DUSTINO
User’s Guide
ITM-DOPA-B-01: PCB Ant.
ITM-DOUF-B-01: U.FL Conn.

All information contained in these materials, including products and product specifications, represents information on the product at the time of publication and is subject to change by IOTeam S.r.l. without notice.
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<td>31/01/2017</td>
<td>First release</td>
<td>Final</td>
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1. Introduction

1.1. Description

This document describes DUSTINO, an Arduino MKR1000 form factor board that represents a key solution for easy and fast prototyping of the Dust wireless technology.

It is Arduino IDE compatible and powered by USB or battery.

It will especially be useful for both the Makers’ community, as an Arduino compatible board, and the R&D teams of larger entities.

Being the DUSTY on the board CE and FCC certified, there's no need to certify the single board produced using Dustino, making it faster and more inexpensive to prototype and produce.

**Dustino is available in two models that depend on the Dusty model on board:**

- **Dustino PCB-Ant is equipped with Dusty PCB-Ant**
- **Dustino U.FL Ant Connector is equipped with Dusty U.FL Ant Connector**

The board is based on Microchip’s Cortex M0+ USB Host (ATSAML21G18B-MU) and the Linear Technology Wireless SmartMesh IP™ (DUSTY Module)

Its main features are:
- SmartMesh IP™ Embedded Wireless Mesh Networking
- >99.999% Data Reliability in Industrial IoT
- >10 Years of Battery Life
- Delivers your real-time critical information
- No wires, place sensors anywhere
- Encryption & authentication
- Secured network
- Complete Mesh Networking Software
- No network software development
- Powered by USB or battery (2 x 1,5 V)
- Battery monitoring
- Arduino MKR1000 form factor
- Arduino IDE compatible

The **DUSTINO** Board can be used with Arduino IDE for a fast and easy software development cycle (https://www.arduino.cc/en/Main/Software).

The software can also be developed using the Atmel Studio IDE commonly
preferred by professional software engineers. (http://www.atmel.com/Microsite/atmel-studio/).

1.2. Kit contents

The following items are included in the box:

- 1x Dustino board

1.3. Getting started

The Dustino board is a ready-to-use Internet of Things (IoT) hardware.

Please refer to the software chapter to learn how to get started with the Dustino board.
2. System overview

2.1. Board layout: Arduino IDE compatible

The layout of the Dustino board is shown in the picture below.

![Dustino PCB Antenna](image1)

*Figure 1: Dustino PCB Antenna*

![Dustino PCB U.FL Connector](image2)

*Figure 2: Dustino PCB U.FL Connector*
2.2. Block diagram

An overview of the functions of the Dustino board is shown in the figure below:

![Dustino block diagram](image)

Figure 3: Dustino block diagram

2.3. Board Specifications

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPU Clock speed</td>
<td>32MHz</td>
</tr>
<tr>
<td>Flash Memory</td>
<td>256Kb</td>
</tr>
<tr>
<td>Connector</td>
<td>1 USB</td>
</tr>
<tr>
<td></td>
<td>1 SWD Debugger</td>
</tr>
<tr>
<td></td>
<td>Arduino MKR100 Format compatible PinOut (14 pin)</td>
</tr>
<tr>
<td>Board supply voltage</td>
<td>3.3V CC</td>
</tr>
<tr>
<td>Temperature</td>
<td>-40°C to +85°C</td>
</tr>
<tr>
<td>Dimensions</td>
<td>68x30 mm</td>
</tr>
<tr>
<td>RoHS status</td>
<td>Compliant</td>
</tr>
</tbody>
</table>

Table 1: Board specifications
2.4. ATMEL SAMD21G18A low-power ARM

The Atmel SAMD21 Ultra low-power microcontroller using the 32-bit ARM® Cortex®-M0+ processor is the core of the entire board.

**Memory**
- 256KB in-system self-programmable Flash
- 32KB SRAM Main Memory

**Clock Frequency**
- 32.768kHz crystal oscillator (XOSC32K)

**Arduino compliance**
[https://www.arduino.cc/en/Main/ArduinoMKR1000](https://www.arduino.cc/en/Main/ArduinoMKR1000)

- Digital i/o Pins: 20
- PWM Pins: all but 2 and 7
- USART: 2 (USB and TTL Digital)
- Analog Input Pins: 6, 12-bit DAC
- Analog Output Pins: 1, 10-bit DAC
- External Interrupts: All pins except pin 4

More information can be found on the ATMEL SAMD21 Data Sheet (See the link in the References and Useful Links chapter)

2.5. DUSTY Module

Dusty PCBAnt and Dusty Ant Conn are the world’s first wireless mesh Internet of Things (IoT) modules with integrated PCB antenna or U.FL Antenna Connector that utilize the SmartMesh IP™ from Linear Technology Corp.

