



Merus Power Dynamics Oy Presentation

Aki Leinonen

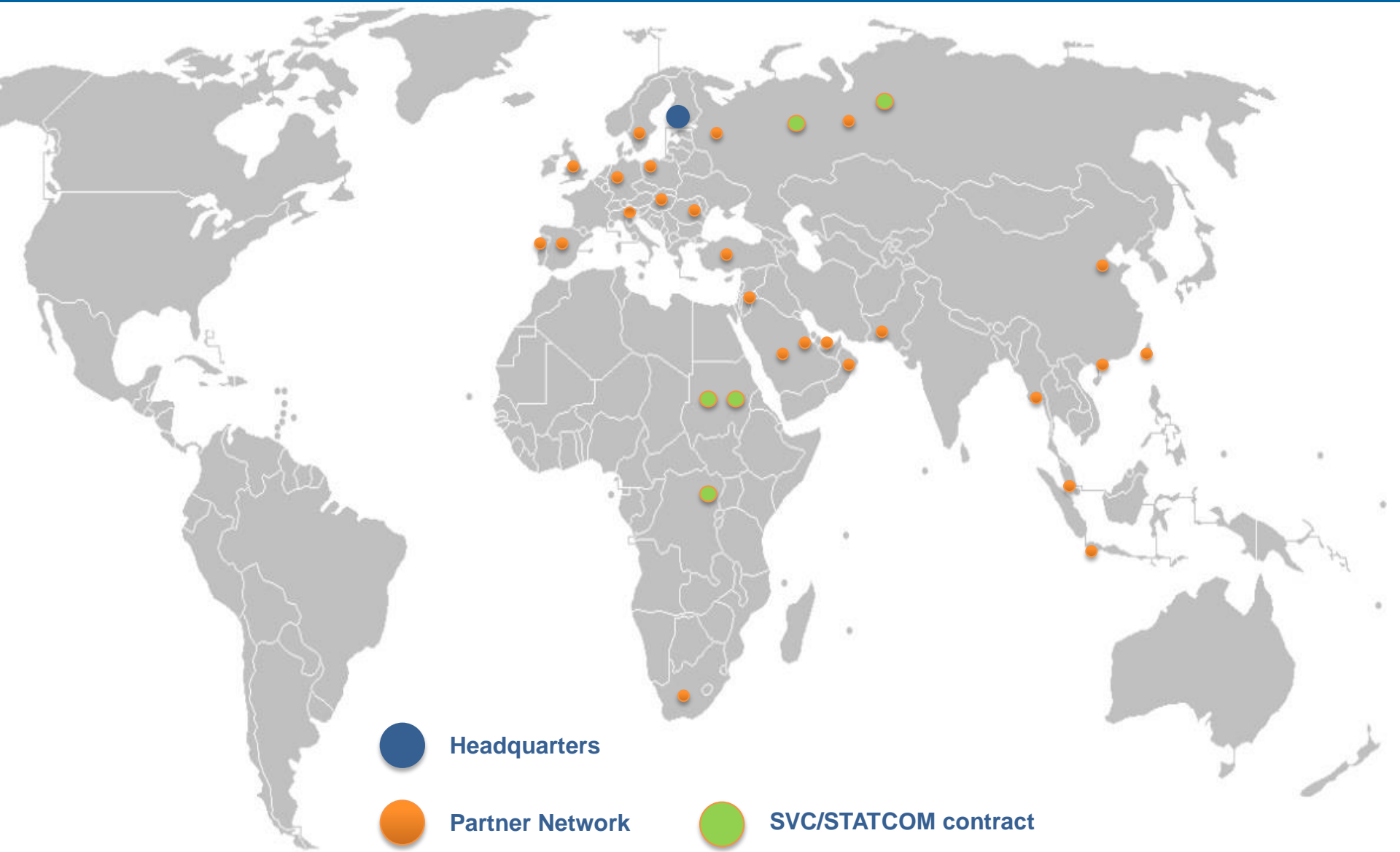
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www.meruspowers.com

- The company provides efficient, reliable and competitive solutions to its customers.
- The company's core competence is dynamic harmonic filtering and reactive power compensation.
- Merus Power is headquartered in Finland and is located in the old industrial facilities in city of Nokia.
- Company has ISO 9000 Quality system.

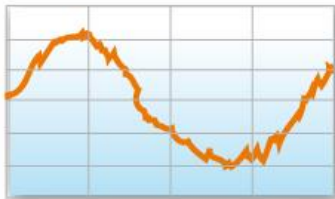


Geographical activity



- Merus Power offers solutions for power quality, energy efficiency and grid compliance.

Electricity problem

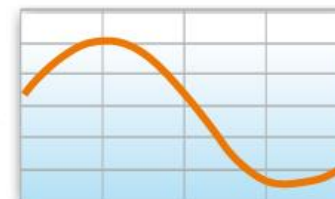


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Merus solution



Result



- Customers save energy, increase revenue, productivity and meet regulators grid connection criteria.

Wide Range of Power Quality Solutions

Active Harmonic Filters

Statcom

Static Var Compensator



208-480V

70 kVAr



38.5kV

250 MVar

Commercial Buildings

- Data centers
- Hospitals
- Airports
- Financial institutions
- Shopping malls
- Hotels

Light Industry

- Automotive
- Textile
- Clothing
- Pharmaceuticals
- Food & Beverages
- Microeletronic

Heavy Industry

- Steel & Metal
- Mining
- Oil & Gas
- Chemical
- Pulp and Paper
- Cement

Infrastructure

- Water and waste water treatment plants
- HVAC
- Lifts and Cranes
- Wind Farms
- Solar Farms

Utilities

- Transmission utilities
- Distribution utilities

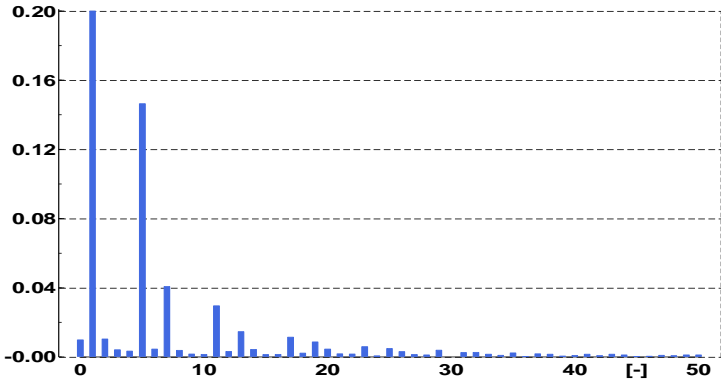


Variable Speed Drive Application

Harmonic distortion from VFDs



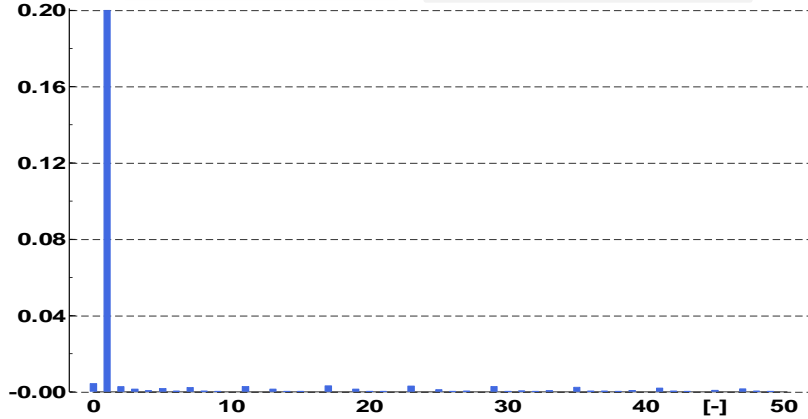
Before Merus Active Filter



$I_{thd} = 158A$



After Merus Active Filter



$I_{thd} = 8A$

Fast and accurate performance ensured effective compliance with IEEE519-1992 and G5/4-1 standards.

