

**lococube® STG-800
Starter Kit STA-800**

MANUAL



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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. It must not be used for life critical, medical or fail safe 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

The picture below shows the BARTH[®] lococube[®] STG-800 with the Connection Cable VK-16 (Art. No. 0091-0016). The lococube[®] is shipped without Connection Cable. The Starter Kit STA-800 includes one lococube[®] STG-800 and the Connection Cable VK-20 which provides similar function as the VK-16.



1.1 Features

- High-Performance 32 Bit ARM[®] Cortex[®]
- 3 analog Inputs 0 to 30 VDC, 12 bit ADC
- Event Counter Input 25 kHz
- Pulse and Frequency Counter Input 40 μ s
- 4 Solid-State Power Outputs up to 1.5 A
- 1 Power PWM Output 16 Bit 1 Hz to 25 kHz
- CAN 2.0A/B and SAE J1939 Interface
- CANopen[®] Interface (Open Source)
- Comprehensive Fail Safe Functions
- Programmable Status LED
- TTL-232 3.3V Interface
- Intuitive graphical Programming Capability
- Open Source Programming
- ARDUINO[®] Programming
- Wide Operating Voltage Range 7 to 32 VDC
- Wide Operating Temp. Range -40 to +70[°]C
- Vibration resistant and rugged Sealing
- CE, UL und ECE-R10 certified
- 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 Delivery content

- 1x lococube[®] STG-800
- 1x Connector for Power Supply and CAN
- 1x Connector for I/O
- 1x Connection Cable VK-20 (STA-800 only)

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 standards that apply in specific cases.

Fastening the STG-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 STG-800 on wiring harness, tubes or other mechanical parts.



The lococube® is intended to be mounted in enclosed cabinets (indoor use) and the like, that afford protection against fire hazards, environmental conditions and mechanical impact.

2.2 Wiring

2.2.1 Overview

The graphic below shows the connection layout of the BARTH® lococube® STG-800.

X1 connector: supply and CAN pins

1	+VDD	positive supply terminal
2	GND	ground terminal
3	CANH	CAN high terminal
4	CANL	CAN low terminal

X2 connector: inputs and outputs

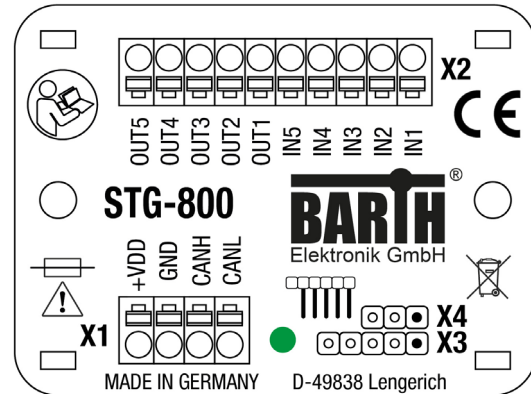
1	IN1	analog / digital input
2	IN2	analog / digital input
3	IN3	analog / digital input
4	IN4	digital input / event counter
5	IN5	digital input / frequency counter
6	OUT1	highside output
7	OUT2	highside output
8	OUT3	highside output
9	OUT4	highside output
10	OUT5	lowside output / PWM

X3 connector: Open Source ISP (via VK-35)

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: TTL232 interface (via VK-16/20)

1●	GND	ground terminal
2	TX	3V3 TTL TX terminal
3	RX	3V3 TTL RX terminal



2.2.2 Connecting the power supply

The STG-800 features an outstanding 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 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 of the lococube®!

Connect the supply voltage of 7 to 32 VDC to the 4-pole terminal X1 of the STG-800. 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 pluggable spring terminal connectors for a wire gauge of 0.25 to 1.5mm².

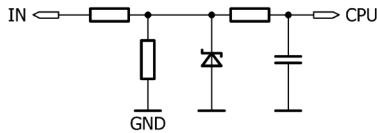


**Ensure correct power supply voltage range and polarisation!
External fusing of 5A max. is mandatory!
Disregarding may cause irreversible damage of the lococube®!**

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 IN3 are selectable analog/digital inputs
- IN4 is an digital or event counter input up to 25kHz
- IN5 is an digital or frequency counter input up to 25kHz
- Wide input voltage range 0 to 32VDC
- IN1 to IN3 are 0 to 10/30 V compatible (12 bit)
- 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 named X2 contains the inputs of the lococube®. While IN4 and IN5 are pure digital inputs, IN1 to IN3 provide both digital or analog (0-30V) functionality. The voltage range for all inputs may not exceed 32 VDC. All inputs refer to GND.

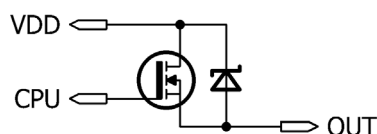


Please refer to the appendix for detailed electrical specification of the inputs.

