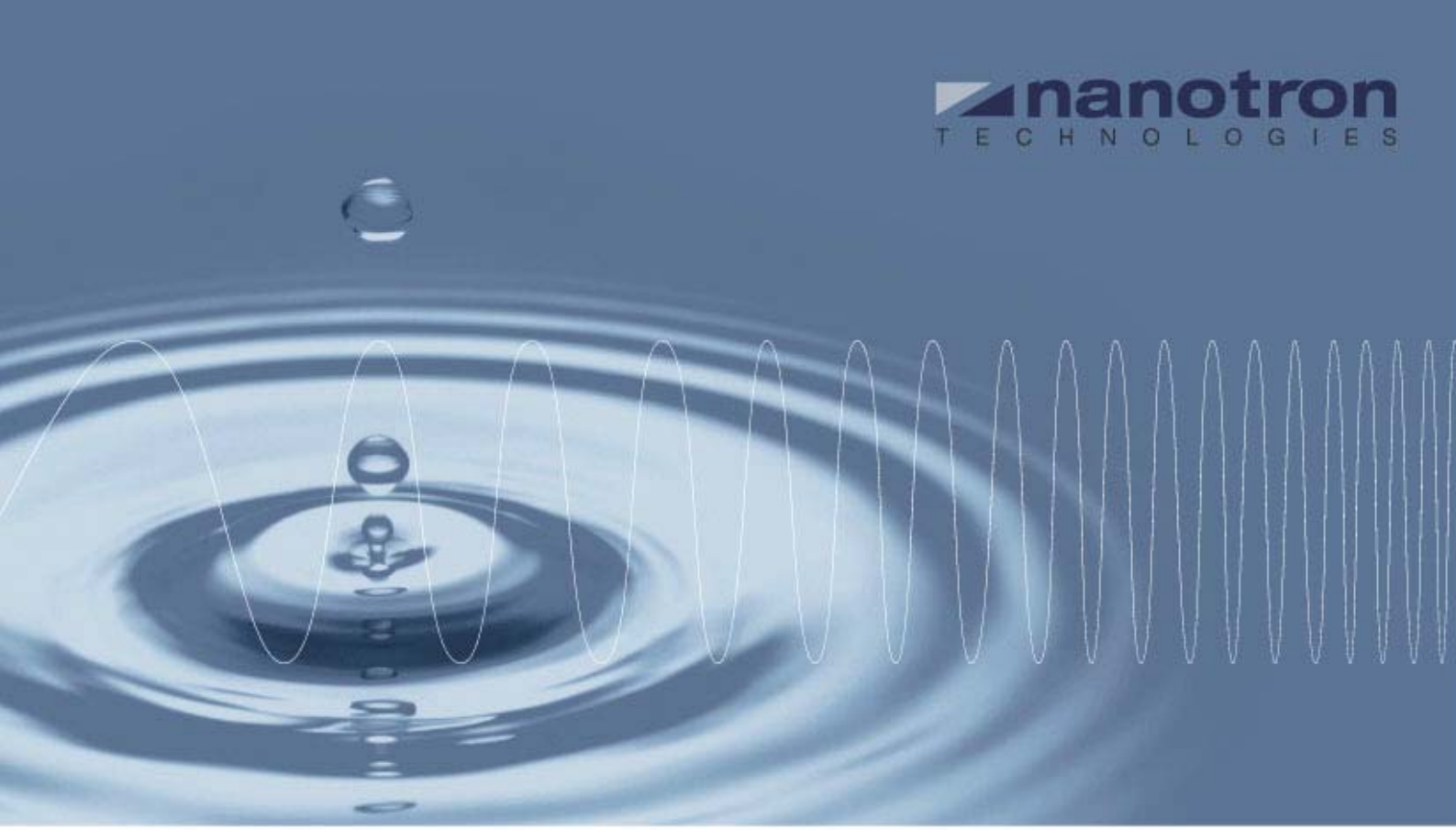

nanoLOC AVR Module

Technical Description

Version 1.00

NA-07-0195-0435-1.0

Chirp it.

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Life Support Policy

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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 15 cm (6 inches) 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.

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

Table of Contents

List of Figures

1 Overview

This smart *nanoLOC AVR Module* is only 35 mm by 14 mm and less than 3 mm thick. Yet it integrates all the required components for a complete RF module based on Nanotron's innovative *nanoLOC TRX Transceiver*. As well as the *nanoLOC* chip, this module includes the *Atmel AVR ATmega644V* microcontroller, a band pass filter, a balun, and an integrated 2.4 GHz chip antenna.