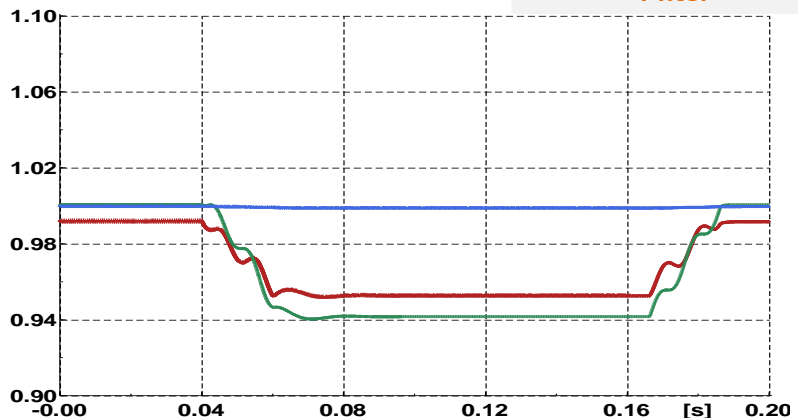


Welding application

Load Unblancing with Welding



Before Merus Active Filter

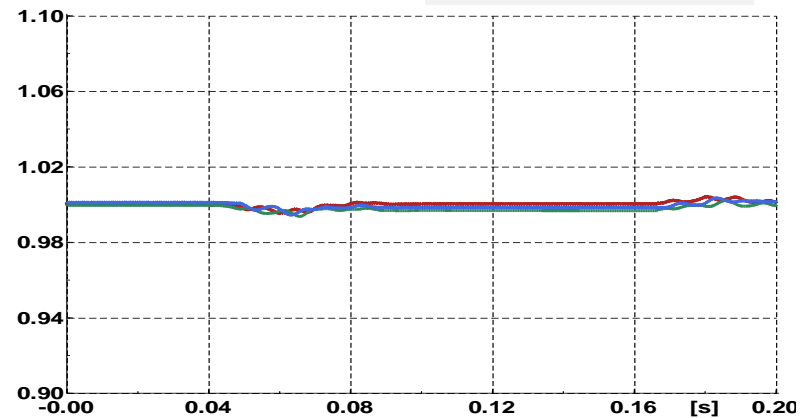


$$U_{ub} = 3.7 \%$$

$$\Delta U = 6.0 \%$$



After Merus Active Filter



$$U_{ub} = 0.025 \%$$

$$\Delta U = 0.7 \%$$

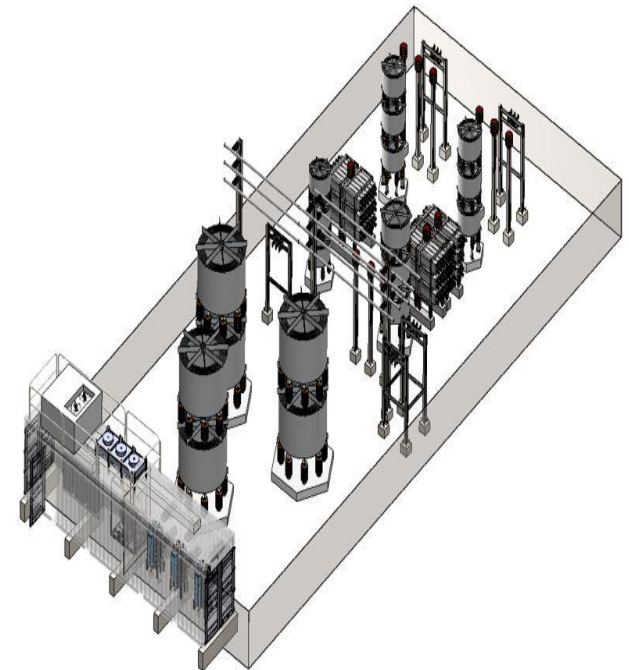
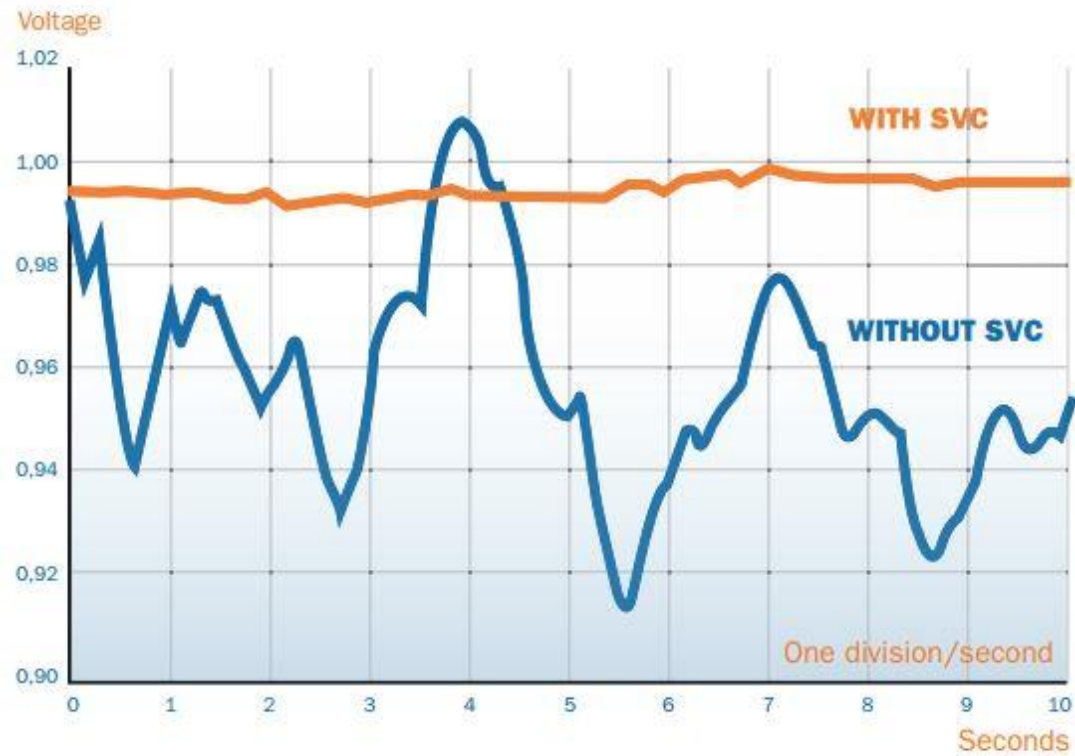
Fast response ensures that load is balanced across three phases.

Voltage Stabilization

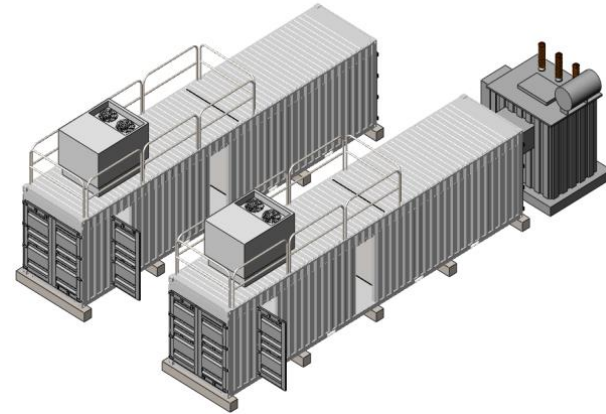


Electric Arc Furnace Application

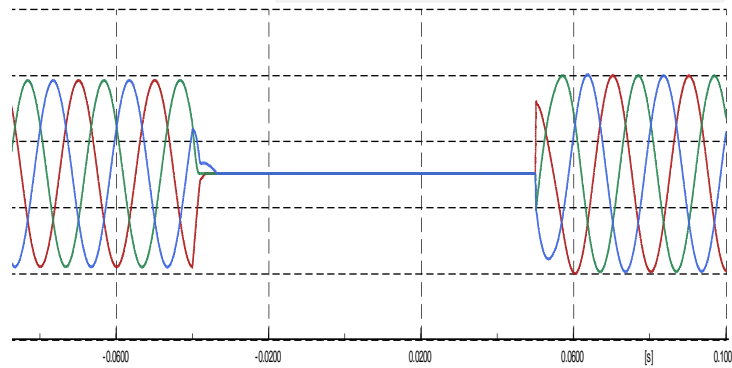
Merus SVC



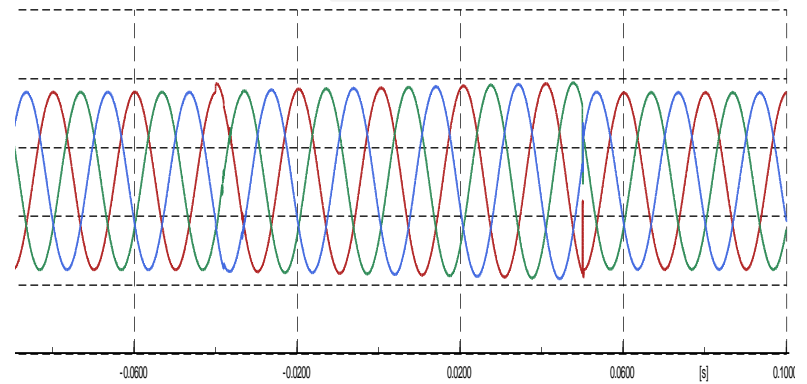
Prolonged Industrial Processes

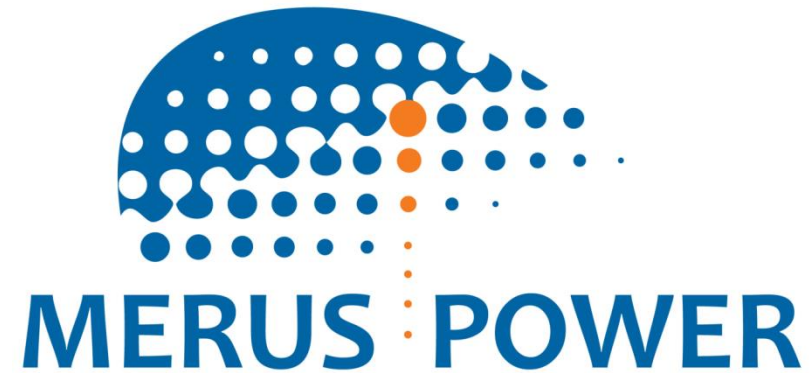


Before Merus Energy Storage



After Merus Energy Storage





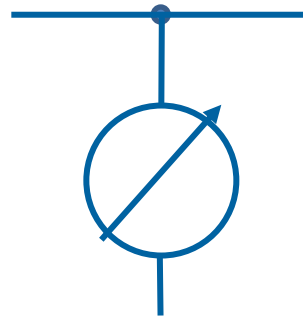
Active Harmonic Filter



Device connected parallel with the load to be compensated. The device can be understood as controlled current source which provides any kind of current waveform in real time!

