Documentation

Description of the model of the Fortran Based SMA Hybrid Controller for power flow and stability studies in PSS®E

Model Generation G
Document Revision 10
Feb 06, 2024

Note

The following PSS®E versions are currently supported:

- version 32 (Intel Visual Fortran Compiler 11.1),
- version 33 (Intel Visual Fortran Compiler 11.1),
- version 34 (Intel Visual Fortran Compiler 11.1 and Intel Visual Fortran Compiler 15.0 (x86)).

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

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

SMAHYCF_*AR*_*P*_Cc.obj is the model object file of SMAHYCF, where *A* is the model generation, *R* is model revision, *P* is the PSS®E version for which the model was built, C is the compiler type, c is the compiler revision. (e.g. SMAHYCF_G10_34_IVF111.obj is model generation G in revision 1.0 for PSS®E version 34, compiled with Intel Visual Fortran Compiler 11.1).

Model version	**Description**
G1.0	First release of SMAHYCF for PSS®E Note: This model does not contain the implementation of Hybrid functionality in this version. Also, functionalities of FCAS are not implemented in this model so parameters related to these functions are 'don't care'
G1.1	1. P, Q Measurement filters using PT1_psse were moved from MW to pu for removing the DSTATE errors 2. Introduction of Meas structure to segregate all V, f, P, Q measurements within one structure
G1.2	Addition of Grid Voltage Control functionality Addition of Hybrid Control Functionality Addition of DC-DC only to Sys Cfg and associated functionality with DC-DC systems BugFix: MIDTRM line of code. Was not working properly. Giving error "Model is not available in MSTRT & MRUN" Removal of "Use Kernel32", "Use INTRINSIC" and "IMPLICIT NONE" to be compilable with PSS/E 35
G1.3	1. Addition of a separate Bus for voltage measurement 2. Addition of FCAS and HandlePrioFrqResp
G1.4	1. BugFix: PF control mode rectified
G1.5	1. Update to software release v17 2. BugFix : Docu() function returns an incorrect number of CONs and VARs. 3. Provision of reverse P, Q measurement to take into account the removal of dummy bus line/tie line 4. Fixing of active power limits based on reactive power setpoint 5. Additional three PVFro – PVTo and BESSFro – BESSTo buses to take into account multiple PV and BESS inverters 6. Bug fix in the RampPVBatMaxMin function 7. Changed the logic for turning VAR(L+47) high
G1.6	1. Update to firmware version 18 and 19 2. Removed un-used CONS from the structures to remove confusion for the user 3. Q(P) Limitation function - part of firmware 19 in PwrApPrioModeAt
G1.7	1. BugFix: Initialization issue with SMAGF model
G1.8	1. BugFix: Misalignment of VARs for AutoPoicontrolMode_PoCo 2. BugFix: Frt Detection Bus filter not added.
G1.9	1. Change of flag L+47 to 1.0 when there is a setpoint change instead of using KPAUSE

	2. Modification of initialization of Hybrid PoCo Logic
G2.0	1. Removal of Pv available power switch when L+47 turns high 2. Reduction of threshold for detection of frequency change used for turning L+47 to 1.0 3. Removal of filter over voltage at PCC measurement and voltage over FRT bus 4. Introduction of CON(J+20) as PvSetpoint

Model validity

For simulation of the SMA Sunny Central solar and storage inverters the model "SMASC" must be used.

Contents

1 Introduction and background

This document is intended to provide guidance to the PSS®E user in deploying the SMA Hybrid Controller model for controlling various quantities of battery storage or photovoltaic (PV) solar parks at the point of common coupling (PCC, or point of interconnection, POI). Combination of storage and PV components is possible, too.

2 Dynamic model

The Fortran Based Hybrid Controller model has been implemented as a PSS®E User Bus model ('USRBUS') called "SMAHYCF" (s. Figure 1).

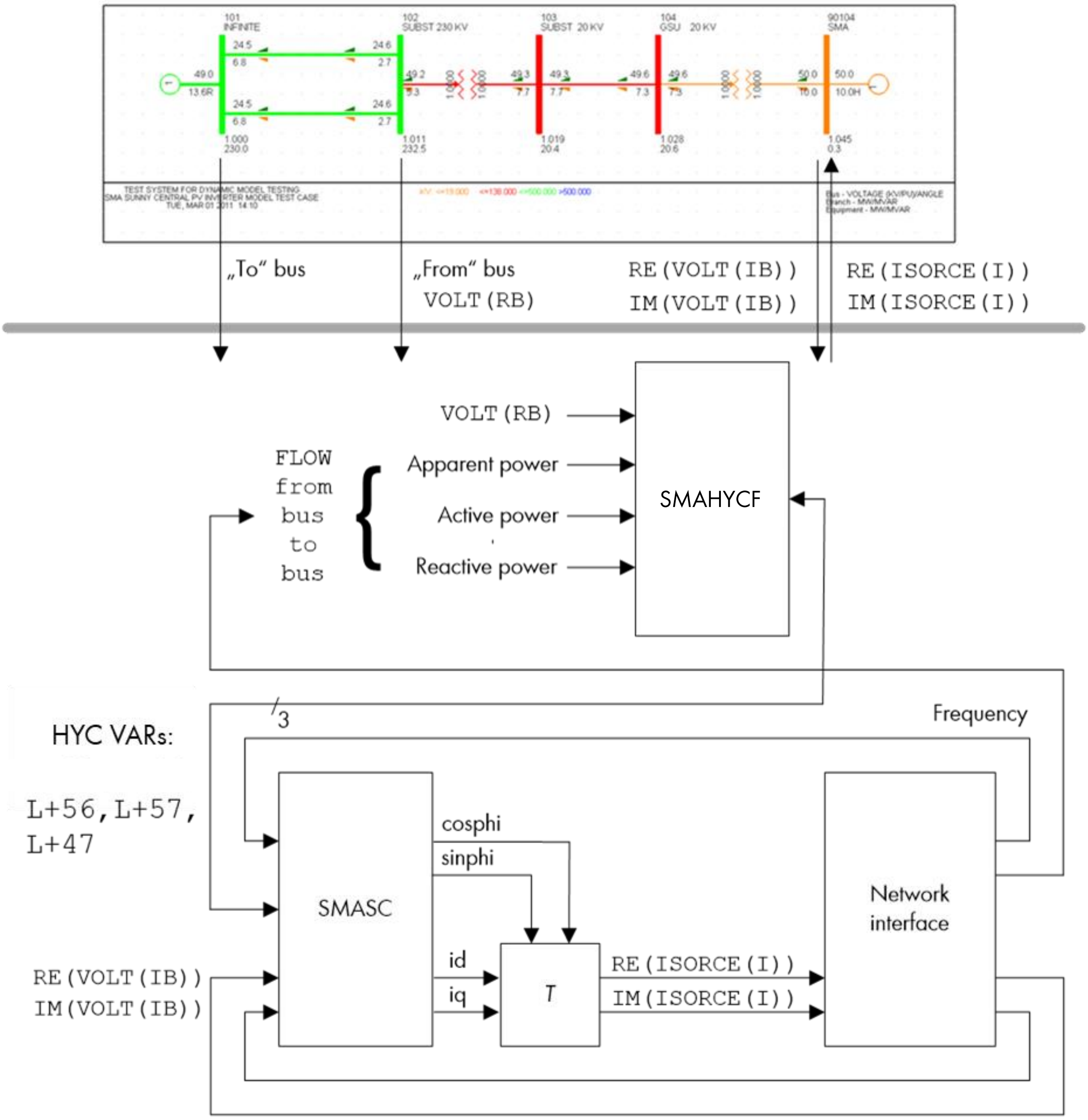

Figure 1: Hybrid Controller block diagram.

The model has three sources of excitation which are: the grid voltage magnitude at the "remote" bus and the active and reactive power flowing from the "from" bus to the "to" bus. The "remote" bus is the bus whose voltage must be controlled by the Hybrid Controller (HC). The "from" bus is the bus from which the active power and the reactive power are flowing to the "to" bus – were the active and reactive power are quantities to be controlled by the HC. The model's outputs are the actuating variables active and reactive power which are sent to the inverter model SMASC using the SMAHYC's VAR(L+56) and VAR(L+57) in case of PV generator and VAR(L+58) and VAR(L+59) in case of Battery generator.

Please note the quantities measured at the POI can be accessed through variables VAR(L+1) ... VAR(L+3).

Please find below the architecture of a PV + BESS plant and its associated configuration in correspondence with the ICONs and CONs.

