

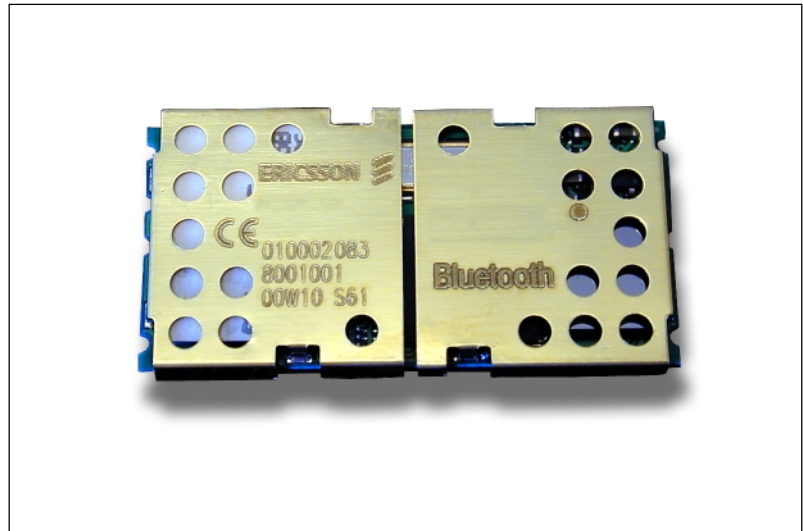
# ROK 101 007 Bluetooth Module

## Key Features

- Pre-qualified Bluetooth 1.0B Module
- RF output power class 2
- FCC and ETSI approved
- 460 kb/s max data rate over UART
- Multiple interface for different applications
  - UART for data
  - PCM for voice
  - USB for voice and data
- I<sup>2</sup>C interface
- Internal crystal oscillator
- HCI firmware included
- Multi Point Operation
- Built-in shielding

## Suggested Applications

- Computers and peripherals
- Handheld devices and accessories
- Access points



## Description

ROK 101 007 is a short-range module for implementing Bluetooth functionality into various electronic devices. The module consists of three major parts; a baseband controller, a flash memory, and a radio that operates in the globally available 2.4–2.5 GHz free ISM band.

Both data and voice transmission is supported by the module. Communication between the module and the host controller is carried out using a high-speed USB interface compliant with USB Specifications 1.1 or an UART/PCM interface. When using the USB interface, the module appears as a USB slave device and therefore requires no PC resources.

ROK 101 007, which is compliant with Bluetooth version 1.0B, is a Class 2 Bluetooth Module (0 dBm) and is type-approved. The module supports all Bluetooth profiles.

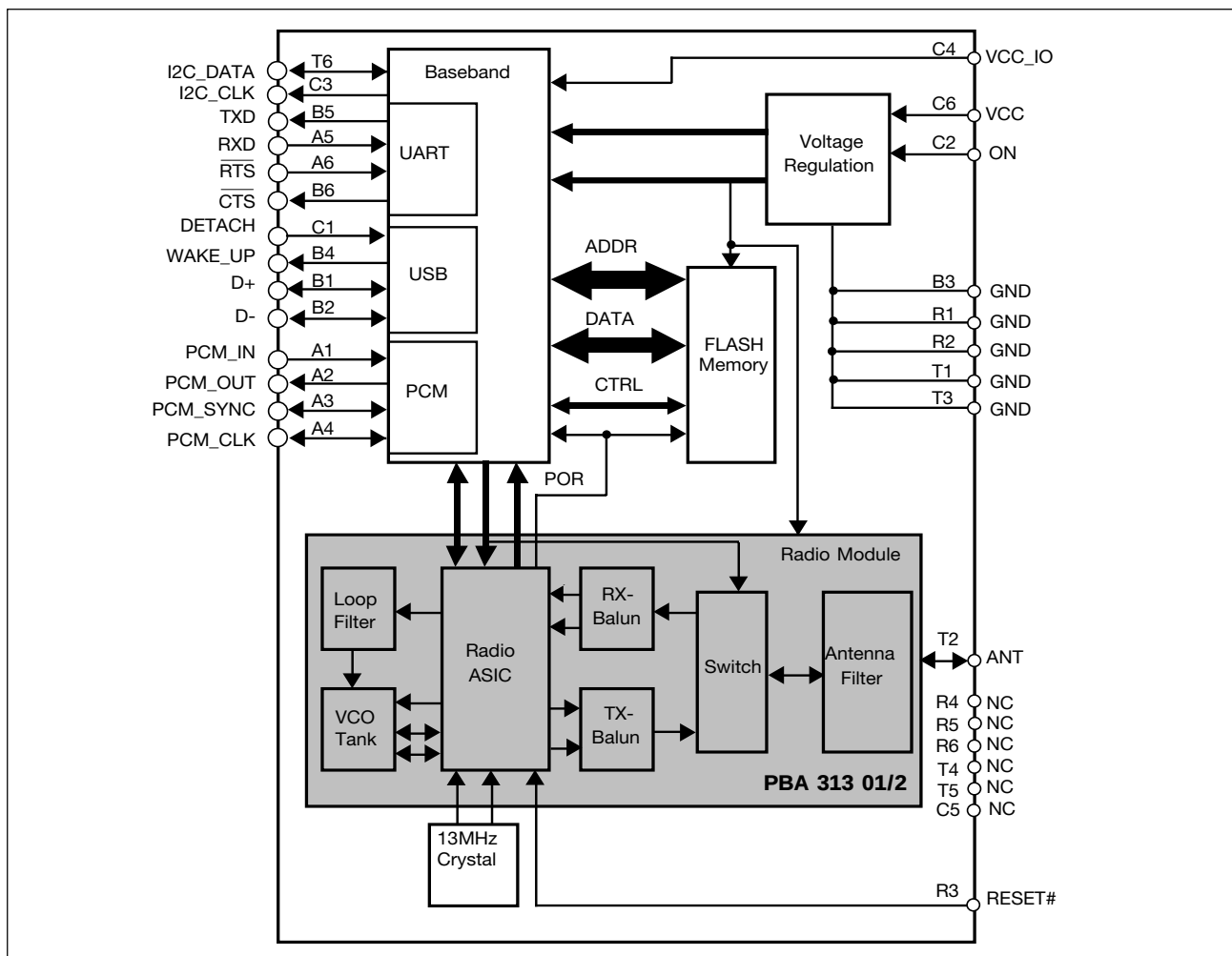


Figure 1. Block Diagram

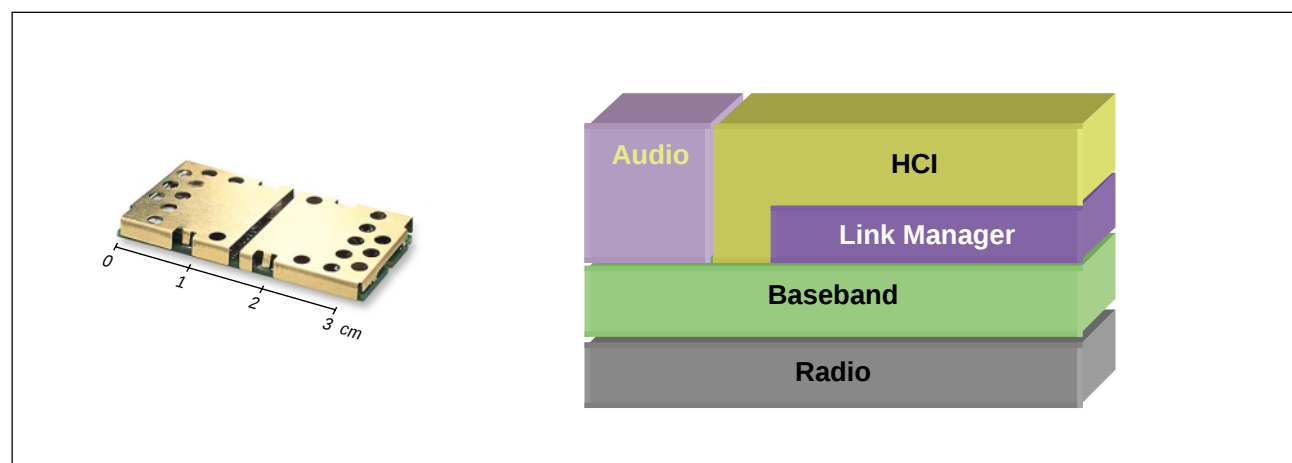


Figure 2. Actual size of the Ericsson Bluetooth Module, and also showing the HW and FW stack.

## Absolute Maximum Ratings

| Parameter             | Symbol       | Min  | Typ | Max                | Unit |
|-----------------------|--------------|------|-----|--------------------|------|
| Temperature           |              |      |     |                    |      |
| Storage temperature   | $T_{Stg}$    | -30  |     | +85                | °C   |
| Operating temperature | $T_{Amb}$    | 0    |     | +75                | °C   |
| <b>Power Supply</b>   |              |      |     |                    |      |
| $V_{CC}$              | $V_{CC}$     | -0.3 |     | +5.25              | V    |
| $V_{CC\_IO}$          | $V_{CC\_IO}$ | -0.8 |     | +3.6               | V    |
| Digital Inputs        |              |      |     |                    |      |
| Input low voltage     | $V_{IL}$     | -0.5 |     |                    | V    |
| Input high voltage    | $V_{IH}$     |      |     | $V_{CC\_IO} + 0.3$ | V    |

## Recommended Operating Conditions

|                           |              |  |      |  |    |
|---------------------------|--------------|--|------|--|----|
| Temperature               |              |  |      |  |    |
| Ambient temperature, Test | $T_{amb}$    |  | +23  |  | °C |
| <b>Power Supply</b>       |              |  |      |  |    |
| Positive Supply Voltage   | $V_{CC}$     |  | +3.3 |  | V  |
| I/O Ports Supply Voltage  | $V_{CC\_IO}$ |  | +3.3 |  | V  |