Shunt Active Filter

Active Filter = controlled current source

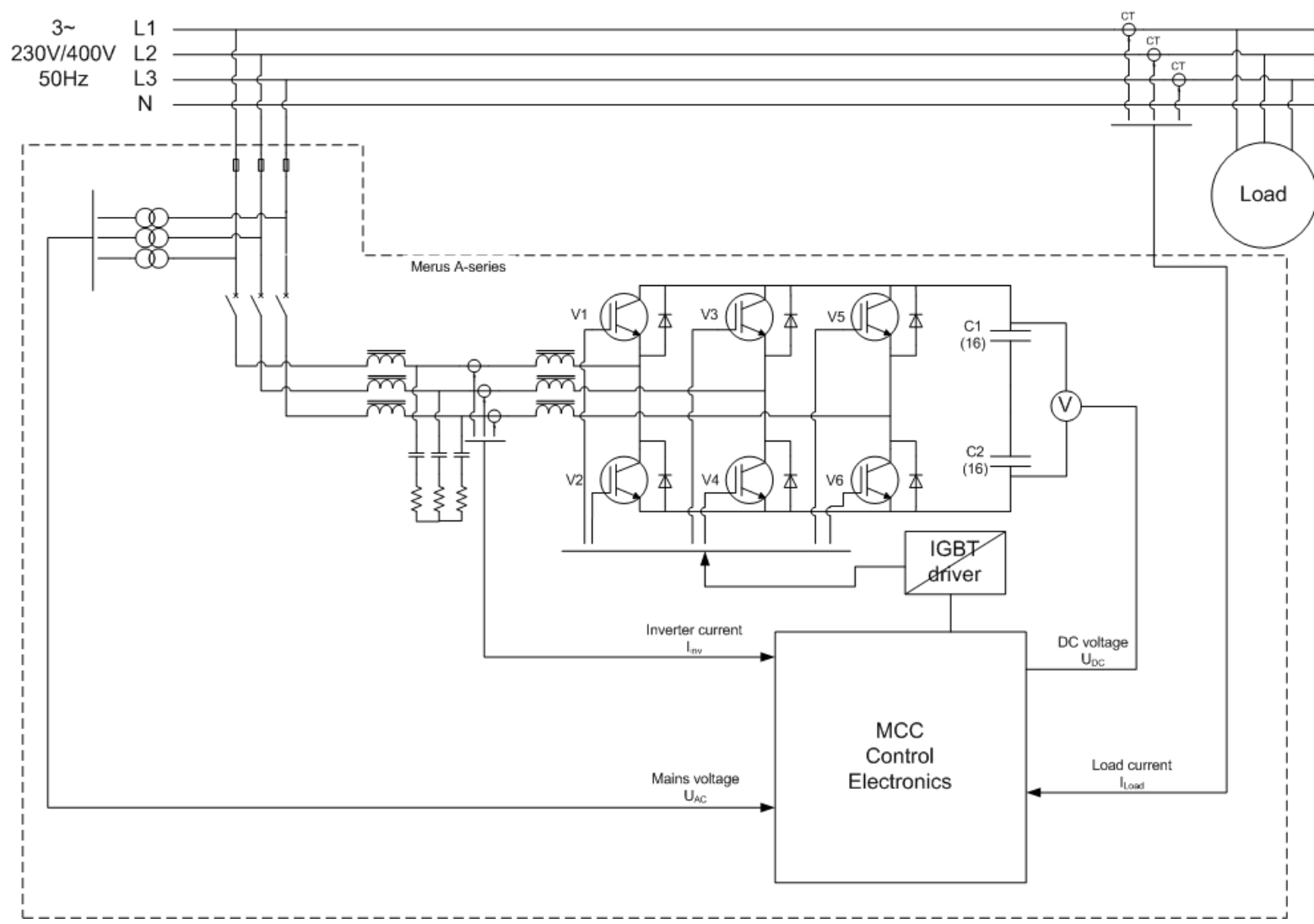


$$Q_{AF} = U * I_{AF} = 1 * I_{AF} = 100\%$$

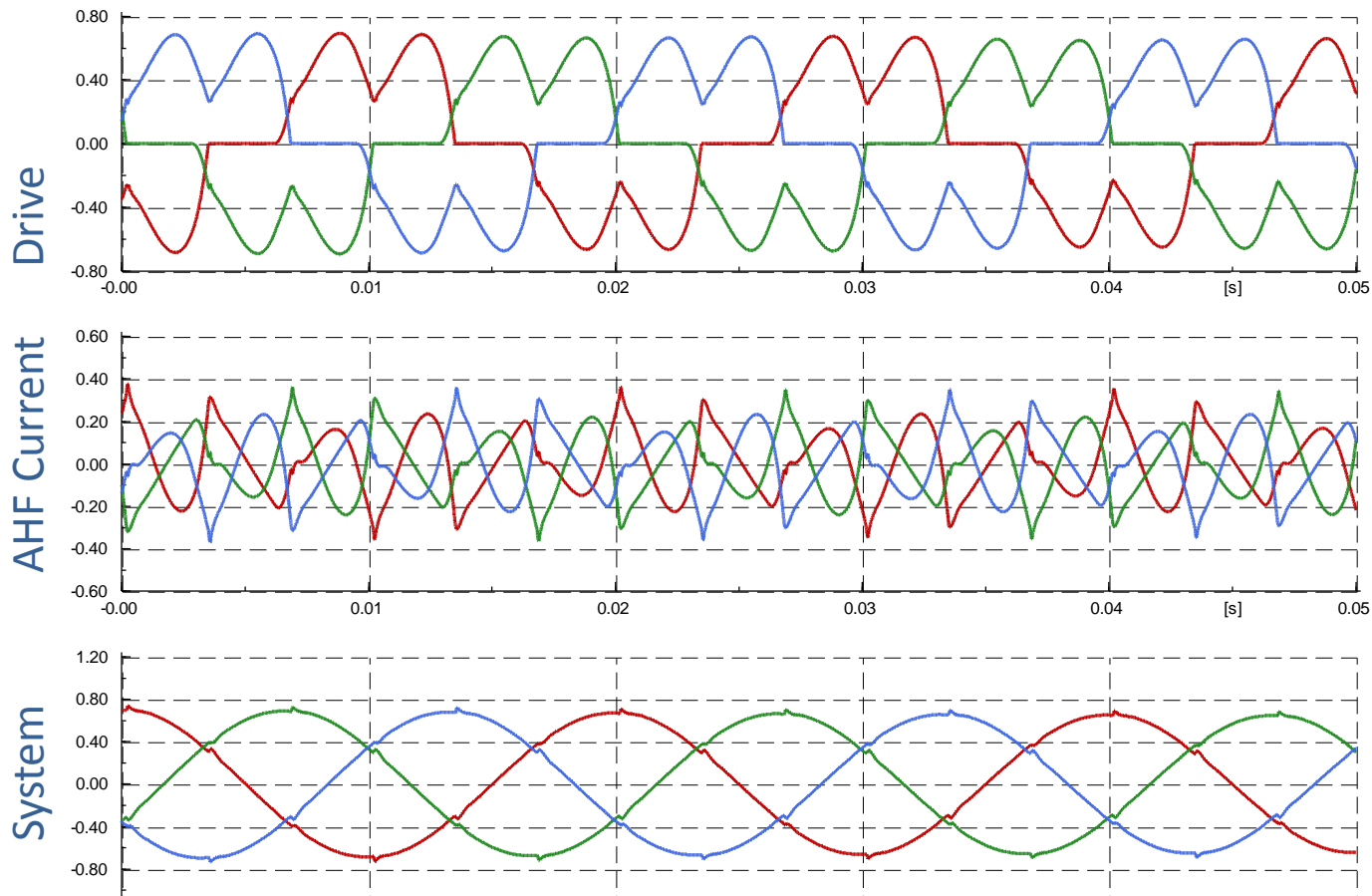


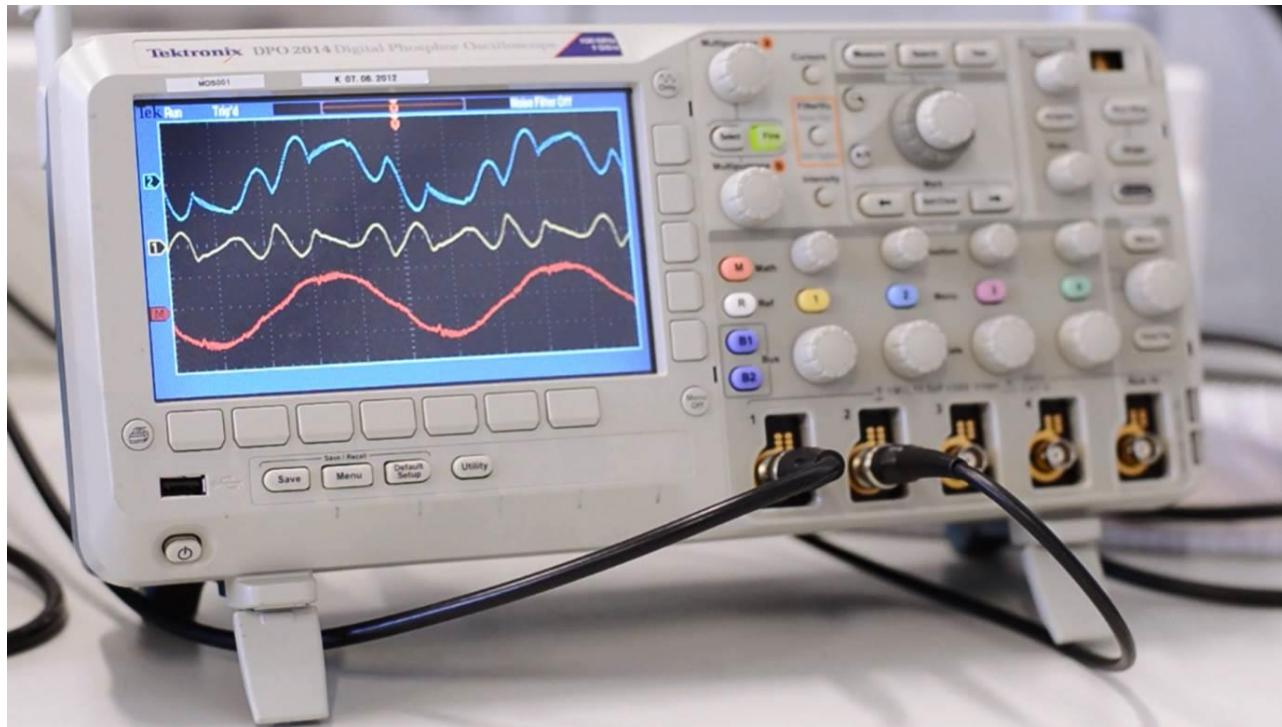
- Elimination of harmonic currents and voltages in real time
- Real time total power factor correction
- Real time reactive power compensation
- Elimination of voltage fluctuations and flicker
- Load balancing
- Problems created by voltage unbalance

Operation principle



AHF harmonic performance





Load current, AHF current and system current

Active Filter specification



- Voltage range 208 – 690V 50/60Hz
- Unit current 50A , 100, 150, 200 and 420A
- Neutral current compensation capacity $3 \cdot I_N$
- Parallel connection up to seven units
- Harmonic mitigation up to 50th
- Full current load balancing capacity
- Protection class IP21, option IP54
- Flexible human machine interface
- Open – closed loop current measuring options
- Operation modes
 - ALL harmonic
 - All but no reactive power
 - Selectable
- Power quality monitoring
- Remote monitoring Modbus TCP



Load Power MAIN

Load Active Power		Load Reactive Power	
kW		kVAr	
PL1	0	QL1	0
PL2	0	QL2	0
PL3	0	QL3	0
PL4	0	Total	0

