



Gunnar Stranne

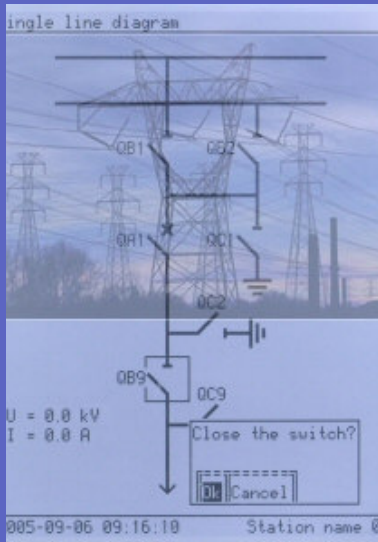


Selection and application of IEDs

Rio de Janeiro
April 23-25, 2006



Content of the Presentation



- Introduction
- Application solutions
- Remote signaling
- Tripping and lock-out arrangement
- Trip circuit supervision arrangement
- Testing of IED 670
- Voltage selection schemes
- Summary and conclusions

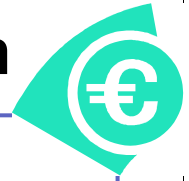


IED670 for cost efficient management of protection, control, measuring, monitoring and data communication

- Extensive protection library mapped to IEC61850 permits selection of desired functions
 - E.g. Differential and Distance protection functions
 - Standardized function library
 - Possibility of multi-instances of common functions
- Standardized function blocks for control, interlocking and measuring
- Flexible common hardware
- Flexible engineering software
 - Virtual I/O (saves hardware)
 - Logic (IEC1131-3 style)
- Alternative HMI
 - Small - text
 - Large - graphic
- Engineering tools
- Graphical programming
- Reporting and analysis
- Testing



Where are the economic benefits of IED 670 Integration



	Installation	Operation	Maintenance	Analysis
Complete functionality	?%	?%	?%	?%
Autonomous service	?%	?%	?%	?%
New functions e.g. interoperability	?%	?%	?%	?%
Communication	?%	?%	?%	?%

The benefits must be calculated for each application depending on the existing conditions and the possible improvements considering many influencing factors.



IED 670 A Major Leap in Grid Reliability!



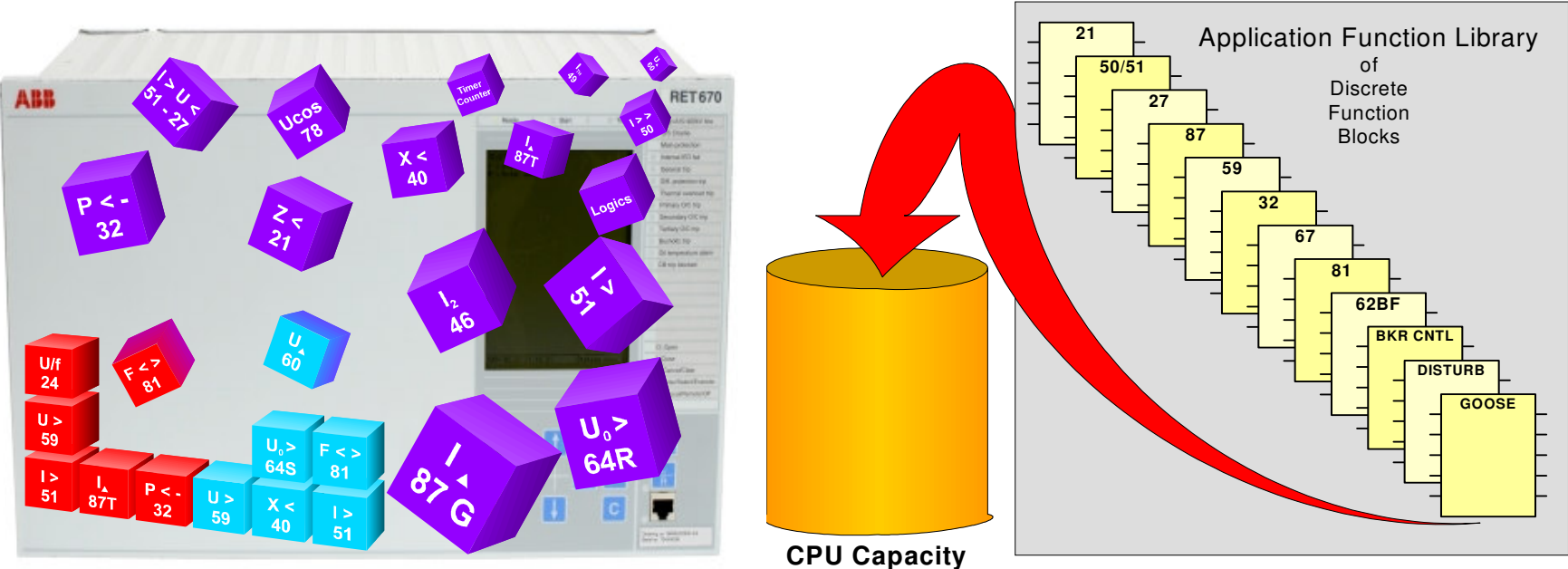
- Protection and control functions can now use the same hardware and the same basic software
- Flexible IED sizes depending on need for I/O and large or small local HMI
- Increased availability through functional integration, self-supervision and automatic reporting
- Possibility of integration all P&C IED's into a substation automation system with immediate access to all information



IED 670 A Major Leap in Grid Reliability! Further benefits!

- Fewer Components & Fewer Cables in a station also leads to Improved Availability
- Integration increases availability and decreases unavailability - provided (n-1) criteria and redundancy aspects are met!
- The available functionality of the IED 670 terminals is increased over the previous IED solutions!
- Reduced panel-space for equipment
- Automatic reporting and high speed communication and new functions reduces operating costs!

Application Function Library (AFL)

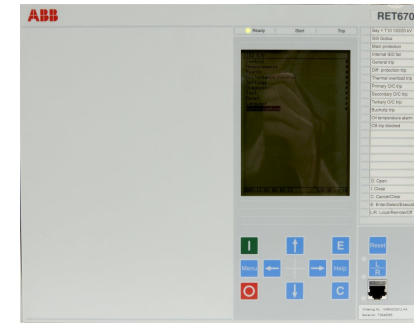


**Know one IED 670 product
and you can handle all!**



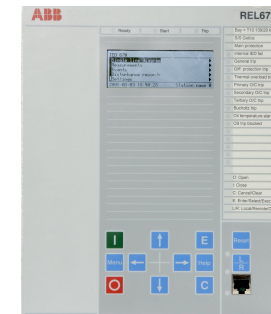
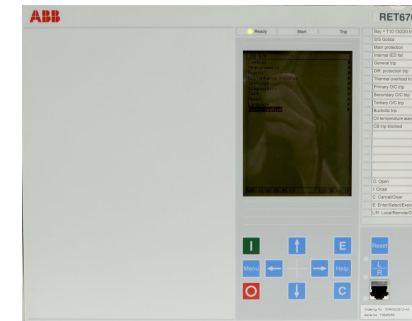
IED 670 and the Redundancy concept

- Redundancy is required when remote back-up cannot be achieved.
 - All faults must be cleared
 - Single failure criteria must be fulfilled
- Redundancy includes
 - Selection of relay and the measuring principle
 - Different manufacturer are often required when the same measuring principle is used
 - DC supply (batteries), CT core and CVT fuse (MCB)
 - Different supplies must be utilized for the two systems
 - Different measuring principles, simplicity to use and high availability & self supervision with trouble reporting functions permits use of IED 670 in both systems!
- Engineering and commissioning process
 - “Type” mistakes should not influence both systems



IED 670 Integration of functions

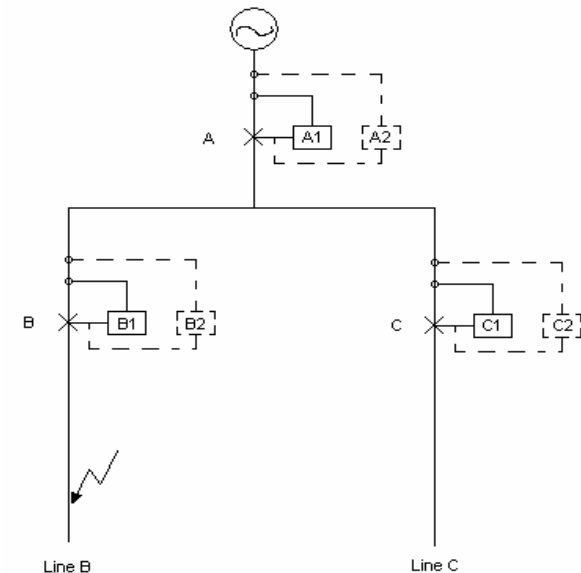
- The IED 670 concept allows a very high integration level of functions
 - **Our customers decide how far to go...**
 - Back-up & redundant functionalities must be ensured
- Integration levels involve
 - **Multiple objects** in the same IED (e.g. Double breaker or 1 1/2 breaker bays)
 - Line, breaker 1 and breaker 2 integrated.
 - **Several bays** in the same IED
 - Distribution feeders, Line/Transformer in H-arrangement etc.
 - **Integration of Protection, Control and Measuring**
 - Arrangements for testing
 - **Customer organization acceptance**



Unavailability improvements with numerical technology

- Results shown in DPSP paper 2001 for the 500 series products

Main result	Electromechanical / static		Numerical with self supervision	
	Single	Redun-dant	Single	Redun-dant
Dependability	98.4	99.5	99.4	99.4
Security	68.1	49.5	95.5	92.1
Unavailability of line C	0.02	0.03	0.01	0.02



- The unavailability improvement with numerical technology was shown to be about twice the earlier methods
- The security was much improved
- Dependability was not impaired



Availability and unavailability of IED 670

- The availability and unavailability is easy to calculate
- We assume 100 years MTTF based on fault statistics
- We assume 1 day MTTR based on availability of one spare IED unit

• For one unit :

Availability $A1 = \text{MTTF}/(\text{MTTF}+\text{MTTR})=$

Unavailability $U1 = 1- A1 = \text{MTTR}/(\text{MTTF}+\text{MTTR})$

$= 0,0000274$ (corresponds to 14 minutes per year)

Where **MTTF** (Mean Time To Failure) = 100 years and **MTTR** (Mean Time To Repair) = 1 day

• For a complete system with N units :

Availability $AN = (1-U1)^N$

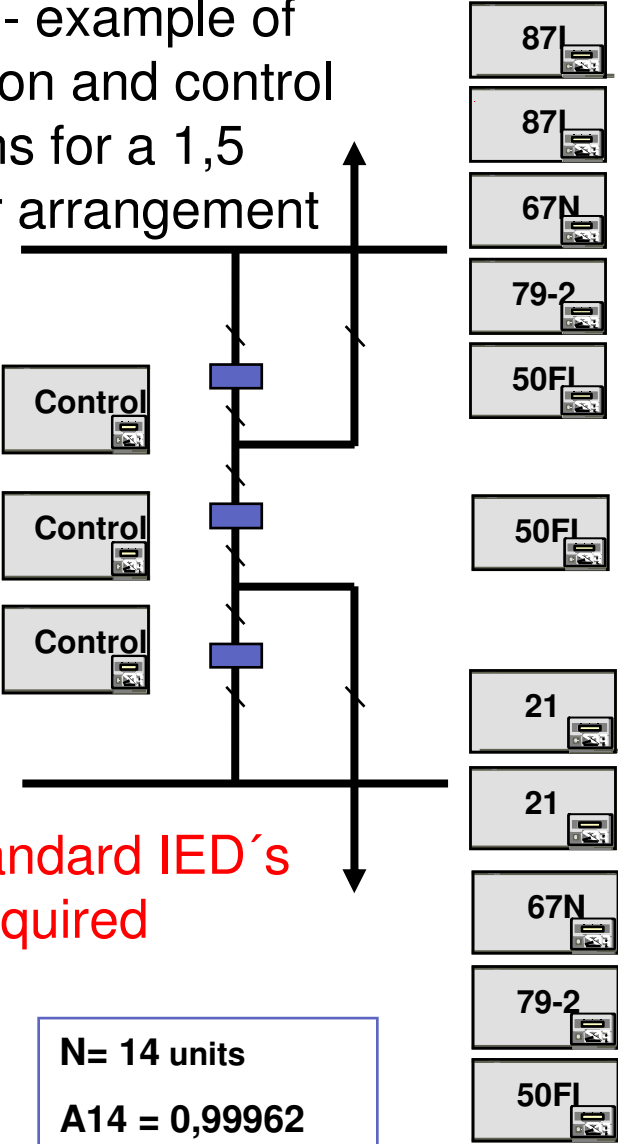
Unavailability $UN = 1- AN$

- The IED protection and control **function** Reliability, involves the Security and Dependability issues. These issues are handled in a separate presentation



Example of possible integration with IED 670 ...

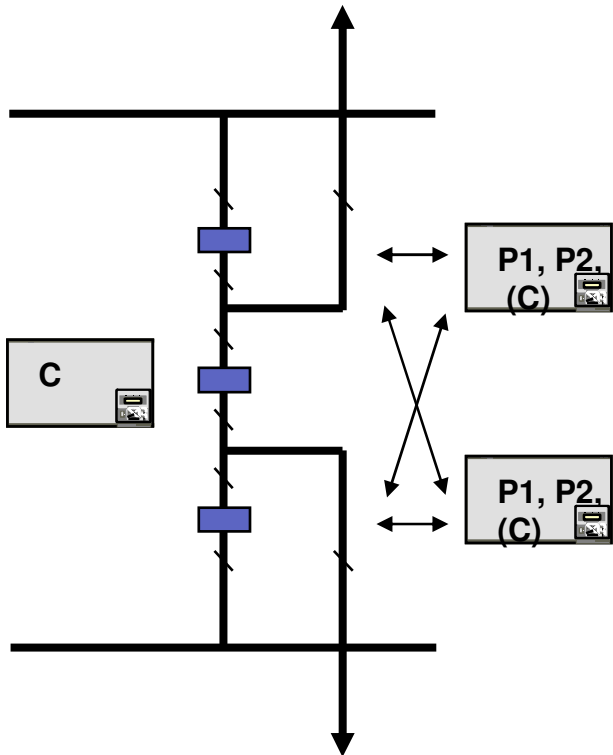
400 kV - example of protection and control functions for a 1,5 breaker arrangement



14 standard IED's are required

N= 14 units
 A14 = 0,99962
 U14 = 0,00038

Less components and less cabling = Higher availability



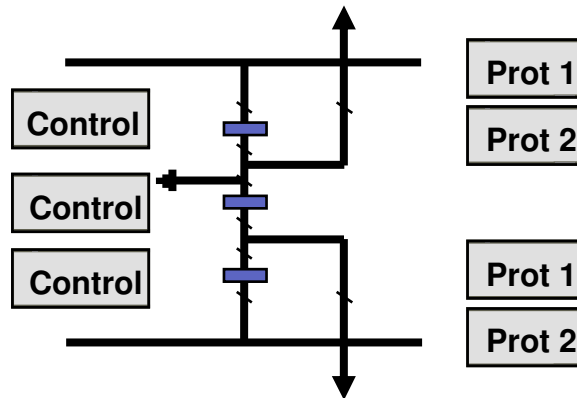
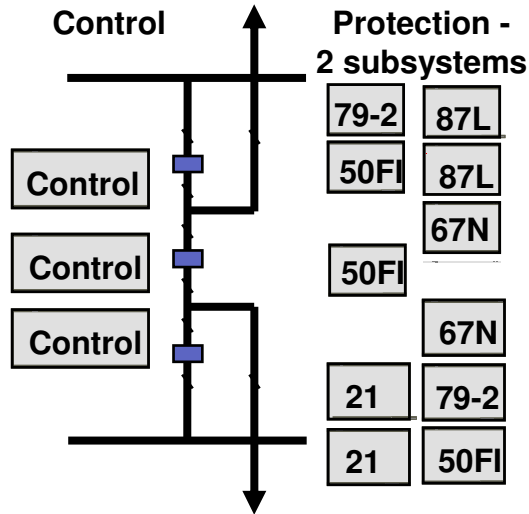
3 IED 670 can do the same job Today with higher availability!

