

radino40 DW3000

Datasheet — Ultra-Wideband + Bluetooth® LE module with production-ready FiRa™ software



The In-Circuit **radino40 DW3000** combines Nordic Semiconductor's **nRF52840** microprocessor and Qorvo's **DW3000** transceiver in a small form-factor, **EMC-compliant** module — including on-board PA / LNA for extended range.

The radino40 DW3000 integrates UWB and Bluetooth® functionality and can be used in location tracking systems with a high precision of 10 cm. The module is fully **CE certified** — and ships with a complete, field-proven **UWB software platform**: FiRa™-compliant firmware, direct ranging with iPhone and Android smartphones, and a full SDK.

10 cm

ranging
precision

CH

5+9

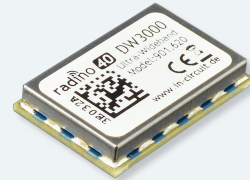
6.5 / 8 GHz
UWB

6.8 Mbps

UWB data
rate

14.9×22.9 mm

module size



radino40 DW3000 · Model 901.620 · fully shielded, EMC-compliant

Features

- ▶ UWB transceiver **DW3000** by Qorvo (Decawave)
 - Direct ranging with Apple (U1/U2) and Android UWB smartphones
 - Supports UWB channel 5 (6.5 GHz) and 9 (8 GHz)
 - Fully aligned with the FiRa™ PHY, MAC, and certification development
 - Data rates of 110 kbps, 850 kbps, 6.8 Mbps
- ▶ **nRF52840** by Nordic Semiconductor
 - 32-bit ARM® Cortex®-M4 CPU with FPU, 64 MHz
 - 1 Mbyte flash, 256 kbyte RAM
 - Dynamic multiprotocol transceiver: Bluetooth 5 / BLE, IEEE 802.15.4/Thread, ANT/ANT+, proprietary 2.4 GHz
 - 4×4 channel PWM unit with EasyDMA
 - 12-bit 200 ksps ADC
 - 5× 32-bit timer with counter mode
 - USB 2.0, I²C, QSPI, SPI, UART, NFC-A
 - Quadrature decoder (QDEC), 3× RTC
- ▶ On-board **PA and LNA**
- ▶ **37 GPIOs**

Software Included

- ▶ **FiRa™ firmware** (DS-TWR, static STS) — production-ready
- ▶ **iPhone ranging** via Apple Nearby Interaction
- ▶ **Android ranging** via documented BLE session-setup protocol
- ▶ 2D positioning with EKF/Kalman filtering, reference Android app
- ▶ USB bootloader for field updates, full **SDK** (GCC/Makefile)

Details on page 2.

Applications

- ▶ Precision real-time location systems (RTLS) using two-way ranging or TDoA schemes in a variety of markets:
 - Healthcare
 - Industrial — collision avoidance, proximity warning
 - Consumer — access, keyless entry, find-my
 - Social distancing
 - Other
- ▶ Location-aware wireless sensor networks
- ▶ Smartphone-interactive products

More Information

www.in-circuit.de

FiRa™ DS-TWR

Apple NI

Android UWB

BLE 5

NFC-A

USB DFU

CE / RED

RoHS

Hardware. Software. Wireless.

Skip years of RF and firmware development: the radino40 DW3000 platform is developed, certified and maintained in-house in Germany. You integrate a documented BLE/UWB interface into your mobile app — we take care of the embedded side, from evaluation kit to customized OEM/ODM series product.

Smartphone Ranging Out of the Box

1

Flash & power up

Anchors run the FiRa firmware — no configuration, fully interchangeable.

2

BLE session setup

The phone discovers anchors over BLE and negotiates all FiRa session parameters.

