

Title: **SUBSTATION CONTROL AND
AUTOMATION APPLICATION
GUIDE FOR PHASE 6 SIEMENS
SOLUTION**

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Compiled by

Ian Naicker

**Chief Engineer – Control
and Automation, PTMC**

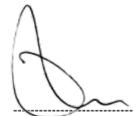
Date: 30/09/2021

Approved by

Rishi Hariram

**Manager – Control and
Automation, PTMC**

Date: 30/09/2021

Authorized by

Nelson Luthuli

**Acting Senior Manager –
PTMC**

Date: 01/10/2021

Supported by SCOT/SC

**Marlini Sukhnandan
SCOT/SC Chairperson**

Date: 30/09/2021

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1. Introduction

This document provides guidelines on determining the most suitable automation commodity solutions for Greenfield Transmission substation applications. The applications covered by this document form part of the Siemens Phase 6 integrated solution for protection and control for Eskom Transmission.

2. Supporting clauses

2.1 Scope

The scope of this document is limited to the available automation commodity solutions. The applications covered by this document form part of the Siemens Phase 6 integrated solution for protection and control for Eskom Transmission.

2.1.1 Purpose

This application design guide provides guidelines which serve to assist users with prescribing the most suitable technical solutions to be acquired and applied to specific substation applications. The intent of this document is primarily focused on defining guidelines for all automation related commodities.

2.1.2 Applicability

This document shall apply throughout Eskom Holdings SOC Limited's Transmission Division.

2.2 Normative/informative references

Parties using this document shall apply the most recent edition of the documents listed in the following paragraphs.

2.2.1 Normative

- [1] ISO 9001, Quality Management Systems
- [2] 0.53/03055 Automation Equipment Cabinet (600 x 600 x 2400)
- [3] 0.52/30615 Protection Fixed Frame Equipment Cabinet (800 x 600 x 2400)
- [4] 240-60725641 Specification for Standard (19 inch) Equipment Cabinets
- [5] 240-64100247 Standard for Earthing of Secondary Plant in Substations
- [6] SANS 1091:2012 National colour standard
- [7] 0.52/30578 Gateway Panel - Main 1 (6AGW-2101-M1)
- [8] 0.52/30579 Gateway Panel - Main 2 (6AGW-2101-M2)
- [9] 0.52/30580 Automation HMI Server Module - Main 1 (6AHMI-2100-M1)
- [10] 0.52/30581 Automation HMI Server Module - Main 2 (6AHMI-2100-M2)
- [11] 0.52/30513 Fibre Switching Panel - Main 1 (6AFS-2100-M1)
- [12] 0.52/30516 Fibre Switching Panel - Main 2 (6AFS-2100-M2)
- [13] 0.52/30514 Automation Common Equipment Panel (6ACE-2100)

2.2.2 Informative

None

2.3 Definitions

2.3.1 General

Definition	Description
Configuration	Includes the programming, engineering and administration of the Gateway system.
HMI	The human machine interface used for the operation and monitoring of the Substation.
SICAM PAS	Siemens Substation Information Control Automation Monitoring Power Automation System
Substation Automation	Using data from IEDs, control and automation capabilities within the substation and control commands from remote master station to control substation primary plant equipment
WinCC	Siemens SCADA software for controlling and monitoring of Substation.

2.3.2 Disclosure classification

Controlled disclosure: controlled disclosure to external parties (either enforced by law, or discretionary).

2.4 Abbreviations

Abbreviation	Description
A	Amps
AC	Alternating Current
DC	Direct Current
DHCP	Dynamic Host Configuration Protocol
DMS	Distribution Management Centre
EMS	Energy Management Centre
GPS	Global Positioning System
HMI	Human Machine Interface
IDF	Intermediate Distribution Frame
IEC	International Electrotechnical Commission
IED	Intelligent Electronic Device
IEEE	Institute of Electrical and Electronics Engineers
IGMP	Internet Group Management Protocol
IRIG	Inter-range Instrumentation Group
M1	Main 1
M2	Main 2
MCB	Miniature Circuit Breaker
MSTP	Multiple Spanning Tree Protocol
NCC	National Control Centre

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Abbreviation	Description
NTP	Network Time Protocol
PIU	Process Interface Unit
RCDP	RUGGEDCOM Discovery Protocol
RSTP	Rapid Spanning Tree Protocol
SANS	South African National Standards
SCADA	Supervisory Control and Data Acquisition
SCC	Standby Control Centre
SNMP	Simple Network Management Protocol
SNTP	Simple Network Time Protocol
USB	Universal Serial Bus
VAC	Voltage Alternating Current
VDC	Voltage Direct Current
VRRP	Virtual Router Redundancy Protocol
W	Watts

2.5 Roles and responsibilities

This document shall be applied by both Project Engineers and Control Applications staff for Eskom Transmission.

2.6 Process for monitoring

Not applicable.

2.7 Related/supporting documents

Not applicable.

3. Automation Design Guidelines

3.1 Transmission – System Architecture

This application design guide provides guidelines which serve to assist users with prescribing the most suitable technical solutions to be acquired and applied to specific substation applications.

A summarized version of the Transmission Integrated Protection and Control system network architecture is presented Figure 1 below indicating all automation commodities.

The system solution incorporates a two-tier network architecture design consisting of both low and top tiers. The low tier consists of low capacity network switches which provide the physical connectivity to end devices such as the Process Interface Units (PIUs), Intelligent Electronic Devices (IEDs), Gateways, Human Machine Interfaces (HMIs) and routers. The top-tier consists of high capacity, high-speed, Gigabit backbone switches which provide physical connectivity to the low-tier switches.

The system design incorporates a dual main philosophy whereby the solution architecture constitutes both Main 1 and Main 2 control systems, each of which are physically separated into two fully redundant and functionally independent schemes. The automation commodities, namely the gateway switch, station switch, backbone switch which includes the GPS module, router, gateway and HMI modules are developed into schemes based on the requirements for greenfield substation applications.

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There are four main scheme types which encompass the full suite of automation commodities. These schemes are listed in Table 1 below. These schemes are designed for both 110 VDC and 220 VDC substation applications.

Table 1: Automation Schemes

Scheme Number	Scheme Type
6AGW-2101-M1	Gateway Panel - Main 1
6AGW-2101-M2	Gateway Panel - Main 2
6AHMI-2100-M1	HMI Server Module - Main 1
6AHMI-2100-M2	HMI Server Module - Main 2
6AFS-2100-M1	Fibre Switching Panel - Main 1
6AFS-2100-M2	Fibre Switching Panel - Main 2
6ACE-2100	Common Equipment Panel

