

Scientific and Technical Center of Unified Power System



European User's Group Meeting
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Relay and Automation Testing with IEC 61850- 9-2 LE (by the example of generator- transformer unit of Nizhny Novgorod HPP)

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Introduction

In December 2013, JSC "RusHydro" began a pilot installation of optical current and voltage transformers. The project envisages installation of relay protection and automation devices with IEC 61850-9-2LE standard support.

JSC "RusHydro" entrusted STC UPS to perform bench tests of relay protection and automation terminals using the RTDS.

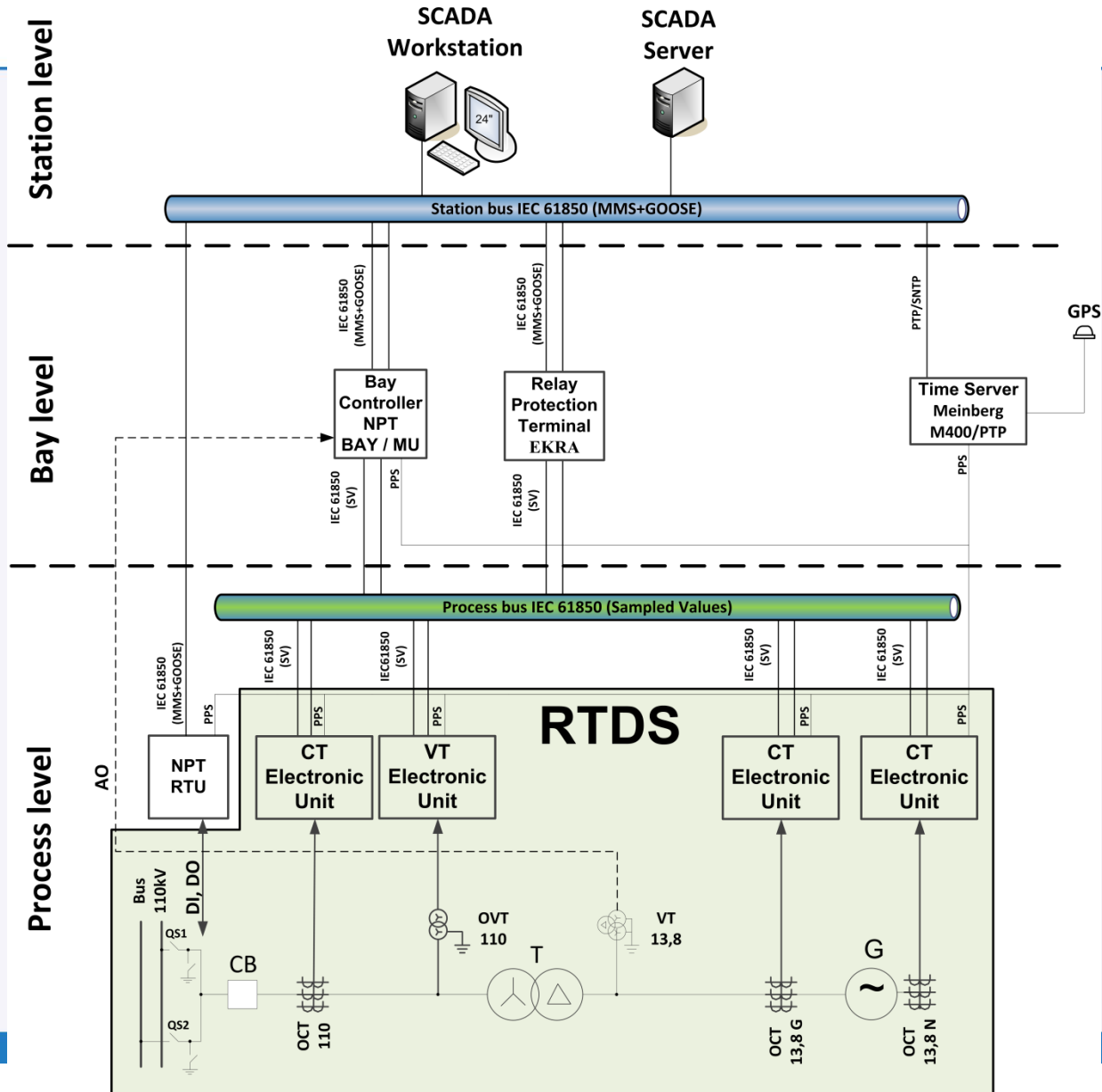


Equipment

Our test bench contains the following equipment:

