



PORSCHE

## BBridge Requirements

**Porsche Engineering**  
driving technologies

Version: 1.1

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29.03.2016	1.0	Complete	Ulf Schlieben
06.04.2016	1.1	Review , Freigabe PES	J. Duerr / U. Schlieben

## Distribution

Name/Role	Company
Peter Willimowski	Bombardier PRIMOVE GmbH

## Table of contents

<b>1</b>	<b>Introduction .....</b>	<b>4</b>
1.1	Definitions, Acronyms and Abbreviations.....	4
1.1	Boundary Conditions, .....	4
1.2	Customer, Contractor .....	4
1.3	Contact Persons.....	5
1.4	Document Approval .....	5
<b>2</b>	<b>Scope of Supply and Services, Development Content, Conditions .....</b>	<b>6</b>
2.1	Scope of Supply and Services .....	6
2.2	Development Content.....	6
2.3	Conditions.....	6
2.3.1	Hardware .....	6
2.3.1.1	SPI – Interface .....	7
2.3.2	Software .....	7
2.3.3	Debug and Programming the Device .....	7
2.3.4	Specification from Customer.....	7
<b>3</b>	<b>BBridge Software .....</b>	<b>8</b>
3.1	Description .....	8
3.2	Application .....	8
3.2.1	Connection .....	8
3.2.2	Validation.....	9
3.2.3	Wakeup .....	9
3.2.4	Data Storage Parameter.....	9
3.2.5	Send/Recive Data over Bluetooth .....	9
3.3	Operating Modes .....	9
3.3.1	IDLE Mode.....	9
3.3.2	SCANNER Mode.....	9
3.3.3	CONNECTABLE Mode.....	10
3.4	Native Driver .....	10
3.4.1	SPI Native Driver .....	10
3.5	Software Abstraction Layer .....	10
3.6	TI - Bluetooth Stack.....	10
3.7	TI - OSAL.....	10
<b>4</b>	<b>Completion .....</b>	<b>11</b>
4.1	Support of first time operation.....	11
4.2	Testing and Documentation .....	11

## 1 Introduction

The BBridge Software implements and encapsulates the network management functionality that is necessary for running a Bluetooth LE network. It provides a software abstraction layer that is useable from a  $\mu$ Controller system.

The BBridge Software is designed to run on the Bombardier Panther hardware platform.

This document describes the project overview and deliverables that are required to fulfil the project.

### 1.1 Definitions, Acronyms and Abbreviations

Definition, Acronym, Abbreviation	Description
Panther	$\mu$ Controller Host System that uses the BBridge software for networking
BBridge	Application that manages the networking over Bluetooth LE
Bluetooth LE	Bluetooth Low Energy , low range wireless personal area network technology

### 1.1 Boundary Conditions,

The boundary conditions will be taken over from section „9. Allgemeine Randbedingungen /Konditionen“, document „15.0635.10 Angebot Bluetooth Bridge.pdf“.

### 1.2 Customer, Contractor

Customer:

Bombardier Primove GmbH

Neustadter Straße 62

68309 Mannheim, Germany

Contractor:

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## 1.3 Contact Persons

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## 1.4 Document Approval

Hereby the development partners are confirming that the content of the document "BBridge\_Requirements.pdf" meets the requirements for fulfilling the project.

Date/Customer:\_\_\_\_\_

Date/Contractor:\_\_\_\_\_

## 2 Scope of Supply and Services, Development Content, Conditions

The scope is the development of an Operating System Software for Bluetooth LE Network Management based on the CC2540 chip from Texas Instruments.

### 2.1 Scope of Supply and Services

Following documentation has to be delivered:

- Requirements Document
- System UML
- Software API
- Unit Tests with Documentation
- Setup Description of IAR Development Environment
- Source Code

### 2.2 Development Content

Following software components has to be developed,

- BBridge Application
- BBridge Native Driver
- BBridge Software Application Layer

Setup and parametrization of software has to be done for the,

- Texas Instrument OSAL
- Texas Instrument Bluetooth LE Stack

### 2.3 Conditions

#### 2.3.1 Hardware

The BBridge software is designed for the CC2540 Bluetooth LE chip from Texas Instruments.

