COMPISO

P-HIL
200kVA to MVA

CAPS

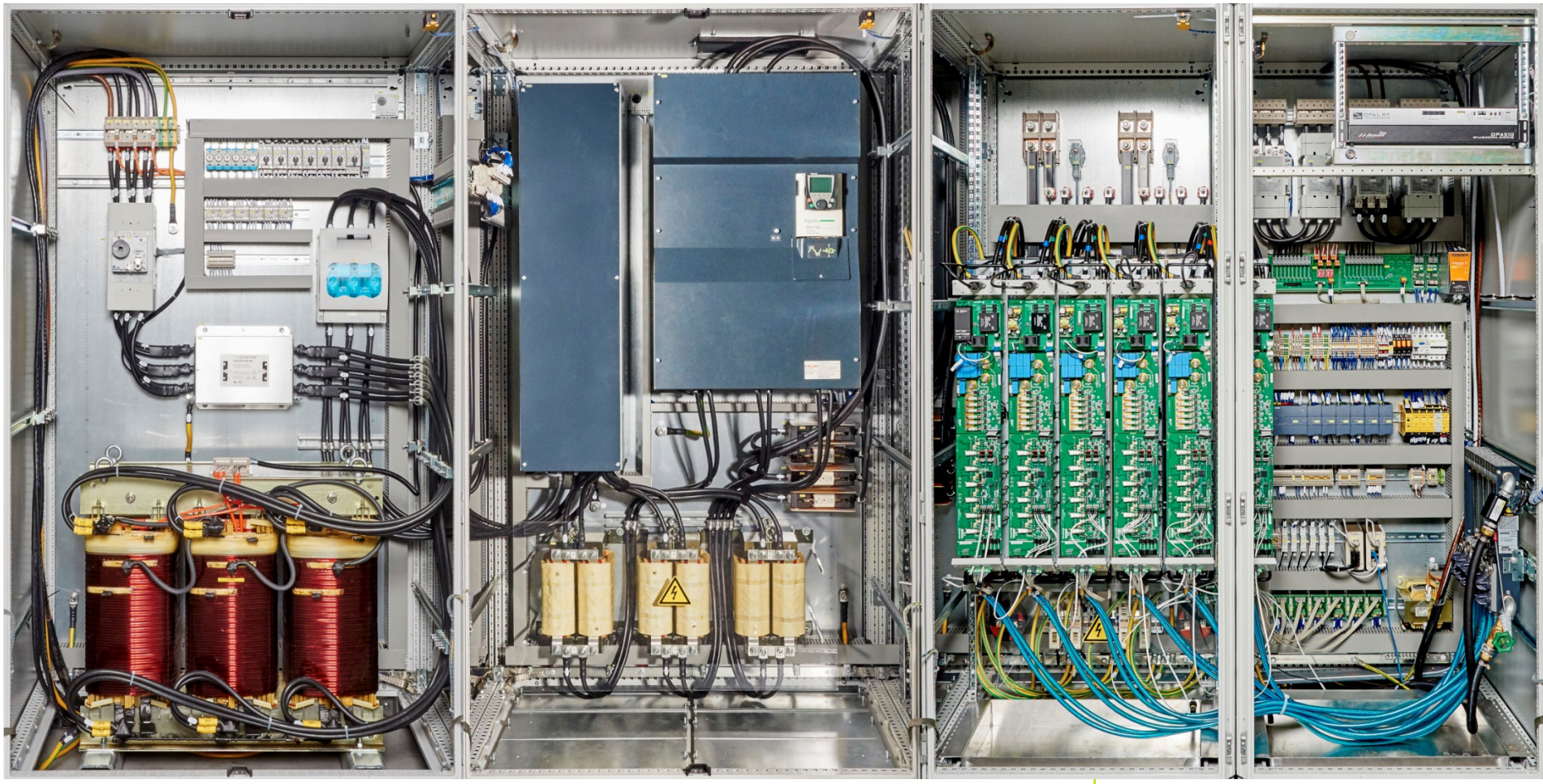
Nov 6th 2015

WORLDWIDE
AUSTRIAN
POWER

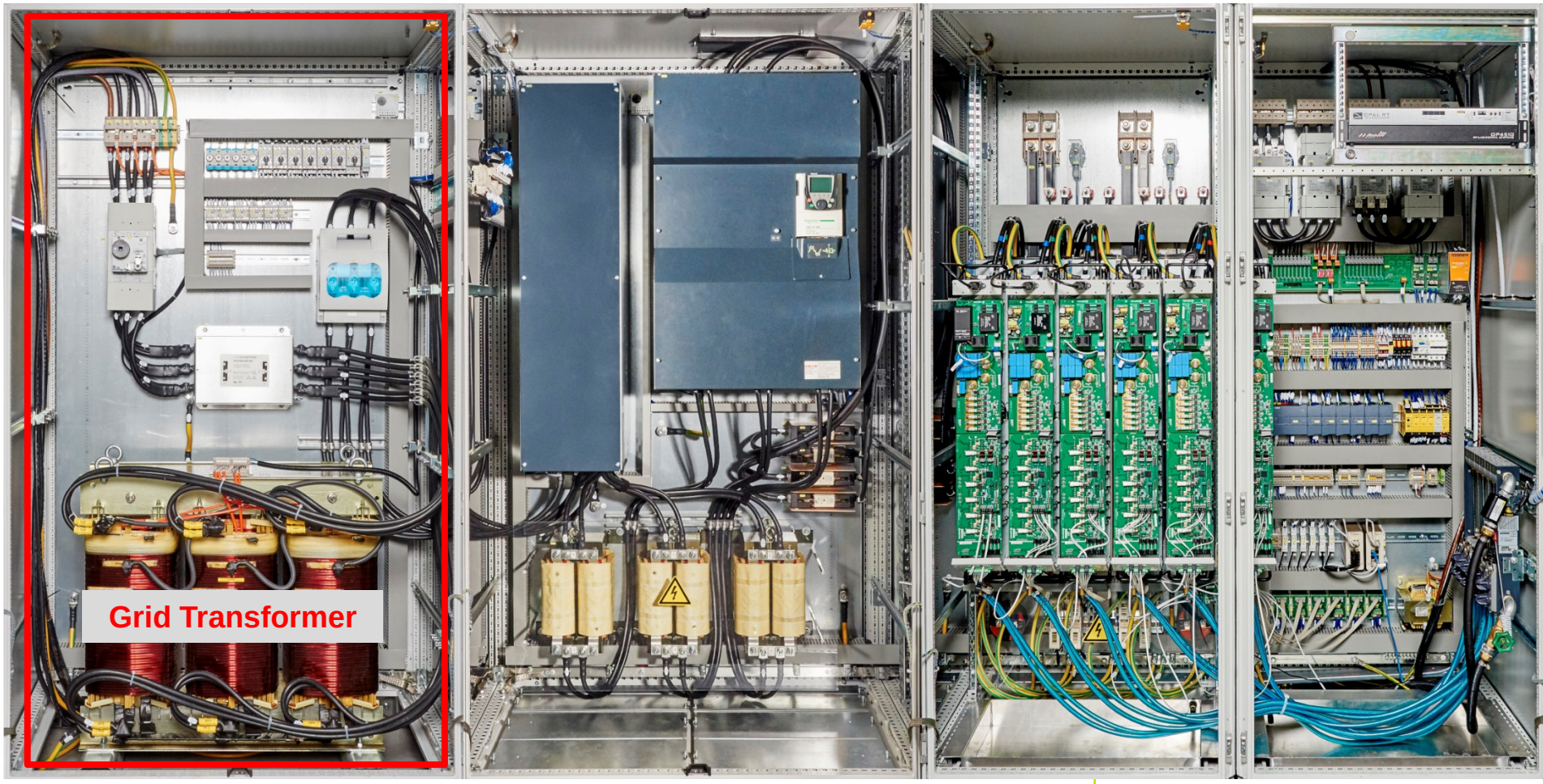
ENJOY ….

