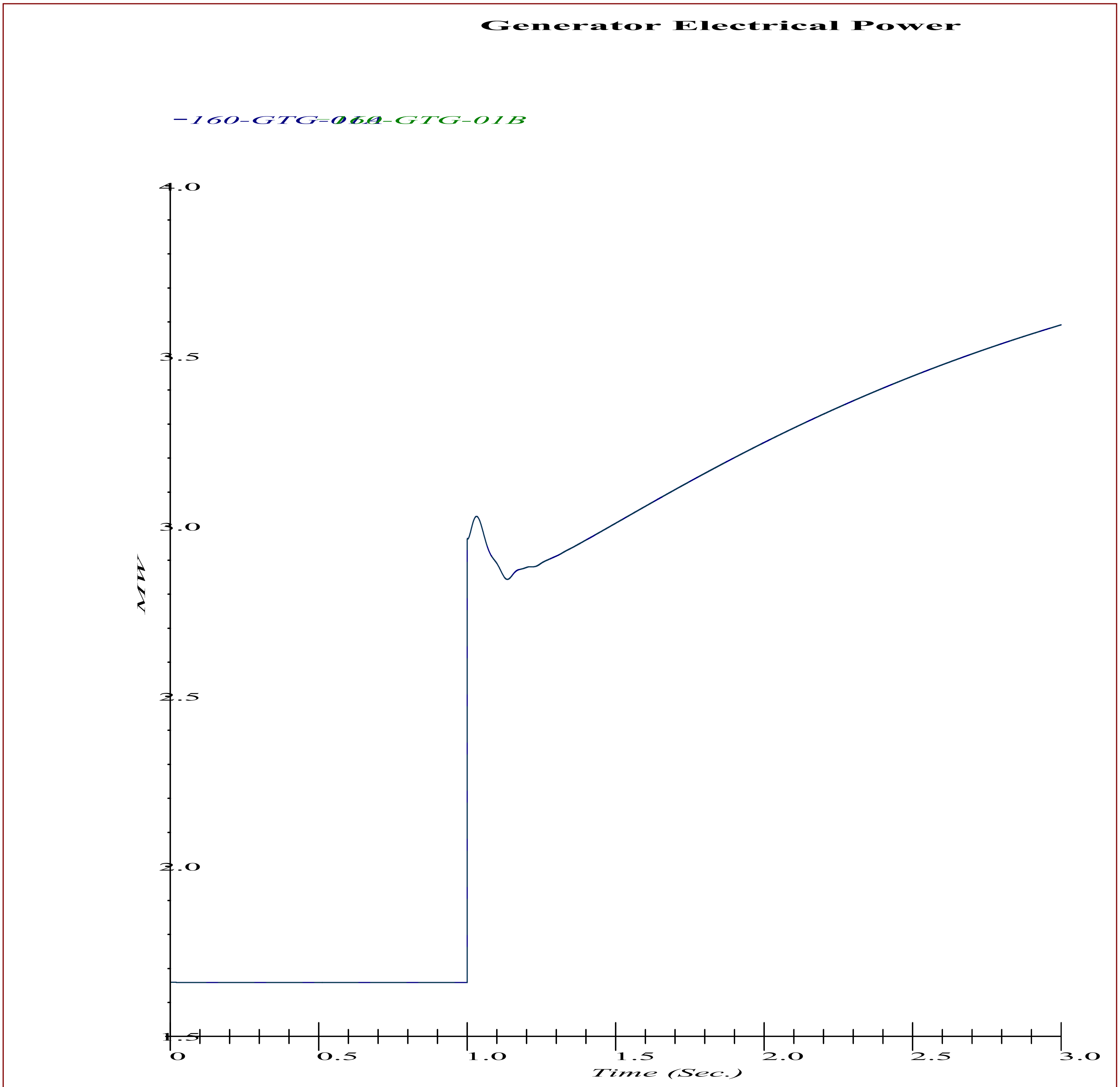

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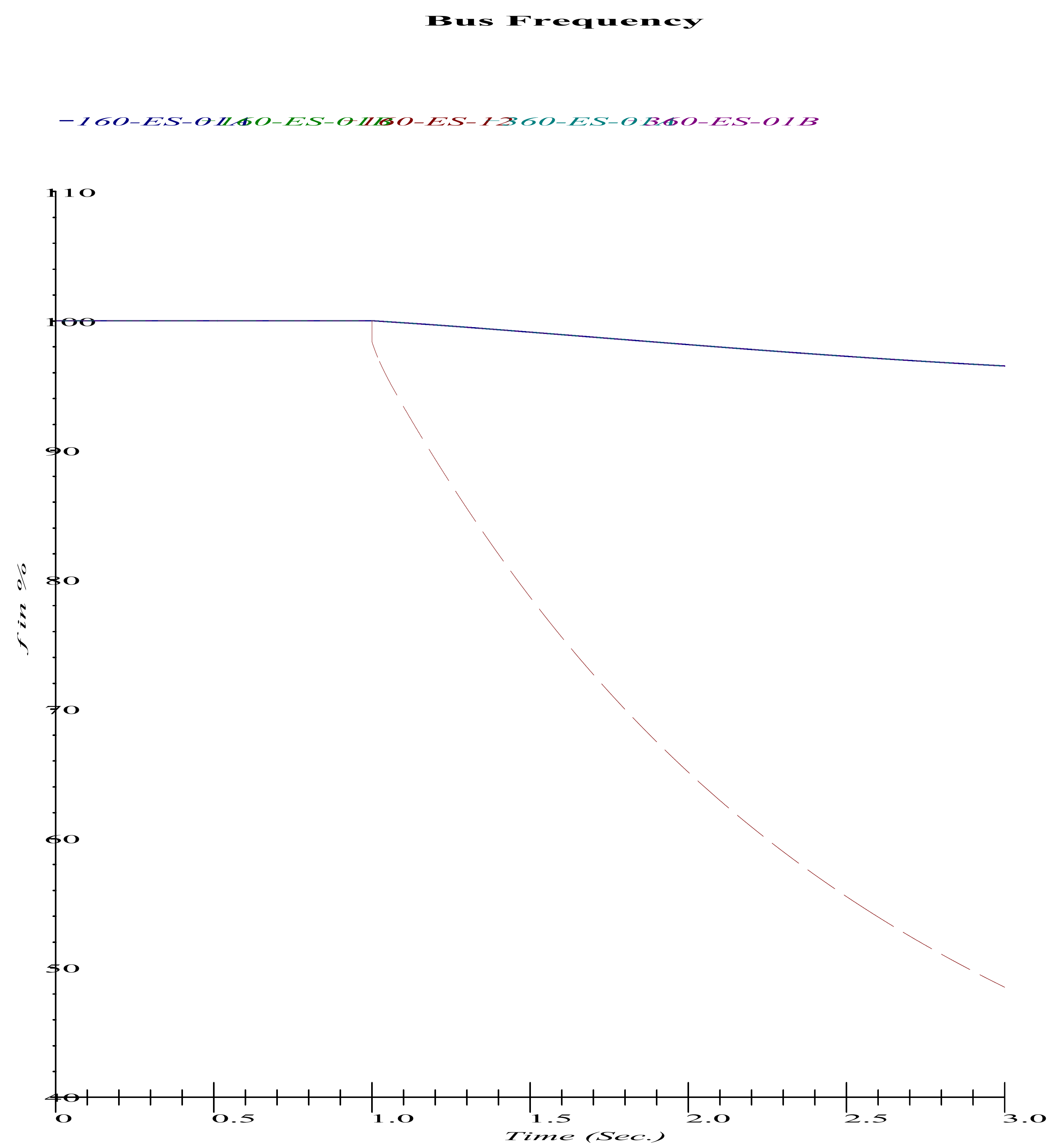

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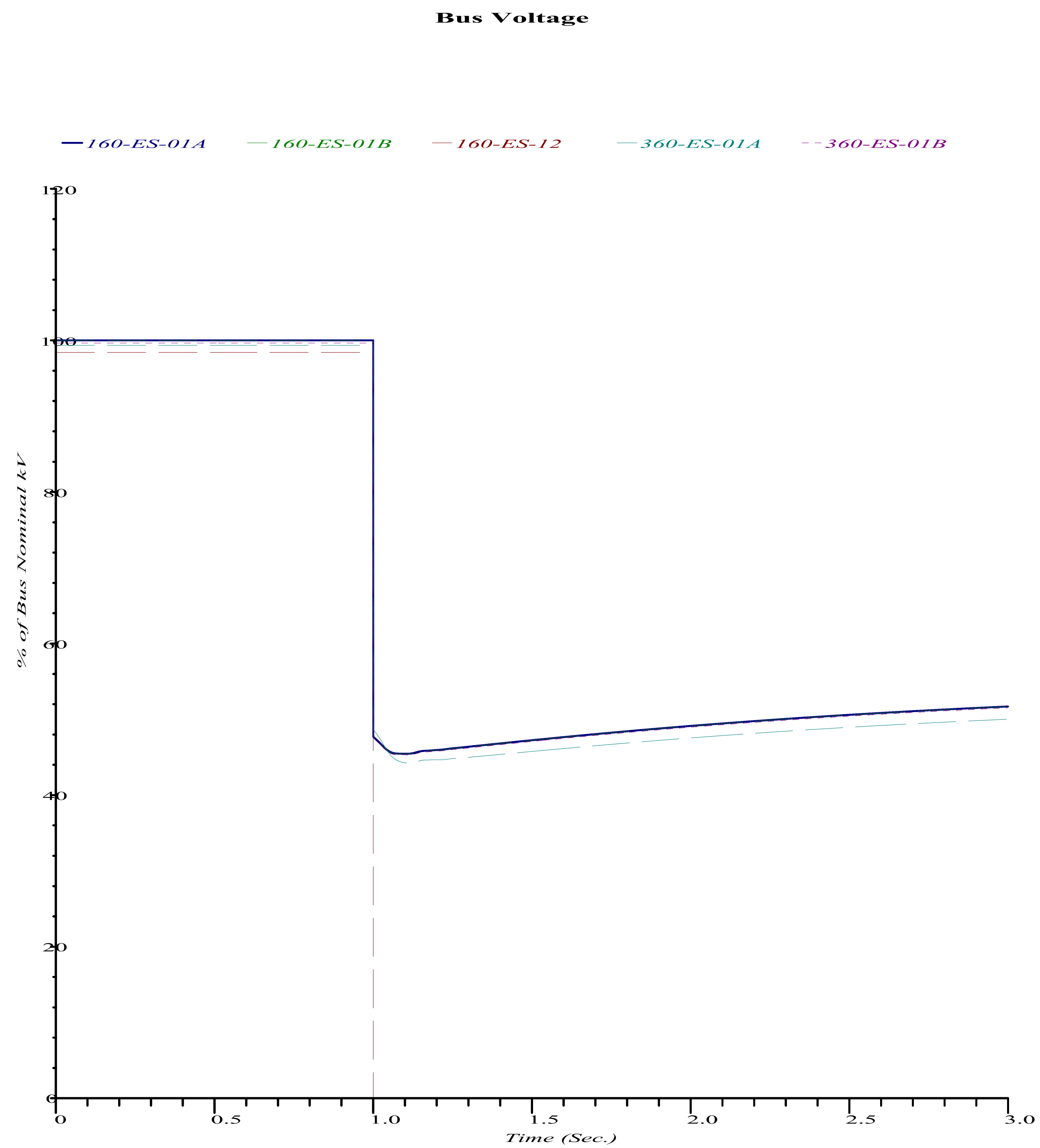

