Data Sheet / User Manual

Radio Module RB-TW-2400

1 Table of Content

1.1 Introduction

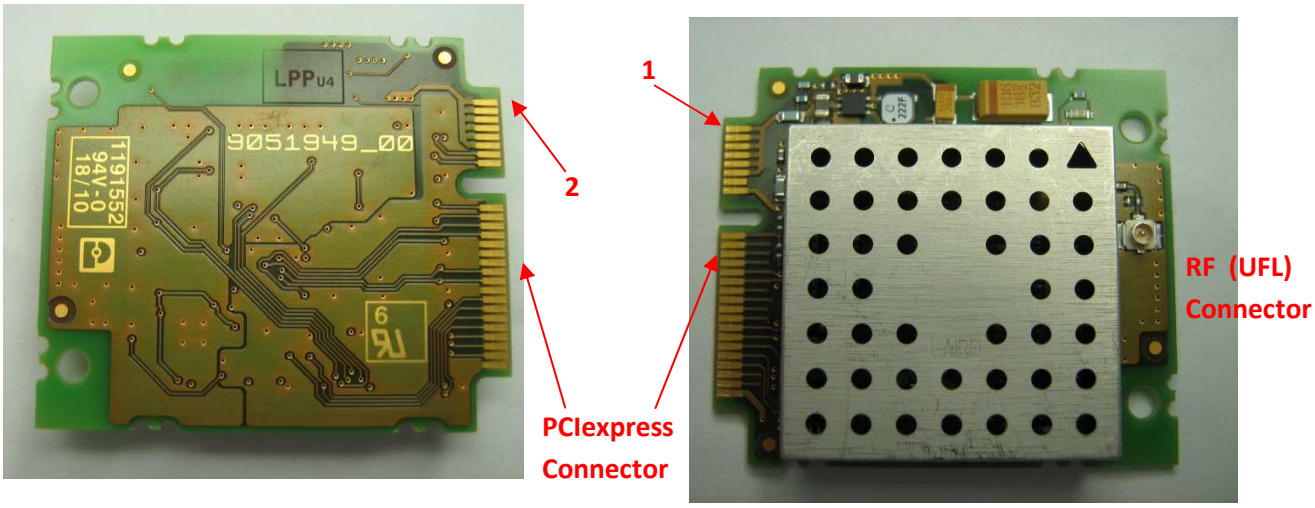
The hardware with the PCB identifier 9054212_01 and the module is Type Approved with the type name RB-TW-2400.

The radio module RB-TW-2400 is a radio platform with an implemented radio stack, named Trusted Wireless (TW). TW is a proprietary network with a frequency hopping technology.

2 Electrical Interface and Connectors

This section describes the signals available on the module interface connectors.

2.1 Pin Numbering



2.2 Pin Description

PIN	Signal Name	Function	Type	Description
1	VCC Power		PWR	3.7-6.0VDC Power supply
2	GND Power		PWR	Power GND
3	VCC Power		PWR	3.7-6.0VDC Power Supply
4	GND Power		PWR	Power GND

5	VCC Power		PWR	3.7-6.0VDC Power supply
6	GND Power		PWR	Power GND
7	VCC Power		PWR	3.7-6.0VDC Power supply
8	GND Power		PWR	Power GND
9	VCC Power		PWR	3.7-6.0VDC Power supply
10	GND Power		PWR	Power GND
11	VCC Power		PWR	3.7-6.0VDC Power supply
12	GND Power		PWR	Power GND
13	NC			
14	Power ON/OFF		IN	Set Open/Low, pin is internally pulled-up with 10kOhm. OFF = PIN to GND
15	Digital GND		GND	Digital GND
16	Power out		OUT	3V3DC regulated output; max. load 20mA
17	RESET		IN	Set Open/Low, pin is internally pulled-up with 120kOhm. Reset = PIN to GND
18	Indication1	Part of the API	OUT	API Comminication interface
19	Indication2	Part of the API	OUT	API Comminication interface
20	RF Link	Link	OUT	Raed H/L
21	API Select	Use SPI or UART	IN	Switch able H/L SPI =
22	SPI	SIMO	IN	API Comminication interface
23	SPI	enable	OUT	API Comminication interface
24	SPI	SOMI	OUT	API Comminication interface
25	SPI	CLK	OUT	API Comminication interface
26	GND	Digital GND	GND	Digital GND
27	UART API		IN	API Comminication interface

28	UART GND	Digital GND	GND	GND Digital
29	UART API	TX	OUT	API Comminunication interface
30	GND	Digital GND	GND	GND Digital
31-52	for internal use		NC	NC

2.3 Characteristics

2.3.1 Power supply

Signal Name	Parameter		Value	Unit
VCC Power	Power Supply	min	3.7	V DC
		max	6.0	V DC

The module is equipped with Step Down Converter.