## Electrical Characteristics

### DC Specifications

Unless otherwise noted, the specification applies for  $T_{Amb} = 0$  to  $+75^{\circ}\text{C}$ ,  $3.175 < V_{CC} < 5.25\text{V}$

| Parameter                | Condition        | Symbol       | Min                     | Typ | Max                     | Unit |
|--------------------------|------------------|--------------|-------------------------|-----|-------------------------|------|
| <b>Power Supply</b>      |                  |              |                         |     |                         |      |
| Supply Voltage           |                  | $V_{CC}$     | 3.175                   | 3.3 | 5.25                    | V    |
| I/O Ports Supply Voltage | See note 10      | $V_{CC\_IO}$ | 2.7                     | 3.3 | 3.6                     | V    |
| <b>Digital Inputs</b>    |                  |              |                         |     |                         |      |
| Logical Input High       | Except ON signal | $V_{IH1}$    | $0.7 \times V_{CC\_IO}$ |     | $V_{CC\_IO}$            | V    |
| Logical Input Low        | Except ON signal | $V_{IL2}$    | 0                       |     | $0.3 \times V_{CC\_IO}$ | V    |
| Logical Input High       | ON signal only   | $V_{IH2}$    | 2.0                     |     | $V_{CC}$                | V    |
| Logical Input Low        | ON signal only   | $V_{IL2}$    | 0                       |     | 0.4                     | V    |
| <b>Digital Outputs</b>   |                  |              |                         |     |                         |      |
| Logical Output High      |                  | $V_{OH}$     | $0.9 \times V_{CC\_IO}$ |     | $V_{CC\_IO}$            | V    |
| Logical Output Low       |                  | $V_{OL}$     | 0                       |     | $0.1 \times V_{CC\_IO}$ | V    |

| 5Parameter                              | Condition                                                                                                                                                | Symbol       | Min | Typ  | Max | Unit    |
|-----------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|-----|------|-----|---------|
| <b>Average Current Consumption</b>      | Average $I_{CC} + I_{CC\_IO}$                                                                                                                            |              |     |      |     |         |
| Standby                                 |                                                                                                                                                          | $I_{STA}$    |     | 5.95 |     | mA      |
| Shutdown - SW                           |                                                                                                                                                          | $I_{SSW}$    |     | 2.35 |     | mA      |
| Shutdown - HW                           | See note 1                                                                                                                                               | $I_{SHW}$    |     | 1    |     | $\mu A$ |
| Page Scan Mode R0                       | Page Scan Enable<br>Page scan window: continuous<br>Page scan interval : n/a (0s)                                                                        | $I_{PSM1}$   |     | 50   |     | mA      |
| Page Scan Mode R1                       | Page Scan Enable<br>Page scan window: 11.25ms<br>Page scan interval : 1.28s                                                                              | $I_{PSM2}$   |     | 6.35 |     | mA      |
| Page Scan Mode R2                       | Page Scan Enable<br>Page scan window: 11.25ms<br>Page scan interval : 2.56s                                                                              | $I_{PSM3}$   |     | 6.15 |     | mA      |
| Inquiry Scan<br>with Page Scan Mode R0. | Inquiry Scan Enable<br>Page Scan Window : 2.56s –11.25ms<br>Page Scan Interval : 2.56s<br>Inquiry Scan Window : 11.25ms<br>Inquiry Scan Interval : 2.56s | $I_{ISM1}$   |     | 50   |     | mA      |
| Inquiry Scan<br>with Page Scan Mode R1. | Inquiry Scan Enable<br>Page Scan Window : 11.25ms<br>Page Scan Interval : 1.28s<br>Inquiry Scan Window : 11.25ms<br>Inquiry Scan Interval : 2.56s        | $I_{ISM2}$   |     | 6.55 |     | mA      |
| Inquiry Scan<br>with Page Scan Mode R2. | Inquiry Scan Enable<br>Page Scan Window : 11.25ms<br>Page Scan Interval : 2.56s<br>Inquiry Scan Window : 11.25ms<br>Inquiry Scan Interval : 2.56s        | $I_{ISM3}$   |     | 6.35 |     | mA      |
| Connect State                           | Established connection<br>with data transfer                                                                                                             | $I_{CS}$     |     | 26   |     | mA      |
| $V_{CC\_IO}$ Current                    | Only $I_{CC\_IO}$ , $V_{CC\_IO}=TBD$                                                                                                                     | $I_{CC\_IO}$ |     | TBD  |     | mA      |

**RF Specifications**

| Parameter                                  | Condition                                   | Symbol        | Min   | Typ     | Max   | Unit     |
|--------------------------------------------|---------------------------------------------|---------------|-------|---------|-------|----------|
| <b>General</b>                             |                                             |               |       |         |       |          |
| Frequency Range                            |                                             |               | 2.402 |         | 2.480 | GHz      |
| Double Sided IF Bandwidth                  |                                             |               |       | 1       |       | MHz      |
| Antenna load                               |                                             |               |       | 50      |       | $\Omega$ |
| VSWR                                       | RX mode                                     |               |       | 3:1     |       |          |
| VSWR                                       | TX mode, see note 2                         |               |       | 3:1     |       |          |
| <b>Receive Performance</b>                 |                                             |               |       |         |       |          |
| Sensitivity level                          | $P_{IN}$ : -70dBm,<br>75kHz offset (max),   |               |       |         | 0.1%  | BER      |
| Max input level                            | $P_{IN}$ : -20dBm,<br>75kHz offset (max),   |               |       |         | 0.1%  | BER      |
| $C/I$ co-channel                           | C: -60 dBm                                  |               |       |         | 14    | dB       |
| $C/I$ 1MHz                                 | C: -60 dBm                                  |               |       |         | +4    | dB       |
| $C/I$ 2MHz                                 | C: -60 dBm                                  |               |       |         | -30   | dB       |
| $C/I$ $\geq 3$ MHz                         | C: -67 dBm                                  |               |       |         | -40   | dB       |
| Blocking, $C/I_{DC-5GHz}$                  | See figure 6                                |               |       |         |       |          |
| Out-of-band blocking                       | 30-1910 MHz                                 |               | +4    |         |       | dBm      |
|                                            | 1910-2000 MHz                               |               | -10   |         |       | dBm      |
|                                            | 2000-2399 MHz                               |               | -27   |         |       | dBm      |
|                                            | 2484-3000 MHz                               |               | -27   |         |       | dBm      |
|                                            | 3.00-12.75 GHz                              |               | -10   |         |       | dBm      |
| Spurious Emissions                         | 30 MHz to 1 GHz                             |               |       |         | -57   | dBm      |
| Spurious Emissions                         | 1 GHz to 12.75 GHz                          |               |       |         | -47   | dBm      |
| <b>Transmitter Performance</b>             |                                             |               |       |         |       |          |
| Frequency deviation                        | see notes 3,4<br>and figure 3               | $f_{Mod}$     | 140   |         | 175   | kHz      |
| Initial frequency error                    | see note 5                                  |               | -48   |         | +48   | kHz      |
| TX power                                   |                                             |               | -2    | 1.5     | 4     | dBm      |
| TX carrier drift in 1 slot (366 $\mu$ s)   |                                             | $f_{Drift1}$  | -25   |         | 25    | kHz      |
| TX carrier drift in 3 slots (1598 $\mu$ s) |                                             | $f_{Drift2}$  | -40   |         | 40    | kHz      |
| TX carrier drift in 5 slots (2862 $\mu$ s) | see figure 4                                | $f_{Drift3}$  | -40   |         | 40    | kHz      |
| 20 dB bandwidth                            | Measured with RBW: 10 kHz and peak detector |               |       |         | 1.000 | MHz      |
| Spurious Emissions                         | 30 MHz – 1GHz                               |               |       |         | -36   | dBm      |
| Spurious Emissions                         | 1 GHz – 12.75 GHz                           |               |       |         | -30   | dBm      |
| Spurious Emissions                         | 1.8 Hz – 1.9 GHz                            |               |       |         | -47   | dBm      |
| Spurious Emissions                         | 5.15 GHz – 5.3 GHz                          |               |       |         | -47   | dBm      |
| <b>Timing performance</b>                  |                                             |               |       |         |       |          |
| LPO_CLK frequency                          | Trimmed, see note 6                         | $f_{LPO-CLK}$ |       | 3,2     |       | kHz      |
| Tolerance of LPO_CLK                       | see note 6                                  |               | -250  |         | +250  | ppm      |
| System clock frequency                     |                                             | $f_{SYS-CLK}$ |       | 13.0000 |       | MHz      |
| Tolerance of system clock                  | see note 5                                  |               | -20   |         | +20   | ppm      |
| Channel switching time                     | see figure 5                                |               |       | 150     |       | $\mu$ s  |
| <b>Received Signal Strength Indicator</b>  |                                             |               |       |         |       |          |
| RSSI                                       | Input power = -40 dBm                       |               | 15    |         | 25    | n/a      |
| RSSI                                       | Input power = -60 dBm                       |               | 3     |         | 11    | n/a      |

## RF Specifications continued...

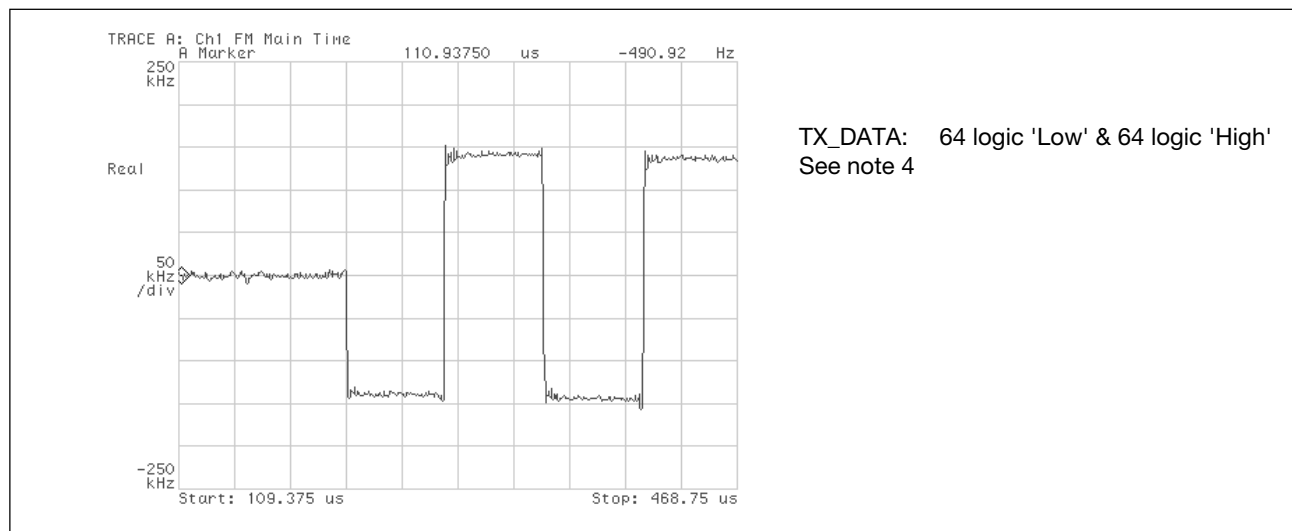


Figure 3. Frequency Deviation

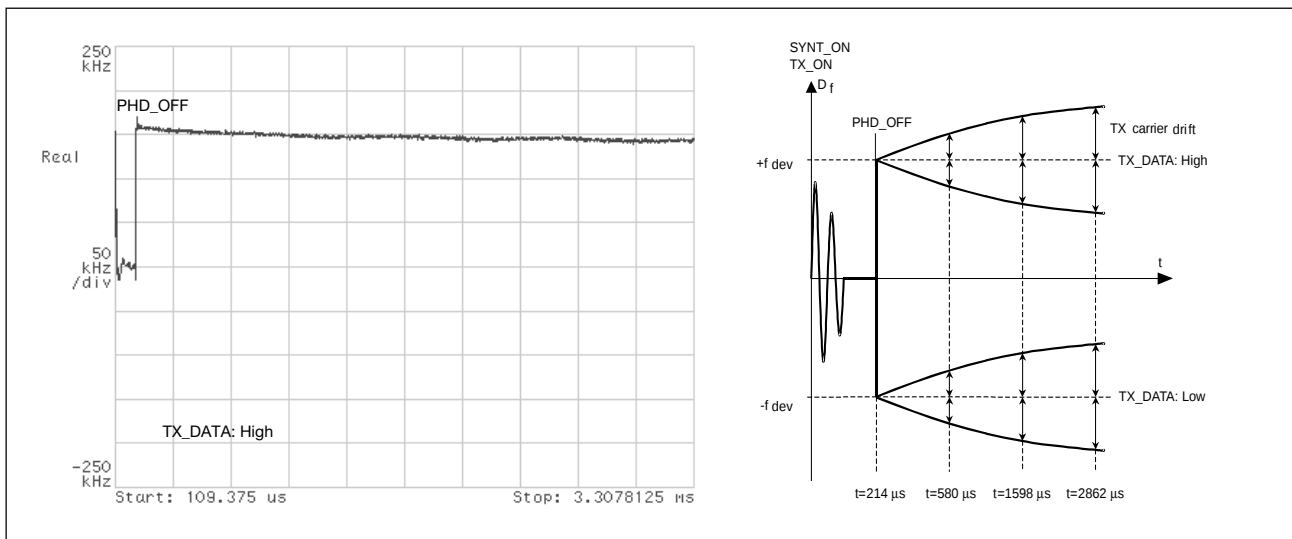


Figure 4. Frequency drift.