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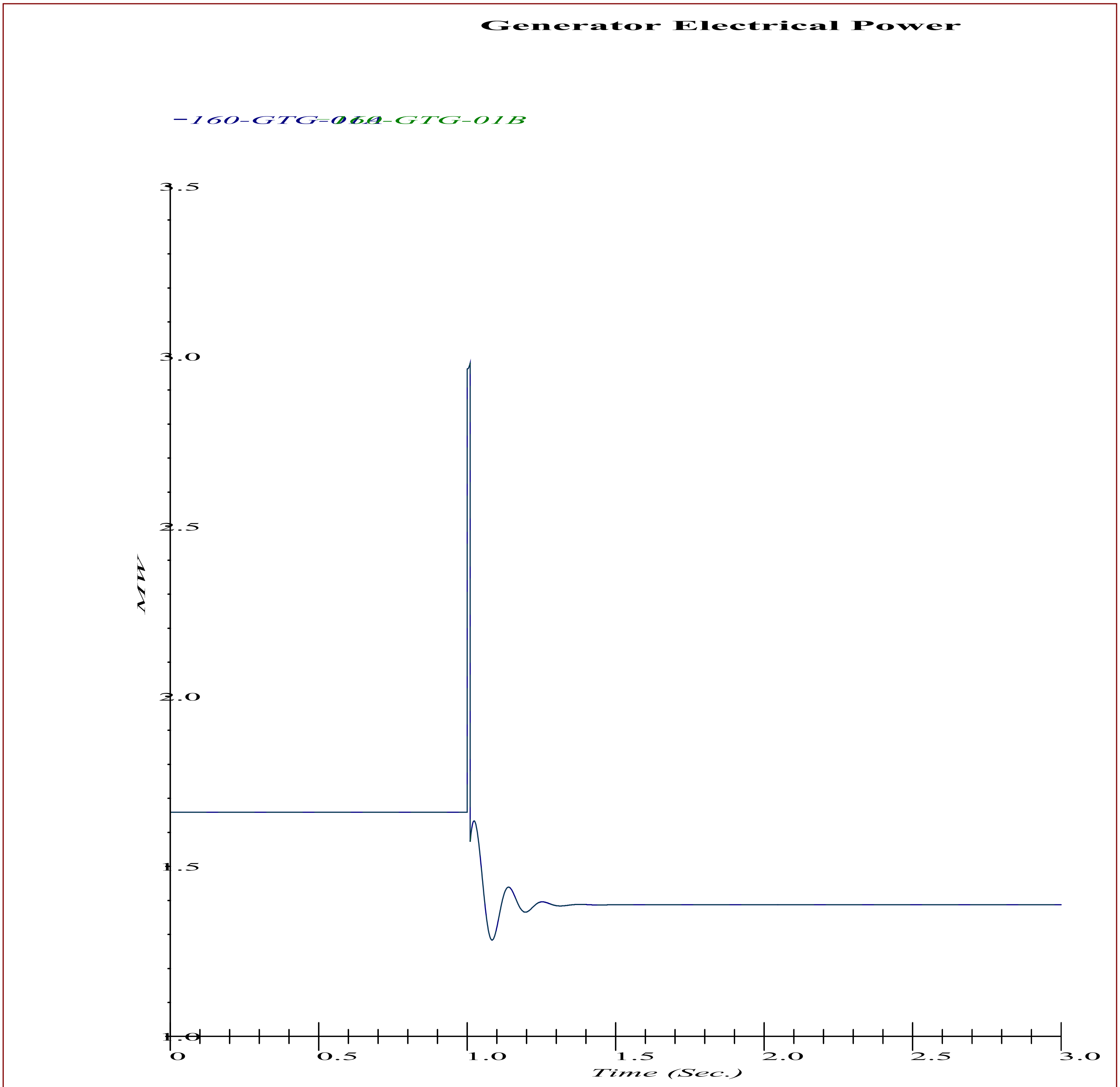

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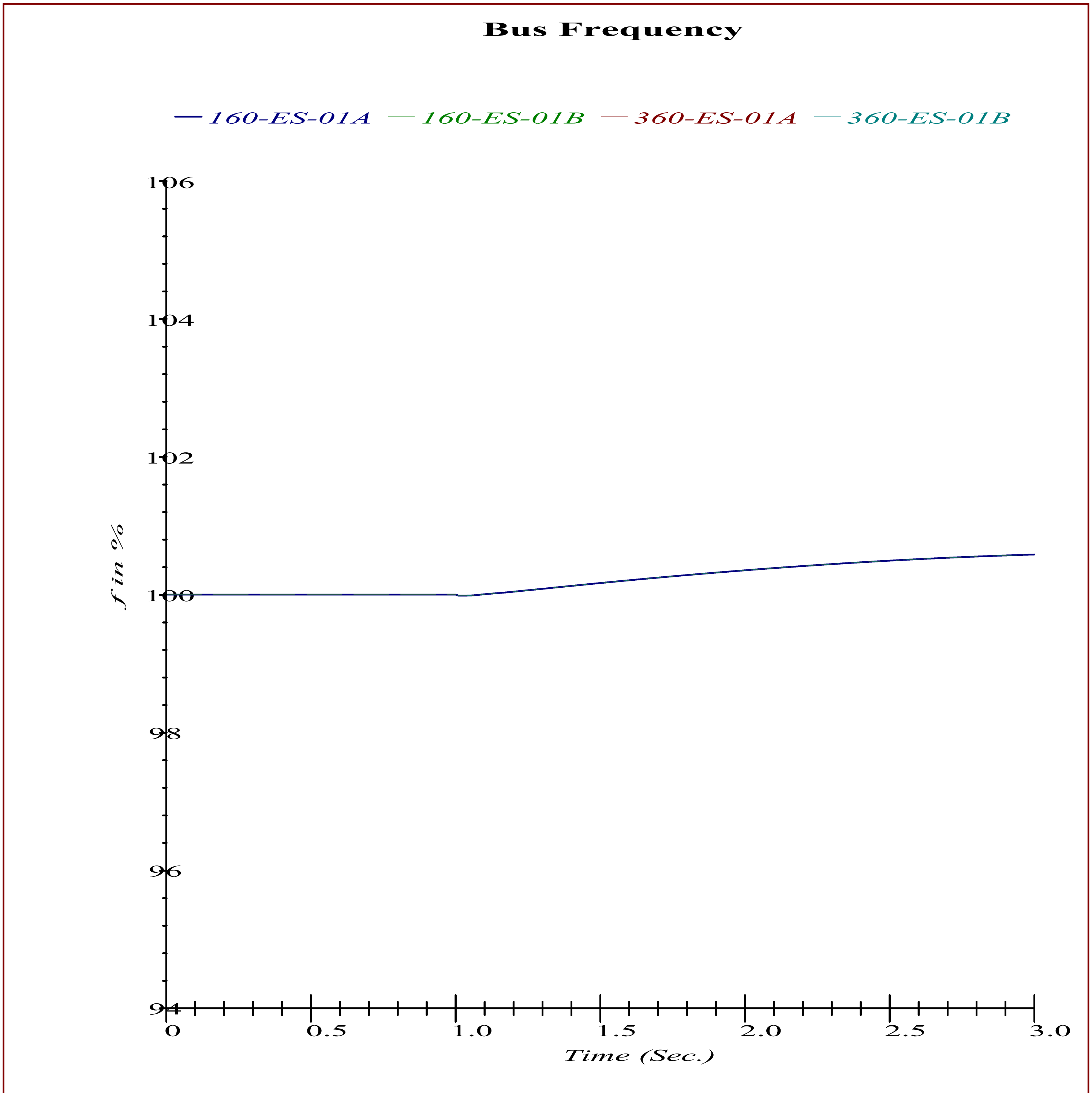

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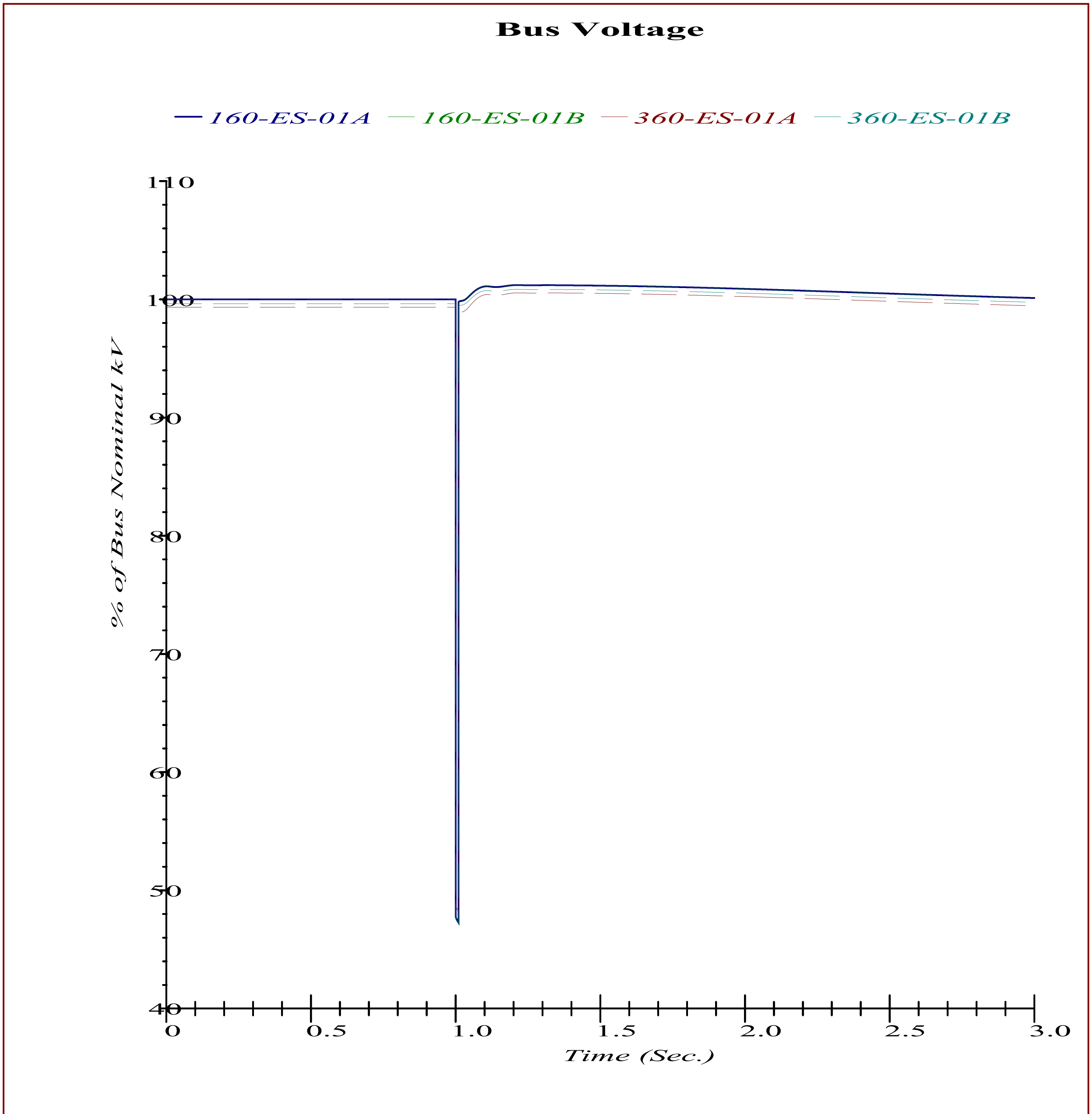