2.3.2 Current consumption

Signal Name	Parameter		Value	Unit
Vcc Power	Icc @ VccPowe = 5.0V DC	TX max	250	mA
		RX max	35	mA

2.3.3 Input/output signals

	Parameter		Value	Unit
Vin Low	Logic LOW level input voltage	max	0.8	V
Vin High	Logic HIGH level input voltage	min	2.1	V
Vout Low	Logic LOW level input voltage	max	0.6	V
Vout High	Logic HIGH level input voltage	min	2.7	V

2.3.4 Environmental

Temperatures characteristics

Parameter		Value	Unit
Storage temperature	min	- 40	°C
	max	+ 85	°C
Operating temperature	min	- 40	°C
	max	+ 80	°C

3 Antennas

This chapter gives a quality overview of the different antenna options.

On the Boards itself the RF interface is an U.FL. connector for external antennas. Different types of external antennas are available.

3.1 Antenna Accessories

Part Number	0138498	
Name	U.FL to reverse polarity SMA adapter cable	
Connector	U.FL and reverse polarity SMA jack (outer thread and pin)	
Cable length	129mm +-5mm (pigtail overall) 100mm +-5mm (cable length)	
Cable loss	0.8dB	

Part Number	2701402	
Name	RAD-PIG-EF316-N-RSMA	
Connector	RSMA (male) and N (female)	
Cable length	0,5m	
Cable loss	0,75 dB	

Part Number	2867694	
Name	RAD-PIG-EF316-N-SMA	
Connector	SMA (male) and N (female)	
Cable length	0,3m	
Cable loss	1,5 dB/m	

Part Number	2903263 2903264 2903265 2903266	
Name	RAD-PIG-RSMA/N -0,5 -1 -2 -3	
Connector	RSMA (male) and N (male)	
Cable length	0,5m 1m 2m 3m	
Cable loss	TBD dB/m	

Part Number	2867649 2867652 2867665 2885634	
Name	RAD-CAB-EF393- 3M -5M -10M -15M	
Connector	N (male) / N (male)	
Cable length	3m 5m 10m 15m	

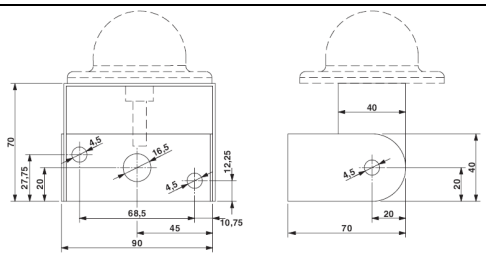
Cable loss	0,45 dB/m	

Part Number	2884512 2884525	
Name	RAD-CAB-EF142-3M	
Connector	SMA (male) / SMA (male)	
Cable length	3m 5m	
Cable loss	0,93 dB/m	

3.2 Recommended antennas

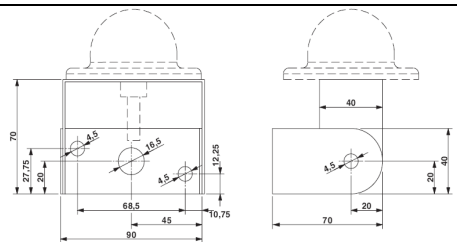
Part Number	2701362	
Name	RAD-ISM-2400-ANT-OMNI-2-1-RSMA	
Polarization	Vertical	
Gain	+2.0dBi	
Cable lenght	150cm	

