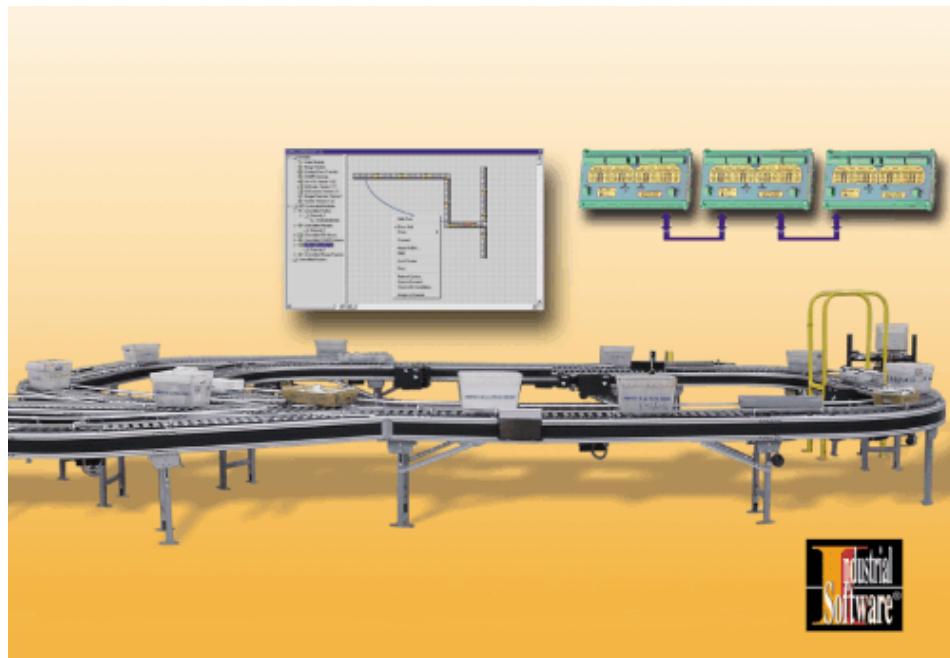




# CANopen ROLLER SPEED CONTROL (CRSC) module User's Manual

Version 1.0



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# CHAPTER 1

## DEFINITIONS, SAFETY AND OPERATING INSTRUCTIONS

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- 1.1. EXPLANATION OF SYMBOLS
- 1.2. DEFINITIONS AND ABBREVIATIONS
- 1.3. NUMERICAL DATA
- 1.4. SAFETY AND OPERATING INSTRUCTIONS



## 1.1. EXPLANATION OF SYMBOLS



This symbol indicates important directions for the **proper use** of the CANopen Roller Speed Control (CRSC) module.



This symbol provides **important notes** and/or other useful information.



This symbol indicates that special attention should be paid in order to ensure correct use as well as to avoid **dangers**.

## 1.2. DEFINITIONS AND ABBREVIATIONS

<b>CAL</b>	- CAN Application Layer
<b>CAN</b>	- Controller Area Network. A standardized serial bus system.
<b>CiA</b>	- CAN in Automation international users and manufacturers group
<b>CMS</b>	- CAN Message Specification. CAL service element.
<b>COB</b>	- Communication Object. An unit of transportation in a CAN Network. Data must be sent across a CAN Network inside a COB.
<b>COB-ID</b>	- COB Identifier. Identifies a COB uniquely in a Network by a number called the COB identifier.
<b>CRSC</b>	- CANopen Roller Speed Control (CRSC) module
<b>DCF</b>	- Device Configuration File
<b>EDS</b>	- Electronic Data Sheet
<b>EMC</b>	- Electromagnetic Compatibility
<b>ESD</b>	- Electrostatic Discharge
<b>Err</b>	- Error
<b>HEX</b>	- Hexadecimal {number(s)}
<b>ID</b>	- Identification/Identification Number
<b>LED</b>	- Light Emitting Diode
<b>NID</b>	- Node Identification Number
<b>NMT</b>	- Network Management. One of the service elements of CANopen Application Layer in the Can Reference Model. It performs initialization, configuration and error handling in a CANopen network.
<b>OD</b>	- Object Dictionary
<b>OSI</b>	- Open System Interconnection
<b>PDO</b>	- Process Data Object
<b>RO</b>	- Read Only

<b>RPDO</b>	- Receive Process Data Object
<b>RW</b>	- Read/Write
<b>SDO</b>	- Service Data Object
<b>TPDO</b>	- Transmit Process Data Object
<b>BLDC</b>	- BrushLess DC (motor)

### 1.3. NUMERICAL DATA

Decimal values are represented as figures without additional features (e.g. 1458).

Binary values are marked **b** at the end of the figures (e.g. 1011b).

Hexadecimal values are represented in two manners:

- The figures are preceded by **0x** (e.g. 0x5FA3).
- Using a mark **h** at the end of the figures (e.g. 5FA3h).

### 1.4. SAFETY AND OPERATING INSTRUCTIONS

The CANopen Roller Speed Control (CRSC) modules are quality products, which have been manufactured according to recognized electrical engineering regulations. The modules have left the manufacturing company's premises meeting all relevant safety requirements. In order to preserve this condition and to ensure an interference-free operation of the modules, the technical specifications outlined in this documentation must be observed.



Field of application: material- handling systems.



Skilled electricians may only install the modules.



The modules may only be operated within the limits defined in the technical data.



The maximum operating voltages must not be exceeded.



For better protection, use an external fuse.



The neighboring parts as well as the installation of the cable system may produce a significant influence on the EMC of the modules. Therefore the electrician has to ensure the EMC of the entire system.



In regions endangered by electrostatic discharges, a good ESD protection for the plugs and the cables to be connected should be provided.



Before starting up, the continuous CAN-Bus must be terminated on both ends with a 120  $\Omega$  bus terminating resistor between CAN+ and CAN-.



For bus, respectively connecting cables (CAN+ with CAN-, +V with 0 V), only use signal cables with twisted wire pairs with screen.





# CHAPTER 2

## GENERAL INFORMATION

---

- 2.1. POWERED ROLLER CONVEYOR CONFIGURATION**
- 2.2. CONVEYOR ZONE**
- 2.3. UPSTREAM/DOWNSTREAM CONVEYOR ZONES**
- 2.4. CONVEYOR AREAS**
  - 2.4.1. Standard (Linear) Area**
  - 2.4.2. Merge Area**
  - 2.4.3. Pusher Transfer Area**
  - 2.4.4. Divert Area**
- 2.5. CONVEYOR MODES OF OPERATION**
  - 2.5.1. Regular Mode of Operation**
  - 2.5.2. Accumulation**
  - 2.5.3. Jog**
  - 2.5.4. Train**
  - 2.5.5. Singulation**
  - 2.5.6. Purge**
- 2.6. "CONTROL MODULE - TO - CONVEYOR" INTERFACE**

- 2.6.1. Brushless Powered Roller Interface**
- 2.6.2. Photosensor Interface**
- 2.7. CRSC ZONES**
- 2.8. LOCAL/REMOTE ZONES**
  - 2.8.1. Local Zones**
  - 2.8.2. Remote Zones**
- 2.9. ZONE-TO-ZONE INFORMATION FLOW**
  - 2.9.1. Information Flow Between Two Adjacent Zones**
  - 2.9.2. Information Flow Among CRSC Zones**
  - 2.9.3. Information Flow Between Two Adjacent Remote Zones**
- 2.10. GLOSSARY**

This document describes the principle of operation of the CANopen Roller Speed Control module (CRSC) as well as the principle of its communication with the other devices of the system.

The serial bus system CAN is multimaster compatible- this means that several CAN stations are able to request the bus at the same time. The messages with the highest priority will be transmitted immediately.

The data transfer is managed by the message's priority.

The priority of the messages is determined by **message identifiers**, e.g. there are no transport addresses, but message identifiers within the CAN system. All stations at the same time can receive the message, which is being sent. A station accepts the relevant messages only, by utilization of special filtering methods. The message identifier transmitted with the message is the basis for the decision as to whether the message will be accepted or not.

The bus coupler meets the ISO 11898 requirements and allows data transmission at a maximum rate of 1 Mbit/s.

CRSC are designated for flexible motorized roller conveyor automation.

The Reference Model, the Device Model, the Communication Model, the Physical Layer, the Data Link Layer and the Application Layer correspond to CiA Draft Standard 301 Version 4.0 - Application Layer and Communication Profile for CANopen devices.

## 2.1. POWERED ROLLER CONVEYOR CONFIGURATION

A general view of a powered roller conveyor is shown in Fig. 2.1.

If a package (also referred to as **tray** or **packet**) is placed on the conveyor, it will be transported (transferred) along the conveyor due to the rotation of the conveyor rollers.

The conveyor provides one **Main Direction** of package transportation- this is the case when the conveyor is on **RUN (GO)** mode of operation. The opposite direction is referred to as **INVERSE** (or also referred to as **REVERSE**).

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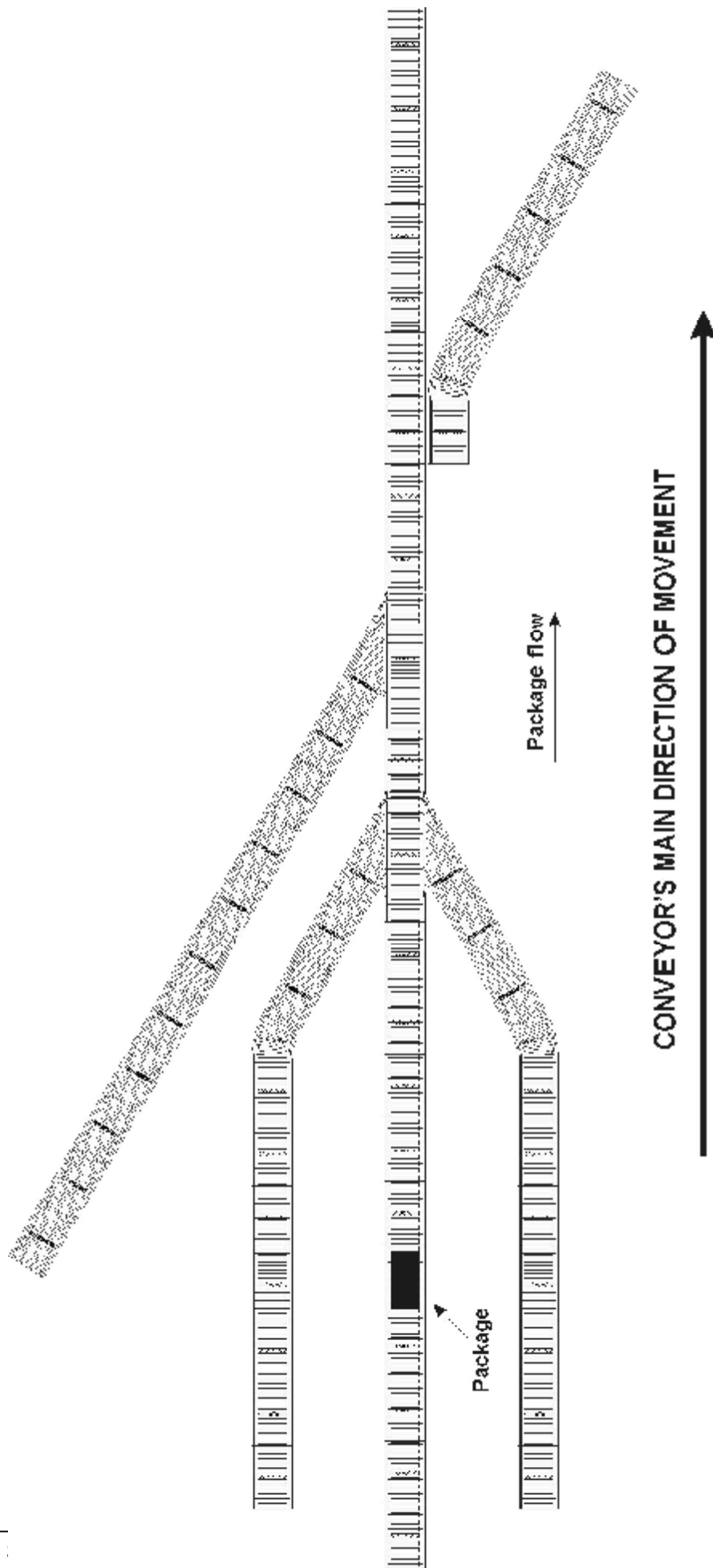


Fig. 2.1

## 2.2. CONVEYOR ZONE

Basic cells referred to as zones - Fig. 2.2 assembles the conveyor. A zone consists of a set of **slave rollers** driven (by means of belts or chains) by one **Powered Roller**.

The zones are well recognized in Fig. 2.1.

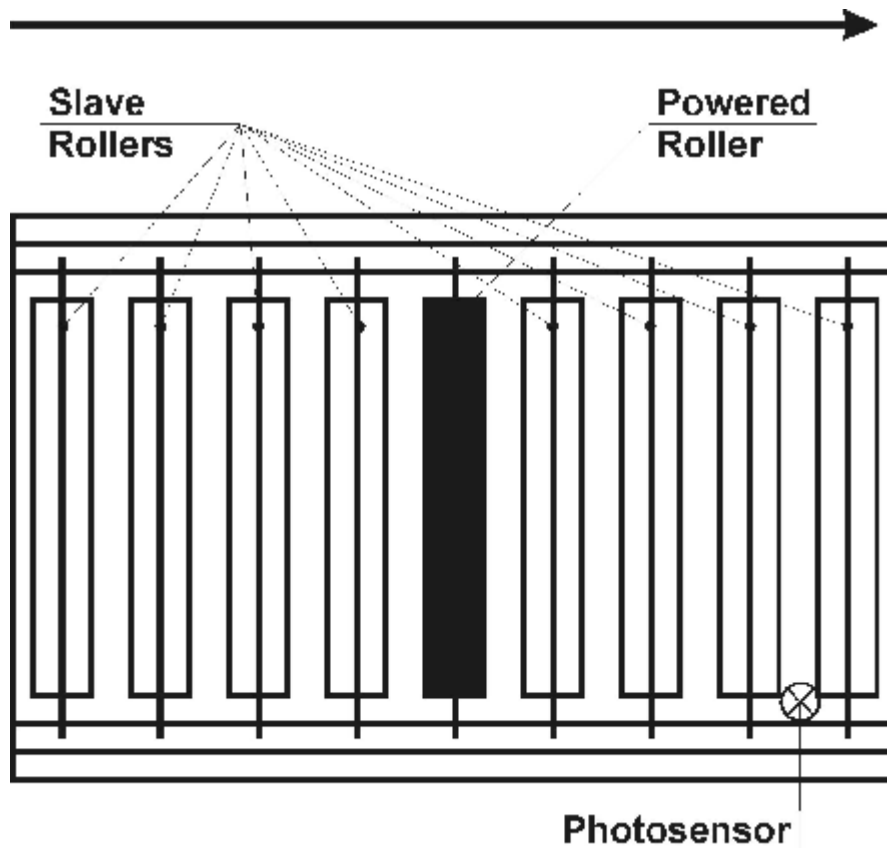


Fig. 2.2

As shown in Fig. 2.2 a zone consists of:

- One motorized (master) roller, referred to as **Powered Roller**. A DC brushless motor, usually incorporated with the roller itself (for example ITOH Powered rollers) drives the powered roller.

Brushless Motors are driven directly from internal CRSC electronic.

- A set of **slave rollers** driven by the powered roller.
- One **photosensor** used to sense the presence of the package on the zone. Both Dark-operated and Light-operated photosensors may be used.

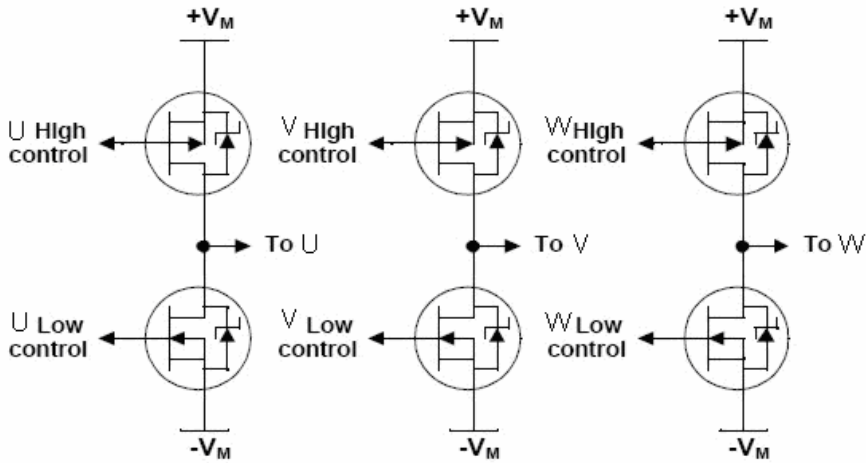
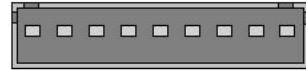
From electronic point of view the conveyor zone may be regarded as a black box with two I/O sections: Powered Roller Interface Section and Photosensor Section-Fig.2.3.

The **ERROR** signal is generated when the DC motor is overloaded.

The **ALARM** signal is generated when the photosensor gain factor is improper.

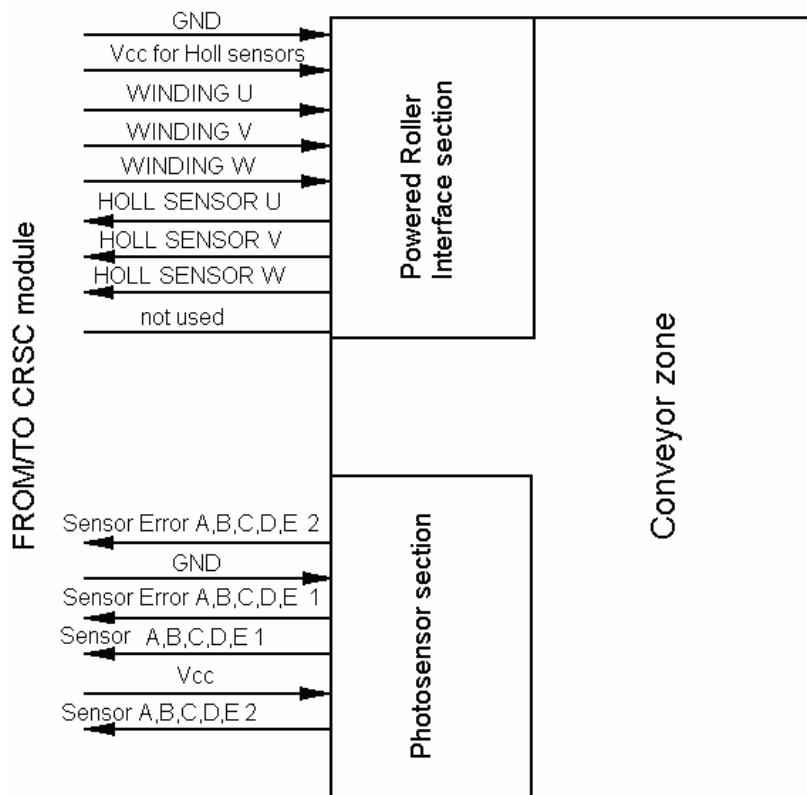
The designations of the other terminals are self-explanatory.

1 2 3 4 5 6 7 8 9



a) Power interface section

GST 9 pin motor connector	
Pin assignment	
1	GND
2	Vcc
3	WINDING U
4	WINDING V
5	WINDING W
6	HALL SENSOR U
7	HALL SENSOR V
8	HALL SENSOR W
9	Not used



1. Sensor Error A,B,C,D,E 2
2. GND
3. Sensor Error A,B,C,D,E 1
4. Sensor A,B,C,D,E 1
5. Vcc
6. Sensor A,B,C,D,E 2



b) Photosensor section

Fig.2.3

## 2.3. UPSTREAM/DOWNSTREAM CONVEYOR ZONES

The above terms depend upon the direction of the conveyor (packages) movement.