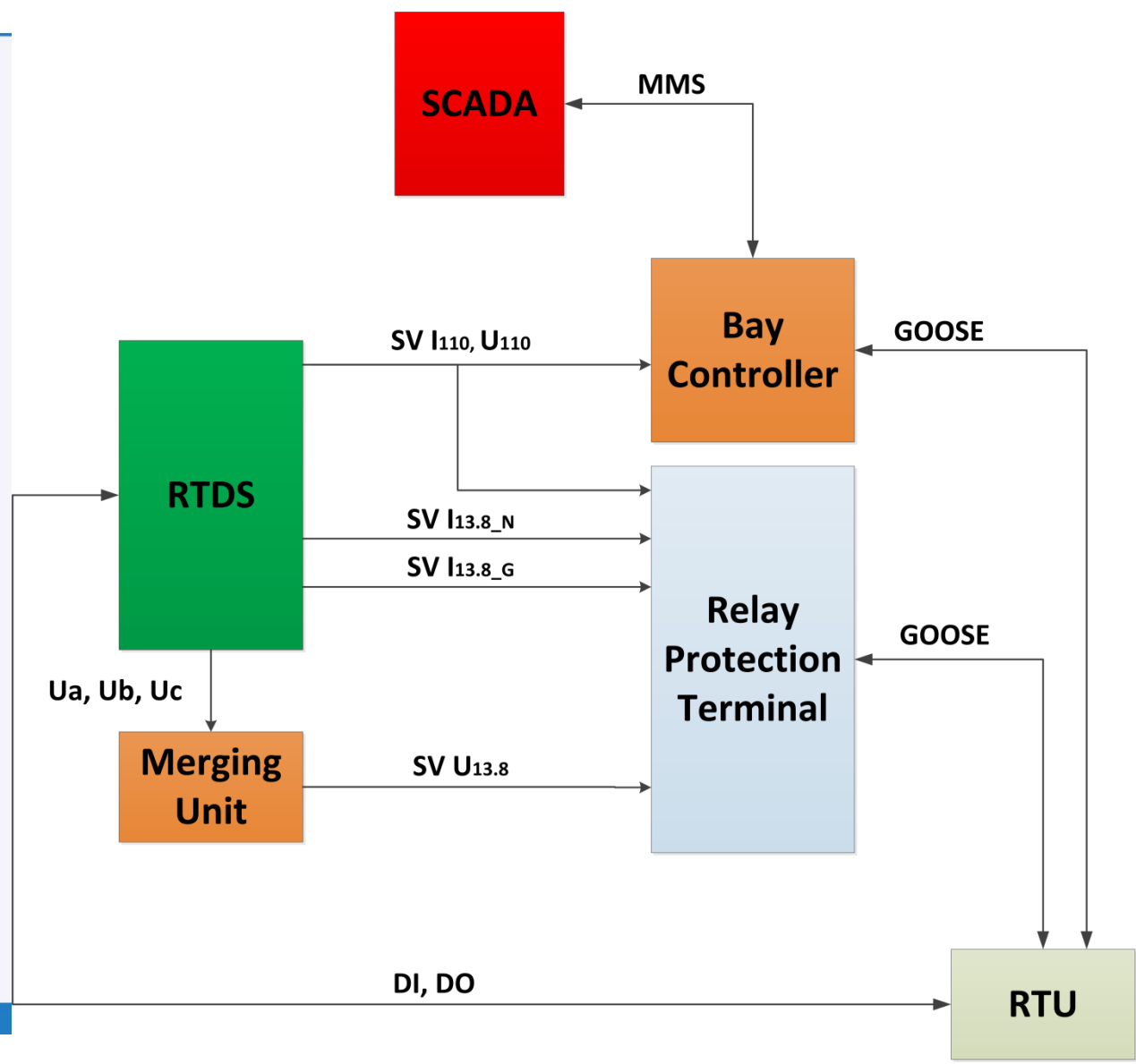
- ✓ RTDS
- ✓ RTU
- ✓ Bay Controller + Merging Unit
- ✓ Relay Protection Terminal
- ✓ Time Server
- ✓ SCADA Server and Workstation
- ✓ Industrial Ethernet Switch

