



# **BX18 Arc generator Installation and EtherCAT programmers manual**



**Document revision 0.8**

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## 2 Document history

Version number	Date	Changes	Author	State
0.1	06-Jan-2023	Initial version	M. Bax	Draft
0.2	06-Jan-2023	Added note to command output PDO that only 1 bit at a time is allowed to change, else error is flagged by bit #1 in status feedback.	M.Bax	Draft
0.3	07-Jan-2023	Updated the servo feedback figures	M.Bax	Draft
0.4	9-Jan-2023	Switched the electrode positive and negative bit meaning in section 7.1.1	M.Bax	Draft
0.5	19-Feb-2023	Updated the appendix B to include ESTOP. Updated the input PDO status table to include ESTOP.	M.Bax	Draft
0.6	20-Mar-2023	Added chapter 8, updated appendix A	M.Bax	Draft
0.7	25-Mar-2023	Added chapters 3,4,5 and 6	M. Bax	Draft
0.8	04-May-2023	Updated the status and command tables to include the change indicating bits for ontime, offtime and current and the bit to reset these. Applicable for BX18 firmware versions 0.3 or newer.  Also added the firmware update chapter.	M.Bax	Draft

## 3 Welcome note

Thank you for purchasing the BaxEDM BX18 Arc Generator! BaxEDM is a startup company. We focus on bringing EDM arc generators and related products to market that will allow upgrading of outdated/defective EDM machines or the construction of custom EDM machines. BaxEDM has a very strong focus on uncompromising product quality and we continuously seek ways to improve our products. Therefore, your feedback is highly appreciated.

## 4 Intended use




This product is designed only for inclusion by professional installers within other equipment; it must not be operated as a stand alone product.


## 5 Safety Information

### 5.1 General safety instructions







The BX18 arc generator operates at a potentially lethal working voltage of 150V, and can supply high power levels. In addition, the radiated emission levels of the arcing process are very high. These properties require that care must be taken in the application of the BX18 arc generator and in the design and use of the EDM machine in which it is integrated.


This document contains instructions for use, implementation tips and safety requirements. The following symbols are used throughout the document to highlight safety related requirements or other information that requires extra attention.

	<b>WARNING:</b> Risk of personal injury or death from electric shock
	<b>CAUTION:</b> A caution alerts you to potential hazards. Failure to observe a caution may result in minor injury, damage to the product or might disrupt equipment in the environment.
	<b>IMPORTANT:</b>

	An important instruction alerts you to important critical information
	<p><b>NOTE:</b></p> <p>Indicates content that provides additional information</p>

## 5.2 Safety instructions for the BX18 arc generator and the parent EDM machine

	<p><b>WARNING:</b></p> <p>Do not touch the workpiece during EDM operation.</p>
	<p><b>WARNING:</b></p> <p>Do not touch the electrode or EDM wire during operation.</p>
	<p><b>WARNING:</b></p> <p>Do not operate the machine without protective earth.</p>
	<p><b>WARNING:</b></p> <p>Do not operate the machine without an earth leakage current breaker in the mains supply.</p>
	<p><b>WARNING:</b></p> <p>Never operate unshielded EDM machines in case you have a pace maker or similar electronic devices.</p>
	<p><b>WARNING:</b></p> <p>Do not operate the machine without a warning light.</p>


	<p><b>CAUTION:</b></p> <p>It is the responsibility of the engineer/installer of the custom EDM machine to implement the correct EMC measures.</p>
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## 5.3 EMC

The BX18 Arc generator is constructed from a 19" closed aluminum grounded enclosure. Without cables attached, the radiated emission levels are very low.

When an unshielded power cable is connected, it will partly function as an antenna that will couple a large amount of radiated emission into the environment. This emission could disturb other equipment in that same environment, which could introduce safety risks.

In order to prevent this, the power cable to the EDM machine should be shielded and grounded. The EDM machine itself should be enclosed by a grounded shielded cage.

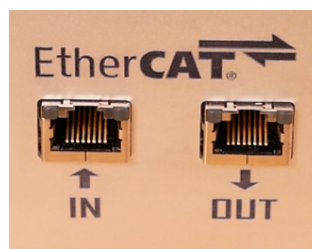
	<p><b>CAUTION:</b></p> <p>It is the responsibility of the engineer/installer of the custom EDM machine to implement these EMC measures.</p>
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## 6 Electrical interfaces

The BX18 arc generator has 5 different types of electrical interfaces, 1 on the front panel, 4 on the back. The functions of these interfaces and their individual pinouts are described in the following sections.