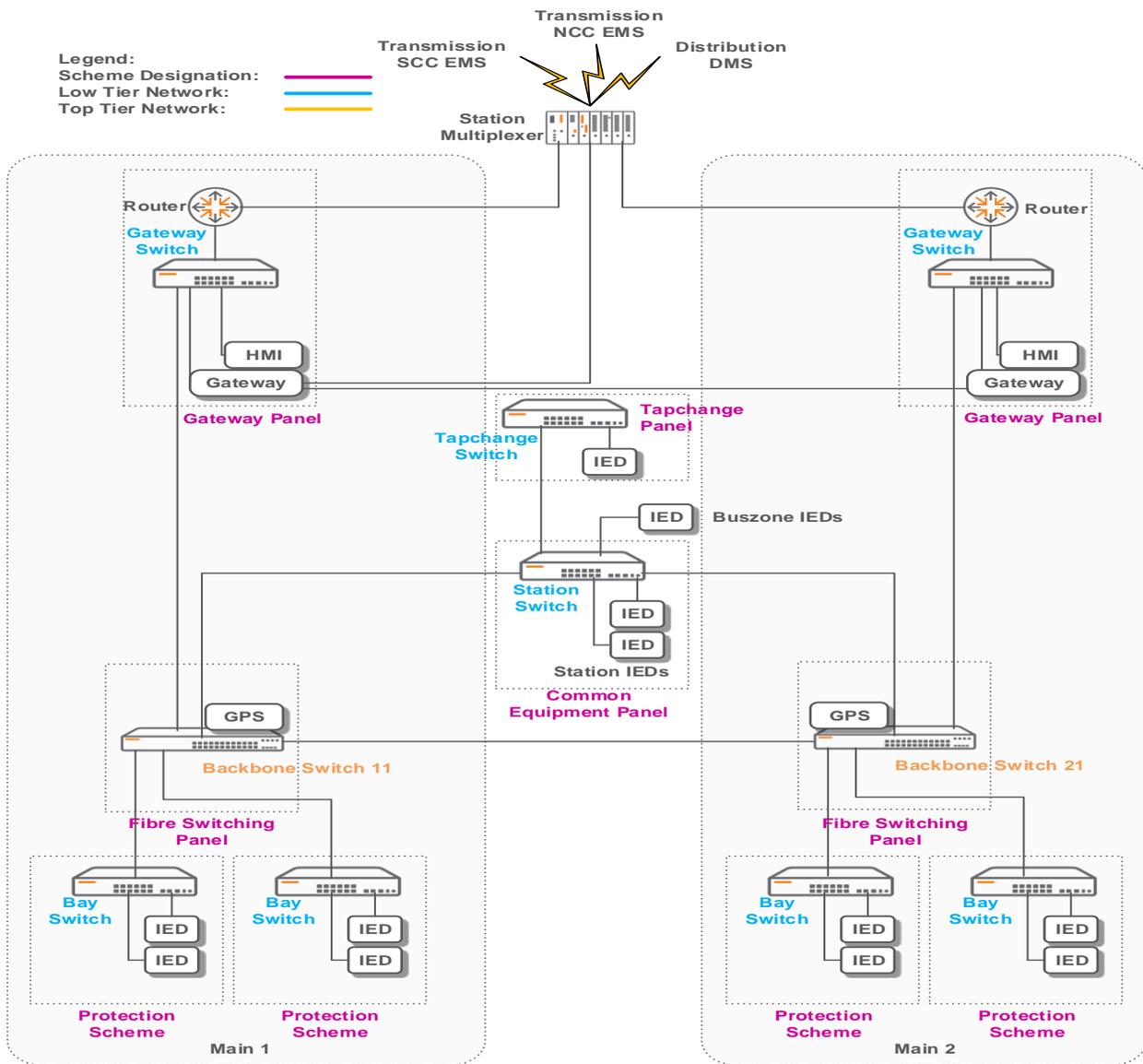


Figure 1: Transmission Network Architecture

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3.2 Contract/Agreement Data

The applications covered by this document form part of the Phase 6 integrated solution for protection and control for Eskom Transmission.

Table 2: Contract Details

Supply Contract Number	4600067750
Development Contract Number	4600059995

3.3 Panel Details

Panels used for scheme construction are free-issued by the *Purchaser* and are based on the requirements detailed in 240-60725641 Specification for Standard (19 inch) Equipment Cabinets [3]. The “Type A” Automation Equipment Cabinet is used. Refer to drawing 0.53/03055 Automation Equipment Cabinet for panel details [2]. Refer to drawing 52/30615 Protection Fixed Frame Equipment Cabinet (800 x 600 x 2400) for details [3].

The Type A Automation Equipment Cabinet is 600 x 600 x 2400 mm in dimension including the cabinet plinth of 100 mm in height. The exterior colour of the panel is G29 semi-gloss light grey, accordance with SANS 1091: 2012 National colour standard [5].

The panel is equipped with bottom gland plates, fabricated from 2 mm mild steel, each supporting knock-outs in sizes 20 mm and 25 mm. Each gland plate is equipped with four 25 mm and twenty 20 mm knockouts.

Each gland plate is equipped with M10 earthing studs with nuts which are bonded to each gland plate. Bonding of the panel to the substation earth needs to be done in accordance with 240-6400247 Standard for Earthing of Secondary Plant Equipment in Substations [4].

The panel features both front and rear access with doors spanning 550 mm in width. Rear access to the panel is a mandatory requirement for both installation and maintenance purposes. Sufficient clearance needs to be factored in when determining the placement of panels to ensure ease of access.

The panel does not feature any internal lighting. Acceptable illumination levels from external light sources shall be considered when determining the placement of panels.

The panel used for the HMI Server Module will not be free-issued by the *Purchaser* but supplied by the *Supplier*. The panel is a 12U cabinet, 592(H) x 560(W) x 550(D) mm in dimensions. The exterior colour of the panel is G29 semi-gloss light grey, accordance with SANS 1091: 2012 National colour standard [5].

3.4 6AGW-2101 Gateway Panel

Table 3: 6AGW-2101 Gateway Panel Overview

Scheme number:	6AGW-2101
Area of application:	Applicable for all greenfield substations. The gateway panel is used for functions related to local and remote control, visualisation and control interlocking.
Scheme overview:	<p>The scheme consists of the following hardware:</p> <ul style="list-style-type: none"> a) Advantech ECU-4784 Gateway b) Siemens RuggedCom RSG2100 Gateway Switch c) Siemens RuggedCom RX1500 Router d) 16 A AC plug socket e) Multimode Fibre Patch Leads

Gateway Software and Functions	The following software and functions/libraries are provided with the substation gateway. These include: a) SICAM PAS b) IEC 61850 Client Interface driver c) IEC 60870-5-101 Slave interface driver d) SICAM PAS SoftPLC e) SICAM SCC f) SNMP Interface
Scheme dimensions:	600 x 600 x 2400 mm (W x D x H) single panel.

3.4.1 6AGW-2101 Free-Issue Material and Licenses

The following items shall be free-issued by the *Purchaser* and do not form part of the scheme equipment supply. These include:

- 1 x 19-Inch "Type A" Automation Equipment Cabinet with front and rear access.
- 1 x 19-Inch Fibre Patch Panel.
- 1 x Windows 10 licence key

Note: Each 19-inch Fibre Patch Panel can accommodate 2 x 12 core fibre cables.

3.4.2 6AGW-2101 Equipment Overview

The schematics for the 6AGW-2101 Gateway panel are detailed in drawing numbers 0.52/30578 - Scheme 6AGW-2101-M1 and 0.52/30579 - Scheme 6AGW-2101-M2 for Main 1 and Main 2 respectively. Both variants, from a hardware perspective are identical, however minor differences do exist in the internal wiring of each panel. These differences pertain to the interfacing of the IEC60870-5-101 serial links between the Gateway in each panel, to the X.21 ports of the multiplexer residing in the telecommunications panel.

Note: The 6AGW-2101 Main 1 Gateway panel interfaces directly with the telecommunications panel whereas the 6AGW-2101 Main 2 Gateway panel does not interface directly with the telecommunications panel. This convention is embedded in the design of each panel. Please refer to sheet 7 of the schematics for further detail. The general arrangement for the front and internal views of the 6AGW-2101 gateway panel are presented in Figure 2.