2.5.1. Features

- SmartMesh IP™ Embedded Wireless Mesh Networking
- >99.999% Data Reliability in Industrial IoT
- >10 Years of Battery Life Delivers your real-time critical information
- No wires, place sensors anywhere
• Encryption & authentication
• Secured network
• Complete Mesh Networking Software
• No network software development

More information can be found on the DUSTY Data Sheet (See the link in the References and Useful Links chapter)
3. Connectors

This chapter gives you an overview of the Dustino connectivity. The connectors’ placement is depicted in the figure below.

![Dustino Connectors](image)

**Figure 4:** Dustino connectors (front view)

**Figure 5:** PRGM Connector (back view)

<table>
<thead>
<tr>
<th>Connector</th>
<th>ID</th>
<th>Side</th>
</tr>
</thead>
<tbody>
<tr>
<td>USB</td>
<td>J1</td>
<td>front</td>
</tr>
<tr>
<td>SWD Connector</td>
<td>J2</td>
<td>front</td>
</tr>
<tr>
<td>Arduino</td>
<td>J3</td>
<td>front</td>
</tr>
<tr>
<td>Arduino</td>
<td>J4</td>
<td>front</td>
</tr>
<tr>
<td>Battery connector</td>
<td>WP1:+3V</td>
<td>front</td>
</tr>
<tr>
<td></td>
<td>WP2: Gnd</td>
<td></td>
</tr>
<tr>
<td>PRGM</td>
<td>J5</td>
<td>back</td>
</tr>
</tbody>
</table>

**Table 2 Dustino connectors**
3.1. USB cdc Uart interface

The board is equipped with a USB (J1) Full-Speed (12 Mbps) device port on USB Micro-b connector. Dustino can be powered through this interface.

![USB Interface](image)

Figure 6: USB Interface

3.2. SWD Connector

The Dustino board features an on-board SWD Connector (J2) that can be used to program and debug the microcontroller.

This connector should be used if you are not using the Arduino IDE programmable mode.

Use this connector with Atmel Studio development environment and the Atmel ICE probe.

**Warning**

Using SWD to download your application you override the Arduino boot loader

![SWD Connector](image)

Figure 7: SWD Connector
### 3.3. Arduino connectors

The connectors J3 and J4 provide users with a standard Arduino MKR1000 slot as listed below.

<table>
<thead>
<tr>
<th>Name</th>
<th>Conn.</th>
<th>Pin</th>
</tr>
</thead>
<tbody>
<tr>
<td>+3.3V</td>
<td>J2</td>
<td>1</td>
</tr>
<tr>
<td>SWDIO</td>
<td>J2</td>
<td>2</td>
</tr>
<tr>
<td>GND</td>
<td>J2</td>
<td>3</td>
</tr>
<tr>
<td>SWCLK</td>
<td>J2</td>
<td>4</td>
</tr>
<tr>
<td>GND</td>
<td>J2</td>
<td>5</td>
</tr>
<tr>
<td>TX</td>
<td>J2</td>
<td>6</td>
</tr>
<tr>
<td>Not used</td>
<td>J2</td>
<td>7</td>
</tr>
<tr>
<td>RX</td>
<td>J2</td>
<td>8</td>
</tr>
<tr>
<td>Not used</td>
<td>J2</td>
<td>9</td>
</tr>
<tr>
<td>RESET</td>
<td>J2</td>
<td>10</td>
</tr>
</tbody>
</table>

