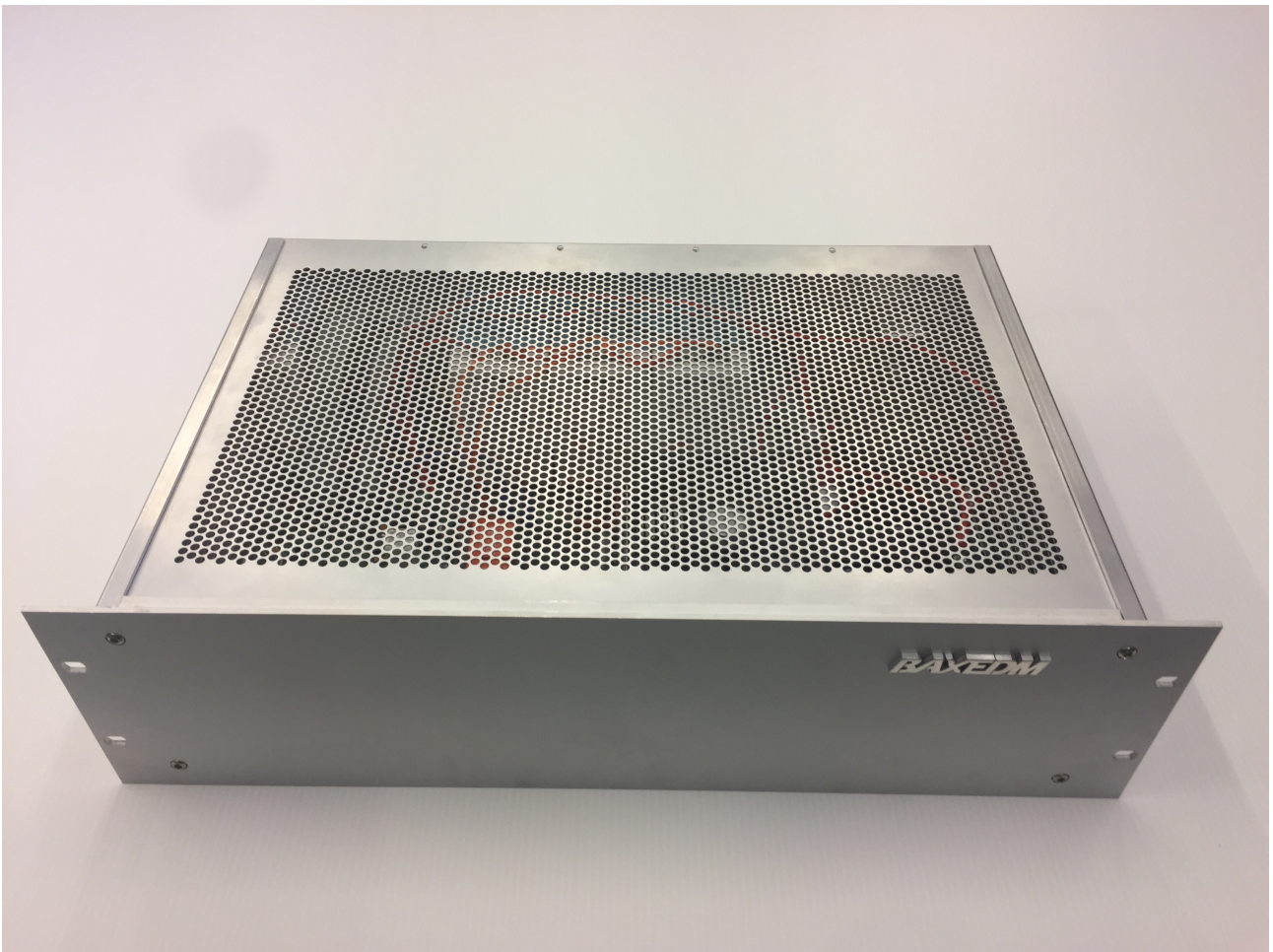




## **BX17 Arc Generator manual and general implementation guide**



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## 1 Document Revision History

Revision number	Date	State	Change notes
0.1	24 Jun 2018	Draft	Initial Version
0.2	27 Oct 2018	Draft	-Added voltage specification for digital input and outputs -Added section “Essential installation requirements” -Added operational limits to the section “Arc control” -Added section “LED Indicators and Error Codes” -Added supply current to the serial GET command -Updated X6 Auxilary IO table with edgfind function input -Updated some URLs linking to the BaxEDM website -Minor spelling corrections
0.3	1 Jan 2019	Draft	-Added single shot mode <ul style="list-style-type: none"> <li>• Added paragraph 8.2.3</li> <li>• Updated the table in paragraph 6.6</li> <li>• Added single shot mode commands to the table in paragraph 11.2</li> </ul> -Corrected several typos
0.4	27 Aug 2019	Draft	-Changed the serial commands for the edgefinding mode. -Added a note about reverse polarity for cutting thick aluminum to section 6.3 -Updated section 9.3

## 2 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]	UM0412 User Manual – Getting started with DfuSe USB device firmware upgrade STMicroelectronics extension	ST-Microelectronics
[4]	www.dynomotion.com	Dynomotion

### 3 Welcome note

Thank you for buying the BaxEDM BX17 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 We focus on bringing EDM arc generators and related products to market that will allow upgrading of outdated/defective EDM machines or the construction of custom EDM machines.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 BX17 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 BX17 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.



**WARNING:**

Risk of personal injury or death from electric shock



**CAUTION:**

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.



**IMPORTANT:**

An important instruction alerts you to important critical information



**NOTE:**

Indicates content that provides additional information

## 5.2 Safety instructions for the BX17 arc generator and the parent EDM machine



**WARNING:**

Do not touch the workpiece during EDM operation.



**WARNING:**

Do not touch the electrode or EDM wire during operation.



**WARNING:**

Do not operate the machine without protective earth.



**WARNING:**

Do not operate the machine without an earth leakage current breaker in the mains supply.



**WARNING:**

Do not operate the machine without a warning light. A tested solution is given in section 6.7



**CAUTION:**

Do not use the product without proper measures against EMC.

## 5.3 EMC

The BX17 Arc generator is constructed from a 19" closed aluminium grounded enclosure. Without cables attached, the radiated emission levels are very low.

When an unshielded power cable is connected, it will partly function as 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.



**CAUTION:**

It is the responsibility of the engineer/installer of the custom EDM machine to implement these EMC measures.



**NOTE:**

Unshielded power cables can be used, as long as the generator and cable reside inside the shielded cage of the parent machine.





BaxEDM cannot be held responsible nor accountable for injuries or damages resulting from misuse or incorrect implementation of the BX17 Arc generator.

## 6 Device Interfaces

### 6.1 Overview



*Illustration 1: Overview of the backside of the BX17 generator, including all interfaces*

### 6.2 X1 – Mains power inlet, power-on button and fuse

The X1 terminal is a standard C13 socket for the mains supply voltage. The center pin is functional earth and the left and right pins are live and neutral. The input voltage range is 100V-240V, 50-60Hz.



*Illustration 2: The X1 interface*

### 6.3 X2 – EDM Power Output

The X2 socket is the output of the EDM Arc power. The correct plug for this socket is type SpeakON NL4FX by Neutrik. The power cable used for connecting to the EDM machine should be a twisted pair high frequency Litze power cable, with a current capacity of 30A minimum. The maximum output voltage is 150V.

The minimum cable requirement is to use a 10AWG Litze cable consisting out of 1000 strands of 40 AWG wire, 0.15" outside diameter. This type has been tested and works well.

The length of the cable is critical. The positive/negative twisted pair length should be  $\leq 1.5\text{m}$ . This is required to keep the cable induction as small as possible.

The socket contains 4 pins which are used as two pairs to increase the current capability. These pins should be shorted in the plug as well. See the table below.



