

User Manual Radio Modules

deRFmega128-22A00

deRFmega128-22A02

deRFmega128-22C00

deRFmega128-22C02





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Document history

Date	Version	Description
2010-01-25	01.00	Initial version
2010-03-30	01.01	Addition of deRFmega128-22C00
2010-08-25	01.02	Updated deRFmega128-22A00 / -22A02 to Rev02 Addition of deRFmega128-22C02 New pin designation Updated footprint receptacles
2010-09-07	01.03	Updated Programming section

Mailing list

Firm	Division / Name
DE	Dev. / A. Palm

Author / Check / Release

	Firm	Division / Name
Author	DE	Dev. / A. Palm
Check		
release		



Abbreviations

Abbreviation	Description
ADC	Analog to Digital Converter
BOD	Brownout-Detection
CE	Consumer Electronics
FCC	Federal Communications Commission
GPIO	Generals Purpose Input Output
JTAG	Joint Test Action Group
RF	Radio Frequency
SPI	Serial Peripheral Interface
TWI	Two-Wire Interface
UART	Universal Asynchronous Receiver Transmitter



1. Overview

The pluggable compact radio modules deRFmega128-22A00, deRFmega128-22A02 and the solderable radio module deRFmega128-22C00 and deRFmega128-22C02 include Atmel's Single-Chip ATmega128RFA1, which combines an 8-Bit AVR microcontroller with a 2.4GHz transceiver.

2. Application

The main applications for the radio modules are:

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



3. Features

The radio modules deRFmega128-22A00 and deRFmega128-22C00 offer the following features:

- Compact size: 30 x 22.7 mm (for 22A00) and 30 x 20.4 mm (for 22C00)
- Pluggable: 2 male connectors, 23 pins per row, 1.27mm pitch
- RF shielding
- Usable signals: power supply, peripheral, programming, debugging, tracing, ADC, GPIO
- Application interfaces: 2 x UART, 1 x TWI
- Debug/Programming interfaces: 1 x SPI, 1 x JTAG
- Onboard chip-antenna 2.4GHz
- Onboard EEPROM for firmware update over-the-air and/or process data storing (1Mbit, serial, TWI, onboard Pull-ups on SDA and SCL)
- Certification: CE, FCC

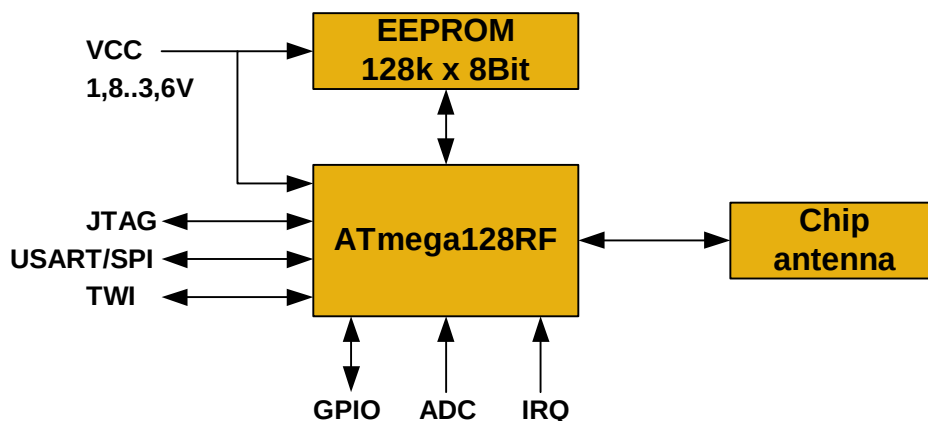


Figure 1: block diagram deRFmega128-22A00 / 22C00

The deRFmega128-22A02 and deRFmega128-22C02 offer the same features like the deRFmega128-22A00 except the chip antenna is replaced by a coaxial receptacle (U.FL) for connecting an external antenna.

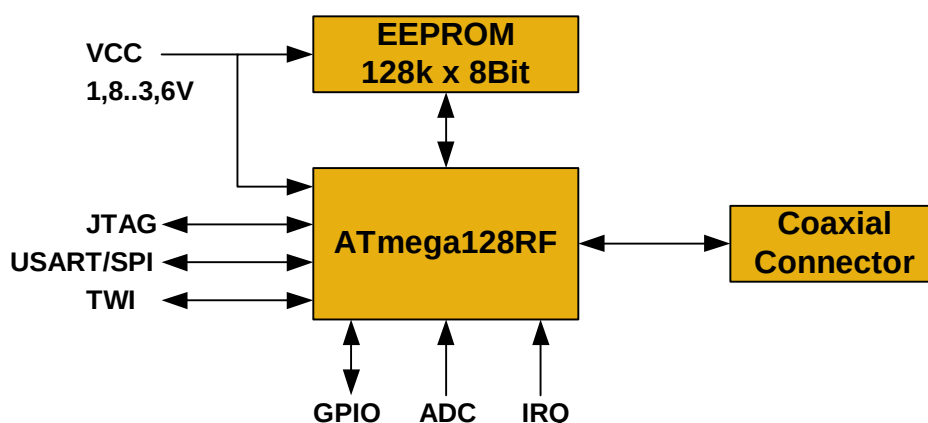


Figure 2: block diagram deRFmega128-22A02 / 22C02



4. Technical data

Table 1: Mechanical data

Mechanical	
<i>Radio modules</i>	
Size (L x B)	30 x 22.7 mm (for deRFmega128-22A00 / 22A02) 30 x 20.4 mm (for deRFmega128-22C00 / 22C02)
<i>Connectors</i>	
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 B x H)	29.2 x 2.5 x 2.5 mm
<i>Pins</i>	
pitch	1.27 mm