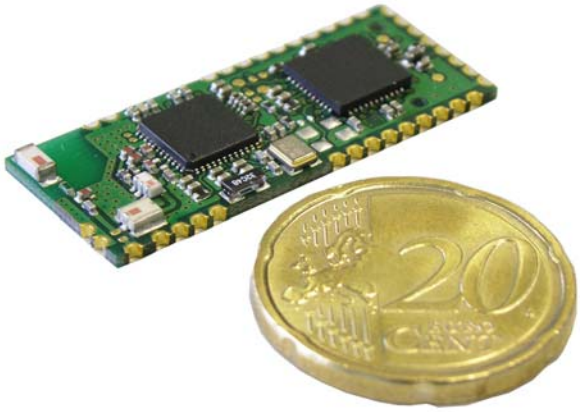

Figure 1: nanoLOC AVR Module

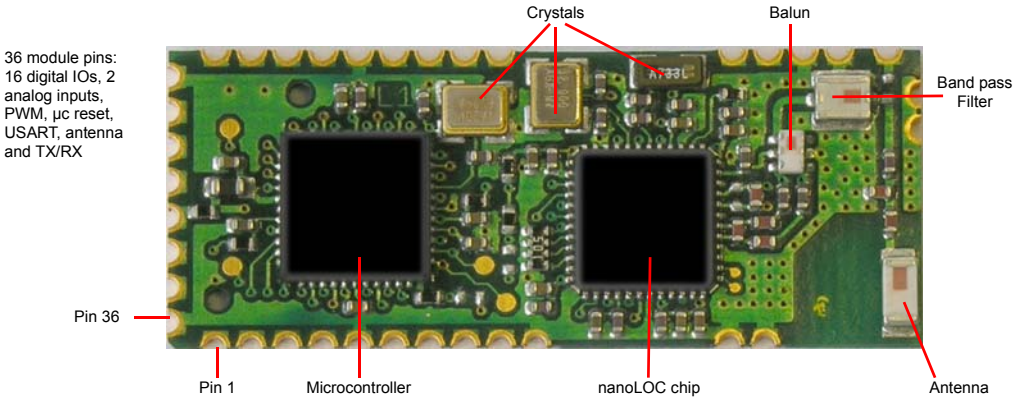

Figure 2: nanoLOC AVR Module - components side

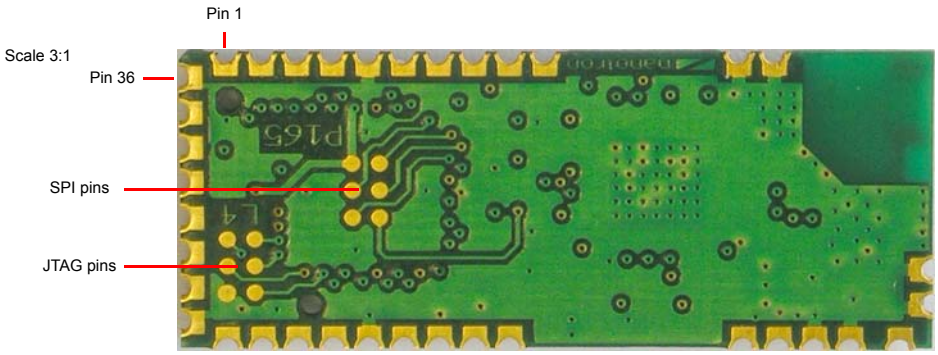

Figure 3: nanoLOC AVR Module - pad side

Certification

The *nanoLOC AVR Module* has been certified for use in Europe (R&TTE) and Japan (ARIB-T66). Certification is pending for the US (FCC).

Key Components

Table 1: Key components

Component	Description
nanoLOC TRX Transceiver	*nanoLOC* supports a freely adjustable center frequency with 3 non-overlapping frequency channels within the 2.4 GHz ISM band. This provides support for multiple physically independent networks and improved coexistence performance with existing 2.4 GHz wireless technologies. Data rates are selectable from 2 Mbps to 125 kbps. Due to the chip's unique chirp pulse, adjustment of the antenna is not critical. This significantly simplifies the system's installation and maintenance ("pick and place"). A sophisticated MAC controller with CSMA/CA and TDMA support is included, as is Forward Error Correction (FEC) and 128 bit hardware encryption. To minimize software and microcontroller requirements, nanoLOC also provides scrambling, automatic address matching, and packet retransmission. Integrated into the *nanoLOC TRX Transceiver* is the DDDL, a Digital Dispersive Delay Line which is responsible for distinguishing between two possible incoming signals that are generated by another nanoLOC chip. This received signal is either an Upchirp, a Downchirp, or a folded pulse (an Upchirp and a Downchirp at the same time). All of these signals have the same center frequency and the same bandwidth. The difference between an Upchirp and a Downchirp occurs only in the phase information of the complex spectrum. This phase information is enough for the DDDL 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 DDDL acts like a matched filter for one of the possible transmitted pulses. For more details see *nanoLOC TRX Transceiver (NA5TR1) Datasheet* available from Nanotron.
Atmel AVR ATmega644V microcontroller	This is a low power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture with 64 Kb Flash, 4 Kb SRAM, and 2 Kb EEPROM. This microcontroller drives the *nanoLOC* chip via the SPI interface and operates between 1.8 V and 5.5 V. For more details, refer to the *Atmel ATmega644V Datasheet* available from *Atmel*.
Matching circuits (Balun)	At the RF interface of the *nanoLOC* chip, a differential impedance of 150 Ω exists which is matched to the asymmetrical 50 Ω impedance of the antenna port by a 150 / 50 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.
Integrated 2.4 GHz chip antenna	As well as this integrated antenna, an external 2.4 GHz antenna can also be connected to the module.
ISM band pass filter	For an improved robustness against out of band inferences, an ISM band pass filter is connected at the antenna port.
32.768 kHz, 16 MHz, and 32 MHz quartz crystals	The 32.768 kHz Quartz is used for the Real Time Clock oscillator. The 16 MHz Quartz is used by the ATmega microcontroller, while the 32 MHz Quartz works with the internal oscillator circuitry of the *nanoLOC* chip.
Connectors	The *nanoLOC AVR Module* is programmable over JTAG or SPI interfaces. 36 peripheral module pins in total are provided, with 16 programmable digital IOs and 2 analog inputs. The module also provides a pulse-width modulation (PWM) output, a microcontroller reset input, a Universal Synchronous RX/TX (USART) input/output, and a TX/RX signal that enables an external PA.

