CNX200M IP500® Module

- Low Power Wireless Networking Dual-Band Module -

DATASHEET

The CNX200M is a dual-band module that supports simultaneous communication in the sub-GHz and 2.4GHz frequency bands.

The module complies with the IEE802.15.4 standards and also offers O-QPSK modulation in the European, American and Japanese bands, up to the worldwide ISM bands.

CNX200M is designed to address the challenging demands of the IP500® standard for secured and fail-safe communication.

Dedicated CNX200M solutions can also support the EN54-25 and VdS requirements for fire and safety.

Key Features:

- Realizes simultaneous Dual-Band Operation with help of an internal microchip (Atmel RF transceiver AT86RF215)
- Internal microchip (Atmel Cortex-M4) with Pico Power Technology ATSAM4L8C is used
- On Board AES 128-Bit Encryption Accelerator
- Data transfer speed for sub-GHz 100 kb/s for EU and Japan, 250 kb/s USA and India.
- Data transfer speed for 2.4 GHz 250 kb/s.
- Various Integration Options: Serial (UART), GPIO, analog to digital converter
- Conform to IEEE 802.15.4-2006
- Compact Dimensions: 15.0 mm x 40.0 mm

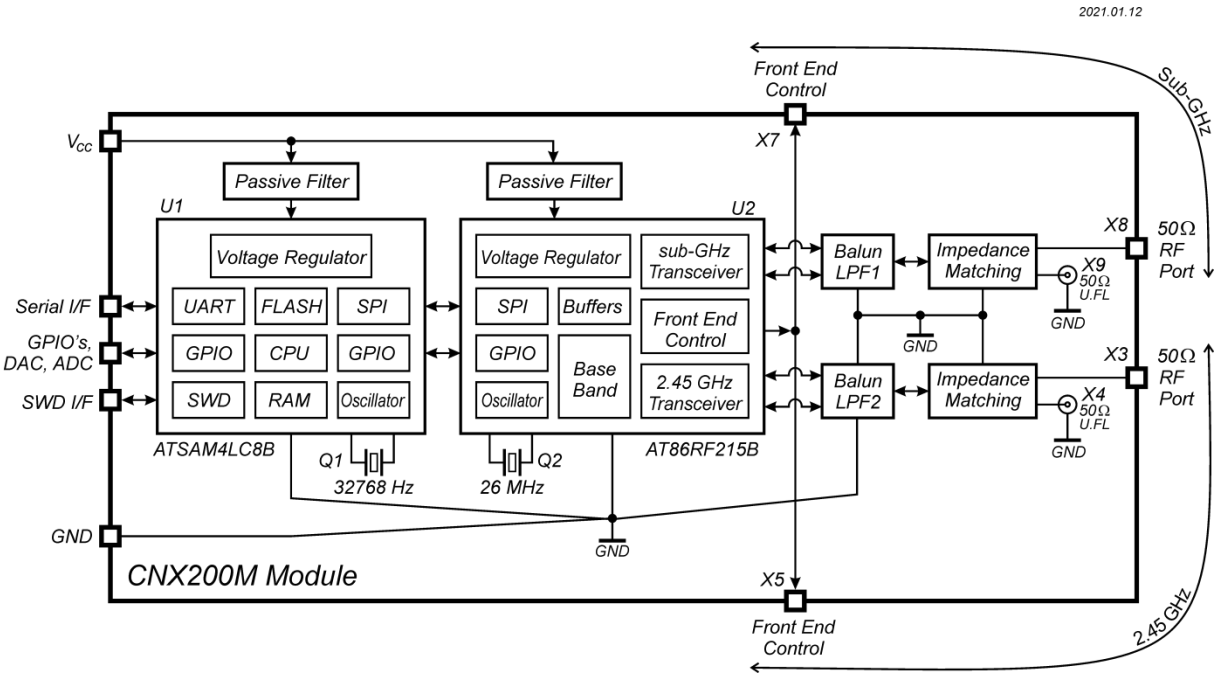

Figure 1: CNX200M Block Diagram

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Revision	Date	Author	Description
0.1	30.06.2017	EAL	Initial
0.12	05.07.2017	Zla	Minor changes
0.13	24.08.2017	EAL, Zla	Modification after external document review; detailed listing of all possible frequency band options
0.14	17.08.2018	Aob	Pin and Data rate modifications
0.15	23.08.2018	Aob	Addition of Regional Setting characteristics
0.16	24.08.2018	Aob	Re-addition of modulation table
0.18	30.08.2018	Aob	Pin Assignment edit
0.19	17.10.2019	Aob	Update of Antenna table
0.20	29.10.2019	Aob	Addition of storage table & pins for programming
0.21	01.11.2019	Aob, Zla	Minor editorial changes
0.22	12.01.2021	USt	Max. current, text change in 'Notes' to Pin Assignment, Pin Assignment on page 13, 14 is according to new firmware; List of Tables, List of Figures added
0.23	12.01.2021	USt	Minor editorial changes, Block Diagram better resolution

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1. CNX200M IP500® Module

This document gives the reader a technical overview of the module. It should give you also an understanding of the wide integration possibilities of the module and a user-specific application, so that your application can act as an end node in an IP500® network.

