Onethinx OTX-18

PSoC® 6x LoRaWAN module

psacertified™
level one

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2 General description

The Onethinx LoRaWAN™ Core module (OTX-18) is a ready-to-use LoRaWAN™ module, featuring Cypress's newest PSoC 6x and Semtech's next generation of sub-GHz radio transceiver SX1261.

The chipset and components used on the Onethinx LoRaWAN™ Core module are the best in class, delivering significant advantages to the developer and user. In today's world security is inevitable though complex as well. The OTX-18 module unburdens the developer from being a security expert and enables you to build any LoRaWAN™ application you can think of with an ultra-short time-to-market.

The OTX-18 is designed for extended battery life with just 4.2 mA of active receive current consumption. The module can transmit up to +14 dBm with a highly efficient integrated power amplifier and antenna.

The module is developed in close cooperation with Cypress and Escrypt, tailored to suit IoT projects that requires ultra-secure end-to-end encryption combined with robust LoRaWAN™ functionality. The Onethinx Core module contains our own PSoC® 6x optimized LoRaWAN™ stack for industries best performance. Due to the integrated 868/915MHz antenna and the ready implemented isolated and certified LoRaWAN™ stack the module is ready to use 'out of the box'. The Cypress PSoC 6x configurable analog and digital blocks ensure an easy and direct connection to virtually any sensor without the need of additional components.

This makes the Onethinx Core module extremely well suited for projects that require high security demands and optimal performance like public security, agriculture, leak detection, disaster precaution, gas- and water metering, street lighting applications and many more.

3 Feature list

- ✓The only LoRaWAN™ module with latest Cypress PSoC® 6x MCU
- ✓Based on the latest Semtech® SX126x chipset for extended battery use
- ✓Bluetooth® low energy (BLE) 5.0
- ✓Embedded secure element functionality with secure boot
- ✓PSA certified (OTX-18P)
- ✓Locked down LoRaWAN™ stack runs isolated from user code for ultimate security
- ✓Highly efficient integrated antenna
- ✓Adding wireless configuration possibilities, over the air firmware upgrades
- ✓Recommended by Cypress®, ESCRYPT® and The Things Network®
- ✓Easy to connect to virtually any sensor
- ✓1.2 uA power consumption in hibernate mode

4 Versions

Onethinx Core Module version naming scheme: OTX-18Z.YY

Z:		
	S	Standard Secure version • MCU: PSoC63 • Secure LoRa Alliance certified stack • Secure boot • M4 Core is open for application development
	P	PSA Certified version • MCU: PSoC64 with PSA • Secure LoRa Alliance certified stack • Secure boot • M4 Core is open for application development
	A	Configurable LoRaWAN stack • MCU: PSoC63 • Secure stack (not LoRa Alliance certified) • Secure boot • M4 Core is open for application development
	<blank>	Open (stackless) version • MCU: PSoC63 • No stack • M0+ & M4 Core open for application development
YY:		
	EU	868 MHz
	US	915 MHz

