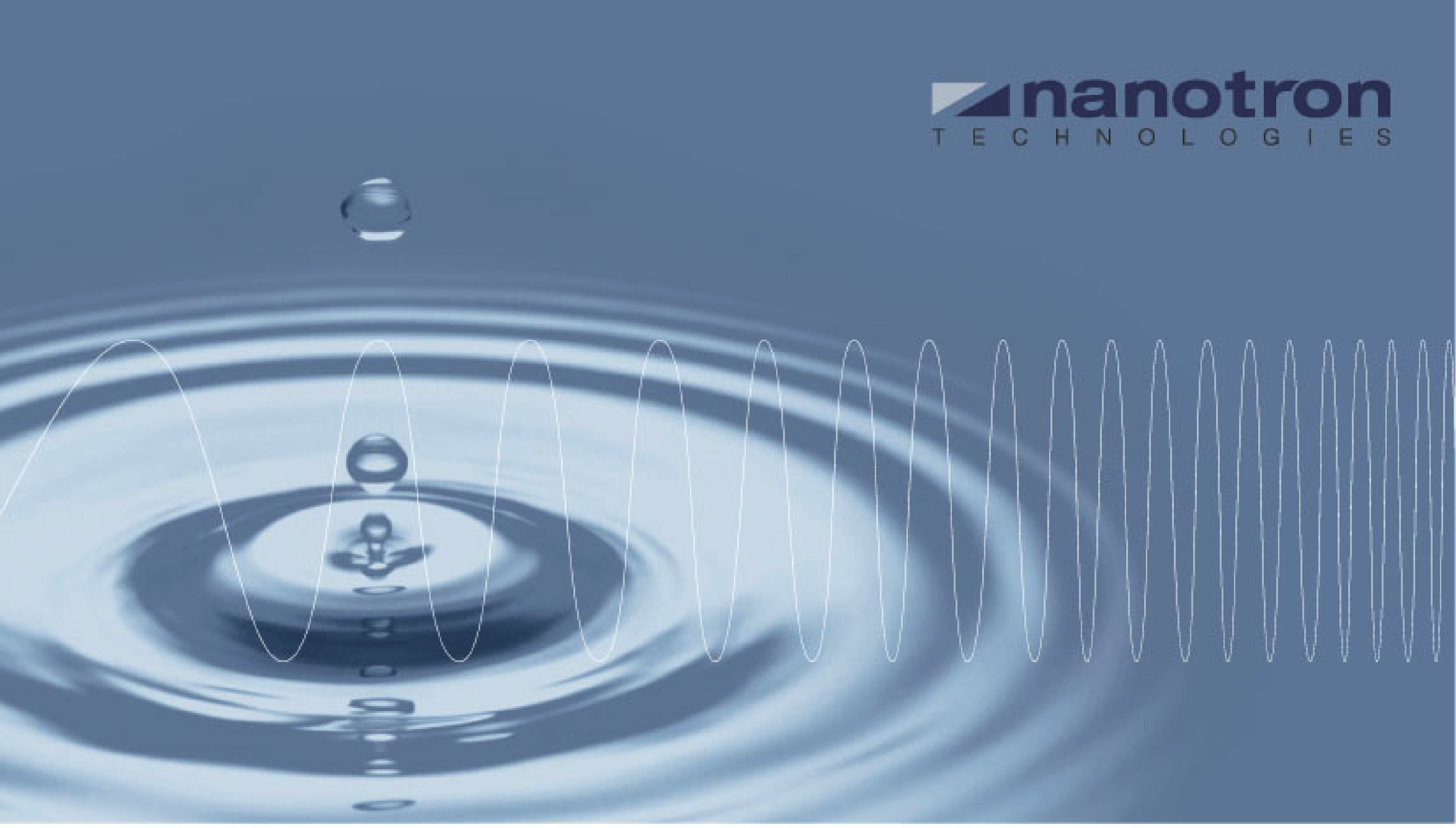

FCC Required Exhibit 12

nanoNET TRX User Manual (UserMan)

FCC ID: SIFNANONET-TRX

FCC Information to the user pursuant to FCC Rules Part 15, Subpart B, can be found on page iii.

Document Information

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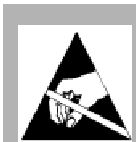

CAUTION! Electrostatic Sensitive Device. Precaution should be used when handling the device in order to prevent permanent damage.

Regulatory Information

Electromagnetic Interference / Compatibility

Nearly every electronic device is susceptible to electromagnetic interference (EMI) if inadequately shielded, designed, or otherwise configured for electromagnetic compatibility.

To avoid electromagnetic interference and/or compatibility conflicts, do not use this device in any facility where posted notices instruct you to do so. In aircraft, use of any radio frequency devices must be in accordance with applicable regulations. Hospitals or health care facilities may be using equipment that is sensitive to external RF energy. With medical devices, maintain a minimum separation of 6 inches (15 cm) between pacemakers and wireless devices and some wireless radios may interfere with some hearing aids. If other personal medical devices are being used in the vicinity of wireless devices, ensure that the device has been adequately shielded from RF energy. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

EC Declaration of Conformity

The *2.4GHz Chirp Spread Spectrum (CSS) Low-Power RF Transceiver*, model number *nanoNET TRX* has been certified to comply with the requirements of the R&TTE Directive
1999/5/EC and the standards EN 300 328 V 1.4.1:2003, EN 301 489-17 V1.2.1, and
EN 60950-1:2001.

CE 0681

FCC User Information

Statement according to FCC part 15.19:

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.

Statement according to FCC part 15.21:

Modifications not expressly approved by this company could void the user's authority to operate the equipment.

RF exposure mobil:

The internal / external antennas 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."

Statement according to FCC part 15.105:

This equipment has been tested and found to comply with the limits for a Class A and Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation and 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 instructions as provided in the user manual, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. 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 or her own expense.

If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to connected.
- Consult the dealer or an experienced technician for help.

Table of Contents

1. About the nanoNET TRX RF Performance Evaluation Kit

The *nanoNET TRX* is a highly integrated mixed signal chip utilizing a new wireless communication technology – *Chirp Spread Spectrum* (CSS) – developed by *Nanotron*. It is designed for robust wireless networks operating in the *2.45 GHz* ISM band, and has extremely low power consumption over a wide range of operating temperatures. The *nanoNET TRX RF Performance Evaluation Kit* enables the testing and measurement of wireless communication using the *nanoNET TRX* chip in real world conditions and facilitates the development of applications using the powerful features of the *nanoNET MCF microcontroller board*. With the Evaluation Kit, the range, robustness, and performance of the *nanoNET TRX* transceiver can be demonstrated.

The *nanoNET MCF microcontroller board* uses the Motorola ColdFire microcontroller which provides a powerful platform for application development for wireless communication. It also provides an Xilinx FPGA to extend the microcontroller bus structure for further applications (for example, a graphic display), two ADCs creating two analog input channels, a DAC with two analogue output channels, a power supply block, and mounting connectors for up to two *nanoNET RF Test Modules*.

