

User Manual

USB Radio Sticks

deRFusb-23E00

deRFusb-23E06

deRFusb-13E00

deRFusb-13E06





Table of contents

| | |
|--|----|
| 1. Overview | 5 |
| 2. Application..... | 5 |
| 3. Features | 5 |
| 4. Technical data | 7 |
| 5. Mechanical size | 9 |
| 6. Pin assignment..... | 10 |
| 7. Programming..... | 14 |
| 7.1. JTAG interface | 14 |
| 7.2. USB interface | 14 |
| 7.3. Required hardware | 14 |
| 7.4. Programming and debugging details | 15 |
| 8. Onboard transceiver | 16 |
| 9. Onboard flash (option)..... | 17 |
| 10. Radio certification | 18 |
| 10.1. United States (FCC) | 18 |
| 10.2. European Union (ETSI) | 19 |
| 11. Ordering information..... | 20 |
| 12. Revision notes..... | 21 |



Document history

| Date | Version | Description |
|------------|---------|-----------------|
| 2011-03-31 | 01.00 | Initial version |

Mailing list

| Firm | Division / Name |
|------|-----------------|
| DE | APA |

Author / Check / Release

| | Firm | Division / Name |
|---------|------|-----------------|
| Author | DE | Dev. / APA |
| Check | | |
| release | | |



Abbreviations

| Abbreviation | Description |
|--------------|--|
| ADC | A nalog to D igital C onverter |
| AES | A dvanced E ncryption S tandard |
| CE | (Applications) - C onsumer E lectronics |
| DAC | D igital to A nalog C onverter |
| ETSI | E uropean T elecommunications S tandards I nstitute |
| FCC | F ederal C ommunications C ommission |
| GPIO | G enerals P urpose I nterface O utput |
| IC | (Certification) - I ndustry C anada |
| ISM | I ndustrial, S cientific and M edical frequency band |
| JTAG | J oint T est A ction G roup |
| MAC | M edium A ccess C ontrol |
| MCU, μ C | M icrocontroller U nit |
| PWM | P ulse W idth M odulation |
| RF | R adio F requency |
| SPI | S erial P eripheral I nterface |
| TWI | T wo- W ire S erial I nterface |
| UART | U niversal A synchronous R eceiver T ransmitter |
| USART | U niversal S ynchronous/ A synchronous R eceiver T ransmitter |
| USB | U niversal S erial B us |
| WPAN | W ireless P ersonal A rea N etwork |



1. Overview

The compact designed USB radio sticks deRFusb-23E00 and deRFusb-13E00 contain a powerful CORTEX-M3 microcontroller with 256 kBytes High-Speed Flash. Additional flash memory to store user defined data is provided using the USB radio sticks deRFusb-23E06 and deRFusb-13E06, it is usable as mass storage device.

Depending on the transmission frequency of 2.4 GHz - deRFusb-23E00/06 - or 868/915 MHz - deRFusb-13E00/06 - the ATMEL low-power transceivers AT86RF231 or alternatively AT86RF212 are integrated. They provide a complete radio transceiver interface between the antenna and the microcontroller and an extended functional range such as a 128-Bit AES hardware engine to assure data security.

The USB radio sticks provide a programming and debugging interface to the user, by default via USB.

2. Application

The main applications for the USB radio sticks deRFusb-23E00/06 and deRFusb-13E00/06 are:

- 2.4GHz and Sub-GHz range IEEE 802.15.4
- ZigBee® Pro
- ZigBee® RF4CE
- ZigBee® IP
- 6LoWPAN
- SP100
- Wireless Sensor Networks (WSN)
- industrial and home controlling and monitoring

3. Features

The USB radio sticks deRFusb-23E00 and deRFusb-23E06 offer the following features:

- compact size (in case): 71.0 x 23.0 x 8.7 mm
- USB powered
- 3 free programmable status LEDs
- RF shielding
- Debugging/Programming interfaces: 1 x DBGU (Debug-Unit) or 1 x JTAG with 10 pin connector mounting option, USB
- Onboard transceiver and chip ceramic antenna 2.4GHz
- Optional: onboard 2 GByte flash
- Certification: FCC, IC, conformity ETSI/CE

The block diagram below shows layout and interaction of the main deRFusb-23E00/06 components:

