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## nRF401 Evaluation Board

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### 1. General description

This document describes the **nRF401** Evaluation Board and its use with Nordic VLSI's **nRF401** 433MHz Single chip RF Transceiver.

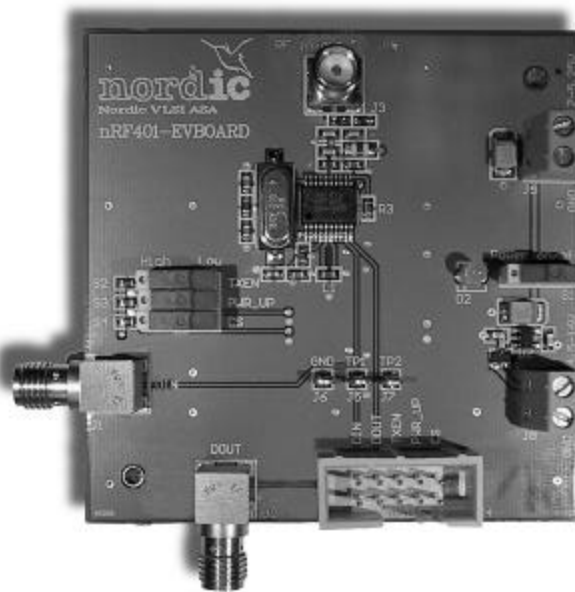


Figure 1. The **nRF401** Evaluation Board



### 2. Introduction

The Evaluation Board for the **nRF401** Single chip 433MHz RF transceiver has been developed to enable customers to test the functionality and to verify the performance parameters of the device. This document specifies the usage of the Evaluation Board and suggests some evaluation testbenches.

The Evaluation Board is intended for evaluation purposes only. It is not intended for incorporation into an end product.

### 3. Getting started

To test the **nRF401** device to its full extent, the following instrumentation should be at your disposal:

- DC voltage supply (+2.7V to +5.25V)
- Dual channel oscilloscope
- Low frequency generator / digital pattern generator
- RF signal generator with FSK modulation capability
- RF Spectrum analyser
- Bit-error-rate meter (optional)

No software is necessary to use the Evaluation Board.

ETSI document **EN 300 220-1 V1.2.1** describes the technical characteristics and test methods for radio equipment to be used in the 433MHz ISM band. A copy of this document can be obtained from the ETSI web-site at <http://www.etsi.org>.



#### 4. nRF401 Evaluation Board description

Appendix 1 shows the nRF401 Evaluation Board circuit diagram. The PCB layout and component placement is shown in Appendix 2. The component list is given in Appendix 3.

Setting of transmit/receive mode is done by using on-board slideswitch S2 (TXEN). Selection of normal mode or standby mode is done by using on-board slideswitch S3 (PWR\_UP). Selection of either channel#1 (433.92MHz) or channel#2 (434.33MHz) is done by using on-board slideswitch S4 (CS). The DIN, DOUT and RF in/out signals are made available at SMA connectors.

The DIN, DOUT, TXEN, PWR\_UP and CS signals are also available to an external microcontroller or PC at header J4.

**When using header J4, the slideswitches S2 (TXEN), S3 (PWR\_UP) and S4 (CS) should be set to High.**

Figure 2 shows the block diagram of the nRF401 Evaluation Board.

