



INDUSTRIAL SHIELDS

M-DUINO FAMILY

M-Duino Family User Guide:



Ethernet PLC User Guide

Revised March 2018

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 DESIGNED 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 DESIGNED 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 machine, 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

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 must 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 establish 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, EXPRESS OR IMPLIED, REGARDING MERCHANTABILITY, 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.

If no event shall the responsibility of INDUSTRIAL SHIELDS for any act exceed the individual price of the product on which liability is asserted.

IN NO EVENT SHALL INDUSTRIAL SHIELDS BE RESPONSIBLE 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 INAPPROPRIATE MODIFICATION OR REPAIR.

Table of Contents

1	General Description M-DUINO FAMILY product	10
1.1	Zone - Nomenclature	10
1.2	Zone Distribution.....	10
1.3	A Zone Features.....	12
1.4	Mechanical dimension	13
1.5	General Features	14
2	Technical Specifications:	15
2.1	General Specifications:.....	15
2.2	Performance Specification:	15
3	Precautions.....	16
3.1	Arduino Board	16
3.2	Intended Audience	16
3.3	General Precautions	16
4	Software interface.....	16
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.....	23
7.2.1	Analog Shield.....	23
7.2.2	Relay Shield	24
7.3	C Zone.....	25
7.3.1	Analog Shield (C Zone)	25
7.3.2	Relay Shield C Zone	26
7.4	D Zone	27
7.4.1	Analog Shield (D Zone)	27
7.4.2	Relay Shield D Zone	28
8	Switch configuration	29
8.1	A Zone: Communications	29
8.2	Analog Shield.....	31

8.3	Relay Shield	31
9	M-Duino Arduino I/Os 5V pins	32
10	A Zone Features: Communications & RTC & uSD.....	32
10.1	RS-232	32
10.2	RS-485	33
10.3	I2C.....	33
10.4	SPI.....	34
10.5	TTL	34
10.6	Ethernet.....	34
10.7	RTC.....	35
10.8	uSD	35
11	I/O technical details:	36
12	Typical Connections	39
13	Connector details:	43
14	Mechanical Characteristics	44



INDUSTRIAL SHIELDS

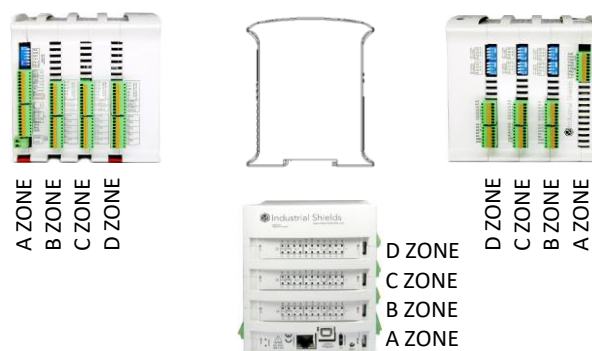


1 General Description M-DUINO FAMILY product

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 D the shield from above. Having a B and a C in the middle of them. It can have a minimum of 2 zones (A, B) and a maximum of 4 (A, B, C, D). The nomenclature is represented on the picture below:

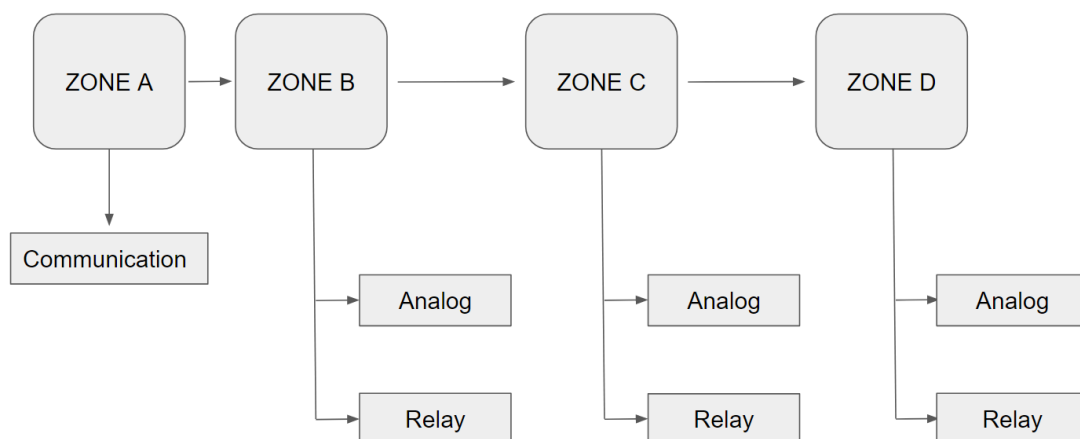


- The inputs in the zone B are named I0.X, being X any number suitable in the Shield. Outputs are named as Q0.X and relays as R0.X
- The inputs in the zone C are named I1.X, being X any number suitable in the Shield. Outputs are named as Q1.X and relays as R1.X
- The inputs in the zone D are named I2.X, being X any number suitable in the Shield. Outputs are named as Q2.X and relays as R2.X

1.2 Zone Distribution

A zone is completely common for every single M-Duino Family PLC. The rest of zones can have two different shields. The two shields that can be in every Zone (except for A Zone) are the Analog Shield or the Relay Shield. Only 1 Shield is allowed per Zone.

Depending on the combination that is made to build the PLC it can provide more Analog Inputs/Outputs or Relays Outputs. All the zones (B, C, D) can be one of the two Shields:



The distribution of the different features that provide the M-Duino Family is the following one:

Shield	B Zone	C Zone	D Zone
Analog Shield	13 Inputs (13 Digital inputs, 6 of which can work as Analog Input) 8 Outputs (8 Digital Outputs, 3 of which can work as Analog Output)	13 Inputs (13 Digital inputs, 6 of which can work as Analog Input) 8 Outputs (8 Digital Outputs, 3 of which can work as Analog Output)	11 Inputs (11 Digital Inputs, 4 of which can work as Analog Input) 6 Outputs (6 Digital Outputs, 2 of which can work as Analog Outputs)
Relay Shield	6 Inputs (6 Digital Inputs, 4 of which can work as Analog Input) 11 Outputs (8 Relay Outputs, 3 Digital Outputs, 3 of which can work as Analog Output)	6 Inputs (6 Digital Inputs, 4 of which can work as Analog Input) 11 Outputs (8 Relay Outputs, 3 Digital Outputs, 3 of which can work as Analog Output)	6 Inputs (6 Digital Inputs, 4 of which can work as Analog Input) 9 Outputs (7 Relay Outputs, 2 Digital Outputs, 2 of which can work as Analog Output)

1.3 A Zone Features

Shield	A Zone
Communication Shield	(1x) Ethernet (1x) USB (1x) I2C (3x) TTL (1x) RS-232 (1x) HALF/FULL Duplex RS-485 (1x) SPI external Port (1x) RTC (1x) uSD Socket

This is the list of our products depending on the combination of the shields. As it is already said above the A Zone is totally common for all the M-Duino Family.

M-Duino	B Zone		C Zone		D Zone	
	Analog	Relay	Analog	Relay	Analog	Relay
M-Duino 19R+ M-Duino 21+	X	X				
M-Duino 38R+ M-Duino 38AR+ M-Duino 42+	X X	X	X	X X		
M-Duino 50RRA+ M-Duino 53ARR+ M-Duino 53ARA+ M-Duino 57AAR+ M-Duino 57R+ M-Duino 58+	X X X X X	X X	X X	X X X X X	X X X	X X X

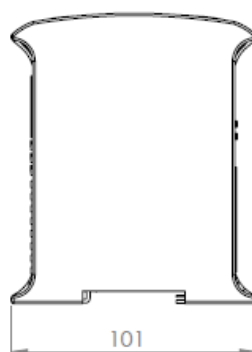
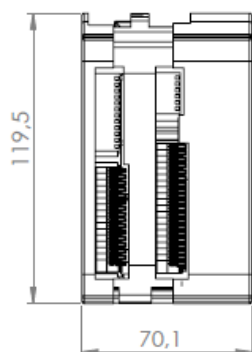
The nomenclature of the M-Duino Family products consists on placing the name of the Shield/s after the total number of I/Os of the product.

For example M-Duino53ARR+ is a PLC with the 3 extra Zones (B, C, D), which are Analog, Relay, Relay respectively. It has 53 I/Os.

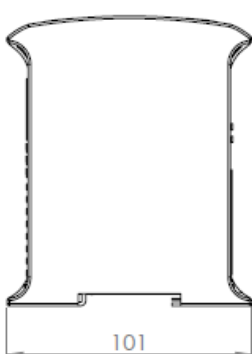
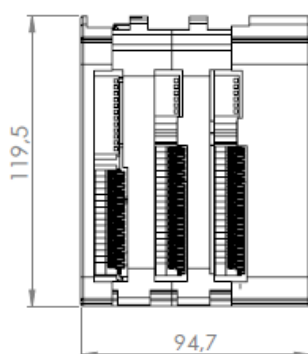
M-Duino	B Zone	C Zone	D Zone
M-Duino53ARR+	A	R	R

* There are 2 different exceptions. M-Duino38R+/M-Duino57R+ should be called with this nomenclature M-Duino38RR+/M-Duino57RRR+, as everything is Relay it is omitted. Also for the M-duino21+/42+/58+ as they are all Analog they are not represented with this nomenclature. With the nomenclature represented in the User Guide they would be: M-Duino21A+/M-Duino42AA+/M-Duino58AAA+

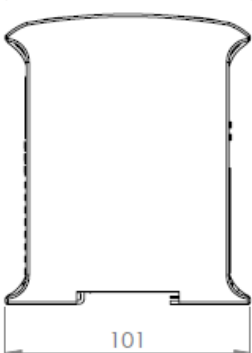
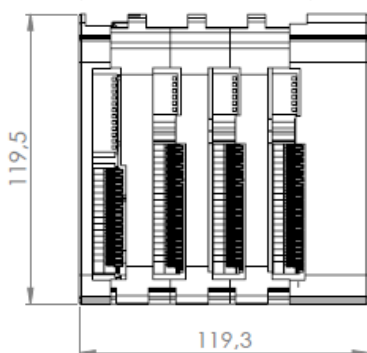
1.4 Mechanical dimension



