IOP 2019 – Integrated Application Design

Version: 2019-09-18

1 Overview

Changes in this version:

- *Removed TXA PU-M2, as GE will not bring the T60 to the IOP*
- *Swapped L1 MU (ABB) with BT MU (Siemens) to have PRP only in L1 and HSR in BT*
- *Added signals for synchrocheck to HV GOOSE Matrix*

The following figure is an overview of the substation single line and functions serving as the scenario for the integrated application. That same scenario was already the basis for the IOP 2017 in New Orleans.

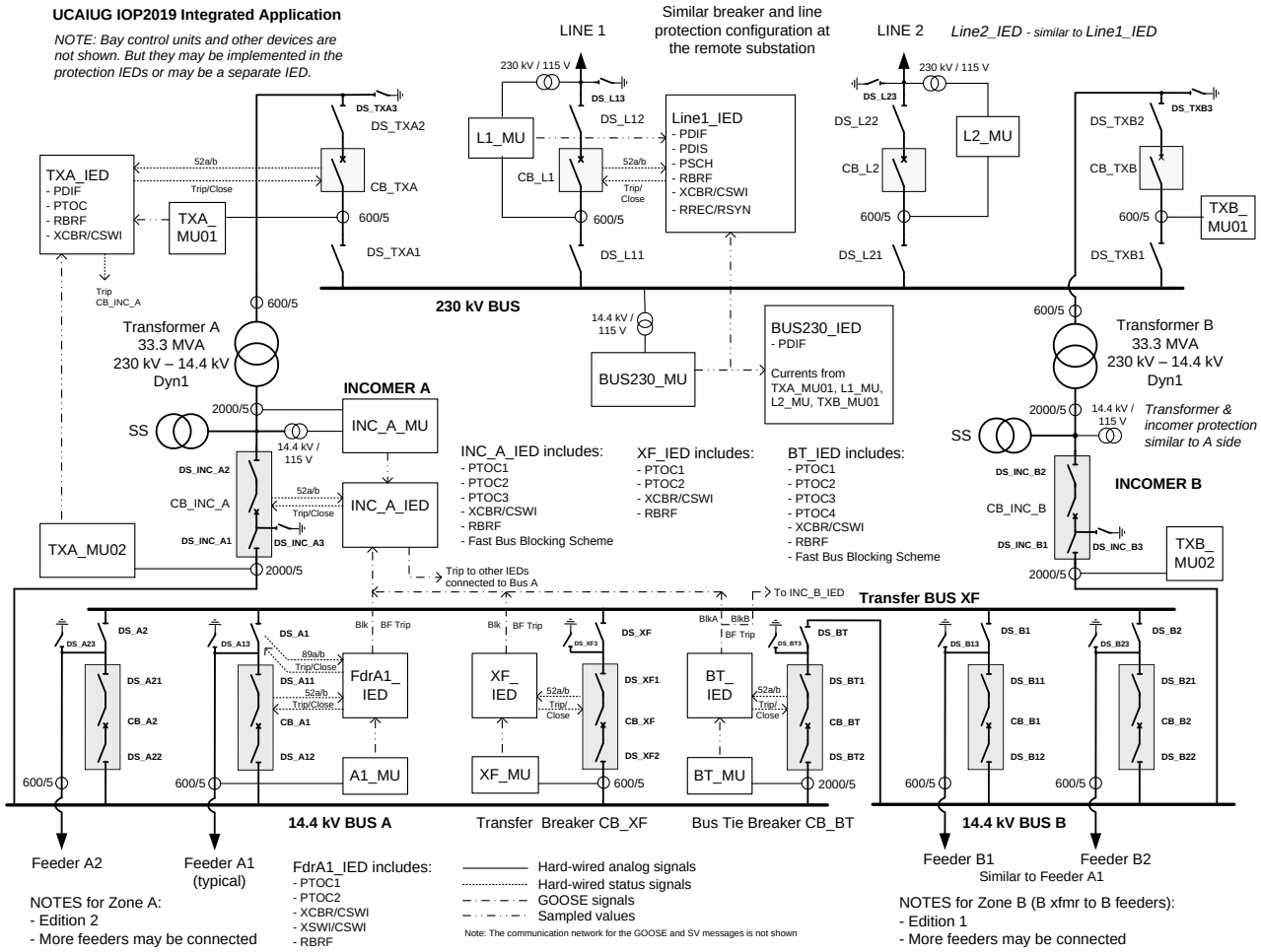

Figure 1: Overview of integrated application scenario

It is also foreseen to have a second substation at the other end of the lines and a control center.

Based on the available devices, it was decided to abandon differential protection for the lines but use distance protection with a POTT scheme.

The application will be designed as two projects – one for the HV part and one for the LV part, using SED file exchange to configure the interactions between IEDs in the two projects.

As the MU TXA_MU02 and TXB_MU02 only communicate with protection devices on the HV side, those will be allocated in the HV project, even that from their primary side, they are connected to the LV.

2 Communication network design

2.1 Structure of communication network

The communication network will have:

- One station bus supporting PRP
- One process bus supporting HSR
- One process bus supporting PRP

The process bus is used for the traffic associated with Sampled values. All GOOSE messages will be sent over the Station bus. For devices not supporting redundancy that need to be connected to the process bus, Redboxes will be used.

VLANs are used to limit message flow from process bus to station bus. There is:

- One VLAN ID for traffic in the HSR process bus
- One VLAN ID for traffic in the PRP process bus
- One VLAN ID for traffic that goes between PRP and HSR process bus

In chapter 3, the connectivity of the various devices is described. For the connection to the process bus it is indicated, how it is connected. The following terminology is used:

- HSR: native HSR connection
- PRP: native PRP connection
- SAN (HSR): Connection to HSR through RedBox
- SAN (PRP): Connection to PRP through RedBox
- HSR → PRP: Connection to HSR, but data need to be available as well on PRP

2.2 Requirement for connecting test equipment

Besides the IEDs described in chapter 3 and various clients that are connected to the station bus, we need to be able to connect various test equipment:

- Test tools like GOOSE and SV trackers that check the network for presence of the messages
- Test equipment that can send simulated messages

The test equipment needs to be able to connect to either HSR or PRP process bus through Redboxes. We should foresee several spare connections for those.

3 IEC 61850 function decomposition, device allocation and signal exchange

In this section, the function allocation to the devices is detailed. Also, a GOOSE/SV subscription Matrix is provided.

It must be noted that this document does not show MMXUs. Various devices may report data from MMXU.

