UHF
RFID System

BLUEBOX UHF Controller Micro IA
1 RF Port, 500 mW RF Power

Preface

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Safety Instructions / Warning - Read before start-up!

- The device may only be used for the intended purpose designed by the manufacturer. The operation manual should be conveniently kept available at all times for each user.
- Unauthorized changes and the use of spare parts and additional devices that have not been sold or recommended by the manufacturer may cause fire, electric shocks or injuries. Such unauthorized measures shall exclude any liability by the manufacturer.
- The liability-prescriptions of the manufacturer in the issue valid at the time of purchase are valid for the device. The manufacturer shall not be held legally responsible for inaccuracies, errors, or omissions in the manual or automatically set parameters for a device or for an incorrect application of a device.
- Repairs may be executed by the manufacturer only.
- Only qualified personnel should carry out installation, operation, and maintenance procedures.
- Use of the device and its installation must be in accordance with national legal requirements and local electrical codes.
- When working on devices the valid safety regulations must be observed.

CE IP65

This manual applies to the following devices:

Description:	Order Number:
Read / write 500mW UHF RFID RTU (Ready to Use) device with one external antenna. Serial RS232 / RS485 communication interface. EU1 (865 MHz … 868MHz) version.	5721U

This manual is valid as of firmware version:

Order Number	Hardware Version	Firmware Version
5721U	1	1.61M

Table of Contents

1 Introduction

The **BLUEBOX Micro UHF** hereinafter named **BLUEBOX** is an UHF read / write RFID device operating in the 840 MHz to 960 MHz frequency band and suitable for industrial application, it communicates with a 'host' system (typically a PC or a PLC) through a RS232 / RS485 serial line. The **BLUEBOX** acts as a joint through a set of commands between the host system and one or more RFID transponders (or tags) present near the antenna. The same 'master/slave' protocol is used for the communication between the host system ('master') and the **BLUEBOX** ('slave'), independently of the kind of connection (point to point or multipoint). Through these communication channels, it is also possible to configure the functional parameters and to upgrade the firmware, the 'BLUEBOX Show' software of the SDK is foreseen to explicate these operations. **BLUEBOX** is designed and developed to allow installation and maintenance experts to perform all power supply and communication connections without the need to open the device.

2 Technical Specifications

2.1 Electrical Features

Power Supply	10 … 36 Vdc
Power Rating	4W @RFout=27dBm
Operating Frequency	865 MHz … 868 MHz
RF Transmit Power	Max 500mW (27dBm) conducted
RF Receive Sensitivity	Max -87dBm
Antenna	Integrated
Reading Distance	3 mt[1]
Supported Transponders	ISO 18000-63[2] (EPC Class-1 Gen-2 V2)
Communication Interface	Serial RS232 / RS485
Status Display	1LED, buzzer
Connections	1 M12 Connectors (5-poles A-coded male for power supply and serial interface)

2.2 Mechanical Features

Dimensions	120 x 122 x 37 mm
Material	Plastic
Protection Class	IP65

2.3 Environmental Conditions

Operating Temperature	-20°C … +55°C
Storage Temperature	-40°C … +85°C
Humidity	Up to 95%, non condensing

[1] Reading distance depends on transponder type, antenna and environmental conditions.

[2] ISO 18000-6C became ISO 18000-63 in 2012 due to ISO naming rules that do not allow letters in standards names.

3 Operating Features

In 'continuous' mode the **BLUEBOX** is characterized by the coexistence of 2 'parallel' and asynchronous activities: the tag identification (inventory) and the communication with the 'host' system. The 'continuous' identification activity interacts with the communication activity through a buffer that contains the code of the last identified tags or that is empty indicating the absence of tags. Due to synchronization and filtering reasons, the buffer is handled for each identified tag by a parameter defined as 'hold time' (same as 'filter time' defined below, to be set in the range of 0 … 99 seconds or 0 ... 99 minutes, default value 1 second) and allows to extend 'artificially' the presence of the tag after it leaves the antenna's influence area; this behavior is observable looking at the yellow led status that is 'on' indicating the presence of tags. Through the command 'data request' it is possible to get the data contained in the buffer.

The **BLUEBOX** handles also a 100 elements FIFO queue which is combined with the 'filter time' general parameter (to be set in a range of 0 … 99 seconds or 0 ... 99 minutes, default value 1 second) that prevents the queue saturation in case of a tag 'continuous' presence. When a tag is identified, the **BLUEBOX** verifies if it belongs to the list of read tags. If the tag do not belong to the list (it is defined as 'new'), its code will be inserted in the queue, a filter time assigned to the tag will be started and the buzzer will be activated for 0.5 seconds. Otherwise (the tag belong to the list of read tags), the **BLUEBOX** verifies if the relative filter time is expired. In this case (the filter time is expired), the tag is defined as 'new' and will be processed as described above, otherwise only the relative filter time will be rearmed. Through the command 'queue data request' and the relative 'ACK, it is possible to get the data contained in the queue and unload it; the indication of the reading antenna and the transponder type could be enabled/disabled through flags defined in the general parameters.

Buffer and FIFO queue will hold onto a maximum of 82 bytes of tag data. Once the 82 bytes of tag data limit is reached, the exceeded bytes will be discarded!

In 'continuous' mode the **BLUEBOX** can be configured to obtain the behavior of a 'spontaneous' reader that will send a message on the serial line every time that a 'new' transponder is identified (or for every identified tag with or without a 100ms filter time according to 'spontaneous' message mode configuration). This feature is enabled (on) / disabled (off) via communication software.

- If configured and available an host can receive the 'spontaneous' message through the serial port. The 'spontaneous' message is sent only once and no ACK/NAK reply message is implemented, see the protocol manual for

details. Do not use the 'spontaneous' message feature in a RS485 'multipoint' network to avoid communication errors due to unmanaged collisions on RS485 bus!

In case of a 'spontaneous' message send error, due to a connection or communication error, no further attempts will be made and the tag will be discarded!

BLUEBOX will hold onto a maximum of 100 tags when configured to use the 'spontaneous' message. Once the 100 tag limit is reached, the new tags will be discarded!

The **BLUEBOX** allows the execution of 'on request' functions. During the execution of these functions, the 'continuous' identification activity will be suspended temporarily; the involved commands are relative to device configuration and tag read/write specific activities.

If not required, the 'continuous' identification activity can be disabled through flags defined in the general parameters. In this case, the **BLUEBOX** will only execute the 'on request' commands.

'Test' modes are also defined:

- 'RF Reading' test: in 'continuous' mode allows the user to easily and quickly test the read range of the reader with fast beeping (100ms) the buzzer for every identified tag. This 'test' mode is stored in non volatile memory and its status is kept at every reader restart and until it is disabled.

- 'RF Power' test: allows the user to easily and quickly test the minimum RF output power needed to read a tag in a fixed position. The reader sweeps from the minimum RF output power to maximum RF output power or until it finds a tag, increasing the RF power of 1 dB every 500ms with fixed Q selection algorithm and Q=0. It is an 'on request' function which temporarily suspends the 'continuous' mode.

- 'RF Sensitivity' test: allows the user to easily and quickly test the minimum RF input sensitivity needed to read a tag in a fixed position. The reader sweeps from the minimum RF input sensitivity to maximum RF input sensitivity or until it finds a tag, increasing the RF sensitivity of 1 dB every 500ms with fixed Q selection algorithm and Q=0. It is an 'on request' function which temporarily suspends the 'continuous' mode.

- Read Reflected Power: allows the user to read the reflected power of the antenna at a given frequency to check the antenna connection.
- Read RSSI: allows the user to read the signal strengh received by the antenna at a given frequency to check the presence of external RF sources.

3.1 General Parameters

This section provides details on the configurable general parameters of the **BLUEBOX**.

