dresden elektronik

User Manual
Radio Modules

deRFarm7-15A02
deRFarm7-25A00
deRFarm7-25A02

Document Version V1.2
2014-04-11

Table of contents

Document history

Date	Version	Description
2011-02-10	1.0	Initial version
2012-01-05	1.1	Addition - PCB design, transceiver signal description Update - Certification section
2014-04-11	1.2	Update - Technical data, PCB design, RF components Addition - Clock, Transceiver description, USB interface, Pre-flashed firmware, Mechanical Size

Abbreviations

Abbreviation	Description
ADC	Analog to Digital Converter
BOD	Brownout-Detection
CE	Consumer Electronics
DAC	Digital to Analog Converter
DBGU	Debug Unit
ETH	Ethernet, family of frame-based computer networking technologies for local area networks (LAN).
EMAC	Ethernet Media Access Controller
ETSI	European Telecommunications Standards Institute
FCC	Federal Communications Commission
GPIO	Generals Purpose Input Output
ISM	Industrial, Scientific and Medical frequency band
JTAG	Joint Test Action Group
ISP	In-System-Programming
MAC	Medium (Media) Access Control
MCU, µC	Microcontroller Unit
PCB	Printed Circuit Board
PCBA	Printed Circuit Board Assembled
PWM	Pulse Width Modulation
RF	Radio Frequency
RMII	Reduced Media Independent Interface
SPI	Serial Peripheral Interface
TWI	Two-Wire Serial Interface
U[S]ART	Universal [Synchronous/]Asynchronous Receiver Transmitter
USB	Universal Serial Bus

1. Overview

The deRFarm7 radio modules by dresden elektronik provide the access to the world of IEEE 802.15.4 technology. It is possible to establish a gateway from Ethernet to IEEE 802.15.4 Wireless Sensor Networks or just monitoring, controlling and sniffing of such networks. The software stack is free and open for custom applications and development.

The compact designed radio modules contain a powerful ARM7 microcontroller with 512 kB High-Speed Flash, On-chip USB 2.0 Full Speed Transceiver, Ethernet MAC 10/100 base-T in RMII-Mode and an onboard transceiver for 2.4 GHz or 868/915 MHz.

The 46 pin interface gives access to most hardware functions of the microcontroller.

A long radio transmission range can be achieved by using the coaxial jack (U.FL) version with an external antenna attached. In the Sub-GHz band several hundred meters can be reached without problems. The 2.4 GHz version is able to cover up to 200 m with a ceramic chip antenna. All versions have a 128-bit AES encryption unit installed.

The 512 kB Flash and 128 kB RAM of the deRFarm7 modules provide enough resources to be used for any tasks within a wireless sensor network.

2. Application

The main applications for the deRFarm7 radio modules are:

- 2.4GHz IEEE 802.15.4
- 868MHz / 915MHz IEEE 802.15.4
- ZigBee Pro
- ZigBee RF4CE
- ZigBee IP
- 6LoWPAN
- ISA SP100
- Wireless Sensor Networks
- Industrial and home controlling/monitoring
- Gateway applications between IEEE 802.15.4 and other networks, e.g. Ethernet

3. Features

The radio modules offer the following features:

- pluggable: 2 male connectors, 23 pins per row, 1.27mm pitch
- available signals: ADC, GPIO, PWM
- application interfaces: 1x UART, 1x TWI, 1x USB, 1x SPI, 1x Ethernet-MAC
- Debug/Programming interfaces: 1x DBGU, 1x JTAG
- RF shielding

The radio modules are available with different transceivers and RF output options:

- transceiver for 868/915 MHz (1 channel in EU and 10 channels in US band)
- transceiver for 2.4 GHz (16 channels)
- Onboard chip-antenna
- Onboard U.FL coaxial connector
- Certification: FCC certified
- Compliant: CE, ETSI

Figure 1 shows the functional overview.

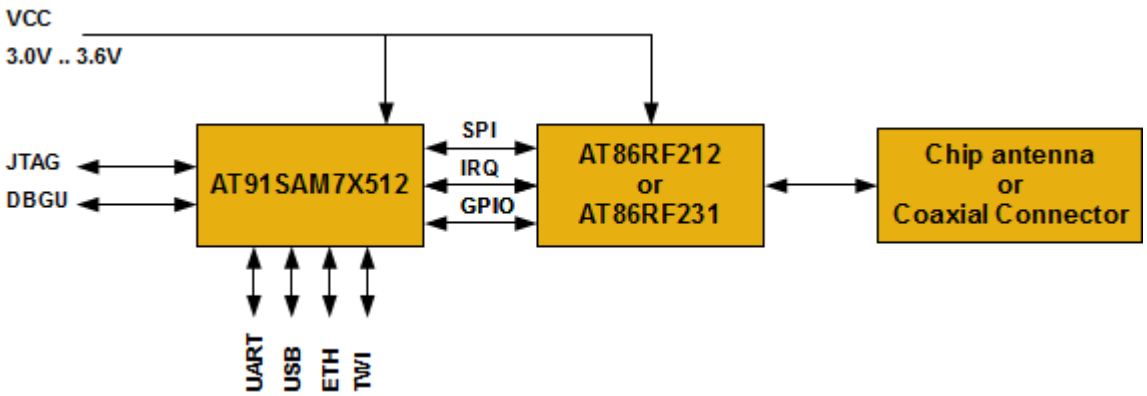


Figure 1: Block diagram

4. Options

This chapter gives a short overview of the different available radio module variants and their assembled feature parts.

The dresden elektronik radio module series deRFarm7 and deRFmega128 are pin compatible and changeable. The pluggable modules are useful for development applications or to test Sub-GHz and 2.4GHz modules in the target environment. See **Figure 5** for mechanical properties.

4.1. Radio module for Sub-GHz application

The pluggable sub GHz radio module is available with an U.FL coaxial connector. The RF shielding covers the microcontroller, the transceiver, the quartz crystals and all necessary passive components.

