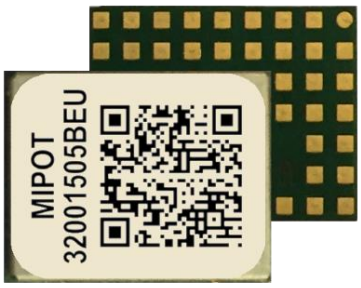
Wireless Protocol Modules MiP Series 32001505xUS Family

Host Based LoRa™ Module

Datasheet



Overview

The 32001505xUS is a family of transceivers operating in the 915 MHz SRD Band optimized for very long range, low power applications, suitable for LPWA networks. Based on LoRa® RF Technology and LoRaWAN™ protocol, it provides ultra-long range spread spectrum communication and high interference immunity.

Thanks to its small LGA form factor (11.3 mm x 8.9 mm) and its low current consumption, this module allows the implementation of highly integrated low power solutions for Internet of Things (IoT) applications, security systems, sensor networks, metering, smart buildings, agriculture, and supply chain management.

The available radio stacks support a wide range of applications as the wM-Bus standard (32001505AUS), or accelerating the development of a LoRaWAN application (32001505BUS) using the LoRa modulation, or performing a local star network using the LoRa Mipot stack (32001505CUS). Using the LoRa Modem stack (32001505DUS), it is easy to create point-to-point applications or build a more complex custom stack. The 32001505FUS contains all the forementioned stacks allowing to switch between them at runtime.

Contents

1. Product Features

Mechanical highlights:

- ✓ Extremely compact dimensions
- ✓ LGA pattern

RF performances:

- ✓ -135 dBm Sensitivity @LoRa®
- ✓ 20 dBm Output Power

Low power characteristics:

- ✓ Sleep current consumption 2.2 µA
- ✓ 11 mA in RX mode

Additional features:

- ✓ LoRaWAN™ specifications 1.0.4
- ✓ Smart serial interface selector (UART, LPUART, SPI, I^2C)

Multiple Stacks available:

- ✓ wM-Bus (32001505AUS)
- ✓ LoRaWAN™ specifications 1.0.4 (32001505BUS)
- ✓ LoRa Mipot (32001505CUS)
- ✓ LoRa Modem (32001505DUS)
- ✓ LoRa Multistack (32001505FUS)

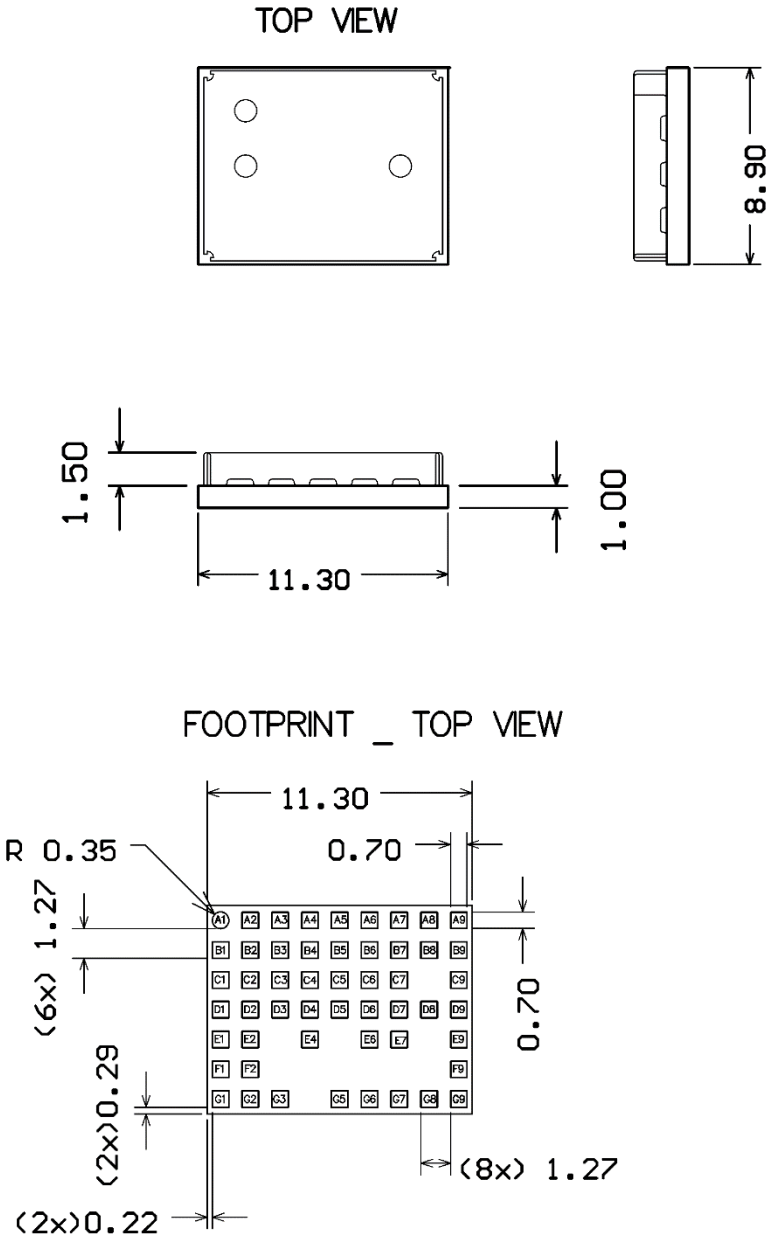
Emission designator:

- ✓ LoRa® DTS: 500KF1D
- ✓ LoRa® FHSS: 125KFXD

Regulatory compliance:

- ✓ USA FCC Rules and Regulations CFR 47, Part 15, Subpart B (10-1-20 Edition)
- ✓ USA FCC Part 15.247 (10-1-20 Edition): Operation within the bands 902 - 928 MHz, 2400 - 2483.5 MHz, and 5725 - 5850 MHz.
- ✓ USA FCC Part 15.209 (10-1-20 Edition): Radiated emission limits; general requirements.
- ✓ USA FCC 47 CFR Part 2.1091 Radiofrequency radiation exposure evaluation: mobile devices.
- ✓ ANSI C63.10-2013: American National Standard for Testing Unlicensed Wireless Devices.
- ✓ CANADA ICES-003 Issue 7 (October 2020)
- ✓ CANADA RSS-247 Issue 2 (February 2017).
- ✓ CANADA RSS-Gen Issue 5 amendment 1 (March 2019).
- ✓ CANADA ISED RSS-102 Issue 5 (2015-03) – Radio Frequency Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)

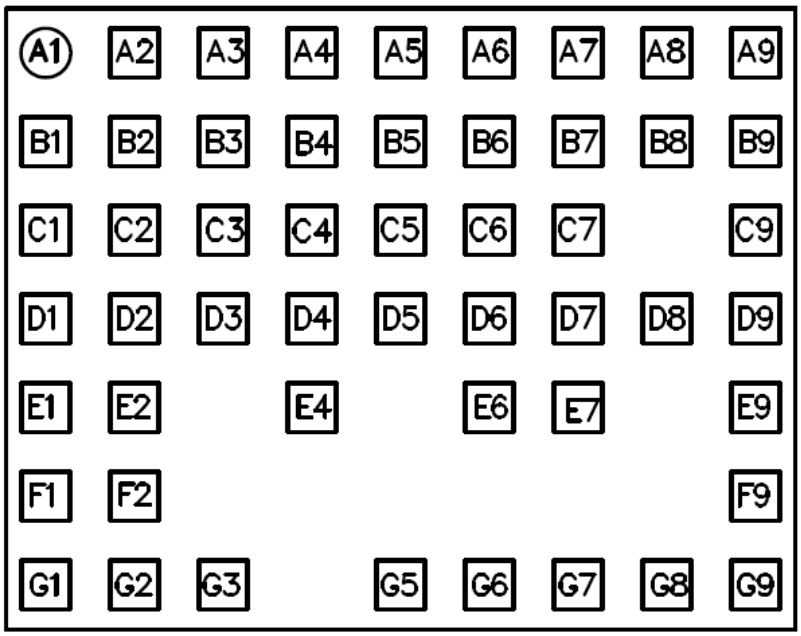
2. Mechanical Dimensions



