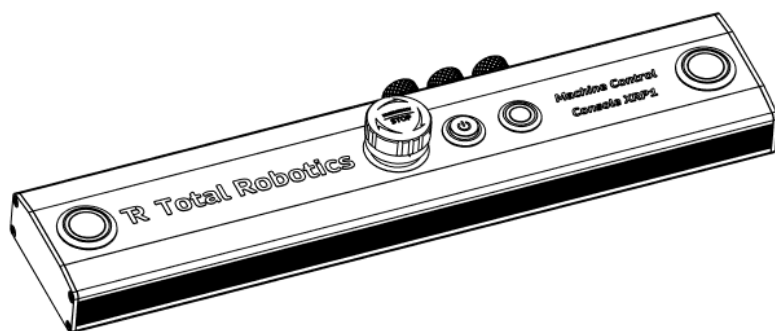




User manual MCC-XRP1

Machine Control Console

MCC-XRP1 programmable machine control Console

This manual contains important information on how to connect the MCC-XRP1 to a working machine.

Please read this manual with particular care and familiarise yourself with the requirements of the EU Machinery Directive 2006/42/EC and the directives, regulations and standards relating to machinery safety.

If necessary, please contact us. You can find our contact details in the "Contact information" section of this document.

Total Robotics Oy
www.totalrobotics.fi

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1 Opening words

Dear customer,

We thank you and congratulate you on your wise decision to purchase the MCC-XRP1 programmable machine control console.

The MCC-XRP1 is designed for use in light industry to control a machine that is mainly powered by compressed air, ready to meet the requirements of the European Union Machinery Directive (2006/42/EC), including machine safety.

Due to the scope of the Machinery Directive and its associated regulations and applicable standards, we cannot make this a manual covering all requirements, so:

The MCC-XRP1 may only be installed, programmed and commissioned by persons who have the necessary professional qualifications to perform the work, assess the risks and comply with the requirements of the EU Machinery Directive 2006/42/EC and other regulations and standards relating to machinery safety

In addition to the above, we require that the persons involved in the above-mentioned work read this manual with particular care and comply with the prohibitions, instructions and advice given in it, in so far as they do not conflict with the above-mentioned Machinery Directive.

In case of doubt, please contact us. You can find our contact details in the "Contact Information" section of this document

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3 Used terms and abbreviations

3.1 Machinery Directive

The Machinery Directive refers here to the EU Machinery Directive 2006/42/EC and related regulations.

3.2 Applicable standards

Applicable standards are defined here as standards related to machine safety, such as EN ISO 13849-1, SFS-EN ISO 13850, SFS-EN ISO 13851, SFS-EN ISO 4414, SFS-EN 1037 + A1.

3.3 Machine

Machine means the combination of interconnected parts or components, as defined in the Machinery Directive, to which the MCC-XRP1 is intended to be connected.

3.4 Machine manufacturer

The machine manufacturer here means the entity (legal entity or person) within the meaning of the Machinery Directive that programs and installs the MCC-XRP1 on its own or someone else's machine.

3.5 Program

The program here refers to a customer program written into the memory of the MCC-XRP1 that implements the functionality of the device, but also the user safety and security measures required by the Machinery Directive.

3.6 Operator

The term 'operator' is used here to refer to all persons who use the machine before or after its authorised placing in service.

3.7 Main valve activation condition

The main valve activation condition is defined here as the programmed conditions, specified by the manufacturer of the machine, under which the main valve of the machine can be safely opened.

Please note that the activation condition must always meet the requirements of the Machinery Directive, regulations and any applicable standards.

3.8 Work cycle

A work cycle is defined here as a repetitive identical event performed by a machine, which starts when the work cycle start conditions are met and ends normally when the work cycle end conditions are met.

An example of a single work cycle could be a machine that the user starts from the console button(s) to join two parts placed on it, and which ends with the machine stopping to wait for these joined parts to be removed.