General MAIN

Previous setting ◀ ▶ Next setting

0 1 Set value

+1 +10 +100 +1000

-1 -10 -100 -1000

Ready to RUN

OK

Start Settings

Log Monitoring

Alarm Log Trip Log Event Log MAIN

LOG - TRIPS

18 / 6 / 12:13:14
1: max Heatsink 1 Temperature TRIP

18 / 6 / 12:13:17
1: max Heatsink 2 Temperature TRIP

ACK

Harmonic Currents (A) MAIN

◀ ▶

0 0 0 0 0 0 0

Ithd Ih2 Ih3 Ih4 Ih5 Ih6 Ih7

Easy to use graphical user interface with touchscreen

- Platform allows easy customizing



M-Series Statcom - Active Harmonic Filter



Merus M1000 Statcom – performance features

- Ultra fast response
 - Response time 0 ->90% is less than 0.6ms
 - Maximum flicker reduction factor up to 10 pu.
- Active harmonic filtering capability
 - M1000 module can actively mitigate harmonic currents thus additional passive filter circuits are not mandatory
- Low losses on average over tap to tap
 - Overall losses are ~1 % depending on compensation system configuration and load profile





Merus M1000 Statcom – design

- Modular design, each module has
 - Independent cooling system
 - Independent control and protection system
 - Number of modules in parallel operation has no limit
- High level of redundancy
 - M1000 module can be switched off for maintenance while rest of modules are in normal operation



M-Series Statcom - AHF



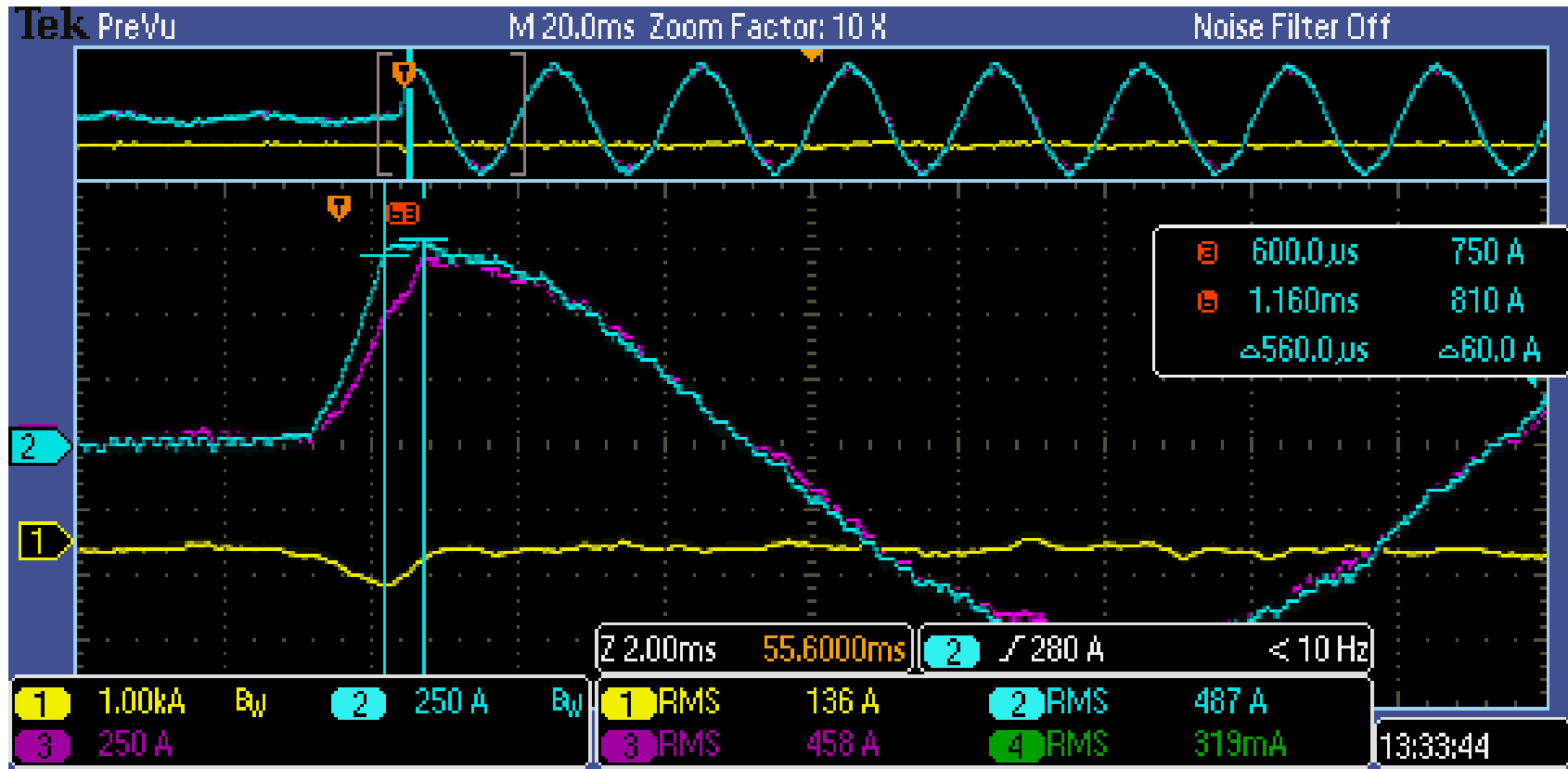
- Open loop control - currents from PCC
- Open loop control - voltages from PCC
- Closed loop control - currents from loads

