
BlueNRG-1 UART bootloader protocol

Introduction

The BlueNRG-1 is a very low power Bluetooth low energy (BLE) single-mode system-on-chip, compliant with Bluetooth® specification. The architecture core is a Cortex-M0 32-bit.

This application note contains the specifications of the BlueNRG-1 UART bootloader.

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1 UART bootloader configuration

To communicate with the BlueNRG-1 bootloader the host UART shall be configured with the following settings:

- UART data 8 bit
- NO parity
- Stop bit 1
- NO flow control
- Baud rate in the range [500 – 460800]

The BlueNRG-1 bootloader is configured to use the UART pin:

- UART RX = DIO11
- UART TX = DIO8

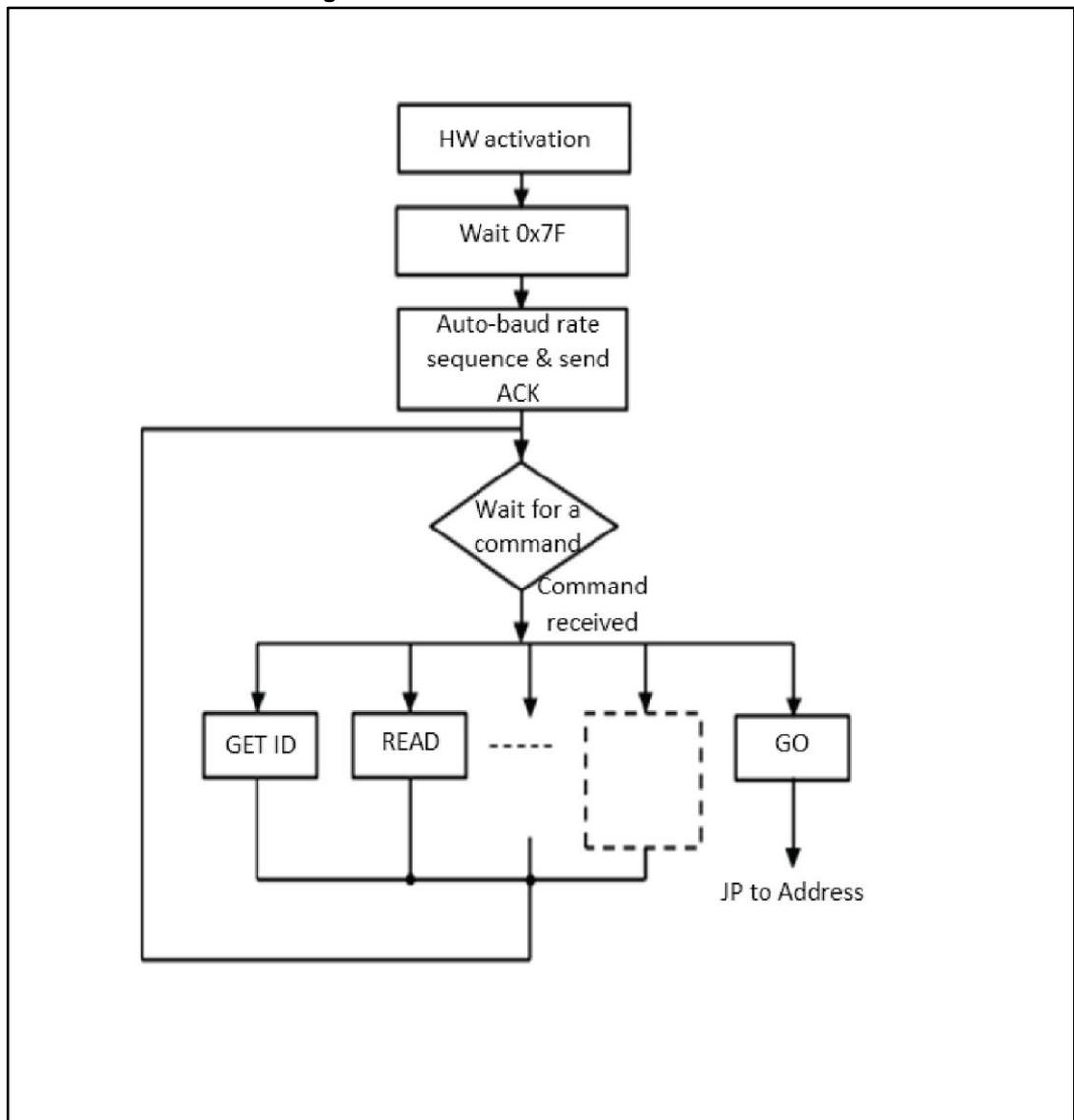
2 UART bootloader activation

The BlueNRG-1 bootloader is activated by hardware forcing high DIO7 while resetting the device. Once the BlueNRG-1 bootloader is activated, the code starts a procedure to auto-detect the host UART baud rate and it begins to scan the USART RX line pin, waiting to receive from the host the 0x7F data frame: one start bit, 0x7F data bits, no parity bit and one stop bit. The duration of this data frame is measured using the SysTick timer. The count value of the timer is then used to calculate the corresponding baud rate factor with respect to the current system clock.

Once the baud rate is calculated, the firmware initializes the BlueNRG-1 serial interface accordingly, using this calculated baud rate. An acknowledge byte (0x79) is returned to the host, which signals that the BlueNRG-1 is ready to receive commands.

In the next figure follows a flow chart of the BlueNRG-1 UART bootloader protocol, at device side.

Figure 1: UART bootloader for BlueNRG-1



3 UART bootloader commands

The supported commands are listed in the table below. Each command is further described in this section.

Table 1: BlueNRG-1 UART bootloader commands

Command	Command code	Command description
Get List Command	0x00	Gets the version and the allowed commands supported by the current version of the bootloader
Get Version	0x01	Gets the bootloader version
Get ID	0x02	Gets the chip ID
Read Memory	0x11	Reads up to 256 bytes of memory starting from an address specified by the application
Go	0x21	Jumps to user application code located in the internal Flash memory or in RAM
Write Memory	0x31	Writes up to 256 bytes to the RAM or Flash memory starting from an address specified by the application
Erase	0x43	Erases from one to all the Flash memory pages
Readout Protect	0x82	Enables the read protection
Readout Unprotect	0x92	Disables the read protection

All communications from the host to the BlueNRG-1 device are safety because they are verified by:

- Checksum: received blocks of data bytes are XORed. A byte containing the computed XOR of all previous bytes is added to the end of each communication (checksum byte). By XORing all received bytes, data + checksum, the result at the end of the packet must be 0x00
- For each bootloader command, the host sends a byte and its complement
- Each packet is either accepted (ACK answer) or discarded (NACK answer):
 - ACK = 0x79
 - NACK = 0x1F

3.1 Get List command

The Get List command allows to get the version of the bootloader and the supported commands. When the BlueNRG-1 bootloader receives the Get List command, it transmits the bootloader version and the supported command codes to the host. The following figures describe the commands from both host and device side.

