TruPlasma DC 3010 (2karc/s)

DC Power Supply

USER MANUAL

Warning!
This operating manual is required for the safe operation of **TruPlasma DC** 3010 Power Supplies. As a result, the operating manual should be kept close to the unit at all times.

Operating Instructions for TruPlasma DC 3010 Power Supply

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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 DC 3010 DC generator is designed to power industrial vacuum process chambers in PVD 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 DC** 3010. "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 DC** 3010 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 DC** 3010 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 61000-6-4:** 2007/A1:2011 " Electromagnetic compatibility (EMC) – Part 6-4: Generic standards –Emission standard for industrial environments.

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 DC 3010 system must be firmly secured and placed in a horizontal position.

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 DC** 3010 power supply is designed for powering sputtering cathodes in PVD surface treatment technologies. It's most important features are:

- high efficiency switched-mode power conversion performance,
- up to 1000V operating output voltage,
- full output power capability at an output voltage as low as 400V,
- ultrafast arc switch-off and recovery,
- extremely low arc energy,
- wide variety of user adjustable parameters.

The **TruPlasma DC** 3010 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:

- Local: Standard Operator Panel located on the front panel of the **TruPlasma DC**,
- Remote: RS-232,
- Remote: RS-485,
- Remote: Profibus,
- Remote: DeviceNet,
- Remote: Analog interface.

2.1. TruPlasma DC 3010 block diagram

A block diagram of the **TruPlasma DC** 3010 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,
- control electronics and LCD display panel (SOP).

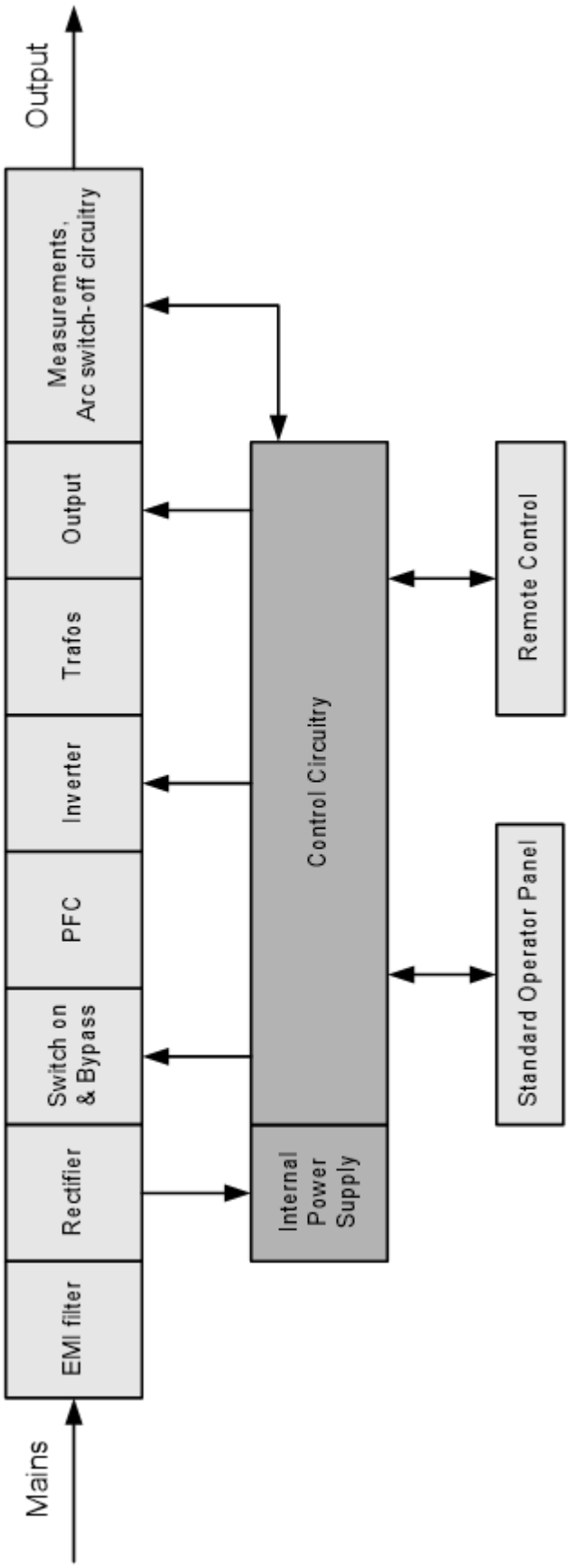


Fig.2.1. TruPlasma DC 3010 **block diagram**

3. Electrical and mechanical specifications

3.1. Electrical and mechanical specification in tables

Electrical specification – Overall			
Mains voltage	**V AC**		3x400-480**+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 18
Recommended fusing	**A**		3 x 32, B-class
Efficiency	**%**		Approximately 92%
Warm-up delay	**second**		< 5

Electrical specification – Power supply section			
Nominal output values			**P_n = 10 kW** **U_n = 1000 V** **I_n = 25 A** **(see power characteristics Fig. 3.2.)**
Ignition			Output voltage boost up to 1500V (see chapter 3.9. Ignition feature)
Control source options			Local - Standard Operator Panel Remote - RS-232 Remote - RS-485/Profibus (optional) Remote - Analog interface Remote - DeviceNet
Output control			P – power control U – voltage control I – current control

Mechanical Specification			
Size (Width x Height x Length)	**mm**		482 **(19")** x 134 **(3U)** x 683
Weight	**kg**		Approx. 45

Arc detection criteria			
Imax **Overcurrent detection** an arc is detected when output current exceeds Imax threshold value	**A** **ms** **ms**		user adjustable: Imax threshold 10 … 130% In Imax break-time 0.1 ... 80 Imax ramp-time 0 … 100
UxI **Cross detection** an arc is detected when output current exceeds Ix threshold while output voltage drops below Ux threshold	**V** **A** **ms** **ms**		user adjustable: Ux threshold 0 … 90% Un, Ix threshold 5% … 100% In UxI break-time 0.1 … 80 UxI ramp-time 0 … 100
UxI_observer works like UxI detector, but Ux threshold is set automatically due to output voltage (Uact)	**V** **V**		user adjustable: Ux offset 10 … 200 automatically adjustable: Ux obs. = Uact – Ux offset
dU **Dynamic voltage change detector (microarc)** detector is armed, when output voltage exceeds dUON threshold and then triggered when output voltage drops below dUOFF threshold	**V** **V** **µs** **V**		user adjustable: dU ON threshold 5% ... 80%Un dU OFF threshold 0 ... 75%Un dU break-time [1] 5… 1000 dU offset [1] 30 … 200
dU_observer automatically sets dU detection thresholds based on mean output voltage	**V** **V** **V**		user adjustable: dU offset [1] 30 … 200 automatically adjustable: dU ON obs. = Uact – 10V dU OFF obs. = Uact – dU ON obs.
Arc Burst detects series of appearing arcs	**µs**		user adjustable: ON-time below 1 … 1000 Number in a row 1 … 100
Maximum amount of detected and suppressed arcs per second	**arc/sec**		2000
Arc energy	**mJ/kW**		< 0.3 (independent of cable length)

[1] dU break time and dU offset parameters are common for dU and dU_observer

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, EN50178) -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**		> 1.5
Flow rate	**l/min**		> 4
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

Cooling water parameters	
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.

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

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.

While installing the power supply in the IP4x rack cabinet the compressed air may be supplied to the cabinet, instead of direct supplying each unit, with the flow rate of 120 l/h.

Compressed air flow rate			
Single power supply (i.e. rack cabinet IP00)	**l/min**		Approx. 22
Rack cabinet (at least IP40)	**l/min**		2

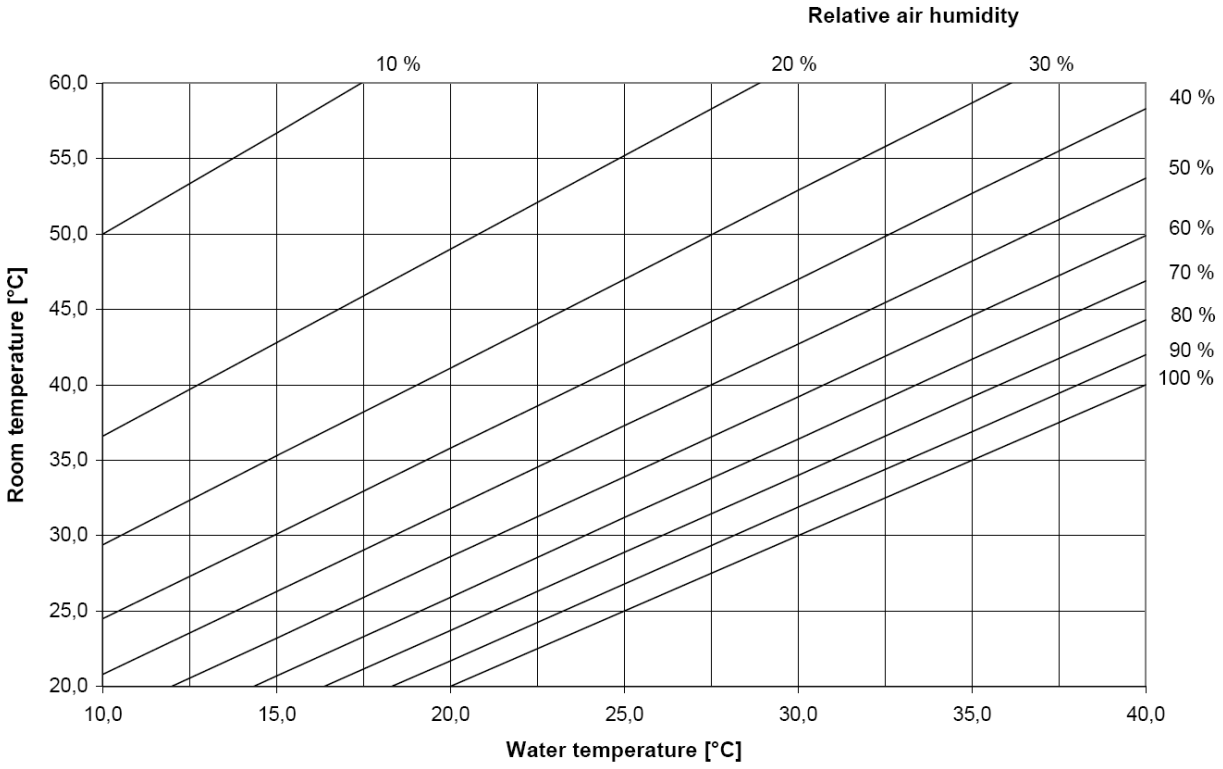


Fig. 3.1. Dew point diagram.

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

3.5. TruPlasma DC 3010 power characteristics

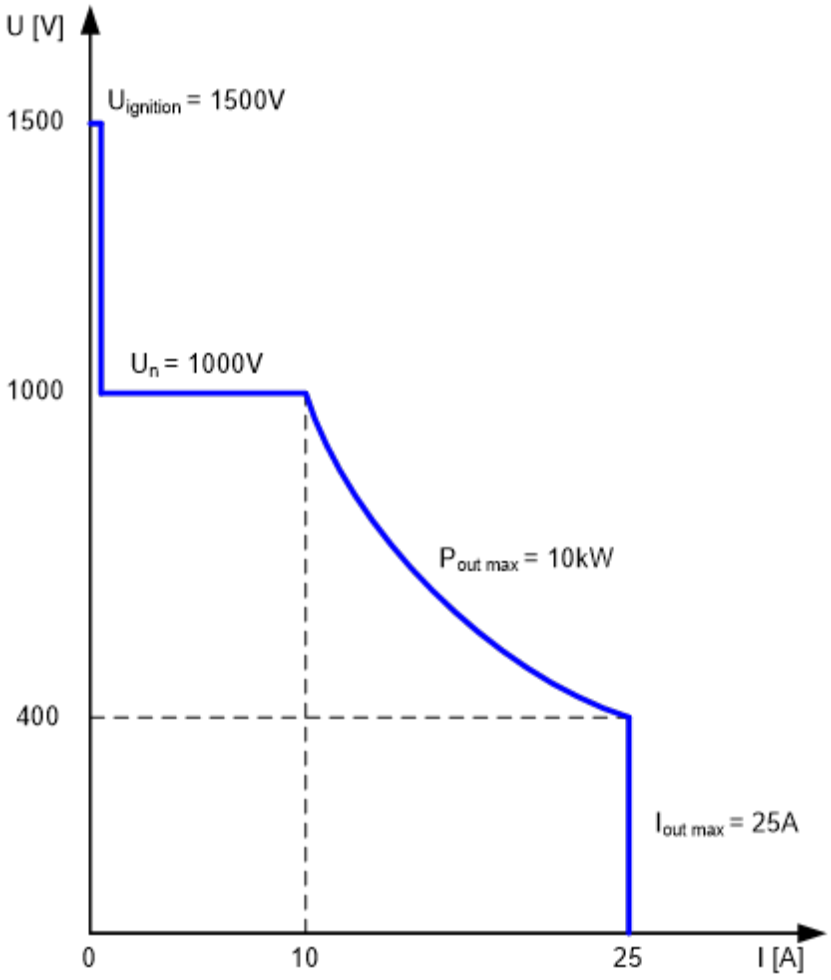


Fig. 3.2. Power characteristics of **TruPlasma DC** 3010 module.

3.6. Long Ramp

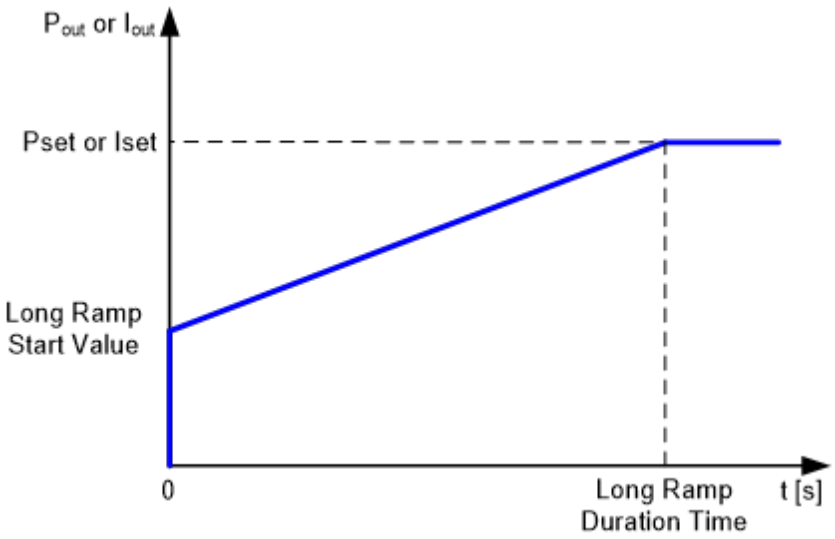


Fig. 3.3. Long Ramp.

Activation of **Long Ramp mode** and setting **Long RampT** and **Long RampS** parameters allow user to control duration of the rising edge of output power after power supply has been switched on or after change of setting value. Long Ramp parameters (Pset or Iset and duration time) can be changed while this feature is active.

- **Long RampS** is the **Long Ramp Start Value** that appears immediately after switching on supply. It can be set at a range from **0** to **100%** of power setpoint value (**Power Long Ramp**) or current setpoint value (**Current Long Ramp**).

- **Long RampT** is the **Long Ramp Duration Time** of power increasing from Long Ramp start value to set value and can be set in a range from **0 to 7200s** with 1s resolution.

3.7. Process Timer

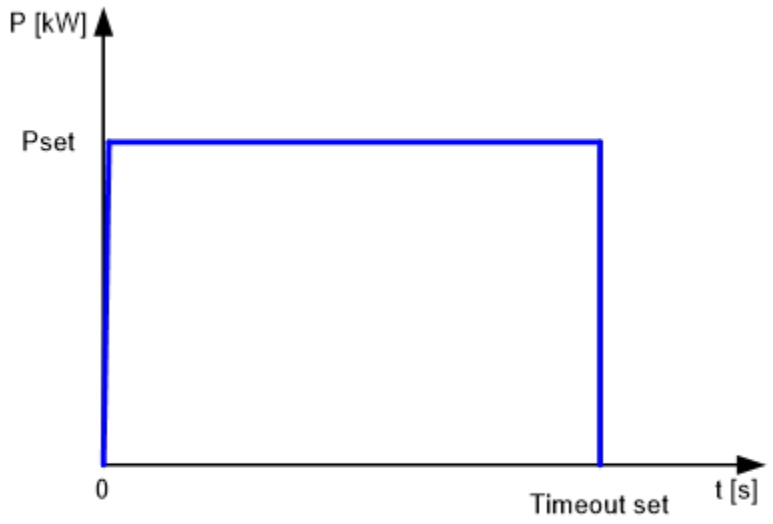


Fig. 3.4. Process Timer.

Activation of **Process timer mode** and setting **Timeout set** parameter allows user to control duration of power on the output:

- after power supply has been switched on – **Pon**
- or after power supply reaches output power setpoint value – **Pset**

- **Timeout set** parameter is a duration time of power on the output and can be set in a range from 0 to 36000s with 1s resolution.
- **Remaining time** parameter shows how much time is left to switch off the power

3.8. Target Life

Target life mode allows to define limit value for the energy which might be delivered to up to 8 targets. For each target, a limit value for the energy in kWh (set) may be entered. A warning message is output as soon as 100% of the energy has been reached.

- **Tlife Src.** parameter allows to choose 1 of 8 defined targets

- life time of the targets (in kWh) are assigned in **Tlife1 … 8** parameter

3.9. Ignition feature

TruPlasma DC 3010 power supply is equipped with plasma ignition support feature, which helps to ignite magnetron discharge.

Ignition pulses are generated when following conditions are met:

- Ignition feature is set to enable,
- Output current is lower than the ignition current threshold *Ign Ion Thld*,
- Output voltage is higher than the ignition voltage threshold *Ign Uon Thld*.

Parameters of ignition pulses:

- Additional 500V is added to output voltage during ignition pulses (max 1500V at the output terminals),
- Duration of ignition pulses is adjustable using parameter *Ign time* in the range from 1 to 100 us,
- Frequency of ignition pulses is constant and fixed to 50Hz,

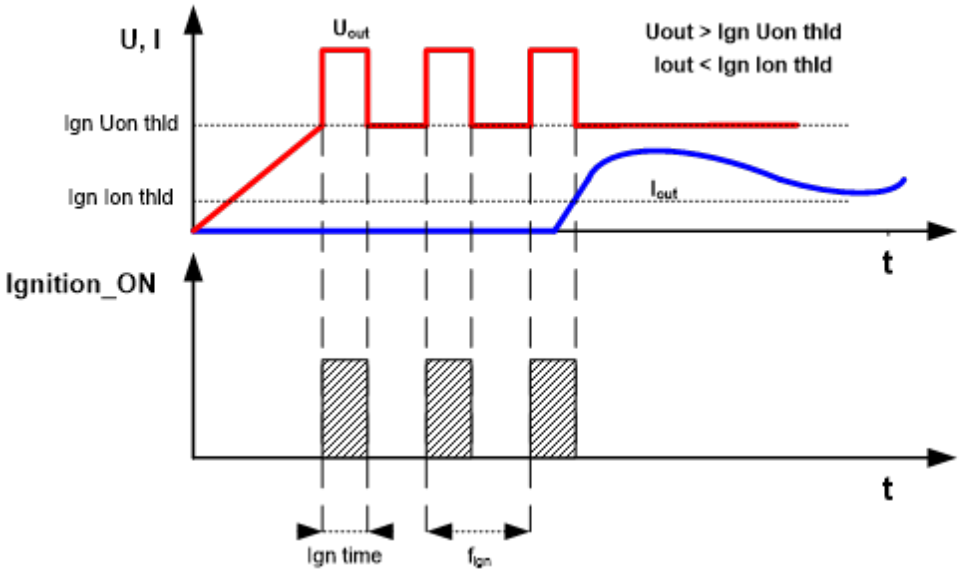
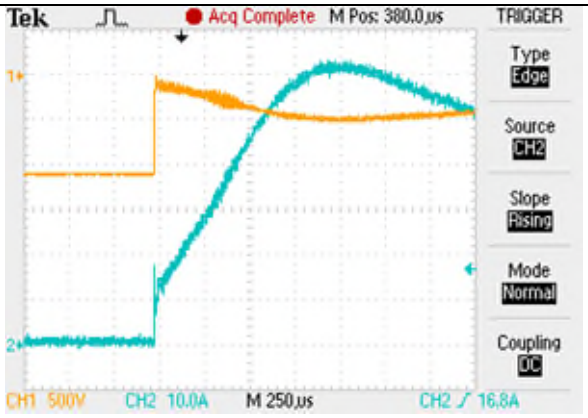


Fig. 3.5. Ignition.

