

Technical Documentation

for metraTec QR15 v2 HF RFID Module



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1 General Information / Security Advice

1.1 Notes on the Use of this Documentation

This user manual and integration guide uses different symbols to point out potentially dangerous situations. The following signs and symbols are used throughout the document.



ATTENTION

Declares a potentially hazardous situation. If this is not avoided, the product or something in its surrounding could be damaged.



NOTES

Declares notes for the user as well as other useful information, where no harmful or dangerous situations can be expected.

1.2 Security Advice

The QR15 HF RFID Module was not designed for use in dangerous environments. Using this product in applications where a failure could directly result in severe injuries or death (“high risk activities”) is not permitted. This includes but is not limited to applications in nuclear facilities, flight control systems, life support systems or weapon systems. The manufacturer denies the suitability of this device for such scenarios.

1.3 Export Restriction

The QR15 HF RFID Module contains components that underlie US export restrictions. It is therefore forbidden to export the product to countries that are on the US trade embargo list. The same applies to any countries that are on the EU embargo list.

1.4 Further Documentation

While this documentation explains the electrical and mechanical characteristics of the QR15 module, it might be useful to also read the metraTec Protocol Guide, which explains the ASCII protocols used to control the module in full detail.

Source: <http://www.metratec.com> → Support → Downloads → Documentation

2 Product Description

The QR15 HF RFID Module is an easy to use RFID module which can be integrated into your electronics without big effort. This allows you to equip your product with RFID functionality without designing your own RF board. Thanks to the tested and extremely flexible firmware you can read and write data to any tag that follows the ISO 15693 standard in no time. Even special features, e.g. sensor tags, can be used without firmware modifications. With its internal antenna a read range of up to 100mm is possible.

Thanks to the fast firmware, the module is perfect for applications in printers and similar devices where high reading and writing speed is needed.

2.1 Product Revision History / Migrating from prior Revisions

This document applies to QR15 v2 revisions starting from 01.00. All future revisions 1.xx will be according to this documentation. The hardware revision is printed on the board or can be checked using the Read Hardware Revision (RHR) command. Compared to its predecessors revision QR15 modules feature the following improvements:

- ✓ switchable RF output power level
- ✓ up to 100 mm read range
- ✓ increased RX sensitivity
- ✓ two switchable Receivers
- ✓ improved EMI / EMC behaviour
- ✓ default 5V UART interface for 100% backward compatibility to QR15 v1 or 3V3 UART hardware option for glueless interfacing to 3V3 microcontrollers



Fig. 1: QR15 v2 top view

2.2 Intended Use

The QR15 HF RFID Module reads RFID tags that comply to the ISO 15693 standard on a short range of 30-80 mm. Custom tag commands can be used without firmware changes if the tags follow the ISO 15693 standard with regard to the air interface. For transponders that use the ISO 14443A or a protocol with MIFARE® technology, please use our QR14 RFID Module.

2.3 Technical Specification

	Min.	Typ.	Max.
Supply voltage	4.7 V	5.0 V	5.5 V
Supply Current Standby		20mA	
Supply Current RF on 200mW	135	150mA	160mA
Supply Current RF on 100mW	95	110mA	120mA

RF output power 200mW	150mW	200mW	225mW
V_In_low (GPIO)	-0.3 V	0	0.9 V
V_In_high (GPIO)	2.3 V	3.3 V	3.45 V
V_out_low (GPIO)	-	0	0.4 V
V_out_high (GPIO)	2.9 V	3.3 V	3.45 V
Operating Temperature ⁽¹⁾	-25°C	20°C	+85°C
Antenna port impedance		Internal antenna, 2250 mm ²	
Carrier frequency ⁽²⁾		13.56 MHz	
Supported RFID Protocol		ISO 15693	
Dimensions		50,08 x 50,08 mm	
Antenna Connector		n.a.	
Communication Interface ⁽³⁾		5V UART	
Humidity			Non-condensing

(1) RFID performance may vary with temperature, check in application

(2) assigned worldwide

(3) SPI available on request

2.4 Pin assignments and description

All connectors are standards 2.54mm pin headers with 9.2 mm mating length.