Illustration 3: The X2 interface

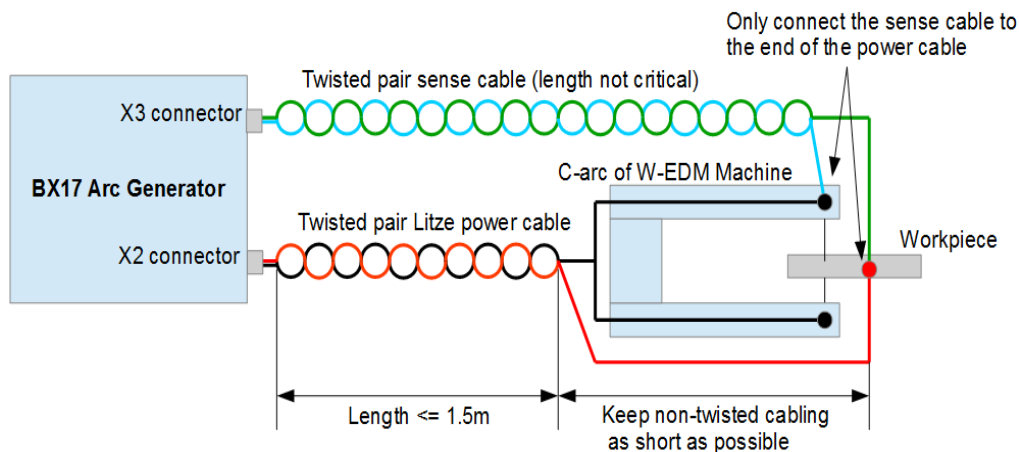


Illustration 4: Power output and sense input cabling

Pin Name X2 connector	Function
1(+)	Positive output, short to 1(-) and connect to the workpiece
1(-)	Positive output, short to 1(+) and connect to the workpiece
2(+)	Negative output, short to 2(-) and connect to the EDM wire.
2(-)	Negative output, short to 2(+) and connect to the EDM wire.

The pin names are printed/molded inside the plug.

The polarity of the power output and sense wire in the table above works well for almost all workpiece materials except for thicker aluminum. For thin aluminum the polarity as described in

the table can be used, however for cutting thicker (>5mm thick) workpieces from aluminum, it is best to reverse polarity to the workpiece of the power output as well as the sense wire.



It is essential that the sense wire positive input is connected to the positive power output and the sense wire negative lead to the negative power output at all times. So when reversing polarity for cutting thicker aluminum workpieces, remember to switch polarity to the workpiece for the sense input as well as the power output. Failure to do so may cause damage and will void the guarantee of the BX17 arc generator.

## 6.4 X3 – Sense input

The X3 connector is the interface for the differential input sense signal. The required plug for this socket is of type 3-pin mini XLR. The pin numbering is indicated inside the plug. Pin 1 is the left pin, pin 3 the right pin, and pin 2 is the bottom pin. The sense cable must be connected to the end of the power cable as indicated in Illustration 4.



*Illustration 5:  
The X3 interface*

Pin Number	Function
1	Positive input for differential sense signal
2	Not connected
3	Negative input for differential sense signal

## 6.5 X5 – Communication and Arc sensing Interface

Pin Number	Function
1	GND for RS-485
2	RS-485 Data – (B)
3	RS-485 Data + (A)
4	Not connected
5	Reserved, do not connect
6	GND for feedrate control signal



7	Negative differential feedrate control signal
8	Positive differential feedrate control signal
9	Not connected

## 6.6 X6 – Auxiliary Digital IO

The auxiliary isolated inputs and outputs are reserved for additional functions that will be added to the generator by means of software updates in the future.

The digital inputs of the BX17 are 5V compatible inputs. The open collector digital outputs can sink up to 10 mA.

Pin number	Name	Function
1	Isolated open collector output #1	Edge detection signal output
2	Isolated open collector output #3	Reserved
3	Isolated input #1	Positive – External EDM Enable/Disable.
4	Isolated input #1	Negative– External EDM Enable/Disable.
5	Isolated input #2, positive	Positive – External Edgefind mode Enable/Disable (enabling overrules EDM enable).
6	Isolated input #2, negative	Negative – External Edgefind mode Enable/Disable(enabling overrules EDM enable).
7	Isolated input #3, positive	Positive – External single shot trigger input
8	Isolated input #3, negative	Negative – External single shot trigger input
9	Isolated open collector output #2	Reserved
10	Common ground for outputs	Common ground for outputs
11	Not connected	N.A.
12	Not connected	N.A.
13	Not connected	N.A.
14	Not connected	N.A.
15	Not connected	N.A.

## 6.7 X4 – Warning Light

Pin Number	Function
1	Positive 12V output for LED warning light
2	Not connected
3	Negative 12V output for LED warning light

**WARNING:**

Do not operate the machine without a warning light.

**IMPORTANT:**

The 12V output can supply 300 mA max. If more than 300 mA is drawn, this will trigger a power error in the generator (red LED will blink inside). Incandescent bulbs have a high start current and can therefore not be used.

It is strongly advised to use a warning light that is clearly visible, even in direct sunlight. An tested example is given below, which is a beacon light with LED bulb. These can be purchased in the BaxEDM store: <https://baxedm.com/shop/>



## 7 Essential installation requirements



### CAUTION:

The following installation requirements list must be satisfied in order to guarantee good performance or to prevent damage to the BX17 arc generator.

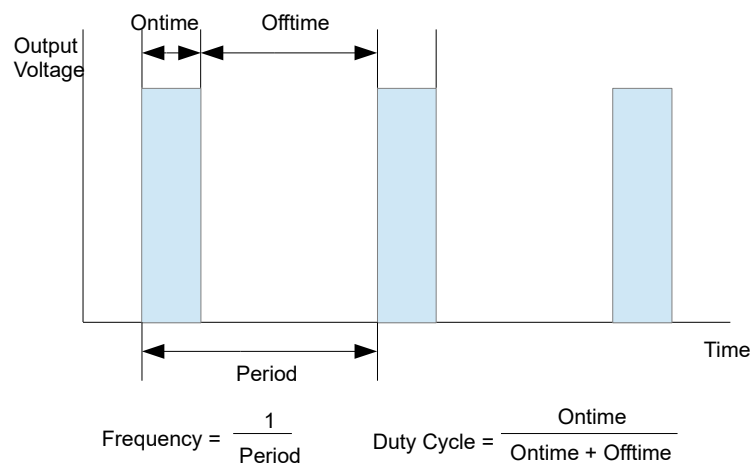
- The ventilation grids on the bottom and top of the generator enclosure must be left completely free for proper ventilation. Placing the generator on top of a flat table surface is therefore not allowed.
- Do not mount the enclosure upside down.
- Only use the BX17 with a grounded mains power connection.
- Install power cable and sense cable according to Illustration 4: Power output and sense input cabling.
- Use only shielded cables for interfacing with the X5 and X6 connectors.
- Use shielded EMC connector hoods for the X5 and X6 connectors, and connect the shield of the cable only to one side of the cable to prevent ground loops.
- The sense wire positive connection must be connected to the positive power output lead and the negative sense wire connection must be connected to the negative power output lead at all times. Under reversed polarity conditions for cutting thick aluminum, the polarity to the workpiece must be switched, not the polarity between the sense wire and power output leads.

## 8 The EDM process explained

### 8.1 EDM Control Parameters Explained

Electric discharge machining works by creating an arc between an electrode and workpiece. The arc is very hot and will erode the workpiece as well as the electrode. During the eroding process, the arc eats away metal by melting off metal particles. If the arc is not interrupted, it will continue to eat away metal from the point at which it first struck. When the arc is interrupted and re-initiated, it will jump to the next closest distance and eats away metal at that point. So in order to get an even cut and good surface finish, the arcing is a cyclic on/off process.

The arc on time determines the amount of material that is eroded away on each arc strike. The arc off time is required for the cyclic process but also to allow good flushing. The combined ontime + offtime determines the frequency of the cyclic process. The duty cycle is defined as the ratio of ontime/(ontime+offtime). The duty cycle together with the EDM current determines the cutting speed. The ontime and EDM current determine the surface finish.



If one compares EDM cutting with sawing, then the ontime would be the height of the sawtooth on the blade, the ontime+offtime the distance between the saw teeth and how fast you move the saw, and the EDM current would be how hard you press on the saw during sawing.

For rough cutting, high ontimes can be used in combination with high current. This will give a high cutting speed with a rough surface finish. For finish cutting a small ontime and low current is required.

