TR-72G

RF Transceiver Module Series

Data Sheet

IQRF®
Smarter Wireless. Mesh.

Description

TR-72G 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 RF circuitry, MCU, integrated LDO regulator, serial EEPROM, optional temperature sensor and optional on-board antenna requires no external components. Ultra low power consumption fits for battery powered applications. Flexible MCU pins enable extended functionality and simpler application circuitry and PCB. Extended MCU memories include built-in operating system which significantly reduces application development time. Optional DPA framework supports applications even without programming.

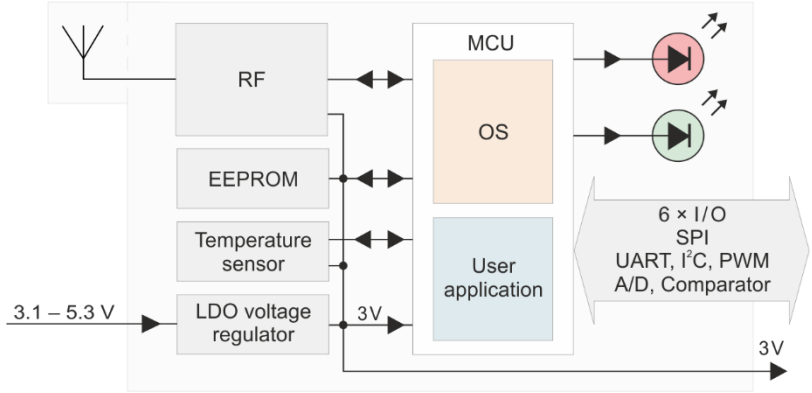
Key features

- Operating system (upgradeable at the user), easy to use
- DPA framework for mesh network applications
- GFSK modulation
- Selectable RF band 868 / 916 MHz, multiple channel
- RF output power 10 mW (10 dBm) with antenna connector
- Eff. radiated power 1.6 mW (2 dBm) with on-board antenna
- MCU with significantly extended memories for program and data
- Extended MCU resources (interrupt capability and programmable internal pull-ups on all pins, remappable digital peripherals, …)
- Extra low power consumption, power management modes
- SPI interface supported by OS in background
- Serial EEPROM 256 Kb
- Multiple PWM output
- Extended programmable HW timer options
- +3 V LDO regulator output, battery monitoring
- 2 LEDs
- 8 pins, 6 I/Os
- A/D converter (multiple channels) and analog comparator
- Options: on-board antenna, U.FL connector, temperature sensor
- SIM card format fits KON-SIM-02 and KON-SIM-01 connectors
- Shielding can (optional)
- 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



Technical specifications — ***Typical values*** *unless otherwise stated*

Parameters specified in this datasheet are typical values. They are at power supply V_{OUT} = 3 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 ± 60 mV (V_{CC} > 3.1 V), 100 mA max.
Operating temperature [1]	-40 °C to +85 °C
Supply current	
Deep sleep mode	< 2 µ A (All peripherals disabled [3], RF IC in Standby mode)
Sleep mode	2.3 µA (all peripherals disabled [3], RF IC in Sleep mode)
Run mode	
RF sleep	1.8 mA
RF ready	3.3 mA
RX mode	
STD	12.5 mA
LP [4]	190 µA
XLP [4]	13 µA
TX mode	8 mA – 25 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	19.8 kb/s
RF receiver category	1.5 (according to ETSI EN 300 220-1 V3.1.1)
RF sensitivity	-103 dBm [5A], -94 dBm [5B], (STD RX mode, `checkRF(0)`). See *Diagram 3*.
RF output power [5A]	Up to 10 dBm (for 50 Ω load), programmable in 8 levels (0 – 7).
Effective radiated power [2, 5B]	Up to 2.0 dBm (868 MHz band), 0.0 to 2.0 dBm (916 MHz band). See *Table 1*.
RF interface [5A]	Single-ended, output impedance 50 Ω
Antenna [5B]	PCB meander line, linear polarization, omnidirectional. See *Diagram 1*.
RF range [2, 5B]	500 m
Input voltage on C1, C2, C5 to C8 pins	0 V to V_{OUT}
A/D converter	10 bit, multiple inputs. Refer to MCU datasheet.
Temperature sensor	MCP9808E/MC (for TR types with 'T' postfix only, e.g. TR-76GT)
Size (L x W x H)	25.1 mm x 14.9 mm x 2.1 mm (TR-72Gxx), 31.8 mm x 14.9 mm x 2.1 mm (TR-72GAx) 25.1 mm x 14.9 mm x 3.3 mm (TR-72Gxx-S), 31.8 mm x 14.9 mm x 3.3 mm (TR-76GAx-S)
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 under real conditions before volume use.

