Multifrequency Current Injection MCI

- **Petersen coil regulation with current injection**
- **No additional inductors necessary**
- **Current injection AND zero-sequence voltage measurement via Power Auxiliary Winding (PAW)**
- **Small dimensions**
- **Useable for networks up to 1300A Ice (20 kV)**

1. Use of the Multifrequency Current Injection

The Multifrequency Current Injection (MCI) is designed for automatic tuning of arc suppression coils (ASC) in compensated networks using a new multifrequency method.

In faultless grid operation the MCI calculates network characteristics as the detuning of the arc suppression coil, the actual earth capacitance and damping without moving the ASC.

1.1 Support of the REG-DP(A) in tuning the Petersen-coil

There are situations in the grid in which classic regulation cannot be used to successfully tune the Petersen coil.

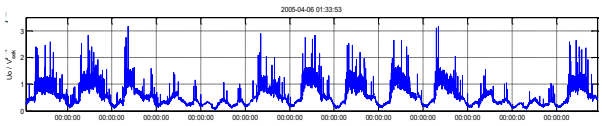


Figure 1: Flickering zero sequence voltage

- Flickering zero sequence voltage
- Very symmetrical grids (balanced)

Specifically for these cases A. Eberle and EGE have developed the multifrequency current injection MCI.

The MCI creates a multifrequency signal that is fed into the grid through the power auxiliary winding in the Petersen coil. The REG-DP(A) calculates a resonance curve based on the grid's response (zero sequence voltage).

1.2 Features

1.2.1 No additional inductors

Up to 8 frequency components are directly injected into the power auxiliary winding (PAW) of the arc suppression coil, without the need of additional inductors compared to other current injections.

1.2.2 No separate zero-sequence voltage measurement

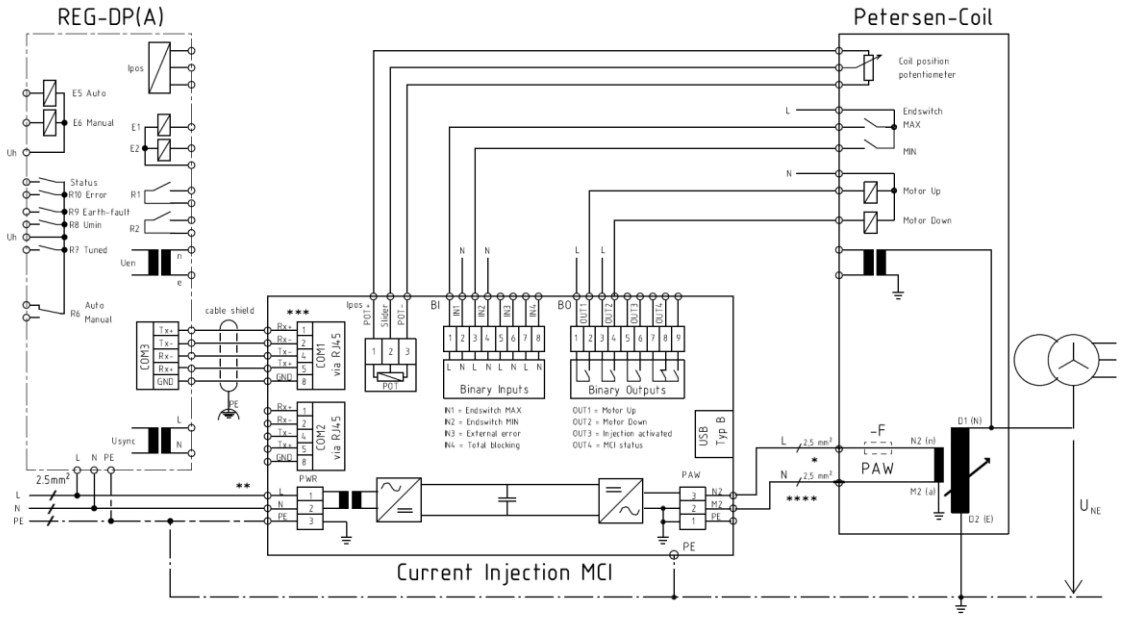
MCI measures the voltage response of the network directly at the power auxiliary winding (PAW) without the need of an additional voltage transformer. By initial calibration of MCI at the coil all non-linear effects of the coil are taken into account. Therefor the zero-sequence voltage is high accurate and not influenced by the coil position.