Note that in automatic machines the work cycle can be continuous and consist of a series of individual work cycles. That is, a work cycle is the concept of a period of time required for a single part or operation.

3.9 Work cycle start condition

Here, the start condition of a work cycle refers to the programmed conditions, defined by the machine manufacturer, under which the work cycle programmed into the machine can safely start. The start conditions may, for example, be the status of a specific sensor in combination with the button(s) of the MCC-XRP1.

Please note that the work cycle start condition must always comply with the requirements of the Machinery Directive, regulations and any applicable standards.

3.10 Work cycle stopping condition

Here, the work cycle stopping condition refers to the programmatic conditions defined by the machine manufacturer that stops either a single or continuous cycle

Please note that the work cycle stopping condition must always comply with the requirements of the Machinery Directive, regulations and any applicable standards.

3.11 Safety limit(s)

The safety limit(s) here refers to the sensor(s) whose function is to protect the operator.

Note that the safety limit and its implementation must always comply with the requirements of the Machinery Directive, regulations and any applicable standards.

3.12 Quick stop

The term 'quick stop' here refers to the operator's pressing of the emergency stop button, which is indicated by the number 5 in the 'Part names, Figure 1' section of the manual.

3.13 Programmatic quick stop

A programmed quick stop is defined here as a condition detected by the program that is judged to require an immediate stop of the machine.

3.14 Fault memory

Fault memory here refers to the permanent memory area on EEPROM of the MCC-XRP1 processor from which the machine manufacturer, when writing the program, has allocated a specific memory area for storing the fault or error code.

3.15 Fault memory reset

Fault memory reset here refers to the operation of clearing the MCC-XRP1 fault or error code from the processor's persistent memory (EEPROM).

3.16 Main valve

The main valve here means the electrically controlled valve on the pneumatic machinery used to control the entry or exit of compressed air into or out of the machinery.

3.17 Shut-off valve

A shut-off valve here means a manually operated separate valve that can be used to shut off the compressed air to the machine, for example to prevent maintenance, repair or operation.

4 Features in a nutshell

The MCC-XRP1 is designed to control pneumatic operated machines used in light industry.

The MCC-XRP1 is programmed via the ICSP connector (PROG), the programming language is C and the programming can be done with tools such as Atmel Studio, Arduino IDE, avr-gcc + avrdude and transferred (flash) to the microcontroller using AVRISP MKII or USBASP type programming device (in- circuit programmer).

For air valves, the MCC-XRP1 has 5 NPN-type outputs (OUT) and a shared 24 volt voltage supply.

Similarly, for sensors and limit switches, the MCC-XRP1 has 4 PNP-type opto-isolated inputs (IN), a shared 24 V supply and a ground (gnd).

For the user, the MCC-XRP1 has three programmable push buttons with programmable LED lighting to indicate the status of the button.

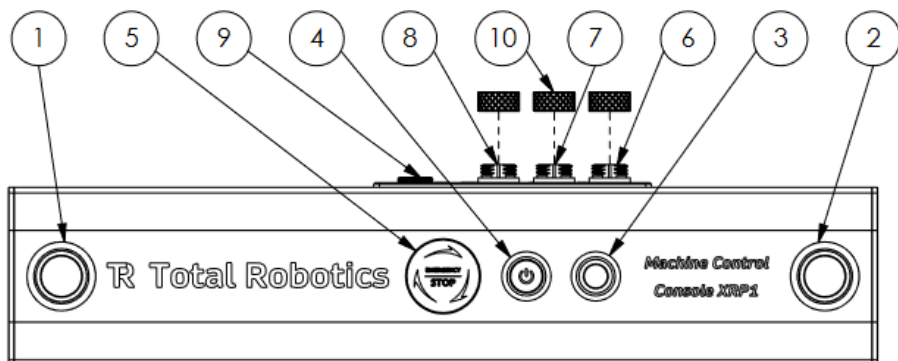
To operate, the MCC-XRP1 requires 24 V of good quality DC power from a power supply with a power output sufficient for its consumption, typically 2-4 amps.

