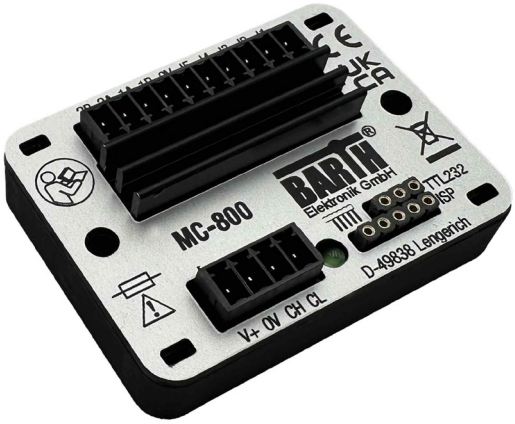
lococube®
Motor Controller MC-800

MANUAL



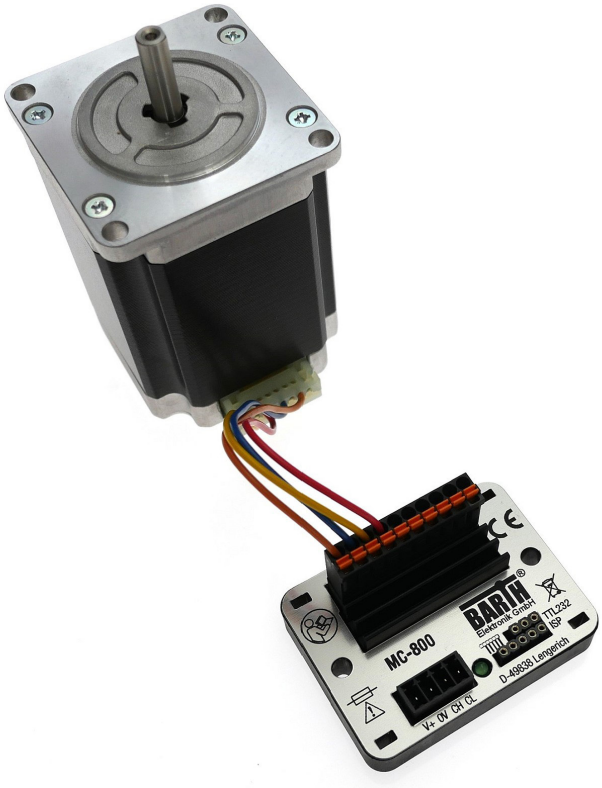


TABLE OF CONTENT

SAFETY INSTRUCTIONS

This manual contains notices which you should observe to ensure your own personal safety, as well as to protect the product and the connected equipment. These notices are highlighted in the manual by a warning symbol and are marked as follows according to the level of danger:

Only qualified personnel should be allowed to install and work on this equipment. Qualified persons are defined as persons who are authorized to commission, to ground and to tag circuits, equipment and systems in accordance with established safety practices and standards.

Turn off the power supply before performing any wiring operations! Short circuits can be harmful, critical and can cause explosions and serious burns!

Please read this manual carefully and observe all safety instructions!

DESTINATED USE

The Motor Controller MC-800 is designed as stepper motor controller for universal motion & control applications. It must not be used for life critical, medical or fail safe applications.

DISCLAIMER

BARTH® Elektronik GmbH assumes no liability for usage and functionality of the MC-800 in case of disregarding this manual. The strict accordance of this manual is important since the installation methods, peripheral connections, usage and maintenance can not be controlled by BARTH Elektronik GmbH. Therefore BARTH Elektronik GmbH assumes no liability for any claim.

1 Product description

The picture below shows the Motor Controller MC-800 lococube® (Art. No. 0890-0800).

1.1 Features

- Ultracompact CAN motor controller up to 2.8 A
- Parameter communication via CAN
- Dynamic motor current adjustment via CAN
- Speed and ramps freely configurable
- Step and stop modes dynamically adjustable
- Open-loop or closed-loop operation
- Inputs for Encoder and limit switches
- Wide operating voltage range 7 to 32 VDC
- Engineered and manufactured in Germany

1.2 Applications

- Universal motion & control
- Robotics and CNC systems
- Industrial process control
- X-by Wire systems
- Technical education / university

1.3 General description

The MC-800 is a highly integrated CAN motor controller to directly drive one bipolar stepper motor up to 2.8 A. It has never been easier to realize simple motion & control or pick & place applications without the need of programming.