Structure of generator-transformer unit's ACS



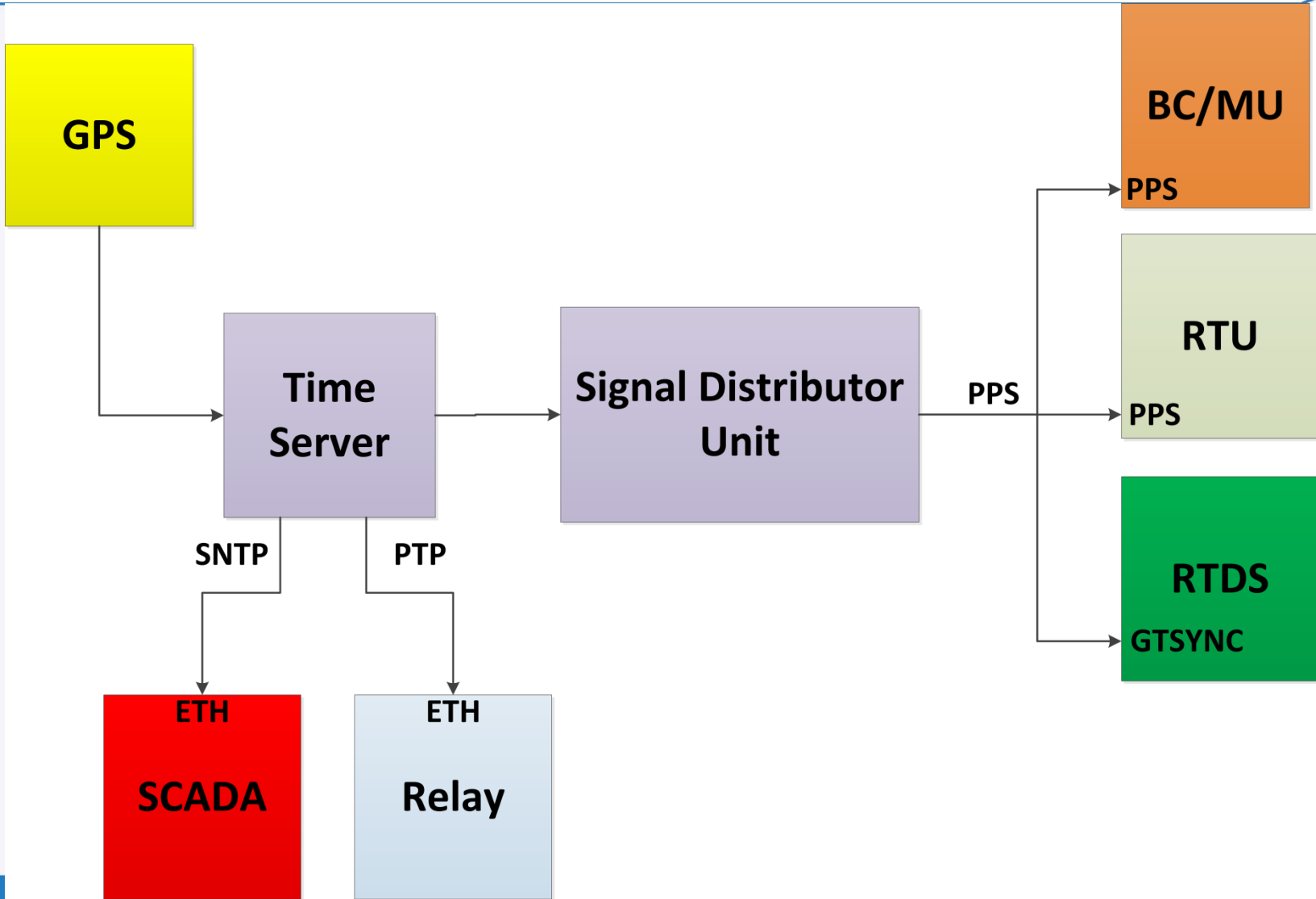


Communication structure

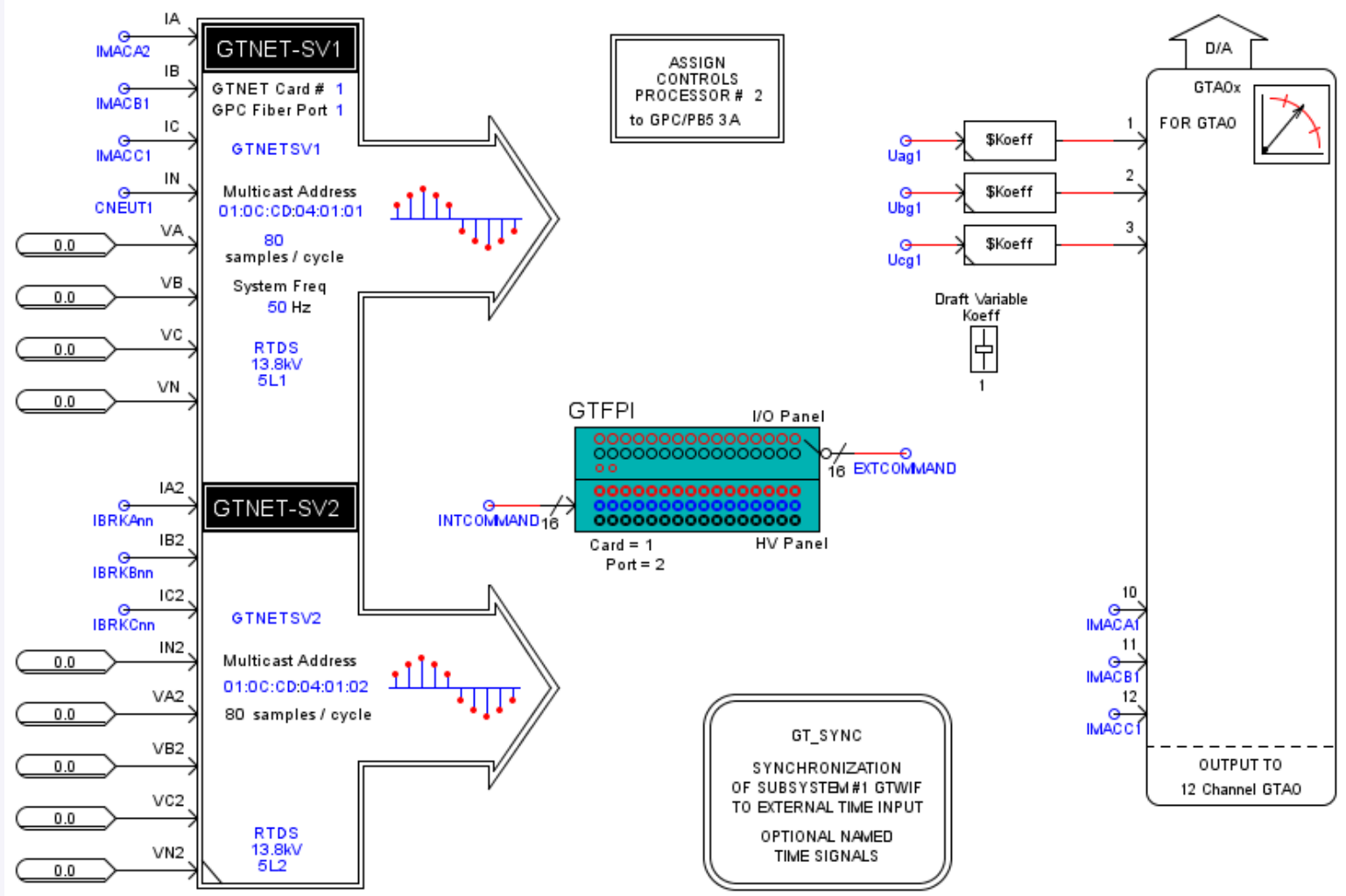




Time synchronization structure



IO configuration





SV configuration

_rtds_ctl_GTNET_SV9-2_V5.def

SV-2 OUTPUT CHANNEL QUALITY ENABLES

SV-1 OUTPUT CHANNEL QUALITY ENABLES CONFIGURATION SV-2 OUTPUT IEC 61850 CONFIG

CHANNEL SCALING SV-1 OUTPUT IEC 61850 CONFIG

| Name | Description | Value | Unit | Min | Max |
|---------|--|----------|------|-----|---------|
| APPID | APPID (hex) | 4000 | | | |
| VLANPRI | VLAN priority | 4 | | 0 | 7 |
| VLANID | VLAN ID (hex) | 001 | | | |
| LDpre | LDName prefix (4-7 characters) | PTechN | | | |
| LDprei | LDName prefix (0-11 characters,blank is *) | * | | | |
| LDpreii | LDName prefix (0-10 characters,blank is *) | * | | | |
| LDsuf | LDName suffix (eg. 00) | 13 | | 00 | 99 |
| MACH | Output multicast address (eg. 01:0C:CD) | 01:0C:CD | | | |
| MACL | Output Multicast address (eg. 04:01:02) | 04:01:01 | | | |
| INCRT | Include refresh time field in message | FALSE | | 0 | 0 |
| INCSSF | Include sample sync field in message | TRUE | | | |
