

TR-72D-433

RF Transceiver Module Series

Data Sheet



Smarter Wireless. Simply.

Description

TR-72D-433 is a family of IQRF transceiver modules operating in the 433 MHz license free ISM (Industry, Scientific and Medical) frequency band. Its highly integrated ready-to-use design containing MCU, RF circuitry, integrated LDO regulator, serial EEPROM and optional temperature sensor requires no external components. Extended RF power results in higher RF range. Ultra low power consumption fits for battery powered applications. MCU with built-in operating system significantly reduces application development time. Optional DPA framework supports applications even without programming.

There is no difference between TR and DCTR transceiver versions from IQRF OS v4.02D. All TRs support both OS as well as DPA approaches.



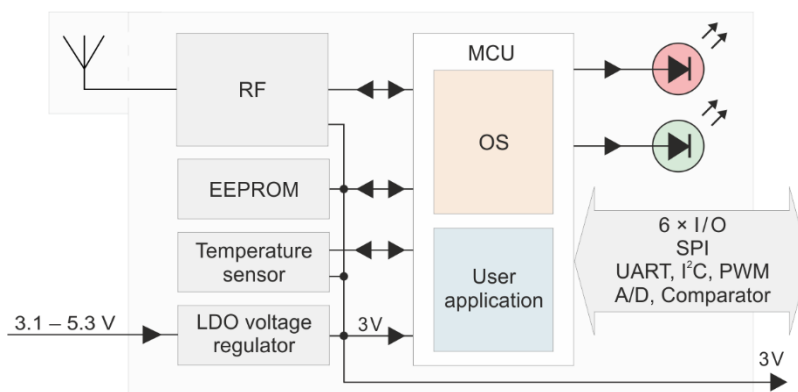
Key features

- Operating system (upgradeable at the user), easy to use
- DPA framework for Data controlled approach (formerly DCTR)
- GFSK modulation
- RF band 433 MHz, multiple channel
- RF output power 18 mW
- MCU with extended resources, user interrupt capability
- Extra low power consumption, power management modes
- SPI interface supported by OS in background
- Serial EEPROM 256 Kb
- PWM output
- Programmable HW timer
- +3 V LDO regulator output, battery monitoring
- 2 LEDs
- 8 pins, 6 I/Os
- A/D converter (2 channels), analog comparator
- Options: U.FL antenna connector, temperature sensor
- SIM card format fits KON-SIM-02 and KON-SIM-01 connectors
- Shielding can

Applications

- Bidirectional RF communication
- Point-to-point or network wireless connectivity
- Telemetry, AMR (automatic meter reading)
- WSN (wireless sensor network)
- Building automation
- Street lighting control
- Wireless monitoring, control and regulation
- Remote data acquisition
- RF connectivity in many other fields
- Also for municipal and indoor areas
- Internet of Things

Block diagram



The information contained in this publication regarding device applications and the like is provided only for your convenience and may be superseded by updates. It is your responsibility to ensure that your application meets your specifications.

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Technical specifications
Typical values unless otherwise stated

Parameters specified in this datasheet are typical values. They are at power supply $V_{OUT} = 3\text{ V}$ only. V_{OUT} voltage different from 3 V can impact on RF range and other parameters.

