(DC)TR-76D

RF Transceiver Module

Data Sheet

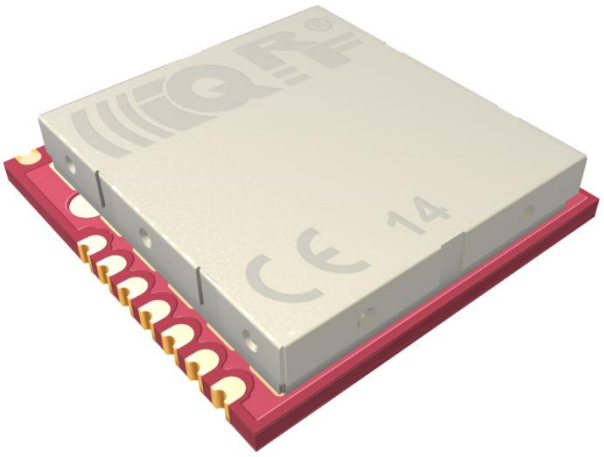
Preliminary

Smarter wireless. Simply.

Description

(DC)TR-76D is a family of IQRF transceiver modules operating in the 868 MHz and 916 MHz license free ISM (Industry, Scientific and Medical) frequency band. Its highly integrated ready-to-use design containing MCU, RF circuitry, serial EEPROM and optional on-board antenna requires no external components. SMT mounting and very small dimensions allow space saving. 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.

This document is valid for TR as well as DCTR transceiver versions. For simplicity, only TR is used further on throughout the document.



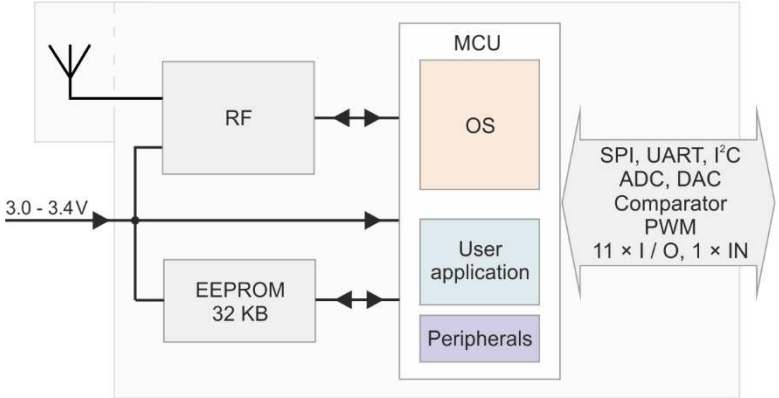
Key features

- Operating system (upgradeable at the user), easy to use
- DPA framework for DCTR (Data Controlled Transceiver)
- GFSK modulation
- Selectable RF band 868 / 916 MHz, multiple channel
- Selectable RF bit rate
- RF output power 8 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
- Battery monitoring
- 18 pins, 11 I/O pins, 1 input only pin
- A/D converter (4 channels), D/A converter, analog comparator
- Options: on-board antenna or soldering antenna pad-hole
- Stamp-hole pads, SMT mounting, compatible with SIM card connector without metallic holder (KON-SIM-02)
- 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



Electrical specifications

***Typical values** unless otherwise stated*

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

Supply voltage (V_{CC}) [1]	3.0 V min., 3.4 V max., stabilized
Operating temperature [2]	-40 °C to +85 °C
Supply current	
Deep sleep mode (OS v4.00 or higher only)	56 nA (all peripherals disabled [4], RF IC in Standby mode)
Sleep mode	610 nA (all peripherals disabled [4], RF IC in Sleep mode)
Run mode	
RF sleep	1.6 mA
RF ready	3.0 mA
RX mode	
STD	11.8 mA
LP [5]	250 µA
XLP [5]	16.3 µA
TX mode	8.3 mA – 21.5 mA (according to RF output power)
RF band	868 MHz or 916 MHz (software configurable)
RF channels	See IQRF OS User's guide, Appendix *Channel maps*
RF data modulation	GFSK (Gaussian Frequency Shift Keying)
RF data transmission bit rate [6]	19.8 kb/s
RF sensitivity [7]	-104 dBm (STD RX mode, `checkRF(0)`)
RF output power (TR-76D) [7]	9 dBm (for 50 Ω load), programmable in 8 levels (0 – 7). See *Diagram 1*.
Effective radiated power (TR-76DA)	6.5 dBm (868 MHz band), 2.0 to 6.5 dBm (916 MHz band). See *Diagrams 2A, 2B*.
RF interface (TR-76D)	Single-ended, output impedance 50 Ω
Antenna (TR-76DA)	PCB meander line, linear polarization, omnidirectional
RF range (TR-76DA)	500 m [3A], 1100 m [3B]
Input voltage on Q4 to Q15 pins	0 V to VCC
A/D converter	10 bit, 4 inputs. Refer to MCU datasheet.
Size (L x W x H)	15.2 mm x 14.9 mm x 3.3 mm (TR-76D) 23.3 mm x 14.9 mm x 3.3 mm (TR-76DA)

Note 1: RF power and other parameters depend on supply voltage. Refer to datasheets of MCU and RF IC used. Test your application with respect to required supply voltage range.

Note 2: RF range may change with lower temperature. Frost, condensation or humidity over 85% may disable module functionality. Module suitability should be tested in final application before volume use.

Note 3: Arrangement:

3A: Two TR-76DA transceivers plugged in DK-EVAL-04x kits, vertically, 1.6 m above the ground, in free space (with reflective planes at min. 100 m distance), bidirectional communication.

