Nordic VLSI ASA

nRF24E1 Evaluation board **nRF24E1-EVBOARD**

GENERAL DESCRIPTION

This document describes the **nRF24E1-EVBOARD** and its use with the Nordic VLSI **nRF24E1** Single Chip 2.4 GHz RF transceiver with embedded 8051 micro controller and 9 channel 12 bit ADC.

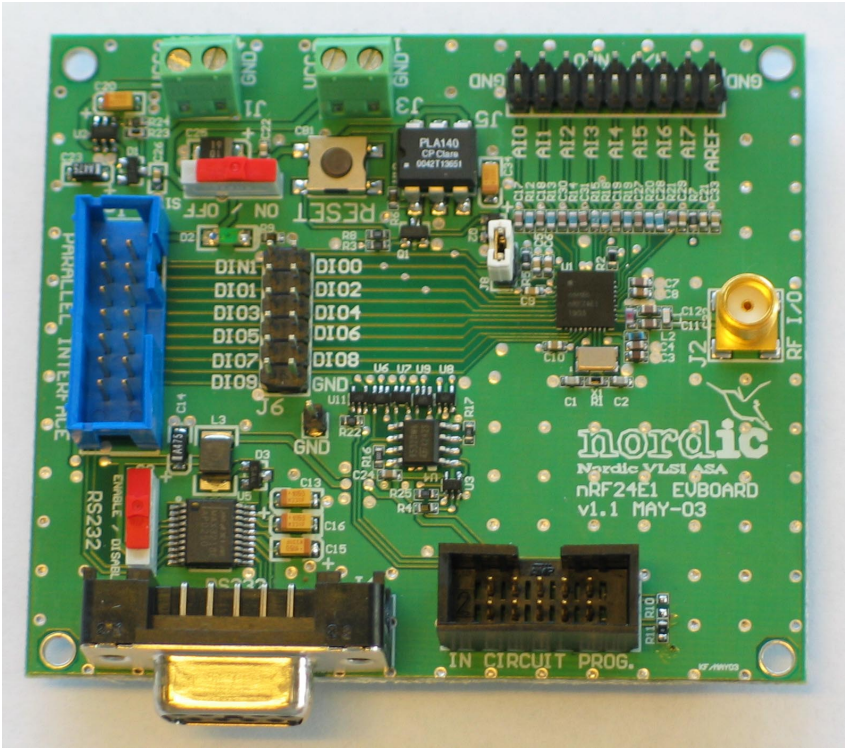


Figure 1: The **nRF24E1-EVBOARD**

INTRODUCTION

The Evaluation Board for the **nRF24E1** Single Chip 2.4 GHz Transceiver with embedded 8051 micro controller and A/D converter has been developed to enable customers to test functionality, develop firmware, run communication and verify the performance parameters of the device. This document describes the usage of the **nRF24E1-EVBOARD**.

The **nRF24E1-EVBOARD** is intended for evaluation and development purposes only. It is not intended for incorporation into an end product.

GETTING STARTED

The **nRF24E1-EVBOARD** is shipped with an EEPROM programmer and emulator (programming dongle). The nRF programming dongle enables you to emulate a 4k serial SPI EEPROM and program the **nRF24E1-EVBOARD** on board SPI EEPROM through PC software.
The following equipment is needed to work efficiently with the **nRF24E1-EVBOARD**:

- PC with 2 free USB ports, running (supplied) nRFPROG software
- 2 nRF EEPROM programmer and emulator (supplied)
- 1.9 V to 3.6V or 4.6 – 12V DC voltage supplies
- 2 male A/B USB cables

To evaluate the performance of the device the following instrumentation should be available:

- Logic analyzer
- Ampere meter
- RF signal generator with GFSK modulation capability
- RF Spectrum analyzer
- Low frequency, high accuracy signal generator (A/D tests)

PROGRAMMING DONGLE DESCRIPTION

The programming dongle is fitted 'on-top' (Figure 2) of the **nRF24E1-EVBOARD** and emulates the needed external EEPROM through PC software. The nRFPROG software is documented in nRFPROG GETTING STARTED [1].