3.1 HV part

3.1.1 Single line overview

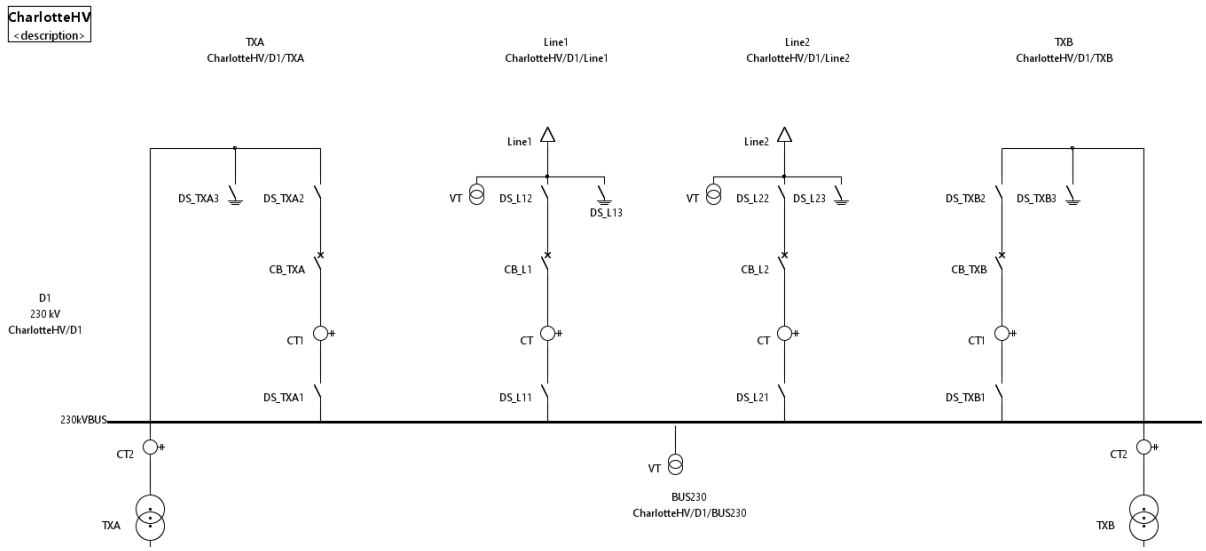

Figure 2: Single line HV part

3.1.2 Bay Line1

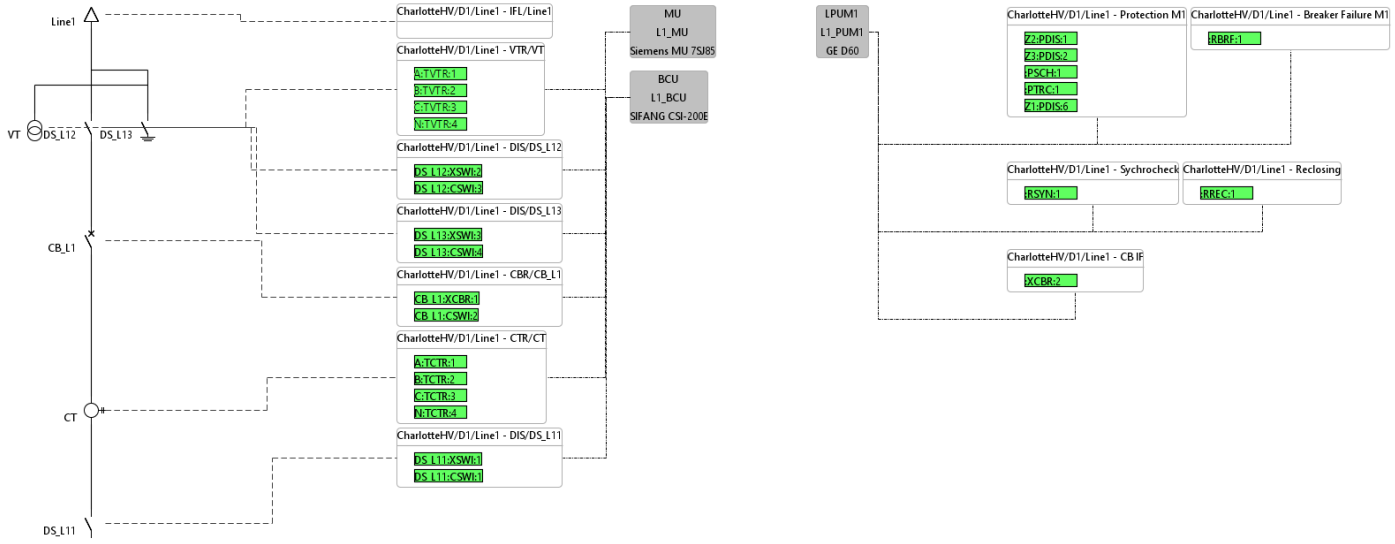

Figure 3: Implementation of Bay Line1

Connections:

Device Fct	Device Type	SB	PB	Remark
MU	Siemens MU 7SJ85	PRP	PRP	
BCU	SIFANG CSI-200E	PRP	PRP	
PU M1	GE D60	SAN	PRP	

Implementation remarks:

- Use R-GOOSE to remote SS
- No M2 PU

3.1.3 Bay Line2

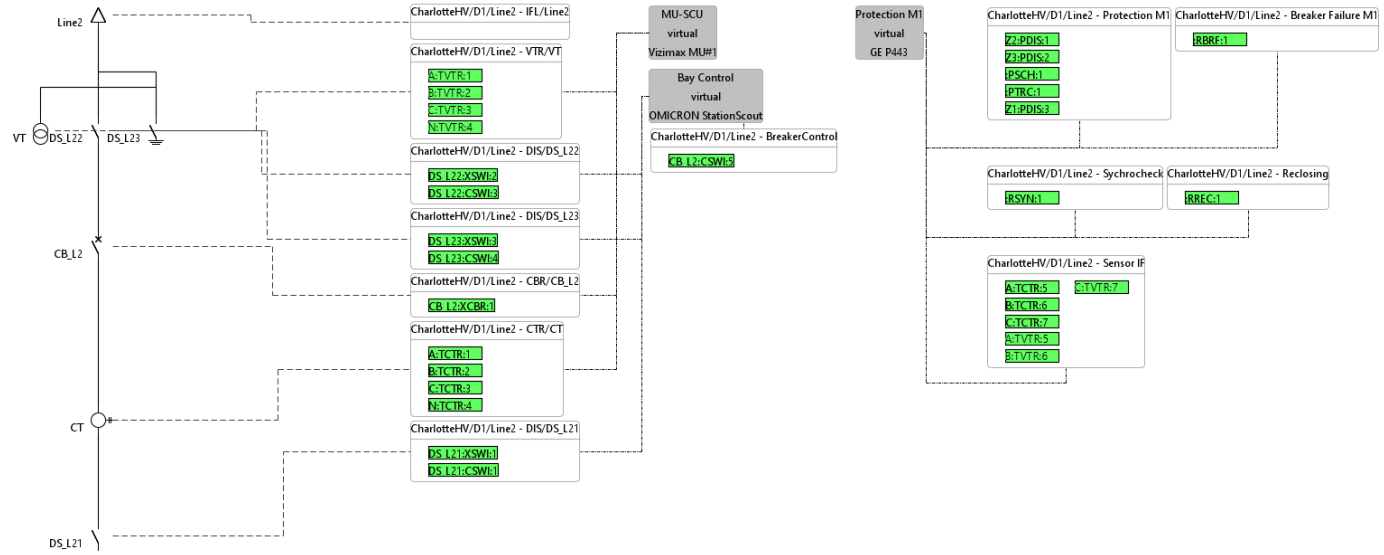

Figure 4: Implementation of Bay Line2

Connections:

Device Fct	Device Type	SB	PB	Remark
MU-SCU	Vizimax MU#1	SAN	PRP	Used for BB Protection
BCU	OMICRON SScout	SAN		
PU M1	GE P443	PRP		No SV

Implementation remarks:

- No M2 PU
- CB interface through MU-SCU

3.1.4 Bay TXA

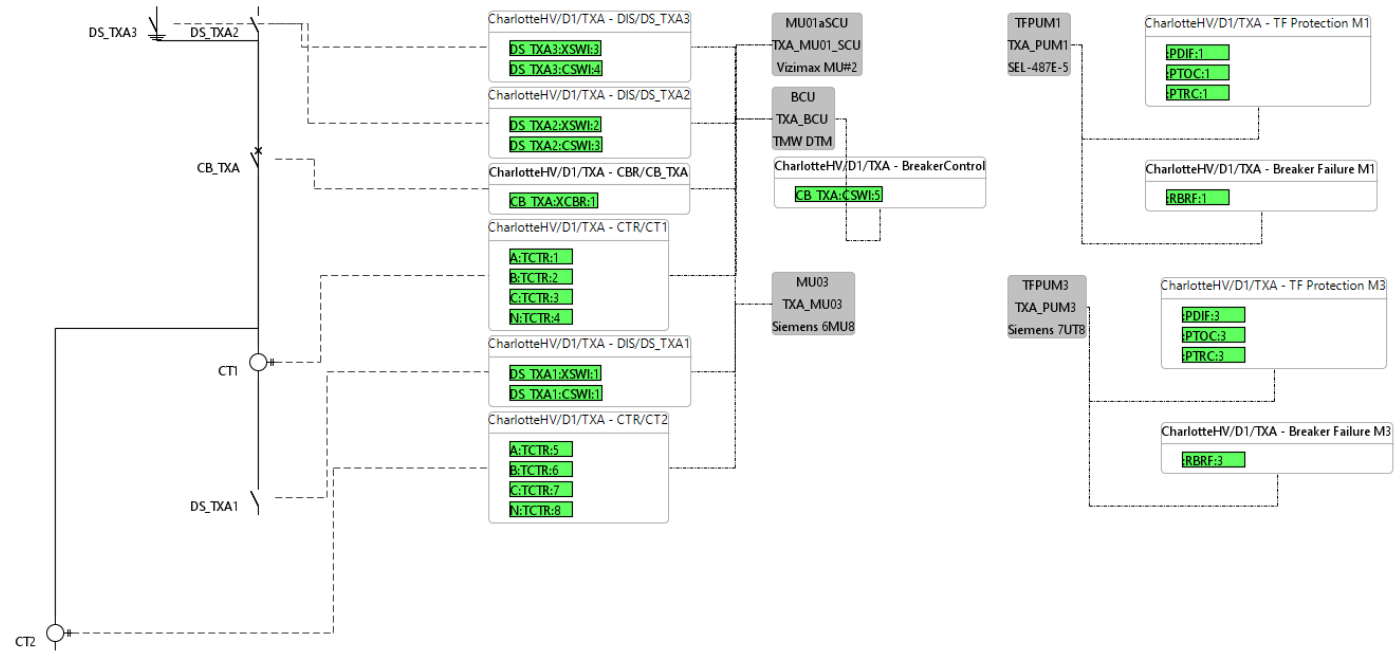

Figure 5: Implementation of Bay TXA

Device Fct	Device Type	SB	PB	Remark
MU01-SCU	Vizimax MU#1	SAN	PRP	
MU03	Siemens 6MU8	PRP	PRP	Used for BB Protection
BCU	TMW DTM	SAN		
PU M1	SEL-487E-5	PRP	SAN (PRP)	
PU M3	Siemens 7UT8	PRP	PRP	

NOTE: MU02 is shown in LV / Incomer A

Implementation remarks:

- CB interface through MU-SCU over SB
- LV side will be tripped through GOOSE to PU-BCU in IncomerA from protection and from breaker failure.

3.1.5 Bay TXB

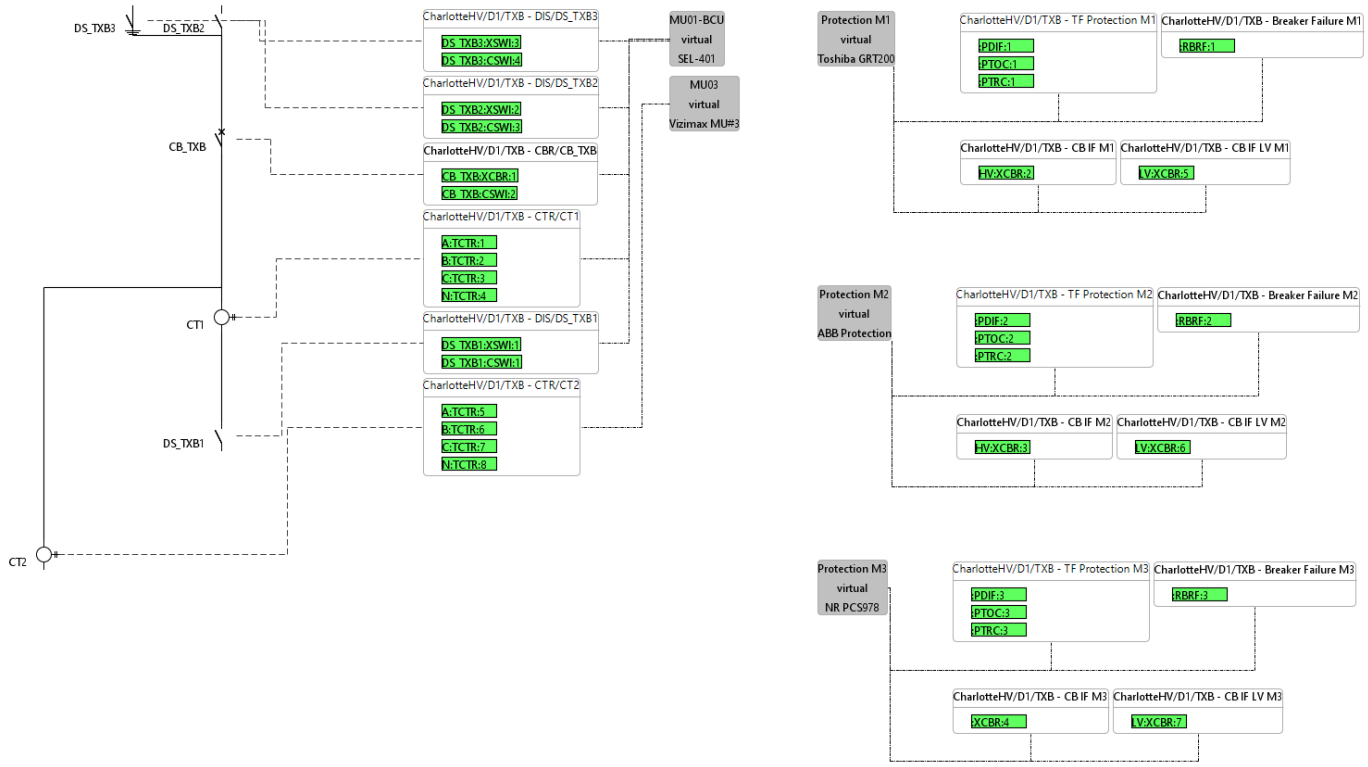

Figure 6: Implementation of Bay TXB

Connections:

Device Fct	Device Type	SB	PB	Remark
MU01-BCU	SEL-401	PRP	SAN (HSR)	
MU03	Vizimax PMU/MU#3	SAN	PRP	Used for BB Protection / PRP PB
PU M1	Toshiba GRT200	PRP	HSR	
PU M2	ABB Protection	PRP	HSR	
PU M3	NR PCS978	SAN/PRP/HSR	HSR	

NOTE: MU02 is shown in LV / IncomerB

Implementation remarks:

- BCU combined with MU01
- Wired trip from protection to LV side
- GOOSE based initiate of breaker failure in IncomerB PU