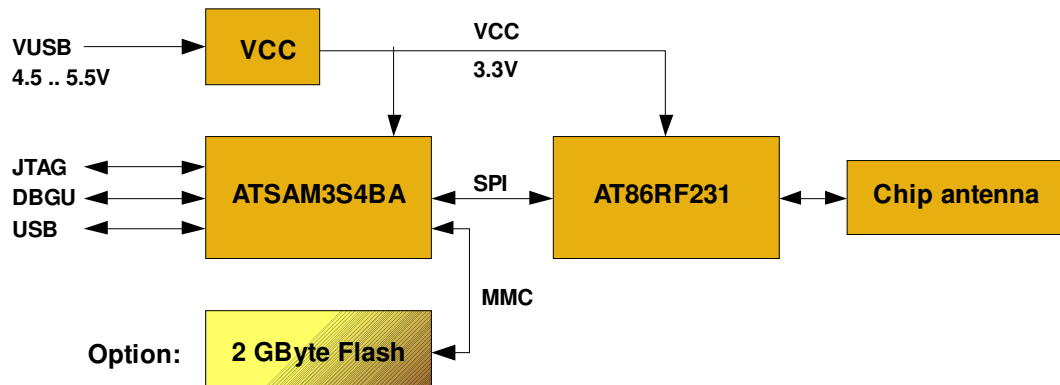


Figure 1: block diagram deRFusb-23E00 / 06

The deRFusb-13E00 and deRFusb-13E06 offer the same features like the deRFusb-23E00 / 06 except the built-in Sub-GHz transceiver and onboard Sub-GHz chip antenna.

- Onboard transceiver and chip ceramic antenna for Sub-GHz

Layout and interaction of the main deRFusb-13E00/06 components:

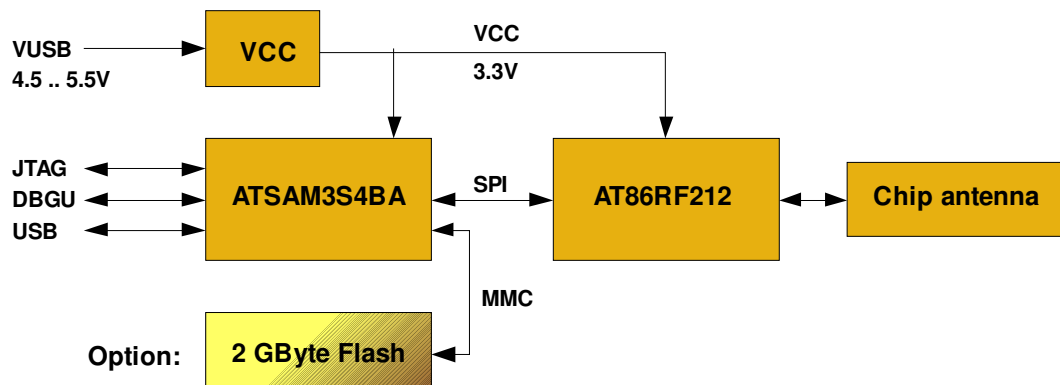


Figure 2: block diagram deRFusb-13E00 / 06



4. Technical data

Table 1: Mechanical data

| Mechanical | |
|-----------------------------------|-------------------------------------|
| <i>Radio module</i> | |
| Size (length x width x height) | 71.0 x 23.0 x 8.7 mm (in case) |
| | 63.5 x 19.0 x 5.5 mm (without case) |
| <i>Connectors</i> | |
| USB | chassis plug type A |
| 10 pin header - connection option | 2 x 5 pins, 1.27 mm pitch |

Table 2: Environment

| Temperature and humidity range | | | | | |
|---------------------------------------|--------|------------|------------|------------|-------------|
| | | <i>Min</i> | <i>Typ</i> | <i>Max</i> | <i>Unit</i> |
| Working area | T_work | - 40 | | +85 | °C |
| Working area | | 25 | | 80 | % r.H. |

Table 3: Electrical data

| Electrical (VUSB = 5.0VDC) | | | | | |
|-----------------------------------|---------------------|------------|------------|------------|-------------|
| | <i>Parameter</i> | <i>Min</i> | <i>Typ</i> | <i>Max</i> | <i>Unit</i> |
| Supply voltage | VUSB | 4.5 | 5.0 | 5.5 | VDC |
| Current consumption | I_TXon (TX_PWR = 3) | | 51 | | mA |
| | I_TXoff | | 32 | | mA |
| | I_sleep | | TBD | | mA |
| | I_RXon | | TBD | | mA |



