



PORSCHE

# BBridge: Function Requirements

PEG-GX

**Porsche Engineering**  
driving technologies

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Open Point	Section	Tbd by
Disconnection: Is disconnecting necessary? How to prevent a reconnect after a disconnect command?	2.2.1.6	Bombardier
Purpose of input signal D_CTRL_WDM_ASC		Bombardier
Purpose of input signal D_WUP_CU_BT		Bombardier
Purpose of input signal A_COMP_REF		Bombardier

## Review

Role	Name	Department	Date	Version	Signature

# Table of contents

<b>1</b>	<b>INTRODUCTION.....</b>	<b>4</b>
1.1	DEFINITIONS .....	4
1.1.1	<i>Panther</i> .....	4
1.1.2	<i>BBridge</i> .....	4
1.1.3	<i>Internal communication</i> .....	4
1.1.3.1	SPI Interface .....	4
1.1.3.2	Wakeup line .....	4
1.1.3.3	Control line .....	4
1.1.3.4	Event Control Signal (ECS).....	4
1.1.3.5	Event Control Message (ECM) .....	4
1.1.3.6	Command Control Acknowledgement.....	4
1.1.3.6.1	ACK/NACK .....	4
1.1.4	<i>External communication</i> .....	5
1.1.4.1	Validated Connection .....	5
1.1.4.1.1	Device filtering mechanism .....	5
1.1.4.1.2	Device identity validation.....	5
1.1.5	<i>Operating modes</i> .....	5
1.1.5.1	BBridge Scanner .....	5
1.1.5.2	BBridge Connectable.....	5
1.1.5.3	BBridge Idle.....	5
1.1.5.4	Standard Bluetooth Modes (N/A) .....	5
<b>2</b>	<b>USE CASES.....</b>	<b>6</b>
2.1	BBRIDGE AS INITIATING ACTOR .....	6
2.1.1	<i>External Communication:</i> .....	6
2.1.1.1	BBridge Scanner establishes connection with BBridge Connectable devices .....	7
2.1.1.2	Receive Message.....	7
2.1.1.3	Transmit Message.....	7
2.1.1.4	Scan for "BBridge Connectable" devices.....	7
2.1.2	<i>Internal communication: BBridge with Panther</i> .....	8
2.1.2.1	Wake up Panther .....	8
2.1.2.2	Output Event Control Signal .....	8
2.2	PANTHER AS INITIATING ACTOR .....	9
2.2.1	<i>Input Commands</i> .....	9
2.2.1.1	Read Received Message.....	9
2.2.1.2	Get values .....	10
2.2.1.2.1	Get Memory value .....	10
2.2.1.2.2	Read Connected Devices .....	10
2.2.1.2.3	Read Configuration value .....	10
2.2.1.3	Load Event Control Message .....	10
2.2.1.4	Set Operating Mode.....	11
2.2.1.4.1	Switch to Idle mode .....	11
2.2.1.4.2	Switch to BBridge Scanner mode .....	11
2.2.1.4.3	Switch to BBridge Connectable mode .....	11
2.2.1.5	Set values.....	12
2.2.1.5.1	Set Transmit(TX) data.....	12
2.2.1.5.2	Set Memory value .....	12
2.2.1.5.3	Set Configuration value .....	12
2.2.1.6	Disconnect from selected Target device.....	12
2.2.2	<i>Registers Interface</i> .....	13
2.2.2.1	Flash Software .....	13

## 1 Introduction

The goal of this document is to provide an overview of the possible use case scenarios for the Panther and BBridge applications.

### 1.1 Definitions

#### 1.1.1 Panther

The Panther device is the main board from Bombardier for this project.

#### 1.1.2 BBridge

The main goal of a BBridge application is to provide a communication channel over Bluetooth so Panther devices can communicate with each other.

The BBridge hardware and application are embedded in the Panther devices.

#### 1.1.3 Internal communication

Is the interface through which the Panther and the BBridge communicate.

Given the architecture of the Panther's main board, the internal communication consists of a SPI interface, Wakeup line and a Control line.

##### 1.1.3.1 SPI Interface

In this context the Panther acts as master and the BBridge as slave.