M-Duino 1 BLOCK I/Os



M-Duino 2 BLOCKS
I/Os



M-Duino 3 BLOCKS
I/Os

1.5 General Features

CONECTABLE PLC ARDUINO 24Vcc M-DUINO				
MODEL TYPE	B Zone	B+C Zone	B+C+D Zone	
Input Voltage	12 to 24Vdc			Fuse protection (2.5A) Polarity protection
I max.	1.5A			
Size	101x119.5x70.1	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 – RS485 – RS232 -- SPI – (3x) Rx, Tx (Arduino pins)			Max232-Max485- W5500
Type of signals				
An/Dig Input 10bit (0-10Vcc)	0 to 10V Input Impedance: 39K Separated PCB ground			
Digital Isolated Input (24Vcc)	5 to 24Vdc I min: 2 to 12 mA Galvanic ISOLATION			
* Interrupt isolated Input HS (24Vcc)	5 to 24Vdc I min: 2 to 12 mA Galvanic ISOLATION			
Analog Output 8bit (0-10Vcc)	0 to 10Vdc I max: 40 mA Separated PCB ground			
Digital Isolated Output (24Vcc)	5 to 24Vdc I max: 0.3 A Galvanic ISOLATION Diode Protected for Relay			
Digital Isolated Output Relay	220V Vac I max: 5A Galvanic Isolation Diode protected for Relay			
PWM Isolated Output 8bit (24Vcc)	5 to 24Vdc I max: 0.3 A Galvanic ISOLATION Diode Protected for Relay			
Expandability	I2C - 127 elements - Serial Port RS232/RS485			
* 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	M-DUINO B+C ZONE	M-DUINO B+C+D 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 earth terminal.		
Shock resistance		80m/s ² in the X, Y and Z direction 2 times each.		
Ambient temperature (operating)		0° to 45°C		
Ambient humidity (operating)		10% to 90% (no condensation)		
Ambient environment (operating)		With no corrosive gas		
Ambient temperature (storage)		-20° to 60°C		
Power supply holding time		2ms min.		
Weight		445g max.	542g max.	850g 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 8 kb used by bootloader
Program capacity (SRAM)	8kb
EEPROM	4kb
Clock Speed	16MHz
Clock Speed	16MHz

3 Precautions

Read this manual before attempting to use the M-Duino PLC and follow its descriptions for reference during operation.

3.1 Arduino Board

All M-Duino family PLCs include Arduino Mega Board as controller.

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 M-Duino under different conditions from what has been specified in this manual or integrating M-Duino to 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 M-Duino 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 M-Duino.

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.

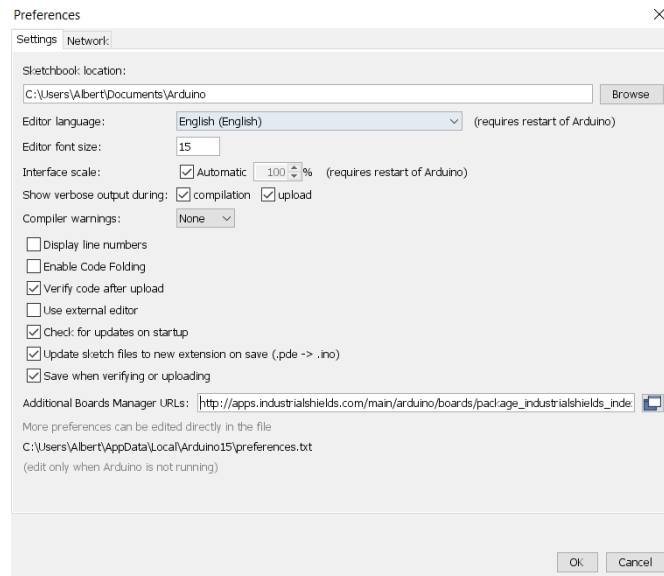
In order to install Industrial Shields boards, these are the steps that must be followed.

Requirements:

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

Steps:

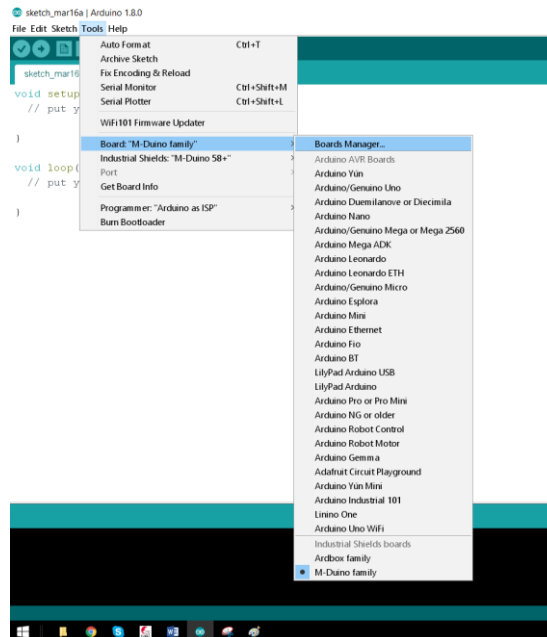
1. Open Arduino IDE and go to: "File -> Preferences" located in the top left corner.



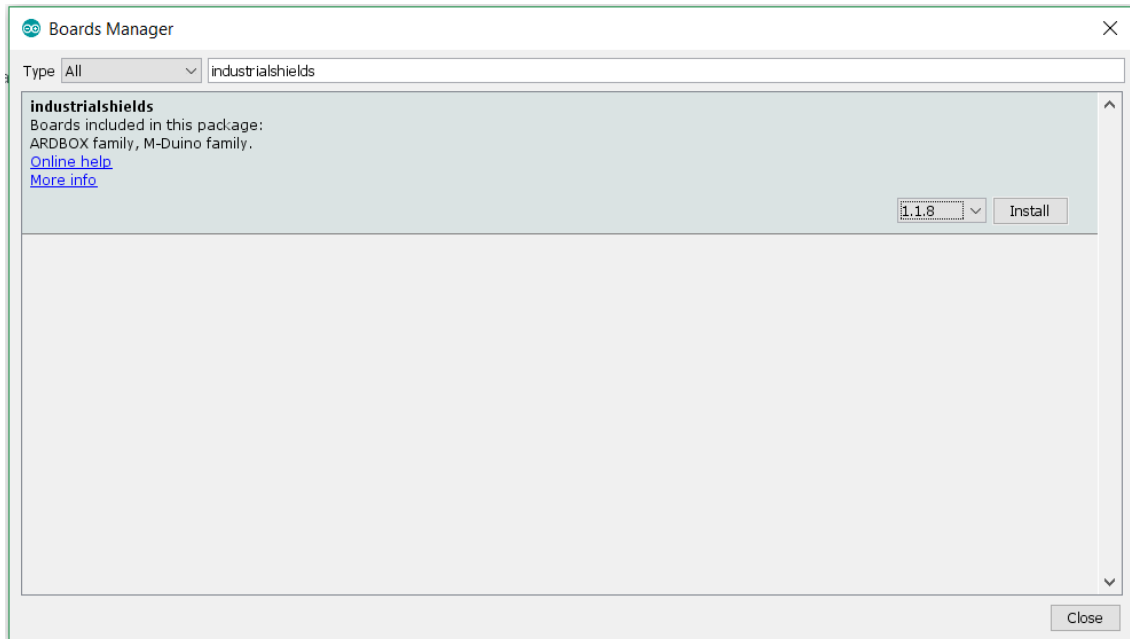
2. In Additional Boards Manager URLs write the following:

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

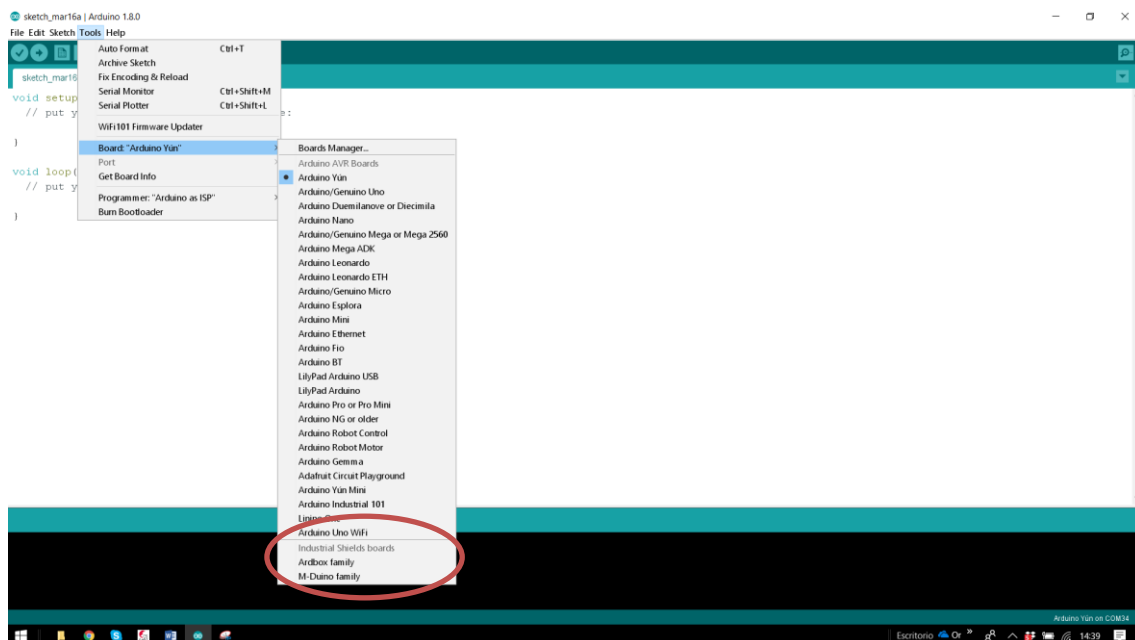


5. Search for “industrialshields” on the browser.



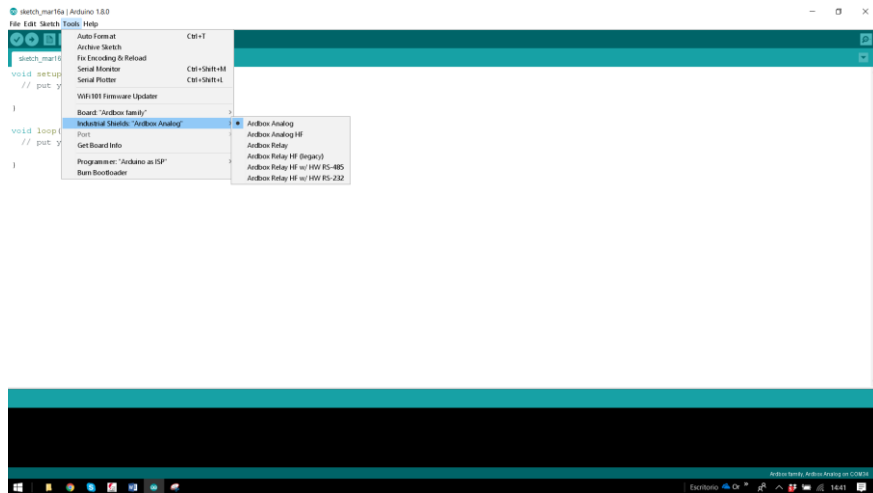
6. Click install (selecting the latest version).

