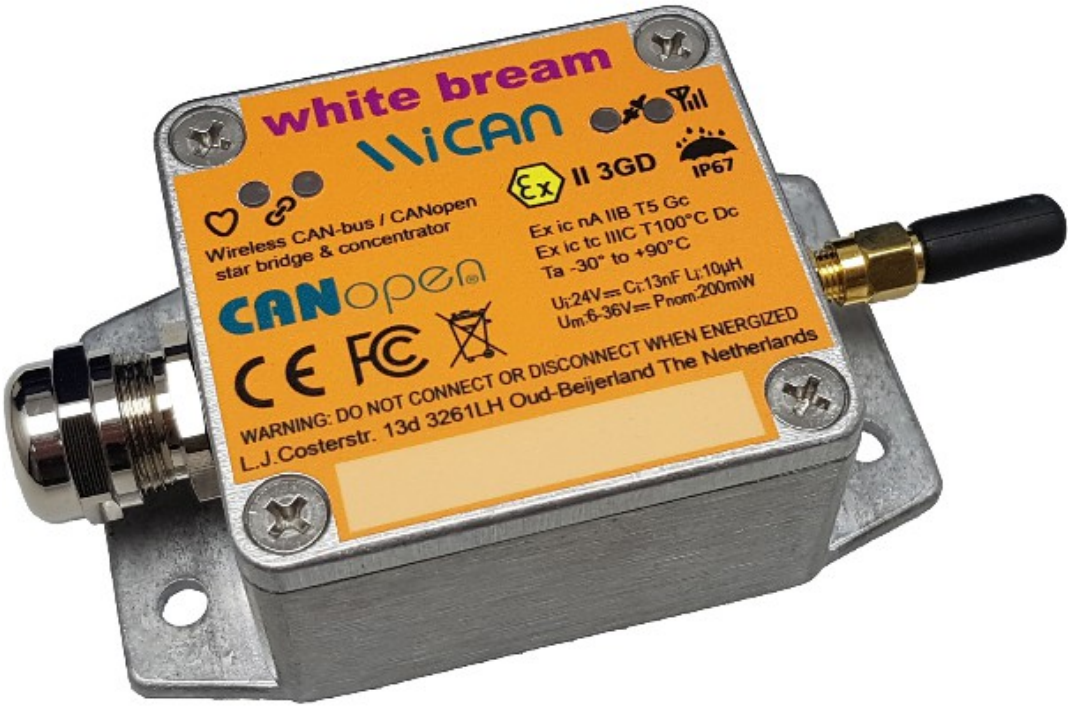
white bream CAN•net

WiCAN

Wireless CAN-bus Bridge & concentrator



White Bream Oud-Beijerland The Netherlands https://whitebream.com			
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1 Preface

1.1 Disclaimer

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1.3 Warranty

This product is warranted to be in good working order for a period of two years from the date of purchase. Should this product fail to be in good working order at any time during this period, we will, at our option, replace or repair it at no additional charge except as set forth in the following terms. This warranty does not apply to products damaged by misuse, modifications, accident or disaster.

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2 Description

The WiCAN bridge & concentrator connects the physical CAN-bus to a proprietary 802.15.4-based 2.4GHz radio network. Such a network can consist of multiple bridges in order to join two or more CAN-bus segments to each other. Additionally these devices function as the concentrator and physical CAN-bus gateway for our WiCAN wireless CANopen-based sensor and measuring devices.

2.1 Functionality

- Wireless bridge for CAN-bus data
- Operates as CANopen® device with device monitoring & configuration and SYNC regeneration
- Transparent for J1939 or other 29-bit CAN applications
- Supports more than 100 nodes in the wireless domain
- Configuration via CANopen or using PC application via (internal) micro-USB port
- Internal button activates radio association; if no 'coordinator' is found, then it becomes the coordinator. Otherwise it pairs with the found coordinator.
- Possibility for branding or custom firmware with specific behaviour

