

REQUIREMENTS AND SOLUTIONS FOR DYNAMIC VOLTAGE RESTORER A CASE STUDY

P. Dähler, R. Affolter, O. Apeldoorn
ABB Industrie AG
5300 Turgi, Switzerland

ABB Automation

ABB Industrie AG, Schweiz

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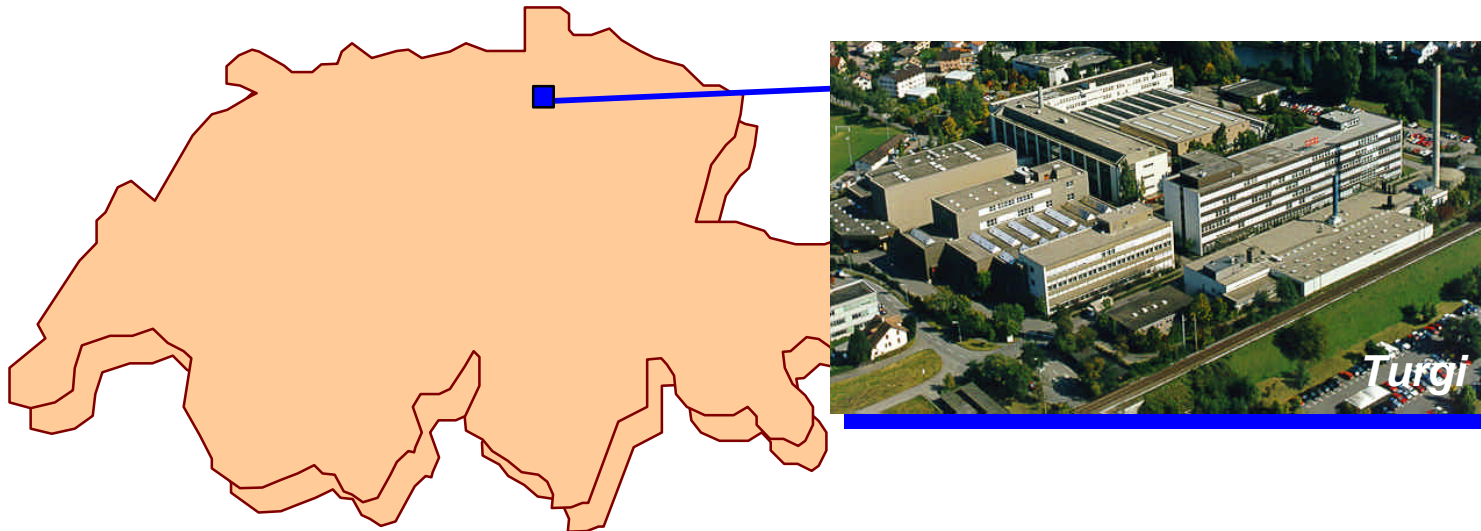


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Introduction

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Power Electronics Systems



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Market requirements

Market requirements determine:

- Sag & Swell compensation capability
- Reliability and Availability
- Losses
- Control and Protection
- Harmonics
- Monitoring