3B: Two TR-76DA transceivers plugged in DK-EVAL-04x kits through the RNG-EXT-01 adapters, vertically, 1.6 m above the ground, in free space (with reflective planes at min. 100 m distance), bidirectional communication.

Test software: E09-LINK example (STD mode, `setRFpower(7)`, `checkRF(0)`), bit rate 19.8 kb/s.

Note 4: Additional current is consumed when a peripheral (e.g. watchdog, Brown-out detection etc.) is enabled.

Note 5: Depends on interferences.

Note 6: Several RF bit rates different from 19.8 kb/s will be available in future IQRF OS versions.

Note 7: RF circuitry and RF balun included, built-in PCB antenna not included.

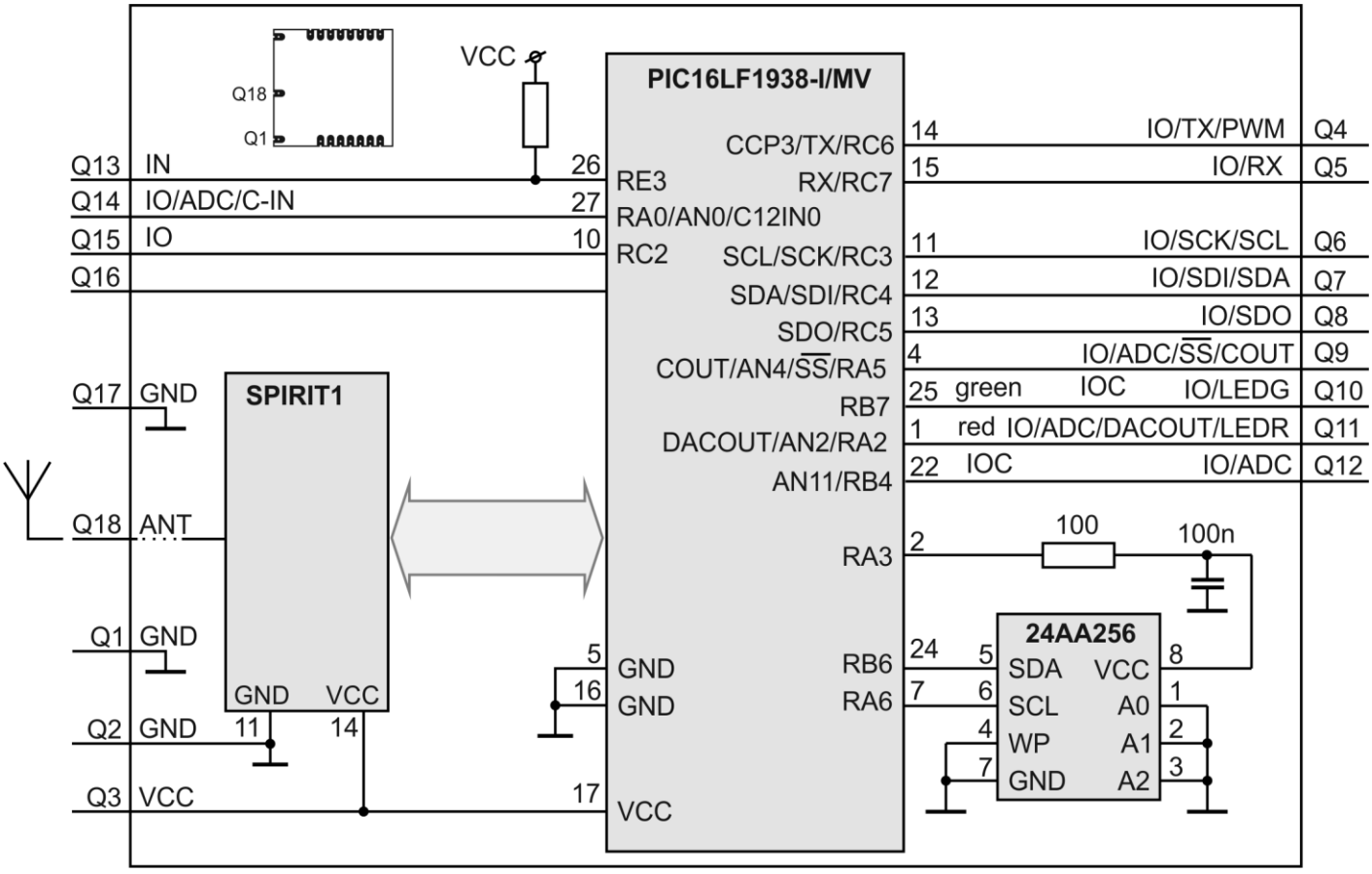
Absolute maximum ratings

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

Supply voltage (V_{CC})	4.0 V
Voltage on Q4 to Q15 pins (configured as inputs) vs. GND	-0.3 V to (V_{CC} + 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.*

Simplified schematic



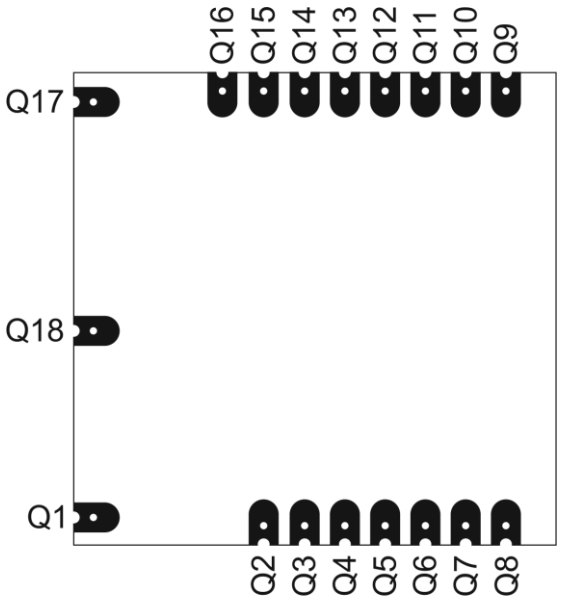
Basic components

IC	Type	Manufacturer	Note
MCU	PIC16LF1938–I/MV	Microchip	
RF IC	SPIRIT1	STMicroelectronics	
RF balun	BALF-SPI-01D3	STMicroelectronics	
EEPROM	24AA256-I/CS16K	Microchip	256 Kb

