AN4307

BM78 EEPROM Upgrade Protocol

Introduction

The BM78 module is a fully certified, embedded 2.4 GHz Bluetooth® Low Energy wireless module with Basic Rate (BR) and Enhanced Data Rate (EDR) features. This application note provides the details about the list of procedures and data formats to conduct the EEPROM upgrade.

The BM78 module includes the following components:

- On-board Bluetooth stack
- Power management subsystem
- 2.4 GHz transceiver
- Radio Frequency (RF) power amplifier

The user can use the BM78 module to embed the Bluetooth functionality into any application. The EEPROM settings configure the behavior of the BM78 firmware, and the external host Microcontroller Unit (MCU) upgrades the EEPROM settings.

Table of Contents

1. Quick References

1.1 Reference Documentation

For further details, refer to the following:

- *Bluetooth Core Specification v5.2* (Core_v5.2)

1.2 Software Requirements

Note: For the following software tools and firmware files, refer to the www.microchip.com/BM78.

- IS1678 UI Tool

1.3 Acronyms and Abbreviations

Table 1-1. Acronyms and Abbreviations

Acronyms and Abbreviations	Description
BDR	Basic Data Rate
BLE	Bluetooth Low Energy
BR	Basic Rate
EDR	Enhanced Data Rate
OCF	OpCode Command Field
OGF	OpCode Group Field
RF	Radio Frequency
MCU	Microcontroller Unit
Core_v5.2	Bluetooth Core Specification v5.2