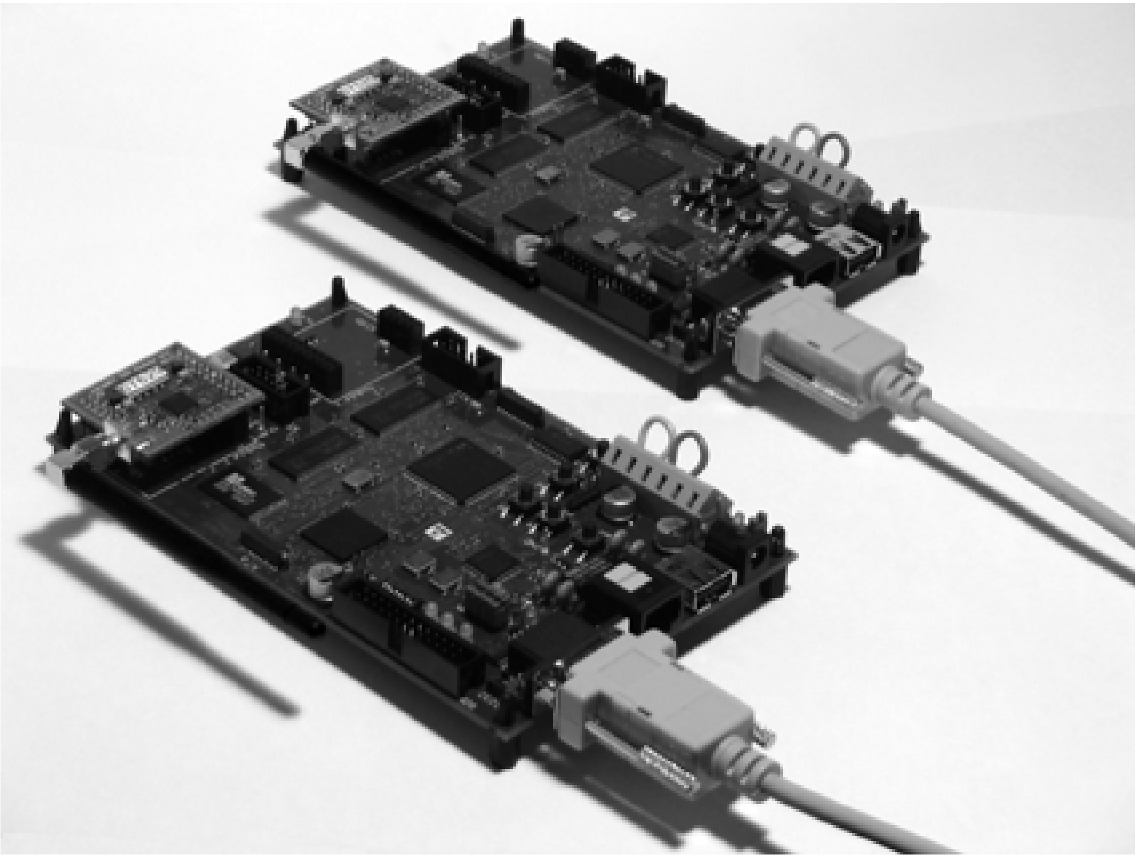

Figure 1: RF Performance Evaluation Kit hardware

The evaluation kit includes:

- *Two nanoNET TRX RF Test Modules*

  The *nanoNET TRX RF Test Module* contains the *nanoNET TRX* transceiver along with external circuitry required for its operation. It provides basic RF functionality including transmission (TX), and reception (RX), as well as basic digital operations.

- *Two 2.4 GHz Omnidirectional Antennas*

  These high-quality sleeve dipole omnidirectional indoor antennas have a frequency range of 2.40 to 2.48 GHz.

- *Two nanoNET MCF Microcontroller Boards*

  The *nanoNET MCF Microcontroller board* provides an effective platform for the evaluation of the *nanoNET TRX* chip, as it uses Motorola's ColdFire® MCF5272 Integrated Microprocessor, an IC ideally suited for getting the highest performance out of the *nanoNET TRX* chip.

  Note: The MCF boards have been preflashed with the RFPAT firmware required for use with the RFPAT user interface and is, therefore, ready for use.

- *Two RS232 Serial Cables*

  These are used to connect the MCF boards to one or two PCs using the RS232 ports.

- *Software CD*

  This CD contains the *nanoNET RF Performance Analysis Tool* (*RFPAT*) and related configuration files. The *RFPAT* application can be used to perform a wide range of tests, including basic RF packet transmission and reception demonstrations, interference testing, and coexistence tests. Configuration files for the specific chip included on the *RF Test Module* are provided.

- *nanoNET TRX RF Performance Evaluation Kit Quick Start Guide*

  The *nanoNET TRX RF Performance Evaluation Kit Quick Start Guide* provides basic instructions for setting up and running the kit. This User Manual provides a description of the basic and advanced tasks that can be performed using *RFPAT* software in conjunction with the included *MCF boards* and the *RF Test Modules*.

FCC certification is valid only for the complete Evaluation Kit. To use components of the Evaluation Kit individually, such as the RF Test Module, the user is responsible for obtaining a separate grant from the FCC.

2. nanoNET TRX RF Test Module Version 5

The *nanoNET TRX RF Test Module Version 5* contains the *nanoNET TRX* (48 pin) transceiver along with external circuitry required for its operation. It provides RF functions, including modulation, transmission (TX), and reception (RX), as well as basic digital operations.

Each block of the *RF Test Module Version 5* is described in the following sections.

- *nanoNET TRX (48 Pin) Transceiver (48 pin)*

  The *nanoNET TRX* transceiver has extremely low power consumption, operates over a wide range of temperatures, and performs effortlessly in robust wireless networks operating in the *2.45 GHz* ISM band. The new transmission technology *Chirp Spread Spectrum* (CSS) developed by Nanotron has up and down chirps with a symbol duration of $T_{symbol} = 1\ \mu s$ and an effective bandwidth of $B_{chirp} = 64\ MHz$. The chip offers three different data rates: *500 kbps*, *1 Mbps,* and *2 Mbps*.

  Note: The *RF Test Module Version 5* includes a preproduction phase *nanoNET* TRX Chip and does not conform in all points to the *nanoNET* TRX Chip specifications.

- *SMA Connector*

  The SMA connector is used to connect a 50 Ω antenna to the *RF Test Module*.

- *Impedance Matching Circuits*

  At the RF interface of the *TRX*, there is a differential impedance of 150 Ω, which is matched to the unsymmetrical (single ended) 50 Ω impedance of the SMA connector by a 150 Ω / 50 Ω RF balun. Additional external components at the RF interface have a power and noise matching function that allows a sharing of the antenna without an external RX/TX – RF switch.

- CDDL - Complementary Dispersive Delay Line

  The CDDL is a highly sophisticated SAW filter which incorporates two filters within a single device. Within the *nanoNET* system, the SAW Filter is responsible for distinguishing between two possible incoming signals that are generated by another *nanoNET* transceiver. This received signal is either an up-chirp, a down-chirp, or a folded pulse (up-chirp and down-chirp at the same time). All of these signals have the same center frequency and the same bandwidth. The difference between an up-chirp and a down-chirp occurs only in the phase information of the complete spectrum. This phase information is enough for the CDDL to compress a pulse at one output port and expand it at the other (that is, to extend the incoming signal to the doubled duration). In this way the CDDL acts like a matched filter for one of the possible transmitted pulses.

- 32768 Hz Quartz

  The 32768 Hz Quartz is used for the real time clock oscillator.

- 16 MHz Quartz

  The 16 MHz Quartz provides a frequency reference for the Local Oscillator and for other digital activities in the chip.

- EEPROM

  This memory is used for storing basic parameters for the *nanoNET TRX* transceiver and for storing the ID of the chip.

- Connectors

  Two connectors are provided to mount the *RF Test Module Version 5* on an either an Evaluation Board or an Adapter Board. These connectors provide to the *RT Test Module* a regulated 3.3 V power supply as well as control signals and data.

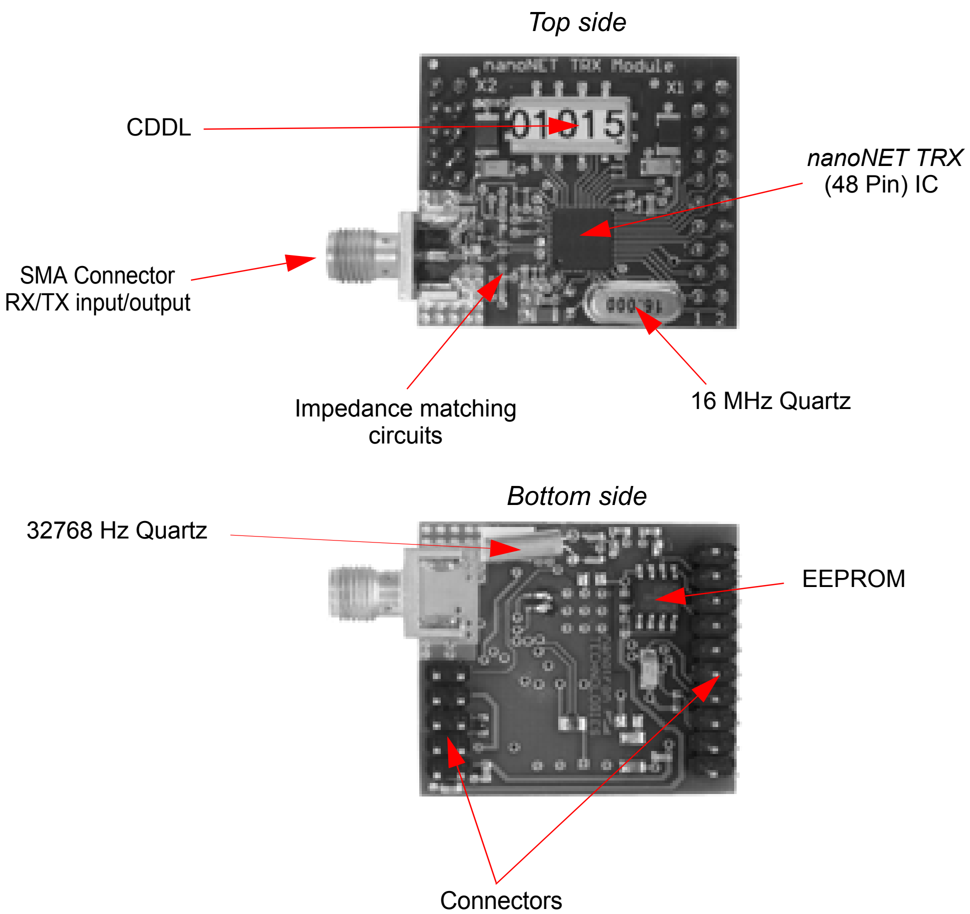

Figure 2: RF Test Module Version 5

3. nanoNET TRX RF Test Module Version 12

The *nanoNET TRX RF Test Module* Version 12 contains the *nanoNET TRX* (44 pin) transceiver along with external circuitry required for its operation. It provides basic RF functionality including transmission (TX), and reception (RX), as well as basic digital operations.