3

UWB ranging

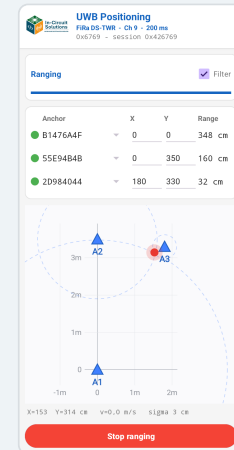
Direct secure DS-TWR between phone and anchors — distance at 10 cm precision.

4

Position

With three anchors: 2D position with EKF filtering, live in the reference app.

iPhone: Apple Nearby Interaction (U1/U2 chip; direction data where the phone provides it) ·
Android: FiRa-capable devices, Android 12+ (verified incl. current Samsung Galaxy models).



Reference Android app: live FiRa DS-TWR ranging to three anchors, EKF-filtered 2D position ($\sigma = 3$ cm)

Software Deliverables

FiRa™ Firmware (production)

- ▶ DS-TWR ranging, unicast & one-to-many, static STS
- ▶ Anchor / tag / phone-interop operating modes
- ▶ Kalman-filtered positioning, LED indication, serial CLI

Mobile Integration

- ▶ Apple Nearby Interaction support (Qorvo NI GATT service)
- ▶ Documented BLE protocol for Android session setup
- ▶ Reference Android app with source available

SDK & Tools

- ▶ radino40-DW3000 SDK: GCC toolchain, Makefile projects
- ▶ Demo projects: FiRa positioning, PingPong (TWR), throughput
- ▶ Web-based provisioning and evaluation tools

Lifecycle & OEM/ODM

- ▶ USB DFU bootloader — field updates without a debugger
- ▶ Firmware maintenance and feature development by In-Circuit
- ▶ Custom hardware: form factor, battery, housing, certification

Evaluation & Demo Hardware

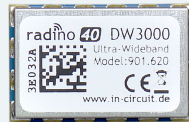
The quickest way to evaluate: the **radino40 DW3000 Spider board** — the module on a development carrier with USB and accessible pin headers. The smartphone ranging setup shown above runs on three Spider boards as anchors, out of the box. Available from In-Circuit on request.

Why In-Circuit

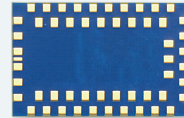
- ▶ Hardware, RF and embedded software from one team — made in Dresden, Germany
- ▶ Proven in industrial UWB safety systems (ICPROX collision avoidance)
- ▶ From evaluation kit to certified series product, incl. long-term firmware maintenance

Overview

The In-Circuit radino40 DW3000 combines a **nRF52840** microprocessor and the **DW3000** RF transceiver. Despite its small form factor, the radino40 DW3000 offers great connectivity: many GPIOs and interfaces (USB 2.0, I²C, QSPI, SPI, UART, NFC-A) of the nRF52840 can be connected to external circuitry.