Figure 2: Get List command: host side

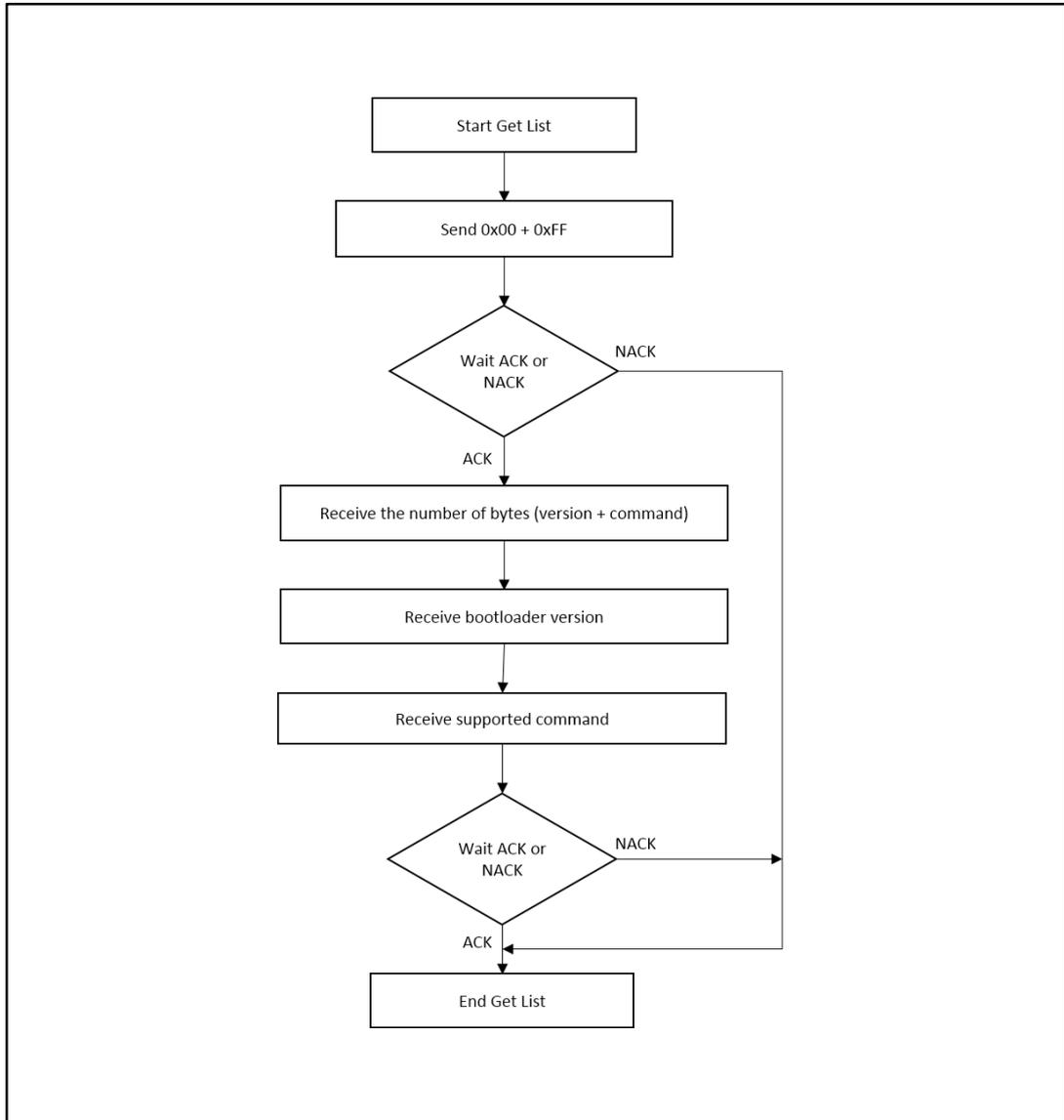
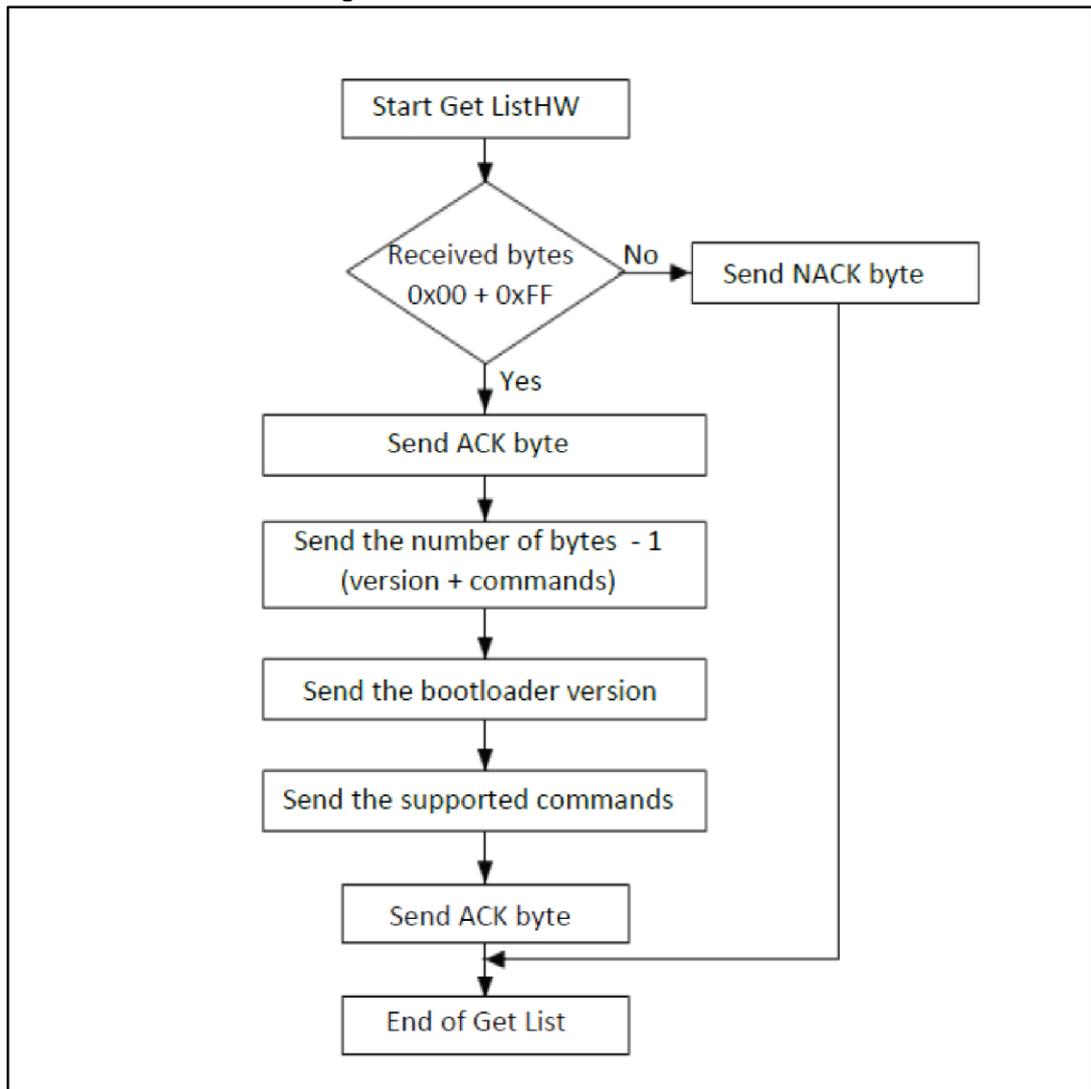


Figure 3: Get list command: device side



The BlueNRG-1 sends the bytes as follows:

Byte 1: ACK

Byte 2: N = 9 = the number of bytes to follow -1 except current and ACKs.

Byte 3: Bootloader version (0 < Version <= 255), example: 0x01 = Version 1.0

Byte 4: 0x00 – Get List command

Byte 5: 0x01 – Get Version command

Byte 6: 0x02 – Get ID command

Byte 7: 0x11 – Read Memory command

Byte 8: 0x21 – Go command

Byte 9: 0x31 – Write Memory command

Byte 10: 0x43 – Erase command

Byte 11: 0x82 – Readout Protect command

Byte 12: 0x92 – Readout Unprotect command

Byte 13: ACK. This is the last byte

3.2 Get Version command

The Get Version command is used to get the bootloader version. When the bootloader receives the command, it transmits the information described below to the host.

Figure 4: Get Version command: host side

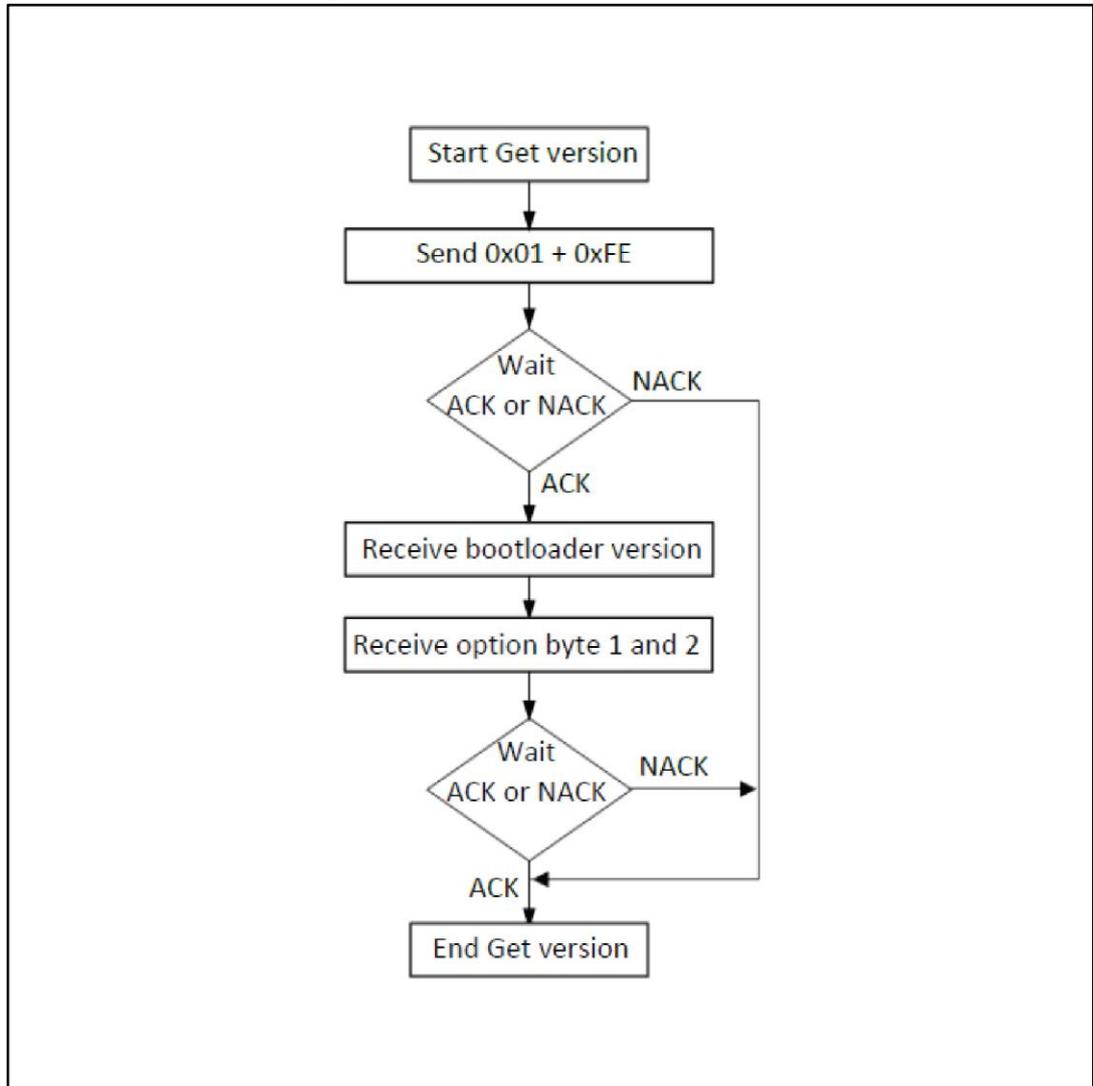
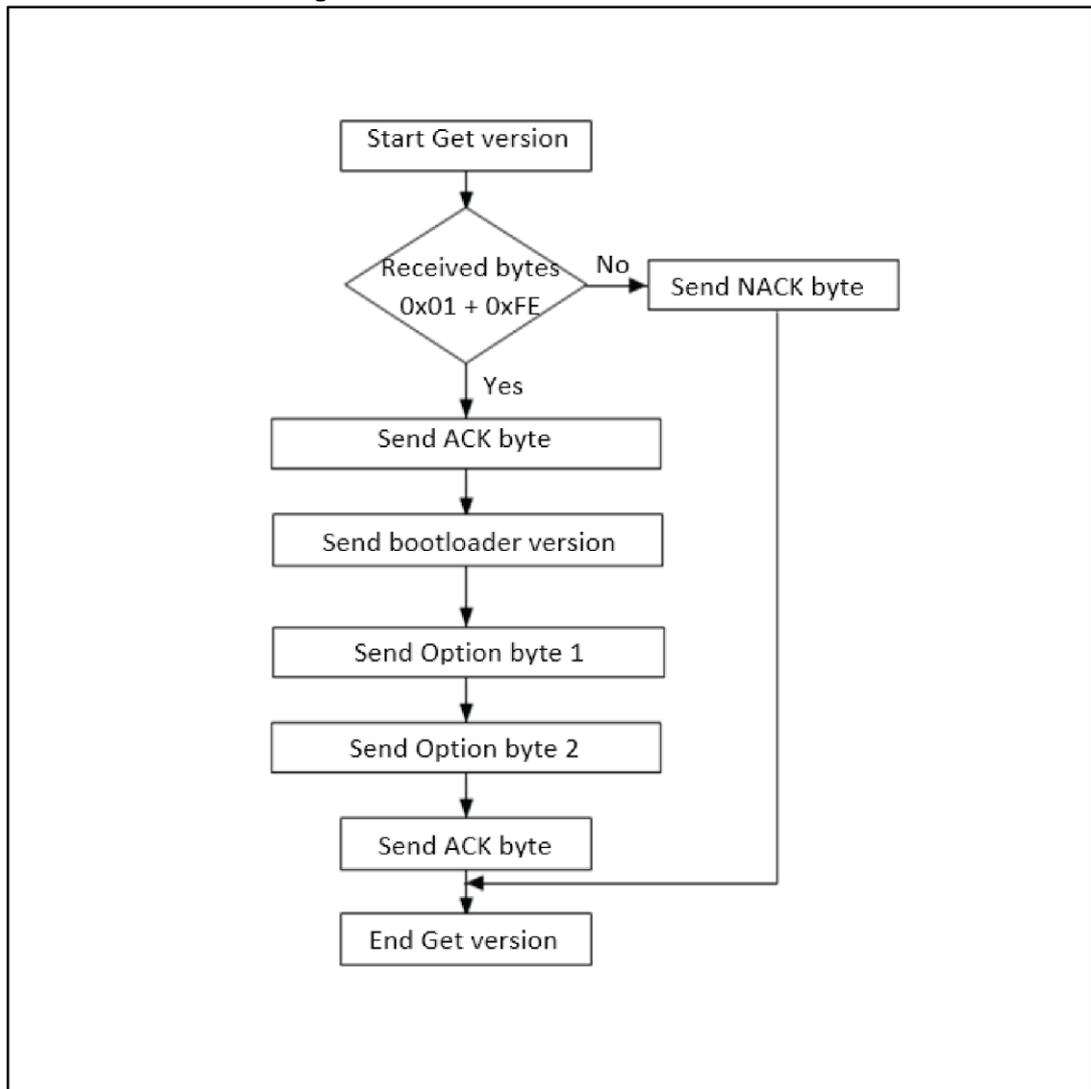