For the left-to-right direction of the conveyor movement (Fig. 2.4):

- Zone **N+1** is the downstream zone in relation to zone **N**
- Zone **N-1** is the upstream zone in relation to zone **N**
- Zone **N** is the upstream zone in relation to zone **N+1**
- Zone **N** is the downstream zone in relation to zone **N-1**

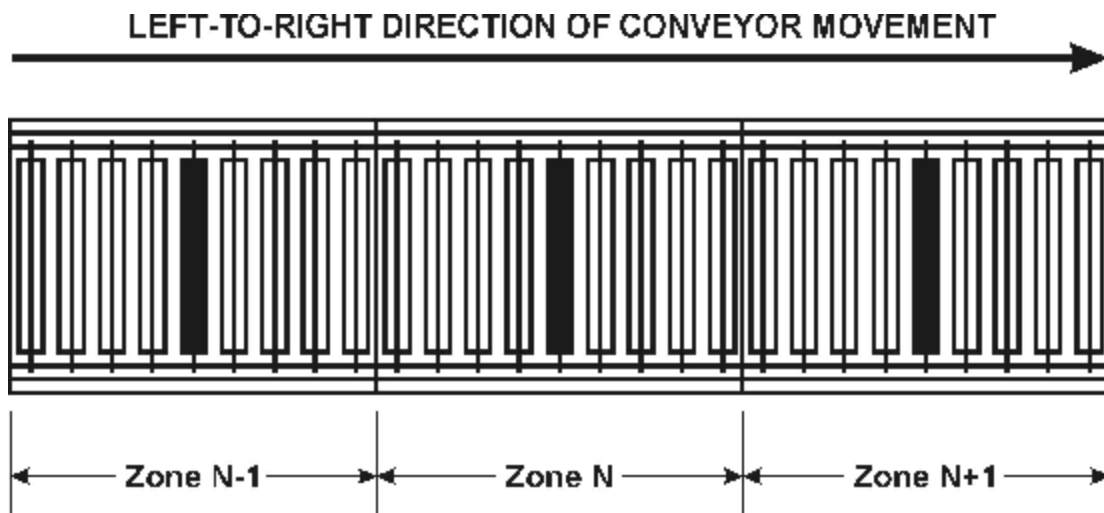


Fig.2.4

For the right-to-left direction of the conveyor movement (Fig. 2.5):

- Zone **N+1** is the upstream zone in relation to zone **N**
- Zone **N-1** is the downstream zone in relation to zone **N**
- Zone **N** is the downstream zone in relation to zone **N+1**
- Zone **N** is the upstream zone in relation to zone **N-1**

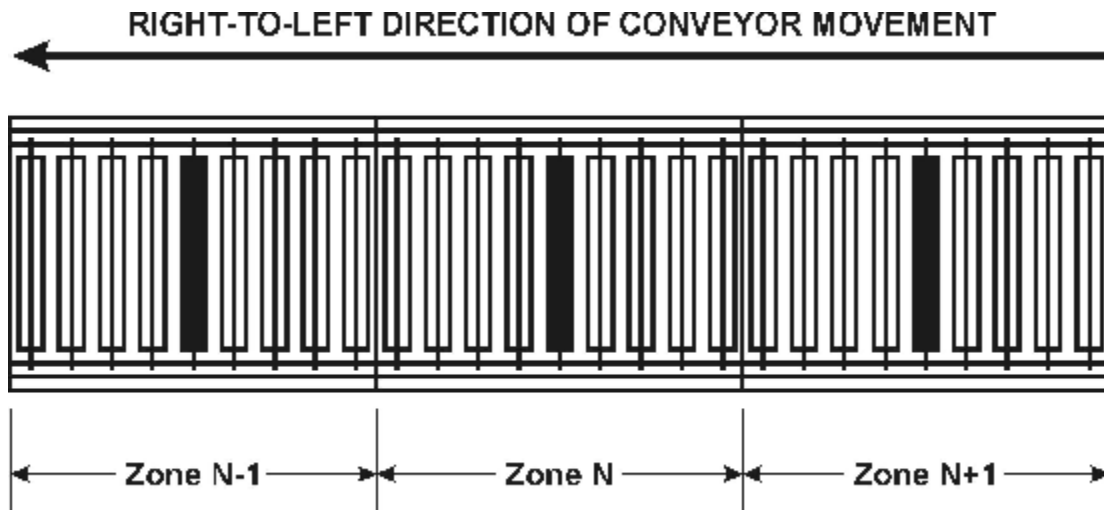


Fig. 2.5

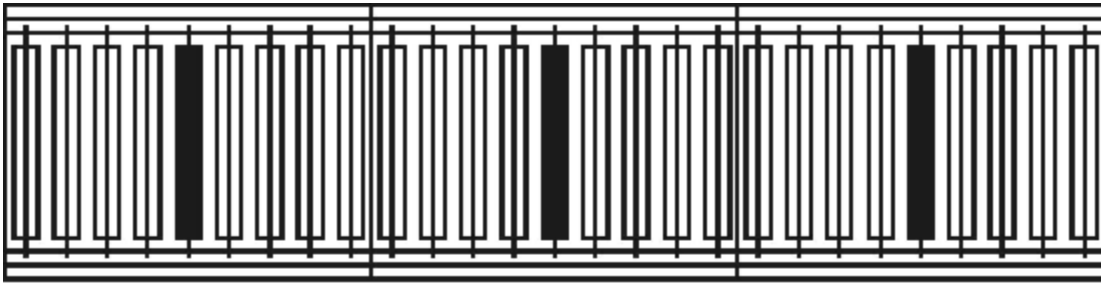
## 2.4. CONVEYOR AREAS

Several typical areas may be identified on a conveyor - refer to Fig. 2.1.

### 2.4.1. Standard (Linear) Area

The **standard** or **linear** conveyor **area** consists of a set of linear or curved zones as shown in Fig. 2.6. The packages are transferred along the conveyor in an ordinary way.

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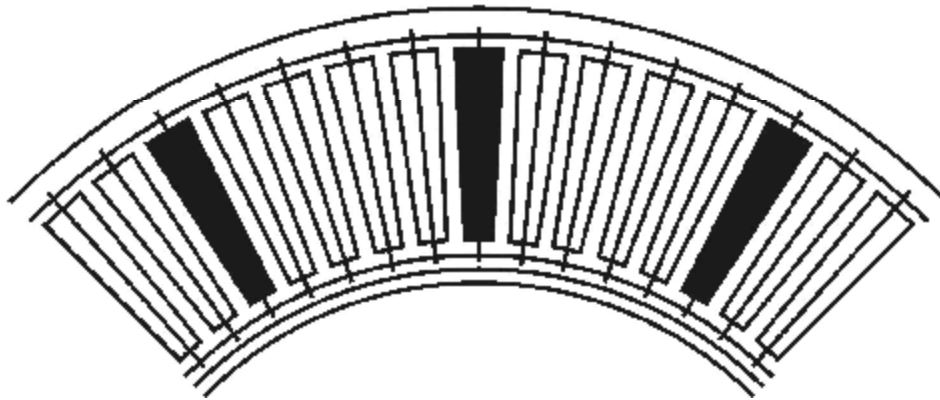


Fig. 2.6

### 2.4.2. Merge Area

This is the area, where the packages from two or three conveyor lanes are merged onto one conveyor lane - Fig. 2.7.

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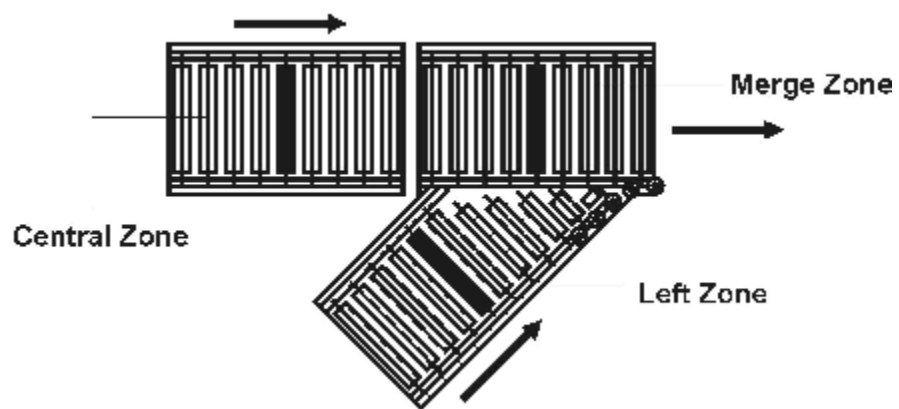
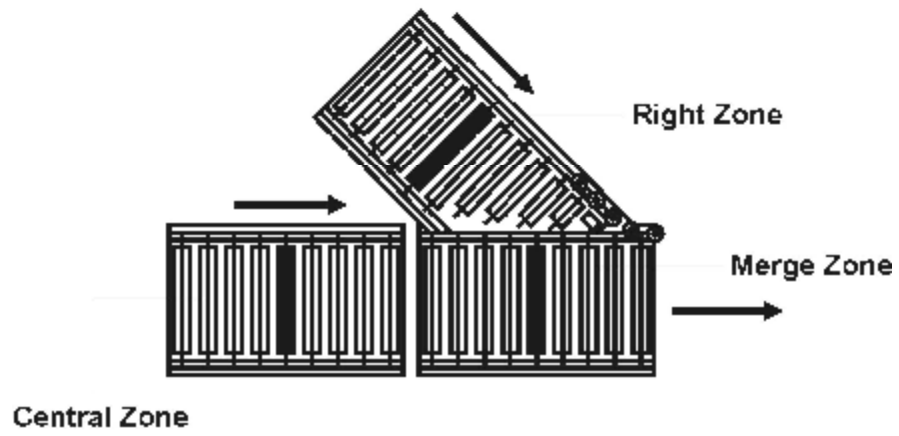
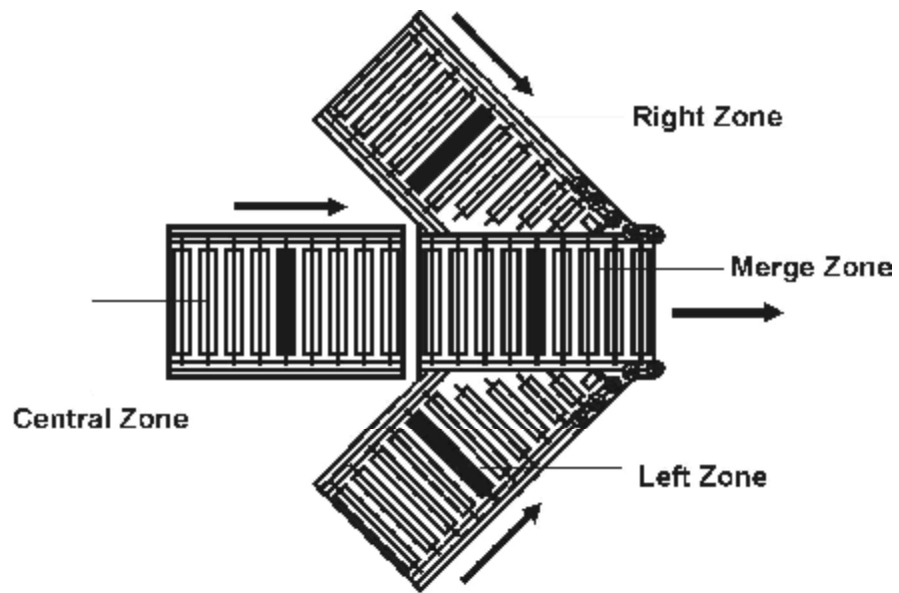


Fig. 2.7

The denomination of the Merge area zones is as shown in Fig. 2.7.

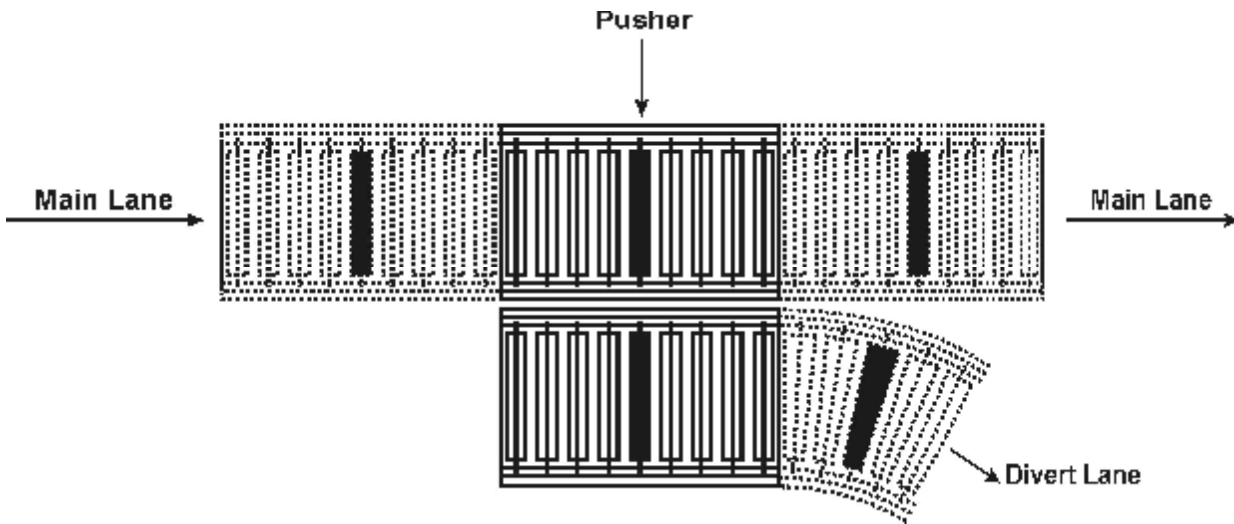


The right and left zones are physically equal. Therefore their denominations **must not** be necessarily associated with the left/right denominations of the Control Module.

The Merge zone and the Central zone **must be** strictly connected with the respective zones of the Control Module.

### 2.4.3. Pusher Transfer Area

This is the conveyor area where a **pusher** transfers the packages from the main lane on the divert lane - Fig. 2.8.



2.8

Fig.

### 2.4.4. Divert Area

This is the conveyor area where the package is transferred to the left divert lane or to the right divert lane - Fig. 2.9.

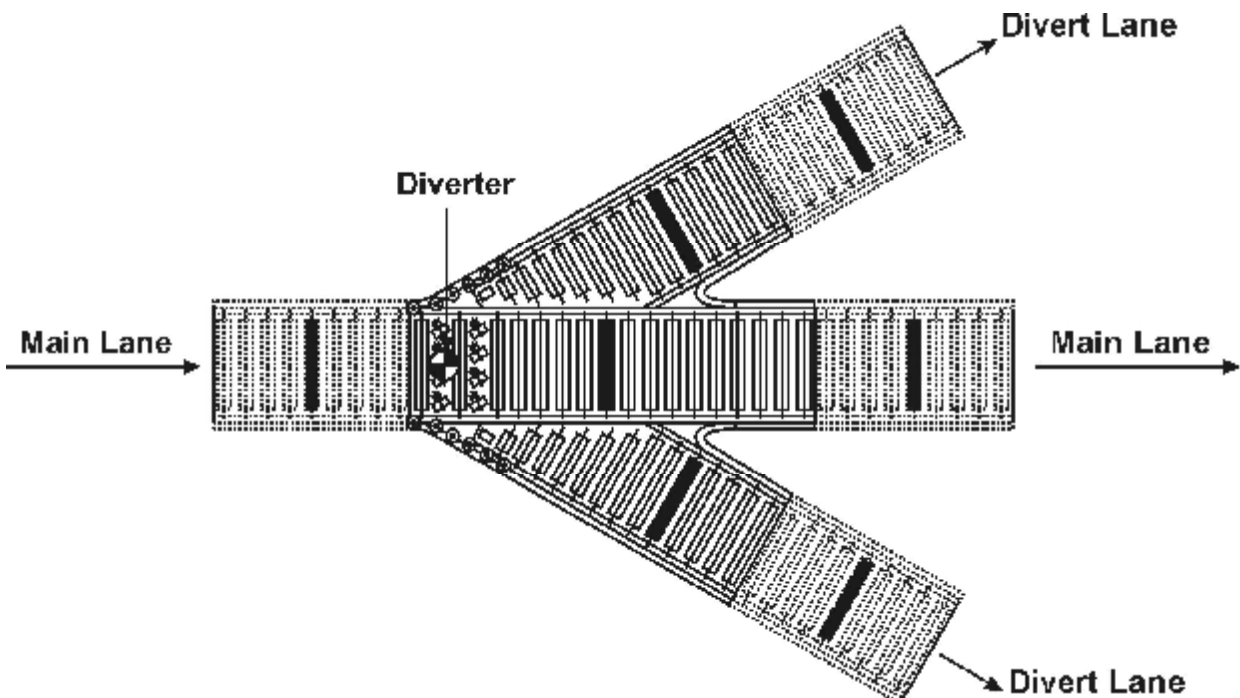


Fig. 2.9

### 2.4.5. RAT area

RAT is a right angle transfer device. This is the conveyor area can work like a diverter, and like a merger. Some of the lines can be stopped (for example if it works like a diverter and the left line is stopped, then the package will be transferred to the main line or to right divert line). See fig.2.10

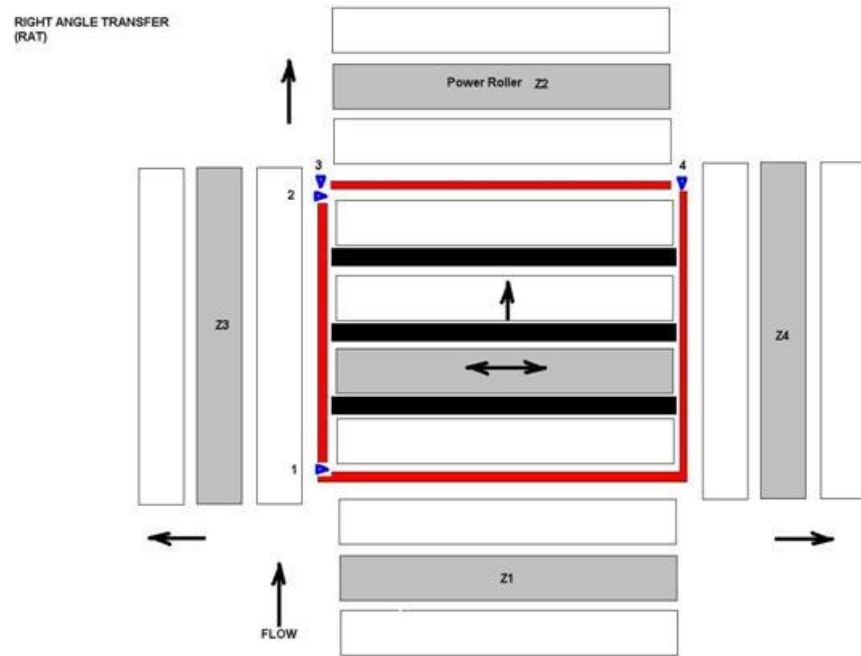


Fig. 2.10

## 2.5. CONVEYOR MODES OF OPERATION

Several typical conveyor modes of operation must be explained in order to facilitate the appreciation of the description to follow henceforth.

### 2.5.1. Regular Mode of Operation

The conveyor is transferring the packages in a ordinary way during this mode of operation.

### 2.5.2. Accumulation

This mode of operation is pertinent to the zone condition when the conveyor zone contains package(s) and is holding (i.e. **Full and stopped**) the package until the downstream zone is available to receive the package.

The accumulation may be caused by the operator (for maintenance or repair), by a downstream zone fault condition signal, by a merge operation signal etc.

This function overrides photosensor input.

### 2.5.3. Jog

One or several specified zones are forced to jog unconditionally during this mode of operation.

This function overrides all accumulation functions.

### 2.5.4. Train

This mode of operation defines the case when the zone transfers the packages as they come from the upstream zone without gaps between the adjacent packages.

### 2.5.5. Singulation

This mode of operation is relevant to the case when the zone establishes **one zone gap** between the adjacent packages, accumulating until the downstream zone is cleared. In other words the one zone gap is effected for the outgoing (from the zone) packages, while the function accumulation is valid for the incoming (into this zone) packages.

### 2.5.6. Purge

All zones of the conveyor are forced to operate in order to clear the conveyor completely.

## 2.6. "CONTROL MODULE - TO - CONVEYOR" INTERFACE

The **conveyor zone** (as described in subsection 2.2) is the basic conveyor cell to be controlled by the Control Module.

Therefore, the respective section of the Control Module is referred to as (control) **zone** also.

One Control Module can control **up to four** conveyor zones, i.e. the Control Module incorporates four similar (control) zones: Zone **D**, Zone **C**, Zone **B** and Zone **A**. CRSC also have additional double

sensor interface ( sensor Zone **E**). Zones **A, B, C** and **D** also have additional sensor input interface, so for special devices you can connect upto 10 sensors.

The interconnections between a Control Module zone and a conveyor zone are shown in Fig. 2.10.

