TR-75D

RF Transceiver Module

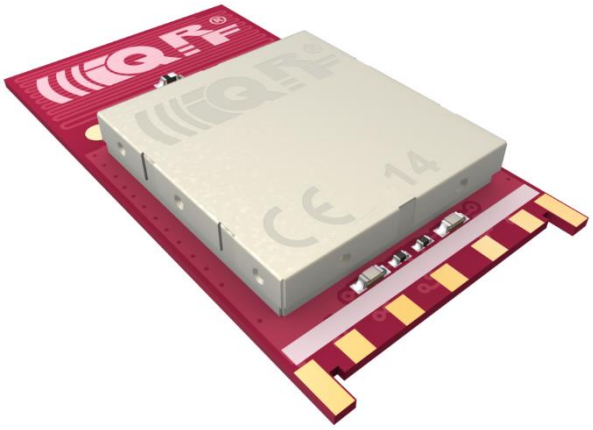
Data Sheet

Preliminary

Smarter Wireless. Simply.

Description

TR-75D 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 on-board antenna requires no external components. Vertical mounting and very small dimensions allow space saving. Extended RF power results in higher RF range. Extra 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.

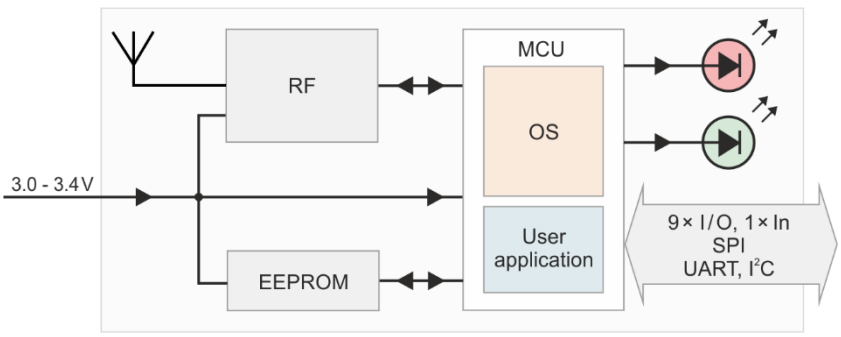
Key features

- Operating system (upgradeable at the user), easy to use
- DPA framework for Data controlled approach
- GFSK modulation
- Selectable RF band 868 / 916 MHz, multiple channel
- RF output power 10 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
- 12 pins (9 I/O pins, 1 input only pin)
- A/D converter (3 channels)
- Analog comparator
- Vertical mounting, SIM card compatible
- Shielding can
- Small dimensions

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.

IQRF Tech MAKES NO REPRESENTATIONS OR WARRANTIES OF ANY KIND TO STATED CONDITION, QUALITY, PERFORMANCE, MERCHANTABILITY OR FITNESS FOR PURPOSE and disclaims all liability arising from this information and its use. Use of IQRF Tech devices in life support and/or safety applications is entirely at the buyer's risk, and the buyer agrees to defend, indemnify and hold harmless IQRF Tech from any and all damages, claims, suits, or expenses resulting from such use. No licenses are conveyed, implicitly or otherwise, under any IQRF Tech intellectual property rights.

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)
Additional LED supply current	About 2 mA per LED. Rough value for brief guidance only.
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 receiver category	1.5 (according to ETSI EN 300 220-1 V3.1.1)
RF sensitivity [7]	-101 dBm (STD RX mode, `checkRF(0)`). See *Diagram 4*.
Effective radiated power [3, 7]	Up to 6.5 dBm [3A], 11 dBm [3B] (868 MHz band), 2.0 to 6.5 dBm (916 MHz band).), programmable in 8 levels (0 – 7). See *Diagrams 2A, 2B*.
Antenna	PCB meander line, linear polarization, omnidirectional. See *Diagram 1*.
RF range	500 m [3A], 1100 m [3B]
Input voltage on I/O pins	0 V to VCC
A/D converter	10 bit, 3 inputs. Refer to MCU datasheet.
Size (L x W x H)	27.5 mm x 14.9 mm x 3.3 mm

Note 1: RF power and other parameters depend on the 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 the final application at real conditions before volume use.
Note 3: Arrangement: Two TR-75DA transceivers plugged in DK-EVAL-04A kits, vertically, 1.6 m above the ground, in free space, bidirectional communication.
3A: TR-75DA transceivers plugged directly in DK-EVAL-04A kits.
3B: TR-75DA transceivers plugged in DK-EVAL-04A kits through the RNG-EXT-01 adapters.
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, RF balun and built-in PCB antenna included.