##### 1.1.3.2 Wakeup line

It is used by the BBridge to notify the Panther hardware that a Bluetooth connection with another BBridge device has been established. The Wakeup line is driven high for X milliseconds by the BBridge.

##### 1.1.3.3 Control line

It is used by the BBridge for Event Control. With an Event Control Signal (ECS) the BBridge notifies the Panther hardware that a new Event Control Message (ECM) has to be retrieved.

##### 1.1.3.4 Event Control Signal (ECS)

The Control line is driven high for X milliseconds by the BBridge.

##### 1.1.3.5 Event Control Message (ECM)

The ECM is the data to be retrieved after a toggling of the Control line. This data contains the event ID and the event DATA SIZE to be further read from the BBridge by the Panther.

##### Event format suggestion (3 bytes):

[EVT\_ID (1Byte) ] [EVT\_DATA\_SIZE (2Bytes)]

##### 1.1.3.6 Command Control Acknowledgement

###### 1.1.3.6.1 ACK/NACK

After any input/output command from the Panther to the BBridge, the BBridge uses the ECS and sends an ECM to the Panther to state that the command has been correctly executed(ACK) or not(NACK).

## 1.1.4 External communication

Is the Bluetooth communication channel handled by the BBridge device that allows the Panther to communicate with other Panther devices.

### 1.1.4.1 Validated Connection

It consists of a Bluetooth connection (with additional functionality) between two BBridge applications where the following applies:

- 1- The standard Bluetooth communication is established
- 2- The standard Bluetooth PIN/Bonding authentication is successful
- 3- A device identity validation procedure is successful

Attention: Not to be confused with a standard Bluetooth connection only.

#### 1.1.4.1.1 Device filtering mechanism

This mechanism allows the BBridge to filter BBridge devices from any standard Bluetooth device.

By definition, the "BBridge Scanner" mode is always scanning for visible Bluetooth devices within range, however, a connection shall only be initiated with BBridge devices.

The procedure uses pre-defined configurable values to search matches in received advertised messages.

#### 1.1.4.1.2 Device identity validation

It is the process to identify a valid BBridge peer device in a Bluetooth connection. It consists of a Seed/Key authentication procedure.

## 1.1.5 Operating modes

These are the operating modes which the Panther application can configure the BBridge application to operate in.

### 1.1.5.1 BBridge Scanner

This mode is the standard Bluetooth "Peripheral" mode with additional functionality. In this mode, the BBridge is always scanning for devices in "BBridge Connectable" mode and it is capable of connecting to more than one "BBridge Connectable" device.

It scans the area looking for broadcasted messages using the Device Filtering mechanism to decide which device to connect to. If matching devices were found, the connection is established using the Device identity validation mechanism.

### 1.1.5.2 BBridge Connectable

This is the standard Bluetooth "Central" mode with additional functionality. In this mode, the BBridge is always advertising its presence with pre-defined configurable values in the advertised message. Furthermore it can only receive one single connection from one BBridge device in "Scanner" mode.

### 1.1.5.3 BBridge Idle

In this mode the "External communication" is not operative, it allows the Panther application to configure the BBridge operating modes and their properties.

### 1.1.5.4 Standard Bluetooth Modes (N/A)

As discussed with Bombardier, the BBridge shall not provide operability with the standard Bluetooth modes. For this application it was decided that only "BBridge Scanner" and "BBridge Connectable" modes shall be made available.