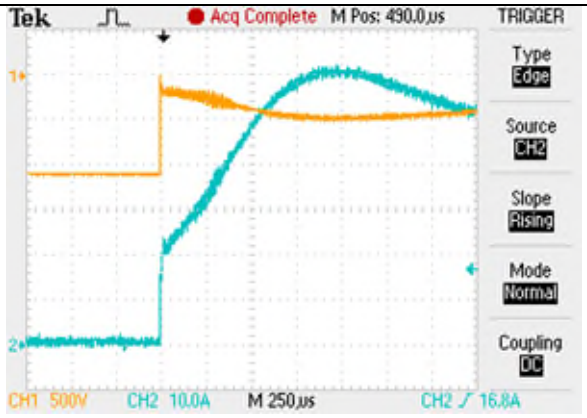
It is very important, that just after plasma ignition the output current can be delivered immediately. In order to enhance the dynamic reaction of the power supply's regulators a current booster has been added.

The *IGNi_corr* setting controls the initial current step, which will be generated at plasma ignition. This is initially set to 10% and should be enough to sustain the freshly ignited plasma without a risk of hitting the Imax threshold or provoking an arc.

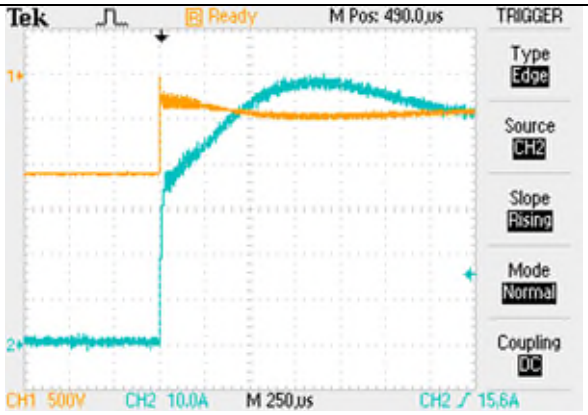
A response to a step load change from open load to 8,3Ω simulating plasma ignition is presented below with several *IGNi_corr* settings:



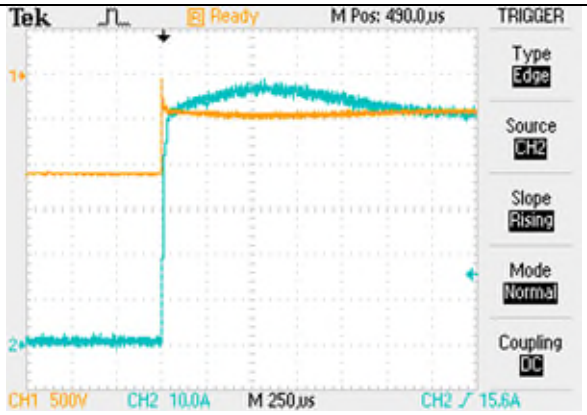
IGNi_corr = 5%



IGNi_corr = 10%



IGNi_corr = 20%



IGNi_corr = 30%

3.10.Power Loss Compensation

The Power Loss Compensation function increases the instantaneous output power of the power supply to compensate the power loss related to arcing.

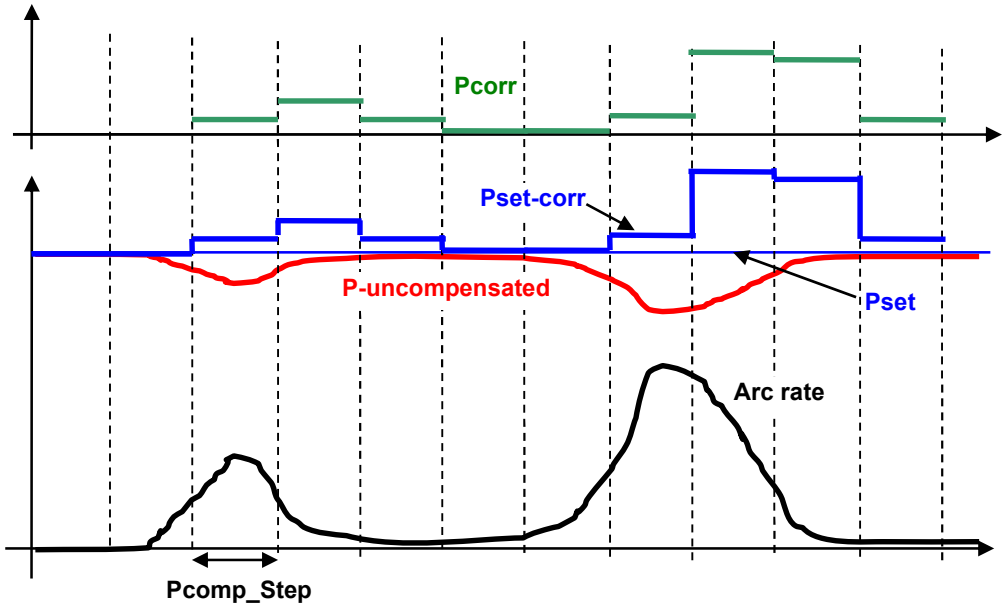


Fig. 3.6. Power Loss Compensation.

When the **Power_Compensation** (Pcomp) function is enabled, the arc related loss of energy is integrated within time frames equal to the **Pcomp_Step** [10ms] value. This extra energy is returned during the next time frame by means of increasing the instantaneous output power by an appropriate factor.

This incrementing factor must be limited, however, to avoid a runaway effect, which might happen in some cases: Increased power can lead to increased arcing, more power loss, which in turn would increase the power setting even more. The **Max_Pcomp_Val** parameter defines the maximum allowed power compensation value and is given as a percentage of the power setpoint value - settable in a range from 1 to 100%. Setting this parameter to eg. 20% allows the instantaneous output power to reach 120% of the power setpoint for power loss compensation purposes. The maximum instantaneous output power of the unit will be limited to 110% of the units nominal power value (Pn).

During some heavy arcing events (eg. arc bursts) it may happen that the power loss encountered during one Pcomp_Step time frame is too high to be returned in the next one considering the applied power limit. In this case the residual energy loss is stored in a separate buffer and can still be returned in the succeeding time frames if possible. The capacity of this buffer is also limited in order to avoid too long compensation times. The **Max_Pcomp_Time** setting defines this capacity by setting the time in seconds. A full residual energy buffer will be discharged within this time period considering the **Max_Pcomp_Val** and assuming there is no further power loss during this time. If the residual buffer is full – the **Pcomp warning** will appear.
Pcorr shows the actual power compensation value in kW, which is added to the power setpoint value.

Ploss shows the actual residue energy loss [kW x Pcomp_Step] resulting from limited power compensation related to the **Max Pcomp Val** setting.

3.11.Joule Mode

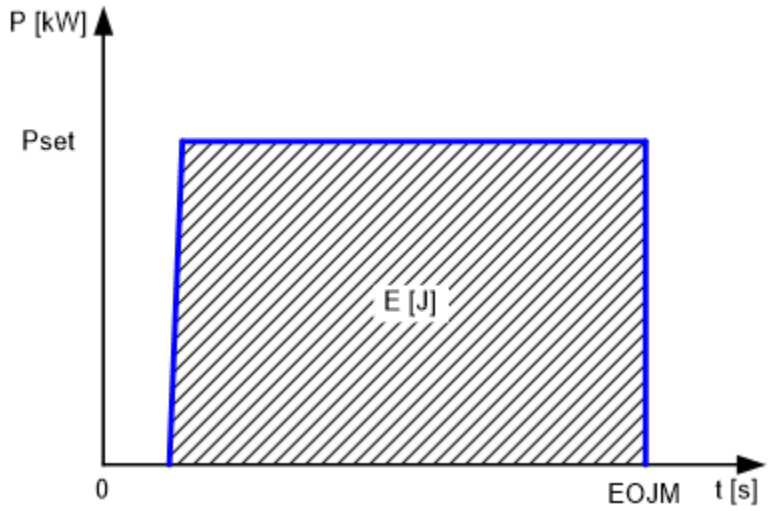


Fig. 3.7. Joule mode.

In **Joule Mode**, a limit value is specified for the energy discharged to the load. After this limit value has been reached, the power is switched off. In this way, it can be ensured that the same results (layer thicknesses) are attained under different process conditions (ARCs, load impedances).

- **Joule ModeS** parameter is a limit value for the energy discharged to the load and can be set in a range from 0 to 20000kJ with 1kJ resolution.
- **Joule ModeR** parameter shows how much energy has been delivered to the load

4. Installation and connections

4.1. Installation site

Enclosure

TruPlasma DC 3010 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. 45kg 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.

Special handgrips (4 pieces) for lifting and moving are attached to **TruPlasma DC** 3010.

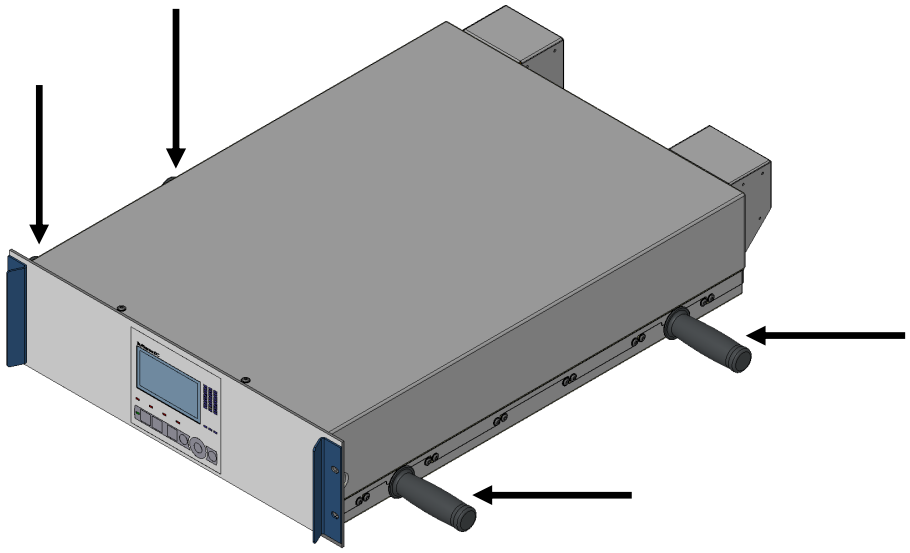


Fig. 4.1. TruPlasma DC 3010 with handgrips.

HEAVY OBJECT.
May result in severe injury.

Weight 45kg.

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, even if it works in parallel or synchronous mode.

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 DC** 3010. 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.

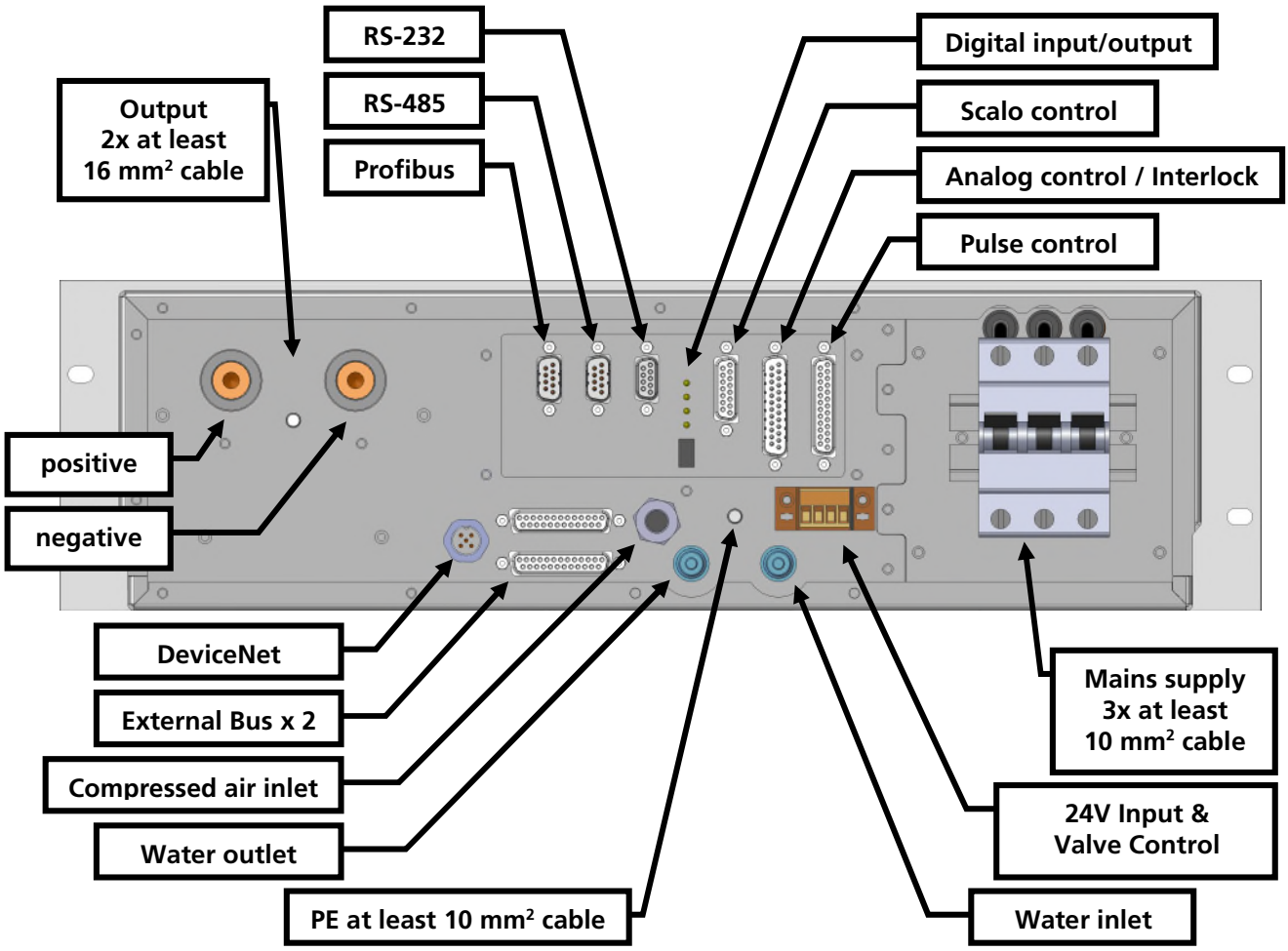


Fig. 4.2. Description of connectors and terminals on the rear panel.

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

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

4.4. Power terminals description

Terminal	Description	Cable	Cable endings
MAINS	3 x 400-480 V AC	3x min. 6mm^2	3x ferrule or M5
PE	Protective earth	min. 6 mm^2	M6
OUTPUT	1500V / 50A	2x min. 10 mm^2 copper twisted on entire length and shielded cable is necessary. Shielded output cables connected to power supply via EMC cable gland with tight and full 360-degree metal-to-metal contact of screen connection. Shield connected to ground (from chamber side) using high voltage (preferably 3kV) cable.	2x M8

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 (quick connect adaptors are attached)
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
Profibus	communication port	see below	SUBD 9pin male
RS-232	communication port	see below	SUBD 9pin female
RS-485	communication port	see below	SUBD 9pin male
Analog control	analog interface	see below	SUBD 25pin female
DeviceNet	communication port	see below	5pin female micro connector
External Bus	connection terminals for parallel or synchronous operation mode, see chapter 5. for details		2x SUBD 25pin male
24V Input	optional external voltage 24V±10%supply of the control system – max 2A	see below	BLZ 5.08/4 or 2 x BLZ 5.08/2 (delivered with power supply)
Valve ctrl.	cooling water valve control terminal	see below	
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

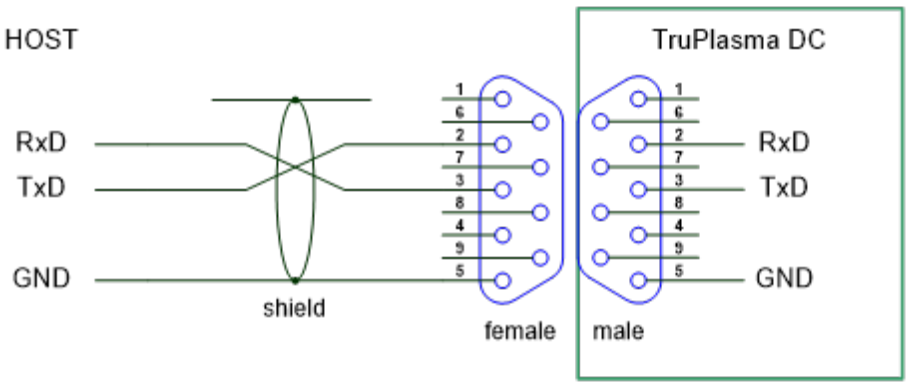


Fig. 4.3. RS-232 connection diagram.

Do NOT connect the shield with earth (PE).

RS-232 communication baud rate can be set from the range: 9600, 19200, 38400, 57600 and 115000 bps, and it works in standard 8n1 (8 bits of data, non parity, 1 bit of stop).

Default baud rate is 115200 bps.

4.8. Profibus communication terminal

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

Pin no.	Name	Type	Description
3	**RxD/TxD-P**	Digital I/O	Differential I/O signal
5	**DGND**	GND	Isolated Profibus ground
6	**VP**	+5V DC	Isolated Profibus supply voltage
8	**RxD/TxD-N**	Digital I/O	Differential I/O signal
others	**-**	n/c	n/c

Termination resistors are necessary only at both ends of the cable.

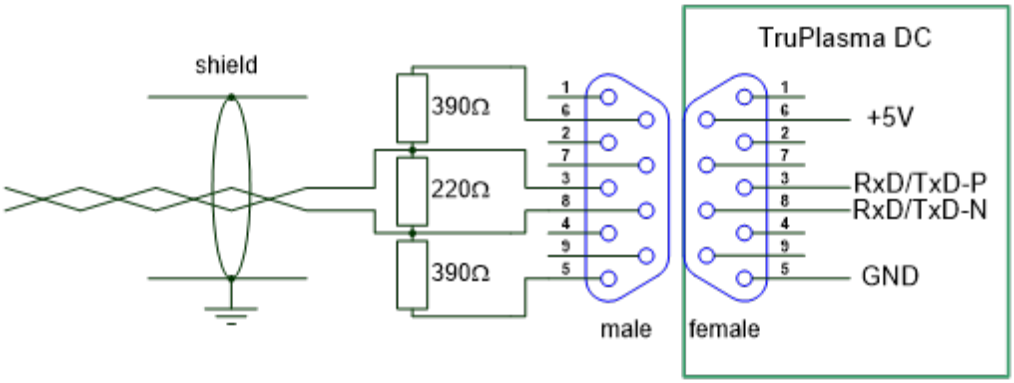


Fig. 4.4. Profibus connection diagram.

4.9. RS-485 communication terminal

RS-485 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
1	**B – OUT**	Digital output	RS485 output B
2	**–**	n/c	n/c
3	**–**	n/c	n/c
4	**B – IN**	Digital input	RS485 input B
5	**–**	n/c	n/c
6	**A – OUT**	Digital output	RS485 output A
7	**GND**	GND	Can be used for cable shield
8	**GND**	GND	Can be used for cable shield
9	**A – IN**	Digital input	RS485 input A

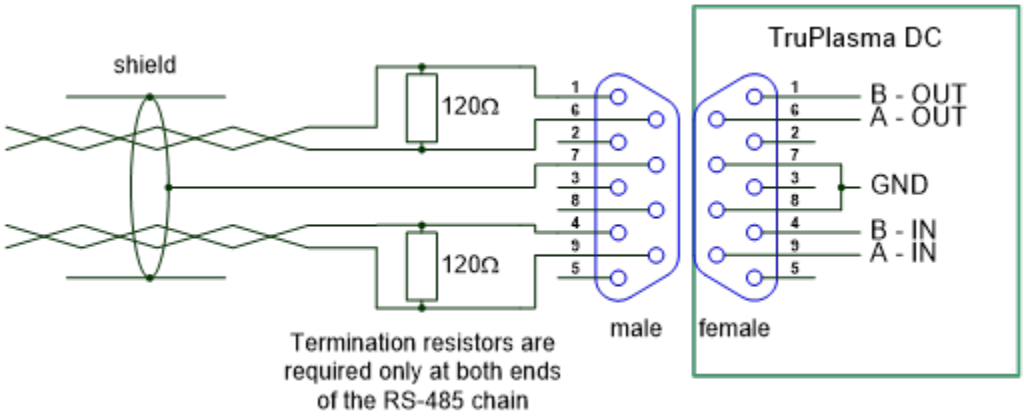


Fig. 4.5. RS-485 connection diagram.

RS-485 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).

Default baud rate is 115200 bps.

4.10. DeviceNet communication terminal

DeviceNet port is located on the rear side of the device and uses a 5-pin male connector. The table below provides descriptions of pins.

Pin no.	Name	Description
1	Screen	shield
2	V+	supply
3	V-	supply
4	CAN_H	data transmit / receive
5	CAN_L	data transmit / receive

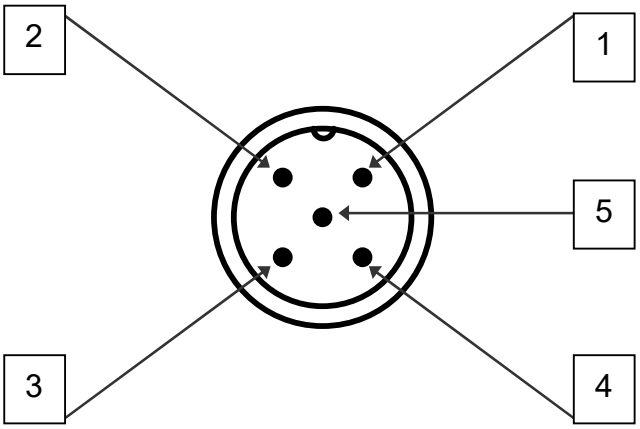
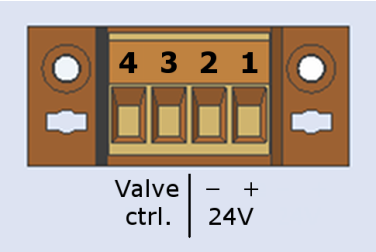


Fig. 4.6. DeviceNet connector.

