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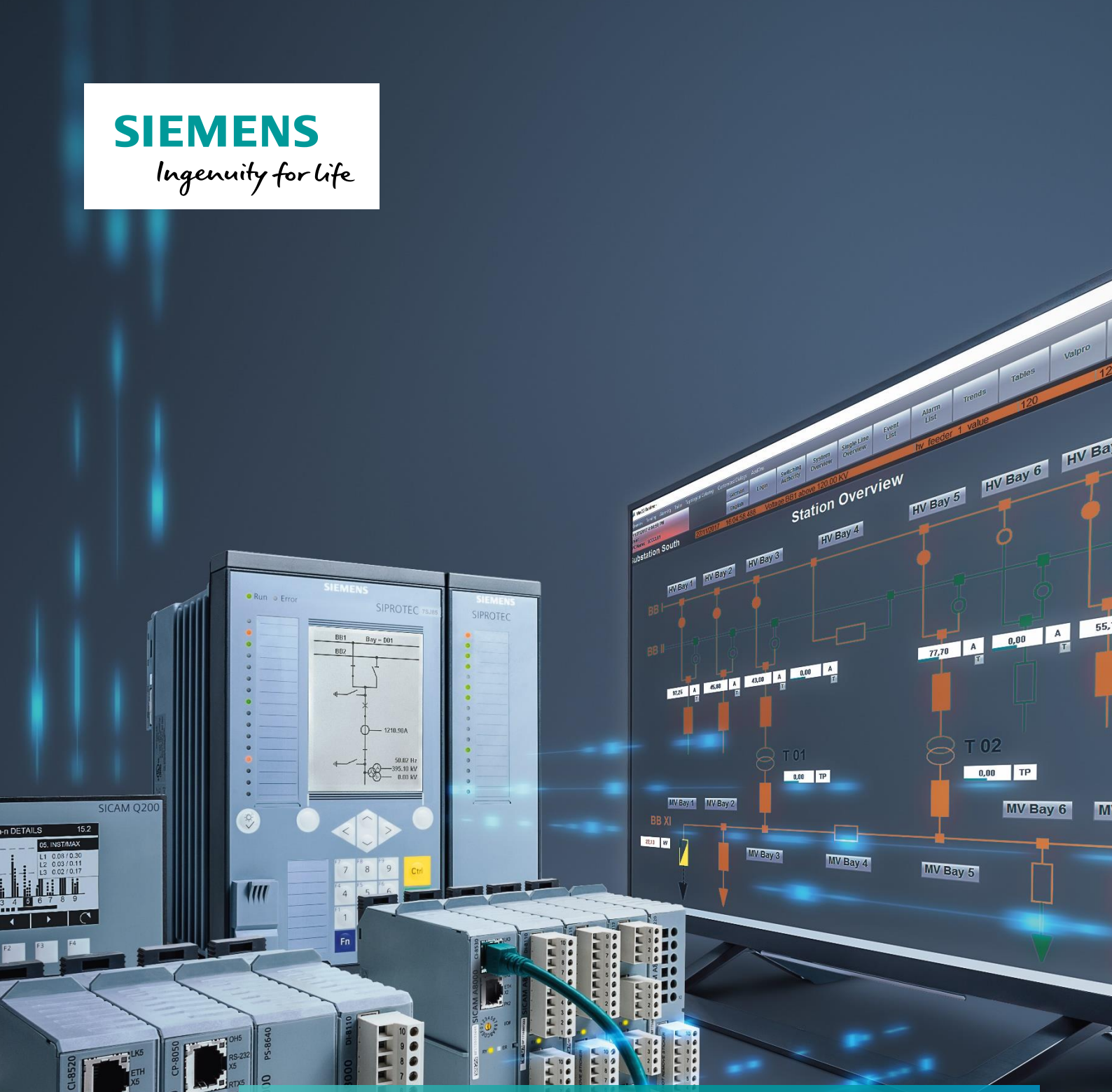

Distributed busbar protection 7SS85 for more than 14 / 15 measuring points

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SIPROTEC 5 Application

Distributed busbar protection 7SS85 for more than 14 / 15 measuring points

APN-074, Edition 2

Content

1 Distributed busbar protection 7SS85 for more than 14 / 15 measuring points

1.1 Introduction

A distributed busbar protection 7SS85 is capable to handle up to 24 measuring points when no sampling-rate configuration higher than "4000Hz, 1 ASDU" is used. Note that for more than 20 measuring points the back-up protections, for example overcurrent and breaker failure, should be done in the merging units. Only busbar differential and end-fault protection shall be included in the central unit.

As the ETH-BD-2FO supports a bandwidth of 100 Mbit/s, it is recommended to subscribe a maximum of 14 measuring points with one module. In order to handle up to 24 measuring points, two ETH-BD-2FO modules are required.

The traffic in the network must be controlled in such a way that each communication interface (ETH-BD-2FO) receives a maximum traffic of 100Mbit/s. To achieve it, a design value of max. 60% of the bandwidth occupied by sampled values must be considered.

This application note describes the network configuration in DIGSI 5 and IEC 61850 System Configurator, when more than 14 measuring points need to be supported. Further on the configuration of VLANs in a RUGGEDCOM Switch, required for this application, is described.

In case a 7SS85 Significant Property F – K is used, up to 15 measuring points can be supported by an ETH-BD-2FO. If more than 30 measuring points are necessary (7SS85 SF F-K only) the corresponding actions shall be extended to 3 ETH-BD-2FO modules / 3 subnets in the 7SS85.

1.2 Topology example

The Figure 1 shows a schematic of a busbar differential protection for 20 measuring points. Please note that for simplifying reasons the communication redundancy and sample values synchronization are not shown here.

The amount of merging units shall be well-balanced in both ETH-BD-2FO modules.

