INDUSTRIAL SHIELDS

USER GUIDE

ARDBOX ANALOG

Version:
003-001-70_Ardbox_Analog

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2 ARDBOX

A compact PLC based in Open Source Hardware technology. With different Input/Outputs Units.

INDUSTRIAL SHIELDS

COMPACT PLC ARDUINO 12-24Vdc ARDBOX ANALOG		
Supply Voltage	12-24Vdc	Fuse protection (1A) Polarity protection
Max. current consumption	0,5A	
Size	100x45x115	
Clock Speed	16MHz	
Flash Memory	32KB of which 4KB are used by bootlader	
SRAM	2.5KB	
EEPROM	1KB	
Communications	I2C[1] – USB -- RS232 -- RS485 – SPI	
TOTAL Input points	**10**	
TOTAL Output points	**10**	
INPUTS	Digital range:12/24 Vdc (7.6 to 25.4 Vdc) Analog range: 0-10 Vdc	
Digital	**10**	12/24Vdc I min: 3/6 mA Separated PCB ground
Analog 10 bits	**9** of 10 Digital input	0-10V Input Impedance: 39K Separated PCB ground
*** Interrupt HS**	**1** of 10 Digital input	12/24Vdc I min: 5/10 mA Separated PCB ground
*The same input is not simultaneously compatible as InterrupHS and Digital. IMPORTANT		
OUTPUTS	Digital Isolated range: 5/12/24 Vdc (4.6 to 25.4 Vdc) Analog range: 0-10 Vdc	

[1] Pull-up resistance required for i2c (IS.ACI2C-4.7K)

Digital Isolated	**10**	5/12/24 Vdc I max: 0.3 A Galvanic INSULATION Diode Protected for Relay
Analog 8 bits	**7**	0-10 Vdc I max: 40 mA Separated PCB ground
PWM Isolated 8bit	**6** of 10 Digital isolated Output	5/12/24 Vdc I max: 0.3 A Galvanic INSULATION Diode Protected for Relay
Expandability	I2C[1] – RS232 - RS485 - SPI	
Reference	IS.AB20AN.base	

3 Precautions

Read this manual before attempting to use the Ardbox and follow its descriptions for reference during operation

1.1. Arduino Board

All Ardbox family PLCs include Arduino LEONARDO Board as controller.

1.2. Intended Audience

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

1.3. General Precautions

The user must operate Ardbox according to the performance specifications described in this manual.

Before using Ardbox under different conditions from the what is specified in this manual or integrating Ardbox 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 Ardbox 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 Ardbox.

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.

4 Technical Specifications

4.1 General Specifications:

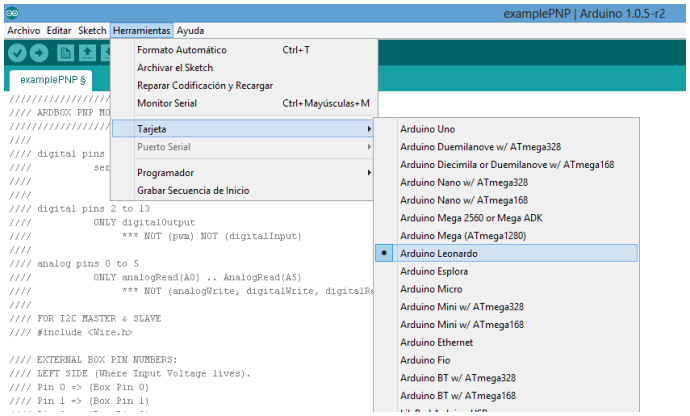
Power supply voltage	**DC power supply**	12/24Vdc
Operating voltage range	**DC power supply**	11.4 to 25.4Vdc
Power consumption	**DC power supply**	30VAC max.
External power supply	**Power supply voltage**	12/24Vdc
	Power supply output capacity	700Ma
Insulation resistance		20MΩ min.at 500Vdc between 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/s2 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		340g max.

4.2 Performance Specification:

Arduino Board	**ARDUINO LEONARDO**
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	ATmega32u4
Flash Memory	32kb of which 4 kb are used by bootloader
Program capacity (SRAM)	2.5kb
EEPROM	1kb
Clock Speed	16MHz

5 Software interface

Industrial Shields programming environment is Arduino IDE.
https://www.arduino.cc/en/Main/Software



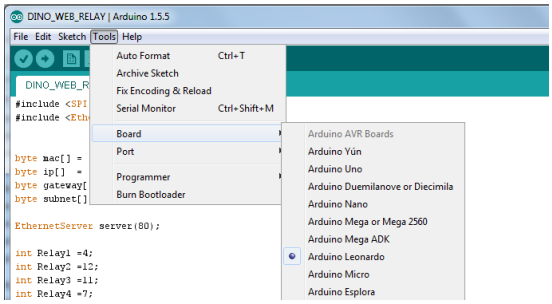
You can download start code for Ardbox Relay at www.industrialshields.com , section *20 IOs PLCs /Ardbox Relay / Document files*.

6 How to connect PLC Arduino to PC

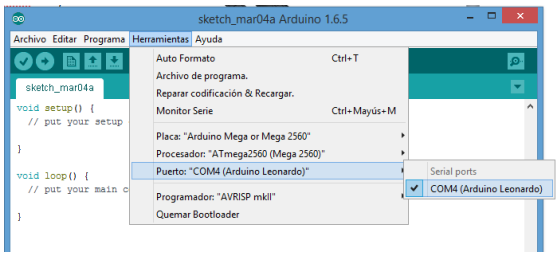
- Connect USB cable from PLC to PC.
  NOTE: Ardbox Family use micro USB cable.

