lococube® STG-950
Art. No. 0850-0950

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 lococube® is designed for universal measuring, controlling and regulating applications.

DISCLAIMER

BARTH® assumes no liability for usage and functionality of the lococube® 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®. Therefore BARTH® assumes no liability for any claim.

1 Product description

1.1 Features

- Highly flexible mini-PLC for OEM solutions
- Connector for customer-tailored AddOn board
- High-Performance 32 Bit ARM® Cortex® M4
- 3 analog Inputs 0 to 30/0 to 10 VDC, 12 bit ADC
- 2 digital Inputs up to 25 kHz
- 4 Solid-State Power Outputs up to 1.5 A
- 1 Power PWM Output 16 Bit up to 25 kHz
- CAN 2.0A/B, CAN FD, CANopen® and SAE J1939
- Comprehensive Fail Safe Functions
- Open Source ‚C' Programming
- Wide Operating Voltage Range 7 to 32 VDC
- Wide Operating Temp. Range -40 to +70°C
- Vibration resistant and rugged due to potting
- ECE-R10 certified
- CE, UL und (in progress)
- **AddOn board functions (under development):**
  - Current input / output 4-20 mA
  - Voltage input / output 0-10 V
  - PT100 / PT1000
  - Measuring bridges for pressure, weighting, temperature
  - Galvanically isolated inputs / outputs
  - Galvanically isolated CAN / CAN-FD bus
  - RS-232 and RS-485
  - MODBUS
  - 1-Wire®
  - IO-Link®
  - WLAN, Bluetooth®, NFC®, RFID
  - Ethernet, MQTT, Node-RED
  - Engineered and manufactured in Germany

1.2 Applications

- Industrial and process control
- Test and control systems
- Automotive and maritime technology
- Technical education
- White goods

1.3 Scope of delivery

- 1x lococube® STG-950
- 1x Connector for supply and CAN
- 1x Connector for I/O
- 1x Connector for AddOn board interface

2 Installation

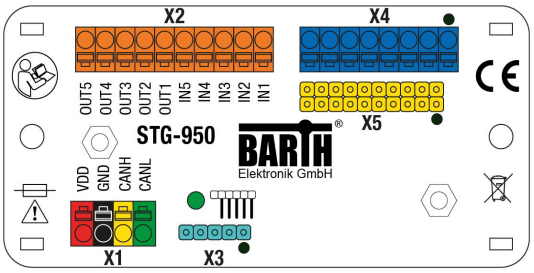
2.1 Mounting

> **The lococube® must be installed and wired by a trained technician who knows and complies with both the universally applicable engineering rules and the regulations and standards that apply in specific cases.**

Fastening the STG-950 is possible by using either the integrated mounting holes for screws or the holes for cable ties. The cable tie installation method is recommended for fastening the lococube® on wiring harnesses, tubes or other mechanical parts.

2.2 Wiring

2.2.1 Overview



X1 connector: Power supply and CAN-interface

1	VDD	Positive supply terminal
2	GND	Ground terminal
3	CANH	CAN high terminal
4	CANL	CAN low terminal

X2 connector: GPIO

1	IN1	Analog / digital input
2	IN2	Analog / digital input
3	IN3	Analog / digital input
4	IN4	Analog / digital input
5	IN5	Analog / digital input
6	OUT1	High-side output
7	OUT2	High-side output
8	OUT3	High-side output
9	OUT4	High-side output
10	OUT5	Low-side output

X3 connector: Open source ISP

1 ●	+3V3	Positive power supply (Pin 1)
2	GND	Ground terminal
3	SYS_SWDIO	System data IO
4	SYS_SWCLK	System clock
5	SYS_RESETN	System reset (inverted)

X4 connector: AddOn board extension

1 ●	X5:4	AddOn board pin 4
2	X5:6	AddOn board pin 6
3	X5:8	AddOn board pin 8
4	X5:10	AddOn board pin 10
5	X5:12	AddOn board pin 12
6	X5:14	AddOn board pin 14
7	X5:16	AddOn board pin 16
8	X5:18	AddOn board pin 18