1.2.3 I/O wiring directly at MCI (in preparation)

To easy the wiring between REG-DP(A) / MCI and the arc suppression coil (ASC) the I/O signals can be wired directly at MCI (up/down commands, limit switches and potentiometer). Only the Modbus communication between REG-DP(A) and MCI has be wired any more ('Mode 1'). In case of a Modbus communication loss there are basic control algorithms in the MCI as a 'fail save mode' given, to maintain a save ASC regulation.

Nevertheless the I/O signals can be also wired directly to the REG-DP(A) ('Mode 2'). In case of a communication loss the REG-DP(A) will go into emergency operation, in order to find without current injection a resonance curve by 'moving coil'.

2. Typical connection of REG-DP(A) and MCI (‘Mode 1’ & ‘Mode 2’)



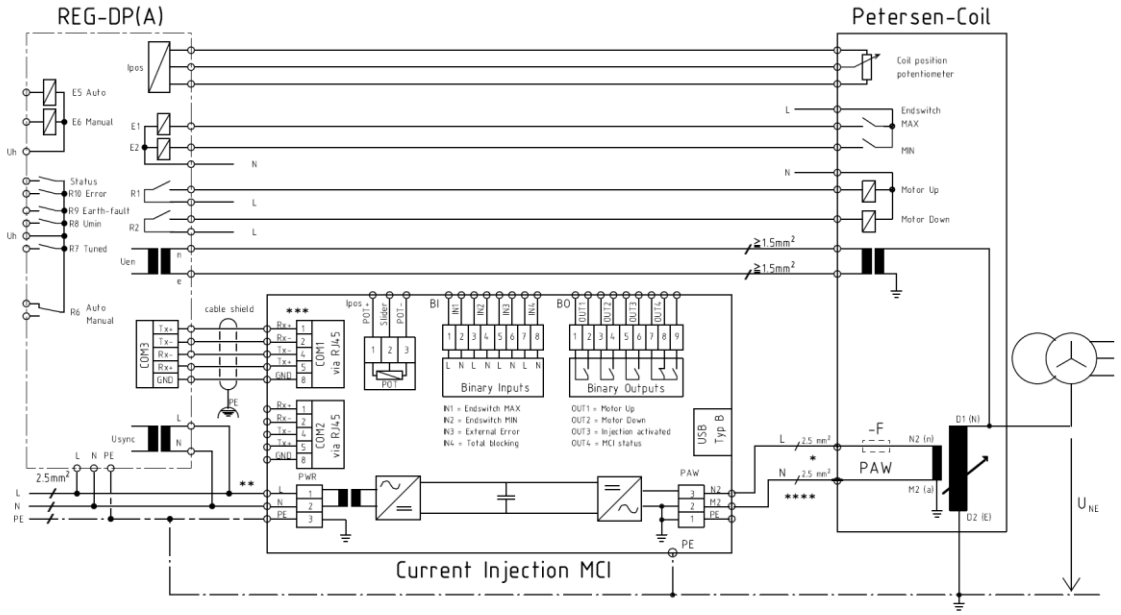
* Cross-section of wires depending on length of connection (see chapter 5.13.3)

** Power supply: 230 V AC (see chapter 5.1)

*** Terminal assignment different in case of using a RJ45/terminal block adapter (see chapter 5.13.7)

**** Current injection & Une measurement on PAW simultaneuously

Figure 2: Mode 1 – Connection of REG-DP(A) and MCI at Petersen coil (I/O wiring at MCI)



* Cross-section of wires depending on length of connection (see chapter 5.13.3)

** Power supply: 230 V AC (see chapter 5.1)

*** Terminal assignment different in case of using a RJ45/terminal block adapter (see chapter 5.13.7)

**** Current injection & Une measurement on PAW simultaneuously

Figure 3: Mode 2 – Connection of REG-DP(A) and MCI at Petersen coil (I/O wiring at REG-DP(A))

Please note the fuse at the power auxiliary winding!

During the earth fault the power auxiliary winding provides the supply voltage of 500 V.

The supply cable of the power auxiliary winding to MCI must have a 10 A (690 V AC) fuse!

3. Applicable for 1300 A networks (20 kV)

The multifrequency current injection (MCI) is applicable for 20 kV networks with average damping up to 1300 A (capacitive earth current).