Pins are marked in the top layer for reference. An Eagle library is available for easy integration into PCB designs.

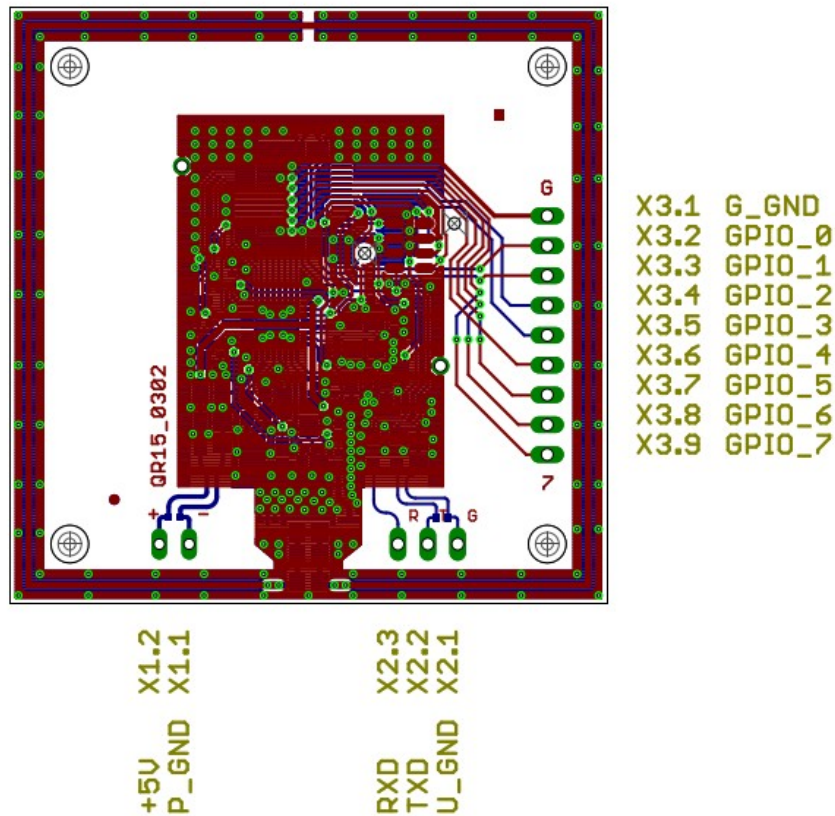


Fig. 2: QR15 v2 Pin Positions and Naming (top view)

Power connector is the two position pin header X1.

Pin Name	Pin Nr.	Pin Direction	PCB Pin Marking	Pin Function
P_GND	X1.1	PWR	"-"	power supply GND, internally connected to G_GND
+5V	X1.2	PWR	"+"	main supply, connect low noise regulated 5V supply

Tab. 1: Power Supply Pins

UART connector is the three position pin header X2.

Pin Name	Pin Nr.	Pin Direction	PCB Marking	Pin Function
U_GND	X2.1	Pass.	"G"	UART GND, NOT internally connected to P_GND and G_GND
TXD	X2.2	out	"T"	5V UART Transmit data output 100 Ohm series protection resistor and EMI low pass filter
RXD	X2.3	in	"R"	5V UART Receive data input

Tab. 2: UART Pin connections

GPIO connector is the nine position pin header X3.

