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 11
May 02, 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
G2.1	1. Update to firmware version 20 2. Removal of CONS like PvPwrApMaxTot and BatPwrApMaxTot

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).

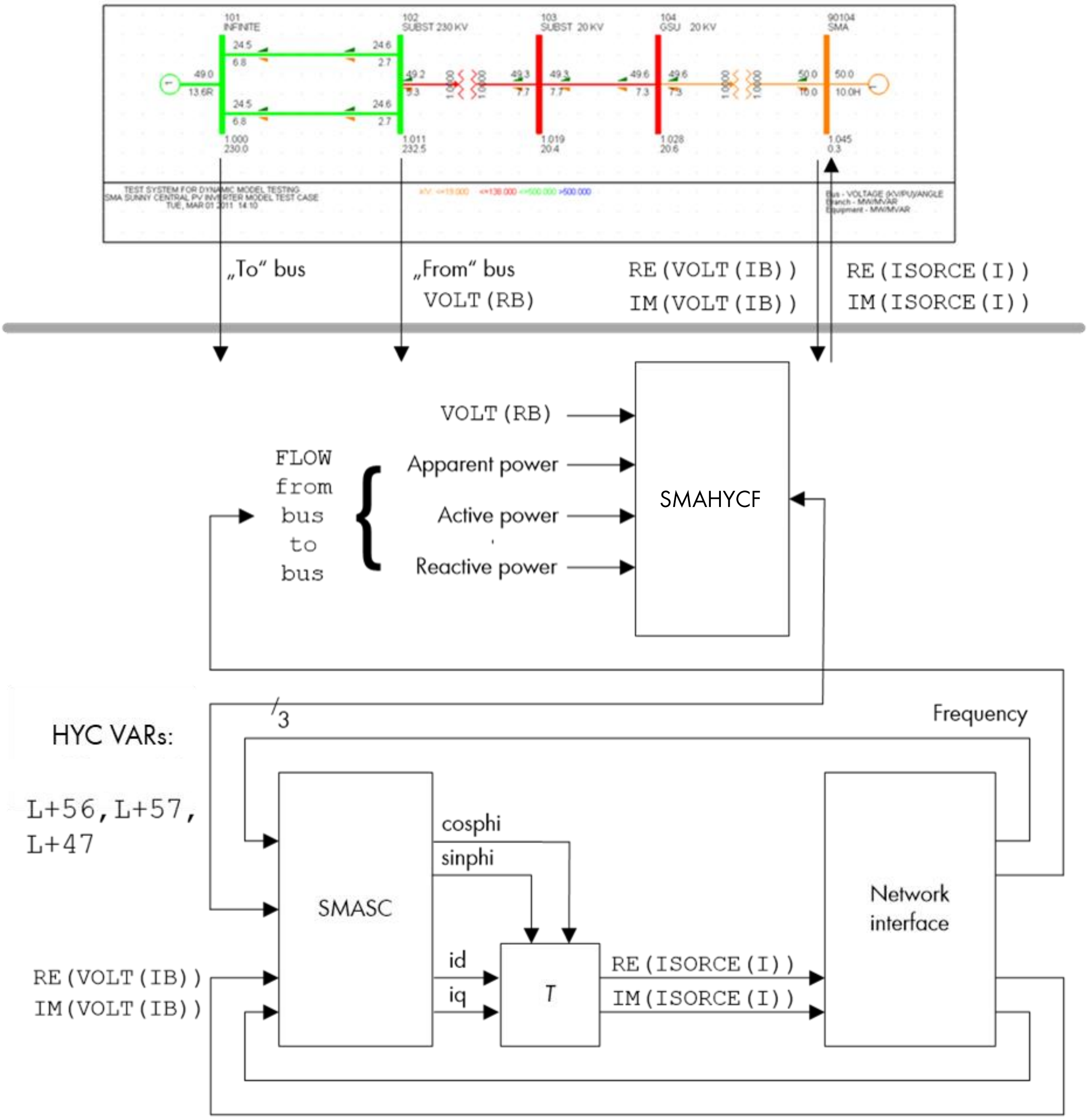

Figure 1: Hybrid Controller block diagram.

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.

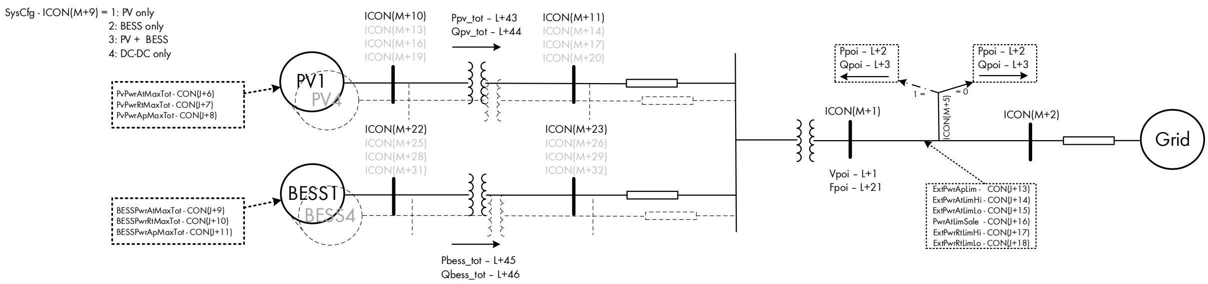

Figure 2: Hybrid Controller Configuration.

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 'SMAHYCF21’ 504 0 34 262 10 453 FBN TBN -1 1 ICON(M+4) ICON(M+5) ... ICON(M+33) CON(J) CON(J+1) ... CON(J+261)

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)

7. CON(J+16) – Cumulative Active power target for PV inverter in kW. If set to 0.0, then the cumulative PV inverter power from load flow is considered as the target power (PvPwrAtSpt)

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	HyconToInv_AtPwr_TmDelay	HYC to inverter comm time delay in s (Active Power) implemented as PT1 filter	0.02

J+4	HyconToInv_RtPwr_TmDelay	HYC to inverter comm time delay in s (Reactive Power) implemented as PT1 filter	0.02
J+5	PvPwrAtMaxTot	Cumulative PV active power rating in kW	-
J+6	PvPwrRtMaxTot	Cumulative PV reactive power rating in kVAr (0.6 times the PvPwrAtMaxTot)	-
J+7	BESSPwrAtMaxTot	Cumulative BESS active power rating in kW	-
J+8	BESSPwrRtMaxTot	Cumulative BESS reactive power rating in kVAr (0.6 times the BESSPwrAtMaxTot)	-
J+9	ExtPwrApLim	Apparent power limitation at PCC in kVA	-
J+10	ExtPwrAtLimHi	Maximum active power limitation at PCC in kW	-
J+11	ExtPwrAtLimLo	Minimum active power limitation at PCC in kW	-
J+12	PwrAtLimSale	Maximum active power limitation (Sales) at PCC in kW	-
J+13	ExtPwrRtLimHi	Maximum reactive power limitation at PCC in kVAr	-
J+14	ExtPwrRtLimLo	Minimum reactive power limitation at PCC in kVAr	-
J+15	QVARScale	Please set this to 0.6	0.6
J+16	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+17	Reserved		-
J+18	Reserved		-
J+19	Reserved		-
J+20	BatPwrAtCtrl.CtrlKi	Control parameter integral gain for the power PI controller	0.4
J+21	BatPwrAtCtrl.CtrlKp	Control parameter proportional gain for the power PI controller	0
J+22	BatPwrAtCtrl.DynSpntSwitchHysPc	Hysteresis for switching to the limit if measurement exceeds the limit, in % of PwrAtNomPoi	0
J+23	BatPwrAtCtrl.Ena	Enables the PI controller for active power control (Enable this for Bat only systems)	0
J+24	BatPwrAtCtrl.EnaAdapCtrl	Enables adaptive control (Yes: related to the connected nominal device power / No: related to PwrAtRtNomPoi	1