Note 2: Arrangement: Two TR-72GA transceivers plugged directly in DK-EVAL-04A kits, vertically, 1.6 m above the ground, in free space, bidirectional communication.
Test software: E16-RANGE-TEST example (STD mode, `setRFpower(7)`, `checkRF(5)`, Preamble Quality Test active).

Note 3: Additional current is consumed when a peripheral (e.g. watchdog, Brown-out detection, etc.) is enabled.

Note 4: Depends on interferences.

Note 5: **5A:** For TR types without a built-in antenna.
5B: For TR types with built-in antenna.

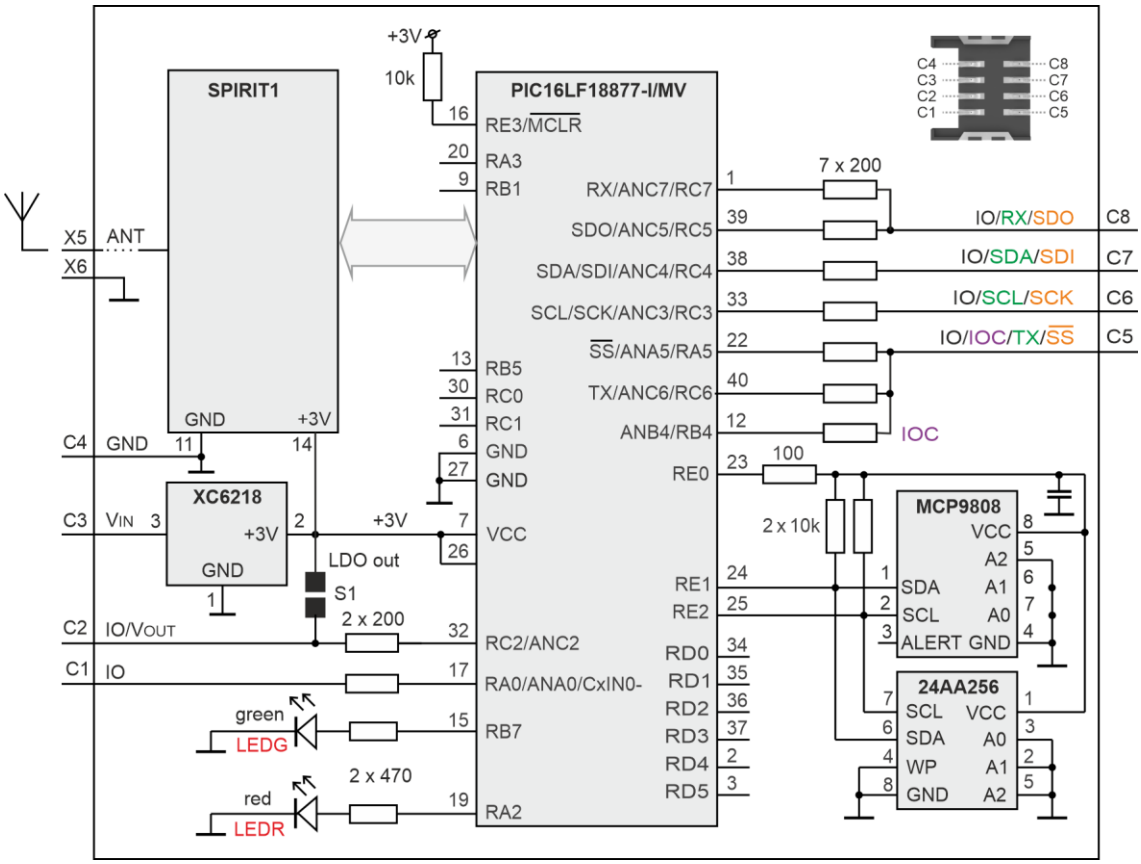
Absolute maximum ratings

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.*

Simplified circuit diagram



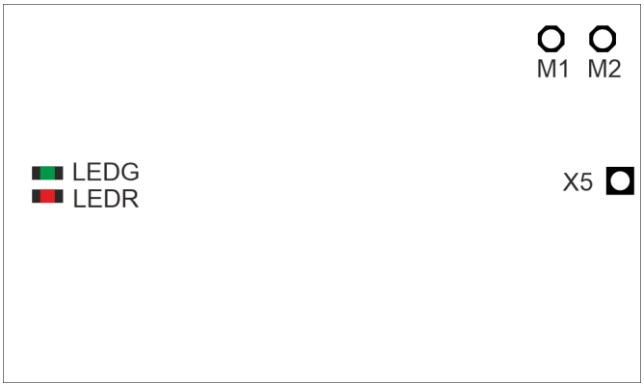
Consider that some of TR pins share several MCU pins connected in parallel. When using multiple functions on these pins, you need to avoid possible collisions.

The colors indicate the constraints on the MCU digital peripheral pin remapping using PPS with respect to IQRF OS and DPA. See *Note 2* below and the Application note *AN015 - IQRF HW design*, chapter *PPS*.

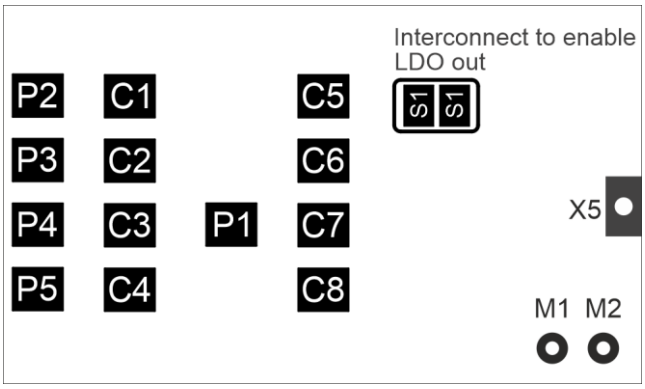
Basic components

IC	Type	Manufacturer	Note
MCU	PIC16LF18877-I/MV	Microchip	
RF IC	SPIRIT1	STMicroelectronics	
RF balun	BALF-SPI-01D3	STMicroelectronics	
LDO voltage regulator	XC6218	Torex Semiconductor	
Temperature sensor	MCP9808E/MC	Microchip	For types with ‘T‘ postfix only, e.g. TR-72GT
EEPROM	24AA256-I/CS16K	Microchip	256 Kb

Pin	Name	Description
C1	**IO / C-IN**	
	RA0	General I/O pin
	ANA0	Analog A/D input
	CxIN0-	Comparator –input