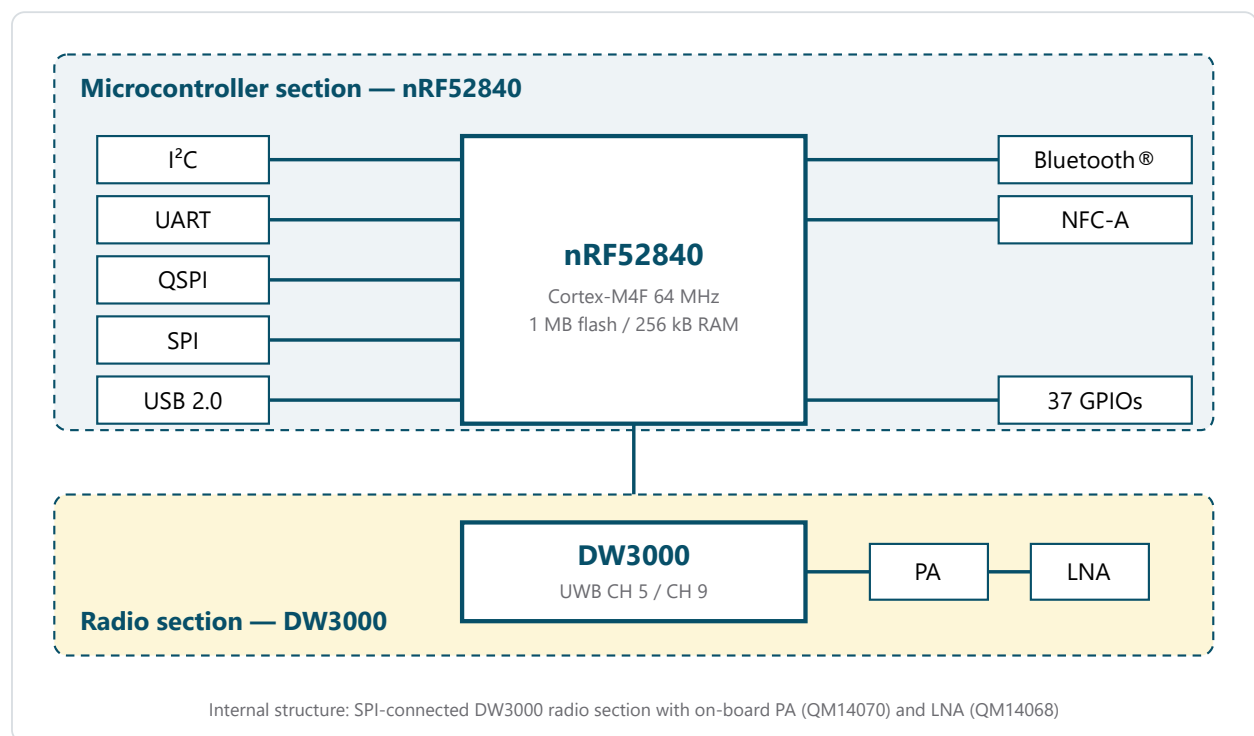


Top view



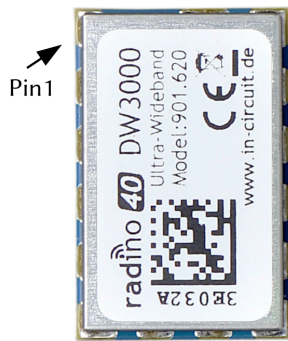
Bottom view

Block Diagram

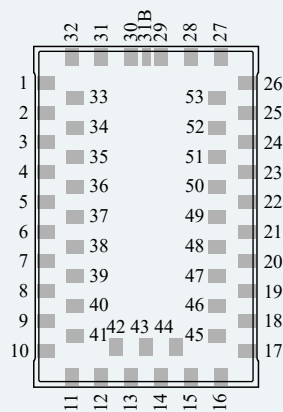


Pinout

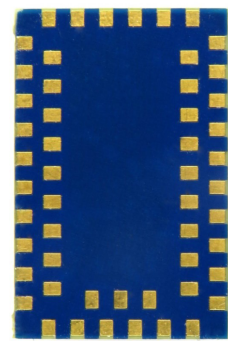
Pin 1 is located at the top-left corner (top view) and marked on the module shield.