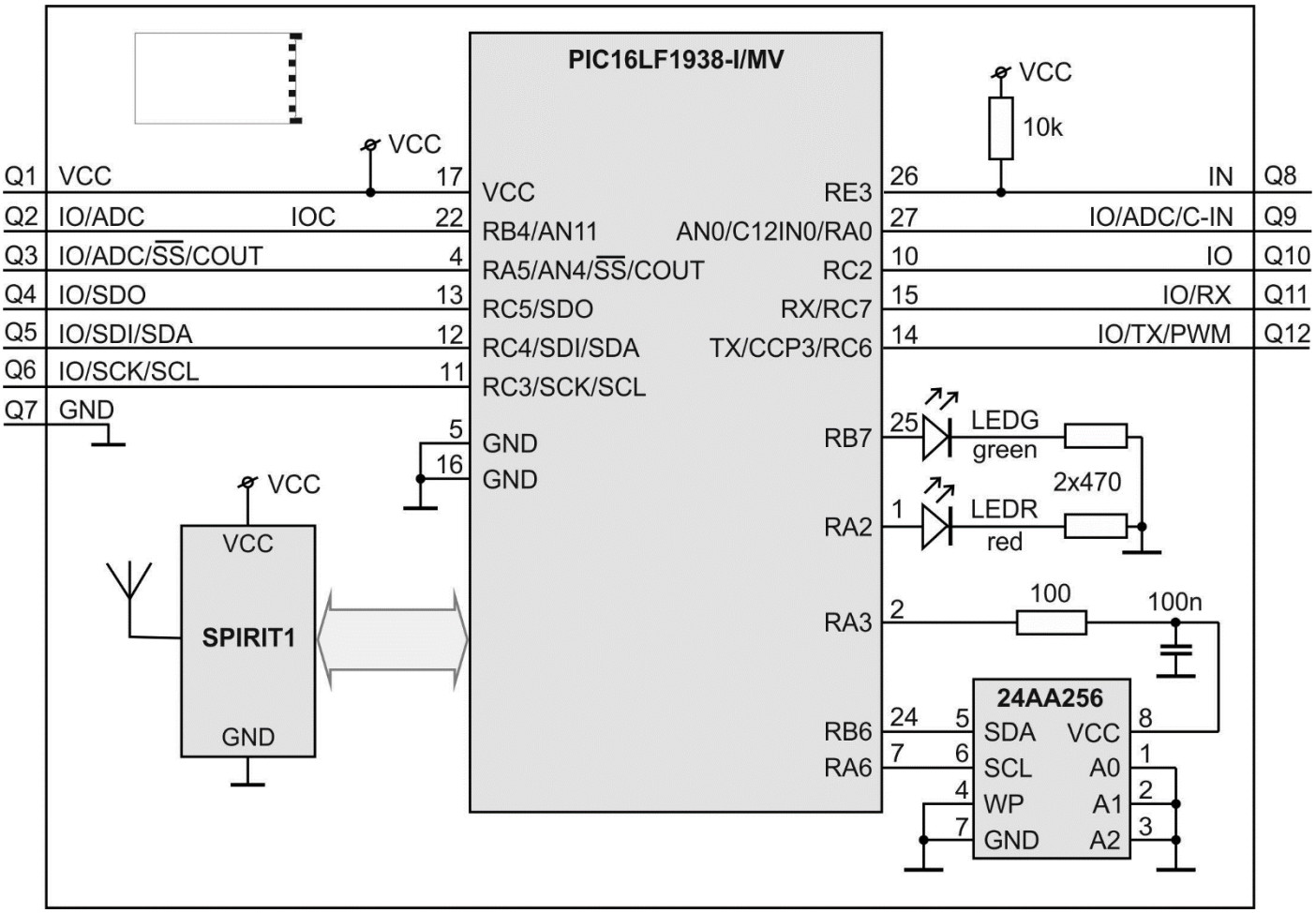
Absolute maximum ratings

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})	3.9 V
Voltage on I/O 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