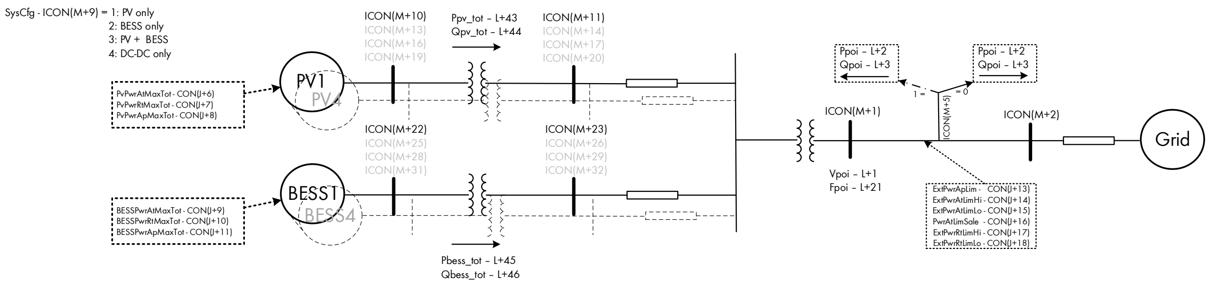

Figure 2: Hybrid Controller Configuration.

2.1 Initialization

SMAHYC initializes from the steady-state solution and adjusts all internal variables and states accordingly provided the active, reactive, apparent power limits are not exceeded. If that's the case, then a flat run is not possible and the hybrid controller will try to adjust the active power and reactive power in such a way that the associated power is within the limits.

2.2 Dyr file entry

The model's dyr file entry is as follows:

BusNum 'USRBUS' 1 'SMAHYCF20' 504 0 34 252 10 404 FBN TBN -1 1 ICON(M+4) ICON(M+5) ... ICON(M+33) CON(J) CON(J+1) ... CON(J+251)

FBN: "FromBusNumber"

TBN: "ToBusNumber"

2.3 Reference Changes to the Model

Following VARs can be used to change the various references to the Hycon Model

1. VAR(L+18) – Active power reference change at Poi in case of PV or Hybrid system

2. VAR(L+13) - Active power reference change at Poi in case of BESS System or for BESS setpoint in case of Hybrid systems

3. VAR(L+14) – Reactive power reference change at Poi in case of both PV, BESS or Hybrid systems

4. VAR(L+16) – Voltage reference change at Poi (Used for VtgPwrRtDroop, GridVtgCtrl)

5. VAR(L+17) – Frequency reference change at Poi (Used for FrqDroop, FCASCont)

6. VAR(L+15) – Power Factor reference change at Poi (Used for FixCosPhi)

2.4 Model parameters

In this section there is given a standard parameterization only. Please consider contacting SMA to obtain the parameter set for the controller that must be simulated in your study.

2.4.1 ICONs

ICON	Parameter	Description	Default
M	RBus	Bus number of the remotely voltage regulated bus (The voltage measurement at this bus is used for functions like FrtDetection, VoltageDroop, GridVtgControl, etc)	
M+1	FroBus	Bus number of the PCC from bus (P, Q are measured between FroBus and ToBus and used as measurement value for various functions)	n/a
M+2	ToBus	Bus number of the PCC to bus (P, Q are measured between FroBus and ToBus and used as measurement value for various functions)	n/a
M+3	CID	Circuit id for power measurement routine FLOW	-1
M+4	FrtBusNumber	Bus number of the Frt detection bus. Set this to the bus number whose voltage you want to use for Frt detection. Else set it 0. In that case RBus will be used for Frt detection	0
M+5	PowerFlowReverse	Reverse the power flow measured using PCC From and To Bus (Set this to 1 if you would like to reverse the power flow measured. This is provided in case you don't want to have a dummy tie line at PCC or have a T-connection at the PCC	0
M+6	Reserved	Reserved	0
M+7	OUTPUT_LOG_EN	Enable output write to LPDEV	1
M+8	Reserved	Reserved	0
M+9	SysCfg	1: PV only 2: BESS only 3: PV/BESS Hybrid configuration 4: DC-DC configuration	
M+10	PV1_Fro	Bus number of the PV1 from bus	
M+11	PV1_To	Bus number of the PV1 to bus	
M+12	CID	Circuit id for power measurement routine FLOW	
M+13	PV2_Fro	Bus number of the PV2 from bus	
M+14	PV2_To	Bus number of the PV2 to bus	

M+15	CID	Circuit id for power measurement routine FLOW	
M+16	PV3_Fro	Bus number of the PV3 from bus	
M+17	PV3_To	Bus number of the PV3 to bus	
M+18	CID	Circuit id for power measurement routine FLOW	
M+19	PV4_Fro	Bus number of the PV4 from bus	
M+20	PV4_To	Bus number of the PV4 to bus	
M+21	CID	Circuit id for power measurement routine FLOW	
M+22	BESS1_Fro	Bus number of the BESS1 from bus	
M+23	BESS1_To	Bus number of the BESS1 to bus	
M+24	CID	Circuit id for power measurement routine FLOW	
M+25	BESS2_Fro	Bus number of the BESS2 from bus	
M+26	BESS2_To	Bus number of the BESS2 to bus	
M+27	CID	Circuit id for power measurement routine FLOW	
M+28	BESS3_Fro	Bus number of the BESS3 from bus	
M+29	BESS3_To	Bus number of the BESS3 to bus	
M+30	CID	Circuit id for power measurement routine FLOW	
M+31	BESS4_Fro	Bus number of the BESS4 from bus	
M+32	BESS4_To	Bus number of the BESS4 to bus	
M+33	CID	Circuit id for power measurement routine FLOW	

2.4.2 CONs

CON	Parameter	Description	Default
J+0	CycleTime	Hybrid Controller cycle time in s	40
J+1	Poi_freq_flt_tm	Frequency measurement filter time constant in s	0.02
J+2	Poi_power_flt_tm	Power and Voltage measurement filter time constant in s	0.02
J+3	Poi_Base_KV	POI base V	-
J+4	HyconToInv_AtPwr_TmDelay	HYC to inverter comm time delay in s (Active Power) implemented as PT1 filter	0.02
J+5	HyconToInv_RtPwr_TmDelay	HYC to inverter comm time delay in s (Reactive Power) implemented as PT1 filter	0.02
J+6	PvPwrAtMaxTot	Cumulative PV active power rating in kW	-

J+7	PvPwrRtMaxTot	Cumulative PV reactive power rating in kVAr (0.6 times the PvPwrAtMaxTot)	-
J+8	PvPwrApMaxTot	Cumulative PV apparent power rating in kVA	-
J+9	BESSPwrAtMaxTot	Cumulative BESS active power rating in kW	-
J+10	BESSPwrRtMaxTot	Cumulative BESS reactive power rating in kVAr (0.6 times the BESSPwrAtMaxTot)	-
J+11	BESSPwrApMaxTot	Cumulative BESS apparent power rating in kVA	-
J+12	Reserved	Reserved	-
J+13	ExtPwrApLim	Apparent power limitation at PCC in kVA	-
J+14	ExtPwrAtLimHi	Maximum active power limitation at PCC in kW	-
J+15	ExtPwrAtLimLo	Minimum active power limitation at PCC in kW	-
J+16	PwrAtLimSale	Maximum active power limitation (Sales) at PCC in kW	-
J+17	ExtPwrRtLimHi	Maximum reactive power limitation at PCC in kVAr	-
J+18	ExtPwrRtLimLo	Minimum reactive power limitation at PCC in kVAr	-
J+19	QVARScale	Please set this to 0.6	0.6
J+20	PvPwrAtSpt	If this CON is set to 0.0, then PvTarget is equal to cumulative load flow PV power else it is equal to 'PvPwrAtSpt in kW. This CON is only relevant in case of Hybrid systems. The Hycon will try to increase the Pv active power to its PvTarget in case the PV has a higher priority compared to Battery. You can set this equal to CON(J+8) if you don't want to restrict the PV power to its load flow value.	0.0
J+21	Reserved		-
J+22	Reserved		-
J+23	Reserved		-
J+24	BatPwrAtCtrl.CtrlKi	Control parameter integral gain for the power PI controller	0.4
J+25	BatPwrAtCtrl.CtrlKp	Control parameter proportional gain for the power PI controller	0
J+26	BatPwrAtCtrl.DynSpntSwitchHysPc	Hysteresis for switching to the limit if measurement exceeds the limit, in % of PwrAtNomPoi	0
J+27	BatPwrAtCtrl.Ena	Enables the PI controller for active power control	0

