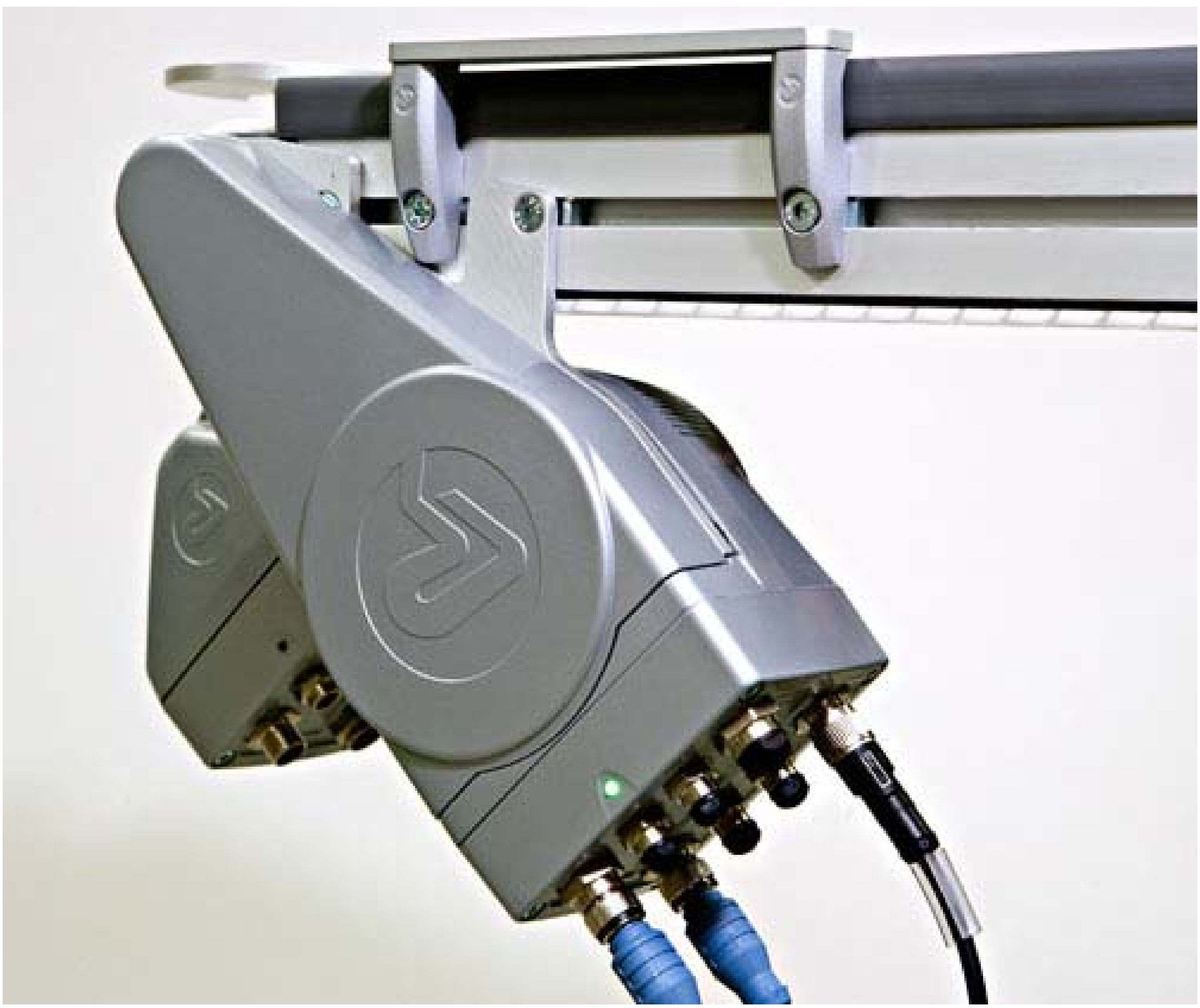
5113269 -3

Conveyor system X45*e*

User Documentation, Electrical system description



FlexLink®

Conveyor system X45*e*

FlexLink®

Conveyor system X45*e*

User Documentation, Electrical system description

5113269-3

FlexLink®

1 Overview

The electrical and control part of the platform X45e are structured in an object oriented way. All motors in the platform have an integrated distributed control system and the local sensors are connected directly to the motor unit. It is a big advantage both regarding software developing, electrical design as well as electrical installation.

The control hierarchy in the platform can be implemented in two ways. The most uncomplicated solution is a stand alone control of the motors with no control system in the level above. All input needed for the motors to execute their task are gathered via the digital inputs.

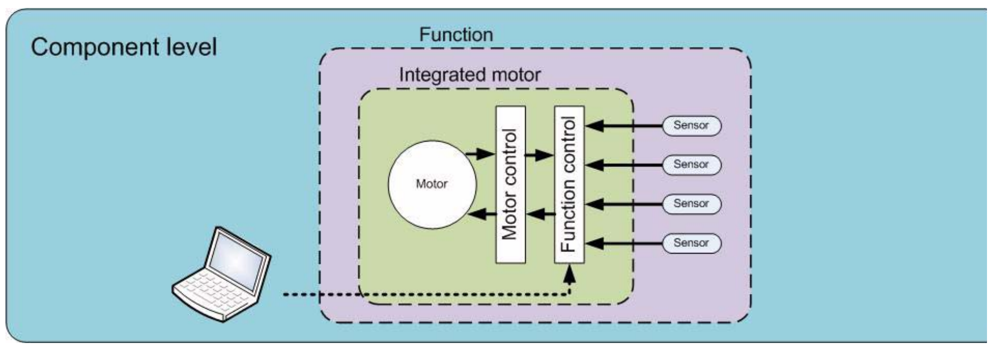


Figure 1 Autonomous control

The other way to implement the control is to connect the motors via a network. The motors are executing their task in the distributed control but commands based on information on system level can be sent from the line controller through a network master/scanner module.

If RFID are to be used, there can be a separate network for this purpose.