Table 4: Radio data transmission

| Radio (VUSB = 5.0VDC) | | | | | |
|------------------------------|----------------------------|------------|-----------------------------|------------|--------------------------------------|
| | <i>Parameter / feature</i> | <i>Min</i> | <i>Typ</i> | <i>Max</i> | <i>Unit</i> |
| deRFusb-23E00/06 | | | | | |
| Antenna | Chip ceramic | | | | |
| | Antenna gain | | +1.3 - 0.5 | | dBi (peak) dBi (average) |
| | Antenna diversity: no | | | | |
| Range | line of sight | | >200 | | m |
| Frequency range | | | 2.4 | | GHz |
| Transmitting power conducted | TX_PWR = 0 | | +0.5 | | dBm |
| Receiver sensitivity | | | - 101 | | dBm |
| Data rate | | | 250 500 1 2 | | kb/s kb/s Mb/s Mb/s |
| deRFusb-13E00/06 | | | | | |
| Antenna | Chip ceramic | | | | |
| | Antenna gain | | - 0.7 - 2.6 | | dBi (peak) dBi (average) |
| | Antenna diversity: no | | | | |
| Range | line of sight | | >200 | | m |
| Frequency range | | | 868 915 | | MHz (band) |
| Transmitting power conducted | TX_PWR = 0 | | +3.6 | | dBm |
| Receiver sensitivity | | | - 110 | | dBm |
| Data rate | | | 20 40 250 500 1 | | kb/s kb/s kb/s kb/s Mb/s |

5. Mechanical size

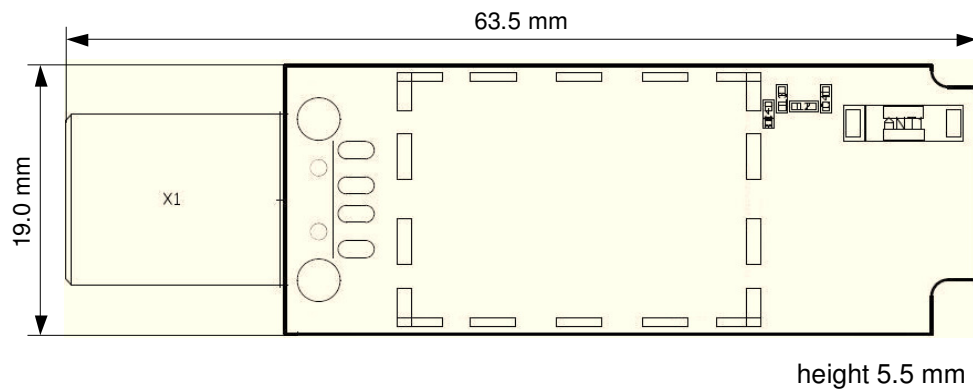


Figure 3: Size deRFusb-23E00 and deRFusb-23E06

Placed in case the mechanical size is 71.0 x 23.0 x 8.7 mm (length x width x height).

These dimensions are the same at the deRFusb-13E00 and deRFusb-13E06 radio sticks.

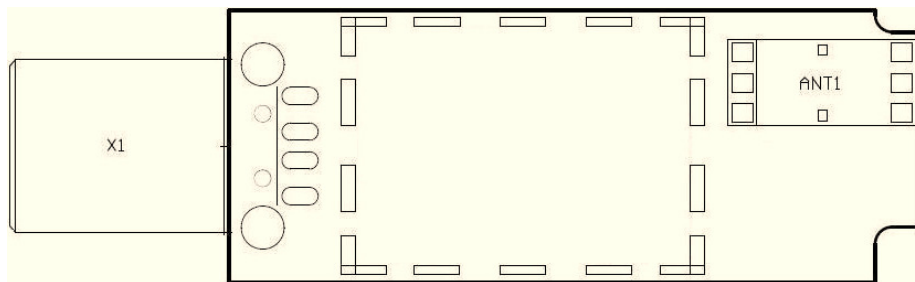


Figure 4: deRFusb-13E00 and deRFusb-13E06

The connector for all radio stick design versions is USB type A.



Figure 5: USB type A connection

6. Pin assignment

The 10 pin connector offers the programming interface (JTAG) and debugging interface (Debug RXD and Debug TXD) to the user. It is directly accessible from the USB stick bottom side.