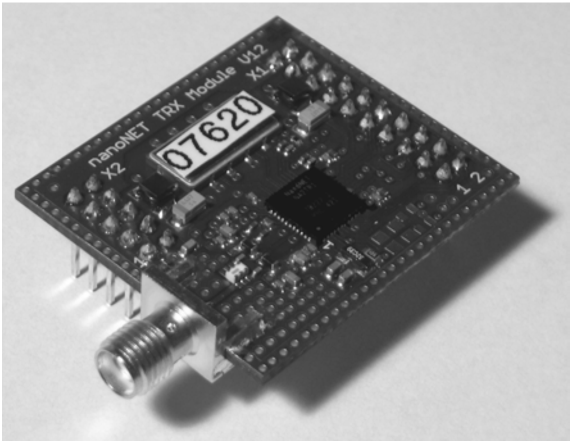

Figure 3: nanoNET TRX RF Test Module (Ver. 12)

The *nanoNET TRX RF Test Module* consists of the following components:

- *nanoNET TRX Transceiver (44 pin)*

  The *nanoNET TRX* transceiver has extremely low power consumption, operates over a wide range of temperatures, and performs effortlessly in robust wireless networks operating in the *2.45 GHz* ISM band. The new transmission technology *Chirp Spread Spectrum* (CSS) developed by *Nanotron Technologies* has up and down chirps with a symbol duration of $T_{symbol} = 1$ *µs* and an effective bandwidth of $B_{chirp} = 64$ *MHz*. The chip offers three different data rates: *500 kbps*, *1 Mbps,* and *2 Mbps*.

- *SMA connector (RX/TX input/output)*

  The SMA connector is used to connect a 50 Ω antenna to the *RF Test Module Version 12*.

- *Impedance Matching Circuits*

  At the RF interface of the *TRX*, there is a differential impedance of 150 Ω, which is matched to the unsymmetrical (single ended) 50 Ω impedance of the SMA connector by a 150 Ω / 50 Ω RF balun. Additional external components at the RF interface have a power and noise matching function that allows a sharing of the antenna without an external RX/TX – RF switch.

- *CDDL – Complementary Dispersive Delay Line*

  The CDDL is a highly sophisticated SAW filter which incorporates two filters within a single device. Within the *nanoNET* system, the SAW Filter is responsible for distinguishing between two possible incoming signals that are generated by another *nanoNET* transceiver. This received signal is either an up-chirp, a down-chirp, or a folded pulse (up-chirp and down-chirp at the same time). All of these signals have the same center frequency and the same bandwidth. The difference between an up-chirp and a down-chirp occurs only in the phase information.This phase information is enough for the CDDL to compress a pulse at one output port and expand it at the other (that is, to extend the incoming signal to the doubled duration). In this way the CDDL acts like a matched filter for one of the possible transmitted pulses.

- *32768 Hz Quartz*

  The 32768 Hz Quartz is used for the real time clock oscillator.

- *16 MHz Quartz*

  To provide the required 16 MHz, the *RF Test Module* uses either a 16 MHz Quartz or a 16 MHz external oscillator, depending on the chip used. Modules with the 16 MHz Quartz use the internal oscillator circuitry and can operate within a range of between 0°C to 85°C. Modules with the 16 MHz Quartz external oscillator do not use the internal oscillator circuitry and can operate within a range of -40°C to 85°C.

- *Connectors*

  Two connectors are provided to mount the *RF Test Module* on an either an Evaluation Board or an Adapter Board. These connectors provide to the *Test Module* a regulated 3.3 V power supply as well as control signals and data.

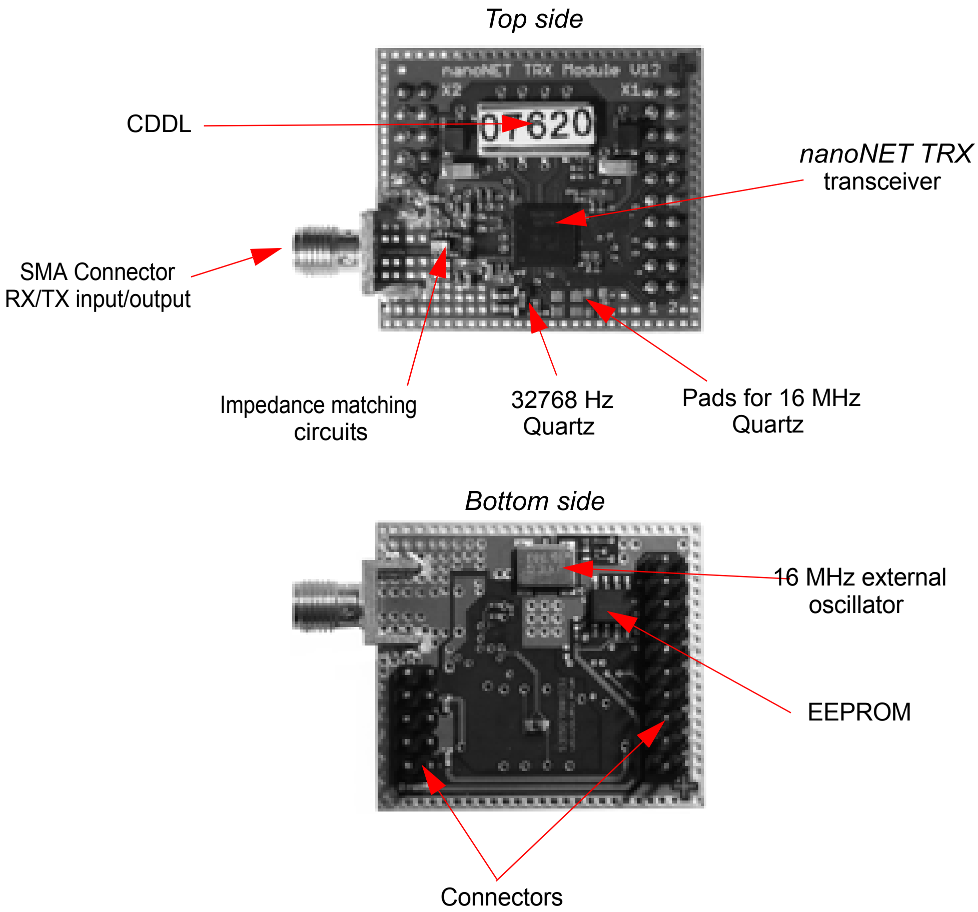

Figure 4: nanoNET TRX RF Test Module (Version 12) Components

4. nanoNET MCF Microcontroller Board

The *nanoNET MCF Microcontroller Board* is designed to be used with the *nanoNET TRX RF Test Modules* for evaluating the RX and TX of the *nanoNET TRX* transceiver. It supports up to two *RF Test Modules* for wireless communication as well as supporting baseband communication for application testing free of interference from wireless transmissions. The *MCF board* includes a 66 MHz Motorola ColdFire© microcontroller, 32 MB RAM, 2 MB flash memory, two ADCs with two analogue input channels, a DAC with two analogue output channels, a power supply block, and a wide range of interfaces.