The MCC-XRP1 is equipped with a 1.25 amp internal fuse.

Note that the emergency stop button (quick stop) is connected in series with the power switch, i.e. the power is immediately cut off when either switch tip is opened and immediately restored when both tips are closed. Pay particular attention to this when starting the machine and read carefully what is written in this manual under 'Installation and connection' and there under the sub-topic 'Main valve'.

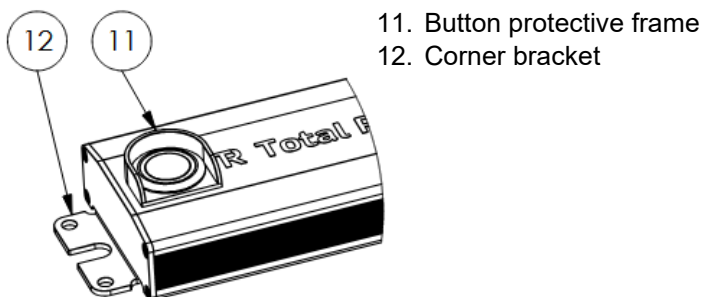
5 Part names

Figure 1



- | | |
|--------------------------|--------------------------------------|
| 1. Left button | 6. Output connector (OUT) |
| 2. Right button | 7. Input connector (IN) |
| 3. Option button | 8. ICSP programming connector (PROG) |
| 4. Power switch | 9. Power supply connecto (DC24V) |
| 5. Emergency stop button | 10. Protective plugs for connectors |

Figure 2 (optional accessories)



The type plate is located on the bottom of the MCC-XRP1.

6 Permitted uses

The MCC-XRP1 is intended to be used to control, via compressed air valves, pneumatic machines which are mainly powered by a compressed air of less than 5 bar and which are not considered to present a risk of serious injury and the required maximum safety level is PLb, SIL1 (see EN ISO 13849-1).

Typical applications may include machines to replace hand-operated machines to glue or press parts together using pneumatic cylinders.

The use of vacuum ejectors as part of the machine is permitted.

The MCC-XRP1 can also be used for cutting, shaping, stamping or similar operations using compressed air cylinders, provided that the machine can be designed in such a way that the previously mentioned safety level requirement PLb, SIL1 is not exceeded.

An example of the former could be a machine where an operator places a piece on a carrier it and typically an operation considered hazardous at S2 level is performed inside fixed guards that fully protect the operator. In this case, any safety functionality programmed into the MCC-XRP1 is only used to protect the operator from movements of the moving carrier that are not assessed as likely to cause serious injury, i.e. PLb, SIL1 is not exceeded.

7 Applications requiring an installation permit from the product manufacturer

- Machines in which compressed air is used to drive a turbine or any shaft exceeding 600 RPM and the shaft power is greater than 100 W.
- Machines with a compressed air cylinder pressure chamber size greater than 1 litre.
- Machines to which a stepper motor, servo, solenoid or similar non-pneumatic auxiliary device is connected for turning, positioning, locking or a similar function.

8 Specifically prohibited uses

- Machinery in potentially explosive atmospheres (ATEX)
- For machines requiring a safety level higher than PLb, SIL1 (EN ISO 13849-1).
- Aerial work platforms / personal lifts.
- In moving machines / vehicles.
- Machines whose main energy is something else than compressed air at less than 5 bar (e.g. hydraulic pump, electric motor).
- To be connected to machines and machine combinations that are controlled using, in addition to the MCC-XRP1, e.g. programmable logic controllers, computers or similar control modules.

9 Risk assessment

The installation of MCC-XRP1 is subject to the manufacturer carrying out a full risk assessment as required by the Machinery Directive and the applicable standard, including the tests required in this document prior to putting into service.