Following this 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.

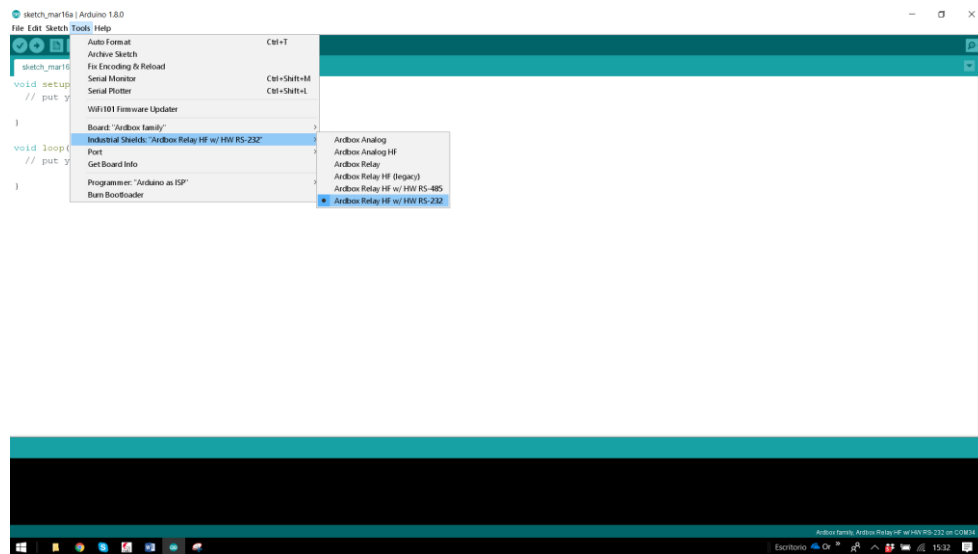
NOTE:

M-Duino Family use USB-B cable.

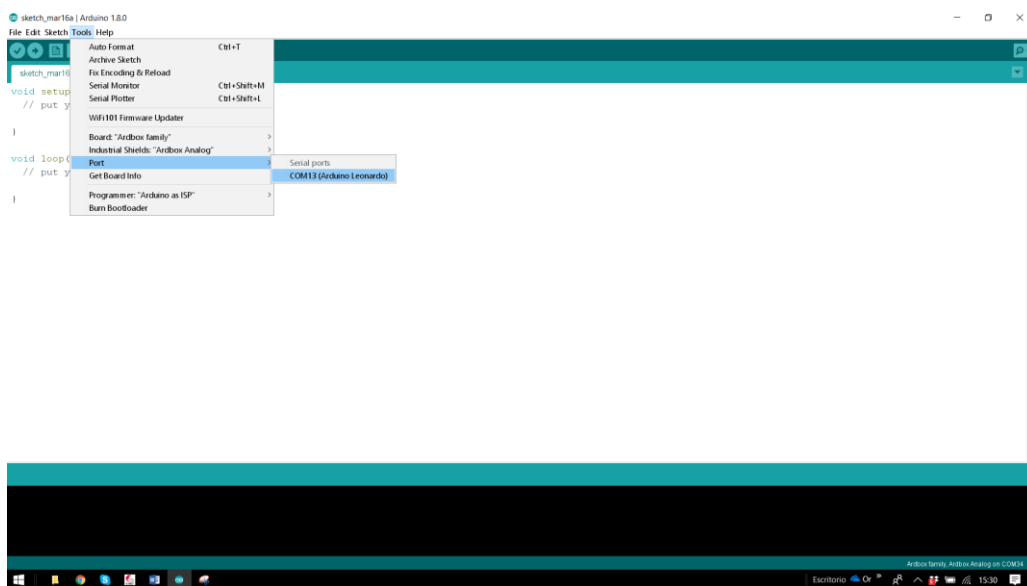


- Open Arduino IDE interface:
- Select Industrial Shields boards -> M-Duino Family

- Select the correct M-Duino Board.

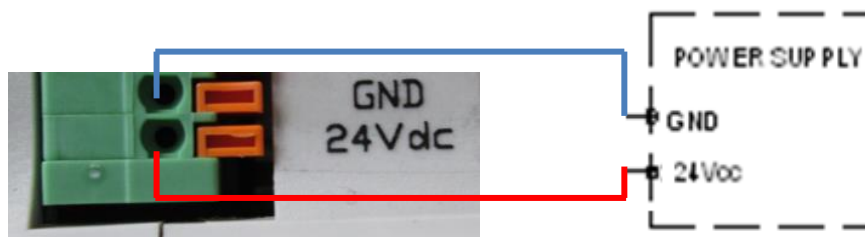


- Select correct port.



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



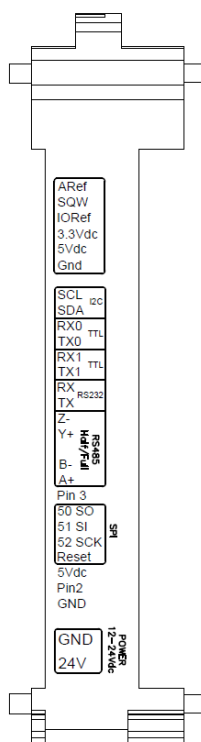
* Not recommended for industrial applications. The Jack connector needs to be removed and use the live and GND connectors.



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	RX1/SS
TX1	18	TX1/SS
RX	17	RX2(serial 2)
TX	16	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

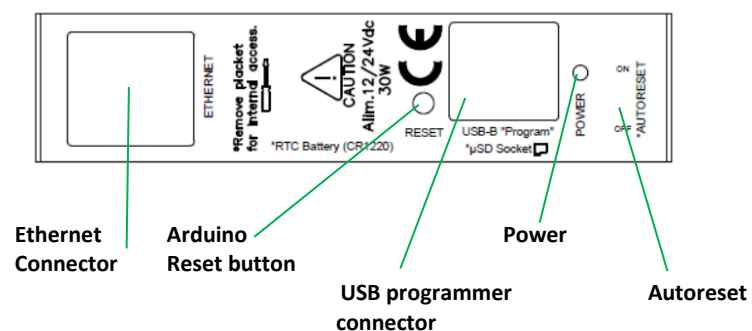
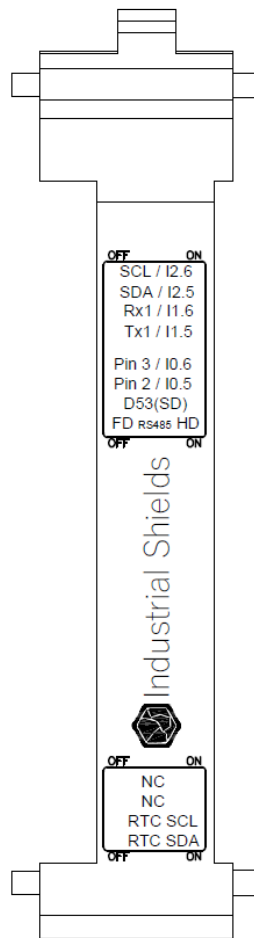


Configuration Switch* (see section 8 for Communications configuration. Enabling Communications disables some I/Os)

Communication Pinout

Power supply connectors
(24Vdc – Gnd)

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



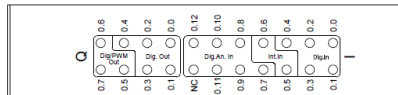
**NOTE: Autoreset. Arduino mega has auto reset when using serial communication code. Set switch to OFF when using serial communication. When uploading code to Arduino Mega set switch to ON.*

7.2 B Zone

7.2.1 Analog Shield

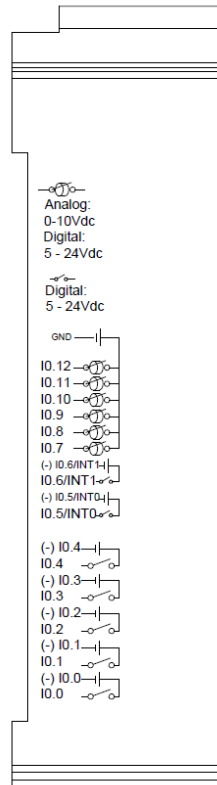
B Zone		
M-Duino Connector	Arduino Pin	Function ¹
I0.12	A5	Analog/ Digital In
I0.11	A4	Analog/ Digital In
I0.10	A3	Analog/ Digital In
I0.9	A2	Analog/ Digital In
I0.8	A1	Analog/ Digital In
I0.7	A0	Analog/ Digital In
(-)I0.6/INT1	-	GND I0.6
I0.6/INT1 ²	3	Interrupt 1 In
(-)I0.5/INT0	-	GND I0.5
I0.5/INT0 ²	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 ²	23	Digital Input
(-)I0.0	-	GND I0.0
I0.0 ²	22	Digital Input

Top Zone



Led indicator I/Os state

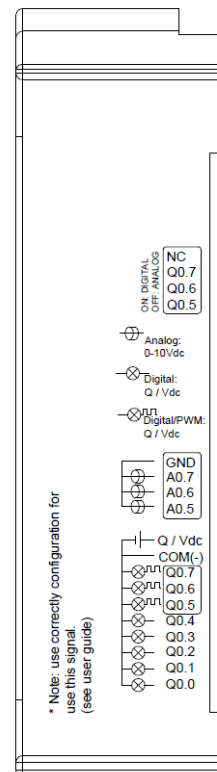
B Zone		
M-Duino Connector	Arduino Pin	Function ²
GND	GND	GND
A0.7 ¹	6	Analog Out
A0.6 ¹	5	Analog Out
A0.5 ¹	4	Analog Out
Q/Vdc	-	External Isolated Out Vdc
COM(-)	-	External Isolated Out Gnd
Q0.7 ¹	6	Digital/PWM Out
Q0.6 ¹	5	Digital/PWM Out
Q0.5 ¹	4	Digital/PWM Out
Q0.4	40	Digital Out
Q0.3	39	Digital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



ANALOG/DIGITAL Inputs

INTERRUPT Inputs (isolated)

DIGITAL Inputs (isolated)



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

ANALOG Outputs

VOLTAGE SUPPLY/REFERENCE for DIGITAL/PWM Outputs (isolated)

PWM/DIGITAL Outputs

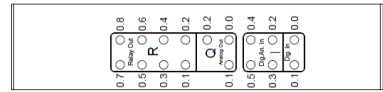
¹ See section 8 to select suitable switch configuration for (10 to 24Vdc/An-Dig) configurable I/Os.