Size	82,5 / 7,8mm	
Connector	RSMA	

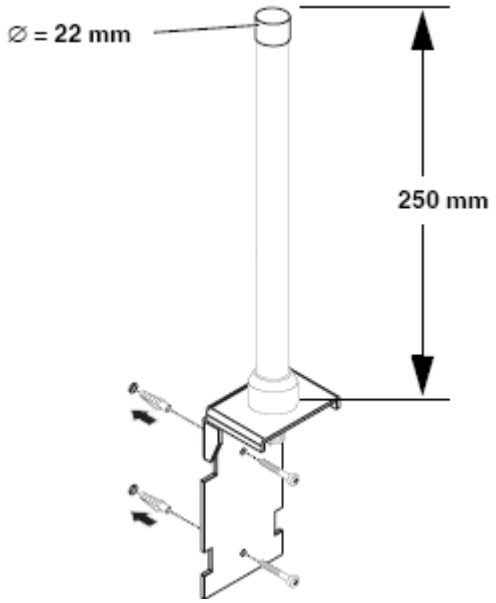
Part Number	2701358	
Name	RAD-ISM-2400-ANT-VAN-3-0-RSMA	
Polarization	Vertical	
Gain	+3.0dBi	
Cable lenght	150cm	
Size		
Connector	RSMA	

3.3 Recommended antennas professional use

Part Number	2692526	
Name	RAD-ISM-2459-ANT-FOOD-6-0	

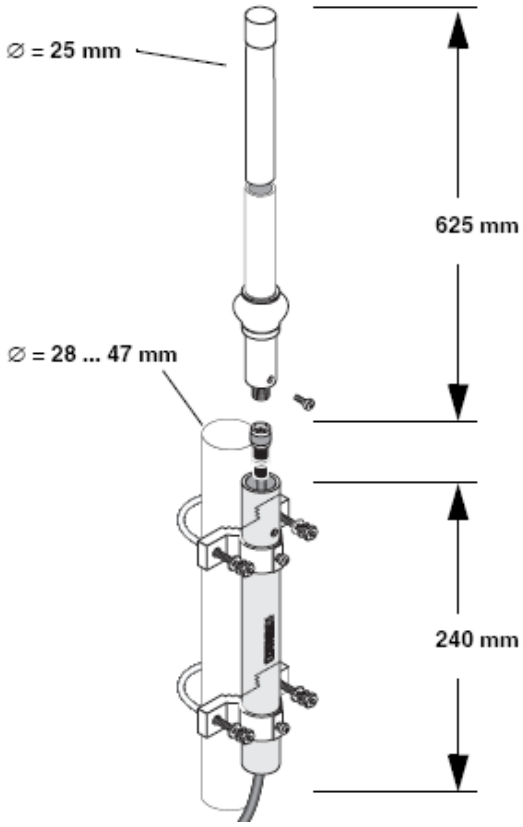
Polarization	Vertical	
Gain	+6dBi	
Cable lenght	100cm N(m) SMA(m)	
Size		
Connector	N- (female)	

Part Number	2885919	
Name	RAD-ISM-2400-ANT-OMNI-6-0	
Polarization	Vertical	
Gain	+6dBi	
Cable lenght	--	

Size	250 /22 mm	
Connector	N- (female)	

Part Number	2903219	
Name	RAD-ISM-2400-ANT-OMNI-6-0-SW	
Polarization	Vertical	
Gain	+6dBi	
Cable lenght	--	
Size		
Connector	N- (female)	

Part Number	2867623	
Name	RAD-ISM-2400-ANT-OMNI-9-0	
Polarization	Vertical	
Gain	+9dBi	
Cable lenght	--	

