

**Mini-PLC STG-660 CAN  
Art. No. 0850-0660**

**MANUAL**



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## 1 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!**

## 2 DESTINATED USE

The Mini-PLC is designed for universal measuring, controlling and regulating applications. It must not be used for life critical, medical or fail safe applications.

## 3 DISCLAIMER

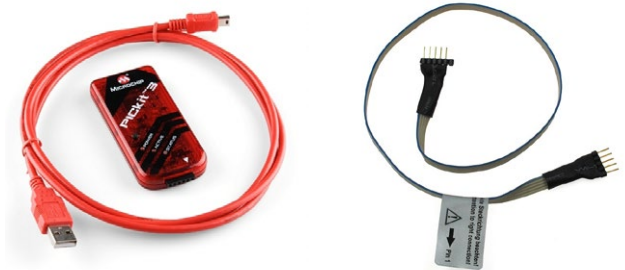
**BARTH Elektronik GmbH assumes no liability for usage and functionality of the Mini-PLC in case of disregarding this manual. The strict accordance of this manual is important since the installation methods, peripheral connections, usage and maintenance can not be controlled by BARTH Elektronik GmbH.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

## 4 PRODUCT DESCRIPTION

The picture below shows the BARTH<sup>®</sup> Mini-PLC STG-660 (Art. No. 0660-0660) including the spring terminal connector set.



This picture shows the MICROCHIP<sup>®</sup> PICkit 3 Programmer (Art. No. 0017-0045) and the BARTH<sup>®</sup> Connection Cable VK-6 (Art. No. 0091-0006).



### 4.1 Features

- Small and universal CAN Logic Controller
- Programmable with all PIC18<sup>®</sup> Compilers
- 6 analog Inputs 0..30 VDC, 12 bit ADC
- 4 digital Inputs up to 10 kHz
- 8 Power Outputs up to 1.5 A
- 1 Power PWM Output 2 A/1 to 32 kHz
- 1 CAN Interface
- Reliable Solid-State Outputs
- Fail Safe Oscillator
- Programmable Status LED
- TTL-232/USB Connection to PC
- Wide Operating Voltage Range 7..32 VDC
- Wide Operating Temp. Range -40..+60°C
- Ultraflat Housing, Height 10 mm
- Vibration resistant and rugged Sealing
- Engineered and manufactured in Germany

### 4.2 Applications

- Technical Education
- Industrial Automation
- Test Systems

### 4.3 General description

The innovative STG-660 extends the established BARTH<sup>®</sup> CAN Mini-PLC series with an outstanding Open Source hardware concept. With similar dimensions in comparison to the STG-600, the STG-660 provides hardware-oriented programming at lowest current consumption and the well-known small form factor. The CAN bus allows the user to

connect a variety of CAN or RS-485 network components to the Mini-PLC, for example: displays, stepper motors or CAN sensors.

The STG-660 does not need any peripheral components to operate. Both inputs and outputs features highly integrated and rugged protection circuits to operate the Mini-PLC in really harsh environment.

These outstanding features open up a variety of application fields in industrial, automotive and 12/24V battery-powered applications. The STG-660 is also available as customer-tailored OEM version.

#### 4.4 Delivery content

- BARTH® Mini-PLC STG-660 CAN
- Spring terminal connectors (for supply, CAN, I/O)

### 5 INSTALLATION

#### 5.1 Mounting



**The Mini-PLC 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-660 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-660 on wiring harness, tubes or other mechanical parts.

**Take care to meet the environmental conditions of the Mini-PLC.**

#### 5.2 Wiring

##### 5.2.1 Overview

The graphic below shows the connection layout of the BARTH® Mini-PLC STG-660 CAN.

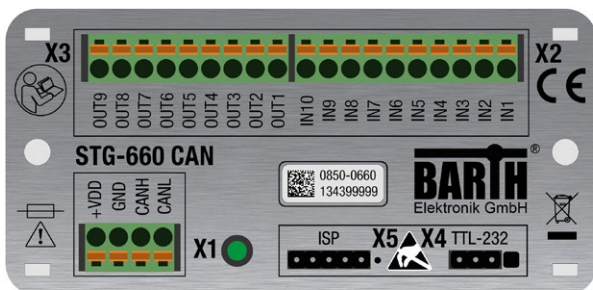
**X1 connector: supply and CAN pins**

**X2 connector: PLC inputs**

**X3 connector: PLC outputs**

**X4 connector: TTL-232/USB interface (VK-16)**

**X5 connector: MICROCHIP® ICSP® (VK-6)**



#### 5.2.2 Connecting the power supply

The STG-660 features an outstanding wide supply voltage range from 7 to 32 VDC at lowest current consumption. So the Mini-PLC 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 Mini-PLC!**

Connect the supply voltage of 7 to 32 VDC to the 4-pole terminal X1 of the STG-660. 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 1.5mm<sup>2</sup>.