Figure 5: Get Version command: device side



The BlueNRG-1 sends the bytes as follows:

Byte 1: ACK

Byte 2: Bootloader version (0 < Version <= 255), example: 0x01 = Version 1.0

Byte 3: Option byte 1: 0x00

Byte 4: Option byte 2: 0x00

Byte 5: ACK

3.3 Get ID command

The Get IDcommand is used to get the version of the chip ID (identification). When the bootloader receives the command, it transmits the product ID to the host.

Figure 6: Get ID command: host side

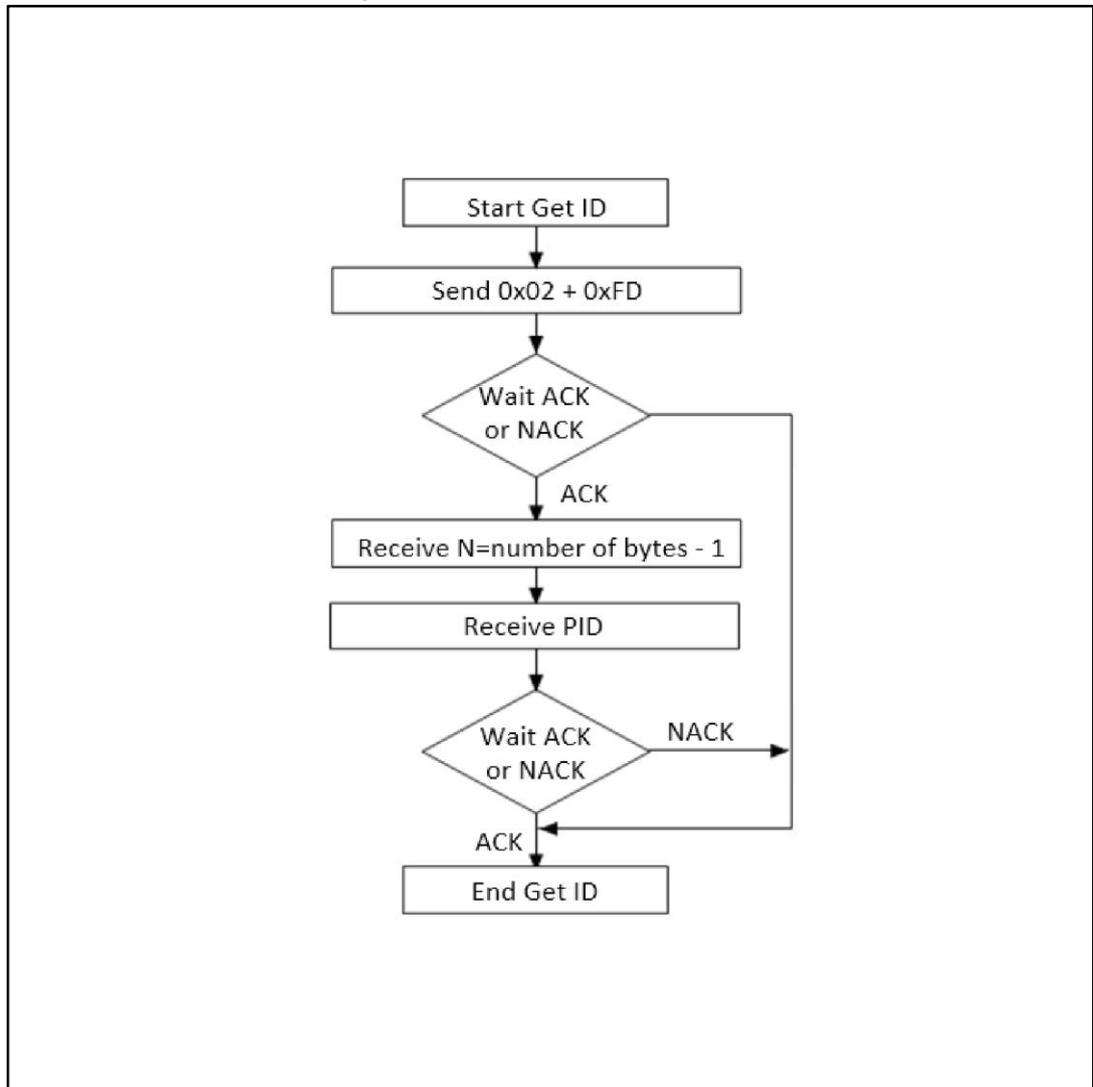
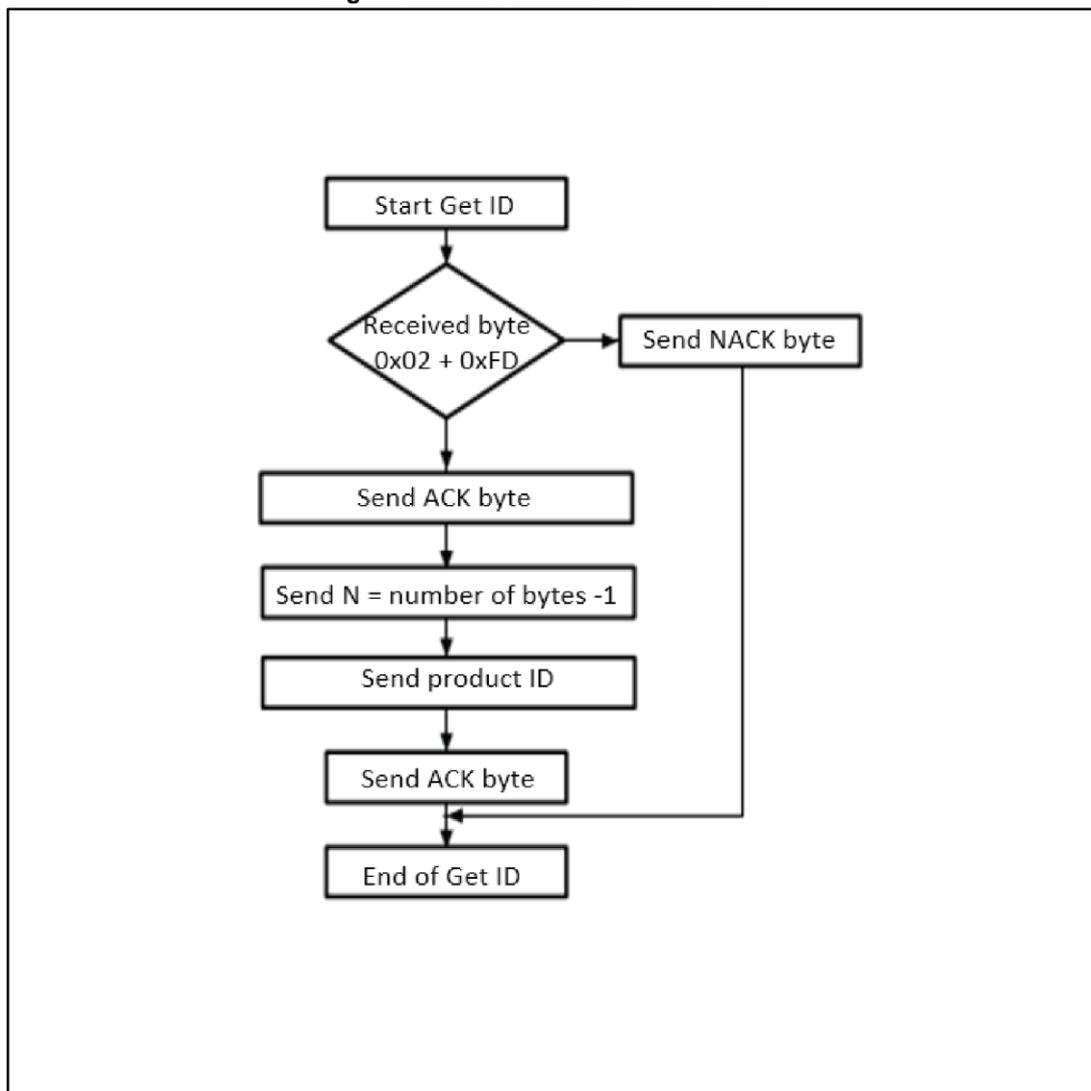


Figure 7: Get ID command: device side



The BlueNRG-1 device sends the bytes as follows:

Byte 1: ACK

Byte 2: 0x02: the number of bytes -1, except for current byte and ACKs

Byte 3-5: PID

Byte 6: ACK

3.4 Read Memory command

The Read Memory command is used to read data from any valid memory address in RAM and Flash memory

When the bootloader receives the Read Memory command, it transmits the ACK byte to the application. After the transmission of the ACK byte, the bootloader waits for an address (4 bytes, byte 1 is the address MSB and byte 4 is the LSB) and a checksum byte, then it checks the received address. If the address is valid and the checksum is correct, the bootloader transmits an ACK byte, otherwise it transmits a NACK byte and aborts the command.