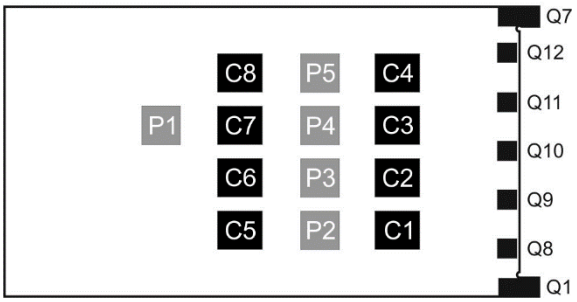
IC	Type	Manufacturer	Note
MCU	PIC16LF1938–I/MV	Microchip	
RF IC	SPIRIT1	STMicroelectronics	
RF balun	BALF-SPI-01D3	STMicroelectronics	
EEPROM	24AA256-I/CS16K	Microchip	256 Kb

For more information refer to datasheets of ICs used.

Pin	Name	Description
Q1, C3	**Vcc**	Power supply voltage
Q2	**IO / ADC**	
	RB4	General I/O pin, programmable pull-up Interrupt / Wake-up on change (IOC) RFPGM / (X)LP mode termination
	AN11	Analog A/D input
Q3, C5	**IO / ADC / -SS / COUT**	
	RA5	General I/O pin
	AN4	Analog A/D input
	-SS	SPI Slave select
	C2OUT	Comparator output
Q4 [1], C8	**IO / SDO**	
	RC5	General I/O pin
	SDO	SPI data out
Q5 [1], C7	**IO / SDI / SDA**	
	RC4	General I/O pin
	SDI	SPI data
	SDA	I^2C data
Q6, C6	**IO / SCK / SCL**	
	RC3	General I/O pin
	SCK	SPI clock input
	SCL	I^2C clock
Q7, C4	**GND**	Ground
Q8	**IN**	
	RE3	General input only pin
Q9, C1	**IO / ADC / C-IN**	
	RA0	General I/O pin
	AN0	Analog A/D input
	C12IN0	Comparator –input
Q10, C2	**IO**	
	RC2	General I/O pin
Q11	**IO / RX**	
	RC7	General I/O pin
	RX	UART RX
Q12	**IO / TX / PWM**	
	RC6	General I/O pin
	TX	UART TX
	CCP3	PWM output
P1–P5	For manufacturer only	

Top view

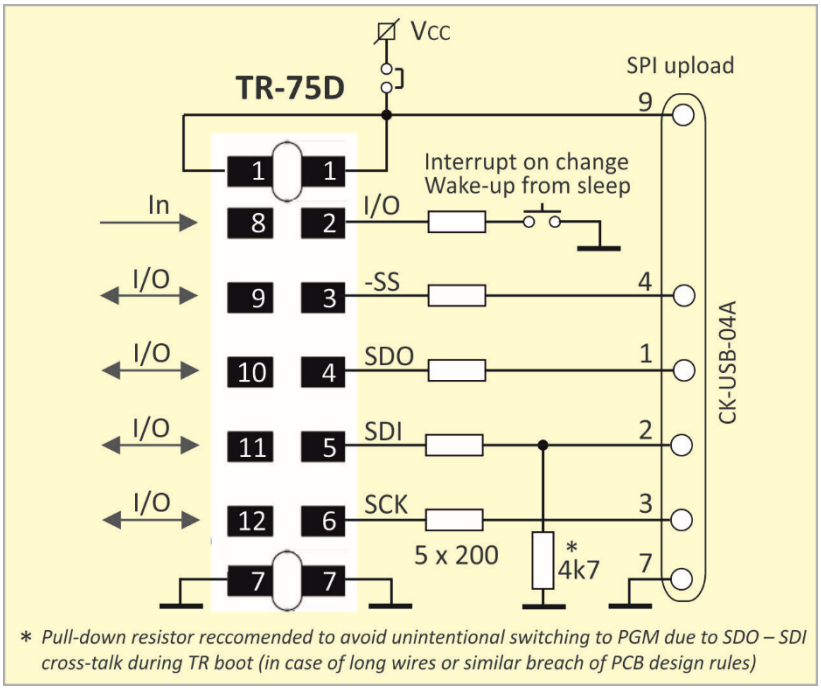
Bottom view



Note 1: Pin Q4 is used as output and pin Q5 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.