J+25	BatPwrAtCtrl.EnaDynSpntSwitch	Enables dynamic setpoint switching if limits are exceeded	0
J+26	BatPwrAtCtrl.EnaStepReset	Enables resetting of the integrator if step change is detected	0
J+27	BatPwrAtCtrl.FeedForwardOff-set	A constant offset which will be added to the set-point	0
J+28	BatPwrAtCtrl.MeasFilterTm	Filter time for actual measurement in s	0
J+29	BatPwrAtCtrl.OvershootResetPc	Offset for detecting a overshoot, in % of PwrAtNomPoi	100
J+30	BatPwrAtCtrl.PiCtrlLimPc	The upper and lower limit of the output of the PI controller for active power control	5
J+31	BatPwrAtCtrl.PilotControlGain	The gain factor for the pilot control	1
J+32	BatPwrAtCtrl.SpntDelaySamples	To delay the active power setpoint	3
J+33	BatPwrAtCtrl.StepResetThrsldPc	Threshold for detecting a step change, in % of PwrAtNomPoi	20
J+34	Dispatch.EnaPrioBatPwrAt	Enables reduction of pv setpoint by the maxi-mum P(f) battery response	1
J+35	Dispatch.PvBatSpntSplitPc	To split the reactive power setpoint between the PV and battery system. (80% -> PV = 80%, Bat-tery = 20%)	80
J+36	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+37	EgyShift.ChrFromPvSpntLimPc	Charging from PV is limited to this value. (in % based on the maximum charge power of the battery system)	50
J+38	EgyShift.DisBatSpntLimPc	The battery provides this amount of power if the EnergyShifting function wants to discharge the battery system (in % based on the maximum dis-charge power of the battery system)	10
J+39	FCASCont.DelayedActTm	Activation time for the Delayed Raise (Lower) Service after a Frequency Disturbance in s	60
J+40	FCASCont.DelayedDelTm	Maximum time to deliver the Delayed Raise (Lower) Service after a Frequency Disturbance in s	600
J+41	FCASCont.Ena	Enables function	0
J+42	FCASCont.EnaDelayedLower	Enables the Delayed Lower Service	1
J+43	FCASCont.EnaDelayedRaise	Enables the Delayed Raise Service	1
J+44	FCASCont.EnaFastLower	Enables the Fast Lower Service	1
J+45	FCASCont.EnaFastRaise	Enables the Fast Raise Service	1
J+46	FCASCont.EnaSlowLower	Enables the Slow Lower Service	1

J+47	FCASCont.EnaSlowRaise	Enables the Slow Raise Service	1
J+48	FCASCont.FastDelTm	Maximum time to deliver the Fast Raise (Lower) Service after a Frequency Disturbance in s	60
J+49	FCASCont.FrqOffsets[1]	Frequency Offsets to the nominal frequency to define the droop curve in Hz (need to be increasing)	1.6
J+50	FCASCont.FrqOffsets[2]	Frequency Offsets to the nominal frequency to define the droop curve in Hz (need to be increasing)	-1
J+51	FCASCont.FrqOffsets[3]	Frequency Offsets to the nominal frequency to define the droop curve in Hz (need to be increasing)	-0.15
J+52	FCASCont.FrqOffsets[4]	Frequency Offsets to the nominal frequency to define the droop curve in Hz (need to be increasing)	0.15
J+53	FCASCont.FrqOffsets[5]	Frequency Offsets to the nominal frequency to define the droop curve in Hz (need to be increasing)	1
J+54	FCASCont.FrqOffsets[6]	Frequency Offsets to the nominal frequency to define the droop curve in Hz (need to be increasing)	1.1
J+55	FCASCont.FrqOffsets[7]	Frequency Offsets to the nominal frequency to define the droop curve in Hz (need to be increasing)	1.2
J+56	FCASCont.FrqOffsets[8]	Frequency Offsets to the nominal frequency to define the droop curve in Hz (need to be increasing)	1.3
J+57	FCASCont.FrqOffsets[9]	Frequency Offsets to the nominal frequency to define the droop curve in Hz (need to be increasing)	1.4
J+58	FCASCont.FrqOffsets[10]	Frequency Offsets to the nominal frequency to define the droop curve in Hz (need to be increasing)	1.5
J+59	FCASCont.FrqRecoverOffsets[1]	Frequency Offsets to the nominal frequency to define the recovery thresholds	-0.1
J+60	FCASCont.FrqRecoverOffsets[2]	Frequency Offsets to the nominal frequency to define the recovery thresholds	0.1
J+61	FCASCont.PwrAtDataPc[1]	The active power data corresponding to the frequency offsets in % relative to PwrAtNomPoi	-100
J+62	FCASCont.PwrAtDataPc[2]	The active power data corresponding to the frequency offsets in % relative to PwrAtNomPoi	100

J+63	FCASCont.PwrAtDataPc[3]	The active power data corresponding to the frequency offsets in % relative to PwrAtNomPoi	0
J+64	FCASCont.PwrAtDataPc[4]	The active power data corresponding to the frequency offsets in % relative to PwrAtNomPoi	0
J+65	FCASCont.PwrAtDataPc[5]	The active power data corresponding to the frequency offsets in % relative to PwrAtNomPoi	-100
J+66	FCASCont.PwrAtDataPc[6]	The active power data corresponding to the frequency offsets in % relative to PwrAtNomPoi	-100
J+67	FCASCont.PwrAtDataPc[7]	The active power data corresponding to the frequency offsets in % relative to PwrAtNomPoi	-100
J+68	FCASCont.PwrAtDataPc[8]	The active power data corresponding to the frequency offsets in % relative to PwrAtNomPoi	-100
J+69	FCASCont.PwrAtDataPc[9]	The active power data corresponding to the frequency offsets in % relative to PwrAtNomPoi	-100
J+70	FCASCont.PwrAtDataPc[10]	The active power data corresponding to the frequency offsets in % relative to PwrAtNomPoi	-100
J+71	FCASCont.SlowActTm	Activation time for the Slow Raise (Lower) Service after a Frequency Disturbance in s	6
J+72	FCASCont.SlowDelTm	Maximum time to deliver the Slow Raise (Lower) Service after a Frequency Disturbance in s	300
J+73	FixCosPhi.CosPhiExtModExp	Defines the excitation of the external CosPhi septoint for active power export / 1041:FIXCOSPHI_SIGN_MODE_OVER_EX	1041
J+74	FixCosPhi.CosPhiExtModImp	Defines the excitation of the external CosPhi septoint for active power import / 1041:FIXCOSPHI_SIGN_MODE_OVER_EX	1041
J+75	FixCosPhi.CosPhiLimLo	External CosPhi setpoint is limited to this value	0.8
J+76	FixCosPhi.ExtSpntMode	Defines if the external setpoint CosPhiSpntExp should be used as well for active power import 1:FIXCOSPHI_SPNT_MODE_IMP_EXP	1
J+77	FixCosPhi.PwrAtFilterTm	First order filter time constant for the active+reactive power of the genset system	1
J+78	FrqDroop.DroopMode	Defines the characteristic of the droop curve 2:FRQDROOP_MODE_HOLD 3:FRQDROOP_MODE_HOLDNOM 1:FRQDROOP_MODE_NOM	3
J+79	FrqDroop.Ena	Enables function	0
J+80	FrqDroop.EnaPrioFrqResp	Enables prioritization of frequency response setpoints (PRL,DS3,FCAS,FFR or EFR)	0
J+81	FrqDroop.EnaRamp	Enables ramp after frequency event. The ramp refers to PwrAtRateMax (PwrAtMode) 0:ENA_NO / 1:ENA_YES	1