- Open Arduino IDE interface:
  Available at:
  http://arduino.cc/download.php?f=/arduino-1.0.6-windows.exe

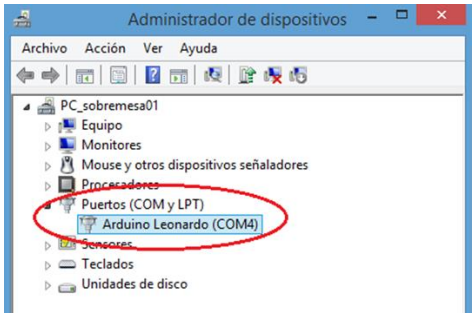
- Select Arduino Board
  NOTE: Ardbox integrates Arduino Leonardo as controller board.



- Select correct port.

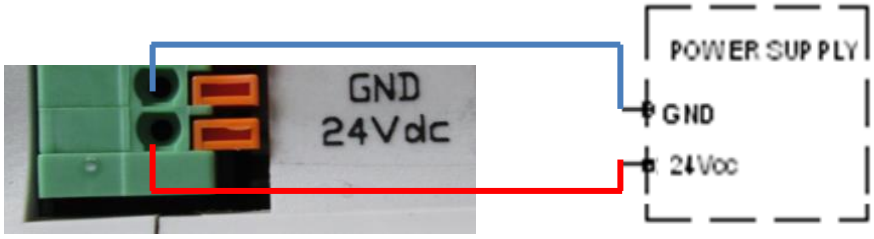


IMPORTANT:
Verify the USB port is detected:



7 How to connect PLC to power supply

- Ardbox 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

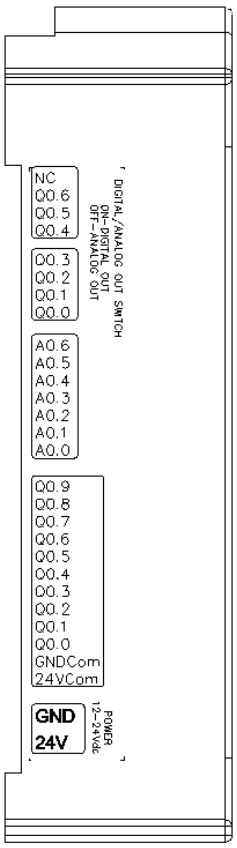
* Not recommended for industrial applications. The *Jack* connector needs to be removed and use the live and GND connectors.

INDUSTRIAL SHIELDS

8 Ardbox Analog I/O Pinout:

Zone Connections

RIGHT Zone		
Ardbox Connector	*Arduino Pin*	Function
A0.6	*3*	Analog Out
A0.5	*5*	Analog Out
A0.4	*6*	Analog Out
A0.3	*9*	Analog Out
A0.2	*10*	Analog Out
A0.1	*11*	Analog Out
A0.0	*13*	Analog Out
Q0.9	*0*	Digital Output
Q0.8	*1*	Digital Output
Q0.7	*7*	Digital Output
Q0.6	*3*	PWM/digital Output
Q0.5	*5*	PWM/digital Output
Q0.4	*6*	PWM/digital Output
Q0.3	*9*	PWM/digital Output
Q0.2	*10*	PWM/digital Output
Q0.1	*11*	PWM/digital Output
Q0.0	*13*	PWM/digital Output
GNDCOM	-	Isolated GND
24VCOM	-	Isolated VIN



RIGHT Zone

Switch config*
(see section 9 for Analog/Digital Outputs configuration)

Analog Outputs pinout

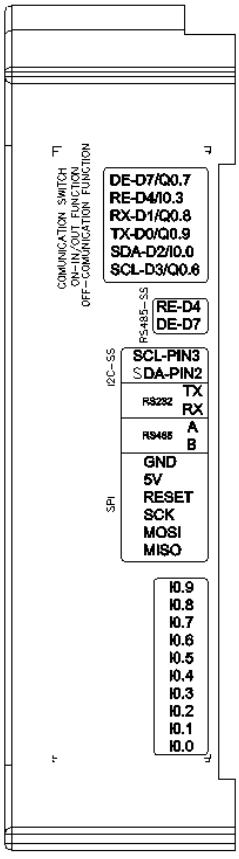
Digital/PWM Output pinout

Isolated VIN/GND for Outputs

Power supply connectors (24Vdc – Gnd)

LEFT Zone		
Ardbox Connector	*Arduino Pin*	Function
RE	*7*	RS485/SPI(SS)
DE	*4*	RS485/SPI(SS)
SCL	*3*	I2C/SPI(SS)
SDA	*2*	I2C/SPI(SS)
TX	*0*	RS232
RX	*1*	RS232
A	-	RS485
B	-	RS485
GND	-	GND
5V	-	5V OUT
RESET	-	RESET
SCK	-	SPI
MOSI	-	SPI
MISO	-	SPI
I0.9	*A0*	Analog/Digital Input
I0.8	*A1*	Analog/Digital Input
I0.7	*A2*	Analog/Digital Input
I0.6	*A3*	Analog/Digital Input
I0.5	*A4*	Analog/Digital Input
I0.4	*A5*	Analog/Digital Input
I0.3	*4 / A6**	Analog/Digital Input
I0.2	*8 / A8**	Analog/Digital Input
I0.1	*12 /A11**	Analog/Digital Input
I0.0	*2*	Digital interrupt

*Use A6, A8 and A11 for analog values

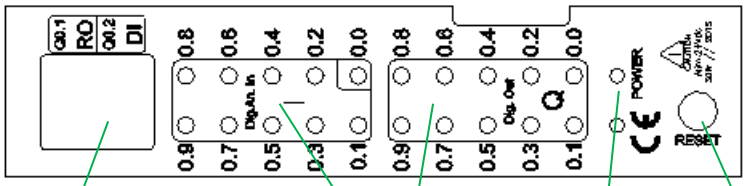


LEFT Zone

Switch config*
(see section 9 for Switch configuration. Enabling Communications disables some I/Os)

Communications pinout
(SPI, I2C, RS485, RS232)

Inputs pinout



Config switch *
(see section 9 for communications configuration)

Input / Output LED

Power LED

Arduino Reset button

9 Switch configuration

General Switches Configurations

TOP ZONE		
ENABLED CONNECTION	**ON**	**OFF**
Q0.1	Q0.1	RO
RO	RO	Q0.1
Q0.2	Q0.2	DI
DI	DI	Q0.2

LEFT ZONE		
SWITCH CONFIGURATION		
ARDUINO PIN	**OFF***	**ON**
7	DE	Q0.7
4	RE	I0.3
1	Q0.8	RX
0	Q0.9	TX
2	SDA	I0.0
3	SCL	Q0.6

***IMPORTANT:**

LEFT ZONE. To enable communication connections the switchs must be set to “OFF”. Set to “ON” position to enable I/Os PLC connection. Communications and I/Os on the chart can not work simultaneously. For exemple if DE is enabled (OFF), Q0.7 will not work. OFF position provides direct connection to Arduino Pin (NOT for TX and RX), so they can be programmed according to Arduino pin features.