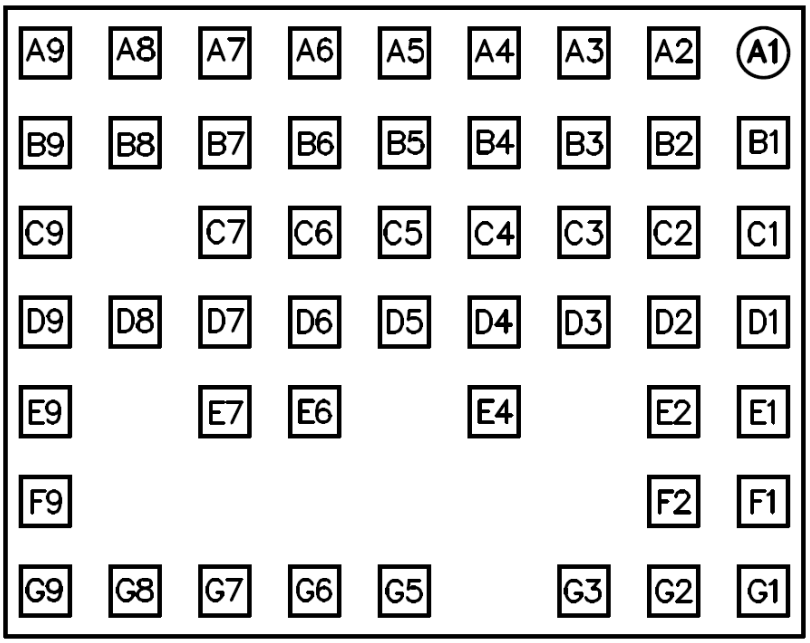
Note: Dimension in mm. General tolerance ±0.1 mm. The tolerance is not cumulative

3. Pin Definition

Top View



Bottom View



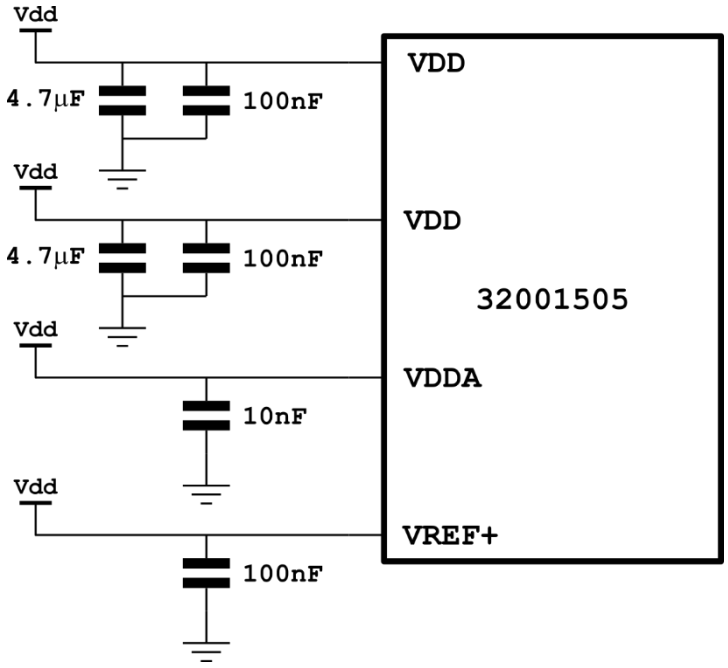
Pad	Name	Type	Pad	Name	Type
A1	SPI1_MISO	I/O	D1	GND	S
A2	SPI1_SCK	I/O	D2	NC	-
A3	SPI1_NSS	I/O	D3	NC	-
A4	LPUART1_TX	I/O	D4	GND	S
A5	LPUART1_RX	I/O	D5	NC	-
A6	SPI1_MOSI	I/O	D6	NC	-
A7	I2C1_SCL	I/O	D7	VBAT	S
A8	I2C1_SDA	I/O	D8	NC	-
A9	VDD	S	D9	SPI2_MISO	I/O
B1	NWAKE	I	E1	GND	S
B2	NDATA_INDICATE	O	E2	GND	S
B3	USART2_TX	I/O	E4	NC	-
B4	USART2_RX	I/O	E6	NC	-
B5	USART1_TX	I/O	E7	NC	-
B6	USART1_RX	I/O	E9	SPI2_MOSI	I/O
B7	NC	-	F1	ANT	RF I/O
B8	VDDA	S	F2	GND	S
B9	VDD	S	F9	SPI2_NSS	I/O
C1	BOOT0	I/O	G1	GND	S
C2	NC	-	G2	GND	S
C3	NC	-	G3	GND	S
C4	GND	S	G5	NRST	I
C5	NC	-	G6	NC	-
C6	NC	-	G7	NC	-
C7	VREF+	S	G8	NC	-
C9	GND	S	G9	SPI2_SCK	I/O

Note: NC means “do not connect”, leave the pin floating.