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 recommended to implement the following arrangement:

- Serial protective resistors on each I/O pin used.
- Pin Q2 configured as an input with the 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 Q5 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). 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 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*.

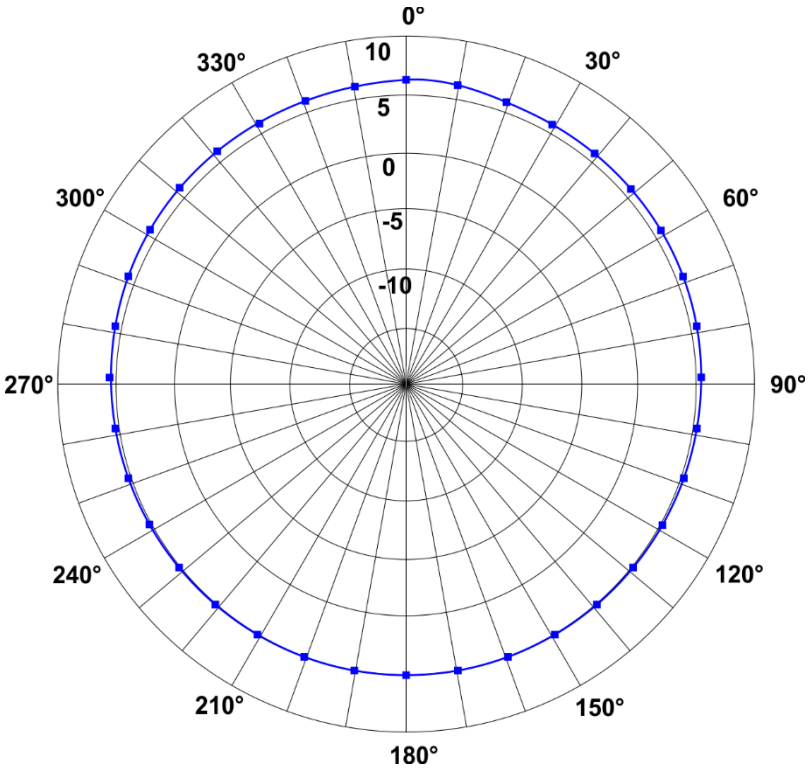
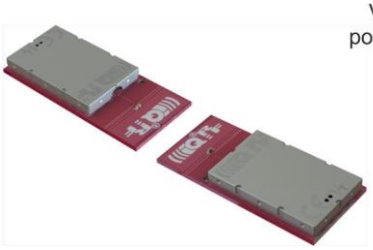


Diagram 1: *TR-75DA RF output power [in dBm] vs. antenna orientation (radiation patterns) in horizontal plane, when the antenna is oriented vertically.*

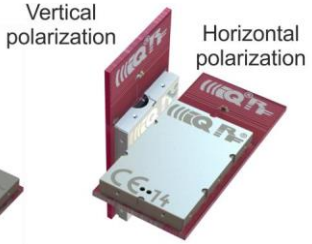
Examples of the correct and incorrect arrangement of TR-7xDA pairs:

Correct

Correct



Incorrect
Wrong radiation angle



Incorrect
Mismatched polarization

Incorrect
Wrong radiation angle
Mismatched polarization

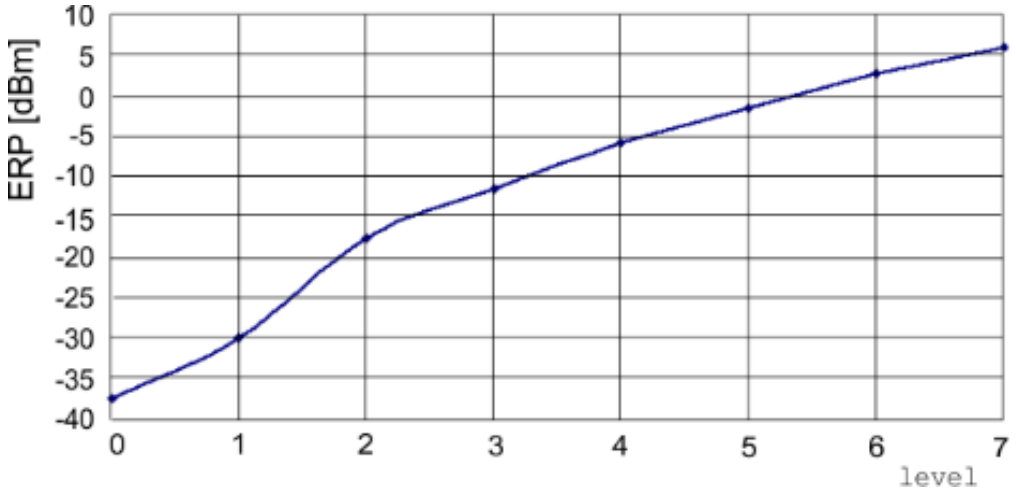


Diagram 2A: *Effective radiated power (ERP) vs. level in the* `setRFpower(level)` *function. TR-75DA, 868 MHz band, channels 0 to 67. Refer to IQRF OS Reference guide.*

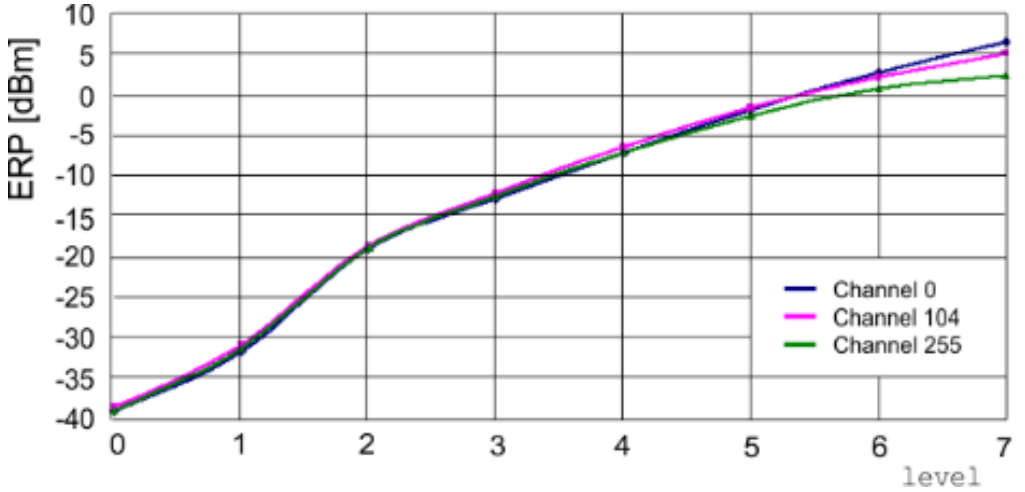


Diagram 2B: *Effective radiated power (ERP) vs. level in the* `setRFpower(level)` *function. TR-75DA, 916 MHz band. Refer to IQRF OS Reference guide.*

