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Application of SCADA system Case Study of 132/11KV Substation

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Abstract
The aim of this paper is design a data acquisition system (SCADA) to power distribution electrical network which supply the power from a vicinity Distribution Network Operator (DNO) 132KV overhead line through one underground cable terminated to one of the 132KV lattice towers to an industrial state. (It should be mentioned that feeding this high-profile industrial state by one underground cable does not comply firm capacity). The design starts from 132/11KV substation and continues to entire 11KV network up to each factory containing the 400V main circuit breaker on the LV side of the transformer.

Key words: *SCADA system, Distribution Network Operator, Circuit breaker and Transformer.*

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I. Introduction

Over the past decade the industrial control systems (ICS) has been increasing rapidly. There are many reasons for this trend considering new technologies that offer a higher level of control and integration (Sverko, M., Grbac, T. Galinac, 2021). Furthermore, the volume of data generated during the control of the industrial process is increasing. Therefore, the need of industrial control systems gets more significant to maintain, more monitoring the internal and external process. This paper illustrate electrical network distribution issues of the supervisory control by building data acquisition system (SCADA) network component as a simple system and example of the best practices in the application.

In order to provide a basic understanding of the basic components of a SCADA system with outline the basic structure of RTUs from a description of the planning process of an electrical network point of view, we will first give a brief overview of the power network which supply the power from a vicinity Distribution Network Operator (DNO) 132KV overhead line through one underground cable terminated to one of the 132KV lattice towers to an industrial state. (It should be mentioned that feeding this high-profile industrial state by one underground cable does not comply firm capacity). The design starts from 132/11KV substation and continues to entire 11KV network up to each factory containing the 400V main circuit breaker on the LV side of the transformer, figure (1) shows the 11KV network that supplied two transformers 132/11KV with sustain rating12.5MVA.

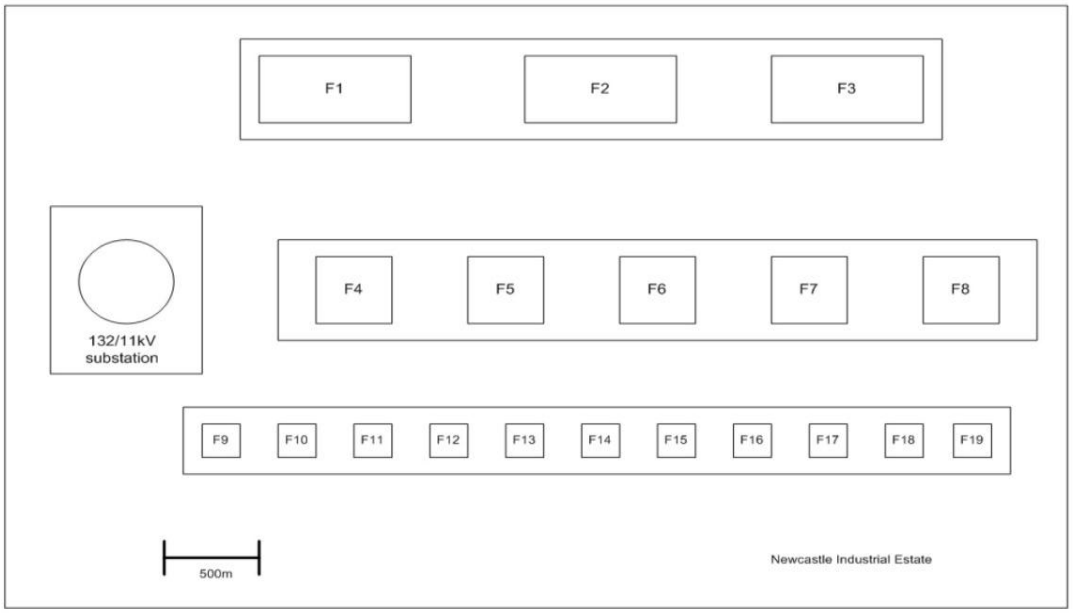

Figure 1: Network Layout

This part will describe the basic components of a SCADA system with outline the basic structure of RTUs , figure (2 & 3) (SCADA) Systems the majority of distribution control centres are equipped with Supervisory Control and Data Acquisition. We will start with a broad overview of a SCADA system by illustration the three fundamental components.

