Documentation

Description of model for

SMA Sunny Central Storage

inverter in grid forming mode for power flow and stability studies in PSS®E

Please consider the environment before you print this document

Document Revision 7
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Note

The following PSS®E versions are currently supported:

- version 32 compiled with Intel Visual Fortran Compiler Revision 11.1,
- version 33 compiled with Intel Visual Fortran Compiler Revision 11.1,
- versions 34.2 and 34.4 compiled with Intel Visual Fortran Compiler Revisions 11.1 and 15.0 (x86).
- versions 35.5 compiled with Intel Visual Fortran Compiler Revisions 15.0 (x86).

Please contact SMA if models for other simulation platforms are required. Currently, SMA supports

- DIgSILENT PowerFactory (rms models)
- Siemens Power Technologies International PSS®E (rms models)
- General Electric International PSLF (rms models)
- Manitoba Hydro International Ltd. PSCAD® (instantaneous value models)
- ATP-EMTP (instantaneous value models)
- EMTP-RV (instantaneous value models)
- The Mathworks Matlab/Simulink® (rms and instantaneous value models, SMA internal only)

SMA model support

In case you require support from SMA Solar Technology AG regarding questions of model handling, model parameterization, or interpretation of simulation results, please send all relevant files to SMA including:

- The models you were using, or a reference to the model versions,
- the network in *.raw or *.sav format,
- the dyr file,
- simulation scripts in *.idv or *.py (Python) format that exactly replicate the relevant scenario,
- information on the PSS/E version.

Model history

Model version	Author	Description
1.04	Oliver Glitza	First release of SMA SC grid forming model; this version represents SMA SC SW Release 8
2.06	Oliver Glitza	First release of SMA SC grid forming model representing SMA SC SW Release 9
2.07	Oliver Glitza	Allows initialization with negative active power
2.08	Rahul Bhatia	1. BugFix: Writing of initial P & Q values to Hycon VARs 2. Shifting of Subroutines and Functions to CONTAINS 3. Using For loop for reading the plant controller VAR index
3.00	Rahul Bhatia	New release of SMA SC grid forming model; this version represents SMA SC SW Release 9. This is the second generation of the Grid forming model in PSS/E.
3.01	Rahul Bhatia	BugFix: Protection Settings not working BugFix: ICON(M+2) with CHRCIN not working with v33
3.02	Rahul Bhatia	1.BugFix: Filt1.ABControlDFilTm & ABControlQFilTm not initialized correctly 2. Spike Mitigation Algorithm Implementation 3. Hardware current limitation of StkAmpLimon
3.03	Rahul Bhatia	1.Introduced CON – Rtg.VarRtg to have adjustable reactive power rating 2.Introduced CON – Filt.AvalPwrFilTm as a filter for available power (active and reactive) 3. Communication of available active power to Hycon model.
3.04	Rahul Bhatia	1.Update to Firmware release R10
3.05	Rahul Bhatia	1.Addition of HiVolOnLim and DynVolOnLimEna to VirtImp 2. Addition of CONs for VARtg, WRtg, AmpRtg 3. Addition of Setpoint filters and Rate limiter 4. Addition of SoC logic and DcAmpLimit controller 5. Bugfixes related to firmware release 10
3.06	Rahul Bhatia	1. Solving the base conversion issue

Model validity

The inverter model "SMAGF" described in this document is mainly intended for simulation of the SMA Sunny Central inverters in grid forming mode.

Contents

1 Power flow model

An equivalence power plant utilizing SMA Sunny Central inverters may be modeled for power flow purposes as a generator connected to a P/V[1] bus (PSS®E type 2) with the appropriate nominal voltage. The

- aggregate MVA of the plant (`MBASE`),
- maximum active power (`PT`) and
- reactive power limits (`QT` and `QB`)

must be specified as integral multiple of the individual inverter unit ratings. However, the active power dispatch for the power flow simulation may be anywhere in the range of zero to (aggregate) `PT`.

[1] The symbol *U* or *u* is used for voltage throughout the document.

1.1 Generator data in PSS®E

Figure 1 shows a typical data mask for the machine entry in the PSS®E load flow program. It is important that the “R Source” and “X Source” values are parameterized as given by Table 1.

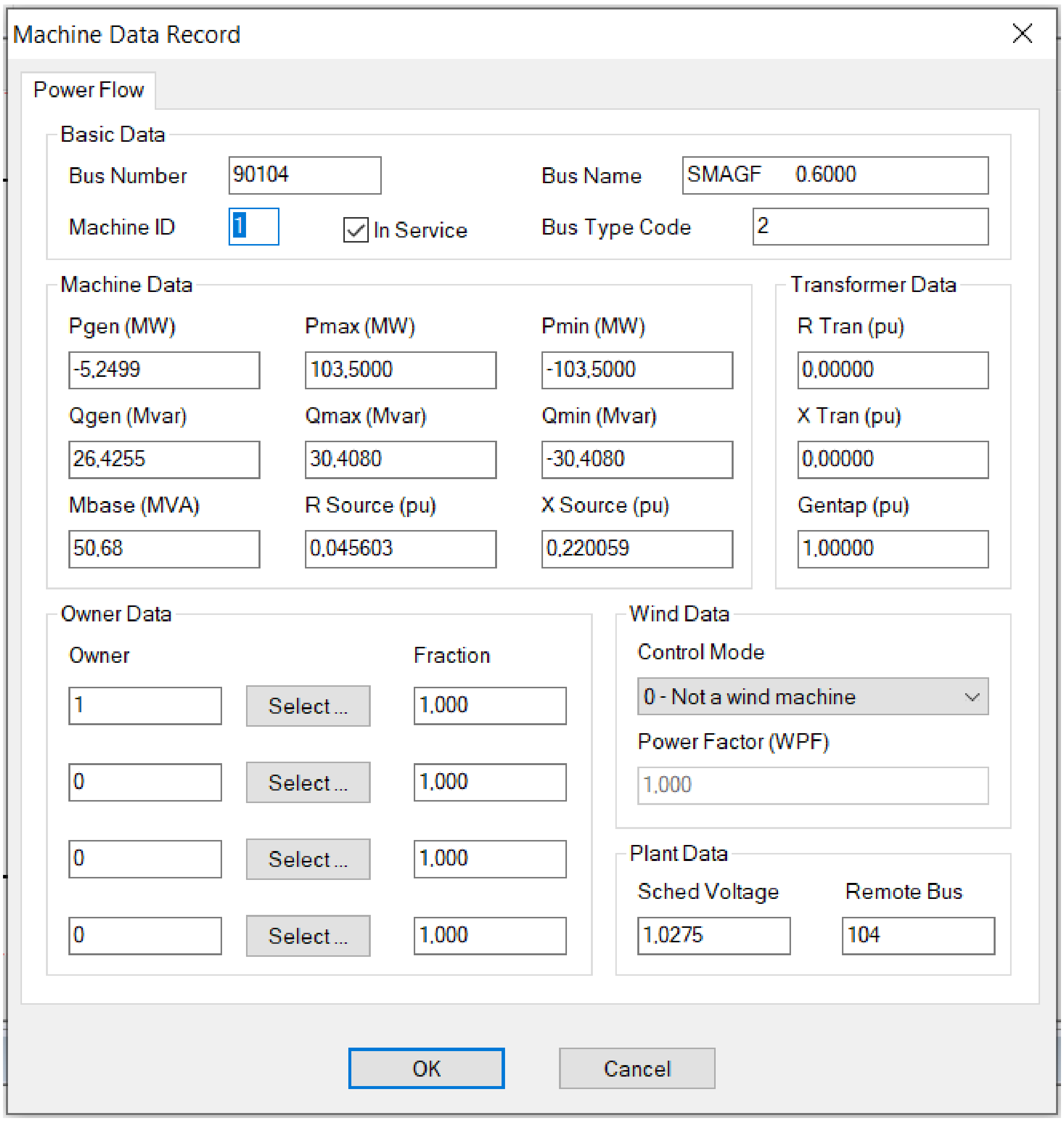

Figure 1: Typical data mask for machine entry in the PSS®E load flow program.