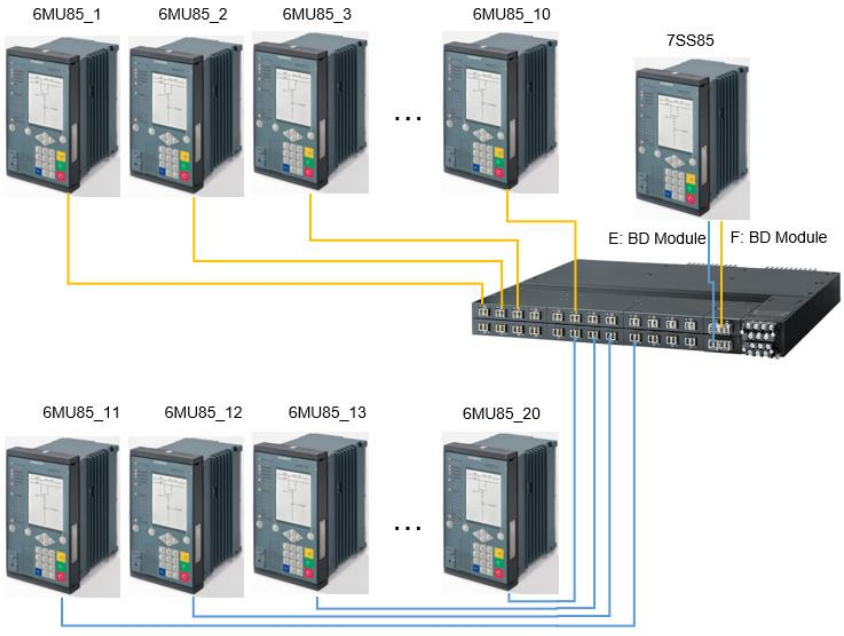


Figure 1. Simplified scheme for a distributed busbar differential protection using two ETH-BD-2FO modules

1.3 Configuration in DIGSI 5

Sample Values and GOOSE messages are directly embedded into Ethernet data packets and work on publisher-subscriber mechanism on multicast MAC addresses. Other type of protocols and services like MMS, DIGSI, web server, SNTP, among others, are IP based. Therefore, although for the process bus communication the IP addresses are not relevant, they must be properly configured in the ETH-BD-2FO modules.

When different types of traffic should be separated from each other, Virtual Local Area Networks – VLANs - can be used as shown below.

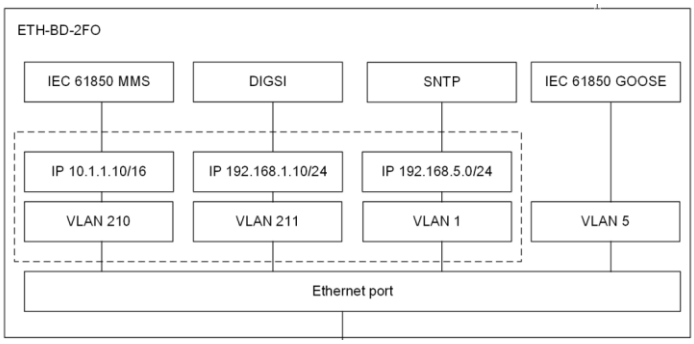


Figure 2. VLANs distribution example

On the other side, even belonging to the same type of information, whether a traffic greater than 100 MBit/s is expected in the network some type of segmentation will be required. It could be a physical segmentation, a VLAN separation or a MAC filtering mechanism. In this application note we'll use VLAN segmentation

1.3.1 Configuration in DIGSI when IP based protocols are required

The VLAN settings in DIGSI must be activated and properly parametrized when several IP-Based protocols are used and an IP-address separation must be granted (for example, if required by the customer specification).

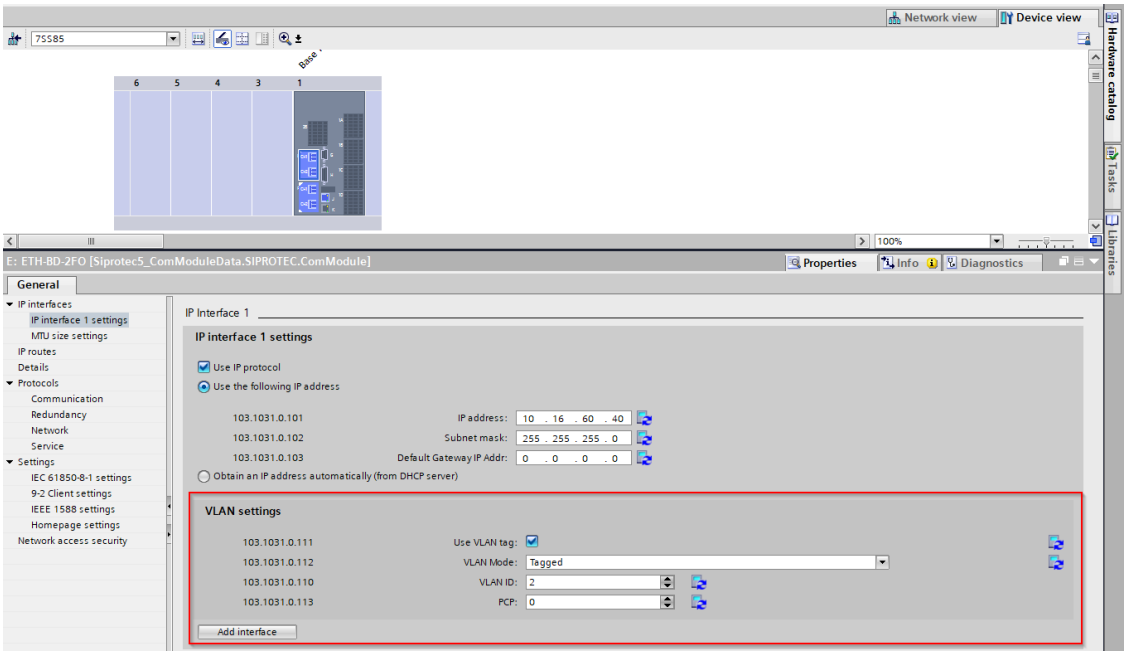


Figure 3. VLAN Settings in DIGSI 5

Up to 3 independent interfaces can be created via the "Add interface" button below the VLAN settings. If several IP interfaces are created in the same module, the corresponding one shall be assigned to each IP based protocol.