2.2.4 Connecting the outputs

Depending on load type and current the STG-800 is able to drive electric loads directly without any additional driver or protection circuit. The mini-PLC provides 4 digital solid-state highside outputs and 1 solid-state lowside switch.

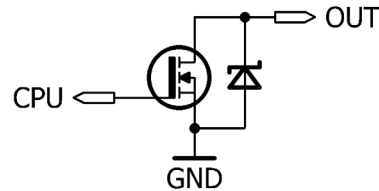
Outputs OUT1-4



- Rugged solid-state highside 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 OUT5



- Solid state lowside switch with PWM capability
- 16 bit PWM resolution from DC to 25kHz
- Sinks up to 2A
- N-MOSFET solid-state design
- Outstanding electromagnetic compatibility (EMC)
- Electrostatic discharge protection (ESD)

The 10-pole connector X2 contains the digital outputs of the lococube®. While OUT1 to OUT4 are overload-protected highside switches, OUT5 is carried out as lowside switch with PWM capability without short circuit protection. A logical HIGH within miCon-L will switch the mini-PLS's supply voltage at OUT1 to OUT4, while OUT5 switches lowside (GND). Avoid a sink current exceeding 2A at OUT5 because this outputs is not protected against short-circuiting or overload current !



The total current sourced by OUT1 to OUT4 must not exceed 4A! Avoid reverse voltage at any output higher than the lococube's® supply voltage! OUT5 provides NO short circuit protection. Take care the sink current not exceeds 2A! Negligence may cause irreversible damage of the lococube®!



If you use C-Programming take care of not switching OUT1 to OUT4 higher than 100Hz (25kHz for OUT5)! Rise and fall times of the output driver IC will cause higher power-losses resulting in heat dissipation.



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

2.2.5 Connecting the CAN interface

The X1 connector of the STG-800 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 STG-800. Please add a 120R resistor at both ends (2) for CAN bus termination.

3 Programming

3.1 Programming Options

The lococube® STG-800 supports several programming options. The table below shows all supported programming environments:

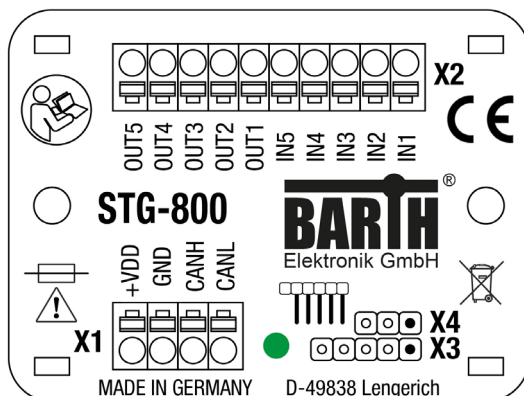
Programming	Software	Manual
Graphical	miCon-L	9022-0021
C	KEIL® µVision	9022-0020
	Arduino®	9022-0022



Please download the related Product Documentation:
<https://barth-elektronik.com/en/getstarted.html>

3.2 Programming Interface

Both X3 and X4 connectors ensure programming of the STG-800. For graphical miCon-L programming the X4 connector is reserved for application communication via the Connection Cable VK-16 (BARTH® Art. No. 0091-0016) or VK-20 (BARTH® Art. No. 0091-0020).



If you choose the Open Source Programming Option, use the X3 connector for programming and debugging via the Connection Cable VK-35 (BARTH® Art. No. 0091-0035). In this case the X4 connector can be used as TTL232 UART interface within your application.

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 pluggable spring terminal connectors, ultra-lightweight
Programming options	miCon-L Software, graphical (function block style), simulation, CAN programming and visualisation, free license Open Source, C-Programming
Interfaces	UART TTL232 (3.3V TTL level) USB (VK-16 or VK-20 required) reserved for miCon-L software communication or USB/COM CAN 2.0A/B/open®/SAE J1939 NMEA2000 (open source)