C2	**IO/VOUT**	
	RC2	General I/O pin (if S1 disconnected)
	ANC2	Analog A/D input
	VOUT	On-board +3 V LDO output (if S1 connected)
C3	**VIN**	Power supply voltage
C4	**GND**	Ground
C5	**IO/TX/-SS**	
	RA5	General I/O pin,
	-SS [2]	SPI Slave select
	ANA5	Analog A/D input
	RB4	General I/O pin Interrupt / Wake-up on change (IOC) supported by IQRF OS and DPA. RFPGM / (X)LP mode termination. Dedicated for DPA menu (for DPA v4.30 or higher)
	RC6	General I/O pin
	TX [2]	UART TX
	ANC6	Analog A/D input
C6	**IO/SCK/SCL**	
	RC3	General I/O pin
	SCK [2]	SPI clock input
	SCL [2]	I²C clock
	ANC3	Analog A/D input
C7 [1]	**IO/SDI/SDA**	
	RC4	General I/O pin.
	SDI [2]	SPI data input
	SDA [2]	I²C data
	ANC4	Analog A/D input
C8 [1]	**IO/RX/SDO**	
	RC5	General I/O pin.
	SDO [2]	SPI data output
	ANC5	Analog A/D input
	RC7	General I/O pin
	RX [2]	UART RX
	ANC7	Analog A/D input
X5	**ANT**	Antenna input (except TR-72GAx types)
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



TR-72G top *view*



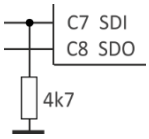
TR-72G b*ottom view*

All MCU pins connected to TR I/O pins (C1, C2, C5. C6, C7, and C8) are equipped with the interrupt on change capability and programmable pull-up resistor and can be used as analog inputs for A/D converter.

Note 1: Pin C8 is used as output and pin C7 as input during the initial approximately 200 ms boot-up (after TR reset) 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 the C7 pin** must be used otherwise a **cross-talk** between C8 and C7 may cause an unintentional switching to PGM.