2 Absolute Maximum Ratings

Table 2: Absolute maximum rating

Parameter	Value	Unit
Min. operating temperature	-40	°C
Max. operating temperature	+85	°C
Max. supply voltage (VCC)	2.7	V
Max. DC current per I/O pin	40	mA
Voltage on /RESET with respect to GND	-0.5 to 13.0	V

Note: It is critical that the ratings provided in *Absolute Maximum Ratings* be carefully observed. Stress exceeding one or more of these limiting values may cause permanent damage to the device.

3 Electrical Characteristics

3.1 General / DC Parameters

Table 3: General / DC-Parameters

Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
T_{op}	Operating temperature	–	-40	–	+85	°C
Vcc	Supply voltage	f_{cpu} does not exceed recommended value at given supply voltage[1]	2.3	–	2.7	V
Icc	Supply current	no external connections besides power supply	–	–	100	mA
V_{IL}	Input low voltage	VCC = 2.3V - 2.4V VCC = 2.4V - 2.7V	-0.5 -0.5	–	0.2Vcc 0.3Vcc	V
V_{IH}	Input high voltage	VCC = 2.3V - 2.4V VCC = 2.4V - 2.7V	0.7Vcc 0.6Vcc	–	Vcc+0.5 Vcc+0.5	V

1. *The ATmega644V microcontroller specifies a maximum CPU clock frequency against supply for safe voltage operation. For more information, see Atmel ATmega644V Microcontroller Datasheet (2593L–AVR–02/07) on page 318.*

3.2 RF Parameters

Table 4: RF parameters

Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
Z_{ant}	Line impedance of antenna signal ANT	–	–	50	–	Ω
R_{data}	Data rate	–	125	–	2000	kb/s
P_{sens}	Receiver sensitivity	–	–	–	-97[1]	dBm
P_{tx}	Transmit power	–	-33	–	0	dBm

1. *The displayed value is the minimum receive signal power required for BER = 10e-3, which is equivalent to the maximum receiver sensitivity.*

4 Module Layout

4.1 Measures

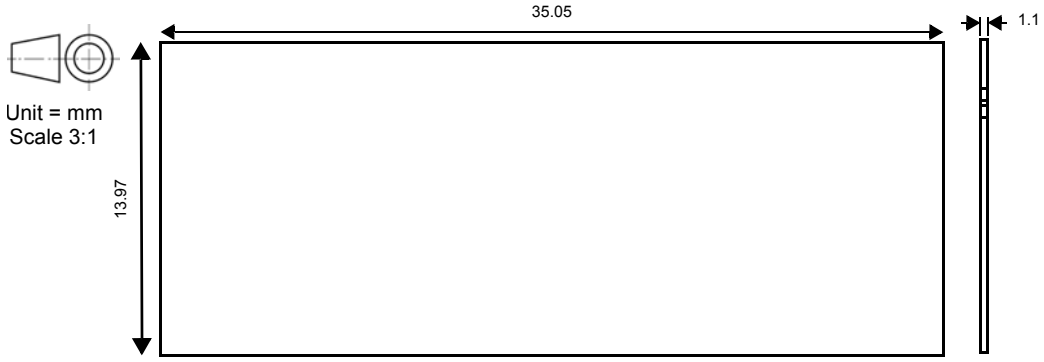

Figure 4: nanoLOC AVR Module - measures

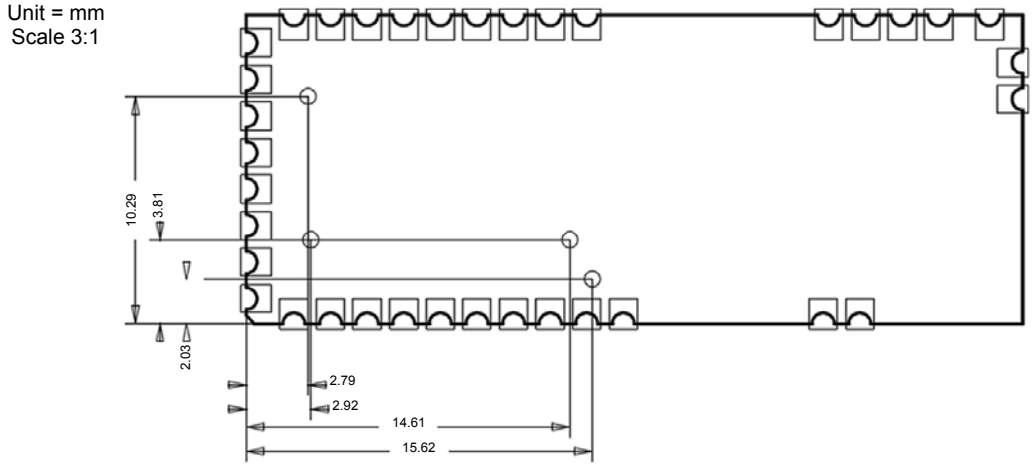

Figure 5: nanoLOC AVR Module – measures SPI pads (top side)

4.2 Pin Layout

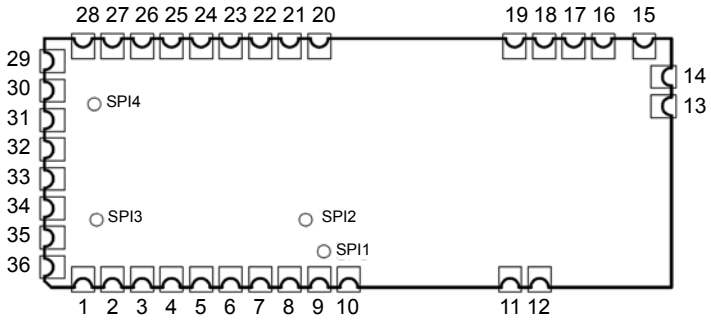

Figure 6: Pin layout - top view

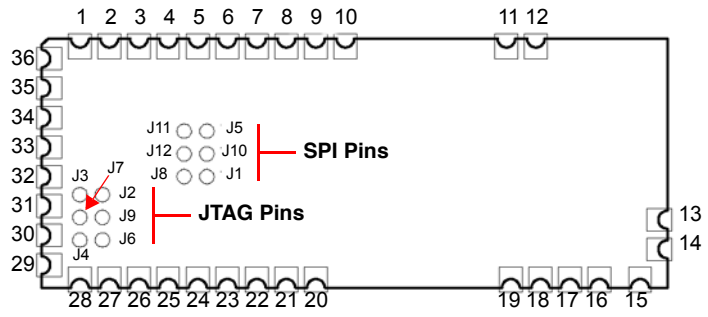

Figure 7: Pin layout - bottom view (inverted)

