USER MANUAL

Longo programmable controller
LPC-3.IOU.001
Input Output Universal PLC

Version 3

SMARTEH d.o.o. / Poljubinj 114 / 5220 Tolmin / Slovenia / Tel.: +386(0) 388 44 00 / e-mail: info@smarteh.si / www.smarteh.si

Written by SMARTEH d.o.o.

User Manual

Document Version: 003
February, 2016

STANDARDS AND PROVISIONS: Standards, recommendations, regulations and provisions of the country in which the devices will operate, must be considered while planning and setting up electrical devices. Work on 100 .. 230 V AC network is allowed for authorized personnel only.

DANGER WARNINGS: Devices or modules must be protected from moisture, dirt and damage during transport, storing and operation.

WARRANTY CONDITIONS: For all modules LONGO LPC-3 – if no modifications are performed upon and are correctly connected by authorized personnel – in consideration of maximum allowed connecting power, warranty of 24 months is valid from the date of sale to the end buyer, but not more than 36 months after delivery from Smarteh. In case of claims within warranty time, which are based on material malfunctions the producer offers free replacement. The method of return of malfunctioned module, together with description, can be arranged with our authorized representative. Warranty does not include damage due to transport or because of unconsidered corresponding regulations of the country, where the module is installed.

This device must be connected properly by the provided connection scheme in this manual. Misconnections may result in device damage, fire or personal injury.
Hazardous voltage in the device can cause electric shock and may result in personal injury or death.
NEVER SERVICE THIS PRODUCT YOURSELF!
This device must not be installed in the systems critical for life (e.g. medical devices, aircrafts, etc.).

If the device is used in a manner not specified by the manufacturer, the degree of protection provided by the equipment may be impaired.

Waste electrical and electronic equipment (WEEE) must be collected separately!

LONGO LPC-3 complies to the following standards:

- EMC: EN 61000-6-3:2007 + A1:2011, EN 61000-6-1:2007, EN 61000-3-2:2006 + A1:2009 + A2: 2009, EN 61000-3-3:2013,
- LVD: IEC 61010-1:2010 (3rd Ed.), IEC 61010-2-201:2013 (1st Ed.)

Smarteh d.o.o. operates a policy of continuous development. Therefore we reserve the right to make changes and improvements to any of the products described in this manual without any prior notice.

MANUFACTURER:
SMARTEH d.o.o.
Poljubinj 114
5220 Tolmin
Slovenia

Index

Longo programmable controller LPC-3.IOU.001

1 DESCRIPTION

Smarteh third generation of customizable PLCs (Programmable Logic Controller) is ideal solution for the automation of machines and production lines where high number of various input, output and communication connections per single PLC is desirable. LPC-3 controllers offers through its innovative design a very attractive solution for a competitive price. The modules are designed with special attention to the machine building market.

LPC-3.IOU.001 (Input Output Universal) is an innovative PLC with software selection of the type and function for each of the 16 inputs and 2 analog outputs. Each of 16 inputs can be individually configured as digital (-12 .. 30 V) input with a settable range of switching voltages, as analog voltage (-10 .. 10 V) or current (-20 .. 20 mA) input. In addition 8 high accuracy analog inputs can be individually selected for direct connection of up to 8 thermocouples (E, J, K, N, R, S, T), 8 thermistors (Pt100, Pt200, Pt500, Pt1000, Ni1000, NTC 10 kΩ), 8 voltage 0 .. 1 V or 8 current 0 .. 10 mA sources. Up to 2 fast counters and 2 quadrature encoders can also be selected.

16 galvanic isolated transistor outputs (2 groups of 8 outputs) guarantee a current source up to 1.2 A. Outputs are current and thermal protected. 2 selectable voltage (-10 .. 10 V) or current (-20 .. 20 mA) analog outputs are also integrated.

LPC-3.IOU.001 is equipped with Ethernet connection and can be used as a Modbus TCP Slave device, with an USB port, used for programming and debugging. It also includes 2 galvanic isolated CAN bus, used for local or remote connection to other LPC-3 PLCs.

Integrated "Setting Storage FLASH", "RTC" and "NV RAM", doesn't need the battery for it's functioning.

Smarteh IDE (Integrated Development Environment) software tool is used with all the PLCs from the LPC-3 family and it supports all five standard PLC programmable languages (FBD, LD, SFC, ST, IL). It also supports "off line", "on line" debugging and local program transferring. Distributed processing is supported, which makes it possible to handle fast operations.

Controller is powered from external power supply.

NOTE: For proper connection please refer to CONNECTION & CONFIGURATION GUIDE and for proper system configuration and data allocation please refer to PROGRAMMING GUIDE chapter of this user manual.

2 FEATURES

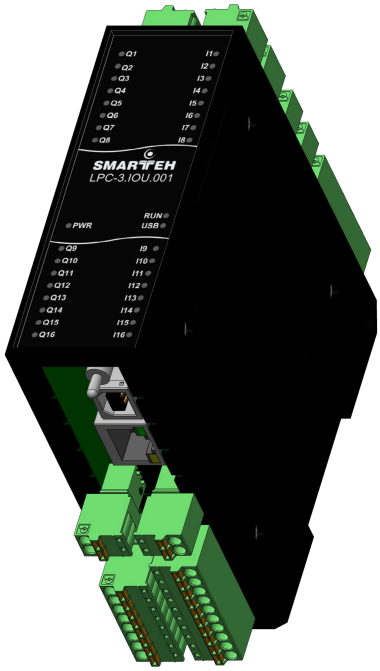


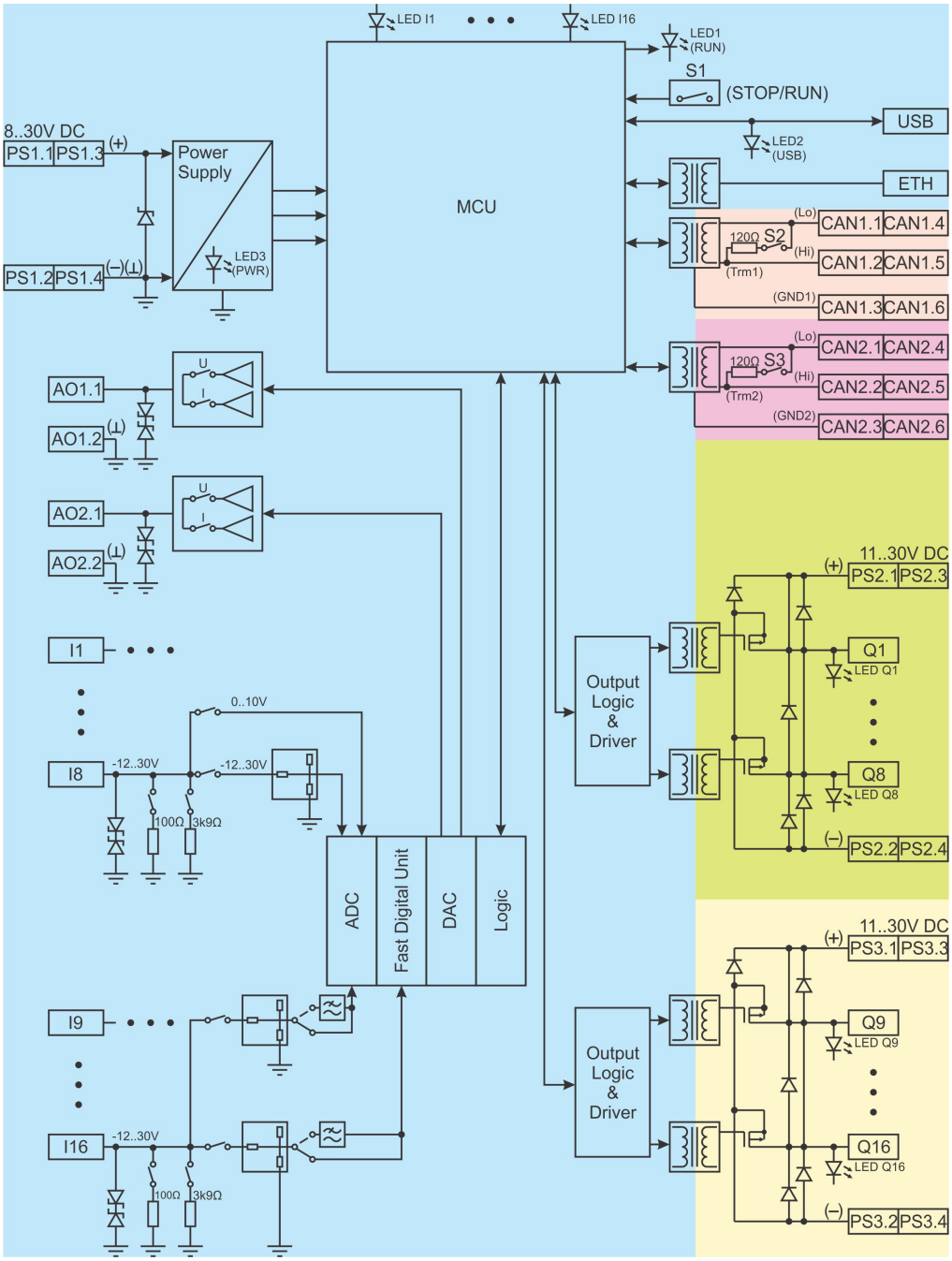
Figure 1: LPC-3.IOU.001 PLC.

Table 1: Technical data		
Ethernet connectivity with Modbus TCP slave (server) functionality		
USB port for Debugging, Application and Default parameters transfer		
2 galvanic isolated (2500 V DC) CAN ports		
RTC and 32 kB non-volatile memory with super capacitor for needed energy storage		
4 kb Flash memory available for parameter storage		
16 individually software selectable inputs	digital	-12 .. 30 V (up to 2 fast counters or quadrature encoders)
	analog	-10 .. 10 V -20 .. 20 mA 0 .. 1 V (up to 8 thermocouples or/and thermistors, …) 0 .. 10 mA
2 individually selectable analog outputs -10 .. 10 V or -20 .. 20 mA		
16 digital outputs 11 .. 30 V, 1.2 A galvanic isolated (500 V AC) outputs, over current and thermal protected		
Disconnect-able spring type connectors		
Double PLC power supply and CAN port connectors for easy integration		
35 status LEDs		
Quality design		

3 INSTALLATION

3.1 Block diagram

Figure 2: PLC block diagram[1]



1 **Coloured areas** represents different voltage domains - galvanic isolated areas. **Please refer** to TECHNICAL SPECIFICATIONS for details.

3.2 Input & output function type selection

Table 2: PLC input function type selection[2]

		Available inputs															
Input function	**No. of inputs**	**I1**	**I2**	**I3**	**I4**	**I5**	**I6**	**I7**	**I8**	**I9**	**I10**	**I11**	**I12**	**I13**	**I14**	**I15**	**I16**
Digital	16	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Fast counter	2									✓				✓			
Quadrature encoder	2										✓				✓		
Analog -10 .. 10 V unipolar	16	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Analog -10 .. 10 V differential	8	✓		✓		✓		✓		✓		✓		✓		✓	
Analog -20 .. 20 mA unipolar	16	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Analog -20 .. 20 mA differential	8	✓		✓		✓		✓		✓		✓		✓		✓	
Analog 0 .. 1 V unipolar	8	✓	✓	✓	✓	✓	✓	✓	✓								
Analog 0 .. 1 V differential	4	✓		✓		✓		✓									
Analog 0 .. 10 mA differential	8	✓	✓	✓	✓	✓	✓	✓	✓								
Thermocouple unipolar	8	✓	✓	✓	✓	✓	✓	✓	✓								
Thermocouple differential	4	✓		✓		✓		✓									
Thermistor unipolar	8	✓	✓	✓	✓	✓	✓	✓	✓								

Table 3: PLC analog output function type selection[3]

		Output	
Output type	**No. of outputs**	AO1	AO2
Analog -10 .. 10 V	2	✓	✓
Analog -20 .. 20 mA	2	✓	✓
High Z	2	✓	✓

2 **Column *No. of inputs*** represents maximum number of individual input functions. that can be selected per one LPC-3.IOU PLC. **Note that, all together there are physically 16 inputs** (input connections) available. For differential analog/quadrature encoder input selection, two/three inputs will be used per one analog/digital input function. **Each input can** only be connected to one function at the time. **Please refer to** PROGRAMMING GUIDE for details.

3 **Column *No. of outputs*** represents maximum number of analog outputs that can be selected per one LPC-3.IOU PLC. **Each output can** only be used as voltage, current or High Z type at the time. **Please refer to** PROGRAMMING GUIDE for details.

Table 4: PLC digital outputs[4]																	
		Output															
Output type	No. of outputs	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16
Digital	16	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Table 5: External Power Supply[5]		
PS1.1 (+)	PLC power supply	8 .. 30 V DC, 1 A
PS1.2 (-)	Reference point (⊥)	0 V
PS1.3 (+)	PLC power supply	8 .. 30 V DC, 1 A
PS1.4 (-)	Reference point (⊥)	0 V
PS2.1 (+)	Digital output Q1..Q8 power supply	11 .. 30 V DC, 8 A
PS2.2 (-)	Digital output Q1..Q8 reference point	0 V to PS2.1/PS2.3
PS2.3 (+)	Digital output Q1..Q8 power supply	11 .. 30 V DC, 8 A
PS2.4 (-)	Digital output Q1..Q8 reference point	0 V to PS2.3/PS2.1
PS3.1 (+)	Digital output Q9..Q16 power supply	11 .. 30 V DC, 8 A
PS3.2 (-)	Digital output Q9..Q16 reference point	0 V to PS3.1/PS3.3
PS3.3 (+)	Digital output Q9..Q16 power supply	11 .. 30 V DC, 8 A
PS3.4 (-)	Digital output Q9..Q16 reference point	0 V to PS3.3/PS3.1

Table 6: Switch		
S1	Operation mode (RUN/STOP)	*RUN*: PLC normal operational mode *STOP*: application not running, connected PLCs outputs in their off state
S2	CAN1 bus termination	*On*: corresponding channel is internally terminated with 120 Ω *Off*: no internal termination present
S3	CAN2 bus termination	*On*: corresponding channel is internally terminated with 120 Ω *Off*: no internal termination present

Table 7: LED.I1 .. LED.I16[6]	
Input status LED	*On*: LED is switched On *Off*: LED is switched Off

Table 8: LED.Q1 .. LED.Q16	
Output status LED	*On*: source voltage present, LED is switched On *Off*: output Off or over current /over temperature protection active, LED is switched Off

4 **Column *No. of outputs*** represents maximum number of digital outputs, that can be used per one LPC-3.IOU PLC. **Please refer to** PROGRAMMING GUIDE for details.

5 **Wires** connected to the module must have cross sectional area at least 0.75 mm^2. Minimum temperature rating of wire insulation must be 85 °C.

6 **LED.I1 .. LED.I16** can be switched On/Off by Smarteh IDE software. LED.I1 .. LED.I16 are not directly connected to individual input I1..I16. **Please refer to** CONNECTION & CONFIGURATION GUIDE for details.

Table 9: LED		
LED1	Application running (RUN)	*On*: application is running *Off*: application is stopped or PLC in boot mode
LED2	USB connectivity (USB)	*On*: USB connection established *Off*: no USB connection
LED3	Power (PWR)	*On*: PLC is powered On *Off*: PLC has no power supply

Table 10: CAN[7]			
Master CAN1 M	CAN1.1	CAN1 Low (Lo)	0 .. 5 V
	CAN1.2	CAN1 High (Hi)	
	CAN1.3	CAN1 reference point (Gnd1)	0 V to CAN1
Slave CAN2 S	CAN2.1	CAN2 Low (Lo)	0 .. 5 V
	CAN2.2	CAN2 High (Hi)	
	CAN2.3	CAN2 reference point (Gnd2)	0 V to CAN2
Master CAN1 M	CAN1.4	CAN1 Low (Lo)	0 .. 5 V
	CAN1.5	CAN1 High (Hi)	
	CAN1.6	CAN1 reference point (Gnd1)	0 V to CAN1
Slave CAN2 S	CAN2.4	CAN2 Low (Lo)	0 .. 5 V
	CAN2.5	CAN2 High (Hi)	
	CAN2.6	CAN2 reference point (Gnd2)	0 V to CAN2

Table 11: Analog output[8]				
		Set as voltage output	Set as current output	Disabled
AO1.1	Analog output 1	-10 .. 10 V, 5 mA	-20 .. 20 mA	High Z
AO1.2	Reference point (⊥)	0 V		
AO2.1	Analog output 2	-10 .. 10 V, 5 mA	-20 .. 20 mA	High Z
AO2.2	Reference point (⊥)	0 V		

7 **Wires** connected to the module must have cross sectional area at least 0.14 mm^2. Use twisted-pair cables of type CAT5+ or better, shielding is recommended. Minimum temperature rating of wire insulation must be 85 °C. **Galvanic isolation** of 2500 V DC between CAN1, CAN2 and rest of the PLC circuit is provided.

8 **Wires** connected to the module must have cross sectional area at least 0.75 mm^2. Minimum temperature rating of wire insulation must be 85 °C. **Type** (voltage, current or High Z) of both analog outputs can be individually set by Smarteh IDE software. **Please refer to** CONNECTION & CONFIGURATION GUIDE for details.

Table 12: Input[9]				
	Input set as			
	Digital	Digital	Fast counter	Quadrature encoder
	-12 .. 30 V R_{in}= 3.9 kΩ Max. input freq. = 25 Hz	-12 .. 30 V R_{in}= 3.9 kΩ Max. input freq.= 50 Hz	-12 .. 30 V R_{in}= 3.9 kΩ Max. input freq.= 100 kHz	-12 .. 30 V R_{in}= 3.9 kΩ Max. input freq.= 50 kHz
I1	Digital input 1			
I2	Digital input 2			
I3	Digital input 3			
I4	Digital input 4			
I5	Digital input 5			
I6	Digital input 6			
I7	Digital input 7			
I8	Digital input 8			
I9		Digital input 9	Fast counter 1, count input	
I10		Digital input 10		Quad. encoder 1, input (A)
I11		Digital input 11		Quad. encoder 1, input (B)
I12		Digital input 12		Quad. encoder 1, (Reset) input
I13		Digital input 13	Fast counter 2, count input	
I14		Digital input 14		Quad. encoder 2, input (A)
I15		Digital input 15		Quad. encoder 2, input (B)
I16		Digital input 16		Quad. encoder 2, (Reset) input

9 **Wires** connected to the module must have cross sectional area at least 0.75 mm^2. Minimum temperature rating of wire insulation must be 85 °C. **Input I1..I8** can be set as digital -12 .. 30 V, voltage -10 .. 10 V, current -20 .. 20 mA, voltage 0 .. 1 V (used for thermocouple, thermistor, … connection) or 0 .. 10 mA. In addition, input filter can also be selected. **Input I9..I16** can be set as digital -12 .. 30 V, voltage -10 .. 10 V and current -20 .. 20 mA. 2 fast counters or quadrature encoders can be selected. In addition, input filter can also be selected. **Please refer to** CONNECTION & CONFIGURATION GUIDE for details.