J+82	FrqDroop.EnaShiftPreFaultVal	Enables the shifting of the pre-fault value with the external setpoint PwrAtLimSale 0: ENA_NO / 1: ENA_YES	0
J+83	FrqDroop.FrqOffsets[1]	Frequency Offsets to define the droop curve in Hz (need to be increasing)	1.3
J+84	FrqDroop.FrqOffsets[2]	Frequency Offsets to define the droop curve in Hz (need to be increasing)	-0.8
J+85	FrqDroop.FrqOffsets[3]	Frequency Offsets to define the droop curve in Hz (need to be increasing)	-0.5
J+86	FrqDroop.FrqOffsets[4]	Frequency Offsets to define the droop curve in Hz (need to be increasing)	0
J+87	FrqDroop.FrqOffsets[5]	Frequency Offsets to define the droop curve in Hz (need to be increasing)	0.5
J+88	FrqDroop.FrqOffsets[6]	Frequency Offsets to define the droop curve in Hz (need to be increasing)	0.8
J+89	FrqDroop.FrqOffsets[7]	Frequency Offsets to define the droop curve in Hz (need to be increasing)	0.9
J+90	FrqDroop.FrqOffsets[8]	Frequency Offsets to define the droop curve in Hz (need to be increasing)	1
J+91	FrqDroop.FrqOffsets[9]	Frequency Offsets to define the droop curve in Hz (need to be increasing)	1.1
J+92	FrqDroop.FrqOffsets[10]	Frequency Offsets to define the droop curve in Hz (need to be increasing)	1.2
J+93	FrqDroop.MaxPwrDecrease	Maximum absolute power decrease at over frequency events in %PwrAtNomPoi	200
J+94	FrqDroop.MaxRelPwrIncrease	Maximum relative power increase in % of difference between PwrAtNomPoi and pre-fault power	100000 0
J+95	FrqDroop.MinHoldTm	Minimum hold time if function becomes active and ResetMode = ERCOT, in s	0.5
J+96	FrqDroop.MinPwrSpnt	Absolute minimum power setpoint generated by P(f)-characteristic in %PwrAtNomPoi	-100
J+97	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+98	FrqDroop.PwrAtDataPc[1]	The active power data corresponding to the frequency offsets in % relative to PwrAtNomPoi	0
J+99	FrqDroop.PwrAtDataPc[2]	The active power data corresponding to the frequency offsets in % relative to PwrAtNomPoi	200

J+100	FrqDroop.PwrAtDataPc[3]	The active power data corresponding to the frequency offsets in % relative to PwrAtNomPoi	100
J+101	FrqDroop.PwrAtDataPc[4]	The active power data corresponding to the frequency offsets in % relative to PwrAtNomPoi	100
J+102	FrqDroop.PwrAtDataPc[5]	The active power data corresponding to the frequency offsets in % relative to PwrAtNomPoi	100
J+103	FrqDroop.PwrAtDataPc[6]	The active power data corresponding to the frequency offsets in % relative to PwrAtNomPoi	0
J+104	FrqDroop.PwrAtDataPc[7]	The active power data corresponding to the frequency offsets in % relative to PwrAtNomPoi	0
J+105	FrqDroop.PwrAtDataPc[8]	The active power data corresponding to the frequency offsets in % relative to PwrAtNomPoi	0
J+106	FrqDroop.PwrAtDataPc[9]	The active power data corresponding to the frequency offsets in % relative to PwrAtNomPoi	0
J+107	FrqDroop.PwrAtDataPc[10]	The active power data corresponding to the frequency offsets in % relative to PwrAtNomPoi	0
J+108	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+109	FrqDroop.ResetFrqOffset[1]	Reset frequency offsets	-0.2
J+110	FrqDroop.ResetFrqOffset[2]	Reset frequency offsets	0.2
J+111	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+112	FrqDroop.ResetTm	Switch off delay for reset frequency	0
J+113	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+114	FrtDetection.Ena	Enables function	0
J+115	FrtDetection.FilterTm	Filter time for upper and lower limits in sec	300
J+116	FrtDetection.PreFrtSamples	Re-initializes pi controllers to the pre frt output	5
J+117	FrtDetection.RefMode	Defines the reference point for FRT detection 1: FRTDETECT_REF_MODE_DEDICATED 0: FRTDETECT_REF_MODE_POI	0
J+118	FrtDetection.StopDelay	Stop delay for leaving state FRT in sec	2

J+119	FrtDetection.ThrsldMode	Selects the source for the calculation of upper and lower thresholds 0: FRTDETECT_MODE_MEAS 1: FRTDETECT_MODE_NOM	1
J+120	FrtDetection.VtgLoLimPc	Lower voltage threshold for FRT detection in percentage of VtgNom	50
J+121	FrtDetection.VtgUpLimPc	Upper voltage threshold for FRT detection in percentage of VtgNom	150
J+122	GridService.EnaFrqRespForPv	Enables frequency response (FFR, EFR, PRL, DS3, FCAS) for pv systems.	0
J+123	GridService.EnaPrioBatFrqResp	Enables the prioritization of the activated battery P(f) function (FFR, EFR, FCR, FCAS)	0
J+124	GridService.FrqActDelay	Activation delay for P(f)-characteristics	0.1
J+125	GridService.FrqEnaActFrt	Enables activation of P(f)-characteristics during FRT	1
J+126	GridService.FrqPoiCompFactor	Compensation factor for measured frequency if fast active power changes is causing phase angle jumps	0
J+127	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+128	GridService.FrqPoiFilterTm	Filter time for actual frequency in s	0
J+129	GridService.FrqPoiRateMax	Maximum allowed rate for actual frequency at POI in Hz/s. 18443	0.04
J+130	GridService.FrqPreFault-ValHoldTm	Holds the pre-fault value for the specified time	1
J+131	GridService.FrqUseBatPwr	Uses the battery power to fulfill P(f)-characteristics	0
J+132	GridService.OverFrqRefMode	Defines the reference for over frequency event / 0: FRQDROOP_REFMODE_MEAS / 1: FRQDROOP_REFMODE_SPNT	0
J+133	**GridService.PoiPwrAtCtrl-Mode**	**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**	**0**