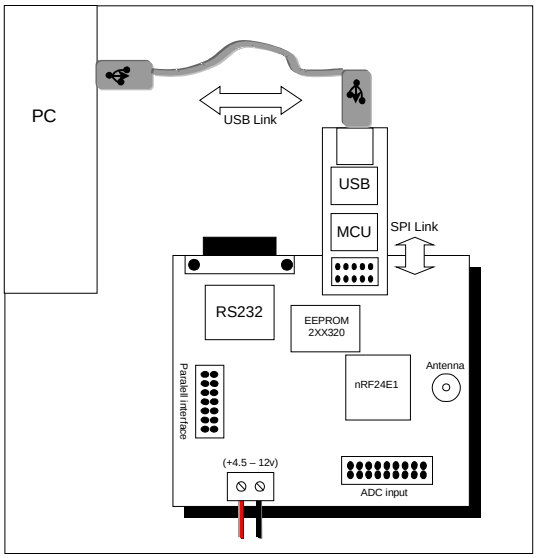


Figure 2: **nRF24E1-EVBOARD** with programming dongle

Emulating the external EEPROM needed by the **nRF24E1** will increase the flexibility and speed of SW development and de-bugging. When a program is running well, the on-board EEPROM can be programmed trough the programming dongle enabling the **nRF24E1-EVBOARD** to run stand-alone.

Supply

Main power supply is fed to the nRF programming dongle through the USB interface (J101). Supply voltage to the **nRF24E1-EVBOARD** interface stage runs through J102 from the **nRF24E1-EVBOARD.** The programming dongle must hence be plugged in the EVBOARD connector J7 in order to have proper signal levels on J102**.**

nRF24E1-EVBOARD interface

The pin-out of the interface (J102) to the **nRF2401-EVBOARD** can be found under the **nRF24E1-EVBOARD** description (EVBOARD connector J7). The PC interface (J101) is a standard USB B-connector interface.

USB addressing (S101)

If both of the supplied programming dongles is connected to the same USB HUB (same PC), they need a unique USB address each.
On the programming dongle, S101 can be set to USB address 1 or 2 both to give the two boards a unique USB address for the HUB and an easy way to visually identify the two EVBOARDS.

Remember that the address must be set prior to attaching the programming dongles to he USB HUB. This USB address will also be used by the nRFPROG windows user interface to identify the **nRF24E1-EVBOARDS**.

nRF24E1-EVBOARD DESCRIPTION

Appendix 1 shows the **nRF24E1-EVBOARD** circuit diagram and PCB layout. The component list is given in Appendix 2.

Figure 3 shows the block diagram of the **nRF24E1-EVBOARD**.

