NG03

New Generation 2005

convertron® MPT

MATRIX Inverter System

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NEWAGE AVK SEG

NG03: The New Product Genesis

Innovation – made by experience

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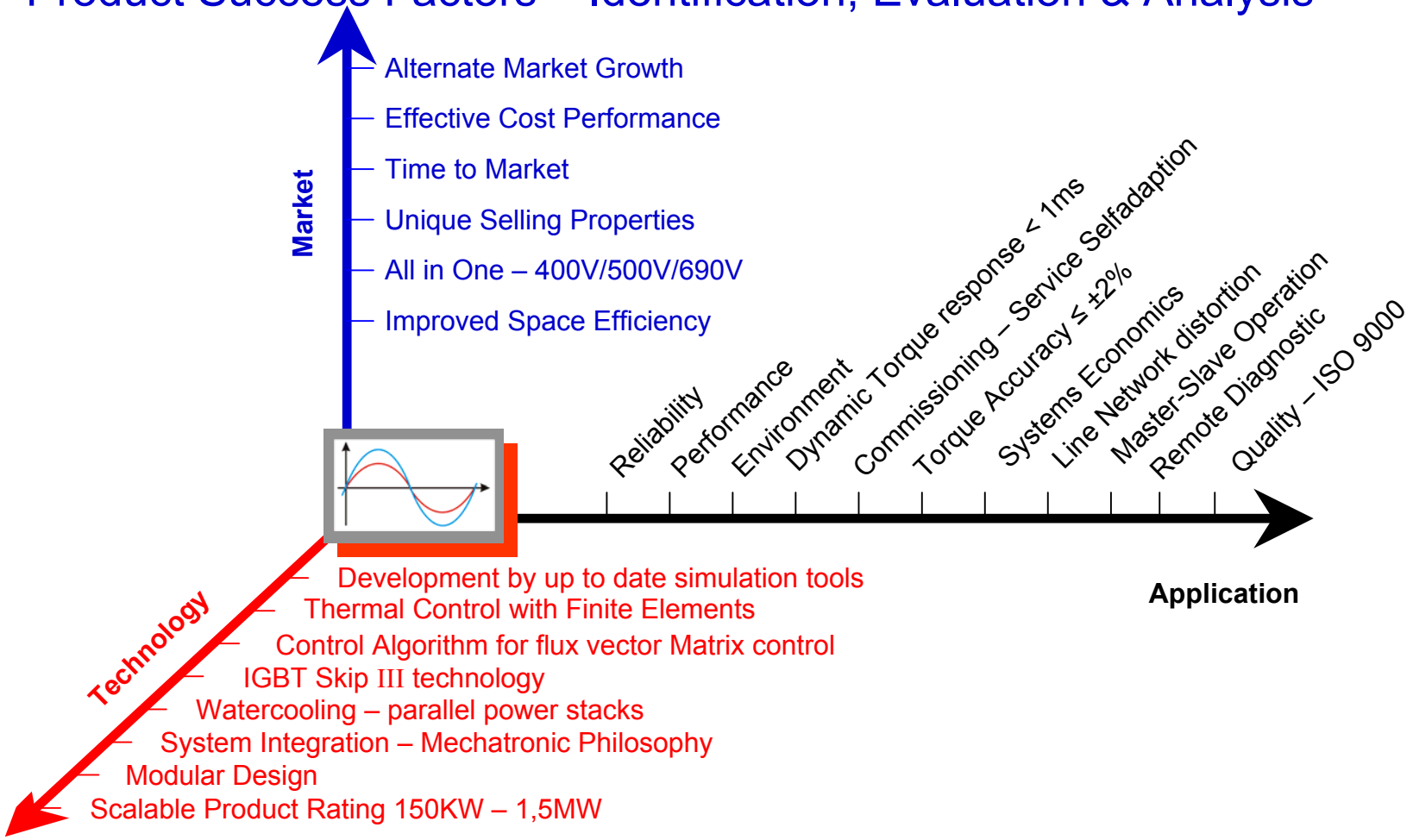
NG03: Phase 2 - New Converter Design Criteria

Product Success Factors – Identification, Evaluation & Analysis



The Magic Triangle

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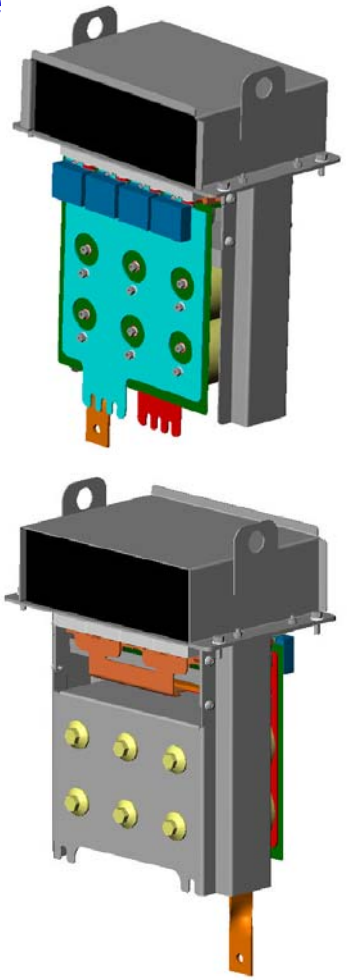
NG03: Single Phase Power Pole

High Performance IGBT Power Module

- Electrical Performance
  - Single Phase Module
  - Higher Performance Density
  - Low Power Losses
  - Polypropylene Capacitors
  - Ride Through Control Ready (Transient Voltage Sag)
  - Intelligent Control Board
    - ✓ Current & Temperature Analog Sensors
    - ✓ Parallel Module Control



Integrated & Modular Design: Electrically, Mechanically & Thermally

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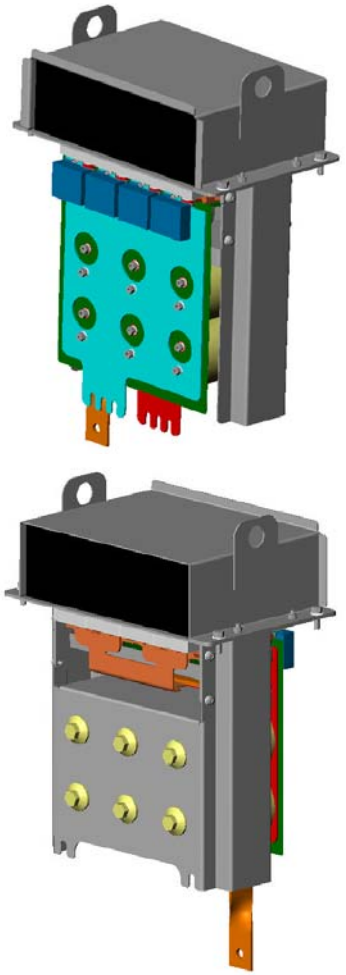
NG03: Single Phase Power Pole

High Performance IGBT Power Module

- Thermal
  - Lower Losses
  - Improved Heat Management – (Top Discharge)
  - Air Cooled Ready
  - or Water Cooled Ready
- Mechanical
  - Easy Module Exchange for Maintenance & Service
- Physical
  - Compact Packaging
  - Low Weight (Approx. 25kg)



Integrated & Modular Design: Electrically, Mechanically & Thermally

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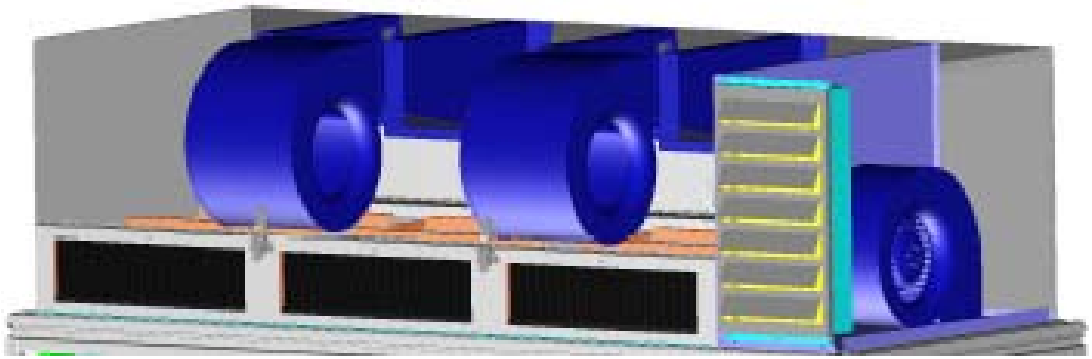
NG03: Converter Cooling

Converter Heat Sink & Air Blower Module Unit

- Integrated Heat Dissipation Management
  - Heat Sink Ventilation
  - Air Conditioner Ready
- Cabinet Thermally Isolated
- Easy Service & Maintenance
- Ready for External Air Duct
- Crane Ready for Easy Mounting & Removal
- Air Conditioning Ready



Smarter Ventilation & Heat Dissipation Management

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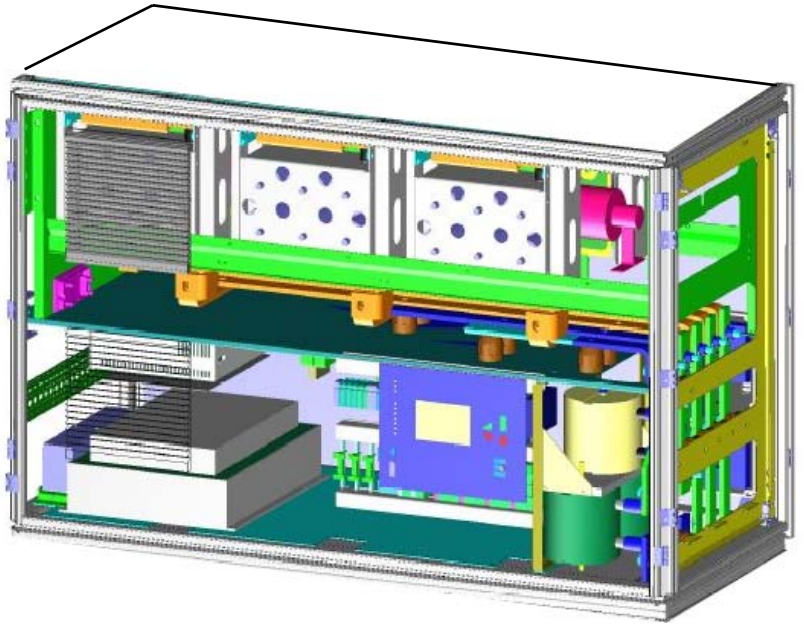
NG03: Power Converter Bridge

1.7 MW Power Converter Module Design :

- Six (6) Single-Phase Modules
- Chassis Factory Mounted; with
  - dV/dt Resistors
  - 1 kW Heater
- Busbars Connections
- dV/dt Choke In Very Short Distance
- Short Fibre-Optic Lines
- EMC Shielded Area Provide Noise Immunity for CSC Control & Electronic



Compartmentalized Design

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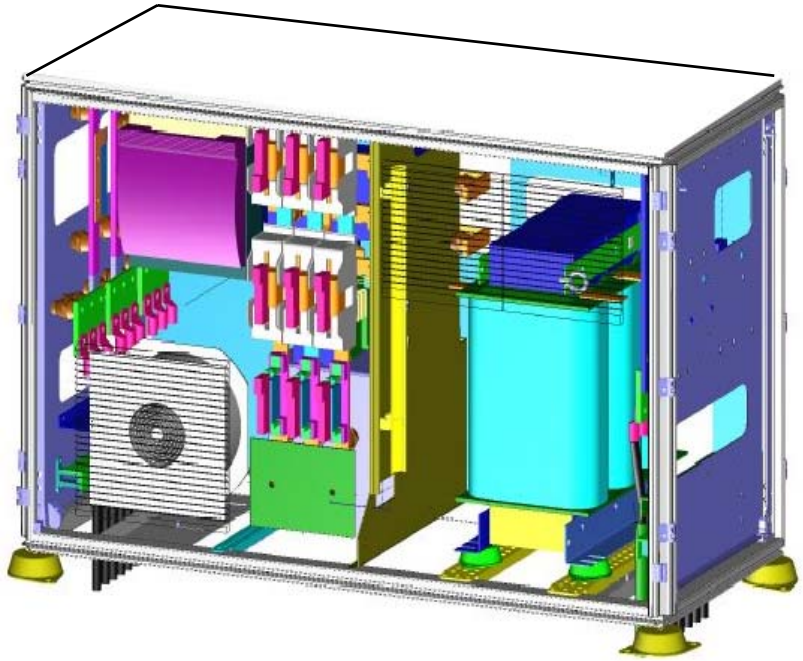
NG03: Line Side – Machine Side Interface