Parameter	Description	Range	Default
Device Address	Device address of the reader on serial interface.	0 … 255	255
Baud Rate	Communication baud rate on serial interface.	1200 2400 4800 9600 19200 38400 57600 115200	19200
Data Bits	Data bits on serial interface.	7 8	8
Stop Bits	Stop bits on serial interface.	1 2	1
Parity	Parity on serial interface.	None Even Odd	None
Filter Time	Reading and tag queue management filter time. Note that 0 setting is internally overwritten with 1 second.	0 … 99 sec 0 … 99 min	1 second
Buzzer Management	Buzzer management on 'new tag' event.	Disabled Enabled	Enabled
Reading Antenna Information	To add the reading antenna information to the tag's code.	Disabled Enabled	Disabled
Transponder Type Information	To add the transponder type information in the tag's code.	Disabled Enabled	Disabled
'Spontaneous' Mode	Spontaneous mode.	Disabled Enabled	Disabled

Parameter	Description	Range	Default
'Continuous' Mode	'Continuous' mode.	Disabled Enabled	Enabled

The general parameters are managed through the 'Read General Parameters' and 'Write General Parameters' commands as described in protocol technical manuals where the parameters 1…7 fields with default values are:

1	2	3	4	5	6	7
Device Address	Serial1	Serial2	0x00	0x00	Filter Time	Functional Flags
0xFF	**0x48**	**0x10**	**0x00**	**0x00**	**0x01**	**0x80**

Where:

Parameter	Description
Device Address	Device address of the reader on serial interface in the range 0 … 255.

Serial1	Serial interface communication settings.
	• High nibble: baud rate:
	  ○ 0x0: 1200 bps;
	  ○ 0x1: 2400 bps;
	  ○ 0x2: 4800 bps;
	  ○ 0x3: 9600 bps;
	  ○ 0x4: 19200 bps;
	  ○ 0x5: 38400 bps;
	  ○ 0x6: 57600 bps;
	  ○ 0x7: 115200 bps.
	• Low nibble: data bits:
	  ○ 0x7: 7 bits;
	  ○ 0x8: 8 bits.

Serial2	Serial interface communication settings.
	• High nibble: stop bits:
	  ○ 0x1: 1 bits;
	  ○ 0x2: 2 bits.
	• Low nibble: parity:
	  ○ 0x0: None;
	  ○ 0x1: Even;
	  ○ 0x2: Odd.

Filter Time	Reading management filter time (0 setting is internally overwritten with 1 second): • Decimal 0 … 99 for time in seconds (0 … 99 seconds);

<table>
<tr><th>Parameter</th><th>Description</th></tr>
<tr><td></td><td>• Decimal 100 … 199 for time in minutes (0 … 99 minutes).</td></tr>
<tr><td>Functional Flags</td><td>Flags. Single bits are dedicated to disable (0 value) or enable (1 value) functions:
<table>
<tr><th>Bit</th><th>Description</th></tr>
<tr><td>Bit 7</td><td>Automatic buzzer management</td></tr>
<tr><td>Bit 6</td><td>Not used</td></tr>
<tr><td>Bit 5</td><td>Reading antenna information</td></tr>
<tr><td>Bit 4</td><td>Transponder type information</td></tr>
<tr><td>Bit 3</td><td>‘Spontaneous’ mode</td></tr>
<tr><td>Bit 2</td><td>Not used</td></tr>
<tr><td>Bit 1</td><td>Not used</td></tr>
<tr><td>Bit 0</td><td>‘Continuous’ mode (0=enabled, 1=disabled).</td></tr>
</table></td></tr>
</table>

3.2 Configuration Parameters

This section provides details on the configurable operational parameters of the **BLUEBOX**.

3.2.1 ‘Spontaneous’ Message

This section provides details on the configurable ‘spontaneous’ message parameters of the **BLUEBOX**

Parameter	Description	Range	Default
Message Trigger	The ‘spontaneous’ message trigger event: • 0: One ‘spontaneous’ message for every ‘new tag’; • 1: One ‘spontaneous’ message for every identified tag (slow mode with a filter time of 100ms). • 2: One ‘spontaneous’ message for every identified tag (fast mode with no filter time). Note that this parameter become effective only after a reboot of the reader.	0 1 2	0
Message on Serial Interface	‘Spontaneous’ message on serial interface. Note that this parameter become effective only after a reboot of the reader.	Disabled Enabled	Enabled
Message on CAN bus Interface	‘Spontaneous’ message on CAN bus interface.	Disabled Enabled	Enabled

Parameter	Description	Range	Default
	Note that this parameter become effective only after a reboot of the reader.		
Format	The 'spontaneous' message format. • 0: Message is sent with BlueBox protocol rules; • 1: Message is sent, without any control character, in dual char string form; • 2: Message is sent like in option 1 but at the end CR will be appended; • 3: Message is sent like in option 1 but at the end CR+LF will be appended. • 4: Message is sent, without any control character, in ASCII form. Non printable chars (0x20..0x7E) are replaced with '.' (0x2E). • 5: Message is sent like in option 4 but at the end CR will be appended. • 6: Message is sent like in option 4 but at the end CR+LF will be appended. • 7: Message is sent like in option 1 with an STX char at the begin of the message. • 8: Message is sent like in option 2 with an STX char at the begin of the message. • 9: Message is sent like in option 3 with an STX char at the begin of the message. • 10: Message is sent like in option 4 with an STX char at the begin of the message. • 11: Message is sent like in option 5 with an STX char at the begin of the message. • 12: Message is sent like in option 6 with an STX char at the begin of the message. Note that this parameter become effective only after a reboot of the reader.	0 1 2 3 4 5 6 7 8 9 10 11 12	0
Encoding	The 'spontaneous' message encoding. Note that this parameter become effective only after a reboot of the reader.	None Decimal	None

The 'spontaneous' message format and encoding allowed values are

Format	Encoding
0	None
1	None
2	None
3	None
4	None, Decimal
5	None, Decimal
6	None, Decimal
7	None
8	None
9	None
10	None, Decimal
11	None, Decimal
12	None, Decimal

The 'spontaneous' message parameters are stored in configuration page nr. 0x09 and are managed through the 'Read RAM/ROM Configuration Parameters' and 'Write RAM/ROM Configuration Parameters' commands as described in protocol technical manuals where the parameters 1…7 fields with default values are:

1	2	3	4	5	6	7
Message Trigger	Interface	Format	Encoding	0x00	0x00	0x00
0x00	**0x00**	**0x00**	**0x00**	**0x00**	**0x00**	**0x00**

Where:

Parameter	Description
Message Trigger	The 'spontaneous' message trigger event: • 0x00: One 'spontaneous' message for every 'new tag'; • 0x01: One 'spontaneous' message for every identified tag (slow mode with a filter time of 100ms). • 0x02: One 'spontaneous' message for every identified tag (fast mode with no filter time).