10 Installation and connection

10.1 Installation

Follow these installation instructions carefully to avoid failure or malfunction of the MCC-XRP1.

10.1.1 Installation and environmental conditions

When you are installing MCC-XRP1, make sure that it is used within these limits:

- ambient temperature: +5 – +40°C
- ambient humidity: 10–95 % RH (25 °C:ssa, non-condensing)
- pollution degree: 2
- do not use the MCC-XRP1 in the following environments where:
 - direct sunlight.
 - rapid temperature changes that cause condensation.
 - in places where flammable or corrosive gases are present.
 - dust, metal particles or salts in the air.
 - in places where petrol, paint thinners, alcohol or other organic solvents or strong alkaline solutions such as ammonia or sodium hydroxide are handled.
 - vibrations, shocks or water droplets.
 - power transmission lines, high-voltage equipment, power cables, power equipment, radio transmitters or other similar devices that typically cause large switching/induction spikes. Maintain a minimum distance of 1 meter between these devices and the MCC-XRP1.

10.1.2 Static electricity

Before installing and touching the MCC-XRP1, always touch the grounded metal first to discharge any static electricity you may have generated. In particular, be careful not to discharge static electricity into any open connectors 6-9 during installation and always close the unused terminals with the protective plugs supplied with these terminals (see "Part Names - Figure 1").

In use, the MCC-XRP1 is recommended to be mounted, for example, on a desktop with an antistatic coating, while the user is wearing an antistatic wristband to prevent static electricity from discharging into the MCC-XRP1 or into any electrical components or assemblies that may be manufactured on the machine, such as printed circuit boards.

10.2 Guards

Always equip the machine with guards that comply with the regulations.

10.3 Connections

When connecting sensors and air valves, use good quality wires that can withstand, among other things, possible bending/folding of the wires.

The connectors used for the connection can be found in the manual under "Part Names" and the corresponding connector pin order under "Specifications".

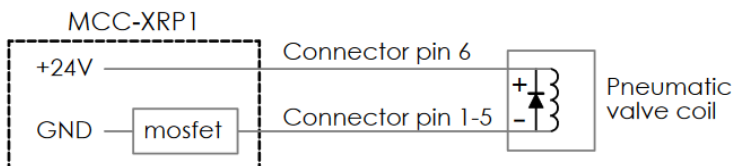
10.3.1 Supply voltage

To operate, the MCC-XRP1 requires 24 V of good quality DC power from a power supply with a power output sufficient for its consumption, typically 2-4 amps.

The MCC-XRP1 is protected by an internal 1.25 A slow-blow fuse, which is not replaceable.

10.3.2 Outputs

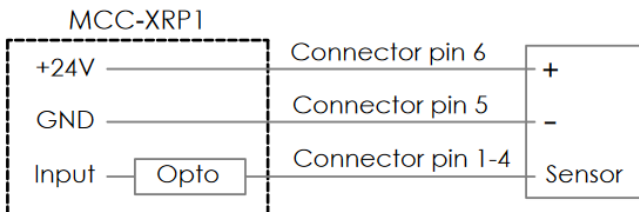
The MCC-XRP1 can be connected to directly control a maximum of five 24V pneumatic valves with a current consumption lower than the given limits in the technical specification (150/500 mA).



Note: Pneumatic air valves must have a flyback diode to protect the electronics against inductive spikes from the coil.

10.3.3 Inputs

A maximum of four 24 V PNP type sensors can be connected to the MCC-XRP1 with a current consumption lower than the given limits given in the technical specification (50/150 mA).



Note: The inputs are opto-isolated from the 5V supply voltage of the MCC-XRP1 processor.

10.3.4 ICSP programming connector

This connector is intended solely for programming the MCC-XRP1. Under no circumstances do we recommend using the I/O ports/pins behind them (MISO, MOSI, SCK, 5 VDC) for any other purpose, as they are not explicitly protected against e.g. overload. The internal 24V/5V power supply of the device has a maximum power of 2 W.