Furthermore, it is very important that the active power (Pgen), the reactive power (Qgen) and MBASE always satisfy the equation

$Pgen^2 + Qgen^2 <= MBASE^2$.

Otherwise, the model will not initialize correctly.

2 Dynamic model

The plant dynamic model has been implemented as a PSS®E user model called "SMAGFxxx", making use of PSS®E's "coordinated call model" technique.

2.1 Initialization

SMAGF initializes the active power dispatch from the steady-state solution and adjusts all internal variables and states accordingly.

Care must be taken that the reactive power limits of the inverter are not hit at initialization.

2.2 Machine array variables

Machine array variables are assigned as follows:

`ETERM(I)`	Measured Bus Voltage magnitude in p.u.
`PELEC(I)`	Measured Active power in p.u.
`QELEC(I)`	Measured Reactive power in p.u.
`VOTHSG(I)`	Measured Bus Frequency (Hz)
`ANGLE(I)`	Measured Bus angle
`ECOMP(I)`	Real component of current in p.u.
`VUEL(I)`	Imaginary component of current in p.u.
`EFD(I)`	Desired reactive power in p.u. (from plant control model)
`XADIFD(I)`	Desired active power in p.u. (from plant control model)

2.3 Dyr file entry

The model's dyr file entry is as follows:

```
BusNum 'USRMDL' 1 'SMAGF306' 1 1 4 221 0 324 ICON(M) ICON(M+1)
ICON(M+2) ICON(M+3) CON(J) CON(J+1) ... CON(J+220)
```

2.4 Model parameters

In this section there is given a standard parameterization only.

Table 1 provides a guidance on how ICON(M+2) should be set up based on the Inverter Type. It also provides the value of "R Source" and "X Source" values 1 p.u. for different inverter types as well as based on the Grid frequency

Table 1: Model Setup based on Inverter Type

Inverter Type	Rated apparent power (MVA)	Nominal Voltage Line-Line (kV)	ICON(M+2) InvType	Gen. Impedance R + jX p.u. (50Hz)	Gen.Impedance R + jX p.u. (60Hz)
SCS1900	1,900	0,337	1900	0.0502 + j0.2523	0.0502 + j0.3027
SCS2200	2,200	0,385	2200	0.0445 + j0.2238	0.0445 + j0.2686
SCS2475	2,475	0,434	2475	0.0394 + j0.1981	0.0394 + j0.2378
SCS2900	2,940	0,520	2940	0.0326 + j0.164	0.0326 + j0.1967
SCS2300UPXT	2,667	0,600	2667	0.0348 + j0.2185	0.0348 + j0.2622
SCS2400UPXT	2,800	0,630	2800	0.0331 + j0.2081	0.0331 + j0.2497
SCS2530UPXT	2,933	0,660	2933	0.0316 + j0.1986	0.0316 + j0.2383
SCS2630UPXT	3,067	0,690	3067	0.0302 + j0.19	0.0302 + j0.228
SCS3450UP	3,450	0,600	3450	0.0343 + j0.1854	0.0343 + j0.2225
SCS3600UP	3,620	0,630	3620	0.0326 + j0.1765	0.0326 + j0.2118
SCS3800UP	3,800	0,660	3800	0.0312 + j0.1688	0.0312 + j0.2026
SCS3950UP	3,960	0,690	3960	0.0297 + j0.1609	0.0297 + j0.1931
SCS3450UPXT	4,000	0,600	4000	0.0397 + j0.215	0.0397 + j0.258
SCS3600UPXT	4,200	0,630	4200	0.0378 + j0.2048	0.0378 + j0.2457
SCS3800UPXT	4,400	0,660	4400	0.0361 + j0.1954	0.0361 + j0.2345
SCS3950UPXT	4,600	0,690	4600	0.0345 + j0.1869	0.0345 + j0.2243

- Please set the ICON(M+2) and generator impedance in the load flow model based on the inverter used for the project

2.4.1 ICONs

Table 2: List of ICONs

ICON	Parameter	Description	Range	Default
M	PlntCtlType	1 = HyCon, 0 = no plant control **(PSS/E Specific)**	n/a	1
M+1	PlntCtlBus	Number of plant controller bus **(PSS/E Specific)**	n/a	n/a
M+2	InvType	InvType used. Refer Table 1 – Similar to Inverter Type selection in mask of inverter model block in PSCAD	n/a	4600
M+3	SCSOpCmd	21521: Grid Forming P/f and Q/V droop	n/a	21521

		22321: Grid Forming angle inertia and Q/V droop 22322: Grid Forming P/f droop and voltage Inertia 22323: Grid Forming angle inertia and voltage inertia **(PSS/E Specific)**		

2.4.2 CONs

Table 3: List of CONs

CON	Parameter	Description	Range min-max	Default
J+0	Rtg.VARtg	Apparent power rating in kVA can be set using this parameter. If set to 0.0, then rated apparent power as per Inverter type (ICON(M+2)) will be used	n/a	0.0
J+1	Rtg.WRtg	Active power rating in kW can be set using this parameter. If set to 0.0, then rated Active power as per Inverter type (ICON(M+2)) will be used	n/a	0.0
J+2	Rtg.VarRtg	Reactive power rating in kVar can be set using this parameter. If set to 0.0, then rated reactive power as per Inverter type (ICON(M+2)) will be used	n/a	0.0
J+3	Rtg.AmpRtg	Current rating in A can be set using this parameter. If set to 0.0, then rated current rating as per Inverter type (ICON(M+2)) will be used	n/a	0.0
J+4	Rtg.VADrtPriMod	Prioritizing of control in case of derating 0: Q Priority, 1: P Priority	0 or 1	0
J+5	Spt.WGraMod	Active power gradient, activation	0 or 1	0
J+6	Spt.VArGraMod	Reactive power gradient, activation	0 or 1	0
J+7	Spt.WGra	Gradient for active power p.u./s	n/a	100
J+8	Spt.VArGra	Gradient for reactive power p.u./s	n/a	100
J+9	Spt.WFilMod	Filter for active power setpoint, activation	0 or 1	0
J+10	Spt.VArFilMod	Filter for reactive power setpoint, activation	0 or 1	0
J+11	Spt.WFilTm	WSpt, filter time constant in s	3*timestep - n/a	0.02
J+12	Spt.VArFilTm	VArSpt, filter time constant in s	3*timestep - n/a	0.02