The integrated CAN 2.0A/B interface provides easiest plug & play interfacing to a lococube® mini-PLC without the need to program the MC-800. All motor parameters are communicated via CAN Bus between the mini-PLC and MC-800.

These outstanding features open up a variety of application fields in industrial, automotive and 12/24 V battery-powered applications. Also robotic systems can be easily controlled using the powerful and easy-to-use MC-800.

1.4 Connection and operation

The Motor Controller MC-800 can be directly connected to any BARTH® lococube® mini-PLC using the standard CAN interface. There is no need to program the MC-800 separately because all settings and parameters are communicated via CAN between the mini-PLC and motor controller.

1.5 Delivery content

- 1x lococube® Motor Controller MC-800
- 1x Connector for supply and CAN
- 1x Connector for I/O and stepper motor

2 Installation

2.1 Mounting

The MC-800 must be installed and wired by a trained technician who knows and complies with both the universally applicable engineering rules and the standards that apply in specific cases.

Fastening the MC-800 follows using either the integrated mounting holes for screws or the holes for cable ties. The cable tie installation method is recommended for fastening the MC-800 on wiring harness, tubes or other mechanical parts.

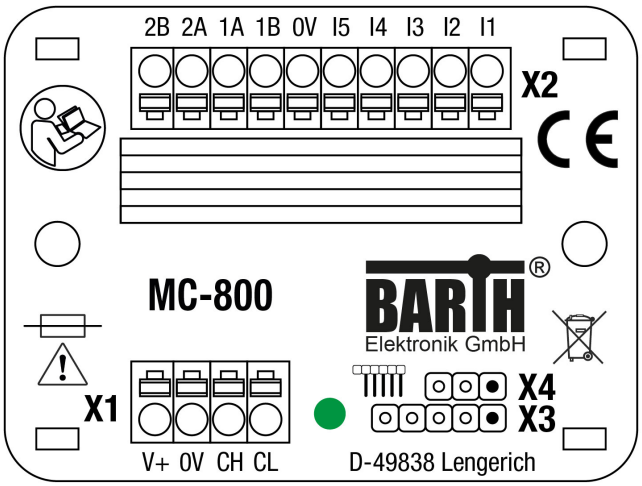
The heatsink of the MC-800 may reach temperatures up to 100°C.
Take care to not cover the MC-800's heatsink ensuring proper heat dissipation and protect your peripheral components against damage due to heat!

The MC-800 is intended to be mounted in enclosed cabinets (indoor use) and the like, that afford protection against fire hazards, environmental conditions and mechanical impact.
Take care to meet the environmental conditions of the MC-800 and ensure proper heat dissipation of its heatsink.

2.2 Wiring

2.2.1 Overview

The picture below shows the connection layout of the lococube® Motor Controller MC-800.



X1: Power supply and CAN connector:

1	V+	positive supply (+7 to 32 VDC)
2	0V	ground terminal (GND)
3	CH	CAN high terminal
4	CL	CAN low terminal

X2: Motor, input and output connector

1	I1	analog input AIN1
2	I2	analog input AIN2
3	I3	analog input AIN3
4	I4	digital input DIN4 / encoder A
5	I5	digital input DIN5 / encoder B
6	0V	analog / encoder ground (GND)
7	1B	bipolar stepper coil 1B
8	1A	bipolar stepper coil 1A
9	2A	bipolar stepper coil 2A
10	2B	bipolar stepper coil 2B

Both X3 and X4 connectors are reserved for factory programming only.
Connecting these terminals may cause irreversible damage of the MC-800!

2.2.2 Connecting the power supply

The MC-800 features an outstanding wide supply voltage range from 7 to 32 VDC at lowest stand-by current consumption. So the MC-800 can be integrated within battery supplied 12 or 24 VDC systems (cars, trucks, battery powered cars, forklifts and digger, for example).

Turn off the power supply before performing any wiring operations!

False electrical connection, voltage reversal or disregarding the electrical specifications may cause irreversible damage to the MC-800!

Connect the supply voltage of 7 to 32 VDC to the 4-pole terminal of the MC-800. Wire the positive supply to the ‚V+' marked connection. The negative (ground) will be wired to the ‚0V' connection. All terminals may be used within a wire gauge from 0.25 to 1.5mm².

Ensure correct power supply voltage range and polarisation! External fusing of 3 A max. is mandatory! Disregarding may cause irreversible damage of the MC-800!