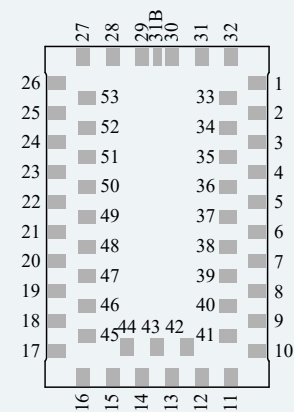
Top View



Top view — pins seen from top side



Bottom View



Bottom view — pins seen from bottom side

Pin List

Pin	Name	nRF52840 aQFN73 Pin/Name	DW3000 Port/Name	Description / Function
1	P0.17	AD12/P0.17	-	GPIO
2	P0.15	AD10/P0.15	-	GPIO
3	P0.14	AC9/P0.14	-	GPIO
4	P0.12	U1/P0.12/TRACEDATA1	-	GPIO; Trace buffer TRACEDATA[1]
5	P0.07	M2/P0.07/TRACECLK	-	GPIO; Trace buffer clock
6	P0.03	B13/P0.03/AIN1	-	GPIO (low-freq.); Analog input
7	P0.05	K2/P0.05/AIN3	-	GPIO; Analog input
8	P0.29	A10/P0.29/AIN5	-	GPIO (low-freq.); Analog input
9	P0.31	A8/P0.31/AIN7	-	GPIO (low-freq.); Analog input
10	P0.01	F2/P0.01/XL2	-	GPIO; Analog input; Connection for 32.768 kHz crystal
11	Reset	AC13/P0.18/RESET	-	GPIO; nRF52840 reset
12	GND	B7/VSS	-	Ground
13	P0.06	L1/P0.06	-	GPIO; (RXD)
14	P0.08	N1/P0.08	-	GPIO; (TXD)
15	VDD	VDD	VDD	Power supply
16	P0.13/BSL	AD8/P0.13	-	GPIO (internal 1k pull-down)
17	USB-	AD4/D-	-	USB-D-
18	USB+	AD6/D+	-	USB-D+
19	P0.09	L24/P0.09/NFC1	-	GPIO (low-freq.); NFC antenna input
20	P0.10	J24/P0.10/NFC2	-	GPIO (low-freq.); NFC antenna input
21	BT_ANT	→H23/ANT	-	Bluetooth antenna connection
22	P1.07	P23/P1.07	-	GPIO (low-freq.)
23	P1.05	T23/P1.05	-	GPIO (low-freq.)
24	P1.03	V23/P1.03	-	GPIO (low-freq.)
25	P1.01	Y23/P1.01	-	GPIO (low-freq.)
26	P1.00	AD22/P1.00/TRACEDATA0	-	GPIO (low-freq.); Trace buffer TRACEDATA[0], SWO
27	DEC_PWR			Needs at least 47 µF ceramic to GND

Pin	Name	nRF52840 aQFN73 Pin/Name	DW3000 Port/Name	Description / Function
28	GND	VSS	VSS	Ground
29	DEC_RF			Needs at least 47 µF ceramic to GND
30	GND	VSS	VSS	Ground
31	DW_ANT	-	18/RF1	Antenna pin DW3000
32	GND	VSS	VSS	Ground
33	P0.16	AC11/P0.16	-	GPIO
34	SYNC	P2/P1.08	9/SYNC/GPIO7	GPIO; DW3000 external synchronization
35	P1.14	B15/P1.14	-	GPIO
36	P0.11	T2/P0.11	-	GPIO
37	P0.02	A12/P0.02/AIN0	-	GPIO (low-freq.); Analog input
38	P0.04	J1/P0.04/AIN2	-	GPIO; Analog input
39	P0.28	B11/P0.28/AIN4	-	GPIO (low-freq.); Analog input
40	P0.30	B9/P0.30/AIN6	-	GPIO (low-freq.); Analog input
41	P0.00	D2/P0.0/XL1	-	GPIO; Analog input; Connection for 32.768 kHz crystal
42	P0.27	H2/P0.27	-	GPIO
43	P0.26	G1/P0.26	-	GPIO
44	P1.09	R1/P1.09/TRACEDATA3	-	GPIO; Trace buffer TRACEDATA[3]
45	VUSB	AD2/VBUS	-	Power supply
46	SWCLK	AA24/SWDCLK	-	Serial wire debug clock input
47	SWDIO	AC24/SWDIO	-	Debug serial data
48	GND	VSS	VSS	Ground
49	GND	VSS	VSS	Ground
50	EXTCLK	-	21/XTI/EXTCLK	DW3000 reference crystal input
51	P1.02	W24/P1.02	-	GPIO (low-freq.)
52	P1.04	U24/P1.04	-	GPIO (low-freq.)
53	P1.06	R24/P1.06	-	GPIO (low-freq.)