Operating Principle

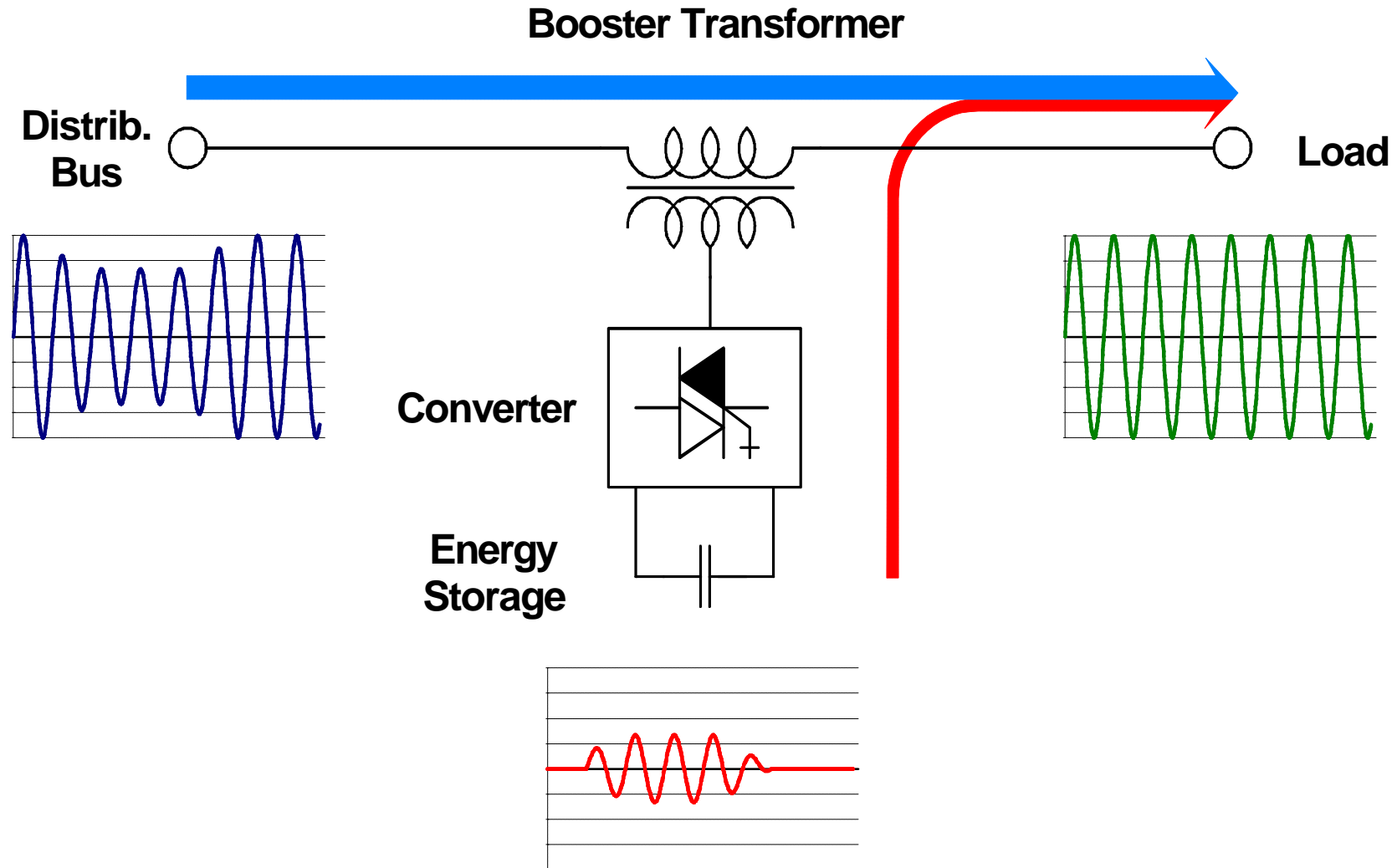


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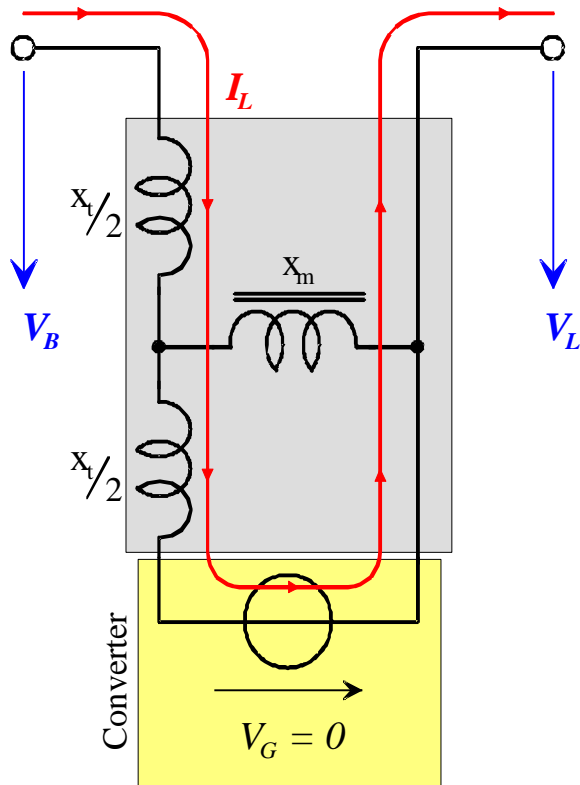
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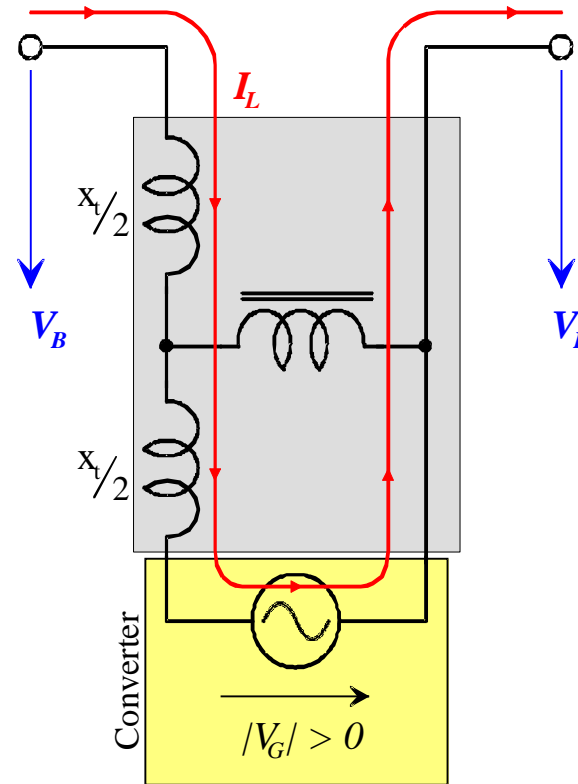


Operating Principle

Standby



Boost



shorted CT !