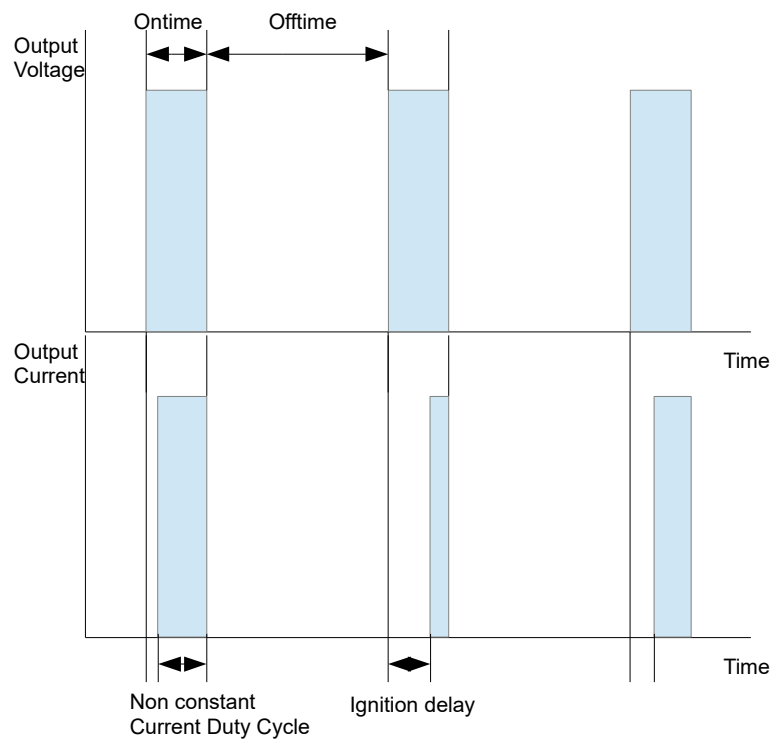
The ideal combination of the ontime, offtime and current depends on the desired cut (rough/finish), material type, thickness and flushing conditions. Therefore, this arc generator allows the user to choose the ontime, offtime and current freely. Once a parameter set is found that works well, it can be stored in the parameter library for use at a later time.

As a starting point, the library already contains several parameter sets that have been experimentally verified.

## 8.2 EDM Operating Modes Explained

### 8.2.1 ISO-Frequency

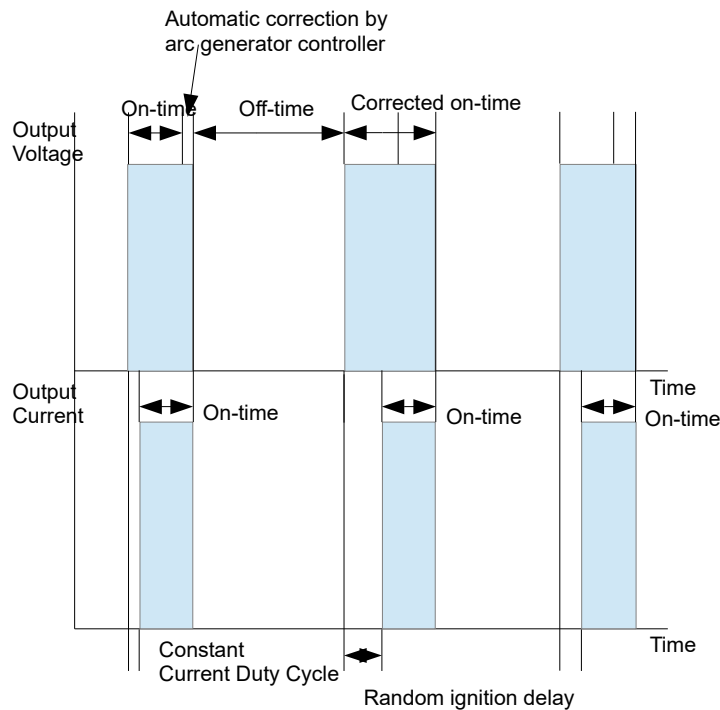
In ISO-Frequency mode, the frequency and duty cycle of the output voltage is constant during machining. If the output voltage goes high, the arc will not instantaneously ignite or might not ignite at all. The arc ignites after a certain delay that has a large random nature. Since this delay is random, the duty cycle of the current through the gap has this same random behavior. This means that in ISO-Frequency mode, the amount of energy supplied by each arc strike is random as well. This in turn means that each arc strike removes a different non-constant amount of material, which affects the surface finish of the cut negatively.





## 8.2.2 ISO-Pulse

In ISO-Pulse mode the Arc generator compensates for the random ignition delay, by stretching the output voltage on-time such that the energy in every arc strike is exactly the same. This means that the duty cycle of the output voltage is not fixed anymore, but determined by the arc delay.



## 8.2.3 Single shot by external trigger

For research purposes, it is also possible to run the BX17 generator in single shot mode. In this mode, the output of the generator is not a continuous pulse train, but rather a single pulse when a trigger is given. The pulse will have the configured on-time and current level. The off-time is ignored. Both ISO-Frequency as ISO-pulse single shots are supported.

The trigger can be given by serial command (see paragraph 11.2), or by a rising edge on the external trigger input (see paragraph 6.6).

It is important to note that when configuring the on-time and by applying external triggers, the correct current output pulse shape can only be guaranteed if the resulting duty cycle is  $\leq 50\%$ .

Single shot mode can only be enabled by the serial terminal interface, not by the BX17 dashboard application.

Single shot mode is supported by BX17 firmware version 0.9.5 or later. To see which version your BX17 is currently running, use the VERSION command in the serial terminal.

### **8.2.4 Edge finding mode**

Edge finding mode is not used during machining. It is used to find the edge of the workpiece prior to machining. When edge finding mode is enabled, a low voltage (current limited to a few mA) is applied across the gap and the gap voltage is measured. Whenever the wire or electrode touches the workpiece, this voltage drops to zero and the arc generator signals that the edge has been found. Consult the API section of this document to see how the API can be used to create edge finding algorithms for implementation in motion control.

## 9 Essential Requirements for Successful EDM Application

Successful Electric Discharge Machining depends on multiple subfunctions. All functions are equally important for good results. Even if only a single subfunction fails, the results will be very poor or non existing. Some subfunctions are easy to implement and some are very hard. The following sections of this chapter list these required subfunctions and provides details.

### 9.1 Motion control

For die sinking as well as wire EDM, motion control is essential. The electrode or wire needs to be positioned and fed at the correct rate in order to efficiently cut. For EDM applications, it is absolutely essential that play in the positioning mechanism is reduced to an absolute minimum. Even the slightest play ruins the feedrate control loop stability. This means that trapezoidal threads are a no-go. Use ballscrew type screws instead.

The best solution for EDM application would be to choose linear motors, but since these are not affordable for low cost machines, the second best choice are pre-tensioned ball screws.

The motion control system is operated quite differently compared to traditional CNC milling machines. In milling, the RPM and feedrate are constant for a single cut and are prescribed by the G-code.

In EDM applications, the feedrate varies continuously and is determined by the cutting process itself. During cutting even negative speeds (backwards along the path prescribed by the G-code) occur quite frequently. The requirement for the motion control system that it should be able to move at negative speeds is very demanding. There are not many OEM motion control platforms that meet that requirement.

The best known motion control platform that does meet this requirement is Kmotion (see [www.dynomotion.com](http://www.dynomotion.com)).

### 9.2 Feed Rate control

Feed rate control (also known as cutting speed) together with arc generation are the most difficult aspects of an EDM machine. As described, the feed rate during EDM needs to be continuously adjusted, depending on the behavior of the arc.

A basic form of feed rate control is choosing a constant feed rate. Then, depending on a measurement of a low-pass filtered gap voltage, the motion control system is commanded to feed at the constant rate, stop the feed or move the feed backwards.

There are several downsides to this approach. Firstly, the operator needs to choose a feed rate which is different for each material and thickness. Secondly, the actual feed rate will not converge to an optimum. It will always keep fluctuating quite a lot, which reduces the quality of the cut. This is especially true when the thickness of the workpieces varies along the cut. Lastly, if the EDM parameters are changed (on-time, off-time, current) the values that determine the voltage thresholds at which the feed/stop/backwards decisions are taken will be very different. These values need to be experimentally determined and finding the best values takes quite some time. So for this feed rate control strategy, after every EDM parameter change, a complete retuning is required. Clearly, this is not desirable.

BaxEDM has developed several solutions to overcome these problems. Firstly, the BX17 Arc generator contains an arc voltage sampling and averaging mechanism that provides a feed rate control signal which is fully independent of the arc parameters that are chosen by the operator. This eliminates the need to re-tune upon choosing different parameters and parameters can actually be modified during machining.

Secondly, a new feed rate control strategy was designed which does not require a fixed feed rate input before machining. The control algorithm automatically searches and converges to the optimal cutting speed. When a workpiece is cut that varies in thickness (a heatsink for instance), the feed rate follows the thickness automatically.