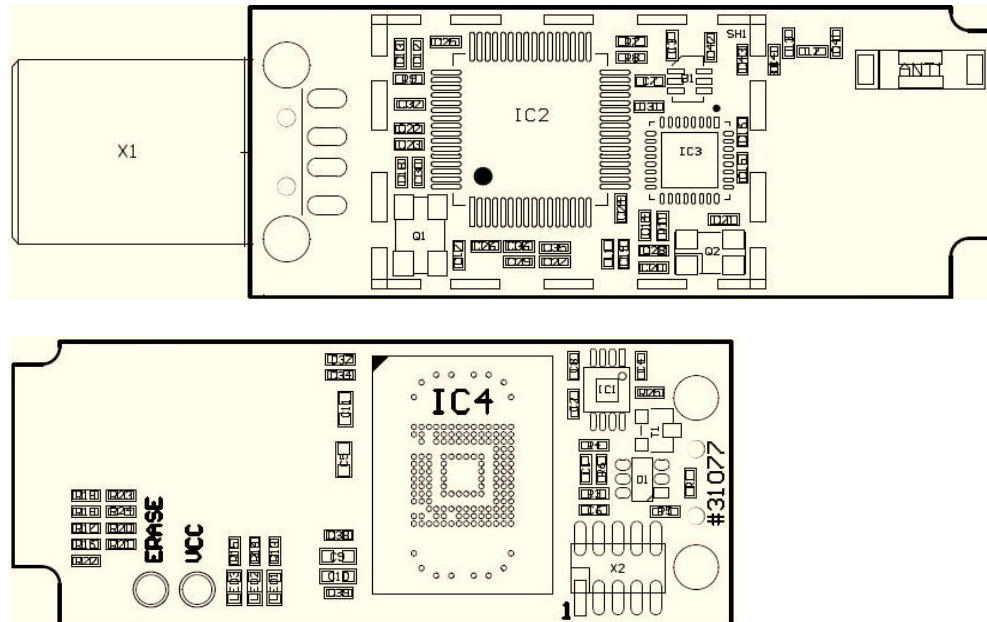


Figure 6: Top and bottom overlay deRFusb-23E06 and deRFusb-23E00 (without IC4)

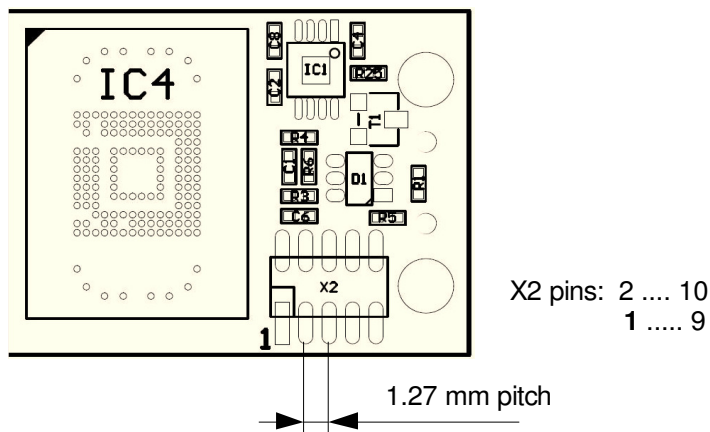


Figure 7: 10 pin connector with footprint receptacle

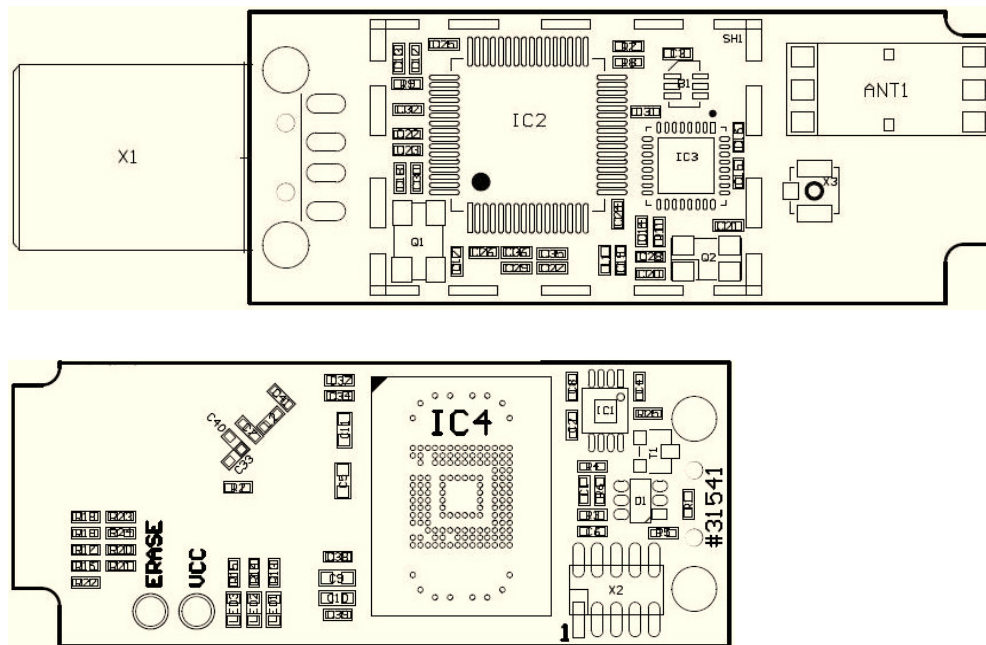


Figure 8: Top overlay deRFusb-13E06 and deRFusb-13E00 (without IC4)