X5 connector: AddOn board interface

1 ●	VDD	AddOn board pin 1: fused 100mA
2	GND	AddOn board pin 2: Function depends on AddOn
3	PB10 / 13	AddOn board pin 3: USART3 TX / FDCAN2 TX
4	X4:1	AddOn board pin 4: Function depends on AddOn
5	PC11 / PB12	AddOn board pin 5: USART3 RX / FDCAN2 RX
6	X4:2	AddOn board pin 6: Function depends on AddOn
7	PB5	AddOn board pin 7: SP13 MOSI
8	X4:3	AddOn board pin 8: Function depends on AddOn
9	PB4	AddOn board pin 9: SP13 MISO
10	X4:4	AddOn board pin 10: Function depends on AddOn
11	PC10	AddOn board pin 11: SP13 SCK
12	X4:5	AddOn board pin 12: Function depends on AddOn
13	PA3 / PB7	AddOn board pin 13: ADC1 4 / 12C1 SDA
14	X4:6	AddOn board pin 14: Function depends on AddOn
15	PC4 / PA15	AddOn board pin 15: ADC2 5 / 12C1 SCL
16	X4:7	AddOn board pin 16: Function depends on AddOn
17	PB0 / PA4	AddOn board pin 17: ADC1 15 / DAC1 out1
18	X4:8	AddOn board pin 18:
19	+5V	AddOn board pin 19: fused 50mA
20	+3	AddOn board pin 20: fused 50 mA

2.2.2 Connecting the power supply

The STG-950 features an outstandingly wide supply voltage range from 7 to 32 VDC at lowest current consumption. So the lococube® can be integrated within battery supplied 12V or 24V DC systems (cars, trucks, battery powered cars,

forklifts and diggers, 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 of the lococube®!

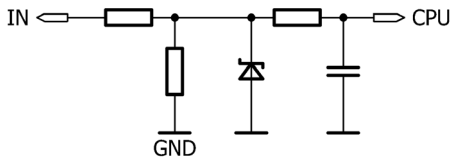
Connect the supply voltage of 7 to 32 VDC to the 4-pole terminal X1 of the lococube®. Wire the positive supply to the ‚VDD' marked connection. The negative (ground) will be wired to the ‚GND' connection. All terminals are carried out as plugable spring terminal connectors for a wire gauge of 0.25 to 1.5mm².

Ensure correct power supply voltage range and polarisation!
External fusing of 6A max. is mandatory! Disregarding may cause irrversible damage of the lococube®!

2.2.3 Connecting the inputs

You can connect sensors, switches or buttons to the inputs. The sensors may be temperature, flow, pressure, photo-electric sensors or proximity switches, for example.

Inputs IN1-5



- IN1 to IN5 are selectable analog/digital inputs
- Wide input voltage range 0 to 32VDC
- Comprehensive integrated protection circuits
- Outstanding electromagnetic compatibility (EMC)
- Electrostatic discharge protection (ESD)

Due to the pull-down resistors integrated in the lococube® any switch (NO/NC) can simply be connected between the positive supply (VDD) and the desired input.

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

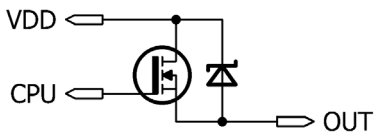
The 10-pole connector X2 contains the inputs and outputs of the lococube®. The voltage range for all inputs may not exceed 32 VDC. All inputs refer to GND.

Please refer to the appendix for detailed electrical specification of the inputs.

2.2.4 Connecting the outputs

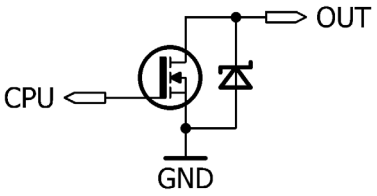
Depending on load type and current the lococube® is able to drive electric loads directly without any additional driver or protection circuit. The lococube® provides 4 digital solid-state highside outputs and 1 solid-state lowside switch.