For further information which are not handled here or in our other documentation papers, we can be contacted at: info@corenetix.com . The CNX Development Kit for getting started and PCB layout files can be provided on request.

2. Specifications

The following mentioned Absolute Maximum Ratings are the values beyond which damage to the device may occur. Under no circumstances must the absolute maximum ratings given in this table be violated. Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device.

Functional operation of the device at these or other conditions, beyond those indicated in the operational sections of this specification, is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Attention! CNX200M is an ESD-sensitive device. Precaution should be taken when handling the device in order to prevent permanent damage.

2.1. Electrical Characteristics

General Characteristics						
Symbol	**Parameter**	**Condition**	**Min**	**Typ**	**Max**	**Unit**
T_{oper}	Operating Temperature		-40		+85	°C
V_{cc}	Supply Voltage		2.7		3.6	V
I_{max}	Current max at Vcc			120		mA
I_{deep_sleep}	Deep sleep current of CNX200M	All functions off, states in memory, Wake-Up ready for trigger		<4		µA
$I_{AVG,RUN}$	MCU average runtime current of CNX200M	Benchmark: Firmware CNX200 @ 48MHz			40	mA
V_{ESD}	Electro-Static Discharge Robustness	Human Body Model	4			kV
		Charged Device Model	550			V

Table 1 – General Characteristics

GPIO Characteristics						
Symbol	**Parameter**	**Condition**	**Min**	**Typ**	**Max**	**Unit**
RPULLUP	Pull-up resistance	DIO Pin		40		kΩ
RPULLDOWN	Pull-down resistance	DIO Pin		40		kΩ
VIL	Input low-level voltage	DIO Pin	-0.3		0.2 * VCC	V
VIH	Input high-level voltage	DIO Pin	0.8 * VCC		VCC +0.3	V
VOL	Output low-level voltage	DIO Pin			0.4	V
VOH	Output high-level voltage	DIO Pin	VCC - 0.4			V
I_{OL}	Output low-level current	DIO Pin, 1.68V<VCC<2.7V, (2.7V<VCC<3.6V)			1.6 (3.2)	mA
I_{OH}	Output high-level current	DIO Pin, 1.68V<VCC<2.7V, (2.7V<VCC<3.6V)			1.6 (3.2)	mA
ILEAK	Input leakage current	DIO Pin		0.01	1	uA
CIN	Input capacitance	DIO Pin		5		pF

Table 2 – GPIO Characteristics

ADC Characteristics						
Symbol	**Parameter**	**Condition**	**Min**	**Typ**	**Max**	**Unit**
VDDANA	Supply voltage		1.6		3.6	V
ADCRES	Resolution			12	12	Bit
ADC_REF	Reference Voltage	Differential mode	1.0		VDDANA – 0.6	V
		Unipolar and Window modes	1.0		1.0	V
		Using divide by two function (differential)	2.0		VDDANA	V
ADCININTV	Absolute min, max input voltage		-0.1		VDDANA + 0.1	V
RSAMPLE	Input channel source resistance				0.5	kΩ
CSAMPLE	Sampling capacitance		2.9	3.6	4.3	pF

