

SIQORE DIGITAL KEY DEMO KIT User Guide



Introduction

SIQORE's Digital Key Evaluation Kit is designed for demonstrating the application concept of Ultra-Wideband (UWB) and Bluetooth Low Energy (BLE) based on Car Connectivity Consortium (CCC) 3.0 specifications. It includes a UWB module (SMK100), a BLE module (SSL100), and a CAN BUS module (TD3USPCAN).

This evaluation kit provides a practical concept of the CCC Digital Key from the UWB and BLE wireless application perspective. Please contact us so we can further introduce our solution and help to accelerate the development of your next Digital Key.



Revision History				
Revision	Date	Description	Author	
V1	2023/6/27	Initial version	Yuri	
V1.1	2023/7/17	Corrected the name of pins in 2.2.2 MK8000 Firmware Programming and Debugging Setup section.	Yuri, Evie	



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1. Recognizing Demo Board

The following is the connection diagram of the whole set of equipment using CAN bus.



It is composed of a Digital Key (tag), a central and five anchors. The following introduces each device.



Top view of SIQORE Digital Key Demo Kit v1.





Digital Key (tag) top view.



Digital Key (tag) bottom view.



1.1.1 Description of Digital Key (tag)

Digital Key

Digital Key - jumper setting



Jumper setting of the Digital Key (tag).



It is location of reset button, LED, and the battery on the demo kit.

When the jumper setting is in Digital Key (Key-fob), there is 1 reset button (J13) and 1 red LED (D1) indicating connection status. Users can reset key-fob board by pressing button J13 after plugging in battery (J13 only resets the SSL100 without resetting the CAN or MK8000 module). Key-fob can connect with vehicle central when BLE RSSI > -65dBm and disconnect when UWB range > 10m. Red LED (D1) will be turned on when the key-fob is connected to the vehicle.



1.2. Vehicle Central





Vehicle Central top view.

Vehicle Central bottom view.



1.2.1 Description of Vehicle Central

Vehicle Central - jumper setting Please add jumper on: J9, J5, J20.



Jumper setting of the Vehicle Central.

The following is the location of the reset button, LEDs, and battery on the demo kit.



Reset



When the jumper setting is in Central, there is 1 reset button (J13) and 3 LEDs to indicate different statuses. Users can reset the vehicle board by pressing button J13 after plugging in the battery (J13 only resets the SSL100 without resetting the CAN or MK8000 module). Key-fob can connect with vehicle central when BLE RSSI > -65dBm and disconnect when UWB range > 10m. When the central connects to the key-fob and the distance in between is within the setting range, the corresponding LED will be turned on. Different LEDs also represent different statuses of the vehicle.

The default settings are as follows:

- Red LED (D1): vehicle welcome light, turns on between 0.5m to 5m range.
- Yellow LED (D2): unlock the vehicle door and turn on between 0.5m to 3m range.
- Green LED (D3): allows vehicle engine to start and turns on when the range is less than 0.5m.

Users can change the distance to connect or disconnect BLE and UWB, as well as the corresponding LEDs.

The following picture shows that the red LED (D1) of the key-fob turns on when it is connected to the vehicle. At the vehicle side, the green LED (D3) turns on because the distance between the key-fob and the vehicle is less than 0.5m.









Vehicle Anchor top view.

Vehicle Anchor bottom view.



1.3.1. Description of Vehicle Anchor

Vehicle Anchor - jumper setting Please add jumper on: J1, J4, J20.





2. Programing and Debugging

(If the MK8000 and SSL100 have been programmed, this step can be ignored)

2.1. Firmware Programing

Firmware programming involves two modules: SSL100 and MK8000. The generation of MK8000 firmware depends on the MK8000 SDK. For details, please refer to the MK8000 SDK.

2.2. Debugging

User can check the debug log of SSL100 and MK8000 by connect cable to their debug port.

2.2.1. SSL100 Firmware Programming and Debugging Setup

For SSL100 programming and debugging, please connect a STK/WSTK debug adapter to Silicon Lab's development mainboard. Then, please use an IDC 10 pin female-female cable to connect between debug adapter's "MINI" port and J2 of CCC Demo Kit. Users need to configure mainboard debugging to "OUT" option. Users can reset SSL100 by pressing button J13 after powering on (J13 only resets the SSL100 without resetting the CAN or MK8000 module).

Details are shown in the picture below:







To program SSL100, user can follow the steps below:

- 1. Plug in Silab Mainboard connected with device to be programmed.
- 2. Start Simplicity Studio.
- 3. Verify JLink is detected and click "Start" button (as red frame below).

