

## PROGRAMMING MANUAL

# KEIL<sup>®</sup> C Programming for BARTH<sup>®</sup> lococube<sup>®</sup>

# **PROGRAMMING MANUAL**

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## 1 Introduction

The BARTH® lococube® STG-8xx features an Open Source Hardware Design allowing full access to the CPU's memory and peripherals.

The powerful KEIL® µVision® Software Suite is the tool of choice for everyone who is familar with C-Programming. KEIL® opens up a variety of hardware-oriented features in a realtime environment with powerful debugging features to guarant shortest time-to-market with your lococube® project.

## 1.1 Supported models

lococube® Model	Programmer Connection Cable
STG-800	ST-Link/V2 (Art. No. 0017-0066)
STG-810	VK-35 (Art. No. 0091-0035)
STG-820	or: PG-30 (Art. No. 0017-0030)
STG-850	
STG-860	

## 2 Software download



Please note that an once Open Source programmed lococube® can not be graphical programmed afterwards! The miCon-L runtime will be overwritten and has to be factory-reinstalled!

In the first step please download the KEIL®  $\mu Vision \ensuremath{\mathbb{R}}$  by Software Suite from:

http://www2.keil.com/stmicroelectronics-stm32/mdk



All product-related software packages are available from: <u>https://www.barth-elektronik.com/en/</u> download.html

The packages includes free and ready-to-use sample programming templates. Each template refers to the specific hardware design and contains all required port connections. To create your own project simply modify or extend one of the following programming templates. Please login or register for free Downloadcenter access.

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## 3 Installation

Now first install the KEIL® µVision® Software Suite:

MDK for STM32L0 and ST × +							-		×
♦ ● ①   www2.keil.com/stmicroelectronics-stm32/mdk/	C C	Q, Suchen	☆	Ó	÷	ŵ	ø	◙	≡
Home / MDK Version 5 / STMicroelectronics / Installation & Activation								.earn	ing
MDK for STM32L0 and STM32 Installation & Activation	2F0						ji p	Platfo	orm
MDK for STM32F0 and STM32L0 provides software developers working with STM32 devices with a free-to-use professional tool suite. Kell MDK is the most comprehensive software development system for ARM processor-based microcontroller applications.					Quic!	k Lin	ks tronic	:5	
Based on MDK Version 5, the MDK for STM32F0 and STM32I the CMSIS-RTOS RTX Kernel, and the µVision IDE/Debugger. T STM32 CubeMX and the resulting project exported to MDK.	Based on MDK Version 5, the MDK for STM32F0 and STM32L0 edition includes the ARM C/C++ Compiler, the CMSIS-RTOS RTX Kernel, and the µ//sion IDE/Debugger. The STM32 peripherals can be configured using STM32 CubeNX and the resulting project exported to MDK.				NDK V Device Evalua	n 5 Board	s		
Download MDK Core				• 5	Softwa	ire Pa	cks		
Product Serial Number (PSN)									
To activate the MDK for STM32F0 and STM32L0 Edition, use the MDK, please refer to the Activation guide below.	e following Proc	duct Serial Number (PSN). F	or m	ore de	etails o	on hov	w to a	ctivate	•
U1E21-CM9GY-L3G4L									

#### Please follow the software setup instructions.

ARM Version 5.22 Evaluati × +								-		×
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Product Information	Home / Product Downloads									
ARM Development Tools C166 Development Tools C51 Development Tools C251 Development Tools Debug Adapters	ARM Microcontroller Development Kit Version 5 22 The Keil ARM Evaluation Kit allow • Review the hardware require	rs you t ments	o create programs for Al	RM7, AR	V19, Ci	ortex-P	V and	1 MCU	device	is.
Evaluation Boards Product Brochures Newsletters	Note the limitations of the eva MDK5 Overview and Introduc MDK5 Installation instruction:	Note the imitations of the evaluation tools     MOKS Overview and Introduction     MDKS Overview and Introduction								
Device Database® Device List	(MD5:74d87b53d2fe03c65dfb80d	2d0b3	c5f8)							
Compliance Testing ISO/ANSI Compliance Validation and Verification	To install the ARM Softw Right-click on MDK522.EXE PDF files may be opened with ZIP files may be opened with	are and sa h Acrot PKZIP	ve it to your computer. bat Reader. or WINZIP.							
Distributors Overview			MDK522.EXE (696,2 Friday, November 11, 201	82K) 16						

After successful software installation the Pack Installer will be lauched:

Pack Installer	×
Welcome to the Keil Pack Installer Pack Installer is a utility for managing Software Packs on the local computer and provides the following windows:	
<b>Devices</b> : List supported devices. Select a device to show related Packs and examples.	
Boards : List supported boards. Select a board to show related Packs and examples.	
Packs : List and manage Software Packs. Install a Pack for access within µVision.	
Examples : List example projects. Copy projects and launch µVision for testing examples.	
Pack Installer connects to <u>www.keii.com/pack</u> to obtain the published Software Packs. To install a local Software Pack use <b>File - Import</b> from the menu.	
✓ Show this dialog at startup OK Help	