Table 13: Input[10]						
	Input set as					
	Analog					
	-10 .. 10 V R_{in}= 200 kΩ Unipolar	**-10 .. 10 V R_{in}= 400 kΩ Differential**	**-20 .. 20 mA[11] R_{in}= 100 Ω Unipolar**	**-20 .. 20 mA[11] R_{in}= 100 Ω Differential**	**0 .. 1 V R_{in}> 2 MΩ Unipolar**	**0 .. 10 mA[12] R_{in}= 100 Ω Unipolar**
I1	Analog input 1	Analog input 1	Analog input 1	Analog input 1	Analog input 1	Analog input 1
I2	Analog input 2		Analog input 2		Analog input 2	Analog input 2
I3	Analog input 3	Analog input 2	Analog input 3	Analog input 2	Analog input 3	Analog input 3
I4	Analog input 4		Analog input 4		Analog input 4	Analog input 4
I5	Analog input 5	Analog input 3	Analog input 5	Analog input 3	Analog input 5	Analog input 5
I6	Analog input 6		Analog input 6		Analog input 6	Analog input 6
I7	Analog input 7	Analog input 4	Analog input 7	Analog input 4	Analog input 7	Analog input 7
I8	Analog input 8		Analog input 8		Analog input 8	Analog input 8
I9	Analog input 9	Analog input 5	Analog input 9	Analog input 5		
I10	Analog input 10		Analog input 10			
I11	Analog input 11	Analog input 6	Analog input 11	Analog input 6		
I12	Analog input 12		Analog input 12			
I13	Analog input 13	Analog input 7	Analog input 13	Analog input 7		
I14	Analog input 14		Analog input 14			
I15	Analog input 15	Analog input 8	Analog input 15	Analog input 8		
I16	Analog input 16		Analog input 16			

10 **Wires** connected to the module must have cross sectional area at least 0.75 mm^2. Minimum temperature rating of wire insulation must be 85 °C. **Input I1..I8** can be set as digital -12 .. 30 V, voltage -10 .. 10 V, current -20 .. 20 mA, voltage 0 .. 1 V (used for thermocouple, thermistor, … connection) or 0 .. 10 mA. In addition, input filter can also be selected. **Inputs I9..I16** can be set as digital -12 .. 30 V, voltage -10 .. 10 V and current -20 .. 20 mA. 2 fast counters or quadrature encoders can be selected. In addition, input filter can also be selected. **Please refer to** CONNECTION & CONFIGURATION GUIDE for details.

11 **Take care when -20 .. 20 mA**, 0 .. 10 mA, Pt100 or Pt200 is selected not to exceed <-3 or > 3 V of input voltage on corresponding input. 100 Ω internal resistor can permanently be damaged and it can result in wrong measurement or measurement out of specified tolerances. **Please refer to** CONNECTION & CONFIGURATION GUIDE for details.

12 **Take care when -20 .. 20 mA**, 0 .. 10 mA, Pt100 or Pt200 is selected not to exceed <-3 or > 3 V of input voltage on corresponding input. 100 Ω internal resistor can permanently be damaged and it can result in wrong measurement or measurement out of specified tolerances. **Please refer to** CONNECTION & CONFIGURATION GUIDE for details.

Table 13: Input (continue)[13]			
	Input set as		
	Thermocouples	Thermistors	
	E, J, K, N, R, S, T	Pt100	Pt200 Pt500 Pt1000 NTC 10 kΩ Ni1000
	0 .. 1 V R_{in}> 2 MΩ	0 .. 1 V[14] R_{in}= 100 Ω	0 .. 1 V R_{in}= 3.9 kΩ
I1	Analog input 1	Analog input 1	Analog input 1
I2	Analog input 2	Analog input 2	Analog input 2
I3	Analog input 3	Analog input 3	Analog input 3
I4	Analog input 4	Analog input 4	Analog input 4
I5	Analog input 5	Analog input 5	Analog input 5
I6	Analog input 6	Analog input 6	Analog input 6
I7	Analog input 7	Analog input 7	Analog input 7
I8	Analog input 8	Analog input 8	Analog input 8
I9			
I10			
I11			
I12			
I13			
I14			
I15			
I16			

13 **Wires** connected to the module must have cross sectional area at least 0.75 mm^2. Minimum temperature rating of wire insulation must be 85 °C. **Input I1..I8** can be set as digital -12 .. 30 V, voltage -10 .. 10 V, current -20 .. 20 mA, voltage 0 .. 1 V (used for thermocouple, thermistor, … connection) or 0 .. 10 mA. In addition, input filter can also be selected. **Inputs I9..I16** can be set as digital -12 .. 30 V, voltage -10 .. 10 V and current -20 .. 20 mA. 2 fast counters or quadrature encoders can be selected. In addition, input filter can also be selected. **Please refer to** CONNECTION & CONFIGURATION GUIDE for details.

14 **Take care when -20 .. 20 mA**, 0 .. 10 mA, Pt100 or Pt200 is selected not to exceed <-3 or > 3 V of input voltage on corresponding input. 100 Ω internal resistor can permanently be damaged and it can result in wrong measurement or measurement out of specified tolerances. **Please refer to** CONNECTION & CONFIGURATION GUIDE for details.

Table 14: Digital output[15]		
	Source 11 .. 30 V DC[16] Max. current per output = 1.2 A Max. output frequency = 50 Hz	Source 11 .. 30 V DC[17] Max. current per output = 1.2 A Max. output frequency = 50 Hz
Q1	Digital output 1	
Q2	Digital output 2	
Q3	Digital output 3	
Q4	Digital output 4	
Q5	Digital output 5	
Q6	Digital output 6	
Q7	Digital output 7	
Q8	Digital output 8	
Q9		Digital output 9
Q10		Digital output 10
Q11		Digital output 11
Q12		Digital output 12
Q13		Digital output 13
Q14		Digital output 14
Q15		Digital output 15
Q16		Digital output 16

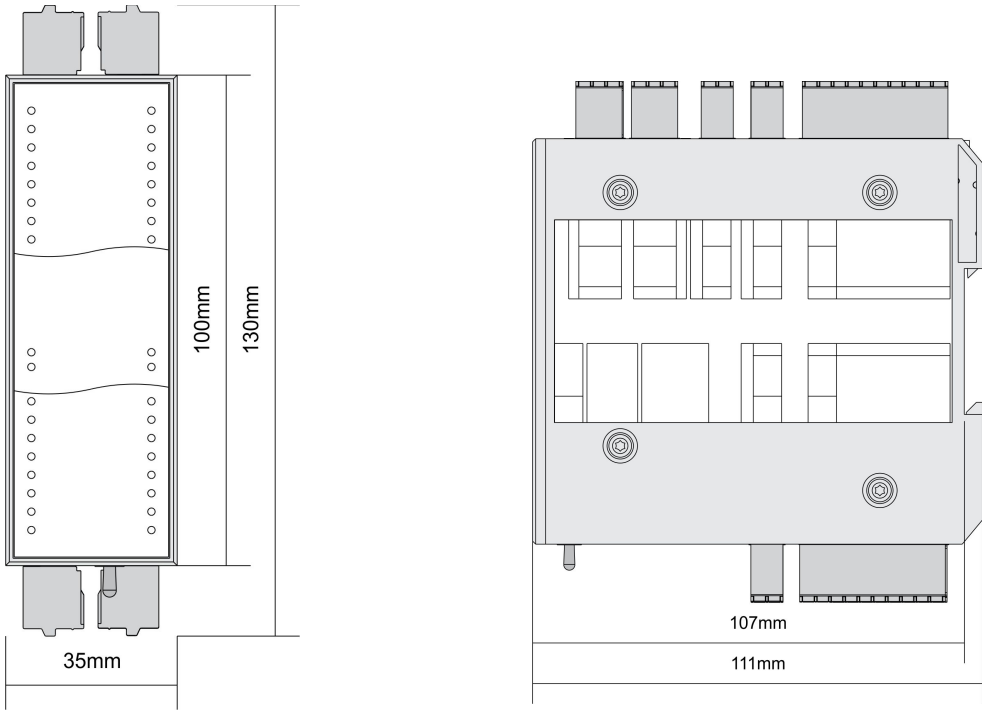
15 **Wires** connected to the module must have cross sectional area at least 0.75 mm^2. Minimum temperature rating of wire insulation must be 85 °C. **Galvanic isolation** (500 V AC) between digital outputs Q1..Q8, PS2.1, PS2.2, PS2.3, PS2.4 and digital outputs Q9..Q16, PS3.1, PS3.2, PS3.3, PS3.4 and rest of the PLC circuit is provided.

16 **Digital outputs Q1..Q8** are source type of outputs in reference to PS2.1/PS2.3 negative (-) voltage. Positive power supply is provided from PS2.1 (+) / PS2.3 (+) connection. **Please refer to** CONNECTION & CONFIGURATION GUIDE for details.

17 **Digital outputs Q9..Q16** are source type of outputs in reference to PS2.1/PS2.3 negative (-) voltage. Positive power supply is provided from PS3.1 (+) / PS3.3 (+) connection. **Please refer to** CONNECTION & CONFIGURATION GUIDE for details.

3.3 Mounting instructions

Figure 3: Housing dimensions



Module surrounding area must be free for optimal cooling.

EXTERNAL SWITCH OR CIRCUIT-BREAKER AND EXTERNAL OVERCURRENT PROTECTION: The unit is allowed to be connected to installation with over current protection that has nominal value of 6 A or less.
RECOMMENDATION ON SWITCH OR CIRCUIT-BREAKER PROTECTION: There should be two poles main switch in the installation in order to switch off the unit. The switch should meet the requirements of standard IEC60947 and have a nominal value at least 6 A. The switch or circuit-breaker should be within easy reach of the operator. It should be marked as the disconnecting device for the equipment.
All connections, PLC attachments and assembling must be done while PLC is not connected to the main power supply.
Wires connected to the PLC must have cross sectional area at least 0.75 mm^2. Minimum temperature rating of wire insulation must be 85 °C.

1. Switch OFF external power supply PS1, PS2 and PS3.
2. Mount LPC-3 PLC to the provided place inside an electrical panel (DIN EN50022-35 rail mounting).
3. Mount other LPC-3 PLC (if required). Mount each PLC to the DIN rail first and then make required connections or connect disconnect-able connectors.
4. Connect needed input, output and communication wires.
5. Switch ON power supply PS1, PS2 and PS3.

4 TECHNICAL SPECIFICATIONS

Table 15: General technical specifications	
LPC-3.IOU.001 external power supply PS1	8 .. 30 V DC
LPC-3.IOU.001 external power consumption PS1	Max. 5 W
PS1 rated isolation voltage to PS2 and PS3	500 V AC
Digital output Q1..Q8 power supply PS2	11 .. 30 V DC
Maximum PS2 current	8 A
PS2 rated isolation voltage to PS1 and PS3	500 V AC
Digital output Q9..Q16 power supply PS3	11 .. 30 V DC
Maximum PS3 current	8 A
PS3 rated isolation voltage to PS1 and PS2	500 V AC
CAN1 isolation voltage to CAN2	2500 V DC
CAN1 or CAN2 isolation voltage to PS1, PS2, PS3	2500 V DC
Connection type	Disconnect-able spring type connectors for stranded wire 0.14 to 2.5 mm^2
Ethernet	RJ-45 10/100T IEEE 802.3i
USB	B connector type, device mode, low speed, full speed
RTC	capacitor backed up with retention of cca. 30 days.
Dimensions (L x W x H)	110 x 100 x 35 mm
Weight	350 g
Ambient temperature	0 to 50 °C
Ambient humidity	max. 95 %, no condensation
Maximum altitude	2000 m
Mounting position	vertical
Transport and storage temperature	-20 to 60 °C
Pollution degree	2
Over-voltage category	II
Electrical equipment	Class II (double insulation)
Protection class	IP 30

Table 16: Analog output technical specifications[18]		
	Set as analog output type	
	Voltage -10 .. 10 V	Current -20 .. 20 mA
Analog output range	-10 .. 10 V	-20 .. 20 mA
Max. current source or sink current on full scale	5 mA per output	20 mA per output
Max. short circuit source or sink current	40 mA per output	20 mA per output
Load resistance for analog outputs	R > 2000 Ω	R < 500 Ω
Analog output accuracy of the full scale value for ambient temperature range 0 .. 50 °C	±0.35 %	±0.50 %
DAC resolution	min. 3600 levels	min. 3600 levels
Max. transition time per channel	5 mili sec.	5 mili sec.

Table 17: Input technical specifications for inputs set as external voltage source digital input[19]						
	Input I1..I8	Input I9..I16				
Digital input range	-12 .. 30 V					
Input resistance	3.9 kΩ					
Max. input frequency, ADC set to 14 bit	25 Hz	50 Hz				
Max. input frequency, ADC set to 20 bit	1 Hz	50 Hz				
Input “Off” threshold voltage[20]	-10 .. 10 V DC	1	3	7	16 V DC	
Input “ON” threshold voltage[20]	-10 .. 10 V DC	4	6	10	20 V DC	

Table 18: Input technical specifications for inputs set as external voltage source fast counter input[21]				
	Fast Counter 1; Input I9 Fast Counter 2; Input I13			
Fast counter input range	-12 .. 30 V			
Input resistance	3.9 kΩ			
Max. input frequency, input filter Off[22]	100 kHz			
Max. input frequency, input filter On[22]	500 Hz			
Input “Off” threshold voltage[20]	1	3	7	16 V DC
Input “ON” threshold voltage[20]	4	6	10	20 V DC

18 **Analog output** voltages and currents are measured to analog output reference point (⊥).
19 **Digital input** voltages are measured to digital input reference point (⊥).
20 **Threshold** programmed by Smarteh IDE software. **Please refer to** CONNECTION & CONFIGURATION GUIDE for details.
21 **Fast counter** input voltages are measured to fast counter input reference point (⊥).
22 **Input filters** are programmed by Smarteh IDE software. **Please refer to** CONNECTION & CONFIGURATION GUIDE for details.

Table 19: Input technical specifications for inputs set as external voltage source quadrature encoder input[23]				
	Quadrature Encoder 1; Input I10(A), I11(B), I12(Reset) Quadrature Encoder 2; Input I14(A), I15(B), I16(Reset)			
Quadrature encoder input range	-12 .. 30 V			
Input resistance	3.9 kΩ			
Max. input frequency, input filter Off[24]	50 kHz			
Max. input frequency, input filter On[24]	500 Hz			
Input "Off" threshold voltage[25]	1	3	7	16 V DC
Input "On" threshold voltage[25]	4	6	10	20 V DC

Table 20: Input technical specifications for inputs I1..I16 set as analog input -10 .. 10 V[26]		
	ADC resolution set to	
	14 bit	20 bit
Analog input range	-10 .. 10 V	
Input resistance in unipolar connection	200 kΩ	
Input resistance in differential connection	400 kΩ	
Analog input accuracy of the full scale value for temperatures 20 .. 30 °C (unipolar and differential)	±0.25 %	
Analog output accuracy of the full scale value for temperatures 0 .. 50 °C (unipolar and differential)	±0.35 %	
ADC resolution when	Min. 56000 levels	Min. 900000 levels
Max. input frequency I1..I8	25 Hz	1 Hz
Max. input frequency, input filter Off I9..I16	25 Hz	1 Hz
Max. input frequency, input filter On I9..I16	10 Hz	1 Hz

23 **Quadrature encoder** input voltages are measured to quadrature encoder input reference point (⊥).
24 **Input filters** are programmed by Smarteh IDE software. **Please refer to** CONNECTION & CONFIGURATION GUIDE for details.
25 **Threshold** is programmed by Smarteh IDE software. **Please refer to** CONNECTION & CONFIGURATION GUIDE for details.
26 **Analog input -10 .. 10 V** voltages are measured to analog input reference point (⊥). **Note:** ADC set to 14bit resolution is recommended for differential input setting.

Table 21: Input technical specifications for inputs I1..I8 set as analog input -20 .. 20 mA[27]		
	ADC resolution set to	
	14 bit	20 bit
Analog input range	-20 .. 20 mA	
Input resistance unipolar connection	100 Ω	
Input resistance differential connection	200 Ω	
Analog input accuracy of the full scale value for temperatures 20 .. 30 °C (unipolar and differential)	±0.45 %	
Analog input accuracy of the full scale value for temperatures 0 .. 50 °C (unipolar and differential)	±0.65 %	
ADC resolution when	Min. 56000 levels	Min. 900000 levels
Max. input frequency	25 Hz	1 Hz

Table 22: Input technical specifications for inputs I9..I16 set as analog input -20..20 mA[27]		
	ADC resolution set to	
	14 bit	20 bit
Analog input range	-20 .. 20 mA	
Input resistance unipolar connection	100 Ω	
Input resistance differential connection	200 Ω	
Analog input accuracy of the full scale value for temperatures 20 .. 30 °C unipolar and differential	±0.65 %	
Analog input accuracy of the full scale value for temperatures 0 .. 50 °C unipolar and differential	±0.85 %	
ADC resolution when	Min. 56000 levels	Min. 900000 levels
Max. input frequency off	25 Hz	1 Hz
Max. input frequency on	10 Hz	1 Hz

27 **Analog input -20 .. 20 mA** currents are measured to analog input reference point (⊥). **Note:** ADC set to 14 bit resolution is recommended.

Table 23: Input technical specifications for inputs I1..I8 set as unipolar analog input 0 .. 1 V[28]	
Analog input range	0 .. 1 V
Input resistance unipolar and differential	>2 MΩ
Analog input accuracy of the full scale value for temperatures 20 .. 30 °C unipolar	±0.02 %
Analog input accuracy of the full scale value for temperatures 0 .. 50 °C unipolar	±0.03 %
Analog input accuracy of the full scale value for 0 .. 100 mV input voltage and temperatures 20 .. 30 °C	±0.005 %
Analog input accuracy of the full scale value for 0 .. 100 mV input voltage and temperatures 0 .. 50 °C	±0.007 %
ADC resolution (ADC set to 20 bit)	Min. 1000000 levels
Max. input frequency	1 Hz

Table 24: Input technical specifications for inputs I1..I8 set as unipolar analog input 0 .. 10 mA[29]	
Analog input range	0 .. 10 mA
Input resistance	100 Ω
Analog input accuracy of the full scale value for temperatures 20 .. 30 °C	±0.20 %
Analog output accuracy of the full scale value for temperatures 0 .. 50 °C	±0.30 %
ADC resolution (ADC set to 20 bit)	Min. 1000000 levels
Max. input frequency	1 Hz

Table 25: Input technical specifications for 100 Ω input I1..I8 resistors[30]	
Input resistance for temperatures 20 .. 30 °C	±0.15 %
Input resistance for temperatures 0 .. 50 °C	±0.20 %

Table 26: Input technical specifications for 100 Ω input I9..I16 resistors	
Input resistance for temperatures 0 .. 50 °C	±0.50 %

28 **Analog input 0 .. 1 V** voltages are measured to analog input reference point (⊥). **Please refer to** CONNECTION & CONFIGURATION GUIDE for details. **Accuracies for thermocouple** temperature measurements are written in Thermocouple programming guide **and accuracies for thermistor** temperature measurements are written in Thermistor programming guide chapter. **Please refer to** PROGRAMMING GUIDE chapter for details.