TOP ZONE. Communications and outputs can not work simultaneously. If Q0.1 is enabled RO must be disabled and conversely.

RS- 485 Switch configuration

RS-485 CONFIGURATION			
TOP ZONE		**LEFT ZONE**	
Q0.1	OFF	DE	OFF
RO	ON	RE	OFF
Q0.2	OFF	RX	(ON/OFF)
DI	ON	TX	(ON/OFF)
		SDA	(ON/OFF)
		SCL	(ON/OFF)

RS485: Enable RE/DE/DI and RO internal pins with configuration switches. I0.3, Q0.1, Q0.2 and Q0.7 not available. The defined Arduino Mega pins for RS485 are showed in the chart below.

RS-232 Switch configuration

RS-232 CONFIGURATION			
TOP ZONE		LEFT ZONE	
Q0.1	(ON/OFF)	DE	(ON/OFF)
RO	(ON/OFF)	RE	(ON/OFF)
Q0.2	(ON/OFF)	RX	ON
DI	(ON/OFF)	TX	ON
		SDA	(ON/OFF)
		SCL	(ON/OFF)

RS232: Enable RX and TX connections with configuration switches. Q0.8 and Q0.9 not available

I2C Switch configuration

i2c CONFIGURATION			
TOP ZONE		LEFT ZONE	
Q0.1	(ON/OFF)	DE	(ON/OFF)
RO	(ON/OFF)	RE	(ON/OFF)
Q0.2	(ON/OFF)	RX	(ON/OFF)
DI	(ON/OFF)	TX	(ON/OFF)
	(ON/OFF)	SDA	OFF
		SCL	OFF

I2C: Enable SCL and SDA connections (direct Arduino pins) with configuration switches. I0.0 and Q0.6 not available. In order to implement this communication a 4.7kΩ pull-up resistor (IS.ACI2C-4.7K) is required.

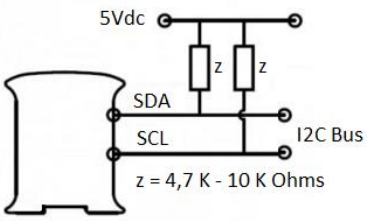
Analog/Digital Output Switch Configuration

RIGHT SIDE		
SWITCH CONFIG		
Output	ON	OFF
NC	NC	NC
Q0.6	DIGITAL	A0.6
Q0.5	DIGITAL	A0.5
Q0.4	DIGITAL	A0.4
Q0.3	DIGITAL	A0.3
Q0.2	DIGITAL	A0.2
Q0.1	DIGITAL	A0.1
Q0.0	DIGITAL	A0.0

10 Communications

10.1 I2C

I2C communication requires a pull-up resistor (IS.ACI2C-4.7K)



Check the switch configuration in section 9 to enable I2C port.

10.2 SPI

The Ardbix 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	Ardbox connection	Mega board pin
MISO	MISO	MISO
MOSI	MOSI	MOSI
CLOCK	SCK	SCK
Reset	RESET	Reset
SS	SCL (pin 3)/SDA (pin 2)/DE (pin 7)/ RE(pin 4)	pin 3 /pin 2 /pin 7/pin 4

Check the switch configuration at section 9 to enable SS pins.

10.3 RS-232

The Arduino Leonardo function code to access the RS-232 port in the Ardbox is *Seria1* (pins 0 and 1of the Arduino Leonardo). Check the switch configuration in section 9 to enable RS -232 port.

For an example of RS-232 communication check out Industrial Shields blog.

http://blog.industrialshields.com/es/2015/08/rs485-and-rs232-implementation-to-in/

10.4 RS-485

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

RS485 pinout	
Function	**Arduino Pin**
DI	10
RO	11
RE	4
DE	7

In order to use RS-485 a serial port must be created on pins 10 and 11 using SoftwareSerial function. Following there is a simple Arduino demo sketch which reads a byte from RS-485 port and echoes it back to the RS-485 bus.

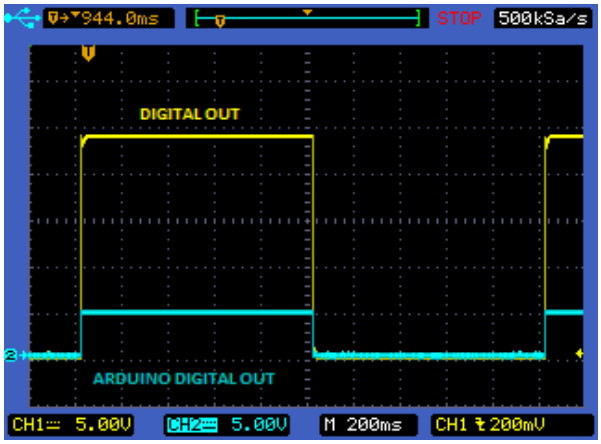
```
#define SSerialRX       11 // RO  //RS485 Receive pin
#define SSerialTX       10 // DI  //RS485 Transmit pin
#define SSerialTxControl 7  // DE  //RS485 Direction pin
#define GroundRE        4  // RE
#define RS485Transmit    HIGH
#define RS485Receive     LOW
SoftwareSerial RS485Serial(SSerialRX, SSerialTX);
void setup() {
digitalWrite(GroundRE,LOW);
RS485Serial.begin(4800);
}
void loop() {
digitalWrite(SSerialTxControl, RS485Receive);
if (RS485Serial.available()) { // Read from RS485!
   digitalWrite(PinLED, HIGH);
   byteRecv = RS485Serial.read();
digitalWrite(SSerialTxControl, RS485Transmit);
RS485Serial.write(byteRecv);
}
}
```