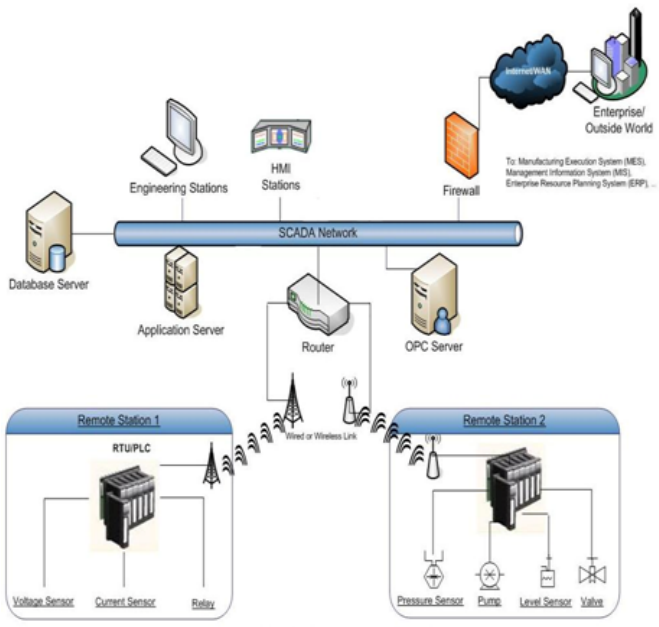

Figure 2: Open Control SCADA Network Architecture

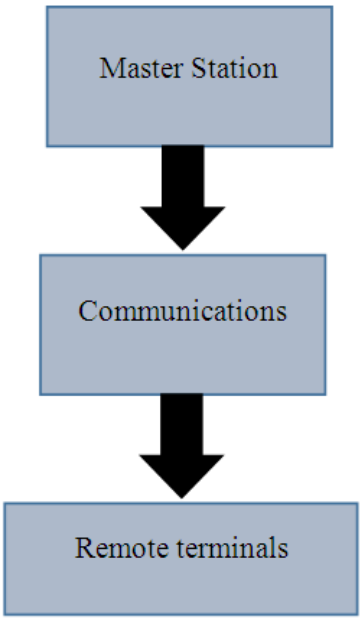

Figure 3: The three components of a SCADA

SCADA systems consist:

1) RTUs which are all over the substations and networks.
2) Communications system used to transfer data between RTUs and computers in the SCADA master station. The system can be radio, telephone, cable, satellite, etc., or any combination of these.
3) master station
4) Collection of standard and/or custom software [sometimes called Man Machine Interface (MMI)] systems used to provide the SCADA master station and operator terminal application, support the communications system, and monitor and control RTUs.

On this high-profile industrial network all of the circuit breakers, high voltage tap changers, and disconnectors must be controlled by the SCADA system. RTUs code the signals and process them to master station. Below figure is replied here to check which items of system should be control by SCADA.