### 6.1 Front panel interface

The BX18 front panel interface is the EtherCAT interface, consisting of an EtherCAT input as well as an EtherCAT output.



The input, labeled “IN” is used to control the BX18 over EtherCAT. The output is labeled “OUT” and is used optionally if the application requires multiple EtherCAT devices on the same bus and the arc generator is not the last device on the daisy chain. For the complete software specification on the use of EtherCAT, please refer to chapter 4.



**NOTE:**

For good noise immunity of the EtherCAT interface, the use of Ethernet cables of class 7 or higher is recommended.

## 6.2 Rear panel interfaces

The rear panel has 4 different interfaces; X1, EDM output, X2 and X3. The following paragraphs describe their functions and pinouts.

### 6.2.1 Mains inlet - X1

The mains inlet X1 is of the standard type IEC C13.



It has the following specifications:

Property	Specification
Input voltage	110V-230V
Input frequency	50-60Hz
Max power	350W
Device fuses	Two fuses of 4A each , slow blow. The fuses can be replaced by opening the flip-out door on the chassis body of interface X1.



**WARNING:**

- Do not operate the arc generator without an earth connection
- Do not operate the arc generator without an earth leakage current breaker in the mains supply.




## 6.2.2 EDM Output

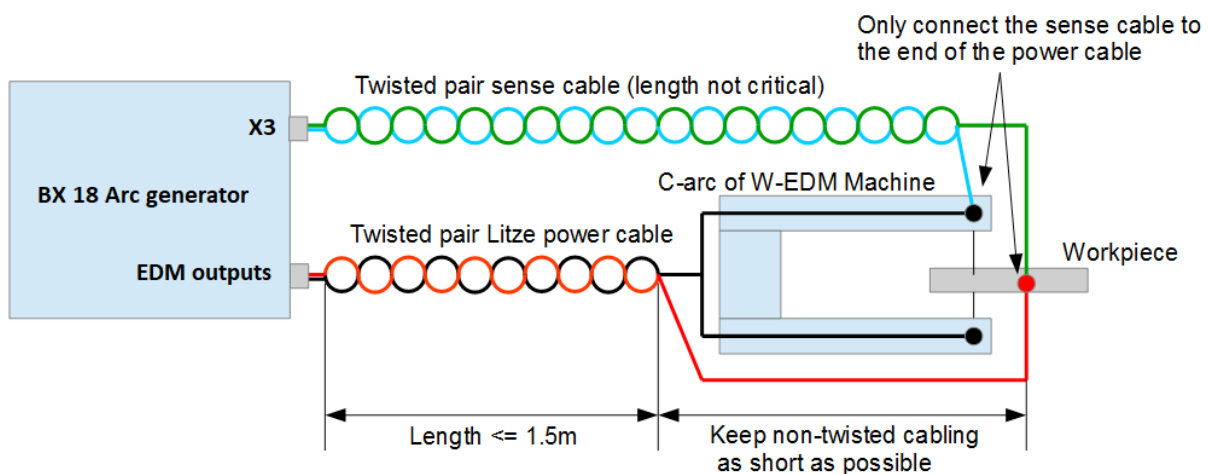
The EDM output on the rear of the BX18 has 3 different interfaces onto which ring terminals can be fixed.



Terminal label	Function	Fastener type
EDM: Workpiece	EDM power output that should be connected to the workpiece. It can either be positive or negative, depending on the arc generator settings.	M4
EDM: Electrode	EDM power output that should be connected to the electrode. It can either be positive or negative, depending on the arc generator settings.	M4
Unlabeled	Ground and/or fastening hole for an isolating plastic cover.	M3, max 8 mm long



	<p><b>CAUTION:</b></p> <p>The EDM electrode and workpiece terminals may never be connected to a ground potential. This will lead to damage to the arc generator. Both outputs must be kept electrically floating.</p>
	<p><b>CAUTION:</b></p> <p>For the M3 ground mounting point, do not use screws longer than 8mm. Longer screws will lead to damage and malfunction.</p>
	<p><b>NOTE:</b></p> <p>Long power cables degrade EDM performance. Keep the power cable max length to 1.5m. Make sure to twist the power cables together to minimize induction as indicated in the illustration below.</p>