- GOOSE based tripping of LV side through IncomerB BCU from breaker failure

3.1.6 Bay BUS230

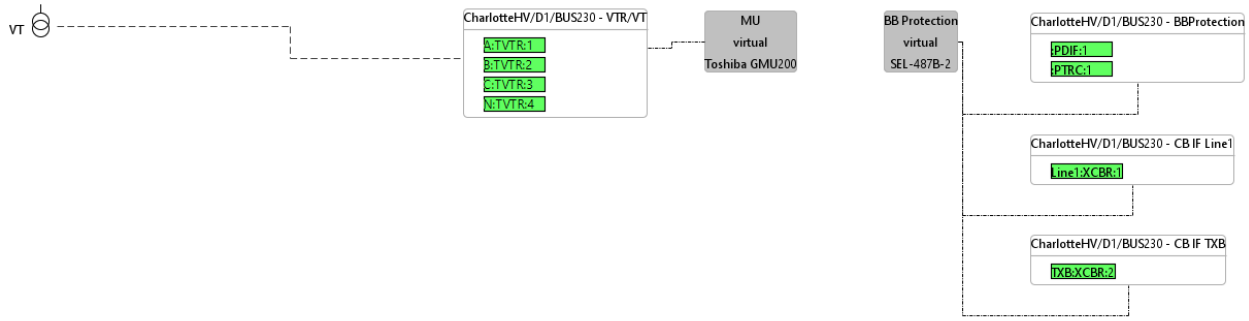

Figure 7: Implementation of Bay BUS230

Connections:

Device Fct	Device Type	SB	PB	Remark
MU	Toshiba GMU200		HSR → PRP	
PU	SEL-487B-2	SAN/PRP	SAN (PRP)	

Implementation remark:

- Tripping of Line2 and TXA through GOOSE to SCU

3.1.7 GOOSE / SV Matrix for HV Part

The following table provides an overview on GOOSE / SV Signal flow

Sending Device	Signal	L1 BCU	L1 PU-M1	L2 MU-SCU	L2 BCU	L2 PU-M2	TXA MU01-SCU	TXA BCU	TXA PU-M1	TXA PU-M3	TXB MU01-BCU	TXB PU-M1	TXB PU-M2	TXB PU-M3	BUS230 PU		IncA PU-BCU	IncB BCU	IncB PU	BT PU-BCU		Substation 2	
Bay L1																							
MU	TCTR.AmpSv TVTR.VolSv	x	x												x								BCU may subscribe for MMXU
BCU	DIS_L11XSWI.Pos														x								
PU-M1	RBRF.OpEx			x			x				x											x	
	RREC.OpCls	x																					
	PSCH.Op																					x	
	RSYN.Rel	x																					
Bay L2																							
MU-SCU	TCTR.AmpSv TVTR.VolSv				x										x								BCU may subscribe for MMXU
	XCBR.Pos				x	x									x								
BCU	CSWI.OpOpn CSWI.OpCls CSWI.SelOpn CSWI.SelCls			x																			
	DIS_L21XSWI.Pos														x								
PU-M1	RBRF.OpEx	x					x				x											x	
	PTRC.Tr			x																			
	RREC.OpCls			x																			
	PSCH.Op																					x	
	RSYN.Rel				x																		
Bay TXA																							
MU01-SCU	TCTR.AmpSv								x	x													
	XCBR.Pos							x	x	x					x					x			in BT PU to determine voltage source
MU02	TCTR.AmpSv								x	x													
MU03	TCTR.AmpSv														x								
BCU	CSWI.OpOpn CSWI.OpCls						x																

Sending Device	Signal	L1 BCU	L1 PU-M1	L2 MU-SCU	L2 BCU	L2 PU-M2	TXA MU01-SCU	TXA BCU	TXA PU-M1	TXA PU-M3	TXB MU01-BCU	TXB PU-M1	TXB PU-M2	TXB PU-M3	BUS230 PU		IncA PU-BCU	IncB BCU	IncB PU	BT PU-BCU		Substation 2	
	CSWI.SelOpn CSWI.SelCls																						
	DIS_TXA1XSWI.Pos														x								
PU-M1	PTRC.Tr						x										x						
	RBRF.OpEx	x		x							x						x						
PU-M3	PTRC.Tr						x										x						
	RBRF.OpEx	x		x							x						x						
Bay TXB																							
MU01-BCU	TCTR.AmpSv											x	x	x									
	XCBR.Pos																			x			determine voltage source
	DIS_TXA1XSWI.Pos														x								
MU02	TCTR.AmpSv											x	x	x									
MU03	TCTR.AmpSv														x								
PU-M1	PTRC.Tr																		x				as BF Initiate signal
	RBRF.OpEx	x		x			x											x					
PU-M2	PTRC.Tr																		x				as BF Initiate signal
	RBRF.OpEx	x		x			x											x					
PU-M3	PTRC.Tr																		x				as BF Initiate signal
	RBRF.OpEx	x		x			x											x					
Bay BUS320																							
MU	TVTR.VolSv	x	x								x												for synch Check and metering
PU	PTRC.Tr		x	x		x	x		x	x		x	x	x									to PUs to initiate BF