4. Hardware Integration

4.1. Decoupling capacitors

Each power supply pin must be decoupled with capacitors with the values suggested in the figure.



4.2. Layout guidelines

For better noise rejection, put the decoupling capacitors as close as possible to the power pins of the module, giving precedence to the low value ones.

The trace connecting to the RF pin must have an impedance of 50 Ω. For better performance, connect the GND pads around the RF pin without thermals.

5. Electrical Characteristics

5.1. Absolute Maximum Ratings

Parameter	Max.	Unit
Supply Voltage (VDD)	3.9	V
Radio Frequency Input Level, pin F1	0	dBm
Voltage Standing Wave Radio (VSWR) at RF Input, ANT, pin F1	10:1	
I/O Pin voltage	VDD + 0.3	V
Storage Temperature	-40 ÷ 100	°C
Operating Temperature	-40 ÷ 85	°C

6. Operating Condition

Note: All RF parameters measured with input (pad F1, ANT) connected to a 50-Ω impedance signal source or load.

6.1.1. GENERAL ELECTRICAL CHARACTERISTICS @ 25 °C

Parameter	Min.	Typ.	Max.	Unit	Notes
Supply Voltage (VDD)	2.1	3.0	3.6	V	
VDDA	0	-	3.6	V	
VBAT	1.55	-	3.6	V	
VIN	-0.3	-	VDD + 0.3	V	
Sleep DC Current	-	2.2	3.0	µA	
Data Rate 2-FSK	-	-	48	kbit/s	
Data Rate LoRa®	0.98	-	21.9	kbit/s	

6.1.2. RECEIVER ELECTRICAL CHARACTERISTICS @ 25 °C

Parameter	Min.	Typ.	Max.	Unit	Notes
DC Current Drain	-	-	11	mA	6
Operating Frequency	902.0	-	928.0	MHz	
Channel Frequency Precision	-	±15	-	kHz	
Sensitivity, 2-FSK	-	-115	-	dBm	2,3,5
Sensitivity, LoRa®	-	-135	-	dBm	2,4,5
Spurious radiated level	-	-	-57	dBm	
Output Logic Low	GND	-	0.05	V	
Output Logic High	VDD - 0.2	-	VDD	V	