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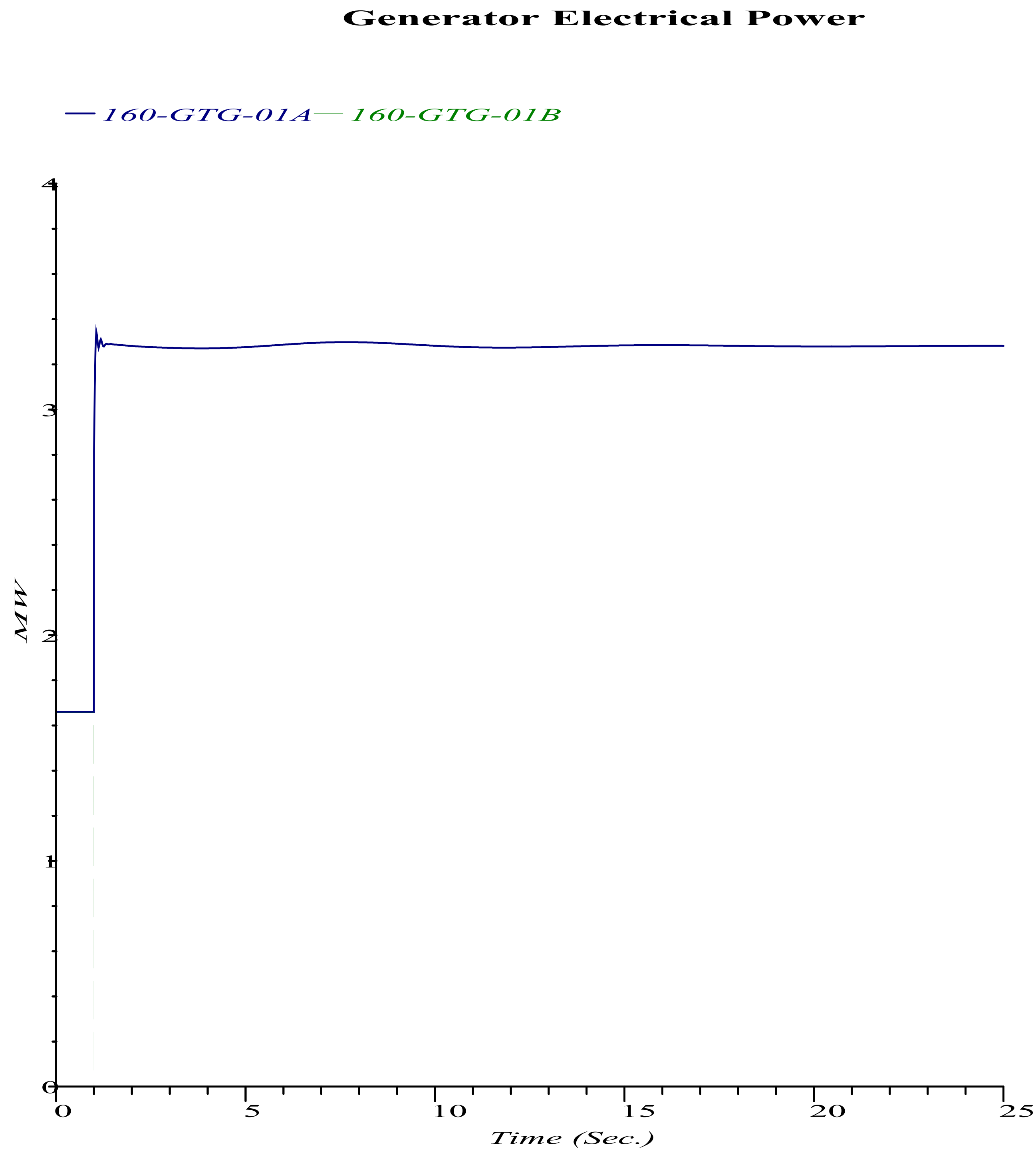

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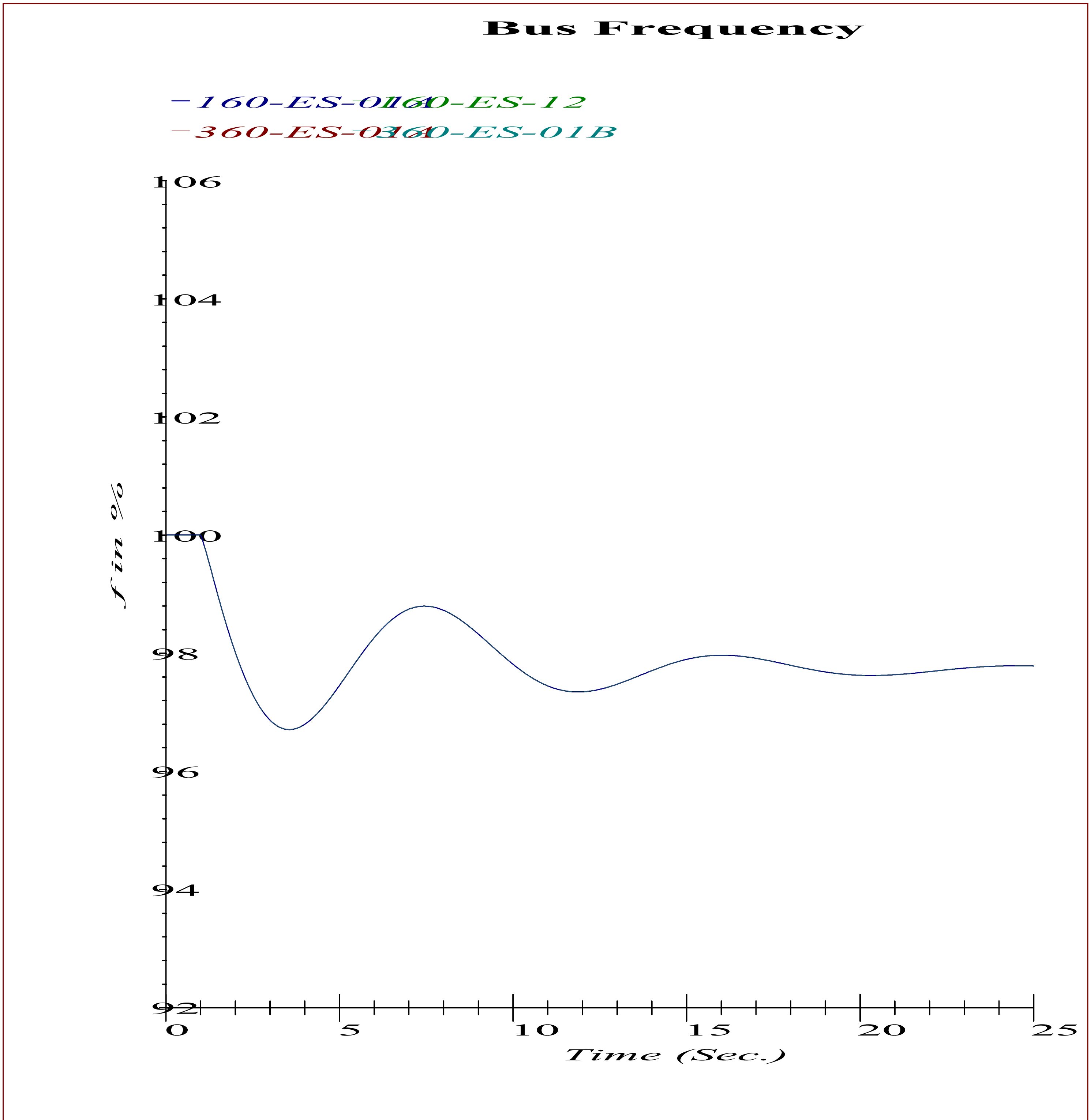

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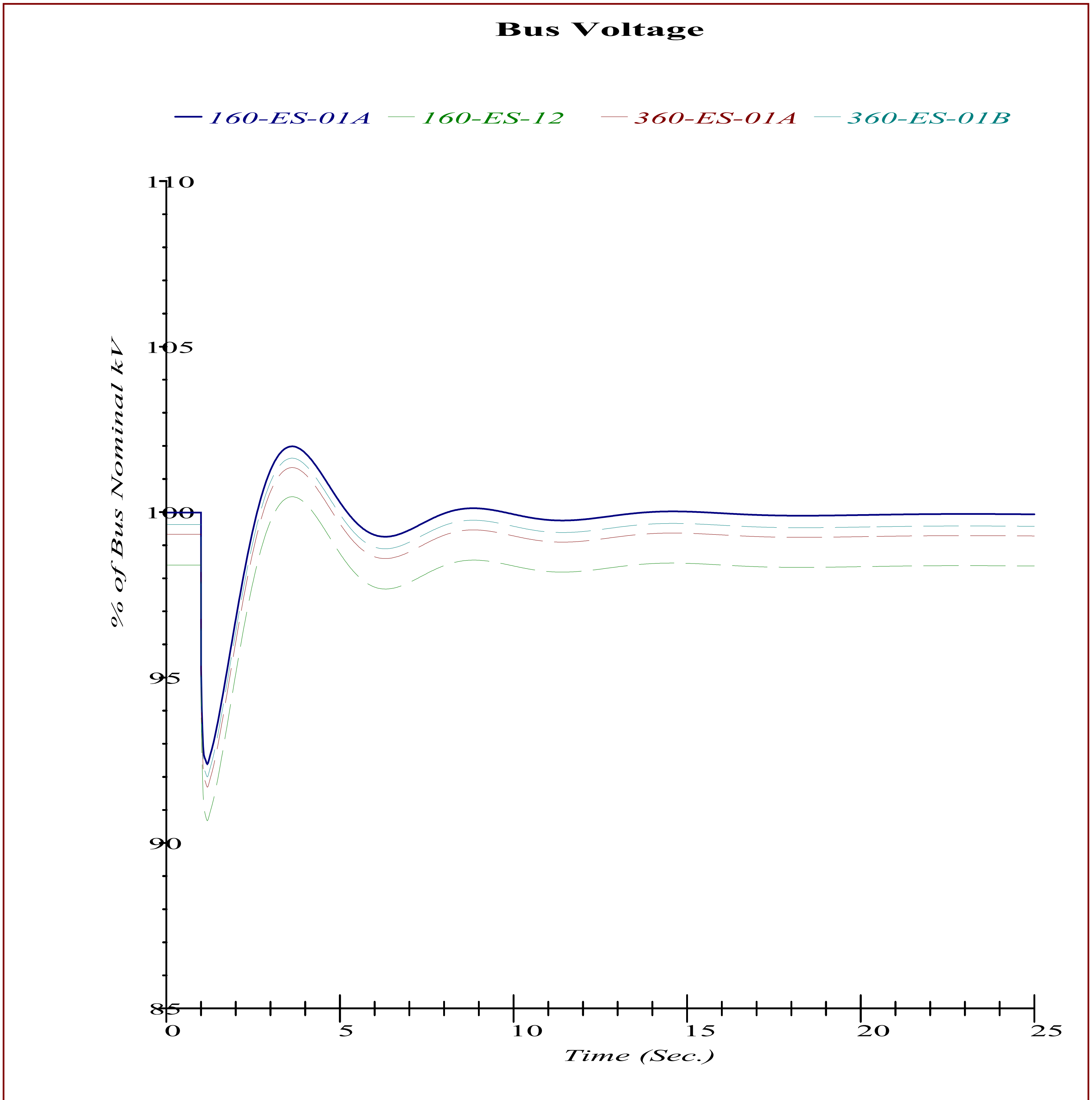