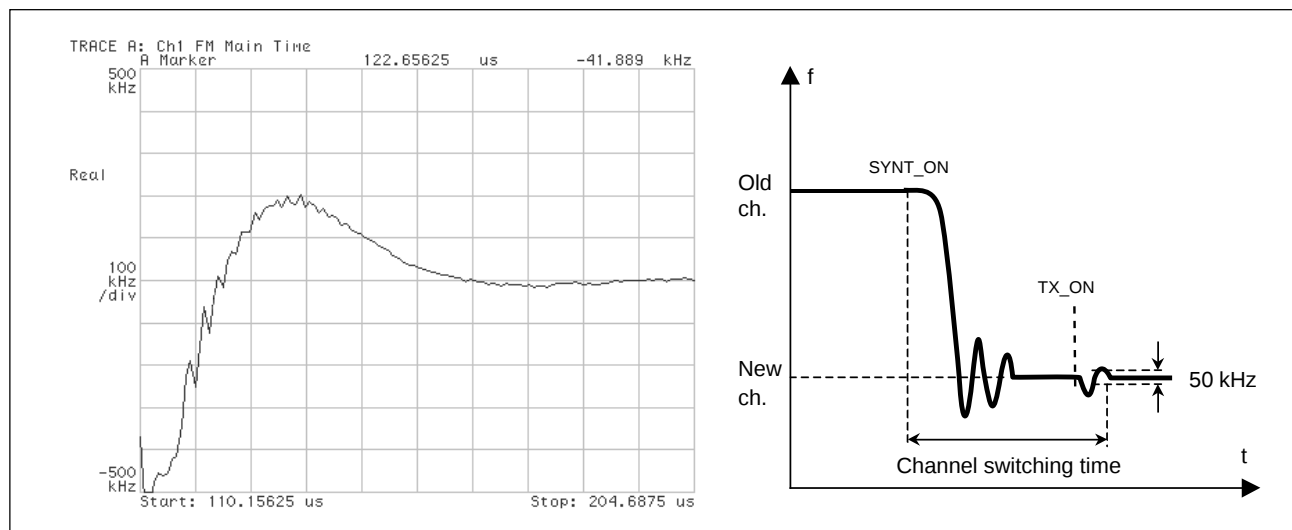


Figure 5. Channel switching time

RF Specifications continued...

C/I Blocking

The blocking characteristics can be basically split into two regions: In-band and Out-of-band. Blocking is performed both on the chip and on the module level.

- **In-band**
  - Filtering on chip
  - C/I @ 2MHz: -30 dB -> 0.1%BER
  - C/I ≥ 3MHz: -40 dB -> 0.1%BER
- **Out-of-band**
  - Antenna filter, DC to 1.9 GHz and 3:rd harmonic.
  - Switch, low freq. and 2:nd harmonic.
  - RX-balun, low freq. and 2:nd harmonic.
  - On-chip IF filter

Figure 6 shows the combination blocking effect of the antenna switch, antenna filter and RX balun. In addition to the blocking characteristics shown in figure 6, there is antenna isolation and filtering on the chip.

Marker 1 shows the region where the Bluetooth band is located. Markers 2 - 4 show the blocking at the telecom frequency bands.

An example of the total blocking characteristics can be seen in figure 7.

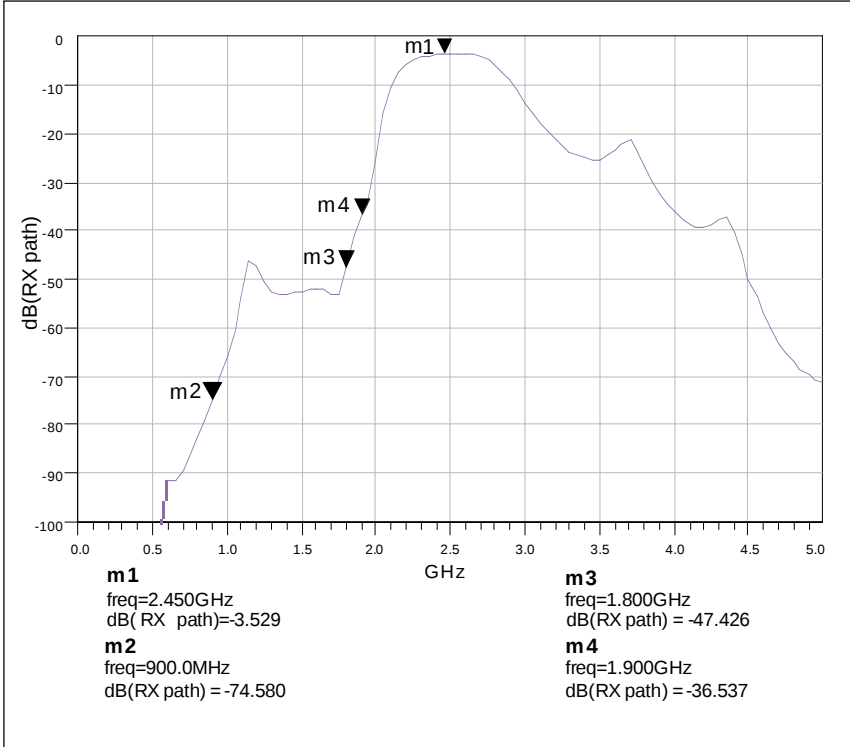


Figure 6. Typical blocking characteristics excluding antenna isolation and on chip filtering.

| Example 1                                                     |         | Example 2                                        |         |
|---------------------------------------------------------------|---------|--------------------------------------------------|---------|
| Interference of +33 dBm at 1015 MHz.                          |         | Interference of +33 dBm at 1910 MHz.             |         |
| • Antenna isolation                                           | 15 dB   | • Antenna isolation                              | 25 dB   |
| • Antenna filter, Antenna switch, RX-balun                    | 27 dB   | • Antenna filter, Antenna switch, RX-balun       | 36 dB   |
| • Interference level before IF filter +33-15-27=              | -9 dBm  | • Interference level before IF filter +33-25-36= | -28 dBm |
| 0.1% BER requires a C/I of more than -40 dB at the IF filter. |         |                                                  |         |
| • 0.1% BER carrier level -40 + (-9)=                          | -49 dBm | • 0.1% BER carrier level -40 + (-28)=            | -68 dBm |

Figure 7. Blocking examples.

| Pin Description |          |       |           |                                                                                        |
|-----------------|----------|-------|-----------|----------------------------------------------------------------------------------------|
| Pin             | Pin Name | Type  | Direction | Description                                                                            |
| A1              | PCM_IN   | CMOS  | In        | PCM data, see notes 7,9                                                                |
| A2              | PCM_OUT  | CMOS  | Out       | PCM data, see notes 7,9                                                                |
| A3              | PCM_SYNC | CMOS  | In/Out    | Sets the PCM data sampling rate, see notes 7,9                                         |
| A4              | PCM_CLK  | CMOS  | In/Out    | PCM clock that sets the PCM data rate, see notes 7,9                                   |
| A5              | RXD      | CMOS  | Input     | RX data to the UART, see note 9                                                        |
| A6              | RTS      | CMOS  | Input     | Flow control signal, Request To Send data from UART, see notes 7,9                     |
| B1              | D+       | CMOS  | In/Out    | USB data pin, see notes 9,10                                                           |
| B2              | D-       | CMOS  | In/Out    | USB data pin, see notes 9,10                                                           |
| B3              | GND      | Power | Power     | Signal ground                                                                          |
| B4              | WAKE_UP  | CMOS  | Output    | Indicates that the module wants to be attached to the USB, Active High. See notes 9,10 |
| B5              | TXD      | CMOS  | Output    | TX data from the UART, see note 9                                                      |
| B6              | CTS      | CMOS  | Output    | Flow control signal, Clear To Send data from UART, see note 9                          |
| C1              | DETACH   | CMOS  | Input     | Indicates that the USB host wants to detach the module, Active High. See notes 7,9     |
| C2              | ON       | Power | Input     | When tied to $V_{CC}$ , the module is enabled.                                         |
| C3              | I2C_CLK  | CMOS  | Output    | I2C clock signal, see note 9                                                           |
| C4              | VCC_IO   | Power | Power     | External supply rail to the Input / Output ports                                       |
| C5              | NC       | -     | -         | Do not connect                                                                         |
| C6              | VCC      | Power | Power     | Supply Voltage                                                                         |
| R1              | GND      | Power | Power     | Signal ground                                                                          |
| R2              | GND      | Power | Power     | Signal ground                                                                          |
| R3              | RESET#   | CMOS  | Input     | Active low reset, see notes 8,9                                                        |
| R4              | NC       | -     | -         | Do not connect                                                                         |
| R5              | NC       | -     | -         | Do not connect                                                                         |
| R6              | NC       | -     | -         | Do not connect                                                                         |
| T1              | GND      | Power | Power     | Signal Ground                                                                          |
| T2              | ANT      | RF    | In/Out    | 50 $\Omega$ Antenna connection                                                         |
| T3              | GND      | Power | Power     | Signal Ground                                                                          |
| T4              | NC       | Power | Power     | Test point, internal voltage regulator - Do not connect                                |
| T5              | NC       | -     | -         | Do not connect                                                                         |
| T6              | I2C_DATA | CMOS  | In/Out    | I2C data signal, see note 9                                                            |

## Notes

1. Current consumption is based upon when the module is when 'ON' is low and 'VCC\_IO' is grounded.
2. During the TX mode, the VSWR specification states the limits that are acceptable before any other RF parameters are strongly effected, i.e. frequency deviation and initial frequency error.
3. Frequency deviation measurements are now recorded differentially,  $(f_{Mod1} - f_{Mod0}) / 2$ .
4. Provided that the TX INV register (bit 0) has been set in the enable register at startup.
5. Tolerance for the system clock takes into account both the complete temperature range and aging of the crystal.
6. LPO\_CLK frequency is pre-trimmed within a tolerance of  $\pm 250$ ppm.
7. 100k $\Omega$  pull-up resistors to  $V_{CC\_IO}$  are used on the module. PCM signals direction is programmable
8. RESET# signal must be fed from an open drain output.
9. CMOS buffers are low voltage TTL compatible signals.
10. To be compliant with the USB specification,  $V_{CC\_IO} \geq 3.11V$