29 **Analog input 0 .. 10 mA** currents are measured to analog input reference point (⊥). Please refer to CONNECTION & CONFIGURATION GUIDE for details.

30 **100 Ω internal resistors** on inputs I1..I8 are factory calibrated. **Input resistor values** are measured to input reference point (⊥). **Please refer to** CONNECTION & CONFIGURATION GUIDE for details.

Table 27: Input technical specifications for 3.9 kΩ input I1..I8 resistors[31]	
Input resistance for temperatures 20 .. 30 °C	±0.15 %
Input resistance for temperatures 0 .. 50 °C	±0.20 %

Table 28: Input technical specifications for 3.9 kΩ input I9..I16 resistors	
Input resistance for temperatures 0 .. 50 °C	±0.50 %

Table 29: Input technical specifications for I1..I8 average junction temperature measurement[32]	
Junction temperature measurement range[33]	-40 .. 125 °C
Resolution	< 0.1 °C
Junction temperature measurement error 0 .. 50 °C	< ±4 °C
Junction temperature measurement error 20 .. 30 °C	< ±2 °C

31 **3.9 kΩ internal resistors** on inputs I1..I8 are factory calibrated. **Input resistor values** are measured to input reference point (⊥). **Please refer to** CONNECTION & CONFIGURATION GUIDE for details. Additional more accurate results can be achieved by manually calibrate.

32 **Junction temperature** is typically used for thermocouple junction temperature compensation. It is average temperature of I1..I8 terminals. For proper junction temperature measurement only PLC self cooling is allowed. Avoid external forced cooling or heating of the PLC (e.g. fan cooling). Cooling required space around PLC must be respected, as written in MOUNTING INSTRUCTIONS. **For more accurate** thermocouple junction temperature measurement, external compensation temperature sensor must be provided and connected to properly selected and programmed PLC input. **Please refer to** CONNECTION & CONFIGURATION GUIDE and PROGRAMMING GUIDE for details.

33 **Note that LPC-3.IOU.001** can only operate when ambient temperature is in range between 0 .. 50 °C. Junction temperature measurement range is theoretical temperature range, that can be read.

Table 30: Output technical specifications for digital outputs[34]	
Digital output type	Source, P channel FET output
Rated source output voltage	11 .. 30 V DC
Max. source output current per channel[35]	1.2 A
Max, output switching frequency	50 Hz
Max. turn on time to 90 % of supply voltage	200 µs
Max. turn off time to 10 % of supply voltage	250 µs
Continuous output FET reverse drain current per channel, limited by total power dissipation	3 A
Continuous output sum reverse current through Q1..Q8 / Q9..Q16 corresponding reference point	-1.5 A
Inductive load switch-Off energy dissipation single pulse, only one channel active	10 J
Inductive load switch-Off energy dissipation single pulse, all channel simultaneously active	1 J
Capacitive load switch - On dissipation all channels	limited by digital outputs internal thermal protection
Output FET max. On resistance	350 mΩ
Max. output Off leakage current	50 µA
Over current protection	Yes
Thermal protection	Yes

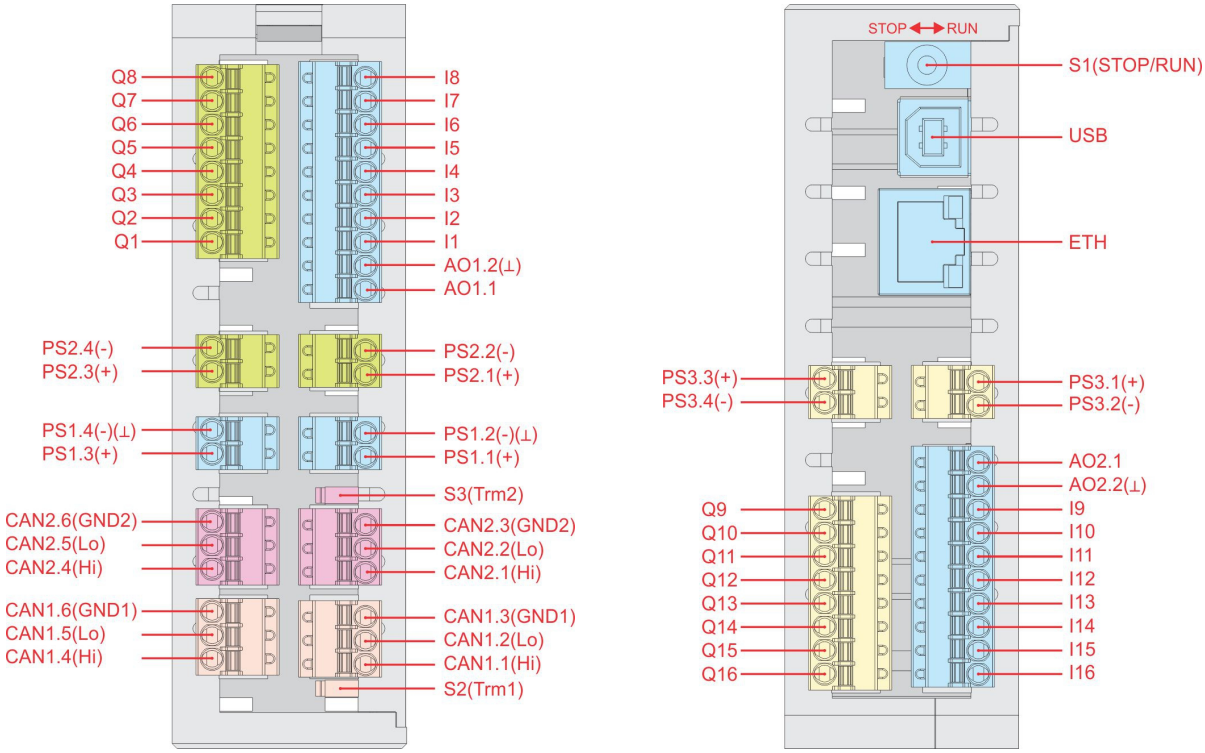
34 **Digital outputs Q1..Q8** voltages and currents are measured to digital outputs Q1..Q8 reference point PS2.1/PS2.3. **Digital outputs Q9..Q16** voltages and currents are measured to digital outputs Q9..Q16 reference point PS3.1/PS3.3. Please refer to CONNECTION & CONFIGURATION GUIDE for details.

35 **Sum current** on power supply pin for transistors outputs can not exceed 8 A. **Please refer to** INSTALLATION GUIDE for details.

5 CONNECTION & CONFIGURATION GUIDE

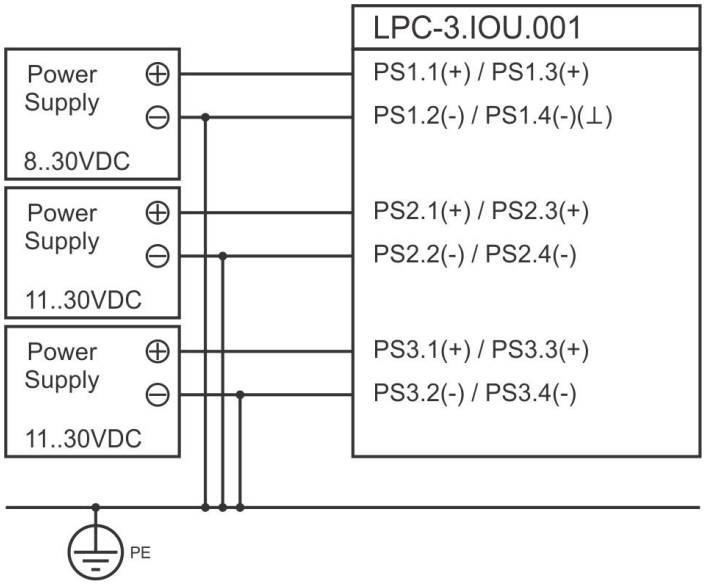
5.1 Main connection scheme & configuration

Figure 4: PLC main connection scheme[36]

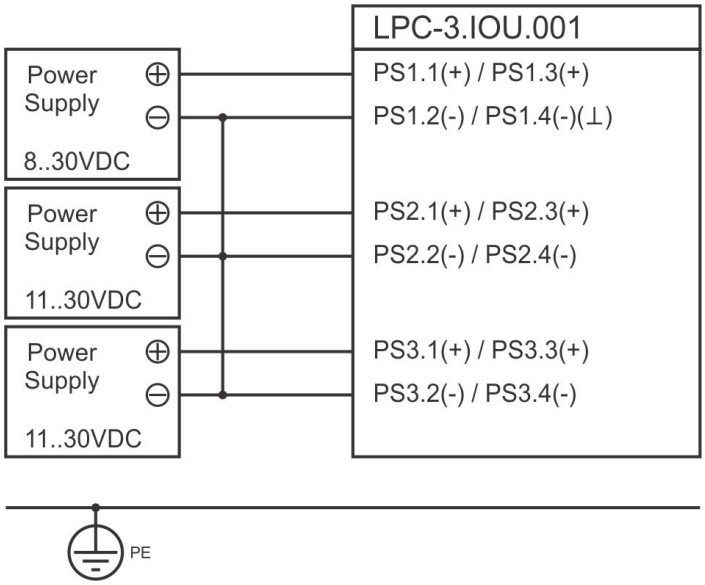


36 **Coloured areas** represents galvanic isolated areas. **Please refer to** General technical specifications in chapter TECHNICAL SPECIFICATIONS for details.

Figure 5: Grounding possibilities[37]



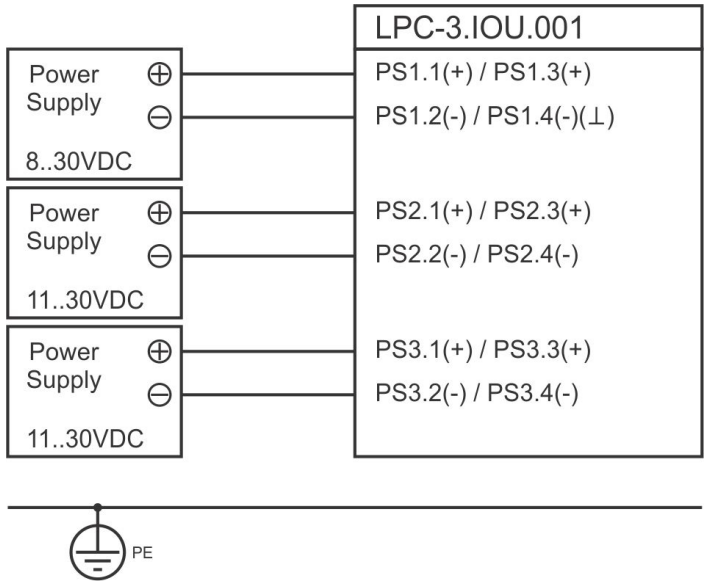
a) All PLC negative power supply poles connected together on to the Protective Earth (PE) ⏚ functional earthing.



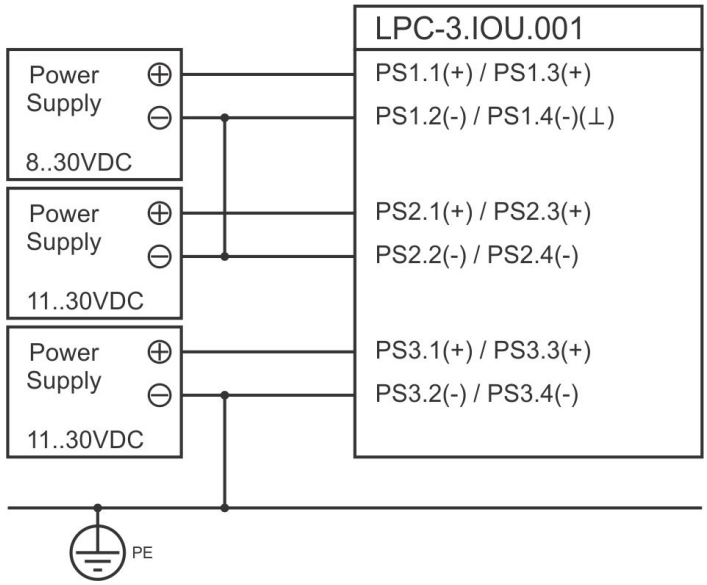
b) All PLC negative power supply poles connected together but not to the Protective Earth (PE) ⏚ functional earthing.

37 **Potential differences** between any two negative power supply poles could not exceed prescribed values. **Please refer to** TECHNICAL SPECIFICATIONS for details.

Figure 5: Grounding possibilities[38]



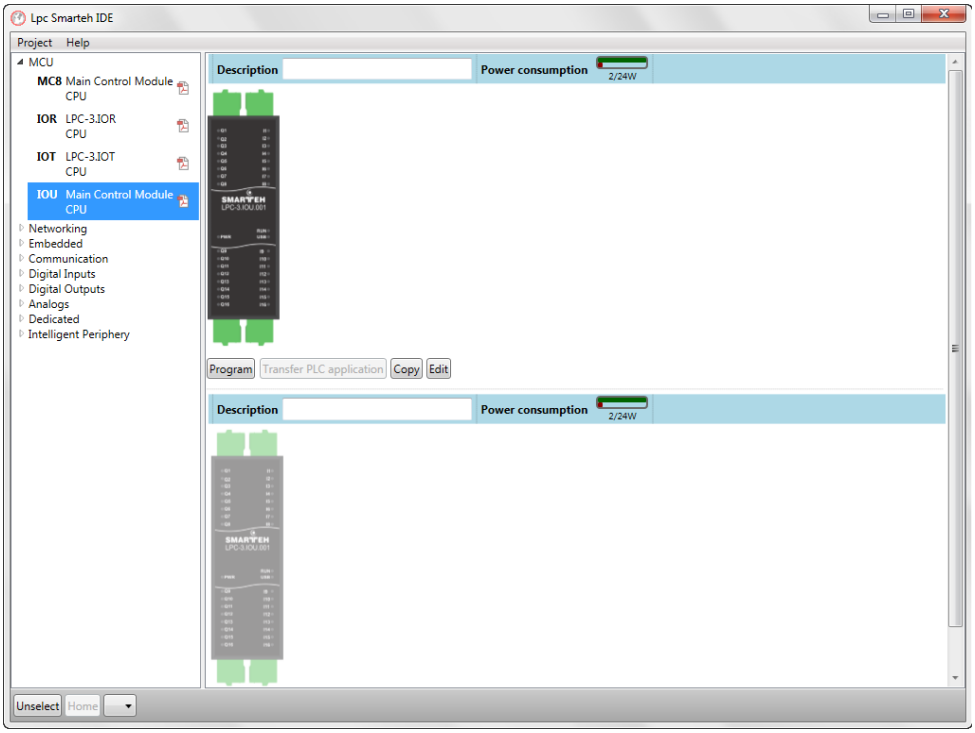
c) Not any PLC negative power supply poles connected together or to the Protective Earth (PE) ⏚ functional earthing.



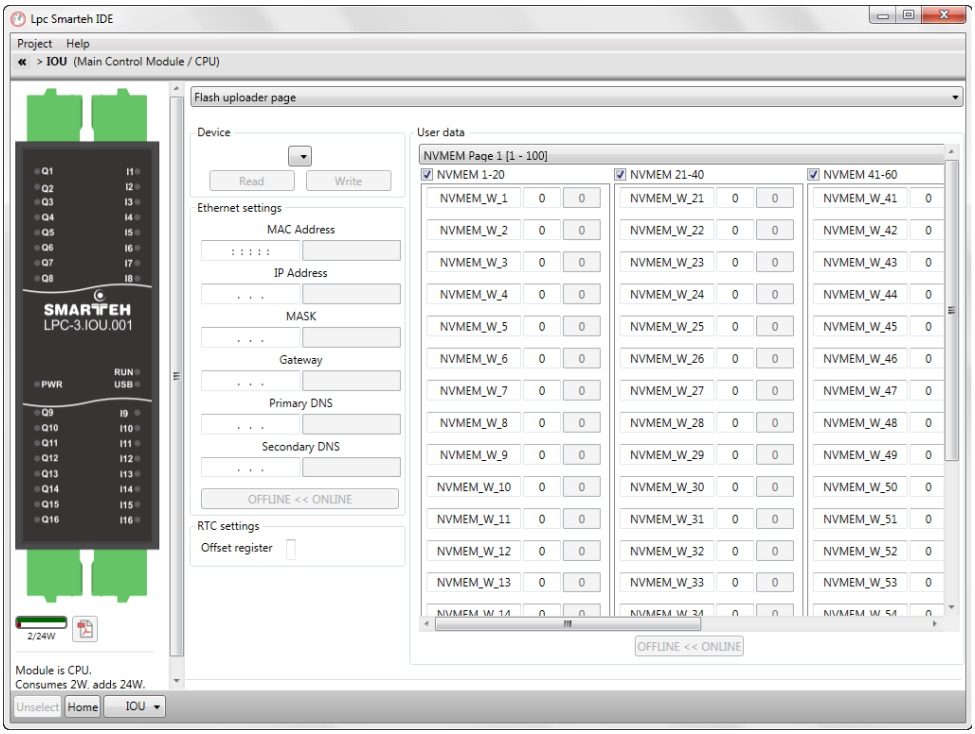
d) Mixed connection where required, selected PLC negative power supply poles connected together and/or to the Protective Earth (PE) ⏚ functional earthing.

38 **Potential differences** between any two negative power supply poles could not exceed prescribed values. **Please refer to** TECHNICAL SPECIFICATIONS for details.

Figure 6: Main configuration of the PLC[39]



Smarteh IDE configuration interface.

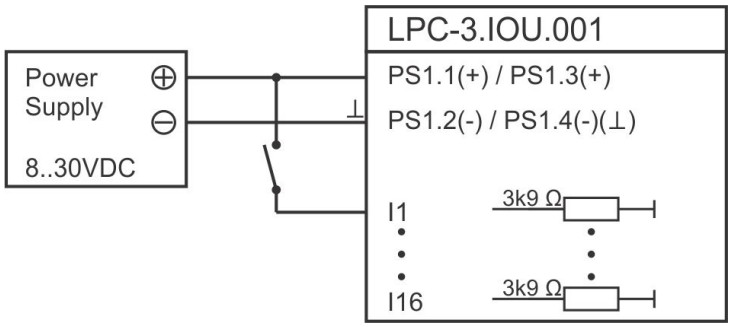


Smarteh IDE flash uploader page.