Pin Name	Pin Nr.	Pin Direction	PCB Marking	Pin Function
G_GND	X3.1	Pass.	"G"	GPIO GND, internally connected to P_GND
GPIO_0	X3.2	I/O	none	3.3V GPIO, direction is configurable via FW command, alternate functions on request,

				high drive pin, 15mA drive strength
GPIO_1	X3.3	I/O	none	3.3V GPIO, direction is configurable via FW command, alternate functions on request, high drive pin, 15mA drive strength
GPIO_2	X3.4	I/O	none	3.3V GPIO, direction is configurable via FW command, alternate functions on request, 4mA drive strength
GPIO_3	X3.5	I/O	none	3.3V GPIO, direction is configurable via FW command alternate functions on request, 4mA drive strength
GPIO_4	X3.6	I/O	none	3.3V GPIO, direction is configurable via FW command, alternate function: SPI clock (SCK), 4mA drive strength,

GPIO_5	X3.7	I/O	none	3.3V GPIO, direction is configurable via FW command, alternate function: SPI slave select (SSEL), alternate function: RS485 transmit driver enable (TXDEN), 4mA drive strength
GPIO_6	X3.8	I/O	none	3.3V GPIO, direction is configurable via FW command, alternate function: SPI clock Master In Slave Out (MISO), 4mA drive strength
GPIO_7	X3.9	I/O	"7"	3.3V GPIO, direction is configurable via FW command, alternate function: SPI Master Out Slave In (MOSI), 4mA drive strength

Tab. 3: Overview of digital input/output pins

2.5 Mechanical Specification

PCB dimensions as well as pin positions remain unchanged compared to prior revisions of the QR15.

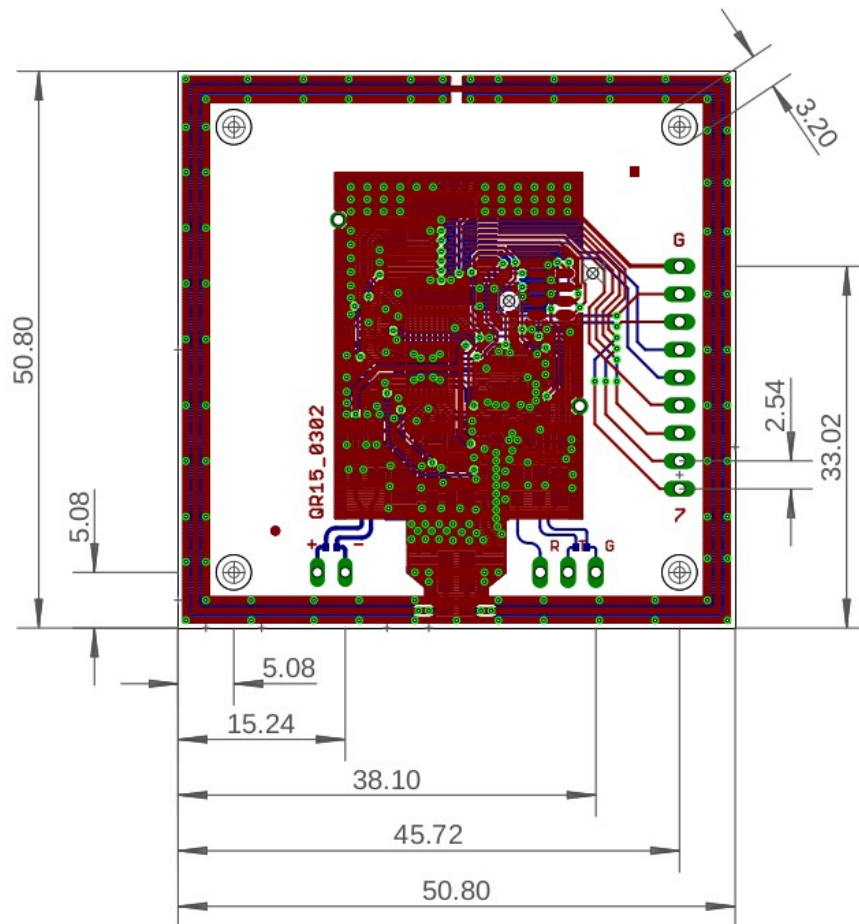


Fig. 3: Mechanical Dimensions QR15 v2

2.6 Scope of Delivery

The QR15 HF RFID Module comes with the following parts:

- QR15 HF RFID Module
- Documentation, Drivers and Demo Software are available via download from metraTec's website

2.7 Accessories

The following accessories and modules are available to extend and evaluate the functionality of the QR15 HF RFID Module:

- UDB Mini Evaluation Board
- HF Field Detector
- different RFID tags suitable for almost every application

3 RFID Integration Guide

3.1 General Hints

The QR15 features an onboard antenna emitting a magnetic field at 13.56MHz.