² See section 8 to select suitable switch configuration for enable these connections.

7.2.2 Relay Shield

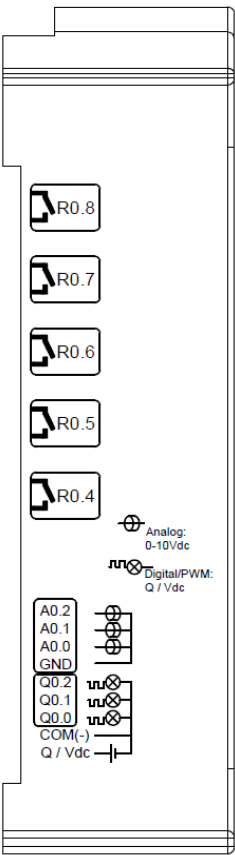
B Zone		
M-Duino Connector	Arduino Pin	Function ³
R0.8	37	Relay Out
R0.7	38	Relay Out
R0.6	39	Relay Out
R0.5	40	Relay Out
R0.4	24	Relay Out
A0.2 ¹	6	Analog Out
A0.1 ¹	5	Analog Out
A0.0 ¹	4	Analog Out
GND	GND	GND
Q0.2 ¹	6	Digital/PWM Out
Q0.1 ¹	5	Digital/PWM Out
Q0.0 ¹	4	Digital/PWM Out
GNDCOM	--	External Isolated Out Gnd
24VCOM	--	External Isolated Out Vdc

Top Zone



Led indicator I/Os state

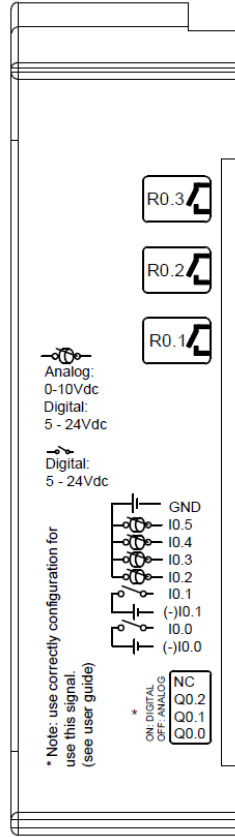
B Zone		
M-Duino Connector	Arduino Pin	Function ²
R0.3	25	Relay Out
R0.2	22	Relay Out
R0.1	23	Relay Out
GND	GND	GND
I0.5	A3	Analog/Digital Input
I0.4	A2	Analog/Digital Input
I0.3	A1	Analog/Digital Input
I0.2	A0	Analog/Digital Input
I0.1 ²	3	Interrupt 1 In
(-)I0.1	--	GND I0.1
I0.0 ²	2	Interrupt 0 In
(-)I0.0	--	GND I0.0



RELAY Outputs

ANALOG Output (Switch Configuration)

DIGITAL/PWM Outputs (isolated)



RELAY Outputs

ANALOG/DIGITAL Inputs

INTERRUPT Inputs (isolated)

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

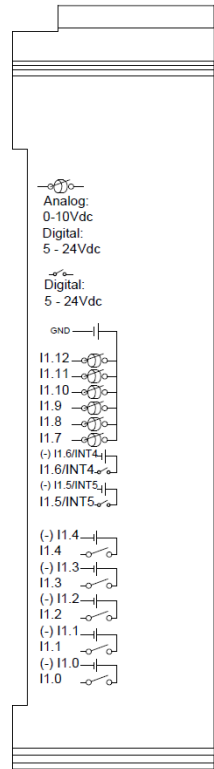
¹ See section 8 to select suitable switch configuration for (10 to 24Vdc/An-Dig) configurable I/Os.

² See section 8 to select suitable switch configuration for enable these connections.

7.3 C Zone

7.3.1 Analog Shield (C Zone)

C Zone		
M-Duino Connector	Arduino Pin	Function ⁴
I1.12	A11	Analog/ Digital In
I1.11	A10	Analog/ Digital In
I1.10	A9	Analog/ Digital In
I1.9	A8	Analog/ Digital In
I1.8	A7	Analog/ Digital In
I1.7	A6	Analog/ Digital In
(-)I1.6/INT1	NC	GND I1.6
I1.6/INT1 ²	19	Interrupt 1 In
(-)I1.5/INT0	NC	GND I1.5
I1.5/INT0 ²	18	Interrupt 0 In
(-)I1.4	NC	GND I1.4
I1.4	31	Digital Input
(-)I1.3	NC	GND I1.3
I1.3	30	Digital Input
(-)I1.2	NC	GND I1.2
I1.2	29	Digital Input
(-)I1.1	NC	GND I1.1
I1.1	28	Digital Input
(-)I1.0	NC	GND I1.0
I1.0	27	Digital Input

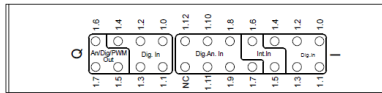


ANALOG/DIGITAL Inputs

INTERRUPT Inputs (isolated)

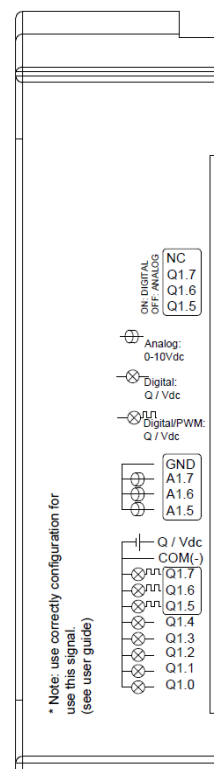
DIGITAL Inputs (isolated)

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 select correct configuration for outputs).

ANALOG Outputs

VOLTAGE SUPPLY/REFERENCE for DIGITAL/PWM Outputs (isolated)

PWM/DIGITAL Outputs

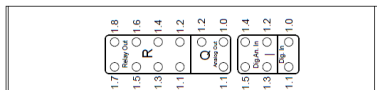
¹ See section 8 to select suitable switch configuration for (10 to 24Vdc/An-Dig) configurable I/Os.

² See section 8 to select suitable switch configuration for enable these connections.

7.3.2 Relay Shield C Zone

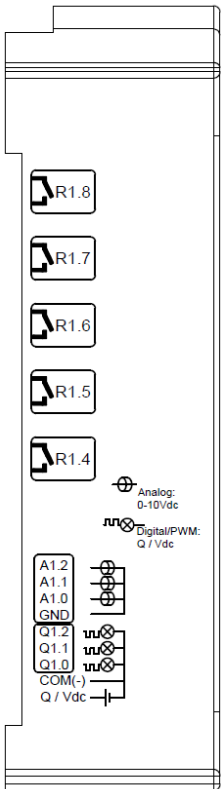
B Zone		
M-Duino Connector	Arduino Pin	Function ⁵
R1.8	42	Relay Out
R1.7	43	Relay Out
R1.6	44	Relay Out
R1.5	45	Relay Out
R1.4	29	Relay Out
A1.2 ¹	11	Analog Out
A1.1 ¹	10	Analog Out
A1.0 ¹	8	Analog Out
GND	GND	GND
Q1.2 ¹	11	Digital/PWM Out
Q1.1 ¹	10	Digital/PWM Out
Q1.0 ¹	8	Digital/PWM Out
GNDCOM	--	External Isolated Out Gnd
24VCOM	--	External Isolated Out Vdc

Top Zone



Led indicator I/Os state

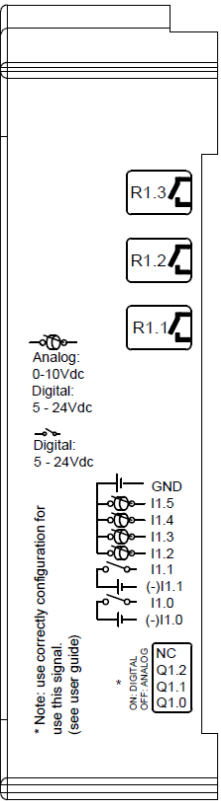
C Zone		
M-Duino Connector	Arduino Pin	Function ²
R0.3	30	Relay Out
R0.2	27	Relay Out
R0.1	28	Relay Out
GND	GND	GND
I0.5	A9	Analog/Digital Input
I0.4	A8	Analog/Digital Input
I0.3	A7	Analog/Digital Input
I0.2	A6	Analog/Digital Input
I0.1 ²	19	Interrupt 1 In
(-)I0.1	--	GND I0.1
I0.0 ²	18	Interrupt 0 In
(-)I0.0	--	GND I0.0



RELAY Outputs

ANALOG Output (Switch Configuration)

DIGITAL/PWM Outputs (isolated)



RELAY Outputs

ANALOG/DIGITAL Inputs

INTERRUPT Inputs (isolated)

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

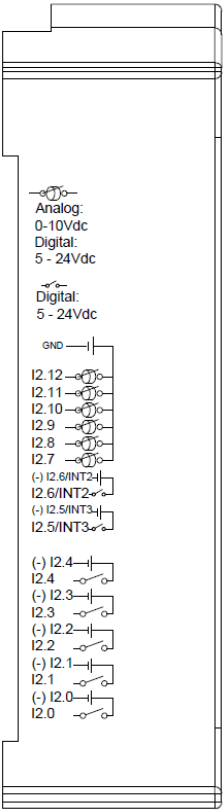
¹ See section 8 to select suitable switch configuration for (10-24Vdc/An-Dig) configurable I/Os.