Filters, Grid Interface & Auxiliary Control Section

- Bottom Entry Cable Connection
- Dedicated Customer Control Interface
- Oscillations Decoupled Choke
- Improved Component Protection
  - Grid Filter Protection Fuse
  - Integrated Grid Side Contactor
- Circuit Breaker Ready - Option
- Shock-Damped Cabinet Construction



Improved Converter Control System Protection

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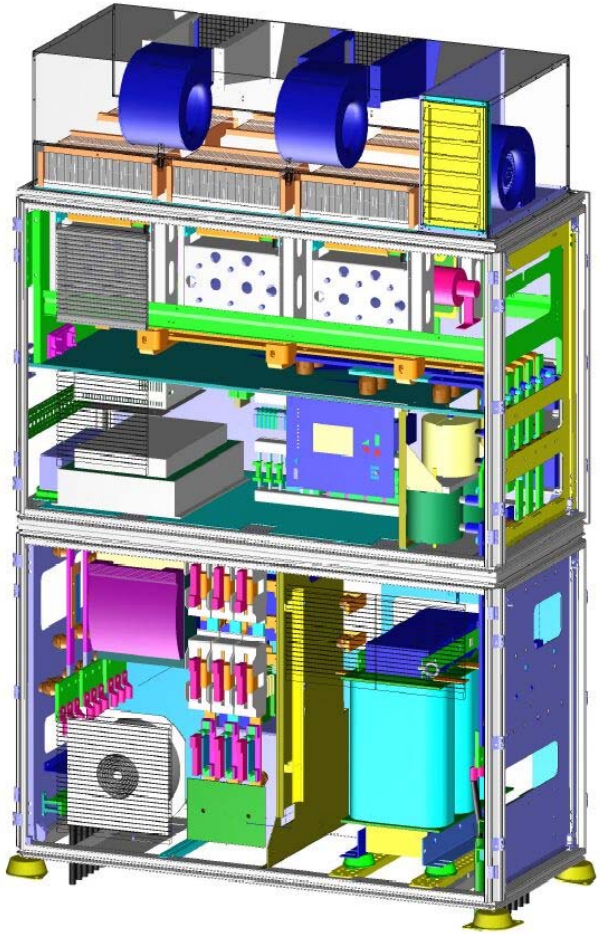
NG03: Complete Design Layout

Complete Final Interior Design 650 kW Module

- Compact Packaging
- Three Functional Zones in two Frames
  - High Power Zone Chassis - Converter
  - Controller & Low Power Interface Zone
  - Connection and Filter Components
- Zone Dedicated Air Conditioning
- High Noise Immunity
  - EMC Shielding
  - Short Distances Between Components
  - Minimal Use of Cable
  - Mostly Copper Busbars Connection
- IEC Code Compatible.
- Small Cabinet
- Sturdy Cabinet Construction



Cost Efficiency & Technical Performance

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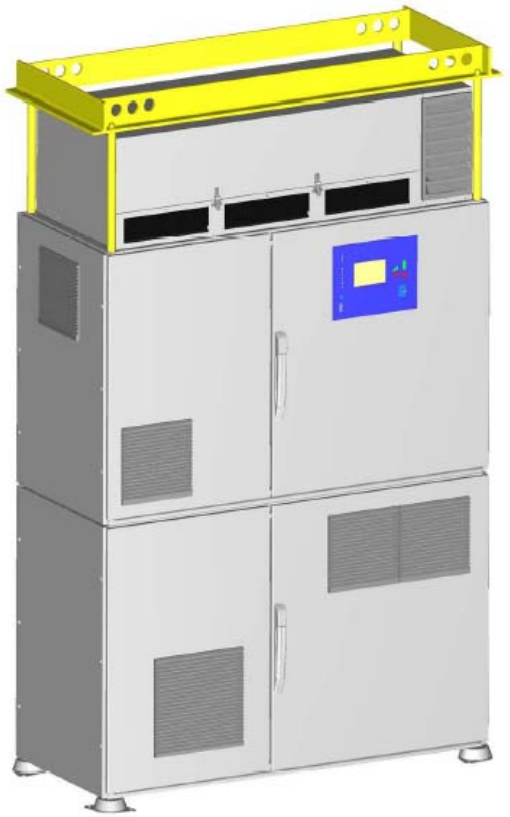
NG03: Cabinet Specifications

NG03 - Phase 2 Outside Design

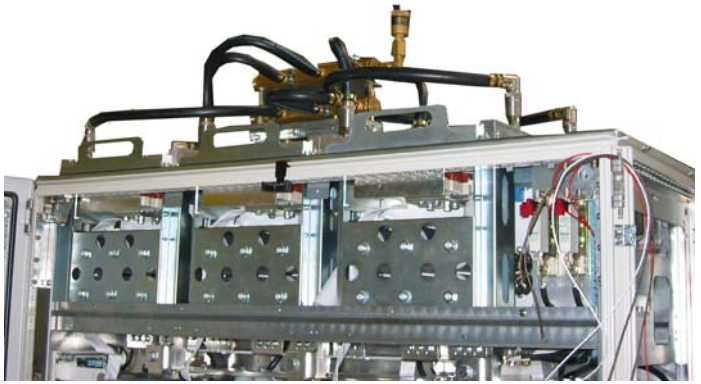
- Upper Cabinet Half is IP54
- Lower Cabinet Half is IP23
- Easy Component Acces & Service
- Dual Access: Front & Back Doors
- Cabinet Connections Sealed Waterproof
- Handling: Fork Lift & Crane Ready
- Blower Section is Top Mounted
- Outside Dimensions 600x1400x2200mm
- Two Vertical Cascaded Switchboards



NG03: Water Cooled System

Water Cooled Power Bridge Module

- Simplified Design
- Simplified Maintenance & Service
  - Quick & Easy Valve Coupling
  - Automatic Valve Closing
  - No Additional Water Run-Off Protection Needed
- Same Footprint as Air Cooled Unit
- Only Water Needed (No Liquid Coolant)
- Water Section Sealed & Isolated
- Dedicated Water Inlet & Outlet Per Module
- De-aerator on Highest Point



Efficient, Easy Maintenance & Service

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NG03: 1.7 MW Wind Turbine Power Converter System

The NG03 *CONCYLE*® Converter

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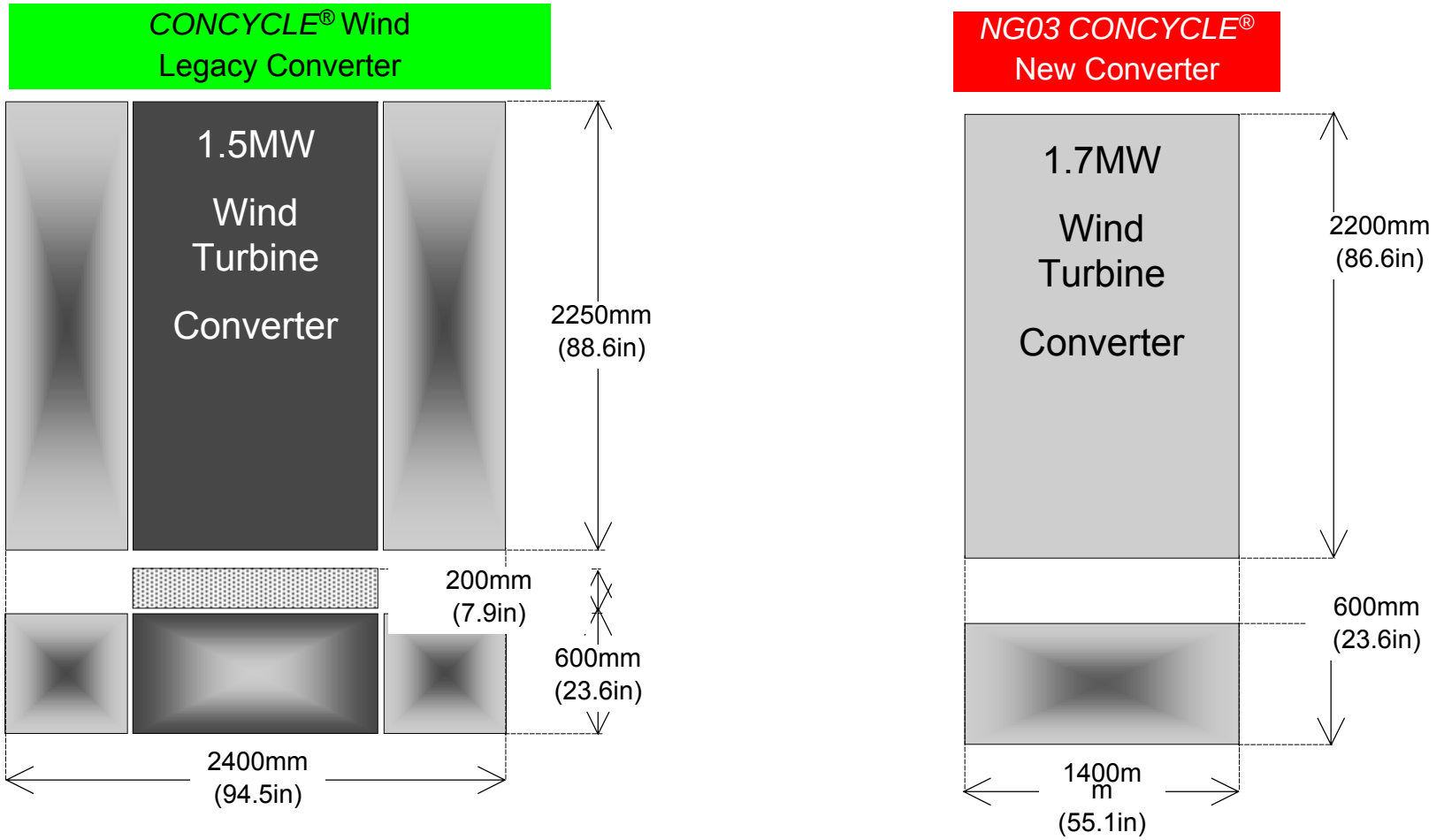
NG03: Power Density

NG03 *CONCYLE*® vs. *CONCYCLE*® Wind: Comparison of Dimensions



II. Generation ←→ *III. Generation* *(more than 3000 field installations)*

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NG03: NG03 CONCYLE® & CONCYCLE® Actual Systems

NG03 CONCYLE® & CONCYCLE® Wind Converter Control System

1,5 MW GE WE

1.7 MW NG03

II. Generation ← → III. Generation

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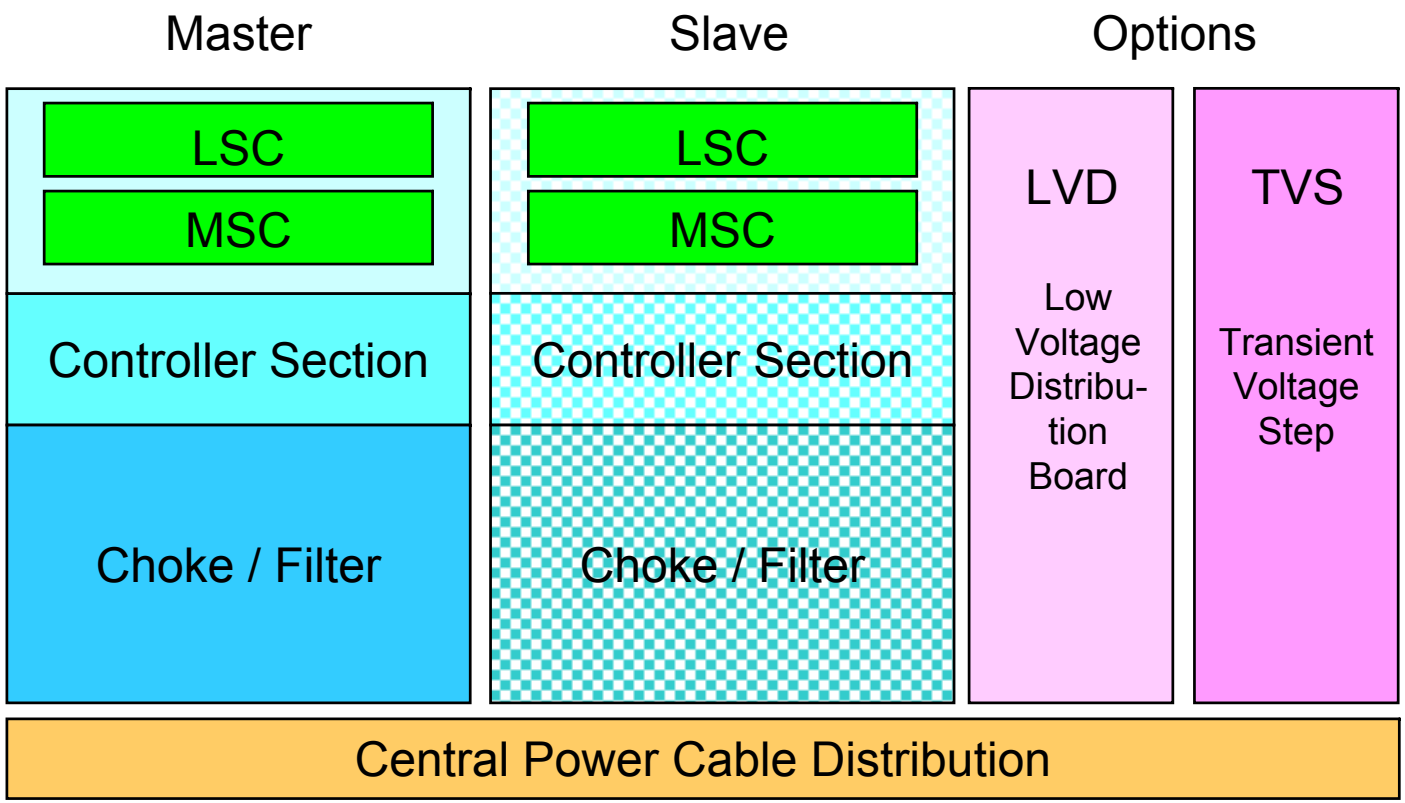
NG03: Master-Slave Configuration