N= 3 units
 A3 = 0,99991
 U3 = 0,00008

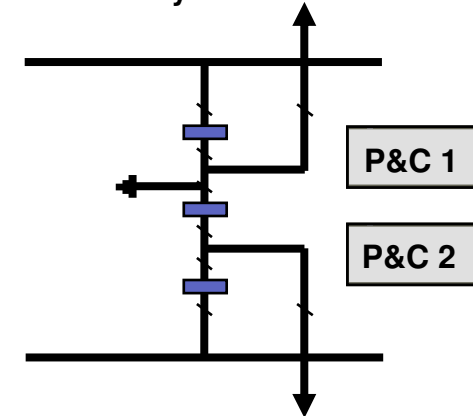


Integration increases availability and decreases unavailability

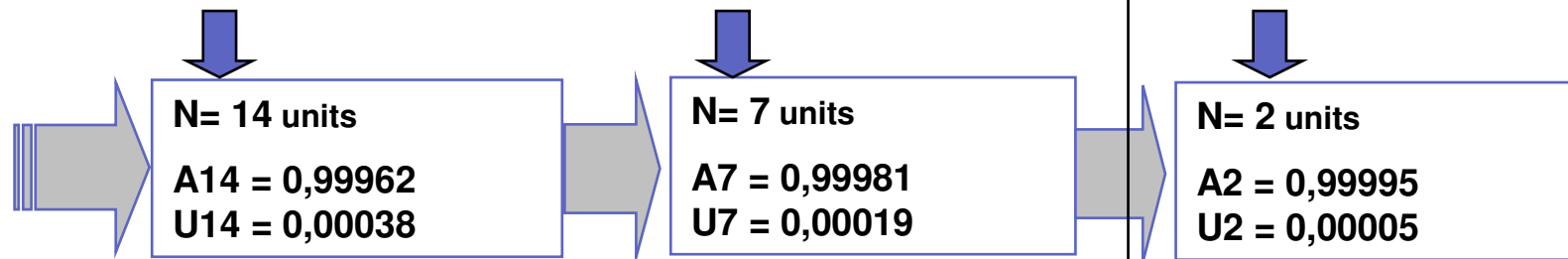
Conventional IED arrangements for Control & Protection



Possible with IED 670 2 subsystems for P&C



Less components and less cabling = Higher availability



Improvement of unavailability

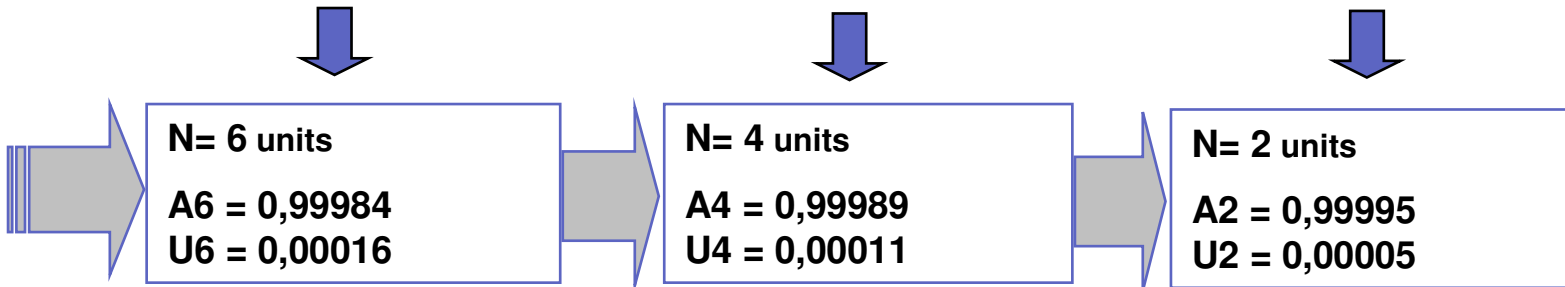
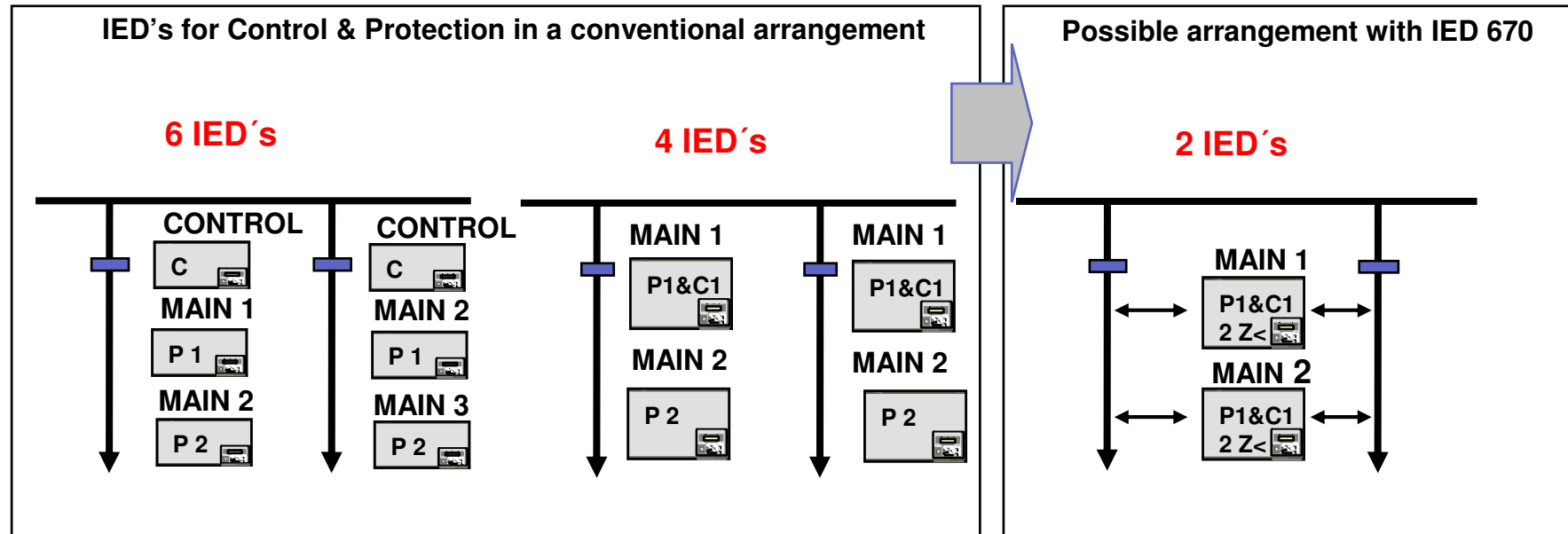
2 times

7,6 times



Fewer Component + Fewer Cables = Improved Availability !

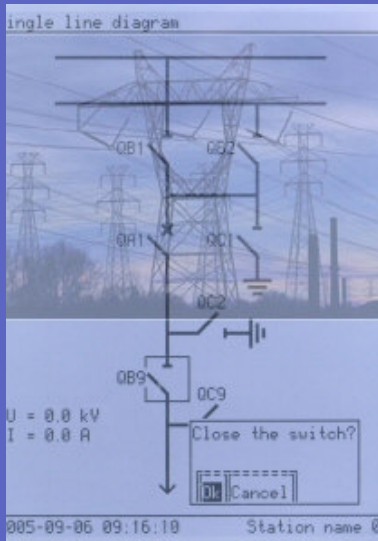
Examples for a double line



Improvement of unavailability **1,5 times** **3,2 times**

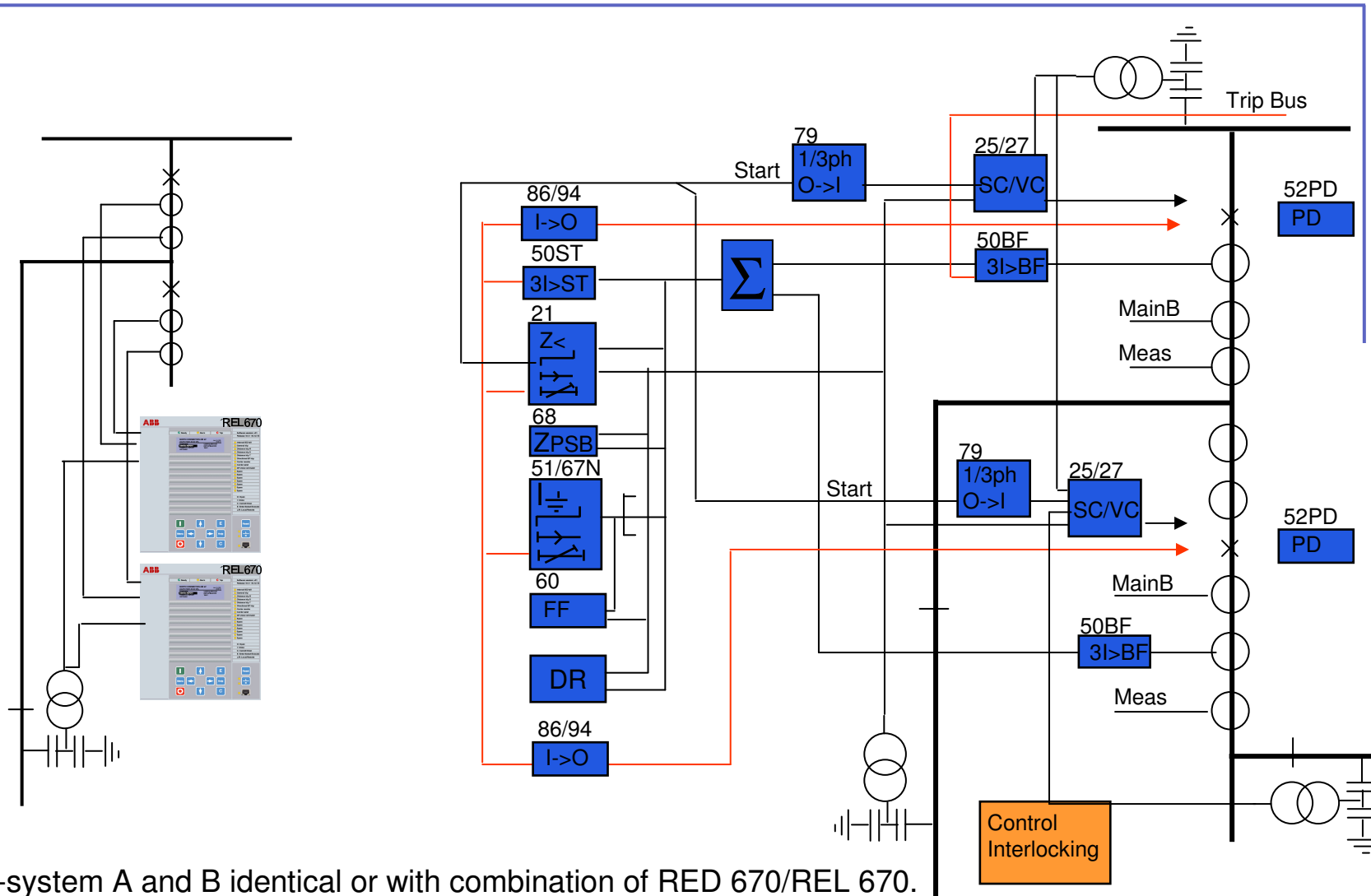


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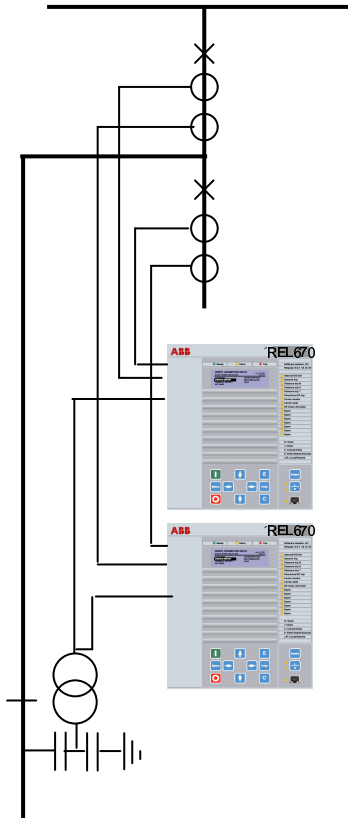
REL 670 Multi-Breaker application



Sub-system A and B identical or with combination of RED 670/REL 670.
 Measuring can utilize separate inputs to achieve higher accuracy
 Ordering code: REL670xx-B32-X00-F01H07-A-A-B-A-A6X0-DA-X-XD
 1ph trip, 1A, 110-125V DC

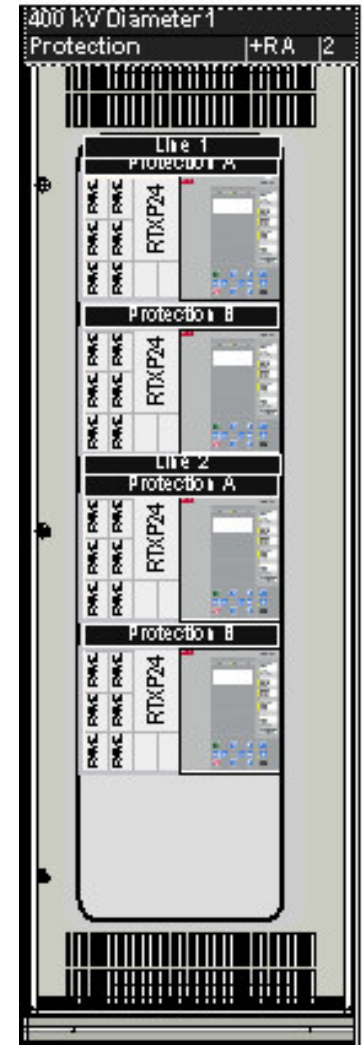


REL 670 Multi-Breaker application



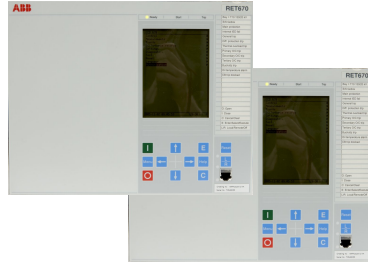
Efficient panel
engineering and
construction!