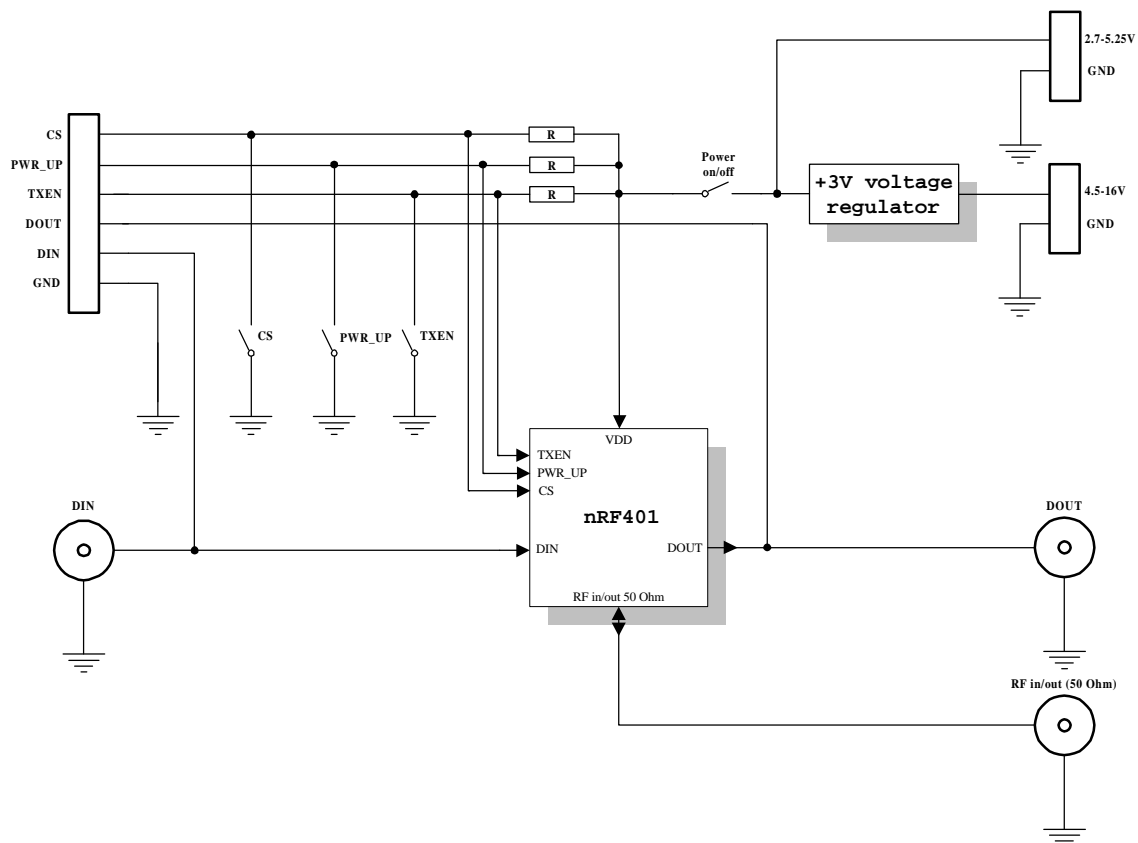


Figure 2. Block diagram of the nRF401 Evaluation Board

Power and ground is applied to the Evaluation Board via connector J8 or J9. A +3V voltage regulator is included after connector J8, enabling an input voltage in the range of +4.5V to +16V. **Connector J9 is an unregulated power input, and voltage range**



**on this input must be restricted to +2.7V to +5.25V.** The supply of the **nRF401** device can be switched on/off by using slide-switch S1.

Diode D1 included after connector J8 is for protection against accidental reversal of the power supply polarity. **Such a protection is not included after connector J9.**

The crystal reference oscillator is composed of the 4.000MHz crystal X1, resistor R1, and capacitors C1 and C2. R1 ensures that the crystal oscillator will start at power up, C1 and C2 provide the correct load for the crystal. The applied crystal has an overall frequency tolerance (frequency tolerance at 25°C + temperature drift) that does not exceed  $\pm 35$  ppm in the operating temperature range -25°C to +75°C.

The on-chip VCO requires an external inductance L1. For VCO operation at 433MHz, 22nH is optimal.

The PLL synthesiser loopfilter is an external single-ended second order lag/lead filter. The PLL filter shown in the circuit diagram is optimised for bit rates up to 20 kbit/s. Filter cutoff frequency is 10kHz and resulting PLL phase margin is 65 degrees.

For convenient connection of the differential antenna output/input pins to a single ended antenna or 50 $\Omega$  test equipment, a differential to single ended matching network is included. This network matches the single ended antenna or 50 $\Omega$  test equipment impedance at SMA connector J3 to the differential load impedance at the **nRF401**'s output/input stage. The employed matching network introduces an insertion loss of approximately 2dB at 434MHz.

The external bias resistor R3 connected between the RF\_PWR pin and VSS sets the output power. The power level adjust input RF\_PWR can be used to reduce transmit power level while simultaneously reducing DC power consumption in transmit mode. The RF output power may be set to levels up to +10dBm as described in the **nRF401** datasheet. On the Evaluation Board R3=22K which sets the output power to +10dBm.



## 5. Test and evaluation measurements

ETSI document **EN 300 220-1 V1.2.1** describes the technical characteristics and test methods for radio equipment to be used in the 433MHz ISM band.