The feedrate control algorithm that works together with the BX17 generator has been written for a Kflop motion controller in combination with a Kanalog IO extension board [4]. The control algorithm is available upon request.

The speed control output signal (X3 connector) of the BX17 arc generator has a differential output voltage range of 0-2V. A differential voltage is used because the EMC conditions around an EDM machine are very harsh, which causes noise on single ended signals. Differential signals have a high common mode noise rejection which makes them ideal for EDM applications.

The motion controller of the EDM machine needs to read in this voltage in order to adjust the feed rate. Most motion controllers do not have an analog input for differential signals, so a small adapter board is required on the motion control side to translate differential into single ended.

The single ended inputs on motion controllers have a larger input voltage range than the output range of the generator. The preferred controller [4] has an input voltage range of +/-10V. In order to make better use of the ADC resolution, the adapter board should have a gain as well. By choosing the gain of the adapter board 5, the differential output voltage of the generator 0-2V, is translated into a single ended voltage of 0-10V. This uses half the range of the ADC in [4], which is sufficient, and keeps the adapter board simple (no offset required, only a 5x gain). The adapter (differential to single ended converter) is available in the BaxEDM webshop:

<https://baxedm.com/product/differential-to-single-ended-converter/>

In order to explain what the speed control signal physically represents, it is first important to understand the difference between arc voltage and gap voltage, as these terms are frequently misunderstood. The arc voltage is the voltage across the arc, when current is flowing. This voltage strongly depends on the length of the arc, and much less on the current if the distances are small. In EDM applications the distances are usually quite small, roughly ~0.025 mm. The average of this distance remains small during cutting, so the arc voltage is quite constant. Typical values are roughly 8-16V.

The gap voltage is the low-pass filtered voltage across the gap. This includes voltages when there is no arcing. The gap voltage is not constant at all. Typical values are 0-150V. The gap voltage is influenced by many things, here are a few listed:

- Arc strike yes/no
- Ignition delay of the arc
- EDM on-time
- EDM off-time
- EDM current
- flushing conditions
- water conditions
- material of the workpiece
- Thickness of the workpiece

Ideally, the speed control signal would directly represent the distance between the wire/electrode and workpiece. However, this distance cannot be measured directly. It needs to be measured indirectly. The BX17 generator generates the indirectly measured distance signal (a.k.a. speed control signal), from the only items from the list above that are related to distance. These are the arc strike yes/no and ignition delay.

Note: the voltage levels now mentioned are including the 5x gain

Region 1: Voltage > 9.5V	No Arc
Region 2: 2.0V < Voltage < 9.5V	Arcing is taking place
Region 3: Voltage < 2.0V	Short circuit

For Region 2, the speed control signal is determined by the percentage of the arcs that actually strike, and their accompanying ignition delay. If every arc struck without delay, the voltage would be 2.0V. If 50% of the arcs would strike without delay, the voltage would be 6.0V.

Machining takes place in Region 2. The lower the voltage is in Region 2, the faster the machine will cut, but the harder it becomes to control the speed of the machine to keep the voltage constant in region 2 and wire breaks for W-EDM machines are likely to occur. A good starting point for machining is a target voltage of 8V. Depending on the mechanics and motors (position control bandwidth) of your machine, the voltage can be lowered to further improve the cutting performance.

When the voltage is in Region 3, there is a short circuit and the machine should backup at high speed immediately. If then still the voltage remains in Region 3, there is an unresolvable short circuit condition and the machine need to be shut down. This can occur if there are stresses in the material and cutting releases stress causing a cut piece to pinch the EDM wire.



## **9.3 Wire handling**

For any wire-EDM machine, correct wire handling is essential for achieving good accuracy and keeping wire usage as low as possible. This section gives some guidelines on how to find the best settings for your custom machine.

### **9.3.1 Wire speed**

The required EDM wire renewal rate varies between 1 and 6 meters/min, for standard 0.25mm brass wire. The right speed needs to be determined experimentally. If the speed is too high, the only problem is that wire is wasted, which is not economically desirable. A too low wire speed will erode the wire too much and will weaken it and cause the wire to break. The configuration of the cutting power of the arc generator will affect the cutting speed but also the required wire renewal rate. Cutting at high power levels requires a fast wire travel speed and vice versa.

### **9.3.2 Wire tension**

For 0.25mm brass EDM wire, which is the most commonly used wire type, a wire tension force between 8-30N is required. For tall workpieces, the wire tension must be increased to prevent the wire from bending under the water flushing pressure. Increasing the wire tension also requires increasing the wire renewal rate for the same EDM cutting power. For higher tensions wear on the wire must be kept low, as the higher tension will break the wire faster. Similar to the wire renewal rate, the correct wire tension needs to be determined experimentally as well, as each custom EDM machine will behave differently.

## **9.4 Flushing**

During the EDM process, a lot of particles are created inside the gap between the EDM wire and the workpiece. If these particles are not cleared away quickly, they will interfere with the arcing process, or worse, collect in the arc gap and cause hard short circuits and EDM wire breaks. It is therefore absolutely essential to use a high water pressure to flush away these particles. As an indication, commercial machines can go up to 10 Bar water pressure. The BaxEDM example wire EDM machine uses a flushing pressure of 3-6 bar, which is manually selectable by a control valve. Note that when working at high water pressures, it is necessary to submerge the workpiece in order to prevent a very large spray in all directions.

The nozzles that spray against the workpiece should be as close to the workpiece as possible (~1mm), since under submerged cutting conditions, the water pressure rapidly decreases if the nozzles are positioned further away.

## **9.5 Water treatment**

For wire-EDM machines specifically, the flushing medium is water. This water needs to be treated and kept clean for proper EDM results. The sections below cover the required water treatment information.

### **9.5.1 Water Filtering**

The EDM process produces very fine particles. It also requires clean flushing water for proper cutting action. Since the flushing process is a closed loop water system, these particles need to be

filtered out of the waste water, to re-cycle the water in the closed loop system. As a guideline, all particles larger than 1 micro meter should be filtered out.

Although this can be achieved by inexpensive commercial water filters (if multiple stages are used), these filters cannot handle the large volume of particles the EDM process creates, and will need to be replaced frequently. Therefore, it is advised to use dedicated OEM filters designed specifically for EDM applications.

### 9.5.2 Water conductivity

The conductivity level of the water that is used in the EDM flushing process is critical. Tap water cannot be used since the conductivity level is too high, causing excessive corrosion on the workpiece and poor cutting quality. Pure distilled water can also not be used, as it has a conductivity value that is too low. This makes it harder for arcs to form.

As a guideline, the water conductivity level for EDM should be in the range of 15-25 MicroSiemens.

To get the water at the right conductivity level, normal tap water is loaded into the EDM machine and is pumped through a closed loop circular system that includes a water deionisation filter and water conductivity meter.

When the high conductivity water is pumped through the deionisation filter, the conductivity level slowly drops. When the conductivity level is in the required range the pump should shut down and only periodically turn on subsequently to keep the conductivity in the right range, as the EDM cutting process will increase the conductivity over time.

## 9.6 Arc Generation

In an EDM system, the arc generation is one of the most difficult subfunctions. Luckily, BaxEDM has introduced the BX17 Arc generator to remove this difficulty from designing a custom EDM machine. The BX17 is easy to integrate in any custom EDM machine and provides professional results.

## 10 PC Software installation

The arc generator can be controlled by a dedicated control application called BX17 Dashboard, or by a standard serial terminal. Communication to the generator should run through an USB to RS-485 converter. The following sections provide the details to install these applications and required USB driver.

### 10.1 Installation of the USB-RS485 driver



**NOTE:**

Although any type of USB to RS-485 interface cable can be used, this section assumes that the USB-RS485-WE-1800-BT from FTDI is used. This cable is available in the BaxEDM webshop: <https://baxedm.com/shop/>

Visit <http://www.ftdichip.com/Drivers/VCP.htm> to download the required Virtual Com Port driver for your specific system. An installation guide is also listed on the page. Be careful to find only genuine FTDI parts. Many users of counterfeit USB to serial adapters have problems with their

interfaces.

## 10.2 Installation of the BX17 Dashboard application

Perform the following steps to install the BX17 Dashboard application:

- Download the “BX17-Dashboard-RevXX.zip” file from: <https://baxedm.com/dashboard-application/>
- Extract the zip and place the “BX17Dashboard.exe” in an installation directory of your choice, e.g. “C:\Program Files\BX17Dashboard.exe”
- Download the “EDMparameterLib.json” file which contains the latest material EDM parameters from:  
<https://baxedm.com/material-edm-parameter-library/>
- Save the “EDMparameterLib.json” file to the same directory as the BX17Dashboard executable
- Create a shortcut to the executable (right click → create shortcut), and move the shortcut to a convenient location, for instance your desktop.

