TruPlasma Bipolar 4010 with switch

Power Supply

USER MANUAL

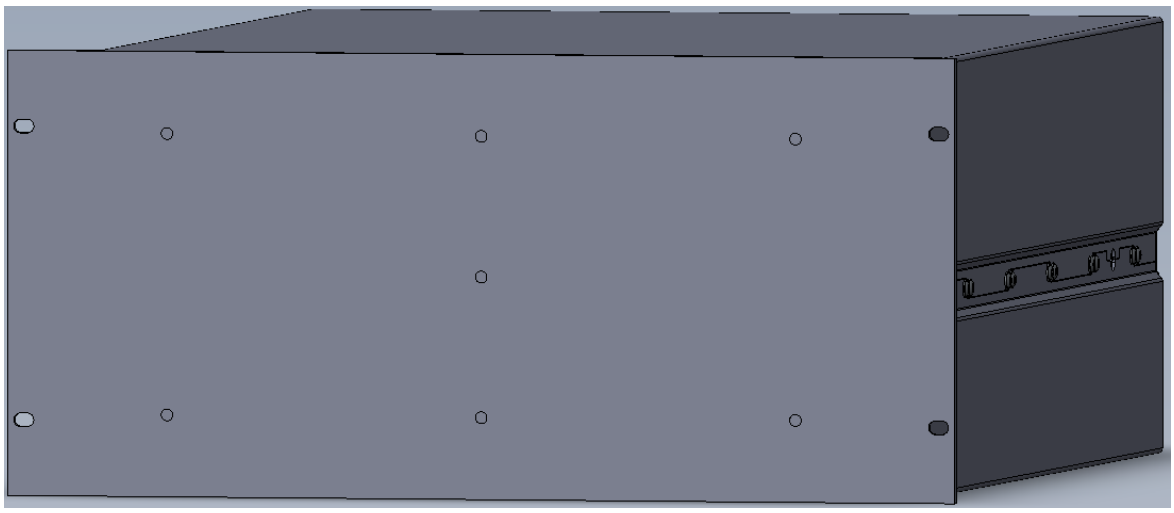
Warning!

This operating manual is required for the safe operation of **TruPlasma Bipolar 4010 with switch** Power Supplies. As a result, the operating manual should be kept close to the unit at all times.

Operating Instruction

for TruPlasma Bipolar 4010 with switch

Power Supply



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In the interests of providing superior equipment, TRUMPF Huettinger reserves the right to make product modifications without notifications or obligation. To the best of our knowledge the information contained in this manual is the most accurate available as of date of publishing.

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Returning Units for Repair

Before returning any product for adjustment or repairs please call **TRUMPF Huettinger Services** to discuss the problem with a service engineer representative. Be prepared to give the serial number of the unit and reason for return. This consultation call will help the Customer Service Department to determine if the unit needs to be returned. Such technical consultations are always available free of charge.

Table of contents

1. Safety Information

1.1. Important information

TruPlasma Bipolar 4010 with switch generator is designed to power industrial vacuum process chambers in PECVD surface treatment technologies. Any other uses or any uses beyond these mentioned above are considered to be improper. TRUMPF Huettinger Company shall not be held liable for any losses or damages resulting in any improper usage.

Correct usage also includes:

- Full compliance with all instructions from operating manual.
- Full adherence to inspection and maintenance intervals.

Safe operating procedures and proper equipment usage are the sole responsibilities of the system's user.

1.2. Explanation of symbols and notes

Failure to comply with these precautions may cause physical injury or result in damage of equipment.

Failure to comply with these warnings may result in death, serious physical injury or damaged equipment.

Failure to comply with this information can affect the generator's performance.

Useful notices and tips regarding proper handling, operation and maintenance.

1.3. Personnel

Only qualified personnel should work with the **TruPlasma Bipolar 4010 with switch** "Qualified" is defined as personnel who are familiar with the safe installation procedures, maintenance and operation.

All of the personnel working with this equipment must take appropriate precautions to protect themselves against the possibility of electrical shocks or fatal injuries. They must be familiar with the entire **TruPlasma Bipolar 4010 with switch** operating instruction manual and understand all of its contents.

Do not be careless around this equipment!

1.4. Safety standards profile

Power unit is intended to use in an industrial environment.

There may be potential difficulties in ensuring electromagnetic compatibility in other environment, due to conducted as well as radiated disturbances.

The **TruPlasma Bipolar 4010 with switch** Power Supply was designed and constructed in compliance with the requirements outlined in the following standards and EC directives:

Standards:

- **EN 61010-1:** 2010 Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 1: General requirements.
- **EN 61000-6-2:** 2005/AC:2005 " Electromagnetic compatibility (EMC). Part 6-2: Generic standards –Immunity for industrial environments.
- **EN 55011:** 2009/A1:2010 Class A and Group 2; Industrial, scientific and medical equipment – Radio-frequency disturbance characteristics – Limits and methods of measurement.

EC directives:

- **2014/35/EC** Low Voltage Directive of 26 February 2014 on the harmonization of the laws of the Member States relating to the making available on the market of electrical equipment designed for use within certain voltage limits.
- **2014/30/EC** EMC Directive of 26 February 2014 on the harmonization of the laws of the Member States relating to electromagnetic compatibility.

➲ **Check external fuse value and grounding circuit before switching mains on.**

➲ **Never unscrew or remove rear terminals covers before switching mains off..**

1.5. Transportation and storage

Transportation

TruPlasma Bipolar 4010 with switch system must be firmly secured and placed in a horizontal position.

Very heavy! Lifting the power supply requires more than one person (weights are differentiated according to the output power)

Storage

Storage environments should be dry, free of aggressive vapors and not exposed to temperatures from beyond the 1K4 class range – EN 50178 (i.e.: -25, +55ºC). See table 'Environment'.

Before storage and transportation remove all cooling water residues from the generator by carefully blowing compressed air through the lines.

2. General information

Description

The **TruPlasma Bipolar 4010 with switch** power supply is designed for plasma-assisted film deposition PECVD and dual cathode sputtering processes, where reliability and performance are critical. It's most important features are:

- high efficiency switched-mode power conversion performance,
- up to 600V operating output voltage,
- full output power capability at an output voltage as low as 320V,
- ultrafast arc switch-off and recovery,
- extremely low arc energy,
- wide variety of user adjustable parameters,
- two switchable outputs

The **TruPlasma Bipolar 4010 with switch** power supply is assembled in one industrial steel enclosure ready to insert into a 19'' rack power system. All cable ends and electric terminals for user connections are located at the rear of the module.

Microprocessor

Power supply is microprocessor-controlled. All control-signal connections are digitally and opto-isolated providing high resistance against electromagnetic disturbances.

Interfaces

A multi-control system gives user a possibility of selecting from a variety of control sources.

Depending on configuration, there are available:

- Remote: RS-232,
- Remote: EtherCat,

2.1. TruPlasma Bipolar 4010 with switch block diagram

A block diagram of the **TruPlasma Bipolar 4010 with switch** is shown below. This **TruPlasma Bipolar 4010 with switch** block diagram consists of the following functional blocks:

- input EMI filter to reduce electromagnetic interferences delivered to mains,
- three-phase rectifier,
- circuit providing a soft switch-on,
- power factor correction circuit,
- MOSfet switch-mode DC/DC power converter,
- output section,
- arc detection and arc switch-off circuitry,
- switch module
- control electronics

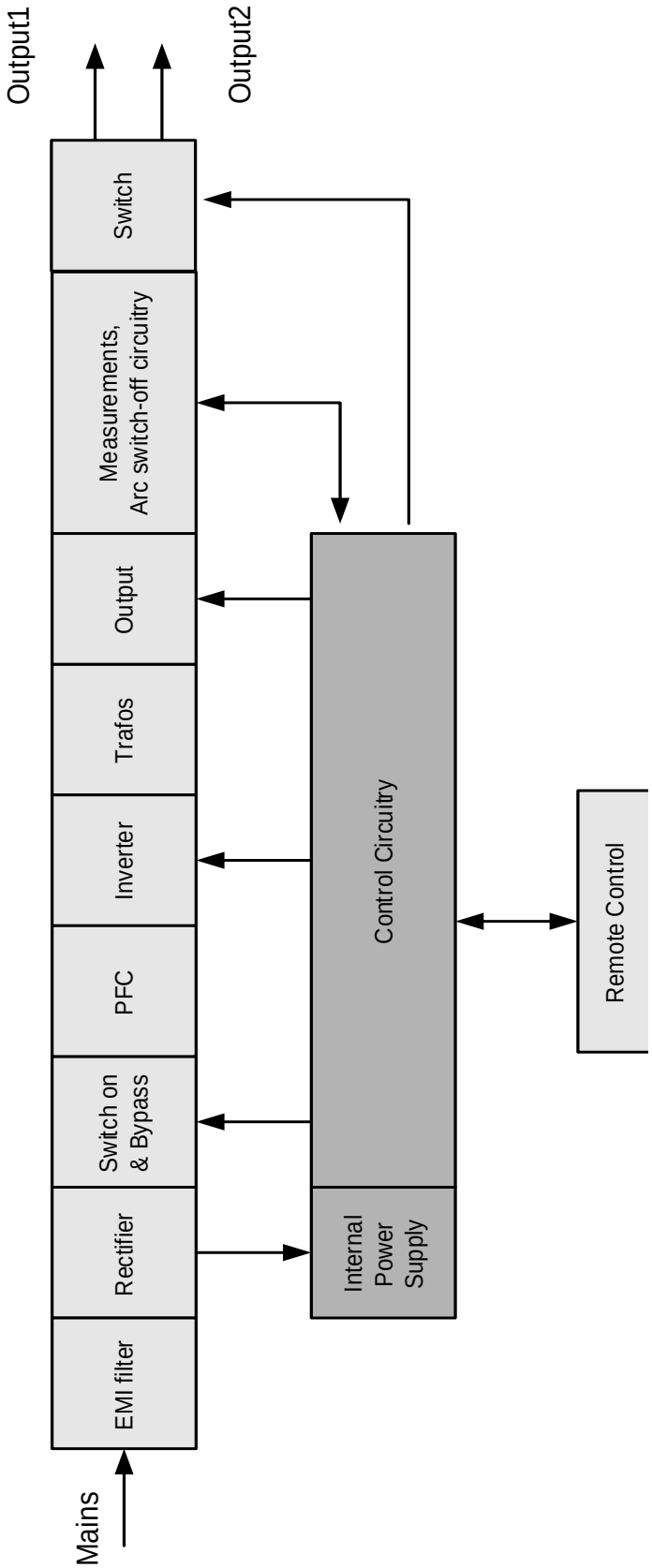


Fig.2.1. TruPlasma Bipolar 4010 with switch block diagram

3. Electrical and mechanical specifications

3.1. Electrical and mechanical specification in tables

Electrical specification – Overall			
Mains voltage	**V AC**		3x340-440 **+PE** It is recommended to maintain a power quality according to EN 61000-2-4 (class 3).
Mains frequency	**Hz**		50/60 (range: 47 to 63)
Maximum mains input current	**A**		3 x 20 A
Recommended fusing	**A**		3 x 32, B-class
Efficiency	**%**		Approximately 91%
Warm-up delay	**second**		< 5

Electrical specification – Power supply section			
Nominal output values (both outputs)			**$P_{n\ mean}$ = 20 kW (Blink)** **$U_{n\ RMS}$ = 600 V** **$I_{n\ RMS}$ = 50 A** **(see power characteristics Fig. 3.2)**
Output frequency	**kHz**		5-50
Control source options			Remote - RS-232 Remote - EtherCat
Output control			P – power control U – voltage control I – current control

Mechanical Specification			
Size (Width x Height x Length)	**mm**		482 **(19")** x 222 **(5HU)** x 700
Weight	**kg**		Approx. 30

Arc detection criteria			
Imax **Overcurrent detection** an arc is detected when output current exceeds threshold value	**A** **%**		user adjustable: Imax Threshold 4,9 … 65,1 Imax offset 0 … 100
Dynamic U x I **Cross detection** reacts when output voltage drops while output current rises	**A** **V**		user adjustable: Ix 4,9 … 50,1 Ux 0 … 800
dU **Dynamic voltage change (microarc)** an arc is detected when output voltage immediately drops by the set value.	**%**		user adjustable: dU Thld 0 … 100
Usag **Voltage-based detector**	**%**		user adjustable: Uout Sag Factor 10 … 50
Breaktime and Ramp time	**µs** **ms** **µs**		Hard arc break time 10 … 2000 Hard arc Ramp Time 0 … 2 Micro arc break time 10 … 1000
Arc Burst	**us** **us**		BreakTime: 25 … 10000 Number in row: 1 … 100 On-Time Below 1 … 1000
Maximum amount of detected and suppressed arcs per second	**arc/sec**		20000

3.2. Environmental specification

Environmental Specification			
Ambient operating temperature	**°C** **°F**		+5 … +45 (Class 3K3, EN 50178) +41…+113
Storage temperature	**°C** **°F**		-25 … +55 (Class 1K4, EN 50178) -13 … +131
Relative humidity	**%** **g/m³**		5...85 Non-condensing 1…25 (Class 3K3, EN 50178)
Air pressure	**kPa** **mbar**		86-106 (Class 3K3, EN 50178) 860-1060 (max altitude: approximately 2000m above sea level)
Degree of Pollution			2 (see chapter 4.1. Installation site: contamination)

3.3. Cooling water specification

Cooling water parameters			
Temperature	**°C**		+20 to +35 The temperature must be higher than dew point.
Pressure	**bar**		< 7
Differential pressure input to output	**bar**		> 2
Flow rate	**l/min**		> 5
Flow rate in standby mode	**l/min**		1 … 2
Conductivity	**µS/cm**		50 … 600
Protection class IP			IP40

Total Hardness	Max Ph-Value
8 °dH	7.8
6 °dH	8.1
4 °dH	8.3

Description	Limit Value
Aggressive carbonic acid	must not be detected
Ammonia	must not be detected
Nitrite	< 1 mg/l
Iron	< 0.3 mg/l
Manganese	< 0.05 mg/l
Sulfate	< 250 mg/l
Chloride	< 250 mg/l
COD (chemical oxygen demand)	< 40 mg/l
Microbiologic growth: - number of colonies - sulfate reducing agents	 < 1000/ml must not be detected

Min. 1l/min of cooling water is required in standby mode.
If the minimal water flow for standby mode cannot be provided, mains must be switched off.

3.4. Compressed air specification

To avoid problems with humidity condensation it is recommended to connect the compressed air to the dedicated terminal in the power supply. It is especially important when generator operates in tropical areas with high humidity.
The condensed water could lead to internal short circuits and finally to damage of the power supply.

The table with air quality parameters with references to ISO 8573-1/2010 standard below:

Compressed air parameters				Quality class according to ISO 8573-1
Pressure	**bar**		0.1 … 0.2	
Pressure dew point	**°C**		max. +3 (see the next page for dew point diagram)	4
Oil content	**mg/m³**		< 0.1	2
Dust-free			Acc. to Tab. 2 ISO 8573-1/2001	2

Compressed air connector is placed on the rear side of the generator (see chapter *4.3. Connection terminals* and chapter *4.5. Cooling terminals descriptions*).

To prevent water condensation, connect compressed air 60 minutes before usage.

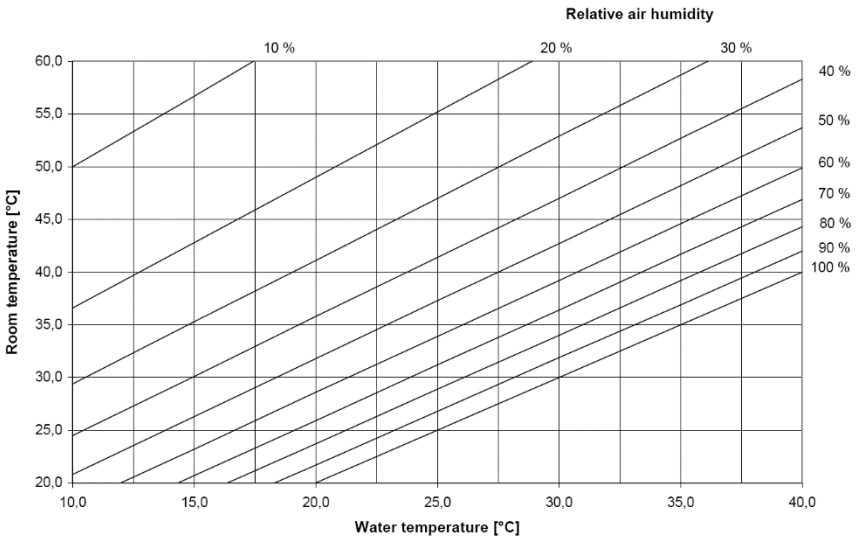


Fig. 3.1. Dew point diagram.

The dew point diagram has been created with an assumed air pressure of 1013 mbar.