Table 3 – ADC Characteristics

The integrated radio transceiver can cover the frequency bands: Band1 = [860.0; 930.0] MHz and Band2 = [2400.0; 2483.5] MHz. The following table will show some RF characteristics. See p.2.2 for regional setting and limits.

RF Characteristics Band1 (sub-GHz)						
Symbol	**Parameter**	**Condition**	**Min**	**Typ**	**Max**	**Unit**
TX_{pwr}	Transmit power		-12		+14	dBm
RX_{sens}	Receiver sensitivity	PER=1%, O-QPSK 100kbps		-107		dBm
DataRate	Data Rate		100		250	Kbps
Z_{Port}	RF port impedance			50		Ω
I_{Tx}	Transmit current	Transmit continuously at V_{cc} = 3 V, P_{out} = +14 dBm		78 + $I_{AVG,RUN}$		mA
I_{Rx}	RX current	Continuous receive		41 + $I_{AVG,RUN}$		mA

Table 4 – RF Characteristics (Band1)

RF Characteristics Band2 (2.4GHz)						
Symbol	**Parameter**	**Condition**	**Min**	**Typ**	**Max**	**Unit**
TX_{pwr}	Transmit power		-14		+14	dBm
RX_{sens}	Receiver sensitivity	PER=1%, O-QPSK 250kbps		-103		dBm
DataRate	Data Rate			250		Kbps
Z_{Port}	RF port impedance			50		Ω
I_{Tx}	Transmit current	Transmit continuously at V_{cc} = 3 V, P_{out} = +14 dBm		78 + $I_{AVG,RUN}$		mA
I_{Rx}	RX current	Continuous receive		41 + $I_{AVG,RUN}$		mA

Table 5 – RF Characteristics (Band2)

The following section describes the quality of modulation and the Error Vector Magnitude (EVM).

The **Table 6** below shows the typical O-QPSK offset Error Vector Magnitude (EVM) values according to IEEE Std. 802.15.4g™-2012: IEEE Standard for Local and metropolitan area networks--Part 15.4: Low-Rate Wireless Personal Area Networks (LR-WPANs) Amendment 3: Physical Layer (PHY) Specifications for Low-Data-Rate, Wireless, Smart Metering Utility Networks.

Modulation, Data Rate	**I/Q Offset EVM**			
	900MHz Band		**2.45 GHz Band**	
	P_RF = 0 dBm	P_RF_{max} = +14.5 dBm	P_RF = 0 dBm	P_RF_{max} = +14.0 dBm
	[%]	[%]	[%]	[%]
O-QPSK, 100kbps	4	2	3	2

Table 6 - RF Characteristic – Error Vector Magnitude[1]

[1] Test Conditions: AT86RF215 v.3, Nominal Power Supply Voltage Vcc = 3.0 V, Frequency channel (sub-GHz band) = 902 MHz, Modulation: O-QPSK, Nominal Data Rate: 100 kbps. Frequency channel (2.4GHz band) = 2445 MHz, Modulation: O-QPSK, Nominal Data Rate: 250 kbps.

2.2. Regional Settings Characteristics

The **Table 7** below outlines the specifications of the CNX200M module in each region according to each frequency band. It shows the RF characteristics classified by the RF restrictions in the different countries.