J+134	GridService.PwrApNomPoi	Nominal apparent power at POI in kVA	2000
J+135	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+136	GridService.PwrAtNomPoi	Nominal active power at point of interest in kW	1000
J+137	GridService.PwrAtPoiFilterTm	Filter time for actual active power at POI in s which is used for apparent power limitation	0
J+138	GridService.PwrRtNomPoi	Nominal reactive power at POI in kVar	1000
J+139	GridService.PwrRtPoiFilterTm	Filter time for actual reactive power at POI in s which is used for apparent power limitation	0
J+140	GridService.UnderFrqRefMode	Defines the reference for under frequency events / 0: FRQDROOP_REFMODE_MEAS / 1: FRQDROOP_REFMODE_SPNT	0
J+141	GridVtgCtrl.Ena	Enables function	0
J+142	GridVtgCtrl.IntGain	Integral gain for voltage control (ki)	5
J+143	GridVtgCtrl.IntLimAwu	Integral limit for voltage control (anti windup)	0.5
J+144	GridVtgCtrl.PropGain	Proportional gain for voltage control (kp)	0
J+145	GridVtgCtrl.VtgFilterTm	Filter time of actual voltage in s	0
J+146	PoCo.EnaOpenLoopSptDiff	Enables compensation of open-loop setpoint changes (Relevant for PV+BESS system only)	1
J+147	PoCo.K_I	Integral gain (Relevant for PV+BESS system only)	1
J+148	PoCo.K_P	Proportional gain (Relevant for PV+BESS system only)	0
J+149	PoCo.OutMax	Maximum control value, in pu (Relevant for PV+BESS system only)	1
J+150	PoCo.OutMin	Minimum control value, in pu (Relevant for PV+BESS system only)	-1
J+151	PoCo.OvershootReInitHystTicks	Number of time steps that the PI controller must be at the limit before initialization due to an overshoot is allowed (Relevant for PV+BESS system only)	10
J+152	PoCo.OvershootRel-nitHystWNom	Hysteresis for initialization as a result of an overshoot, in % of sum of nominal power of all devices in operation (Relevant for PV+BESS system only)	1
J+153	PoCo.WGraMeasTarget	Rate of change for dynamic target powers (Relevant for PV+BESS system only)	0.2

J+154	PoCo.WGraOpenLoop	Rate of change when changing from closed-loop to open-loop control, in pu/s (Relevant for PV+BESS system only)	0.2
J+155	PoCo.WGraTarget	Rate of change for target powers, in pu/s (Relevant for PV+BESS system only)	0.02
J+156	PoCo.WaitTmsDevAtLimit	Time for detecting a device is not following its control value, in s (Relevant for PV+BESS system only)	3
J+157	PvPwrAtCtrl.CtrlKi	Control parameter integral gain for the power PID controller	0.4
J+158	PvPwrAtCtrl.CtrlKp	Control parameter proportional gain for the power PI controller	0
J+159	PvPwrAtCtrl.DynSpntSwitchHysPc	Hysteresis for switching to the limit if measurement exceeds the limit, in % of PwrAtNomPoi	0
J+160	PvPwrAtCtrl.Ena	Enables the PI controller (Enable this for PV only systems)	0
J+161	PvPwrAtCtrl.EnaAdapCtrl	Enables adaptive control (Yes: related to the connected nominal device power / No: related to PwrAt(Rt)NomPoi)	1
J+162	PvPwrAtCtrl.EnaDynSpntSwitch	Enables dynamic setpoint switching if limits are exceeded	0
J+163	PvPwrAtCtrl.EnaStepReset	Enables resetting of the integrator if step change is detected (PV)	0
J+164	PvPwrAtCtrl.FeedForwardOffset	A constant offset which will be added to the setpoint in kW	0
J+165	PvPwrAtCtrl.MeasFilterTm	Filter time for actual measurement in s	0
J+166	PvPwrAtCtrl.OvershootResetPc	Offset for detecting a overshoot, in % of PwrAtNomPoi	1
J+167	PvPwrAtCtrl.PiCtrlLimPc	The upper and lower limit of the output of the PI controller	5
J+168	PvPwrAtCtrl.PilotControlGain	The gain factor for the pilot control	1
J+169	PvPwrAtCtrl.SpntDelaySamples	To delay the active power setpoint	2
J+170	PvPwrAtCtrl.StepResetThrsldPc	Threshold for detecting a step change, in % of PwrAtNomPoi	1
J+171	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+172	PwrRtCtrl.CtrlKi	Control parameter intregral gain for the power PI controller	0.4
J+173	PwrRtCtrl.CtrlKp	Control parameter proportional gain for the power PI controller	0
J+174	PwrRtCtrl.DynSpntSwitchHysPc	Hysteresis for switching to the limit if measurement exceeds the limit, in % of PwrRtNomPoi	0
J+175	PwrRtCtrl.Ena	Enables the PI controller for reactive power control	0
J+176	PwrRtCtrl.EnaAdapCtrl	Enables adaptive control (Yes: related to the connected nominal device power / No: related to PwrAtRtNomPoi)	1
J+177	PwrRtCtrl.EnaDynSpntSwitch	Enables dynamic setpoint switching if limits are exceeded	0
J+178	PwrRtCtrl.EnaStepReset	Enables reseting of the integrator if step change is detected	0
J+179	PwrRtCtrl.FeedForwardOffset	A constant offset which will be added to the setpoint	0
J+180	PwrRtCtrl.MeasFilterTm	Filter time for actual measurement in s	0
J+181	PwrRtCtrl.OvershootResetPc	Offset for detecting a overshoot, in % of PwrRtNomPoi	100
J+182	PwrRtCtrl.PiCtrlLimPc	The upper and lower limit of the output of the PI controller for reactive power control	5
J+183	PwrRtCtrl.PilotControlGain	The gain factor for the pilot control	1
J+184	PwrRtCtrl.SpntDelaySamples	To delay the active power setpoint	3
J+185	PwrRtCtrl.StepResetThrsldPc	Threshold for detecting a step change, in % of PwrRtNomPoi	20
J+186	PwrRtPwrAtLim.Ena	Enables function / 0: ENA_NO / 1: ENA_YES	0
J+187	PwrRtPwrAtLim.PwrAtFilterTm	Filter time for active power measurement in s	0
J+188	PwrRtPwrAtLim.PwrAtLimHiPc[1]	The active power breakpoints for the upper reactive power limits in % relative to PwrAtNomPoi	0
J+189	PwrRtPwrAtLim.PwrAtLimHiPc[2]	The active power breakpoints for the upper reactive power limits in % relative to PwrAtNomPoi	50
J+190	PwrRtPwrAtLim.PwrAtLimHiPc[3]	The active power breakpoints for the upper reactive power limits in % relative to PwrAtNomPoi	70
J+191	PwrRtPwrAtLim.PwrAtLimHiPc[4]	The active power breakpoints for the upper reactive power limits in % relative to PwrAtNomPoi	100
J+192	PwrRtPwrAtLim.PwrAtLimHiPc[5]	The active power breakpoints for the upper reactive power limits in % relative to PwrAtNomPoi	101
J+193	PwrRtPwrAtLim.PwrAtLimHiPc[6]	The active power breakpoints for the upper reactive power limits in % relative to PwrAtNomPoi	102