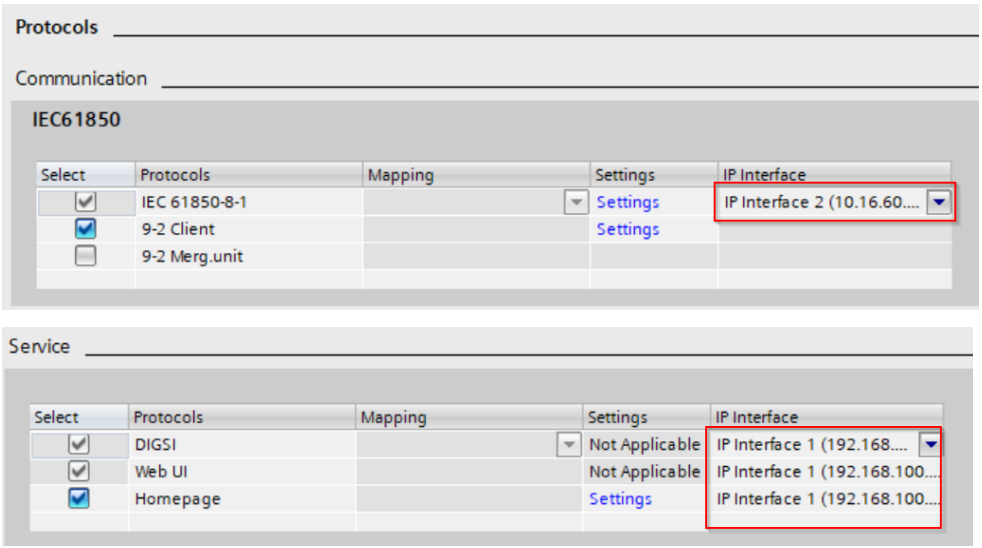


Figure 4. Assignment of different IP addresses to different communication / service protocols

1.3.2 Configuration in DIGSI when no IP protocols are required

In our example, a TCP/IP based network for engineering, troubleshooting and diagnosis is foreseen but not IP-traffic separation is required; i.e. a single IP-Address can be used for the communication with DIGSI, with the Web-client and other applications as Wireshark. Hence the VLAN configuration in DIGSI 5 can be left deactivated as per default.

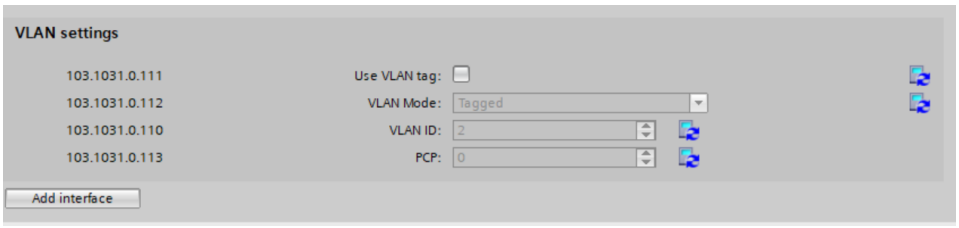


Figure 5. VLAN Settings disabled in DIGSI 5

As a result, the “IP Interface” column is not shown in the settings of “Protocols” in the communication module in DIGSI 5.

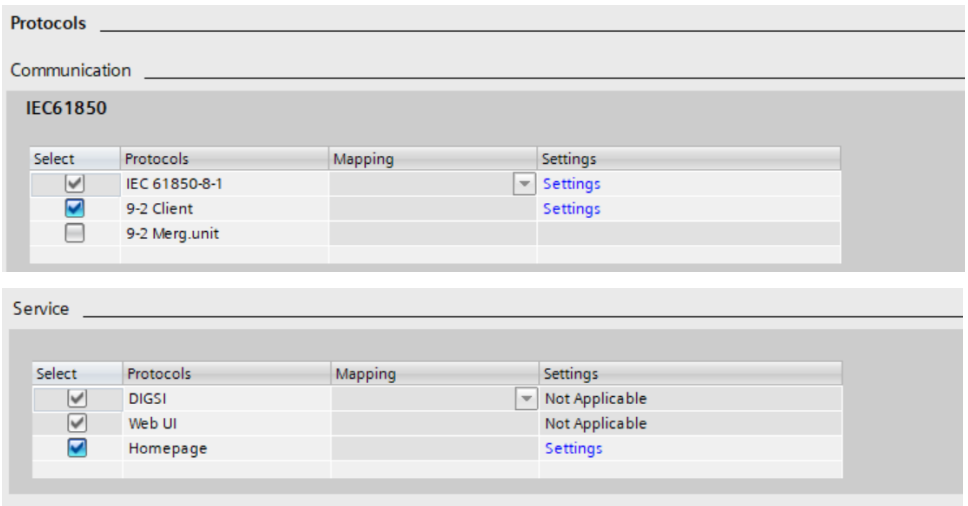


Figure 6. Protocol Settings when using a single IP interface

As the sample values represent the higher load in the network, we'll limit the SV traffic to the 60% of the bandwidth supported by the communication module, i.e. 60MBit/s, to simplify the design. This limit is reached when more than 14 bays are required (15 for the 7SS85 SF F-K). Therefore, in our example two different network segments for the process bus traffic will be implemented: one for the port E of the 7SS85 and its merging units (blue lines in Figure 1.) and one for the port F of the 7SS85 and its corresponding merging units (yellow lines in Figure 1.). As mentioned before, we'll go for the segmentation using VLANs.