Table 1: Naming convention of the OTX-18 LoRaWAN module

5 Pinout

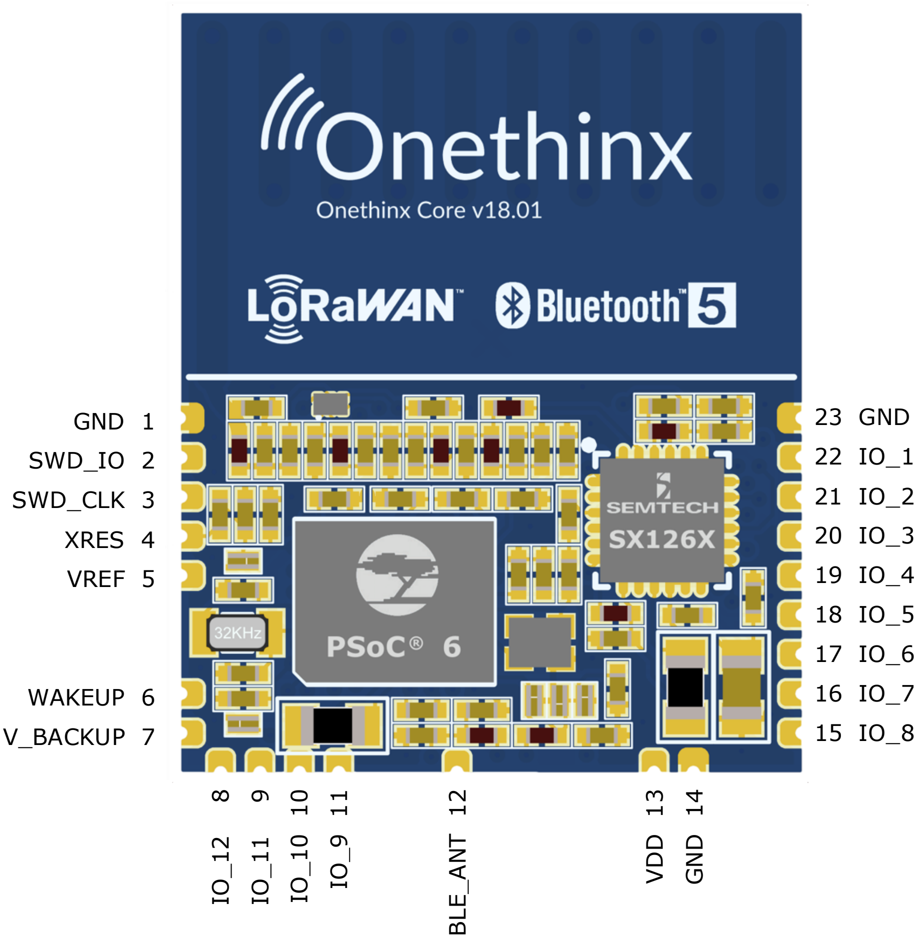


Figure 1: OTX-18 pinout

The following table give a detailed description of the pins.

OTX-18 pin	PSOC6x pin	Signal	Description
1		GND	Ground
2	P6_6	SWD_IO	Serial Wire Debug Data / GPIO
3	P6_7	SWD_CLK	Serial Wire Debug Clock / GPIO
4		XRES	Reset Input (active high)
5		VREF	Analog Vref Out
6	P0_4	Wakeup	Wakeup input (active high)
7		V_BACKUP	Backup power
8	P10_1	IO_12	General Purpose IO
9	P11_5	IO_11	General Purpose IO
10	P10_0	IO_10	General Purpose IO
11	P11_7	IO_9	General Purpose IO
12		BLE_ANT	Bluetooth Radio RF output
13		V_IN	Power +3.3V
14		GND	Ground
15	P12_5	IO_8	General Purpose IO
16	P12_4	IO_7	General Purpose IO
17	P9_2	IO_6	General Purpose IO
18	P10_3	IO_5	General Purpose IO
19	P9_3	IO_4	General Purpose IO
20	P10_2	IO_3	General Purpose IO
21	P9_1	IO_2	General Purpose IO
22	P9_0	IO_1	General Purpose IO
23		GND	Ground

Table 2: OTX-18 Pin description

6 Specifications

6.1.1 Absolute maximum ratings

Parameter	Description	Min	Typ	Max	Units
VDD.max	Maximum supply voltage	-0.5		3.7	V
T.ambMax	Storage temperature limits	-55		125	°C
I.totalMax	Supply current limits	-10		250	mA
V.GPIOMax	GPIO voltage limits	-0.5		VDD+0.5	V
I.GPIOMax	GPIO current limits	-25		25	mA

Table 3: Absolute maximum ratings

6.1.2 Recommended operating range

Parameter	Description	Min	Typ	Max	Units
VDD	supply voltage	1.8	3.3	3.6	V
T.amb	temperature limits	-40		85	°C

Table 4: Recommended operating conditions

6.1.3 DC specifications

Parameter	Description	Min	Typ	Max	Units
VI.L	GPIO input voltage low threshold	0.3*VDD			V
VI.H	GPIO input voltage high threshold			0.7*VDD	V
VO.L	GPIO output voltage low threshold			0.4	V
VO.H	GPIO output voltage high threshold	VDD-0.5		VDD+0.5	V