Mechanical Specification

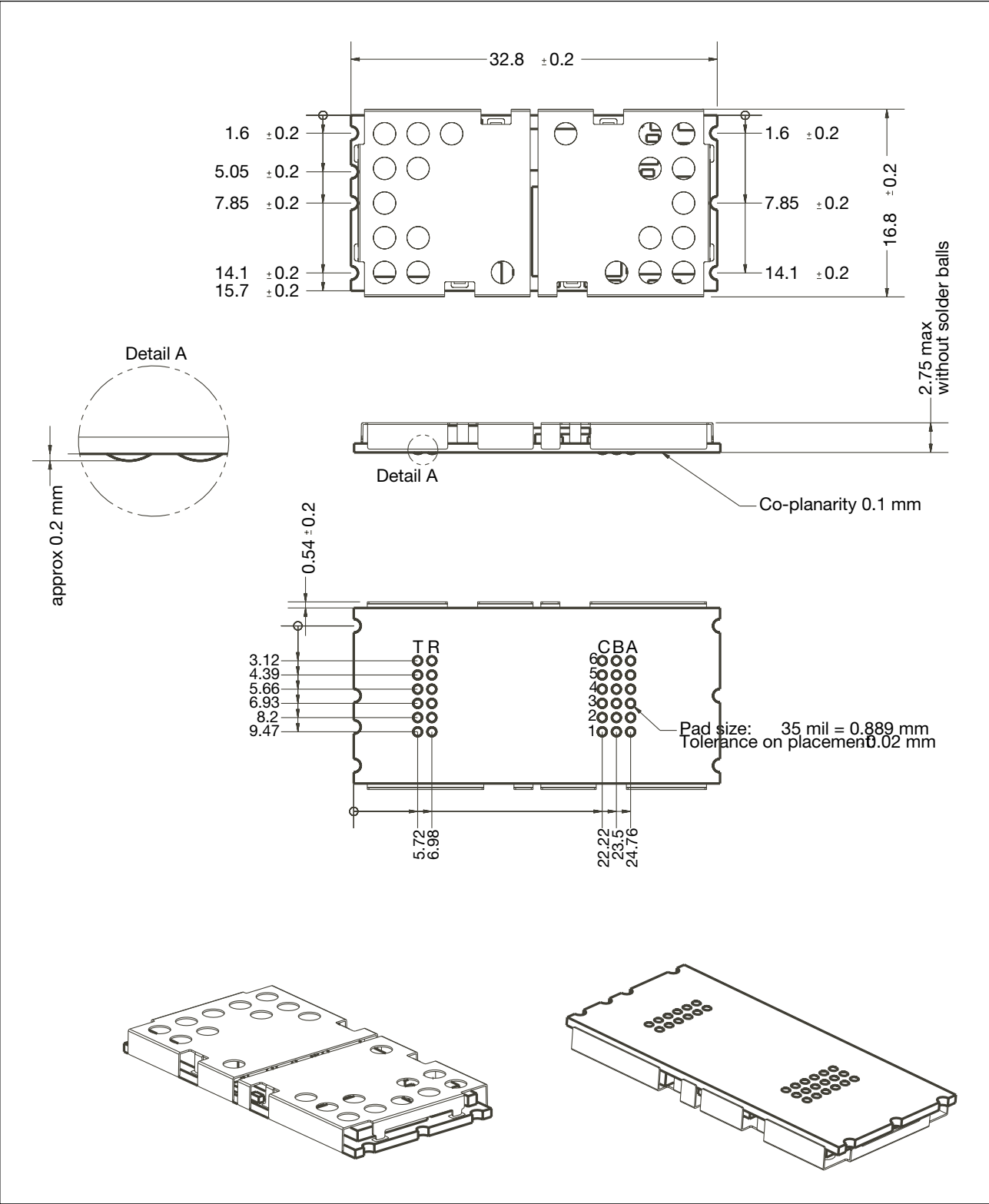


Figure 8. Mechanical dimensions.

## Application Block Schematics

### USB Application

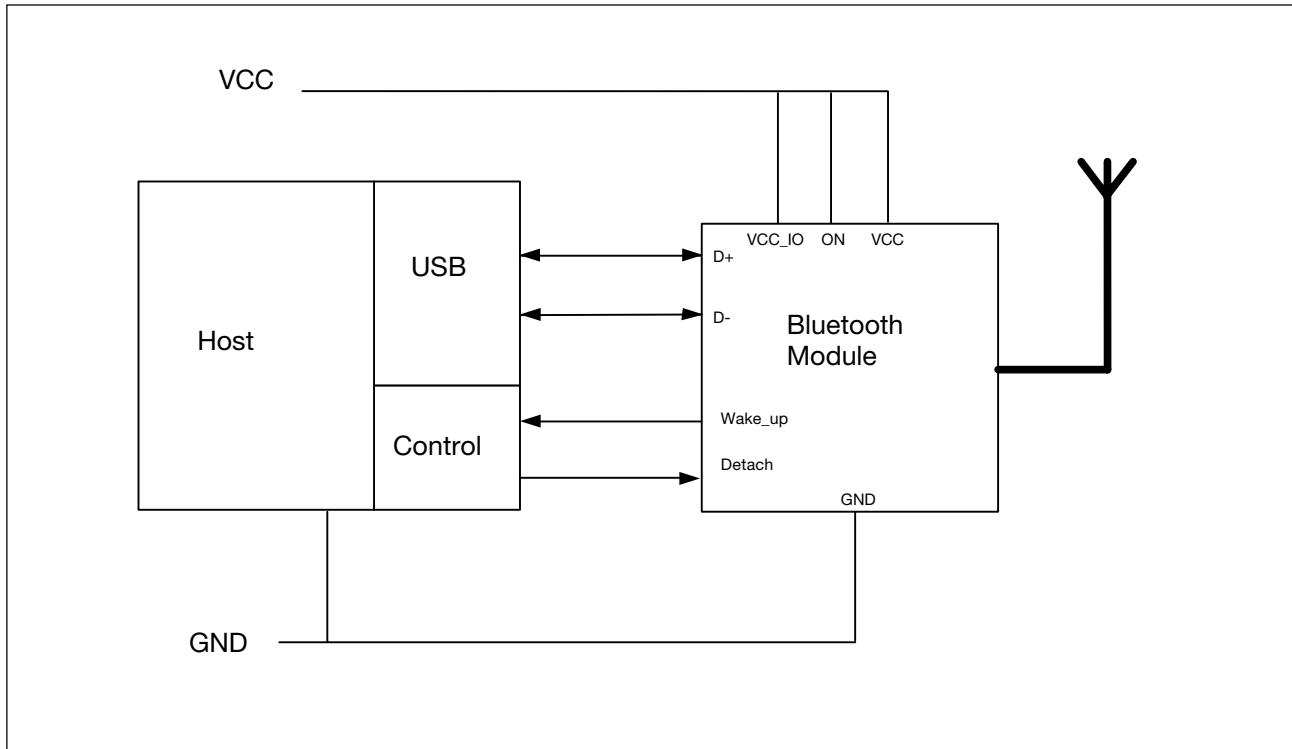


Figure 9. A typical USB configuration.

### UART and PCM Application

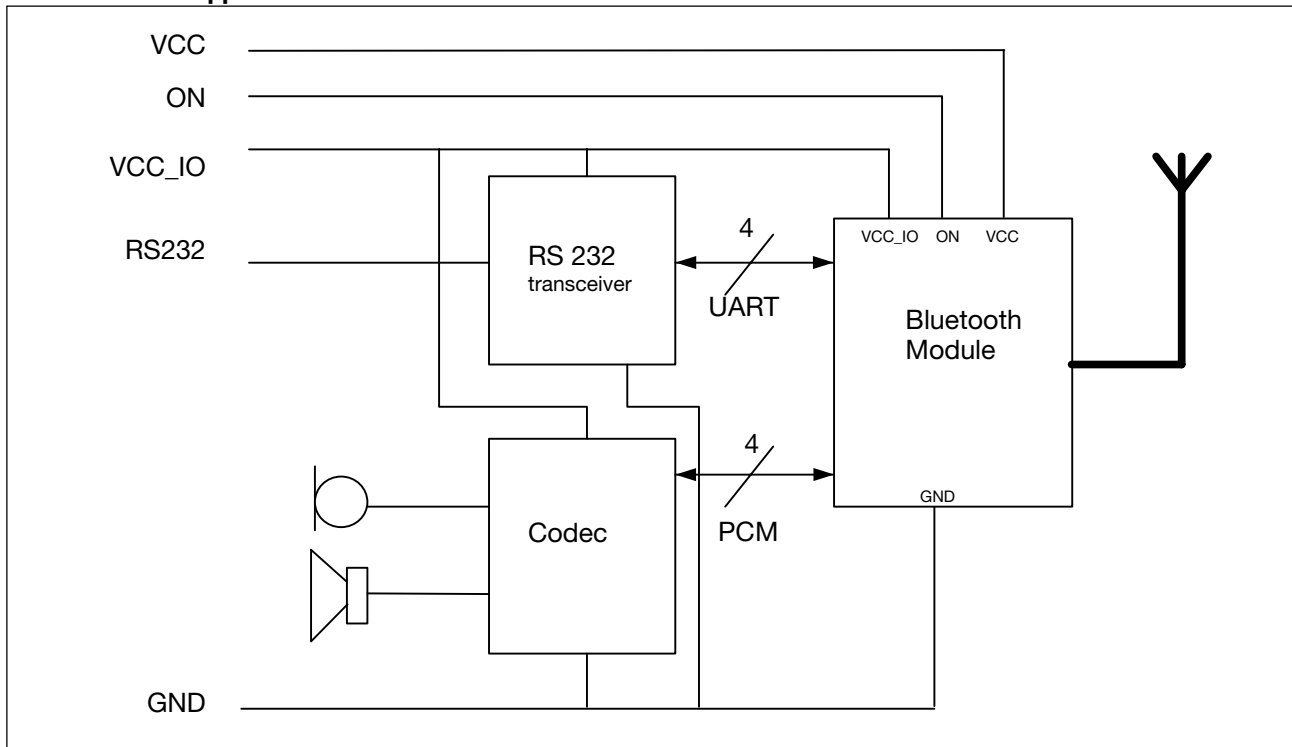


Figure 10. A typical UART or PCM configuration.

## Functional Description

The ROK 101 007 is a complete Bluetooth module that has been specified and designed according to the Bluetooth System v1.0B. Its implementation is based on a high-performance integrated radio transceiver (PBA 313 01 /2) working with a baseband controller, a flash memory and surrounding secondary components features low energy consumption for use in battery operated devices.

### Block Diagram

ROK 101 007 has five major operational blocks. Figure 11 illustrates the interaction of the various blocks. The functionality of each block is as follows:

1. Radio functionality is achieved by using the Bluetooth Radio, PBA 313 01/ 2. Six operational blocks are shown for the radio section and their operation is as follows:

- 1a) VCO-tank is a part of the phase locked loop. The modulation is performed directly on the VCO. To ensure high performance the VCO-tank is laser trimmed.