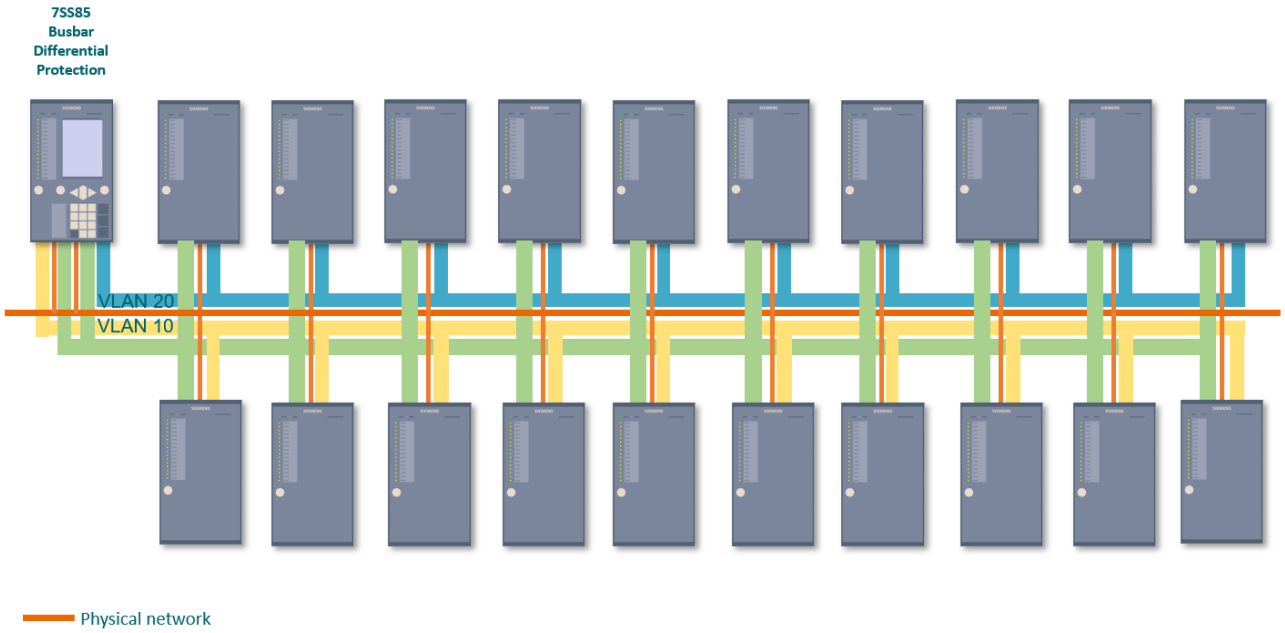


Figure 7. VLANs distribution for the example in this application note

VLAN 10→ Port F 7SS85 and MUs

VLAN 20 → Port E 7SS85 and MUs

The green network indicates the IP-traffic from/to PC

According to the IEC 61850 Standard a device shouldn't be connected through two different access points to the same network. It is, however, the case in our application as ports E and F of the 7SS85 will be connected to the same physical network. For that, we'll need to implement a workaround during the configuration in SYSCON, creating two independent subnets. In addition, the IP-traffic must reach all devices. Therefore, the same IP address segment will be used for all of them.

Take the following table as example when assigning the IP addresses for the protection device and merging units:

Subnet 1		Subnet 2	
6MU85_01	10.16.**60**.5	6MU85_11	10.16.**60**.70
6MU85_02	10.16.**60**.10	6MU85_12	10.16.**60**.80
6MU85_03	10.16.**60**.15	6MU85_13	10.16.**60**.85
6MU85_04	10.16.**60**.20	6MU85_14	10.16.**60**.90
6MU85_05	10.16.**60**.25	6MU85_15	10.16.**60**.95
6MU85_06	10.16.**60**.30	6MU85_16	10.16.**60**.100
6MU85_07	10.16.**60**.35	6MU85_17	10.16.**60**.105
6MU85_08	10.16.**60**.45	6MU85_18	10.16.**60**.110
6MU85_09	10.16.**60**.50	6MU85_19	10.16.**60**.115
6MU85_10	10.16.**60**.55	6MU85_20	10.16.**60**.120
7SS85_Port E	10.16.**60**.40	7SS85_Port F	10.16.**60**.41

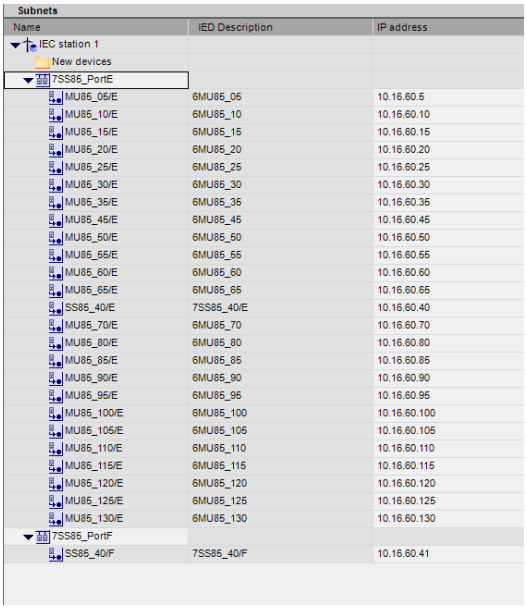
The IP addresses used here are only indicative. They must be adapted to your own network.

Now, configure the sample values and the GOOSE messages for circuit breaker, disconnector positions, trip signals and breaker failure protection as usual in DIGSI 5.

Create the IEC 61850 station (Edition 2.1 if strongly recommended) and assign to it the merging units and protection device. Export the changes to the IEC 61850 System Configurator.

1.4 Configuration in IEC 61850 System Configurator

In the System Configurator, under “Network”, you’ll find the ports E and F of the 7SS85 assigned to different subnets. This happens because, as mentioned before, the IEC 61850 Standard doesn’t allow the connection of two different access points of a device to the same network.

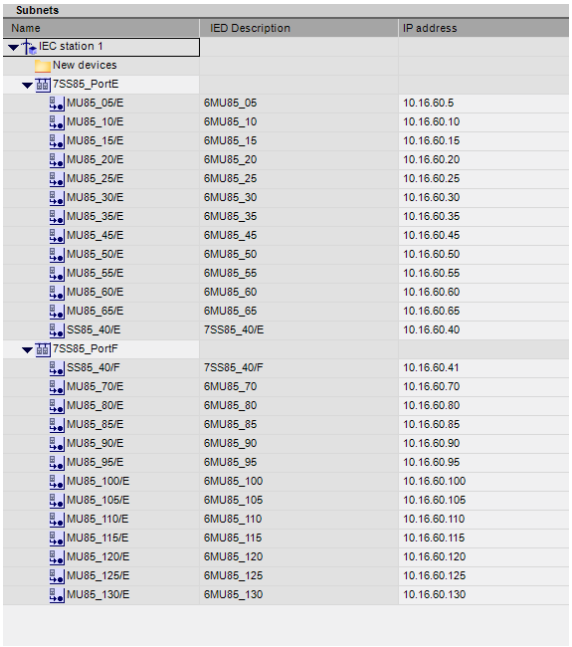


Subnets

Name	IED Description	IP address
IEC station 1		
New devices		
7SS85_PortE		
MU85_05/E	6MU85_05	10.16.60.5
MU85_10/E	6MU85_10	10.16.60.10
MU85_15/E	6MU85_15	10.16.60.15
MU85_20/E	6MU85_20	10.16.60.20
MU85_25/E	6MU85_25	10.16.60.25
MU85_30/E	6MU85_30	10.16.60.30
MU85_35/E	6MU85_35	10.16.60.35
MU85_45/E	6MU85_45	10.16.60.45
MU85_50/E	6MU85_50	10.16.60.50
MU85_55/E	6MU85_55	10.16.60.55
MU85_60/E	6MU85_60	10.16.60.60
MU85_65/E	6MU85_65	10.16.60.65
SS85_40/E	7SS85_40/E	10.16.60.40
MU85_70/E	6MU85_70	10.16.60.70
MU85_80/E	6MU85_80	10.16.60.80
MU85_85/E	6MU85_85	10.16.60.85
MU85_90/E	6MU85_90	10.16.60.90
MU85_95/E	6MU85_95	10.16.60.95
MU85_100/E	6MU85_100	10.16.60.100
MU85_105/E	6MU85_105	10.16.60.105
MU85_110/E	6MU85_110	10.16.60.110
MU85_115/E	6MU85_115	10.16.60.115
MU85_120/E	6MU85_120	10.16.60.120
MU85_125/E	6MU85_125	10.16.60.125
MU85_130/E	6MU85_130	10.16.60.130
7SS85_PortF		
SS85_40/F	7SS85_40/F	10.16.60.41