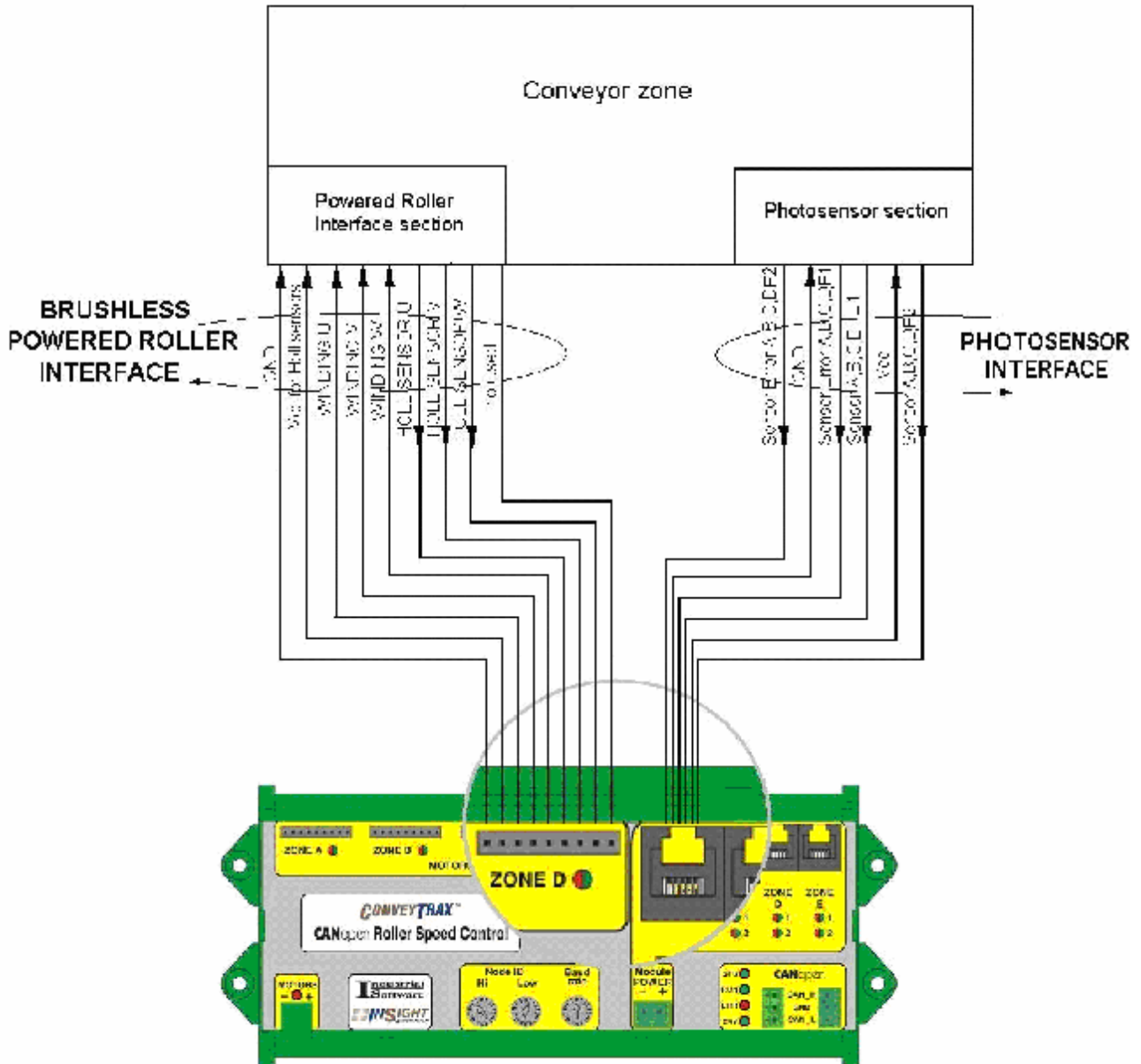


Fig. 2.10

### 2.6.1. Brushless Powered Roller Interface

Four terminals are available for communication between the Control Module zone and the Powered Roller interface section of the conveyor zone, namely:

- **GND** – ground.
- **Vcc for Holl sensors** – 24 V DC power supply for the Hall sensors provided by the Control Module on these terminals.
- **Winding U, V, W** – winding U, V and W of the BLDC motor.

- **Holl sensor U, V, W** – the Hall sensors in winding U, V and W of the BLDC motor.



For More Information, see Chapter 6 – “Motor Control Details”

### 2.6.2. Photosensor Interface

Four terminals are available for communication between the Control Module zone and the Photosensor section of the conveyor zone, namely:

- **GND – ground**
- **Sensor A, B, C, D, E 1, 2** - A signal for availability of package on the zone is transmitted to the Control Module via this terminals ( two sensors per connector)
- **Vcc** - - 24 V DC power supply for the photosensor is provided by the Control Module on these terminals.



The type of the photosensor must be taken into account: **dark operated** or **light operated** photosensor when configuring the respective CRSC!

- **Sensor Error A, B, C, D, E 1, 2** - In case the intensity of the photosensor beam is not satisfactory (i.e. the photosensor gain factor is improper) an alarm signal is transmitted to the Control Module.

A 6-pin connector is used for the above connections. Fig.2.11.

1. Sensor Error A,B,C,D, E 2
2. GND
3. Sensor Error A,B,C,D, E 1
4. Sensor A,B,C,D, E 1
5. Vcc
6. Sensor A,B,C,D, E 2



Photosensor section



Fig. 2.11

## 2.7. CRSC ZONES

Each CANopen Roller Speed Control module (CRSC) incorporates up to four (programmable) zones (Fig. 2.11), hence **one CRSC may control up to four linear conveyor zones**.

The connection of several CRSCs to a conveyor is illustrated in Fig.2.12.

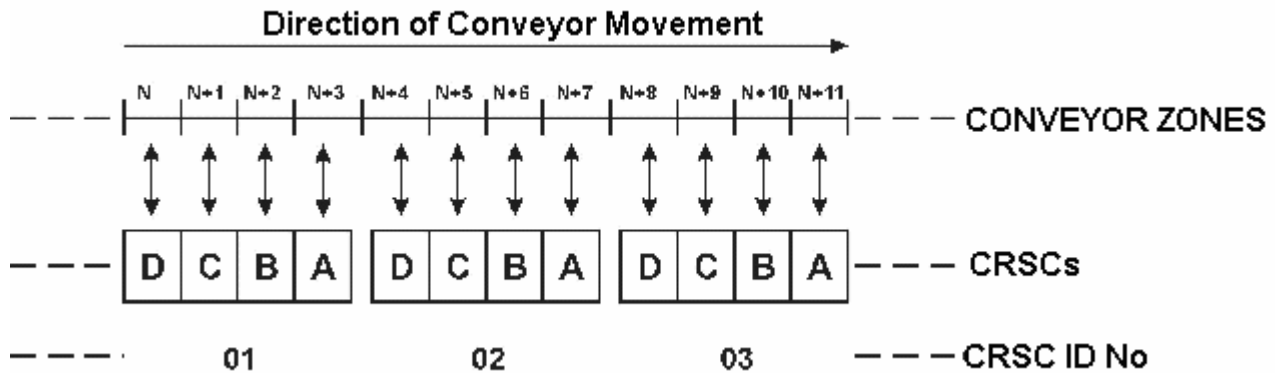



Fig. 2.12

 Based on the above, CRSC zones will be considered henceforth taking into account that these CRSC zones reflect (are related to) the corresponding conveyor zones.

## 2.8. LOCAL/REMOTE ZONES

The above terms reflect the fact that the zones belong to one CRSC or belong to different CRSCs.

### 2.8.1 Local Zones

These are the zones that belong to one CRSC - Fig.2.13.

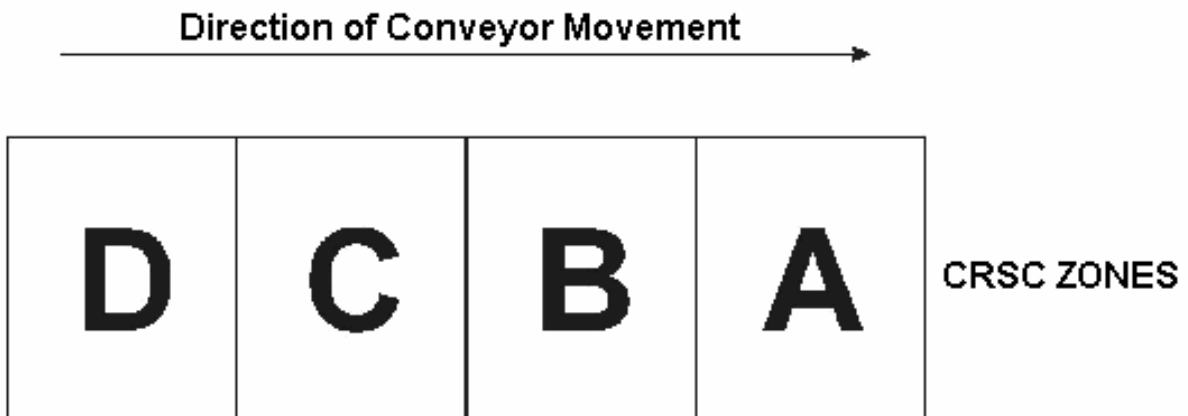


Fig. 2.13

The above zones are referred to as **local zones**.

Furthermore:

Zone **D** is the upstream zone in relation to zone **C**

Zone **C** is the upstream zone in relation to zone **B**

Zone **B** is the upstream zone in relation to zone **A**

and vice versa

Zone **A** is the downstream zone in relation to zone **B**

Zone **B** is the downstream zone in relation to zone **C**

Zone **C** is the downstream zone in relation to zone **D**

Sensor Interface to zone E has additional functions and they are not referred here.

### 2.8.2. Remote Zones

These are the zones that belong to different CRSCs - Fig. 2.14.

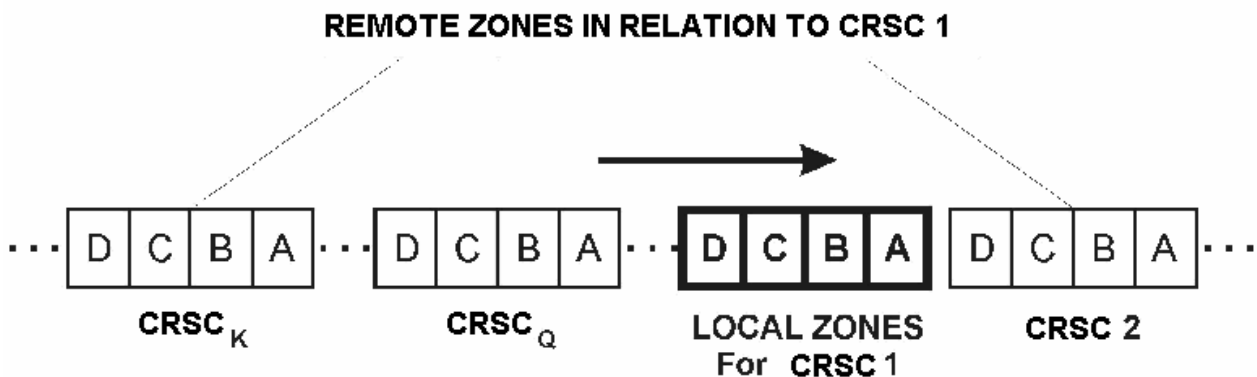


Fig. 2.14

## 2.9. ZONE-TO-ZONE INFORMATION FLOW

Two adjacent zones have to exchange information during the regular conveyor operation.

The downstream zone should inform the upstream zone about its state of operation, for example:

- Its powered roller is running, or
- Its powered roller is stopped, or
- Its powered roller is on inverse mode of operation, or
- Its powered roller is overloaded, or
- There is a package on the zone, or
- The photosensor gain is improper etc.

The upstream zone should inform the downstream zone about similar events.

### 2.9.1. Information Flow Between Two Adjacent Zones

The information flow between two adjacent zones is illustrated in Fig. 2.15.

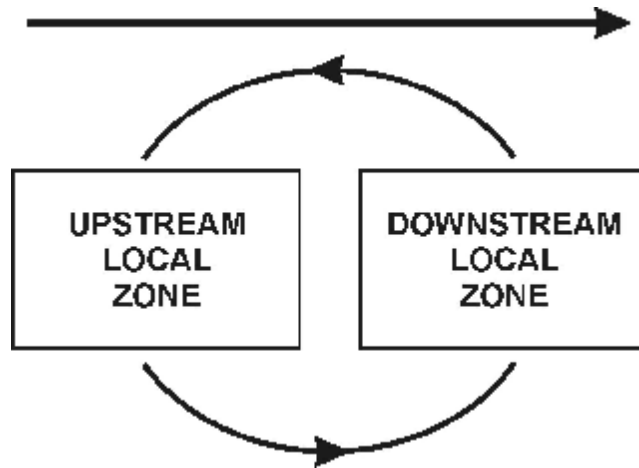


Fig. 2.15

### 2.9.2. Information Flow Among CRSC Zones

The information flow among the four CRSC zones is shown in Fig. 2.16.

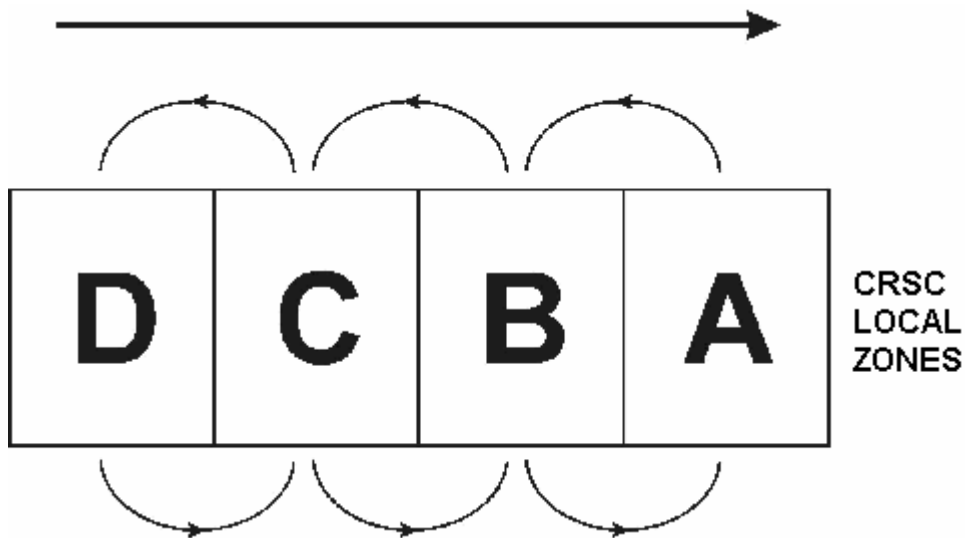



Fig. 2.16

 All operations between these zones are organized locally, i.e. inside the CRSC.

### 2.9.3. Information Flow Between Two Adjacent Remote Zones

The communication between two adjacent remote zones is illustrated in Fig. 2.17. In fact this is the communication between two CRSCs.

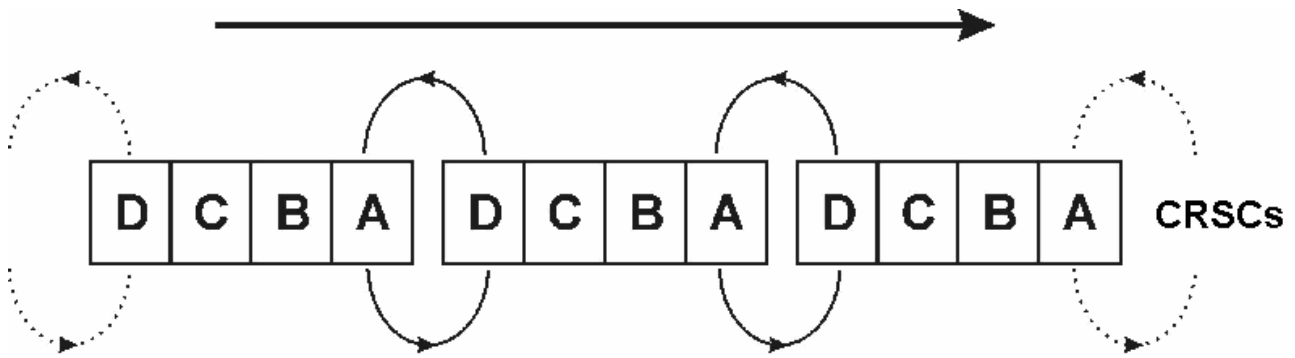



Fig. 2.17

 All operations between these adjacent remote zones are organized in the frame of the CANopen Network.

## 2.10. GLOSSARY

**Accumulation** - A mode of operation when the zone contains package(s) and is holding.

**Cross Transfer Area** - The area where a pusher transfers the packages from one to another lane.

### Direction

**Main** - The normal operation direction of the conveyor.

**Inverse** - The opposite of the main direction.

**Downstream Zone** - The next zone in the main direction of the conveyor movement.

**Jog** - Mode of operation when one or several specified zones are forced to jog unconditionally.

**Linear Area** - Also referred to as STANDARD AREA. A set of linear and/or curved conveyor zones.

**Local Zones** - The zones belonging to the same CRSC

**Merge Area** - The conveyor area where the packages from two or three lanes are merged into one (merge) lane.

**Package** - A separate (usually wrapped or boxed) object to be transported by the conveyor.

The term **tray** or the term **tote** is also used instead of the term package.

**Photosensor** - A device, mounted on the end of the conveyor zone to sense the presence of a package on the zone.

**Powered Roller** - also referred to as DRIVE ROLLER or MOTORIZED ROLLER or MASTER ROLLER. This is a roller driven by a motor. The powered roller drives the slave rollers of the zone by means of belts or chains.

**Purge** - Mode of operation when **all zones** are forced to move in order to clear the conveyor completely.

**Remote Zones** - The zones belonging to different CRSCs.

**Roller Interface** - The interface card of the brushless DC motor driving the Powered Roller.

**Singulation** - Mode of operation when the zone establishes **one zone gap** between the adjacent packages and accumulating until the downstream zone is cleared.

**Slave Rollers** - A set of rollers in a conveyor zone driven by the Powered Roller.

**Standard Area** - Also referred to as LINEAR AREA. A set of linear and/or curved conveyor zones.

**Tote** - A term, sometimes used instead of the term **package**.

**Train** - Mode of operation when the zone transfers the packages as they arrive, without gap between the adjacent packages.

**Tray**-A term frequently used instead of the term **package**.

**Upstream Zone** - The preceding zone

**Zone** - A basic (linear or curved) cell of the conveyor consisting of a set of slave rollers, driven by one Powered Roller.

The similar basic cell of the CRSC, dedicated to a conveyor zone.



# CHAPTER 3

## CANopen POWERED ROLLER/MERGER CONTROL MODULE (CRSC)

---

- 3.1. GENERAL DESCRIPTION**
- 3.1.1. CANopen Interface**
- 3.1.2. CANopen and Application Status LED Indicators**
- 3.1.3. Purge Input**
- 3.1.4. Power Supply**
- 3.1.5. Power LED Indicator**
- 3.1.6. Installation Push Button**
- 3.1.7. Photosensor and Powered Roller Interfaces**
  - 3.1.7.1. Photosensor Interface
  - 3.1.7.2. Powered Roller Interface
- 3.1.8. Zone Status LED Indicators**
  - 3.1.8.1. Sensor Zone Status LED Indicators

- 3.1.8.2. Motor Zone Status LED Indicators
- 3.1.9. **Node ID HEX Switches**
- 3.1.10. **Baud rate or Configuration HEX Switch**
- 3.2. **CRSC SIZE AND MECHANICAL INSTALLATION**
- 3.3. **CRSC TERMINALS**
  - 3.3.1. **Photosensor/Powered Roller Connectors**
  - 3.3.2. **CRSC Power Connector**
  - 3.3.3. **Purge Connector**
  - 3.3.4. **CANopen Connector**
- 3.4. **CRSC SPECIFICATIONS**

### 3.1 GENERAL DESCRIPTION

The CANopen Control Module is shown in Fig. 3.1.