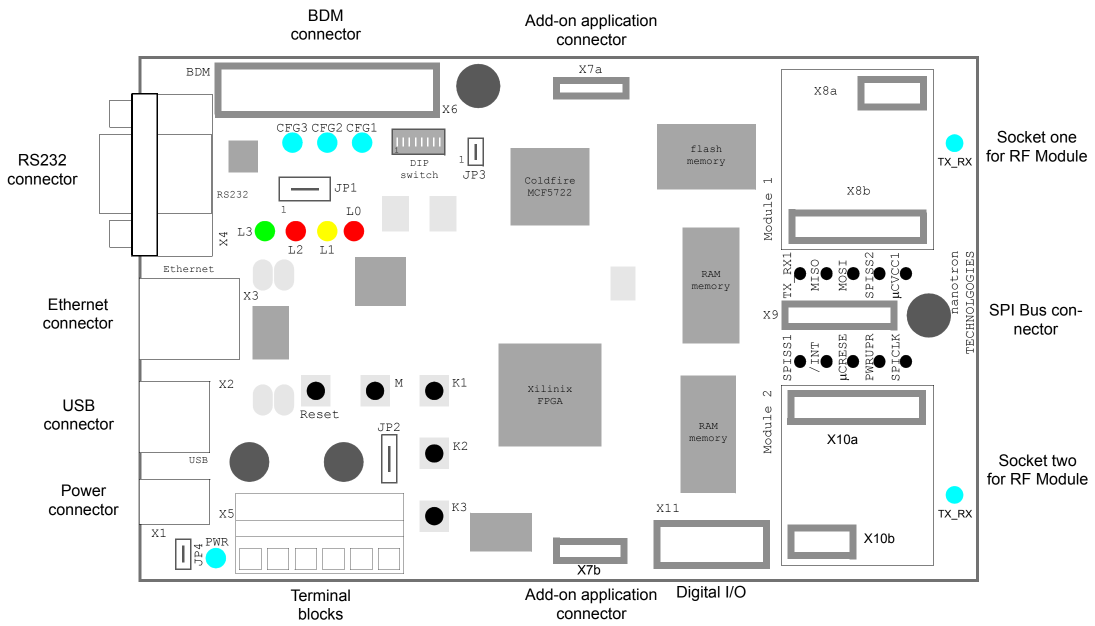

Figure 5: MCF Microcontroller board component locations

The *nanoNET MCF Microcontroller Board* consists of following components:

- *Motorola ColdFire© Microcontroller*

  The Motorola ColdFire© microprocessor MCF5272, clocked at 66 MHz, is based on a variable-length RISC processor with a 32-bit address bus and a 32-bit data bus. A 2 MByte boot flash as well as a 32 MByte SDRAM are provided as external components on the board.

- *Xilinx FPGA*

  The *MCF board* provides an FPGA (Field Programmable Gate Array) to extend the microcontroller bus structure for add on applications using connectors `X7a` and `X7b`.

- *Connector X1 (Power Supply Jack)*

  This 2.1 mm barrel connector provides a supply voltage to the board. For details on the power supply for the MCF board, see "*Power Supply*" on page 11.

- *Connector X2 (USB)*

  The *MCF board* provides a USB interface (full speed specified by version 1.1). The USB interface is not used for the Evaluation Kit.

- *Connector X3 (Ethernet 10/100BASE TX)*

  The MCF Board provides a 10/100BASE TX Ethernet interface to use, for example, to connect to boards for a fast wired communication channel or to a network if a TCP/IP stack is part of the software. The Ethernet interface is not used for the Evaluation Kit

- *Connector X4 (RS232 Serial Interface)*

  The MCF board provides an RS232 serial interface for connecting to a serial port of a PC. The UART1 of the controller uses an external driver that provides RS232 compatibility for connection of terminal.

- *Connector X5 (Terminal Blocks)*

  This power supply using a CAGE CLAMP® (series 236) provides an alternate power supply for the board. See Table 1: *"MCF board power supply guidelines"* on page 5–11 for minimum and maximum voltage requirements for the board. The polarity of the terminal blocks are shown below:

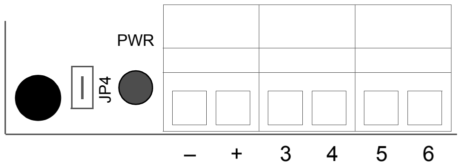

Figure 6: Connector X5 (Terminal Blocks)

  The analogue and digital 3.3 V supply voltages of the *RF Test Module* mounted on connectors `X8a` and `X8b` are fed separately from connector `X5` to connector `X8a` so that both currents of the module can be measured. Connect the Ampere meter between pins 3 and 4 to measure the power supply current of the digital part of the TRX chip, and between pins 5 and 6 for the power supply current of the analogue part of the TRX chip.

  In normal operation, both pins 3 and 4 and pins 5 and 6 must be shorted.

- *Connector X6 (BDM for Flash Memory and MCF5272 Debugging)*

  The *MCF board* provides a BDM connector that can be used to program the flash memory as well as to run the MCF5272 microcontroller in debug mode. A special adapter is required to interface between a parallel port cable connected to a standard IBM PC parallel port (DB25 female connector) on the PC and the BDM connector on the *MCF board*. The BDM is not used for the Evaluation Kit.

  Note: The *RF Performance Evaluation Kit* does not include a development environment nor an adapter to connect a parallel port cable to the BDM connector. Contact a *Nanotron Technologies* sales representative for information about the *RF Performance Development Kit*.

- *Connectors X7a and X7b (add-on application board)*

  The *MCF board* provides an interface for extending the microcontroller bus structure for further applications, such as an LCD matrix display. The Evaluation Kit does not require an add-on application and, therefore, X7a and X7b are, therefore, not used.

- *Connectors X8a and X8b (Digital I/O signals of Module 1)*

  The *nanoNET TRX RF Test Modules* included in the Evaluation Kit are mounted on these interfaces (labeled `Module 1`) on each *MCF board*. Connector `X8a` provides a supply power to the *RF Test Module*, while connector `X8b` provides signals between the *RF Test Module* and the MCF5272 ColdFire© microprocessor.

  Note: Do not mount the *RF Test Module* on the set of connectors `X10a` and `X10b` (labeled `Module 2`) as they are not used in the Evaluation Kit.

- *Connector X9 (ADC and DAC)*

  This user-definable connector provides two ADCs (analogue to digital converter) creating two analogue input channels, a DAC (digital to analogue converter) with two analogue output channels. This connector is not used in the Evaluation Kit.

- *Connector X10a and X10b (Digital I/O signals of Module 2)*

  This second set of connectors (labeled `Module 2`) is provided for a second *RF Test Module* or for an SPI interface and is used in a development environment only. These connectors are not used with the Evaluation Kit. If an *RF Test Module* is mounted on the *MCF board* using these connectors, an error will be generated.

- *Connector X11 (Digital I/O)*

  This connector is used to transmit digital I/O signals from/to *RF Test Module*(s). Its voltage level is 3.3 V and it is not buffered. It can be used to provide a baseband connection without RF interference. It is used primarily for testing applications and is not used for the Evaluation Kit.

- *Status Indication LEDs*

  The LEDs `CFG1`, `CFG2`, and `CFG3` provide a boot up status indication. During boot up, all three LEDs (`CFG1`, `CFG2`, `CFG3`) are illuminated briefly to indicate that the boot up was successful. They are also used as error indicators. If a few seconds after boot up, they begin to start flashing intermittently, then the *MCF board* needs to be rebooted. The boot process can be restarted by pushing the `Reset` button to restart. They can also be configured by software to provide an indication of the status of the Ethernet controller during board operation. They are configured for this purpose for the Evaluation Kit.

  LEDs `L0`, `L1`, `L2`, `L3` are used as error indicators. If a few seconds after boot up, they begin to continuously blink 5 times per second, the likely cause is that an *RF Test Module* has been placed in the wrong socket. Reinstall the *RF Test Module* in connectors `X8a` and `X8b` (`Module 1`). Also, after the *MCF board* has booted up, LED `L3` will flash continually indicating the board is operating. These LEDs are also part of the user interface for the Coldfire© microcontroller and can be configured by software as user-definable status indications. Except LED3, they are not configured for the Evaluation Kit.

  The power indication LED (`PWR`) will be illuminated to indicate a correct power supply has been attached to the board, either in the Power Supply Jack (`X1`) or in the Terminal Blocks (`X5`). The `TX_RX` LEDs indicates an *RF Module* is transmitting or receiving data. It is switched off by default. To enable this LED, check the `RfTxExtPampOutEn` register in the more settings dialog. See "*Viewing Chip Register Settings*" on page 33 for details.

- *Jumpers*

  The *MCF board* provides a number of jumpers for taking measurements, changing settings, or giving access to I/O lines:

  - Jumper 1 is used (closed as default) to connect the appropriate ports of the controller to the LEDs. Otherwise these ports can be used for another purpose instead of the LEDs.
  - Jumper 2 (default is opened) is the parallel connection of the appropriate ports of the controller to the key buttons (K1, K2, M1 and M2). They can also be used for another purpose instead of key buttons if desired.
  - Jumper 3 (default is opened) is the output of the Pulse Width Modulator, it can be connected to a speaker for example.
  - Jumper 4 is (default is closed) used to measure the load current of the ColdFire board.

  In the Evaluation Kit, the default settings are used.

- *Key Buttons*

  The *MCF board* provides a set of five key buttons (labeled `RESET`, `M`, `K1`, `K2` and `K3`). The RESET button is used to reset the microprocessor in the event of an error during boot up. The remaining four are software configured and not used for the Evaluation Kit.