3.5. TruPlasma Bipolar 4010 with switch power characteristic

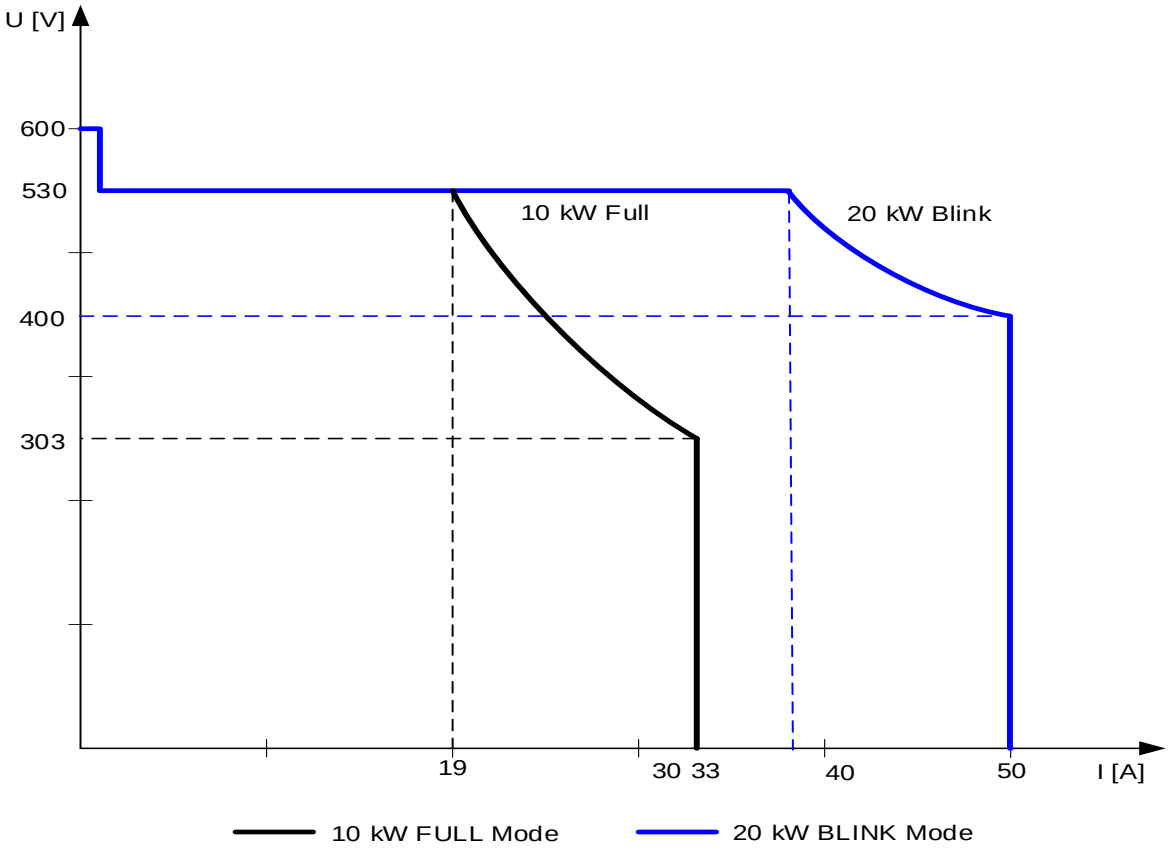


Fig. 3.2. Power characteristic of **TruPlasma Bipolar 4010 with switch** module.

3.6. Description of continous working modes

Power supply can work in continuous mode on one of the outputs. The second output is short circuited. In that case the current and power maximum values are shown below:

Output parameters				
Ton/(Ton+Toff) > 50 %	**A** **kW**		I max P max	**33** **10**
Ton/(Ton+Toff) < 50 %	**A** **kW**		I max P max	**50** **20**

FULL MODE

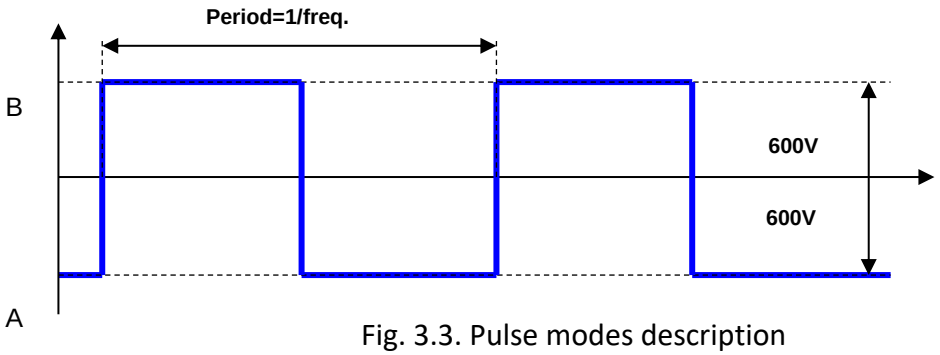


Fig. 3.3. Pulse modes description

Parameter	Description	Range
Frequency	$\boldsymbol{Frequency = \frac{1}{Period}}$	5 kHz – 50 kHz
Duty	$\boldsymbol{Duty = \frac{Pulse\ A}{Pulse\ A + Pulse\ B}}$	1 % - 99 %

Frequency of released power pulses (polarization A and B) can be changed with power on in range from 5 kHz to 50 kHz with 0,1 kHz step
Duty cycle for A and B polarization can be set from 1% to 99%.
Power supply controls and measures mean power, RMS current and RMS voltage on the output.

Outputs cannot be grounded!

BIPULSE MODE

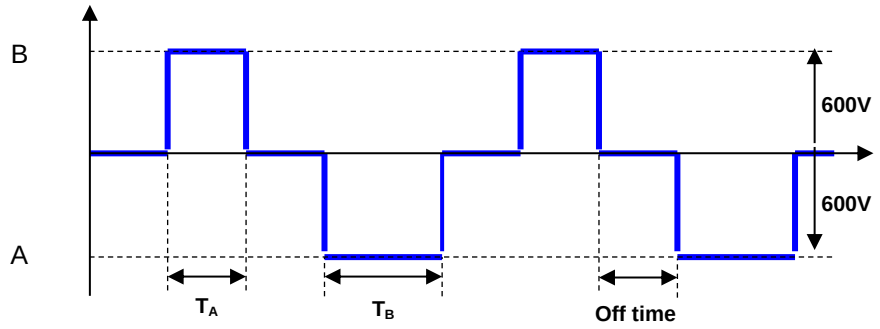


Fig. 3.4. BiPulse modes description

Parameter	Description	Range
Frequency	$\boldsymbol{Frequency = \frac{1}{Period}}$	5 kHz – 50 kHz
Duty	$\boldsymbol{Duty = \frac{Pulse\ A}{Pulse\ A + Pulse\ B}}$	1 % - 99 %
Off time	-	1 % - 20 %

Frequency of released power pulses (polarization A and B) can be changed with power on in range from 5 kHz to 50 kHz with 0,1 kHz step
Duty cycle for A and B polarization can be set from 1 % to 99 %.
Power supply controls and measures mean power, RMS current and RMS voltage on the output.

Outputs cannot be grounded!

TRAPEZ MODE

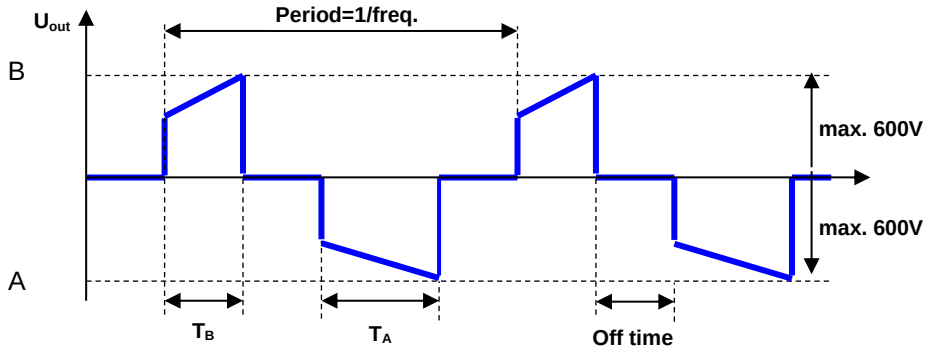


Fig. 3.5. TRAPEZ modes description

Parameter	Description	Range
Frequency	$\boldsymbol{Frequency = \frac{1}{Period}}$	5 kHz – 50 kHz
Duty	$\boldsymbol{Duty = \frac{Pulse\ A}{Pulse\ A + Pulse\ B}}$	1 % - 99 %
Off time	-	1 % - 20 %

Frequency of released power pulses (polarization A and B) can be changed with power on in range from 5 kHz to 50 kHz with 0,1 kHz step and duty cycle for pulses can be set from 1 % to 99 %. Accretion speed is dependent on the off time value.
Power supply controls and measures mean power, RMS current and RMS voltage on the output.

Outputs cannot be grounded!

3.7. Blink mode

Power supply can work in blink mode on one of the outputs or in both outputs in the same time. In case of dual output working mode pulse on must be shifted an meet the following terms:

- $BlinkPowerOnOut1 + 2 * T_{switch} \leq BlinkPowerOffOut2$
- $BlinkPowerOnOut2 + 2 * T_{switch} \leq BlinkPowerOffOut1$
- $BlinkOut1 = n * BlinkOut2$
- $BlinkOut2 = n * BlinkOut1$

Where:

Blink_Out1= BlinkPowerOn_Out1 + BlinkPowerOff_Out1

Blink_Out2= BlinkPowerOn_Out2 + BlinkPowerOff_Out2

T_SWITCH – time of minimum break between switching outputs.

The maximum current and power parameters are the same as in the continuous mode except that duty is defined as:

$$duty = \frac{BlinkPowerOn\_Out1}{BlinkPowerOn\_Out1 + BlinkPowerOff\_Out1} + \frac{BlinkPowerOn\_Out2}{BlinkPowerOn\_Out2 + BlinkPowerOff\_Out2}$$

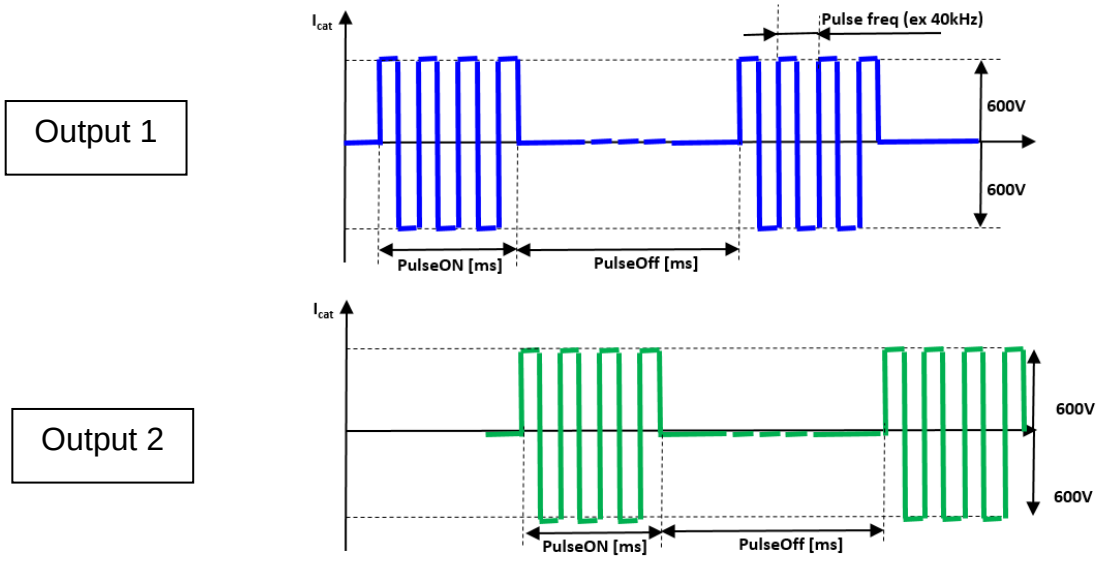


Fig. 3.6. Dual output blink mode

Dual output blink mode parameters			
Blink on	**ms**		1 … 500
Blink off	**ms**		1 … 500
T_Switch	**ms**		0,1

4. Installation and connections

4.1. Installation site

Enclosure

TruPlasma Bipolar 4010 with switch power supply is built in a standard 19" enclosure and is designed to fit into a standard 19", 800mm deep, rack cabinet. Weight of device is approx. 30kg and mechanical construction of cabinet should be strong enough to support it. Temperature inside cabinet should not exceed 45°C measured at front panel of module.

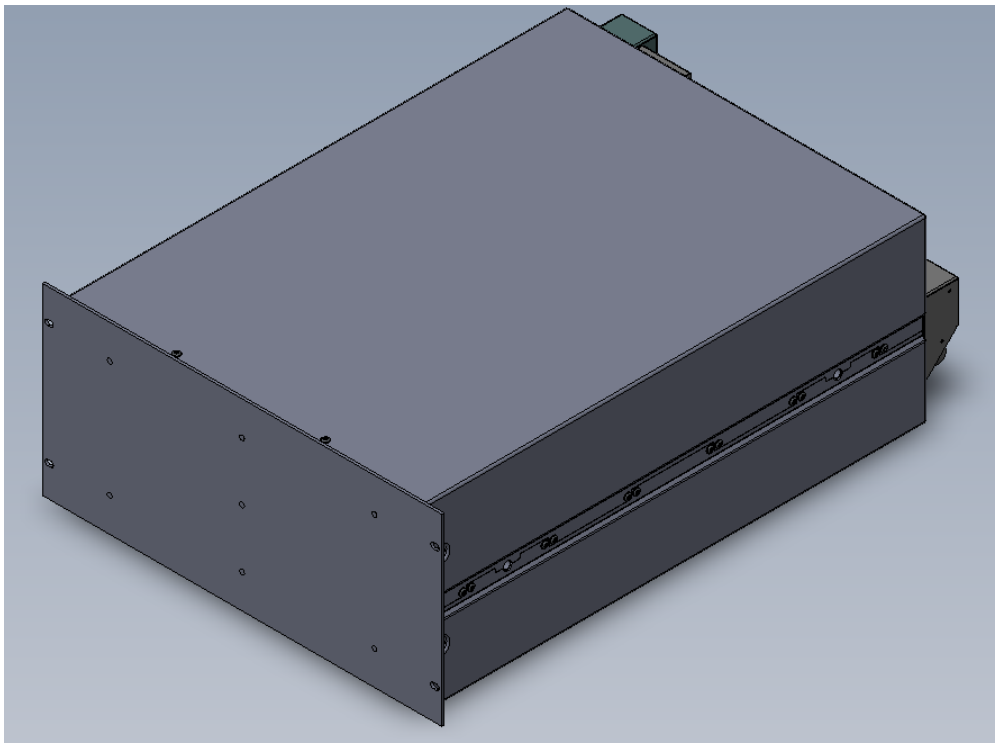


Fig. 4.1. TruPlasma Bipolar 4010 with switch.

HEAVY OBJECT.
May result in severe injury.
Do not lift or move without adequate equipment.
Weight 30kg.

Contamination

Cooling air should be kept free from corrosive vapors and any particles that could become conductive after exposure to moisture.

Unpacking

Inspect the devices packaging for damage and compare its contents carefully with delivery documents**.**

4.2. Fusing

External mains fuses are highly recommended with respect to EN61010-1 standard. A set of three-phase 32A B-class fuses will provide necessary protection.

A set of fuses has to be provided for each power supply separately.

Usage of circuit breakers with the same tripping characteristic and rated current instead of fuses is also possible.

All terminal connection operations have to be made when power supply is not powered with mains and (if applicable) external 24V.

4.3. Connection terminals

All connection terminals are located on rear side of **TruPlasma Bipolar 4010 with switch**. Output terminals should be covered by cap delivered with the device. Sufficient space for cables should be provided (at least ½U) between modules installed together inside one cabinet.

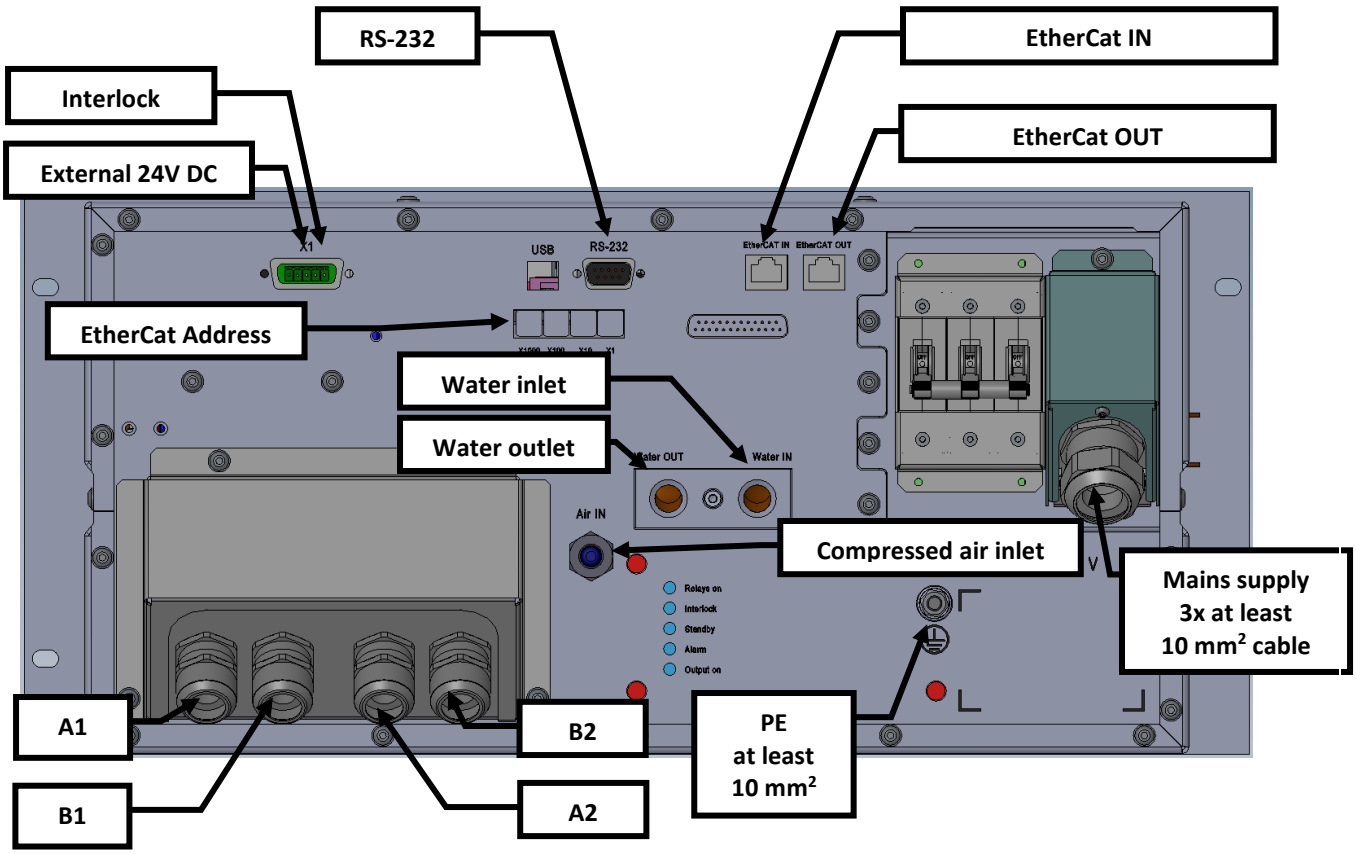


Fig. 4.2. Description of connectors and terminals on the rear panel.