COMPISO
P-HIL SOLUTIONS

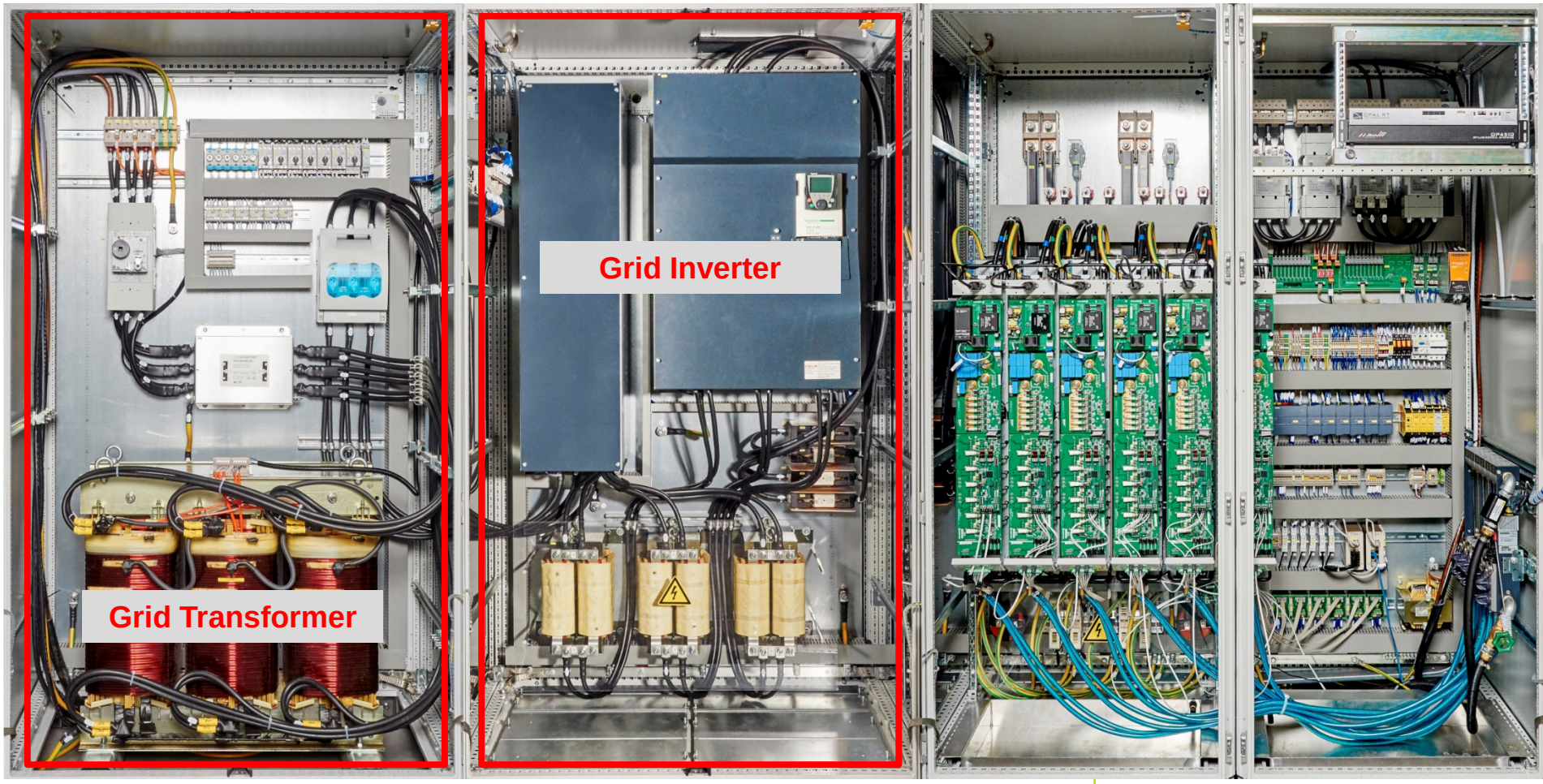
COMPISO P-HIL Solutions



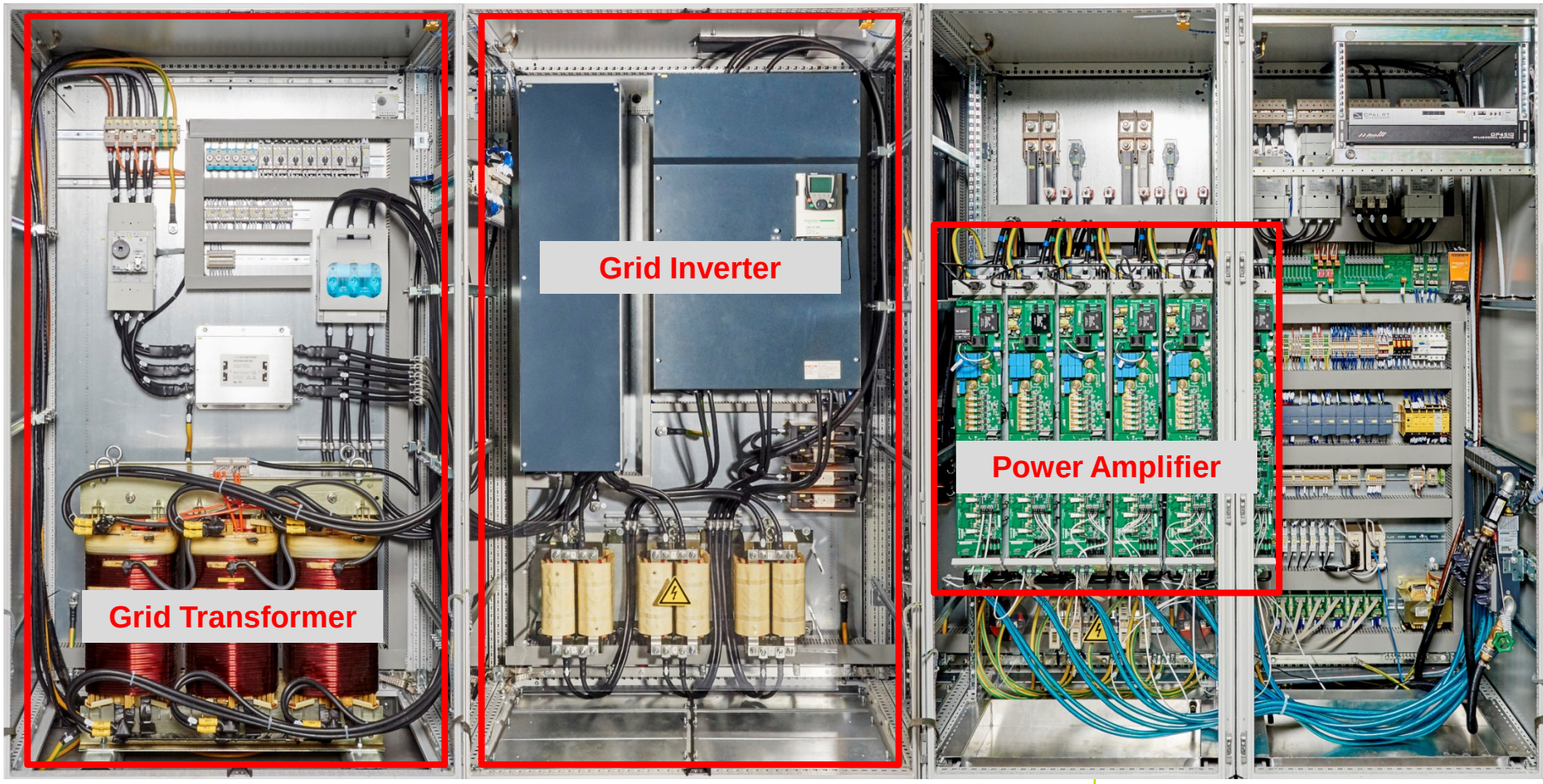
COMPISO P-HIL Solutions



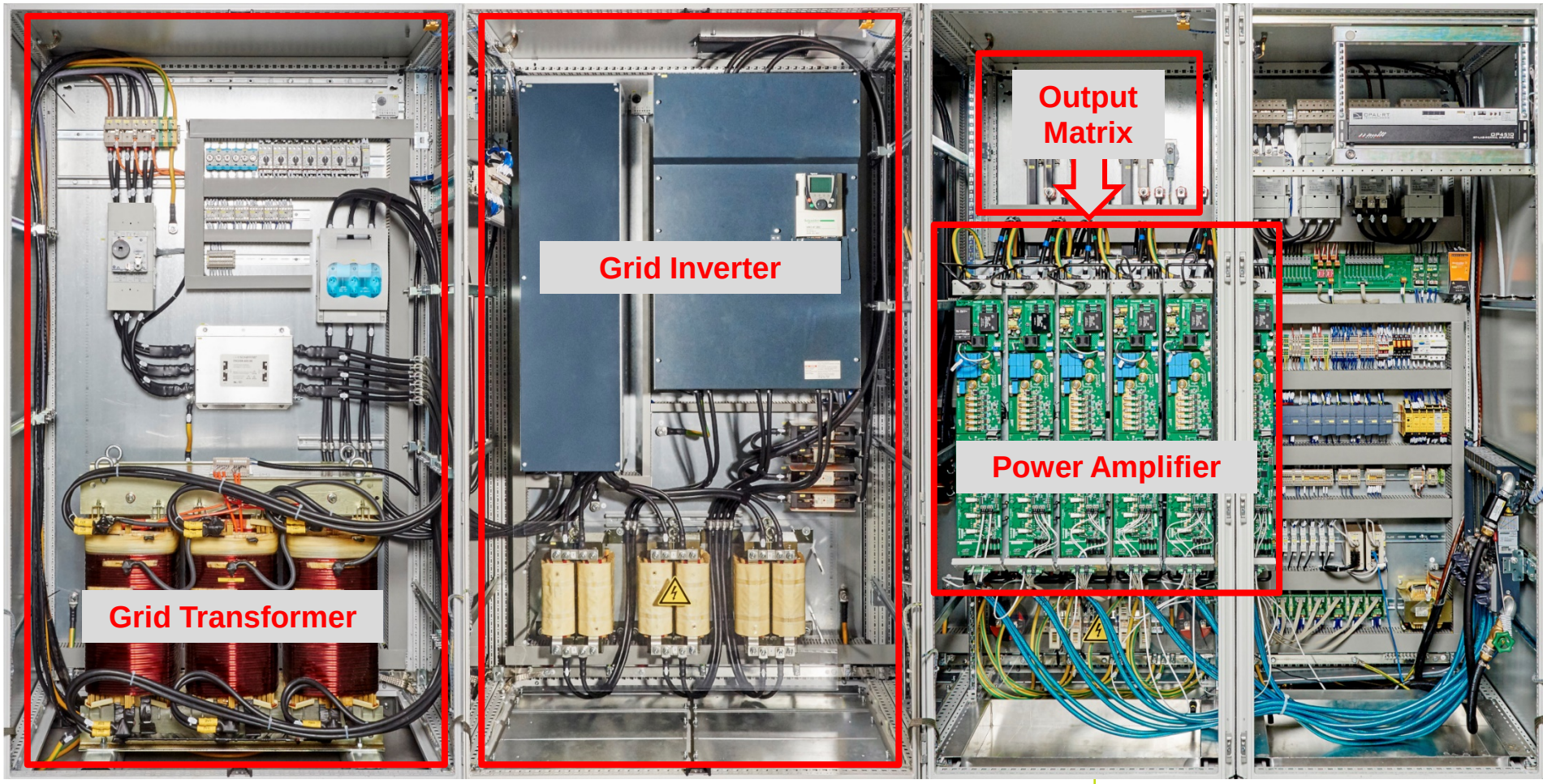
COMPISO P-HIL Solutions



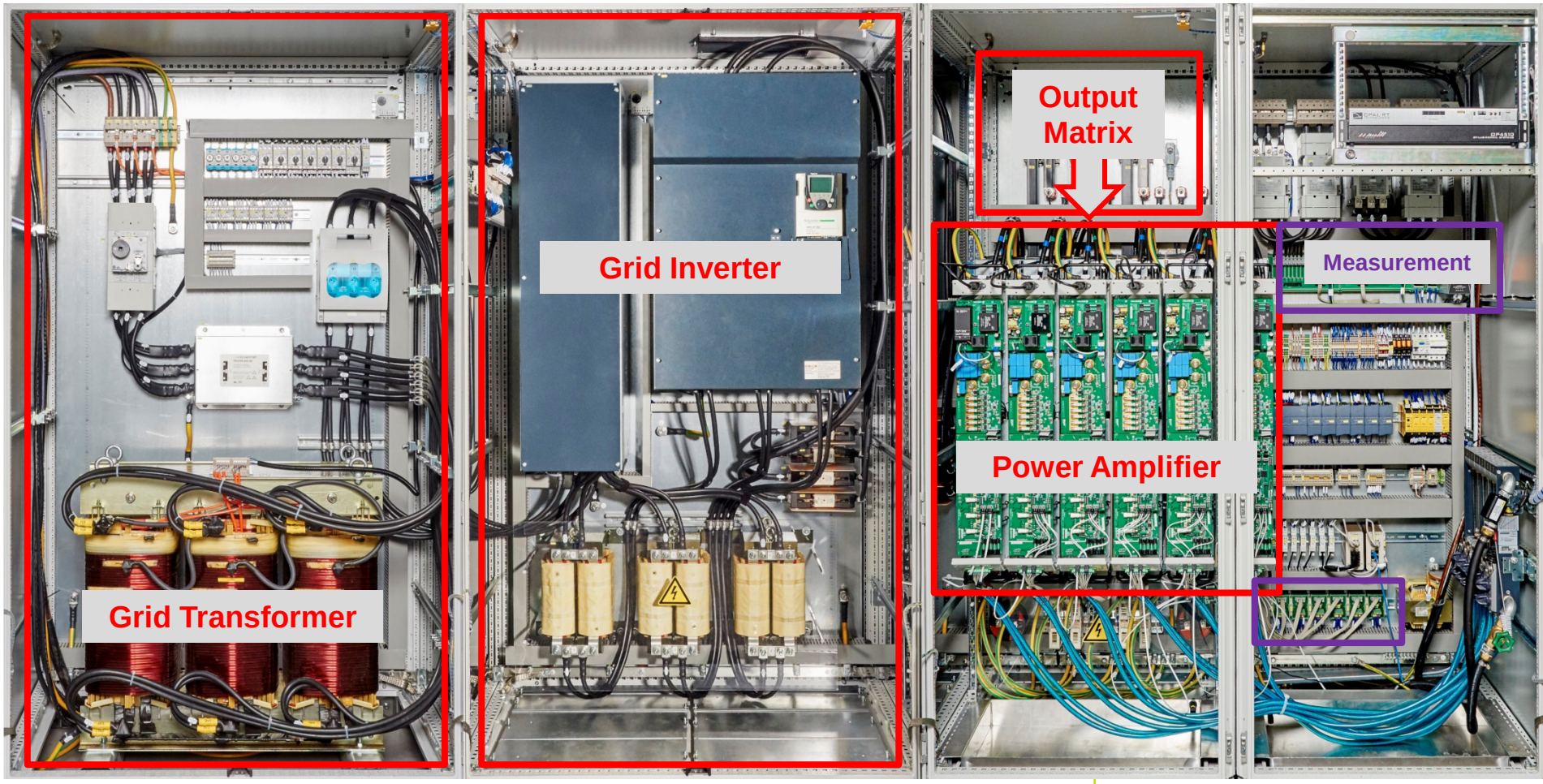
COMPISO P-HIL Solutions



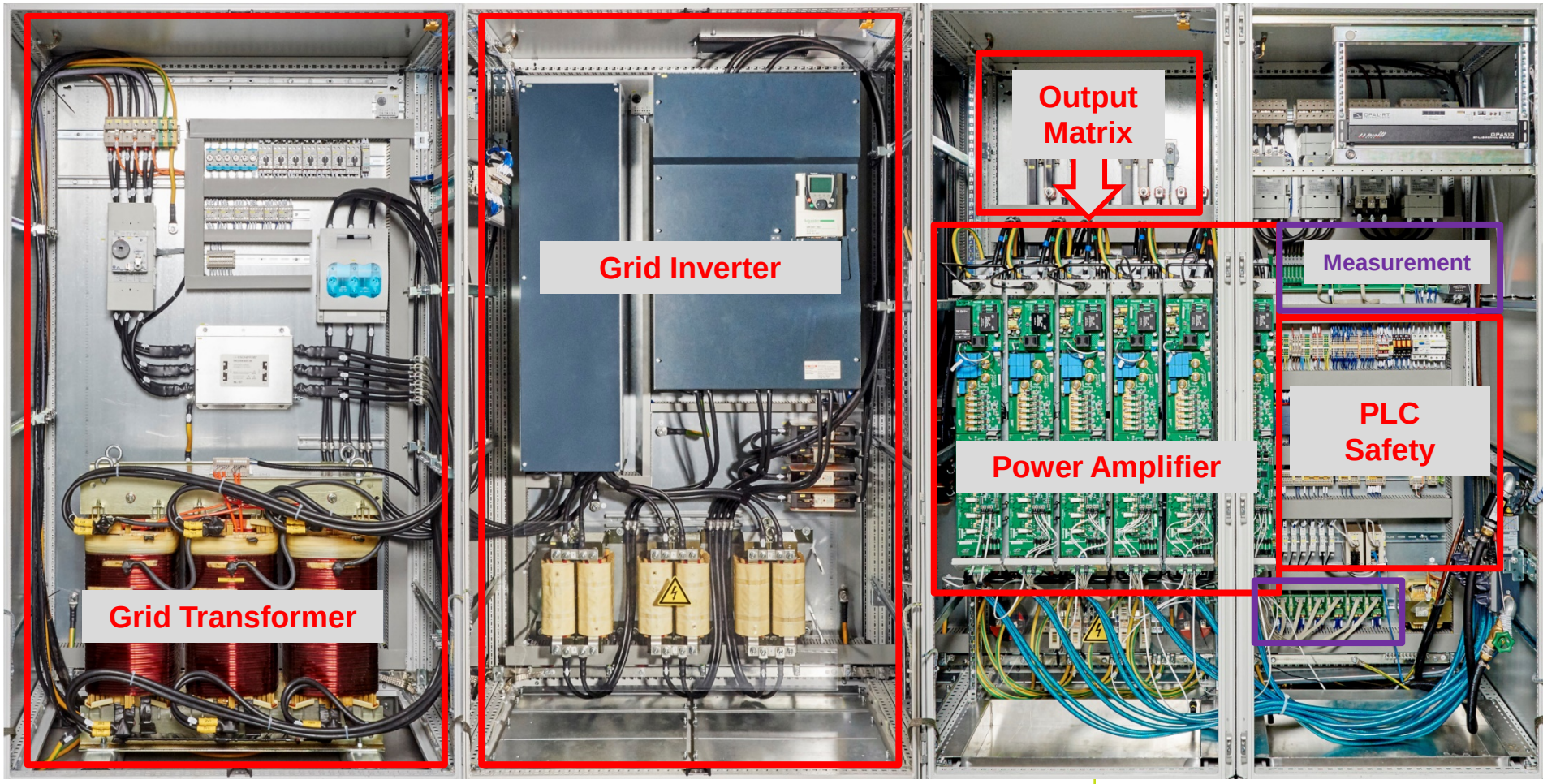
COMPISO P-HIL Solutions



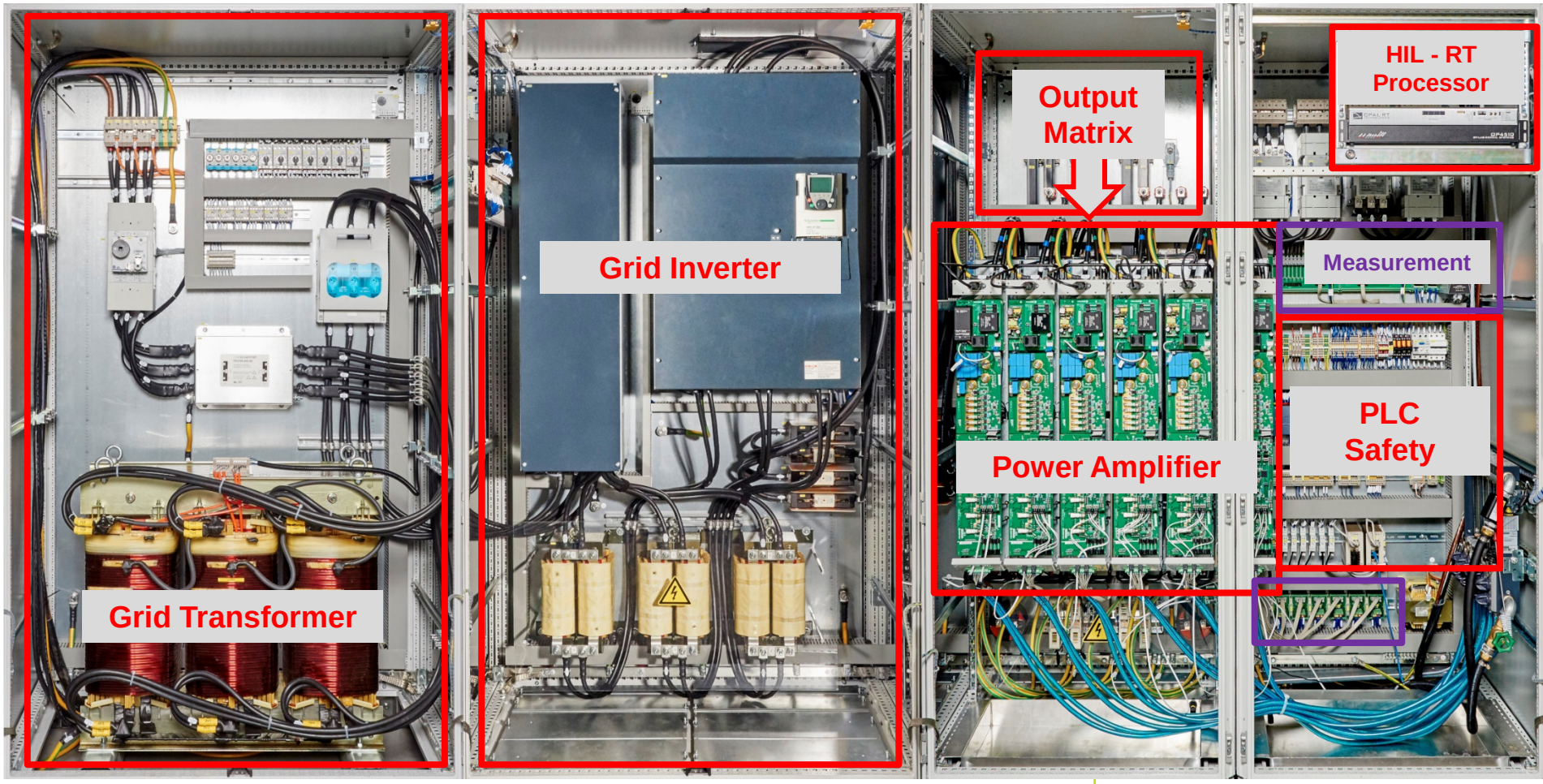
COMPISO P-HIL Solutions



COMPISO P-HIL Solutions

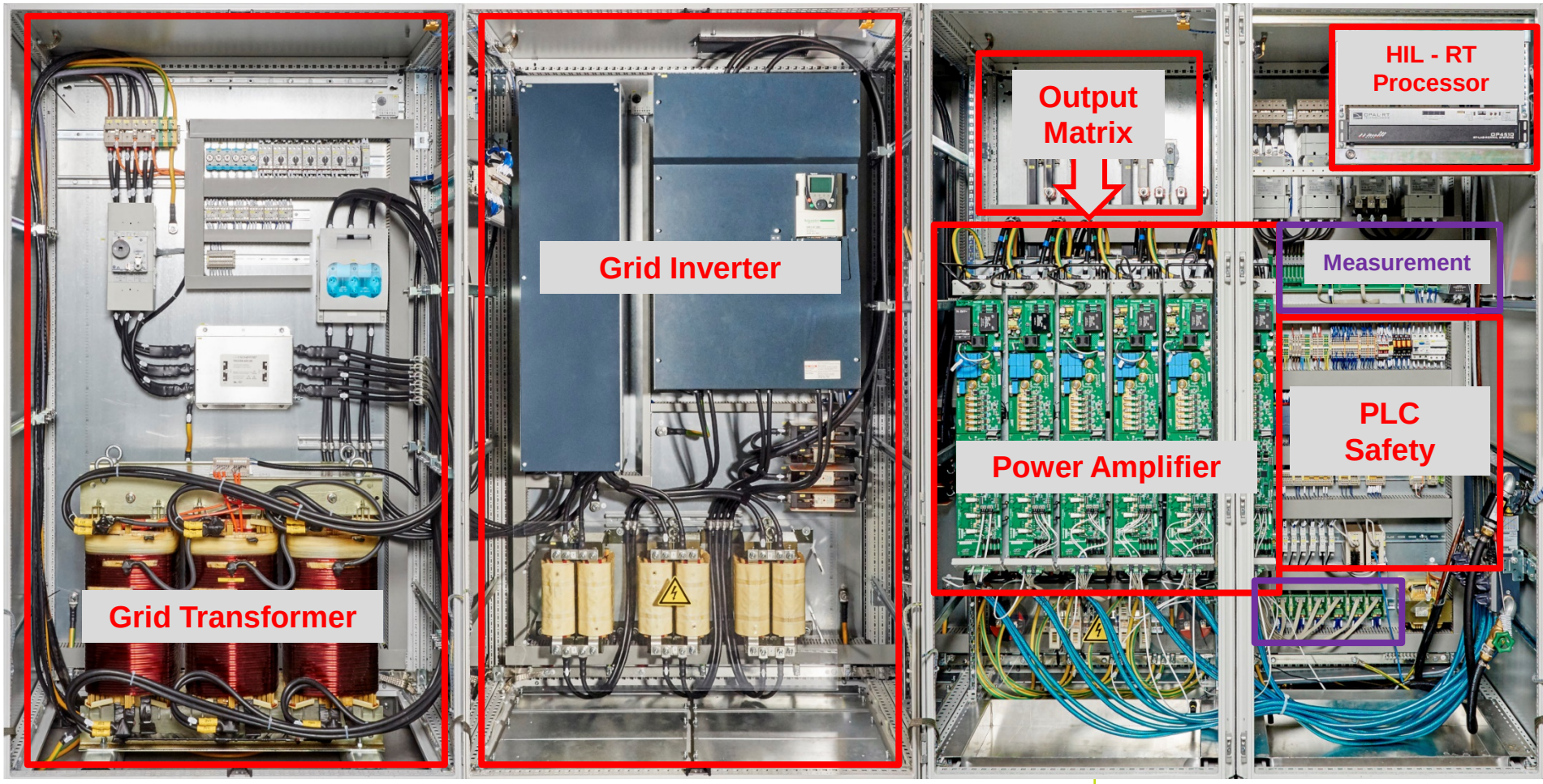


COMPISO P-HIL Solutions



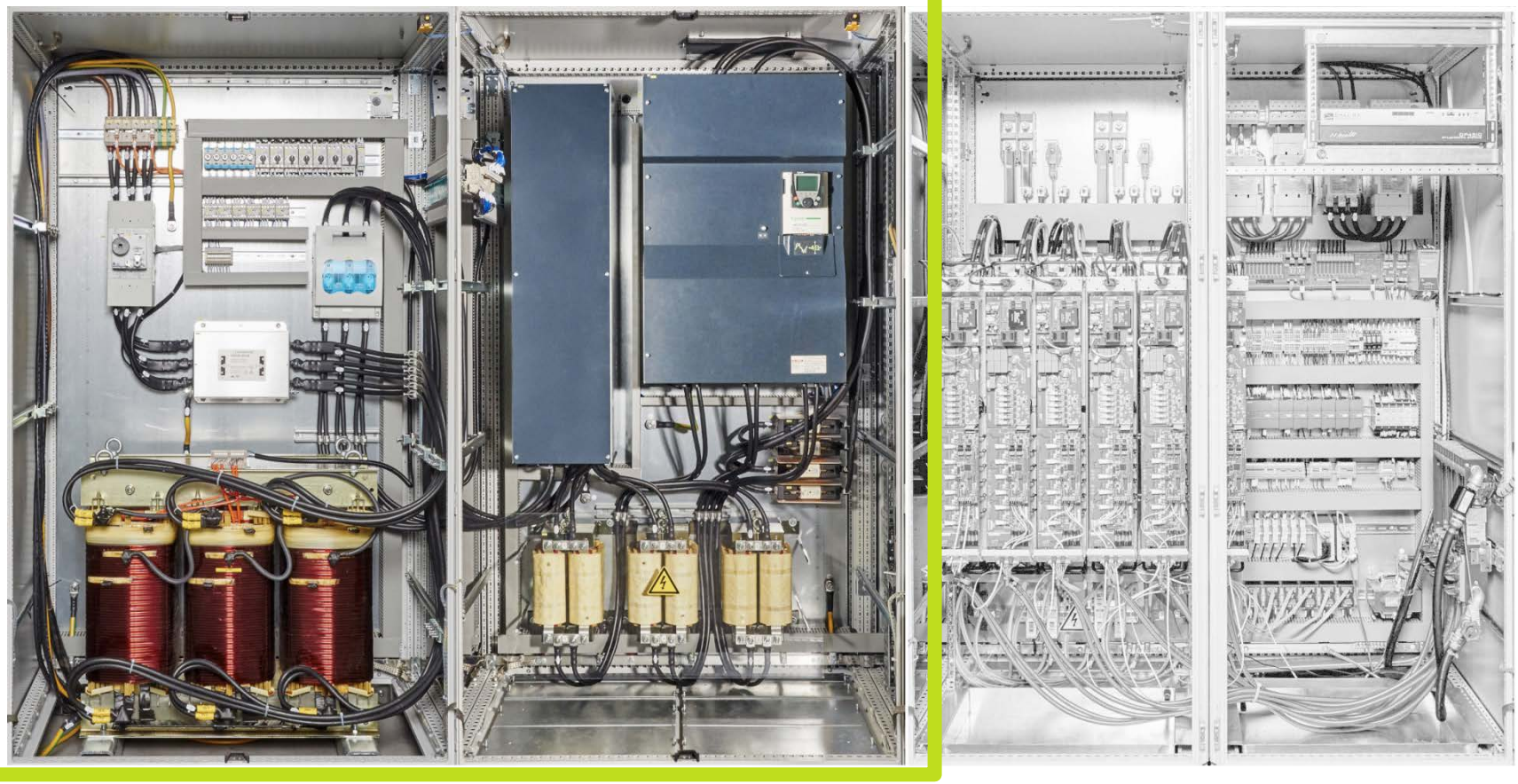
COMPISO P-HIL Solutions

P-HIL Turn Key Solution Provider

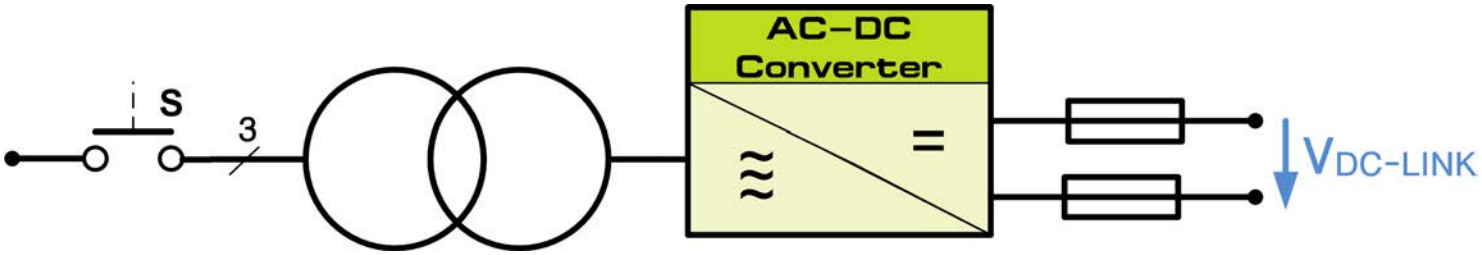


COMPISO
GRID CONVERTER BLOCK

COMPISO Grid Converter Block



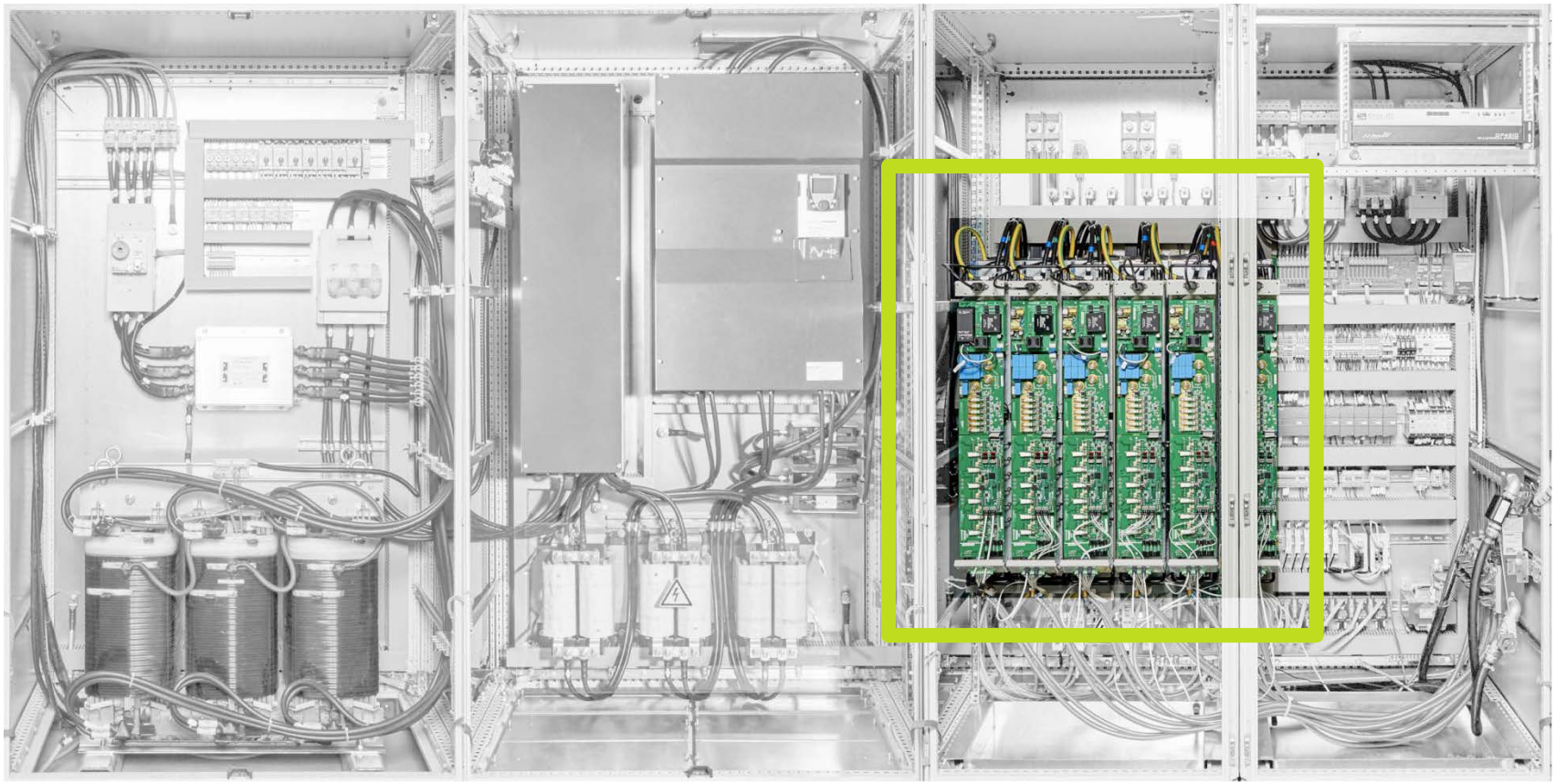
COMPISO Grid Converter Block



- Power: 100kVA up to 1MVA
- Bidirectional Energy Flow
- Galvanic Isolation (Grid Transformer)
- V_{DC_LINK} = 770V
- Supply Grid: 50/60 Hz; V_{AC} 400 – 690V
- Perfectly balanced with Power Amplifier Block

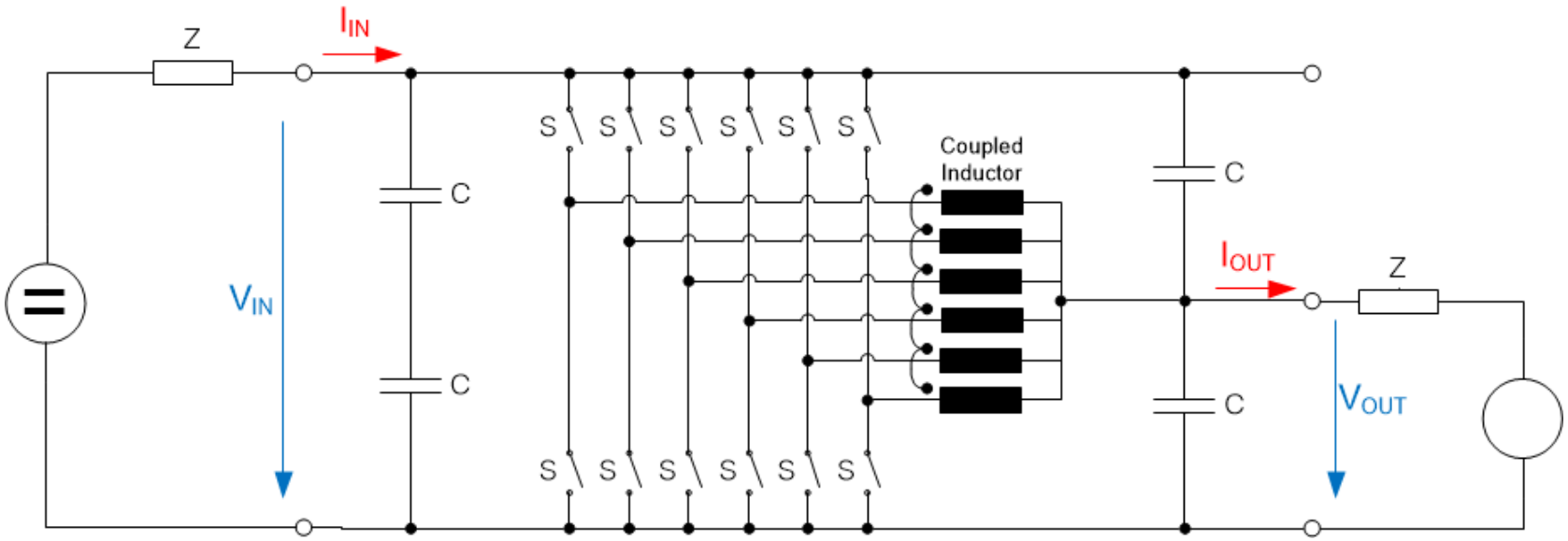
COMPISO
DIGITAL AMPLIFIER

COMPISO Digital Amplifier

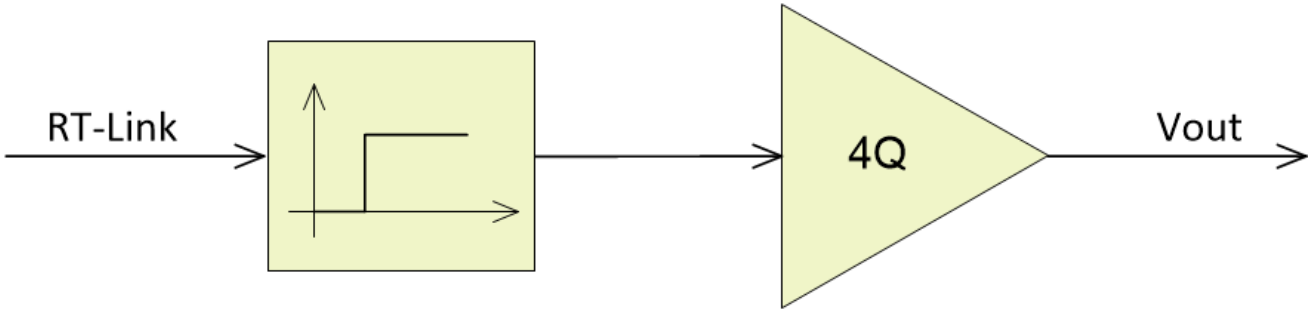


Inverter Technology

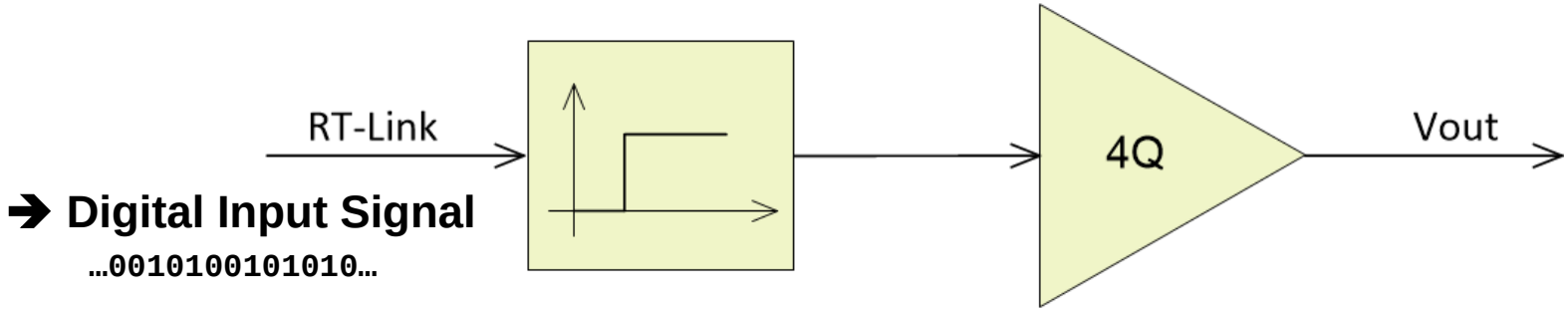
- 6-leg step-up / step down converter with coupled inductors
- f_{PWM} = 6 x 20.833 Hz = 125 kHz