2.2 Specifications

- IEEE 802.15.4 protocol using XBee technology
- Globally approved 2.4GHz ISM band
- Maximum wireless bandwidth ~100kbps
- Distance 60m indoors, up to 1200m outdoors. Longer distances possible using directional antennas.
- Large FIFO buffers allow for buffering of bursts on either side
- Separate priority FIFO helps in preserving timing of messages with ID ≤ 0x100
- CANopen SYNC-message PLL on receiving devices to reduce radio latency jitter effects
- Supports LSS node ID assignment and Fastscan (CiA 305)
- Supports automatic bit-rate detection between 10kbps and 1Mbps (CiA 801)
- Up-to-date EDS file generated by and downloadable from the device
- Supports firmware update via wired or wireless CAN interface, including firmware of the XBee radio module
- Supports power management & monitoring features (CiA 302-9 + custom)
- Bus powered Um 6-36VDC, power <500mW
- 5-pin spring-contact termination for CAN, power and shield
- Ground and shield individually terminated to enclosure/earth via 1nF class Y1 safety capacitors
- Aluminium IP65 enclosure 64x58mm, height 35mm

- Integrated mounting flanges (94mm wide), optionally without flanges
- M16 brass cable gland entries in sides
- Antenna (RP-SMA) connection mounted via isolated M16 gland fitting
- Optional 5-pole industrial M12 plug connection
- External and internal earthing bonding points (connected to enclosure)
- ATEX intrinsic safety 'ic' (IEC 60079-11), increased safety 'nA' (IEC 60079-15), and dust ignition protection 'tc' (IEC 60079-31)

2.3 Wireless link

WiCAN devices use a Digi IEEE 802.15.4 Xbee3 transceiver module for wireless communication. The functionality of those modules is extended with a multicast mechanism to eliminate unreliable broadcasts and a software PLL to regenerate the CANopen SYNC message.

2.3.1 Multicasting

Messages in a CAN network are broadcast by nature. Obviously, the 802.15.4 radio infrastructure also supports broadcast messaging. However, there are distinct differences between wired CAN and a radio network, with the wired network being very reliable and the radio network being very unreliable by nature. Additionally, broadcasts in the 802.15.4 protocol lack an acknowledgement mechanism and have low priority and are therefore subject to (much) greater latencies.

With the WiCAN devices, we eliminated broadcasts for normal messages and replaced them with a proprietary multicast mechanism. All devices on the network keep a list of all other bridge/concentrator devices. All messages are sent to each of the bridges individually.

2.3.2 SYNC Regeneration

CANopen uses a SYNC message to provide a timebase mechanism across the network. Because of wireless latency, timing gets rather sloppy or downright worthless at short SYNC intervals. This is overcome with a SYNC recovery mechanism. This mechanism detects the parameters of a SYNC producer in the network. Then all other devices recreate an identical SYNC signal based on those parameters.
Note that the network may be subject to phase differences between SYNC sources.

2.3.3 Self contained WiCAN devices

The WiCAN sensor devices are self contained. Therefore the wireless CAN interface 'knows' which message ID's it understands and which not. Bridge/concentrator devices in the network also know this and eliminate all messages that are known to be discarded by the recipient.

2.3.4 Transparent CAN (DeviceNet, J1939, NMEA 2000)

In order to use non CANopen communication using 11-bit CAN identifiers, the CANopen function of the network must be disabled.

Messages with 29-bit CAN identifiers always get sent to all bridge devices.

2.3.5 Performance & limitations

Connecting CANopen devices over a wireless link strips some of the reliability and ruggedness features of the CAN bus protocol. Additionally, there are bandwidth limitations that are less easily defined than with a wireline approach. Use of more than 2 bridge devices in a network results in multicast transmissions, which decreases effective bandwidth proportionally to the number of bridges. When the wireline feed bit-rate and message rate exceed the available RF bandwidth, increased message latency may occur and ultimately message loss.

3 Operation

3.1 Indicators

The device features four bi-color LED indicators, all of which are visible on the front panel of the device.

Icon	Function	LED Pattern	Description
♡	Heartbeat / status	Orange or red on Green flashing Orange blinking Orange flickering Red blink x5	Power fail Okay & powered Bootloader mode Firmware verify or install in progress Firmware about to be installed
🔗	CANopen status / activity Note: Red flash and green flash patterns can be shown simultaneously	Red/green flickering Green blinking Green single flash Green triple flash Green blink Red blinking Red single flash Red double flash Red triple flash Red quadruple flash Red on	Auto bit-rate or LSS in progress State PRE-OPERATIONAL State STOPPED Software download in progress CAN-bus data transmitted Invalid configuration CAN errors exceed warning level Guard or heartbeat event SYNC error Receive PDO event timeout CAN-bus off
🔗	Wireless status / activity	Green on Red blink Green 'off' blink	Connected Message ACK error Wireless data received
📶	Signal quality	Orange blink Red flash	<todo>

3.2 Controls

The device has one control button which can be accessed after opening the cover of the enclosure. A 3-second press triggers the association procedure. Initial power-up and factory reset trigger the same operation.