Space saving design!

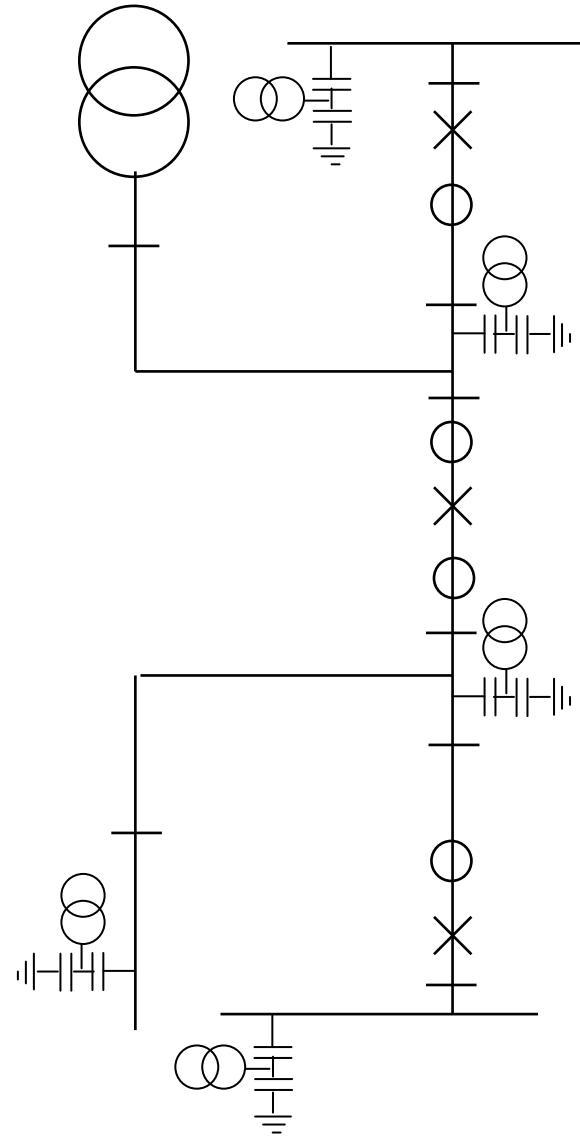
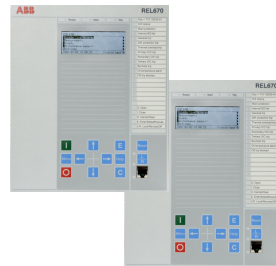


REL 670 Multi-Breaker application

RET 670 with
Transformer
protection with 2*BFP
and with Control
2*9I+3U
2-BIM+1-BOM

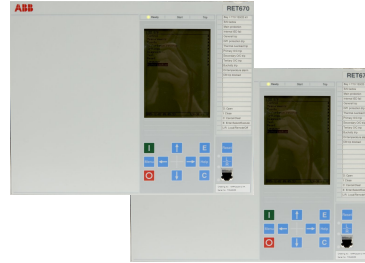


RED/L 670 with
Line protection
with 2*AR,SC,BPF
and with Control
1*6I+6U
2-BIM+1-BOM

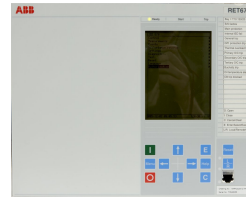


REL 670 Multi-Breaker application

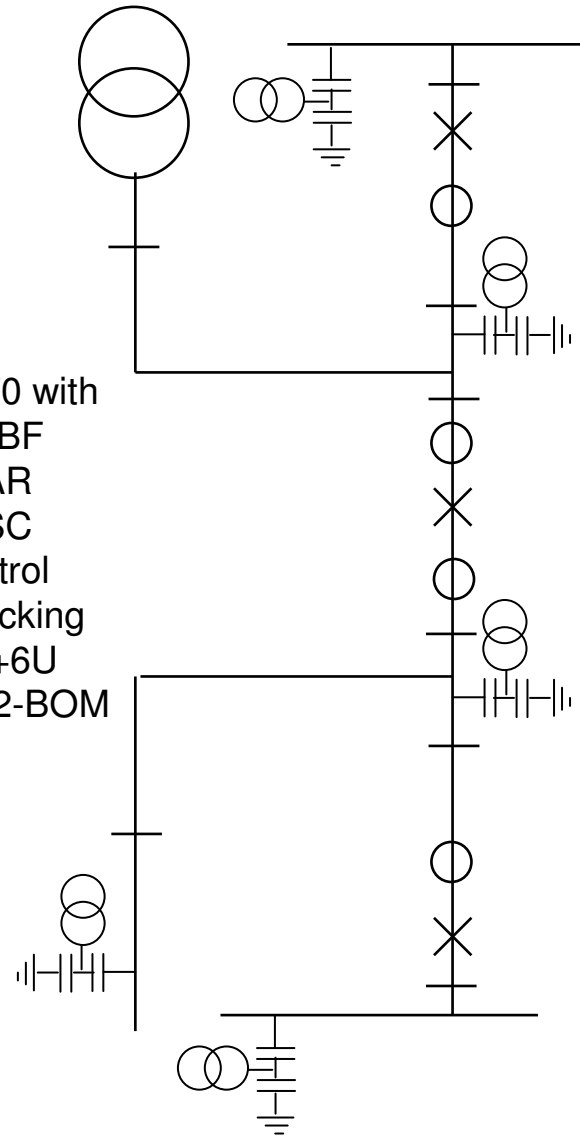
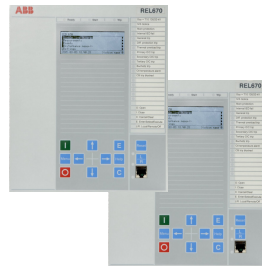
RET 670 with
Transformer
protection
2*9I+3U
2-BIM+1-BOM



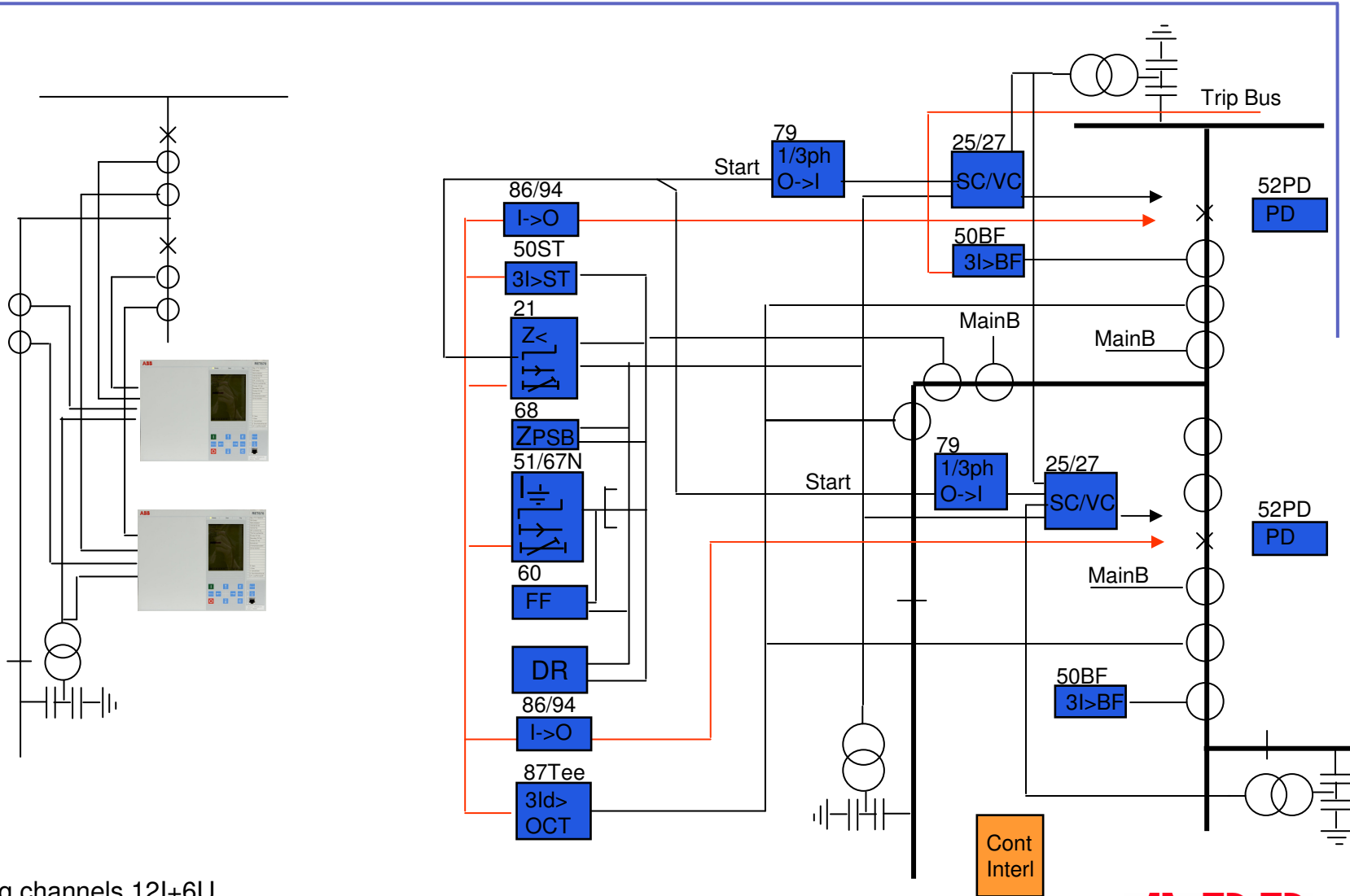
REC670 with
3-CBF
2-AR
3-SC
Control
Interlocking
2*6I+6U
3-BIM+2-BOM



RED/L 670 with
Line protection
1*6I+6U
1-BIM+1-BOM



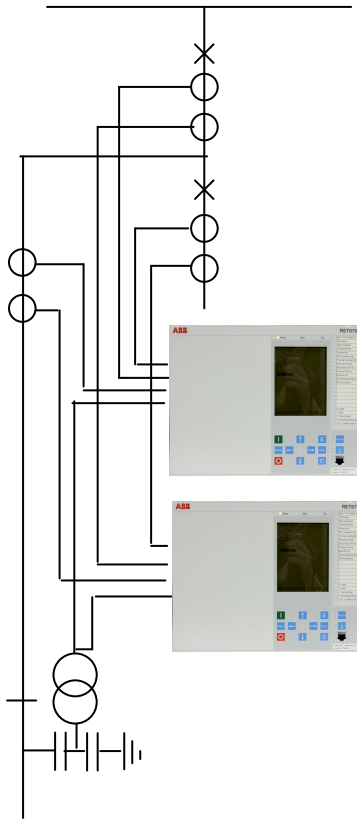
REL 670 Multi-Breaker application w. Tee



Analog channels 12I+6U
 Ordering code: REL670xx-B32-X00-A02F01H07-A-A-B-A-A6A6-DA-X-XD
 1ph trip, 1A, 110-125V DC

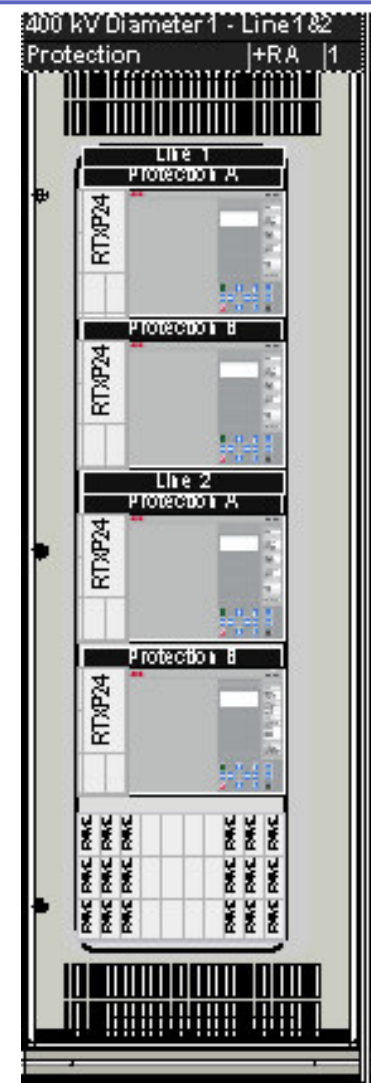


REL 670 Multi-Breaker application w. Tee

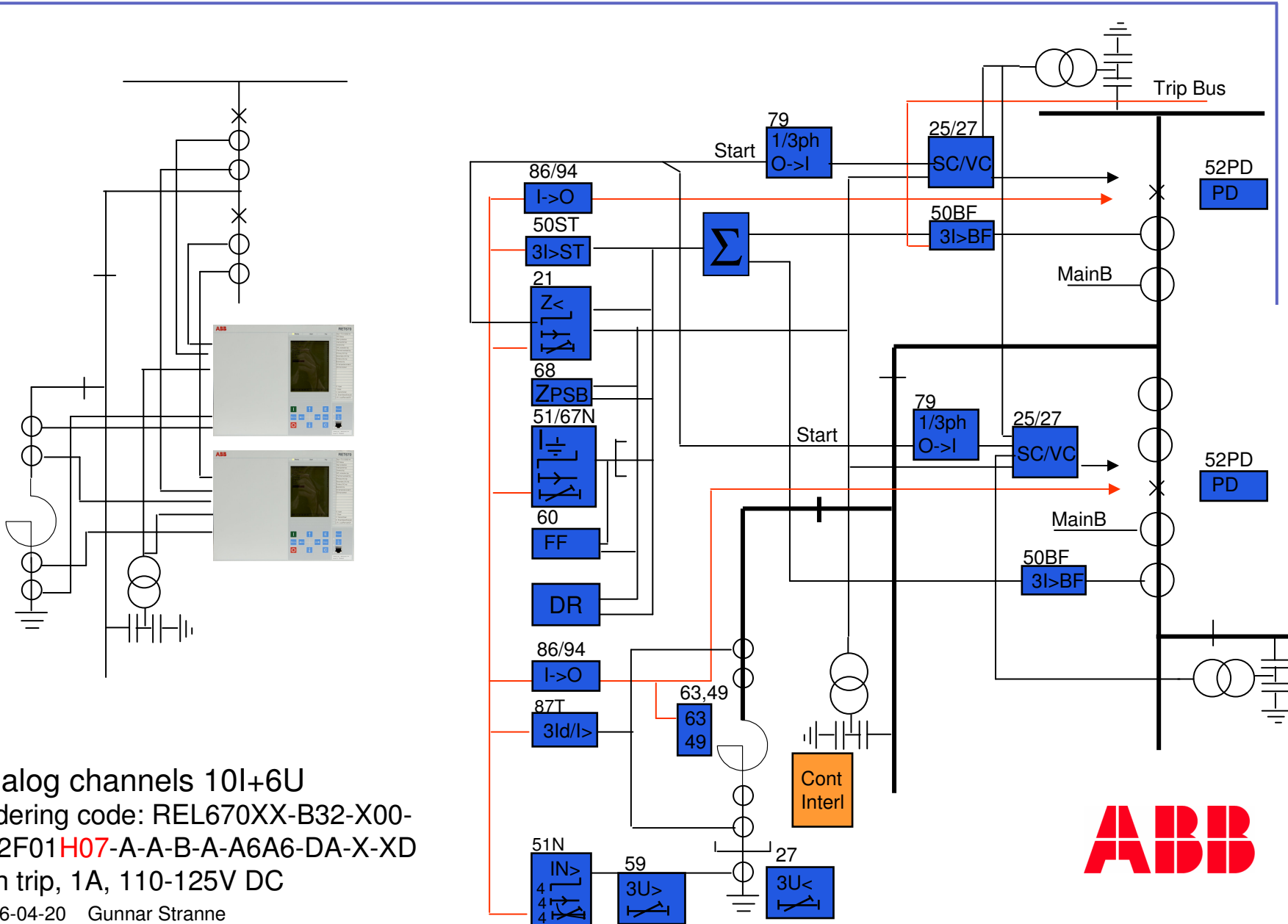


Efficient panel
engineering and
construction!