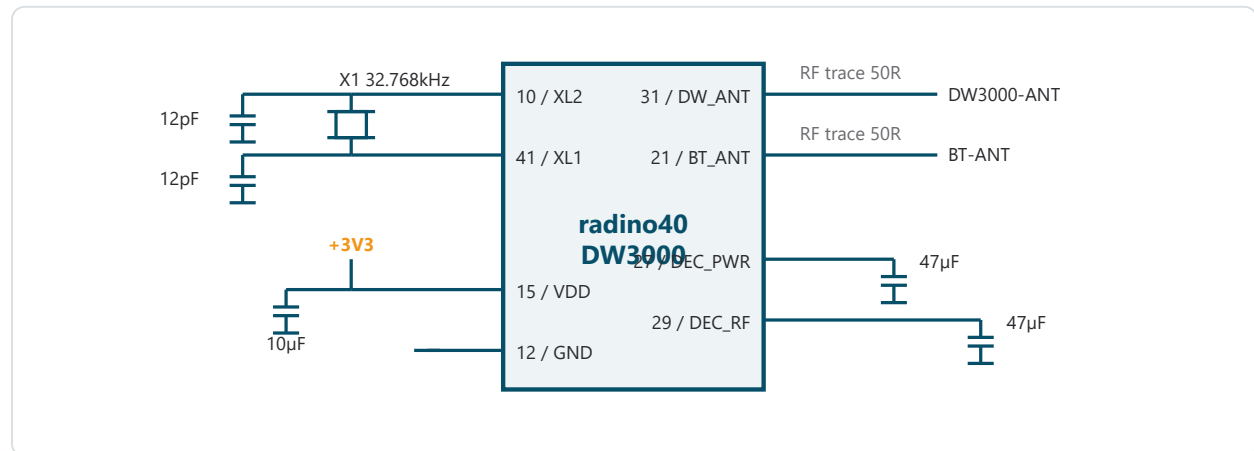
Interconnection

The nRF52840 and the DW3000 are connected internally. The interconnections are listed below.

Signal Name	nRF52840 aQFN73 Pin/Name	DW3000 Port/Name	Description / Function
RF_SS	AD16/P0.20	37/SPICS	DW3000 SPI chip select
RF_SCK	AC15/P0.19	34/SPICLK	DW3000 SPI clock
RF_MOSI	AC19/P0.23	35/SPIMOSI	DW3000 SPI data output
RF_MISO	AC17/P0.21	36/SPIMISO	DW3000 SPI data input
RF_RST	B17/P1.12	33/RST	DW3000 reset pin
SYNC	P2/P1.08	9/SYNC/GPIO7	DW3000 external synchronization
RF_IRQ	AD20/P0.24	1/IRQ/GPIOP8	DW3000 interrupt request output
RF_WAKEUP	B19/P1.11	32/WAKEUP	DW3000 wake up
RXOKLED	AC21/P0.25	3/GPIO0/RXOKLED	DW3000 GPIO; can be configured to indicate reception of a good frame
SFDLED	AD18/P0.22	4/GPIO1/SFDLED	DW3000 GPIO; can be configured to indicate SFD discovery
RXLED	A20/P1.10	6/GPIO2/RXLED	DW3000 GPIO; can be configured to indicate RX mode
TXLED	A16/P1.13	7/GPIO3/TXLED	DW3000 GPIO; can be configured to indicate TX mode
EXTPA	---	8/GPIO4/EXTPA	PA enable
EXTRXE	---	2/GPIO6/EXTRXE	LNA enable

Internal biasing (see interconnection diagram, datasheet A002): 10 M Ω on the RF_RST net, 100 k Ω on the RF_WAKEUP net.