Figure 8. Subnet assignment in SYSCON after import from DIGSI 5

Rearrange the merging units using the drag and drop functionality, in such a way those to be subscribed by each port belong to its same segment:



Subnets

Name	IED Description	IP address
IEC station 1		
New devices		
7SS85_PortE		
MU85_05/E	6MU85_05	10.16.60.5
MU85_10/E	6MU85_10	10.16.60.10
MU85_15/E	6MU85_15	10.16.60.15
MU85_20/E	6MU85_20	10.16.60.20
MU85_25/E	6MU85_25	10.16.60.25
MU85_30/E	6MU85_30	10.16.60.30
MU85_35/E	6MU85_35	10.16.60.35
MU85_45/E	6MU85_45	10.16.60.45
MU85_50/E	6MU85_50	10.16.60.50
MU85_55/E	6MU85_55	10.16.60.55
MU85_60/E	6MU85_60	10.16.60.60
MU85_65/E	6MU85_65	10.16.60.65
SS85_40/E	7SS85_40/E	10.16.60.40
7SS85_PortF		
SS85_40/F	7SS85_40/F	10.16.60.41
MU85_70/E	6MU85_70	10.16.60.70
MU85_80/E	6MU85_80	10.16.60.80
MU85_85/E	6MU85_85	10.16.60.85
MU85_90/E	6MU85_90	10.16.60.90
MU85_95/E	6MU85_95	10.16.60.95
MU85_100/E	6MU85_100	10.16.60.100
MU85_105/E	6MU85_105	10.16.60.105
MU85_110/E	6MU85_110	10.16.60.110
MU85_115/E	6MU85_115	10.16.60.115
MU85_120/E	6MU85_120	10.16.60.120
MU85_125/E	6MU85_125	10.16.60.125
MU85_130/E	6MU85_130	10.16.60.130

Figure 9. Subnet assignment in SYSCON according to the application

With this workaround the IP-addressing of the two subnets maintains the rules of a unique network and can be managed as such when using the same physical infrastructure.

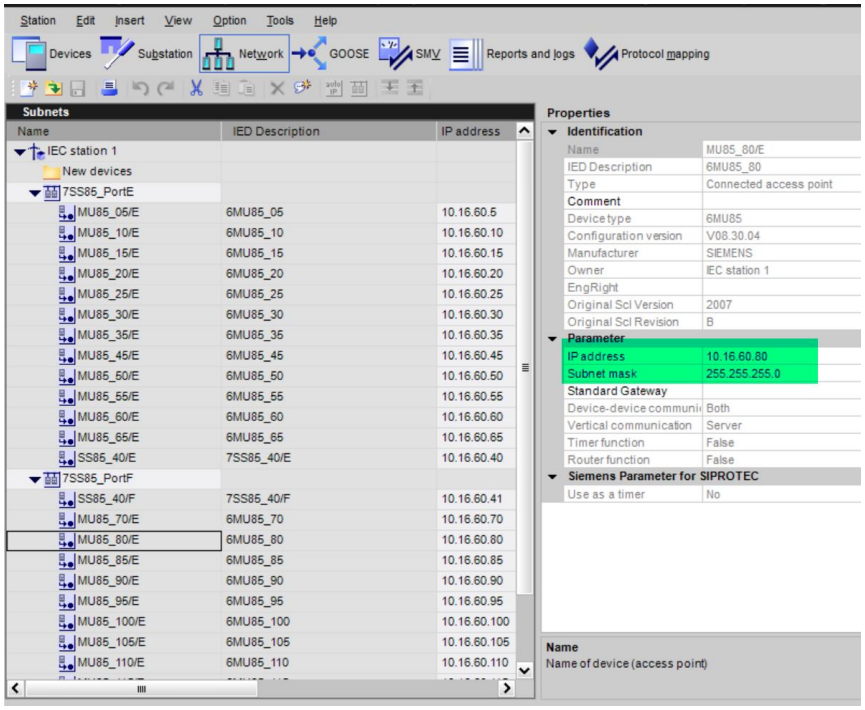


Figure 10. IP Address and Subnet mask parameters

Now, in the GOOSE and SMV editors connect the signals as described in the manuals *Software IEC 61850 System Configurator V5.90* and *SIPROTEC 5 Process Bus V8.03 and higher*.

The parameters of each control block muss be adapted for the SV datasets. There it is also possible to assign the VLAN ID. To do that, go to the dataset and click on the properties of the “SMV Control Block” at the right side of the screen, as shown in the Figure 11. Alternative you can right-click on the dataset and select the option “Configure SMV”:

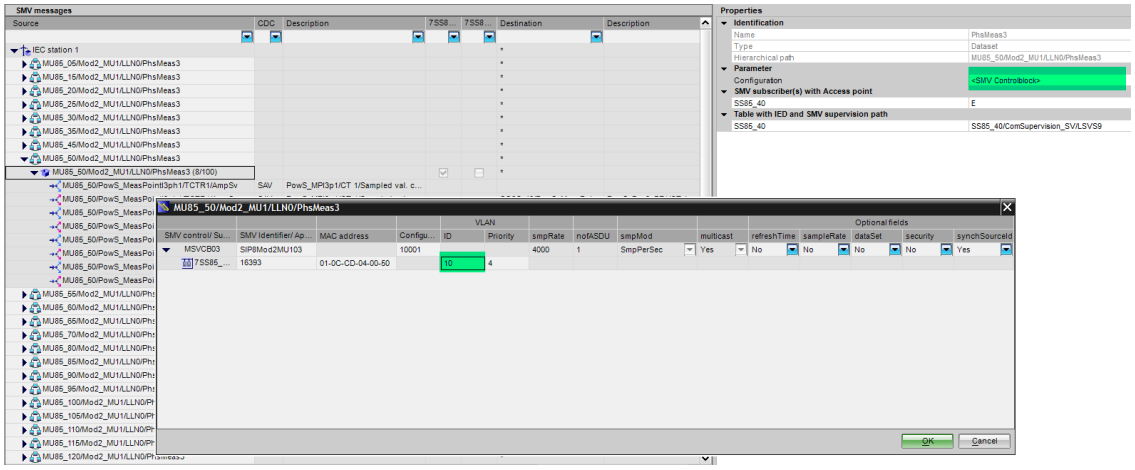


Figure 11. Assignment of VLAN ID in an SV dataset

Assign the VLAN ID as defined:

VLAN 10→ Port F 7SS85 and corresponding MUs

VLAN 20 → Port E 7SS85 and corresponding Mus

In a similar way, you can assign the VLAN ID for the GOOSE messages.