J+13	Filt.VolDQFilTm	DQ Voltage, filter time constant in s	3*timestep - n/a	0.46
J+14	Filt.VolPsFilTm	Voltage filter time constant for conversion VA to Amp in s	3*timestep - n/a	0.005
J+15	Filt.AmpDFilTm	D axis current, filter time constant in s	3*timestep - n/a	0.01
J+16	Filt.AmpQFilTm	Q axis current, filter time constant in s	3*timestep - n/a	0.01
J+17	Filt.ABControlDFilTm	Filter time constant for D-axis voltage for AB Control in s **(PSS/E Specific)**	3*timestep - n/a	0.01
J+18	Filt.ABControlQFilTm	Filter time constant for Q-axis voltage for AB Control in s **(PSS/E Specific)**	3*timestep - n/a	0.01
J+19	Filt.AvalPwrFilTm	Filter time constant for calculated available active and reactive power in s	3*timestep - n/a	0.1
J+20	Filt.VolSptGra	Rate limiter in p.u/s over voltage setpoint (VAR(L+3)) applied to the inverter	n/a	5.0
J+21	AcCtl.WSptScal	AC current control, active power setpoint scaling factor	1 - n/a	1
J+22	AcCtl.VArSptScal	AC current control, reactive power setpoint scaling factor	1 - n/a	1
J+23	AcCtl.DrpHz	Active power frequency droop	n/a	-2.0
J+24	AcCtl.DrpVol	Reactive power voltage droop	n/a	0.1
J+25	AcCtl.DrpTheta	Factor angle pre-control	n/a	-0.12
J+26	AcCtl.InertiaVolH	Inertia: Voltage magnitude inertia constant H_vol = 0.5 * (dQ/Snom) / (RoCoV/Vnom)	n/a	1.5
J+27	AcCtl. InertiaThetaH	Inertia: Voltage angle inertia constant H_theta = 0.5 * (dP/Snom) / (RoCoF/Fnom)	n/a	2.5
J+28	AcCtl.DrpThetaFilTm	AC current control, Time constant of low pass filter for bandwidth limitation of phase feed forward damping	3*timestep - n/a or 0	0.0
J+29	AcCtl.InertiaHzFbDmp	Inertia: Frequency feedback gain of voltage angle inertia control	n/a	0.0
J+30	AcCtl.InertiaHzFbFilTm	Inertia: Frequency feedback time constant of voltage angle inertia control	n/a	0.0
J+31	AcCtl.InertiaHzFbFil2Tm	Inertia: Frequency feedback time constant of voltage angle inertia control	n/a	0.0
J+32	AcCtl.InertiaHzFwdDmp	Inertia: Feed-forward damping gain of voltage angle inertia control	n/a	0.0
J+33	AcCtl.InertiaVolFwdDmp	Inertia: Feed-forward damping gain of voltage magnitude inertia control	n/a	0.0

J+34	AcCtl.InertiaVolFbDmp	Inertia: Voltage feedback gain of voltage magnitude inertia control	n/a	0.0
J+35	AcCtl.InertiaVolFbDmp-FilTm	Inertia: Voltage feedback time constant of voltage magnitude inertia control	n/a	0.0
J+36	AcCtl.InertiaVolFbDmp-Fil2Tm	Inertia: Voltage feedback time constant of voltage magnitude inertia control	n/a	0.0
J+37	AcCtl.AmpDLimKp	AC current control, proportional amplification for active current limit	n/a	0.6
J+38	AcCtl.AmpDLimKi	AC current control, integral amplification for active current limit	n/a	22.5
J+39	AcCtl.InertiaAmpDLimKp	Inertia: AC current control, proportional amplification for active current limit	n/a	0.6
J+40	AcCtl.InertiaAmpDLimKi	Inertia: AC current control, integral amplification for active current limit	n/a	22.5
J+41	AcCtl.AmpPsDLim_Ki2Fac	AC current control, double integral amplification for active current limit	n/a	0.00033333
J+42	AcCtl.AmpPsDLim_I2RocofLim	AC and DC limit control, minimum/maximum range control signal	n/a	6.0
J+43	AcCtl.AmpPsDLim_I2CtlDownGain	AC current control, additional double integral amplification, if active current limit is not exceeded	n/a	3.0
J+44	AcCtl.AmpQLimKp	AC current control, proportional amplification for reactive current limit	n/a	2.4
J+45	AcCtl.AmpQLimKi	AC current control, integral amplification for reactive current limit	n/a	90.0
J+46	AcCtl.InertiaAmpQLimKp	Inertia: AC current control, proportional amplification for reactive current limit	n/a	2.4
J+47	AcCtl.InertiaAmpQLimKi	Inertia: AC current control, integral amplification for reactive current limit	n/a	90.0
J+48	AcCtl.AmpPsQLim_Ki2Fac	AC current control, double integral amplification for reactive current limit	n/a	0.00033333
J+49	AcCtl.AmpPsQLim_I2RocofLim	AC current control, minimum/maximum range control signal	n/a	6.0
J+50	AcCtl.AmpPsQLim_I2CtlDownGain	AC current control, additional double integral amplification, if reactive current limit is not exceeded	n/a	3.0
J+51	AcCtl.InertiaThetaW-CtlEna	Inertia: Enable active power inertia control	0 to 1	0
J+52	AcCtl.InertiaThetaWCtlV-olLim	Voltage limit for power regulation in phase inertia	n/a	0.5

J+53	AcCtl.InertiaVolVArCtlEna	Inertia: Enable reactive power inertia control	0 or 1	0
J+54	AcCtl.InertiaVolVArCtlVol-Lim	Voltage limit for power regulation in the voltage inertia	0 to 1	0.5
J+55	AcCtl.Iner-tiaThetaFwdDmpFilTm	Inertia: Time constant for bandwidth limi-tation of angle feed-forward damping	3*timestep - n/a or 0	0.0
J+56	AcCtl.Iner-tiaThetaFwdDmp	Inertia: Voltage angle feed-forward damping gain of voltage angle inertia control	n/a	-0.12
J+57	AcCtl.AmpPsDFbEna	Inertia: Activation of inner active current feedback of voltage angle inertia control	0 or 1	1
J+58	AcCtl.AmpPsQFbEna	Inertia: Activation of inner reactive cur-rent feedback of voltage magnitude iner-tia control	0 or 1	1
J+59	Ac-Ctl.AmpDLim_VolPsNomLim	AC current control, active current limi-ation, voltage limit for accurate active power limitation	0 to 1	1
J+60	Ac-Ctl.AmpQLim_VolPsNomLim	AC current control, reactive current limi-ation, voltage limit for accurate reactive power limitation	0 to 1	1
J+61	AcCtl.AmpDQLimEna	AC current control, limiting controller ac-tivation	0 or 1	1
J+62	AcCtl.PriModPsRelEna	AC current control, Prioritization mode - positive sequence relative - for current limitation, activation	0 or 1	0
J+63	AcCtl.VolABKi	AC voltage control integral gain	n/a	120
J+64	AcCtl.VolABKp	AC voltage control Proportional gain **(PSS/E Specific)**	n/a	0.01
J+65	AcCtl.AmpDQFilTm	AC current control, DQ current filter time constant	3*timestep - n/a or 0	0.02
J+66	AcCtl.ParamFilTm	Inertia: Low pass filter time constant for smooth inertia parameter change	3*timestep - n/a or 0	10.0
J+67	AcCtl.PreFreezeDlTm	PreFreeze delay time [ms]	0 - 20	20.0
J+68	AcCtl.PreFreezeFilTm	PreFreeze filter time constant	3*timestep - n/a or 0	0.02
J+69	AcCtl.InertiaHzDmp	Inertia: Voltage frequency damping gain of voltage angle inertia control	n/a	-1.0
J+70	AcCtl.InertiaVolDmp	Inertia: Voltage magnitude damping gain of voltage magnitude inertia control	n/a	0.03
J+71	AcCtl.PlantLevelInertia	Enable plant level inertia	0 or 1	0
J+72	Frt.Frt_Mod	Grid forming FRT: Mode	1, 2, 3, 4	2