| INCSR | Include sample rate field in message | FALSE | | 0 | 0 |
| CONFREV | ConfRev (hex) | 0 | | 0 | FFFFFFF |
| sName | Substation Name | RTDS | | | |
| sLevel | Voltage Level | 13.8kV | | | |
| sBay | Bay | 5L1 | | | |
| VDLY | Delay voltage inputs by 1 timestep | NO | | | |

Update Cancel Cancel All

2_V5.def

SV-2 OUTPUT IEC 61850 CONFIG

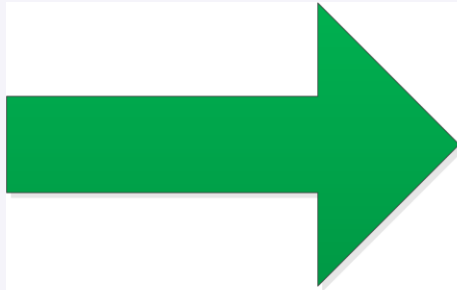
SV-1 OUTPUT IEC 61850 CONFIG

| Value | Unit | Min | Max |
|----------|------|-----|---------|
| 4000 | | | |
| 4 | | 0 | 7 |
| 001 | | | |
| PTechG | | | |
| * | | | |
| * | | | |
| 13 | | 00 | 99 |
| 01:0C:CD | | | |
| 04:01:02 | | | |
| FALSE | | 0 | 0 |
| TRUE | | | |
| FALSE | | 0 | 0 |
| 1 | | 1 | FFFFFFF |
| RTDS | | | |
| 13.8kV | | | |
| 5L2 | | | |
| NO | | | |

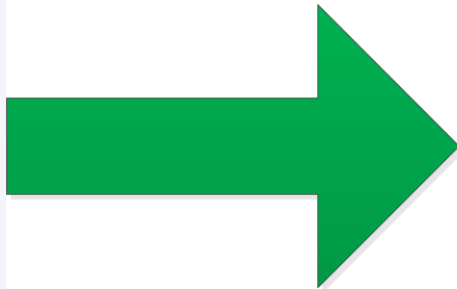
Update Cancel Cancel All



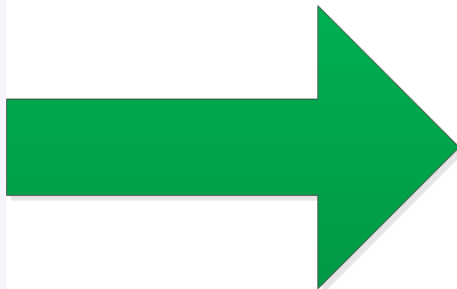
Types of tests



SCADA functional testing



Relay Protection functional testing



Testing in increased data traffic mode



SCADA function testing

SCADA test contains the following items:

- ✓ Getting and processing current information
- ✓ Automated control
- ✓ Switches interlocking

SCADA function testing



SCADA «ЦПП 220 кВ»