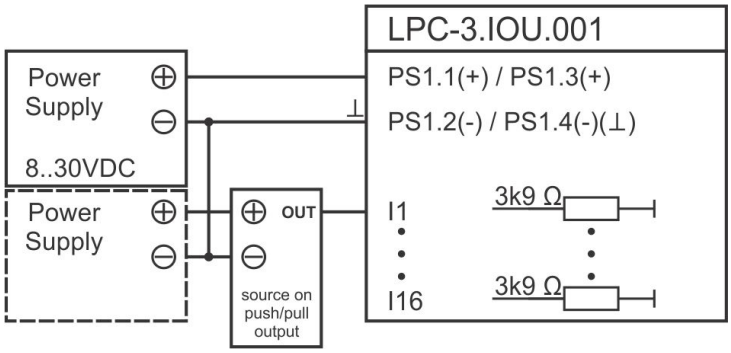
39 **Configuration** of the PLC is done using Smarteh IDE software tool. **Please refer to** PROGRAMMING GUIDE for details.

5.2 Digital input connection scheme & configuration guide

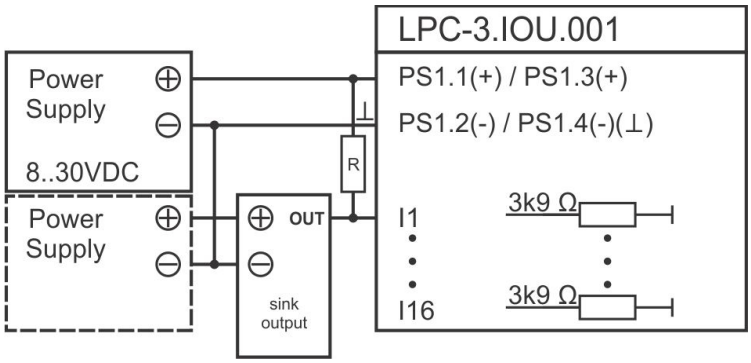
Figure 7: Digital input I1..I16 connection scheme[40]



a) Voltage free contact connection to PLC input.



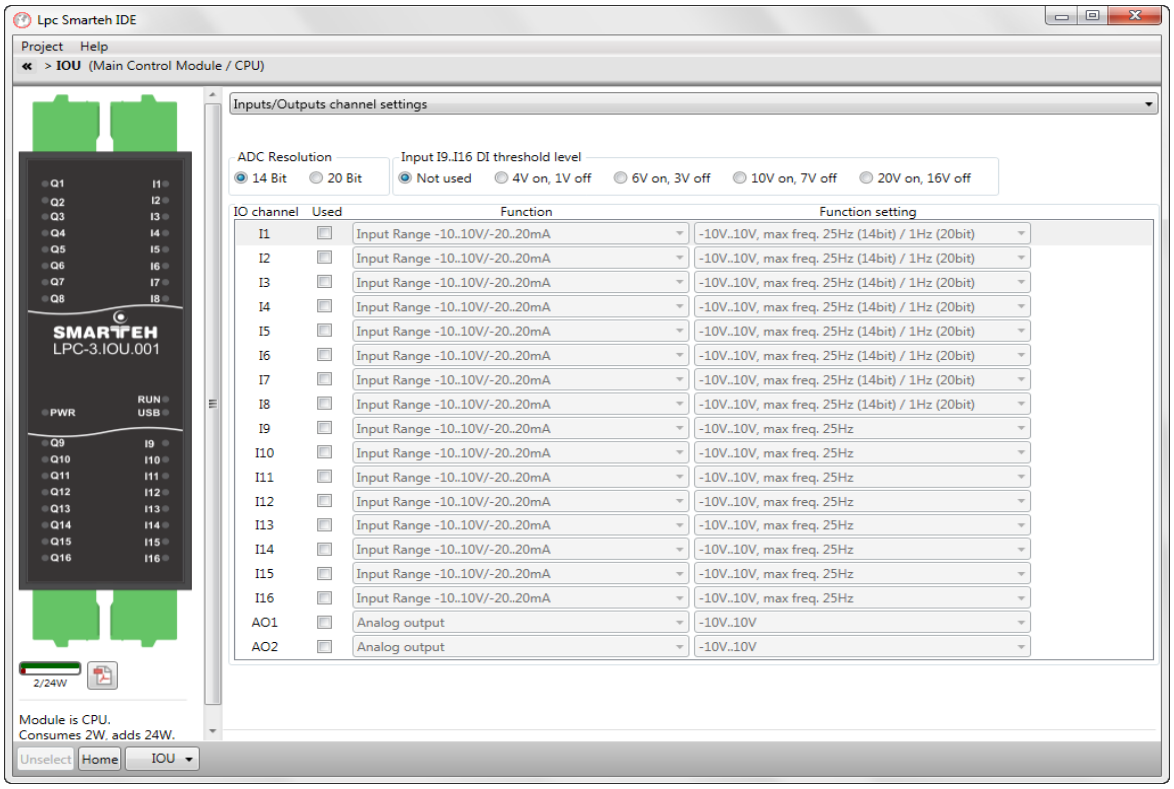
b) Active voltage source or push/pull output connection to PLC input.



c) Active voltage sink output connection to PLC input.

40 **Inputs I1..I16 are not galvanic isolated** between each other and to the rest of the PLC circuit on the same reference potential (⊥). **For galvanic isolation** of the PLC I1..I16 inputs to inputs on other LPC-3.IOU, use CAN1/CAN2 galvanic isolated communication ports for data exchanging. Digital outputs Q1..Q8 and Q9..Q16 on the same LPC-3.IOU PLC are galvanic isolated to inputs I1..I16. **Use galvanic isolated** free contacts and/or digital input voltage sources.

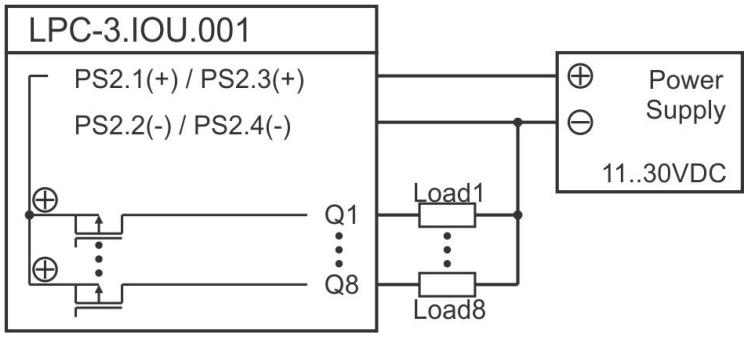
Figure 8: Digital input I1..I16 configuration



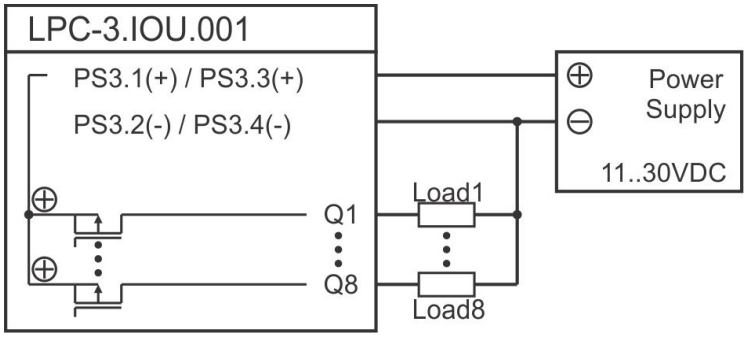
Smarteh IDE input setting interface.

5.3 Digital output connection scheme & configuration guide

Figure 9: Digital output Q1..Q16 connection scheme[41]



a) PLC digital output Q1..Q8 connection to loads.



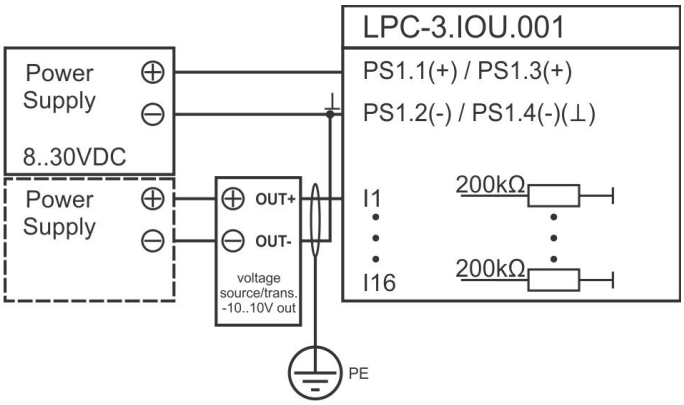
b) PLC digital output Q9..Q16 connection to loads.

NOTE: Digital output Q1..Q16 signals are always available in Smarteh IDE.

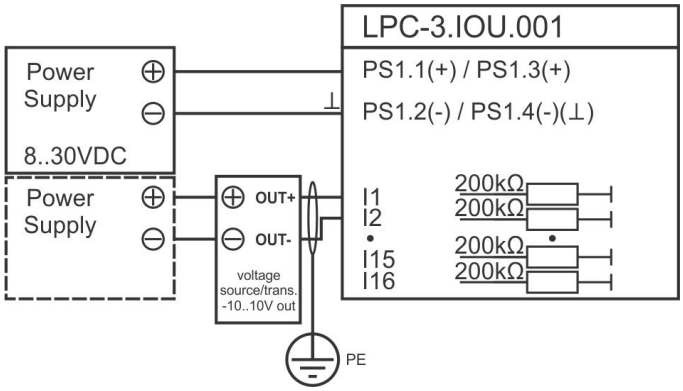
41 **Outputs Q1..Q8 are galvanic isolated** to outputs Q9..Q16, to inputs I1..I16 and to the rest of the PLC circuit on the same reference potential (⊥).

5.4 Analog input -10 .. 10 V connection scheme & configuration guide

Figure 10: Analog input I1..I16, -10 .. 10 V connection scheme[42]



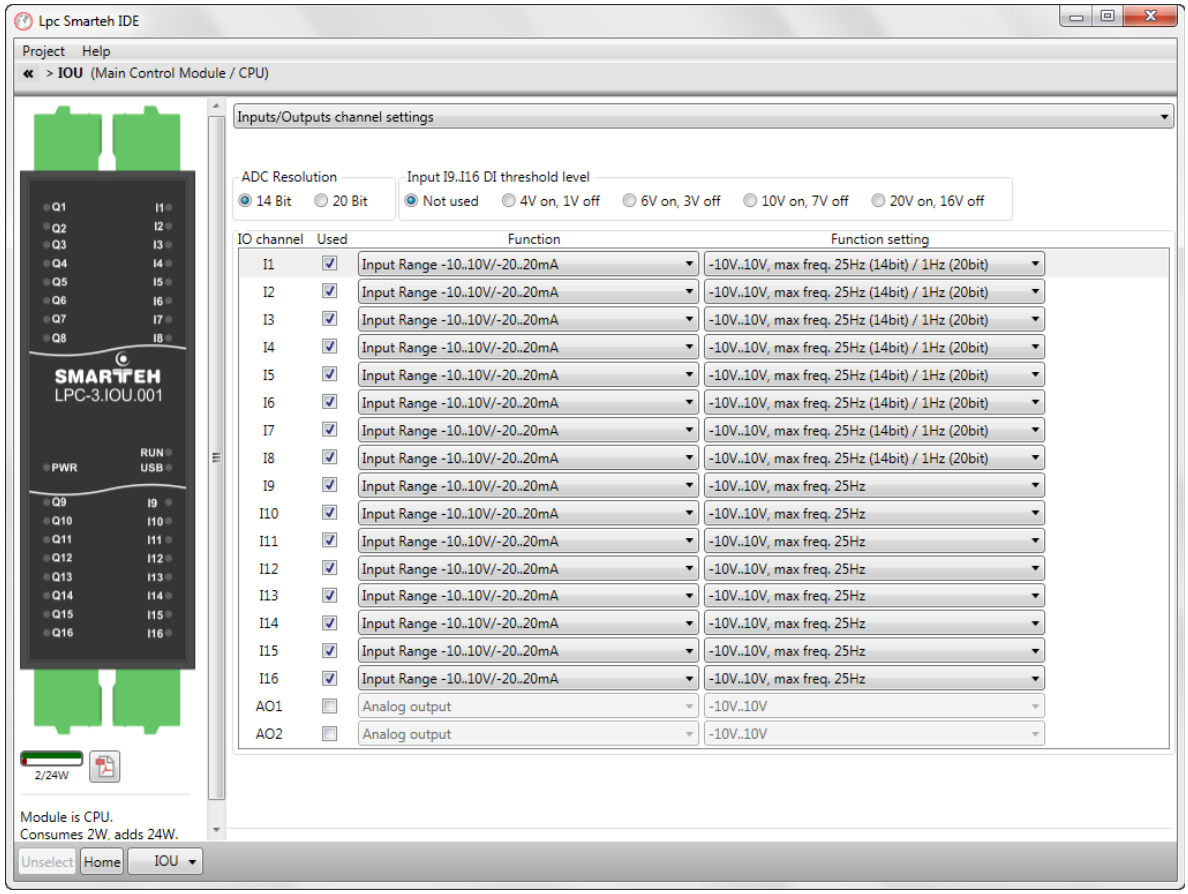
a) Unipolar connection of active voltage source/transducer -10 .. 10 V to PLC input.



b) Differential connection of active voltage source/transducer -10 .. 10 V to PLC input.

42 **Inputs I1..I16 are not galvanic isolated** between each other and to the rest of the PLC circuit on the same reference potential (⊥). **For galvanic isolation of the PLC I1..I16 inputs** to inputs on other LPC-3.IOU, use CAN1/CAN2 galvanic isolated communication ports for data exchanging. Digital outputs Q1..Q8 and Q9..Q16 on the same LPC-3.IOU PLC are galvanic isolated to inputs I1..I16. **Cables for wiring analog signals** must be shielded twisted-pair type. This reduce but not eliminate interferences. Potential difference between the cable shield end and earth potential may cause current through the shield which cause unwanted disturbance. To avoid this effect ground only one end of the cable shielding. **Use galvanic isolated** analog input voltage sources.

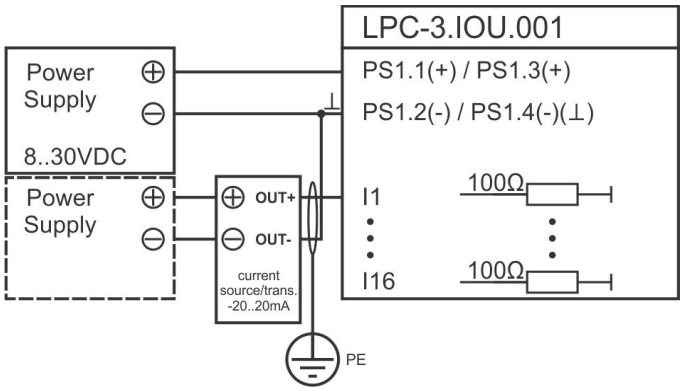
Figure 11: Analog input I1..I16, -10 .. 10 V configuration[43]



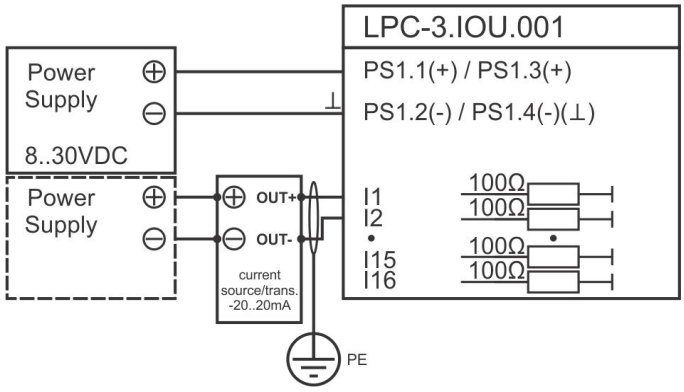
43 **Configuration** of the PLC is done using Smarteh IDE software tool. **Please refer to** PROGRAMMING GUIDE for details.

5.5 Analog input -20 .. 20 mA connection scheme & configuration guide

Figure 12: Analog input I1..I16, -20 .. 20 mA connection scheme[44]



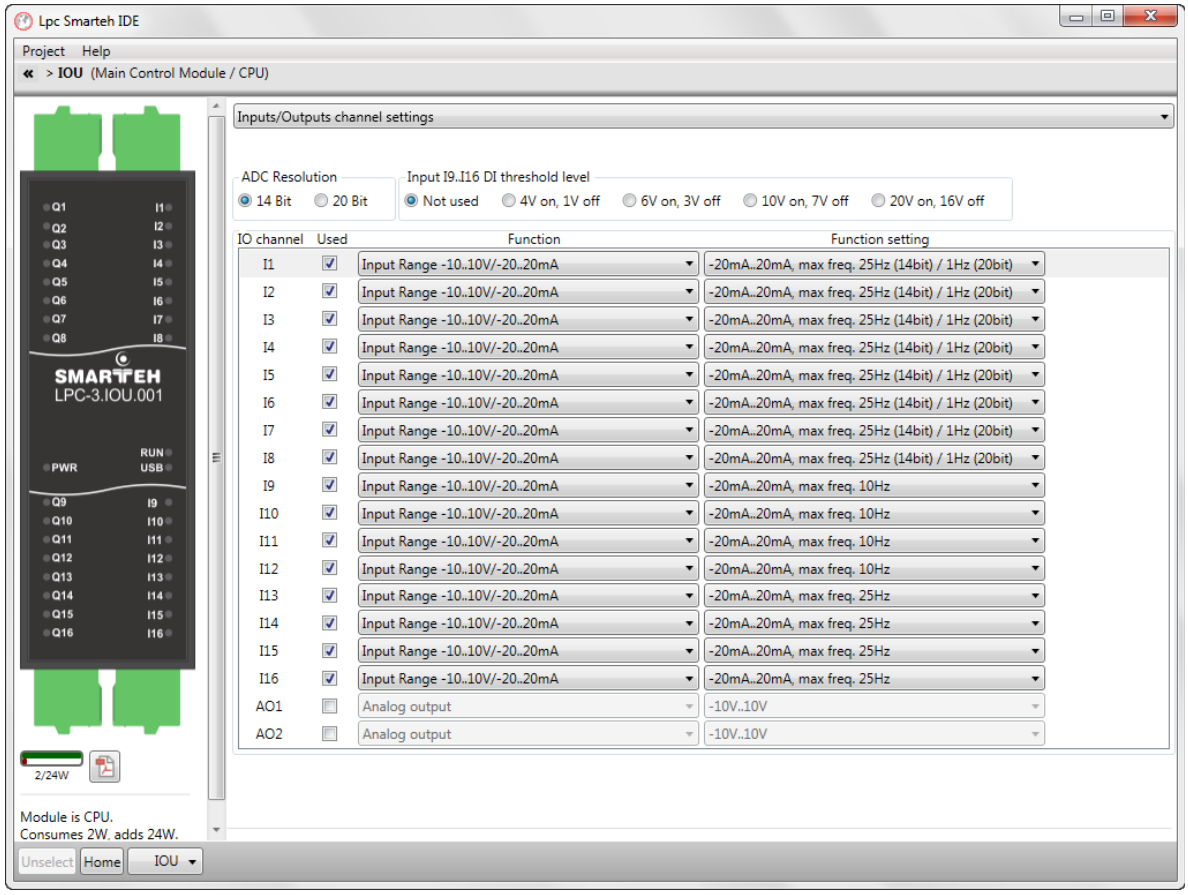
a) Unipolar connection of active current source/transducer -20 .. 20 mA to PLC input.



b) Differential connection of active voltage source/transducer -20 .. 20 mA to PLC input.