Master-Slave Converter Architecture



Standardized Design, Modular, Expanded Functionality

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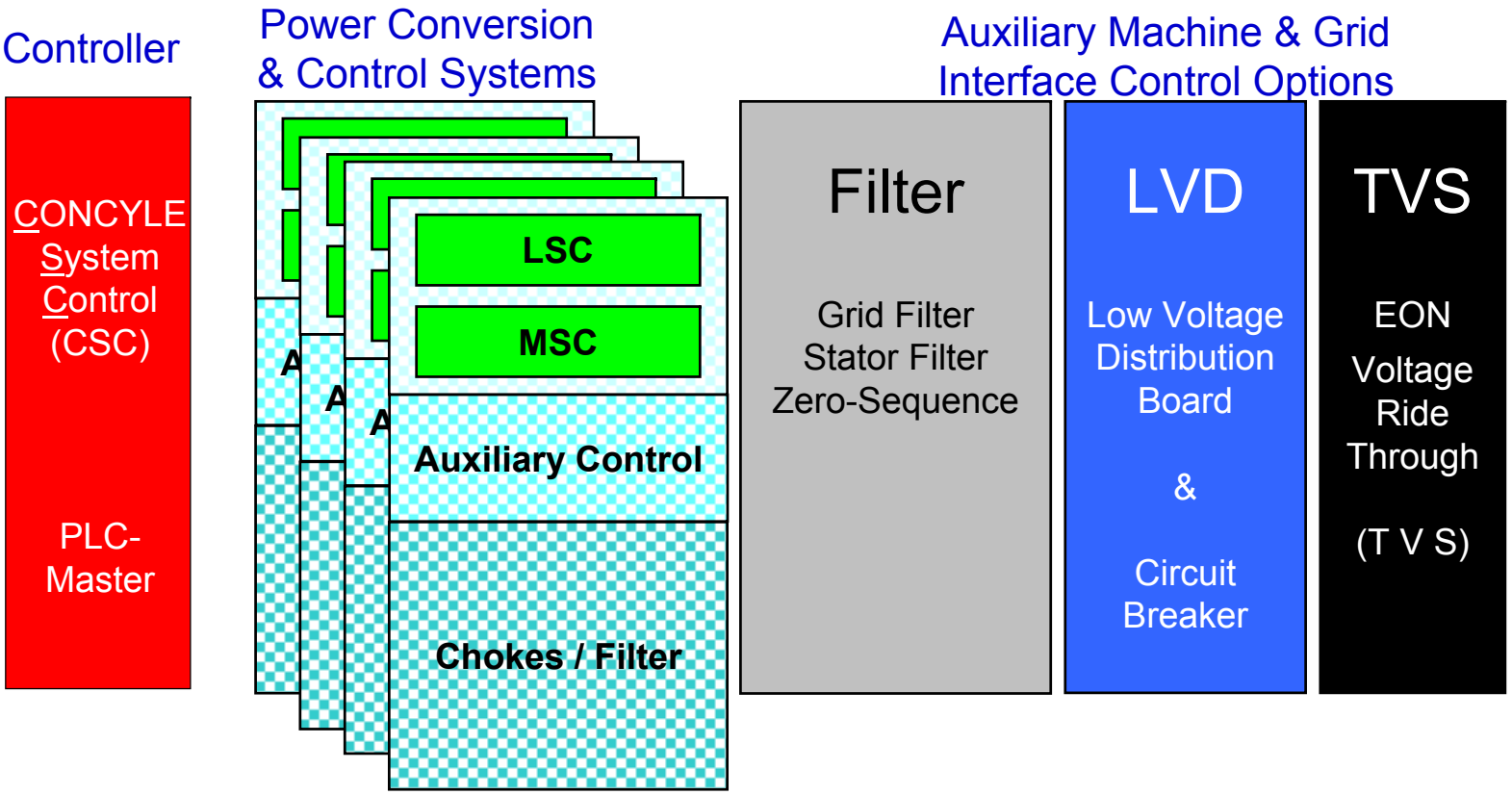
NG03: Multi-MW Class Wind Turbine Converter Example

5.0 MW Wind Turbine: Modular & Scalable Power Converter



Fully Integrated and Comprehensive Solution

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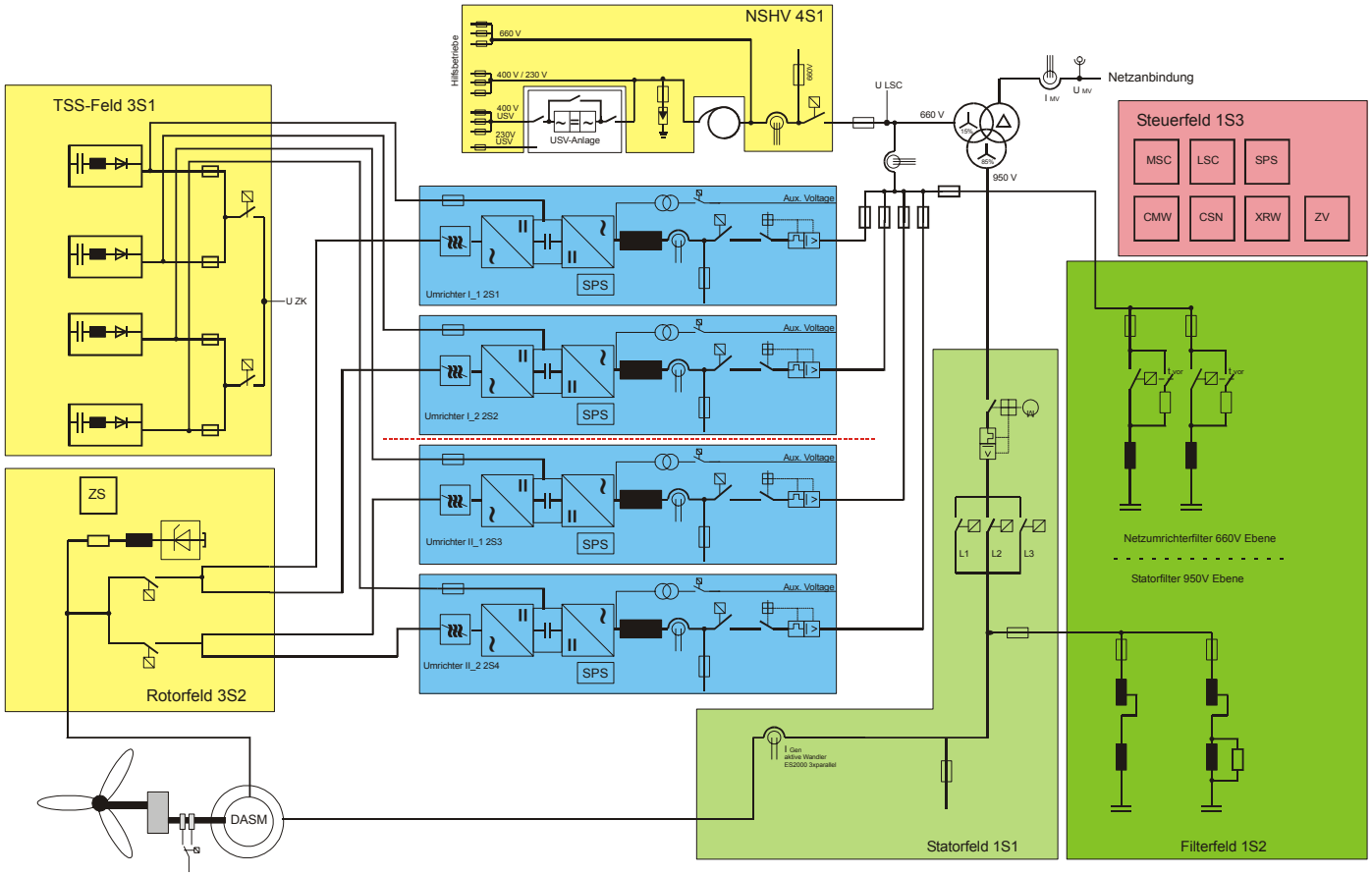
NG03: Multi-MW Class Wind Turbine Converter Example

5.0 MW Wind Turbine: System Layout



5.0 MW Layout

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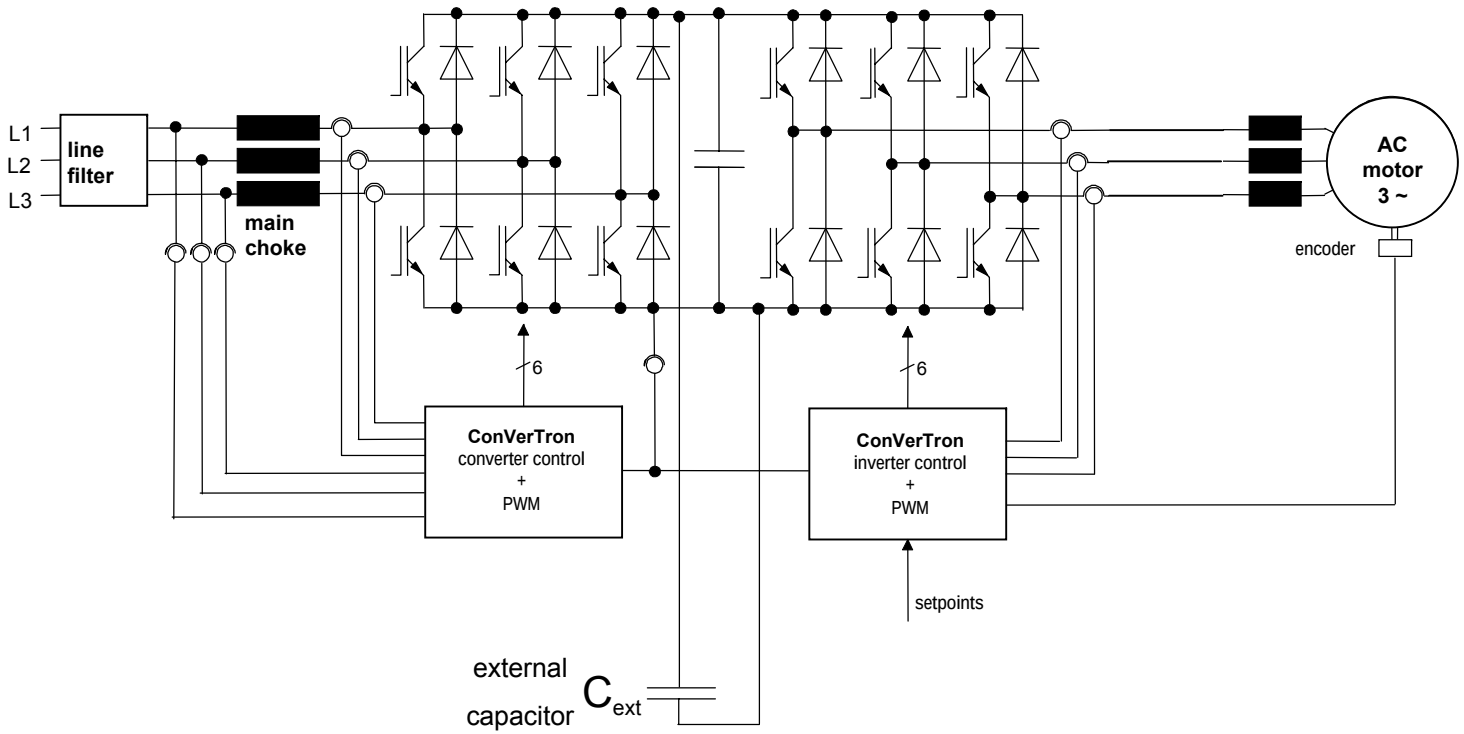
NG03: Principle Drawing



