INDUSTRIAL SHIELDS

# MDUINO PLC ARDUINO ETHERNET & WIFI & BLE 42 I/Os ANALOG / DIGITAL

Wi-Fi & Bluetooth Controller User Guide:

# MDUINO PLC ARDUINO ETHERNET & WIFI & BLE 42 I/Os ANALOG / DIGITAL User Guide

**Revised, May 2019**

# Preface

This User Guide is been implemented by Boot & Work, S.L. working under the name Industrial Shields.

## Purpose of the manual

The information contained in this manual can be used as a reference to operating, to functions, and to the technical data of the signal modules, power supply modules and interface modules.

## Intended Audience

This User Guide is intended for the following audience:

- Persons in charge of introducing automation devices.
- Persons who design automation systems.
- Persons who install or connect automation devices.
- Persons who manage working automation installation.

**Warnings:**

- Unused pins should not be connected. Ignoring the directive may damage the controller.
- Improper use of this product may severely damage the controller.
- Refer to the controller's User Guide regarding wiring considerations.
- Before using this product, it is the responsibility of the user to read the product's User Guide and all accompanying documentation.

# Application Considerations and Warranty

## Read and Understand this Manual

Please read and understand this manual before using the product. Please consult your comments or questions to Industrial Shields before using the product.

## Application Consideration

THE PRODUCTS CONTAINED IN THIS DOCUMENT ARE NOT SAFETY RATED. THEY SHOULD NOT BE RELIED UPON AS A SAFETY COMPONENT OR PROTECTIVE DEVICE FOR ENSURING SAFETY OF PERSONS, AS THEY ARE NOT RATED OR DESSIGNED FOR SUCH PURPOSES.

Please know and observe all prohibitions of use applicable to the products.

FOR AN APPLICATION INVOLVING SERIOUS RISK TO LIFE OR PROPERTY WITHOUT ENSURING THAT THE SYSTEM AS A WHOLE HAS BEEN DESSIGNED TO ADDRESS THE RISKS, NEVER USE THE INDUSTRIAL SHIELDS PRODUCTS.

NEVER USE THE INDUSTRIAL SHIELDS PRODUCTS BEFORE THEY ARE PROPERLY RATED AND INSTALLED FOR THE INTENDED USE WITHIN THE OVERALL EQUIPMENT OR SYSTEM.

Industrial Shields shall not be responsible for conformity with any codes, regulations or standards that apply to the combination of products in the customer's application or use of the product.

The following are some examples of applications for which particular attention must be given. This is not intended to be an exhaustive list of all possible uses of the products, nor is it intended to imply that the uses may be suitable for the products:

- Systems, machines, and equipment that could present a risk to life or property.
- Nuclear energy control systems, combustion systems, railroad systems, aviation systems, medical equipment, amusement machines, vehicles, safety equipment, and installation subject to separate industry or government regulations.
- Outdoor use, uses involving potential chemical contamination or electrical interference, or conditions or uses not described in this document.

At the customer's request, INDUSTRIAL SHIELDS will provide applicable third party certification documents identifying ratings and limitations of use that apply to the products. This information by itself is not sufficient for a complete determination of the suitability of the products in combination with the system, machine, end product, or other application or use.

# Disclaimers

## Weights and Dimensions

Dimensions and weights are nominal and they are not used for manufacturing purposes, even when tolerances are shown.

## Performance Data

The performance data given in this manual is provided as a guide for the user in determining suitability and does not constitute a warranty. It may represent the result of INDUSTRIAL SHIELDS's test conditions, and the users most correlate it to actual application requirements. Actual performance is subject to the INDUSTRIAL SHIELDS Warranty and Limitations of Liability.

## Change in Specifications

Product specifications and accessories may be changed at any time based on improvements and other reasons.

It is our practice to change model numbers when features are changed, or published ratings or when significant construction changes are made. However, some specifications of the products may be changed without any notice. When in doubt, special numbers may be assigned to fix or stablish key specifications for your application on your request. Please consult with your INDUSTRIAL SHIELDS representative at any time to confirm actual specifications of purchased products.

## Errors and Omissions

The information in this document has been carefully checked and is believed to be accurate; however, no responsibility is assumed for clerical, typographical, or proofreading errors, or omissions.

# Warranty and Limitations of Liability

## Warranty

Industrial Shields's exclusive warranty is that the products are free from defects in materials and workmanship for a period of one year (or other period if specified) from date of sale by Industrial Shields.

INDUSTRIAL SHIELDS MAKES NO REPRESENTATION OR WARRANTY, EXPRESSED OR IMPLIED, REGARDING MERCHANABILITY, NON-INFRINGEMENT, OR FITNESS FOR PARTICULAR PURPOSE OF THE PRODUCTS. ANY BUYER OR USER ACKNOWLEDGES THAT THE BUYER OR USER ALONE HAS DETERMINED THAT THE PRODUCTS WILL SUITABLY MEET THE REQUIREMENTS OF THEIR INTENDED USE. INDUSTRIAL SHIELDS DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED

## Limitations of Liability

INDUSTRIAL SHIELDS SHALL NOT BE RESPONSIBLE FOR SPECIAL, INDIRECT, OR CONSEQUENTIAL DAMAGES, LOSS OF PROFITS OR COMERCIAL LOSS IN ANY WAY CONNECTED WITH THE PRODUCTS, WHETHER SUCH CLAIM IS BASED ON CONTRACT, WARRANTY, NEGLIGENCE, OR STRICT LIABILITY.

IN NO EVENT SHALL INDUSTRIAL SHIELDS BE RESPONISBLE FOR WARRANTY, REPAIR OR OTHER CLAIMS REGARDING THE PRODUCTS UNLESS INDUSTRIAL SHIELDS'S ANALYSIS CONFIRMS THAT THE PRODUCTS WERE PROPERLY HANDLED, STORED, INSTALLED, AND MAINTAINED AND NOT SUBJECT TO CONTAMINATION, ABUSE, MISUSE, OR INAPPROPIATE MODIFICATION OR REPAIR.

# Table of Contents


1 General Description Wi-Fi & Bluetooth CONTROLLER ..... 10

1.1 Zone - Nomenclature ..... 10

1.2 Zone Distribution ..... 11

1.3 A Zone Features ..... 11

1.4 Mechanical dimension ..... 12

1.5 General Features ..... 13

2 Technical Specifications: ..... 14

2.1 General Specifications: ..... 14

2.2 Performance Specification: ..... 14

3 Precautions ..... 15

3.1 Arduino Board ..... 15

3.2 Intended Audience ..... 15

3.3 General Precautions ..... 15

4 Software interface ..... 15

5 How to connect PLC Arduino to PC ..... 19

6 How to connect PLC to power supply ..... 20

7 M-duino Family Pinout ..... 21

7.1 A Zone connection ..... 21

7.2 B Zone (Analog Shield) ..... 23

7.3 C Zone (Analog Shield) ..... 24

8 Switch Configuration ..... 25

8.1 A Zone: Communications ..... 25

8.2 B Zone: Analog Shield ..... 27

9 I/Os 5V pins ..... 27

9.1 I2C pins – SDA/SCL ..... 28

9.2 Serial 0 – RX0/TX0 ..... 28

9.3 Serial 1 – RX1/TX1 ..... 28

9.4 SPI – MISO/MOSI/SCK ..... 29

9.5 Pin 2/Pin 3 ..... 29

10 A Zone Features: Communications & RTC & uSD ..... 30

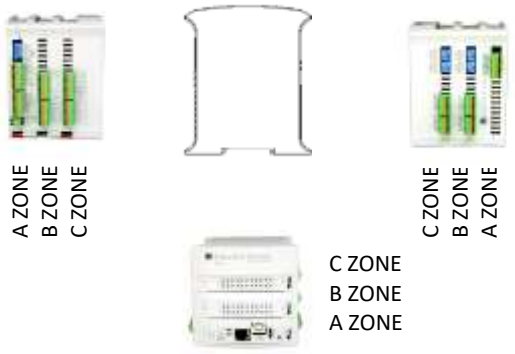
10.1 RS-232 ..... 30
10.2 RS-485 ..... 30
10.3 I2C ..... 30
10.4 SPI ..... 31
10.5 TTL ..... 31
10.6 Ethernet ..... 31
10.7 RTC ..... 31
10.8 uSD ..... 32
10.9 WiFi & BLE ..... 33
10.9.1 General Specifications: ..... 33
10.9.2 WiFi & Bluetooth Module Configuration ..... 33
11 I/O technical details: ..... 36
12 Typical Connections ..... 38
13 Connector details: ..... 42
14 Mechanical Characteristics ..... 43

# 1 General Description Wi-Fi & Bluetooth CONTROLLER

## 1.1 Zone - Nomenclature

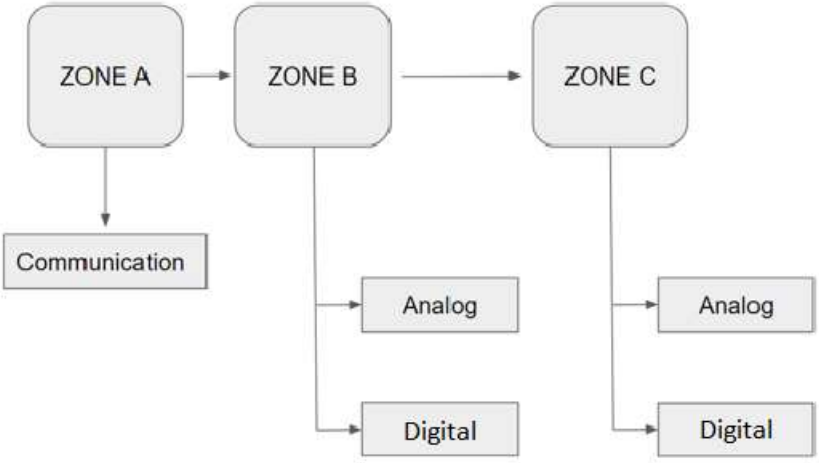
The nomenclature shown in this point will be used in the whole User Guide, so it is important to understand this nomenclature.

The nomenclature to differentiate the zones is based on the Alphabet, being A the shield from below and C the shield from above. Having a B in the middle of them. It has 3 zones (A, B, C):




- The inputs in the zone B are named I0.X, being X any number suitable in the Shield. Digital Outputs are named as Q0.X and Analog Outputs as A0.X.
- The inputs in the zone C are named I1.X, being X any number suitable in the Shield. Digital Outputs are named as Q1.X and Analog Outputs as A1.X.

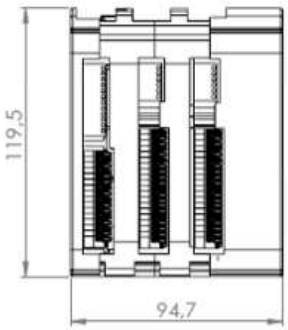
## 1.2 Zone Distribution

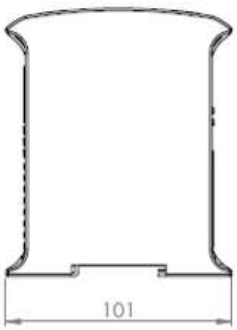



## 1.3 A Zone Features

| Shield | A Zone |
|---|---|
| Communication Shield | (1x) Ethernet<br>(1x) USB<br>(1x) I2C<br>(3x) TTL<br>(1x) RS-232<br>(1x) HALF/FULL Duplex RS-485<br>(1x) SPI external Port<br>(1x) RTC<br>(1x) uSD Socket<br>(1x) WiFi & BLE |

## 1.4 Mechanical dimension




M-Duino 2 BLOCKS
I/Os

2.