3.2.1 Switching CANopen function

CANopen functionality can be disabled by holding the button for 10 seconds during power-up. A red double flash of the CANopen status LED indicates CANopen

functionality is off. Similarly, a green double flash indicates that the CANopen functionality has been turned back on.

3.3 Association procedure

In search mode, the device tries to find a matching coordinator (default name 'coordinator'). If one is found, then the device switches to bridge mode and associates with that coordinator. If none are found, then the device switches to coordinator mode.

Variable search delays reduce the chance of multiple devices deciding to become the coordinator of the network. After switching mode, the new setting is saved to non-volatile memory to retain the setting between power cycles. When a specific device must become the coordinator, then it must be allowed to perform the association procedure without other powered devices in the vicinity.

3.3.1 Mode 'bridge'

A WiCAN device in bridge mode is a slave device from the wireless network's point of view. It receives multicast address updates from the coordinator. Bridge devices can join and leave the network at will.

3.3.2 Mode 'coordinator'

In coordinator mode, the device has the additional task of maintaining a list of all devices in the wireless network updating the multicast lists on associated devices. The coordinator must be powered for the wireless network to be functional.

4 Specifications

4.1 Electronic

Parameter	Min	Typ	Max	Unit
Nominal input voltage	6	24	36	V
Input voltage surge	-60		60	V
Input current		15		mA
Input current limiter		55		mA
Input fuse		125		mA-FF
Power dissipation		80		mW
Radio				
Frequency		2.4		GHz
Transmit power		8		dBm
Receive sensitivity		-103		dBm
Indoor/urban range		60		m
Outdoor/RF line of sight range		1200		m
CAN-bus				
Common mode voltage	-7		14	V
Fault protection	-36		36	V
Transient protection via 100Ω	-100		100	V
Recessive output voltage		2.3		V
Signaling rate	10		1000	kbps

4.1.1 Entity parameters (IecEx/ATEX)

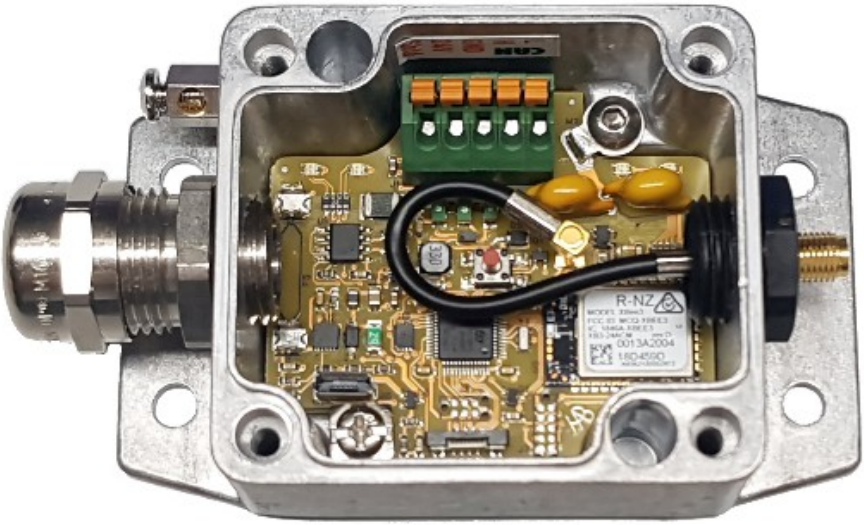
The following parameters are applicable for using the device as intrinsically safe equipment. Note that the allowed input voltage is less than the 'non-ATEX' maximum input voltage!

Parameter	Min	Max	Unit
Input voltage Ui		24	V
Input current Ii		N/A	mA
Input power Pi		N/A	mW
Input inductance Li		<10	µH
Input capacitance Ci		23	nF
Ambient temperature Tamb	-30	+90	°C

Input current (Ii) and input power (Pi) are internally limited by the equipment. Hence these can be ignored during the assessment of intrinsic loop parameters.

4.2 Connections

Here is an overview of the inside of the enclosure. On the top side is the 5-way CAN bus connection. In the middle and on the right are the MMCX antenna connection and the RP-SMA breakout. On the bottom left is the earth inside terminal and the micro-USB connection.



CAN-bus & power connection signals are available on a 5-pin 3.5mm pitch clamp terminal block, located on the inside of the device behind the screw-mounted front panel.