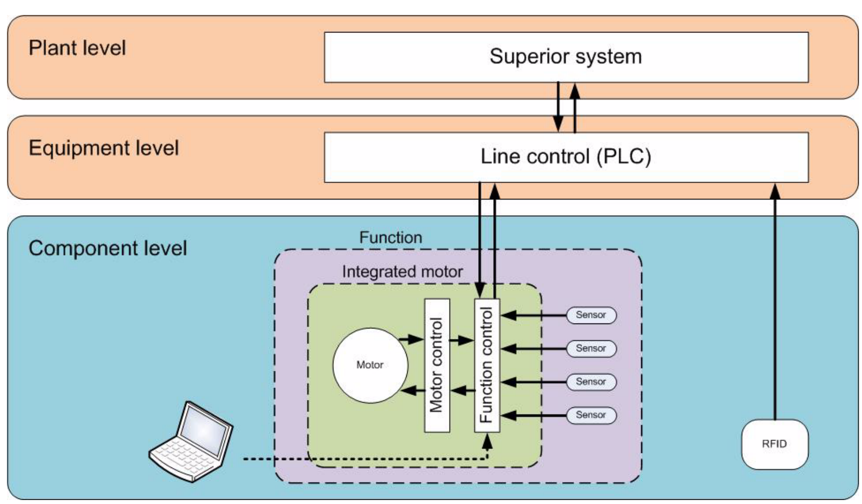


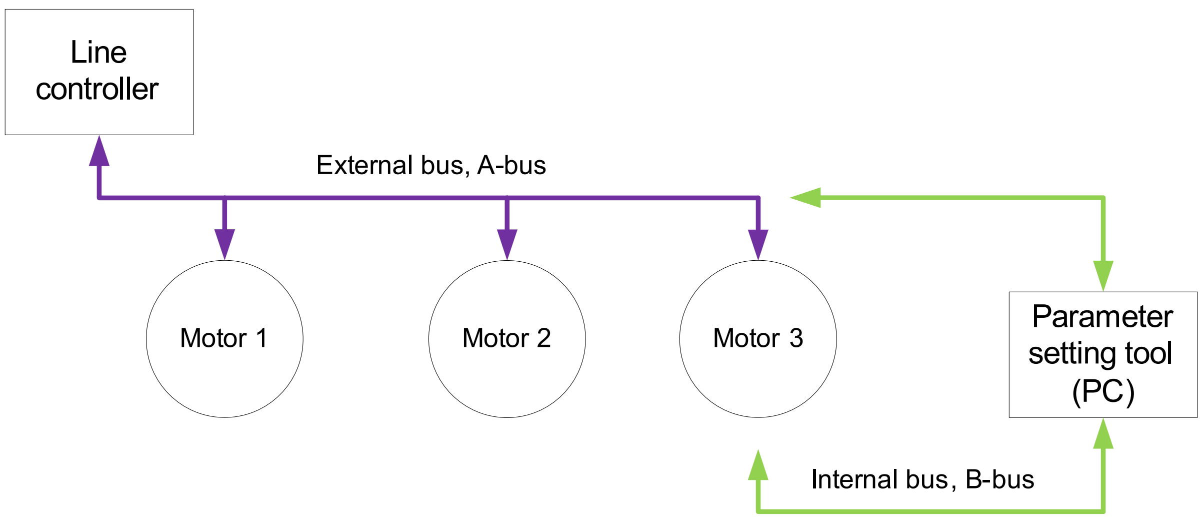
Figure 2 Line control

2 Hardware

2.1 Integrated motor

The motors in the X45e platform are integrated with controllers and sensor connectors.

2.1.1 Communication buses



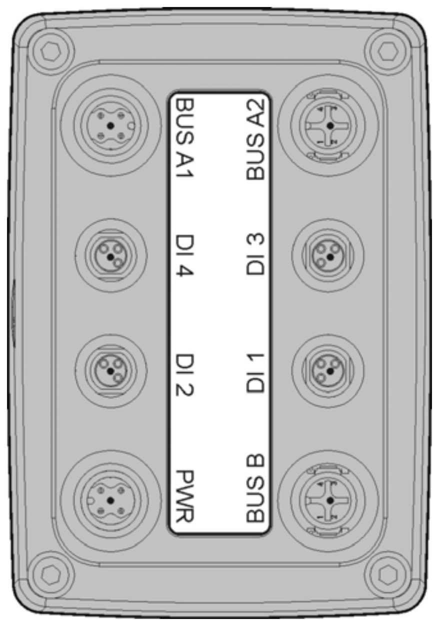
External bus, A-Bus

All motors can communicate up to a line controller via a field bus. This communication bus is called the A-Bus or the external bus. Via the Parameter setting tool software it is possible to connect to this network for reading and writing parameters to all motors.

Internal bus, B-Bus

The motor units have also an internal network called the B-Bus. This is used for communication inside the motor unit but can also be reached from the Parameter setting tool software via a separate contact, see below. If this is used only the connected motor can be reached. Some parameters has to be changed via this network (address and A-Bus network protocol)

2.1.2 Motor interface



BUS A1 – External bus, in
Connect this if external network is used

BUS A2 – External bus, out
Connect this if external network is used

DI 4 – Digital input 4:
Sensor, connect if used in specific function

DI 3 – Digital input 3:
Sensor, connect if used in specific function

DI 2 – Digital input 2:
Sensor, connect if used in specific function

DI 1 – Digital input 1:
Sensor, connect if used in specific function

PWR - Power in:
Connect power cable

BUS B – Internal bus:
Used for parameter setting

2.2 Electrical cabinet

The electrical cabinet to these systems have to be designed according to some rules. The main function with the cabinet is to supply power to the motors. Additional features can be line control and safety functions. Only the X45e specific features are described in this document.

2.2.1 Power supply

A main 24 VDC power supply is needed in every X45e system. The consumers of power can be divided in the following categories:

- Drive power supply
- Electronics power supply
- External bus power supply

<u>Drive power supply:</u>

The power consumption for a drive unit (conveyor motor) is depending a lot on two parameters, conveyor speed (x axis) and chain pull (the different curves).
(Use Flexlink Chainpull software to calculate actual force)

Maximum continuous current for a drive unit: 1,7 A (20 m/min and 100 N)

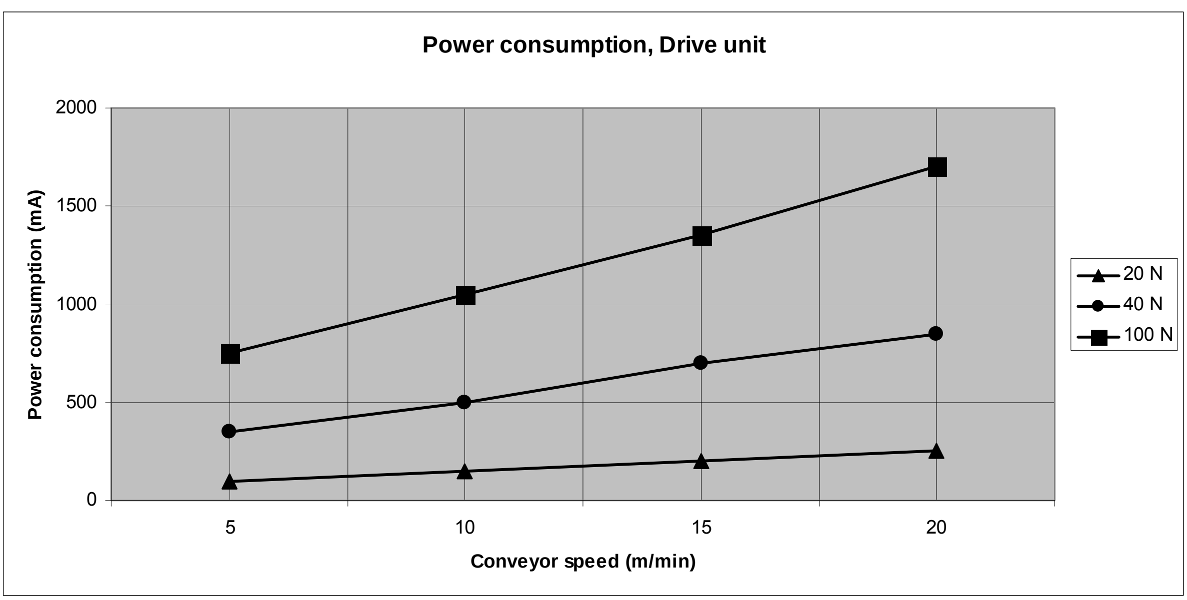


Figure 3 Power consumption, Drive unit

The power consumption for a function unit depends only on rotation speed of the rotation disc. This relation is not linear due to the fact that there has to be a stand still torque.