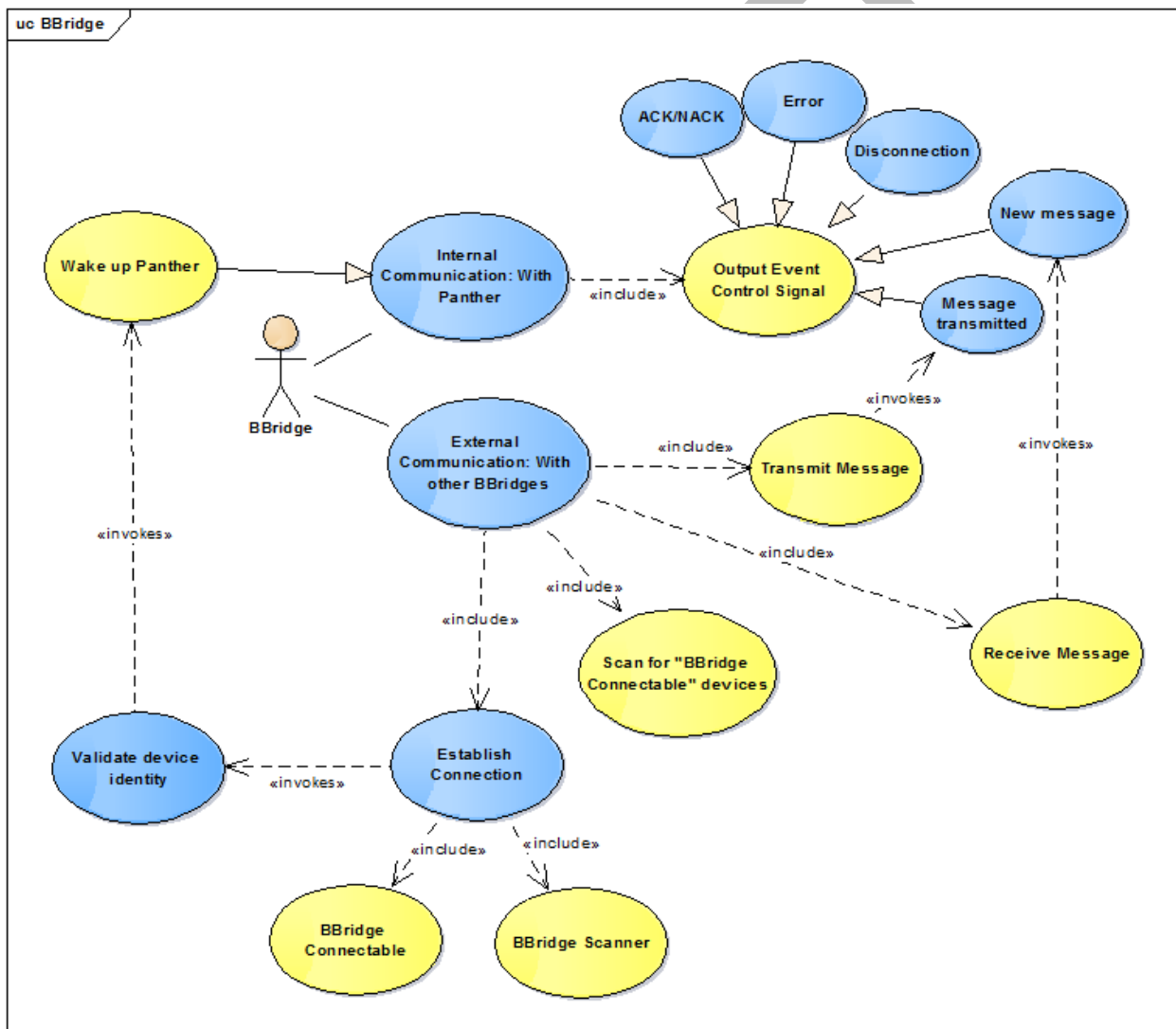
The following modes are not available:

- Observer
- Broadcaster
- Peripheral
- Central

## 2 Use Cases

The use cases described below represents the application and operation needs from the perspective of the BBridge and the Panther devices.

### 2.1 BBridge as initiating actor



#### 2.1.1 External Communication:

This section describes the communication functionalities between two or more BBridge devices.

## 2.1.1.1 BBridge Scanner establishes connection with BBridge Connectable devices

### Preconditions:

BBridge application is in "BBridge Scanner" mode.

A nearby BBridge device in "Connectable" mode is available after the Device Filtering Mechanism.

### Main Flow:

The BBridge application initiates a Bluetooth connection using the authentication parameters pre-configured by the Panther application. After standard Bluetooth connection is established the Device identity validation procedure is initiated [S1]. In case an error occurs [A1] is followed. Otherwise (upon validation success), the Panther shall be notified over the Wakeup line [S2].

### Sub Flows:

[S1] Initiate Device identity validation.