All or any combination



I_d ; I_q Control via optic link

Dynamic response test: 0..90% step change: test results

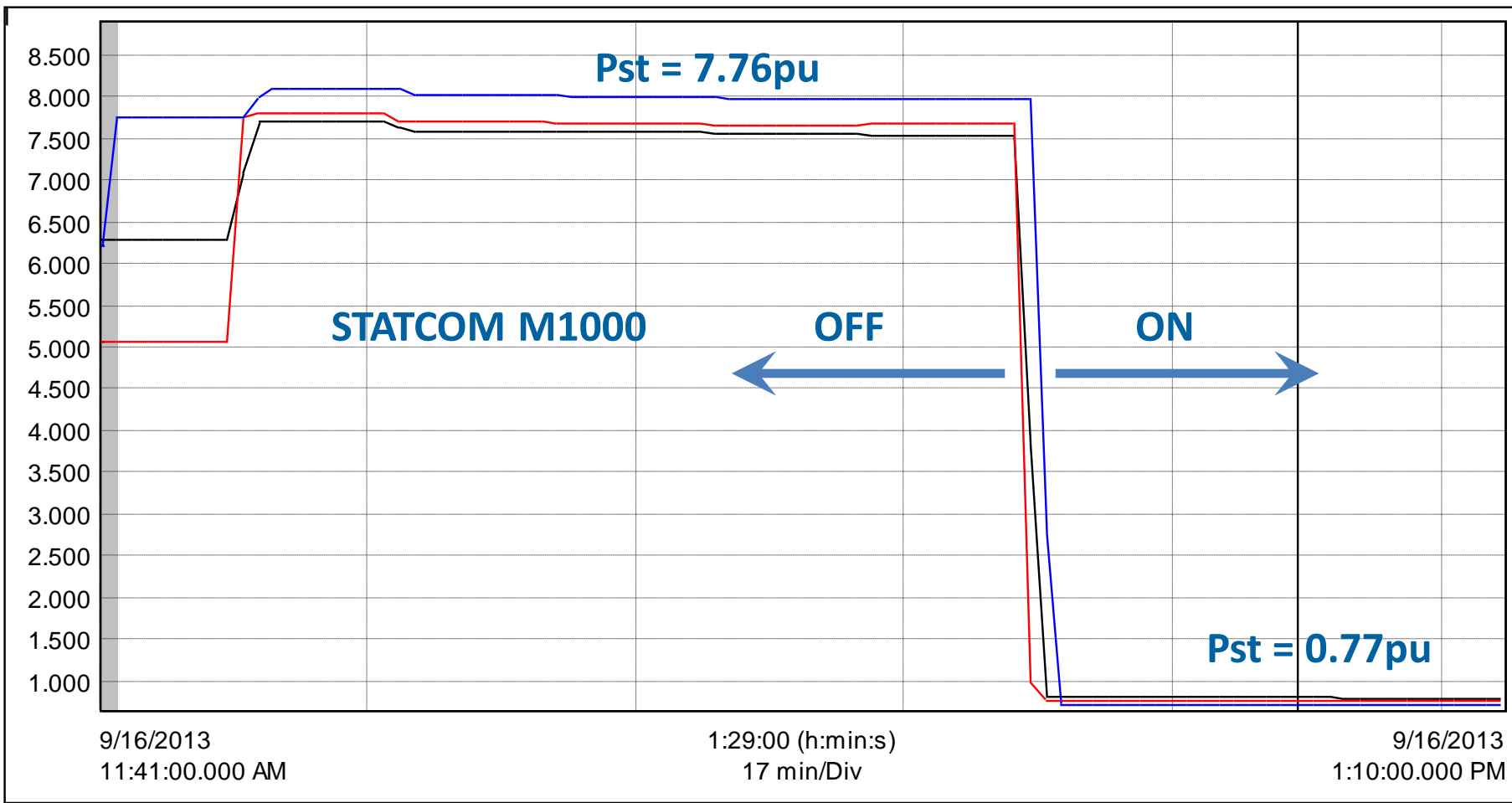


Response time $\Delta t = 600\mu s$

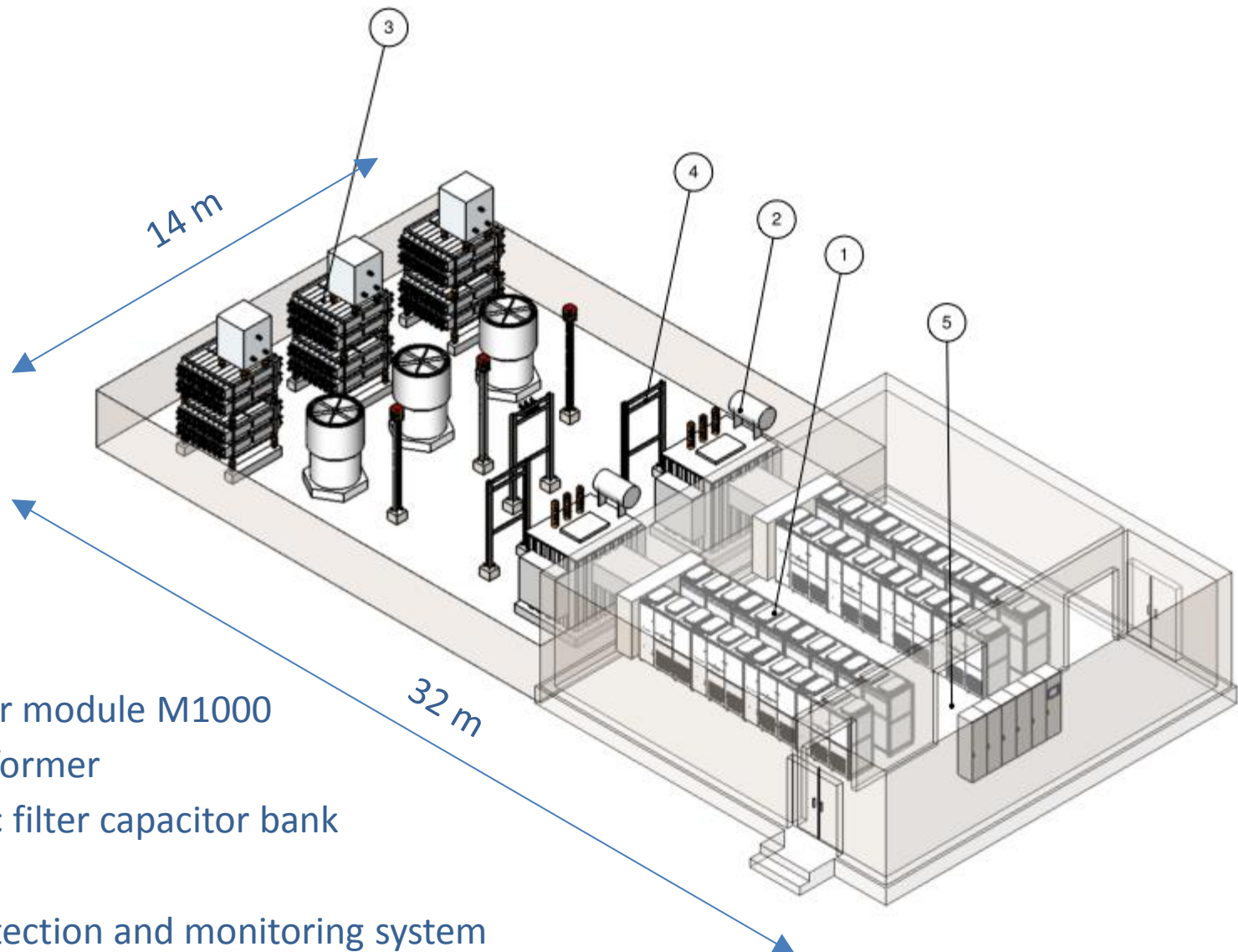
Ch3 (purple): Load current
 Ch4 (green): M1000 current
 Ch1 (yellow): System current

Flicker reduction factor

Measured flicker reduction
when load is highly inductive thus active power is nearly negligible



Statcom Lay – out 50Mvar at 33kV

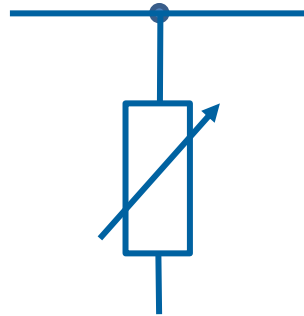


1. Merus power module M1000
2. Power transformer
3. 2nd Harmonic filter capacitor bank
4. Switchgear
5. Control, protection and monitoring system



Static Var Compensator (SVC)

SVC= controlled impedance



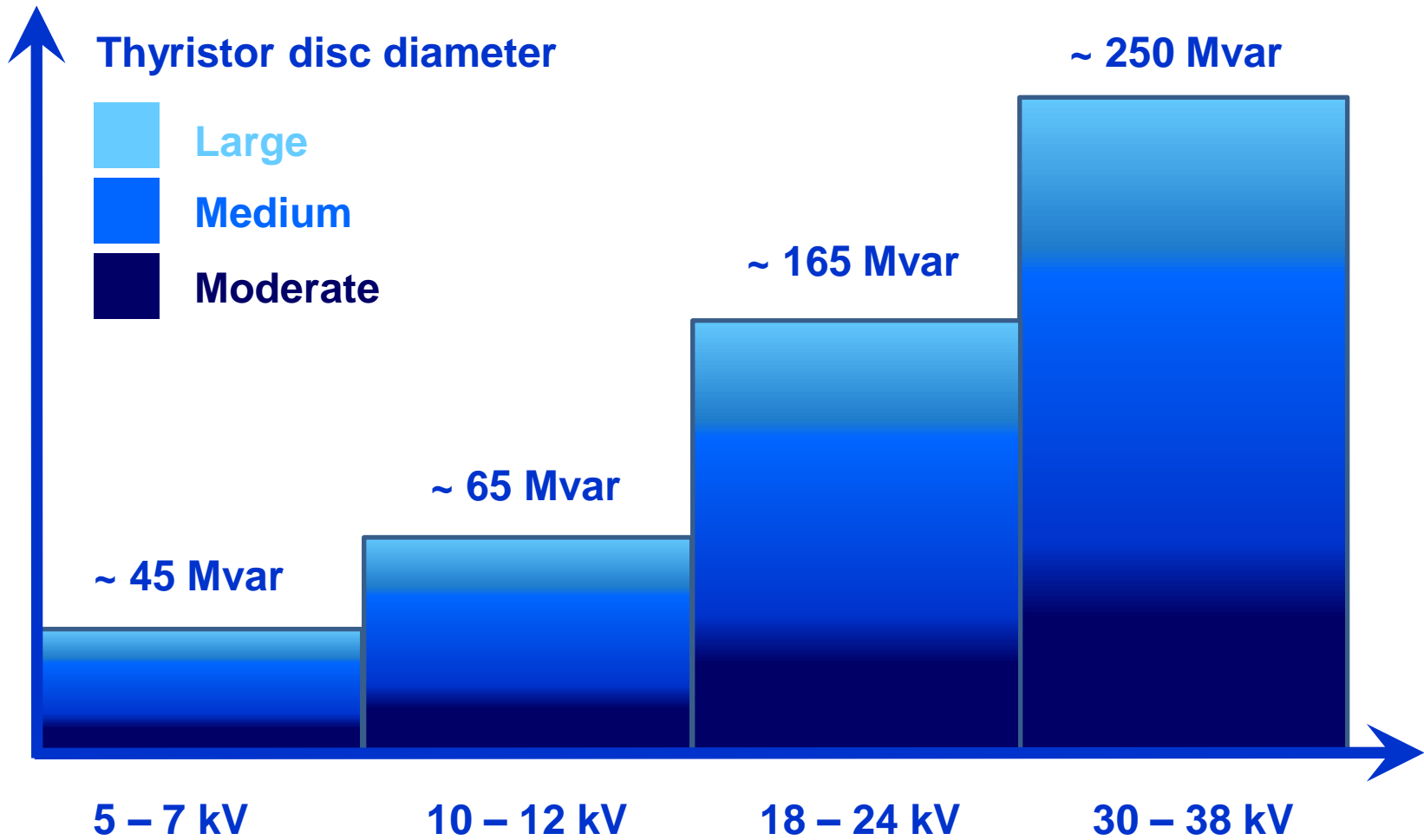
$$Q_{SVC} = \frac{U^2}{Z_{svc}} = \frac{1^2}{Z_{svc}} = 100\%$$

$$Q_{SVC} = \frac{0.9^2}{Z_{svc}} = 81\%$$

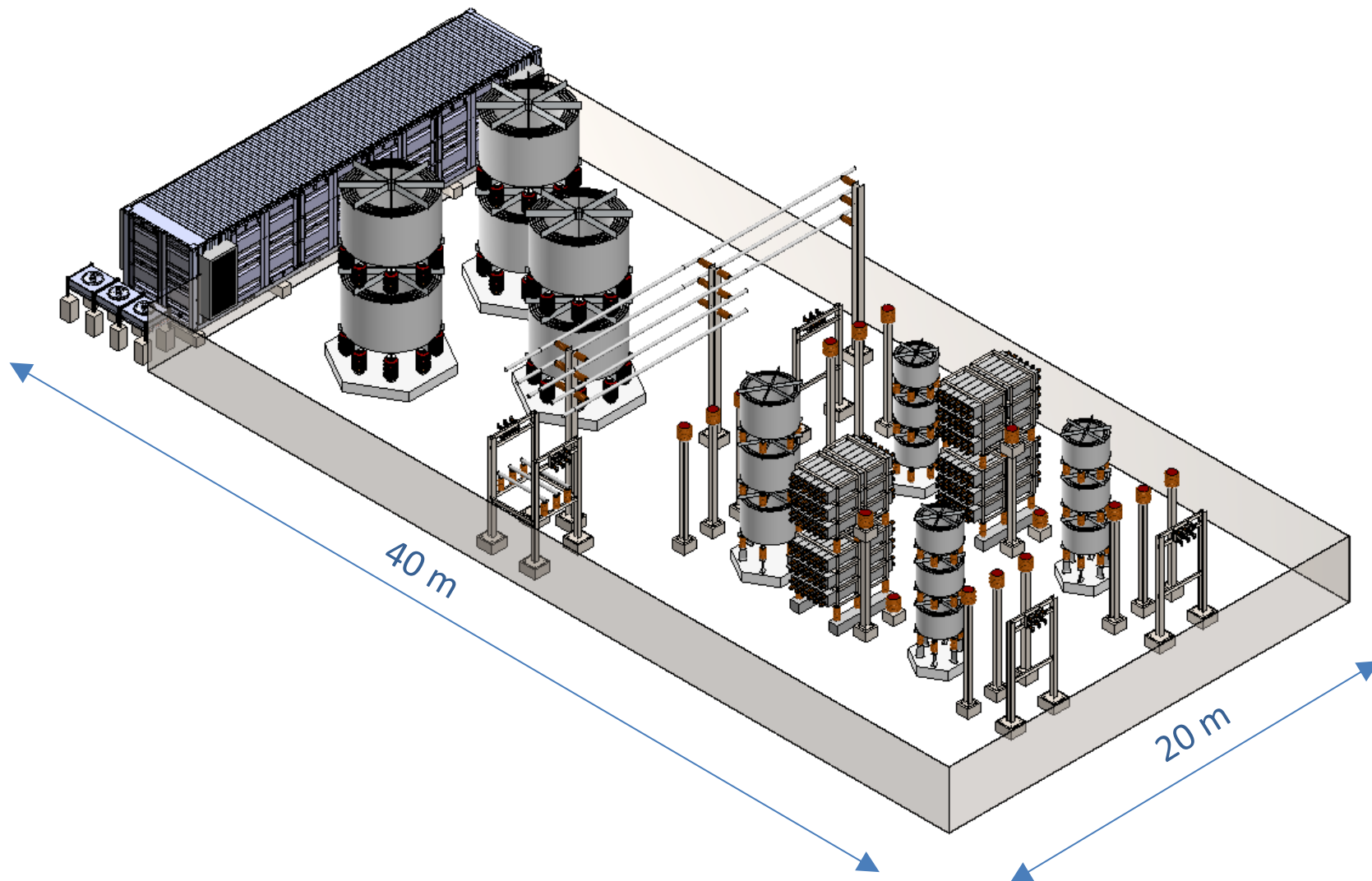


- Dynamic power factor correction
- Dynamic voltage control
- Elimination of voltage fluctuations
- Elimination flicker by factor up to 2
- Load balancing
- Problems created by voltage unbalance

