Manual

WAGO-I/O-SYSTEM 757

Bluetooth® Module RS-232

757-801

Version 1.0.0

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Every conceivable measure has been taken to ensure the accuracy and completeness of this documentation. However, as errors can never be fully excluded, we always appreciate any information or suggestions for improving the documentation.

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We wish to point out that the software and hardware terms as well as the trademarks of companies used and/or mentioned in the present manual are generally protected by trademark or patent.

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1 Notes about this Documentation

Note

Keep this documentation!
The operating instructions are part of the product and shall be kept for the entire lifetime of the device. They shall be transferred to each subsequent owner or user of the device. Care must also be taken to ensure that any supplement to these instructions are included, if applicable.

1.1 Validity of this Documentation

This documentation applies to 757-801 (*Bluetooth*® Module RS-232).

1.2 Copyright

1.3 Symbols

DANGER

Personal Injury!
Indicates a high-risk, imminently hazardous situation which, if not avoided, will result in death or serious injury.

DANGER

Personal Injury Caused by Electric Current!
Indicates a high-risk, imminently hazardous situation which, if not avoided, will result in death or serious injury.

WARNING

Personal Injury!
Indicates a moderate-risk, potentially hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION

Personal Injury!
Indicates a low-risk, potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

NOTICE

Damage to Property!
Indicates a potentially hazardous situation which, if not avoided, may result in damage to property.

NOTICE

Damage to Property Caused by Electrostatic Discharge (ESD)!
Indicates a potentially hazardous situation which, if not avoided, may result in damage to property.

Note

Important Note!
Indicates a potential malfunction which, if not avoided, however, will not result in damage to property.

Information

Additional Information:
Refers to additional information which is not an integral part of this documentation (e.g., the Internet).

1.4 Number Notation

Table 1: Number notation

Number code	Example	Note
Decimal	100	Normal notation
Hexadecimal	0x64	C notation
Binary	'100' '0110.0100'	In quotation marks, nibble separated with dots (.)

1.5 Font Conventions

Table 2: Font conventions

Font type	Indicates
italic	Names of paths and data files are marked in italic-type. e.g.: *C:\Programme\WAGO-I/O-CHECK*
Menu	Menu items are marked in bold letters. e.g.: **Save**
>	A greater-than sign between two names means the selection of a menu item from a menu. e.g.: **File** > **New**
Input	Designation of input or optional fields are marked in bold letters, e.g.: **Start of measurement range**
“Value”	Input or selective values are marked in inverted commas. e.g.: Enter the value “4 mA” under **Start of measurement range**.
[Button]	Pushbuttons in dialog boxes are marked with bold letters in square brackets. e.g.: **[Input]**
[Key]	Keys are marked with bold letters in square brackets. e.g.: **[F5]**

2 Important Notes

This section includes an overall summary of the most important safety requirements and notes that are mentioned in each individual section. To protect your health and prevent damage to devices as well, it is imperative to read and carefully follow the safety guidelines.

2.1 Legal Bases

2.1.1 Subject to Changes

WAGO Kontakttechnik GmbH & Co. KG reserves the right to provide for any alterations or modifications that serve to increase the efficiency of technical progress. WAGO Kontakttechnik GmbH & Co. KG owns all rights arising from the granting of patents or from the legal protection of utility patents. Third-party products are always mentioned without any reference to patent rights. Thus, the existence of such rights cannot be excluded.

2.1.2 Personnel Qualification

All sequences implemented on this device may only be carried out by electrical specialists with sufficient knowledge in automation. The specialists must be familiar with the current norms and guidelines for the devices and automated environments.

2.1.3 Intended Use of the Product

This product is designed for use in applications for closed and open-loop control and automation technologies and can be employed for home, business and industrial applications. The conditions for use described in this documentation must be observed for all applications, however. This also includes the properties listed in the section “Technical Data.” Uses other than those outlined here are prohibited.

2.1.4 Technical Condition of Specified Devices

The components to be supplied Ex Works, are equipped with hardware and software configurations, which meet the individual application requirements. WAGO Kontakttechnik GmbH & Co. KG will be exempted from any liability in case of changes in hardware or software as well as to non-compliant usage of components.

Please send your request for modified and new hardware or software configurations directly to WAGO Kontakttechnik GmbH & Co. KG.

2.2 Safety Advice (Precautions)

For installing and operating purposes of the relevant device to your system the following safety precautions shall be observed:

DANGER

Use SELV/PELV power source only!
The *Bluetooth*® Module RS-232 IP67 must only be powered from a PELV (Protective Extra Low Voltage) or SELV (Safety Extra Low Voltage) power source complying with the limited power source (LPS) requirements per DIN EN 60950-1.

WARNING

Special requirements for power supply within the scope of application of UL 508!
For UL 508 approval, the device must be operated using a 24 V Class 2 power supply unit or a Class 2 transformer in compliance with UL 1310 or UL 1585.

WARNING

Warning of RF radiation!
Never use the *Bluetooth*® Module RS-232 IP67 in areas where operation of radio equipment is prohibited. The *Bluetooth*® Module RS-232 IP67 contains a radio transmitter that can impair the function of medical electronic equipment such as hearing aids and pacemakers. Your doctor or the manufacturer of these devices can advise you.

⚠ WARNING

Please note the following information about FCC Part 15!

FCC Part 15.19
This device complies with Part 15 of the FCC Rules.
Operation is subject to the following 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.

FCC Part 15.21
Modifications not expressly approved by this company could void the user‘s authority to operate the equipment.

Installation by qualified electrician only
Only qualified staff can install and maintain the *Bluetooth*® Module RS-232 IP6. The transmitted must be off when working on or nearer to the antenna than specified below.

HF-Exposition
The external antenna operated with the *Bluetooth*® Module RS-232 IP67 must be at least 20 cm away from people. The antenna may not be positioned, so that it works in conjunction with any other antenna or transmitter.

NOTICE

Replace defective or damaged devices!
Replace defective or damaged device/module (e.g., in the event of deformed contacts), since the long-term functionality of device/module involved can no longer be ensured.

NOTICE

Pre-assemble free cable ends!
The end of the *Bluetooth*® Module RS-232 IP67’s connection cable is free. If cable ends have not been pre-assembled, liquid or dirt can penetrate into the *Bluetooth*® Module RS-232 IP67 and ruin it. Pre-assemble the connection cable according the environment or use the connection cable in an environment complying with IPX0 protection class!

NOTICE

Cleaning only with permitted materials!
Clean soiled contacts using oil-free compressed air or with ethyl alcohol and leather cloths.

NOTICE

Do not use any contact spray!
Do not use any contact spray. The spray may impair contact area functionality in connection with contamination.

NOTICE

Do not reverse the polarity of connection lines!
Avoid reverse polarity of data and power supply lines, as this may damage the devices involved.

NOTICE

Avoid electrostatic discharge!
The devices are equipped with electronic components that you may destroy by electrostatic discharge when you touch. Pay attention while handling the devices to good grounding of the environment (persons, job and packing).

NOTICE

Limit the length of the power supply feed line!
The length of the feed line between the power supply unit and the product connecting cable is limited to ensure proper power supply. Supply voltage filtering must be provided if the length of the power supply feed line exceeds 3 m.

3 Device Description

The *Bluetooth*® Module RS-232 IP67 is a serial *Bluetooth*® adapter. As wireless serial adapter (WSA), the module is used, e.g., as cable substitute for serial connections, while permitting easy access both via tablet PCs or smartphones, as well as via standard PCs with *Bluetooth*® interface.

The WSA is equipped with a serial interface for data exchange according to the RS-232 standard. It also features an internal antenna for wireless data exchange according to the *Bluetooth*® Serial Port Profile (SPP) standard.

The WSA meets IP 67 environmental protection ratings. The 5 m long connecting cable provides both data and power supply for the device, while meeting IPX0 environmental ratings. The device may be installed at any location within the range of the connecting cable that is in line with the requirements for the specific application.

The current operating and connection status is indicated (visualized) by 5 LEDs.

3.1 View

Figure 1: View of device

Table 3: Legend for “View of device” figure

Item	Description
1	Internal antenna, see section “Antenna”
2	Marking field (item 757-0041)
3	Side adhesive label, see section “Labeling”
4	Status LEDs, see section “Display Elements”
5	Connecting cable, see section “Connecting Cable”

3.2 Labeling

A label containing device-specific information is attached to the side of the device.

Figure 2: 757-801 side marking/label (example)

Table 4: Legend for side marking/label

Item	Designation	Description
1	SN	Serial number
2	MAC-ID	Hardware address
3	(14-digit number)	Manufacturing number

The device name plate is a label attached to the back of the device.

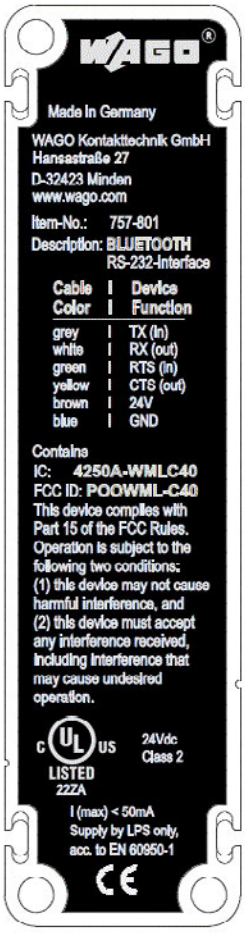


Figure 3: 757-801 back marking (example)

3.3 Connectors

3.3.1 Connecting Cable

The end of the cable is cut straight in the as-delivered condition.

Figure 4: End of cable in as-delivered condition

Before the device can be used, the free end of the connection cable must be properly pre-assembled.

Figure 5: Example of end of cable with separated wires and wire mesh (shield)

Table 5: Wire assignment

Wire Color	Cross Section	Description
Blue	0.75 mm^2	GND
Brown	0.75 mm^2	24 VDC
Gray	0.34 mm^2	TX (in)
Yellow	0.34 mm^2	CTS (in)
Green	0.34 mm^2	RTS (out)
White	0.34 mm^2	RX (out)

Signal conveying wires must be connected properly. The cable shield must be attached in an appropriate manner (see also section “Connect Devices”).

3.3.2 Antenna

The WSA has an integrated antenna with low directivity. The antenna is located near the company logo. If there is line of sight between two communicating devices, the WSA must be aligned such that the company logo is facing the front of the other device (see figure “Alignment of the WSA”).

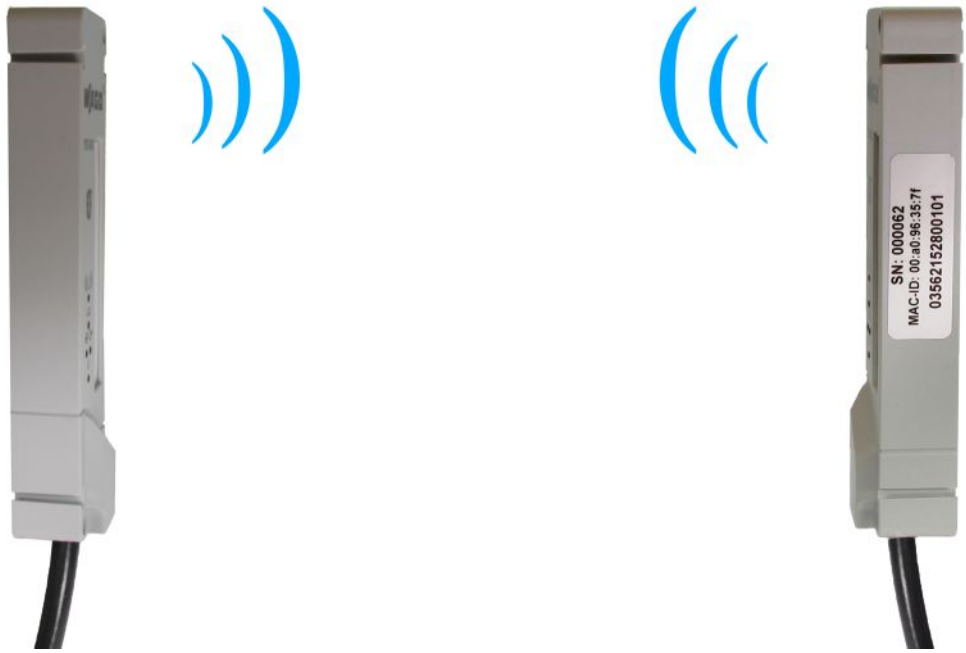


Figure 6: Alignment of the WSA

The antenna diagram below illustrates antenna wave deflection on rotation around the longitudinal axis of the WSA. The deflection characteristics of the antenna can change, depending on what type of surface the WSA is installed.

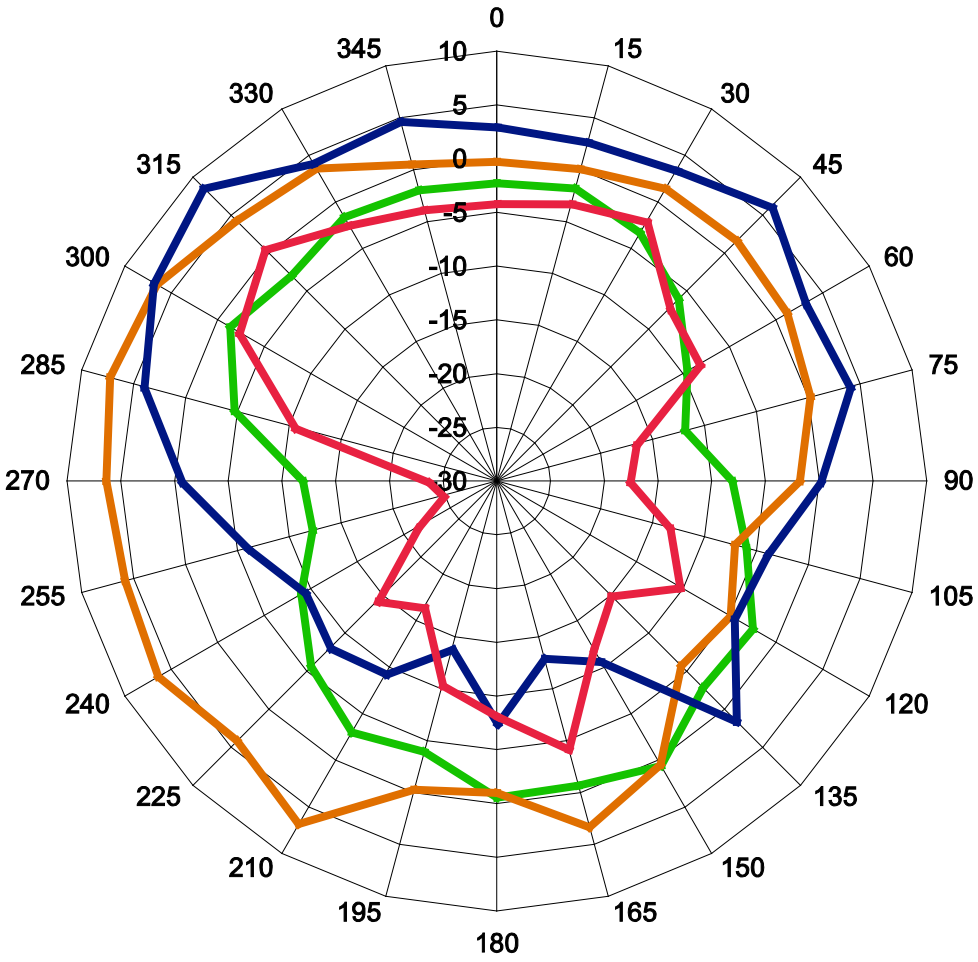


Figure 7: Antenna diagram; reception characteristics based on device alignment

Table 6: Legend for antenna diagram

Legend	
	WSA mounted on metallic surface, horizontal measurement
	WSA mounted on metallic surface, vertical measurement
	WSA not mounted on metallic surface, horizontal measurement
	WSA not mounted on metallic surface, vertical measurement

3.4 Display Elements

Visualization of the operating and connection status is specific to the current operating mode. The following table applies to normal operation:

Table 7: Indicators in normal operation

LED	Status	Description
	 ON (blue)	Radio link established, no exchange of data
	 Single flashing (blue), approx. 0.3 Hz	Ready for use, no existing radio connection.
	 Rapid alternating flashing (blue), approx. 4 Hz	Connect or device discovery
	 Flickering (blue)	Radio link established, with data exchange
	 OFF	No radio link
	 ON (green)	Good signal quality for radio link
	 ON (yellow)	Mediocre signal quality for radio link
	 ON (red)	Poor signal quality for radio link
	 OFF / OFF	No data exchange at the RS-232 interface
	 Flashing (yellow) / OFF	Inbound data at the RS-232 interface
	 OFF / Flashing (yellow)	Outbound data at the RS-232 interface
	 Flashing (yellow) / Flashing (yellow)	Inbound/Outbound data at the RS-232 interface
	 OFF	No power supply, not ready for operation
	 ON (green)	Ready for operation

The LEDs flash when the system is started and to indicate the time frame for mode switchover.