[S2] Notify Panther over wakeup line

### Alternative Flows:

[A1] Goes to initial state of Scanner mode.

### Possible errors:

[1] Connection failed

[2] Validation failed

## 2.1.1.2 Receive Message

### Preconditions:

There must exist a Validated connection between (at least) two BBridge devices (A and B).

### Main Flow:

When A sends a message to B, B receives the message over the External Communication Interface. The BBridge then notifies the Panther that a new message is available to be retrieved [S1].

### Sub Flows:

[S1] After the message is received, the BBridge application notifies the Panther device with a Event Control Signal. The Corresponding Event Control Message states that a "new message" is available.

## 2.1.1.3 Transmit Message

### Preconditions:

There must exist a Validated connection between the sender BBridge and the receiver BBridge.

The Panther device has set a new message to be transmitted containing the data and the receiver BBridge.

### Main Flow:

The BBridge application transmits the message over Bluetooth to the receiver BBridge device and the transmitting Panther is notified [S1].

### Sub Flows:

[S1] After the message is sent, the BBridge application notifies the Panther device with a "ECM" as "Message transmitted".

## 2.1.1.4 Scan for "BBridge Connectable" devices

### Preconditions:

BBridge application is in "BBridge Scanner" mode.

### Main Flow:

In Scanner mode the BBridge application is always scanning for a nearby BBridge Connectable devices to connect with. After scanning [S1], [S2] or [S3] is executed.

**Sub Flows:**

[S1] No Panther devices where found in range -> No further action shall be taken

[S2] Exactly 1 Panther device has been found -> The application initiates a connection

[S3] More than 1 Panther devices have been found -> The BBridge application initiates a connection with every device found as in [S2]

## 2.1.2 Internal communication: BBridge with Panther

This section describes the communication functionalities between the Panther and the BBridge devices on the same main board.

### 2.1.2.1 Wake up Panther

**Preconditions:**

A Validated Connection with another BBridge device has been established.

**Main Flow:**

A connection between two "BBridge" devices has been established and validated.

The BBridge devices notify their respective Panther devices by toggling the Wakeup line.

**Note:**

This is done by driving a high signal for X milliseconds on the corresponding Wakeup pin.

### 2.1.2.2 Output Event Control Signal

**Preconditions:**

None

**Main Flow:**

This mechanism is used when the BBridge needs to notify the Panther about an event on the BBridge side. It indicates to the Panther device that a new Event Control Message is available for retrieval. Then [S1] is followed, alternatively [A1] is followed.

**Sub Flows:**

[S1] The Panther retrieves the Event Control Message

**Alternative Flow:**

[A1] The BBridge discards the event after X milliseconds.



## 2.2 Panther as initiating actor



### 2.2.1 Input Commands

The Panther device communicates with the BBridge using the Internal communication interface. The Panther application inputs specific commands to the interface so the BBridge can react accordingly.

#### 2.2.1.1 Read Received Message

##### Preconditions:

BBridge is in "BBridge Scanner" or "BBridge Connectable" mode.

At least one connection has been established (and validated).  
BBridge has received a message from another BBridge device.  
Panther has received an Event Control Signal on the Control line.

**Main Flow:**

Upon receiving the ECS, the Panther retrieves the ECM to read the Event ID and the size of the data to be retrieved. Then the Panther starts to retrieve the data [S1] - by requesting the correct amount of bytes - from the communication interface.

**Sub Flows:**

[S1] Panther retrieves the data from BBridge application.

**Alternative Flows:**

TODO: what to do when the Panther does not retrieve the message.

## 2.2.1.2 Get values

This section lists all the values that can be retrieved from the BBridge application.

Every entered "Get Value" command generates a positive (ACK) or negative (NACK) acknowledgement. The ACK returned contains the size of the data to be retrieved from the communication interface.

**Main flow:**

Panther device requests a specific value from the communication interface. The BBridge Outputs a Event Control Signal [S1] and waits for the Panther to load the ECM (with Event ID and size of data to be retrieved). Then the Panther starts to retrieve the data [S2] - by requesting the correct amount of bytes - from the communication interface.

**Sub Flows:**

[S1] The BBridge Outputs a ECS

[S2] Panther retrieves the data from BBridge application.

