HILMOT

A **TREW** Company

H-20 ZPA
ZPA MOTOR CONTROL MODULE

TABLE OF CONTENTS

SAFETY INSTRUCTIONS

Intended Use

The ZPA Motor Control Module is a field module for controlling one or two conveyor zones equipped with DC roller motors.

Read through these instructions thoroughly. Familiarize yourself with the device before installing, mounting, or operating.

Always operate the device as described in the instructions to ensure that the device and connected systems function correctly. The protection of operating personnel and plant is only guaranteed if the device is operated in accordance with its intended use.

General Safety Instructions

Only instructed specialist staff may operate the device in accordance with the operating manual. User modification and/or repair are dangerous and will void the warranty and exclude the manufacturer from any liability. If serious faults occur, stop using the device. Secure the device against inadvertant operation. Contact Hilmot for any additional assistance.

The connection of the device and maintenance work when live may only be carried out by a qualified electrical specialist. The operating company bears the responsibility for observing locally applicable safety regulations.

Store the unused device in the original packaging. This offers the device optimal protection against impact and moisture.

Ensure that the ambient conditions comply with regulations.

> *Note: Disposal*
> *Electronic waste is hazardous waste. When disposing of the equipment, observe the current statutory requirements in the respective country of use, as well as local regulations.*

GENERAL DESCRIPTION
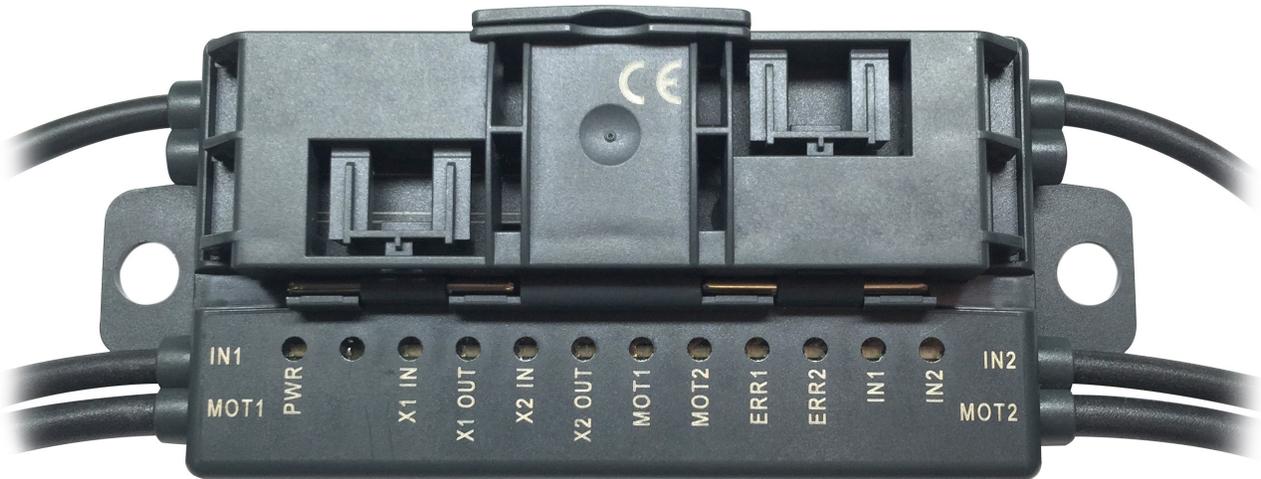
The Motor Control Module is a field module with two sensor inputs and two electronic outputs for controlling DC roller motoros. The module is optimized for use with the Interroll EC310 Motorized Drive Roller.

The module can control two consecutive zones of an accumulating conveyor section. A zone consists of a roller motor and a zone sensor, e.g. for a light barrier. Both zone controllers are logically coupled within the module. The upstream zone controller within the module can be deactivated to control a single zone.

Two interfaces are available for coupling with the neighboring zones of the conveyor. The interfaces each provide a signal input and a signal output. The interfaces can be connected directly to **(24)** V-compatible I/Os.

The compact housing can be installed directly into support profiles or cable ducts. The power supply is connected using insulation piercing technology via a black AS-Interface flat cable. The swiveling flat cable guide is locked using a snap-fit without the use of tools.

The sensor inputs and motor outputs are connected using cable outputs with M8 round plug connectors. Cable outputs with 4-pin M12 round plug connectors are provided for zone coupling.

The module is configured using three rotary switches on the back of the module.

LED Indicators
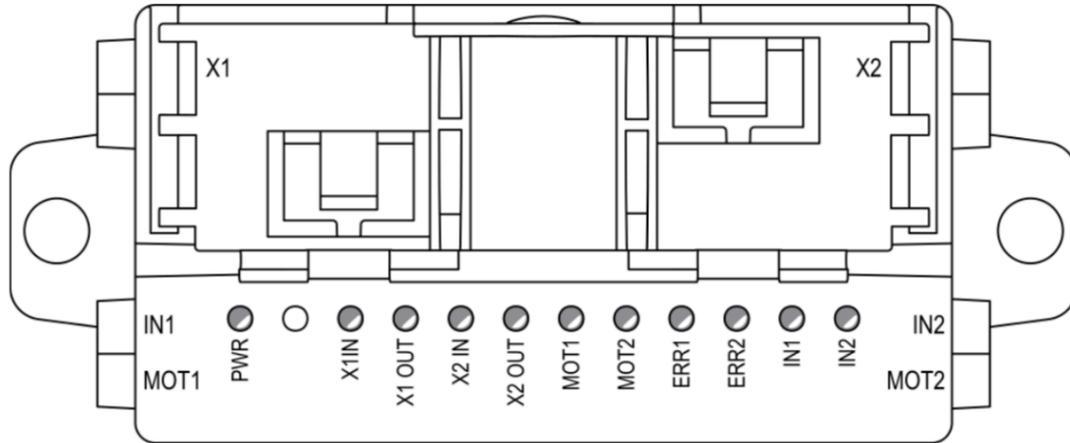
LED	Color	Function
PWR	green	Supply Voltage
X IN	yellow	Zone coupling input active
X OUT	yellow	Zone coupling output active
MOT	yellow	Motor active
ERR	yellow	steady: motor fault flashing: motor power supply fuse blown
IN	yellow	switching state of the sensor inputs
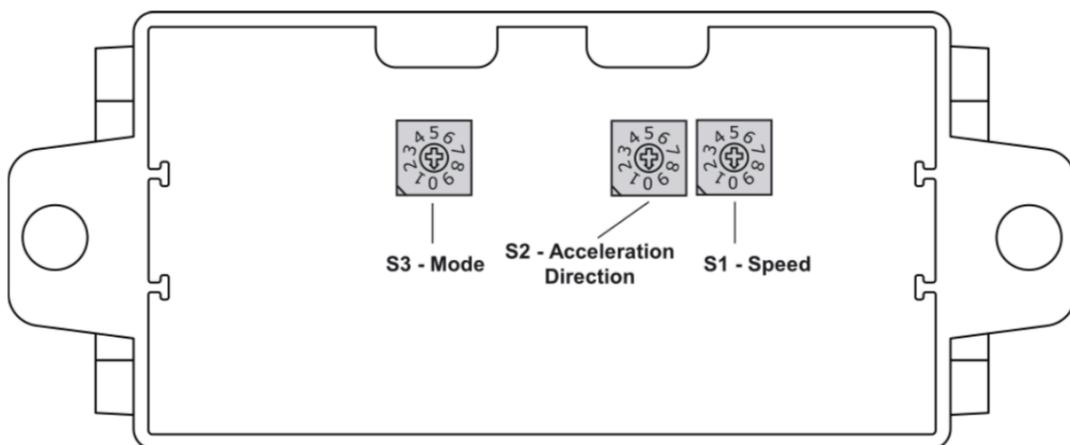
Note: The configuration of the switches is applied at power up. To change the configuration the Motor Control Module has to be repowered after modifying the switches. Motor power supply fuses are not replaceable.