- 1b) Loop filter, filters the tuning voltage of the VCO-tank.
  - 1c) RX-balun handles transformation from unbalanced to balanced transmission.
  - 1d) TX-balun handles biasing of the output amplifier stage and transformation from balanced to unbalanced transmission.
  - 1e) Antenna switch directs the power either from the antenna filter to the receive ports or from the ASIC output ports to the antenna filter.
  - 1f) Antenna filter band-pass filters the radio signal.
2. The baseband controller is an ARM7-Thumb based chip that controls the operation of the radio transceiver via one of the interface methods; USB or UART. Additionally, the baseband controller has a PCM Voice interface and I<sup>2</sup>C interface.
  3. A Flash memory is used together with the baseband controller. Please, refer also to the Firmware section.

4. The power management block regulates and filters the supply voltage.  $V_{CC}$  is typically 3.3V and two regulated voltages are produced, 2.8V and  $2.2V_{NOM}$ .
5. An internal clock is mounted on the module. The clock frequency is 13MHz and is generated from a crystal oscillator that guarantees a timing accuracy within  $\pm 20ppm$ .

### Bluetooth Module stack

The Host Controller Interface (HCI) handles the communication by the transport layer through the UART or USB interface with the host. The Baseband and radio provides a secure and reliable radio link for higher layers.

The following sections describe the Bluetooth module stack in more detail. It is implemented in accordance with and complies with the Specification of the Bluetooth System v1.0B.

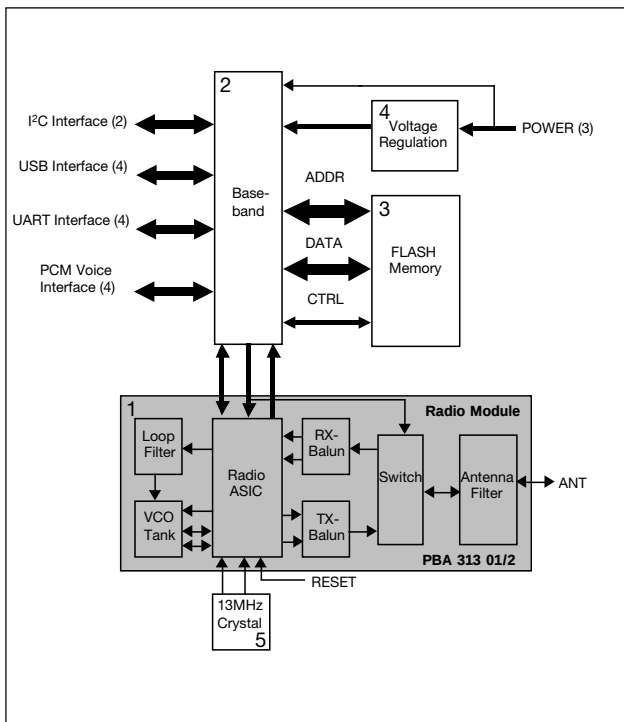


Figure 11. Simplified Block Diagram

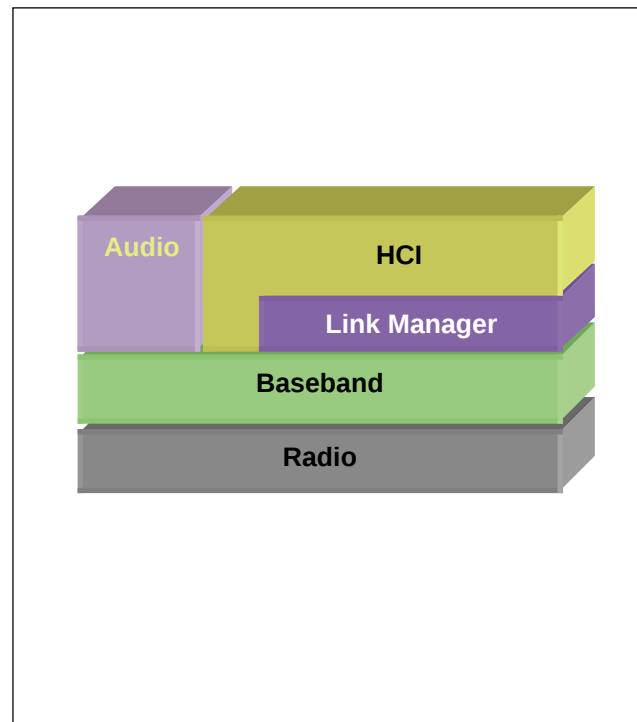


Figure 12. HW/FW parts included in the Ericsson Bluetooth module.

### Bluetooth Radio Interface

The Bluetooth module is a class 2 device with 4dBm maximum output power with no power control needed. Nominal range of the module with a typical antenna is up to a range of 10 m (at 0 dBm). It is compliant with FCC and ETSI regulations in the ISM band.

### Baseband

Bluetooth uses an ad-hoc net structure with a maximum of eight active units in a single piconet. By default the first unit setting up a connection is the master of the point to point link. The master transmits in the even timeslots and the slave transmits in the odd timeslots.

For full duplex transmission, a Time-Division Duplex (TDD) scheme is used. Packets are sent over the air in timeslots, with a nominal length of 625  $\mu$ s. A packet can be extended to a maximum of 5 timeslots (DM5 and

DH5 packets) and is then sent by using the same RF channel for the entire packet.

Two types of connections are provided - Asynchronous Connectionless Link (ACL) for data and the Synchronous Connection Oriented Link (SCO) for voice. Three 64 kb/s voice channels can be supported simultaneously. Furthermore, there are also packages used for link control purposes.

A variety of different packet types with error correction schemes and data rates can be used over the air interface. Also asymmetric communication is available for high speed communication in one direction.

The Baseband provides the link-setup and control routines for the layers above. Furthermore, the Baseband also provides Bluetooth

security like encryption, authentication and key management.

Please refer to the Specification of the Bluetooth System v1.0B part B for in-depth information regarding the Baseband.

### Firmware (FW)

The module includes firmware for the host controller interface, HCI, and the link manager, LM.

The FW resides in the Flash and is available in object code format.

### Link Manager (LM)

The Link Manager in each Bluetooth module can communicate with another Link Manager by using the Link Manager Protocol (LMP) which is a peer to peer protocol.

The LMP messages have the highest priority and are used for link-setup, security, control and power saving modes. The receiving Link Manager

| Type | User Payload (bytes) | FEC | CRC | Symmetric Max. rate | Asymmetric Max. rate |
|------|----------------------|-----|-----|---------------------|----------------------|
| ID   | na                   | na  | na  | na                  | na                   |
| NULL | na                   | na  | na  | na                  | na                   |
| POLL | na                   | na  | na  | na                  | na                   |
| FHS  | 18                   | 2/3 | yes | na                  | na                   |

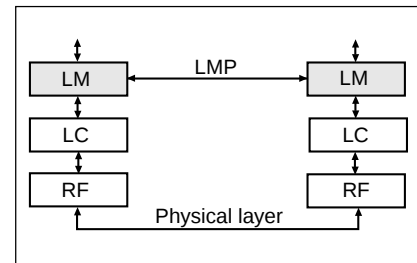
*Link control packets*

| Type | Payload Header (bytes) | User Payload (bytes) | FEC | CRC | Symetric Max. rate (kb/s) | Asymmetric Max rate (kb/s) |         |
|------|------------------------|----------------------|-----|-----|---------------------------|----------------------------|---------|
|      |                        |                      |     |     |                           | Forward                    | Reverse |
| DM1  | 1                      | 0-17                 | 2/3 | yes | 108.8                     | 108.8                      | 108.8   |
| DH1  | 1                      | 0-27                 | no  | yes | 172.8                     | 172.8                      | 172.8   |
| DM3  | 2                      | 0-121                | 2/3 | yes | 258.1                     | 387.2                      | 54.4    |
| DH3  | 2                      | 0-183                | no  | yes | 390.4                     | 585.6                      | 86.4    |
| DM5  | 2                      | 0-224                | 2/3 | yes | 286.7                     | 477.8                      | 36.3    |
| DH5  | 2                      | 0-339                | no  | yes | 433.9                     | 723.2                      | 57.6    |
| AUX1 | 1                      | 0-29                 | no  | no  | 185.6                     | 185.6                      | 185.6   |

*ACL packets*

| Type | Payload header (bytes) | User Payload (bytes) | FEC   | CRC   | Symmetric Max. rate (kb/s) |
|------|------------------------|----------------------|-------|-------|----------------------------|
| HV1  | na                     | 10                   | 1/3   | no    | 64.0                       |
| HV2  | na                     | 20                   | 2/3   | no    | 64.0                       |
| HV3  | na                     | 30                   | no    | no    | 64.0                       |
| DV   | 1D                     | 10+(0-9) D           | 2/3 D | Yes D | 64.0+57.6 D                |

*SCO packets*



*Figure 13. Link manager*

filter-out the message and does not need to acknowledge the message to the transmitting LM due to the reliable link provided by the Baseband and radio.

LM to LM communication can take place without actions taken by the host. Discovery of features at other Bluetooth enabled devices nearby can be found and saved for later use by the host.

Please refer to the Specification of the Bluetooth System v1.0B part C for in-depth information regarding the LMP.

*Table 1: Link Control Packets Table, ACL Packets Table, SCO packets*

### Host Control Interface (HCI)

The HCI provides a uniform command I/F to the Baseband and Link Manager and also to HW status registers.

There are three different types of HCI packets:

- HCI command packets – from host to Bluetooth module HCI.
- HCI event packets – from Bluetooth module HCI to host.
- HCI data packets – going both ways.

It is not necessary to make use of all different commands and events for an application. If the application is aimed at a pre-specified profile, the capabilities of such a profile is necessary to adjust to – see Specification of the Bluetooth System v1.0B Profiles.

- With the HCI UART Transport Layer on top of HCI, the module will communicate with a host through the UART I/F. The PCM I/F is also available for communicating voice.
- With the HCI USB Transport Layer on top of the HCI, the module will communicate with a host through the USB. Detach and Wake\_up signals are also available for notebook implementations.

Please refer to the Specification of the Bluetooth System v1.0B part H:1-4 for in-depth information regarding the HCI and different transport layers

Please refer to the Specification of the Bluetooth System v1.0B part H:4 regarding the HCI and UART transport layers.

### PCM Voice Interface

The standard PCM interface has a sample rate of 8 kHz (PCM\_SYNC). The PCM clock is variable between 200 kHz and 2.0MHz. The PCM data can be linear PCM (13-16bit),  $\mu$ -Law (8bit) or A-Law (8bit).

The PCM I/F can be either master or slave – providing or receiving the PCM\_SYNC. Redirection of PCM\_OUT and PCM\_IN can be accomplished as well.

Over the air the encoding is programmable to be CVSD, A-Law or  $\mu$ -Law. Preferably the robust CVSD encoding should be used.

### USB Interface

The module is a USB high-speed class device (12Mbps) that has the

full functionality of a USB slave and is compliant to the USB 1.1 specification. Data transfer occurs on the bi-directional ports, D+ & D-.

Additionally, there are two side band signals for a notebook application. Two side band signals Wake\_up and Detach are used to control the state from which the notebook resumes. When the host is in a power down mode, Wake\_up wakes the host up when the Bluetooth system receives an incoming connection. The host indicates that it is in Suspend mode by using the Detach signal.