COMPISO Digital Amplifier



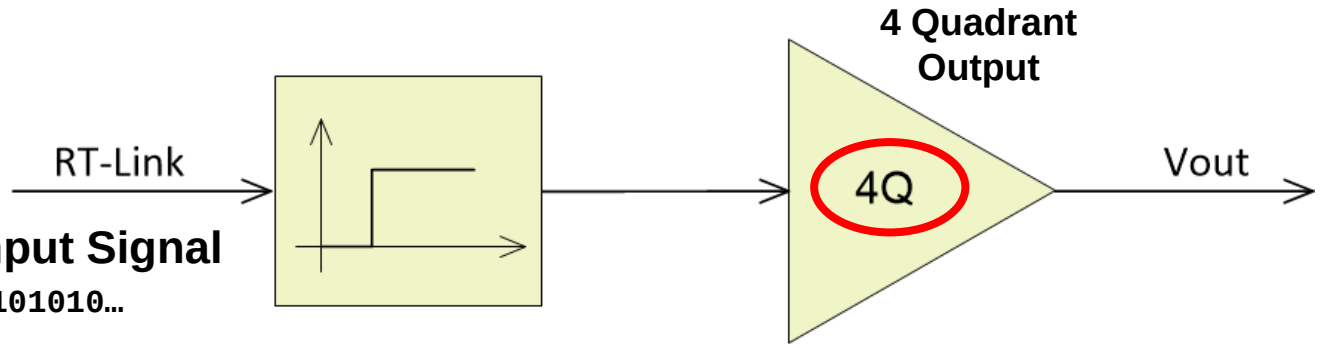
COMPISO Digital Amplifier



➔ **Digital Input Signal**

…0010100101010…

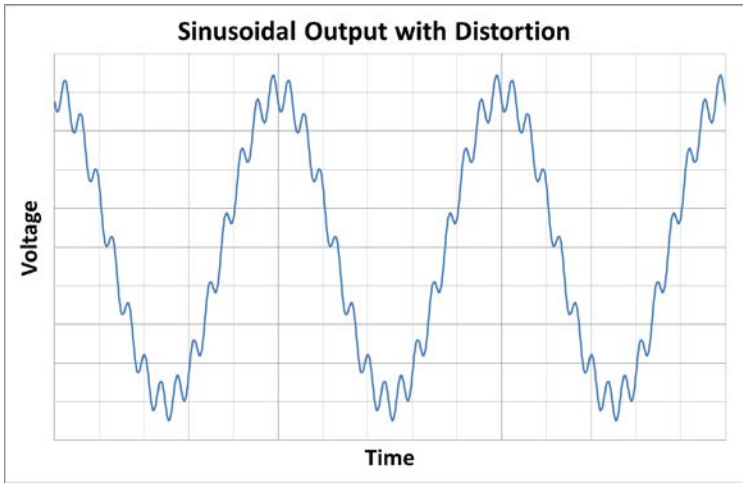
COMPISO Digital Amplifier



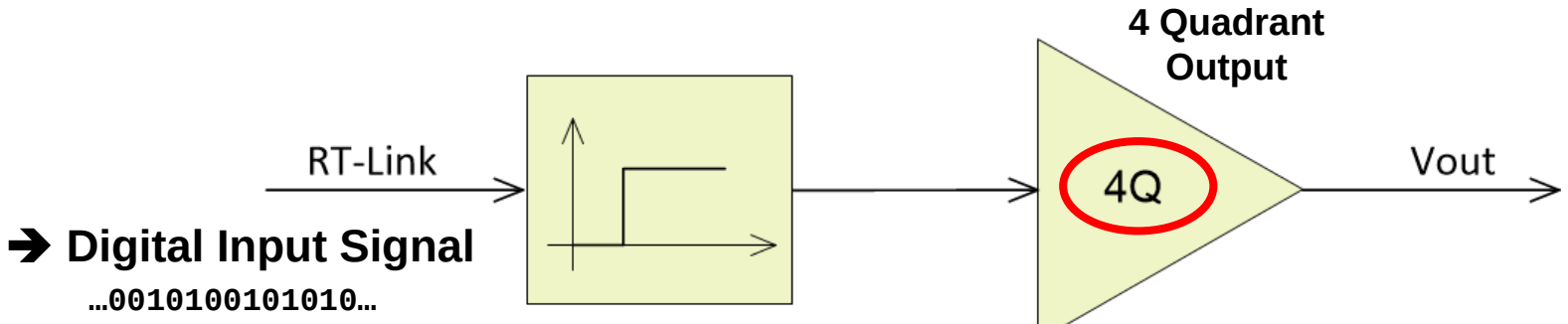
➔ **Digital Input Signal**

…0010100101010…

➔ **Analogue Output Signal**



COMPISO Digital Amplifier

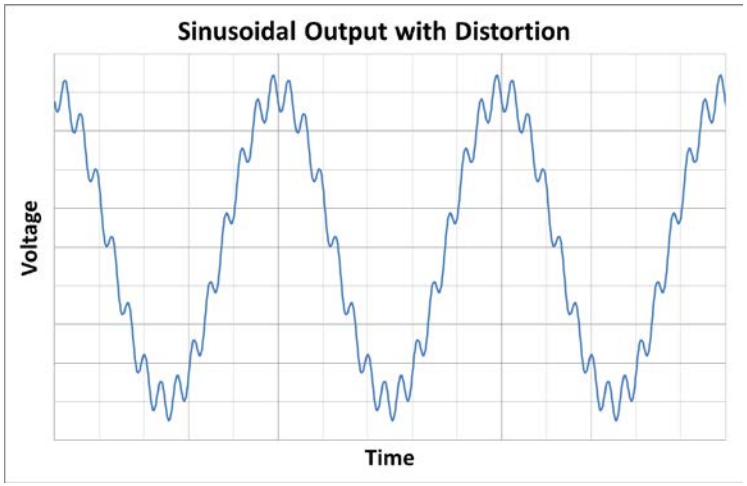


➔ **Digital Input Signal**

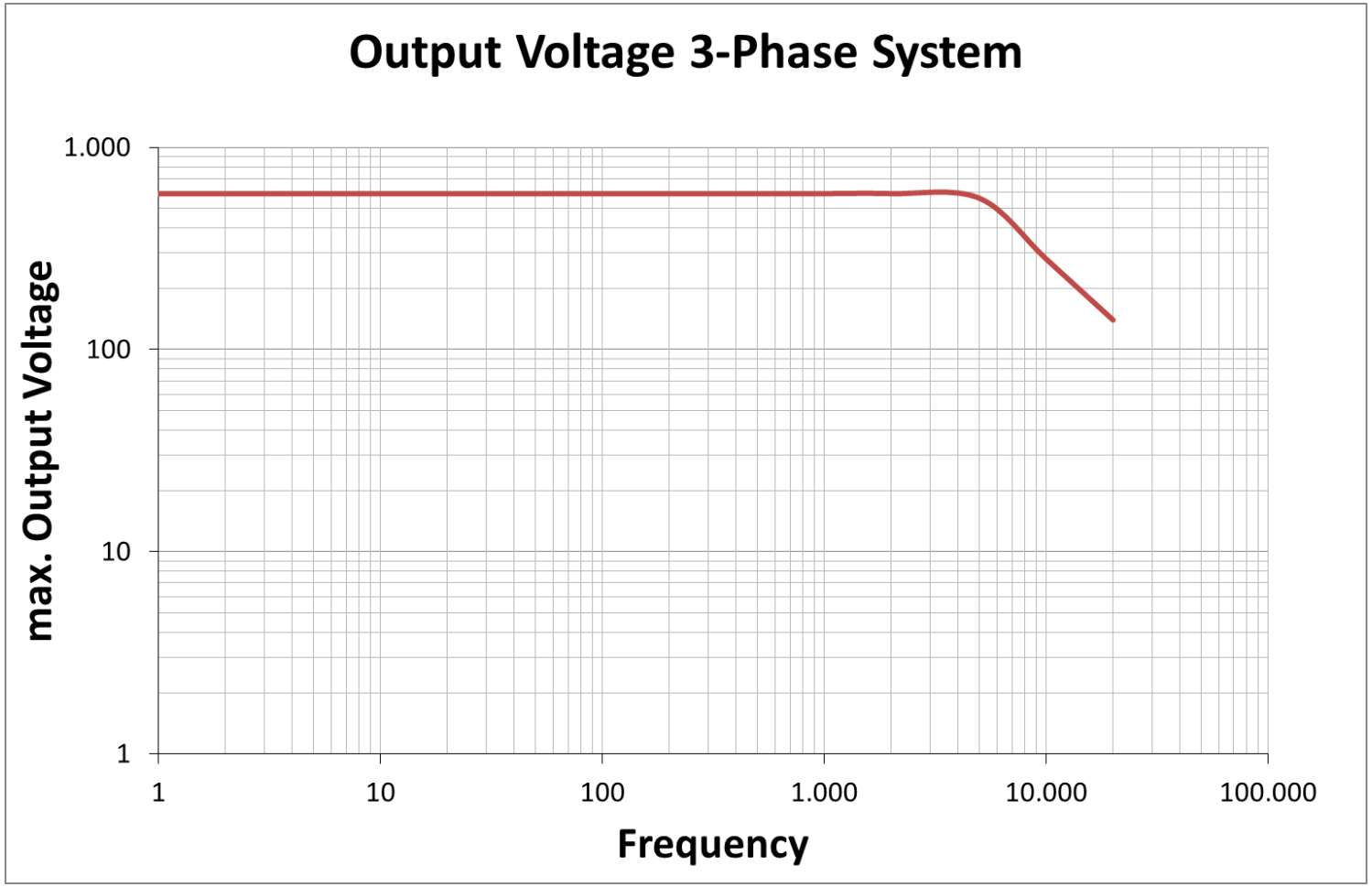
…0010100101010…

4 µs
Transport Delay
HIL ➔ PWM

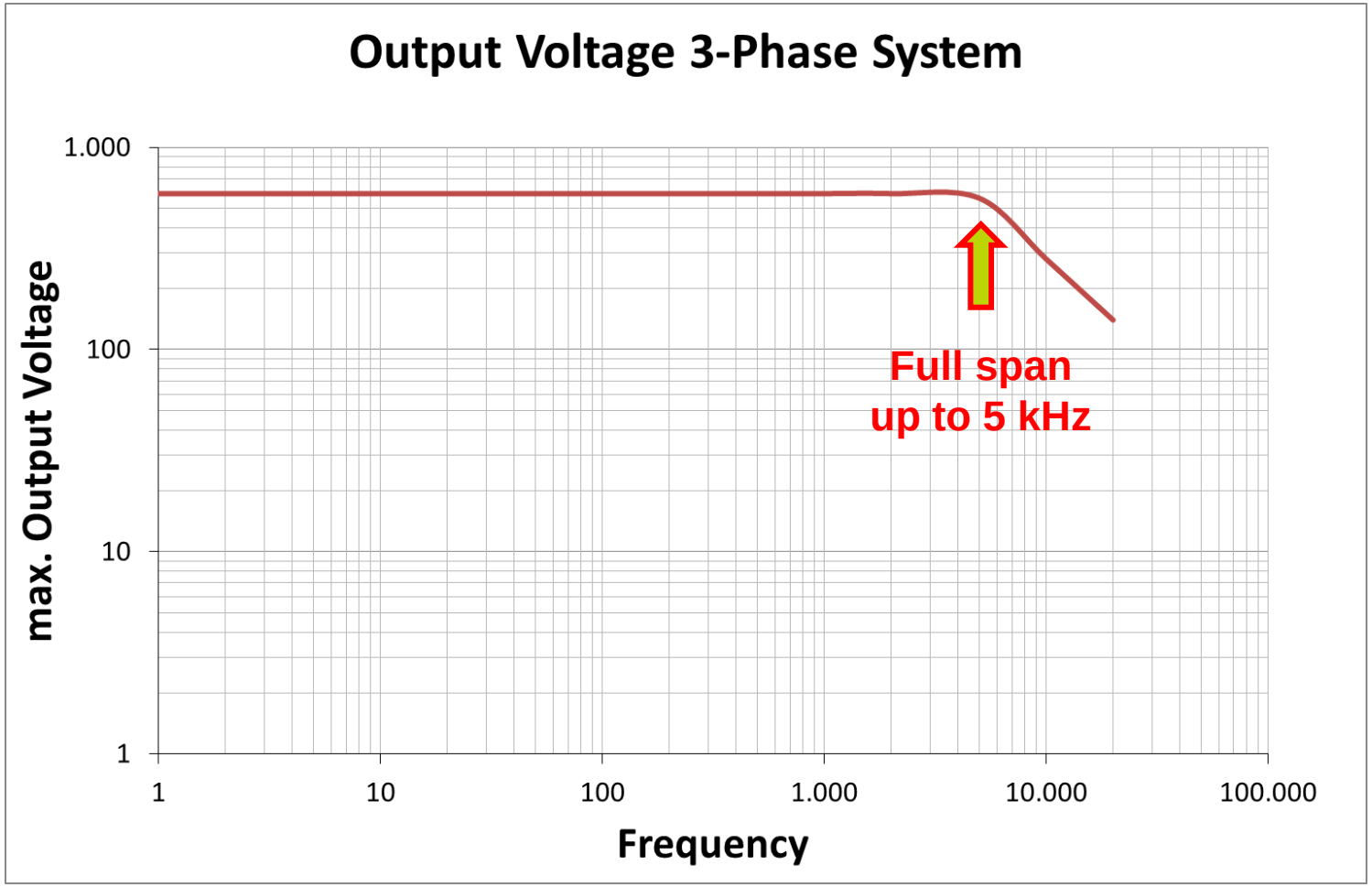
➔ **Analogue Output Signal**



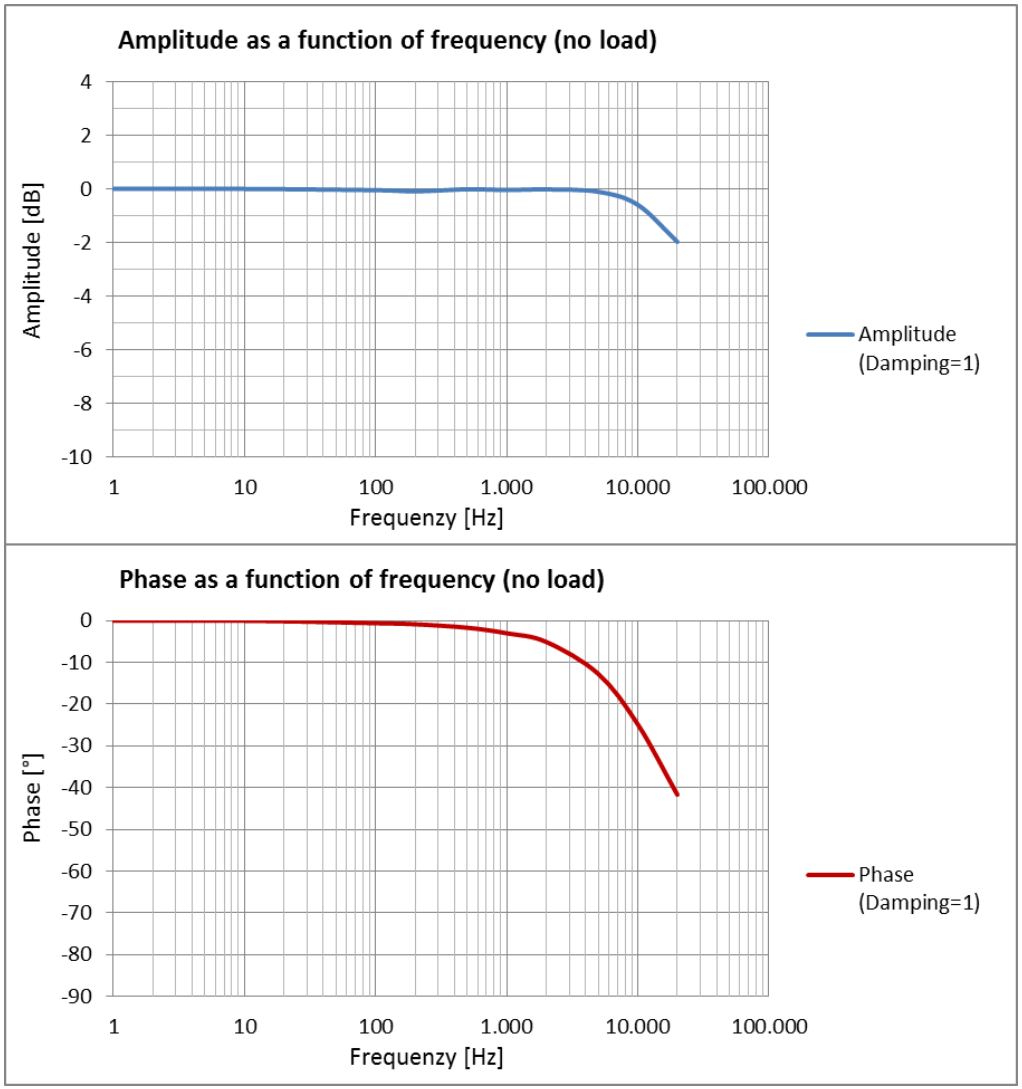
Full Span Bandwidth



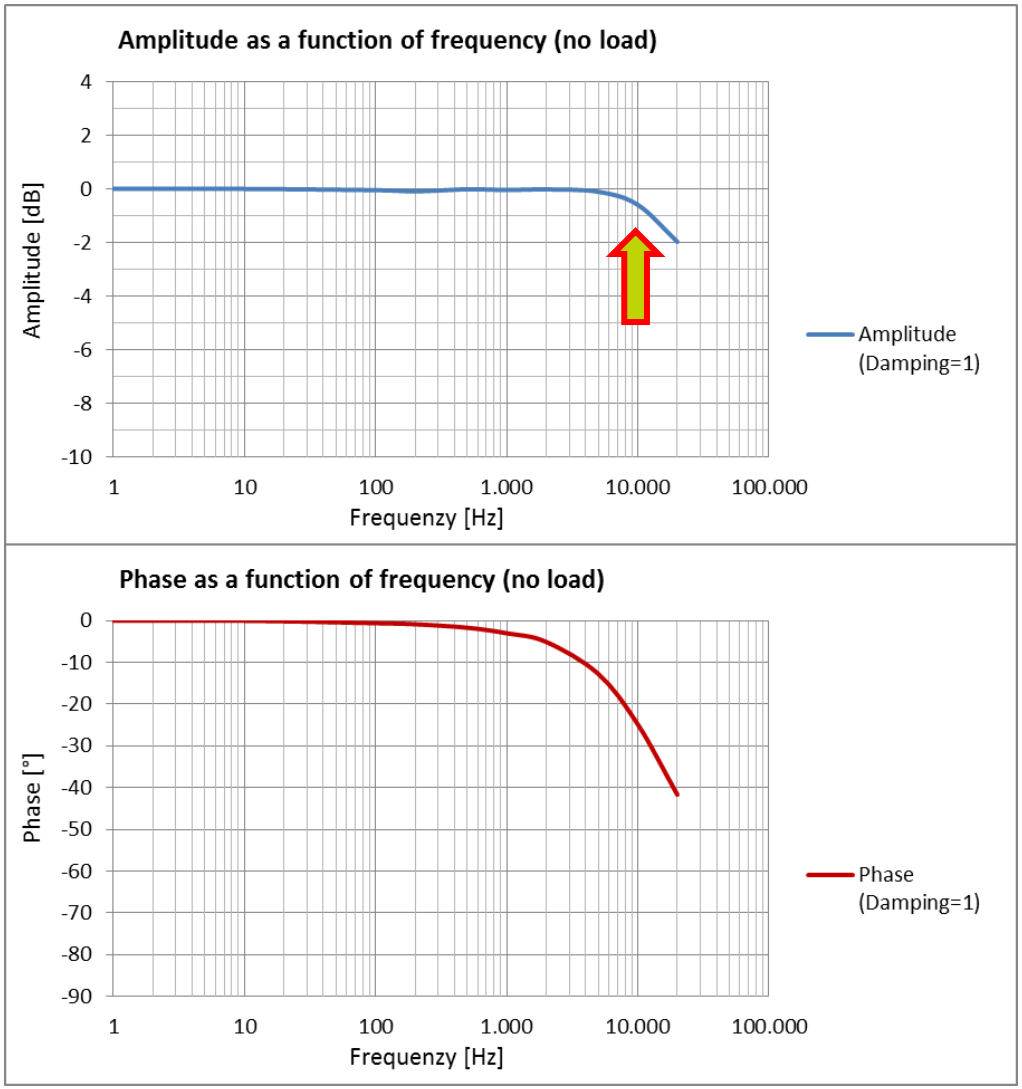
Full Span Bandwidth



Transfer Function – Low Signal (Harmonics)

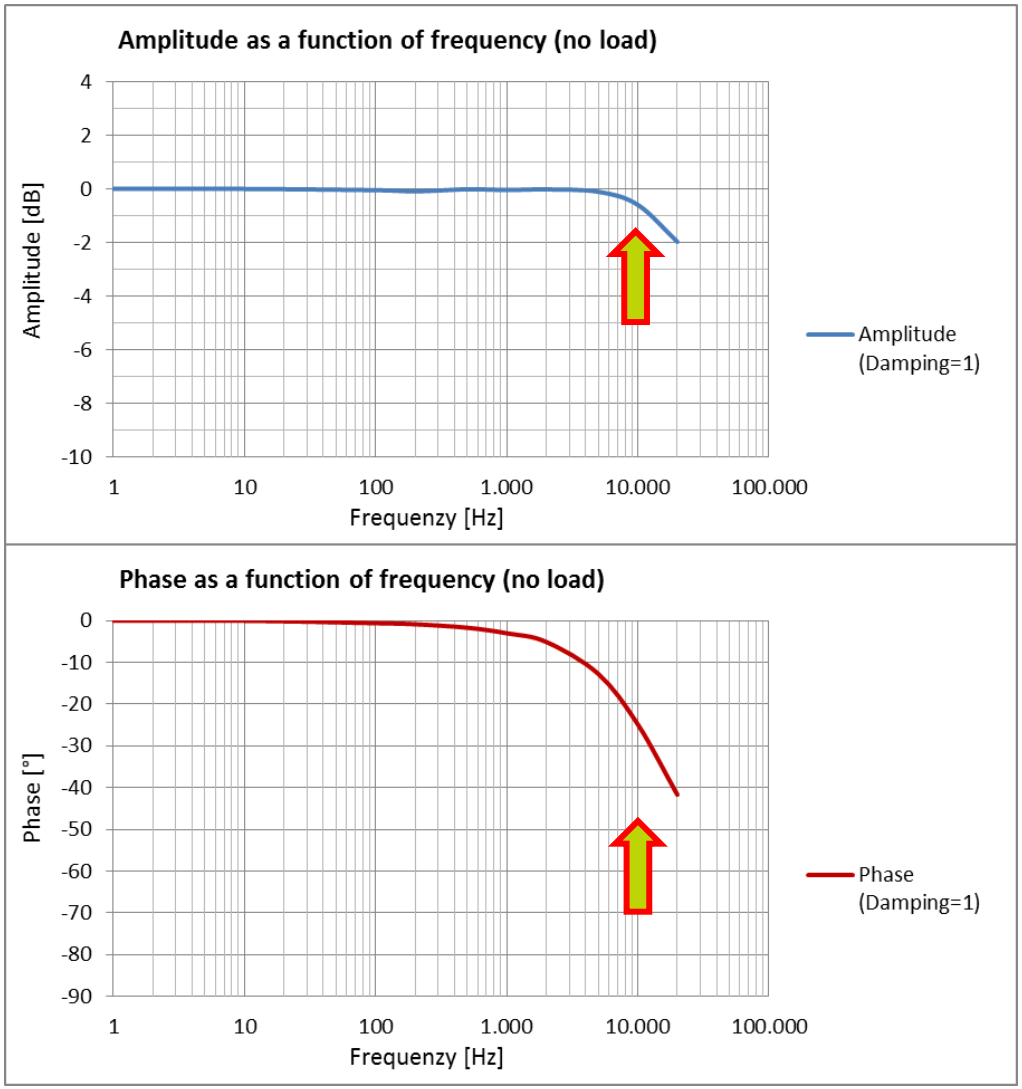


Transfer Function – Low Signal (Harmonics)



10 kHz
-1 dB

Transfer Function – Low Signal (Harmonics)



10 kHz
-1 dB

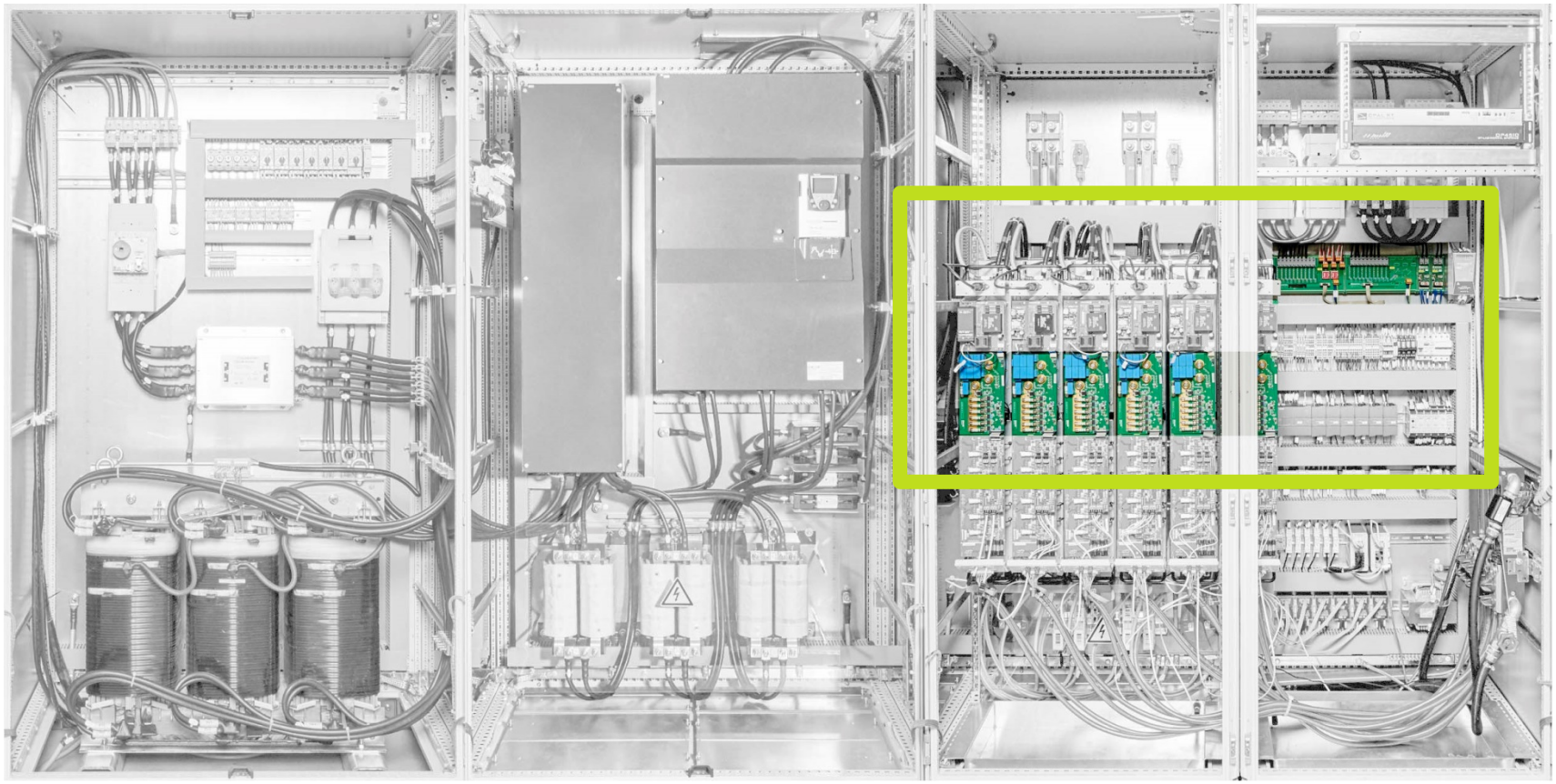
10 kHz
-25°

CDA Specification

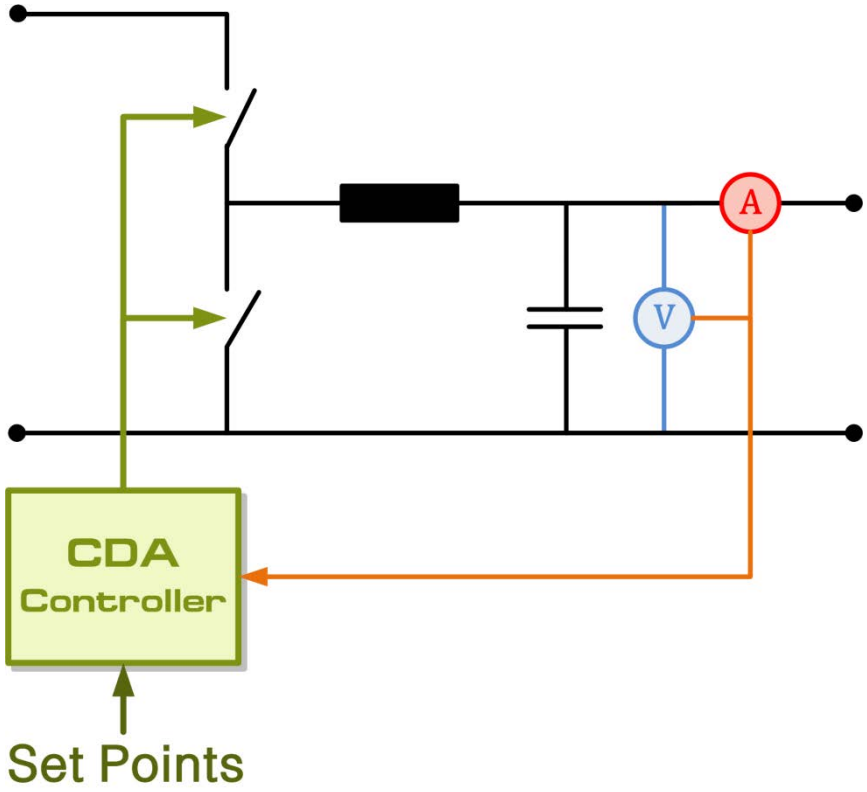
CDA SPECIFICATION	
Digital Amplifier DC & AC ratings	
Input voltage range	40 to 800 V_{DC} (nominal)
Output voltage range – DC	0 to V_{IN} - 10 V_{DC}
Output voltage range - AC	0 to 250 V_{RMS} (nominal) single- phase system (against V_{IN}/ 2)
Output voltage range - AC	0 to 480 V_{RMS} (nominal) three- phase system
Current range - DC	0 to ± 150 A_{DC}
Current range - AC	0 to 126 A_{RMS}
Current overload capability	10% (1 min.)
Power- DC	0 to 120 kW
S- AC Single Phase	0 to 31,5 kVA single- phase system (against V_{IN}/ 2)
S- AC 3 Phase	0 to 105 kVA three- phase system
Full Span Output Voltage	DC to 5 kHz sine wave
Signal Quality	
Output ripple voltage	V_{PEAK} < 0,25 % V_{IN}
Switching frequency	20.833 Hz x 6 = 125 kHz
Efficiency	98,5 % (at step down operation, V_{IN} = 800 V, V_{OUT} = 400 V, I_{OUT} = 100 A, f_{PWM} = 125 kHz)
Operating modes	
DC operation	2 quadrant - source / sink operation
	4 quadrant operation with 2 CDARs as bridge
AC operation	4 quadrant operation
Load regulation	< ± 1% of V_{IN} (steady state)