## 1.5 General Features

| CONECTABLE PLC ARDUINO 24Vcc M-DUINO | | |
|---|---|---|
| **MODEL TYPE** | **WiFi & BLE Controller General Spec.** | |
| **Input Voltage** | 12 to 24Vdc | Fuse protection (2.5A)<br>Polarity protection |
| **I max.** | 1.5A | |
| **Size** | 101x119.5x94.7 | 101x119.5x119.3 |
| **Clock Speed** | 16MHz | |
| **Flash Memory** | 256KB of which 8KB used by bootloader | |
| **SRAM** | 8KB | |
| **EEPROM** | 4KB | |
| **Communications** | I2C – Ethernet Port – USB – WiFi &BLE – RS485 – RS232 -- SPI – (1x) Rx, Tx (Arduino pins) | Max232-Max485-W5500-ESP32 |
| **USB consideration!** | **Only meant for uploading or debugging, not always connected as a serial in a project!** | **Cannot be working in a final application** |
| **An/Dig Input 10bit** (0-10Vcc) | 0 to 10V<br>Input Impedance: 39K<br>Separated PCB ground | |
| **Digital Isolated Input** (24Vcc) | 7 to 24Vdc<br>I min: 2 to 12 mA<br>Galvanic Isolation | |
| *** Interrupt isolated Input HS** (24Vcc) | 7 to 24Vdc<br>I min: 2 to 12 mA<br>Galvanic Isolation | |
| **Analog Output 8bit** (0-10Vcc) | 0 to 10Vdc<br>I max: 20 mA<br>Separated PCB ground | |
| **Digital Isolated Output** (24Vcc) | 5 to 24Vdc<br>I max: 70 mA<br>Galvanic Isolation<br>Diode Protected for Relay | Imax 24Vdc: 410 mA |
| **PWM Isolated Output 8bit** (24Vcc) | 5 to 24Vdc<br>I max: 70 mA<br>Galvanic Isolation<br>Diode Protected for Relay | |
| **Expandability** | I2C - 127 elements - Serial Port RS232/RS485/WiFi/BLE | |
| *** By using this type of signal can no longer use Digital signal (24Vdc)** | | |

# 2 Technical Specifications:

## 2.1 General Specifications:

| Item | | M-DUINO B ZONE |
|---|---|---|
| **Power supply voltage** | **DC power supply** | 12 to 24Vdc |
| **Operating voltage range** | **DC power supply** | 11.4 to 25.4Vdc |
| **Power consumption** | **DC power supply** | 30VAC max. |
| **External power supply** | **Power supply voltage** | 24Vdc |
| | **Power supply output capacity** | 700Ma |
| **Insulation resistance** | | 20MΩ min.at 500Vdc between the AC terminals and the protective earth terminal. |
| **Dielectric strength** | | 2.300 VAC at 50/60 Hz for one minute with a leakage current of 10mA max. Between all the external AC terminals and the protective ground terminal. |
| **Shock resistance** | | 80m/s$^2$ in the X, Y and Z direction 2 times each. |
| **Ambient temperature (operating)** | | 0º to 45ºC |
| **Ambient humidity (operating)** | | 10% to 90% (no condensation) |
| **Ambient environment (operating)** | | With no corrosive gas |
| **Ambient temperature (storage)** | | -20º to 60ºC |
| **Power supply holding time** | | 2ms min. |
| **Weight** | | 552g max. |

## 2.2 Performance Specification:

| | |
|---|---|
| **Arduino Board** | **ARDUINO MEGA 2560** |
| **Control method** | Stored program method |
| **I/O control method** | Combination of the cyclic scan and immediate refresh processing methods. |
| **Programming language** | Arduino IDE. Based on wiring (Wiring is an Open Source electronics platform composed of a programming language. “similar to the C”. http://arduino.cc/en/Tutorial/HomePage |
| **Microcontroller** | ATmega2560 |
| **Flash Memory** | 256KB of which 8KB are used by the bootloader |
| **Program capacity (SRAM)** | 8KB |
| **EEPROM** | 4KB |
| **Clock Speed** | 16MHz |
| **Clock Speed** | 16MHz |

# 3 Precautions

Read this manual before attempting to use the WiFi & BLE PLC and follow its descriptions for reference during operation.

## 3.1 Arduino Board

The MDUINO PLC ARDUINO ETHERNET & WIFI & BLE 42 I/Os ANALOG/DIGITAL PLUS includes an Arduino Mega Board as controller and a ESP32 Dev programmable chip as a Wi-Fi & BLE gateway.

## 3.2 Intended Audience

This manual is intended for technicians, which must have knowledge on electrical systems.

## 3.3 General Precautions

The user must operate M-Duino according to the performance specifications described in this manual.

Before using the MDUINO PLC ARDUINO ETHERNET & WIFI & BLE 42 I/Os ANALOG / DIGITAL PLUS under different conditions from what has been specified in this manual or integrating into nuclear control systems, railroad systems, aviation systems, vehicles, combustion systems, medical equipment, amusement machines, safety equipment and other systems, machines, and equipment that may have a serious influence on lives and property if used improperly, consult your INDUSTRIAL SHIELDS representative. Ensure that the rating and performance characteristics of the Ethernet/WiFi/BLE Controller are sufficient for the systems, machines, and equipment, and be sure to provide the systems, machines, and equipment double safety mechanisms. This manual provides information for programming and operating the MDUINO PLC ARDUINO ETHERNET & WIFI & BLE 42 I/Os ANALOG / DIGITAL PLUS.

# 4 Software interface

Industrial Shields PLC are programmed using Arduino IDE, which is a software based on the C language. They can also be programmed using directly C but it is much easier working with Arduino IDE as it provides lots of libraries that helps in the programming.

Industrial Shields provides boards for programming the PLCs much easier. Basically it is no needed to define the pins and if that pins are inputs or outputs. Everything is set up automatically if using the boards.

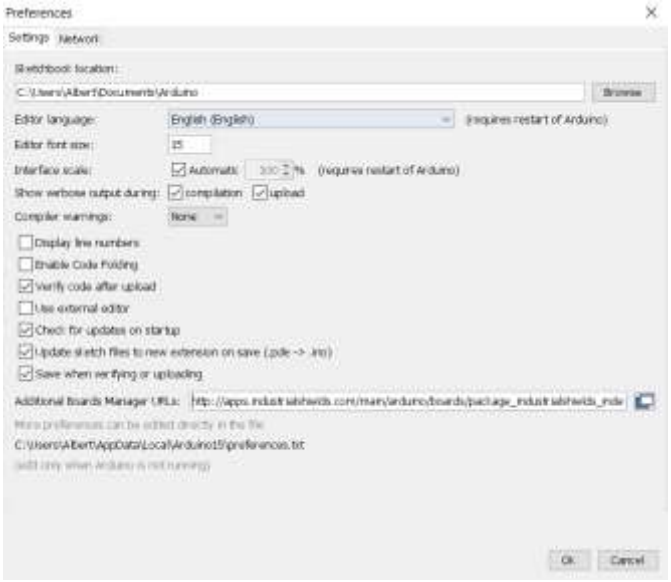
In order to install Industrial Shields boards, these are the steps that must be followed.

**Requirements:**

Arduino IDE 1.8.0 or above (better to have always the latest version).

**Steps:**

1. Open Arduino IDE and go to: “File -> Preferences” located in the top left corner.



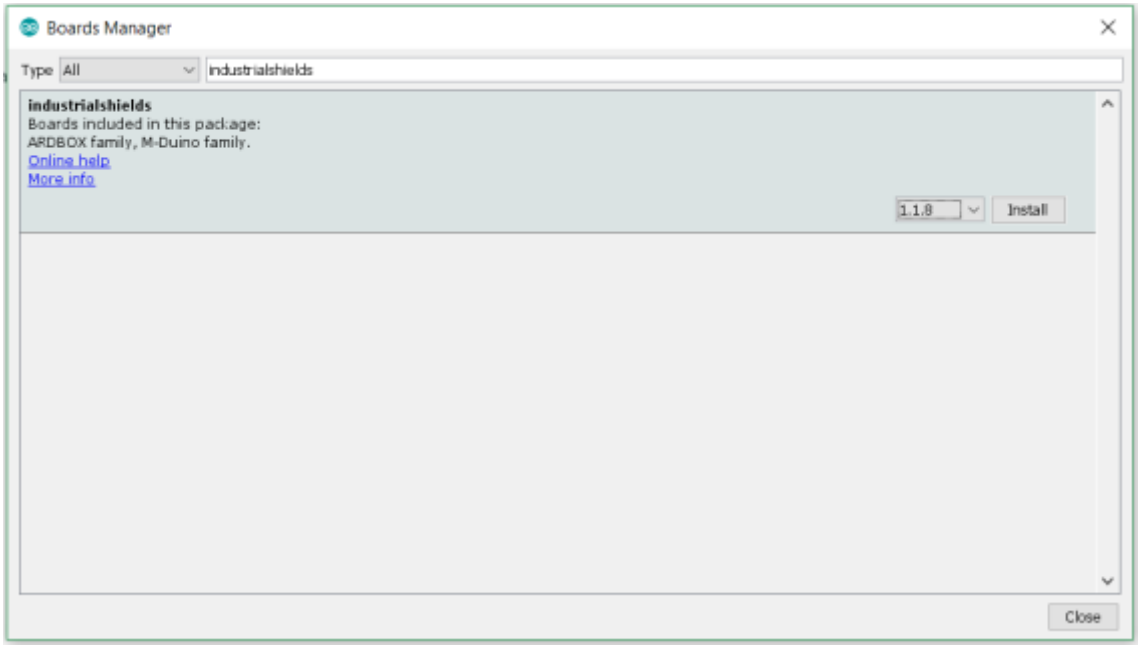

2. In Additional Boards Manager URLs write the following:

*http://apps.industrialshields.com/main/arduino/boards/package_industrialshields_index.json*

3. Press OK to save the changes.

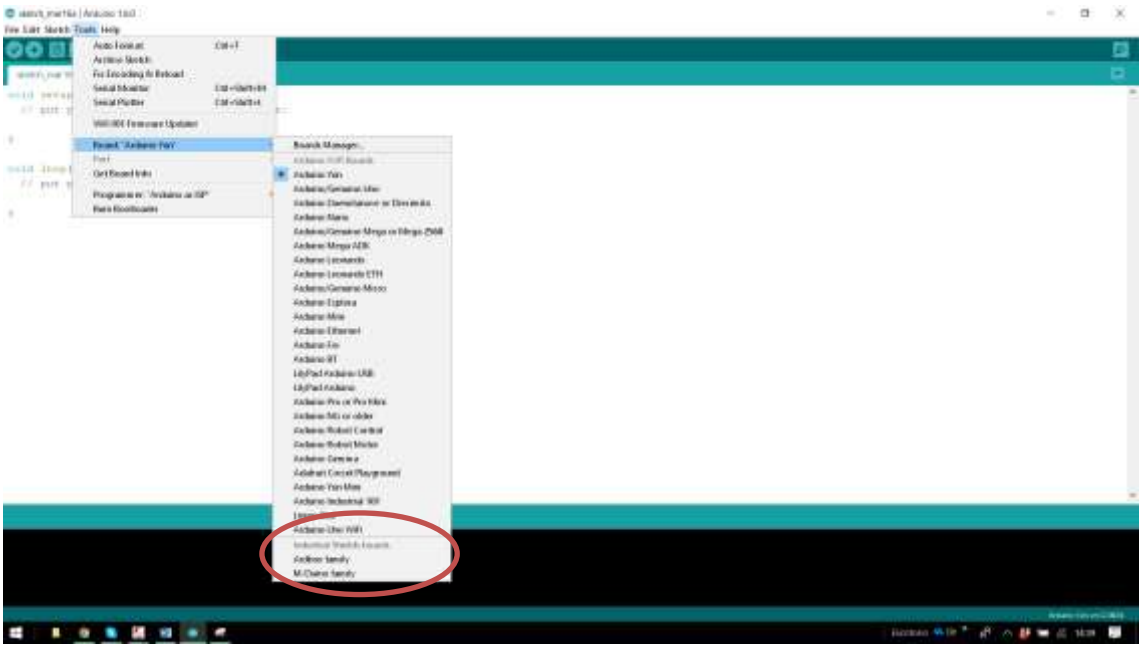
4. Go to: Tools -> Board: … -> Boards Manager