**Ensure correct power supply voltage range and polarisation! External fusing of 8A max. is mandatory! Disregarding may cause irreversible damage of the PLC!**

#### 5.2.3 Connecting the inputs

You can connect sensors, switches or buttons to the inputs. The sensors may be temperature, flow, pressure, photoelectric sensors or proximity switches, for example. The STG-660 is well suitable for any sensor featuring a voltage output, 0 to 10 VDC, for example.

##### Common features of the inputs

- IN1 to IN6 are selectable analog/digital inputs
- IN7 and IN10 are pure digital inputs (up to 10kHz)
- Wide input voltage range 0 to 32VDC
- IN1 to IN6 are 0 to 10 V compatible
- Comprehensive integrated protection circuits
- Outstanding electromagnetic compatibility (EMC)
- Electrostatic discharge protection (ESD)

Due to the pull-down resistors integrated in the STG-660 any switch (NO/NC) can simply be connected between the positive supply (VDD) of the STG-660 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 Mini-PLC!**

The 10-pole connector named X2 contains the inputs of the Mini-PLC. While IN7 to IN10 are pure digital inputs, IN1 to IN6 provide both digital or analog 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.

## 5.2.4 Connecting the outputs

Depending on load type and current the STG-660 is able to drive electric loads directly without any additional driver or protection circuit. The Mini-PLC provides 8 digital solid-state highside outputs and 1 solid-state lowside switch with PWM functionality.

### Common features of outputs OUT1 to OUT8

- Rugged solid-state highside switch up to 1.5A
- Paralleling permissible up to 6A
- 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)

### Features of output OUT5

- Solid state lowside switch with PWM capability
- Sinks up to 2A
- Rugged solid-state design
- Fast demagnetization of inductive loads
- Outstanding electromagnetic compatibility (EMC)
- Electrostatic discharge protection (ESD)

The 9-pole connector X3 contains the digital outputs of the Mini-PLC. While OUT1 to OUT8 are overload-protected highside switches, OUT9 is carried out as lowside switch with PWM capability without short circuit protection. A logical HIGH will switch the Mini-PLC's supply voltage at OUT1 to OUT8, while OUT9 switches lowside (GND). Avoid a sink current exceeding 2A at OUT9 because this outputs is not protected against short-circuiting or overload current !



**The total current sourced by OUT1 to OUT8 must not exceed 6A!  
Avoid reverse voltage at any output higher than the Mini-PLC's supply voltage!  
OUT9 provides NO short circuit protection.  
Take care the sink current not exceeds 2A!  
Negligence may cause irreversible damage of the Mini-PLC!**

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

## 5.2.5 Connecting the CAN interface

The X1 connector of the STG-660 contains the CAN specific ,CANH' and ,CANL' pins.



**The voltage at CANH or CANL must not exceed -27 or +40 VDC referred to ground (GND). Higher voltages may cause irreversible damage of the Mini-PLC!**

Please refer to the appendix for detailed electrical specification of the CAN interface. There is no termination resistor integrated in the STG-660.

## 6 OPERATION AND PROGRAMMING

### 6.1 Programming software

BARTH® supplies several third party compilers to program their range of Open Source Mini-PLC's.

Please refer to

[www.barth-elektronik.de](http://www.barth-elektronik.de)  
[www.microchip.com](http://www.microchip.com)  
[www.rs-online.de](http://www.rs-online.de)

to receive further information about suitable software products. Any compiler which supports the PIC18F46K80-I/ML can be used to program the STG-660.

### 6.2 Programming templates

For free programming templates and datasheets please download the following software package:

[www.barth-elektronik.de/download/9045-0012-A.zip](http://www.barth-elektronik.de/download/9045-0012-A.zip)

This package includes:

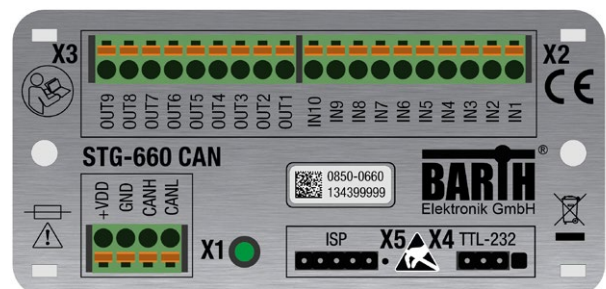
- Virtual Windows® COM port driver for USB connection
- Programming templates for BARTH® Mini-PLC
- Datasheets

### 6.3 Virtual COM port driver installation

Before you establish USB connection (X4) to a Windows® PC you have to install the USB-/COM-port driver (folder ,USBdriver') from the software download package. Please follow the instructions of the SETUP routine.