4.3 Pin Description

Table 5: Pin description

Pin	Signal	Description	Direction
1	DIGIO1	Digital general purpose microcontroller port	input/output
2	DIGIO2	Digital general purpose microcontroller port	input/output
3	DIGIO3	Digital general purpose microcontroller port	input/output
4	DIGIO4	Digital general purpose microcontroller port	input/output
5	GND	Ground connection	–
6	DIGIO5	Digital general purpose microcontroller port	input/output
7	DIGIO6	Digital general purpose microcontroller port	input/output
8	DIGIO7	Digital general purpose microcontroller port	input/output
9	DIGIO8	Digital general purpose microcontroller port	input/output
10	GND	Ground connection	–
11	GND	Ground connection	–
12	GND	Ground connection	–
13	GND	Ground connection	–
14	GND	Ground connection	–
15	ANT	Antenna signal (output)	input/output
16	GND	Ground connection	–
17	GND	Ground connection	–
18	TX_RX	Control signal for external PA	output
19	/RESET	Reset-Signal for microcontroller	input
20	DIGIO9	Digital general purpose microcontroller port	input/output
21	DIGIO10	Digital general purpose microcontroller port	input/output
22	DIGIO11	Digital general purpose microcontroller port	input/output
23	DIGIO12	Digital general purpose microcontroller port	input/output
24	GND	Ground connection	input/output
25	DIGIO13	Digital general purpose microcontroller port	input/output
26	DIGIO14	Digital general purpose microcontroller port	input/output
27	DIGIO15	Digital general purpose microcontroller port	input/output
28	DIGIO16	Digital general purpose microcontroller port	input/output
29	GND	Ground connection	–
30	AIN1	10-bit ADC (Channel 0)	input
31	AIN2	10-bit ADC (Channel 1)	input

Table 5: Pin description (Continued)

Pin	Signal	Description	Direction
32	PWMOUT	PWM signal	output
33	VCC	Positive supply voltage	input
34	RXD	UART receive signal	input
35	TXD	UART transmit signal	output
36	GND	Ground connection	–

4.4 Pins for SPI Programming

Table 6: Pins for SPI programming

Pin	Signal	Description	Direction
J12	SPISSN	SPI Slave Selected; Active Low	Digital Input
J8	SPICLK	SPI Clock	Digital Input
J5	SPIRXD	SPI Receive Data (MOSI)	Digital Input
J10	SPITXD	SPI Transmit Data (MISO)	Digital Output
J1	PONRESET	Power on reset signal	Digital Input
J11	VCCAT	Microcontroller supply voltage Note: pin 33 (VCC) can also be used.	–
J4	GND	Ground connection	–

4.5 Pins for JTAG Programming

Table 7: Pins for JTAG programming

Pin	Signal	Description	Direction
J3	/RESET	Microcontroller reset	Digital Input
J7	TMS	Test Mode Select Input	Digital Input
J4	GND	Ground connection	–
J2	TDI	Test Data Input	Digital Input
J9	TDO	Test Data Output	Digital Output
J6	TCK	Test Clock	Digital Output
J11	VCCAT	Microcontroller supply voltage	–

5 Soldering Information

5.1 Recommended Temperature Profile for Lead Free Reflow Soldering

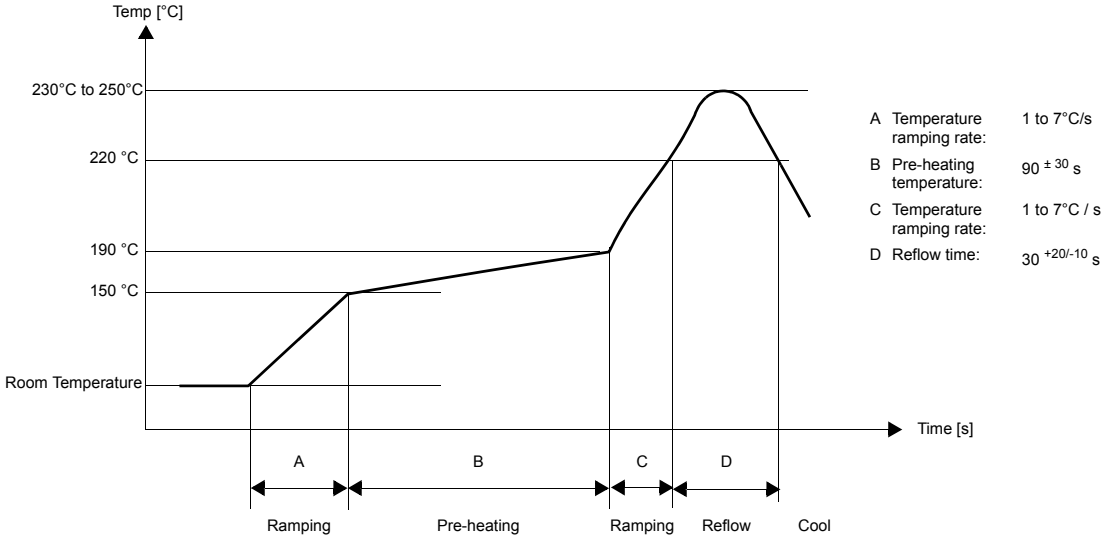

Figure 8: Recommended soldering temperature profile

5.2 Recommended Foot Pattern

The same dimensions for the solder paste screen are recommended, depending on the solder screen thickness.