Supply voltage (V_{CC})	3.1 V to 5.3 V
LDO output (V_{OUT})	+3 V \pm 60 mV ($V_{CC} > 3.1\text{ V}$), 100 mA max.
Operating temperature ¹	-40 °C to +85 °C
Supply current	
Deep sleep mode (OS v4.00 or higher only)	1.9 μ A (all peripherals disabled ² , RF IC in Standby mode)
Sleep mode	2.5 μ A (all peripherals disabled ² , RF IC in Sleep mode)
Run mode	
RF sleep	1.95 mA
RF ready	3.0 mA
RX mode	
STD	12 mA
LP ³	240 μ A
XLP ³	18 μ A
TX mode (TR-72DC-433 with no antenna)	8.2 mA – 22.8 mA (according to RF output power)
Additional LED supply current	About 2 mA per LED. Rough value for brief guidance only.
RF band	433 MHz
RF channels	See IQRF OS User's guide, Appendix <i>Channel maps</i>
RF data modulation	GFSK (Gaussian Frequency Shift Keying)
RF data transmission bit rate	19.8 kb/s
RF receiver category	1.5 (according to ETSI EN 300 220-1 V3.1.1)
RF sensitivity	-104 dBm (STD RX mode, <code>checkRF(0)</code>). See <i>Diagram 2</i> .
RF output power (TR-72DC-433 with no antenna)	Up to 12.6 dBm (for 50 Ω load), programmable in 8 levels (0 – 7). See <i>Diagram 1</i> .
RF interface	Single-ended, output impedance 50 Ω
Input voltage on C1, C2, C5 to C8 pins	0 V to V_{OUT}
A/D converter	10 bit, 2 inputs. Refer to MCU datasheet.
Temperature sensor	MCP9808E/MC (for TR types with 'T' postfix only, e.g. TR-72DT-433)
Size (L x W x H)	25.1 mm x 14.9 mm x 3.3 mm
Storage environment	Temperature +16 °C to +24 °C, relative humidity 65 % max., chemically indifferent

Note 1: RF range may change with lower temperature. Frost, condensation or humidity over 85% may disable module functionality. Transceiver suitability should be tested in the final application at real conditions before volume use.

Note 2: Additional current is consumed when a peripheral (e.g. watchdog, Brown-out detection etc.) is enabled.

Note 3: Depends on interferences.

Absolute maximum ratings

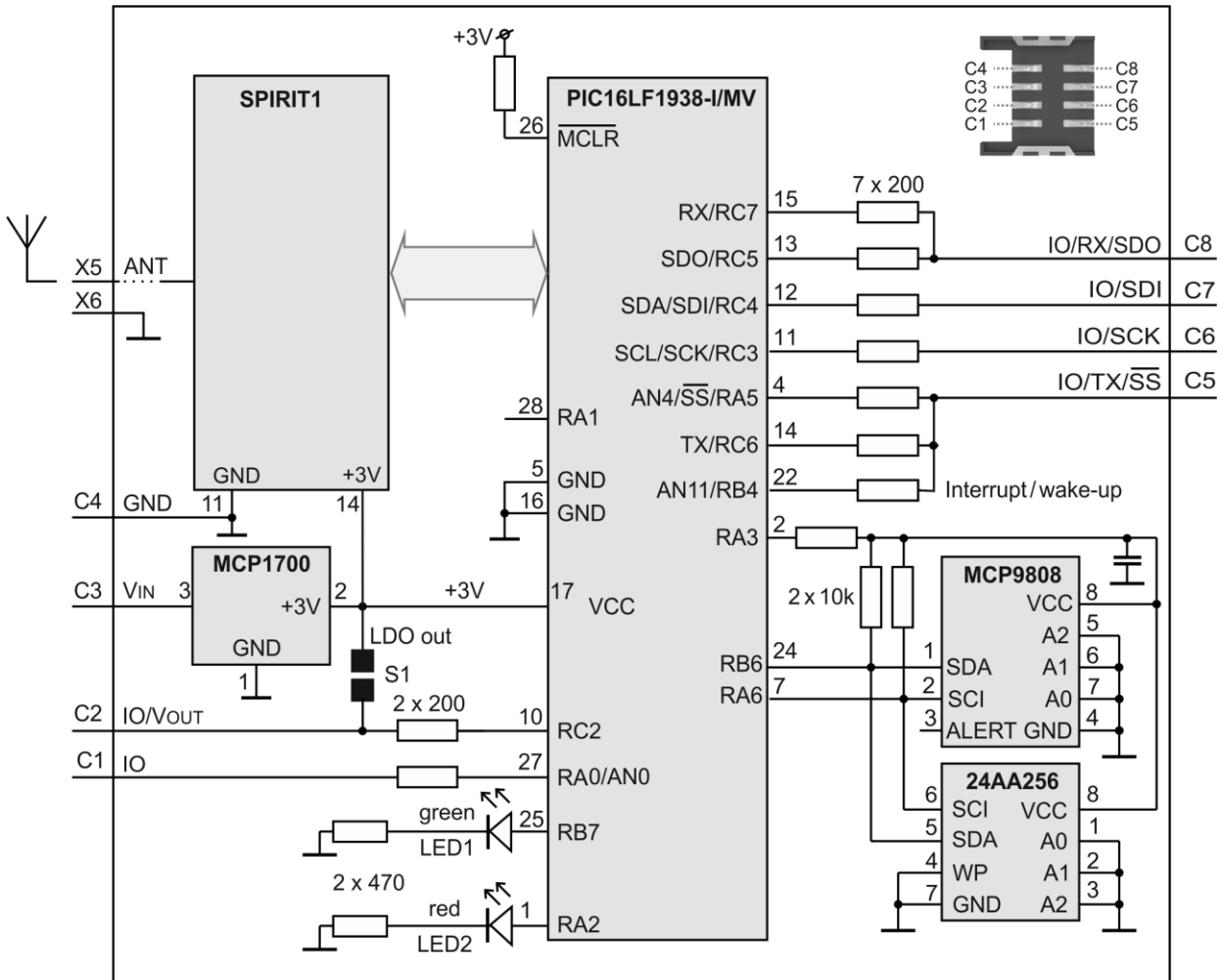
Stresses above listed maximum values may cause permanent damage to the device and affect device reliability. Functional operation under these or any other conditions beyond those specified is not supported.