1.5 Configuration of VLANs in the RUGGEDCOM switches

Figure 12. shows the schematic of a set up using a redundant PRP network and a connection to a PC via a red box, similar to the configuration we use as example in this application note. Please note that for simplification reasons no SV synchronization is shown.

The RUGGEDCOM switches and red box must be properly parametrized to allow a controlled flow of data according to the required VLANs.

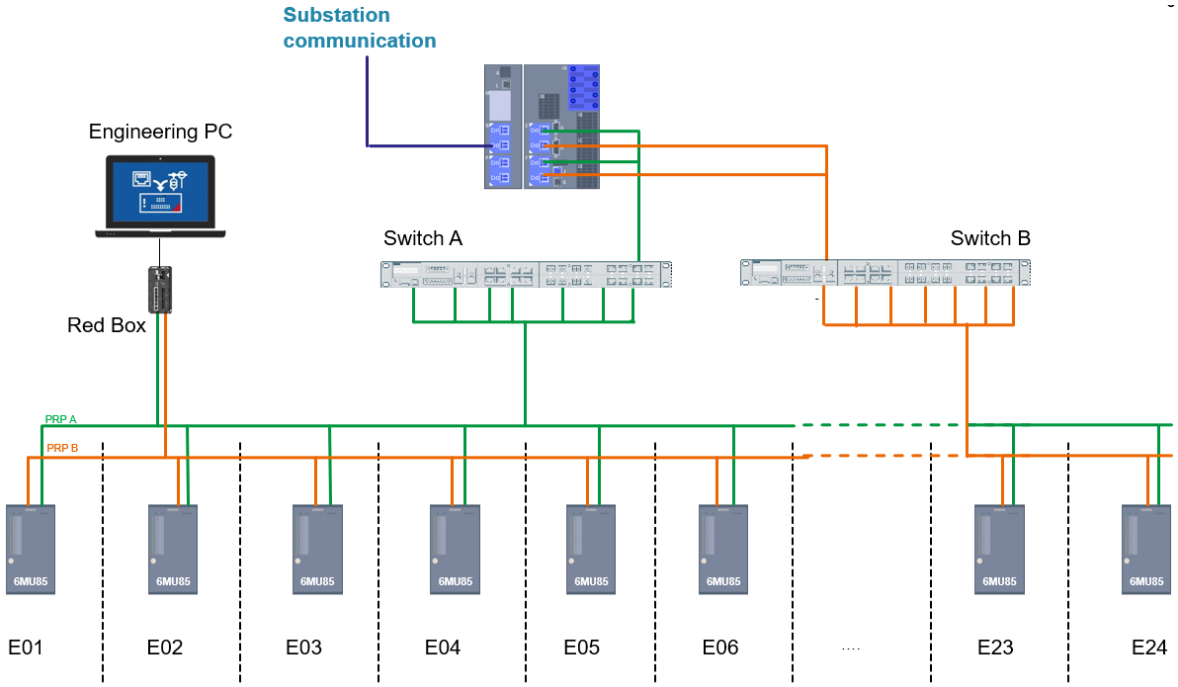


Figure 12. Scheme of a distributed busbar differential protection using a PRP network

In this chapter, it is shown how the proper VLAN configuration is achieved for the RUGGEDCOM switches. The configuration of the red box regarding VLANs is similar to the switches. Hence the explanation below can be used for it as well.

The switch can be configured using the RS-232 Serial Console Port or using an Ethernet Port. We'll use the connection to an ethernet port.

a. Getting connection

To establish a direct connection to an ethernet port consider the following default IP addresses:

Device	Port	IP Address/Mask
RSG2488	MGMT	10.0.0.1/8
RSG2488	All other Ethernet ports	192.168.0.1/24
RSG2228		192.168.0.1/24
RSG909R		192.168.0.1/24
RSG907R		192.168.0.1/24

Remember using in your PC an IP address falling within the subnet of the device.

Now you have several options to access the switch: directly with a SSH client or remotely using a web server, terminal or workstation running terminal emulation software. We'll work with the web server option.

Get access to the switch / red box by typing on your web browser the IP address of the connected port (for example https:// 192.168.0.1). Upon connecting to the device, some Web browsers may report the Web server's certificate cannot be verified against any known certificates. This is expected behavior, and it is safe to instruct the browser to accept the certificate. Once the certificate is accepted, all communications with the Web server through that browser will be secure.

Once the connection is established the login box appears. Below the default values

Username	Password
admin	admin

Keep in mind that if the switch has been previously configured you must know the IP address used as well as the enabled username and password.

b. Configuring VLANs

The port assignment for our example would look like in the Figure 13. For simplicity only the PRP A is shown.