Pos.	Data Rate	Chip Rate	Channel Centre Frequency	Nominal RF Power for Tx	AT Command (AT+RG)	Country
	[kbit/s]	[kchip/s]	[MHz]	[dBm]	[text]	[text]
sub-GHz Band						
0	250	2000	868.3	+14	AT+RG=0	-
1	100	200	868.3	+8	AT+RG=1	EU
2	250	1000	866	+10	AT+RG=2	India
3	100	200	924.2	+10	AT+RG=3	Japan
4	250	1000	914	+10	AT+RG=4	USA
World-wide accepted 2.45 GHz ISM Band						
0	250	2000	2460	+14	N.A	-
1-4	250	2000	2460	+10	N.A	World-wide

Table 7 – CNX200M Geographical Region (Country) Allocation Scheme

NOTE:

- This list can be extended on demand.
- '0' is the default regional setting and it is used for testing purposes.
- Using the AT command to set to a regional value not described in the table above (i.e. value from 0 to 4) sets the device to the same values as with '0'.

2.3. Storage

Storage	Parameter	Condition	Min.	Max.	Unit
Maximum allowed ranges	Temperature		-40	+85	°C
	Relative Humidity	Non condensing		≤ 85	%
Recommended (1 year)	Temperature		+15	+30	°C
	Relative Humidity		30	60	%

Table 8 - CNX200M Storage Details

2.4. Mechanical Drawings

The key dimensions for the CNX200M module are: 40.0 mm x 15.0 mm x 3.7 mm and are depicted in details in the following technical drawing. All dimensions in mm.
The mass of the CNX200M module equals 4.2 g.

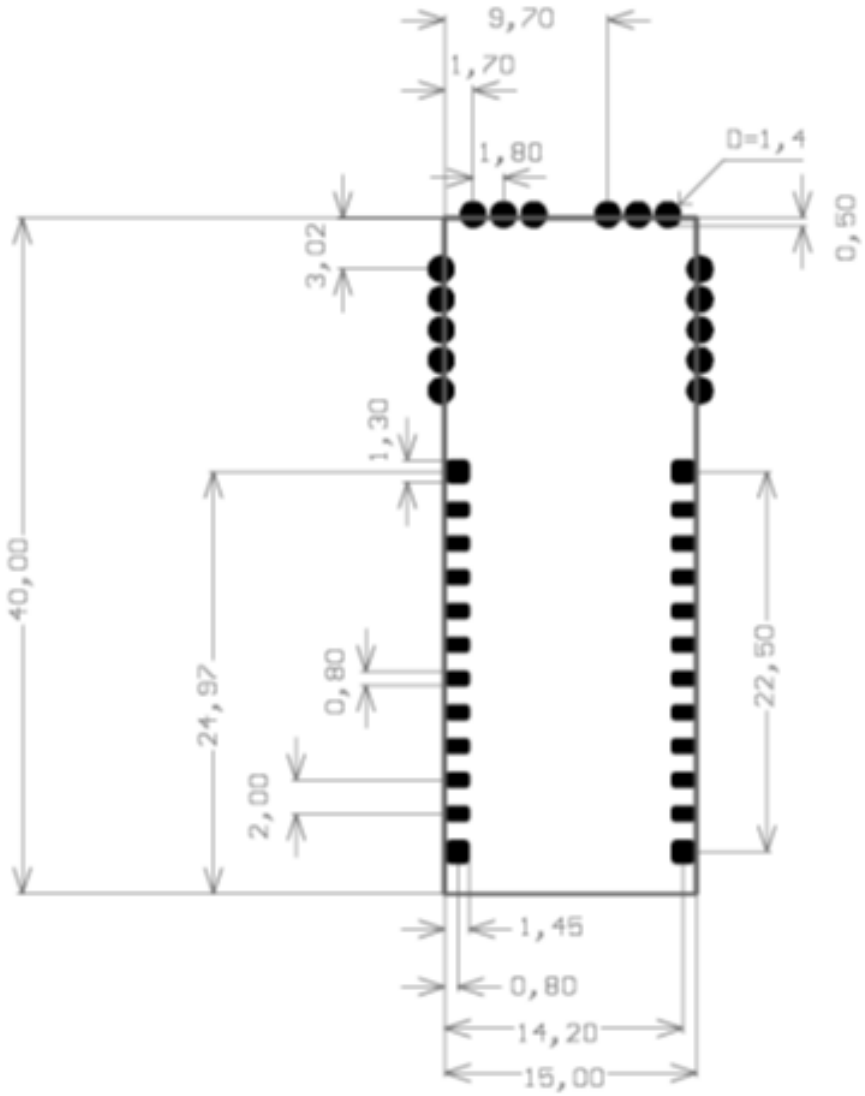

Figure 2 – CNX200M Module, Key Dimensions

2.5. Pin Assignment

The following list shows the pin list and pin assignment for the CNX200M module.