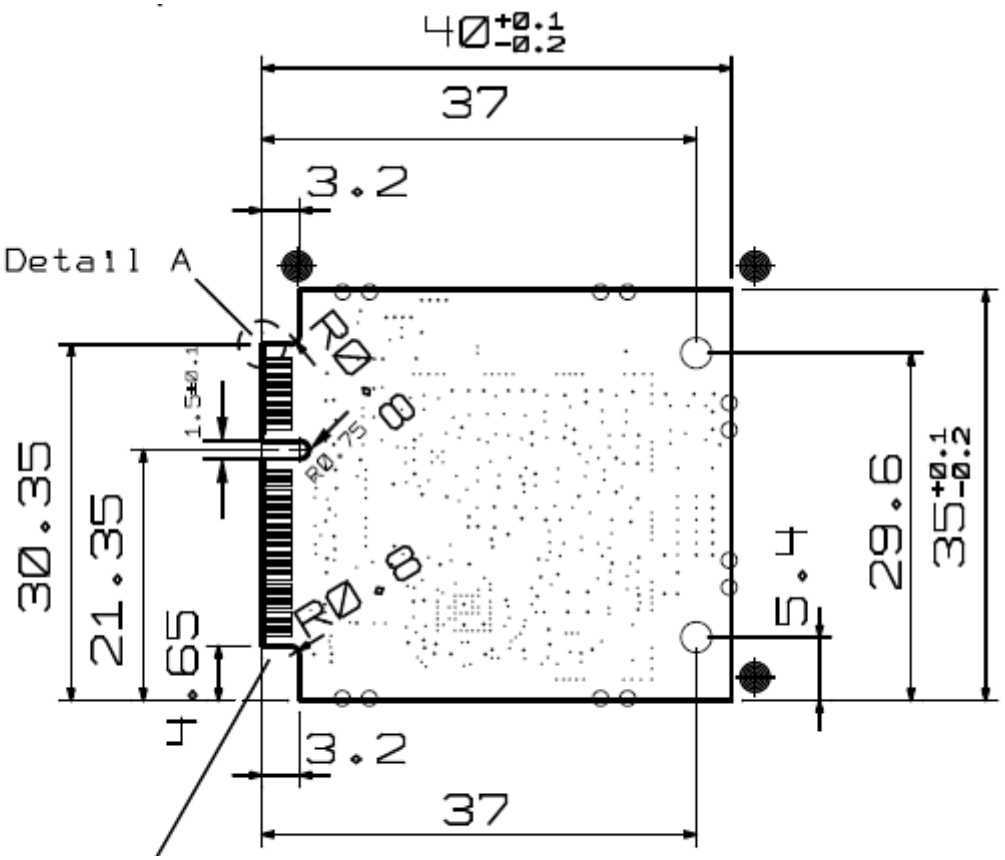
Size		
Connector	N- (female)	

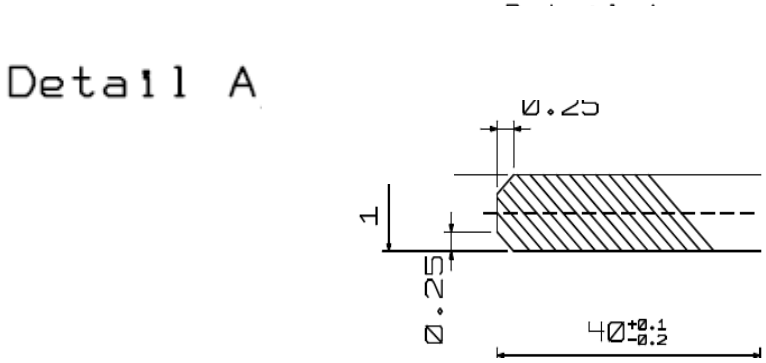
Part Number	2867610	
Name	RAD-ISM-2400-ANT-PAN-8-0	
Polarization		
Gain	+8dBi	
Cable lenght	--	
Size (height x width x depth)		102 mm x 95 mm x 32 mm
Connector	SMA- (female)	

4 Mechanics

4.1 Module Outlines

Dimensions





4.2 Connector

The connector has 52 contacts and is compatible with PCI Express Mini Card elect mechanical specification.

5 Operation

5.1 Overview

The API module's job is it to serve the interface to external devices (in most cases this is the Application Controller (AC). It provides a set of commands available for the external device (hereinafter referred to as AC).

5.2 Communication Interface

The RC provides two communication interfaces which can be selected by the user. These two interfaces are mutually exclusive and must be selected by the user before boot up. The protocol is the same on both interfaces with minor differences explained later on. The user's device (which controls the RC) is hereinafter referred to as application controller (AC).