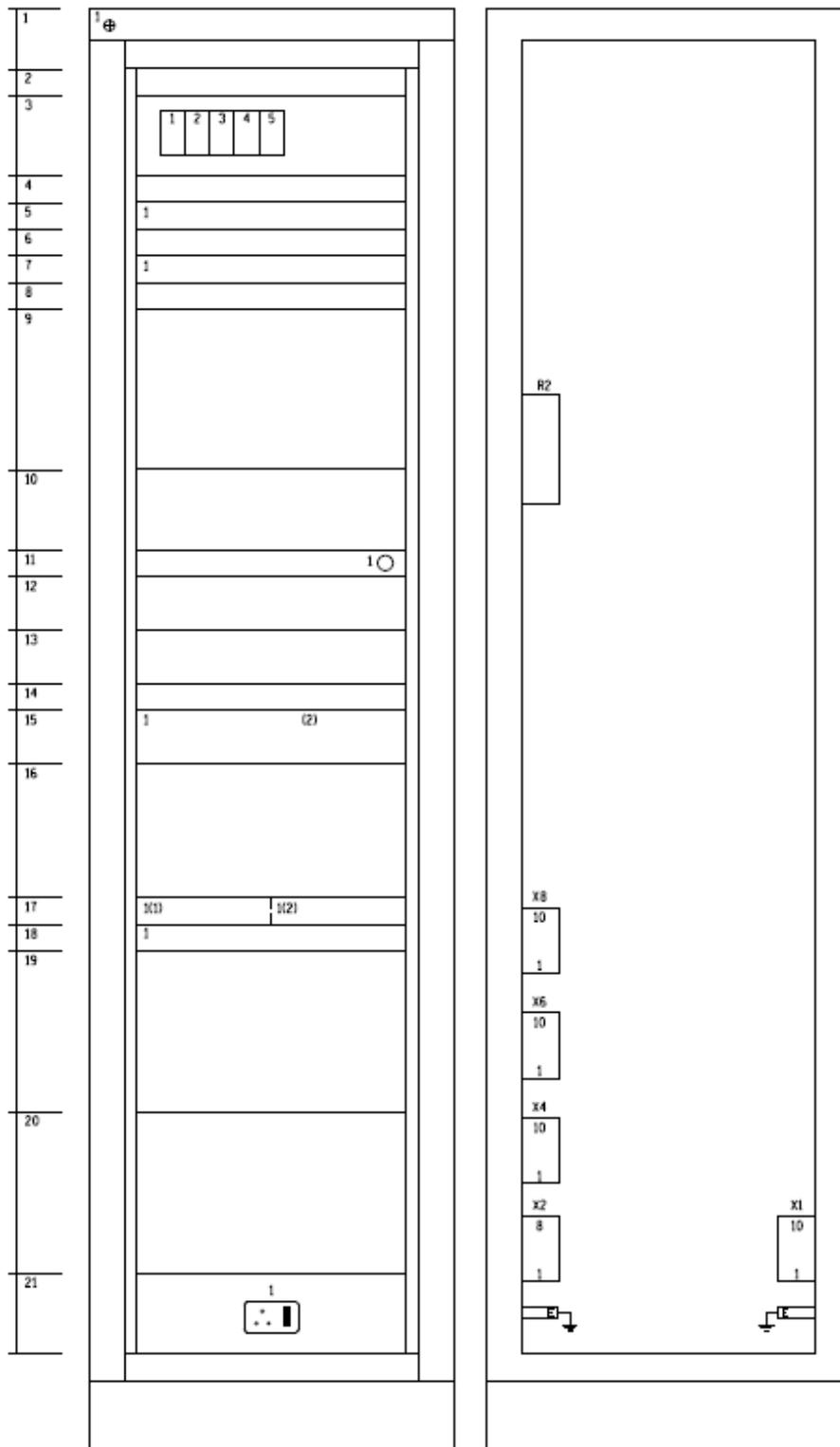


Figure 2: 6AGW-2101 Gateway Panel Main 1 - Front and Internal Views

The detailed equipment list with reference to Figure 2 above is presented below. The location indices shown in Figure 2 are used to identify each piece of equipment listed in Table 4 and Table 5 below.

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The design can be adjusted to accommodate either 110 VDC or 220 VDC substation supply. Internal equipment to the panel which are affected by the respective station voltages will differ in part number depending on the applied station voltage. These part numbers need to be correctly applied in the respective scheme drawings. The automation devices are equipped with wide-range power supply units which are rated to operate at both 110 VDC and 220 VDC. The applicable equipment part numbers for the respective station voltages are tabulated below.

Table 4: 6AGW-2101 Gateway Panel Equipment List (Front View)

Location		Description	Part Number	
			110 VDC	220 VDC
1	1	Panel Not Healthy lamp	22IN220VRDLTZ	
2	1	1 U Blanking plate	-	
3	1	DC Isolating MCB	5SY5216-6 (B16)	
	2-4	DC Isolating MCB's	5SY5206-6 (B6)	
	5	230 VAC MCB	5SY7210-7CC (C10)	
4	1	1 U Blanking plate	-	
5	1	RSG2100 Gateway Switch (Small Bay Switch)	6GK6021-0AS23-3DB0-Z A05+B05+C00+D00+E02+F00+G00+H00+J00+ K01	
6	1	1 U Blanking plate	-	
7	1	RX1500 Router	6GK6015-0AM23-3DC0-Z A03+B16+C00+D00+E01	
8	1	1 U Blanking plate	-	
9	1	6 U Blanking plate	-	
10	1	3 U Blanking plate	-	
11	1	Lamp Check Push Button	-	
12	1	2 U Blanking plate	-	
13	1	2 U Blanking plate	-	
14	1	1 U Blanking plate	-	
15	1	Gateway Server	Advantech ECU4784	
	2	SICAM PAS USB Licence Dongle	-	
16	1	5 U Blanking plate	-	
17	1(1)	Fibre Patch Panel 1 Cable 1 - Main 1 Fibre Switching Panel	Free Issue	
	1(2)	Fibre Patch Panel 1 Cable 2 - Main 1 HMI Server Module	Free Issue	
18	1	1 U Blanking plate	-	
19	1	6 U Blanking plate	-	
20	1	6 U Blanking plate	-	
21	1	AC Plug socket	CRABTREE (68964P)	

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Table 5: 6AGW-2101 Gateway Panel Equipment List (Rear View)

Location		Description	Part Number	
			110 VDC	220 VDC
GPW	X1 (1-10)	Spring Terminals	WDU 10 SL	
	X1 (E)	Earth Terminals	WPE 10	
	X2 (1-8)	Spring Terminals	WDU 10 SL	
	X2 (E)	Earth Terminals	WPE 10	
	X4 (1-10)	Spring Terminals	WDU 4 SL	
	X6 (1-10)	Spring Terminals	WDU 4 SL	
	X8 (1-10)	Spring Terminals	WDU 4 SL	
R2	1	DC Fail Relay	60.13.9.110	60.13.9.220
	2	Gateway Fail Relay	60.13.9.110	60.13.9.220
	3	Router Fail Relay	60.13.8.230	
	4	Gateway Switch Fail Relay	60.13.8.230	

3.4.3 6AGW-2101 Ordering Options

The primary ordering options for the 6AGW-2101 are listed in Table 6 below.

Table 6: 6AGW-2101 Gateway Panel Primary Ordering Options

Options	SAP Material Number	Description
1	673559	6AGW-2101 M1 Gateway panel (110 VDC)
2	673560	6AGW-2101 M1 Gateway panel (220 VDC)
3	673561	6AGW-2101 M2 Gateway panel (110 VDC)
4	673562	6AGW-2101 M2 Gateway panel (220 VDC)
5	674205	Substation Gateway Server
6	673991	Gateway Switch (Small Bay Switch)
7	673995	Router
8	674035	1 metre LC-LC Duplex MM 50/125 fibre optic patch cord, Non-Ruggedized
9	674037	3 metre LC-LC Duplex MM 50/125 fibre optic patch cord, Non-Ruggedized
10	674043	2 metre SC-LC Duplex MM 50/125 fibre optic patch cord, Non-Ruggedized

Coupled to the primary ordering options are the add-on items, which are to be ordered separately, per Main in the case where the Gateway is a master to a Legacy GE D400 Gateway. The item is tabulated below.

Table 7: 6AGW-2101 Gateway Panel Add-on ordering options

Options	SAP Material Number	Description
1	674164	Protocol IEC60870-5-101 Master

Engineering services for the various commodities are available and optional based on the *Purchaser's* in-house skills and resource availability. The engineering ordering options are structured based on Table 8 below.

Table 8: 6AGW-2101 Gateway Panel Engineering Ordering Options

Options	SAP Service Number	Description
1	3000018237	Substation Gateway Base Engineering (Per Substation Gateway)
2	3000018238	Substation Gateway per Bay Engineering (Per Substation Gateway)
3	3000018240	Gateway Per Bay Engineering Interlocking (Per Substation, Includes GW 1 and GW 2)
4	3000018241	Gateway Interlocking per instance (Per Substation, Includes GW 1 and GW 2 per instance)
5	3000018242	Gateway Per Bay Engineering Interlocking – SIEMENS solution (Per Substation, Includes GW 1 and GW 2)
6	3000018243	Gateway Interlocking per instance - SIEMENS solution (Per Substation, Includes GW 1 and GW 2 per instance)
7	3000018244	Integration of existing D400 Signals into Substation Gateway – X-Small Station (100-599 I/O) (Per Substation, Includes GW 1 and GW 2)
8	3000018245	Integration of existing D400 Signals into Substation Gateway – Small Station (600-1399 I/O) (Per Substation, Includes GW 1 and GW 2)
9	3000018246	Integration of existing D400 Signals into Substation Gateway – Medium Station (1400-2299 I/O) (Per Substation, Includes GW 1 and GW 2)
10	3000018247	Integration of existing D400 Signals into Substation Gateway – Large Station (2300-2999 I/O) (Per Substation, Includes GW 1 and GW 2)
11	3000018248	Integration of existing D400 Signals into Substation Gateway – X-Large Station (3000-4000+ I/O) (Per Substation, Includes GW 1 and GW 2)
12	3000018259	Engineering - Bay Switch (Per Main)
13	3000018260	Engineering – Router (Per Main)

Note 1: Option 4 is only to be selected when a new interlocking CFC logic block is required for a bay type that has not been implemented as a template by Siemens. Once implemented, this bay type will be available in the Gateway as a template.