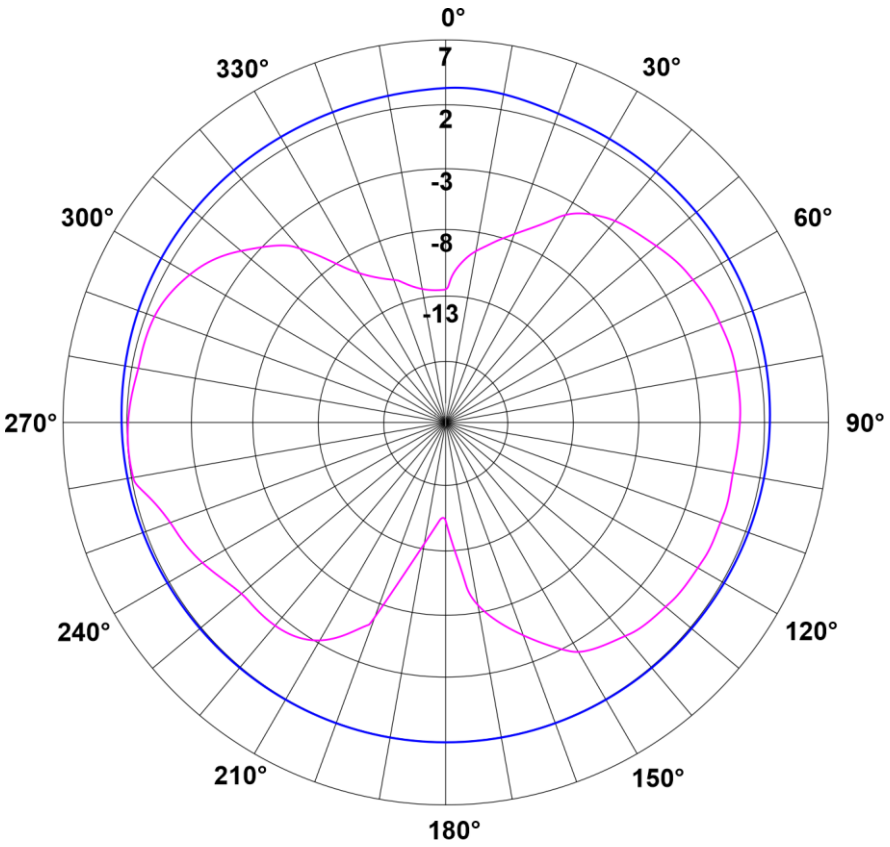
Note 2: All MCU pins dedicated to digital signals of internal peripherals (e.g. UART, I²C, SPI, PWM, timers, analog comparator output, etc.) are remappable in SW. See the MCU datasheet, chapter *Peripheral Pin Select (PPS)* and the application note *AN015 - IQRF HW design*, chapter *PPS*. The list above denotes only the pins assigned to UART, I²C, and SPI by default. Other remappable peripherals (e.g. PWM or analog comparator output) are not denoted there.

See the Application note *AN015 - IQRF HW design*.

RF range

Refer to the Application note *AN014 – 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.
  - The physical arrangement of devices (especially mutual orientations of antennas with respect to polarization and radiation patterns)
- Application software:
  - RF output power is selectable from 8 levels
  - To increase immunity to RF noise, incoming RF signals can be filtered according to signal strength. See the *IQRF OS Reference guide*, function `checkRF` and configuration parameter *RX filter*.



Vertical antenna

Horizontal antenna

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

Examples of the correct and incorrect arrangement of TR-72GA pairs:

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

The **Effective radiated power** (ERP) in the 868 MHz band is constant for all channels. The ERP in the 916 MHz band decreases to higher channels. The ERP drop on channel 255 relative to the power on channel 0 is 2 dBm.

level	ERP [dBm]			
	868 MHz	916 MHz		
	Channels 0 to 67	Channel 0	Channel 104	Channel 255
7	2	2	1	0
6	-1	-1	-2	-3
5	-6	-6	-7	-8
4	-10	-10	-11	-12
3	-16	-16	-17	-18
2	-22	-22	-23	-24
1	-34	-34	-35	-36
0	-42	-42	-43	-44

Table 1: *TR-72GA effective radiated power (ERP) vs.* `level` *in the* `setRFpower(level)` *function.*