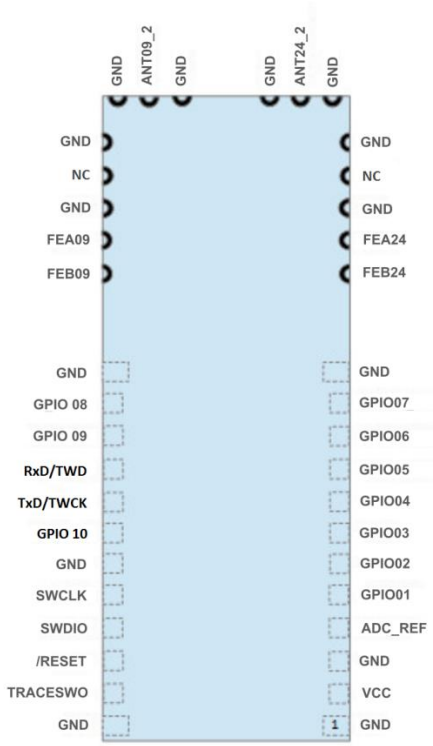

Figure 3 - Pin Assignment

PIN	Symbol	Dir[2]	Description
01	GND		Ground
02	VCC	-	Power Supply
03	GND	-	Ground
04	ADC_REF	AI	ADC Reference Voltage
05	GPIO01	DIO, AI	Digital I/O or Analog Input
06	GPIO02	DIO, AI	Digital I/O or Analog Input
07	GPIO03	DIO, AI	Digital I/O or Analog Input
08	GPIO04	DIO	Digital I/O
09	GPIO05	DIO	Digital I/O
10	GPIO06	DIO	Digital I/O
11	GPIO07	DIO	Digital I/O
12	GND	-	Ground

[2] DIO Digital Input/ Output, DI Digital Input, DO Digital Output AI Analogue Input, AO Analogue Output

13	FEB24		RF front end control output
14	FEA24		RF front end control output
15	RF_GND	-	RF Ground 2.45GHz
16	NC		not connected
17	RF_GND	-	RF Ground 2.45GHz
18	RF_GND	-	RF Ground 2.45GHz
19	ANT24_2		2.45GHZ RF port
20	RF_GND	-	RF Ground 2.45GHz
21	RF_GND	-	RF Ground 2.45GHz
22	ANT09_2		sub-GHz RF port
23	RF_GND	-	RF Ground sub-GHz
24	RF_GND	-	RF Ground sub-GHz
25	NC		not connected
26	RF_GND	-	RF Ground sub-GHz
27	FEA09		RF front end control output
28	FEB09		RF front end control output
29	GND	-	Ground
30	GPIO08	DIO	Digital I/O
31	GPIO09	DIO	Digital I/O
32	RxD/TWD	DI	Serial Interface Input Pin (UART)
33	TxD/TWCK	DO	Serial Interface Output Pin (UART)
34	GPIO10	DIO	Digital I/O
35	GND	-	Ground
36	SWCLK	DI	Module Programming Interface (manufacturer use only!)
37	SWDIO	DIO	Module Programming Interface (manufacturer use only!)
38	/RESET	DI	Module Programming Interface (manufacturer use only!)
39	TRACESWO	DO	Module Programming Interface (manufacturer use only!)
40	GND	-	Ground

Table 9 - Pin Assignment List

NOTES:

1. The previous version of the CNX200 module (v1.0) had the following differences:
    - The pins RxD/TWD and GPIO10 were switched. Thus, GPIO10 was pin number 32 and RxD/TWD was pin number 34.
    - Also, at pin 16 was ANT24_1 and at pin 25 was ANT09_1. Both pins were also not connected.
2. Pins for programming the module:
    - To program the module with an external programmer, use pins 35 to 40.
    - To control the module via its serial interface for AT-commands, use pins: 29, 32, 33 and 35.
    - For programming via SAM-BA, use pins: 33 to 35.