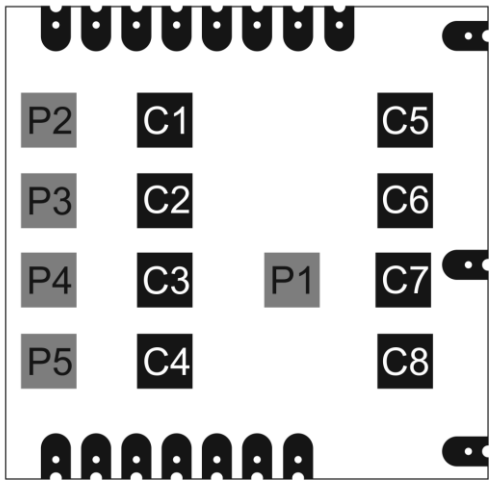
For more information refer to datasheets of ICs used.

Pin	Name	Description
Q1 [8]	**GND**	Ground
Q2, C4	**GND**	Ground
Q3, C3	**Vcc**	Power supply voltage
Q4	**IO** / **TX** / **PWM**	
	RC6	General I/O pin
	TX	UART TX
	CCP3	PWM output
Q5	**IO** / **RX**	
	RC7	General I/O pin
	RX	UART RX
Q6, C6	**IO** / **SCK** / **SCL**	
	RC3	General I/O pin
	SCK	SPI clock input
	SCL	I²C clock
Q7 [9], C7	**IO** / **SDI** / **SDA**	
	RC4	General I/O pin
	SDI	SPI data
	SDA	I²C data
Q8 [9], C8	**IO** / **SDO**	
	RC5	General I/O pin
	SDO	SPI data out
Q9, C5	**IO** / **ADC** / **-SS** / **COUT**	
	RA5	General I/O pin
	AN4	Analog A/D input
	-SS	SPI Slave select
	C2OUT	Comparator output
Q10 [10]	**IO** / **LEDG**	
	RB7	General I/O pin, programmable pull-up Interrupt / Wake-up on change (IOC)
	LED1	LEDG supported by OS
Q11 [10]	**IO** / **ADC** / **LEDR**	
	RA2	General I/O pin
	AN2	Analog A/D input
	LED2	LEDR supported by OS
	DACOUT	D/A converter output
Q12	**IO** / **ADC**	
	RB4	General I/O pin, with programmable pull-up Interrupt / Wake-up on change (IOC) RFPGM / (X)LP mode termination
	AN11	Analog A/D input
Q13	**IN**	
	RE3	General input only pin
Q14, C1	**IO / ADC / C-IN**	
	RA0	General I/O pin
	AN0	Analog A/D input
	C12IN0	Comparator –input
Q15, C2	**IO**	
	RC2	General I/O pin
Q16	–	Do not use, leave unconnected
Q17 [8]	**GND**	Ground
Q18 [8]	**ANT**	Antenna
P1–P5	For manufacturer only	