4.11.Valve control and 24V external supply terminal

24V and **Valve ctrl**. terminals are located on the rear side of device and uses 4-pin connector.



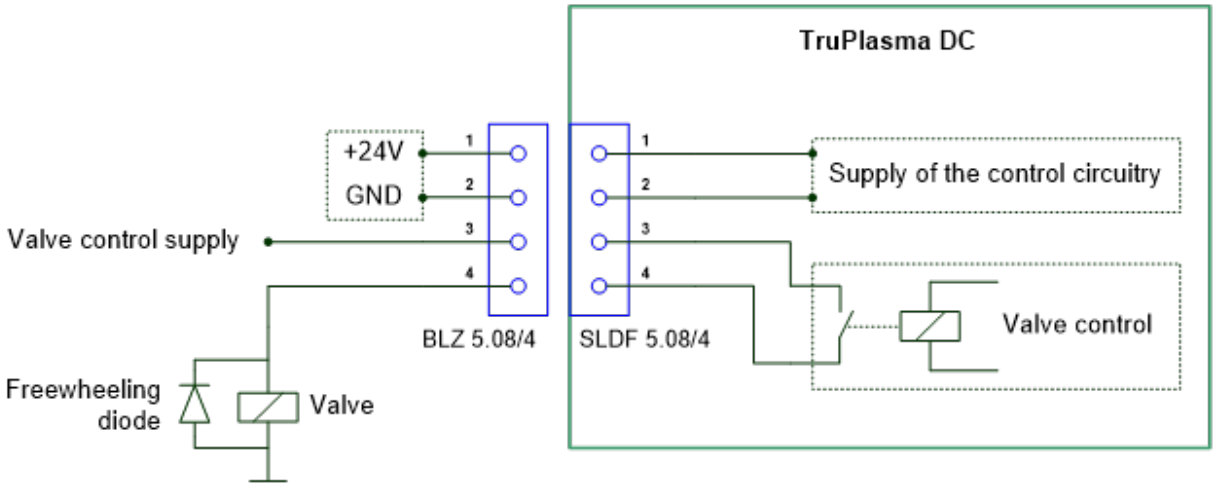


Fig. 4.7. External supply (24V) and valve control circuitry diagram.

External supply (24V) can be used in case of mains absence.
For external supply 24V±10% and up to 2A should be provided.
Connecting external supply (24V) is not necessary to control water valve.

There are three modes of Water Valve Control accessible from the front panel after entering OEM access code: WaterCtrl_v1, WaterCtrl_v2 and Default_v2. Below there are descriptions of each mode.

WaterCtrl_v1:

Valve control terminals are connected to relay with normally open contacts.

Relay closes when:
- bit Power ON is active (main relays are closed), or
- any temperature measurement warning is active.

Relay opens when:
- any temperature measurement is lower than 3°C below warning threshold, and
- power ON bit is inactive.

The relay closes for at least 30s.

WaterCtrl_v2 (Default_v2):

Valve control terminals are connected to relay with normally open contacts.

Relay closes when:
- output power or current is at least 20% of the nominal value, or
- any temperature measurements exceed 38°C, or
- any temperature warning is active.

Relay opens when:
- output power or current is less than 20% of the nominal value for at least 30s, and
- any temperature measurements drop below 35°C, and
- no temperature warning is active.

The relay closes for at least 30s.

Maximum voltage at valve control terminals: 24V.
Maximum relay current: 1A.

In case a valve control circuitry is not equipped with freewheeling diode, an external one must be provided.

4.12. Analog control terminal

Analog control connector is located on the rear side of device and uses a 25-pin male SUBD connector. Table below provides description of pins.

Pin no.	Name	Type	Description		
1	**Uact**	Analog output	0..10 V against GND represents **0…1000 V** output voltage		
2	**Iact**	Analog output	0..10 V against GND represents **0…25 A** output current		
3	**Pact**	Analog output	0..10 V against GND represents **0…10 kW** output power		
14	**Set Value**	Analog Input Depending on the **RegSel** setting (pins 10 and 11) one of four control modes can be selected	RegSel0	RegSel1	Control Mode
			Low	Low	**Power control**. 0…10V at input represents 0…10 kW power setting
			Low	High	**Voltage control**. 0…10V at input represents 0…1000 V voltage setting
			High	Low	**Current control**. 0…10V at input represents 0…25 A current setting
			High	High	**Not used**
4, 17	**GND**	Ground	Reference ground for all analog signals.		
5, 18	**GND**	Ground	Reference ground for all digital signals.		
8	**PowerON**	Digital Input	Connect to 24V in order to switch the internal power relays ON and prepare unit for operation.		
9	**Release**	Digital Input	Connect to 24V with the Power ON input active in order to provide power to output terminals.		
10, 11	**RegSel**	Digital Inputs	**Control mode selector**: RegSel1 (pin 10) and RegSel0 (pin11) High = Connected to 24V; Low = Connected to GND or open. See description for pin 14 (Set Value)		
12	**Interlock**	Digital input	Interlock must be disabled (connected to +24V, pin 19) to enable power supply switch-ON. This is a relay-based hardware connection.		
19	**+24V**	Supply output	24V supply for all digital inputs.		
6	**Coll.**	Digital output (isolated)	All optocoupler collectors are connected to this common pin. **Max. voltage between this pin and the remaining isolated digital outputs must not exceed 30V.**		
21	**NoFaultInd.**	Digital output (isolated)	No fault indication. Voltage from pin 6 is coupled to this pin to show, that the unit is powered up and no alarms are active. Maximum pin voltage is 30V. Maximum current is 10mA.		
22	**PowerONind**	Digital output (isolated)	Voltage from pin 6 is coupled to this pin to show, that the unit is running. Maximum pin voltage is 30V. Maximum current is 10mA.		
24	**NVR**	Digital output (isolated)	Nominal Value Reached. Voltage from pin 6 is coupled to this pin to show, that the output parameter is within 5% of its set value or nominal output value . Maximum pin voltage is 30V. Maximum current is 10mA.		
7	**ArcOccurs**	Digital output (isolated)	Voltage from pin 6 is coupled to this pin for ca. 20ms to show that an arc has occurred. These signals are not synchronized with the actual arc occurrence (50 - 500ms time shift). The number of "blinks" show the number of arcs.		
13, 25	**Alarm**	Digital output	Potential-free contacts are shortened when the unit is powered up and alarm state is present. Maximum load is 30V, 0.5A.		

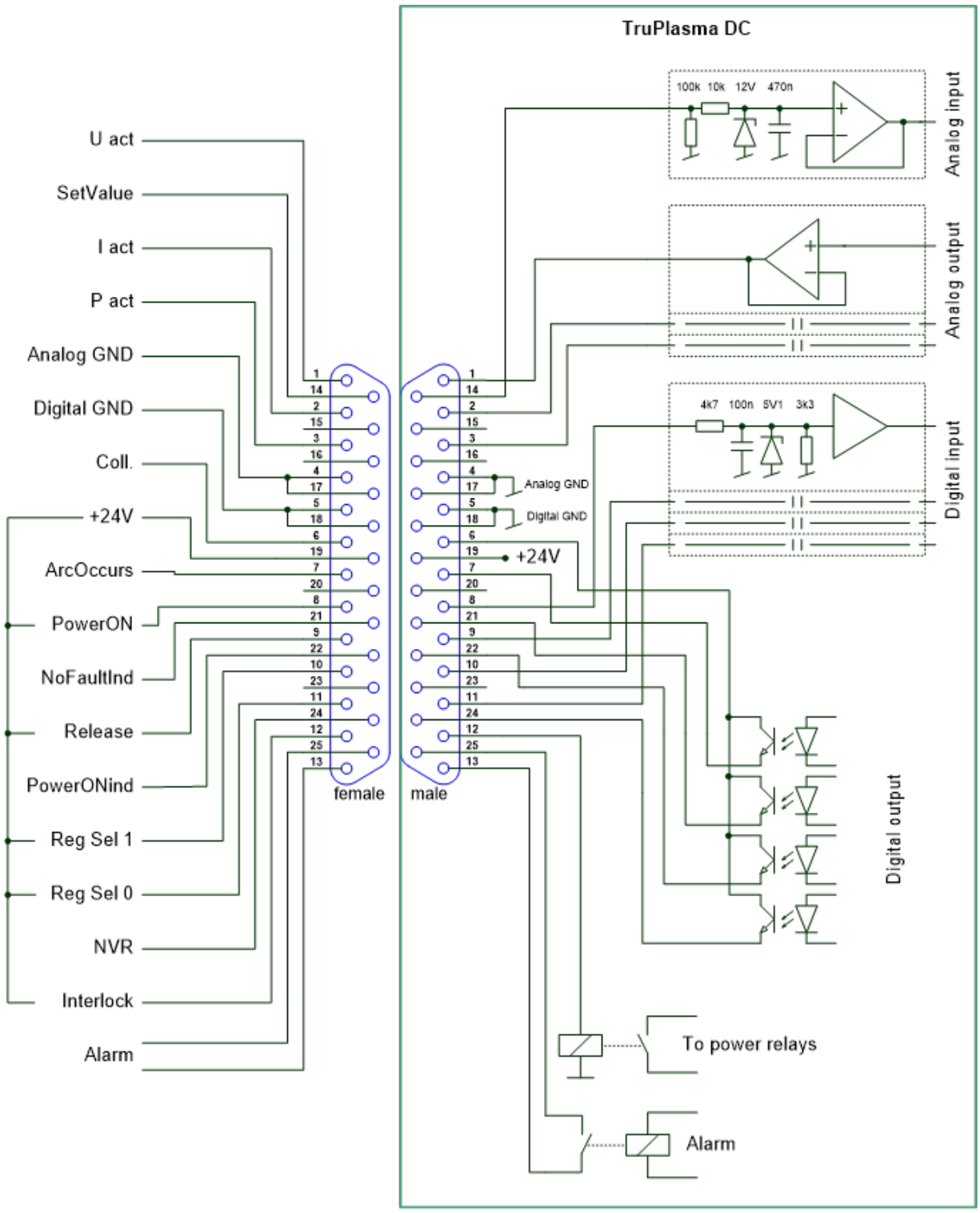


Fig. 4.8. Analog control connection and circuit diagram.

5. Parallel and Synchronous operation modes

5.1. Parallel operation mode

It is possible to connect up to five **TruPlasma DC** 3010 power supplies together which will function as **TruPlasma DC** 3100 unit. In such cases outputs of both units should be connected in parallel. Each power supply is equipped with double EXTERNAL BUS terminal to simplify connection configuration.

Additional connections between units are required. See Fig. 5.1 for details.

In parallel operation mode one of power supplies operates as a Master device and the others as a Slave device. All parameters are set in Master unit, which automatically controls Slave units. External control (user) links (e.g. RS-232, RS-485, Analog, Profibus) must only be connected to Master unit. Adjustable parameters are blocked in Slave device, but monitoring of most important parameters is possible using one of the interfaces or front panel display.
Communication protocols for power supplies working in parallel mode are the same as protocols for a single unit. The only difference is that ranges of power and current are wider. The ranges of arc detection settings are within limits of individual power supply.
CAN protocol and logic signals are used in order to communicate between units.

Auto configuration.
Auto configuration mode allows to configure the operation automatically. In all units working in the system Auto configuration has to be activated. The Master unit has to be selected. Other units will be automatically set as Slave.
After changing operation mode to Auto configuration/ Master units must be reset by switching mains off and on.

Other precautions concerning parallel operation mode:
- arc detection parameters are set to the same value in all units by a Master unit
- after changing operation mode (Single → Master (or Slave), Master (or Slave) → Single) units must be reset by switching off and on
- power/current readout of Master unit displays total values of Master and Slave units
- power/current readout of Slave unit displays values of Slave unit only

Connection of power supplies

- **each device should be connected directly to the chamber**
- **connection cables should have the same lenght to ensure the same inductance (maximum recommended cable length is 10m)**

Following connections and settings are necessary to configure power supplies for parallel operation:

- one device must be set to Master and the others to Slave mode,
- number of Slave devices has to be set in "Configuration" menu in SOP, see chapter 7.5 configuration menu,
- PARALLEL BUS – cable used for communication between units (optionally available) connected to EXTERNAL BUS terminals,
- parallel operation bus consists of PARALLEL BUS cables and must be terminated with dedicated terminators (optionally available),
- each device should be connected directly to the chamber with the same cables length.

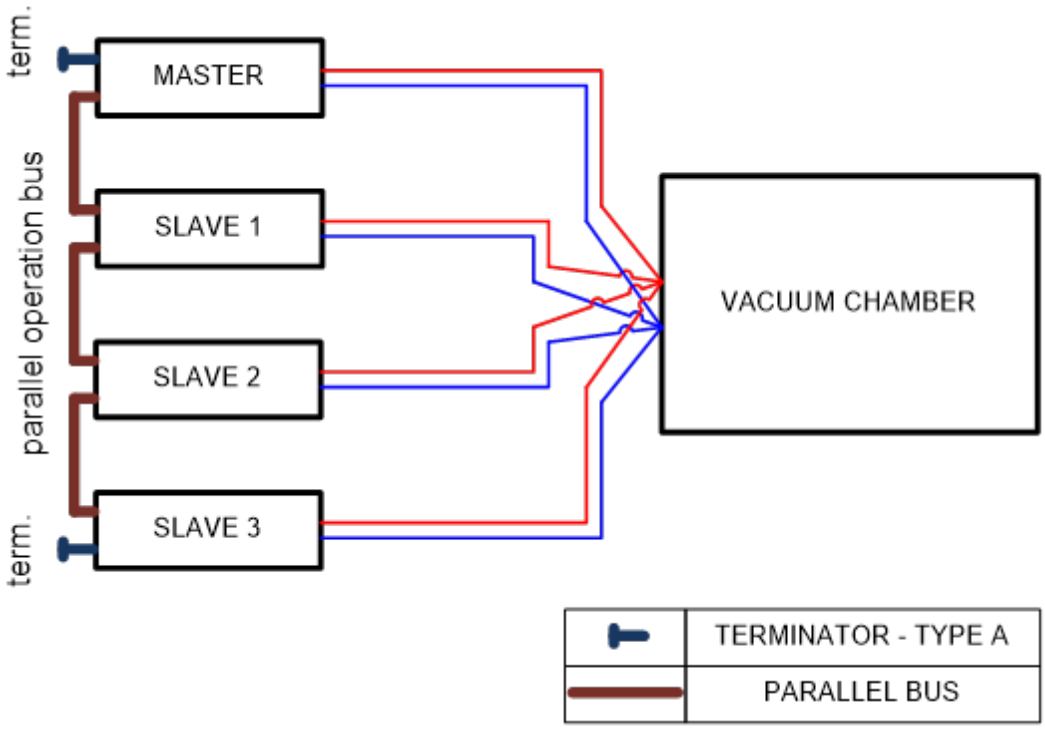


Fig.5.1. Connection of Master and Slave units for parallel operation.

Both ends of the parallel operation bus have to be terminated with apropriate terminators

"Synchro Conn" alarm can be triggered in following situations:

- no communication between Master and Slave unit,
- no PARALLEL BUS cable,
- no Master unit,
- no Slave unit,
- more than one unit set as Master simultaneously.

5.2. Synchronous operation mode

When power supplies work in the same system with separated cathodes, it is possible to synchronize up to five of them. Synchronous mode provides output power inhibiting in all power supplies when one of them detects an arc. Output power is inhibited for amount of time equal to break time setting in unit which detects an arc.
Parameters (e.g. output power setting or arc detection) in all units working in synchronous mode might be set independently.
Logic signals are used in order to communicate between units.

Following connections and settings are necessary to configure power supplies for synchronous operation:

- **Synchro ON** parameter in all devices must be set to active,
- SYNCHRONOUS BUS – cable used for communication between units (optionally available) connected to EXTERNAL BUS terminals,
- synchronous operation bus consists of SYNCHRONOUS BUS cables and has to be terminated with dedicated terminators (optionally available).

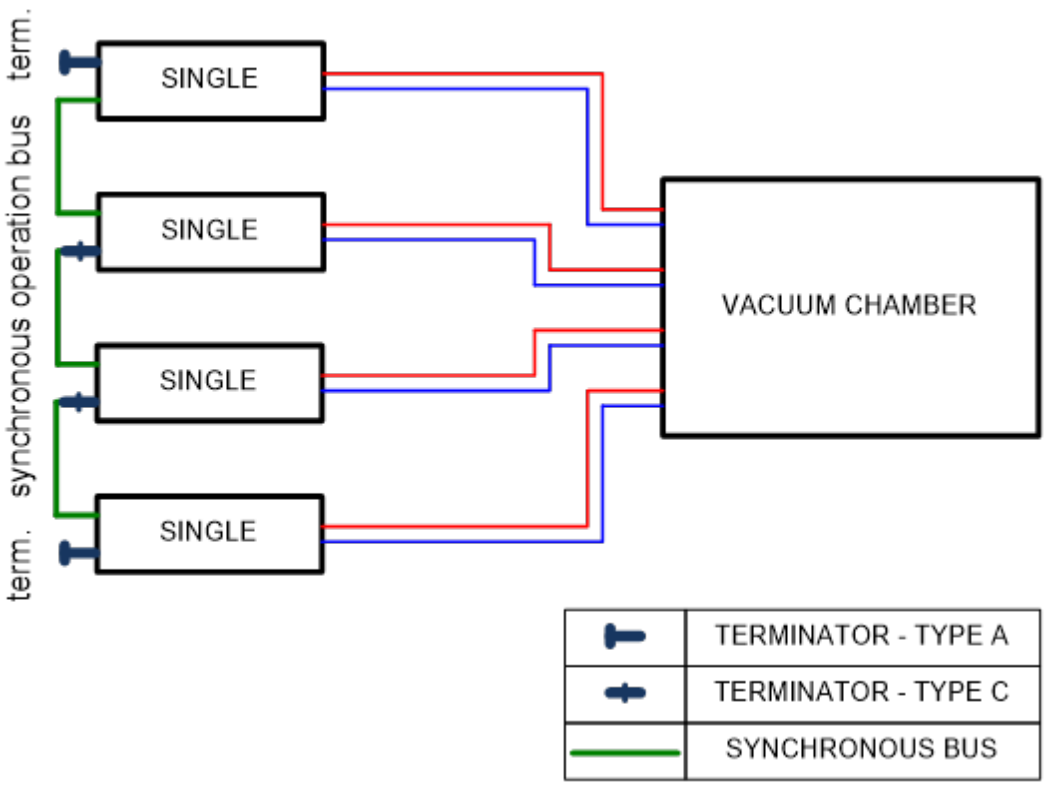


Fig.5.2. Synchronous operation.

Both ends of the synchronous bus have to be terminated with apropriate terminators

5.3. Parallel and synchronous operation simultaneously

It is possible to run parallel and synchronous operation mode simultaneously. All rules for parallel and synchronous operation have to be considered.

In example below three groups (A, B, C) of power supplies working in parallel mode are synchronized.

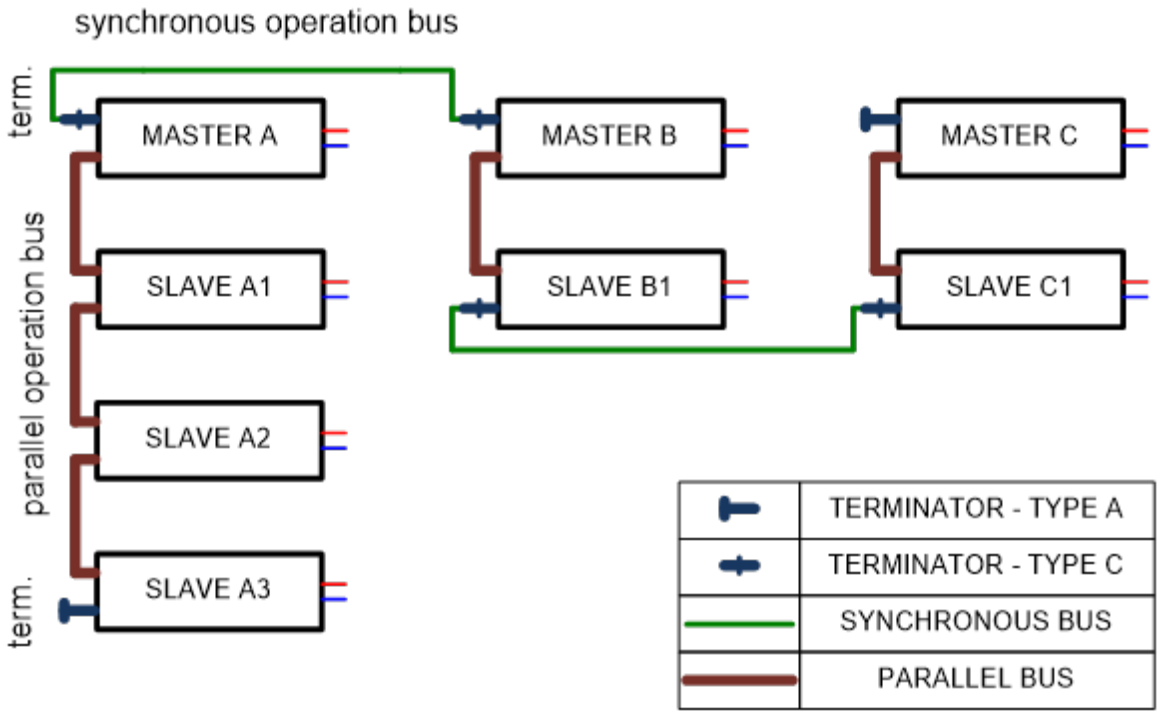


Fig.5.3. Parallel and synchronous operation.