44 **Inputs I1..I16 are not galvanic isolated** between each other and to the rest of the PLC circuit on the same reference potential (⊥). **For galvanic isolation of the PLC I1..I16 inputs** to inputs on other LPC-3.IOU, use CAN1/CAN2 galvanic isolated communication ports for data exchanging. Digital outputs Q1..Q8 and Q9..Q16 on the same LPC-3.IOU PLC are galvanic isolated to inputs I1..I16. **Cables for wiring analog signals** must be shielded twisted-pair type. This reduce but not eliminate interferences. Potential difference between the cable shield end and earth potential may cause current through the shield which cause unwanted disturbance. To avoid this effect ground only one end of the cable shielding. **Use galvanic isolated** analog input voltage sources.

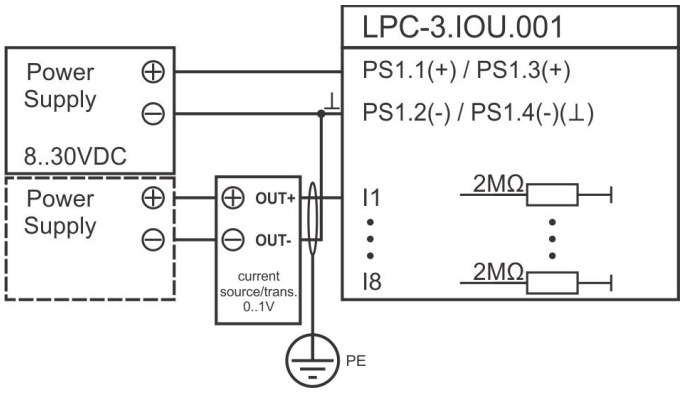
Figure 13: Analog input I1..I16, -20 .. 20 mA configuration[45]



45 **Configuration** of the PLC is done using Smarteh IDE software tool. **Please refer to** PROGRAMMING GUIDE for details.

5.6 Analog input 0 .. 1 V connection scheme & configuration guide

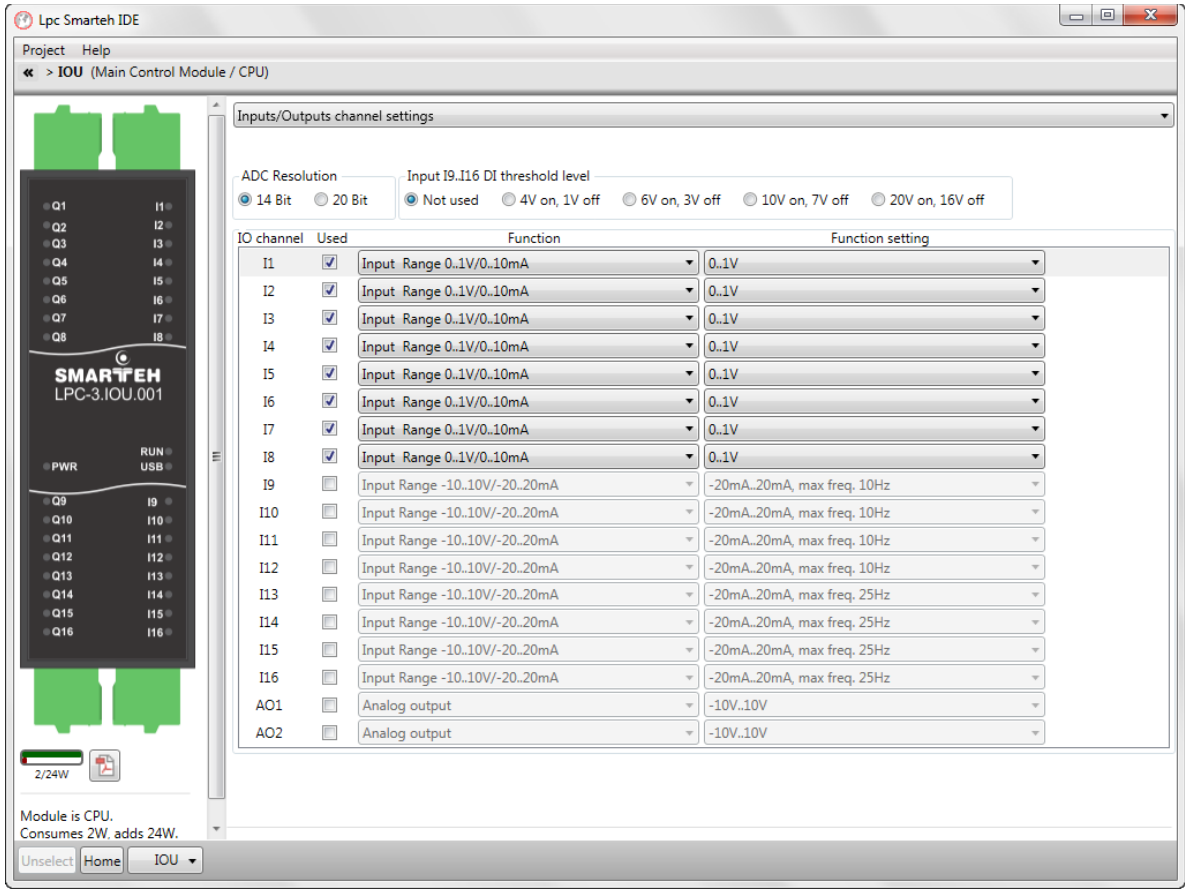
Figure 14: Analog input I1..I8, 0 .. 1 V connection scheme[46]



Unipolar connection of active voltage source/transducer 0 .. 1 V to PLC input.

46 **Inputs I1..I16 are not galvanic isolated** between each other and to the rest of the PLC circuit on the same reference potential (⊥). **For galvanic isolation of the PLC I1..I16 inputs** to inputs on other LPC-3.IOU, use CAN1/CAN2 galvanic isolated communication ports for data exchanging. Digital outputs Q1..Q8 and Q9..Q16 on the same LPC-3.IOU PLC are galvanic isolated to inputs I1..I16. **Cables for wiring analog signals** must be shielded twisted-pair type. This reduce but not eliminate interferences. Potential difference between the cable shielded end and earth potential may cause current through the shield which cause unwanted disturbance. To avoid this effect ground only one end of the cable shielding. **Use galvanic isolated** analog input voltage sources.

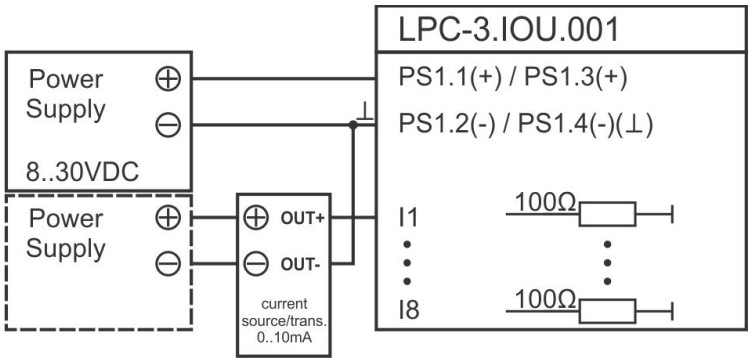
Figure 15: Analog input I1..I8, 0 .. 1 V configuration[47]



47 **Configuration** of the PLC is done using Smarteh IDE software tool. **Please refer to** PROGRAMMING GUIDE for details.

5.7 Analog input 0 .. 10 mA connection scheme & configuration guide

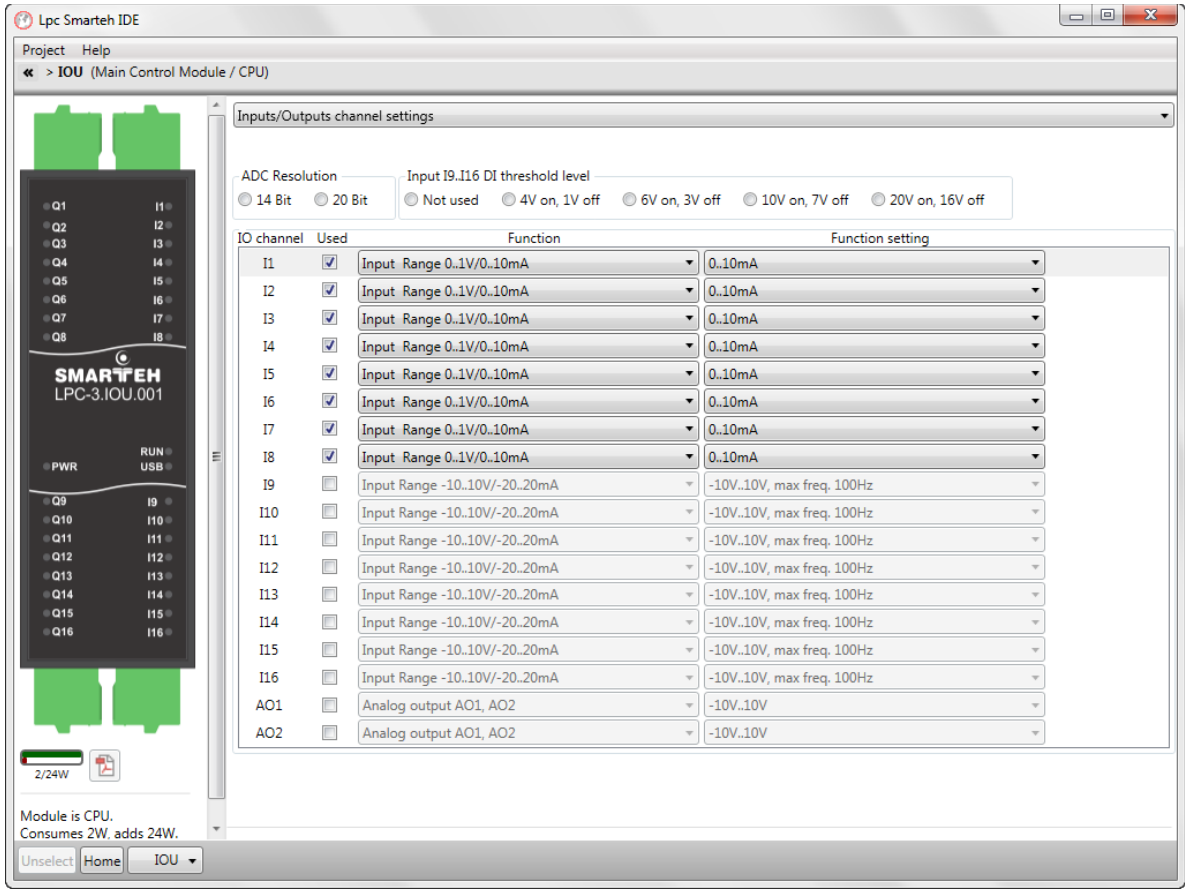
Figure 16: Analog input I1..I8, 0 .. 10 mA connection scheme[48]



Unipolar connection of active current source/transducer 0 .. 10 mA to PLC input.

48 **Inputs I1..I16 are not galvanic isolated** between each other and to the rest of the PLC circuit on the same reference potential (⊥). **For galvanic isolation of the PLC I1..I16 inputs** to inputs on other LPC-3.IOU, use CAN1/CAN2 galvanic isolated communication ports for data exchanging. Digital outputs Q1..Q8 and Q9..Q16 on the same LPC-3.IOU PLC are galvanic isolated to inputs I1..I16. **Cables for wireing analog signals** must be shilded twiste-pair type. This reduce but not eliminate interfrences. Potential diffrerence between the cable shild end and earth potential may cause current through the shild which cause anwanted disturbance. To avoid this effect ground only one end of the cable shielding. **Use galvanic isolated** analog input voltage sources.

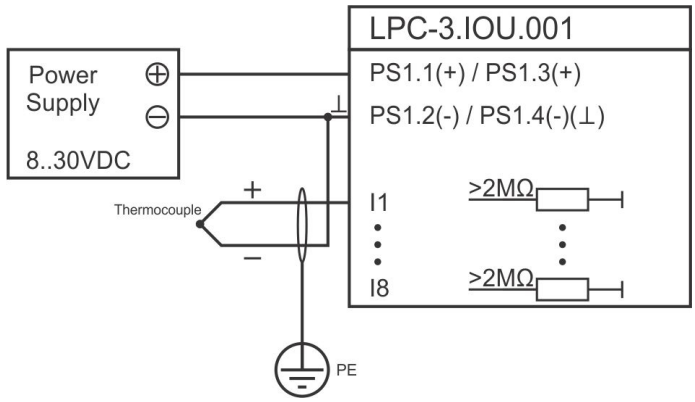
Figure 17: Analog input I1..I8, 0..10 mA configuration[49]



49 **Configuration** of the PLC is done using Smarteh IDE software tool. **Please refer to** PROGRAMMING GUIDE for details.

5.8 Thermocouple connection scheme & configuration guide

Figure 18: Analog input I1..I8, thermocouple connection scheme[50]

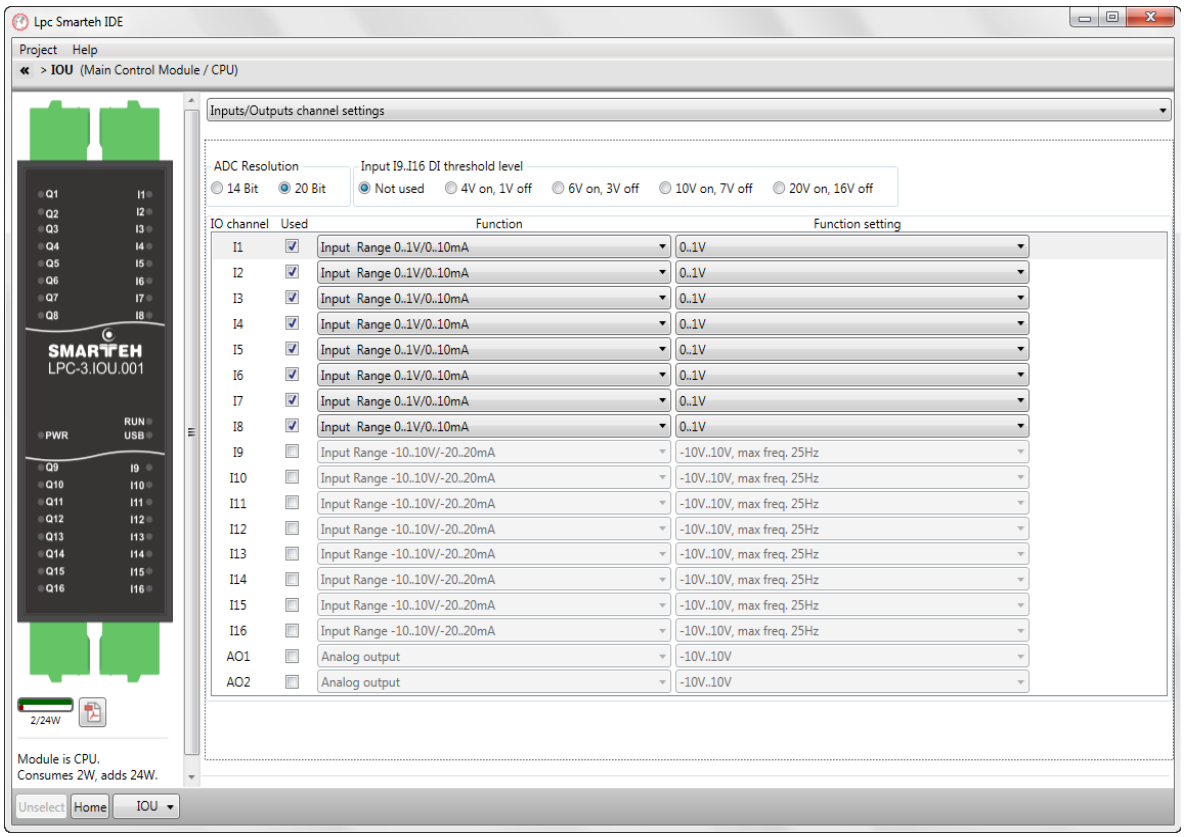


Unipolar connection of thermocouple temperature sensing element to PLC input.

NOTE: Using this method only allows measuring temperatures higher than junction temperature.

50 **Inputs I1..I16 are not galvanic isolated** between each other and to the rest of the PLC circuit on the same reference potential (⊥). **For galvanic isolation of the PLC I1..I16 inputs** to inputs on other LPC-3.IOU, use CAN1/CAN2 galvanic isolated communication ports for data exchanging. Digital outputs Q1..Q8 and Q9..Q16 on the same LPC-3.IOU PLC are galvanic isolated to inputs I1..I16. **Cables for wiring analog signals** must be shielded twisted-pair type. This reduce but not eliminate interferences. Potential difference between the cable shielded end and earth potential may cause current through the shield which cause unwanted disturbance. To avoid this effect ground only one end of the cable shielding. **Use galvanic isolated** analog input voltage sources. **Accuracies for thermocouple** temperature measurements are written in Thermocouple programming guide chapter. **Please refer to** PROGRAMMING GUIDE chapter for details.