COMPISO MEASUREMENT

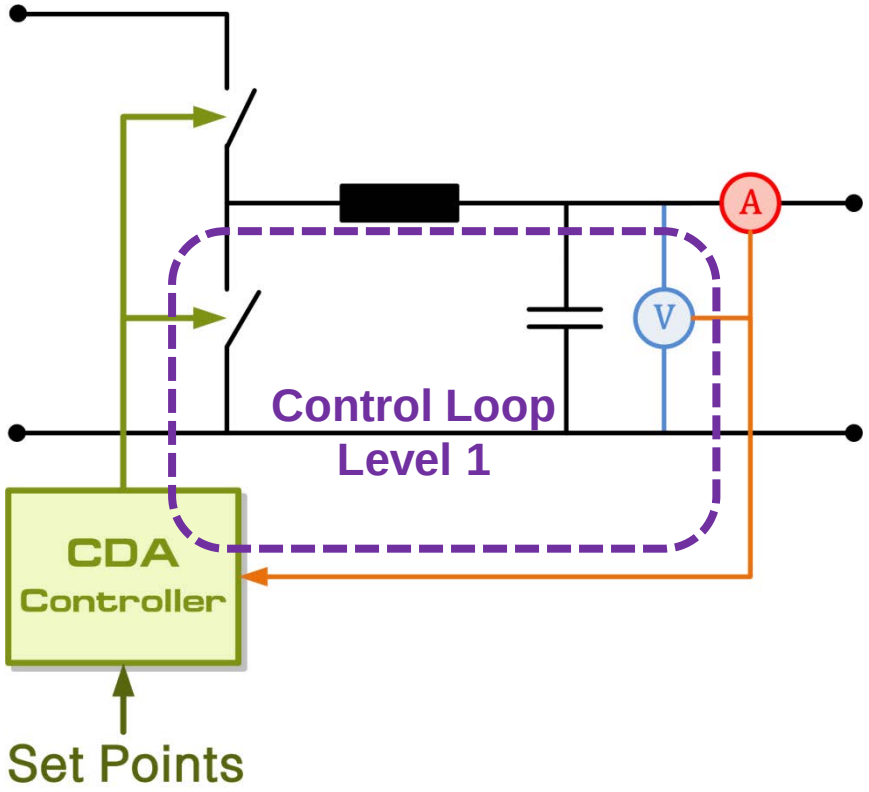
Measurement



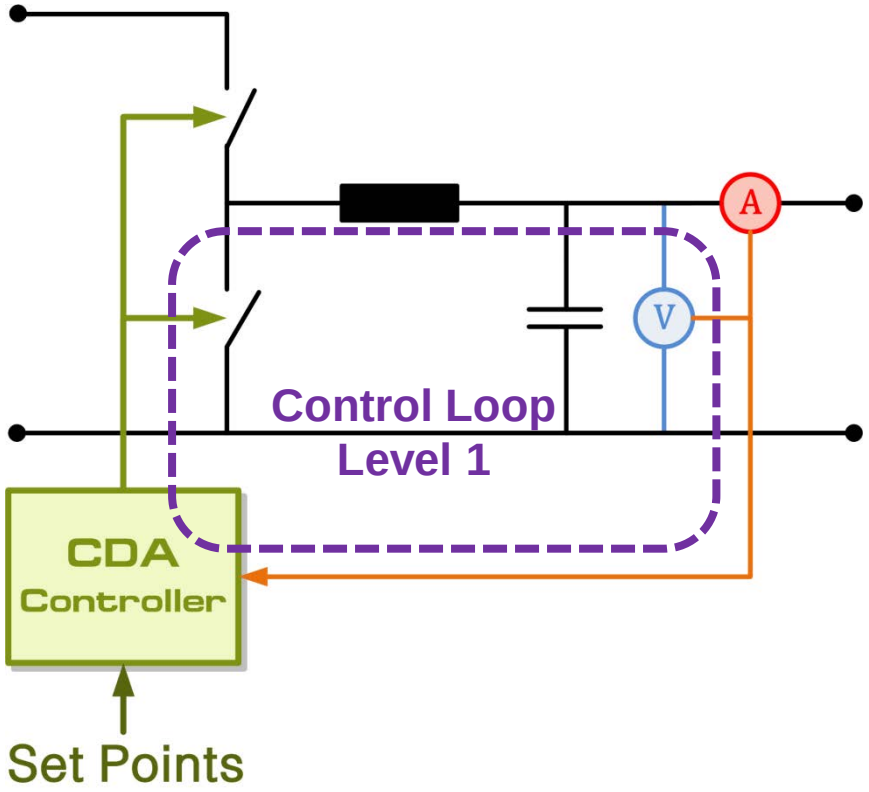
CDA Measurement Processing



CDA Measurement Processing

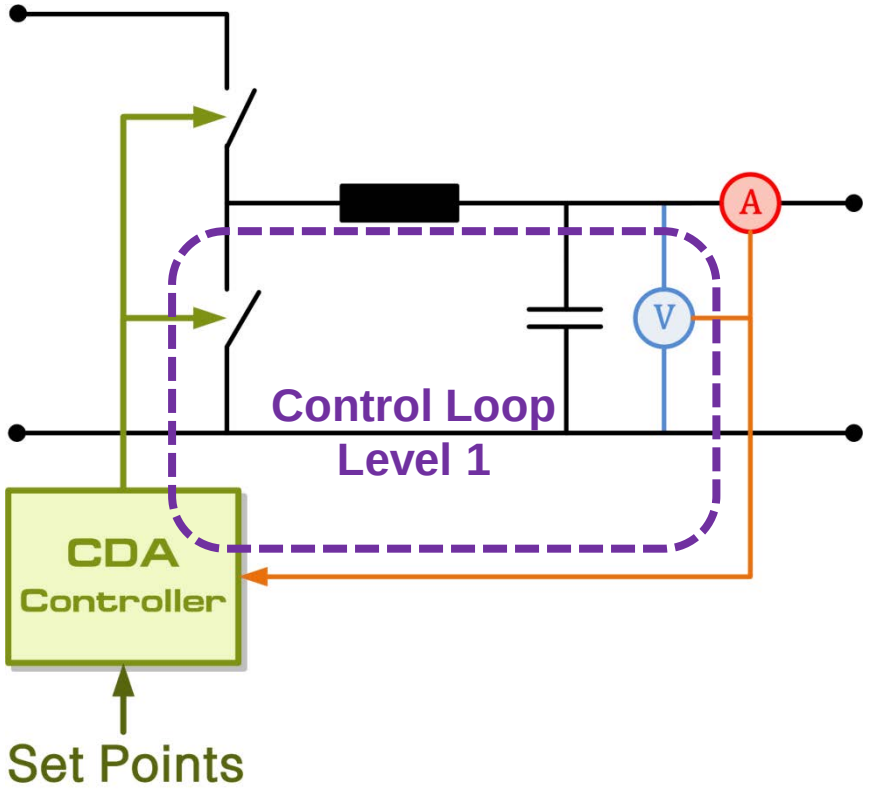


CDA Measurement Processing



V-Source
I-Source
(250 kHz)

CDA Measurement Processing



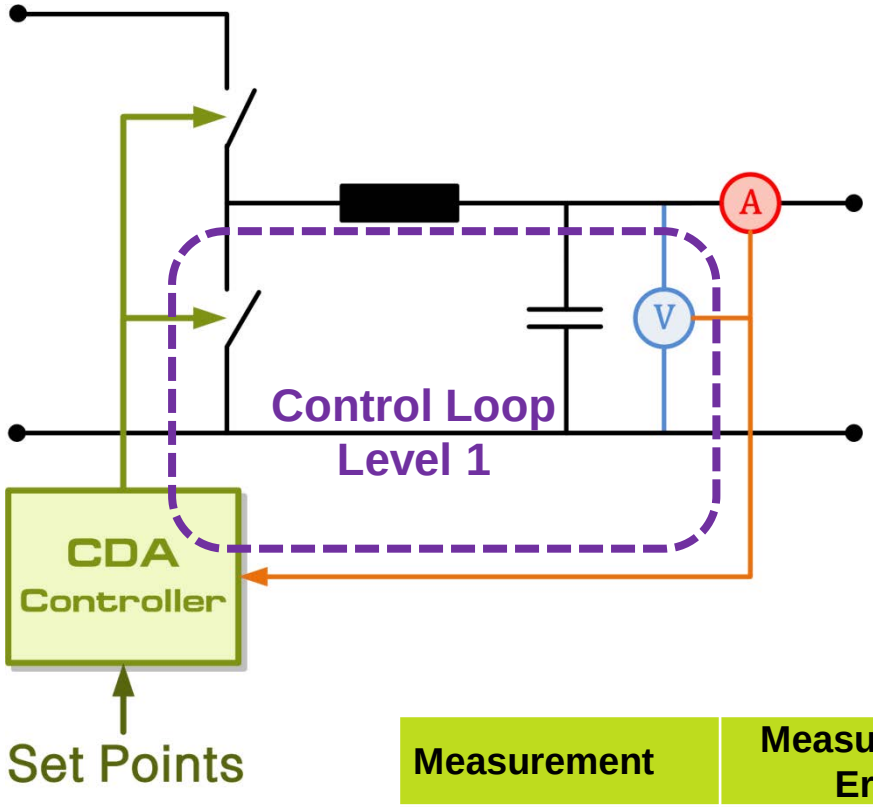
V-Source
I-Source
(250 kHz)

Loop Level 1:

- Fast sampling (MHz)
- low latency
- medium accuracy

- ➔ active damping

CDA Measurement Processing



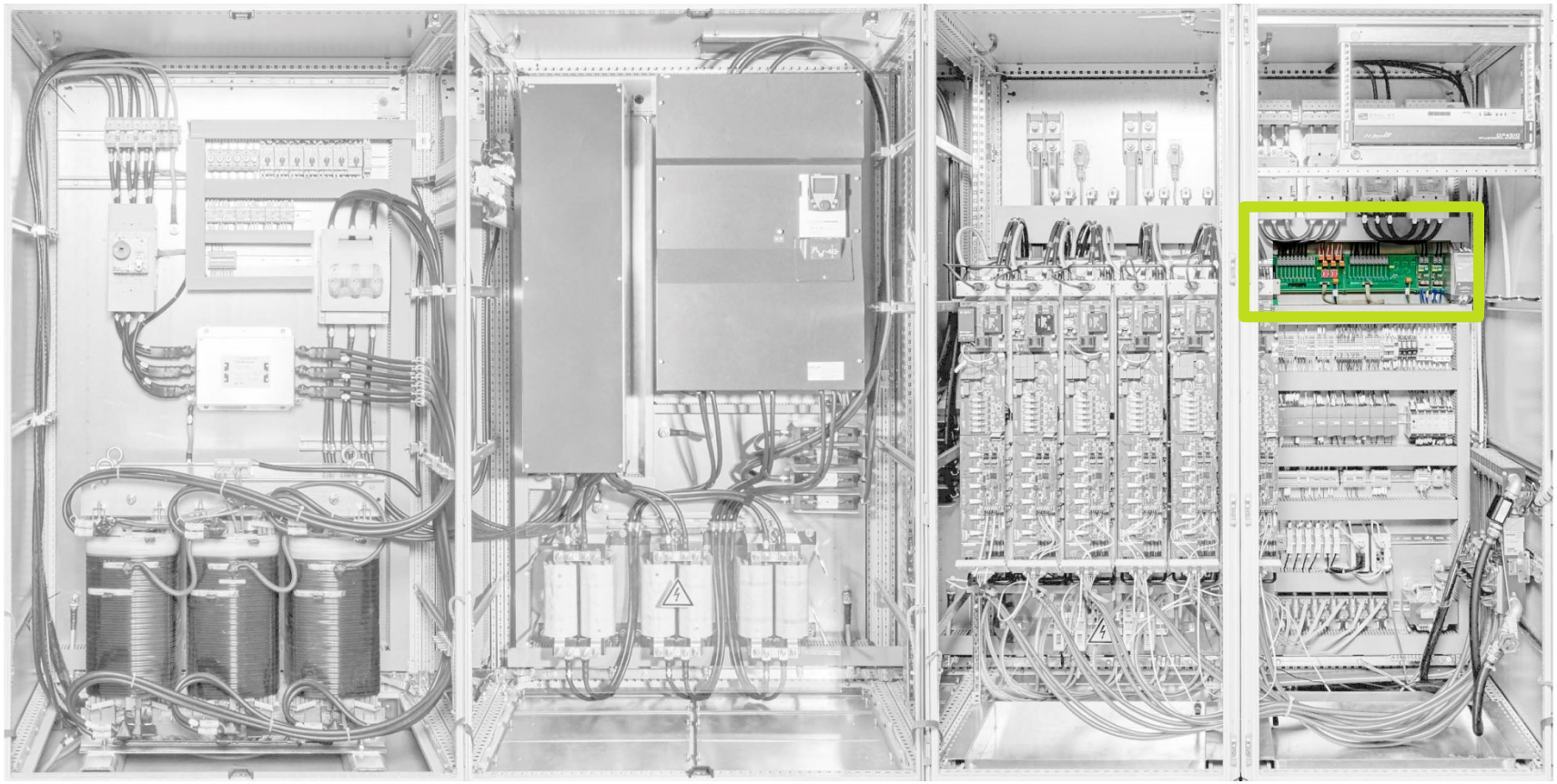
Loop Level 1:

- Fast sampling (MHz)
- low latency
- medium accuracy

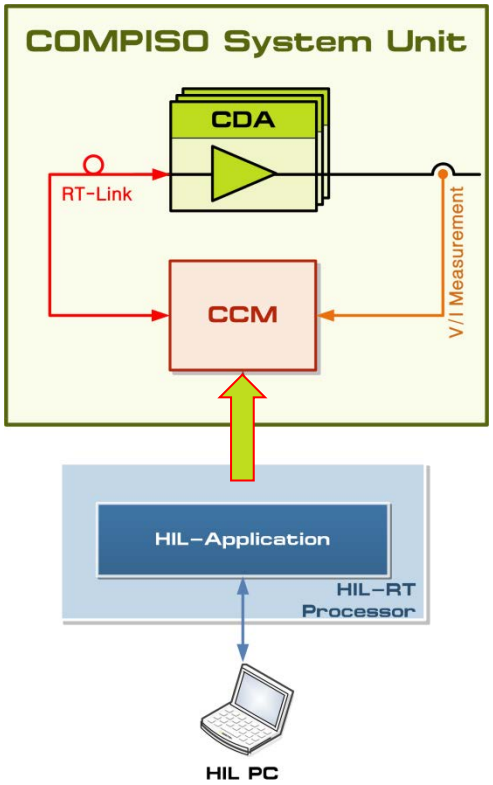
- ➔ active damping

Measurement	Measurement Error	ADC Resolution	Max. Value
Current	5 %	12 Bit	± 200 A
Voltage	1 %	12 Bit	± 1.000 V

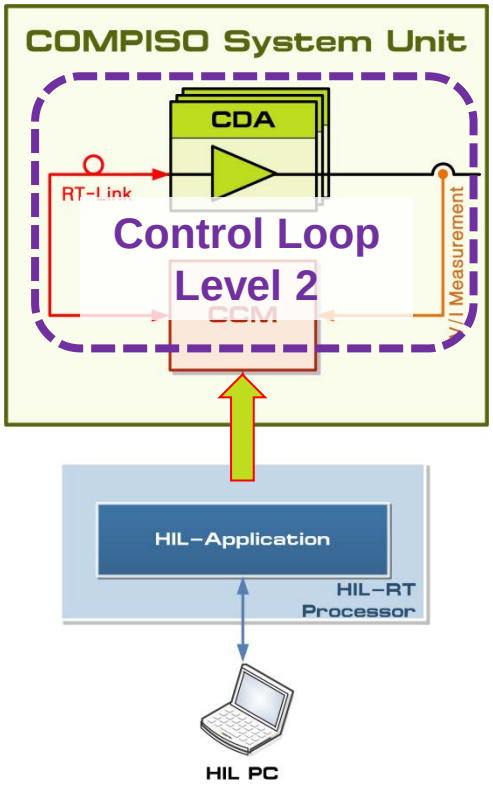
Cabinet Measurement



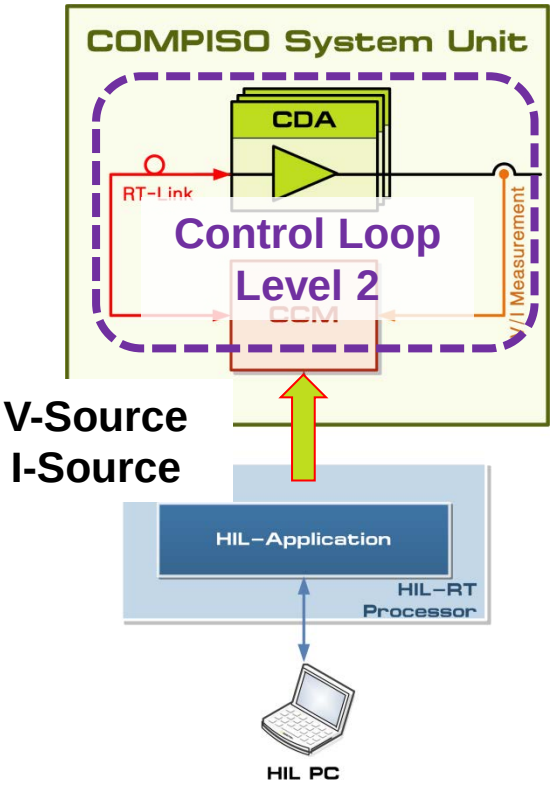
Cabinet Measurement



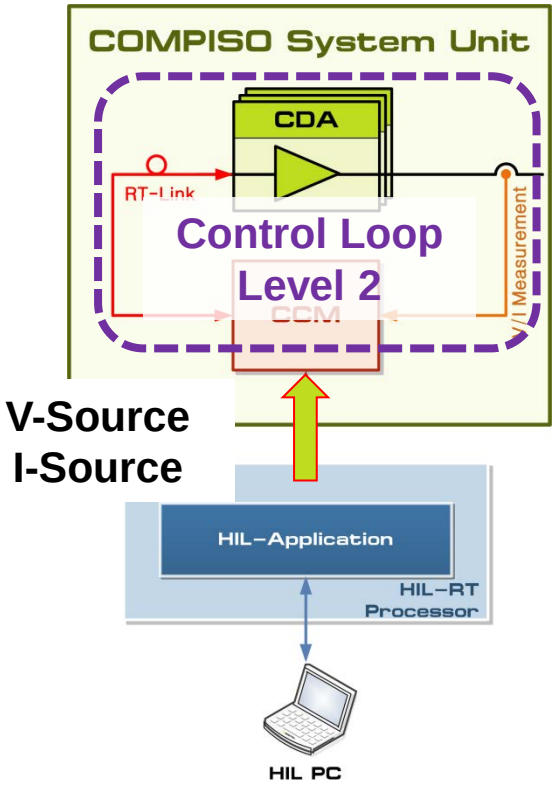
Cabinet Measurement



Cabinet Measurement



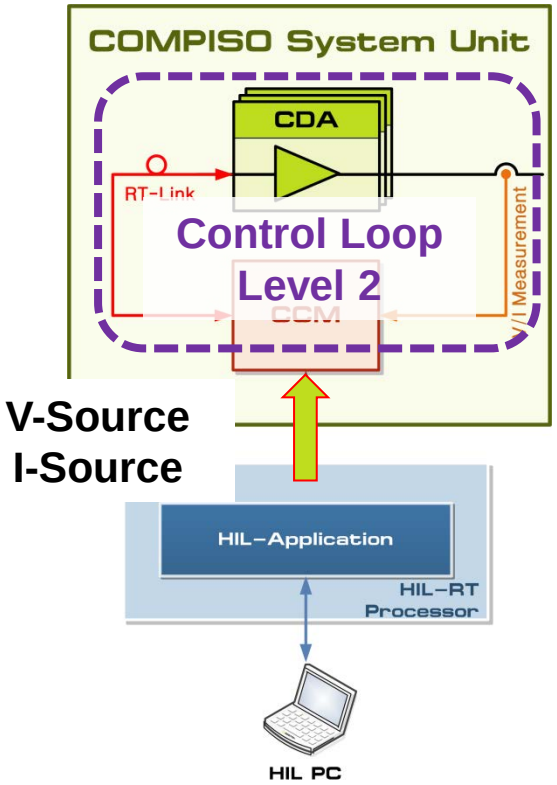
Cabinet Measurement



Loop Level 2:

- Slower sampling (250kHz)
- Longer latency (2+4µs)
- High accuracy

Cabinet Measurement

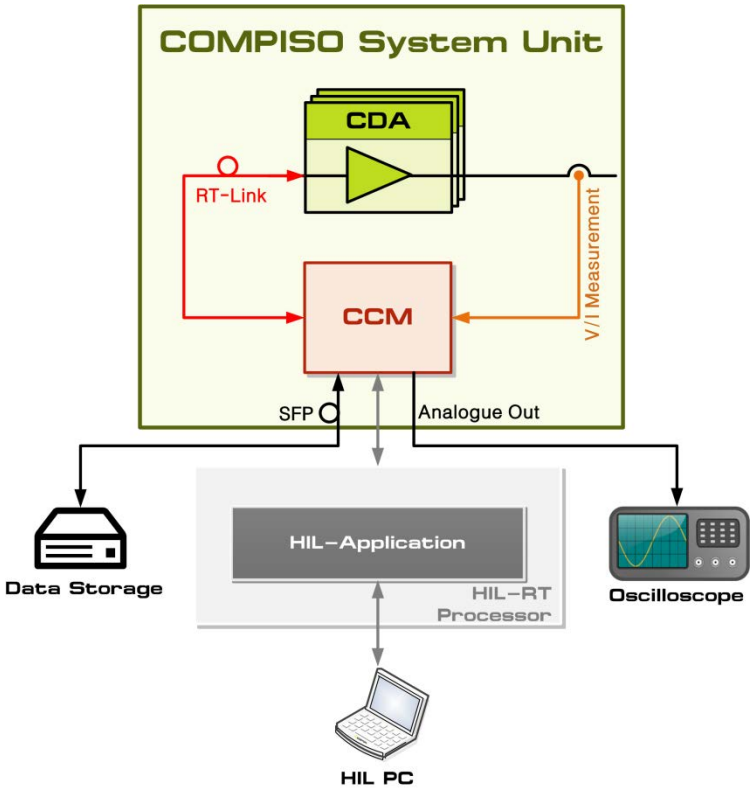


Loop Level 2:

- Slower sampling (250kHz)
- Longer latency (2+4µs)
- High accuracy

Measurement	Measurement Error	ADC Resolution	Max. Value
Current	1,1%	15 Bit	± 200 A
Voltage	0,3%	16 Bit	± 1.000 V

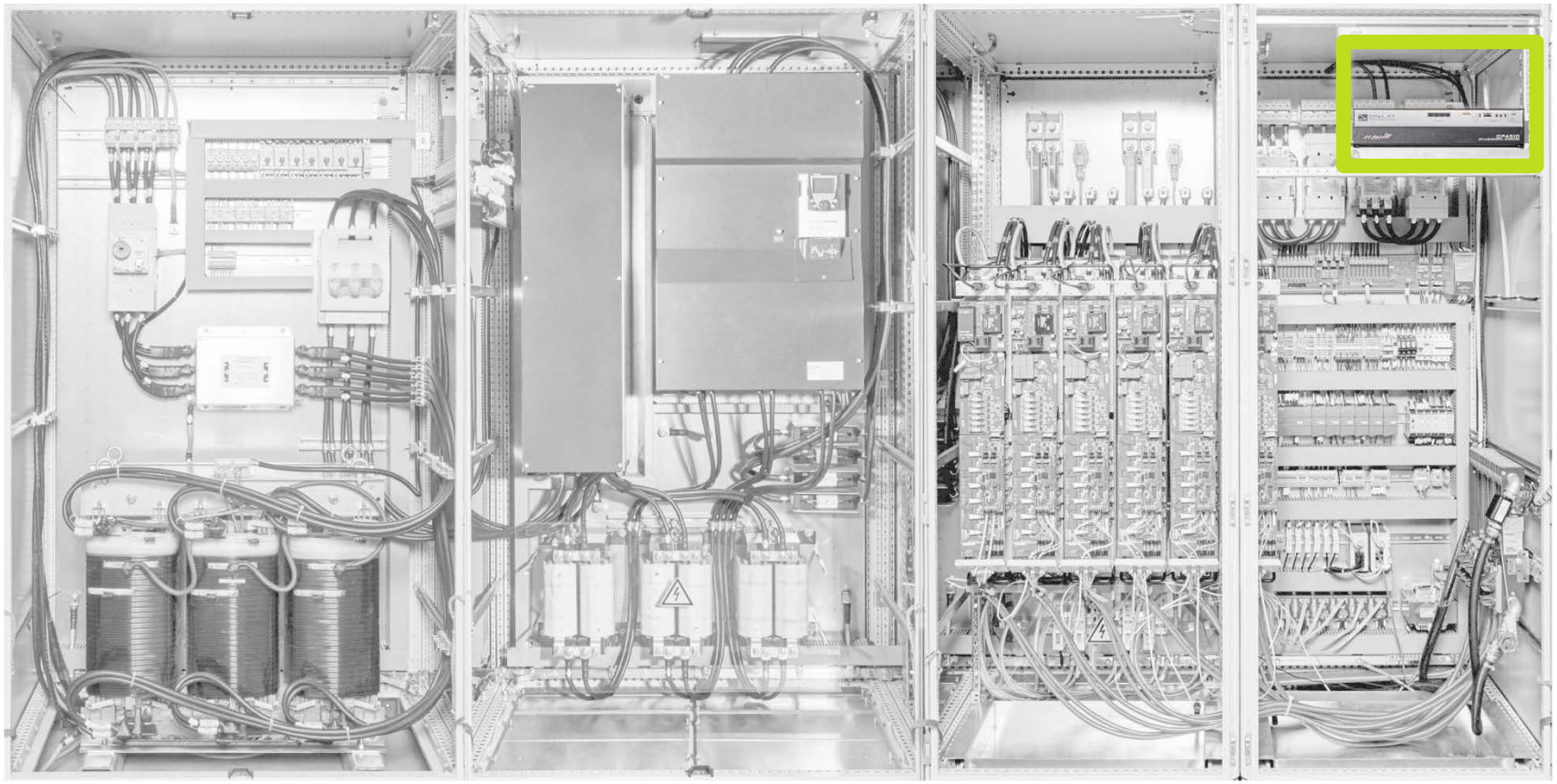
Cabinet Measurement – Data Tracking



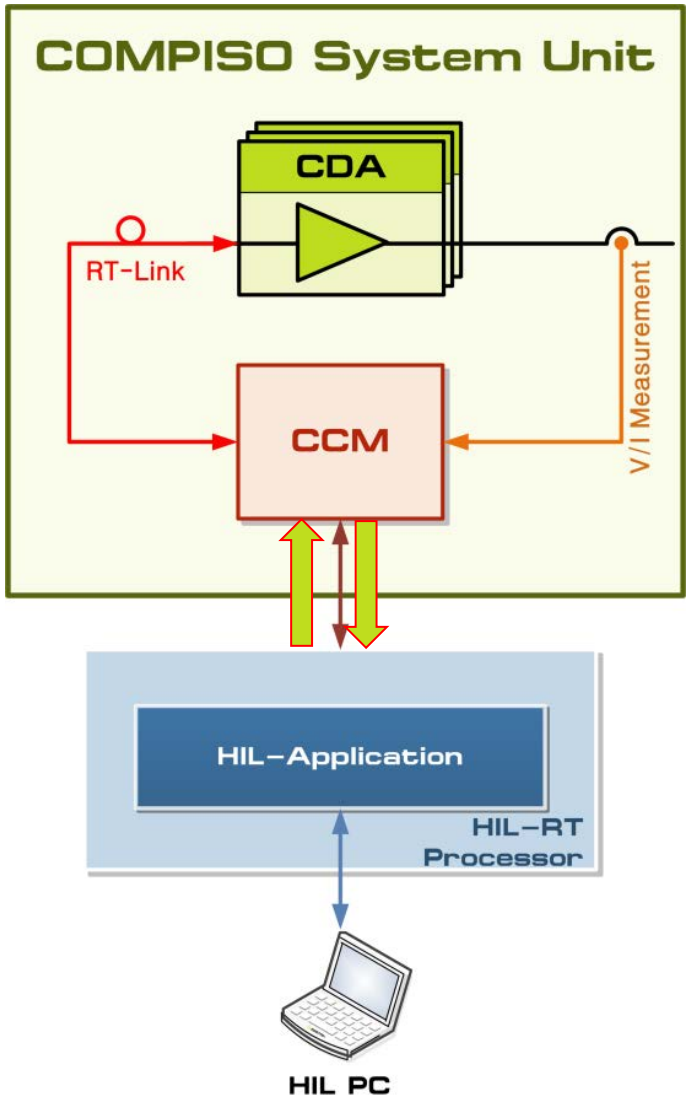
- Data Tracking
  - Digital: SFP (2 – 8 Gbps Optical Interface)
  - Analogue Output Channels (3 Chan, 0..5V or +/- 5V)