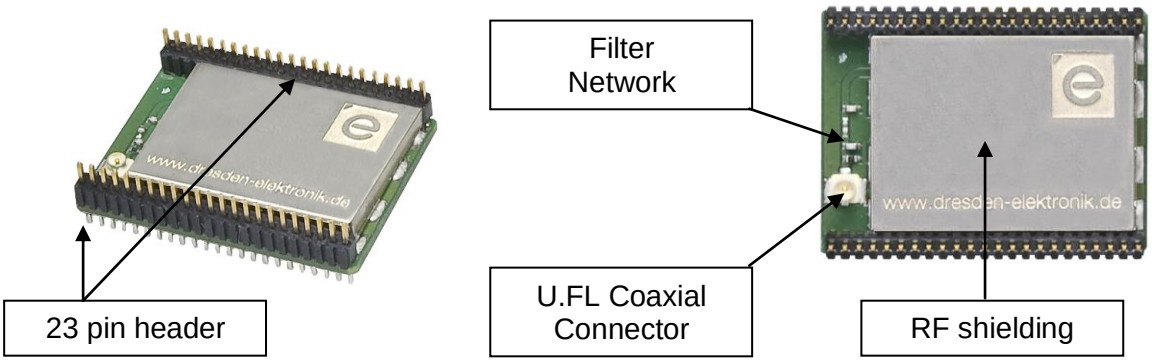


Figure 2: Sub-GHz radio module with coaxial output

4.2. Radio module for 2.4GHz application

The 2.4GHz radio module is available with either a chip antenna or an U.FL coaxial connector as pluggable variant. The RF shielding covers the microcontroller, the transceiver, the quartz crystals and all necessary passive components.

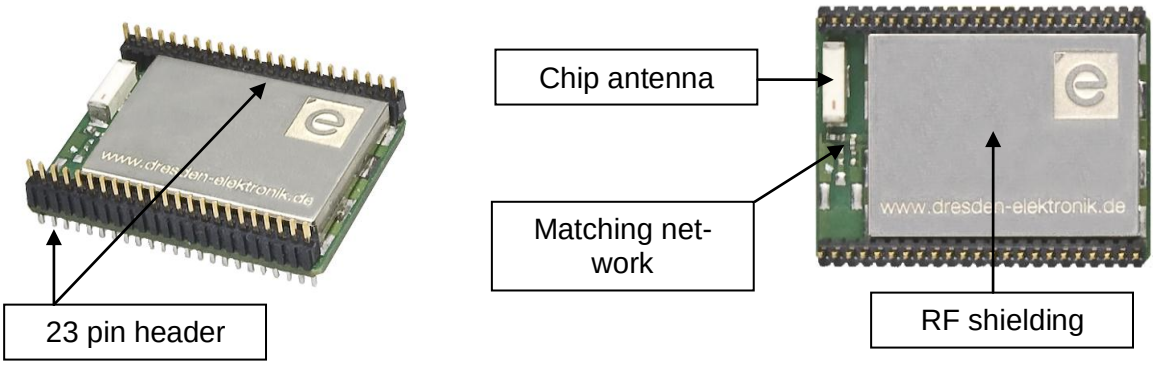


Figure 3: 2.4 GHz radio module with chip antenna

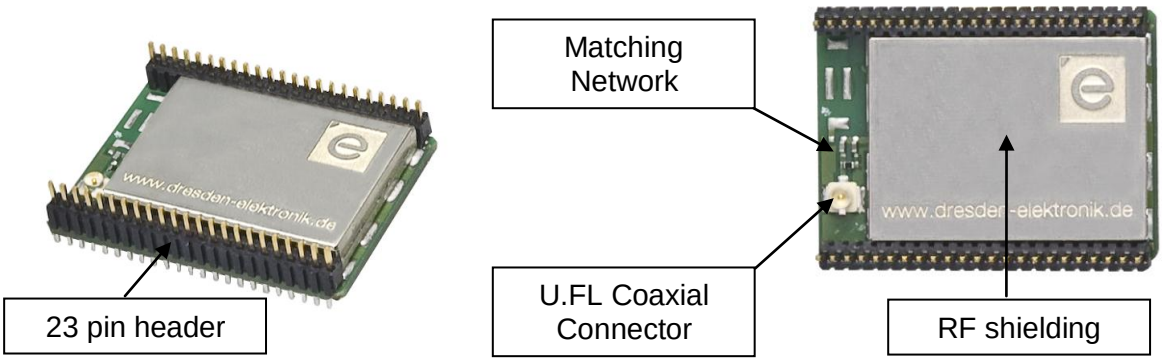


Figure 4: 2.4 GHz radio module with coaxial output

5. Technical data

Table 1: Mechanical data

Mechanical	
Radio modules	
Size (length x width x height)	30 x 22.7 x 8.2 mm
Weight	tbd
Connectors	
number of headers	2
pins per header	23
Pitch	1.27 mm
pin length	3.05 mm
pin diameter	0.51 mm
Insulator (L x W x H)	29.2 x 2.5 x 2.5 mm
Pins	
Pitch	1.27 mm

Table 2: Temperature range

Temperature range					
		Min	*Typ*	*Max*	*Unit*
Operating temperature range	T_{work}	-40		+85	°C
Humidity		25		80	% r.H.
Storage temperature range		-40		+125	°C

Table 3: Electrical data

Electrical (Supply voltage VCC = 3.3V)					
deRFarm7-15A02					
	Parameter	*Min*	*Typ*	*Max*	*Unit*
Supply Voltage	VCC	3.0	3.3	3.6	V
Current consumption	I_{TXon} (TX_PWR = +10 dBm)		52		mA
	I_{TXon} (TX_PWR = +5 dBm)		46		mA
	I_{TXon} (TX_PWR = 0 dBm)		43		mA
	I_{RXon}		36		mA
	I_{Idle} (Txoff, MCK = 12MHz)		21		mA
	I_{Idle} (Txoff, MCK = 48MHz)		38		mA
	I_{Sleep} (depends on Sleep Mode)		250		µA
deRFarm7-25A00 / 25A02					
	Parameter	*Min*	*Typ*	*Max*	*Unit*
Supply Voltage	VCC	3.0	3.3	3.6	V
Current consumption	I_{TXon} (TX_PWR = +3 dBm)		38		mA
	I_{TXon} (TX_PWR = +1 dBm)		37		mA
	I_{TXon} (TX_PWR = -17 dBm)		32		mA
	I_{RXon}		36		mA
	I_{Idle} (Txoff, MCK = 12MHz)		21		mA
	I_{Idle} (Txoff, MCK = 48MHz)		38		mA
	I_{Sleep} (depends on Sleep Mode)		250		µA

