User manual

The BlueNRG-2N ACI command data format

Introduction

This document describes the BlueNRG-2N application command interface (ACI) which is provided to access the BlueNRG-2N Bluetooth Low Energy host and controller components.

User applications, like programs running in another silicon chip, can send ACI commands to control the BlueNRG-2N device. The ACI commands should be sent over a UART or SPI connection.

Refer to the BlueNRG-2N datasheet reference section for more information about the BlueNRG-2N device.

1 BlueNRG-2N ACI commands

The BlueNRG-2N ACI commands utilize and extend the standard HCI data format.

According to the Bluetooth specifications, a standard HCI packet can be:

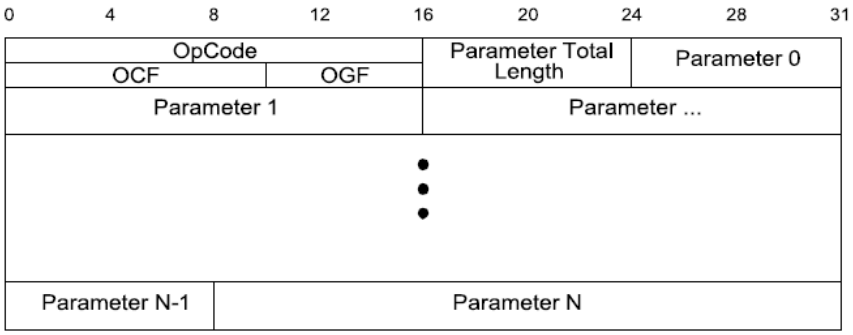
- HCI command packet
- HCI ACL data packet
- HCI synchronous data packet
- HCI event packet

In the BlueNRG-2N, the HCI synchronous data packet is not supported, but the other three are.

HCI command packet format

- When an external device gives a command to the BlueNRG-2N, the command must be formatted in a HCI command packet
- The BlueNRG-2N only receives the HCI command packets, but does not transmit

Figure 1. HCI command packet



- Each HCI command uses a 2-byte OpCode to uniquely identify different types of commands
- The OpCode is divided into two fields: the OpCode group field (OGF) and the OpCode command field (OCF):

The OGF is the upper 6 bits and the remaining lower 10 bits are used by the OCF.

All HCI commands are grouped into logical groups by the Bluetooth specification and each group is assigned a unique OGF value.

Table 1. OGF value

Group name	OGF value
Link control commands	0x01
Link policy commands	0x02
Controller and baseband commands	0x03
Information parameters	0x04
Status parameters	0x05
Testing commands	0x06
LE controller commands	0x08
Vendor specific commands	0x3F

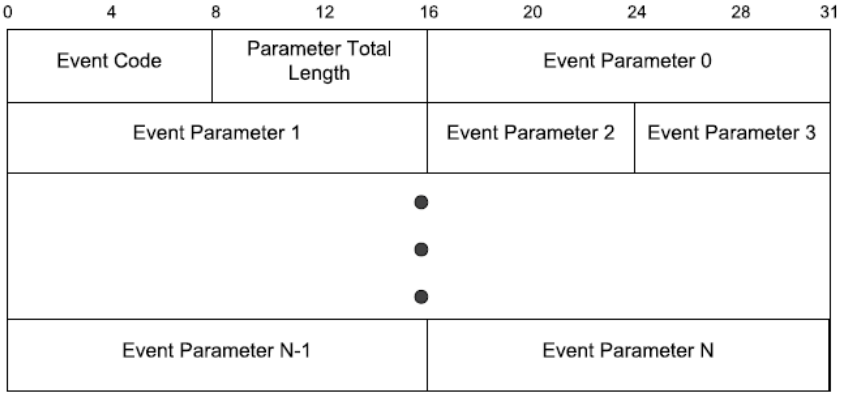
- Depending on the OGF, the commands can be categorized into 3 sets:
  1. Standard HCI commands: the commands with an OGF value other than 0x3F. These commands are designed for the controller. All standard HCI commands are clearly defined in the Bluetooth specifications.
  2. Vendor specific (VS) HCI commands: the commands with an OGF value 0x3F and are designed for the controller. Each vendor can define their own VS commands based on the hardware implementation.
  3. Vendor specific (VS) ACI commands: the commands also with an OGF value 0x3F, but these commands are designed to control/access the host. The Bluetooth specification does not define any command for the host, so all the ACI commands are naturally vendor specific.
- To clarify, the commands designed to control the controller are called HCI commands. This name is defined by the Bluetooth specification and we maintain it here in order to comply with the specification.
- The commands designed to control the host are called ACI commands. We give it a different name to indicate that this command is rather assigned to the host, i.e. to the whole Bluetooth LE system, and not only to the controller at the lower level. However, because both ACI and HCI commands are the commands received from the external device via the ACI interface, and both of them share the same data format, sometimes it is not important to differentiate between the two.
- In practice, the value of the OpCode is more important. Each command, regardless of whether it is a HCI or an ACI command, matches only one OpCode value. The user application should guarantee the OpCode value is used correctly.