Table 8: Indicators during system start

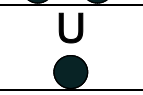
LED	Status	Description
	 Single flash (yellow)	Initial flashing after applying power
	 Single flash (yellow)	Second flash after approx. 3 s. Marks the beginning of the period in which mode switchover can take place.
	 Single flash (yellow)	Third flash after approx. 10 s. Marks the end of the period during which a mode switchover can take place.

The following table applies to the time period in which mode switchover can take place. (See also section “Function Description”> … >“Operating Modes“ and section “Commissioning”> … >“Switching of Operating Modes.”)

Table 9: Indicators for mode switchover

LED	Status	Description
	 OFF / OFF	Normal operation
	 OFF / ON	Normal operating mode ready, mode switchover can take place
	 ON / OFF	“AutoConnect” mode ready, mode switchover can take place
	 ON / ON	“Restore default settings” mode ready, mode switchover can take place

Table 10: Indicators in the “AutoConnect” mode

LED	Status
	 ON (blue), rapid flickering, approx. 20 Hz
	 ON (yellow), brief flicker every 2 s
	 ON (green)

3.5 Technical Data

3.5.1 Device Data

Table 11: Technical data – device data

Dimensions (W x H x D) mm (without connecting cable)	30 x 117 x 20
Weight	approx. 420 g
Mounting	Screw mounting
Connections	RS-232 interface (RX/TX) with hardware flow control (CTS/RTS) at the open cable ends.
Baud rates	9600, 19200, 38400, 57600, 115200
Configuration	AT commands via a terminal program
Indicators	4 single-color, 1 multi-color LEDs
Operating temperature, rigid design	-20 °C … +60 °C
Operating temperature, moving design	-5 °C … +60 °C
Storage temperature	-30 °C … +80 °C
Current consumption	max. 50 mA at 24 V
Supply voltage	10 V … 32 VDC

3.5.2 Connecting Cable

Table 12: Technical data – connecting cable

Length	approx. 5 m
Cable structure	Outer sheath PUR, halogen-free, black
Diameter	6.6 mm (tolerance 0.2 mm)
Shielding	Copper braiding, tin-plated, 0.1 mm single-wire diameter
Conductor configuration	Total of 6 conductors with the following properties: 4 conductors, each at 0.34 mm² extremely finely stranded 43 mm x 0.1 mm 2 conductors, each at 0.75 mm² extremely finely stranded 21 mm x 0.205 mm PP9Y insulation, halogen-free Wire identification: Color coding
Bending radius	10-times the cable diameter
Bending resistance	1 million cycles

3.5.3 *Bluetooth*® Communication

Table 13: Technical data – *Bluetooth*® communication

Bluetooth® version	2.1
Radio/Range	Class 1 / max. 100 m
Antenna	integrated
RF output power	max. +10 dBm
RF input sensitivity	typ. -82 dBm
Frequency range	2.402 GHz … 2.483 GHz (ISM band)
Type of communication	Point-to-point connection
Profiles supported	“Serial Port Profile” (SPP)
Coexistence properties	AFH (Adaptive Frequency Hopping)
	Adaptive transmission power with configurable upper limits for data exchange and device discovery.
	Configurable channel blacklist for “Frequency Hopping Spread Spectrum” (FHSS).
	Coexistence optimized device discovery supported (media allocation < 5%, allocation duration < 100 ms).
Safety	*Bluetooth*® safety mode 4
	“Secure Simple Pairing”
	128-bit encryption

3.6 Approvals

Conformity Marking

Bluetooth®

FCC "Federal Communications Commission" FCC ID: POOWML-C40

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.

$_{C}UL_{US}$ UL508

4 Function Description

The WSA's primary function is to transmit data between RS-232 and radio interface. In this function, both WSA's RS-232 and radio interface transmit received data to the respective other interface.

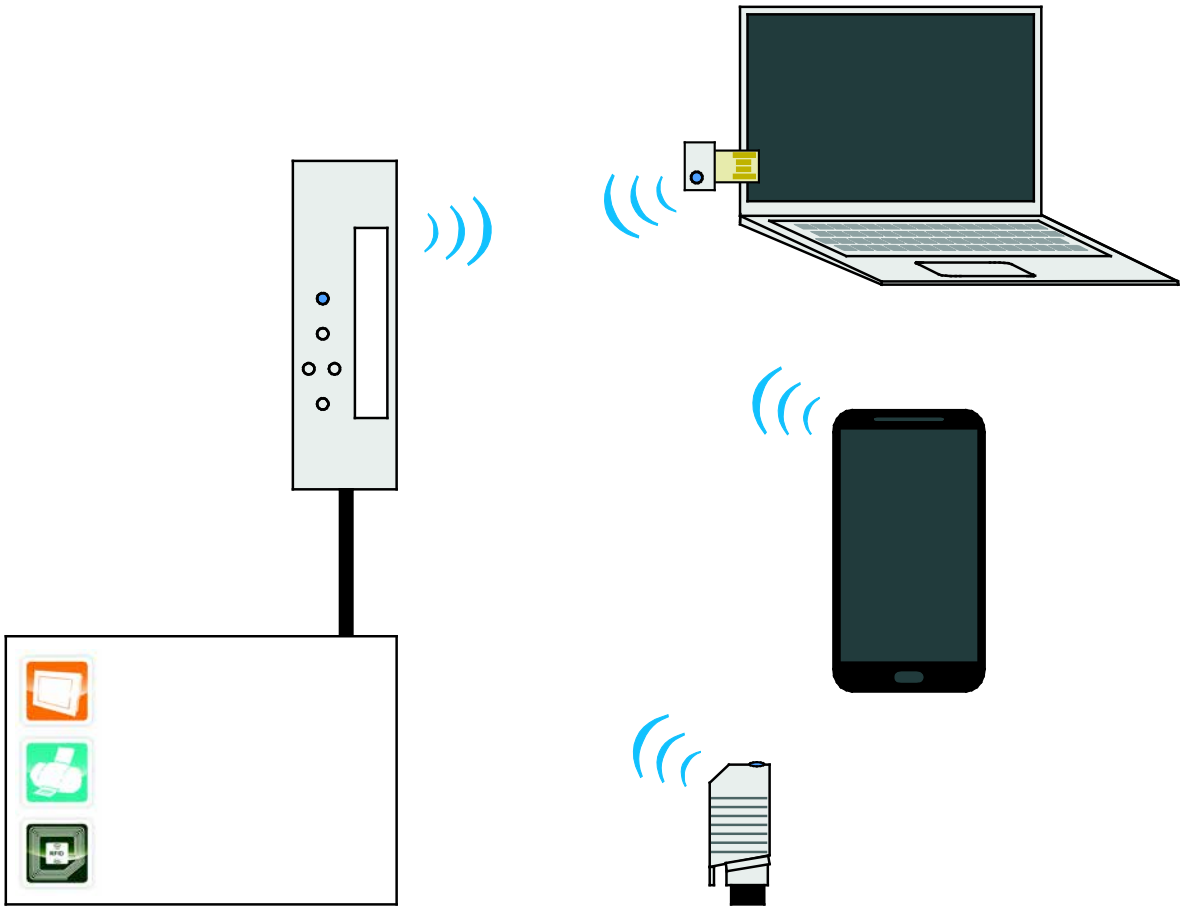


Figure 8: WSA as media adapter

The WSA can therefore fulfill the function of a media adapter or of a protocol converter, and enables RS-232 devices to communicate with SPP devices and vice versa.

The WSA can be configured via an AT command interface. This AT command interface can be used to define settings that enable a radio link to be set up by external devices. You can also define via this AT command interface that the WSA is to actively set up a radio link to an external device.

The WSA can be used without previously being configured via the AT command interface. For this, the WSA can be switched to other special operating modes by targeted interruption of power supply at specific intervals. In these operating modes, processes are initiated which adapt the configuration automatically as required. This includes discovering a further WSA automatically within the defined range and configuring and establishing a link. A detailed description of this “AutoConnect” function is given in the section “Operating Modes.”

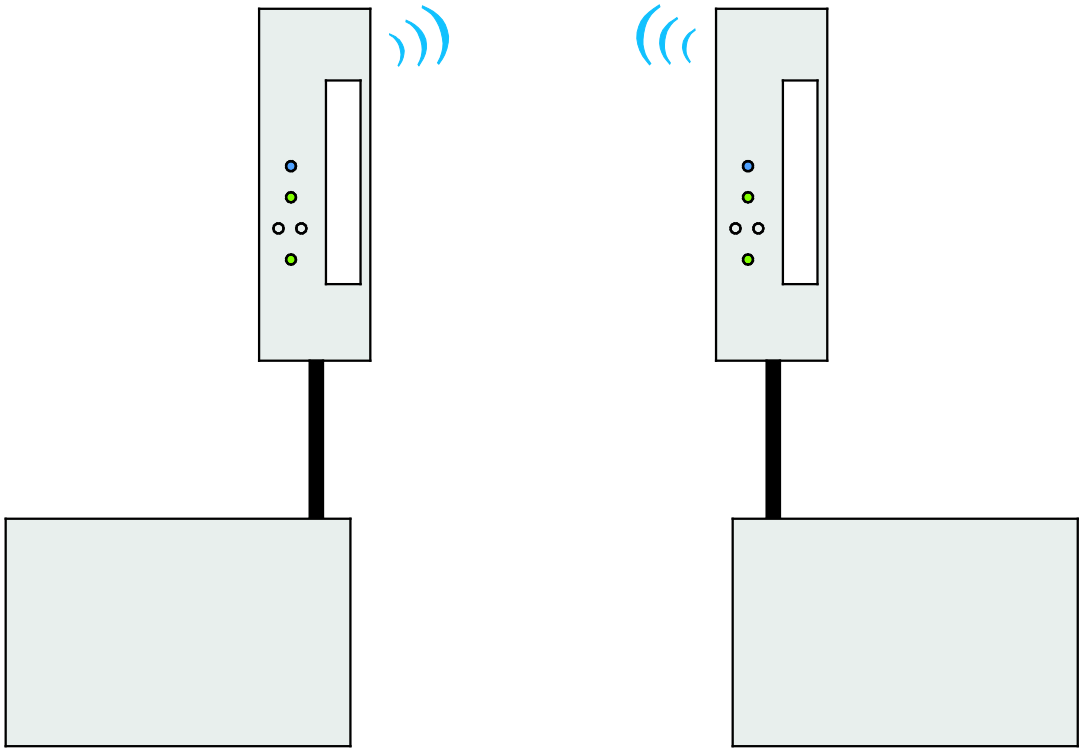


Figure 9: WSA to WSA link

You can also configure the WSA so that it automatically restores a radio link when a connection has been disrupted. In a link to a further WSA, for example, the device can act as a substitute for an RS-232 wired link.

Information

RS-232 devices with different properties can be connected!
When using two WSAs, RS-232 devices with different RS-232 interface properties can also be linked with one another. For example, an RS-232 device with a defined baud rate of 9600 baud can communicate in this case with another RS-232 device with a defined baud rate of 19200 baud, which would normally not be possible via a direct RS-232 wired link.

4.1 Radio Interface

Most of the functions of the WSA require that a radio link exist between it and other devices in accordance with the *Bluetooth*® SPP standard.

Refer to the documentation for the external device concerned to learn how a radio link to the WSA is established from an external device.

You can set up a radio link from the WSA to an SPP-compatible external device using the AT command interface, or by switching the operating mode.

The WSA offers two SPP services at the *Bluetooth*® interface:

Table 14: SPP services

SPP Port Index	Designation	Function
1	DATA	Data exchange
2	CONFIG	Configuration

Simultaneous use of both SPP services is supported, meaning two radio links to one external device, or one radio link each to two different external devices can exist at the same time.

Note

The “DATA” SPP service is the standard when links are established!
Devices compliant with the *Bluetooth*® SPP standard can select the service to which a link is to be set up while the link is being established. Not all devices, however, offer the user the option of selecting the SPP service. Devices which do not offer this selection option frequently select the SPP service with the lowest port index automatically. If a link to the WSA is set up using such a device, the SPP service “DATA” is used.

4.1.1 SPP Service “DATA”

This service enables access to the RS-232 interface, allowing the WSA to function as a media converter or as a protocol converter.

Links which are set up by the WSA to an external device always utilize the “DATA” SPP service.

4.1.2 SPP Service “CONFIG”

This service enables access to the AT command interface and, thus, to the device configuration. For a detailed description of this refer to the section “AT Command Interface”.

4.2 AT Command Interface

Access to the AT command interface of the WSA is gained either via the RS-232 interface, or via the radio interface, but not via both of these simultaneously.

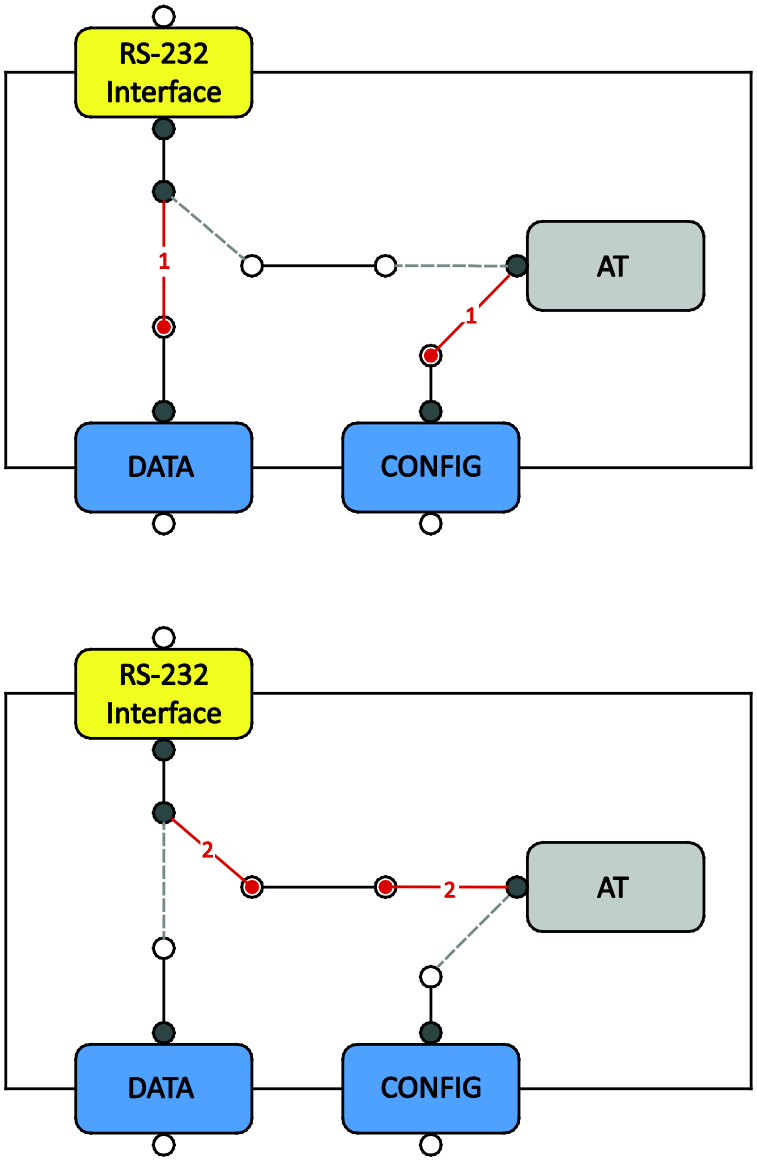


Figure 10: Link management

As two simultaneous links are possible using the radio interface, the AT command interface of the WSA can be accessed via one link, while, at the same time the second link can be used for media conversion.