6. 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 DC 3010 arc detection system is equipped with five kinds of arc detection criteria:

Imax – current-based detector – reacts when output current exceeds user defined *Imax threshold*

UxI – voltage and current-based detector (cross-detector) – reacts when output voltage is lower than user-defined *Ux threshold*, while current is higher than user-defined *Ix threshold*

UxI_observer – voltage and current-based detector (cross-detector) – reacts when output voltage is lower than automatically set *Ux threshold*, while current is higher than user-defined *Ix threshold. Ux* is equal to ouctual output voltage – *Ux offset* user-defined setting (*Ux_obs* = *Uact* – *Ux_offset*).
Ux_offset is a user-defined parameter in the range of 10 to 200V

dU – voltage-based detector (microarc) – armed when output voltage exceeds user-defined *dU_ON* threshold and is triggered when voltage drops below user-defined *dU_OFF* threshold.

dU_observer – automatically sets dU detection thresholds based on mean output voltage. Works like **dU** arc detector, but *dU_ON* and *dU_OFF* thresholds are automatically set due to mean output voltage:
dU_ON_obs. = Uact – 10V
dU_OFF_obs. = *dU_ON_obs.* – *dU_offest*
dU_offset is a user-defined parameter in the range of 30 to 200V

Arc Burst – detects arcs appearing continuously. After series of arcs between which power delivery time is shorter than *ON-time_below* parameter an additional break time equal to break time in UxI criterion and recovery ramp is being provided. *Number_in_a_row* parameter describes a number of arcs in series. *ArcBurst_Cnt* counts arc bursts described in this criterion. See Fig. 6.6.

Notes:

- In **TruPlasma DC** 3010 maximum amount of detected and suppressed microarcs can be as high as 2000 per second. This is valid only when cable length between power supply and load is not longer than 10 meters, otherwise frequency is limited to lower values (overheating protection).

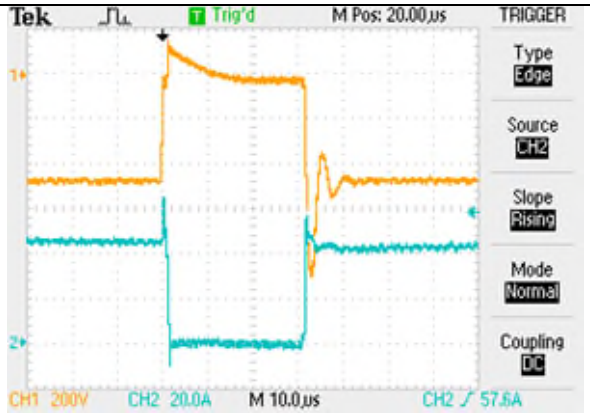
Number of detected arcs is displayed by the front panel display or can be read from communication interface with respect to the criteria which detects an arc.

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.

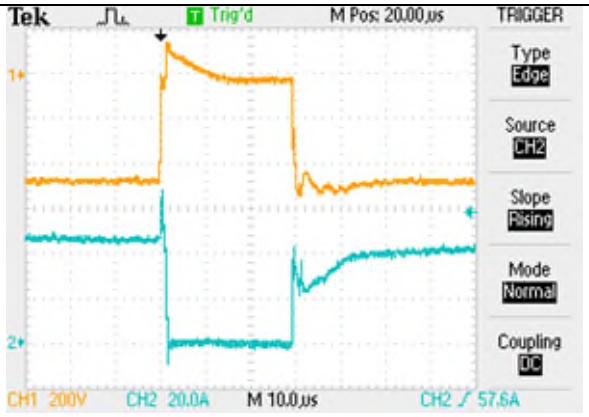
After break time, a shut-down signal is released and output power returns to its previous setting value with a ramp, which is also programmable. By setting **ramp time** parameter, time after which power reaches its set value may be controlled. For two different arc detection criteria (Imax and UxI), there are two different parameters for break time and ramp time which can be set through RS232, Profibus or front panel display.
There is no ramp time parameter for dU arc detection criteria.

Depending on the dynamic properties of the particular cathode and also the power cable type and arrangement around the chamber - the cathode voltage may show significant overshoots when the power is being restored after an arc break. This happens if the current value is being forced to be immediately the same as just before the arc. As a result - the peak cathode power may reach twice the value of the steady-state power for a very short time (2-5us).

In order to eliminate this phenomena the output power is restored in 2 steps and the initial current value is decreased. This is controlled by the Soft Start Advance time setting.



Soft Start Advance time = 0



Soft Start Advance time = 2,5us

This value determines how much time before the main power is restored a short pre-pulse will be generated. This pulse carries a small amount of energy – enough to softly accelerate the current and avoid voltage overshoots. Also, the larger the setting – the lower the initial current value.

Setting the Soft Start Advance time to 2,5us should be appropriate in most cases. In order to confirm or adjust this setting an oscilloscope must be connected to observe the cathode voltage during arcing handled by the dU criterion.

I_{max}

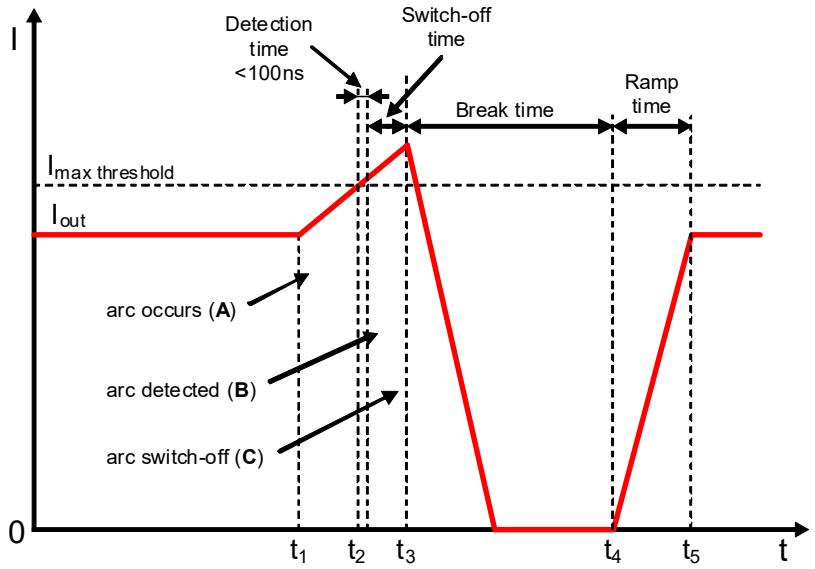


Fig. 6.1. I_{max} criterion arc detection example.

UxI

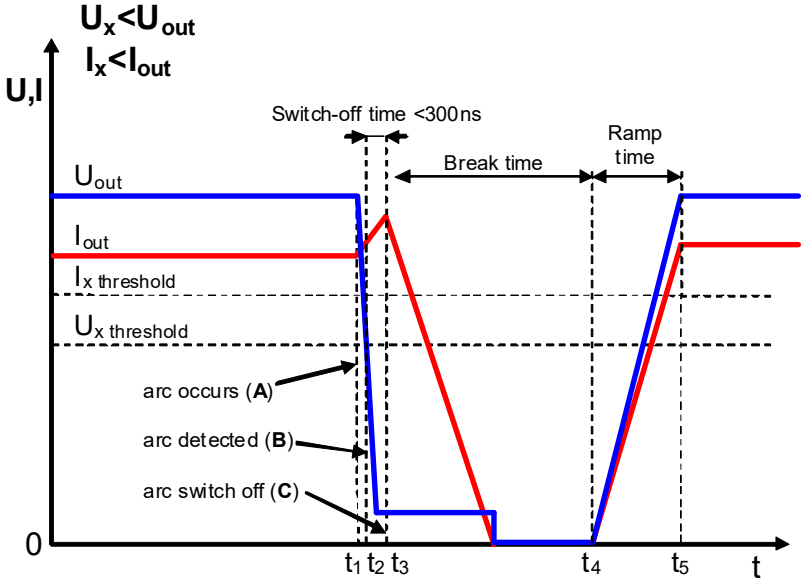


Fig. 6.2. **UxI** (cross detection) criterion arc detection example. $U_x<U_{out}$, $I_x<I_{out}$.

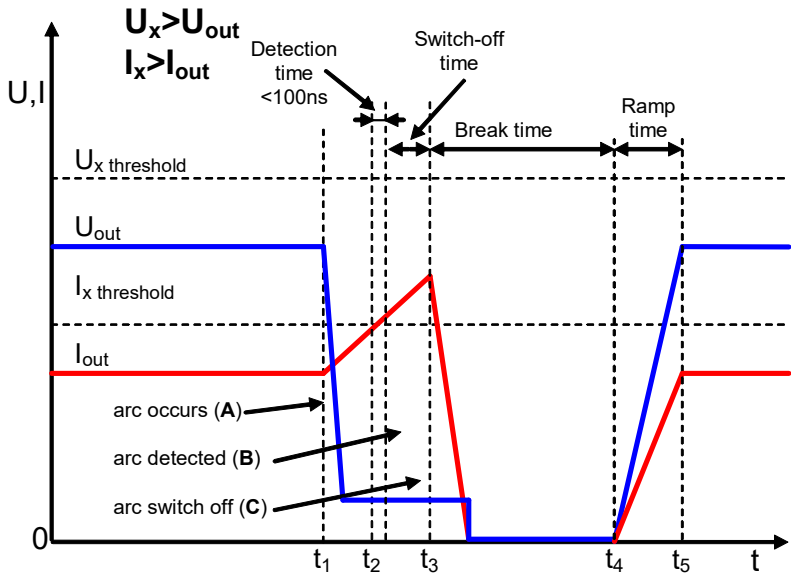


Fig.6.3. **UxI** (cross detection) criterion arc detection example. $U_x>U_{out}$, $I_x>I_{out}$.

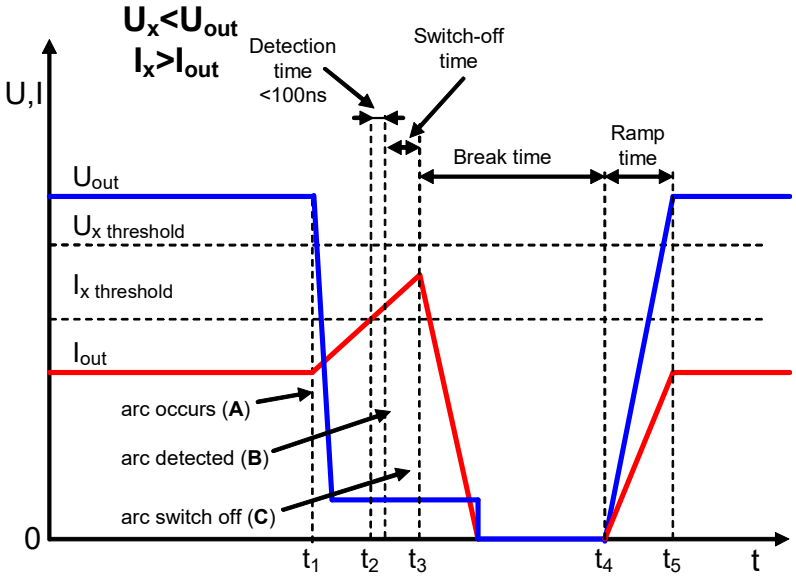


Fig. 6.4. **UxI** (cross detection) criterion arc detection example. $U_x<U_{out}$, $I_x>I_{out}$.

dU

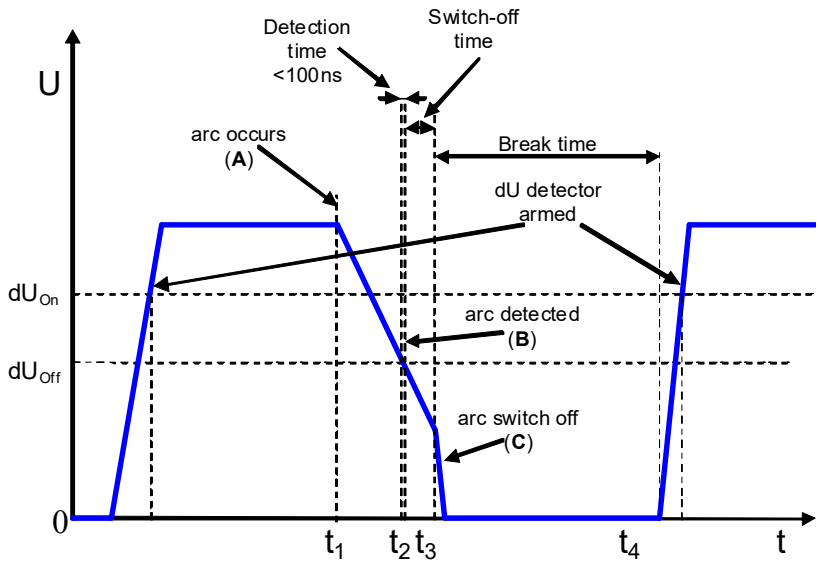


Fig. 6.5. **dU** (dynamic voltage change) criterion arc detection example.

Arc Burst

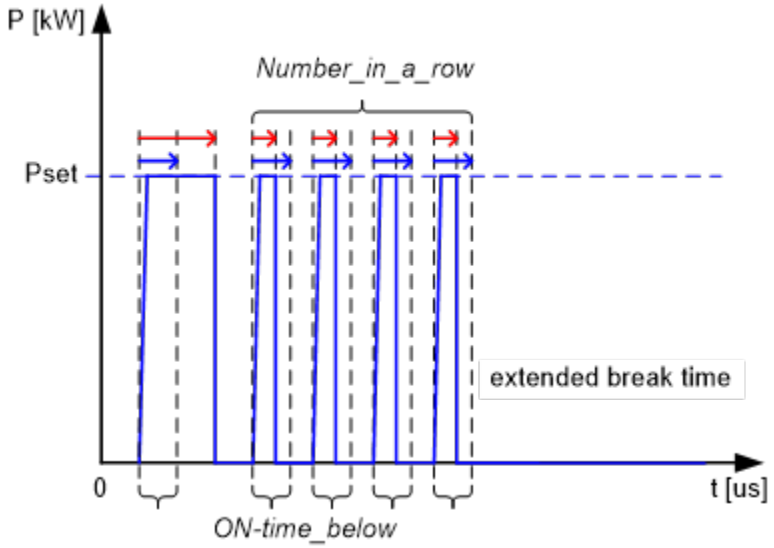
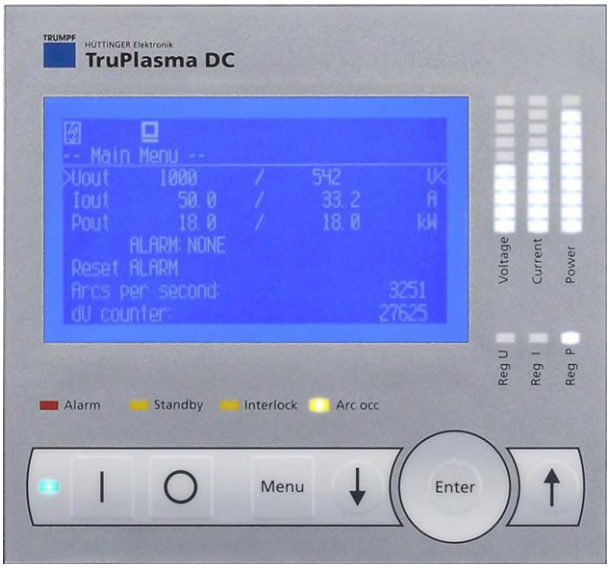


Fig. 6.6. **Arc Burst** detection example.

7. Standard Operator Panel (SOP)

7.1. LED description

To increase interactive between customer and device, the Standard Operator Panel has the LED indicators. Even if user is remote from Power Supply, he can check most important process indicators and quickly respond. SOP has two kinds of LED indicators. First group are single LEDs which are corresponding to most important process events, for example: alarm, turn on, arc occur, etc. Second group are bar graphs which indicates levels for most important parameters, for example: actual voltage, actual power, etc. Following table shows LED indicators used in SOP:



Function name	Color	Description
Standby	yellow	Power supply is powered, but not yet switched-on.
ON	green	Power supply is running.
Interlock	yellow	Interlock or door-closed detection circuits are open.
Arc occ	yellow	Blinks after an arc is detected.
Alarm	red	Blinks when critical conditions occur. Audible signal/beep is also activated.
Reg U	white	Indicates that voltage regulator is currently active.
Reg I	white	Indicates that current regulator is currently active.
Reg P	white	Indicates that power regulator is currently active.
Bar Graph – Voltage	white	Level of actual output voltage.
Bar Graph – Current	white	Level of actual output current.
Bar Graph – Power	white	Level of actual output power.

7.2. Buzzer

To inform about warning or error events, the Standard Operator Panel has the buzzer. Beep signal is linked to Alarm LED signal. Buzzer became active when warning or alarm state occurs. It remains active until the user presses any button or resets alarms.

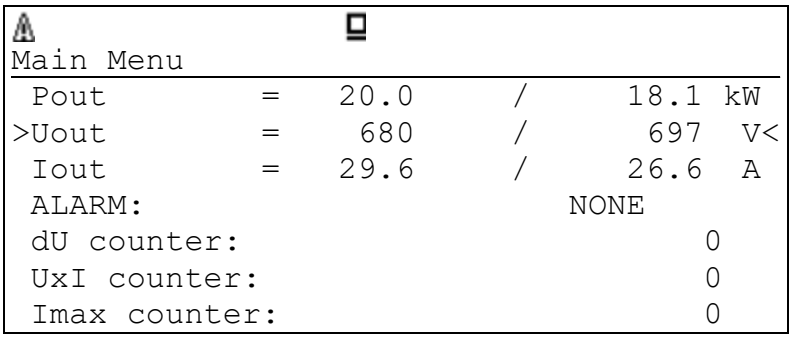
7.3. Screen saver

Standard Operator Panel has screen saver option which duration time is adjustable in menu. The user can either enable or disable screen saver by menu. The principle of screen saver is turn off the display backlight when is not any activity for some time in the device navigation.

7.4. Menu structure

Display interface has graphic and text areas:

- Text area consists of eight text lines at forty characters showing the process parameters (see below).

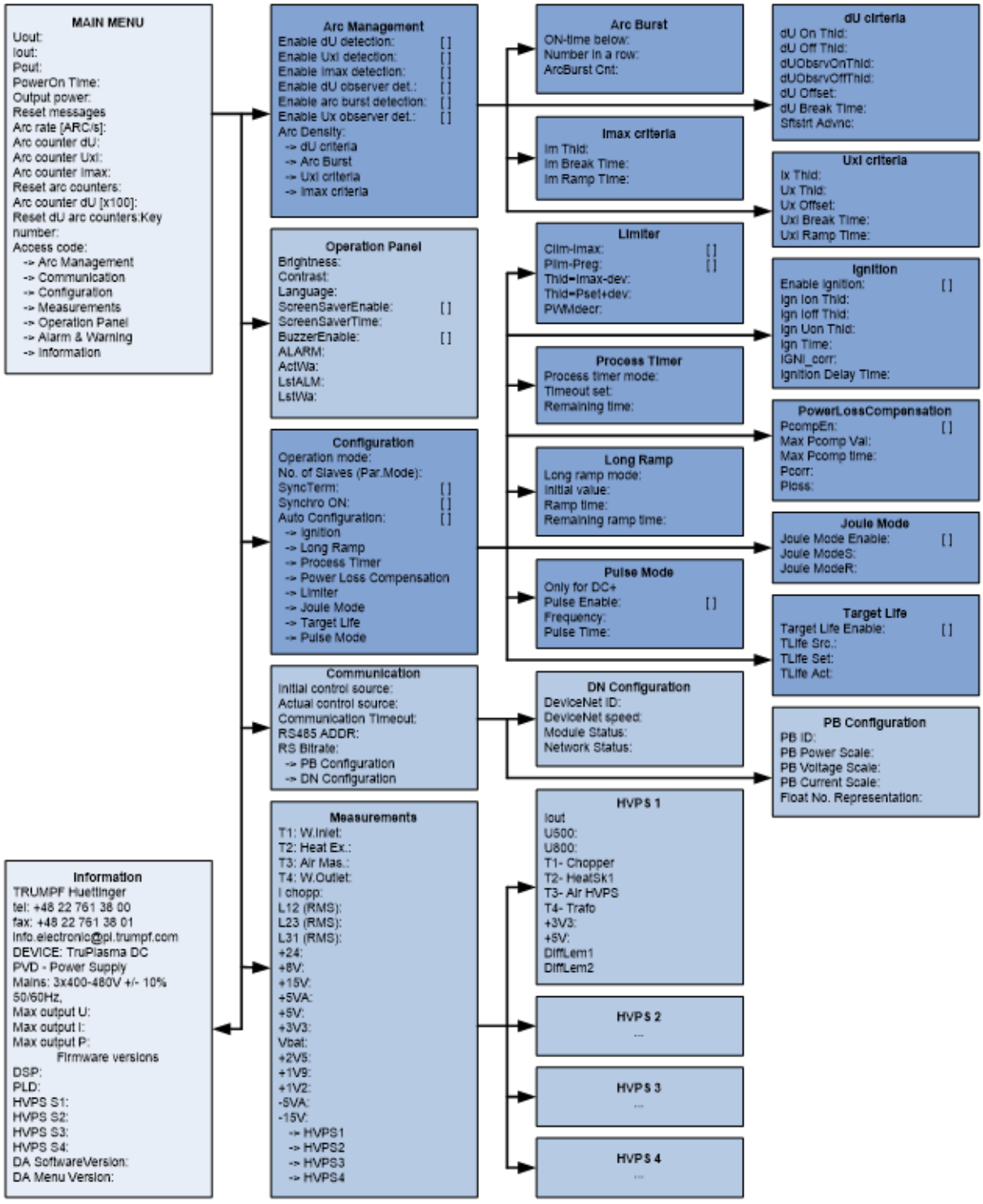


- Graphic area consists of pictograms (see below). Those are small figures placed on the top of display. They are responsible for indicating the most important events for the process, for example: power on, warning or fault, etc.