#	Name	Description	Signal
1	SHIELD	Shield	1nF to case
2	+V	Bus power supply	6-36VDC
3	-V	Bus ground	0V, 1nF to case
4	CAN-H	CAN H-signal	
5	CAN-L	CAN L-signal	

4.2.1 Antenna

Internal antenna connection is provided in the form of a MMCX receptable.
In the default configuration of the device, this connects to an RP-SMA socket, which is mounted in a M16 cable gland adaptor. Note that the shield of the antenna is connected to device ground, not to the device enclosure & earth terminals!

4.2.2 Earth connections

The device has two earthing terminals. One terminal on the outside of the enclosure accepts wires up to 6 mm², both solid core and stranded wires with ferrule.
On the inside, another earthing terminal accepts wires up to ~1.5 mm². With this connection, stranded wires must be finished with a ferrule or with a suitable cable lug.

4.2.3 Micro-USB

#	Name	Description	Signal
1	VBUS	USB Power	5V
2	D-	USB Data -	
3	D+	USB Data +	
4	DBG-TX	Serial debug output	LVTTL
5	GND	Ground	0V

USB VBUS is protected by a 125mA-FF fuse. Then it passes a 3.3V LDO regulator and is connected to the main 3.3V VCC system of the bridge device. There is no priority mechanism to determine which power source will be used when both 'main' power input and USB power are connected.

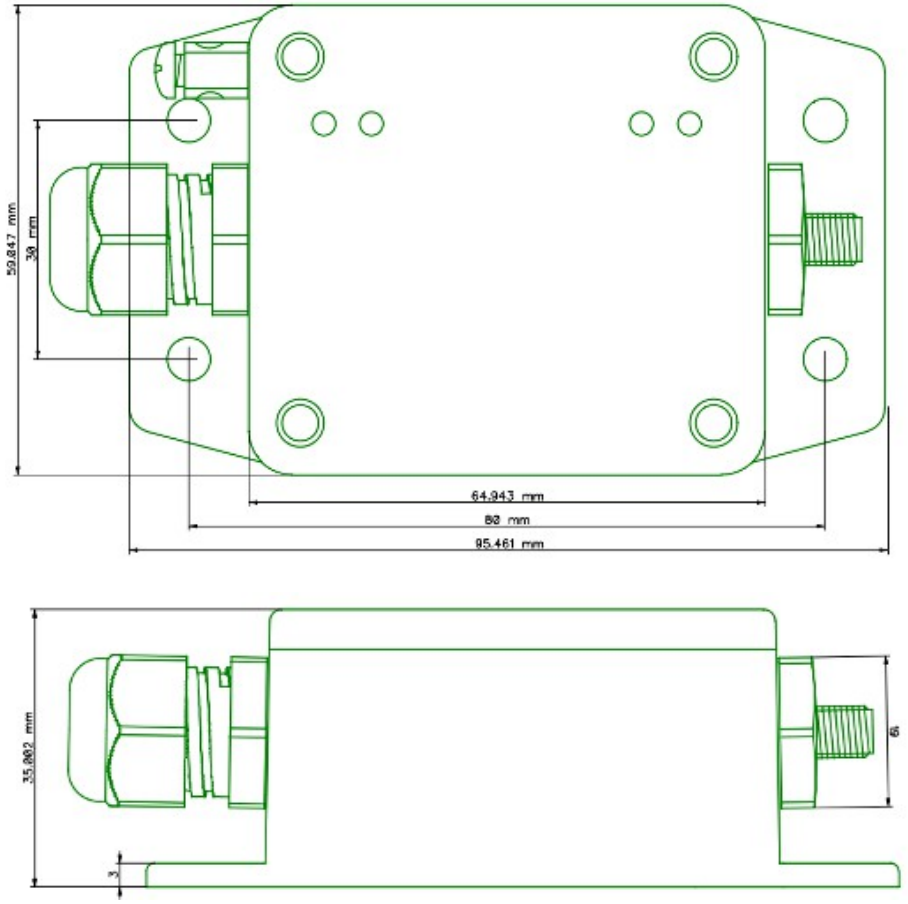
4.2.4 M12 CANopen® pluggable connection (optional)

#	Name	Description	Signal
1	SHIELD	Shield	Not connected
2	+V	Bus power supply	6-36VDC
3	-V	Bus ground	0V
4	CAN-H	CAN H-signal	
5	CAN-L	CAN L-signal	

4.3 Environmental

Parameter	Min	Max	Unit
Operating temperature range	-30	+80	°C
Non-operating temperature range	-40	+120	°C
Humidity	0	100	%RH
Ingress Protection	IP65		
Conformal coating	Type 2		

4.4 Dimensions



5 Installation

Common industry practise shall be observed when installing the device. For example regarding moisture and condensation, and avoiding areas with high risk for impact.