² See section 8 to select suitable switch configuration for enable these connections.

7.4 D Zone

7.4.1 Analog Shield (D Zone)

D Zone		
M-Duino Connector	Arduino Pin	Function ⁶
I2.12	-	Analog/ Digital In
I2.11	-	Analog/ Digital In
I2.10	A15	Analog/ Digital In
I2.9	A14	Analog/ Digital In
I2.8	A13	Analog/ Digital In
I2.7	A12	Analog/ Digital In
(-)I2.6/INT1	NC	GND I2.6
I2.6/INT1 ²	21	Interrupt 1 In
(-)I2.5/INT0	NC	GND I2.5
I2.5/INT0 ²	20	Interrupt 0 In
(-)I2.4	-	-
I2.4	-	-
(-)I2.3	NC	GND I2.3
I2.3	35	Digital Input
(-)I2.2	NC	GND I2.2
I2.2	34	Digital Input
(-)I2.1	NC	GND I2.1
I2.1	33	Digital Input
(-)I2.0	NC	GND I2.0
I2.0	32	Digital Input

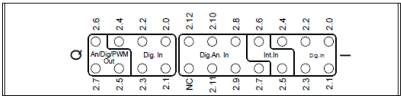


ANALOG/DIGITAL Inputs

INTERRUPT Inputs (isolated)

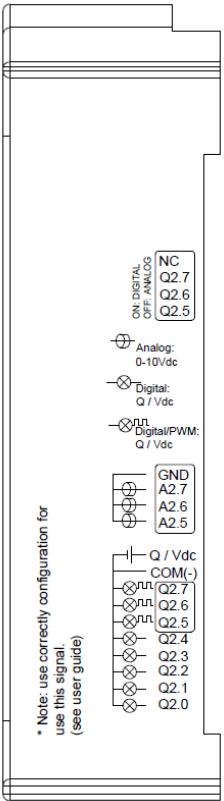
DIGITAL Inputs (isolated)

Top Zone



Led indicator I/Os state

D Zone		
M-Duino Connector	Arduino Pin	Function ²
GND	GND	GND
A2.7	-	-
A2.6 ¹	13	Analog Out
A2.5 ¹	12	Analog Out
Q/Vdc	-	External Isolated Out Vdc
COM(-)	-	External Isolated Out Gnd
Q2.7	-	-
Q2.6 ¹	13	Digital/PWM Out
Q2.5 ¹	12	Digital/PWM Out
Q2.4	-	-
Q2.3	49	Digital Out
Q2.2	48	Digital Out
Q2.1	47	Digital Out
Q2.0	53	Digital Out



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

ANALOG Outputs

VOLTAGE SUPPLY/REFERENCE for
DIGITAL/PWM Outputs (isolated)

PWM/DIGITAL Outputs

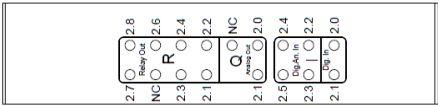
¹ See section 8 to select suitable switch configuration for (10-24Vdc/An-Dig) configurable I/Os.

² See section 8 to select suitable switch configuration for enable these connections.

7.4.2 Relay Shield D Zone

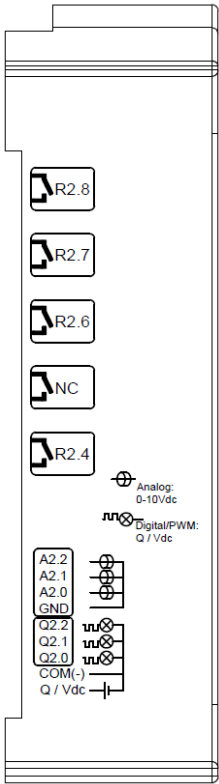
D Zone		
M-Duino Connector	Arduino Pin	Function ⁷
R2.8	47	Relay Out
R2.7	48	Relay Out
R2.6	49	Relay Out
R2.5	-	-
R2.4	34	Relay Out
A2.2	-	-
A2.1 ¹	13	Analog Out
A2.0 ¹	12	Analog Out
GND	GND	GND
Q2.2	-	Digital/PWM Out
Q2.1 ¹	13	Digital/PWM Out
Q2.0 ¹	12	Digital/PWM Out
GNDCOM	--	External Isolated Out Gnd
24VCOM	--	External Isolated Out Vdc

Top Zone



Led indicator I/Os state

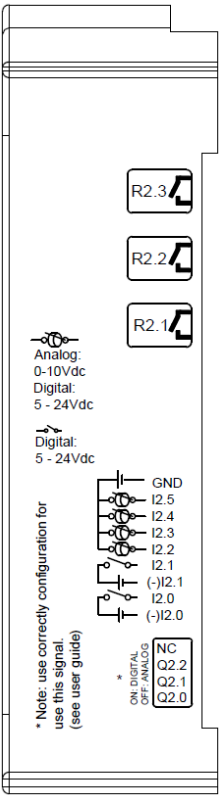
D Zone		
M-Duino Connector	Arduino Pin	Function ²
R2.3	35	Relay Out
R2.2	32	Relay Out
R2.1	33	Relay Out
GND	GND	GND
I2.5	A15	Analog/Digital Input
I2.4	A14	Analog/Digital Input
I2.3	A13	Analog/Digital Input
I2.2	A12	Analog/Digital Input
I2.1 ¹	21	Interrupt 1 In
(-)I2.1	--	GND I2.1
I2.0 ¹	20	Interrupt 0 In
(-)I2.0	--	GND I2.0



RELAY Outputs

ANALOG Output (Switch Configuration)

DIGITAL/PWM Outputs (isolated)



RELAY Outputs

ANALOG/DIGITAL Inputs

INTERRUPT Inputs (isolated)

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

¹ See section 8 to select suitable switch configuration for (10-24Vdc/An-Dig) configurable I/Os.

² See section 8 to select suitable switch configuration for enable these connections.

8 Switch configuration

8.1 A Zone: Communications

LEFT ZONE				
Switch	Analog Shield		Relay Shield	
	ON	OFF	ON	OFF
D ZONE				
SCL/I2.6	I2.6	SCL	I2.1	SCL
SDA/I2.5	I2.5	SDA	I2.0	SDA
C ZONE				
RX1/I1.6	I1.6	RX1	I1.1	RX1
TX1/I1.5	I1.5	TX1	I1.0	TX1
B ZONE				
Pin 3/I0.6	I0.6	Pin 3	I0.1	Pin 3
Pin 2/I0.5	I0.5	Pin 2	I0.0	Pin 2
uSD & RS-485				
D53(SD)	D53(SD)	Q2.0	D53(SD)	-
FD RS-485 HD	HD	FD	HD	FD



*Although the Serigraphy of the Switches will only reference to the Analog Shields, if a Relay Shield is connected the IX.6 changes for IX.1 and the IX.5 changes for IX.0. Being X a value inside of [0..2].

4. SCL/I2.6: Choosing between SCL or the input I2.6. If this switch is ON, it enables the I2.6 input and disables the SCL. If this switch is OFF, it enables SCL and disables I2.6. If it is a Relay Shield I2.6 is changed for I2.1

3. SDA/I2.5: Choosing between SDA or the input I2.5. If this switch is ON, it enables the I2.5 input and disables the SDA. If this switch is OFF, it enables SDA and disables I2.5. If it is a Relay Shield I2.5 is changed for I2.0

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. . If it is a Relay Shield I1.6 is changed for I1.0

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. . If it is a Relay Shield I1.5 is changed for I1.0

4. Pin 3/I0.6: 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. If it is a Relay Shield I0.6 is changed for I0.1

3. Pin 2/I0.5: 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 2 and disables I0.5. If it is a Relay Shield I0.5 is changed for I0.0

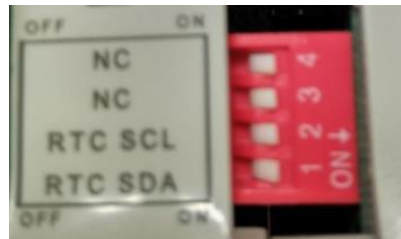
2. D53(SD): If this Switch is ON, it enables the Chip Select of the microSD socket. If this switch is OFF, it disables the Chip Select of the microSD socket.

*If the D Zone is an Analog Shield, Q2.0 is also related with D53. Being D53 in ON Mode the Q2.0 MUST NOT be used because it can corrupt the microSD. In order to use the Q2.0 the switch D53(SD) must be set to OFF.

*If the D Zone is a Relay Shield there is no problem and it can be set always to ON. Q2.0 of the Relay Shield is related with D12, so it doesn't affect in any case to the microSD. The pin53 is not connected at all to any input/output, it only connects to the uSD chip select.

1. FD RS-485 HD: Choosing between SCL or the input I2.6. If this switch is ON, it enables the I2.6 input and disables the SCL. If this switch is OFF, it enables SCL and disables I2.6.

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 activates 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 activates 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 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

D ZONE		
SWITCH	ON	OFF
NC	-	-
Q2.7	-	-
Q2.6	Q2.6	A2.6
Q2.5	Q2.5	A2.5



For the Analog Shield 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 QX.X, being X any number of the tables above.

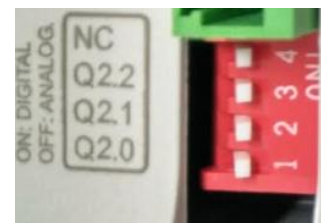
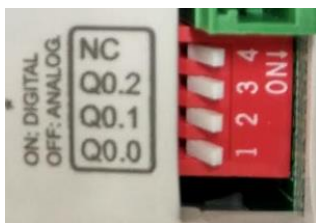
If it is desired to use an Analog Output the pin must be set to OFF and the pin that will provide this analog output is represented with AX.X, being X any number of the tables above.