### I<sup>2</sup>C Interface

A master I<sup>2</sup>C I/F is available on the module. The control of the I<sup>2</sup>C pins are performed by Ericsson specific HCI commands available in the FW implementation – see Appendix C.

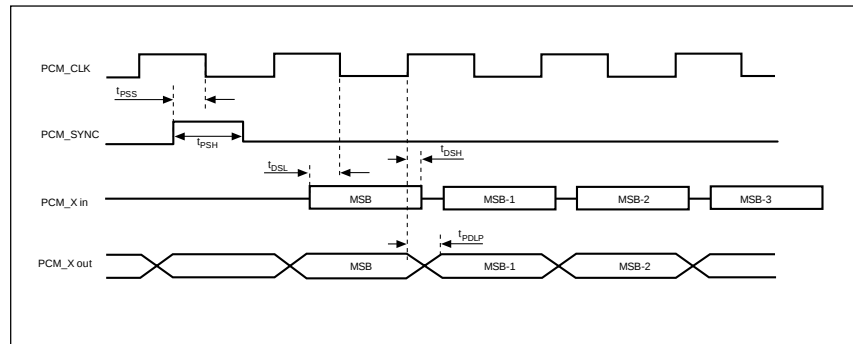


Figure 14. PCM timing

## Module HW Interfaces

### UART Interface

The UART implemented on the module is an industry standard 16C450 and supports the following baud rates: 300, 600, 900, 1200, 1800, 2400, 4800, 9600, 19200, 38400, 57600, 115200, 230400 and 460800 bits/s. 128 byte FIFOs are associated with the UART.

Four signals will be provided for the UART interface. TxD & RxD are used for data flow, and RTS & CTS is used for flow control.

| Name          | Description                         | Min | Typ | Max  | Unit |
|---------------|-------------------------------------|-----|-----|------|------|
| $f_{pcmClk}$  | PCM data-transfer clock frequency 1 | 128 |     | 2000 | kHz  |
| $f_{pcmSync}$ | PCM sample rate sync. frequency     |     | 8   |      | kHz  |
| $t_{CCH}$     | PCM_CLK high period                 | 200 |     |      | ns   |
| $t_{CCL}$     | PCM_CLK low period                  | 200 |     |      | ns   |
| $t_{PSS}$     | PCM_SYNC (setup) to PCM_CLK (fall)  | 100 |     |      | ns   |
| $t_{PSH}$     | PCM_SYNC pulse length               | 200 |     |      | ns   |
| $t_{DSL}$     | PCM_X in (setup) to PCM_CLK (fall)  | 100 |     |      | ns   |
| $t_{DSH}$     | PCM_X in (hold) from PCM_CLK (fall) | 100 |     |      | ns   |
| $t_{PDLP}$    | PCM_X out valid from PCM_CLK (rise) | 150 |     |      | ns   |

Table 2. PCM parameters

### Antenna

The ANT pin should be connected to a 50Ω-antenna interface, thereby supporting the best signal strength performance. Ericsson Microelectronics can recommend application specific antennas – see Appendix C.

### Power-up Sequence

There is no need for a power up sequence if V<sub>CC</sub>, ON and V<sub>CC\_IO</sub> are tied together.

A power up sequence, if used, shall be applied accordingly: Connection of the supply rails, GND and then V<sub>CC</sub>; then the ON signal should be applied in order to initiate the internal regulators; and finally, the V<sub>CC\_IO</sub> supply rail can be activated.

The power-down sequence is similar to the power-up procedure but in the reverse format. Therefore, the disconnection of the signals shall be as follows: V<sub>CC\_IO</sub>, ON, V<sub>CC</sub> and finally GND.

### RESET#

The assignment of the RESET# input is to generate a reset signal to the complete Bluetooth module. During power-up the reset signal is set 'low' automatically so that power supply glitches are avoided. Therefore no reset input should be required after power-up.

When implementing an external RESET#, the signal should be fed from an open drain output.

### Power

There are three inputs to the Voltage Management section (V<sub>CC</sub>, V<sub>CC\_IO</sub>, ON). V<sub>CC</sub> is the supply voltage that is typically 3.3V.

A separate power supply rail (V<sub>CC\_IO</sub>) is provided for the I/O ports, UART, PCM and USB. To be compliant with the USB 1.1 specification, V<sub>CC\_IO</sub> ≥ 3.11V. V<sub>CC\_IO</sub> can either be connected to V<sub>CC</sub> or to a dedicated supply rail, which is the same as the logical interface of the host.

### Shielding / EMC Requirements

The module has its own RF shielding and is approved according to the standards by FCC and ETSI.

If the approval number is not visible on the outside when the module is utilized in the final product, an exterior label must state that there is a transmitter module inside the product.

### Ground

Ground should be distributed with very low impedance as a ground plane. Connect all GND pins to the ground plane.

## Assembly Guidelines

### Solder Paste

The ROK 101 007 module is made for surface mounting and the SSP connection pads have been formed after printing eutectic Tin/Lead solder paste. The solder paste to use is not critical as long as this is a normal

eutectic solder paste. A preferred solder paste height is 150μm.

### Soldering Profile

It must be noted that the module should not be allowed to be hanging upside down in the re-flow operation. This means that the module has to be assembled on the side of the PCB that is soldered last.

The re-flow process should be a regular surface mount soldering profile (full convection strongly preferred); the ramp-up should not be higher than 2°C/s and with a peak temperature of 210-235°C during 20-60 seconds.

### Pad Size

It is recommended that the pads on the PCB should have a diameter of 0.7-0.9 mm. The surface finish on the PCB pads should be Nickel/Gold or a flat Tin/Lead surface or OSP (Organic Surface Protection).

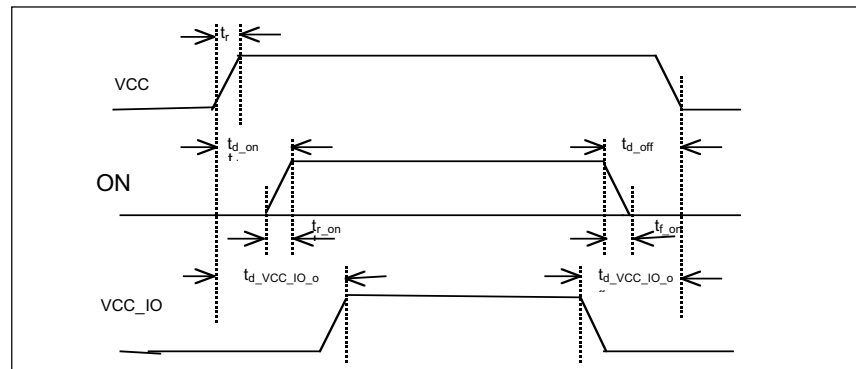


Figure 15. Power up sequence

| Parameter           | Min          | Nom | Max | Unit |
|---------------------|--------------|-----|-----|------|
| $t_r$               |              |     | 1   | ms   |
| $t_{r\_on}$         |              |     | 60  | μs   |
| $t_{r\_off}$        |              |     | 60  | μs   |
| $t_{d\_on}$         | $t_r$        |     |     | μs   |
| $t_{d\_off}$        |              |     |     | μs   |
| $t_{dvcc\_io\_on}$  | $t_{d\_on}$  |     |     | μs   |
| $t_{dvcc\_io\_off}$ | $t_{d\_off}$ |     |     | μs   |

Table 3. Power up parameters

**Placement**

The placement machine should be able to recognize odd BGA combinations (all ball recognition preferred) and be able to pick the component asymmetrical. The module contains a flat pick-area of 10mm diameter minimum. The weight of the module is typically 2.8gr.

**Storage**

Keep the component in its dry pack when not yet using the reel. After removal from the dry pack ensure that the modules are soldered onto the PCB within 48 hours.

**Marking**

Every module is marked with the following information on the:

- a) Component designation: "ROK 101 007".
- b) Ericsson's name and logotype.
- c) Manufacturing code (place, year, week) and batch number.
- d) CE logotype
- e) Type approval RTA no. See manual

**Ordering Information**

| Package | Part No.      |
|---------|---------------|
| 30 GP   | ROK 101 007/1 |
| 30 SSP  | ROK 101 007/2 |

**Packaging**

All devices will be delivered in a package protecting them from electrostatic discharges and mechanical shock. The package will be marked with the following information:

- a) Delivery address.
- b) Purchase order-number
- c) Type of goods and component designation.
- d) Ericsson's name and logotype.
- e) Date of manufacture and batch number.
- f) Number of components in the package.

**Abbreviations**

|      |                                               |
|------|-----------------------------------------------|
| ASIC | - Application Specific Integrated Circuit     |
| BER  | - Bit Error Rate                              |
| CMOS | - Complementary Metal Oxide Semiconductor     |
| C/I  | - Carrier to Interference Ratio               |
| DCE  | - Data Circuit terminating Equipment          |
| GP   | - Gold Print                                  |
| HCI  | - Host Controller Interface                   |
| ISM  | - Industrial Scientific and Medical           |
| PCB  | - Printed Circuit Board                       |
| PCM  | - Pulse Code Modulation                       |
| PDA  | - Personal Digital Assistant                  |
| PtP  | - Point to Point                              |
| Rx   | - Receive                                     |
| SIG  | - Special Interest Group                      |
| SSP  | - Screen Solder Print                         |
| Tx   | - Transmit                                    |
| UART | - Universal Asynchronous Receiver Transmitter |
| USB  | - Universal Serial Bus                        |
| VCO  | - Voltage Controlled Oscillator               |

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## APPENDIX A

## Getting Started

The ROK 101 007 Bluetooth module is easy to use when designing a Bluetooth application. However, there is a need for know-how in the Bluetooth System specification v1.0B as well as the Profile specification v1.0B when designing and end-customer product.

- Bluetooth module
- Know-how in Bluetooth specification regarding HCI commands
- Test board with UART/PCM or USB I/F
- Visual C++ for PC SW design
- Preferably HCIDriver, L2CAP, RFCOMM and SDP from Ericsson

The list above show some parts that would make designing convenient.

All information needed, regarding how to drive the HCI over UART is specified in part H4 of the Bluetooth System v1.0B further more part H1 and also Appendix IX with message charts is relevant.

Below follow an example of how to set up an ACL link between to Bluetooth modules by using the UART I/F and also a schematic of how to interface the module and control it by a host, normally a PC or microcontroller.

### Principle schematic for UART inter- connect

The inter-connection to the level-shifter when designing a test-board could be according to the schematic below. (Figure A1.)

The Bluetooth module can be connected as a DCE/DTE and a modem/nullmodem cable could therefor be used in-between the test-board and the PC.

## Setting up a Bluetooth point-to-point connection

The Host Controller Interface (HCI) in the module is a command I/F. The host presents commands to the HCI and receives events back from the HCI of the module. The module Link Manager provides link set up capability to the HCI.

- Host\_B Bluetooth module is set in paging scan mode – listening for a Bluetooth device asking for a new connection
- Host\_A Bluetooth module is set in paging mode asking for a connection to Host\_B

This is accomplished by first setting up the connection between the Host and the module and thereafter creating the connection between the modules using HCI commands.