5. Search for “industrialshields” on the browser.



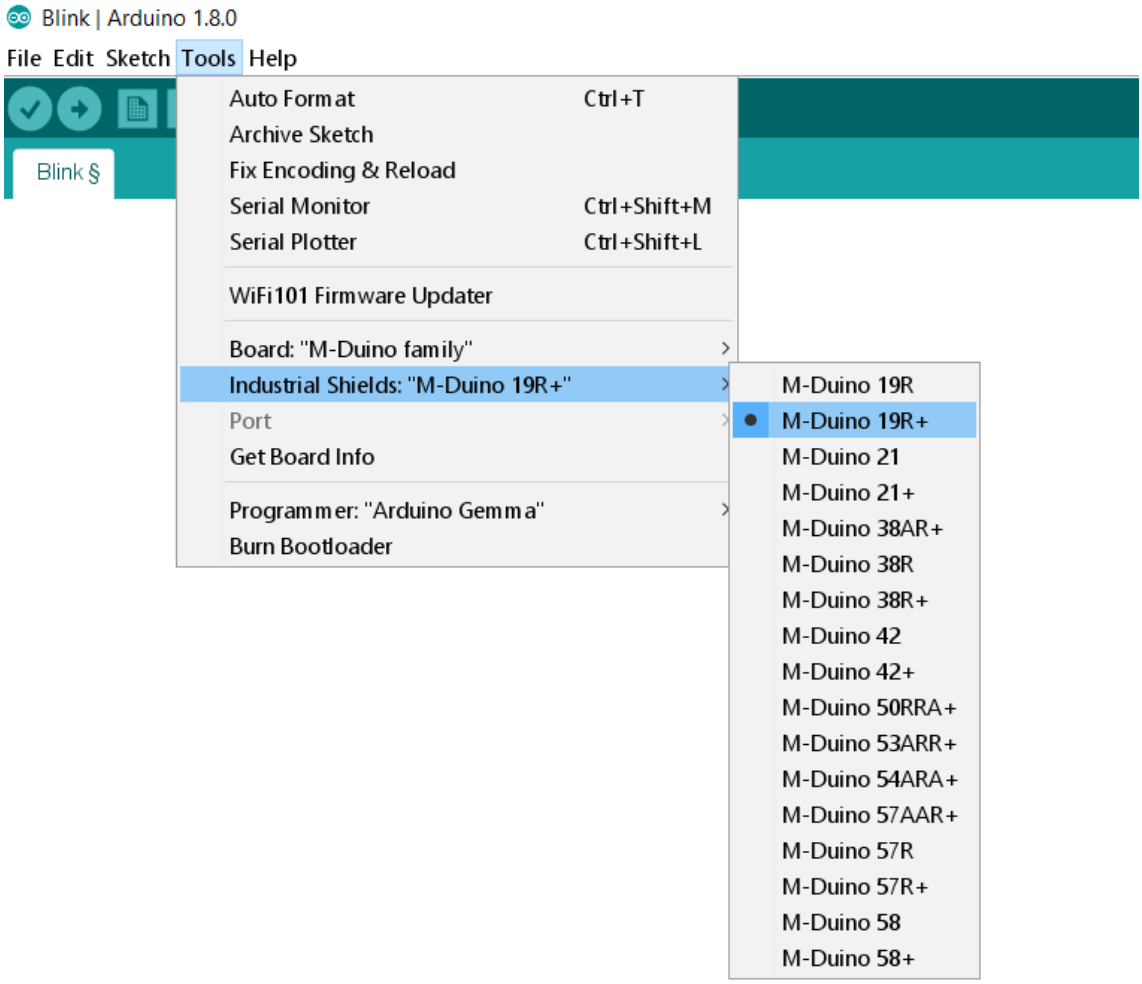

6. Click install (selecting the latest version).

Following these steps you will be able to see now the Industrial Shields Boards:



Once it is selected the Ardbox Family or M-Duino family an extra option will appear on Tools:

There, it can be selected the exact model for every family.




Also there are some examples of programming in File -> Examples -> M-Duino Family.

Furthermore there are some extra libraries that can be found in Industrial Shields github.

https://github.com/IndustrialShields/

# 5 How to connect PLC Arduino to PC

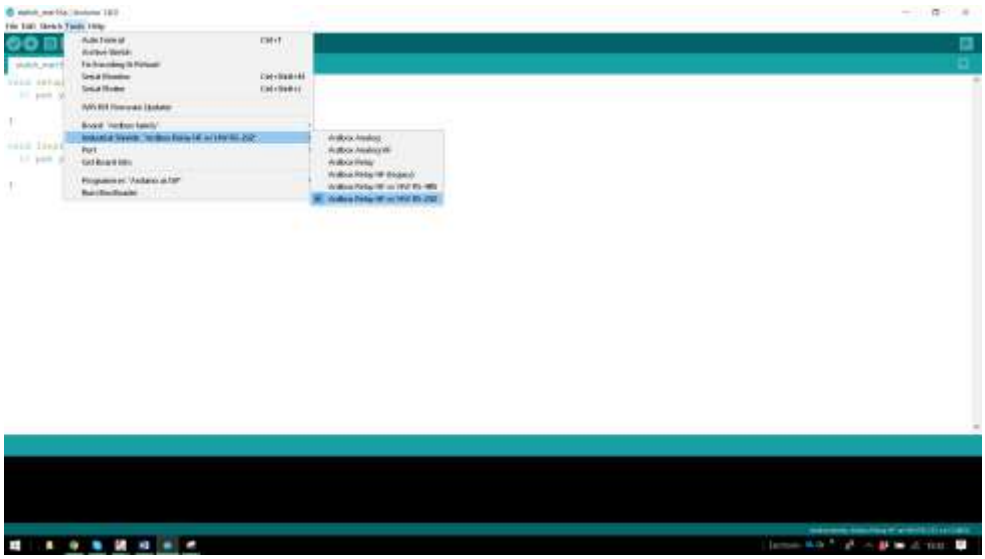
- Connect USB port from PLC to PC.

**NOTE:**
M-Duino Family uses USB-B cable.

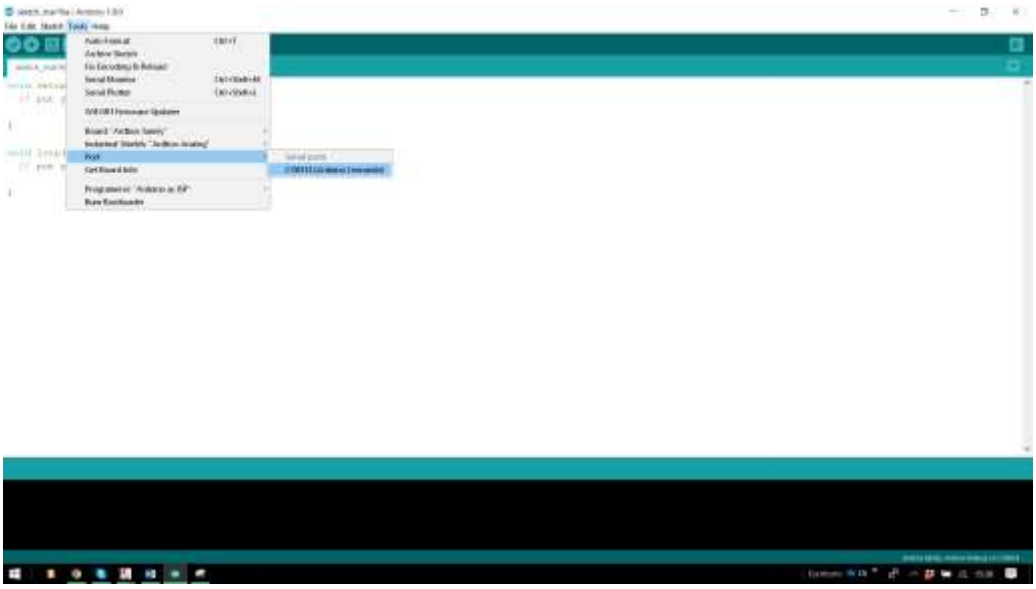
- Open Arduino IDE interface:

- Select Industrial Shields boards -> M-Duino Family

- Select the correct M-Duino Board:
  **M-Duino 42+**

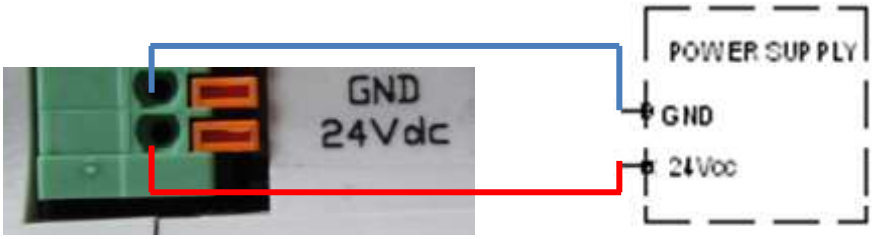


- Select correct port.



# 6 How to connect PLC to power supply

- M-Duino Family PLCs are 12-24Vdc supplied. IMPORTANT: The polarity **IS NOT REVERSAL!**
- Make sure that the live and GND connector of the power supply match the PLC.
- Make sure that the power supply mains output is not higher than 24Vdc.



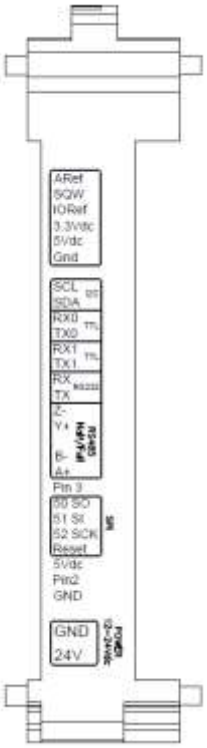

- Suggested power suppliers

* Not recommended for industrial applications. The *Jack* connector needs to be removed and use the live and GND connectors.

# 7 M-duino Family Pinout

## 7.1 A Zone connection

| Base (common unit) | | |
|---|---|---|
| A Zone | | |
| **M-Duino Connector** | *Arduino Pin* | Function |
| **SCL** | *21* | I2C/SS |
| **SDA** | *20* | I2C/SS |
| **RX0** | *1* | RX0/SS |
| **TX0** | *0* | TX0/SS |
| **RX1** | *19* | DON'T USE |
| **TX1** | *18* | DON'T USE |
| **TX** | *16* | RX2(serial 2) |
| **RX** | *17* | TX2(serial 2) |
| **Z-** | - | RS485 |
| **Y+** | - | RS485 |
| **B-** | - | RS485 |
| **A+** | - | RS485 |
| **PIN3** | *3* | Arduino Pin |
| **50 SO** | *50* | SPI |
| **51 SI** | *51* | SPI |
| **52 SCK** | *52* | SPI |
| **Reset** | *Reset* | SPI |
| **Vin5** | *Vin5* | 5V |
| **PIN2** | *2* | Arduino Pin |
| **GND** | - | Gnd |
| **GND** | - | Gnd |
| **24Vdc** | | Power Supply |



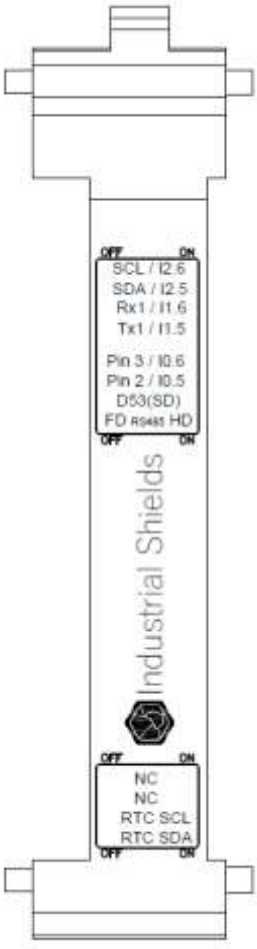

Configuration Switch* (see section 8 for configuring the communications. Enabling communications disables some I/Os)

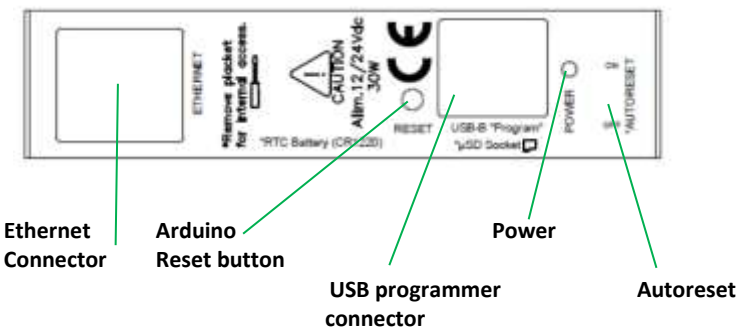
Communication Pins (**Serial 1 is used by the ESP32 Wi-Fi & BLE integrated module**)

Power supply connectors (24Vdc – GND)