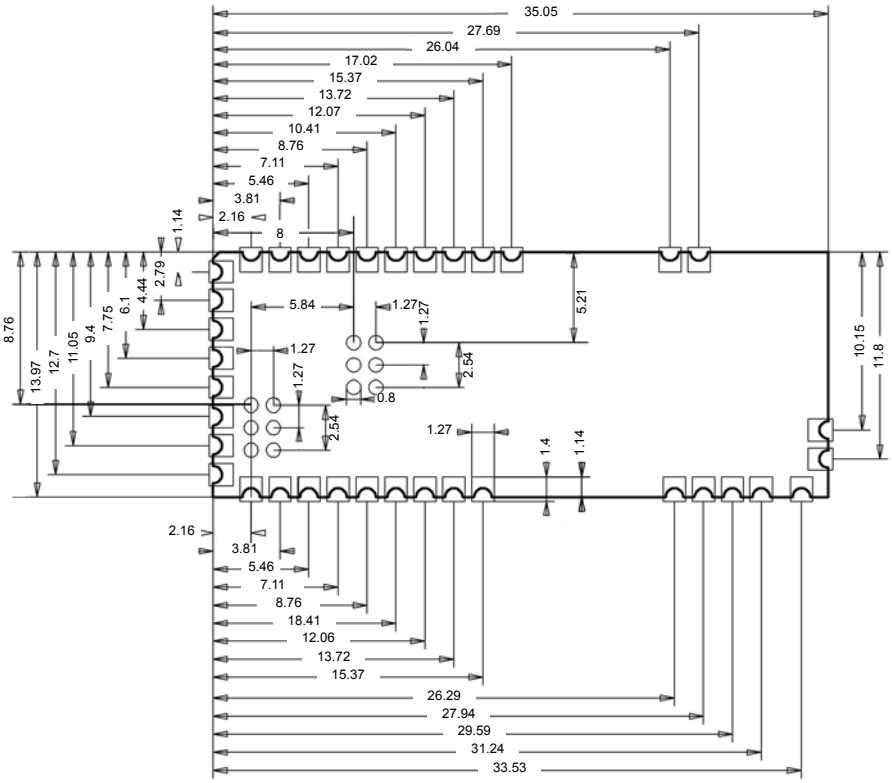

Figure 9: nanoLOC AVR Module – recommended foot pattern

6 Schematics

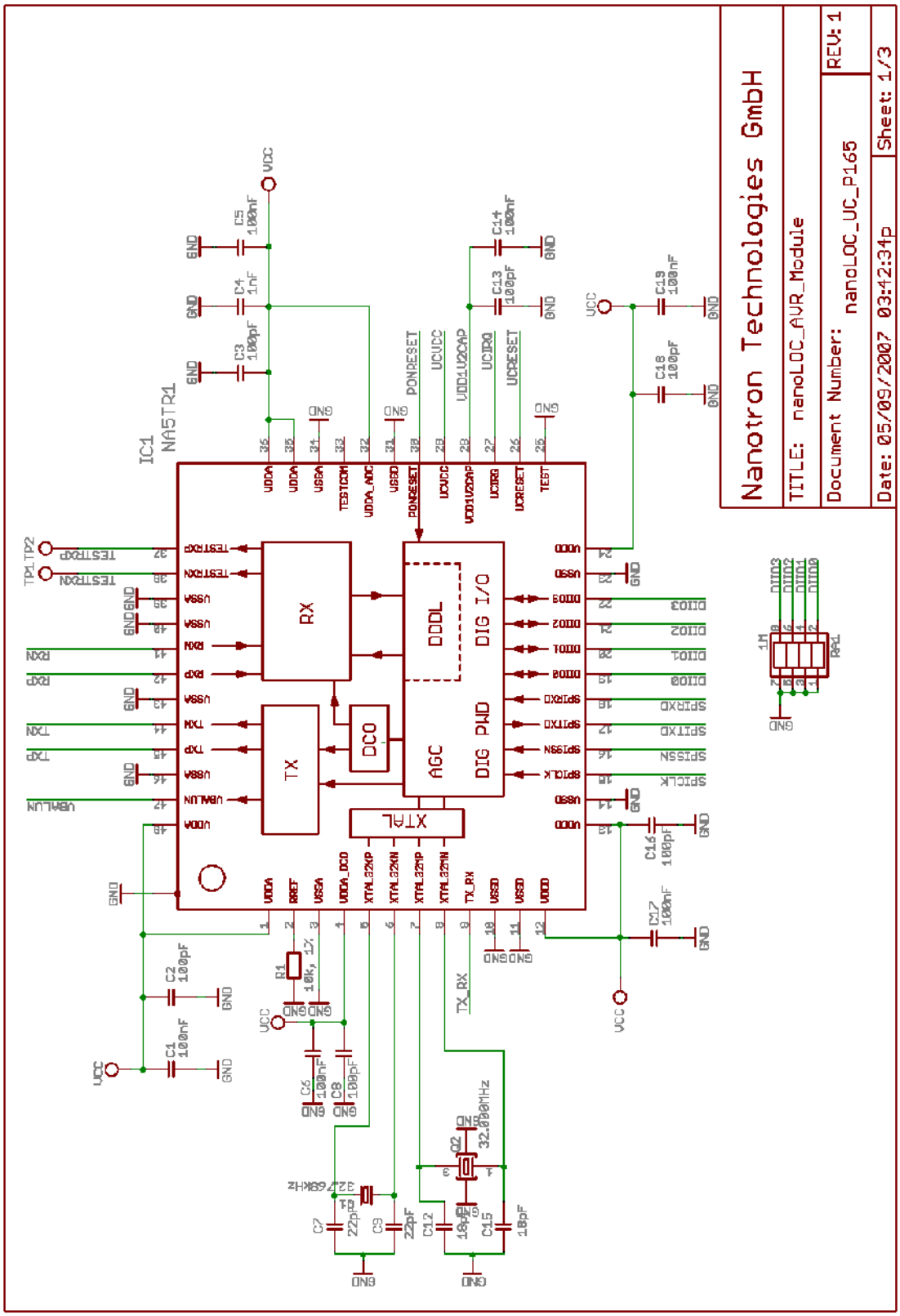

Figure 10: nanoLOC AVR Module – schematics 1 of 3