5. Using the RF Performance Evaluation Kit

For a smooth operation of the Evaluation Kit, two computers that have RS232 connector ports (or one computer with two RS232 connector ports) are required with both running Microsoft® Windows® 2000 or XP operating system and each having a minimum of 5MB hard disk space. Also, a power supply is required, either as a 2.1 mm barrel connector or as a bare wire for use with the board's terminal block.

5.1. Power Supply

The power supply is provided by either connector X1 or x5 (see "*nanoNET MCF Microcontroller Board*" on page 7). The MCF board provides connectors (X7a and X7b) for an external peripheral device such as an LED display, although the Evaluation Kit does not include an external device. Nevertheless, the following guidelines should be followed when providing a power supply for the board.

Table 1: MCF board power supply guidelines

Operating Mode	Minimum		Maximum	
	Absolute	Recommended	Recommended	Absolute
Without external device	4.5 V	4.8 V	6 V	9 V
With external device	6.2 V	6.5 V	7.5 V	9 V

Warning: Recommended voltage for the Evaluation Kit without the use of an external device is 7.5 V as a higher voltage will generate heat due to power dissipation.

A lower supply voltage is preferable as higher supply voltages cause the voltage regulator to heat up.The polarity of the inner connector is positive.

The board provides three supply voltages: 3.3 V, 1.8 V and 5 V. The microcontroller and the *nanoNET TRX RF Test Modules* operate at 3.3 V while the core voltage of the FPGA is 1.8 V. A 5 V supply is fed to the external connectors `X7a` and `X7b` for add-on applications.

As soon as the external supply voltage is applied, the power LED is illuminated.

5.2. Flash Software

The MCF Boards have been pre-flashed with the RFPAT flash software for use with the *RF Performance Evaluation Tool*.

5.3. Setting Up the MCF Boards

Warning: Since the Coldfire Microprocessor does not boot when the RX line on the serial (D-Sub 9) connector has a voltage level above 1.3 Volts, connect the RS232 serial cable **AFTER** the board has finished its boot sequence and the LED L3 begins to continuously blink indicating a successful boot-up.

It is important that the steps described below be followed precisely to bring the MCF Boards up to a running state.

For each MCF board:

1. Attach to one of the *nanoNET TRX RF Test Modules* a 2.4 GHz sleeve dipole antenna model 17010.11 that has been provided in the Evaluation Kit.

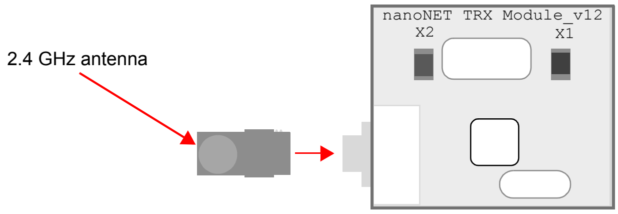

Figure 7: Attaching antenna to RF Test Module

Warning: To use the Evaluation Kit, you MUST use the antennas that have been provided with the Evaluation Kit in order to remain within the scope of FCC Certification for FCC Class A and Class B devices. The usage of any other antenna voids the users authority to operate the equipment under FCC regulations.

For specifications of the 2.4 GHz sleeve dipole antenna model 17010.11, see "*Antenna Specifications for Model 17010.11*" **on page 21**.

2. Carefully install the *RF Test Module* onto the MCF board using the two connectors labelled `Module 1` (connectors `X8a/b`).

   Note: The Evaluation Kit uses only one *RF Test Module* per board and for the kit to operate correctly, the *RF Test Module* **MUST** be mounted on the connectors labelled `Module 1` or an error will be generated (LEDs 1 to 4 blinking continuously indicating this error).

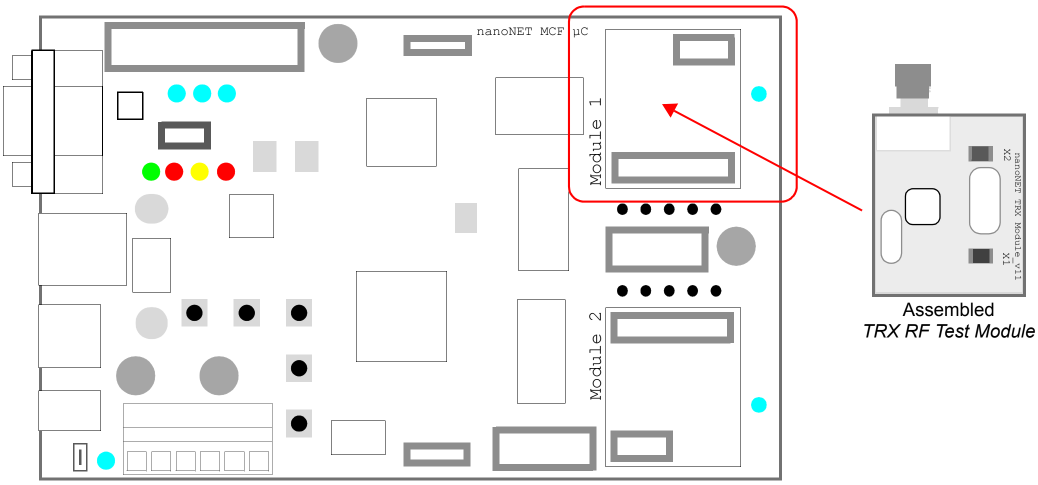

Figure 8: Mounting the RF Test Module on the MCF board

3. Connect the MCF board to an external DC power supply. The guidelines described in Table 1: *"MCF board power supply guidelines"* on page 11 should be followed when providing a power supply for the board.

   The MCF board provides two power supply connectors - a 2.1 mm barrel connector (label `X1`) as well as terminal blocks (label `X5`) with CAGE CLAMP® (series 236). The terminal blocks (maximum 2.5mm^2 conductor) can be used when a reliable power supply connection is required. The polarity of the power supply is as shown.

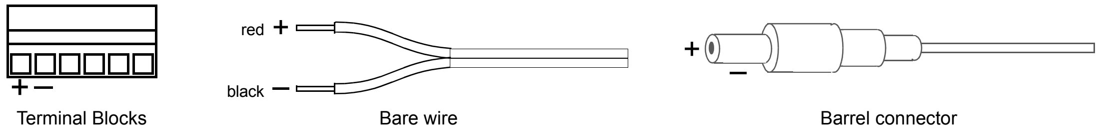

Figure 9: Terminal blocks, barrel connector and power supply options

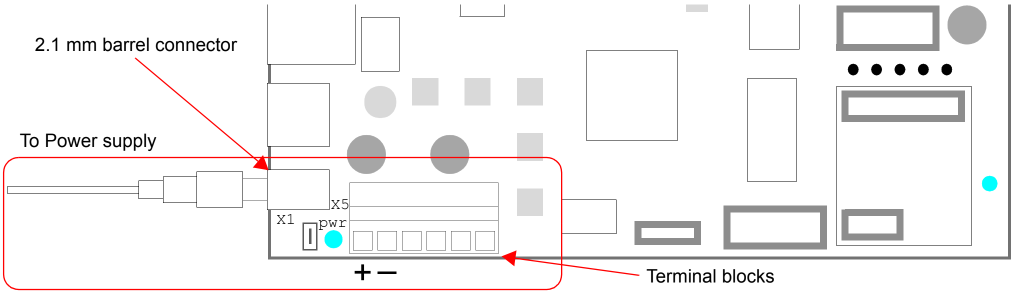

Figure 10: Connecting the barrel connector power supply

4. Once the power supply has been provided, the Power LED will illuminate to indicate the board has been powered up. It then begins its boot up process.

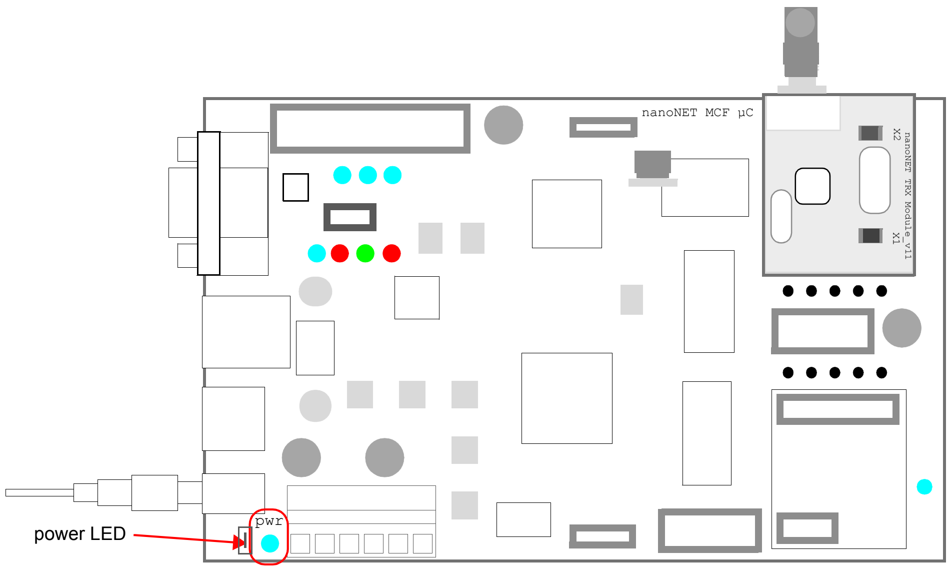

Figure 11: Power supply indicator

5. After a period of a few seconds, three LEDs (`CFG1`, `CFG2`, `CFG3`) will illuminate briefly to indicate that the Ethernet controller has been initialized.