The device does not have a preferred mounting orientation.

The cover plate contains light pipes for the LED indicators. These light pipes protrude to the interior of the enclosure. Make sure that internal wiring is not exerting excessive force on the light pipes.

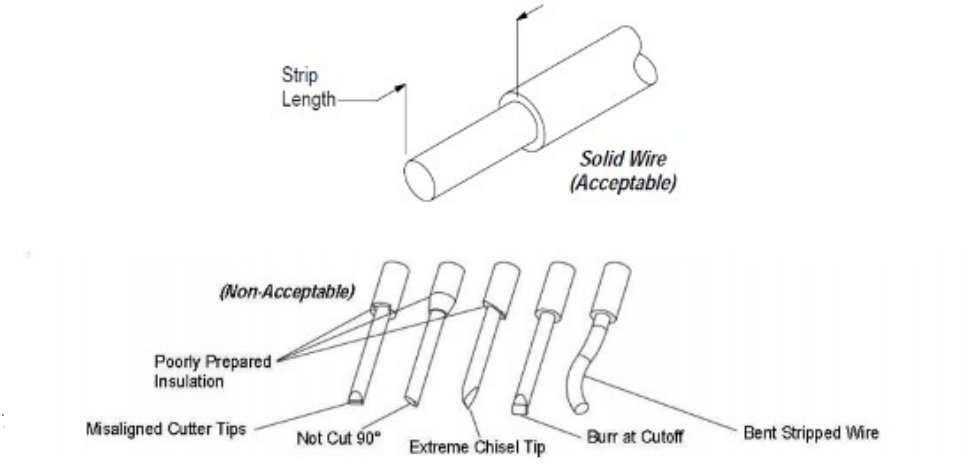
5.1 Mounting torques

Fastener	Torque
Cover screw	1.4 Nm
Earth terminal	2 Nm
Cable gland	7 Nm
Cable gland compression nut	<tbd>
Antenna gland	3.5 Nm
Antenna SMA connector	0.6 Nm

5.2 Terminal instructions

5.2.1 Wire selection and preparation

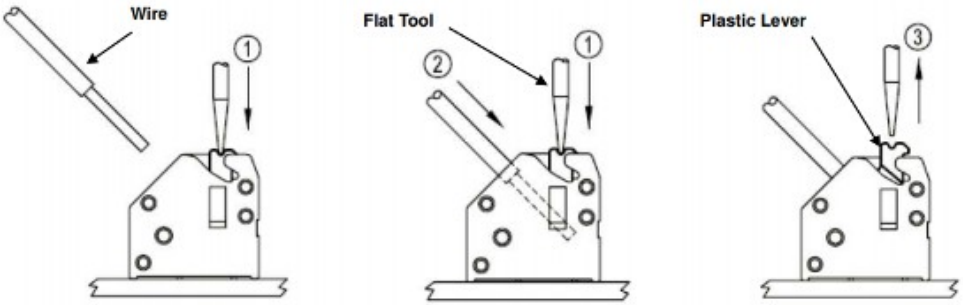
Use wires with outside diameter of less than 2.6mm and with cores within the allowed diameter as given in the specifications; stranded 0.25mm² to 1.0mm² with suitable ferrule or solid 0.5mm² to 2.5mm². Wires must be stripped for 8±0.5mm.



Shielded cables shall be terminated using heat shrink shield-to-wire terminations or an equivalent means of reliably connecting the shield to a terminal connection.

5.2.2 Wire assembly

Push down the lever with a flat tool. Then insert the wire fully so that the insulation is inserted into the hole. Release the lever to fix the wire.



5.3 Cable length and sizes

The maximum bit-rate of the CAN-bus is determined by the length of the trunk and by the length of the stubs towards the individual CAN devices. Depending on communication requirements, it might be necessary to shorten the connection cable of this device to match the signal integrity requirements.

Bit-rate	Trunk length (max)	Spur length (max)	Spur length (total)
1Mbps	25m	1.5m	7.5m
800kbps	not supported		
500kbps	100m	5.5m	27.5m
250kbps	200m	11m	55m
125kbps	400m	22m	110m
100kbps	500m	27m	137m
50kbps	1km	55m	275m
20kbps	2.5km	135m	680m
10kbps	5km	275m	1375m

Please be aware of cable resistance and associated voltage drop. Once the lengths go into three-digit figures, these losses can become quite significant, especially with small conductor sizes!