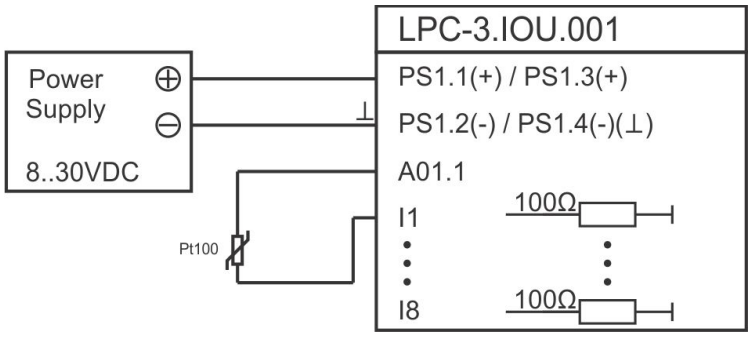
Figure 19: Analog input I1..I8, thermocouple configuration[51]



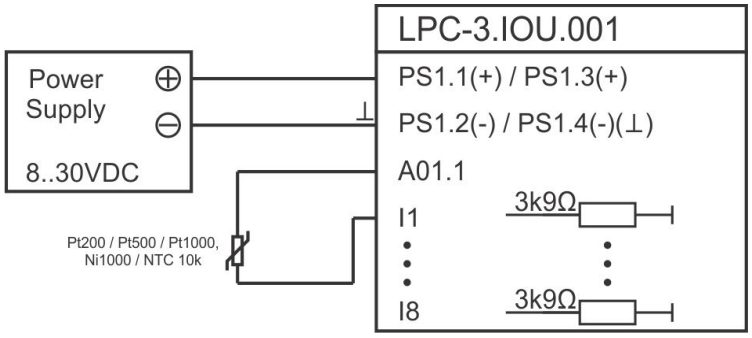
51 **Configuration** of the PLC is done using Smarteh IDE software tool. **Please refer to** PROGRAMMING GUIDE for details.

5.9 Thermistor connection scheme & configuration guide

Figure 20: Analog input I1..I8, thermistor connection scheme[52]



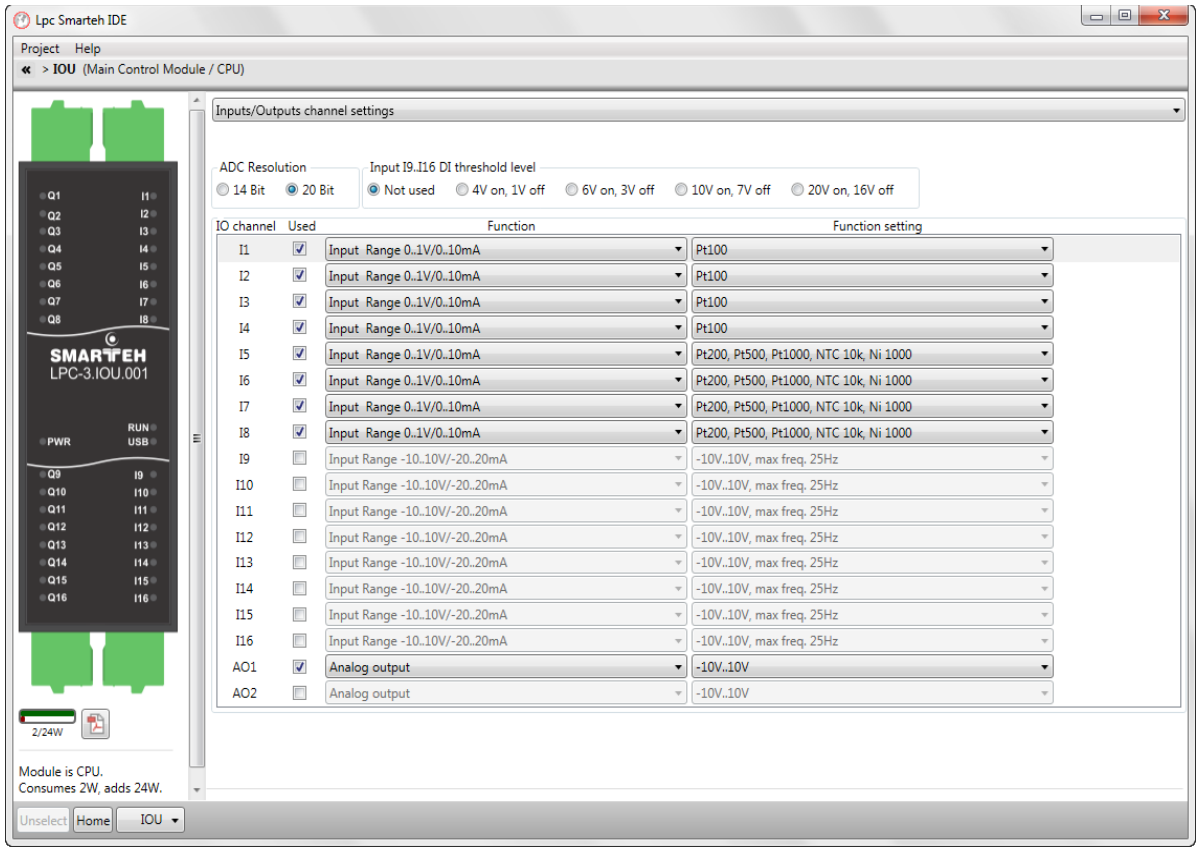
a) Pt100 connection of thermistor temperature sensing element to PLC input.



b) Pt200, Pt500, Pt1000, Ni1000, NTC10 kΩ connection of thermistor temperature sensing element to PLC input.

52 **Inputs I1..I16 are not galvanic isolated** between each other and to the rest of the PLC circuit on the same reference potential (⊥). **For galvanic isolation of the PLC I1..I16 inputs** to inputs on other LPC-3.IOU, use CAN1/CAN2 galvanic isolated communication ports for data exchanging. Digital outputs Q1..Q8 and Q9..Q16 on the same LPC-3.IOU PLC are galvanic isolated to inputs I1..I16. **Cables for wiring analog signals** must be shielded twisted-pair type. This reduce but not eliminate interferences. Potential difference between the cable shielded end and earth potential may cause current through the shield which cause unwanted disturbance. To avoid this effect ground only one end of the cable shielding. **Use galvanic** isolated analog input voltage sources. **Accuracies for thermistor** temperature measurements are written in Thermistor programming guide chapter. **Please refer to** PROGRAMMING GUIDE chapter for details.

Figure 21: Analog input I1..I8, thermistor configuration[53]

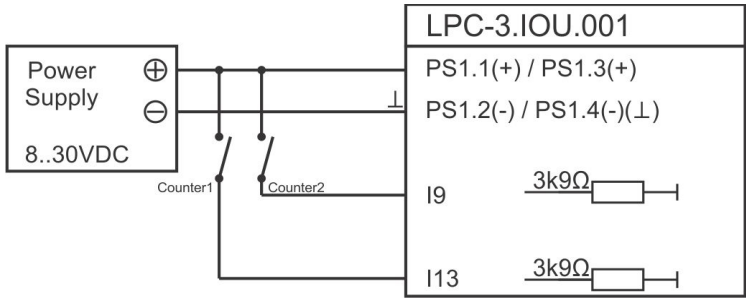


Thermistor options are Pt100 or Pt200/Pt500/Pt1000/NTC 10k/Ni 1000.

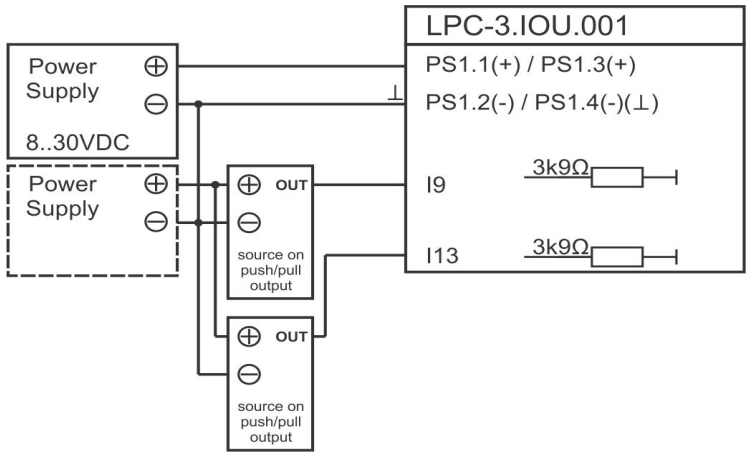
53 **Configuration** of the PLC is done using Smarteh IDE software tool. **Please refer to** PROGRAMMING GUIDE for details.

5.10 Fast counter connection scheme & configuration guide

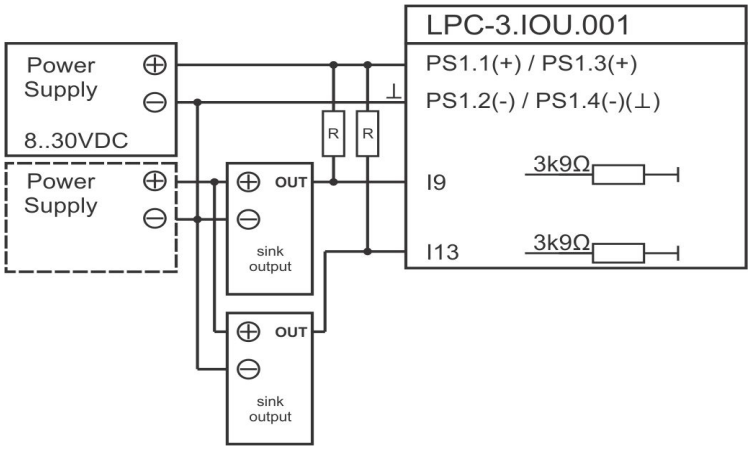
Figure 22: Fast counter digital input I9 & I13 connection scheme[54]



a) Voltage free contact fast counter connection to PLC input.



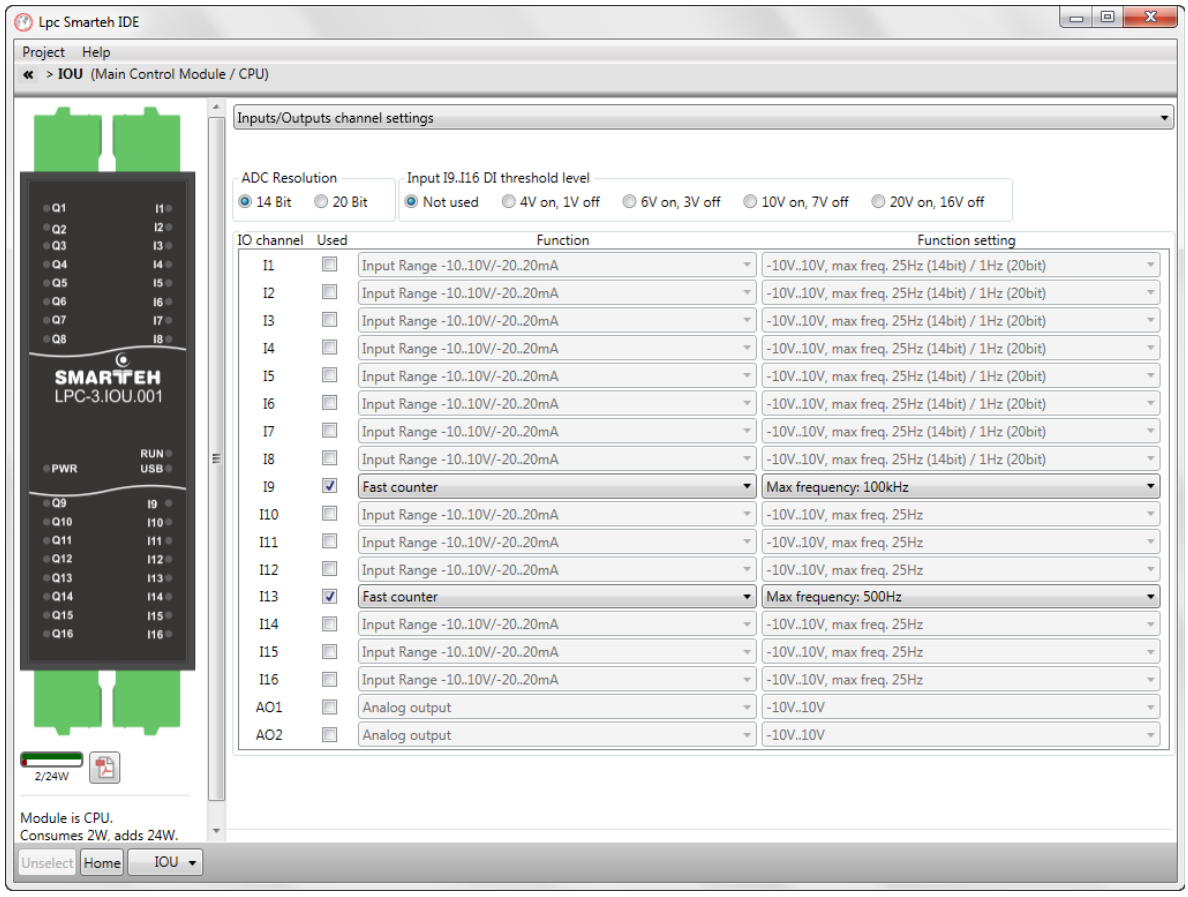
b) Active voltage source or push/pull fast counter output connection to PLC input.



c) Active voltage sink fast counter output connection to PLC input.

54 **Inputs I1..I16 are not galvanic isolated** between each other and to the rest of the PLC circuit on the same reference potential (⊥). **For galvanic isolation** of the PLC I1..I16 inputs to inputs on other LPC-3.IOU, use CAN1/CAN2 galvanic isolated communication ports for data exchanging. Digital outputs Q1..Q8 and Q9..Q16 on the same LPC-3.IOU PLC are galvanic isolated to inputs I1..I16. **Use galvanic isolated** free contacts and/or digital input voltage sources.

Figure 23: Fast counter digital input I9 & I13 configuration[55]

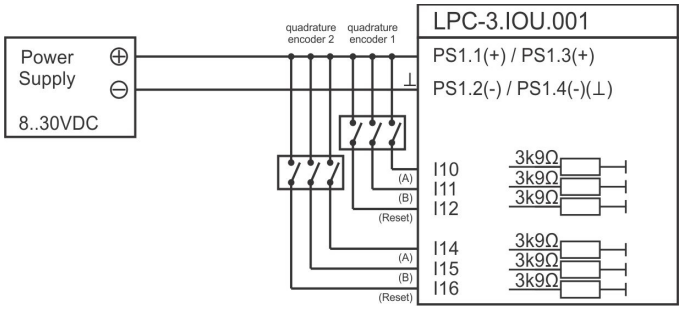


Fast counter options are 100 kHz or 500 Hz.

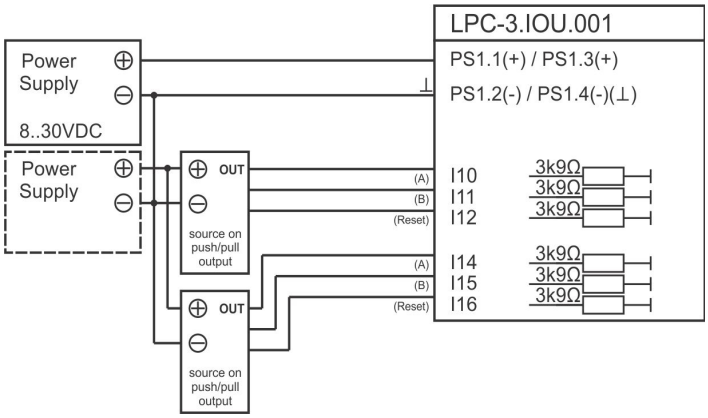
55 **Configuration** of the PLC is done using Smarteh IDE software tool. **Please refer to** PROGRAMMING GUIDE for details.

5.11 Quadrature encoder connection scheme & configuration guide

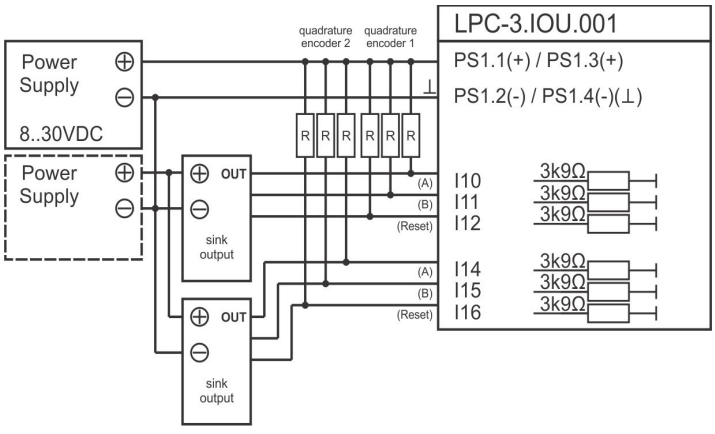
Figure 24: Quadrature encoder digital input I10, I11, I12 & I14, I15, I16 connection scheme[56]



a) Voltage free contact fast counter connection to PLC input.



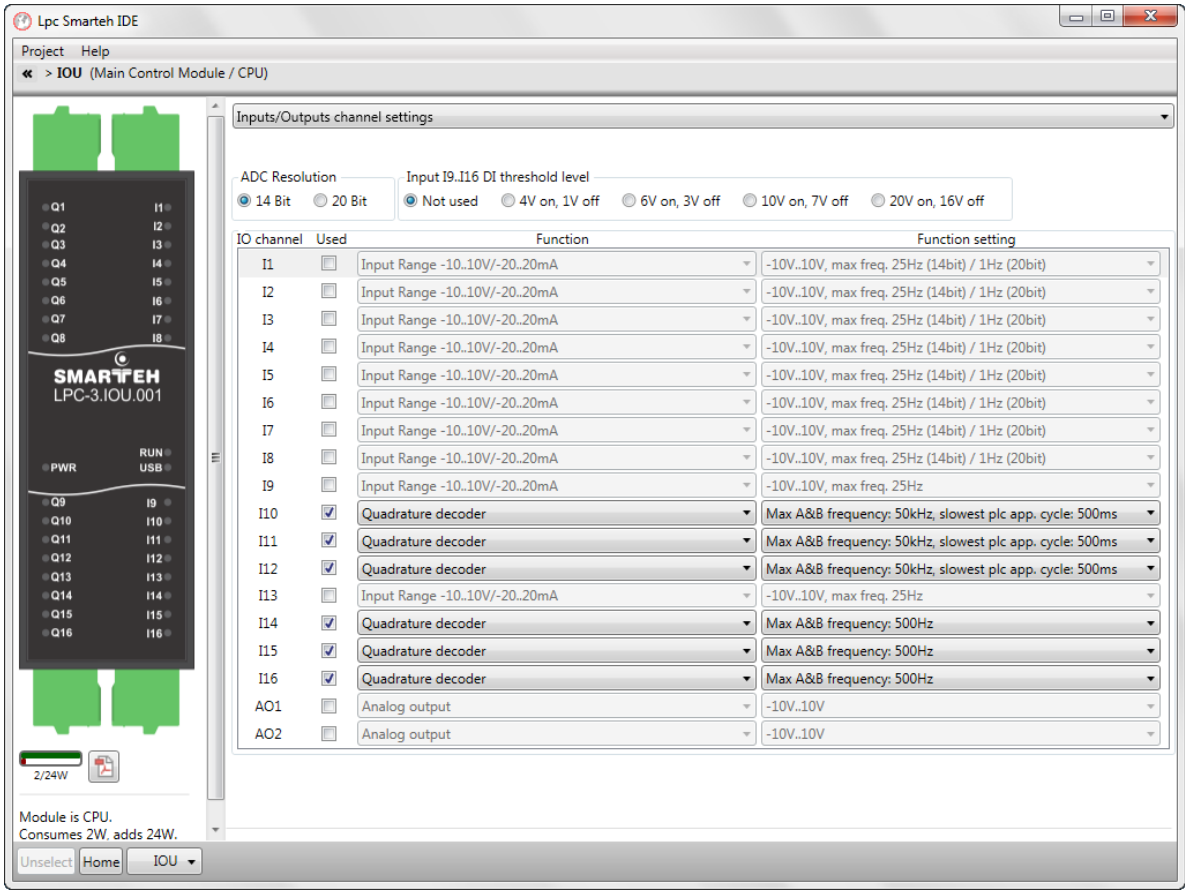
b) Active voltage source or push/pull fast counter output connection to PLC input.



c) Active voltage sink fast counter output connection to PLC input.