Проект Управление Конструкторы Инструменты Пароли Вид Окна Справка

10 мин. НИРТ SCADA Техсредства ОРУ-220кВ

Журнал Трвог

11:13:50.106 11.09.2013 <PC2> SA330N-Неиспр.кан.св.

| Событие | Время/Дата | Расположение |
|-------------------------------------|-------------------------|--|
| SA330N-Неиспр.кан.св. | 11:13:50.106 11.09.2... | Лаборатория АСУ ТП и связи к.207 Шкаф №2 АСУ ... |
| СК Ниссламаш-Кан.св. с сервером ош. | 11:13:12.527 11.09.2... | Лаборатория АСУ ТП и связи к.207 Шкаф №2 АСУ ... |

Журнал событий Интервал просмотра 10 мин

| Наименование сигналов | Статус события | Время/Дата | Источник |
|-----------------------------|----------------|-------------------------|-------------------|
| SA330N-р. блок 1 квл. 2 | Включено | 11:58:09:456 11.09.2013 | устройство |
| B Q1-W1E-откл. | Включено | 11:58:09:485 11.09.2013 | устройство |
| B Q1-W1E-вкл. | Отключено | 11:58:09:493 11.09.2013 | устройство |
| B Q1-W1E-сост. | Отключено | 11:58:09:493 11.09.2013 | Логический сигнал |
| ШП-1-W1E QS1-упр.разр.от БУ | Включено | 11:58:09:493 11.09.2013 | Логический сигнал |
| ШП-2-W1E QS2-упр.разр.от БУ | Включено | 11:58:09:493 11.09.2013 | Логический сигнал |
| ЛР-W1E QS3-упр.разр.от БУ | Включено | 11:58:09:493 11.09.2013 | Логический сигнал |
| B Q1-W1E-сост. | Отключено | 11:58:09:517 11.09.2013 | устройство |
| SA330N-Лог. сигнал 3 | Включено | 11:58:09:526 11.09.2013 | устройство |
| SA330N-Лог. сигнал 5 | Включено | 11:58:09:526 11.09.2013 | устройство |
| SA330N-Лог. сигнал 7 | Включено | 11:58:09:526 11.09.2013 | устройство |
| SA330N-КА3-разр.откл. | Включено | 11:58:09:526 11.09.2013 | устройство |
| ШП-1-W1E QS1-упр.разр.от КП | Включено | 11:58:09:526 11.09.2013 | устройство |
| SA330N-КА5-разр.откл. | Включено | 11:58:09:526 11.09.2013 | устройство |
| ШП-2-W1E QS2-упр.разр.от КП | Включено | 11:58:09:526 11.09.2013 | устройство |
| SA330N-КА7-разр.откл. | Включено | 11:58:09:526 11.09.2013 | устройство |

Ресурс коммутационных аппаратов

| Аппарат | Уровень 1 | Уровень 2 | Уровень 3 | Уровень 4 | Уровень 5 | Уровень 6 | Уровень 7 | Уровень 8 | Уровень 9 | Уровень 10 |
|---------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|------------|
| Q1 | 1000 | 500 | 0 | 35 | | | | | | |
| QKB1E | 1000 | 500 | 0 | 31 | | | | | | |
| QS1 | 1000 | 500 | 0 | 18 | | | | | | |
| QSG1 | 1000 | 500 | 0 | 6 | | | | | | |
| QS2 | 1000 | 500 | 0 | 19 | | | | | | |
| QSG2 | 1000 | 500 | 0 | 6 | | | | | | |
| QS3 | 1000 | 500 | 0 | 24 | | | | | | |
| QSG3.1 | 1000 | 500 | 0 | 6 | | | | | | |
| QSG3.2 | 1000 | 500 | 0 | 7 | | | | | | |
| QSG4 | 1000 | 500 | 0 | 11 | | | | | | |

Техсредства ОРУ 220кВ

11.09.2013 11:58:19

ВЛ 220кВ (W1E) ОВ-220кВ (QKB1E)

ОСШ-220

S 0,0 МВт
P 0,0 МВт
Q 0,0 Мвар
I 0,0 А
U 0,0 кВ

S 0,0 МВт
P 0,0 МВт
Q 0,0 Мвар
I 0,0 А
U 0,0 кВ

U 0,0 кВ
F 0,00 Гц

Q1 QKB1E

QSG2 QSG1 QSG2 QSG1

QS2 QS1 QS2 QS1

2СШ-220 1СШ-220

U 0,0 кВ
F 0,00 Гц

U 0,0 кВ
F 0,00 Гц

ИЗМ/Сигнализация ОМП РЗА Плакаты Графики/Веломость Квитирование

Аналоговая индикация

| Устройство | Значение | Масштаб |
|-----------------|----------|---------------|
| 1СШ-220-Ун ср. | 0 кВ | 0-300 |
| 1СШ-220-F | 0,000 Гц | 49,000-51,000 |
| 2СШ-220-Ун ср. | 0 кВ | 0-300 |
| 2СШ-220-F | 0,000 Гц | 49,000-51,000 |
| ОСШ-220-Ун ср. | 0 кВ | 0-300 |
| ОСШ-220-F | 0,000 Гц | 49,000-51,000 |
| ВЛ-220 кВ W1E-P | 0,0 МВт | 0,0-1000,0 |

Скада Версия 3.8.0.4941

Время сеанса 00:33 Тек.время: 11.9.2013 11:58:19 Администраторы



Relay protection function testing

Relay protection function test contains:

- ✓ Differential generator protection operability
- ✓ Differential transformer protection operability
- ✓ Field-failure protection operability
- ✓ Relay testing in a wide frequency range
- ✓ And so on...