S1 - Speed

Speed Switch	EC310 Speed Signal
0	3.96 V
1	4.78 V
2	5.61 V
3	6.44 V
4	8.50 V
5	9.63 V
6	10.00 V
7	7.26 V
8	Reserved
9	Reserved

S2 - Acceleration / Direction

The direction setting not only defines the direction of the connected motors,
but also which of both zones the upstream and downstream zone is.
See **chapter 3 "Installation & Operation"** for more information.

The acceleration times refer to the maximum speed setting. If a lower speed is selected,
the acceleration will be the same, but the time for reaching the selected speed is shorter.

Acc. / Dir Switch	Acceleration (full speed time)	Direction
0	0 ms	CW
1	500 ms	CW
2	1000 ms	CW
3	1500 ms	CW
4	3000 ms	CW
5	0 ms	CCW
6	500 ms	CCW
7	1000 ms	CCW
8	1500 ms	CCW
9	3000 ms	CCW
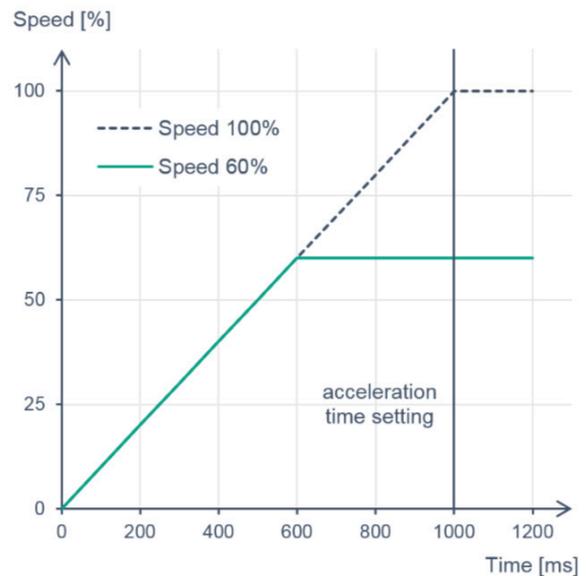
S3 - Mode

Mode Switch	Operation Mode	Upstream Zone active
0	Standard ZPA	✓
1	Enhanced ZPA	✓
2	Standard ZPA – Single zone	✗
3	Enhanced ZPA – Single zone	✗
4	Transportation	✓[1]
5	Long Zone	✗
6	Direct Control	✓
7 … 9	Reserved	

1 *The transportation mode is also able to control a single zone, so connecting a motor and photo eye to the upstream zone is optional.*

> **Note: The position of the upstream zone depends on the direction setting. For cw rotation, the upstream zone is zone 1, for ccw rotation zone 2 is the upstream zone. See chapter 3 for more information.**