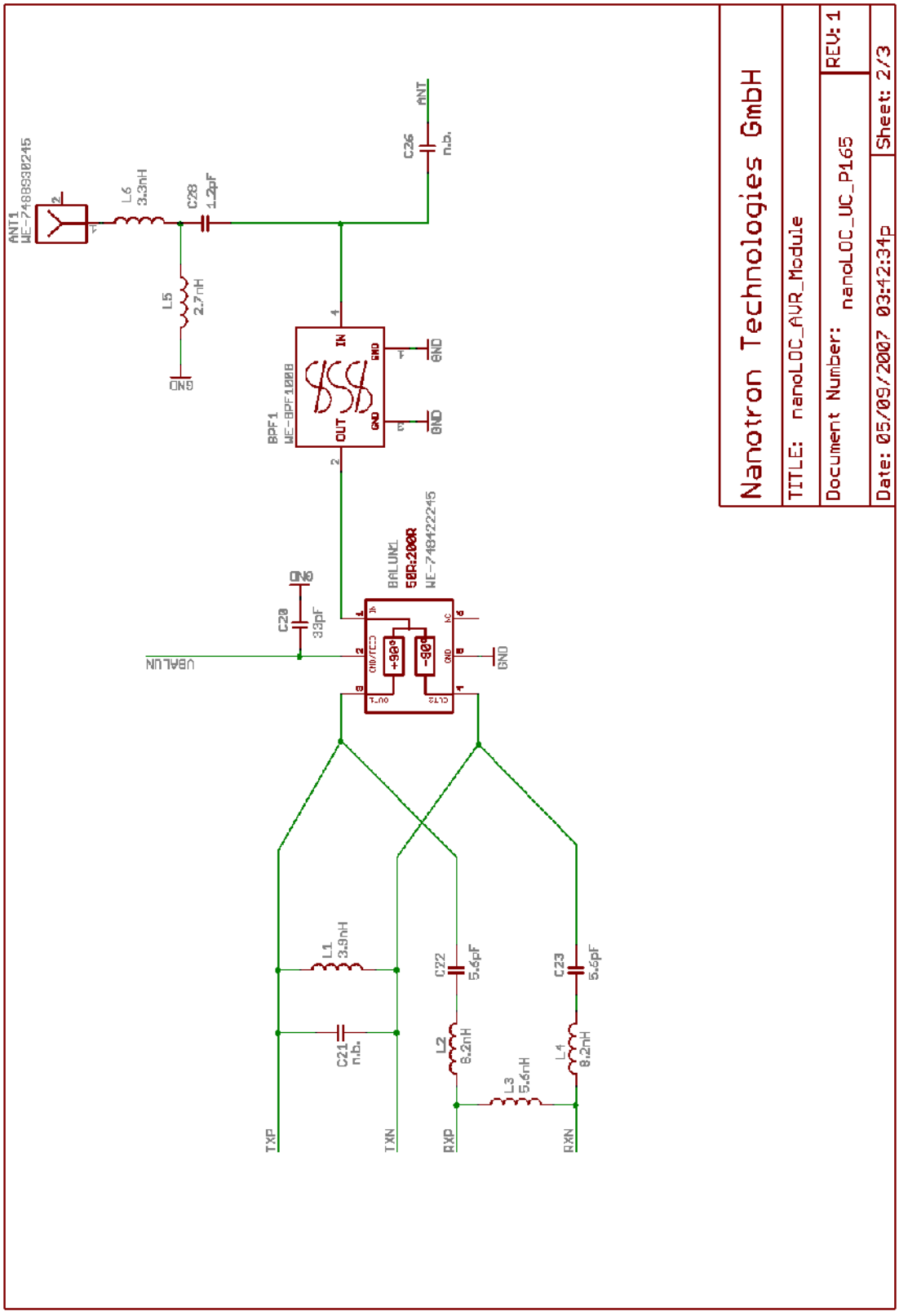

Figure 11: nanoLOC AVR Module – schematics 2 of 3

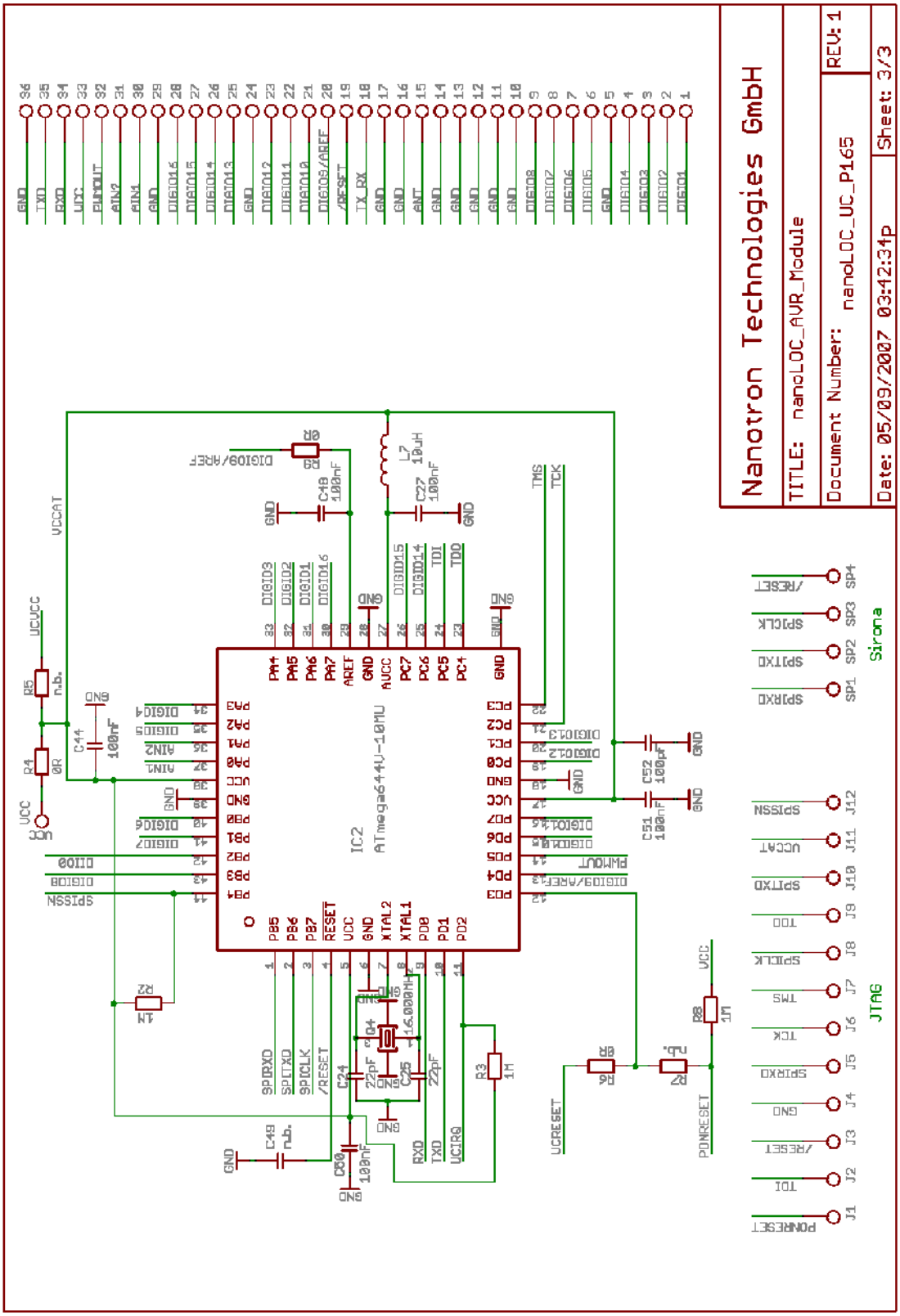

Figure 12: nanoLOC AVR Module – schematics 3 of 3

7 PCB Layout