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Topology

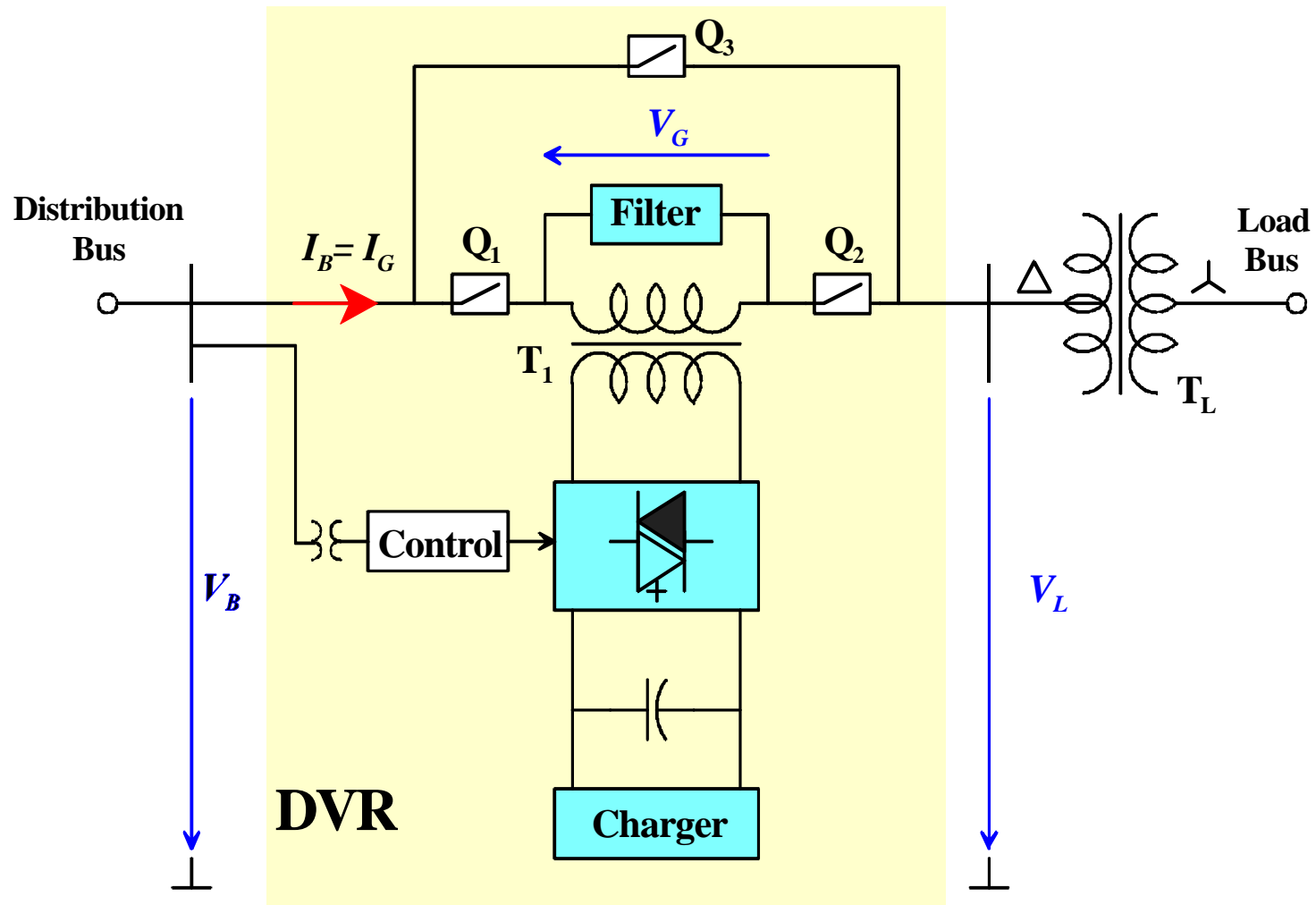


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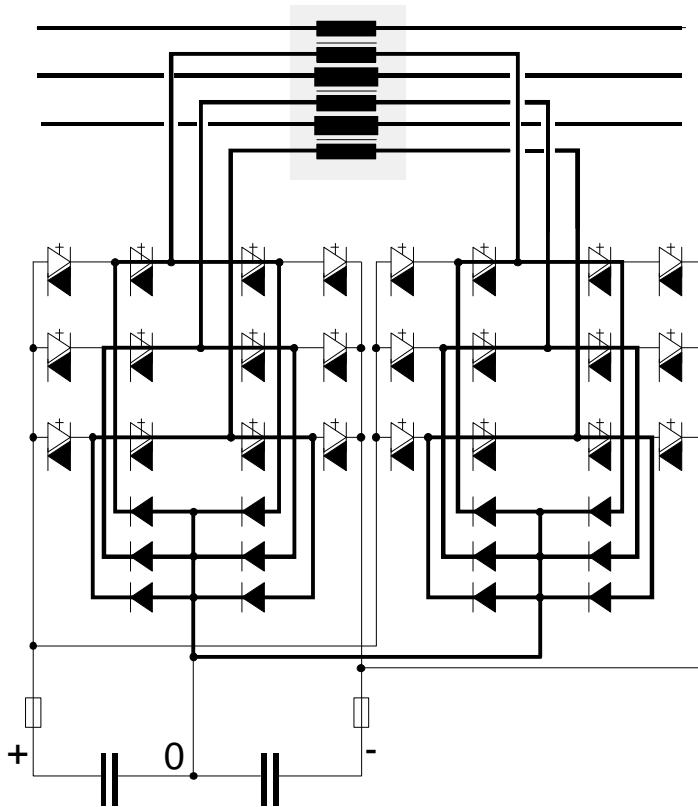
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Topology

Short circuit operation (SCO-Mode)