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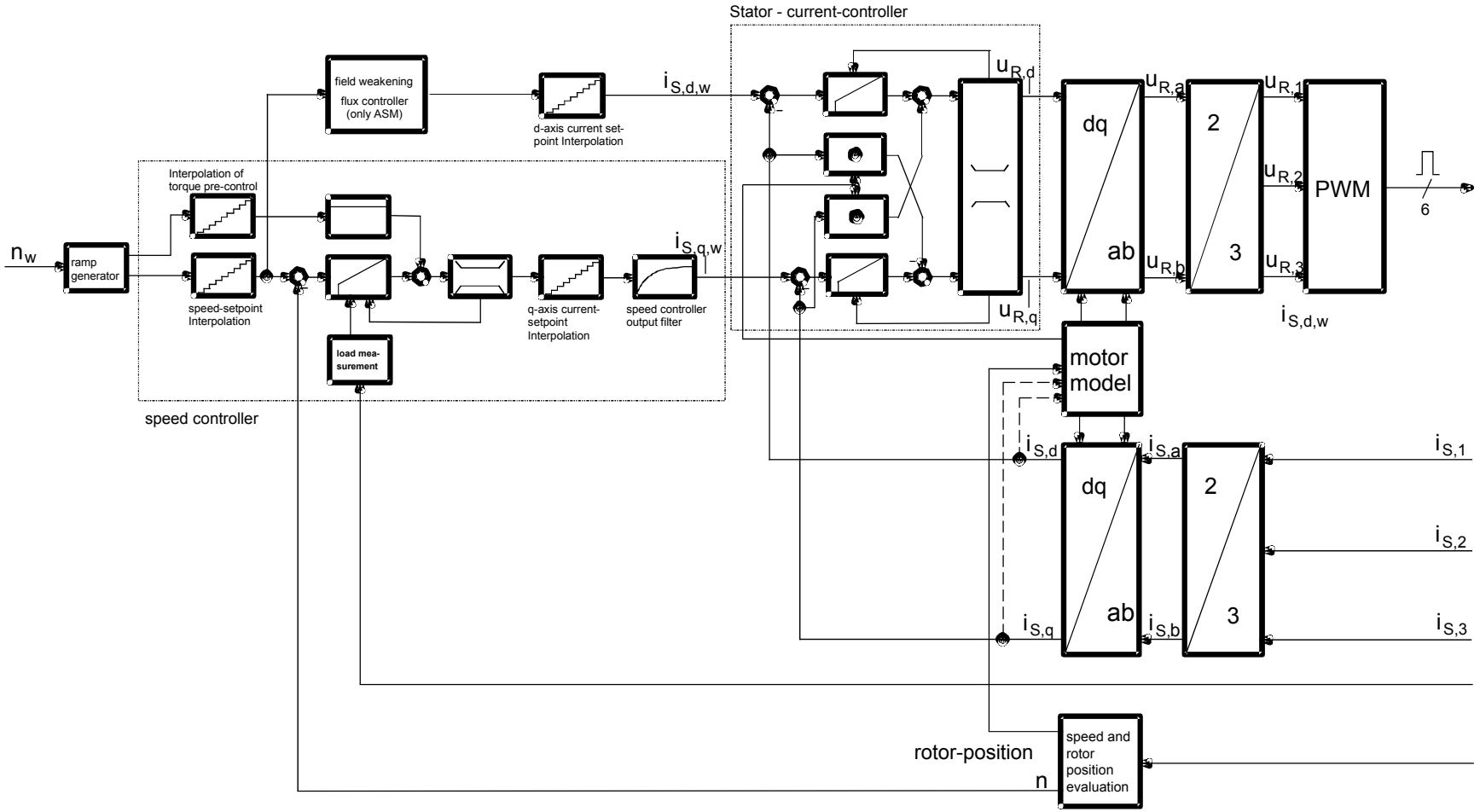
NG03: MATRIX Software Design



Principle Software Design

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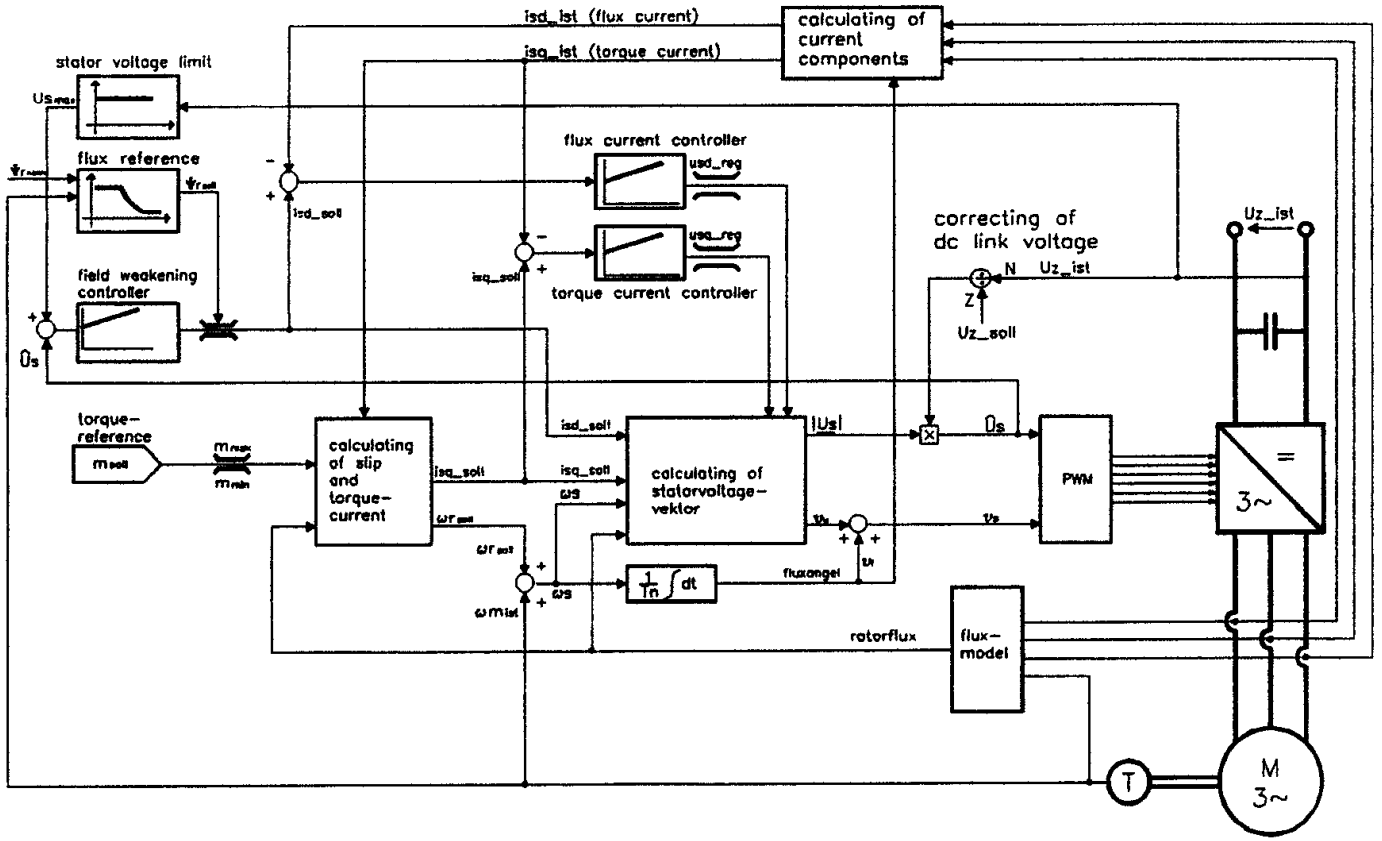
NG03: MATRIX Controller design

Regenerative Motor Inverter



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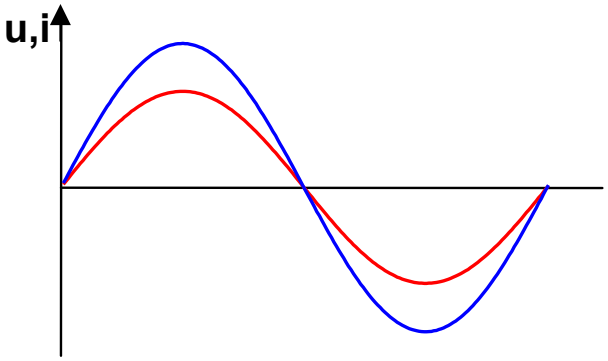
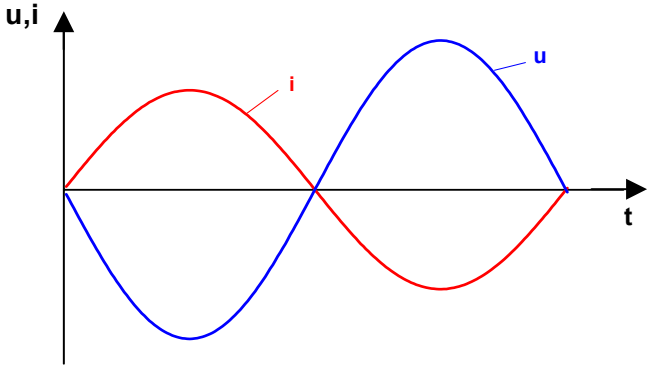
NG03: Line Feedback Characteristics

- **Quasi sinusodial power feedback (≤ 3%)**
- **Power factor (cos φ) can be adjusted freely for reactive power compensation**
- **Advanced Power line filter (APLF) reduces line disturbance to a minimum**
- **Worldwide, uniform applications can be realized to minimum project costs ans risk**



motor active



generator active

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NG03: Flux Vector MATRIX Control

Control Modes of ASM (dynamometer)

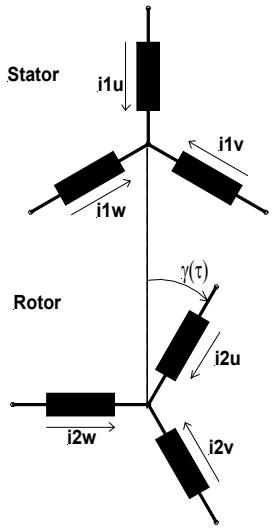
Conventional speed control with static machine model and
Stator flux control V/Hz

- Application with pumps and blowers (single drives)
- not suitable for dynamic application

Modern speed control with self adjusting high dynamic machine modell and MATRIX Flux Vector Control

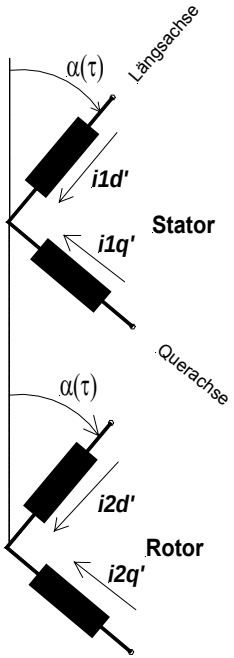
- ideal for high dynamic Applications:
  - Cutter knife drives
  - Tooling machines
  - Automotive test beds
  - Servo application (master-slave, positioning)
- Speed control reaction better than standard DC-motor

NG03: Flux Vector MATRIX Control



Interaction of inductivities between stator and rotor system

Transformation from 3-phase 3-axis system to a 2-axis rotating rotor flux system



No Interaction between stator and rotor rystem - coupling only between longitudinal- and cross axis possible.