The CC2540 Bluetooth LE chip is part of the Bombardier Panther hardware, developed by the customer.

The hardware interface between the Panther Hardware and BBridge and is described in following documents :

- PINNING\_Bluetooth\_CC2540\_B0undB.pdf
- B0\_Sample\_Schematics\_Bluetooth.pdf
- B\_Sample\_Schematics\_Bluetooth.pdf
- ORU\_power\_sequences.pdf

## **2.3.1.1 SPI – Interface**

The BBridge and the Panther Host Device communicate with each other over the SPI port. The BBridge is configured as slave and the Panther Host Device is configured as master.

## **2.3.2 Software**

For the BBridge Bluetooth communication part, the Bluetooth LE stack from Texas Instrument is requested by the customer. Basis Version is: "Bluetooth Low Energy Software Stack 1.4.1."

## **2.3.3 Debug and Programming the Device**

The BBridge software doesn't provide any debug or programming interface. This subject is handled by the CC2540 build in hardware/software interface from Texas Instrument.

Implementation has to be done by the customer.

Detailed information on how to use this interface is available in the application note 118 from Texas Instruments (AN118 – <http://www.ti.com/lit/an/swra410/swra410.pdf>).

## **2.3.4 Specification from Customer**

Development will base on the customer specification,

- 3EGM401000-5431\_TI\_COM\_TRD\_3.6kW\_Update\_2015-10-12.docx

## 3 BBridge Software

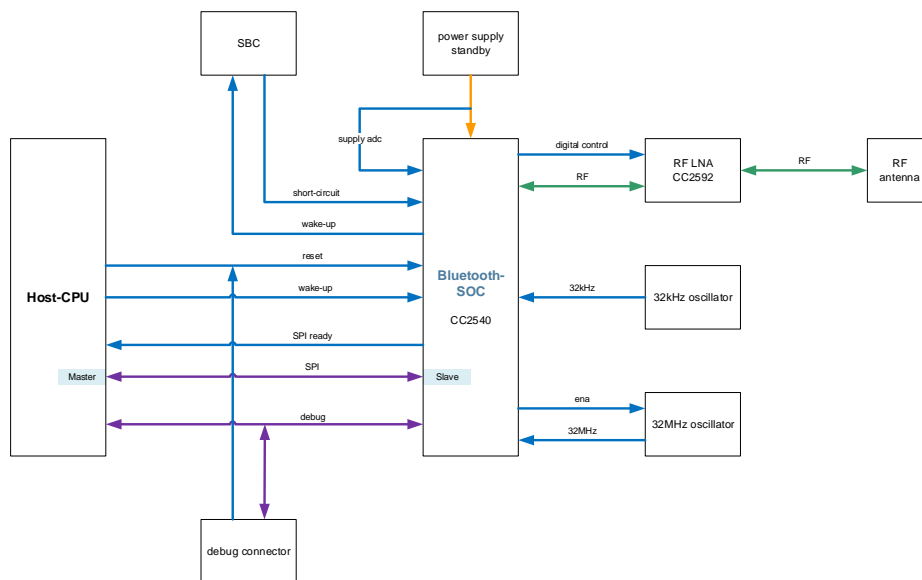
### 3.1 Description

The BBridge software handles the communication between devices over Bluetooth LE, it encapsulates the handling of the parameters, connection, identification and data transfer. For the Panther host system a software abstraction layer will be provided.

Figure 1 shows the system overview.

Blockschaltbild BBridge - Hardware

PEG-GX, U. Schlieben, S. Lill, J. Dürr  
14.01.2016



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Figure 1: System Overview

### 3.2 Application

The BBridge Application handles all functionalities that are needed to manage the network.

#### 3.2.1 Connection

Handles the connection, identification with other BBridge devices. The logic is configurable and able to manage three (3) simultaneous connections.