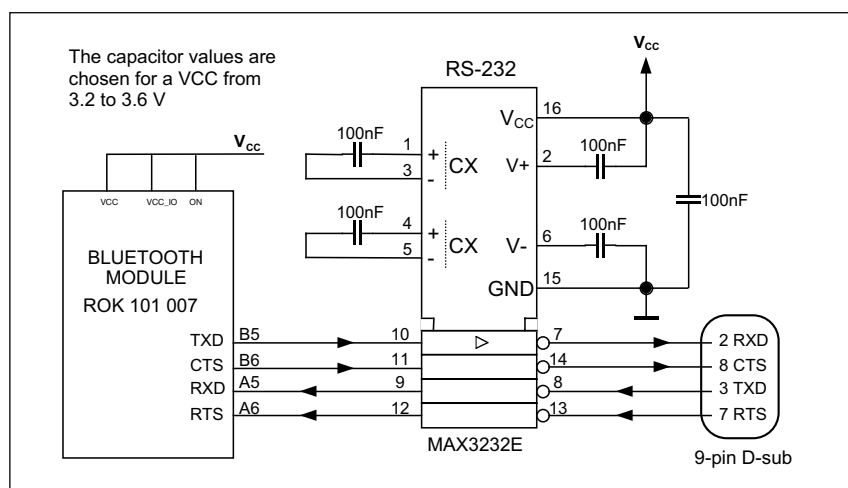


Figure A1. Bluetooth module connected as a DCE through level shifter

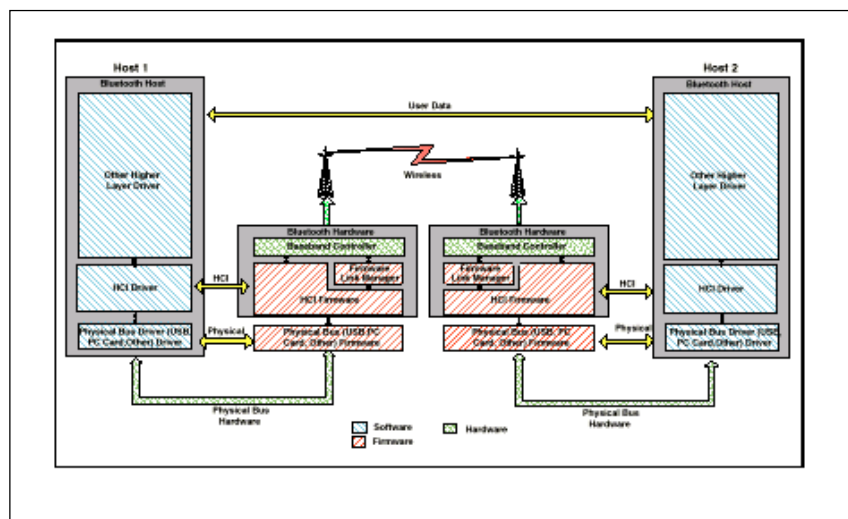


Figure A2. Bluetooth host to host communication

## Host set-up via UART:

There are 4 different types of HCI-packets accepted on the UART I/F.

| HCI packet type     | HCI packet indicator |
|---------------------|----------------------|
| HCI command packet  | 0x01                 |
| HCI ACL data packet | 0x02                 |
| HCI SCO data packet | 0x03                 |
| HCI event packet    | 0x04                 |

Table A1. HCI packets

The HCI packet indicator shall be sent immediately before the HCI packet. When the entire HCI packet has been received a new indicator should be expected.

The default speed setting is 57.6 kb/s and can be changed by sending a specified bit stream to the I/F - see Appendix C on how to change the speed setting of the UART.

When the speed set-up for the UART is made for both Host\_ A & B, the Command Packets can be sent and Event Packets received by the hosts. See HCI over UART in part H:4 of the Bluetooth System v1.0B for detailed information regarding parameters and protocol.

### Soft Reset

First HCI command packet to send should be the RESET packet.

A Command\_Complete\_Event with a status parameter should be returned to the host.

### Buffer information

Buffer information should be exchanged between the module and respective host by using HCI commands.

- Read\_Buffer\_Size: Providing the host with information on buffer size for ACL and SCO data packets for the module returned with a Command\_Complete\_Event packet. The host shall use this information for controlling the transmission
- Host\_Buffer\_Size: Providing the module with information on buffer size for ACL and SCO packets to the host.

It is the host that manages the data buffers of the Host Controller on the module.

### Timers

It could be necessary to set important timers used by the module for time out handling. The timers are all set by writing to registers using HCI commands.

The default values can be checked in Specification of the Bluetooth System v1.0B part H:1 or by using Read\_xxx\_xxx commands.

### Bluetooth Address

The hosts, using the HCI command Read\_BD\_ADDR will find the Bluetooth address of the module by the Command\_Complete\_Event with the BD\_ADDR as a parameter.

By Remote\_Name\_Request, the BD\_ADDR of the remote module can also be found.

## Inquiry

The HCI command Inquiry with the parameters LAP, Inquiry\_Length, and Num\_Responses can also be used for collecting BD\_ADDR of remote Bluetooth units.

## Creating a Point-to-point connection

### Page Scan mode

| Command               | OCF    | Command parameters | Return parameters |
|-----------------------|--------|--------------------|-------------------|
| HCI_Write_Scan_Enable | 0x0005 | Scan_Enable        | Status            |

Table A2. HCI Write Scan Enable OCF code

To set a Bluetooth module in the mode for being able to connect to (Host\_B), page scan mode, there are some settings that should be performed.

The Write\_Scan\_Enable command with correct parameter (Scan\_Enable=0x001A) will set the module in Page scan mode if the Command\_Complete\_Event is successful.

Furthermore the setting of authentication and encryption should be disabled (default) by using the:

- Write\_Authentication\_Enable
- Write\_Encryption\_Mode

The basic settings for getting into scan mode could be according to the below suggested script list.

- Read Buffer Size
- Set Event Filter
- Write Scan Enable: (Scan Enable: 0x03)
- Write Voice Setting: (Voice Channel Setting: 0x0060)
- Write Authentication Enable: (Authentication Enable: 0x00)

- Set Event Filter: (Connection Setup Filter: Connections from All Devices, Auto Accept: 0x02)

| • Write Connection Accept |        |                                                                                           |                   |
|---------------------------|--------|-------------------------------------------------------------------------------------------|-------------------|
| Command                   | OCF    | Command parameters                                                                        | Return parameters |
| HCI_Create_Connection     | 0x0005 | BD_ADDR<br>Packet_Type<br>Packet_Scan_Repetition_Mode<br>Packet_Scan_Mode<br>Clock_Offset |                   |

Table A3. HCI Create Connection OCF code

Timeout: (Connection Accept Timeout: 0x2000)

- Write Page Timeout: (Page Timeout: 0x3000)

### Page mode

The Create\_Connection command is used to set-up a link to another Bluetooth device.

Create\_Connection:  
BD\_ADDR: 0xYYYYYYYYYYYY,  
Packet Type: 0x0007,  
Page Scan Repetition Mode: 0x01,  
Page Scan Mode: 0x00, Clock Offset: 0x0000

This command will cause the Link Manager to try to create a connection to the Bluetooth module with the appropriate BD\_ADDR. The local Bluetooth module (Host\_A) starts the paging process to set up a link to the page-scanning remote device (Host\_B).

By LMP the negotiation between the two Bluetooth modules Link Managers (LM) the link set-up can be completed.

### ACL link up and running

Host\_A is the master of the point-to-point piconet and Host\_B is slave. The unit starting the paging process is by definition the master. The link set-up is completed when the event Connection\_Complete\_Event is returned to both Host\_A and Host\_B with the connection handle as one of the parameters and the status parameter 0x00 (success). When Bluetooth link is up and running the HCI data packets can be sent from host to host.

The host must take care of generating the packages going from Host to Host Controller in the module over the UART I/F, in the same way the Host must arrange the packages received from the Host Controller.

Both sides need information on what kind of data is received, to be able to interpret the bit flow correctly.

For extensive information on setting up a Bluetooth link please refer to Bluetooth System v1.0B Appendix IX Message Sequence Charts

### Adding an SCO link

When creating a voice connection using the PCM I/F, an ACL link must be up and running between the two devices, an SCO link can thereafter be added.

The control of the PCM I/F (FS, PCM\_IN/OUT and PCM\_CLK) is handled by Ericsson specific HCI command – see Appendix C.

## Driving SW

### HCI- API

The Bluetooth module includes all HCI command capabilities according to Bluetooth System v1.0B. Furthermore, there is some Ericsson specific commands available for accessing HW registers and HW control – see Appendix C. SW for driving the module should be developed for the HCI interface.

There is source code SW available with Ericsson Bluetooth Developers Kit (EBDK), see Appendix B, which can be used for driving the module. This SW comes with the EBDK and has an HCI-API for application development on the HCI I/F.

### Higher layer-API

Software (HCIdriver, L2CAP, RFCOMM and SDP) are available in a generic, source code format, i.e. to be adapted to various operating systems.

- HCIdriver – implements the HCI command driver used by the host
- L2CAP – handles protocol multiplexing, segmentation and re-assembly of packets
- RFCOMM – provides a serial port emulation over the L2CAP protocol
- SDP – Service Discovery Protocol provides information on the services available on a Bluetooth device

Additional SW for the application shall be developed for the actual application on top of the RFCOMM API. If the application is according to a SIG predefined profile, it should be implemented accordingly. New applications can be the driver of the specification of new profiles decided by the SIG – see Specification of the Bluetooth System v1.0B Profiles.

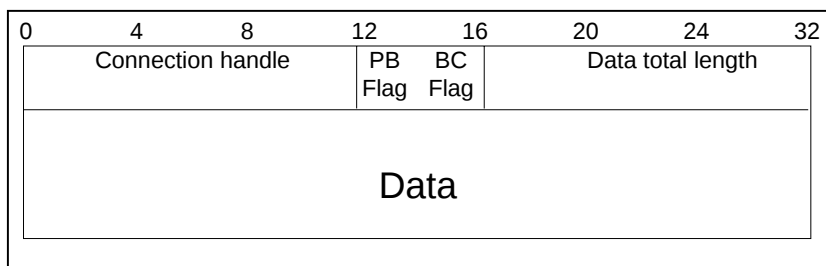


Table A4. ACL data packet

## APPENDIX B

### Development tools

#### Ericsson Bluetooth Development Kit (EBDK)

The easiest way of getting started is to use the Ericsson Bluetooth Developers Kit. It provides all parts necessary for developing applications for the Bluetooth module.

Available are:

- PC plug&play
- Demos using radio/baseband
- Macro capability
- C++ v5.0 Source code for use in applications
- HCI driver, L2CAP, SDP and RFCOMM for applications using UART communication
- Pins for electrical measurements
- Antennas

Development can easily take place on the EBDK platform and thereafter the implementation of the full Bluetooth capability can be setup by developed SW/HW and the Bluetooth module.

Software (HCI driver, L2CAP, RFCOMM and SDP) will be available in source code for PC.