WARNING !

Check inlet and outlet water connection. Changing water flow direction will cause power supply's malfunction!

WARNING !

To prevent water condensation, connect compressed air 60 minutes before usage.

4.4. Power terminals description

Terminal	Description	Cable	Cable endings
MAINS	3 x 340-440 V AC	3x min. 10 mm^2	3x ferrule
PE	Protective earth	min. 10 mm^2	M6
OUTPUT 1	600V / 50A	2x min. 16 mm^2 Copper twisted on entire length and shielded cable is recommended. Shielded output cables connected to power supply via EMC cable gland with tight and full 360-degree metal-to-metal contact of screen connection. Use dedicated cable (TRUMPF Huettinger cable type DC15).	2x M8
OUTPUT 2	600V / 50A	2x min. 16 mm^2 Copper twisted on entire length and shielded cable is recommended. Shielded output cables connected to power supply via EMC cable gland with tight and full 360-degree metal-to-metal contact of screen connection. Use dedicated cable (TRUMPF Huettinger cable type DC15).	2x M8
External 24V	24V / 1A	2 x 1.5 mm^2	WEIDMULLER BLZ 5.08/4

Do NOT turn on unit's power until the power supply is properly grounded!

Properly and firmly made connections and installation of Power Supply are necessary to fulfill safety and EMC standards.

4.5. Cooling connectors description

Terminal	Description	Hose ending
Water inlet	Stainless steel or polyurethane (PU)	ø 10 mm (G3.8 inch threaded holes)
Water outlet		
Compressed air inlet	Polyurethane (PU)	ø 8 mm (quick connect adaptor with $^1/_8$" external thread and stopper are attached)

4.6. Communication terminals description

Terminal	Description	Connection	Cable endings
RS-232	communication port	see below	SUBD 9pin female
EtherCat IN	communication port	see below	RJ – 45
EtherCat OUT	communication port	see below	RJ – 45
Others	not used in this application		n/a

4.7. RS-232 communication terminal

RS-232 port is located on the rear side of device and uses a 9-pin male SUBD connector. Table below provides description of pins.

Pin no.	Name	Type	Description
2	**RxD**	digital input	RS232 receives data
3	**TxD**	digital output	RS232 transmits data
5	**GND**	GND	Ground, can be used for cable shield
others	-	n/c	n/c

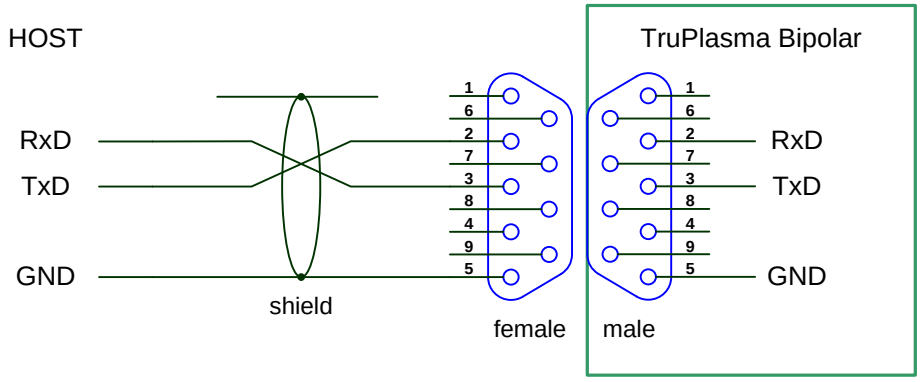


Fig. 4.3. RS-232 connection diagram.

WARNING !

Do NOT connect the shield with earth (PE).

WARNING !

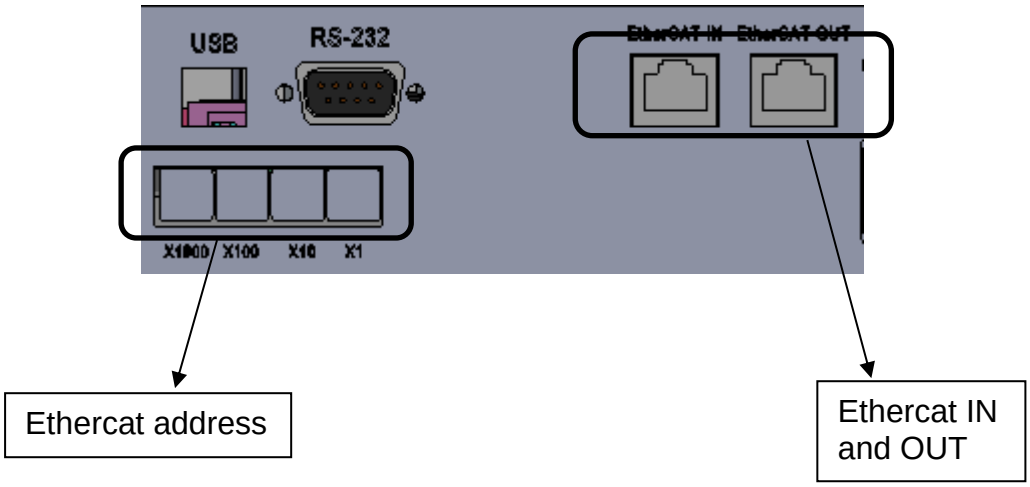
Do not forget about the shield otherwise it will result in error occurrence

RS-232 communication baud rate can be set from the range: 9600, 19200, 38400, 57600 and 115200 bps, and it works in standard 8n1 (8 bits of data, non-parity, 1 bit of stop).
In order to get errorless communication, cable length shouldn't be longer than 3 m.

Default baud rate is 115200 bps.

4.8. EtherCat communication terminal

EtherCAT port is located on the rear side of device and uses a RJ - 45 connector.
This interface is compliant with EtherCAT specification.



The EtherCAT protocol is optimized for process data and is transported directly within the standard IEEE 802.3 Ethernet frame using Ethertype 0x88a4. It may consist of several sub-telegrams, each serving a particular memory area of the logical process images that can be up to 4 gigabytes in size. The data sequence is independent of the physical order of the nodes in the network; addressing can be in any order. Broadcast, multicast and communication between slaves is possible, but must be initiated by the master device. If IP routing is required, the EtherCAT protocol can be inserted into UDP/IP datagrams. This also enables any control with Ethernet protocol stack to address EtherCAT systems.

4.9. External 24 V and interlock terminal

External 24 V DC connector is located at the rear side of the module and uses a 5-pin PSC 1,5/ 5-M connector. Pin assignment is shown in the table below.

Pin no.	Name	Type	Description
1	**GND**	Ground	Reference ground
2	**+24 V**	Supply input	External 24 V DC supply
3	**+24V**	Supply output	24V supply for all digital inputs
5	**Interlock**	Digital input	Interlock must be disabled (connected to +24V, pin 3) to enable power supply switch-ON. This is a relay-based hardware connection

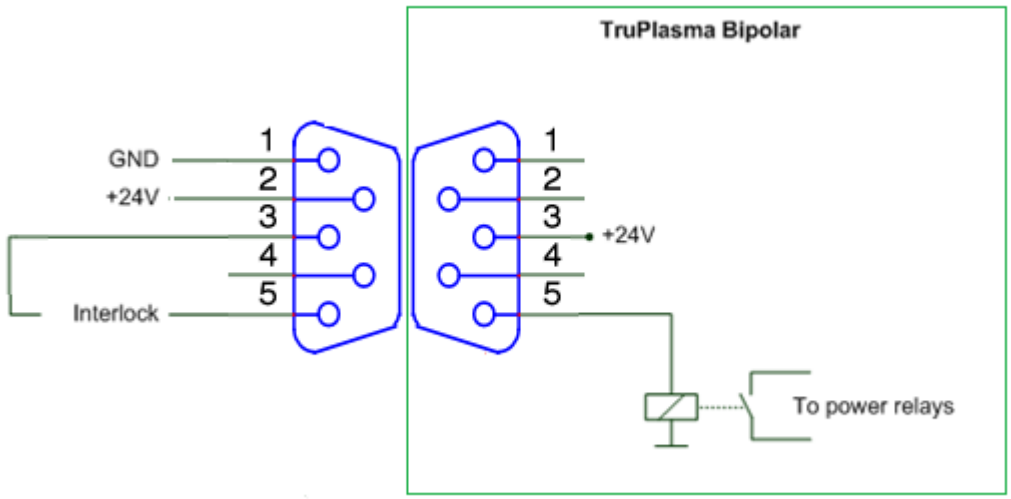


Fig. 4.6. 24 V DC and interlock circuit diagram.

Interlock as a system of protection against electric shock has
MTTF = 498 678 hours .

5. Arc management

Electric arcs, observed inside vacuum chamber during all stages of surface treatment process may affect treated surface in a negative manner. In such events arcs should be suppressed as fast as possible. From an electrical point of view, arc occurrence is defined as a rapid change of impedance in chamber's electric terminals.

TruPlasma Bipolar 4010 with switch arc detection system is equipped with four kinds of arc detection criteria:

Imax – current-based detector – reacts when output current exceeds user defined Imax threshold. The threshold can be set as a fixed value (Imax Thld [A]) or as a percentage of set output current (Imax Offset [%]). If Imax Offset is set to "0" then threshold is defined as a set value by Imax Thld. Otherwise threshold is defined as a relative value of Iset by Imax Offset parameter.

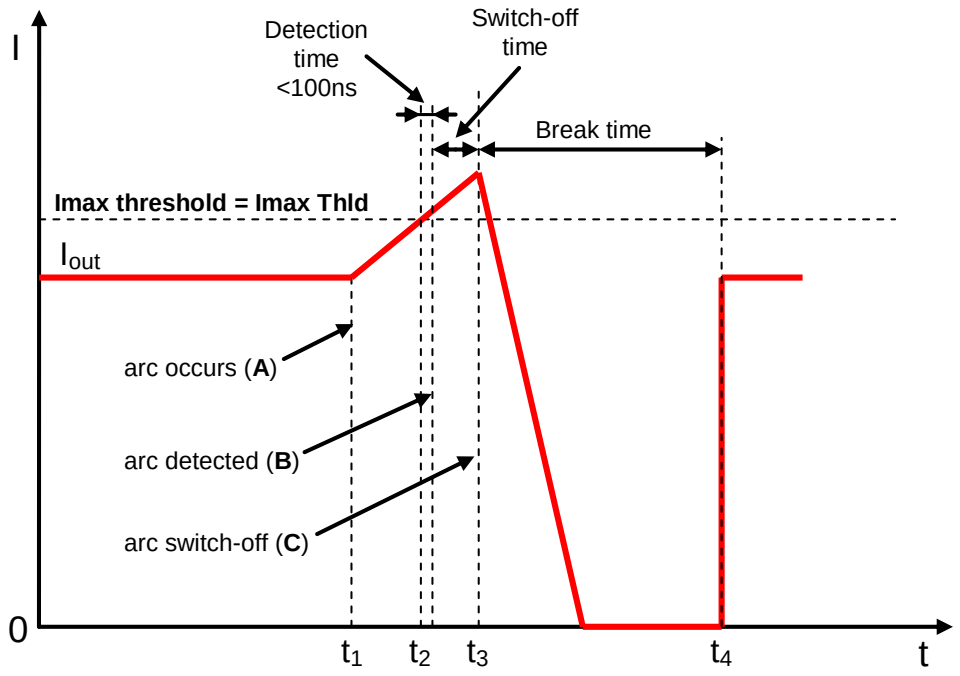


Fig. 6.1. I_{max} criterion arc detection example - **Imax Offset [%] = 0**.

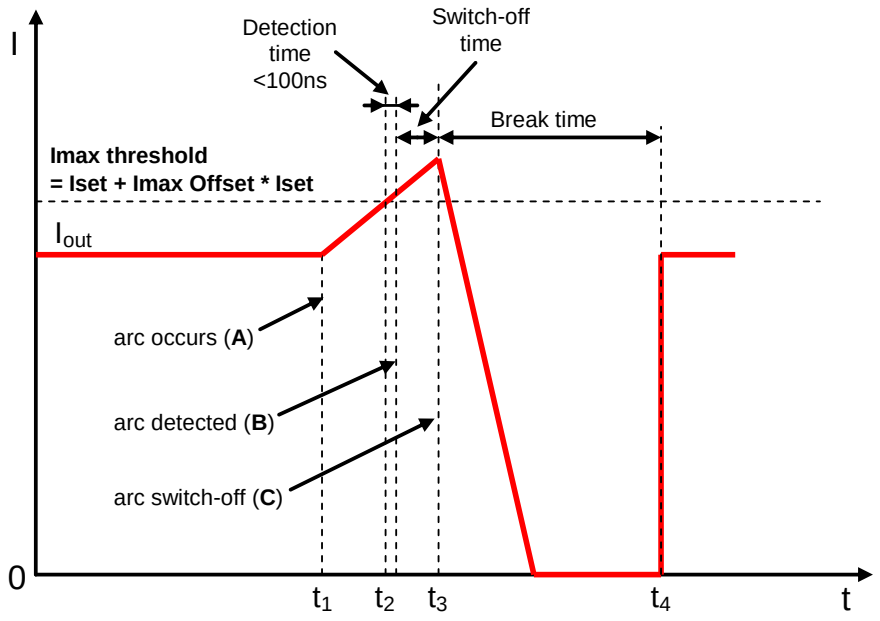


Fig. 6.2. I_{max} criterion arc detection example - **Imax Offset [%] ≠ 0**.

UxI – voltage and current-based detector (cross-detector) – reacts when output voltage is lower than user-defined D_UxI U threshold while output current is higher than user-defined D_UxI I threshold

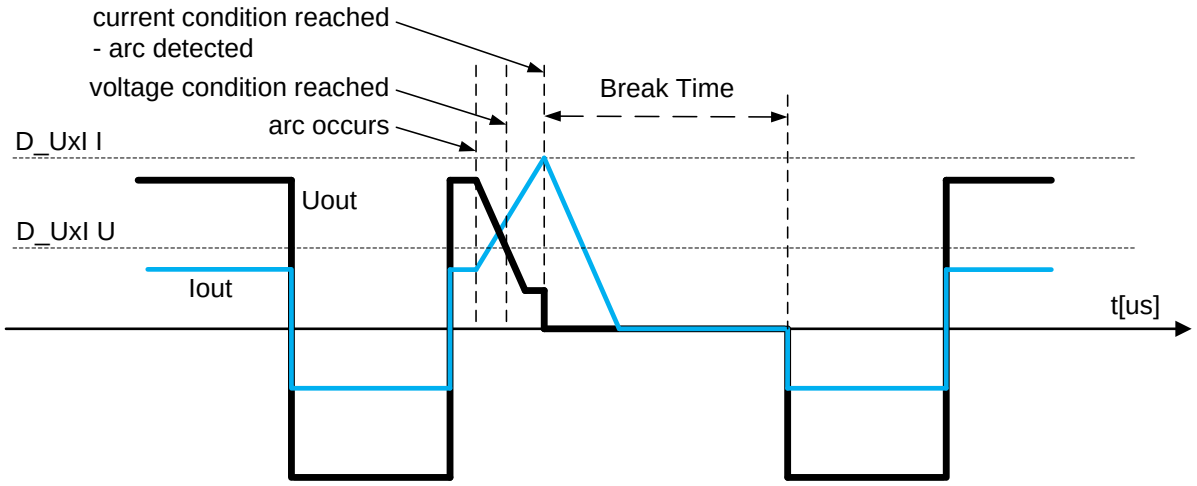


Fig. 6.3. **UxI** (cross detection) criterion arc detection example.

dU – voltage-based detector (microarc) – the generator remembers the shape of output voltage waveform from the last pulse. It compares momentarily output voltage value with corresponding value from the last pulse reduced by dU Thld %. If the present value is lower an arc is detected.