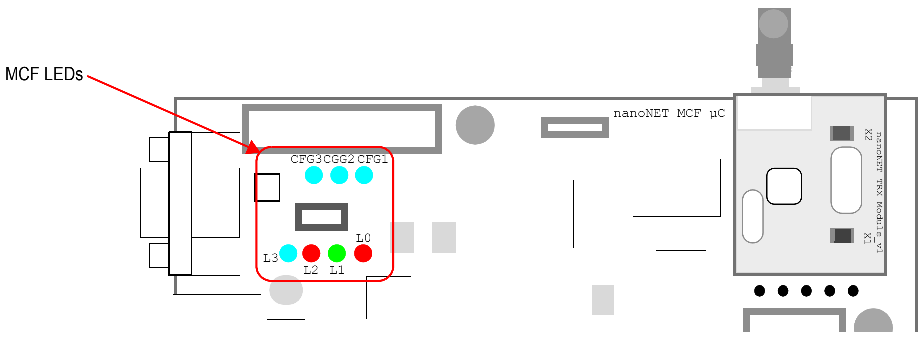

Figure 12: MCF board LEDs

6. Once the MCF board has been successfully booted up, LED L3 will flash continually indicating the board is operating.

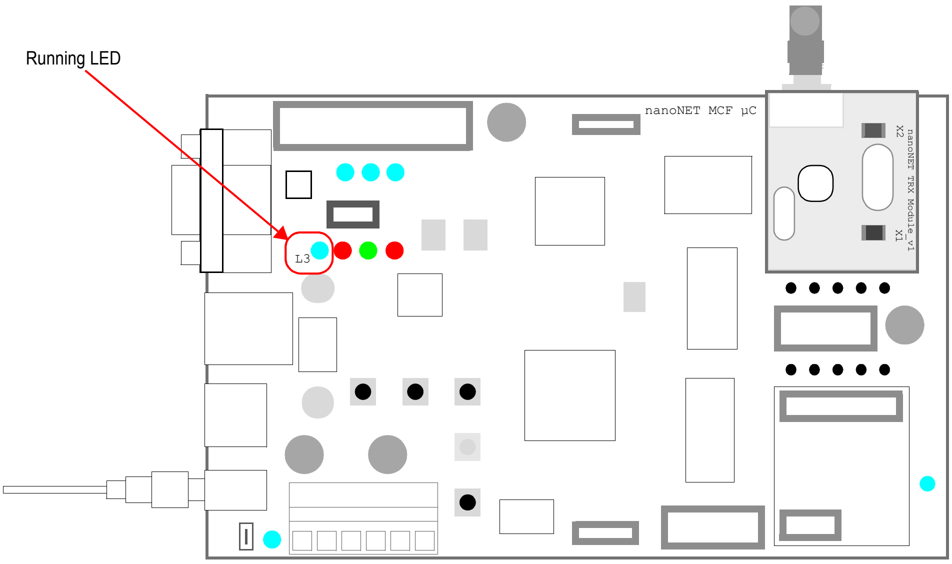

Figure 13: Running indicator (LED 3)

7. Finally, connect a 9-pin RS232 cable to the RS232 connector on the MCF board (label `X4`) and to a RS232 serial port on a computer running either Microsoft® Windows® 2000 or XP.

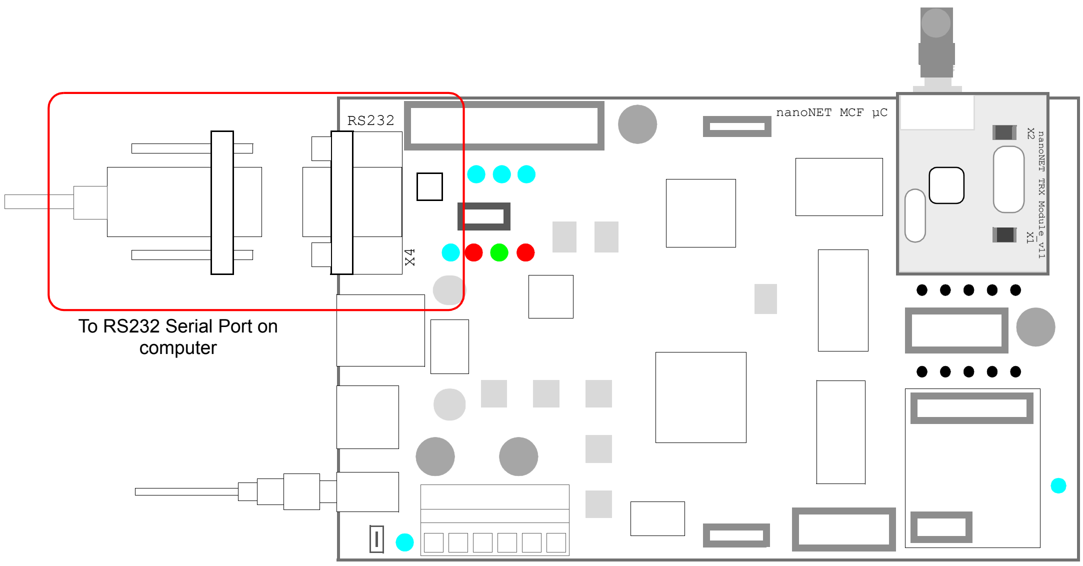

Figure 14: Connecting the RS23 cable to the MCF board

Repeat this procedure with the second MCF board and then launch the RF Performance Evaluation Tool. See "*Installing the RF Performance Analysis Tool*" on page 15.

5.4. Error Indications

A number of conditions will generate an error, the most common of which is the *nanoNET TRX RF Test Module* installed in the wrong socket on the MCF board. To indicate this and any other error condition, the MCF board causes the LEDs (`L0`, `L1`, `L2`, `L3`) to blink continuously.

To resolve this error condition:

1. Disconnect from power supply and the RS232 cable from the MCF board before attempting any troubleshooting.
2. Ensure that the RF Test Module is installed in the socket labeled `Module 1`.
3. Reconnect the power supply as in step 3 in "*Setting Up the MCF Boards*" on page 11.
4. If the MCF board continues to show an error condition (LEDs blinking continuously), then push the `Reset` button to restart the boot process.

   The power LED and LEDs (`CFG1`, `CFG2`, `CFG3`) will illuminate briefly to indicate that the boot up was successful.
5. Reconnect the RS232 cable.

5.5. Installing the *RF Performance Analysis Tool*

To install the *RF Performance Analysis Tool*:

1. Copy to a destination directory, for example, `C:\RFPAT\`, (on both PCs if two PCs are to be used) the *RF Performance Analysis Tool* (RFPAT) executable (`RFPAT.exe`) from the *nanoNET RF Evaluation Kit* CDROM.
2. Ensure that the two MCF boards are connected to the RS232 ports.
3. Launch two instances (two on one PC or one each on two PCs) of the RFPAT software by running `rfpat.exe`.

For details on using the RFPAT software, see "*RF Performance Analysis Tool*" on page 17.

5.6. Shutting Down an MCF Board

To safely shut down the MCF board:

1. Close the RFPAT applications running on the MCF boards.
2. Disconnect the power supply and the RS232 cables from the boards.
3. Disconnect the antennas from the *nanoNET TRX RF Test Modules*.
4. Carefully remove the *nanoNET TRX RF Test Module* from the MCF boards.
5. Store the Evaluation Kit hardware in ESD protection bags.

6. RF Performance Analysis Tool

The *RF Performance Analysis Tool* (RFPAT) provides a convenient means of evaluating the wireless link between two stations. It does so by evaluating the RF performance of the *nanoNET TRX* hardware. It enables the user to perform short and long term measurements of several types of error rates for different *nanoNET TRX* register configurations. And since the RFPAT application is also used for internal chip evaluation purposes, it gives access to many TRX chip registers that are not used for common operations.

The RFPAT application cannot be expected to demonstrate all features of the *nanoNET TRX* transceiver. In fact, only a small fraction of features are used while many others remain untouched, such as CSMA, RTS/CTS, real time clock, time beacon packets, TDMA mode, packets longer than 128 bytes, and so on.