HIL
HARDWARE IN THE LOOP

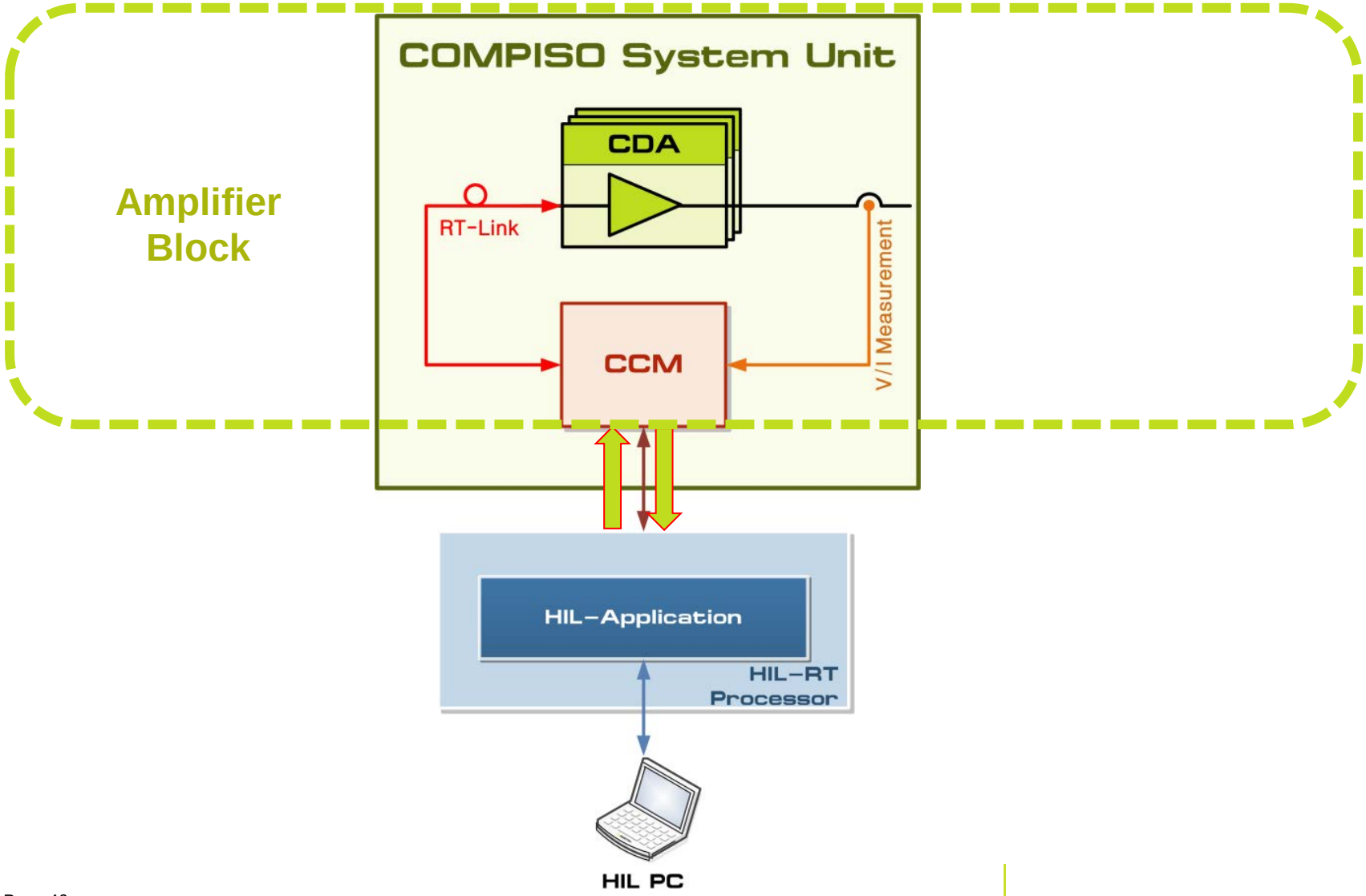
HIL Box



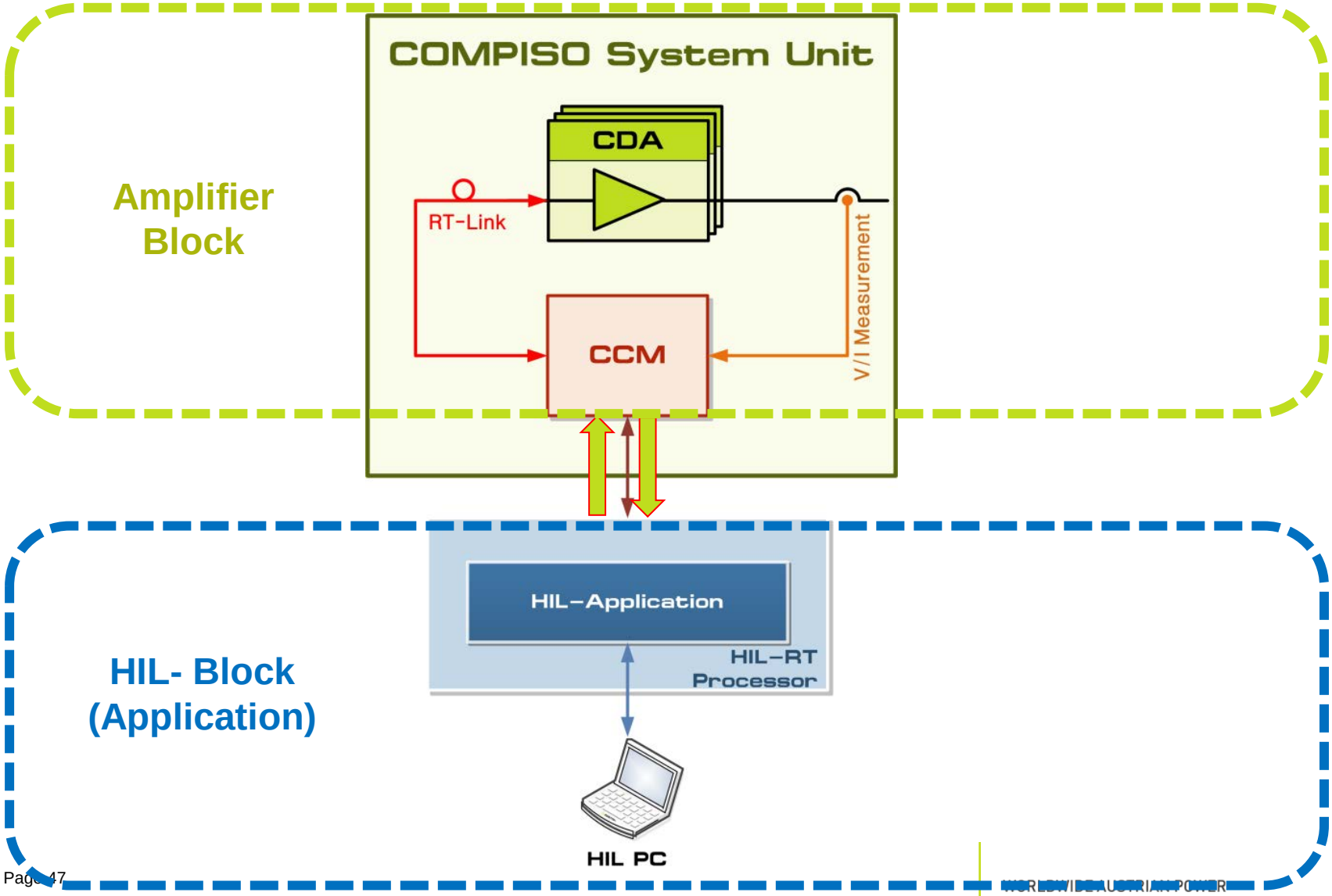
Power Amplifier / HIL Architecture



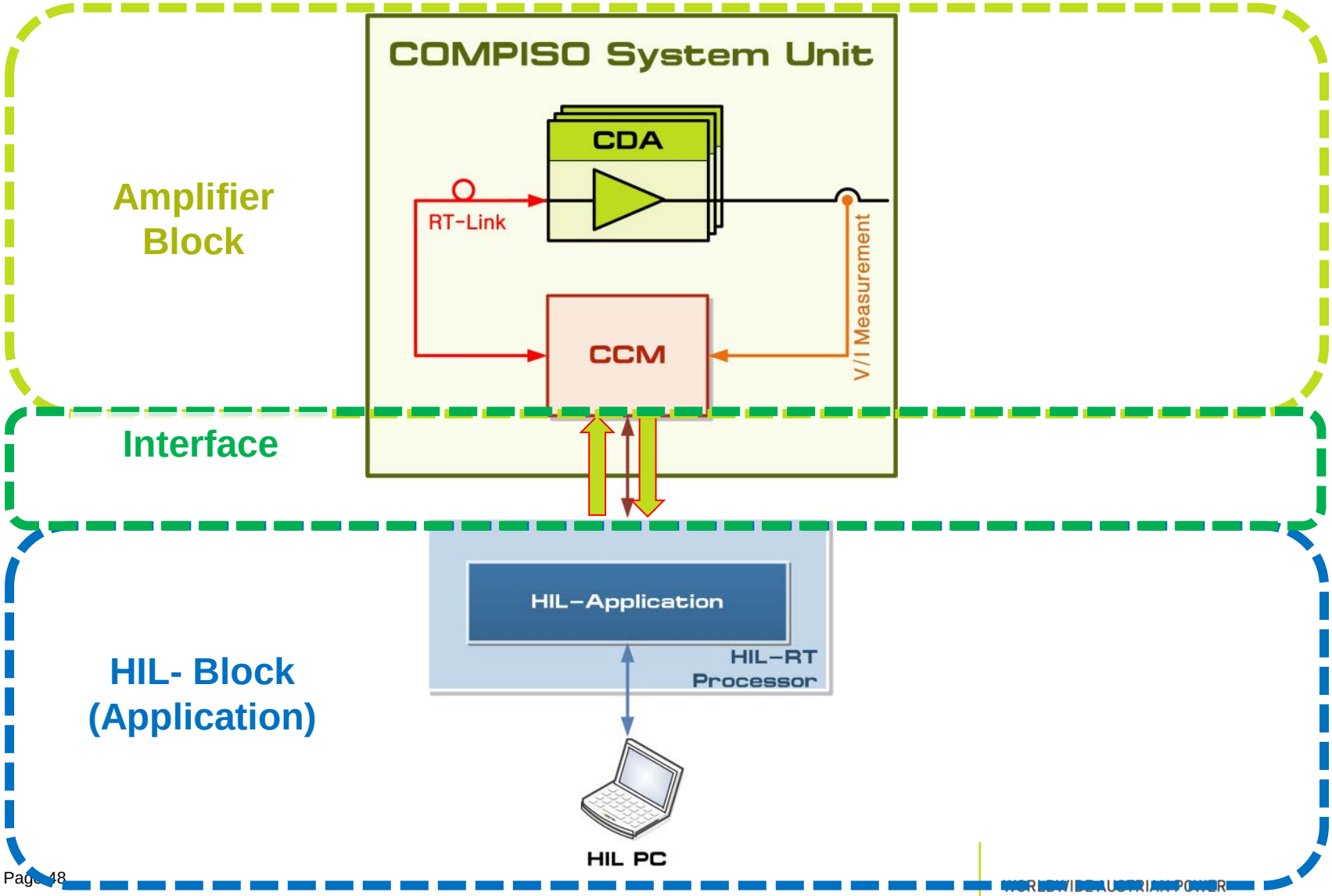
Power Amplifier / HIL Architecture



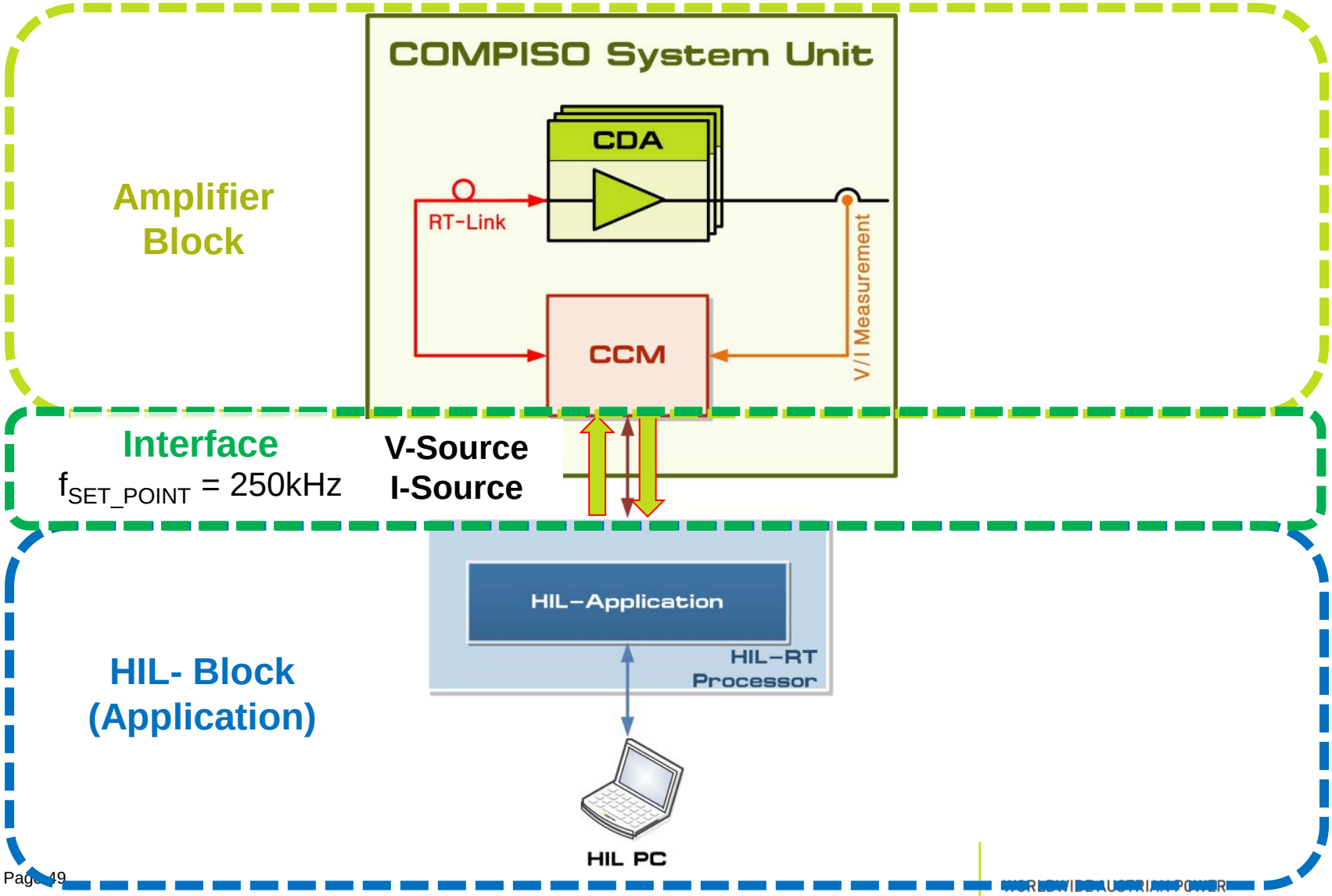
Power Amplifier / HIL Architecture



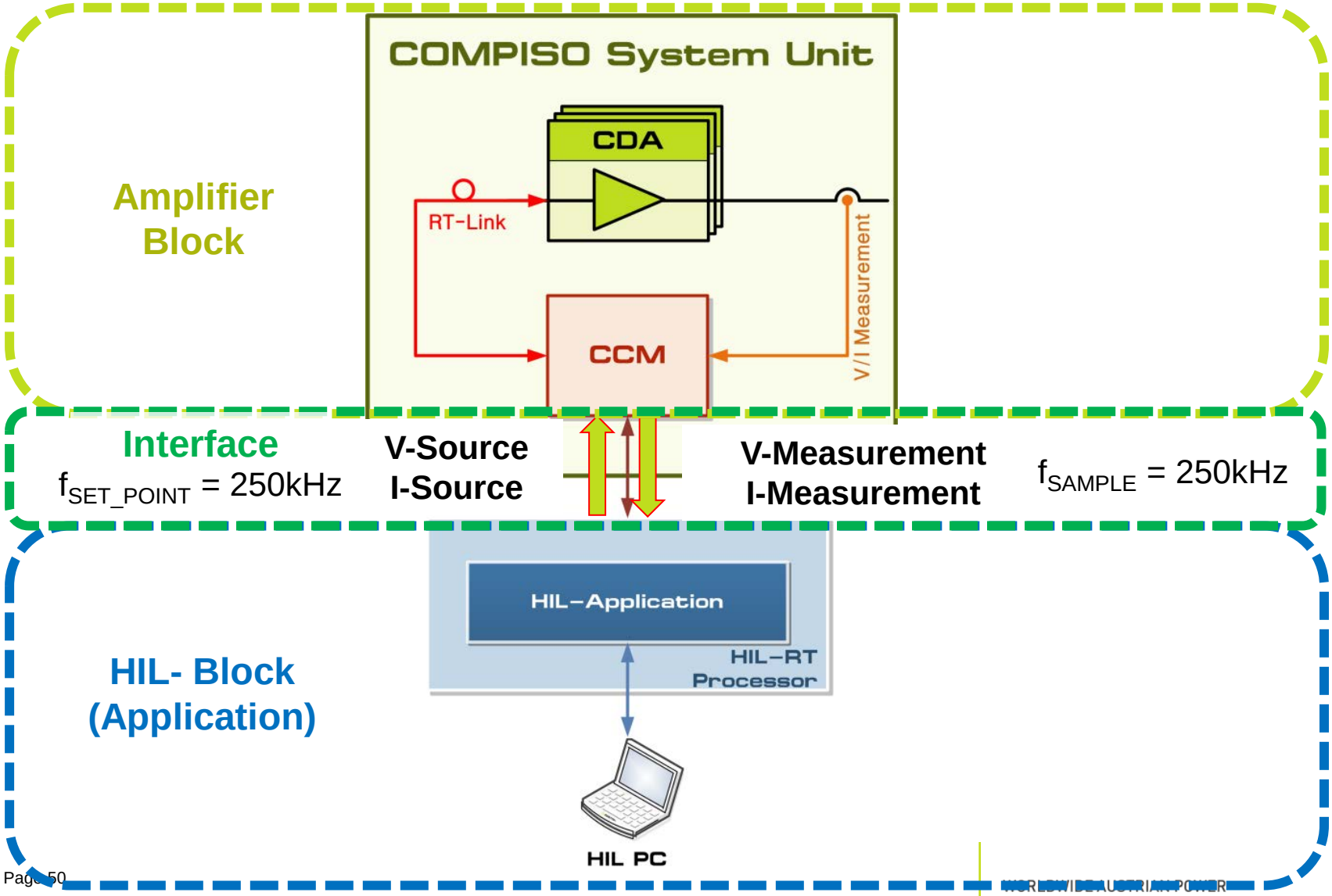
Power Amplifier / HIL Architecture



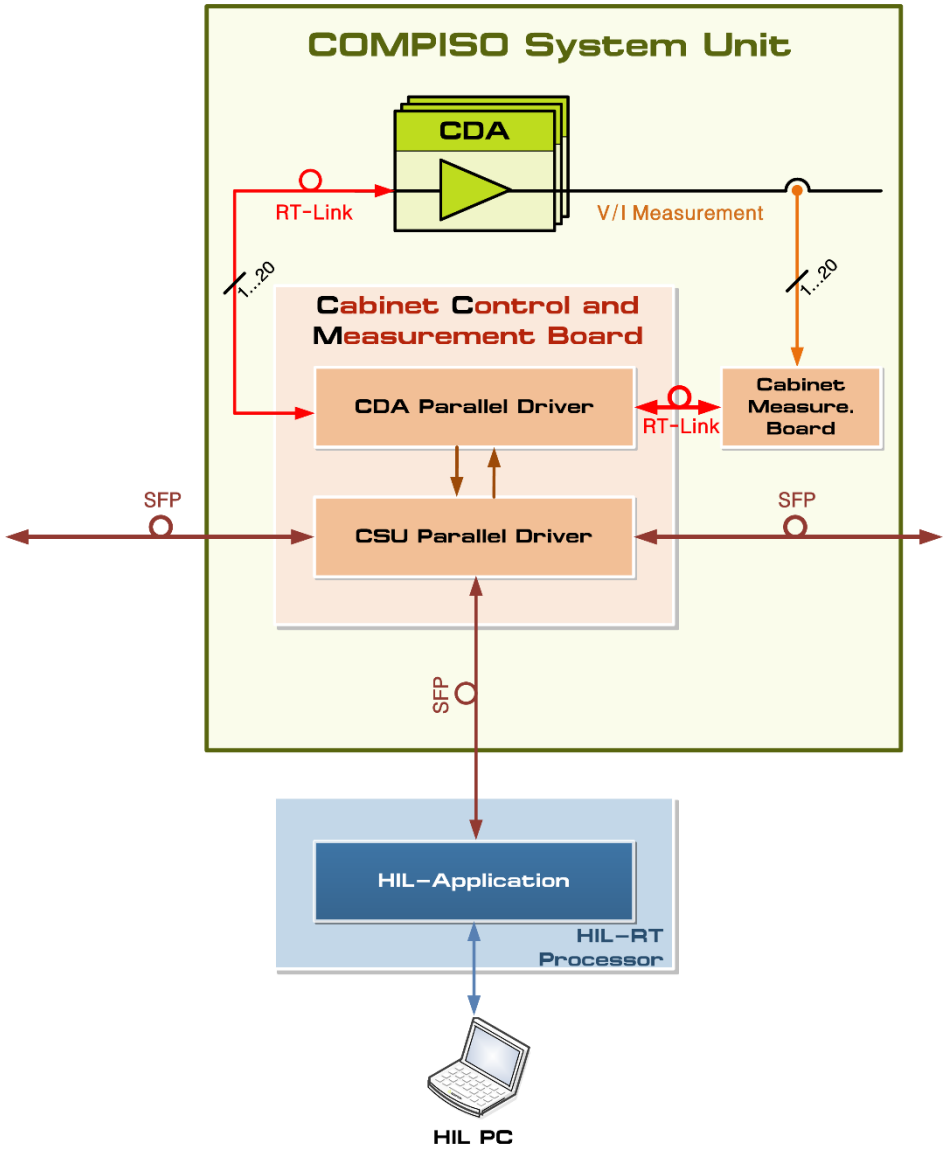
Power Amplifier / HIL Architecture



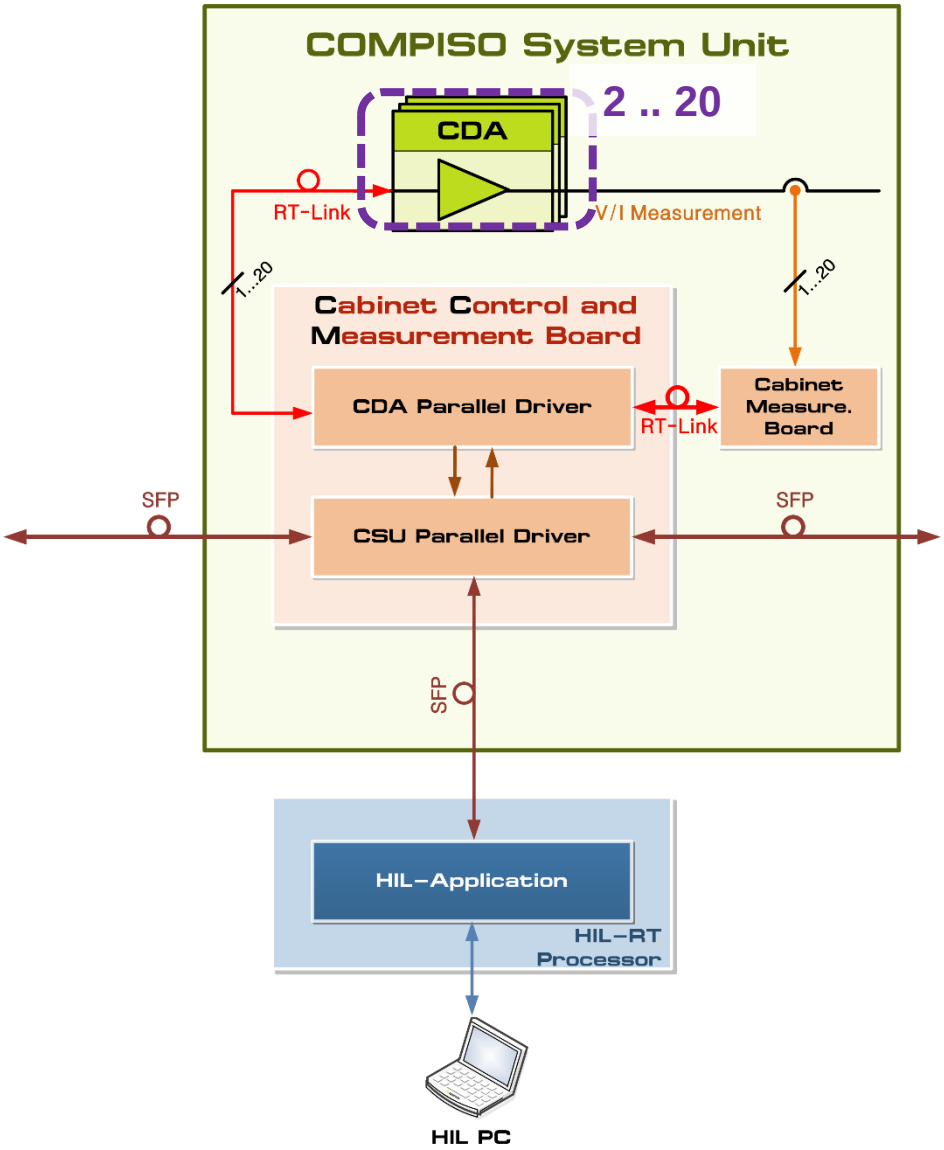
Power Amplifier / HIL Architecture



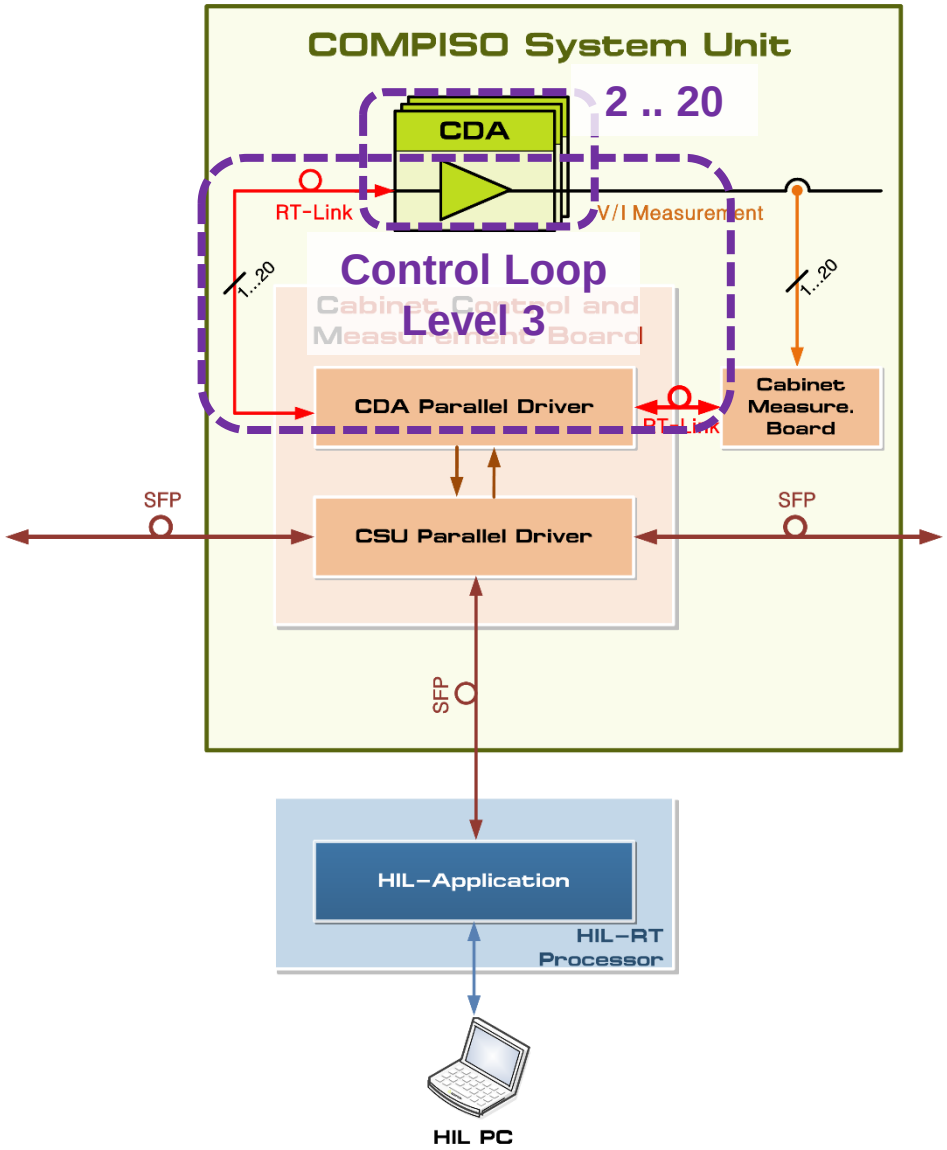
CDA (Amplifier) Parallel Driver



CDA (Amplifier) Parallel Driver



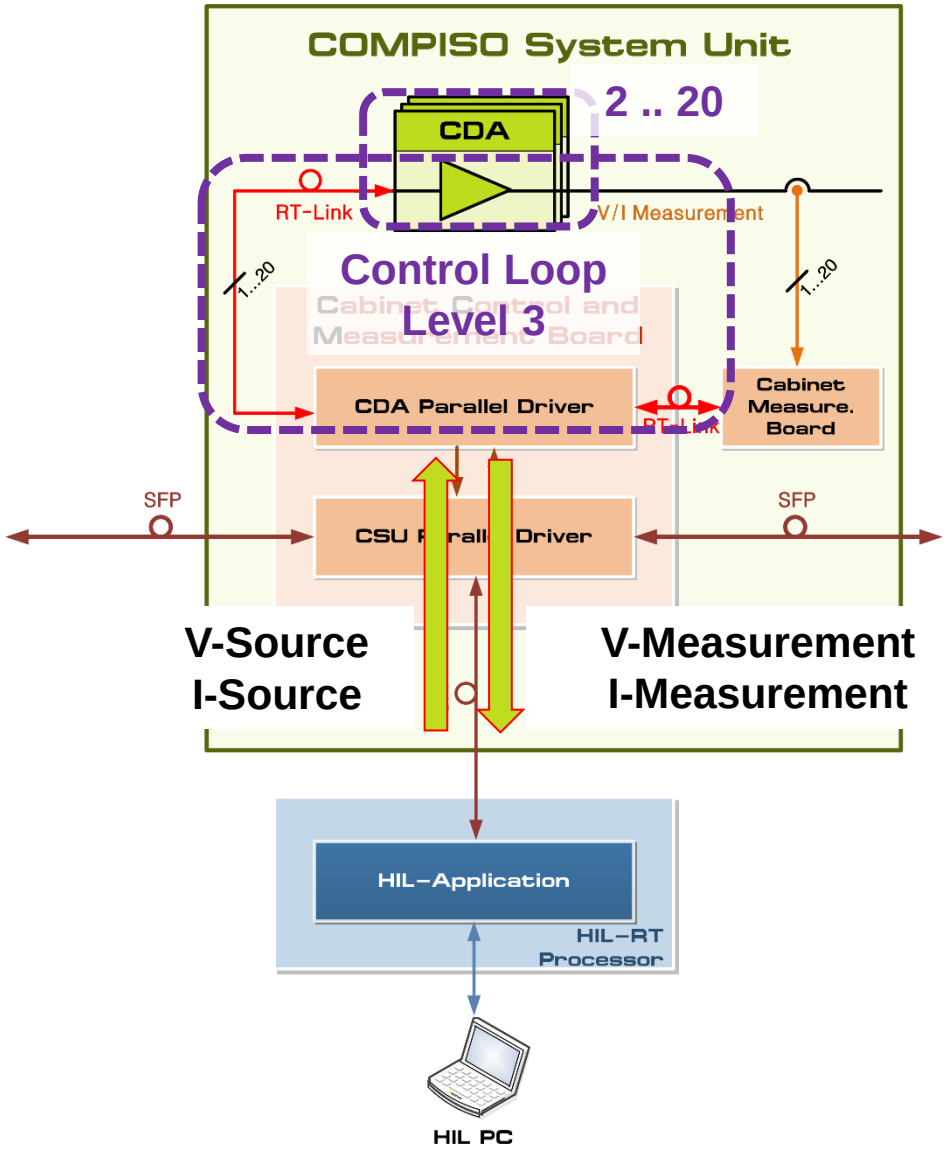
CDA (Amplifier) Parallel Driver



Loop Level 3:

- CDA Parallel Driver
- 2 .. 20 Amps
- Balancing parallel amplifiers

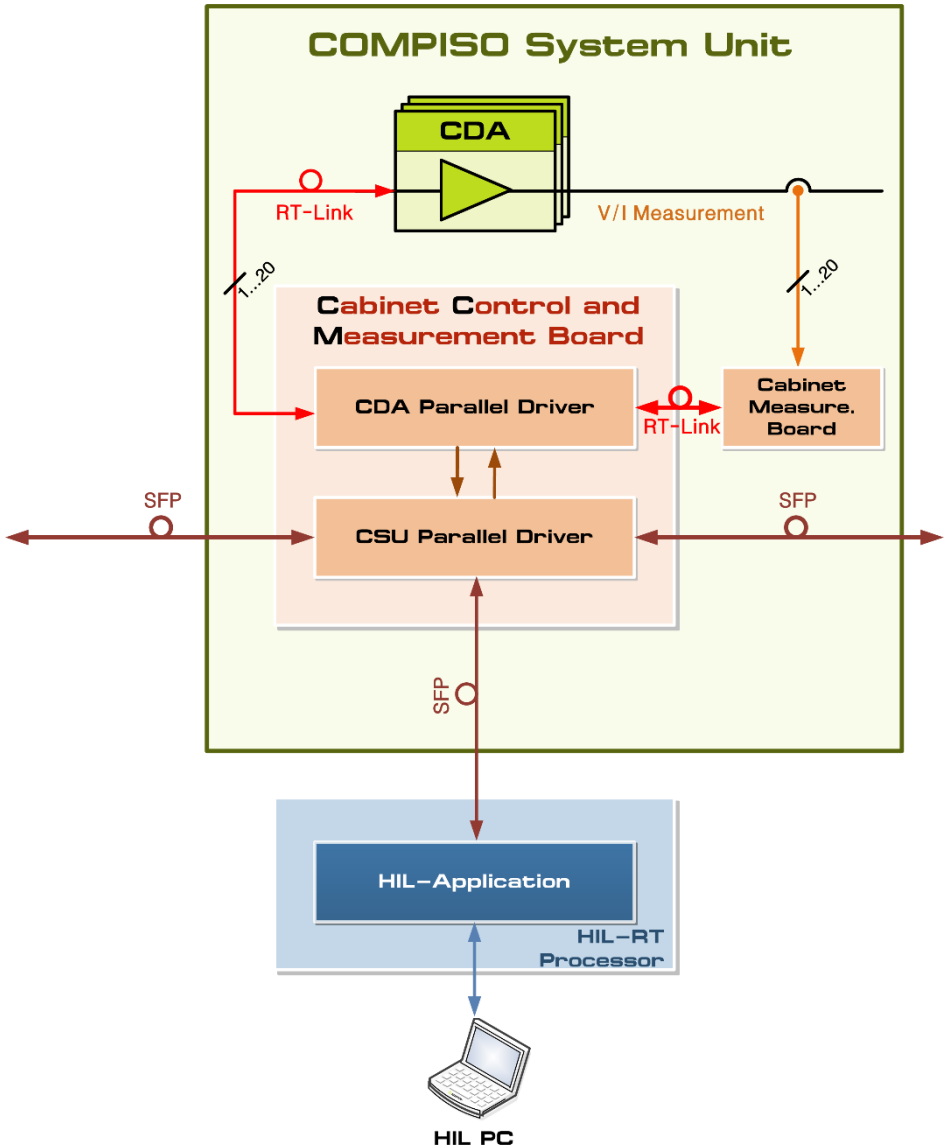
CDA (Amplifier) Parallel Driver



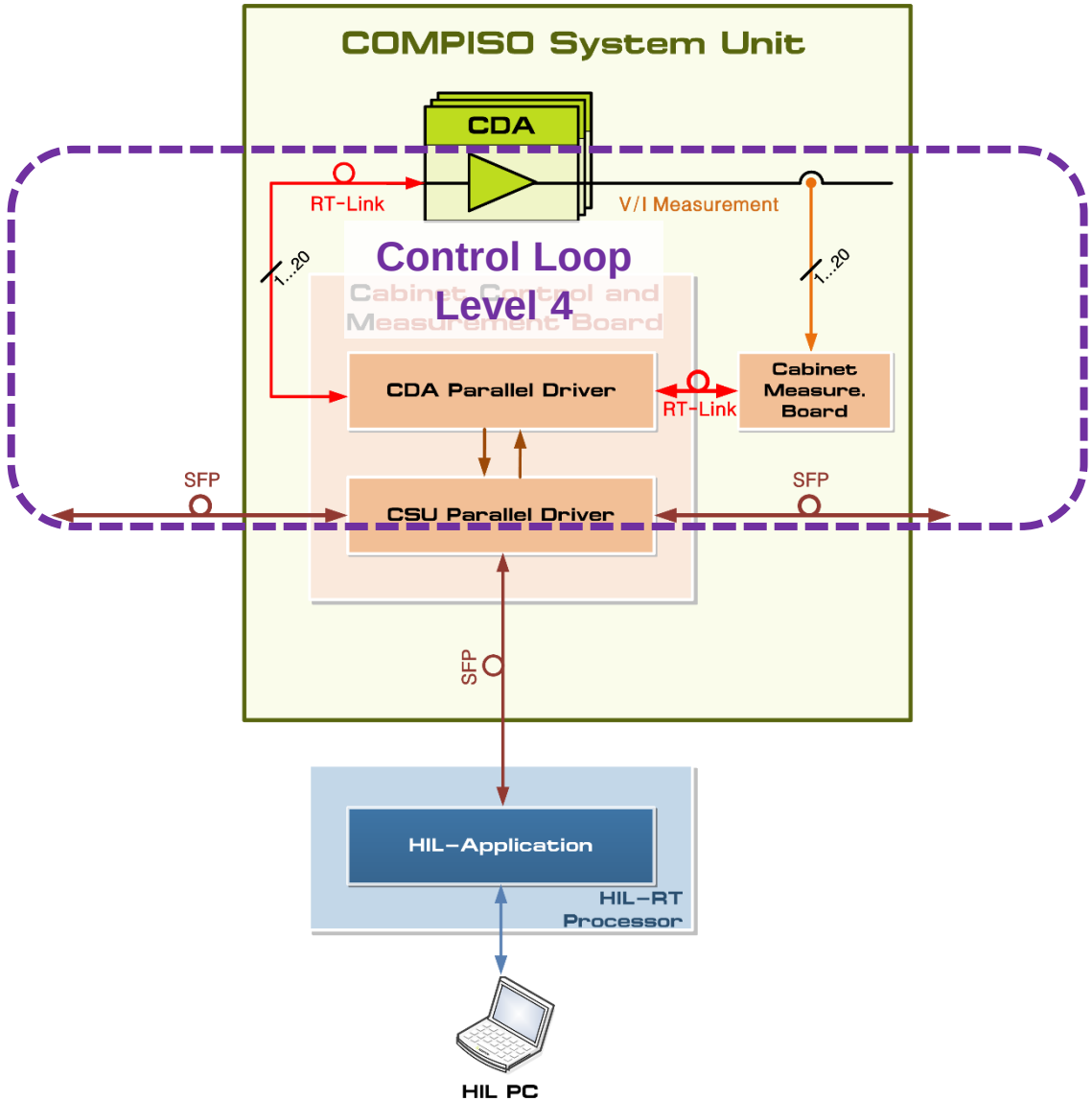
Loop Level 3:

- CDA Parallel Driver
- 2 .. 20 Amps
- Balancing parallel amplifiers

CSU (Cabinet) Parallel Driver



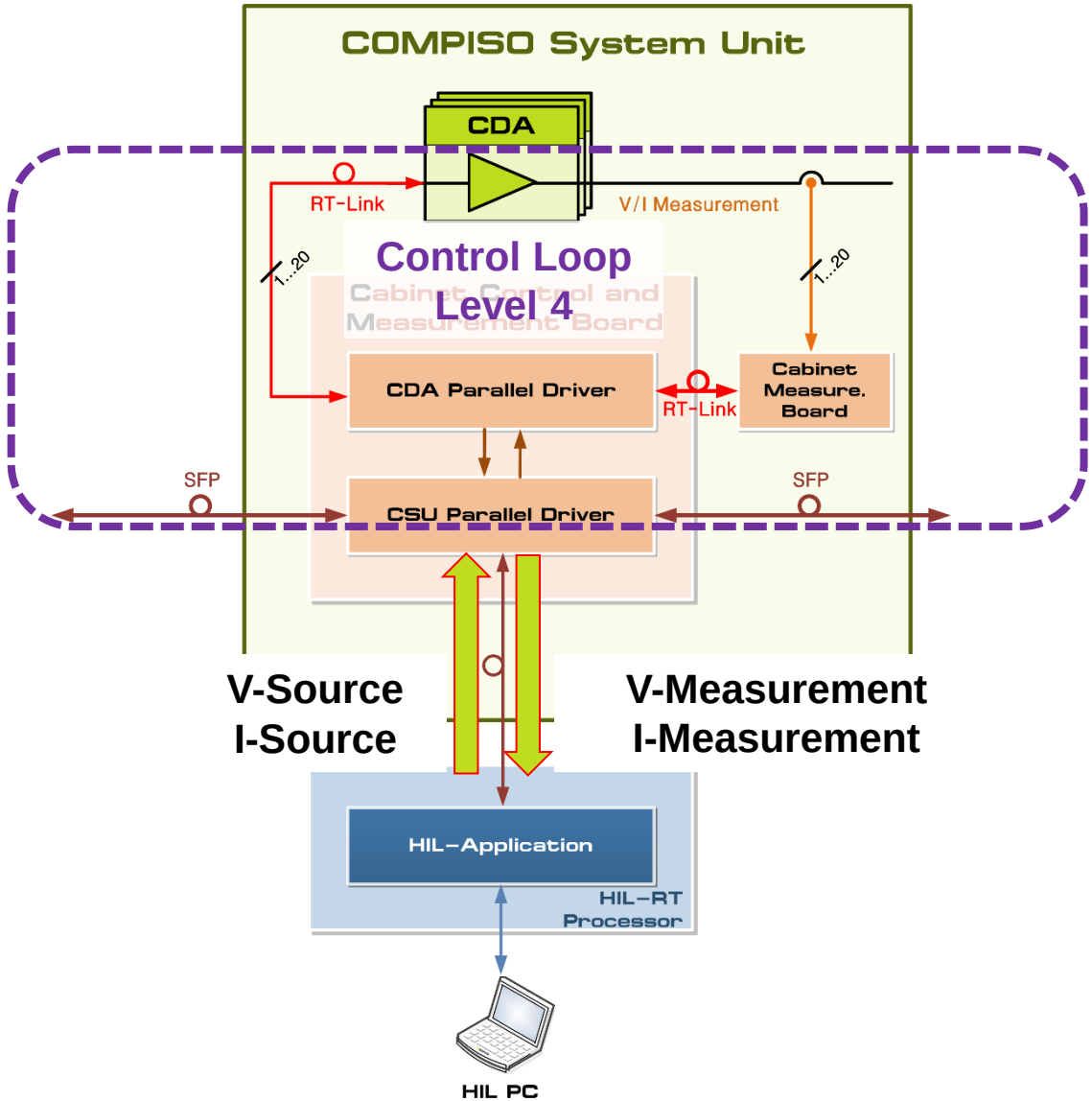
CSU (Cabinet) Parallel Driver



Loop Level 4:

- CSU Parallel Driver
- 2 .. 6 Cabinets
- Balancing several cabinet

CSU (Cabinet) Parallel Driver

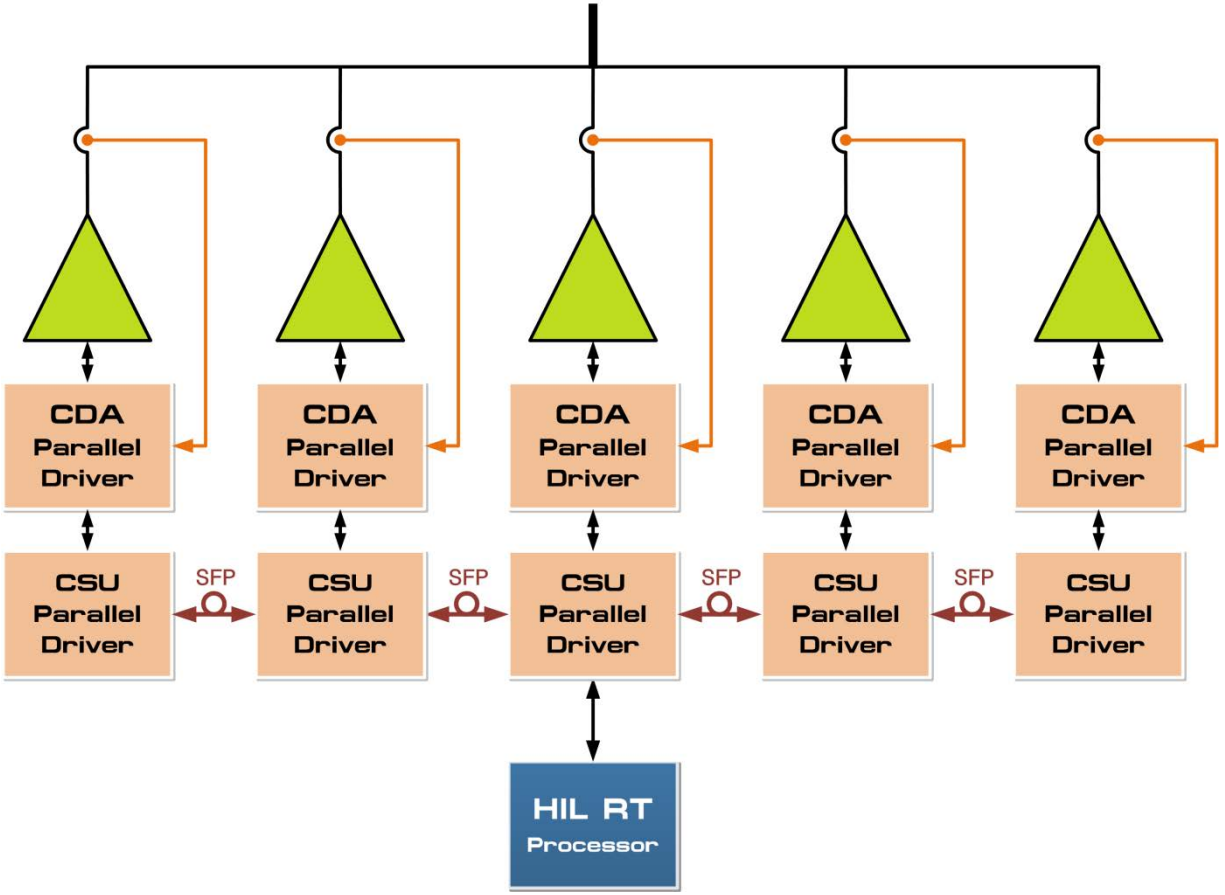


Loop Level 4:

- CSU Parallel Driver
- 2 .. 6 Cabinets
- Balancing several cabinet

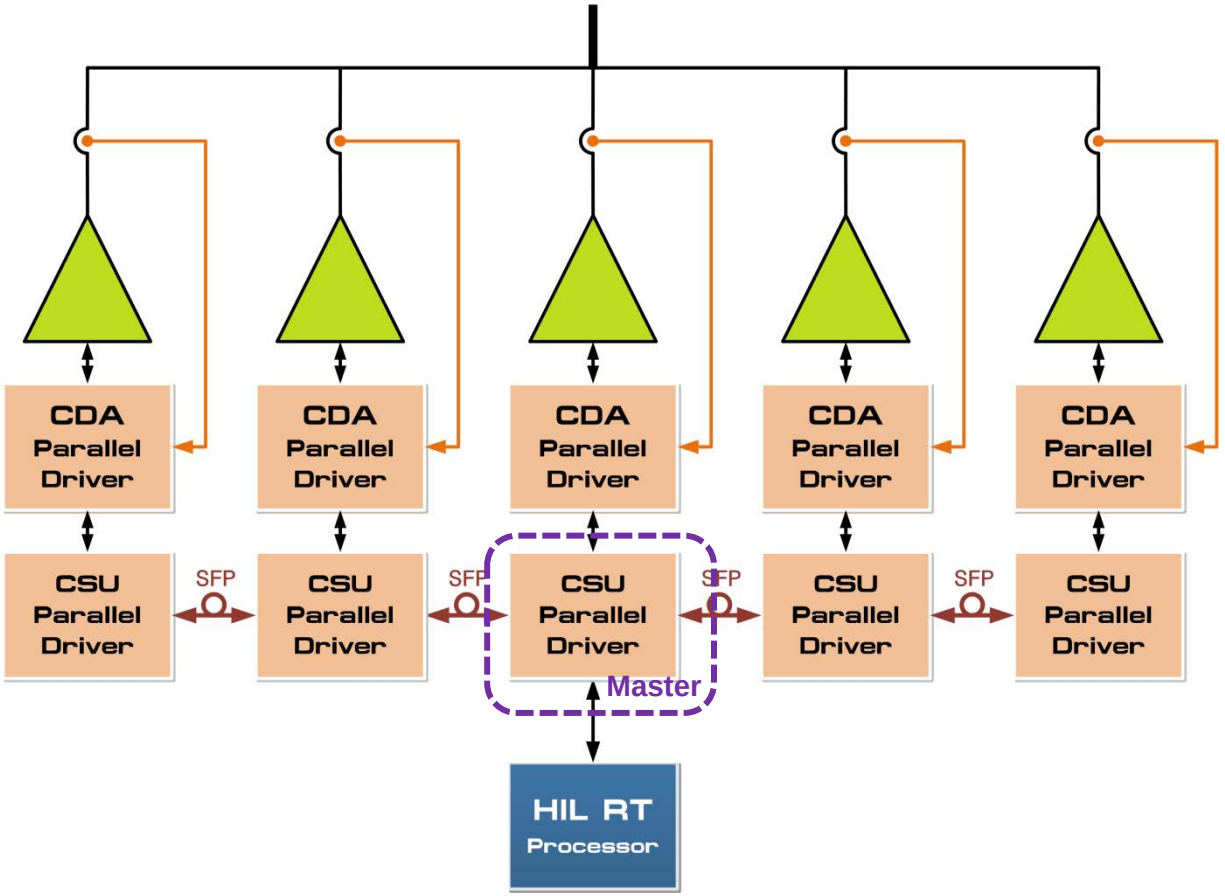
P-HIL 1 MVA System

- Single 1 MVA Block



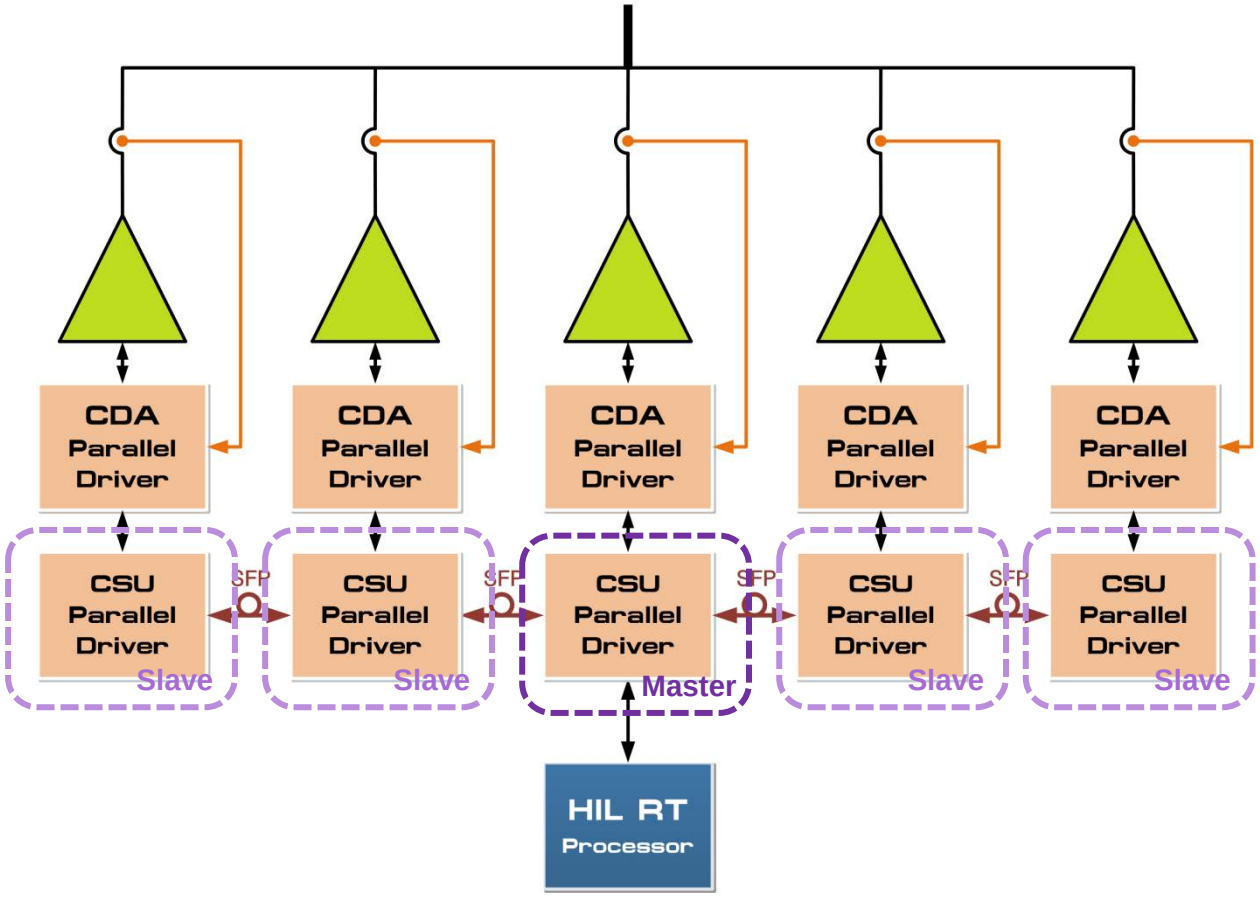
P-HIL 1 MVA System

- Single 1 MVA Block



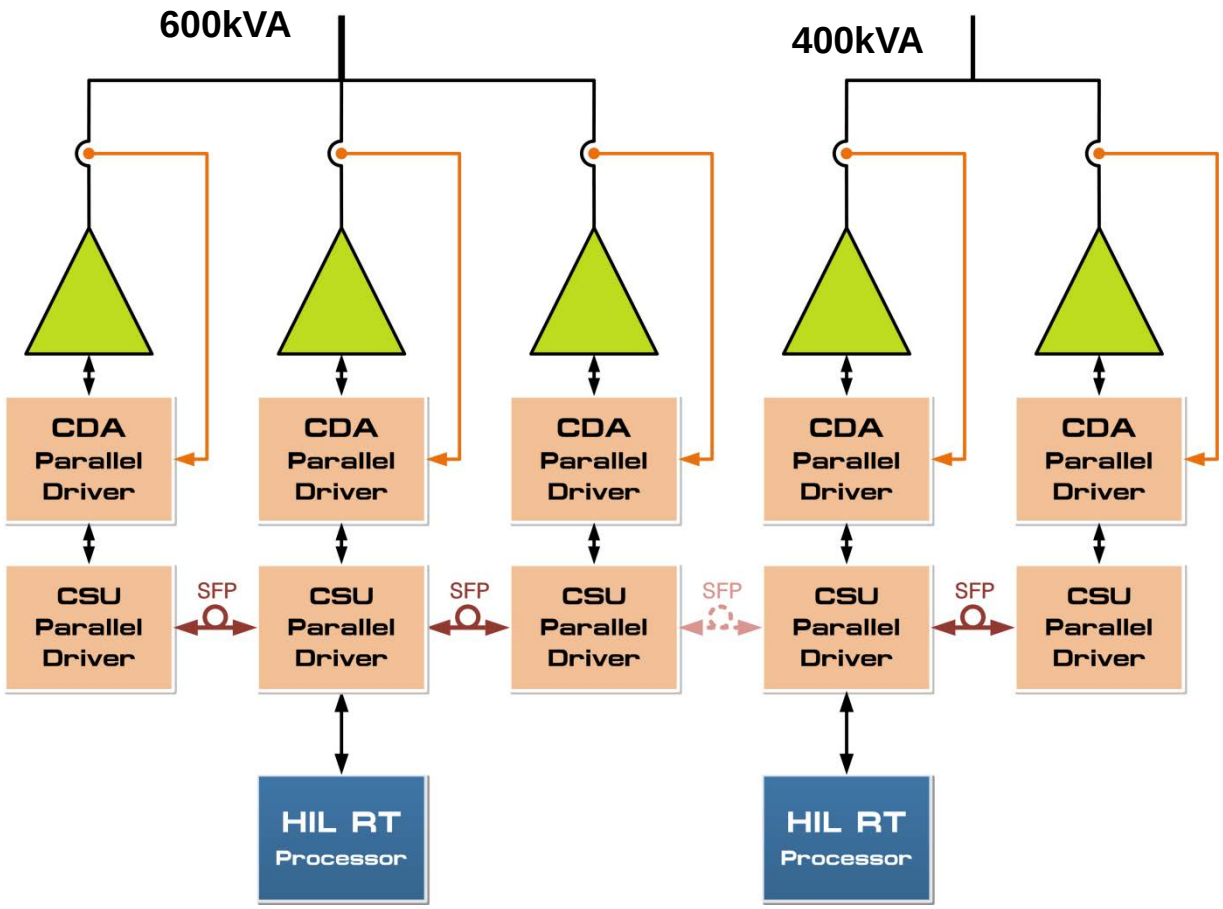
P-HIL 1 MVA System

- Single 1 MVA Block



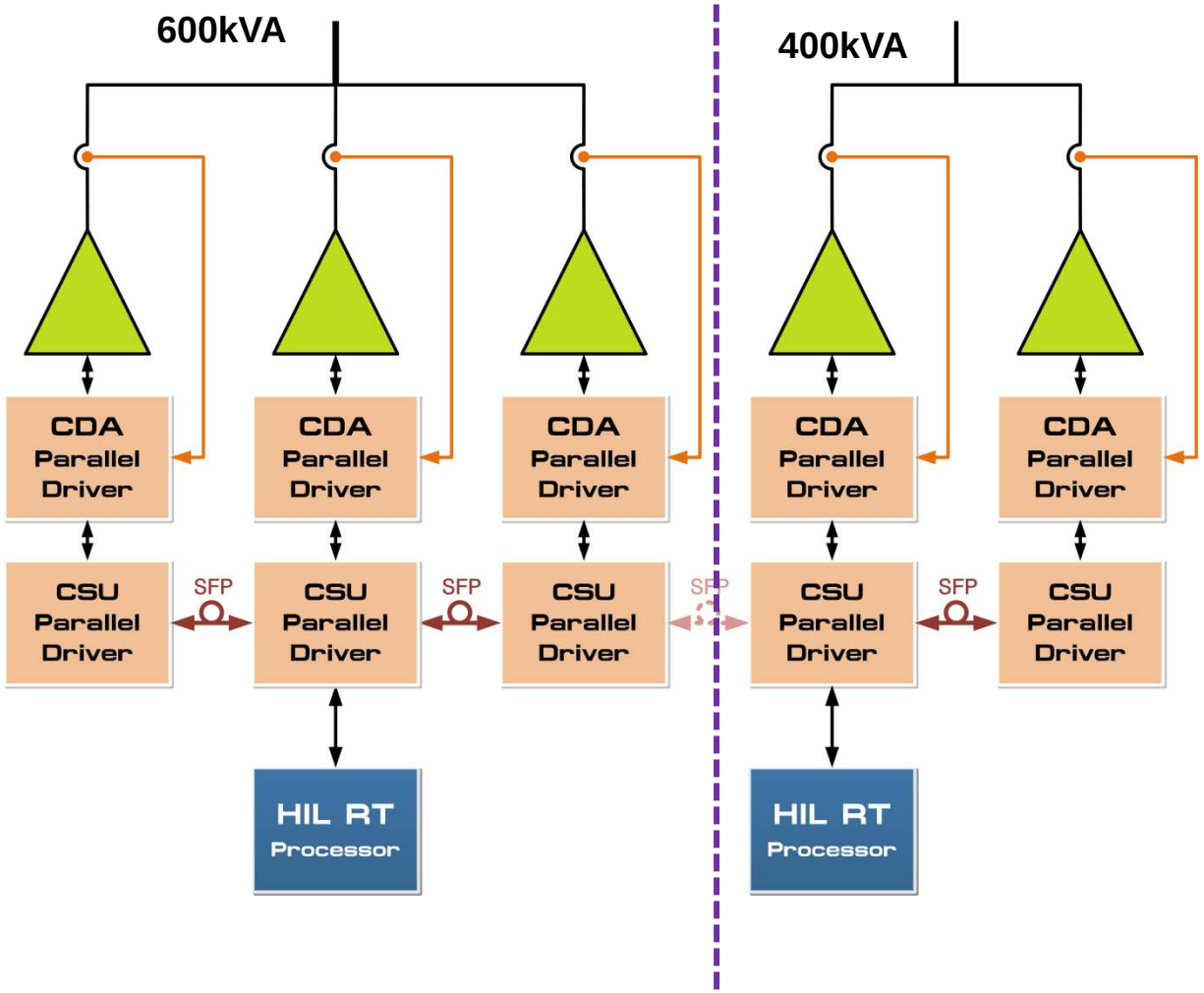
P-HIL 1 MVA System – Split Op Mode

- Split System
  - 3 x // für AC
  - 2 x // für DC



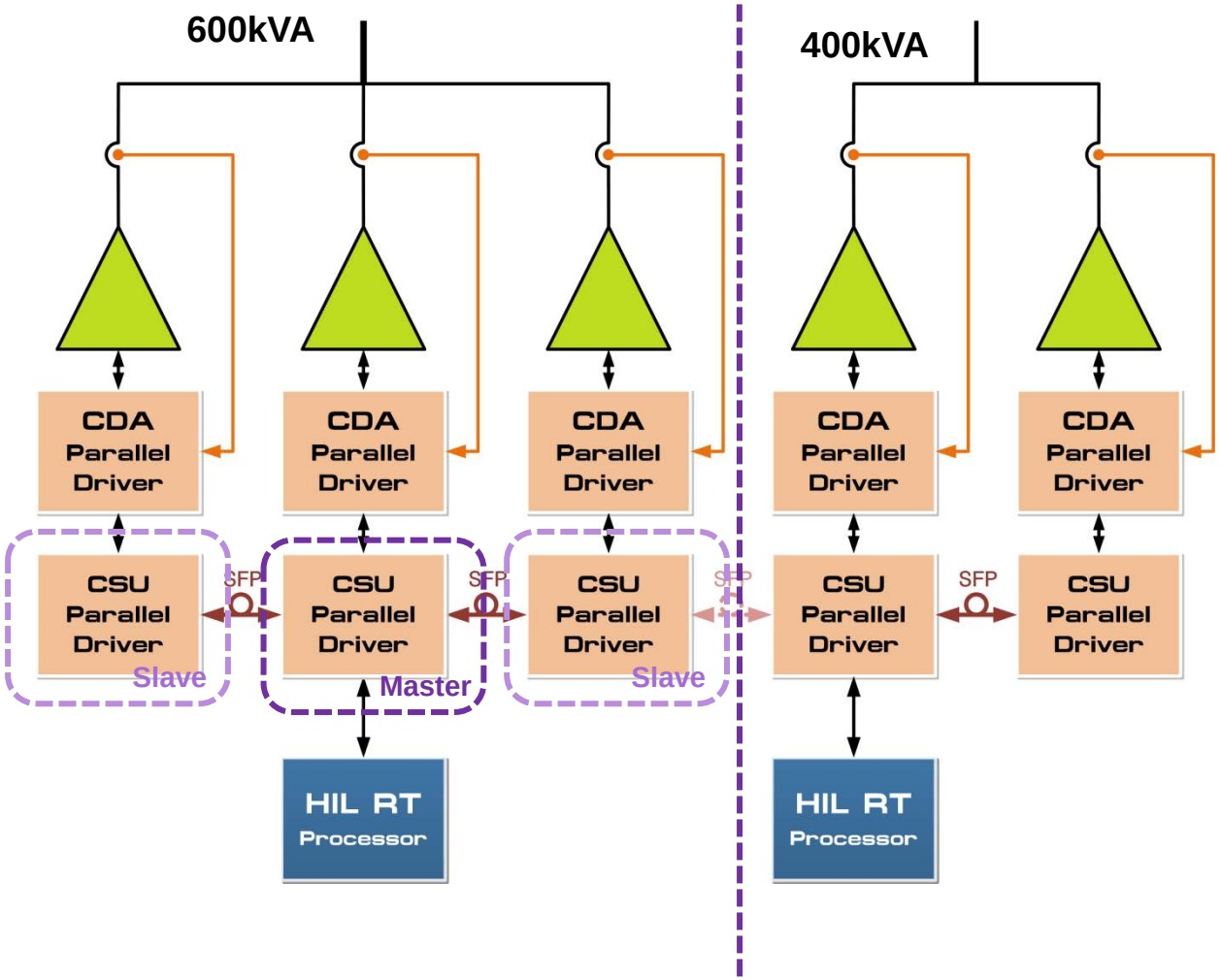
P-HIL 1 MVA System – Split Op Mode

- Split System
  - 3 x // für AC
  - 2 x // für DC



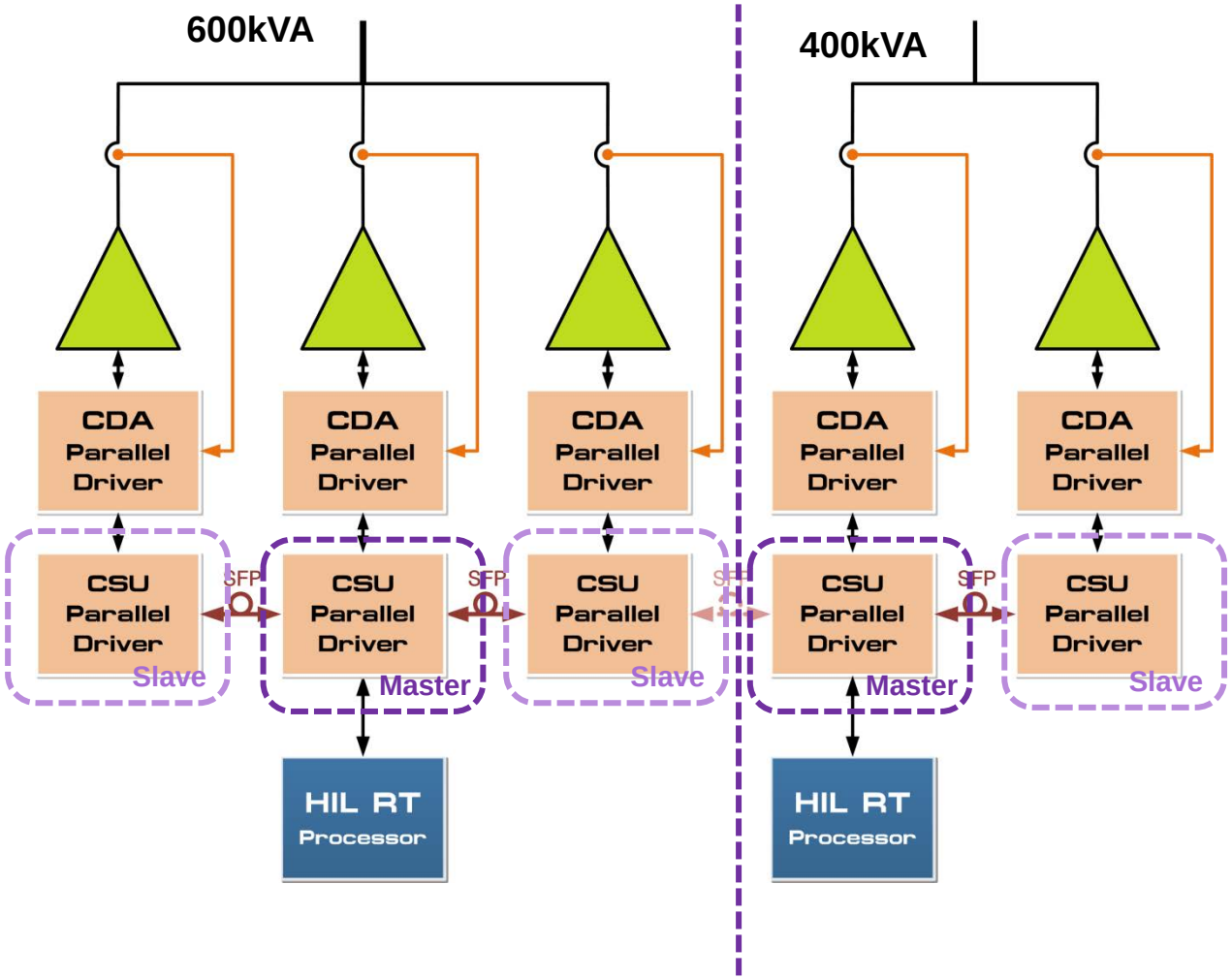
P-HIL 1 MVA System – Split Op Mode

- Split System
  - 3 x // für AC
  - 2 x // für DC



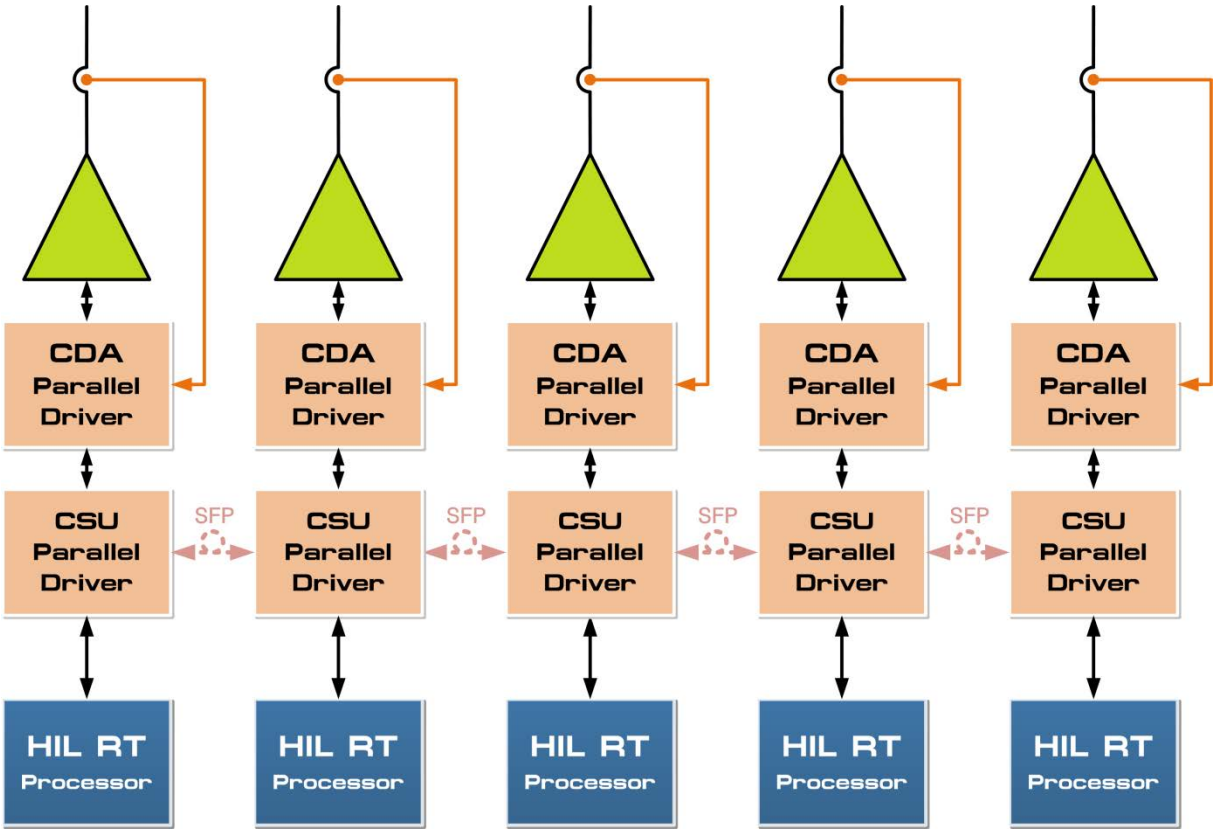
P-HIL 1 MVA System – Split Op Mode

- Split System
  - 3 x // für AC
  - 2 x // für DC



P-HIL 1 MVA System – Split Op Mode

- Split System
- 5 Individual Systems

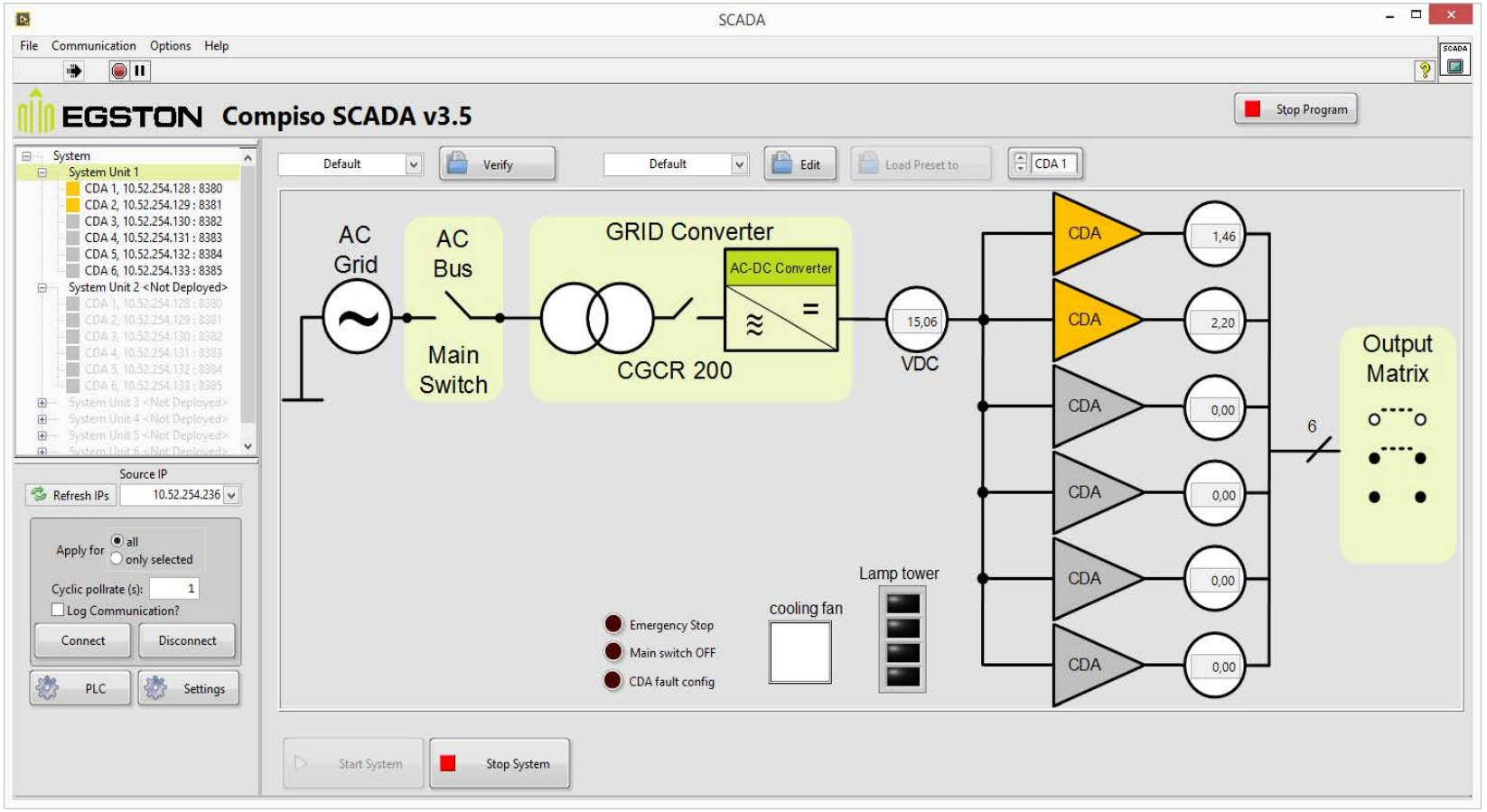


Supported HILs – Fibre optic interface

- OPAL-RT
  - OP4510 (currently integrated in the cabinet)
  - OP5600 over SFP
- In preparation (via SFP Interface)
  - RTDS
  - National Instruments
  - Plexim

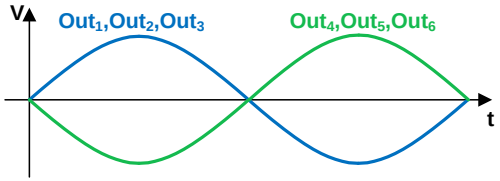
COMPISO SCADA

SCADA

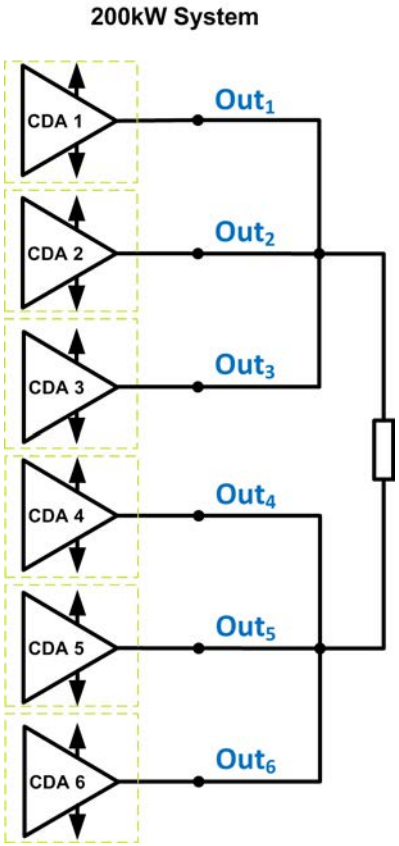

SCADA
File Communication Options Help
EGSTON Compiso SCADA v3.5
Stop Program
System
System Unit 1
CDA 1, 10.52.254.128 : 8380
CDA 2, 10.52.254.129 : 8381
CDA 3, 10.52.254.130 : 8382
CDA 4, 10.52.254.131 : 8383
CDA 5, 10.52.254.132 : 8384
CDA 6, 10.52.254.133 : 8385
System Unit 2 <Not Deployed>
Source IP
Refresh IPs
10.52.254.236
Apply for
all
only selected
Cyclic pollrate (s):
1
Log Communication?
Connect
Disconnect
PLC
Settings
Default
Verify
Default
Edit
Load Preset to
CDA 1
AC Grid
AC Bus
Main Switch
GRID Converter
AC-DC Converter
CGCR 200
15,06
VDC
CDA
1,46
2,20
0,00
0,00
0,00
0,00
6
Output Matrix
Lamp tower
cooling fan
Emergency Stop
Main switch OFF
CDA fault config
Start System
Stop System

COMPISO P-HIL
200 KVA SYSTEM

OP-Mode: Single Phase



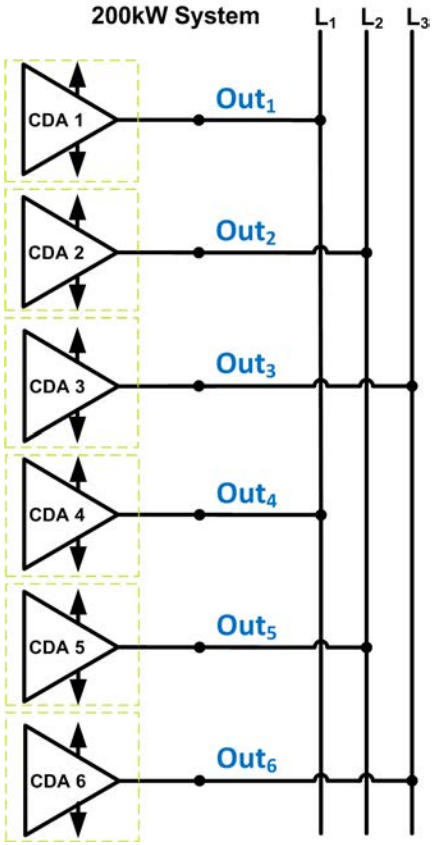
- CSU 200 kVA
  - V_{LN} = 0 .. 500 V_{RMS}
  - I_L = 0 .. 378 A_{RMS}
  - S = 70 .. 180 kVA



OP-Mode: 3-Phase - symmetrical

- 2 CDAs drive 1 phase

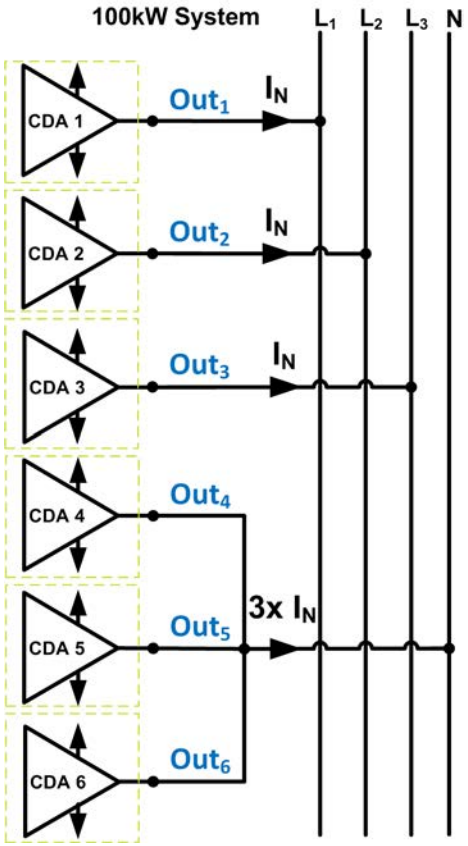
- CSU 200 kVA
  - V_{LL} = 0 .. 480 V_{RMS}
  - I_L = 0 .. 250 A_{RMS}
  - S = 0 .. 200 kVA



Op-Mode: 3 Phase with N

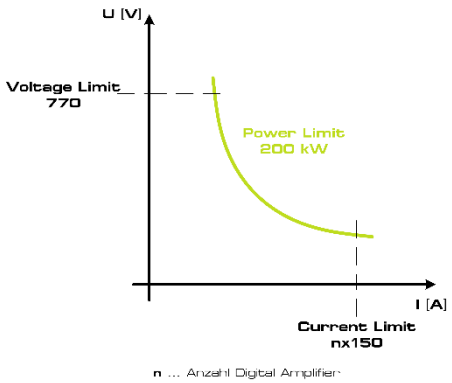
- 1 CDA per Phase
- 3 CDAs for N

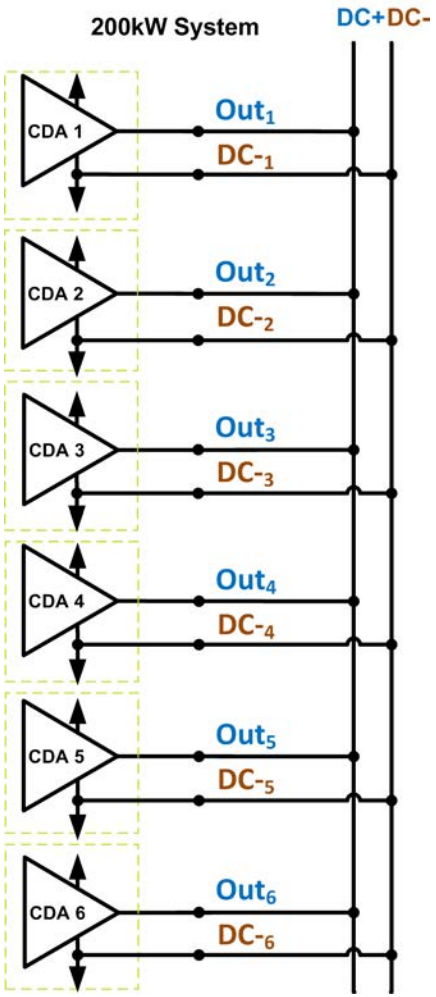
- CSU 200 kVA
  - V_{LL} = 0 .. 480 V_{RMS}
  - I_L = 0 .. 125 A_{RMS}
  - I_N = 0 .. 375 A_{RMS}
  - S = 0 .. 100 kVA



OP-Mode: DC

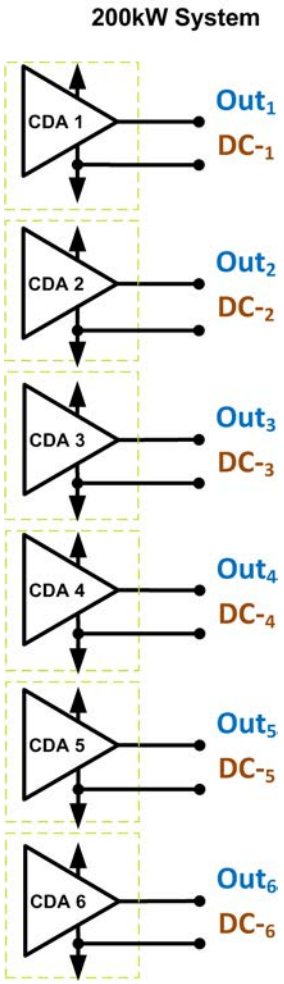
- 6 CDAs parallel
- CSU 200 kVA
  - V_{DC} = 0 .. 750 V
  - I_{DC} = 0 .. 900 A
  - P = 0 .. 200 kW





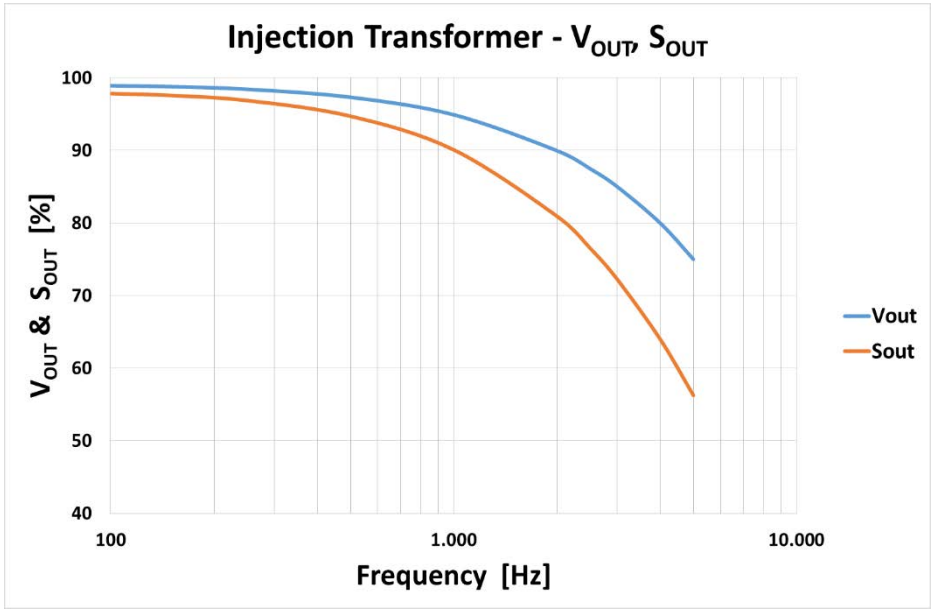
OP-Mode: Independent Digital Amplifier

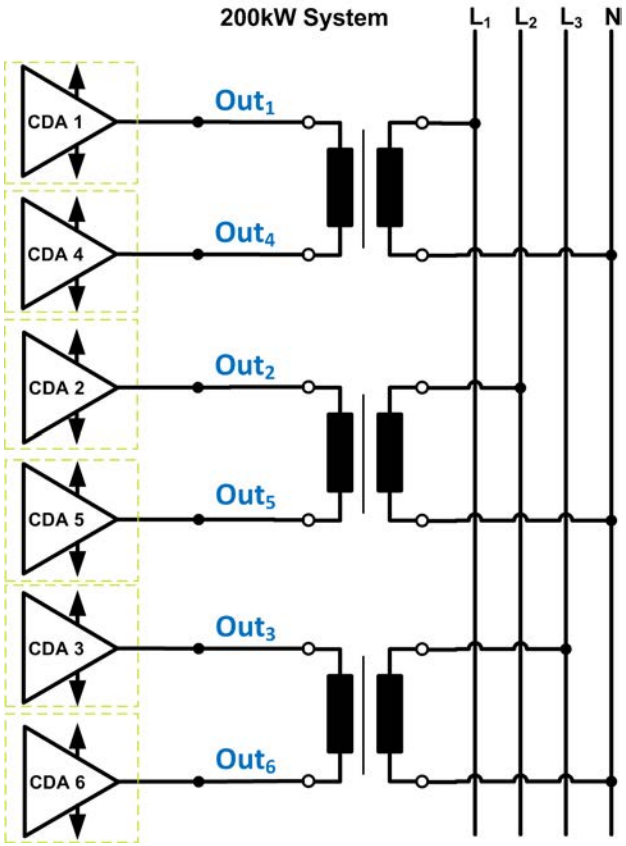
- For every Digital Amplifier
  - V_{DC} = 0 .. 750V
  - V_{LL} = 0 .. 480V_{RMS}
  - I_{DC} = 150 A
  - I_{AC} = 125 A_{RMS}
  - P = 120 kW
  - S = 33 kVA



OP-Mode: Output Transformer (additional)

- Output configurations:
  - V_{LL} = 690 ..3.300 V_{RMS}

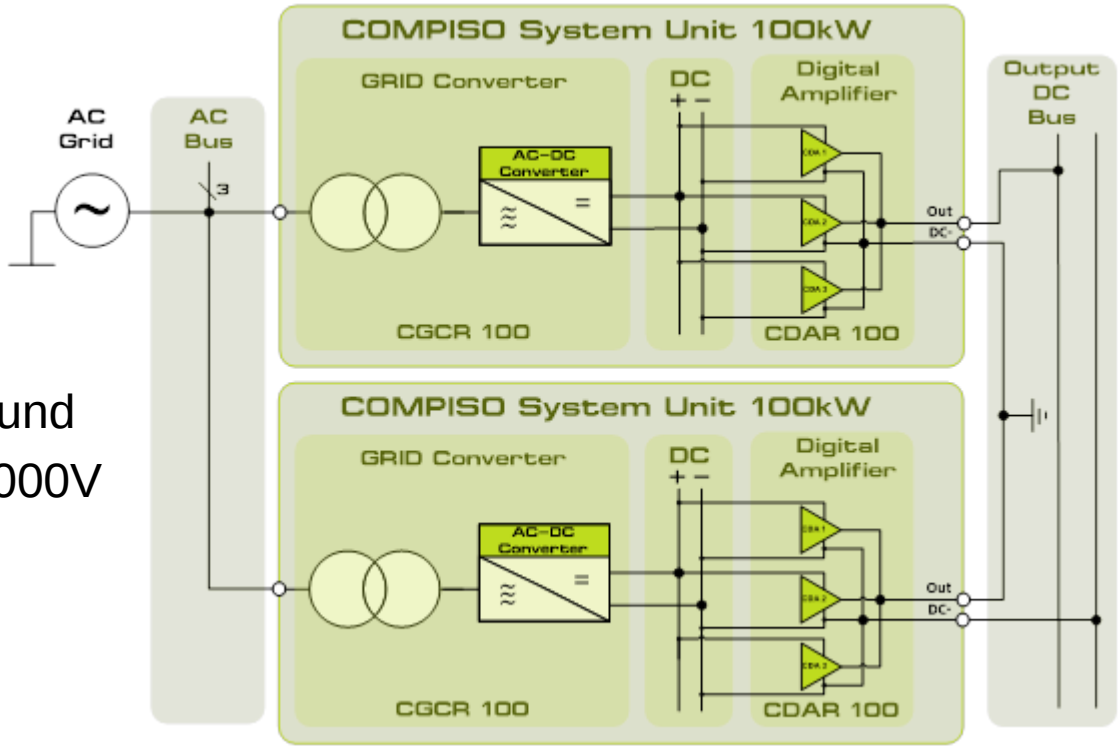




Serial Operation Mode

- 2 Blocks in Serial
- V_{OUT} = 0 .. 1.500V_{DC}

- Important
  - Middle Point ➔ Ground
  - -1.000V < V_{OUT} < 1.000V



COMPISO
HIL APPS

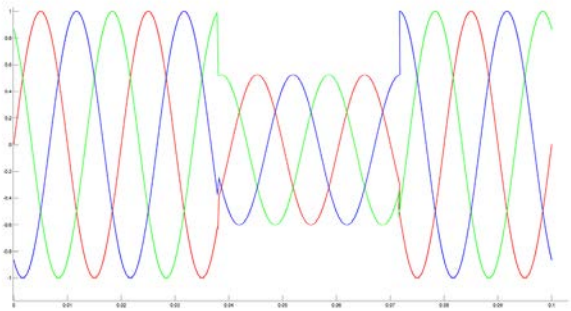
HIL Application Strategy

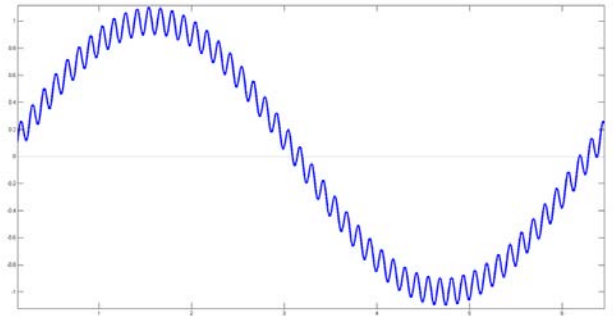
- We provide the sources (Matlab / Simulink) to the customers
- Customer is invited to adapt sources
- Customers are invited to develop own applications

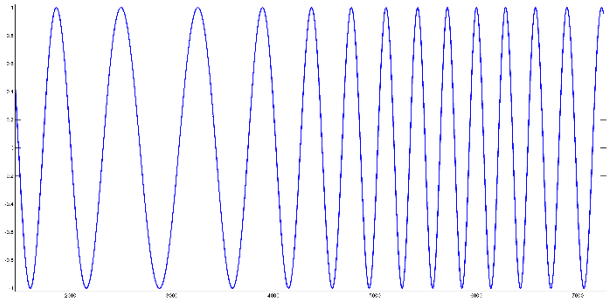
- ➔ no additional costs for adaptions

HIL Grid Applications

- Arbitrary Wave Form Generator
  - Grid Fault Simulations
    - LVRT (Low Voltage Ride Through) Test Sequence
    - HVRT (High Voltage Ride Through) Test Sequence
  - Frequency Drift Sequence
  - Phase Jump Sequence
  - Harmonics Measurement
    - Perfect Sine Voltage Wave form
    - Background Harmonic Voltage Distortion
- Photovoltaic Generator Simulator
- Virtual AC Load
- Grid Impedance Emulation







P-HIL
TARGET MARKETS

Potential Applications

- **Grid Applications**
  - Grid Emulator (50, 60, 400 Hz)
  - Grid Load
  - PV-Inverter Emulation
  - Wind-Generator Emulation
  - UPS (Uninterruptible Power Supply) Emulation
  - Grid Inverter Emulation
  - Grid Motor / Generator Emulation
- **Motor Applications**
  - Motor / Generator Emulator
  - Drive Inverter Emulator
  - Frequency Inverter Emulator
- **Aerospace / Military**
  - 400 Hz Supply Grid Emulator
  - DC-Supply emulation
  - 400 Hz Aerospace device emulator
  - AC-DC Coupling Emulator
  - Generator / Motor Emulator
  - 400 Hz Inverter Emulator
- **Automotive Applications**
  - **Electrical drive train emulation**
    - Battery Emulator
    - Drive Inverter Emulator
    - Motor Emulator
  - **eVehicle Applications**
    - eVehicle charging station emulator
    - Test Bench for charging
  - **Test Benches for combustion engine drive train**
    - Drive Inverter for electrical machines connected to combustion machines, wheel, gear boxes
- **Transportation**
  - Supply Grid Emulator
  - Machine Emulator
  - Inverter Emulator
  - Electrical drive train emulation

Thank you…

…for your
Attention

G. Pammer Oct. 2015

WORLDWIDE
AUSTRIAN
POWER