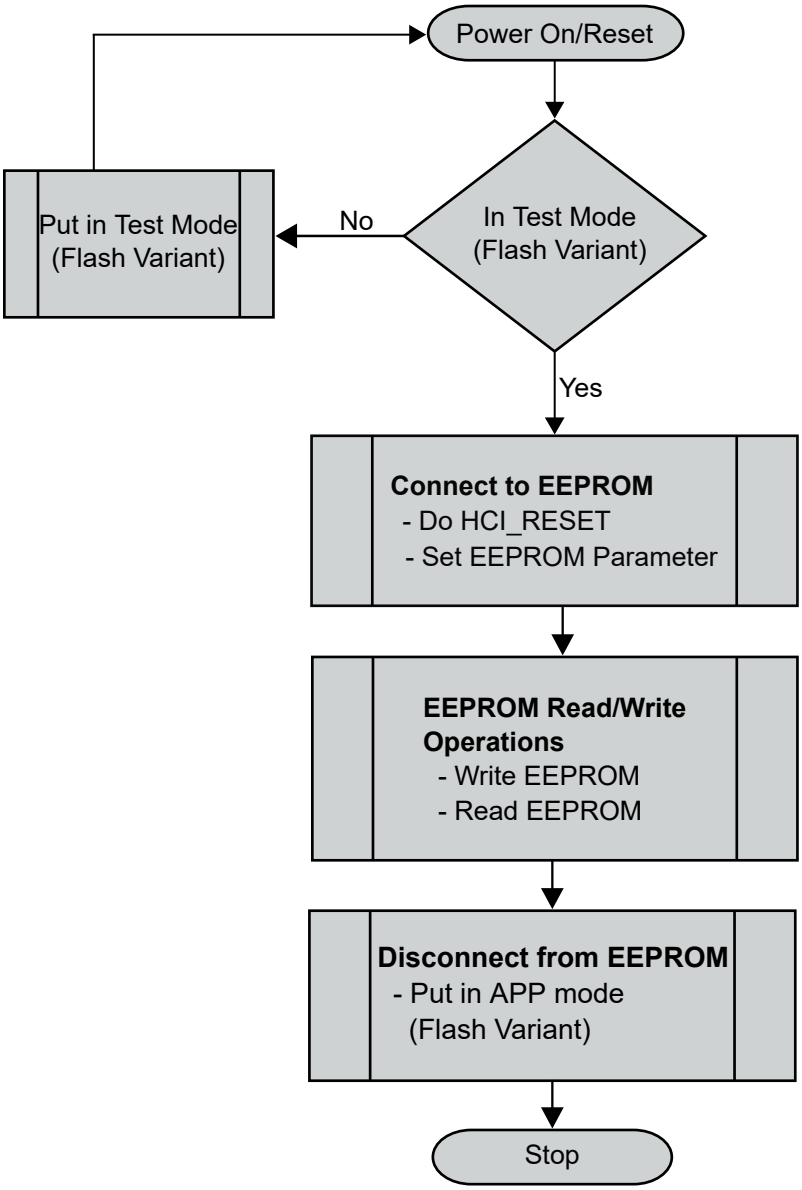
2. BM78 Module Overview

The EEPROM configuration memory stores the EEPROM settings, and the EEPROM settings configure the BM78 module firmware behavior. The IS1678 UI tool allows users to edit the configurable EEPROM setting and generates the output as a structured text file. The IS1678 UI tool also allows users to download the structured text file into the EEPROM memory. In addition to the IS1678 UI tool, the host MCU can also upgrade the EEPROM settings. With either the IS1678 UI tool or with the host MCU, the EEPROM upgrade procedure uses the same protocol as described in the following sections.

2.1 EEPROM Programming Process

The following figure illustrates the steps to follow to perform any EEPROM programming operation with respect to the protocols.

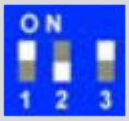
Figure 2-1. Overview of EEPROM Programming Process



The following are the steps in the EEPROM programming process:

- In Test Mode (Flash Variant) – Set the BM78 module into the Test (Write EEPROM) mode. Set the pin P2_0 to ON and the pin P2_4/EAN to the OFF state to enter the Memory Programming mode, and, then, initiate a hardware reset using the RESET pin. The following table provides details about the BM78 Evaluation Board (EVB) mode switch positions. For more details, refer to the *BM78 Evaluation Board (EVB) User's Guide* (DS70005246A).
- Connect to EEPROM – Send the `HCI_Reset` command to the BM78 module to activate the EEPROM read/write operation, and, then, send the `HCI_EEPROM_PAGE_WRITE_NUM` command to set the EEPROM parameter.
- EEPROM Read/Write Operations – Use the `HCI_EEPROM_WRITE` command for the EEPROM setting update, and use the `HCI_E2PROM_READ` to read back the EEPROM setting for verification.
- Disconnect from EEPROM – The host MCU sets the BM78 module into the Application mode using the pins P2_0 and P2_4/EAN. Set the pins P2_0 to ON and P2_4/EAN to the OFF state, and, then, initiate a hardware reset using the RESET pin. The following table provides details about the BM78 Evaluation Board (EVB) mode switch positions. For more details, refer to the *BM78 Evaluation Board (EVB) User's Guide* (DS70005246A).

Table 2-1. BM78 Evaluation Board (EVB) Mode Switch Positions

Mode		Switch Positions	Pin Definition		
			1/P2_0	2/P2_4	3/EAN
Flash	Write Flash		ON	ON	ON
ROM	Test (Write EEPROM)		ON	OFF	ON
	Application (default)		OFF	OFF	ON
Flash	Test (Write EEPROM)		ON	OFF	OFF
	Application (default)		OFF	OFF	OFF

3. EEPROM Operation Command and EEPROM Operation Event

The EEPROM operation command is packed into the HCI command packet, and the E2PROM operation event is packed into the HCI event packet. For more details, see the following table from Bluetooth Core Specification v5.2 (Core_v5.2).

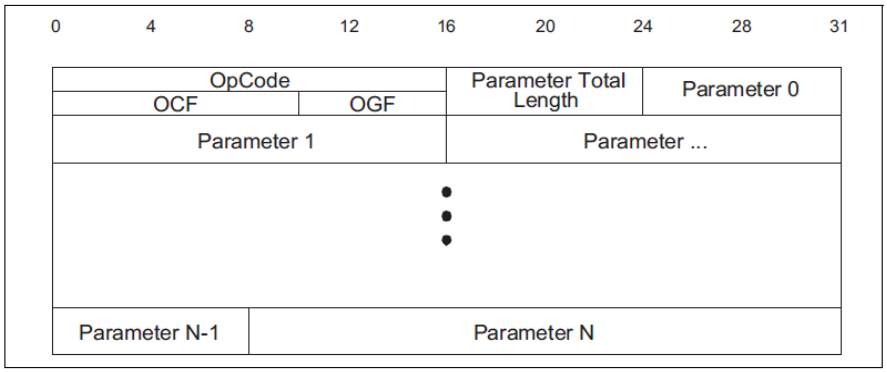
Table 3-1. HCI Packet Indicators

HCI Packet Type	HCI Packet Indicator
HCI command packet	0x01
HCI ACL data packet	0x02
HCI synchronous data packet	0x03
HCI event packet	0x04
HCI ISO data packet	0x05