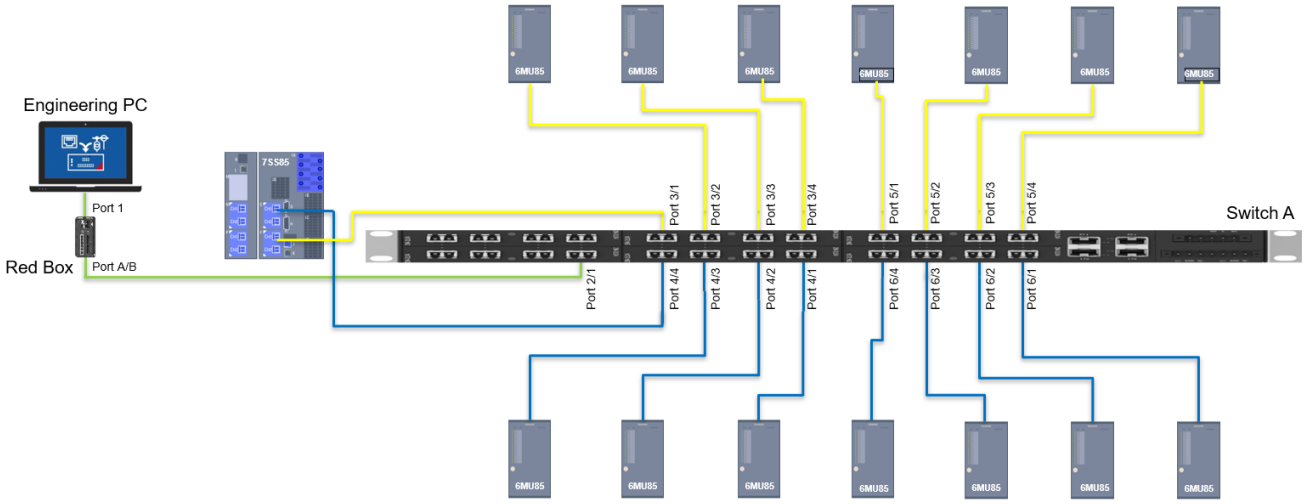


Figure 13. Switch Port assigment

Go to the Menu Option ***"Virtual LANs"*** and enable the awareness of VLANs in the Menu Option ***"Configure Global VLAN Parameters"***

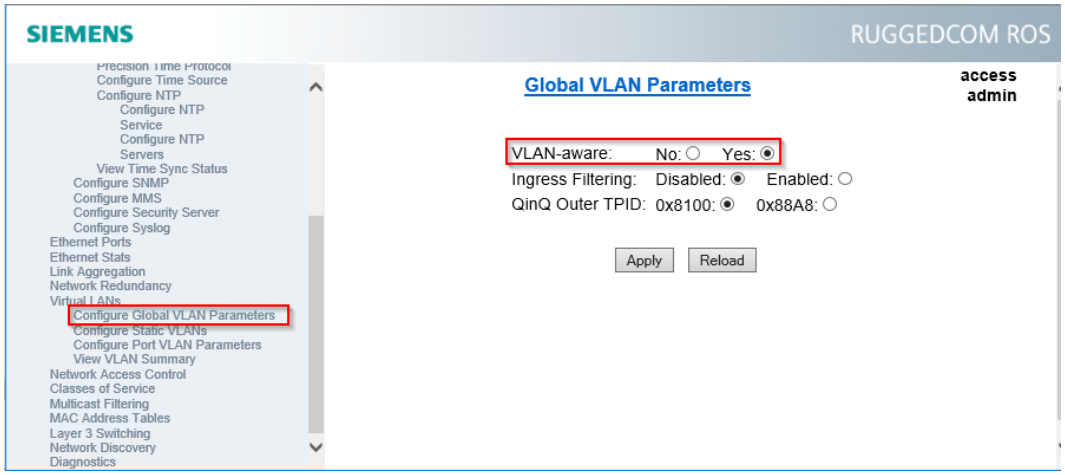


Figure 14. Global VLAN Parameters in switch Ruggedcom

Then ***"Configure Static VLANs"*** on switches and RedBox as shown next. In order to allow different type of messages in several ports, the configuration using "Trunk" and "Forbidden ports" will be preferred.

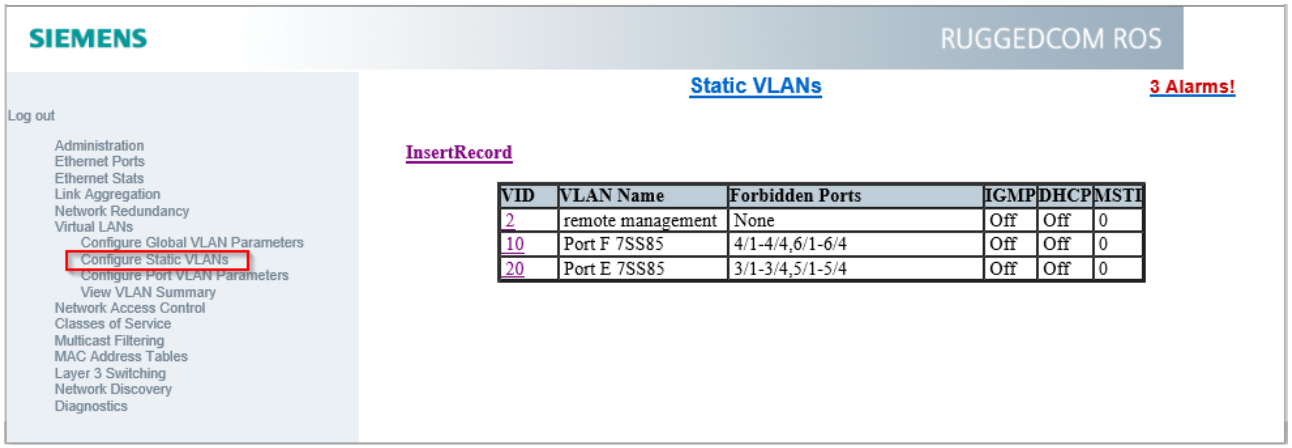


Figure 15. Static VLAN Parameters in switch Ruggedcom

The parameter 'Forbidden Ports' defines the VLAN traffic which is **not** allowed on the port. The configuration shown in the Figure 15. must be understood as follows:

VLAN 2 information can go through all ports.

VLAN 10 is not allowed through ports 4/1- 4/4, 6/1-6/4. This means, the Merging Units which shall deliver information to port F of the 7SS85 must be connected in the ports 3/1-3/4 or 5/1-5/4