Table 5: DC specifications

6.1.4 LoRa specifications

Parameter	Description	Min	Typ	Max	Units
RF.SIN	RF input sensitivity (SF = 12, BW = 125KHz)		-137		dBm
RF.POUT	RF output power (OTX-18x.EU)		+14		dBm
RF.FO	RF frequency offset		+/- 8	+/- 25	ppm

Table 6: LoRa specifications

6.1.5 Bluetooth specifications

Parameter	Description	Min	Typ	Max	Units
RX.SIN	BT RF input sensitivity		-95		dBm
RX.PMAX	BT RF output power		+4		dBm

Table 7: Bluetooth specifications

6.1.6 Low Power specifications

Low power specifications are measured with the following conditions: Chip power mode = ULP, VDD = 3V3, SX1261 in sleep mode with cold start, RF switch turned off. Active cores are in infinite loops.

Parameter	Description	Min	Typ	Max	Units
I.Active	Both cores active		3.67		mA
I.DS.CM4	CM4 in deep sleep		0.74		mA
I.DS	Both cores in deep sleep		7.60		µA
I.HIB1	Both cores in hibernate (RTC active)		1.66		µA
I.HIB2	Both cores in hibernate, no RTC		1.2		µA

Table 8: Low power specifications

6.1.7 Physical specifications

Parameter	Description	Typ	Units
DIM	Length x Width x Height	24.5 x 20 x 2.4	mm
M	Weight	1.35	g

Table 9: physical parameters

7 Design guidelines

The Onethinx module has an integrated antenna, which should be in free space for best results. The figure below shows the advised module positioning and corresponding pad locations.