**Table 3 SWD Connector**

**Figure 8**: Arduino Mkr1000 pinout (front view)
<table>
<thead>
<tr>
<th>Name</th>
<th>Conn.</th>
<th>Pin</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AREF</td>
<td>J3</td>
<td>1</td>
<td>AREF</td>
</tr>
<tr>
<td>A0</td>
<td>J3</td>
<td>2</td>
<td>A0 DAC0</td>
</tr>
<tr>
<td>A1</td>
<td>J3</td>
<td>3</td>
<td>A1 INT</td>
</tr>
<tr>
<td>A2</td>
<td>J3</td>
<td>4</td>
<td>A2 INT</td>
</tr>
<tr>
<td>A3</td>
<td>J3</td>
<td>5</td>
<td>A3 PWM</td>
</tr>
<tr>
<td>A4</td>
<td>J3</td>
<td>6</td>
<td>A4 PWM</td>
</tr>
<tr>
<td>A5</td>
<td>J3</td>
<td>7</td>
<td>A5</td>
</tr>
<tr>
<td>A6</td>
<td>J3</td>
<td>8</td>
<td>A6</td>
</tr>
<tr>
<td>D0</td>
<td>J3</td>
<td>9</td>
<td>D0 INT</td>
</tr>
<tr>
<td>D1</td>
<td>J3</td>
<td>10</td>
<td>D1 INT</td>
</tr>
<tr>
<td>D2</td>
<td>J3</td>
<td>11</td>
<td>D2</td>
</tr>
<tr>
<td>D3</td>
<td>J3</td>
<td>12</td>
<td>D3</td>
</tr>
<tr>
<td>D4</td>
<td>J3</td>
<td>13</td>
<td>D4 INT</td>
</tr>
<tr>
<td>D5</td>
<td>J3</td>
<td>14</td>
<td>D5 INT</td>
</tr>
<tr>
<td>D6</td>
<td>J4</td>
<td>1</td>
<td>D6</td>
</tr>
<tr>
<td>D7</td>
<td>J4</td>
<td>2</td>
<td>D7</td>
</tr>
<tr>
<td>D8</td>
<td>J4</td>
<td>3</td>
<td>MOSI</td>
</tr>
<tr>
<td>D9</td>
<td>J4</td>
<td>4</td>
<td>SCK</td>
</tr>
<tr>
<td>D10</td>
<td>J4</td>
<td>5</td>
<td>MISO</td>
</tr>
<tr>
<td>D11</td>
<td>J4</td>
<td>6</td>
<td>SDA</td>
</tr>
<tr>
<td>D12</td>
<td>J4</td>
<td>7</td>
<td>SCL</td>
</tr>
<tr>
<td>D13</td>
<td>J4</td>
<td>8</td>
<td>RX</td>
</tr>
<tr>
<td>D14</td>
<td>J4</td>
<td>9</td>
<td>TX</td>
</tr>
<tr>
<td>RESET</td>
<td>J4</td>
<td>10</td>
<td>RESET</td>
</tr>
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<td>GND</td>
<td>J4</td>
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<td>GND</td>
</tr>
<tr>
<td>VCC</td>
<td>J4</td>
<td>12</td>
<td>VCC 3.3V</td>
</tr>
<tr>
<td>VIN</td>
<td>J4</td>
<td>13</td>
<td>VIN</td>
</tr>
<tr>
<td>+5V</td>
<td>J4</td>
<td>14</td>
<td>+5V</td>
</tr>
</tbody>
</table>

Table 4 Arduino pinout mapping
4. Usage

This chapter describes how to connect, configure and interact with the Dustino board.

4.1. Power supply

The board can be powered by two different power supply sources:
- External Battery +3 V
- Through the Micro USB connector

4.2. Push buttons and LEDs

A basic user interface is provided through on-board buttons and LEDs

![Push button & LEDs](image)

Figure 9: Push button & LEDs

<table>
<thead>
<tr>
<th>OBJECT</th>
<th>DESCRIPTION</th>
<th>COLOR</th>
<th>SAMD21 Port</th>
<th>Arduino Pin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Push Button</td>
<td>RESET</td>
<td>n.a</td>
<td>n.a</td>
<td>n.a</td>
</tr>
<tr>
<td>LED 1</td>
<td>User LED</td>
<td>Green</td>
<td>PB09</td>
<td>n.a</td>
</tr>
<tr>
<td>LED 2</td>
<td>Power On</td>
<td>Green</td>
<td>n.a.</td>
<td>n.a</td>
</tr>
</tbody>
</table>

Table 5 Push button & LEDs
5. Radiation pattern plots of the Dusty PCB-Ant module

The following figures show the radiation pattern of the Dusty PCB-Ant module mounted on the Dustino board.