Note 2: Options 5 and 6 which are the interlocking solutions following the Siemens implementation philosophy are currently not tested and hence currently not a selectable option.

Note 3: Options 7, 8, 9, 10 and 11 are to be selected when a GE D400 is to be slaved to the Siemens Gateways

3.4.4 6AGW-2101 Standing and Momentary DC Loads

The DC burdens for the 6AGW-7100 Gateway panel, tabulated below should be used for battery sizing calculations. This information is derived from the data sheets for the various components and not actual measured values. The values tabulated below are based on maximum peak burden.

Table 9: 6AGW-2101 Gateway Panel Standing Loads

Component	Quantity	Per Device (W)	Standing Load (W)
Advantech ECU 4784 Gateway Server	1	19	19
Siemens RuggedCom RSG2100 Network Switch	1	28	28
Siemens RuggedCom RX1500 Router	1	65	65
DC and Equipment Fail Monitoring Relays	2	1.3	2.6

Table 10: 6AGW-2101 Gateway Panel Momentary Loads

Component	Quantity	Per Device (W)	Momentary Load (W)
Watchdog Relay	2	1.3	2.6
Indication Lamp	1	2.2	2.2

3.4.5 Cabling Requirements

Below is a summary of the minimum cable requirements for interfacing to the 6AGW-7100 Gateway Panel.

Table 11: 6AGW-2101 Gateway Panel Cabling Requirements

Function	Recommended Cable Size (mm ²)	Minimum Number of cores/pairs	Recommended Gland Size	No. of Glands
DC Supply	4	2	1	1
230 VAC Supply with earth leakage	4	2	1	1
230 VAC Supply	4	2	1	1
Supervisory Alarms and Indications	0.5	10	PG 13.5	1
RS-422/485 Communication	0.5	6	PG 13.5	3
Fibre	-	12	PG 13.5	2

3.4.6 Software Requirements

This section provides a high-level overview of the software configuration/settings which are to be enabled in the various devices to ensure system operation and system interoperability. Additional information related to the configuration and settings can be found in the applicable commodity configuration guides.

Table 12: 6AGW-2101 Gateway Panel Software configuration/settings

SICAM PAS V8.08	Protocols: IEC 61850 Client, IEC 61850 Server (Optional), IEC 60870-5-101 Slave, IEC 60870-5-101 Master (Optional) and SNMP Libraries and Functions: SICAM PAS SoftPLC and SICAM SCC
Siemens RuggedCom RSG2100 Network Switch	Protocols: SNTP, SNMP, IEEE 802.1Q, RSTP, MSTP, LLDP, RCDP
Siemens RuggedCom RX1500 Router	Protocols: SNTP, SNMP, IEEE 802.1Q, RSTP, MSTP, IGMP, LLDP, DHCP and VRRP

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3.5 6AHMI-2100 HMI Server Module

Table 13: 6AHMI-2100 HMI Server Module Overview

Scheme number:	6AHMI-2100
Area of application:	Applicable for all greenfield substations. The HMI Server module houses the HMI Server and is located in close proximity to the operator workstation for ease of connecting to the HMI monitor(s), keyboard, mouse and speaker located at the operator workstation.
Scheme overview:	The scheme consists of the following devices: a) 12U Wall mount server panel b) Advantech ECU 4784 c) 1 x DC-DC converter d) 1 x DC Fail Relay e) 1 x Fibre Patch Box
Peripheral Equipment	a) SKB-107-TP Keyboard b) SM502 Silicone Mouse c) 2 x LG 24MP58VQ IPS Type HMI Monitor d) Logitech S150 USB Stereo Speaker
HMI Template Pages	The SIMATIC WinCC HMI is provided with an example project which can be used and modified to meet the relevant application requirements. The example project includes template pages which consist of the following. a) Analogues b) Buszone c) Equipment Pages d) Overview e) Station Alarms f) Station Level Communications Diagram g) HV Level Communications Diagram h) EHV Level Communications Diagram i) Bus-coupler j) Bus-section k) Double Busbar Feeder l) Breaker and a Half Feeder m) Double Busbar Transformer n) Double Busbar Reactor o) Breaker and a Half Transformer p) Breaker and a Half Reactor q) Tap Changer r) Diameter
HMI Software	SIMATIC WinCC
Scheme dimensions:	592(H) x 560(W) x 550(D) wall mount panel.

3.5.1 6AHMI-2100 Free-Issue Material and Licences

The following item shall be free-issued by the *Purchaser* and does not form part of the scheme equipment supply:

- a) 1 x 12-Core Fibre Patch Box
- b) 1 x Windows 10 licence key

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3.5.2 6AHMI-2100 Equipment Overview

The schematics for the 6AHMI-2100 HMI Server Module are detailed in drawing numbers 0.52/30580 - Scheme 6AHMI-2100-M1 and 0.52/30581 - Scheme 6AHMI-2100-M2 for Main 1 and Main 2 respectively. Both Main 1 and Main 2 panels, from a hardware perspective, are identical. The internal devices of the 6AHMI-2100 HMI Server Module are equipped with wide-range power supply units which are rated to operate at both 110 VDC and 220 VDC. The HMI Hardware Platform also housed in the 6AHMI-2100 HMI Server Module has 2 wide-range power supply units. Thus, the 6AHMI-2100 HMI Server Module is suited for both 110 VDC and 220 VDC applications.

The 6AHMI-2100 HMI Server Module is equipped with a 90 W, (135-370 VDC)/19 VDC DC converter which serves as a 19 VDC supply to the two HMI display monitors.

The 6AHMI-2100 HMI Server Module is equipped with a brush plate located at the bottom of the panel to facilitate the entry and exit of cables. When mounting the panel, due consideration should be given to the space beneath the panel to allow for the excess slack from the fibre cable. The 6AHMI-2100 HMI Server module should be mounted as close as possible to operator workstation to minimise the cable run between the module and monitors, keyboard, mouse and speaker. These cables should typically be grouped into a cable sleeve.

The general arrangement for the front view and the rear inside view of the 6AHMI-2100 HMI Server module is presented in Figure 3 and Figure 4 below.