INSTALLATION & OPERATION

Connections
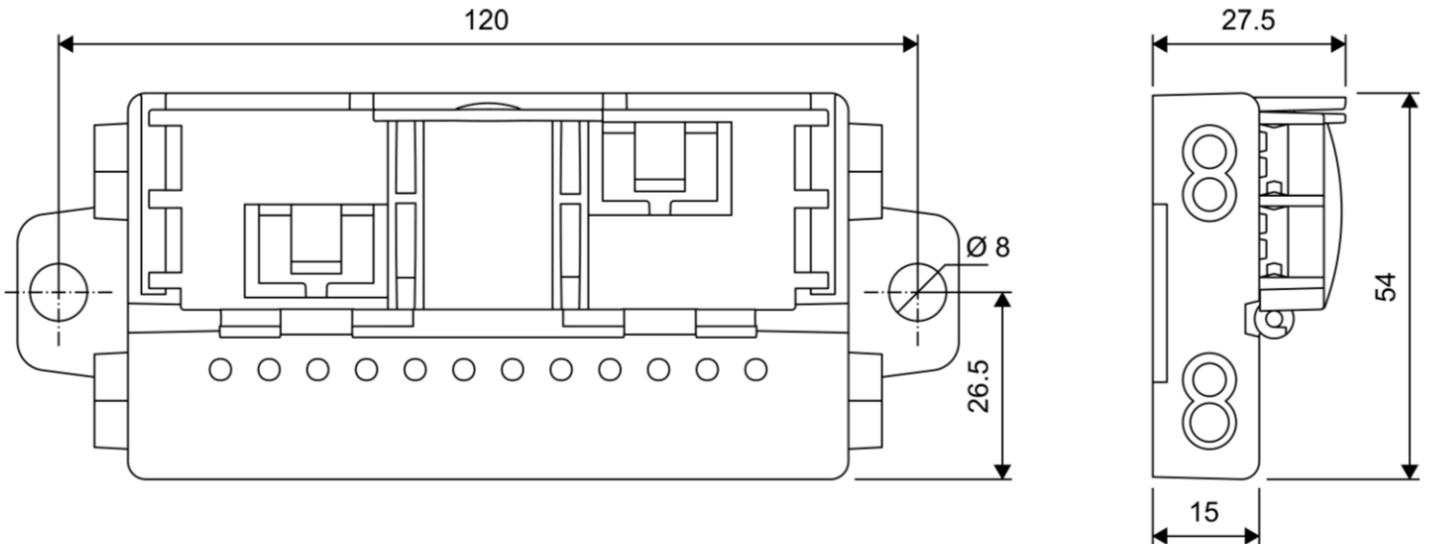
Note: The device is intended to be always mounted with its top upside, as the conveying direction is important for the wiring of the device.
If the device is mounted upside down, the logical and physical conveying direction do not match, which would lead to unexpected behavior.
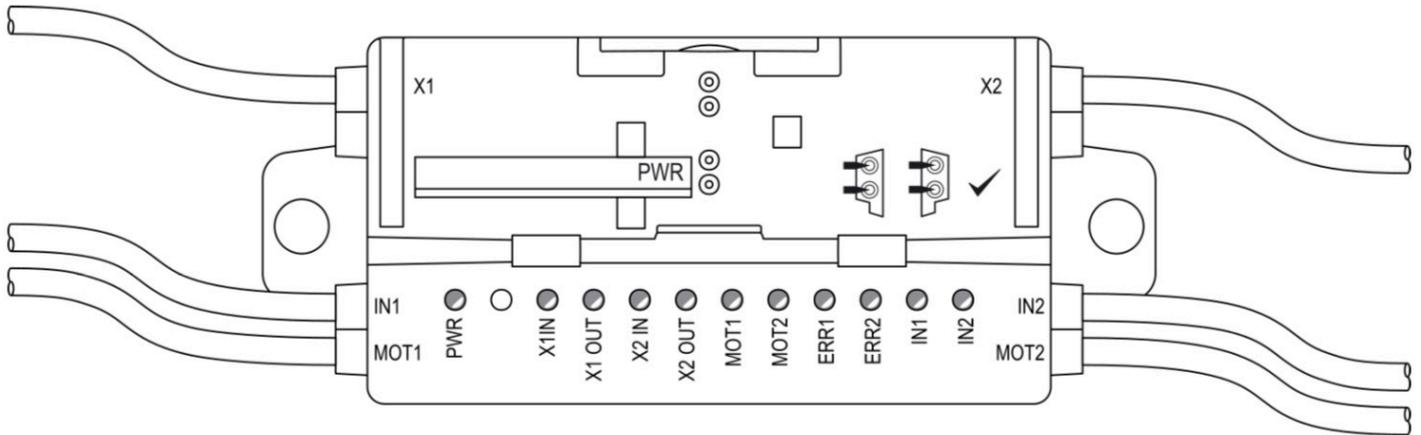
| Connector	Description
PWR	power supply, insulation piercing technology black flat cable
IN	Zone sensor input, female M8 screw locking 1: IN + 2: n.c. 3: IN - 4: IN
MOT	Roller motor connection (compatible to Interroll EC310 MDR), female M8 snap 1: MOT + 2: DIR 3: MOT - 4: ERROR 5: SPEED
X1	Zone interconnection / PLC interface, female M12 screw locking 1: X1 IN 2: X1 IN - 3: X1 OUT 4: X1 OUT -
X2	Zone interconnection / PLC interface, male M12 screw locking 1: X2 OUT 2: X2 OUT - 3: X2 IN 4: X2 IN -

Zone Interconnection

The zone interconnection lines **(X1, X2)** are used to provide and receive information to and from the neighboring zones. The counterparts can either be the zone interconnection lines of other Motor Control Modules or standard 24V I/Os. Every zone interconnection line offers one input and one output. The meaning of both of them depend on the conveying direction.

Interconnection I/O	Description
Downstream X OUT Upstream X IN	Zone sensor state low: Zone empty high: Product detected
Upstream X OUT Downstream X IN	Release signal, output controlled by zone logic low: no release high: release

The interconnection I/O signals are fully compatible to standard 24V I/Os, so they can be used to connect the zone controller to other conveying logic. The zone logic of the Motor Control Module expects the release signal to be applied as long as the photo eye is blocked by a leaving product. If the release signal is reset before the product completely left the zone, the motor will stop immediately, waiting for the release signal to rise again. After the product left the zone (photo eye unblocked) the motor keeps running for the "Motor after run" time. As long as there is no product detected by the photo eye, any incoming release signal is ignored.

This results in two cases (all I/Os of a single zone controller are shown):

   1   Incoming product is detected before release signal is applied
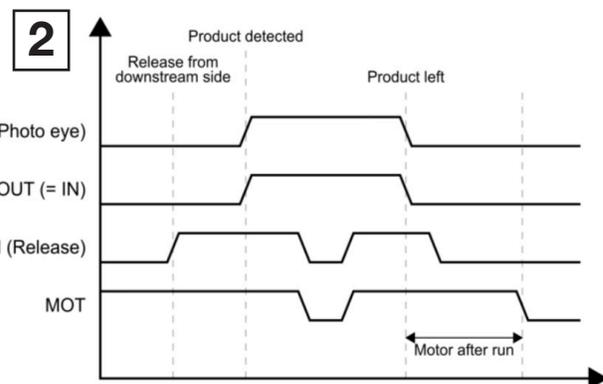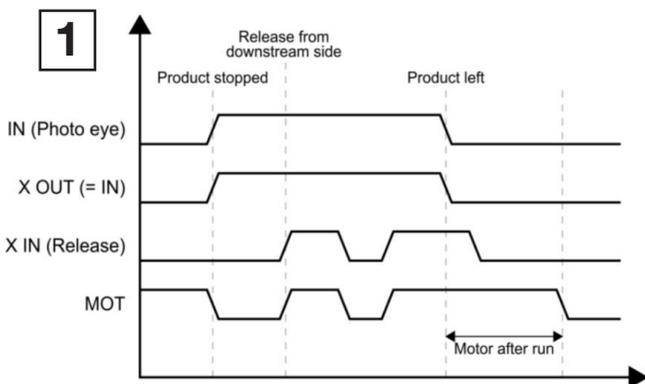
   2   Release signal is applied before incoming product is detected

Mounting

The Motor Control Module is designed to be mounted between two conveyor zones, always with its top upside. The connectors for motor and zone sensor on each side of the Motor Control Module are connected to the corresponding conveyor zone on that side.
The same applies for the zone interconnection cables.