SS: Chip Select pins. These pins can act as TTL, so they can work for the Chip Select pin of any device.

| Base (common unit) | | |
|---|---|---|
| A Zone | | |
| **M-Duino Connector** | *Arduino Pin* | Function |
| **AREF** | *AREF* | Arduino PIN |
| **IOREF2** | *IOREF2* | Arduino PIN |
| **IOREF1** | *IOREF1* | Arduino PIN |
| **7Vdc** | *7Vdc* | - |
| **GND** | *GND* | GND |
| **3.3Vdc** | *3.3Vdc* | Arduino PIN |
| **GND** | *GND* | GND |
| **5Vdc** | *5Vdc* | - |
| **GND** | *GND* | GND |

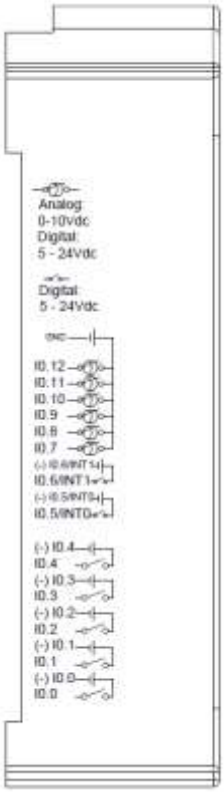





**NOTE: Autoreset. Arduino mega has auto reset when using serial communication code. Set switch to OFF when using serial communication. When uploading code to Arduino Mega set switch to ON.*

## 7.2 B Zone (Analog Shield)

| B Zone | | |
|---|---|---|
| **M-Duino Connector** | *Arduino Pin* | Function |
| **I0.12** | *59* | Analog/ Digital In |
| **I0.11** | *58* | Analog/ Digital In |
| **I0.10** | *57* | Analog/ Digital In |
| **I0.9** | *56* | Analog/ Digital In |
| **I0.8** | *55* | Analog/ Digital In |
| **I0.7** | *54* | Analog/ Digital In |
| **(-)I0.6/INT1** | - | GND I0.6 |
| **I0.6/INT1**[1] | *3* | Interrupt 1 In |
| **(-)I0.5/INT0** | - | GND I0.5 |
| **I0.5/INT0**[1] | *2* | Interrupt 0 In |
| **(-)I0.4** | - | GND I0.4 |
| **I0.4** | *26* | Digital Input |
| **(-)I0.3** | - | GND I0.3 |
| **I0.3** | *25* | Digital Input |
| **(-)I0.2** | - | GND I0.2 |
| **I0.2** | *24* | Digital Input |
| **(-)I0.1** | - | GND I0.1 |
| **I0.1** | *23* | Digital Input |
| **(-)I0.0** | - | GND I0.0 |
| **I0.0** | *22* | Digital Input |

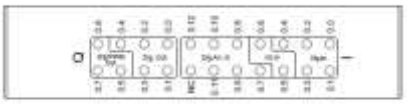



Analog/Digital Inputs

Interrupt Inputs (isolated)

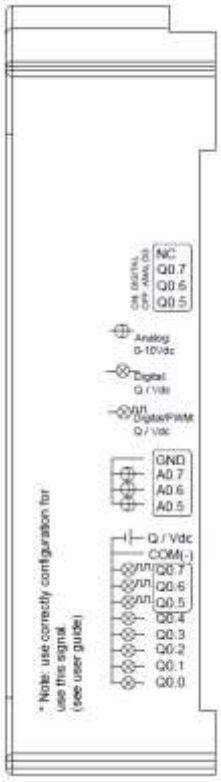
Digital Inputs (isolated)

Top Zone



Led indicator I/Os state

| B Zone | | |
|---|---|---|
| **M-Duino Connector** | *Arduino Pin* | Function |
| **GND** | *GND* | GND |
| **A0.7**[1] | *6* | Analog Out |
| **A0.6**[1] | *5* | Analog Out |
| **A0.5**[1] | *4* | Analog Out |
| **Q/Vdc** | - | External Isolated Out Vdc |
| **COM(-)** | - | External Isolated Out GND |
| **Q0.7**[1] | *6* | Digital/PWM Out |
| **Q0.6**[1] | *5* | Digital/PWM Out |
| **Q0.5**[1] | *4* | Digital/PWM Out |
| **Q0.4** | *40* | Digital Out |
| **Q0.3** | *39* | Digital Out |
| **Q0.2** | *38* | Digital Out |
| **Q0.1** | *37* | Digital Out |
| **Q0.0** | *36* | Digital Out |




Configuration Switch*
(see section 8 to select the correct configuration for outputs).

Analog Outputs

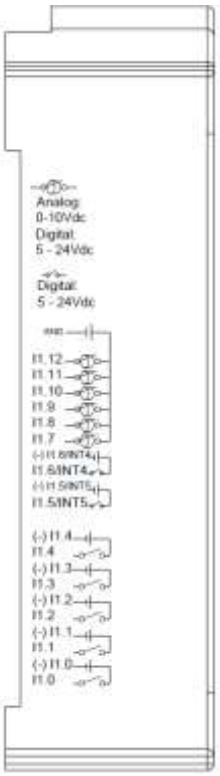
Voltage Supply/Reference for Digital/PWM Outputs (isolated)

PWM/Digital Outputs

[1] See section 8 to select suitable switch configuration for enable these connections.

## 7.3 C Zone (Analog Shield)

| C Zone | | |
|---|---|---|
| **M-Duino Connector** | *Arduino Pin* | Function |
| **I1.12** | *65* | Analog/ Digital In |
| **I1.11** | *64* | Analog/ Digital In |
| **I1.10** | *63* | Analog/ Digital In |
| **I1.9** | *62* | Analog/ Digital In |
| **I1.8** | *61* | Analog/ Digital In |
| **I1.7** | *60* | Analog/ Digital In |
| **(-)I1.6/INT1** | - | GND I1.6 |
| **I1.6/INT1[1]** | *19* | Interrupt 1 In |
| **(-)I1.5/INT0** | - | GND I1.5 |
| **I1.5/INT0[1]** | *18* | Interrupt 0 In |
| **(-)I1.4** | - | GND I1.4 |
| **I1.4** | *31* | Digital Input |
| **(-)I1.3** | - | GND I1.3 |
| **I1.3** | *30* | Digital Input |
| **(-)I1.2** | - | GND I1.2 |
| **I1.2** | *29* | Digital Input |
| **(-)I1.1** | - | GND I1.1 |
| **I1.1** | *28* | Digital Input |
| **(-)I1.0** | - | GND I1.0 |
| **I1.0** | *27* | Digital Input |

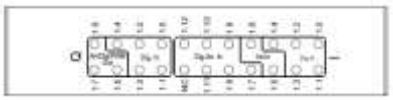



Analog/Digital Inputs

Interrupt Inputs (isolated)

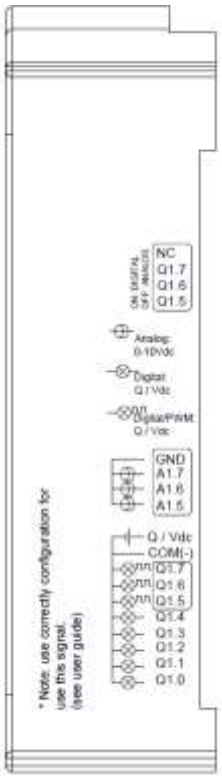
Digital Inputs (isolated)

Top Zone



Led indicator I/Os state

| C Zone | | |
|---|---|---|
| **M-Duino Connector** | *Arduino Pin* | Function |
| **GND** | *GND* | GND |
| **A1.7[1]** | *7* | Analog Out |
| **A1.6[1]** | *9* | Analog Out |
| **A1.5[1]** | *8* | Analog Out |
| **Q/Vdc** | - | External Isolated Out Vdc |
| **COM(-)** | - | External Isolated Out GND |
| **Q1.7[1]** | *7* | Digital/PWM Out |
| **Q1.6[1]** | *9* | Digital/PWM Out |
| **Q1.5[1]** | *8* | Digital/PWM Out |
| **Q1.4** | *45* | Digital Out |
| **Q1.3** | *44* | Digital Out |
| **Q1.2** | *43* | Digital Out |
| **Q1.1** | *42* | Digital Out |
| **Q1.0** | *41* | Digital Out |




Configuration Switch*
(see section 8 to select the correct configuration for outputs).

Analog Outputs

Voltage Supply/Reference for Digital/PWM Outputs (isolated)

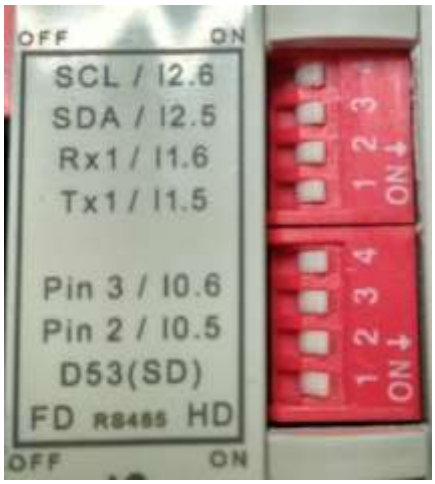
PWM/Digital Outputs

See section 8 to select suitable switch configuration for enable these connections

# 8 Switch Configuration

## 8.1 A Zone: Communications

| LEFT ZONE | | |
|---|---|---|
| Switch | ON | OFF |
| C ZONE | | |
| RX1/I1.6 | I1.6 | RX1 |
| TX1/I1.5 | I1.5 | TX1 |
| B ZONE | | |
| Pin 3/I0.6 | I0.6 | Pin 3 |
| Pin 2/I0.5 | I0.5 | Pin 2 |
| uSD & RS-485 | | |
| D53(SD) | Q2.0 | SD |
| FD RS-485 HD | HD | FD |




**4. SCL/I2.6: ALWAYS AT OFF POSITION.** On the MDUINO PLC ARDUINO ETHERNET & WIFI & BLE 42 I/Os ANALOG/DIGITAL PLUS Controller this switch is **not connected**.

**3. SDA/I2.5: ALWAYS AT OFF POSITION.** On the MDUINO PLC ARDUINO ETHERNET & WIFI & BLE 42 I/Os ANALOG/DIGITAL PLUS Controller this switch is **not connected**.

**2. RX1/I1.6:** Choosing between RX1 or the input I1.6. If this switch is ON, it enables the I1.6 input and disables the RX1. If this switch is OFF, it enables RX1 and disables I1.6.

**1. TX1/I1.5:** Choosing between TX1 or the input I1.5. If this switch is ON, it enables the I1.5 input and disables the TX1. If this switch is OFF, it enables TX1 and disables I1.5.

**4. Pin 3/I0.1:** Choosing between Pin 3 or the input I0.6. If this switch is ON, it enables the I0.6 input and disables the Pin 3. If this switch is OFF, it enables Pin 3 and disables I0.6.

**3. Pin 2/I0.0:** Choosing between Pin 2 or the input I0.5. If this switch is ON, it enables the I0.5 input and disables the Pin 2. If this switch is OFF, it enables Pin 3 and disables I0.5.

**2. D53(SD): ALWAYS AT OFF POSITION.** On a MDUINO PLC ARDUINO ETHERNET & WIFI & BLE 42 I/Os ANALOG/DIGITAL PLUS Controller this switch is **not connected**. It allows the uSD storage.

**1. FD RS-485 HD:** Choosing between FD or HF. If this switch is ON, it enables the Half Duplex (HD) option and disables the FD. If this switch is OFF, it enables Full Duplex (FD) and disables HD.

| LEFT ZONE | | |
|---|---|---|
| SWITCH | ON | OFF |
| NC | - | - |
| NC | - | - |
| RTC SCL | RTC | - |
| RTC SDA | RTC | - |

1. **RTC SDA:** This switch enables the communication to communicate with the RTC using I2C. Having this switch in ON mode it actives this communication, whereas if it is in OFF mode it disables the I2C to reach the RTC.

2. **RTC SCL:** This switch enables the communication to communicate with the RTC using I2C. Having this switch in ON mode it actives this communication, whereas if it is in OFF mode it disables the I2C to reach the RTC.

3. **NC:** Not connected. This switch is not connected to anything, it doesn't matter if it is in ON mode or OFF mode.