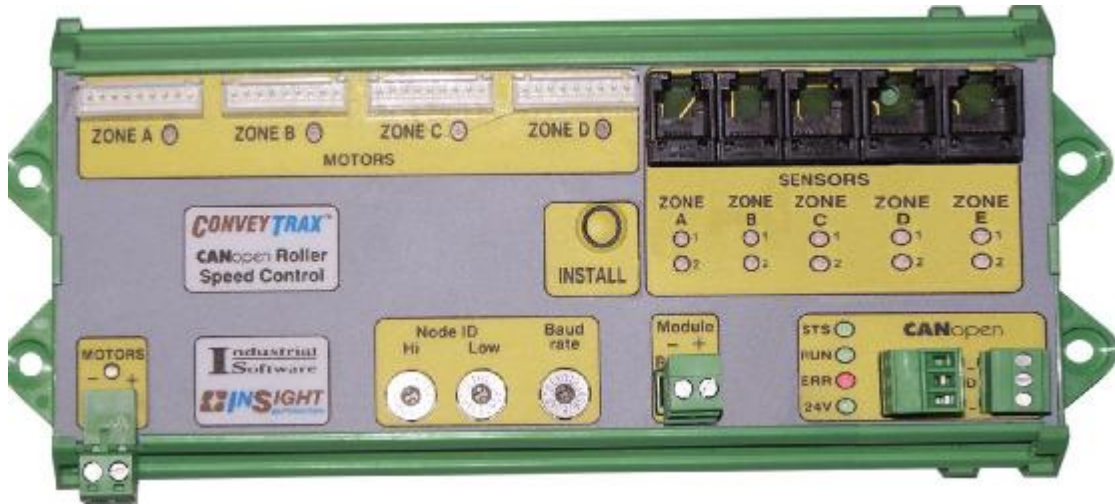


Fig. 3.1



The Control Module may be configured as a **POWERED ROLLER CONTROL MODULE** or as a **MERGER CONTROL MODULE**. Therefore the Control Module generally is referred to as **CANopen ROLLER SPEED CONTROL** module or for short **CRSC**.

Each CRSC incorporates **four similar zones**.

Each CRSC provides the following features:

- CAN interface. The following bit rates (also referred to as **baud rates**) are supported: 1000, 500, 250, 125 kbit/s.
- 3 CANopen and Application Status LED indicators
- 24V DC Purge input for clearing conveyor even without communication.
- Connector for 24V DC Motors power supply, Apr. 80 mA sinks current (not including motors sink).
- Connector for 24V DC Module (sensor) power supply, Apr. 80 mA sinks current (not including sensors sink current).
- Power LED indicator.
- Installation Push button.
- Photosensor(double – for 2 photosensors) and Powered Roller interfaces per zone (four zones altogether)
- Additional 5<sup>th</sup> double sensor interface ( “E” zone ) , used for special functions.
- 1 two-colored Motor Zone Status LED indicators per zone (four zones altogether).
- 1 two-colored Sensor Zone Status LED indicators per sensor (five zones altogether – and in each zone per to sensors).
- 2 HEX Switches for Node ID
- 1 HEX Switch for Baud rate or Configuration selection

The above features are illustrated in the respective group fields on the Front Panel shown in Fig. 3.2.

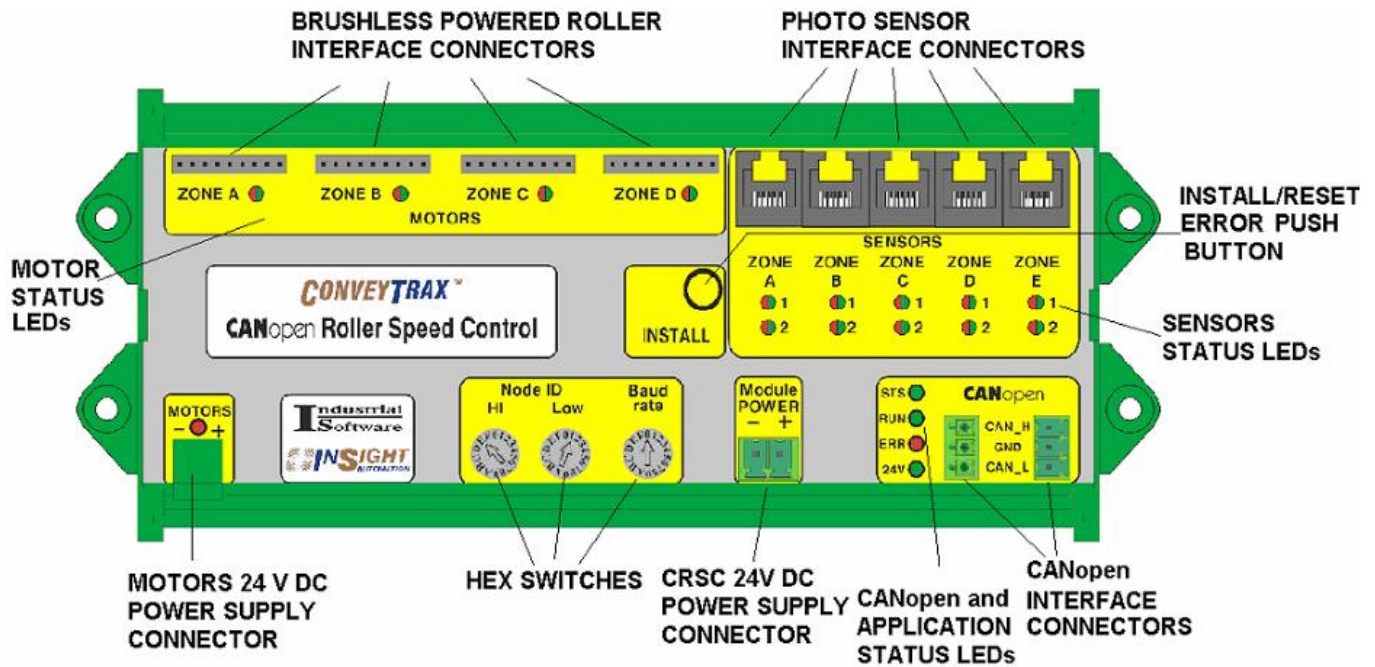


Fig. 3.2

### 3.1.1. CANopen Interface

The 3-pin connectors provides terminals for CAN interface .

For more details you may refer to Table 3.4 and subsection 4.3.

### 3.1.2. CANopen and Application Status LED Indicators

Each CRSC has following diagnostic LED's:

- **2 CANopen Status LED's**

These 2 LEDs are specific and report the CANopen state of the device (i.e. of CRSC) as described in CiA document DR-303-3 – “CANopen Indicator Specification”. These two LED's are labeled as “**RUN**” and “**ERR**”.

**RUN** LED is **Green**

**ERR** LED is **Red**

**RUN** *Blinking* –The Device is in “Pre-Operational Mode”

**RUN** *On* –The Device is in “Operational Mode”

**RUN** *Single Flash, then Off* – The Device Executes “Stopped Mode”

**ERR** *Off* – No Error

**ERR** *Single Flash* – At least one of error counters of the CAN controller has reached or exceeded the warning level

**ERR** *On* – The CAN controller is Bus Off

- **Application Status LED**

This LED is **Green** and is labeled as “**STS**”

It describes the application program status:

**STS On** – The module is “Applicationless”. The User has to download valid application program to the module.

**STS Flickering** – The module has a valid and running program

**STS Off** - The Device is without CANopen kernel and cannot function properly.



**The devices with STS - OFF LED indicators are damaged and have to be replaced!**


### 3.1.3. Purge Input

This is input for clearing the conveyor. 24V DC on this pin will run all four Rollers (i.e. the four conveyor zones) connected to CRSC.



You may connect purge signal to **E1 SENSOR INTERFACE INPUT**



 The Purge mode of operation may be not required and is not used by the customer.

In this case the module may be configured in such a way, that to use the Purge input for other functions, such as:

- Inverse direction of conveyor's movement
- Accumulation mode of operation of specific CRSC zone

etc.

### 3.1.4. Power Supply

There are two power supply voltages. The motor power supply voltage of CRSC is 24 V DC (18 to 30 V). The module (sensor) power supply voltage of CRSC is 24 V DC (18 to 30 V). The module current consumption is 80 mA. for both Motor( not including motor consumption) and Module ( not including Sensor consumption) Power Supply.

For more details you may refer to Table 3.5.

### 3.1.5. MotorPower&Module Power LED Indicators

This LEDs are **Green**.

Power LED indicators are *ON* when 24 V DC power is connected properly to CRSC.

### 3.1.6. Installation Push Button

The Installation Push Button is used during the configuration procedures of CRSC or for clearing Error or Jam indications.

### 3.1.7. Photosensor and Powered Roller Interfaces

Each CRSC provides four sets of Photosensor/Powered Roller interfaces-one set per zone.

There is additional “E” double sensor interface, used to control some specific functions and purge or E-stop functionality.

The interface for one zone is shown in Fig. 3.3.

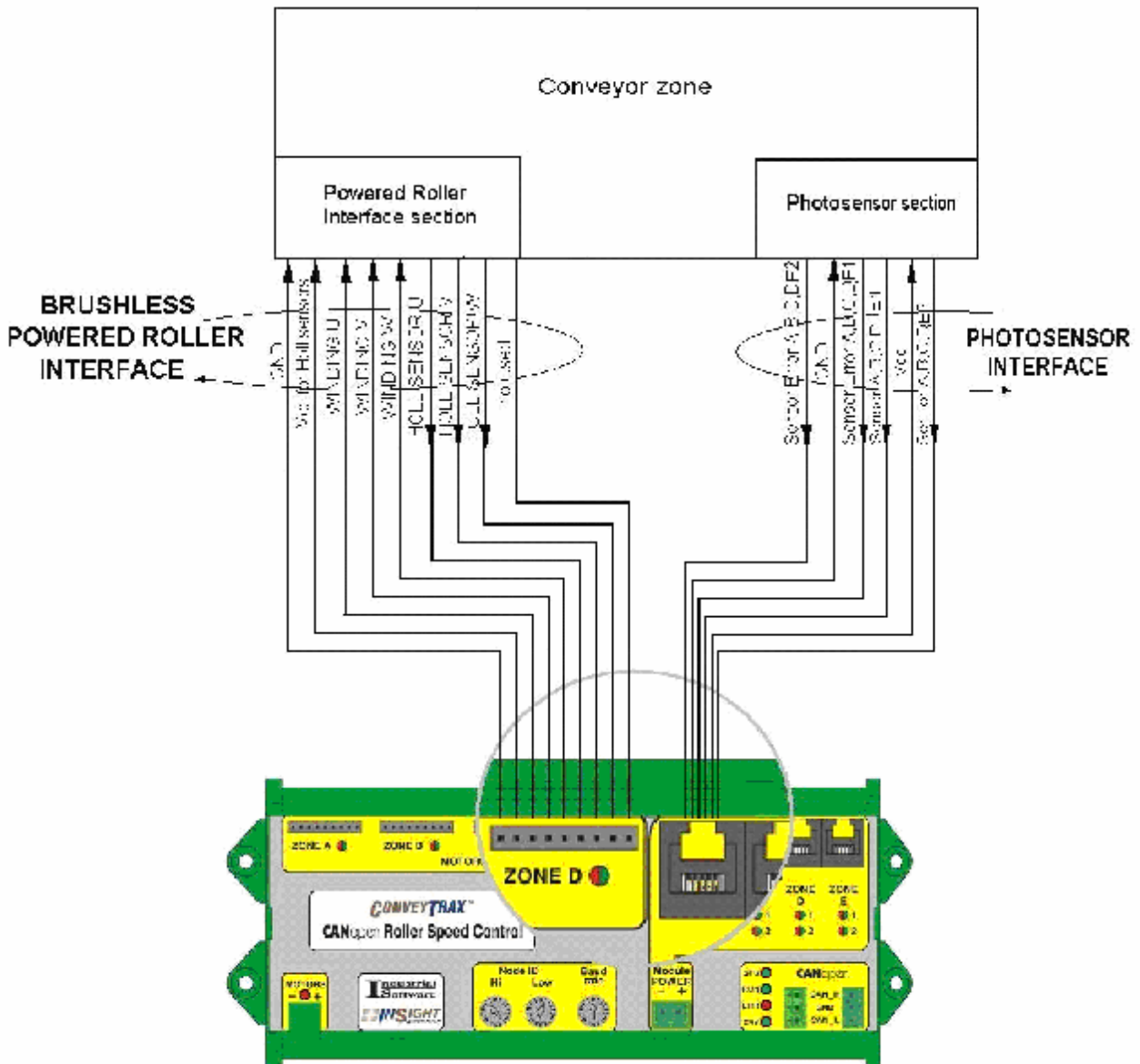





Fig. 3.3

You may refer also to subsection 2.6.

### 3.1.7.1. Photosensor Interface

-  First refer to subsection 2.6.2.
-  The power supply pins for the photosensor are internally connected to the 24 V DC power input of CRSC.
-  If your photosensors do not have Sensor Error output, leave the Sensor Error pin **not connected**.



**Both Sensors Input and Sensors Error inputs are intended for use with 24V DC NPN**

open collector transistor outputs from sensors. For different type of sensors please call Industrial Software.

 **CRSC can be configured to work with Light Operated or Dark Operated sensors individually on each zone.**

#### 3.1.7.2. Powered Roller Interface

The Motor Roller Interface connector has 9 pins. The connector is shown in Table .

- **GND** – the first pin is ground
- **Vcc** – second pin is power supply pin
- **WINDING U** – third pin is connected to winding U
- **WINDING V** - fourth pin is connected to winding V
- **WINDING W** – fifth pin is connected to winding W
- **HALL SENSOR U** – sixth pin is connected to Hall sensor U
- **HALL SENSOR V** - seventh pin is connected to Hall sensor V
- **HALL SENSOR W** - eighth pin is connected to Hall sensor W
- **Not used**



**Run and Direction outputs are open collector outputs, so direct connection of 24V DC to these pins may damage them!**

### 3.1.8. Zone Status LED Indicators

The zone status LED indicators are grouped in two separate field sections: **motor** section and **sensor** section

#### 3.1.8.1. Sensor Zone Status LED Indicators

There is one two colored LEDs for sensor section labeled **ZONE A1,B1,C1,D1,E1,A2,B2,C2,D2,E2**

These LEDs are signaling the following information:

**OFF** – There are no sensor blocked, no error

**Solid Green** - The sensor blocked, no error.

**Solid Red or Solid Orange** - The sensor reports **gain error**.

**Blinking Red or Blinking Green/ Orange** - The sensor reports Jam error.

#### 3.1.8.2. Motor Zone Status LED Indicators

There are three LEDs for motor section labeled **ZONE A,B,C,D**

These LEDs are signaling the following information:

**OFF** - There is no error, motor is not running

**Blinking Green** - Motor is running CW, and the blink ratio is proportional to speed.

**Solid Green** – Motor is running CCW .

**Solid Red** – Motor is constantly overloaded.

**Blinking Red** at 0.5s ratio – There is no motor attached.

**Blinking Red / Green / Orange** (0.33ms each) – no communication with main processor. Possible for example if you attach motor power without module power.

### 3.1.9. Node ID HEX Switches

There are two HEX switches for selection of the CRSC identification number.

The **upper** switch is for **High Node ID**

The lower switch is for **Low Node ID**

### 3.1.10. Baud rate or Configuration HEX Switch

This switch is used for CRSC Baud rate or Configuration selection.

## 3.2. CRSC SIZE AND MECHANICAL INSTALLATION

The respective sizes of CRSC are shown in Fig. 3.4.

The mechanical installation of CRSC is executed in the following order:

- a. Drill 4 clearance holes.
- b. Mount the module with screws.

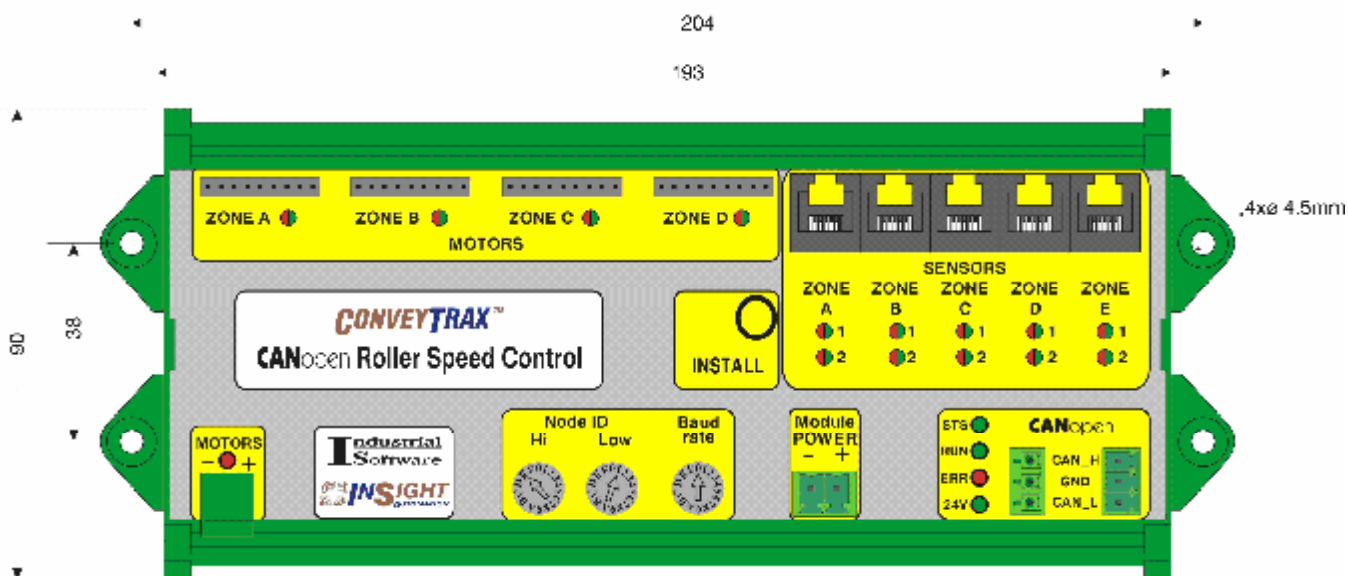


Fig. 3.4

### 3.3. CRSC TERMINALS

The connectors' layout is shown in Fig. 3.5.

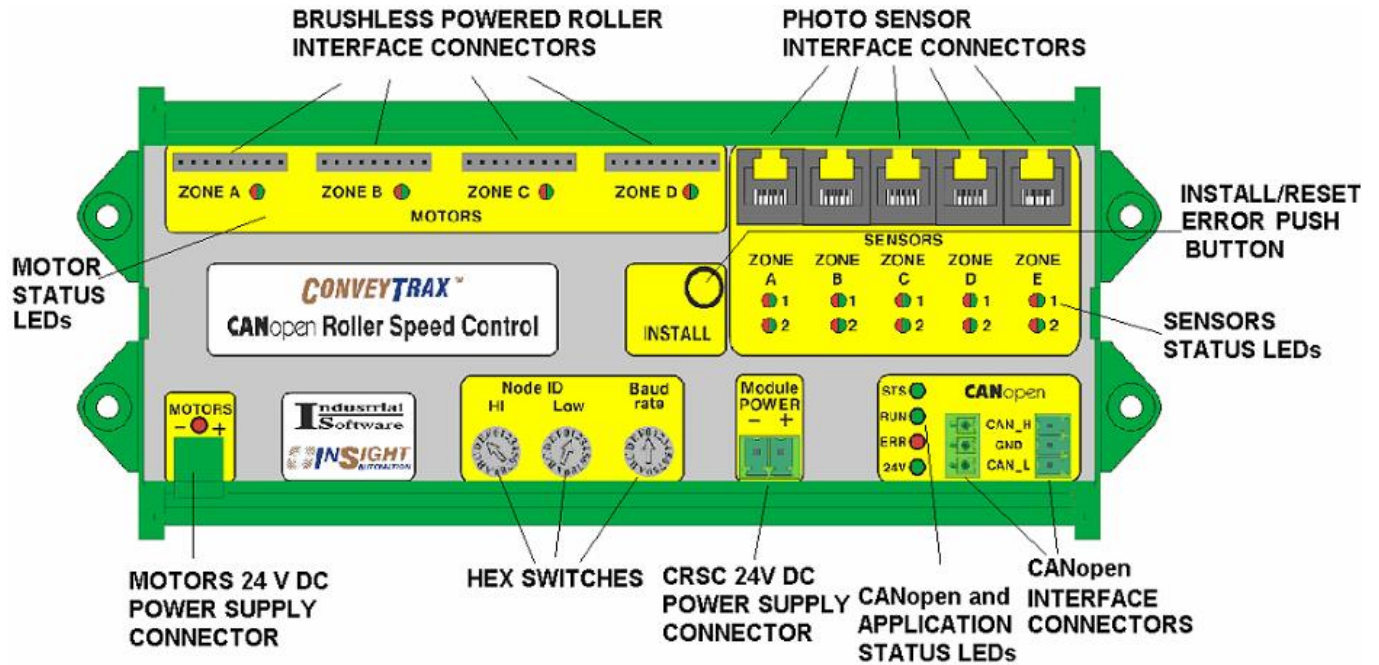


Fig. 3.5

### 3.3.1. Photosensor/Powered Roller Connectors

The connector pin-out information related to Photosensor/Powered Roller interface is outlined in Table 3.1.