Table 2: Temperature range

Temperature range					
		<i>Min</i>	<i>Typ</i>	<i>Max</i>	<i>Unit</i>
Working range	T_work	-40		+85	°C

Table 3: Electrical data

Electrical (Vcc = 3,3VDC)					
	<i>Parameter</i>	<i>Min</i>	<i>Typ</i>	<i>Max</i>	<i>Unit</i>
Supply Voltage	VCC	1.8	3.3	3.6	VDC
Current consumption	I_TXon (TX_PWR = +3dBm)		18		mA
	I_RXon		19		mA
	I_Idle (Txoff, BOD on)		6.5		mA
	I_BODon		5		µA
	I_Sleep (depends on Sleep Mode)	0.5	1.0	5	µA

Table 4: RF data

Radio (Vcc = 3,3VDC)					
	<i>Parameter</i>	<i>Min</i>	<i>Typ</i>	<i>Max</i>	<i>Unit</i>
Transmit power conducted	TX_PWR = 0		-0.9		dBm

5. Mechanical size

5.1. Radio module (pluggable)

Used connectors: SAMTEC "TMS-123-02-L-S"

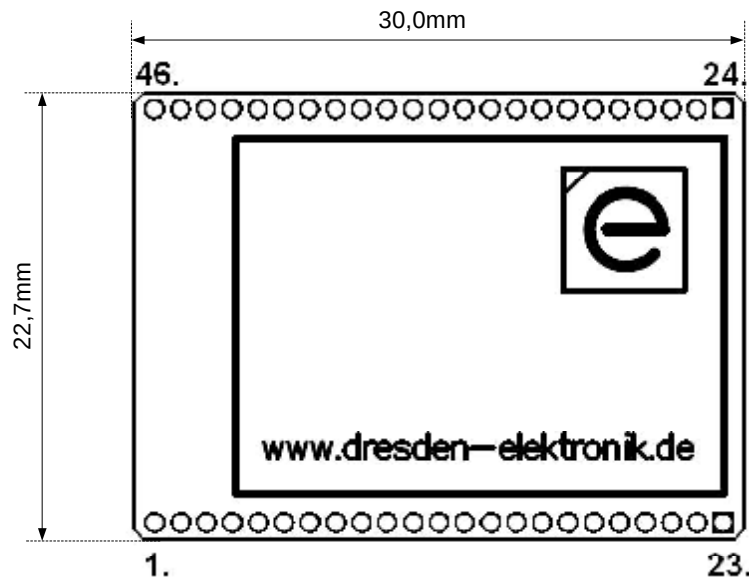


Figure 3: Size deRFmega128-22A00 and deRFmega128-22A02

5.2. Footprint receptacles

Used receptables: SAMTEC "SLM-123-01-L-S"