<table>
<tr><th>Parameter</th><th>Description</th></tr>
<tr><td>Interface</td><td>The interface where to send the ‘spontaneous’ message activation/deactivation. Single bits are dedicated to enable (0 value) or disable (1 value) an interface:
<table>
<tr><th>Bit</th><th>Description</th></tr>
<tr><td>Bit 7</td><td>Not used</td></tr>
<tr><td>Bit 6</td><td>Not used</td></tr>
<tr><td>Bit 5</td><td>Not used</td></tr>
<tr><td>Bit 4</td><td>Not used</td></tr>
<tr><td>Bit 3</td><td>Not used</td></tr>
<tr><td>Bit 2</td><td>Not used</td></tr>
<tr><td>Bit 1</td><td>Not used</td></tr>
<tr><td>Bit 0</td><td>Serial interface</td></tr>
</table></td></tr>
<tr><td>Format</td><td>The ‘spontaneous’ message format:
0x00: Message is sent with BlueBox protocol rules;
0x01: Message is sent, without any control character, in dual char string form;
0x02: Message is sent like in option 1 but at the end CR will be appended;
0x03: Message is sent like in option 1 but at the end CR+LF will be appended.
0x04: Message is sent, without any control character, in ASCII form. Non printable chars (0x20..0x7E) are replaced with ‘.’ (0x2E).
0x05: Message is sent like in option 4 but at the end CR will be appended.
0x06: Message is sent like in option 4 but at the end CR+LF will be appended.
0x07: Message is sent like in option 1 with an STX char at the begin of the message.
0x08: Message is sent like in option 2 with an STX char at the begin of the message.
0x09: Message is sent like in option 3 with an STX char at the begin of the message.
0x0A: Message is sent like in option 4 with an STX char at the begin of the message.
0x0B: Message is sent like in option 5 with an STX char at the begin of the message.
0x0C: Message is sent like in option 6 with an STX char at the begin of the message.
</td></tr>
<tr><td>Encoding</td><td>The ‘spontaneous’ message encoding:
0x00: None;
0x01: Decimal.
</td></tr>
</table>

3.2.2 RF and EPC C1G2 (Class-1 Generation-2)

This section provides details on the configurable RF and EPC C1G2 (Class-1 Gen-2) parameters of the **BLUEBOX**

Parameter	Description	Range	Default
RF Geographical Region	RF geographical region. Note that ETSI, FCC and Brazil readers cannot be altered and only operate per the regulatory laws in USA/Canada, the European Union and Brazil.	EU1: ETSI FCC: FCC BRA: Brazil	EU1: ETSI FCC: FCC BRA: Brazil
RF Trasmit Power	RF conducted transmit power in dBm. Refer to country specific regulations for limitations. You, the user, are responsible to ensure operation with the correct RF settings and are solely responsible for any fines and other damages due to incorrect or non-compliant country/region settings.	0 … 27 dBm	20 dBm
RF Receive Sensitivity	RF receive sensitivity in dBm.	-51 … -87 dBm	-76 dBm
RF Channel	RF channel. Note that 0 value stands for default settings of the selected region. Refer to country specific regulations for channel allocation within the band. You, the user, are responsible to ensure operation with the correct RF settings and are solely responsible for any fines and other damages due to incorrect or non-compliant country/region settings.	EU1: 0 … 10 FCC: 0 … 50 BRA: 0 … 50	0
Antenna 1 Activation	Activation of antenna 1.	Disabled Enabled	Enabled
RF Channel Allocation Time	The maximum period of consecutive transmission on the same RF channel. Note that 0 value stands for default settings of the selected region. Refer to country specific regulations for limitations. You, the user, are responsible to ensure operation with the correct RF settings and are solely responsible for any fines and other damages due to incorrect or non-compliant country/region settings.	0.00 … 0.99 seconds 0 … 99 seconds	0
RF Channel Pause Time	The minimum time between two consecutive transmissions in the same RF channel. Note that 0 value stands for default settings of the selected region. Refer to country specific regulations for limitations. You, the user, are responsible to ensure operation with the correct RF settings and are solely responsible for any fines and	0.00 … 0.99 seconds 0 … 99 seconds	0

Parameter	Description	Range	Default
	other damages due to incorrect or non-compliant country/region settings.		
RF Chip Standby Mode	Activation / deactivation of the standby mode of the RF chip during RF off conditions to reduce power consumption and temperature increase.	Disabled Enabled	Enabled
RSSI Information	The detection tag's signal RSSI I and Q measured values information. Note that this parameter become effective only after a reboot of the reader.	Disabled Enabled	Disabled
Max RSSI Information	The detected tag's signal max RSSI I and Q measured values information. Note that this parameter become effective only after a reboot of the reader.	Disabled Enabled	Disabled
Tag Read Count Information	The tag read count information. Note that this parameter become effective only after a reboot of the reader.	Disabled Enabled	Disabled

Hereinafter the configurable EPC C1G2 (Class-1 Generation-2) parameters of the **BLUEBOX**.

Parameter	Description	Range	Default
Inventory Mode	How the reader does an inventory in 'continuous' mode.	Fast Multi Tag Fast Single Tag Standard Multi Tag Standard Single Tag	Standard Multi Tag
R->T Link Frequency	R->T Link Frequency as defined in EPC Class 1 Generation 2 protocol.	40 kHz 160 kHz 256 kHz 320 kHz 640 kHz	160 kHz
R->T Bit Coding	R->T Bit coding as defined in EPC Class 1 Geneneration 2 protocol.	FM0 Miller 2 Miller 4 Miller 8	Miller 2
Q Selection Algorithm	The Q selection algorithm used for setting the slot-counter parameter as defined in EPC Class 1 Generation 2 protocol.	Dynamic Fixed	Dynamic
Q Value	The Q value used in fixed Q selection algorithm or the starting Q value used in dynamic Q selection	0 … 15	3

Parameter	Description	Range	Default
	algorithm as defined in EPC Class 1 Generation 2 protocol.		
Q Initial	The minimum allowed Q value in dynamic Q algorithm mode.	0 … 15	0
Q Final	The maximum allowed Q value in dynamic Q algorithm mode.	0 … 15	4
Q Adjust Rounds	The maximum Q adjust rounds in dynamic Q algorithm mode.	0 … 5	3
Inventory Cycles	The inventory cycles in inventory command.	0 … 5	3
Search Mode	How the reader singulates (select) tags in 'continuous' mode.	Dual Target Single Target	Dual Target
Session	The session used as defined in EPC Class 1 Generation 2 protocol.	S0 S1 S2 S3	S0
Target	The target used as defined in EPC Class 1 Generation 2 protocol.	A B	A
EPC size	The size of the recognized EPC in bytes. 0 means all EPC sizes,	0 … 62	0
ReadAfterDetect Activation	Activation of the ReadAfterDetect mode in 'continuous' mode. Note that this parameter become effective only after a reboot of the reader.	None TID Custom	None
ReadAfterDetect Password	The password to be used to access to tag's memory in ReadAfterDetect mode (Inventory Mode = Standard Single/Multi Tag with Custom Info). Use a '0' password if the access password is not requested. Note that this parameter become effective only after a reboot of the reader.	0x00 0x00 0x00 0x00 … 0xFF 0xFF 0xFF 0xFF	0x00 0x00 0x00 0x00
ReadAfterDetect Bank	The tag's memory bank to access in ReadAfterDetect mode (Inventory Mode = Standard Single/Multi Tag with Custom Info). Note that this parameter become effective only after a reboot of the reader.	Reserved EPC TID User	Reserved
ReadAfterDetect Address	The tag's memory start address to access in the specified memory bank in ReadAfterDetect mode (Inventory Mode = Standard Single/Multi Tag with Custom Info). Note that this parameter become effective only after a reboot of the reader.	0x00 0x00 0x00 0x00 … 0xFF 0xFF 0xFF 0xFF	0x00 0x00 0x00 0x00

Parameter	Description	Range	Default
ReadAfterDetect Length	The number of tag's memory blocks (2-bytes length) to access in the specified memory bank in ReadAfterDetect mode (Inventory Mode = Standard Single/Multi Tag with Custom Info). In case of Reserved or User bank selected 0 means no tag's memory block access, in case of TID bank selected 0 means auto-length (class identifier, manufacturer identifier, serial number). Note that this parameter become effective only after a reboot of the reader.	0 … 255	0
ReadAfterDetect Info Flags	The tag's info (PC, EPC, CRC) to include in the tag's ID in ReadAfterDetect mode (Inventory Mode = Standard Single/Multi Tag with Custom Info). Note that this parameter become effective only after a reboot of the reader.	PC, EPC, CRC	PC, EPC, CRC
Use AFI	To enable/disable the AFI (Application Family Identifier) management.	Disabled Enabled	Disabled
AFI	The AFI (Application Family Identifier) value.	0 … 255	0

The RF and EPC C1G2 (Class-1 Generation-2) parameters are stored in configuration pages nr. 0x01, 0x02, 0x04 and 0x82 and are managed through the 'Read RAM/ROM Configuration Parameters' and 'Write RAM/ROM Configuration Parameters' commands as described in protocol technical manuals.