### Please search for the ,STM32F091CC' device.

Pack Installer - C:\Keil_v5\ARM\PACK									
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🖾 ST	ARM Cortex-M0, 48 MHz, 32 kB RAM, 256 kB ROM								

#### Select the device-specific packages to be installed.

		~
Packs Examples		<u>4</u>
Pack	Action	Description
- Device Specific	2 Packs	STM32F091CC selected
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····· Keil::STM32NUCLEO_B	🔅 Install	STMicroelectronics Nucleo Boa
Generic	16 Packs	
	🚸 Up to date	CMSIS (Cortex Microcontroller
ARM::CMSIS-Driver_Va	🚸 Install	CMSIS-Driver Validation
ARM::CMSIS-RTOS_Val	🔅 Install	CMSIS-RTOS Validation
	🔅 Install	ARM mbed Client for Cortex-M
	🔅 Install	ARM mbed Cryptographic and
ARM::minar	🚸 Install	mbed OS Scheduler for Cortex-

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Image: Packs	Examples		Þ
Pack		Action	Description
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Now please open the ,License Management' to enable your free KEIL®  $\mu Vision \circledast$  Software Suite.



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#### Add your personal Product Serial Number.

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Product MDK-ARM (	Cortex-M0/M0+ 256K for ST	License ID Code (LIC)/Product variant T0D58-39GY2-ZMSRR-YXCNK-WVZY	4-PS1SI	Support Period Expires: Feb 2018	

To program and debug the lococube® the ST-Link/V2 Programmer (BARTH<sup>®</sup> Art. No. 0017-0066) and Connection Cable VK-35 (BARTH<sup>®</sup> Art. No. 0091-0035) are required.

Please download the ,ST-LINK/V2' driver from

## http://www.st.com

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Now open a sample project in the KEIL®  $\mu\text{Vision} \circledast$  Software Suite.

## 🐺 μVision

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Open the ,options' menu and select ,ST-Link Debugger' as your favourite programmer/debugger tool.

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Please ensure the following programmer settings.

Erase Full Chip     Crase Full Chip     Crase Sectors     C Do not Erase	<ul> <li>✓ Program</li> <li>✓ Verify</li> <li>✓ Reset and R</li> </ul>	RAM for A Start: 0	20000000 Size: 0x0800
Description STM32F0xx 256kB Flash	Device Size 256k	Device Type On-chip Flash	Address Range 08000000H - 0803FFFFH
		Start:	Size:



#### Now build and download a sample project.

😨 C:\Users\ja-mb\Documents\STG-800\STG-800\MDK	🔣 C:\Users\ja-mb\Documents\STG-800\STG-800\MDK-ARM\BC
File Edit View Project Flash Debug Periphe	File Edit View Project Flash Debug Peripherals Too
□ 22 24 4 10 2	B # B B B X B B K P C ← → P C
🧼 🎬 🏙 🧼 🚟   🙀   BGE-136	🧇 🏥 🕮 🥔 🗮 🗰 BGE-136 🔍 🕺
Project  Rebuild Rebuild all target files	Project Download (F8) Project: BGE-136 Download code to flash memory

After successful download you will be able to debug the project.

🗑 C:\Users\ja-mb\Documents\STG-800\STG-800\MDK-ARM\BGE-136.uvprojx - µVision					
file fdit View Project Flash Debug Peripher	erals Jools SVCS Window Help				
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Registers 🕫 🖬	Disassembly				
Register Value	186: u16_mV =	ReadAnalogInput (ADC	IN3);		
8-Core	1871 7				
R0 0x0000000	199: // Pead digital	Input			
R1 0x0000000	1901 (	input			
R2 0x0000100	191: GPIO Pin	State PinState;			
R3 0000000	Ox08003ECE 2003 MOVS r0, #0x03				
P5 0x4102000	<				
R6 0x0000000	main.c startup_stm32f091xc.s				
R7 0x00001000	181 // Read ADC Value from Input	terminal [0 30800	mW1		
R8 DxFFFFFFF	182 - (				
R9 D/FFFFFFF	183 uint16 t u16 mV:				
R10 DAFFFFFFF	184 u16 mV = ReadAnalogInput (A	DC IN1);			
R11 00FFFFFFF	185 u16 mV = ReadAnalogInput(A	DC IN2);			
013 (02) 0.0000000	186 u16 mV = ReadAnalogInput (A	DC IN3);			
P14 ( P) 0x000000	187 }				
P15 (PC) 0-05005CCE	188 -				
P VPSR 0v4100000	189 // Read digital Input				
* Banked	190 - (				
* System	191 GPIO_PinState PinState;				
8- Internal	192 PinState = MAL_GPIO_ReadPi	n (DIN5_Port, DIN4_P1	n) ;		
Mode Thread	193 PinState = MAL_GPIO_ReadPi	n (DIN4_Port, DIN5_Pi	n);		
Stack MSP	199 2				
	195 - // Tan Chil marine bandling				
195 // FOT GAN FECIVE handling, see sample code in MAL_CAN_RXCpltCallback					
Project Registers	<				
Command	0 🖬	Watch 1			
*** Currently used: 16484 Bytes (6%)	^	Name	Value	Type	
200 A 1916 #1 0+03		🔷 u16_mV	Knot in scope>	unsigned short	
WD 1, UID HY, OKOK		H 🔧 ußData	0x2000021C u8Datal1 **	unsigned char[16]	
WS 1, 'uwTick	v	wTick	0x00004934	unsigned int	

To read online values you have to set the optimization level down to ,0' in the ,C/C++ options menu'.