4. **NC:** Not connected. This switch is not connected to anything, it doesn't matter if it is in ON mode or OFF mode.

## 8.2 B Zone: Analog Shield

| B ZONE | | |
|---|---|---|
| SWITCH | ON | OFF |
| NC | - | - |
| Q0.7 | Q0.7 | A0.7 |
| Q0.6 | Q0.6 | A0.6 |
| Q0.5 | Q0.5 | A0.5 |

| C ZONE | | |
|---|---|---|
| SWITCH | ON | OFF |
| NC | - | - |
| Q1.7 | Q1.7 | A1.7 |
| Q1.6 | Q1.6 | A1.6 |
| Q1.5 | Q1.5 | A1.5 |

For the Analog Shield (Zone B & Zone C) if a switch is set to ON, it can only act as Digital Output. If it is set to OFF it can only act as an Analog Output.

If it is desired to use a Digital Output the pin must be set to ON and the pin that will provide this digital output is represented with Q0.X, being X any number of the tables above.

If it is desired to use an Analog Output the pin must be set to OFF and the pin that will provide this analog output is represented with A0.X, being X any number of the tables above.

# 9 I/Os 5V pins

The MDUINO PLC ARDUINO ETHERNET & WIFI & BLE 42 I/Os ANALOG/DIGITAL PLUS has some of the Mega board pins available. These pins can be programmed according to Arduino features such as I/Os operating at 5V or any additional features present in the pins (for example I2C communication in pins SCL and SDA). As this pins are directly connected to the Arduino Mega board they are not as well protect as the normal inputs. These pins are mainly meant to be used as prototyping.

The Arduino board available pins are summarized in the table below. In order to access some of these pins the configuration switch must be set to OFF position (see section 8) and some extra considerations must be taken in consideration when using these pins.

| M-Duino terminal | Arduino pin | Enable Arduino pin |
|---|---|---|
| SCL | 21 | Communication switch: OFF |
| SDA | 20 | Communication switch OFF |
| RX0 | 0 | |
| TX0 | 1 | |
| RX1 | 19 | DON'T USE! |
| TX1 | 18 | DON'T USE! |

| | | |
|---|---|---|
| MISO | 50 | |
| MOSI | 51 | |
| SCK | 52 | |
| Pin 3 | 3 | Communication switch: OFF |
| Pin 2 | 2 | Communication switch: OFF |

***IMPORTANT:** Do not connect the terminals in the chart above to voltages higher than 5V. These terminals provide direct access to the Mega board.

A part from the switch configuration there are some special conditions depending on these 5V. Now it is going to be shown the considerations to operate with these pins.

In the WiFi & BLE Controller, Serial 1(Tx1 & Rx1) is used to communicate through the ESP32 integrated in the MDUINO PLC ARDUINO ETHERNET & WIFI & BLE 42 I/Os ANALOG/DIGITAL PLUS.

## 9.1 I2C pins – SDA/SCL

The I2C protocol is meant to work in a pull-up configuration. A pull-up configuration means that when the pin is at rest (nothing connected to it) it always reads a HIGH value. In this case it reads 5V when nothing is connected. The pull-up configuration is stablished by default in these pins.

If it is meant to work them as a GPIO at 5V, it has to be considered that they are pull-up inputs.

*IMPORTANT: I2.5 & I2.6 are not pull-up inputs although they are referred to the I2C pins (switch configuration). There is a “reverse pull-up circuit “that is stablished in order to have the same behaviour as the other inputs.

## 9.2 Serial 0 – RX0/TX0

The Serial0 protocol can work also as a 5V pin. These pins should be used ultimately, only in case that all the 5V pins are already performing a function. This is because they are shared with the USB interface. If using these pins, the USB communication cannot be working at the same time. When the PLC is not installed, the USB communication is normally required for debugging, uploading and intercommunicating with the Ethernet controller. If using both interfaces at the same time the Arduino board will get blocked.

These pins are not stablished with a pull-up or a pull-down configuration. The state of these pins is unknown. If these pins must be used, they require a pull-up or a pull-down configuration. The Arduino board allows the pins to be set in a pull-up configuration. If not it must be stablished an external pull-up or pull-down circuit in order to correctly work with these pins.

## 9.3 Serial 1 – RX1/TX1

In the WiFi & BLE Controller, Serial 1 is used to communicate through the ESP32 integrated in the MDUINO PLC ARDUINO ETHERNET & WIFI & BLE 42 I/Os ANALOG/DIGITAL PLUS.

**DON'T USE SERIAL 1**

## 9.4 SPI – MISO/MOSI/SCK

These pins can only work as a 5V pins if the Ethernet protocol is not going to be used. As the Ethernet protocol uses the SPI to communicate with the Arduino board, both behaviours cannot happen at the same time as the Ethernet would not work.

These pins are not stablished with a pull-up or a pull-down configuration. The state of these pins is unknown. If these pins must be used, they require a pull-up or a pull-down configuration. The Arduino board allows the pins to be set in a pull-up configuration. If not it must be stablished an external pull-up or pull-down circuit in order to correctly work with these pins.

## 9.5 Pin 2/Pin 3

These pins are only referred to the inputs I0.5/I0.6. If the switch configuration is in OFF position the pins Pin 2/Pin 3 will be available.

These pins are not stablished with a pull-up or a pull-down configuration. The state of these pins is unknown. If these pins must be used, they require a pull-up or a pull-down configuration. The Arduino board allows the pins to be set in a pull-up configuration. If not it must be stablished an external pull-up or pull-down circuit in order to correctly work with these pins.

# 10 A Zone Features: Communications & RTC & uSD

## 10.1 RS-232

The Arduino Mega function code to access the RS-232 port in the M-Duino is Serial2 (pins 16 and 17 of the Arduino Mega).

For the RS-232 communication protocol there isn't any switch that affects it. So it does not matter the configuration of the switches to implement a RS-232 communication.

Using the boards of Industrial Shields, there is a library that simplifies the RS-232 implementation.

## 10.2 RS-485

For RS485 communication protocol the defined Arduino Mega pins are showed in the chart below.

| Function | Arduino Pin |
|---|---|
| DI | 14 |
| RO | 15 |
| RE | 11 |
| DE | 46 |

For the RS-485 communication protocol there is only one switch that affects in this communication. The RS-485 protocol will be always enabled, the only switch that affects is the one called "FD rs-485 HD" (See Section 8). This switch makes the choosing between RS-485 Half Duplex or RS-485 Full Duplex (RS-422).

Using the boards of Industrial Shields, there is a library that simplifies the RS-485 implementation.

## 10.3 I2C

I2C communication **DOES NOT REQUIRE** a pull-up resistor for the M-Duino Family. The pull-up resistor is already implemented in the PCB.

I2C communication is configured by switches, so the switches must be configured in order to enable the I2C communication.

To enable I2C the switches SCL/I2.6(I2.1) & SDA/I2.5(I2.0) must be set to OFF mode. In this mode the inputs are totally disabled and the I2C is now enabled.

Industrial Shields does not provide any library to implement the I2C as it can be used the standard library of Arduino called Wire.

## 10.4 SPI

The M-Duino pins used for the SPI bus are summarized in the table below. For SPI bus MISO, MOSI and CLOCK pins are common to all the connected devices to the M-Duino, conversely, each of the connected devices will have a single and dedicated SS pin.

| Function | M-Duino connection | Mega board pin |
|---|---|---|
| MISO | 50 S0 | 50 |
| MOSI | 51 SI | 51 |
| CLOCK | 52 SCK | 52 |
| Reset | Reset | Reset |
| SS | SCL/SDA/RX0/TX0/RX1/TX1/RX3/TX3/Pin2/Pin3 | 21/20/1/0/19/18/15/14/2/3 |

Check the switch configuration at section 8 to enable SS pins.

## 10.5 TTL

M-Duino has one TTL port, RX0/TX0 (RX1/TX1 is used for Wi-Fi and BLE communication). TTL0 is accessed with the function Serial (pins 0 and 1 of the Arduino Mega).

## 10.6 Ethernet

M-Duino Ethernet port controller is based on w5500 IC, which is the compatible IC compatible with Arduino Ethernet2 Shield libraries. All Ethernet shield Arduino libraries are compatible with the M-Duino. In the M-Duino, W5500 IC communicates to the Mega board via SPI bus (SS Arduino Mega pin 10).

## 10.7 RTC

M-Duino RTC Module is based on the DS1307 Chip. This chip works with the I2C protocol communication, so it is required to have enabled the I2C protocol.

4 switches have to be configured in order to enable the RTC features:

| LEFT ZONE | | |
|---|---|---|
| SWITCH | ON | OFF |
| NC | - | - |
| NC | - | - |
| RTC SCL | RTC | - |
| RTC SDA | RTC | - |

RTC SCL & RTC SDA must be set to ON mode to enable the I2C wires to the RTC. If they are in OFF mode, the Arduino won't communicate with the RTC.

| Switch | Analog Shield | |
|---|---|---|
| | ON | OFF |
| SCL/I2.6 | I2.6 | SCL |
| SDA/I2.5 | I2.5 | SDA |

I2C must be enabled in order to communicate with the RTC. See section 11 I2C to enable it.

Using the boards of Industrial Shields, there is a library that simplifies the RTC implementation called RTC.

### 10.8 uSD

The micro SD uses the SPI communication to interact with the Arduino Mega. The SPI protocol is always enabled, as there are no switches that configure it. However, there is a switch that must be placed to ON mode in order to communicate with the uSD:

D53(SD): If this Switch is OFF, it enables the Chip Select of the microSD socket and disables Q2.0. If this switch is ON, it enables the Q2.0 output. If the switch is in ON mode the microSD can't be used.

The uSD socket is found in the TOP part of the communication Shields, so in the frontal part of the PLC, it is required to open the plastic found in the frontal part and the socket is located under the supply of the Arduino.

| Switch | Analog Shield | |
|---|---|---|
| | ON | OFF |
| D53(SD) | Q2.0 | D53(SD) |

Using the boards of Industrial Shields, there is a library that simplifies the uSD implementation called SD. It is the same as the Arduino library, with the only modification of using the pin 53 to select the Chip Select of the uSD chip.

## 10.9 WiFi & BLE

The WiFi and Bluetooth integrated module consists in a single 2.4 GHz Wi-Fi and Bluetooth combo chip designed with the TSMC ultra-low-power 40 nm technology. It is designed to achieve the best power and RF performance, showing robustness, versatility and reliability in a wide variety of applications and power scenarios. Some applications are Generic Low-power IoT Sensor Hub, Generic Low-power IoT Data Loggers and Mesh Network.
It is designed for Internet-of-Things (IoT) applications.

### 10.9.1 General Specifications:

**Wi-Fi**

- 802.11 b/g/n
- 802.11 n (2.4 GHz), up to 150 Mbps

**Bluetooth**

- Bluetooth 4.2 BR/EDR BLE dual mode controller
- +12 dBm transmitting power
- NZIF receiver with -97 dBm BLE sensitivity

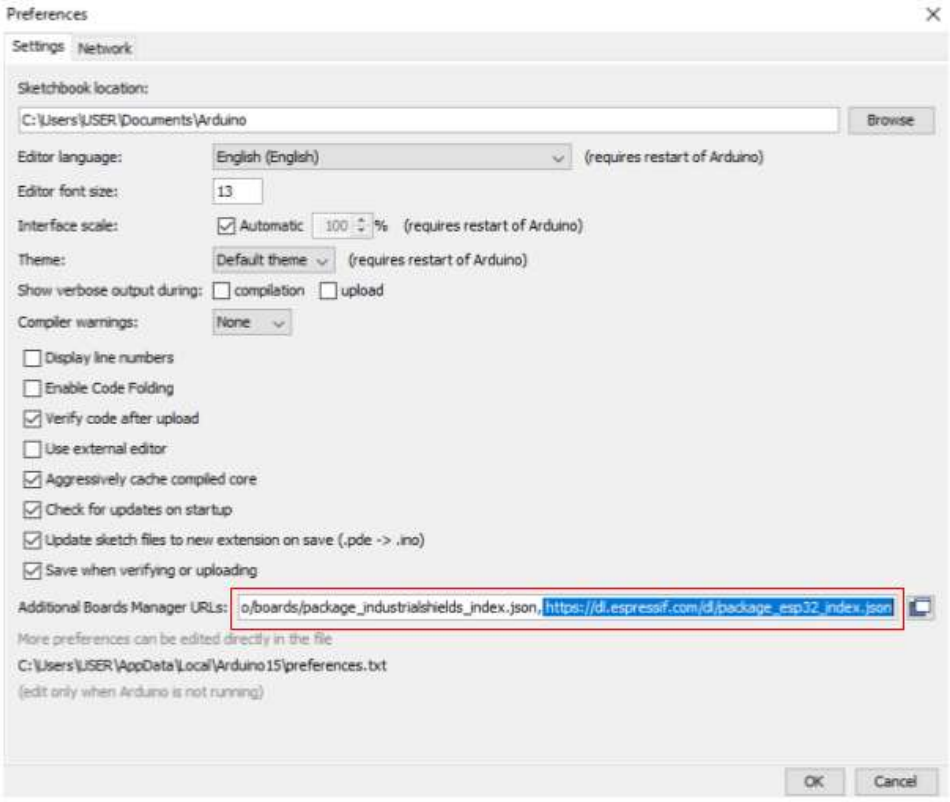
### 10.9.2 WiFi & Bluetooth Module Configuration

In order to configure the WiFi & BLE module, you must connect it to a PC.
To connect it you will need a micro USB to USB cable.