		1: GRIFORM_FRT_MOD_DISABLE 2: GRIFORM_FRT_MOD_FULL_VI 3:GRIFORM_FRT_MOD_FULL_VI_K_FAC_BASIC 4:GRIFORM_FRT_MOD_FULL_VI_K_FAC_ADVANCED		
J+73	Frt.LoVolOnLim	Grid forming FRT: Lower voltage limit for entering FRT Mode **(PSS/E Specific)**	0 to 1	0.8
J+74	Frt. HiVolOnLim	Grid forming FRT: Upper voltage limit for entering FRT Mode **(PSS/E Specific)**	1 to n/a	1.1
J+75	Frt.LoVolOffLim	Grid forming FRT: Lower voltage limit for return to normal mode	0 to 1	0.9
J+76	Frt.HiVolOffLim	Grid forming FRT: Upper voltage limit for return to normal mode	1 to 2	1.1
J+77	Frt.DynVolOnLimEna	Grid forming FRT: Activation of dynamic offset voltage limits for entering FRT mode **(PSS/E Specific)**	0 or 1	0
J+78	Frt.DynVolOffLimEna	Grid forming FRT: Activation of dynamic offset voltage limits for return to normal mode	0 or 1	0
J+79	Frt.VirtImpSwDetLim	Grid forming FRT: Current threshold for activation of virtual impedance	1 to 2	1.4
J+80	Frt.VirtImpDlTm	Grid forming FRT: Delay time for activation of virtual impedance	n/a	4
J+81	Frt.VirtImpLockTm	Grid forming FRT: Minimum duration time of virtual impedance	n/a	100
J+82	Frt.VirtImpWaitTm	Grid forming FRT: Minimum duration time for reactivation of virtual impedance	n/a	200
J+83	Frt.ResetTm	Time to jump back to initial state in FRT-Detection-Statemachine	n/a	30
J+84	Frt.AmpCtlEna	Grid forming FRT: Activation of adaptive current control	0 or 1	1.0
J+85	Frt.AMaxNomInit	Grid forming FRT: Init value of maximum short circuit current in the virtual impedance	n/a	1.0
J+86	Frt.AMaxNom	Grid forming FRT: maximum short circuit current	n/a	1.0
J+87	Frt.AmpCtlFilTm	Grid forming FRT: Adaptive current control, filter time constant	3*timestep - n/a or 0	0.004
J+88	Frt.CtlDevLimMax	Grid forming FRT: Adaptive apparent current control, maximum control deviation	n/a	0.2

J+89	Frt.NegCtlDev_Gain	Amplification or reduction of the negative control deviation of the VI controller	n/a	1
J+90	Frt.AmpCtlKp	Grid forming FRT: Adaptive current control, proportional gain	n/a	0.0
J+91	Frt.AmpCtlKi	Grid forming FRT: Adaptive current control, integral gain	n/a	10.0
J+92	Frt.VirtImpReact	Grid forming FRT: Virtual impedance, reactance	n/a	0.167
J+93	Frt.VirtImpReactMin	Grid forming FRT: Virtual impedance, minimum reactance	n/a	0.167
J+94	Frt.VirtImpReactFFWEna	Activation of the pre-control of the virtual reactance of the difference	0 or 1	1
J+95	Frt.VirtImpReactFFWFac	Grid forming FRT: Virtual impedance, factor of feedforward of virtual reactance	n/a	0.68
J+96	Frt.VirtImpRis	Grid forming FRT: Virtual impedance, resistance	n/a	0
J+97	Frt.VirtImpRisInit	Grid forming FRT: Virtual impedance, resistance, init Value	n/a	0.3
J+98	Frt.VirtImpRisFilTm	Grid forming FRT: Virtual impedance, time constant for decaying resistance	3*timestep - n/a	0.008
J+99	Frt.VolPsQFilTm	Grid forming FRT: VolPsQ control during virtual impedance, filter time constant of VolPsQ voltage	3*timestep - n/a	0.004
J+100	Frt.VolPsQCtlKp	Grid forming FRT: VolPsQ control during virtual impedance, proportional gain	n/a	-4.0
J+101	Frt.VolPsQCtlDZn	Grid forming FRT: VolPsQ Control during virtual impedance, limit of proportional zone gain	n/a	0.25
J+102	Frt.VolPsQCtlDZnKp	Grid forming FRT: VolPsQ Control during virtual impedance, proportional zone gain	n/a	0.0
J+103	Frt.VolPsQCtlHzOfsMax	Grid forming FRT: VolPsQ control during virtual impedance, maximum actuating variable in Hz	n/a	1.0
J+104	Frt.VolPsQCtrlEna	Value of the VolPsQ P controller	0 or 1	0.0
J+105	Frt.AMaxNomInitTm	Grid forming FRT: Initialization time of maximum short circuit current in the virtual impedance	n/a	0.0
J+106	Frt.ArmsMsMaxLim	Grid forming FRT: maximum limit for measured short circuit current in the virtual impedance	n/a	1.3

J+107	Frt.AmpCtlOfsKiFac	Grid forming FRT: Adaptive current control, factor of current control offset	n/a	4.0
J+108	Frt.AmpCtlOfsAMaxSpt	Grid forming FRT: Adaptive current control, maximum short circuit current of current control offset	n/a	1.3
J+109	Frt.VirtImpReactFFWOfs	Grid forming FRT: Virtual impedance, offset of feedforward of virtual reactance	n/a	0.03
J+110	Frt.KFacPs	Grid forming: K-Factor positive sequence	n/a	6.0
J+111	Frt.FFWVolFilTm	Grid forming FRT: Virtual impedance, time constant of voltage adjustment of feedforward of virtual reactance	n/a	0.001
J+112	Frt.AmpPsQPrioEna	Grid forming FRT: Virtual impedance, activation of the reactive current priority	0 or 1	1.0
J+113	Frt.PsDCtlRng	Grid forming FRT: Virtual impedance, amplification factor for limitation of the active current with reactive current priority	n/a	0.25
J+114	Frt.AmpPsDFFWMin	Grid forming FRT: Virtual impedance, minimum short circuit current of feedforward of virtual reactance	n/a	0.18
J+115	Frt.FFWAmpLimOfs	Grid forming FRT: Virtual impedance, short circuit current offset of feedforward of virtual reactance	n/a	0.03
J+116	Frt.EnaAmpPsDSptMan	Enable Manual setpoint for active current component	0 or 1	0.0
J+117	Frt.AmpPsDSptMan	Manual setpoint for active current component	n/a	0.0
J+118	Frt.AmpPsDFilTm	Grid forming FRT: Virtual impedance, time constant of the active current adjustmen	3*timestep - n/a or 0	0.3
J+119	Frt.AmpPsDMin	Grid forming FRT: Virtual impedance, current d axis positive sequence, maximum charge limit	n/a	-1.0
J+120	Frt.AmpPsQFilTm	Grid forming FRT: Virtual impedance, time constant of the reactive current adjustment	3*timestep - n/a or 0	0.3
J+121	OvAmp.AmpMaxNomSecFilTm	Overcurrent: Filter time constant of overcurrent factors	n/a	0.02
J+122	OvAmp.AmpMaxNomSec0Tm	Overcurrent: Duration in milliseconds for sector 0	n/a	76000
J+123	OvAmp.AmpMaxNomSec1Tm	Overcurrent: Duration in milliseconds for sector 1	n/a	100