Table 4: Quartz crystal properties

Quartz crystal					
	Parameter	*Min*	*Typ*	*Max*	*Unit*
MCU crystal	frequency		18.432		MHz
	Frequency tolerance		+/- 30		ppm
	Load capacitance		16		pF
Transceiver crystal	frequency		16.000		MHz
	Frequency tolerance		+/-10		ppm
	Load capacitance		9		pF

Table 5: Radio data of deRFarm7-25A00 / 25A02

Radio 2.4GHz (Supply voltage VCC = 3.3V)					
	Parameter / feature	*Min*	*Typ*	*Max*	*Unit*
Antenna	Type	Chip ceramic			
	Gain	-0.2	+0.5	+0.9	dBi (peak)
	Diversity	No			
Coaxial connector	Type	U.FL-R-SMT-1(01)			
Range[1]	line of sight		>200	250	m
Frequency range[2]	PHY_CC_CCA = 0x0B...0x1A	2405		2480	MHz
Channels	PHY_CC_CCA = 0x0B...0x1A	16			
Transmitting power conducted	TX_PWR = 0x00	+1.7	+2.4	+3.3	dBm

[1] Measured with deRFarm7-25A00 plugged into deRFbreakout Board standing on a tripod with a height of 1.4 meters and PER≤1%

[2] Operating the transmitter at channel 26 requires to ensure a duty cycle ≤29%

Receiver sensitivity	Data Rate = 250kBit/s Data Rate = 500kBit/s Data Rate = 1000kBit/s Data Rate = 2000kBit/s		-96 -92 -90 -84		dBm dBm dBm dBm
Data rate (Brutto)	TRX_CTRL_2 = 0x00 TRX_CTRL_2 = 0x01 TRX_CTRL_2 = 0x02 TRX_CTRL_2 = 0x03		250 500 1000 2000		kBit/s kBit/s kBit/s kBit/s

Table 6: Radio data of deRFarm7-15A02

Radio (Supply voltage VCC = 3.3V)					
	Parameter / feature	*Min*	*Typ*	*Max*	*Unit*
Coaxial connector	Type	U.FL-R-SMT-1(01)			
Range	line of sight (915MHz) line of sight (868MHz)		>250 >250		m m
Frequency range	PHY_CC_CCA = 0x00 PHY_CC_CCA = 0x01...0x0A	 906	868.3	 924	MHz MHz
Channels	PHY_CC_CCA = 0x00 PHY_CC_CCA = 0x01...0x0A	1 10			
Transmitting power conducted	TX_PWR = 0x00 @ 915MHz[3] TX_PWR = 0x00 @ 868MHz[4]	+9.1	+9.3 +4.9	+9.5	dBm dBm

[3] FCC: Depending on transmit and receive data rate. Reduce the output power to ensure conformity according to FCC part 15. For TRX_CTRL_2 = 0x0D set TX_PWR = 0x82. For TRX_CTRL_2 = 0x2E set TX_PWR = 0x85.

[4] ETSI: reduce the output power to PHY_TX_PWR = 0x64 to ensure conformity according to EN 300 220 V2.3.1

Receiver sensitivity	Data Rate = 20kBit/s Data Rate = 40kBit/s Data Rate = 100kBit/s Data Rate = 200kBit/s Data Rate = 250kBit/s Data Rate = 400kBit/s Data Rate = 500kBit/s Data Rate = 1000kBit/s		-103 -102 -95 -93 -96 -87 -94 -91		dBm dBm dBm dBm dBm dBm dBm dBm
Data rate (Brutto)	TRX_CTRL_2 = 0x00 TRX_CTRL_2 = 0x08 TRX_CTRL_2 = 0x09 TRX_CTRL_2 = 0x2A		20 100 200 400		kBit/s kBit/s kBit/s kBit/s
	TRX_CTRL_2 = 0x04 TRX_CTRL_2 = 0x0C TRX_CTRL_2 = 0x0D TRX_CTRL_2 = 0x2E		40 250 500 1000		kBit/s kBit/s kBit/s kBit/s

6. Mechanical size

This chapter describes the mechanical properties of the radio modules and the recommended footprint for receptacles and soldering pads.

6.1. Radio module (pluggable)

The pluggable radio modules have a size of 30.0 x 22.7 mm (see **Figure 5**).

Used connectors: SAMTEC “TMS-123-02-L-S”

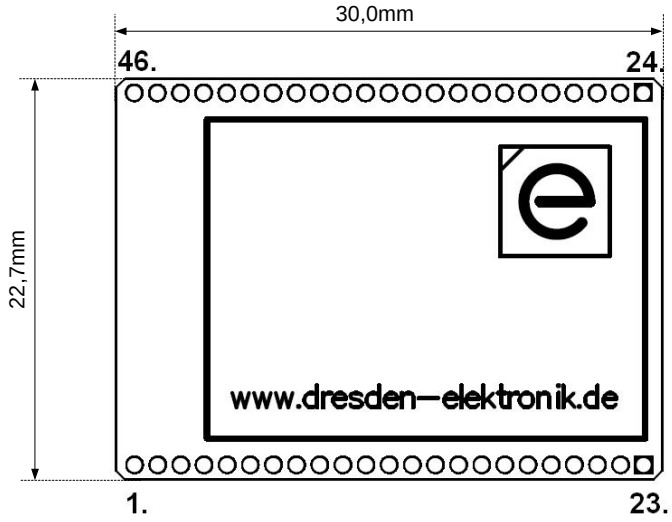


Figure 5: Size deRFarm7-15A02 / 25A00 / 25A02

6.2. Footprint receptacles

The receptacle footprint of all pluggable radio modules is shown in **Figure 6**. The pitch is 1.27 mm. We recommend the hole size of 0.6 mm with an annular ring of 0.2 mm. Be careful of the header placement because the radio module will be plugged reversed.