Top view



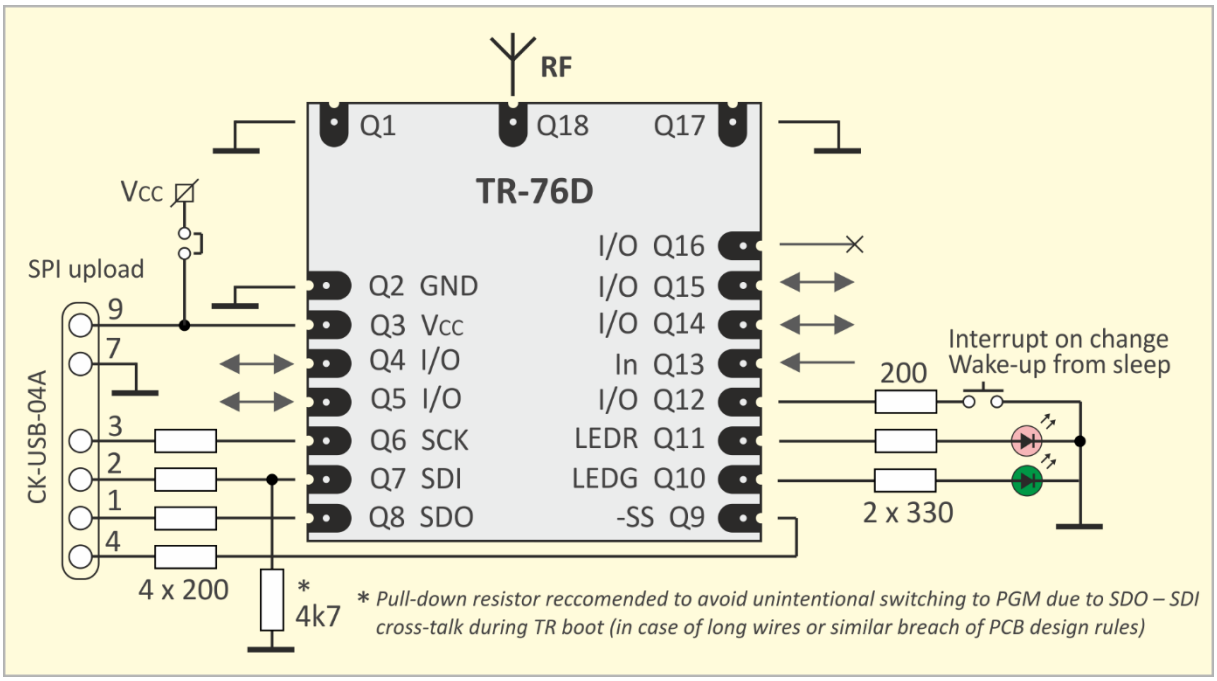
Bottom view



Note 8: Not implemented for TR-76DA.
Note 9: Pin Q8 is used as output and pin Q7 as input during initial ~200 ms boot-up (after power supply rising-up) to detect programming mode. That is why these two pins should not be interconnected to each other.
Note 10: This pin is affected by IQRF OS (and possibly DPA) LED functions and system LED indication.

There are no on-board protection series resistors on I/O pins. It is recommended to use 200 Ω series resistors on each pin.

Recommended circuit for development



For development, it is recommend to implement the following arrangement:

- Serial protective resistors on each I/O pin used.
- Both system LEDs (LEDR and LEDG) for IQRF OS and DPA status indication and for possible user indication. When the Q10 and Q11 pins are used as user I/Os, it must be taken into account that these pins can be affected by IQRF OS or DPA.
- Pin Q12 configured as input with internal pull-up resistor and equipped with a pushbutton connected to the ground. Then pressing the button can generate an interrupt on pin change, wake-up the transceiver from sleep, terminate RFPGM mode, initiate bonding etc.
- Pull-down resistor on pin Q7 recommended to avoid unintentional switching to PGM mode due to SDO - SDI cross-talk during TR boot (in case of long wires or similar breach of PCB design rules only).
- SPI interface for wired upload of application code into the transceiver using an IQRF programmer, e.g CK-USB-04A.

Depending on actual user application and power supply range, it may be required to isolate interface pins and/or power supply from user circuitry during uploading. For details refer to the CK-USB-04A User's guide, chapter *Application/In-circuit upload*.

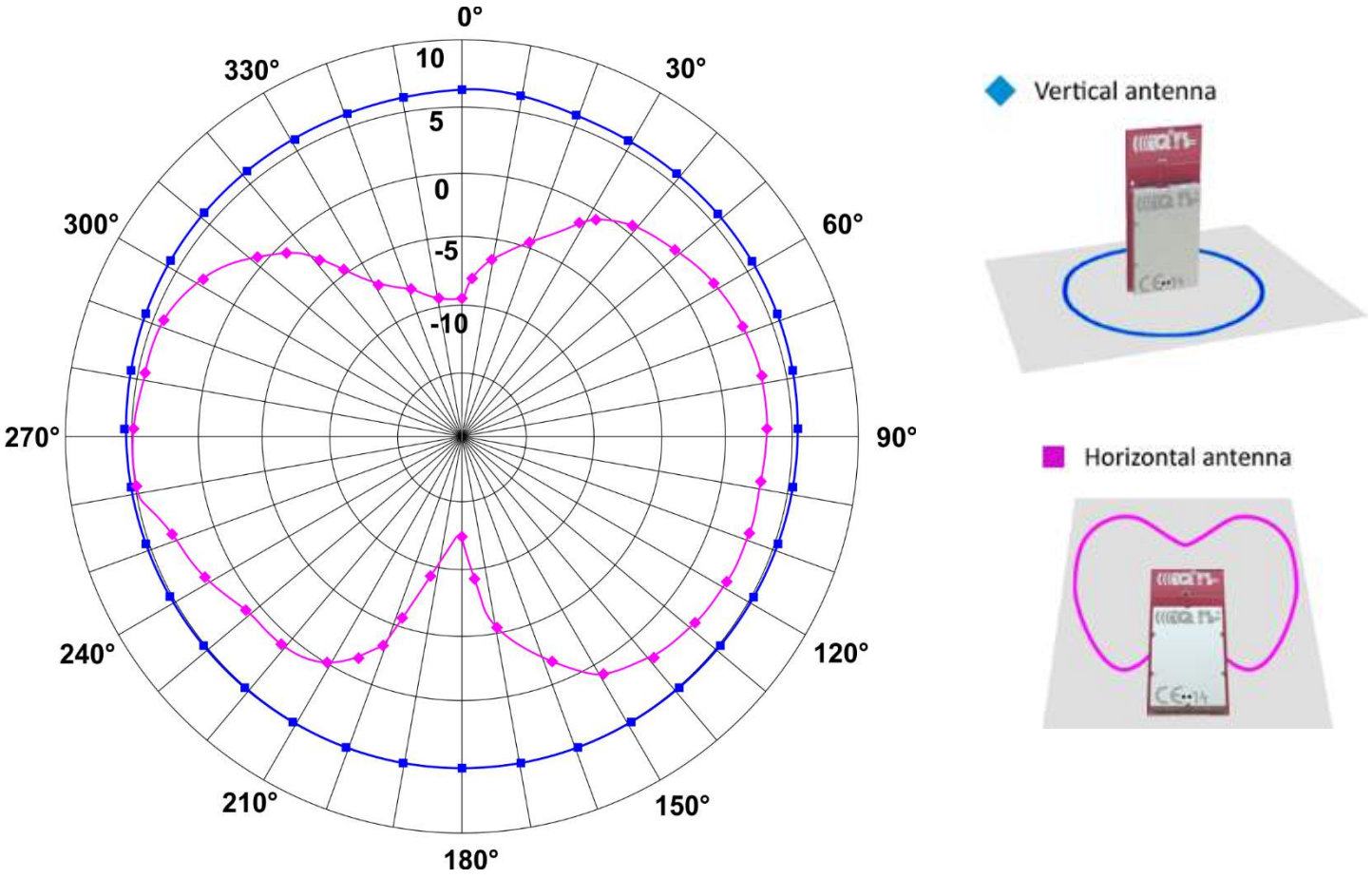
RF range

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)
  - 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 against RF noise, incoming RF signal can be filtered according to signal strength.