Hardware Interface

Two interfaces provided by the RC are the serial peripheral interface (SPI) and a universal asynchronous receiver transmitter (UART). On the SPI-interface the RC has the slave role, thus the clock is provided by the user. Since the RC needs time for command processing and is also able to initiate a communication cycle on its own, two additional handshake lines (Ready & Indication) are used. The usage is explained in the next sub section. The SPI-interface is selected by default if the 'API-Select'-pin is not connected to Vcc. If the 'API-Select'-pin is connected to Vcc during boot up the UART-interface is selected. The UART-interface operates at 19200 Baud with 8 databits, 1 stopbit and no parity. It only utilizes the two data-lines (TXD, RXD) and ground, handshake-lines are not foreseen. Protocol on the UART-interface is similar to the protocol used on the SPI-interface it is also described in this section.

5.2.1 Communication Cycles (SPI)

Communication on the SPI-Interface only takes place if the ready line is set by the RC. With this line, the RC can control, when the AC is allowed to transmit/receive data. This is necessary for example, to process commands on the RC correctly. A communication cycle can only be initiated by the SPI master, when the ready line is set. In this case the AC can always transmit 7 Byte (A command of 5 Bytes and 2 Byte CRC Check) to the RC. The 16bit Checksum used in the RC is based on the CCITT-16 polynomial (x^16 + x^12 + x^5 + 1). A properly received request will always be responded to. Depending on the command requested additional (payload) data is transferred.

AC initiated communication.

This means, that the AC wants to write something to the RC or wants to read something from the RC (request). This Communication is always initiated by transmitting a Command (5 Byte) to the RC. This is always possible, as soon as the ready line is set from the RC side.

After receiving a command from the AC, the RC has to evaluate the command and decide, whether the AC wants to transmit something or wants to read something. In both cases the RC has to prepare the response. This preparation will take some time. The RC indicates using the indication line, that the preparation is ready. Then the AC will read always 5+2 Byte as answer to the command. This 5+2 Byte give some information for the AC, e.g. how many data bytes will follow, or if the command was done successfully. After reading this 5+2 Byte, the AC could itself need some further preparation time. This will mean, that the AC stops at that point the generation further SPI-clocks. As soon as the evaluation and preparation is done on the AC side, the next clock steps could be done and the data transfer (reading or writing) will be done. After this, the ready-line will go down on the RC Side, because a new preparation to receive a new command has to be done.

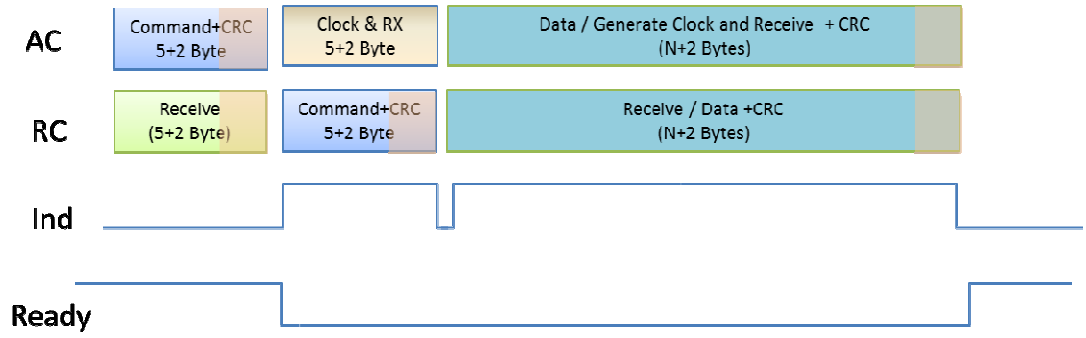


Figure 1: Frame structure (Communication initiated by AC)

There are AC initiated API commands without response (not further Data-Transfer required). In this case, the indication line as shown in figure 2 will not occur.

RC initiated communication

Also the RC can trigger a communication cycle as shown in fig. 3. This is done by setting the indication-line. On this indication (or Request) the AC is reading 5+2 Bytes, the Command Bytes. After the transfer of this 7 Bytes, the AC and or RC may have to prepare the DMAs. The RC indicates this, removing the ready line during this time. Normally the RC has not to do this, and the Ready line will not change. When the ready line is set again, the AC can start the data-transfer by sending the clocks until the communication is done.

After the Data-Transfer the RC resets the ready line again, and prepares the DMA for the next communication cycle.