J+124	OvAmp.AmpMaxNomSec2Tm	Overcurrent: Duration in milliseconds for sector 2	n/a	900
J+125	OvAmp.AmpMaxNomSec3Tm	Overcurrent: Duration in milliseconds for sector 3	n/a	4000
J+126	OvAmp.AmpMaxNomSec4Tm	Overcurrent: Duration in milliseconds for sector 4	n/a	9000
J+127	OvAmp.AmpMaxNomSec4TransTm	Overcurrent: Duration in milliseconds for sector 4 in transition mode	n/a	13900
J+128	OvAmp.AmpMaxNomSec4ThmDrtTm	Intermediate time within the fourth and last sector in the virtual impedance in milliseconds	n/a	2000
J+129	OvAmp.AmpMaxNomSec0	Overcurrent: Nominal current factor for maximum apparent current in sector 0	n/a	1
J+130	OvAmp.AmpMaxNomSec1	Overcurrent: Nominal current factor for maximum apparent current in sector 1	n/a	1.57
J+131	OvAmp.AmpMaxNomSec2	Overcurrent: Nominal current factor for maximum apparent current in sector 2	n/a	1.25
J+132	OvAmp.AmpMaxNomSec3	Overcurrent: Nominal current factor for maximum apparent current in sector 3	n/a	1.16
J+133	OvAmp.AmpMaxNomSec4	Overcurrent: Nominal current factor for maximum apparent current in sector 4	n/a	0.95
J+134	OvAmp.AmpMaxNomSec3Obs	Overcurrent: Nominal current factor for current observation to move in sector 3	n/a	1.0
J+135	OvAmp.AmpMaxNomSec4Obs	Overcurrent: Nominal current factor for current observation to move in sector 4	n/a	1.0
J+136	OvAmp.AmpMaxNomSec4ObsHys	Overcurrent: Nominal current factor for current Hysteresis observation to move in sector 4	n/a	0.03
J+137	OvAmp.AmpPsDMaxNomSec0	Overcurrent: Nominal current factor for maximum active current in sector 0	n/a	1
J+138	OvAmp.AmpPsDMaxNomSec1	Overcurrent: Nominal current factor for maximum active current in sector 1	n/a	1.57
J+139	OvAmp.AmpPsDMaxNomSec2	Overcurrent: Nominal current factor for maximum active current in sector 2	n/a	1.25
J+140	OvAmp.AmpPsDMaxNomSec3	Overcurrent: Nominal current factor for maximum active current in sector 3	n/a	1.16
J+141	OvAmp.AmpPsQMaxNomSec0	Overcurrent: Nominal current factor for maximum reactive current in sector 0	n/a	1.0
J+142	OvAmp.AmpPsQMaxNomSec1	Overcurrent: Nominal current factor for maximum reactive current in sector 1	n/a	1.57
J+143	OvAmp.AmpPsQMaxNomSec2	Overcurrent: Nominal current factor for maximum reactive current in sector 2	n/a	1.25

J+144	OvAmp.AmpPsQMaxNomSec3	Overcurrent: Nominal current factor for maximum reactive current in sector 3	n/a	1.16
J+145	OvAmp.VirtImpEna	Overcurrent: Activation of overcurrent for virtual impedance	0 or 1	0
J+146	OvAmp.AcCtlEna	Overcurrent: Activation of overcurrent for grid forming	0 or 1	0
J+147	OvAmp.AmpMaxNomInit	Overcurrent: Init value of nominal current factor for maximum apparent current in the virtual impedance	n/a	1.57
J+148	OvAmp.TmpStkFilTm	Time constant of the low-pass filtering of the stack temperature	3*timestep - n/a or 0	0.5
J+149	OvAmp.TmpLimNormal	Overcurrent: Temperature limit for normal mode	n/a	142
J+150	OvAmp.TmpLimTrans	Overcurrent: Temperature limit for transition mode	n/a	147
J+151	OvAmp.NormalModHysTm	Overcurrent: Duration of hysteresis to move from normal mode to emergency mode	n/a	1000
J+152	OvAmp.TransModHysTm	Time hysteresis in milliseconds for switching between emergency and transition mode	n/a	150
J+153	OvAmp.ChangeModHysTm	Time hysteresis in milliseconds for switching between modes	n/a	125
J+154	OvAmp.ArmsMsMaxLim	Overcurrent: Maximum limit for measured short circuit current in the virtual impedance	n/a	1.62
J+155	OvAmp.StkAmpLimOn	Overcurrent: Hardware current limit at which the FPGA activates the FRT	n/a	3000
J+156	OvAmp. AmpCtlOfsAMaxSpt	Overcurrent: Adaptive current control, maximum short circuit current of current control offset	n/a	1.62
J+157	Ctl.HzOutLim	AC and DC limit control, minimum/maximum range control signal [Hz]	n/a	5.0
J+158	Ctl.VolDQLim	Current setpoint calculation: voltage filter freeze limit, Grid forming modeGriF		
J+159	HW.OvAmpLimEna	Hardware current limit: Activation of overcurrent hardware current limits	0 or 1	0
J+160	HW.StkAmpLimOnFac	Calibration Factor for HW_StkAmpLimOn **(PSS/E Specific)**	n/a	10
J+161	HzCtl.Hi1Lim	Monitoring the power frequency: upper switch-off limit 1	n/a	51