Application Circuit

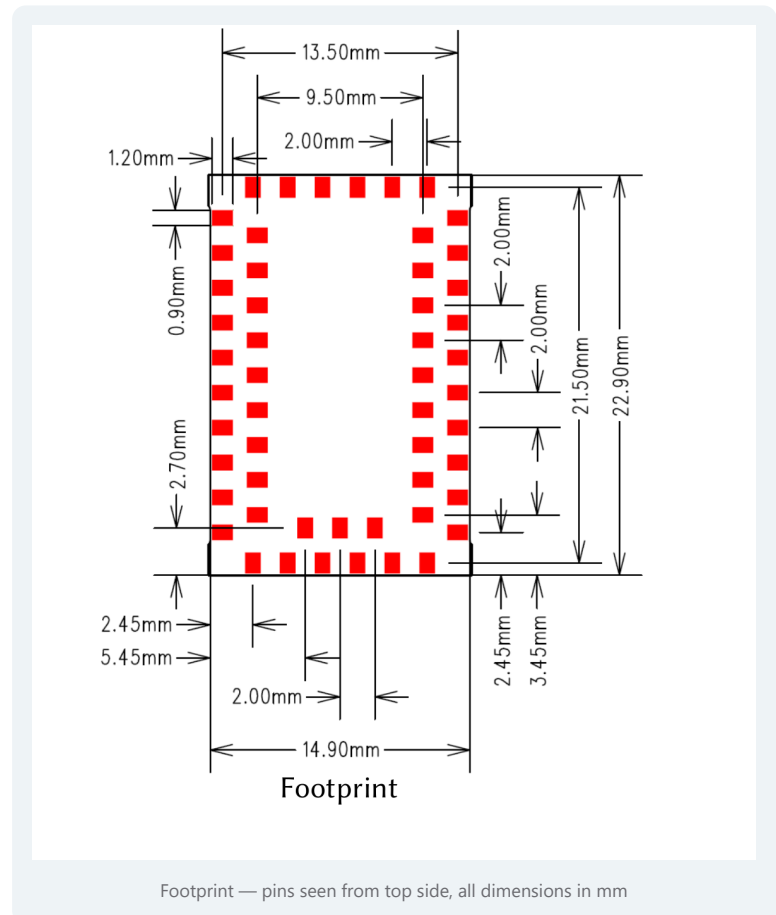


Ref	Function
X1	Crystal, for RTC functionality (32.768 kHz, 2×12 pF)
X2	Power supply, 10 µF (min.) ceramic capacitor in parallel
X3	2× 47 µF (min.) ceramic capacitor needed for operation (DEC_PWR, DEC_RF)
BT-ANT	Bluetooth antenna (50 Ω RF trace)
DW3000-ANT	DW3000 antenna (50 Ω RF trace)

The radino40 DW3000 is designed to be assembled like a standard SMT component: place it directly on your PCB with the footprint on the next page and solder it in a regular reflow process (profile see "Packaging & Processing").

■ Dimensions & Footprint

Module size **14.90 × 22.90 mm**, fully shielded. The module is assembled like a standard SMT component — solderable in a regular reflow process using the footprint below. Pin 1 is marked on the module shield.



Footprint drawings (EPS/SVG) for direct import into PCB layout tools are available from In-Circuit on request. All radino40 modules are pin-compatible and share this outline and footprint.

Absolute Maximum Ratings

Note: these are absolute maximum ratings beyond which the module can be permanently damaged. These are not maximum operating conditions.