Maximum continuous current for a function motor: 0.5 A

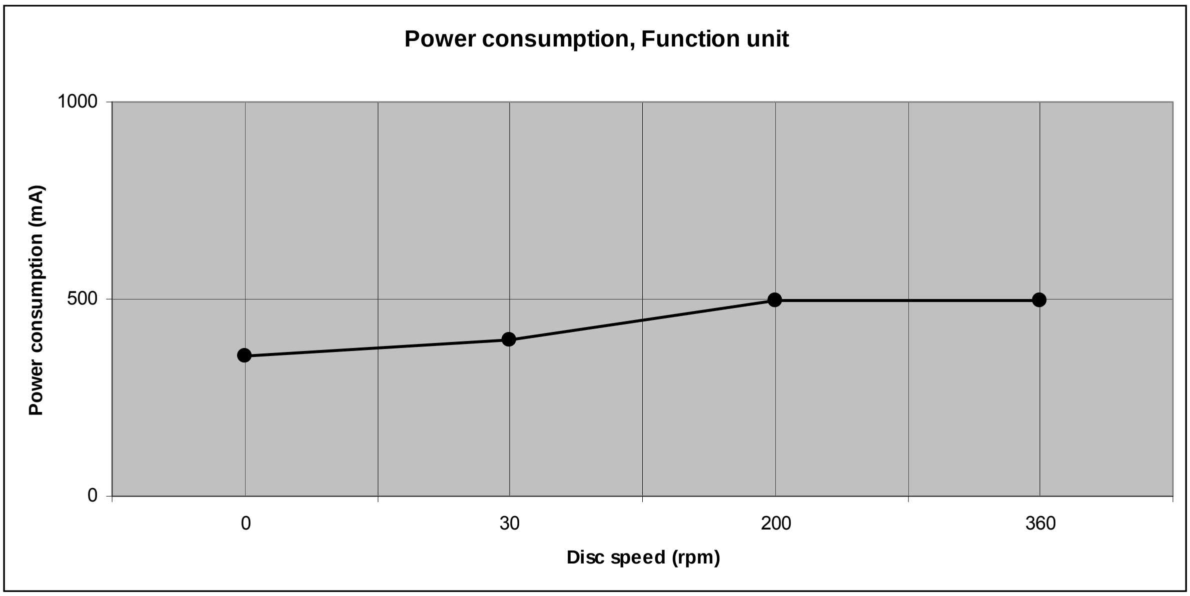


Figure 4 Power consumption, Function unit

<u>Electronics power supply:</u>

Each motor unit has continuous power consumption of approximately 85 mA for feeding all electronic components (except the external bus transceiver, see below)

<u>External bus power supply:</u>

If the motors are connected into a network all motors has to be supplied with power to CAN transceivers. These consume approximately 10 mA per motor unit.

2.2.2 Line control

Another main function for the electrical cabinet is the line control (this is not needed in the stand alone case).

Except the actual controller, there has to be a device for communicating over the external bus.
The easiest way to achieve this is to use a real master/scanner device.

If a Siemens S7-300 controller is used the following product can be used as a CANopen master: - Systeme Helmholz: CAN 300 PRO

If an Allen Bradley controller (CompactLogix) is used the following product can be used as a DeviceNet scanner: - 1769-SDN Scanner Module

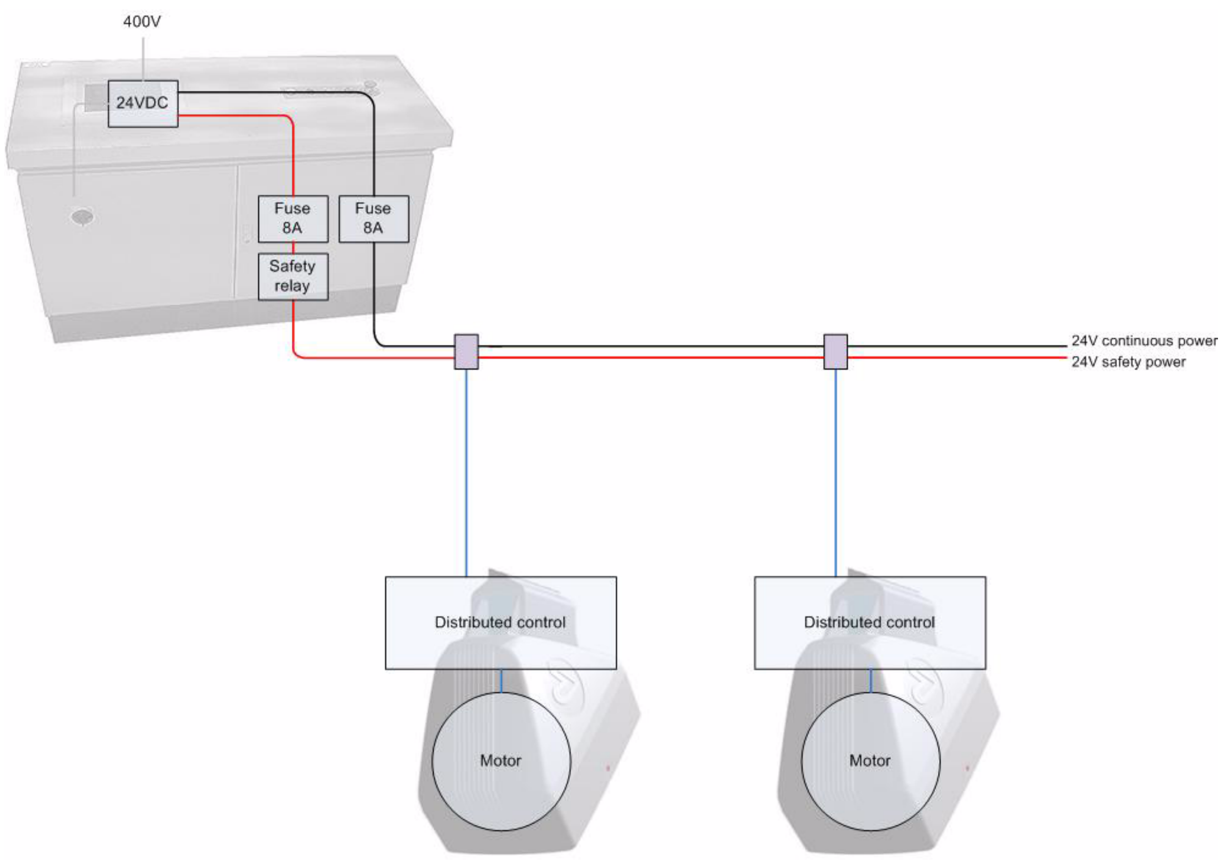
An alternative solution is to use a gateway that acts like a master/scanner on the external network (e.g. Profibus DP slave to CANopen master).

2.2.3 Safety function

The motors are prepared for the ability to cut the drive power but keep the logic power to the units. If the system will be designed with this feature some safety components has to be added in the main cabinet.

The power line with safe power has to be cut by a safety relay or a corresponding unit. This power supplies all the motors with drive power.

The continuous power line supplies all electrical components inside the motors. This makes the motors able to communicate even during a safety stop.



2.3 Electrical installation

One big advantage with the X45e platform is the process of installation and cabling