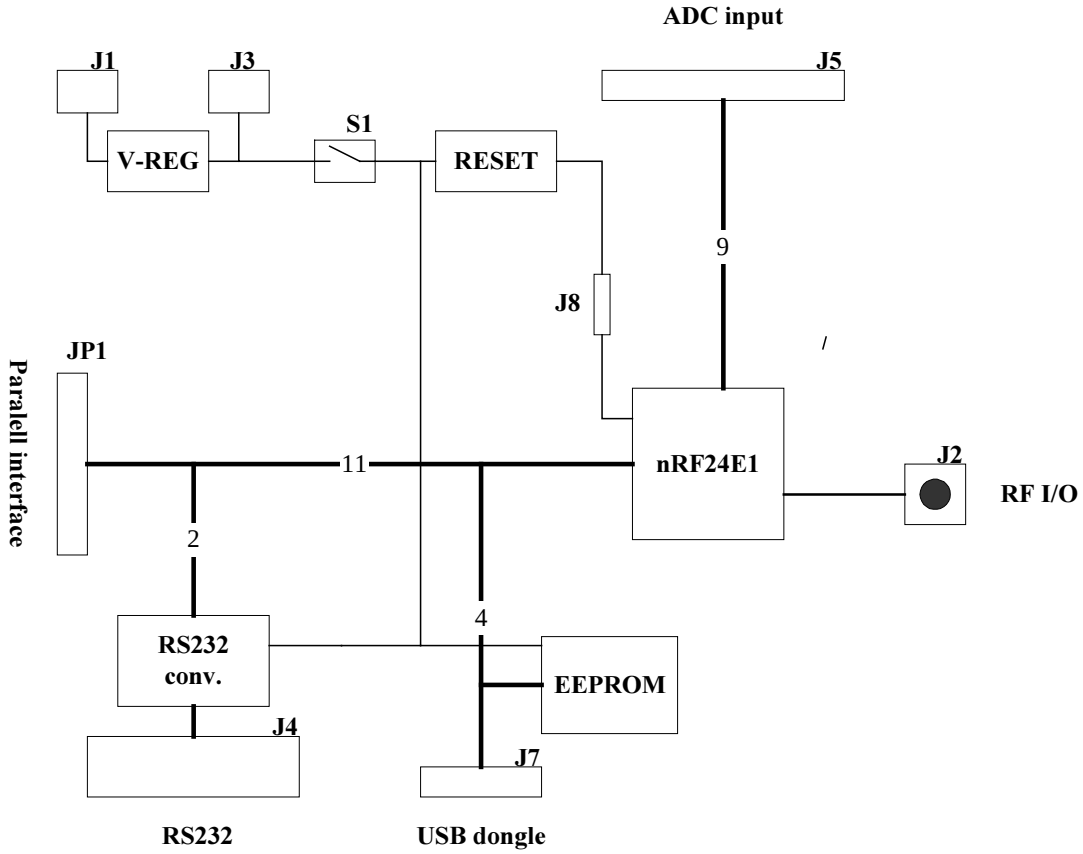


Figure 3: Block diagram of the **nRF24E1-EVBOARD**

Supply (J1, J3)

Power supply and ground is fed to the **nRF2E1-EVBOARD** either through an on-board voltage regulator (connector J1) or directly from an external supply (J3).

S1 is the board ON/OFF switch for both VDD connectors.
ON is shown by a lit green LED. Note that if the supply voltage is ~1.9 V the light from the LED will be weak.

Please note the voltage limitations on the two connectors. The on-board voltage regulator accepts an input voltage between 4.5 and 12 V, the regulated output voltage is 3V. Using the on-board voltage regulator is the preferred choice when developing SW and testing functionality.

For device testing over the supply range (1.9 – 3.6V), J3 must be utilized. Pay special attention to the max value (3.6V) since this is also the absolute maximum rating of the **nRF24E1**.

NOTE:

Voltages above 3.6V on J3 for extended time will destroy the **nRF24E1**!

Digital I/O ports

All signals in digital I/O ports 0 and 1 of the 8051 controller can be accessed trough JP1 (parallel interface). The pin out is listed in Table 1

JP1 pin #	**nRF24E1** port#	Signal name	Functionality
1	-	GND	
2	-	GND	
3	P0.7	DIO9	GPIO / PWM
4	P0.6	DIO8	GPIO / T1
5	P0.5	DIO7	GPIO / T0
6	P0.4	DIO6	GPIO / INT1_N
7	P0.3	DIO5	GPIO / INT0_N
8	P0.2	DIO4	GPIO / TxD
9	P0.1	DIO3	GPIO /RxD
10	P0.0	DIO2	GPIO / EEPROM_CSN
11	P1.1	DIO1	SPI_DO /GPIO
12	P1.0	DIO0	SPI_SCK / GPIO / T2
13	P1.2	DIN0	SPI_DI / GPI
14	-	VCC	**nRF24E1-EVBOARD** supply voltage

Table 1: **nRF24E1-EVBOARD**, JP1 pin out

All signals are also available for measurements on J6, the signal names are found on the PCB silk screen.