**No switching during
SCO - Mode**



**No switching losses
No harmonics**

Topology

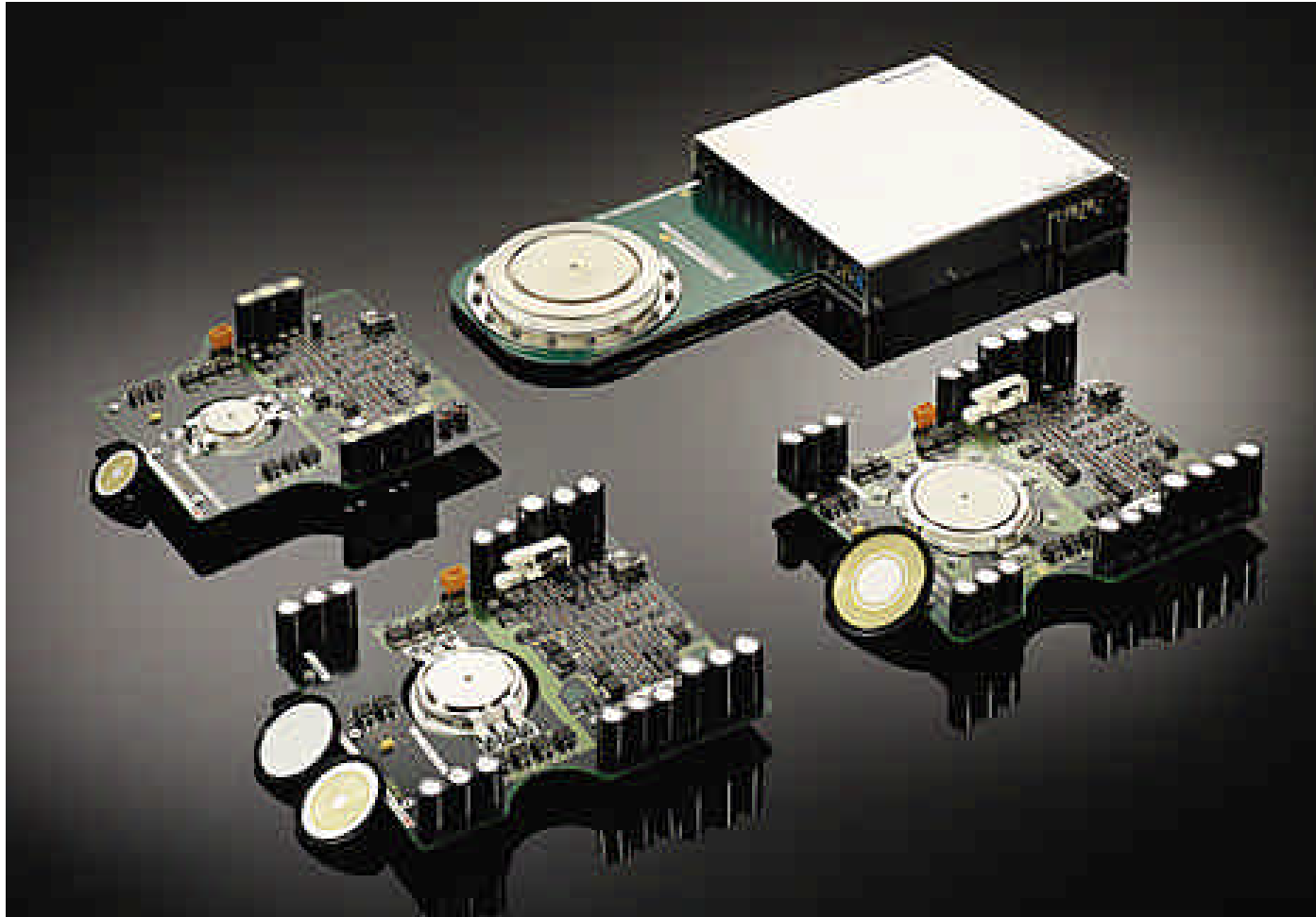


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Compensation Requirements

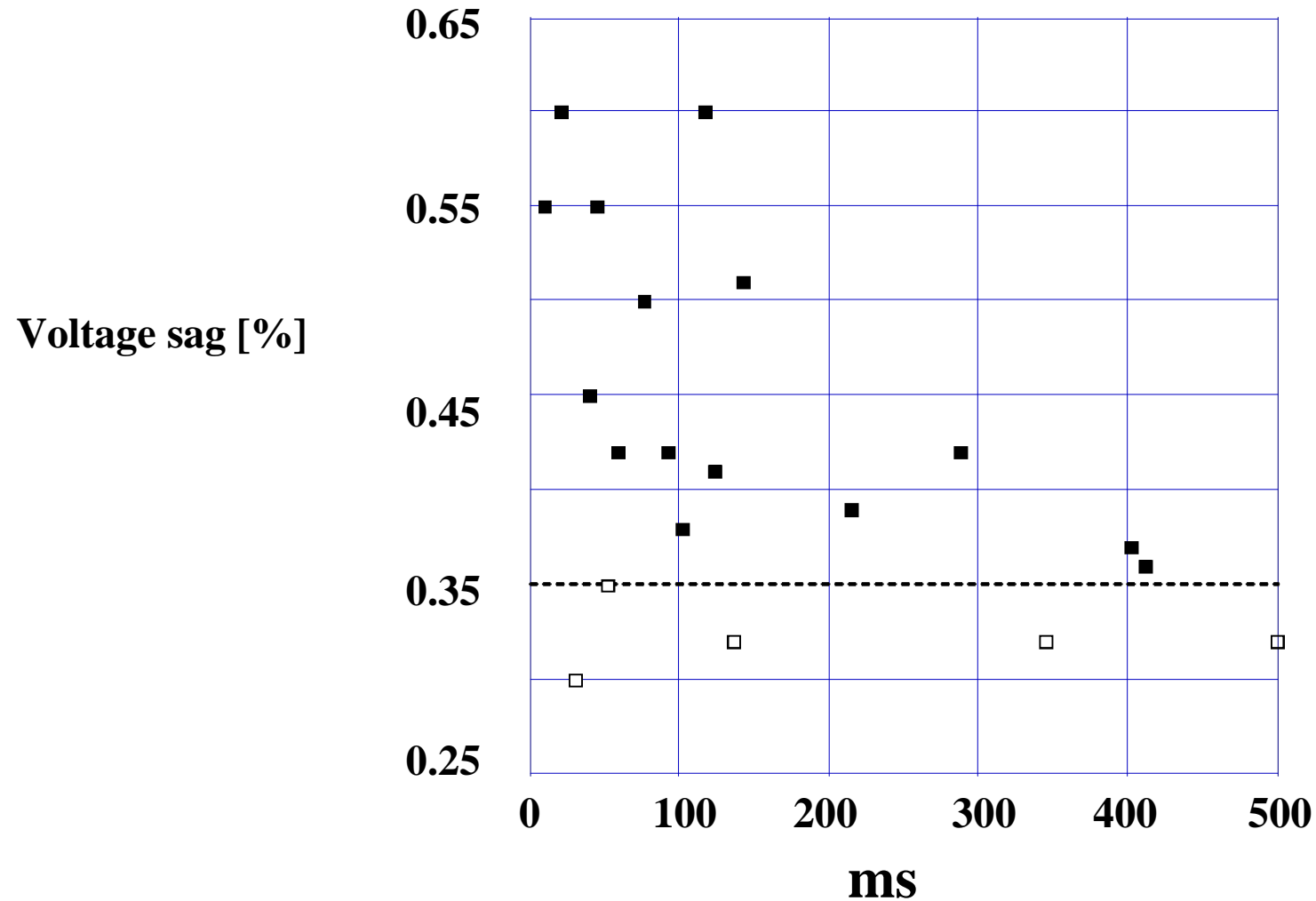


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Compensation Capability

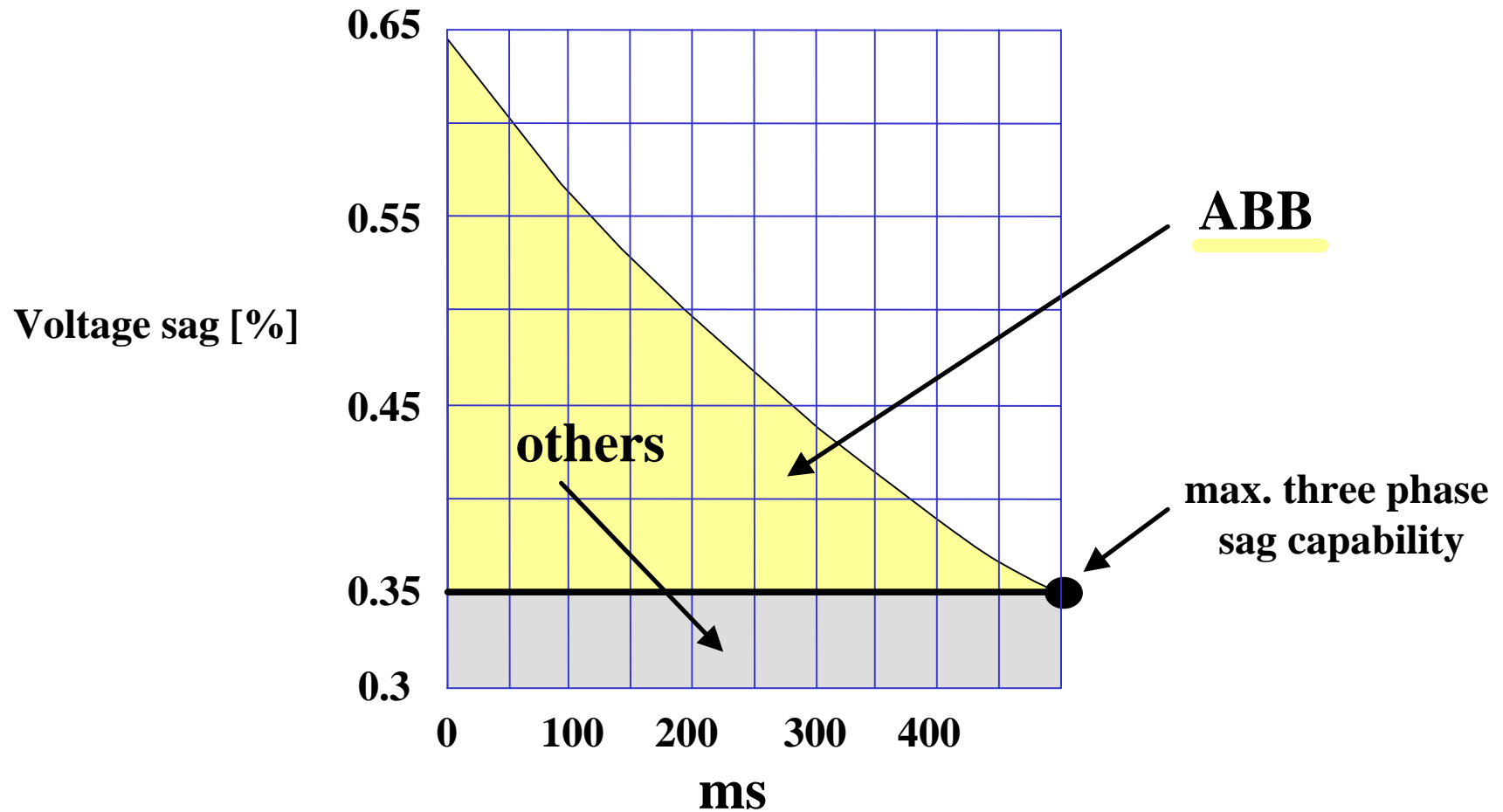


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Reliability Availability

- An Availability of $> 98,5\%$ can be achieved
- This is reached by
 - ▶ Simple Design
 - ▶ Low number of Parts
 - ▶ Implementation of the robust IGCT
 - ▶ Overcurrent capability

Reliability Availability

- 4 MVA load
- In operation since 1.5 years
- no IGCT failure (~200FIT)
- thyristor technology is at 100 FIT