Outputs OUT 1-4



- Rugged solid-state higside switch up to 1.5A
- Switching up to 100Hz
- Paralleling permissible up to 4A
- Short circuit protection and current limitation
- Fast demagnetization of inductive loads
- Stable behaviour at undervoltage
- Comprehensive integrated protection circuits
- Outstanding electromagnetic compatibility (EMC)
- Electrostatic discharge protection (ESD)

Output OUT 5



- 700mA Solid state lowside switch with PWM capability
- 16 bit PWM resolution from DC to 10 kHz
- Comprehensive integrated protection circuits
- Outstanding electromagnetic compatibility (EMC)
- Electrostatic discharge protection (ESD)

The total current sourced by OUT1 to OUT5 must not exceed 6A!
Avoid reverse voltage at any output higher than the lococube´s® supply voltage!

Take care of not switching OUT1 to OUT4 higher than 100Hz (OUT5: 10kHz)!
Rise and fall times of the output driver IC will cause higher power-losses resulting in heat dissipation. Please also refer to the appendix for detailed electrical specification of the outputs.

Please refer to the appendix for detailed electrical specification of the outputs.

2.2.5 Connecting the CAN interface

The X1 connector of the lococube® contains the CAN-specific pins ‚CANH' and ‚CANL'.

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

There is no termination resistor (120R) integrated in the lococube®. Please add a 120R resistor at both ends (2) for CAN bus termination.

3 Programming

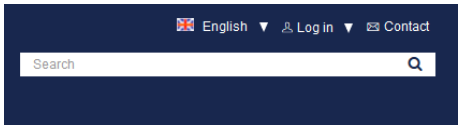
3.1 Programming options

The lococube® STG-950 supports several programming options. The table below shows all supported programming environments:

Programming	Software	Manual
C	STM32 Cube IDE	coming soon
	KEIL® µVision	9022-0020

We kindly refer you to the following manufacturer website:

www.barth-elektronik.com



Type in the product name (e.g. STG-950) and get the product-related documents and software.

3.2 Programming interface

To program the STG 950, please use the VK-35 connection cable (BARTH® item no. 0091-0035). Programming and debugging takes place via the X3 connector.

4 Appendix

4.1 Specifications

4.1.1 General

Hardware design	BARTH® lococube® mini-PLC fully enclosed in proprietary PU resin, tiny and rugged housing with plugable spring terminal connectors, ultra-lightweight
Programming options	C programming
Interfaces	ISP (VK-35 & ST-Link required)
	CAN-FD/CAN 2.0A/B/open®/SAE J1939/NMEA2000

4.1.2 Power supply

Operating voltage	7 to 32 VDC
Current consumption	nominal 10 mA at 32 VDC (depending on configuration)
Fusing	6 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 < 2 W

4.1.3 Inputs

Number digital	4+1
Number analog	5
Analog / digital input IN1 - IN5	U_{IN} = 0 to 32 VDC R_{IN} > 11 kOhm f_{IN} <= 1kHz t_{IN} >= 1 ms
Accuracy ADC IN1 - IN5	<0.15 VDC
ADC resolution (internal)	12 Bit
Potential isolation	no (common GND)
ESD/TVS protection	yes

4.1.4 Outputs

Number digital	4+1
Number PWM	1
Output OUT1 - OUT4	Output type: solid state (highside) I_{OUT} <= 1.5 A (resistive load) @ f_{OUT} = 0 to 100 Hz U_{OUT} >= U_{IN}-0.45 V I_{TOT}<= 6 A (paralleling permissible) Maximal allowable load inductance for a single switch off (one output): V_{DD}=12VDC, I_L=1.5A, Z_L<=70mH V_{DD}=12VDC, I_L=1A, Z_L<=200mH On-state resistance V_{DD} to OUT: R_{ON}<=180 mOhm Turn-on time: t_{ON}<=250 µs Turn-off time: t_{OFF}<=270 µs
PWM Output OUT5	Output type: solid state (lowside) I_{OUT} <= 700 mA (resistive load) @ f_{OUT} = 1 kHz to 10 kHz I_{OUT} <= 700 mA (resistive load)
Potential isolation	no