When the address is valid and the checksum is correct, the bootloader waits for N that is the number of bytes to be transmitted – 1 and for its complemented byte (checksum). If the checksum is correct it then transmits the needed data ((N + 1) bytes) to the application, starting from the received address. If the checksum is not correct, it sends a NACK before aborting the command.

If the readout protection is active, a NACK byte is send to the host when the Read Memory command is received.

Figure 8: Read Memory command: host side

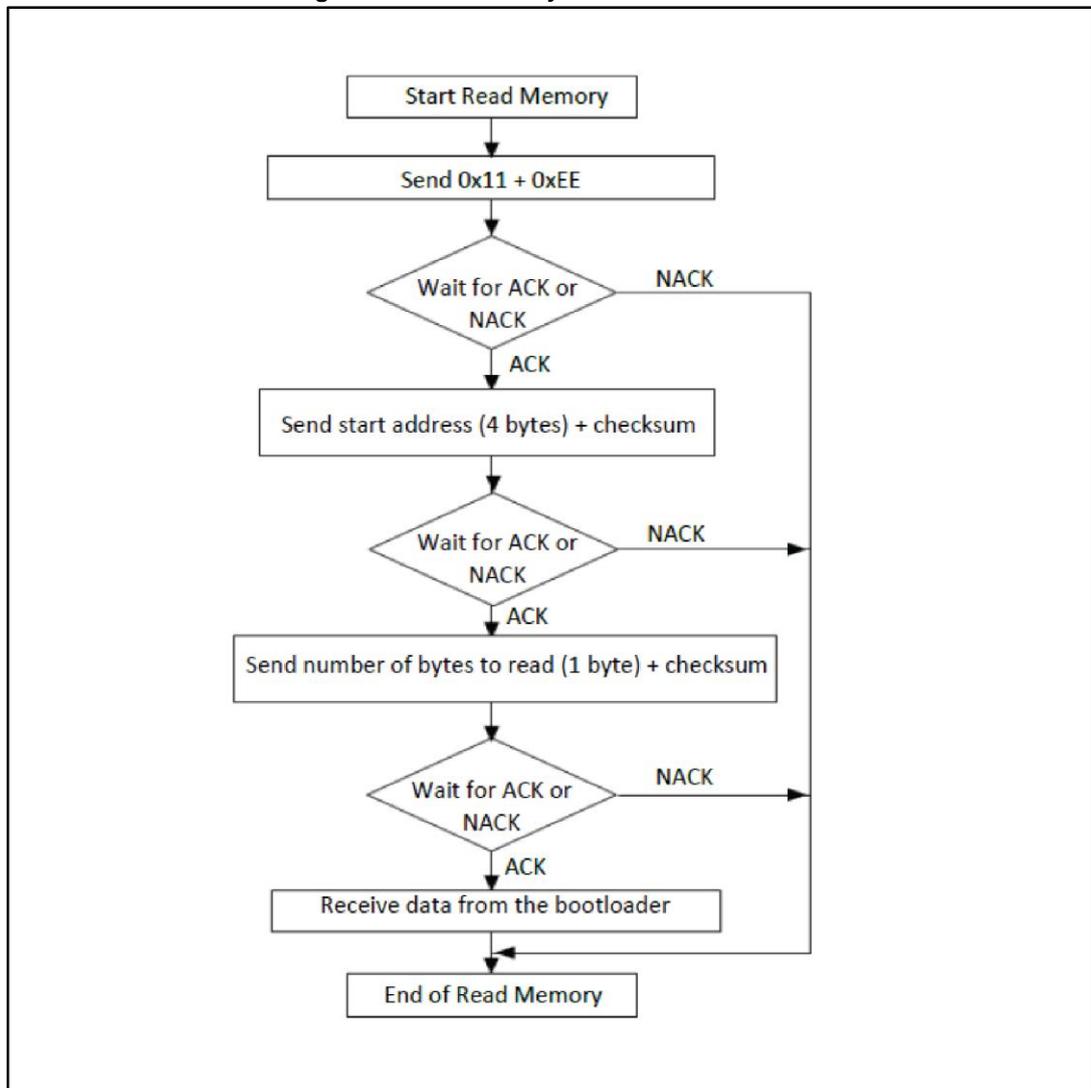
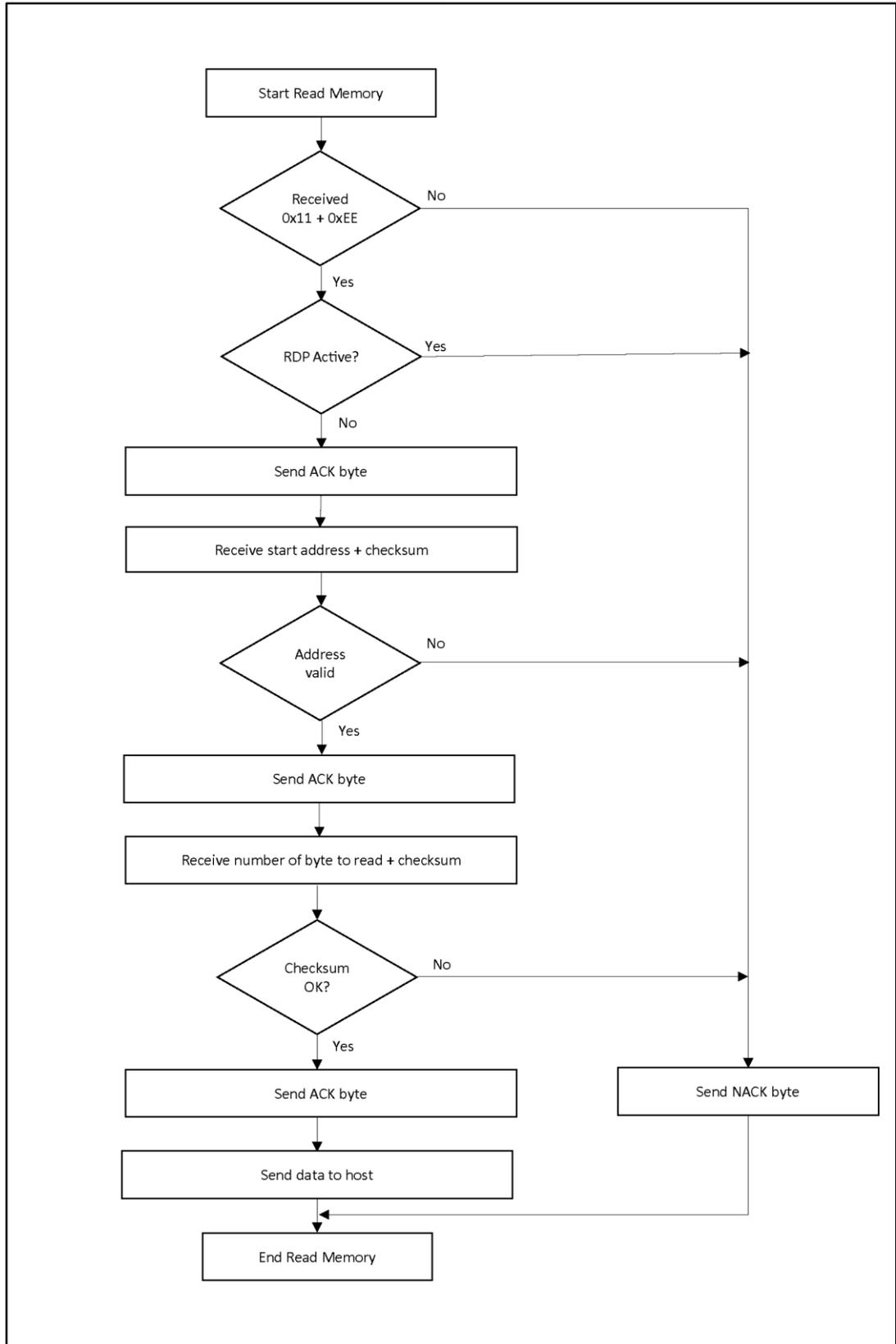


Figure 9: Read Memory command: device side



The host sends bytes to the BlueNRG-1 as follows:

Byte 1: 0x11

Byte 2: 0xEE

Wait for ACK

Byte 3 to 6: start address

- Byte 3: MSB
- Byte 6: LSB

Byte 7: Checksum: XOR of address bytes

Wait for ACK

Byte 8: Number of bytes to read -1 ($0 < N \leq 255$)

Byte 9: Checksum: XOR byte 8 (complement of byte 8)

3.5 Go command

The Go command is used to execute the downloaded code or any other code by jumping to an address specified by the application. When the bootloader receives the Go command, it transmits the ACK byte to the application. After the transmission of the ACK byte, the bootloader waits for an address (4 bytes, byte 1 is the address MSB and byte 4 is LSB) and a checksum byte, then it checks the received address. If the address is valid and the checksum is correct, the bootloader transmits an ACK byte, otherwise it transmits a NACK byte and aborts the command.