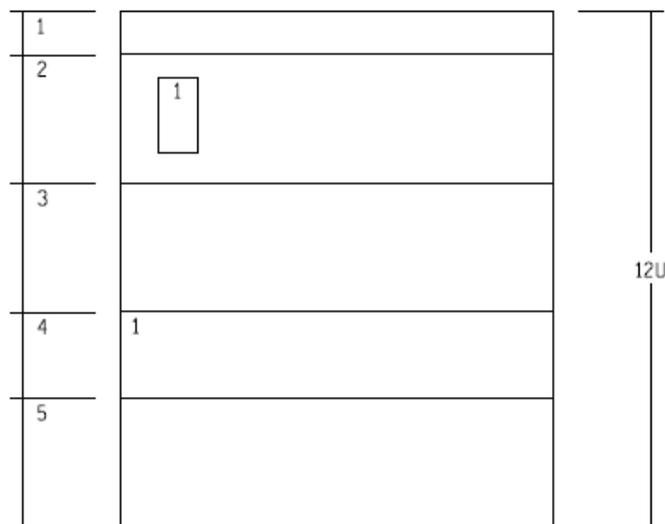


Figure 3: 6AHMI-2100 HMI Server Module - Front View

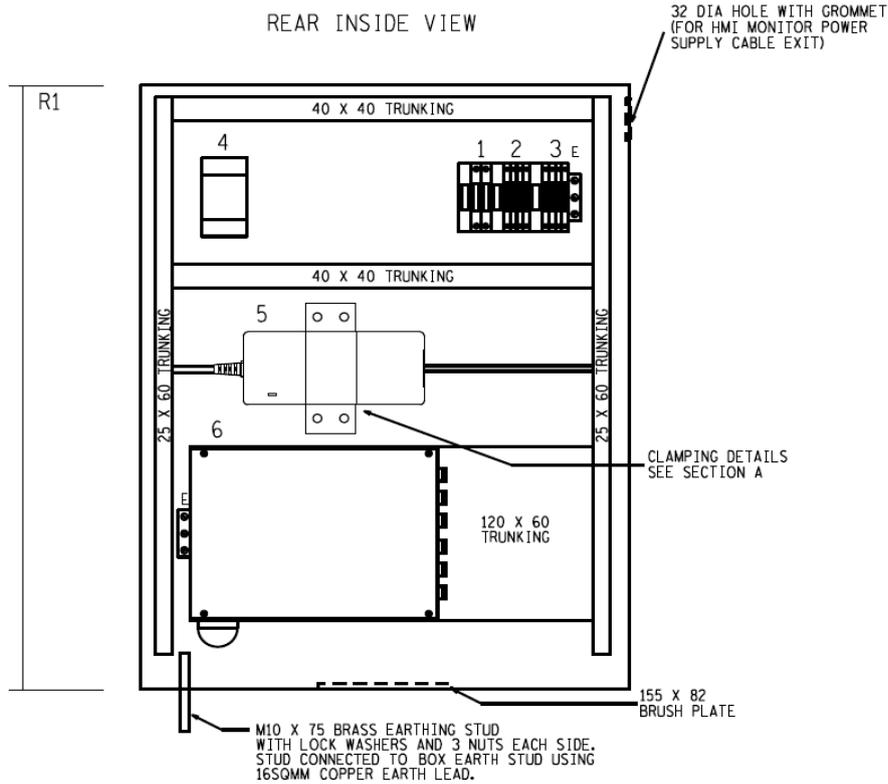


Figure 4: 6AHMI-2100 HMI Server Module – Rear Inside View

The detailed equipment list with reference to Figure 3 and Figure 4 above is presented below. The location indices shown in Figure 3 and Figure 4 are used to identify each piece of equipment listed in Table 14 and Table 15 below.

The design can be adjusted to accommodate either 110 VDC or 220 VDC substation supply. Internal equipment to the panel which are affected by the respective station voltages will differ in part number depending on the applied station voltage. These part numbers need to be correctly applied in the respective scheme drawings. The automation devices are equipped with wide-range power supply units which are rated to operate at both 110 VDC and 220 VDC. The applicable equipment part numbers for the respective station voltages are tabulated below.

Table 14: 6AHMI-2100 HMI Server Module Equipment List (Front View)

Location		Description	Part Number	
			110 VDC	220 VDC
1	1	1 U Blanking plate	-	
2	1	DC Isolating MCB	5SY5206-6 (B6)	
3	1	3 U Blanking plate	-	
4	1	HMI Hardware Platform	Advantech ECU 4784	
5	1	3 U Blanking plate	-	

Table 15: 6AHMI-2100 HMI Server Module Equipment List (Rear Inside View)

Location		Description	Part Number	
			110 VDC	220 VDC
R1	E	Earth Terminals	ET6	
	1 X1(1-2)	Power Supply Terminals	WDU 10SL	
	2 X2(1-4)	Spring Terminals	WDU 4SL	
	3 X3(1-4)	Spring Terminals	WDU 4SL	
	4	Main 1 DC Fail Relay	60.13.9.110	60.13.9.220
	5	90 W (135-370 VDC)/19 VDC Converter	GS90A19-P1M	
	6	12-Core Fibre Patch Box	Free Issue	

3.5.3 6AHMI-2100 Ordering Options

The primary ordering options for the 6AHMI-2100 are listed in Table 16 below.

Table 16: 6AHMI-2100 HMI Server Module Primary Ordering Options

Options	SAP Material Number	Description
1	673563	6AHMI-2100 M1 HMI Server Module (110 VDC)
2	673564	6AHMI-2100 M1 HMI Server Module (220 VDC)
3	673565	6AHMI-2100 M2 HMI Server Module (110 VDC)
4	673566	6AHMI-2100 M2 HMI Server Module (220 VDC)
5	674206	HMI Hardware Platform
6	674211	LED LCD Monitor
7	674332	Industrial Keyboard & Mouse
8	674036	2 metre LC-LC Duplex MM 50/125 fibre optic patch cord, Non-Ruggedized
9	Not Available	Logitech S150 USB Stereo Speakers

Note: 2 x LED Monitors, 1 x Industrial Keyboard, 1 x Industrial Mouse and 1 x USB Speakers are required per main HMI Server Module.

Engineering services for the various commodities are available and optional based on the *Purchaser's* inhouse skills and resource availability. The engineering ordering options are structured based on Table 17 below.

Table 17: 6AHMI-2100 HMI Server Module Engineering Ordering Options

Options	SAP Service Number	Description
1	3000018249	Substation HMI Base Engineering (Per Substation HMI)
2	3000018250	Substation HMI per Bay Engineering (Per Substation HMI)
3	3000018251	Integration of existing D400 Signals into Substation HMI – X-Small Station (100-599 I/O) (Per Substation, Includes HMI 1 and HMI 2)
4	3000018252	Integration of existing D400 Signals into Substation HMI – Small Station (600-1399 I/O) (Per Substation, Includes HMI 1 and HMI 2)

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Options	SAP Service Number	Description
5	3000018253	Integration of existing D400 Signals into Substation HMI – Medium Station (1400-2299 I/O) (Per Substation, Includes HMI 1 and HMI 2)
6	3000018254	Integration of existing D400 Signals into Substation HMI – Large Station (2300-2999 I/O) (Per Substation, Includes HMI 1 and HMI 2)
7	3000018255	Integration of existing D400 Signals into Substation H – X-Large Station (3000-4000+ I/O) (Per Substation, Includes HMI 1 and HMI 2)
8	3000018256	Creation of new instance for HMI (Per Substation, Includes HMI 1 and HMI 2 per instance)

Note 1: Options 3, 4, 5, 6 and 7 are to be selected when a GE D400 is to be integrated with the Siemens Gateways

Note 2: Options 8 is only to be selected when a new instance of bay type is required to be created in the HMI that has not been implemented as a template by Siemens. Once created, this bay type will be available in the HMI as a template.

3.5.4 6AHMI-2100 Standing and Momentary DC Loads

The DC burden for the 6AHMI-2100 HMI Server Module, tabulated below should be used for battery sizing calculations. The HMI monitors are included as well as they derive power from the 6AHMI HMI Server Module. This information is derived from the data sheets for the various components and not actual measured values. The values tabulated in Table 18 are based on maximum peak burden.

Table 18: 6AHMI-2100 HMI Server Module Standing Loads

Component	Quantity	Per Device (W)	Standing Load (W)
Advantech ECU 4784	1	19	19
LG 24MP58VQ IPS Type HMI Monitor	2	25	50
DC Fail Monitoring Relay	1	1.3	1.3

Table 19: 6AHMI-2100 HMI Server Module Momentary Loads

Component	Quantity	Per Device (W)	Momentary Load (W)
Watchdog Relay	1	1.3	1.3

3.5.5 Cabling Requirements

Below is a summary of the minimum cable requirements for interfacing to the 6AHMI-2100 HMI Server Module.

Table 20: 6AHMI-2100 HMI Server Module Cabling Requirements

Function	Recommended Cable Size (mm ²)	Minimum Number of cores/pairs	Recommended Gland Size	No. of Glands
DC Supply	4	2	-	1
Supervisory Alarms and Indications	0.5	10	PG 13.5	1
Fibre	-	12	PG 13.5	1

3.5.6 Software Requirements

This section provides a high-level overview of the software configuration/settings which are to be enabled in the various devices to ensure system operation and system interoperability. Additional information related to the configuration and settings can be found in the applicable commodity configuration guides.