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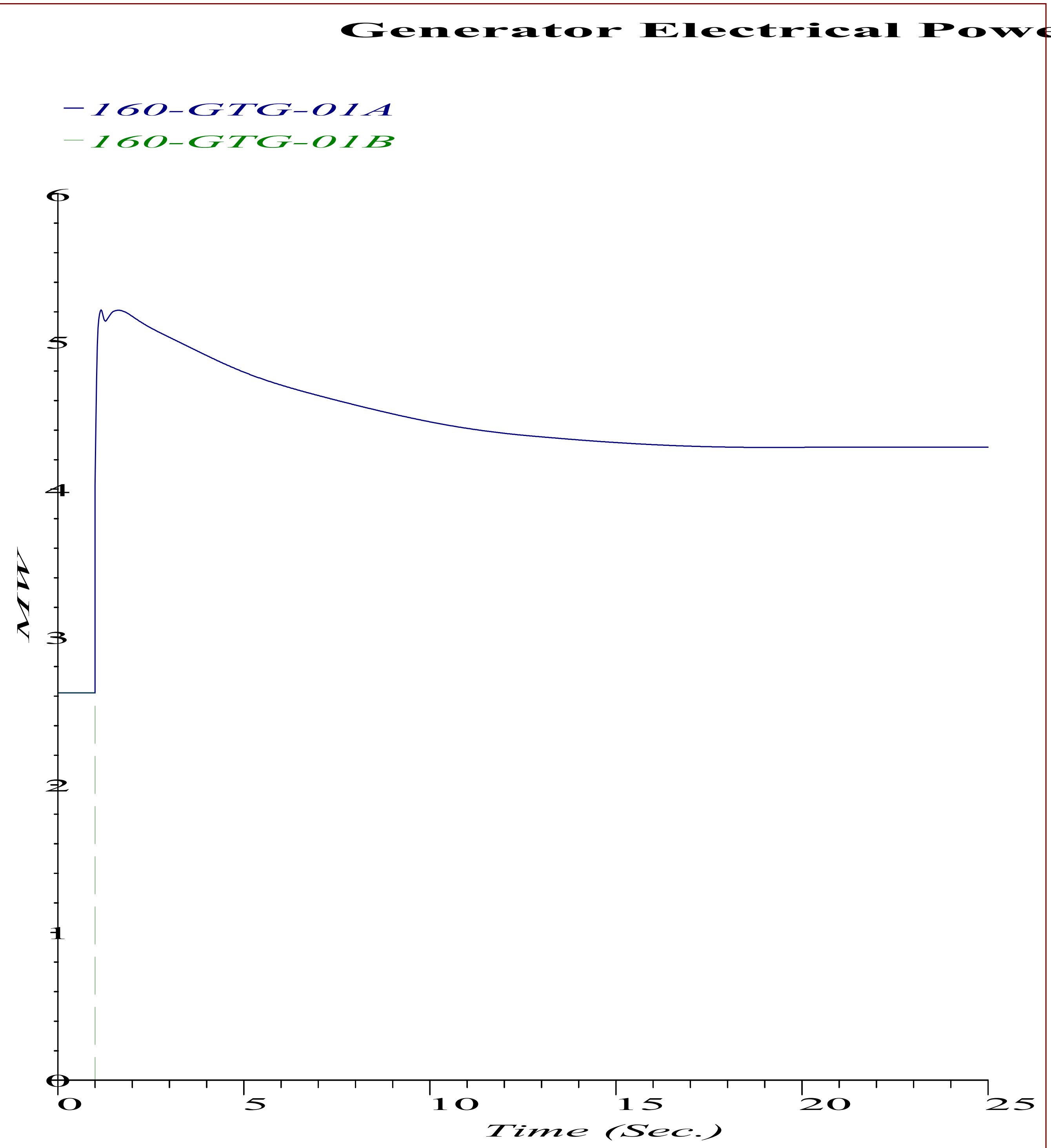

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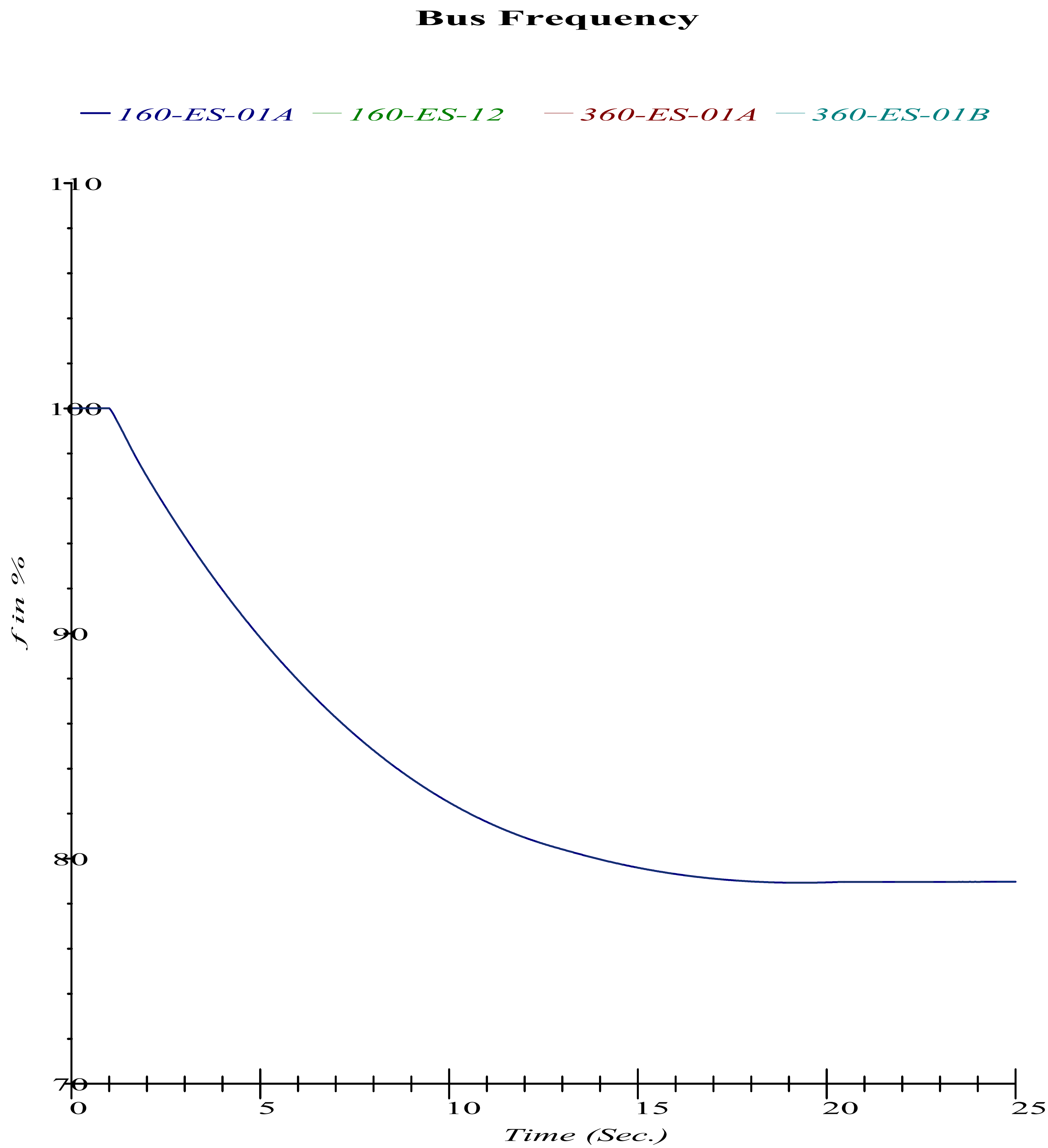

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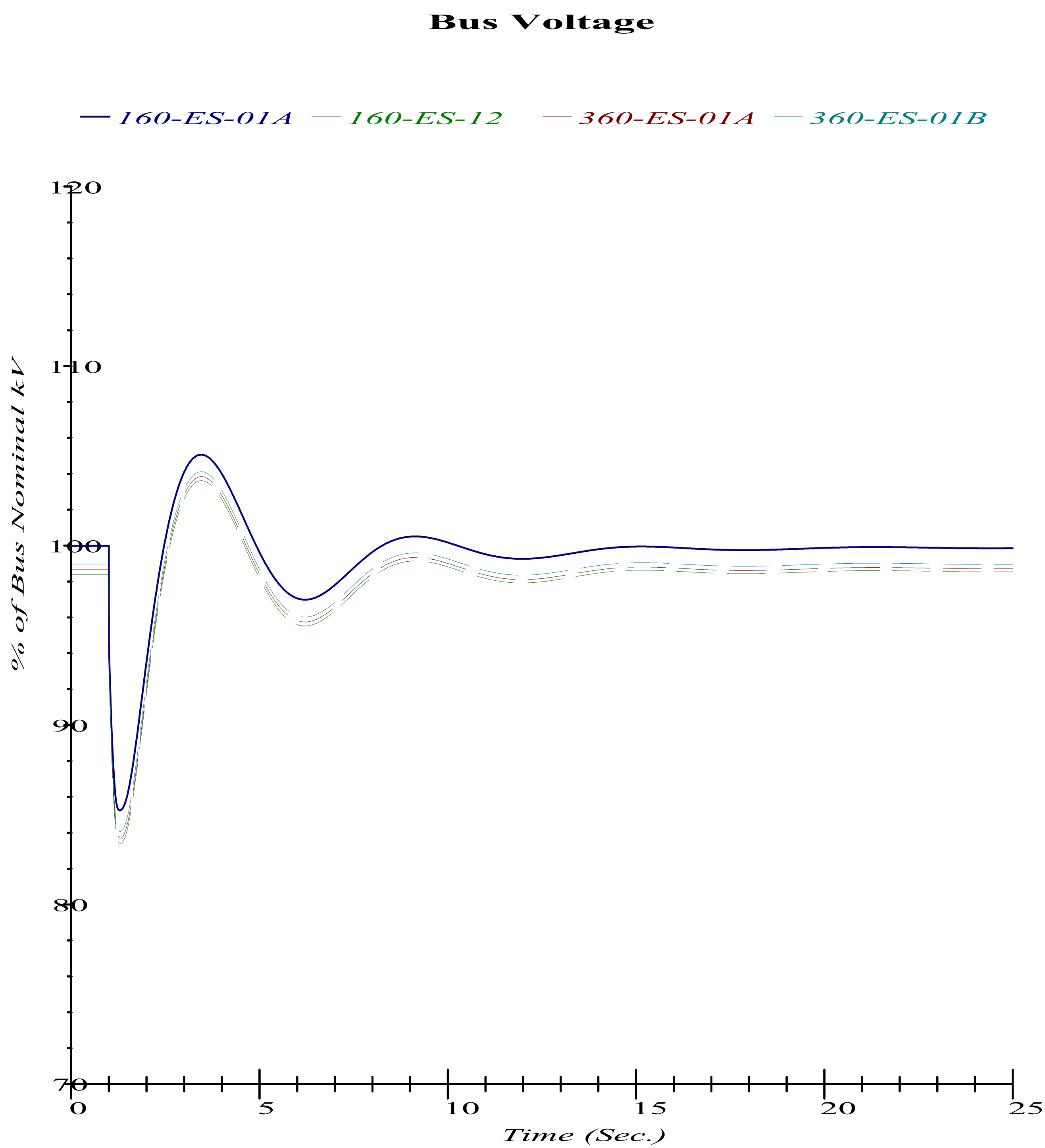