6.1.3. TRANSMITTER ELECTRICAL CHARACTERISTICS @ 25 °C

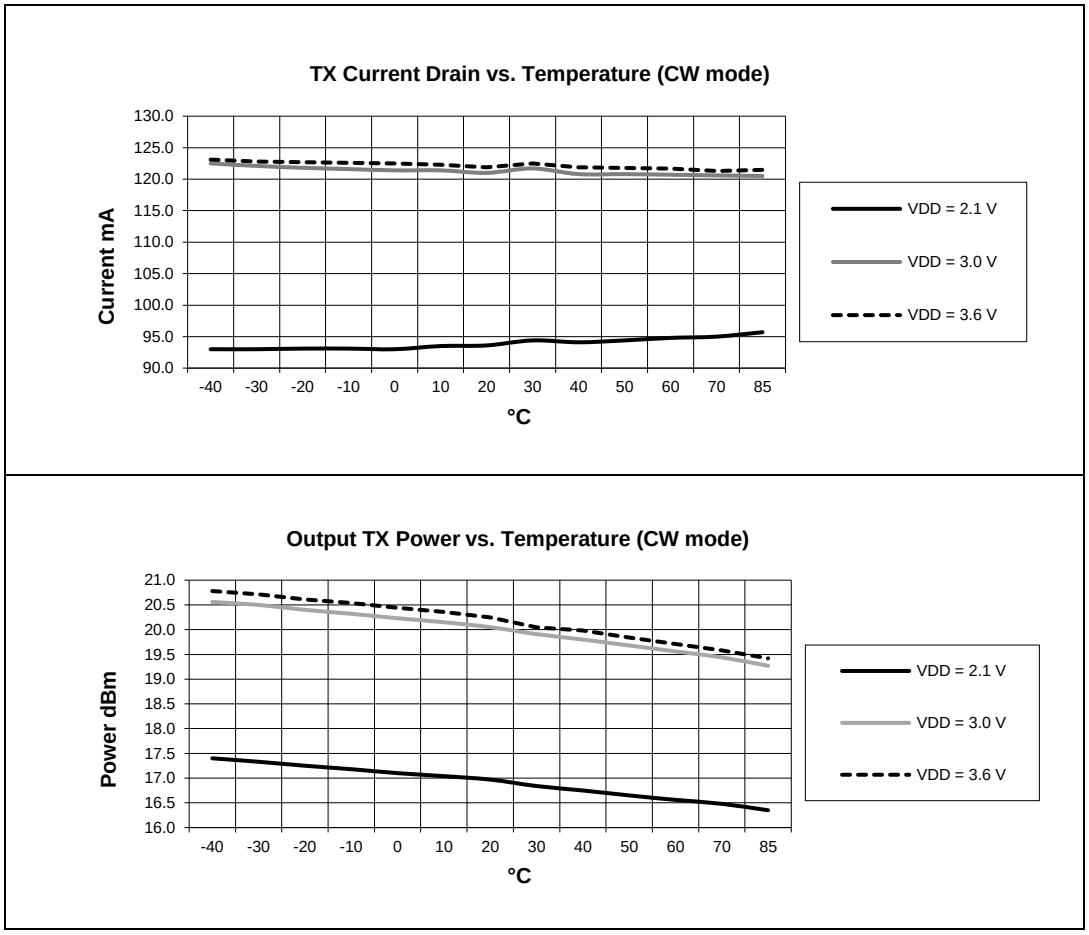
Parameter	Min.	Typ.	Max.	Unit	Notes
Current Drain (CW @20 dBm)	-	138	-	mA	1,2
Operating frequency	902.0	-	928.0	MHz	
Occupied Bandwidth LoRa® DTS	500	-	-	kHz	
Occupied Bandwidth LoRa® FHSS	-	125	-	kHz	8
Operating Channel Width LoRa® DTS	-	600	-	kHz	
Operating Channel Width LoRa® FHSS	-	200	-	kHz	8
Maximum Output power (50 Ω load)	-	20	-	dBm	1,2,7
RF Output Impedance	-	50	-	Ω	
Input Logic Low	GND	-	0.05	V	
Input Logic High	VDD - 0.2	-	VDD	V	

Notes:

1) VDD = 3.6 V.
2) All RF parameters measured with input (pin F1, ANT) connected to 50-Ω impedance signal source or load.
3) Pseudo random code NRZ, 2-FSK BER (bit error rate) = 0.1 % or better, 2-level FSK modulation without pre-filtering, Bit Rate = 4.8 kbit/s, frequency deviation = 5 kHz, filter bandwidth = 20 kHz.
4) LoRa® PER (packet error rate) = 1 %, packet of 64 bytes, preamble of 8 bytes, error correction code CR = 4/5, CRC on payload enabled, no reduced encoding, no implicit header.
5) Sensitivities given using highest LNA gain step.
6) Power consumption measured with -140 dBm signal and AGC ON.
7) In order not to exceed the maximum power permitted by the FCC PART 15 regulation, choose an appropriate antenna system and power supply.
8) Single hop OBW and OCW.

7. Temperature Range Curves

Note: All RF parameters measured with input (pad F1) connected to a 50-Ω impedance signal source or load.



8. Exposure assessment

A conservative evaluation distance of 20 cm has been used to perform the assessment.