Table 3.1 a)

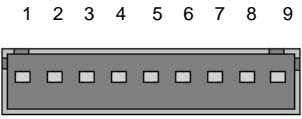
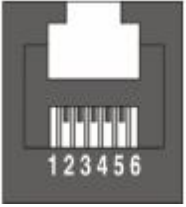
Connector	Pin No	PART OF	Descriptions
	1	<b>MOTOR INTERFACE</b>	GND
	2		Vcc
	3		WINDING U
	4		WINDING V
	5		WINDING W
	6		HALL SENSOR U
	7		HALL SENSOR V
	8		HALL SENSOR W
	9		Not used

Table 3.1 b)

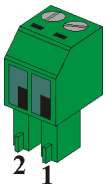
Connector	Pin No	PART OF	Descriptions
	1	<b>PHOTO - SENSOR INTERFACE</b>	Sensor Error A,B,C,D,E 2
	2		GND
	3		Sensor Error A,B,C,D,E 1
	4		Sensor A,B,C,D,E 1
	5		Vcc
	6		Sensor A,B,C,D,E 2

The connections between the module zone and the respective conveyor zone are shown already in Fig. 3.3.

### 3.3.2. CRSC Power Connectors

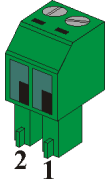
The connector pin-out information related to the module power supply is outlined in Table 3.2.

Table 3.2

Module (Sensor) Power Connection	Micro Pin	Function
	1	+ Power Supply
	2	- Power Supply

The connector pin-out information related to the module power supply is outlined in Table 3.3.


Table 3.3


Module (Sensor) Power Connection	Pin No	Function
	1	+ Power Supply
	2	- Power Supply

### 3.3.3. CANopen Connectors

The connector pin-out information related to CANopen interface shown in Table 3.4 is in accordance with the document *CiA Draft Recommendation DR-300-1 - CANopen Cabling and Connector Pin Assignment, Version 1.0, Oct. 10, 1999, item 7.3.*

Table 3.4

CANopen Connection Female connector	Pin No	Function
	1	CAN_L
	2	CAN_GND
	3	CAN_H

CANopen Connection Male connector	Pin No	Function
	1	CAN_L
	2	CAN_GND
	3	CAN_H

\*\*) Optional CAN external positive supply, dedicated for supply of transceiver and opto-couplers, if galvanic isolation of the bus node applies.

## 3.4. CRSC SPECIFICATIONS

The main technical CRSC specifications are described in Table 3.5.

Table 3.5

<b>Electrical</b>	
Module Power Voltage	18 - 30 VDC Main Power Supply
Module Current Consumption	Main Power Supply - 80 mA excluding motor power and current drawn by the photosensor
Interface Capacity	4 sensors/ 4 brushless motors
Galvanic insulation	CANopen to processor, Power to processor, Motor to motor, Sensor to sensor, motor & sensor to processor, Power to CANopen
CAN Voltage & Current	6 – 30 V DC / 30 mA average
<b>Network</b>	
Topology	Bus, double terminated.
Media	Twisted pair.
Interface	According ISO 11898

Table 3.5 Cont.

<b>Purge Input Signal</b>	10 - 30 V DC / 4 mA
<b>Environmental</b>	
Temperature	
Operational (ambient)	-40 °C to +85 °C
Storage	-55 °C to +85 °C
Humidity	95% RH, non-condensing
Shock	10 G
Vibration	2 G, at 10 to 500 Hz
Electromagnetic compatibility	IEC801, level 3
<b>Standards</b>	
IEC	IEC 801, IEC1131-1, ISO 11898
<b>Physical</b>	
Size (max. dimensions)	157mm*90mm*36.2mm
Mounting	DIN Rail
Weight (without DIN Rail)	Approx. 170 g.
Housing / Material	Polyamide PA-F fiber reinforced Face - polycarbonat
<b>Termination's</b>	Plug-in direction vertical to conductor axis, connection point towards the coded side of the header, 3.81 mm step

Recommended wire size	AWG28-16 (24-14) stranded or solid
Zone Status Indicators	Four red LED's - Jam, Motor Fault, Sensor Fault, Direction, Two green LED's - Sensor ON/Off, Roller On/Off
Additional Indicators	Power - red, Application Status – red, CAN RUN – green, CAN error – red
Configuration Switches	2 for Node ID (Hexadecimal, High part & LowPart) 1 for Baudrate
Front Panel	See Fig. 3.2





# CHAPTER 4

## CRSC EXTERNAL WIRING

---

- 4.1. INTRODUCTION
- 4.2. CRSC POWER SUPPLY CONNECTOR
- 4.3. CRSC CANopen INTERFACE CONNECTOR
- 4.4. PURGE INTERFACE CONNECTOR
- 4.5. PHOTOSENSOR/POWERED ROLLER INTERFACE CONNECTORS
- 4.6. COMPLETE SYSTEM WIRING



## 4.1. INTRODUCTION

The external wiring of CRSC although simple requires special attention in order to avoid commissioning troubles and/or devices' damage.

The instructions outlined below are designated to serve as guidance for the installation electricians.

The examples are based on the assumption that a CRSC is controlling linear area zones. Some particularities related to CRSCs controlling other conveyor areas will be discussed separately.

The module terminals are represented by male pin connectors assembled on the module' PCB - Fig. 4.1.

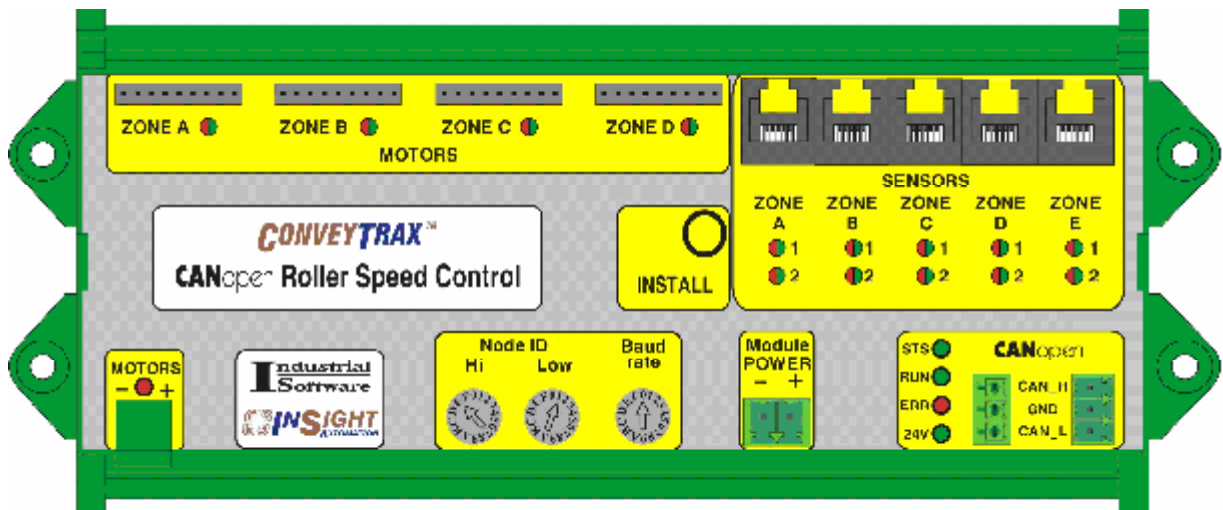


Fig. 4.1

The corresponding voltage polarity (if required) is shown on the front panel of the module (Fig. 4.1).

Each module is supplied by Industrial Software with female connectors with relevant pin number (without female motor connectors). **As a matter of fact when considering the external wiring we refer to wiring of these female connectors. Therefore, the electrician must follow the guidance extended in Tables 3.1, 3.2, 3.3 and 3.4 besides the considerations outlined below.**

## 4.2. CRSC POWER SUPPLY CONNECTORS



These connections are polarity sensitive!

The 24 V DC power supply female 2-pin connector must be wired in accordance with Table 3.2. The correct wiring will provide the electrical connections shown in Fig. 4.2.



**Please check it twice to make sure that your wiring is OK!**

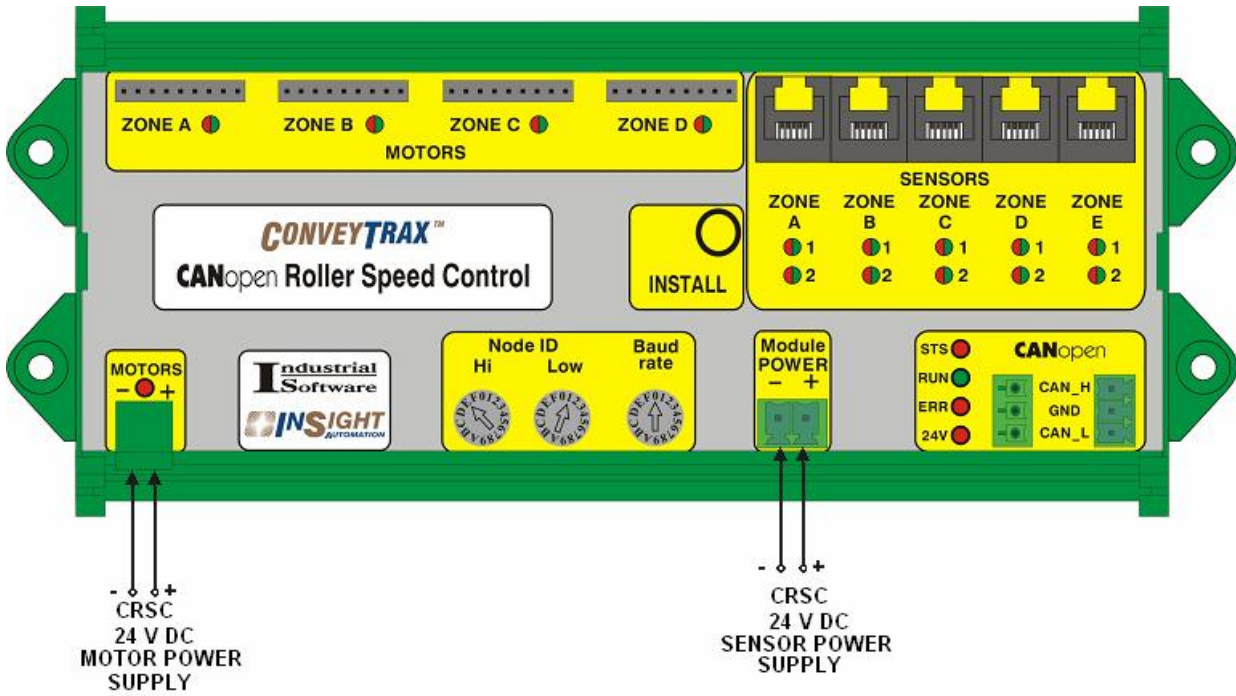


Fig. 4.2



The photosensor supply voltage is internally connected to CRSC 24 V DC Sensor Power Supply - Fig. 4.3. This must be taken into account during the system design.



The motor power supply voltage is internally connected to CRSC 24 V DC Motor Power Supply - Fig. 4.3. This must be taken into account during the system design.



The GROUND terminal of the Powered Roller section (Photosensor/Powered Roller Interface) is internally connected to - 24V DC CRSC Motor Power Supply (24V DC CRSC Sensor Power Supply) - Fig. 4.3.

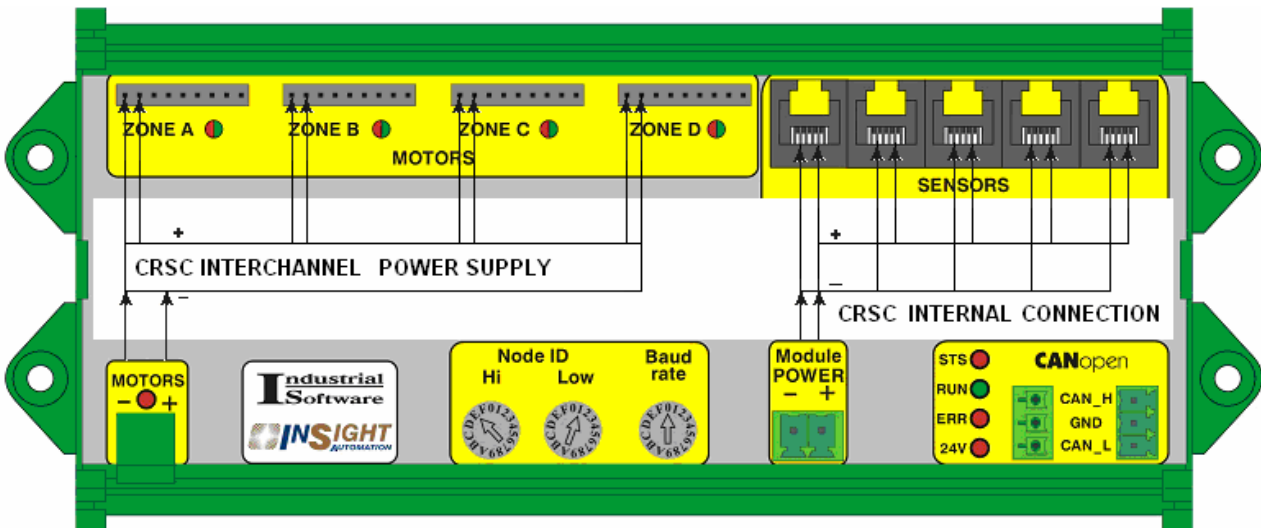


Fig. 4.3

### 4.3. CRSC CANopen INTERFACE CONNECTOR



These connections are polarity sensitive in terms of the terminals for 6-30V DC for CANopen external supply (CANopen\_V+ and CANopen\_GND / V-).

The CANopen interface female 5-pin connector must be wired in accordance with Table 3.4. The correct wiring will provide the electrical connection shown in Fig. 4.4.



**Please check it twice to make sure that your wiring is OK!**

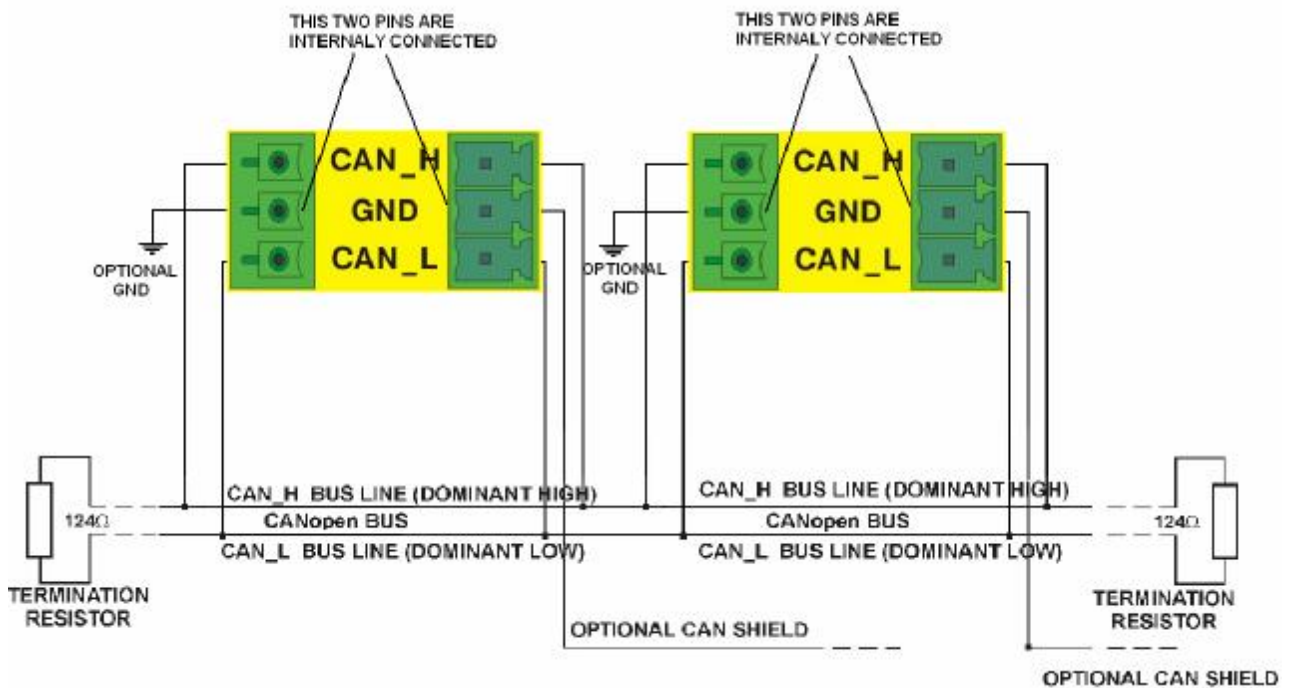


Fig. 4.4

The length of the CANopen BUS is in accordance with the recommendations of the document *CiA Draft Standard 301 - CANopen Application Layer and Communication Profile, Version 4.0, 16/06/1999*:

Baud Rate	Bus Length
1 Mbit/s	25 m
500 kbit/s	100 m
250 kbit/s	250 m
125 kbit/s	500 m

The bus lines have to be terminated by termination resistors at both ends!

## 4.4. PURGE INTERFACE CONNECTION



The Purge signal is taken from sensor E1 output (3 and 4<sup>th</sup> pin of the E sensor zone connector) the sensor zone connectors are shown in Table 3.3. The correct wiring will provide the electrical connection shown in Fig. 4.5.

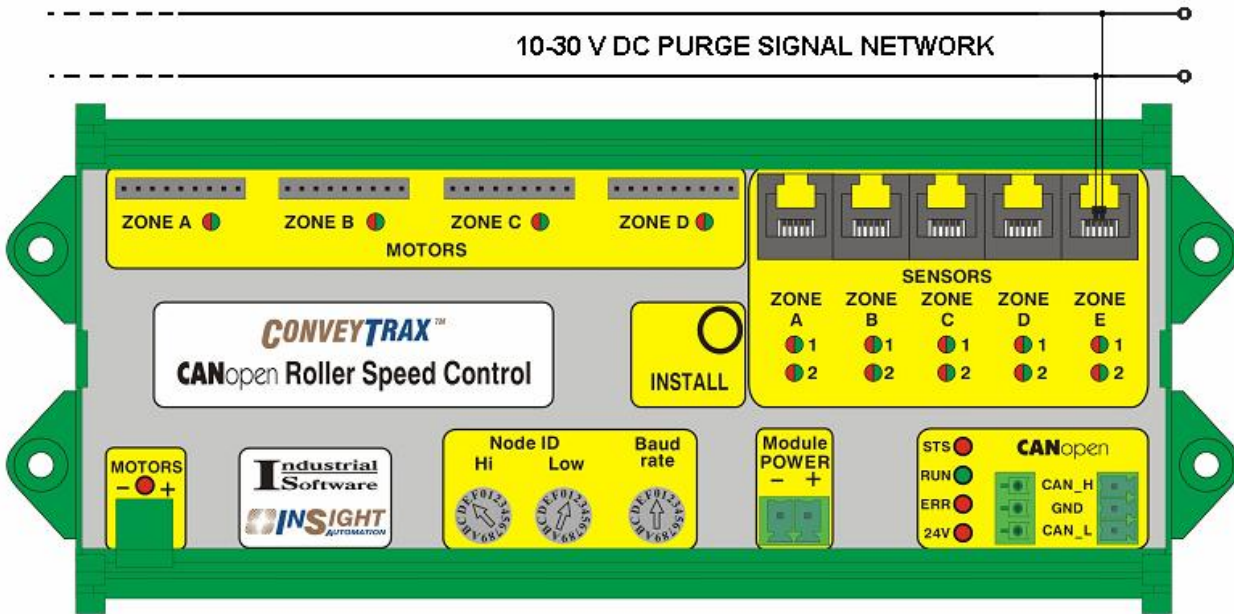


Fig. 4.5



The capacity of the System's Purge Signal power supply must be selected to meet the requirement for 4 mA per one CRSC.

For example, in case of a 1000 module system configuration the required capacity is  $1000 \times 4 \text{ mA} = 4 \text{ A}$  !!!

## 4.5. PHOTOSENSOR/POWERED ROLLER INTERFACE CONNECTORS



These connections are polarity sensitive!

The motor power interface part of the module is supplied with four 9-pin female connectors - one per each zone. The photosensor interface part from the CRSC is supplied with 5-pin female connector.

The Photosensor connectors must be wired in accordance with Table 3.1. The correct wiring will provide the electrical connections shown in Fig. 3.3.