Switch S2 = 0..4 (CW)
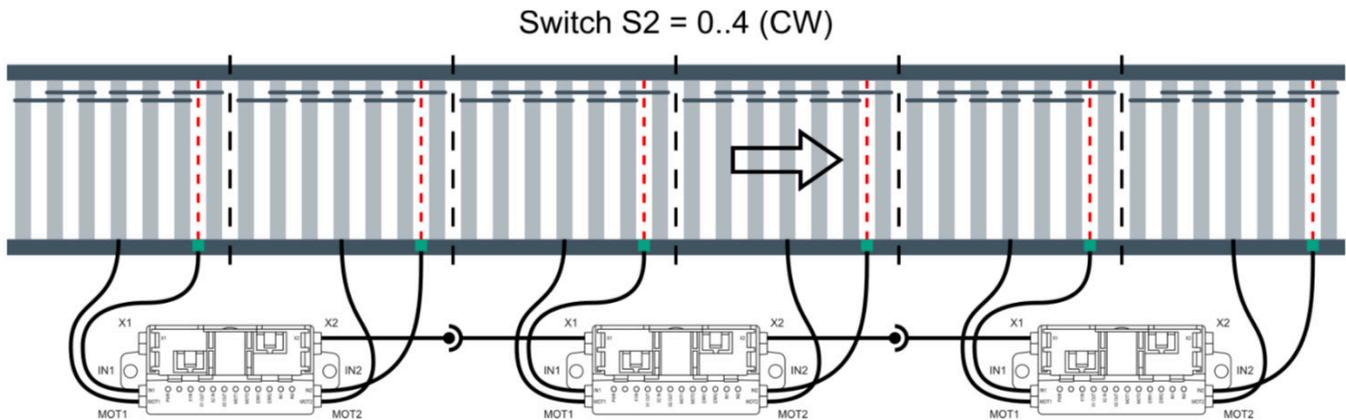
If the conveying direction is reversed, only the direction setting on switch S2 has to be changed, the cabling remains the same. The direction setting defines, which of X1 and X2 the downstream and upstream connector is.

Switch S2 = 5..9 (CCW)
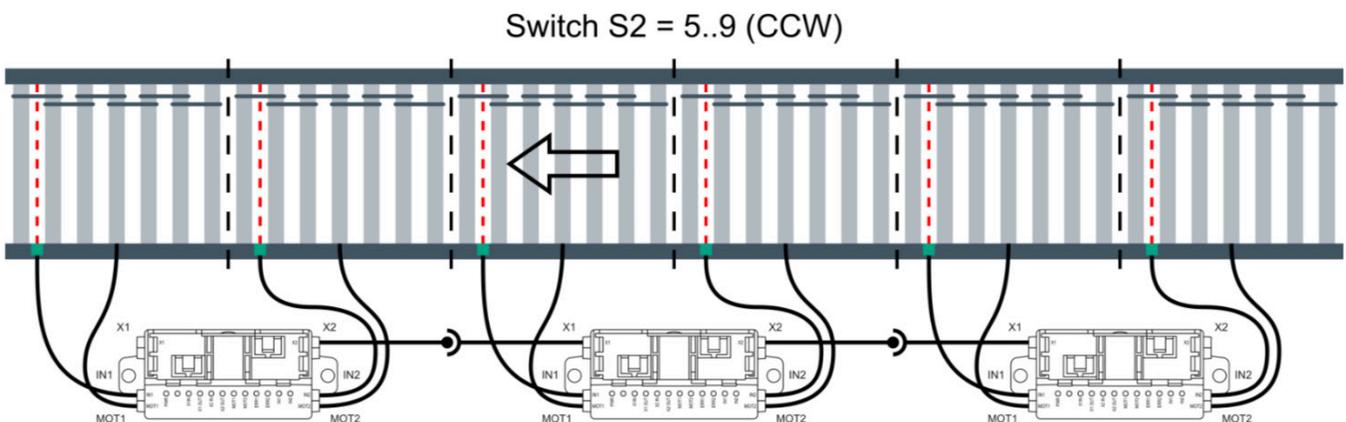
Note: The Motor Control Modules never require you to build cable loops like in the following image. Building such loops will bring the connected zones into wrong logical order, which will prevent correct operation.
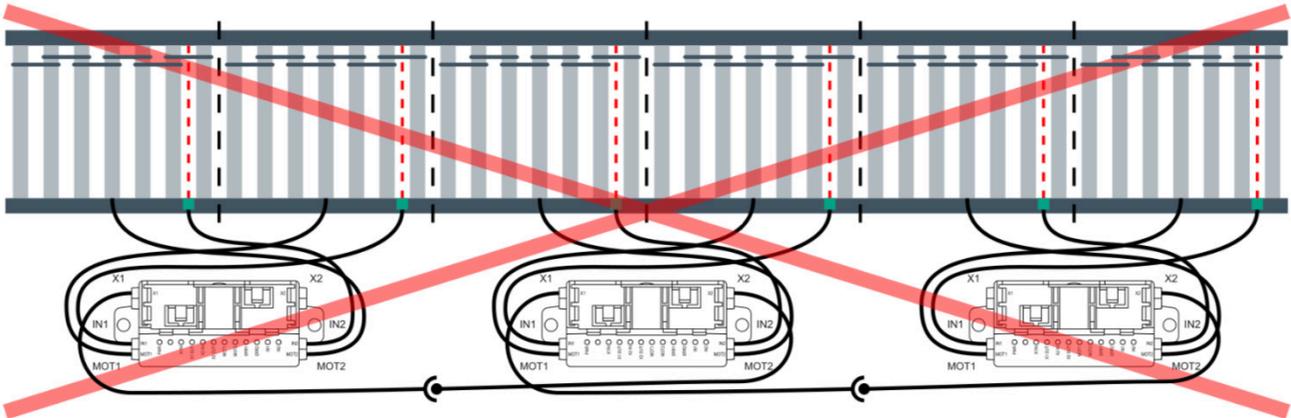
If the Motor Control Module should control a single zone, the corresponding motor and photo eye are connected to the downstream side of the module. In single zone mode the upstream side motor is synchronized with the other one, so it can be used to support the other motor (e.g. for heavy loads or climbs).