CiA 303-1 recommends the following wire cross-section:

- 0 to 40m » 0.25mm² to 0.34mm²
- 40m to 300m » 0.34mm² to 0.6mm²
- 300m to 600m » 0.5mm² to 0.6mm²
- 600m to 1km » 0.75mm² to 0.8mm²

5.3.1 CAN-bus Termination

Short trunk lengths up to 40m can be terminated with a resistor of ~124Ω at each end of the trunk. For longer lengths (and therefore lower bit rates), a higher value of termination resistance is more suitable, probably in the range of 150Ω to 300Ω.

5.3.2 IecEx/ATEX FISCO Cable requirements

With intrinsic safe installation conforming to annex I of IEC 60079-25:2010, the following cable limitations must be observed:

- Loop resistance R_C 15Ω/km to 150Ω/km
- Loop inductance L_C 400µH/km to 1mH/km
- Capacitance C_C 45nF/km to 200nF/km
- Maximum length of each spur: 60m
- Maximum length of trunk including all spurs: 5km
- Maximum number of nodes (excluding power source and terminators): 32

5.4 Specific installation requirements for IecEx/ATEX compliance

The equipment is only considered Ex ic equipment if connected to an intrinsic safety (ic) associated apparatus. When connected to a 'normal' power supply or CAN-bus, then the equipment is considered just a regular piece of electronics.

5.4.1 Earthing

Per IEC 60079-0 requirement, installation shall not rely on electrical contact between the enclosure and the mounting surface. Instead, the enclosure shall be earthed using wire (at least 4 mm²) and the outside earthing terminal.

5.4.2 Antenna earth

For installations that rely on level of protection 'ic', it is important to consider earthing of the antenna ground. The device enclosure must be earthed, but the enclosure is isolated from device ground. An 'ic' circuit shall be earthed at one point only, so if the circuit is grounded elsewhere, then the antenna ground must remain isolated to prevent a second earthing point.

5.4.3 Micro-USB

The internal micro-USB connection shall not be used in ATEX applications.

5.5 Maintenance

The device contains four 125mA ultra-fast fuses. One is in the power supply input and one is in each of the two CAN-bus signals. The fourth fuse is in the power signal from the micro-USB connection. These fuses are soldered onto the board and covered by type 2 conformal coating. As such, these are considered non-replaceable.

Note that unauthorized repair typically voids the warranty and certainly voids IecEx/ATEX certification.

6 CANopen interface

CAN is a very reliable and robust fieldbus technology. The protocol is based on messages with up to 8 bytes of data and an 11-bit identifier. Access to the bus is prioritized by identifier by a CAN controller.

A big limitation of classic CAN is that the message size is limited to 8 bytes. That is very limiting for various network activities such as file transfers and firmware updates. This is where CANopen comes into play.

CANopen is a protocol on top of CAN. CANopen provides a standardized method of defining settings and variables in a device and accessing those via so-called service data objects or SDOs. It also allows for configuration of regular CAN messages (i.e. messages without any CANopen protocol overhead). Other protocol features include power management, file transfer for firmware updates, etc.

6.1 CiA Protocols

The device supports the following CANopen profiles and protocols:

6.1.1 CiA 301 – application layer and communication profile

This specification specifies the CANopen application layer. This includes the data types, encoding rules and object dictionary objects as well as the CANopen communication services and protocols. In addition, this specification specifies the CANopen network management services and protocols. This specification specifies the CANopen communication profile, e.g. the physical layer, the predefined communication object identifier connection set, and the content of the Emergency, Timestamp, and Sync communication objects.

6.1.2 CiA 305 – LSS node ID assignment and Fastscan

This specification specifies the layer setting services (LSS) and protocols for CANopen. These services and protocols are used to inquire or to change the settings of three parameters of the physical layer, data link layer, and application layer on a CANopen device with LSS slave capability by a CANopen device with LSS master capability via the CAN network. The following parameters may be inquired or changed: Node-ID of the CANopen device, bit timing parameters of the physical layer (bit-rate), LSS address compliant to the identity object (1018h).

6.1.3 CiA 302-3 – configuration and program download

This specification defines objects and file formats for the configuration manager and for program download and control.