### 6.4 Connecting the Mini-PLC

In order to program or operate the STG-660, you have to establish proper power supply connection to the X1 connector first.



Programming ensures using the X5 ISP connector with the following connection (Pin 1 marked with a black dot):

Pin	Function
1	VDD +5V
2	GND
3	VPP/MCLR
4	PGC
5	PGD





**The X5 connector is ESD sensitive!  
Electrical stress may cause irreversible  
damage of the Mini-PLC!**

Please use the BARTH® VK-6 connection cable (Art. No. 0091-0006) to connect the Mini-PLC to the PICKIT 3 programmer (Art. No. 0017-0045).

For PC connection the USB connection cable VK-16 (Art. No. 0091-0016) and a PC with installed Windows® operating system are mandatory. Take care that the tappet of the 3-way VK-16 connector shows to right direction of the STG-660 (black square).



**Reversal connection only causes  
malfunction and no damage of the  
Mini-PLC.**

## 6.5 Programming

To program the STG-660 please refer to the BARTH® programming templates and the related datasheets. Microchip® provides a large knowledge base for the PIC18® microcontroller series which is used in the STG-660. Several templates and sample programs will help you to get in touch with the native and hardware-oriented microcontroller programming using your favourite compiler tool. BARTH® recommends to integrate your compiler software within the Microchip MPLABX® software which supports both programming, simulating and debugging.

Get the latest MPLABX® software and several related software tools for the STG-660 on:

[www.microchip.com](http://www.microchip.com)

## 7 APPENDIX

### 7.1 Specifications

#### 7.1.1 General

<b>Hardware design</b>	BARTH® Mini-PLC fully enclosed in proprietary PU resin, tiny and rugged housing with pluggable spring terminal connectors, ultra-lightweight
<b>Programming</b>	Open Source PLC programmable with any compiler which supports the Microchip® PIC18F46K80-I/ML
<b>Interfaces</b>	X4: TTL-232 (5V TTL level) USB (VK-16 required)  X5: Microchip® ICSP® programming interface (VK-6 required)  X1: CAN or RS-485

#### 7.1.2 Power supply

<b>Operating voltage</b>	7 to 32 VDC
<b>Current consumption</b>	nominal 15 mA at 32 VDC (depending on configuration)
<b>Fusing</b>	8 A max. (external) mandatory for voltage reversal protection
<b>Voltage reversal protection</b>	yes (combined with external fuse)
<b>ESD/TVS protection</b>	yes
<b>Heat dissipation air (at full load)</b>	normally < 2.5 W

#### 7.1.3 Inputs

<b>Number digital</b>	4+6
<b>Number analog</b>	6
<b>Digital input IN7 - IN10</b>	$U_{IN} = 0..30$ VDC $R_{IN} > 30$ kOhm $U_{LOW} \leq 2$ VDC $U_{HIGH} > 4$ VDC $f_{IN} \leq 1$ kHz $t_{IN} \geq 1$ ms
<b>Analog input IN1 - IN6</b>	$U_{IN} = 0..30$ VDC $R_{IN} > 11$ kOhm $f_{IN} \leq 100$ Hz $t_{IN} \geq 10$ ms
<b>Accuracy ADC IN1 - IN6</b>	$\pm 2\%$ (0.25 VDC)
<b>ADC resolution (internal)</b>	12 Bit
<b>Potential isolation</b>	no (common GND)
<b>ESD/TVS protection</b>	yes
<b>Permissible cable length (per input)</b>	normally 40 m

### 7.1.4 Outputs

<b>Number digital</b>	8+1
<b>Number PWM</b>	1
<b>Output OUT1 - OUT8</b>	Output type: solid state (highside)  $I_{OUT} \leq 1.5 \text{ A}$ (resistive load) @ $f_{OUT} = 0 \text{ to } 200 \text{ Hz}$ $U_{OUT} \geq U_{IN} - 0,45 \text{ V}$  $I_{TOT} \leq 6 \text{ A}$ (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: $t_{OFF} \leq 270 \mu\text{s}$
<b>PWM output OUT9</b>	Output type: solid state (lowside)  $I_{OUT} \leq 2 \text{ A}$ (resistive load) @ $f_{OUT} = 1 \text{ kHz to } 32 \text{ kHz}$ $I_{OUT} \leq 1 \text{ A}$ (resistive load)
<b>Potential isolation</b>	no