Rating	Min	Max	Unit
Storage temperature	−40	85	°C
V_{DD}	−0.3	3.6	V
Current per IO		10	mA
Total current by sum of all IOs		60	mA

Recommended Operating Conditions

Rating	Min	Typ.	Max	Unit
Operating temperature	−40		85	°C
V_{DD}	2.4	3.3	3.6	V

DC Characteristics

$T_A = -40\text{ °C}$ to 85 °C , $V_{DD} = 2.4\text{ V}$ to 3.6 V (unless otherwise noted)

Symbol	Rating	Min	Max	Unit
V_{IL}	Input low voltage	0	$0.3 V_{DD}$	V
V_{IH1}	Input high voltage	$0.7 V_{DD}$	V_{DD}	V
V_{OL}	Output low voltage	0	0.4	V
V_{OH}	Output high voltage	$V_{DD}-0.4$	V_{DD}	V

Current Consumption Parameters

Nordic Semiconductor nRF52840

$V_{CC} = 3.3\text{ V}$, $T_A = 25\text{ °C}$

Running mode	up to 10 mA
Stop mode	down to 0.4 μA

Qorvo QM14068 (LNA)

Powered by internal 1.8 V regulator; $V_{DD} = 1.8\text{ V}$, $T_A = 25\text{ °C}$

HG mode	10.4 mA
Bypass	6 nA

Qorvo QM14070 (PA)

Output = 50 Ω , $V_{CC} = 3.6\text{ V}$, $T_A = 25\text{ °C}$

TX CH5	up to 155 mA
TX CH9	up to 149 mA
Bypass	5 μA

Qorvo DW3220

$T_{amb} = 25\text{ °C}$

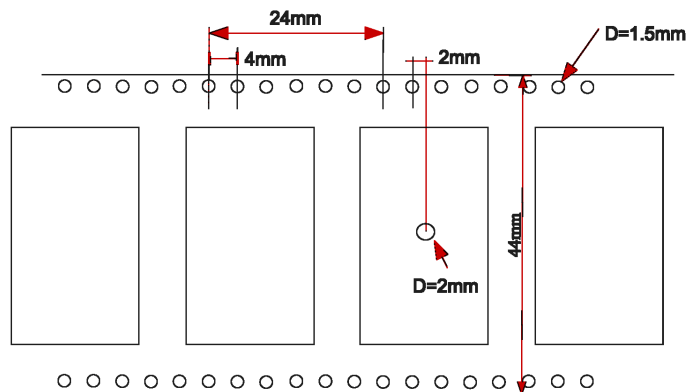
Parameter	Min	Typ.	Max	Unit
Supply current DEEP SLEEP mode	---	260	---	nA
Supply current SLEEP mode	---	850	---	nA
Supply current IDLE_PLL mode ch. 5	---	19	---	mA
Supply current IDLE_PLL mode ch. 9	---	32	---	mA
Supply current IDLE_RC mode	---	8	---	mA
Supply current OSC start-up	---	1.5	---	mA
TX	---	---	35	mA
RX CH5	---	---	72	mA
RX CH9	---	---	88	mA

Values from manufacturers' datasheets — see there for details.

■ Packaging: Tape & Reel Specification

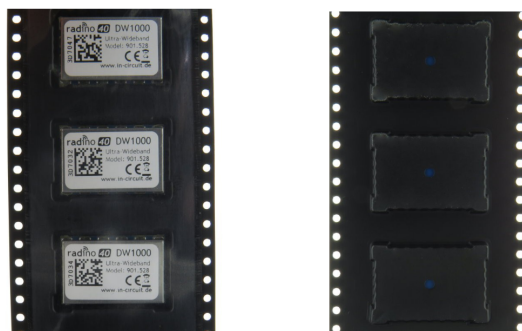
All radino modules come in a tape & reel package suitable for pick and place machines. Small quantities are delivered as cut-tape. There are two kinds of reels available with 100 pcs and 500 pcs per reel (see section Ordering Information). Except for the number of modules, all parameters are the same for both reel sizes:

- ▶ 13" reel size
- ▶ 44 mm tape width
- ▶ Tape pocket dimensions 29 mm × 19 mm × 4 mm
- ▶ Module spacing 24 mm
- ▶ 2 mm hole in the middle of the module body
- ▶ 1.5 mm tape holes for transport
- ▶ Transport direction: barcode to the left