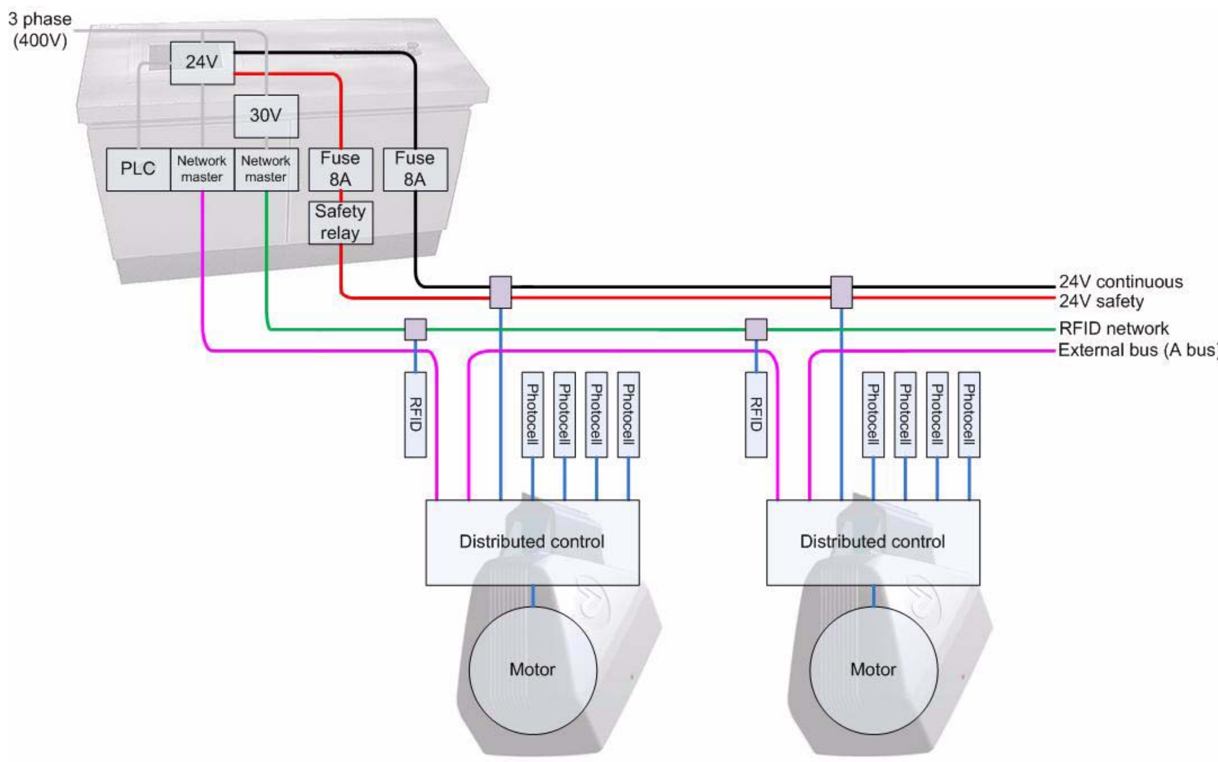


Figure 5 Overview of electrical installation

2.3.1 Power to the motor units

The motor units are supplied with power through a M12 A-coded contact (male contact on the motor).

Pin	Signal name	Direction	Function
1.	+24_POWER	In	+24V Supply for motor
2.	GND	Out	Ground
3.	GND	Out	Ground
4.	+24_LOGIC	In	+24 VDC supply for logic
5	NC	--	Not connected

Table 1 Pin configuration power supply contact

As can be seen in the table above both continuous (electronics) and safe (drive) power has to be distributed. This can be achieved by two separate flat cables (AS-Interface, auxiliary power type) and a connection cable that gathers those two flat cables into one drop cable with the appropriate M12 contact. The components below can be used for this purpose.

- Phoenix contacts: VS-ASI-J-Y-B-M12FS or VS-ASI-J-Y-B-PUR-1,0-M12Fs SCO
- Bihl Wiedemann: BW1974

The AS-I flat cables are rated maximum 8A. Many vendors can also supply a number of useful additional components in this AS-I concept (T-connectors, splitters,…).

2.3.2 External network (A-Bus)

The motor nodes have two standard M12 A-coded contacts for external bus connections (one in-connector and one out-connector). This network can be either CANopen or DeviceNet. Both of these are based on the lower level CAN and use the same connector types. The installation method is described separately for each protocol on the next pages. Use cables designed for CANopen or DeviceNet (same specification due to the fact that both protocols are built on the CAN field bus).

Pin	Signal name	Function
1.	CAN_SHLD	Shield
2.	+24V_CAN	+24VDC supported from outside
3.	GND_CAN	Ground CAN
4.	CAN_H	Dominant High
5.	CAN_L	Dominant Low

Table 2 Pin configuration CANopen/DeviceNet contacts

Example of cable components: (MURR Elektronik)
DeviceNet, CANopen, Male straight to female straight, M12 - M12, 5-pole, shielded
Art. No. 7000-40531-8031000 (1,0m)
Terminator M12, A-coded, 5-pole
Art. No. 7000-13461-0000000

2.3.3 CANopen

The layout on a CANopen network is line type (bus). The motors are linked by daisy chain. Each end has to contain a bus terminator (120 Ohm). Maximum number of nodes is 128.

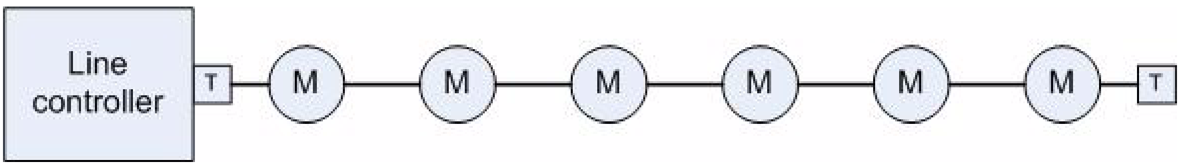


Figure 6 CANopen topology

2.3.4 DeviceNet

The layout on a DeviceNet network is trunk lines and drop lines. The motors on the drop lines are linked by daisy chain. A drop line can also be divided by a branch. Each end of the trunk line has to contain a bus terminator (120 Ohm). Maximum number of nodes is 64.