Table 21: 6AHMI-2100 HMI Server Module Software configuration/settings

SIMATIC WinCC HMI Platform	Application specific. Example project provided can be engineered to meet application requirements.
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3.6 6AFS-2100 Fibre Switching Panel

Table 22: 6AFS-2100 Fibre Switching Panel Overview

Scheme number:	6AFS-2100
Area of application:	Applicable for all greenfield substations. The fibre switching panel includes a high-speed gigabit backbone switch, including a time synchronisation module, which connects to the low tier switches.
Scheme overview:	<p>The scheme consists of the following devices:</p> <ul style="list-style-type: none"> a) Siemens RuggedCom RSG2488 Backbone Network Switch with integrated GPS b) 16 A AC plug socket c) GPS Surge Arrestor d) 3 m LMR-195-DB BNC(M) to TNC(M) Coaxial Cable between GPS module and GPS Surge Arrestor e) 9524B Dual Constellation Antenna f) Goose Neck Antenna Bracket g) 3 m LMR-195-DB BNC(M) to BNC(M) Coaxial Cable for Demodulated IRIG-B Cable between GPS module and Gateway
Scheme dimensions:	600 x 600 x 2400 mm (W x D x H) single panel.

3.6.1 6AFS-2100 Free-Issue Material

The following items shall be free-issued by the *Purchaser* and do not form part of the scheme equipment supply. These include:

- a) 1 x 19-Inch "Type A" Standard Equipment Cabinet with front and rear access.
- b) 8 x 19-Inch Fibre Patch Panels.

Note: Each 19-inch Fibre Patch Panel can accommodate 2 x 12 core fibre cables.

3.6.2 6AFS-2100 Equipment Overview

The schematics for the 6AFS-2100 Fibre switching panel are detailed in drawing numbers 0.52/30513 – Scheme 6AFS-2100-M1 and 0.52/30516 – Scheme 6AFS-2100-M2 for Main 1 and Main 2 respectively. Both Main 1 and Main 2 panels, from a hardware perspective, are identical.

The general arrangement for the front and internal views of the 6AFS-2100 Fibre switching panel are presented in Figure 5.

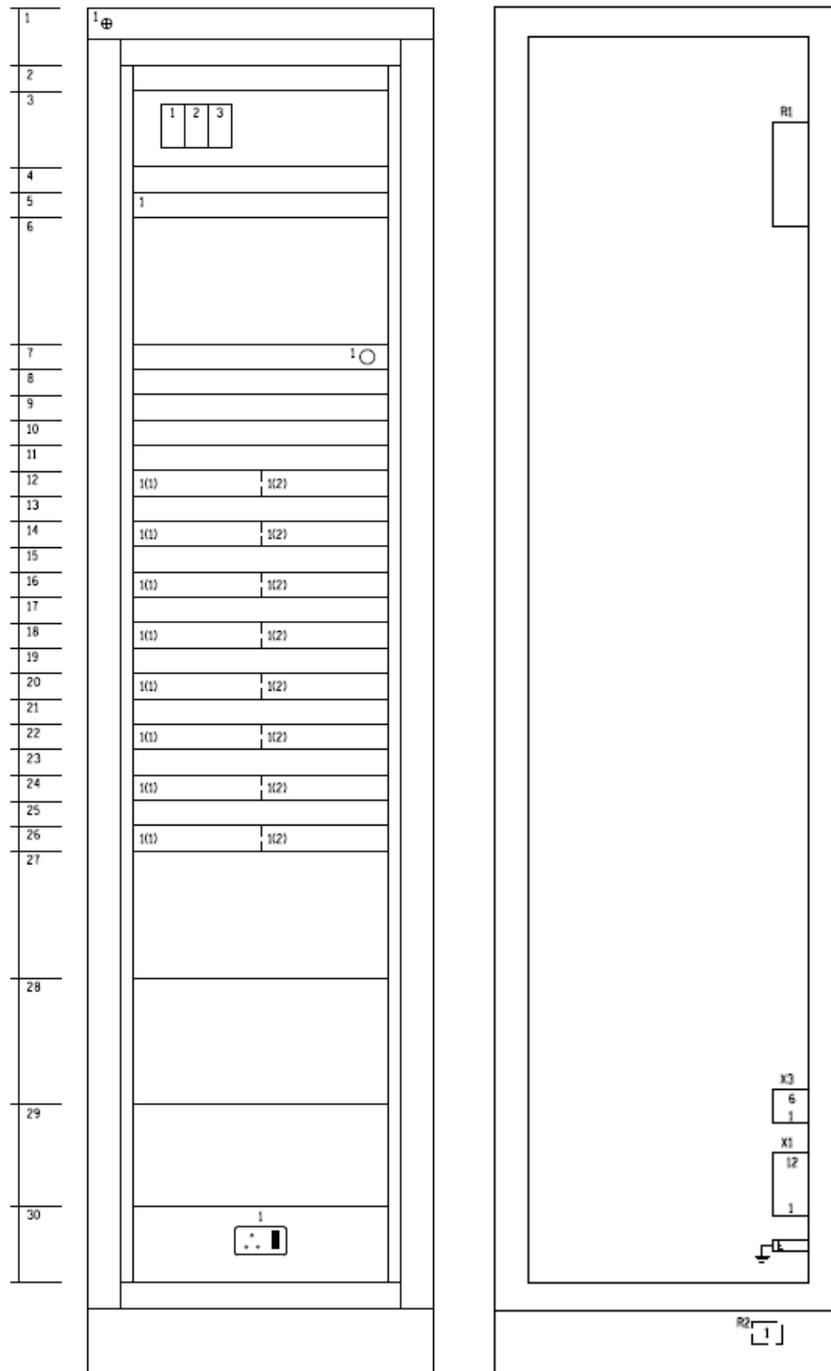


Figure 5: 6AFS-2100 Fibre Switching Panel - Front and Internal Views

The detailed equipment list with reference to Figure 5 above is presented below. The location indices shown in Figure 5 are used to identify each piece of equipment listed in Table 23 and Table 24 below.

The design can be adjusted to accommodate either 110 VDC or 220 VDC substation supply. Internal equipment to the panel which are affected by the respective station voltages will differ in part number depending on the applied station voltage. These part numbers need to be correctly applied in the respective scheme drawings. The RSG2488 Backbone Network Switch with integrated GPS is equipped with wide-range power supplies which are rated to operate at both 110 VDC and 220 VDC. The applicable equipment part numbers for the respective station voltages are tabulated below.

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The Siemens RuggedCom RSG2488 backbone network switch supports up to a maximum of 24 gigabit fibre ports (LC, multimode 850 nm), distributed between 6 fibre modules with 4 ports each. The RSG2488 backbone switch will however be equipped with 16 ports. . The Fibre switching panel can be equipped with a maximum of 8 19-inch fibre patch panels (installed from top to bottom) to interface with the backbone switch.

Table 23: 6AFS-2100 Fibre Switching Panel Equipment List (Front View)

Location		Description	Part Number	
			110 VDC	220 VDC
1	1	Panel Not Healthy lamp	22IN220VRDLTZ	
2		1 U Blanking plate	-	
3	1	DC Isolating MCB	5SY5216-6 (B16)	
	2	DC Isolating MCB	5SY5206-6 (B6)	
	3	230 VAC MCB	5SY7210-7CC (C10)	
4		1 U Blanking plate	-	
5	1	RSG2488 Backbone Network Switch	6GK6024-8GS23-3DA0-Z A59+B05+C05+D05+E05+F00+G60+H61	
6		1 U Blanking plate	-	
7	1	Lamp Check Pushbutton	RB2-BA2, RB2-B, 1xRB2-BE101	
8-11	1	Fibre Patch Panel	Free Issue	
12		1 U Blanking plate	-	
13-16	1	Fibre Patch Panel	Free Issue	
17		1 U Blanking plate	-	
18-21	1	Fibre Patch Panel	Free Issue	
22		1 U Blanking plate	-	
23-26	1	Fibre Patch Panel	Free Issue	
27		5 U Blanking plate	-	
28		5 U Blanking plate	-	
29	1	4 U Blanking plate	-	
30	1	AC Plug socket	CRABTREE (68964P)	

Table 24: 6AFS-2100 Fibre Switching Panel Equipment List (Internal View)

Location		Description	Part Number	
			110 VDC	220 VDC
FSP	X1 (1-12)	Spring Terminals	WDU 10 SL	
	X1 (E)	Earth Terminal	WPE 10	
	X3 (1-6)	Spring Terminals	WDU 10 SL	

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Location		Description	Part Number	
			110 VDC	220 VDC
R1	1	DC Watchdog Auxiliary Relay	60.13.9.110	60.13.9.220
	2	AC Watchdog Auxiliary Relay	60.13.8.230	
R2	1	GPS Surge Protection Device	P8AX09-T/FF	

3.6.3 6AFS-2100 Ordering Options

The ordering options for the 6AFS-2100 are listed in Table 25 below. The ordering options consist of a scheme comprising a backbone switch equipped with 16 ports and a GPS module. The *Purchaser* shall free-issue up to 8 Fibre Patch Panels to complete the scheme.