Space saving design!



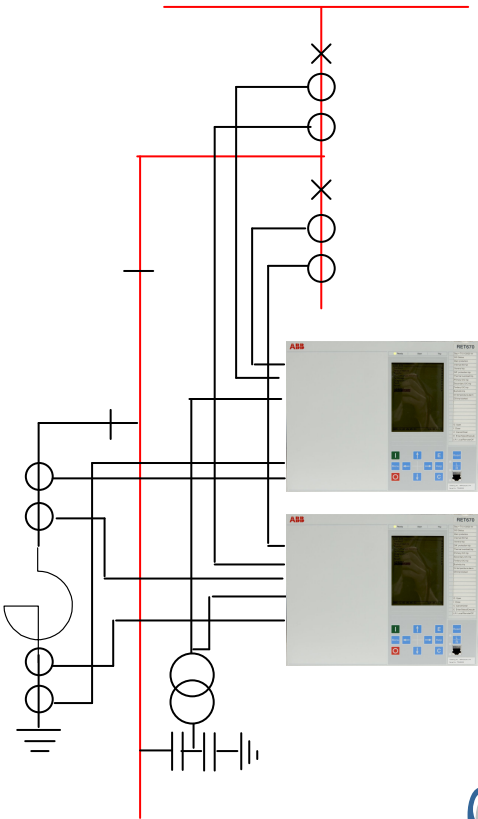
REL 670 Multi-Breaker w Reactor application



Analog channels 10I+6U
 Ordering code: REL670XX-B32-X00-
 A02F01H07-A-A-B-A-A6A6-DA-X-XD
 1ph trip, 1A, 110-125V DC
 2006-04-20 Gunnar Stranne

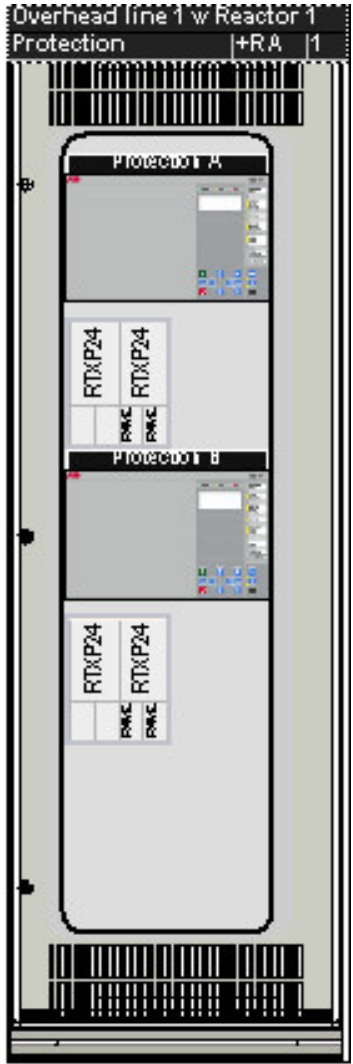


REL 670 Multi-Breaker w Reactor application



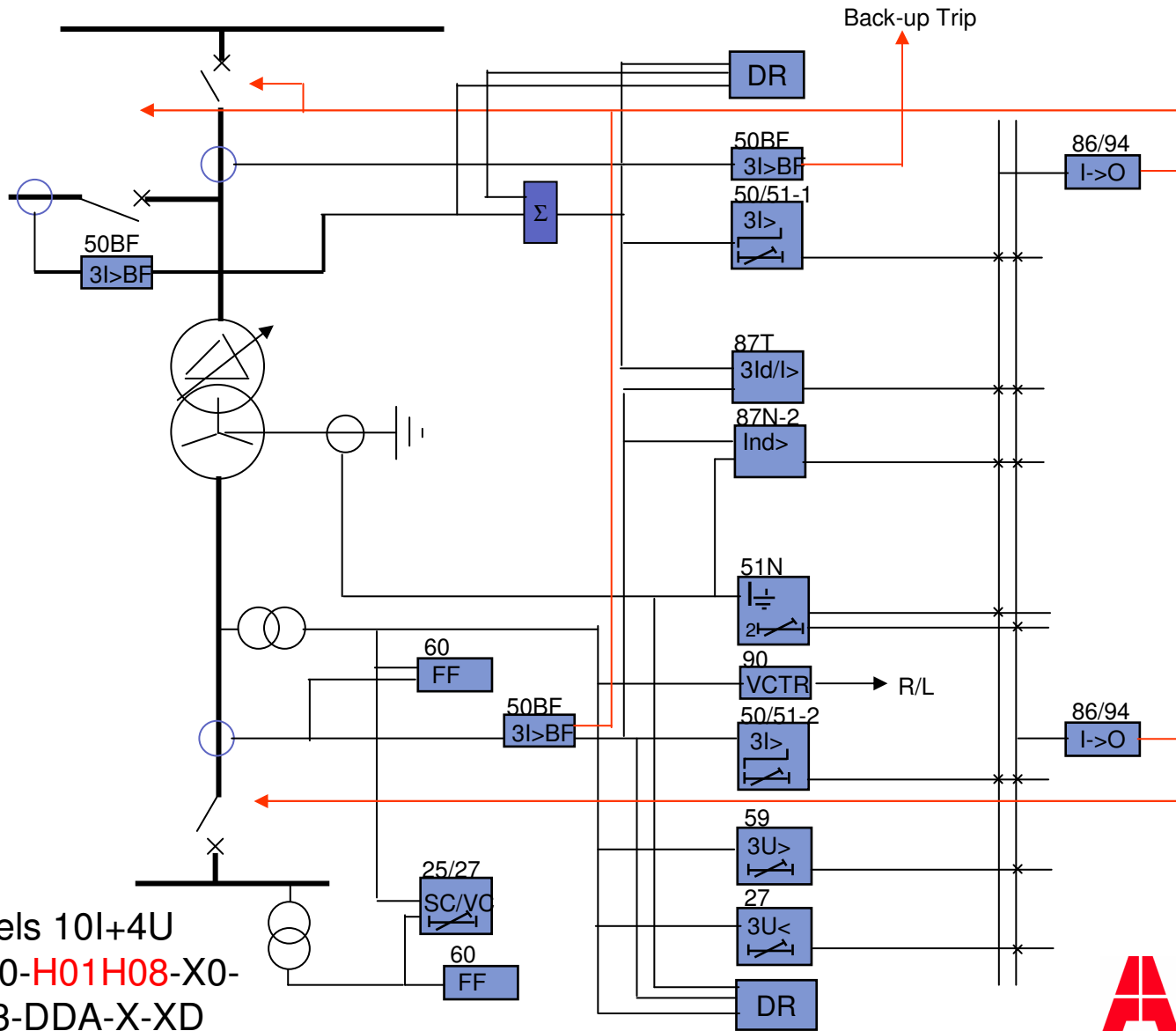
Efficient panel engineering and construction!

Space saving design!



Two-winding transformer - Multi-Breaker - Direct Earthing

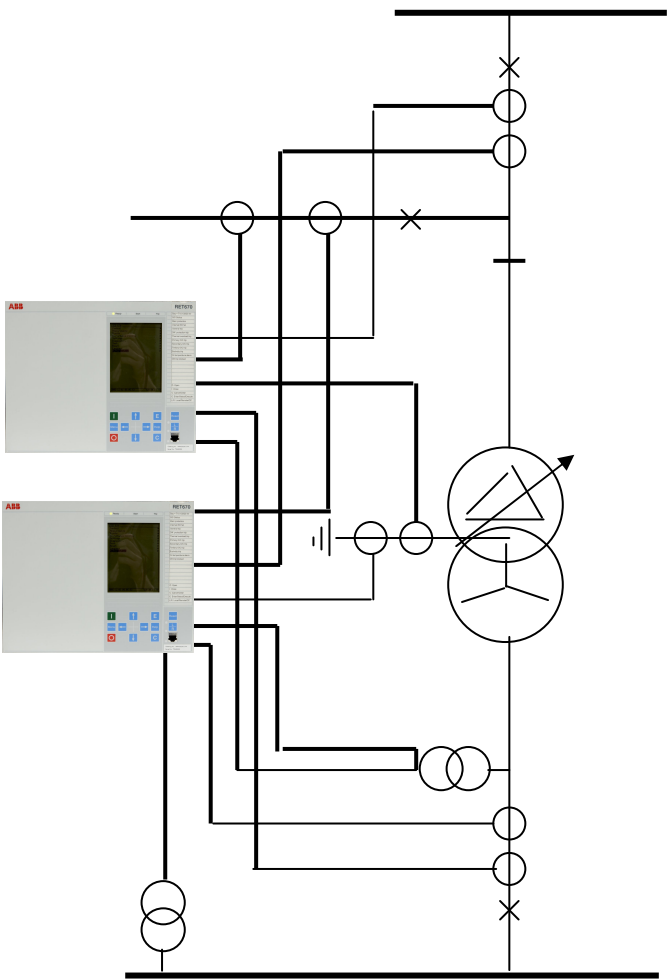
SC (25) Option
for both breakers



Analog channels 10I+4U
RET670xx-B30-H01H08-X0-
C-C-B-A-A3A3-DDA-X-XD

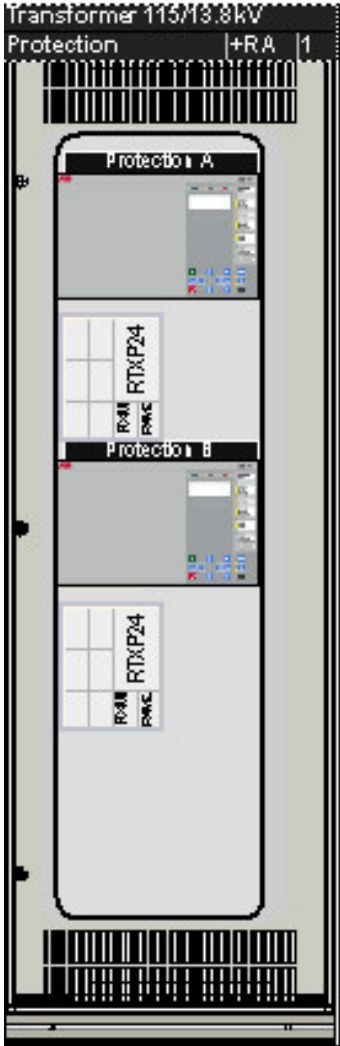


Two-winding transformer - Multi-Breaker - Direct Earthing

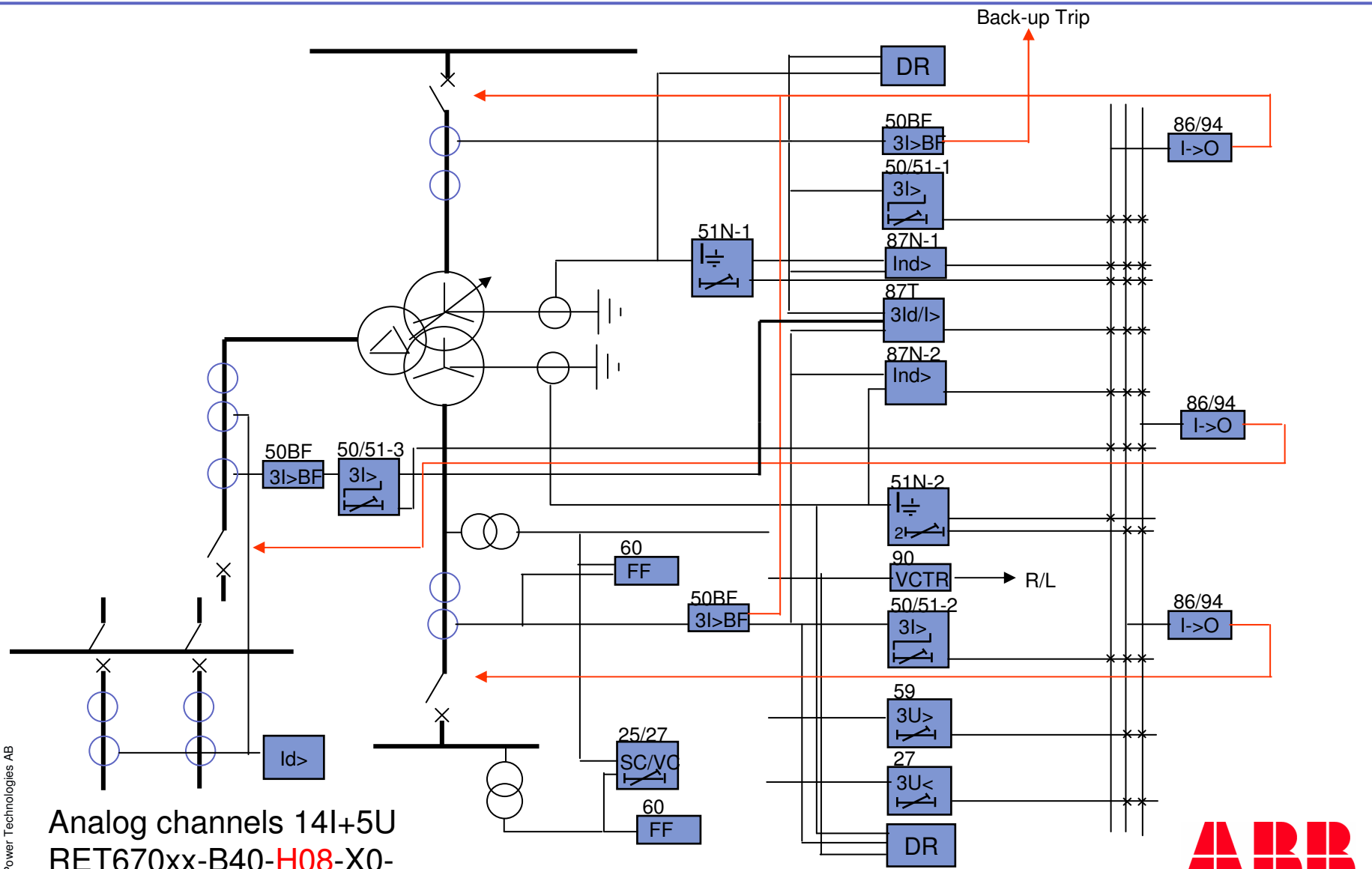


Efficient panel engineering and construction!