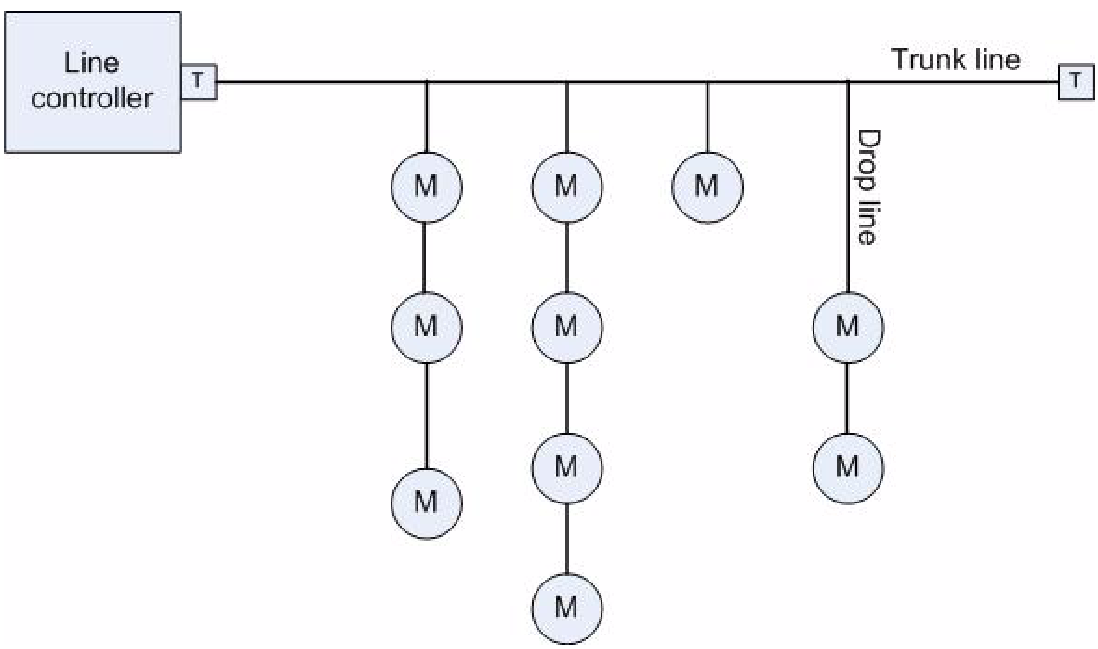


Figure 7 DeviceNet topology

2.3.5 Sensors

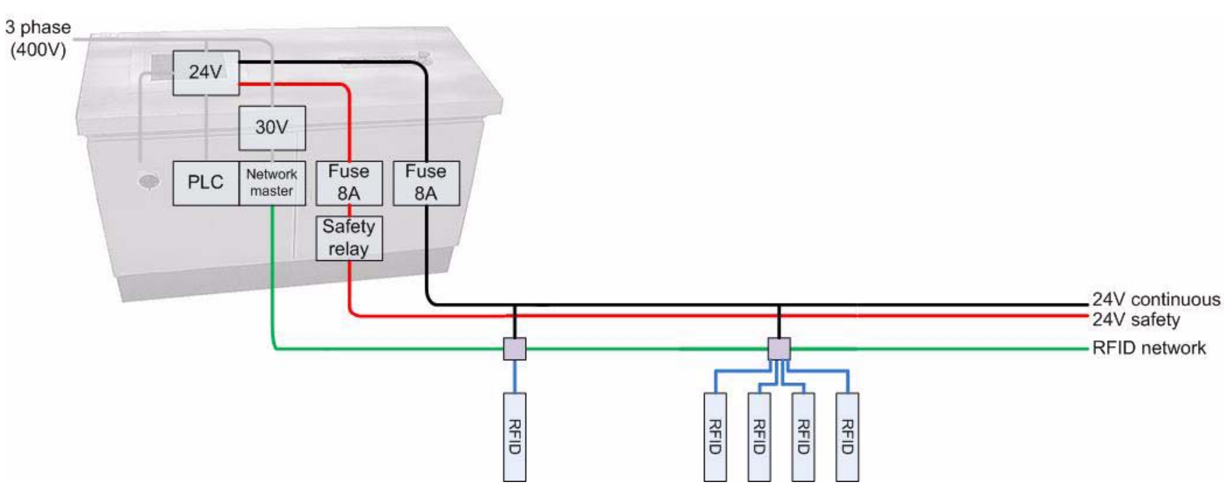
All sensors that are needed for each function are already connected before delivery. Each motor unit has four M8 contacts for digital sensors. If some of them are not connected there is a possibility to connect them with other sensors and read these signals over the external bus.

2.3.6 RFID

The RFID readers/writer used in the X45e platform are IDENT from Pepperl&Fuchs. These units communicate with a line controller via a field bus unit. This field bus unit can be ordered in with many different standard protocols e.g. Profibus, Profinet, DeviceNet and Ethernet IP. The field bus exists in different variants which can connect to 1,2 or 4 reader/writer units.

Recommended RFID components:
(Pepperl + Fuchs)
IQH1-F61-V1: Read/write head
IC-KP-B12-V45: Field bus node (4 channels, Ethernet IP/Profinet IO)
IC-KP2-2HB17-2V1D: Field bus node (2 channels, Ethernet IP/Profinet IO)
IQC33-30: RFID Tag, 16 kBit
IQC21-30P: RFID Tag, 1024 Bit
V1-G-5M-PUR-ABG-V1-W: Cable Read/write head – Field bus node

See FlexLink Product catalogue!



3 Software

3.1 Motor software

Each motor has two microprocessors running program to achieve the desired functionality of the motor. The first one is the drive controller. This controller sends the actual control signals to the motors and receives feedback. The second microprocessor runs the application program which completes the function. This controller receives signals from the sensors and communicates both down to the drive controller and up the line controller, if used. This controller has a set of parameter that can be changed in order to achieve certain function.

- How to set these parameters from a laptop can be read in the user documentation for the Parameter setting tool (51113270 in the Technical library at flexlink.com).

3.1.1 Motor parameters

Heartbeat

Counter limit for sending Heartbeat (on the A-Bus)

Address

The address of the node (Only possible to change on the B-Bus)
CANopen: 0-127
DeviceNet: 0-63

Motor type

1 = Conveyor motor (PM)
2 = Function motor (Stepper motor)
This parameter is read only and is preset from the production.

Enable drive

Enable the drive in Function or a Conveyor motor
0 = Disable
1 = Enable
Only valid if *A-bus enable drive and reset* Is set to 0.

Function mode

Only applicable to a Function motor
1 = Diverter
2 = Merger – Combined Diverter/Merger
3 = Transfer – Stop – Locating unit

A-Bus signal rate

Send Tx PDOs when a counter ≥ PDOTimer.
This timer specifies how often data is to be sent to a line controller.
This parameter must be different from zero in order to make the diagnosis function work from the Parameter setting tool software.

This parameter is only valid for CANopen. When DeviceNet is used this value is set in the DeviceNet scanner module.

HomingSpeed

The speed of Function motor when homing in Homing sequence
Interval: 0 – 360 rpm

Speed

The speed of a Conveyor motor or a Function motor

Conveyor motor

If the motor is a Right version positive speed values runs the conveyor in forward direction.
If the motor is a Left version negative speed values runs the conveyor in forward direction.

Speed value interval:
Right version: 80 – 400 rpm
Left version: - 80 – - 400 rpm

Function motor

Interval: 0 - 360 rpm

Torque

The torque of Conveyor motor
Interval: 0 – 100 %

Automatic reset errors

1 = FEG reset errors automatically when they appear
0 = Leave errors to be cleared by Line controller

Reset errors

Reset all errors by sending 1. If the value re-appears in PDO2Tx[Errors] the error is still valid

Acceleration ramp

The speed increasing ramp of a Function or a Conveyor motor
Increasing interval: 1 – 3000

Deceleration ramp

The speed decreasing ramp of Function or a Conveyor motor
Decreasing interval: 1 – 3000

Receive angle 1

The angle position 0 – 360° for receiving pucks from conveyor 1, counted clockwise relative the home position.

Receive angle 2

The angle position 0 – 360° for receiving pucks from conveyor 2, counted clockwise relative the home position.

Receive angle 3

The angle position 0 – 360° for receiving pucks from conveyor 3, counted clockwise relative the home position.

Release angle 1

The angle position 0 – 360° for releasing pucks to conveyor 1, counted clockwise relative the home position.

Release angle 2

The angle position 0 – 360° for releasing pucks to conveyor 1, counted clockwise relative the home position.

Wait angle 1

When the diverter has released a puck on conveyor 1 it can be set to go to a waiting position. The next receive command is completing the motion to the receive angle. This angle position is also counted clockwise relative the home position.

Wait angle 2

When the diverter has released a puck on conveyor 2 it can be set to go to a waiting position. The next receive command is completing the motion to the receive angle. This angle position is also counted clockwise relative the home position.

Mode

Activates test modes in FEG. This parameter value is automatically reset after reset.

0 = No test
1 = Flashing with LEDs
2 = Show digital input levels on LEDs
99 = Command to reboot the FEG processor.

Requested angle

This value is not set by the operator. It is updated by the homing function (Calibration).

Calibrate

Execute internal calibration sequence for a Function motor if MotorType = 2

Internal FEG Calibrate sequence

1. ECO standing still.
2. FEG changes the mode to: Calibrate mode (PDO2)
3. ECO saves the position and leaves Calibrate mode.
4. Position value in PDO1 is now updated to 0.
5. FEG Request 0 speed. (PDO1)

Thumb of rule for homing position:
- *The home position is always the forward direction of the conveyor the function unit is mounted on*.

Function Parameter 1, 2, 3, 4

See Appendix for detailed description

Time A

Timer value used for delays (in motor state During turn)

Time B

Timer value used for delays (in motor state Post turn)

Time C

Timer value used for delays (max queue)

Time D

Timer value used for delays (max queue)

Time E

Timer value used for delays (in motor state Pre turn)

Turn time limit

Max cycle time for a function motor until an alarm is triggered.
If this value is set to 0 the limit function is disabled.

Interlock mode

0 = No interlock
1 = Max queue
Max queue sensor has to be connected to digital input 4.
The following two timer values are activated:
Time C = On delay
Time D = Off delay

2 = Sensor enable
A sensor has to be connected to digital input 4.
The following two timer values are activated:
Time C = Off delay
Time D = On delay

Program version

This value is the revision of the embedded motor software.
This value is read only and can not be set by the operator.

Factory setting (not used)

1 = Restore factory settings
2 = Do nothing

A-bus enable drive and reset

0 = Disable drive control and clear error through PDO1rx
This means the bits enable and reset in the PDO are inactivated. These two signals have to be sent by SDO. Typically used for stand alone control.

1 = Enable drive control and clear error through PDO1rx
This means the bits enable and reset in the PDO are activated. These two signals are sent over the A-bus.

Network protocol

This value is setting the network type on the external bus (A-bus).
1 = CANopen
2 = DeviceNet

Motor power consumption

Momentary power consumption in Watt.
Only valid for a conveyor motor.