J+194	PwrRtPwrAtLim.PwrAtLimHiPc[7]	The active power breakpoints for the upper reactive power limits in % relative to PwrAtNomPoi	103
J+195	PwrRtPwrAtLim.PwrAtLimHiPc[8]	The active power breakpoints for the upper reactive power limits in % relative to PwrAtNomPoi	104
J+196	PwrRtPwrAtLim.PwrAtLimHiPc[9]	The active power breakpoints for the upper reactive power limits in % relative to PwrAtNomPoi	105
J+197	PwrRtPwrAtLim.PwrAtLim-HiPc[10]	The active power breakpoints for the upper reactive power limits in % relative to PwrAtNomPoi	106
J+198	PwrRtPwrAtLim.PwrAtLimLoPc[1]	The active power breakpoints for the lower reactive power limits in % relative to PwrAtNomPoi	0
J+199	PwrRtPwrAtLim.PwrAtLimLoPc[2]	The active power breakpoints for the lower reactive power limits in % relative to PwrAtNomPoi	50
J+200	PwrRtPwrAtLim.PwrAtLimLoPc[3]	The active power breakpoints for the lower reactive power limits in % relative to PwrAtNomPoi	70
J+201	PwrRtPwrAtLim.PwrAtLimLoPc[4]	The active power breakpoints for the lower reactive power limits in % relative to PwrAtNomPoi	100
J+202	PwrRtPwrAtLim.PwrAtLimLoPc[5]	The active power breakpoints for the lower reactive power limits in % relative to PwrAtNomPoi	101
J+203	PwrRtPwrAtLim.PwrAtLimLoPc[6]	The active power breakpoints for the lower reactive power limits in % relative to PwrAtNomPoi	102
J+204	PwrRtPwrAtLim.PwrAtLimLoPc[7]	The active power breakpoints for the lower reactive power limits in % relative to PwrAtNomPoi	103
J+205	PwrRtPwrAtLim.PwrAtLimLoPc[8]	The active power breakpoints for the lower reactive power limits in % relative to PwrAtNomPoi	104
J+206	PwrRtPwrAtLim.PwrAtLimLoPc[9]	The active power breakpoints for the lower reactive power limits in % relative to PwrAtNomPoi	105
J+207	PwrRtPwrAtLim.PwrAtLim-LoPc[10]	The active power breakpoints for the lower reactive power limits in % relative to PwrAtNomPoi	106
J+208	PwrRtPwrAtLim.PwrRtLimHiPc[1]	The reactive power breakpoints for the upper reactive power limits in % relative to PwrRtNomPoi	60
J+209	PwrRtPwrAtLim.PwrRtLimHiPc[2]	The reactive power breakpoints for the upper reactive power limits in % relative to PwrRtNomPoi	60
J+210	PwrRtPwrAtLim.PwrRtLimHiPc[3]	The reactive power breakpoints for the upper reactive power limits in % relative to PwrRtNomPoi	40
J+211	PwrRtPwrAtLim.PwrRtLimHiPc[4]	The reactive power breakpoints for the upper reactive power limits in % relative to PwrRtNomPoi	40
J+212	PwrRtPwrAtLim.PwrRtLimHiPc[5]	The reactive power breakpoints for the upper reactive power limits in % relative to PwrRtNomPoi	40
J+213	PwrRtPwrAtLim.PwrRtLimHiPc[6]	The reactive power breakpoints for the upper reactive power limits in % relative to PwrRtNomPoi	40
J+214	PwrRtPwrAtLim.PwrRtLimHiPc[7]	The reactive power breakpoints for the upper reactive power limits in % relative to PwrRtNomPoi	40

J+215	PwrRtPwrAtLim.PwrRtLimHiPc[8]	The reactive power breakpoints for the upper reactive power limits in % relative to PwrRtNomPoi	40
J+216	PwrRtPwrAtLim.PwrRtLimHiPc[9]	The reactive power breakpoints for the upper reactive power limits in % relative to PwrRtNomPoi	40
J+217	PwrRtPwrAtLim.PwrRtLim-HiPc[10]	The reactive power breakpoints for the upper reactive power limits in % relative to PwrRtNomPoi	40
J+218	PwrRtPwrAtLim.PwrRtLimLoPc[1]	The reactive power breakpoints for the lower reactive power limits in % relative to PwrRtNomPoi	-60
J+219	PwrRtPwrAtLim.PwrRtLimLoPc[2]	The reactive power breakpoints for the lower reactive power limits in % relative to PwrRtNomPoi	-60
J+220	PwrRtPwrAtLim.PwrRtLimLoPc[3]	The reactive power breakpoints for the lower reactive power limits in % relative to PwrRtNomPoi	-60
J+221	PwrRtPwrAtLim.PwrRtLimLoPc[4]	The reactive power breakpoints for the lower reactive power limits in % relative to PwrRtNomPoi	-60
J+222	PwrRtPwrAtLim.PwrRtLimLoPc[5]	The reactive power breakpoints for the lower reactive power limits in % relative to PwrRtNomPoi	-60
J+223	PwrRtPwrAtLim.PwrRtLimLoPc[6]	The reactive power breakpoints for the lower reactive power limits in % relative to PwrRtNomPoi	-60
J+224	PwrRtPwrAtLim.PwrRtLimLoPc[7]	The reactive power breakpoints for the lower reactive power limits in % relative to PwrRtNomPoi	-60
J+225	PwrRtPwrAtLim.PwrRtLimLoPc[8]	The reactive power breakpoints for the lower reactive power limits in % relative to PwrRtNomPoi	-60
J+226	PwrRtPwrAtLim.PwrRtLimLoPc[9]	The reactive power breakpoints for the lower reactive power limits in % relative to PwrRtNomPoi	-60
J+227	PwrRtPwrAtLim.PwrRtLim-LoPc[10]	The reactive power breakpoints for the lower reactive power limits in % relative to PwrRtNomPoi	-60
J+228	SpntRamp.EnaPwrAtRampTm	Enables time ramp with PwrAtRampTm 0: ENA_NO / 1: ENA_YES	0
J+229	SpntRamp.BatPwrAtRiseRate-Max	maximum positive rate of active power setpoint for battery system in %/s (of related actual power)	20
J+230	SpntRamp.PvPwrAtRiseRateMax	maximum positive rate of active power setpoint for pv system in %/s (of related actual power)	5
J+231	SpntRamp.PwrAtRampTm	Time to ramp a setpoint change	300
J+232	SpntRamp.PwrAtRateMax	maximum rate of active power setpoint for hole system in MW/min	100
J+233	SpntRamp.PwrAtResetThrsldPc	Threshold for reseting the active power setpoint to the actual measurement in % of PwrAtNomPoi	5
J+234	SpntRamp.PwrAtSpntFilterTm	Active power setpoint filter time, if greater than 0 ramps are disabled	0
J+235	SpntRamp.PwrRtRateMax	maximum rate of reactive power setpoint for hole system in MVar/min	100