Besides allowing the configuration to be modified, the AT command interface also enables exporting of status and diagnostics information and text output of context-based help texts.

The format for output by the AT command interface can be configured, enabling it to be optimized for automatic or manual use.

A detailed description of the AT commands is given in the section “Reference AT Commands.” The following table provides an overview of the supported AT command groups.

Table 15: AT Command groups: Section overview

Contents	See section
Check the link to the WAGO radio adapter	“AT”
Call up syntax information	“AT HELP”
Call up device information (status text)	“AT INFO”
Close the AT command interface	“AT LOGOUT”
Restart the WAGO radio adapter	“AT RESET”
Configuration of the device name, the device address and the CoD	“Group AT BTID”
Security settings	“Group AT BTSEC”
Configuration of outbound links	“Group AT CON”
Coexistence settings	“Group AT ECO”
Search for SPP devices within range	“Group AT INQ”
Query information from SPP devices within range	“Group AT RDEV”
Version and status information	“Group AT STATUS”
AT interface configuration, output format, factory default settings	“Group AT SYS”
Configuration of the serial interface	“Group AT UART”

4.3 Factory Default Settings

On delivery, the device configuration is preset with the following values:

Table 16: Factory settings

Parameter	Default value
Bluetooth® device name	WAGO 757-801 SN123456 (example of a device with serial number 123456)
Bluetooth® Class of Device (CoD)	0x1f00
List of allowed devices	(empty)
Enforce secure authentication	OFF
Response to device discovery	when there is no link to the SPP service “DATA”
Response to paging	always
PIN for inbound connections to external devices of older *Bluetooth*® standards	1234
PIN for outbound connections to external devices of older *Bluetooth*® standards	1234
Automatic restore of the outbound wireless connection after restart or loss of connection	OFF
Interval between attempting to restore/establish the outbound wireless connection	30 s
Bluetooth® address to which an outbound connection is established	00:00:00:00:00:00 (blank)

Table 16: Factory settings

Parameter	Default value
Serial port of the external device to which an outbound connection is established	0 (auto)
Blocked radio frequencies	(none)
Advanced coexistence measures	inactive
Use modified device discovery	no
Default present transmit power	+10 dBm
Maximum transmit power	+10 dBm
CoD filter for own device discovery	0x0000 (no filter)
Number of searches for own device discovery	1
Local echo	OFF
AT command output format	simple
User-defined character string	“ ” (empty)
Baud rate	19200
Stop bits	1
Parity	none

Resetting to factory default settings can be achieved by changing to a specific operating mode (see section “Operating Modes”) or using an AT command (see section “Reference AT Commands”> … >“AT SYS CFG CLEAR”). The following settings are not considered when resetting to factory default settings and retain the last value assigned by the user:

- *Bluetooth*® device name
- User-defined character string

4.4 Operating Modes

A limited number of settings can also be defined without using the AT command interface by interrupting power supply to the unit several times in a row using a defined time pattern.

The WSA has several operating modes that can in part be achieved by using suitable AT commands, but also by targeted disruption of the power supply of the device. The latter is then required if no RS-232 link is available or the AT command interface is no longer accessible. That is the case when the settings of the RS-232 interface and/or the authentication settings for the SSP service “CONFIG” have been changed and then are no longer available.

For a detailed description about switching of operating modes, refer to the section “Commissioning”> … >“Switching of Operating Modes.”
The operating modes are switched through in the following order and indicated by specific flashing pattern on the LED:

Table 17: Operating modes

Power Interruptions	Operating Modes
-	**I** **Normal operation** The device is operated normally. The previously configured settings are used.
1 x	**II** **Preparation for switching of operating mode** Automatic switching to normal operation. This mode serves only to protect against accidental activation of mode switching, e.g. during fluctuations in the power supply.
2 x	**III** **"AutoConnect"** The device attempts to connect to another device of the same kind automatically. When successful, the configuration of both devices is modified, so that the connection is restored automatically among other things after a power failure in the future. For this purpose, the following settings are adjusted: • Destination address for the outbound connection • Destination port for the outbound connection • Application of the target device in the list of allowed devices • Enable automatic reconnect (on one of the two radio adapters only)
3 x	**IV** **Reset to factory settings** All functionally relevant device settings (including the baud rate of the wired serial interface) are reset to their original values. The device then restarts automatically.

The specific LED flashing patterns for the set modes are given in the section "Device Description"> … >"Display Elements."

4.5 Security Settings for the Radio Communications Interface

The device supports all security mechanisms of Version 2.1 of the *Bluetooth*® standard. To adjust security-related behavior, certain AT commands are also available (e.g. commands of the "AT BTSEC" group).

Note

Radio link only with correct security settings!
The *Bluetooth*® standard attaches great importance to security. Consequently, a radio link may only be set up when the security settings for the devices to be linked are compatible and correct.

4.5.1 Visibility and Connectivity

Bluetooth® devices can be used to search for devices that are within range. In addition, device names and available services of the devices found can be queried.

Visibility of the WSA
The device can be configured such that it replies always, never, or only when no data link exists. The AT command "AT BTSEC INQ" is used for configuring this setting.

Connectivity of the WSA
The device can be configured such that it accepts a direct link setup by an external device always, never or only when no radio link currently exists. The AT command “AT BTSEC PAG” is used for configuring this setting.

A device that is not “visible” for search queries and that can only connect under certain conditions provides only a very small area of attack to potential attackers.

4.5.2 Encryption

In older versions of the *Bluetooth*® standard, a so-called *Bluetooth*® PIN formed the basis for encryption. Wireless data transfer between the WSA and external devices is always encrypted. Therefore, a correct PIN must be configured or input when linking older *Bluetooth*® devices, regardless of the type of authentication (see section “Authentication”).

4.5.3 Authentication

The main component of the security mechanism of *Bluetooth*® technology is performing mutual authentication before a wireless connection is established. In principle, you can choose between informal and secure authentication.

- *Bluetooth*® devices can perform an **informal authentication** without the need for configuration or user input. This type of authentication offers only slight security.

- **Secure authentication** on the other hand offers a high degree of security, but does require user interaction.

Since the WSA has no display or keyboard, all settings related to authentication must be defined in advance using AT commands. These settings include:

- Type of authentication. The AT command “AT BTSEC AUTH” is used for this.
- PIN for **inbound** links, i.e., links established from external devices to the WSA. The AT command “AT BTSEC PIN” is used for this.
- PIN for **outbound** links, i.e., links established from the WSA to external devices. The AT command “AT CON TAR PIN” is used for this.
- List of MAC IDs for external devices with which secure authentication is to be provided. The AT command “AT BTSEC ADEV” is used for this.

Which settings must be made and how is based, among other things, on the version of the *Bluetooth*® standard that is supported by the external device and on the input/output possibilities.

***Bluetooth*® Standard 2.0 or older**
If the external device is a device compliant with *Bluetooth*® Standard 2.0 or an older version, the PIN is used for authentication and encryption. A link can be set up when the same PIN is configured and entered at by both communicating parties. The PIN for inbound links is required for incoming links (see section “Reference AT Commands”> … >“AT BTSEC PIN”), as is the PIN for outbound

links for outgoing links (see section “Reference AT Commands”> … > “AT CON TAR PIN”).

Bluetooth® Standard 2.1 or newer

For an external device is a device compliant with *Bluetooth*® Standard 2.1 or newer, “Secure Simple Pairing” (SSP) is used for authentication. If the WSA and/or the external device are configured such that only secure authentication is permitted, a link can only be established after secure authentication.

To ensure that secure authentication is successful, the *Bluetooth*® MAC ID for the external device must be entered in advance in the list of accepted devices in the WSA configuration (see section “Reference AT Commands”> … > “AT BTSEC ADEV”). This entry must be made and present at both ends when 2 WSAs are linked. If a link is set up with an external device equipped with a display and keyboard, a message window is displayed when the link is being set up. The procedure must be confirmed by the user in this window. If neither the WSA, nor the external device are configured such that secure authentication is mandatory, the link is set up without a corresponding entry in the list of accepted devices. A message window may nevertheless also be displayed in this case at the other device. This window informs and prompts the user to confirm the setup of the link.

The figure below illustrates the authentication procedure, based on the settings for the external device and on the version of the *Bluetooth*® standard it supports.

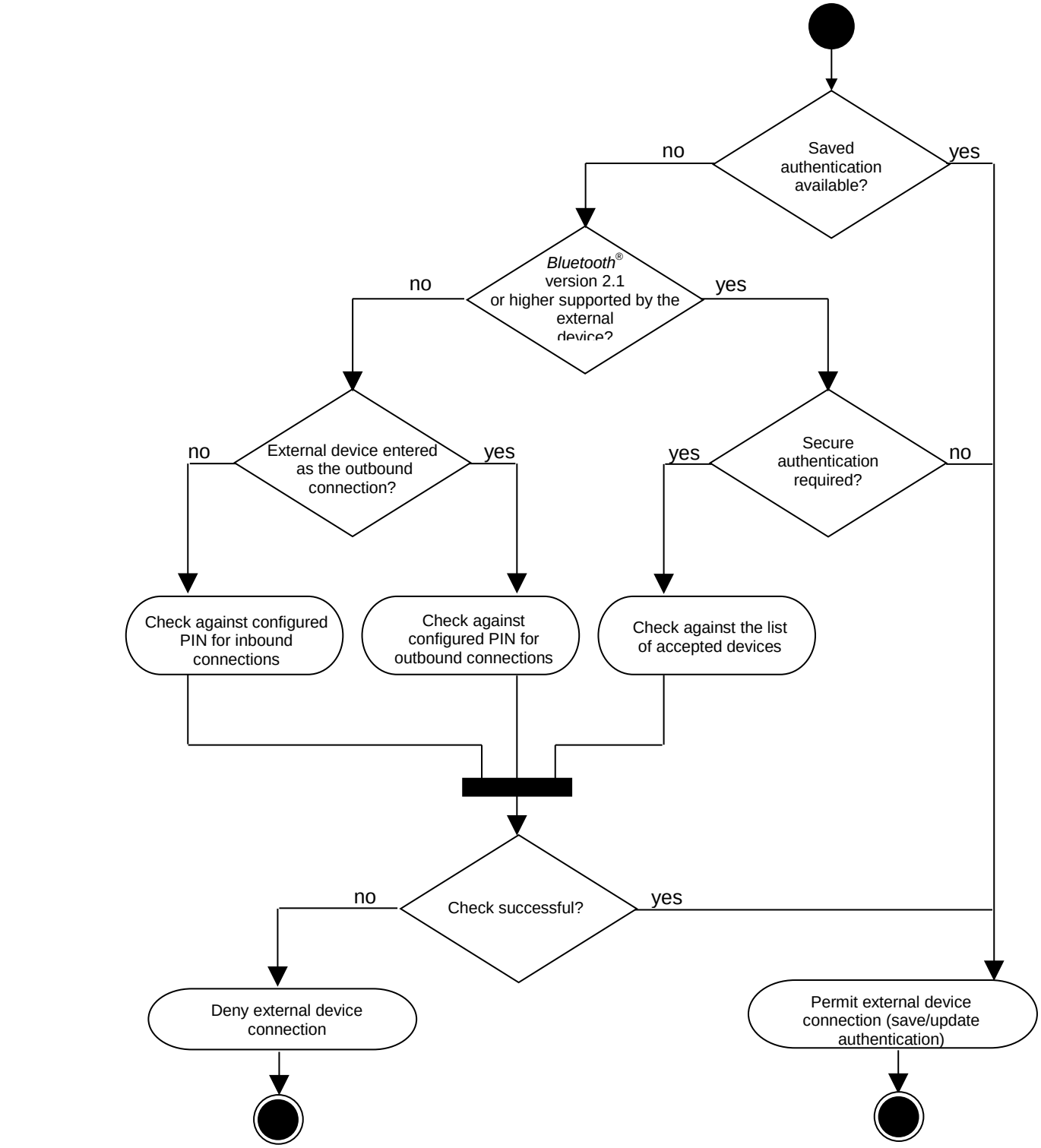


Figure 11: Authentication based on configuration and *Bluetooth*® standard

Depending on the properties of the *Bluetooth*® device with which authentication is to be carried out, the WSA configuration may have to be modified to account for the counterpart's security settings.

4.6 Special Coexistence Properties

Bluetooth® technology uses the unlicensed ISM frequency band for international use from 2.4 GHz for data transfer. This frequency band is also used by devices that use other technologies such as WLAN in accordance with IEEE 802.11 b/g. To minimize interference, *Bluetooth*® technology offers the following effective coexistence mechanisms:

- **Frequency Hopping Spread Spectrum (FHSS)**
  When transmitting, the frequency is switched up to 1600 times per second. The actual narrowband radiant power (1 MHz channel bandwidth) is distributed time-averaged over a wide band (79 MHz).

- **Adaptive Frequency Hopping (AFH)**
  If interference occurs from other radio systems (see figure, violet), *Bluetooth*® systems (blue/red) can avoid the affected channels in future transmissions (red transparent). Radio systems that do not support the automatic adjustment can continue to use these frequencies.