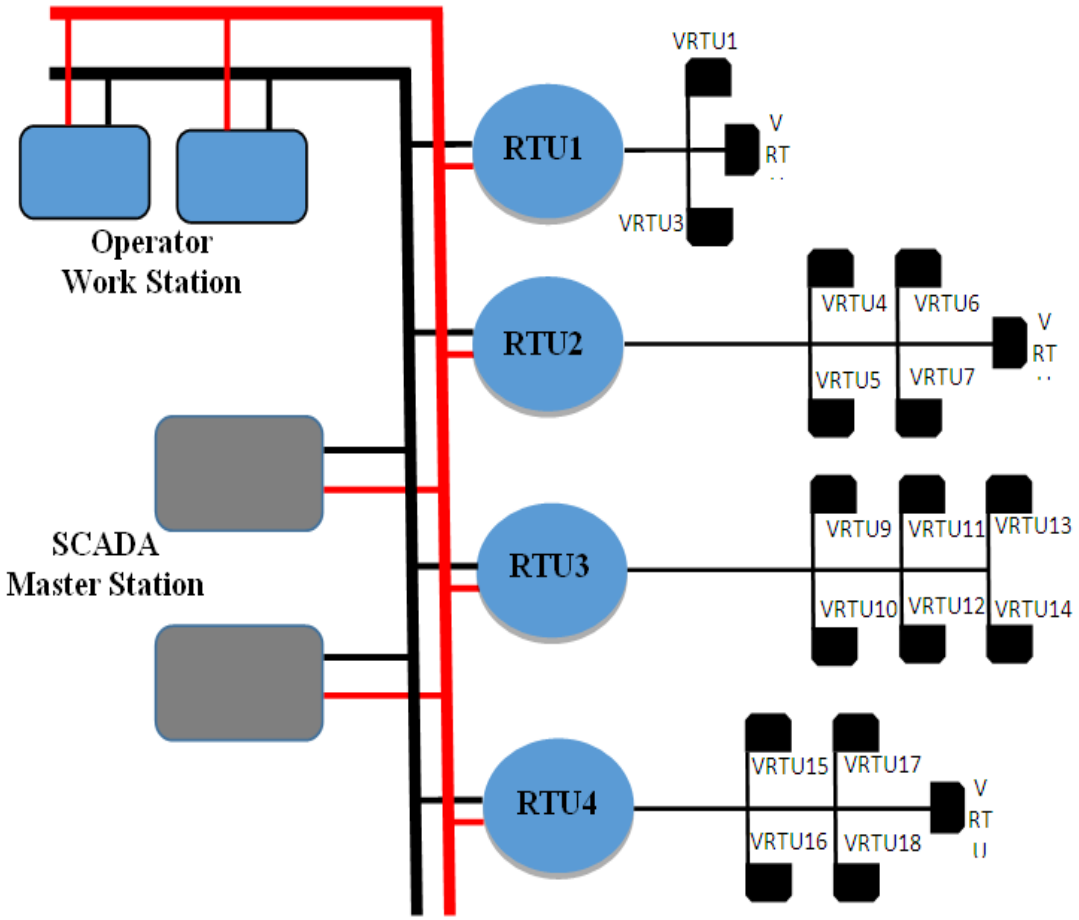

Figure 4: SCADA Architecture for Industrial State

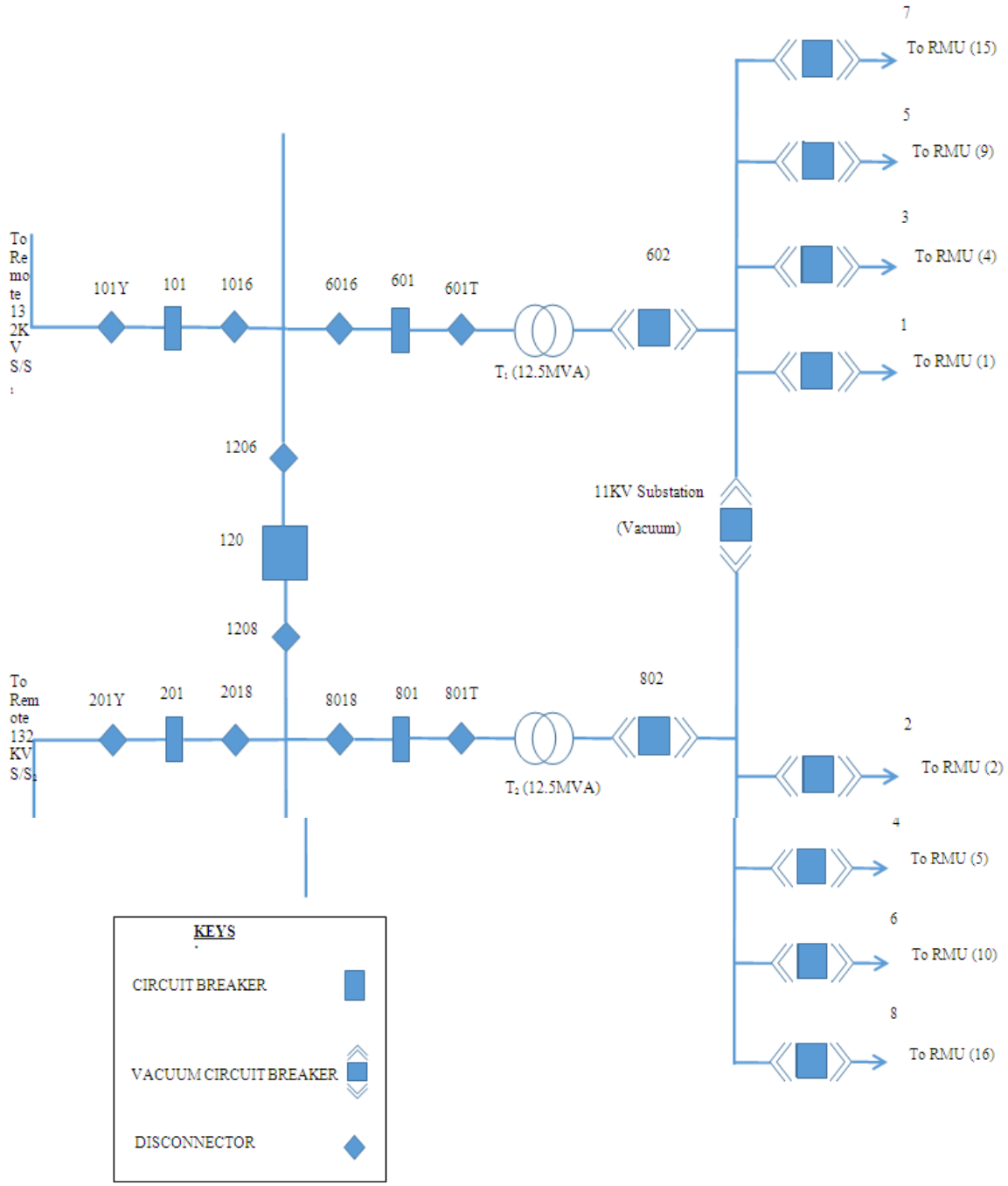

Figure 5: 132/11KV Substation Single Busbar

Table 1: 132 kV line breakers 101 and 201 (for example 1)

Alarm No.	DESCRIPTION
1	Distance protection, Main 1 – operated
2	Distance protection, Main 2 – operated
3	Direction O/C protection – operated
4	Directional E/F protection – operated
5	CB fail protection – operated
6	Auto-reclose relay – lockout
7	Distance protection, Main 1, inoperative – alarm

8	Distance protection, Main 2, inoperative – alarm
9	Auto-reclose – in progress
10	Auto-reclose - out of service
11	MCB for control and protection circuit 1 supply tripped
12	MCB for control and protection circuit 2 supply tripped
13	Trip signal send to PLC
14	Trip signal received from PLC
15	CB SF6 gas low pressure – alarm
16	CB SF6 gas low pressure – lockout
17	VT protection supply, circuit 1 – fail
18	VT protection supply, circuit 2 – fail
19	Trip circuit 1 fault
20	Trip circuit 2 fault
21	CB spring not charged
22	MCB for CB motor supply tripped
23	MCB for disconnectors motor supply tripped
24	MCB for signalling supply tripped
25	System in synchronism
26	Synchronising selector switch - off (blocking of CB close command)
27	Synchronising selector switch - normal (synchro-check)
28	Synchronising selector switch – manual override synchronising
29	Synchronising selector switch - remote and SCADA system synchronizing
30	L/R/S selector switch – local
31	L/R/S selector switch – remote
32	L/R/S selector switch – supervisory
33	101 CB-open
34	101 CB – closed
35	101Y disconnector – open
36	101Y disconnector- closed
37	1016 disconnector – open
38	1016 disconnector – closed
39	Trip circuit healthy