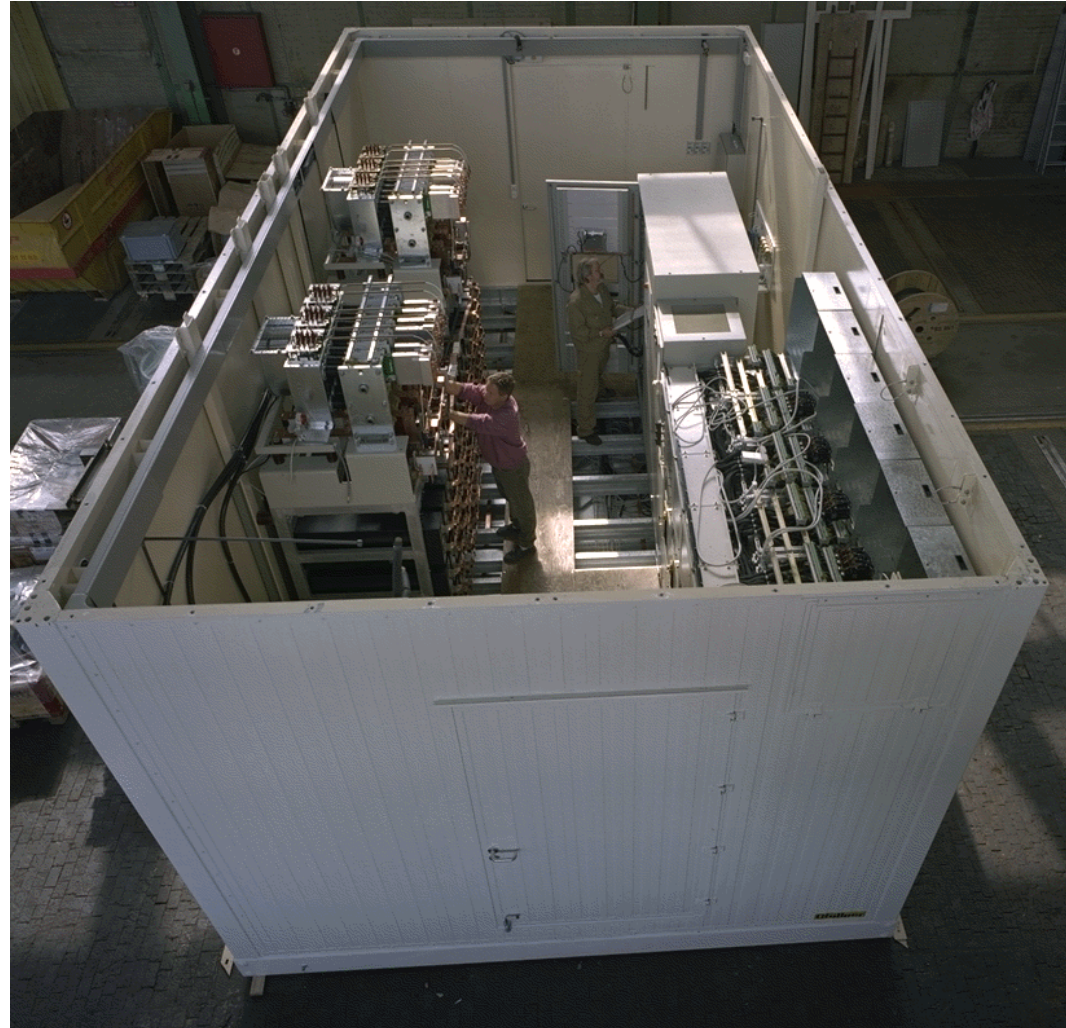


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Losses

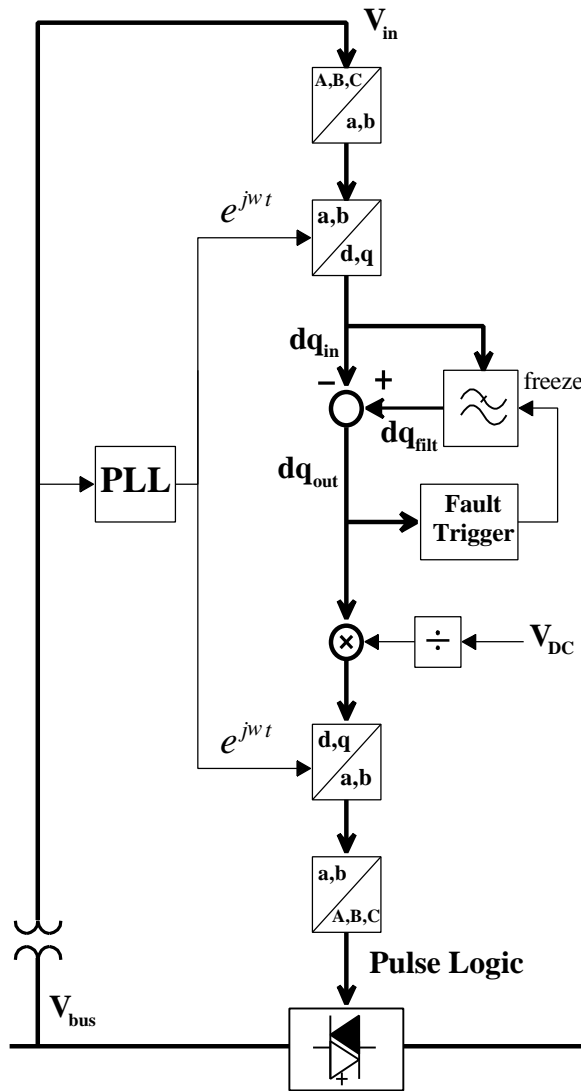
- Definition at SCO-Mode (Standby)
- Transformer losses (measured)
- Converter (calculated)
- Energy storage (calculated)
- Auxiliaries (measured)

Goal η $h = 98,5\%$

Losses

Feature	IGBT	GTO	IGCT
device on-state loss	100 %	70 %	50 %
device turn-off loss	100 %	100 %	100 %
device turn-on loss	100 %	30 %	5 %
gate drive power	1 %	100 %	50 %
short-circuit current	self limited (= f(t))	external (choke)	external (choke)
dv/dt snubber	no	yes	no
di/dt snubber	no	yes	yes
switch chip	discrete	monolithic	monolithic
diode chip	discrete	monolithic	monolithic
chip mount	solder	pressure	pressure