The slot for the micro USB input is located on the right side of your equipment.

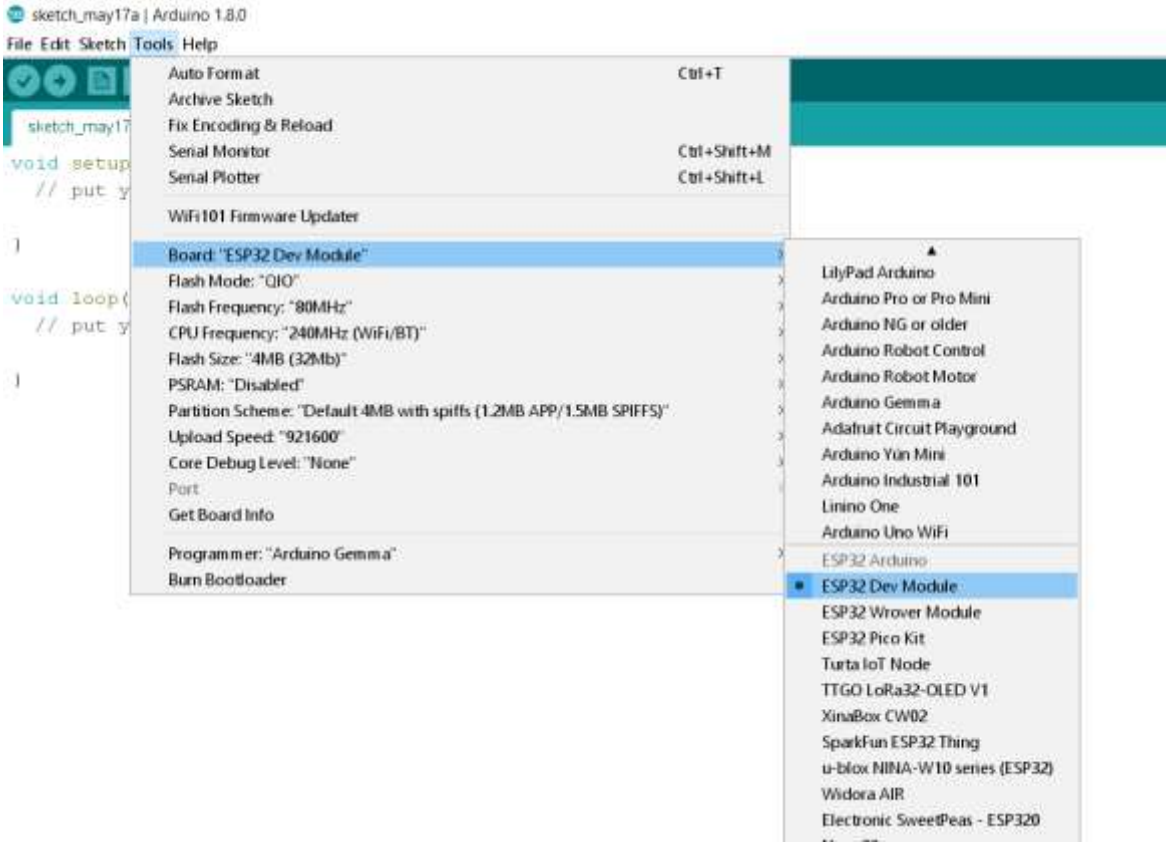
To load the program into the ESP32 you have to install the board on the Arduino IDE software.
Go to File > Preferences and into Additional Boards Manager URLs add the next
URL: https://dl.espressif.com/dl/package_esp32_index.json

*If you already have one URL put it next to the other separeted by coma, like in the image below.




Now you are able to install the board. Go to *Tools* > *Boards* > *Boards Manager* and search by ESP32.
Will appear the esp32 by Espressif Systems. Install it.

Once it is installed go to *Tools* > *Boards* and choose **ESP32 Dev Module**




The internal connections between the ESP32 module and the Arduino Mega are the following:

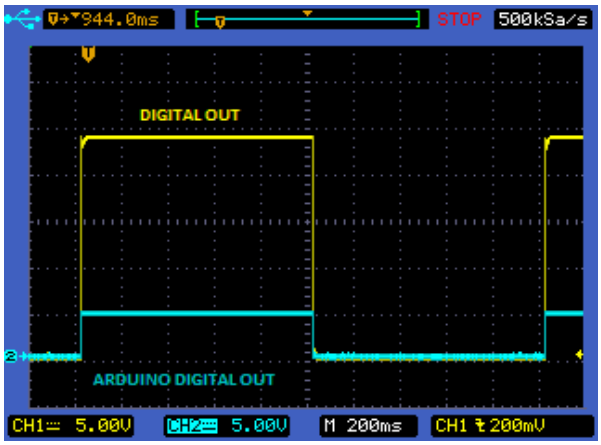
| Arduino Mega Pinout | ESP32 Pinout |
|---|---|
| 5Vdc | Vcc |
| GND | GND |
| Tx1 (Pin 18) | TxD |
| Rx1 (Pin19) | RxD |

WiFi and Bluetooth are always enabled as there are no switches that configure it.

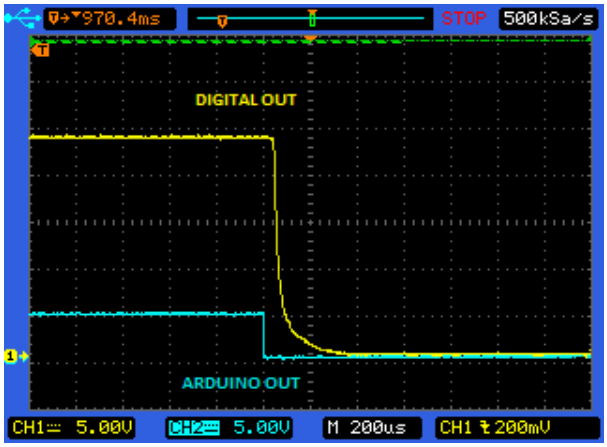
The WiFi and Bluetooth module uses Serial1 for communication.

# 11 I/O technical details:

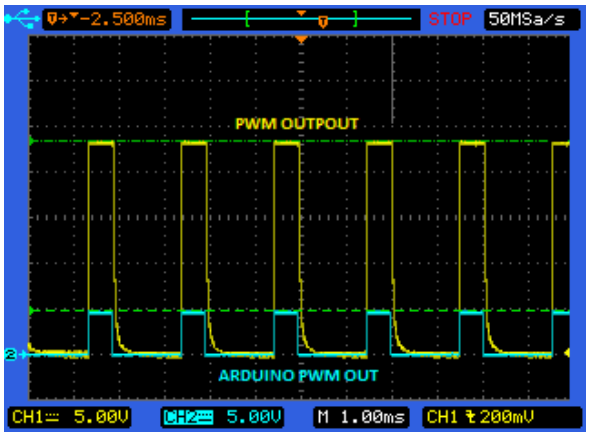
Digital Output Waveform:



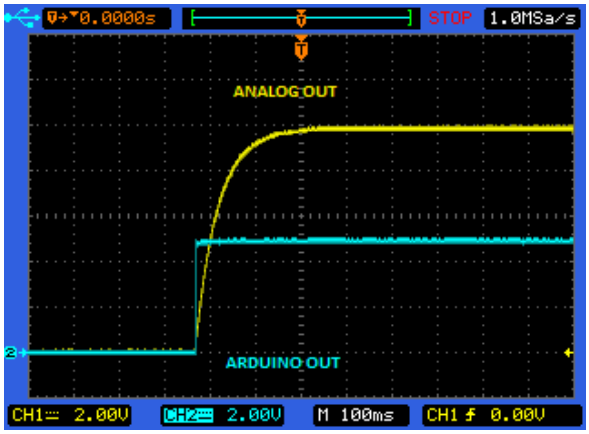

Digital Out-put Turn-off:



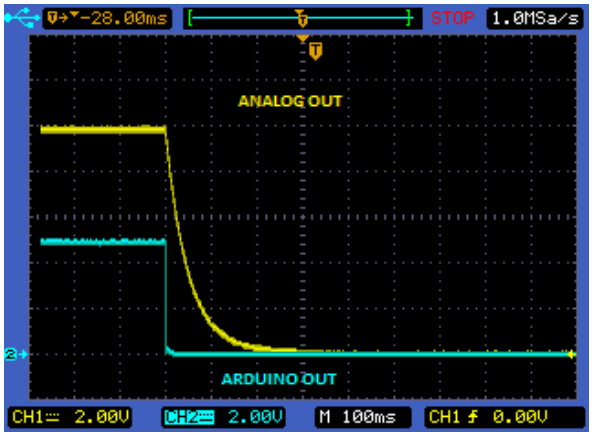

PWM Waveform:



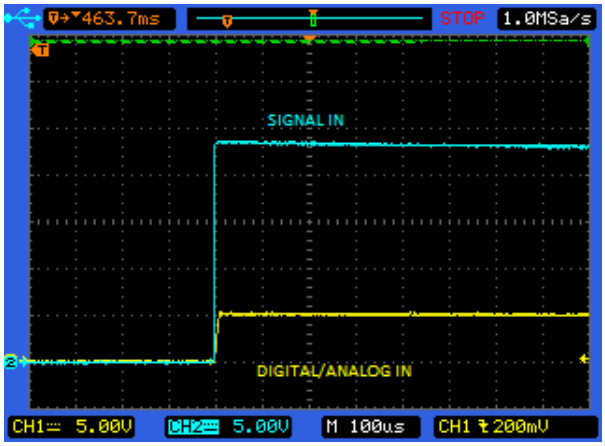
Analog Out Turn On:



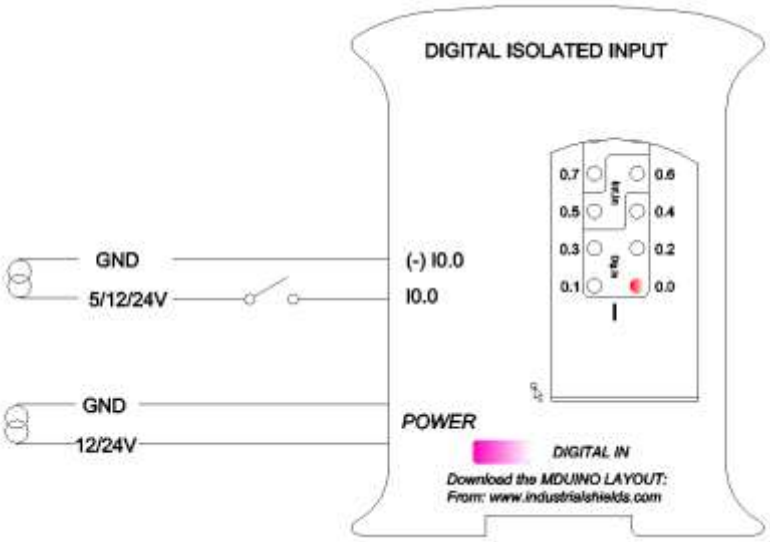

Analog Out Turn-Off:

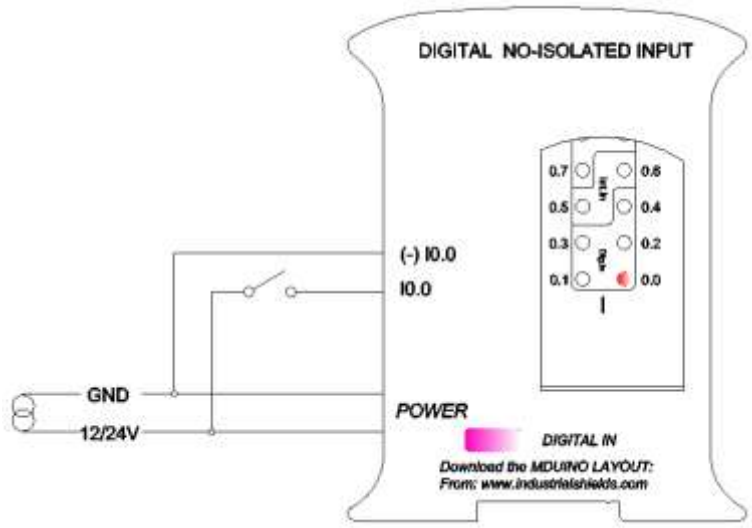


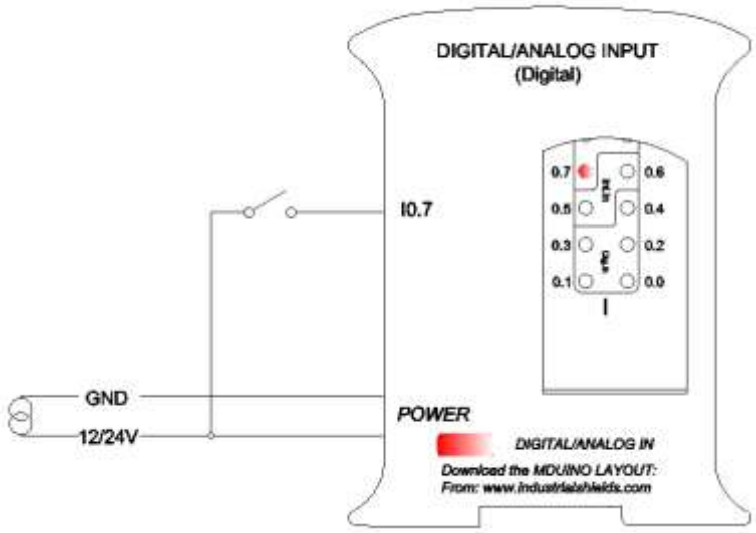

Analog /Digital input Turn-on:

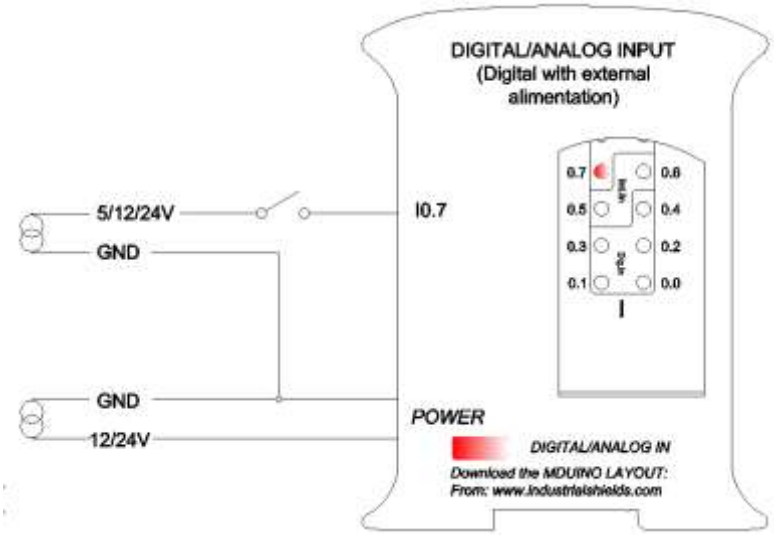


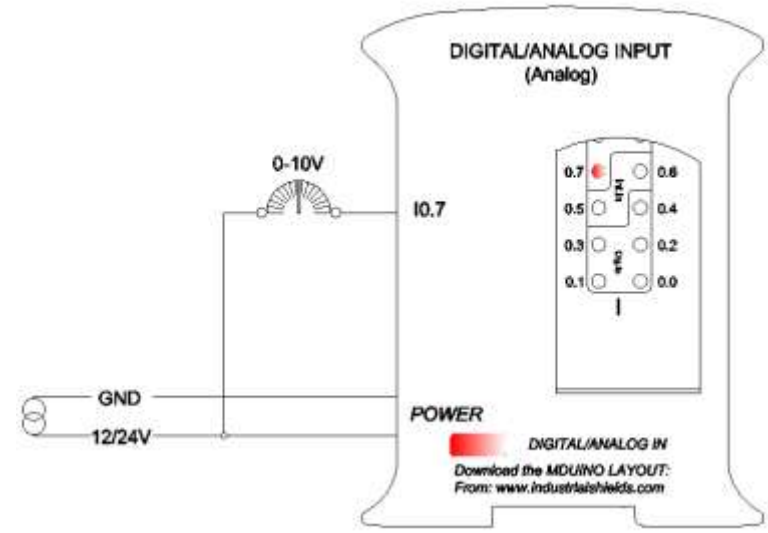
## 12 Typical Connections

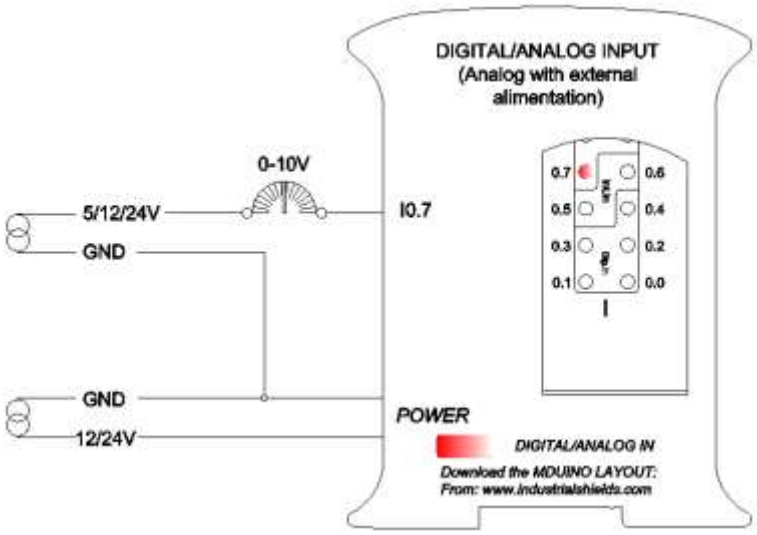


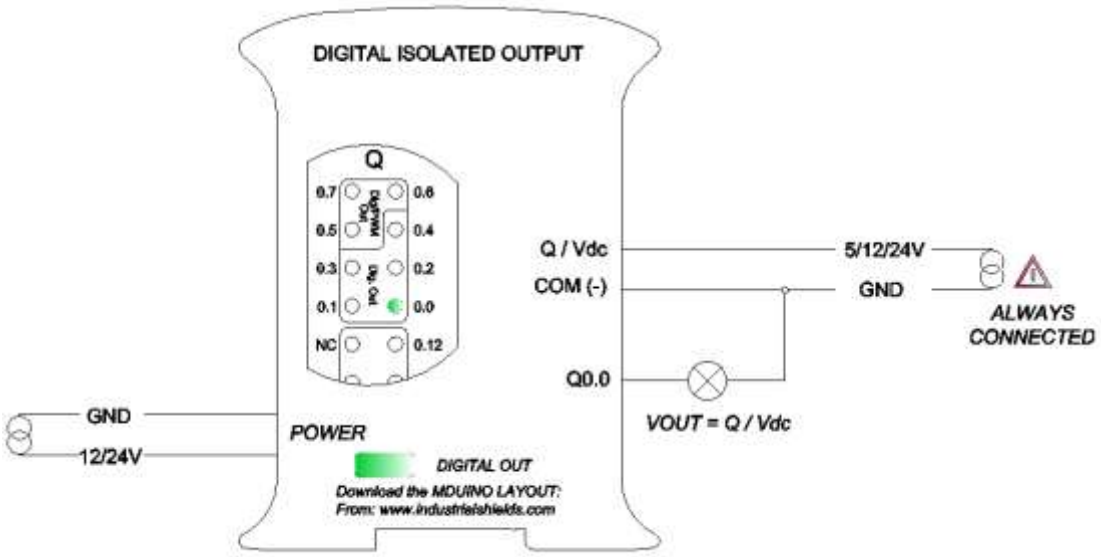



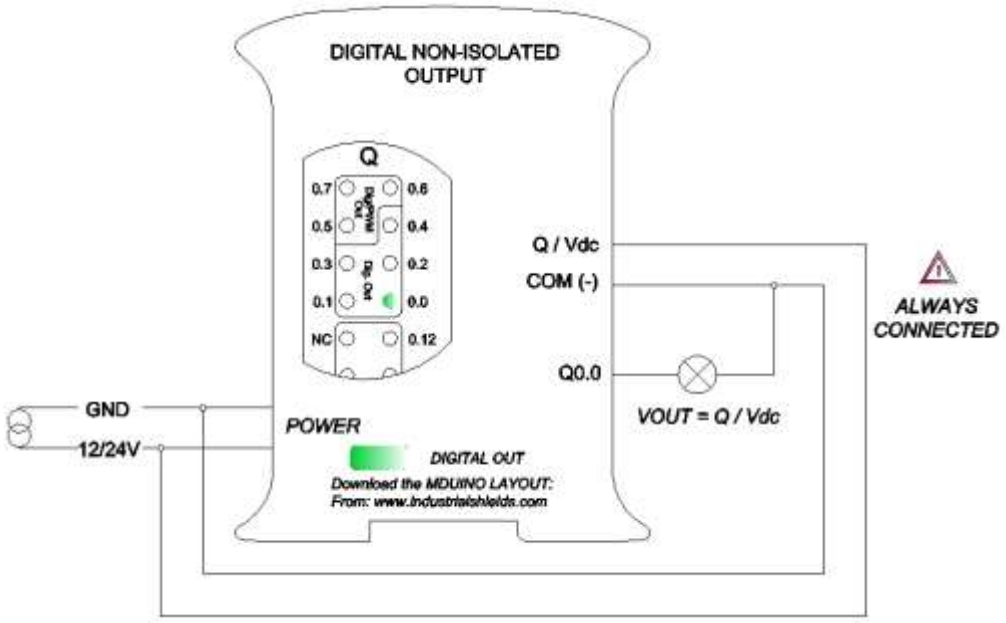



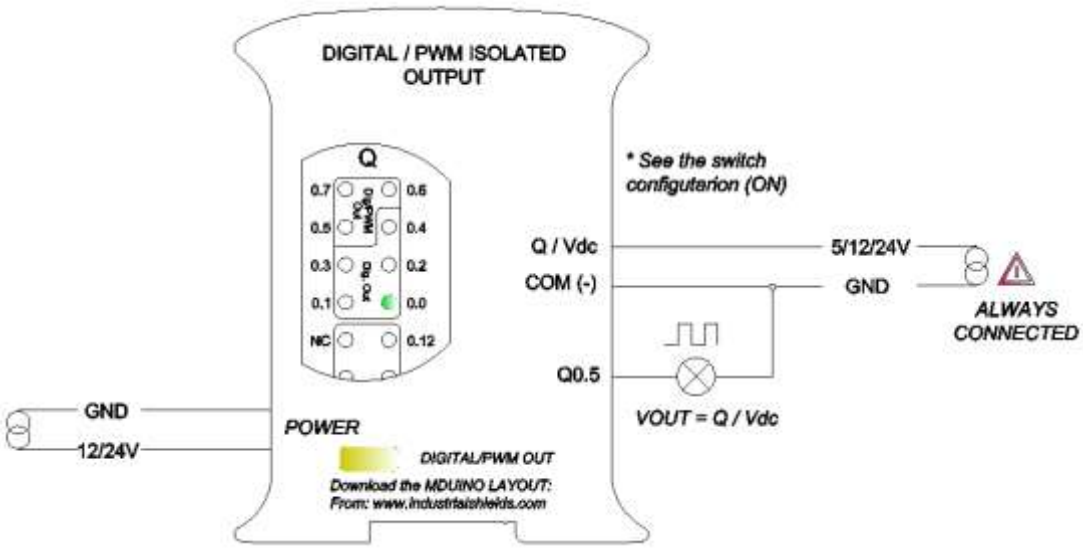

DIGITAL/ANALOG INPUT
(Digital with external
alimentation)
5/12/24V
GND
GND
12/24V
I0.7
POWER
DIGITAL/ANALOG IN
Download the MDUINO LAYOUT:
From: www.industrialshields.com
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
I