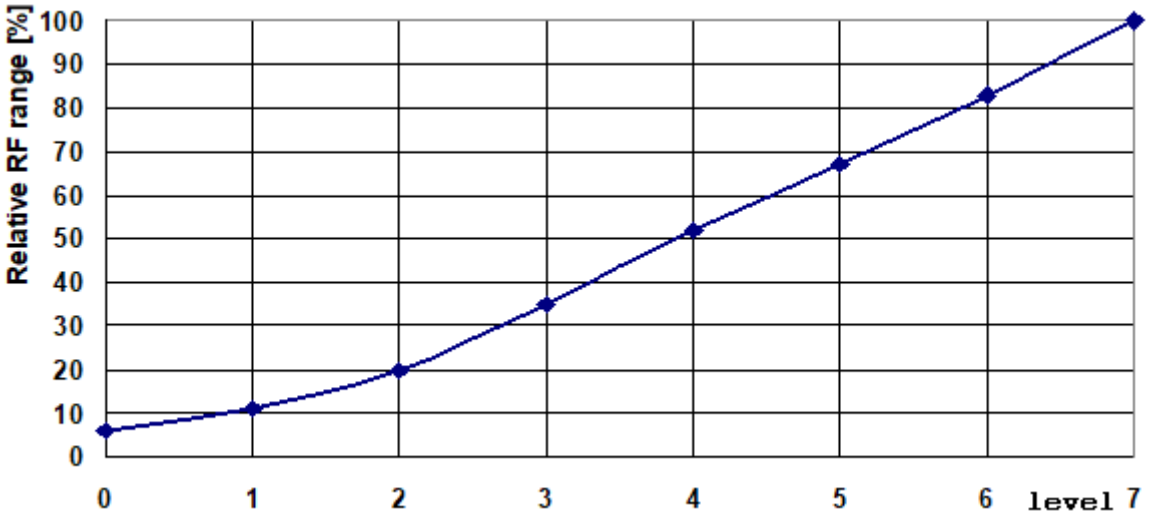


Diagram 2: *TR-72G(A) relative RF range vs.* `level` *in the* `setRFpower(level)` *function.*

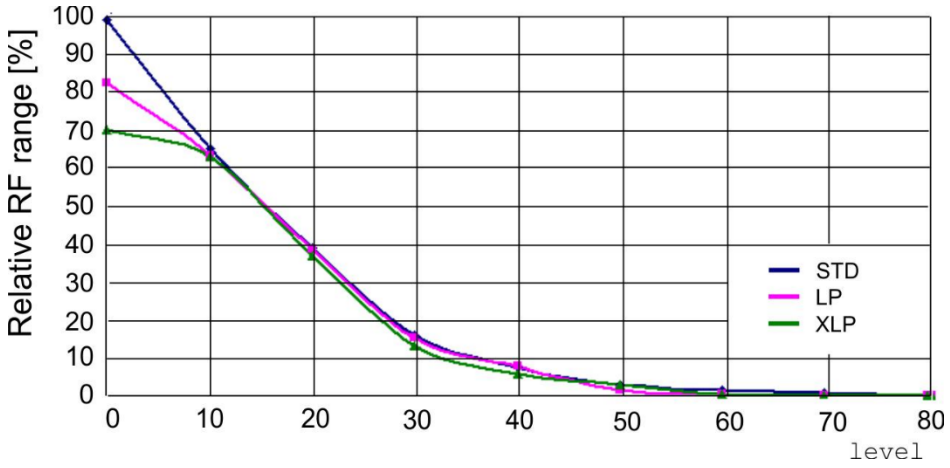


Diagram 3: *Relative RF range vs.* `level` *in the* `checkRF(level)` *function in STD, LP, and XLP RX modes.*