The EEPROM command packet always starts with 0x01. The following figure illustrates the rest of the HCI command from the Core_v5.2. The OpCode has a 16-bit length, where the OpCode Command Field (OCF) combines each OpCode in the lower 10 bits and the OpCode Group Field (OGF) in the upper 6 bits.

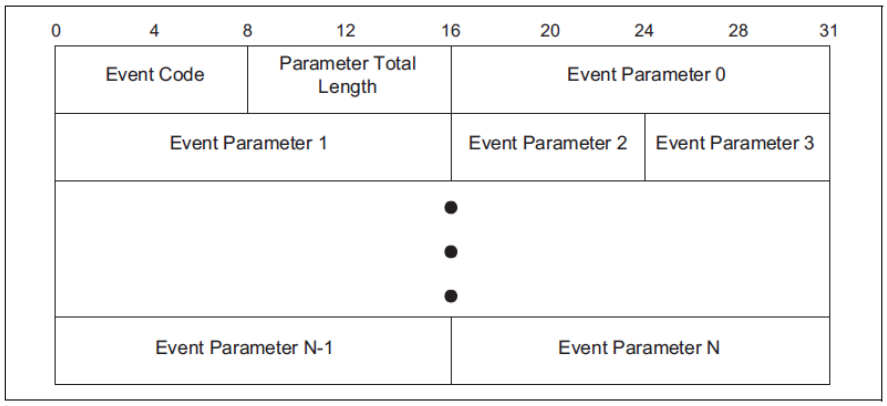
Note: This application note defines the OpCode for the EEPROM operation.

Figure 3-1. HCI Command Packet



The EEPROM event packet always starts with 0x04. The following figure illustrates the E2PROM event = 0x04, along with the rest of the HCI event packet from the Core_v5.2.

Figure 3-2. HCI Event Packet



The EEPROM event is packed in the `HCI_Command_Complete` event with the event code set to 0x0E. For more details, refer to Section 7.7.14 from the *Bluetooth Core Specification v5.2*.

Table 3-2. HCI Command Complete Event

Event	Event Code	Event Parameters
`HCI_Command_Complete`	0x0E	• `Num_HCI_Command_Packets` • `Command_Opcode` • `Return_Parameters`

3.1 HCI_Reset Command and Event

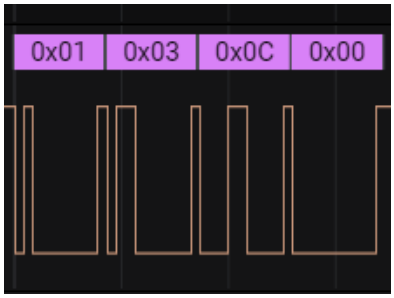
Use the `HCI_Reset` command to enable the EEPROM operation. The OGF is 0x03 and the OCF is 0x03, so the HCI OpCode is 0x0C03. For more details, refer to the *Bluetooth Core Specification v5.2*.

Table 3-3. HCI Reset Command

Command	OCF	Command Parameters	Return Parameters
`HCI_Reset`	0x0003		Status

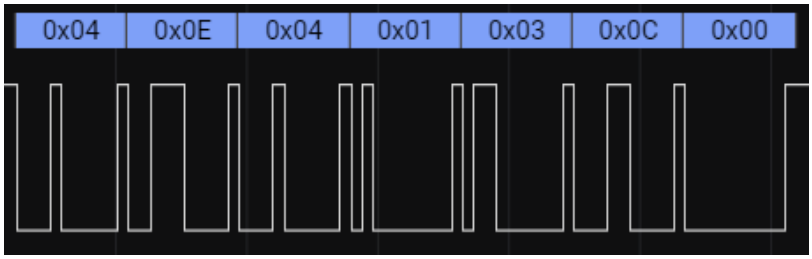
- Example data – The `HCI_Reset` command
  - 0x01 – HCI command packet
  - 0x03 0x0C – OpCode 0x0C03 is sent in little endian as 0x03 and 0x0C
  - 0x00 – The `HCI_Reset` packet has no parameter, so the length field is set to 0x00