J+162	HzCtl.Hi1LimTm	Monitoring the power frequency: waiting time upper switch-off limit 1	n/a	1000
J+163	HzCtl.Hi2Lim	Monitoring the power frequency: upper switch-off limit 2	n/a	55
J+164	HzCtl.Hi2LimTm	Monitoring the power frequency: waiting time upper switch-off limit 2	n/a	10000
J+165	HzCtl.Hi3Lim	Monitoring the power frequency: upper switch-off limit 3	n/a	55
J+166	HzCtl.Hi3LimTm	Monitoring the power frequency: waiting time upper switch-off limit 3	n/a	10000
J+167	HzCtl.Hi4Lim	Monitoring the power frequency: upper switch-off limit 4	n/a	55
J+168	HzCtl.Hi4LimTm	Monitoring the power frequency: waiting time upper switch-off limit 4	n/a	10000
J+169	HzCtl.Hi5Lim	Monitoring the power frequency: upper switch-off limit 5	n/a	55
J+170	HzCtl.Hi5LimTm	Monitoring the power frequency: waiting time upper switch-off limit 5	n/a	10000
J+171	HzCtl.Hi6Lim	Monitoring the power frequency: upper switch-off limit 6	n/a	55
J+172	HzCtl.Hi6LimTm	Monitoring the power frequency: waiting time upper switch-off limit 6	n/a	10000
J+173	HzCtl.Lo1Lim	Monitoring the power frequency: lower switch-off limit 1	n/a	49
J+174	HzCtl.Lo1LimTm	Monitoring the power frequency: waiting time lower switch-off limit 1	n/a	1000
J+175	HzCtl.Lo2Lim	Monitoring the power frequency: lower switch-off limit 2	n/a	45
J+176	HzCtl.Lo2LimTm	Monitoring the power frequency: waiting time lower switch-off limit 2	n/a	10000
J+177	HzCtl.Lo3Lim	Monitoring the power frequency: lower switch-off limit 3	n/a	45
J+178	HzCtl.Lo3LimTm	Monitoring the power frequency: waiting time lower switch-off limit 3	n/a	10000
J+179	HzCtl.Lo4Lim	Monitoring the power frequency: lower switch-off limit 4	n/a	45
J+180	HzCtl.Lo4LimTm	Monitoring the power frequency: waiting time lower switch-off limit 4	n/a	10000
J+181	HzCtl.Lo5Lim	Monitoring the power frequency: lower switch-off limit 5	n/a	45
J+182	HzCtl.Lo5LimTm	Monitoring the power frequency: waiting time lower switch-off limit 5	n/a	10000

J+183	HzCtl.Lo6Lim	Monitoring the power frequency: lower switch-off limit 6	n/a	45
J+184	HzCtl.Lo6LimTm	Monitoring the power frequency: waiting time lower switch-off limit 6	n/a	10000
J+185	VCtl.Hi1Lim	Monitoring the grid voltage: upper switch-off limit 1	n/a	1.15
J+186	VCtl.Hi1LimTm	Monitoring the grid voltage: waiting time upper switch-off limit 1	n/a	1000
J+187	VCtl.Hi2Lim	Monitoring the grid voltage: upper switch-off limit 2	n/a	1.3
J+188	VCtl.Hi2LimTm	Monitoring the grid voltage: waiting time upper switch-off limit 2	n/a	100
J+189	VCtl.Hi3Lim	Monitoring the grid voltage: upper switch-off limit 3	n/a	2.0
J+190	VCtl.Hi3LimTm	Monitoring the grid voltage: waiting time upper switch-off limit 3	n/a	10000
J+191	VCtl.Hi4Lim	Monitoring the grid voltage: upper switch-off limit 4	n/a	2.0
J+192	VCtl.Hi4LimTm	Monitoring the grid voltage: waiting time upper switch-off limit 4	n/a	10000
J+193	VCtl.Hi5Lim	Monitoring the grid voltage: upper switch-off limit 5	n/a	2.0
J+194	VCtl.Hi5LimTm	Monitoring the grid voltage: waiting time upper switch-off limit 5	n/a	10000
J+195	VCtl.Hi6Lim	Monitoring the grid voltage: upper switch-off limit 6	n/a	2.0
J+196	VCtl.Hi6LimTm	Monitoring the grid voltage: waiting time upper switch-off limit 6	n/a	10000
J+197	VCtl.Lo1Lim	Monitoring the grid voltage: lower switch-off limit 1	n/a	0.8
J+198	VCtl.Lo1LimTm	Monitoring the grid voltage: waiting time lower switch-off limit 1	n/a	1000
J+199	VCtl.Lo2Lim	Monitoring the grid voltage: lower switch-off limit 2	n/a	0.45
J+200	VCtl.Lo2LimTm	Monitoring the grid voltage: waiting time lower switch-off limit 2	n/a	300
J+201	VCtl.Lo3Lim	Monitoring the grid voltage: lower switch-off limit 3	n/a	0.0
J+202	VCtl.Lo3LimTm	Monitoring the grid voltage: waiting time lower switch-off limit 3	n/a	1000
J+203	VCtl.Lo4Lim	Monitoring the grid voltage: lower switch-off limit 4	n/a	0.0

J+204	VCtl.Lo4LimTm	Monitoring the grid voltage: waiting time lower switch-off limit 4	n/a	1000
J+205	VCtl.Lo5Lim	Monitoring the grid voltage: lower switch-off limit 5	n/a	0.0
J+206	VCtl.Lo5LimTm	Monitoring the grid voltage: waiting time lower switch-off limit 5	n/a	1000
J+207	VCtl.Lo6Lim	Monitoring the grid voltage: lower switch-off limit 6	n/a	0.0
J+208	VCtl.Lo6LimTm	Monitoring the grid voltage: waiting time lower switch-off limit 6	n/a	1000
J+209	Spk.dVol	1-time step change in voltage to activation entry and exit of spike mitigation logic **(PSS/E Specific)**	0.1 – 2.0	0.3
J+210	Spk.AmpHoldTm	Time in seconds during which the current is held to its [Pre-fault Value*Spk.AmpHoldFac(X)] **(PSS/E Specific)**	0 – 0.1	0.005
J+211	Spk.AmpHoldFacD	Factor to scale the active part of Pre-fault value between 0.0 and [Pre-fault value] **(PSS/E Specific)**	0 to 1.0	0.0
J+212	Spk.AmpHoldFacQ	Factor to scale the reactive part of Pre-fault value between 0.0 and [Pre-fault value] **(PSS/E Specific)**	0 to 1.0	0.0
J+213	SoC. DcVolIni	SoC Model: Initial value of the DC voltage for battery in kV **(PSS/E Specific)**	n/a	1.1
J+214	SoC. DcVolMax	SoC Model: Maximum value of the DC voltage for battery in kV **(PSS/E Specific)**	n/a	1.3
J+215	SoC. DcVolMin	SoC Model: Minimum value of the DC voltage for battery in kV **(PSS/E Specific)**	n/a	0.8
J+216	SoC. DcAh	SoC Model: Capacity of the battery in Ah **(PSS/E Specific)**	n/a	1e4
J+217	DcCtl.AmpKp	DC current control, proportional amplification, Grid forming mode	n/a	0.0
J+218	DcCtl.AmpKi	DC current control, integral amplification, Grid forming mode	n/a	5.0
J+219	DcCtl.AmpKi2Fac	DC current control, double integral amplification for DC current limit, Grid forming mode	n/a	0.00033
J+220	DcCtl.AmpI2CtlDownGain	DC current control, additional double integral amplification, if DC current limit is not exceeded, Grid forming mode	n/a	3.0