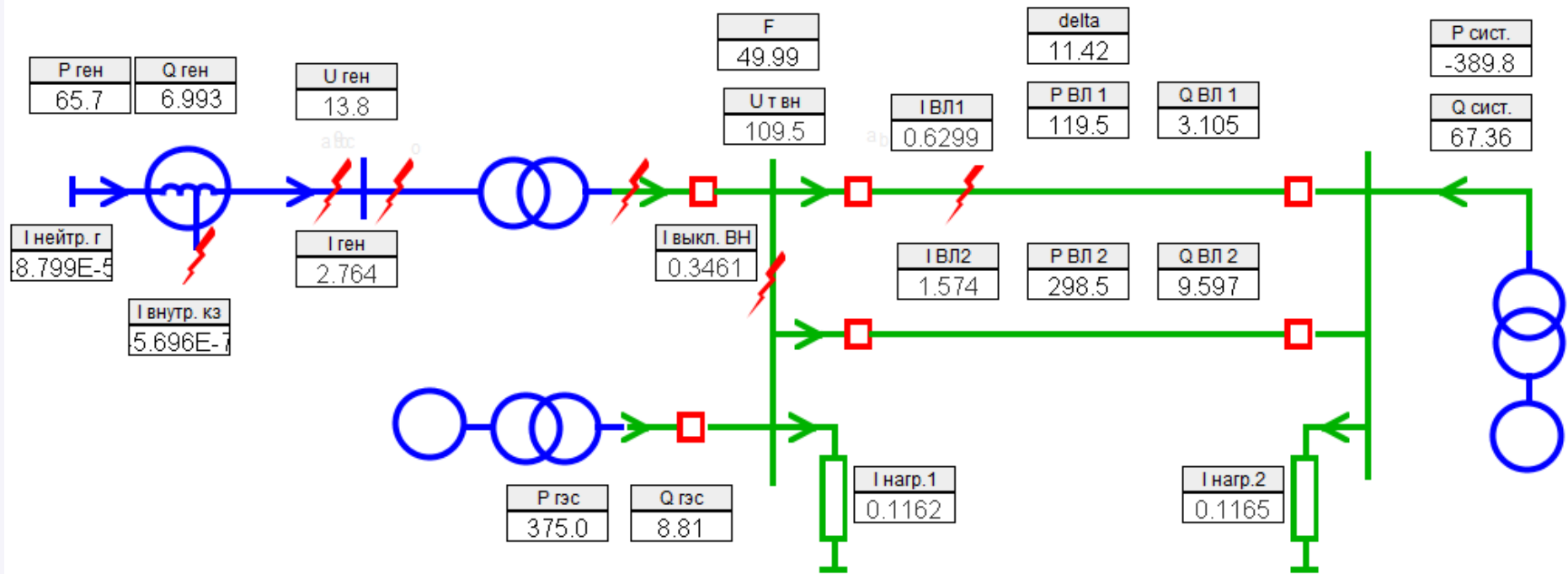
Relay protection function testing

Each of the tests contains the following steps:

- ✓ Normal system operation
- ✓ Short circuit or other faults emulation
- ✓ Relay protection operation