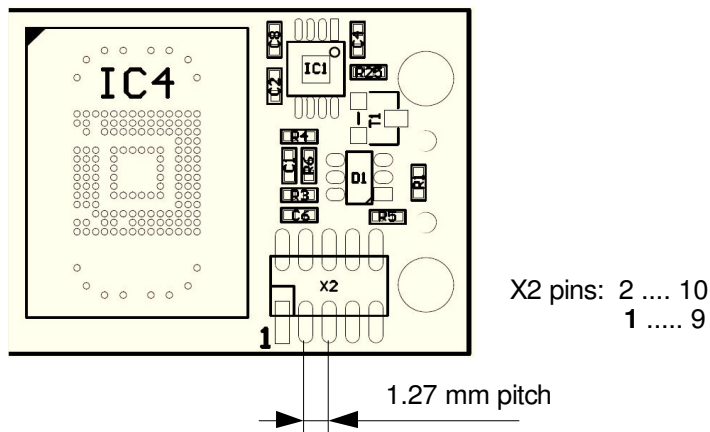


Figure 9: 10 pin connector with footprint receptacle



Table 5: Pin assignment of deRFusb-23E00/06 and deRFusb-13E00/06

| µC Pin | name | function | comments |
|---------------------------------------|----------------------------|--------------------|-------------------|
| <i>USB connector</i> | | | |
| 56 | DDM | USB DM | |
| 57 | DDP | USB DP | |
| <i>10 pin connector</i> | | | |
| 53 | PB7/TCK/SWCLK | JTAG TCK | pin 1 |
| | GND | | pin 2 |
| 49 | PB5/TWCK1/PWML0/WKUP13/TDO | JTAG TDO | pin 3 |
| | VCC | | pin 4 |
| 51 | PB6/TMS/SWDIO | JTAG TMS | pin 5 |
| 39 | NRST | /Reset | pin 6 |
| | VCC | | pin 7 |
| 30 | PA9/URXD0/NPCS1/PWMFI0 | Debug RXD | pin 8 |
| 33 | PB4/TWD1/PWMH2/TDI | JTAG TDI | pin 9 |
| 29 | PA10/UTXD0/NPCS2 | Debug TXD | pin 10 |
| <i>Miscellaneous</i> | | | |
| 13 | PA19/RK/PWML0/A15/AD2 | LED1 | red |
| 9 | PA17/TD/PCK1/PWMH3/AD0 | LED2 | yellow |
| 10 | PA18/RD/PCK2/A14/AD1 | LED3 | green |
| 35 | PA5/RXD0/NPCS3 | Hardware ID1 | |
| 34 | PA6/TXD0/PCK0 | Hardware ID2 | |
| 32 | PA7/RTS0/PWMH3/XIN32 | Hardware ID3 | |
| <i>Internal transceiver interface</i> | | | |
| 20 | PA15/TF/TIOA1/PWML3 | RXTS/DIG2 | Timestamp |
| 11 | PA21/RXD1/PCK1/AD8 | SLP-TR | |
| 21 | PA14/SPCK/PWMH3 | SCK | SPI |
| 27 | PA12/MISO/PWMH1 | MISO | SPI |
| 22 | PA13/MOSI/PWMH2 | MOSI | SPI |
| 28 | PA11/NPCS0/PWMH0 | SELN | |
| 47 | PA1/PWMH1/TIOB0/A18 | IRQ | |
| 23 | PA24/RTS1/PWMH1/A20 | RST | Transceiver Reset |
| 36 | PA4/TWCK0/TCLK0 | CLKM | |
| <i>2 GByte flash memory</i> | | | |
| 42 | MCDA0 | ext. Flash Data 0 | |
| 52 | MCDA1 | ext. Flash Data 1 | |
| 26 | MCDA2 | ext. Flash Data 2 | |
| 37 | MCDA3 | ext. Flash Data 3 | |
| 38 | MCCDA | ext. Flash Command | |
| 41 | MCCK | ext. Flash Clock | |
| <i>Erase pin</i> | | | |
| 55 | PB12/PWML1/ERASE | | |



Table 6: Signal description list

| Signal name | Function | Type | Active level | Comments |
|------------------------------|-----------------------|---------|--------------|------------------|
| <i>Power - USB connector</i> | | | | |
| DDM | USB Full Speed Data – | Analog | | |
| DDP | USB Full Speed Data + | Digital | | |
| <i>JTAG</i> | | | | |
| TCK | Test Clock | Input | | onboard Pull-up |
| TDI | Test Data In | Input | | onboard Pull-up |
| TDO | Test Data Out | Output | | |
| TDM | Test Mode Select | Input | | onboard Pull-up |
| <i>Reset</i> | | | | |
| RSTN | Microcontroller Reset | I/O | Low | Pull-Up resistor |
| <i>UART0</i> | | | | |
| URXD0 | UART Receive Data | Input | | |
| UTXD0 | UART Transmit Data | Output | | |

7. Programming

7.1. JTAG interface

The deRFusb-23E00/06 and deRFusb-13E00/06 can be programmed over JTAG interface (TDI, TDO, TCK, TMS) with a suitable JTAG-programmer for ARM-based microcontrollers.