### 6.2.3 ESTOP and warning light connector - X2

Connector X2 has 6 pins:



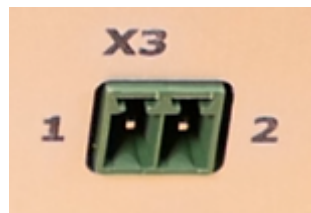
Pin number	Function / description
1	ESTOP overwrite. Connect this pin to pin #2 in X2 to disable ESTOP

	functionality
2	+12V non isolated output, can be used for a light that indicates the generator has power, and/or connect it to pin #1 to disable the ESTOP functionality.
3	+24V isolated ESTOP input. Run continuous 24V to this pin for normal operation. Disconnecting the 24V will lead to an immediate ESTOP condition.
4	Isolated ground to be used for the ESTOP input.
5	+12V warning light output, non isolated. This output becomes active when the EDM output is enabled. The sourcing current capacity of this pin is 1A. Only use LED lights, not incandescent bulbs, since the inrush current of incandescent bulbs might trigger a LV power error.
6	Non isolated ground, to be used for the EDM active warning light

	<p><b>NOTE:</b></p> <p>Only use LED lights to connect to X2, not incandescent bulbs. The inrush current of incandescent bulbs might trigger a LV power error.</p>
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#### 6.2.4 Arc sense input - X3

Connector X3 has two pins:



Pin number	Function / description
1	Sense wire input for the workpiece potential. Connect this pin with a long twisted pair thin cable to the end of the workpiece EDM power cable, as indicated in the illustration in section 6.2.2
2	Sense wire input for the electrode potential. Connect this pin with a long twisted pair thin cable to the end of the electrode EDM power cable, as indicated in the illustration in section 6.2.2

# 7 EtherCat Interface

## 7.1 Input PDOs

Input PDOs (Process Data Objects) are data variables that can be read by the EtherCAT master. The BX18 arc generator uses 3 input PDOs which are described in the following sub sections.

### 7.1.1 Input PDO - Status

The status input PDO is of type uint16\_t, two bytes. The following table describes the function of the individual bits.

Bit number (LSB = #0)	Meaning when 0	Meaning when 1
0	Requested settings are valid	Requested settings are invalid, see appendix A
1	Requested state transition valid	Requested state transition invalid, see appendix B
2	EDM output disabled	EDM output active
3	Edgefind mode disabled	Edgefind find mode enabled
4	Edge not found	Edge found
5	ISO frequency mode for EDM	ISO pulse mode for EDM
6	Electrode negative operation	Electrode positive operation
7	No fault	Power fault
8	No fault	Low voltage supply fault
9	No fault	High voltage supply fault
10	ESTOP Inactive	ESTOP Activated
11	The Ontime parameter has not changed since last reset toggle of bit #4 in the output control PDO.	The Ontime parameter has changed since last reset toggle of bit #4 in the output control PDO.
12	The Offtime parameter has not changed since last reset toggle of bit #4 in the output control PDO.	The Offtime parameter has changed since last reset toggle of bit #4 in the output control PDO.
13	The Current parameter has not changed since last reset	The Current parameter has changed since last reset

	toggle of bit #4 in the output control PDO.	toggle of bit #4 in the output control PDO.
14-15	Reserved	Reserved

### 7.1.2 Input PDO - EDMservofeedback

The EDMservofeedback input PDO is of type uint16\_t. This input PDO is only valid when the EDM output is enabled. The maximum value is 4095 and the minimum value is 0. The table below describes the ranges.

Range	Meaning
EDMservofeedback < 800	The EDM process is shorting out. The lower the value, the stronger the short.
800 < EDMservofeedback < 4000	EDM is taking place. In the upper region of this range only a small percentage of the EDM pulses are actually striking arcs. In the lower region all arcs are striking and occasional shorts might happen.  The CNC must servo the machine axes to control this voltage. An initial value for the servo to target for the EDMservofeedback can be 3000. The lower the target in this range is chosen, the more aggressive the cut will be, cutting faster but with less cutting stability (more servo fluctuations). A compromise will need to be chosen for each material and arc generator setting.
EDMservofeedback > 4000	The EDM process is not arcing, for instance when the gap between the electrode and workpiece is too large.