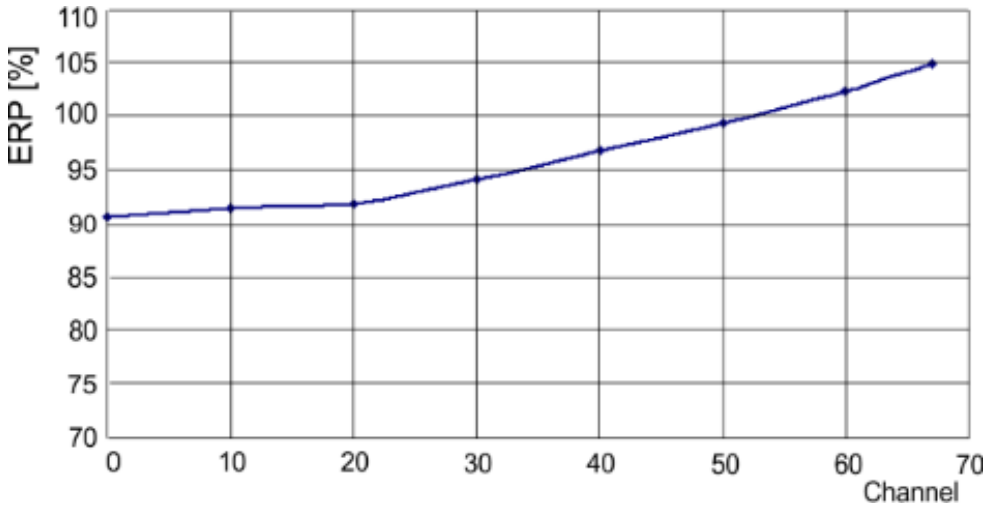


Diagram 3A: *Relative effective radiated power (ERP) vs. channel, with respect to channel 52 (100 %). TR-75DA, 868 MHz band.*

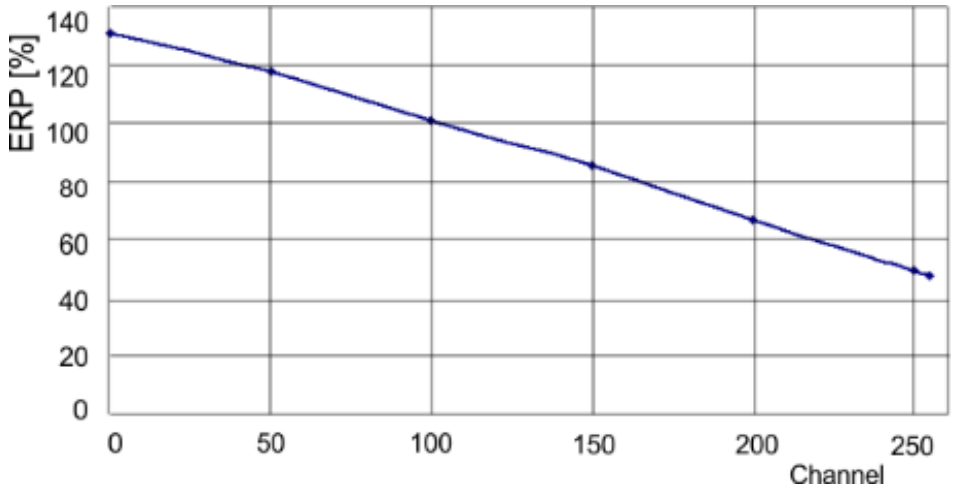


Diagram 3B: *Relative effective radiated power (ERP) vs. channel, with respect to channel 104 (100%). TR-75DA, 916 MHz band.*

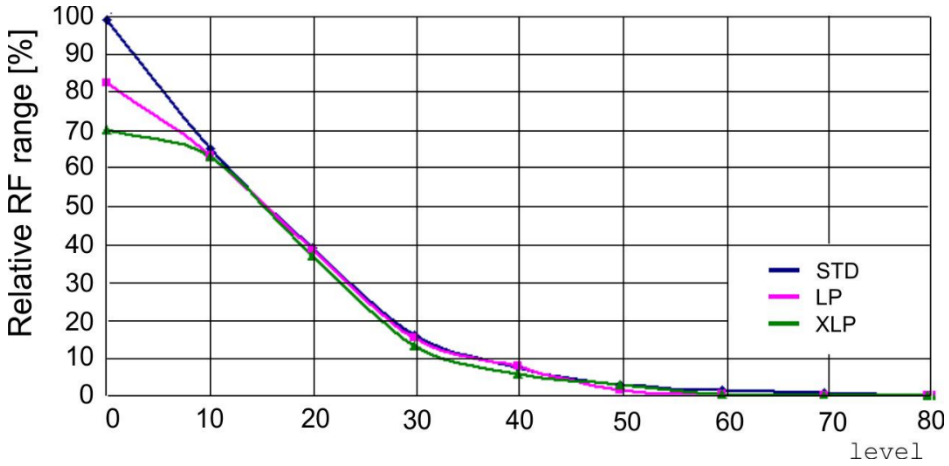


Diagram 4: *Relative RF range vs.* `level` *in the* `checkRF(level)` *function in STD, LP and XLP RX modes. Refer to IQRF OS Reference guide.*