Appendix

A. Recommended Antennas for use with the CNX200M Module

The CNX200M module has two U.FL antenna connectors. The connector, at X8/X9 of (see block diagram at the front page of this document) serves to attach the sub-GHz antenna. The 2.4 GHz antenna is attached to the connector at X3/ X4, which is schematically depicted in the module block diagram of (see block diagram at the front page of this document).

Subject No.	Postition on "List of Items"	Type of Device	Connector Type	Operating Frequency Range		Cable Loss	Antenna Gain		Provided Radiation Characteristic	Manufacture	Part Number
				Min	Max	@ 915 MHz	Gain	at frequency			
				[MHz]	[MHz]	[dB]	[dBi]	[MHz]			
1	Pos_26	Coaxial Cable	SMA(f) - U.FL(f)	DC (0 Hz)	6000	0,7	Not Applicable		Not Applicable	Taoglas	CAB.718
2	Pos_27		SMA(f) - U.FL(f)	DC (0 Hz)	6000	0,4				Taoglas	CAB.719
3	Pos_28		SMA(f) - U.FL(f)	DC (0 Hz)	6000	0,7				Taoglas	CAB.720
4	Pos_29		SMA(f) - U.FL(f)	DC (0 Hz)	6000	0,4				Taoglas	CAB.721
5	Pos_30	Short Dipole Antennae with SMA	SMA(m)	900	940	Not Specified	2	Operating Band	None	Joymax Electronics Co., Ltd.	GAF-121XSAXX
6	Pos_31		SMA(m)	890	960	Not Applicable	0	Operating Band	None	Joymax Electronics Co., Ltd.	GHX-321XSAXX
7	Pos_32		SMA(m)	890	960		0	Operating Band	None	Joymax Electronics Co., Ltd.	GWX-152XSAXX
8	Pos_33	SMD Antenna	N.A	885	945		-0,2	915	Horiz. and Vert.	Mitsubishi Materials	AM11DG-ST01 / 915 MHz
9	Pos_34										
10	Pos_35	Antennae with U.FL Cable	U.FL(f)	Only Center Spefified: 915		Not Specified	3	915	None	Anaren Integrated Radio	66089-0906
11	Pos_36		U.FL(f)	750	950	Not Specified	1,6	Operating Band	None	Linx Technologies	ANT-868-PW-QW-UFL
12	Pos_37		U.FL(f)	865	965	Not Specified	1,8	Operating Band	None	Linx Technologies	ANT-916-PW-QW-UFL
~~13~~	~~Pos_08~~		~~U.FL(f)~~	~~850~~	~~920~~	~~Not Specified~~	~~2~~	~~Operating Band~~	~~Horiz. and Vert.~~	~~Chang Hong Information Co., Lt~~	~~DA-8T91-01-1~~
14	Pos_38		U.FL(f)	902	928	Not Specified	1,5	915	3D, YZ, XY,XZ	Taoglas	FXP290.07.0100A
15	Pos_39		U.FL(f)	824	960	0,47	2	Operating Band	None	Joymax Electronics Co., Ltd.	GBF-A038MPXX
16	Pos_40		U.FL(f)	902	928	Not Specified	2,67	910	Horiz. and Vert.	Taoglas	PC91.07.0100A.db
17	Pos_41		U.FL(f)	900	930	Not Specified	-1,8	920	YZ, XY,XZ	Mitsubishi Materials	UB14CP-100ST01
18	Pos_42		U.FL(f)	824 MHz ... 894 MHz, 880 MHz ... 960 MHz,		Not Specified	2,3	824 MHz .. 960 MHz	None	Molex	1052630001
19	Pos_43		U.FL(f)	1710 MHz ... 1880 MHz, 1850 MHz ... 1990			3,1	1710 ... 2690 MHz			1052630002
20	Pos_44		U.FL(f)	MHz, 1920 MHz ... 2170 MHz, 2500 MHZ ...							1052630003
21	Pos_45		U.FL(f)	824 MHz ... 960 MHz,		Not Specified	1,6	824 MHz .. 960 MHz	YZ, XY,XZ	Molex	1461850050
22	Pos_46		U.FL(f)	1710 MHz ... 2700 MHz,			3,4	1710 MHz ... 2700 MHz			
23	Pos_47		U.FL(f)	3 GHZ ... 6 GHz			4,2	3 GHz ... 6 GHz			
24	Pos_48		U.FL(f)	2350	2600	Not Specified	1,6	Operating Band	None	Linx Technologies	ANT-2.4-PW-QW