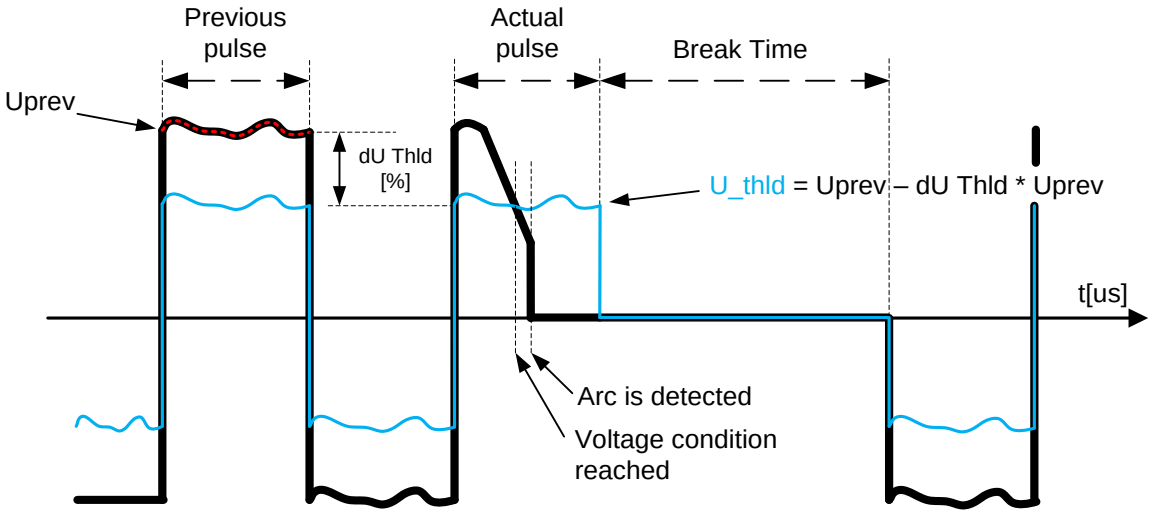


Fig. 6.4. **dU** (dynamic voltage change) criterion arc detection example.

Usag – Voltage-based detector – it compares RMS output voltage value of present pulse with RMS output voltage value of previous pulse reduced by Uout thld %. If present value is lower the sag is detected.

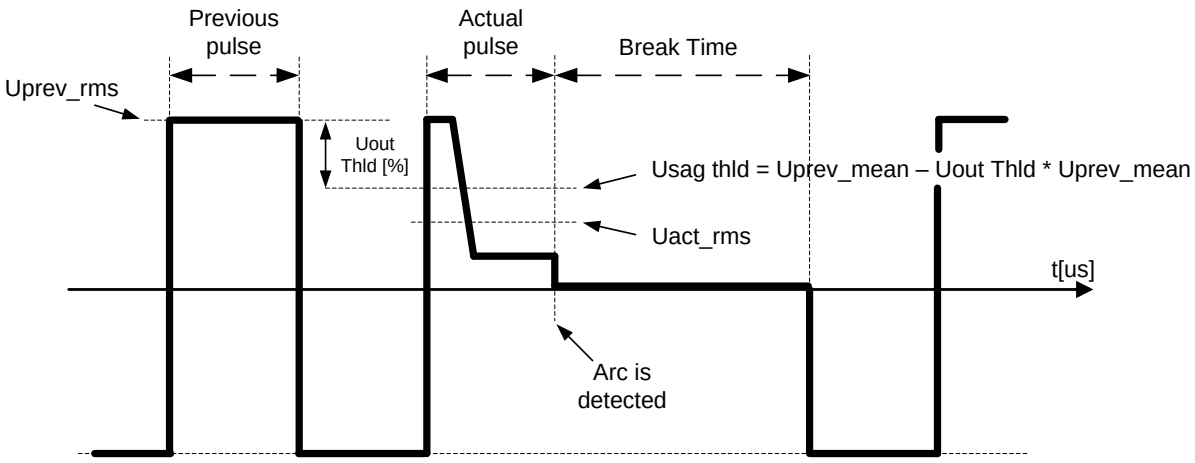


Fig. 6.5. **Usag** detection example.

Notes:

- In **TruPlasma Bipolar 4010 with switch** maximum frequency of detected and suppressed arcs can be as high as 20000Hz. This is valid only when cable length between power supply and load is no longer than 10 meters, otherwise frequency is limited to lower values (overheating protection).

Number of detected arcs is displayed by the front panel display or can be read from communication interface with respect to the criteria which detects an arc.
Once an arc has been detected shut-down signal is activated and output power is switched off. At the same moment, a time control procedure and **break time** counter are initiated.

After break time, a shut-down signal is released and output power returns to its previous setting value. **Break time** parameter can be set through RS232 or EtherCat.

6. Digital interfaces

6.1. RS-232 transmission protocol description

TruPlasma Bipolar acts as a slave device in the communication process. It never initiates any transmissions. Computer (PC) sends a command which is executed by **TruPlasma Bipolar** and a reply is generated (see note 1). Standard commands are shown below. Additional commands can be implemented if necessary. Baud rate can be chosen by byte channel no. 28. Default value is 38400bps. The RS communication works in standard 8n1 (8 bits of data, non-parity, 1 bit of stop, LSB first).

Serial communication interface data format:

		Start	LSB	2	3	4	5	6	7	MSB	Stop		

Frame general description

Command:

0	1	2	3	4	5	6	7	...	
LEN	~LEN	DST_H	DST_L	SRC_H	SRC_L	CMD_H	CMD_L	…	
							...	LEN-2	LEN-1
							...	CRC_H	CRC_L

Reply:

0	1	2	3	4	5	6	7	8	9
LEN	~LEN	DST_H	DST_L	SRC_H	SRC_L	ACK_H	ACK_L	CMD_H	CMD_L
...							…	LEN-2	LEN-1
…							…	CRC_H	CRC_L

Where: LEN, ~LEN: length and inverted length (byte, byte);

DST_H, DST_L: receiver number (word); - default value for RS232 is:

DST_H = 0xFF;

DST_L = 0xFF;

SRC_H, SRC_L: sender number (word); - default value for RS232 is:

SRC_H = 0x00;

SRC_L = 0x00;

CMD_H, CMD_L: command code (word);

CRC_H, CRC_L: checksum (word); - all bytes sum (without LEN and ~LEN);

ACK_H, ACK_L: reply code (word);

ACK == 0x4000 => OK.

ACK != 0x4000 => fault

6040 Normal run

PC to unit:

0	1	2	3	4	5	6	7	8-11	12-15
0x17	0xE8	DST_H	DST_L	SRC_H	SRC_L	0x60	0x40	$Uset_{0-3}$	$Iset_{0-3}$
16-19	20	21	22						
$Pset_{0-3}$	Bits	CRC_H	CRC_L						

Where:

Uset (float)	Voltage setpoint [V]	0…U_n V
Iset (float)	Current setpoint [A]	0…I_n A
Pset (float)	Power setpoint [kW]	0…P_n kW

Bits:

0: Mains relays ON (1), OFF (0) (edge sensitive 0⟶1), OFF (0)
1: Power ON (1), OFF (0) (edge sensitive 0⟶1), OFF (0)
2: Reset arc counters (1 transmission is sufficient)
3: RS controls the Bipolar unit (1), monitoring only (0)
4: -
5:
6: -
7: Reset Alarms

IMPORTANT: When controlling Bipolar unit digitally, (by way of RS232) a command must be sent at least once every 3 seconds to keep power supply running. If, for any reason, transmission fails – an alarm "ActSourceFail " (code 61613) will appear after 4-5 seconds and power supply will be switched off.

unit reply to PC

0	1	2	3	4	5	6	7	8	9
0x1E	0xE1	DST_H	DST_L	SRC_H	SRC_L	ACK_H	ACK_L	CMD_H	CMD_L
10-13	14-17	18-21	22-23	24-25	26-27	28-29			
$Uact_{0-3}$	$Iact_{0-3}$	$Pact_{0-3}$	$Bits_{0-2}$	Im_{0-1}	Arc/s_{0-3}	CRC_{0-1}			

Where:

Uact (float)	Output RMS voltage [V]	0...U_n V
Iact (float)	Output RMS current [A]	0...I_n A
Pact (float)	Output RMS power [kW]	0...P_n kW

Bits0: Acknowledge bits.
- 0: Relays ON acknowledge (1), or OFF (0)
- 1: Power ON (1), INHIBIT (0)
- 2: -
- 3: RS232 control
- 4: -
- 5: -
- 6: -
- 7: -

Bits1: more acknowledge bits.
- 0: Interlock (1), no interlock (0)
- 1: -
- 2: -
- 3: FPGA (1) OK (0)
- 4: Power Off Sequence
- 5: -
- 6: WarningActive (1), inactive (0).
- 7: AlarmActive (1), inactive (0).

Bits2: more acknowledge bits.
- 0: RegU ON (1), OFF (0)
- 1: RegI ON (1), OFF (0)
- 2: RegP ON (1), OFF (0)
- 3: -
- 4: -
- 5: -
- 6: -
- 7: Arc occ.

Im (integer)	Arc counter (Imax criterion)	0...65535
Arc/s(float)	Arcs per second counter	

Other parameters can be accessed for reading or adjustment, through their channel numbers. Byte, integer and float values have separate channel number lists. Command strings for reading and setting these values together with channel lists are presented below.

6101 Identification of device:

PC to unit:

0	1	2	3	4	5	6	7	8	9
0x0A	0xF5	DST_H	DST_L	SRC_H	SRC_L	0x61	0x01	CRC_H	CRC_L

unit reply to PC

0	1	2	3	4	5	6	7	8	9
0x20	0xDF	DST_H	DST_L	SRC_H	SRC_L	ACK_H	ACK_L	0x75	0x41
10	...	29	30	31					
S_{00}	…	S_{19}	CRC_H	CRC_L					

Where: $S_{00} \div S_{19}$: device type (char[20]);

6141 Set a floating point value

PC to unit:

0	1	2	3	4	5	6	7	8	9
0x10	0xEF	DST_H	DST_L	SRC_H	SRC_L	0x61	0x41	CHN_H	CHN_L
10	11	12	13	14	15				
VAL_0	VAL_1	VAL_2	VAL_3	CRC_H	CRC_L				

Where:

CHN (int)	Channel number
Val (float)	Value to be set

Unit reply:

0	1	2	3	4	5	6	7	8	9
0x0E	0xF1	DST_H	DST_L	SRC_H	SRC_L	ACK_H	ACK_L	0x61	0x41
10	11	12	13						
CHN_H	CHN_L	CRC_H	CRC_L						

Where:

CHN (int)	Channel number

6142 Read a floating point value

PC to unit:

0	1	2	3	4	5	6	7	8	9
0x0C	0xF3	DST_H	DST_L	SRC_H	SRC_L	0x61	0x42	CHN_H	CHN_L
10	11								
CRC_H	CRC_L								

Where:

CHN (int) Channel number

Unit reply:

0	1	2	3	4	5	6	7	8	9
0x12	0xED	DST_H	DST_L	SRC_H	SRC_L	ACK_H	ACK_L	0x61	0x42
10	11	12	13	14	15	16	17		
CHN_H	CHN_L	VAL_0	VAL_1	VAL_2	VAL_3	CRC_H	CRC_L		

Where:

CHN (int) Channel number
Val (float) Value to be set

6151 Set an double integer value

PC to unit:

0	1	2	3	4	5	6	7	8	9
0x10	0xEF	DST_H	DST_L	SRC_H	SRC_L	0x61	0x51	CHN_H	CHN_L
10	11	12	13	14	15				
VAL_0	VAL_1	VAL_2	VAL_3	CRC_H	CRC_L				

Where:

CHN (int) Channel number
Val (int) Value to be set

Unit reply:

0	1	2	3	4	5	6	7	8	9
0x0E	0xF1	DST_H	DST_L	SRC_H	SRC_L	ACK_H	ACK_L	0x61	0x51
10	11	12	13						
CHN_H	CHN_L	CRC_H	CRC_L						

Where:

CHN (int) Channel number

6152 Read an double integer value

PC to unit:

0	1	2	3	4	5	6	7	8	9
0x0C	0xF3	DST_H	DST_L	SRC_H	SRC_L	0x61	0x52	CHN_H	CHN_L
10	11								
CRC_H	CRC_L								

Where:

CHN (int) Channel number

Unit reply:

0	1	2	3	4	5	6	7	8	9
0x12	0xED	DST_H	DST_L	SRC_H	SRC_L	ACK_H	ACK_L	0x61	0x52
10	11	12	13	14	15	16	17		
CHN_H	CHN_L	VAL_0	VAL_1	VAL_2	VAL_3	CRC_H	CRC_L		

Where:

CHN (int) Channel number
Val (float) Value to be set

6121 Set an integer value

PC to unit:

0	1	2	3	4	5	6	7	8	9
0x0E	0xF1	DST_H	DST_L	SRC_H	SRC_L	0x61	0x21	CHN_H	CHN_L
10	11	12	13						
VAL_H	VAL_L	CRC_H	CRC_L						

Where:

CHN (int) Channel number
Val (int) Value to be set

Unit reply:

0	1	2	3	4	5	6	7	8	9
0x0E	0xF1	DST_H	DST_L	SRC_H	SRC_L	ACK_H	ACK_L	0x61	0x21
10	11	12	13						
CHN_H	CHN_L	CRC_H	CRC_L						

Where:

CHN (int) Channel number

6122 Read an integer value

PC to unit:

0	1	2	3	4	5	6	7	8	9
0x0C	0xF3	DST_H	DST_L	SRC_H	SRC_L	0x61	0x22	CHN_H	CHN_L
10	11								
CRC_H	CRC_L								

Where:

CHN (int) Channel number

Unit reply:

0	1	2	3	4	5	6	7	8	9
0x10	0xEF	DST_H	DST_L	SRC_H	SRC_L	ACK_H	ACK_L	0x61	0x22
10	11	12	13	14	15				
CHN_H	CHN_L	VAL_H	VAL_L	CRC_H	CRC_L				

Where:

CHN (int) Channel number
Val (float) Value to be set

6111 Set a byte value

PC to unit:

0	1	2	3	4	5	6	7	8	9
0x0D	0xF2	DST_H	DST_L	SRC_H	SRC_L	0x61	0x11	CHN_H	CHN_L
10	11	12							
VAL	CRC_H	CRC_L							

Where:

CHN (int) Channel number
Val (int) Value to be set

Unit reply:

0	1	2	3	4	5	6	7	8	9
0x0E	0xF1	DST_H	DST_L	SRC_H	SRC_L	ACK_H	ACK_L	0x61	0x11
10	11	12	13						
CHN_H	CHN_L	CRC_H	CRC_L						

Where:

CHN (int) Channel number

6112 Read a byte value

PC to unit:

0	1	2	3	4	5	6	7	8	9
0x0C	0xF3	DST_H	DST_L	SRC_H	SRC_L	0x61	0x12	CHN_H	CHN_L
10	11								
CRC_H	CRC_L								

Where:

CHN (int) Channel number

Unit reply:

0	1	2	3	4	5	6	7	8	9
0x0F	0xF0	DST_H	DST_L	SRC_H	SRC_L	ACK_H	ACK_L	0x61	0x12
10	11	12	13	14					
CHN_H	CHN_L	VAL	CRC_H	CRC_L					

6301 Read alarm code and description

PC to unit:

0	1	2	3	4	5	6	7	8	9
0x0A	0xF5	DST_H	DST_L	SRC_H	SRC_L	0x63	0x01	CRC_H	CRC_L

Unit reply:

0	1	2	3	4	5	6	7	8	9
LEN	~LEN	DST_H	DST_L	SRC_H	SRC_L	ACK_H	ACK_L	0x63	0x01
10	11	12 to n-2				n-1	n		
$CODE_H$	$CODE_L$	Description				CRC_H	CRC_L		

6302 Read again last alarm code and description

PC to unit:

0	1	2	3	4	5	6	7	8	9
0x0A	0xF5	DST_H	DST_L	SRC_H	SRC_L	0x63	0x02	CRC_H	CRC_L

Unit reply:

0	1	2	3	4	5	6	7	8	9
LEN	~LEN	DST_H	DST_L	SRC_H	SRC_L	ACK_H	ACK_L	0x63	0x02
10	11	12 to n-2				n-1	n		
$CODE_H$	$CODE_L$	Description				CRC_H	CRC_L		

6.2. Ethercat protocol

Index	ObjectCode	SI	DataType	M/O/C	B/S	Access	CA	rx/tx	Default	Name	Description
CDP: Communication Area											
0x1000	VAR		UDINT	M		RO	N			**Device Type**	Bit 0-15: device profile number (5003). NOTE: Representation is hexadecimal (i.e. 5003dec -> 0x138B) Bit 16-31: 0x0000 sub-profile number is defined in 0xF010 bit 15..0 (refer to ETG.1000)
0x1008	VAR		STRING(30)	M		RO	N			**Manufacturer Device Name**	name of the devcie as non-zero terminated string (see ETG.1000)
0x1009	VAR		STRING(20)	M		RO	N			**Manufacturer Hardware Version**	hardware version of the devcie as non-zero terminated string (see ETG.1000)
0x100A	VAR		STRING(8)	M		RO	N			**Manufacturer Software Version**	software version of the devcie as non-zero terminated string (see ETG.1000)
0x1018	RECORD		IDENTITY	M		RO	Y			**Identity Object**	
		0x01	UDINT	M		RO				Vendor ID	
		0x02	UDINT	M		RO				Product Code	
		0x03	UDINT	M		RO				Revision Number	
		0x04	UDINT	M		RO				Serial Number	NOTE: If not used it shall be 0x00000000
0x10F8	VAR		ULINT	M		RO	N			**Timestamp Object**	Local Timestamp of the device in ns See ETG.1020 (chapter 13.5)
SDP: PDO Mapping											
0x1600	RECORD					RO	Y			**Module #1 RxPDO Mapping (Default)**	
		0x01	(BOOL)	M		RO				0x7000:0x01: Output ON Request	
		0x02	(BOOL)	M		RO				0x7000:0x02: Error reset	
		0x03	(BIT(6))	M						0x0000:0x00	padding
		0x04	(USINT)	M		RO				0x7004:0x01: Regulation / Control Mode	
		0x05	(REAL)	M		RO				0x7005:0x01: Setpoint	
0x1601	RECORD					RW	Y			**Module #1 RxPDO Mapping (User)**	
		0x01-0x10	UDINT	O		RW				(empty)	(empty)
0x1602	RECORD					RO	Y			**Module #2 RxPDO Mapping (Default)**	
		0x01	(BOOL)	M		RO				0x7010:0x01: Output ON Request	
		0x02	(BOOL)	M		RO				0x7010:0x02: Error reset	
		0x03	(BIT(6))	M						0x0000:0x00	padding
		0x04	(USINT)	M		RO				0x7014:0x01: Regulation / Control Mode	
		0x05	(REAL)	M		RO				0x7015:0x01: Setpoint	
0x1603	RECORD					RW	Y			**Module #2 RxPDO Mapping (User)**	
		0x01-0x10	UDINT	O		RW				(empty)	(empty)
0x17FF	RECORD					RW	Y			**Device RxPDO Mapping**	
		0x01-0x10	UDINT	O		RW				(empty)	(empty)
0x1A00	RECORD					RO	Y			**Module #1 TxPDO Mapping (Default)**	
		0x01	(BOOL)	M		RO				0x6000:0x01: Output ON Indication	