For another example check Indsutrial Shields blog

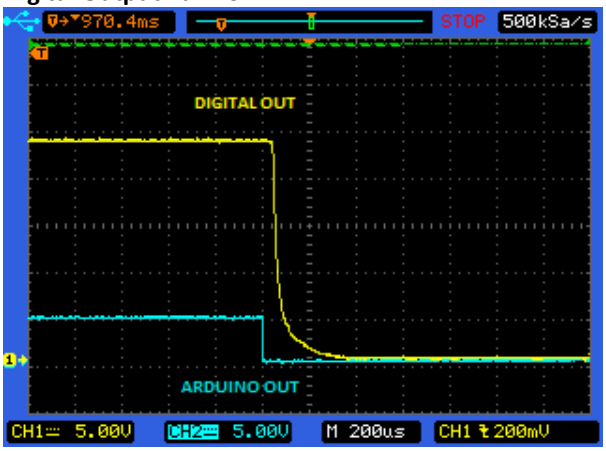
http://blog.industrialshields.com/es/2015/08/rs485-and-rs232-implementation-to-in/

11 I/0 technical details

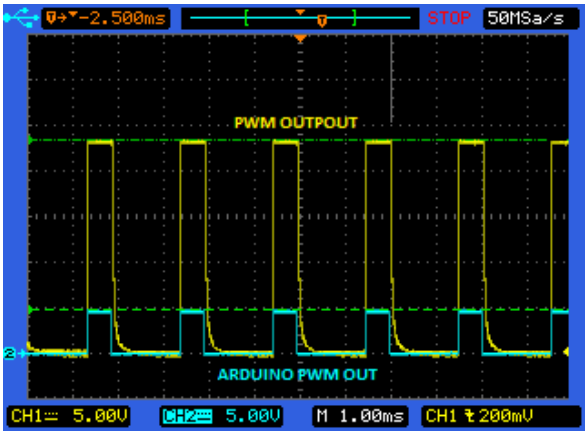
Digital Output Waveform



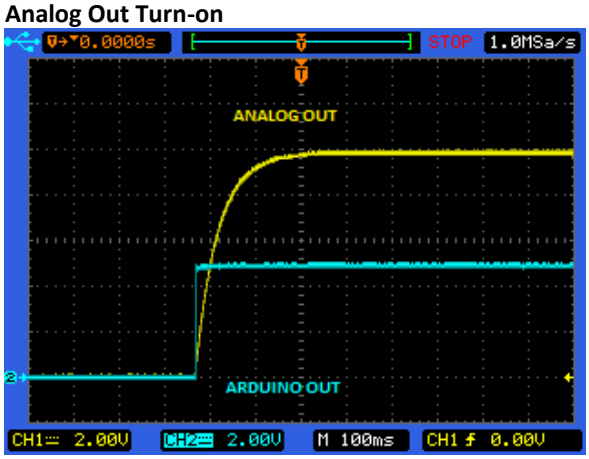
Digital Output Turn-off



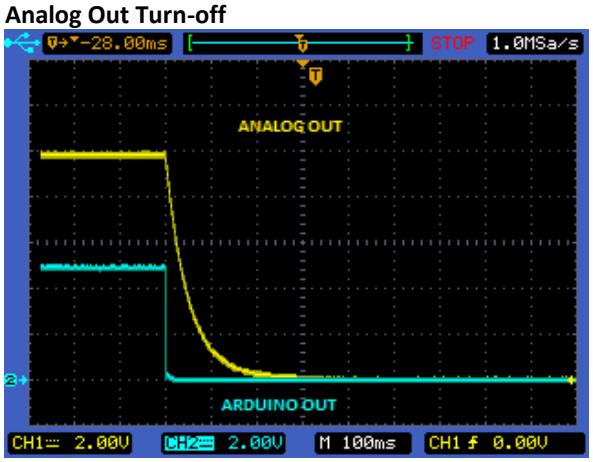