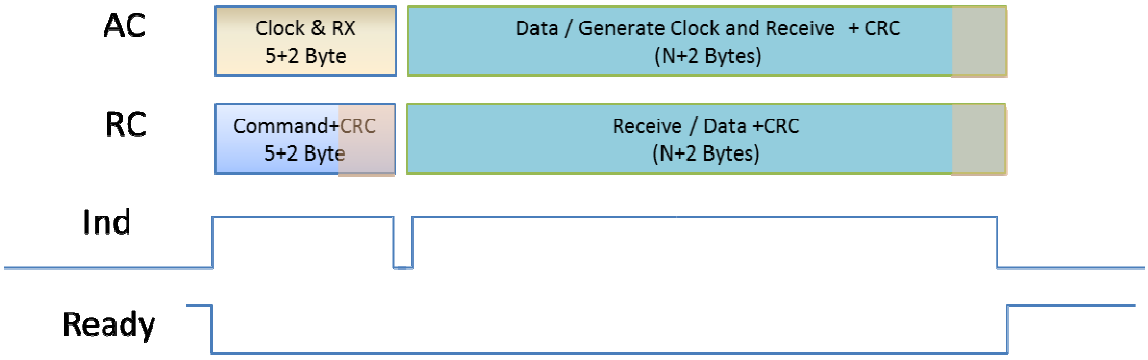


Figure 2: Frame structure (Communication triggered by RC)

5.2.2 Communication Cycles (UART)

The API communication can also be done using the UART instead of the SPI. In this case, the transmitted commands and data are exactly the same as on the SPI. The main difference is the communication control. As we have a real full duplex communication link, the Indication line and the ready line are not necessary. The commands and data structures can be transmitted without further separate lines. Nevertheless, the waiting and evaluation of the command has also to be done on both sides.

5.3 Operation

In order to operate the RC it needs a valid configuration. A default configuration is loaded at boot up, nevertheless a unique node ID must be configured after every boot up. After the RC was configured it is ready to be started by the user, this is done by setting the RC to normal operation mode. During normal operation the RC is ready for application message exchange.

5.4 Configuration

Before the RC is functional it needs to be configured to suite the users needs. A default configuration which is described in the next subsections is loaded at boot up. The default configuration does not contain a node ID. The node ID always has to be assigned by the user.

Configuration is done with the help of a special command described in the next subsection.

Configuration Command

GET / SET Config Command

The GET and SET Config commands are used to transfer configuration data to and from the RC-Module. The command structure is depictured in the following figure:

	7	6	5	4	3	2	1	0	
Command Byte									1 = ACK, 0 = NACK
									0001: GET Config, 1001: SET Config
Length	x	x	x	x	x	x	x	x	
Parameter Adr Hi	x	x	x	x	x	x	x	x	
Parameter Adr Lo	x	x	x	x	x	x	x	x	
Data (Optional)	x	x	x	x	x	x	x	x	

The command byte is used to choose whether a parameter should be read or written.

In case of a read request, the response will have the ACK bit set when the parameter address was valid. The response to a write request will have set the ACK bit only when a valid parameter address is given and the length for the addressed parameter is correct.

The length byte is used to indicate the length of the parameter data. It is only used in a write-request or in a read-response. In write-response and read-request it can be set any value.

A length value of ‘0’ indicates that the parameter length is 1 byte, but is transferred in the optional data field. The maximum length for a configuration parameter is 64 bytes.

The parameter address high and low bytes are used to address the parameter which should be read or written to. A table with parameter addresses is shown in the next subsection.

The data field is used optionally. It can be utilized for parameter values which have a length of only one byte. In order to use this field for parameter data the length value has to be set to '0'. In read-requests and write-responses it is ignored.

Configuration Parameters

The following table lists the user-accessible parameters, their addresses, their lengths and if applicable, their meaning.