101 // ACAG ADO VALAC LION IN	-
Options for Target 'BGE-136'	
Device   Target   Output   Listing   User C/C++   Asm	
Preprocessor Symbols	_
Define: USE_HAL_DRIVER.STM32F091xC	
Undefine:	
Language / Code Generation	
Execute-only Code Stric	t /
Optimization: Level 3 (-03) - Enu	m (
✓ Optimize f <default>     □ Plair</default>	n C
Split Load Level 1 (-01)     Rea	d-(
One ELF Level 2 (-02) Rea	d-)
Paths/Inc;/Drivers/STM32F0xx	J.

# MANUAL

PROGRAMMING

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Date:	21.02.2019
Revision:	А

## 4 First steps

The product-related BARTH® software packages include numerous free and ready-to-use sample programming templates. Each template refers to the lococube's® hardware design and contains all required port connections. To create your own project simply modify or extend one of the following programming templates. Choose and open your favourite sample programming template project in the KEIL® µVision® Software.

## 4.1 Hardware setup



For electrical connection of your lococube® please refer to the product-related manual.

The picture below shows the typical hardware setup.

- lococube® mini-PLC
- Power Supply Connection (7 to 32VDC)
- Programmer ST-Link/V2
- USB Cable
- Connection Cable VK-35





## 4.2 Software setup

CO- 📕 • DEDOCS •	9045 • 9045-0014-A • STG-800 • S	FG-800-TwoLevelController • MDK-AR	м •	- 🗂	MDK-ARM durchsuchen	
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Open the ,main.c' from the sample project.



#### Rebulid the project.



Wait... and have a look at the Output Window during the Rebuild.



## PROGRAMMING MANUAL

#### Now start your Debug Session...

T2:\DBDOCS\9045\9045-0014-A\STG-800\STG-800\TwoLeveKontroller\MDK-ARH\STG-800.uvprojx - µVision				
File Edit View Project F	lash Debug Peripherals	Tools SVCS Window Help		
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Project	0 × 🔬 main	Enter or leave a debug session		
E 🌱 Project: STG-800	31			
🗄 🔬 STG-800	32	*/		
Application/User	33	/* Includes		
stm32f0xx it.c	35	<pre>#include "stm32f0xx hal.h"</pre>		
⊞ nain.c	36	<pre>#include "main_hal.h"</pre>		
🕀 📄 main_hal.c	37	/t Drivara variablas		
Drivers/STM32F0xo	HAL_Driver 39	CanTxMsgTypeDef CAN_TX_Msg;		
Drivers/CMSIS	40	CanRxMsgTypeDef CAN RX Msg;		
Application/mbk-	41 42	10 uinti6_t ui6Timer = 0;		
· chois	43	/* Private function prototypes		
	44			
	95	t Shrief SYSTICK callback		
	47	* Bretval None		
	48	*/		
	19 50 F	void HAL_SYSTICK_Callback(void)		
	51	// Decrement ul6Timer every 1 ms down to 0		
	52	<pre>if (ul6Timer &gt; 0 )</pre>		
	53	ul6Timer;		
	55			
l.				
2:\DBDOC5\9045\	9045-0014-A\SIG-	800\STG-800-TwoLevelController\MDK-ARM\STG-800.uvprojx - µVision		
File Edit View F	roject Flash Deb	ug Peripherals Tools SVCS Window Help		
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Registers	<b>Q</b> :	× Disassembly		
Desister	Mahar	0x0800489A 0000 MOV5 r0.r0		
Register	value	62: MainTnit():		
Core		63: // LED On		
R0	0x0800489D	Novosoo489C E7EEEEO BI W MainInit (ovosoo3880)		
R1	0x20000660	64: WAL GRIO WriteBin/LED GRIO Bort LE		
R2	0x0000000	64. INAL_GPIO_WIICEFIN(LED_GPIO_FOIC, LE		
R3	0x0800488D			
R4	0x08004938			
R5	0x00000001			
R6	0x08004938	main.c startup_stm32f091xc.s		
	0xFFFFFFFF	51 // Decrement ulfTimer every 1 me down to		
	<b>OxFFFFFFFF</b>	52 if ( ulfTimer > 0 )		
	0xFFFFFFFF	52 II (UIOIIMEI > 0 )		
- R10	0xFFFFFFFF	55 UIGIIMEI;		
	0xFFFFFFFF	24 7		
	OVEEEEEEE	55		
	0x20000660	56 -		
	ana 0000000			

... or download (F8) your application instead of debugging.



Now you are at the point to create your own programs. Have fun with your lococube®!