The parameters that are directly related to the approval of equipment operating in the 433MHz ISM band are:

- **Carrier power (conducted)**
- **Effective radiated power (radiated)**
- **Modulation bandwidth**
- **Spurious emissions (in transmit mode)**
- **Spurious radiation (in receive mode)**

In addition, the following measurement may be of interest to the user:

- **BER as a function of RF input level (receiver sensitivity)**

When measuring performance related parameters, losses in differential to single ended matching network, connectors and cables must be taken into account. These are typically in the order of 3-4dB.

Figures 3 through 5 show typical testbenches for the different measurements. The actual setup may vary depending on the equipment available.

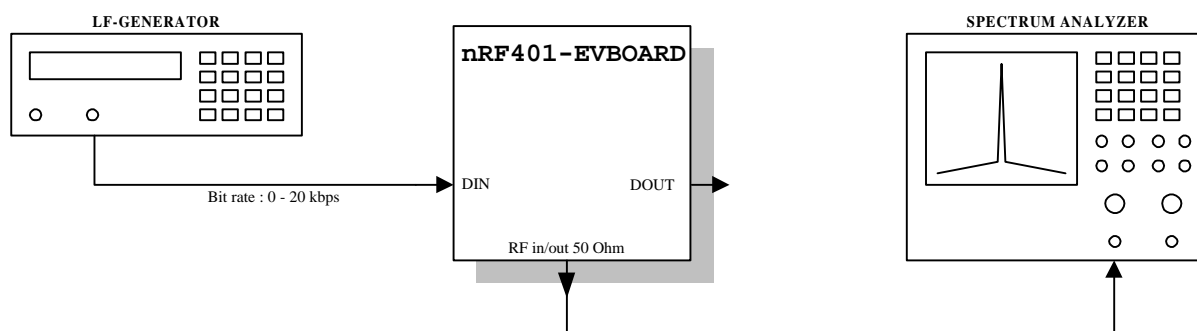


Figure 3. Typical carrier power/modulation bandwidth-testbench



**nRF401 Evaluation Board**

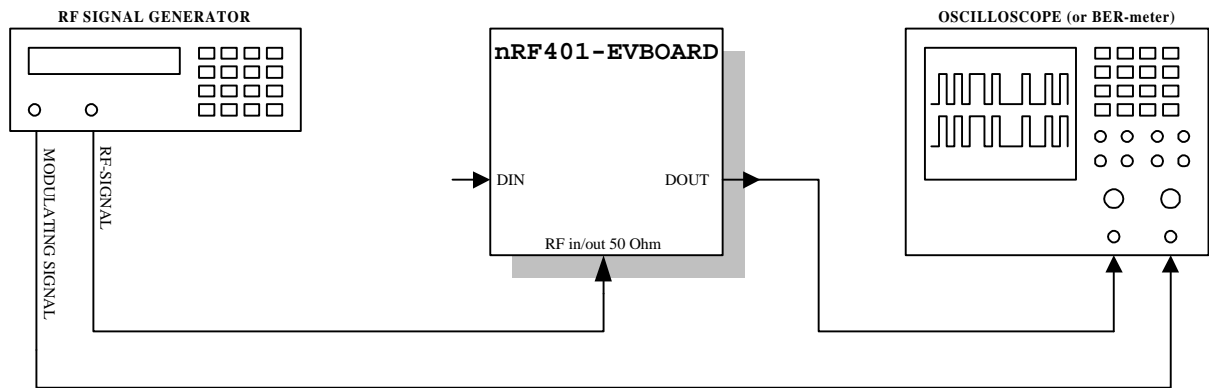


Figure 4. Typical receiver sensitivity-testbench

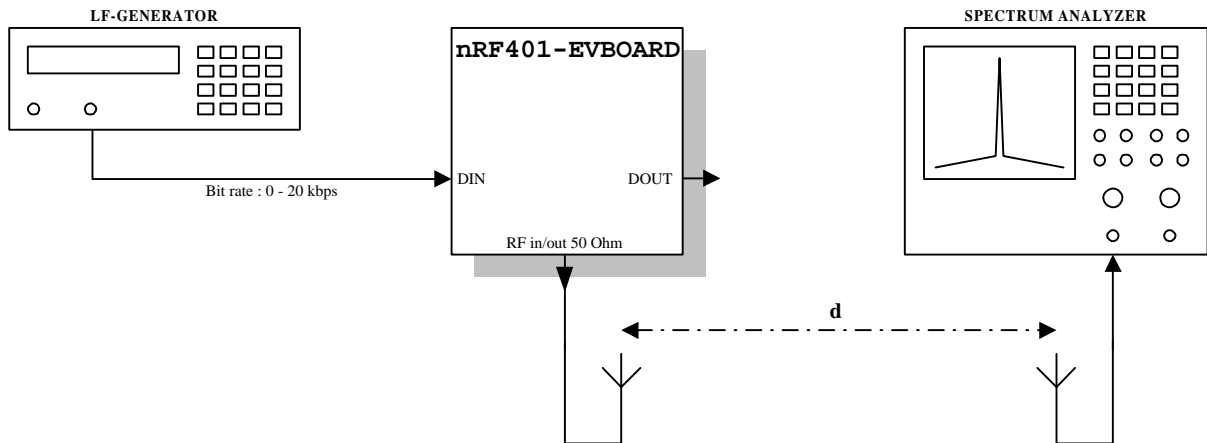


Figure 5. Typical spurious emission/ERP-testbench



APPENDIX 1 – nRF401 Evaluation Board Circuit Diagram

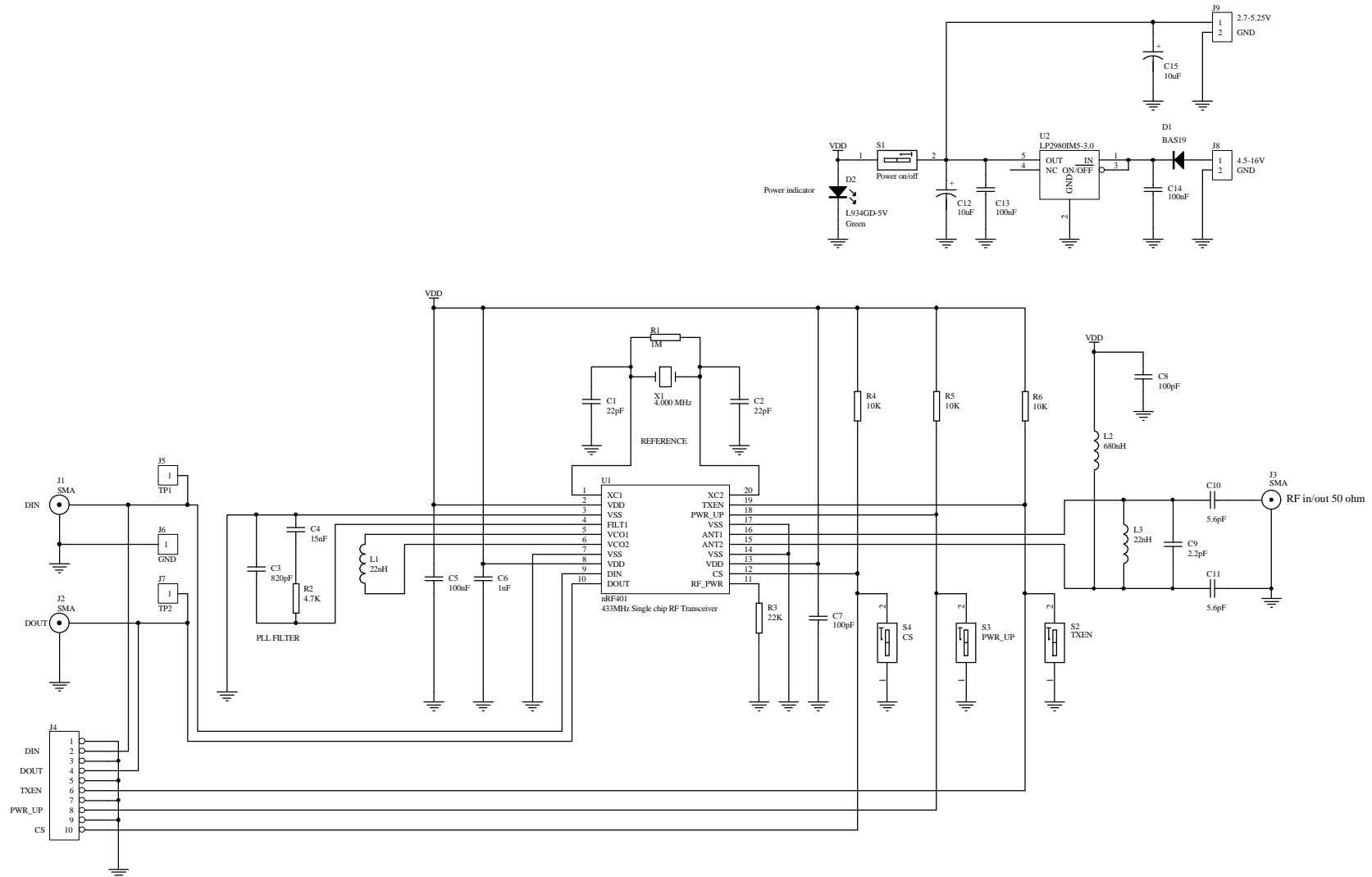
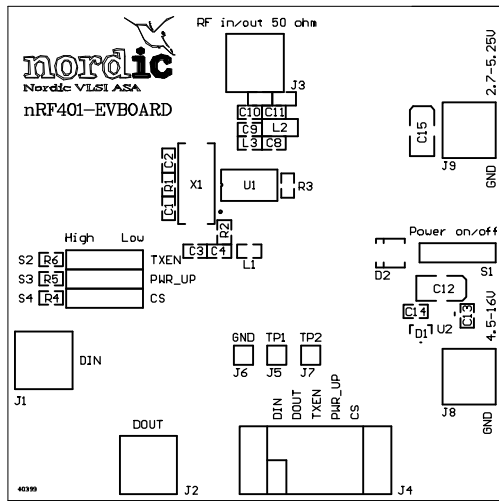