## 10.3 Installation and configuration of the serial terminal

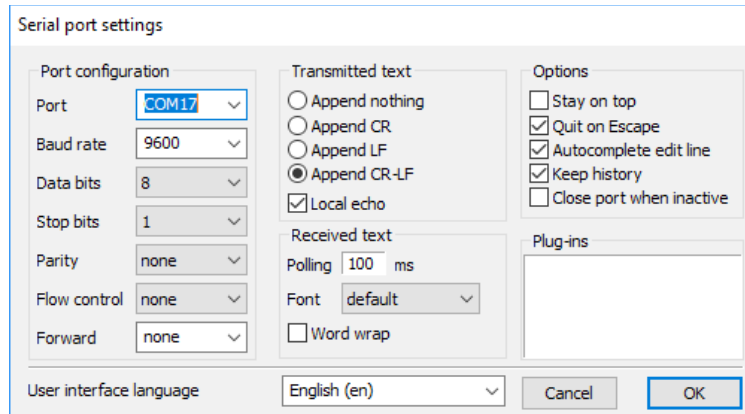


### NOTE:

Although any type of serial terminal can be used, this section assumes that Termite is used. This application is also recommended by BaxEDM.

Perform the following steps to install and configure the Termite terminal application:

- Download the Termite (program only) zip package from  
[https://www.compuphase.com/software\\_termite.htm](https://www.compuphase.com/software_termite.htm)
- Extract the zip package and copy the “Termite.exe” file to an installation directory of your choice.
- Create a shortcut to the executable (right click → create shortcut), and move the shortcut to a convenient location, for instance your desktop.
- Run the Termite application and click the “settings” button in the main screen.
- Set the configuration according to the screenshot below:

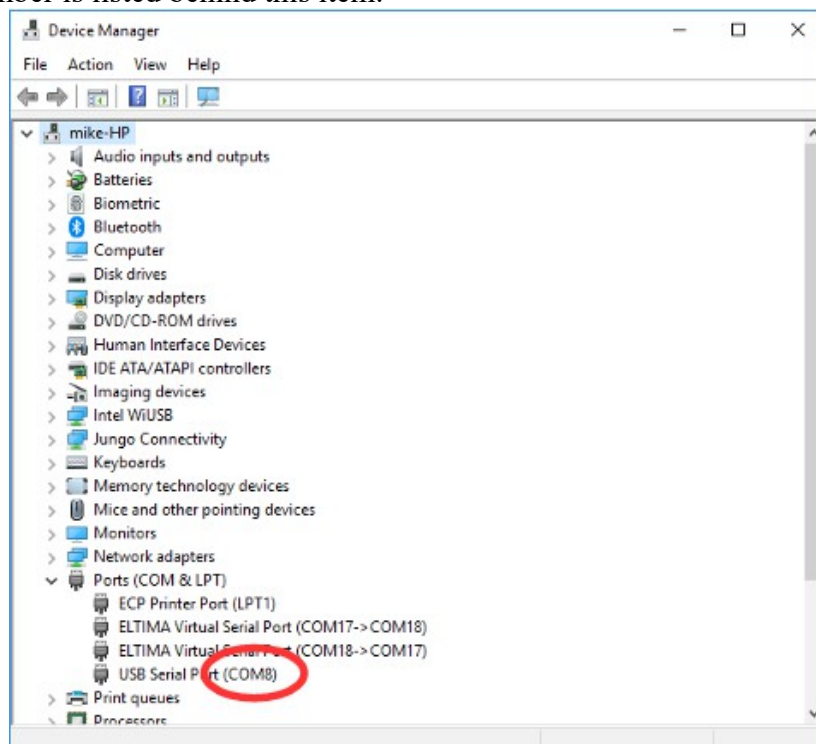
**NOTE:**

The COM port number is different for each PC. To find the right com port number if multiple are listed, follow the steps below.

In order to find the com port number, perform the following steps in Windows:

- Open the windows control panel
- In the control panel, open “Device manager”
- In the Device manager, expand the item “Ports (COM & LPT)”
- Search for an item called “USB Serial Port”

The com port number is listed behind this item:



## 11 Operation

### 11.1 Operation by BX17 Dashboard control application

The BX17 Dashboard application provides a control user interface to use all the functions of the generator and to maintain a library of EDM parameters. The following sections describe how these can be used.

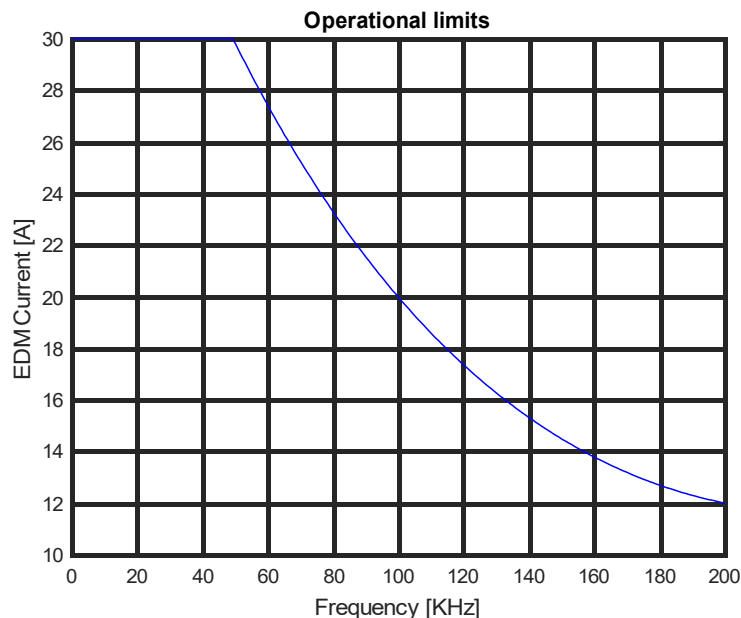
#### 11.1.1 Arc Control

Before the control tab can be used, it is required to turn the generator on and open the serial port number of the USB to RS-485 virtual com port. This is done by selecting the right port in the lower left corner of the screen and by pressing “Open”. After pressing open, the message “Serial port opened...” should appear next to the buttons.

The control tab lists the actual EDM parameters of the BX17 Dashboard application. The parameters in the large displays at the top (current, on-time, off-time) can be modified by moving the sliders next to it, or by selecting the slider and use the up/down arrows on the keyboard. The resulting frequency and duty cycle is calculated from these inputs and displayed in the smaller displays below.

The parameters in the dashboard application are subject to operational limits. These are:

- The duty cycle should be  $\leq 50\%$
- The maximum frequency is 200 KHz
- The current should lie in the operational area specified by the area under the following graph:



If a parameter combination is chosen that lies outside of the operational limits, the parameter displays turn red and the “Send Config” button will be disabled.



Changing the parameters in the dashboard will not directly change the parameters in the generator. Only when the button “Send Config” is pressed, the parameters in the generator are updated according to the values displayed in the dashboard.

The button “Get Config” is used to retrieve the parameters from the generator and display them, so that at all times it is possible to see how the generator is configured.



**NOTE:**

Upon startup of the dashboard application, a default parameter set is shown, which is likely different from the actual set in the generator. So after startup press the “Get Config” button to update the displays with the actual values.

The “Enable Arc” and “Disable Arc” buttons speak for themselves. They are used to turn the EDM power output on/off.