Supply voltage (V_{CC})	5.5 V
Voltage on C1, C2, C5 to C8 pins (configured as inputs) vs. GND	-0.3 V to ($V_{OUT} + 0.3$ V)
Storage temperature	-40 °C to +85 °C
Ambient temperature under bias	-40 °C to +85 °C

Caution: *Electrostatic sensitive device. Observe appropriate precautions for handling.*

See the application note [AN015 - IQRF HW design for TR-7xD transceivers](#).

Simplified schematic

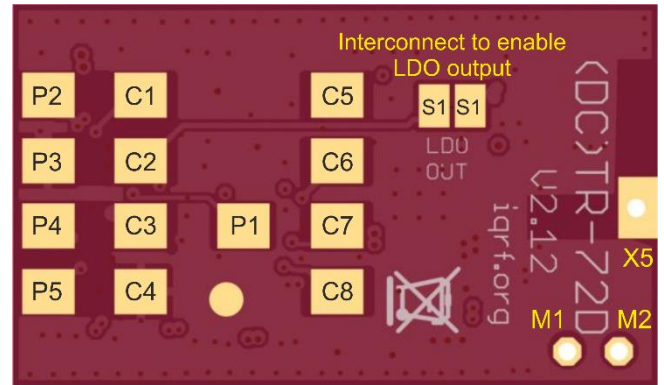


Basic components

IC	Type	Manufacturer	Note
MCU	PIC16LF1938-I/MV	Microchip	
RF IC	SPIRIT1	STMicroelectronics	
RF balun	BALF-SPI-02D3	STMicroelectronics	
LDO voltage regulator	MCP1700T-3002E/TT	Microchip	
Temperature sensor	MCP9808E/MC	Microchip	For types with 'T' postfix only, e.g. TR-72DT-433
EEPROM	24AA256-I/CS16K	Microchip	256 Kb

For more information refer to datasheets of ICs used.