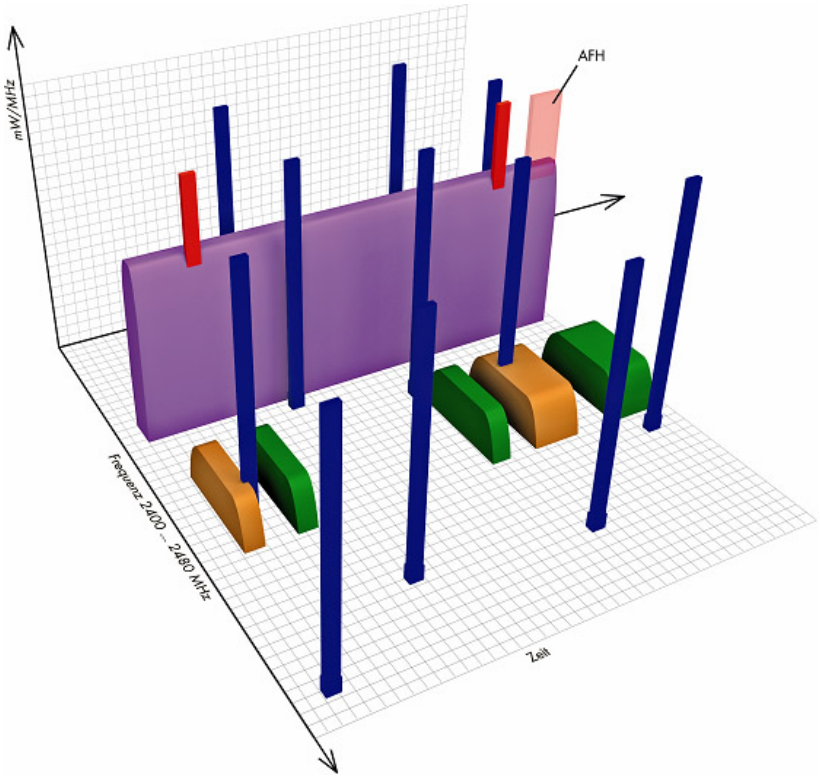


Figure 12: Adaptive Frequency Hopping (AFH)

- **Adaptive Transmit Power**
  If there is a connection between two *Bluetooth*® devices with a high signal strength, the devices automatically reduce their transmit power.

The specified mechanisms are used automatically by the WSA. Beyond the mechanisms contained in the standard, the device provides other setting options to further improve coexistence that can be configured via AT commands:

- **Configurable channel map**
  The user can manually specify which frequencies are not used by the device for data transfer and thus configure in advance one's own frequency usage plan. Certain frequency ranges can be exclusively reserved for certain technologies or devices. The AT command “AT ECO BLK” is used for this.

- **Configurable limitation of the transmit power**
  The user can specify limits for the transmit power initially used and for the maximum transmit power that the device does not exceed during device discovery and as part of automatically adjusting the transmit power. This effectively limits the distance at which the transmit power can interfere with other devices. The AT command “AT ECO TXPWR” is used for this.

- **Modified device discovery**
  The device can be set so that it does not continuously transmit for several seconds, in contrast to typical implementations, during device discovery (inquiry), but only for a maximum duration of 100 ms and at an interval of at least 2 s, to ensure that the percentage of transmission activity (duty cycle/media allocation) does not exceed 5%. The AT command “AT ECO INQ” is used for this.

4.7 Diagnostics Functions

The WSA enables export of diagnostics information via the AT command interface. Available diagnostics information can be broken down into the following groups:

- Information about external devices that support the SPP *Bluetooth*® standard and which are within range (“AT RDEV”)
- Information about link quality and activity (“AT STATUS”)
- Information about the status of the WSA (“AT STATUS”)

A detailed description is provided in the following sections: “Reference AT Commands”> … >“Group AT STATUS: Version and Status Information” and “Reference AT Commands”> … >“Group AT RDEV: Devices within Range.”

5 Mounting

You can mount the WSA directly on your system using three M4 mounting screws. The length of the screw shaft must be selected according to the type of mounting used.

5.1 Mounting Instructions

The following information shall always be observed:

DANGER

Do not work on components while energized!
Disconnect the power supply from the system before beginning mounting.
Always switch off all power supply sources for the WSA before mounting or removing the WSA.
Always provide for sufficient potential equalization in your system.

NOTICE

Warning of material damage due to tensile force or tensions
To protect the WSA from tensile forces or tension that may arise, do not bridge spaces with the WSA.
Screw the WSA down only on flat contact surfaces to protect it from warping.
To avoid damaging the WSA, do not mount it in shear areas of moving devices.

NOTICE

Avoid electrostatic discharge!
The devices are equipped with electronic components that you may destroy by electrostatic discharge when you touch. Pay attention while handling the devices to good grounding of the environment (persons, job and packing).

5.2 Direct Mounting on Your System

Direct mounting of the WSA is to be carried out as follows:

1. De-energize the section of your system to which you wish to mount the WSA.

2. Ensure that the mounting surface of your system is flat and even and that it is not located within the shear area of moving devices.

3. Attach the WSA using the 3 fixing holes provided for this purpose (see figure “WSA fixing holes”).

Figure 13: WSA fixing holes

Table 18: Legend for “WSA fixing holes” figure

Fixing hole	Diameter	Length
1	4 mm/0.157 in	16 mm
2	4 mm/0.157 in	16 mm
3	4 mm/0.157 in	16 mm

6 Connect Devices

⚠ WARNING

Special requirements for power supply within the scope of application of UL 508!
For UL 508 approval, the device must be operated using a 24 V Class 2 power supply unit or a Class 2 transformer in compliance with UL 1310 or UL 1585.

NOTICE

Pre-assemble free cable ends!
The end of the *Bluetooth*® Module RS-232 IP67's connection cable is free. If cable ends have not been pre-assembled, liquid or dirt can penetrate into the *Bluetooth*® Module RS-232 IP67 and ruin it. Pre-assemble the connection cable according the environment or use the connection cable in an environment complying with IPX0 protection class!

NOTICE

Limit the length of the power supply feed line!
The length of the feed line between the power supply unit and the product connecting cable is limited to ensure proper power supply. Supply voltage filtering must be provided if the length of the power supply feed line exceeds 3 m.

6.1 Preparation of Connecting Cable

First prepare the open end of the connecting cable for installation:

1. Remove the outer insulation.
2. Push back the shield mesh.
3. Remove any unneeded shield foil.
4. Separate the 6 inner wires.
5. Shorten the inner (filling) conductor.
6. Prepare the 6 inner wires.

Figure 14: Assembled connecting cable

Table 19: Allocation of wire colors

Wire Color	Function	Description
Blue	Ground line	GND
Brown	Power cable	24 V DC
Gray	Data line	TX (in)
Yellow	Data line	CTS (in)
Green	Data line	RTS (out)
White	Data line	RX (out)

6.2 Attaching the Connecting Cable

1. Twist the shield mesh so that the shield connection is similar to that of a fine-stranded wire.
2. Connect the cable shield to the terminal provided for it.
3. Connect the ground line (blue) to the terminal provided for it.
4. Connect the data lines (gray, yellow, green, white) to the terminals provided for them.
5. Connect the power supply line (brown) to the terminal provided for it.
6. Take appropriate measure to properly protect the contact points against touch and/or moisture.

6.3 Connection Examples

6.3.1 Using the WAGO Interface Module 289-383

The WAGO 289-383 interface module enables the WSA to be connected using a 9-pole D-Sub socket. The fed-in power supply is filtered and the shielding is connected to the DIN rail to discharge disruptions to the ground potential.

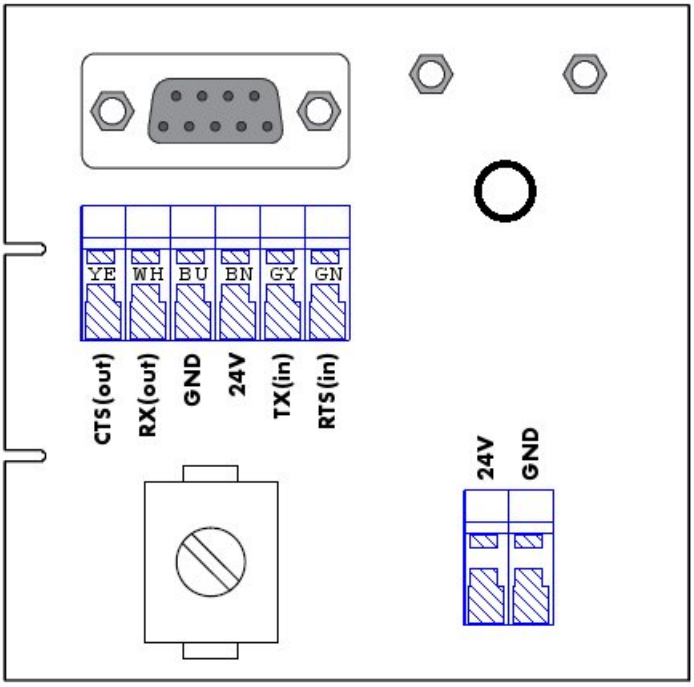


Figure 15: WAGO 289-383 interface module

Table 20: Connection to the WAGO 289-383 interface module

WAGO 289-383 Interface Module			Direction	Connecting Cable 757-801	
D-Sub	Terminals				
Pin	Pin	Marking		Wire Color	Description
2	WH	RX(out)	←	White	RX(out)
3	GY	TX(in)	→	Gray	TX(in)
5	BU	GND	-	Blue	GND
7	GN	RTS(in)	→	Green	RTS(in)
8	YE	CTS(out)	←	Yellow	CTS(out)
	BN	24 V	-	Brown	24 V
Shield (screen)	Shield clamping saddle		-	Shield (screen)	-

Power supply for the WSA is fed in via the second terminal block.

Table 21: Connection to the WAGO 289-383 interface module, power supply

Power supply		WAGO 289-383 Interface Module
		Terminals
Description		Marking
24 V		24 V
0 V		GND

6.3.2 Using the WAGO Interface Module 289-384

You can use the WAGO 289-384 interface module to connect the WSA with electrical isolation to the service interface of fieldbus couplers or PLCs of the WAGO-I/O SYSTEM 750.

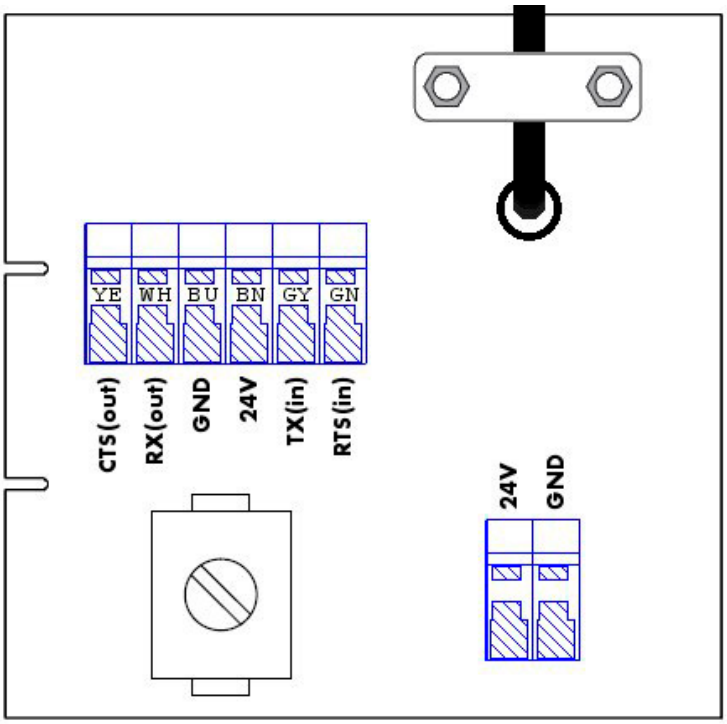


Figure 16: WAGO 289-384 interface module

Table 22: Connection to the WAGO 289-384 interface module

WAGO 289-384 Interface Module		**Direction**	**Connecting Cable 757-801**	
Terminals				
Pin	**Marking**		**Wire Color**	**Description**
WH	RX(out)	←	White	RX(out)
GY	TX(in)	→	Gray	TX(in)
BU	GND	-	Blue	GND
BN	24 V	-	Brown	24 V
Shield clamping saddle		-	Shield (screen)	

Power supply for the WSA is fed in via the second terminal block.

Table 23: Connection to the WAGO 289-384 interface module, power supply

Power Supply		**WAGO 289-384 Interface Module**
		Terminals
Description		**Marking**
24 V		24 V
0 V		GND

Note

Always observe the interface parameters for the service interface!
To address the service interface via a wireless connection using the WAGO-I/O-CHECK or WAGO-I/O-PRO software, the interface must be configured at the WSA:

- Baud rate: 19200
- Parity: even
- Stop bits: 1
- Hardware flow control: none

6.3.3 Connecting a PC RS-232 Interface

The PC serial port is usually designed as a 9-pole D-Sub interface with contact pins.

Note

If required, use a USB to D-Sub adapter!
If the PC is not equipped with a D-Sub interface for connection via the RS-232 interface, you can use a USB to D-Sub adapter, such as the WAGO 761-9005.

Table 24: Pin assignment for D-Sub 9-pole connector to the 757-801, data lines

PC (D-Sub connector, 9-pole)			**Connecting Cable 757-801**	
Pin	**Description**	**Direction**	**Wire Color**	**Description**
1	DCD			
2	RxD	←	White	RX(out)
3	TxD	→	Gray	TX(in)
4	DTR			
5	GND	-	Blue	GND
6	DSR			
7	RTS	→	Green	RTS(in)
8	CTS	←	Yellow	CTS(out)
9	RI			
Enclosure	Shield (screen)	--	Shield (screen)	

A separate power supply is required for the WSA.

Table 25: Pin assignment for D-Sub 9-pole connector to the 757-801, power supply

Power supply		Connecting Cable 757-801	
Description		**Wire Color**	**Description**
DC 24 V		Brown	24 V
0 V		Blue	GND

6.3.4 Connecting the 750-652 I/O Module

You can connect the WSA to the 750-652 I/O module.

Table 26: Connection to the 750-652 I/O module

I/O Module 750-652			Direction	Connecting Cable 757-801	
Pin	**Description**	**Function**		**Wire Color**	**Description**
1	D0	RTS	→	Green	RTS(in)
2	D2	CTS	←	Yellow	CTS(out)
3	M	Ground	-	Blue	GND
4	S	Shield (screen)	-		Shield (screen)
5	D1	TxD	→	Gray	TX(in)
6	D3	RxD	←	White	RX(out)
7	M	Ground	-	Blue	GND
8	S	Shield (screen)	-		Shield (screen)

A separate power supply which fulfills the following requirements is also required here:

Table 27: Connection to the 750-652 I/O module, power supply

Power supply		Connecting Cable 757-801	
Description		**Wire Color**	**Description**
24 V DC		Brown	24 V
0 V		Blue	GND

6.3.5 Connecting the 767-5203 Modul

You can also connect the WSA to the 767-5203 module.

Table 28: Connection to the 767-5203 module

Module 767-5203 (X3/X4)		Cable 756-5311/060-015	Direction	Connecting Cable 757-801	
Pin	**Description**	**Wire Color**		**Wire Color**	**Description**
1	RTS	Brown	→	Green	RTS(in)
2	TxD	White	→	Gray	TX(in)
3	CTS	Blue	←	Yellow	CTS(out)
4	RxD	Black	←	White	RX(out)
5	GND	Gray	-		
Enclosure	Shield	Shield (screen)	-		Shield (screen)

Power supply for this must be connected to the digital inputs/outputs X1/X2 of the serial interface.

Table 29: Connection to the 767-5203 module, power supply

Module 767-5203 (X1/X2)		Cable 756-5311/060-015		Connecting Cable 757-801	
Pin	**Description**	**Wire Color**		**Wire Color**	**Description**
1 or 2 or 4	24 V or Input/Output B or Input/Output A	Brown or white or black		Brown	24 V
3	0 V	Blue		Blue	GND

7 Configuration

7.1 AT Command Interface

Depending on the application, it may be necessary to change the device configuration. This can be performed via AT command interface.

Note

Use of this interface requires that you are familiar with the use of serial ports!
Use of the AT command interface requires that you set up a serial link to the WSA and that you can transfer any characters from the ASCII character set via this link. To do this you need a device equipped with the necessary hardware and software. This documentation does not provide information as to how to set up and use a serial interface with such a device. The section “Commissioning” does contain a few examples of this, however.

7.1.1 Using the AT Command Interface

The AT command interface of the WSA employs the question/response principle, where all processes are represented by the exchange of specific character strings. Requests to display or change parameter values are sent to the WSA as an AT command. The WSA processes the command and returns an answer.