Refer to IQRF OS Reference guide, function `checkRF`.

Diagram 1: TR-7xDA RF output power [in dBm] vs. antenna orientation (radiation patterns)



Examples of correct and incorrect arrangement of TR-7xDA pairs:

Correct	Correct	Incorrect	Incorrect	Incorrect
		Wrong radiation angle	Mismatched polarization	Wrong radiation angle Mismatched polarization

Diagram 2A: Effective radiated power (ERP) vs. level in the `setRFpower(level)` function, TR-76DA, 868 MHz band, channels 0 to 67. Refer to IQRF OS Reference guide.

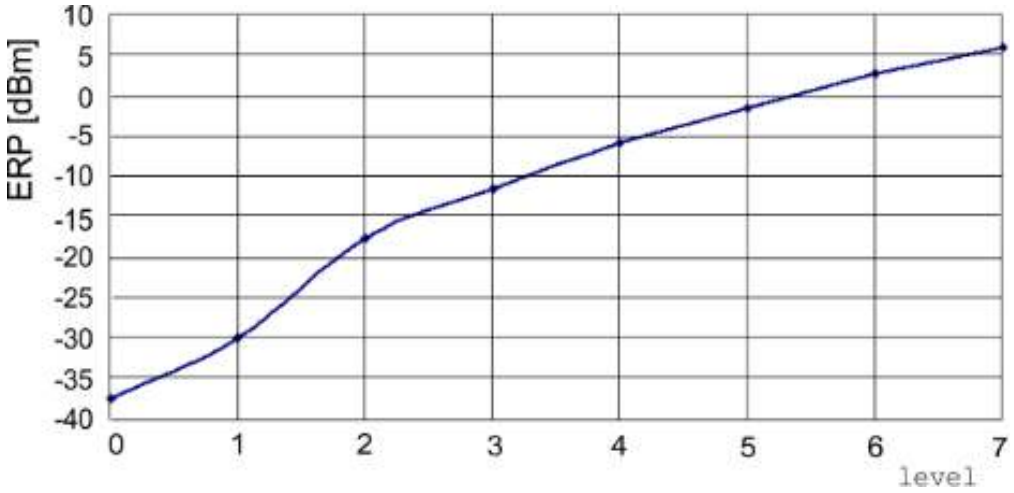


Diagram 2B: Effective radiated power (ERP) vs. level in the `setRFpower(level)` function, TR-76DA, 916 MHz band. Refer to IQRF OS Reference guide.

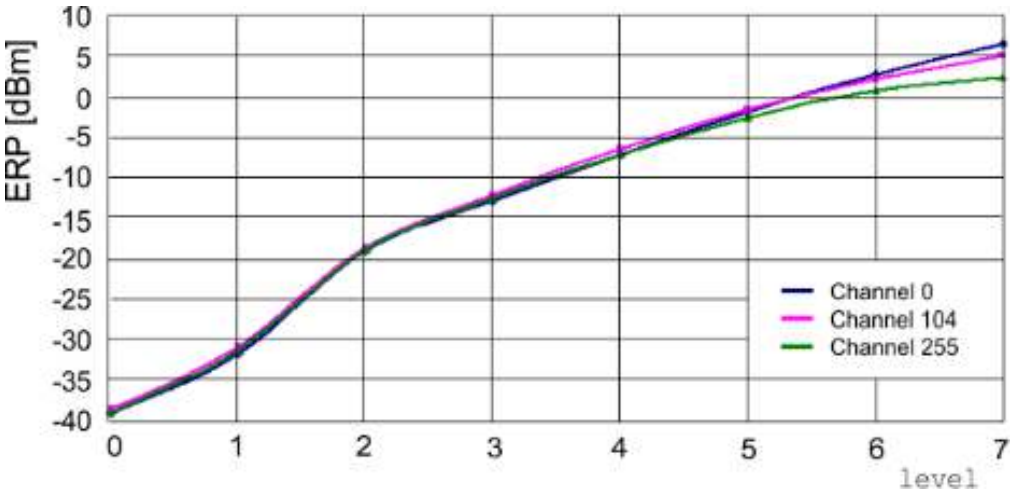


Diagram 3A: Relative effective radiated power (ERP) vs. channel, TR-72DA, 868 MHz band, with respect to channel 52 (100 %).