10.4 Shut-off valve, oil and water separator

According to the Machinery Directive, the machine must always have a manual shut-off valve to disconnect the machine from the compressed air supply, for example for maintenance.

Note: The shut-off valve can be, for example, a quick coupling.

In addition to the shut-off valve, it is recommended to install an oil and water separator and, if necessary, an air regulator to reduce the operating pressure to 5 bar or less.

10.5 Structure of electrically controlled valves

The outputs of the MCC-XRP1 are of the NPN type (grounding type). Make sure that the coil of the pneumatic valves you use is galvanically isolated from the other metal parts of the valve and that no unintentional connection is possible, even during maintenance or similar operations.

10.6 Main valve

IMPORTANT: The main valve must never be connected directly to any voltage source of the MCC-XRP1 so that the activation of this valve cannot be controlled programmatically via the output of the MCC-XRP1.

IMPORTANT: Install a 3/2-type main valve on the machine and program to pushbuttons a safe activation condition for the output of the main valve to avoid an unforeseen hazard situation at the start-up when the valve opens and the compressed air "rushes" into the machine pneumatics and its cylinders moves fast to their initial/default positions indicated by the valves.

At the same time, we recommend using a Soft Start-up type of main valve, because in the beginning the cylinders' pistons lack back pressure and the back pressure valves typically installed on the cylinders to limit the speed do not work.

Note that the slow opening speed of the Soft Start-up soft-start valve can partly control the rate of filling of the pressurised chambers of the machine, but the friction of the cylinders and mechanisms will determine at what point the piston/pistons will start to move when the pressure rises, i.e. depending on the machine, the event may still be dangerous and require other protective measures when designing the machine.

10.7 Placement and mounting of the MCC-XRP1

The MCC-XRP1 must be located in such a way that operator can use it easily and it's not subject to impact or falling objects, the operating environment is clean, and none else don't have access to the buttons of the MCC-XRP1 or to enter an area considered hazardous when the machinery is in use.

Note: If necessary, the MCC-XRP1 can be equipped with separately ordered (left/right) button protective frames and attached to the machine or workbench using corner brackets installed at the ends of the housing, following the installation instructions provided.

Optional accessories are shown on page 10, Figure 2.

11 Programming

The MCC-XRP1 is programmed via the ICSP programming connector (#8, PROG) and requires comprehensive knowledge of programming the ATmega328P-AU by C and using the ICSP interface..

Note: inputs 3-4 are connected to interrupt inputs PD2, PD3.

11.1 ATmega328P-AU Pinout

Port	(Arduino)	Item	Note
PD5	5	#1 left button	input, active LOW
PD6	6	#1 button left LED	output, active HIGH
PD7	7	#3 option button	input, active LOW
PB0	8	#3 button option LED	output, active HIGH
PB1	9	#2 right button	input, active LOW
PB2	10	#2 button right LED	output, active HIGH
PC0	A0	#6 output 1 (GX12, pin 1)	output, active HIGH
PC1	A1	#6 output 2 (GX12, pin 2)	output, active HIGH
PC2	A2	#6 output 3 (GX12, pin 3)	output, active HIGH
PC3	A3	#6 output 4 (GX12, pin 4)	output, active HIGH
PC4	A4	#6 output 5 (GX12, pin 5)	output, active HIGH
PD0	0	#7 input 1 (GX12, pin 1)	input, active HIGH
PD1	1	#7 input 2 (GX12, pin 2)	input, active HIGH
PD2	2	#7 input 3 (GX12, pin 3)	input, active HIGH
PD3	3	#7 input 4 (GX12, pin 4)	input, active HIGH
PB3	11	#8 MOSI (GX12, pin 4)	programming
PB4	12	#8 MISO (GX12, pin 3)	programming
PB5	13	#8 SCK (GX12, pin 2)	programming
PC6		#8 RESET (GX12, pin 1)	programming

11.2 Variables, program initialization

Prefer a programming approach that keeps the use of dynamic memory (SRAM) within safe limits throughout the program cycle, and that at the beginning of the program, the necessary global variables and constants are clearly named, inputs and outputs are defined.