**Alternative Flows:**

TODO: Define what happens when Panther does not retrieve data within X milliseconds

TODO: Define what happens when Panther starts to send a different command instead of retrieving data

### 2.2.1.2.1 Get Memory value

**Preconditions:**

None

### 2.2.1.2.2 Read Connected Devices

**Preconditions:**

BBridge is in "BBridge Scanner" or "BBridge Connectable" mode.

### 2.2.1.2.3 Read Configuration value

**Preconditions:**

None

## 2.2.1.3 Load Event Control Message

**Preconditions:**

The Panther has received an Event Control Signal.

**Main flow:**

After the ECS, the BBridge waits for the Panther to load the ECM (with Event ID and size of data to be retrieved) [S1].

**Sub Flows:**

[S1] Panther loads the ECM.

**Alternative Flows:**

[A1] In case the Panther does not load the ECM (TODO: decide how to proceed)

## 2.2.1.4 Set Operating Mode

**Preconditions:****Main Flow:**

The BBridge application initiates the business logics and enables the command interface for the current mode selected.

**Sub Flows:**

None

**Alternative Flows:**

[A1] In case the mode is not available or an error occurs an error notification is generated (using a Signal control Message)

### 2.2.1.4.1 Switch to Idle mode

**Preconditions:**

None

**Main Flow:**

The application switches to Idle mode. In case a connection is active, it is disconnected and all connection-related states are lost.

**Sub Flows:**

None

**Alternative Flows:**

None

### 2.2.1.4.2 Switch to BBridge Scanner mode

**Preconditions:**

The application is in "Idle mode"

**Main Flow:**

The BBridge application initiates the business logics and enables the command interface for the Scanner Mode.

**Sub Flows:**

None

### 2.2.1.4.3 Switch to BBridge Connectable mode

**Preconditions:**

The application is in "Idle mode"

**Main Flow:**

The BBridge application initiates the business logics and enables the command interface for Connectable mode.

**Sub Flows:**

None

## 2.2.1.5 Set values

This section lists all the values that can be set to the BBridge application.

Every entered "Set Value" command generates a positive (ACK) or negative (NACK) acknowledgement. The ACK returned contains the Event ID explaining what was acknowledged.

**Main flow:**

Panther device writes a specific command and value to the communication interface. The BBridge executes the command received, outputs an ECS [S1] and waits for the Panther to load the ECM (with Event ID). Then the Panther starts retrieves the ECM [S2] from the communication interface.

**Sub Flows:**

[S1] The BBridge outputs an Event Control Signal on the Control line

[S2] Panther retrieves the ECM from BBridge application, which contains the ACK for the command.

### 2.2.1.5.1 Set Transmit(TX) data

**Preconditions:**

The BBridge application is in Connectable or Scanner mode

**Main Flow:**

Regular Main Flow from "Set values", however, when data has been transmitted, the BBridge sends ECS and ECM [S1]+[S2] to acknowledge the that Transmission was completed or failed.

**Sub Flows:**

[S1] The BBridge outputs an Event Control Signal

[S2] The Panther retrieves the Event Control Message

**Note:** The data to be transmitted shall contain a destination device available in the "Connected devices list".

### 2.2.1.5.2 Set Memory value

**Preconditions:**

The BBridge application is in IDLE Mode

**Note:** Values given in this function are stored in the BBridge's NVM (Non-Volatile Memory).

### 2.2.1.5.3 Set Configuration value

**Preconditions:**

The BBridge application is in IDLE Mode

## 2.2.1.6 Disconnect from selected Target device

**Preconditions:**

There is one or more Valid connections active.

**Main Flow:**

Panther device requests a disconnection in the Communication interface. The BBridge executes the disconnection and returns ECS [S1] and ECM [S2].

**Sub Flows:**

[S1] The BBridge outputs an ECS

[S2] The Panther retrieves the ECM

## 2.2.2 Registers Interface

**Preconditions:**

Hardware interface is correctly connected as described in the specs

**Main Flow:**

The Panther application programs the BBridge application as described in the specification

### 2.2.2.1 Flash Software

Flashing new software is done by using the pre-defined TI library.