		0x02	(BOOL)	M		RO				0x6000:0x02: Output ON Req. Indication	
		0x03	(BOOL)	M		RO				0x6000:0x03: ECAT is not active control	
		0x04	(BOOL)	M		RO				0x6000:0x04: Control value out of range	
		0x05	(BOOL)	M		RO				0x6000:0x05: Error present	
		0x06	(BOOL)	M		RO				0x6000:0x06: Warning present	
		0x07	(BOOL)	M		RO				0x6002:0x01: Interlock open	
		0x08	(BOOL)	M		RO				0x6002:0x02: OverTemp Error	
		0x09	(USINT)	M		RO				0x6004:0x01: Regulation / Control Mode Display	
		0x0A	(REAL)	M		RO				0x6005:0x01: Actual Setpoint	
		0x0B	(REAL)	M		RO				0x6006:0x01: Actual Output Voltage	
		0x0C	(REAL)	M		RO				0x6006:0x02: Actual Output Current	
		0x0D	(REAL)	M		RO				0x6006:0x03: Actual Output Power	
0x1A01	RECORD					RW	Y			**Module #1 TxPDO Mapping (User)**	
		0x01-0x20	UDINT	O		RW				(empty)	(empty)
0x1A02	RECORD					RO	Y			**Module #2 TxPDO Mapping (Default)**	
		0x01	(BOOL)	M		RO				0x6010:0x01: Output ON Indication	
		0x02	(BOOL)	M		RO				0x6010:0x02: Output ON Req. Indication	
		0x03	(BOOL)	M		RO				0x6010:0x03: ECAT is not active control	
		0x04	(BOOL)	M		RO				0x6010:0x04: Control value out of range	
		0x05	(BOOL)	M		RO				0x6010:0x05: Error present	
		0x06	(BOOL)	M		RO				0x6010:0x06: Warning present	
		0x07	(BOOL)	M		RO				0x6012:0x01: Interlock open	
		0x08	(BOOL)	M		RO				0x6012:0x02: OverTemp Error	
		0x09	(USINT)	M		RO				0x6014:0x01: Regulation / Control Mode Display	
		0x0A	(REAL)	M		RO				0x6015:0x01: Actual Setpoint	
		0x0B	(REAL)	M		RO				0x6016:0x01: Actual Output Voltage	
		0x0C	(REAL)	M		RO				0x6016:0x02: Actual Output Current	
		0x0D	(REAL)	M		RO				0x6016:0x03: Actual Output Power	
0x1A03	RECORD					RW	Y			**Module #2 TxPDO Mapping (User)**	
		0x01-0x20	UDINT	O		RW				(empty)	(empty)
0x1BFF	RECORD					RW	Y			**Device TxPDO Mapping**	
		0x01-0x20	UDINT	O		RW				(empty)	(empty)
CDP: Sync Managers Configuration											
0x1C00	ARRAY	0x01..0x04	USINT	M		RO	Y			**Sync Manager Communication Type**	Sync Manager Communication Type
0x1C12	ARRAY	0x01..0x05	UINT	O		RW	Y			**RxPDO Assignment**	Assignment of Sync Manager 2
0x1C13	ARRAY	0x01..0x05	UINT	O		RW	Y			**TxPDO Assignment**	Assignment of Sync Manager 3
0x1C32	RECORD						Y			**Output SM Parameter**	Output parameter of Sync Manager 2

		0x01	UINT	M		R / W (Pre-OP)				Synchronization Type	0x00: Free Run (not synchronized) 0x01: Synchronous - synchronized with SM Event
		0x02	UDINT	O		RO				Cycle Time	Cycle Time
		0x04	UINT	M		RO				Synchronization Types supported	0x0001: Free Run (not synchronized) 0x0002: SM synchron supported 0x4000: Dynamic Cycle Times supported
		0x05	UDINT	M		RO				Minimum Cycle Time	Minimum Cycle Time
		0x08	UINT	C		RW				Get Cycle Time	Get Cycle Time
		0x0C	UINT	M		RO				Cycle Time Too Small	Cycle Time Too Small
0x1C33	RECORD						Y			**Input SM Parameter**	Input parameter of Sync Manager 3
		0x01	UINT	M		R / W (Pre-OP)				Synchronization Type	0x00: Free Run (not synchronized) 0x01: Synchronous - synchronized with SM Event 0x22 - Synchronous - synchronized with SM2 Event
		0x02	UDINT	O		RO				Cycle Time	Cycle Time
		0x04	UINT	M		RO				Synchronization Types supported	0x0001: Free Run (not synchronized) 0x0002: SM synchron supported 0x4000: Dynamic Cycle Times supported
		0x05	UDINT	M		RO				Minimum Cycle Time	Minimum Cycle Time
		0x08	UINT	C		RW				Get Cycle Time	Get Cycle Time
		0x0C	UINT	M		RO				Cycle Time Too Small	Cycle Time Too Small
Manufacturer Specific Area: Input Data of the Modules											
0x2nn0	RECORD						Y			**Power Generator Status**	
		0x01	REAL	X		RO		TX		Actual Pulse Frequency	Actual Pulse Frequency [kHz]
		0x02	REAL	X		RO		TX		Actual Duty Cycle	Actual Duty Cycle [%]
		0x03	BOOL	X		RO		TX		Ready	1 = Ready
		0x04	BOOL	X		RO		TX		Power Off Seq.	1 = Power Off Seq.
0x2nn1	RECORD						Y			**Blinking Status**	
		0x01	USINT	X		RO		TX		Blink Mode Indication	Blink Mode Indication 0 = Off 1 = Internal
		0x02	REAL	X		RO		TX		Actual Blink Power On Time	Actual Blink Power On Time [ms]
		0x03	REAL	X		RO		TX		Actual Blink Power Off Time	Actual Blink Power Off Time [ms]
0x2nn2	RECORD						Y			**Arc Counters**	
		0x01	UINT	X		RO		TX		Imax Arc Cnt	Imax Arc Cnt
		0x02	UINT	X		RO		TX		UxI Arc Cnt	UxI Arc Cnt
		0x03	UINT	X		RO		TX		dU Arc Cnt	dU Arc Cnt
		0x04	UINT	X		RO		TX		Usag Arc Cnt	Usag Arc Cnt
		0x05	UINT	X		RO		TX		Arc Burst Cnt	Arc Burst Cnt
		0x06	REAL	X		RO		TX		Arc Rate	Arc Rate [1/s]
		0x07	REAL	X		RO		TX		Micro Arc Rate	Micro Arc Rate [1/s]
		0x08	REAL	X		RO		TX		Hard Arc Rate	Hard Arc Rate [1/s]
Manufacturer Specific Area: Output Data of the Modules											
0x3nn1	RECORD						Y			**Arc Counters Reset**	
		0x01	BOOL	X		RW		RX	1	Arc Counter Reset	0->1 = Arc Counter Reset (edge sensitive)
Manufacturer Specific Area: Configuration Data of the Modules											
0x4nn0	RECORD						Y			**Power Generator Configuration**	
		0x01	USINT	X	B	RW				Initial Control Source	Initial Control Source 0 = RS232 1 = EtherCAT
		0x02	USINT	X		RW				Actual Control Source	Actual Control Source 0 = RS232 1 = EtherCAT
		0x03	USINT	X	B	RW				Bipolar Mode	Bipolar Mode 0 = Full 1 = Bipulse 2 = Bipulse Trapezium

		0x04	REAL	X	B	RW				Pulse Frequency	Pulse Frequency [kHz]
		0x05	REAL	X	B	RW				Pulse Duty Cycle	Pulse Duty Cycle [%]
0x4nn1	RECORD						Y			**Blinking Configuration**	
		0x01	USINT	X	B	RW				Blink Mode	Blink Mode 0 = Off 1 = Internal
		0x02	REAL	X	B	RW				Blink Power On Time	Blink Power On Time [ms]
		0x03	REAL	X	B	RW				Blink Power Off Time	Blink Power Off Time [ms]
0x4nn2	RECORD						Y			**Arc Management Config**	
		0x01	USINT	X	B	RW				Arc Detection Mode	The actual arc detection mode, defined as follows: Bit 0: dU Enable Bit 1: UxI Enable Bit 2: Imax Enable Bit 3: Usag Enable Bit 4: Arc Burst Enable
		0x02	BOOL	X	B	RW				Opposite Pulse En	1 = Opposite Pulse En
		0x03	BOOL	X	B	RW				Arc Counter Overflow En	1 = Arc Counter Overflow En
0x4nn3	RECORD						Y			**Micro Arc Criteria**	
		0x01	REAL	X	B	RW				dU Thld	dU Thld [%]
		0x02	USINT	X	B	RW				Uout Sag Factor	Uout Sag Factor [%]
		0x03	REAL	X	B	RW				Break Time	Break Time [us]
0x4nn4	RECORD						Y			**Hard Arc Criteria**	
		0x01	REAL	X	B	RW				Imax Thld	Imax Thld [A]
		0x02	REAL	X	B	RW				Ux Thld	Ux Thld [V]
		0x03	REAL	X	B	RW				Ix Thld	Ix Thld [A]
		0x04	REAL	X	B	RW				Break Time	Break Time [us]
		0x05	REAL	X	B	RW				Ramp Time	Ramp Time [ms]
		0x06	USINT	X	B	RW				Imax Offset	Imax Offset [%]
0x4nn5	RECORD						Y			**Arc Burst Criteria**	
		0x01	UINT	X	B	RW				Break Time	Break Time [us]
		0x02	USINT	X	B	RW				Number in row	Number in row
		0x03	UINT	X	B	RW				On-time Below	On-time Below [us]
SDP: Input Data of the Modules											
0x6nn0	RECORD						Y			**Device Status**	Device Status
		0x01	BOOL	M		RO		TX	0	Output ON Indication	0 = Output OFF (default) 1 = Output ON
		0x02	BOOL	M		RO		TX		Output ON Requested Indication	1 = Output ON requested
		0x03	BOOL	M		RO		TX		ECAT is not active control	1 = ECAT is not active / does not have control
		0x04	BOOL	M		RO		TX		Control value out of range	1 = a control value (in 0x7nnX) is out of range / tolerance. (i.e. a control value is too high/low and was limited to its max/min value)
		0x05	BOOL	M		RO		TX		Error present	1 = Error present
		0x06	BOOL	M		RO		TX		Warning present	1 = Warning present
0x6nn2	RECORD						Y			**Device Status Errors**	Most important device errors
		0x01	BOOL	M		RO		TX		Interlock open	1 = Interlock open
		0x02	BOOL	M		RO		TX		OverTemp Error	1 = OverTemp error
		0x04	BOOL	O		RO		TX		AC line Error	1 = AC line error
0x6nn4	RECORD						Y			**Regulation / Control Mode Display**	
		0x01	USINT	M		RO		TX		Regulation / Control Mode Display	Display the actual set control mode: 0 = Voltage mode 1 = Current mode 2 = Power mode Optional: 8..x = Manufacturer specific mode

0x6nn5	RECORD						Y			**Actual Setpoint**	
		0x01	REAL	M		RO		TX		Actual Setpoint	The setpoint to regulate the output power too in Volts, Amps, or Watts based on the present regulation mode
0x6nn6	RECORD						Y			**Actual Values**	Power Output Values
		0x01	REAL	M		RO		TX		Actual Output Voltage [V]	Actual output voltage, in Volts
		0x02	REAL	M		RO		TX		Actual Output Current [A]	Actual output current, in Amperes
		0x03	REAL	M		RO		TX		Actual Output Power [W]	Actual output power, in Watts
0x6nn8	RECORD						Y			**Internal Device Temperatures**	Most important / process relevant internal device temperatures
		0x01	REAL	O		RO		TX		Temp Water	Most important water temp, in degrees C
SDP: Output Data of the Modules											
0x7nn0	RECORD						N			**Device Control**	Device Control
		0x01	BOOL	M		R / W (OP)		RX	1	Output ON Request	0 = Output OFF (default) 0->1 = Output ON request (edge sensitive)
		0x02	BOOL	M		RW		RX	1	Error reset	0->1 = Error reset (edge sensitive)
0x7nn4	RECORD						N			**Regulation / Control Mode**	
		0x01	USINT	M		RW		RX		Regulation / Control Mode	Request to set the control mode: 0 = Voltage mode 1 = Current mode 2 = Power mode Optional: 3 = Automatic mode
0x7nn5	RECORD						N			**Setpoint**	
		0x01	REAL	M		RW		RX		Setpoint	If 0x7nn4 = 0, 1, 2: The actual setpoint, in Volts, Amperes or Watts
0x7nn6	RECORD						Y			**Automatic Mode Setpoints**	If 0x7nn4 = 3: Automatic mode setpoints
		0x01	REAL	O		RW		RX		Setpoint Voltage [V]	Setpoint voltage, in Volts
		0x02	REAL	O		RW		RX		Setpoint Current [A]	Setpoint current, in Amperes
		0x03	REAL	O		RW		RX		Setpoint Power [V]	Setpoint power, in Watts
SDP: Configuration Data of the Modules											
SDP: Information Data of the Modules											
0x9nn0	RECORD						Y			**Device Rating**	Device Rating
		0x01	REAL	O		RO				Max Voltage Rating [V]	Maximum voltage rating, in Volts
		0x02	REAL	O		RO				Max Current Rating [A]	Maximum currents rating, in Amperes
		0x03	REAL	O		RO				Max Power Rating [W]	Maximum power rating, in Watts
CDP: Semiconductor Device Profile Area											
0xF000	RECORD			M			Y			**Semiconductor Device Profile**	
		0x01	UINT	M		RO				Index Distance	Index offset between PDO entries of two consecutive modules (for ETG.5003 = 0x10), e.g. 0x7000, 0x7010
		0x02	UINT	M		RO				Maximum Number of Modules	Up to 255 modules are possible. A device can support less than this. This entry described the supported number of modules
0xF010	ARRAY	0x01..0xnn	UDINT	M		RO	Y			**Module Profile List**	Each sub-index lists the profile-number of the corresponding module (hexadecimal representation, i.e. SDP 2000 is 0x07D0) Bit 15…0: SDP Number Bit 31...16: 0x0000
CDP: Exception Handling Data											
0xF380	VAR		USINT	M		RO	N	TX		**Active Exception Status**	A condensed summary byte describing the collection of active device exceptions after corresponding masks (0xF3Ax) were applied. Bit 0: Device Warning Bit 1: Manufacturer Warning Bit 2: Device Error Bit 3: Manufacturer Error Bit 4...7: Reserved

0xF381	ARRAY	0x01..0xnn	UDINT	M		RO	Y	TX		**Active Device Warning Details**	Expanded details of the device warning exceptions. Bit 0 - Warning present Bit 1 - Reserved Bit 2 - OverTemp Warning Bit 3 - Cooling/Fan Warning Bit 4 - AC Line Warning Bit 5 - Voltage Limit Exceeded Warning Bit 6 - Current Limit Exceeded Warning Bit 7 - Power Limit Exceeded Warning Bit 8-15 - Reserved
0xF382	ARRAY	0x01..0xnn	UDINT	O		RO	Y	TX		**Active Manufacturer Warning Details**	Expanded details of the manufacturer warning exceptions specified by the manufacturer Bit 0: Warning present Bit 1: EEPROM New Data Map Bit 2: EEPROM Warning Bit 3: Low Water Flow Bit 4: Act. Source Warning Bit 5: Wrong Water Direction Bit 6: Low Inlet Water Temp Warning Bit 7: Blink Power On 1 Time Too Long Bit 8: Blink Power On 2 Time Too Long Bit 9: No multiplicatio of Blink T1 and T2 times Bit 10: Blink only on one output Bits 11-15 - Reserved
0xF383	ARRAY	0x01..0xnn	UDINT	M		RO	Y	TX		**Active Device Error Details**	Expanded details of the device error exceptions. Bit 0 - Error present Bit 1 - Interlock open Bit 2 - OverTemp Error Bit 3 - Cooling/Fan Error Bit 4 - AC Line Error Bit 5-15 - Reserved
0xF384	ARRAY	0x01..0xnn	UDINT	O		RO	Y	TX		**Active Manufacturer Error Details**	Expanded details of the manufacturer error exceptions specified by the manufacturer Bit 0: Error present Bit 1: Inverter Error Bit 2: FPGA Configuration Fail Bit 3: U24 Fail Bit 4: Act. Source Fail Bit 5: Internal Component Fail Bit 6: U500 Fail Bit 7: U800 Fail Bit 8: Short Circuit Bit 9: Low Inlet Water Temp Alarm Bit 10: Output Power Fail Bits 11-15 - Reserved
0xF390	VAR		USINT	M		RO	N	TX		**Latched Exception Status**	A condensed summary byte describing the collection of device exceptions after corresponding masks (0xF3Ax) were applied. Bit 0 : Device Warning Bit 1: Manufacturer Warning Bit 2: Device Error Bit 3: Manufacturer Error Bit 4...7: Reserved
0xF391	ARRAY	0x01..0xnn	UDINT	M		RO	Y	TX		**Latched Device Warning Details**	Expanded details of the device warning exceptions. Bit 0 - Warning present Bit 1 - Reserved Bit 2 - OverTemp Warning Bit 3 - Cooling/Fan Warning Bit 4 - AC Line Warning Bit 5 - Voltage Limit Exceeded Warning Bit 6 - Current Limit Exceeded Warning Bit 7 - Power Limit Exceeded Warning Bit 8-15 - Reserved
0xF392	ARRAY	0x01..0xnn	UDINT	C		RO	Y	TX		**Latched Manufacturer Warning Details**	Expanded details of the manufacturer warning exceptions specified by the manufacturer Mandatory if 0xF382 supported
0xF393	ARRAY	0x01..0xnn	UDINT	M		RO	Y	TX		**Latched Device Error Details**	Expanded details of the device error exceptions. Bit 0 - Error present Bit 1 - Interlock open Bit 2 - OverTemp Error Bit 3 - Cooling/Fan Error Bit 4 - AC Line Error Bit 5-15 - Reserved
0xF394	ARRAY	0x01..0xnn	UDINT	C		RO	Y	TX		**Latched Manufacturer Error Details**	Expanded details of the manufacturer error exceptions specified by the manufacturer Mandatory if 0xF384 supported
0xF3A1	ARRAY	0x01..0xnn	UDINT	M	B	RW	Y			**Device Warning Mask**	Bitmask to include the corresponding device warning exception bits (as defined in the device warning details) in the active and latched exception status objects (0xF380 bit 0 and 0xF390 bit 0), if the corresponding bit is TRUE. Default of all bits TRUE (no masking).