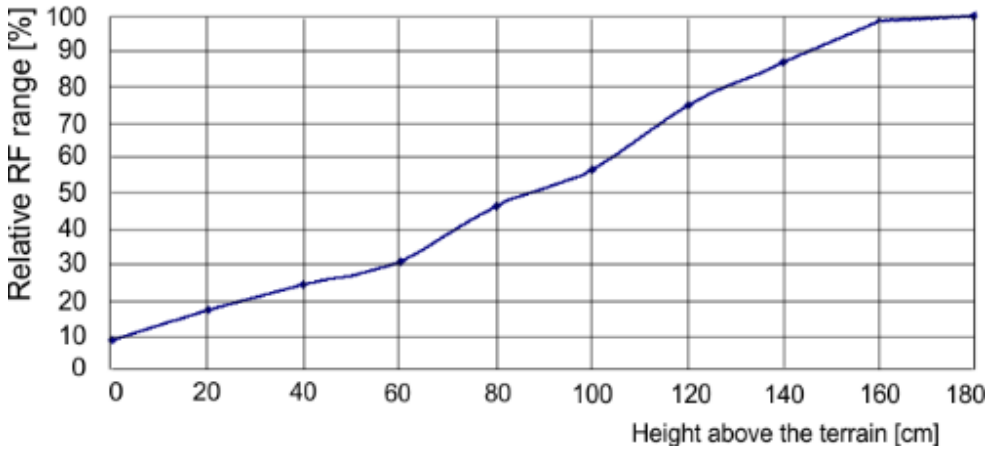
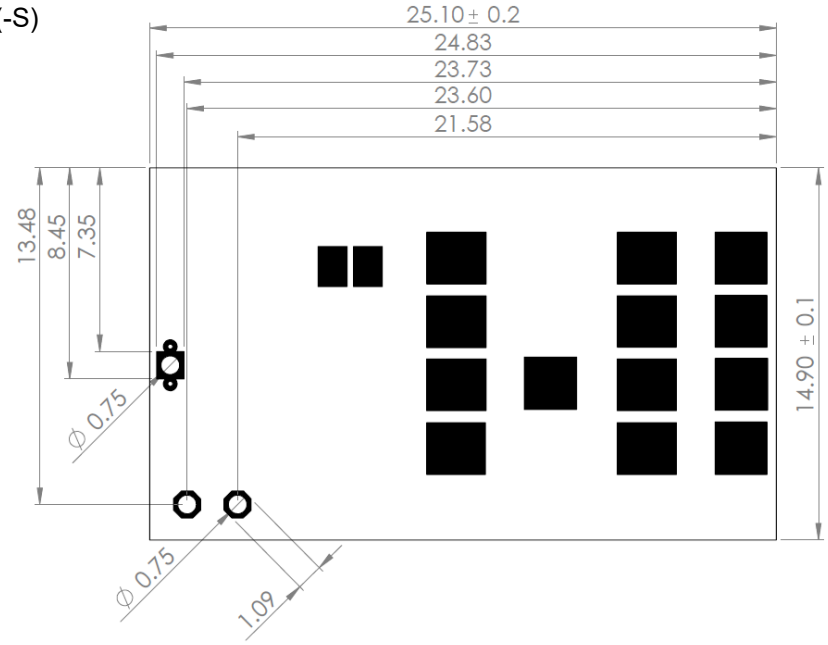


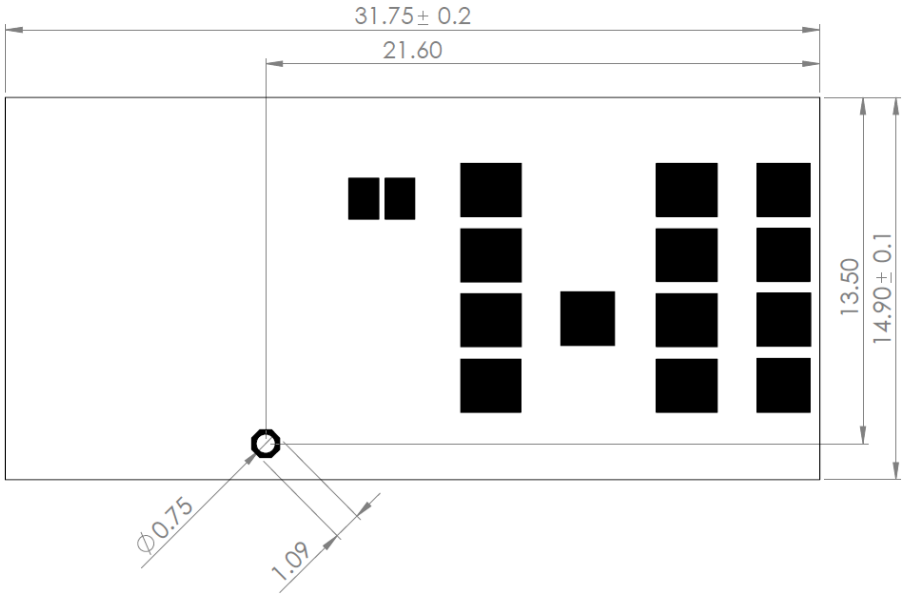
Diagram 4: *TR-72GA relative RF range vs. antenna height above the ground, 868 MHz and 916 MHz bands.*

Mechanical drawings

TR-72G(C)(T)(-S)



TR-72GA(T)(-S)



Top view, Units: mm

Hardware revision

TR-72G(C) v2.01	First release.
TR-72GA v2.01	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 the Application notes *AN015 - IQRF HW design* and *AN014 – RF range*, and IQRF video tutorial set.