Note: The Bluetooth specification uses bit-wise little endian format for the OpCode. So in Figure 1. HCI command packet, the OGF field is placed to the right. In this document, when writing an OpCode in the format of 0xXXXX, we imply the most significant bit to the left. For example, if an OpCode is 0xFE81, its top 6-bit OGF is "111111", i.e. 0x3F, so it is a vendor specific command , and its OCF is 10-bit 0x281. As another example, if an OpCode is 0x0406, the 6-bit OGF is 0x01, and its OCF is 0x06. So this is a standard HCI command, HCI_Disconnect.

HCI event packet

- The BlueNRG-2N uses event packets to acknowledge a command or to notify that its status has updated to the user application. The BlueNRG-2N only sends HCI event packets, but does not receive them.

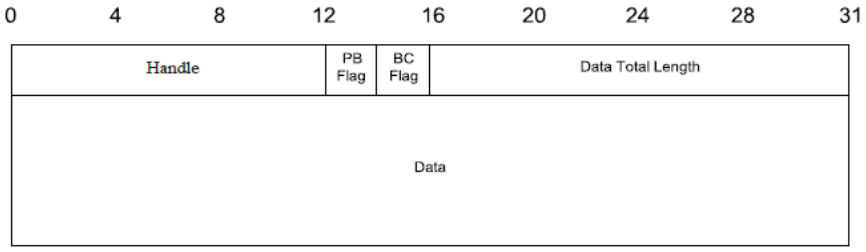
Figure 2. HCI event packet



HCI ACL data packet

- The ACL data packets are used to exchange data.

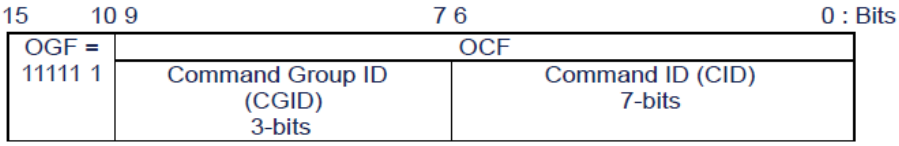
Figure 3. HCI ACL data packet



Vendor specific (VS) commands

- The Vendor specific commands can be either ACI VS commands to access the host of the BlueNRG-2N, or the HCI VS commands to access the LE controller. Both types command use the OGF value of 0x3F.
- The OCF field of the OpCode of the VS commands is further divided into two fields: Command Group ID and Command ID

Figure 4. OpCode format for VS commands



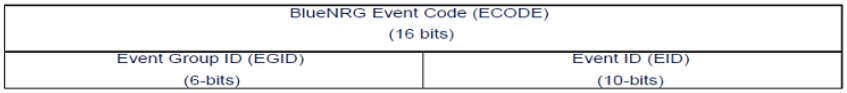
- Figure 4. OpCode format for VS commands above gives the 16-bit OpCode format (see also Figure 1. HCI command packet)
- The OGF field is always 0x3F for VS commands. The 10-bit OCF field is split into two parts:
  - 3-bit Command Group ID (CGID)
  - 7-bit Command ID (CID).
- The CGID is used by the BlueNRG-2N ACI interface to route the commands to different logical layers, e.g. L2CAP, GAP, GATT, etc. It also helps to categorize the VS commands with a more clear structure. The CID determines the ID of each command. Each CGID group can have up to 128 VS commands.

Table 2. CGID group

Command group	Description	CGID
HCI	HCI extension commands	0x0
GAP	Generic access profile commands	0x1
GATT	Generic attribute profile commands	0x2
L2CAP	L2CAP commands	0x3
Reserved		0x4 – 0x7

- The VS event also has a slightly different format than the standard HCI event (see also Figure 2. HCI event packet):
  - The 8-bit event code of the VS event always has the value of 0xFF
  - The 16-bit event parameter 0 has a different format.

Figure 5. Event parameter 0 format for VS events



- The event parameter 0 is the first return parameter in the HCI event packets, following the parameter length field
- These 2 bytes together are defined as the BlueNRG-2N Event Code (ECODE). ECODE is further divided into 2 fields:
  - Event Group ID (EGIO)
  - Event ID (EID).
- The BlueNRG-2N combines the events into logical groups using the EGID. And the EID is used to specify an event in the group. The EGID occupies 6-bits in the ECODE field while the EID occupies the remaining 10 bits.

Table 3. EGID group

Event Group	Description	EGID
HCI	HCI extension events	0x0
GAP	Generic access profile events	0x1
L2CAP	L2CAP events	0x2
GATT	Generic attribute profile events	0x3

2 Acronyms

Table 4. **Acronyms**

Terms	Description
ACL	Asynchronous connection-oriented logical transport
ACI	Application command interface
HCI	Host command interface

3 Reference

Table 5. **Reference**

What	Where	Description
BlueNRG-2N datasheet	www.st.com/bluenrg-2n	BlueNRG-2N device datasheet

Revision history

Table 6. **Document revision history**

Date	Version	Changes
29-Nov-2020	1	Initial release.

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