The RFPAT tool consists of two parts:

- Firmware portion flashed onto the *MCF Microcontroller Board*

  This program accesses the *nanoNET TRX* hardware. It performs the transmission and reception of packets and updates a variety of statistic counters. The two *MCF boards* included in the kit have been pre-flashed with the firmware portion of the tool.

- Executable and a configuration file provided on the software CD

  The executable `RFPAT.exe` is a GUI that runs on a Windows® PC. It sends commands to the *MCF Microcontroller Board*, reads the statistic counter values, calculates and averages the values and rates to be displayed, and then formats them appropriately.

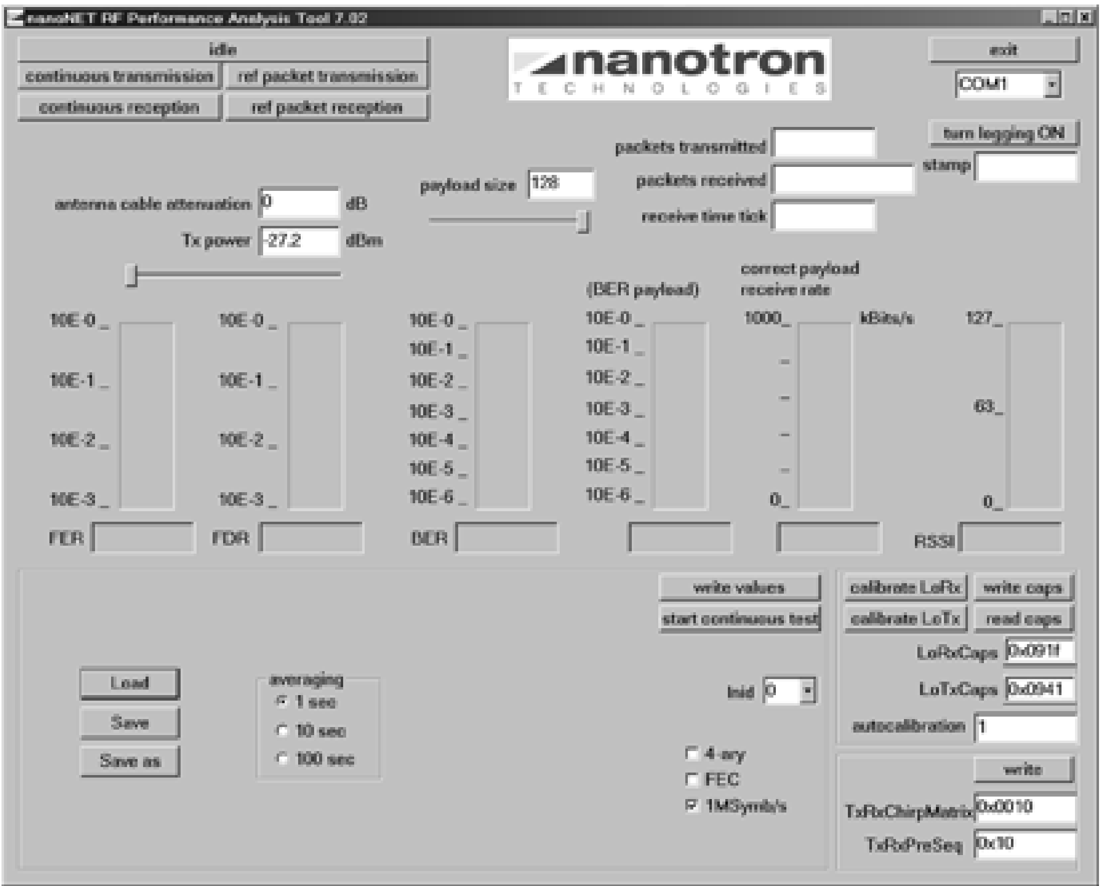

Figure 15: RF Performance Analysis Tool Version 7.02

6.1. Preparing for RF Evaluation

Once the Evaluation Kit has been assembled and connected to a PC(s), prepare the RFPAT application for RF evaluations as follows:

1. Start two instances of the RFPAT application, one for each TRX transceiver connected to the MCF board.
2. Load the configuration files and verify that the settings have been written to each of the transceivers.
3. Select a test mode on the TX station.
4. Select a test mode on the RX station.
5. Perform the evaluation.

These steps are described in detail in the remainder of this document.

6.2. Starting the RFPAT Application

It is assumed in this section that the hardware of the Evaluation Kit has been set up and running properly. If not, refer to the document *nanoNET TRX RF Performance Evaluation Kit Quick Start Guide* for set up procedures.

To start up the RFPAT application

1. Ensure that the Evaluation Kit hardware is powered on and running, as described in "*Setting Up the MCF Boards*" on page 11.

   The LED `L3` should be flashing intermittently on each MCF board indicating both boards are running properly.

2. Start two instances of the RFPAT application `RFPAT.exe` (in the `RFPAT_702_104` directory) .

   The Evaluation Kit requires two sets of stations for the evaluation of RF performance. Therefore, one instance of the application needs to be running for each of the two MCF boards in the Kit. Launch a second instance of the application for the second MCF board.

With two applications running, one will serve as a sending station (TX) while the second will serve as the receiving station (RX).

Manually Selecting the COM Ports

Manual setting of the COM port is possible by choosing an available COM port from the drop-down list.

If a different COM port is required than the one automatically selected by the RFPAT application, choose an available port from the dropdown list.

On each running RFPAT application, a drop-down list is provided which shows all the available COM ports on the PC to which one (or both) of the MCF boards via the RS232 cable are connected. When the RFPAT application is launched, it searches for the first free COM port on the PC and automatically selects that free port. It appears as the port displayed.

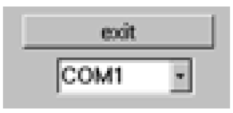

Figure 16: COM port drop-down list

6.3. Initializing and Selecting a Chip Register Settings File

The chip register settings file is an ASCII configuration file that provides a set of parameters for the specific chip on the *RF Test Module* included in the kit. It also provides additional configuration settings required for the RFPAT application (for example, autocalibration). The file can be visually inspected, if required, to check which chip register settings are in the file. These same settings are also displayed in the various fields of the RFPAT application user interface, where they can be overwritten, if required.

To load the chip register settings file

1. Select the `Load` button and navigate to the RFPAT directory that contains the configuration file (same directory as the RFPAT application).

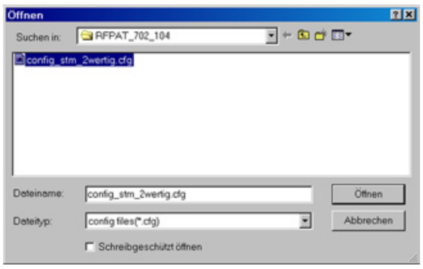

Figure 17: Configuration file

2. Select `Open` to initialize the chip registers with settings from the configuration file and to configure the RFPAT application. A message should appear indicating the initialization was successful.

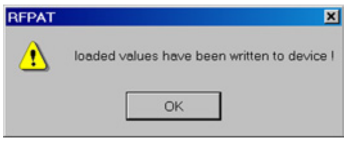

Figure 18: Configuration load successful message

If the initialization was unsuccessful, a message should appear indicating the *MCF Evaluation Board* is not responding correctly.

Figure 19: Configuration load unsuccessful message

Some possible reasons for the error message include no power connection (is the LED `L3` flashing?), RS232 cable not connected properly, or the configuration file not compatible with the chip on the *RF Test Module*.

3. Click OK to complete the configuration load.

After the values have been written to the chip, the frequency values of the Local Receive Oscillator Capacitors (`LoRxCaps`) and Local Transmit Oscillator Capacitors (`LoTxCaps`) are read back from the chip and displayed in the RFPAT user interface, as shown below.

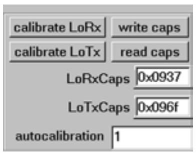

Figure 20: Local receive and transmit oscillator capacitor settings

This provides a means of verifying that the chip registers have been updated. If the `LoRxCaps` and `LoTxCaps` values are either `0x0000` or `0x0FFF`, then the RFPAT firmware has not properly initialized the chip with the configuration values. In this case, reload the configuration file.

After you have successfully run two instances of the *RF Performance Evaluation Tool* and initialized the chip with register settings, you are ready to start the measurements. See "*Test Modes*" on page 20.

6.4. Initializing Chip with Default Values

Normally, the loading of the configuration file will initialize the chip. However, if the RFPAT application attempts to communicate with the chip before the configuration file has been loaded, the chip will be initialized with default values taken from the firmware. A message should appear indicating this initialization.

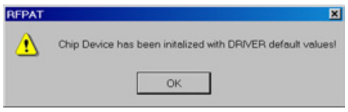

Figure 21: Chip initialization with default values message

As with loading the configuration file, after the values have been written to the chip, the frequency values `LoRxCaps` and `LoTxCaps` are read back from the chip and displayed in the RFPAT application.