Table 25: 6AFS-2100 Fibre Switching Panel Primary Ordering Options

Options	SAP Material Number	Description
1	673567	6AFS-2100 M1 Fibre Switching Panel (110 VDC)
2	673568	6AFS-2100 M1 Fibre Switching Panel (220 VDC)
3	673569	6AFS-2100 M2 Fibre Switching Panel (110 VDC)
4	673570	6AFS-2100 M2 Fibre Switching Panel (220 VDC)
5	673985	Backbone Network Switch with GPS Module and Accessories
6	674604	30 m LMR-400-DB Coaxial Antenna Cable
7	674605	60 m LMR-400-DB Coaxial Antenna Cable
8	674606	3 m LMR-195-DB BNC(M) to BNC(M) Coaxial IRIG-B Cable between GPS module and Gateway
9	674037	3 metre LC-LC Duplex MM 50/125 fibre optic patch cord, Non-Ruggedized

Note: The number of patch cords required to be ordered per 6AFS-2100 Fibre Switching Panel is dependent on the number of ports used on the Backbone Network Switch.

Engineering services for the RSG2488 Backbone Network Switch is available and optional based on the *Purchaser's* in-house skills and resource availability. The engineering ordering options are structured based on Table 26 below.

Table 26: 6AFS-2100 Fibre Switching Panel Engineering Ordering Options

Options	SAP Service Number	Description
1	3000018257	Engineering: Backbone Switch (Per Main)

3.6.4 6AFS-2100 Standing and Momentary DC Loads

The DC burdens for the 6AFS-2100 fibre switching panel, tabulated below should be used for battery sizing calculations. This information is derived from the data sheets for the various components and not actual measured values. The values tabulated below are based on maximum peak burden.

Table 27: 6AFS-2100 Fibre Switching Panel Standing Loads

Component	Quantity	Per Device (W)	Standing Load (W)
Siemens RuggedCom RSG2488 Backbone Network Switch	1	66	66
DC Fail Monitoring Relay	1	1.3	1.3

Table 28: 6AFS-2100 Fibre Switching Panel Momentary Loads

Component	Quantity	Per Device (W)	Momentary Load (W)
Watchdog Relays	1	1.3	6.5
Indication Lamps	1	2.2	2.2

3.6.5 Cabling Requirements

Below is a summary of the minimum cable requirements for interfacing to the 6AFS-7100 Fibre Switching Panel.

Table 29: 6AFS-2100 Fibre Switching Panel Cabling Requirements

Function	Recommended Cable Size (mm ²)	Minimum Number of cores/pairs	Recommended Gland Size	No. of Glands
DC Supply	4	2	1	1
230 VAC Supply with earth leakage	4	2	1	1
230 VAC Supply	4	2	1	1
Supervisory Alarms and Indications	0.5	10	PG 13.5	1
Fibre	-	12	PG 13.5	16

Note: The standard gland plate is equipped with 20 x 20 mm and 4 x 25mm gland knockouts.

3.6.6 Software Requirements

This section provides a high-level overview of the software configuration/settings which are to be enabled on the RSG2488 Backbone Network Switch to ensure system operation and system interoperability. Additional information related to the configuration and settings can be found in the commodity configuration guide.

Table 30: 6AFS-2100 Fibre Switching Panel Software configuration/settings

Siemens RuggedCom RSG2100 Network Switch	Protocols: SNTP, SNMP, IEEE 802.1Q, RSTP, MSTP, LLDP, RCDP
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3.7 6ACE-2100 Common Equipment Panel

Table 31: 6ACE-2100 Common Equipment Panel Overview

Scheme number:	6ACE-2100
Area of application:	Applicable for all greenfield substations. The common equipment panel features both Station IED 1 and Station IED 2 which provide an interface for substation hardwired inputs and outputs. Furthermore, common schemes such as the tap change, measurement and Buszone panels connect to the common equipment panel network switch.
Scheme overview:	The scheme consists of the following devices: a) 2 x 6MD85 Siprotec 5 IEDs b) Siemens RuggedCom RSG2100 Network Switch c) 4 x DC-DC Converters d) Krone Interface Modules e) 16 A AC plug socket
Scheme dimensions:	800 x 600 x 2400 mm (W x D x H) single panel.

3.7.1 6ACE-2100 Free-Issue Material

The following items shall be free-issued by the *Purchaser* and do not form part of the scheme equipment supply. These include:

- a) 1 x 19-Inch Protection fixed frame equipment cabinet (800 x 600 x 2400) with rear access.
- b) Up to 5 x 19-Inch Fibre Patch Panels.

Note: Each 19-inch Fibre Patch Panel can accommodate 2 x 12 core fibre cables.

3.7.2 6ACE-2100 Equipment Overview

The schematics for the 6ACE-2100 common equipment panel are detailed in drawing numbers 0.52/30514 – Scheme 6ACE-2100.

The general arrangement for the front and internal views of the 6ACE-2100 common equipment panel are presented below.

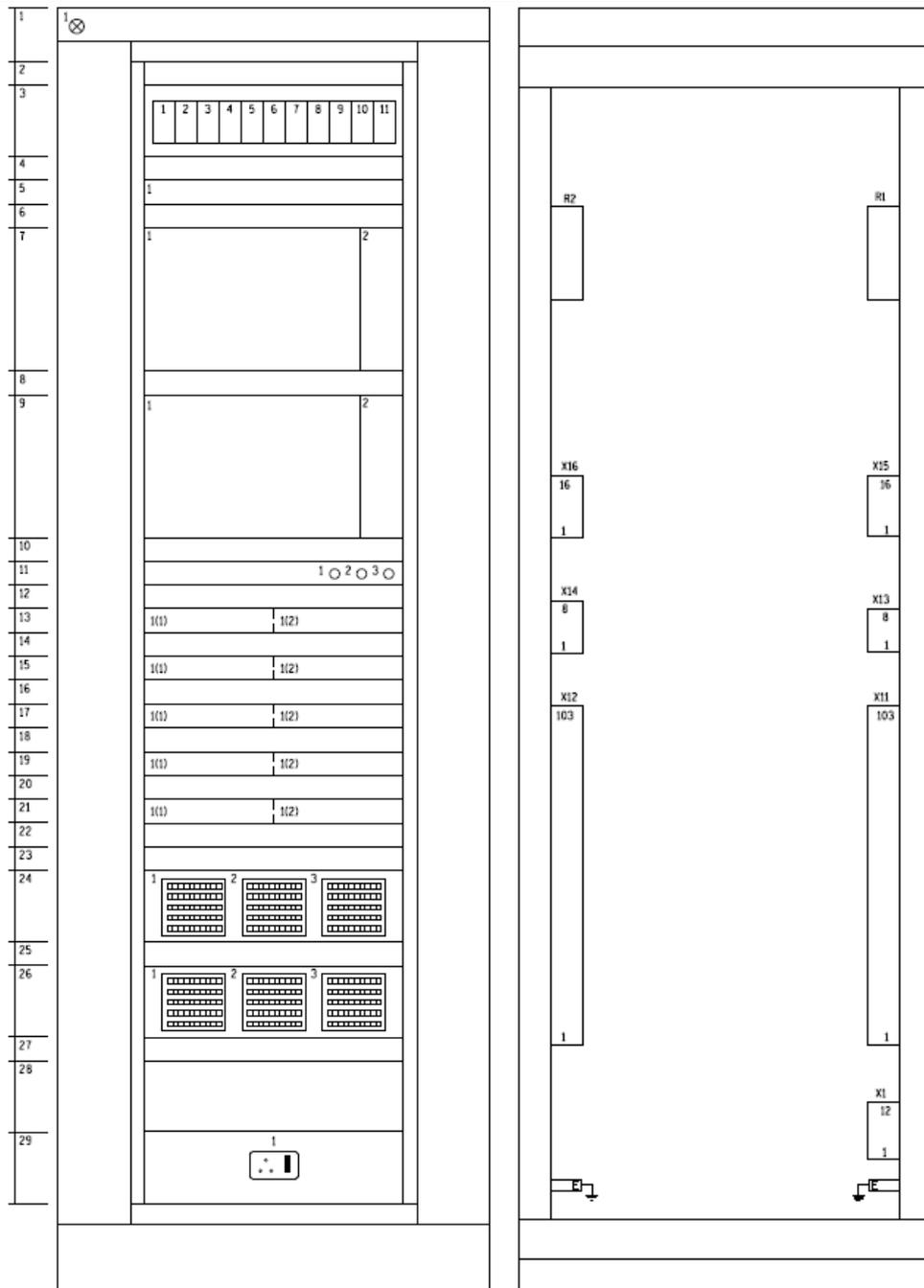


Figure 6: 6ACE-2100 Common Equipment Panel - Front and Internal Views

The detailed equipment list with reference to Figure 6 above is presented below. The location indices shown in Figure 6 are used to identify each piece of equipment listed in Table 35 and Table 36 below.