J+236	SpntRamp.PwrRtSpntFilterTm	Reactive power setpoint filter time, if greater than 0 ramps are disabled.	0
J+237	VtgPwrRtDroop.PwrRtDataPcDb Hi	Higher deadband reactive power limit in per- centage of PwrRtNomPoi	0
J+238	VtgPwrRtDroop.PwrRtDataPcD- bLo	Lower deadband reactive power limit in % of PwrRtNomPoi	0
J+239	VtgPwrRtDroop.PwrRtDataPc[1]	The reactive power data corresponding to the voltage breakpoints in % relative to PwrRtNomPoi	-5
J+240	VtgPwrRtDroop.PwrRtDataPc[2]	The reactive power data corresponding to the voltage breakpoints in % relative to PwrRtNomPoi	5
J+241	VtgPwrRtDroop.PwrRtDataPc[3]	The reactive power data corresponding to the voltage breakpoints in % relative to PwrRtNomPoi	4
J+242	VtgPwrRtDroop.PwrRtDataPc[4]	The reactive power data corresponding to the voltage breakpoints in % relative to PwrRtNomPoi	3
J+243	VtgPwrRtDroop.PwrRtDataPc[5]	The reactive power data corresponding to the voltage breakpoints in % relative to PwrRtNomPoi	2
J+244	VtgPwrRtDroop.PwrRtDataPc[6]	The reactive power data corresponding to the voltage breakpoints in % relative to PwrRtNomPoi	1
J+245	VtgPwrRtDroop.PwrRtDataPc[7]	The reactive power data corresponding to the voltage breakpoints in % relative to PwrRtNomPoi	-1
J+246	VtgPwrRtDroop.PwrRtDataPc[8]	The reactive power data corresponding to the voltage breakpoints in % relative to PwrRtNomPoi	-2
J+247	VtgPwrRtDroop.PwrRtDataPc[9]	The reactive power data corresponding to the voltage breakpoints in % relative to PwrRtNomPoi	-3
J+248	VtgPwrRtDroop.PwrRtDataPc[10]	The reactive power data corresponding to the voltage breakpoints in % relative to PwrRtNomPoi	-4
J+249	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+250	VtgPwrRtDroop.VtgBreak-points[1]	The voltage breakpoints in % relative to the nominal voltage	5
J+251	VtgPwrRtDroop.VtgBreak-points[2]	The voltage breakpoints in % relative to the nominal voltage	-5
J+252	VtgPwrRtDroop.VtgBreak-points[3]	The voltage breakpoints in % relative to the nominal voltage	-4
J+253	VtgPwrRtDroop.VtgBreak-points[4]	The voltage breakpoints in % relative to the nominal voltage	-3
J+254	VtgPwrRtDroop.VtgBreak-points[5]	The voltage breakpoints in % relative to the nominal voltage	-2
J+255	VtgPwrRtDroop.VtgBreak-points[6]	The voltage breakpoints in % relative to the nominal voltage	-1
J+256	VtgPwrRtDroop.VtgBreak-points[7]	The voltage breakpoints in % relative to the nominal voltage	1
J+257	VtgPwrRtDroop.VtgBreak-points[8]	The voltage breakpoints in % relative to the nominal voltage	2
J+258	VtgPwrRtDroop.VtgBreak-points[9]	The voltage breakpoints in % relative to the nominal voltage	3
J+259	VtgPwrRtDroop.VtgBreak-points[10]	The voltage breakpoints in % relative to the nominal voltage	4
J+260	VtgPwrRtDroop.VtgFilterTm	Filter time for voltage measurement	0
J+261	VtgPwrRtDroop.VtgSpntFilterTm	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_RB_Frt
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)	PLLANG
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)	PvPwrAtAvail
VAR(L+55)	BatPwrAtAvail
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)	FrqRespPwrAtSpnt
VAR(L+101)	PreFaultMeasOut
VAR(L+102)	PreFaultSpntOut
VAR(L+103)	FrqRespActDelay_state
VAR(L+104)	FrqRespActDelay_timer
VAR(L+105)	Flag_FrqOutsideDb
VAR(L+106)	TimeDelay for FrqDroop
VAR(L+107)	Frq_After_Delay
VAR(L+108)	Reset
VAR(L+109)	Reset_delay
VAR(L+110)	EnaRamp
VAR(L+111)	EnaRamp_delay
VAR(L+112)	State_ResetTm
VAR(L+113)	ResetTm_Time
VAR(L+114)	Reset_OR_FrqOutside
VAR(L+115)	PwrSpntPu_hold
VAR(L+116)	PwrSpntPu_hold
VAR(L+117)	InPrefaultVal
VAR(L+118)	ShiftPreFaultVal
VAR(L+119)	PreFaultVal
VAR(L+120)	RateLimiter_Input
VAR(L+121)	HoldValue_delay
VAR(L+122)	Unused
VAR(L+123)	HoldValue_delay2
VAR(L+124)	HoldValue_delay3
VAR(L+125)	HoldValue_delay4
VAR(L+126)	EnaShiftPreFaultVal
VAR(L+127)	PvBatMaxOut
VAR(L+128)	PvBatMinOut
VAR(L+129)	FrqDroopActive
VAR(L+130)	PwrAtLimSales
VAR(L+131)	PwrAtSpntFilterTm
VAR(L+132)	PvBatMax_Hold
VAR(L+133)	PvBatMin_Hold
VAR(L+134)	IsFrqLo
VAR(L+135)	IsFrqLo_delay
VAR(L+136)	PreFaultMeasOut
VAR(L+137)	PreFaultSpntOut
VAR(L+138)	Hold_PreFaultVal_process
VAR(L+139)	Timer1
VAR(L+140)	Timer2
VAR(L+141)	PreFaultSpt_hold

VAR(L+142)	PreFaultMeas_hold
VAR(L+143)	FrqDroopActive_delay1
VAR(L+144)	FrqDroopActive_delay2
VAR(L+145)	FrqDroopActive_delay3
VAR(L+146)	FrqDroopActive_delay4
VAR(L+147)	HoldSpnt_Flag
VAR(L+148)	ExtBatPwrAtSpnt
VAR(L+149)	EnaCritGridRamp_delay1
VAR(L+150)	EnaCritGridRamp_delay2
VAR(L+151)	EnaCritGridRamp_Out
VAR(L+152)	FrqDroopActive_Out
VAR(L+153)	BatPwrAtSpnt_Out
VAR(L+154)	FrtActive_delay
VAR(L+155)	ResetSpntMax
VAR(L+156)	ResetSpntMin
VAR(L+157)	ResetMax_delay
VAR(L+158)	PvBatMax_delay
VAR(L+159)	ResetMin_delay
VAR(L+160)	PvBatMin_delay
VAR(L+161)	FrqDroop_delay
VAR(L+162)	FrqDroop_delay2
VAR(L+163)	PvBatMaxOut
VAR(L+164)	PvBatMinOut
VAR(L+165)	PvBatMaxOut_delay
VAR(L+166)	PvBatMaxOut_delay2
VAR(L+167)	PvBatMinOut_delay
VAR(L+168)	PvBatMinOut_delay2
VAR(L+169)	EnaCritGridRamp_dly
VAR(L+170)	EnaCritGridRamp_dly2
VAR(L+171)	EnaCritGridRamp_local
VAR(L+172)	FrqDroopActive_local
VAR(L+173)	PvBatMaxOut_filter
VAR(L+174)	PvBatMinOut_filter
VAR(L+175)	FrqDroopActive_Dly1
VAR(L+176)	FrqDroopActive_Dly2
VAR(L+177)	FrqDroop_SR
VAR(L+178)	PvBatMaxAddRstThshld_Delay
VAR(L+179)	PvBatMinSubRstThshld_Delay
VAR(L+180)	InitCond
VAR(L+181)	FrtActive_delay
VAR(L+182)	Setpoint_delay1
VAR(L+183)	Setpoint_delay2