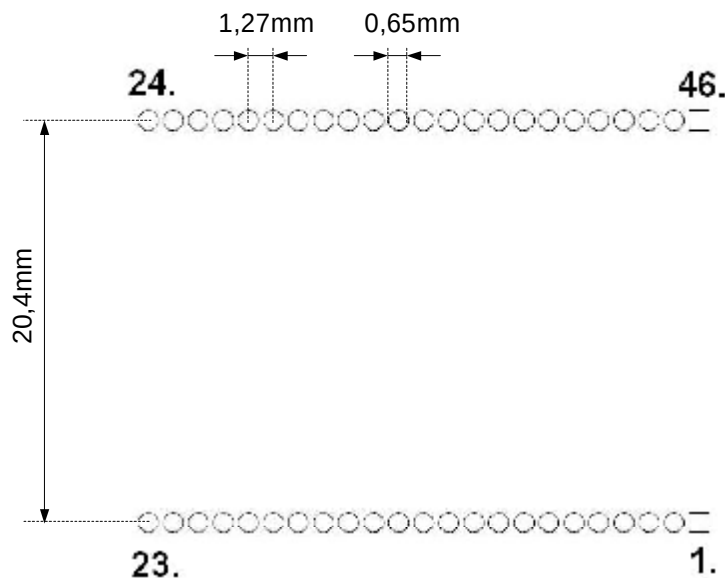


Figure 4: Footprint receptacles 1.27mm pitch

5.3. Radio module (solderable)

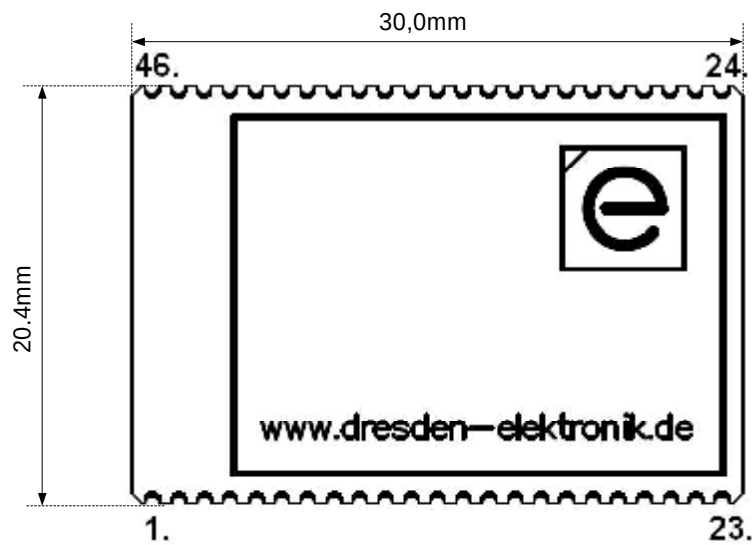


Figure 5: Size deRFmega128-22C00 and deRFmega128-22C02

5.4. Footprint Pads

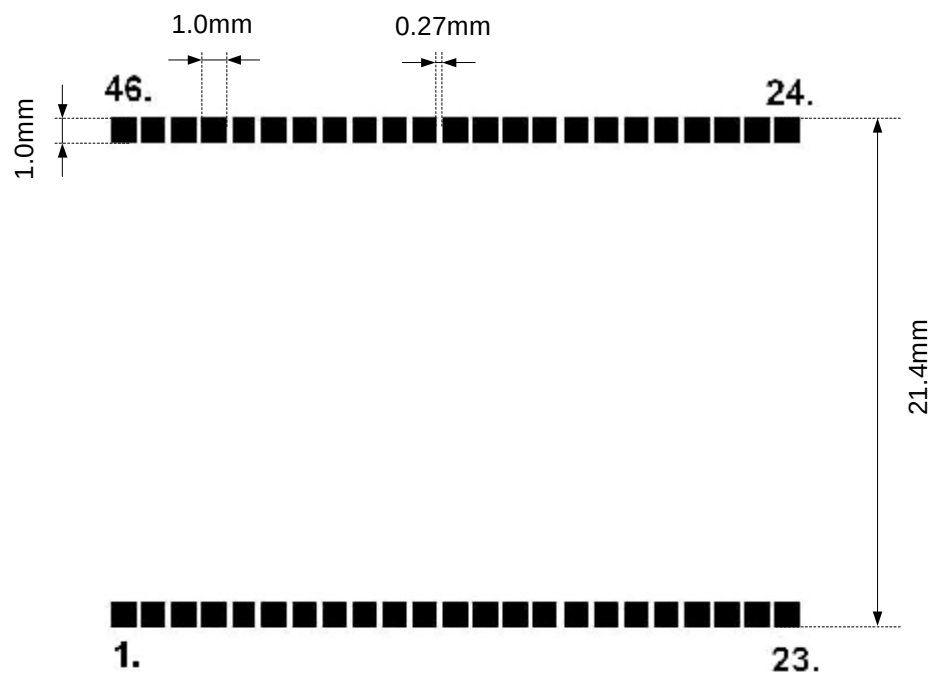


Figure 6: Footprint for deRFmega128-22C00 and deRFmega128-22C02

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



6. Soldering Profile of deRFmega128-22C00 and deRFmega128-22C02

Table 5 gives the soldering profile for the radio modules.

Table 5: Soldering Profile

Profile Feature	Values
Average-Ramp-up Rate (217°C to Peak)	3°C/sec max.
Preheat Temperature 175°C ±25°C	180 sec. max
Temperature Maintained Above 217°C	60 sec. to 150 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.