J+28	BatPwrAtCtrl.EnaAdapCtrl	Enables adaptive control (Yes: related to the connected nominal device power / No: related to PwrAtRtNomPoi	1
J+29	BatPwrAtCtrl.EnaDynSpntSwitch	Enables dynamic setpoint switching if limits are exceeded	0
J+30	BatPwrAtCtrl.EnaStepReset	Enables resetting of the integrator if step change is detected	0
J+31	BatPwrAtCtrl.FeedForwardOffset	A constant offset which will be added to the setpoint	0
J+32	BatPwrAtCtrl.MeasFilterTm	Filter time for actual measurement in s	0
J+33	BatPwrAtCtrl.OvershootResetPc	Offset for detecting a overshoot, in % of PwrAtNomPoi	100
J+34	BatPwrAtCtrl.PiCtrlLimPc	The upper and lower limit of the output of the PI controller for active power control	5
J+35	BatPwrAtCtrl.PilotControlGain	The gain factor for the pilot control	1
J+36	BatPwrAtCtrl.SpntDelaySamples	To delay the active power setpoint	3
J+37	BatPwrAtCtrl.StepResetThrsldPc	Threshold for detecting a step change, in % of PwrAtNomPoi	20
J+38	Dispatch.EnaPrioBatPwrAt	Enables reduction of pv setpoint by the maximum P(f) battery response	1
J+39	Dispatch.PvBatSpntSplitPc	To split the reactive power setpoint between the PV and battery system. (80% -> PV = 80%, Battery = 20%)	80
J+40	Dispatch.PwrRtDispatchMode	Defines the reactive power dispatching to PV and Battery inverters 1:PWR_RT_DISPATCH_MODE_NOM 0:PWR_RT_DISPATCH_MODE_SPLIT	0
J+41	EgyShift.ChrFromPvSpntLimPc	Charging from PV is limited to this value. (in % based on the maximum charge power of the battery system)	50
J+42	EgyShift.DisBatSpntLimPc	The battery provides this amount of power if the EnergyShifting function wants to discharge the battery system (in % based on the maximum discharge power of the battery system)	10
J+43	FCASCont.DelayedActTm	Activation time for the Delayed Raise (Lower) Service after a Frequency Disturbance in s	60
J+44	FCASCont.DelayedDelTm	Maximum time to deliver the Delayed Raise (Lower) Service after a Frequency Disturbance in s	600
J+45	FCASCont.Ena	Enables function	0
J+46	FCASCont.EnaDelayedLower	Enables the Delayed Lower Service	1

J+47	FCASCont.EnaDelayedRaise	Enables the Delayed Raise Service	1
J+48	FCASCont.EnaFastLower	Enables the Fast Lower Service	1
J+49	FCASCont.EnaFastRaise	Enables the Fast Raise Service	1
J+50	FCASCont.EnaSlowLower	Enables the Slow Lower Service	1
J+51	FCASCont.EnaSlowRaise	Enables the Slow Raise Service	1
J+52	FCASCont.FastDelTm	Maximum time to deliver the Fast Raise (Lower) Service after a Frequency Disturbance in s	60
J+53	FCASCont.FrqOffsets[1]	Frequency Offsets to the nominal frequency to define the droop curve in Hz (need to be increasing)	1.6
J+54	FCASCont.FrqOffsets[2]	Frequency Offsets to the nominal frequency to define the droop curve in Hz (need to be increasing)	-1
J+55	FCASCont.FrqOffsets[3]	Frequency Offsets to the nominal frequency to define the droop curve in Hz (need to be increasing)	-0.15
J+56	FCASCont.FrqOffsets[4]	Frequency Offsets to the nominal frequency to define the droop curve in Hz (need to be increasing)	0.15
J+57	FCASCont.FrqOffsets[5]	Frequency Offsets to the nominal frequency to define the droop curve in Hz (need to be increasing)	1
J+58	FCASCont.FrqOffsets[6]	Frequency Offsets to the nominal frequency to define the droop curve in Hz (need to be increasing)	1.1
J+59	FCASCont.FrqOffsets[7]	Frequency Offsets to the nominal frequency to define the droop curve in Hz (need to be increasing)	1.2
J+60	FCASCont.FrqOffsets[8]	Frequency Offsets to the nominal frequency to define the droop curve in Hz (need to be increasing)	1.3
J+61	FCASCont.FrqOffsets[9]	Frequency Offsets to the nominal frequency to define the droop curve in Hz (need to be increasing)	1.4
J+62	FCASCont.FrqOffsets[10]	Frequency Offsets to the nominal frequency to define the droop curve in Hz (need to be increasing)	1.5
J+63	FCASCont.FrqRecoverOffsets[1]	Frequency Offsets to the nominal frequency to define the recovery thresholds	-0.1
J+64	FCASCont.FrqRecoverOffsets[2]	Frequency Offsets to the nominal frequency to define the recovery thresholds	0.1

J+65	FCASCont.PwrAtDataPc[1]	The active power data corresponding to the frequency offsets in % relative to PwrAtNomPoi	-100
J+66	FCASCont.PwrAtDataPc[2]	The active power data corresponding to the frequency offsets in % relative to PwrAtNomPoi	100
J+67	FCASCont.PwrAtDataPc[3]	The active power data corresponding to the frequency offsets in % relative to PwrAtNomPoi	0
J+68	FCASCont.PwrAtDataPc[4]	The active power data corresponding to the frequency offsets in % relative to PwrAtNomPoi	0
J+69	FCASCont.PwrAtDataPc[5]	The active power data corresponding to the frequency offsets in % relative to PwrAtNomPoi	-100
J+70	FCASCont.PwrAtDataPc[6]	The active power data corresponding to the frequency offsets in % relative to PwrAtNomPoi	-100
J+71	FCASCont.PwrAtDataPc[7]	The active power data corresponding to the frequency offsets in % relative to PwrAtNomPoi	-100
J+72	FCASCont.PwrAtDataPc[8]	The active power data corresponding to the frequency offsets in % relative to PwrAtNomPoi	-100
J+73	FCASCont.PwrAtDataPc[9]	The active power data corresponding to the frequency offsets in % relative to PwrAtNomPoi	-100
J+74	FCASCont.PwrAtDataPc[10]	The active power data corresponding to the frequency offsets in % relative to PwrAtNomPoi	-100
J+75	FCASCont.SlowActTm	Activation time for the Slow Raise (Lower) Service after a Frequency Disturbance in s	6
J+76	FCASCont.SlowDelTm	Maximum time to deliver the Slow Raise (Lower) Service after a Frequency Disturbance in s	300
J+77	FixCosPhi.CosPhiExtModExp	Defines the excitation of the external CosPhi septoint for active power export / 1041:FIXCOSPHI_SIGN_MODE_OVER_EX	1041
J+78	FixCosPhi.CosPhiExtModImp	Defines the excitation of the external CosPhi septoint for active power import / 1041:FIXCOSPHI_SIGN_MODE_OVER_EX	1041
J+79	FixCosPhi.CosPhiLimLo	External CosPhi setpoint is limited to this value	0.8

J+80	FixCosPhi.ExtSpntMode	Defines if the external setpoint CosPhiSpntExp should be used as well for active power im-port 1:FIXCOSPHI_SPNT_MODE_IMP_EXP	1
J+81	FixCosPhi.PwrAtFilterTm	First order filter time constant for the ac-tive+reactive power of the genset system	1
J+82	FrqDroop.ActDelay	Activation delay for P(f)-characteristic	0.1
J+83	FrqDroop.DroopMode	Defines the characteristic of the droop curve 2:FRQDROOP_MODE_HOLD 3:FRQDROOP_MODE_HOLDNOM 1:FRQDROOP_MODE_NOM	3
J+84	FrqDroop.Ena	Enables function	0
J+85	FrqDroop.EnaActFrt	Enables activation during	1
J+86	FrqDroop.EnaPrioFrqResp	Enables prioritization of frequency response setpoints (PRL,DS3,FCAS,FFR or EFR)	0
J+87	FrqDroop.EnaRamp	Enables ramp after frequency event. The ramp refers to PwrAtRateMax (PwrAtMode) 0:ENA_NO / 1:ENA_YES	1
J+88	FrqDroop.EnaShiftPreFaultVal	Enables the shifting of the pre-fault value with the external setpoint PwrAtLimSale 0: ENA_NO / 1: ENA_YES	0
J+89	FrqDroop.FrqOffsets[1]	Frequency Offsets to define the droop curve in Hz (need to be increasing)	1.3
J+90	FrqDroop.FrqOffsets[2]	Frequency Offsets to define the droop curve in Hz (need to be increasing)	-0.8
J+91	FrqDroop.FrqOffsets[3]	Frequency Offsets to define the droop curve in Hz (need to be increasing)	-0.5
J+92	FrqDroop.FrqOffsets[4]	Frequency Offsets to define the droop curve in Hz (need to be increasing)	0
J+93	FrqDroop.FrqOffsets[5]	Frequency Offsets to define the droop curve in Hz (need to be increasing)	0.5
J+94	FrqDroop.FrqOffsets[6]	Frequency Offsets to define the droop curve in Hz (need to be increasing)	0.8
J+95	FrqDroop.FrqOffsets[7]	Frequency Offsets to define the droop curve in Hz (need to be increasing)	0.9
J+96	FrqDroop.FrqOffsets[8]	Frequency Offsets to define the droop curve in Hz (need to be increasing)	1
J+97	FrqDroop.FrqOffsets[9]	Frequency Offsets to define the droop curve in Hz (need to be increasing)	1.1
J+98	FrqDroop.FrqOffsets[10]	Frequency Offsets to define the droop curve in Hz (need to be increasing)	1.2
J+99	FrqDroop.MaxPwrDecrease	Maximum absolute power decrease at over frequency events in %PwrAtNomPoi	200