Tape dimensions: 44 mm width, 24 mm module spacing, 2 mm body hole, 1.5 mm transport holes

Transport
direction
(Barcode to
the left)



radino40 modules in tape (photo shows radino40 DW1000) — transport direction: barcode to the left

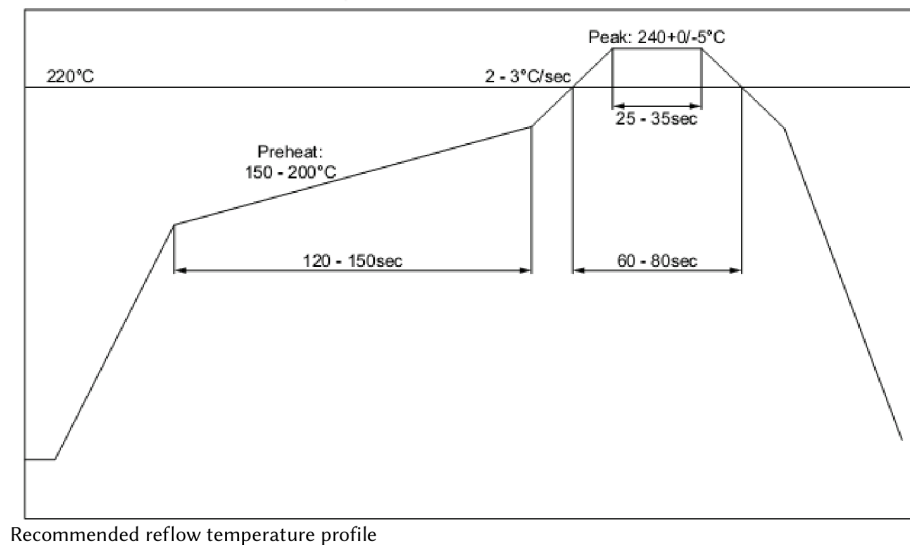
All modules of the radino40 family are pin-compatible and share the same outline dimensions, footprint and tape & reel packaging — an existing radino40 design can be upgraded to the DW3000 without PCB changes.

Reflow Temperature Profile

The single most critical stage in the automated assembly process is the reflow stage. The reflow profile shall not exceed the following maximum ratings:

- ▶ Heating gradients < 3 °C/sec
- ▶ Peak zone temperature of the module < 245 °C
- ▶ Time in peak zone < 40 sec
- ▶ Time above 220 °C < 80 sec

Excessive temperatures, transport times and shocks during the reflow process **MUST** not be applied to the module.



Recommended reflow temperature profile

Recommended reflow temperature profile

Washability

The radino modules are wash-resistant, but are not sealed. In-Circuit recommends manufacturing without washing. If washing is needed, make sure that a drying time is provided to the modules before applying electrical power. The drying time should be sufficient to allow any moisture that may have migrated into the module to evaporate, thus eliminating the potential for shorting damage during power-up or testing. If the wash contains contaminants, the performance may be adversely affected, even after drying.

Ordering Information

Part	Ordering code	MOQ	Package
radino40 DW3000	901.620C	1	Cut tape; reels 100 / 500

All radino modules are available online at www.in-circuit.de · Evaluation hardware (radino40 DW3000 Spider board), SDK access and OEM/ODM engineering services on request.

Certifications



European RED Directive Statements

The radino40 DW3000 module has been tested and found to comply with Annex II of the Radio Equipment Directive (RED) 2014/53/EU and is subject of a notified body opinion. The module has been approved for antennas with gains of 2 dBi or less.



RoHS / WEEE compliant

WEEE-Reg.-Nr. DE 17225017

Get in Touch

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Revision History

Version	Date	Changes	Editor
A001	2025/04/01	Initial version	Kormann
A002	2026/06/09	Module revision C	Kormann
A003	2026/08/24	New layout; software platform section added; smartphone interoperability updated	Träger