3.2 LV Part

3.2.1 Single line overview

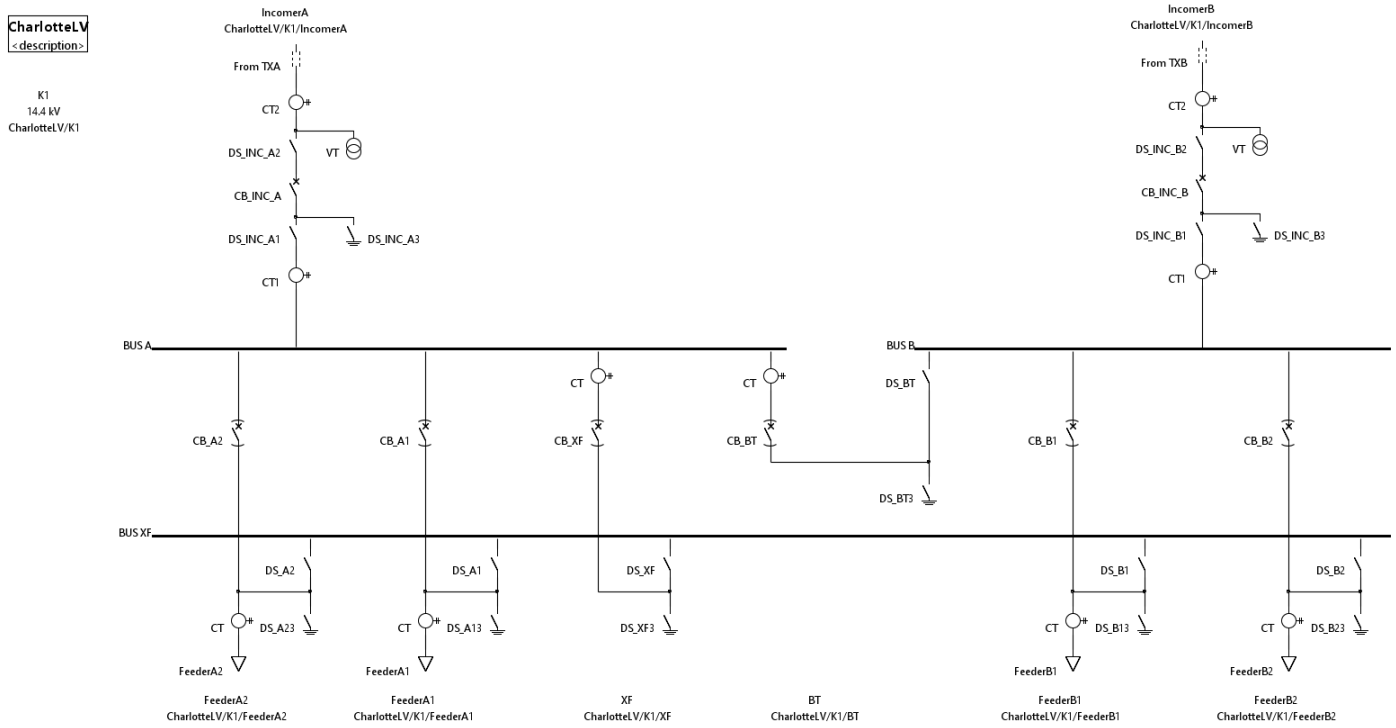

Figure 8: Single line LV Part

3.2.2 Bay IncomerA

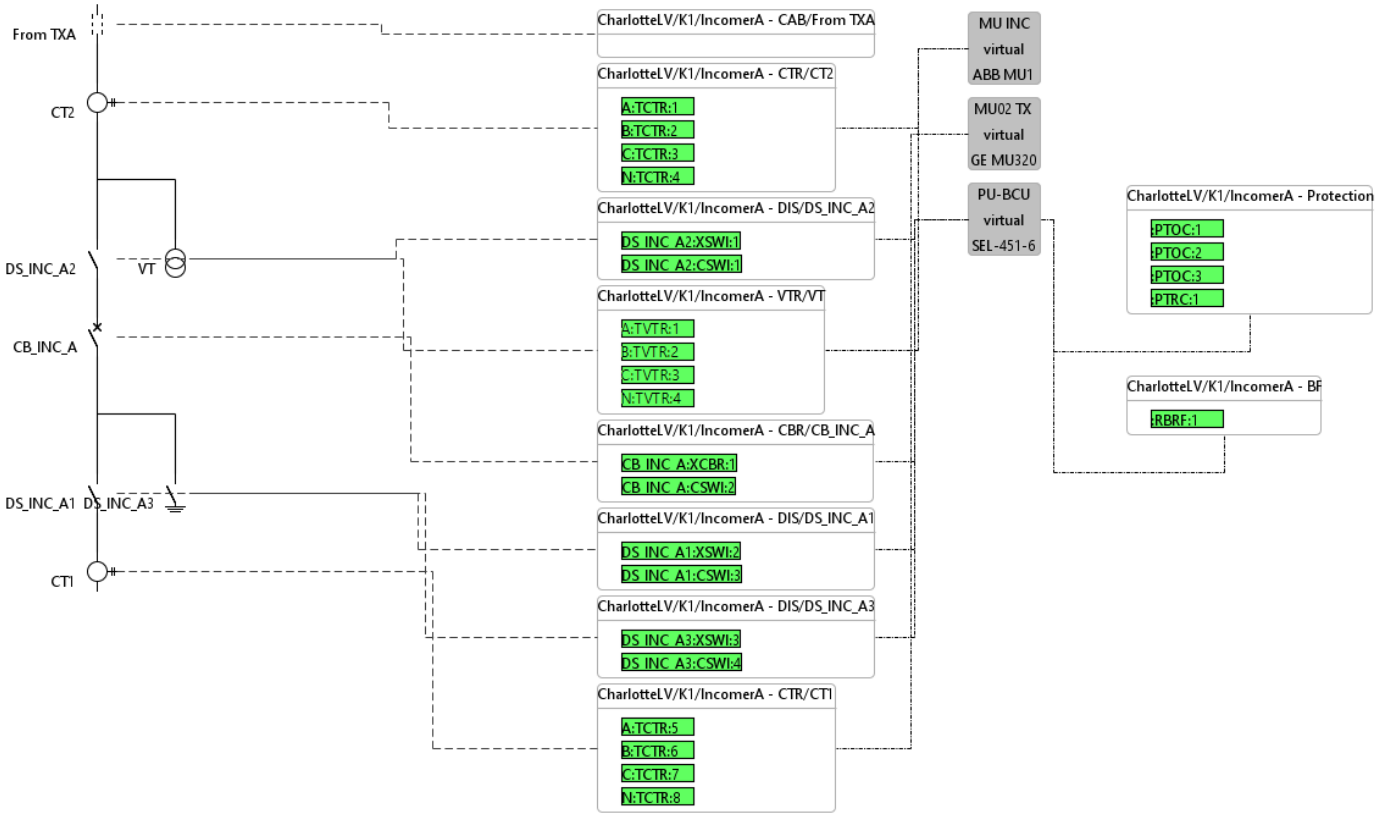

Figure 9: Implementation of Bay IncomerA

Connections:

Device Fct	Device Type	SB	PB	Remark
MU02	GE MU320	SAN	PRP	SV sent to HV TX Prot, as this is only used by HV side, the device will be part of the SCL HV project.
MU	ABB MU1		HSR	
PU-BCU	SEL-451-6	SAN/PRP	SAN(HSR)	

Implementation remark:

- Protection and BCU combined
- BB Trip from fast bus blocking scheme sent with GOOSE to BCUs

3.2.3 Bay IncomerB

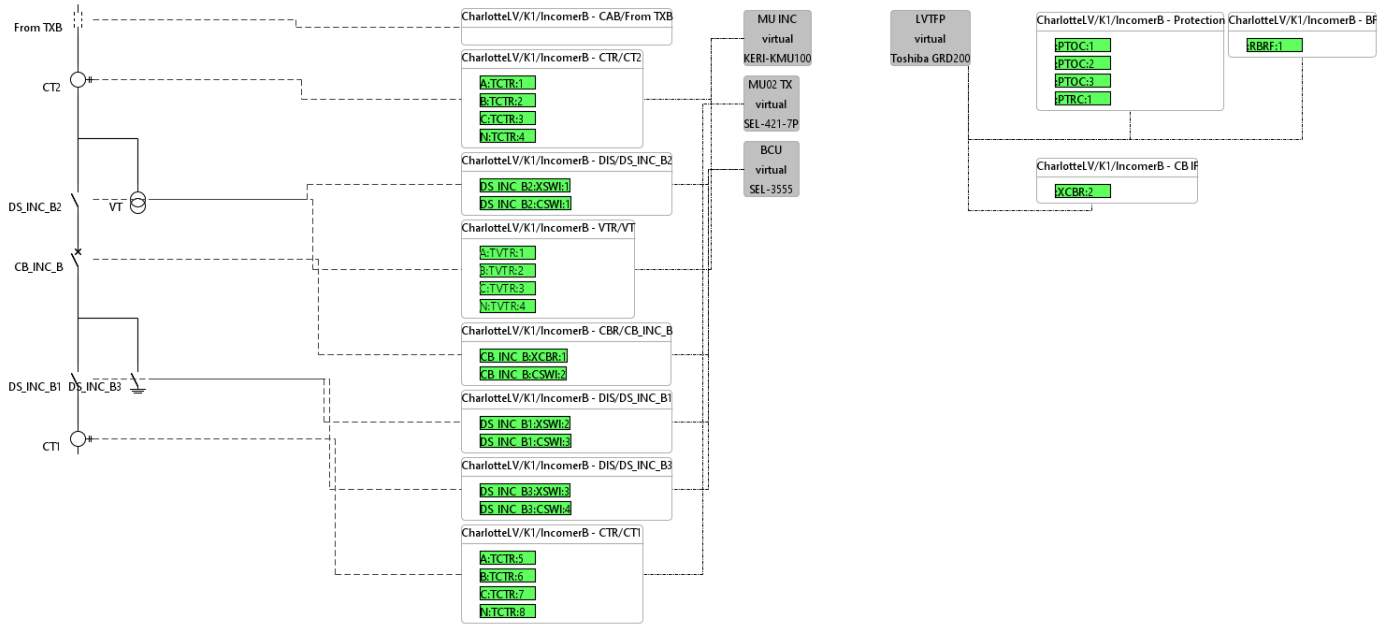

Figure 10: Implementation of Bay IncomerB

Connections:

Device Fct	Device Type	SB	PB	Remark
MU02	SEL-421-7P		SAN	SV sent to HV TX Prot, as this is only used by HV side, the device will be part of the SCL HV project.
MU	KERI KMU100		HSR	
BCU	SEL-3555	PRP		
PU	Toshiba GRD200	PRP	HSR	

Implementation remark:

- BB Trip from fast bus blocking scheme sent with GOOSE to BCUs

3.2.4 Bay FeederA1

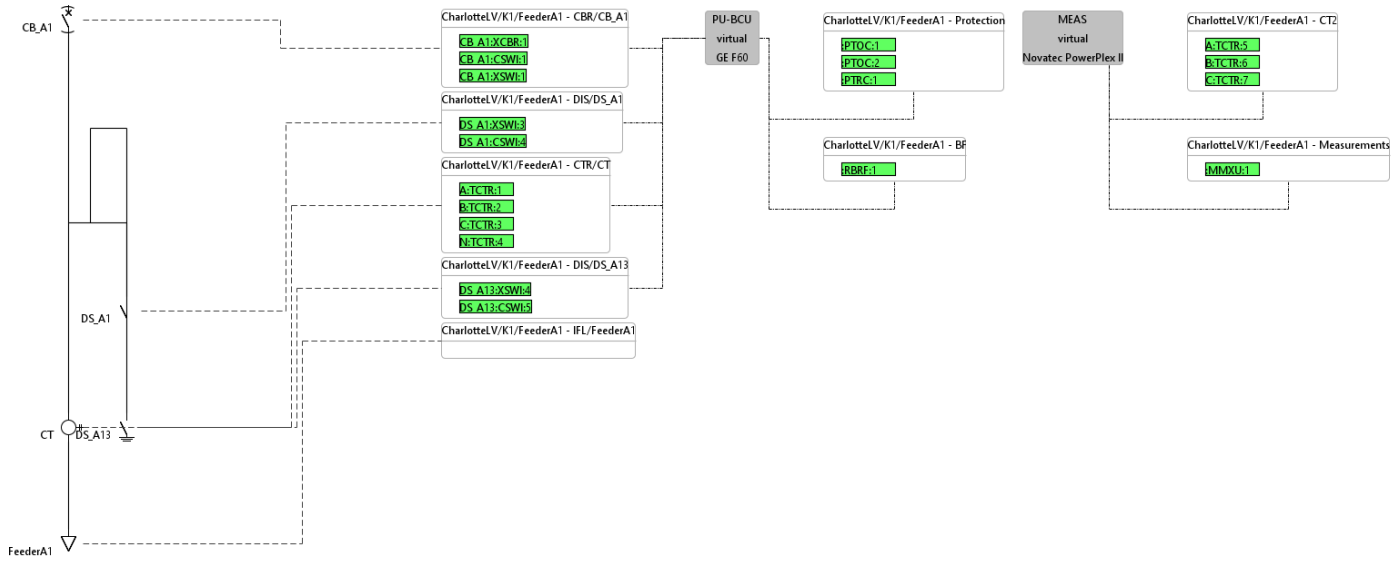

Figure 11: Implementation of Bay FeederA1

Connections:

Device Fct	Device Type	SB	PB	Remark
MEAS	Novatech PowerPlex II	SAN		
PU-BCU	GE F60	SAN		

Implementation remark:

- No Process Bus / no SV

3.2.5 Bay FeederA2

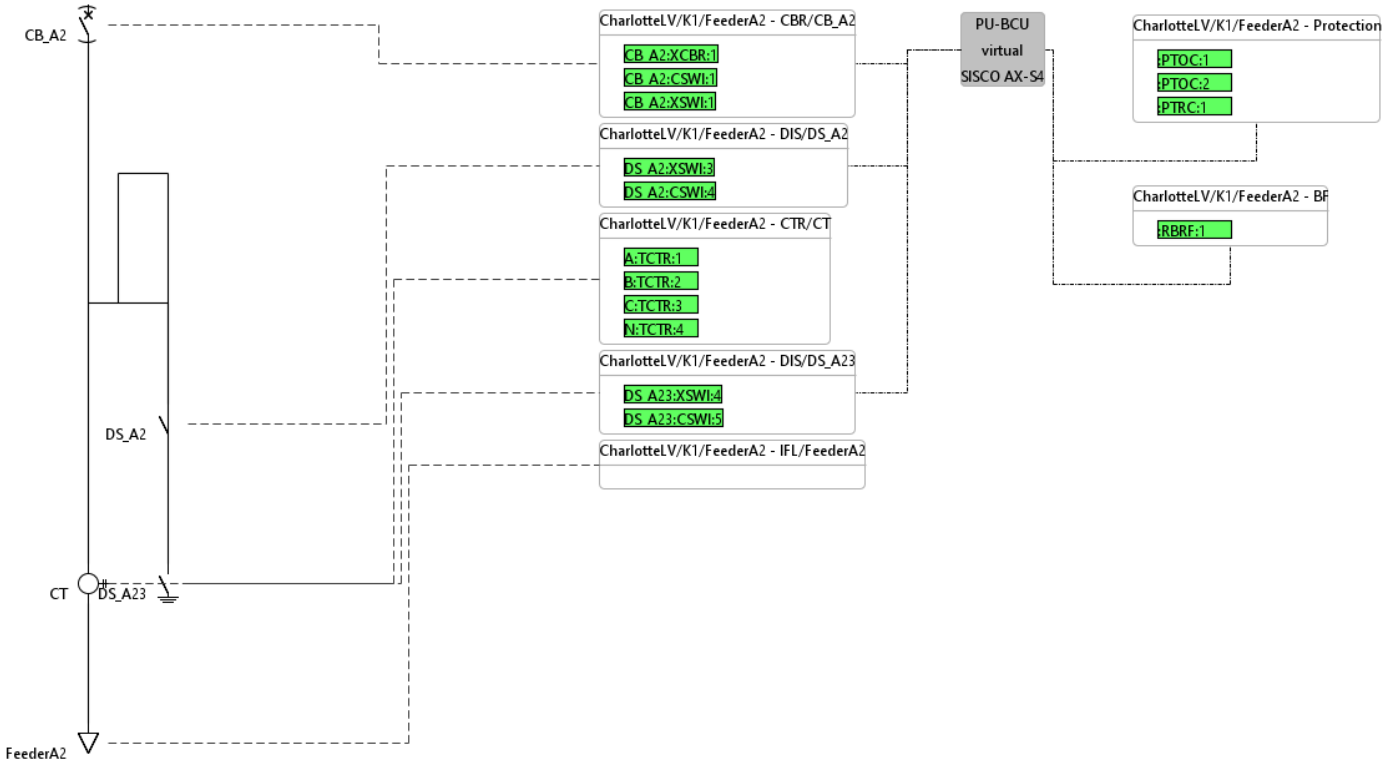

Figure 12: Implementation of Bay FeederA2

Connections:

Device Fct	Device Type	SB	PB	Remark
PU-BCU	SISCO AX-S4	SAN		

Implementation remark:

- No Process Bus / no SV
- Simulated bay only (limited Protection functionality)
- Combined BCU-PU