Operating years

Accumulated time when the enable signal is on (years)
This value is stored in the permanent memory of the motor unit.

Operating days

Accumulated time when the enable signal is on (days)
This value is stored in the permanent memory of the motor unit.

Operating hours

Accumulated time when the enable signal is on (hours)
This value is stored in the permanent memory of the motor unit.

Operating minutes

Accumulated time when the enable signal is on (minutes)
This value is lost when no power is supplied

Operating seconds

Accumulated time when the enable signal is on (seconds)
This value is lost when no power is supplied

Operating cycles (High word)

Accumulated number of cycles executed by a function motor. This value has to be interpreted together with the next parameter (the low word). These two values are only updated when the operating time is increased by 1 hour.

Operating cycles (Low word)

Accumulated number of cycles executed by a function motor. This value has to be interpreted together with the next parameter (the high word). These two values are only updated when the operating time is increased by 1 hour.

3.1.2 Motor state

The function motors have an internal sequence in order to complete its cycle.

	State	
0	Resque	
1	Init	Movement after power up
2	Pre-turn	Movement to receive the puck
3	During turn	Movement to release the puck
4	Post-turn	Movement after releasing the puck
5	Calibration	Movement during calibration
6	Idle	Wait for new order

Table 3 Motor state

3.2 Line control

The main purpose with the line control system is to send commands to the motors and receive status signals. If RFID are used the status of each RFID has to be read in order to send correct commands. Other tasks could be emergency/safety stop and HMI functionalities and communication with superior systems.

Some system can be designed without a line controller. These motor has to be parameterized to stand alone mode and will not communicate with anything except via digital inputs. The start/stop is following the supplied power.

3.2.1 Communication with motor nodes

Standard block handling the communication with the motor nodes can be downloaded from the X45e software download homepage at www.flexlink.com. There are two variants of these standard blocks:

- Allen Bradley (CompactLogix) with a DeviceNet Scanner
- Siemens (Siematic S7-300) with a CANopen master from Systeme Helmholdts (CAN 300 PRO)

3.2.2 Route handling

All the logic regarding reading and write RFID has to be dealt with in the line controller. This identification results in a route handling that can be achieved by the line controller sends some commands to the motors via the external network.

3.2.3 Alarm handling

The line controller can read out all alarms from the motors.
See chapter *External communication / Cyclic data / Data2:Error* for more info.
It is also possible to send a reset command to the motor units.

3.2.4 Safety functions

Because of the layout with two different power buses (logic and drive), there are possible to communicate with the nodes even under an emergency stop. This safety function has to be dealt with in the line controller.

3.2.5 Line start/stop

The overall start and stop of the line is of course something that has to be controlled from the line controller.

3.3 External communication

The external communication is the data transfer between the motors and the line controller. It uses two M12 connectors on each motor in order to interlink the units (daisy chain). These connectors are marked BUS A1 and BUS A2 on the motor label. The communication can be divided into two categories. First there is cyclic data. This data is sent frequent and contains all basic data needed for external control. The other kind of communication is acyclic data. This is not sent frequently but often on request. These two data transfer types have different names depending on which protocol is used.

3.3.1 Cyclic data

This data is time critical low volume data (less than 8 byte).

Line controller -> Motor

	Data0	Data1	Data2	Data3	Data4	Data5	Data6	Data7
	Control	Not used	Not used	Not used	Not used	Not used	Not used	Not used

Data 0: Control

Bit 7: Reset alarm
Bit 6: Enable
Bit 5: Reversed speed. Only for conveyor motors
Bit 4: Control bit 4 = Receive puck from conveyor 3
Bit 3: Control bit 3 = Receive puck from conveyor 2
Bit 2: Control bit 2 = Receive puck from conveyor 1
Bit 1: Control bit 1 = Release the puck to conveyor 2
Bit 0: Control bit 0 = Release the puck to conveyor 1

Motor -> Line controller

	Data0	Data1	Data2	Data3	Data4	Data5	Data6	Data7
	Status	Confirmation	Error	Byte3	Byte4	Byte5	Byte6	Byte7

Data 0: Status

Bit7: In position
Bit6: State bit 3 (see table below)
Bit5: State bit 2
Bit4: State bit 1
Bit3: Digital input 4
Bit2: Digital input 3
Bit1: Digital input 2
Bit0: Digital input 1

Data 1: Confirmation
Bit7: Not used
Bit6: Not used
Bit5: Not used
Confirmation bit 4 = Receive puck from conveyor 3
Confirmation bit 3 = Receive puck from conveyor 2
Confirmation bit 2 = Receive puck from conveyor 1
Confirmation bit 1 = Release the puck to conveyor 2
Confirmation bit 0 = Release the puck to conveyor 1

Data 2: Error

Bit7: Not used
Bit6: Error bit 6 – Turn time limit
Bit5: Error bit 5 – internal fault
Bit4: Error bit 5 – Locked rotor
Bit3: Error bit 4 – PCB over temp
Bit2: Error bit 3 – Low UDC
Bit1: Error bit 2 – High UDC
Bit0: Error bit 1 – Over current

Hand shake communication

When using the control and confirmation bits it is recommended use the following guidelines.

These requirements have to be fulfilled before a new command is sent to the unit:

- Step = 6 (Idle): Divider/Combiner
- Step = 3 (During turn): Locating unit
- No old commands are active (either receive or release)
- Unique evaluation for the application (RFID, sensor, …)

Then new commands can be sent to the unit. If both receive and release commands are used both can be sent simultaneously. These commands are individually reset by the confirmation bits from the motor.

3.3.2 Acyclic data

Acyclic data are for changing parameters that are not sent frequently over the communication bus. A list of these parameters can be found under Software/Motor software/Motor parameters.

3.3.3 Network trouble shooting

If problems occur regarding the external network Kvaser has software called CanKing that can be useful (for CANopen and DeviceNet). It is free to download from their homepage (www.kvaser.com).

The Parameter setting tool software has also some diagnostic features that can be helpful. More info on this issue can be found in the separate user documentation regarding this software (5113270 in the Technical library at www.flexlink.com).

3.4 CANopen

The baudrate on the X45e implementation of CANopen is 250Kb.

If Siemens S7-300 is chosen as a line controller and the CANopen master module CAN 300 PRO is used the following PLC blocks are supported and delivered by Systeme Helmholz:
FB20 - CANopen IO Read
FB21 - CANopen IO Write
FB24 - CANopen SDO (both for read and write)

Today there is only support for cyclic communication (not change of state, strobed or polled)

3.4.1 EDS file

Some CANopen masters use an EDS file (Electronic Data Sheet) for configuring how the slave communicates. A CANopen EDS file can be downloaded from the X45e software download homepage at www.flexlink.com.

3.4.2 The PDO – Process Data Exchange

Receive-PDO (RPDO) are sent from the master (line controller) and received by the slave (motor).

	Data0	Data1	Data2	Data3	Data4	Data5	Data6	Data7
PDO1Rx	Control	Not used	Not used	Not used	Not used	Not used	Not used	Not used

Transmit-PDO (TPDO) are sent from the slave (motor) and received by the master (line controller).