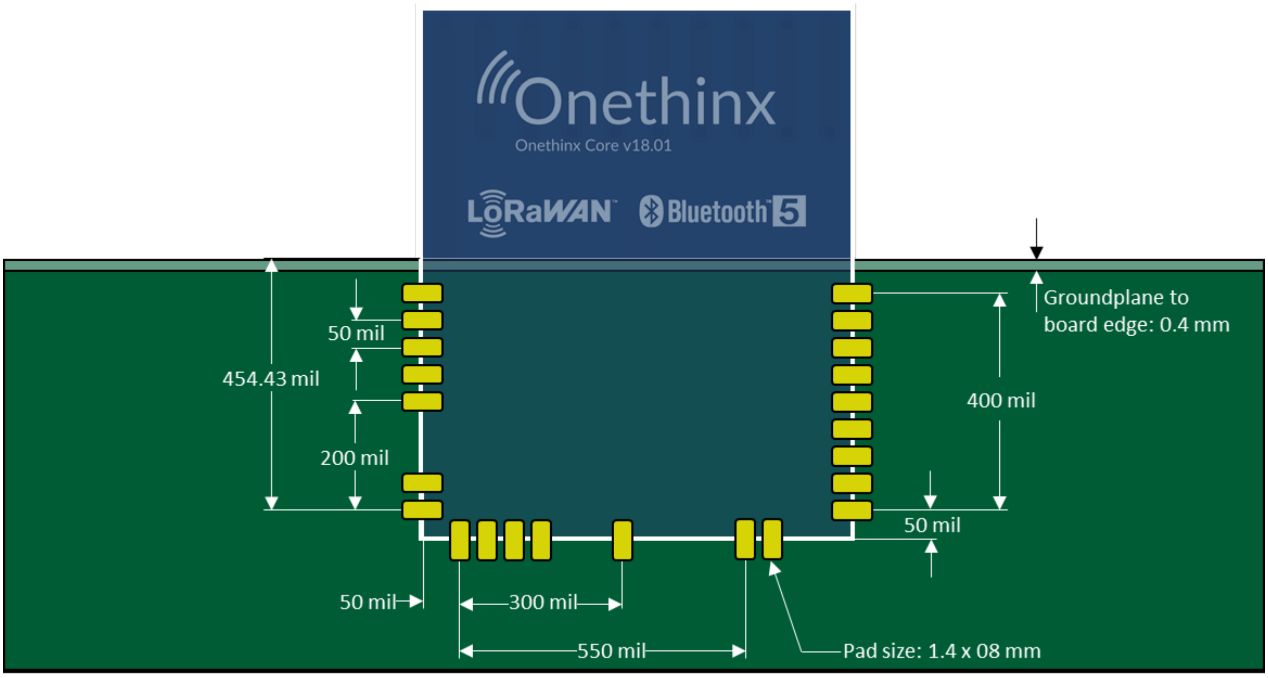
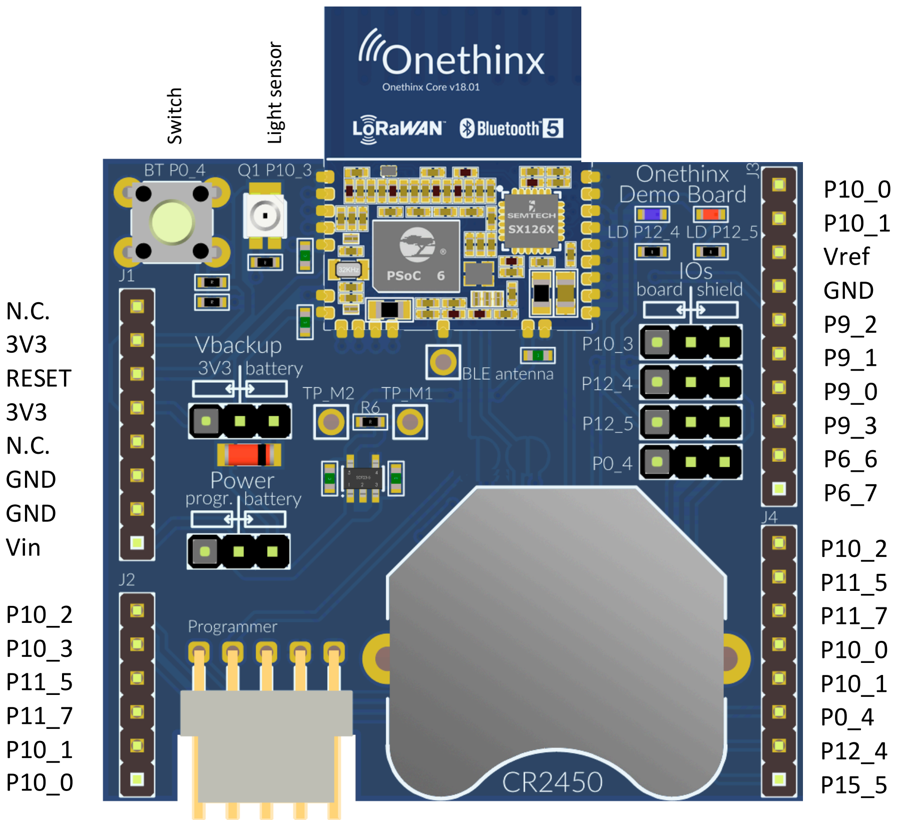


Figure 2: OTX-18 PCB design guidelines and pad placement

There are library components available for several commonly-used PCB design IDEs. Please check the Onethinx website, forum and Github before creating your own.

8 Reference design

The design files of the Onethinx devkit are available on our website. The connection header size and positioning allow the devkit to act as a battery-powered Arduino with LoRaWAN, so you are able to add shields to it (you will need to configure the I/O of course).



	Board	Shield
P10_3	Light sensor	GPIO
P12_4	Red LED	GPIO
P12_5	Blue LED	GPIO
P0_4	Button/Light	WakeUp or GPIO