Pictogram	Description
	Output power released
	Display control
	RS-232/485 control
	Profibus control
	DeviceNet control
	EtherCAT control
	Analog control
	Warning
	Alarm
	Unit works as a Master in parallel operation mode
	Unit works as a Slave in parallel operation mode
	NVR – Nearest Value Reached
	Power long ramp
	Current long ramp
	Output timer active
	End of output timer
	Ready
	Wait, not ready
	OEM access mode
	STP access mode

Principle of menu navigation is use four switches (Menu, Enter, Up, Down). Menu of SOP has sub menu (three levels) structure. At the beginning of device operation the SOP display main page. The user can either choose parameters or sub menu on page by pressing Up or Down button and select it by Enter button. Each press Menu button brings user to upper level of menu structure.

ON and OFF buttons allow quick switching power on and off.



Access level:	STD	STP	OEM
Access code:	0	1	321

Fig.7.1. Standard Operator Panel menu structure.

7.5. Description of displayed data and settings

MAIN MENU – Basic controls and readouts

Display	Modif.	Description
>Uout= 680 / 679V <	Yes	Voltage regulator setting (first number) and actual power supply's output voltage readout (second number).
>Iout= 25.0 / 24.5A <	Yes	Current regulator setting (first number) and actual power supply's output current readout (second number).
>Pout= 20.0 /16.6kW <	Yes	Power regulator setting (first number) and actual power supply's output power readout (second number).
>PowerOnTime: hh:mm.ss <	No	Time elapsed from last switching power on.
>Output power: ON <	Yes	If control mode is set to DISPLAY panel, power supply can be switched on.
ALARM: NONE	No	When ALARM LED blinks, it cyclically displays conditions which trigger alarm.
> Reset messages <	Yes	Reset occurred alarms, warnings.
Arc rate [ARC/s]: 0/s	No	Arc frequency.
Arc counter dU: 0	No	Number of arcs detected by dU criterion, which occurred since last counter reset (max 65535).
Arc counter UxI: 0	No	Number of arcs detected by UxI criterion, which occurred since last counter reset (max 65535).
Arc counter Imax: 0	No	Number of arcs detected by Imax criterion, which occurred since last counter reset (max 65535).
>Reset arc counters: NO<	Yes	Reset arc counters. If dU counter(x100) is full, then counter will also be reset.
>Arc counter dU [x100]: <	No	dU arc counter – range: 0 – 10 000 (x100).
>Reset dU arc counters: <	Yes	Reset dU arc x100 counter.
Key number: 123	No	Parameter for OEM access code generating.
>Access code: STD <	Yes	Entering proper access code following menus are accessible: -> Arc Management OEM -> Communication STP, OEM -> Configuration OEM -> Measurements STP, OEM -> Operation Panel STP, OEM -> Alarm & Warning STD, STP, OEM -> Information STD, STP, OEM Access codes: STD – 0; STP – 1; OEM – 321.

Annotations:

- ON and OFF buttons at operator panel allow quick switching power on and off

Arc Management

Display	Modif.	Description
>Enable dU detection <	Yes	Enables or disables dU detection criterion.
>Enable UxI detection <	Yes	Enables or disables UxI detection criterion.
>Enable Imax detection <	Yes	Enables or disables Imax detection criterion.
>Enable dU observer detection <	Yes	Enables or disables dU observer detection criterion.
>Enable arc burst detection <	Yes	Enables or disables Arc Burst detector.
>Enable Ux observer detection <	Yes	Enables or disables Ux observer detection criterion.
>Arc Density 2000 <	Yes	Threshold for "TooManyArcs" alarms. If number of arcs per second is higher this threshold, Power Supply will generate alarm and switch off power on output. Alarm is activated if Arc Density parameter is different than 0. **[0…8000]**
-> dU criteria	-	Submenus. See below.
-> Arc Burst	-	
-> UxI criteria	-	
-> Imax criteria	-	

Arc Management –> **dU criteria**

Display	Modif.	Description
>dU On Thld: 444 V<	Yes	dU_on voltage threshold for dU criterion. **[50…800 V]**
>dU Off Thld: 331 V<	Yes	dU_off voltage threshold for dU criterion. **[0…750 V]**
dUObsrvOnThld: 369 V	No	dU_on voltage threshold for dU observer criterion.
dUObsrvOffThld:269 V	No	dU_off voltage threshold for dU observer criterion.
>dU Offset: 100 V<	Yes	Min. difference level between ON and OFF voltage thresholds for standard and observer mode. **[30…200 V]**
>dU BreakTime: 50.5us<	Yes	Break time for standard and observer dU detection criterion. **[5…1000 µs]**
>SftStrt Advc: 8.0 us<	Yes	Soft-start pre-pulse advance time. See chapter 6. **[0 … 5 µs]**

Arc Management –> **Arc Burst**

Display	Modif.	Description
>ON-time below: 8 µs <	Yes	The shortest time between power releasing and arc detection **[1…1000µs]**
>Number in a row: 10 <	Yes	Arc burst is detected when number of arcs in a row exceeds this value **[1…100]**
ArcBurst Cnt: 0	No	Arc burst counter

Arc Management –> **UxI criteria**

Display	Modif.	Description
>Ix Thld: 13.0 A <	Yes	Current threshold value for UxI detection criterion. **[2.5… 25A]**
>Ux Thld: 259 V <	Yes	Voltage threshold value for UxI detection criterion. **[0…900V]**
>Ux Offset: 259 V <	Yes	Difference level between Uact and Ux threshold in observer mode. **[10…200 V]**
>UxI Break Time: 8.0ms<	Yes	Break time for UxI detection criterion. **[0.1…80ms]**
>UxI Ramp Time: 12.0ms<	Yes	Ramp time for UxI detection criterion. **[0…100ms]**

Arc Management –> **Imax criteria**

Display	Modif.	Description
>Im Thld: 85.5 A <	Yes	Current threshold value for Imax detection criterion. **[2.5…32.5A]**
>Im Break Time: 2.0ms <	Yes	Break time for Imax detection criterion. **[0.1…80ms]**
>Im Ramp Time: 10.0ms <	Yes	Ramp time for Imax detection criterion. **[0…100ms]**

Communication

Display	Modif.	Description
>Initial control source: RS232 <	Yes	Initial control source after reboot: **DISPLAY**, **ANALOG**, **RS232**, **PROFIBUS**, **RS485** or **DeviceNet**.
>Actual control source: RS232 <	Yes	Control source of the power supply: **DISPLAY**, **ANALOG**, **RS232**, **PROFIBUS**, **RS485** or **DeviceNet**.
>Communication Timeout: 3s <	Yes	Delay time for communication lost alarm generating. **[0…65s]**
>RS485 ADDR= 255 <	Yes	RS485 address **[0…65535]**
>RS Bitrate: 115200 <	Yes	Baud rate for RS communication **[9600, 19200, 38400, 57600, 115200]**
-> PB Configuration	-	Submenus. See below.
-> DN Configuration	-	

Communication –> **PB Configuration**

Display	Modif.	Description
>PB ID = 120 <	Yes	Profibus ID setting **[0…127]**
>PB Power Scale: 10000 <	Yes	Scale value for power regulator, when power is set by integer data type via Profibus transmission protocol (see chapter 9.2. Profibus transmission protocol description).
>PB Voltage Scale: 10000 <	Yes	Scale value for voltage regulator, when voltage is set by integer data type via Profibus transmission protocol (see chapter 9.2. Profibus transmission protocol description).
>PB Current Scale: 10000 <	Yes	Scale value for current regulator, when current is set by integer data type via Profibus transmission protocol (see chapter 9.2. Profibus transmission protocol description).
>Float No. Representation: Intel<	Yes	Float data type for Profibus **[Motorola, Intel]**

Communication –> **DN Configuration**

Display	Modif.	Description
>DeviceNet ID: 63 <	Yes	DeviceNet ID setting **[0…63]**
>DeviceNet speed: 250k<	Yes	DeviceNet speed setting **[128k, 250k, 500k]**
Module Status:	No	**NoPower** – There is no power applied to the device. **DeviceOp** – The device is operating in a normal condition. **DevInStb** – The device needs commissioning due to configuration missing, incomplete or incorrect. The Device may be in the Standby state. **MinorFault** – Recoverable Fault. **UnrecFault** – The device has an unrecoverable fault; may need replacing. **DevSelfTest** – The Device is in Self Test.
Network Status:	No	**NoPower** – Device is not on–line. **NotConn** – Device is on–line but has no connections in the established state. **LinkOk** – The device is on–line and has connections in the established state. **ConnTimeout** – One or more I/O Connections are in the Timed–Out state. **CritLinkFail** – Failed communication device. The device has detected an error that has rendered it incapable of communicating on the network **CommFaulted** – A specific Communication Faulted device. The device has detected a Network Access error and is in the Communication Faulted state. The device has subsequently received and accepted an Identify Communication Faulted Request – Long Protocol message.

Configuration

Display	Modif.	Description
>Operation Mode: Single<	Yes	Working mode in parallel operation: **Single**, **Master** or **Slave**.
>No. of Slaves (Par. Mode): 0<	Yes	Number of slave power supplies working in parallel operation mode.
>SyncTerm: <	Yes	Should be enabled when power supply works in Single mode and disabled when external terminators are used in Master, Slave or Synchronous operation mode.
>Synchro ON: <	Yes	Enables or disables synchronous working mode. When the unit is not connected to other generator this option must be disabled. Enabling this option when no units connected may cause improper operation of the unit..
>Auto Configuration: <	Yes	When enabled, in parallel operation, only one power supply has to be set as Master and others will be configured as Slave automatically.
-> Ignition	-	Submenus. See below.
-> Long Ramp	-	
-> Process Timer	-	
-> Power Loss Compensation	-	
-> Limiter	-	
-> Joule Mode	-	
-> Target Life	-	
-> Pulse Mode	-	

Configuration –> **Ignition**

Display	Modif.	Description
>Enable ignition: <	Yes	Enables or disables ignition mode.
>Ign Ion Thld: 0.70A <	Yes	Current ignition threshold. **[0…0.5A]**
>Ign Ioff Thld: 2.70A <	Yes	Current ignition threshold. Not used in this application. **[0…1.25A]**
>Ign Uon Thld: 900V <	Yes	Voltage ignition threshold. **[500…1000V]**
>Ign Time: 500µs <	Yes	Ignition pulse time. **[0…100µs]**
>IGNi_corr: 15% <	Yes	Ignition current booster. **[0…50%]**
>Ignition Delay Time: 3s<	Yes	Delay time for "NO LOAD" alarm. It is disabled when set to 0. **[0…10s]**

Configuration –> **Long Ramp**

Display	Modif.	Description
>Long ramp mode: OFF <	Yes	Enables or disables Long Ramp. **OFF** – disabled **P En** – Power Long Ramp **I En** – Current Long Ramp
>Initial value: 0.0% <	Yes	Long Ramp Time start value setting. **[0…100%]**
>Ramp time: 940s <	Yes	Long Ramp Time duration setting. **[0…7200s]**
Remaining ramp time: 939s	No	Countdown-timer shows time left until end of ramp.

Configuration –> **Process Timer**

Display	Modif.	Description
>Output timer mode: OFF <	Yes	Enables or disables Output Timer function. **OFF** – disabled **ON** – starts after switching power on **ON P** – starts after output power reaches setpoint value
>Timeout Set: 3600s <	Yes	Output Timer Time duration setting. **[0…36000s]**
Remain_Time: 939s	No	Countdown-timer shows time left until end of Output Timer

Configuration –> **Power Loss Compensation**

Display	Modif.	Description
>PcompEn <	Yes	Enables or disables Power Loss Compensation function.
>Max Pcomp Val: 45% <	Yes	Maximum allowed power compensation value. **[0…100 %]**
>Max Pcomp time: 15s <	Yes	Determines maximum amount of time for power loss compensation. **[0…25 s]**
Pcorr: 0 kW	No	Actual power compensation value in kW, which is added to the power setpoint value.
Ploss: 0 kW	No	Actual residue energy loss [kW x 10ms] resulting from limited power compensation related to the *Max Pcomp Val* setting.

Configuration –> **Limiter**

Display	Modif.	Description
>Clim-Imax: <	Yes	Enables or disables Current Limiter function.
>Plim-Preg: <	Yes	Enables or disables Power Limiter function.
>Thld=Imax-dev: 0 %<	Yes	Threshold for current limiter expressed in Imax setting reduced by dev value in percentage. **[0…50 %]**
>Thld=Pset+dev: 0 %<	Yes	Threshold for power limiter expressed in Pset setting incremented by dev value in percentage. **[0…50 %]**
>PWMdecr: 15 %<	Yes	Output power reduction in percentage in the moment of crossing threshold for current or power limiter.

Configuration –> **Joule Mode**

Display	Modif.	Description
>Joule Mode Enable: <	Yes	Enables or disables Joule Mode function.
>Joule ModeS 100kJ<	No	Amount of the energy in Joule mode. **[0 … 20000kJ]**
>Joule ModeR 0kJ<	No	Amount of delivered energy to the load in Joule mode.

Configuration –> **Target Life**

Display	Modif.	Description
>Target Life Enable <	Yes	Enables or disables Target Life function.
>TLife Src.: 1 <	Yes	Selected target type from described below **[1 … 8]**
>TLife Set: 100.0kWh <	Yes	Target lifetime definition **[0.0 … 36000kWh]**
TLife Act: 0.0kWh	No	Actual target lifetime **[0.0 … 36000kWh]**

Configuration –> **Pulse Mode (TruPlasma DC+ only)**

Display	Modif.	Description
>Pulse Enable <	Yes	Enables or disables Pulse mode.
>Frequency: 500 Hz <	Yes	Pulsing frequency setting **[20…15000Hz]**
>Pulse time: 20µs <	Yes	Duration of output power inhibition during each pulse cycle **[1…100µs]**

Measurements

Display	Modif.	Description
T1:W. Inlet= 24.6°C	No	Temperature of inlet water.
T2:Heat Ex.= 24.6°C	No	Temperature of heat exchanger.
T3:Air Mas.= 24.6°C	No	Temperature of air at control PCB.
T4:W.Outlet= 24.6°C	No	Temperature of outlet water.
L12 (RMS)	No	Mains actual RMS voltage, phases 1-2.
L23 (RMS)	No	Mains actual RMS voltage, phases 2-3.
L31 (RMS)	No	Mains actual RMS voltage, phases 3-1.
+24V: 24.0 V	No	Internal power supply output voltage.
...	No	Internal measurements.
-> HVPS 1 -> HVPS 2 -> HVPS 3 -> HVPS 4	-	Sub-menus. Readouts of measurements at internal modules.

Measurements –> **HVPS 1…4**

Display	Modif.	Description
Iout 10.0 A	No	Output current of HVPS unit.
U500: 555 V	No	Rectified mains voltage.
U800: 800 V	No	Inverter supply voltage.
T1-Chopper = 24.6°C	No	Temperature of output chopper.
T2-HeatSk1 = 24.6°C	No	Temperature of heatsink.
T3-Air HVPS= 24.6°C	No	Temperature of air at control PCB.
T4-Trafo= 24.6°C	No	Temperature of main transformer.
+3V3 3.37 V	No	Internal supply voltage.
+5V 5.03 V	No	
DiffLem1 0.0 A	No	Internal sections differential current.
DiffLem2 0.0 A	No	

Operation Panel

Display	Modif.	Description
>Brightness = 90 % <	Yes	LCD screen brightness. **[0…100%]**
>Contrast = 50 % <	Yes	LCD screen contrast. **[0…100%]**
>Language = English <	Yes	Not used. Default language is English.
> ScreenSaverEnable <	Yes	Enables or disables screen saver.
>Screen Saver Time: 10 min<	Yes	Screen saver delay time. **[1…60min]**
>BuzzerEnable <	Yes	Enables or disables buzzer.
ALARM: NONE	No	Active alarm state.
ActWa: NONE	No	Active warning state.
LstALM: NONE	No	Last alarm state.
LstWa: NONE	No	Last warning state.

8. Interfaces

8.1. RS-232/485 transmission protocol description

TruPlasma DC acts as a slave device in the communication process. It never initiates any transmissions. Computer (PC) sends a command which is executed by **TruPlasma DC** 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).

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 (edge sensitive 0→1), OFF (0)
1: Power ON (edge sensitive 0→1), OFF (0)
2: Reset arc counters (0 → 1; 1 transmission is sufficient)
3: Reset Alarms
4: -
5: RS controls the **TruPlasma DC** unit (1), monitoring only (0)
6: -
7: Display Control (1)

IMPORTANT: When controlling **TruPlasma DC** 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 "RS :NO CTRL" 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
0x27	0xD8	DST_H	DST_L	SRC_H	SRC_L	ACK_H	ACK_L	CMD_H	CMD_L
10-13	14-17	18-21	22-24	25-26	27-28	29-30	31-34	35-36	37-38
$Uact_{0-3}$	$Iact_{0-3}$	$Pact_{0-3}$	$Bits_{0-2}$	Im_{0-1}	UxI_{0-1}	dU_{0-1}	Arc/s_{0-3}	$dUx100_{0-1}$	CRC_{0-1}

Where:

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

Bits0: Acknowledge bits.
- 0: Relays ON acknowledge (1), or OFF (0)
- 1: Power ON (1), INHIBIT (0)
- 2: Ramp active
- 3: Master Active (in parallel mode)
  or Pulse Mode ON (1) / OFF (0) (in **TruPlasma DC**+)
- 4: Display control
- 5: Alarms to read.
- 6: RS232/485 control
- 7: Ready

Bits1: more acknowledge bits.
- 0: Interlock (1), no interlock (0)
- 1: OverTemp Bit: 1=Overtemp
- 2: PowerFail (1), power OK (0)
- 3: FPGA (1) OK (0)
- 4: EEprom Error (1), OK (0)
- 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: Pcomp Active
- 4: EOJM
- 5: EOTL
- 6: EOPT
- 7: Arc occ.

Im (integer)	Arc counter (Imax criterion)	0...65535
UxI (integer)	Arc counter (UxI criterion)	0...65535
dU (integer)	Arc counter (dU criterion)	0...65535
Arc/s(float)	Arcs per second counter	
dU[x100](integer)	Arc counter (dU criterion) [x100]	0…10000

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.

6040 Normal run – for DC+

PC to unit:

0	1	2	3	4	5	6	7	8-11	12-15
0x1B	0xE4	DST_H	DST_L	SRC_H	SRC_L	0x60	0x40	$Uset_{0-3}$	$Iset_{0-3}$
16-19	20	21-22	23-24	25	26				
$Pset_{0-3}$	Bits	$Fset_{0-1}$	$RTset_{0-1}$	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
Fset (uint16)	Frequency setpoint [Hz]	20…15000Hz
RTset (uint16)	Reverse Time setpoint [us]	1…100us

Bits:

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

IMPORTANT: When controlling **TruPlasma DC** 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 "RS :NO CTRL" 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
0x27	0xD8	DST_H	DST_L	SRC_H	SRC_L	ACK_H	ACK_L	CMD_H	CMD_L
10-13	14-17	18-21	22-24	25-26	27-28	29-30	31-34	35-36	37-38
$Uact_{0-3}$	$Iact_{0-3}$	$Pact_{0-3}$	$Bits_{0-2}$	Im_{0-1}	Uxl_{0-1}	dU_{0-1}	Arc/s_{0-3}	$dUx100_{0-1}$	CRC_{0-1}

Where:

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

Bits0: Acknowledge bits.
- 0: Relays ON acknowledge (1), or OFF (0)
- 1: Power ON (1), INHIBIT (0)
- 2: Ramp active
- 3: Master Active (in parallel mode)
  or Pulse Mode ON (1) / OFF (0) (in **TruPlasma DC+**)
- 4: Display control
- 5: Alarms to read.
- 6: RS232/485 control
- 7: Ready

Bits1: more acknowledge bits.
- 0: Interlock (1), no interlock (0)
- 1: OverTemp Bit: 1=Overtemp
- 2: PowerFail (1), power OK (0)
- 3: FPGA (1) OK (0)
- 4: EEprom Error (1), OK (0)
- 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: Pcomp Active
- 4: EOJM
- 5: EOTL
- 6: EOPT
- 7: Arc occ.