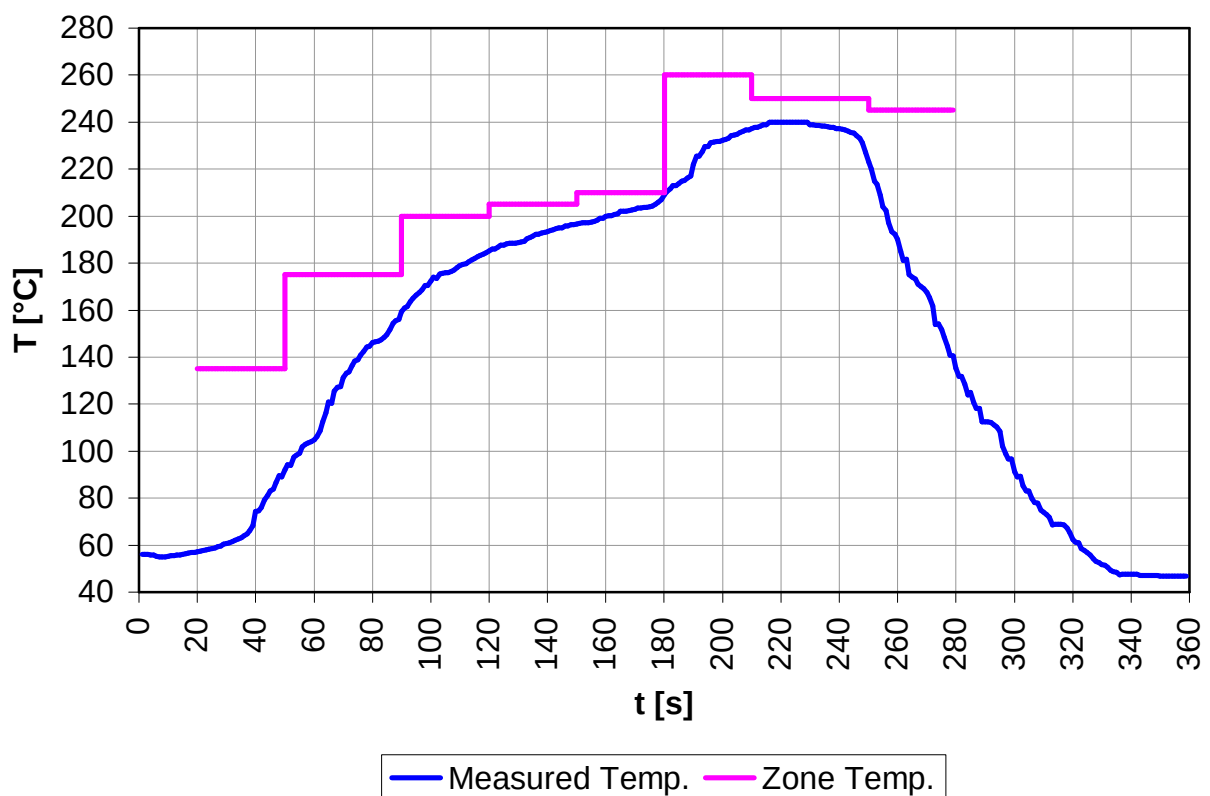


Figure 7: Recorded soldering profile

A solder process without supply of nitrogen causes a discoloration of the metal RF-shielding.

7. Pin assignment

Both pin headers respectively pin contacts 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, DGND, RSTN, RSTON, AREF and CLKI are free programmable port pins (GPIO).