Space saving design!



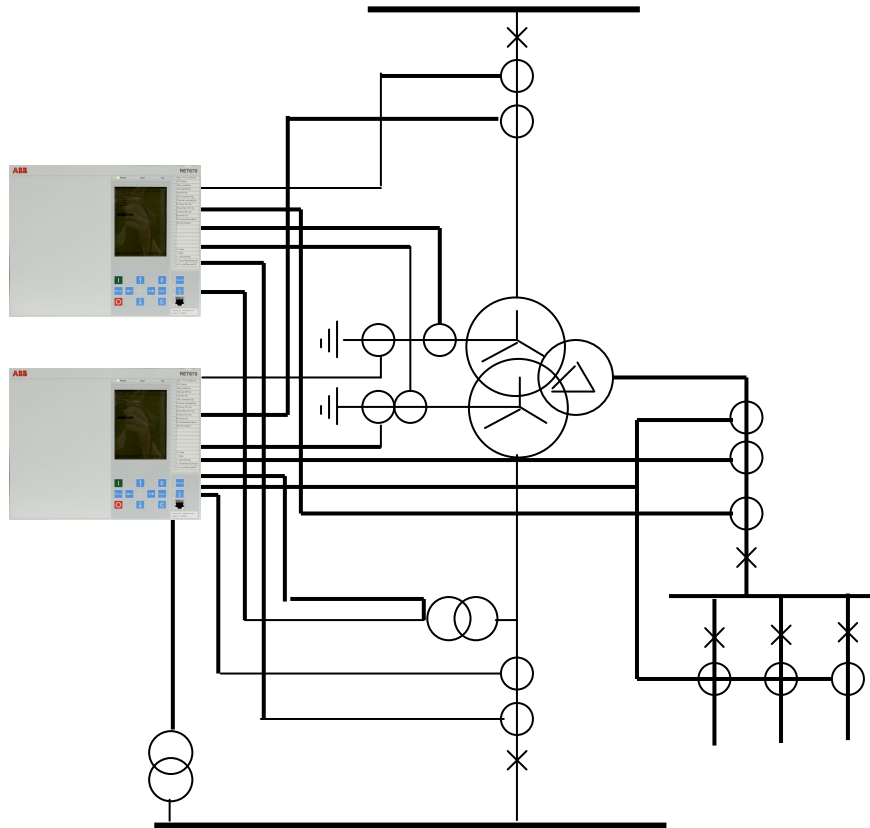
RET 670 Three-winding transformer – Direct Earthing



Analog channels 14I+5U
 RET670xx-B40-H08-X0-
 C-C-B-A-A3A3-DDA-X-XD



RET 670 Three-winding transformer – Direct Earthing



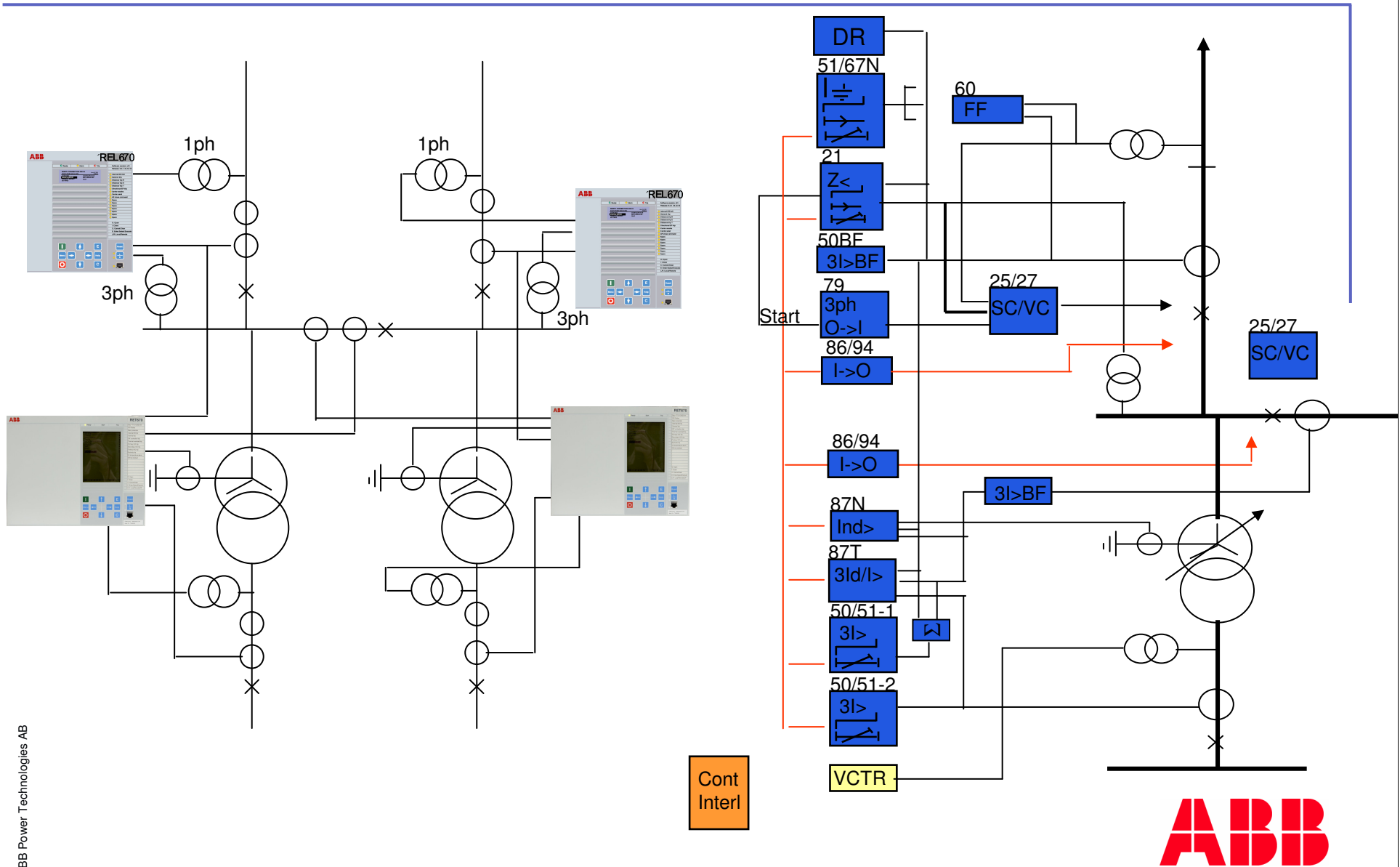
Efficient panel engineering and construction!



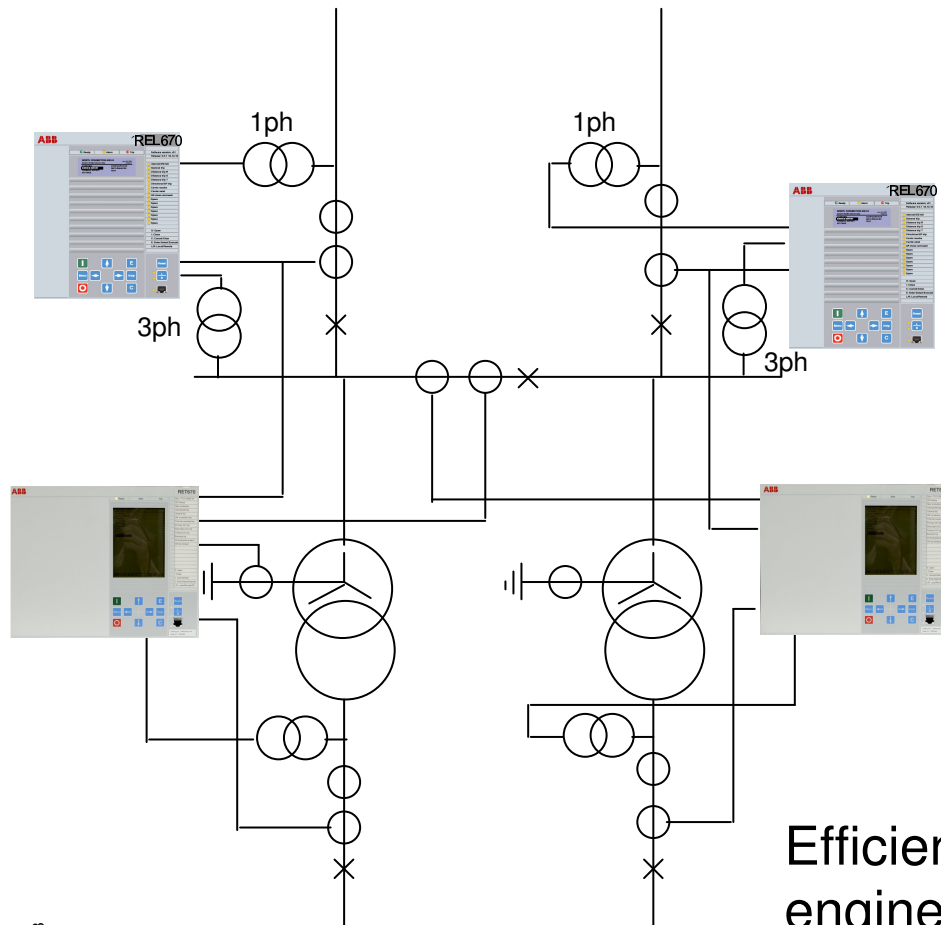
Space saving design!



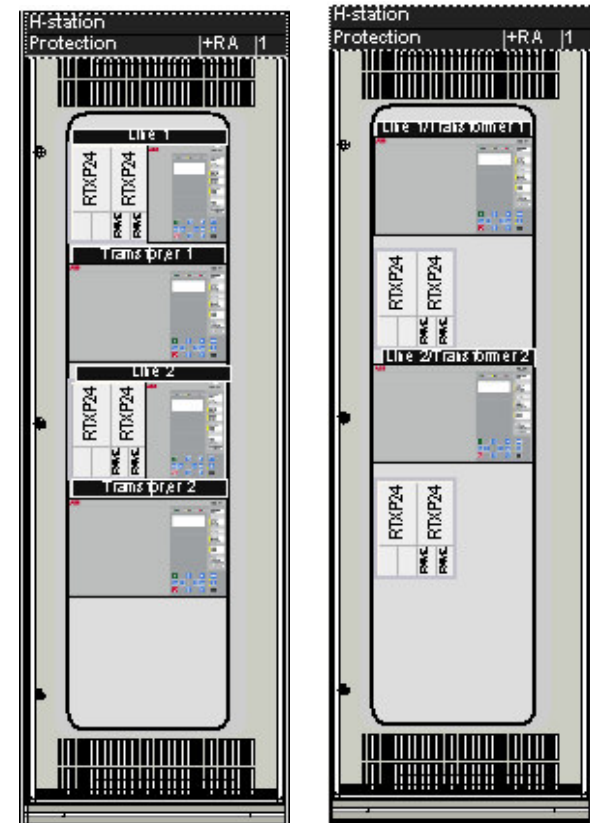
H-station application



H-station application



Alt. with Trafo/Line
Combined in RET670!

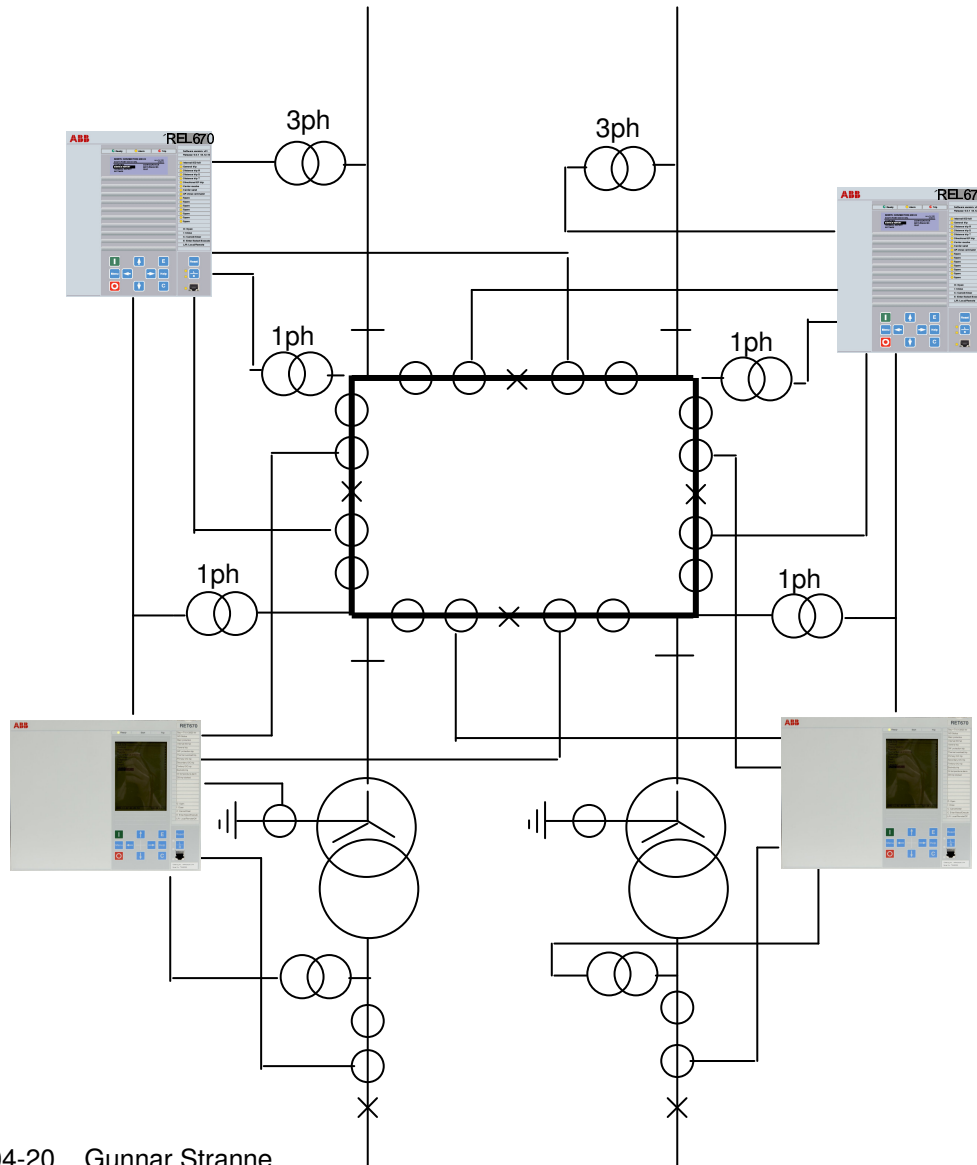


Efficient panel
engineering and
construction!