Im (integer)	Arc counter (Imax criterion)	0...65535
UxI (integer)	Arc counter (UxI criterion)	0...65535
dU (integer)	Arc counter (dU criterion)	0...65535
Arc/s(float)	Arcs per second counter	
dU[x100](integer)	Arc counter (dU criterion) [x100]	0…10000

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.

6040 Normal run – for DC+ Extented Freq

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	23-24	25	26				
$Pset_{0-3}$	Bits	$Fset_{0-1}$	$RTset_{0-1}$	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
Fset (uint16)	Frequency setpoint [kHz]	2…100 kHz
RTset (float)	Reverse Time setpoint [us]	1…100 us

Bits:

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

IMPORTANT: When controlling **TruPlasma DC** 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 "RS :NO CTRL" 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
0x27	0xD8	DST_H	DST_L	SRC_H	SRC_L	ACK_H	ACK_L	CMD_H	CMD_L
10-13	14-17	18-21	22-24	25-26	27-28	29-30	31-34	35-36	37-38
$Uact_{0-3}$	$Iact_{0-3}$	$Pact_{0-3}$	$Bits_{0-2}$	Im_{0-1}	Uxl_{0-1}	dU_{0-1}	Arc/s_{0-3}	$dUx100_{0-1}$	CRC_{0-1}

Where:

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

Bits0: Acknowledge bits.
0: Relays ON acknowledge (1), or OFF (0)
1: Power ON (1), INHIBIT (0)
2: Ramp active
3: Master Active (in parallel mode) or Pulse Mode ON (1) / OFF (0) (in DC+)
4: Display control
5: Alarms to read.
6: RS232/485 control
7: Ready

Bits1: more acknowledge bits.
0: Interlock (1), no interlock (0)
1: OverTemp Bit: 1=Overtemp
2: PowerFail (1), power OK (0)
3: FPGA (1) OK (0)
4: EEprom Error (1), OK (0)
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: Pcomp Active
4: EOTL
5: EOJM
6: EOPT
7: Arc occ.

Im (integer)	Arc counter (Imax criterion)	0...65535
UxI (integer)	Arc counter (UxI criterion)	0...65535
dU (integer)	Arc counter (dU criterion)	0...65535
Arc/s(float)	Arcs per second counter	
dU[x100](integer)	Arc counter (dU criterion) [x100]	0…10000

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 TruPlasma DC:

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

TruPlasma DC reply:

0	1	2	3	4	5	6	7	8	9
0x23	0xDC	DST_H	DST_L	SRC_H	SRC_L	ACK_H	ACK_L	0x68	0x0C
10	...	32	33	34					
S_{00}	…	S_{22}	CRC_H	CRC_L					

Where: $S_{00} \div S_{22}$: device type (char[23]);

6141 Set a floating point value

PC to TruPlasma DC:

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

TruPlasma DC 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 TruPlasma DC:

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

TruPlasma DC 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 TruPlasma DC:

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

TruPlasma DC 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 TruPlasma DC:

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

TruPlasma DC 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 TruPlasma DC:

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

TruPlasma DC 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 TruPlasma DC:

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

TruPlasma DC 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 describtion

PC to TruPlasma DC:

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

TruPlasma DC 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 describtion

PC to TruPlasma DC:

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

TruPlasma DC 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		

Channel numbers:

Byte

Chan	Text	Range	Adjustable?
9	Warnings Sources Bits 1: 0="EE NoData" 1="EE CheckSum" 2="EE Write Err" 3="Arc Fmax" 4="Calbr Done" 5="UnClbtnStat" 6="T1 Warn" 7="T2 Warn"	0 … 255	NO
10	Warnings Sources Bits 2: 0="T3 Warn" 1="T4 Warn" 2="CSPC1_Warn" 3="CSPC2_Warn" 4="CSPC3_Warn" 5="CSPC4_Warn" 6="Water Flow" 7="Water Dir"	0 … 255	NO
11	Warnings Sources Bits 3: 0="CSPC1 CW" 1="CSPC2 CW" 2="CSPC3 CW" 3="CSPC4 CW" 4="DA CTW" 5="RS232 CW" 6="RS485 CW" 7="DN CW"	0 … 255	NO
12	Warnings Sources Bits 4: 0="PB CW" 1="Analog CW" 2="SynchCon W" 3="ASrc CW" 4="Slave1 W" 5="Slave2 W" 6="Slave3 W" 7="Slave4 W"	0 … 255	NO
68	Warnings Sources Bits 5: 0="EE NewMap" 1="Dev U" 2="Dev I" 3="Dev P" 4="No Plasma" 5="Pcomp" 6="CAN Warn" 7=”ECAT CW”	0 … 63	NO
1	Alarms Sources Bits 1: 0="EE Error" 1="EE CheckSumErr" 2="FpgaConfFail" 3="CSPC1 AI" 4="CSPC2 AI" 5="CSPC3 AI" 6="CSPC4 AI" 7="CSPC SAR"	0 … 255	NO

Chan	Text	Range	Adjustable?
2	Alarms Sources Bits 2: 0="U24 max" 1="U24 min" 2="T1 off" 3="T2 off" 4="T3 off" 5="T4 off" 6="DF Fail" 7="Phase Fail"	0 … 255	NO
3	Alarms Sources Bits 3: 0="CSPC1 CT" 1="CSPC2 CT" 2="CSPC3 CT" 3="CSPC4 CT" 4="DA CT" 5="RS232 CT" 6="RS485 CT" 7="DN CT"	0 … 255	NO
4	Alarms Sources Bits 4: 0="PB CT" 1="Analog CT" 2="SynchConn" 3="ASrc CT" 4="Slave1 Al" 5="Slave2 Al" 6="Slave3 Al" 7="Slave4 Al"	0 … 255	NO
60	Alarms Sources Bits 5: 0="I2C EE" 1="I2C Temp" 2="I2C PF" 3="I2C RTC" 4="ParBus Err" 5="CAN Err" 6="NoLoad" 7="ShortCircuit"	0 … 255	NO
61	Alarms Sources Bits 6: 0="ArcDensity" 1="PLD SW ver" 2="CLC Freq.High" 3="CLC Shorted" 4="EtherCAT Fail" 5="ParModeConf" 6="Global Alarm" 7="InWaterMin"	0 … 15	NO
62	Alarms Sources Bits 7: 0="Wrong Configuration" 1="Parallel Mode Malfunction" 2="Converter Failed" 3="Parallel Self Test Failed" 4="User24 Calibration Failed" 5="CSPC uneq I"	0 … 63	NO
19	Initial control source, bit rate: 0: Display ini; 1: Analog ini; 2: RS232 ini;	0 … 32	YES

Chan	Text	Range	Adjustable?
	3: Profibus ini; 4: RS485 ini; 5: DeviceNet ini; 6: EtherCAT ini;		
20	Actual control source, bit rate: 0: Display; 1: Analog; 2: RS232; 3: Profibus; 4: RS485; 5: DeviceNet; 6: EtherCAT;	0 … 32	YES
22	Parallel Operation Mode (=0 Single), bit rate: 0: Master; 1: Slave1; 2: Slave2; 3: Slave3; 4: Slave4;	0 … 16	YES
23	Long ramp modes, bit rate: 0: Power ramp (1 On/0 Off); 1: Current ramp (1 On/0 Off);	0 … 2	YES
24	ProcessTimer modes, bit rate: 0: Power On (1 On/0 Off); 1: Power regulator (1 On/0 Off);	0 … 2	YES
26	Synchro mode enable	0 … 1	YES
27	Ignition mode enable	0 … 1	YES
28	RS speed: 0: 9600 bps; 1: 19200 bps; 2: 38400 bps; 3: 57600 bps; 4: 115200 bps;	0 … 16	YES
29	Synchro Bus Termination (1 On/0 Off)	0 … 1	YES
32	Target Life enable	0 … 1	YES
33	Joule mode enable	0 … 1	YES
34	Power Compensation Enable	0 … 1	YES
35	Current and Power Limiter modes, bit rate: 0: Current Limiter On (1 On/0 Off); 1: Power Limiter On (1 On/0 Off);	0 … 2	YES
200	Arc criteria Enable/Disable, bit rate: 0: dU En (1 On/0 Off); 1: Uxl (1 On/0 Off); 2: Imax (1 On/0 Off); 3: dU Obs (1 On/0 Off); 4: Arc Burst Detector (1 On/0 Off); 5: Ux Obs (1 On/0 Off);	0 … 31	YES
205	Reset arc counters (for 1 transmission is enough)	0 … 1	YES
206	Reset dUCnt[x100]	0 … 1	YES
300	Profibus profile Type: 0: Module; 1: rsv; 2: Scalo;	0 … 4	YES

Chan	Text	Range	Adjustable?
301	Float type(for Profibus) 0:Motorola, 1: Intel	0 … 1	YES
320	DeviceNet speed: 0: 125 kbps; 1: 250 kbps; 2: 500 kbps;	0 … 4	YES

Word:

Chan	Text	Range	Adjustable?
	Communication:		
3	RS485 Address	0 … 65535	YES
32	Communication Timeout	0 … 65s	YES
300	Profibus ID	0 … 125	YES
301	Power Scale	0 … 65535	YES
302	Voltage Scale	0 … 65535	YES
303	Current Scale	0 … 65535	YES
320	DeviceNet ID	0 … 63	YES
	DC unit Parameters:		
12	Ignition current booster	0 … 50%	YES
20	Ignition Pulse Time	0 … 100 us	YES
33	Ignition Delay Time	0 … 10s	YES
26	Maximum Power Compensation Value	0 … 100 %	YES
28	Maximum Power Compensation Time	0 … 25 s	YES
30	Number of slave for Parallel Operation mode	0 … 4	YES
41	Long ramp time	0 … 7200s	YES
40	Long Ramp Start Value	0 … 100%	YES
44	Long ramp rest value	-	NO
42	ProcessTimer Time	0 … 36000	YES
43	ProcessTimer rest value	0 …36000	NO
11	Current clamp at set %Imax value below Imax	0 … 50%	YES
15	Power clamp at set %Pset value above Pset	0 … 50%	YES
10	The PWM power control is reduced by this % value.	0 … 50%	YES
23	CLim Cnt	-	NO
24	PLim Cnt	-	NO
8	Target Life Source select	1 … 8	YES
	Arc detection settings		
202	Time between succeeding arcs for Arc Burst detection	1 … 1000 us	YES
201	Number of arcs in row for Arc Burst detection	1 … 100	YES
216	Arc Burst detection counter	0 … 65535	NO
221	Arc Density. For volume higher than 0 activates detection of „Too many arcs “alarm	0 … 8000	YES
	CSPC24 S1:		
1001	Rectified mains voltage	0…1000V	NO
1002	Rectified mains voltage after PFC	0…1000V	NO
1027	+3V3	0…3.586	NO
1028	+5V	0…7.2	NO
	CSPC24 S2:		

2001	Rectified mains voltage	0...1000V	NO
2002	Rectified mains voltage after PFC	0...1000V	NO
2027	+3V3	0…3.586	NO
2028	+5V	0…7.2	NO
	CSPC24 S3:		
3001	Rectified mains voltage	0...1000V	NO
3002	Rectified mains voltage after PFC	0...1000V	NO
3027	+3V3	0…3.586	NO
3028	+5V	0…7.2	NO
	CSPC24 S4:		
4001	Rectified mains voltage	0...1000V	NO
4002	Rectified mains voltage after PFC	0...1000V	NO
4027	+3V3	0…3.586	NO
4028	+5V	0…7.2	NO

Double Word:

Chan	Text	Range	Adjustable?
902	Serial number	-	NO

Float:

Chan	Text	Range	Adjustable?
	Arc detection threshold settings		
200	Voltage On threshold for dU arc det. Criterion	$0.1U_n$ … U_nV 50 … 800	YES
202	Voltage Off threshold for dU arc det. Criterion	0 … $0.9U_n$V 0 … 750	YES
203	dU Offset	30 … 200V	YES
204	Break time for dU criterion	5…1000µs	YES
222	Soft-start pre-pulse advance time for dU criterion	0 … 5 us	YES
230	Voltage On threshold for dU_observer arc det. Criterion	$0.1U_n$ … U_nV	NO
231	Voltage Off threshold for dU_observer det. Criterion	0 … $0.9U_n$V	NO
208	Voltage threshold for UxI arc det. Criterion	0 … $0.9U_n$V 0 … 900	YES
207	Current threshold for UxI arc det. Criterion	$0.05I_n$ … I_nA	YES
209	Break time for UxI criterion	0.1…80ms	YES
210	Ux Offset	10 … 200V	YES
226	Ramp time for UxI criterion	0.0…100ms	YES
205	Current threshold for Imax arc det. Criterion	$0.1I_n$ … $1.3I_n$A	YES
206	Break time for Imax criterion	0.1…80ms	YES
227	Ramp time for Imax criterion	0.0…100ms	YES
	DC unit Parameters:		
22	Voltage ON threshold for Ignition mode	$0.5U_n$…U_nV	YES
20	Current ON threshold for Ignition mode	0 … $0.01I_n$ A	YES
21	Current OFF threshold_2 for Ignition mode (floating anode)	0 … $0.05I_n$ A	YES
25	Actual Power Correction value [kW]	-	NO
26	Actual Power Losses value [kW]	-	NO

51	Target Life delivered energy [kWh]	0 … 36000.0	NO
52	Target Life setpoint [kWh]	0 … 36000.0	YES
55	Joule Mode energy setpoint [kJ]	0 … 20000.0	YES
56	Joule Mode Actual Energy [kJ]	0 … 20000.0	NO
	Measurments:		
900	CMPC24 DSP version	-	NO
901	CMPC24 PLD version	-	NO
902	CSPC24 S1 version	-	NO
903	CSPC24 S2 version	-	NO
904	CSPC24 S3 version	-	NO
905	CSPC24 S4 version	-	NO
906	Display Panel version	-	NO
907	XML for DA22 version	-	NO
908	User24 version	-	NO
909	User24 bootloader version	-	NO
920	Controller supply voltage	0...32V	NO
921	+8V	0…11.84	NO
922	+15V	0...20.686	NO
923	+5VA	0…7.2	NO
924	+5V	0…7.2	NO
925	+3V3	0…3.586	NO
926	Vbat	0…3.586	NO
927	+2V5	0…3.0	NO
928	+1V9	0…3.0	NO
929	+1V2	0…3.0	NO
930	-5VA	-7.325…0	NO
931	-15V	-21.0 … 0	NO
932	Temperature T1:	0…100°C	NO
933	Temperature T2:	0…100°C	NO
934	Temperature T3:	0…100°C	NO
935	Temperature T4:	0…100°C	NO
936	I chopp [A]		NO
600	Upeak [V]		NO
937	L12 (RMS) [V]		NO
938	L23 (RMS) [V]		NO
939	L31 (RMS) [V]		NO
	CSPC24 S1:		
1001	Iout	0...Inom	NO
1003	Temperature T1:	0…100°C	NO
1004	Temperature T2:	0…100°C	NO
1005	Temperature T3:	0…100°C	NO
1006	Temperature T4:	0…100°C	NO
1029	DiffLem1 [A]		NO
1030	DiffLem2 [A]		NO
	CSPC24 S2:		
2001	Iout	0...Inom	NO

2003	Temperature T1:	0…100°C	NO
2004	Temperature T2:	0…100°C	NO
2005	Temperature T3:	0…100°C	NO
2006	Temperature T4:	0…100°C	NO
2029	DiffLem1 [A]		NO
2030	DiffLem2 [A]		NO
	CSPC24 S3:		
3001	Iout	0...Inom	NO
3003	Temperature T1:	0…100°C	NO
3004	Temperature T2:	0…100°C	NO
3005	Temperature T3:	0…100°C	NO
3006	Temperature T4:	0…100°C	NO
3029	DiffLem1 [A]		NO
3030	DiffLem2 [A]		NO
	CSPC24 S4:		
4001	Iout	0...Inom	NO
4003	Temperature T1:	0…100°C	NO
4004	Temperature T2:	0…100°C	NO
4005	Temperature T3:	0…100°C	NO
4006	Temperature T4:	0…100°C	NO
4029	DiffLem1 [A]		NO
4030	DiffLem2 [A]		NO

Acknowledge and failure codes (HEX format)

4000 Transmission OK and command executed.
4001 Transmission length error. Byte1 is not a cancellation of Byte0.
4002 Check sum error.
The two byte checksum is not equal to sum of bytes no. 2 … (n-2).
4004 Unknown Command.
4005 Bad Address
4006 Channel address not exist.
4010 Write EEPROM error.
4020 Write EEPROM disabled by slave mode (6141, 6121, 6111).
4030 Write EEPROM disabled.

8.2. Profibus transmission protocol description

Profibus is an interface that allows magnetron units to communicate with Profibus master. Magnetron power supply (DC3000) acts as a slave device in the communication process. It never initiates transmission. Profibus master sends commands coded in modules, which are executed by power supply, and a reply is generated. Convenient and flexible construction of Profibus profile allows user to construct all communication (length of input and output buffer) via Profibus by using only one module or several modules. It is only limited by the imagination and innovation of customer. Recognized modules are presented below, but new functional modules can be implemented for special orders.

Baud Rate for communication between Profibus master and Profibus slave
Profibus slave (DC3000) has an auto–baudrate feature which adjusts automatically to rate of Profibus master system during start-up. Baud rates are accessible in a range from 9.6 kbits to 12 Mbits.

Setting Profibus ID
ID number is set via front panel console (if available) or through RS232 or Profibus. Software activates ID number once after reset, therefore, if ID number has been changed unit must be restarted (powered-off completely and powered-on again).

Profibus module construction

DC3000 uses transmission modules, which have different byte length. Module sequences and their quantities can be different (choice of modules and length of frame depends only on user) in conditions when there are no more than 20 modules and the quantity of maximum input and output bytes does not exceed 80. It is always possible to increase this limitation by special order.
All integer (2 bytes) values are listed with the most significant byte (MSB) coming first. Floating-point values can be represented in both: INTEL and MOTOROLA standards. The standard of floating-point values is set via front panel console, by RS232 or Profibus (ref. to module 21 or module 22 descriptions). Additional modules can be implemented if necessary. All modules (except modules 21 and 22) are available from channel level of module 21 (as an integer value) and module 22 (as a floating point number). All types of modules are presented below.

Module 1 - Control Bits

ident. 0x82,0x00,0x00,0x01

This module is represented by one byte which includes 8 control bits:

LSB 0: Profibus master controls DC3000 (1).
1: -
2: Mains relays ON (1)(edge sensitive 0→1), OFF (0).
3: Power ON (1) (edge sensitive 0→1), OFF (0).
4: Alarms Reset
5: Reset arc counters (1 transmission is sufficient)
6: -
MSB 7: -

Voltage SetPoint:

Module 2 - Voltage SetPoint in integer format

ident. 0x82,0x01,0x00,0x02

This module consists of two bytes, which represent voltage setpoint value in a 16-bit integer format. The full voltage range of power supply:

0 … Un [V]

is represented by a

0 … Uscale integer value

integer value = Uscale * Uset / Un

where:

Uset – voltage setpoint

Un – nominal voltage of power supply

Uscale – user defined setting – can be set via front panel, by RS232 or Profibus (ref. to module 21 or module 22 descriptions).

Note: Resolution depends on Uscale value.

Module 3 - Voltage SetPoint value in a floating-point format

ident. 0x82,0x03,0x00,0x03

This module consists of 4 bytes which represent voltage setpoint value in a floating-point format with respect to a selected standard. This value must not exceed nominal output voltage of power supply - Un. [V]

Important: If none of the above-mentioned modules are selected, then the voltage setpoint is set to a maximum (Un).

Current SetPoint:

Module 4 - Current SetPoint in integer format

ident. 0x82,0x01,0x00,0x04

This module consists of two bytes which represent current setpoint value in a 16-bit integer format. Full current range of power supply

0 … In [A]

is represented by a

0 … Iscale integer value

integer value = Iscale * Iset / In

where:

Iset – current setpoint

In – nominal current of power supply

Iscale – user defined setting – can be set via Front Panel, RS232 or Profibus (refer to module 21 or module 22 descriptions).

Note: Resolution depends on Iscale value.