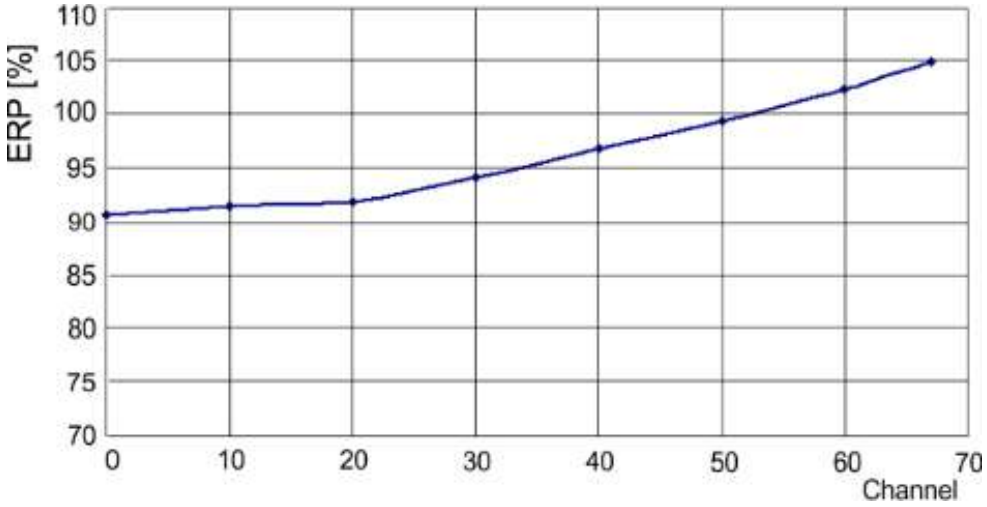


Diagram 3B: Relative effective radiated power (ERP) vs. channel, TR-76DA, 916 MHz band, with respect to channel 104

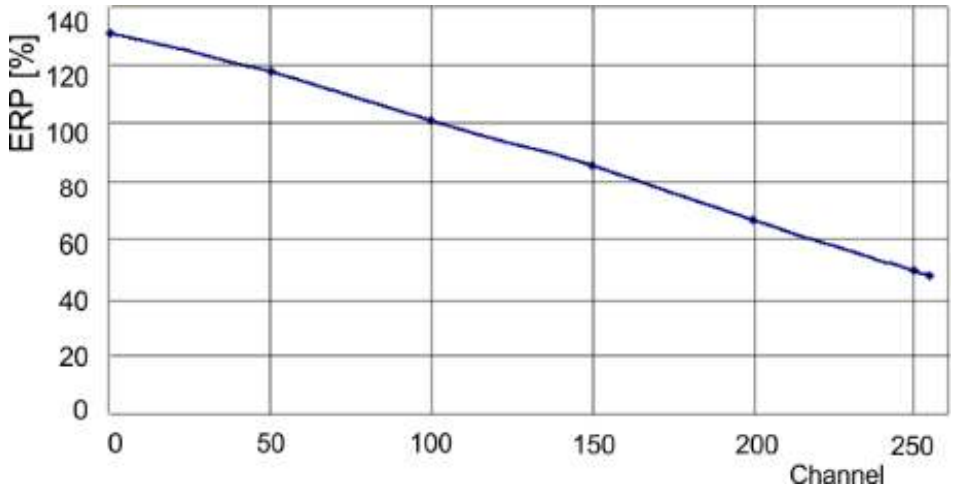


Diagram 4: Relative RF range vs. `level` in the `checkRF(level)` function in STD, LP and XLP RX modes. Refer to IQRF OS Reference guide.

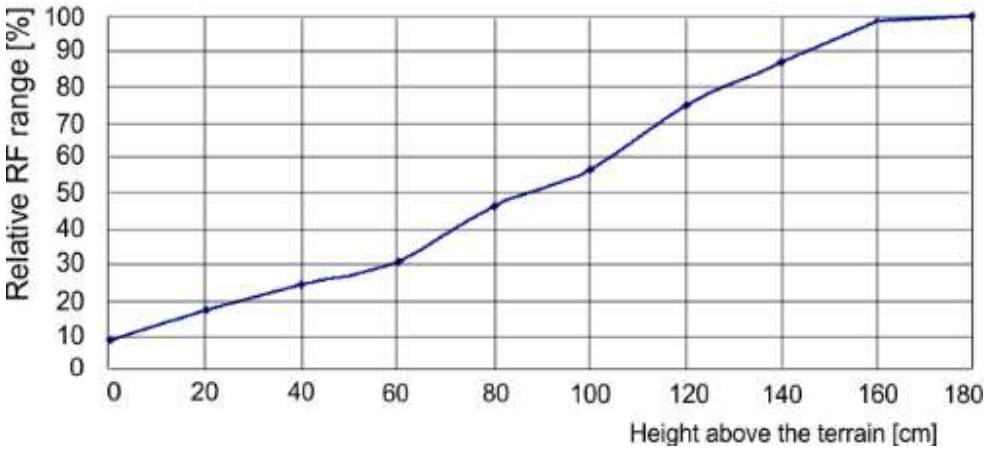
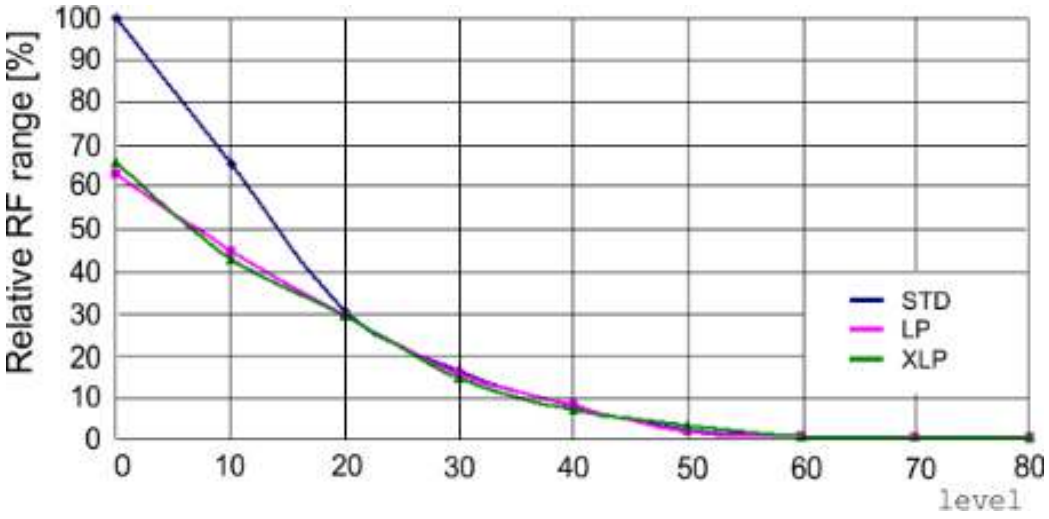
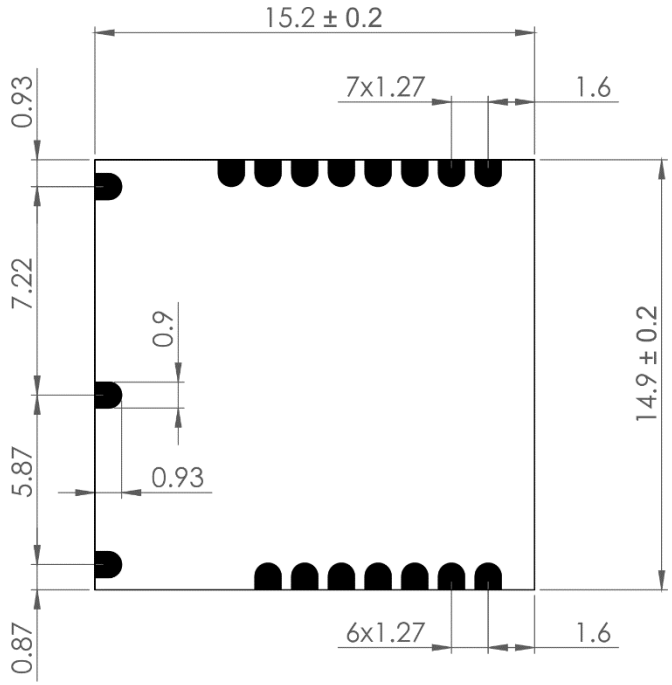