When the address is valid and the checksum is correct, the bootloader firmware performs the following actions:

- It initializes the registers of the peripherals used by the bootloader to their default reset values
- It initializes the user application's main stack pointer
- It jumps to the memory location programmed in the received 'address + 4' (which corresponds to the address of the application's reset handler).

For example if the received address is 0x10040000, the bootloader jumps to the memory location programmed at address 0x10040004.

Figure 10: Go command: host side

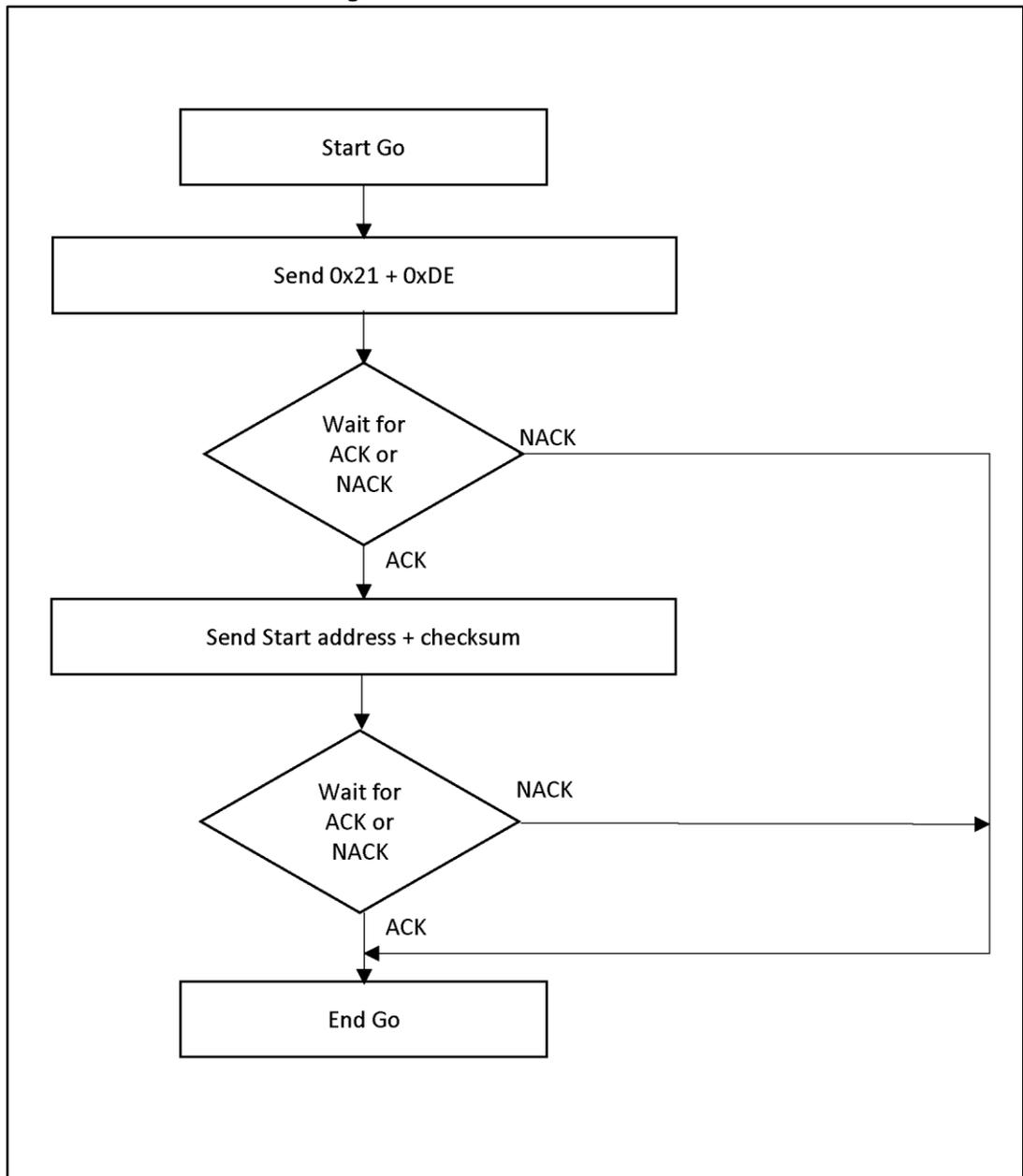
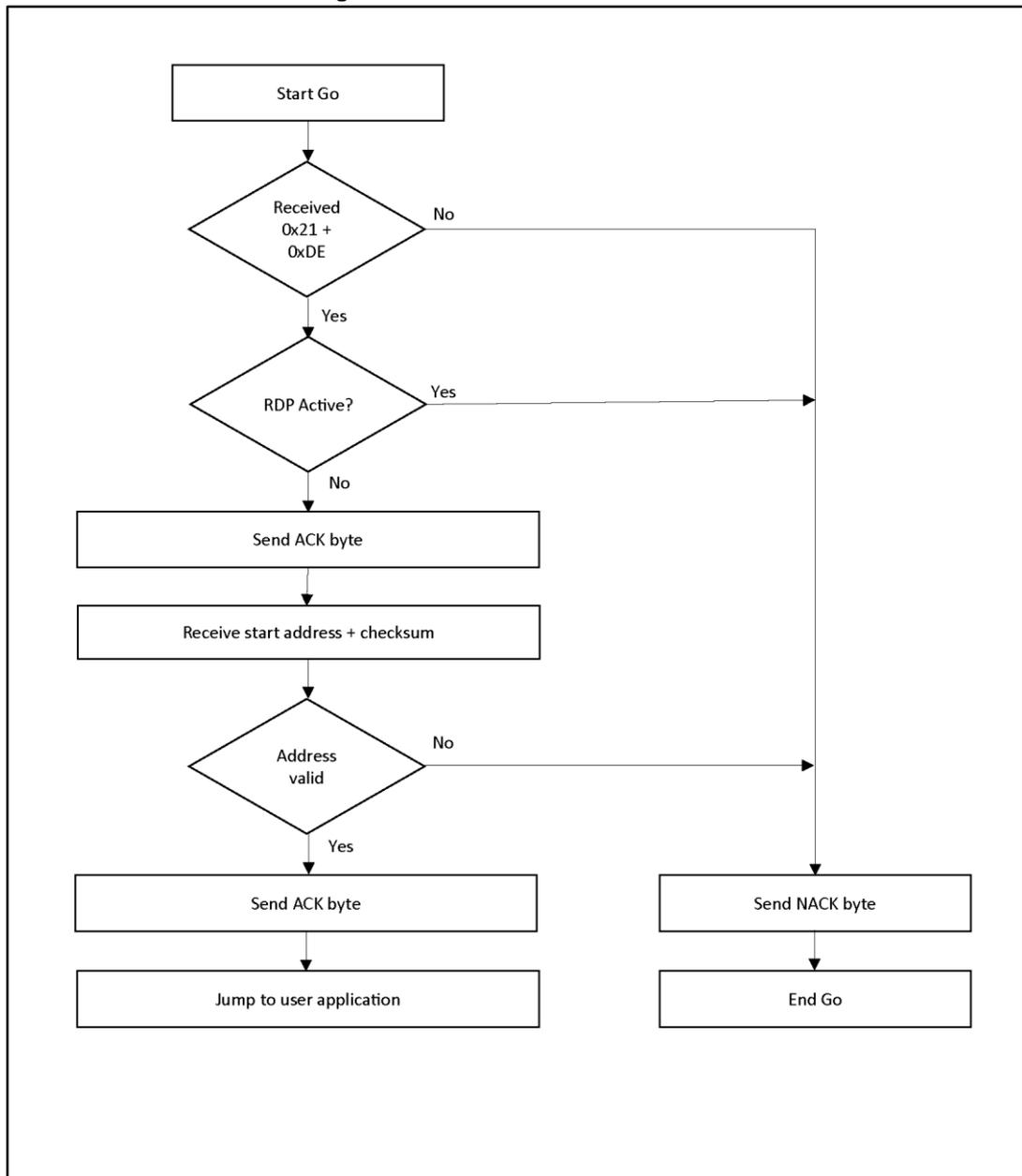


Figure 11: Go command: device side



The host sends bytes to the BlueNRG-1 as follows:

Byte 1: 0x21

Byte 2: 0xDE

Wait for ACK

Byte 3 – 6: start application address

- Byte 3: MSB
- Byte 6: LSB

Byte 7: checksum: XOR of address bytes

Wait for ACK

3.6 Write Memory command

The Write Memory command is used to write data to any valid memory address RAM or Flash memory.

When the bootloader receives the Write Memory command, it transmits the ACK byte to the application. After the transmission of the ACK byte, the bootloader waits for an address (4 bytes, byte 1 is the address MSB and byte 4 is the LSB) and a checksum byte, and then it checks the received address.

If the received address is valid and the checksum is correct, the bootloader transmits an ACK byte, otherwise it transmits a NACK byte and aborts the command. When the address is valid and the checksum is correct, the bootloader performs these actions:

- Gets a byte, N, which contains the number of data bytes to be received
- Receives the user data ((N + 1) bytes) and the checksum (XOR of N and of all data bytes)
- Programs the user data to memory starting from the received address
- At the end of the command, if the write operation is successful, the bootloader transmits the ACK byte; otherwise it transmits a NACK byte to the application and aborts the command

The maximum length of the block to be written for the BlueNRG-1 is 256 bytes.

If the readout protection is active, a NACK byte is sent to the host when the Write Memory command is received.