Table 2: 132kV transformer breakers for 601

Alarm No.	**DESCRIPTION**
1	Differential protection – operated
2	O/C protection – operated
3	E/F protection – operated
4	Restricted E/F protection – operated
5	Blank
6	Buchholz relay – tip
7	Buchholz relay – alarm
8	Oil temperature indicator – tip
9	Oil temperature indicator – alarm
10	Winding temperature indicator – tip
11	Winding temperature indicator – alarm
12	OLTC protection relay – trip
13	OLTC protection relay –alarm

14	OLTC in progress
15	OLTC out-of-step
16	Transformer oil level – max.
17	Transformer oil level – mm.
18	MCB control and protection circuit 1 supply tripped
19	MCB control and protection circuit 2 supply tripped
20	601 CB fail protection – operated
21	601 CB SF6 gas low pressure alarm
22	601 CB SF6 gas low pressure – lockout
23	Trip circuit 1 – fault
24	Trip circuit 2 – fault
25	MCB for 601 CB motor supply tripped
26	MCB for disconnectors motor supply tripped
27	MCB for signalling supply tripped
28	OLTC motor protection switch – tripped
29	Cooling fan, Group 1 & 2 – failure
30	OLTC oil level - max.
31	QLTC oil level – min.
32	Loss of power supply for cooling – alarm
33	Loss of power supply for OLTC motor – alarm
34	OLTC end limit – high
35	OLTC end limit – low
36	Transformer thermostat – alarm
37	Automatic voltage regulator- faulty
38	Transformer pressure relay – alarm
39	Trans former pressure relief vent – trip
40	OLTC pressure relief vent – trip
41	CB spring not charged
42	L/R/S selector switch – local
43	L/R/S selector switch – remote
44	L/R/S selector switch – supervisory
45	601 CB-open
46	601 CB-closed
47	6016 disconnector- open
48	6016 disconnector – closed
49	601T disconnector – open
50	601T disconnector – closed
51	R/S selector switch for tap changer – remote
52	R/S selector switch for tap changer – supervisory
53	Tap changer – automatic
54	Tap changer – manual
55	Transformer – master
56	Transformer – follower
57	Transformer – independent

Table 3: 132KV Transformer Breaker 801

Alarm No.	Description
1	Differential protection - operated
2	O/C protection - operated
3	E/F protection - operated
4	Restricted E/F protection - operated
5	Blank
6	Bucholz relay - tip
7	Bucholz relay - alarm
8	Oil temperature indicator - tip
9	Oil temperature indicator - alarm
10	Winding temperature indicator - tip
11	Winding temperature indicator - alarm
12	OLTC protection relay - trip
13	OLTC protection relay - alarm
14	OLTC in progress
15	OLTC out-of-step
16	Transformer oil level - max
17	Transformer oil level - min

18	MCB control and protection circuit 1 supply tripped
19	MCB control and protection circuit 2 supply tripped
20	801 CB fail protection - operated
21	801 CB SF6 gas low pressure - alarm
2 2	801 CB SF6 gas low pressure - lockout
23	Trip circuit 1 - fault
24	Trip circuit 2 - fault
25	MCB for 801 CB motor supply tripped
26	MCB for disconnectors motor supply tripped
27	MCB for signalling supply tripped
28	OLTC motor protection switch - tripped
29	Cooling fan, group 1 & 2 - failure
30	OLTC oil level – max.
31	OLTC oil level – min.
32	Loss of power supply for cooling - alarm
33	Loss of power supply for OLTC motor - alarm
34	OLTC end limit - high
35	OLTC end limit - low
36	Transformer thermostat - alarm
37	Automatic voltage regulator - faulty
38	Transformer pressure relay - alarm
39	Transformer pressure relief vent - trip
40	OLTC pressure relief vent - trip
41	801 CB spring not charged
42	L/R/S selector switch - local
43	L/R/S selector switch - remote
44	L/R/S selector switch - supervisory
45	801 CB – open
46	801 CB - closed
47	8018 disconnector - open
48	8018 disconnector – closed
49	801T disconnector - open
50	801T disconnector - closed
51	R/S selector switch for tap changer - remote
52	R/S selector switch for tap changer - supervisory
53	Tap changer - automatic
54	Tap changer - manual
55	Transformer - master
56	Transformer - follower
57	Transformer - independent