2.4.3 VARs

Table 4: List of VARs

VARs	Description
L+0	WSpt – Use this VAR to set active power setpoint when ICON(M) is set to 0
L+1	VarSpt – Use this VAR to set reactive power setpoint when ICON(M) is set to 0
L+2	FrqSpt - Use this VAR to set frequency setpoint
L+3	VolSpt - Use this VAR to set voltage setpoint
L+4	TmpStk – Use this VAR to set the temperature of stack – Default is 119 degrees
L+5	Xpu – X part of impedance for current injection – should be equal to X for gen. in LF
L+6	Rpu - R part of impedance for current injection – should be equal to R for gen. in LF
L+7	Unused
L+8	Unused
L+9	SetpointChangeFlag – Flag to detect setpoint change when ICON(M) is set to 0
L+10	Meas1.Vinv_d – d-axis inverter terminal voltage
L+11	Meas1.Vinv_q – q-axis inverter terminal voltage
L+12	Meas1.Iinv_d – d-axis inverter current
L+13	Meas1.Iinv_q – q – axis inverter current
L+14	Vth_r – real part of thevenin voltage applied in the current injection routine
L+15	Vth_i – imaginary part of thevenin voltage applied in the current injection routine
L+16	FRTDetect – Flag to Check whether FRT is enabled or not
L+17	VI_X – reactive part of Virtual impedance when in FRT
L+18	VI_R – real part of Virtual impedance when in FRT
L+19	Unused
L+20	AmpDQRtg
L+21	StkAmpLimOn
L+22	PreFaultCurrD
L+23	PreFaultCurrQ
L+24	SpikeFlagOn
L+25	SpikeFlagOff
L+26	SpikeTimer
L+27	Meas1.Pinv_hold
L+28	Meas1.Qinv_hold
L+29	Unused
L+30	VCtlHi1Lim_Out – Flag to check whether High Voltage Protection 1 is activated
L+31	VCtlHi1Lim_timer
L+32	VCtlHi2Lim_Out - Flag to check whether High Voltage Protection 2 is activated
L+33	VCtlHi2Lim_timer
L+34	VCtlHi3Lim_Out - Flag to check whether High Voltage Protection 3 is activated

L+35	VCtlHi3Lim_timer
L+36	VCtlHi4Lim_Out - Flag to check whether High Voltage Protection 4 is activated
L+37	VCtlHi4Lim_timer
L+38	VCtlHi5Lim_Out - Flag to check whether High Voltage Protection 5 is activated
L+39	VCtlHi5Lim_timer
L+40	VCtlHi6Lim_Out - Flag to check whether High Voltage Protection 6 is activated
L+41	VCtlHi6Lim_timer
L+42	VCtlLo1Lim_Out - Flag to check whether Low Voltage Protection 1 is activated
L+43	VCtlLo1Lim_timer
L+44	VCtlLo2Lim_Out - Flag to check whether Low Voltage Protection 2 is activated
L+45	VCtlLo2Lim_timer
L+46	VCtlLo3Lim_Out - Flag to check whether Low Voltage Protection 3 is activated
L+47	VCtlLo3Lim_timer
L+48	VCtlLo4Lim_Out - Flag to check whether Low Voltage Protection 4 is activated
L+49	VCtlLo4Lim_timer
L+50	VCtlLo5Lim_Out - Flag to check whether Low Voltage Protection 5 is activated
L+51	VCtlLo5Lim_timer
L+52	VCtlLo6Lim_Out - Flag to check whether Low Voltage Protection 6 is activated
L+53	VCtlLo6Lim_timer
L+54	HzCtlHi1Lim_Out - Flag to check whether High Frequency Protection 1 is activated
L+55	HzCtlHi1Lim_timer
L+56	HzCtlHi2Lim_Out - Flag to check whether High Frequency Protection 2 is activated
L+57	HzCtlHi2Lim_timer
L+58	HzCtlHi3Lim_Out - Flag to check whether High Frequency Protection 3 is activated
L+59	HzCtlHi3Lim_timer
L+60	HzCtlHi4Lim_Out - Flag to check whether High Frequency Protection 4 is activated
L+61	HzCtlHi4Lim_timer
L+62	HzCtlHi5Lim_Out - Flag to check whether High Frequency Protection 5 is activated
L+63	HzCtlHi5Lim_timer
L+64	HzCtlHi6Lim_Out - Flag to check whether High Frequency Protection 6 is activated
L+65	HzCtlHi6Lim_timer
L+66	HzCtlLo1Lim_Out - Flag to check whether Low Frequency Protection 1 is activated
L+67	HzCtlLo1Lim_timer
L+68	HzCtlLo2Lim_Out - Flag to check whether Low Frequency Protection 2 is activated
L+69	HzCtlLo2Lim_timer
L+70	HzCtlLo3Lim_Out - Flag to check whether Low Frequency Protection 3 is activated
L+71	HzCtlLo3Lim_time
L+72	HzCtlLo4Lim_Out - Flag to check whether Low Frequency Protection 4 is activated
L+73	HzCtlLo4Lim_timer
L+74	HzCtlLo5Lim_Out - Flag to check whether Low Frequency Protection 5 is activated
L+75	HzCtlLo5Lim_timer

L+76	HzCtlLo6Lim_Out - Flag to check whether Low Frequency Protection 6 is activated
L+77	HzCtlLo6Lim_timer
L+78	Control_Angle
L+79	Inverter_Voltage_Angle
L+80	CosPhi
L+81	SinPhi
L+82	Meas1.Vinv_d
L+83	Meas1.Vinv_q
L+84	Meas1.Vth_d
L+85	Meas1.Vth_q
L+86	Meas1.Iinv_d
L+87	Meas1.Iinv_q
L+88	AmaxSpt
L+89	Vmag_Filt
L+90	Vmag.Filt
L+91	Result_enaGoToSec2
L+92	ErrorCounter1
L+93	Result_enaGoToSec3
L+94	ErrorCounter2
L+95	Result_enaGoToSec4
L+96	ErrorCounter3
L+97	Result_enaGoToSec3FromSec0
L+98	ErrorCounter4
L+99	TempStk_Filt
L+100	CounterSec0
L+101	OvAmpStt
L+102	SubStt
L+103	noOvercurrentStt
L+104	HWTresholdHi
L+105	EnaThmDerating
L+106	AmaxNom
L+107	AmaxNomD
L+108	AmaxNomQ
L+109	AmaxNomInit
L+110	HysMode
L+111	HysMode_timer
L+112	TmpAcCtlOvAmpActive
L+113	Unused
L+114	disaOverCurrent_delay
L+115	AmaxNom_filt
L+116	AmaxNomD_filt

L+117	AmaxNomQ_filt
L+118	AMaxSpt
L+119	StkAmpLimOn
L+120	Vinv_d_filt
L+121	Vinv_q_filt
L+122	SW_FRT
L+123	SW_FRT_timer
L+124	VirtImpEna
L+125	FRT_States_timer
L+126	VirtImpEna_delay
L+127	Local_ResetTm_timer
L+128	AmaxSpt_Filt
L+129	AmpMax_Filt
L+130	Meas.Iinv_q_Filt
L+131	VI_X_PiCtrlWithLimit_Out
L+132	VI_X_PiCtrl_Integrator
L+133	VI_R_Filt
L+134	Iinv_d_filt
L+135	Iinv_q_filt
L+136	VI_X
L+137	VI_R
L+138	AmaxSpt_Filt2
L+139	AmaxSpt_timer
L+140	FFW_VolDiff_Filt
L+141	FFW_VI_X1_delay
L+142	VolPsDSpt_Ofs
L+143	VI_AmpPsDSpt
L+144	AWFFWAmpPsD
L+145	VolPsQSpt_Ofs
L+146	Soc_sat
L+147	DCVol
L+148	CtlOut_P_Dc
L+149	CtlOut_I_Dc
L+150	Ki_max_hold
L+151	Ki_min_hold
L+152	PiCtrlWithLimit_Output
L+153	PiCtrl_Integrator
L+154	PiCtrl_Integrator2
L+155	PiCtrl_Integrator3
L+156	PiCtrlWithLimit_Output
L+157	PiCtrl_Integrator