## 3.2.2 Validation

The BBridge is using a Seed/Key approach to validate devices. The Seed/Key algorithms are provided by Bombardier.

## 3.2.3 Wakeup

After establishing a valid connection between two BBridges, the Panther will be woken up.

Wake up is implemented by using a hardware line between BBridge and Panther.

## 3.2.4 Data Storage Parameter

The BBridge provides an interface to store and retrieve data from its internal non-volatile memory.

Data space in the CC2540 non-volatile memory is 8 Bytes.

## 3.2.5 Send/Recive Data over Bluetooth

The BBridge provides an interface to send/receive a byte stream between connected devices.

## 3.3 Operating Modes

The BBridge has three different operating modes, that are necessary for the different operating requirements.

### 3.3.1 IDLE Mode

In the IDLE Mode the BBridge is waiting for an external event, or the Panther host system. Following read and set functions are implemented:

- Data Storage
- Operating Mode
- Broadcast Message
- Filter Message
- Advertisement Interval

### 3.3.2 SCANNER Mode

In the SCANNER Mode the BBridge is actively searching for other BBridge devices over the network. If the BBridge was able to setup a valid connection it wakes up the Panther host system.

Following read and set functions are implemented:

- Send Data
- Receive Data
- Filter Message
- Disconnect Device
- Connection States and Parameters

### 3.3.3 CONNECTABLE Mode

In the CONNECTABLE Mode the BBridge is advertising its broadcast message over the network. This mode is waiting for a scanner device to initiate a Bluetooth connection.

- Send Data
- Receive Data
- Broadcast Message
- Disconnect Device
- Connection States and Parameters

### 3.4 Native Driver

The evaluation of the CC2540 chip in combination with the Bluetooth LE stack shows that the chip has some limitations/problems/bugs. To get this solved the contractor has to be able to write native drivers for accessing the hardware without using the library provided by Texas Instruments.

Porsche Engineering Services GmbH is the Copyright owner of the native drivers and provides them without warranty of any kind. The customer is allowed to use the native driver without any additional fees.

#### 3.4.1 SPI Native Driver

The errata of the TI Bluetooth LE Library 4.1.1 shows that using the SPI over UART function can produce system hang-ups. Therefore the contractor decided to write an own SPI native driver.

### 3.5 Software Abstraction Layer

The network management logic is encapsulated inside the BBridge software. The Panther host system has access to a small subset of generic commands that allow a simple usage of the Bluetooth network.

Detailed description: "BBridge\_Architecture\_Interfaces\_Protocol.pdf"

### 3.6 TI - Bluetooth Stack

For the Bluetooth network the Texas Instruments Bluetooth LE Stack for the CC2540 Device has to be used. The stack is requested by the customer.

Bluetooth Low Energy Software Stack Version 1.4.1 , 13.11.2015

<http://www.ti.com/tool/ble-stack>

### 3.7 TI - OSAL

Operating System Abstraction Layer provided by Texas Instrument for the CC2540 chip.

This layer is used by the Texas Instruments Bluetooth LE Stack V.1.4.1

## 4 Completion

### 4.1 Support of first time operation

The contractor supports the customer during the initial operation time. Long term trouble-shooting based on Panther hardware or additional system requirements, that are not described in "3EGM401000-5431\_TI\_COM\_TRD\_3.6kW\_Update\_2015-10-12.docx", are not covered by the first time support.

### 4.2 Testing and Documentation

The complete software is described by following documents:

- BBridge\_Requirements.pdf
- BBridge\_Software\_Requirements\_Test\_Cases.pdf
- BBridge\_Architecture\_Interfaces\_Protocol.pdf
- BBridge\_Transport\_Layer\_Protocol.pdf

The Bridge\_Software\_Requirements\_Test\_Cases.pdf document describes the atomic software functions and is used as basis for the testing specification.

For the system validation Unit Testing and Blackbox Testing will be performed.

An automated test will generate test results and export them in XML-Format.