Figure 12: Write Memory command: host side

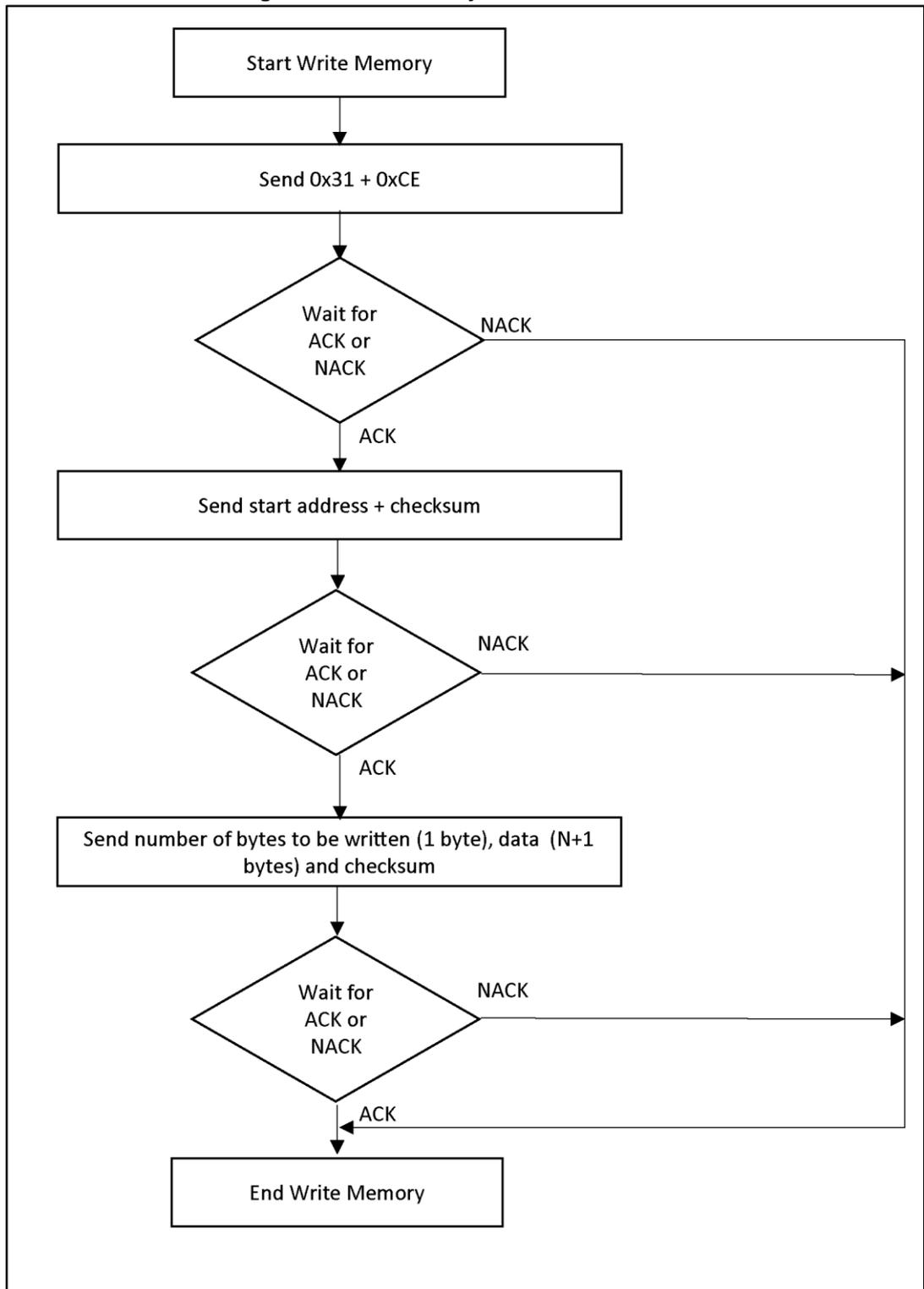
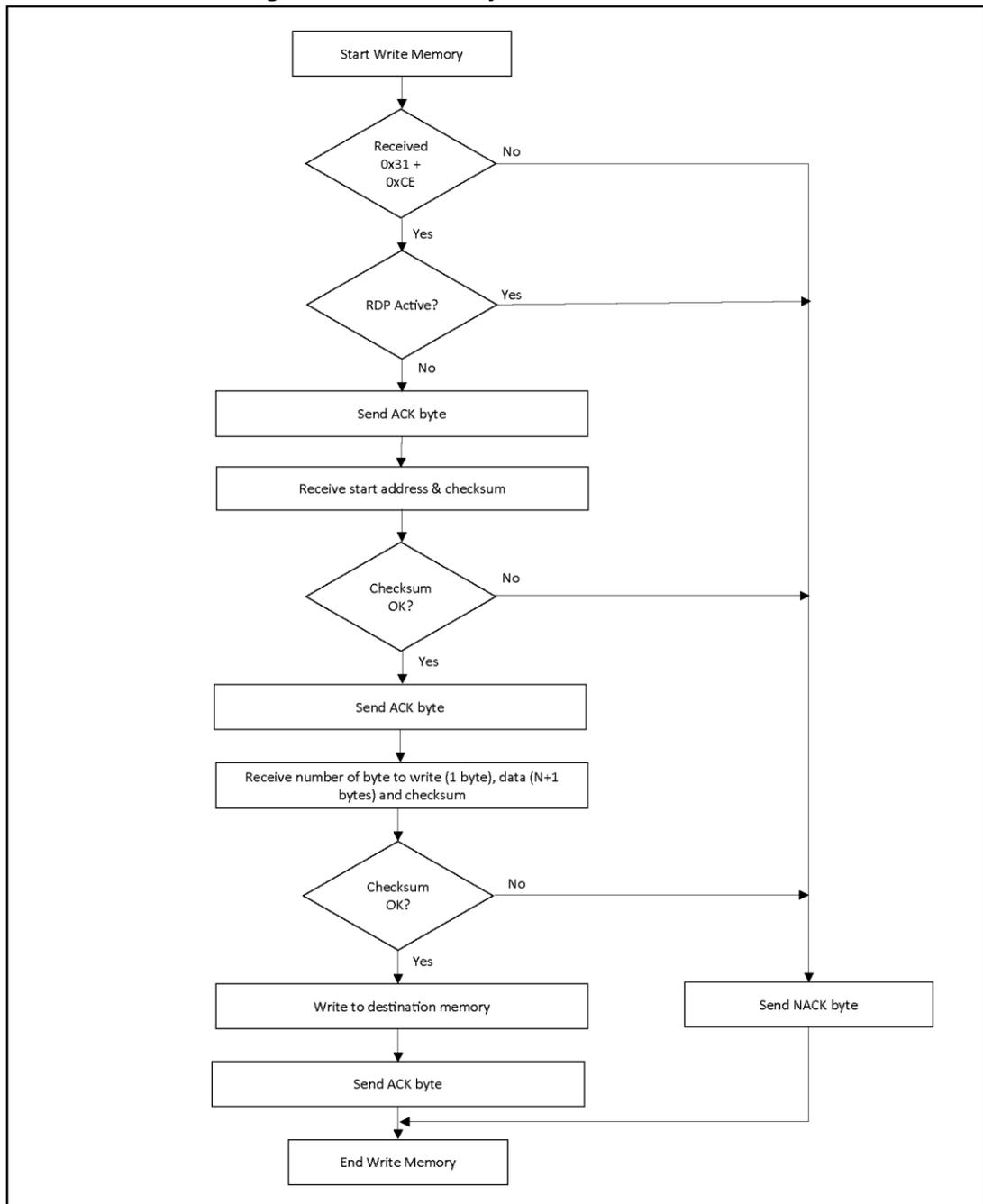


Figure 13: Write Memory command: device side



The host sends the bytes to the BlueNRG-1 as follows:

Byte 1: 0x31

Byte 2: 0xCE

Wait for ACK

Byte 3 to byte 6: start address

- Byte 3: MSB
- Byte 6: LSB

Byte 7: Checksum: XOR (Byte 3, Byte 4, Byte 5, Byte 6)

Wait for ACK

Byte 8: Number of bytes to be received ($0 < N \leq 255$)

N + 1 data bytes: (Max 256 bytes)

Checksum byte: XOR (N, N+1 data bytes)

Wait for ACK

3.7 Erase Memory command

The Erase Memory command allows the host to erase Flash memory pages. When the bootloader receives the Erase Memory command, it transmits the ACK byte to the host. After the transmission of the ACK byte, the bootloader receives one byte (number of pages to be erased), the Flash memory page codes and a checksum byte. If the checksum is correct then the bootloader erases the memory and sends an ACK byte to the host, otherwise it sends a NACK byte to the host and the command is aborted.

Erase Memory command specifications are as follows:

1. The bootloader receives one byte that contains N, the number of pages to be erased – 1. N= 255 is reserved for mass erase request. For $0 < N \leq 79$, N + 1 pages are erased.
2. The bootloader receives (N + 1) bytes, each byte containing a page number