The parameters 1…7 fields with default values are of page 0x01 are:

1	2	3	4	5	6	7
RF Receive Sensitivity	Functional Flags	0x00	0x00	0x00	0x00	0x00
0x4C	**0x00**	**0x00**	**0x00**	**0x00**	**0x00**	**0x00**

Where:

Parameter	Description
RF Receive Sensitivity	Absolute value of the RF receive sensitivity in the range 51 … 87.
Functional Flags	Functional flags. Single bits are dedicated to disable (0 value) or enable (1 value) functions:

Parameter	Description
	<table><tr><th>Bit</th><th>Description</th></tr><tr><td>Bit 7</td><td>Not used</td></tr><tr><td>Bit 6</td><td>Not used</td></tr><tr><td>Bit 5</td><td>Not used</td></tr><tr><td>Bit 4</td><td>Not used</td></tr><tr><td>Bit 3</td><td>Max RSSI information</td></tr><tr><td>Bit 2</td><td>Tag read count information</td></tr><tr><td>Bit 1</td><td>RSSI information</td></tr><tr><td>Bit 0</td><td>To disable the RF chip standby mode (0=enabled, 1=disabled).</td></tr></table>

The parameters 1…7 fields with default values of page 0x02 are:

1	2	3	4	5	6	7
RF Geograph. Region	RF Transmit Power	RF Channel	Antennas Activation	EPC C1G2	RF Maximum Allocation Time	RF Minimum Pause Time
0x02	0x14	0x00	0x01	0x30	0x00	0x00

Where:

Parameter	Description
RF Geographical Region	RF geographical region: • 0x01: North America (FCC compliant); • 0x02: Europe (ETSI compliant); • 0x03: Brazil (FCC subset compliant).
RF Transmit Power	RF conducted transmit power in the range 0 … 24.
RF Channel	RF channel. Channel 0 stands for default settings of the selected region.
Antennas Activation	A byte whose bits are dedicated to disable (0 value) or enable (1 value) the antennas to use: <table><tr><th>Bit</th><th>Description</th></tr><tr><td>Bit 7</td><td>Not used</td></tr><tr><td>Bit 6</td><td>Not used</td></tr><tr><td>Bit 5</td><td>Not used</td></tr><tr><td>Bit 4</td><td>Not used</td></tr><tr><td>Bit 3</td><td>Not used</td></tr></table>

<table>
<tr><th>Parameter</th><th>Description</th></tr>
<tr><td></td><td>
<table>
<tr><td>Bit 2</td><td>Not used</td></tr>
<tr><td>Bit 1</td><td>Not used</td></tr>
<tr><td>Bit 0</td><td>Antenna 1</td></tr>
</table>
</td></tr>
<tr><td>EPC C1G2</td><td>A byte whose bits are dedicated to manage Q value and session/target parameters:
<table>
<tr><th>Bit</th><th>Description</th></tr>
<tr><td>Bit 7 ... 4</td><td>Q value in fixed Q selection algorithm or starting Q value in dynamic Q selection algorithm, as defined EPC Class 1 Generation 2 protocol (0x0=0 … 0xF=15)</td></tr>
<tr><td>Bit 3 … 2</td><td>Session as defined in EPC Class 1 Generation 2 protocol (00b=S0, 01b=S1, 10b=S2, 11b=S3)</td></tr>
<tr><td>Bit 1</td><td>Q selection algorithm (0=dynamic, 1=fixed);</td></tr>
<tr><td>Bit 0</td><td>Target as defined in EPC Class 1 Generation 2 protocol (0=A, 1=B)</td></tr>
</table>
</td></tr>
<tr><td>RF Maximum Allocation Time</td><td>The maximum period of consecutive transmission on the same RF channel. 0 stands for default settings of the selected region. The allowed values are:
• Decimal 0 … 99 for time in mseconds (0.00 … 0.99 seconds);
• Decimal 100 … 199 for time in seconds (0 … 99 seconds).</td></tr>
<tr><td>RF Minimum Pause Time</td><td>The minimum time between two consecutive transmission in the same RF channel. 0 stands for default settings of the selected region. The allowed values are:
• Decimal 0 … 99 for time in mseconds (0.00 … 0.99 seconds);
• Decimal 100 … 199 for time in seconds (0 … 99 seconds).</td></tr>
</table>

The parameters 1…7 fields with default values of page 0x04 are:

1	2	3	4	5	6	7
Inventory Mode	R->T Link Frequency	R->T Bit Coding	0x00	EPC Size	Use AFI	AFI
0x02	**0x02**	**0x01**	**0x00**	**0x00**	**0x00**	**0x00**

Where:

<table>
<tr><th>Parameter</th><th>Description</th></tr>
<tr><td>Inventory Mode</td><td>A byte whose bits are dedicated to manage the inventory mode, the search mode and the ReadAfterDetect info activation parameters:
<table>
<tr><th>Bit</th><th>Description</th></tr>
<tr><td>Bit 7</td><td>Not used</td></tr>
<tr><td>Bit 6</td><td>Search mode (how the reader singulates tags in ‘continuous’ mode):
• 0b: Dual Target (the reader singulates tags in both A and B states)</td></tr>
</table>
</td></tr>
</table>

Parameter	Description
	<table><tr><td></td><td>• 1b: Single Target (the reader singulates only tags that are in A state)</td></tr><tr><td>Bit 5</td><td>Activation of the ReadAfterDetect with custom info as defined in ReadAfterDetect Password, Bank, Address, Length and EPC Info parameters (0b=OFF, 1b=ON)</td></tr><tr><td>Bit 4</td><td>Activation of the ReadAfterDetect with auto TID info (0b=OFF, 1b=ON)</td></tr><tr><td>Bit 3 … 0</td><td>Inventory mode (how the reader does an inventory in 'continuous' mode): • 0x0: Fast Multi Tag: Inventory mode that does not take the tag to the Opened but to the Acknowledged state. This inventory mode is not as secure as the standard mode, but it is faster • 0x1: Fast Single Tag: The same inventory mode like the Fast Multi Tag, but with the slot count of 1. This has the effect that no anticollision procedure is performed • 0x2: Standard Multi Tag: Inventory mode like defined in the EPC C1G2 standard • 0x4: Standard Single Tag: The same inventory mode like the Standard Multi Tag, but with the slot count of 1. This has the effect that no anticollision procedure is performed</td></tr></table> Note that allowed values are: <table><tr><th>Inventory Mode</th><th>ReadAfterDetect with Custom Info</th><th>ReadAfterDetect with Auto TID</th><th>Search Mode</th></tr><tr><td>Fast Multi Tag, Fast Single Tag</td><td>Disabled</td><td>Disabled</td><td>Dual Target, Single Target</td></tr><tr><td>Standard Multi Tag, Standard Single Tag</td><td>Disabled</td><td>Disabled</td><td>Dual Target, Single Target</td></tr><tr><td>Standard Multi Tag, Standard Single Tag</td><td>Disabled</td><td>Enabled</td><td>Dual Target, Single Target</td></tr><tr><td>Standard Multi Tag, Standard Single Tag</td><td>Enabled</td><td>Disabled</td><td>Dual Target, Single Target</td></tr></table>
R->T Link Frequency	R->T link frequency: • 0x00: 40 kHz; • 0x02: 160 kHz; • 0x04: 256 kHz; • 0x05: 320 kHz; • 0x06: 640 kHz.
R->T Bit Coding	R->T bit coding: • 0x00: FM0; • 0x01: Miller 2; • 0x02: Millller 4; • 0x03: Miller 8. Note that allowed values are:

Parameter	Description
	<table><tr><th>R->T Link Frequency</th><th>R->T Bit Coding</th></tr><tr><td>40 kHz</td><td>FM0, Miller 2, Miller 4, Miller 8</td></tr><tr><td>160 kHz</td><td>FM0, Miller 2, Miller 4, Miller 8</td></tr><tr><td>256 kHz</td><td>Miller 4, Miller 8</td></tr><tr><td>320 kHz</td><td>Miller 4, Miller 8</td></tr><tr><td>640 kHz</td><td>Miller 4, Miller 8</td></tr></table> DRM (Dense Reader Mode): <table><tr><th>R->T Link Frequency</th><th>R->T Bit Coding</th></tr><tr><td>256 kHz</td><td>Miller 4, Miller 8</td></tr><tr><td>320 kHz</td><td>Miller 4, Miller 8</td></tr></table>
EPC Size	The size of the recognized EPC in bytes. 0 means all EPC sizes.
Use AFI	To enable/disable the AFI (Application Family Identifier) management: • 0x00: Disabled; • 0x01: Enabled.
AFI	The AFI (Application Family Identifier) value.

The parameters 1…14 fields with default values of page 0x82 are:

1	2	3	4	5	6	7
ReadAfterDetect Password0	ReadAfterDetect Password1	ReadAfterDetect Password2	ReadAfterDetect Password3	ReadAfterDetect Bank	ReadAfterDetect Address0	ReadAfterDetect Address1
0x00	0x00	0x00	0x00	0x00	0x00	0x00

8	9	10	11	12	13	14
ReadAfterDetect Address2	ReadAfterDetect Address3	ReadAfterDetect Length	ReadAfterDetect Info Flags	Q	Q Adjust Rounds	Inventory Cycles
0x00	0x00	0x00	0x03	0x05	0x03	0x03

Where:

Parameter	Description
ReadAfterDetect Password0 ….	The password to be used to access to tag's memory in ReadAfterDetect mode. Use a '0' password if the access password is not requested.

<table>
<tr><th>Parameter</th><th>Description</th></tr>
<tr><td>ReadAfterDetect Password3</td><td></td></tr>
<tr><td>ReadAfterDetect Bank</td><td>The tag’s memory bank to access in ReadAfterDetect mode:
0x00: Reserved;
0x01: EPC;
0x02: TID;
0x03: User.</td></tr>
<tr><td>ReadAfterDetect Address0
…
ReadAfterDetect Address3</td><td>The tag’s memory start address to access in the specified memory bank in ReadAfterDetect mode.</td></tr>
<tr><td>ReadAfterDetect Length</td><td>The number of tag’s memory blocks (2-bytes length) to access in the specified memory bank in ReadAfterDetect mode. In case of Reserved or User bank selected, 0 means no tag’s memory block access; in case of TID bank selected, 0 means auto-length (class identifier, manufacturer identifier, serial number).</td></tr>
<tr><td>ReadAfterDetect Info Flags</td><td>The tag’s info (PC, EPC, CRC) to include in the tag’s ID in ReadAfterDetect mode. A byte whose bits are dedicated to disable (0 value) or enable (1 value) functions:
<table>
<tr><th>Bit</th><th>Description</th></tr>
<tr><td>Bit 7</td><td>Not used</td></tr>
<tr><td>Bit 6</td><td>Not used</td></tr>
<tr><td>Bit 5</td><td>Not used</td></tr>
<tr><td>Bit 4</td><td>Not used</td></tr>
<tr><td>Bit 3</td><td>Not used</td></tr>
<tr><td>Bit 2</td><td>CRC field</td></tr>
<tr><td>Bit 1</td><td>EPC field</td></tr>
<tr><td>Bit 0</td><td>PC field</td></tr>
</table></td></tr>
<tr><td>Q</td><td>Minimum and maximum Q value to be used in dynamic Q selection algorithm:
High nibble: minimum Q value (0x0 … 0xF);
Low nibble: maximum Q value (0x0 … 0xF).</td></tr>
<tr><td>Q Adjust Rounds</td><td>Maximum Q adjust rounds in dynamic Q selection algorithm.</td></tr>
<tr><td>Inventory Cycles</td><td>The inventory cycles in inventory command.</td></tr>
</table>

3.2.3 Dynamic Power Management

This section provides details on the configurable dynamic RF power management parameters of the **BLUEBOX**

Parameter	Description	Range	Default
Mode	How the reader manages the power in 'continuous' mode. Note that this parameter become effective only after a reboot of the reader.	Off Up Up/down	Off
Power Step	The power step in dynamic power management mode activated. Note that this parameter become effective only after a reboot of the reader.	1 … 5 dB 10 … 500 mW	1 dB
Time Step	The time step in dynamic power management mode activated. Note that this parameter become effective only after a reboot of the reader.	0.1 … 9.9 seconds	1.0 sec

The dynamic power management parameters are stored in configuration page nr. 0x07 and are managed through the 'Read RAM/ROM Configuration Parameters' and 'Write RAM/ROM Configuration Parameters' commands as described in protocol technical manuals where the parameters 1…7 fields with default values are:

1	2	3	4	5	6	7
Mode	Power Step	Time Step	0x00	0x00	0x00	0x00
0x00	**0x01**	**0x0A**	**0x00**	**0x00**	**0x00**	**0x00**

Where:

Parameter	Description
Mode	Dynamic power management activation / deactivation in 'continuous' mode: • 0x00: Off; • 0x01: Up, only increase power by power step every time step; • 0x02: Up / Down, increase power and then decrease it by power step every time step.
Power Step	Power step: • 0x01 … 0x05 for power step in dB (1 … 5 dB); • 0x81 … 0xB2 for power step in mW x 10 (10 … 500 mW).
Time Step	Time step: • Decimal 1 … 99 for time in ms x 100 (0.1 … 9.9 seconds).

3.3 Device Status

The information about the current status of the **BLUEBOX** shall be read with the 'Read Device Status' command as described in protocol technical manuals where the status bytes 1 and 2 have the following meaning.

<table>
<tr><th>Status Byte</th><th>Description</th></tr>
<tr><td>Status Byte 1</td><td>Byte whose bits have the following meaning:
<table>
<tr><th>Bit</th><th>Description</th></tr>
<tr><td>Bit 7</td><td>Not used</td></tr>
<tr><td>Bit 6</td><td>Not used</td></tr>
<tr><td>Bit 5</td><td>RF status (0=off, 1=on)</td></tr>
<tr><td>Bit 4</td><td>'Continuous' mode (1=enabled)</td></tr>
<tr><td>Bit 3</td><td>Not used</td></tr>
<tr><td>Bit 2</td><td>Not used</td></tr>
<tr><td>Bit 1</td><td>Not used</td></tr>
<tr><td>Bit 0</td><td>Not used</td></tr>
</table></td></tr>
<tr><td>Status Byte 2</td><td>Byte whose bits have the following meaning:
<table>
<tr><th>Bit</th><th>Description</th></tr>
<tr><td>Bit 7</td><td>Dip witch SW1-4 (1=closed)</td></tr>
<tr><td>Bit 6</td><td>Dip witch SW1-3 (1=closed)</td></tr>
<tr><td>Bit 5</td><td>Dip witch SW1-2 (1=closed)</td></tr>
<tr><td>Bit 4</td><td>Dip witch SW1-1 (1=closed)</td></tr>
<tr><td>Bit 3</td><td>Not used</td></tr>
<tr><td>Bit 2</td><td>Not used</td></tr>
<tr><td>Bit 1</td><td>Not used</td></tr>
<tr><td>Bit 0</td><td>Not used</td></tr>
</table></td></tr>
</table>

4 Installation

4.1 General Instructions

- Several devices installed next to each other interfere if they are not correctly configured.
- When mounting several nearby devices adhere to the minimum distances between them.
- Installing a device in or on metal reduces the read and write distance.
- Keep the device away from direct sunlight, high humidity, extreme temperatures, and sources of electromagnetic interference. Any combination of these conditions might degrade performance or shorten the life of the device.
- Connect the device using a suitable cable as defined in electrical connections section.
- Power the device using a suitable external power supply as defined in electrical connections section. The boot sequence begins in either case when power is supplied to the device. This sequence typically completes within 5 seconds. After the boot sequence finishes, the device accepts commands, not before. The LED on the device alerts you to the status as defined in status indications section.