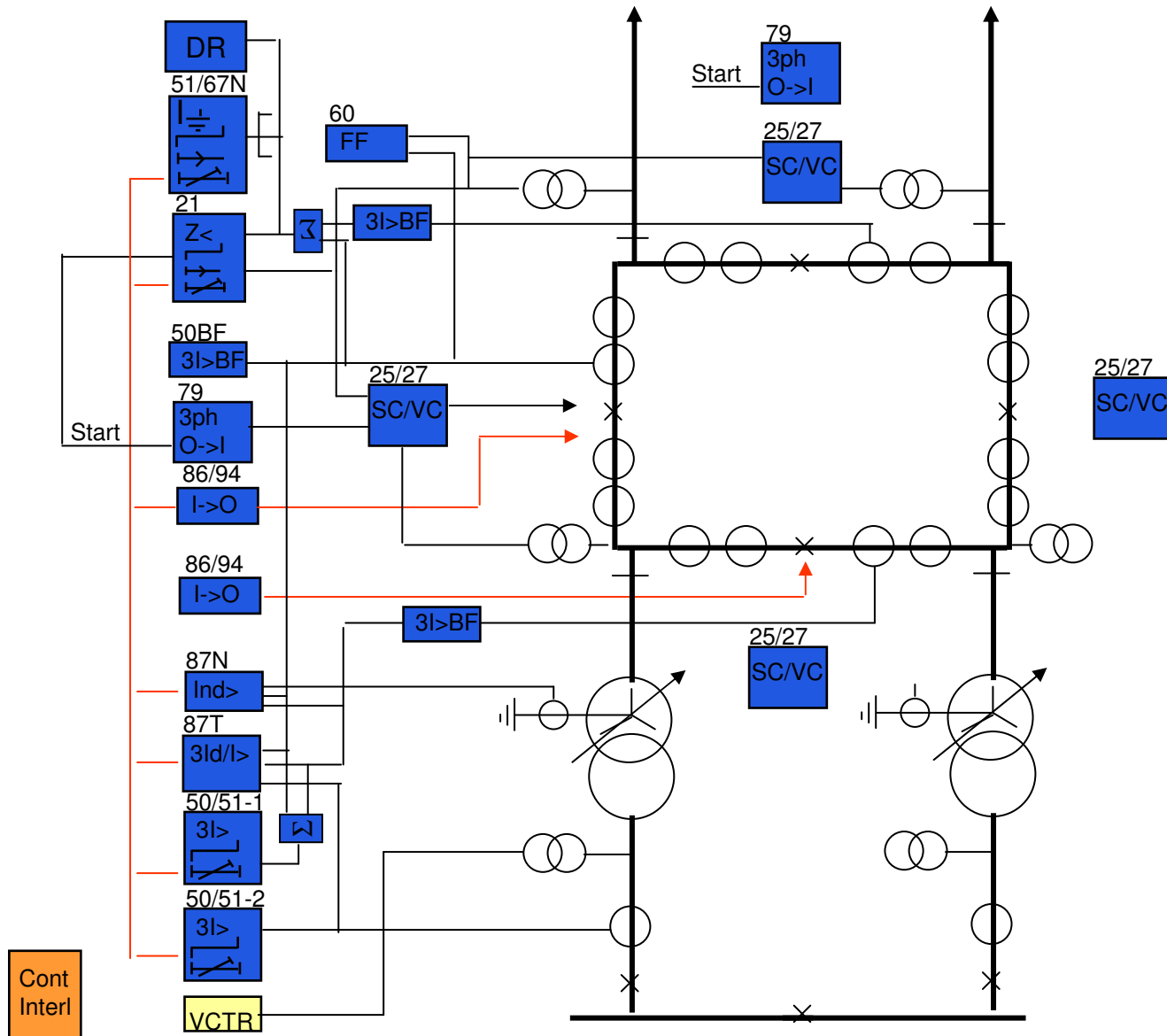
Space saving design!



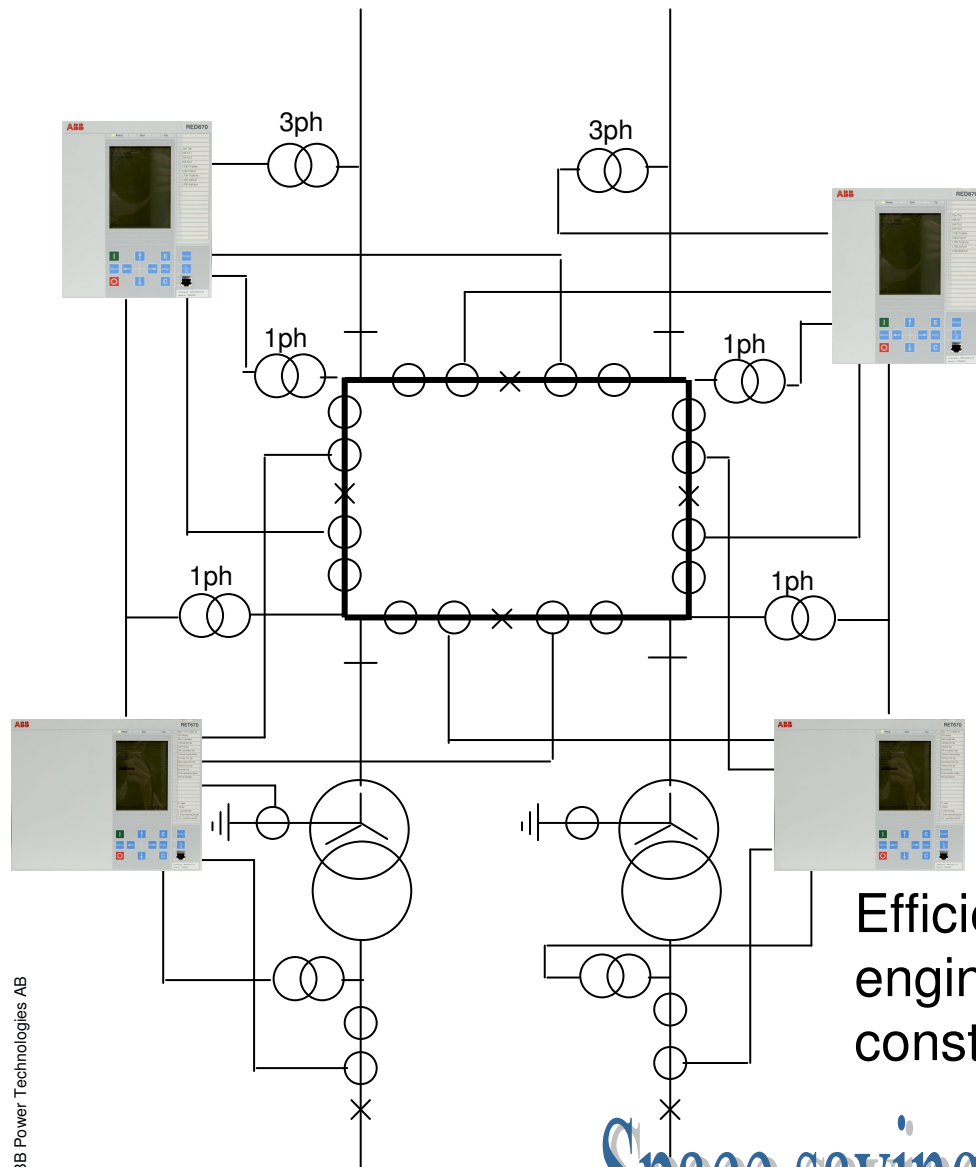
4-CB Ring Breaker application



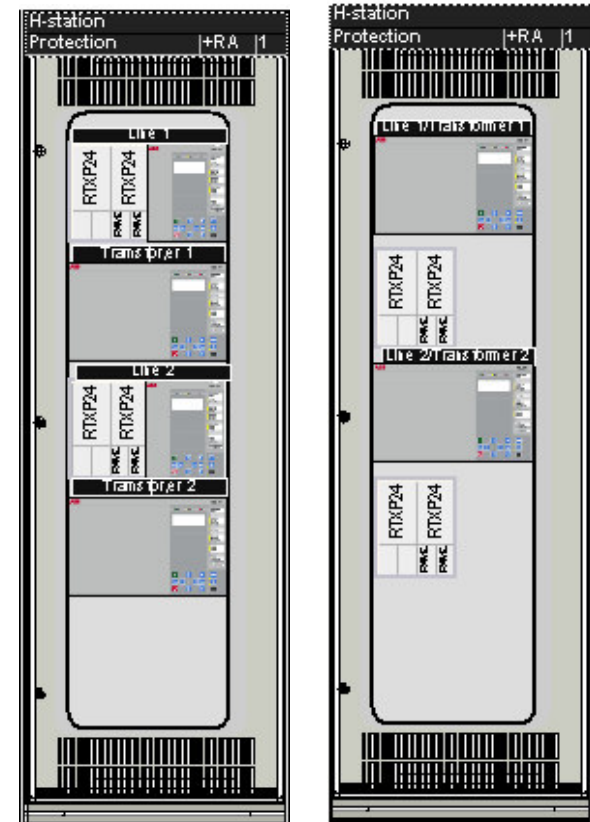
4-CB Ring Breaker application



4-CB Ring Breaker application



Alt. with Trafo/Line
Combined in RET670!



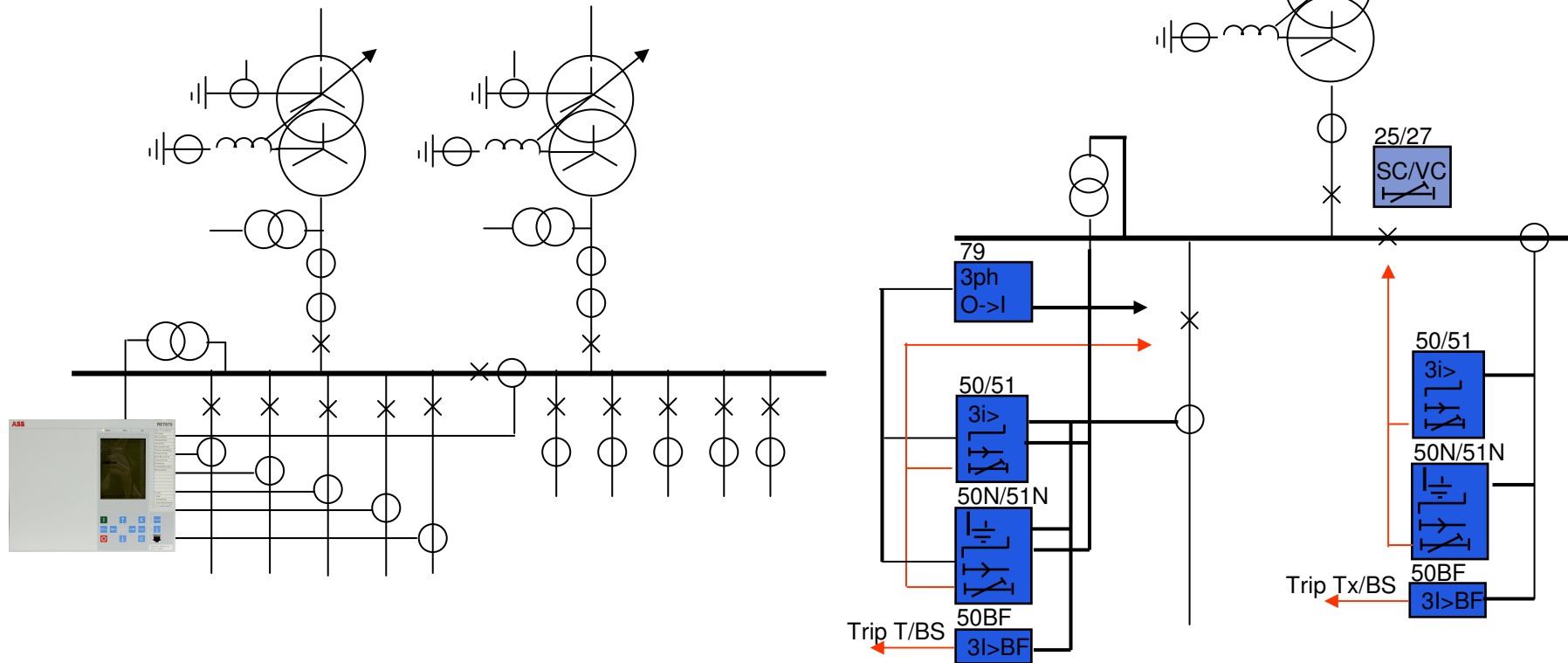
Efficient panel
engineering and
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Space saving design!