UART / RS232 (J4)

The **nRF24E1** UART is fed to an on board RS232 converter in addition to the parallel interface JP1.

The converted RS232 signal is available at J4, which is a standard 9-pin female DSUB for connection to PC or other equipment.

S2 disables the RS232 converter and tri-states its outputs. This enables the nRF24E1 UART to be accessed through JP1.

NOTE:

The RS232 converter will also shut down and outputs tri-stated if a RS232 plug is not present on J4.

EEPROM

The **nRF24E1-EVBOARD** is fitted with a standard 25xx320 SPI EEPROM for program code (U4). The EEPROM is accessed trough the nRF24E1 SPI master found on port 1 (P1).

On the **nRF24E1-EVBOARD** the SPI and control signals are all buffered (U6-U9). This buffering is not needed in a final application, but utilized on the EVBOARD to avoid overloading P1 and enabling in circuit programming of U4.

As the nRF24E1 features an SPI master it must be overridden by the programming dongle when the **nRF24E1-EVBOARD** on board EEPROM is to be programmed.

J7 interfaces the programming dongle that is shipped with the **nRF24E1-EVBOARDS**. This external EEPROM emulator and programmer eases the development of firmware, and enables the user to download new firmware trough an USB interface.

The pin out of J7 is listed in table Table 2.

Pin number	Pin name	Comment
1	VCC	**nRF24E1-EVBOARD** supply voltage
2	VER	**nRF24E1-EVBOARD** rev. code
3	CSO	CS override for EEPROM programming
4	CS	Chip select from nRF24E1
5	SDO	SPI data out
6	WP	On board EEPROM write protect
7	SDI	SPI data in
8	SCK	SPI clock
9	RESET	nRF24E1 reset
10	GND	System GND

Table 2 **nRF24E1-EVBOARD** J7 pin out

RF I/O (J2)

For convenient connection of the differential antenna output/input pins to a single ended antenna or 50Ω test equipment, a differential to single ended matching network is included. This network matches the 50Ω single end antenna or 50Ω test equipment impedance at the SMA connector J2 to the recommended differential load impedance at the **nRF24E1**'s RF I/O stage (pins ANT1 & ANT2). The employed matching network introduces an insertion loss of approximately 1dB at 2.4 GHz. The components utilized in the single end matching network on the **nRF24E1-EVBOARD** has the tightest tolerances available. This is done to minimize the influence of component variations in the single end match during **nRF24E1** RF performance tests. In a final application less accurate and hence cheaper components can be utilized if some variation in output power and sensitivity can be accepted.

A/D input (J5)

The 8 external ADC inputs and the external ADC reference voltage (AREF) are fed through J5. The signals are single ended, and each input is paired with a GND. All inputs are low pass filtered through first order RC units, the cut off is 3.2 MHz. The AREF is similarly filtered with a cut of frequency of 1.5 kHz.

RESET

Since the nRF24E1 has no external reset pin a solid state relay (U10) is put in on the supply line to ensure a controlled shut off of VDD and hence reset, during firmware debugging.

A **nRF24E1** reset is generated either by pressing the RESET button on the PCB, manually trough the PC software or by downloading new software to the EEPROM emulator.

This reset circuitry is not necessary in a final application since the nRF24E1 then will be the system master and features power on, watch dog and interrupt reset routines.