The MCI is also applicable for networks with lower or higher nominal voltage. The maximum possible capacitive current changes indirectly proportional.

Figure 4: MCI connected to REG-DP(A) with Device Status and Communication LED lit

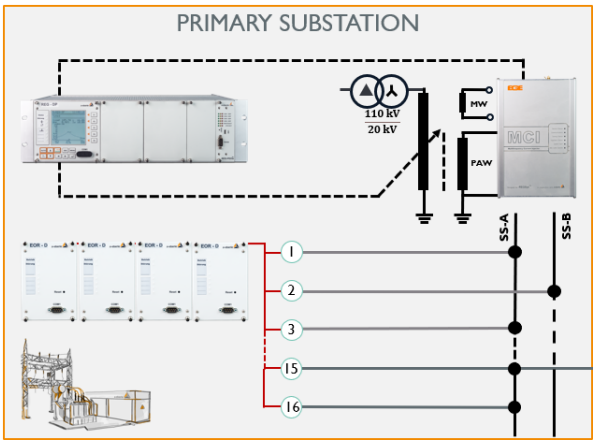


Figure 5: MCI connected to Petersen coil; system solution with REG-DP(A) and EOR-D

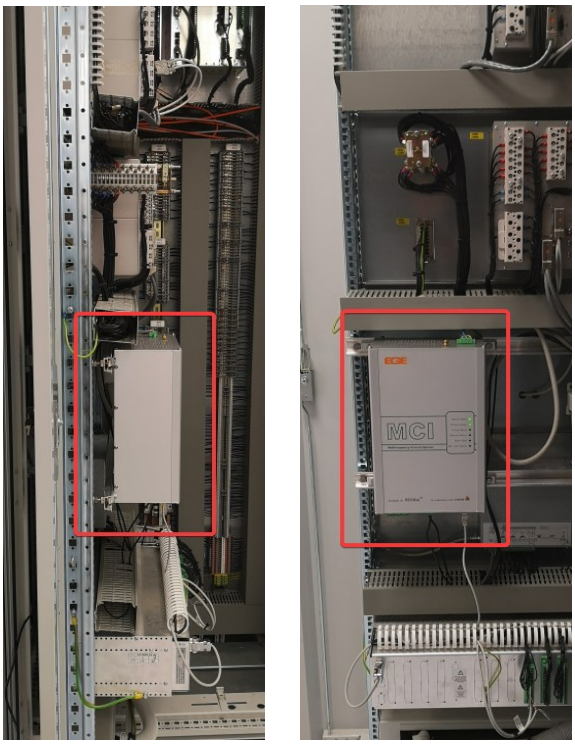


Figure 6: Installation example at the backside of a control cabinet's front door (MCI side & front view)

4. SCADA / Communication

Connecting the MCI unit via COM 3 to the regulator REG-DP(A), the connection to all common communication protocols is possible. The regulator features a system bus (E-LAN), whereby can be communicated with other system devices.

The following protocols are available (other protocols on request):

- IEC 60870 - 5 - 101 / 103 / 104
- IEC 61850
- DNP 3.0 via Ethernet
- DNP 3.0
- MODBUS RTU / MODBUS TCP

5. Technical specifications

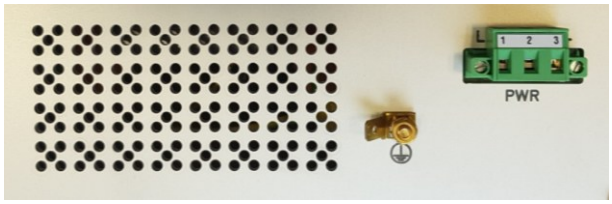


Figure 7: MCI connection terminals – top view

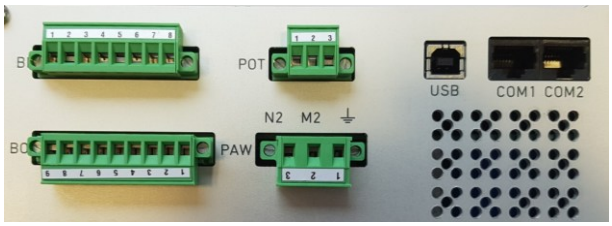


Figure 8: MCI connection terminals – bottom view

5.1 Power supply (PWR)

Nominal voltage (U_n)	230 V AC +25%/-30%
Frequency	50 Hz
Input power	< 160 VA
Internal fuse	T1A / 250 V
Isolation level	4 kV