6.5. Test Modes

The RFPAT application provides a wide range of test modes for evaluating the wireless link.

- Continuous Transmission Mode

  This mode is used to determine the throughput of the wireless link by measuring the correct payload receive rate.

- Reference Packet Mode

  This mode is used for measuring the precise frame error rate, frame drop rate, and bit error rate at a user-defined TX output power and payload size.

- Continuous Chirp Test Mode

  This mode is used to determine the chip output power by sending a continuous stream of chirps that can be measured by laboratory test equipment.

7. Antenna Specifications for Model 17010.11

This section provides the specifications for the antenna used by the nanoNET TRX, namely, Antenna Model 17010.11, as shown below:

Figure 22: Model 17010.11

Electrical Items	**Specifications**
Model	17010.11
Type of antenna	Sleeve dipole antenna
Frequency range	2.40~2.48 GHz
Electrical length	1 / 2 λ
Nominal impedance	50 Ω
Polarization	Vertical
V.S.W.R	Less than 2.0
Gain	2.15 dBi

Mechanical Items	**Specifications**
Element	ø 0.1x7 CuAg -wire
Sleeve	Urethane (black)
Connector	SMA-male (right angle)
Antenna total length	90 ± 2mm

7.1. Vertical Diagram for Model 17010.11

The following shows the vertical diagram for the antenna model 17010.11 measured at 2.40 GHz, 2.45 GHz, and 2.50 GHz

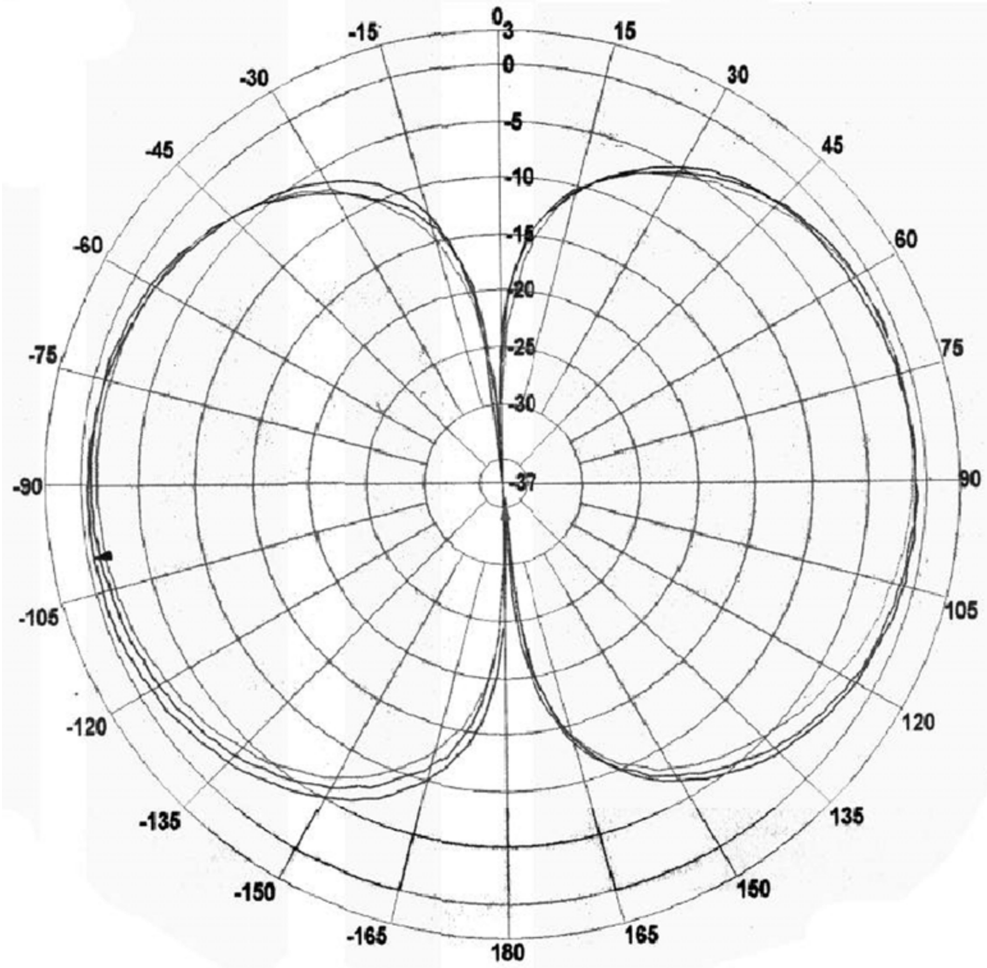

Figure 23: Vertical Diagram for Antenna model 17010.11

Beam Peak Values

Frequency	[dB]	at [deg]
2.40 GHz	-0.61	-99.94
2,45 GHz	-0.74	81.95
2,50 GHz	-0.64	67.96

Null Depth Values

Frequency	[dB]	at [deg]
2.40 GHz	-38.47	-4.00
2,45 GHz	-53.94	-2.00
2,50 GHz	-41.44	177.90

7.2. Azimuth Diagram for Model 17010.11

The following shows the Azimuth diagram for the antenna model 17010.11 measured at 2.40 GHz, 2.45 GHz, and 2.50 GHz

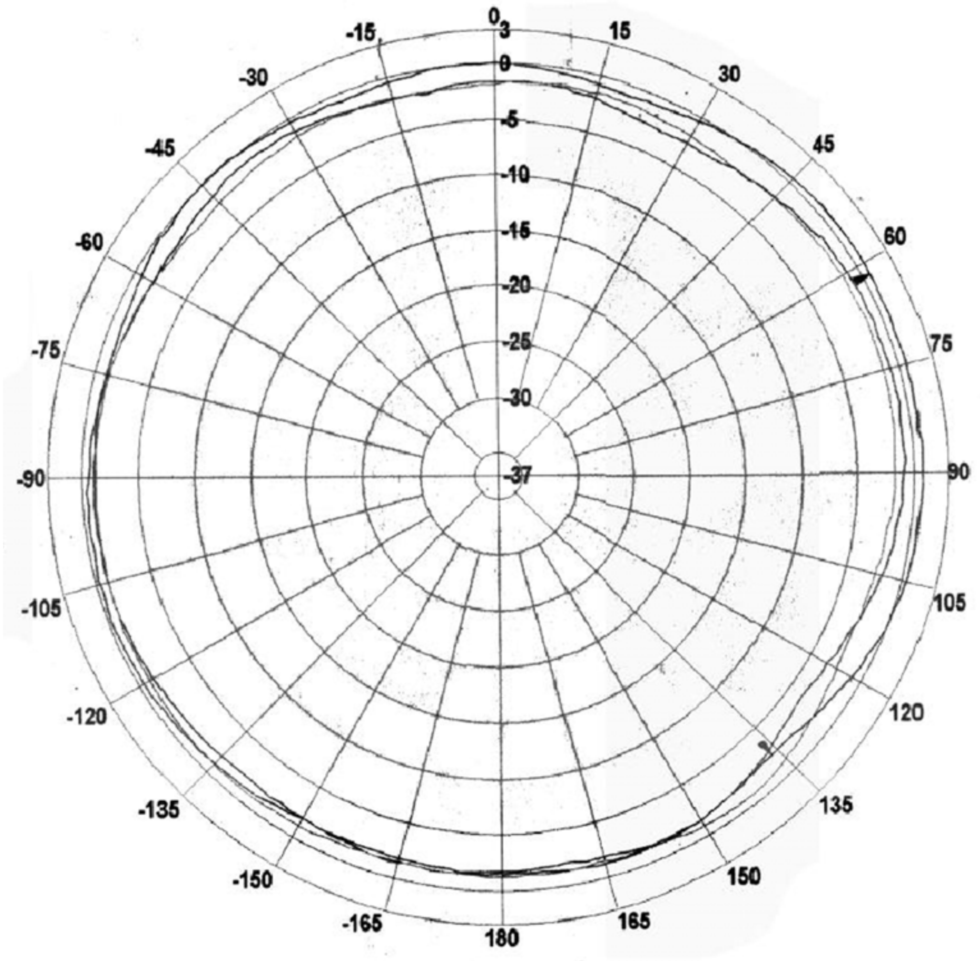

Figure 24: Azimuth Diagram for Antenna model 17010.11

Beam Peak Values

Frequency	[dB]	at [deg]
2.40 GHz	0.85	61.97
2,45 GHz	-0.38	111.94
2,50 GHz	-0.69	143.92

Null depth values

Frequency	[dB]	at [deg]
2.40 GHz	-2.26	135.92
2,45 GHz	-3.57	125.93
2,50 GHz	-2.59	113.94