7.2. USB interface

The alternative programming feature for the deRFusb radio sticks is provided by the USB interface.

The interface represents a USB 2.0 Full-Speed Device (not USB certified). The USB interface logs on at the host as Mass Storage Device and as deRFusb-xxxx.

For a more details of the interface please refer to the ATSAM3S ATMEL data sheet:

- Preliminary PDF: doc6500.pdf
- Preliminary Summary PDF: 6500s.pdf

http://www.atmel.com/dyn/products/product_docs.asp?category_id=163&family_id=605&subfamily_id=2127&part_id=4691

7.3. Required hardware

JTAG interface

For the JTAG interface Dresden elektronik ingenieurtechnik gmbh offers the hardware components for a fast start-up. The following hardware setups are possible:

1. Option ATMEL SAM-ICE programmer
 - (A) deRFusb-23E00/06 or deRFusb-13E00/06
 - (B) SAM-ICE-Adapter with onboard RS232 level shifter
 - (C) SAM-ICE programmer
 - (D) RS232 cable

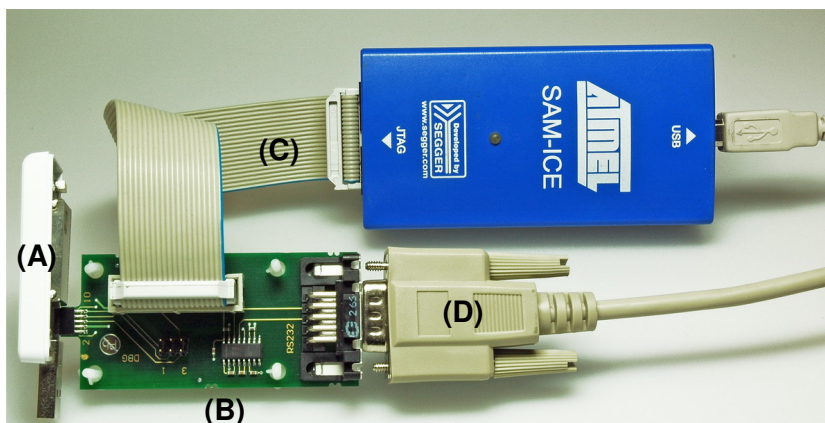


Figure 10: USB radio stick with SAM-ICE programmer

2. Option OLIMEX ARM programmer

- (A) deRFusb-23E00/06 or deRFusb-13E00/06
- (B) SAM-ICE-Adapter with onboard RS232 level shifter
- (C) Olimex USB-ARM programmer
- (D) RS232 cable

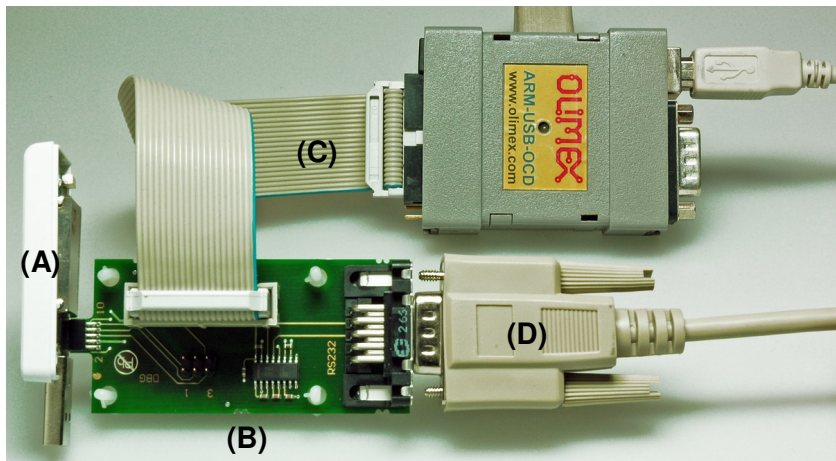


Figure 11: USB radio stick with OLIMEX ARM programmer

Attention: The SAM-ICE-Adapter has no own power supply!
Connect the USB radio stick with an USB Type-A extension cable to a laptop or PC.