Pin	Name	Description
C1	IO/ADC/C-IN	
	RA0	General I/O pin
	AN0	Analog A/D input
	C12IN0	Comparator –input
C2	IO/VOUT	
	RC2	General I/O pin (when S1 disconnected)
	VOUT	On-board +3 V LDO output (when S1 connected)
C3	VIN	Power supply voltage
C4	GND	Ground
C5	IO/ADC/TX/-SS /PWM/COU	
	RA5	General I/O pin,
	-SS	SPI Slave select
	AN4	Analog A/D input
	C2OUT	Comparator output
	RC6	General I/O pin
	TX	UART TX
	CCP3	PWM output
	RB4	General I/O pin, with programmable pull-up and interrupt/wake-up on change (IOC), RFPGM termination
	AN11	Analog A/D input
	C6	IO/SCK/SCL
RC3		General I/O pin
SCK		SPI clock input
SCL		I ² C clock
C7 ¹	IO/SDI/SDA	
	RC4	General I/O pin. Used as input during initial about 200 ms boot-up (after power supply rising-up) to recognize programming mode.
	SDI	SPI data
	SDA	I ² C data
C8 ¹	IO/RX/SDO	
	RC5	General I/O pin. Used as output during initial about 200 ms boot-up (after power supply rising-up) to recognize programming mode. That is why it should not be interconnected with the C7 pin.
	SDO	SPI data out
	RC7	General I/O pin
	RX	UART RX
X5	ANT	Antenna input
P1–P5		For manufacturer only
S1		LDO output enable. Interconnect both S1 pads to enable. Default (from the factory) disabled.
M1, M2		Holes for possible mechanical fixation

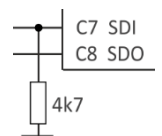


Bottom view

Note 1: Pin C8 is used as output and pin C7 as input during the initial approximately 200 ms boot-up (after power supply rising-up) to detect a possible request to enter the programming mode (PGM - wired upload via SPI). After reset, the OS generates a determinate sequence on the C8 pin. If this sequence is copied to the C7, the OS jumps to the PGM bootloader. (The PGM mode is indicated by short red LED flashing every 2 s.)

This must be taken into account to avoid collisions with application circuitry connected to these pins.

The C7 pin must not be interconnected to C8 or left unconnected or without a **defined level** on its input. This level must be arranged **by application hardware**. If the application circuitry ensures no such level, a **pull-down resistor on C7 pin** must be used otherwise a **cross-talk** between C8 and C7 may cause an unintentional switching to PGM.



See the application note [AN015 - IQRF HW design for TR-7xD transceivers](#).

RF range

RF range strongly depends on the following design aspects:

- Hardware:
 - Construction of the devices (especially TR location within the device, PCB layout, ground planes, conductive areas and bulk objects such as metallic parts and batteries in the nearest surroundings, with respect to possible reflections and counterpoise effect). To achieve an efficient range and reliable connectivity, no parts impacting the range must be placed close to the built-in meander antenna. Even non-conductive parts including a mainboard PCB under the antenna can significantly impact the range.
 - Physical arrangement of devices (especially mutual orientations of antennas with respect to polarizations and radiation patterns)
- Application software:
 - RF output power is selectable from 8 levels
 - To increase immunity to RF noise, incoming RF signal can be filtered according to signal strength.

Refer to IQRF OS Reference guide, function `checkRF` and Application note AN014 *RF range optimizing at TR-7xDx transceivers*.