Figure 3-3. Example of `HCI_Reset` Command



- Example data – The event to `HCI_Reset`
  - 0x04 – HCI event packet
  - 0x0E – Command complete event of HCI event
  - 0x04 – Total 4 bytes of parameter appended
  - 0x01 0x03 0x0C – The processed HCI command
  - 0x00 – Indicate a success

Figure 3-4. Event to `HCI_Reset` Command



3.2 HCI_EEPROM_WRITE_NUMBER Command and Event

Use the `HCI_EEPROM_WRITE_NUMBER` command to specify the size of the EEPROM write operation. The OCF is 0x2D and the HCI OpCode is 0xFC2D.

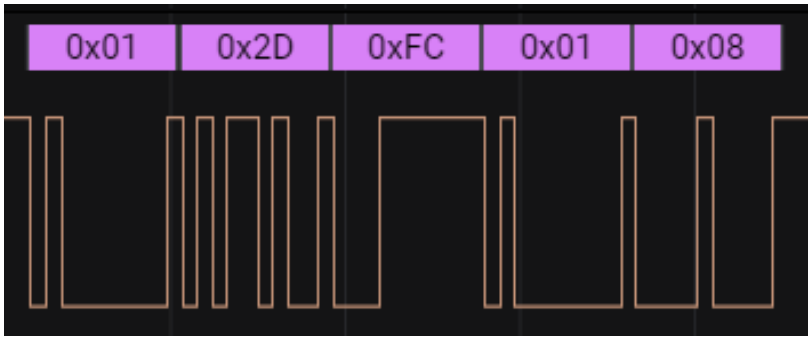
- `Page_Write_Number` – For the BM78 module, the `Page_Write_Number` parameter is fixed as 0x08 and takes 1 byte.

Table 3-4. `HCI_EEPROM_Page_Write_Number` Command

Command	OCF	Command Parameters	Return Parameters
`HCI_EEPROM_Page_Write_Numbe r`	0x2D	`Page_Write_Number`	Status
Use the `HCI_EEPROM_Page_Write_Number` command to set the number of EEPROM page write.			
`Page_Write_Number`			Size – 1 byte
Value	**Parameter Description**		
0xXX	For the BM78 module, the supported number of EEPROM page write Atmel – 8 bytes ISSI – 16 bytes A-plus – 8 bytes		
Status			Size – 1 byte
Value	**Parameter Description**		
0x00	`HCI_EEPROM_Page_Write_Number` command succeeded		
0x01-0xFF	`HCI_EEPROM_Page_Write_Number` command failed		

- Example data – The `HCI_EEPROM_WRITE_NUMBER` command
  - 0x01 – HCI command packet
  - 0x2D 0xFC – OpCode 0xFC2D is sent in a little endian as 0x2D 0xFC
  - 0x01 – The parameter length
  - 0x08 – The write number is 0x08 for the BM78 module

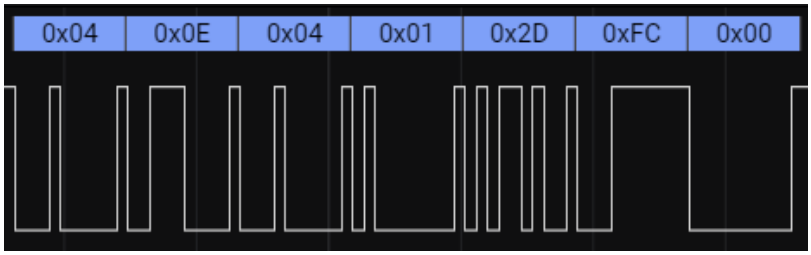
Figure 3-5. Example of Data `HCI_EEPROM_WRITE_NUMBER` Command



- Example data – Event to the `HCI_EEPROM_WRITE_NUMBER` command
  - 0x04 – HCI event packet
  - 0x0E – Command complete event of HCI event

– 0x04 – Total 4 bytes of parameter appended
– 0x01 0x2D 0xFC – The processed HCI command
– 0x00 – Indicate a success

Figure 3-6. Event of `HCI_EEPROM_WRITE_NUMBER` Command



3.3 HCI_EEPROM_WRITE Command and Event

Use the `HCI_EEPROM_WRITE` command to write data into the EEPROM location specified by the `Start_Address` parameter. The OCF is 0x27 and the HCI OpCode is 0xFC27.