Assembly

TR-72Gx modules should be mounted in the 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*, 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-72Gx modules:

- Wired upload with TR-72Gx plugged via the SIM connector in the CK-USB-04(A) programmer.
- For TR-72Gx 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 the 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

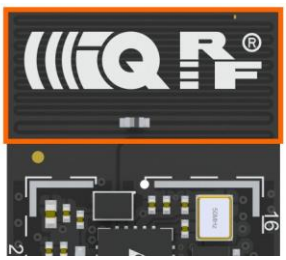
TR-72G A P-S

- Other options
  - ***nil*** **-** No other option
  - **S** **-** Shielding can
- Peripheral options
  - ***nil*** **-** No other option
  - **T** **-** Temperature sensor
- Antenna options
  - ***nil*** **-** soldering pad-hole (no antenna, no U.FL connector)
  - **A** **-** PCB antenna
  - **C** **-** U.FL connector (mini-coax)
- Transceiver series

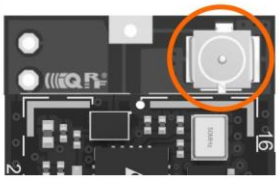
Type	Antenna connection	Temperature sensor	Shielding can
TR-72G	Soldering pad-hole	–	–
TR-72GC	U.FL connector	–	–
TR-72GA	PCB antenna	–	–
TR-72GT	Soldering pad-hole	Yes	–
TR-72GCT	U.FL connector	Yes	–
TR-72GAT	PCB antenna	Yes	–

Type	Antenna connection	Temperature sensor	Shielding can
TR-72G-S	Soldering pad-hole	–	Yes
TR-72GC-S	U.FL connector	–	Yes
TR-72GA-S	PCB antenna	–	Yes
TR-72GT-S	Soldering pad-hole	Yes	Yes
TR-72GCT-S	U.FL connector	Yes	Yes
TR-72GAT-S	PCB antenna	Yes	Yes

TR-72G(T)

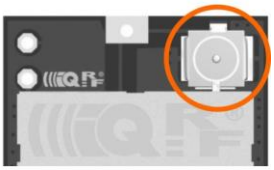


TR-72GA(T)



TR-72GC(T)

TR-72GA(T)-S



TR-72GC(T)-S

Document history

250624	Variants without a shielding can are added. Variants with the shielding can are renamed using the “-S” postfix.
240709	LEDs renamed to LEDG and LEDR. LEDs added to pinout diagram on page 5.
240410	Slightly more precise electrical parameters. The pin description is revised with respect to PPS. *Simplified circuit diagram* is slightly improved. Directives in chapter *Quality management* update. Some minor improvements. Document non-preliminary.
230829	TR-72G added to chapter *Hardware revision*. Descriptions of the *Antenna options* pictures are slightly extended. A bug in *Note 5* in chapter *Technical specifications* is fixed.
230519	The pull-up resistor value on the -MCLR MCU pin is specified in *Simplified circuit diagram*. The description of pins on page 5 is slightly extended.
221118	Bug in *Table 1* fixed.
220718	Preliminary release.

Sales and Service

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

Partners and distribution

Distributors: www.iqrf.org/partners
IQRF E-shop: https://eshop.iqrf.org

Quality management

ISO 9001 : 2016 certified.

When used under the conditions of use specified by the manufacturer, the product complies with the essential requirements and other relevant provisions of the directives 2004/108/EC (EMC), 2014/53/EU (RED), and 2018/738/EU (RoHS).

Harmonized standards or other relevant technical specifications used on the basis of which conformity is declared:

Radio spectrum:	*ETSI EN 301 489-3 V2.1.1*
EMC:	*ETSI EN 301 489-1 V2.2.3*
	EN 55032 ed. 2
	EN 55035
Safety:	*EN IEC 62368-1 ed. 2+A11*
RoHS:	*EN IEC 63000*

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