5.2 Power circuit (PAW)

Maximal operation voltage	500 V AC +/-20 %
Maximal voltage during injection	165 V rms
Network frequency	50 Hz
Nominal current	5 A rms
Frequency range of generated current components	15 – 160 Hz (8 frequency components)
Operation time (Duty)	continuous/short-term

5.3 Binary inputs (BI)

Number of channels	4
Voltage level	230 V AC, 50 Hz
High-Level	>= 140 V
Low-Level	<= 40 V
Overload capacity (permanent)	120 %
Current drain per channel	1.5 mA
Galvanic isolation level	4 kV

5.4 Binary outputs (BO)

Number of channels	4
Relay contacts	3 x single-pole NO contact (SPNO) 1 x single-pole NO/NC contact (SPDT)
Voltage switched	250 V AC
Switching capacity	5 A AC
Galvanic isolation level	4 kV

5.5 Potentiometer input (POT)

Potentiometer resistance range	150 Ω – 3 kΩ
Measuring voltage	5 V DC
Galvanic isolation level	4 kV

5.6 Communication (COM1/2, USB)

System communication COM1	RS-485 – Full Duplex, RJ45 connector (Modbus interface to COM3 of REG-DP(A))
System communication COM2	RS-485 – Full Duplex, RJ45 connector (reserved; limited functionality)
Service communication	USB 2.0, Type B

5.7 Electromagnetic compatibility

1MHz – burst disturbance	IEC/EN 60255-22-1 IEC/EN 61000-4-18 2,5kV asym. 1 kV sym
Electrostatic discharge (Class 4)	IEC/EN 60255-22-2 IEC/EN 61000-4-2 8kV contact, 15 kV air
Radio frequency interference	IEC/EN 60255-22-3 IEC/EN 61000-4-3 80MHz - 1GHz / 10V/m 1,4GHz - 2,7GHz / 10V/m
Fast transient disturbance (Class A)	IEC/EN 60255-22-4 IEC/EN 61000-4-4 4kV, 5kHz or 100kHz, 2kV (communication)
Surge immunity	IEC/EN 60255-22-5 IEC/EN 61000-4-5 4kV, 4kV L-PE, 2kV L-L

Immunity to conducted disturbances, induced by radio-frequency fields	IEC/EN 60255-22-6 IEC/EN 61000-4-6 150kHz - 80MHz, 10V
Power frequency immunity (Class A)	IEC/EN 60255-22-7 IEC/EN 61000-4-16 150 V Common mode, 300 V differential mode
Voltage dips	IEC/EN 60255-11 IEC/EN 61000-4-11 IEC/EN 61000-4-29 IEC/EN 61000-4-17 1 cycle/ 20 ms
Power frequency magnetic field immunity	IEC/EN 61000-4-8 30 A/m continuous, 300 A/m 3s
Ring wave immunity (Class 4)	IEC/EN 61000-4-12 4kV L-PE, 2kV L - L
Emissions	IEC/EN 60255-25

5.8 Waste heat

Waste heat	200 W

5.9 Electrical safety

Degree of pollution	2
Safety class	I
Over-voltage category	II
IP code	IP20

5.10 Ambient conditions

Storage temperature	-45…+85°C
Operating temperature	-25…+65°C
Relative humidity	< 95 %, non-condensing

5.11 Dimensions and weight

Case	anodized aluminium
Case dimensions (WxHxD)	210 x 310 x 130 mm
Total dimensions (WxHxD)	260 x 360 x 141 mm
Mounting holes spacing	170 x 330 mm or 230 x 270 mm
Weight	10 kg
Connectors	detachable, fixed with screws
Cooling system	passive

5.12 MCI Installation

⚠ **CAUTION!**	**Horizontal installation of MCI not permitted!** The current injection MCI must be installed in a vertical manner in order to guarantee the passive cooling. A horizontal installation is not permitted therefor!

⚠ **CAUTION!**	**Comply with the grounding of MCI!** The current injection MCI must be connected permanently at the housing's PE-connector as well as with the PE-terminal of the 'PAW'-connector and the PE-terminal of the power supply connector. See following chapters 5.13.1, 5.13.2, 5.13.3.