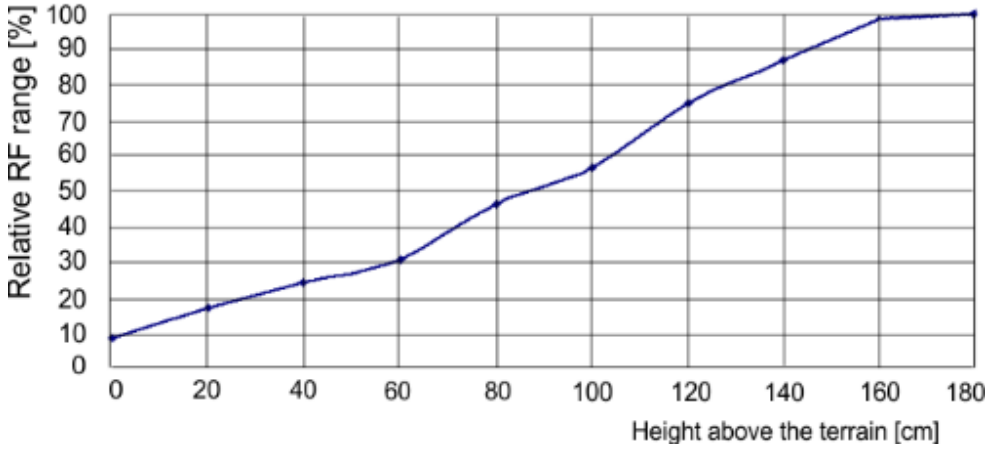
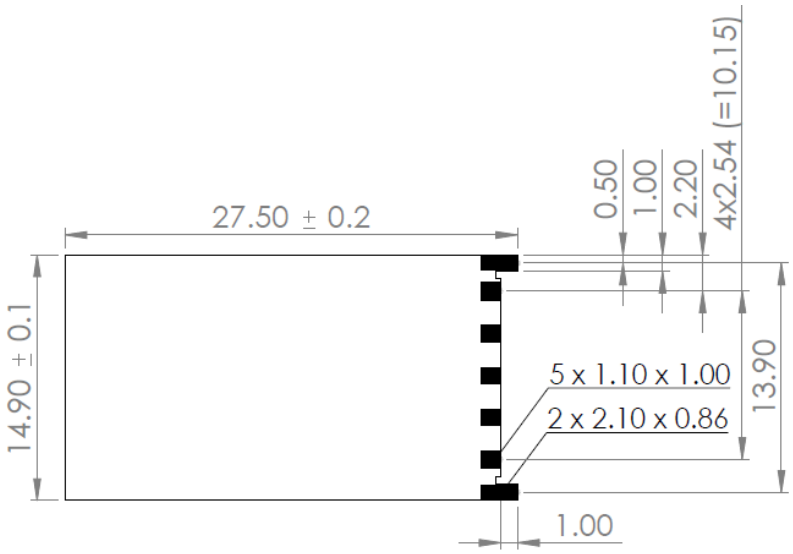