11.3 Setup function

- initialize all needed inputs and outputs.
- read the fault memory on the EEPROM and prevent the use of the machine if necessary.
- read the position of the machine's cylinders from the sensors and prevent the use of machine if it cannot be started safely.
- establish a main valve activation condition that ensures that it is safe to turn on the pressure.

11.4 Program cycle (main program)

11.4.1 Work cycle start and end condition

Define the starting and stopping conditions of the work cycle as carefully as possible and secure that the conditions defined as starting conditions are valid for a sufficiently long period of time, or otherwise ensure that the operator has no possibility of entering the danger zone while the machine is still in the dangerous working cycle phase.

11.4.2 Safety limits and monitoring of incidents

IMPORTANT: If the safety of the machine is to be improved by the use of a separate safety limit(s), it is recommended that these safety limits be connected to the processor interrupt inputs (PD2, PD3) of the MCC-XRP1 via input connector of #7 (pins 3, 4), and linked to the main program by using an interrupt routine so that it is executed immediately, no matter what stage of the machine's cycle.

11.4.3 Fault and error monitoring

Write the main program so that it includes a function that monitors for possible machine faults and errors, button jams, or sensor failures at appropriate points in the work cycle. However, the monitoring of machine faults or malfunctions must be an additional safety measure and the components and solutions used must be reliable enough to last for the intended maintenance period or lifetime of the machine.

Please note that, almost without exception, a fault or error condition on the machine requires a programmed quick stop and the recording of the fault or error code in the fault memory to prevent operation of the machine, until the cause has been properly investigated and corrected by service personnel.

11.4.4 Programmatic quick stop

If a programmed quick stop is required, always deactivate the main valve first to make the machine harmless, and only then do the any other actions, such as recording the cause of the quick stop in the fault memory.

11.5 Measuring the amount of free memory (SRAM)

We recommend adding code to the program to measure the amount of free dynamic memory during testing phase, storing the values in EEPROM and reading them from there using a separate microcontroller with a program port, for example using the SoftwareSerial function.

Also check out Arduino's MemoryFree library.

11.6 Use of EEPROM memory

Note that the ATmega328P-AU manufacturer claims that 100 000 write/erase cycles can be reliably written to the eeprom memory. There is no limit to the number of read cycles, but please take this write/erase limitation into account even when designing your test program.

11.7 Reporting and clearing a fault code

A fault code (error condition) may be indicated to the operator, for example by flashing the lights of the buttons in the specific order indicated in the machine's manual, but pressing them must not remove the fault code from the memory or allow the machine to be used until it has been checked by the person responsible for its maintenance.

The most recommended way to clear the fault code is to temporarily load a separate program into the MCC-XRP1 that will reset the code, while ensuring that the cause of the fault is properly investigated by service personnel.

12 Testing

Before commissioning, the machine must undergo at least the tests listed below.

12.1 Testing machine start-up

Test that the machine will not start unpredictably and dangerously after a normal shutdown, power failure or quick stop.

12.2 Testing the machine shutdown

Test that the machine goes completely depressurised (and de-energised) after pressing the power switch.

12.3 Work cycle testing

Test that the work cycle cannot be started unintentionally and that the conditions specified as start conditions are valid for a sufficiently long period of time, or that it is otherwise ensured that the operator does not have the opportunity to enter the danger zone, while the machine is in a potentially dangerous phase of the work cycle.