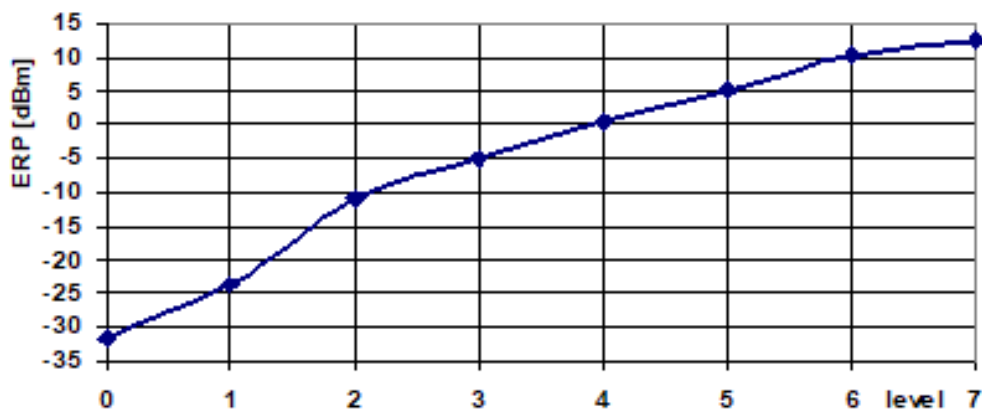


Diagram 1A: Effective radiated power (ERP) vs. level in the `setRFpower(level)` function. Refer to IQRF OS Reference guide. TR-72DC-433 without an antenna and antenna cable.

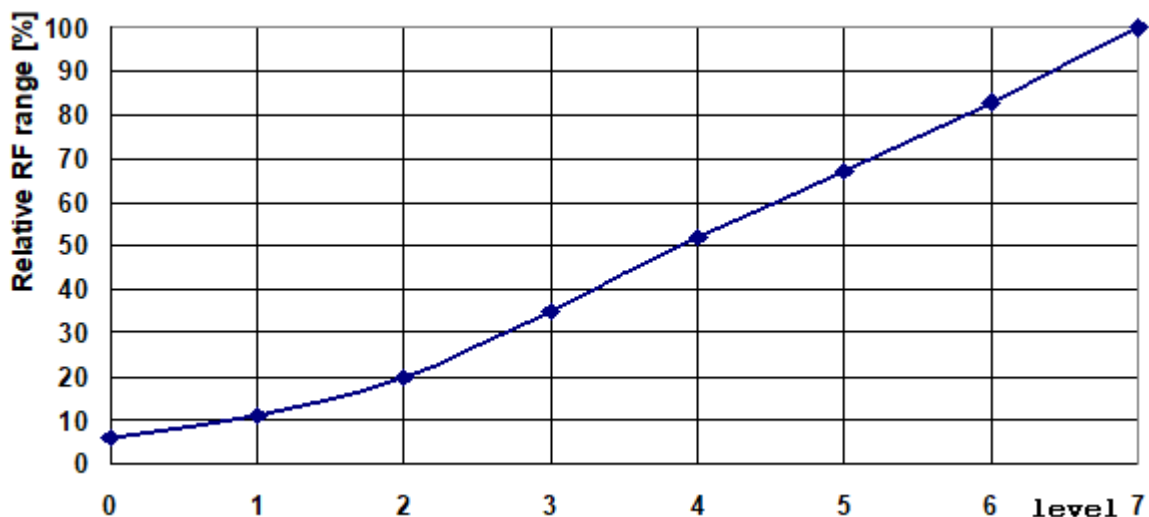


Diagram 1B: Relative RF range vs. level in the `setRFpower(level)` function. Refer to IQRF OS Reference guide.