0xF3A2	ARRAY	0x01..0xnn	UDINT	C	B	RW	Y			**Manufacturer Warning Mask**	Bitmask to include the corresponding manufacturer warning exception bits (as defined in the manufacturer warning details) in the active and latched exception status objects (0xF380 bit 1 and 0xF390 bit 1), if the corresponding bit is TRUE. Default of all bits TRUE (no masking). Mandatory if 0xF382 supported
0xF3A3	ARRAY	0x01..0xnn	UDINT	M	B	RW	Y			**Device Error Mask**	Bitmask to include the corresponding device error exception bits (as defined in the device error details) in the active and latched exception status objects (0xF380 bit 2 and 0xF390 bit 2), if the corresponding bit is TRUE. Default of all bits TRUE (no masking).
0xF3A4	ARRAY	0x01..0xnn	UDINT	C	B	RW	Y			**Manufacturer Error Mask**	Bitmask to include the corresponding manufacturer error exception bits (as defined in the manufacturer error details) in the active and latched exception status objects (0xF380 bit 3 and 0xF390 bit 3), if the corresponding bit is TRUE. Default of all bits TRUE (no masking). Mandatory if 0xF384 supported
Manufacturer Specific Area: Device Data											
0xF500	RECORD						Y			**Device Temperatures**	Device Temperatures
		0x01	REAL	X		RO		TX		Device Temp. 1	Device Temp. 1, in degrees C
		0x02	REAL	X		RO		TX		Device Temp. 2	Device Temp. 2, in degrees C
		0x03	REAL	X		RO		TX		Device Temp. 3	Device Temp. 3 in degrees C
		0x04	REAL	X		RO		TX		Device Temp. 4	Device Temp. 4, in degrees C
0xF501	RECORD						Y			**Device Measurements**	Device Measurements
		0x01	REAL	X		RO		TX		U500	U500 [V]
		0x02	REAL	X		RO		TX		U800	U800 [V]
		0x03	REAL	X		RO		TX		24V	24V
		0x04	REAL	X		RO		TX		24V Ext.	24V Ext.
0xF502	RECORD						Y			**Software version**	
		0x01	UDINT	X		RO				DSP software ver	DSP software ver
		0x02	UDINT	X		RO				PLD software ver	PLD software ver
CDP: CDP Device Specific Inputs											
0xF6F0	ARRAY	0x01..0xnn	UDINT	M		RO	Y	TX		**Input Latch Local Timestamp**	Local controller time corresponding to the input latch time in microseconds. It starts at zero on device power-up. If device has physical inputs: time of latching those inputs If device has no physical inputs: time immediately prior to writing to input SyncManager
CDP: CDP Device Specific Information Data											
0xF9F0	VAR		STRING(16)	M		RO	N			**Manufacturer Serial Number**	A string representing the manufacturer's serial number for the device. NOTE: This may have the same value as 0x1018:04.
0xF9F1	ARRAY	0x01..0xnn	UDINT	M		RO	Y			**CDP Functional Generation Number**	Common device profile functional generation number which this device supports.
0xF9F2	ARRAY	0x01..0xnn	UDINT	M		RO	Y			**SDP Functional Generation Number**	SDP functional generation number which this module supports. It shall be specified by each SDP.
0xF9F3	VAR		STRING(40)	M		RO	N			**Vendor Name**	String identifying the vendor text.
0xF9F4	ARRAY	0x01..0xnn	STRING(30)	M		RO	Y			**Semiconductor SDP Device Name**	String identifying the device type of this device, as defined by the SDP.
0xF9F5	ARRAY	0x01..0xnn	USINT	M		RW	Y	RX/TX		**Output Identifier**	The host (e.g. PLC application) increments this value each output change to verify the device has received the output(s). The slave shall not change the received value. Value shall be copied to the TxPDO if 0xF9F5 is mapped.
0xF9F6	VAR		UDINT	O		RO	N			**Time since power on**	Time since device has been powered on in seconds.
0xF9F8	VAR		UDINT	M		RO	N			**Firmware Update Functional Generation Number**	FwUpdat Functional Generation Number supported by the device/module. Value shall be specified by the Firmware Update Profile (ETG.5003-2) 0x00000000: FW Update according to ETG.5003-2 not supported

CDP: CDP Command Objects											
0xFBF 0	RECORD		COMMAND_PAR	M			N			**Device Reset Command**	Execution of this command causes the device to emulate a complete power cycle. This includes an ESC reset. Some devices may require this reset to maintain a specific state not matching power cycle behavior for proper operation, per the SDP. NOTE: As consequence of an ESC reset all following devices are disconnected from the network. There are two versions of this command: Standard Reset: as described above Factory Reset: as described above, but additionally, all parameters are restored to as-shipped defaults
		0x01	ARRAY [0..5] OF BYTE	M		RW				Command	A device reset is initiated when the following byte sequence is sent. Byte 0: 0x74 Byte 1: 0x65 Byte 2: 0x73 Byte 3: 0x65 Byte 4: 0x72 Byte 5: Standard Reset = 0x00 ; Factory Reset = 0x66
		0x02	USINT	M		RO				Status	Supported values: 0: Reserved 1: Reserved 2: last command completed, error, no response 3: Reserved 3-99: Reserved; shall be 0 100-200: indicates how much of the command has been executed (in %, 100 = 0%, 200 = 100%) 201-254: Reserved; shall be 0 255: command is executing (if the percentage display is not supported)
		0x03	ARRAY [0..1] OF BYTE	M		RO				Response	Byte 0: see Subindex 2 Byte 1: Unused - Shall be zero
0xFBF 1	RECORD		COMMAND_PAR	M			N			**Exception Reset Command**	Execution of this command clears the latched exceptions.
		0x01	ARRAY [0..4] OF BYTE	M		RW				Command	A Latched Exception Reset is initiated when the following byte sequence is sent. Byte 0: 0x74 Byte 1: 0x65 Byte 2: 0x73 Byte 3: 0x65 Byte 4: 0x72
		0x02	USINT	M		RO				Status	Supported values: 0: last command completed, no error, no response 1: Reserved 2: last command completed, error, no response 3: Reserved 3-99: Reserved; shall be 0 100-200: indicates how much of the command has been executed (in %, 100 = 0%, 200 = 100%) 201-254: Reserved; shall be 0 255: command is executing (if the percentage display is not supported)
		0x03	ARRAY [0..1] OF BYTE	M		RO				Response	Byte 0: see Subindex 2 Byte 1: Unused - Shall be zero
0xFBF 2	RECORD		COMMAND_PAR	M			N			**Store Parameters Command**	Execution of this command will store all parameters to non-volatile memory. If a device automatically saves all non-volatile parameters at the time they are written, this command will not take any action.

		0x01	ARRAY [0..3] OF BYTE	M		RW				Command	Read: Bit 0 = 1: slave saves the non-volatile parameters when writing 0xFBF2:01 with 0x65766173 Bit 1 = 1: slave saves the non-volatile parameters automatically when they are written Bit 2-31: reserved, shall be 0 Write: With the value 0x65766173 the non-volatile values will be stored in the non-volatile memory of the slave. If other values are written the Abort Code "0x06040043 Parameter is incompatible" shall be returned.
		0x02	USINT	M		RO				Status	Supported values: 0: last command completed, no error, no response 1: Reserved 2: last command completed, error, no response 3-99: Reserved; shall be 0 100-200: indicates how much of the command has been executed (in %, 100 = 0%, 200 = 100%) 201-254: Reserved; shall be 0 255: command is executing (if the percentage display is not supported)
		0x03	ARRAY [0..1] OF BYTE	M		RO				Response	Byte 0: see Subindex 2 Byte 1: Unused - Shall be zero
0xFBF3	RECORD		COMMAND_PAR	M			N			**Calculate Checksum Command**	Execution of this command will calculate a checksum for parameters stored in non-volatile memory. In the event that this calculation may interfere with the safe or expected functional operation of a device, it may be optionally restricted to functioning only in certain functional conditions while in OPERATIONAL state. If the Checksum cannot be calculated the Abort Code "0x08 00 00 21" shall be returned. All devices shall be able to calculate the checksum in PREOP without restriction. Even if the manufacturer chooses to store the checksum itself in non-voltile or volatile memory, the device shall perform the calcaluation at the time of executing this command and return this calculated value. This command shall therefore not return a value calculated prior to executing this command.
		0x01	ARRAY [0..3] OF BYTE	M		RW				Command	Read: Returns information about the supported checksum type Bit 0 = 0: no non-volatile parameters supported Bit 0 = 1: non-volatile parameters supported; at least 1 of the defined bits 1-7 shall be set Bit 1 = 1: CRC-32 Bit 2 = 1: MD5 Bit 3 = 1: SHA-1 Bit 4-6: Reserved; shall be 0 Bit 7 = 1: other algorithm Bit 8...31: Reserved, shall be 0 Write: Checksum Type Selection and Start Calculation A write access to this subindex shall only set one bit true in Bit[0…7]. If other values are written the Abort Code "0x06040043 Parameter is incompatible" shall be returned. Bit 0 = 1: Use default checksum algorithm of the slave Bit 1 = 1: CRC-32 Bit 2 = 1: MD5 Bit 3 = 1: SHA-1 Bit 4-6: Reserved; shall be 0 Bit 7 = 1: other algorithm Bit 8...31: Reserved, shall be 0

		0x02	USINT	M		RO				Status	Supported values: 0: Reserved 1: last command completed, no error, reply there 2: last command completed, error, no response 3: Reserved 3-99: Reserved; shall be 0 100-200: indicates how much of the command has been executed (in %, 100 = 0%, 200 = 100%) 201-254: Reserved; shall be 0 255: command is executing (if the percentage display is not supported)
		0x03	ARRAY [0..65] OF BYTE	M		RO				Response	Byte 0: see Subindex 2 Byte 1: Unused - Shall be zero Byte 2-n: Checksum return value. Size varies depending on checksum type used. The maximum length shall be 64 bytes.

7. Interface software

7.1. PVD Power requirements

Attached CD includes PVD Power control software.

Note: PVD Power requires .NET Framework version 4.0.
Microsoft .NET Framework Version 4.0 Redistributable Package (x86) is available at Microsoft Download Center:
http://www.microsoft.com/en-us/download/details.aspx?id=17718

System requirements

Supported operating systems:
- Windows XP SP3
- Windows Server 2003 SP2
- Windows Vista SP1 or later
- Windows Server 2008 (not supported on Server Core Role)
- Windows 7
- Windows Server 2008 R2 (not supported on Server Core Role)
- Windows 7 SP1
- Windows Server 2008 R2 SP1

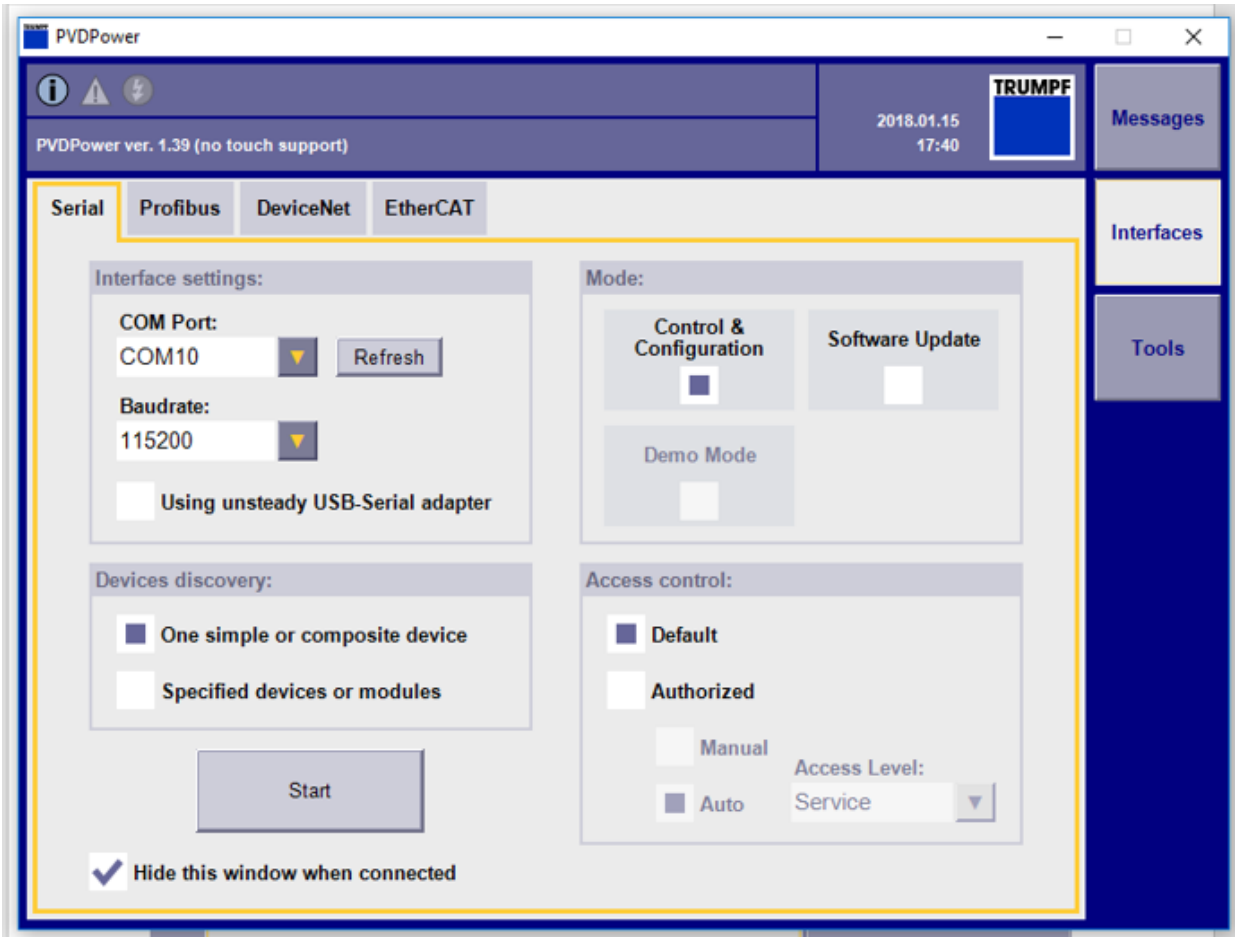
Supported Architectures:
- x86
- x64
- ia64 (some features are not supported on ia64 for example, WPF)

Hardware Requirements:
- Recommended Minimum: Pentium 1 GHz or higher with 512 MB RAM or more
- Minimum disk space:
- x86 – 850 MB
- x64 – 2 GB

Prerequisites:
- Windows Installer 3.1 or later

7.2. PVD Power Operation

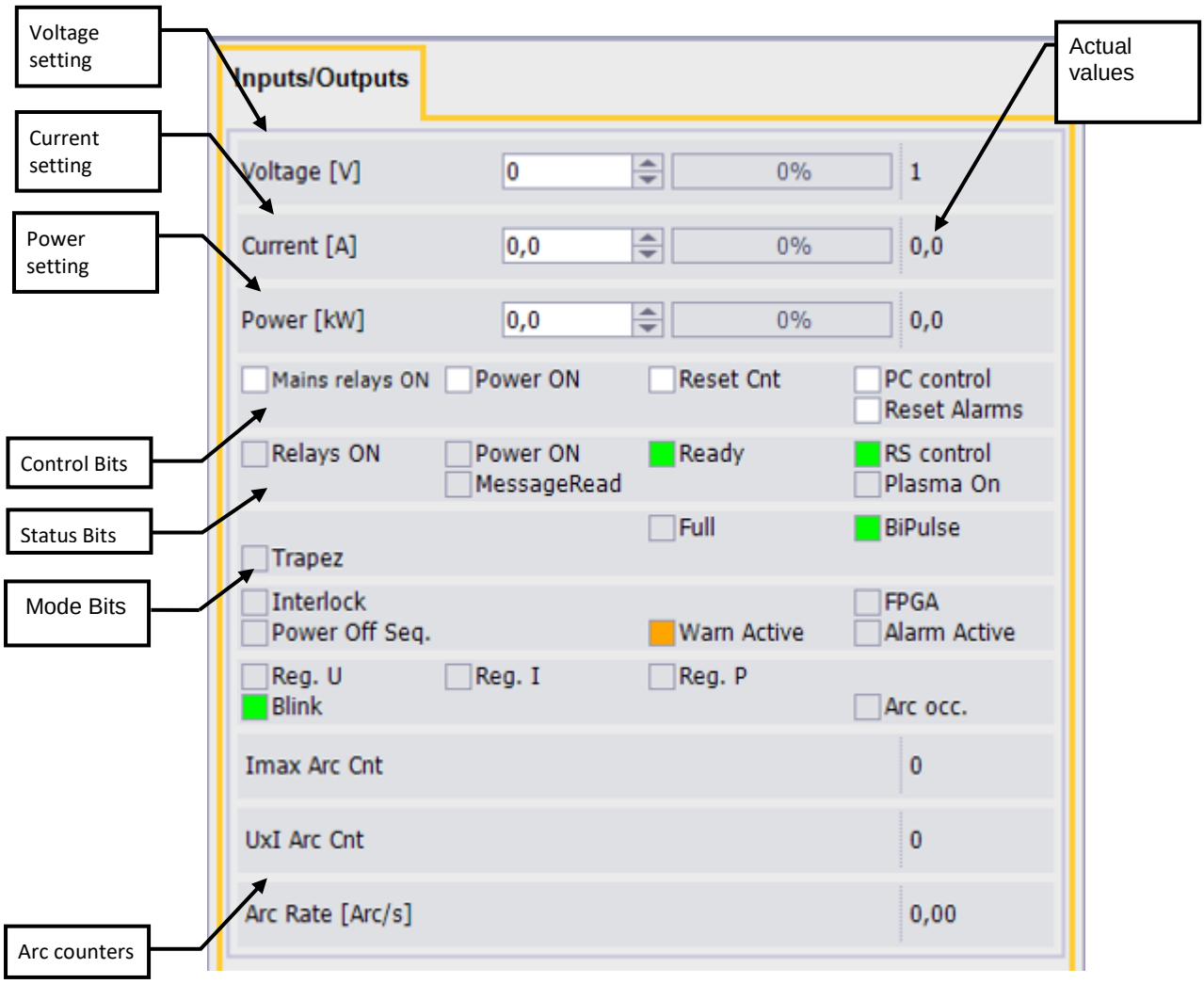
In order to activate PVD Power software, “PVDPower_x.xx.exe” file must be running. Check the correct COM port and baudrate to avoid error messages.
When RS232 is configured, press “Start” button to initiate communication with **TruPlasma Bipolar** unit.