Figure 14: Erase Memory command: host side

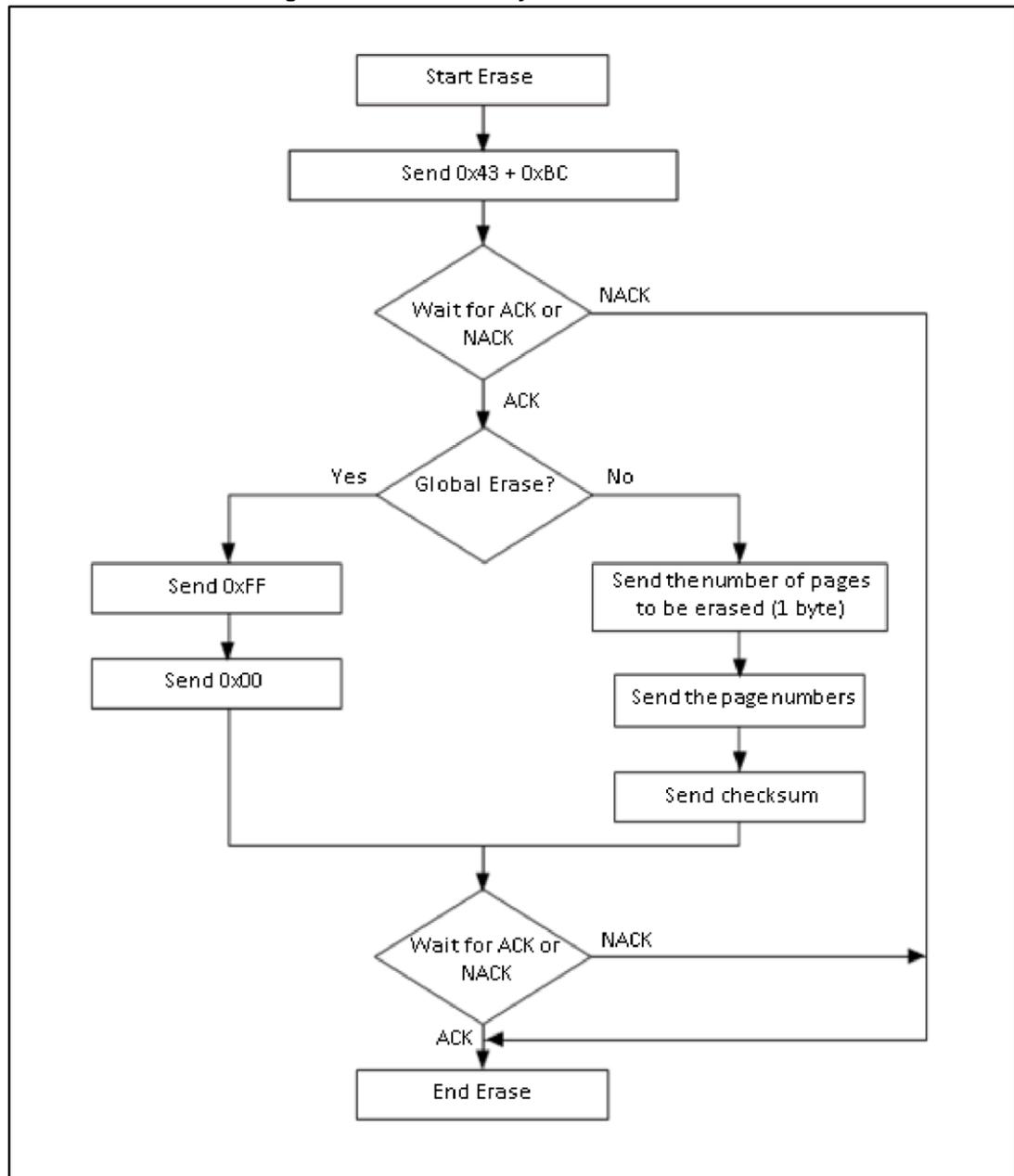
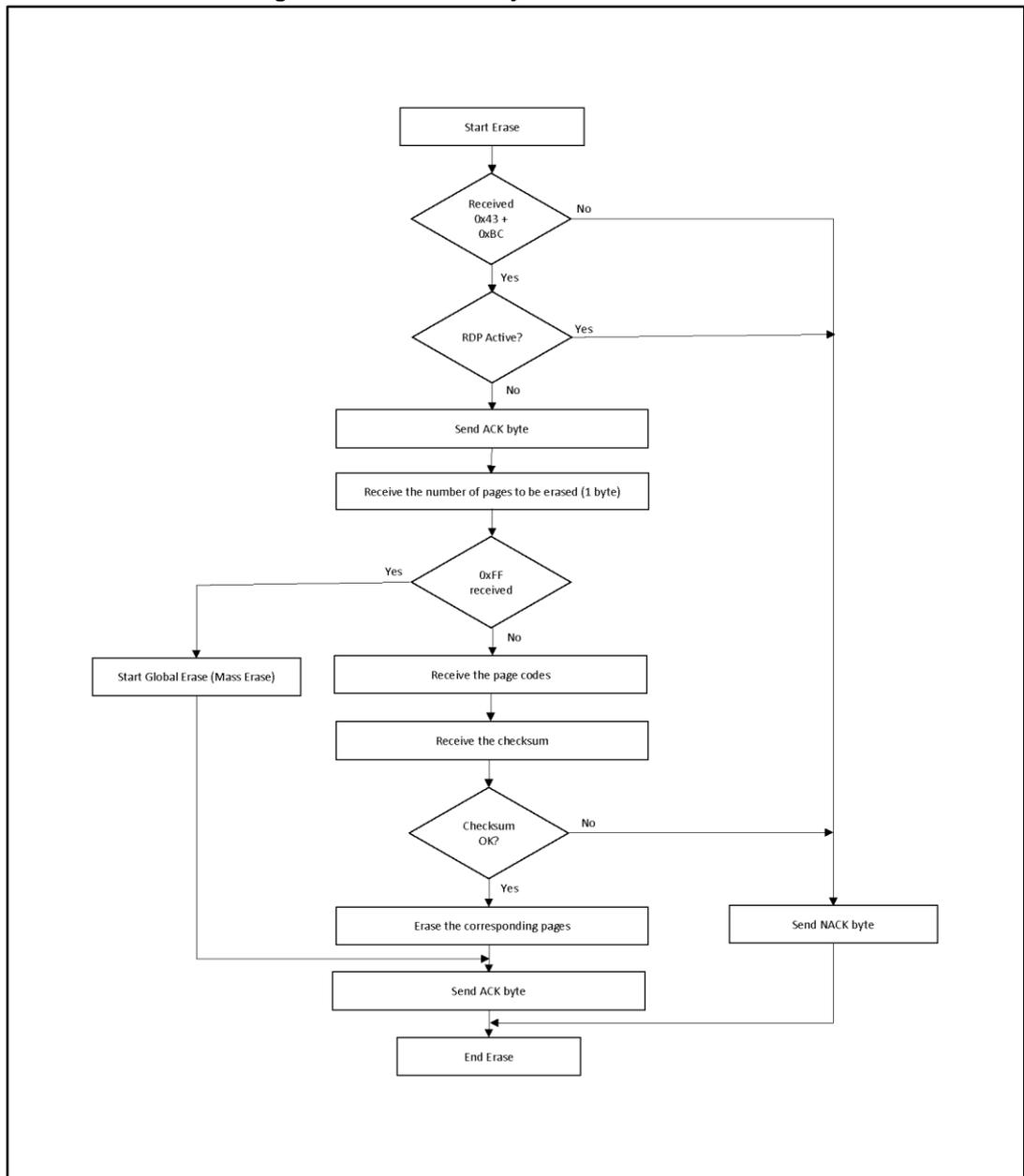


Figure 15: Erase Memory command: device side



The host sends bytes to the BlueNRG-1 as follows:

Byte 1: 0x43

Byte 2: 0xBC

Wait for ACK

Byte 3: 0xFF or number of pages to be erased – 1 (0 <= N <= maximum number of pages)

Byte 4: 0x00 (in case of mass erase) or ((N+1 bytes (page numbers) and then checksum XOR(N, N+1 bytes))

Wait for ACK

3.8 Readout Protect command

The Readout Protect command is used to enable the Flash memory read protection. When the bootloader receives the Readout Protect command, it transmits the ACK byte to the host. After the transmission of the ACK byte, the bootloader enables the read protection for the Flash memory.

At the end of the Readout Protect command, the bootloader transmits the ACK byte and generates a system Reset to take into account the new configuration of the BlueNRG-1.