2.2.3 Connecting the CAN interface

The 4-pole connector of the MC-800 also contains the CAN-specific pins ‚CH' (-> CAN high) and ‚CL' ->(CAN low).

The voltage at CANH or CANL must not exceed -32 or +32 VDC referred to ground (GND). Higher voltages may cause irreversible damage to the mini-PLC!

There is no termination resistor integrated in the MC-800. **Please refer to the appendix for detailed electrical specification of the CAN interface.**

2.2.4 Connecting the inputs

You can connect sensors, switches or buttons to the inputs. The types may be limit switches, encoder, temperature, flow, pressure, photoelectric sensors or proximity switches, for example.

Features of I1 to I3

- I1 to I3 are analog inputs from 0 to 30 VDC (12 Bit)
- I4 and I5 are digital inputs, also for encoder (A/B)
- Wide input voltage range from 0 to 32 VDC
- Comprehensive integrated protection circuits
- Outstanding electromagnetic compatibility (EMC)
- Electrostatic discharge protection (ESD)

Due to the pull-down resistors integrated in the MC-800 any switch (NO/NC) can simply be connected between the positive supply (V+) of the MC-800 and the desired input.

The voltage at any input must not exceed 32 VDC referred to ground (GND). Higher voltages or reverse voltage lower than -32 VDC may cause irreversible damage of the MC-800!

The 10-pole connector named X2 contains the inputs of the motor controller. While I1 to IN3 are analog inputs, I4 and I5 are pure digital inputs. Please only use I4 and I5 for encoder connection (I4->‚A', I5->‚B', encoder ground->0 V).
Please only use the X2.6 terminal to refer any input to GND. **Please refer to the appendix for detailed electrical specification of the inputs.**

2.2.5 Connecting the stepper motor

The MC-800 is capable to directly drive one bipolar stepper motor up to 2.8 A. Depending on load and motor frequency the maximum allowable current may be lower than 2.8 A. The internal temperature monitor will limit the maximum current.

Choosing the right motor type:
- bipolar stepper
- voltage up to supply voltage
- nominal phase current <3 A

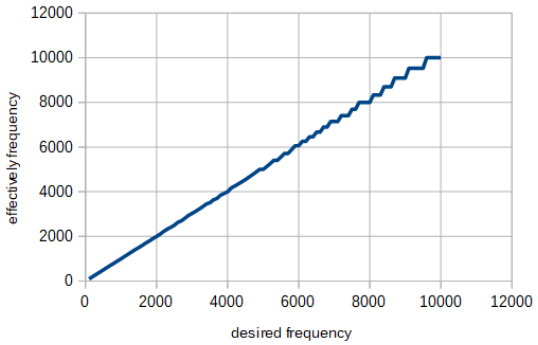
The 10-pole connector X2 contains the motor outputs for on bipolar stepper motor. To properly connect the stepper motor to the MC-800 please use ‚1A' and ‚1B' terminals for the first phase of your motor. The second phase will be connected to ‚2A' and ‚2B' terminals of the MC-800.

Take care to not set phase current above 2 A for continuous operation. For intermediate operation current up to 2.8 A is allowed.

The heatsink of the MC-800 may reach temperatures up to 100°C.
Take care to not cover the MC-800's heatsink ensuring proper heat dissipation and protect your environment against damage due to heat!

3 CAN Communication

There is no programming necessary to operate the MC-800. The MC-800 will be parameterized using a common 2-wired CAN2.0A/B interface using a fixed baud rate of 250 kBit/s. The MC-800 uses 6 sequenced CAN-IDs. Default CAN-IDs are 0x200 to 0x205, the base CAN-ID is 0x200 in this case. The MC-800 receives all CAN message types with 11 or 29 Bit identifier. Messages from 0x000 to 0x7FF will be send with 11 Bit identifier – anything bigger than that with 29 Bit identifier.



The effective frequency gets increasingly inaccurate at higher frequencies.

3.1 Set Position (0x201)

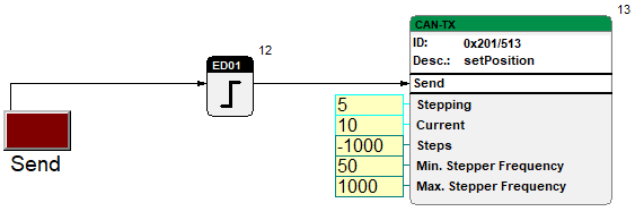
This message initializes the MC-800 and starts moving the connected stepper motor.