Extra-ordinary equation system necessary

Plain and easy dynamic equation system

Schematic Reaction Diagram

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NG03: Flux Vector MATRIX Control

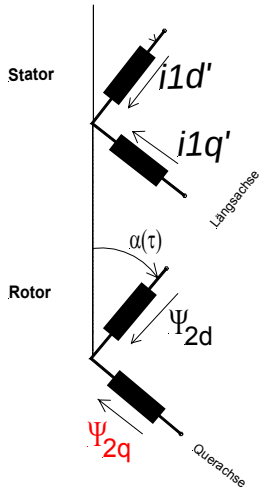
Regulation of I_{1d}‘ equal

Rotorlongit. flux const: $\Psi 2d$ = const

Rotorcross flux disappears: $\Psi 2q = 0$

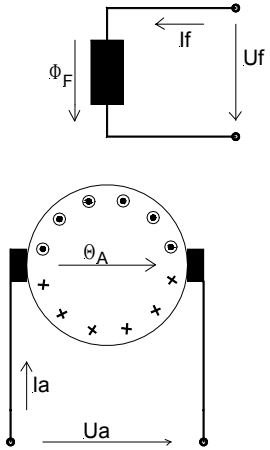
Analog to DC-motor:

const. magnetizing exciting field in a compensated DC-machine



Ψ_{2d} ⟺ Φ_f

I_{1q}‘ ⟺ I_a



$M_{el} \sim \Psi_{2d} \times I_{1q}$‘

$M_{el} \sim I_a \times \Phi_F$

Operation with const. Flux Vector MATRIX Control

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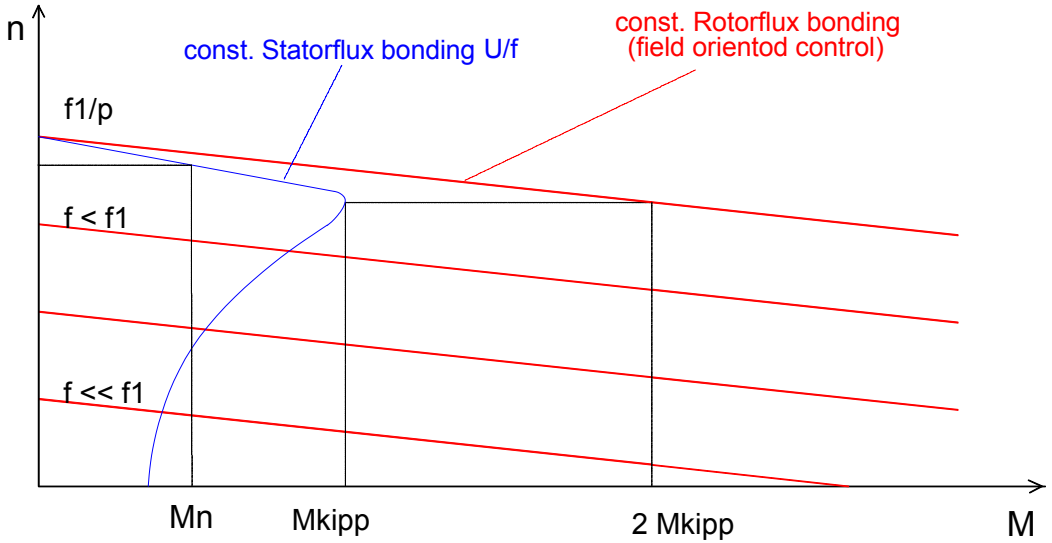
NG03: Flux Vector MATRIX Control

Const.Statorflux V/Hz Control

Const. Rotorflux MATRIX Control



Const. Rotorflux MATRIX Control:

- Dynam. speed diagramm better than DC-motor
- no pull out torque
- autom. speed-slip compensation between full-load and 0-load condition

Speed - Torque - Diagram Characteristic

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NG03: Current Torque Circle Diagram = f (T)

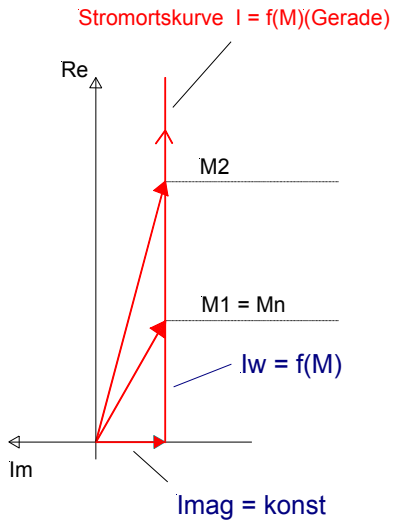
Flux-Vector MATRIX Control with const. Rotorflux

Current Circle Diagram is linear

No Pull out torque

Optimized red. motor current

Current Circle Diagram C = f(T) (linear)



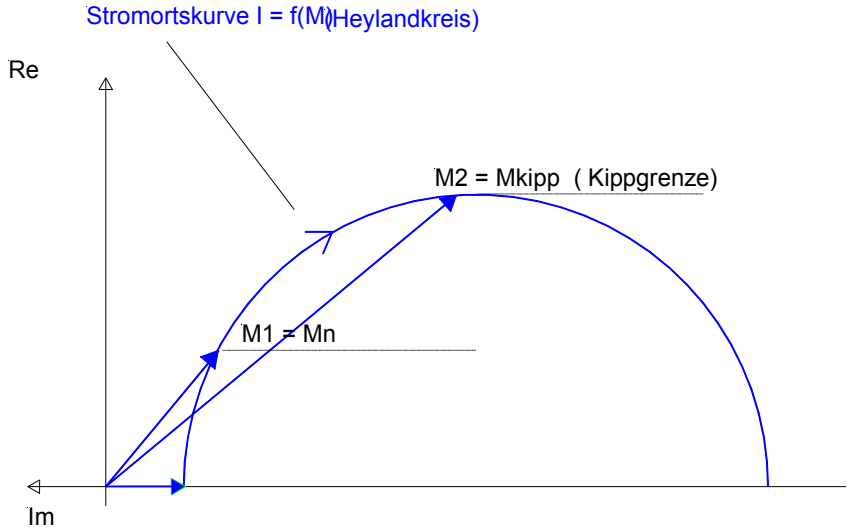
Conventional Control with V/Hz Statorflux

Current Circle Diagram is un-linear (Heyland-Circle)

Pull out torque 2..4xTnom.

Not optimized for dynam. application

Current Circle Diagram C = f(T) (Heyland Circle)



Target: Double Inverter Output Current = Double Motor Torque

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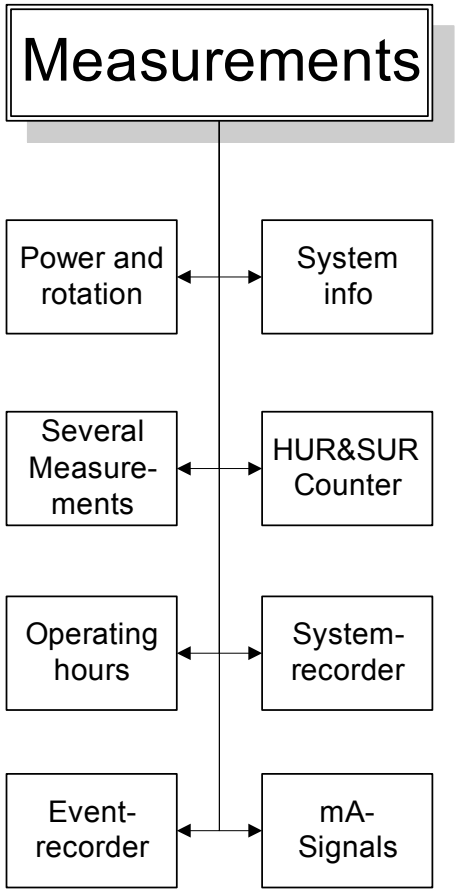
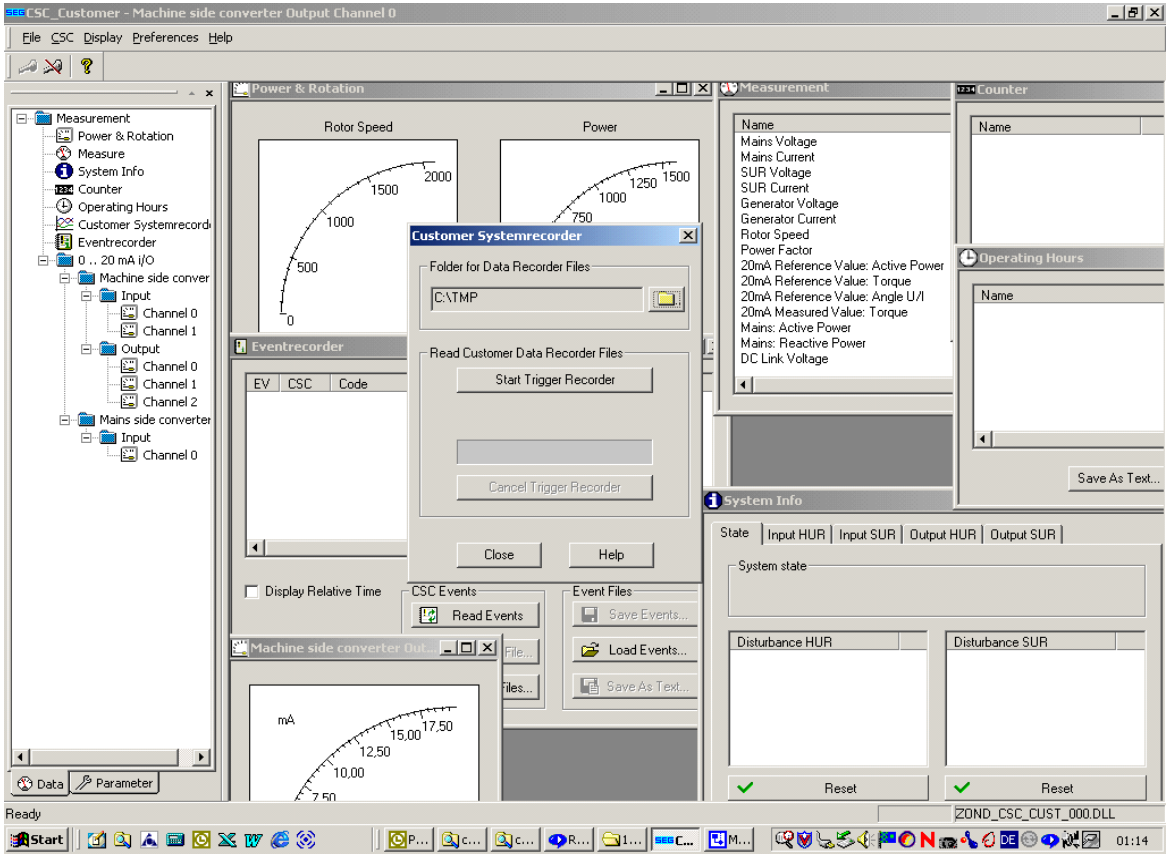
HMI User Interface: Customer Dedicated Access

Operation & Maintenance Data Tracking Tools





Analog "Voice Recorder"

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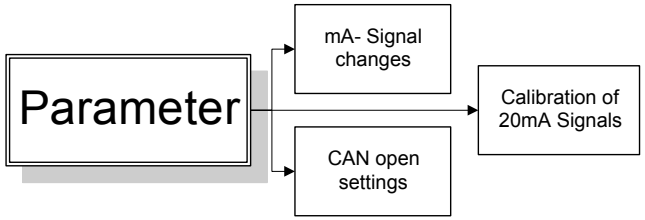
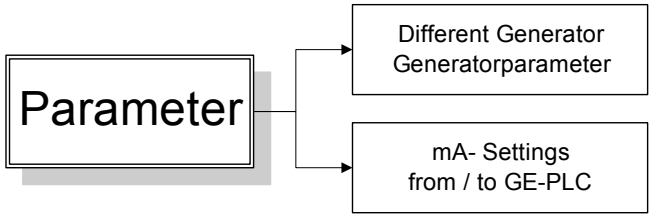
HMI User Interface: Customer Dedicated Access