4.2 Notes on Tag Mounting

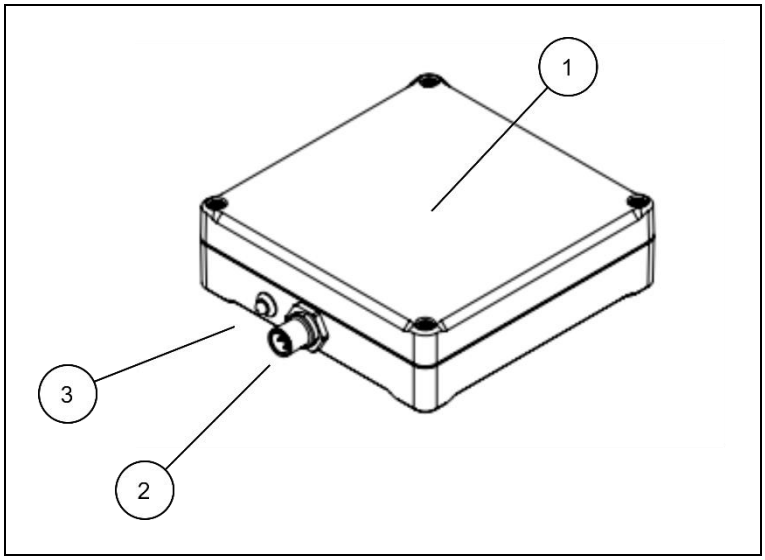
- For installation in and on metal tags provided for this purpose must be used.
- The tag must be placed in the reading area of the device antenna. The angle of aperture and the operating distance must be adhered to.
- The orientation of the device antenna axis must correspond with the axis of the tag for best performance.

4.3 Avoiding Interference

The device generates a modulated electrical field the UHF band 865 – 868 MHz. To avoid interference of the data communication no other devices generating interference emission in this frequency band must be operated in the vicinity.

Observe the notes on installation when several RFID UHF devices are operated simultaneously.

4.4 Mechanical Design

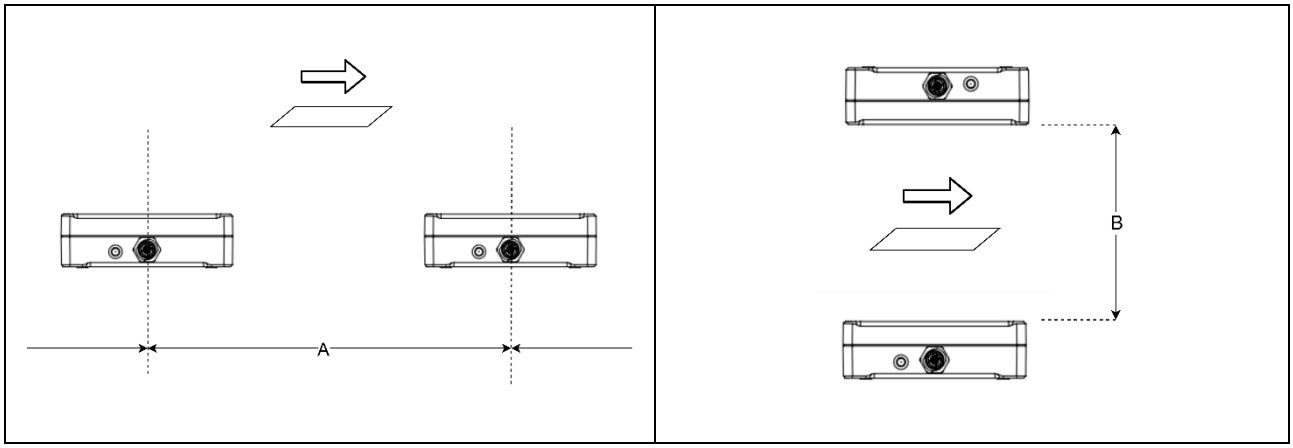


1. Sensing face (antenna)
2. Electrical connections
3. Status indications

4.5 Fixing

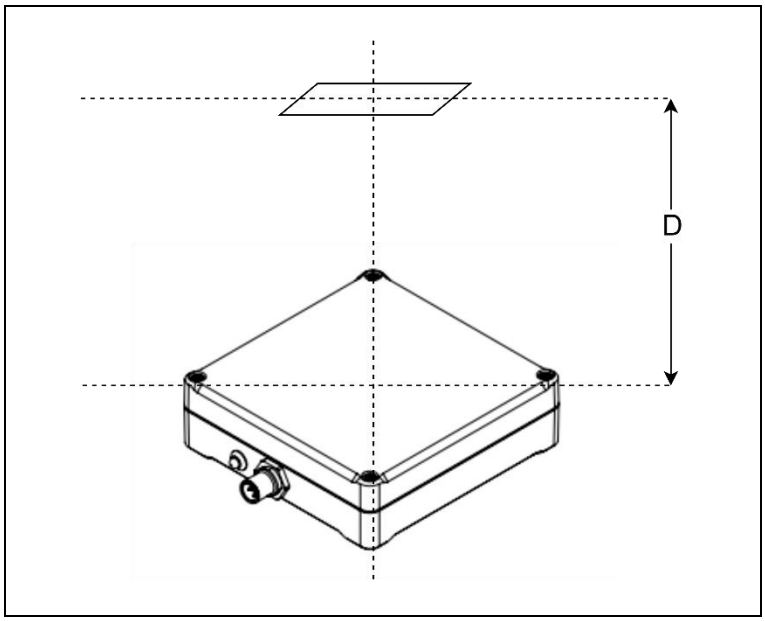
To install the device, it is necessary to remove the top cover. Fix the enclosure to a support (wall, column, ...) using the 4 holes (already provided within the enclosure) choosing suitable screws

4.6 Mounting Distances



Operating Mode	Distance Side (A)	Distance Front (B)
Reading and writing at 100% transmitter power (simultaneous operation)	> 6.0mt	> 10.0mt
Reading and writing at 100% transmitter power (alternating operation)	> 0.3mt	> 0.3mt

4.7 Positioning of the Tags



- Align the tag on the antenna central axis.
- See the tag datasheet for the distance D.

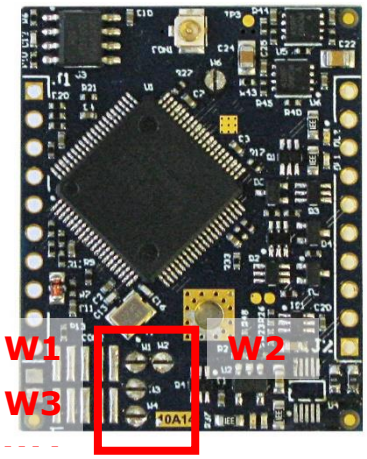
5 Hardware Settings

5.1 Main Board

S2	
Dip 1	On: To use RS232 interface.
Dip 2	On: To use RS232 interface.
Dip 3	On: To use RS485 interface.
Dip 4	On: To use RS485 interface.