L+158	PiCtrl_Integrator2
L+159	PiCtrl_Integrator3
L+160	CtlOut_Dc
L+161	AmpDOfs_DcLim_Stt
L+162	Iinv_d_fil
L+163	Iinv_q_fil
L+164	Vmag_fil1
L+165	Vmag_fil2
L+166	CtlOut_P_D
L+167	CtlOut_I_D
L+168	Ki_max_hold
L+169	Ki_min_hold
L+170	PiCtrlWithLimit_Output
L+171	PiCtrl_Integrator
L+172	PiCtrl_Integrator2
L+173	PiCtrl_Integrator3
L+174	PiCtrlWithLimit_Output
L+175	PiCtrl_Integrator
L+176	PiCtrl_Integrator2
L+177	PiCtrl_Integrator3
L+178	CtlOut_D
L+179	CtlOut_P_Q
L+180	CtlOut_I_Q
L+181	Ki_max_hold
L+182	Ki_min_hold
L+183	PiCtrlWithLimit_Output
L+184	PiCtrl_Integrator
L+185	PiCtrl_Integrator2
L+186	PiCtrl_Integrator3
L+187	PiCtrlWithLimit_Output
L+188	PiCtrl_Integrator
L+189	PiCtrl_Integrator2
L+190	PiCtrl_Integrator3
L+191	CtlOut_Q
L+192	VirtImpEna_delay
L+193	WAval
L+194	VarAval
L+195	IC1_Delay
L+196	IC2_Delay
L+197	IC1_Delay
L+198	IC2_Delay

L+199	AmpDOfs_DrtStt
L+200	AmpQOfs_DrtStt
L+201	WSptOut
L+202	VarSptOut
L+203	WSptFilt
L+204	VarSptFilt
L+205	Ud_filt
L+206	Uq_filt
L+207	AmpPsDSpt
L+208	AmpPsQSpt
L+209	dHz
L+210	dTheta
L+211	dVol
L+212	Iinv_d_filt
L+213	Iinv_q_filt
L+214	Vmag.filt
L+215	DrpAmpDFilTm_filt
L+216	HPF_Filt_out_dHz
L+217	dHz_HPF_delay
L+218	DrpAmpDFilTm2_filt
L+219	HPF_Filt_out_dHz2
L+220	dHz2_HPF_delay
L+221	DrpAmpD_filt
L+222	InteriaPhsCtl_Kp_filt
L+223	InteriaPhsCtl_Ki_filt
L+224	AmpPsD_int
L+225	DrpAmpQFilTm_filt
L+226	HPF_Filt_out_dVol
L+227	dVol_HPF_delay
L+228	DrpAmpQFilTm2_filt
L+229	HPF_Filt_out_dVol2
L+230	dVol2_HPF_delay
L+231	DrpAmpQ_filt
L+232	InteriaVolCtl_Kp_filt
L+233	InteriaVolCtl_Ki_filt
L+234	AmpPsQ_int
L+235	dAmpD_filt
L+236	DrpHz_Filt
L+237	DrpTheta_Filt
L+238	DrpVol_Filt
L+239	Vinv_q_filt

L+240	VirtImpEna_delay
L+241	dHz_out
L+242	dHz_filt
L+243	dHz_Filt_delay1
L+244	dHz_Filt_delay2
L+245	dHz_Filt_delay3
L+246	dHz_Filt_delay4
L+247	dHz_Filt_delay5
L+248	dHz_Filt_delay6
L+249	dHz_Filt_delay7
L+250	dHz_Filt_delay8
L+251	dHz_Filt_delay9
L+252	dHz_Filt_delay10
L+253	dHz_Filt_delay11
L+254	dHz_Filt_delay12
L+255	dHz_Filt_delay13
L+256	dHz_Filt_delay14
L+257	dHz_Filt_delay15
L+258	dHz_Filt_delay16
L+259	dHz_Filt_delay17
L+260	dHz_Filt_delay18
L+261	dHz_Filt_delay19
L+262	dHz_Filt_delay20
L+263	dHz_Filt_delay21
L+264	dTheta_out
L+265	dTheta_filt
L+266	dTheta_Filt_delay1
L+267	dTheta_Filt_delay2
L+268	dTheta_Filt_delay3
L+269	dTheta_Filt_delay4
L+270	dTheta_Filt_delay5
L+271	dTheta_Filt_delay6
L+272	dTheta_Filt_delay7
L+273	dTheta_Filt_delay8
L+274	dTheta_Filt_delay9
L+275	dTheta_Filt_delay10
L+276	dTheta_Filt_delay11
L+277	dTheta_Filt_delay12
L+278	dTheta_Filt_delay13
L+279	dTheta_Filt_delay14
L+280	dTheta_Filt_delay15

L+281	dTheta_Filt_delay16
L+282	dTheta_Filt_delay17
L+283	dTheta_Filt_delay18
L+284	dTheta_Filt_delay19
L+285	dTheta_Filt_delay20
L+286	dTheta_Filt_delay21
L+287	dVol
L+288	dVol_filt
L+289	dVol_Filt_delay1
L+290	dVol_Filt_delay2
L+291	dVol_Filt_delay3
L+292	dVol_Filt_delay4
L+293	dVol_Filt_delay5
L+294	dVol_Filt_delay6
L+295	dVol_Filt_delay7
L+296	dVol_Filt_delay8
L+297	dVol_Filt_delay9
L+298	dVol_Filt_delay10
L+299	dVol_Filt_delay11
L+300	dVol_Filt_delay12
L+301	dVol_Filt_delay13
L+302	dVol_Filt_delay14
L+303	dVol_Filt_delay15
L+304	dVol_Filt_delay16
L+305	dVol_Filt_delay17
L+306	dVol_Filt_delay18
L+307	dVol_Filt_delay19
L+308	dVol_Filt_delay20
L+309	dVol_Filt_delay21
L+310	VolPsDSpt
L+311	VolPsDSpt_rate
L+312	Vinv_d
L+313	Vinv_q
L+314	Vinv_d_FRT
L+315	Vinv_q_FRT
L+316	Vinv_d_filt
L+317	Vinv_q_filt
L+318	Vinv_d_int
L+319	Vinv_q_int
L+320	Iinv_d_filt
L+321	Iinv_q_filt

L+322	ur
L+323	ui

3 Disclaimer

This document and the associated models have been prepared to facilitate the behavioral simulation of the response of SMA Sunny Central inverters to grid and parameter disturbances. The modeling data presented herein are intended to produce simulation results that closely approximate the response of the inverters to these disturbances, and do not necessarily represent the physical implementation of the inverter or plant control algorithms.