Scale 3:1

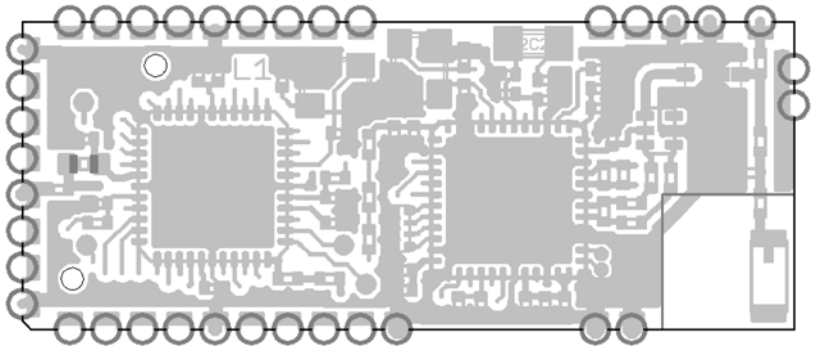

Figure 13: nanoLOC AVR Module – top side

Scale 3:1

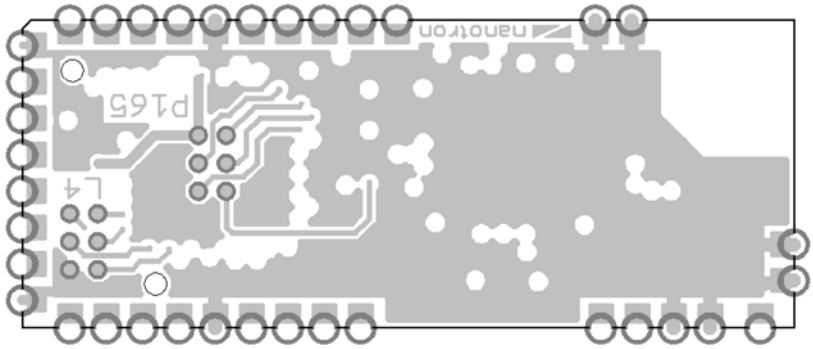

Figure 14: nanoLOC AVR Module – bottom side (inverted)