The Maximum Gain to meet FCC Radiofrequency radiation exposure limits is:

Technology/Mode	Band	Frequency (MHz)	Distance (cm)	FCC General Population Limit (mW/cm^2)	Maximum Gain to comply with RF Exposure Limits (dBi)
LoRa	ISM (USA)	902 - 928	20	0.60	16.10

9. Antenna details

To perform the assessments the following antenna has been used as reference:

Antenna model	2J0B15 – C885G		
Parameters	868/915 MHz ISM Antenna		
Standards	ZigBee, ISM, SIGFOX, LoRa		
Band (MHz)	868		915
Frequency (MHz)	863 - 870		902 – 928
Return Loss (dB)	~-7.8		-8.0
VSWR	2.4:1		2.4:1
Efficiency (%)	66.1		75.2
Peak Gain (dBi)	2.7		3.3
Average Gain (dB)	-1.8		-1.2
Impedance (Ω)		50	
Polarization		Linear	
Radiation Pattern		Omni-Directional	
Max. Input Power (W)		25	

10. Application Notes

Title	Description	Doc
Command Reference Manual	Description of commands for the wM-Bus stack	32001505AUS_Com_Ref
Command Reference Manual	Description of commands for the LoRaWAN stack	32001505BUS_Com_Ref
Command Reference Manual	Description of commands for the LoRa Mipot stack	32001505CUS_Com_Ref
Command Reference Manual	Description of commands for the LoRa Modem stack	32001505DUS_Com_Ref
Command Reference Manual	Description of commands for the multi-stack module	32001505FUS_Com_Ref
Manufacturing Process Information for LGA MiP Series Modules	Packaging information, Tape& Reel Specification, Reflow soldering information	AN_MNF002

11. Ordering Information

Title	Description	DoC
32001505AUS	MiP-Wm-1C128N-US	United States
32001505BUS	MiP-Lw-1C128N-US	United States
32001505CUS	MiP-LoMi-1C128N-US	United States
32001505DUS	MiP-LoMo-1C128N-US	United States
32001505FUS	MiP-LwMo-1C128N-US	United States

12. Regulatory Approvals

Models: 32001505AUS, 32001505BUS, 32001505CUS, 32001505DUS, 32001505FUS

U.S.

FCC ID: 2AQJP-MIP

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.

CANADA

IC: 28566-MIP

HVIN: 32M01514A

PMN:	32001505AUS, 32001505BUS, 32001505CUS, 32001505DUS, 32001505FUS	HVIN:	32M01514A
HMN:	-	FVIN:	-

Doc	Title	Description
DoI	32001505xUS_DoI	Declaration of Identity

13. Revision History

Revision	Date	Description
0.0	18.01.2021	Draft
0.9	28.02.2021	Preliminary
0.10	28.04.2021	- Pin C4 is GND, Pin C3 is TIM2_CH2 - Added pin D4 (GND) - Bottom view of the pinout - Added TX OBW and TX OCW
0.11	08.09.2021	- Corrected “power down current” to “sleep current” in Product Features - V_{DD} min set to 2.1 V
1.0	11.11.2021	- Corrected temperature curves parameter according to V_{DD} min. - Added Top view
1.1	21.12.2021	Corrected OBW and OCW, Corrected bit rate
1.2	01.02.2022	Template change
1.3	28.09.2022	Change to family datasheet
1.4	23.11.2022	Added 32001505AUS module references
1.5	25.10.2023	Added regulatory approvals labels, exposure assessment and antenna details

Annex: Labeling requirement for the host device

The device shall be properly labeled to identify the module within the host device.

The certification labels of the module shall be clearly visible at all times when installed in the host device, otherwise the host device must be labeled to display the FCC ID and IC of the module, preceded by the words "Contains transmitter module", or the word "Contains", or similar wording expressing the same meaning, as follows:

Contains FCC ID: 2AQJP-MIP

Contains IC: 28566-MIP

This module is only authorized for the rules listed in Supported FCC/ISED rules. The host device manufacturer is responsible for compliance to any other FCC rules that apply to the host device not covered by this module grant of certification. It is mandatory for the host device manufacturer to assure the final device's compliance with FCC Part 15 Subpart B even if certification has been granted to this module.

This module can only be used when installed in a host device that follows the required instructions.

The module grantee shall provide a notice that any deviation(s) from the defined parameters of the antenna trace, as described by the instructions, require that the host product manufacturer must notify the module grantee that they wish to change the antenna trace design. In this case, a Class II permissive change application is required to be filed by the grantee, or the host manufacturer can take responsibility through the change in FCC ID (new application) procedure followed by a Class II permissive change application.