PWM Waveform



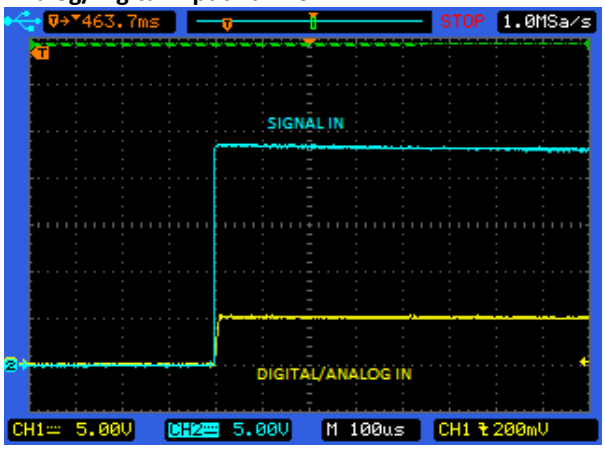
Analog Out Turn-on



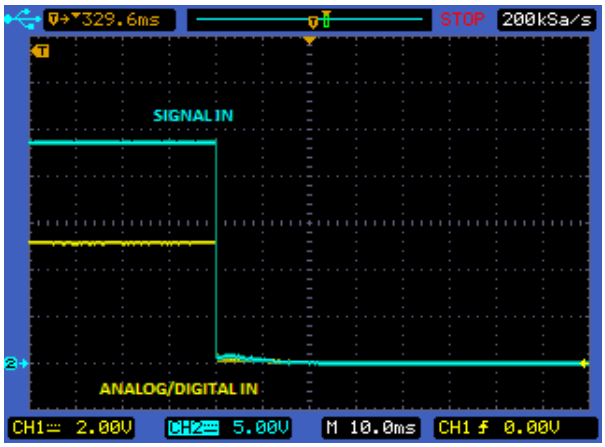
Analog Out Turn-off



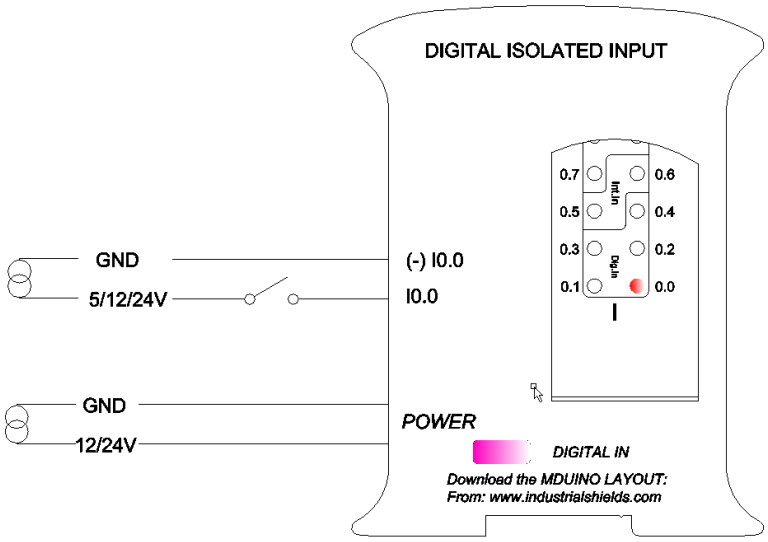
Analog/Digital Input Turn-on

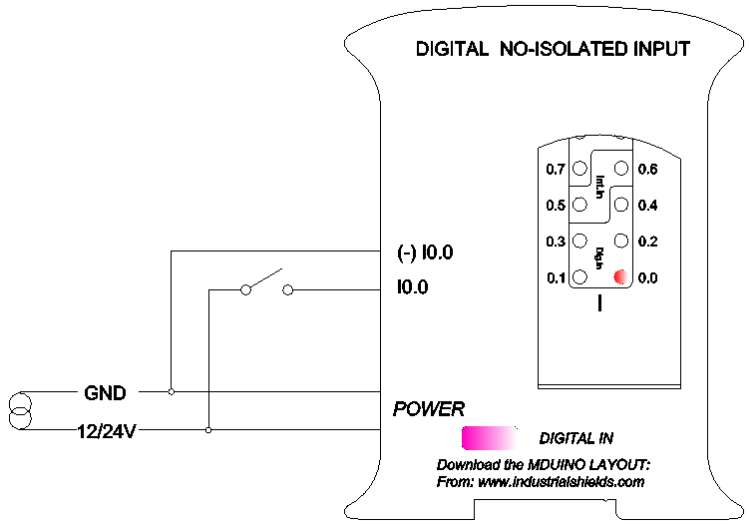


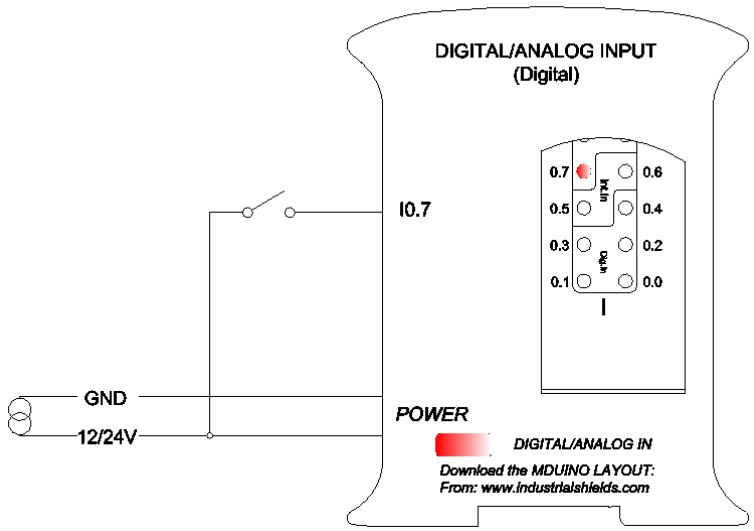
Analog/Digital Input Turn-off

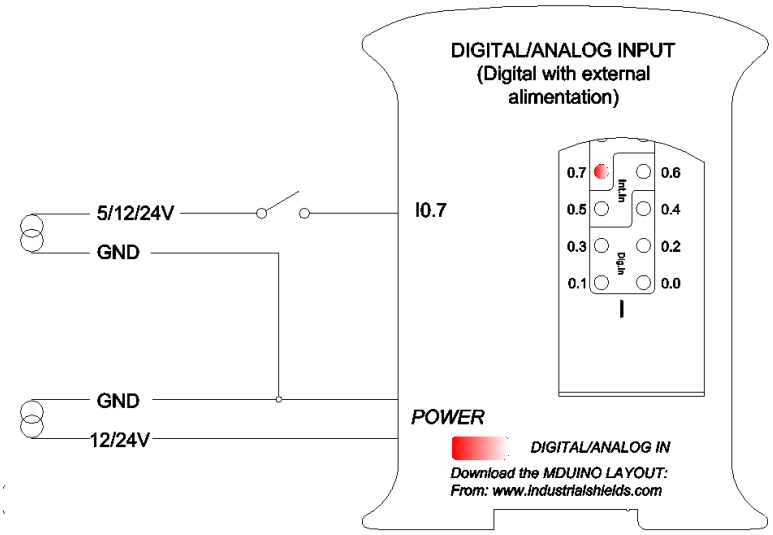

329.6ms
STOP