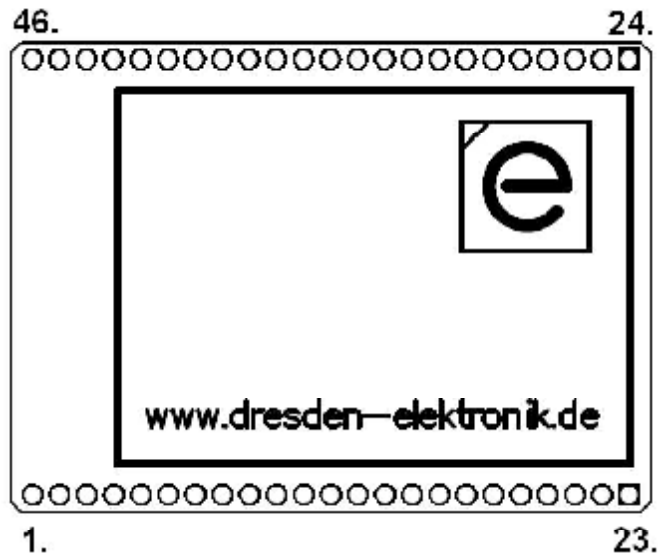


Figure 8: Top overlay deRFmega128-22A00

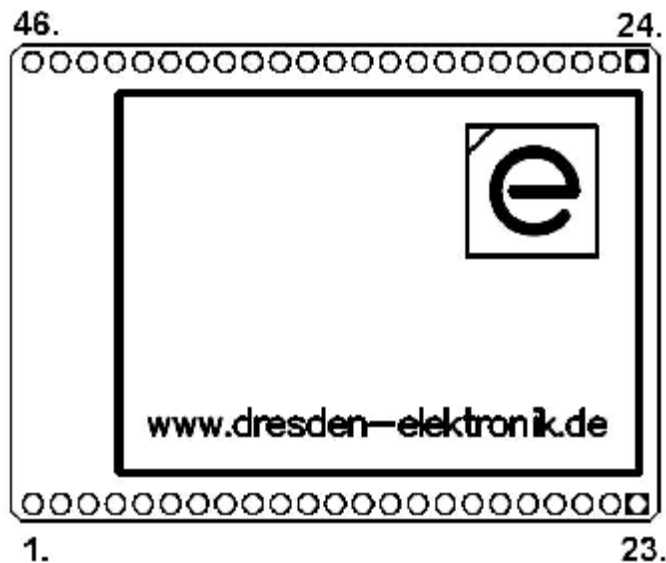


Figure 9: Top overlay deRFmega128-22A02



Figure 10: Top overlay deRFmega128-22C00

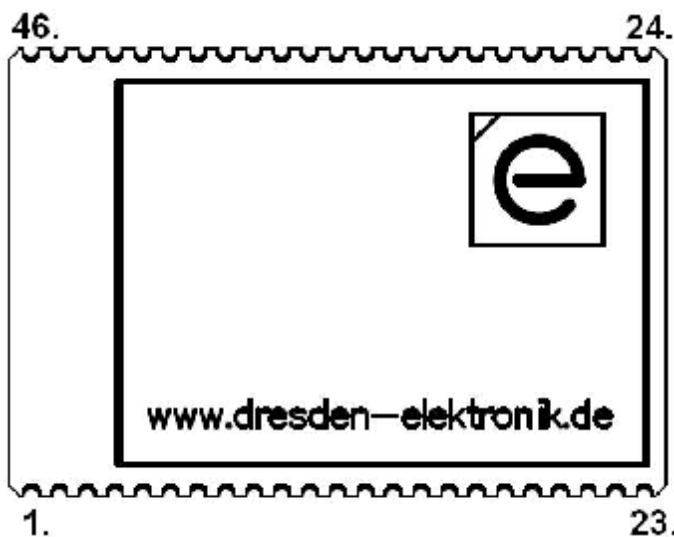


Figure 11: Top overlay deRFmega128-22C02



Table 6: Pin assignment of deRFmega128-22A00 / 22A02 / 22C00 / 22C02

Pin assignment			
Pin	µC-Port	Pin	µC-Port
1	VCC	24	VCC
2	DGND	25	DGND
3	AREF	26	PE0/RXD0/PCINT8
4	PG1/DI1	27	PD2/RXD1/INT2
5	RSTN	28	PE1/TXD0
6	PG2	29	PD6/T1
7	PD0/SCL/INT0	30	PE2/XCK0/AIN0
8	PG5/OC0B	31	PE3/OC3A/AIN1
9	PD1/SDA/INT1	32	PD4/ICP1
10	PD3/TXD1/INT3	33	PE4/OC3B/INT4
11	PD7/T0	34	PF0/ADC0
12	PD5/XCK1	35	PE5/OC3C/INT5
13	PB1/SCK/PCINT1	36	PF1/ADC1
14	CLKI	37	PE6/T3/INT6
15	PB2/MOSI/PCINT2/PDI	38	PF4/ADC4/TCK
16	PB0/SSN/PCINT0	39	PE7/ICP3/CLKO/INT7
17	PB3/MISO/PCINT3/PDO	40	PF5/ADC5/TMS
18	PB6/OC1B/PCINT6	41	PF2/ADC2
19	PB4/OC2/PCINT4	42	PF6/ADC6/TDO
20	PB7/OC0A/OC1C/PCINT7	43	RSTON
21	PB5/OC1A/PCINT5	44	PF7/ADC7/TDI
22	DGND	45	DGND
23	DGND	46	DGND

Be careful: with User Manual version 01.02 the pin designation was changed from X1 (1 to 23) and X2 (1 to 23) to an incremental pin numbering from 1 to 46, beginning in the bottom left corner and move counter-clockwise around the module at top view. There were no electrical changes made!



Table 7: 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
PB0	SSN		PCINT0	
PB1	SCK		PCINT1	
PB2	MOSI	PDI	PCINT2	
PB3	MISO	PDO	PCINT3	
PB4		OC2A	PCINT4	
PB5		OC1A	PCINT5	
PB6		OC1B	PCINT6	
PB7	OC0A	OC1C	PCINT7	
PD0	SCL	INT0		Onboard Pull-Up Resistor 4k7
PD1	SDA	INT1		Onboard Pull-Up Resistor 4k7
PD2	RXD1	INT2		
PD3	TXD1	INT3		
PD4		ICP1		
PD5		XCK1		
PD6		T1		
PD7		T0		
PE0	RXD0		PCINT8	
PE1	TXD0			
PE2	XCK0	AIN0		
PE3	OC3A	AIN1		
PE4	OC3B	INT4		
PE5	OC3C	INT5		
PE6	T3	INT6		
PE7	ICP3	INT7	CLKO	
PF0	ADC0			
PF1	ADC1			
PF2	ADC2	DIG2		
PF4	ADC4		TCK	
PF5	ADC5		TMS	
PF6	ADC6		TDO	
PF7	ADC7		TDI	
PG1		DIG1		
PG2	AMR			
PG3	TOSC2			
PG4	TOSC1			
PG5	OC0B			

Note: The I/O port pins PF3/ADC3/DIG4 and PG0/DIG3 are not available!
PG4/TOSC1 and PG3/TOSC2 are connected internal with a 32.768kHz crystal.



Table 8: Signal description list

Signal name	Function	Type	Active Level	Comments
Power				
VCC	Voltage Regulator Power Supply Input	Power		1.8V to 3.6V
GND		Ground		
Clocks and Oscillators				
CLKI	External Clock Input	Input		
CLKO	Divided System Clock Output	Output		
JTAG				
TCK	Test Clock	Input		No pull-up resistor
TDI	Test Data In	Input		No pull-up resistor
TDO	Test Data Out	Output		
TDM	Test Mode Select	Input		No pull-up resistor
Serial Programming				
PDI	Data Input	Input		
PDO	Data Output	Output		
SCK	Serial Clock	Input		
Reset				
RSTN	Microcontroller Reset	I/O	Low	Pull-Up resistor
USART				
TXD0 – TXD1	Transmit Data			
RXD0 – RXD1	Receive Data			
XCK0 – XCK1	Serial Clock			
Timer/Counter and PWM Controller				
OC0A-OC3A	Output Compare and PWM Output A for Timer/Counter 0 to 3			
OC0B-OC3B	Output Compare and PWM Output B for Timer/Counter 0 to 3			
OC0C-OC3C	Output Compare and PWM Output C for Timer/Counter 0 to 3			
T0, T1, T3	Timer/Counter 0,1,3 Clock Input	Input		
ICP1 ICP3	Timer/Counter Input Capture Trigger 1 and 3	Input		
AMR	Automated Meter Reading	Input		
Interrupt				
PCINT0 - PCINT7	Pin Change Interrupt Source 0 to 7	Output		
INT0 – INT7	External Interrupt Input 0 to 7	Input		
SPI				
MISO	SPI Master In/Slave Out	I/O		
MOSI	SPI Master Out/Slave In	I/O		
SCK	SPI Bus Serial Clock	I/O		
SSN	SPI Slave Port Select	I/O		



Signal description list (continued)