Used receptacles: SAMTEC “SLM-123-01-L-S”

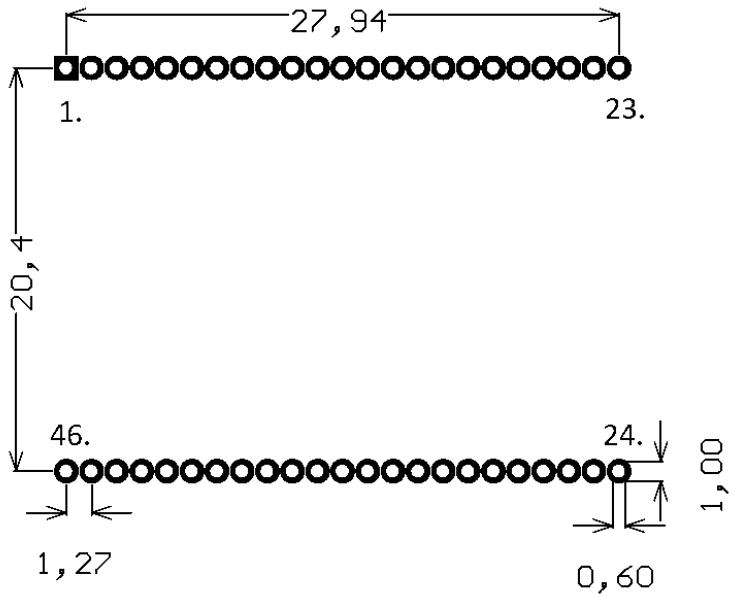
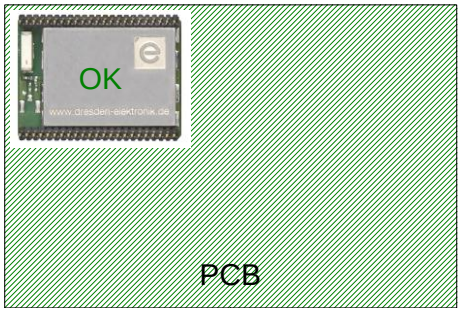


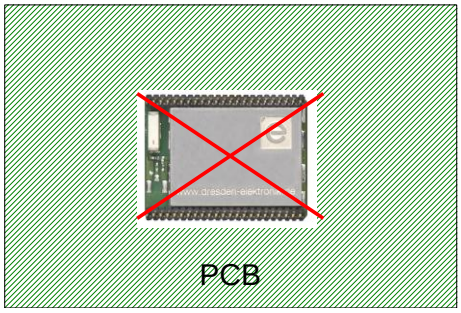
Figure 6: Footprint receptacles 1.27mm pitch

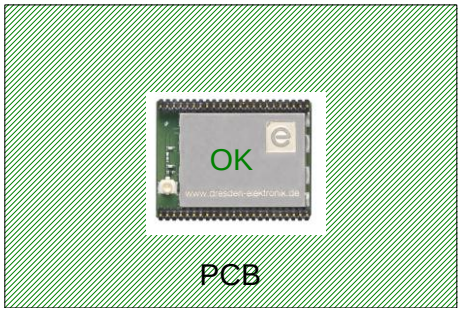
7. PCB design

The PCB design of the radio module base board and placement affects the radio characteristic. The radio module should be placed at an edge of the base board. The chip antenna should be directed to PCB border.

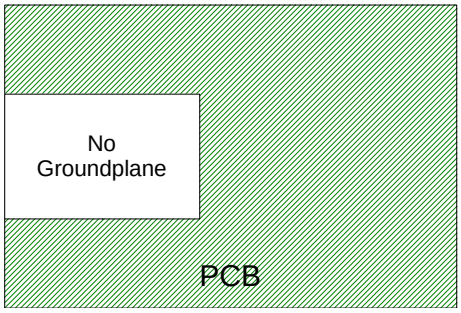


Do not place the radio module with chip antenna in the center of the base board. The radio module option with coaxial connector can be placed also in the center of a base board. Ensure that the necessary coaxial cable is long enough to connect an external antenna.





Do not place ground areas below the radio module and near the chip-antenna.



If the base board with the radio module will be placed into a metal case, it is necessary to use the radio module variant with coaxial connector and an external antenna.

8. Soldering profile

Table 7 describes the details of the soldering profile for the radio modules.

Table 7: Soldering Profile

Profile Feature	Values
Average-Ramp-up Rate (217°C to Peak)	3°C/sec max.
Preheat Temperature 175°C ±25°C	120 sec. max
Temperature Maintained Above 217°C	60 sec.
Time within 5°C of Actual Peak Temperature	20 sec. to 40 sec.
Peak Temperature Range	260°
Ramp-down Rate	6°C/sec max.
Time 25°C to Peak Temperature	8 min. max.

Figure 7 shows a recorded soldering profile for a radio module. The blue colored line illustrates a temperature sensor placed next to the soldering-contacts of the radio module. The pink line shows the set temperatures depending on the zone within the reflow soldering machine.

Figure 7: Recorded soldering profile

A solder process without supply of nitrogen causes a discoloration of the metal RF-shielding. It is possible that the placed label shrinks due the reflow process.

9. Pin assignment

Both pin headers provide the most important signals to the customer: power supply, peripheral, programming, debugging, tracing, analog measurement and free programmable ports. All provided signals except VCC, GND, RSTN, JTAGSEL, TDI, TDO, TCK, TMS, USBDM, USBDP and ADVREF are free programmable port pins (GPIO).

Figure 8, **Figure 9** and **Figure 10** show the Top overlay and the pin numbers of the radio modules. **Table 8**, **Table 9** and **Table 10** show the external available signals of deRFarm7 radio modules.