⚠ **CAUTION!**	**Comply with grounding of Power Auxiliary Winding (PAW)!** In case one side of the PAW is grounded, it is necessary to connect the grounded side of PAW at terminal M2. In case the PAW is not grounded, the PAW can be grounded with the PE-terminal of the 'PAW'-connector, in case the MCI itself is grounded properly, see chapters 5.13.1, 5.13.2, 5.13.3.

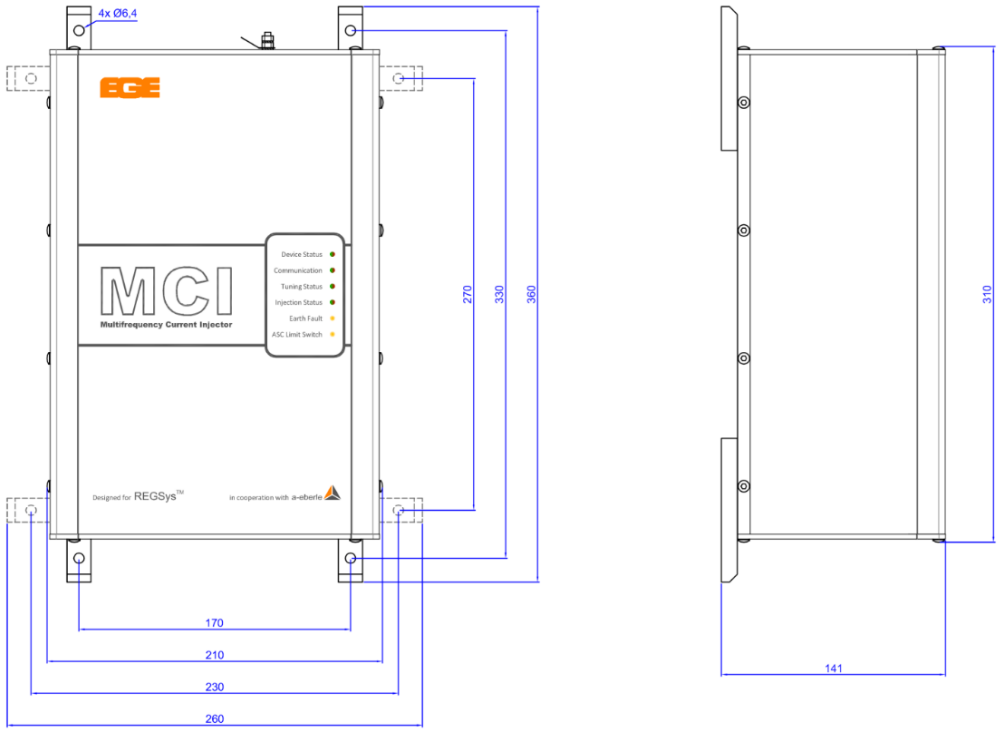


Figure 9: Basic MCI dimensions and mounting holes

The mounting brackets at the backside of MCI can be turned by 90°, see Figure 9.

5.13 Terminal configuration

5.13.1 Protective earth (PE)

The M4 earthing pin (screw) on the top of the case is provided for protective grounding of MCI. FAST-ON connector 6.3 mm is also possible to use.

5.13.2 Power supply (PWR)

External fuse: ≥ 2 A

Connector: GMSTB 2.5/ 3-STF-7.62, conductor cross section min/max: 0.7/2.5 mm²

PIN	Marking	Function / Polarity	Description
1	**L**	Phase conductor	
2	**N**	Neutral conductor	
3	**PE**	Protective earth conductor	

5.13.3 Power circuit (PAW)

External fuse: ≥ 10 A (690 V AC)

Connector: GIC 2.5/ 3-STF-7.62, conductor cross section min/max: 1.5/2.5 mm²

PIN	Marking	Function / Polarity	Description
1	**PE**	Protective earth conductor	Internally connected to M2
2	**M2**	Neutral conductor	Internally connected to PE
3	**N2**	Phase conductor	

Recommended cross-section of wires depending on length for connection of MCI (PAW connector) to power auxiliary winding of ASC. It's not recommended to use wires longer than 200 m. Wires 1.5 mm² and 2.5 mm² only be used for installation inside of control box. Improperly selected conductor cross-section affect the accuracy of MCI calculation.