> *Note: Some operation modes require a special setting for operating a single zone.*
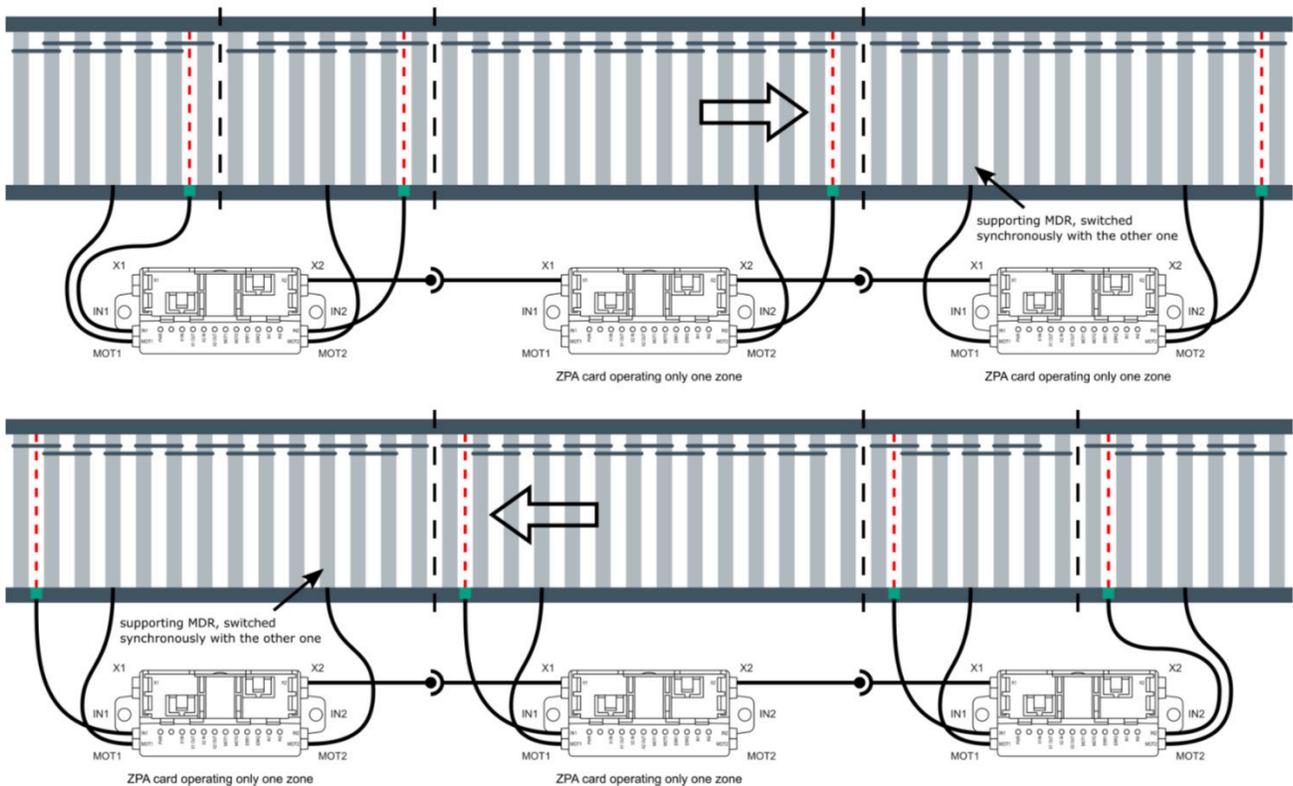
Changing Mounting Side

As soon as the mounting side of the Motor Control Modules is switched, e.g. for a conveyor curve, two interconnection line plugs of the same gender have to be connected to each other. This is done via a crossover cable with the matching gender. The crossover cable ensures that outputs of one interconnection line are connected to the inputs of the other line.
For connections between **(2)** X1 connectors a male/male crossover cable is needed,
for the X2 connectors a female/female crossover cable is needed.

male / male
crossover cable

female / female
crossover cable

Switch S2 = 5..9 (CCW)

female / female
crossover cable

Switch S2 = 0..4 (CW)
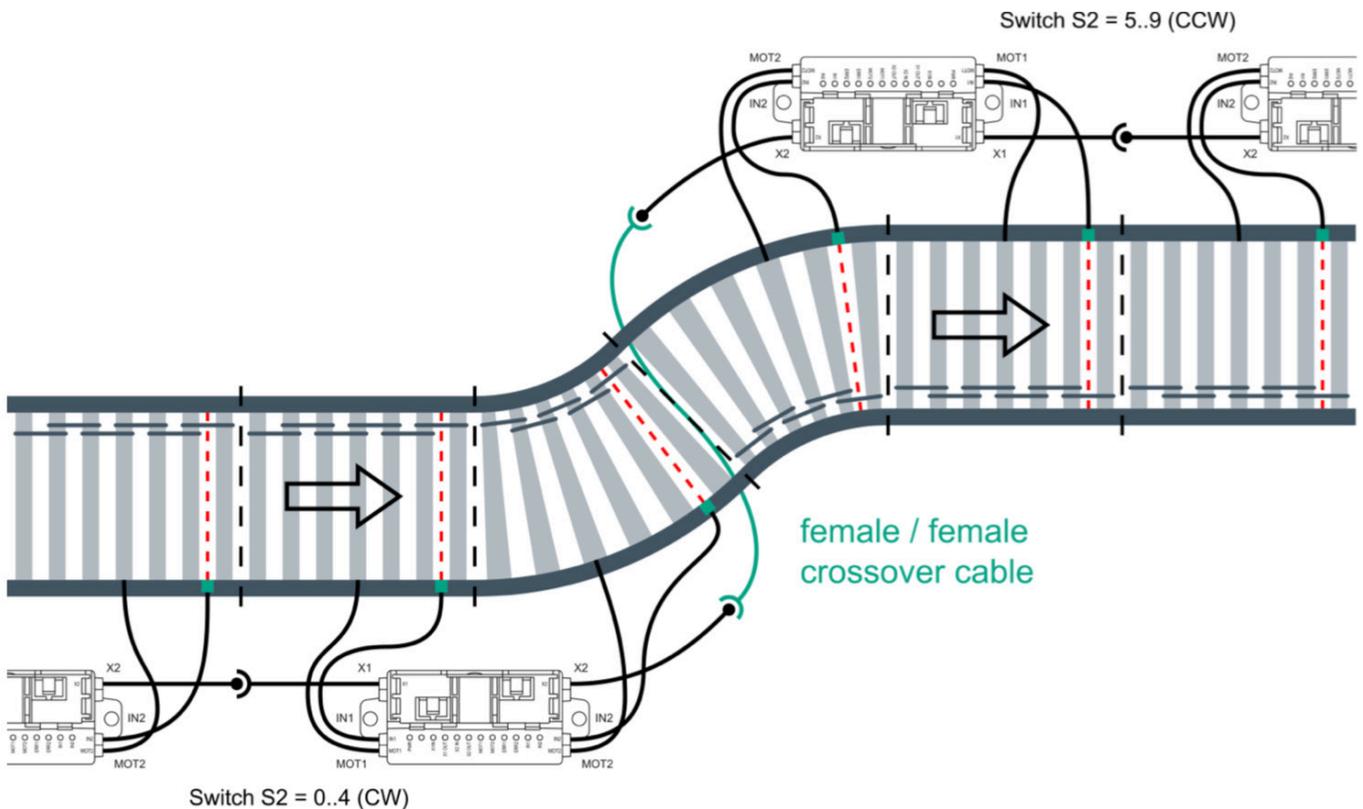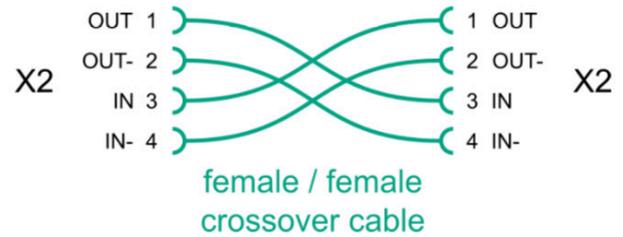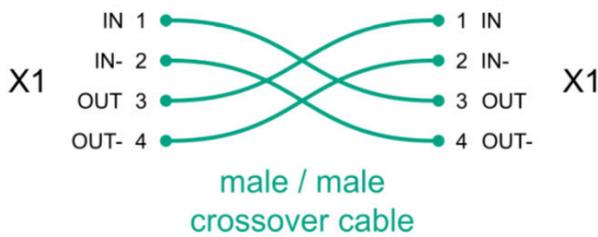
Connecting to PLC I/Os