A new command may only be executed if the previous one has been processed, i.e. the WSA has sent a reply and completed with the console character. Overlapping processing of AT commands is not supported.

A specific syntax is defined for commands and replies; this is described in more detail in the sections “Basic Structure of an AT Command” and “Basic Structure of Replies to AT Commands.” A complete description and explanation of all available commands is given in the section “Reference AT Commands.”

The AT command interface can be used with different external devices. Access can be provided, for example, by a PLC using a PLC program, or by a Windows PC using terminal programs such as HTerm, RealTerm or HyperTerminal.

Note

Note on the use of terminal programs
In some terminal programs, the characters entered at the PC in the prompt line are not displayed.
To simplify entering of AT commands in such a case, you can configure the WSA using an AT command (`AT SYS ECHO = 1`) such that it reflects or “echoes” the input.

7.1.2 Opening the AT Command Interface

There must be a link to the device's AT command interface in order to use AT commands, i.e., you must either set up a radio link to the SPP service "CONFIG", or you must switch the RS-232 interface to the AT command interface.

Note

Access possible via RS-232 or SPP "CONFIG" service!
Access to the AT command interface via RS-232 and using the SPP "CONFIG" service are mutually exclusive. If the AT command interface is not yet in use, access is possible in both ways. However, if access to the AT command interface has already been granted via RS-232, linking to the SPP service "CONFIG" is no longer possible. On the other hand, if a link to the SPP service "CONFIG" already exists and an attempt is made to switch from the RS-232 interface to the AT command interface, the device will perform a restart. This will discontinue all existing radio links to SPP services. If a further attempt is made after the restart to initiate a switchover from RS-232 to the AT command interface, this will be successful.

To switch the RS-232 interface to the AT command interface, the character string "+++" with preceding and subsequent transmission pause of 1 second must be sent to the device. As this character string is not an AT command, you may not use a "carriage return" at the end of input.

Note

RS-232 settings must be identical!
Ensure that the RS-232 settings for the device you wish to use to access the WSA are identical to those for the module. If you are not sure how the WSA is currently configured, simply reset it to the factory default settings.

An initial character string does not have to be sent to access the AT command interface via the SPP service "CONFIG." The AT command interface is opened automatically on successful setup of a link to the SPP service "CONFIG."

If the interface is opened successfully, the WSA outputs a welcome message, which contains essential device information such as the version status.

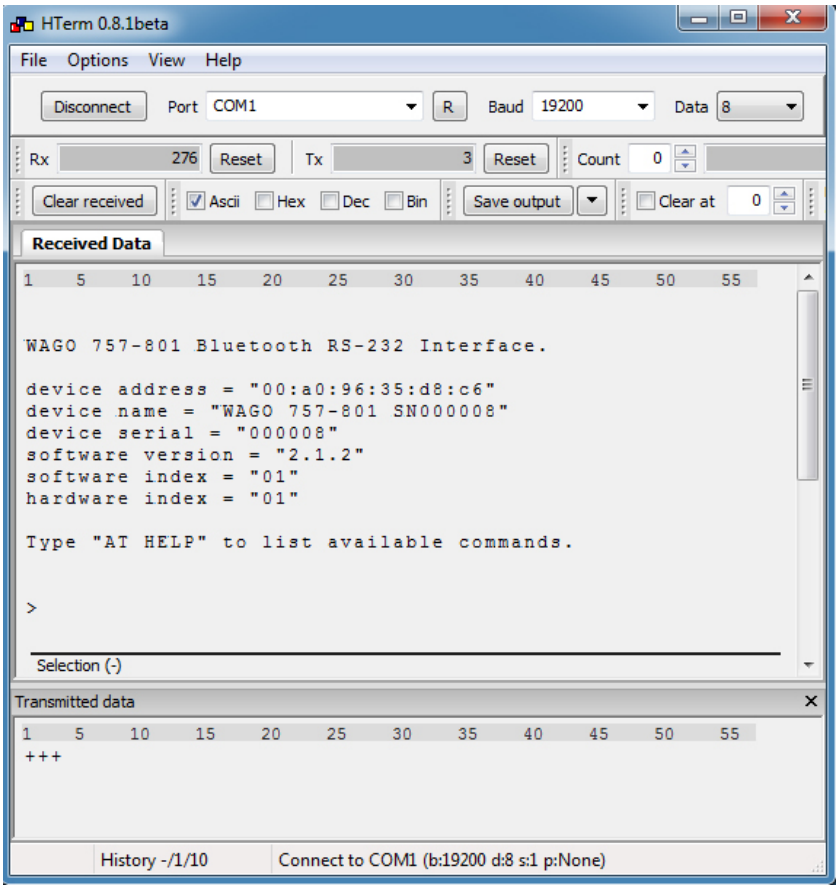


Figure 17: Welcome message in HTerm with Windows 7

Note

Welcome message is hardware/software specific!
The welcome message may not appear, depending on the hardware and software being used. In this case, use an AT command to test the connection, e.g. the welcome message is output again via “AT INFO.”

7.1.3 Basic Structure of an AT Command

- Every AT command consists of the command and any additional parameters separated by spaces.
- AT commands that affect device settings use an equal sign = between the command and parameter.
- AT commands for reading device settings or information can optionally contain a question mark ? at the end of the command.
- The command is concluded with the character for “carriage return.” This character is 0x0d or decimal 13 from the ASCII code. This character is transmitted automatically when using the PC software HyperTerminal, for example, when you press the Enter key.

7.1.4 Basic Structure of Replies to AT Commands

The WSA responds to commands received with a status message and requested actual values if necessary. The content of the response depends on the settings of the output format (see section “Reference AT Commands”> … >“AT SYS OUTPUT”). However, each response generally starts with a 2-digit success or error code and ends with the console character “>”.

Success or error codes:

Table 30: Success or error codes

Code	Label	Description
00	SUCCESS	The command was executed successfully.
01	(failed)	The command could not be executed.
02	INVALID PARAMETER	An invalid parameter was used.
04	INT OUT OF RANGE	A parameter falls outside the range of values currently allowed.
05	INVALID CHANNEL COUNT	The channel map should not be applied because too few usable radio frequencies would otherwise remain.
06	PARSE ERROR	Unknown or faulty command.
08	NOT CONNECTED	The command cannot be executed because there is currently no wireless connection to the SPP “CONFIG” service.
09	NO ENTRY	The requested parameter is not available or the associated entry is currently blank.

Example:

Request

```
AT BTID NAME ?
```

Response

```
00 SUCCESS
bdname = “WAGO 757-801 SN012345“

>
```

The help for an AT command is output by entering `HELP` after the command. The following character conventions are used in the output:

Table 31: Character conventions of the AT commands

Prefix		Explanation
Braces	**{…}**	For command parameters
Pipes	**|…|**	To separate individual options
Parentheses	**(…)**	To display value types
Brackets	**[…]**	For optional parameters
Ellipsis	**…**	Indicates a command group for which a detailed syntax display is available.

7.1.5 Effectiveness of AT Commands

If the device configuration is modified by AT commands, the new setting is saved immediately. However, settings of some command groups only take effect after the device is restarted. In this case, the device should be restarted after completing the configuration before using the device further. Affected parameters or command groups are:

- *Bluetooth*® device name and CoD (`AT BTID`)
- Security setting for inbound connections (`AT BTSEC`)
- Advanced coexistence settings (`AT ECO`)
- Settings of the wired serial interface (`AT UART`)

8 Commissioning

8.1 Switching of Operating Modes

The WSA is equipped with 4 operating modes (see also section “Function Description”> … >“Operating Modes”).
You can switch the operating mode either by a targeted interruption of the power supply, or using AT commands.

Table 32: WSA operating modes

	Operating Mode
I	Normal operation
II	Preparation for switching of operating mode
III	“AutoConnect”
IV	Restoration of factory default settings

8.1.1 Switching of Operating Mode by Interrupting the Power Supply

Switchover of the operating mode is initiated by interrupting the power supply within a time frame of around 3 to 10 seconds after power has been applied to the WSA. When it starts up again the WSA will be in the next operating mode.

If this process is repeated several times in a row, the user can switch through the various operating modes one after another. After reaching the last mode, selection starts again from the beginning.

If the mode is not switched within the defined time frame after applying the power supply, the operating mode currently selected is enabled and the WSA starts again in normal mode after the next restart or after an interruption in the power supply.

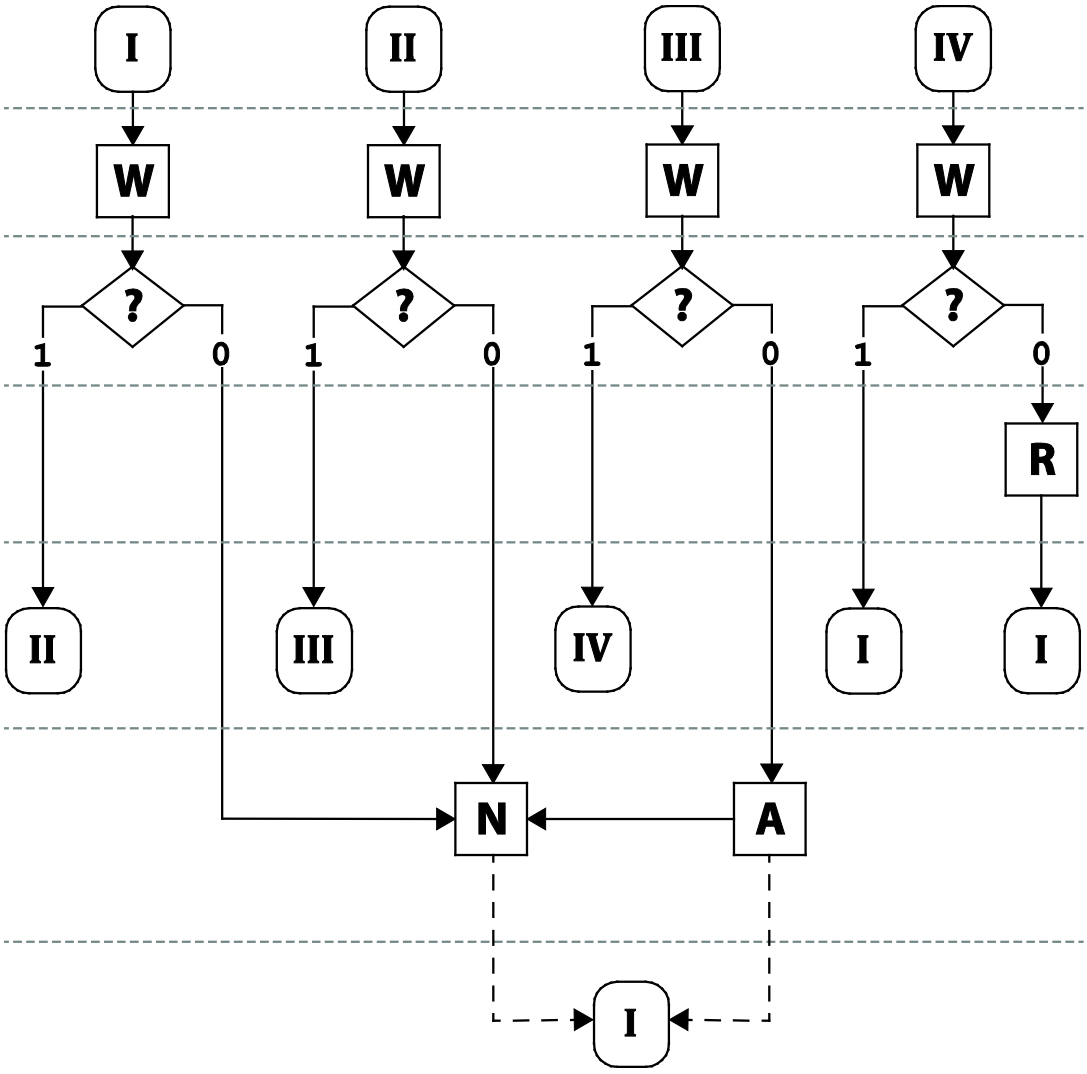


Figure 18: Operating mode status diagram

Table 33: Legend for status diagram

[ ]	Description
[I],[II], [III], [IV]	Start in operating mode …
[W]	Wait for interruption of power supply within a time frame of 3 … 10 s
[?]	Switching of operating mode initiated?
(1) (0)	Yes No
[R]	Restore factory default setting
[A]	“AutoConnect” attempts to locate a device of the same type. When successful: Saving of the modified configuration and switching to [N]ormal operation.
[N]	Normal operation as defined in the configuration.
- - - - - - - - ->	Power supply interruption outside the time frame: Restart in operating mode [I]

Note

Response of the WSA on interruption of power supply
In the event of power supply interruption outside the defined time frame, the WSA will be restarted in the operating mode [I].

8.1.2 Switching of Operating Mode using AT Commands

You can also define the operating mode III (“AutoConnect” mode) using AT commands, or reset the function for operating mode IV (restoration of factory default settings):

- Activate “AutoConnect” operating mode: `AT CON AUTO`.
- Reset operating mode IV: `AT SYS CFG CLEAR` followed by `AT RESET`

8.2 Optimizing the Security Settings

A number of *Bluetooth*® devices allow users only a limited configuration of security settings. With some devices, the user is not even shown which security settings are currently active in the device.

Configuration of the security settings for the WSA is, by contrast, very flexible. To a certain degree, these settings can also be adapted to the specific security settings of other devices. Methods are presented below which make the search for suitable security settings more transparent. In some constellations however, neither secure nor informal authentication is possible. In such a case, it is not possible to establish a link to the device concerned.

Note

Always use secure settings whenever possible!
If you used non-secure settings in your initial configuration for a radio link, follow the steps given below to return to secure settings. Configure the devices with defined settings such that they are not discoverable for general device discovery.

8.2.1 External Devices based on *Bluetooth*® Standard 2.1 or Newer, Not Equipped with Input/Output Means

For secure authentication with devices that support *Bluetooth*® standard 2.1 or higher, user interaction is usually required. This normally consists of entering a character string or acknowledging a dialog window.

Secure authentication without user interaction is possible for links between 2 WSAs when both devices have the other device in their list of accepted devices (see section “Reference AT Commands”> … >“AT BTSEC ADEV”). This setting enables automatic authentication for the particular other device as soon as the authentication procedure is begun.

If the external device is not equipped with a display and input means (e.g., touchscreen), or with an alternative form of automatic authentication, configure the devices to be linked such that secure authentication is not required. This does require however that the external device accepts informal authentication.

8.2.2 External Devices Based on *Bluetooth*® Standard 2.1 or Higher Whose Security Settings Are Not Known

Devices that support the *Bluetooth*® standard Version 2.1 or higher and which do not offer the user the option of configuring security settings often permit only secure authentication. In this case, define the following settings in the WSA configuration:

1. Enter the MAC ID of the device concerned in the list of accepted devices (see section “Reference AT Commands”> … >“AT BTSEC ADEV”).

2. Enforce secure authentication (see section “Reference AT Commands”> … >“AT BTSEC AUTH”).

Secure authentication is enforced when the WSA is set such that only secure authentication is accepted.

8.2.3 External Devices Based on *Bluetooth*® Standard 2.0 or Older Whose Security Settings Are Not Known

Identical PINs must be selected for secure authentication of devices that support the *Bluetooth*® Standard up to Version 2.0. If you do not know the PIN for the external device, try “0000”, “1111”, “1234” or a blank character string as the PIN settings. If none of these settings apply, authentication can only be informal. This does require however that the external device also accepts informal authentication.