Signal name	Function	Type	Active Level	Comments
<i>Two-Wire-Interface</i>				
SDA	Two-Wire Serial Interface Data	I/O		Onboard 4k7 Resist.
SCL	Two-Wire Serial Interface Clock	I/O		Onboard 4k7 Resist.
<i>Analog-to-Digital Converter</i>				
ADC0 – ADC7	Analog to Digital Converter Channel 0 to 7	Analog		
AREF	Analog Reference	Analog		
<i>Analog Comparator</i>				
AIN0	Analog Comparator Positive Input	Analog		
AIN1	Analog Comparator Negative Input	Analog		
<i>Radio Transceiver</i>				
DIG1/DIG2	Antenna Diversity Control Output	Output		

8. Programming

8.1. Required Hardware

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

1. Option

- (A) deRFmega128-22A00 or deRFmega128-22A02
- (B) deRFtoRCB
- (C) Sensor Terminal Board
- (D) JTAG-ICE mkII or similar programmer, e.g. AVR Dragon
- (E) RS232 Level-Shifter for debugging

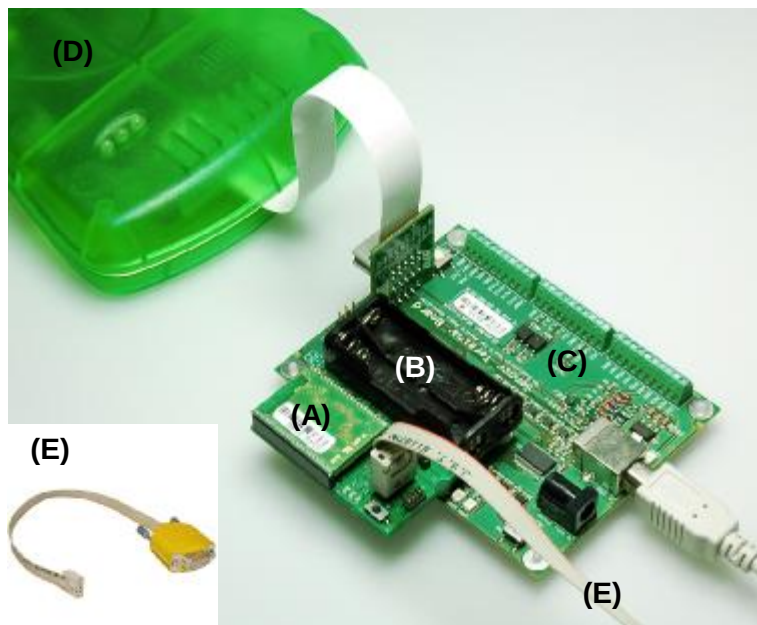


Figure 12: Programming option 1

2. Option

- (A) deRFmega128-22A00 or deRFmega128-22A02
- (B) deRFtoRCB
- (C) JTAG-ICE mkII or similar programmer, e.g. AVR Dragon
- (D) JTAG-ICE-Adapter (10 pins, pitch 1.27mm to 30 poles flat cable)
- (E) RS232 Level-Shifter for debugging

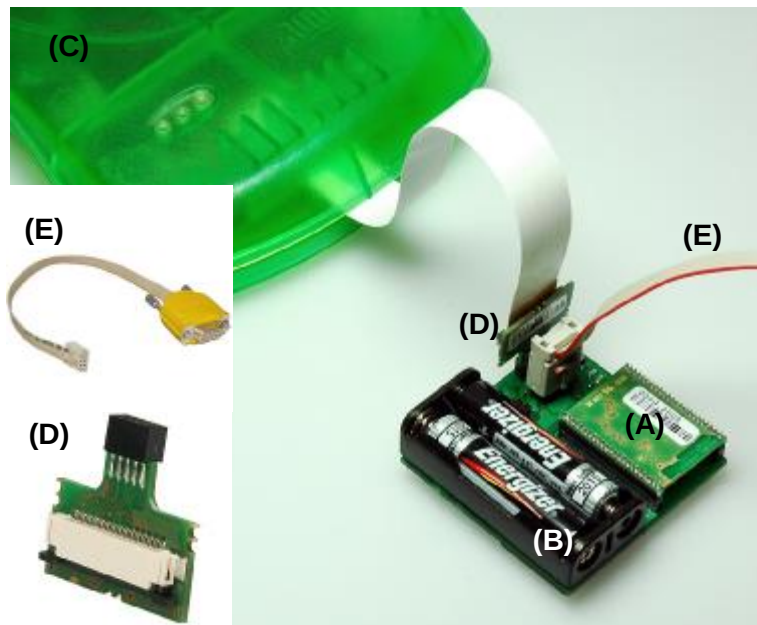


Figure 13: Programming option 2

8.2. JTAG interface

The deRFmega128-22A00 / 22A02 / 22C00 / 22C02 are programmable over JTAG interface (TDI, TDO, TCK, TMS). If the JTAG-ICE mkII programmer will be used, no external pull-up resistors are necessary. Use the pin connection shown in Figure 14 to connect the radio module to a suitable JTAG programmer, for example the JTAG-ICE mkII.