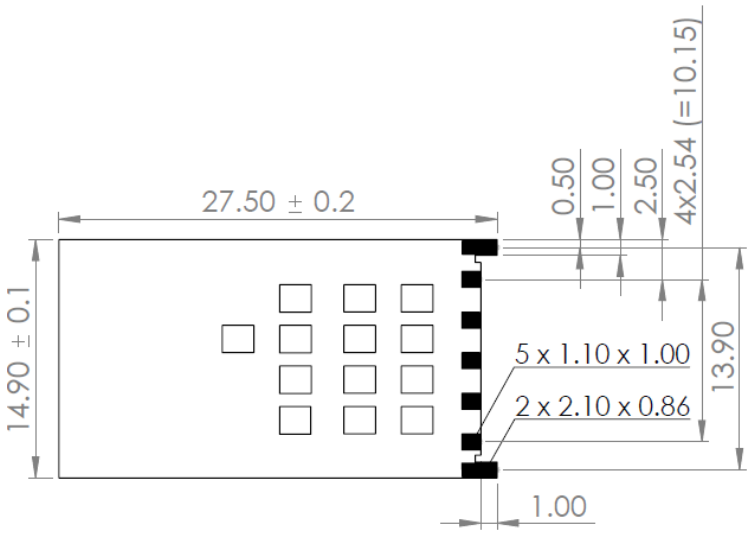
Diagram 5: *Relative RF range vs. antenna height above the ground. TR-75DA, 868 MHz and 916 MHz bands.*

Mechanical drawings

Top



Bottom



Units: mm.

Hardware revision

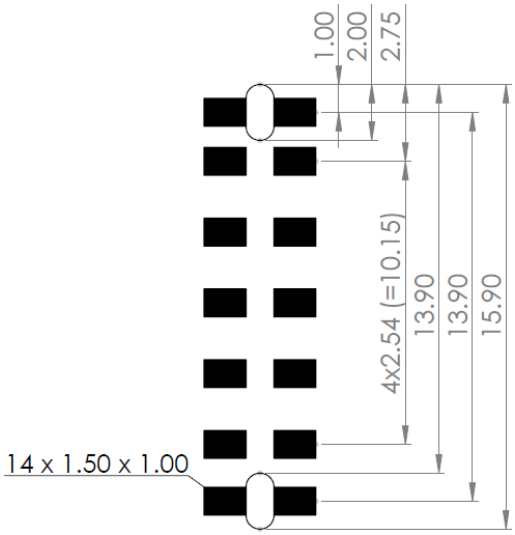
- TR-75DA v1.00 First release.

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.

Recommended PCB layout



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 cleanness 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 the relative permeability (μ_r) as close to 1 within given frequency band. E.g. μ_r = 4 **at 868 MHz** decreases relative range to approx. 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 the specifications.

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-75Dx transceivers:

- Wired upload with TR-75Dx plugged via the SIM connector in the CK-USB-04A programmer.
- For TR-75Dx 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

T R-75D A

- Antenna
  - **A** - PCB antenna
- Transceiver series. TR / DCTR are not differentiated from IQRF OS v4.02D.

Type	Antenna connection	Data controlled
TR-75DA	PCB antenna	Yes

Document history

- 180130 Block diagram revised. RF parameters in chapter *Electrical specifications* revised. A bug in *Note 1* in pin description table fixed. Chapter *RF range* extended. Directives in *Quality management* updated.
- 171108 First release. Preliminary.

Sales and Service

Corporate office

IQRF Tech s.r.o., Prumyslova 1275, 506 01 Jicin, Czech Republic, EU
Tel: +420 493 538 125, Fax: +420 493 538 126, www.iqrf.tech
E-mail (commercial matters): sales@iqrf.org

Technology and development

www.iqrf.org
E-mail (technical matters): support@iqrf.org

Partners and distribution

www.iqrf.org/partners

Quality management

ISO 9001 : 2009 certified

Complies with ETSI directives EN 301 489-1 V1.9.2:2011, EN 301 489-3 V1.6.1:2013, EN 300 220-1 V3.1.1:2017, EN 300 220-2 V3.2.0:2017 and ERC Recommendation 70-03 (2017) and VO-R/10/05.2014-3.

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

Trademarks

The IQRF name and logo are registered trademarks of IQRF Tech s.r.o.
PIC, SPI, Microchip and all other trademarks mentioned herein are a property of their respective owners.

Legal

All information contained in this publication is intended through suggestion only and may be superseded by updates without prior notice. No representation or warranty is given and no liability is assumed by IQRF Tech s.r.o. with respect to the accuracy or use of such information.

Without written permission, it is not allowed to copy or reproduce this information, even partially.

No licenses are conveyed, implicitly or otherwise, under any intellectual property rights.

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

On-line support: support@iqrf.org

Smarter Wireless. Simply.