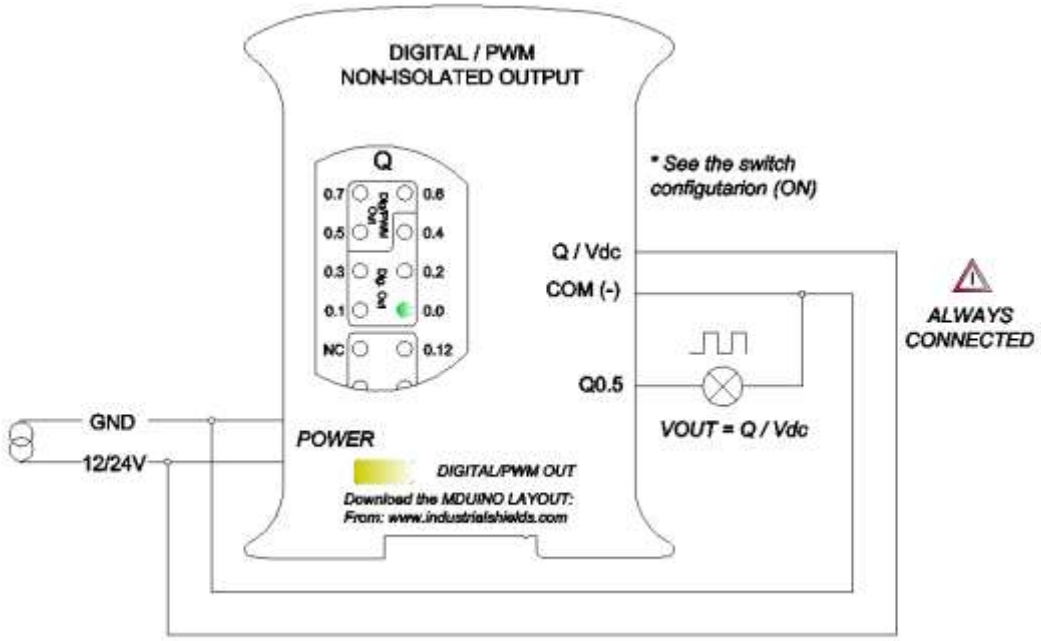

DIGITAL/ANALOG INPUT
(Analog)
0-10V
I0.7
GND
12/24V
POWER
DIGITAL/ANALOG IN
Download the MDUINO LAYOUT:
From: www.industrialshields.com
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
I

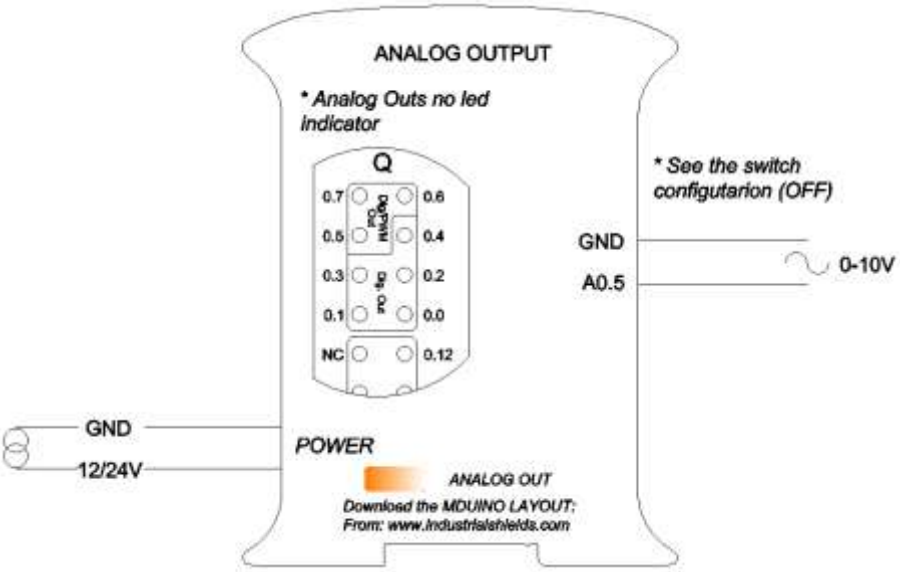

DIGITAL/ANALOG INPUT
(Analog with external
alimentation)
0-10V
5/12/24V
GND
GND
12/24V
I0.7
POWER
DIGITAL/ANALOG IN
Download the MDUINO LAYOUT:
From: www.industrialshields.com
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
I


DIGITAL ISOLATED OUTPUT
Q
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
NC
0.12
Dig. Out
PWM Out
Q / Vdc
COM (-)
5/12/24V
GND
ALWAYS CONNECTED
Q0.0
VOUT = Q / Vdc
GND
12/24V
POWER
DIGITAL OUT
Download the MDUINO LAYOUT:
From: www.industrialshields.com


DIGITAL NON-ISOLATED OUTPUT
Q
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
NC
0.12
Dig. Out
PWM Out
Q / Vdc
COM (-)
ALWAYS CONNECTED
Q0.0
VOUT = Q / Vdc
GND
12/24V
POWER
DIGITAL OUT
Download the MDUINO LAYOUT:
From: www.industrialshields.com


DIGITAL / PWM ISOLATED OUTPUT
Q
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
NC
0.12
Dig. Out
PWM Out
* See the switch configuration (ON)
Q / Vdc
COM (-)
5/12/24V
GND
ALWAYS CONNECTED
Q0.5
VOUT = Q / Vdc
GND
12/24V
POWER
DIGITAL/PWM OUT
Download the MDUINO LAYOUT:
From: www.industrialshields.com


DIGITAL / PWM
NON-ISOLATED OUTPUT
Q
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
NC
0.12
Dig Out
PWM
* See the switch
configuration (ON)
Q / Vdc
COM (-)
Q0.5
VOUT = Q / Vdc
ALWAYS
CONNECTED
GND
12/24V
POWER
DIGITAL/PWM OUT
Download the MDUINO LAYOUT:
From: www.industrialshields.com


ANALOG OUTPUT
* Analog Outs no led
indicator
Q
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
NC
0.12
Dig Out
PWM
* See the switch
configuration (OFF)
GND
A0.5
0-10V
GND
12/24V
POWER
ANALOG OUT
Download the MDUINO LAYOUT:
From: www.industrialshields.com

# 13 Connector details:

The connector inside the PLCs that mounts on the PCB is  MC 0,5/10-G-2,5 THT – 1963502 from Phoenix contact. MC0,5/10-G-2,5THT

For I/O and power supply there is a FK-MC 0,5/10-ST-2,5 - 1881406 connector from Phoenix contact. FK-MC 0,5/10-ST-2,5

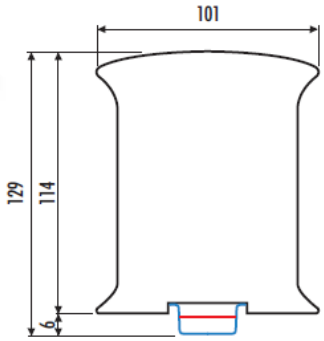
Connection details:

| **Article reference** | MC 0,5/10-G-2,5 THT |
|---|---|
| **Height** | 8,1mm |
| **Pitch** | 2,5mm |
| **Dimension** | 22,5mm |
| **Pin dimensions** | 0,8x0,8mm |
| **Pin spacing** | 2,50mm |

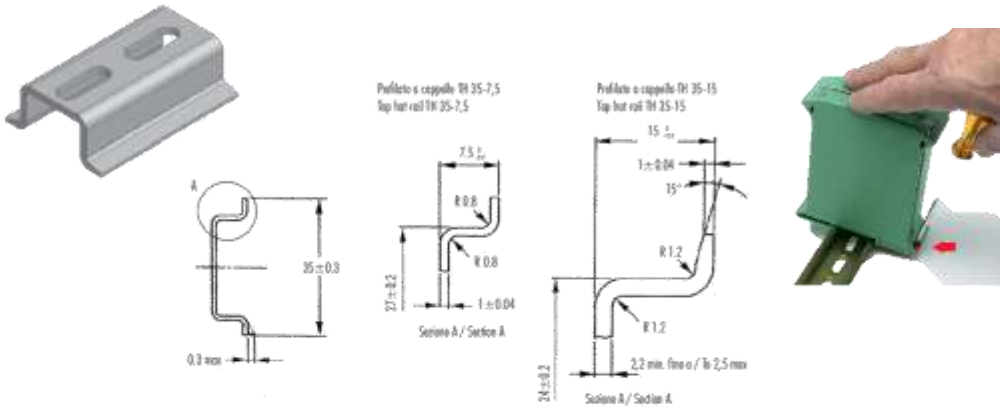
| **Article reference** | FK-MC 0,5/10-ST-2,5 |
|---|---|
| **Rigid conduit section min.** | 0,14 mm² |
| **Rigid conduit section max.** | 0,5 mm² |
| **Flexible conduit section min.** | 0,14 mm² |
| **Flexible conduit section max.** | 0,5 mm² |
| **Conduit section AWG/kcmil min.** | 26 |
| **Conduit section AWG/kcmil max.** | 20 |

# 14 Mechanical Characteristics

- **Dimension :**




- **DIN Rail mounting**




| CARATTERISTICHE | | METODO | UNITA' DI MISURA | BLEND PC/ABS |
|---|---|---|---|---|
| Meccaniche | Resistenza a trazione allo snervamento | ASTM D638 | MPa | 68 |
| | Resistenza a trazione a rottura | ASTM D638 | MPa | 48 |
| | Allungamento a rottura | ASTM D638 | % | 50 |
| | Modulo in flessione | ASTM D790 | MPa | 2094 |
| | Prove Izod con intaglio | ISO 180/1A | KJ/m² | 5.5 |
| Termiche | Temp. di rammollimento Vicat, metodo B | ASTM D1525 | °C | 114 |
| | Temperatura filante 1.81 MPa | ASTM D648 | °C | 97 |
| Fisiche | Peso specifico | ASTM D792 | gr/cm3 | 1.21 |
| | Ritiro nello stampo | ASTM D955 | % | 0.4/0.6 |
| | Melt Flow Index 260°C - 90N | ASTM D1238 | gr/10' | 11.1 |
| Comportamento alla Fiamma | Autoestinguenza (min di spessore) | UL94 | - | V-0 (0.8) |
| | Filo Incandescente, 3.2 mm | IEC695.2.1 | °C | 960 |

Italmusic si riserva il diritto di modificare il materiale con cui realizza i propri prodotti senza obbligo di preavviso.

| FEATURES | | TEST METHOD | UNITS | BLEND PC/ABS |
|---|---|---|---|---|
| Mechanical test | Resistance to tensile stress at yield | ASTM D638 | MPa | 68 |
| | Tensile strength | ASTM D638 | MPa | 48 |
| | Ultimate elongation | ASTM D638 | % | 50 |
| | Flexing modulus | ASTM D790 | MPa | 2094 |
| | Izod test notched | ISO 180/1A | KJ/m² | 5.5 |
| Thermal test | Vicat softening temperature method B | ASTM D1525 | °C | 114 |
| | Deflecting temperature 1.81 MPa | ASTM D648 | °C | 97 |
| Physical test | Specific gravity | ASTM D792 | gr/cm3 | 1.21 |
| | Mould shrinkage | ASTM D955 | % | 0.4/0.6 |
| | Melt Flow Index 260°C - 90N | ASTM D1238 | gr/10' | 11.1 |
| Flame test | Self extinguishing (thickness in mm) | UL94 | - | V-0 (0.8) |
| | Incandescent wire 3.2 mm | IEC695.2.1 | °C | 960 |

Italmusic can operate any change of the materials without being obliged to forewarn.

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