Parameter	Adr Hi	Adr Lo	Length	Meaning
Node ID	0	1	1	1 = master, 2-250 = slave or repeater
Repeat	0	2	1	0 = do not repeat, 1 = repeat (ignored at master)
OTA Datarate	0	3	1	2 = 16k, 3 = 125k, 4 = 250k, 5 = 500k
NetType	2	13	1	0 = Mesh, 1 = Star/P2P
Network ID	2	15	2	0…127, >127 reserved
Retries	2	5	1	2 = 1 Retry
TX Power	1	4	1	0…20dBm
LNA Enabled	1	5	1	0 = off, 1 = on
RF-Band	1	6	1	1…8

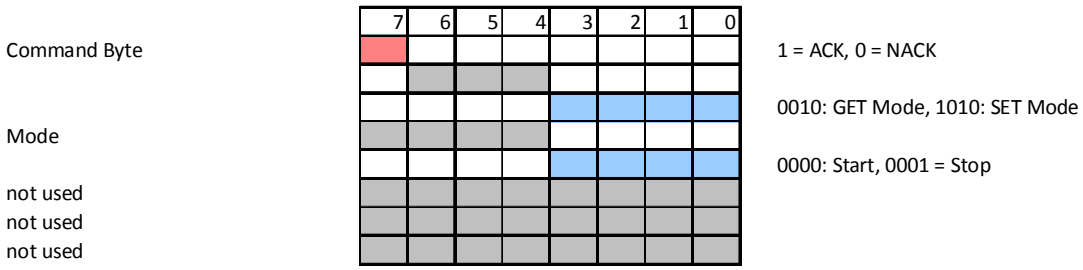
Default Configuration

The default configuration is loaded during boot up. It may be changed to the suite the users needs. The node ID is set to invalid, so the user has to change it.

Parameter	Value
Node ID	255 (=invalid)
Repeat	3
OTA Datarate	4 (=250 kBaud)
NetType	0 (=Mesh)
Network ID	127
Retries	3 (=2 Retries)
TX-Power	20 dBm
LNA Enables	1 (=enabled)
RF-Band	1

5.4.1 Modecontrol

In order to set the mode into operational condition the mode has to be switched to operational. This can only been done after proper configuration. If the RC is in operation mode it can be halted by changing the mode to stop. Further password protected modes are preserved for production line testing. The command structure is depictured in the following figure:



5.4.2 Application Message Exchange

This command is used to exchange application data with the RC. It is structured as follows:

	7	6	5	4	3	2	1	0	
Command Byte									1 = ACK, 0 = NACK
									0101: GET Message, 1101: SET Message
Length Hi	x	x	x	x	x	x	x	x	
Length Lo	x	x	x	x	x	x	x	x	
Application Port	x	x	x	x	x	x	x	x	
Destination/Source Node ID	x	x	x	x	x	x	x	x	

In the command byte it is distinguished between a write-request, thus the user wants to send a message to the radio network, and a read-response. The read-response is initiated by the RC itself in order to eliminate the need to poll for new messages. The read-response resembles the command “Get Message’ and has the ACK bit set.

Length high and low fields are used to communicate the length of the application message exchanged.

The application port field is used to run several applications in parallel. Ports 0-6 can be used by the user’s application. Port 7 is reserved for internal purposes.

The destination or source node id field is used depending on the direction of the message (from radio network to user or from user to radio network). In case the user wants to send a message to the radio network it is used as the destination ID. A broadcast can be sent when ‘255’ is used as destination ID. In case the RC received a message from the radio network, the field will hold the source node if of the original sender of the message.

If the RC internal buffer is full or it is unable to send the message, a further request to send a message will result in a negative response, thus the ACK-bit is not set.

6 FCC and IC Compliance for RB-TW-2400

6.1 FCC Statement for RB-TW-2400

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.

6.2 Antenna

Our module type RB-TW-2400 is for OEM integrations only. The end-user product will be professionally installed in such a manner that only the authorized antennas are used.

6.3 Caution

Any changes or modifications NOT explicitly APPROVED by Phoenix Contact could cause the module to cease to comply with FCC rules part 15, and thus void the user's authority to operate the equipment.

6.4 IC Compliance

Operation is subject to the following two conditions:

(1) this device may not cause harmful interference, and

(2) this device must accept any interference received, including interference that may cause undesired operation.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes:

(1) l'appareil ne doit pas produire de brouillage, et

(2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

This device has been designed to operate with an antenna having a maximum gain of 9 dBi.

Having a higher gain is strictly prohibited per regulations of Industry Canada. The required antenna impedance is 50 ohms.

To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (EIRP) is not more than that required for successful communication.