In case of errors or alarms appearance search for solutions in the error list and alarm causes

Operation

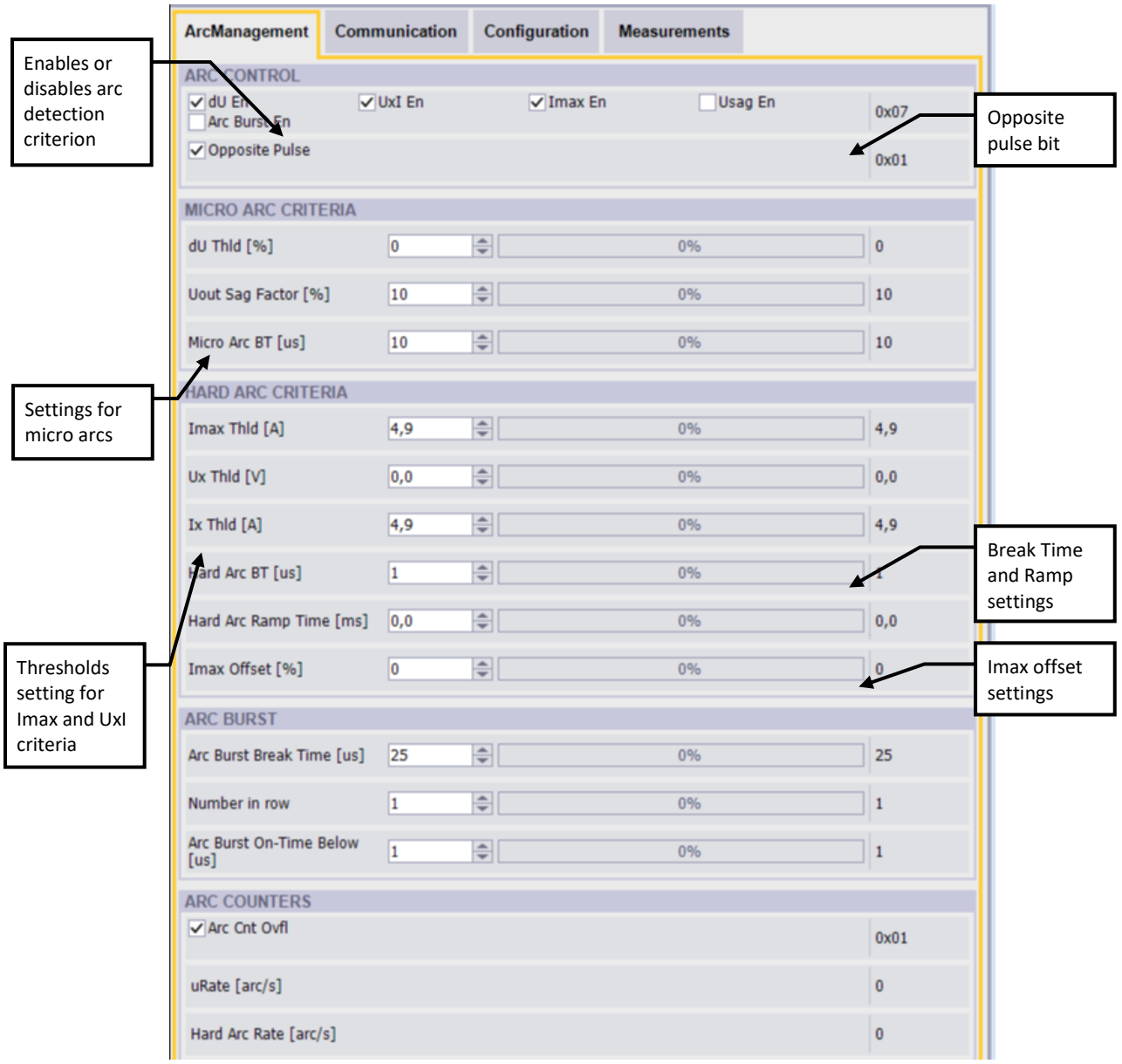
Operation tab contains basic controls and readouts.



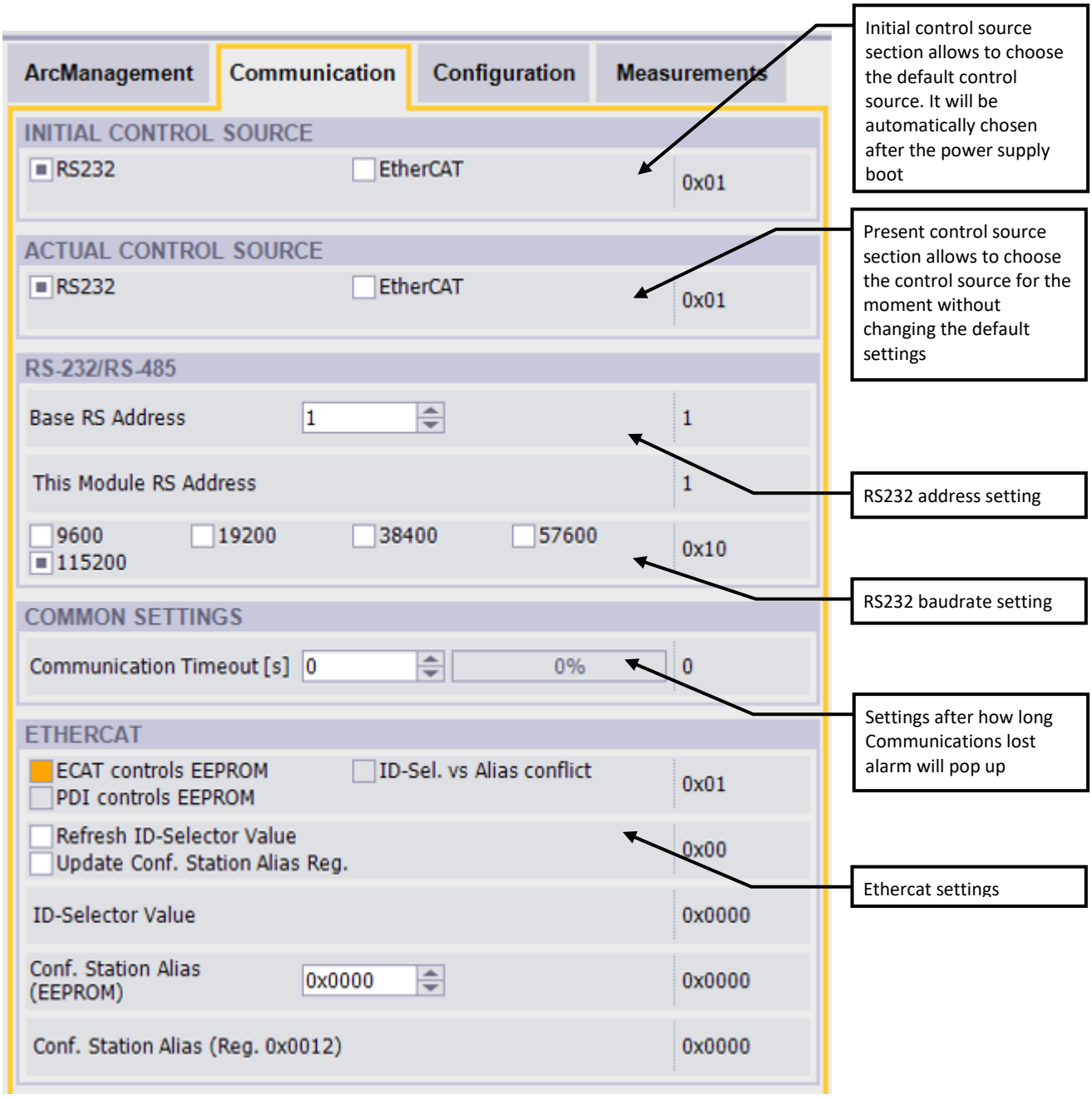
Booting the power supplies process:

If the Alarm Active Bit is on, find out what possible errors may have occurred and check the Reset Alarms bit in Control Bits section.	If the Interlock Bit is on, check all possible interlock causes (fig.4.2.)	Set the Voltage, Current and Power on the chosen levels	Choose the desired work mode in the Mode Bits section	Check the Mains relays ON (wait for the “Relays ON” bit to turn green) and then Power ON Bit in Control Bits section.

Arc Management

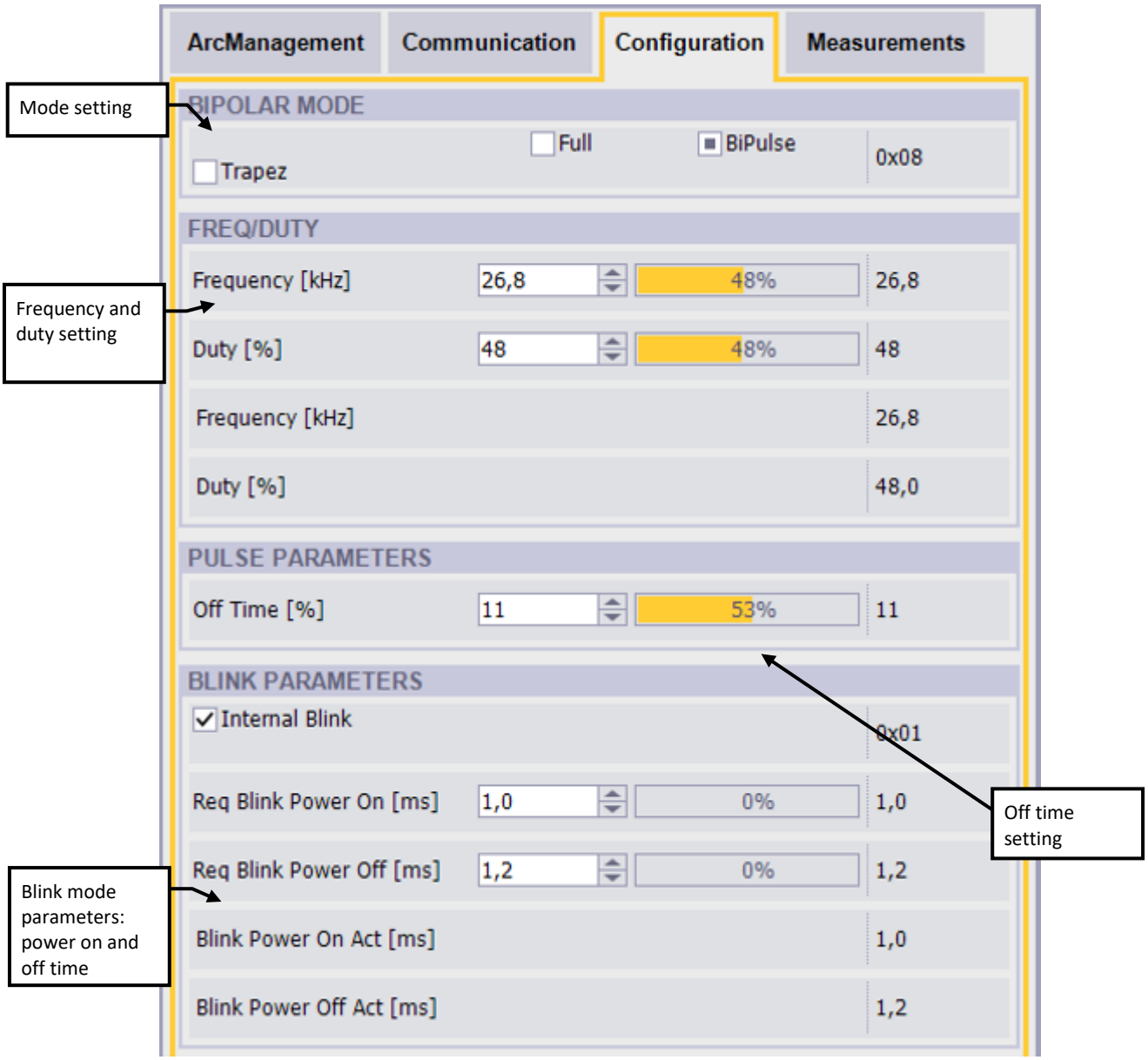


Communication

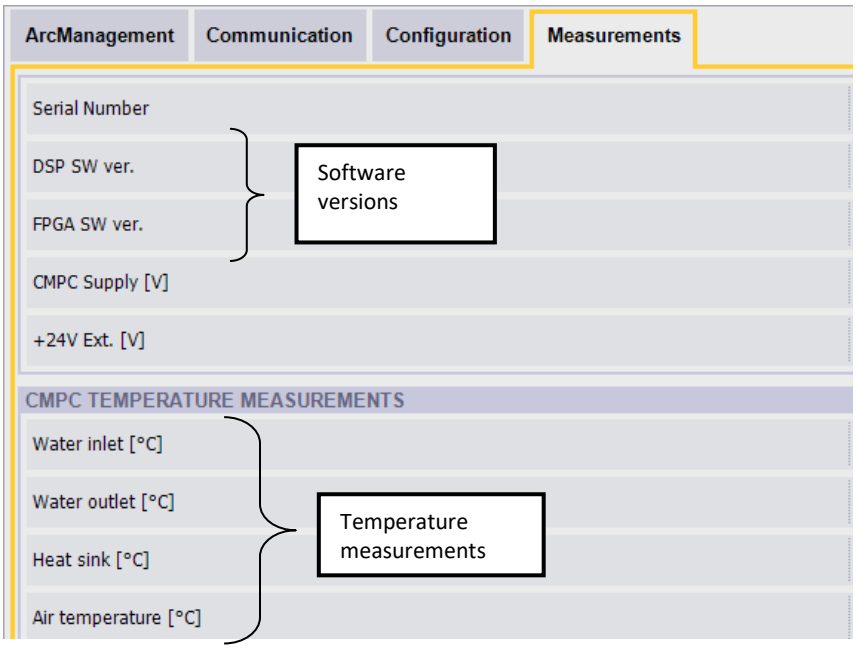


In order to permanently change the control source remember to check the correct box in the initial control source section