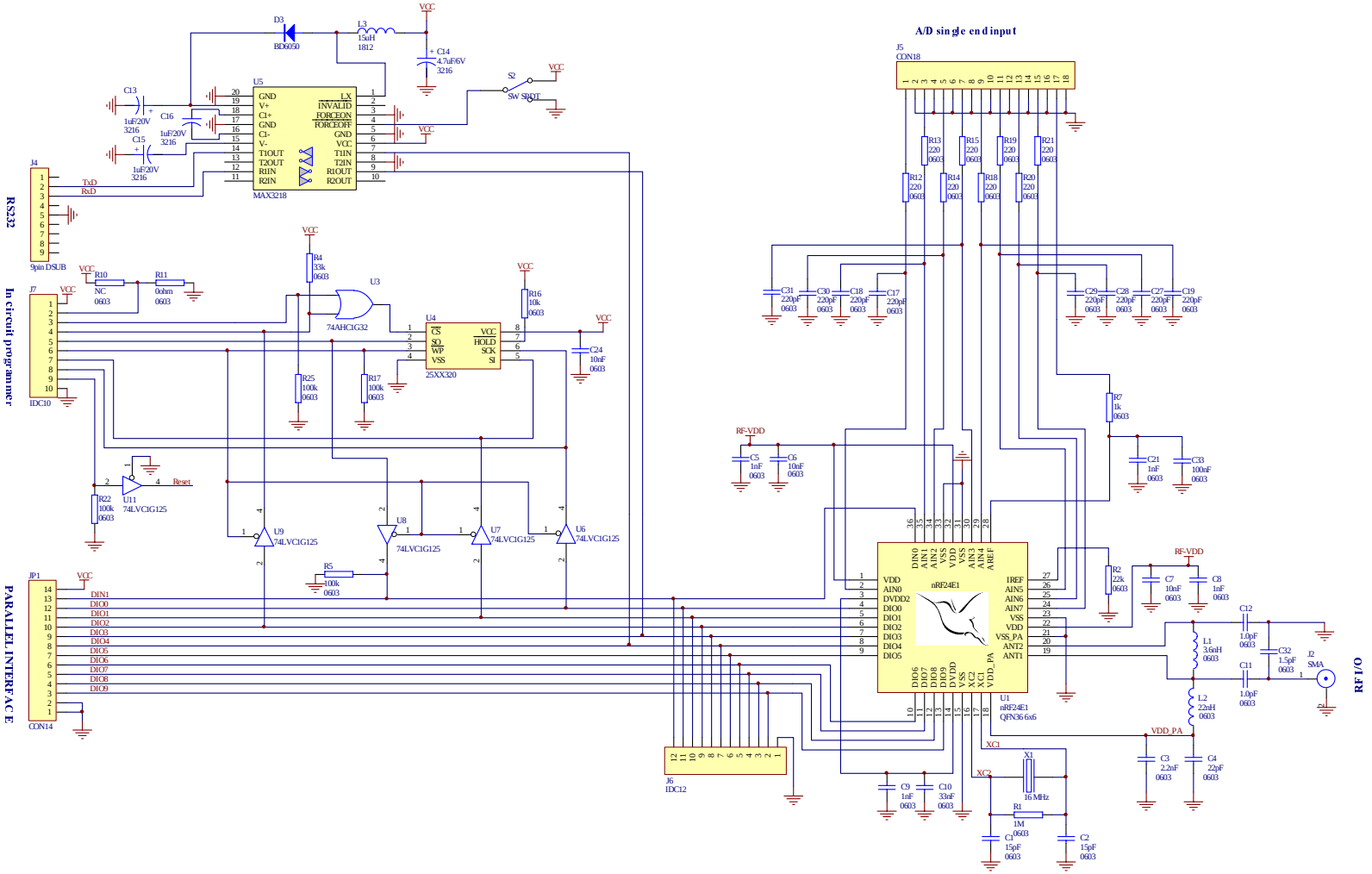
nRF24E1 voltage and current measurements (J8)

To enable measurement of nRF24E1 current consumption a jumper (J8) is set on the **nRF24E1** supply line. The jumper is never to be removed, except when replaced by an ampere meter for measurements. The exact supply voltage to the **nRF24E1** can also be measured on J8.