6.1.4 CiA 302-9 – power management & monitoring features

This specification defines additional CANopen services and functionalities, especially those related to dedicated application requirements. This part of the additional application layer function documents specifies the energy saving modes and the related communication parameters for energy saving.

6.1.5 CiA 801 – automatic bit-rate detection between 10kbps and 1Mbps

This technical report describes the recommended practice and gives application hints for implementing automatic bit-rate detection in CANopen devices.

6.2 Service Dictionary Objects

The device provides one SDO server with support for the following SDOs among others. This table only lists those entries that have some practical use. The full list of service objects can be found in the device-specific EDS file.

Index	Subidx	Description	Default
0x1008	0	Manufacturer device name	
0x1009	0	Manufacturer hardware version	
0x100A	0	Manufacturer software version	
0x1800	0-5	Transmit PDO1 communication parameters	
“	1	COB-ID	0x180+$NODE
“	2	Type	0xFF
“	3	Inhibit time	0
“	5	Timer	1000
0x1A00	0	Transmit PDO1 mapping parameters	3
“	~~1~~	~~Analog input, temperature, 2 bytes~~	~~0x7100, 1, 2~~
“	~~2~~	~~Analog input, humidity, 2 bytes~~	~~0x7100, 2, 2~~
“	~~3~~	~~Analog input, VOC, 2 bytes~~	~~0x7100, 3, 2~~
“	~~4-8~~	~~Unused entries~~	~~0, 0, 0~~
0x1F80	0	NMT Startup	2
0x2F90	0	Device input voltage	UINT16
0x2F91	0	Device CPU voltage	UINT16

Index	Subidx	Description	Default
0x2FA1	0	Device CPU temperature	INT16

6.3 Default operation

Out of the box, the device is configured to switch to OPERATIONAL state autonomously. The node-ID is programmed to 1 for a concentrator node and to 2 for a 'slave' node. Their bit-rate is preset to 250kbps. The automatic bit-rate detection kicks in when bus errors occur before any valid messages have been received. After listening for all known bit-rates with no success, it reverts to the preset value and stays there.

- Node-ID preset at 1 for concentrator and 2 for end device
- Bit-rate predefined to 250kbps
- Automatic switch to NMT state OPERATIONAL
- TPDO1 (CAN-ID 0x180+$NODEID) sends RSSI and radio error counter upon change or every minute
- All defaults can be changed using SDO or LSS configuration

6.3.1 TPDO1

Illustrated below is an example of a TPDO1 message that could be received from the device. The CAN-ID assumes that the device has node-ID 1.

This example comes from another device/manual and is to be updated for the WiCAN bridge device.

CAN-ID	DLC	B[0]	B[1]	B[2]	B[3]	B[4]	B[5]	B[6]	B[7]
0x181	6	0x9C	0xFF	0xF4	0x1	0x27	0x10	-	-

~~According to the mapping of parameters of TPDO1, which can be found in SDO 0x1A00, the first two bytes are mapped to subindex 2 of SDO 0x7100, bytes 2 & 3 are mapped to subindex 2 of 0x7100, and bytes 4 & 5 are mapped to subindex 3 of SDO 0x7100.~~

~~Therefore this message tells us that the temperature is 0xFF9C = -100, which represents -1.00°C. Humidity value is 0x1F4 = 500, which represents 50.0%RH. Finally VOC is 0x2710 = 10000, which is the VOC value in ppm.~~

6.4 Interfacing without CANopen

This device is a CANopen device. CANopen is a fairly complex communication protocol that relies on CAN-bus communication. Unfortunately, easy to use implementations are

rather scarce and/or expensive. Luckily, you can get quite far using just raw CAN protocols, especially with relatively non-complex modules such as this device.

6.4.1 Receiving sensor data

The section on default operation lists the default TPDO's for the device. These are sent with CAN-ID relative to the node-ID of the device. Each TPDO contains a selection of device data, which can be processed without any knowledge about CANopen.

6.4.2 Changing configuration

The SDO protocol is used to communicate with the device to alter settings or to read data that is not part of the default TPDO configuration. Luckily, a raw implementation of the expedited SDO upload and download protocol is not too difficult to grasp and implement.

<todo examples of SDO requests>

7 Ordering information

Part no.	Description	Revision
82-951-201	Wireless CAN-bus Bridge & concentrator	A, Jul 6, 2019
82-951-301	Wireless CAN-bus Bridge & concentrator with M12 CANopen male connector	A, Jul 6, 2019

Default configuration comes with brass M16 'Ex' cable gland, MMCX to isolated M16 RP-SMA adapter cable, and a miniature RP-SMA 2.4GHz stub antenna.