VAR(L+184)	Setpoint_delay3
VAR(L+185)	Setpoint_delay4
VAR(L+186)	Setpoint_delay5
VAR(L+187)	Setpoint_delay6
VAR(L+188)	PvBatMaxOut
VAR(L+189)	PvBatMinOut
VAR(L+190)	PrioFrqResp_state
VAR(L+191)	PvBatMaxOut_old
VAR(L+192)	Unused
VAR(L+193)	Hold
VAR(L+194)	timer1
VAR(L+195)	timer2
VAR(L+196)	PvBatMaxOut
VAR(L+197)	PvBatMinOut
VAR(L+198)	FreqRespPwrAtMax
VAR(L+199)	FreqRespPwrAtMin
VAR(L+200)	ExtPwrRtSpntOut
VAR(L+201)	PwrRtSpnt
VAR(L+202)	InitVtgSpnt
VAR(L+203)	VtgSpnt_Filt
VAR(L+204)	VtgPoi_Filt
VAR(L+205)	PwrAtPoi_filter
VAR(L+206)	CosPhiSpnt
VAR(L+207)	PwrRtOut
VAR(L+208)	InitCosPhi
VAR(L+209)	Unused
VAR(L+210)	Unused
VAR(L+211)	PwrRtRateMax_Out
VAR(L+212)	PwrRtSpntTot
VAR(L+213)	LimitRtHi
VAR(L+214)	LimitRtLo
VAR(L+215)	PwrAtPoiFilterTm
VAR(L+216)	PwrRtSpntFilterTm
VAR(L+217)	InitCond
VAR(L+218)	FrtActive_delay
VAR(L+219)	Setpoint_delay1
VAR(L+220)	Setpoint_delay2
VAR(L+221)	Setpoint_delay3
VAR(L+222)	Setpoint_delay4
VAR(L+223)	Setpoint_delay5
VAR(L+224)	Setpoint_delay6
VAR(L+225)	PwrRtPwrAtLimHi

VAR(L+226)	PwrRtPwrAtLimLo
VAR(L+227)	PwrAtPoi_filt
VAR(L+228)	PvPwrAtLim
VAR(L+229)	BatPwrAtSpntOut
VAR(L+230)	PwrCtlOut
VAR(L+231)	PwrSpnt_delay
VAR(L+232)	Reset_Timer
VAR(L+233)	Reset_Signal
VAR(L+234)	ResetOut_delay
VAR(L+235)	HoldInt_Out_delay
VAR(L+236)	HoldInt_Active
VAR(L+237)	PwrMsTot_Filt
VAR(L+238)	FrtActive_delay
VAR(L+239)	PiCtrlWithLimit_out
VAR(L+240)	PwrCtl_Integrator
VAR(L+241)	PiCtrl_int_delay1
VAR(L+242)	PiCtrl_int_delay2
VAR(L+243)	PiCtrl_int_delay3
VAR(L+244)	PiCtrl_int_delay4
VAR(L+245)	PiCtrl_int_delay5
VAR(L+246)	PiCtrl_int_delay6
VAR(L+247)	PiCtrl_SetIC_Freeze
VAR(L+248)	PwrCtlOut
VAR(L+249)	PwrSpnt_delay
VAR(L+250)	Reset_Timer
VAR(L+251)	Reset_Signal
VAR(L+252)	ResetOut_delay
VAR(L+253)	HoldInt_out_dly
VAR(L+254)	HoldInt_Active
VAR(L+255)	PwrMsTot_Filt
VAR(L+256)	FrtActive_delay
VAR(L+257)	PiCtrlWithLimit
VAR(L+258)	PwrCtl_Integrator
VAR(L+259)	PiCtrl_int_delay1
VAR(L+260)	PiCtrl_int_delay2
VAR(L+261)	PiCtrl_int_delay3
VAR(L+262)	PiCtrl_int_delay4
VAR(L+263)	PiCtrl_int_delay5
VAR(L+264)	PiCtrl_int_delay6
VAR(L+265)	PiCtrl_SetIC_Freeze
VAR(L+266)	PvPwrAtSpnt
VAR(L+267)	AutoMode

VAR(L+268)	BatPwrAtSpnt
VAR(L+269)	DisablePvRrc
VAR(L+270)	DevAtUpLimitPv
VAR(L+271)	TimeOutTimerPVup
VAR(L+272)	DevAtLoLimitPv
VAR(L+273)	TimeOutTimerPVDown
VAR(L+274)	DevAtUpLimitBat
VAR(L+275)	TimeOutTimerBatup
VAR(L+276)	DevAtLoLimitBat
VAR(L+277)	TimeOutTimerBatDown
VAR(L+278)	TargetPVOut
VAR(L+279)	TargetBatOut
VAR(L+280)	PvPwrAtLimTotOut_delay1
VAR(L+281)	PvPwrAtLimTotOut_delay2
VAR(L+282)	PvPwrAtLimTotOut_delay3
VAR(L+283)	BatPwrAtLimT0otOut_delay1
VAR(L+284)	BatPwrAtLimTotOut_delay2
VAR(L+285)	BatPwrAtLimTotOut_delay3
VAR(L+286)	TimeOutReachedCtrlPrioChange
VAR(L+287)	TimeOutTimerCtrlPrioChange
VAR(L+288)	WsptOldSumHold
VAR(L+289)	PwrAtPoiHold
VAR(L+290)	Hold_delay
VAR(L+291)	Hold_delay2
VAR(L+292)	LimHiFlag_hold
VAR(L+293)	PwrAtPoiHoldMax
VAR(L+294)	PwrAtPoiHoldMin
VAR(L+295)	PwrAtPoiDelay
VAR(L+296)	PwrAtPoiDelayHold
VAR(L+297)	TimeOutReachedHoldChange
VAR(L+298)	TimeOutTimerHoldChange
VAR(L+299)	ForcePrioUp5Delay
VAR(L+300)	ForcePrioUp
VAR(L+301)	POICtrlState
VAR(L+302)	WSpt_Delay1
VAR(L+303)	WSpt_Delay2
VAR(L+304)	SetCtrlPrio_entry
VAR(L+305)	Trigger_state
VAR(L+306)	Trigger_state_timer1
VAR(L+307)	Trigger_state_timer2
VAR(L+308)	CtrlPrio
VAR(L+309)	CtrlPrio_delayed