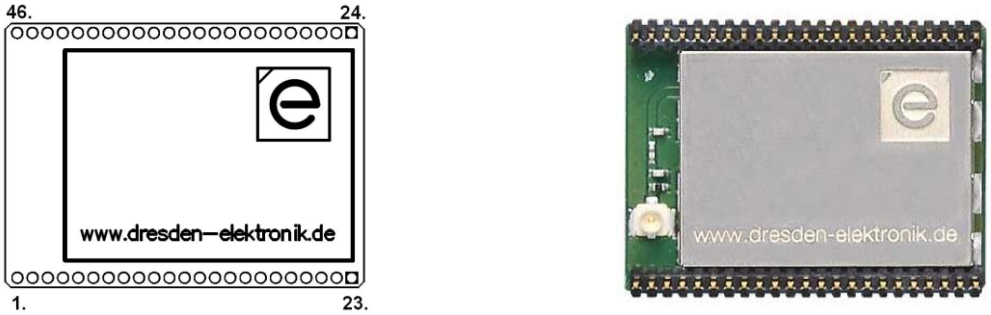


Figure 8: Top overlay deRFarm7-15A02

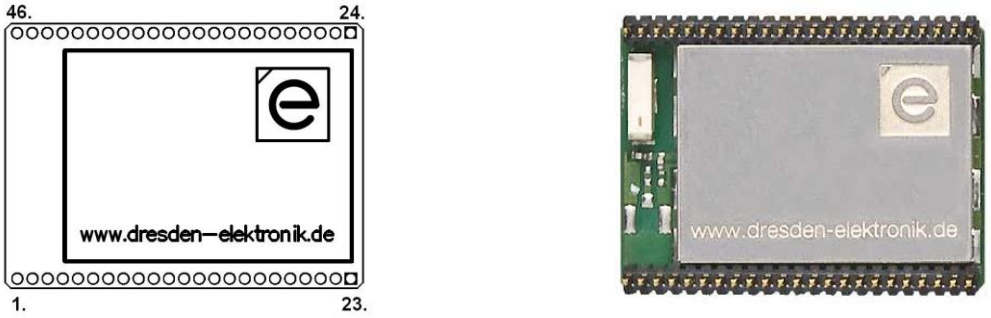


Figure 9: Top overlay deRFarm7-25A00

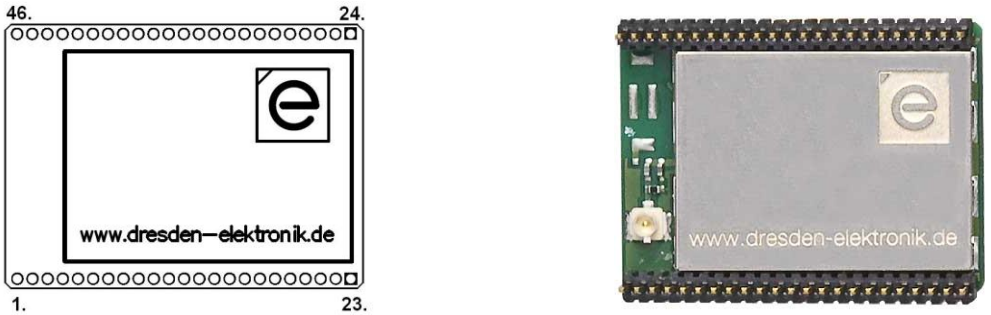


Figure 10: Top overlay deRFarm7-25A02

Table 8: Pin assignment of deRFarm7 – radio module family

Pin assignment			
Pin	*µC-Port*	*Pin*	*µC-Port*
1	VCC	24	VCC
2	GND	25	GND
3	ADVREF	26	PA27/DRXD/PCK3
4	USBDM	27	PA0/RXD0
5	RSTN	28	PA28/DTXD
6	PB3/ETX1	29	PA4/CTS0/SPI1_NPCS3
7	PA11/TWCK	30	PB9/EMDIO
8	PB26/TIOB1/RI1	31	PB21/PWM2/PCK1
9	PA10/TWD	32	USBDP
10	PA1/ TXD0	33	PB19/PWM0/TCLK1
11	PB25/TIOA1/DTR1	34	PB27/TIOA2/PWM0/AD0
12	PB2/ETX0	35	PA14/SPI0_NPCS2/IRQ1
13	PA18/SPI0_SPCK	36	PB28/TIOB2/PWM1/AD1
14	PA3/RTS0/SPI1_NPCS2	37	PB5/ERX0
15	PA17/SPI0_MOSI	38	TCK
16	PB0/ETXCK/EREFCK	39	PB7/ERXER
17	PA16/SPI0_MISO	40	TMS
18	PB8/EMDC	41	PB1/ETXEN
19	PB6/ERX1	42	TDO
20	PB18/EF100/ADTRG	43	JTAGSEL
21	PB15/ERXDV/ECRSDV	44	TDI
22	GND	45	GND
23	GND	46	GND

Table 9: Description of available I/O port pins

Description of available I/O port pins on header pins				
I/O port pin	*Alternate function (signal name)*			*Comments*
PA0	RXD0			
PA1	TXD0			
PA3	RTS0			
PA4	CTS0			
PA10	TWD			
PA11	TWCK			
PA14	IRQ1			
PA16	SPI0_MISO			
PA17	SPI0_MOSI			
PA18	SPI0_SPCK			
PA27	DRXD	PCK3		
PA28	DTXD			
PB0	ETXCK/EREFCK	PCK0		
PB1	ETXEN			
PB2	ETX0			
PB3	ETX1			
PB5	ERX0			
PB6	ERX1			
PB7	ERXER			
PB8	EMDC			
PB9	EMDIO			
PB15	ERXDV/ECRSDV			
PB18	EF100	ADTRG		
PB19	PWM0	TCLK1		
PB21	PWM2	PCK1		
PB25	TIOA1	DTR1		
PB26	TIOB1	RI1		