Solution v5_workspace - Simplicity Studio™	
File Edit Navigate Search Project Run Window Help	
♠ Welcome 🕑 Recent 🏢 Tools 📩 Install 🍁 Preferences	🗄 🛱 🖌 🞜 Launcher 📢
Image: Debug Adapters Solution X X X Y Image: Debug Adapters Solution Y Image: Debug Adapters Image: Debug Adapters	Welcome to Simplicity Studio Everything you need to develop, research, and configure devices for IoT applications.
	Get Started Select a connected device or search for a product by name to see available documentation, example proj
	Connected Devices All Products Connected Devices J-Link Silicon Labs (440264045) (ID: 000440264045) Start
🗅 My Products 🛛 🗳 🕈 🕷 🖻 🗉 🗖	
Enter product name	
→ My Products 1 → BG22 Explorer Kit (BG22-EK4108A)	Recent Projects

4. Click compatible tools tab.

J-Link Silicon Labs (440264045) (ID: 000440264045)

OVERVIEW EXAMPLE PROJECTS & DEMOS DOCU	JMENTATION	COMPATIBLE TOOLS			
				Create New	Project
General Information	Board			Target Part	
Connected Via:				SILICON LABS	
Debug Mode: External Device (OUT) Change				and the second s	
Adapter FW: 0v8p7b171 No FW dir specified	View Docur	rd		EFR32BG22C112F352GM32	
Secure FW: Unknown Read FW Version	Debug Interfa	ice:	,	view bocuments	/
Preferred SDK:	SWD -	Detect Target Part			
Gecko SDK Suite v4.3.0 Manage SDKs 👻					



5. Click "Launch" button under Simplicity Commander.

J-Link Silicon Labs (440264045) (ID: 000440264045)

OVERVIEW EXAMPLE PROJECTS & DEMOS DOCUMER		TIBLE TOOLS	
Device Console Development kit serial and admin command-line console utility	LAUNCH	Network Analyzer Wireless packet capture and analysis tools	LAUNCH
Application Builder Embedded software framework application builder for Zigbee and Gecko Bootloader	LAUNCH	AoA Analyzer Graphical tool for analyzing Angle of Arrival calculation in a Bluetooth Direction Finding setup	LAUNCH
• Positioning Tool Interactive tool for AoA Locator boards	LAUNCH	Bluetooth NCP Commander Interactive tool for sending BGAPI commands to a Bluetooth device	LAUNCH
Wigrate Projects Migrate projects from version 4 workspace to version 5 workspace	LAUNCH	Graphical and command-line utility to manage flash and security of EFM and EFR devices in development and production environments	LAUNCH

- 6. Select debug interface to Silab Mainboard. Change device to EFR32BG22CxxxF352.
- 7. Click "Device Info" tab.

💅 Simplicity Com	mander		_	
440264045 V De	bug Interface SWD $$	✓ Device EFR32BG22C	XXXF352	Reload Tab
Kit	Update Kit Installation package			Browse Install Package
Device Info Flash	Kit Information Kit: Firmware version: JLink serial number: VCOM port: Nickname: Debug Mode:	Wireless Pro Kit 0v8p7b171 440264045 COM19	Network Information IP Address: Gateway: DNS Server: MAC Address:	0.0.0.0/0 0.0.0.0 0.0.0.0 Edit
Console	Board Information Wireless Pro Kit Mainboard		BRD4002A Rev. A06 -	S/N: 220500913
.og Window 3:55:16.510 WARNING	:: Can not look up target device automatic	cally because adapter is in	n debug mode OUT.	



- 8. If device is properly detected, under MCU Information data will show up.
- 9. Click "Flash" tab.



- 10. Select hex file to program.
- 11. Click "Flash" button. Wait until programming is complete.

440264045 > Debug Interface[SWD 10000 kHz > Device [FR32BG22CcocF352] Reload Ta Flash MCU Binary File Hicle_canbus_multi/GNU ARM v10.2.1 - Default/bt_soc_ccc_vehicle_canbus_multi.hex Browse Kit Flash start address: 00000000 \$ Reset MCU after flashing \$ Verify upload Flash Device Info Flash Erase/Write Protection Write protect flash range 00000000 \$ > > 00000000 \$ Protect Blank Check Remove Protection Erase chip Debug Lock Tools The unlock function only works using Silicon Labs kits. Unlock debug access Lock debug access Lock debug access Console Console Recover bricked device Unlock debug access Lock debug access	💅 Simplicity Comm <u>F</u> ile <u>H</u> elp	ander		- 0	×
Flash MCU Kit Flash start address: Device Info Flash Flash Flash Flash Eise Flash	440264045 V Debu	g Interface SWD 🛛 🗸 10000 kHz 🗠 Device EFR32BG22Cxxx	F352	Relo	ad Tal
	Kit Evice Info Flash Console	Flash MCU Binary File hicle_canbus_multi/GNU ARM v10.2.1 - Default/bt_soc_ccc_vehic Flash start address: 00000000 ♀ Reset MCU after flashin Flash start address: 00000000 ♀ Lock Main Flash Lock Main Flash Debug Lock Tools The unlock function only works using Silicon Labs kits. Unlocking the chip will erase all data on flash and SRAM. Recover bricked device Unlocking the chip will erase all data on flash and SRAM.	cle_canbus_multi.H ng ✓ Verify uplo 0 ÷ Jser Page e Protection	ex Browse ad Flash Protect Erase chip	ess



On PC side, the baud rate of COMPORT for debug log serial port is 115200. User can use terminal programs such as Putty or TeraTerm to read the debug log outputs from SSL100. Once key-fob and vehicle central are connected, users can see distance measurements between key-fob and vehicle in the debug log. Please note that this debug log may change for different firmware version, but main data should still be the same.