S3	
Dip 1	On: RS485 fail-safe resistor connected to +5V.
Dip 2	On: RS485 fail-safe resistor connected to GND.
Dip 3	On: RS485 120Ω line termination resistor connected.
Dip 4	Not used.

5.2 Front-End Board

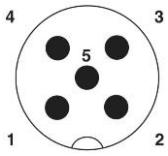


Solder jumpers	
W1	On: force 255, 19200, 8, n, 1.
W2	On: enables ‘spontaneous’ mode.
W3	Not used.
W4	Not used.

6 Connections

- The device must be connected by a skilled qualified person.
- Device of protection class III.
- Electric supply via SELV circuits only.
- Disconnect power before connecting the device.
- The IP rating indicated in the data sheet is only guaranteed if the M12 connectors are firmly screwed.
- The device can be damaged by insufficiently tightened M12 connectors.
- Screw the M12 connector to the device applying 1 to 1.5 Nm.

6.1 Power Supply and Serial Line



5-poles M12 A-coded male connector

Pin	No	Min	Typical	Max	Description
+ PWR	1	10Vdc	12/24Vdc	36Vdc	DC power supply
RS232-TXD RS485-RT+	2				RS232 connection (to host) RS485 connection (positive)
- PWR	3				DC power supply return path
RS232-RXD RS485-RT-	4				RS232 connection (from host) RS485 connection (negative)
PE	5				Protected Earth

To ensure interference-free operation, the device must be connected to an earth potential free from external voltage.

Hereinafter a cross reference table between connection pin number and the color of the wires of a standard open ended cable.

Pin	No	Wire Cable Color
+ PWR	1	Brown
RS232-TXD RS485-RT+	2	White
- PWR	3	Blue
RS232-RXD RS485-RT-	4	Black
PE	5	Grey

7 Status Indications

The **BLUEBOX** uses one yellow LED. The following tables provides the indicator states and flash rates.

LED State	Description
On	The indicator is constantly on
Off	The indicator is constantly off
Blinking	The indicator turns on and off with a frequency of 2 Hz: on for 250 ms, followed by off for 250 ms
Slow Blink	The indicator turns on and off with a frequency of 1 Hz: on for 500 ms, followed by off for 500 ms

LED	Color	State	Meaning
SYSTEM	(yellow)	Blinking	• Antenna active, no tag detected in 'continuous' mode.
	(yellow)	Slow Blink	• Antenna not active in 'continuous' mode.
	(yellow)	On	• Antenna active, tag detected in 'continuous mode. • System initialization.
	(off)	Off	• Power supply for the device is missing. • Hardware defect. • System upgrade.

Buzzer:

- The buzzer is activated for 0.5 seconds at the end of the initialization phase in case of no hardware defects detected, otherwise 3 short beeps (0.25 seconds) shall signal an hardware defect.
- During normal operation, if the 'automatic' management of the buzzer is enabled by the flag defined in the general parameters, the buzzer is activated for 0.5 seconds at every identification of a 'new' tag.
- During normal operation, if the RF test mode is enabled, the buzzer is activated for 50ms at every identification of a tag.

- During firmware upgrade procedure, the buzzer is activated for 0.25 seconds at the end of the file download in case of no file errors detected, otherwise 5 short beeps (0.15 seconds) shall signal an error

8 Antenna

This section provides details on the antenna of the **BLUEBOX**.

The **BLUEBOX** integrates an RF antenna inside the case.

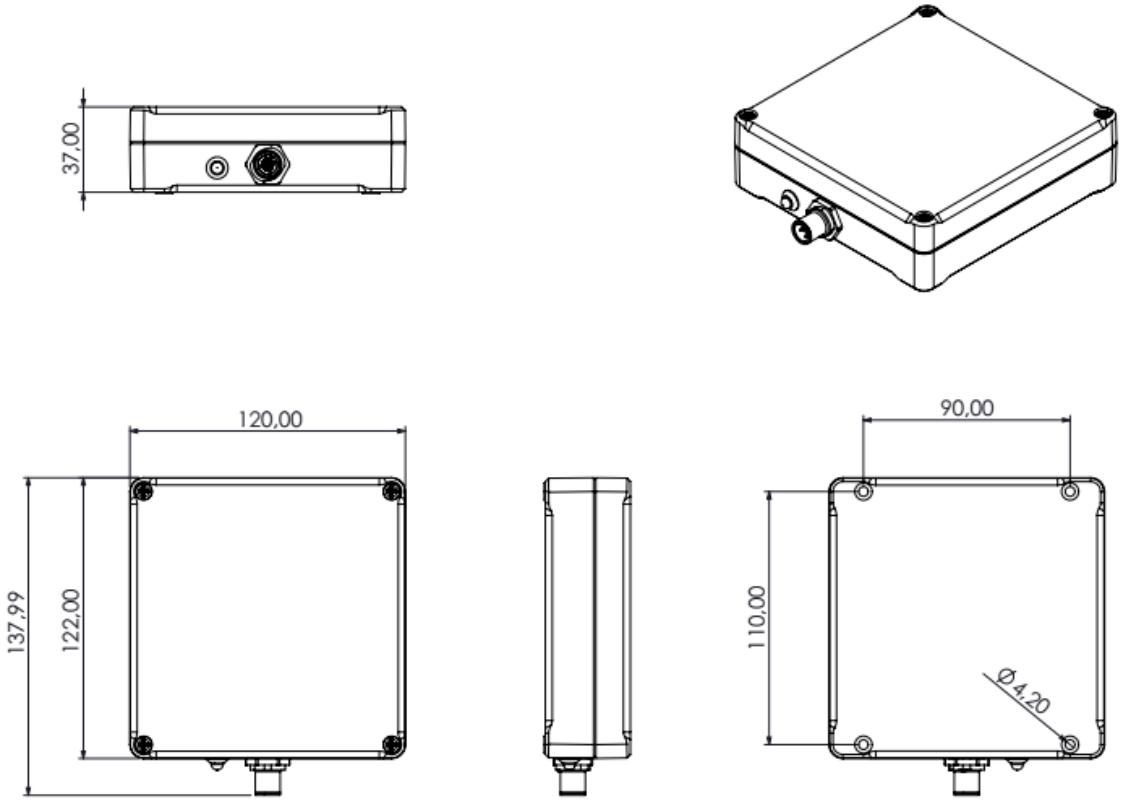
The read range of an RFID system always depends on various factors like antenna size, transponder size, transponder IC type, orientation between transponder and reader antenna, position of the transponder versus the reader antenna, noise environment, metallic environment, etc. Therefore all data about read ranges can only be typical values measured under laboratory conditions. In real live applications the read range may differ from the data mentioned in the datasheet.

9 Maintenance, Repair and Disposal

If used correctly, no maintenance and repair measures are necessary

- The device must only be repaired by the manufacturer.
- After use dispose of the device in an environmentally friendly way in accordance with the applicable national regulations.
- Keep the device free from soiling.
- Do not open the device.

10 Mechanical Drawings



All dimensions are in mm.