Feeder integration

Separate functions for all feeders can be coordinated in one IED 670

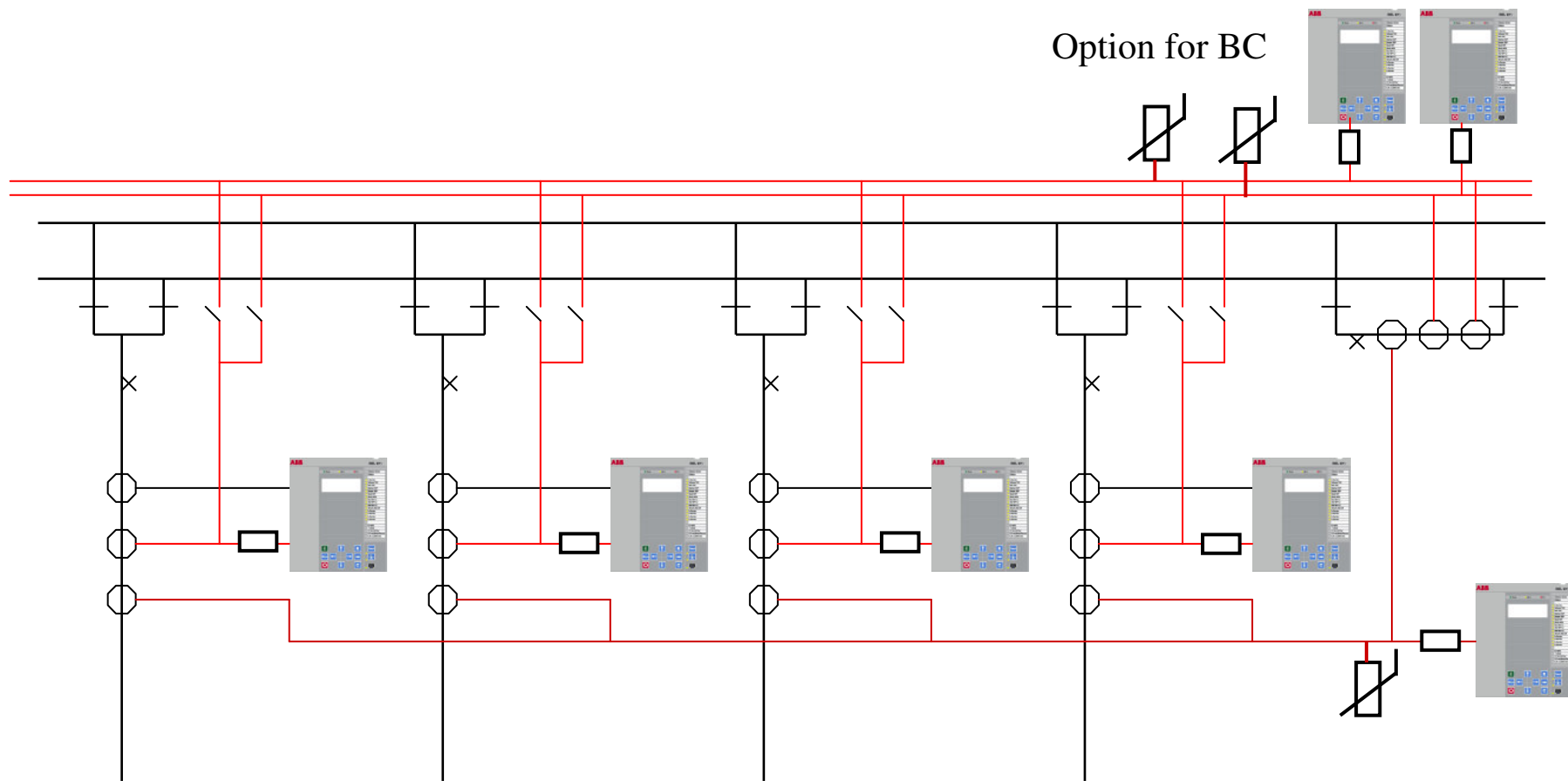


Typical feeder shown.
BS Synchro check as option

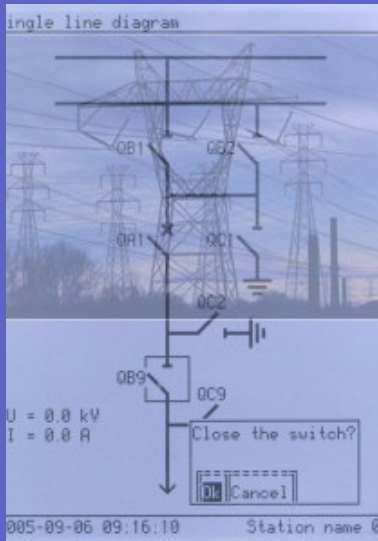
Analog channels 18I+4U



Decentralized High impedance Busbar protection with REx670

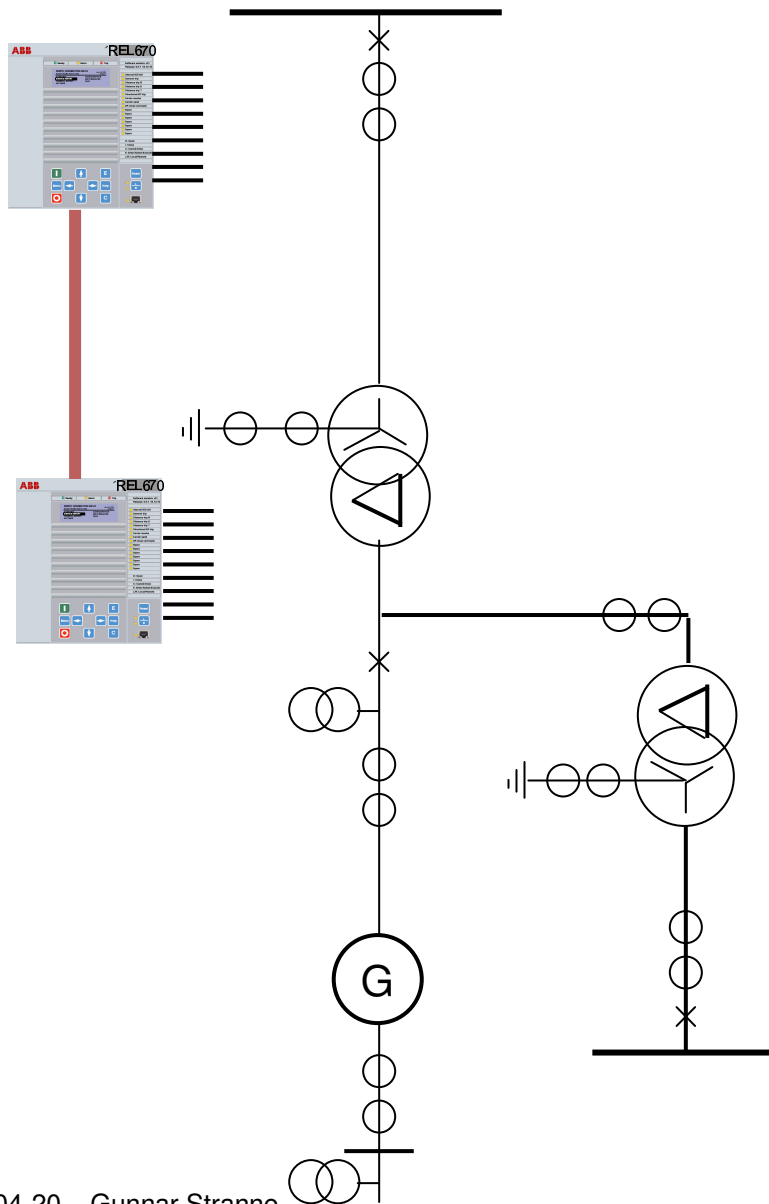


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Generator and Unit transformers – Binary signal transfer



- REC670 (or other 670 IED) can be used to send binary signals between power station and substation. Many time around 1 km of distance.

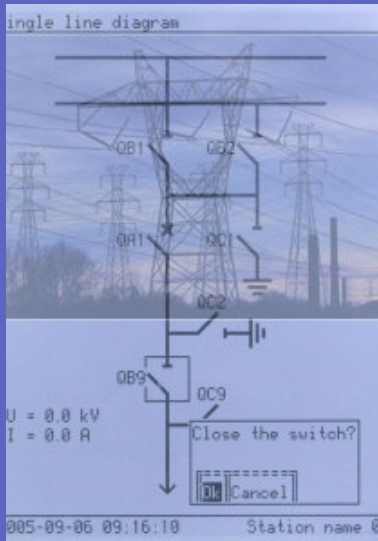
- Up to 192 binary signals are available in both directions.

- Can be used for status, intertripping, control, phase indication etc.

- LDCM optical communication board for single mode 62,5/125 μm is required.

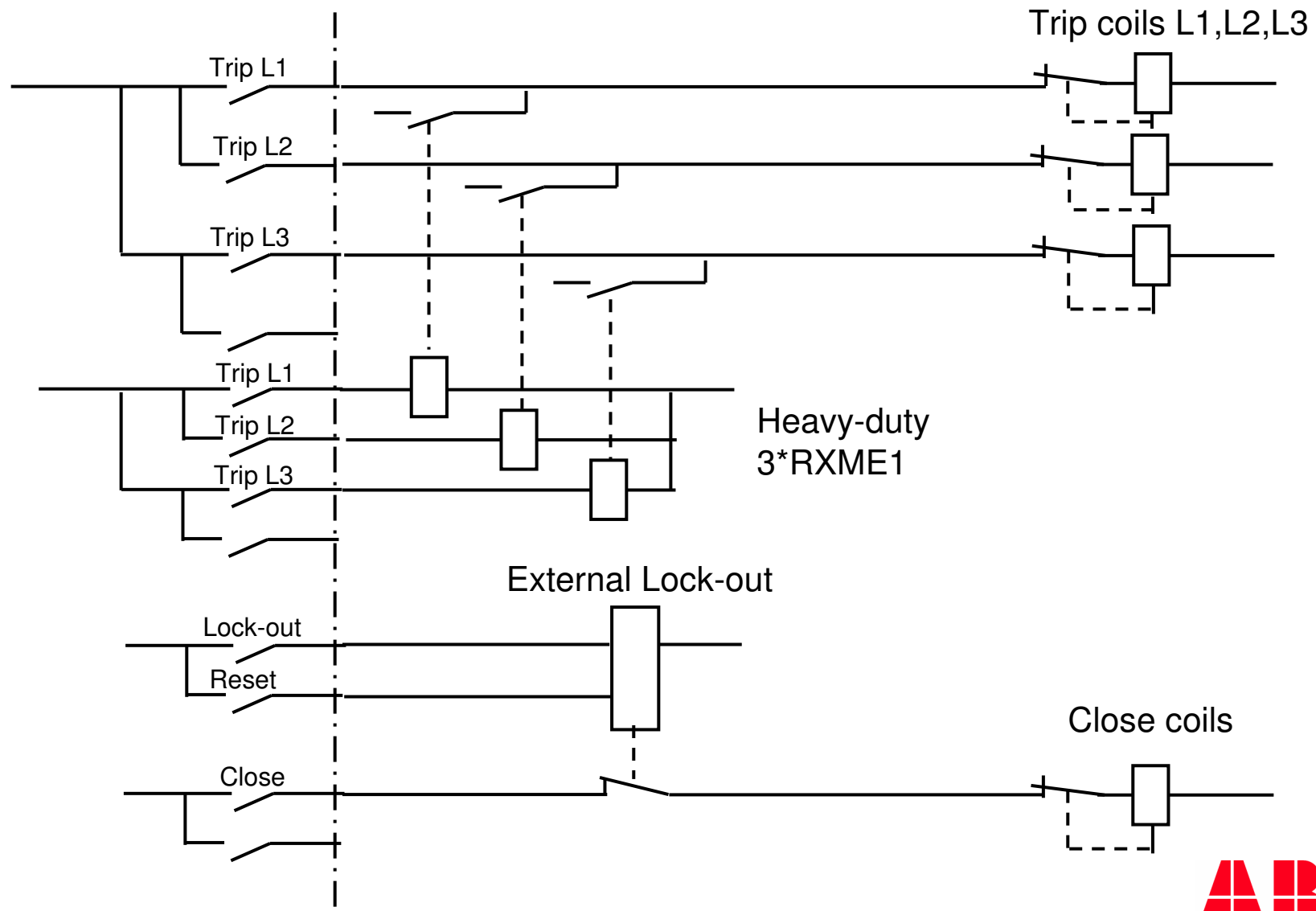


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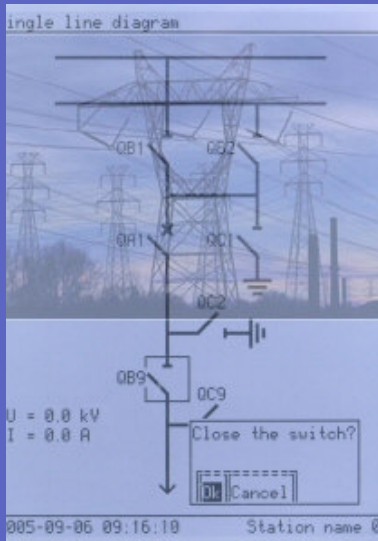


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Trip and Lock-out arrangement with reinforcement

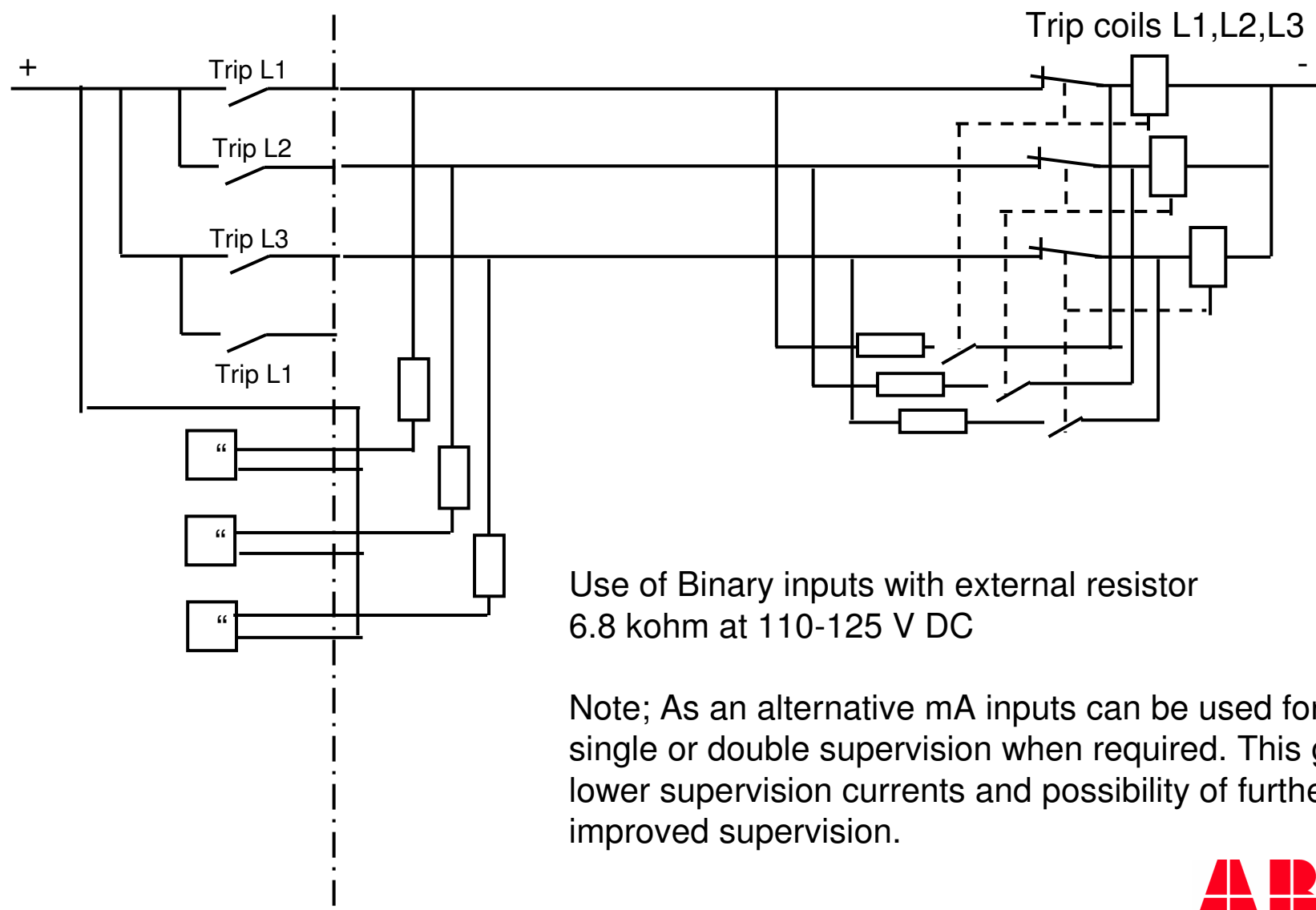


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Trip circuit supervision

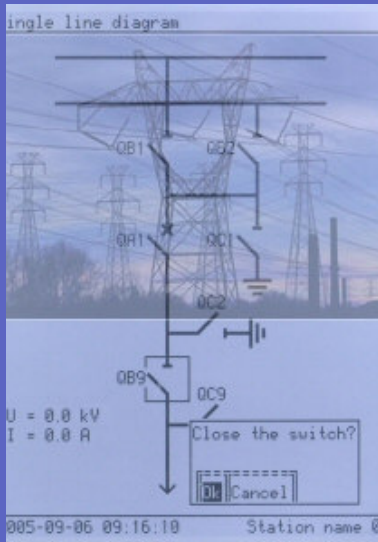


Use of Binary inputs with external resistor
6.8 kohm at 110-125 V DC

Note; As an alternative mA inputs can be used for single or double supervision when required. This gives lower supervision currents and possibility of further improved supervision.