Table 4: 132 kV bus section breakers 120

Alarm No.	DESCRIPTION
1	Busbar differential protection, Zone 1 – operated
2	Busbar differential protection, Zone 2- operated
3	VT synchrocheck relay supply fail
4	DC fail Busbar differential protection supply
5	Busbar protection CT circuit open
6	O/C protection – operated
7	E/F protection- operated
8	CB fail protection – operated
9	CB SF6 gas low pressure – alarm
10	CB SF6 gas low pressure – lockout
11	Trip circuit 1 fault
12	Trip circuit 2 fault
13	MCB for control and protection circuit 2 supply tipped
14	MCB for control and protection circuit 2 supply tripped
15	MCB for CE motor supply tripped
16	MCB for disconnectors motor supply tripped
17	MCE for signalling supply tripped
18	CB spring not charged
19	System in synchronisation
20	Synchronisation selector switch - off (blocking of CB close command)
21	Synchronizing selector switch - normal (synchro-check)
22	Synchronizing selector switch - manual override synchronizing
23	Synchronizing selector switch - remote and SCADA system synchronizing
24	L/R/S selector switch – local

25	L/R/S selector switch – remote
26	L/R/S selector switch – supervisory
27	120 CB-open
28	120 CB-closed
29	1206 disconnector – open
30	1206 disconnector – closed
31	1208 disconnector – open
32	1208 disconnector – closed
33	Trip circuit healthy

Table 5: 11KV transformer incomer breaker 602

Alarm No.	Description
1	O/C protection - operated
2	E/F protection - operated
3	Restricted E/F protection - operated
4	MCB for control and protection supply tripped
5	Trip circuit fault
6	602 CB spring not charged
7	MCB for CB motor supply tripped
8	MCB for signalling supply tripped
9	L/R/S selector switch - local
10	L/R/S selector switch - remote
11	L/R/S selector switch - supervisory
12	602 CB - open
13	602 CB - closed
14	602 CB – Rack out
15	602 CB in Transformer Earth Position
16	602 CB in Busbar Earth Position
17	Trip circuit healthy

Table 6: Status at a substation for 11KV transformer incomer breaker 802

Alarm No.	Description
1	O/C protection - operated
2	E/F protection - operated
3	Restricted E/F protection - operated
4	MCB for control and protection supply tripped
5	Trip circuit fault
6	802 CB spring not charged
7	MCB for CB motor supply tripped
8	MCB for signalling supply tripped
9	L/R/S selector switch - local
10	L/R/S selector switch - remote
11	L/R/S selector switch - supervisory
12	802 CB - open
13	802 CB - closed
14	802 CB – Rack out
15	802 CB in Transformer Earth Position
16	802 CB in Busbar Earth Position
17	Trip circuit healthy

Table 7: Status at a substation for 11KV bus section 220

Alarm No.	Description
1	Busbar differential protection – zone 1 - operated
2	Busbar differential protection – zone 2 - operated
3	Under frequency protection, 1 step - operated
4	Under frequency protection, 2 step - operated
5	Under frequency protection, 3 step - operated
6	Under frequency protection, 4 step - operated
7	Busbar differential protection – DC supply fail
8	Under frequency protection – DC supply fail
9	Under frequency protection – VT circuit fail
10	Busbar protection – CT circuit open
11	O/C protection - operated
12	E/F protection - operated
13	MCB for control and protection supply tripped
14	Trip circuit fault
15	220 CB spring not charged
16	MCB for CB motor supply tripped
17	MCB for signalling supply tripped
18	L/R/S selector switch - local
19	L/R/S selector switch - remote
20	L/R/S selector switch - supervisory
21	220 CB - open
22	220 CB - closed
23	220 CB – Rack out
24	220 CB – Busbar Earth Position Section 1
25	220 CB – Busbar Earth Position Section 2
26	Trip circuit healthy

Table 8: Typical status at a substation for 11KV feeder breakers and this table is used for CB of feeders (1, 2, 3, 4, 5, 6, 7 and 8)

Alarm No.	Description
1	O/C protection - operated
2	E/F protection - operated
3	Sensitive E/F protection - operated
4	MCB for control and protection supply tripped
5	Trip circuit fault
6	7 CB spring not charged
7	MCB for CB motor supply tripped
8	MCB for signalling supply tripped
9	L/R/S selector switch - local
10	L/R/S selector switch - remote
11	L/R/S selector switch - supervisory
12	7 CB - open
13	7 CB - closed
14	7 CB – Rack out
15	7 CB in Transformer Earth Position

16	7 CB in Busbar Earth Position
17	Trip circuit healthy

Table 9: RMU 1 to 19 circuit breaker (example for RMU1)

Alarm No.	Description
1	O/C protection - operated
2	E/F protection - operated
3	Sensitive E/F protection - operated
4	MCB for control and protection supply tripped
5	Trip circuit fault
6	1 CB spring not charged
7	MCB for CB motor supply tripped
8	MCB for signalling supply tripped
9	L/R/S selector switch - local
10	L/R/S selector switch - remote
11	L/R/S selector switch - supervisory
12	1 CB - open
13	1 CB - closed
14	1 CB – Rack out
15	1 CB in Transformer Earth Position
16	1 CB in Busbar Earth Position
17	Trip circuit healthy

Typical SCADA I/O – unmanned substation:

A typical RTU status point list for the 132 kV side of this substation would be as shown in Tables below. Alarms have been grouped in the RTU virtual database for onward transmission to the central master station on a 'need- to-know basis'.