4.1.5 Interfaces

CAN	CAN 2.0A/B: 11/29 bit ID, base frame format Baud rates: 50, 100, 125, 250, 500 kbit, 1Mbit
	CANopen® multi line, single line, master, slave
	SAE J1939
	NMEA 2000
	CAN-FD
	Meets or exceeds the requirements of applications ISO 11898-2, loss of ground protection from –32 V to +32 V, thermal shutdown protection

4.1.6 Security features

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

4.1.7 Program and data memory

Memory	µC-internal flash program memory: 512 kB µC-extermal flash program memory: 4 MB SRAM: 128 kB EEPROM: 8kB, >1M write cycles

4.1.8 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.

4.1.9 Electrical connection

Electrical Connection	plugable spring terminal connectors 0.25 to 1.5 mm² Manufacturer: Phoenix Contact Series: COMBICON Type: FMC1,5/x-ST-3,5-BK

4.1.10 Electromagnetic compatibility (EMC)

Electrostatic discharge (ESD) on IN1 to IN5	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

4.1.11 Environmental conditions

Operation temperature	-40 to +70 °C (IEC 60068-2-1/2)
Storage temperature	-40 to +70 °C (IEC 60068-2-1/2)
Relative humidity	5 to 95% non-condensing (IEC 60068-2-30)
Air pressure (in operation)	500 to 1500 hPa
Shock resistance	min. 300 m/s² (IEC 60068-2-27)
Vibration resistance	min. 80 m/s² @ 10..100 Hz (IEC 60068-2-6)
Degree of protection	IP 20 (not evaluated by UL) (EN 50178, IEC 60529)
Drop	Drop height: 1000 mm (IEC 60068-2-31)
Free fall (packaged)	1500 mm (IEC 60068-2-32)

4.1.12 Weight and dimensions (without connectors or AddOn board)

Weight	70 g (without connectors)
Dimensions	93 x 45 x 15 mm (LxWxH) Height housing: 21 mm
Mounting	via two M4 screws or 3.6mm cable ties

4.1.13 MTTF and MTTFd

Calcuation basis	DIN EN ISO 13849-1:2008 (@T=25°C)
Calculation formula	DIN EN ISO 13849-1:2008 Annex C.5: MTTF, MTTFd data of electrical components (typical and worst case) D.1: Parts count method (worst case with safety factor 10) $MTTF = \frac{1}{\sum_{1}^{n} \frac{1}{MTTFn}}$ $MTTFd = MTTF \cdot 2$ $MTTFd = \frac{MTTF \cdot 2}{10}$ (worst case)
MTTF [years]	195
MTTFd [years]	390
MTTFd worst case [years]	39
Explanation	This information is given without any guarantee. The indicated product is no safety component according to the machine directive 2006/42/EC (subject to modifications).

4.1.14 Certifications & Approvals

CE	2004/108/EG 2004/108/EC 2014/30/EU
c UL us	Certification in progress
CANopen®	CANopen® Vendor ID: 46Ah
E1	Cert. No. E1*10R05/01*8717*01 ECE R 10, Rev. 5 (for nominal 12V automotive applications)

4.1.15 Ordering information

Ordering information mini-PLC	mini-PLC STG-950 Art. No. 0850-0950 GTIN 4251329406110
Ordering information accessory	Connection Cable VK-35 Art. No. 0091-0035 GTIN 4251329401276
	Programmer ST-Link/V2 ISOL Art. No. 0017-0066 GTIN 4251329401269
	Programmer PG-30 Art. No. 0017-0030 GTIN 4251329401481

4.2 Documents, videos and software

Detailed information, additional documents, application notes and videos relating to this product are downloadable from www.barth-elektronik.de

4.3 Disposal

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

4.4 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	lococube® mini-PLC
Type	STG-950
Art. No.	0850-0950
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 equivalents of the aforementioned CE regulations. We therefore deem the product to be in full compliance with UKCA regulations and take full legal responsibility for it. This declaration was issued on 30.11.2021.

BARTH® Elektronik GmbH
Lengerich, 07.12.2021

Dipl.-Ing. (FH) D. Barth, CEO