Default ID	0x201
DLC	8 Byte
Direction	Transmit to MC-800
Format	Intel (Byte 0=LSB)

Byte 0	Bit0: Enable Bit2+3: Stepping 0: Full 1: Half 2: Quarter 3: Eight
Byte 1	Current: 0.1 to 2.8 A [value x 10]
Byte 2 **Byte 3**	Moving steps: -32768 to +32767
Byte 4 **Byte 5**	Minimal stepper frequency: 1 to 10000 Hz
Byte 6 **Byte 7**	Maximal stepper frequency: 1 to 10000 Hz

EXAMPLE
Move stepper with 1 A, half stepping mode, 50-1000 Hz, 1000 steps back.

B0	B1	B2	B3	B4	B5	B6	B7
0x05	0x0A	0x18	0xFC	0x32	0x00	0xE8	0x03



3.2 Set Velocity (0x205)

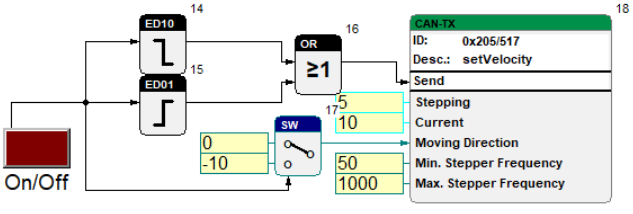
This message initializes the MC-800 and starts moving the connected stepper motor.

Default ID	0x205
DLC	8 Byte
Direction	Transmit to MC-800
Format	Intel (Byte 0=LSB)

Byte 0	Bit0: Enable
	Bit2+3: Stepping 0: Full 1: Half 2: Quarter 3: Eight
Byte 1	Current 0.1 to 2.8 A [value x 10]
Byte 2 **Byte 3**	Moving direction -10: reverse -1: ramp down stop 0: immediately stop 1: ramp down stop 10: forward
Byte 4 **Byte 5**	Minimal stepper frequency: 1 to 10000 Hz
Byte 6 **Byte 7**	Maximal stepper frequency: 1 to 10000 Hz

EXAMPLE
Move stepper with 1 A, half stepping mode, 50-1000 Hz, reverse direction.

B0	B1	B2	B3	B4	B5	B6	B7
0x05	0x0A	0xF6	0xFF	0x32	0x00	0xE8	0x03



3.3 Get Data (0x202)

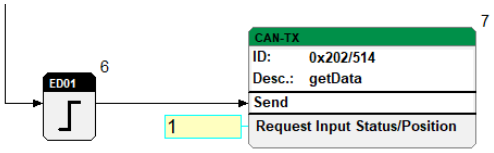
This message requests I/O and position data from the MC-800.

Default ID	0x202
DLC	1 Byte
Direction	Transmit to MC-800
Format	Intel (Byte 0 = LSB)

Byte 0	Bit0: request input status
	Bit1: request position
Byte 1	
Byte 2	
Byte 3	
Byte 4	
Byte 5	
Byte 6	
Byte 7	

EXAMPLE
Request status of analog and digital inputs.

B0	B1	B2	B3	B4	B5	B6	B7
0x01							



1: input status
2: position

3.4 Status Position (0x204)

This message will be send by MC-800 at the following conditions:

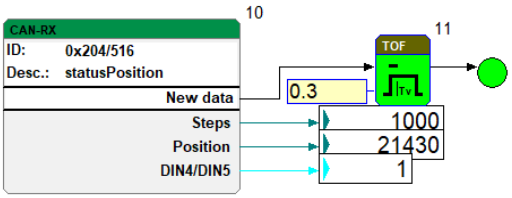
- cyclic every 1000 ms without moving
- cyclic every 50 ms at moving active
- on every change of DIN4 or DIN5 at velocity mode (0x205) minimal 1 ms cycle time
- after receiving of getData message with Byte0 = 0x02.

Default ID	0x204
DLC	4 Byte
Direction	Receive from MC-800
Format	Intel (Byte 0 = LSB)

Byte 0	remaining steps
Byte 1	
Byte 2	encoder position
Byte 3	
Byte 4	Bit0: DIN4
	Bit1: DIN5
Byte 5	
Byte 6	
Byte 7	

EXAMPLE
The MC-800 sends this message with 1000 remainig steps, encoder position 21430 and DIN4 high.