8.2.4 Other Recommendations

Authentication data can be stored in the devices during the authentication procedure. For devices equipped with a display and input means this is frequently signaled by the fact that user input is requested only on initial setup of a link.

Many devices offer the option of deleting or resetting stored authentication data. Deleting/Resetting of this data at one device only may result in the other device attempting to establish links using obsolete authentication data.

If authentication should fail repeatedly, it may be meaningful to delete the authentication data in all of the devices involved and re-configure authentication.

8.3 Example: Connecting to Another WSA

Proceed as described below to automatically connect 2 WSAs with one another:

1. Switch the WSA to operating mode III AutoConnect by interrupting the power supply two times within the defined time frame (see section “Switching of Operating Mode by Interrupting the Power Supply”).

2. Now, switch the second WSA to operating mode III AutoConnect, likewise by interrupting its power supply two times within the defined time frame.

3. Wait until both devices have a permanently lit, blue LED.

The two WSAs are now linked to one another.

The link set up in this manner will be restored automatically after an interruption. You can use AT commands to configure the time within which a reconnect is carried out after a disruption (see section “Reference AT Commands”> … >“AT CON RETRY”).

Note

RS-232 interface parameters remain unaffected by this!
A link using AutoConnect applies only to the radio interface and has no impact on the RS-232 interface parameters.
Baud rate, parity, stop bits and hardware flow control all remain unaffected and unchanged. If the WSA is still using its factory default settings, for example, these RS-232 interface parameters are still valid. If the RS-232 devices to be linked require different RS-232 interface parameters, modify the WSA configuration accordingly using the AT command interface. You can make these changes either prior to or after AutoConnect.

8.4 Example: Connecting with a *Bluetooth*® Interface in Windows 7

Windows 7 provides integrated drivers that detect standard USB *Bluetooth*® dongles when connected, enabling “Plug-and-Play”.

1. Connect your *Bluetooth*® dongle to the PC.

2. Wait until the *Bluetooth*® dongle is detected and all the necessary drivers have been installed.

3. In the system settings for your PC select *Control panel > Hardware and Sound > Devices and Printers > Add a device*.
   The “Add device” window then opens. If a WSA has been detected, its symbol will appear in this window.

Note

The WSA *Bluetooth*® function must be active for this!
The WSA can only be discovered and detected by the PC when the WSA is also ready for use. Depending on the type and version of the *Bluetooth*® dongle and driver software, you may have to enter the *Bluetooth*® MAC ID in advance in the list of accepted devices (see section “Optimizing the Security Settings” and section “Function Description”> … >“Security Settings for the Radio Communications Interface”).

4. Click the mouse button on the WSA device symbol to activate the [Next] button.

5. Click on [Next]. If a dialog window or a balloon tip appears requesting that you confirm the action, do this to continue with the procedure. The PC will now attempt to establish a link with the WSA. If successful, the WSA will be added to the PC and the WSA symbol becomes visible under *Control panel > Hardware and Sound > Devices and Printers*.

6. Double-click on the WSA symbol to display the WSA properties.
   In the tab *Services* you can activate both the *Serial Port (SPP) “CONFIG”* and the *Serial Port “DATA”*. It is also displayed here at which COM port you must establish the link to the WSA to use the corresponding *Bluetooth*® service.

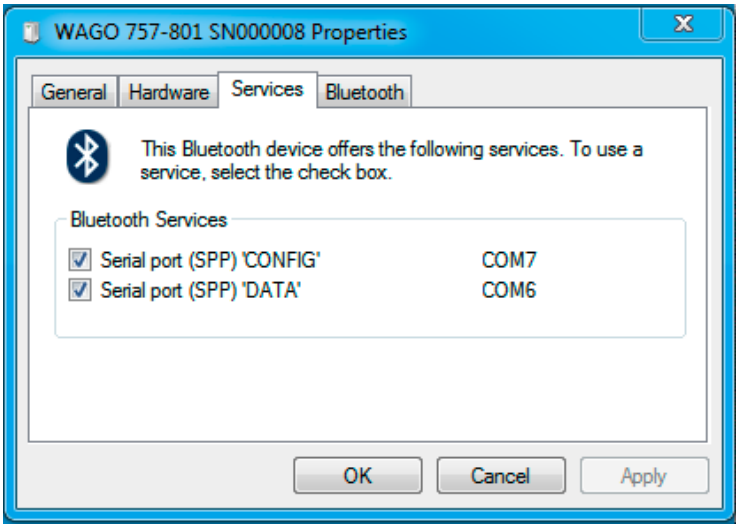


Figure 19: Properties of the WSA; “Services” tab (example)

You can now use the configured COM interfaces in terminal programs.

8.5 Example: Configuration with a PC using the SPP Service “CONFIG”

1. Reset the WSA to its factory default settings.

2. Perform a configuration for the WSA at a Windows PC (see section “Example: Connecting with a *Bluetooth*® Interface in Windows 7”).

3. Activate the *Bluetooth*® service “Serial Connection (SPP) ‘CONFIG’” by double-clicking on the device symbol for the WSA under *System control panel* > *Hardware and Sound* > *Devices and Printers* to open the window containing the WSA properties. The port for the specific serial connection is given in the tab “Services”.

4. Open a suitable terminal program (e.g., HyperTerminal, HTerm, RealTerm).

5. Select the appropriate port for serial connection (SPP) “CONFIG”.

Note

Always select an adequate baud rate!
Too low of a baud rate would result in a non-meaningful restriction of the bandwidth for the link. You should therefore select a baud rate of 19200 or higher, for example. You can leave the other interface parameters, such as parity, in their default settings.

6. Make the connection (“Connect”).
   The LEDs of the WSA indicate whether a link has been established.

7. You can then enter the required AT commands. Always be sure to end each command with a “carriage return”.

8.6 Example: Configuration via RS-232 Using a PC

1. Reset the WSA to its factory default settings.

2. Connect the WSA to the PC via the RS-232 interface.

3. Open a compatible terminal program (e.g., HyperTerminal, HTerm, RealTerm).

4. Select the appropriate port for the RS-232 interface on the PC (e.g., “COM1”).

5. Select the interface parameters based on the factory default settings for the WSA:
   - “Baud” (Baud rate: 19200)
   - “Stop” (Stopbits: 1)
   - “Parity” (Parity: none)
   - “CTS Flow control” (hardware flow control: none)

6. Set up the connection (“Connect”).

7. Enter the following character string “+++”.

Note

Do not send a “carriage return” after entering this string!
The character string “+++” is not an AT command and is therefore not terminated with a “carriage return”.

8. Wait until the welcome message is displayed.

9. If required, enter the AT command “AT INFO” after a few seconds.

10. Send a “carriage return” after entering this command.

The AT command interface is now available for use.

8.7 Example: Connecting to an Android Smartphone

Note

We cannot guarantee this functionality
The instruction steps given below have been tested representatively for the following devices:

- HTC Sensation (Android 4.0.3)
- Sony XPERIA U (Android 4.0.4)
- Samsung Galaxy S3 (Android 4.1.1)
- Samsung Galaxy Note (Android 4.1.2)

WAGO cannot, however, provide any guarantee that a link can be set up with your smartphone, on account of the large variety and rapid development of standard versions and configurations.

Proceed as follows to link your Android smartphone to the WSA:

1. Activate the *Bluetooth*® function of your smartphone.

2. In the *Bluetooth*® settings for your smartphone set its discoverability to "Visible to all nearby Bluetooth devices".

3. Open the RS-232 interface for your WSA, for example using a suitable terminal program at the PC. Ensure here that the interface parameters are correctly configured.

4. Enter the character string "+++".

Note

Do not send a "carriage return" after entering this string!
The character string "+++" is not an AT command and is therefore not terminated with a "carriage return".

5. Wait until the welcome message appears.
   You are now at the AT command interface. The AT commands that you now enter must therefore each be concluded with a "carriage return".
   After entering the command, wait until you receive a reply from the RS-232 interface before you enter the next AT command.

6. Use the following AT command to set the number of attempts for device discovery to a sufficiently high number so as to increase the chances that your smartphone will be discovered by the WSA:
   "`AT INQ COUNT = 10`"

7. Start the search for *Bluetooth*® devices within range with:
   "`AT INQ START`".

8. Have the names of the discovered devices listed:
   "`AT RDEV FOUND NAMES ?`".

If your smartphone does not appear in this list repeat the search procedure from Step 7.

9. Add your smartphone to the list of accepted devices: "`AT BTSEC ADEV ADD = FOUND 0`". The "`0`" in the example shown here denotes the first device in the list of discovered devices. If your smartphone is the second device in this list, select "`1`", if it is the third device in this list, select "`2`", and so on.

10. Enforce secure authentication: "`AT BTSEC AUTH = 1`".

11. Restart the WSA: "`AT RESET`". The modified security settings will be activated after this restart and the RS-232 interface is reset to data transmission.

12. Start a compatible terminal app on your smartphone.

13. Link your smartphone to the WSA using the terminal app. You can then transfer data between the terminal app on your smartphone and the RS-232 interface.

Note

Connecting to an iPhone/iPad
Connectivity to iOS-based devices with *Bluetooth*® capabilities is also possible. For this, a corresponding app must be available which runs the serial interface.

9 Reference AT Commands

The following AT commands can be entered via a command interface and used to configure the WSA.

Some AT commands contain information in angle brackets, e.g. `<hex>` or `<Name>` that have to be replaced by the respective parameters.

This command is concluded with the character for “carriage return”. This character is 0x0d, or decimal 13 from the ASCII code. This character is automatically sent, for example, when using the HyperTerminal software by pressing Enter.

9.1 AT

The command `AT` is used for checking the link to the WSA. If the connection is successful, the radio adapter returns the `00 SUCCESS` message.

9.2 Group “AT BTID”: Identifiers

Commands starting with “AT BTID” involve identifiers of the WSA, e.g. the device name, the *Bluetooth*® MAC ID and the CoD, which can be read by other devices.

9.2.1 AT BTID ?

The `AT BTID ?` command queries the *Bluetooth*® MAC ID and device name.

9.2.2 AT BTID ADR ?

The `AT BTID ADR ?` command queries the *Bluetooth*® MAC ID of the WSA. In the command output, `BDADR` is used for the MAC ID if necessary.

9.2.3 AT BTID COD

This command queries (`AT BTID COD ?`) or modifies (`AT BTID COD = <hex>`) the CoD of the WSA as a hexadecimal value.

The CoD is a 32-bit field specifying the capabilities and functionality of a *Bluetooth*® device and is sent with the packet “Frequency Hop Synchronization” (FHS) during device discovery.

The CoD allows rapid classification of remote devices in various device categories such as Network, Audio or Telephony.

In the current version of *Bluetooth*® standards, the 32-bit field of the CoD contains 24 relevant bit positions. From these 24 bits, again 6 bits (the “Minor Device Class”) are settable with the AT command `AT BTID COD`.

Example: `AT BTID COD = 1f04`

CoD structure:

Table 34: CoD structure

Bit position	Description	Default values
23..16	**"Major Service Class"** Not assigned according to the *Bluetooth*® specification	00000000
15, 14	Reserved	00
13	**"Limited Discoverable Mode"** Temporary visibility according to the *Bluetooth*® specification. No evaluation because this setting for the WSA depends on the configuration or connection.	0
12..8	**"Major Device Class"** No uniquely classified device according to the *Bluetooth*® specification	11111
7..2	**"Minor Device Class"** (user-assignable) If the "Major Device Class" is not uniquely specified ("11111"), the value "000000" is suggested.	000000
1, 0	Format type for the structure of the CoD, reserved	00

The default CoD for the WSA is 0x1f00
(binary, see the following representation).

Table 35: CoD structure, binary

Bit	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
WAGO device class	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0
	Major Service Class											Major Device Class					Minor Device Class						Type:	

Note

Only change "Minor Device Class" for specific classification!
Use your own bit allocation of the "Minor Device Class" for specific classification of the WSA.
Do not change the other areas of the CoD because this could make connecting to other devices no longer possible.

9.2.4 AT BTID HELP

The `AT BTID HELP` command displays the syntax of all commands starting with `AT BTID`.

9.2.5 AT BTID NAME

This command queries (`AT BTID NAME ?`) or configures (`AT BTID NAME = <Name>`) the *Bluetooth*® device name of the WSA.

The name may not exceed a length of 32 alphanumeric characters.

If the WSA is configured to respond to device discovery, external devices can query the *Bluetooth*® device name.
This simplifies identification of *Bluetooth*® devices.

If the WSA is reset to the factory settings, the device keeps the last value, i.e. a device name assigned by the user stays until it is changed again explicitly.

Example: `AT BTID NAME = MyName1`

9.3 Group “AT BTSEC”: Security

Commands that start with “AT BTSEC” affect safety-related device settings.

9.3.1 AT BTSEC ADEV

The `AT BTSEC ADEV` or `AT BTSEC ADEV ?` command outputs a list of allowed devices. The listed MAC IDs specify for which devices secure authentication is allowed.
This form of authentication is then relevant if the other device uses *Bluetooth*® version 2.1 or higher and one side requires secure authentication. In this case, a connection is only established if there is a list item for the device. The list is unnecessary if the external device uses *Bluetooth*® version 2.0 or lower or neither the radio adapter nor the external device require secure authentication.

Output example:

```
at btsec adev

00 SUCCESS

results:
0:  bdadr=“1c:65:9d:50:e9:f3“
1:  bdadr=“00:00:00:00:00:00“
2:  bdadr=“00:00:00:00:00:00“
3:  bdadr=“00:00:00:00:00:00“
4:  bdadr=“00:00:00:00:00:00“
5:  bdadr=“00:00:00:00:00:00“
6:  bdadr=“00:00:00:00:00:00“
7:  bdadr=“00:00:00:00:00:00“

>
```

9.3.1.1 AT BTSEC ADEV ADD = <Device>

The `AT BTSEC ADEV ADD = <device>` command adds a device to the list of allowed devices. This can occur by direct transfer of the MAC ID, but it is also possible to apply devices from the list of found or trusted devices.

Examples

1. To add device with MAC ID 00:11:22:33:44:55 to the list of allowed devices:

   ```
   AT BTSEC ADEV ADD = 00:11:22:33:44:55
   ```

2. To add device in the list of found devices under index 2 to the list of allowed devices:

```
AT BTSEC ADEV ADD = FOUND 2
```

3. To add device in the list of trusted devices under index 4 to the list of allowed devices:

```
AT BTSEC ADEV ADD = TRUSTED 4
```

9.3.1.2 AT BTSEC ADEV DEL = <Index>

The `AT BTSEC ADEV DEL = <Index>` command deletes the device under the specified index from the list of allowed devices. If the device is in the list of trusted devices, it is also removed from that list.

Example: `AT BTSEC ADEV DEL = 2`

9.3.1.3 AT BTSEC ADEV CLEAR

The `AT BTSEC ADEV CLEAR` command clears all entries from the list of allowed devices.

9.3.2 AT BTSEC AUTH

This command queries (`AT BTSEC AUTH ?`) or determines (`AT BTSEC AUTH = <x>`) if the WSA itself always requires secure authentication. Valid values are `x ="0"` (informal authentication allowed) and `x = "1"` (secure authentication is forced).

Example: `AT BTSEC AUTH = 1`

Note

Authentication always occurs if required by the other side!
Regardless if authentication is required in the settings of the WSA, secure authentication always takes place if the other side requires it.

9.3.3 AT BTSEC HELP

The `AT BTSEC HELP` command displays the syntax of all commands starting with `AT BTSEC`.