Diagram 5: TR-76DA relative RF range vs. antenna height above the ground, 868 MHz and 916 MHz band.

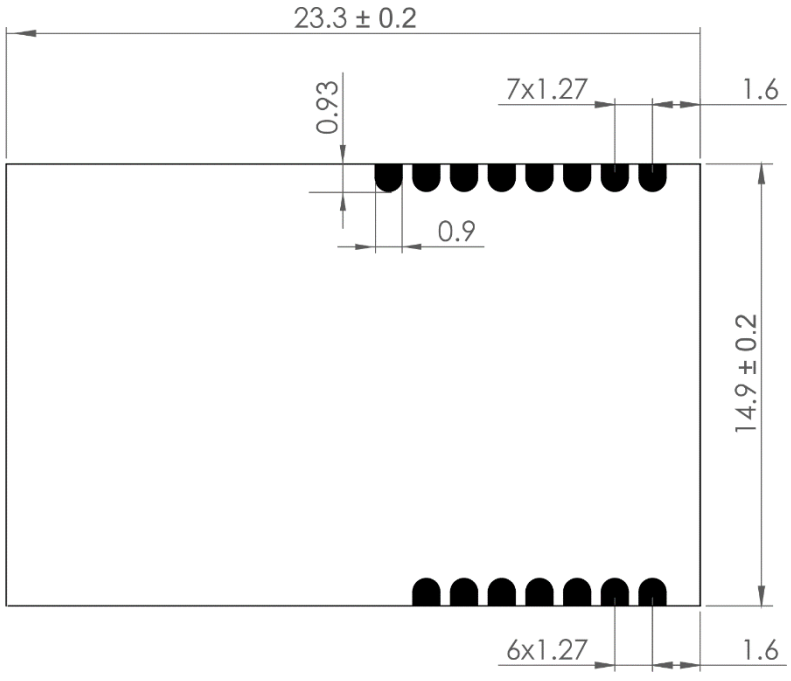


Mechanical drawings

TR-76D



TR-76DA



Top view. Units: mm.

Hardware revision

- TR-76D(A) v1.02 Minor improvements to optimize production. TR-76DA also for 916 MHz band.
- TR-76D(A) v1.01 Minor improvements to optimize production. TR-76DA for 868 MHz band only.
- TR-76D(A) v1.00 First standard release**.** TR-76DA for 868 MHz band only.

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.

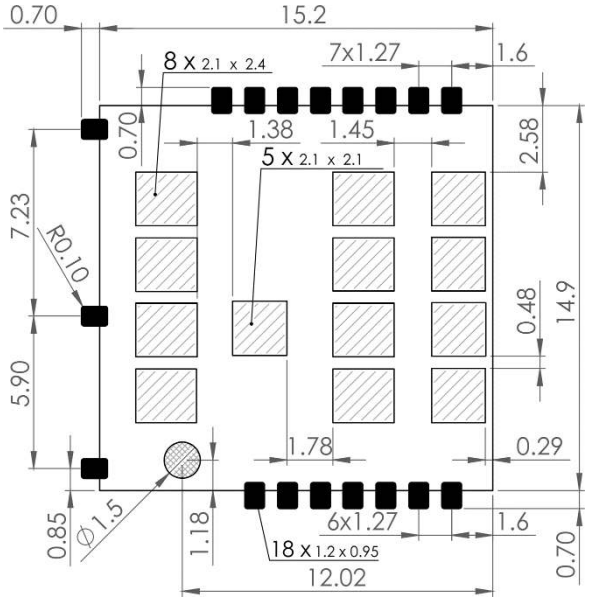
Assembly

For proper mounting of surface mount TR-76Dx modules and avoiding damage during solder reflow assembly the IPC/JEDEC J-STD-020C standard must be observed. The parts must be baked dry according to IPC/JEDEC J-STD-033C,MSL 4 before reflow soldering. For reflow profile and details refer to the AN010 Application note – SMT mounting of IQRF TR modules. It is not allowed to connect wires to pads C1 to C8 and P1 to P5 by soldering.