**Please check it twice to make sure that your wiring is OK!**

## 4.6. COMPLETE SYSTEM WIRING

The complete system wiring is illustrated in Fig. 4.6.

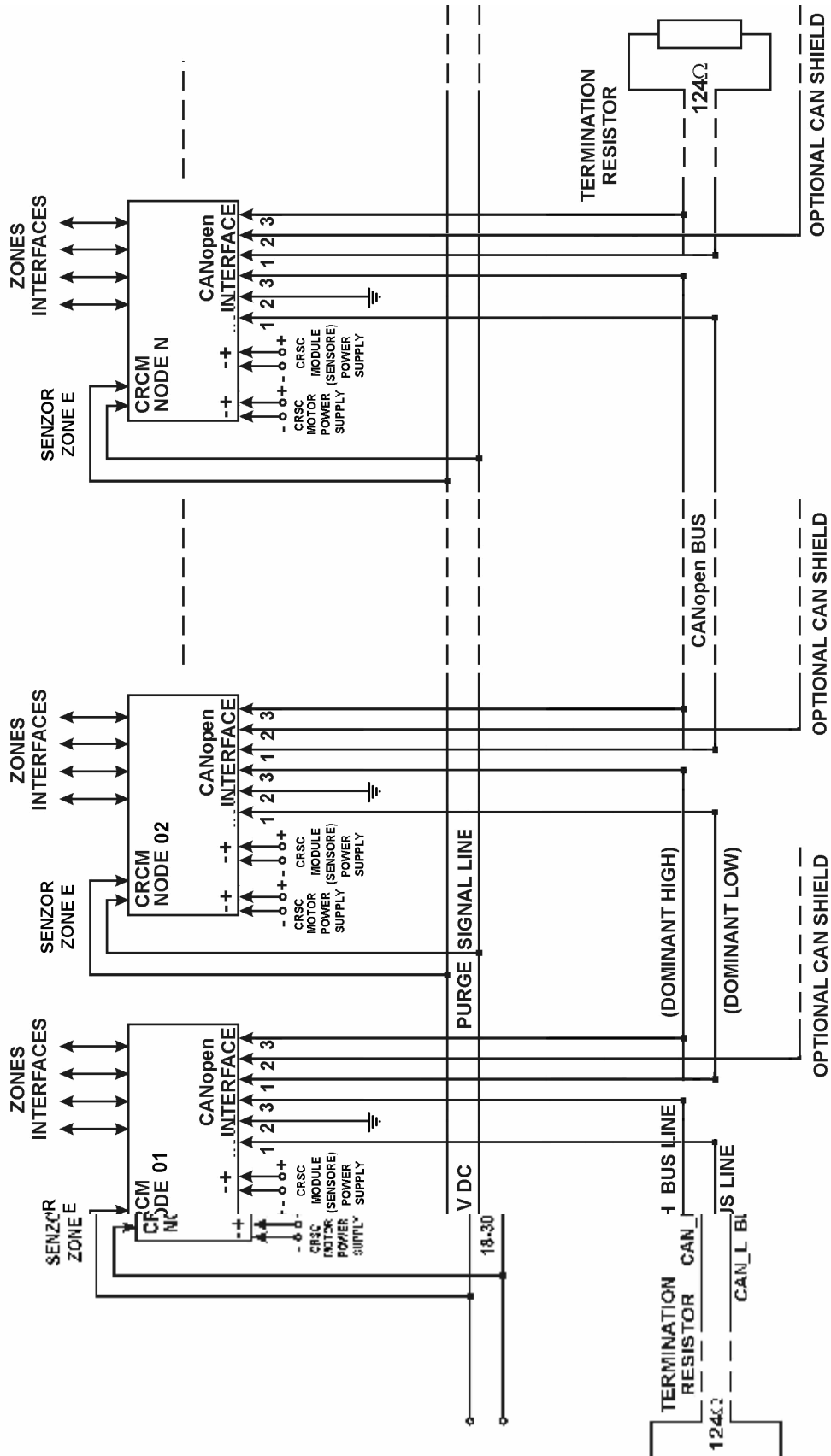


Fig. 5.6





# CHAPTER 5

## CRSC PRINCIPLES OF OPERATION

---

- 5.1. INTRODUCTION
  - 5.1.1. Linear CRSC/ Merge CRSC
  - 5.1.2. Local Operation/ Remote Operation
- 5.2. LINEAR CRSC FUNCTIONS
  - 5.2.1. Linear CRSC Functions for Local Operation
  - 5.2.2. Linear CRSC Functions for Remote Operation
- 5.3. MERGE CRSC FUNCTIONS
  - 5.3.1. Merge CRSC Functions for Local Operation
  - 5.3.2. Merge CRSC Functions for Remote Operation
  - 5.3.3. **E-stop reaction/ Recovery**



## 5.1. INTRODUCTION

As already explained a CRSC can control **up to 4 zones**.

These up to four zones, controlled by a single CRSC are referred to as **local zones** (Fig. 2.13).

These up to four zones may be of two types:

- **Type 1**-linear and/or curved zones forming a standard (linear) area as described in subsection 2.4.1.
- **Type 2**-central zone + merge zone + (right zone) + (left zone), forming a merge area as described in subsection 2.4.2., Fig. 2.7.

A CRSC may be configured to control up to four zones of type 1 or of type 2.

### 5.1.1. Linear CRSC/Merge CRSC

A CRSC configured to control up to 4 zones of a linear area is referred to as **Linear CRSC**.

A CRSC configured to control up to 4 zones of a merge area is referred to as **Merge CRSC**.

### 5.1.2. Local Operation/Remote Operation

A Linear CRSC coordinates:

- The proper functions of its up to 4 zones as described in subsection 2.9.2.

The Linear CRSC function is referred to as **Local Operation** in this case.

- The proper interaction between the adjacent remote zones (upstream, respectively downstream) as described in subsection 2.9.3.

The Linear CRSC function is referred to as **Remote Operation** in this case.

A Merge CRSC coordinates:

- The proper interaction of its up to 4 zones as described in subsection 2.9.2, but related to the respective merge area zones.

The Merge CRSC function is referred to as **Local Operation** in this case.

- The proper interaction between upstream adjacent remote zones, respectively downstream adjacent remote zones as described in subsection 2.9.3 but related to the respective merge area zones and the relevant linear area zones.

The Merge CRSC function is referred to as **Remote Operation** in this case.

The *local operation* of both the Linear CRSC and the Merge CRSC is organized *inside* (internally) the respective CRSC itself.

The *remote operation* for both types of CRSC is organized *in the frame of the CANopen network*.

## 5.2. LINEAR CRSC FUNCTIONS

The functions of the Linear CRSC depend on the mode of operation.

### 5.2.1. Linear CRSC Functions for Local Operation

A Linear CRSC coordinates the following functions between its up to 4 zones (in other words controls the package transfer between the local zones as already explained in subsection 2.9.2.):

- If a sensor of a zone reaches a tray, the motor runs unless accumulation state is forced.
- If a sensor of a zone reaches a tray, the motor of downstream zone is also running, ready to receive a tray.
- After the sensor of the zone "loses" the tray the motor of downstream zone continues to run 3s (configurable). This time is necessary for small trays to reach the sensor of downstream zone.
- If an error is developed on a zone (Jam, Motor Error), accumulation is forced on upstream zone.
- If a "Full and stopped" condition takes place on a zone, accumulation is forced on the upstream zone.
- If a zone is configured in "Singulation" mode, accumulation is forced until downstream zone is full. Special timeout is added to support "Half size" trays.

### 5.2.2. Linear CRSC Functions for Remote Operation

The proper interaction between the adjacent remote zones (upstream, respectively downstream) is coordinated in the case of remote operation - Fig. 5.1 (you may refer also to Fig. 2.17).

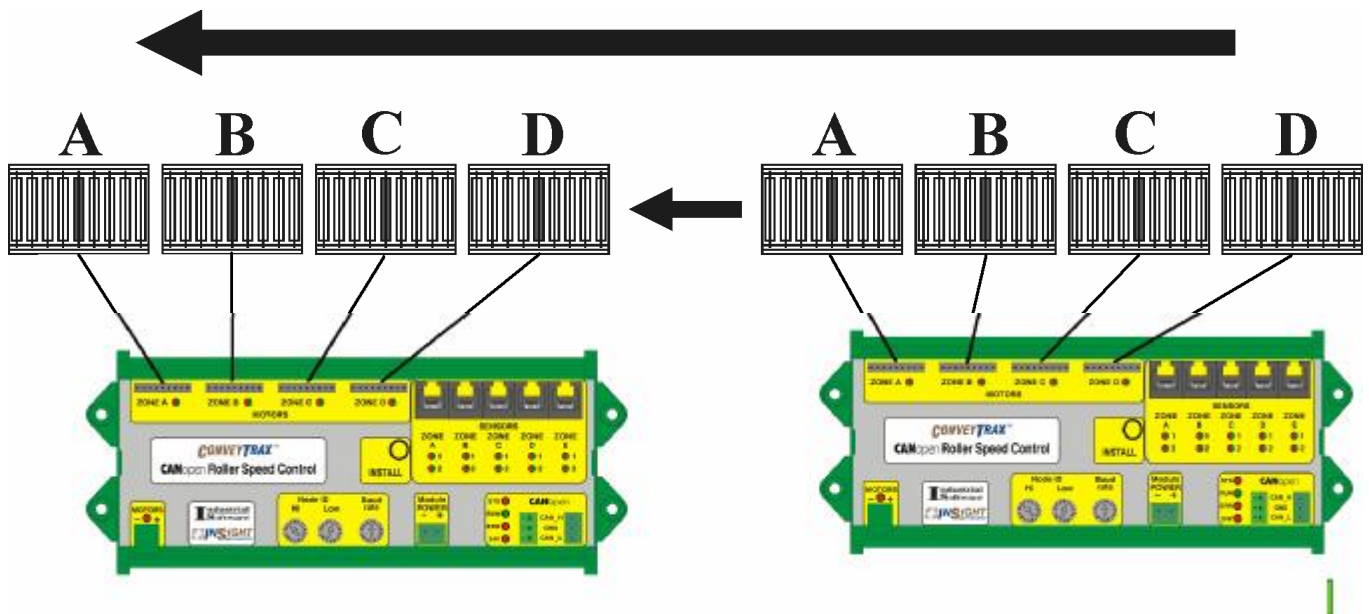



Fig. 5.1

Remote operations (transferring trays between zones, controlled from different CRSC's using CANopen) are similar to local operation. The main difference is that the information for zone states is not operated internally in CRSC, but is transferred over CANopen Network as **Process Data Object (PDO)**.

There are few Object Dictionary Entries, which are mapped to PDO, which report (in **Transmit PDO - TPDO**) and receive (**Receive PDO - RPDO**) states of the zones

 Here and everywhere in the documentation we will use HEXADECIMAL Numbers, using presentation *0x*):

- Objects, mapped to **TPDO**

*0x2001 – Zone Status*

*Subindex 1 – for Zone A*

*Subindex 2 – for Zone B*

*Subindex 3 – for Zone C*

*Subindex 4 – for Zone D*

Values of these entries are:

0 - There is no package on the appropriate zone

1 - There is a package on the appropriate zone and it's motor is running

2 - There is a package on the appropriate zone, but the motor is not running

The zone is "Full and Stopped" in case of accumulation condition or motor fault.

*0x200A – Status of the module*

This object is added to the PDO for monitoring purposes.

Each bit of this entry describes some error for all 4 zones

Transmit PDO mode is event triggered, propagated over the network only when the most downstream zone of the module (always A) or the most upstream zone of the module (A or B or C or D, when module is configured for 1 or 2 or 3 or 4 zone in use) changes status.

Object *0x200A* is also propagated with "Emergency" message as "Manufacturer Status Register" and is copied in CANopen object *0x1002 – Manufacturer Status Register*

- Objects, mapped to **RPDOs**

*0x2002 - input flow control*

*Subindex 1 – Receives value from upstream remote zone.*

*Subindex 2 – Receives value from downstream remote zone*

Default mapping for **TPDO** is as follows:

- **Length** – 8 bytes

1<sup>st</sup> byte – Zone Status A (BYTE), *Object 0x2001, Subindex 1*

2<sup>nd</sup> byte – Zone Status B (BYTE), *Object 0x2001, Subindex 1*

3<sup>th</sup> byte – Zone Status C (BYTE), *Object 0x2001, Subindex 1*

4<sup>th</sup> byte – Zone Status D (BYTE), *Object 0x2001, Subindex 1*

In this byte also is copied the state of most upstream zone of the module, if less than 4 zones are used. It helps you always use this byte in the downstream module mapping, no matter how many zones use in its upstream.

5,6 byte – Status (Error) Register of the module, object *0x200A*

7,8 byte – reserved for future use

- **COB-ID** – This is the COB identifier- identifies a COB uniquely in a network by a number called **COB Identifier**.

As defined in CANopen default Master/Slave connection set:


To connect CRSC to the control system, you have to configure 2 RPDOs as follows:

RPDO 0 – With COB-ID of its upstream module TPDO COB-ID

1<sup>st</sup> byte mapped to object 0x2002, subindex 1 (Upstream object).

RPDO 1 - With COB-ID of its downstream module TPDO COB-ID

4<sup>th</sup> byte mapped to object 0x2002, subindex 2 (Downstream object).

 The above information is necessary if *Installation Tool* other than RollOn is used. In Industrial Software's RollOn Tool these PDO mappings are done automatically and exported as **Device Configuration Files (DCF)** for use by other CANopen installation tools.

### 5.3. MERGE CRSC FUNCTIONS

The functions of the Merge CRSC depend on the mode of operation.

Fig. 5.2 shows how the zones have to be connected to powered rollers of the merger area.

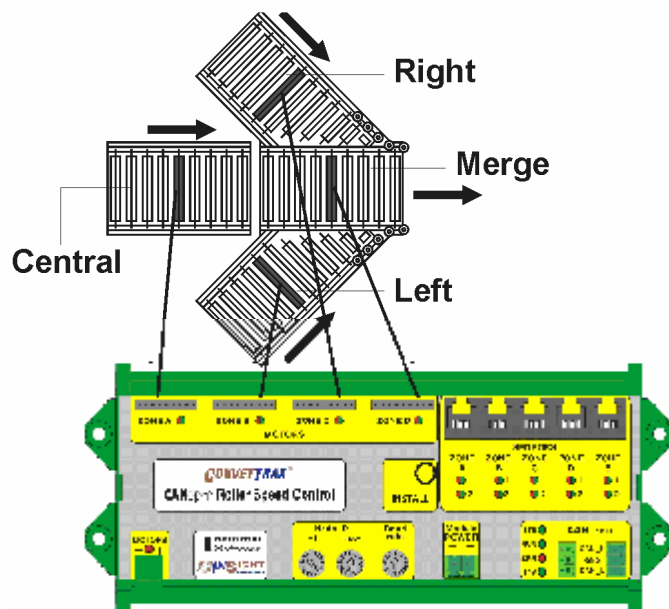


Fig. 5.2

CRSC in merge mode can control up to 4 zones. These zones are named **CENTRAL** Zone, **LEFT** Zone, **RIGHT** Zone and **MERGE** Zone.

Of course, you may use Left zone physically on your Right CRSC merge zone and vice versa.

Central zone of merger is connected to A zone of CRSC.

Left zone of merger is connected to B zone of CRSC.

Right zone of merger is connected to C zone of CRSC.

Merge zone of merger is connected to D zone of CRSC.

### 5.3.1. Merge CRSC Functions for Local Operation

 In this mode of operation the CRSC has up to 3 upstream zones and 1 downstream zone

The sequence of operation is as follows:

- If there is a tray on some of the 3 input zones, they are transferred to Merge zone in “First come, first released”. Accumulation is forced to other zones, which are waiting.

All other rules, described for CRSC in linear transfer mode are also valid.

Note that the Merge zone is in fact the downstream zone for Left, Right and Central zones.

For example, if Jam is taking place at the Merge zone, then accumulation is forced at Central, Left and Right zones.

### 5.3.2. Merge CRSC Functions for Remote Operation

In this mode of operation the Merge CRSC coordinates the functions of the merge area zones with the respective upstream/downstream remote conveyor zones.

The information is operated over CANopen Network as **Process Data Object (PDO)**.

The Object Dictionary Entries, subject to be mapped to PDO, which report (in Transmit PDO - TPDO) and receive (Receive PDO - RPDO) states of the zones are as follows:

- Objects, mapped to **TPDO**

*0x2001 – Zone Status*

*Subindex 1 – for Central Zone*

*Subindex 2 – for Left Zone*

*Subindex 3 – for Right Zone*

*Subindex 4 – for Merge Zone*

Values of these entries are:

0 - There is no package on the appropriate zone

1 - There is a package on the appropriate zone and its motor is running

2 - There is a package on the appropriate zone, but its motor is not running

The zone is “Full and Stopped” in case of accumulation condition or motor fault.

*0x200A – Status of the module*

This object is added to the PDO for monitoring purposes.

Each bit of this entry describes some error for all 4 zones

Transmit PDO mode is event triggered, propagated over the network when any zone changes status (See the difference in Linear Transfer Mode).

Object *0x200A* is also propagated with “Emergency” message as “Manufacturer Status Register” and is copied in CANopen object *0x1002* – Manufacturer Status Register

- Objects, mapped to **RPDOs**

*0x2002* - input flow control

*Subindex 1* – Receives value from upstream to central remote zone.

*Subindex 2* – Receives value from downstream to merge remote zone.

*Subindex 3* – Receives value from upstream to left remote zone.

*Subindex 4* – Receives value from upstream to right remote zone.


*Subindex 5 – 7* – Reserved for priority control

Default mapping for **TPDO** is as follows:

- **Length** – 8 bytes
  - 1<sup>st</sup> byte – Zone Status Central (BYTE), *Object 0x2001, Subindex 1*
  - 2<sup>nd</sup> byte – Zone Status Left (BYTE), *Object 0x2001, Subindex 1*
  - 3<sup>rd</sup> byte – Zone Status Right (BYTE), *Object 0x2001, Subindex 1*
  - 4<sup>th</sup> byte – Zone Status Merge (BYTE), *Object 0x2001, Subindex 1*
  - 5,6 byte – Status (Error) Register of the module, *object 0x200A*
  - 7,8 byte – reserved for future use
- **COB-ID** – As defined in CANopen default Master/Slave connection set

To connect CRSC to the control system in Merge, you have to configure 4 RPDOs as follows:

- RPDO 0 – With COB-ID of it's Upstream to central zone module TPDO COB-ID, 1<sup>st</sup> byte mapped to object 0x2002, subindex 1 (Central Upstream object).
- RPDO 1 – With COB-ID of it's Downstream to merge module TPDO COB-ID, 4<sup>th</sup> byte mapped to object 0x2002, subindex 2 (Downstream object)
- RPDO 2 – With COB-ID of it's Upstream to left zone module TPDO COB-ID, 1<sup>st</sup> byte mapped to object 0x2002, subindex 3 (Left Upstream object).
- RPDO 3 – With COB-ID of it's Upstream to right zone module TPDO COB-ID, 1<sup>st</sup> byte mapped to object 0x2002, subindex 4 (Upstream object).

 This information is necessary if *Installation Tool* other than RollOn is used. In Industrial Software's RollOn Tool these PDO mappings are done automatically and exported as Device Configuration (DCF) files for use by other CANopen Installation tools.

### 5.3.3. E-stop reaction/ Recovery

see Fig. 7.9.



# CHAPTER 6

## CRSC MOTOR CONTROL DETAILS

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### CHAPTER 6. CRSC MOTOR CONTROL DETAILS

- 6.1. Introduction
- 6.2. Principles of operation
- 6.3. Configuring motors via Rollon
- 6.4. Configurable parameters



## 6.1 Introduction

### 6.1.1 Functional Principles of a brushless DC motor

3-phase (BrushLess DC)BLDC motors are widely used in modern conveyor design. In BLDC motors, the magnets rotate and the current-carrying coils are stationary .Current direction is controlled by electronic switches, the switch sequence and timing is established by some type of rotor-position sensors (usually Hall effect based).

Fig. 6.1 shows the BLDC motor internals, which consist of a multi-pole permanent magnet rotor and stator with multiple coils linked together using a triangle or star coils connection. The stator is usually made from magnetic steel sheets.