J+100	FrqDroop.MaxRelPwrIncrease	Maximum relative power increase in % of difference between PwrAtNomPoi and pre-fault power	1000000
J+101	FrqDroop.MinHoldTm	Minimum hold time if function becomes active and ResetMode = ERCOT, in s	0.5
J+102	FrqDroop.MinPwrSpnt	Absolute minimum power setpoint generated by P(f)-characteristic in %PwrAtNomPoi	-100
J+103	FrqDroop.OverFrqMode	Mode of power decrease during over frequency event 2: FRQDROOP_LIMIT_EXTERNAL_LIMIT 1: FRQDROOP_LIMIT_LIMITED 0: FRQDROOP_LIMIT_UNLIMITED	0
J+104	FrqDroop.PwrAtDataPc[1]	The active power data corresponding to the frequency offsets in % relative to PwrAtNomPoi	0
J+105	FrqDroop.PwrAtDataPc[2]	The active power data corresponding to the frequency offsets in % relative to PwrAtNomPoi	200
J+106	FrqDroop.PwrAtDataPc[3]	The active power data corresponding to the frequency offsets in % relative to PwrAtNomPoi	100
J+107	FrqDroop.PwrAtDataPc[4]	The active power data corresponding to the frequency offsets in % relative to PwrAtNomPoi	100
J+108	FrqDroop.PwrAtDataPc[5]	The active power data corresponding to the frequency offsets in % relative to PwrAtNomPoi	100
J+109	FrqDroop.PwrAtDataPc[6]	The active power data corresponding to the frequency offsets in % relative to PwrAtNomPoi	0
J+110	FrqDroop.PwrAtDataPc[7]	The active power data corresponding to the frequency offsets in % relative to PwrAtNomPoi	0
J+111	FrqDroop.PwrAtDataPc[8]	The active power data corresponding to the frequency offsets in % relative to PwrAtNomPoi	0
J+112	FrqDroop.PwrAtDataPc[9]	The active power data corresponding to the frequency offsets in % relative to PwrAtNomPoi	0
J+113	FrqDroop.PwrAtDataPc[10]	The active power data corresponding to the frequency offsets in % relative to PwrAtNomPoi	0

J+114	FrqDroop.PwrAtRateMax	Maximum rate of active power setpoint after a frequency disturbance in MW/min. Is active for the time ResetTm if Reset Mode is Ramp	10
J+115	FrqDroop.ResetFrqOffset[1]	Reset frequency offsets	-0.2
J+116	FrqDroop.ResetFrqOffset[2]	Reset frequency offsets	0.2
J+117	FrqDroop.ResetMode	Defines where to use the reset mode 4: FRQDROOP_RESET_BOTH 6: FRQDROOP_RESET_ERCOT 1: FRQDROOP_RESET_OFF 2: FRQDROOP_RESET_OVERFRQ 5: FRQDROOP_RESET_RAMP 3: FRQDROOP_RESET_UNDERFRQ	1
J+118	FrqDroop.ResetTm	Switch off delay for reset frequency	0
J+119	FrqDroop.UnderFrqMode	Mode of power increase during under frequency event 2: FRQDROOP_LIMIT_EXTERNAL_LIMIT 1: FRQDROOP_LIMIT_LIMITED 0: FRQDROOP_LIMIT_UNLIMITED	0
J+120	FrqDroop.UseBatPwr	Uses the battery power to fulfill the frequency droop	0
J+121	FrtDetection.Ena	Enables function	0
J+122	FrtDetection.FilterTm	Filter time for upper and lower limits in sec	300
J+123	FrtDetection.PreFrtSamples	Re-initializes pi controllers to the pre frt output	5
J+124	FrtDetection.RefMode	Defines the reference point for FRT detection 1: FRTDETECT_REF_MODE_DEDICATED 0: FRTDETECT_REF_MODE_POI	0
J+125	FrtDetection.StopDelay	Stop delay for leaving state FRT in sec	2
J+126	FrtDetection.ThrsldMode	Selects the source for the calculation of upper and lower thresholds 0: FRTDETECT_MODE_MEAS 1: FRTDETECT_MODE_NOM	1
J+127	FrtDetection.VtgLoLimPc	Lower voltage threshold for FRT detection in percentage of VtgNom	50
J+128	FrtDetection.VtgUpLimPc	Upper voltage threshold for FRT detection in percentage of VtgNom	150
J+129	GridService.EnaFrqRespForPv	Enables frequency response (FFR, EFR, PRL, DS3, FCAS) for pv systems.	0
J+130	GridService.EnaPrioBat-FrqResp	Enables the prioritization of the activated battery P(f) function (FFR, EFR, FCR, FCAS)	0

J+131	GridService.FrqPoiCompFactor	Compensation factor for measured frequency if fast active power changes is causing phase angle jumps	0
J+132	GridService.FrqPoiDynMod	This mode determines if the POI frequency should be directly used, filtered or ramped. 1: FRQ_POI_DYNMODE_FILTERTM 0: FRQ_POI_DYNMODE_OFF 2: FRQ_POI_DYNMODE_RAMP	1
J+133	GridService.FrqPoiFilterTm	Filter time for actual frequency in s	0
J+134	GridService.FrqPoiRateMax	Maximum allowed rate for actual frequency at POI in Hz/s. 18443	0.04
J+135	GridService.PoiPwrAtCtrlMode	Defines which device class is controlling the active power of the POI 3:POI_CTRL_MODE_AUTO 2: POI_CTRL_MODE_BAT 1: POI_CTRL_MODE_PV Please set this parameter to 3 in case of PV+BESS, 1 in case of PV and 2 in case of Battery system	3
J+136	GridService.PwrApNomPoi	Nominal apparent power at POI in kVA	2000
J+137	GridService.PwrApPrioMode	Defines the prioritization to limit the apparent power 1: PWR_AP_PRIO_MODE_ACTIVE 0: PWR_AP_PRIO_MODE_OFF 2: PWR_AP_PRIO_MODE_REACTIVE 3:PWR_AP_PRIO_MODE_REACTIVE_FRQDROOP	1
J+138	GridService.PwrAtNomPoi	Nominal active power at point of interest in kW	1000
J+139	GridService.PwrAtPoiFilterTm	Filter time for actual active power at POI in s which is used for apparent power limitation	0
J+140	GridService.PwrRtNomPoi	Nominal reactive power at POI in kVar	1000
J+141	GridService.PwrRtPoiFilterTm	Filter time for actual reactive power at POI in s which is used for apparent power limitation	0
J+142	GridVtgCtrl.Ena	Enables function	0
J+143	GridVtgCtrl.IntGain	Integral gain for voltage control (ki)	5
J+144	GridVtgCtrl.IntLimAwu	Integral limit for voltage control (anti windup)	0.5
J+145	GridVtgCtrl.PropGain	Proportional gain for voltage control (kp)	0
J+146	GridVtgCtrl.VtgFilterTm	Filter time of actual voltage in s	0
J+147	PvPwrAtCtrl.CrtlKi	Control parameter integral gain for the power PID controller	0.4

J+148	PvPwrAtCtrl.CtrlKp	Control parameter proportional gain for the power PI controller	0
J+149	PvPwrAtCtrl.DynSpntSwitchHysPc	Hysteresis for switching to the limit if measurement exceeds the limit, in % of PwrAtNomPoi	0
J+150	PvPwrAtCtrl.Ena	Enables the PI controller	0
J+151	PvPwrAtCtrl.EnaAdapCtrl	Enables adaptive control (Yes: related to the connected nominal device power / No: related to PwrAt(Rt)NomPoi)	1
J+152	PvPwrAtCtrl.Ena-DynSpntSwitch	Enables dynamic setpoint switching if limits are exceeded	0
J+153	PvPwrAtCtrl.EnaStepReset	Enables resetting of the integrator if step change is detected (PV)	0
J+154	PvPwrAtCtrl.FeedForwardOff-set	A constant offset which will be added to the setpoint in kW	0
J+155	PvPwrAtCtrl.MeasFilterTm	Filter time for actual measurement in s	0
J+156	PvPwrAtCtrl.OvershootResetPc	Offset for detecting a overshoot, in % of PwrAtNomPoi	1
J+157	PvPwrAtCtrl.PiCtrlLimPc	The upper and lower limit of the output of the PI controller	5
J+158	PvPwrAtCtrl.PilotControlGain	The gain factor for the pilot control	1
J+159	PvPwrAtCtrl.SpntDelaySam-ples	To delay the active power setpoint	2
J+160	PvPwrAtCtrl.StepResetThrsldPc	Threshold for detecting a step change, in % of PwrAtNomPoi	1
J+161	PwrRt.PwrRtCtrlMode	Defines which reactive power function is used 1074: PWR_RT_MODE_FIX_COSPHI 1984: PWR_RT_MODE_GRID_VTG_CTRL 303: PWR_RT_MODE_OFF 1069: PWR_RT_MODE_VTG_DROOP 1070:PWR_RT_MODE_VTG_DROOP_EXT_SPNT	303
J+162	PwrRtCtrl.CtrlKi	Control parameter intregral gain for the power PI controller	0.4
J+163	PwrRtCtrl.CtrlKp	Control parameter proportional gain for the power PI controller	0
J+164	PwrRtCtrl.DynSpntSwitchHysPc	Hysteresis for switching to the limit if measurement exceeds the limit, in % of PwrRtNomPoi	0
J+165	PwrRtCtrl.Ena	Enables the PI controller for reactive power control	0
J+166	PwrRtCtrl.EnaAdapCtrl	Enables adaptive control (Yes: related to the connected nominal device power / No: related to PwrAtRtNomPoi)	1