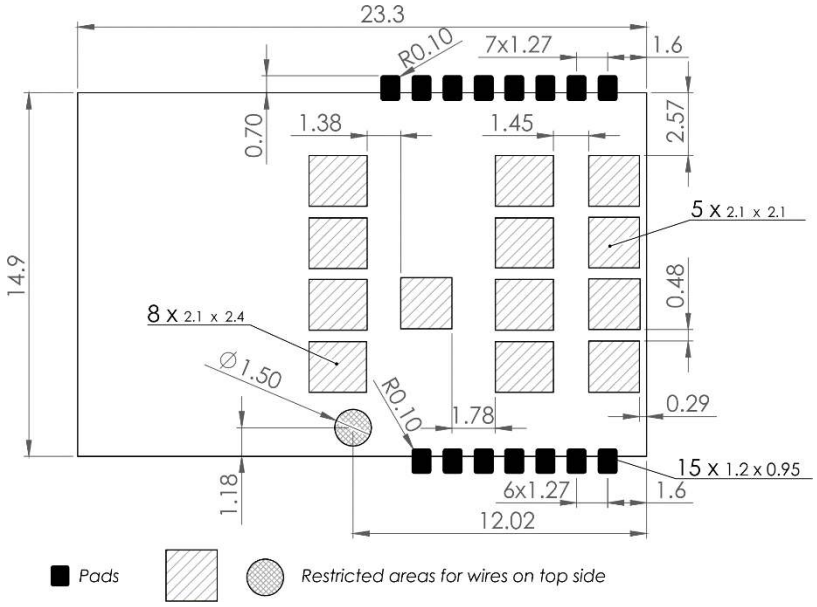
Caution: *TR-76Dx must not be plugged in a SIM connector with metallic holder.*

Recommended PCB layout

TR-76D:



TR-76DA:



Top view. Units: mm.

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, the ion cleanless of the TR modules must be less than 1 µg/cm^2 of NaCl equivalent otherwise there is a risk of corrosion.

Such a surface treatment always impacts the RF range. Thus, sealing material should have relative permeability (μ_r) as close to 1 within given frequency band. E.g. $\mu_r = 4$ at 868 MHz decreases reletive range to cca 70%.

Protecting materials, methods, accomplishments and handling must comply with general requirements and rules for proper use with electronic devices. Damaging, either chemical or mechanical (even due to the thermal expansivity of the material used) must be avoided. Testing is necessary to ensure that the application meets with specifications.

Operating system

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

DPA framework and DCTR

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-76Dx modules:

- Wired upload with TR-76Dx plugged via the SIM connector in the CK-USB-04A programmer.
- For TR-76Dx 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.
  - Wireless upload: See the IQRF OS User's guide, Appendix *RFPGM – RF programming™*.

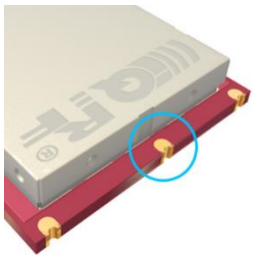
Product information

Ordering codes

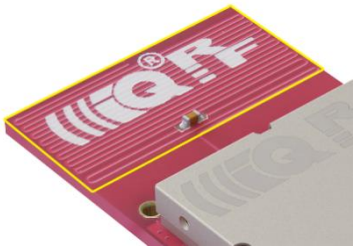
DC T R-76D A

- Antenna options
  - **nil** - soldering pad-hole (no antenna, no U.FL connector)
  - **A** - PCB antenna
- Transceiver series
- DCTR / TR options
  - **nil** - TR
  - **DC** - DCTR

Type	Antenna connection
(DC)TR-76D	Soldering pad-hole
(DC)TR-76DA	PCB antenna



TR-76D



TR-76DA

Document history

- 170322 Diagrams 3A and 3B added. Preliminary.
- 170314 Updated for HW v1.02 and IQRF OS v4.00 (preliminary). Electrical specification revised. Chapter *Sealing* added. Chapter *Recommended circuit for development* slightly extended. Variances in mechanical drawings slightly precised. Some minor improvements.
- 160304 Pin Q12 description slightly extended.
- 160219 More detailed RF range specification. Q7 and Q8 pin description extended.
- 160118 Note 10 added in pin description table. Chapter *Recommended circuit for development* added. A bug in *Key features, antenna options* fixed.
- 151005 ETSI directives updated. Preliminary.
- 151001 First release. Preliminary.

Sales and Service

Corporate office

MICRORISC s.r.o., Prumyslova 1275, 506 01 Jicin, Czech Republic, EU
Tel: +420 493 538 125, Fax: +420 493 538 126, www.microrisc.com.

Partners and distribution

Please visit www.iqrf.org/partners.

Quality management

ISO 9001 : 2009 certified

Complies with ETSI directives EN 301489-1 V1.9.2:2011, EN 301489-3 V1.6.1:2013, EN 300220-1 V2.4.1:2012, EN 300220-2 V2.4.1:2012 and VO-R/10/05.2014-3.

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

Trademarks

Legal

The IQRF® products utilize several patents (CZ, EU, US)

On-line support: support@iqrf.org

Smarter wireless. Simply.