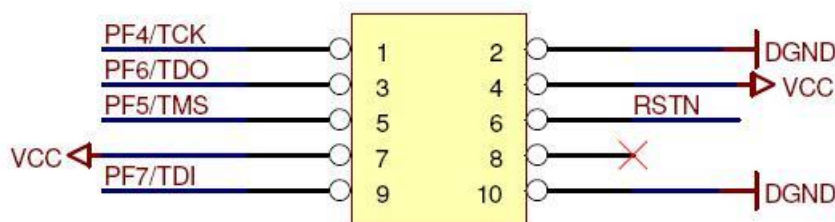


Figure 14: JTAG connector

It is necessary to use the latest version of AVR Studio (min. V4.18 + Service Pack 1 & 2) and to upgrade the JTAG programmer firmware (min. V06.06; 06.06). For more details see “deRF Getting Started Web Version” on dresden elektronik homepage.

9. Debugging and Tracing

Debugging and tracing of the radio module is possible with the deRFtoRCB adapter and the RS232-Level-Shifter. Both components were offered by dresden elektronik ingenieurtechnik gmbh. The used pin connection is shown in Figure 15 to connect the radio module to a suitable debug and trace hardware.

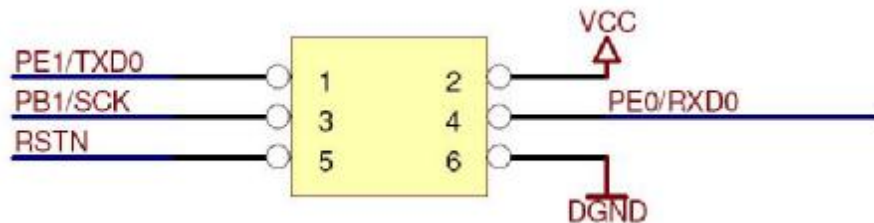


Figure 15: Debug interface

For more details see “deRF Getting Started Web Version” on dresden elektronik homepage.

10. Onboard EEPROM

The deRFmega128-22A00 / 22A02 / 22C00 / 22C02 contain a Serial-TWI-EEPROM with a memory size of 128k x 8Bit.

The EEPROM power supply and the pull-ups will be switched on with a LOW-Signal on port pin PD6/T1. It is necessary to wait until the TWI interface on the ATmega128RFA1 is initialized before the communication on the data bus (PD1 and PD0) can be started.

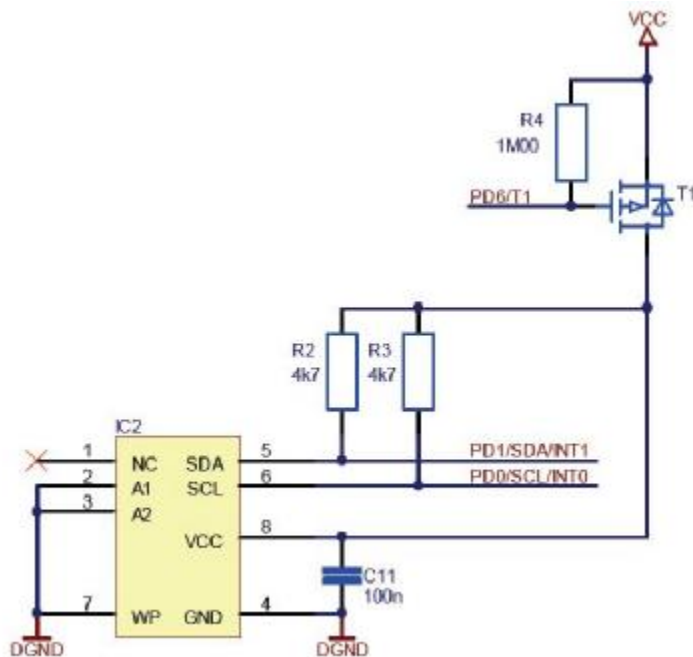


Figure 16: Schematic of EEPROM

11. RF components

11.1. deRFmega128-22A00 / 22C00

The chip antenna on the deRFmega128-22A00 / 22C00 is matched with:

- $L1 = 1,0\text{nH}$ (0402)
- $L2 = 2,2\text{nH}$ (0402)

Some hints for the positioning of the radio module:

- avoid metallized environments in the near
 - è mismatching of the antenna
 - è decreased transmit-range
- place the module at the edge of a device

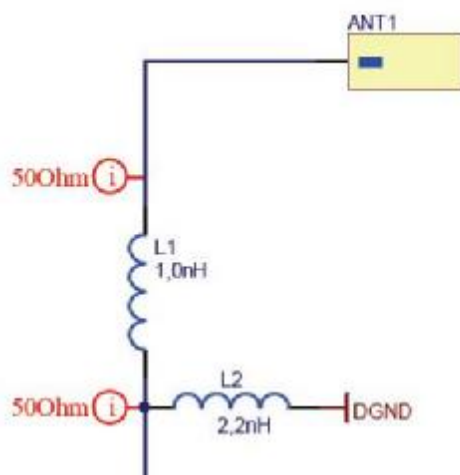


Figure 17: Matching circuit with chip-antenna

11.2. deRFmega128-22A02 / 22C02

The U.FL coaxial connector on the deRFmega128-22A02 / 22C02 is matched with:

- $L2 = 1,0\text{pF}$ (0402)
- $C19 = 22\text{pF}$ (0402)
- $R1 = 10\text{k}$ (0402)

The deRFmega128-22A02 / 22C02 are suitable for applications in plastic or metal cases.