![Radiation pattern plot](image)

**Figure 10**: Radiation pattern plot of Dusty PCB-Ant. module gain azimuthal

<table>
<thead>
<tr>
<th></th>
<th>Max</th>
<th>Min</th>
<th>Avg</th>
<th>Mdn</th>
<th>Eff</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3.1</td>
<td>-11.5</td>
<td>-1.3</td>
<td>-0.8</td>
<td>-0.11</td>
</tr>
</tbody>
</table>

**Table 6** Radiation gain azimuthal
Figure 11: Radiation pattern plot of Dusty PCB-Ant. module - gain elevation

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Max</td>
<td>-4.4</td>
<td>dBic</td>
</tr>
<tr>
<td>Min</td>
<td>-7.2</td>
<td>dBic</td>
</tr>
<tr>
<td>Avg</td>
<td>-0.1</td>
<td>dBic</td>
</tr>
<tr>
<td>Mdn</td>
<td>-0.7</td>
<td>dBic</td>
</tr>
</tbody>
</table>

Table 7 Radiation gain elevation
6. Getting Started with Arduino IDE and Sketch Projects

6.1. Tools

The following tools are needed:
- Arduino IDE (Release 1.6.4 or newer)
- USB cable

6.2. Setup the Environment

Download and install the Arduino IDE from the Arduino web site (See the link in chapter 8.).
The first time you run the Arduino IDE, it is necessary to load the Arduino Zero & SmartEverything Core.
Click on the Tools -> Boards -> Boards Manager… menu entry

Figure 12: Launch Board Manager
The two installation steps shall be done as follows:

1) Select from “Type” combo Arduino and choose Arduino SAMD Boards in order to install the core of the Arduino Zero.

![Arduino Zero Core Installation](image)

Figure 13 : Arduino Zero Core Installation

2) Insert the following URL:

https://raw.githubusercontent.com/ioteamit/ioteam-arduino-core/master/package_ioteam_index.json

in the Additional URL for board manager through setup panel as shown in the figure below
3) Select from board manager the IOTEAM Boards in order to install the core of the Dustino.
The installation procedure will automatically install all the necessary USB drives. Once the installation is completed, you can connect the Board and start coding.

If the Driver installation process does not complete successfully, follow the steps described in chapter 9.

6.3. Run the software

Verify the code

![Figure 16: Arduino IDE: Verify the code](image-url)
Load the software on the connected board.

![Arduino IDE: Upload the code](Figure 17)

6.4. Importing the components Library

In order to use the Wi-Fi, SigFox and Dust, specific libraries is required. To include these libraries use the menu Sketch - Include Library - Manage Libraries.

![Arduino IDE: Launch Manage Libraries interface](Figure 18)
Once the Library Manager is started, you can filter the available libraries writing:

- exteepr

in the right top text box and then you can select the necessary library.

![Arduino IDE: Library Manager](image1)

**Figure 19**: Arduino IDE: Library Manager

Another way to install the supported components Library is to go to the GitHub repository and download the zip file.

![GitHub libraries repository](image2)

**Figure 20**: GitHub libraries repository

Once it is downloaded, go to the “include Library” menu and use the “Add .ZIP Library...” item.
6.5. Official GitHub library repository

Here is the official repository where the zip file can be downloaded from:

- Dusty - [github.com/ioteamit/dusty_LTC5800_library](https://github.com/ioteamit/dusty_LTC5800_library)
7. References and Useful Links

7.1. Data sheets

ATMEL SAMD21 Ultra low-power ARM® Cortex®-M0+ D21

DUSTY module:

LTC5800 Datasheet:

Dust Manager CLI commands

DustCloud
https://dustcloud.atlassian.net/wiki/

My Linear
https://www.linear.com/mylinear/

Dusty FW Upgrade
http://www.linear.com/solutions/4260

7.2. Tools

• Arduino IDE - https://www.arduino.cc/en/Main/Software
• Atmel Studio - http://www.atmel.com/microsite/atmel-studio/

7.3. Web Sites

• IOTEAM S.r.l. - www.ioteam.it
• Arduino - www.arduino.cc
• Atmel - www.atmel.com
• Analog Device - www.microchip.com
8. Troubleshooting

8.1. Driver installation problems

It can happen that the installation of the driver does not automatically complete successfully. The driver to manage the COM Port is not installed properly and the device is reported as an Unknown Device.

If this happens, it is necessary to install the driver manually.

The correct drivers can be found on the following directory:

C:\Users\<login name>\AppData\Local\Arduino15\packages\Arrow\hardware\samd\<installed Rel>\drivers.

![Figure 21: Correct USB Driver installation](image-url)