SVC Power range

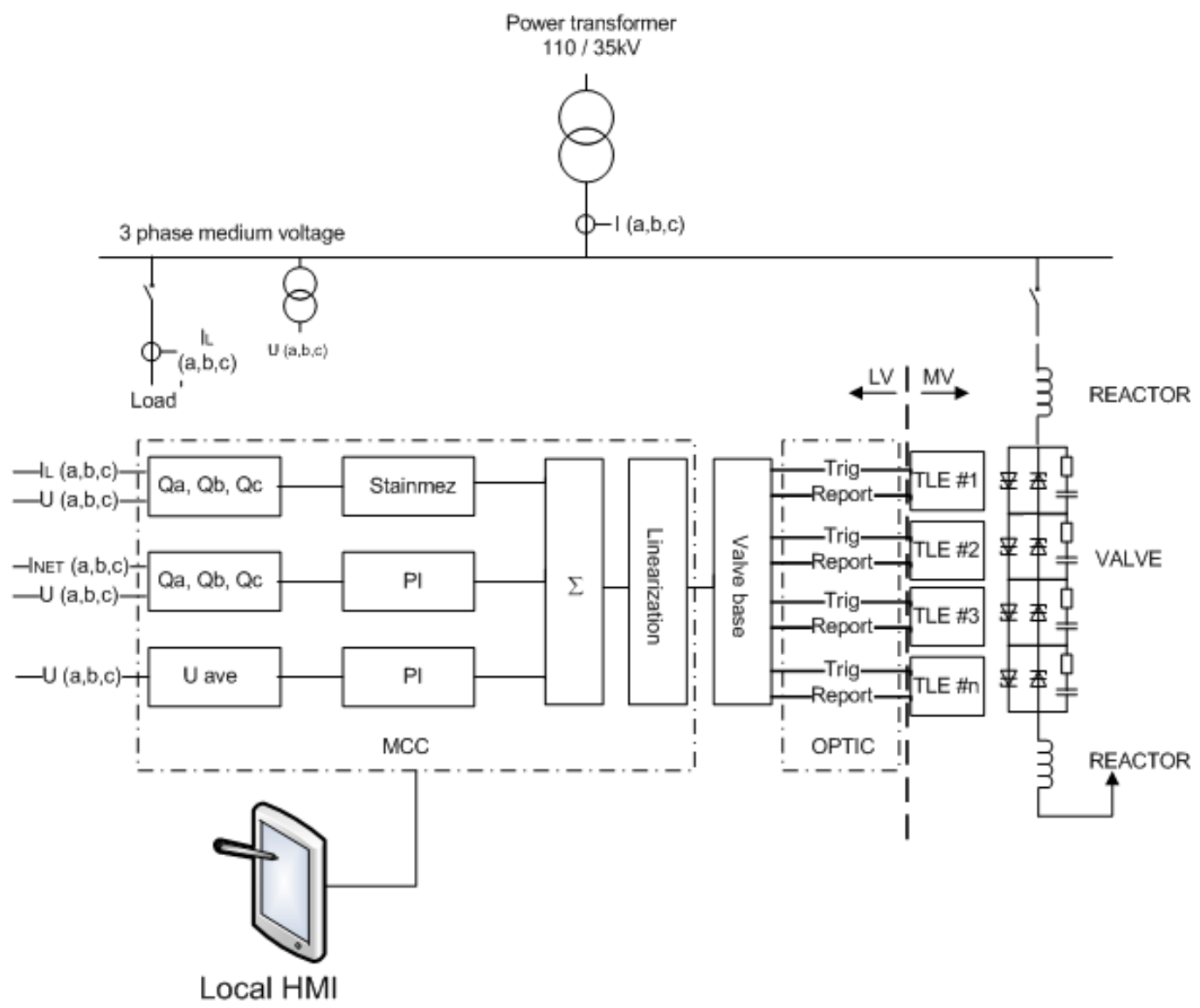


Static Var Compensator SVC





SVC control block diagram



Control and protection



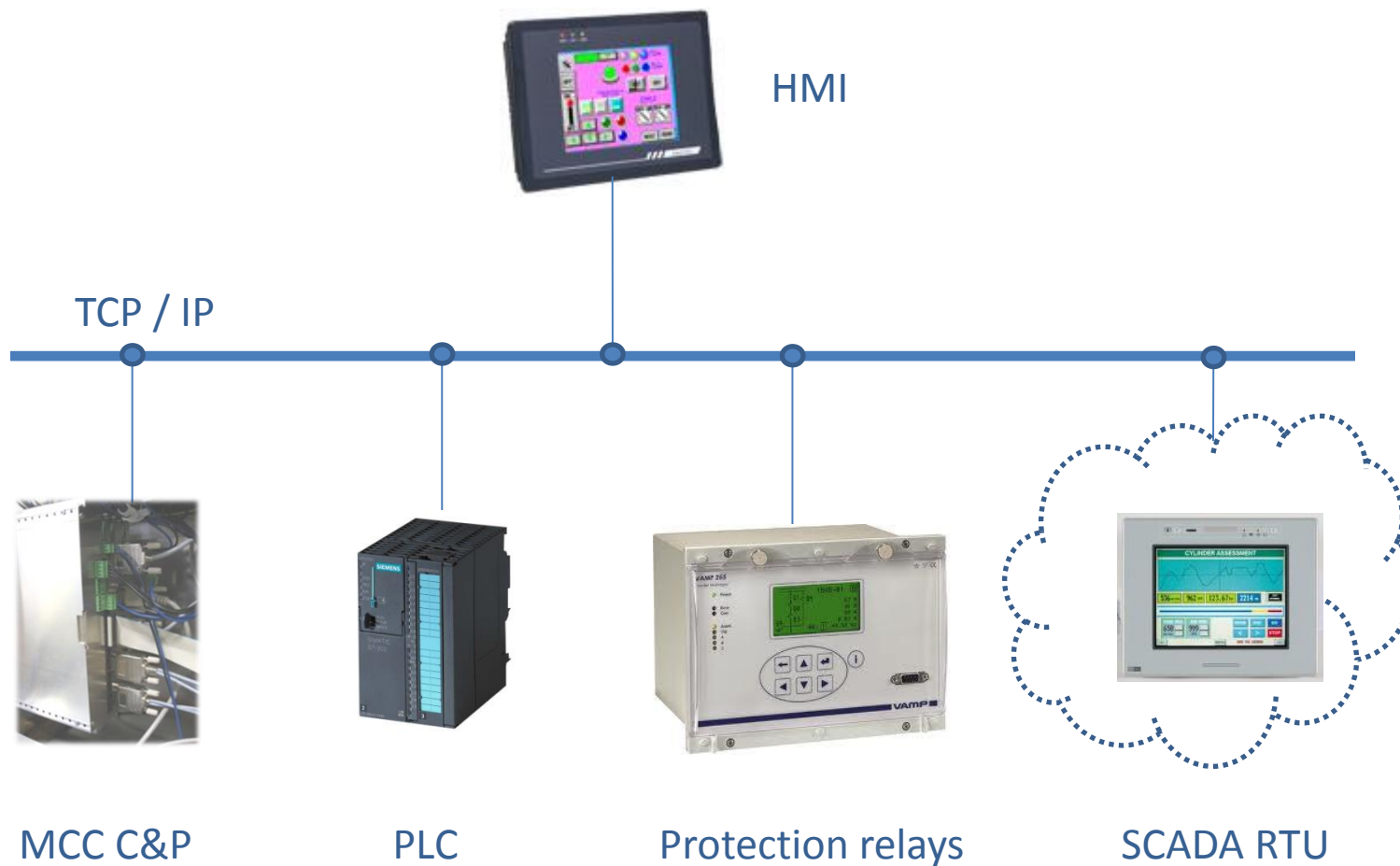
MCC controller



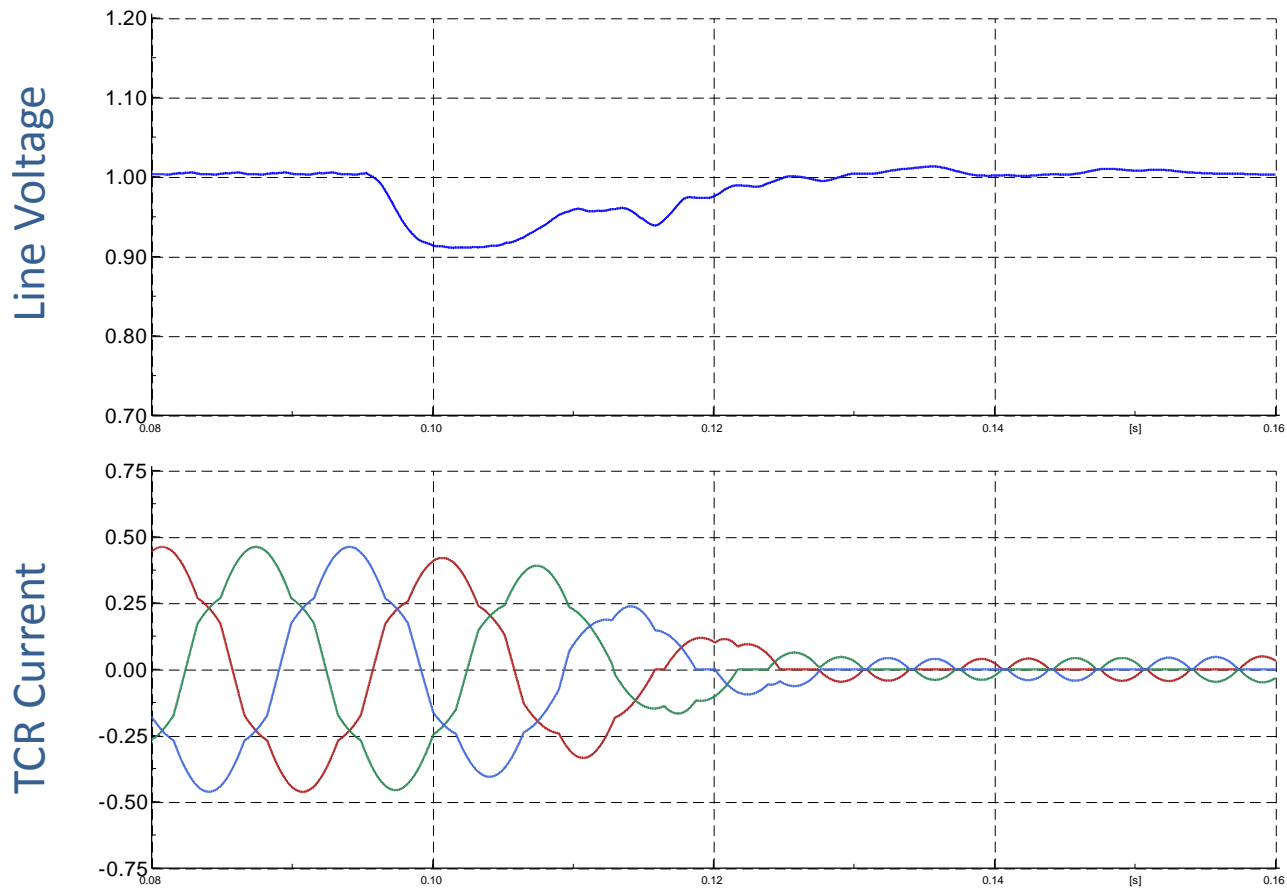
Orsys DSP module



- Modular Controller Concept
- Any control application possible by different stack combinations
- Remote communications via TCP/IP
- Robust design for harsh environment



SVC response





MES Energy Storage System Heavy Industry

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The device can be understood as controlled current source which provides any kind of current waveform in real time including active power!

Device is connected parallel with the load to be compensated.



1) Operation mode: **Normal system supply**

- Elimination of harmonic currents and voltages in real time
- Real time total power factor correction
- Real time reactive power compensation
- Elimination of voltage fluctuations and flicker
- Load balancing
- Problems created by voltage unbalance

2) Operation mode: Interruption and voltage sags in **system supply**

- Real Active and reactive power source
- Voltage control



Fault Mode - Active Power Support during Power Outages

- Voltage sags
- Auto reclosings
- Seconds Power Outages
- During Emergency Diesel Energizing

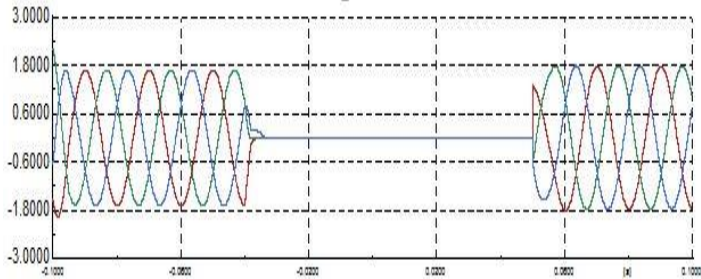
Normal Mode- Power Quality Improvement

- Active Harmonic Filtering
- Power Factor Improvement
- Voltage Stabilization
- Load Balancing