56 **Inputs I1..I16 are not galvanic isolated** between each other and to the rest of the PLC circuit on the same reference potential (⊥). **For galvanic isolation** of the PLC I1..I16 inputs to inputs on other LPC-3.IOU, use CAN1/CAN2 galvanic isolated communication ports for data exchanging. Digital outputs Q1..Q8 and Q9..Q16 on the same LPC-3.IOU PLC are galvanic isolated to inputs I1..I16. **Use galvanic isolated** free contacts and/or digital input voltage sources.

Figure 25: Quadrature encoder digital input I10, I11, I12 & I14, I15, I16 configuration[57]



NOTE: This input detects a reference position for the Quadrature Decoder. When using reset input, if inputs A, B, and reset are all zero, the counter is also reset to zero. Reset can be triggered with hardware signal or from PLC application with QuadDec_Reset.

57 **Configuration** of the PLC is done using Smarteh IDE software tool. **Please refer to** PROGRAMMING GUIDE for details.

6 PROGRAMMING GUIDE

6.1 Basic programming

There are several logical units attached with this module. They can be accessed from the Smarteh IDE application. Some units are enabled by default, others can be enabled through Smarteh IDE. Unit is enabled when any of its variables is used.

PLC has 32 kB of non-volatile memory, which is available to any variable used inside application simply by setting the variable *Option* to *Retain*.

PLC also provides 4 kB of ROM (flash) memory area to the user who would like to use some initialization data or some fixed parameters. This area can be accessed from application only for reading. Setting the values of variables in Flash can be issued with Flash uploader page. In Flash memory area there are some preloaded data stored:

MAC: is unique for every unit produced. This value can be also found on the label attached on the housing of the unit.

IP: default value is 192.168.19.225

MASK: default value is 255.255.255.0

Gateway, Primary DNS, Secondary DNS: default 0.0.0.0

Flash memory unit

This unit enables only reading from its variables. Setting the variables is issued with one of *Smarteh IDE* plugins, *Flash uploader page*.
Flash unit provides reading of a portion of a flash memory inside MC8 module. Flash memory is non-volatile, therefore keeps data forever.

Usually this area is used for setting some data to the default value even before installation of the unit to its position. After, when PLC is commissioned, the data are already present and there is no need for further setting. This keeps its data in area and some startup parameters can be written.

RTC and NVRAM unit

For RTC back-up and for Retain variables stored in NVRAM, there is Super Capacitor instead of battery integrated inside PLC. This way replacement of the discharged battery is avoided. The Retention time is minimum 30 days from the power down.

RTC time provides date and time information. Along, alarming function is also supported.

Modbus slave unit

Modbus TCP/IP slave has 512 addresses in each memory section.

Coils:	00000 to 00511
Discrete Inputs:	10000 to 10511
Input Register:	30000 to 30511
Holding Registers:	40000 to 40511

Supports up to 3 connections to the slave unit. Scan rate is 500 ms or greater.

CANopen unit

CANopen unit consists of Master (CAN1) and Slave (CAN2) communication ports. They are independent, thus can be connected to two different CAN network at the same time.

The ports can operate at baud rates 50 kbps, 125 kbps or 250 kbps.

It follows the internationally standardized (EN 50325-4) CAN-based higher-layer protocol for embedded control systems. Advised rules and concepts by this standard must be followed to fulfill the conditions and so achieving normal operation and results.

The structure of the network as cable type and lengths, baud rates, number of the nodes and termination must be taken into account within the recommendations and requirements, when designing the network.

The bus network can consist of at least one Master and at least one Slave node by the standard, but it is advised that with increased number of nodes, the Master node fastest interval is reduced. Below are two examples:

Example 1: network with 1 master and 9 slaves, every slave have defined 32 (4x8) byte of data and baud rate 125 Kbps. Fastest Cycle time for this configuration is 50 ms.

Example 2: network with 1 master and 4 slaves, every slave have defined 4 byte of data and baud rate 250 Kbps. Fastest Cycle time for this configuration is 5 ms.

5 millisecond is the fastest recommended cycle time.

It is recommended to power-up all the nodes on the same network at the same time, if some or all nodes had been reprogrammed (to reinitialize the communication properly).

Additional operational information

After the installation of the PLC it must be at least 20 minutes on external power supply, before the internal super capacitor is charged and the retain memory is ready to save variables without loosing them switching power supply off.

RUN / STOP Switch

Run: Status (RUN) LED on indicate that the PLC program is up and user program is running.

Stop: When the switch is turn to STOP state, the status (RUN) LED is Off. The application switch to the boot loader, this fact allow users to program LPC-3.IOU.001.

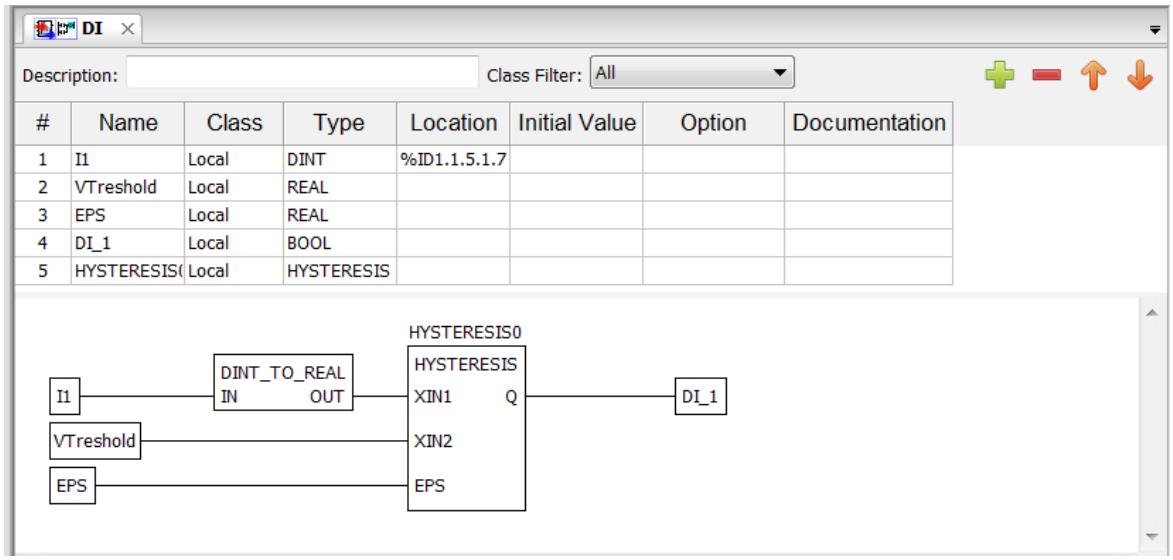
When the user is done programming, the PLC via USB, the switch must be turned ON and the LPC-3.IOU.001 starts the application.

PLC task cycle time

Main PLC task interval (under Project tab → Resource → Tasks → Interval) time is not recommended to be set lower than 5 ms.

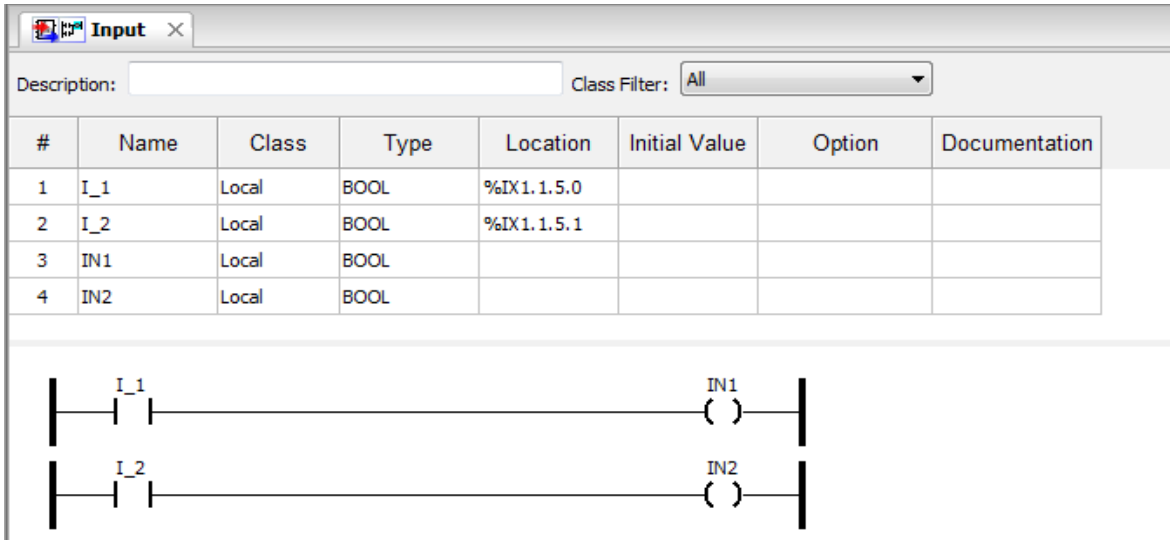
6.2 Digital input I1..I8 programming

Figure 26: Digital Input I1..I8 LD language example[58]



6.3 Digital input I9..I16 programming

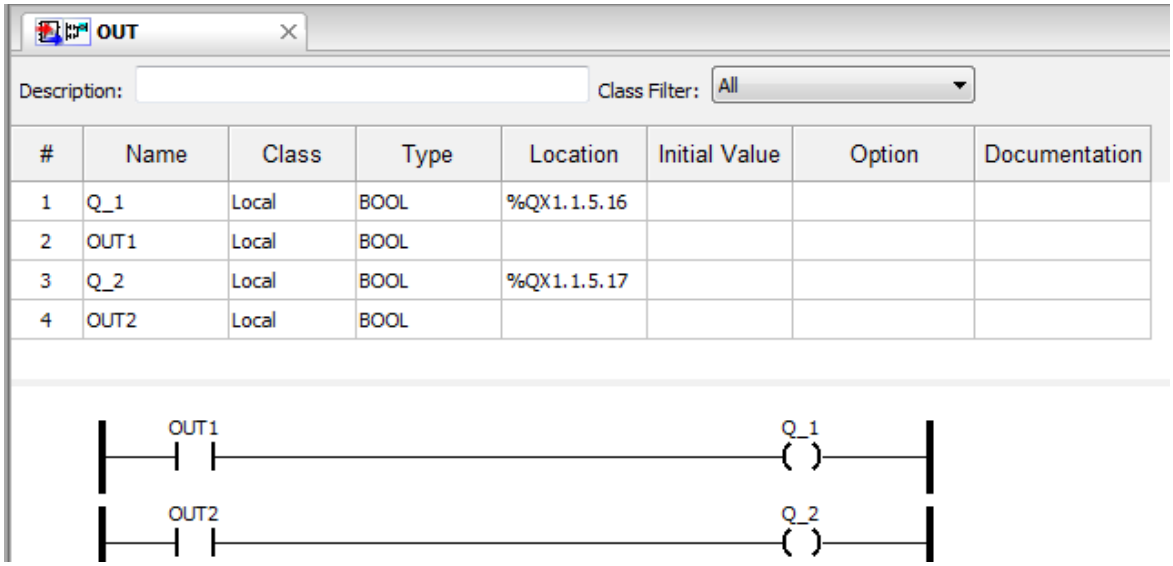
Figure 27: Digital Input I9..I16 LD language example[59]



58 **Configuration** of the PLC is done using Smarteh IDE software tool. **Please refer to** PROGRAMMING GUIDE for details.

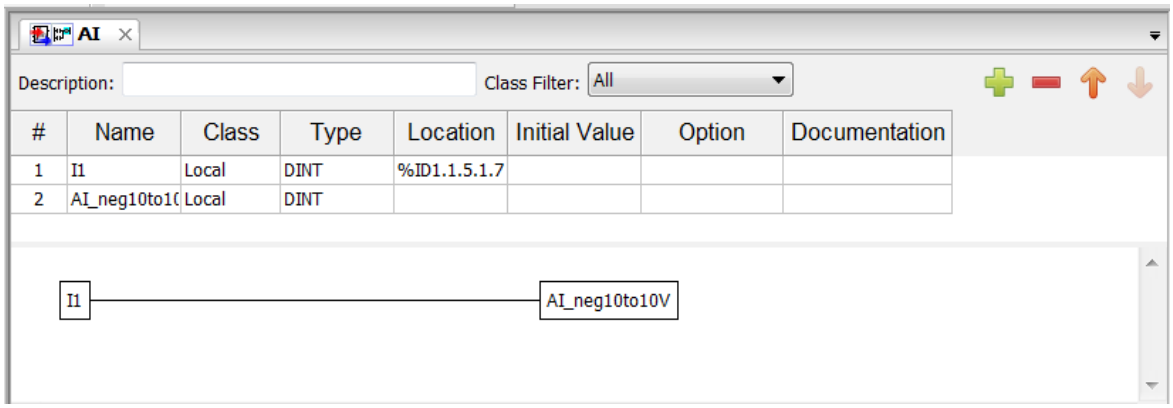
6.4 Digital output Q1..Q16 programming

Figure 28: Digital output Q1..Q16 LD language example[59]



6.5 Analog input unipolar -10 .. 10 V programming

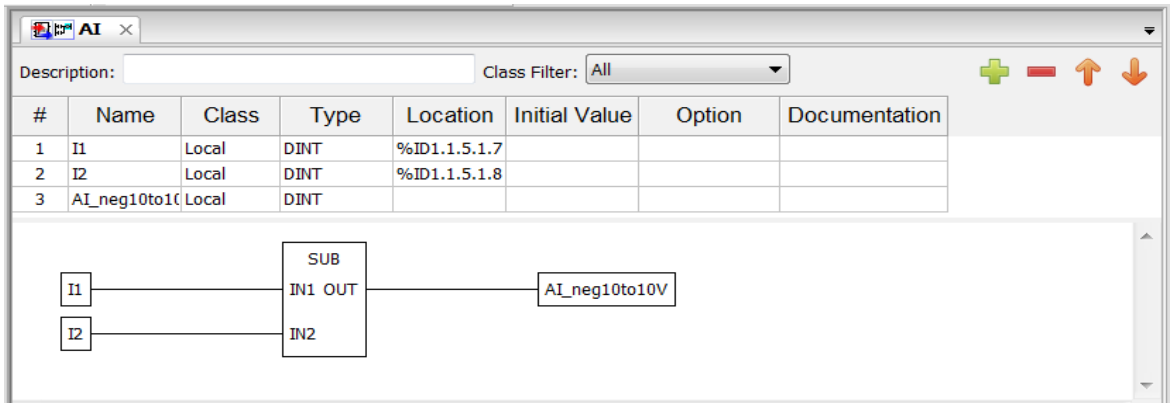
Figure 29: Analog input unipolar -10 .. 10 V LD language example[60]



59 **Configuration** of the PLC is done using Smarteh IDE software tool. **Please refer to** PROGRAMMING GUIDE for details.

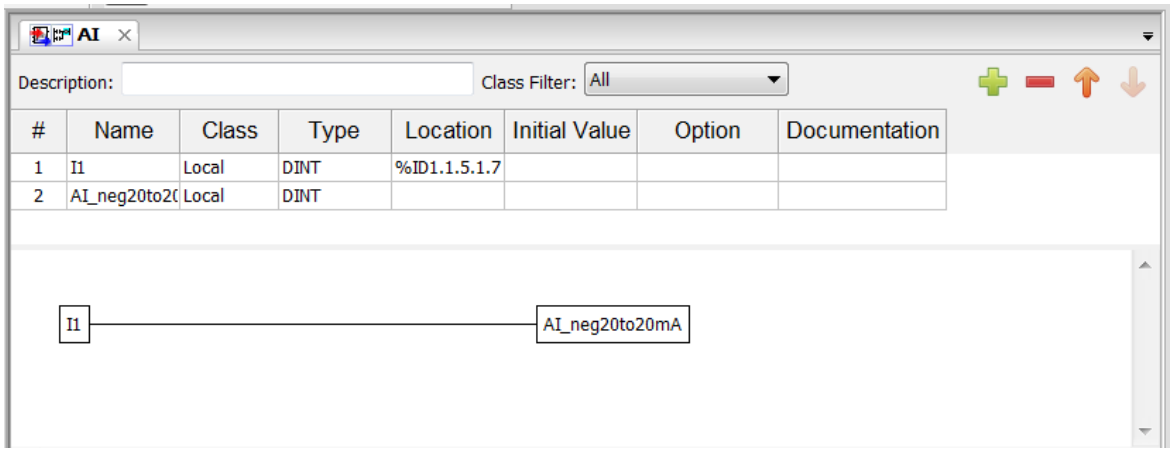
6.6 Analog input differential -10 .. 10 V programming

Figure 30: Analog input differential -10 .. 10 V LD language example[60]



6.7 Analog input unipolar -20 .. 20 mA programming

Figure 31: Analog input unipolar -20 .. 20 mA LD language example[61]

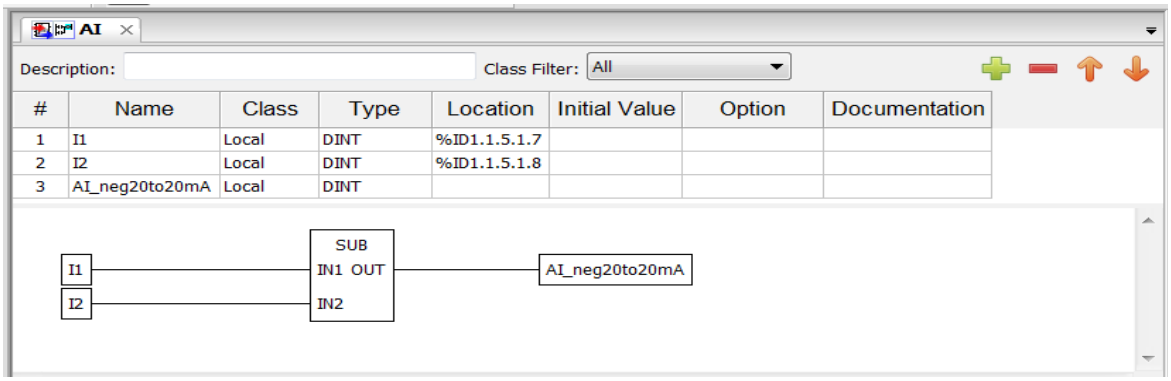


60 **14 bits ADC settings** should be used for better common mode interference (CMI) filtering. **Configuration** of the PLC is done using Smarteh IDE software tool. **Please refer to** PROGRAMMING GUIDE for details.