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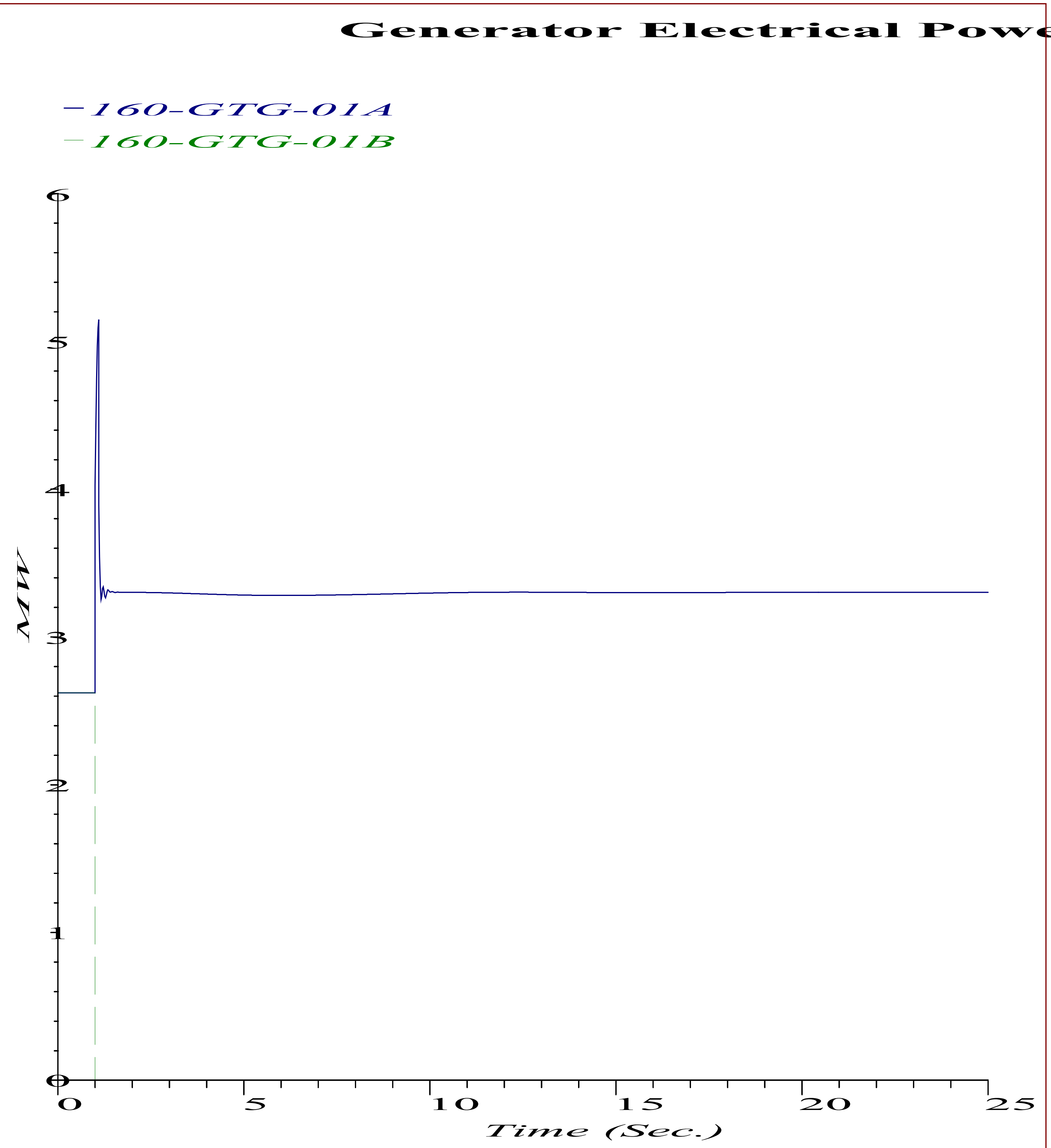

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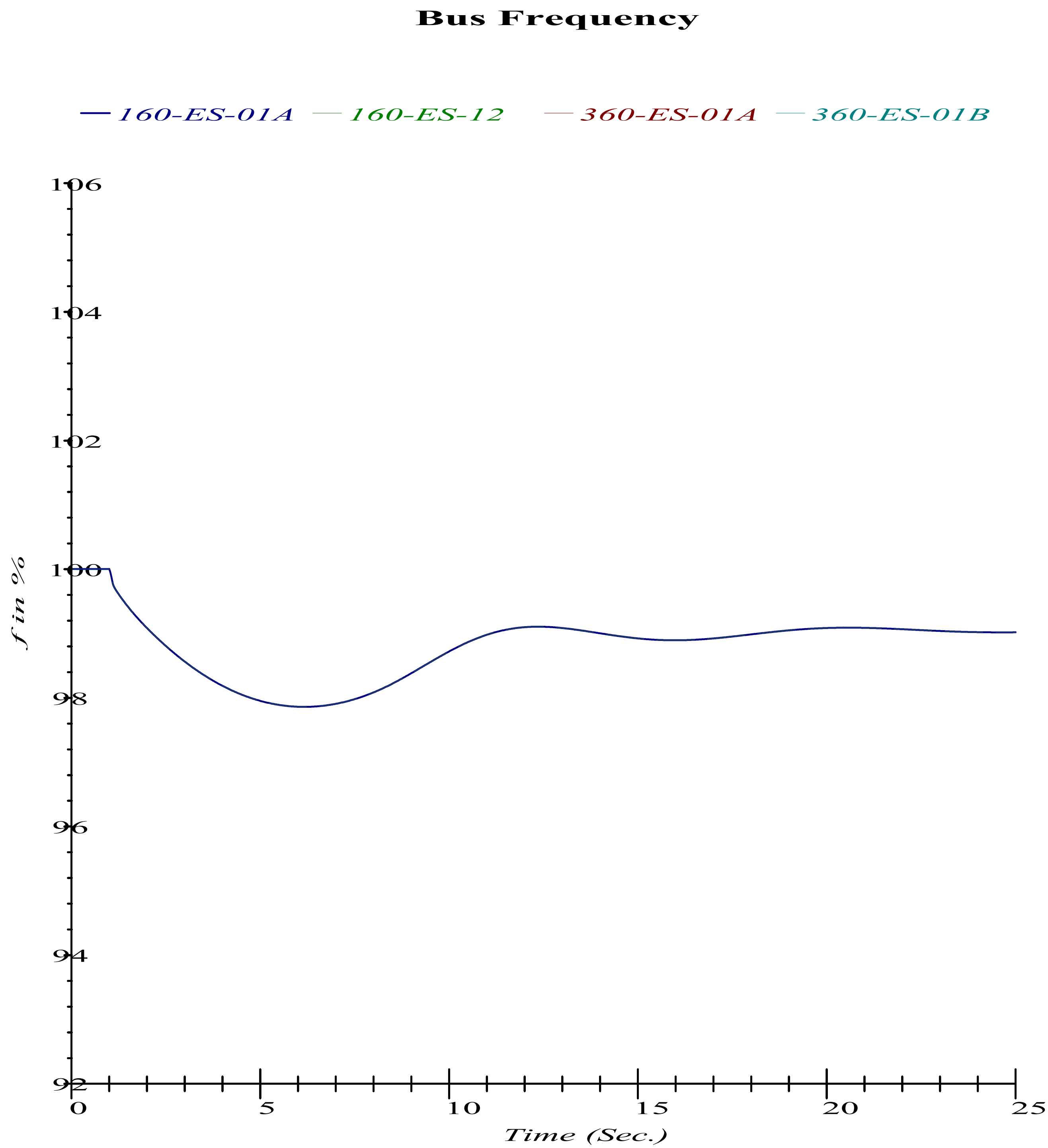