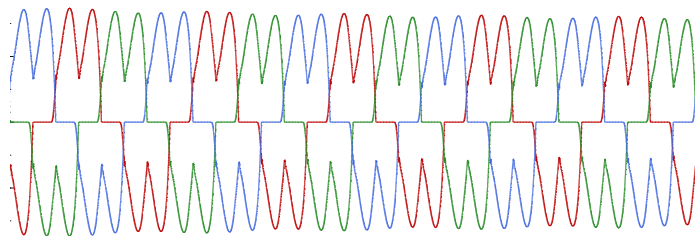


MES – Operation Principle

Power Outages

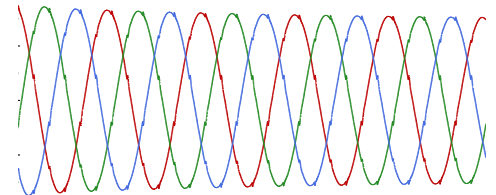


Poor Power Quality



Customer Benefit

Uninterrupted high power quality



Fault Mode

Normal Mode

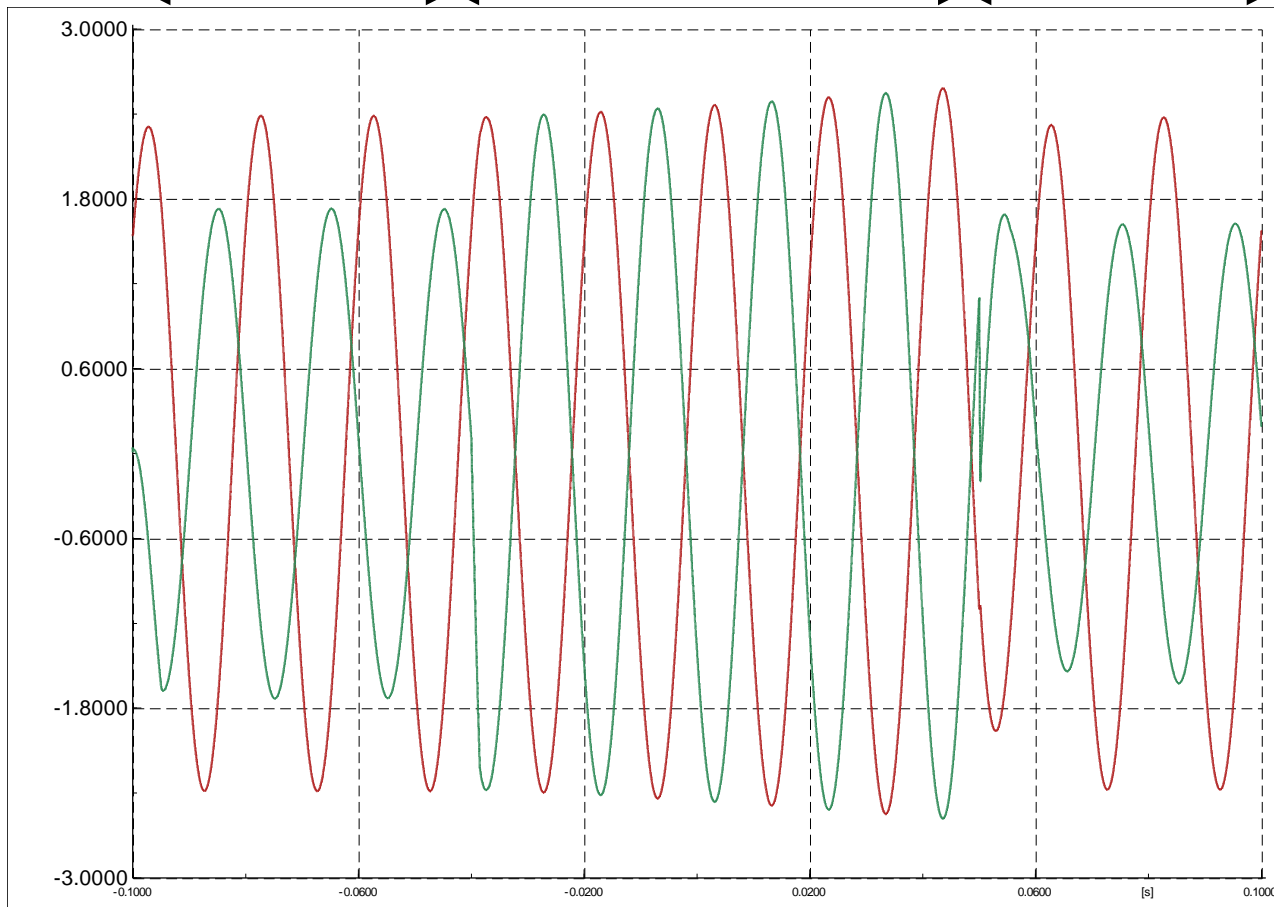
MES – Operation Principle



MES1000
Operation mode:
Reactive power
and
voltage control

MES1000
Operation mode:
Energy source
and
voltage control

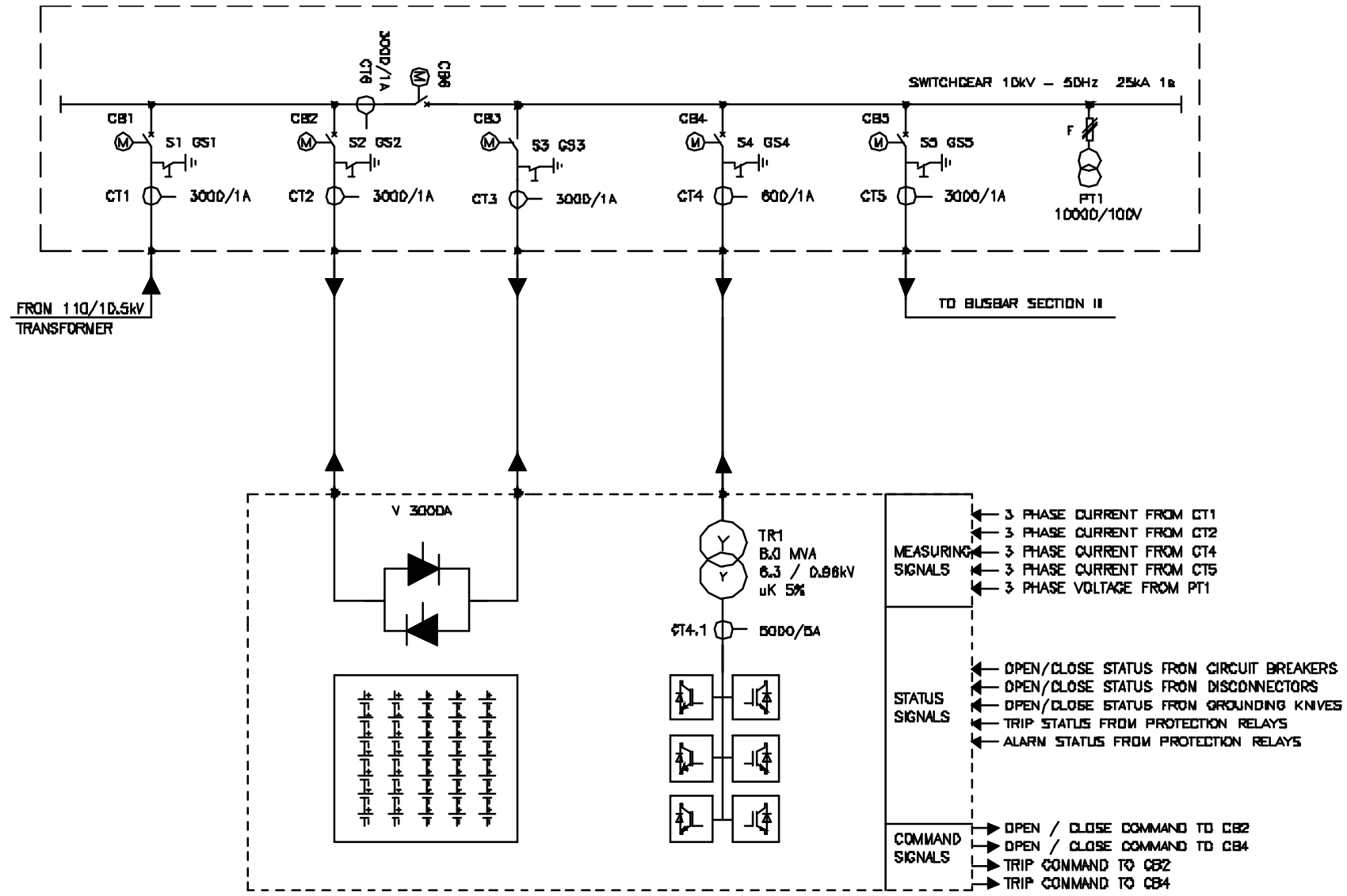
MES1000
Operation mode:
Reactive power
and
voltage control

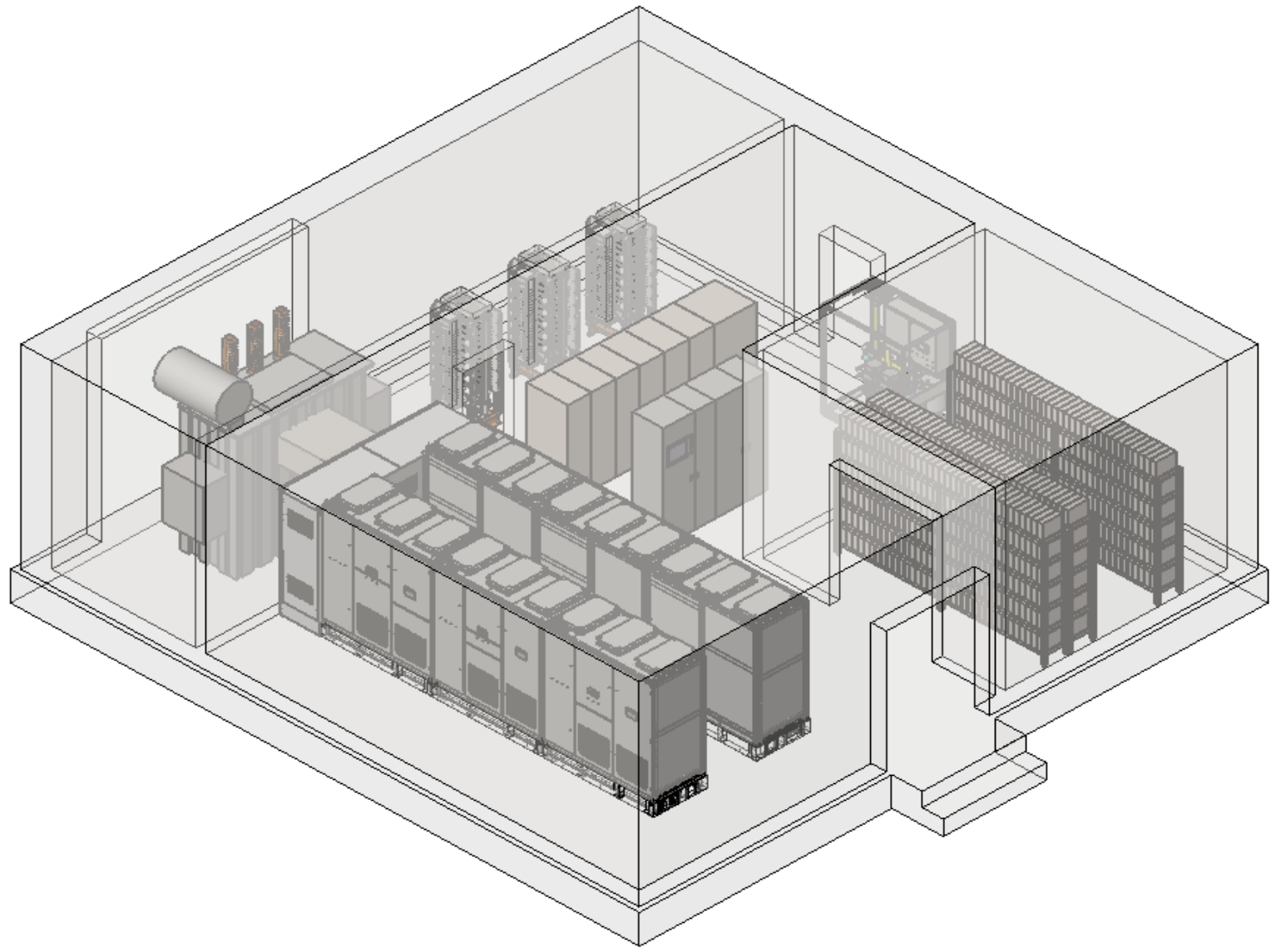