B0	B1	B2	B3	B4	B5	B6	B7
0xE3	0x03	0xB6	0x53	0x01			



3.5 Status Input (0x203)

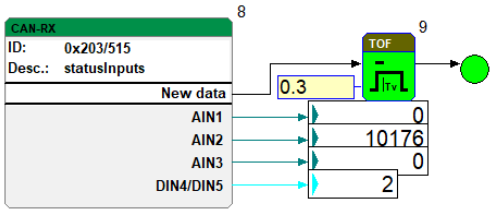
This message will be send by MC-800 after receiving of getData message with Byte 0 = 0x01.

Default ID	0x203
DLC	7 Byte
Direction	Receive from MC-800
Format	Intel (Byte 0=LSB)

Byte 0	AIN1 [mV]
Byte 1	
Byte 2	AIN2 [mV]
Byte 3	
Byte 4	AIN3 [mV]
Byte 5	
Byte 6	Bit0: DIN4
	Bit1: DIN5
Byte 7	

EXAMPLE
The MC-800 send this message with 10176 mV at AIN2 and high on DIN5.

B0	B1	B2	B3	B4	B5	B6	B7
0x00	0x00	0xC0	0x27	0x00	0x00	0x02	



3.6 Set ID (0x200)

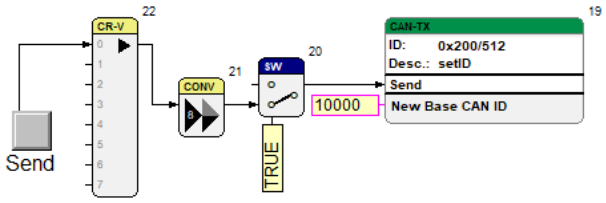
With this message, it is possible to change the base CAN-ID of the MC-800.

Default ID	0x200
DLC	4 Byte
Direction	Transmit to MC-800
Format	Intel (Byte 0=LSB)

Byte 0	new base CAN ID
Byte 1	
Byte 2	
Byte 3	
Byte 4	
Byte 5	
Byte 6	
Byte 7	

EXAMPLE
Change the base CAN-ID from 0x200 to 0x10000.

B0	B1	B2	B3	B4	B5	B6	B7
0x00	0x00	0x01	0x00				



In case you want to change the base CAN ID, please document the new base ID and store it somewhere safe! Once the base CAN ID is changed, it can only be changed again by knowing the current base ID!

At higher frequencies, the effective frequency might be inaccurate.
Step loss may occur not properly reaching zero position.

Inversion of direction by changing moving direction between +10 to -10 is not possible.

Parameter changing by changing moving direction with +10 to -10 is not provided.

This command can ramp down or stop previous setPosition (0x201) command.

Every change of DIN4 or DIN5 will send the statusPosition message (0x204) at minimal 1 ms cycle time.

4 Operation and programming

To operate the MC-800 with a CAN Bus equipped lococube® mini-PLC, please refer to the manual of the mini-PLC you want to use for your project. The related manual also shows all programming options available for your mini-PLC to properly control the motor controller MC-800 via CAN communication. A miCon-L example program is available for the STG-800 below.

1 

miCon-L
Fast, easy and intuitive programming by connecting functions blocks.

lococube® STG-800

miCon-L V3.8.1 EN
Example program for STG-800

The miCon-L example program may not be used for productive use and strictly serves as an example to showcase the MC-800's functions!

5 Appendix

5.1 Specifications

5.1.1 General

Hardware design	BARTH® CAN motor controller with pluggable spring terminal connectors
Interfaces	CAN 2.0A/B

5.1.2 Power supply

Operating voltage	7 to 32 VDC
Current consumption	depending of the connected stepper motor, 2.8 A max
Fusing	3 A max. (external) mandatory for voltage reversal protection
Voltage reversal protection	yes (combined with external fuse)
ESD/TVS protection	yes, integrated
Heat dissipation air (at full load)	normally < 5 W

5.1.3 Inputs

Number analog	3
Number digital (encoder)	2
Analog input IN1 - IN3	U_{IN} = 0..30 VDC R_{IN} > 11 kΩ f_{IN} <= 11 kHz t_{IN} >= 1 ms
Digital input IN4 - IN5	U_{IN} = 0..30 VDC R_{IN} > 20 kΩ U_{LOW} =< 3 VDC U_{HIGH} >= 5 VDC f_{IN} <= 25 kHz t_{IN} >= 40 µs
Accuracy ADC IN1 - IN3	< 0.15 VDC
ADC resolution (internal)	12 Bit
Potential isolation	no (commond GND)
ESD/TVS protection	yes