8.3 Relay Shield

B ZONE		
SWITCH	ON	OFF
NC	-	-
Q0.2	Q0.2	A0.2
Q0.1	Q0.1	A0.1
Q0.0	Q0.0	A0.0

C ZONE		
SWITCH	ON	OFF
NC	-	-
Q1.2	Q1.2	A1.2
Q1.1	Q1.1	A1.1
Q1.0	Q1.0	A1.0

D ZONE		
SWITCH	ON	OFF
NC	-	-
Q2.2	-	-
Q2.1	Q2.1	A2.1
Q2.0	Q2.0	A2.0



For the Relay Shield 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 QX.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 AX.X, being X any number of the tables above.

9 M-Duino Arduino I/Os 5V pins

The M-Duino 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).

The Arduino board available pins are summarized in the table below. In order to access some of this pins the configuration switch must be set to OFF position (see section 8).

M-Duino terminal	Arduino pin	Enable Arduino pin
SCL	21	Communication switch: OFF
SDA	20	Communication switch OFF
RX0	0	
TX0	1	
RX1	19	Communication switch: OFF
TX1	18	Communication switch: OFF
RX3	15	
TX3	14	
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.

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 9). 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. 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.

Switch	Analog Shield		Relay Shield	
	ON	OFF	ON	OFF
D ZONE				
SCL/I2.6	I2.6	SCL	I2.1	SCL
SDA/I2.5	I2.5	SDA	I2.0	SDA

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 three TTL ports, RX0/TX0 and RX1/TX1, RX3/TX3. TTL0 is accessed with the function Serial (pins 0 and 1 of the Arduino Mega). TTL1 is accessed with the function Serial1 (pins 18 and 19 of the Arduino Mega). TTL3 is accessed with the function Serial3 (pins 14 and 15 of the Arduino Mega).

If using TTL3, the RS-232 communication protocol is totally disabled as it also uses the Serial 3.

In order to use the TTL pins the configuration of the switches have to be the following one:

Switch	Analog Shield		Relay Shield	
	ON	OFF	ON	OFF
C ZONE				
RX1/I1.6	I1.6	RX1	I1.1	RX1
TX1/I1.5	I1.5	TX1	I1.0	TX1

If the switches RX1/I1.6(I1.1) & TX1/I1.5(I1.0) are in OFF mode, the RX1/TX1 will be enabled. In order to use TTL3 these switches must be in OFF mode.

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).

Using the boards of Industrial Shields, there is a library that simplifies the Ethernet implementation called Ethernet2.

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		Relay Shield	
	ON	OFF	ON	OFF
SCL/I2.6	I2.6	SCL	I2.1	SCL
SDA/I2.5	I2.5	SDA	I2.0	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 ON, it enables the Chip Select of the microSD socket. If this switch is OFF, it disables the Chip Select of the microSD socket.

*If the D Zone is an Analog Shield, Q2.0 is also related with D53. Being D53 in ON Mode the Q2.0 MUST NOT be used because it can corrupt the microSD. In order to use the Q2.0 the switch D53(SD) must be set to OFF.

*If the D Zone is a Relay Shield there is no problem and it can be set always to ON. Q2.0 of the Relay Shield is related with D12, so it doesn't affect in any case to the microSD. The pin53 is not connected at all to any input/output, it only connects to the uSD chip select.

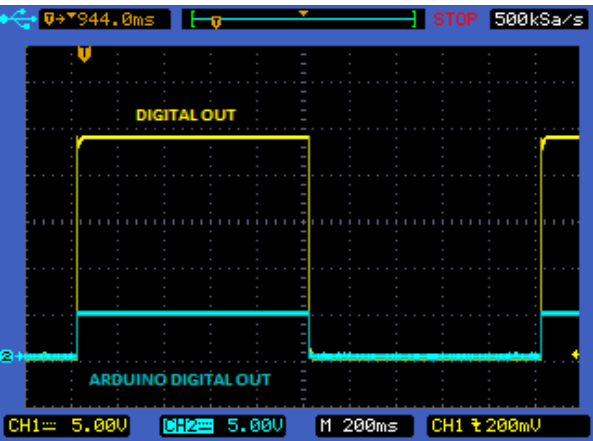
The uSD socket is found in the TOP part of the communication Shields, so in the frontal part of the PLC, it is required to open the plastic found in the frontal part and the socket is located under the supply of the Arduino.

LEFT ZONE				
Switch	Analog Shield		Relay Shield	
	ON	OFF	ON	OFF
uSD				
D53(SD)	D53(SD)	Q2.0	D53(SD)	-

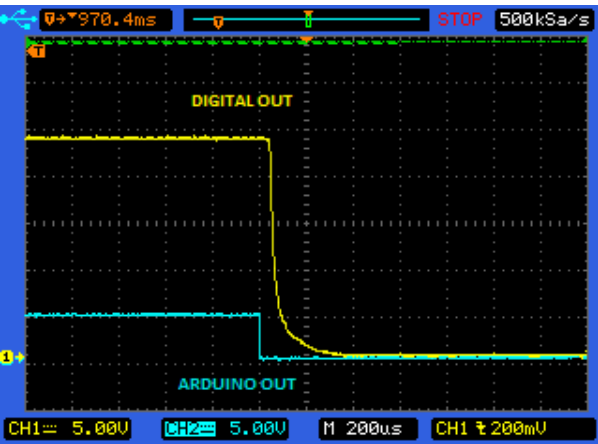
Using the boards of Industrial Shields, there is a library that simplifies the uSD implementation called SD. It is the same as the Arduino library, with the only modification of using the pin 53 to select the Chip Select of the uSD chip.

11 I/O technical details:

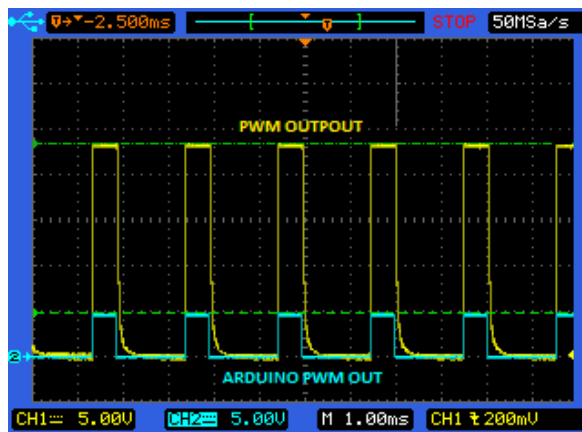
Digital Output Waveform:



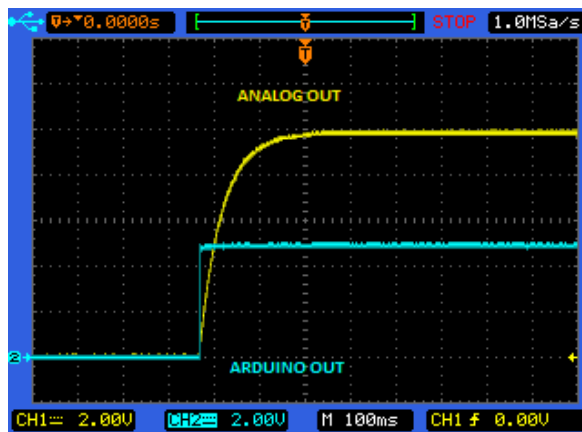
Digital Out-put Turn-off:



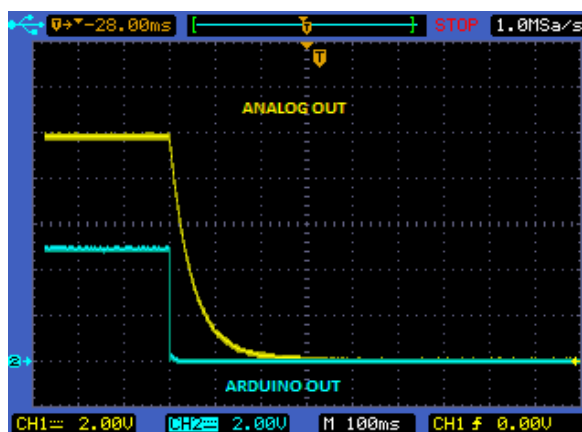
PWM Waveform:



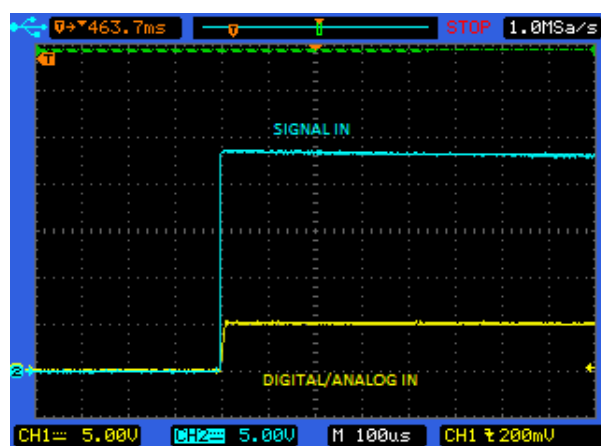
Analog Out Turn On:



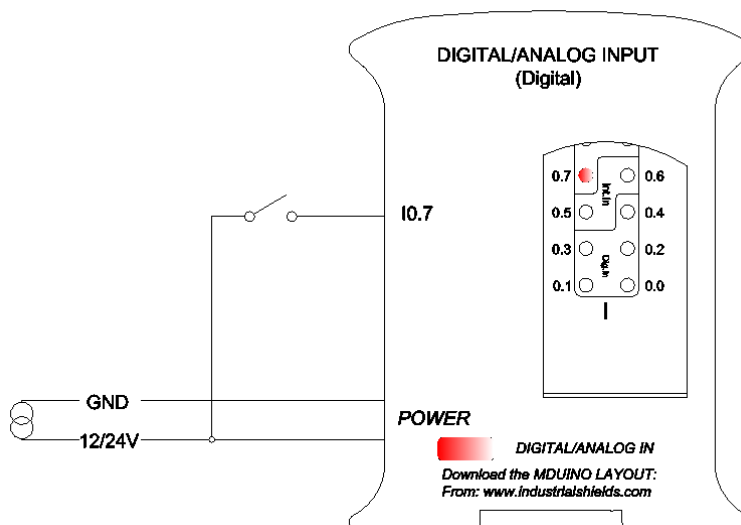
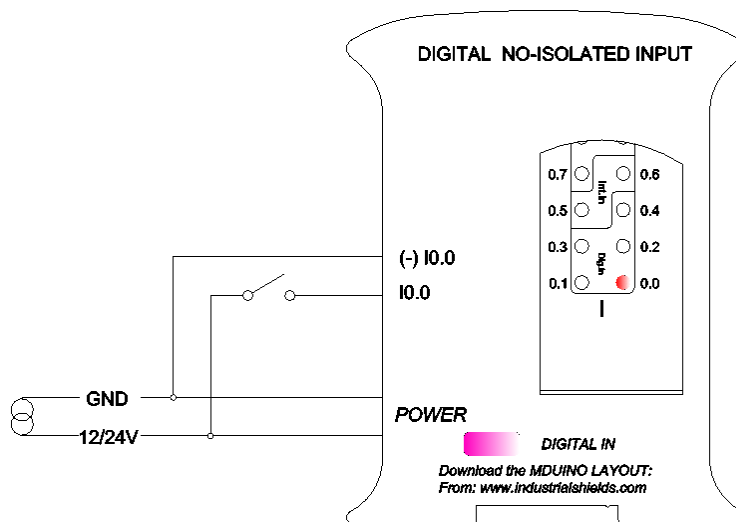
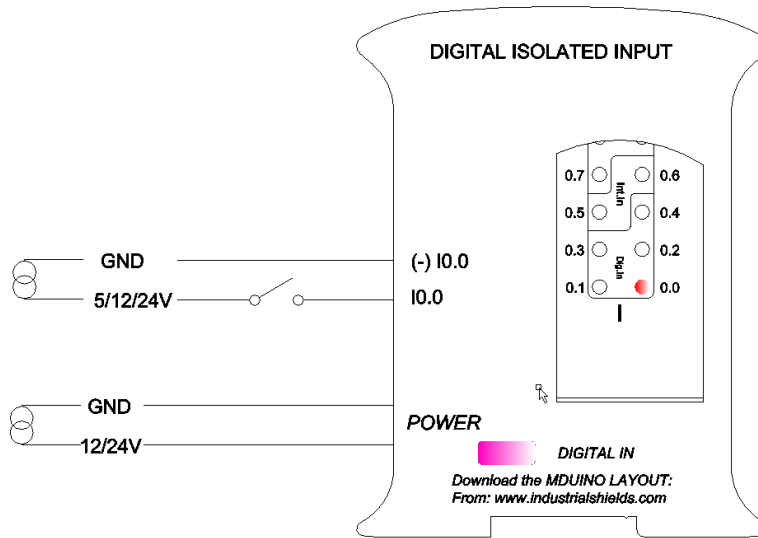
Analog Out Turn-Off:

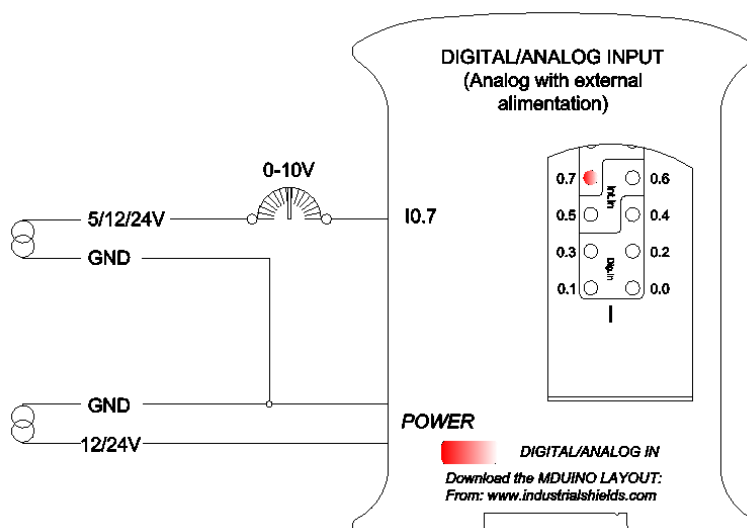
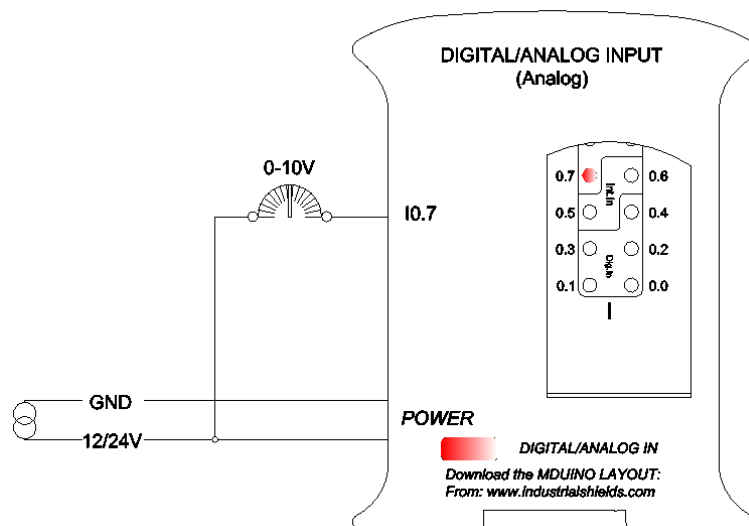
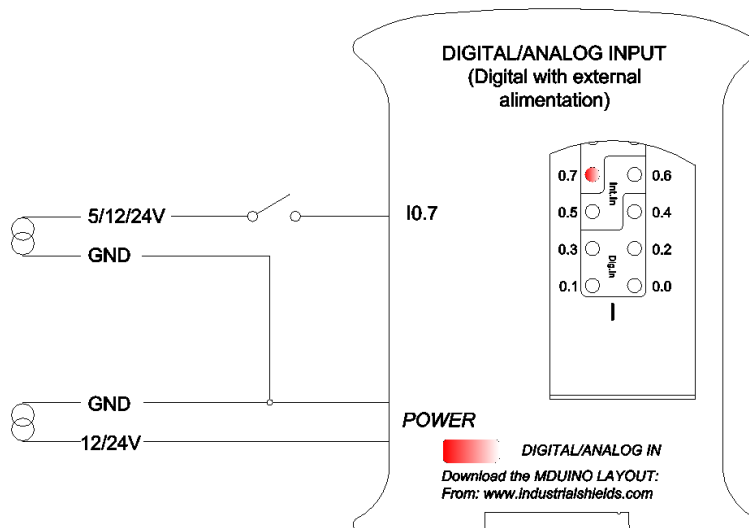


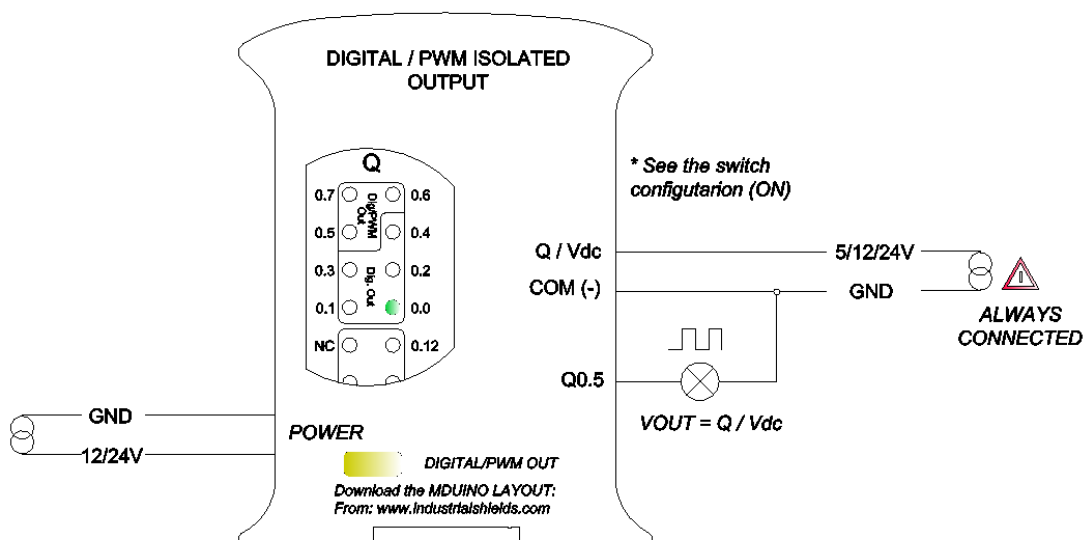
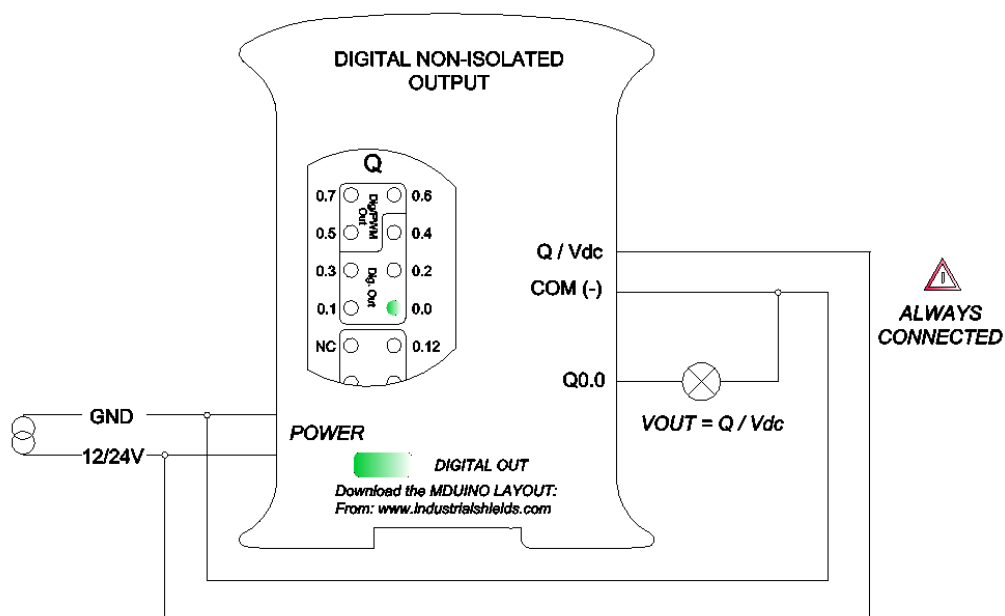
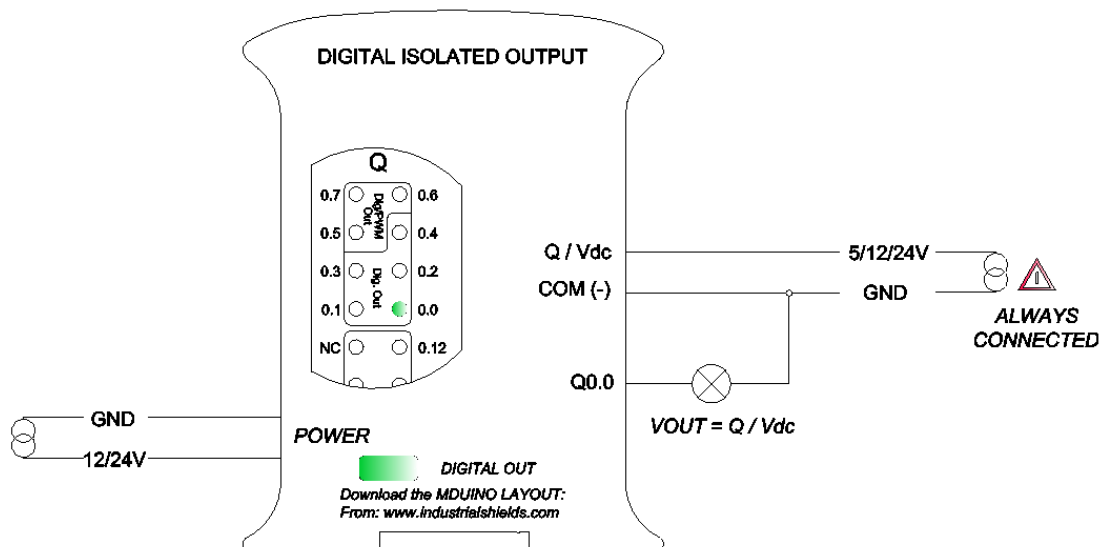
Analog /Digital input Turn-on:

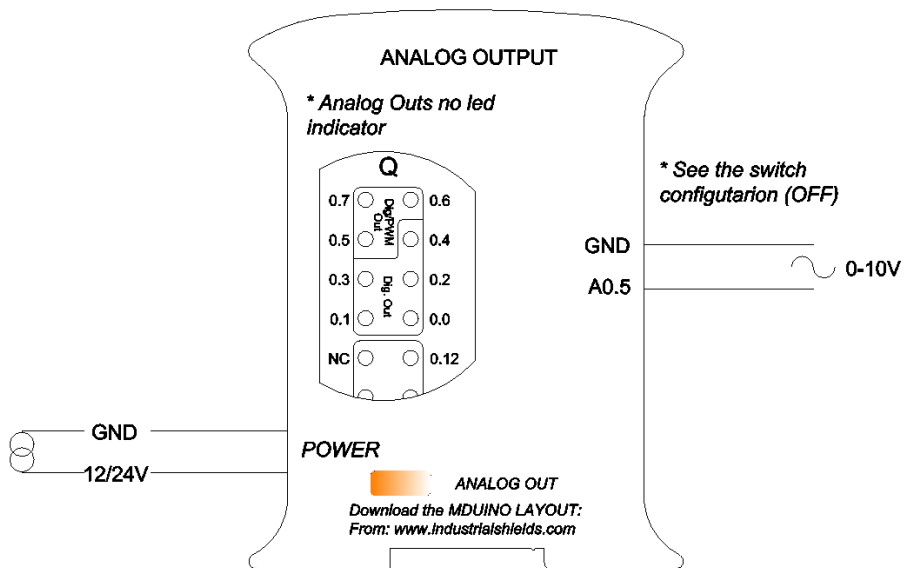
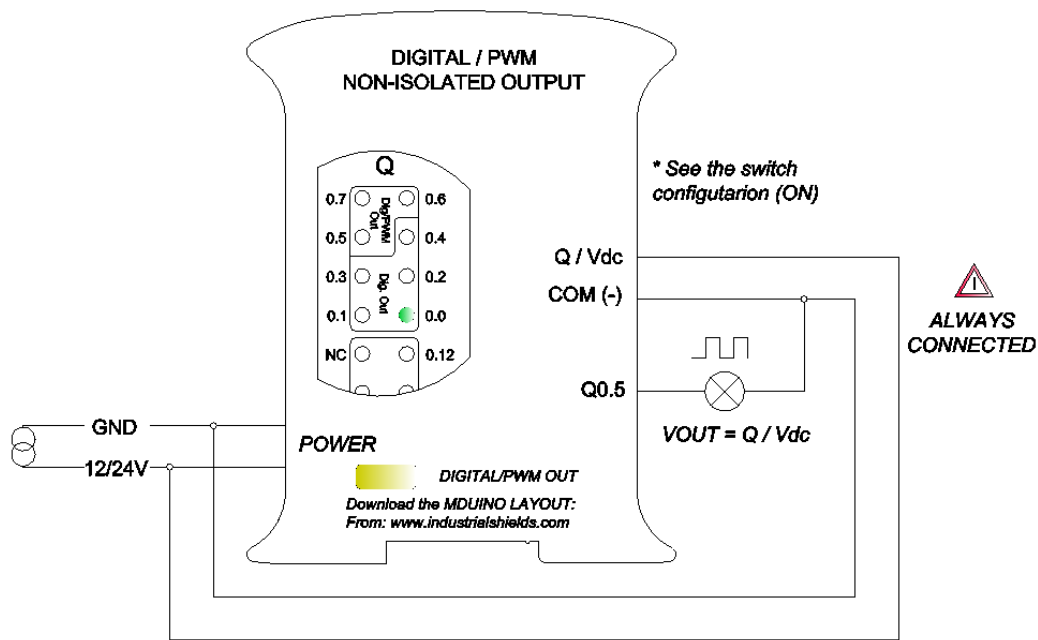


12 Typical Connections









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](#)

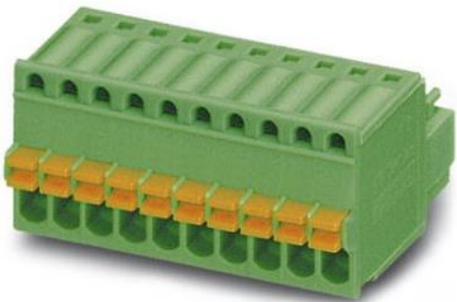
For I/O and power supply there is a FK-MC 0,5/10-ST-2,5 - 1881406 connector from Phoenix contact. [FK-MC 0,5/10-ST-2,5](#)

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

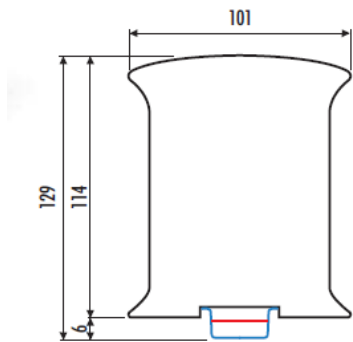


Article reference	FK-MC 0,5/10-ST-2,5
Rigid conduit section min.	0,14 mm ²
Rigid conduit section max.	0,5 mm ²
Flexible conduit section min.	0,14 mm ²
Flexible conduit section max.	0,5 mm ²
Conduit section AWG/kcmil min.	26
Conduit section AWG/kcmil max.	20

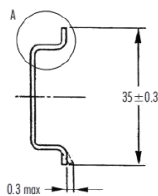
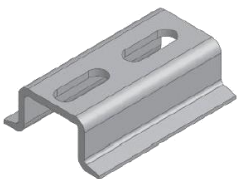


14 Mechanical Characteristics

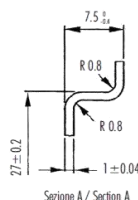
- Dimension M-duino Family:



- DIN Rail mounting

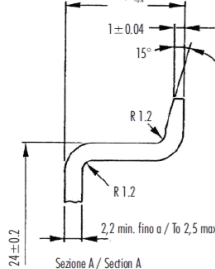


Profilato a cappello TH 35-7,5
Top hat rail TH 35-7,5



Sezione A / Section A

Profilato a cappello TH 35-15
Top hat rail TH 35-15



Sezione A / Section A



CARATTERISTICHE	METODO	UNITA' DI MISURA	BLEND PC/ABS
Mecchaniche			
Resistenza a trazione allo spezzamento	ASTM D638	MPa	68
Resistenza a trazione a rottura	ASTM D638	MPa	48
Allungamento a rottura	ASTM D638	%	59
Modulo in flessione	ASTM D790	MPa	2894
Proof load con intaglio	ISO 180/14	KJ/m ²	5.5
Termiche			
Temp. di transizione V502, metodo B	ASTM D1525	°C	114
Temperatura Ronto 1.81 MPa	ASTM D448	°C	97
Fisiche			
Peso specifico	ASTM D792	gr/cm ³	1.21
Ritiro sullo stampo	ASTM D955	%	0.4/0.6
Melt Flow Index 260°C - 98N	ASTM D1238	gr/10'	11.1
Comportamento alla fiamma			
Autosostegno (mm di spessore)	UL94	-	V-0 (0.8)
Filo Intardescen. 3.2 mm	IEC 695.2.1	°C	960

Italtronic 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	%	59
Flexure modulus	ASTM D790	MPa	2894
Load test notched	ISO 180/14	KJ/m ²	5.5
Thermal test			
Vicat softening temperature method B	ASTM D1525	°C	114
Softening temperature 1.81 MPa	ASTM D448	°C	97
Physical test			
Specific gravity	ASTM D792	gr/cm ³	1.21
Mould shrinkage	ASTM D955	%	0.4/0.6
Melt Flow Index 260°C - 98N	ASTM D1238	gr/10'	11.1
Flame test			
Self extinguisher (thickness in mm)	UL94	-	V-0 (0.8)
Intardescen thread 3.2 mm	IEC 695.2.1	°C	960

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

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