J+167	PwrRtCtrl.EnaDynSpntSwitch	Enables dynamic setpoint switching if limits are exceeded	0
J+168	PwrRtCtrl.EnaStepReset	Enables reseting of the integrator if step change is detected	0
J+169	PwrRtCtrl.FeedForwardOffset	A constant offset which will be added to the setpoint	0
J+170	PwrRtCtrl.MeasFilterTm	Filter time for actual measurement in s	0
J+171	PwrRtCtrl.OvershootResetPc	Offset for detecting a overshoot, in % of PwrRtNomPoi	100
J+172	PwrRtCtrl.PiCtrlLimPc	The upper and lower limit of the output of the PI controller for reactive power control	5
J+173	PwrRtCtrl.PilotControlGain	The gain factor for the pilot control	1
J+174	PwrRtCtrl.SpntDelaySamples	To delay the active power setpoint	3
J+175	PwrRtCtrl.StepResetThrsldPc	Threshold for detecting a step change, in % of PwrRtNomPoi	20
J+176	PwrRtPwrAtLim.Ena	Enables function / 0: ENA_NO / 1: ENA_YES	0
J+177	PwrRtPwrAtLim.PwrAtFilterTm	Filter time for active power measurement in s	0
J+178	PwrRtPwrAtLim.PwrAtLim-HiPc[1]	The active power breakpoints for the upper reactive power limits in % relative to PwrAtNomPoi	0
J+179	PwrRtPwrAtLim.PwrAtLim-HiPc[2]	The active power breakpoints for the upper reactive power limits in % relative to PwrAtNomPoi	50
J+180	PwrRtPwrAtLim.PwrAtLim-HiPc[3]	The active power breakpoints for the upper reactive power limits in % relative to PwrAtNomPoi	70
J+181	PwrRtPwrAtLim.PwrAtLim-HiPc[4]	The active power breakpoints for the upper reactive power limits in % relative to PwrAtNomPoi	100
J+182	PwrRtPwrAtLim.PwrAtLim-HiPc[5]	The active power breakpoints for the upper reactive power limits in % relative to PwrAtNomPoi	101
J+183	PwrRtPwrAtLim.PwrAtLim-HiPc[6]	The active power breakpoints for the upper reactive power limits in % relative to PwrAtNomPoi	102
J+184	PwrRtPwrAtLim.PwrAtLim-HiPc[7]	The active power breakpoints for the upper reactive power limits in % relative to PwrAtNomPoi	103
J+185	PwrRtPwrAtLim.PwrAtLim-HiPc[8]	The active power breakpoints for the upper reactive power limits in % relative to PwrAtNomPoi	104

J+186	PwrRtPwrAtLim.PwrAtLim-HiPc[9]	The active power breakpoints for the upper reactive power limits in % relative to PwrAtNomPoi	105
J+187	PwrRtPwrAtLim.PwrAtLim-HiPc[10]	The active power breakpoints for the upper reactive power limits in % relative to PwrAtNomPoi	106
J+188	PwrRtPwrAtLim.PwrAtLim-LoPc[1]	The active power breakpoints for the lower re-active power limits in % relative to PwrAtNomPoi	0
J+189	PwrRtPwrAtLim.PwrAtLim-LoPc[2]	The active power breakpoints for the lower re-active power limits in % relative to PwrAtNomPoi	50
J+190	PwrRtPwrAtLim.PwrAtLim-LoPc[3]	The active power breakpoints for the lower re-active power limits in % relative to PwrAtNomPoi	70
J+191	PwrRtPwrAtLim.PwrAtLim-LoPc[4]	The active power breakpoints for the lower re-active power limits in % relative to PwrAtNomPoi	100
J+192	PwrRtPwrAtLim.PwrAtLim-LoPc[5]	The active power breakpoints for the lower re-active power limits in % relative to PwrAtNomPoi	101
J+193	PwrRtPwrAtLim.PwrAtLim-LoPc[6]	The active power breakpoints for the lower re-active power limits in % relative to PwrAtNomPoi	102
J+194	PwrRtPwrAtLim.PwrAtLim-LoPc[7]	The active power breakpoints for the lower re-active power limits in % relative to PwrAtNomPoi	103
J+195	PwrRtPwrAtLim.PwrAtLim-LoPc[8]	The active power breakpoints for the lower re-active power limits in % relative to PwrAtNomPoi	104
J+196	PwrRtPwrAtLim.PwrAtLim-LoPc[9]	The active power breakpoints for the lower re-active power limits in % relative to PwrAtNomPoi	105
J+197	PwrRtPwrAtLim.PwrAtLim-LoPc[10]	The active power breakpoints for the lower re-active power limits in % relative to PwrAtNomPoi	106
J+198	PwrRtPwrAtLim.PwrRtLim-HiPc[1]	The reactive power breakpoints for the upper reactive power limits in % relative to PwrRtNomPoi	60
J+199	PwrRtPwrAtLim.PwrRtLim-HiPc[2]	The reactive power breakpoints for the upper reactive power limits in % relative to PwrRtNomPoi	60

J+200	PwrRtPwrAtLim.PwrRtLim-HiPc[3]	The reactive power breakpoints for the upper reactive power limits in % relative to PwrRtNomPoi	40
J+201	PwrRtPwrAtLim.PwrRtLim-HiPc[4]	The reactive power breakpoints for the upper reactive power limits in % relative to PwrRtNomPoi	40
J+202	PwrRtPwrAtLim.PwrRtLim-HiPc[5]	The reactive power breakpoints for the upper reactive power limits in % relative to PwrRtNomPoi	40
J+203	PwrRtPwrAtLim.PwrRtLim-HiPc[6]	The reactive power breakpoints for the upper reactive power limits in % relative to PwrRtNomPoi	40
J+204	PwrRtPwrAtLim.PwrRtLim-HiPc[7]	The reactive power breakpoints for the upper reactive power limits in % relative to PwrRtNomPoi	40
J+205	PwrRtPwrAtLim.PwrRtLim-HiPc[8]	The reactive power breakpoints for the upper reactive power limits in % relative to PwrRtNomPoi	40
J+206	PwrRtPwrAtLim.PwrRtLim-HiPc[9]	The reactive power breakpoints for the upper reactive power limits in % relative to PwrRtNomPoi	40
J+207	PwrRtPwrAtLim.PwrRtLim-HiPc[10]	The reactive power breakpoints for the upper reactive power limits in % relative to PwrRtNomPoi	40
J+208	PwrRtPwrAtLim.PwrRtLim-LoPc[1]	The reactive power breakpoints for the lower reactive power limits in % relative to PwrRtNomPoi	-60
J+209	PwrRtPwrAtLim.PwrRtLim-LoPc[2]	The reactive power breakpoints for the lower reactive power limits in % relative to PwrRtNomPoi	-60
J+210	PwrRtPwrAtLim.PwrRtLim-LoPc[3]	The reactive power breakpoints for the lower reactive power limits in % relative to PwrRtNomPoi	-60
J+211	PwrRtPwrAtLim.PwrRtLim-LoPc[4]	The reactive power breakpoints for the lower reactive power limits in % relative to PwrRtNomPoi	-60
J+212	PwrRtPwrAtLim.PwrRtLim-LoPc[5]	The reactive power breakpoints for the lower reactive power limits in % relative to PwrRtNomPoi	-60
J+213	PwrRtPwrAtLim.PwrRtLim-LoPc[6]	The reactive power breakpoints for the lower reactive power limits in % relative to PwrRtNomPoi	-60