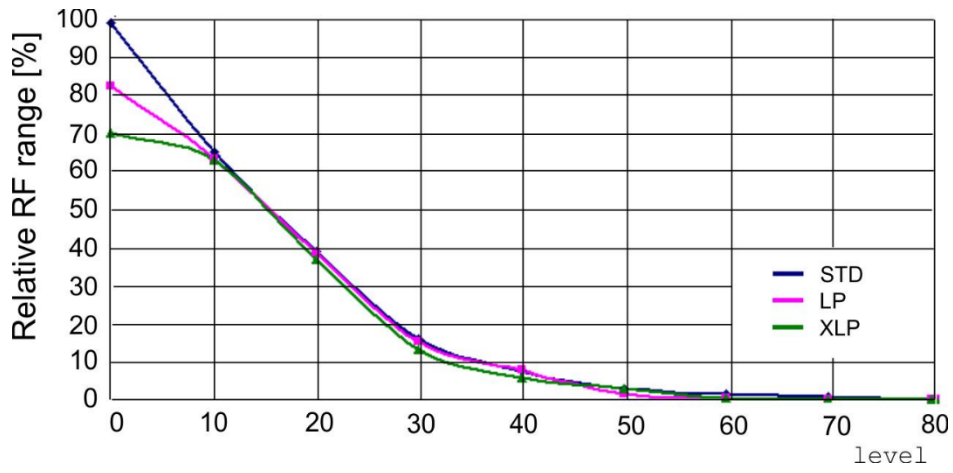
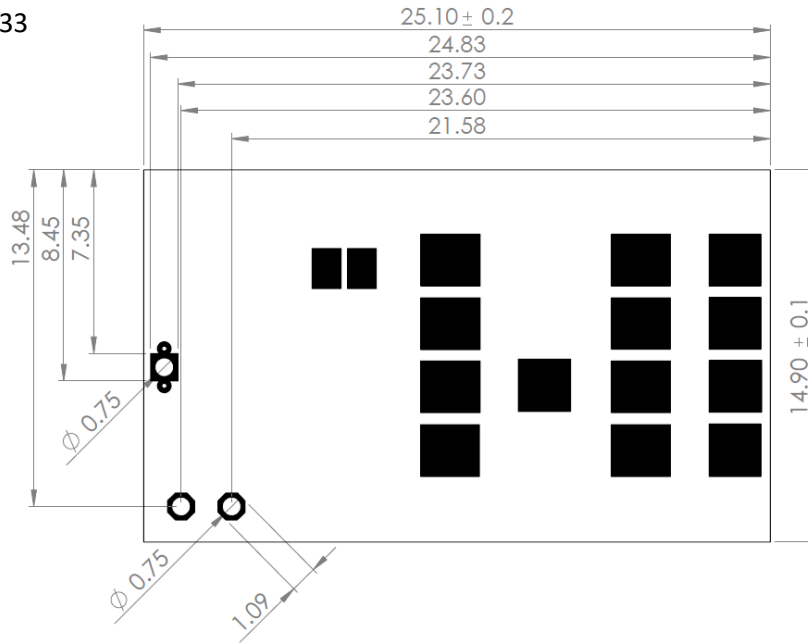


Diagram 2: Relative RF range vs. *level* in the *checkRF(level)* function in STD, LP and XLP RX modes. Refer to IQRF OS Reference guide.

Mechanical drawings

TR-72D(C)(T)-433



Top view, Units: mm

Hardware revision

- v2.14 Slightly optimized for production.
- v2.12 First release.

Application

Users have to ensure observing local provisions and restrictions relating to the use of short-range devices **by software**, e.g. the CEPT ERC/REC 70-03 Recommendation and subsequent amendments in EU.

See IQRF video tutorial set on www.iqrf.org/videos.

See the application note [AN015 - IQRF HW design for TR-7xD transceivers](#).

Assembly

TR-72Dx-433 modules should be mounted in SIM connector. They are not intended for SMT reflow soldering. Recommended SIM connector: KON-SIM-02 or KON-SIM-01. It is not allowed to connect wires to pads (except the M1, M2 and S1 pads) by soldering.

Sealing

In case of sealing or protecting TR modules against a harsh environment by coating, encapsulating or potting using a lacquer, gel or other filling matter, refer to the *Application note AN015 – IQRF HW design for TR-7xD transceivers*, chapter *Sealing*.

Operating system

See IQRF OS User's guide and IQRF OS Reference guide.

DPA framework

See DPA Framework technical guide.

Application software

See IQRF Quick start guide and IQRF application examples.