The output results of sample distance are shown below:

[I] drv ucan read: 0 [I] CANID 1 - Distance: 85 cm [I] CANID 1 - AVG Distance: 82 cm [I] CANID 2 - AVG Distance: 0 cm [I] drv ucan read: 0 [I] CANID 1 - Distance: 62 cm [I] CANID 1 - AVG Distance: 75 cm [I] CANID 2 - AVG Distance: 0 cm [I] drv ucan read: 0 [I] CANID 2 - Distance: 43 cm [I] CANID 1 - AVG Distance: 75 cm [I] CANID 2 - AVG Distance: 43 cm [I] drv ucan read: 0 [I] CANID 2 - Distance: 6 cm [I] CANID 1 - AVG Distance: 75 cm [I] CANID 2 - AVG Distance: 24 cm [I] drv ucan read: 0 [I] CANID 2 - Distance: 83 cm [I] CANID 1 - AVG Distance: 75 cm [I] CANID 2 - AVG Distance: 44 cm [I] drv ucan read: 0 [I] CANID 2 - Distance: 75 cm [I] CANID 1 - AVG Distance: 75 cm [I] CANID 2 - AVG Distance: 54 cm [I] drv gpio write GPIO Write [I] Light ON [I] drv_gpio write GPIO Write [] Door UNLOCKED





2.2.2 MK8000 Firmware Programming and Debugging Setup

For MK8000 programming, please use a USB to UART cable and connect Power and Ground at jumper pin J19 (the upper jumper pin close to "J19" is GND), Tx, and Rx at jumper pin J1 (Connect MRx of J1 jumper pin to USB Tx, contact MTx to USB Rx). See the following photo for more details.



Users can reset MK8000 by pressing button J12 after plugging in the battery (J12 only resets the MK8000 without resetting the CAN or SSL100 module). When the cable setup is correct, user can start to program MK8000 module. Please refer to MK8000_EVB_Quick_Start_Guide" for more information.



For MK8000 debugging, please use a USB to UART cable to connect Ground and debug output at jumper pin J21 of CCC Demo Kit (Debug output is the upper pin). Please make sure the battery is plugged in.



After connecting USB to PC, check the COM port and open the debug tool such as Putty or TeraTerm. The baud rate of the serial port is 921600. Sample debug log is shown as follows:

B COM33 - PuTTY	_
60 [APP][INFO]Hello from MKSEMI! 180 [APP][INFO]Build information	
Vendor · MKSEMT	
Chip : MK8000	
Date : Apr 26 2023	
Vers	ion : V0.4.0
450 [DRV][INF0]]edec id C86513	
2100 [DRV] [INFO] load cap : 00000050	
2250 [APP] [INFO] WDT close	
4020 [MAC] [INFO] 2080000 - Exchange Table	
4230 [MAC] [INFO] 2080018 - Control Structure	
4410 [MAC][INFO]20800A8 - Link Descriptor	
4590 [MAC] [INFO] 20800D0 - RX Descriptor	
4800 [MAC][INFO]20801C0 - TX Descriptor	
4980 [MAC][INFO]20801F0 - RX Buffer	
5160 [MAC][INF0]2080DF0 - TX Buffer	
5370 [DRV] [INFO]uwb open	
5490 [APP][INFO]Ranging lib version: 0.8.2.0	
5640 [APP][INFO]AoA lib version: 0.7.7.1	



3. CAN BUS Connection 3.1 CAN BUS Networking Mode

The CAN BUS network connection is shown as follows:



CANL of all CAN devices are all connected together, and CANH of all CAN devices are connected together. There is a 120 OHM resistor on each board already, so no external resistor is required. Users can reset CAN bus by pressing button J11 after plugging in the battery (J11 only resets the CAN BUS without resetting MK8000 or SSL100 module).



3.2. CAN bus connector



Vehicle Central connection diagram. User can connect Vehicle Central and Anchor through J17.



1 Vehicle Central and 2 Vehicle Anchor connection example.



4. Power On Order 4.1. Power on procedure of Digital Key

Start Vehicle (Anchor) Power on Vehicle (Central) Power on Vehicle (Central) Reset Check devices, troubleshoot and Key-fob shut down all devices. Power on 3 LEDs light up No and turn off at the same time Yes Red light of No Key-fob light on Yes End

- 1. Power on all vehicle anchors.
- 2. Power on vehicle central.
- 3. Reset vehicle central.
- 4. Power on key-fob.
- 5. Verify if device is working. If user see that all LEDs light up at the same time then turn off, this means that system is ready. If the LEDs light up but did not turn off, this means that there is something wrong with the system.
- Once key-fob is sufficiently close to vehicle central, its red LED will light up. This means that both are connected via BLE and UWB ranging should be starting.

Digital Key



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