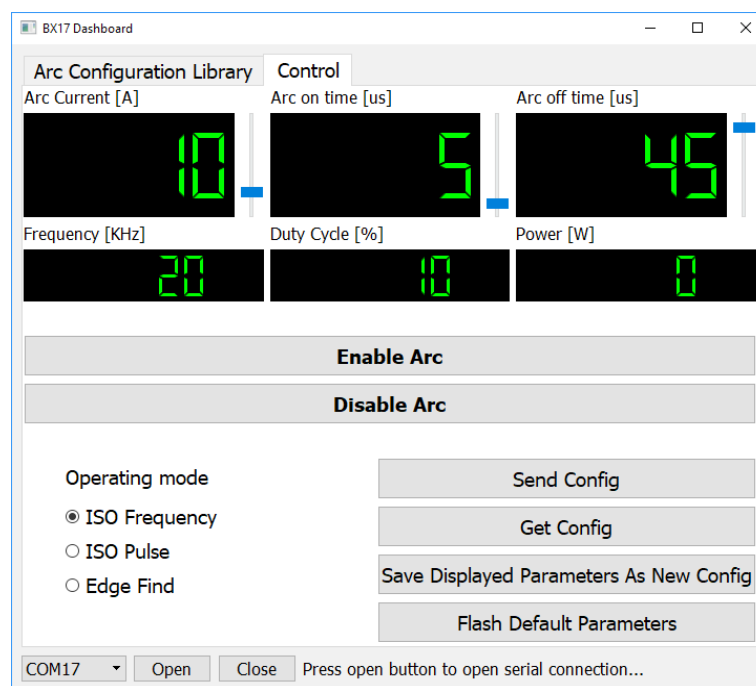
**NOTE:**

The user can choose to use the “Enable Arc” and “Disable Arc” buttons, or the use the external input of the generator to perform the same action. This input can be coupled to the motion control electronics, such that the generator can be turned on/off by using M-codes in the G-code of the CNC application. See chapter 6.6.

The button “Save Displayed Parameters As New Config” creates a new line in the library tab with the displayed parameters. This line can then be modified to include the material, thickness and other parameters and can then be saved in the library for later use

The button “Flash Default Parameters” programs the currently displayed parameters to the permanent memory of the BX17 arc generator. When this is done, the generator then picks these values as default after each turn-on.

The operating mode radio buttons select the operating mode as described in chapter 8.2.



### 11.1.2 Arc Configuration Library

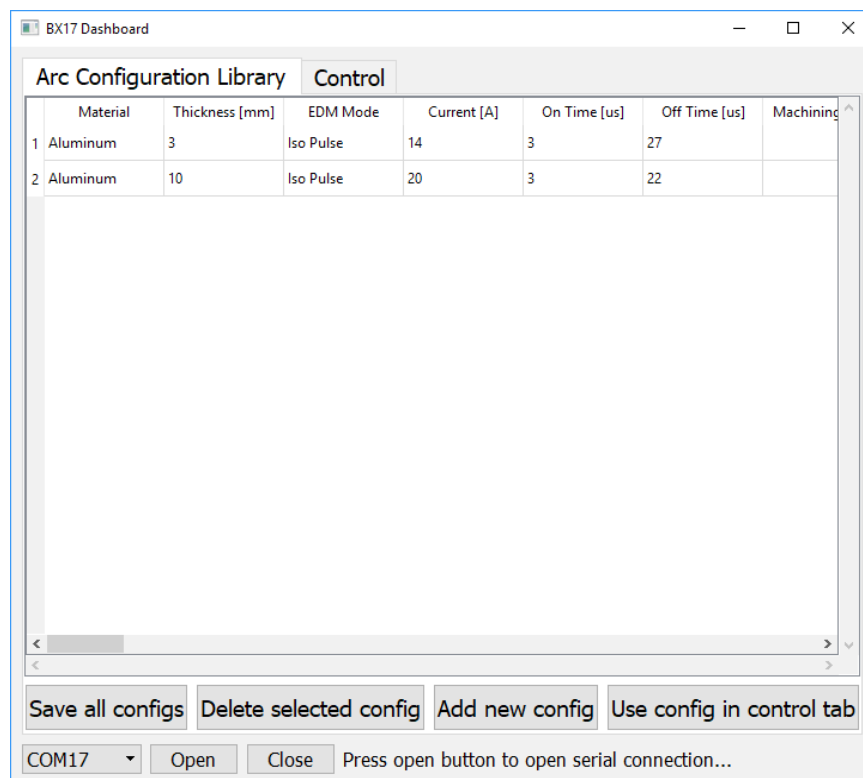
The arc configuration library allows you to pick a parameter set for a particular material type and thickness, that has proven to work well on that specific material and thickness by a previous experiment.

The library can be updated by downloading a new library file “EDMparameterLib.json” and copying it to the directory where the BX17 Dashboard executable resides.

The library will grow over time as BaxEDM will perform cutting experiments on all sorts of materials and users of the BaxEDM generator will provide feedback on parameter sets that they have found themselves.

If your material is not in the list, you can find the parameters yourself. For rough cutting, start with an existing set of another material and lower the current. Then gradually increase the current and duty cycle to increase the cutting speed. Eventually your EDM wire will break, since the BX17 has ample power to overheat the EDM wire. For fast cutting, the trick is to find the parameter set that provides enough power to cut fast, but not enough to break the wire.

For finish cutting, lower the current and increase the frequency.



The button “Save all configs” saves the currently displayed list to the “EDMparametersLib.json” library file. The button “Delete selected config” deletes the line in the table that contains the cell that has been selected. The button “Add new config” adds a newline at the bottom of the table. The button “Use config in control tab” copies the parameters of the line that is selected to the displays in the control tab, so that the configuration can be sent to the generator.

## 11.2 Operation by serial terminal (ASCII API)

Once Termite has been installed and configured (see chapter 10.3) the serial port can be opened. The following command list can then be used to control the arc generator. Type the command in the entry line in the bottom of the Termite screen and press enter.



### NOTE:

All commands are case sensitive.



### CAUTION:

By using the serial terminal, it is possible to set parameters outside of the operational limits that are normally imposed by the Dashboard application (see section 11.1.1). This is possible for experimentation purposes. If misused, this might trigger an overcurrent error or in extreme cases overheat and/or damage the generator. It is therefore advised to use the Dashboard application.

Single spaces in the commands are indicated by a blue mark |. Required input values for commands or replied values are indicated by green marks, e.g. X.

Command	Description
EDMON	This command enables the EDM power output.
EDMOFF	This command disables the power output
CURRENT <span style="color: blue;"> </span> <span style="color: green;">X</span>	This command sets the EDM current. The valid input range is 5-30A, in whole numbers. For example to set 17A, send CURRENT 17
ONTIME <span style="color: blue;"> </span> <span style="color: green;">X</span>	This command sets the EDM on-time. The valid input range is 1-100 us, in whole numbers. For example to set 5 us, send ONTIME 5
OFFTIME <span style="color: blue;"> </span> <span style="color: green;">X</span>	This command sets the EDM off-time. The valid input range is 1-100 us, in whole numbers. For example to set 50 us, send OFFTIME 50
SETTINGS	This command will print an overview of all actual settings to the terminal
SAVEDEFAULTS <span style="color: blue;"> </span> <span style="color: green;">[X,Y,Z]</span>	This command saves the default values for current on-time and off-time to non volatile memory. <span style="color: green;">X</span> is the current, subject to the same input range as the CURRENT command. <span style="color: green;">Y</span> is the on-time, subject to the same input range as the ONTIME command. <span style="color: green;">Z</span> is the off-time, subject to the same input range as the OFFTIME command.

GET	Returns the actual EDM settings and supply current in the format [X,Y,Z,A] X is the current. Y is the on-time. Z is the off-time. A is the current in Ampere
ISOFREQUENCY	Selects ISO-frequency as EDM operating mode
ISOPULSE	Selects ISO-Pulse as EDM operating mode
EDGEFINDON	Turns the EDM power output off and configures the generator to report when the wire touches the workpiece, through interface X6, output #1.
EDGEFINDOFF	Turns the edgefind function off and returns to the the EDM power output state the generator was in before the edgefind function was enabled.
POWER	Reports the DC power used by the internal power supplies.
IOTEST	This command puts the generator in a test mode, that echos the 3 individual digital inputs to their respective outputs. This testmode can only be left by a system reset.
READDEFAULTS	This command prints the default arc parameter settings
VERSION	This command prints the software version number
FLASHPARAMSRESET	This command erases the non volatile memory section where the default arc parameters are stored. It can be used if the memory is corrupted.
SINGLESHOTMODEON	Enable single shot mode
SINGLESHOTMODEOFF	Disable single shot mode
TRIGGER	Trigger a single shot, this can also be done by a rising edge on the external trigger input, see paragraph 6.6

### 11.3 Operation by MODBUS RTU

The MODBUS RTU functionality will be added in a future firmware release when a customer has an application that requires it.

## 12 Firmware updates

The firmware of the BX17 arc generator can be updated through an USB interface in the inside of the enclosure. In order to install new firmware, a PC tool is required. A link to download the installer for this tool is provided on:

<https://baxedm.com/bx17-firmware/>



**NOTE:**

The software is subject to a software licence agreement (SLA) from ST-Micro electronics. This software license agreement (SLA0048 document) is included in the download package.