PB27	TIOA2	PWM0	AD0	
PB28	TIOB2	PWM1	AD1	

Table 10: Signal description list

Signal name	Function	Type	Active Level	Comments
Power				
VCC	Voltage Regulator Power Supply Input	Power		3.0V to 3.6V
GND		Ground		
JTAG				
TCK	Test Clock	Input		On-board Pull-up
TDI	Test Data In	Input		On-board Pull-up
TDO	Test Data Out	Output		
TMS	Test Mode Select	Input		On-board Pull-up
JTAGSEL	JTAG Selection	Input		On-Board Pull-down
Debug Unit				
DRXD	Debug Receive Data	Input		
DTXD	Debug Transmit Data	Output		
Reset				
RSTN	Microcontroller Reset	I/O	Low	Pull-Up resistor
Clocks, Oscillators				
PCK0 - PCK3	Programmable Clock Output	Output		
U[S]ART				
TXD0	Transmit Data	I/O		
RXD0	Receive Data	Input		
RTS0	Request To Send	Output		
CTS0	Clear To Send	Input		
DTR1	Data Terminal Ready	Output		
RI1	Ring Indicator	Input		

Signal name	Function	Type	Active Level	Comments
Timer/Counter and PWM Controller				
TIOA1 – 2	I/O Line A	I/O		
TIOB1 – 2	I/O Line B	I/O		
TCLK1	External Clock Inputs	Input		
PWM Controller				
PWM0 – 2	PWM Channels	Output		
Interrupt				
IRQ1	External Interrupt Inputs	Input		
SPI				
SPI0_MISO	Master In / Slave Out	I/O		
SPI0_MOSI	Master Out / Slave In	I/O		
SPI0_SPCK	SPI Serial Clock	I/O		
SPI0_NPCS2	SPI Peripheral Chip Select 2	Output	Low	
SPI1_NPCS2	SPI Peripheral Chip Select 2	Output	Low	
SPI1_NPCS3	SPI Peripheral Chip Select 3	Output	Low	
Two-Wire-Interface				
TWD	Two-Wire Serial Interface Data	I/O		
TWCK	Two-Wire Serial Interface Clock	I/O		
USB Device Port				
USBDM	USB Device Port Data -	Analog		
USBDP	USB Device Port Data +	Analog		
Analog-to-Digital Converter				
AD0 – AD1	Analog Inputs	Analog		Digital pulled-up inputs at reset
ADTRG	ADC Trigger	Input		
ADVREF	ADC Reference	Analog		
Ethernet MAC 10/100 (RMII Mode)				
ETXCK/ EREFCK	Reference Clock	Input		RMII only

Signal name	Function	Type	Active Level	Comments
ETXEN	Transmit Enable	Output		
ETX0 – ETX1	Transmit Data	Output		
ERX0 – ERX1	Receive Data	Input		
ERXER	Receive Error	Input		
EMDC	Management Data Clock	Output		
EMDIO	Management Data Input/Output	I/O		
ERXDV/ ECRSDV	Carrier Sense and Data Valid	Input		RMII only
EF100	Force 100 Mbits/sec.	Output	High	RMII only

10. Onboard transceiver

The main difference between the deRFarm7-15A02 and the deRFarm7-25A00/25A02 radio modules is the built-in 2.4GHz or alternatively Sub-GHz transceiver in combination with the appropriate onboard chip antenna. The signal connection between MCU and Transceiver is shown in **Section 10.2 Table 11**.

deRFarm7-25A00 / 25A02 - AT86RF231 transceiver

The low-power 2.4GHz transceiver is designed for industrial and consumer IEEE 802.15.4, ZigBee, RF4CE, ISA SP100 and high data rate ISM applications. **[1]**

deRFarm7-15A02 - AT86RF212 transceiver

The low-power, low-voltage 800/915MHz transceiver is designed for low-cost IEEE 802.15.4, ZigBee and high data rate ISM applications available Europe and North America. **[2]**

10.1. 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.

10.2. Internal transceiver connection to the MCU

Table 11 shows the internal signal connection between MCU and transceiver. This description is valid for all deRFarm7 radio modules.

Table 11: Internal connection of MCU and Transceiver

µC Pin	TRX Pin	Signal name	function	comments
Internal transceiver interface				
D1	22	PA23/TD/SPI1_MOSI	MOSI	Master Out / Slave In
D2	20	PA24/RD/SPI1_MISO	MISO	Master In / Slave Out
A1	19	PA22/TK/SPI1_SPCK	SCLK	SPI Serial Clock
A2	23	PA21/TF/SPI1_NPCS0	SEL	SPI Select
J1	24	PA29/FIQ/SPI1_NPCS3	IRQ	1. Interrupt request signal 2. Frame Buffer Empty Indicator
H7	8	PA9/CTS1	RSTN	Transceiver Reset
C10	17	PA15/TCLK2	CLKM[5]	Master clock signal output, internal lowpass filter assembled
H8	11	PA8/RTS1	SLP_TR	Controls sleep, transmit start, receive states
F2	10	PB23/TIOA0/DCD1	DIG2	1. Antenna Diversity RF switch control 2. RX Frame Time Stamping

[5] For best radio performance results it is recommended to deactivate the clock output. According to transceiver datasheet register 0x03 must be set to value 0x00 to deactivate CLKM.

11. Clock

The radio modules contain an external onboard 18.432 MHz 30ppm quartz crystal for the MCU and a 16.000MHz 10ppm quartz crystal for the transceiver. For optimum RF timing characteristics it is necessary to use a low tolerance crystal. The crystal assignment on the PCB is shown in **Table 12**.

Table 12: Crystal assignment

µC Pin	TRX Pin	Signal name	function	comments
Clock				
J8	-	XOUT	18.432MHz quartz crystal	MCU crystal
J7	-	XIN		
-	26	XTAL1	16.000MHz quartz crystal	Transceiver crystal
-	25	XTAL2		

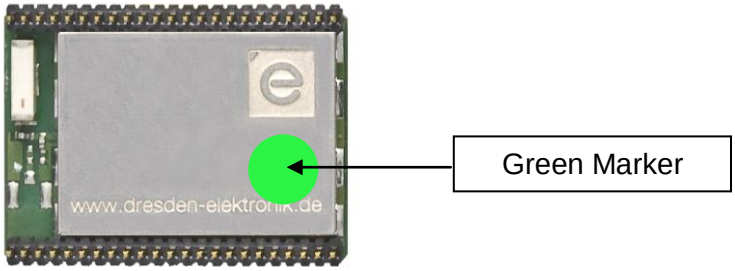
12. Programming

The programming procedures are described in the ‘User Manual Software Programming’ **[4]**, which is available on the dresden elektronik webpage. It describes step-by-step the update process of the radio module, the required software and hardware for programming via USB or JTAG and the driver installation on different operating systems.