J+214	PwrRtPwrAtLim.PwrRtLim-LoPc[7]	The reactive power breakpoints for the lower reactive power limits in % relative to PwrRtNomPoi	-60
J+215	PwrRtPwrAtLim.PwrRtLim-LoPc[8]	The reactive power breakpoints for the lower reactive power limits in % relative to PwrRtNomPoi	-60
J+216	PwrRtPwrAtLim.PwrRtLim-LoPc[9]	The reactive power breakpoints for the lower reactive power limits in % relative to PwrRtNomPoi	-60
J+217	PwrRtPwrAtLim.PwrRtLim-LoPc[10]	The reactive power breakpoints for the lower reactive power limits in % relative to PwrRtNomPoi	-60
J+218	SpntRamp.EnaPwrAtRampTm	Enables time ramp with PwrAtRampTm 0: ENA_NO / 1: ENA_YES	0
J+219	SpntRamp.BatPwrAtRiseRate-Max	maximum positive rate of active power set-point for battery system in %/s (of related ac-tual power)	20
J+220	SpntRamp.PvPwrAtRiseRate-Max	maximum positive rate of active power set-point for pv system in %/s (of related actual power)	5
J+221	SpntRamp.PwrAtRampTm	Time to ramp a setpoint change	300
J+222	SpntRamp.PwrAtRateMax	maximum rate of active power setpoint for hole system in MW/min	100
J+223	SpntRamp.PwrAtResetThrsldPc	Threshold for reseting the active power set-point to the actual measurement in % of PwrAtNomPoi	5
J+224	SpntRamp.PwrAtSpntFilterTm	Active power setpoint filter time, if greater than 0 ramps are disabled	0
J+225	SpntRamp.PwrRtRateMax	maximum rate of reactive power setpoint for hole system in MVar/min	100
J+226	SpntRamp.PwrRtSpntFilterTm	Reactive power setpoint filter time, if greater than 0 ramps are disabled.	0
J+227	VtgPwrRtDroop.PwrRtDataPcD bHi	Higher deadband reactive power limit in per-centage of PwrRtNomPoi	0
J+228	VtgPwrRtDroop.PwrRtDataPcD-bLo	Lower deadband reactive power limit in % of PwrRtNomPoi	0
J+229	VtgPwrRtDroop.PwrRtDataPc[1]	The reactive power data corresponding to the voltage breakpoints in % relative to PwrRtNomPoi	-5
J+230	VtgPwrRtDroop.PwrRtDataPc[2]	The reactive power data corresponding to the voltage breakpoints in % relative to PwrRtNomPoi	5

J+231	VtgPwrRtDroop.PwrRtDataPc[3]	The reactive power data corresponding to the voltage breakpoints in % relative to PwrRtNomPoi	4
J+232	VtgPwrRtDroop.PwrRtDataPc[4]	The reactive power data corresponding to the voltage breakpoints in % relative to PwrRtNomPoi	3
J+233	VtgPwrRtDroop.PwrRtDataPc[5]	The reactive power data corresponding to the voltage breakpoints in % relative to PwrRtNomPoi	2
J+234	VtgPwrRtDroop.PwrRtDataPc[6]	The reactive power data corresponding to the voltage breakpoints in % relative to PwrRtNomPoi	1
J+235	VtgPwrRtDroop.PwrRtDataPc[7]	The reactive power data corresponding to the voltage breakpoints in % relative to PwrRtNomPoi	-1
J+236	VtgPwrRtDroop.PwrRtDataPc[8]	The reactive power data corresponding to the voltage breakpoints in % relative to PwrRtNomPoi	-2
J+237	VtgPwrRtDroop.PwrRtDataPc[9]	The reactive power data corresponding to the voltage breakpoints in % relative to PwrRtNomPoi	-3
J+238	VtgPwrRtDroop.PwrRtDataPc[10]	The reactive power data corresponding to the voltage breakpoints in % relative to PwrRtNomPoi	-4
J+239	VtgPwrRtDroop.SpntSrc	Selects the setpoint source for the voltage set-point 2: VTG_SPNTSRC_MODE_EXTSPNT 3: VTG_SPNTSRC_MODE_MEAS 1: VTG_SPNTSRC_MODE_PARAM	1
J+240	VtgPwrRtDroop.VtgBreak-points[1]	The voltage breakpoints in % relative to the nominal voltage	5
J+241	VtgPwrRtDroop.VtgBreak-points[2]	The voltage breakpoints in % relative to the nominal voltage	-5
J+242	VtgPwrRtDroop.VtgBreak-points[3]	The voltage breakpoints in % relative to the nominal voltage	-4
J+243	VtgPwrRtDroop.VtgBreak-points[4]	The voltage breakpoints in % relative to the nominal voltage	-3
J+244	VtgPwrRtDroop.VtgBreak-points[5]	The voltage breakpoints in % relative to the nominal voltage	-2
J+245	VtgPwrRtDroop.VtgBreak-points[6]	The voltage breakpoints in % relative to the nominal voltage	-1

J+246	VtgPwrRtDroop.VtgBreak-points[7]	The voltage breakpoints in % relative to the nominal voltage	1
J+247	VtgPwrRtDroop.VtgBreak-points[8]	The voltage breakpoints in % relative to the nominal voltage	2
J+248	VtgPwrRtDroop.VtgBreak-points[9]	The voltage breakpoints in % relative to the nominal voltage	3
J+249	VtgPwrRtDroop.VtgBreak-points[10]	The voltage breakpoints in % relative to the nominal voltage	4
J+250	VtgPwrRtDroop.VtgFilterTm	Filter time for voltage measurement	0
J+251	VtgPwrRtDroop.VtgSpntFil-terTm	Filter time for the voltage setpoint in s	3

2.4.3 VARs

VAR(L+0)	Reserved
VAR(L+1)	Volt_RB
VAR(L+2)	P_pcc
VAR(L+3)	Q_pcc
VAR(L+4)	S_pcc
VAR(L+5)	Volt_RBFrt
VAR(L+6)	Volt_RB_init
VAR(L+7)	P_pcc_init
VAR(L+8)	Q_pcc_init
VAR(L+9)	STEPCOUNTER
VAR(L+10)	Reserved
VAR(L+11)	Reserved
VAR(L+12)	Reserved
VAR(L+13)	BESS_W_Spt
VAR(L+14)	POI_Var_Spt
VAR(L+15)	POI_PF_Spt
VAR(L+16)	POI_Vol_Spt
VAR(L+17)	POI_Hz_Spt
VAR(L+18)	PwrAtLimSales
VAR(L+19)	ExtPwrAtLimLo
VAR(L+20)	ExtPwrAtLimHi
VAR(L+21)	Frq_pcc
VAR(L+22)	PV_P_pu_add
VAR(L+23)	PV_Q_pu_add
VAR(L+24)	PV_S_pu_add
VAR(L+25)	BESS_P_pu_add
VAR(L+26)	BESS_Q_pu_add
VAR(L+27)	BESS_S_pu_add
VAR(L+28)	PvPwrAtAvail
VAR(L+29)	BatPwrAtAvail

VAR(L+30)	BESS_W_Spt_init
VAR(L+31)	POI_Var_Spt_init
VAR(L+32)	POI_PF_Spt_init
VAR(L+33)	POI_Vol_Spt_init
VAR(L+34)	POI_Hz_Spt_init
VAR(L+35)	PwrAtLimSales_init
VAR(L+36)	ExtPwrAtLimLo_init
VAR(L+37)	ExtPwrAtLimHi_init
VAR(L+38)	Reserved
VAR(L+39)	Reserved
VAR(L+40)	HybridPwrAtMaxTot
VAR(L+41)	Plant_Base
VAR(L+42)	HybridPwrAtTot
VAR(L+43)	Ppv_com
VAR(L+44)	Qpv_com
VAR(L+45)	Pbess_com
VAR(L+46)	Qbess_com
VAR(L+47)	Inv_read_Flg
VAR(L+48)	Ppv_inv_init
VAR(L+49)	Qpv_inv_init
VAR(L+50)	Pbess_inv_init
VAR(L+51)	Qbess_inv_init
VAR(L+52)	DCDC_PBase
VAR(L+53)	PInitTotDCDC
VAR(L+54)	Reserved
VAR(L+55)	Reserved
VAR(L+56)	Ppv_cmd_inv_filt
VAR(L+57)	Qpv_cmd_inv_filt
VAR(L+58)	Pbess_cmd_inv_filt
VAR(L+59)	Qbess_cmd_inv_filt
VAR(L+60)	BatWSptMax
VAR(L+61)	BatWSptMin
VAR(L+62)	Ppv_cmd_inv
VAR(L+63)	Qpv_cmd_inv
VAR(L+64)	Pbess_cmd_inv
VAR(L+65)	Qbess_cmd_inv
VAR(L+66)	Reserved
VAR(L+67)	Reserved
VAR(L+68)	Reserved
VAR(L+69)	Reserved
VAR(L+70)	Reserved
VAR(L+71)	Reserved
VAR(L+72)	Reserved
VAR(L+73)	Reserved
VAR(L+74)	Reserved
VAR(L+75)	FrtActive