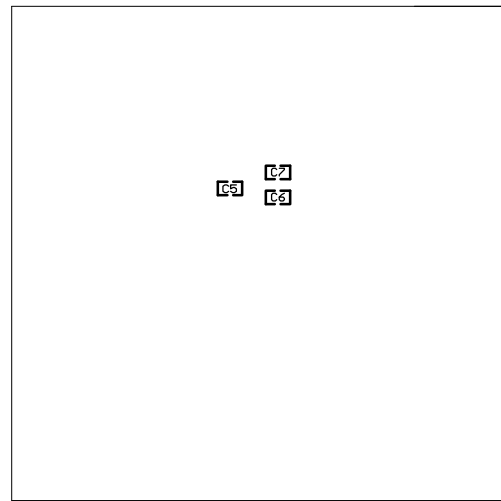
Figure A.1. nRF401 Evaluation Board Circuit Diagram



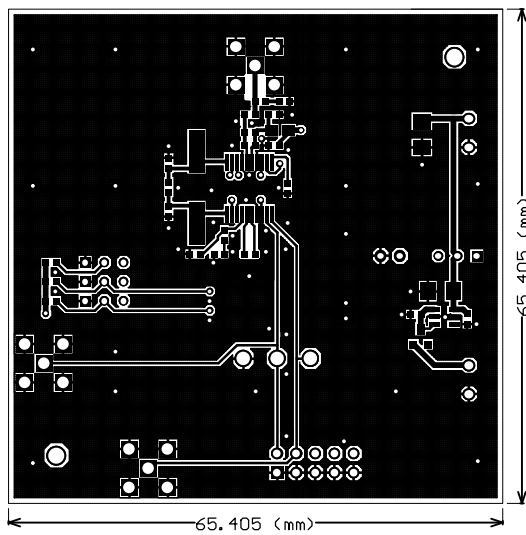
APPENDIX 2 – nRF401 Evaluation Board PCB Layout