200kSa/s
SIGNAL IN
ANALOG/DIGITAL IN
CH1 2.00V
CH2 5.00V
M 10.0ms
CH1 0.00V

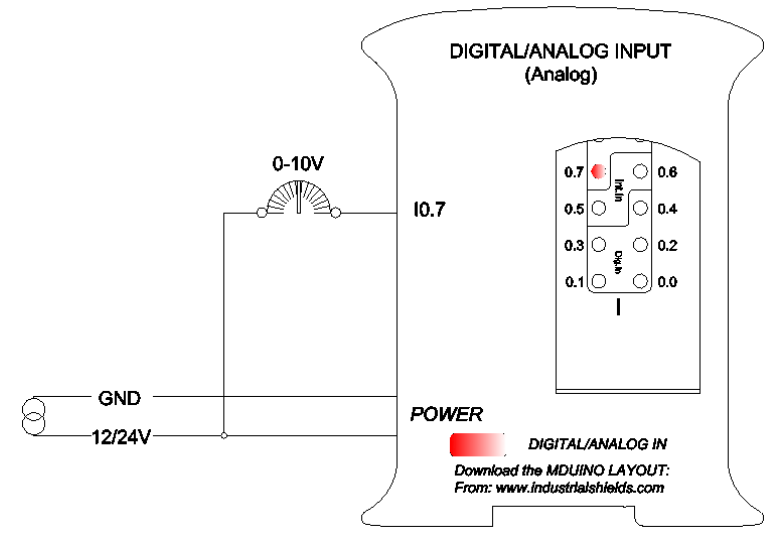
12 Typical Connections

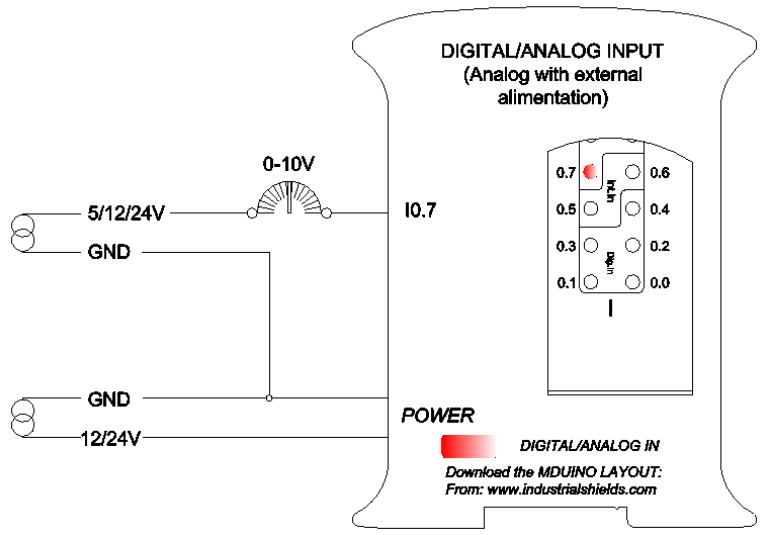


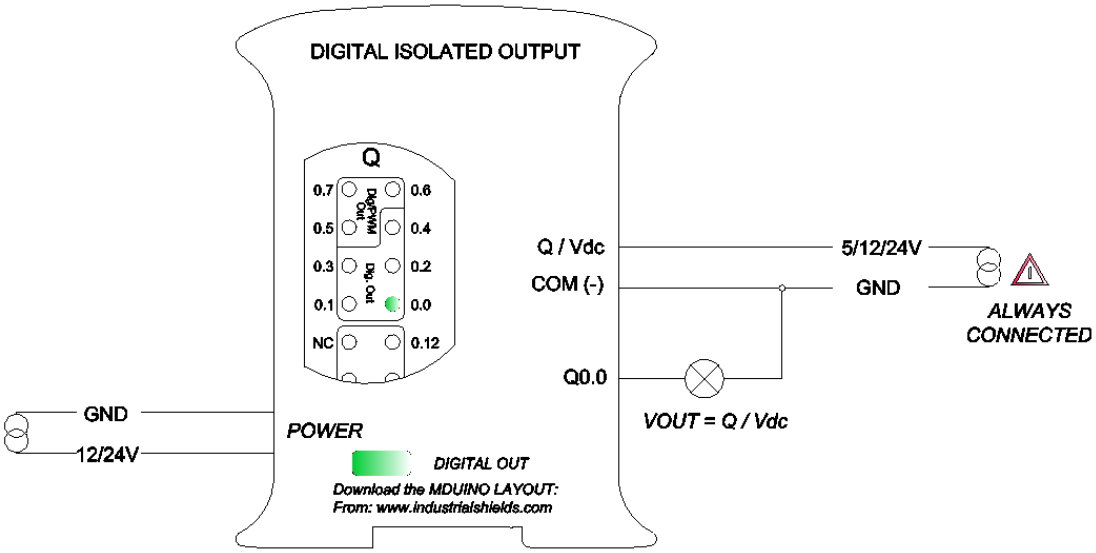


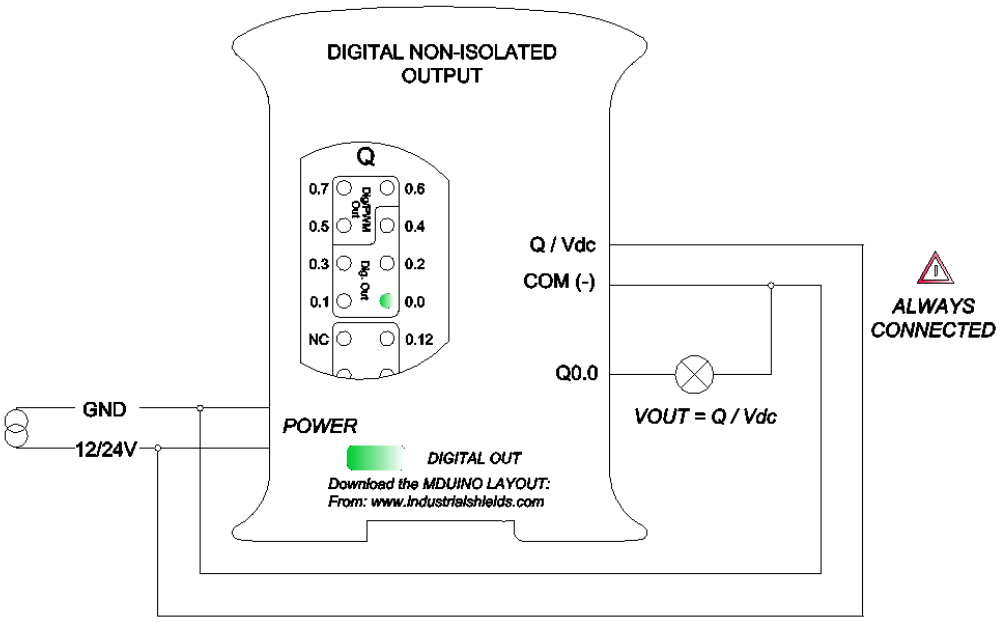


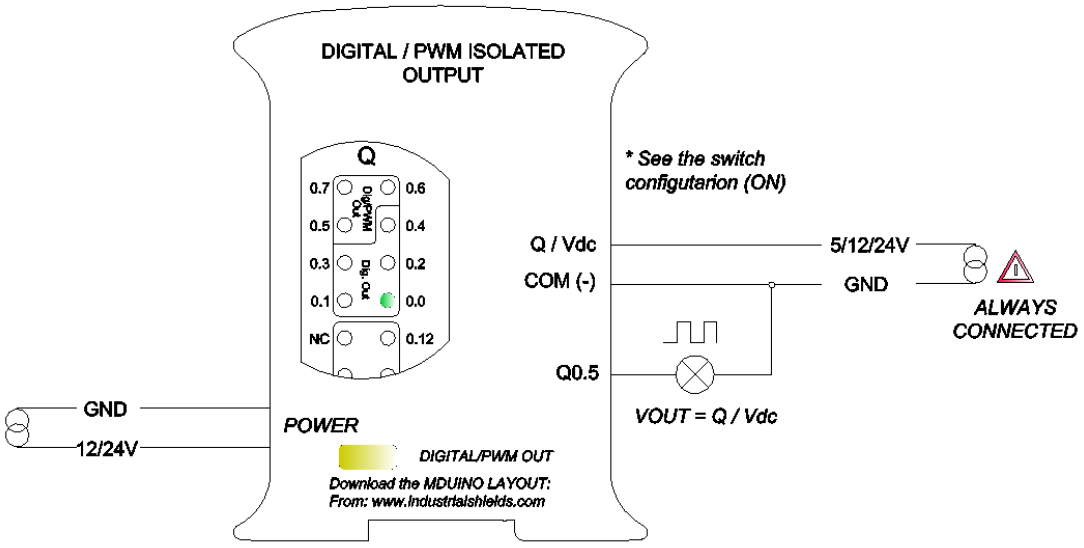

DIGITAL/ANALOG INPUT
(Digital with external
alimentation)
5/12/24V