Module 5 - Current SetPoint in a floating point-format

ident. 0x82,0x03,0x00,0x05

This module consists of 4 bytes which represent the current setpoint value in a floating-point format with respect to selected standard. This value must not exceed nominal output current of power supply - In.[A]

Important: If none of the two above-mentioned modules are selected, then current setpoint is set to maximum (In).

Power Setpoint:

Module 6 - Power SetPoint in integer format

ident. 0x82,0x01,0x00,0x06

This module consists of two bytes which represent power setpoint value in a 16-bit integer format. The full power range of power supply

0 … Pn [kW]

is represented by a

0 … Pscale integer value

integer value = Pscale * Pset / Pn

where:

Pset – power setpoint

Pn – nominal power of power supply

Pscale – user defined setting – can be set via front panel, through RS232 or Profibus (ref. to module 21 or module 22 descriptions).

Note: The resolution depends on Pscale value.

Module 7 - Power SetPoint in a floating point format

ident. 0x82,0x01,0x00,0x07

This module consists of 4 bytes, which represent power setpoint value in a floating-point format with respect to selected standard. This value must not exceed nominal output power of the power supply - Pn [kW].

Important: If neither of the two above-mentioned modules are selected, then power setpoint is set to maximum (Pn).

Select control mode:

These two modules – will be omitted if any of previous modules (2 .. 7) are defined – select desired control mode and regulate setpoint at same time. When a certain control mode is selected, remaining setpoints are fixed to maximum. For instance, if power-control mode is selected, then current and voltage setpoints are fixed to their nominal values.

Setpoint value can be presented in both – integer or floating-point format – as in modules 2 … 7. The control mode is selected by two low significant bits from first additional byte.

Bits	RegP	RegU	RegI
2^0	0	1	0
2^1	0	0	1

Important: If any of the previous modules from 2 to 7 are chosen, Select control mode module will be omitted.

Module 8 – Select control mode; integer format setpoint

ident. 0x82,0x02,0x00,0x08

This module consists of three bytes, with control mode selected in first byte (RegSelect) and setpoint in last two bytes in integer format. Depending on selected control mode the last two bytes are scaled by user-defined Pscale, Uscale or Iscale values (see ex. in module 2, 4 and 6). Setpoints for remaining (unselected) parameters are set to their nominal values.

Module 9 – Select control mode; floating-point format setpoint

ident. 0x82,0x04,0x00,0x09

This module consists of five bytes, with control mode being selected in first byte (RegSelect) and a setpoint on last 4 bytes in floating-point format according to selected standard. Setpoints for remaining (unselected) parameters are set to their nominal values.

Settings for pulse generator:

Module 10 - Frequency Setting (for pulsed units only)

ident. 0x82,0x01,0x00,0x0A

This single byte module sets frequency value in kHz(for DC4000) or Hz(for DC3000 plus).
For DC4000, values 2 … 100 represent a frequency setting of 2kHz ….100kHz.
For DC3000 plus, values 20 … 15000 represent a frequency setting of 20Hz ….15000Hz.
Values from beyond unit's frequency range will be limited.

Module 11 – Pulse Time Setting (for pulsed units only)

ident. 0x82,0x01,0x00,0x0B

This single byte module sets off-pulse time value in microseconds.
For DC4000, values 10 … 100 represent an off-time setting of 1.0 ….10.0us.
For DC3000 plus, values 10 … 1000 represent an off-time setting of 1.0 ….100.0us.
Values from beyond the unit's off-time range will be limited.

Actual output voltage:

Module 12 - Actual output voltage value in integer format

ident. 0x42,0x01,0x00,0x0C

This module consists of two bytes and shows actual output voltage value in 16-bit integer format.
Full voltage range of power supply
0 … Un [V]
is represented by a
0 … Uscale integer value

integer value = Uscale * Uact / Un
where:
Uact – actual output voltage
Un – nominal voltage of power supply
Uscale – user defined setting – can be set via front panel by RS232 or Profibus (see module 21 or module 22 descriptions).

Note: Resolution depends on Uscale value.

Module 13 – Actual output voltage value in a floating-point format

ident. 0x42,0x03,0x00,0x0D

This module consists of 4 bytes which represent actual output voltage value in a floating-point format with respect to selected standards.

Actual output current:

Module 14 – Actual output current value in integer format

ident. 0x42,0x01,0x00,0x0E

This module consists of two bytes and displays actual output current value in 16-bit integer format.
Full current range of power supply
0 … In [A]
is represented by a
0 … Iscale integer value

integer value = Iscale * Iact / In
where:
Iact – actual output voltage
In – nominal voltage of power supply
Iscale – user defined setting – can be set via front panel by RS232 or Profibus (see module 21 or module 22 descriptions).

Note: The resolution depends on Iscale value.

Module 15 - Actual current value in a floating-point format

ident. 0x42,0x01,0x00,0x0F

This module consists of 4 bytes which represent actual output current value in a floating-point format with respect to selected standard.

Actual output power :

Module 16 - Actual output power in integer format

ident. 0x42,0x01,0x00,0x10

This module consists of two bytes which represent actual output power value in a 16-bit integer format. The full power range of power supply
0 … Pn [kW]
is represented by a
0 … Pscale integer value

integer value = Pscale * Pact / Pn
where:
Pact – output power
Pn – nominal power of power supply
Pscale – user defined setting – can be set via front panel by RS232 or by Profibus (see module 21 or module 22 descriptions).
Note: Resolution depends on Pscale value.

Module 17 - Actual output power value in a floating-point format

ident. 0x42,0x01,0x00,0x11

This module consists of 4 bytes which represent actual output power value in a floating-point format with respect to a selected standard.

Actual pulse generator settings:

Module 18 – Actual Frequency (for pulsed units only)

ident. 0x82,0x01,0x00,0x12

This single byte module shows frequency value in kHz(for DC4000) or Hz(for DC3000 plus).
For DC4000, values 2 … 100 represent a frequency setting of 2kHz ….100kHz.
For DC3000 plus, values 20 … 2000 represent a frequency setting of 20Hz ….15000Hz.

Module 19 – Actual pulse time (for pulsed units only)

ident. 0x82,0x01,0x00,0x13

This single byte module shows off-pulse time value in microseconds.
For DC4000, values 10 … 100 represent an off-time setting of 1.0 ….10.0us.
For DC3000 plus, values 10 … 1000 represent an off-time setting of 1.0 ….100.0us.

Module 20- Acknowledgement Bits

ident. 0x42,0x02,0x00,0x14

This module consists of 3 bytes which present basic binary status data. These bytes are described below.

Bit	name	description
		Byte 0
0	Profibus Ctrl Ack	= 1 when the unit is controlled by Profibus commands = 0 when the unit is controlled from other sources
1	not used	
2	Relays ON	= 1 when power relays are switched ON inside unit
3	Power ON	= 1 when output power is enabled
4	ToggleBit	Bit toggled with frequency equal 1Hz
5	Pulse Mode Ack	= 1 if unit is set to pulsed mode [1)]
6	not used	
7	Slave Ready	= 1 is Power Supply is ready to turn on
		Byte 1
0	Interlock Ack	= 1 when interlock loop is open
1	Over Temp	= 1 when unit overheats
2	Power Fault	= 1 when mains voltage is too low or one phase is missing
3	FPGA Fault	= 1 if FPGA unit fails
4	EEprom write Fault	= 1 if the EEprom FIFO line is overloaded
5	-	-
6	Warning active	= 1 if any warning state is active
7	Alarm Active	= 1 if any alarm state is active
		Byte 2
0	RegU Ack	These 3 bits display output parameter (voltage, current or power), which is actually limited by controller. E.g. bit0=1; bit2=0 at no load conditions even if power control mode is selected.
1	RegI Ack	
2	RegP Ack	
3	Ramp	=1 if ramp is active
4	EOPT/EOJM	End Of Process Timer or End of Joule Mode[1)]
5	EOTL	End of Target Life[1)]
6	Ppeak Ack	= 1 if power supply's mean power is reduced due to peak power limitations [1)]
7	Ipeak Ack	= 1 if power supply's mean output current is reduced due to peak current limitations [1)]

1) if applicable

General set / read modules:

All remaining settings and readouts can be accessed through two types of input / output modules:
module 21 for setting/reading in an integer format and
module 22 for setting/reading in a floating-point format.

Module 21- Set/read parameter in an integer format

ident. 0xC1,0x03,0x03,0x15

Output bytes

1	2	3	4
Data group	Channel	Integer value	
Out_Byte 0	Out_Byte 1	Out_Byte 2	Out_Byte 3

Input bytes

1	2	3	4
Data group	Channel	Integer value	
In_Byte 0	In_Byte 1	In_Byte 2	In_Byte 3

First byte Out/In_Byte0 defines data group number (see table below). Second byte (Out/In_Byte1) represents channel number which is assigned to a parameter. One channel is dedicated for reading and another for the setting of a parameter. The last 2 bytes show actual (In_Byte2 and In_Byte3) or set (Out_Byte2 and Out_Byte3) value of parameter.
Setting and readout should be set or interpreted with respect to range and scale specified in table below. For instance, setting value of 250V to dUOFF parameter (data group=11, channel=5) requires a value of 2500 to be placed in Out_Byte2 and Out_Byte3 (Out_Byte2=0x09; Out_Byte3=0xC4).

Module 22 - Set/read parameter in a floating-point format

ident. 0xC1,0x05,0x05,0x16

Output bytes

1	2	3	4	5	6
Data group	Channels	Floating-point value			
Out_Byte 0	Out_Byte 1	Out_Byte 2	Out_Byte 3	Out_Byte 4	Out_Byte 5

Input bytes

1	2	3	4	5	6
Data group	Channels	Floating-point value			
In_Byte 0	In_Byte 1	In_Byte 2	In_Byte 3	In_Byte 4	In_Byte 5

First byte (Out/In_Byte0) defines data group number (see table below). Second byte (Out/In_Byte1) represents channel number which is assigned to parameter. One channel is dedicated for reading and another for setting parameters. Last 4 bytes show actual (In_Byte2 - In_Byte5) or set (Out_Byte2 - Out_Byte5) value of parameters in floating-point format with respect to selected standard.

Important:

1. **Only specified channel numbers can be used to access data.**
2. **In some instances it takes up to 50ms for a newly set variable to be updated in power supply's control system. Reading such variable at this time may result in display of previous value.**
3. **All values can be accessed in an integer or floating-point format. Binary values for floating point format will be shown as 0.0 (for low) or 1.0 (for high).**
4. **If both modules (21 and 22) are selected then configuration fault error can occur during communication.**

List of data channels accessible through Profibus (see next page):

Data group	Channel nr / description	integer value		Notes
numbers in decimal format		range	scale	
1	2: Control Bits	The 8 bits represent conditions described in Module 1 – Controls Bits		Channel available for reading only. values in floating-point format range from 0.0 … 255.0.
	4: Acknowlegement Bits - Byte0	The 8 bits represent conditions described in Module 20 – Acknowledgement Bits – Byte0		Channel available for reading only. values in floating-point format will range from 0.0 … 255.0.
	8: Acknowlegement Bits – Byte1	The 8 bits represent conditions described in Module 20 – Acknowledgement Bits – Byte1		Channel available for reading only. values in floating-point format will range from 0.0 … 255.0.
	16: Acknowlegement Bits – Byte2	The 8 bits represent conditions described in Module 20 – Acknowledgement Bits – Byte2		Channel available for reading only. values in floating-point format will range from 0.0 … 255.0.
	3: Bits	The 8 bits represent conditions described in Module 1 – Controls Bits		Channel available for setting only. values in floating-point format will range from 0.0 … 255.0.
2	2: Actual Power setpoint	0…P_n[kW]	0…Pscale	read only
	4: Actual Power output	0…P_n[kW]	0…Pscale	read only
	3: Power Setpoint	0…P_n[kW]	0…Pscale	set only, if module 6,7,8,9 wasn't selected
3	2: Actual Voltage setpoint	0…U_n[V]	0…Uscale	read only
	4: Actual Voltage output	0…U_n[V]	0…Uscale	read only
	3: Voltage Setpoint	0…U_n[V]	0…Uscale	set only, if module 2,3,8,9 wasn't selected
4	2: Actual Curent setpoint	0…I_n[A]	0…Iscale	read only
	4: Actual Current output	0…I_n[A]	0…Iscale	read only
	3: Current Setpoint	0…I_n[A]	0…Iscale	set only, if module 4,5,8,9 wasn't selected
6	2: Actual Frequency	2…100[kHz] or 20…15000[Hz]	2…100 or 20…15000	read only
	3: Frequency Setpoint	2…100[kHz] or 20…15000[Hz]	2…100 or 20…15000	set only, if module 10 wasn't selected
7	2: Actual Reverse Time	1.0…10.0[us] or 1.0…100.0[us]	10…100 or 10…1000	read only
	3: Reverse Time Setpoint	1.0…10.0[us] or 1.0…100.0[us]	10…100 or 10…1000	set only, if module 11 wasn't selected

Data group	Channel nr / description	integer value		Notes
numbers in decimal format		range	scale	
10	2: selection of the arc detection criterion	3 low order bits of the low order byte represent the enabled (1) or disabled (0) states: bit0: dU criterion bit1: UxI criterion bit2: Imax criterion bit3: dU_observer criterion bit4: ArcBrstDet bit5: Ux_observer criterion		Channel available for readout only. values in floating-point format will be in the range of 0.0 … 31.0
	3: set arc detection criterion	use 3 low order bits of the low order byte to enable (1) or disable (0) the criterion: bit0: dU criterion bit1: UxI criterion bit2: Imax criterion bit3: dU_observer criterion bit4: ArcBrstDet bit5: Ux_observer criterion		Channel available for setting only. values in floating-point format must be within in a range of 0.0 … 31.0
11	2: dU OFF setting	0 ... 750 V	0 ... 750	Control settings for the dU arc detection criterion. Channels available for readout only.
	4: dU ON setting	50 ... 800V	50 ... 800	
	16: BreakTime setting	5-1000.0us	5-10000	
	32: dUobsr Off Thld	0.0…0.8*Un V	0.0 - 2000.0V	
	64: Voltage offset	30-200V	30-200	
	128: SftStrt Advnc	0.0-5.0us	0-50	
	3: set dU OFF	0 ... 750 V	0 ... 750	Control settings for the dU arc detection criterion. Channels available for setting only.
	5: set dU ON	50 ... 800V	50 ... 800	
	17: set BreakTime	5-1000.0us	5-10000	
	65: Voltage offset	50-200V	50-200	
	129: SftStrt Advnc	0.0-5.0us	0-50	
12	2: Ux thld setting	0-900 V	0-900	Control settings for the UxI arc detection criterion. Channels available for readout only.
	4: Ix thld setting	$0.05I_n$ - I_n A	$0.05I_n$ –I_n *10	
	16: BreakTime setting	0.1-80.0ms	10-8000	
	32: RampTime setting	0.0-100.0ms	0-10000	
	64: Ux Offset setting	10-200 V	10-200	
	3: set Ux thld	0-900 V	0-900	Control settings for the UxI arc detection criterion. Channels available for setting only.
	5: set Ix thld	$0.05I_n$ - I_n A	$0.05I_n$ –I_n *10	
	17: set BreakTime	0.1-80.0ms	10-8000	
	33: set RampTime	0.0-100.0ms	0-10000	
	65: set Ux Offset	10-200 V	10-200	
13	2: Im thld setting	$0.1I_n$ – I_m A	$0.1I_n$ –I_m *10	Control settings for the Imax arc detection criterion. Channels available for readout only. $I_m = I_n$ *1.3
	16: BreakTime setting	0.1-80.0ms	10-8000	
	32: RampTime setting	0.0-100.0ms	0-10000	
	3: set Im thld	$0.1I_n$ – I_m A	$0.1I_n$ –I_m *10	Control settings for the Imax arc detection criterion. Channels available for setting only. $I_m = I_n$ *1.3
	17: set BreakTime	0.1-80.0ms	10-8000	
	33: set RampTime	0.0-100.0ms	0-10000	

Data group	Channel nr / description	integer value		Notes
numbers in decimal format		range	scale	
14	2: ON-time	1-1000	1-1000	Control settings for the Arc buster. Channels available for readout only.
	4: Number in a row	1-100	1-100	
	8: ArcBurst Cnt	0-65535	0-65535	
	3: ON-time	1-1000	1-1000	Control settings for the Arc buster. Channels available for setting only.
	5: Number in a row	1-100	1-100	
15	2: Arc Density	0 – 8000	0 – 8000	readout only
	3: Arc Density	0 – 8000	0 – 8000	set only
21	2: dUcnt	0-65535	0-65535	Arc counters with respect to the arc detection criteria. Channels available for readout only.
	4: UxIcnt	0-65535	0-65535	
	8: Imaxcnt	0-65535	0-65535	
	16:HardArcCnt	0-65535	0-65535	
	32:uArcCnt / s.	0-10000	0-10000	
	64:dUcnt x100	0-10000	0-10000	
	128:HardArcCnt / s.	0-10000	0-10000	
22	3: Arc counter reset	Any value		Reset all arc counters, except dUcnt x100
	5: dUcnt x100 reset	Any value		Reset dUcnt x100 counter
30	2: LongRamp enabled	legal values: bit 0 = Power ramp bit 1 = Current ramp		Readout only: 0=disabled; 1=Power Ramp; 2=Current Ramp
	4: Ramp Time	0-7200s	7200	readout only
	8: Initial Value	0-100%	0-1000	readout only
	16: Remaining Time	0-7200s	7200	readout only
	3: LongRamp feature	0-2	0-2	Set only: 0=disabled; 1=Power Ramp; 2=Current Ramp
	5: Ramp Time	0-7200s	7200	set only
	9: Initial Value	0-100%	0-1000	set only
32	2: Ignition mode enabled	0-1	0-1	readout only: 0=disabled; 1=enabled
	4: Voltage threshold for Ignition mode	0.5U_n…U_nV	0.5U_n…U_n	readout only
	8: Current On threshold for Ignition mode	0.0-0.01I_nA	0.0-0.01I_n*10	readout only
	16: Ignition time	0-100us	0-100	readout only
	32: Current Off threshold for Ignition mode	0.0-0.05I_nA	0.0-0.05I_n*10	readout only
	64: IGNi_corr	0-50%	0-50	readout only

Data group	Channel nr / description	integer value		Notes
numbers in decimal format		range	scale	
32	3: Ignition feature	0-1	0-1	set only: 0=disabled; 1=enabled
	5: Voltage threshold for Ignition mode	0.5U_n…U_nV	0.5U_n…U_n	set only
	9: Current On threshold for Ignition mode	0.0-0.01I_nA	0.0-0.01I_n*10	set only
	17: Ignition time	0-100us	0-100	set only
	33: Current Off threshold for Ignition mode	0.0-0.05I_nA	0.0-0.05I_n*10	set only
	65: IGNi_corr	0-50%	0-50	set only
	129: Ign Delay Time	0-10 s	0-10	set only
33	2: Process Timer enabled	legal values: 0: Power On 1: Power set		readout only: 0=disabled; 1= Power On; 2= Power Set
	4: Timeout	0-36000s	0-36000	readout only
	8: Remaining	0-36000s	0-36000	readout only
	16: EOPT	0-1	0-1	readout only
	3: Process Timer feature	0-2	0-2	set only: 0=disabled; 1= Power On; 2= Power Set
	5: Timeout	0-36000s	0-36000	set only
36	2: Current and Power Limiter Enable	0-3	0-3	Readout only: 0 = Both limiters are disabled; 1 = Current limiter is enabled: 2 = Power limiter is enabled: 3 = Both limiters are enabled;
	4: Thld=Imax-dev[%]	0-50%	0-50	readout only
	8: Thld=Pset+dev[%]	0-50%	0-50	readout only
	16: OvrCur-PWMdecr %	0-50%	0-50	readout only
	32: Current Lim Cnt	0-65535	0-65535	readout only
	64: Power Lim Cnt	0-65535	0-65535	readout only
	3: Current and Power Limiter Enable	0-3	0-3	Set only: 0 = Both limiters are disabled; 1 = Current limiter i=s enabled: 2 = Power limiter is enabled: 3 = Both limiters are enabled;
	5: Thld=Imax-dev[%]	0-50%	0-50	set only
	9: Thld=Pset+dev[%]	0-50%	0-50	set only
	17: OvrCur-PWMdecr %	0-50%	0-50	set only
37	2: Target Life enable	0-1	0-1	Readout only: 0=disabled; 1=enabled
	4: Target Life Source	1-8	1-8	readout only
	8: Target Life Set	0-36000kWh	0-36000	readout only
	16: Target Life Actual	0-36000kWh	0-36000	readout only
	3: Target Life enable	0-1	0-1	set only: 0=disabled; 1=enabled
	5: Target Life Source	1-8	1-8	set only
	9: Target Life Set	0-36000kWh	0-36000	set only