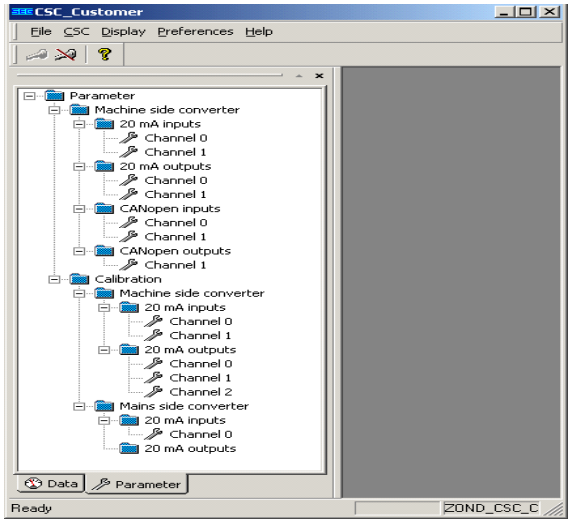
Customer Dedicated Access Parameters

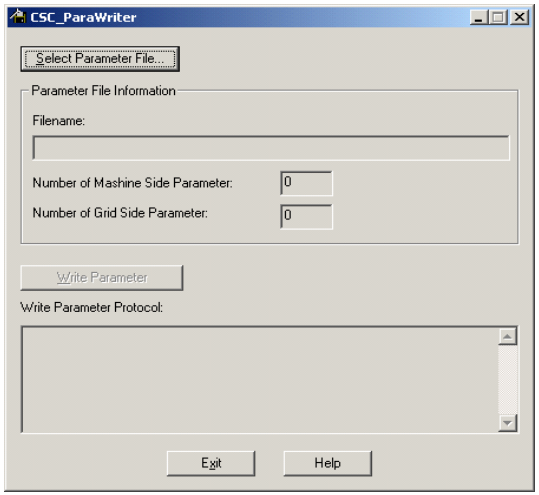
Parameter Types





Parameters Access by Windows Compatible User Interface





Easy and User Friendly SetUp

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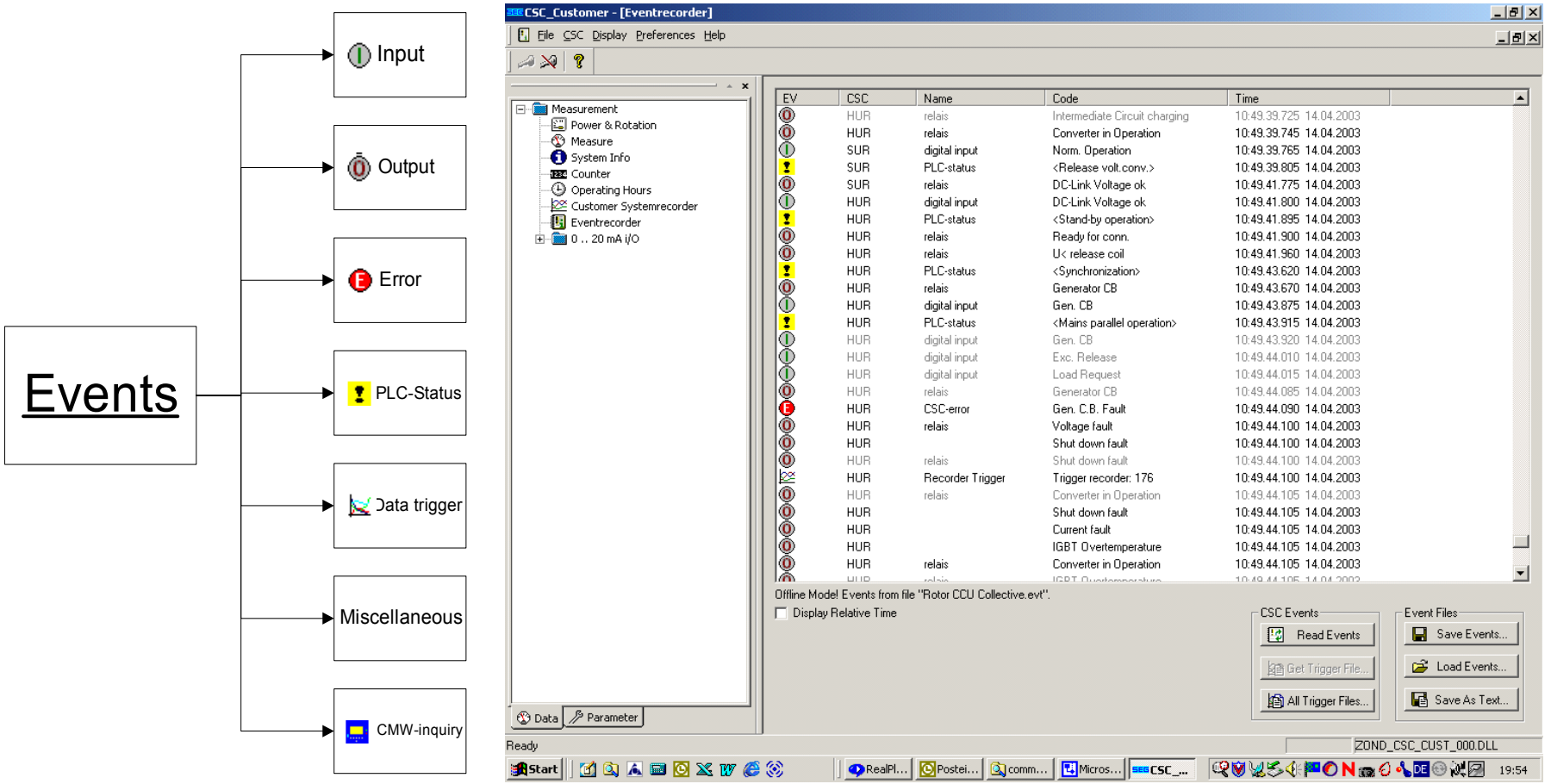
HMI User Interface: Event Data Type

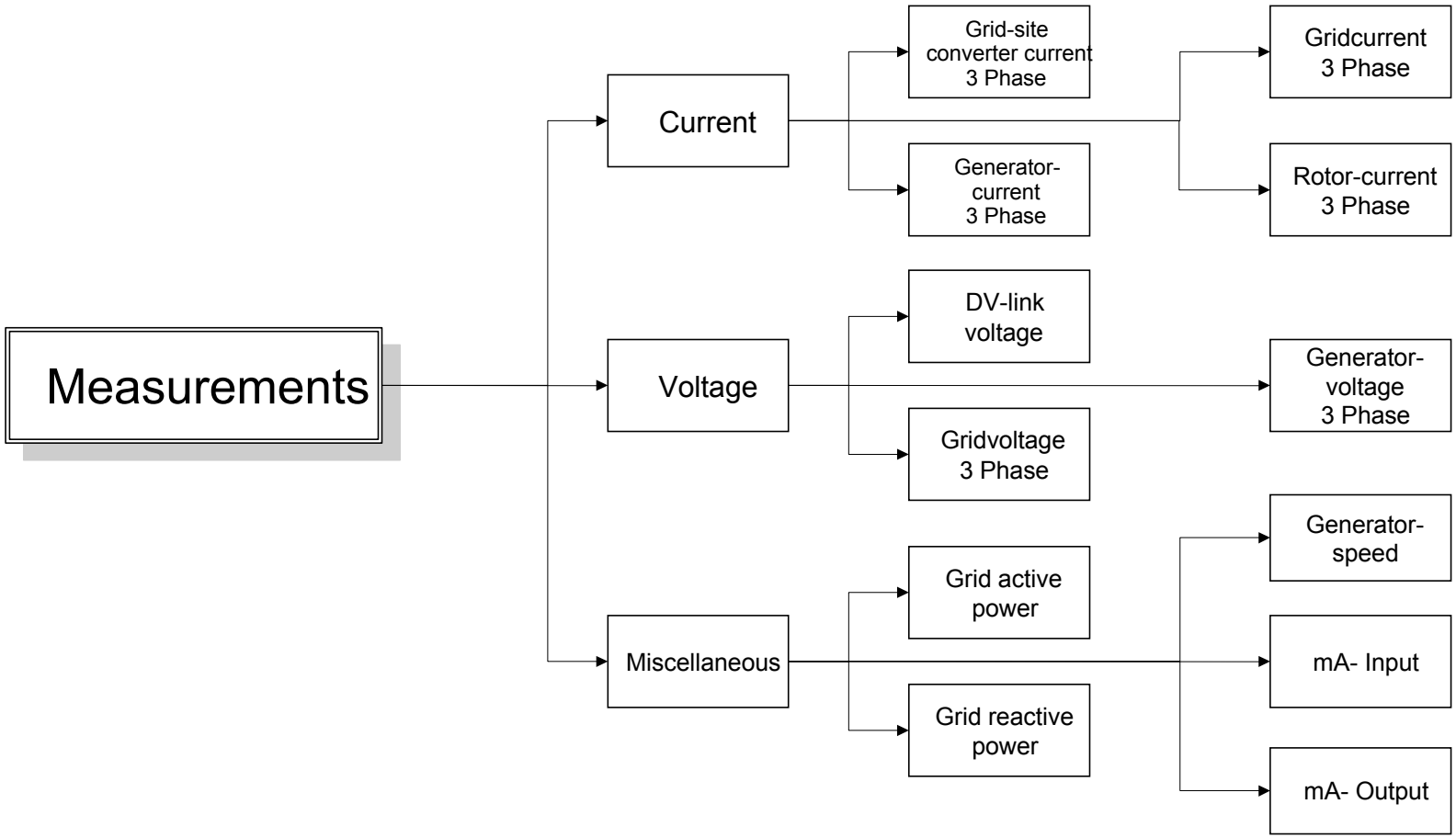
Machine Side & Grid Side Time Stamped Recorded Data



Up to 1000 Events Can Be Recorded

HMI User Interface: Event Monitoring

350msec Pre & 170msec Post Event Trigger of Data Recording



Event Cause Tracking & Analysis Made Easier

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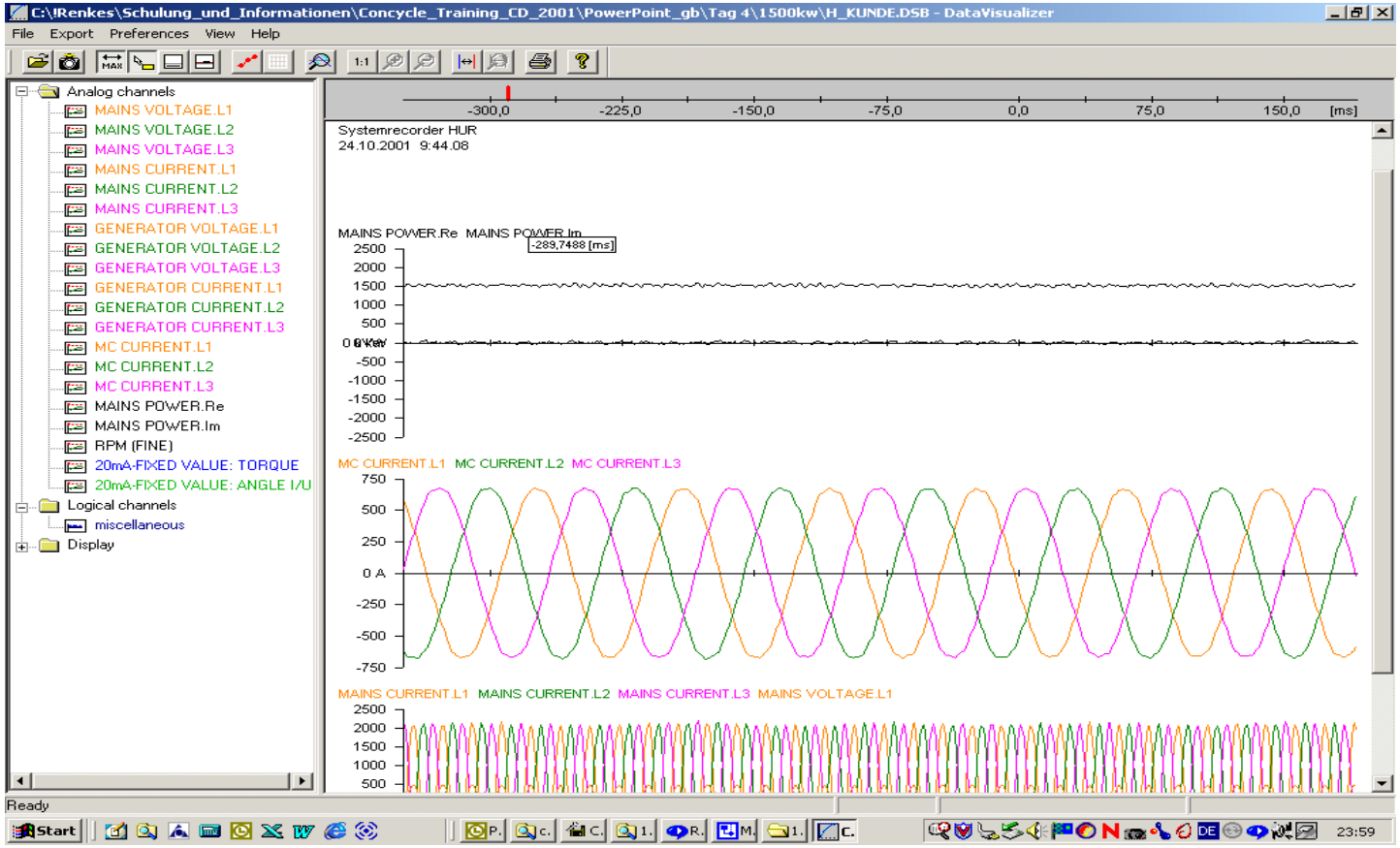
HMI User Interface: Event Monitoring