	Data0	Data1	Data2	Data3	Data4	Data5	Data6	Data7
PDO1Tx	Status	Confirmation	Error	Byte3	Byte4	Byte5	Byte6	Byte7

3.4.3 SDO – Service Data Objects

Index	Sub-index	Size	R/W	Min	Max	Scale	Unit	Name in Parameter setting tool
$1017	0	U16	RW	0	65535	1	ms	
$4000	0	U8	WR	1	127	1		Address
$4000	1	U8	WR	1	2	1		Motor type
$4000	2	U8	WR	0	1	1		
$4000	3	U8	WR	1	6	1		Function mode
$4000	4	U16	WR	10	65535	1	ms	A-Bus signal rate
$4000	5	BOOL	W	0	1	1		Calibrate
$4000	6	BOOL	W	0	1	1		
$4000	7	U16	WR	0	18000	1	rpm	Homing speed
$4000	8	U8	WR	1	3	1		
$4000	9	S16	WR	-32000	32000	1	rpm	Speed
$4000	10	U16	WR	0	1000	1	%	Torque
$4000	11	U16	WR	0	360	1	Deg	Receive angle 1
$4000	12	U16	WR	0	360	1	Deg	Receive angle 2
$4000	13	U16	WR	0	360	1	Deg	Release angle 1
$4000	14	U16	WR	0	360	1	Deg	Release angle 2
$4000	30	U16	WR	0	360	1	Deg	Receive angle 3
$4000	15	U16	WR	0	360	1	Deg	Wait angle 1
$4000	16	U16	WR	0	360	1	Deg	Wait angle 2
$4000	17	U8	WR	1	100	1	Hz/s	Acceleration ramp
$4000	18	U8	WR	1	100	1	Hz/s	Deceleration ramp
$4000	19	BOOL	WR	0	1	1		Enable drive
$4000	20	BOOL	WR	1	1	1		Reset errors
$4000	21	BOOL	WR	0	1	1		
$4000	22	U8	WR	0	3	1		Mode
$4000	23	U8	WR	1	5	1		Function parameter 1
$4000	24	U8	WR	1	5	1		Function parameter 2
$4000	25	U8	WR	1	5	1		Function parameter 3
$4000	26	U8	WR	1	5	1		Function parameter 4
$4000	27	U16	WR	0	65000	1	ms	Time A
$4000	28	U16	WR	0	65000	1	ms	Time B
$4000	33	U16	WR	0	65000	1	ms	Time C
$4000	34	U16	WR	0	65000	1	ms	Time D
$4000	47	U16	WR	0	65000	1	ms	Time E
$4000	31	U8	WR	0	1			Automatic erase errors
$4000	40	U8	WR	0	1			Factory settings
$4000	32	U8	WR	0	1			Interlock mode
$4000	35	U8	WR	0	1			Enable Drv-Clr PDO bits
$100A	0	Str	R					Program version
$1018	0	U16	R					

Table 4 CANopen SDO table

3.5 DeviceNet

The baudrate on the X45e implementation of DeviceNet is 250Kb.

3.5.1 EDS file

Some DeviceNet scanners use an EDS file (Electronic Data Sheet) for configuring how the slave communicates. A DeviceNet EDS file can be downloaded from the X45e software download homepage at www.flexlink.com.

3.5.2 I/O messages

Eight bytes of data are sent from the master (line controller) and received by the slave (motor).

	Data0	Data1	Data2	Data3	Data4	Data5	Data6	Data7
	Control	Not used	Not used	Not used	Not used	Not used	Not used	Not used

Eight bytes of data are sent from the slave (motor) and received by the master (line controller).

	Data0	Data1	Data2	Data3	Data4	Data5	Data6	Data7
	Status	Confirmation	Error	Byte3	Byte4	Byte5	Byte6	Byte7

3.5.3 Explicit messages

Class	Instance	Size	R/W	Min	Max	Scale	Unit	Name in Parameter setting tool
$70	0	U8	WR	1	127	1		Address
$70	1	U8	WR	1	2	1		Motor type
$70	2	U8	WR	0	1	1		
$70	3	U8	WR	1	6	1		Function mode
$70	4	U16	WR	10	65535	1	ms	A-Bus signal rate
$70	5	BOOL	W	0	1	1		Calibrate
$70	6	BOOL	W	0	1	1		
$70	7	U16	WR	0	18000	1	rpm	Homing speed
$70	8	U8	WR	1	3	1		
$70	9	S16	WR	-32000	32000	1	rpm	Speed
$70	10	U16	WR	0	1000	1	%	Torque
$70	11	U16	WR	0	360	1	Deg	Receive angle 1
$70	12	U16	WR	0	360	1	Deg	Receive angle 2
$70	13	U16	WR	0	360	1	Deg	Release angle 1
$70	14	U16	WR	0	360	1	Deg	Release angle 2
$70	30	U16	WR	0	360	1	Deg	Receive angle 3
$70	15	U16	WR	0	360	1	Deg	Wait angle 1
$70	16	U16	WR	0	360	1	Deg	Wait angle 2
$70	17	U8	WR	1	100	1	Hz/s	Acceleration ramp
$70	18	U8	WR	1	100	1	Hz/s	Deceleration ramp
$70	19	BOOL	WR	0	1	1		Enable drive
$70	20	BOOL	WR	1	1	1		Reset errors
$70	21	BOOL	WR	0	1	1		
$70	22	U8	WR	0	3	1		Mode
$70	23	U8	WR	1	5	1		Function parameter 1
$70	24	U8	WR	1	5	1		Function parameter 2
$70	25	U8	WR	1	5	1		Function parameter 3
$70	26	U8	WR	1	5	1		Function parameter 4
$70	27	U16	WR	0	65000	1	ms	Time A
$70	28	U16	WR	0	65000	1	ms	Time B
$70	33	U16	WR	0	65000	1	ms	Time C
$70	34	U16	WR	0	65000	1	ms	Time D
$70	47	U16	WR	0	65000	1	ms	Time E
$70	31	U8	WR	0	1			Automatic erase errors
$70	40	U8	WR	0	1			Factory settings
$70	32	U8	WR	0	1			Interlock mode
$70	35	U8	WR	0	1			Enable Drv-Clr PDO bits
$70	0	Str	R					Program version
$70	0	U16	R					

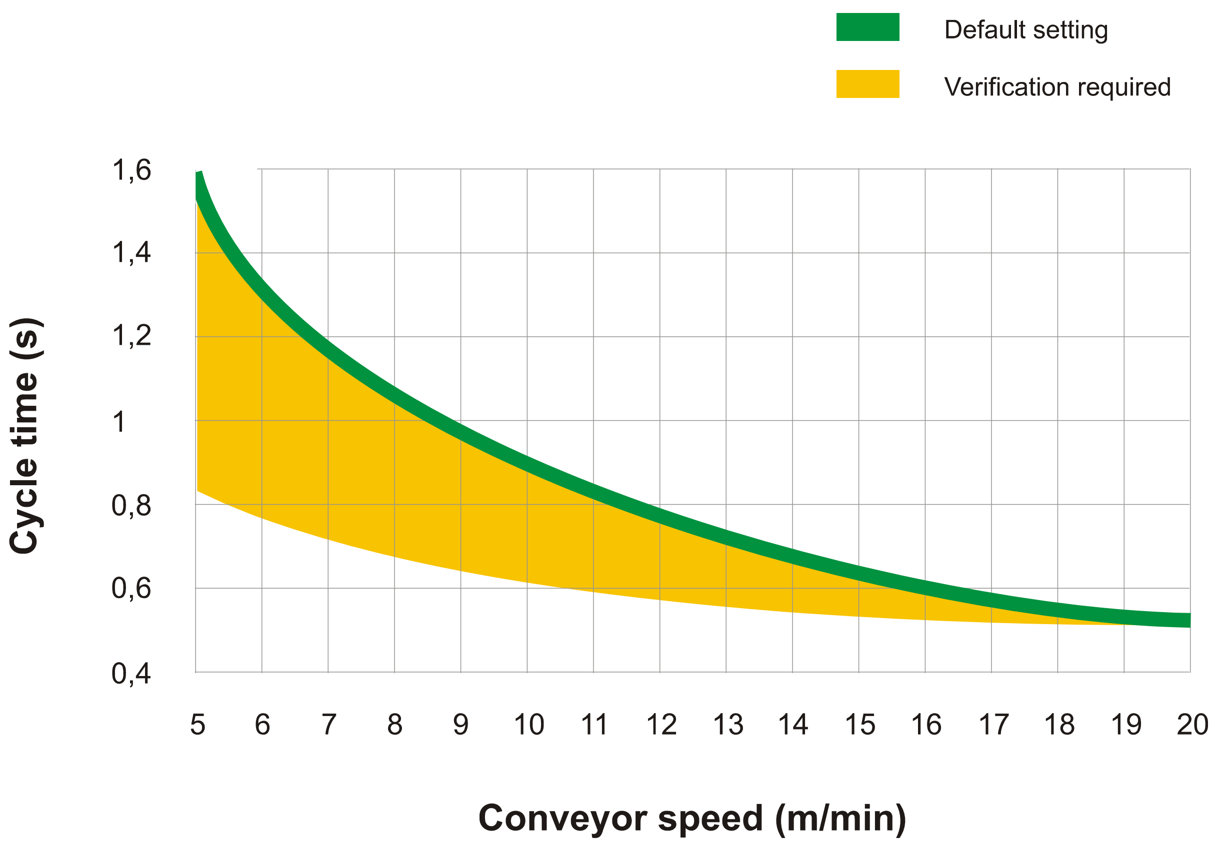
Table 5 DeviceNet explicit messages table