12.4 Testing buttons 1-3

Test that any functions that may be programmed into the buttons in question work correctly and do not cause any dangerous situations at any stage of the program or work cycle

12.5 Abnormal button status detection testing

Test that the program monitors and operates as intended in all respects if it detects an abnormal state of the buttons during the program run, e.g. due to button failure, sticking or some other cause.

12.6 Abnormal condition detection testing of sensors

Test that the program monitors and fully operates as intended if it detects an abnormal state of the sensors during the program run, e.g. due to sensor failure.

12.7 Testing the programmatic quick stop

Test that the program is working as intended in all respects if it detects an issue that requires a programmatic quick stop.

12.8 Fault memory testing

Test that the fault or error code stored in the fault memory prevents the machine from being used as intended, also at start-up.

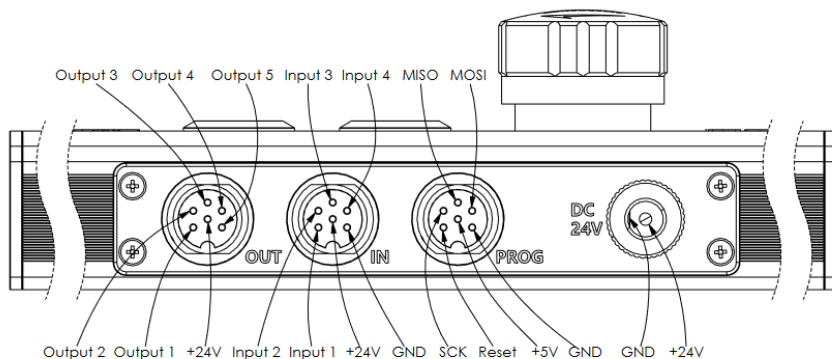
12.9 Test report and plan for regular maintenance and testing

Make a test report of the tests carried out and draw up a test and maintenance plan to monitor and ensure the safe operation of the machine during production.

13 Technical specifications

13.1 Connector panel

13.1.1 Picture of the connector panel



13.1.2 Output connector (OUT)

Pin	Name	Value	Note
1	output 1	NPN (< 150 mA)	*)
2	output 2	NPN (< 150 mA)	*)
3	output 3	NPN (< 150 mA)	*)
4	output 4	NPN (< 150 mA)	*)
5	output 5	NPN (< 150 mA)	*)
6	+24 V DC	Max 500 mA	

*) Each output can be loaded up to 150 mA if the total load of all outputs is less than 500 mA.

13.1.3 Input connector (IN)

Pin	Name	Value	Note
1	input 1	PNP (< 50 mA)	opto-isolated
2	input 2	PNP (< 50 mA)	opto-isolated
3	input 3	PNP (< 50 mA)	opto-isolated
4	input 4	PNP (< 50 mA)	opto-isolated
5	GND	Ground	
6	+24 VDC	Max 150 mA	*)

*) However, the total current consumption shall not exceed 150 mA.

13.1.4 ICSP programming connector (PROG)

Pin	Name	Value	Note
1	Reset	Reset	ICSP
2	SCK	SCK	ICSP
3	MISO	MISO	ICSP
4	MOSI	MOSI	ICSP
5	maa / GND	Ground	ICSP
6	+5 VDC	Power input	ICSP