Table 10: RTU to master station status for line breakers 101

RTU status point	Grouping Breaker Alarm Numbers	RTU to Master Station Description
R1	1, 2	Main Protection Operated
R2	3, 4	Back-up Protection Operated
R3	5	101 CB Fail Protection Operated
R4	6, 7, 8, 11, 12, 17, 18, 19, 20, 24	Main Protection Faulty
R5	10	Auto-reclose- out of service
R6	13	Intertrip sent
R7	14	Intertrip received
R8	15	101 CB Low Gas Pressure Alarm
R9	16, 21, 22	101 CB Faulty
R10	23	Disconnector Faulty
Position Indicators		
R11	25	System in synchronism
R12	26	Synchronising selector switch – off (blocking of CB close command)
R13	27	Synchronising selector switch – normal (synochro-check)
R14	28	Synchronising selector switch – manual override synchronising
R15	29	Synchronising selector switch – remote and SCADA system synchronising
R16	30	L/R/S switch - local
R17	31	L/R/S switch - remote
R18	32	L/R/S switch - supervisory
R19	33	101 CB - open
R20	34	101 CB - closed
R21	35	101Y CB disconnector - open
R22	36	101Y CB disconnector - closed
R23	37	1016 CB dis connector - open
R24	38	1016 CB disconnector - closed

Table 11: RTU to master station status for line breakers 201

RTU status point	Grouping Breaker Alarm Numbers	RTU to Master Station Description
R1	1, 2	Main Protection Operated
R2	3, 4	Back-up Protection Operated
R3	5	201 CB Fail Protection Operated
R4	6, 7, 8, 11, 12, 17, 18, 19, 20, 24	Main Protection Faulty
R5	10	Auto-reclose- out of service
R6	13	Intertrip sent
R7	14	Intertrip received
R8	15	201 CB Low Gas Pressure Alarm
R9	16, 21, 22	201 CB Faulty
R10	23	Disconnector Faulty
Position Indicators		
R11	25	System in synchronism
R12	26	Synchronising selector switch – off (blocking of CB close command)
R13	27	Synchronising selector switch – normal (synochro-check)
R14	28	Synchronising selector switch – manual override synchronising
R15	29	Synchronising selector switch – remote and SCADA system synchronising
R16	30	L/R/S switch - local
R17	31	L/R/S switch - remote
R18	32	L/R/S switch - supervisory
R19	33	201 CB - open
R20	34	201 CB - closed
R21	35	201Y CB disconnector - open
R22	36	201Y CB disconnector - closed
R23	37	2016 CB dis connector - open
R24	38	2016 CB disconnector - closed

Table 12: RTU to master station status for transformer breaker 601

RTU Status Point	Grouping Breaker Alarm nos	RTU to Master Description
R49	1, 6, 8, 10	Main Protection Operated
R50	2, 3, 4	Back-up Protection Operated
R51	7	Bucholtz Alarm
R52	9, 11, 17, 29, 32	Transformer Faulty
R53	20	601 CB fail protection – operated
R54	12, 13,15,28, 31,33,34,35, 37, 40	Tap Changer Faulty
R55	14	Tap Changer in Progress
R56	18, 19, 23, 24, 27	Protection Faulty
R57	22, 25	Circuit Breaker Faulty
R58	26	Disconnectors Faulty
R59	21	CB Low Gas Pressure Alarm
Position Indicators		
R60	42	L/R/S selector switch – local
R61	43	L/R/S selector switch – remote
R62	44	L/R/S selector switch – supervisory
R63	51	R/S selector switch for tap changer – remote
R64	52	R/S selector switch for tap changer – supervisory
R65	53	Tap changer – automatic
R66	54	Tap changer – manual
R67	55	Transformer – master
R68	56	Transformer – follower

R69	57	Transformer – independent
R70	45	601 CB-open
R71	46	601 CB-closed
R72	47	6016 disconnector- open
R73	48	6016 disconnector – closed
R74	49	601T disconnector – open
R75	50	601T disconnector – closed

Table 13: RTU to master station status for transformer breaker 801

RTU Status Point	Grouping Breaker Alarm nos	RTU to Master Description
R49	1, 6, 8, 10	Main Protection Operated
R50	2, 3, 4	Back-up Protection Operated
R51	7	Bucholtz Alarm
R52	9, 11, 17, 29, 32	Transformer Faulty
R53	20	601 CB fail protection – operated
R54	12, 13, 15, 28, 31, 33, 34, 35, 37, 40	Tap Changer Faulty
R55	14	Tap Changer in Progress
R56	18, 19, 23, 24, 27	Protection Faulty
R57	22, 25	Circuit Breaker Faulty
R58	26	Disconnectors Faulty
R59	21	CB Low Gas Pressure Alarm
Position Indicators		
R60	42	L/R/S selector switch – local
R61	43	L/R/S selector switch – remote
R62	44	L/R/S selector switch – supervisory
R63	51	R/S selector switch for tap changer – remote
R64	52	R/S selector switch for tap changer – supervisory
R65	53	Tap changer – automatic
R66	54	Tap changer – manual
R67	55	Transformer – master
R68	56	Transformer – follower
R69	57	Transformer – independent
R70	45	801 CB-open
R71	46	801 CB-closed
R72	47	8018 disconnector- open
R73	48	8018 disconnector – closed
R74	49	801T disconnector – open
R75	50	801T disconnector – closed