Event Data Plotting



Event Cause Tracking & Analysis Made Easier

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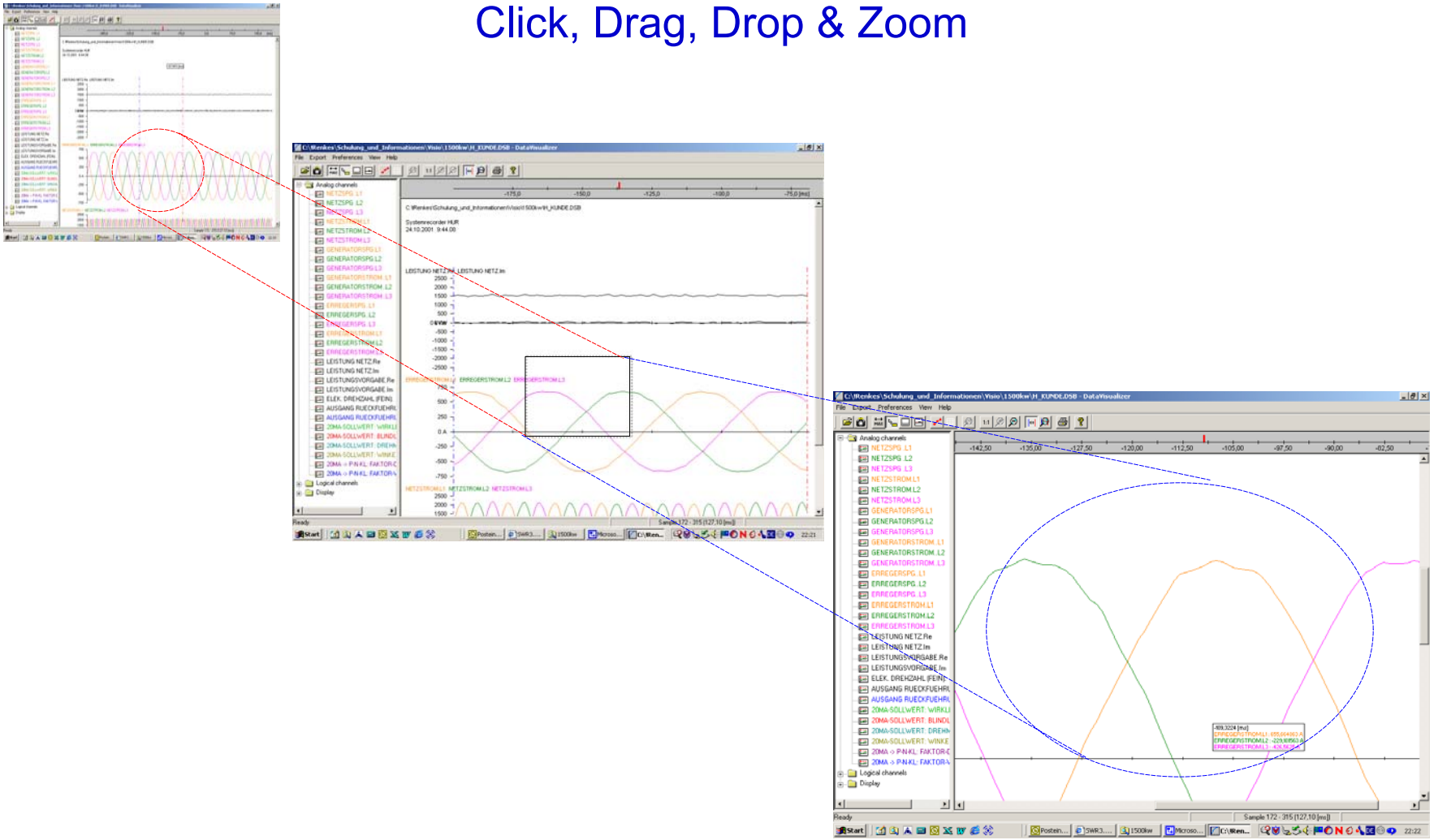
HMI User Interface: Data Recorder - Detail Visual Analysis

Click, Drag, Drop & Zoom



Scope Function by Internet

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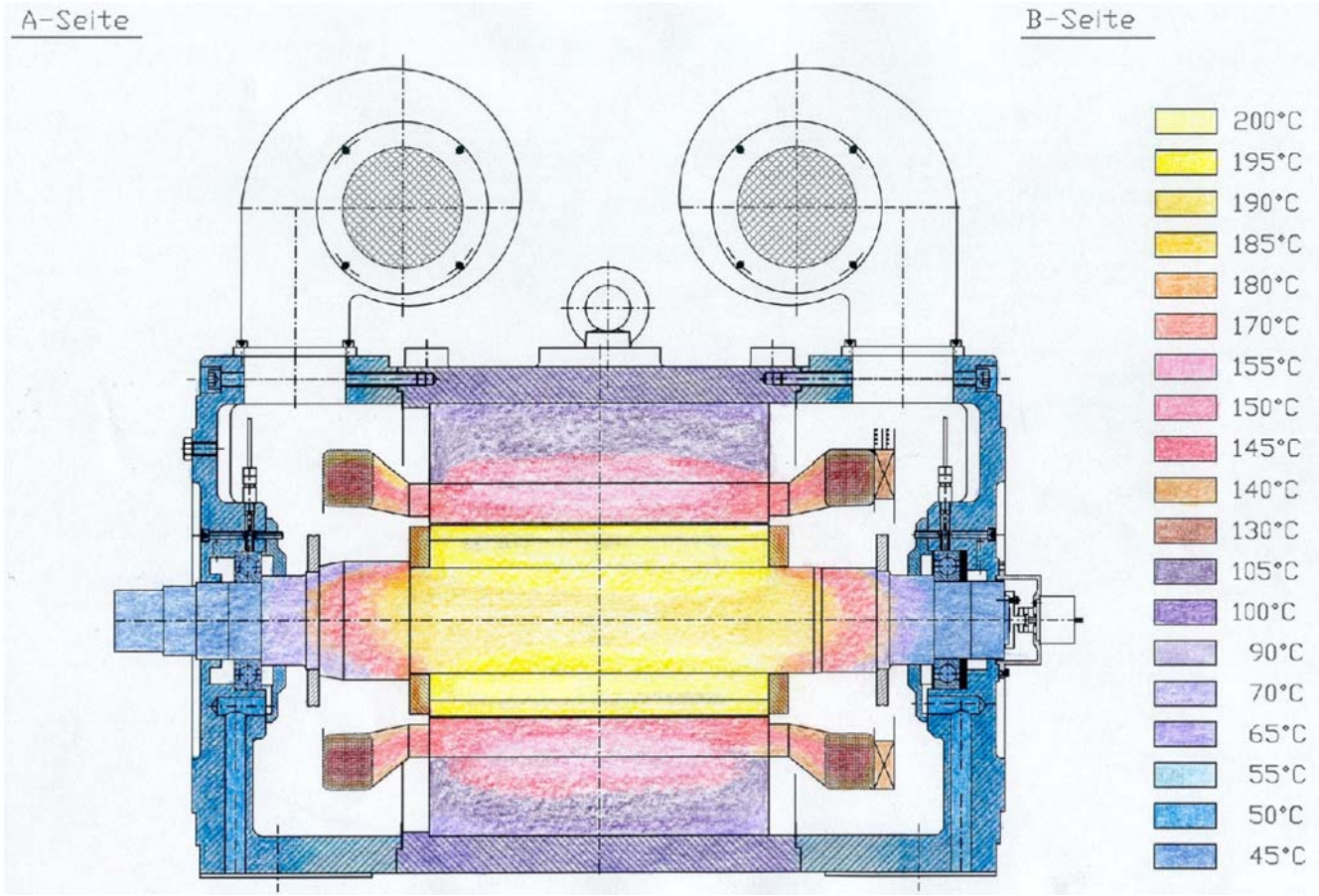
Motor Design

Each Side Blower Cooled



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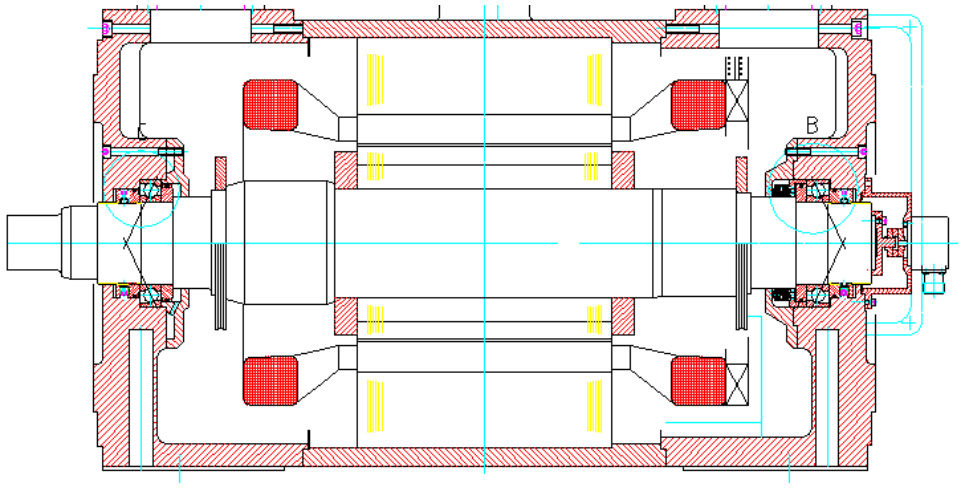
Bearing Concept for 2 Pole Machines

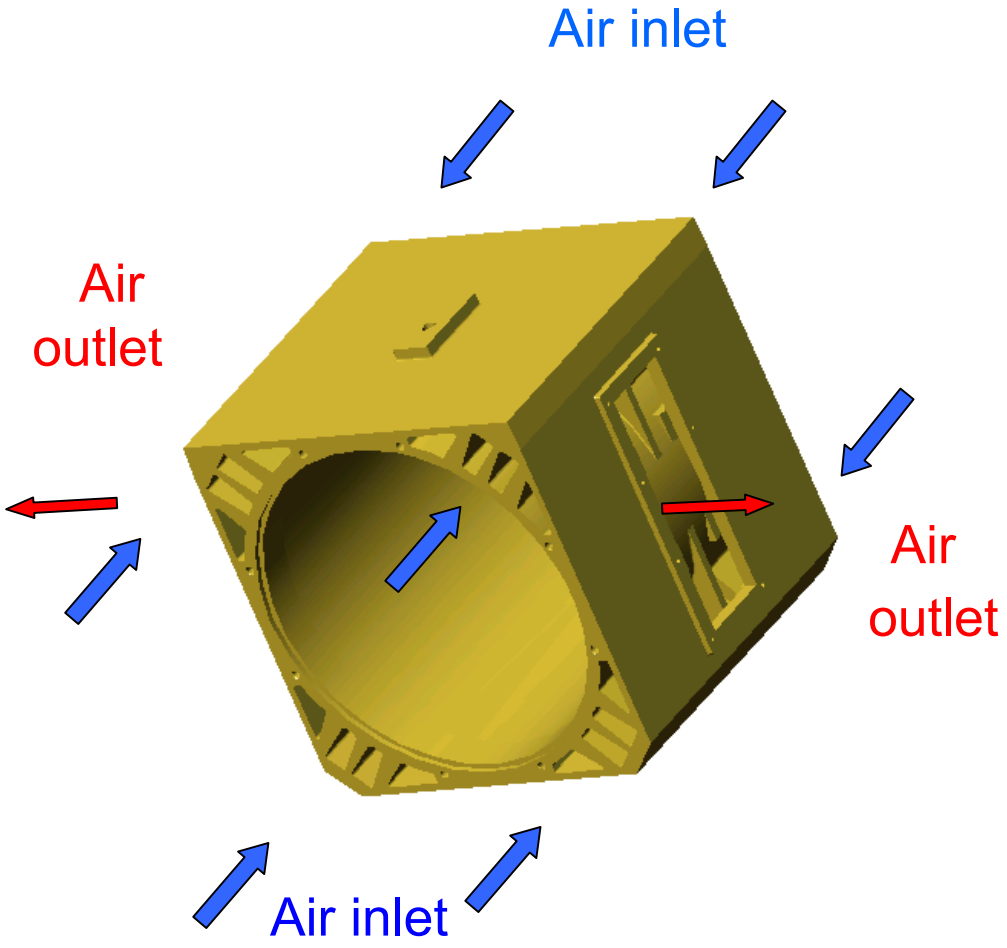


- Hybrid bearing
- 25° pressure angle
- Life time grease lubrication
- “O”-Type with high pre-loading
- High speed applications
- Low maintenance
- Low machine vibrations and high bearing stiffness

Motor Design

Each Side Blower Cooled

- Same temperature on FE & BE winding heads
- Direct rotor cooled
- Optimal cooled bearings on both sides
- 4 point cooling reduced blower noise



Motor Selection

Range DSM3

DSM3 / 4-polig

	AH 100	AH 132	AH 160	AH 180	AH 225	AH 250	AH 315
DSB3 - IP 23; durchzugsbelüftet	4,9…14,2 kW 31-90 Nm	15,5…37 kW 99-236 Nm	42…75 kW 267-477 Nm	65…110 kW 414-700 Nm	110…230 kW 700-1464Nm	200…340 kW 1273-2165Nm	213…370 kW 2000-2350Nm
DSV3 – IP 54; fremdbelüftet	3,7…11 kW 24-70 Nm	11…26,5 kW 70-169 Nm	30…52 kW 191-331 Nm	45…75 kW 286-477 Nm	75…160 kW 478-1019 Nm	140…240 kW 891-1528 Nm	
DSE3 – IP 54; wassergekühlt	4,9…14,2 kW 31-90 Nm	15,5…37 kW 99-236 Nm	42…75 kW 267-477 Nm	65…110 kW 414-700 Nm			