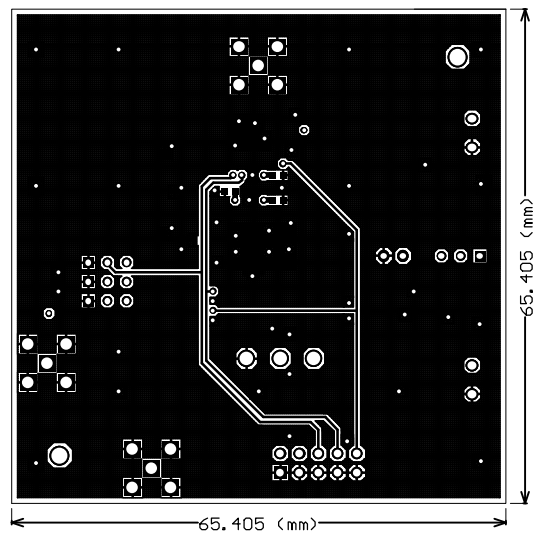
Top silk screen



Bottom silk screen



Top view



Bottom view

Figure A.2. nRF401 Evaluation Board PCB layout



**APPENDIX 3 – nRF401 Evaluation Board Component List**

Component	Description	Value	Tolerance	Units
C1	NP0 Ceramic 0603 Chip Capacitor (Crystal Oscillator)	22	± 5%	pF
C2	NP0 Ceramic 0603 Chip Capacitor (Crystal Oscillator)	22	± 5%	pF
C3	X7R Ceramic 0603 Chip Capacitor (PLL Loop Filter)	820	± 10%	pF
C4	X7R Ceramic 0603 Chip Capacitor (PLL Loop Filter)	15	± 10%	nF
C5	X7R Ceramic 0603 Chip Capacitor (Supply Decoupling)	100	± 10%	nF
C6	X7R Ceramic 0603 Chip Capacitor (Supply Decoupling)	1	± 10%	nF
C7	NP0 Ceramic 0603 Chip Capacitor (Supply Decoupling)	100	± 5%	pF
C8	NP0 Ceramic 0603 Chip Capacitor (Supply Decoupling)	100	± 5%	pF
C9	NP0 Ceramic 0603 Chip Capacitor (Impedance Matching)	2.2	± 0.1pF	pF
C10	NP0 Ceramic 0603 Chip Capacitor (Impedance Matching)	5.6	± 0.25pF	pF
C11	NP0 Ceramic 0603 Chip Capacitor (Impedance Matching)	5.6	± 0.25pF	pF
C12	Tantalum Chip Capacitor (Supply Decoupling)	10	± 20%	µF
C13	X7R Ceramic 0603 Chip Capacitor (Supply Decoupling)	100	± 10%	nF
C14	X7R Ceramic 0603 Chip Capacitor (Supply Decoupling)	100	± 10%	nF
C15	Tantalum Chip Capacitor (Supply Decoupling)	10	± 20%	µF
D1	BAS19, SOT-23 Switching Diode (Protection Diode)			
D2	LED 3mm green (Power indicator)			
L1	0605 Chip Inductor (VCO)	22	± 2%, Q Min > 45@434MHz	nH
L2	0805 Chip Inductor (Impedance Matching)	680	± 10%, SRF>434MHz	nH
L3	0603 Chip Inductor (Impedance Matching)	22	± 2%, Q Min > 45@434MHz	nH
R1	0.1W 0603 Chip Resistor (Crystal oscillator)	1	± 1%	MΩ
R2	0.1W 0603 Chip Resistor (PLL Loop Filter)	4.7	± 1%	kΩ
R3	0.1W 0603 Chip Resistor (Transmitter power setting)	22	± 1%	kΩ
R4	0.1W 0603 Chip Resistor	10	± 1%	kΩ
R5	0.1W 0603 Chip Resistor	10	± 1%	kΩ
R6	0.1W 0603 Chip Resistor	10	± 1%	kΩ
X1	Crystal	4.000	<35 ppm (frequency tolerance at 25°C + temperature drift)	MHz
U1	<b>nRF401</b>			
U2	LP2980IM5-3.0, SOT-23, +3V voltage regulator			

Table A.3. **nRF401** Evaluation Board Component List



### DEFINITIONS

<b>Product specification</b>
This Evaluation Board documentation contains final product specifications. Nordic VLSI ASA reserves the right to make changes at any time without notice in order to improve design and supply the best possible product.
<b>Limiting values</b>
Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Specifications sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability.
<b>Application information</b>
Where application information is given, it is advisory and does not form part of the specification.

Table 1. Definitions.

Nordic VLSI ASA reserves the right to make changes without further notice to the product to improve reliability, function or design. Nordic VLSI does not assume any liability arising out of the application or use of any product or circuits described herein.

### LIFE SUPPORT APPLICATIONS

These products are not designed for use in life support appliances, devices, or systems where malfunction of these products can reasonably be expected to result in personal injury. Nordic VLSI ASA customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify Nordic VLSI ASA for any damages resulting from such improper use or sale.

Product specification Revision Date: 15.05.2000.

nRF401 Evaluation Board order code: 150500-nRF401-EVBOARD.

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**YOUR NOTES**



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