- HCI driver – implements the HCI command driver used by the host
- L2CAP – handles protocol multiplexing, segmentation and re-assembly of packets
- RFCOMM – provides a serial port emulation over the L2CAP protocol
- SDP – Service Discovery Protocol provides information on the services available on a Bluetooth device

Technical support is available from the EBDK distributor. Please contact Ericsson Microelectronics for ordering and information regarding the

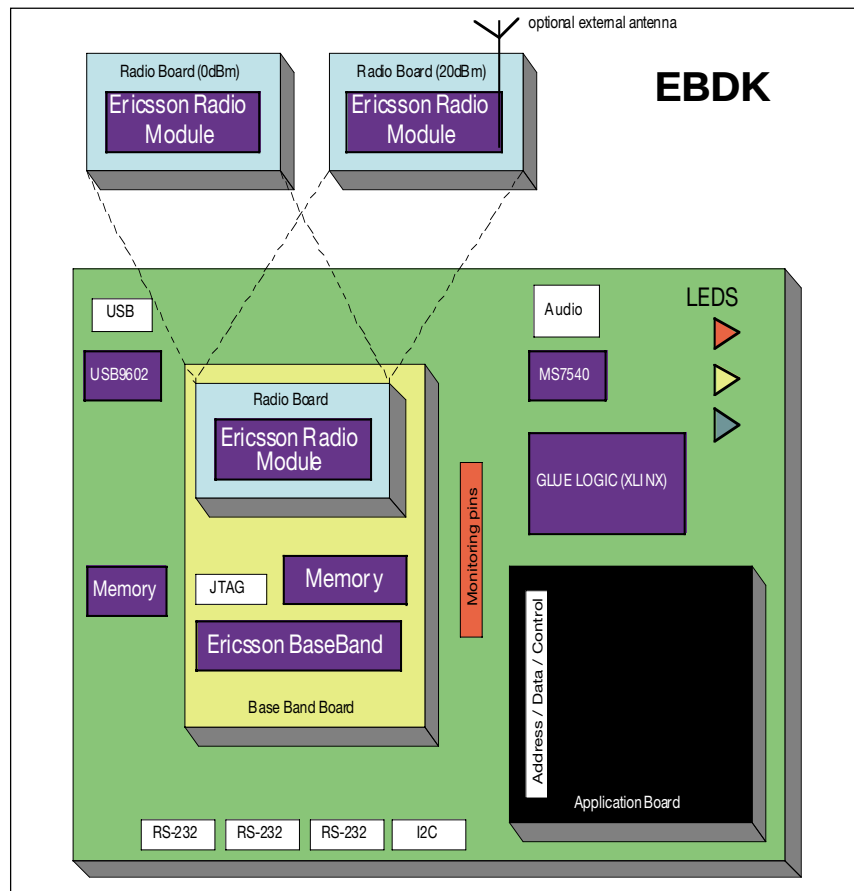


Figure B1. Ericsson Bluetooth Development Kit (EBDK)

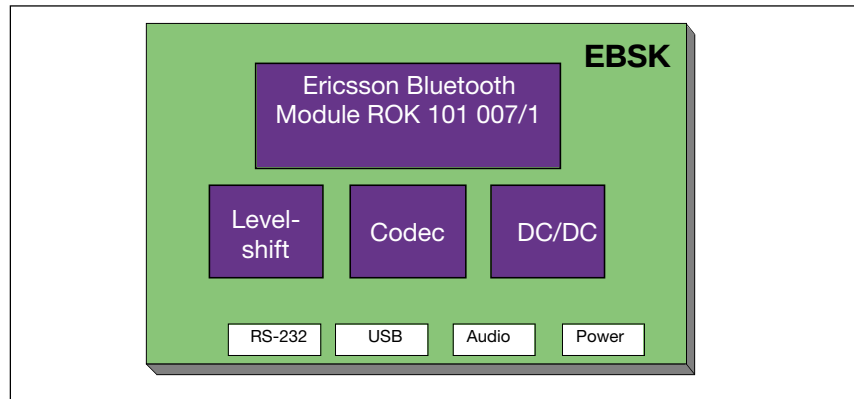


Figure B2. Ericsson Bluetooth Starter Kit (EBSK)

EBDK and regarding extra daughter board with ROK 101 007 as add-on to the EBDK.

#### Ericsson Bluetooth Starter Kit (EBSK)

A very small convenient kit, which preferably is used in point-to-multipoint configuration designs,

based on the Bluetooth module ROK 101 007.

Please contact Ericsson Microelectronics for ordering and information regarding the Ericsson Bluetooth Starter Kit.

## APPENDIX C

### Bluetooth Information

This part will be updated and new information will be added continuously.

#### Radio

Fast Frequency hopping (1600 channel hop/s) with 79(23) channels available (2.402 to 2.480 GHz) and a symbol rate of 1Ms/s over the air exploits the maximum channel bandwidth in the unlicensed ISM band.

To sustain a high transfer rate in busy radio environment, the frequency hopping together with advanced coding techniques maximizes the throughput.

During Page and Inquiry the hopping frequency is risen to 3200 hops/s to enhance the time needed for connection set-up.

Modulation technique is a binary Gaussian Frequency Shift Keying GFSK, with a BT product of 0.5. The channel bandwidth is 1 MHz and the frequency deviation from the carrier frequency of the RF channel is between +/-140 to +/-175 kHz for representing a '1'/'0'.

| Country      | Frequency range   | RF channels        |                  |
|--------------|-------------------|--------------------|------------------|
| Europe & USA | 2400-2483.5 MHz   | $f = 2402 + k$ MHz | $k = 0 \dots 78$ |
| Japan        | 2471-2497 MHz     | $f = 2473 + k$ MHz | $k = 0 \dots 22$ |
| Spain        | 2445-2475 MHz     | $f = 2449 + k$ MHz | $k = 0 \dots 22$ |
| France       | 2446.5-2483.5 MHz | $f = 2454 + k$ MHz | $k = 0 \dots 22$ |

Table C1. Frequency ranges used.

A rapid process is ongoing to harmonise Spanish, French and Japanese frequency ranges with the rest of the world.

#### Data and parameter formats

There are exceptions in the Bluetooth system for data and parameter formats – general rules below.

- All values are in Binary and Hexadecimal little Endian formats
- Negative values must use 2's

complement format

- Array parameter notation is  $\text{parameterA}[i]$ ,  $\text{parameterB}[i]$ ,...
- All parameter values are sent/received in little Endian format. The least significant byte is sent first – unless noted otherwise.

#### HCI Opcodes

The Opcodes have been changed during the ongoing standardisation work. Below is the description on how to send opcodes to the module.

Below is the general HCI command

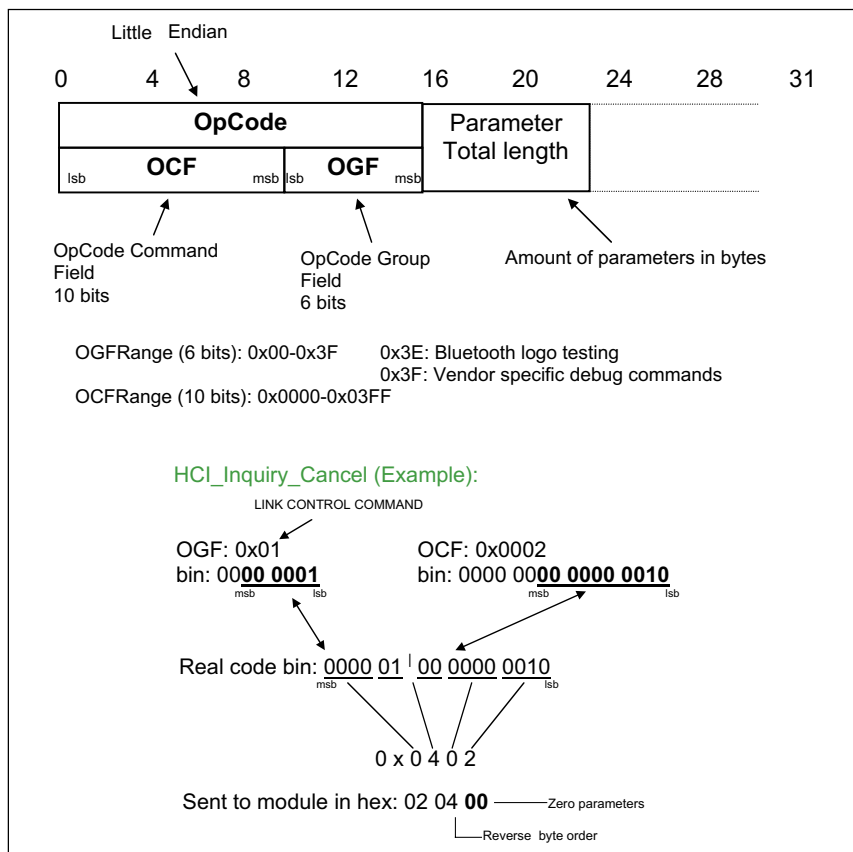


Figure C1. Byte order sent to module

packet format depicted as well as a byte order description.

#### UART speed setting

The baud rate is changed with an Ericsson specific HCI command. HCI\_Ericsson\_Set\_Uart\_Baud\_Rate

The command has one parameter, baud rate - one byte long according to the table below. The op-code for the command is 0xfc07 - the last figure is due to a possible change.

Sending the command should be performed accordingly: 07 fc 01 yz, where yz is the chosen baud rate from the table.

The op-code is sent in reverse byte order. 01 is the parameter length, in this case one byte. Remember to add the HCI packet indicator.

Observe - When changing the baud rate for the module the host also has to change the baud rate.

Observe - Removing power to the module the baud rate will be reset to 57.6 kbps.

Observe - Two zeros are not printed in the beginning of the binary parameters below. The length of the parameter is 1 byte.

#### Ericsson specific HCI commands

By using the Ericsson specific HCI command there are a number of features available for the application design.

| UART speed | Parameter to send |
|------------|-------------------|
| 460.8 kbps | 00000             |
| 230.4 kbps | 00001             |
| 115.2 kbps | 00010             |
| 57.6 kbps  | 00011             |
| 28.8 kbps  | 00100             |
| 14.4 kbps  | 00101             |
| 7200 bps   | 00110             |
| 3600 bps   | 00111             |
| 1800 bps   | 01000             |
| 900 bps    | 01001             |
| 153.6 kbps | 10000             |
| 76.8 kbps  | 10001             |
| 38.4 kbps  | 10010             |
| 19.2 kbps  | 10011             |
| 9600 bps   | 10100             |
| 4800 bps   | 10101             |
| 2400 bps   | 10110             |
| 1200 bps   | 10111             |
| 600 bps    | 11000             |
| 300 bps    | 11001             |

Table C2. UART speed setting parameter

Contact Ericsson Microelectronics for a command reference list.

#### Antennas

Antenna design is not specified and standardised in the Bluetooth System v1.0B.

Many different types of antennas can and will be used. Application specific antennas suitable for production are expected to be a new market for antenna designs.

Ericsson Microelectronics have antennas for the EBDK and other

development kits. Contact Ericsson Microelectronics for information on antennas.

#### Contacting Ericsson Microelectronics

For further information regarding Bluetooth technology, components and development tools, please contact Ericsson Microelectronics:

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[www.ericsson.se/microe](http://www.ericsson.se/microe)