GND
GND
12/24V
I0.7
POWER
DIGITAL/ANALOG IN
Download the MDUINO LAYOUT:
From: www.industrialshields.com
0.7
0.5
0.3
0.1
0.6
0.4
0.2
0.0
Int.In
Dig.In
I

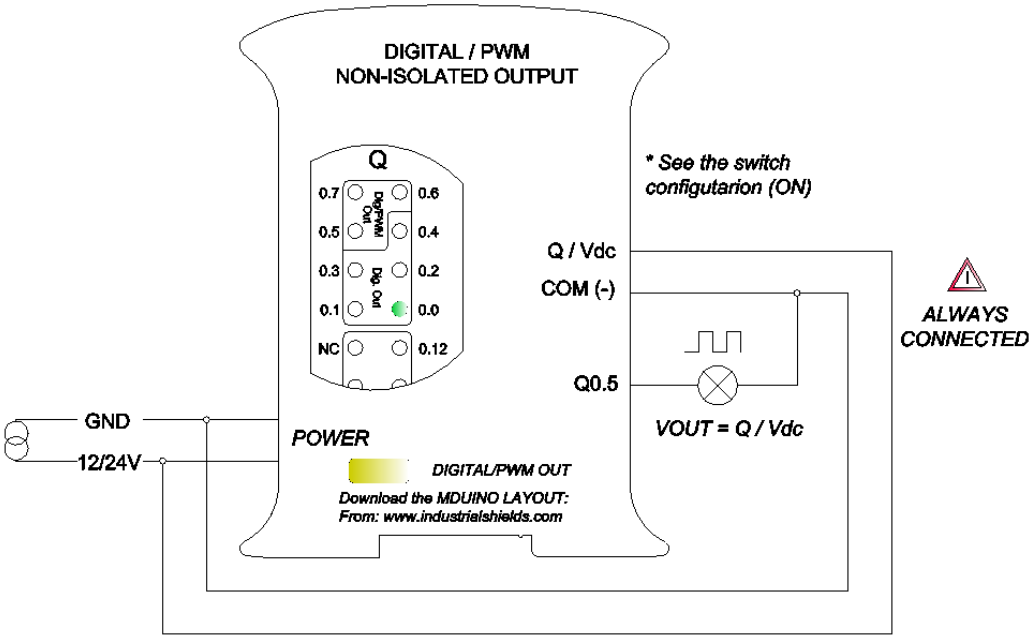

DIGITAL/ANALOG INPUT
(Analog)
0-10V
GND
12/24V
I0.7
POWER
DIGITAL/ANALOG IN
Download the MDUINO LAYOUT:
From: www.industrialshields.com
0.7
0.5
0.3
0.1
0.6
0.4
0.2
0.0
Int.In
Dig.In
I