- `Start_Address` – Indicates the start address of the EEPROM record and takes 2 bytes
- Length – Indicates the write length of the EEPROM record and takes 1 byte (approximately ranging from 1 to 240)
- Data – Indicates the data of the EEPROM record and takes Length bytes

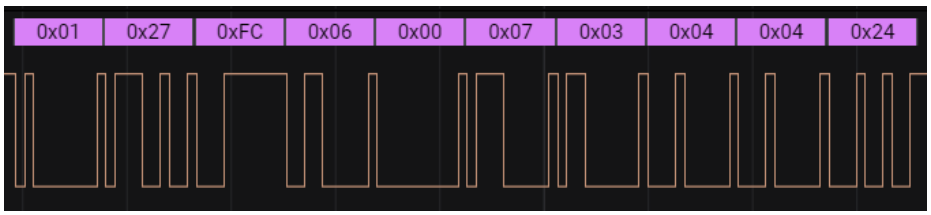
Table 3-5. `HCI_EEPROM_Write` Command

Command	OCF	Command Parameters	Return Parameters
`HCI_EEPROM_WRITE`	0x27	`Start_Address`, Length and Data	Status
Use the `HCI_EEPROM_Write` command to write the data into EEPROM.			
`Start_Address`			Size – 2 bytes
Value	**Parameter Description**		
0xXXXX	Start writing address		
Length			Size – 1 byte
Value	**Parameter Description**		
N	Length of the data written into EEPROM N: 1-240		
Data			Size – N byte
Value	**Parameter Description**		
	N bytes of the data written to EEPROM N: 1-240		
Status			Size – 1 byte
Value	**Parameter Description**		
0x00	`HCI_EEPROM_Write` command succeeded		

.....continued			
Command	OCF	Command Parameters	Return Parameters
0x01-0xFF	`HCI_EEPROM_Write` command failed		

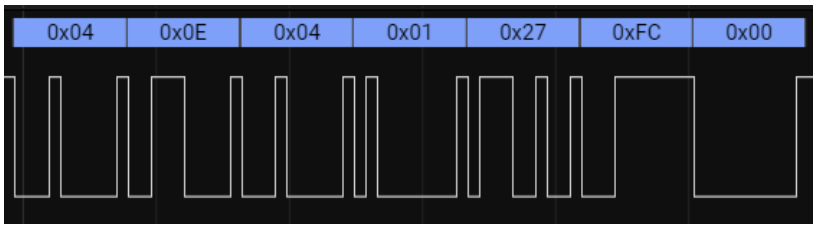
- Example data – `HCI_EEPROM_WRITE` command
  - 0x01 – HCI command packet
  - 0x27 0xFC – OpCode 0xFC27 is sent in a little endian as 0x27 0xFC
  - 0x06 – The parameter length of the HCI command
  - 0x00 0x07 – `Start_Address` of the EEPROM record
  - 0x03 – Write the length of the EEPROM record
  - 0x04 0x04 0x24 – The data of the EEPROM record

Figure 3-7. Example of `HCI_EEPROM_WRITE` Command



- Example data – Event to `HCI_EEPROM_WRITE` command
  - 0x04 – HCI event packet
  - 0x0E – Command complete event of HCI event
  - 0x04 – Total 4 bytes of parameter appended
  - 0x01 0x27 0xFC – The processed HCI command
  - 0x00 – Indicate a success

Figure 3-8. Event of `HCI_EEPROM_WRITE` Command



3.4 HCI_EEPROM_READ Command and Event

Use the `HCI_EEPROM_READ` command to read back the data from the EEPROM location specified by the `Start_Address` parameter. The OCF is 0x29 and the HCI OpCode is 0xFC29. To verify, use the `HCI_EEPROM_READ` command to read back the EEPROM record after a `HCI_EEPROM_WRITE` command.