Figure 4 – *Recommended Antennas*

Subject No.	Type of Device	Manufacturer	Part Number	Link to datasheet	Notes
1	Coaxial Cable	Taoglas	CAB.718	Cable No.1	L = 200 mm x 1.13 mm dia
2		Taoglas	CAB.719	Cable No.2	L = 100 mm x 1.13 mm dia
3		Taoglas	CAB.720	Cable No.3	L = 200 mm x 1.32 mm dia
4		Taoglas	CAB.721	Cable No.4	L = 100 mm x 1.32 mm dia
5	Short Dipole Antennae with SMA Cable	Joymax Electronics Co. Ltd	GAF-121XSAXX	SMA Antennae No.1	Mini-Magnetic, 80 mm height, with cable
6		Joymax Electronics Co. Ltd	GHX-321XSAXX	SMA Antennae No.2	Short Dipole, 53 mm
7		Joymax Electronics Co. Ltd	GWX-152XSAXX	SMA Antennae No.3	Swivel Dipole, 148 mm
8	SMD Antennae	Mitsubishi Materials	AM11DG-ST01/915 MHz	SMD Antennae No.4	Datasheet, Implementation shown on Page 9
9				SMD Antennae No.4	Application Note
10	Antennae with U.FL Cable	Anaren Integrated Radio	66089-0906	UFL Antennae No.5	Band ID = 09, Antenna element = 82 mm
11		Linx Technologies	ANT-868-PW-QW-UFL	UFL Antennae No.7	¼-wave whip, with cable
12		Linx Technologies	ANT-916-PW-QW-UFL	UFL Antennae No.8	¼-wave whip, with cable
14		Taoglas	FXP290.07.0100A	UFL Antennae No.10	PCB: 75 mm x 45 mm x 0.1 mm, with cable

15		Joymax Electronics Co. Ltd	GBF-A038MPXX	UFL Antennae No.11	PCB: 56 mm x 7.5 mm x 5 mm, with cable
16		Taoglas	PC91.07.0100A.db	UFL Antennae No.13	PCB 34 mm x 7 mm x 0.8 mm with foam and cable
17		Mitsubishi Materials	UB14CP-100ST01	UFL Antennae No.14	PCB: 50 mm x 10 mm x 3.5 mm with cable and Mitsubishi AM11DG-ST01
18		Molex	1052630001	U.FL Antennae No.15	6 Band Stand Alone Antenna. PCB: 106.7 mm x 13 mm. General Info
19			1052630002	U.FL Antennae No.15	6 Band Stand Alone Antenna. PCB: 106.7 mm x 13 mm. Datasheet
20			1052630003	U.FL Antennae No.15	6 Band Stand Alone Antenna. PCB: 106.7 mm x 13 mm. Application Note
21		Molex	1461850050	U.FL Antennae No.16	3 Band Combo Flex Antenna. Flex, 84 mm x 15 mm. General Info
22				U.FL Antennae No.16	3 Band Combo Flex Antenna. Flex, 84 mm x 15 mm. Datasheet
23				U.FL Antennae No.16	3 Band Combo Flex Antenna. Flex, 84 mm x 15 mm. Application Note
24		Linx Technologies	ANT-2.4-PW-QW	U.FL Antennae No.17	½-wave whip, with cable

Table 10 - Recommended Antennas with links to datasheets

B. Soldering Profile

The next plot below (Figure 5) shows the soldering profile for the CNX200M module in a reflow soldering process.