USB interface

No additional hardware is necessary using the USB interface to program the deRFusb-23E00/06 and deRFusb-13E00/06 radio sticks.

7.4. Programming and debugging details

For programming via JTAG there are two alternatives:

- OpenOCD
- Segger J-Link or Atmel SAM-ICE.

OpenOCD

A suitable on chip debug system including flash programming and SRAM debugging support is available from various vendors e.g. <http://www.olimex.com/dev/arm-usb-ocd.html>

This open source programming software is recommended for open source toolchains.

Dresden elektronik ingenieurtechnik gmbh provides scripts for ease of use.



Segger J-Link or Atmel SAM-ICE

These In-Circuit-Emulators are commercially available programming adapters. They work well with e.g. the IAR embedded workbench. They are also working with the GDB debug server (for use with open source toolchain).

The programming and debugging features are license dependent.

Debugging and tracing - required hardware

Debugging and tracing of the USB radio sticks is possible with the SAM-ICE adapter. It has following features:

- 10 pin connector for deRFusb-23E00/06 and deRFusb-13E00/06
- 20 pin connector for ARM JTAG programmer
- 6 pin connector for ARM Debug-Unit
- RS232 connector with onboard RS232 level shifter for ARM Debug-Unit

Troubleshooting

The ERASE pin (see section 6) is used to reinitialize the Flash content - and some of its NVM (Non-Volatile Memory) bits - to an erased state. The flash is transferred to its original state.

The pin must be tied high during more than 220 ms to perform a Flash erase operation.

8. Onboard transceiver

The main difference between the deRFusb-23E00/06 and the deRFusb-13E00/06 USB radio sticks is the built-in 2.4GHz or alternatively Sub-GHz transceiver in combination with the appropriate onboard chip antenna.

deRFusb-23E00/06 - AT86RF231 transceiver

The low-power 2.4GHz transceiver is designed for industrial and consumer IEEE 802.15.4, ZigBee®, RF4CE, SP100, WirelessHART™ and high data rate ISM applications.

deRFusb-13E00/06 - AT86RF212 transceiver

The low-power, low-voltage 800/900MHz transceiver is designed for low-cost IEEE 802.15.4, ZigBee® and high data rate ISM applications available Europe and North America.



General transceiver description

These single-chip radio transceivers provide a complete radio transceiver interface between an antenna and a microcontroller.

They comprise the analog radio transceiver and the digital modulation and demodulation including time and frequency synchronization and data buffering. The number of external components is minimized such that only the antenna, the crystal and decoupling capacitors are required. The bidirectional differential antenna pins are used for transmission and reception, thus no external antenna switch is needed.

An internal 128 byte RAM for RX and TX buffers the data to be transmitted or the received data. Two on chip low dropout voltage regulators provide the internal analog and digital 1.8V supply.

The transceivers further contain comprehensive hardware-MAC support (Extended Operating Mode) and a security engine (AES) to improve the overall system power efficiency and timing.

9. Onboard flash (option)

A 2 GByte flash memory to store user defined data is optionally available using the deRFusb-23E06 and deRFusb-13E06 USB radio sticks.

This flash memory is typically applied as mass storage device for user data. It works like a Multimedia Card (MMC). Possible data bit modes are 1bit (default) and 4bit.

The flash is equipped with a memory controller and has a NAND flash architecture. It complies with eMMC Specification Version 4.4. The temperature range for safe operation is from - 25C° to +85C°.



10. Radio certification

10.1. United States (FCC)

The deRFusb-23E00/06 and deRFusb-13E00/06 USB radio sticks comply with the requirements of FCC part 15.

To fulfill FCC Certification requirements, an OEM manufacturer must comply with the following regulations:

The modular transmitter must be labeled with its own FCC ID number, and, if the FCC ID is not visible when the module is installed inside another device, the outside of the device into which the module is installed must also display a label referring to the enclosed module.

This exterior label can use wording such as the following. Any similar wording that expresses the same meaning may be used.

Sample label for USB radio stick deRFusb-23E00 and deRFusb-23E06:

| |
|--|
| FCC-ID: XVV-ARM323E00 |
| <i>This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.</i> |

The FCC certification for deRFusb-13E00/06 USB radio sticks are pending.

The Original Equipment Manufacturer (OEM) must ensure that the OEM modular transmitter is labeled with its own FCC ID number. This includes a clearly visible label on the outside of the final product enclosure that displays the contents shown below. If the FCC ID is not visible when the equipment is installed inside another device, the outside of the device into which the equipment is installed must also display a label referring to the enclosed equipment.