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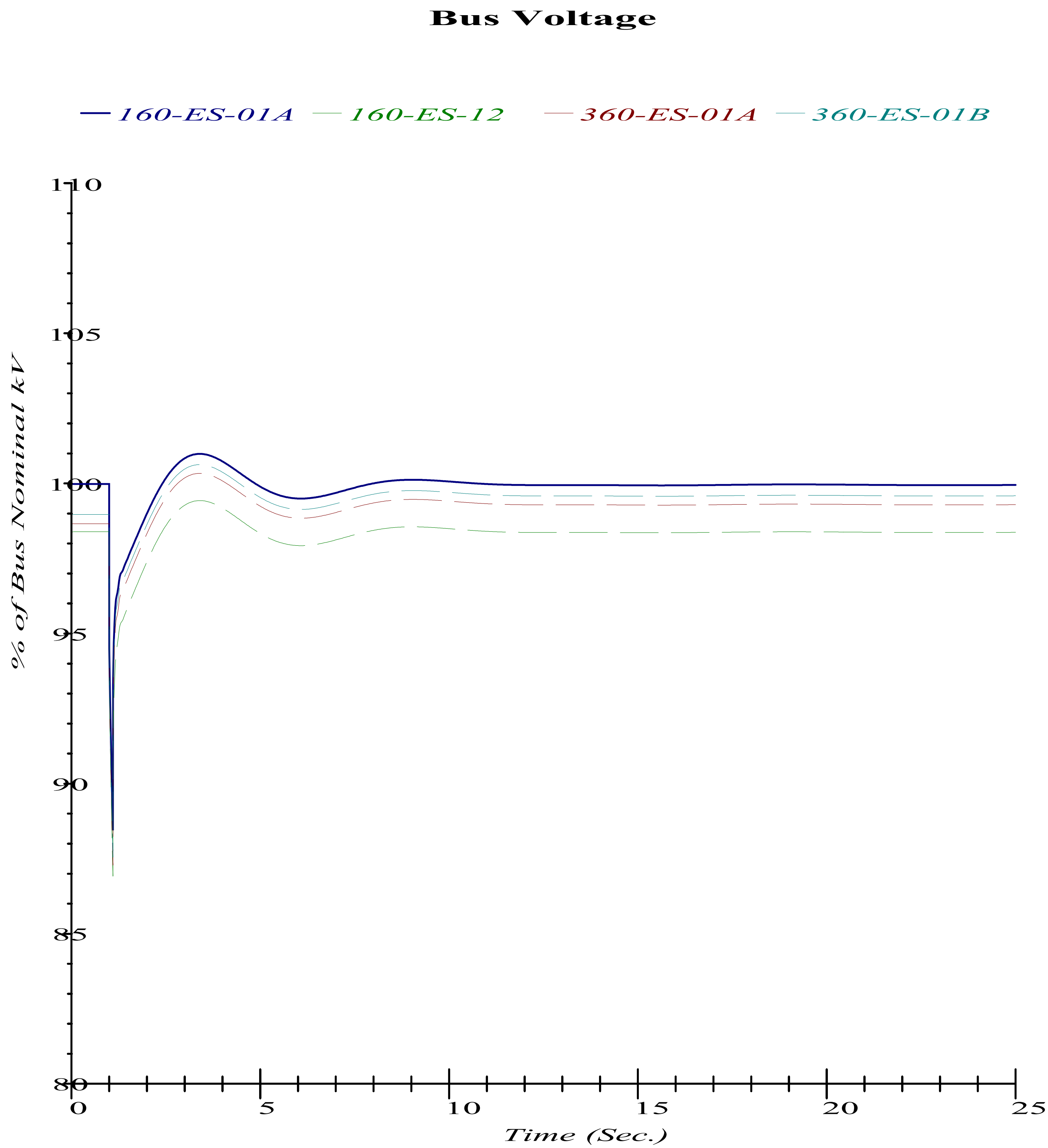

HESS (Indonesia - Pangkah) Limited	JOB NO. 9490	DOC. NO. UPD-TJ-P2-EL-PH-0101	REV. 0
PT. TRIPATRA Engineers & Constructors	SHEET : 1 of 23		
PHILOSOPHY	Onshore Oil Treating Facilities And LPG Recovery Plant Ujung Pangkah Liquid Development Project		

ELECTRICAL DESIGN PHILOSOPHY

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D	CLIENT BY	CLIENT DATE
0	10 Aug 07	Approved for Construction	REN	TRB	JOB	LDWS	21/8/07
D	07 May 07	Approved for Design	REN	TRB	JOB		
C	20 Mar 07	Issued for Approval	RIZ	TRB	REF		
A	26 Feb 07	TRIPATRA Internal Review	RIZ	TRB	REF		

1 INTRODUCTION

1.1 Project Description

Hess (Indonesia-Pangkah) Ltd. (HIPL), as operator, is developing the Ujung Pangkah gas reserves for export to the PLN power station at Gresik. The Ujung Pangkah gas field is located between 2 and 10km offshore off the north coast of East Java approximately 35km north of Gresik.

HIPL has entered into contracts for the engineering, procurement, construction and installation (EPCI) of facilities in order to produce the gas and condensate from the Ujung Pangkah gas field.

In addition to developing the gas reserves, HIPL is in the process of performing the development of the oil reserves associated with the gas field and recover LPG from the produced gas.

1.2 Scope

This philosophy outlines the design principles employed for the electrical system design, selection of electrical equipment, and operation of the electrical system for the Ujung Pangkah Liquids Development Project.

This document describes the requirements for the following aspects of the Electrical systems:

- Power Distribution
- Essential and Critical Power
- Electrical Protection and Control
- Electrical Equipment Selection
- Lighting and Small Power
- Cabling Design
- Earthing and Lightning Protection
- Electrical Substations
- Hazardous Area Classification

This document has been prepared based on the relevant sections of the project Basis of Design package and relevant national and international codes and standards in order to form a clear and concise philosophy.

The development scope and key parameters are covered in the Basis of Design (document number UPD-TJ-P2-PR-BD-0001).

The design of electrical systems shall be based on the following:

- Safety of personnel and equipment during operation and maintenance. Reliability and continuity of service under all working conditions at site
- Secure emergency power supply and distribution for essential loads
- UPS supplies for critical control, communications and safety equipment, where required
- Ease of operation, inspection, maintenance and repairs

Details of electrical equipment requirements are addressed in individual equipment specifications.

2 ABBREVIATIONS AND DEFINITIONS

2.1 Abbreviations

AC	Alternating Current
API	American Petroleum Institute
BASEEFA	British Approval Service for Electrical Equipment in Flammable Atmosphere
BS	British Standard
CB	Circuit Breaker
CCR	Central Control Room
DC	Direct Current
ESD	Emergency Shutdown
ETAP	Electrical Transient Analyzer Program

F&G	Fire & Gas
FEED	Front End Engineering and Design
FVMS	Fused Vacuum Contactor Motor Starter
HV	High Voltage
HVAC	Heating, Ventilation and Air Conditioning
IEC	International Electro-technical Commission
IEEE	Institute of Electrical and Electronics Engineers
IP	Ingress Protection
ISO	International Standard Organization
HIPL	Hess (Indonesia-Pangkah) Limited
LCS	Local Control Station
LPGF	LPG Facility
LV	Low Voltage
MCC	Motor Control Centre
MCCB	Molded Case Circuit Breaker
MCR	Main Control Room
MV	Medium Voltage
OPF	Onshore Processing Facility
OTF	Oil Treatment Facility
PCS	Process Control System
PLC	Programmable Logic Controller
PLN	Perusahaan Listrik Negara
PTB	Physikalisch Technische Bundesanstalt
RCD	Residual Current Device
UCP	Unit Control Panel
UJPKH or UP	Ujung Pangkah
UPS	Uninterruptible Power Supply
VRLA	Valve-Regulated Lead Acid (batteries)

2.2 Vocabulary, Units and Symbols

The vocabulary and graphical symbols used for electrical design documents and drawings shall be as defined in the IEC 60050 and IEC 60617.

Unit shall be as defined in the international system of units (SI).

Additional units allowed for project use are listed in the Basis of Design (document number UPD-TJ-P2-PR-BD-0001).

2.3 Definitions

COMPANY	COMPANY is defined as Hess (Indonesia-Pangkah) Ltd
CONTRACTOR	CONTRACTOR means TPEC specifying/purchasing the equipment for and or behalf of “COMPANY”.
VENDOR / SUPPLIER	VENDOR / SUPPLIER are defined as the company selected to supply the equipment and service detailed in this specification. This is the entity having unit responsibility as defined in the industry codes and standards.

3 REFERENCE DOCUMENTS, CODES AND STANDARDS

3.1 International Codes and Standards

The design shall be in accordance with good engineering practices and in compliance with the latest editions and revisions (unless noted otherwise) of the following Codes, Standards, Company's Specifications and Regulations, as applicable.

In general, IEC codes and standards shall form the basis for the overall Electrical design and specification and installation of electrical equipment.

International Electro-technical Commission (IEC)

IEC 60034	Rotating Electrical Machines
IEC 60038	IEC standard voltages
IEC 60044	Instrument Transformers
IEC 60050	International electro-technical vocabulary
IEC 60056	High Voltage Alternating Current Circuit Breakers
IEC 60059	IEC standard current ratings
IEC 60068	Climatic Tests
IEC 60071	Insulation Co-ordination
IEC 60076	Power Transformers
IEC 60079	Electrical Apparatus for Explosive Gas Atmospheres
IEC 60083	Plugs and socket outlets for domestic and similar general use
IEC 60085	Thermal Evaluation and Classification of Electrical Insulation
IEC 60092-101	Electrical installations in ships - Part 101: Definitions and general requirements
IEC 60099	Surge Arrestors
IEC 60129	Alternating Current Disconnector and Earthing Switches
IEC 60137	Bushings for Alternative Voltages above 1000V
IEC 60146	Semi Conductor Converters
IEC 601 58	Low Voltage Control Gear
IEC 60186	Voltage Transformers
IEC 60227-1 to 5	Conduction and Cables Insulated with PVC of Nominal Voltage of more than 450 / 750 V
IEC 60228	Conductors of Insulated Cables
IEC 60255	Electrical Relays
IEC 60265	High Voltage Switches
IEC 60282	High Voltage Fuses
IEC 60287	Electrical Cables - Calculation of Current Ratings
IEC 60296	Unused Insulating Oil for Transformers and Switchgear
IEC 60298	AC Metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV
IEC 60309-1	Plugs, socket-outlets and couplers for industrial purposes - Part 1: General requirements
IEC 60309-2	Plugs, socket-outlets and couplers for industrial purposes - Part 2: Dimensional inter-changeability requirements for pin and contact-tube accessories
IEC 60331	Characteristics of Fire Resisting Electric Cables,
IEC 60332	Tests on Electric Cables Under Fire Conditions
IEC 60354	Loading Guide for Oil Immersed Transformers.
IEC 60364	Electrical Installation of Buildings
IEC 60417-1	Graphical symbols for use on equipment
IEC 60439	LV Switchgear & Control Gear Assemblies,
IEC 60439-1	Low-voltage switchgear and controlgear assemblies - Part 1: Type-tested and partially type-tested assemblies
IEC 60470	High Voltage Alternating Current Contactors
IEC 60478	Stabilized Power Supplies, D.C. Output.
IEC 60502	Extruded Solid Dielectric Insulated Power Cables for Rated Voltages from 1 KV up to 30 KV.
IEC 60529	Degrees of protection provided by enclosures (IP Code)
IEC 60551	Measurement of Transformer and Reactor Sound Levels
IEC 60598	Luminaries
IEC 60606-1	Application Guide for Power Transformers
IEC 60617	Graphical symbols for diagrams
IEC 60644	High Voltage Fuse Links for Motor Circuit Applications.
IEC 60662	High-pressure sodium vapour lamps
IEC 60694	Common Clauses for High Voltage Switchgear and Control Gear
IEC 60754	Tests on Gases Evolved during Combustion of Electric Cables.
IEC 60755	General requirements for residual current operated protective devices
IEC 60811	Common Test Methods for Insulating and Sheathing Materials of Electric Cables
IEC 60896	Stationary Lead Acid Batteries

IEC 60909-0	Short-circuit currents in three-phase a.c. systems - Part 0: Calculation of currents
IEC 60947	LV Switchgear & Control Gear
IEC 61000	Electromagnetic Compatibility (EMC)
IEC 61024	Protection of structures against lightning
IEC 61034	Measurement of Smoke Density of Electric Cables Burning under Defined Conditions.