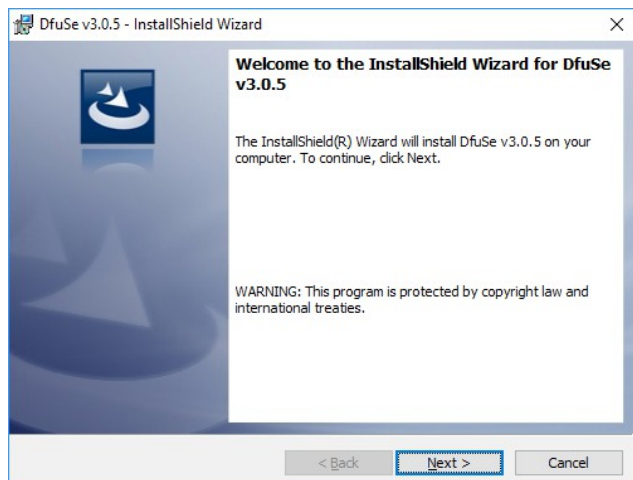
The latest firmware for the BX17 arc generator can be downloaded from the firmware page:

<https://baxedm.com/bx17-firmware/>

### 12.1 Installation of update PC tool

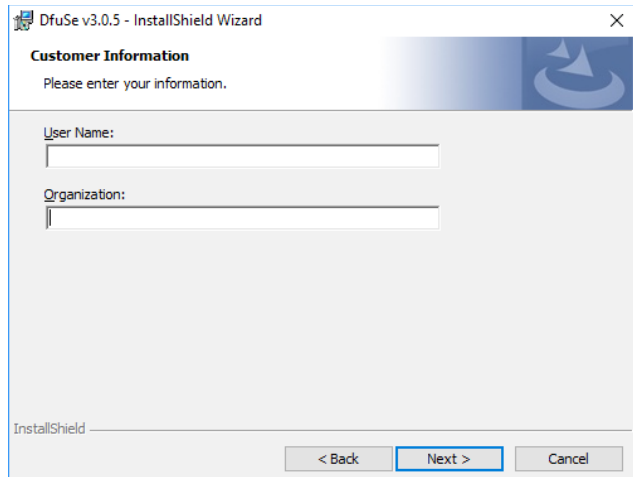
The following steps are required to install the DfuSe PC tool:

1. Extract the zip archive, run the setup executable “DfuSe\_Demo\_V3.0.5\_Setup.exe” and press next.

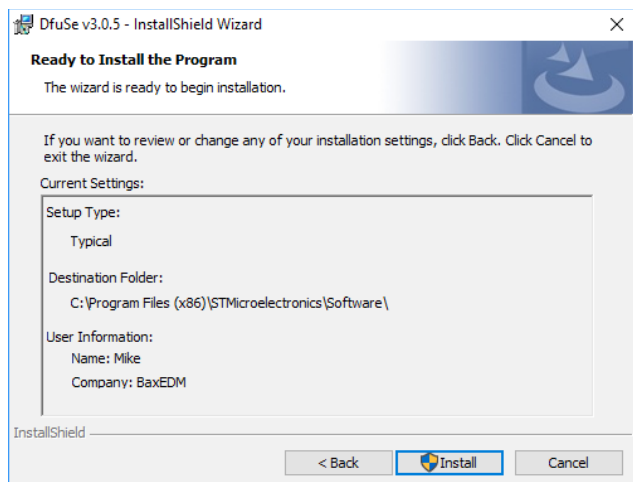




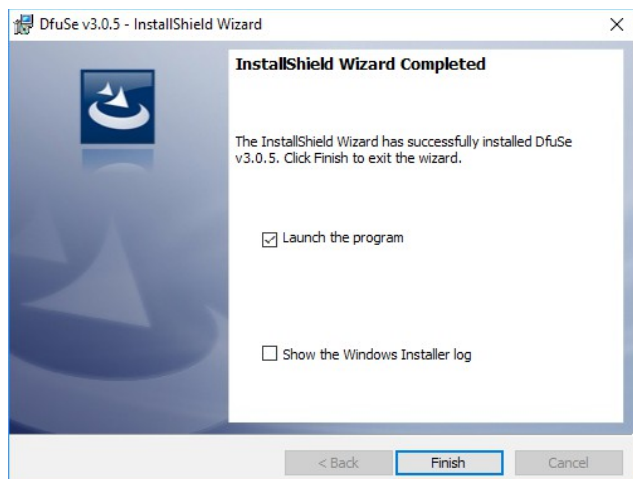
2. Enter your information and press next.



3. Click the install button. If a windows asks for permission, click agree/accept.

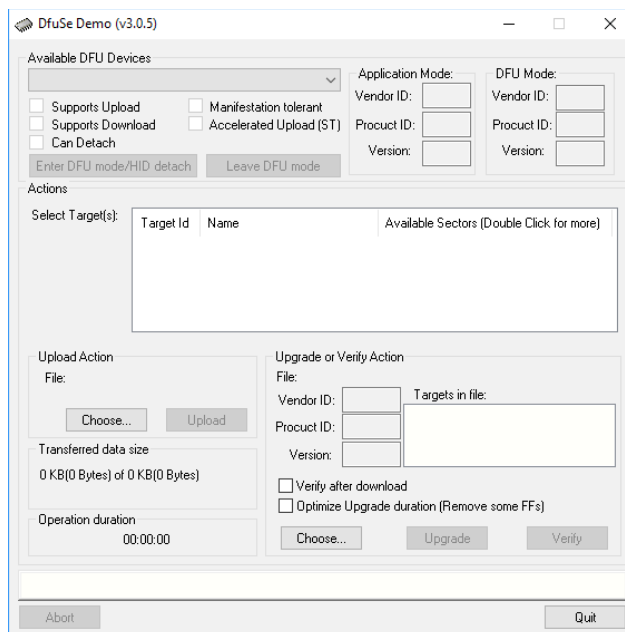


4. Click finish



5. The DfuSe application opens for the first time and is ready to use.

After closing the program, the program can be re-opened by running the “DfuSeDemo.exe” executable, which is installed in the destination folder C:\Program Files (x86)\STMicroelectronics\Software\DfuSe v3.0.5\Bin



## 12.2 Update procedure



### WARNING:

Before starting the update procedure, make sure the BX17 arc generator is completely disconnected from mains by removing the X1 plug.

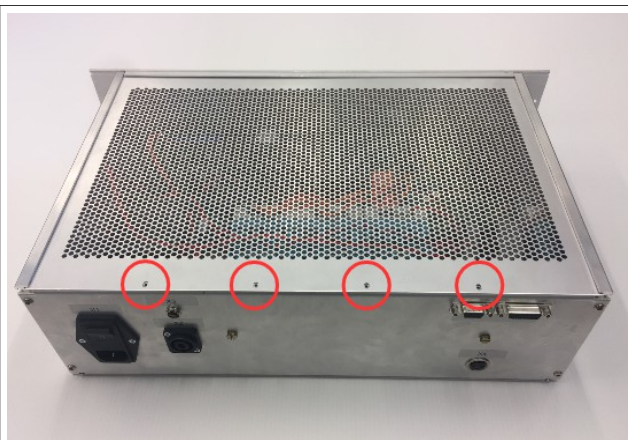


### WARNING:

Before opening the BX17 arc generator, wait at least 10 seconds after the device has been completely disconnected from mains to make sure the internal capacitors have discharged to a safe voltage level.

The following steps are required to update the firmware of the BX17 arc generator:

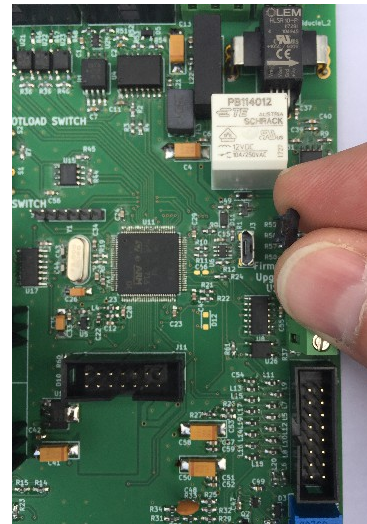
1. Remove the 4 screws from the top cover and slide-off the top cover.