This equipment complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation (FCC 15.19). The internal / external antenna(s) used for this mobile transmitter must provide a separation distance of at least 20 cm from all persons and must not be co-located or operate in conjunction with any other antenna or transmitter.

Installers must be provided with antenna installation instructions and transmitter operating conditions for satisfying RF exposure compliance. This device is approved as a mobile device with respect to RF exposure compliance, and may only be marketed to OEM installers. Use in portable exposure conditions (FCC 2.1093) requires separate equipment authorization.

Modifications not expressly approved by this company could void the user's authority to operate this equipment (FCC section 15.21).

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful inter-



ference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense (FCC section 15.105).

10.2. European Union (ETSI)

The deRFusb-23E00/06 and deRFusb-13E00/06 USB radio sticks have been tested compliant for use in the European Union countries.

If the deRFusb-23E00/06 and deRFusb-13E00/06 USB radio sticks are incorporated into a product, the manufacturer must ensure compliance of the final product to the European harmonized EMC and low-voltage/safety standards. A Declaration of Conformity must be issued for each of these standards and kept on file as described in Annex II of the R&TTE Directive.

The manufacturer must maintain a copy of the deRFusb-23E00/06 and deRFusb-13E00/06 USB radio sticks documentation and ensure the final product does not exceed the specified power ratings, antenna specifications, and/or installation requirements as specified in the user manual. If any of these specifications are exceeded in the final product, a submission must be made to a notified body for compliance testing to all required standards.

The "CE" marking must be affixed to a visible location on the OEM product. The CE mark shall consist of the initials "CE" taking the following form:

- If the CE marking is reduced or enlarged, the proportions given in the above graduated drawing must be respected.
- The CE marking must have a height of at least 5mm except where this is not possible on account of the nature of the apparatus.
- The CE marking must be affixed visibly, legibly, and indelibly.

More detailed information about CE marking requirements you can find at "DIRECTIVE 1999/5/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL" on 9 March 1999 at section 12.



11. Ordering information

The product name includes the following information:

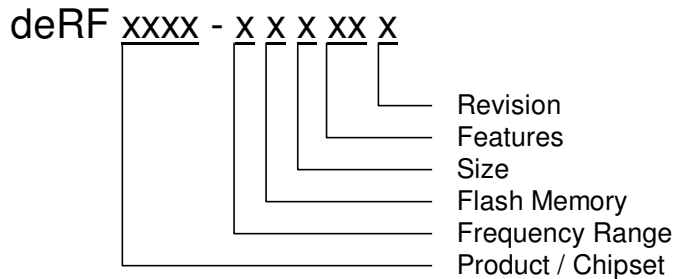


Table 7: product name code

| Product name code | | | |
|-------------------|---------|--------------------------|-----------------|
| Information | Code | Explanation | Comments |
| Product / Chipset | usb | AT91SAM7S | USB radio stick |
| Frequency range | 1 | 868/915 MHz | |
| | 2 | 2.4 GHz | |
| Flash memory | 3 | 256 kByte | |
| Size | E | USB stick | |
| Features | 00 | chip antenna | onboard |
| | 06 | chip antenna, 2 GB flash | onboard |
| Revision | <blank> | Rev 0 | |

Table 8: ordering information

| Ordering information | | |
|----------------------|--------------------|--|
| Part number | Product name | Comments |
| coming soon | deRFusb-23E00 | USB radio stick for 2.4 GHz (delivered with a fitting case) |
| BN-032310 | deRFusb-23E00 JTAG | USB radio stick for 2.4 GHz with assembled JTAG connector |
| coming soon | deRFusb-23E06 | USB radio stick for 2.4 GHz with 2 GByte flash - (delivered with a fitting case) |
| coming soon | deRFusb-23E06 JTAG | USB radio stick for 2.4 GHz with 2 GByte flash with assembled JTAG connector |
| coming soon | deRFusb-13E00 | USB radio stick for Sub-GHz (delivered with a fitting case) |
| coming soon | deRFusb-13E00 JTAG | USB radio stick for Sub-GHz with assembled JTAG connector |
| coming soon | deRFusb-13E06 | USB radio stick for Sub-GHz with 2 GByte flash - (delivered with a fitting case) |
| coming soon | deRFusb-13E06 JTAG | USB radio stick for Sub-GHz with 2 GByte flash with assembled JTAG connector |
| BN-028337 | SAM-ICE-Adapter | program and debug interface adapter for USB radio sticks |



12. Revision notes

Up to now for the deRFusb-23E00/06 and deRFusb-13E00/06 USB radio sticks technical problems, malfunctions or any other critical issues are not known.



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