VAR(L+310)	PrioUp
VAR(L+311)	UseWMax
VAR(L+312)	UpLim2Target
VAR(L+313)	LoLim2Target
VAR(L+314)	ReInit
VAR(L+315)	IC
VAR(L+316)	Holds(1)_delay
VAR(L+317)	Holds(2)_delay
VAR(L+318)	Holds(3)_delay
VAR(L+319)	Holds(4)_delay
VAR(L+320)	Holds(5)_delay
VAR(L+321)	WSpt_pu(1)_delay
VAR(L+322)	WSpt_pu(2)_delay
VAR(L+323)	WSpt_pu(3)_delay
VAR(L+324)	WSpt_pu(4)_delay
VAR(L+325)	WSpt_pu(5)_delay
VAR(L+326)	IsClosedLoop_delay
VAR(L+327)	NumWSptPrio_send(1)_delay
VAR(L+328)	NumWSptPrio_send(2)_delay
VAR(L+329)	NumWSptPrio_send(3)_delay
VAR(L+330)	NumWSptPrio_send(4)_delay
VAR(L+331)	NumWSptPrio_send(5)_delay
VAR(L+332)	Trigg(1)_delay
VAR(L+333)	Trigg(2)_delay
VAR(L+334)	Trigg(3)_delay
VAR(L+335)	Trigg(4)_delay
VAR(L+336)	Trigg(5)_delay
VAR(L+337)	EnaRateLimit(1)_delay
VAR(L+338)	EnaRateLimit(2)_delay
VAR(L+339)	EnaRateLimit(3)_delay
VAR(L+340)	EnaRateLimit(4)_delay
VAR(L+341)	EnaRateLimit(5)_delay
VAR(L+342)	OpenLoop_WSpt(1)
VAR(L+343)	OpenLoop_WSpt(2)
VAR(L+344)	OpenLoop_WSpt(3)
VAR(L+345)	OpenLoop_WSpt(4)
VAR(L+346)	OpenLoop_WSpt(5)
VAR(L+347)	OpenLoop_WSpt(1)_delay
VAR(L+348)	OpenLoop_WSpt(2)_delay
VAR(L+349)	OpenLoop_WSpt(3)_delay
VAR(L+350)	OpenLoop_WSpt(4)_delay
VAR(L+351)	OpenLoop_WSpt(5)_delay

VAR(L+352)	OpenLoop_WSpt_lim(1)
VAR(L+353)	OpenLoop_WSpt_lim(2)
VAR(L+354)	OpenLoop_WSpt_lim(3)
VAR(L+355)	OpenLoop_WSpt_lim(4)
VAR(L+356)	OpenLoop_WSpt_lim(5)
VAR(L+357)	CtrlPrio_ne5_delay
VAR(L+358)	NumWSptPrio_send_delay
VAR(L+359)	QFRT
VAR(L+360)	NotFRT_delay
VAR(L+361)	Ctl_Spt_delay1
VAR(L+362)	Ctl_Spt_delay2
VAR(L+363)	Ctl_Spt_delay3
VAR(L+364)	Ctl_Spt_delay4
VAR(L+365)	Ctl_Spt_delay5
VAR(L+366)	Ctl_Spt_delay6
VAR(L+367)	Ctrl_Spt_SetIC_Freeze
VAR(L+368)	Ctrl_Spt (Output)
VAR(L+369)	u-y_delay
VAR(L+370)	Ctrl_Spt_int
VAR(L+371)	Ena_delay
VAR(L+372)	Ctrl_Spt_delay
VAR(L+373)	PvPwrAtAvailTot
VAR(L+374)	FrtActive_delay
VAR(L+375)	PvPwrAtAvailTot_delay1
VAR(L+376)	PvPwrAtAvailTot_delay2
VAR(L+377)	PvPwrAtAvailTot_delay3
VAR(L+378)	PvPwrAtAvailTot_delay4
VAR(L+379)	PvPwrAtAvailTot_delay5
VAR(L+380)	PvPwrAtAvailTot_delay6
VAR(L+381)	BatWMaxOutAval
VAR(L+382)	FrtActive_delay
VAR(L+383)	BatWMaxOutAval_delay1
VAR(L+384)	BatWMaxOutAval_delay2
VAR(L+385)	BatWMaxOutAval_delay3
VAR(L+386)	BatWMaxOutAval_delay4
VAR(L+387)	BatWMaxOutAval_delay5
VAR(L+388)	BatWMaxOutAval_delay6
VAR(L+389)	PvPwrAtSpntOld
VAR(L+390)	FrtActive_delay
VAR(L+391)	PvPwrAtSpntOld_delay1
VAR(L+392)	PvPwrAtSpntOld_delay2
VAR(L+393)	PvPwrAtSpntOld_delay3

VAR(L+394)	PvPwrAtSpntOld_delay4
VAR(L+395)	PvPwrAtSpntOld_delay5
VAR(L+396)	PvPwrAtSpntOld_delay6
VAR(L+397)	BatPwrAtSpntOld
VAR(L+398)	FrtActive_delay
VAR(L+399)	BatPwrAtSpntOld_delay1
VAR(L+400)	BatPwrAtSpntOld_delay2
VAR(L+401)	BatPwrAtSpntOld_delay3
VAR(L+402)	BatPwrAtSpntOld_delay4
VAR(L+403)	BatPwrAtSpntOld_delay5
VAR(L+404)	BatPwrAtSpntOld_delay6
VAR(L+405)	PvTarget_delay
VAR(L+406)	BatTarget_delay
VAR(L+407)	PvPwrAtLimTotOut
VAR(L+408)	BatPwrAtLimTotOut
VAR(L+409)	RtPwrNomTot
VAR(L+410)	PwrCtlOut
VAR(L+411)	PwrSpnt_delay
VAR(L+412)	Reset_Timer
VAR(L+413)	Reset_Signal
VAR(L+414)	ResetOut_delay
VAR(L+415)	HoldInt_Out_dly
VAR(L+416)	HoldInt_Active
VAR(L+417)	PwrMsTot_Filt
VAR(L+418)	FrtActive_delay
VAR(L+419)	PiCtrlWithLimit_out
VAR(L+420)	PwrCtl_Integrator
VAR(L+421)	PiCtrl_int_delay1
VAR(L+422)	PiCtrl_int_delay2
VAR(L+423)	PiCtrl_int_delay3
VAR(L+424)	PiCtrl_int_delay4
VAR(L+425)	PiCtrl_int_delay5
VAR(L+426)	PiCtrl_int_delay6
VAR(L+427)	PiCtrl_SetIC_Freeze
VAR(L+428)	PwrRtSpntOut
VAR(L+429)	RtPwrNomTot
VAR(L+430)	Vtg_Poi_Flt
VAR(L+431)	HiLimit_Flag
VAR(L+432)	LoLimit_Flag
VAR(L+433)	PwrCtlOut
VAR(L+434)	PwrSpnt_delay
VAR(L+435)	Reset_Timer

VAR(L+436)	Reset_Signal
VAR(L+437)	ResetOut_delay
VAR(L+438)	HoldIntegrator_Out_delay
VAR(L+439)	HoldIntegrator_Active
VAR(L+440)	PwrMsTot_Filt
VAR(L+441)	FrtActive_delay
VAR(L+442)	PiCtrlWithLimit_output
VAR(L+443)	PwrCtl_Integrator
VAR(L+444)	PiCtrl_int_delay1
VAR(L+445)	PiCtrl_int_delay2
VAR(L+446)	PiCtrl_int_delay3
VAR(L+447)	PiCtrl_int_delay4
VAR(L+448)	PiCtrl_int_delay5
VAR(L+449)	PiCtrl_int_delay6
VAR(L+450)	PiCtrl_SetIC_Freeze
VAR(L+451)	PvPwrRtSpnt
VAR(L+452)	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.