Institution of Electrical and Electronic Engineers

IEEE Std 446	Institute of Electrical and Electronic Engineers Recommendations for Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications
IEEE Std 493	Institute of Electrical and Electronic Engineers Recommended Practice for Design of Reliable Industrial and Commercial Power Systems

American Petroleum Institute

API RP505	Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class 1, Zone 0, Zone 1, and Zone 2

British Standards Institution

BS 6651	Code of Practice for Protection of Structures Against Lightning.

3.2 Project Documents

UPD-TJ-P2-PR-BD-0001	Basis of Design
UPD-TJ-P2-EL-SP-1001	Specification for 11 kV Switchgear
UPD-TJ-P2-EL-SP-1002	Specification for 6.6kV Switchgear & MCC
UPD-TJ-P2-EL-SP-1003	Specification for 400V Switchgear & MCC
UPD-TJ-P2-EL-SP-1005	Specification for Power Transformer
UPD-TJ-P2-EL-SP-1006	Specification for AC-DC UPS Systems
UPD-TJ-P2-EL-SP-1009	Specification for Power, Control and Earthing Cables
UPD-TJ-P2-EL-SP-1011	Specification for Electrical Installation
UPD-TJ-P2-EL-SP-1022-01	Specification for Electrical Bulk Material (Miscellaneous)
UPD-TJ-P2-EL-SP-1022-02	Specification for Electrical Bulk Material (Grounding and Lightning Protection Materials)
UPD-TJ-P2-EL-SP-1022-03	Specification for Electrical Bulk Material (Lighting Material & Accessories)
UPD-TJ-P2-EL-SP-1022-04	Specification for Electrical Bulk Material (Lighting Poles)
UPD-TJ-P2-EL-SP-1022-05	Specification for Electrical Bulk Material (Wiring Material)
UPD-TJ-P2-EL-SP-1022-06	Specification for Electrical Bulk Material (Cable Tray & Perforated Tray)
UPD-TJ-P2-EL-SP-1022-07	Specification for Electrical Bulk Material (Power Devices)
UPD-TJ-P2-EL-SP-1022-08	Specification for Electrical Bulk Material (Cathodic Protection)
UPD-TJ-P2-PG-PR-0001	Document and Equipment Numbering Procedure
UPD-TJ-P2 -GE-SP-0015	General Electrical Requirement for Packaged Equipment
UPD-TJ-P2 -GE-SP-0023	Specification for MV&LV Motors
UPD-TJ-P2-ME-SP-0008	Functional Specification for Emergency Diesel Generator
UPD-TJ-P2-EL-PH-0102	Electrical Tie-In Philosophy
UPD-TJ-P2-EL-PH-0103	Power System Operating Philosophy
UPD-TJ-P2-EL-SL-0102	OTF/LPGF Overall Key Single Line Diagram
UPD-TJ-P2-EL-SL-0107	Jetty Loading Arm Distribution Board (463-ED-02) Single Line Diagram
UPD-TJ-P2-EL-SP-0002	Specification for Portable Diesel Generator
UPD-TJ-P2-EL-SP-0003	Specification for Variable Speed Drive

3.3 Indonesian Regulations/Laws

Relevant and applicable Indonesian regulations and laws are listed in the Basis of Design (document number UPD-TJ-P2-PR-BD-0001).

3.4 Order of Precedence

In case of conflict between the Codes, Standards, Specifications etc. as listed herein, the more stringent requirement shall govern. The order of precedence shall be as follows:

- Indonesian Statutory Requirements
- Other relevant National or International Legislation in the absence of Indonesian Legislation
- Certifying Authority requirements, including referenced Codes and Standards
- Basis of Design
- Various Project Documents issued with Tender
- Other specifications
- Good engineering practice

In case of conflict between two references (Regulations, Codes, Standards, specifications, data sheets), the most stringent requirements shall prevail.

All apparent conflicts shall be reported to the COMPANY for resolution

4 DISTRIBUTION VOLTAGES AND FREQUENCY

4.1 Power System Frequency

The alternating-current power system shall operate at a frequency of 50 hertz.

4.2 Power System Voltages

4.2.1 Main Power Supply

Power distribution for normal power will be at:

- 11 kV AC 3-phase main power supply from OPF
- 6,600V AC 3-phase for MV motor loads
- 400V AC 3-phase for LV motor loads
- 400V AC 3-phase and neutral for package equipment and non-motor loads
- 230VAC 1-phase and neutral; for general lighting and small power loads

4.2.2 Emergency Power Supply

Power distribution for emergency power to essential supplies will be at:

- 400V AC 3-phase and neutral for main feeders, package equipment and motor loads
- 230V AC 1-phase and neutral; for lighting and small power loads

4.2.3 Uninterruptible Power Supply (UPS)

The main UPS power supply to critical users shall be distributed at 230VAC 50 hertz. Main UPS systems will be three phase or single phase dependent upon total load requirements. UPS Power equipment shall be provided as 2 x 100% redundant rectifier/inverter units and 2 x 50% batteries.

A dedicated 110V DC UPS System shall be provided for switchgear control, protection and circuit breakers. The DC UPS System shall be provided as 2 x 100% redundant rectifiers and 2 x 50% batteries.

DC UPS systems for Diesel Fire Pumps and Emergency Generators shall be 24V DC, and shall each be 1 x 100% rectifier with 1 x 100% battery.

4.3 Consumer Utilization Voltages

The utilization voltages for various consumers are given in the following Table 4.1

TABLE 4.1 UTILIZATION VOLTAGES

CONSUMER	UTILIZATION VOLTAGE	EARTHING
Motors less than 0.37kW	400V 3ph+E or 230V, 1ph+E, 50Hz (Note 3)	Solid
Motors – 0.37kW up to 132kW	400V, 3ph+E, 50Hz	Solid
Motors – above 132kW	6,600, 3ph+E, 50Hz	Low-resistance
Process Heaters	400V, 3ph+E, 50Hz	Solid
Welding Sockets	400V, 3ph+E+N, 50Hz	Solid
Convenience Sockets (field)	230V, 1ph+E+N, 50Hz	Solid
Lighting (normal – emergency)	230V, 1ph+E+N, 50Hz	Solid
Anti-condensation Heaters	230V, 1ph+E+N, 50Hz	Solid
Diesel Engine Starters & Controls (Supplier)	24V DC, 2 wire	Floating
Switchgear Protection & Controls	110V DC, 2 wire	Floating
MCC Contactor Controls	230V, 1ph+E+N, 50Hz (Note 2)	Solid
Instrumentation, safety and communications system (Note 1)	230V, 1ph+E+N, 50Hz	Solid

Note 1 Supply to equipment to be sourced from 230V AC UPS circuits, to be converted to required operating voltage by Supplier within package.
Note 2 Self derived within switchgear module from main AC power
Note 3 Single phase motors for utility loads only - motor starters shall be integral to the equipment. All process motor loads under PCS control shall be from the MCC at 400V AC 3ph.

5 ELECTRICAL OVERVIEW

5.1 General

Power is generated at 11,000V AC, 3-phase, 50Hz, as part of the OPF facilities.

Main power generators are located at OPF nearby substation and are gas-turbine driven. The main power generators were sized to supply all electrical loads under all operating conditions, for all facilities (OPF and OTF/LPGF), under the worst case load and ambient conditions, with one main power generator off-line. The main power generators are directly feed main 11kV Switchboard (160-ES-01) located in OPF substation.

The main source of power for the OTF and LPGF shall be dual 11kV cable feeders from the OPF 11kV Switchboard (160-ES-01). The dual 11kV feeders shall terminate directly to the OTF/LPGF main 11/6.6kV power transformers.

The 11kV feeders from OPF and the 11/6.6kV transformers shall be sized to supply all OTF and LPGF electrical loads under all operating conditions with one feeder/transformer off-line and shall be sized for the ONAF rating of the 11/6.6kV transformers.

Power will be distributed at 6,600V AC 50Hz in 3-phase (MV), and at 400/230V AC 50Hz in 3-phase with neutral (LV).

The MV power system shall have its neutral earthed via low resistance at the transformer star points. The LV power system shall have its neutral solidly earthed at the transformer and emergency generator star points.

A local emergency generator shall be provided for the OTF/LPGF which shall be diesel engine driven.

The OTF and LPGF electrical systems will in general consist of the following main components:

- Dual 11kV feeders (2 x 100%) from the OPF main 11kV switchboard

- Dual 11/6.6kV Power Transformers (2 x 100%) feeding the OPF/LPGF MV Switchboard, which includes motor starters for MV drives as well as feeders to distribution transformers
- Process LV Switchboard and Utilities LV Switchboard, each fed by dual 6.6/0.4kV Distribution Transformers (2 x 100%)
- OTF/LPGF Essential Switchboard, fed from a local diesel engine driven Emergency Generator sized to support essential loads (1 x 100%)
- Main AC and DC UPS Systems for critical services

The liquids development project also involves additional jetty facilities. Power supply for electrical consumers will be supplied from portable diesel generator. The portable generator will occasionally be operated to supply power to Jetty Loading Arm facilities when crude oil or LPG is offloaded from storage tank to a tanker ship. A small UPS for instrumentation, control and communication system services shall be provided and supplied from existing LV power distribution. The jetty electrical facilities for OTF/LPGF in general consist of the following main components:

- Jetty Loading Arm LV distribution board, fed directly from portable diesel generator
- AC UPS system for critical services, fed from existing LV power distribution

Refer to UPD-TJ-P2-EL-PH-0102, "Electrical Tie-In Philosophy" for details.

5.2 Essential Power Supply

An emergency generator shall be provided at the OTF/LPGF electrical substation, sized to maintain power to essential users only.

The emergency generator will be connected directly to the OTF/LPGF Essential LV Switchboard which shall be single bus section with two incomers. One incomer will be connected to the normal supply from the OTF LV Switchboard, and this will be closed during normal operation. The second incomer will be connected to the emergency generator.

On loss of voltage at the essential switchboard, the emergency generator shall automatically start up and regulate its speed and voltage. The supply from the normal power supply will automatically disconnect, and then the incomer from the emergency generator will automatically close to energize the switchboard.

The controls for the essential switchboard shall be designed so that after the automatic operation, it will be possible to re-close back to the normal switchboard so that normal users can be supplied from the essential power supply. This operation however shall be manually initiated and operating procedures shall be written to ensure in this event the generator is not overloaded by normal users.

5.3 Essential Power Users

Essential power users are generally those users listed below:

- Feeders to all Critical power supplies
- Emergency and escape lighting
- HVAC systems for rooms containing essential equipment
- Safe and Controlled Shutdown
- Hazardous drain pumps (for continuous drain systems only) and flare/vent scrubber pumps
- Turbine enclosure Ventilation
- Lube Oil Cooler Fans, where required by the package SUPPLIER
- Equipment anti-condensation heaters

Where there are two redundant essential users (e.g. pump A and B in a duty/standby arrangement) one shall be fed from an essential switchboard and the other from a normal switchboard.

5.4 Critical Power Supply

Critical Power Supplies are derived from storage batteries and distributed to critical users as either AC or DC supply from UPS systems. The purpose of critical power supplies is to provide the most reliable power supply for critical users.

Autonomy times will as a minimum be in accordance with the statutory requirements and the requirements defined in the instrument and telecommunication philosophies. The autonomy time for the main UPS system shall be 2 hours.