4.1.2 Power supply

Operating voltage	7 to 32 VDC
Current consumption	nominal 10 mA at 32 VDC (depending on configuration)
Fusing	5 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	2+3
Number analog	3
Analog / digital input IN1 - IN3	$U_{IN} = 0$ to 30 VDC $R_{IN} > 11$ kOhm $f_{IN} \leq 1$ kHz $t_{IN} \geq 1$ ms
Digital / counter input IN4 - IN5	$U_{IN} = 0..30$ VDC $R_{IN} > 20$ kOhm $U_{LOW} < 3$ VDC $U_{HIGH} > 5$ VDC $f_{IN} \leq 25$ kHz $t_{IN} \geq 40$ µs
Accuracy ADC IN1 - IN3	<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) $I_{OUT} \leq 1.5 \text{ A}$ (resistive load) @ $f_{OUT} = 0 \text{ to } 100 \text{ Hz}$ $U_{OUT} \geq U_{IN} - 0.45 \text{ V}$ $I_{TOT} \leq 4 \text{ A}$ (paralleling permissible) Maximal allowable load inductance for a single switch off (one output): $V_{DD} = 12 \text{ VDC}$, $I_L = 1.5 \text{ A}$, $Z_L \leq 70 \text{ mH}$ $V_{DD} = 12 \text{ VDC}$, $I_L = 1 \text{ A}$, $Z_L \leq 200 \text{ mH}$ On-state resistance V_{DD} to OUT: $R_{ON} \leq 180 \text{ mOhm}$ Turn-on time: $t_{ON} \leq 250 \mu\text{s}$ Turn-off time: $t_{OFF} \leq 270 \mu\text{s}$
PWM output OUT5	Output type: solid state (lowside) $I_{OUT} \leq 2 \text{ A}$ (resistive load) @ $f_{OUT} = \text{DC to } 25 \text{ kHz}$ $I_{OUT} \leq 1 \text{ A}$ (inductive 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® (Open Source) multi line, single line, master, slave SAE J1939 (Open Source) NMEA 2000 (Open Source) Meets or exceeds the requirements of applications ISO 11898-2, loss of ground protection from -32 V to +32 V, thermal shutdown protection
TTL232	3.3V TTL level, config: 8N1 Baud rates: 2400 to 115.2 kbit/s

4.1.6 Security features

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

Memory	Flash program memory: 256 kB SRAM: 32 kB EEPROM: 8kB, >1M write cycles
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4.1.8 Timebase (oscillator)

Primary Oscillator	Crystal quartz MEMS unit (precise ,micro-electro-mechanical system')
Nominal Frequency	16.000 MHz
Frequency tolerance	$\pm 50 \times 10^{-6}$
Frequency aging	$\pm 5 \times 10^{-6} / \text{year max.}$

4.1.9 Electrical connection

Electrical Connection	plugable spring terminal connectors 0.25 to 1.5 mm ² Manufacturer: Phoenix Contact Series: COMBICON Type: FMC1,5/x-ST-3,5-BK
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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)
Electrostatic discharge (ESD) on OUT1 to OUT5	8 kV (human body model) (MIL-STD883D)
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 $\pm 15000 \text{ V}$ IEC 61000-4-2: Powered Contact Discharge $\pm 8000 \text{ V}$

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/s ² (IEC 60068-2-27)
Vibration resistance	min. 80 m/s ² @ 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

Weight	50 g (without connectors)
Dimensions	60 x 45 x 15 mm (LxWxH)
Mounting	via two M4 screws or 3.6mm cable ties

4.1.13 MTTF and MTTFd

Calculation 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) $MTTF = \frac{1}{\sum_1^n \frac{1}{MTTF_n}}$ $MTTFd = MTTF \cdot 2$ $MTTFd = \frac{MTTF \cdot 2}{10}$ (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

	2004/108/EG 2004/108/EC 2014/30/EU
	File No. E489238 UL 61010-1, 3rd Edition, May 11, 2012, Revised April 29 2016, CAN/CSA-C22.2 No. 61010-1-12, 3rd Edition, Revision dated April 2016 File No. E489238 UL 61010-2-201 Ed.1 January 24, 2014, Revision dated February 20, 2017 CAN/CSA C22.2 No. 61010-2-201:14 Ed.1, February 2014
	CANopen® Vendor ID: 46Ah
	Cert. No. E1-10R-058717 ECE R 10, Rev. 5 (for nominal 12V automotive applications)

4.1.15 Ordering information

Ordering information Mini-PLC	mini-PLC STG-800 Art. No. 0850-0800 GTIN 4251329401207
Ordering information accessory	Connection Cable VK-16 (graphical programming) Art. No. 0091-0016 GTIN 4251329400187
	Connection Cable VK-20 (included in STA-800) Art. No. 0091-0020 GTIN 4251329401542
	Connection Cable VK-35 (Open Source programming) Art. No. 0091-0035 GTIN 4251329401276
	Programmer ST-Link/V2 ISOL (Open Source programming) Art. No. 0017-0066 GTIN 4251329401269
	Programmer PG-30 (Open Source programming) Art. No. 0017-0030 GTIN 4251329401481

4.2 Disposal

	If you wish to finally 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.
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4.3 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	lococube® mini-PLC
Type / Art. No.	STG-800 / 0850-0800
Directive CE 2004/108/EG relating to electromagnetic compatibility (EMC)	Applied norms: 2004/108/EG 2004/108/EC 2014/30/EU
RoHS Directive 2011/65EU	We hereby declare that our product is compliant to the RoHS Directive on restriction of the use of certain hazardous substances in electrical and electronic appliances.

BARTH® Elektronik GmbH
Lengerich, 17.12.2018

D. Barth

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