Therefore the design should have no loops of wires or traces close to the module. This could lead to unintended inductive coupling and affect the function of the RFID module, the host and cause EMI problems.

There should be no wires or traces crossing the area behind the module, traces will detune the internal antenna and reduce reading performance. The same applies to metallic parts of substantial size close to the module. There should be no ground planes parallel to the module, keep the module area clear of copper in all PCB planes.

The module features complete shielding of all RF circuitry which is necessary for the FCC modular approval. However, copper plane and shield cage of the module were designed to work with the onboard antenna. The effect of adding additional metallic parts is rather unpredictable. Please contact metraTec if you have doubts that all of the above hints can be incorporated into your design.

3.2 List of applicable FCC rules and ISED radio standards

HF RFID applications should comply to:

US/FCC: 47 CFR § 15.225 - Operation within the band 13.110-14.010 MHz

CAN/ISED: RSS-210 (Issue 10) Licence-Exempt Radio Apparatus: Category I Equipment

3.3 Specific operational use conditions

Not applicable.

3.4 Limited module procedures

Not applicable.

3.5 Trace antenna designs

Not applicable.

3.6 RF exposure considerations

US/FCC:

The conducted/radiated output power of the device is far below the FCC radio frequency exposure limits. Nevertheless, the device should be used in such a manner that the potential for human contact during normal operation is minimized.

CAN/ISED:

This equipment complies with ISED radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance of 1 **cm** between the radiator and your body.

This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

Cet équipement est conforme aux limites d'exposition aux rayonnements ISED établies pour un environnement non contrôlé. Cet équipement doit être installé et utilisé avec un minimum de 1 **cm** de distance entre la source de rayonnement et votre corps.

Ce transmetteur ne doit pas être placé au même endroit ou utilisé simultanément avec un autre transmetteur ou antenne.

3.7 Antennas

The module may only be operated using the internal antenna.

3.8 Label and compliance information

The host product must be labeled with:

Contains FCC ID: YUH-Q152

Contains IC: 9278A-Q152

3.9 Information on test modes and additional testing requirements

Not applicable.

3.10 Additional testing, Part 15 Subpart B disclaimer

This modular transmitter is only FCC/ISED authorized for the specific rule part/radio standards specification listed on the grant/certificate. The host product manufacturer is responsible for compliance to any other FCC rules/ISED radio standards specifications that apply to the host not covered by the modular transmitter grant of certification.

If the host product manufacturer markets their product as being Part 15 Subpart B compliant (when it also contains unintentional-radiator digital curcuity), then the host product manufacturer shall provide one of the following notices (whichever is applicable in the user manual:

Class A:

For a Class A digital device or peripheral, the instructions furnished the user shall include the following or similar statement, placed in a prominent location in the text of the manual:

Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Class B (use in a residential environment):

For a Class B digital device or peripheral, the instructions furnished the user shall include the following or similar statement, placed in a prominent location in the text of the manual:

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.*
- Increase the separation between the equipment and receiver.*
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.*
- Consult the dealer or an experienced radio/TV technician for help.*

4 Power Supply and Power Consumption

The module does not feature a reverse polarity protection. It is the task of the host board to supply a well filtered 5 V DC supply in order to achieve an optimum RFID performance.

All internal voltages are derived from the 5V supply using onboard regulators. However, RFID systems require a very high level supply quality. Use linear regulators with high precision and high control speed whenever possible. When using switching power supplies make sure the switching speed is above 500 kHz and use an EMC optimized layout as well as shielded inductors.