### 7.1.3 Input PDO - power

The power input PDO is of type uint16\_t, two bytes. Its value denotes the actual supply power being used in Watts. Any power usage in excess of 300 Watt will trigger a power fault. When a power fault occurs, the EDM output turns off automatically.

## 7.2 Output PDOs

Output PDOs (Process Data Objects) are data variables that can be written to by the EtherCat master. The BX18 arc generator uses 4 input PDOs which are described in the following sub sections.

### 7.2.1 Output PDO - control

The controlByte output PDO is of type uint16\_t, two single bytes. The following table describes the function of the individual bits. Note that writing to this PDO must follow appendix B for correct operation. It is only allowed to change 1 bit at a time, otherwise an error is raised (bit #1 in the status PDO will be set and the EDM output will be turned off).

Bit number (LSB = #0)	Meaning when 0	Meaning when 1
0	EDM off	EDM on
1	ISO-Pulse operation	ISO-Frequency operation
2	Edgefind off	Edgefind on
3	Electrode negative operation	Electrode positive operation
4	Toggle this bit from low to high to low to reset the Status.11, Status.12 and Status.13 change indicating bits in the Status input PDO.	
5-14	Reserved	Reserved
15	Normal operation	Reserved for experimental mode

### 7.2.2 Output PDO - onTime

The onTime output PDO is of type uint16\_t, two bytes. The onTime unit is microseconds and is subject to the limits specified in appendix A.

### 7.2.3 Output PDO - offTime

The offTime output PDO is of type uint16\_t, two bytes. The offTime unit is microseconds and is subject to the limits specified in appendix A.

### 7.2.4 Output PDO - current

The current output PDO is of type uint16\_t, two bytes. The current unit is Amperes / 10, (so a value of 300 will give the maximum EDM current of 30A) and is subject to the limits specified in appendix A.

## 8 Handling power errors

The BX18 arc generator internally uses several power supplies. If any of these power supplies signal a NOK, the EDM output will be disabled and the LV power error or HV power error bit in the status PDO is set depending on which supply failed.

It might happen that during EDM operation too much power is drawn, the HV supply signals an error and the generator output is switched off automatically for protection. When the output is switched off however, the supplies will recover, signal a OK and the HV power error bit will reset itself. So it is important to monitor these power error bits such that if the generator turns off, the momentary signaling by the power error bit will tell you why the output was turned off.

HV power errors occur due to overloading and can be prevented by monitoring the power feedback which at all times should stay below 300W. If the power readout shows that the power is close to 300W, reduce the EDM current and/or pulse on time.

LV power errors should not occur during EDM operation. If an LV power error occurs it is likely that the warning light 12V output is overloaded. Disconnect the warning light wires to see if this resolves the problem. If the LV power problem persists, contact BaxEDM.

## 9 Applicable directives and compliance

The BX18 arc generator is CE marked and meets the following directives and standards.

- 73/23/EEC, the Low Voltage Directive (LVD)
- 92/59/EEC, the General Product Safety Directive
- EN60950

This Arc Generator is a “Component power supply” as defined in [2] and therefore EMC cannot be tested independently. It needs to be installed into the end system and connected to the load. Only then the EMC check of the system as a whole can be performed. The test result will be significantly influenced by the application or assembly of the end system.

Based on [2], only products “intended for the end user” (such as an external power supply adaptor) should comply with the EMC directive. Component power supplies like this arc generator, which is intended for incorporation into an EDM machine by professional system integrators, are excluded from the EMC directive.

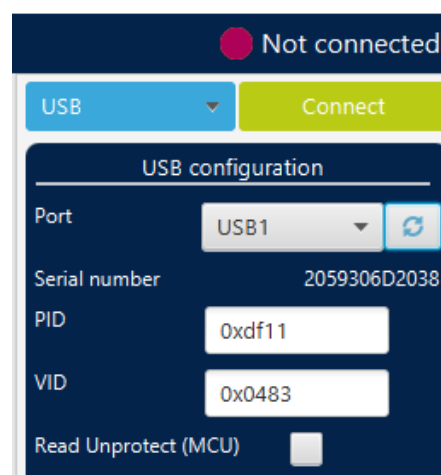
## 10 Maintenance

The BX18 Arc generator requires little maintenance. The top of the enclosure is perforated to allow efficient cooling. Depending on the environment conditions dust might build up inside the enclosure. It is advised to periodically check for excessive dust and if present remove the dust with short bursts of compressed air. Do not use a vacuum cleaner as this might damage the printed circuit boards.