Figure 3: OTX-18-Devkit

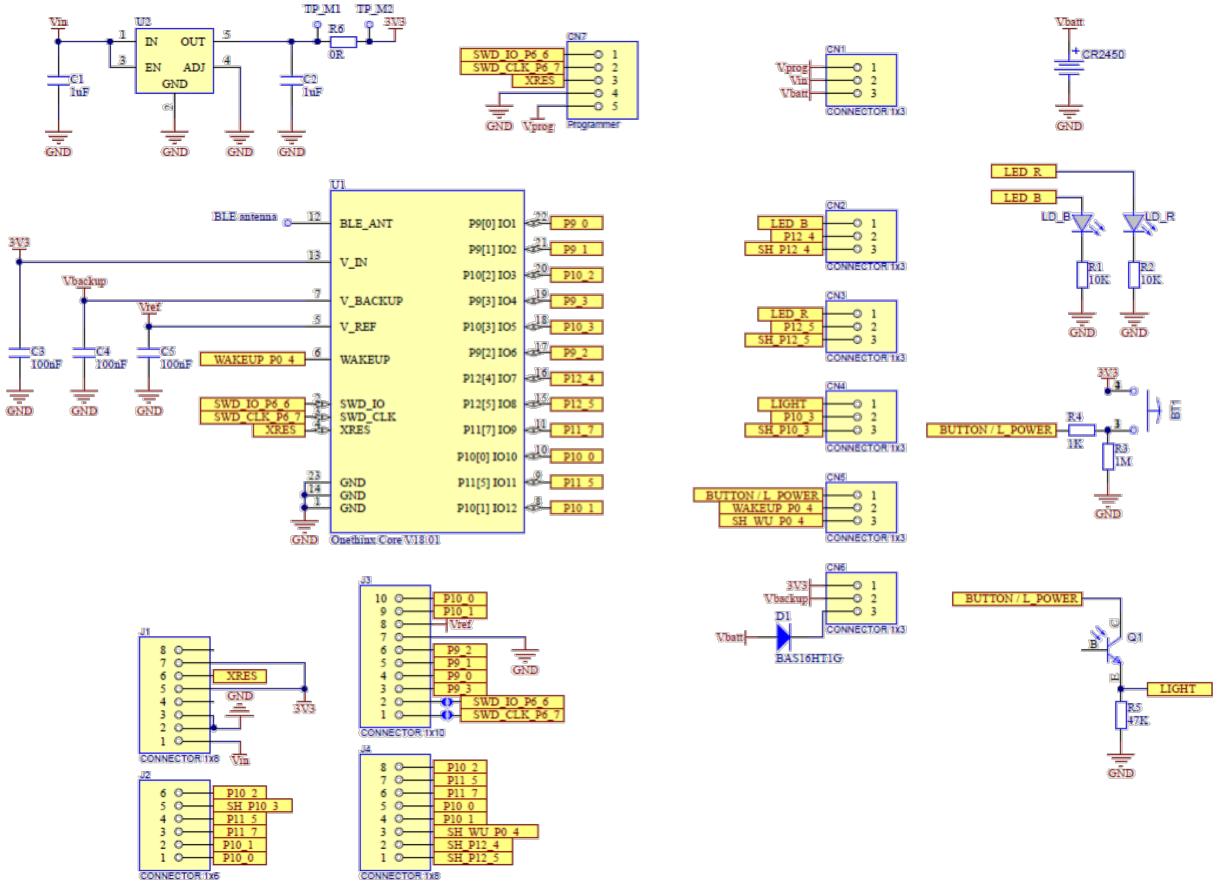


Figure 4: OTX-18 devkit schematic

9 Application Programming Interface (API)

The OTX-18 offers several function calls over the Inter peripheral Communication Bus (IPC). The structures and functions are found in the OnethinxCore*.* files.

9.1 User configuration structures

The user configuration structures are defined in OnethinxCore*.h.

9.1.1 LoRaWAN_keys_t

```
LoRaWAN_keys_t myOTAAKey = {
    .KeyType                        = OTAA_10x_key,
    .PublicNetwork                  = true,
    .OTAA_10x.DevEui                = { 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00 },
    .OTAA_10x.AppEui                = { 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00 },
    .OTAA_10x.AppKey                = { 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, \
                                        0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00 }
};
```

KeyType	Description	LoRaWAN spec
ABP_10x_key	Acivation By Personalization	1.0x
OTAA_10x_key	Over The Air Activation	1.0x
OTAA_11x_key	Over The Air Activation	1.1x
PreStored_key	For future use	
UserStored_key	For future use	

Table 10: Overview of Key types

The OTAA_10x_key is for now the most used key.