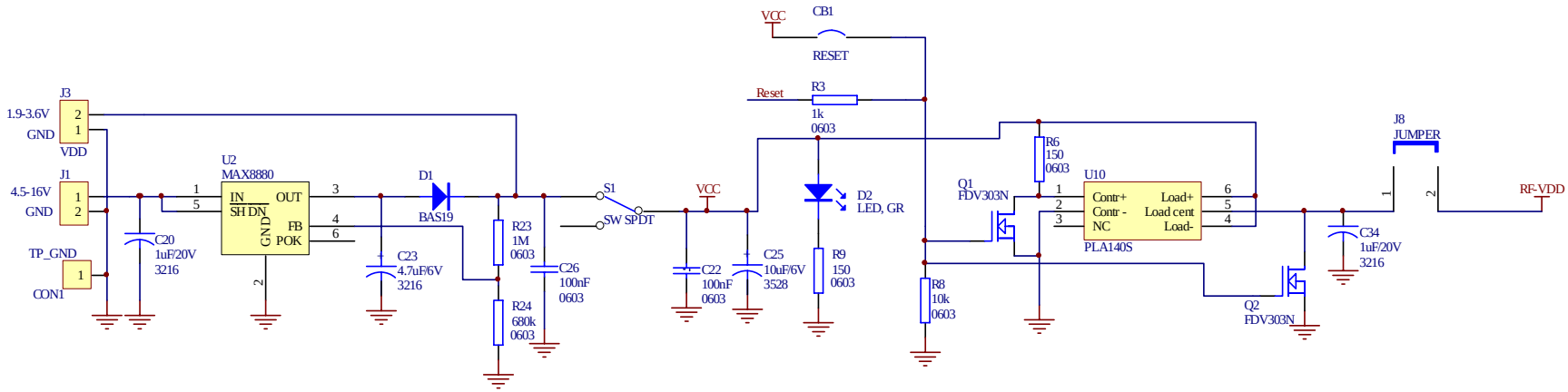
REFERENCES

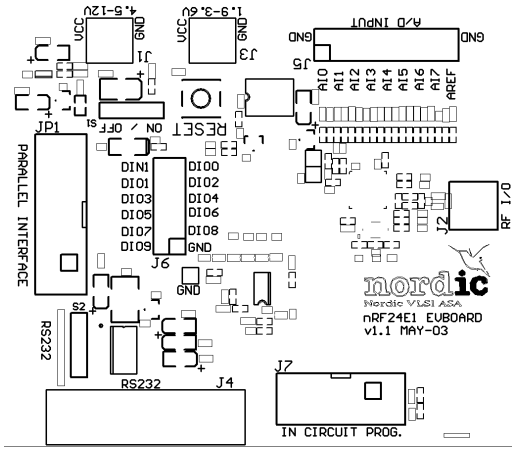
[1] nRFPROG GETTING STARTED, Nordic VLSI document, http://www.nvlsi.no