4 Appendix

4.1 Speed parameter settings

Conveyor velocity (m/min)	Speed parameter Conveyor motor (rpm)	Speed parameter Function motor (rpm)	Release puck delay Time B (ms)
5	92	27	350
6	110	32	
7	122	37	
8	138	42	200
9	153	47	
10	168	52	150
11		57	
12	200	62	
13		67	
14		72	
15	250	77	75
16		82	
17		87	
18		92	
19		97	
20	326	102	

4.2 Cycle time (Function units)



4.3 Function Parameters, detailed table

Function	Function parameter	value	Trigger	Direction	Destination	Extra	Extra
Diverter	1: Init	1		CCW	INA		
		2		CW	INA		
	2: Pre turn	1	DI1	CCW	INA		
		2	DI1	CW	INA		
		3	DI1	CW/CCW	INA	Direction = same as last movement	
		4	DI3	CCW	INA		
		5	DI3	CW	INA		
		6	DI3	CW/CCW	INA	Direction = same as last movement	
		7	External command = 4	CCW	INA		
		8	External command = 4	CW	INA		
		9	External command = 4	CW/CCW	INA	Direction = same as last movement	
		10	External command = 1 or 2			Jump to during prod	
	3: During production	1	DI3	CCW	OUTA	Every other time	Time A delay
				CW	OUTB	Every other time	Time A delay
		2	DI3	CW	OUTA	Every other time	Time A delay
				CCW	OUTB	Every other time	Time A delay
		3	DI3 and DI2	CCW	OUTA		Time A delay
			DI3 and not DI2	CW	OUTB		Time A delay
		4	DI3 and DI2	CW	OUTA		Time A delay
			DI3 and not DI2	CCW	OUTB		Time A delay
		5	DI3 and not DI2	CW	OUTA		Time A delay
			DI3 and DI2	CCW	OUTB		Time A delay
		6	DI3 and not DI2	CCW	OUTA		Time A delay
			DI3 and DI2	CW	OUTB		Time A delay
		7	External command = 1	CCW	OUTA		
			External command = 2	CW	OUTB		
		8	External command = 1	CW	OUTA		
			External command = 2	CCW	OUTB		
	4: Post turn	1	OUTA	CCW	WAA		Time B delay
			OUTB	CW	WAB		Time B delay
		2	OUTA	CW	WAA		Time B delay
			OUTB	CCW	WAB		Time B delay

Function Parameters, detailed table (continued)

Function	Function parameter	value	Trigger	Direction	Destination	Extra	Extra
Merge/Combiner	1: Init	1		CCW	OUTA		
		2		CCW	OUTB		
	2: Pre turn	1	DI1	CW	INA		
			DI2	CCW	INB		
		2	DI1	CCW	INA		
			DI2	CW	INB		
		3	DI1 and OUTA	CW	INA		
			DI1 and OUTB	CCW	INA		
			DI2 and OUTA	CCW	INC		
			DI2 and OUTB	CW	INC		
		4	DI1 and OUTA	CCW	INA		
			DI1 and OUTB	CW	INA		
			DI2 and OUTA	CW	INC		
			DI2 and OUTB	CCW	INC		
		5	Ext cmd = 4 and OUTA	CW	INA		
			Ext cmd = 4 and OUTB	CCW	INA		
			Ext cmd = 8 and OUTA	CCW	INB		
			Ext cmd = 8 and OUTB	CW	INB		
			Ext cmd = 16 and OUTA	CCW	INC		
			Ext cmd = 16 and OUTB	CW	INC		
		6	Ext cmd = 4 and OUTA	CCW	INA		
			Ext cmd = 4 and OUTB	CW	INA		
			Ext cmd = 8 and OUTA	CW	INB		
			Ext cmd = 8 and OUTB	CCW	INB		
			Ext cmd = 16 and OUTA	CW	INC		
			Ext cmd = 16 and OUTB	CCW	INC		
		7	DI1 and OUTA	CW	INA		
			DI1 and OUTB	CCW	INA		
			DI2 and OUTA	CCW	INB		
			DI2 and OUTB	CW	INB		
		8	DI1 and OUTA	CCW	INA		
			DI1 and OUTB	CW	INA		
			DI2 and OUTA	CW	INB		
			DI2 and OUTB	CCW	INB		
	3: During production	1	DI3	CCW	OUTA		Time A delay
			DI4	CW	OUTB		Time A delay
		2	DI3	CW	OUTA		Time A delay
			DI4	CCW	OUTB		Time A delay
		3	DI3	CCW	OUTB		Time A delay
			DI4	CW	OUTA		Time A delay
		4	DI3	CW	OUTB		Time A delay
			DI4	CCW	OUTA		Time A delay
		5	DI3	CW	OUTB		Time A delay
			DI4	CW	OUTA		Time A delay
		6	DI3	CCW	OUTB		Time A delay
			DI4	CCW	OUTA		Time A delay
		7	Ext cmd = 1 and INA	CCW	OUTA		
			Ext cmd = 1 and (INB or INC)	CW	OUTA		
			Ext cmd = 2 and INA	CW	OUTB		
			Ext cmd = 2 and (INB or INC)	CCW	OUTB		
		8	Ext cmd = 1 and INA	CW	OUTA		
			Ext cmd = 1 and (INB or INC)	CCW	OUTA		
			Ext cmd = 2 and INA	CCW	OUTB		
			Ext cmd = 2 and (INB or INC)	CW	OUTB		
	4: Post turn	1					Time B delay

Function Parameters, detailed table (continued)

Function	Function parameter	value	Trigger	Direction	Destination	Extra	Extra
Transfer/Stop/Locating	1: Init	1		CCW	INA		
		2		CW	INA		
		3		CCW	OUTA		
		4		CW	OUTA		
	2: Pre turn	1	DI1	CCW	WAA		Time E delay
		2	DI1	CW	WAA		Time E delay
		3	DI1	CCW	WAB		Time E delay
		4	DI1	CW	WAB		Time E delay
		5	DI1	CCW	INA		Time E delay
		6	DI1	CW	INA		Time E delay
		7	DI1 and External command = 4	CCW	INA		
		8	DI1 and External command = 4	CW	INA		
		9		CW	INA		Time E delay
		10		CCW	INA		Time E delay
	3: During production	1		CCW	OUTA		Time A delay
		2		CW	OUTA		Time A delay
		3		CCW	OUTB		Time A delay
		4		CW	OUTB		Time A delay
		5	External command = 1	CW	OUTA		
		6	External command = 1	CCW	OUTA		
		7	DI1	CCW	OUTB		Time A delay
		8	DI1	CW	OUTB		Time A delay
		9	DI2	CW	OUTA		
		10	DI2	CCW	OUTA		
	4: Post turn	1		CCW	INA		Time B delay
		2		CW	INA		Time B delay
		3		CCW	OUTA		Time B delay
		4		CW	OUTA		Time B delay