Output:

```
at btsec help

00 SUCCESS

Configure security settings using the following
commands:
```

```
AT BTSEC HELP
AT BTSEC ADEV { ? | CLEAR }
AT BTSEC ADEV ADD = {(bdadr)| { FOUND|TRUSTED }(index)}
AT BTSEC ADEV DEL = (index)
AT BTSEC AUTH { ? | (bool) }
AT BTSEC INQ  { ? |  = { A | D | N } }
AT BTSEC PAG  { ? |  = { A | D | N } }
AT BTSEC PIN  { ? |  = (in_pin) }
AT BTSEC TRUSTED { ? | CLEAR | DEL = (index) }

>
```

9.3.4 AT BTSEC INQ

This command queries (`AT BTSEC INQ ?`) or determines (`AT BTSEC INQ = <x>`) if the WSA always (`x ="a"` for "always"), only when disconnected (`x ="d"` for "disconnected") or never (`x ="n"` for "never") responds to a device discovery.

Example: `AT BTSEC INQ = n`

9.3.5 AT BTSEC PAG

This command queries (`AT BTSEC PAG ?`) or determines (`AT BTSEC PAG = <x>`) if the WSA always (`x ="a"` for "always"), only when disconnected (`x ="d"` for "disconnected") or never (`x ="n"` for "never") responds to paging (for connection setup, name query, service query).

Example: `AT BTSEC PAG = d`

9.3.6 AT BTSEC PIN

This command queries (`AT BTSEC PIN ?`) or determines (`AT BTSEC PIN = <Pin>`) the PIN used for secure authentication of external devices of *Bluetooth*® versions 2.0 or lower if the connection is established by the other side.

The PIN must consist of a string of max. 15 characters.

Note

Note different PINs!
Note that 2 PINs are distinguished: one PIN for inbound connections and authentication (AT BTSEC PIN) and one PIN for outbound connections (AT CON TAR PIN).

Note

Pay attention to matching PINs!
Make sure that the input options on the other side can set the selected PIN. For example, some external devices only support the characters 0 to 9.

Example: `AT BTSEC PIN = 4321` or
`AT BTSEC PIN = hello`

9.3.7 Subgroup “AT BTSEC TRUSTED”

Commands that start with “AT BTSEC TRUSTED” affect the list of trusted device.

9.3.7.1 AT BTSEC TRUSTED ?

The `AT BTSEC TRUSTED ?` command displays a list of trusted devices that were able to successfully perform authentication and store authentication data (pairing). Devices on this list do no normally have to authenticate themselves when establishing a connection, but can exchange data immediately. For security reasons, the list is cleared if the setting to force secure authentication is changed.

Information

Informal authentication for commissioning!
During startup, informal authentication can be used to establish connections for the first time.
Devices to which a connection should be established later can then be easily applied from the list of trusted devices to the list of allowed devices.

9.3.7.2 AT BTSEC TRUSTED DEL = <Index>

The `AT BTSEC TRUSTED DEL = <Index>` command deletes the device under the specified index from the list of trusted devices.

Example: `AT BTSEC TRUSTED DEL = 2`

9.3.7.3 AT BTSEC TRUSTED CLEAR

The `AT BTSEC TRUSTED CLEAR` command clears all entries from the list of trusted devices.

9.4 Group “AT CON”: Configuration of Outbound Connections

Commands that start with “AT CON” affect the configuration of outbound connections, i.e. active connections established by the WSA.

9.4.1 AT CON AUTO

The `AT CON AUTO` command automatically connects to another WSA. AutoConnect must be enabled on both radio adapters to establish the connection.

Note

Only use other AT commands after establishing the connection!
AutoConnect can take several minutes. Do no use any other AT commands until the process is complete.

As an alternative to this AT command, AutoConnect can also be initiated by mode switching (see section “Function Description”> … >“Operating Modes”).

9.4.2 AT CON CLOSE

Use the command `AT CON CLOSE` to close the existing link with the SPP service “DATA”, regardless of whether the link was set up by the WSA or the other communication partner.

9.4.3 AT CON HELP

The `AT CON HELP` command lists the syntax of all AT commands starting with “AT CON”.

9.4.4 AT CON OPEN

The `AT CON OPEN` command opens the connection to the external device configured under `AT CON TAR`.

9.4.5 Subgroup “AT CON RETRY”

Commands that start with “AT CON RETRY” concern restoration of the wireless connection.

9.4.5.1 AT CON RETRY = <Reconnect Cycle>

The `AT CON RETRY = <reconnection cycle>` command defines whether the wireless connection should be restored (`reconnection = “1”`) or not (`reconnection = “0”`) automatically after the connection is lost. Attempts to restore a connection can be made after a certain `cycle` in seconds.

Example: `AT CON RETRY = 1 20`

9.4.5.2 AT CON RETRY ?

The `AT CON RETRY ?` command queries the settings for automatic reconnection.

9.4.5.3 AT CON RETRY CYCLE

This command queries (`AT CON RETRY CYCLE ?`) if or determines (`AT CON RETRY CYCLE = <cycle>`) when (after how many seconds) to (re)establish connections.

Example: `AT CON RETRY CYCLE = 5`

9.4.5.4 AT CON RETRY ENA

This command queries (`AT CON RETRY ENA ?`) or determines (`AT CON RETRY ENA = <reconnection>`) if the WSA automatically initiates a new connection in a cycle (`reconnection = "1"`) or not (`reconnection = "0"`) if the wireless connection is interrupted or fails.

Example: `AT CON RETRY ENA = 1`

Note

No reconnection if the other side denies it!
Independent of the `AT CON RETRY ENA` command, the connection is not reestablished if the other side properly closes or denies the connection

9.4.6 AT CON TAR

This command queries (`AT CON TAR ?`) or determines (`AT CON TAR = <address port PIN>`) to which device and with what settings an outbound connection is established. The relevant parameters are:

- `Address:` *Bluetooth*® MAC ID of the external device
- `Port:` Index of the SPP service of the external device to which a connection is established
- `PIN:` PIN expected by the external device (value irrelevant for connections to devices of *Bluetooth*® standard 2.1 or higher)

Example: `AT CON TAR = 00:11:22:33:44:55 0 1234`

9.4.6.1 AT CON TAR ADR

This command queries (`AT CON TAR ADR ?`) or determines (`AT CON TAR ADR = <adr>`) to which device the outbound connection is established:

Examples

- Explicit MAC ID: `AT CON TAR ADR = 00:11:22:33:44:55`
- List of trusted devices: (for index “2”) `AT CON TAR ADR = TRUSTED 2`
- List of found devices: (for index “1”) `AT CON TAR ADR = FOUND 1`

9.4.6.2 AT CON TAR CLEAR

The `AT CON TAR CLEAR` command resets address, port and PIN to the factory settings.

9.4.6.3 AT CON TAR PIN

This command queries (`AT CON TAR PIN ?`) or determines (`AT CON TAR PIN = <PIN>`) the PIN used for outbound connections if the external device uses an older version of the *Bluetooth*® standard.

Example: `AT CON TAR PIN = 1234`

See also section “AT BTSEC PIN”.

9.4.6.4 AT CON TAR PORT

This command queries (`AT CON TAR PORT ?`) or determines (`AT CON TAR PORT = <port index>`) to which serial port index of the external device an outbound connection is established. Possible values are 0 … 63. “0” corresponds to the lowest port index offered by the respective device (equivalent to “auto”).

Example: `AT CON TAR PORT = 0`

9.5 Group “AT ECO”: Coexistence Settings

Commands that start with “AT ECO” affect device settings that determine the coexistence properties of the WSA.

9.5.1 Subgroup “AT ECO BLK”

Commands that start with “AT ECO BLK” concern the radio frequencies of the WSA used for data transmission.

9.5.1.1 AT ECO BLK

This command queries (`AT ECO BLK ?`) or determines (`AT ECO BLK = <channel map>`) which radio frequencies the WSA may use for data transmission.

The value represents a channel map for the 79 possible *Bluetooth*® channels where each channel is encoded as a bit starting with the lowest.
For value `ff.ff.ff.ff.ff.ff.ff.ff.ff.ff.f7` all channels are allowed.
For example, 16 channels at the lower end of the frequency band are blocked with value `00.00.ff.ff.ff.ff.ff.ff.ff.ff.f7`.

Example: `AT ECO BLK = 00.00.ff.ff.ff.ff.ff.ff.ff.ff.f7`

9.5.1.2 AT ECO BLK 15.4 = <Channels>

The `AT ECO BLK 15.4 = <channels>` command adds more channel frequencies to the list of blocked radio frequencies in accordance with IEEE 802.15.4.
With each channel blocked in this manner, a range of 5 MHz around the center frequency is blocked in the channel map. Up to 9 individual channels separated by commas can be specified per command.

Example: `AT ECO BLK 15.4 = 2,8`
blocks the frequency ranges for channels 2 and 8.

9.5.1.3 AT ECO BLK BT <Channels>

The `AT ECO BLK BT <channels>` command adds more channel frequencies to the list of blocked radio frequencies in accordance with IEEE 802.15.1.
With each channel blocked in this manner, a range of 1 MHz around the center frequency is blocked in the channel map. Up to 9 channel ranges separated by commas can be specified per command.

Example: `AT ECO BLK BT 10-10, 20-22`
blocks the frequency ranges for channels 10, 20, 21 and 22.

9.5.1.4 AT ECO BLK WIFI = <Channels>

The `AT ECO BLK WIFI = <channels>` command adds more channel frequencies to the list of blocked radio frequencies in accordance with IEEE 802.11 b/g.
With each channel blocked in this manner, a range of 25 MHz around the center frequency is blocked in the channel map. Up to 2 individual channels separated by commas can be specified per command.

Example: `AT ECO BLK WIFI = 6`
blocks the frequency range for channel 6.

9.5.1.5 AT ECO BLK CLEAR

The `AT ECO BLK CLEAR` clears possible channel blocking. All 79 channels are allowed.

Output:
```
chnmap = “ff.ff.ff.ff.ff.ff.ff.ff.ff.f7“

>
```

9.5.2 AT ECO ENA

This command queries (`AT ECO ENA ?`) or determines (`AT ECO ENA = <x>`) if the WSA uses the stored settings for channel map and modified device discovery or not (see section “Function Description”> … > “Special Coexistence Properties”). The command makes it easy to enable (`x = “1”`) or disable (`x = “0”`) coexistence improvements without, for example, having to reconfigure the channel map.

Example: `AT ECO ENA = 1`

9.5.3 AT ECO HELP

The `AT ECO HELP` command lists the syntax of all AT commands starting with `AT ECO`.

9.5.4 AT ECO INQ

This command queries (`AT ECO INQ ?`) or determines (`AT ECO INQ = <x>`) if a WSA uses `(x = “1”)` the modified device discovery to search for other devices or not `(x = “0”)`. When using the modified device discovery, the interference potential for other radio systems is reduced, but other *Bluetooth*® devices are only found after longer or more frequent searches under certain circumstances.

9.5.5 AT ECO TXPWR ?

The `AT ECO TXPWR ?` command queries the maximum transmit power the WSA uses immediately during or after establishing a connection or during data exchange (see section “Function Description”> … >“Special Coexistence Properties”).

9.5.5.1 AT ECO TXPWR DEF

This command queries (`AT ECO TXPWR DEF ?`) or determines (`AT ECO TXPWR DEF = <transmit power>`) the transmit power the WSA uses initially to search for other devices or immediately after establishing a connection. This value cannot be greater than the value for the maximum allowed transmit power.

If a value is set that cannot be applied, the WSA uses the next smallest valid value.

Example: `AT ECO TXPWR DEF = 4`

9.5.5.2 AT ECO TXPWR MAX

This command queries (`AT ECO TXPWR MAX ?`) or determines (`AT ECO TXPWR MAX = <max. transmit power>`) the maximum transmit power the WSA uses initially to search for other devices or immediately after establishing a connection. This value (in dB) cannot be smaller than the value for the transmit power initially used for device discovery or after establishing a connection.

Example: `AT ECO TXPWR MAX = 4`

9.6 AT HELP

The `AT HELP` command lists the syntax of all available AT commands and command groups. The character conventions for all available “HELP” commands are described in the section “Configuration”> … >“Basic Structure of Replies to AT Commands.”

Output:

```
00 SUCCESS


Attaching “HELP” to any AT command followed by “...”
will list the syntax of the concerning command group in
detail. Available commands:

AT HELP
AT
AT BTID ...
AT BTSEC ...
AT CON ...
AT ECO ...
AT INFO
AT INQ ...
AT LOGOUT
AT RDEV ...
AT RESET
AT STATUS ...
AT SYS ...
AT UART ...

>
```

9.7 AT INFO

The `AT INFO` command outputs a status text that contains some of the device information. This status text is also output once automatically if the AT command interface is opened.

9.8 Group “AT INQ”: Search for SPP Devices within Range

Commands that start with “AT INQ” configure or start the search for other *Bluetooth*® devices in range.

9.8.1 AT INQ

This command queries (`AT INQ ?`) or determines (`AT INQ = <cycles CoD>`) how many passes are made when starting device discovery and how the search results are filtered by which CoD.

Example: `AT INQ = 4 1f00`

9.8.2 AT INQ COD

This command queries (`AT INQ COD ?`) or determines (`AT INQ COD = <CoD filter>`) with which CoD the search results are filtered by reachable *Bluetooth*® devices.
The value represents a bit field of 32 bits. To ensure that a device within range appears in the search results, its CoD must not be equal to 0 at least at the bit positions in which the filter value is not equal to zero.

In the factory default settings, the WSA uses 0x1f00 as its own CoD and 0x0000 as the filter for searching other devices. The value 0x00000 means that search results are not filtered. If the CoD filter for your own device discovery is configured to 0x1f00, other WSA units within range are displayed preferentially (see example).

Example: `AT INQ COD = 1f00`

9.8.3 AT INQ COUNT

This command queries (`AT INQ COUNT ?`) or determines (`AT INQ COUNT = <pass count>`) how many passes are made during device discovery. Each pass takes approx. 2.5 seconds. A higher number of passes increases the probability of finding a specific device, but requires more time.

Example: `AT INQ COUNT = 4`

9.8.4 AT INQ START

The `AT INQ START` command starts the searching for *Bluetooth*® devices in range. After completion, a list of MAC IDs found is output together with the strength of the signal received.
The `AT RDEV FOUND` command can be used to display the list again.

Output:

```
00 SUCCESS

results:
0: bdadr="00:09:dd:50:11:1c" rssi="-38"

>
```

9.9 AT LOGOUT

The command `AT LOGOUT` is only available when the AT command interface has been opened by switchover of the wired, serial interface. The AT command interface is closed when this command is executed. After this, the wired, serial interface is again available for data transmission via the SPP service "DATA". The AT command interface can also be accessed again via the SPP service "CONFIG" after this command has been executed.

9.10 AT RESET

The `AT RESET` command can be used to restart the WSA.

9.11 Group "AT RDEV": Devices within Range

AT commands starting with "AT RDEV" allow you to query and display information about other *Bluetooth*® devices in range.

9.11.1 AT RDEV FOUND ?

The `AT RDEV FOUND ?` command outputs the results list of the *Bluetooth*® devices still within range since the last search again (see section "AT INQ START").

9.11.2 AT RDEV FOUND NAMES ?

The `AT RDEV FOUND NAMES ?` command attempts to query and display the name for each *Bluetooth*® device found. Because there is no guarantee that all corresponding devices still in range are found, not all names may be released under certain circumstances. The order may not be the same as in the list of devices found.
However, the assignment can be made via the *Bluetooth*® MAC ID.

Output:

```
00 SUCCESS

results:

* adr="00:09:dd:50:11:1c" name="PC96585"

>
```

9.11.3 AT RDEV HELP

The `AT RDEV HELP` command lists the syntax of all AT commands starting with `AT RDEV`.