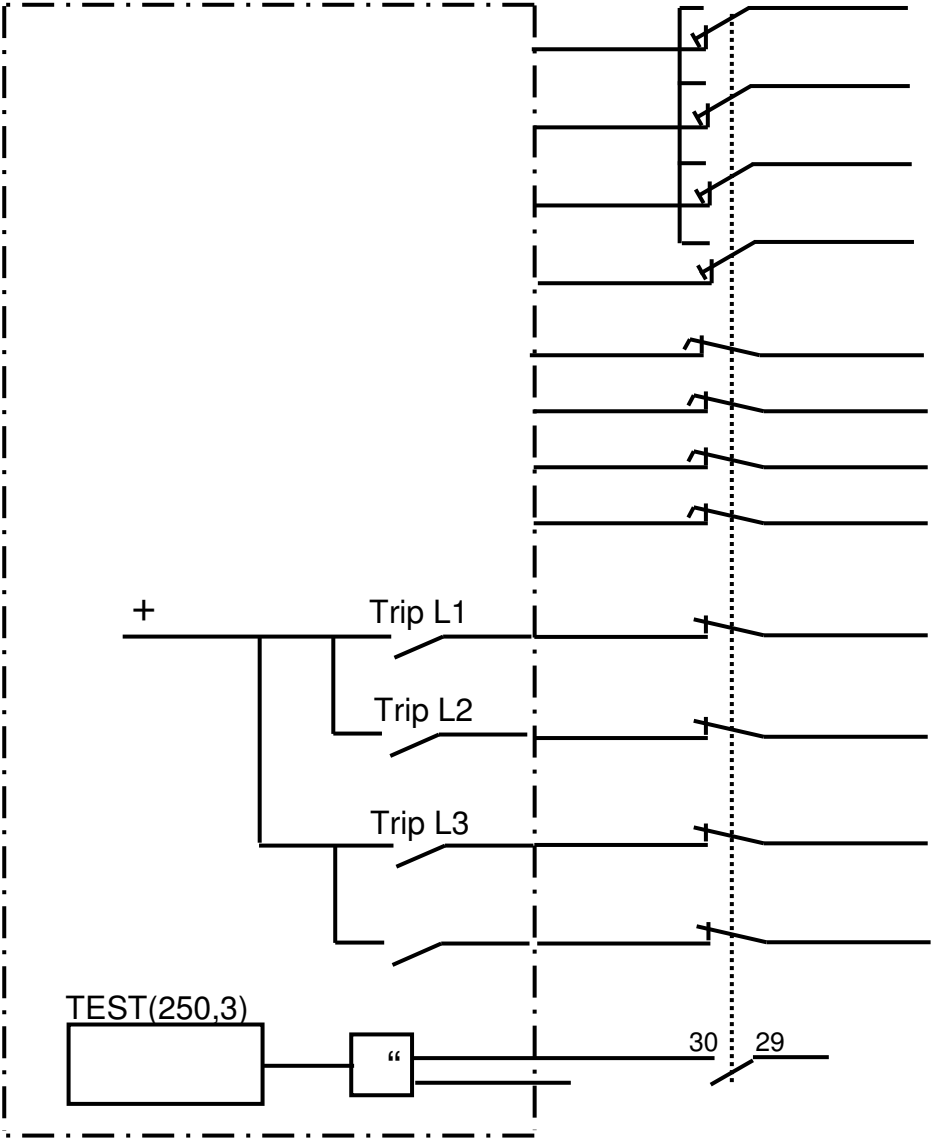


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Testing of IED 670 via secondary injection

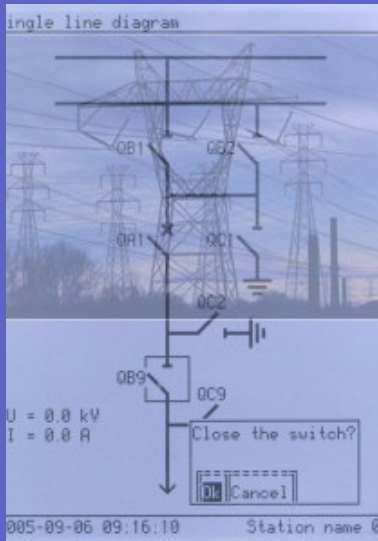


Test switches allows simplified testing at commissioning and maintenance testing also during in service.
 RTXP24 gives access to 24+1 contacts needed for more complex applications.

Software support is available and can be used during activation of the test block.
Contact 29-30 on RTXP24 can;
 - Block communication
 - Block IO where test switch contacts cannot be provided

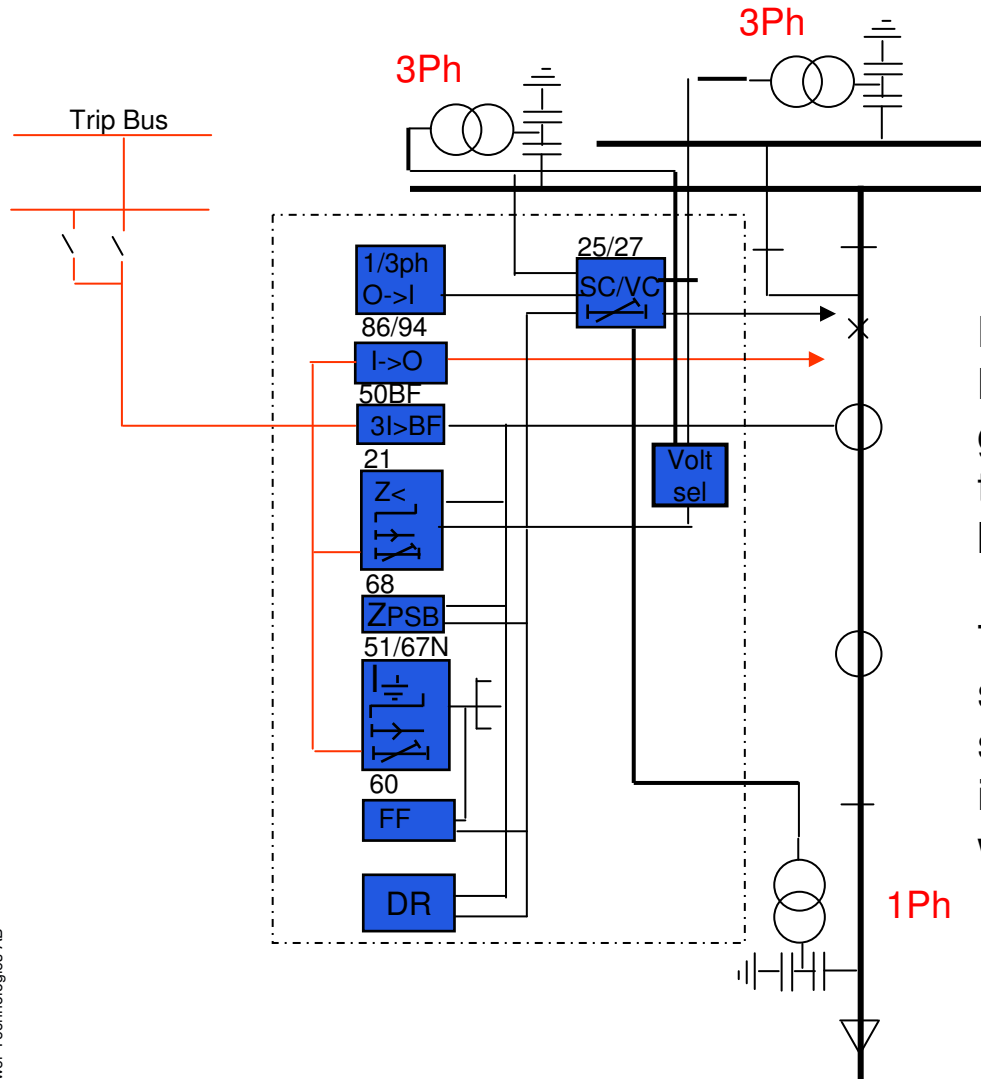


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Voltage selection schemes

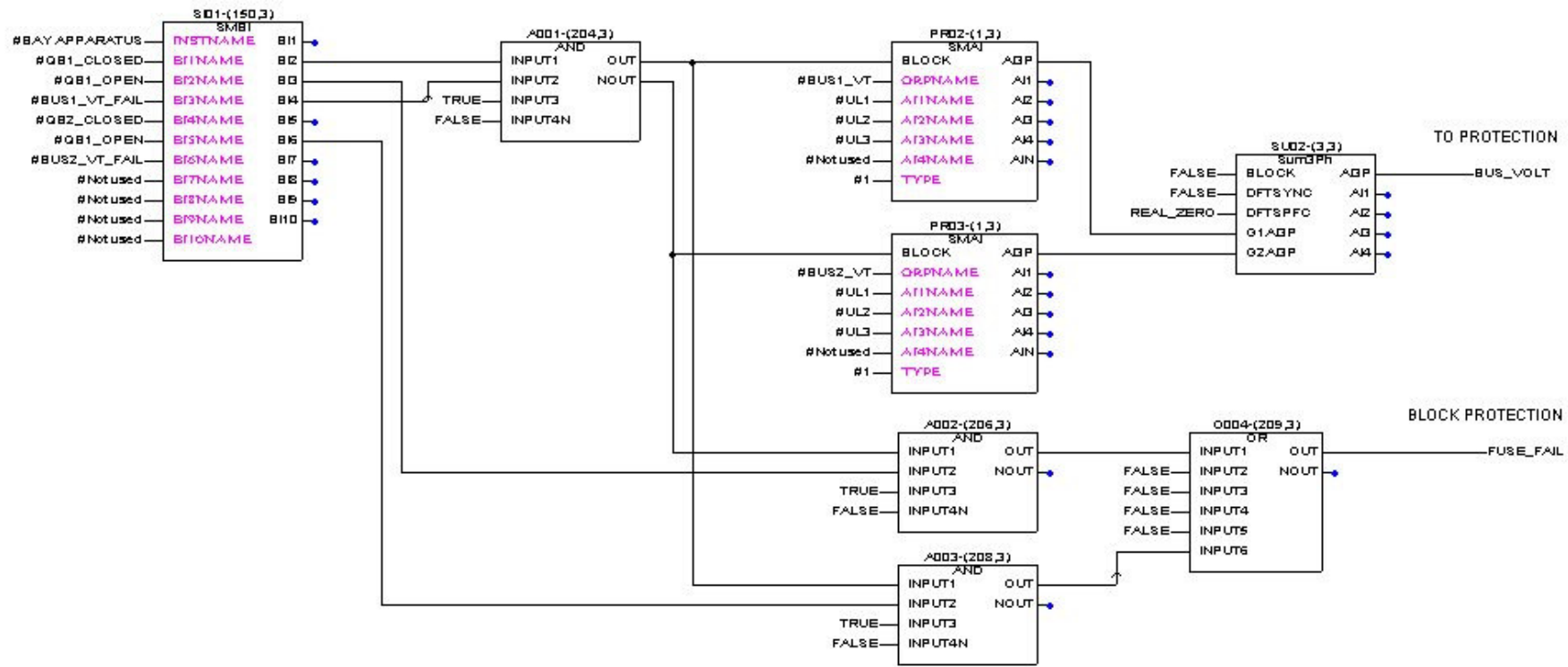


Many Utilities use single phase VT on lines and three phase on busbars. This gives a cost effective solution but means that a voltage selection scheme must be provided.

This can be provided in REx 670 with separate logic which gives a cost effective solution. The high number of analogue inputs is a must for this logic (7U required with DB when SC is required, 6U without)



Voltage selection schemes



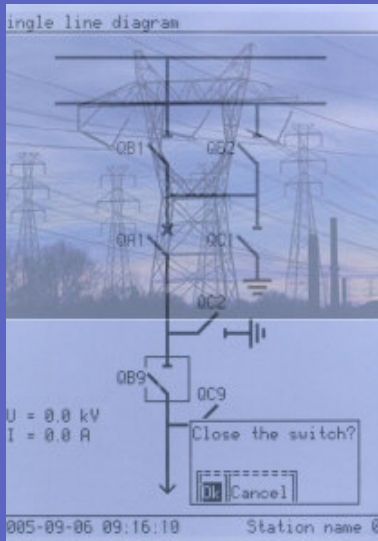
Bus 1 voltage is connected as reference unless bus 1 disconnector is open and bus 2 disconnector is closed.

Fuse failure is for alarming purpose and to block functions.

The derived bus voltage can be used for Distance protection and/or any voltage measuring function (including VCTR for transformers).



Content of the Presentation



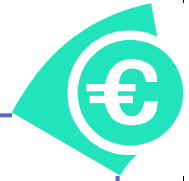
- Introduction
- Application solutions
 - Remote signaling
 - Tripping and lock-out arrangement
 - Trip circuit supervision arrangement
 - Testing of IED 670
 - Voltage selection schemes
- Summary and conclusions

IED 670 Summary and Conclusions

- Very high levels of flexibility are achieved with one common platform
- Prepackaged solutions enable rapid system implementations
- Functions can be allocated as required by customer organization and specifications
- High performance
- Big application library
- P&C&M etc in one IED
- Reduced spareparts
- Simplified training
- Future proof!
- Savings



Economic benefits of IED 670 Integration - example



	Installation	Operation	Maintenance	Analysis
Completely integrated IED functionality	50%	20%	20%	10-90%
Autonomous service	10%	10-50%	10-50%	10-50%
New functions e.g. interoperability	10%	10-50%	10%	10%
Communication	10%	10-50%	10%	10-50%

Please note that this is just an example. The actual benefits must be calculated for each application depending on the existing conditions and the possible improvements considering many influencing factors.