VAR(L+76)	FRT_ExitTm
VAR(L+77)	VoltPoiFilt
VAR(L+78)	PwrAtPoi_pu_hist
VAR(L+79)	PoiFrqComp
VAR(L+80)	FrqPoi_processed
VAR(L+81)	Pfrq_Poi_Filtered
VAR(L+82)	PvBatMaxOut
VAR(L+83)	PvBatMinOut
VAR(L+84)	PwrAtLimPrioRt
VAR(L+85)	PwrRtPoi_Filt
VAR(L+86)	PwrAtSpnt_FCAS
VAR(L+87)	Active_State
VAR(L+88)	FrequencyOutsideDB
VAR(L+89)	State_Fast
VAR(L+90)	FastState_timer
VAR(L+91)	FastDone
VAR(L+92)	State_Slow
VAR(L+93)	SlowState_timer
VAR(L+94)	SlowDone
VAR(L+95)	State_Delayed
VAR(L+96)	DelayedState_timer
VAR(L+97)	DelayedDone
VAR(L+98)	FrqRespPwrAtMaxNom
VAR(L+99)	FrqRespPwrAtMinNom
VAR(L+100)	Flag_FrqOutsideDb
VAR(L+101)	TimeDelay for FrqDroop
VAR(L+102)	Frq_After_Delay
VAR(L+103)	Reset
VAR(L+104)	Reset_delay
VAR(L+105)	EnaRamp
VAR(L+106)	EnaRamp_delay
VAR(L+107)	State_ResetTm
VAR(L+108)	ResetTm_Time
VAR(L+109)	Reset_OR_FrqOutside
VAR(L+110)	PwrSpntPu_hold
VAR(L+111)	PwrSpntPu_hold
VAR(L+112)	InPrefaultVal
VAR(L+113)	ShiftPreFaultVal
VAR(L+114)	PreFaultVal
VAR(L+115)	RateLimiter_Input
VAR(L+116)	HoldValue_delay
VAR(L+117)	Unused
VAR(L+118)	HoldValue_delay2
VAR(L+119)	HoldValue_delay3
VAR(L+120)	HoldValue_delay4
VAR(L+121)	EnaShiftPreFaultVal

VAR(L+122)	PvBatMaxOut
VAR(L+123)	PvBatMinOut
VAR(L+124)	FrqDroopActive
VAR(L+125)	PwrAtLimSales
VAR(L+126)	PwrAtSpntFilterTm
VAR(L+127)	PvBatMax_Hold
VAR(L+128)	PvBatMin_Hold
VAR(L+129)	IsFrqLo
VAR(L+130)	IsFrqLo_delay
VAR(L+131)	FrqDroopActive_delay1
VAR(L+132)	FrqDroopActive_delay2
VAR(L+133)	FrqDroopActive_delay3
VAR(L+134)	FrqDroopActive_delay4
VAR(L+135)	HoldSpnt_Flag
VAR(L+136)	ExtBatPwrAtSpnt
VAR(L+137)	EnaCritGridRamp_delay1
VAR(L+138)	EnaCritGridRamp_delay2
VAR(L+139)	EnaCritGridRamp_Out
VAR(L+140)	FrqDroopActive_Out
VAR(L+141)	BatPwrAtSpnt_Out
VAR(L+142)	FrtActive_delay
VAR(L+143)	ResetSpntMax
VAR(L+144)	ResetSpntMin
VAR(L+145)	ResetMax_delay
VAR(L+146)	PvBatMax_delay
VAR(L+147)	ResetMin_delay
VAR(L+148)	PvBatMin_delay
VAR(L+149)	FrqDroop_delay
VAR(L+150)	FrqDroop_delay2
VAR(L+151)	PvBatMaxOut
VAR(L+152)	PvBatMinOut
VAR(L+153)	PvBatMaxOut_delay
VAR(L+154)	PvBatMaxOut_delay2
VAR(L+155)	PvBatMinOut_delay
VAR(L+156)	PvBatMinOut_delay2
VAR(L+157)	EnaCritGridRamp_dly
VAR(L+158)	EnaCritGridRamp_dly2
VAR(L+159)	EnaCritGridRamp_local
VAR(L+160)	FrqDroopActive_local
VAR(L+161)	PvBatMaxOut_filter
VAR(L+162)	PvBatMinOut_filter
VAR(L+163)	FrqDroopActive_Dly1
VAR(L+164)	FrqDroopActive_Dly2
VAR(L+165)	FrqDroop_SR
VAR(L+166)	PvBatMaxAddRstThshld_Delay
VAR(L+167)	PvBatMinSubRstThshld_Delay

VAR(L+168)	InitCond
VAR(L+169)	FrtActive_delay
VAR(L+170)	Setpoint_delay1
VAR(L+171)	Setpoint_delay2
VAR(L+172)	Setpoint_delay3
VAR(L+173)	Setpoint_delay4
VAR(L+174)	Setpoint_delay5
VAR(L+175)	Setpoint_delay6
VAR(L+176)	PvBatMaxOut
VAR(L+177)	PvBatMinOut
VAR(L+178)	PrioFrqResp_state
VAR(L+179)	PrioFrqResp_state_delay
VAR(L+180)	FrqRespPwrAtSpnt_temp
VAR(L+181)	PvBatMaxOut
VAR(L+182)	PvBatMinOut
VAR(L+183)	FreqRespPwrAtMax
VAR(L+184)	FreqRespPwrAtMin
VAR(L+185)	ExtPwrRtSpntOut
VAR(L+186)	PwrRtSpnt
VAR(L+187)	InitVtgSpnt
VAR(L+188)	VtgSpnt_Filt
VAR(L+189)	VtgPoi_Filt
VAR(L+190)	PwrAtPoi_filter
VAR(L+191)	CosPhiSpnt
VAR(L+192)	PwrRtOut
VAR(L+193)	InitCosPhi
VAR(L+194)	Unused
VAR(L+195)	Unused
VAR(L+196)	PwrRtRateMax_Out
VAR(L+197)	PwrRtSpntTot
VAR(L+198)	LimitRtHi
VAR(L+199)	LimitRtLo
VAR(L+200)	PwrAtPoiFilterTm
VAR(L+201)	PwrRtSpntFilterTm
VAR(L+202)	InitCond
VAR(L+203)	FrtActive_delay
VAR(L+204)	Setpoint_delay1
VAR(L+205)	Setpoint_delay2
VAR(L+206)	Setpoint_delay3
VAR(L+207)	Setpoint_delay4
VAR(L+208)	Setpoint_delay5
VAR(L+209)	Setpoint_delay6
VAR(L+210)	PwrRtPwrAtLimHi
VAR(L+211)	PwrRtPwrAtLimLo
VAR(L+212)	PwrAtPoi_filt
VAR(L+213)	PvPwrAtLim

VAR(L+214)	BatPwrAtSpntOut
VAR(L+215)	PwrCtlOut
VAR(L+216)	PwrSpnt_delay
VAR(L+217)	Reset_Timer
VAR(L+218)	Reset_Signal
VAR(L+219)	ResetOut_delay
VAR(L+220)	HoldInt_Out_delay
VAR(L+221)	HoldInt_Active
VAR(L+222)	PwrMsTot_Filt
VAR(L+223)	FrtActive_delay
VAR(L+224)	PiCtrlWithLimit_out
VAR(L+225)	PwrCtl_Integrator
VAR(L+226)	PiCtrl_int_delay1
VAR(L+227)	PiCtrl_int_delay2
VAR(L+228)	PiCtrl_int_delay3
VAR(L+229)	PiCtrl_int_delay4
VAR(L+230)	PiCtrl_int_delay5
VAR(L+231)	PiCtrl_int_delay6
VAR(L+232)	PiCtrl_SetIC_Freeze
VAR(L+233)	PwrCtlOut
VAR(L+234)	PwrSpnt_delay
VAR(L+235)	Reset_Timer
VAR(L+236)	Reset_Signal
VAR(L+237)	ResetOut_delay
VAR(L+238)	HoldInt_out_dly
VAR(L+239)	HoldInt_Active
VAR(L+240)	PwrMsTot_Filt
VAR(L+241)	FrtActive_delay
VAR(L+242)	PiCtrlWithLimit
VAR(L+243)	PwrCtl_Integrator
VAR(L+244)	PiCtrl_int_delay1
VAR(L+245)	PiCtrl_int_delay2
VAR(L+246)	PiCtrl_int_delay3
VAR(L+247)	PiCtrl_int_delay4
VAR(L+248)	PiCtrl_int_delay5
VAR(L+249)	PiCtrl_int_delay6
VAR(L+250)	PiCtrl_SetIC_Freeze
VAR(L+251)	PvPwrAtSpnt
VAR(L+252)	AutoMode
VAR(L+253)	BatPwrAtSpnt
VAR(L+254)	DisablePvRrc
VAR(L+255)	DevAtUpLimitPv
VAR(L+256)	TimeOutTimerPVup
VAR(L+257)	DevAtLoLimitPv
VAR(L+258)	TimeOutTimerPVDown
VAR(L+259)	DevAtUpLimitBat