4.1 Hints for additional EMC filtering

The QR15 Module contains an RF generator at 13.56 MHz which also generates harmonics. These will be radiated from the module below all current certification limits. When integrating the module into another device with long cables or big ground planes, radiated emissions might increase. It is advisable to follow good layout practices and add additional EMC filtering to comply with all relevant norms. Common mode supply filters are required in most cases to comply with basic radiated emission rules. The following picture shows radiated emissions of a QR15 RFID engine mounted on a metraTec evaluation board.

In most cases the hosts power and UART ground are identical. A four wire connection to the QR15 using +5V, P_GND, RXD and TXD only is best in that case.

A 1nF ceramic cap is forming a low pass filter with a series ferrite bead at TXD. This cap is referenced to U_GND. Hosts wanting to use that cap for preventing RF leaking via UART lines may connect the UART ground via U_GND. The U_GND pin is not internally connected to the QR15 GND signal. The rise time is somewhat larger using that option. Attention should be taken not to introduce a GND loop by using U_GND and G_GND connections.

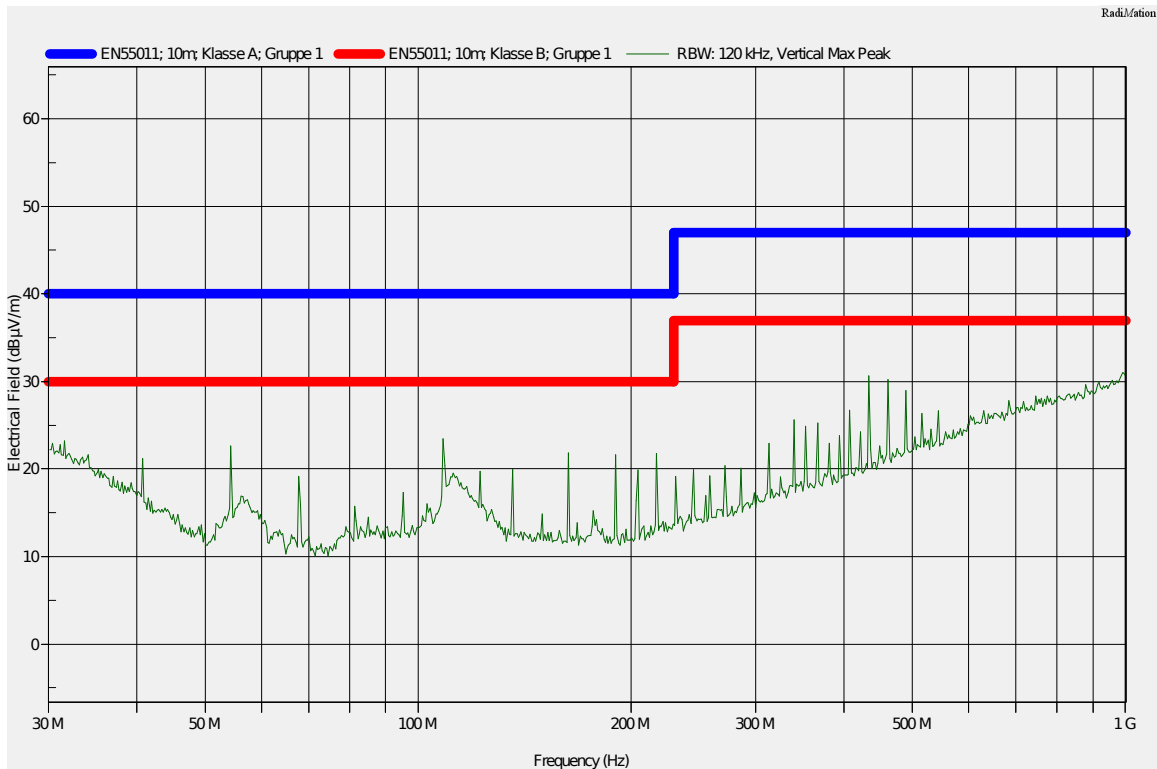


Fig. 4: Radiated Emissions of QR15 RFID engine on metraTec evaluation board at full output power (200mW), 2250 mm² antenna area

5 Communication

The QR15 HF RFID Module communicates with its host using a 5V UART connection. This enables direct connection to a host microcontroller. The communication details of the serial interface are given in the table below.