APPENDIX 1: CIRCUIT DIAGRAM AND PCB LAYOUT



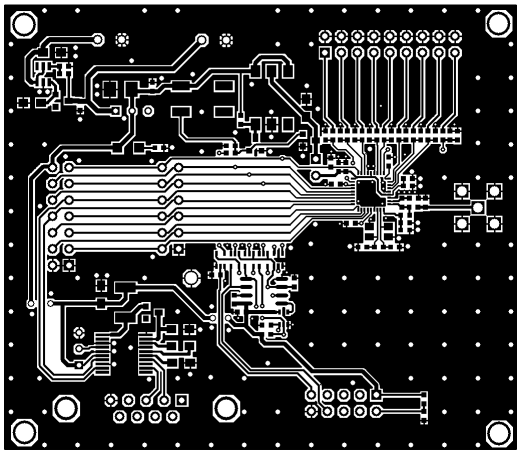
POWER SUPPLY

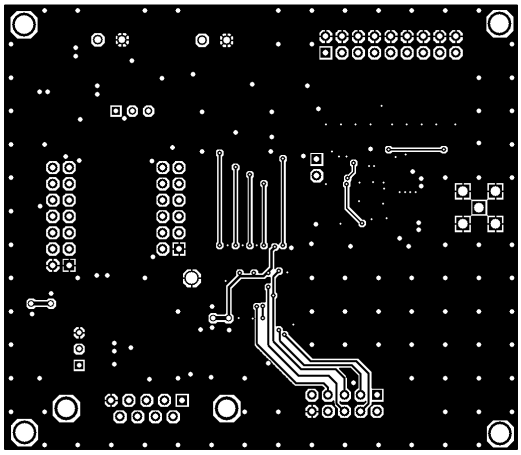




No components in bottom layer

Top silkscreen





Top signal layer

Bottom signal layer

Figure 4 **nRF24E1-EVBOARD** Circuit diagram and PCB layout

APPENDIX 2: COMPONENT LIST

Component list nRF24E1-EVBOARD				
Designator	**Description**	**Part Type**	**Footprint**	**Comment**
C1	Capacitor Ceramic	15pF, +/-5%, 50V, NP0	0603	
C2	Capacitor Ceramic	15pF, +/-5%, 50V, NP0	0603	
C3	Capacitor Ceramic	2.2nF, +/-10%,50V,X7R	0603	
C4	Capacitor Ceramic	22pF, +/-5%, 50V, NP0	0603	
C5	Capacitor Ceramic	1nF, +/-10%,50V,X7R	0603	
C6	Capacitor Ceramic	10nF, +/-10%,50V,X7R	0603	
C7	Capacitor Ceramic	10nF, +/-10%,50V,X7R	0603	
C8	Capacitor Ceramic	1nF, +/-10%,50V,X7R	0603	
C9	Capacitor Ceramic	1nF, +/-10%,50V,X7R	0603	
C10	Capacitor Ceramic	33nF, +/-10%,50V,X7R	0603	
C11	Capacitor Ceramic	1.0pF, +/-0.1 pF, 50V, NP0	0603	
C12	Capacitor Ceramic	1.0pF, +/-0.1 pF, 50V, NP0	0603	
C13	Capacitor tantalum	1.0uF,+/-20%, 20V, Tantalum	3216	
C14	Capacitor tantalum	4.7uF,+/-20%, 6V, Tantalum	3216	
C15	Capacitor tantalum	1.0uF,+/-20%, 20V, Tantalum	3216	
C16	Capacitor tantalum	1.0uF,+/-20%, 20V, Tantalum	3216	
C17	Capacitor Ceramic	220pF, +/-5%, 50V, NP0	0603	
C18	Capacitor Ceramic	220pF, +/-5%, 50V, NP0	0603	
C19	Capacitor Ceramic	220pF, +/-5%, 50V, NP0	0603	
C20	Capacitor tantalum	1.0uF,+/-20%, 20V, Tantalum	3216	
C21	Capacitor Ceramic	1nF, +/-10%,50V,X7R	0603	
C22	Capacitor Ceramic	100nF, +/-10%,50V,X7R	0603	
C23	Capacitor tantalum	4.7uF,+/-20%, 6V, Tantalum	3216	
C24	Capacitor Ceramic	10nF, +/-10%,50V,X7R	0603	
C25	Capacitor tantalum	10uF,+/-20%, 6V, Tantalum	3528	
C26	Capacitor Ceramic	100nF, +/-10%,50V,X7R	0603	
C27	Capacitor Ceramic	220pF, +/-5%, 50V, NP0	0603	
C28	Capacitor Ceramic	220pF, +/-5%, 50V, NP0	0603	
C29	Capacitor Ceramic	220pF, +/-5%, 50V, NP0	0603	
C30	Capacitor Ceramic	220pF, +/-5%, 50V, NP0	0603	
C31	Capacitor Ceramic	220pF, +/-5%, 50V, NP0	0603	
C32	Capacitor Ceramic	1.5pF, +/-0.1 pF, 50V, NP0	0603	
C33	Capacitor Ceramic	100nF, +/-10%,50V,X7R	0603	
C34	Capacitor tantalum	1.0uF,+/-20%, 20V, Tantalum	3216	
CB1	Push button		SKHUAD	
D1	Switch diode	BAS19	SOT-23D	
D2	LED. Green		LED_1206	
D3	Switch diode	BD6050	SOT-23D	