Scale 3:1

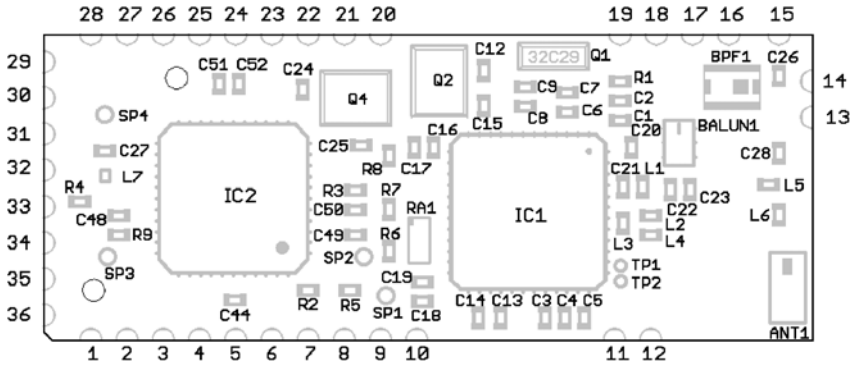

Figure 15: nanoLOC AVR Module – components top side

8 Bill of Materials

Table 8: nanoLOC AVR Module – bill of materials

Part					Manufacturer	
Description	Label	Value	Qty	Package	Company	Product Number
Antenna	ANT1	WE-7488930245	1	WE-ANT30245	Würth-Elektronik	WE-7488930245
Balun	BALUN1	WE-748422245	1	SMD0805	Würth-Elektronik	WE-748422245
Bandpass filter	BPF1	WE-BPF1008	1	SMD1008	Würth-Elektronik	WE-748351124
Capacitors	C28	1.2pF	1	SMD0402	Kemet	C0402C129C5GAC
	C1, C5, C6, C14, C17, C19, C27, C44, C48, C49, C50, C51	100nF	12	SMD0402	Phycomp	2238 787 19849
	C2, C3, C8, C13, C16, C18, C52	100pF	7	SMD0402	Phycomp	2238 587 15609
	C12, C15	18pF	2	SMD0402	Kemet	C0402C180D5GAC
	C4	1nF	1	SMD0402	Phycomp	2238 587 15623
	C7, C9, C24, C25	22pF	4	SMD0402	Phycomp	2238 869 15229
	C20	33pF	1	SMD0402	Phycomp	2238 869 15339
	C22, C23	5.6pF	2	SMD0402	Kemet	C0402C569C5GAC
	C21, C26	n.b.	3	SMD0402		
ICs	IC2	ATmega644V-10MU	1	44M1 Micro Lead Frame Package	Atmel	ATmega644V-10MU
	IC1	NA5TR1	1	NA5TR1_THERM	ST	NA5TR1
Inductors	L5	2.7nH	1	SMD0402	Würth-Elektronik	WE-744784027
	L6	3.3nH	1	SMD0402	Würth-Elektronik	WE-744784033
	L1	3.9nH	1	SMD0402	Würth-Elektronik	WE-744784039
	L3	5.6nH	1	SMD0402	Würth-Elektronik	WE-744784056
	L2, L4	8.2nH	2	SMD0402	Würth-Elektronik	WE-744784082

Table 8: nanoLOC AVR Module – bill of materials

Part					Manufacturer	
Description	Label	Value	Qty	Package	Company	Product Number
	L7	2200nH	1	SMD0603	Murata	LQM18NN2R2K00D
PCB		P165	1	–	Würth-Elektronik	WE-7488930245
Quartz crystals	Q4	16.000MHz	1	SMD03025/4 16.000MHz 30/30/-40+85/12pF	Petermann-Technik	–
	Q2	32.000MHz	1	SMD03025/4 32.000MHz 10/20/-40+85/ 12pF/40R	Petermann-Technik	–
	Q1	32.768kHz	1	QUARTZ_31SMX-31M327(H)	SMI	31M327(H)-C
Resistor	R1	10k, 1%	1	SMD0402	Phycomp	232270671003
Resistor	R5,R6,R9	n.b.	3	SMD0402	Tyco Electron-ics	
Resistor	R4,R7	0Ohm	2	SMD0402	Tyco Electron-ics	CRG0402ZR
Resistor	R2,R3,R8	1M	3	SMD0402	Tyco Electron-ics	CRG0402J1M0-10
Resistor array	RA1	1M	1	4R_ARRAY	Phycomp	235003311105

9 Ordering Information

To order the product described in this document, use the following information.

Table 1: nanoLOC AVR Module ordering Information

Part Description	Part Number	Additional Information
nanoLOC AVR Module	MN0501AVR	nanoLOC Development Kit also available.

Revision History

Date	Version	Description/Changes
1.0	2008-02-12	Initial version.

About Nanotron Technologies GmbH

Nanotron Technologies GmbH develops world-class wireless products for demanding applications based on its patented Chirp transmission system - an innovation that guarantees high robustness, optimal use of the available bandwidth, and low energy consumption. Since the beginning of 2005, Nanotron's Chirp technology has been a part of the IEEE 802.15.4a draft standard for wireless PANs which require extremely robust communication and low power consumption.

ICs and RF modules include the nanoNET TRX, the nanoLOC TRX, and ready-to-use or custom wireless solutions. These include, but are not limited to, industrial monitoring and control applications, medical applications (Active RFID), security applications, and Real Time Location Systems (RTLS). nanoNET is certified in Europe, United States, and Japan and supplied to customers worldwide.

Headquartered in Berlin, Germany, Nanotron Technologies GmbH was founded in 1991 and is an active member of IEEE and the ZigBee alliance.

Further Information

For more information about this product and other products from Nanotron Technologies, contact a sales representative at the following address:

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Email: sales@nanotron.com
Internet: www.nanotron.com