13. Pre-flashed firmware

The radio modules are available with a pre-flashed firmware. A colored marker is placed on the PCB for differentiation of the delivered firmware.

13.1. Wireless UART firmware



Radio modules with pre-flashed wireless UART firmware have a light green marker. Working with the wireless UART requires a terminal program like HyperTerminal or any other. The Wireless UART application example is described in section **13.1.1** for Windows™ and section **13.1.2** for Linux.

The wireless UART firmware makes use of the native USB interface Pin 4 (USBDM) and Pin 32 (USBDP) of the radio module. See **Table 8** and **Table 10** for more details of the used signals. We recommend the use of the dresden elektronik baseboards deRFnode or deRFgateway.

13.1.1. Step-by-Step instructions for Windows™

1. Connect the baseboard with the plugged radio modules with pre-flashed wireless UART firmware **via USB** to your PC(s) and/or Laptop(s). Assemble external antennas if required.

2. If you connect first time to a PC, Windows™ will ask you to install the driver for the USB device. The USB drivers are available on dresden elektronik homepage. See on the products web shop site.

3. The Windows™ device manager tells you which virtual COM-Port (Serial Port) is assigned to each radio module.

4. If you know both COM Ports, open two terminal program sessions.

5. On each terminal session you have to set up the corresponding COM port. Baud rate, data bits, parity and stop bit settings don't care..

6. If all is set up correctly, simply type any character into one terminal and you can see this character on the other terminal (this also works vice versa).

7. The character is received by the radio module and transferred over air to the other radio module, who sends the received character to the own terminal program (see Figure 11).

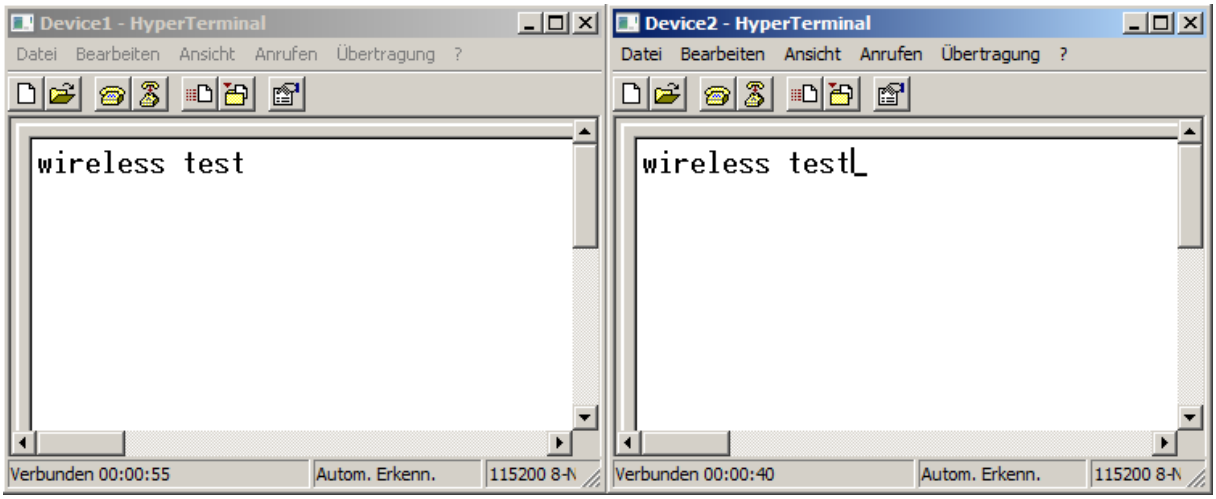


Figure 11: Wireless UART terminal session

13.1.2. Step-by-Step instructions for Linux

In order to use the serial USB port of deRFarm7 products in Linux the following steps must be taken. The user is either required to have root privileges or use sudo.

1. Use the following commands to unload the relevant kernel modules:
   rmmod usbserial

2. Create and open the file */etc/modprobe.d/dresden_elektronik.conf*. If the directory */etc/modprobe.d/* doesn't exist edit the file */etc/modprobe.conf* or */etc/modprobe.conf.local* instead.

   Currently it's not possible to have multiple device types running at the same time. The limit is one device for ftdi_sio and one for usbserial module.
   We will bring all devices in the mainline kernel and lift this limitation.

   Add the following lines to the file:
   #deRFarm7
   #options usbserial vendor=0x1cf1 product=0x001D

Uncomment the options line for the device you own. This is also valid for USB sticks with JTAG connector. For a deRFarm7 e.g.:
#deRFarm7
#options usbserial vendor=0x1cf1 product=0x001D

3. Reload the kernel modules unloaded in Step 1
   modprobe usbserial

4. After connecting the device to PC or laptop USB port a new device should appear in the directory */dev*. The device name is either */dev/ttyUSBx* or */dev/ACMx* there x is a number from 0-9.

5. Open two terminal program sessions for the devices.

6. If all is set up correctly, simply type any character into one terminal and you can see this character on the other terminal (this also works vice versa).

7. The character is received by the radio module and transferred over air to the other radio module, who sends the received character to the own terminal program.

14. Radio certification

14.1. United States (FCC)

The deRFarm7-15A02, deRFarm7-25A00 and deRFarm7-25A02 radio modules 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, then 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 radio module deRFarm7-25A00:

FCC-ID: XVV-ARM725A00
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.

Sample label for radio module deRFarm7-25A02:

FCC-ID: XVV-ARM725A02
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.

Sample label for radio module deRFarm7-15A02:

FCC-ID: XVV-ARM715A02
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.

To be used with the deRFarm7-15A02, deRFarm7-25A02 modules, the external antennas which have been used for testing and which have been approved are specified below in **Section 14.3**. The deRFarm7-15A02, deRFarm7-25A02 modules may be integrated with other custom design antennas which OEM installer must authorize following the FCC 15.21 requirements.