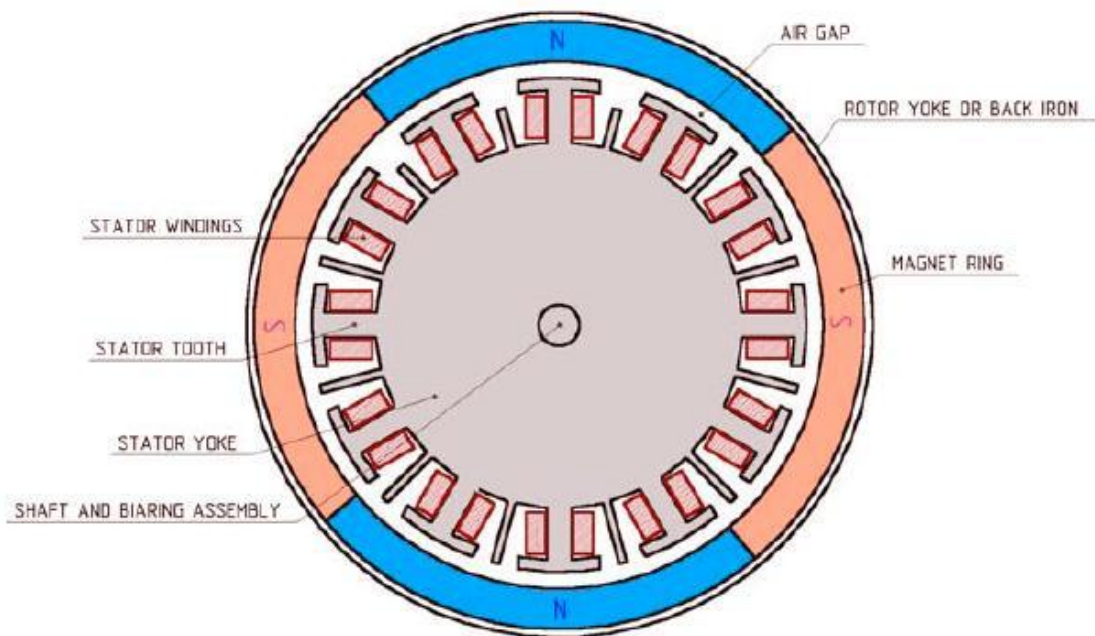


Fig. 6.1.The BLDC motor internals, outer-rotor version

### 6.1.2 Why use brushless DC motors?

Brushless DC motors are synchronous motors suitable for use in a simple means of controlling permanent drives. This type of brushless DC motor will increasingly replace brushed DC motors. Brushed DC motors require maintenance, e.g. to service coal brushes and commutator. Another major problem with a brushed DC machine is the possibility of brush burnout in the event of an overload or stall condition.

BLDC motors have many advantages over brushed DC and induction motors. A few of these are:

Better speed versus torque characteristics

High dynamic response

High efficiency

Long operation life

Noiseless operation

High speed ranges

## 6.2 Principles of operation

On Fig. 6.2 is demonstrated the motor operation. Each half rotor revolution consists of the 6 phases, so the rotor rotates on  $30^\circ$  during each phase. The three bipolar,  $120^\circ$  shifted voltage sources are used for motor controlling. These voltages can be true sinusoidal or be step approximation of sinewave signal.

The switching 3-phase voltage forms the rotating magnetic field, the Figure 2 illustrate the stator fields at once after phases switching events. The 6 events are marking the phase switching moments. This figure illustrates rotation in clock-wise direction, marked by arched arrow. To rotate rotor in opposite direction the reverse phase switching order is used, than be obtained by exchanging the switching order of any two motor coils. The Hall sensors polling order should be reversed as well.

On Fig. 6.2 the following notations were used :H1-H3 – Hall sensor output signals, Wph, Vph,Uph – phase W, V, U driving voltages, WUph,VWph, Uvph – voltages between phase WU, VW, UV.

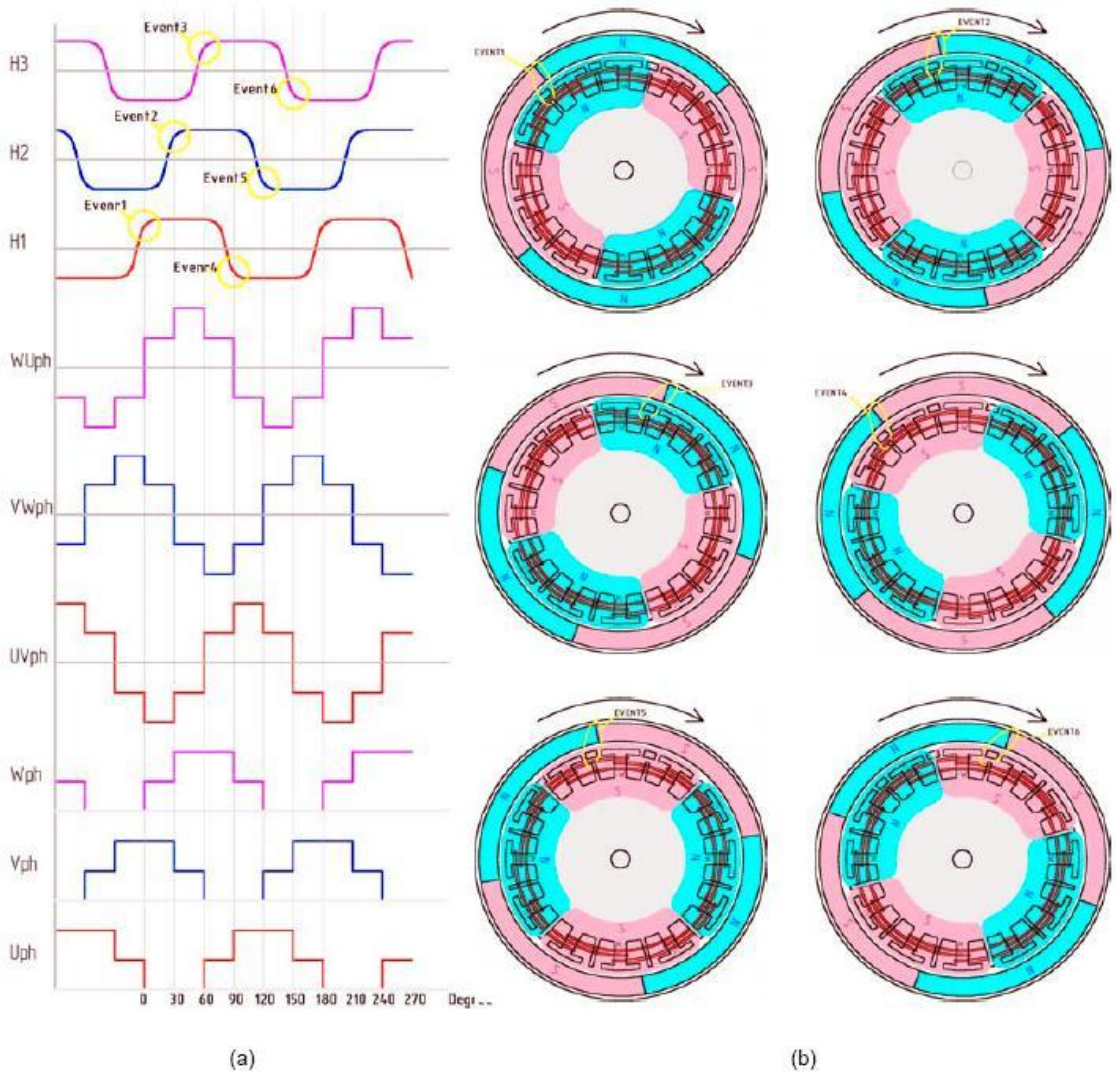


Fig. 6.2. The BLDC coil phases voltages switching (a) and rotor rotation phases (b).





# CHAPTER 7

## CRSC ELECTRONIC DATA SHEET

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- 7.1. GENERAL
- 7.2. CRSC EDS FILE



## 7.1. GENERAL

The usage of devices in a communication network requires configuration of the device parameters and communication facilities. CANopen defines a standardized way to access these parameters via the **Object Dictionary (OD)**.

The Electronic Data Sheet is a general description of a device type.

For more details the user is referred to CiA Draft Standard Proposal 306, Version 1.0, 31/05/2000.

## 7.2. CRSC EDS FILE





## **CHAPTER 8**

# **CONFIGURING POWERED ROLLER CONVEYOR WITHOUT PC, USING CANopen ROLLER SPEED CONTROL module**

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- 8.1. OVERVIEW**
- 8.2. BASIC PRINCIPLES**
- 8.3. RULES FOR SELECTING HEX SWITCH SETTINGS**
  - 8.3.1. Building Linear Lanes**
  - 8.3.2. Rules for Mergers**
  - 8.3.3. Closing Loops**

- 8.3.4. Configuring Pusher Zones**
- 8.3.5. Configuring Diverter Zones**
- 8.3.6. Configuring Scale and Scanner Modules**
- 8.4. OVERALL CONFIGURATION PROCESS**
- 8.5. MAINTAINING THE SYSTEM**
- 8.6. REPLACEMENT OF MODULES**
- 8.7. EXAMPLE OF A COMPLEX SYSTEM CONFIGURED WITHOUT PC**
- 8.8. RULES FOR SELECTION OF NID, BAUDRATE AND CONFIGURATION**

## 8.1. OVERVIEW

Small, not complex systems can be configured and maintained “Manually”, without PC or configuration software, using CANopen Roller Speed Control module (CRSC) and Digital I/O module (DIO88). The configuration is managed via HEX switches and “INSTALL” button on the front panel of the modules.

All main controls for conveyor control systems (Linear transfer, Mergers, Pushers, Diverters, Scale and Scanner interfaces) are based on CRSC and DIO88 modules only.

After you install your devices “Manually”, you can connect your system to PC any time and change the configuration by PC, using standard CANopen configuration tool or RollOn.

## 8.2. BASIC PRINCIPLES

During “Manual” configuration process, each roller executes the following actions:

1. Configures its baud rate at 125 kbits/s
2. Configures and stores to FLASH memory its Process Data Object (PDO) mapping and communication parameters, thus preparing data connections to upstream/downstream modules, depending on HEX switches settings.
3. Detects the type of sensors (DARK/LIGHT Operated), connected to it and zones in use, and stores detected values to FLASH memory.



**All sensors and motor driver cards have to be connected properly to the module during configuration.**

4. Detects and stores to FLASH memory module’s action – Roller, Merge, Pusher, Diverter, Scale or Scanner, depending on the HEX switches settings.

## 8.3. RULES FOR SELECTING HEX SWITCH SETTINGS

### 8.3.1. Building Linear Lanes

For linear lanes, the rule is simple:

The node IDs increases downstream the lane - Fig. 8.1.

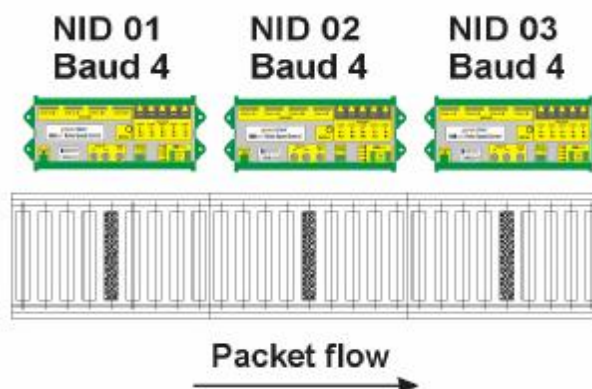


Fig. 8.1

### 8.3.2. Rules for Mergers

Each Merge CRSC must be configured with Node ID+1 with respect to the upstream-to-central zone CRSC Node ID, as well as with Node ID-1 with respect to the downstream-to-merge zone CRSC Node ID as illustrated in Fig. 8.2.

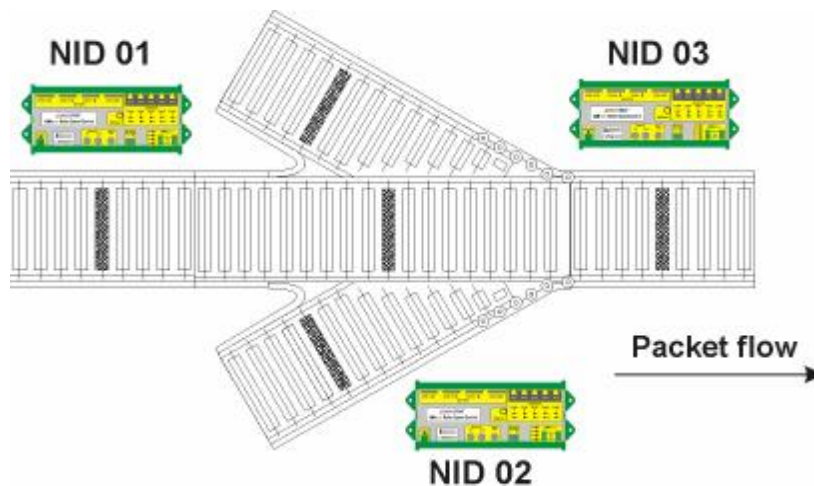


Fig. 8.2

The CRSCs, controlling the RIGHT and the LEFT zones, have to be configured with pre-selected offsets of Node IDs (see Table 8.2) as illustrated in Fig. 8.3.

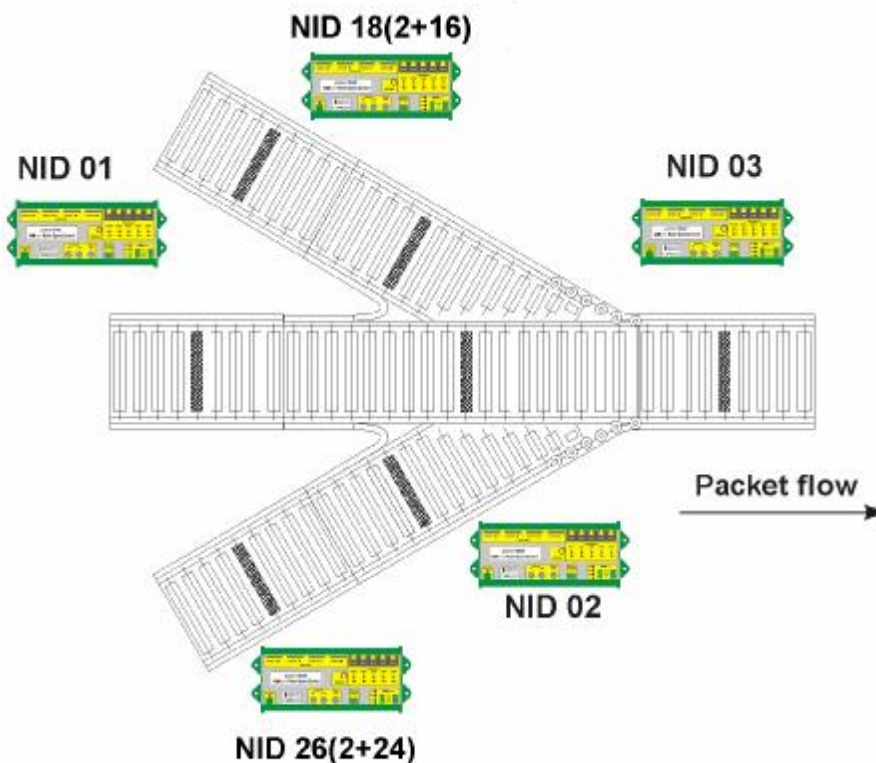


Fig. 8.3

### 8.3.3. Closing Loops

Loops can be closed on Roller Modules-Fig. 8.4. Select on the last module HEX switch combination “Downstream module is No. 1” (See Table 8.2). This HEX switch combination tells to the module, that the downstream module is not with Node ID+1, but with No. 1.

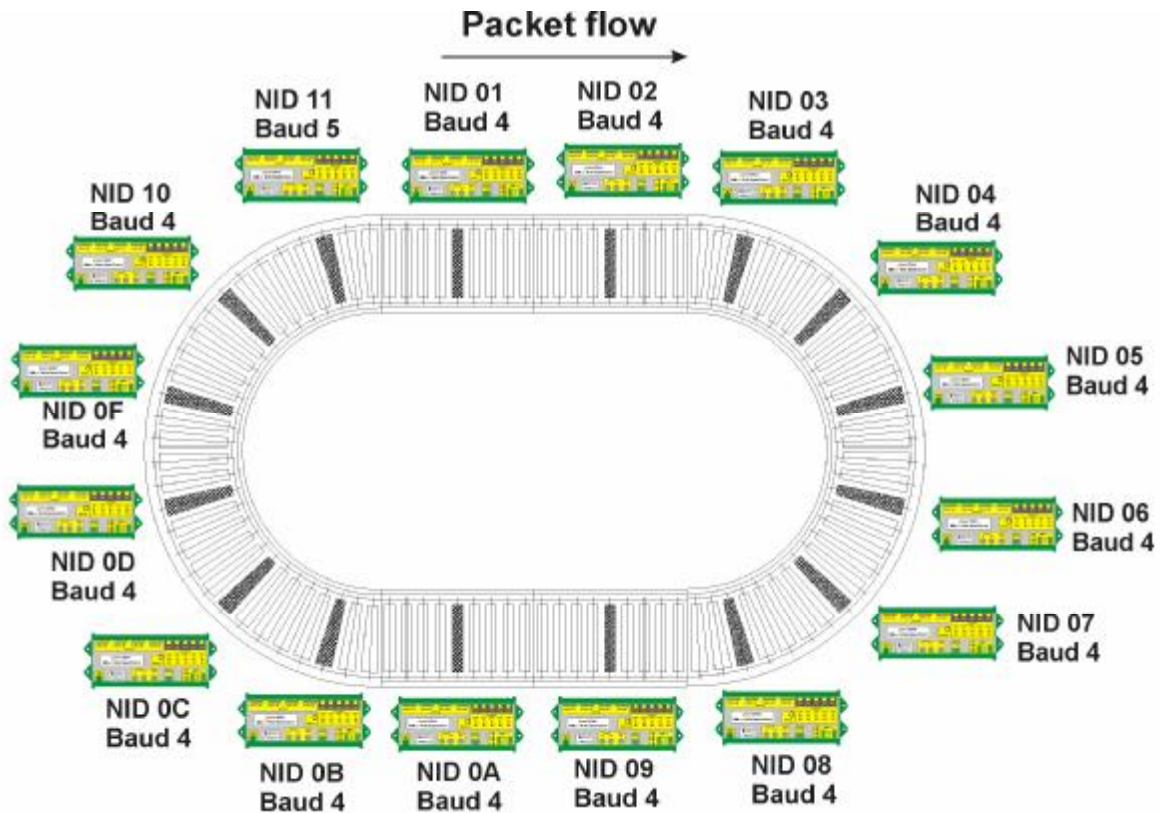


Fig. 8.4

### 8.3.4. Configuring Pusher Zones

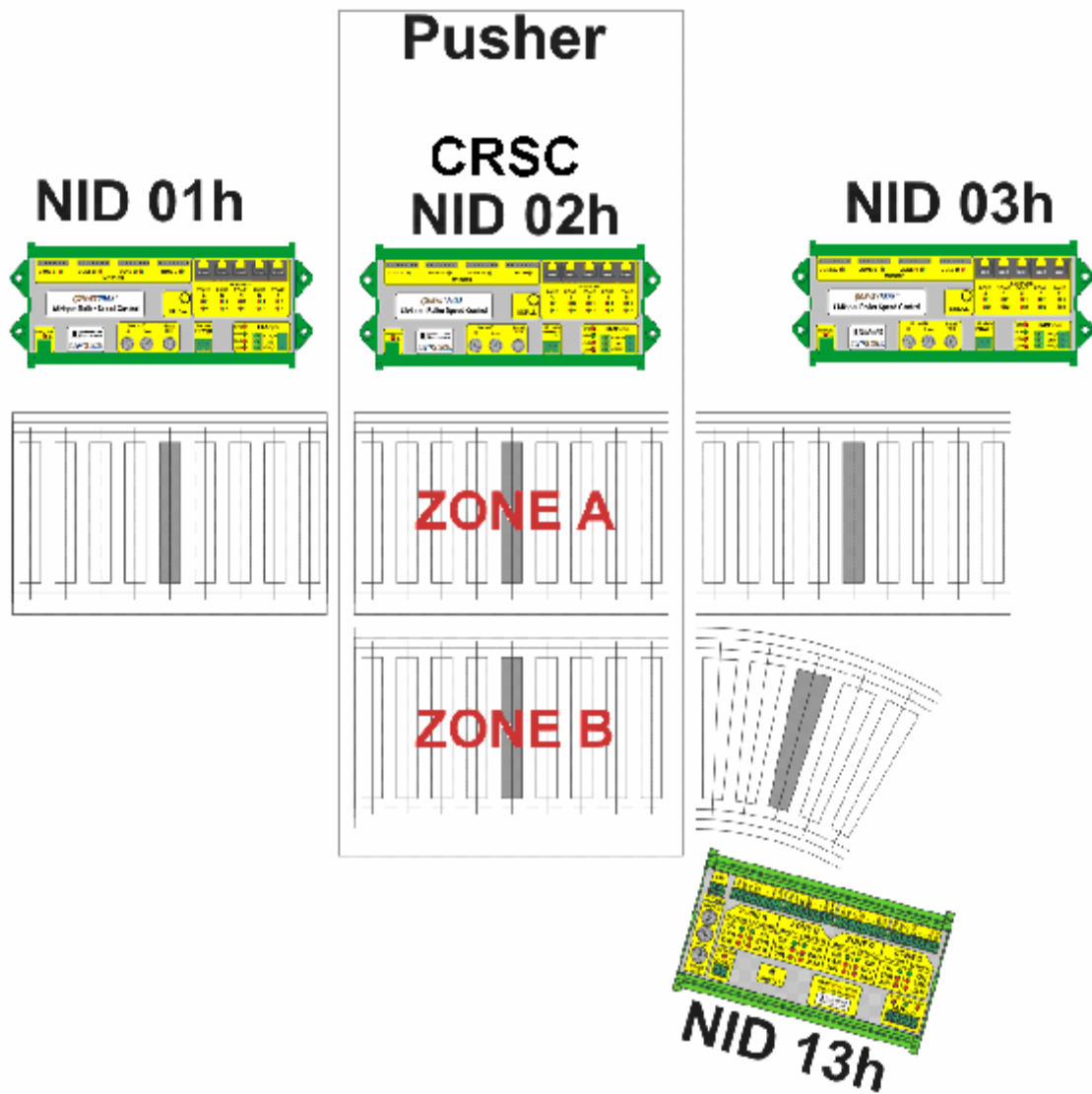
The Pusher is controlled by one device - 1 CRSC. The CRSC controls the roller zones and also controls the actuator with it's outputs, makes decisions depending on its inputs and controls the **accumulation** and **direction** status of the CRSC.