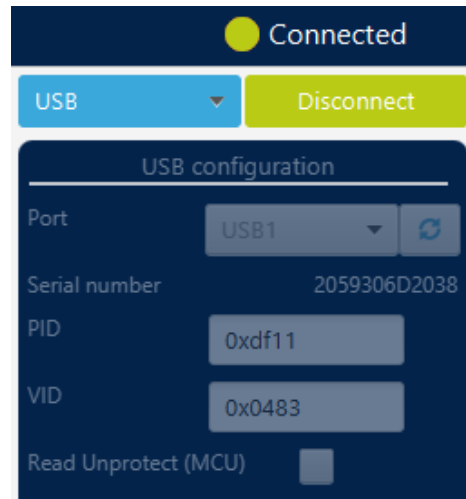
## 11 Firmware updates

The firmware of the BX18 can be updated with the STM32CubeProgrammer software available from ST microelectronics. To perform a firmware update, please prepare a windows PC with this software.

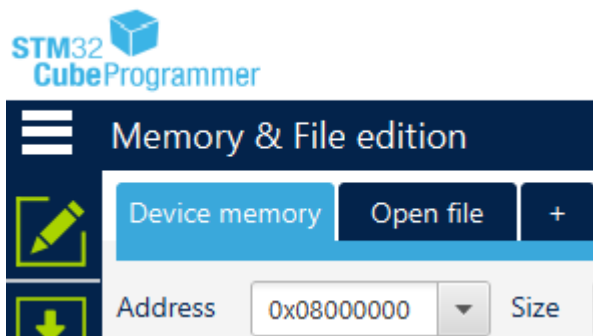
- 1) Disconnect the BX18 from mains and download the firmware file e.g. BX18-Rev03.zip from baxedm.com Then extract it to get the \*.hex file
- 2) Remove the 4 Torx screws from the top cover of the BX18
- 3) Remove the top cover
- 4) Connect a micro USB cable between a windows PC and the BX18 control board, located in the lower left corner inside.
- 5) Make sure the PC is turned on and is supplying USB power by checking LEDs D2 and D3 on the control board, both should be lit.
- 6) Press and hold the switch labeled “RESET SWITCH”
- 7) Press and hold the switch labeled “USB BOOTLOAD SWITCH”
- 8) Release the switch labeled “RESET SWITCH”
- 9) Release the switch labeled “USB BOOTLOAD SWITCH”
- 10) Open the STM32CubeProgrammer application on the windows PC.
- 11) Select USB as connection method, then click connect. You might need to click the refresh port button before connecting.



- 12) Check that the connection is successful.

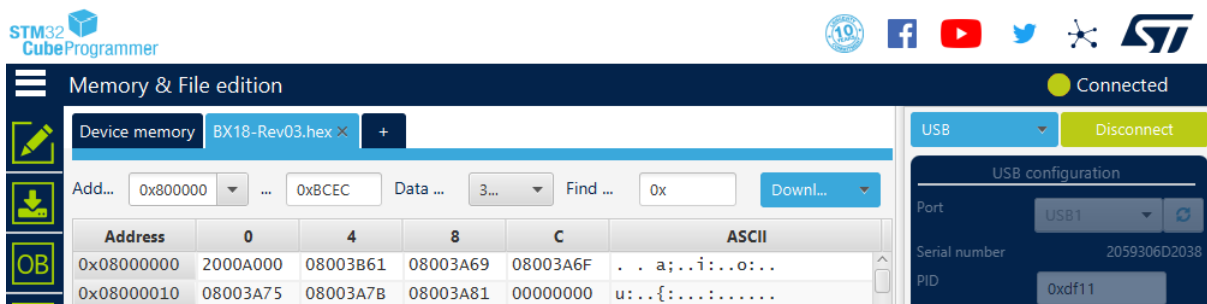


13) Now click on “open file”:



14) Select the BX18 firmware image file, e.g. BX18-Rev03.hex

15) When the file is opened, click on “Download” and wait.