9.1.2 coreConfiguration_t coreConfig

```
coreConfiguration_t coreConfig = {
    .Join.KeysPtr =         &myOTAAKey,
    .Join.DataRate =        DR_0,
    .Join.Power =           PWR_MAX,
    .Join.MAXTries =        10,
    .TX.Confirmed =         false,
    .TX.DataRate =          DR_0,
    .TX.Power =             PWR_MAX,
    .TX.FPort =             1,
};
```

The Join DataRate/Power must always be DR_0/PWR_MAX. The OTX-18 will send <maxTries> number of join requests.

DataRate	Configuration	bits/s	Max payload
DR_0	SF12/125kHz	250	59
DR_1	SF11/125kHz	440	59
DR_2	SF10/125kHz	980	59
DR_3	SF9/125kHz	1 760	123
DR_4	SF8/125kHz	3 125	230
DR_5	SF7/125kHz	5 470	230
DR_6	SF7/250kHz	11 000	230
DR_ADR			

Table 11: DataRate settings overview

9.1.3 coreStatus_t

```
typedef struct {
    parameterStatus_t        parameters;
    radioStatus_t            radio;
    macStatus_t              mac;
    systemStatus_t           system;
} coreStatus_t;
```

The status of the LoRaWAN stack is given in this structure. The four fields are themselves structures. Each have an errorStatus field. The other fields are specific for the subsystem. For the macStatus_t the description is as follows:

```
mac {
       errorStatus           MAC Errors
       bytesToRead           Total bytes in Receive buffer
       isConfigured          System is configured?
       messageReceived       The MAC received a message
       isJoined              Chip mode
       isBusy                Chip mode
       isPublicNetwork       True for LoRaWAN Public Network
       devAddr               deviceAddress
}
```

9.2 Functions

9.2.1 LoRaWAN_Init

```
coreStatus_t LoRaWAN_Init(coreConfiguration_t* coreConfigurationPtr)
```

Call this function to set up the LoRaWAN Stack

9.2.2 LoRaWAN_Join

```
coreStatus_t LoRaWAN_Join(bool waitTillFinished)
```

This function starts the join procedure with the parameters used in the LoRaWAN_Init() function.

9.2.3 LoRaWAN_GetRXdata

```
coreStatus_t LoRaWAN_GetRXdata(uint8_t* buffer, uint8_t length)
```

Use this function to check whether downlink data has been received. Most commonly used some time after LoRaWAN_send.

9.2.4 LoRaWAN_Send

```
coreStatus_t LoRaWAN_Send(uint8_t* buffer, uint8_t length, bool waitTillFinished)
```

Send a data buffer over LoRaWAN. With the waitTillFinished set to false, the user may put the CM4 core to sleep. Make sure to call LoRaWAN_GetRXData() when waking up in order to receive downlink messages.

9.2.5 LoRaWAN_GetStatus

```
coreStatus_t LoRaWAN_GetStatus()
```

Gets the current status of the LoRaWAN stack.

9.2.6 LoRaWAN_GetError

```
errorStatus_t LoRaWAN_GetError()
```

This function provides a test to determine whether there is any error. Please find details of the Error codes in OnethinxCore*.h.

Usage:

```
errorStatus_t  errorStatus = LoRaWAN_GetError();
if( errorStatus.errorValue != errorStatus_NoError ){
  /* handle specific cases like this */
  if( errorStatus.paramErrors != param_OK ){
    /* handle parameter errors */
  }
  if( errorStatus.radioErrors != radio_OK ){
    /* handle radio errors */
  }
  if( errorStatus.macErrors != mac_OK ){
    /* handle mac errors */
  }
  if( errorStatus.systemErrors != system_OK ){
    /* handle system errors */
    switch( errorStatus.systemErrors ){
      case system_BusyError:
      case system_NotStarted:
      case system_UndefinedError:
      default:

    }
  }
}
```

10 Revision history

Revision	Author	Date	Changes
A	RN	23-12-2017	Document creation
B	RN	07-08-2018	Corrected IO5 connection to 10_5. Updated Specifications.
C	JS	26-03-2019	Restructured document. Added API section. Updated specifications.

Table 12: Revision history

11 List of figures and tables

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