Main UPS systems shall be three phase. UPS Power equipment shall be provided as 2 x 100% redundant rectifier/inverter units (UPS A and UPS B) and 2 x 50% batteries based on the calculated design load for all connected critical users.

AC UPS systems shall be of the static, double conversion type with fully-electronic static bypass switches for each UPS A and UPS B system and a separated manual maintenance bypass switch. The by-pass AC supply will be taken from a different supply to that of the UPS main supply to minimize common mode failure.

A dedicated 110V DC UPS System shall be provided for switchgear control, protection and circuit breakers. The DC UPS System shall be provided as 2 x 100% redundant rectifiers and 2 x 50% batteries.

DC UPS systems for Diesel Fire Pumps and Emergency Generators shall preferably be 24V DC, and shall each be 1 x 100% redundant rectifier with 1 x 100% battery.

DC UPS systems for Compressor Gas Turbine backup lube oil pumps shall be 1 x 100% rectifier with 1 x 100% battery.

Batteries shall be Valve-Regulated Lead Acid (VRLA). Dedicated ventilated battery rooms will not be provided. Each battery bank will be installed with an isolator in order to provide facilities for tripping the batteries.

5.5 Critical Power Users

Critical Users are those loads necessary for the operation of safety systems and for facilitating or assisting safe evacuation. It is generally not appropriate for any break in power supply for critical users, even for a short duration.

Critical users are generally those users listed below:

- Fire & Gas safety systems
- Shutdown & Process Control Systems (ESD & PCS)
- Telecommunications systems (Voice & Data)
- Gas Turbine / Compressor UCP
- Switchgear tripping and closing supplies
- Gas Turbine backup Lube oil pumps
- Emergency Generator starting and control
- Diesel Engine Fire Pump Starting and Control
- Escape Route Lighting (self contained with integral battery)
- Exit Lighting (self contained with integral battery)

Control systems, telecommunications and UCPs are typically supplied from common UPS systems which also supply other critical users of various systems and packages.

Battery systems for diesel engines, backup lube oil systems etc will normally be provided as part of the package supply. Diesel engine driven generators and firewater pumps will have battery systems sized for cranking duty rather than autonomy time.

6 ELECTRICAL DESIGN

6.1 Design Life

The facility will be designed for a 25 year operating life, as specified in the Basis of Design (document number UPD-TJ-P2-PR-BD-0001).

6.2 Voltage and Frequency Variations

6.2.1 Frequency Variations

Frequency fluctuations specified herein shall apply to both the normal and essential power systems under all power generation cases.

The power system frequency shall be maintained within ±5% of the nominal value for steady-state and transient conditions including motor starting.

6.2.2 Switchboard Voltage Variations

Voltage fluctuations specified herein shall apply to both the normal and essential power systems under all power generation cases.

Switchboard voltages shall be maintained within ±10% of the nominal value for steady-state conditions.

Switchboard voltages shall be maintained above -15% of the nominal value for transient conditions including motor starting, however the terminal voltage at the motor being started shall be above -20% of the nominal value. Over-voltages shall not exceed 110% of nominal for more than 2 seconds.

6.2.3 Motor Terminal Voltages

The acceptable limits of motor terminal voltage are defined by the motor design and its capability to produce sufficient torque to accelerate the mechanical load at a reduced voltage.

The motors are specified in accordance with IEC 60034 to be suitable for starting voltages of 80% nominal rated voltage. This value represents the criteria to ensure satisfactory mechanical starting performance.

In general, cables are designed for a maximum 15% voltage drop at motor starting which implies a maximum transient variation at the switchboard busbar of 5% as the normal acceptable limit. For large motors however, calculations must consider the total circuit impedance from source to motor terminals to determine actual voltages at switchboards and motor terminals to limit busbar voltage variations as per above.

6.2.4 Critical AC Power Supply

The critical AC power supply is normally subject to the steady state and transient voltage and frequency variations as per the normal supply as defined above since UPS bypass supplies are not conditioned

During normal inverter operation (i.e. all times except when in bypass) the UPS output voltage and frequency shall both be maintained to within ±1%. During transient conditions the voltage variation may be ±10 %. Equipment shall be specified for a maximum rate of change of frequency of 0.2 Hz/sec.

6.2.5 Critical DC Power Supply

Critical DC power supplies shall be designed such that the steady state voltage variation at the supply busbar does not exceed ±5 % under normal float charge conditions.

During battery discharge conditions the voltage may be -20 %.

Design conditions for dedicated DC package equipment shall be as specified by the package Supplier.

6.3 Load Analysis

The overall power requirements shall be determined in the Electrical Load Study Report, which includes the load schedules for each switchboard at the OTF and LPGF, as well as the total additional demand on the OPF. The calculations shall be confirmed during detailed design.

The electrical load schedule is developed using the Mechanical Equipment List as the main reference for Mechanical loads. In the absence of design information, non-process loads are estimated from similar installations. All loads, efficiencies and power factors are estimated or typical for the equipment selected.

Load duties are classified according to their nature as continuous, intermittent and standby duty. Intermittent loads are factored by a duty cycle to enable them to be summed with continuous loads into the average load.

Total loads are calculated as average load, maximum load and design load. As the electrical loads are determined based on the conceptual design, the design load is calculated using a design margin of 25% to allow for changes during design development. Following completion of detailed design, the design margin may be reduced to 10% to allow for future modifications,

The design loads, together with details of the operation of the largest individual loads, are used to determine the nature of the overall load and thus the electrical equipment requirements. In general the power supply must be suitable for the design load, as well as any transient load changes imposed due to specific consumers.

6.3.1 User Classification

The electrical load is classified according to its service as normal, essential and critical.

Normal loads : loads typically related to production, and those of which the loss of supply would not create an unsafe condition or result in damage to equipment. The loads prevail under normal operating conditions.

Essential Loads : loads related to the safety of personnel and equipment but which are suitable for short breaks in the power supply without detriment (such as during starting of emergency generators). Such loads are to be supplied by emergency generators.

Critical Loads : these are typically loads which must be maintained continuously in order to prevent the development of an unsafe condition. These typically include control and safety systems and telecommunications systems. Such loads are typically supplied via battery backed power supplies.

6.4 Power System Studies

Power system studies shall be carried-out using the computer based program ETAP

Short circuit studies analyzing the fault currents resulting from short circuits shall be calculated for three phase and phase to earth conditions.

Load flow analysis shall be performed to check voltage profiles and circuit loading conditions under steady state conditions based on the design loads determined as per section 6.3.

Motor starting studies shall be performed to demonstrate the capability of large motors in the facility to start and accelerate under operating conditions.

Stability studies shall be performed to analyze the transient and dynamic performance of power systems after large load changes and fault disturbances.

6.5 Protection and Co-ordination

Metering and Protection drawings show the individual functions at each switchboard, transformer and generator.

Typical motor starter schematics show the individual control and protection functions for electric motors.

The minimum electrical protection requirements shall be as follows:

- Generators shall have protection on phase and neutral over-current, earth fault, over- speed, percentage differential (unless rated less than 750kVA), loss of excitation/field, voltage restrained phase over-current, negative phase sequence and reverse power. Over/under frequency and under/over voltage shall also be provided, however for the emergency generators this shall automatically be disabled when in emergency operation.
- Transformers shall have protection on phase over-current, short-circuit, restricted earth fault, backup earth fault, differential, over-temperature and overpressure.
- Motors shall be protected against overload, single phasing, stall/locked rotor and short circuit. Motors above 30kW shall be protected against earth fault. Motors 90kW and above shall be provided with electronic motor protection relays and protection against undercurrent and negative sequence current. MV motors shall further be provided with thermal protection by winding and bearing RTDs.

- Bus-Tie CBs shall be provided with phase over-current protection and where applicable shall be provided with synchronism check protection.
- Incomers shall be protected against over-current/short circuit, earth fault and under-voltage.
- Outgoing feeders shall be protected against over-current/short circuit and earth fault
- All main circuit breakers shall be provided with lockout protection

Protection relay co-ordination studies shall be carried out during detailed design to determine the discrimination settings for protective devices to ensure that any possible fault or overload is cleared and isolated with minimum disruption.

6.6 Spare Philosophy

The percentage spare required shall be available at the project completion.

Evolis 17.5 kV circuit breaker

Characteristics

Characterisitics of Evolis circuit breakers in MCset cubicles

The electrical characteristics are given on the circuit breaker designation (rating plate).

Electrical characteristics according to IEC 62271-100

				Evolis/MCset 1				Evolis/MCset 2					
Phase to phase		mm		145				185					
Rated voltage	**Ur**	kV 50/60 Hz		7.2		12		7.2		12		17.5	
Insulation level													
- power frequency withstand	**Ud**	kV 50 Hz 1 min (*)		20		28		20		28		38	
- lightning impulse withstand	**Up**	kV peak		60		75		60		75		95	
Rated current	**Ir**	A	630	■	■	■	■	■	■	■	■	■	■
			1250	■	■	■	■	■	■	■	■	■	■
Short circuit current	**Isc**	kA		25	31.5	25	31.5	31.5	40	31.5	40	25	31.5
Short time withstand current	**Ik/tk**	kA/3 s		25	31.5	25	31.5	31.5	40	31.5	40	25	31.5
Short-circuit making current	**Ip**	kA peak	50 Hz	63	79	63	79	79	100	79	100	63	79
			60 Hz	65	82	65	82	82	104	82	104	65	82

				Evolis/MCset 3									
Phase to phase		mm		240									
Rated voltage	**Ur**	kV 50/60 Hz		7.2			12			17.5			
Insulation level													
- power frequency withstand	**Ud**	kV 50 Hz 1 min (*)		20			28			38			
- lightning impulse withstand	**Up**	kV peak		60			75			95			
Rated current	**Ir**	A	630	–	–	■	–	–	■	–	–	–	
			1250	–	–	■	–	–	■	–	–	■	
			2500	■	■	■	■	■	■	■	■	■	
Short circuit current	**Isc**	kA		25	31.5	40	25	31.5	40	25	31.5	40	
Short time withstand current	**Ik/tk**	kA/3 s		25	31.5	40	25	31.5	40	25	31.5	40	
Short-circuit making current	**Ip**	kA peak	50 Hz	63	79	100	63	79	100	63	79	100	
			60 Hz	65	82	104	65	82	104	65	82	104	

Common characteristics according to IEC 62271-100

Rated switching sequence		O-3 min-CO-3 min-CO	■
		O-0.3 s-CO-3 min-CO	■
		O-0.3 s-CO-15 s-CO	■
Operating times		Opening	10 ms
		Breaking	25 ms
		Closing	31 ms
Service temperature	**T**	°C	– 25 to + 40
Mechanical endurance		Class	M2
		Number of switching operations	10 000
Electrical endurance		Class	E2
Number of switching operations at full Isc value		25 kA	100
		31.5 kA	50
		40 kA	30
Capacitive current breaking capacity		Class	C1
Average relative humidity		Over 24 h	< 95%
		Over 1 month	< 90%

(*) Circuit breaker tested at Ud 42 kV 50 Hz, 1 min
■ Available
– Not available.