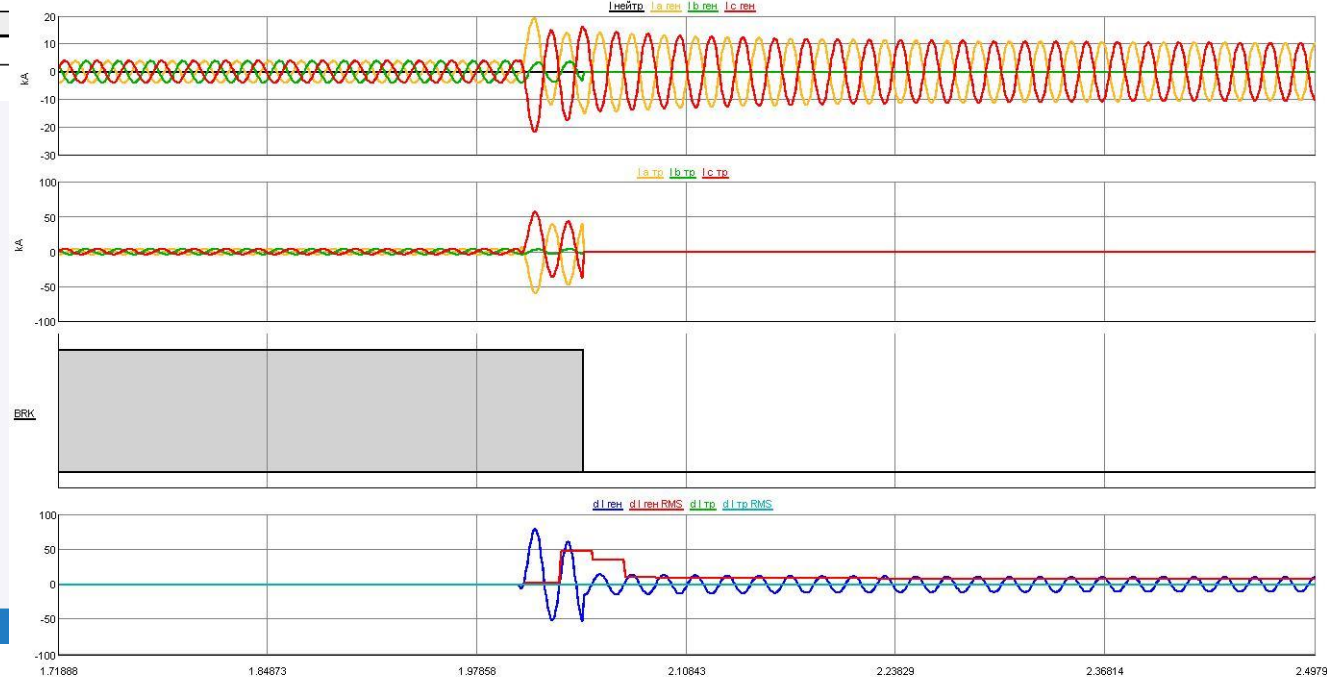
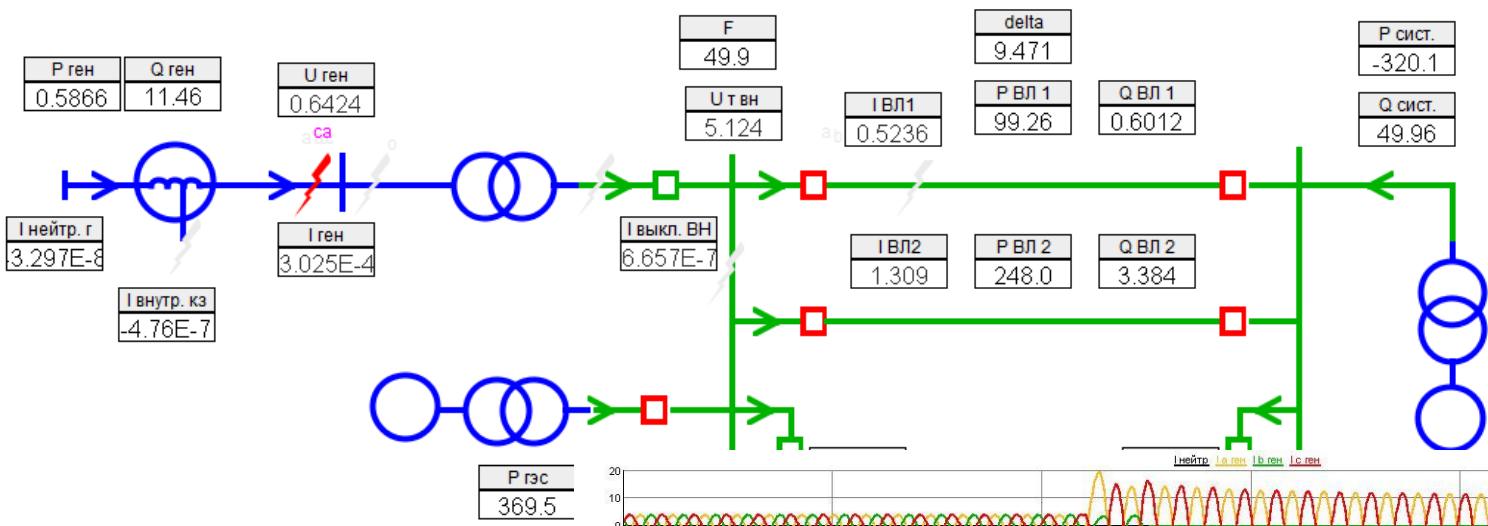


Short circuits





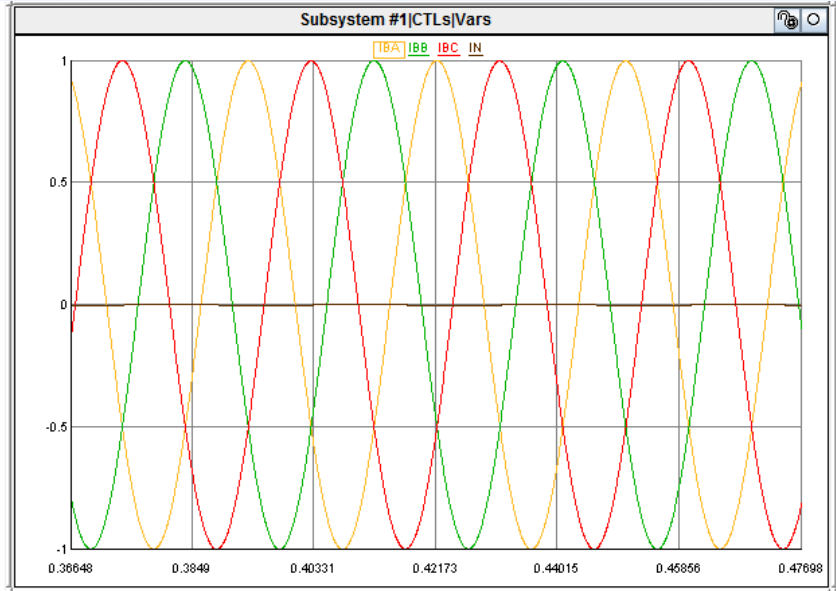
Differential generator protection operability