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Motor Selection

Range 2SB3

2SB3 / 2-polig

AH 112	AH 132	AH 160	AH 180	AH 225	AH 250	AH 315
2SB3 - IP 23; durchzugsbelüftet						
10 kW 16 Nm	20...30 kW 38-57 Nm	45...60 kW 107-143 Nm	90 kW 215 Nm	130 kW 310 Nm	160...250 kW 380-600 Nm	335...400 kW 800-955 Nm
Maximaldrehzahl n_{max} / min^{-1}						
12.000	10.000	8.000	8.000	10.000	9.000	8.500
Trägheitsmoment J_L / kgm^2						
0,0085	0,021 / 0,032	0,061 / 0,08	0,15	0,25	0,33 … 0,44	0,76 / 0,83

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Motor Selection: Projects

DSM3 / 6-pole

- **AH 315**
- **AH 355**
- **AH 450**

6SD3 - IP 23; durchzugsbelüftet

- 290…325 kW 3200-3800Nm
- 330…450 kW 3900-4800Nm
- 250…300 kW 4200-9500Nm

6ZM3 – IP 54; fremdbelüftet

- 225…275 kW 2400-3050Nm

Specifications

Motor-nom. power	**P**	**kW**	**15o (200)**	**315 (25o)(355)**	**650 (550)(500)(450)**
Nom. outputcurrent	**I**	**A**		600	
Nom.output power	**S**	**kVA**		415	
Nom. Output voltage	**U**	**V**	0..linevoltage 3/PE AC		
Output frequency	**f**	**Hz**	0 .. 200		
Overload capabilizy	**-**	**-**	1,25 x 60 seconds		
Grid voltage	**U**	**V**	380 .. 400(±10%) 3/PE AC		
Grid frequencyNennfrequenz	**f**	**Hz**	50 - 60 Hz		
Power factor	**cos φ**	**-**	ca. 1		
efficiencyWirkungsgrad	**η**	**%**	> 96 bei 3kHz switching frequency		
Switching frequencyTaktfrequenz	**f**	**kHz**	3.0 .. 5.6		
Short-circuit/earth-fault proof	**-**	**-**	Yes without restrictions		
Protection mode	**-**	**-**	IP23, IP33, IP54		
Dimensions	**width**	**mm**		1400	
Without roof fan	**high**	**mm**		2000	
Fan stand alone	**high**	**mm**		200	
	depth	**mm**		600	
Mass	**M**	**Kg**		1400	
Ambient temperature	**Tn**	**°C**	Tn = 45°C bis 1000m above sea level		
Rel. humidity	**-**	**%**	Paragraph F - without dew		
Ouput derating	**DP**	**%**	4%/K above Tn; T-limit = 50°C		
Cooling air	**-**	**m³/s**		1,55	
Noise levelm	**-**	**dB(A)**		<<80	
Mode of inverter operation	**-**	**-**	4-Q active front end, Pulswidth Modulation		
Method of regulation	**-**	**-**	Rotor-flux-vector-MATRIX, torque and speed controlled		

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Evaluation of DC – AC Drives for Automotive test Cells

drive system	DC-Motor	AC - frequency inverter PWM 2Q/4Q		
		Competitive inverter		4Q-Sinus AFC active front converter
criterion	plus SCR	Power feedback with B6 thyristor bridge	Power feedback with REVCON IGBT blockform surrent	Flux vector regulation
torque and speed control	4	3	3	5
controlled DC-bank for multimotor application	4	3	No	5
audible motor noise motoric / generatoric	5	3	3	5
ripple torque < 1-10Hz	2	3	3	5
stat./dyn. Overload	5	3	2	5
zero torque	3	3	2	5
line distorsion	3	2	3	5
master/slave application	3	3	3	5
driveability ≤ 1 KHz	5/5	5/4	5/3	5/5
load stability	4/4	5/3	5/3	5/5
field wakening 1 : 4	4	3	3	5
cos φ ± 1	no	no	no	5
compact mech. design	5	2	2	4
total	**56**	**45**	**40**	**74**
legend	0 = bad	5 = best		

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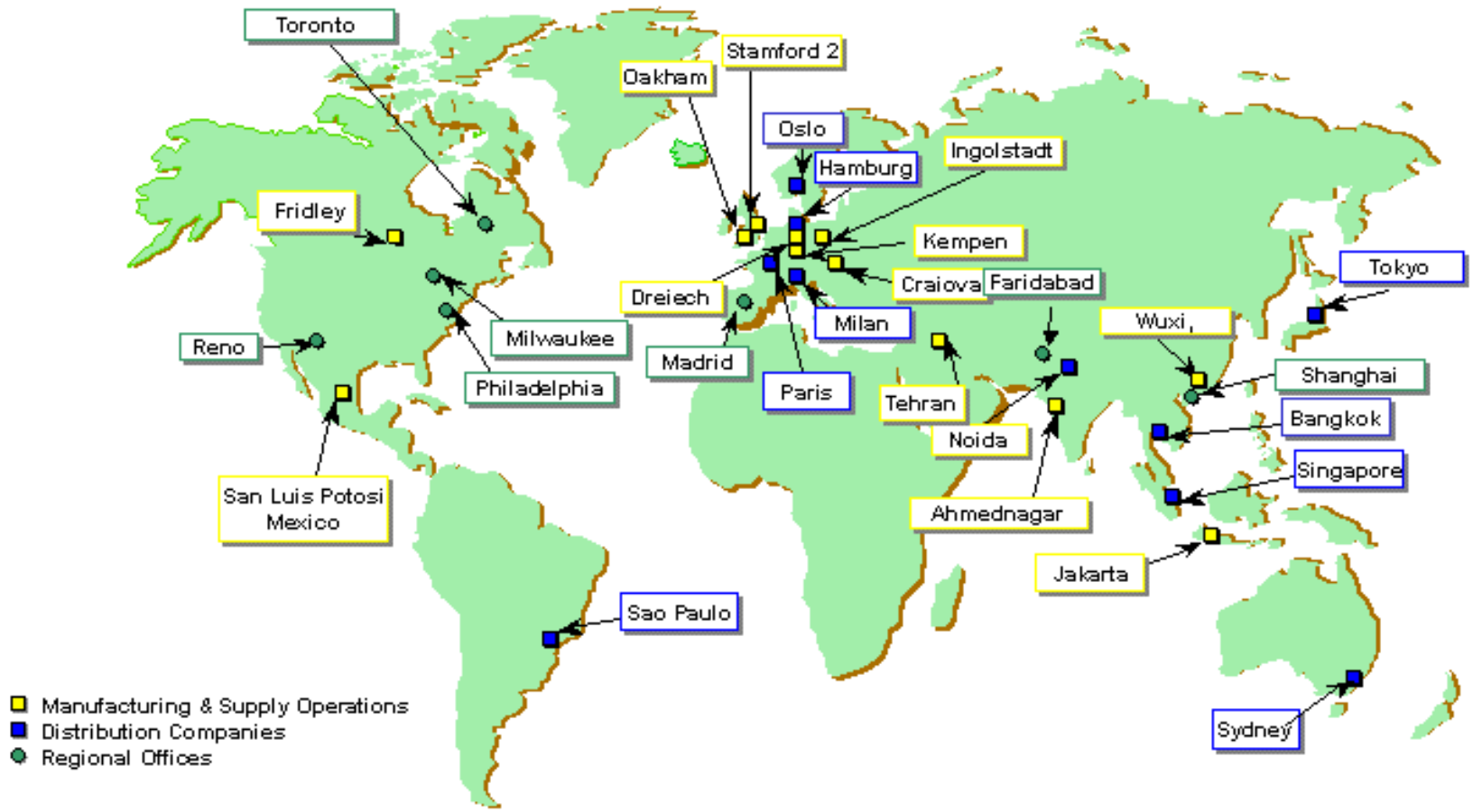
NG03: Value – Benefits Analysis

FEATURES	BENEFITS
Improved Component Integration & Modularized Design	Improved Relability / Flexible Product Configuration Reduced Inventory / Reduced Maintanance Lower Spare Parts Inventory / Longer Component Life
Standardized & Compartmentalized Design Advanced Heat Dissipation Management With option in water colling	Improved Security Improved Noise Immunity & Reduced Audible Noice
Compact Power Density Reduced Footprint Requirement	Reduced Size and Weight / Higher System Economics Room Saving in Control Area / Easy transportation
Virtual R&D design tools in development & MATRIX Process - technology AC|con sinusoidal current at line side converter	NG03 = new generation >> ahead on state of the art More flexibility – Better Reliability High stability at Grid connection
Human Maschine Interface- user friendly customer interface NaviIcon Increased Functionality Data Recorder	Enhanced Options Improved Maintenance & Service Time Improved System Economics Customer friendly

World Wide Locations:



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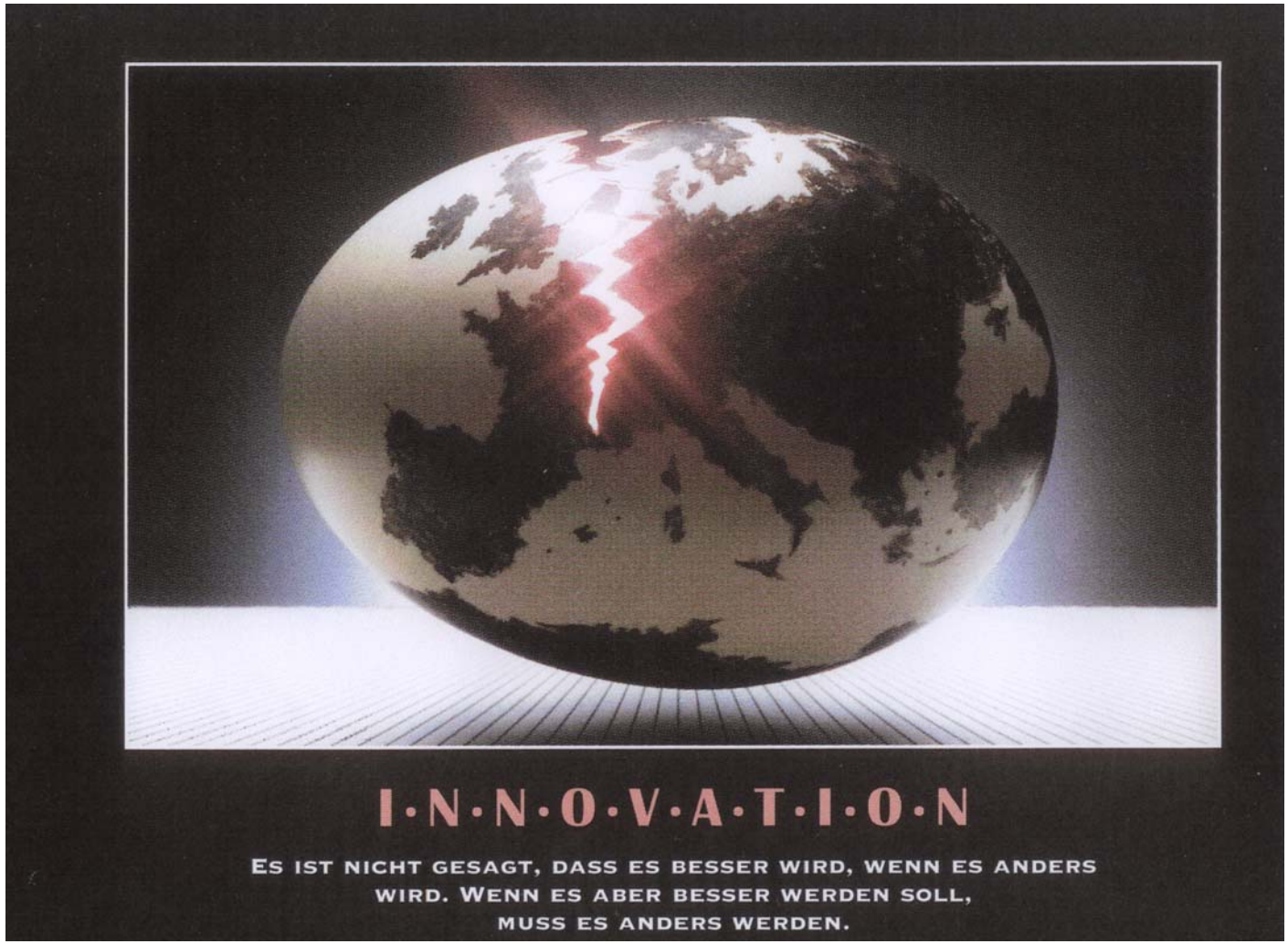
Innovation


I·N·N·O·V·A·T·I·O·N
ES IST NICHT GESAGT, DASS ES BESSER WIRD, WENN ES ANDERS WIRD. WENN ES ABER BESSER WERDEN SOLL, MUSS ES ANDERS WERDEN.