2. Locate the USB interface on the motherboard.



3. Remove the dust cap

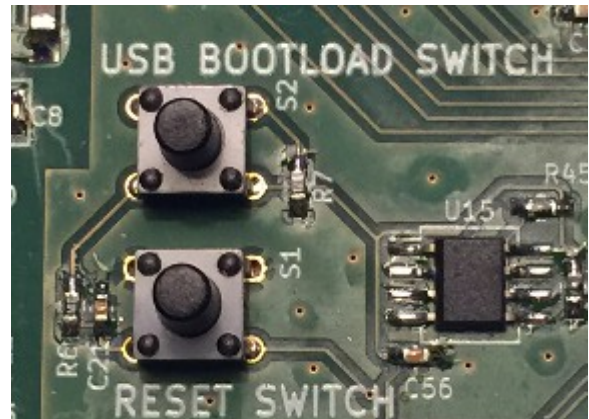


4. Connect your PC with the help of a micro USB cable to the motherboard.



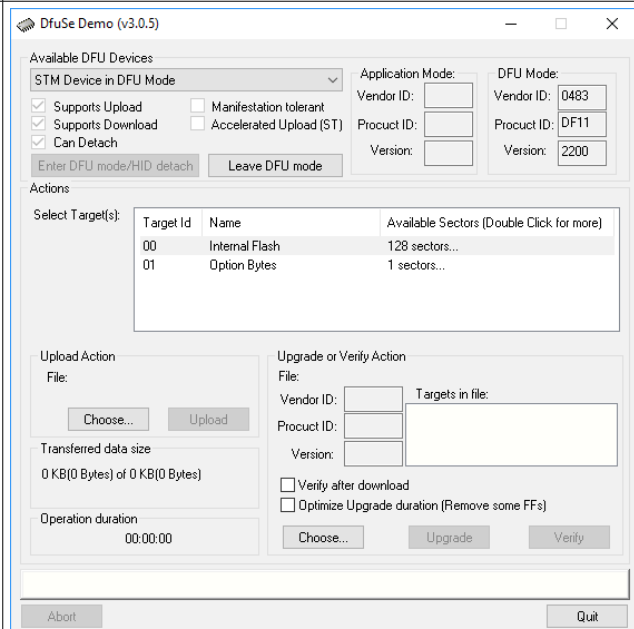
5.

- Locate the “USB BOOTLOAD SWITCH” and “RESET SWITCH” on the motherboard.
- Make sure your PC is turned on and connected to the motherboard
- Press and hold the “USB BOOTLOAD SWITCH”
- Press and release the “RESET SWITCH”
- Release the “USB BOOTLOAD SWITCH”

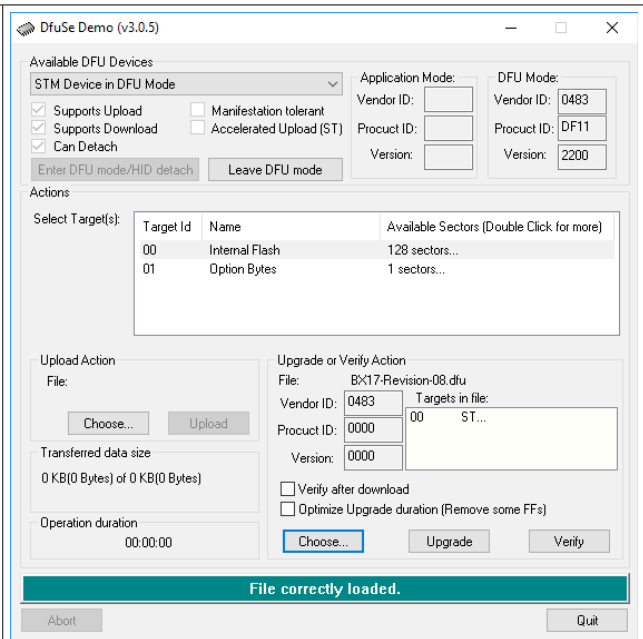


6. Start the DfuSe PC application that you have installed.

7. The DfuSE application should now show “STM Device in DFU Mode” under “Available DFU Devices”.

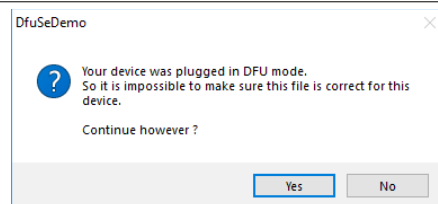


- 8.
- Download the latest firmware file from <https://baxedm.com/bx17-firmware/> with your internet browser and store it locally.
  - In the DfuSe program, click “Choose” and navigate to when you have stored the firmware file and open it.
  - The info box in the lower part of the screen should now state “File correctly loaded”

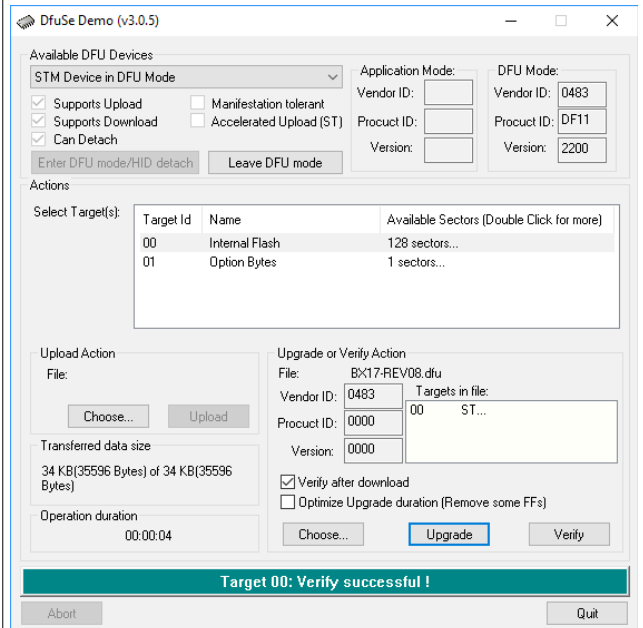


- 9.
- select checkbox “verify after download”
  - Click “upgrade” button

10. Click yes in the pop-up screen.



11. The info box in the lower part of the screen should now state “Target 00: Verify successful!”



<p>12.</p> <ul style="list-style-type: none"> <li>• Remove the USB cable from the motherboard</li> <li>• Gently place back the dust cap on the USB connector (note that it fits only in one way, do not force it in the wrong way, or damage might result)</li> <li>• Slide top cover of the enclosure back into position</li> <li>• Screw the 4 screws that were removed in step 4 back in</li> </ul> <p>The software update procedure has finished.</p>	
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## 13 LED Indicators and Error Codes

Inside the BX17 arc generator there are 4 different colored LEDs on the control board. These can be seen through the ventilation grid on the top of the enclosure.



LED Name	Color	Meaning
LED1	Red	Slow blinking (1 Hz): A problem has been detected with the internal 12V supply. Contact BaxEDM to further resolve the issue.
		Fast blinking (2.5 Hz): A problem has been detected with one or more of the internal 48V supplies. Contact BaxEDM to further resolve the issue.
LED2	Orange	Reserved
LED3	Yellow	Blinking: An overpower condition has occurred and the protection mechanism has triggered. Reset the generator to clear the error. Try lowering the EDM current if the conditions happen again.
LED4	Green	Fast blinking: Normal operation

## 14 Applicable directives and compliance

The following directives and standards are applicable for the BX17 arc generator.

- 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.

## 15 Maintenance

The BX17 Arc generator requires little maintenance. The top of the enclosure is perforated to allow efficient cooling. Depending on the environment conditions dust might buildup 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.

## 16 Technical specifications

Characteristic	Specification
Mains input voltage	100-240V AC, 50-60 Hz
Output current	5-30 Ampere, adjustable in 1A steps
Maximum output voltage	150V
Operating modes	ISO-Frequency ISO-Pulse Edge-Finding
EDM On-time	1-100 us, in 1 us steps
EDM Off-time	1-100 us, in 1 us steps
Operation temperature conditions	0C – 30C
Storage temperature conditions	0C – 40C
Relative Humidity conditions	20% – 80%, non condensing
Air pressure range	950 hPa – 1050 hPa

## 17 List of Terms and Abbreviations

Term/Abbreviation	Meaning
EDM	Electric Discharge Machining
us	Micro Seconds
mA	milli Ampere
Hz	Herz
EMC	Electromagnetic Compatibility
LVD	Low Voltage Directive
SPS	Switching Power Supply
RS-485	Serial Communication Protocol

AC	Alternating Current
ASCII	American Standard Code for Information Interchange
API	Application Programming Interface
N.A.	Not Applicable