7.1 Hardware revision info

Rev	Date	Changes
0	Aug 3, 2018	Prototype
A	Jul 6, 2019	Initial version

8 Document revisions

8.1 Rev 0.1 (July 11, 2019)

Ref	Description
-	Initial version

Annex A: Declaration of Conformity for ATEX & CE

The manufacturer hereby declares that this product is in accordance with the requirements of annex II of the EEC directive 2014/34/EC regarding ATEX, directive 2014/30/EU regarding electromagnetic compatibility (EMC), directive 2014/53/EU regarding radio equipment (RED), directive 2014/35/EU regarding low voltage equipment (LVD), and directive 2011/65/EU regarding RoHS.

Manufacturer, facility:
White Bream
L.J. Costerstraat 13d
3261LH, Oud-Beijerland
The Netherlands

Product: Wireless CAN-bus bridge & concentrator '\\ICAN'

Models: 80-951-201 or 80-951-X01, with X being a number between 3 and 9 – indicating variations of the model with different wiring or connector styles.

ATEX Marking:
II 3G Ex ic nA IIB T5 Gc
II 3D Ex ic tc IIIC T100°C Dc IP65
Tamb -30° to +85°C

Ui: 24V⎓ Um: 7-36V⎓ P: ≤200mW
Ci: ≤1µF Li: ≤12µH

WARNING: DO NOT (DIS)CONNECT WHEN ENERGIZED
WARNING: DO NOT REMOVE OR REPLACE FUSE(S) WHEN ENERGIZED

ATEX Certificate: N/A, conformity verified according annex VIII of directive 2014/34/EC (internal production control). Our IecEx checklists are available on request.

CE & RoHS Marking: CE

continued on next page

This product has been found in conformity with directive 2014/34/EU (ATEX)
by testing and verification with the following standards:

- **EN 60079-0:2018** Explosive atmospheres – Part 0: General requirements
- **EN 60079-11:2011** Explosive atmospheres – Part 11: Equipment protection by intrinsic safety "I"
- **EN 60079-15:2010** Explosive atmospheres – Part 15: Equipment protection by type of protection "n"
- **EN 60079-31:2014** Explosive atmospheres – Part 31: Equipment dust ignition protection by enclosure "t"

This product has been found in conformity with directive 2014/30/EU (EMC)
by testing and verification with the following standards:

- **EN 61000-6-1:2007** Electromagnetic compatibility (EMC) – Part 6-1: Generic standards – Immunity for residential, commercial and light-industrial environments
- **EN 61000-6-3:2007/A1:2011/AC:2012** Electromagnetic compatibility (EMC) – Part 6-3: Generic standards – Emission standard for residential, commercial and light-industrial environments

This product has been found in conformity with directive 2014/53/EU (RED)
by inclusion of pre-certified module complying with the following standards:

- **EN 62311:2008** Assessment of electronic and electrical equipment related to human exposure restrictions for electromagnetic fields (0 Hz - 300 GHz)
- **ETSI EN 301 489-1 V2.1.1 (2017-02)** ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 1: Common technical requirements, in accordance with the specific requirements of:
- **ETSI EN 301 489-17 V3.1.1 (2017-02)** ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 17: Specific conditions for Broadband Data Transmission Systems
- **ETSI EN 300 328 V2.1.1 (2016-11)** Wideband transmission systems; Data transmission equipment operating in the 2,4 GHz ISM band and using wide band modulation techniques
- **ETSI EN 303 417 V1.1.1 (2017-06)** Wireless power transmission systems, using technologies other than radio frequency beam, in the 19 - 21 kHz, 59 - 61 kHz, 79 - 90 kHz, 100 - 300 kHz, 6 765 - 6 795 kHz ranges

This product has been found in conformity with directive 2014/35/EU (LVD)
by testing and verification with the following standards:

- **EN 61010-1:2010/C1:2011** Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 1: General requirements
- **EN 62368-1:2014/A11:2017** Audio/video, information and communication technology equipment - Part 1: Safety requirements
- **EN 62368-3:2017** Audio/video, information and communication technology equipment – Part 3: Safety aspects for DC power transfer through communication cables and ports

This product has been found in conformity with directive 2011/65/EU (RoHS)
by verification with the following standards:

- **EN 50581:2012** Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances

September 24, 2018
Henk Bliek, White Bream, Owner

Annex B: Declaration of Conformity for FCC

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.

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

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

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