The design can be adjusted to accommodate either 110 VDC or 220 VDC substation supply. Internal equipment to the panel which are affected by the respective station voltages will differ in part number depending on the applied station voltage. These part numbers need to be correctly applied in the respective scheme drawings. The automation devices are equipped with wide-range power supplies which are rated to operate at both 110 VDC and 220 VDC. The applicable equipment part numbers for the respective station voltages are tabulated below.

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Table 32: 6ACE-2100 Common Equipment Panel Equipment List (Front View)

Location		Description	Part Number	
			110 VDC	220 VDC
1	1	Panel Not Healthy lamp	22IN220VRDLTZ	
2		1 U Blanking plate	-	
3	1-2	DC Isolating MCB's	5SY5216-6 (B16)	
	3-10	DC Isolating MCB's	5SY5206-6 (B6)	
	11	230 VAC MCB	5SY5210-7CC (C10)	
4		1 U Blanking plate with label	-	
5	1	RSG2100 Station Ethernet Switch (Large Bay Switch)	6GK6021-0AS23-3DB0-Z A05+B05+C05+D05+E02+F00+G05+H00+J00+K01	
6	1	1 U Blanking plate with label	-	
7	1	Station IED 1	6MD85 (P1G356130)	
	2	Blank	-	
8		1 U Blanking plate with label	-	
9	1	Station IED 2	6MD85 (P1G356130)	
	2	Blank	-	
10	1	1 U Blanking plate with label	-	
11	1	Lamp check pushbutton	-	
	2-3	Front Access Ethernet Engineering Ports	-	
12-19	1	19-Inch Fibre Patch Panel	Free Issue	
20-22		1 U Blanking Plate	-	
23		1 U Blanking plate with label	-	
24	1	IED 1 Krone Modules (111-115)	Recessed Subrack: 3x5-Way Back Mount Frames, 15 x LSA-Profil Modules	
	2	IED 1 Krone Modules (121-125)		
	3	IED 1 Krone Modules (131-135)		
25	1	1 U Blanking plate with label	-	
26	1	IED 2 Krone Modules (211-215)	Recessed Subrack: 3x5-Way Back Mount Frames, 15 x LSA-Profil Modules	
	2	IED 2 Krone Modules (221-225)		
	3	IED 2 Krone Modules (231-235)		
27		1 U Blanking Plate	-	
28		1 U Blanking Plate	-	
29	1	AC Plug socket	CRABTREE (68964P)	

Table 33: 6ACE-2100 Common Equipment Panel Equipment List (Internal View)

Location		Description	Part Number	
			110 VDC	220 VDC
CEP	X1 (1-12)	Spring Terminals	WDU 10 SL	
	X1 (E)	Earth Terminal	WPE 10	
	X11 (1-103)	Spring Terminals	WDU 4 SL	
	X12 (1-103)	Spring Terminals	WDU 4 SL	
	X13 (1-8)	Spring Terminals	WDU 4 SL	
	X14 (1-8)	Spring Terminals	WDU 4 SL	
	X15 (1-16)	Spring Terminals	WDU 4 SL	
	X16 (1-16)	Spring Terminals	WDU 4 SL	
R1	1-2	100W (120-370 VDC)/48 VDC Converter (For Digital Input/Output Wetting Supply) for IED 1	MDR-100-48	
	3	AC Watchdog Auxiliary Relay	60.13.8.230	
R2	1-2	100W (120-370 VDC)/48 VDC Converter (For Digital Input/Output Wetting Supply) for IED 2	MDR-100-48	

3.7.3 6ACE-2100 Ordering Options

The ordering options for the 6ACE-2100 are listed in Table 34 below.

Table 34: 6ACE-2100 Common Equipment Panel Ordering Options

Options	SAP Material Number	Description
1	673571	6ACE-2100 Common Equipment Panel (110 VDC)
2	673572	6ACE-2100 Common Equipment Panel (220 VDC)
3	673973	Station IED
4	673989	RSG2100 Station Ethernet Switch (Large Bay Switch)
5	674036	2 metre LC-LC Duplex MM 50/125 fibre optic patch cord, Non-Ruggedized
6	674037	3 metre LC-LC Duplex MM 50/125 fibre optic patch cord, Non-Ruggedized

Note: Two Station IEDs must be ordered per Common Equipment Panel.

Engineering services for the applicable commodities is available and optional based on the *Purchaser's* in-house skills and resource availability. The engineering ordering options are structured based on Table 35 below.

Table 35: 6ACE-2100 Common Equipment Panel Engineering Ordering Options

Options	SAP Service Number	Description
1	3000018239	Engineering: Station IED (Per IED)
2	3000018259	Engineering: Bay Switch (Per Main)

3.7.4 6ACE-2100 Standing and Momentary DC Loads

The DC burdens for the 6ACE-2100 common equipment panel, tabulated below should be used for battery sizing calculations. This information is derived from the data sheets for the various components and not actual measured values. The values tabulated below are based on maximum peak burden.

Table 36: 6ACE-2100 Common Equipment Panel Standing Loads

Component	Quantity	Per Device (W)	Standing Load (W)
Siemens 6MD85	2	28.5	30
Siemens RuggedCom RSG2100 Network Switch	1	28	28
DC Fail Monitoring Relay	2	1.3	1.3

Table 37: 6ACE-2100 Common Equipment Panel Momentary Loads

Component	Quantity	Per Device (W)	Momentary Load (W)
Watchdog Relays	3	1.3	3.9
Indication Lamps	1	2.2	2.2

3.7.5 Cabling Requirements

Below is a summary of the minimum cable requirements for interfacing to the 6AFS-7100 Fibre Switching Panel.

Table 38: 6ACE-2100 Common Equipment Panel Cabling Requirements

Function	Recommended Cable Size (mm ²)	Minimum Number of cores/pairs	Recommended Gland Size	No. of Glands
DC Supply	4	2	1	2
230 VAC Supply with earth leakage	4	2	1	1
230 VAC Supply	4	2	1	1
Supervisory signals to external IDF	0.5	10	-	4
Supervisory signals to external IDF	0.5	25	-	6
Supervisory signals to external IDF	0.5	50	-	16
Fibre	-	12	PG 13.5	8

3.7.6 Software Requirements

This section provides a high-level overview of the software configuration/settings which are to be enabled on the applicable commodities to ensure system operation and system interoperability. Additional information related to the configuration and settings can be found in the commodity configuration guide.

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Table 39: 6ACE-2100 Common Equipment Panel Software configuration/settings

Siemens RuggedCom RSG2100 Network Switch	Protocols: SNTP, SNMP, IEEE 802.1Q, RSTP, MSTP, LLDP, RCDP
Station IED – 6MD85	Protocols: IEC61850 Server

4. Authorisation

This document has been seen and accepted by:

Name and surname	Designation
Nombuso Msibi	Applications Manager - PTMC
Quinton Labuschagne	Senior Consultant - Control Applications - PTMC
Tony Sheerin	Planning and Support Manager - PTMC

5. Revisions

Date	Rev	Compiler	Remarks
Oct 2021	1	Ian Naicker	First issue

6. Development team

The following people were involved in the development of this document:

- Dumisani Gojela
- Ian Naicker

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