5.1.4 Interfaces

CAN	CAN 2.0A/B: 11/29 Bit ID, base frame format supported baud rate: 250 kbit (other rates cutomer-tailored)
	no internal termination resistor (120 R)
	Meets or exceeds the requirements of applications ISO 11898-2, loss of ground protection from –32 V to +32 V, thermal shutdown protection

5.1.5 Security features

Security Features	System and independent watchdog Fail safe oscillator Power on/down reset Supply voltage supervisor

5.1.6 Timebase (oscillator)

Primary Oscillator	Crystal quartz MEMS unit (precise ‚micro-electro-mechanical system')
Nominal Frequency	16 MHz
Frequency tolerance	$\pm 50 \times 10^{-6}$
Frequency aging	$\pm 5 \times 10^{-6}$ / year max.

5.1.7 Electrical connection

Electrical Connection	plugable screw type connector 0.25 to 1.5 mm² Manufacturer: Phoenix Contact Series: COMBICON Type: MC1,5/4-ST-3,5(-BK)

5.1.8 Electromagnetic compatibility (EMC)

Electrostatic discharge (ESD) at supply terminals	20 kV air discharge 30 kV contact discharge (IEC/EN 61 000-4-2, level 3)
Electromagnetic fields	Field strength 10 V/m (IEC/EN 61000-4-3)
CAN bus terminals (CANH, CANL to GND)	IEC 61000-4-2: Unpowered contact discharge ±15000 V IEC 61000-4-2: Powered contact discharge ±8000 V

5.1.9 Environmental conditions

Operation temperature	-20 to +50 °C (IEC 60068-2-1/2)
Storage temperature	-30 to 70 °C (IEC 60068-2-1/2)
Relative humidity	5 to 80% non-condensing (IEC 60068-2-30)
Air pressure (in operation)	500 to 1500 hPa
Shock resistance	min. 50 m/s² (IEC 60068-2-27)
Vibration resistance	min. 10 m/s² @ 10..100 Hz (IEC 60068-2-6)
Degree of protection	IP 20 (not evaluated by UL) (EN 50178, IEC 60529)
Free fall (packaged)	1000 mm (IEC 60068-2-32)

5.1.10 Weight and dimensions

Weight	50 g (without connectors)
Dimensions	60 x 45 x 18 mm (LxWxH) (without connectors)
Mounting	via two M4 screws or 3.6 mm cable ties

5.1.11 Ordering information

Ordering information	Motor Controller MC-800 Art. No. 0890-0800 GTIN 4251329401566
Ordering information accessory	mini-PLC STG-800 Art. No. 0850-0800 GTIN 4251329401207
	Connection Cable VK-16 (graphical programming) Art. No. 0091-0016 GTIN 4251329400187
	Programming adaptor VK-46 (graphical & open source programming) Art. No. 0091-0046 GTIN 4251329406226
	Harness KS-85 (Developer wiring harness) Art. No. 0036-0085 GTIN 4251329406165

5.2 Disposal

If you wish to dispose of the product, ask your local recycling centre or dealer for details about how to do this in accordance with the applicable disposal regulations.

5.3 Conformity declaration

For the following designated product it is hereby confirmed, that the construction in that technical design brought by us in traffic corresponds to the standards specified below. In the event of any alternation which has not been approved by us being made to any device as designated below, this statement shall thereby be made invalid.

Description	Motor Controller
Type	MC-800
Art. No.	0890-0800
Directive 2004/108/EG relating to-electromagnetic compatibility (EMC) CE	Applied norms: 2004/108/EG 2004/108/EC 2014/30/EU
RoHS Directive 2011/65EU	We herby declare that our product is compilant to the RoHS Directive on restriction of the use of certain hazardous substances in electrical and electronic appliances.
UK CA	BARTH Elektronik GmbH declares conformity of the product for which this manual is intended with the UKCA equivalent of the aforementioned CE regulations. We therefore deem the product to be in full compliance with the UKCA regulations and take full legal responsibility for it. This declaration was issued on 30.11.2021.

BARTH® Elektronik GmbH
Lengerich, 23.01.2022

Dipl.-Ing. (FH) D. Barth
Managing Director