The zone interconnection lines are compatible to 24V I/Os.

The inputs of the zone interconnection lines **(X IN)** are galvanically isolated,
so there are no special requirements for connecting other potentials.

The outputs of the zone interconnection lines **(X OUT)** are directly powered from the Motor
Control Module's power supply, so connecting them to other potentials bears the risk
of ground loops.

Only connect the zone interconnection line outputs to isolated sinking inputs of a PLC I/O
card. A common ground of the PLC I/O card may be connected to other Motor Control
Modules, but not to the main power supply.

> *Note: Possibility For Ground Loops!*
> *Current supply of the Motor Control Modules (and motors)*
> *could run through the PLC I/O card.*
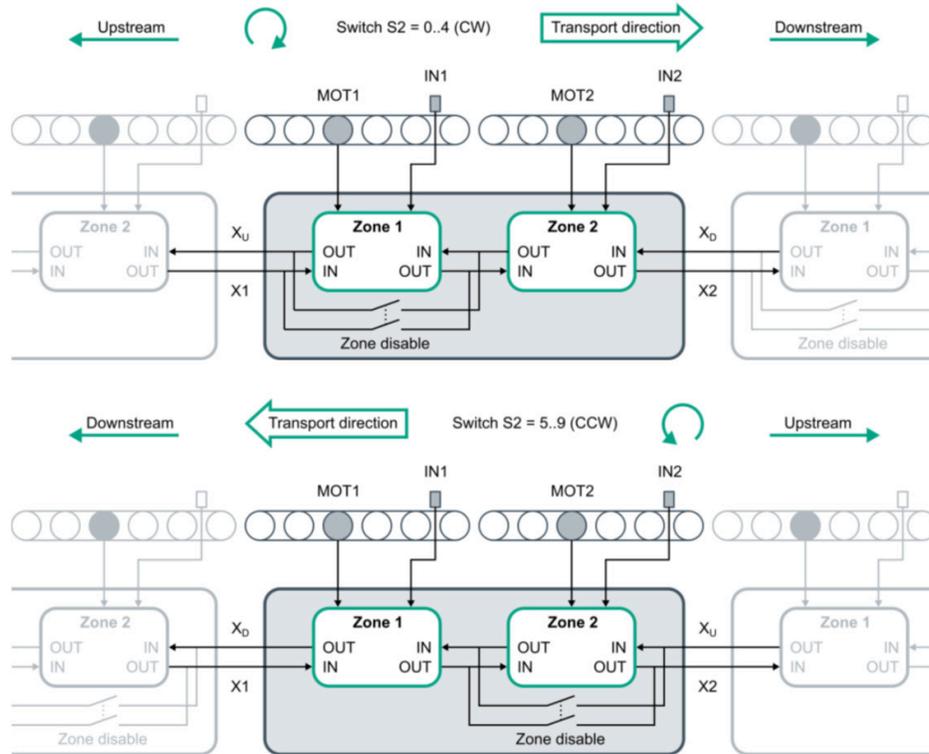
The Motor Control Module contrains two of those zone controllers, which are connected internally to form a chain of two zones. Each of the **MOT, IN, X** connectors are directly connected with the respective zone controller.

If the Motor Control Module is controlling a single conveyor section, only the downstream zone is active. In this case the upstream **X** connector is directly connected to the downstream zone controller.

> *Note: The meaning of the "X" inputs and outputs changes with the direction setting.*

The different operation modes differ in the way the product is conveyed from zone to zone and therefore how the accumulation and release are realized.

The handover of products between each zone is done via the zone interconnection lines **X1** and **X2**. As the downstream connector depends from the direction setting the following chapter will refer to X_D **IN/OUT** for the downstream **X** inputs and outputs, X_U **IN/OUT** for the upstream **X** inputs and outputs.

The X_D **OUT** tells the downstream zone whether there is a product available to be conveyed in or not. It always equals the corresponding zone sensor input **IN**. The X_U **OUT** releases the product in the upstream zone to enter.

Single Accumulation / Single Release

A product is allowed to enter the zone, if the previous product completely left the zone by unblocking the zone sensor **(IN)**. The zone ensures, that only one product is within the zone at any time. If the release signal is received **(X$_D$ IN)** the product is moved out of the zone. An empty zone sets the release signal **(X$_U$ OUT)** and waits for an incoming product **(X$_U$ IN)**. As soon as an incoming product left the upstream zone's sensor **(X$_U$ IN)** the release signal **(X$_U$ OUT)** is reset.

If the release signal **(X$_D$ IN)** is reset while a leaving product is still in front of the zone sensor **(IN)**, the motor is stopped immediately. After unblocking the zone sensor **(IN)** the motor will keep running for a certain time **(Motor After Run)** to ensure the product completely leaves the zone. As soon as the upstream zone sensor **(X$_U$ IN)** is blocked and the release signal is set **(X$_U$ OUT)**, the motor is activated again to receive the product.