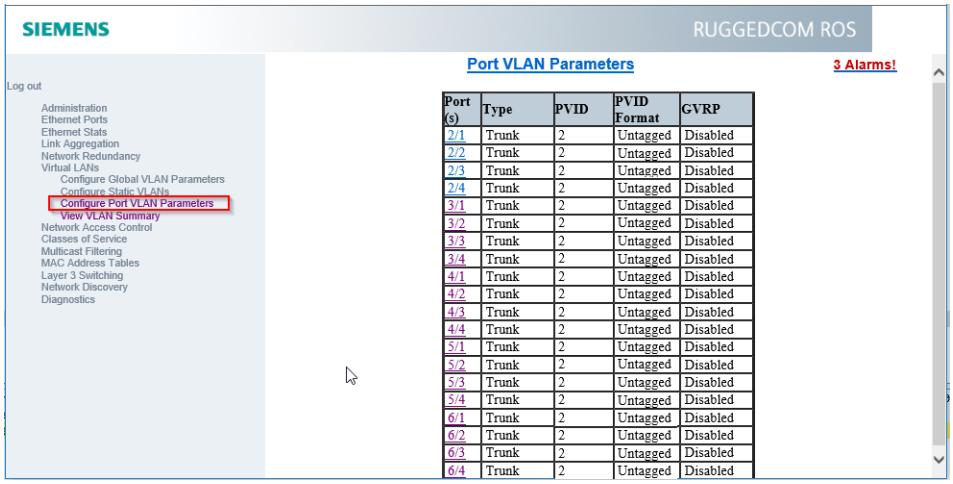
VLAN 20 is not allowed through ports 3/1-3/4 or 5/1-5/4. This means, the Merging Units which shall deliver information to port E of the 7SS85 must be connected in the ports 4/1- 4/4, 6/1-6/4

Afterwards, select the Menu Option ***"Configure Port VLAN Parameters"***

For our application it is not necessary to define different PVIDs as the Ethernet traffic (GOOSE and SV) has been already regulated with the help of the Static VLAN parameters (VID and Forbidden Ports). We have deliberately decided not to use VLANs for the IP-traffic (we disabled the use of VLANs in DIGSI) as the complete traffic shall reach the PC. The last statement assumes, that the PC is connected directly to a redbox. This implementation won't work for a PC belonging to the station bus, since with this configuration the complete process bus traffic is forwarded through the redbox to the PC (required for diagnosis and troubleshooting) and all traffic from the PC side will be forwarded to the process bus (assuming only the required PC applications will generate traffic).

Keep in mind that the ports of the switches to be connected to the redbox as well all involved ports in the redbox and PC network card must be GB capable, as high traffic is expected!

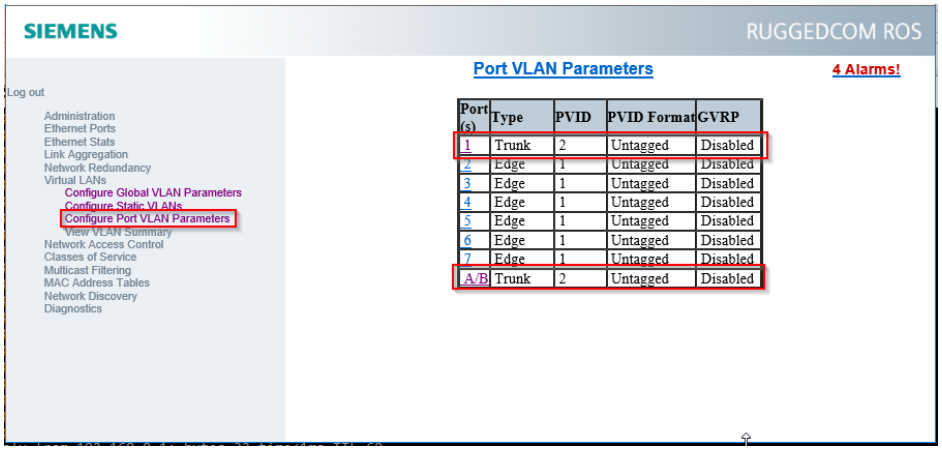
All ports must be configured as "Trunk" and the "PVID Format" must be "Untagged". Internally in the switch we'll use the VLAN2 to forward the IP-traffic to all ports (remember that we created the static VLAN ID 2 and allowed it to go through all ports – see Figure 15.). Hence, the PVID 2 shall be assigned to all ports as shown in the Figure 16.



Port(s)	Type	PVID	PVID Format	GVRP
2/1	Trunk	2	Untagged	Disabled
2/2	Trunk	2	Untagged	Disabled
2/3	Trunk	2	Untagged	Disabled
2/4	Trunk	2	Untagged	Disabled
3/1	Trunk	2	Untagged	Disabled
3/2	Trunk	2	Untagged	Disabled
3/3	Trunk	2	Untagged	Disabled
3/4	Trunk	2	Untagged	Disabled
4/1	Trunk	2	Untagged	Disabled
4/2	Trunk	2	Untagged	Disabled
4/3	Trunk	2	Untagged	Disabled
4/4	Trunk	2	Untagged	Disabled
5/1	Trunk	2	Untagged	Disabled
5/2	Trunk	2	Untagged	Disabled
5/3	Trunk	2	Untagged	Disabled
5/4	Trunk	2	Untagged	Disabled
6/1	Trunk	2	Untagged	Disabled
6/2	Trunk	2	Untagged	Disabled
6/3	Trunk	2	Untagged	Disabled
6/4	Trunk	2	Untagged	Disabled

Figure 16. Port VLAN Parameters in switch Ruggedcom

Below the configuration of VLANs in the RedBox. The Engineering PC is connected to port 1 and receives traffic from all MUs.



Port(s)	Type	PVID	PVID Format	GVRP
1	Trunk	2	Untagged	Disabled
2	Edge	1	Untagged	Disabled
3	Edge	1	Untagged	Disabled
4	Edge	1	Untagged	Disabled
5	Edge	1	Untagged	Disabled
6	Edge	1	Untagged	Disabled
7	Edge	1	Untagged	Disabled
A/B	Trunk	2	Untagged	Disabled

Figure 17. Port VLAN Parameters in Ruggedcom Redbox

The VLAN 1 is the default value for ports in RUGGEDCOM switches and Redboxes.

In case the redbox needs to be connected to a station bus a detailed configuration of VLANs in station and process bus must be done and the settings in switches and redbox correspondingly adapted. This scenario is out of the scope of this application note.

1.6 Conclusions

If it is required to subscribe sampled values for more than 14 measuring points, or more than 15 measuring points when using the 7SS85 Significant Property F – K, then it is necessary to use two ETH-BD-2FO modules in 7SS85. This is due to the module's maximum bandwidth of 100 MBit/s.

When using two modules, the traffic load shall be balanced between them, i.e. subscribing fairly the same amount of measuring points with each module.

Each ETH-BD-2FO of the 7SS85 device and the corresponding bay units (merging units) must belong to the same subnet, which must be different to the subnet used for the other module in SYSCON. In order to limit the GOOSE and SMV traffic handled by each communication module it is necessary to use VLANs.

Especial considerations could be required when IP based protocols shall run in parallel in the same ETH-BD-2FO module.

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