13.1.5 Power supply connector (DC 24V)

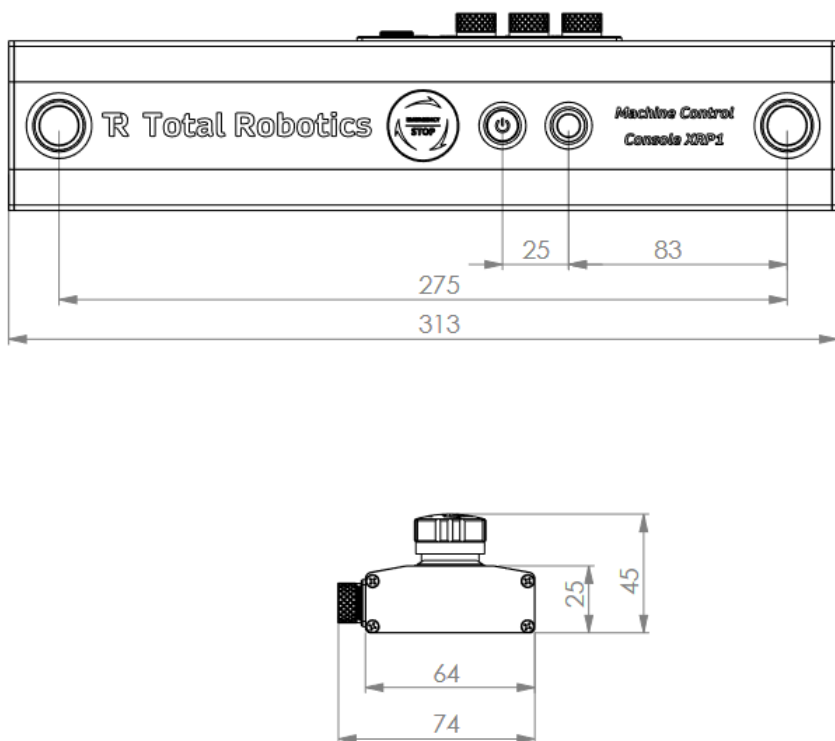
Name	Value	Note
+24 VDC	24 VDC, 2 A	Keskipinni
- GND	Ground	

13.2 Technical table

Feature	Value
Supply voltage	24 - 26V DC
Internal fuse	1.25 A, slow
24V / 5V internal converter	max 2W
Power consumption without load	< 20mA
Processor	ATMega328P-AU, Atmel
Processor clock speed	16 MHz
Programming language	C
Outputs	5 pcs , NPN, 24V
Inputs	4 pcs, 24V, PNP, opto-isolated
Output connector	GX12, 6 pin
Input connector	GX12, 6 pin
ICSP connector	GX12, 6 pin
Power supply connector	DC Power Connector 5.5 x 2.1
LEDs on buttons	programmable
Buttons 1-2 colour	red *)
Button 3 colour	green *)
Buttons 1-3	NO, closing, 1 000 000 operations
Power / start switch (4)	NO, closing, locking, 100 000 operations
Emergency stop button (5)	NC, opening, locking, 100 000 operations
Length	313 mm (+/- 1mm)
Width	64 / 72 mm (+/- 1mm)
Height	25 / 45 mm (+/- 1mm)
Weight	395 g (+/- 20g)
Operating temperature	+5 – +40°C
Operating environment	see Installation and environmental conditions
IP Rating	IP50
Storage temperature	+5 – +50°C

*) customizable (red, yellow, green, blue, white).

13.3 Dimensions



14 EU Declaration of Conformity

We hereby declare that



Machine Control Console MCC-XRP1

Meets the requirements of the Machinery Directive 2006/42/EC, provided that the product is installed and put into service in accordance with the instructions accompanying the product.

The product also meets the requirements of the EMC Directive 2014/30/EU.

The product is designed applying harmonized standards in those parts that are appropriate for the product: EN ISO 13849-1, SFS-EN ISO 13850, SFS-EN ISO 4414, SFS-EN 1037 + A1.

The product must not be put into service until it has been verified that the machinery to which this product is connected complies with the requirements of the Machinery and EMC Directives (2006/42/EC, 2014/30/EU).

If any changes are made to the product, this insurance will not be valid.

Total Robotics Oy

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Finland

The latest user manual is available at:
<https://www.totalrobotics.fi/manuals.html>

CE Declaration of Conformity available at:
https://www.totalrobotics.fi/docs/eu/CE-MCC-XRP1_en.pdf

RoHS certificate available at:
https://www.totalrobotics.fi/docs/eu/RoHS-MCC-XRP1_en.pdf

15 Contact information

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