### 7.1.5 CAN interface

<b>CAN</b>	Type: CAN / RS-485 (no termination resistor inside) Meets or exceeds the requirements of applications ISO 11898-2, loss of ground protection from -27 V to 40 V, thermal shutdown protection
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### 7.1.6 Security features

<b>Security Features</b>	Watchdog (WD) Fail safe oscillator 16 MHz (FSO) Brown out detection (BOD) Power up timer (PUT) (depending on configuration)
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### 7.1.7 Program and data memory

<b>Flash program memory</b>	64 k cell endurance: 10.000 min characteristic retention: 40 yrs
<b>EEPROM data memory</b>	1024 byte byte endurance 100.000 min. characteristic retention: 40 yrs

### 7.1.8 Timebase (oscillator)

<b>Primary Oscillator</b>	Crystal quartz MEMS unit (precise ,micro-electro-mechanical system')
<b>Nominal Frequency</b>	16.000 MHz
<b>Frequency tolerance</b>	$\pm 50 \times 10^{-6}$
<b>Frequency aging</b>	$\pm 5 \times 10^{-6} / \text{year max.}$
<b>Second Fail Safe Oscillator</b>	16 MHz

### 7.1.9 Electrical connection

<b>Electrical Connection</b>	plugable spring terminal connectors 0.25 to 1.5 mm <sup>2</sup>  Manufacturer: Phoenix Contact Series: COMBICON Type: FMC1,5/x-ST-3,5
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### 7.1.10 Electromagnetic compatibility (EMC)

<b>Electrostatic discharge (ESD) on IN1 to IN10</b>	20 kV air discharge 30 kV contact discharge (IEC/EN 61 000-4-2, level 3)
<b>Electrostatic discharge (ESD) on OUT1 to OUT9</b>	8 kV (human body model) (MIL-STD883D)
<b>Electrostatic discharge (ESD) on CAN pins</b>	ESD Protection up to $\pm 12 \text{ kV}$ (Human-Body Model)
<b>Electromagnetic fields</b>	Field strength 10 V/m (IEC/EN 61000-4-3)

### 7.1.11 Environmental conditions

<b>Operation temperature</b>	-40..+60 °C (IEC 60068-2-1/2)
<b>Storage temperature</b>	-40..+70 °C (IEC 60068-2-1/2)
<b>Relative humidity</b>	5 to 95% non-condensing (IEC 60068-2-30)
<b>Air pressure (in operation)</b>	500 to 1500 hPa
<b>Shock resistance</b>	min. 100 m/s <sup>2</sup> (IEC 60068-2-27)
<b>Vibration resistance</b>	min. 50 m/s <sup>2</sup> @ 10..150 Hz (IEC 60068-2-6)
<b>Degree of protection</b>	IP 20, limited by connectors (EN 50178, IEC 60529)
<b>Drop</b>	Drop height: 500mm (IEC 60068-2-31)
<b>Free fall (packaged)</b>	1500 mm (IEC 60068-2-32)

### 7.1.12 Weight and dimensions

<b>Weight</b>	80 g (without connectors)
<b>Dimensions</b>	93 x 45 x 15 mm (LxWxH) Height housing: 10 mm
<b>Mounting</b>	via two M4 screws or 3.6mm cable ties

### 7.1.13 Ordering information

<b>Ordering information Mini-PLC</b>	Mini-PLC STG-660 Art. No. 0850-0660
<b>Ordering information accessory</b>	ISP connection cable VK-6 Art. No. 0091-0006
	USB connection cable VK-16 Art. No. 0091-0016
	PICkit 3 programmer Art. No. 0017-0045

### 7.2 Documents, videos and software

Detailed information, additional documents, application notes and videos relating to this product are downloadable from [www.barth-elektronik.de](http://www.barth-elektronik.de)


### 7.3 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.**

### 7.4 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.

<b>Description</b>	Mini-PLC
<b>Type</b>	STG-660
<b>Art. No.</b>	0850-0660
<b>Directive 2004/108/EG relating to electromagnetic compatibility (EMC)</b>  	Applied norms: EN55022:2006+A1:2007 EN55024:1998+A1:2001 +A2:2003 EN61000-3-2:2006 +A1:2009+A2:2009 EN61000-3-3:2008 EN61000-6-2:2005
<b>RoHS Directive 2011/65EU</b>	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, 17.09.2015

*D. Barth*

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