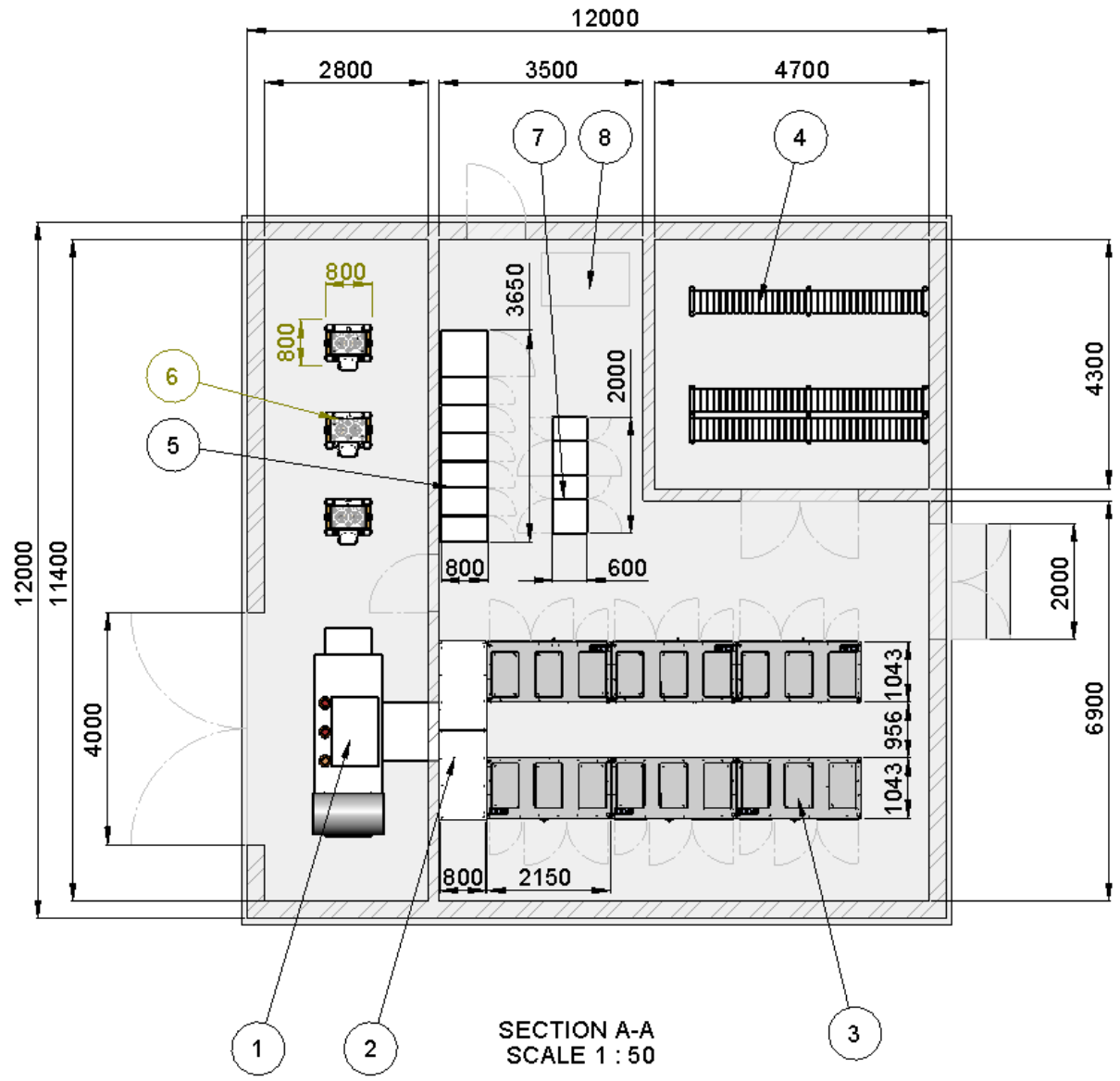
- Nominal active power capacity is 8MVA 3 seconds at 10.5kV
- During fault interruptions and voltage sags the bus voltage at 10.5kV level is maintained $10.5\text{kV} \pm 8\%$ according to the GOST standard
- Nominal continues reactive power capacity is 8Mvar at 10.5kV
- Continues voltage control range at normal operation is $\pm 8\%$ at 10.5kV

MES - SLD





MES - Lay Out





1. Power transformer
2. Busbar system
3. Merus power module M1000
4. Battery system
5. Switchgear
6. Static switch
7. Control, protection and monitoring system
8. Cooling system