- `Start_Address` – Indicates the start address of the EEPROM record and takes 2 bytes
- Length – Indicates the read length of the EEPROM record and takes 1 byte (approximately ranging from 1-240)

Data is returned in the command complete event:

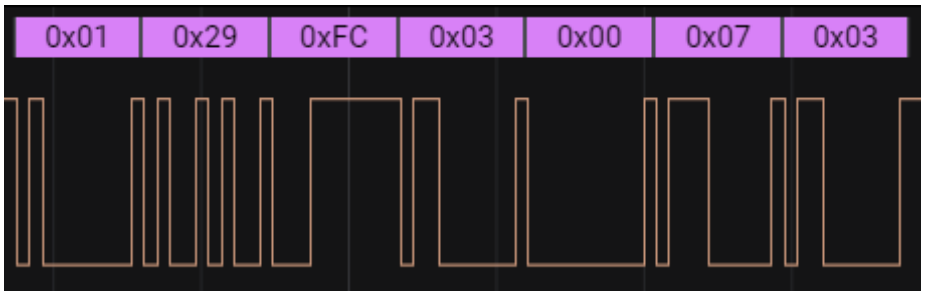
- Status – Indicates the operation status and takes 1 byte
- `Start_Address` – Indicates the start address of the EEPROM record and takes 2 bytes
- Length – Indicates the length of the EEPROM record and takes 1 byte (approximately ranging from 1-240)
- Data – Indicates the data of the EEPROM record and takes Length bytes

Table 3-6. `HCI_EEPROM_Read` Command

Command	OCF	Command Parameters	Return Parameters
`HCI_EEPROM_Read`	0x29	`Start_Address` and Length	Status, `Start_Address`, Length and Data
Use the `HCI_EEPROM_Read` command to read the data from EEPROM.			
`Start_Address`			Size – 2 bytes
Value	**Parameter Description**		
0xXXXX	Start reading address		
Length			Size – 1 byte
Value	**Parameter Description**		
N	Indicates the length of the data to read (in bytes) from EEPROM. N: 1-240		
Status			Size – 1 byte
Value	**Parameter Description**		
0x00	`HCI_EEPROM_Read` command succeeded		
0x01-0xFF	`HCI_EEPROM_Read` command failed. See listing of Error Codes.		
`Start_Address`			Size – 2 bytes
Value	**Parameter Description**		
0xXXXX	Start reading address		
Length			Size – 1 byte
Data			Size – N bytes
Value	**Parameter Description**		
	N bytes of data read from EEPROM		

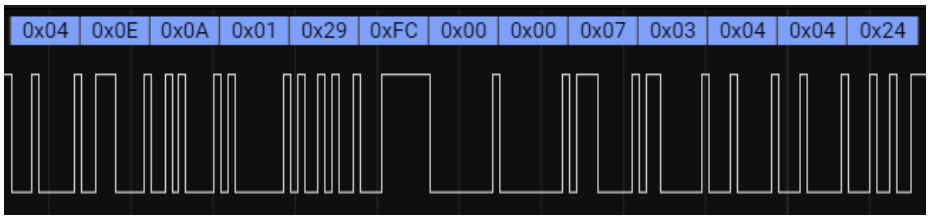
- Example data – `HCI_EEPROM_READ` Command
  - 0x01 – HCI command packet
  - 0x29 0xFC – OpCode 0xFC29 is sent in a little endian as 0x29 0xFC
  - 0x03 – The parameter length of the HCI command
  - 0x00 0x07 – Start_Address of the E2PROM record
  - 0x03 – Read back the length of the EEPROM record

Figure 3-9. Exampe of `HCI_EEPROM_READ` Command



- Example data – Event to `HCI_EEPROM_ READ` command
  - 0x04 – HCI event packet
  - 0x0E – Command complete event of the HCI event
  - 0x0A – Total 10 bytes of parameter appended
  - 0x01 0x29 0xFC – The processed HCI command
  - 0x00 – Indicate a success
  - 0x00 0x07 – `Start_Address` of the EEPROM record
  - 0x03 – Read back the length of the EEPROM record
  - 0x04 0x04 0x24 – Read back data of the EEPROM record

Figure 3-10. Event of `HCI_EEPROM_READ` Command



4. Document Revision History

Revision	Date	Section	Description
A	11/2021	Document	Initial Revision

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