Designator	Description	Part Type	Footprint	Comment
J1	VDD connector		POWER2	
J2	RF I/O	SMA	SMA	
J3	VDD connector	VDD	power2	
J4	RS232 connector	9pin DSUB	DB9A/F	
J5	ADC input		IDC18	
J6	Test connector		IDC12	
J7	Flat cable conn. 10 pin	Flat cable connector 10 pin		
J8	Test connector		SIP2	
JP1	Flat cable conn. 14 pin	Flat cable connector 14 pin		
L1	Wire wound chip inductor	3.6nH,2%	0603	
L2	Wire wound chip inductor	22nH,2%	0603	
L3	Inductor	15uH	1812	Saturation current > 350 mA, R < 1 ohm
Q1	NMOS	FDV303N	SOT-23	
Q2	NMOS	FDV303N	SOT-23	
R1	Resistor	1M	0603	1%
R2	Resistor	22k	0603	1%
R3	Resistor	1k	0603	1%
R4	Resistor	33k	0603	1%
R5	Resistor	100k	0603	1%
R6	Resistor	150	0603	1%
R7	Resistor	1k	0603	1%
R8	Resistor	10k	0603	1%
R9	Resistor	150	0603	1%
R10	Resistor	Not mounted	0603	1%
R11	Resistor	0 ohm	0603	1%
R12	Resistor	220	0603	1%
R13	Resistor	220	0603	1%
R14	Resistor	220	0603	1%
R15	Resistor	220	0603	1%
R16	Resistor	10k	0603	1%
R17	Resistor	100k	0603	1%
R18	Resistor	220	0603	1%
R19	Resistor	220	0603	1%
R20	Resistor	220	0603	1%
R21	Resistor	220	0603	1%
R22	Resistor	100k	0603	1%
R23	Resistor	1M	0603	1%
R24	Resistor	680k	0603	1%
R25	Resistor	100k	0603	1%
S1	Switch SPDT	SW SPDT		
S2	Switch SPDT	SW SPDT		

Designator	Description	Part Type	Footprint	Comment
TP_GND	test point	CON1		GND for test equipment
U1		nRF24E1	QFN36	
U2	Linear voltage regulator	MAX8880EUT-T	SOT23-6	
U3	OR gate	74AHC1G32	SOT353-5	
U4	SPI EEPROM	25XX320	SO-8	
U5	RS232 converter	MAX3218	SSO-20/G4.9	
U6	Line buffer	74LVC1G125	SOT353-5	
U7	Line buffer	74LVC1G125	SOT353-5	
U8	Line buffer	74LVC1G125	SOT353-5	
U9	Line buffer	74LVC1G125	SOT353-5	
U10	Solid state relay	PLA140S	SDIP-6	
U11	Line buffer	74LVC1G125	SOT353-5	
X1	Crystal	16 MHz	TSX-10	LxWxH = 4.0x2.5x0.8, Cl=9pF, ESR < 100 ohm, tolerance + temperature drift < +/- 30 ppm
	Jumper	Short circuit for J8		

Table 3: **nRF24E1-EVBOARD** component list

The **nRF24E1-EVBOARD** is manufactured on a 1.6mm thick, 2 layer FR4 substrate.

DEFINITIONS

Product specification
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.
Limiting values
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.
Application information
Where application information is given, it is advisory and does not form part of the specification.

Table 4: 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 : 13.06.2003

YOUR NOTES

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Nordic VLSI ASA

Main Office:
Vestre Rosten 81, N-7075 Tiller, Norway
Phone: +47 72 89 89 00, Fax: +47 72 89 89 89

Visit the Nordic VLSI ASA website at http://www.nvlsi.no