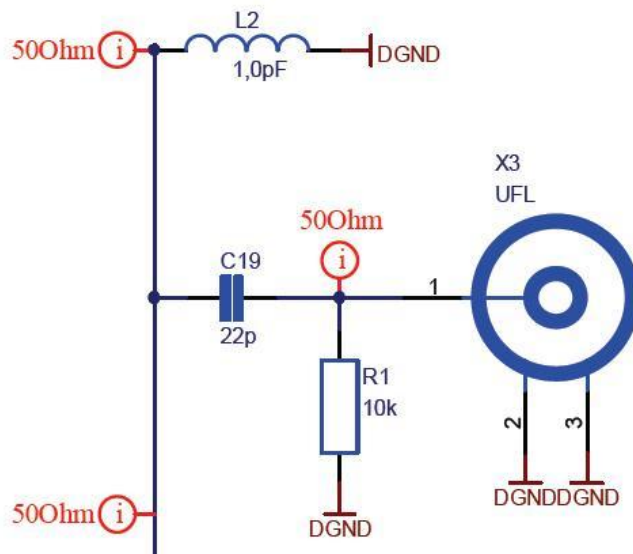


Figure 18: Matching circuit with U.FL-coaxial-connector



12. Radio Certification

12.1. United States (FCC)

The deRFmega128-22A00, deRFmega128-22C00, deRFmega128-22A02 and deRFmega128-22C02 complies 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 deRFmega128-22A00 and deRFmega128-22C00:

FCC-ID: XVV-MEGA22A00

<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>
--

Sample label for radio module deRFmega128-22A02 and deRFmega128-22C02:

FCC-ID: XVV-MEGA22A02

<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>
--

Note: The radio modules deRFmega-22C00 and deRFmega-22C02 fulfill a Permissive Change Class 1 regarding to FCC Section 2.1043 and complies with the requirements of FCC part 15.

To be used with the deRFmega128-22A02 module, the external antenna have been tested and approved which is specified in here below. The deRFmega128-22A02 Module 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 must be 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 operating 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 his own expense (FCC section 15.105).

12.2. European Union (ETSI)

The deRFmega128-22A00, deRFmega128-22C00, deRFmega128-22A02 and deRFmega128-22C02 modules have been certified for use in European Union countries.

If the deRFmega128-22A00, deRFmega128-22C00, deRFmega128-22A02 and deRFmega128-22C02 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 deRFmega128-22A00, deRFmega128-22C00, deRFmega128-22A02 and deRFmega128-22C02 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.



12.3. Approved antennas

The deRFmega128-22A00 and deRFmega128-22C00 have an integrated chip antenna. The design is fully compliant with all regulations.

The deRFmega128-22A02 and deRFmega128-22C02 have 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 10cm "U.FL-to-SMA-Reverse pigtail".

Table 9: Approved antenna(s) and accessory

Approved antenna(s) and accessory				
Part number	Description	Manufacturer	Gain [dBi]	Min. Separation [cm]
BN-023768	Dual-band antenna (2.45GHz and 5.8GHz) with Reverse-SMA-Connector, $\frac{1}{4}$ wave	Antenna Factor	+4,7	20
BN-023769	U.FL-to-SMA-Reverse pigtail, 10 cm	Hirose / Profineon	-0,37	



13. Ordering Information

The product name includes the following information:

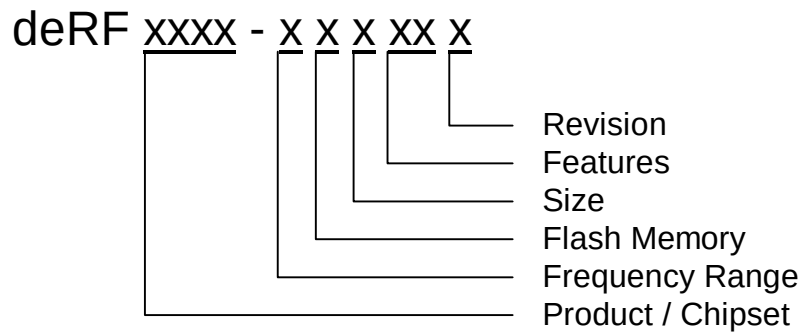


Table 10: Product name code

Product name code			
Information	Code	Explanation	Comments
Product / Chipset	mega128	ATmega128RFA1	radio module
Frequency range	1	780/868/915 MHz	
	2	2.4 GHz	
Flash memory	2	128 kByte	
Size	A	30 x 22.7 mm	pluggable
	C	30 x 20.4 mm	solderable
Features	00	chip antenna	onboard
	02	coaxial connector	onboard U.FL
Revision	<blank>	Rev 0	
	1	Rev 1	
	2	Rev 2	

Table 11: Ordering information

Ordering information		
Part number	Product name	Comments
BN-028182	deRFmega128-22A00	pluggable radio module with onboard chip antenna
BN-028498	deRFmega128-22A02	pluggable radio module with onboard U.FL coaxial connector
BN-028986	deRFmega128-22C00	solderable radio module with onboard chip antenna
BN-028987	deRFmega128-22C02	solderable radio module with onboard U.FL coaxial connector



14. Errata

14.1. Serial TWI EEPROM

Affected devices:

deRFmega128-22A001

deRFmega128-22A021

Problem:

Because of a hardware error the EEPROM, Transistor and Pull-up resistors are not assembled.

Workaround:

Fixed in revision 2.

Note:

The concerned signals PD0, PD1, PD6 can be used without problems.



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Commercial Registry: HRB 749 Dresden Municipal Court
Tax number: 201/107/00726
Sales tax identification number: DE 140125678

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