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, then 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 operated 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 interference 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 its own expense (FCC section 15.105).

Channel 26 issue

The built in transceiver AT86RF231 for 2.4GHz applications has an issue considering the transmitted power in the last channel 26. Because of the restricted band in United States that starts at 2483.5 MHz the limit for spurious emissions are stricter. The best solution to fulfill the FCC requirements is to set a maximum duty cycle of 29% for channel 26. This value is related to a 100ms period, which means that the transceiver can transmit 29ms within a period of 100ms. This leads to a correction factor according to ANSI C63.10-2009 (clause 4.4) that decrease the measured transmit value below the limit and to provide a FCC conform application. More details are given in [2].

Channel 1 to 10 issue

The output power of the built in transceiver AT86RF212 for Sub-GHz applications has to be decreased for high data rate modes in the US band to ensure conformity according to FCC part 15. For TRX_CTRL_2 = 0x0D (400 kBit/s) set a maximum transmit power level of TX_PWR = 0x82 and for TRX_CTRL_2 = 0x2E (1000 kBit/s) set a maximum transmit power level of TX_PWR = 0x85. See **[1]** for more details.

14.2. European Union (ETSI)

The deRFarm7-15A02, deRFarm7-25A00 and deRFarm7-25A02 modules have been tested compliant for use in European Union countries.

If the deRFarm7-15A02, deRFarm7-25A00 and deRFarm7-25A02 modules 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 deRFarm7-15A02, deRFarm7-25A00 and deRFarm7-25A02 modules 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.

Channel 0 issue

The output power of the built in transceiver AT86RF212 for Sub-GHz applications has to be decreased for EU band to ensure conformity according to EN 300 220 V2.3.1. Set the maximum transmit power to PHY_TX_PWR = 0x64. See **[1]** for more details.

14.3. Approved antennas

The deRFarm7-25A00 has an integrated chip antenna. The design is fully compliant with all regulations.

The deRFarm7-15A02 has been tested and approved for use with the antenna listed below. The module may be integrated with other custom design antennas which OEM installer must authorize with respective regulatory agencies. The used antenna was connected to the radio module with a 15cm “U.FL-to-SMA pigtail”.

Please refer to **[5]** if a custom antenna should be used.

Table 13: Approved antenna(s) and accessory

Approved antenna(s) and accessory				
Part number	*Description*	*Manufacturer*	*Gain [dBi]*	*Min. Separation [cm]*
ANT-916-CW-HWR-RPS	½ wave whip antenna (915 MHz) with RP-SMA-Connector	Antenna Factor	0	20
PSKN3-2400RS	½ wave whip antenna (2450 MHz) with RP-SMA-Connector	Mobile Mark	+2.3	20
BN-032125	U.FL to RP-SMA pigtail, 15 cm	Hirose / Profineon	-0,35	

15. Ordering information

The product name includes the following information:

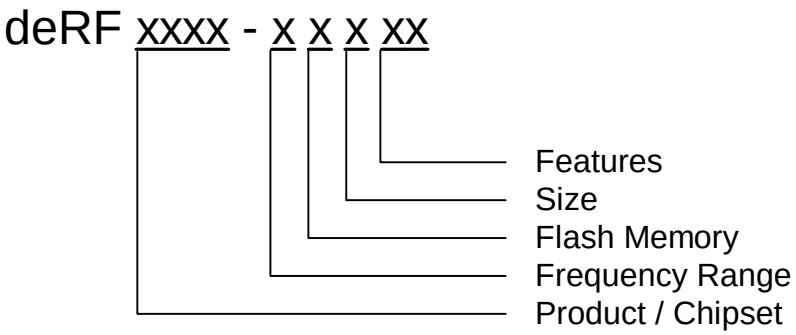


Table 14: product name code

Product name code			
Information	*Code*	*Explanation*	*Comments*
Product / Chipset	arm7	AT91SAM7X	radio module
Frequency range	1	868 / 915 MHz	
	2	2.4 GHz	
Flash memory	5	512 kByte	
Size	A	30 x 22.7 mm	pluggable
Features	00	chip antenna	onboard
	02	coaxial connector	onboard U.FL

Table 15: ordering information

Ordering information		
Part number	*Product name*	*Comments*
BN-033200	deRFarm7-15A02 WUART	pluggable Sub-GHz radio module with onboard U.FL coaxial connector pre-flashed with Wireless UART firmware
BN-033196	deRFarm7-25A00 WUART	pluggable 2.4-GHz radio module with onboard chip antenna pre-flashed with Wireless UART firmware
BN-033197	deRFarm7-25A02 WUART	pluggable 2.4-GHz radio module with onboard U.FL coaxial connector pre-flashed with Wireless UART firmware

16. Revision notes

Up to now no technical problems, malfunctions or any other critical issues are known for the deRFarm7-15A02, deRFarm7-25A00, deRFarm7-25A02 radio modules.

All errata of the ARM7 MCU and transceivers are described in the respective datasheets **[1]**, **[2]** and **[3]**.

17. References

[1] AT86RF212-ZU: AVR Low Power 700/800/900 MHz Transceiver for IEEE802.15.4-2006, IEEE802.15.4-2009, Zigbee, 6LoWPAN, and ISM Applications; Datasheet; 8186-MCU Wireless-02/10

[2] AT86RF231-ZU: AVR Low Power 2.4 GHz Transceiver for ZigBee, IEEE802.15.4, 6LoWPAN, RF4CE, SP100, WirelessHART, and ISM Applications; Datasheet; 8111C-MCU Wireless-09/09

[3] AT91ARM Thumb-based Microcontrollers: AT91SAM7X512; Datasheet; 6120H-ATARM-17-Feb-09

[4] User Manual Software Programming;
URL: http://www.dresden-elektronik.de/funktechnik/products/radio-modules/oem-derfmega/description/?L=0&eID=dam_frontend_push&docID=1917

[5] Customized Antenna Connection to dresden elektronik Radio Modules; Application Note; URL: http://www.dresden-elektronik.de/funktechnik/wireless/white-papers/?L=1&eID=dam_frontend_push&docID=314

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