3.2.6 Bay FeederB1

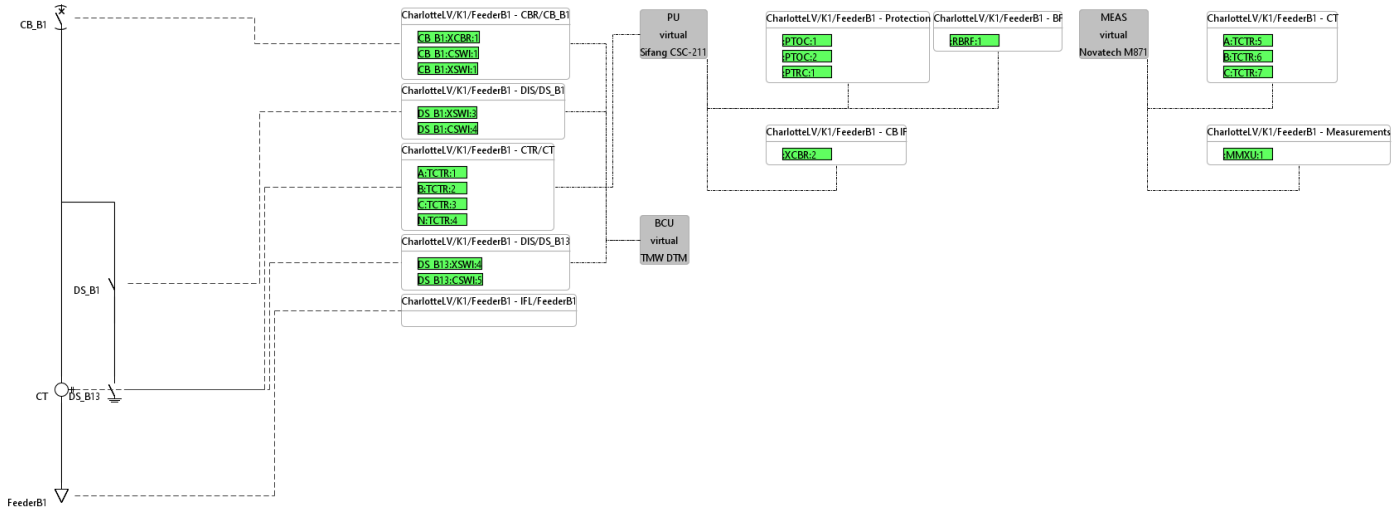

Figure 13: Implementation of Bay FeederB1

Connections:

Device Fct	Device Type	SB	PB	Remark
BCU	Novatech M871	SAN		Ed1 only! Requires downgraded SCD file
PU	Sifang CSC-211	PRP		

Implementation remark:

- No Process Bus / no SV

3.2.7 Bay FeederB2

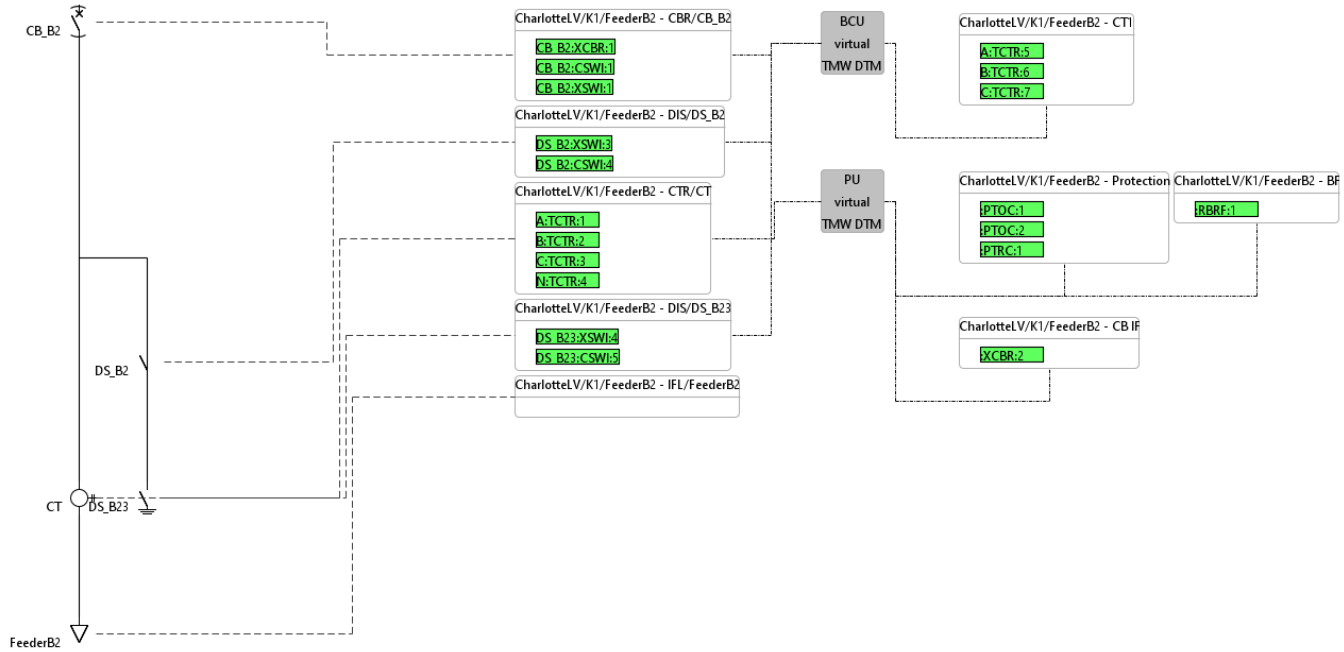

Figure 14: Implementation of Bay FeederB2

Connections:

Device Fct	Device Type	SB	PB	Remark
BCU	TMW DTM	SAN		
PU	TMW DTM	SAN		

Implementation remark:

- No Process Bus / no SV
- Simulated bay only

3.2.8 Bay XF

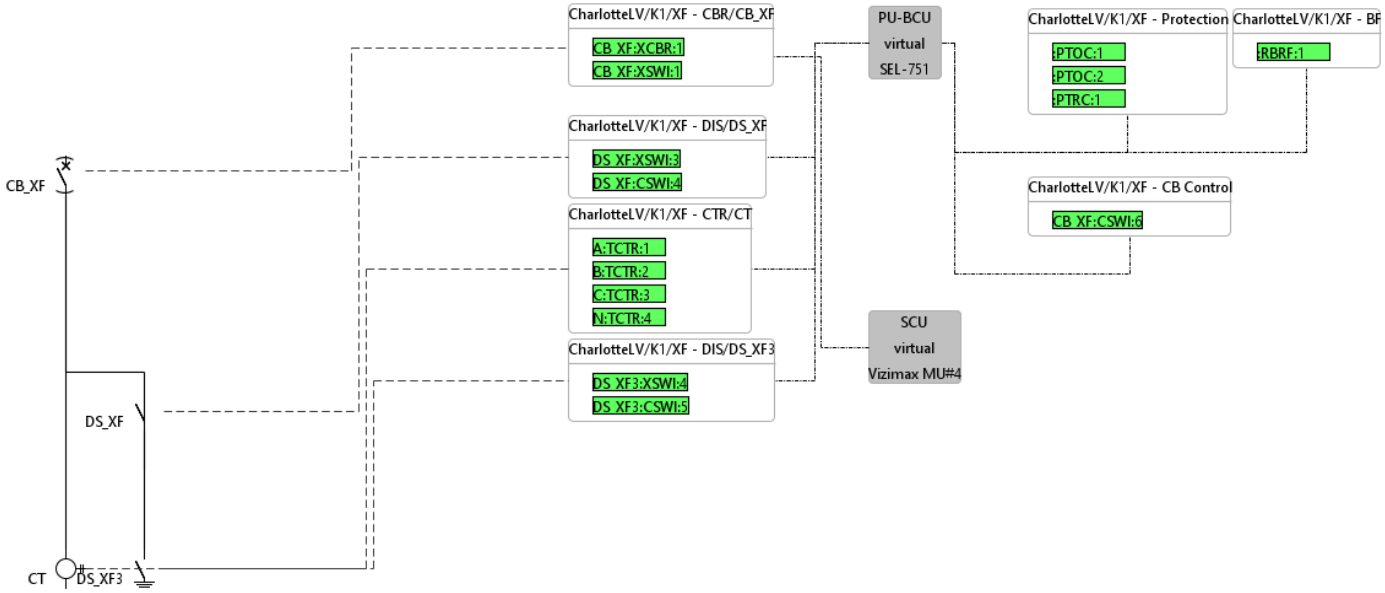

Figure 15: Implementation of Bay XF

Connections:

Device Fct	Device Type	SB	PB	Remark
SCU	Vizimax PMU/MU#4	SAN		
PU-BCU	SEL-751	PRP		

Implementation remark:

- No SV
- CB Interface through SCU

3.2.9 Bay BT

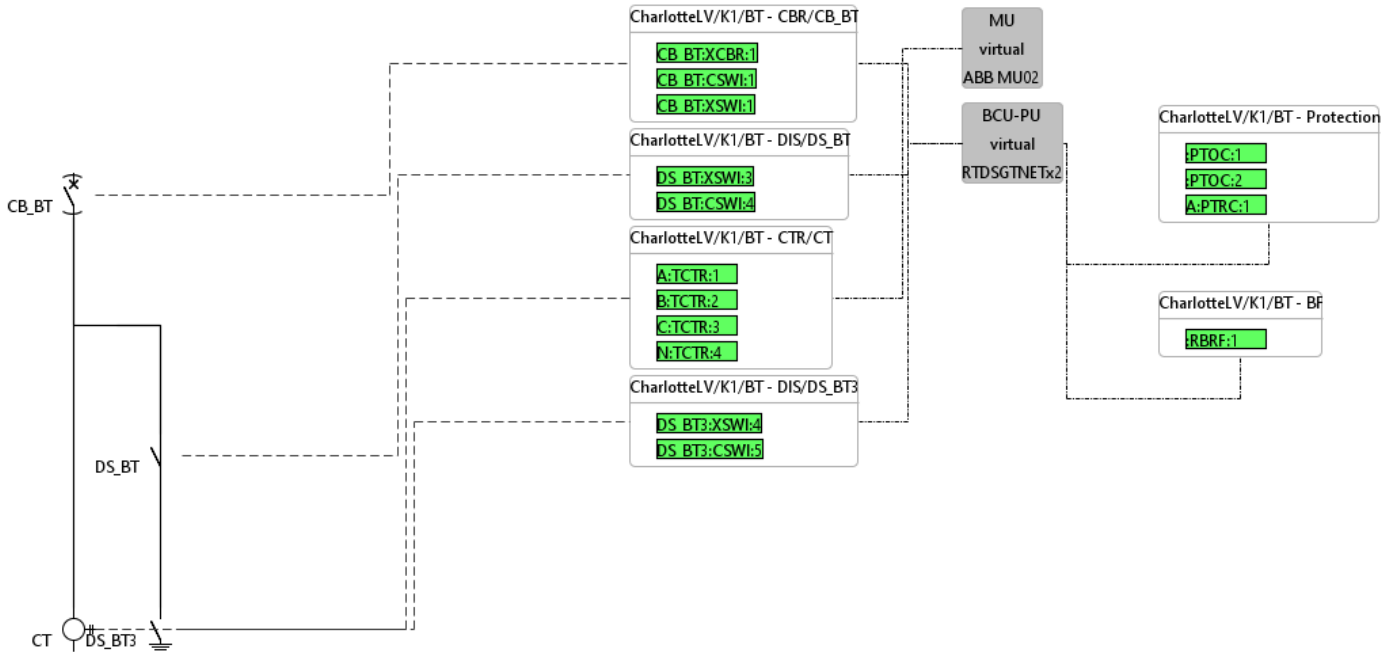

Figure 16: Implementation of Bay BT

Connections:

Device Fct	Device Type	SB	PB	Remark
MU	ABB MU02		HSR	
PU-BCU	RTDSGTNETx2	SAN (2)	SAN (HSR)	is it possible to add LNs XSWI?

Implementation remark:

- Process Bus is PRP
- Combined Protection / BCU
- PU determines the voltage to use for polarization based on breaker positions of CB_TXA / CB_INCA / CB_TXB / CB_INCB

3.2.10 GOOSE / SV Matrix for LV Part

The following table provides an overview on GOOSE / SV Signal flow

Sending Device	Signal	IncA PU-BCU	IncB BCU	IncB PU	FA1 PU-BCU	FA2 PU-BCU	FB1 BCU	FB1 PU	FB2 BCU	FB2 PU	XF SCU	XF PU-BCU	BT PU-BCU		TXA MU01-SCU	TXB MU01-BCU	
Bay IncomerA																	
MU INC	TCTR.AmpSv TVTR.VolSv	x											x				
PU-BCU	RBRF.OpEx				x	x					x		x		x		
	PTRC.Tr												x				BB Trip
	XCBR.Pos												x				determine voltage source
Bay IncomerB																	
MU INC	TCTR.AmpSv TVTR.VolSv		x	x									x				BCU may subscribe for MMXU
BCU	XCBR.Pos												x				determine voltage source
PU	RBRF.OpEx						x		x				x			x	
	PTRC.Tr												x				BB Trip
Bay FeederA1																	

Sending Device	Signal	IncA PU-BCU	IncB BCU	IncB PU	FA1 PU-BCU	FA2 PU-BCU	FB1 BCU	FB1 PU	FB2 BCU	FB2 PU	XF SCU	XF PU-BCU	BT PU-BCU		TXA MU01-SCU	TXB MU01-BCU	
BCU	DS_A1XSWI.Pos											x					for switching of setting group
PU	PTOC1.Str	x											x				for fast bus blocking scheme
	RBRF.OpEx	x											x				
Bay FeederA2																	
PU-BCU	DS_A2XSWI.Pos											x					for switching of setting group
	PTOC1.Str	x											x				for fast bus blocking scheme
	RBRF.OpEx	x											x				
Bay FeederB1																	
BCU	DS_B1XSWI.Pos											x					for switching of setting group
PU	PTOC1.Str			x									x				for fast bus blocking scheme
	RBRF.OpEx		x										x				
Bay FeederB2																	
BCU	DS_B2XSWI.Pos											x					for switching of setting group
PU	PTOC1.Str			x									x				for fast bus blocking scheme
	RBRF.OpEx		x										x				
Bay XF																	
SCU	XCBR.Pos											x					
PU-BCU	CSWI.OpOpn CSWI.OpCls CSWI.SelOpn CSWI.SelCls										x						
	PTOC1.Str	x											x				for fast bus blocking scheme
	RBRF.OpEx	x											x				
Bay BT																	
MU	TCTR.AmpSv												x				
PU-BCU	PTOC1.Str (P51)	x															for fast bus blocking scheme
	PTOC2.Str (P50)		x														for fast bus blocking scheme
	RBRF.OpEx	x	x														