9.11.4 AT RDEV NAME <Device>

The `AT RDEV NAME <device>` command queries the *Bluetooth*® device name of a target device. The target device can be defined directly by specifying the MAC ID (e.g. `device = "11:22:33:44:55:66"`). As an alternative, the MAC ID of a specified index of the list of
found (`device = "FOUND <Index>"`) or
trusted (`device = "TRUSTED <Index>"`) can also be used. The name of the device that has currently established a connection to the SPP "DATA" service can also be queried (`device = "CON"`). If there is no connection to "DATA", the information applies to the SPP "CONFIG" data.

Examples:

- `AT RDEV NAME 11:22:33:44:55:66`
- `AT RDEV NAME FOUND 2`
- `AT RDEV NAME TRUSTED 1`
- `AT RDEV NAME CON`

9.11.5 Subgroup "AT RDEV PORT"

AT commands starting with "AT RDEV PORT" allow the retrieval of information on SPP services provided by external devices.

9.11.5.1 AT RDEV PORT INDEX <Target Device>

The `AT RDEV PORT INDEX <target device>` command queries the port numbers of the SPP services that the target device provides. For a definition of the target device, see section "AT RDEV NAME <device>". If the target device is a WSA, the query returns two results – port indexes 1 and 2.

9.11.5.2 AT RDEV PORT NAME <Device>

The `AT RDEV PORT NAME <device>` command queries the names of the SPP services that the target device provides. For a definition of the target device, see section “AT RDEV NAME <device>.” If the target device is a WSA, the query returns two results – the SPP service names “DATA” and “CONFIG.”

9.12 Group “AT STATUS”: Version and Status Information

AT commands starting with “AT STATUS” display version and status information.

9.12.1 AT STATUS CON ?

The `AT STATUS CON ?` command displays if there are wireless connections to which devices. If there is an active wireless connection, information about the quality of the connection is output. If there is no connection to the SPP “DATA” service, the information applies to the SPP “CONFIG” data.

The information about the quality of the connection includes:

- **Roll**
  Master or Slave

- **“Link Quality Indicator” (LQI)**
  This maps the measured bit error rate (BER) linearly over the following sections:
  • LQI 255..215: BER 0.00 % to 0.1 % (Increment 0.0025 %)
  • LQI 214..90: BER 0.18 % to 10.1 % (Increment 0.0800 %)
  • LQI 89..0: BER 10.74 % to 67.7 % (Increment 0.6400 %)

- **“Received Signal Strength Indicator” (RSSI)**
  The indicator shows the range in which the signal strength is situated:
  • RSSI = 0: optimal range
  • RSSI > 0: high signal strength
  • RSSI < 0: low signal strength

- **AFH Channel Map (CHNMAP)**
  Indicates which *Bluetooth*® channels are currently in use or which channels are exempted from transmission due to known interference or an explicit blocking requirement by the user (see section “AT ECO BLK”).

9.12.2 AT STATUS HWVERS ?

The `AT STATUS HWVERS ?` command outputs the hardware version.

9.12.3 AT STATUS SERIAL ?

The `AT STATUS SERIAL ?` command outputs the serial number.

9.12.4 AT STATUS STATS ?

The `AT STATUS STATS ?` command displays various counter values. The counters are reset at each restart of the WSA. If the maximum value of 65535 is reached, the counters roll over to the 0 with the next increase.

- `con` Number of wireless connections
- `rx` Number of packets received from the *Bluetooth*® interface.
  Even when there is no data transport, the counter value can increase because device-internal control information is updated.
- `tx` Number of packets sent to the *Bluetooth*® interface.
  Even when there is no data transport, the counter value can increase because device-internal control information is updated.
- `u2b` Number of transmitted data frames from a wired serial interface to an external device.
  The counter changes when data is sent.
- `b2u` Number of transmitted data frames from an external device to a wired serial interface.
  The counter changes when data is received.

9.12.5 AT STATUS SWVERS ?

The `AT STATUS SWVERS ?` command outputs the software version.

9.12.6 AT STATUS UPTIME ?

The `AT STATUS UPTIME ?` command outputs in `dd:hh:mm:ss` since the WSA was last restarted.

Output:

```
00 SUCCESS

uptime=“00:03:36:10”

>
```

9.13 Group “AT SYS”: Output Format, Factory Default Settings

AT commands starting with “AT SYS” are used to configure the AT command interface, to reset the WSA to the factory default settings and to query or save a user-defined character string.

9.13.1 AT SYS CFG CLEAR

The `AT SYS CFG CLEAR` command resets the WSA to the factory default settings (see section “Function Description”> … >“Factory Default Settings”).

Note

Restart the device to apply the settings!
Restart the WSA if you have executed the `AT SYS CFG CLEAR` command, as some settings are not applied until the adapter is restarted.

9.13.2 AT SYS ECHO

The command queries (`AT SYS ECHO ?`) or determines (`AT SYS ECHO = <x>`) if characters received on the AT command interface are echoed (`x = “1”`) or not (`x = “0”`).

Note

Only use “AT SYS ECHO” for manual command input!
Only use the `AT SYS ECHO` command in conjunction with manual operation of the AT command interface (e.g. for keyboard input some terminal programs). Otherwise, output of the echo can be aborted by output of the response especially for longer AT commands.

Note

Note on the use of terminal programs
In some terminal programs, the characters entered in the prompt line are not displayed.
To simplify entering of AT commands in such a case you can configure the WSA using an AT command (`AT SYS ECHO = 1`) such that it reflects, or “echoes” the input.

9.13.3 AT SYS HELP

The `AT SYS HELP` command lists the syntax of all AT commands starting with `AT SYS`.

9.13.4 AT SYS OUTPUT

The command queries (`AT SYS OUTPUT = x`) or determines (`AT SYS OUTPUT = <x>`) which format is used to output the responses to the AT command interface. Available formats are:

- `x = "s"`: (s = "short")
  Short output
  Output is optimized by a program for automatic text processing which is why the presentation when using terminal programs may not be fully readable. A carriage return separates parameters; an asterisk "*" identifies hierarchical levels when lists or grouped lists are output.

- `x = "p"`: (p = "plain")
  Plain output
  Short symbolic designations for parameters are output as well as indexes for output of lists.

- `x = "v"`: (v = "verbose")
  Verbose output
  Additional texts and long designations are output for the parameters.
  When lists are output, indexes are also output explicitly.

9.13.5 AT SYS USRSTR

This command queries (`AT SYS USRSTR ?`) or determines (`AT SYS USRSTR = <text>`) a user-defined string of max. 63 characters. In this way, a small amount of data can be saved on the device.

Example: `AT SYS USRSTR = saved_text`

9.14 Group "AT UART": Serial Interface Parameters

AT commands starting with "AT UART" affect the configuration of the wired serial interface of the WSA.

9.14.1 AT UART

This command queries (`AT UART ?`) or sets (`AT UART = baud parity stopb`) the configuration for all parameters regarding the configuration of the service interface of the field coupler or WAGO PLC.

9.14.2 AT UART BAUD

This command queries (`AT UART BAUD ?`) or determines (`AT UART BAUD = <baud>`) the baud rate of the service interface of the fieldbus coupler or WAGO PLC currently used.

Valid baud rates are:

- `“9600“`
- `“19200“`
- `“38400“`
- `“57600“`
- `“115200“`

Example: `AT UART BAUD = 9600`

9.14.3 AT UART HELP

The `AT UART HELP` command outputs the syntax of all AT commands starting with `AT UART`.

9.14.4 AT UART PAR

This command queries (`AT UART PAR ?`) or determines (`AT UART PAR = <parity>`) the parities supported by the wired serial interface.

Valid parities values are:

- `“E“` (“even“): even parity
- `“N“` (“none“): no parity
- `“O“` (“odd“): odd parity

9.14.5 AT UART STOPB

This command queries (`AT UART STOPB ?`) or determines (`AT UART STOPB = <x>`) if the service interfaces uses one (`x = “1”`) or two (`x = “2”`) stop bits.

9.14.6 AT UART FCTRL

This command queries (`AT UART FCTRL ?`) or determines (`AT UART FCTRL = <x>`) whether hardware flow control is enabled (`x = “1”`) or not (`x = “0”`).

9.14.7 AT UART SEG

This command queries (`AT UART SEG ?`) or determines (`AT UART SEG = <x>`) whether recognition of associated segments is active (`x = “1”`) or not (`x = “0”`). If recognition is activated, the WSA will attempt to always transmit associated segments, i.e., to retain the chronological segmenting of the serial interface. Characters received at the interface are therefore not transferred immediately, but only when no further characters are received within a defined time period. If recognition is not activated, the inbound characters are transferred immediately.

Glossary

A

AFH
(**A**daptive **F**requency **H**opping)
The adaptive frequency hopping process is used to temporarily skip faulted or occupied sections of the total available frequency band and use other channels.

ASCII
(**A**merican **S**tandard **C**ode for **I**nformation **I**nterchange)
The basis for character set coding. Character encoding defines 128 characters, consisting of 33 non-printable and 95 printable characters. Each character is assigned a bit pattern consisting of 7 bits. Since each bit can have two values, a total of 2^7 (= 128) different bit patterns exist, which can be interpreted as whole numbers 0–127 (hexadecimal 00–7F).

AT Command
Command for configuring and parameterization of a module. The letters “AT” here stand for “attention.”

AT Command Interface
Besides enabling modification of the configuration, this interface can also be used for exporting of status and diagnostics information and text output of contextual Help texts.

Authentication
Authentication is a process for testing the identity transmitted by a communication partner.

B

Baud rate
Maximum number of changes to the signal status for a serial interface per second, measured in “Baud.” The baud rate value is equal to the frequency of the clock signal for synchronous, serial interfaces.

***Bluetooth*®**
Industry standard according to IEEE 802.15.1 for data radio transmission between devices over short distances. This includes non-connected and connected point-to-point transmission and so-called piconetworks. *Bluetooth*® provides an interface through which both mobile miniature devices such as mobile phones and PDAs and computers and peripheral devices can communicate with one another. The main purpose behind *Bluetooth*® is to do away with the need for wired connections between devices.

C

Channel
A (transmission) channel is a mechanism or resource that enables data transmission over space or time.

Channel map
The channel map defines for a quantity of available channels the portion thereof that is to be used or not used. This makes it possible to reserve certain frequencies for transmission by other devices or technologies.

CoD
(**C**lass **o**f **D**evice)
The *Bluetooth*® Class of Device (CoD) is a 24-bit field that indicates to what standard device type (such as mobile phone or hands-free calling kit) a *Bluetooth*® device corresponds. Vendor-specific types may also be used in addition to standard types.

CR
(**C**arriage **R**eturn)
A “carriage return” is an instruction for text output devices to go to the beginning of the line. In digital word processing/transmission this function causes the cursor to return to the beginning of the line; it is transmitted by the “carriage return” (CR) control character.

CTS
(**C**lear **T**o **S**end)
Control line for an RS-232 interface that grants “send permission”: a High level at this input is a signal to the remote peer that it can receive this data.

D

Device name
The *Bluetooth*® name of a device. This name can be queried by other *Bluetooth*® devices via a radio link.

D-Sub
(D-Subminiature)
Design of a plug connecting system for data links.

F

FCC
(**F**ederal **C**ommunications **C**ommission)
Approval authority for communications devices in the USA

FE
(**F**unctional **E**arth)
FE is used for discharging electromagnetic faults. It is used only an EMC ground connector and does not fulfill the protective earth (ground) (PE) function according to VDE 0100.

FHSS
(**F**requency **H**opping **S**pread **S**pectrum)
General: The frequency hopping process known as “Frequency Hopping Spread Spectrum” involves the division of a frequency range into sub-ranges, between which the data transmission then alternates. This improves co-existence with other networks and provides additional tapping protection and strength against narrow band disturbing influences.
In the context of *Bluetooth*®: Subdivision of the radio channel into 79 sub-channels. The current subchannel is changed each time after transmission of a packet. This may occur up to 1600 times per second.

H

Hardware Flow Control
Data flow control denotes different procedures for controlling data transmission from terminal devices to a data network which do not operate synchronously in such a manner as to provide a continuous data transmission flow as possible without any losses.
Hardware procedures transfer control information via lines, which are also routed to the data lines on the connectors. Hardware flow control is implemented using corresponding signal levels on the associated interface lines.

HF
High **F**requency

I

IEEE
Institute of **E**lectrical and **E**lectronic **E**ngineers

IP Rating
(Ingress **P**rotection acc. to IEC 60529)
Protection classes define, on the one hand, the measures for protection against hazardous voltages (touch protection) and, on the other, protection measures against moisture.

L

LED
(**L**ight-**E**mitting **D**iode)

M

MAC ID
(**M**edia **A**ccess **C**ontrol **Id**entification)
A device MAC ID is its hardware address. *Bluetooth*® MAC IDs enable worldwide, unique identification of a specific *Bluetooth*® radio adapter.

P

Parity
A parity bit is a simple check bit in a data word. The parity check is employed to detect erroneously transmitted data words. Here, a data word refers to a sequence of bits. “Parity” denotes the number of bits assigned as 1 in the data word, and is designated “even” when the number of bits is even; otherwise “odd.”

PIN
(**P**ersonal **I**dentification **N**umber)
The PIN is used to authenticate *Bluetooth*® devices with one another, acting as the basis for encryption.

PLC
(**P**rogrammable **L**ogic **C**ontroller)
A PLC is a device used to control a machine or system and is programmed on a digital basis, such as a WAGO fieldbus controller.

R

RS-232
The RS-232 (official designation ANSI/EIA/TIA-232-F-1997) is a serial interface for point-to-point connections. “RS” stands for “Radio Sector,” but is frequently translated as “Recommended Standard.”

Data is transmitted via this interface bit-serial over a data line and received on a different data line. As only one data line is used at a time, the data is transmitted time-delayed consecutively and asynchronously. The time intervals between transmission of the data may be randomly long.
As the RS-232 interface is a so-called powered interface, data is transferred electrically encoded.
The cable connections used for this interface are 9-pin Sub-D connectors and 9-pin jacks. A distinction is made here between data lines (RxD, TxD and GND) and control lines (DCD, DTR, DSR, RTS, CTS and RI).

RTS
(**R**equest **T**o **S**end)
Data line for an RS-232 interface which makes a “send request”: a high level at this output signals that data are waiting to be sent.

RX and **RxD**
(**R**eceive **D**ata)
Data line for inbound data at an RS-232 interface.

S

SN
Serial **N**umber
SPP
(**S**erial **P**ort **P**rofile)
Bluetooth® profile for emulation of a serial port.

SSP
(**S**ecure **S**imple **P**airing)
Based on *Bluetooth*® standard 2.1 or higher, “Secure Simple Paring” (SSP) is used for secure authentication.

Stop bit
One start bit and up to two stop bits are used in asynchronous, serial data transmission to enable the receiving unit to conduct synchronization to each character that is transmitted.

T

Terminal
User device for entering and displaying data.

Terminal Program
A terminal program (also referred to as *terminal emulation*) is a computer program that emulates the function of a terminal. These are used for programs without any graphical input/output. The user interface is usually text-based.

TX and **TxD**
(**T**ransmit **D**ata)
Data line for outbound data at an RS-232 interface.

W

WLAN
(**W**ireless **L**ocal **A**rea **N**etwork)
Local wireless network, usually referring to a standard of the IEEE-802.11 family. A synonym for this is *Wi-Fi*.

WSA
(**W**ireless **S**erial **A**dapter)
Used here to denote the *Bluetooth*® module RS-232 IP67.

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