The installer of this radio equipment must ensure that the antenna is located or pointed such that it does not emit RF field in excess of Health Canada limits for the general population; consult Safety Code 6, obtainable from Health Canada's website www.hc-sc.gc.ca/rpb

User manuals for transmitters equipped with detachable antennas shall also contain the following notice in a conspicuous location:

This radio transmitter (identify the device by certification number, or model number if Category II) has been approved by Industry Canada to operate with the antenna types listed below with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Immediately following the above notice, the manufacturer shall provide a list of all antenna types approved for use with the transmitter, indicating the maximum permissible antenna gain (in dBi) and required impedance for each.

6.5 Labeling Requirements for End Product

For an end product using the product RB-TW-2400 there must be a label containing, at least, the following information:

Contains FCC ID: YG3RAD2400A Contains IC: 4720B-RAD2400A

The label must be affixed on an exterior surface of the end product such that it will be visible upon inspection in compliance with the modular approval guidelines developed by the FCC.

In accordance with 47 CFR § 15.19 the end product shall bear the following statement in a conspicuous location on the device:

"This device complies with Part 15 of the FCC Rules.

Operation is subject to the following two conditions;

(1) this device may not cause harmful interference, and

(2) this device must accept any interference received, including interference that may cause undesired operation."

When the device is so small or for such use that it is not practicable to place the statement above on it, the information shall be placed in a prominent location in the instruction manual or pamphlet supplied

to the user or, alternatively, shall be placed on the container in which the device is marketed. However, the FCC ID label must be displayed on the device.

In case, where the final product will be installed in locations where the end-user is not able to see the FCC ID and/or this statement, the FCC ID and the statement shall also be included in the end-product manual.

6.6 RF-exposure Statement

This equipment should be installed and operated with minimum distance 20cm between the radiator & your body. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter. As long as these conditions above are met, further transmitter test will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed (for example, digital device emissions, PC peripheral requirements, etc.).

In the event that these conditions can not be met (for example certain laptop configurations or co-location with another transmitter), then the FCC authorization is no longer considered valid and the FCC ID can not be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCCauthorization.

7 Guidelines for Efficient and Safe Use

7.1 General

Read this information before using your OEM module

NOTE Changes or modifications to the product not expressly approved by Phoenix Contact will void the user's authority to operate the equipment.

7.2 Product Care

- Do not expose your product to liquid or moisture.
- Do not expose you product to extreme hot or cold temperature (see section Environmental for further information).
- Do not expose your product to lit candles, cigarettes, cigars, open flames, etc.
- Do not drop, throw or try to bend your product since rough treatment could damage your product.

- Do not attempt to disassemble your product. Doing so will void warranty. The product does not contain consumer serviceable or replaceable components. Service should only be performed by Phoenix Contact.
- Do not paint your product as the paint could prevent normal use.
- If you will not be using your product for a while, store it in a place that is dry, free from damp, dust and extreme heat and cold.
- The clearance and creepage distances required by the end product must be withheld when the module is installed.
- The cooling of the end product shall not negatively be influenced by the installation of the module when the module is installed.

7.3 Radio Frequency Exposure

The OEM Radio Board contains a small radio transmitter and receiver. During communication the module receives and transmits radio frequency (RF) electromagnetic fields (microwaves) in the frequency range 2400 to 2483,5 MHz. The output power of the radio transmitter is very low.

When using the OEM Serial Port Adapter, you will be exposed to some of the transmitted RF energy. This exposure is well below the prescribed limits in all national and international RF safety standards and regulations.

7.4 Electronic Equipment

Most modern electronic equipment, for example, in hospitals and cars, is shielded from RF energy. However, certain electronic equipment is not. Therefore:

NOTE

This equipment emits RF energy in the ISM (Industrial, Scientific, Medical) band. Please insure that all medical devices used in proximity to this device meet appropriate susceptibility specifications for this type of RF energy.

7.5 Power Supply

The RB-TW-2400 must be supplied by a limited power source according to EN 60950-1.

- Connect your power supply only to designated power-sources as marked on the product.
- Make sure all cords and cable are positioned so that they will not be stepped on, tripped over or otherwise subject to damage orstress.
- To reduce risk of electric shock, unplug the unit from any power source before attempting to clean it.