11 Document Revision History

Date	Revision	Description
01/08/18	1.00	First release.
09/10/18	1.01	Updated the reader's firmware versions object of this manual in preface section. Minor changes in general and configuration parameters. Added the AFI management in EPC C1G2 configuration. Minor changes in status indications.
16/10/18	1.02	Updated the reader's firmware versions object of this manual in preface section. Added configuration for the "spontaneous" message format.
22/10/18	1.03	Updated the reader's firmware versions object of this manual in preface section. Added the tag read count info activation flag in RF configuration. Corrections in operating features and configuration parameters.
30/10/18	1.04	Updated the reader's firmware versions object of this manual in preface section. Changed description in "spontaneous" message format field in spontaneous message configuration. Added ASCII mode setup for the "spontaneous" message format field in spontaneous message configuration.
11/01/19	1.05	Updated the company name/logo and BLUEBOX logo. Updated the reader's firmware versions object of this manual. Added the max RSSI info activation flag in RF configuration.
01/02/19	1.06	Updated the reader's firmware versions object of this manual. Added the Brazil RF region support in RF configuration and in regions of operation appendix. Minor changes and corrections in the configuration parameters. Moved the plans of frequencies from RF configuration section to regions of operations appendix.

Date	Revision	Description
		Moved the power requirements from antennas section to regions of operations appendix.
05/02/19	1.07	Updated the reader's firmware versions object of this manual. Move the tag data bytes limit warning from RF configuration parameters to operating features section.
17/05/19	1.08	Updated the reader's firmware versions object of this manual. Added the spontaneous message for every identified tag slow/fast mode selection in spontaneous message configuration parameters. Minor changes and corrections in the configuration parameters.
20/05/19	1.09	Updated the reader's firmware versions object of this manual. Corrected and updated the buzzer behavior description in signalling section.
02/09/19	1.10	Updated the reader's firmware versions object of this manual. Changes and document fixes in all sections.
04/05/20	1.11	Updated the reader's description object of this manual. Updated the reader's firmware versions object of this manual. Replaced ISO 18000-6C with ISO 18000-63. ISO 18000-6C became ISO 18000-63 in 2012 due to ISO naming rules that do not allow letters in standards names. Added the STX + dual char string format setup selection (STX + dual char string, STX + dual char string + CR, STX + dual char string + CRLF) in spontaneous message configuration parameters. Added the STX + ASCII string format setup selection (STX + ASCII string, STX + ASCII string + CR, STX + ASCII string + CRLF) in spontaneous message configuration parameters. Added the message encoding selection (None, Decimal) in spontaneous message configuration parameters. Added the installation section. Added safety informations in electrical connections section. Added the maintenance, repair and disposal section.

Date	Revision	Description
		Format and document fixes in all sections.
02/07/20	1.12	Changes in the operating features and general and configuration parameters.
20/11/20	1.13	Added a note in spontaneous message encoding parameter in spontaneous message configuration parameters.

A. Regions of Operation

The **BLUEBOX** reader has been designed to work in various regions with differing frequency requirements. This document covers operation in North America, Brazil and Europe.

A.1 Operation in Europe

For European operation, the **BLUEBOX** reader supports the frequency plan listed in the table below and is compliant with the ratified ETSI EN 302-208 specification V.3.1.0. This specification states that no listen-before-talk is performed, the maximum continuous transmit time on a channel is four seconds, and the reader enforces the 100 ms off time before reusing the same channel. In some applications (i.e. conveyor systems) it may be necessary for interrogators to transmit while tags are not present. To accommodate such requirements, the device shall include within interrogators a means to minimize the overall length of transmission commensurate with the application. This may include the provision of trigger mechanisms within interrogators to initiate transmissions.

RF Channel	Frequency [MHz]
4	865.7
7	866.3
10	866.9
14	867.5

According to ETSI EN 302208-1 only channels 4, 7, 10 and 13 (internal numerated as 1, 4, 7 and 10) could be used at high power! Other RF channels are present only for test purposes and should not be used in normal operation!

European regulations describe radiating power limits in relation to dipole antenna and ERP (Efficient Radiating Power) is used as a measure. The maximum RF output power is defined by the antenna gain, the half power beam width and the cable attenuation on the reader - antenna connection. For antennas with a half power beam width of up to 70° a power of $P_{ERP,max}$ = 2W ERP is allowed. For other half power beam widths a reduced power of $_{PERP,max}$ = 0.5W ERP. The maximum **BLUEBOX** RF output power is defined as:

$P_{C,max} = P_{ERP,max} - G_{IC} + 5.15 + C_L$

Where:

$P_{C,max}$	Maximum RF output power in dBm
$P_{ERP,max}$	Maximum ERP power of the antenna in dBm
G_{IC}	Circular antenna gain in dBic
C_L	Cable loss in dB

A.1. Operation in North America

The FCC specifies frequency hopping across the North American spectrum allocated to UHF RFID (902–928 MHz, with hopping occurring between 902.75–927.25 MHz in 500 KHz steps). This specification states that no listen-before-talk is performed, the maximum continuous transmit time on a channel is 0.4 seconds.

RF Channel	Frequency [MHz]
1	902.75
2	903.25
3	903.75
…	…
49	926.75
50	927.25

Other RF channels and single channel selection are present only for test purposes and should not be used in normal operation!

FCC regulations describe the radiating power limits in relation to isotropic antenna and EIRP (Efficient Isotropic Radiating Power) is used as a measure. The maximum RF output power is defined by the antenna gain, the half power beam width and the cable attenuation on the reader - antenna connection. A power of $P_{EIRP,max}$ = 36dBm EIRP subject to a maximum conducted power of allowance of 30dBm at the antenna connector is allowed. The maximum **BLUEBOX** RF output power is defined as:

$P_{C,max} = P_{EIRP,max} - G_{IC} - 2.15 + 5.15 + C_L$

Where:

$P_{C,max}$	Maximum RF output power in dBm
$P_{ERP,max}$	Maximum ERP power of the antenna in dBm
G_{IC}	Circular antenna gain in dBic
C_L	Cable loss in dB

A.2. Operation in Brazil

The **BLUEBOX** operates over a subset of the FCC North American spectrum (902–928 MHz, with specific frequency and channel usage dictated by regulations of each country. Frequency hopping spread spectrum (FHSS) is used. No listen-before-talk is performed, the maximum continuous transmit time on a channel is 0.4 seconds.

RF Channel	Frequency [MHz]
1	902.75
2	903.25
3	903.75
4	904.25
5	904.75
6	905.25
7	905.75
8	906.25
9	906.75
10	907.25
26	915.25
27	915.75
28	916.25

RF Channel	Frequency [MHz]
29	916.75
30	917.25
31	917.75
32	918.25
33	918.75
34	919.25
35	919.75
36	920.25
37	920.75
38	921.25
39	921.75
40	922.25
41	922.75
42	923.25
43	923.75
44	924.25
45	924.75
46	925.25
47	925.75
48	926.25
49	926.75
50	927.25

Other RF channels and single channel selection are present only for test purposes and should not be used in normal operation!

Brazil regulations describe the radiating power limits in relation to isotropic antenna and EIRP (Efficient Isotropic Radiating Power) is used as a measure. The maximum RF output power is defined by the antenna gain, the half power beam width and the cable attenuation on the reader - antenna connection. A power of $P_{EIRP,max}$ = 36dBm EIRP subject to a maximum conducted power of allowance of 30dBm at the antenna connector is allowed. The maximum **BLUEBOX** RF output power is defined as:

$$P_{C,max} = P_{EIRP,max} - G_{IC} - 2.15 + 5.15 + C_L$$

Where:

$P_{C,max}$	Maximum RF output power in dBm
$P_{ERP,max}$	Maximum ERP power of the antenna in dBm
G_{IC}	Circular antenna gain in dBic
C_L	Cable loss in dB

B. RS232 DB9 to M12 Connection

RS232 DB-9			RS232 M12	
Pin	Description		Pin	Description
2	RXD	<-->	2	TXD
3	TXD	<-->	4	RXD
5	GND	<-->	3	GND