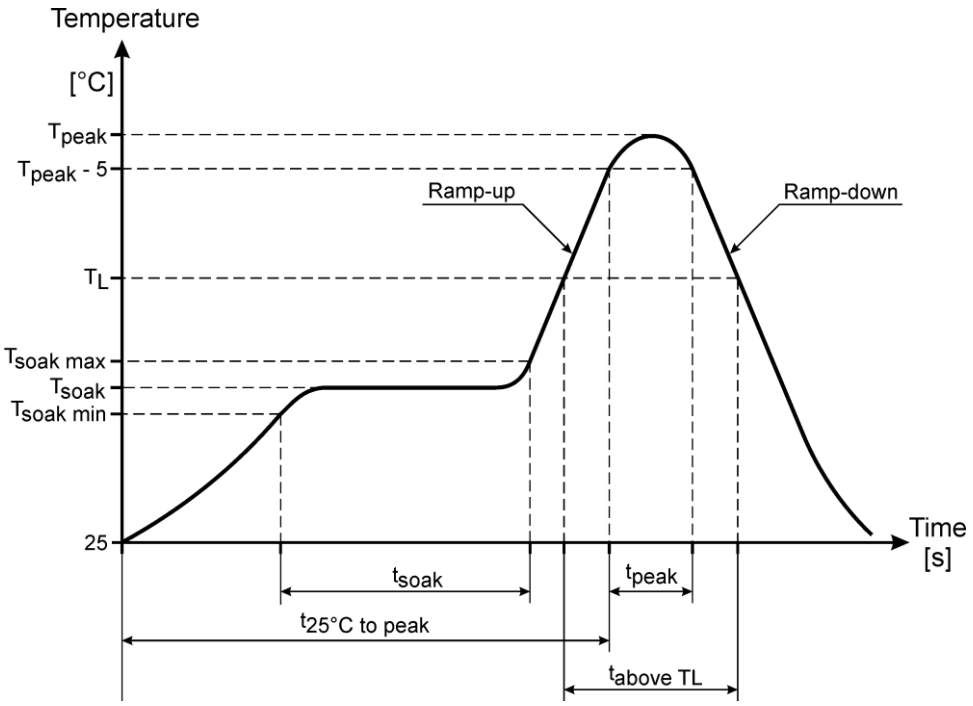

Figure 5 - *Soldering Profile for CNX200M Module*

Profile Feature	Pb-Free Assembly
Average Ramp-Up Rate T_{soak_max} to T_{peak}	3°C/second max.
Preheat - Temperature Min T_{soak_min} - Temperature Max T_{soak_max} - Time t_{soak} (T_{soak_min} to T_{soak_max})	 150°C 200°C 60-180 seconds
Time maintained above: - Temperature T_L - Time t_L	 217°C 60-150 seconds
Peak/Classification Temperature T_{peak}	See Table 12**: Package Classification Reflow Temperature**
Time within 5°C of actual Peak Temperature t_{peak}	20-30 seconds
Ramp-Down Rate	6°C / sec max.
Time 25°C to Peak Temperature	8 minutes max.

Table 11 - Classification Reflow Profiles

Package Thickness	**Volume mm³ < 350**	**Volume mm³ 350 - 2000**	**Volume mm³ > 2000**
≥ 2.5 mm	250 +0 °C [1)]	245 +0 °C [1)]	245 +0 °C [1)]

Table 12 - Package Classification Reflow Temperature. Pb-Free process.

1) Refer to IPC/JEDEC J-STD-020D

END OF DOCUMENT