Programming (upload)

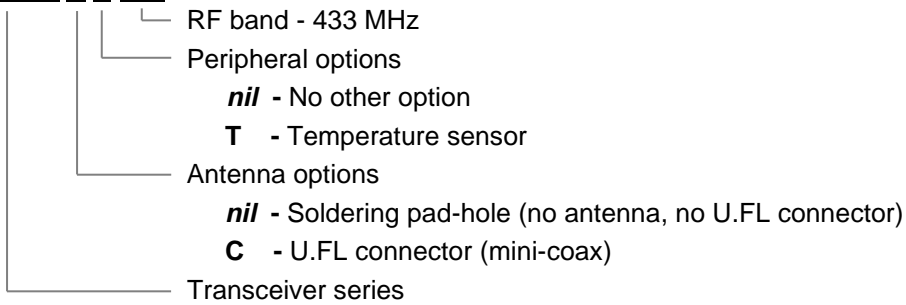
There are the following possibilities to upload an application program in TR-72Dx-433 modules:

- Wired upload with TR-72Dx-433 plugged via the SIM connector in the CK-USB-04(A) programmer.
- For TR-72Dx-433 modules populated in an application:
 - Wired upload
 - Using the CK-USB-04A programmer. See the CK-USB-04A User's guide.
 - Using the CK-USB-04 programmer and the KON-TR-01P adapter. See the KON-TR-01P User's guide.
 - Completely arranged by user application. See the *IQRF SPI Technical guide*, chapter *Programming mode*.
 - Wireless upload: See the IQRF OS User's guide, Appendix *RFPGM – RF programming™*.

Product information

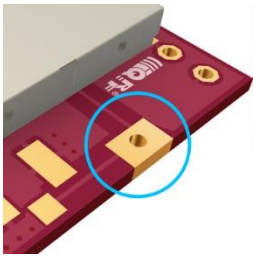
Ordering codes

TR-72D C P-433

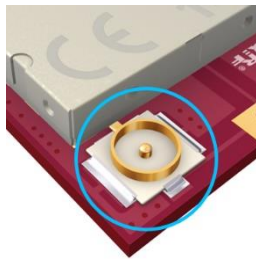


Type	Antenna connection	Temperature sensor	Data controlled
TR-72D-433	Soldering pad-hole	–	Yes
TR-72DC-433	U.FL connector	–	Yes

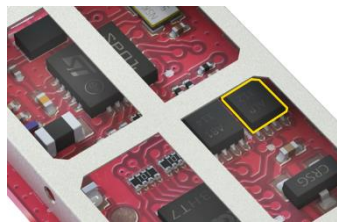
Type	Antenna connection	Temperature sensor	Data controlled
TR-72DT-433	Soldering pad-hole	Yes	Yes
TR-72DCT-433	U.FL connector	Yes	Yes



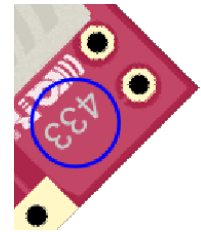
TR-72D-433



TR-72DC-433



TR-72DT-433 (uncovered)



433 MHz band identification

Document history

- 210712 Storage environment added to chapter *Technical specifications*. Supplied current in RF sleep mode revised. Directives in chapter *Quality management* updated.
- 200525 References to application note *AN015 – IQRF HW design for TR-7xD transceivers* added.
- 191209 *Note 1* added to Pin description table. Paragraph *Programming (upload)* in chapter *Application* slightly extended. Chapter *Sealing* relocated into Application note *AN015 – IQRF HW design*, chapter *Sealing*. *Diagram 1B* added.
- 180627 Block diagram revised. RF parameters in chapter *Electrical specifications* revised.
- 180130 Chapter *RF range* extended. Directives in *Quality management* updated.
- 171108 Cosmetic improvements only.
- 170908 First release. Preliminary.

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Complies with directives 2011/65/EU (RoHS) and 2012/19/EU (WEEE).



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