61 **Configuration** of the PLC is done using Smarteh IDE software tool. **Please refer to** PROGRAMMING GUIDE for details.

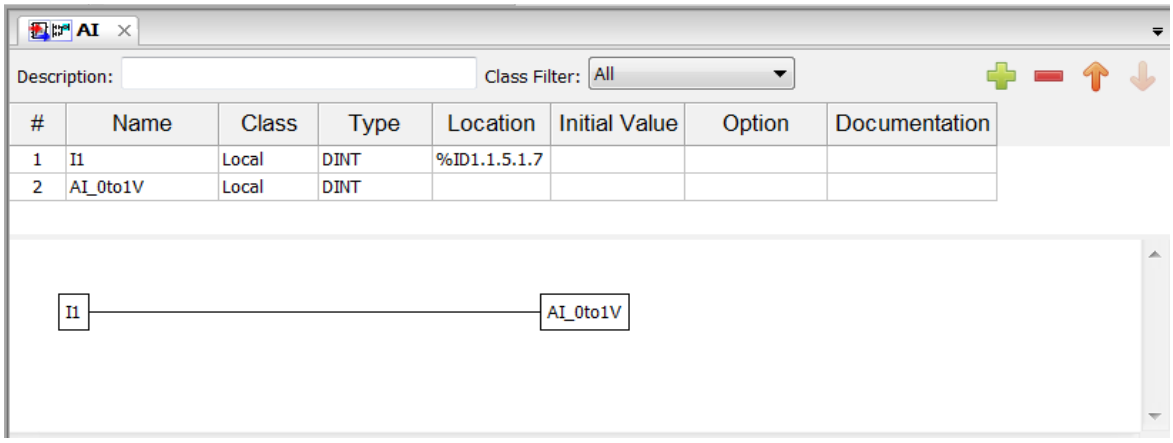
6.8 Analog input differential -20 .. 20 mA programming

Figure 32: Analog input differential -20 .. 20 mA LD language example[62]



6.9 Analog input unipolar 0 .. 1 V programming

Figure 33: Analog input unipolar 0 .. 1 V LD language example[63]

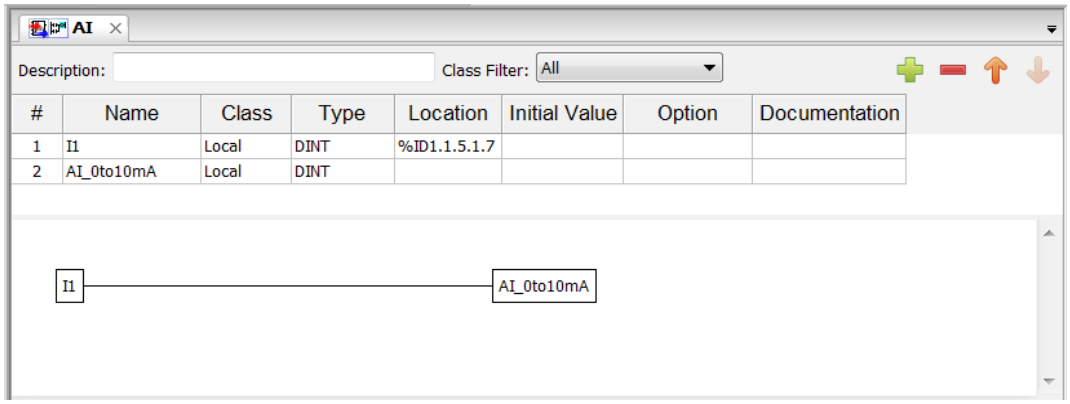


62 **14 bits ADC settings** should be used for better common mode interference (CMI) filtering. **Configuration** of the PLC is done using Smarteh IDE software tool. **Please refer to** PROGRAMMING GUIDE for details.

63 **Measurement accuracy** using filters will heavily increase => + 25 µV. **Configuration** of the PLC is done using Smarteh IDE software tool. **Please refer to** PROGRAMMING GUIDE for details.

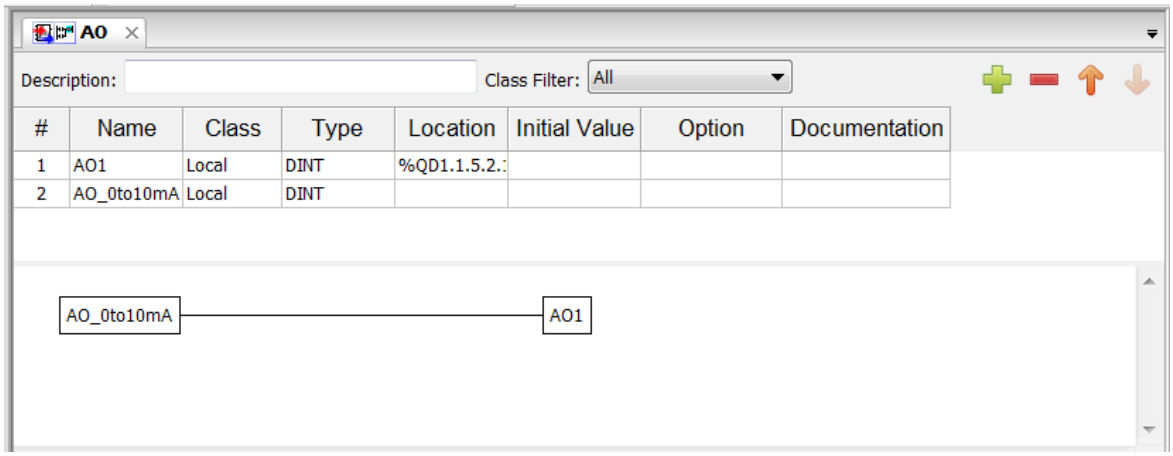
6.10 Analog input 0 .. 10 mA programming

Figure 34: Analog input 0 .. 10 mA LD language example[64]



6.11 Analog output 0 .. 10 mA programming

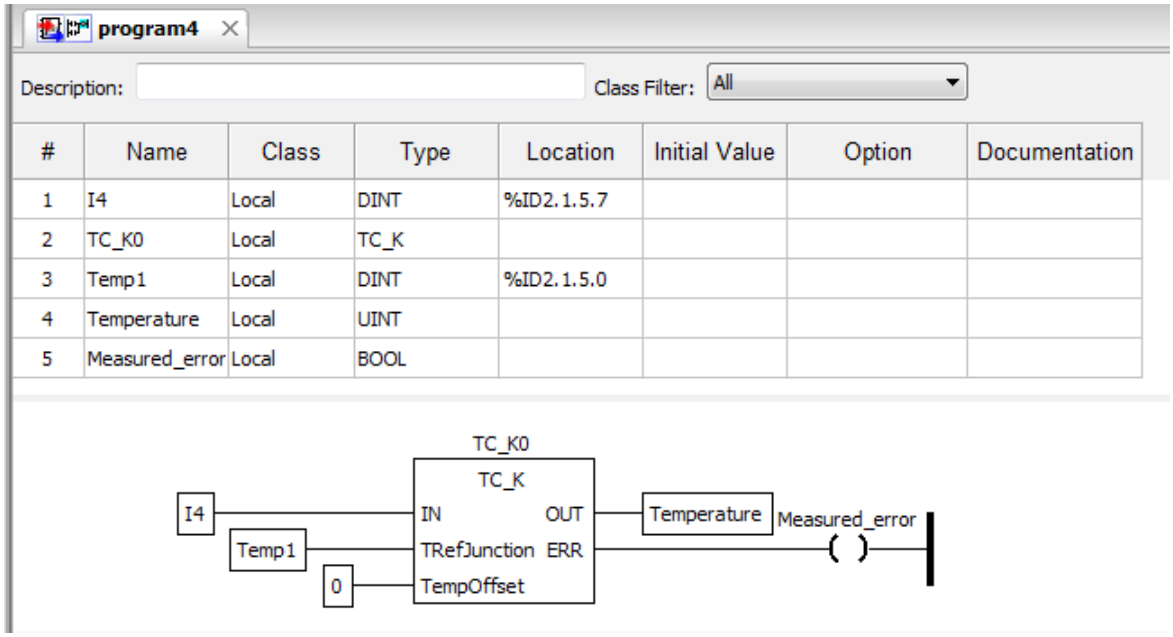
Figure 35: Analog output 0 .. 10 mA LD language example[65]



64 **Configuration** of the PLC is done using Smarteh IDE software tool. **Please refer to** PROGRAMMING GUIDE for details.

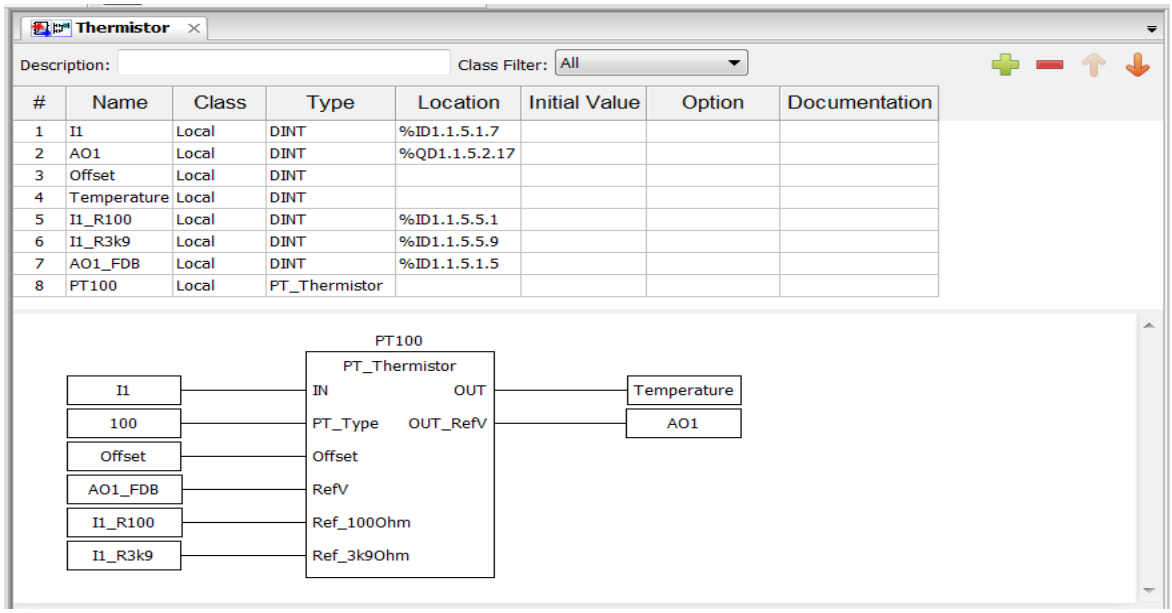
6.12 Thermocouple programming

Figure 36: Thermocouple LD language example[65]



6.13 Thermistor programming

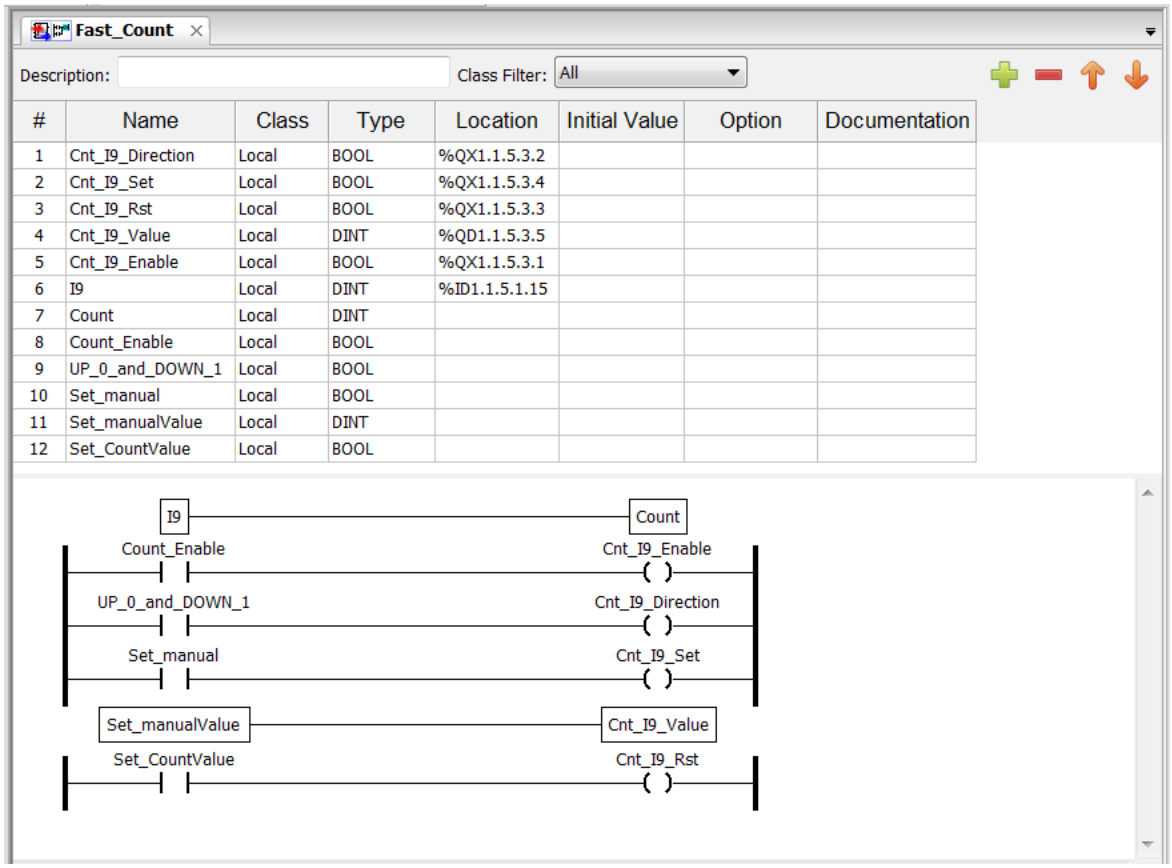
Figure 37: Thermistor LD language example[66]



65 **Configuration** of the PLC is done using Smarteh IDE software tool. **Please refer to** PROGRAMMING GUIDE for details.

6.14 Fast counter programming

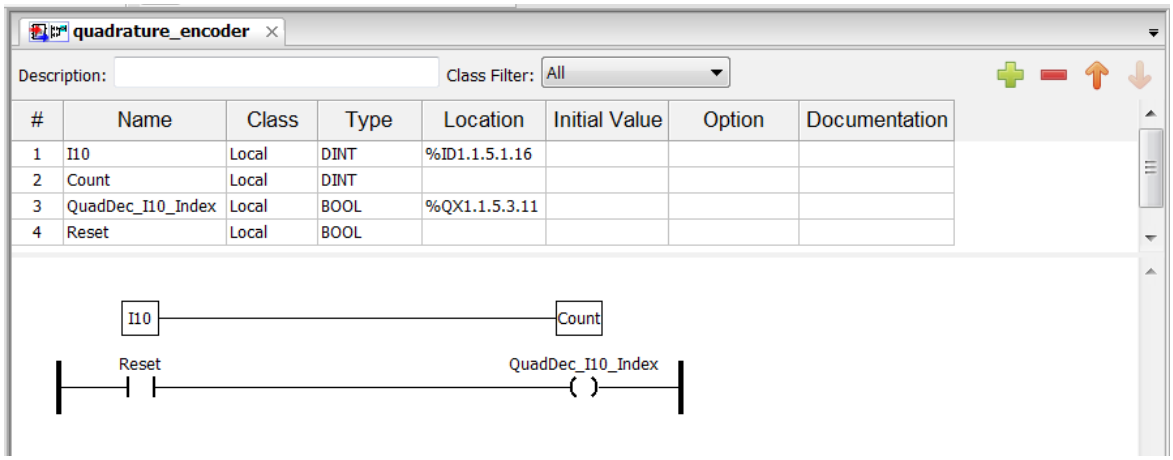
Figure 38: Fast counter LD language example[66]



66 **Configuration** of the PLC is done using Smarteh IDE software tool. **Please refer to** PROGRAMMING GUIDE for details.

6.15 Quadrature encoder programming

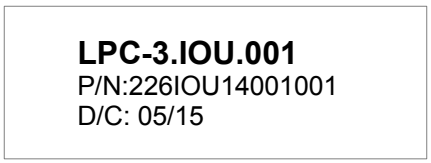
Figure 39: Quadrature encoder LD language example[67]



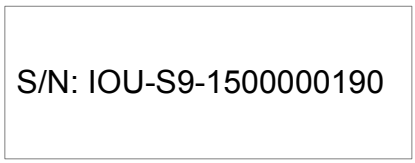
7 MODULE LABELING

Figure 40: Labels on housing

Label 1 (sample):



Label 2 (sample):



Label 1 descriptions:

1. **LPC-3.IOU.001** is the full product name.
2. **P/N: 226IOU14001001** is the part number.
   - **226** – general code for product family,
   - **IOU** – short product name,
   - **14001** – sequence code,
     - 14 – year of code opening,
     - 001 – derivation code,
   - **001** – version code (reserved for future HW and/or SW firmware upgrades).
3. **D/C: 05/15** is the date code.
   - **05** – week and
   - **15** – year of production.

Label 2 descriptions:

1. **S/N:IOU-S9-1500000190** is the serial number.
   - **IOU** – short product name,
   - **S9** – user code (test procedure, e.g. Smarteh person xxx),
   - **1500000190** – year and current stack code,
     - 15 – year (last two digits),
     - 00000190 – current stack number; previous module would have the stack number 00000189 and the next one 00000191.

8 CHANGES

The following table describes all the changes to the document.

Date	V.	Description
01.03.15	1	The initial version, issued as *LPC-3.IOU.001 UserManual*.
01.09.15	2	Technical update.
01.02.16	3	Update figures 19, 21. Added thermocouples note. Page 2 description update.

9 NOTES