Configuration

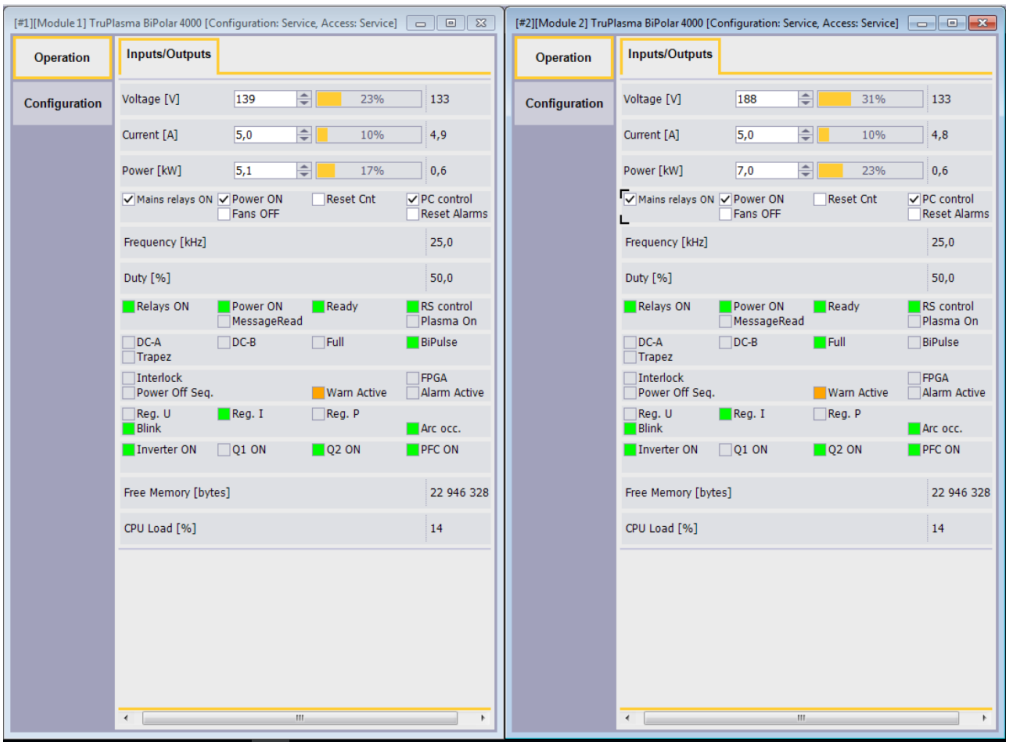


Measurements



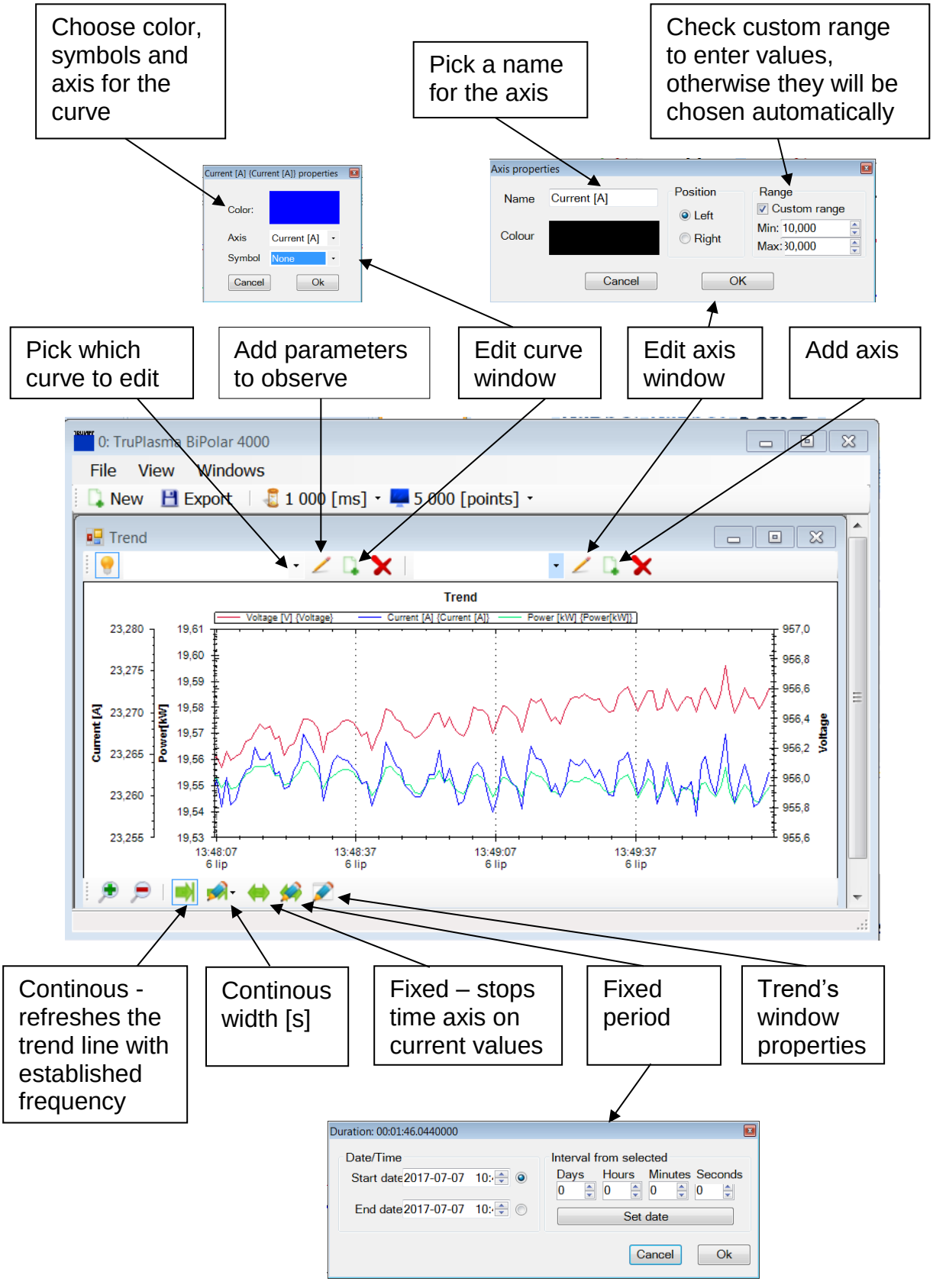
Dual output operation

Dual output independent operation can be controlled by two different windows in the PVD Power software.

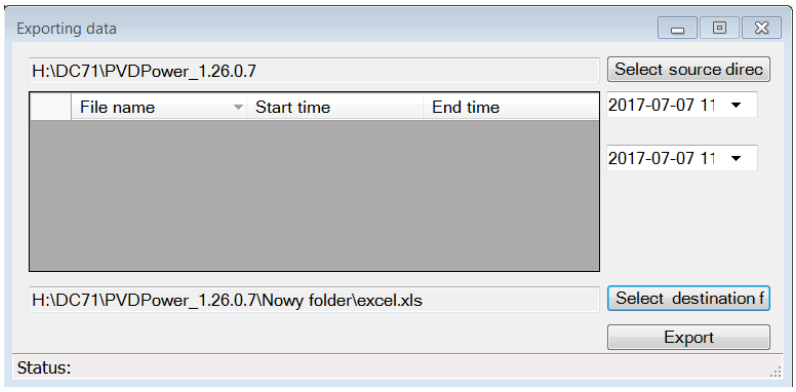


Trend function

In order to see the power supply's trend line go to tools->trend and click on new.



Trend line data export



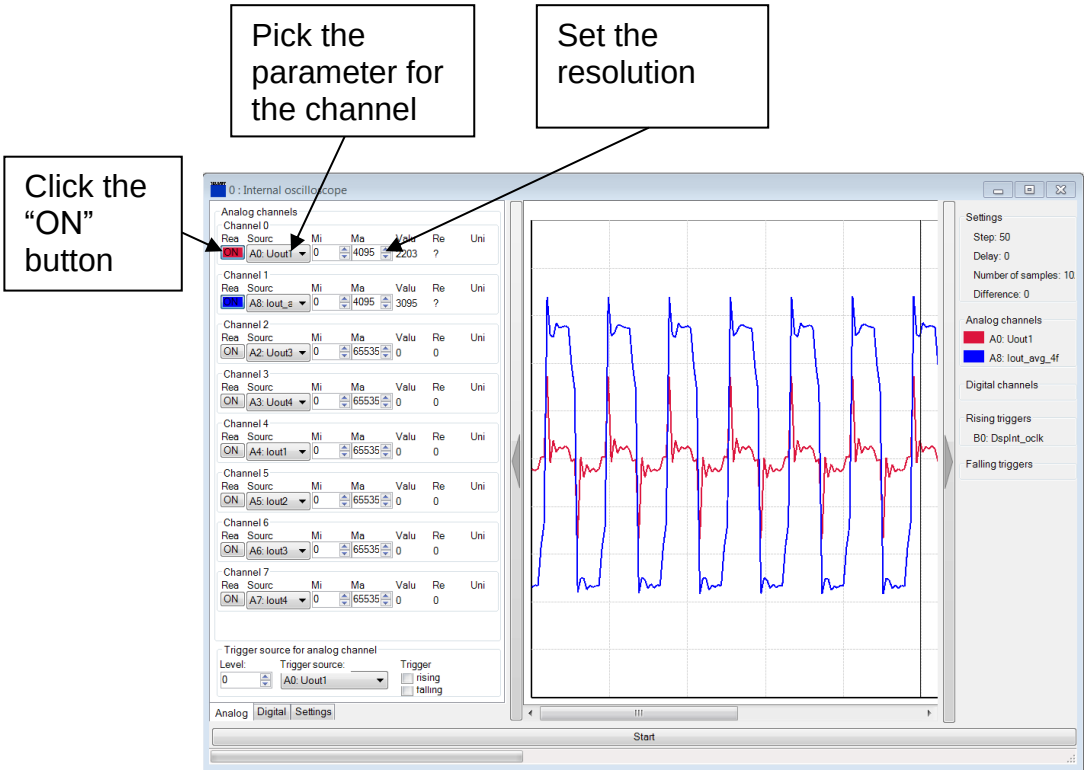
1 Select the source folder

2 Select the beginning and ending date

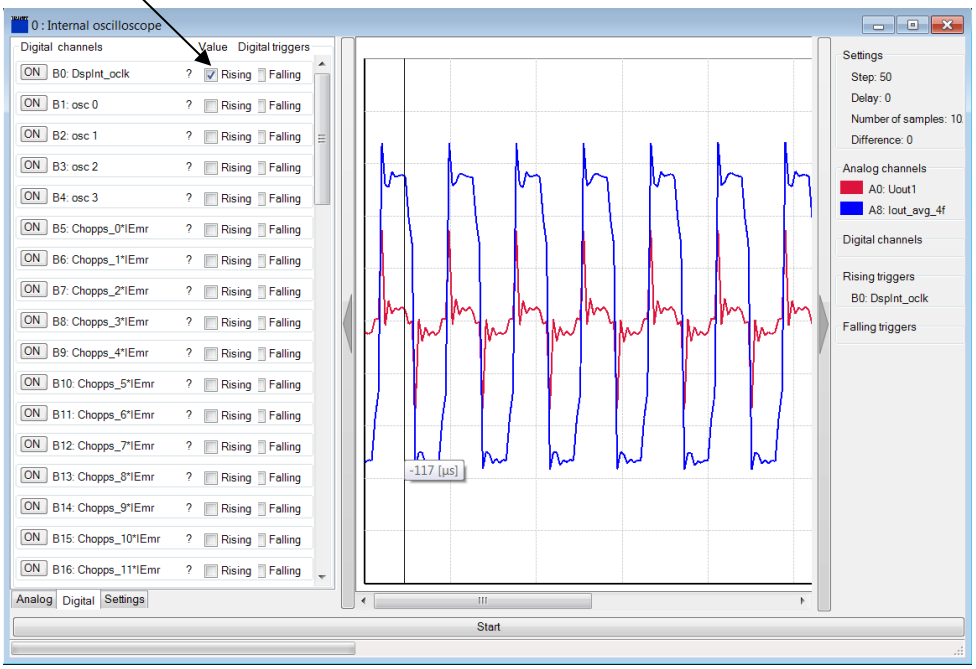
3 Select the destination folder

Internal Oscilloscope

PVDPower contains an 8-channel oscilloscope. It is available after choosing tools -> oscilloscope from the menu.

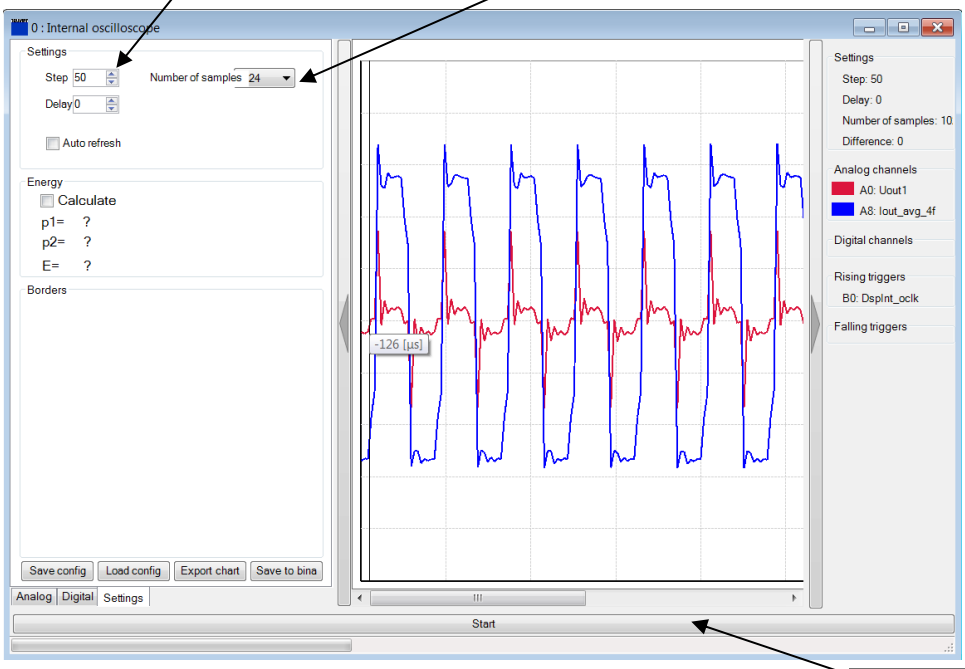


Turn on the digital signals, to trigger the analog ones



Set the step value – one step indicates 20 ns. Example: with the step parameter set on 50 acquisition will occur every 1 µs

Set the number of displayed samples



Press start

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8. Warning and alarm messages

Error codes description.

Error Number	SNr-Param	Description
61601	-	EEPROM error
61602	-	Wrong checksum of data stored in EEPROM
61603	-	FPGA configuration failed
61605	supply voltage (24V) * 100	Too high supply voltage (24V)
61606	supply voltage (24V) * 100	Too low supply voltage (24V)
61607	Sensor ID=xe6 + temperature value Tx*100	Too high temperature on sensor x
61608	-	no communication with DataFlash device
61609	kind of sag	Mains voltage sag detected
61613	2	no RS232 communication available anymore
	7	no communication with EtherCAT interface
	ID of interface, which is in use	no communication with Actual Control Source
61614	1	no communication with EEPROM device
	2	no communication with Temperature measurement module
	3	no communication with Mains measurement module
	4	no communication with RTC device
	5	no communication with Currents measurement module
61616	U500 voltage * 100	U500 Voltage too low
61617	U500 voltage * 100	U500 Voltage too high
61618	-	Inverter Error
61619	U800 voltage * 100	U800 Voltage too low
61620	U800 voltage * 100	U800 Voltage too high
61621	U800 voltage * 100	Too high U800 voltage during Power On sequence
61622	-	CAN configuration error
61623	-	No Load
61624	-	Short Circuit
61625	-	Arc Density exceeded the limit
61626	Minimum, required PLD SW version	PLD software version is too old
61627	Freq [Hz]	CLC switching frequency too high
61631	temperature value *100	Too low temperature of inlet water
61632	kind of wrong configuration	Wrong configuration
61633	U500 voltage * 100	U500fast high
61634	-	dU500/dt high
61635	U800 voltage * 100	U800fast high
61636	-	dU800/dt high
61642	-	Power fail IemrRate
61646	U500 voltage * 100	U500 fast low
61647	U800 voltage * 100	U800 fast low
61649	-	Chopper fail
61690	-	Device type mismatch
61691	-	FPGA regulator mismatch
61692	Freq [Hz]	Blink switching frequency too high
61694	-	PFC emergency error
61695	-	Reverse overcurrent

Error Number	SNr-Param	Description
61706	U800 voltage * 100	U800 shorted
61707	U800 voltage * 100	U800 is not increasing
61709	-	Output emergency error
61710	-	Fans off too long
61712	-	FPGA clock configuration error
61713	-	Internal error
61714	-	Test version. Internal use only
61716	-	No serial (0) or SAP (1) number
61724	-	Too high EEPROM usage

Warning codes description.

Warning Number	SNr-Param	Description
61651	-	No data In memory banks – default restored
61652	-	Checksum error in memory bank
61653	-	EEPROM write error
61654	-	Arc Density exceeded the limit
61655	-	Recalibration done
61656	-	Unauthorized recalibration attempt
61657	Sensor ID=xe6 + temperature value Tx*100	Temperature warning level exceeded Tx
61658	-	Cooling water flow is too low
61659	-	Cooling water flow wrong direction
61661	2,7	No communication with the Actual control source
61663	ID of interface, which is in use	communication fail with actual control source
61664	-	New version of memory map in EEPROM
61665	1	Exceeded maximum allowable difference between voltage set and actual values [mV]
	2	Exceeded maximum allowable difference between current set and actual values [mA]
	3	Exceeded maximum allowable difference between power set and actual values [W]
61666	-	Plasma not detected
61667	-	PlossMax value reached. Power loss cannot be compensated properly
61669	-	Internal CAN bus configuration fail
61670	temperature value *100	Low temperature of inlet water
61697	-	Blink input pulse too short
61698	-	Blink input pulse too long
61701	-	PWM PT too long
61702	-	PWM recipe not saved
61711	-	Test version. Internal use only
61723	-	High EEPROM usage

9. Scope of delivery

Contents of the box:

- TruPlasma Bipolar 4010 with switch power supply
- Dummy plug (interlock removal)
- Output terminals cover
- Mains terminals cover
- Inlet air pipe adaptor with stopper
- User Manual
- Certificate of conformity
- CD (software and manual)

TruPlasma Bipolar 4010 with switch power supply is delivered in ready-to-use condition.
Device is designed to operate correctly when all connections and installation procedures are followed in accordance with user manual. Default settings should assure proper behavior of device in the most commonly used system configurations.

Nevertheless, it would be useful to learn as much as possible about maintenance and operation principles before proceeding with startup. A full understanding of these system operating principles will help user to obtain the most useful information from controller's display as well as understand behavior of the entire power supply. Introducing any changes to device's settings requires full knowledge of system (and also the password).