An example of a Pusher zone is illustrated in Fig. 8.5.



All values are hexadecimal, since the switches are hexadecimal

Also refer to subsection 1.3.



## CRSC NID 02h .configured as pusher control

Fig. 8.5

The following rules hold (refer to Fig. 8.5):

1. One CRSC is used for the zone from which the package is pushed-out (referred to as **push-out zone** i.e. zone **A**) and for the zone to which the package is pushed-in (referred to as **push-in zone** i.e. zone **B**). And also is used to control the actuator.
2. If the Node ID of the CRSC before the Pusher is N, then the CRSC, controlling the zones of the Pusher must be configured with Node ID = N+1.
3. The CRSC after the push-out zone (i.e. zone A) is with N+2.

### 8.3.5. Configuring Diverter Zones

The Diverter is controlled only by one device - 1 CRSC. The CRSC controls the roller zones and also controls the actuator with its outputs, makes decisions depending on its inputs and controls the accumulation and direction statuses of the CRSC - Fig. 8.6.

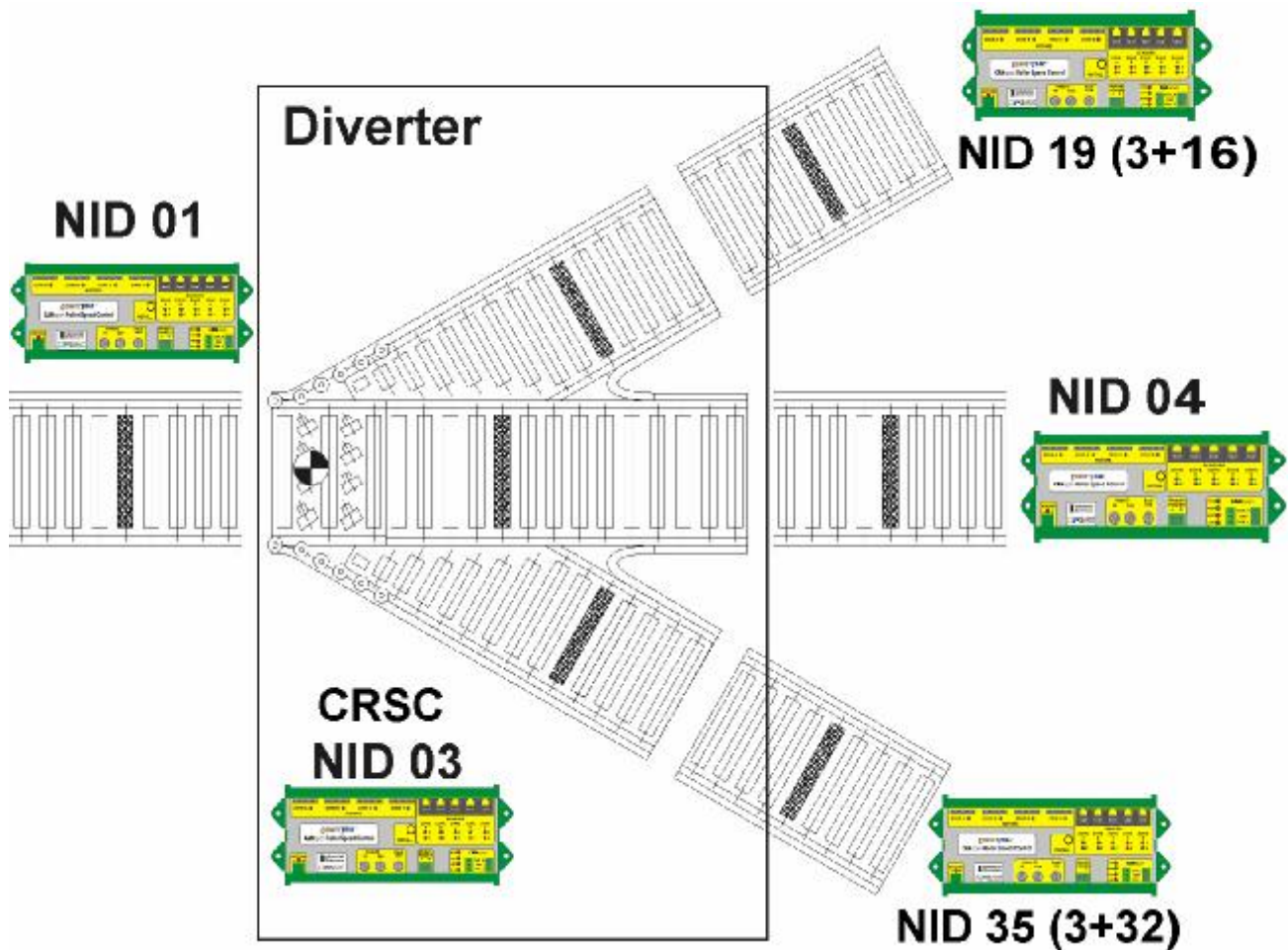


Fig. 8 6

The following rules are used:

1. One CRSC is used for all zones of the Diverter. And also is used to control the actuator.
2. The CRSC, controlling the zones of the Diverter is with N+2.
3. The CRSC after the central zone of the Diverter is with N+3.
4. The CRSCs after the LEFT and RIGHT zones are with predefined offset (see Table 8.4).

### 8.3.6. Configuring RAT Zones

[See the RAT specification and documentation document.](#)

### 8.3.7. Configuring Scale and Scanner Modules

DIO88 is used to control Scales and Scanners. See Table 8.3 or Table 8.4 how to select Scale or Scanner functionality for DIO88.

## 8.4. OVERALL CONFIGURATION PROCESS

1. Connect modules to the conveyor.

Plug-in sensors and motor interface cards.

2. Remove all trays from the conveyor.



**This is important, as during configuration process the modules detect the type of sensors assuming that they are NOT BLOCKED.**

3. Select the appropriate Node IDs by using the Node ID HEX switches (Fig. 8.8).
4. Select the appropriate module' action by using the Baud (configuration) HEX switch (Fig. 8.8).
5. Press the Install button for approximately 2s.

The CAN Status and CAN Run LEDs will flash for a while, then the CAN Status LED will start flickering (showing Firmware OK), the CAN Run LED will be ON (showing operational mode).

## 8.5. MAINTAINING THE SYSTEM

Use LED's on the front panel to maintain your system.

## 8.6. REPLACEMENT OF MODULES

1. Dismantle the damaged module from the conveyor.
2. Install a new one.
3. Select on the HEX switches of the new module the same values as those on the damaged one.
4. Press the "Install" button.

## 8.7. EXAMPLE OF A COMPLEX SYSTEM CONFIGURED WITHOUT PC

An example of a complex system, which can be configured without PC is shown in Fig. 8.7.

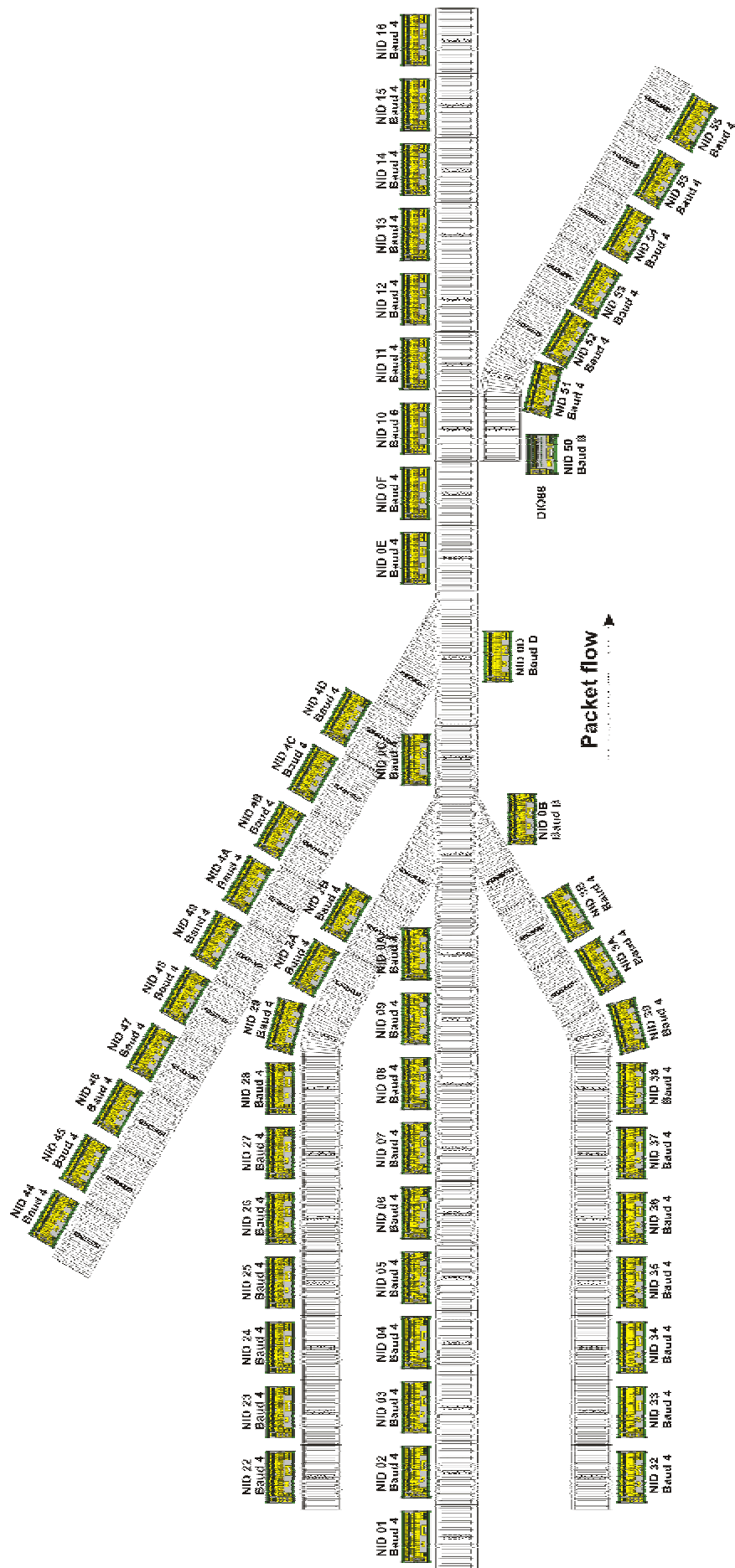


Fig. 8.7

## 8.8. RULES FOR SELECTION OF NID, BAUDRATE AND CONFIGURATION

The selection of Node ID, of Baud rate and Configuration is accomplished by the appropriate HEX Switches (Fig. 8.8) in accordance with the instructions outlined in Tables 8.1 to 8.4.



All digits in tables are hexadecimal except digits in parenthesis, which are decimal. Hexadecimal notation is accepted as a standard for CANopen.

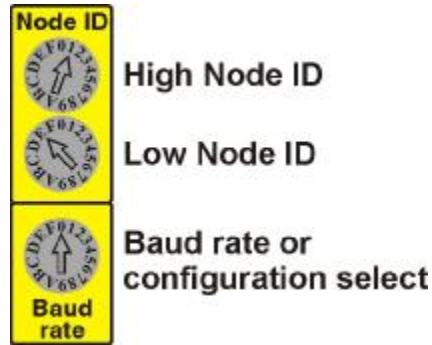


Fig. 8.8 – HEX Switches for Node ID, Configuration or Baudrate

Table 8.1 – Node ID Selection for CRSC

<b>0</b> → Node ID configured from PC
<b>1</b> , <b>7F</b> Node ID 1 ÷ 7F (127 dec.)

Table 8.2 – Baud rate or Configuration Select for CRSC

Baud Rate Switch Values	Comments
<b>0</b> - Baud rate 1M bit/second	Configuration is downloaded from PC. "Install" button doesn't affect the configuration.
<b>1</b> - Baud rate 500 K bits/second	
<b>2</b> - Baud rate 250 K bits/second	
<b>3</b> - Baud rate 125 K bits/second	
<b>4</b> Roller Operation    Downstream Node ID +1 Upstream Node ID-1	This Configuration is used for linear lanes
<b>5</b> Roller Operation    Downstream Node ID is 1	This Configuration is used for closing loops
<b>6</b> Roller Operation for controlling Pusher zones	This Configuration is used to control Pusher zones. DIO88 is used to control Pusher's actuator.
<b>7</b> Roller Operation for controlling Diverter zones	This Configuration is used to control Diverter zones. DIO88 is used to control Diverter's actuator.

Table 8.2 Cont. – Baud rate or Configuration Select for CRSC

<b>8</b> Merger Operation with offsets LEFT + 10, RIGHT+18	CRSC acts as Merger with Roller control connected to it's left zone with Node ID offset +10 (16 dec.)and right zone Node ID offset +18 (24 dec.)
<b>9</b> Merger Operation with offsets LEFT + 10, RIGHT+28	CRSC acts as Merger with Roller control connected to it's left zone with Node ID offset +10 (16 dec.) and right zone Node ID offset +28 (40 dec.)
<b>A</b> Merger Operation with offsets LEFT + 20, RIGHT+28	CRSC acts as Merger with Roller control connected to it's left zone with Node ID offset +20 (32 dec.) and right zone Node ID offset +28 (40 dec.)
<b>B</b> Merger Operation with offsets LEFT + 20, RIGHT+30	CRSC acts as Merger with Roller control connected to it's left zone with Node ID offset +20 (32 dec.) and right zone Node ID offset +30 (48 dec.)
<b>C</b> Merger Operation with offsets LEFT + 20, RIGHT+48	CRSC acts as Merger with Roller control connected to it's left zone with Node ID offset +20 (32 dec.) and right zone Node ID offset +48 (72 dec.)
<b>D</b> Merger Operation with offsets LEFT + 40, RIGHT+48	CRSC acts as Merger with Roller control connected to it's left zone with Node ID offset +40 (64 dec.) and right zone Node ID offset +48 (72 dec.)
<b>E</b> Merger Operation with offsets LEFT + 40, RIGHT+50	CRSC acts as Merger with Roller control connected to it's left zone with Node ID offset +40 (64 dec.) and right zone Node ID offset +50 (80 dec.)
<b>F</b> Merger Operation with offsets LEFT + 40, RIGHT+60	CRSC acts as Merger with Roller control connected to it's left zone with Node ID offset +40 (64 dec.) and right zone Node ID offset +60 (96 dec.)

Table 8.3 – **Node ID Selection for DIO88**

<b>0</b> → Node ID configured from PC
<b>1</b> , <b>7F</b> Node ID 1 ÷ 7F (127 dec.) Pusher Actuator Control or Scale Control
<b>81</b> , <b>FF</b> Node ID 1 ÷ 7F (127 dec.) Diverter Actuator Control or Scanner Control

Table 8.4 – **Baud rate or Configuration Select for DIO88**

<b>Baud Rate Switch Values</b>		<b>Comments</b>
<b>0</b> - Baud rate 1M bit/second		Configuration is downloaded from PC. "Install" button doesn't affect configuration.
<b>1</b> - Baud rate 500 K bits/second		
<b>2</b> - Baud rate 250 K bits/second		
<b>3</b> - Baud rate 125 K bits/second		
<b>4</b> Pusher Actuator Control	next+8	Pusher with CRSC connected to downstream zone of the pushed zone with offset 8 or Diverter with offsets LEFT zone +10, RIGHT zone +18
Diverter Actuator Control	LEFT + 10, RIGHT + 18	
<b>5</b> Pusher Actuator Control	next+10	Pusher with CRSC connected to downstream zone of the pushed zone with offset 10 or Diverter with offsets LEFT zone +10, RIGHT zone +20
Diverter Actuator Control	LEFT + 10, RIGHT + 20	
<b>6</b> Pusher Actuator Control	next+20	Pusher with CRSC connected to downstream zone of the pushed zone with offset 20 or Diverter with offsets LEFT zone +10, RIGHT zone +28
Diverter Actuator Control	LEFT + 10, RIGHT + 28	
<b>7</b> Pusher Actuator Control	next+28	Pusher with CRSC connected to downstream zone of the pushed zone with offset 28 or Diverter with offsets LEFT zone +20, RIGHT zone +28
Diverter Actuator Control	LEFT + 20, RIGHT + 28	
<b>8</b> Pusher Actuator Control	next+30	Pusher with CRSC connected to downstream zone of the pushed zone with offset 30 or Diverter with offsets LEFT zone +20, RIGHT zone +30
Diverter Actuator Control	LEFT + 20, RIGHT + 30	
<b>9</b> Pusher Actuator Control	next+40	Pusher with CRSC connected to downstream zone of the pushed zone with offset 40 or Diverter with offsets LEFT zone +20, RIGHT zone +40
Diverter Actuator Control	LEFT + 20, RIGHT + 40	
<b>A</b> Pusher Actuator Control	next+48	Pusher with CRSC connected to downstream zone of the pushed zone with offset 48 or Diverter with offsets LEFT zone +20, RIGHT zone +48
Diverter Actuator Control	LEFT + 20, RIGHT + 48	
<b>B</b> Pusher Actuator Control	next+50	Pusher with CRSC connected to downstream zone of the pushed zone with offset 50 or Diverter with offsets LEFT zone +40, RIGHT zone +48
Diverter Actuator Control	LEFT + 40, RIGHT + 48	
<b>C</b> Pusher Actuator Control	next+58	Pusher with CRSC connected to downstream zone of the pushed zone with offset 58 or Diverter with offsets LEFT zone +40, RIGHT zone +50
Diverter Actuator Control	LEFT + 40, RIGHT + 50	
<b>D</b> Pusher Actuator Control	next+60	Pusher with CRSC connected to downstream zone of the pushed zone with offset 8 or Diverter with offsets LEFT zone +10, RIGHT zone +18
Diverter Actuator Control	LEFT + 40, RIGHT + 58	

Table 8.4 Cont. – **Baud rate or Configuration Select for DIO88**

<b>E</b> Pusher Actuator Control	next+68	Pusher with CRSC connected to downstream zone of the pushed zone with offset 68 or Diverter with offsets LEFT zone +40, RIGHT zone +60
Diverter Actuator Control	LEFT + 40, RIGHT + 60	
<b>F</b> Scale or Scanner Control	DIO88 acts as Scale or Scanner Control, depending on Node ID switches settings	



There are errors in the firmware of DIO88, Version 4.0 when reading the Baud rate switch.

The modules of this firmware version can operate only on position five (Table 8.4), i.e.

with offset 10h.

There are no problems to configure these modules by Rollon Configuration Tool (positions 0-3 of Table 8.4)





# CHAPTER 9

## VERSIONS / REVISIONS HISTORY

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