The Standard ZPA mode is able to convey products, which are longer than the actual zone. Such a long product is detected, if an incoming product already reached the zone sensor **(IN)** while it has not unblocked the upstream zone's sensor yet **(X$_U$ IN)**. As long as a long product did not leave the upstream zone, the release signal **(X$_U$ OUT)** equals the motor state **(MOT)** to synchronize the motors of the actual zone and the upstream zone.

After the Power on delay the zone searches for undetected products between the zone sensors by activating the motor **(MOT)** until the zone sensor **(IN)** is blocked or the Search timeout has passed. If the upstream zone sensor **(X$_U$ IN)** is blocked after power on, the zone assumes that a part of the product already entered the zone and also sets the release signal **(X$_U$ OUT)** to synchronize the motors until the first gap is detected at the upstream zone's sensor **(X$_U$ IN)**. If both the zone sensor **(IN)** and the upstream zone senor **(X$_U$ IN)** are blocked after power on the zone assumes the presence of a long product, as it cannot determine the length of the product without movement.

In Standard ZPA – Single Zone Mode, the upstream zone is inactive and the corresponding zone sensor input **(IN)** is ignored. The motor **(MOT)** of the upstream zone is synchronized with the motor of the downstream zone.

The following timers are handled by the Standard ZPA mode *(see Pgs. 3.14 & 3.15)*:

- Leaving Timeout
- Receive Timeout
- Delivery Timeout
- Search Timeout
- Motor After Run
- Power On Delay

Block Accumulation / Block Release

A product is allowed to enter the zone if the zone is empty or the previous product already reached the zone sensor **(IN)** and is leaving the zone by receiving the release signal **(X_D IN)**. If the release signal is received **(X_D IN)**, the product is moved out of the zone and the release signal is forwarded to the upstream zone **(X_U OUT)**, allowing exactly one product to enter. As soon as an incoming product left the upstream zone's sensor **(X_U IN)** the release signal **(X_U OUT)** is reset, waiting for the product to reach the zone sensor **(IN)**. Therefore the zone ensures, that only one additional product enters the zone, while the previous one is leaving.

If the release signal **(X_D IN)** is reset while a leaving product is still in front of the zone sensor **(IN)**, the motor is stopped immediately and the forwarded release signal **(X_U OUT)** is reset until the incoming release signal **(X_D IN)** is set again. After the last product unblocked the zone sensor **(IN)** the motor will keep running for a certain time **(motor after run)** to ensure the product completely leaves the zone. As soon as the upstream zone sensor **(X_U IN)** is blocked and the release signal is set **(X_U OUT)**, the motor is activated again to receive the product.

The Enhanced ZPA mode is able to convey products, which are longer than the actual zone. Such a long product is detected, if an incoming product already reached the zone sensor **(IN)** while it has not unblocked the upstream zone's sensor yet **(X_U IN)**. As long as a long product did not leave the upstream zone, the release signal **(X_U OUT)** equals the motor state **(MOT)** to synchronize the motors of the actual zone and the upstream zone. The following product is allowed to enter the zone after the long product left the zone by unblocking the zone sensor **(IN)**.

After the Power on delay the zone searches for undetected products between the zone sensors by activating the motor **(MOT)** until the zone sensor **(IN)** is blocked or the Search timeout has passed. During this search also the release signal **(X_U OUT)** is set. This might lead to a product entering the zone, while another was already present between the zone sensors.

To ensure every product within the zone is moved up to the zone sensor the Motor after run time is extended to the Search timeout as long as the zone was not declared empty before. If both the zone sensor **(IN)** and the upstream zone senor **(X_U IN)** are blocked after power on the zone assumes the presence of a long product, as it cannot determine the length of the product without movement.

In Enhanced ZPA – Single Zone mode, the upstream zone is inactive and the corresponding zone sensor input **(IN)** is ignored. The motor **(MOT)** of the upstream zone is synchronized with the motor of the downstream zone.

The following timeouts are handled by the Standard ZPA mode *(see Pgs. 3.14 & 3.15)*:

- Leaving Timeout
- Receive Timeout
- Delivery Timeout
- Search Timeout
- Motor After Run
- Power On Delay
- Release Delay

No Accumulation / Block Release

In Transportation Mode no accumulation takes place. Products are only moved as long as the release signal **(X$_D$ IN)** is applied. The release signal **(X$_D$ IN)** is immediately forwarded to the upstream zone **(X$_U$ OUT)**, causing all consecutive Transportation zones to start moving by the release signal **(X$_D$ IN)** received by the front most zone.

Connecting a zone sensor is optional, enabling the zone to detect jams by measuring the time for a product to leave the zone **(Leaving timeout)**. If no zone sensor is connected the timeout will never occur and **X$_D$ OUT** won't be set.

As the Transportation mode just forwards the release signal, it also supports single zone operation, without the need for a special setting.

The following timeouts are handled by the Transportation mode *(see Pgs. 3.14 & 3.15)*:

- Leaving timeout (only if zone sensor is connected)

Block Accumulation / Block Release / No Separation

A Long Zone acts like a transportation zone, but with accumulation. As long as the zone sensor **(IN)** is unblocked or the release signal **(X_D IN)** is received, incoming products are allowed to enter by setting the upstream release signal **(X_U OUT)**. Therefore many products can enter the zone without any separation. Products in front of the zone sensor **(IN)** are moved out of the zone as soon as the release signal **(X_D IN)** is received.

After a certain time **(Zone timeout)** with no incoming products the zone enters idle state and stops it's motor, but still setting the release signal **(X_U OUT)**. Any change of the upstream zone's sensor **(X_U IN)** will reset the Zone timeout and activate the motors again.

Jams are detected by measuring the time for a product to leave the zone **(Leaving timeout)**. As the motor **(MOT)** is switched synchronously with the release signal **(X_U OUT)** the Long Zone Mode is able to convey products, which are longer than the actual zone.

In Long Zone Mode the upstream zone is always inactive and the corresponding zone sensor input **(IN)** is ignored. The motor **(MOT)** of the upstream zone is synchronized with the motor of the downstream zone.