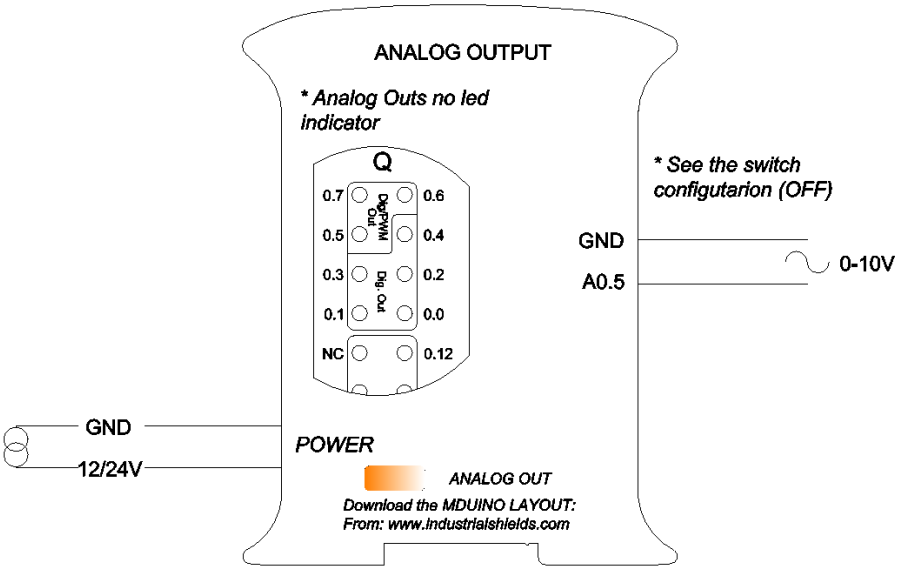

DIGITAL/ANALOG INPUT
(Analog with external
alimentation)
0-10V
5/12/24V
GND
GND
12/24V
I0.7
POWER
DIGITAL/ANALOG IN
Download the MDUINO LAYOUT:
From: www.industrialshields.com
0.7
0.5
0.3
0.1
0.6
0.4
0.2
0.0
Int.In
Dig.In
I


DIGITAL ISOLATED OUTPUT
Q
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
NC
0.12
Dig/PWM Out
Dig. Out
Q / Vdc
COM (-)
Q0.0
5/12/24V
GND
ALWAYS CONNECTED
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/PWM Out
Dig. Out
Q / Vdc
COM (-)
Q0.0
ALWAYS CONNECTED
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/PWM Out
Dig. Out
* See the switch configutarion (ON)
Q / Vdc
COM (-)
Q0.5
5/12/24V
GND
ALWAYS CONNECTED
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/PWM Out
Dig. Out
* See the switch configutarion (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/PWM Out
Dig. Out
* See the switch configutarion (OFF)
GND
A0.5
0-10V
GND
12/24V
POWER
ANALOG OUT
Download the MDUINO LAYOUT:
From: www.industrialshields.com

13 Connector details

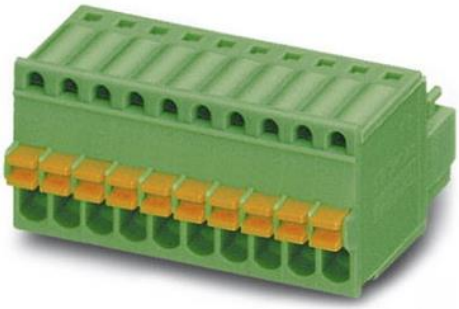
The connector inside the PLCs that mounts on the PCB is MC 0,5/10-G-2,5 THT – 1963502 from Phoenix contact. MC0,5/10-G-2,5THT

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

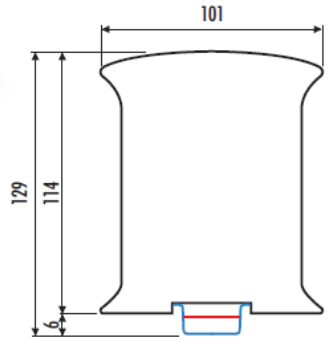
Connection details:

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

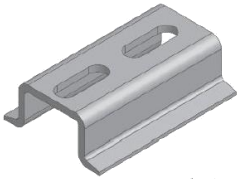


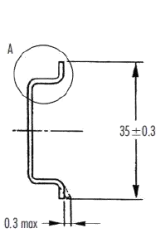
14 ARDBOX Family Dimensions:



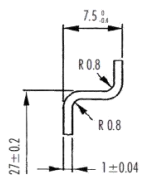
45mm width

15 DIN rail mounting:

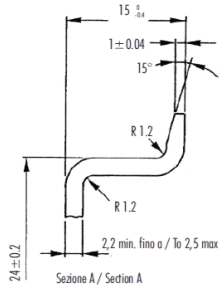




Profilato a cappello TH 35-7,5
Top hat rail TH 35-7,5



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



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	%	59
	Modulo in flessione	ASTM D790	MPa	2894
	Prova Izod con intaglio	ISO 180/1A	KJ/m²	5.5
Termiche	Temp. di rammollimento Vicat, metodo B	ASTM D1525	°C	114
	Temperatura Ricotto 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 - 98N	ASTM D1238	gr/10'	11.1
Comportamento alla fiamma	Autoestinguenza (mm di spessore)	UL94	-	V-0 (0.8)
	Filo Incandescen. 3.2 mm	IEC695.2.1	°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
	Flexing modulus	ASTM D790	MPa	2894
	Izod test notched	ISO 180/1A	KJ/m²	5.5
Thermal test	Vicat softening temperature method B	ASTM D1525	°C	114
	Reheating 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 - 98N	ASTM D1238	gr/10'	11.1
Flame test	Self extinguisher (thickness in mm)	UL94	-	V-0 (0.8)
	Incandescente thread 3.2 mm	IEC695.2.1	°C	960

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

About Industrial Shields:
SPAIN
Divina Pastora 13-15 Baixos 3
08241 Manresa (Barcelona)
Tel.+34 635693611
Mail: industrialshields@industrialshields.com