Wire length	<= 10 m	<= 20 m	<= 50 m	<= 100 m	<= 200 m
Minimum cross-section	1.5 mm²	2.5 mm²	4 mm²	6 mm²	10 mm²

5.13.4 Binary inputs (BI)

Connector: MSTB 2.5/ 8-STF, conductor cross section min/max: 0.7/2.5 mm²

PIN	Marking	Function / Polarity	Description (Default)
1	**IN1-1**	L	Freely programmable (Endswitch – MAX)
2	**IN1-2**	N	
3	**IN2-1**	L	Freely programmable (Endswitch – MIN)
4	**IN2-2**	N	
5	**IN3-1**	L	Freely programmable (External error - MCI is blocked, REG-DP(A) switches to emergency mode)
6	**IN3-2**	N	
7	**IN4-1**	L	Freely programmable (Total blocking - MCI and REG-DP(A) is blocked)
8	**IN4-2**	N	

5.13.5 Binary outputs (BO)

External fuse: ≤ 6 A AC / ≤ 4 A DC (30 V)

Connector: MSTB 2.5/ 9-STF, conductor cross section min/max: 0.7/2.5 mm²

PIN	Marking	Function / Polarity	Description (Default)
1	**OUT1 - COM**		Freely programmable (Motor Up)
2	**OUT1 - NO**		
3	**OUT2 - COM**		Freely programmable (Motor Down)
4	**OUT2 - NO**		
5	**OUT3 - COM**		Freely programmable (Injection activated)
6	**OUT3 - NO**		
7	**OUT4 - COM**		Freely programmable (MCI status)
8	**OUT4 - NC**		
9	**OUT4 - NO**		

5.13.6 Potentiometer input (POT)

Connector: MSTB 2.5/ 3-STF, conductor cross section min/max: 0.7/2.5 mm²

PIN	Marking	Function / Polarity	Description
1	**POT+**	Potentiometer +	
2	**SLIDER**	Potentiometer value	
3	**POT-**	Potentiometer -	

5.13.7 Communication (COM1, COM2, USB)

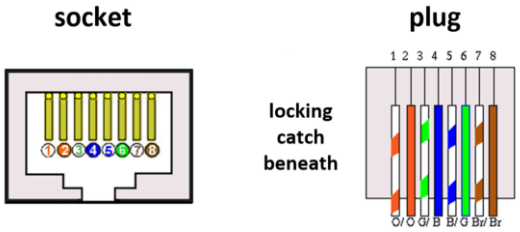
COM1 (RJ45 connector – Modbus interface to COM3 of REG-DP(A))

COM2 (RJ45 connector – reserved; limited functionality)

4-wire RS 485 with shielded telephone or Ethernet cable; distance MCI to REG-DP up to 500 m

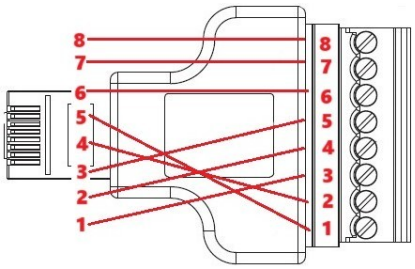
PIN configuration RJ45 socket on the MCI

PIN RJ45	Marking	Function / Polarity
1	**Rx+ (A)**	Data IN
2	**Rx- (B)**	Data IN
4	**Tx- (Z)**	Data OUT
5	**Tx+ (Y)**	Data OUT
8	**GND**	Reference potential



PIN configuration of the optional useable RJ45/terminal adapter

PIN terminal block	Marking	Function / Polarity
3	**Rx+ (A)**	Data IN
4	**Rx- (B)**	Data IN
2	**Tx- (Z)**	Data OUT
1	**Tx+ (Y)**	Data OUT
8	**GND**	Reference potential



Service communication interface (USB connector type B)

PIN	Marking	Function / Polarity	Description
1	**+5V**	Supply	
2	**D-**	Data	
3	**D+**	Data	
4	**GND**	Reference potential	Internally connected to PE
5	**Shield**	Shield	Internally connected to PE
6	**Shield**	Shield	Internally connected to PE

A. Eberle GmbH & Co. KG

Frankenstraße 160
D-90461 Nürnberg

Tel.: +49 (0) 911/62 81 08-0
Fax: +49 (0) 911/62 81 08 96
E-Mail: info@a-eberle.de

http://www.a-eberle.de

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