Table 14: RTU to master station status for line breaker 120

RTU status point	Grouping Breaker Alarm nos	RTU to Master Description
R103	1	Bus Zone 1 Operated
R104	2	Bus Zone 2 Operated
R105	3, 10, 15, 18	Circuit Breaker Faulty
R106	8	CB Fail Protection Operated
R107	4,5,11,12,13,14,17	Protection Faulty

R108	6,7	Back-up Protection Operated
R109	9	CB Low Gas Pressure Alarm
R110	16	Disconnectors Faulty
Position Indicators		
R111	19	System in synchronisation
R112	20	Synch. Selector switch - off (blocking of CB close command)
R113	21	Synchronizing selector switch - normal (synchro- check)
R114	22	Synchronizing selector switch - manual override synchronizing
R115	23	Synch. selector switch – remote and SCADA system synchronizing
R116	24	L/R/S selector switch – local
R117	25	L/R/S selector switch – remote
R118	26	L/R/S selector switch – supervisory
R119	27	120 CB-open
R120	28	120 CB-close
R121	29	1206 disconnector – open
R122	30	1206 disconnector – close
R123	31	1208 disconnector – open
R124	32	1208 disconnector – close

Table 15: RTU to Master Station status for transformer breaker 602

Alarm No.	Description
1	O/C protection - operated
2	E/F protection - operated
3	Restricted E/F protection - operated
4	MCB for control and protection supply tripped
5	Trip circuit fault
6	602 CB spring not charged
7	MCB for CB motor supply tripped
8	MCB for signalling supply tripped
9	L/R/S selector switch - local
10	L/R/S selector switch - remote
11	L/R/S selector switch - supervisory
12	602 CB - open
13	602 CB - closed
14	602 CB – Rack out
15	602 CB in Transformer Earth Position
16	602 CB in Busbar Earth Position
17	Trip circuit healthy

Table 16: RTU to Master Station status for transformer breaker 802

Alarm No.	Description
1	O/C protection - operated
2	E/F protection - operated
3	Restricted E/F protection - operated
4	MCB for control and protection supply tripped
5	Trip circuit fault
6	802 CB spring not charged
7	MCB for CB motor supply tripped
8	MCB for signalling supply tripped
9	L/R/S selector switch - local
10	L/R/S selector switch - remote
11	L/R/S selector switch - supervisory
12	802 CB - open
13	802 CB - closed
14	802 CB – Rack out
15	802 CB in Transformer Earth Position
16	802 CB in Busbar Earth Position
17	Trip circuit healthy

Table 17: RTU to Master Station status for bus section breaker 220

Alarm No.	Description
1	Busbar differential protection – zone 1 - operated
2	Busbar differential protection – zone 2 - operated
3	Under frequency protection, 1 step - operated
4	Under frequency protection, 2 step - operated
5	Under frequency protection, 3 step - operated
6	Under frequency protection, 4 step - operated
7	Busbar differential protection – DC supply fail
8	Under frequency protection – DC supply fail
9	Under frequency protection – VT circuit fail
10	Busbar protection – CT circuit open
11	O/C protection - operated
12	E/F protection - operated
13	MCB for control and protection supply tripped
14	Trip circuit fault
15	220 CB spring not charged
16	MCB for CB motor supply tripped
17	MCB for signalling supply tripped
18	L/R/S selector switch - local
19	L/R/S selector switch - remote
20	L/R/S selector switch - supervisory
21	220 CB - open
22	220 CB - closed
23	220 CB – Rack out
24	220 CB – Busbar Earth Position Section 1
25	220 CB – Busbar Earth Position Section 2
26	Trip circuit healthy

Table 18: RTU to Master Station status for 11KV feeder breakers (1, 2, 3, 4, 5, 6, 7 and 8).

Alarm No.	Description
1	O/C protection - operated
2	E/F protection - operated

3	Sensitive E/F protection - operated
4	MCB for control and protection supply tripped
5	Trip circuit fault
6	7 CB spring not charged
7	MCB for CB motor supply tripped
8	MCB for signalling supply tripped
9	L/R/S selector switch - local
10	L/R/S selector switch - remote
11	L/R/S selector switch - supervisory
12	7 CB - open
13	7 CB - closed
14	7 CB – Rack out
15	7 CB in Transformer Earth Position
16	7 CB in Busbar Earth Position
17	Trip circuit healthy

Table19: RTU to Master Station status for 11KV RMU1 to RMU19

RTU status point	**Grouping Breaker Alarm No.**	**RTU to Master Station Description**
R164	1	Over current Protection Operated
R165	2, 3	Earth Fault Protection Operated
R166	4,5,8	Protection Faulty
R167	6,7	Circuit Breaker Faulty
Position Indicators		
R168	9	L/R/S selector switch - Local
R169	10	L/R/S selector switch -Remote
R170	11	L/R/S selector switch - Supervisory
R171	12	1 CB - Open
R172	13	1 CB - Closed
R173	14	1 CB – Rack Out
R174	15	1 CB in Transformer Earth Position
R175	16	1 CB in Busbar Earth Position

II. Conclusion:

SCADA stands for Supervisory Control and Data Acquisition. It helps industrials to control process remotely, monitor the real time data, interact directly with transmitter, control valves, motor through human interface technology and lastly to record data. Most of the SCADA system was installed for industrial automation. We present the simulation circuit flow, consumption and accumulation of electrical energy. Finally, problem to be solved with the help of the SCADA system is the identification of the mode in which the power is supplied to the system.