	Min.	Typ.	Max.
Baudrate ⁽¹⁾	114 000	115 200	116 500
Databits		8	
Parity		None	
Stopbits	1	1	1.5

(1) Others on request

There is a range of circuits available to convert the 3.3 V UART Signal to RS232, RS422/485 or to USB or Ethernet. A RS485 driver enable signal is available as alternate pin function on GPIO_5 pad. Please contact metraTec if you need advice on converter circuits.

The UART commands used to control the QR15 Module are described in the metraTec Protocol Guide. This guide comprises a detailed description of all commands, response formats and examples. As this protocol is shared among several metraTec products the guide is available in a separate document from metraTec's website.

A 3V3 UART interface hardware option is available for glueless interfacing to 3V3 microcontrollers.

6 Digital Inputs / Outputs (GPIOs)

The QR15 Module has eight freely configurable input/output pins which can be set and read via the module. To use these GPIOs just connect your signals to the corresponding vias (X3). All signals are 3V3 signals.



ATTENTION

Please make sure that you only connect 3.3V level devices to the GPIOs or use the right level shifter if connecting other devices. Some industrial devices use 24 V DC inputs/outputs. If you connect these without proper protection, this will most likely destroy the Dwarf15.

Alternative pin functions are available. Project specific firmware is needed for alternate functions. Please contact metraTec. GPIO functionality and direction setting is disabled when an alternate function for a pin or pin group is selected. Not all functions can be combined.

7 Certification



ATTENTION

Changes or modifications to the module not expressly approved by metraTec could void the user's authority to operate the equipment.

7.1 CE / ETSI (EU)

The QR15 HF RFID Module complies with ETSI EN 300 330. Nonetheless, the integrator of the module has to make sure that all requirements are met by the final product. It is his obligation to declare product conformity. We recommend to assign this task to a qualified third-party test lab specialized on EMC measurements.

7.2 FCC (USA)

To fulfill all FCC requirements the integrator must test the final product to comply with FCC regulations regarding intentional and unintentional radiators before declaring FCC compliance of his own product.

The module meets the requirements for an FCC modular approval as a single-modular transmitter. Please contact metraTec in case a modular approval is beneficial for your integration project.

7.3 IC (Canada)

Certification requirements for Industry Canada (IC) are similar to those of the FCC. Limits of ICES-003 for radiated emissions are similar to the formats specified in FCC Part 15 and CISPR 22. Industry Canada accepts FCC test reports or CISPR 22 test reports for compliance with ICES-003. The integrator is responsible for its product to comply with all relevant IC rules.

8 Further Notes

Electronic devices like the QR15 HF RFID Module are covered by the (German) ElektroG (electronic waste law) as well as the European WEEE directive and as such may not be disposed of by way of the normal household trash. Instead they have to be recycled properly. For you as our customer this is no additional burden, however, as you can send the device back to us for proper recycling. We assure you that the devices received back will be recycled properly and in an environmentally friendly way. Our WEEE Registration ID is DE 56060482.

When selecting electronic components we additionally made sure that all components are free of heavy metals and other harmful substances as required by the RoHS Directive for many industries. Hence, our products are produced in the most environmentally friendly way possible.



9 Version History

<i>Versio n</i>	<i>Change</i>	<i>Changed by</i>	<i>Date</i>
1.0	created	TM	2.10.2020
1.1	UART voltage level changed to 5V default fo backward compatibility	TM	19.4.2021
1.2	UART filter and GND description adapted to 5V version	TM	9.8.2021
1.3	FCC/ISED module integration added	TM	31.8.2022

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Changes in function, form, features can happen without prior notice.