Relay testing in wide frequency range

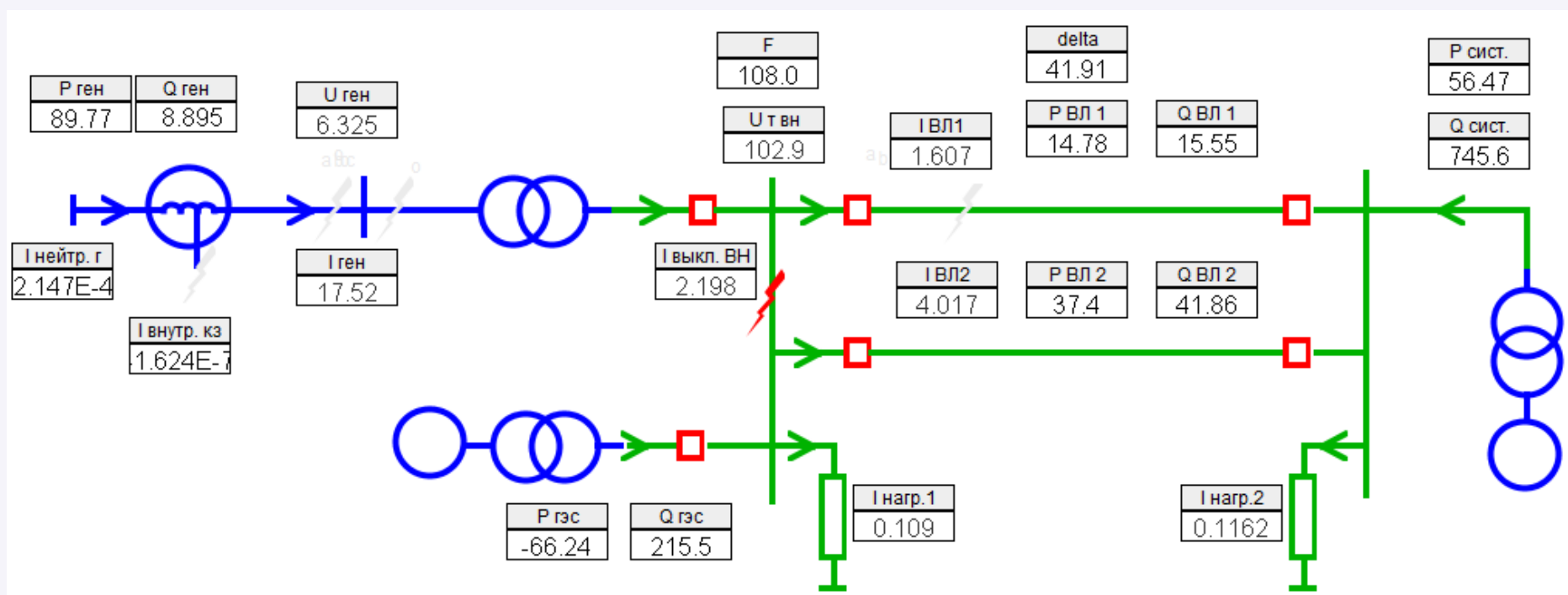
| | | |
|---|--|---|
| AMPL | FREQ | Phase |
| 100.0 80.0 60.0 40.0 20.0 0.0 volts | 100.0 80.0 60.0 40.0 20.0 0.0 Hz | 100.0 80.0 60.0 40.0 20.0 0.0 ° |
| IB A | IB B | IB C |
| 0.958 | -0.2306 | -0.7274 |
| IN | 2.533E-9 | |



| | |
|----------------|--|
| auto-scale | |
| Ir A | |
| auto-scale | |
| Ir B | |
| auto-scale | |
| Ir C | |
| auto-scale | |
| U<CK Cpa6. (t) | |
| U>G Cpa6. (t) | |
| IdTB Откл. A | |
| IdTB Откл. B | |
| IdTB Откл. C | |
| IdTB Откл. | |
| И TB Откл. | |



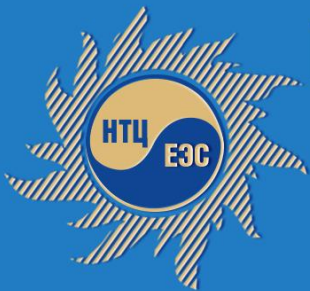
Testing in increased data traffic mode





Conclusions

- ✓ Tests are currently in progress
- ✓ We make regular reports and send them to manufactures of protection and automation equipment
- ✓ We send reports to JSC "RusHydro" in order to adjust our digital model
- ✓ Using the RTDS provides implementation of difficult complex tests



**Научно-технический центр
Единой энергетической
системы**



**Thank you for your
attention!**