The following timeouts are handled by the Long Zone Mode *(see Pgs. 3.14 & 3.15)*:

- Leaving Timeout
- Long Zone Timeout
- Power On Display

Direct Control

In Direct Control Mode no logic is active. The zone is directly controlled by the corresponding **X IN** and **X OUT** signals:

X IN controls the motor **(MOT)** (high: motor on, low: motor off)
X OUT equals the state of the zone sensor **(IN)**

Leaving Timeout
Leaving timeout = 8 seconds

Maximum time allowed between motor **(MOT)** start and unblocking of the zone sensor **(IN)** in case of a leaving product. After the Leaving timeout the motor **(MOT)** is stopped and any release signal **(Xυ OUT)** is reset, waiting for manual removal of the jam. As soon as the zone sensor **(IN)** gets unblocked the Search timeout starts.

Receive Timeout
Receive timeout = 8 seconds

Maximum time between unblocking of the upstream zone's sensor **(Xυ IN)** and blocking of the zone sensor **(IN)**.

After the Receive timeout the zone is declared empty and the motor is stopped, allowing products to enter.

Delivery Timeout
Delivery timeout = 8 seconds

Maximum time allowed for a product to leave the upstream zone sensor **(Xυ IN)** after the release signal **(Xυ OUT)** was set.

After Delivery timeout the motor **(MOT)** is stopped, waiting for upstream zone sensor **(Xυ IN)** to be unblocked or the zone sensor **(IN)** to get blocked.

Search Timeout
Search timeout = 4 seconds

After power up or unexpected unblocking of the zone sensor the zone activates its motor to search for products, which might be in between the zone sensors. After the Search timeout has passed, the zone is declared empty, the motor **(MOT)** is turned off and the release signal is set **(Xυ OUT)**, allowing products to enter.

In Standard ZPA mode, the release signal **(Xυ OUT)** is set during this search only if the upstream zone's sensor **(Xυ IN)** is blocked, assuming a part of the product has already entered the actual zone.

In Enhanced ZPA mode, the release signal **(Xυ OUT)** is set during the search. This might lead to a product entering the zone, while another was already present between the zone sensors. To ensure every product within the zone is moved up to the zone sensor the Motor after run time is extended to the Search timeout as long as the zone was not declared empty before.

Motor After Run
Motor After Run = 2 seconds
Time between unblocking of the zone sensor and actual motor stop. This is to limit motor switching and ensures that products can completely leave a zone after unblocking the zone sensor (which is usually not mounted exactly at the end of the zone). A following product may be received within this time without motor interruption.

In Enhanced ZPA mode the Motor after run time is extended to the Search timeout as long as the zone was not declared empty before.

Power On Delay
Power On Delay = 2...5 seconds (randomized)
Delay after power on before the zones enter normal operation.
(see Pg. 3.16)

Release Delay
Release Delay = 0.1 seconds
In Enhanced ZPA mode forwarding of the release signal **(X$_D$ IN)** to the upstream zone **(X$_U$ OUT)** is delayed, if all of the following conditions are met:
  • A product was stopped in at the zone sensor while no release signal **(X$_D$ IN)** was received
  • A product is available in the upstream zone **(X$_U$ IN)** and it did not start to enter the zone yet

This is to omit current peaks by simultaneously starting all motors along a chain of accumulated products.

Long Zone Timeout
Long Zone Timeout = 10 seconds
Maximum time a Long Zone keeps running the motor while no incoming product is detected. After the Long Zone timeout the zone enters idle state and stops its motor, but still setting the release signal **(X$_U$ OUT)**.

The Long Zone timeout is reset every time the upstream zone's sensor **(X$_U$ IN)** is changed.

Power On Behavior

In Standard ZPA, Enhanced ZPA and Long Zone mode the zones wait for the Power on delay before starting normal operation. The only exception is the zone sensor state **(XD OUT)**, which is propagated one second after power on.

After the power on delay the zones start searching for products until their zone sensor **(IN)** is blocked or the Search timeout has passed. With the Power on delay this search is delayed randomly to omit current peaks by simultaneously activating the motors of all zones, whose zone sensor is not blocked.

During power up the LEDs indicate the rotary switch positions and firmware version (binary coding, least significant bit right):

Step	Displayed value
0	Firmware Version
1	S1 (Speed)
2	S2 (Acceleration / Direction)
3	S3 (Operation Mode)

The step number is indicated by LEDs **X1IN** and **X1OUT**, the value by the eight remaining LEDs to the right. Each step is displayed for one second, so the actual meaning of the LEDs is shown after 4 seconds.

Manual Removal of a Product

When the zone sensor **(IN)** gets unblocked while the motor is inactive a manual packet removal is assumed.

To ensure a correct zone state the zone is searched for a product, which might still be within the zone (e.g. it was just pushed out of the zone sensor in upstream direction). *(see Pg. 3.14 "Search Timeout" for more information)*

Manual Insertion of a Product

A manual insertion of a product into a zone is always supported, provided that the product is placed in front of the zone sensor.

Manual Stop / Release

Between two Motor Control Modules a manual stop / release can be realized.
A simple two-pole switch is inserted into the zone interconnection line, interrupting both the **X IN** and **X OUT** signals.

Manual Stop

As soon as the switch is opened the release signal at the upstream zone **(X_D IN)** is forced low. Therefore the products are stopped at the upstream zone sensor.

Furthermore the zone sensor signal at the downstream zone **(X_U IN)** is also forced low, preventing the zone to activate its motor for receiving the product.
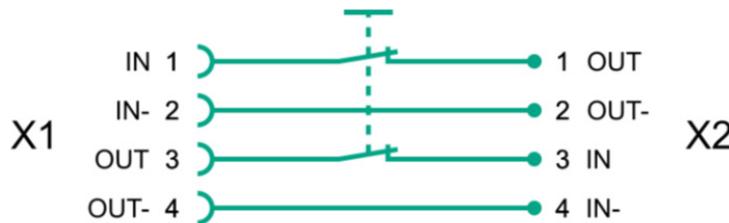
Manual Release

By closing the switch the upstream zone receives the release signal **(X_D IN)** from the downstream zone and activates the motor. At the same time the downstream zone is notified about the incoming product **(X_U IN)** from the upstream zone and therefore also activates its motor to receive it.
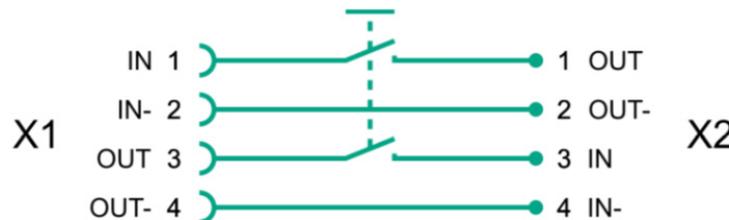
SUPPORT

Support

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