References

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Transformers Reference:

>Techdata of 11KV S11、S11-M series distribution transformer

rated capacity (kVA)	voltage group		connection meghod	impedance voltage	Loss		no-load current (%)	weight (kg)			(LxBxH) (mm) outine dimension			gauge vertica/ horizontal
	High-voltage	Low-voltage			no-load	load		omachine weight	oil weight	gross weight				
10	11 10.5 10 6.3 6	0.4 0.69	Yyno Dyn11	4	0.65	0.4	3.5	90	55	220	650	450	880	400/350
20					0.08	0.52	3	140	60	270	720	490	950	400/350
30					0.10	0.63/0.6	2.3	185	70	330	750	490	970	450/340
50					0.13	0.91/0.87	2	260	80	430	770	550	1030	450/380
63					0.15	1.09/1.04	1.9	260	85	440	800	600	1040	450/380
80					0.18	1.31/1.25	1.9	320	95	520	790	600	1070	450/430
100					0.20	1.58/1.5	1.8	355	100	570	830	640	1050	550/450
125					0.24	1.89/1.8	1.7	425	115	675	1070	700	1150	550/470
160					0.28	2.31/2.2	1.6	510	130	790	1120	700	1220	550/520
200					0.34	2.73/2.6	1.5	550	145	850	1080	690	1160	550/520
250					0.40	3.2/3.05	1.4	630	165	985	1160	740	1190	650/550
315					0.48	3.83/3.65	1.4	755	190	1155	1230	800	1240	650/550
400					0.57	4.52/4.3	1.3	910	225	1405	1310	860	1250	650/550
500					0.68	5.41/5.15	1.2	1050	240	1600	1370	890	1350	750/600
630				4.5	0.81	6.2	1.1	1250	310	1945	1580	1060	1310	850/660
800					0.96	7.5	1	1540	365	2350	1640	1060	1500	850/660
1000					1.15	10.3	1	1690	405	2645	1720	1060	1540	850/660
1250					1.36	12	0.9	1965	560	3230	1790	1190	1740	850/660
1600					1.64	14.5	0.8	2355	650	3805	1830	1210	1850	850/700
2000					1.96	19.8	0.8	2570	615	4245	2190	1900	1950	820/820
2500					2.31	23	0.7	3130	810	5280	2180	1940	2250	1070/1070

Nonte:tapping range of high-voltage:±5%, ±2x2.5%; frequency:50Hz

Quick Details

Place of Origin:	Zhejiang China (Mainland)	Brand Name:	YUANGUANG	Model Number:	S11-M-10kV
Usage:	Power	Phase:	Three	Coil Structure:	Toroidal
Coil Number:	Autotransformer	Losses:	Low losses	Power transformer:	Distribution transformer
Standards:	IEC,GB,ANSI	Iron core:	Silicon sheet	Windings material:	Copper
Connection Symbol:	Dyn11 Yyn0	Rated power range:	30-2000kVA	High voltage range:	6-11kV
Cooling type:	ONAN	Tap changer:	NLTC		

Cables Reference:

BS 6622
IEC 60502-2
REFERENCE GC-11-1-A

TABLE 6B1 SINGLE-CORE 11kV ARMOURED CABLES (COPPER CONDUCTOR)

Nominal Area of Conductors	Thickness of Insulation	Thickness of Extruded Bedding	Nominal armour wire diameter	Thickness of Outer Sheath	Overall Diameter	Approx. Weight	Electrical Characteristics					
							Current Rating		Conductor Resistance		Reactance at 50Hz	Capacitance
							In Air at 40°C	In Ground at 25°C	dc at 20°C	50Hz at 90°C		
sq. mm	mm	mm	mm	mm	mm	kg/km	amp	amp	Ω/km	Ω/km	Ω/km	μF/km
50	3.4	1.2	1.6	1.8	31.7	1600	217	198	0.387	0.493	0.126	0.27
70	3.4	1.2	1.6	1.9	33.3	1870	242	243	0.268	0.342	0.119	0.31
95	3.4	1.2	1.6	1.9	35.1	2210	306	288	0.193	0.247	0.112	0.34
120	3.4	1.2	1.6	2.0	36.6	2510	353	324	0.153	0.196	0.108	0.37
150	3.4	1.2	2.0	2.1	38.8	2950	400	369	0.124	0.159	0.106	0.40
185	3.4	1.2	2.0	2.1	40.5	3370	459	414	0.0991	0.128	0.103	0.44
240	3.4	1.2	2.0	2.2	42.8	4030	544	477	0.0754	0.0980	0.099	0.49
300	3.4	1.2	2.0	2.2	45.2	4720	629	540	0.0601	0.0790	0.096	0.54
400	3.4	1.2	2.0	2.4	47.9	5630	714	612	0.0470	0.0633	0.093	0.59
500	3.4	1.3	2.5	2.5	52.0	6990	799	675	0.0366	0.0511	0.090	0.66
630	3.4	1.4	2.5	2.6	55.6	8520	944	752	0.0283	0.0416	0.087	0.74