Figure 16: Readout Protect command: host side

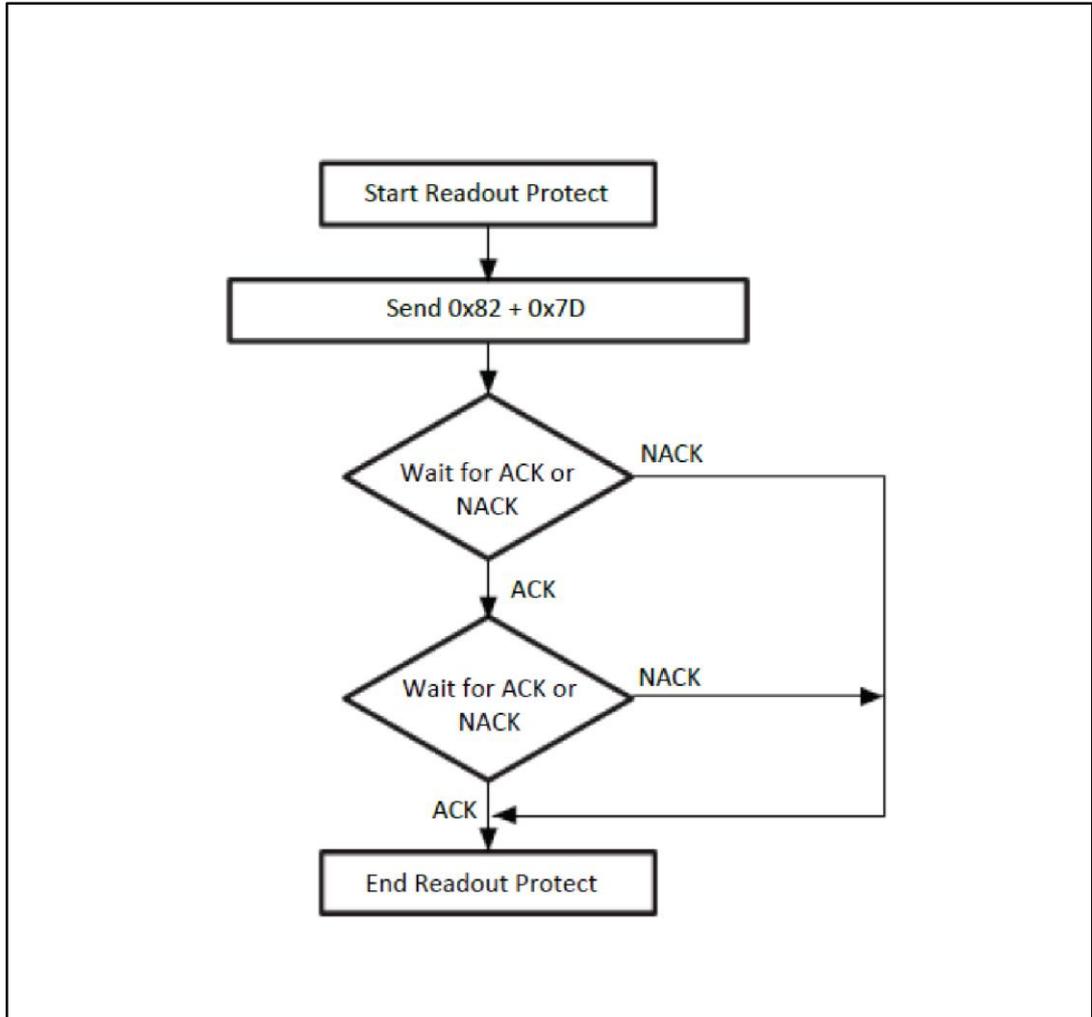
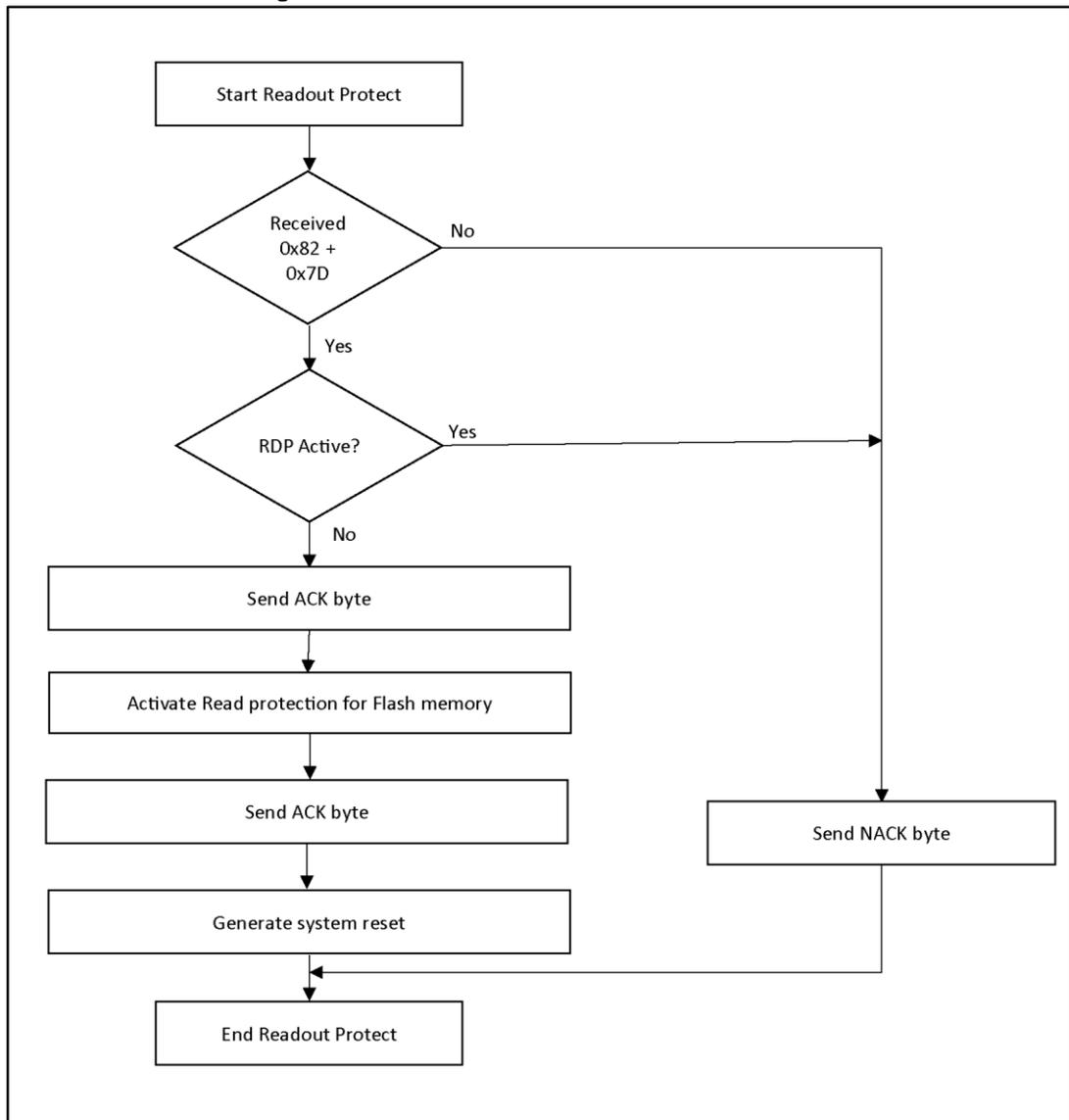


Figure 17: Readout Protect command: device side



3.9 Readout Unprotect command

The Readout Unprotect command is used to disable the Flash memory read protection. When the bootloader receives the Readout Unprotect command, it transmits the ACK byte to the host. After the transmission of the ACK byte, the bootloader erases all the Flash memory sectors and it disables the read protection for the entire Flash memory.

If the erase operation is successful, the bootloader deactivates the Readout Protection. If the erase operation is unsuccessful, the bootloader transmits a NACK and the read protection remains active.

At the end of the Readout Unprotect command, the bootloader transmits an ACK and generates a system Reset.

Figure 18: Readout Unprotect command: host side

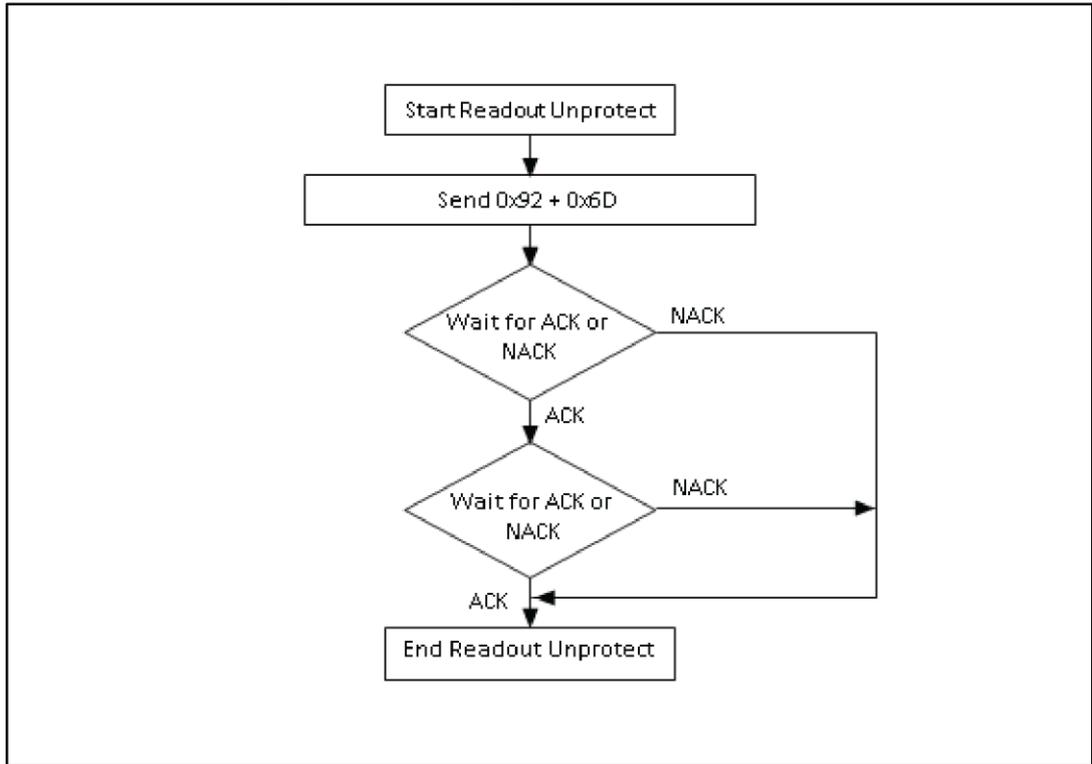
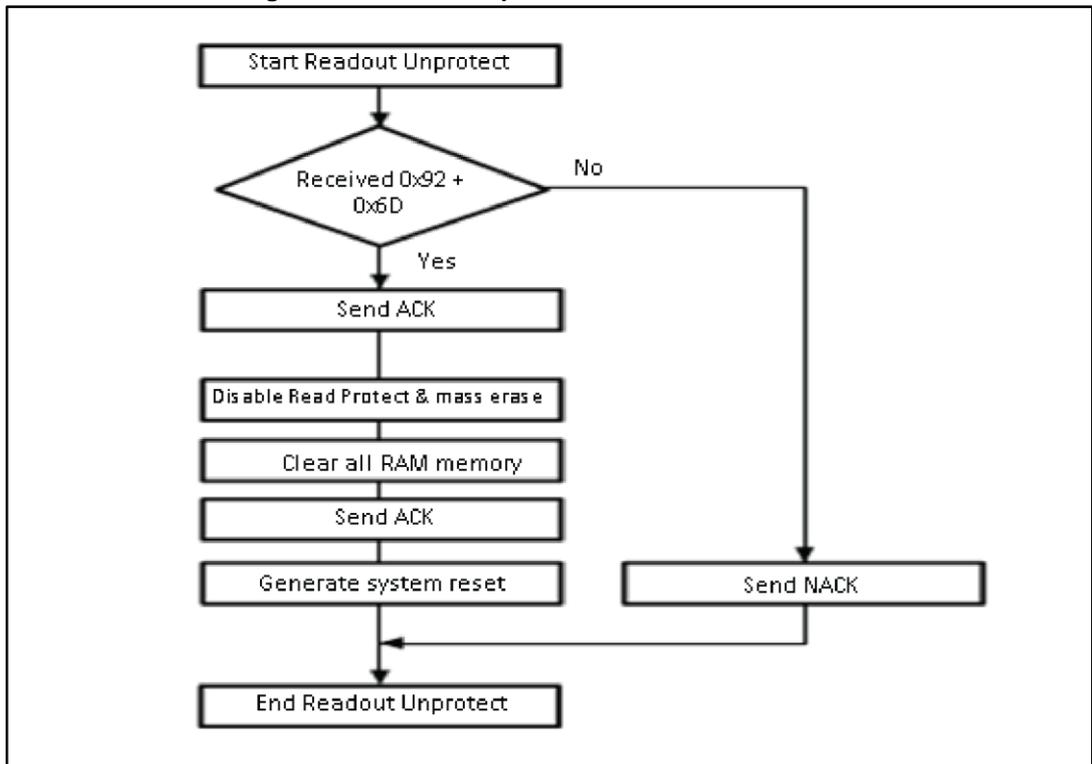


Figure 19: Readout Unprotect command: device side



4 List of acronyms

Table 2: List of acronyms

Term	Description
BLE	Bluetooth low energy

5 Revision history

Table 3: Document revision history

Date	Version	Changes
06-Jul-2016	1	Initial release.

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