16) Now click disconnect, the firmware has been updated

17) Disconnect the USB cable

18) Slide back the top cover

19) Refasten the Torx screws with just 0.1-0.15 Nm max torque. Be careful not to over torque these screws, the threads damage easily.

20) Firmware update done.



## 12 Technical specifications

Characteristic	Specification
Mains input voltage	110-240VAC
Output current	2-30A, adjustable in 0.1A steps
Maximum output voltage	150V
Operating modes	<ul style="list-style-type: none"><li>• ISO-Frequency</li><li>• ISO-Pulse</li><li>• Edge find</li></ul>
EDM On-Time	1-100 us, in 1us steps
EDM Off-Time	1-100 us, in 1us steps
Operating temperature conditions	0C-35C
Storage temperature conditions	-10C-40C
Relative humidity conditions	20%-80%, non condensing
Air pressure range	950 hPa - 1050 hPa

## 13 References

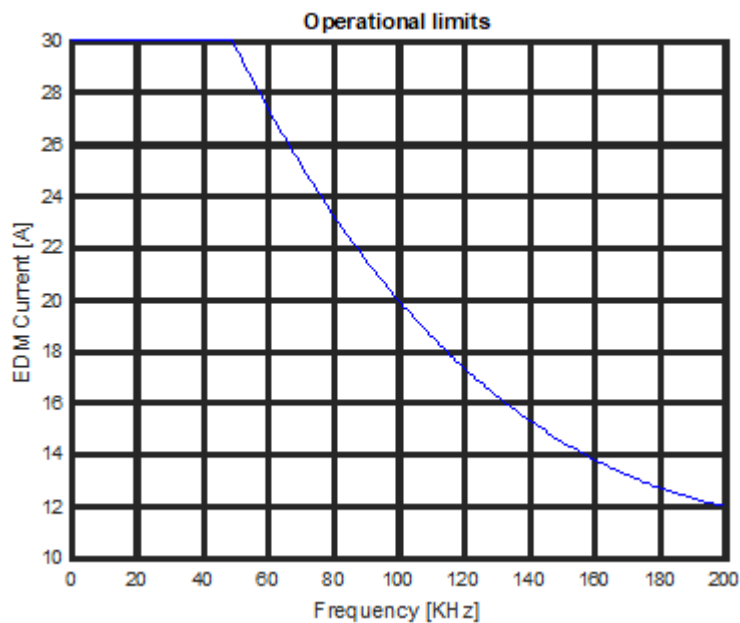
#	Document title	Author / Published by
[1]	“CE Marking Guidance For Power Supplies”	European Power Supply Manufacturers Association
[2]	“Guide for the EMC Directive 2004/108/EC”	European Union
[3]	UM2237 - STM32CubeProgrammer software description	ST-Microelectronics

## Appendix A - Valid parameter settings

The output PDOs for onTime, offTime and current are checked for validity by the arc generator. If any of these PDOs or a combination of these PDOs leads to an invalid arc generator setting, the EDM output is switched off and bit #0 in the status input PDO is set.

The combination of onTime, offTime and current is only valid if:

- The current in [A/10] must lie in the range:  $20 \leq \text{current} \leq 300$  (2A...30A)
- The onTime in [us] must lie in the range:  $1 \leq \text{current} \leq 100$
- The offTime in [us] must lie in the range:  $1 \leq \text{current} \leq 100$
- The frequency in [KHz] must be  $\leq 200$ .
- The Duty cycle  $< 50\%$ . Duty cycle is defined as  $\text{onTime}/(\text{onTime} + \text{offTime})$
- The current must lie below the line specified by the following graph:



## Appendix B - Valid state/mode transitions

The state diagram below depicts all valid state transitions. If a transition is requested that is not listed in the diagram, the EDM output will be switched off and bit #1 in the status input PDO will be set. A successive call for a valid state transition will then clear bit #1.

The transitions between the operating modes ISO-Frequency and ISO-Pulse are allowed in any state.

The control output PDO may only request a single state transition at a time, when more than 1 state transition is requested the EDM output will be switched off and bit #1 in the status input PDO will be set.

Entering and exiting the ESTOP state cannot be done through the EtherCat interface. The ESTOP state transitions are controlled by the ESTOP 24V input only.