Control and Protection



☛ a,b Transformation, eliminate zero sequence

☛ Park's Transformation

☛ Low pass filter

**Voltage recovery
< 1 ms to 100%**

☛ DC Voltage compensation, state of charge

☛ Reproduce phasors

☛ Create 3-phase signals

☛ Pulse Width Modulator PWM

☛ Generate boost voltage

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Harmonics

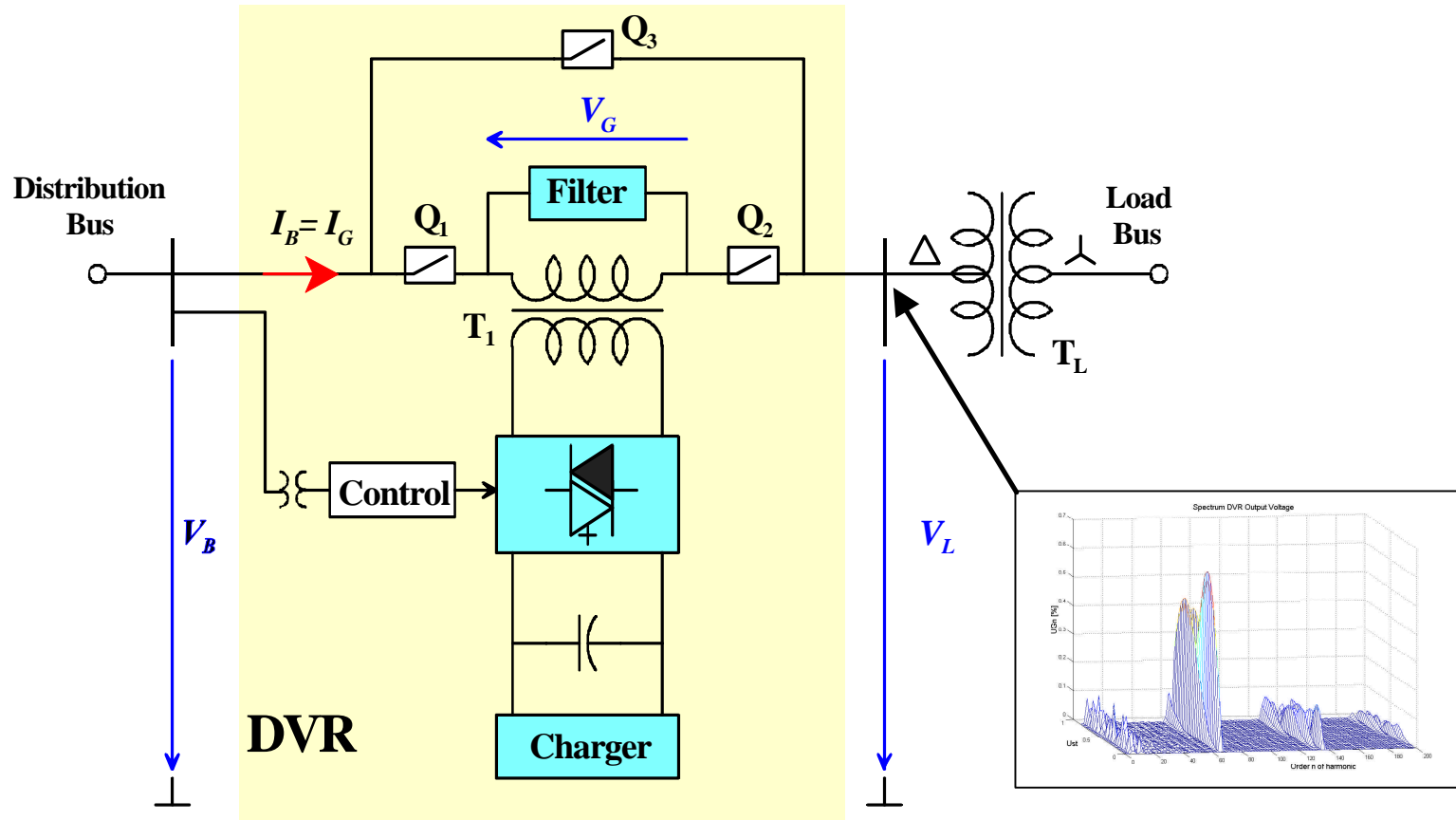


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Harmonics

Spectrum of DVR Output Voltage

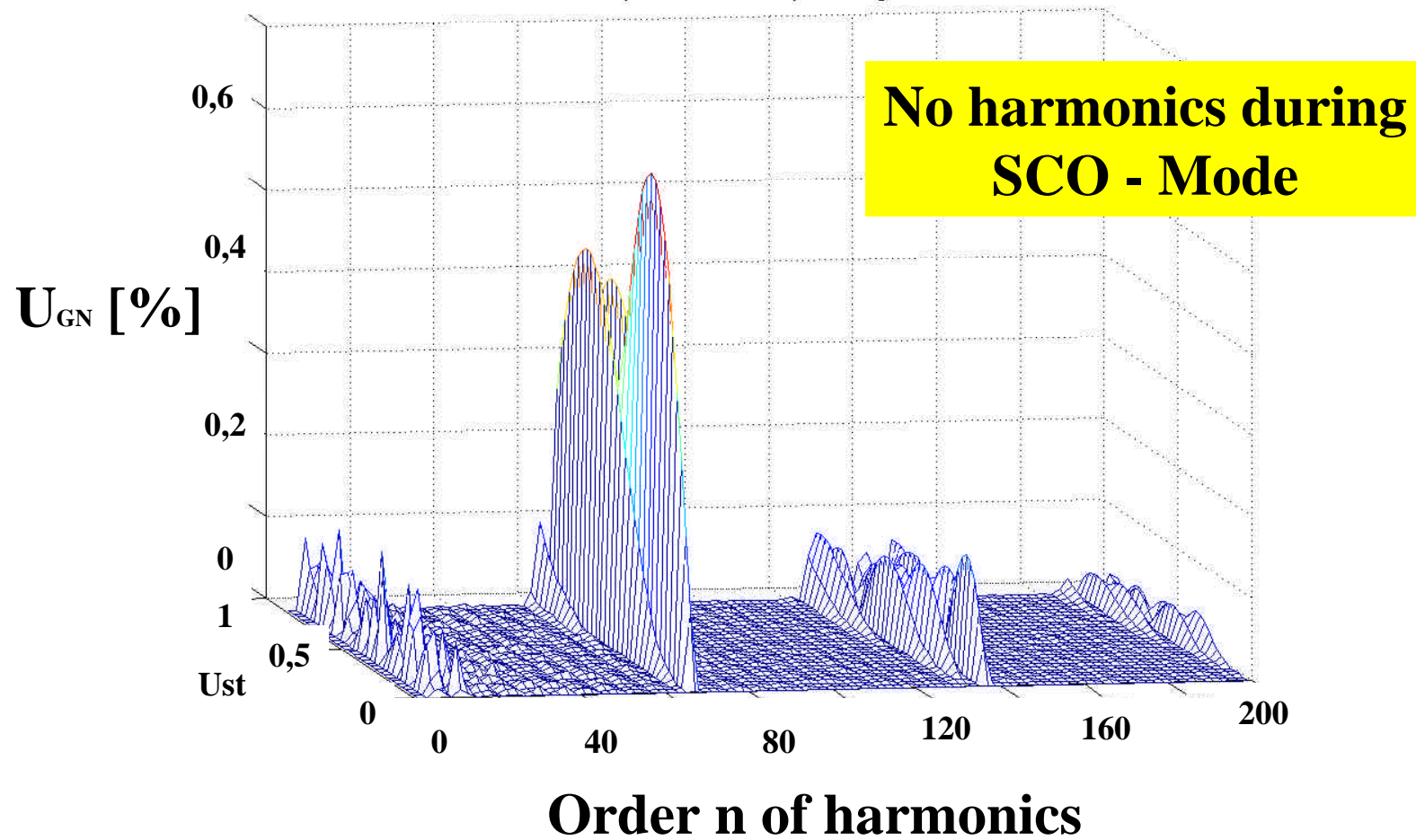


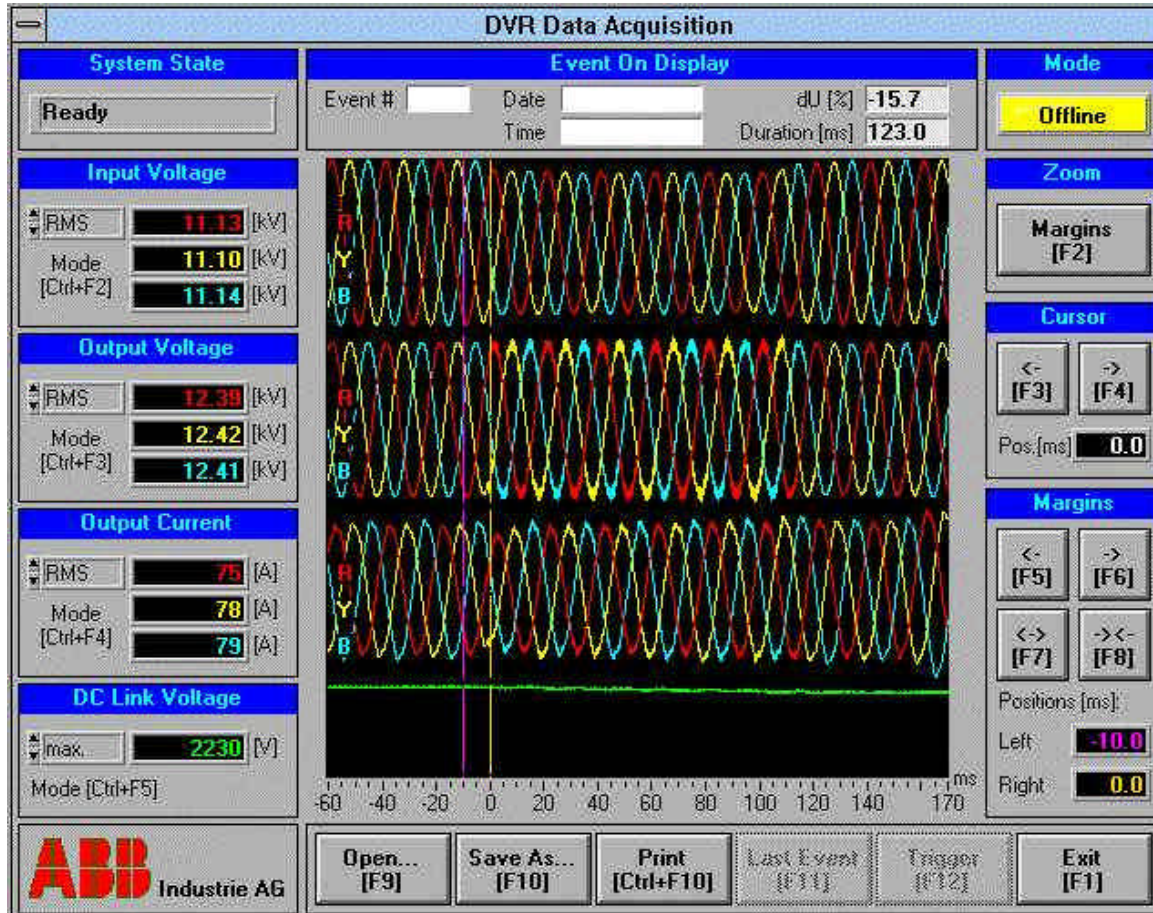
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Monitoring



- automatic data acquisition and logging
- remote online access
- remote data transfer
- PC-based interface RS232 or RS485
- remote diagnostics and software changes

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Design Parameters

- Load & Power Factor which has to be protected
- Voltage to be connected
- Maximum single phase sag [%] or
- Maximum three phase sag [%]
- Length of Sag [ms] to protect
- Area to be protected
- Recovery time for DC Link Voltage to 100%
- Overcurrent capability without going in bypass