VAR(L+260)	TimeOutTimerBatup
VAR(L+261)	DevAtLoLimitBat
VAR(L+262)	TimeOutTimerBatDown
VAR(L+263)	TargetPVOut
VAR(L+264)	TargetBatOut
VAR(L+265)	PvPwrAtLimTotOut_delay1
VAR(L+266)	PvPwrAtLimTotOut_delay2
VAR(L+267)	PvPwrAtLimTotOut_delay3
VAR(L+268)	BatPwrAtLimT0otOut_delay1
VAR(L+269)	BatPwrAtLimTotOut_delay2
VAR(L+270)	BatPwrAtLimTotOut_delay3
VAR(L+271)	TimeOutReachedCtrlPrioChange
VAR(L+272)	TimeOutTimerCtrlPrioChange
VAR(L+273)	WsptOldSumHold
VAR(L+274)	PwrAtPoiHold
VAR(L+275)	Hold_delay
VAR(L+276)	Hold_delay2
VAR(L+277)	LimHiFlag_hold
VAR(L+278)	PwrAtPoiHoldMax
VAR(L+279)	PwrAtPoiHoldMin
VAR(L+280)	PwrAtPoiDelay
VAR(L+281)	PwrAtPoiDelayHold
VAR(L+282)	TimeOutReachedHoldChange
VAR(L+283)	TimeOutTimerHoldChange
VAR(L+284)	ForcePrioUp5Delay
VAR(L+285)	ForcePrioUp
VAR(L+286)	POICtrlState
VAR(L+287)	WSpt_Delay1
VAR(L+288)	WSpt_Delay2
VAR(L+289)	SetCtrlPrio_entry
VAR(L+290)	Trigger_state
VAR(L+291)	Trigger_state_timer1
VAR(L+292)	Trigger_state_timer2
VAR(L+293)	CtrlPrio
VAR(L+294)	CtrlPrio_delayed
VAR(L+295)	PrioUp
VAR(L+296)	UseWMax
VAR(L+297)	UpLim2Target
VAR(L+298)	LoLim2Target
VAR(L+299)	ReInit
VAR(L+300)	IC
VAR(L+301)	Holds(1)_delay
VAR(L+302)	Holds(2)_delay
VAR(L+303)	Holds(3)_delay
VAR(L+304)	Holds(4)_delay
VAR(L+305)	Holds(5)_delay

VAR(L+306)	WSpt_pu(1)_delay
VAR(L+307)	WSpt_pu(2)_delay
VAR(L+308)	WSpt_pu(3)_delay
VAR(L+309)	WSpt_pu(4)_delay
VAR(L+310)	WSpt_pu(5)_delay
VAR(L+311)	IsClosedLoop_delay
VAR(L+312)	NumWSptPrio_send(1)_delay
VAR(L+313)	NumWSptPrio_send(2)_delay
VAR(L+314)	NumWSptPrio_send(3)_delay
VAR(L+315)	NumWSptPrio_send(4)_delay
VAR(L+316)	NumWSptPrio_send(5)_delay
VAR(L+317)	Trigg(1)_delay
VAR(L+318)	Trigg(2)_delay
VAR(L+319)	Trigg(3)_delay
VAR(L+320)	Trigg(4)_delay
VAR(L+321)	Trigg(5)_delay
VAR(L+322)	EnaRateLimit(1)_delay
VAR(L+323)	EnaRateLimit(2)_delay
VAR(L+324)	EnaRateLimit(3)_delay
VAR(L+325)	EnaRateLimit(4)_delay
VAR(L+326)	EnaRateLimit(5)_delay
VAR(L+327)	OpenLoop_WSpt(1)
VAR(L+328)	OpenLoop_WSpt(2)
VAR(L+329)	OpenLoop_WSpt(3)
VAR(L+330)	OpenLoop_WSpt(4)
VAR(L+331)	OpenLoop_WSpt(5)
VAR(L+332)	OpenLoop_WSpt(1)_delay
VAR(L+333)	OpenLoop_WSpt(2)_delay
VAR(L+334)	OpenLoop_WSpt(3)_delay
VAR(L+335)	OpenLoop_WSpt(4)_delay
VAR(L+336)	OpenLoop_WSpt(5)_delay
VAR(L+337)	OpenLoop_WSpt_lim(1)
VAR(L+338)	OpenLoop_WSpt_lim(2)
VAR(L+339)	OpenLoop_WSpt_lim(3)
VAR(L+340)	OpenLoop_WSpt_lim(4)
VAR(L+341)	OpenLoop_WSpt_lim(5)
VAR(L+342)	CtrlPrio_ne5_delay
VAR(L+343)	NumWSptPrio_send_delay
VAR(L+344)	QFRT
VAR(L+345)	NotFRT_delay
VAR(L+346)	Ctl_Spt_delay1
VAR(L+347)	Ctl_Spt_delay2
VAR(L+348)	Ctl_Spt_delay3
VAR(L+349)	Ctl_Spt_delay4
VAR(L+350)	Ctl_Spt_delay5
VAR(L+351)	Ctl_Spt_delay6

VAR(L+352)	Ctrl_Spt_SetIC_Freeze
VAR(L+353)	Ctrl_Spt (Output)
VAR(L+354)	u-y_delay
VAR(L+355)	Ctrl_Spt_int
VAR(L+356)	Ena_delay
VAR(L+357)	Ctrl_Spt_delay
VAR(L+358)	PvPwrAtLimTotOut
VAR(L+359)	BatPwrAtLimTotOut
VAR(L+360)	RtPwrNomTot
VAR(L+361)	PwrCtlOut
VAR(L+362)	PwrSpnt_delay
VAR(L+363)	Reset_Timer
VAR(L+364)	Reset_Signal
VAR(L+365)	ResetOut_delay
VAR(L+366)	HoldInt_Out_dly
VAR(L+367)	HoldInt_Active
VAR(L+368)	PwrMsTot_Filt
VAR(L+369)	FrtActive_delay
VAR(L+370)	PiCtrlWithLimit_out
VAR(L+371)	PwrCtl_Integrator
VAR(L+372)	PiCtrl_int_delay1
VAR(L+373)	PiCtrl_int_delay2
VAR(L+374)	PiCtrl_int_delay3
VAR(L+375)	PiCtrl_int_delay4
VAR(L+376)	PiCtrl_int_delay5
VAR(L+377)	PiCtrl_int_delay6
VAR(L+378)	PiCtrl_SetIC_Freeze
VAR(L+379)	PwrRtSpntOut
VAR(L+380)	RtPwrNomTot
VAR(L+381)	Vtg_Poi_Flt
VAR(L+382)	HiLimit_Flag
VAR(L+383)	LoLimit_Flag
VAR(L+384)	PwrCtlOut
VAR(L+385)	PwrSpnt_delay
VAR(L+386)	Reset_Timer
VAR(L+387)	Reset_Signal
VAR(L+388)	ResetOut_delay
VAR(L+389)	HoldIntegrator_Out_delay
VAR(L+390)	HoldIntegrator_Active
VAR(L+391)	PwrMsTot_Filt
VAR(L+392)	FrtActive_delay
VAR(L+393)	PiCtrlWithLimit_output
VAR(L+394)	PwrCtl_Integrator
VAR(L+395)	PiCtrl_int_delay1
VAR(L+396)	PiCtrl_int_delay2
VAR(L+397)	PiCtrl_int_delay3

VAR(L+398)	PiCtrl_int_delay4
VAR(L+399)	PiCtrl_int_delay5
VAR(L+400)	PiCtrl_int_delay6
VAR(L+401)	PiCtrl_SetIC_Freeze
VAR(L+402)	PvPwrRtSpnt
VAR(L+403)	BatPwrRtSpnt

2.4.4 STATEs

STATE	Description
K	Reserved
K+1	Filtered remote bus frequency
K+2	Filtered remote bus voltage
K+3	Filtered POI active power
K+4	Filtered POI reactive power
K+5	Filtered PV active power
K+6	Filtered PV reactive power
K+7	Filtered BESS active power
K+8	Filtered BESS reactive power
K+9	Frt Detection Voltage Filter

3 Disclaimer

This document and the associated models have been prepared to facilitate the behavioral simulation of the response of SMA Hybrid Controller operating together with SMA Sunny Central storage and/or solar inverters to grid and parameter disturbances. The modeling data presented herein are intended to produce simulation results that closely approximate the response of the Hybrid Controller and the inverters to these disturbances.