Data group	Channel nr / description	integer value		Notes
numbers in decimal format		range	scale	
38	2: Joule Mode enabled	0-1	0-1	Readout only: 0=disabled; 1=enabled
	4: Joule Mode Energy Setpoint	0-20000kJ	0-20000	readout only
	16: Joule Mode Actual Energy	0-20000kJ	0-20000	readout only
	3: Joule Mode enable	0-1	0-1	set only: 0=disabled; 1=enabled
	5: Joule Mode Energy Setpoint	0-20000kJ	0-20000	set only
39	2: Power Compensation En.	0-1	0-1	Readout only: 0=disabled; 1=enabled
				readout only
	4: Power Compensation Step	1-15 ms	1-15	readout only
	8: Maximum Power Compensation Value	0-100%	0-100	
	16: Maximum Power Compensation Time	0-25s	0-25	readout only
	32: Actual Power Correction value	0 - Pn kW	0 – Pn*100	readout only
	64: Power Losses value	0 - Pn kW	0 – Pn*100	readout only
	3: Power Compensation En.	0-1	0-1	set only: 0=disabled; 1=enabled
	9: Maximum Power Compensation Value	0-100%	0-100	set only
	17: Maximum Power Compensation Time	0-25s	0-25	set only

Data group	Channel nr / description	integer value		Notes
numbers in decimal format		range	scale	
40	2: Temp. 1	0-100°C	0-1000	Internal temperature values for CMPC24 readout only
	4: Temp. 2	0-100°C	0-1000	
	8: Temp. 3	0-100°C	0-1000	
	16: Temp. 4	0-100°C	0-1000	
	32: U24	0-100°C	0-1000	
42, 43, 44, 45	2: Temp. 1	0-100°C	0-1000	Internal temperature values of Slave 1 (channel 43), Slave 2 (channel 44), Slave 3 (channel 45) and Slave 4 (channel 46); readout only
	4: Temp. 2	0-100°C	0-1000	
	8: Temp. 3	0-100°C	0-1000	
	16: Temp.4	0-100°C	0-1000	
	32: U500	0...1000V	0-1000	
	64: U800	0...1000V	0-1000	
70	2: read Ctrl 4: read Ctrl ini	legal values: bit 0 = Display panel bit 1 = Analog bit 2 = RS232 bit 3 = Profibus bit 4 = RS485 bit 5 = Devicenet		present control source (Ctrl) and initial control source (Ctrl ini) readout only
	3: set Ctrl 5: set Ctrl ini			present control source (Ctrl) and initial control source (Ctrl ini) set only
71	2: read Work Mode	legal values: bit 0 = Master bit 1 = Slave1 bit 2 = Slave2 bit 3 = Slave3 bit 4 = Slave4		determines if a power supply works in single in parallel working mode. If all bits are equal 0, than DC unit works in Single mode.
	4: No of Slaves	1-4	1-4	readout only
	8: Synchro Bus Termination	0-1	0-1	readout only: 0=off; 1=on
	16: Synchro On	0-1	0-1	readout only: 0=off; 1=on
	3: set Work Mode	legal values: bit 0 = Master bit 1 = Slave1 bit 2 = Slave2 bit 3 = Slave3 bit 4 = Slave4		determines if a power supply works in single in parallel working mode. If all bits are equal 0, than DC unit works in Single mode.
	5: No of Slaves	1-4	1-4	set only
	9: Synchro Bus Termination	0-1	0-1	set only: 0=off; 1=on
	17: Synchro On	0-1	0-1	set only: 0=off; 1=on
72	2: read Profibus ID	0-127		readout only
	4: read Float Standard	0: Motorola, 1: Intel		
	8: read Power Scale	0-65535		
	16: read Voltage Scale	0-65535		
	32: read Current Scale	0-65535		
	3: set Profibus ID	0-127		set only
	5: set Float Standard	0: Motorola, 1: Intel		
	9: set Power Scale	0-65535		
	17: set Voltage Scale	0-65535		
	33: set Current Scale	0-65535		

Data group	Channel nr / description	integer value		Notes
numbers in decimal format		range	scale	
73	2: RS Address	0-65535	0-65535	readout only
	4: RS Speed	legal values: bit0="9600" bit1="19200" bit2="38400" bit3="57600" bit4="115200"		readout only
	3: RS Address	0-65535	0-65535	set only
	5: RS Speed	legal values: bit0="9600" bit1="19200" bit2="38400" bit3="57600" bit4="115200"		set only
74	2: DeviceNet ID	0-63	0-63	readout only
	4: DeviceNet Speed	legal values: bit0="125k" bit1="250k" bit2="500k"		readout only
	3: DeviceNet ID	0-63	0-63	set only
	5: DeviceNet Speed	legal values: bit0="125k" bit1="250k" bit2="500k"		set only
90	2: Errors counter	0-100	0-100	readout only
	4: Error Number	0-100	0-100	readout only
	8: Error Code	0-65535	0-65535	readout only
	16: Module ID (high word)	0-65535	0-65535	readout only
	32: Module ID (low word)	0-65535	0-65535	readout only
	64: Param (high word)	0-65535	0-65535	readout only
	128: Param (low word)	0-65535	0-65535	readout only
	5: Error Number	0-100	0-100	set only

Examples:

First three examples are based on module 21 and the last example is based on module 22.

Example 1

To set a new value of Ux threshold = 220V, the data group 12 and channel 3 are used.
Send:

Data group	Channels	Integer value	
0x0C	0x03	0x08	0xAC

Integer value=0x08AC (HEX) = 2200 (in integer format)
If value was entered properly then unit will send back a confirmation:

Data group	Channels	Integer value	
0x0C	0x03	0x08	0xAC

If a non-existing channel was selected or a value is out of range then unit will reply with:

Data group	Channels	Integer value	
0x0C	0xFF	0xFF	0xFF

Example 2

To read Break Time for cross arc detection (data group 12, channel 16):
Send:

Data group	Channels	Integer value	
0x0C	0x10	N/a	N/a

Reply received:

Data group	Channels	Integer value	
0x0C	0x10	0x07	0xD0

Integer value=0x07D0 (HEX) = 2000 (dec)
As a result, Break Time for cross arc detection is 20ms.

Example 3

In order to read Rectified mains voltage U500 (data group 42, channel 32) :
Send:

Data group	Channels	Integer value	
0x2A	0x20	N/a	N/a

Reply received:

Data group	Channels	Integer value	
0x2A	0x20	0x15	0x90

Integer value=0x1590 (HEX) = 5520 (dec)
As a result rectified mains voltage is 552V.

Example 4

To enable dU and UxI and disable Imax arc detection criteria (in floating-point format, Intel standard)
Send:

Data group	Channels	Float value			
0x0A	0x03	0x40	0x40	0x00	0x00

Reply received:

Data group	Channels	Float value			
0x0A	0x03	0x40	0x40	0x00	0x00

Float value=3.0 (HEX) = 0x40400000, binary = 00000011

Arcs Counters:

Module 23- Imcn

ident. 0x42,0x01,0x00,0x17

Imcn - Arc counter (Imax criterion). This module consists of two bytes which represent actual value of arc counter for Imax in a 16-bit integer. Range of arc counter is: 0 - 65535.

Module 24- UxIc

ident. 0x42,0x01,0x00,0x18

UxIc - Arc counter (UxI criterion). This module consists of two bytes which represent actual value of arc counter for UxI in a 16-bit integer. Range of arc counter is: 0 - 65535.

Module 25- dUcn

ident. 0x42,0x01,0x00,0x19

dUcn - Arc counter (dU criterion) – spark counter. This module consists of two bytes which represent actual value of arc counter for dU in a 16-bit integer. The range of arc counter is: 0 - 10000.

Module 26 – Hard Arcs Counter

ident. 0x42,0x01,0x00,0x1A

This module consists of two bytes which represent actual value of hard arc counter (ArcImax+ArcUxI). The range of ARC counter is: 0 - 10000.

Module 41 –uArcs Counter per second

ident. 0x42,0x01,0x00,0x29

This module consists of two bytes which represent actual value of micro arc (dU criterion) counter per second. The range of arc counter is: 0 - 10000.

Module 42 –Hard Arcs Counter per second

ident. 0x42,0x01,0x00,0x2A

This module consists of two bytes which represent actual value of hard arcs (UxI and Imax criteria) counter per second. The range of hard arcs counter is: 0 - 10000.

Current threshold for Imax arc detection criterion:

Module 27 - Current Imax threshold in an integer format

ident. 0x82,0x01,0x00,0x1B

This module consists of two bytes which represent current threshold value for Imax arc detection criterion in a 16-bit integer format. The scale for current setting is:
0 … 10000 represents a current value of 0 … In (In: nominal output current value)
Range: 0.1In – 1.3In

Module 28 - Current Imax threshold in a floating-point format

ident. 0x82,0x01,0x00,0x1C

This module consists of 4 bytes which represent current threshold value for Imax arc detection criterion in a floating-point format with respect to selected standard. This value must not exceed 1.3 In .

Current threshold for the UxI arc detection criterion:

Module 29 - Current Ix threshold in an integer format

ident. 0x82,0x01,0x00,0x1D

This module consists of two bytes which represent current threshold values for UxI arc detection criterion in a 16-bit integer format. The scaling of this setting is:
0 … 10000 represents a current value of 0 … In (In: nominal output current value)
Range: 0.05In – In

Module 30 - Current Ix threshold in a floating-point format

ident. 0x82,0x01,0x00,0x1E

This module consists of 4 bytes which represent current threshold value for UxI arc detection criterion in a floating-point format with respect to selected standard. This value must not exceed nominal output current of power supply - In.

Voltage Threshold for UxI arc detection criterion:

Module 31 - Voltage Ux threshold in integer format

ident. 0x82,0x01,0x00,0x1F

This module consists of two bytes which represent a voltage threshold value for UxI arc detection criterion in a 16-bit integer format. The scaling for this setting is:
0 .. 10000 represents 0 .. 1000V
Range: 0 – 0.9Un

Module 32 - Voltage Ux threshold in a floating-point format

ident. 0x82,0x01,0x00,0x20

This module consists of 4 bytes which represent voltage threshold value for UxI arc detection criterion in a floating-point format with respect to selected standards. This value must not exceed a 90% of nominal output voltage of the power supply - Un.

Internal temperature measurement

Eight temperature sensors measure temperatures inside power supply. Temperature values can be accessed by the following Profibus modules:

Module nr	ident.	Temp. sensor
33	0x42,0x01,0x00,0x21	T1
34	0x42,0x01,0x00,0x22	T2
35	0x42,0x01,0x00,0x23	T3
36	0x42,0x01,0x00,0x24	T4

The temperature scaling is:
0 .. 100°C is represented by a 0 .. 10000 integer number

Modules not used

37	0x42,0x01,0x00,0x25
38	0x42,0x01,0x00,0x26
39	0x42,0x01,0x00,0x27
40	0x42,0x01,0x00,0x28

How can we create an ideal Profibus communication?

Configuration of communication largely depends on the type of process, target and some additional factors. Modular construction in the Huettinger Profibus profile creates an easy method, which adapts to required processes and allows fast and flexible communication frame between magnetron power supply and control system (for example PLC). Remember that the module sequence and their quantity can be different provided there are no more than 20 modules and that a maximum input or output of bytes quantity does not exceed 80 bytes. In some cases there is a possibility of increasing the maximum amount of modules or bytes. The following examples demonstrate how to configure module(s) to personal demands.

Which modules have higher priority?

In Huettinger Profibus profile main priority is created by a sequence of modules (the first selected module in the communication frame is also the first realized by the program). If for any reason, two or more of the same modules are selected, then the software will realize only the first one of them. The rest of the modules will be ignored (but they stay in the communication frame).
Another example is when a user selects two modules: module 2 and module 3. Both define a voltage setpoint (module 2 in an integer format, module 3 in a floating point format) and create a 6 byte output frame:

0	1	2	3	4	5
Module 2		Module 3			

Nevertheless, only module 2 will be realized because it was first selected and is first in output frame. The second one will be ignored (but it stays in the communication frame).

Some groups modules have certain relationships which are divided into three groups:
Group 1: modules from 2 to 7 (voltage setpoint, current setpoint, power setpoint)
Group 2: modules 8 and 9 (Select control mode)
Group 3: module 21 and 22 – data group between 2 – 7, kind of channels – setpoints.

Together these groups create some kind of a priority basis.
For instance, if a prepared output frame contains modules from group 1, group 2 and group 3, modules from group 2 and specific channels from group 3 will be ignored, because modules from group 1 have higher priority. The same applies when modules from group 2 and group 3 are selected, specific channels from group 3 will be ignored, because modules from group 2 have higher priority.

Annotation - modules from group 1 have a higher priority than modules from group 2 and particular channels from group 3, and group 2 has a higher priority than particular channels from group 3.

For the user's convenience, some parts of modules (especially from group 1, group 2 and group 3) are defined in two formats: integer and floating point. For the integer format an additional parameter is necessary to scale an integer to real value. This parameter is referred to as an "integer scale".

How to use an integer scale?

In order to precisely set or read values in such a current, voltage and power in an integer format, it is necessary to establish the proper value of three parameters in the integer scale. These parameters are: power scale (for power), current scale (for current) and voltage scale (for voltage). These parameters are all available on display panel (menu "CONTROL CFG"), RS232 protocol (word channel no.: 66, 67, 68) or Profibus (module 20 or 21, data group 72). The values of these parameters define nominal value of current (in case of current scale), power (in case of power scale) and voltage (in case of voltage scale). Example: Nominal power (Pn) for DC3025 is 25kW, nominal voltage (Vn) is 800V and nominal current (In) is 62.5A. If two decimal places are required to set and read power or current, and one decimal place is required to set and read voltage, the value of the integer scale should be set in the following manner:

Power scale = 2500, voltage scale = 8000, current scale – 6250.
Another example is when DC3025 has on output of the following values:
Actual voltage = 432, actual current = 32,5A, actual power = 14,04kW.
Actual values can be transformed in a simple way into an integer value as shown below:Integer value of power = Pscale * Pact / Pn = 2500 * 14.04 / 25 = 1404
Integer value of voltage = Vscale * Vset / Vn =8000 * 432 / 800 = 4320
Integer value of current = Iscale * Iset / In = 6250 * 32.5 / 62.5 = 3250
The integer format has one disadvantage – a constant decimal point – because of this accuracy is sometimes lost. One solution for this problem is to use a floating point number.

How to use a floating point?

A floating point number is a 32-bit value (4 bytes), which can describe each value, both integer and fraction. Floating point number is divided into 3 parts: sign, exponent and mantissa. Below are some examples of how to use floating-point numbers.

byte 0		byte 1		byte 2	byte3
bit7	bit 6 bit 0	bit7	bit6 bit0	bit7 bit0	bit7 bit0
S	2^7 2^6 2^5 2^4 2^3 2^2 2^1	2^0	2^{-1} 2^{-2} 2^{-3} 2^{-4} 2^{-5} 2^{-6} 2^{-7}	2^{-8} 2^{-9} 2^{-10} 2^{-11} 2^{-12} 2^{-13} 2^{-14} 2^{-15}	2^{-16} 2^{-17} 2^{-18} 2^{-19} 2^{-20} 2^{-21} 2^{-22} 2^{-23}
sign	exponent		mantissa	mantissa	mantissa

Formula: Value = $(-1)^S * 2^{(\text{exponent} - 127)} * (1+\text{mantissa})$

Example 1: 7.5

64 dec 240 dec 0 dec 0 dec
0h F0h 00h 00h
40 F0 00 00 h = 0100 0000 1111 0000 0000 0000 0000 0000 b

Value = $(-1)^0 * 2^{(129-127)} * (1 + 2^{-1} + 2^{-2} + 2^{-3})$
= $1 * 2^2 * (1 + 0.5 + 0.25 + 0.125)$
= $1 * 4 * 1.875$
= 7.5

Example 2: 600.0

68 dec 22 dec 0 dec 0 dec
44h 16h 00h 00h
44 16 00 00 h = 0100 0100 0001 0110 0000 0000 0000 0000 b

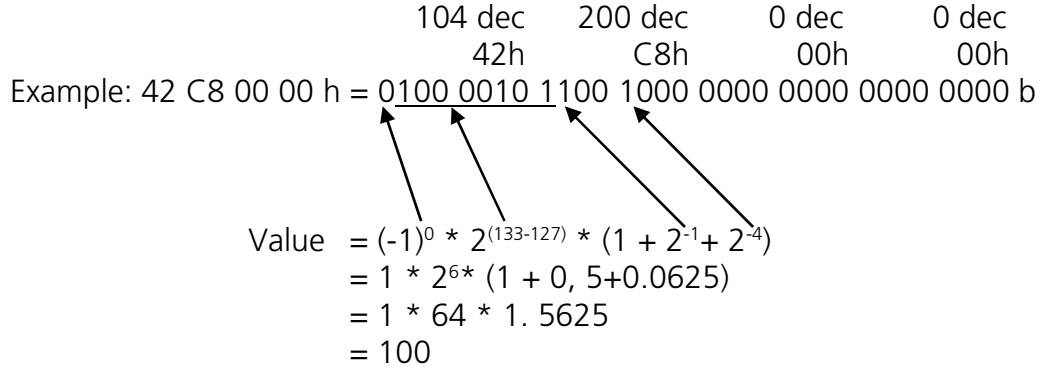
Value = $(-1)^0 * 2^{(136-127)} * (1 + 2^{-3} + 2^{-5} + 2^{-6})$
= $1 * 2^9 * (1 + 0,125 + 0.03125 + 0,015625)$
= $1 * 512 * 1,171875$
= 600

Example 3: 10.0

65 dec 32 dec 0 dec 0 dec
41h 20h 00h 00h
41 20 00 00 h = 0100 0001 0010 0000 0000 0000 0000 0000 b

Value = $(-1)^0 * 2^{(130-127)} * (1 + 2^{-2})$
= $1 * 23 * (1 + 0,25)$
= $1 * 8 * 1,25$
= 10

Example 4: 100.0



For more details please refer to:
http://babbage.cs.qc.edu/courses/cs341/IEEE-754.html
To present a floating point number, two standards are available: Motorola and Intel.

What is the difference between the Motorola and Intel format?

The difference between these two standards is simply merely in an adequate sequence of bytes. An example of floating point format and both standards are presented below:

byte 0		byte 1		byte 2	byte3
bit7	bit 6 bit0	bit7	bit6 bit0	bit7 bit0	bit7 bit0
S	2^7 2^6 2^5 2^4 2^3 2^2 2^1	2^0	2^{-1} 2^{-2} 2^{-3} 2^{-4} 2^{-5} 2^{-6} 2^{-7}	2^{-8} 2^{-9} 2^{-10} 2^{-11} 2^{-12} 2^{-13} 2^{-14} 2^{-15}	2^{-16} 2^{-17} 2^{-18} 2^{-19} 2^{-20} 2^{-21} 2^{-22} 2^{-23}
sign	exponent		mantissa	mantissa	mantissa

Where value = $(-1)^S * 2^{(\text{exponent} -127)} * (1+\text{mantissa})$
Intel format of floating point numbers (for example like those used in Texas Instruments or Intel processors) send a less significant byte (LSB) before the most significant byte (MSB):

byte 0	byte 1	byte 2	byte3

Motorola format of floating point format (for example used in Philips or Motorola processors) send the most significant byte (MSB) before least significant byte (LSB):

byte 3	byte 2	byte 1	byte 0

Annotation– there are no other differences between Motorola and Intel standards other than a sequence of bytes. Accuracy and principles of operation for both formats are always the same.

Examples

The following examples show how to configure modules and how to use all the information which is presented below. All examples are based on the DC3025 device where nominal voltage (Un) is 800V, nominal current (In) is 62,5A and nominal power (Pn) is 25kW. Other parameters are set at following values: power scale (Pscale) is 10000, voltage scale (Vscale) is 8000 and current scale (Iscale) is 6250.

Example 1:
This example shows how to switch on the power in the output and set the voltage to 432V, current to 32.5A and power to 14.04kW in the simplest of configurations. The following modules are selected: Module 6, Module 2, Module 4, Module 1, Module 16, Module 12, Module 14, Module 26, Module 20, Module 8.
Integer value of power setpoint = Pscale * Pset / Pn = 10000*14.04 / 25 = 5616
The value of 5616 has a hex value of 0x15F0h.
Integer value of voltage setpoint = Vscale * Vset / Vn =8000 * 432 / 800 = 4320
The value of 4320 has a hex value of 0x10E0h.
Integer value of current setpoint = Iscale * Iset / In = 6250 * 32.5 / 62,5 = 3250
The value of 3250 has a hex value of 0x0CB2h
The created output frame which Profibus master sends to DC3025 should be:

Bytes	0	1	2	3	4	5	6	7	8	9
Modules	Module 6		Module 2		Module 4		Module 1	Module 8		
Descriptions	Power setpoint		Voltage setpoint		Current setpoint		Control Bits	Select control mode		
Values	0x15	0xF0	0x10	0xE0	0x0C	0xB2	0x0D	0x01	0x0F	0xA0

First six bytes represent setpoints. The next byte, according to the description of module 1, sends the bits which take control of the unit and switch on the relays and power (0x0D = binary 00001101). Last three bytes will be ignored, because module 8 belongs to group 2 in the priority basis. This group has a lower priority than group 1(modules 6, 2, 4). After this directive, unit switch off relays and set the voltage regulator to 400V.

Anotation: Setpoint requests for voltage, current and power will be ignored, but not until the Profibus master takes control of the DC3025.
Magnetron power supply responds by sending the following input frame:

Bytes	0	1	2	3	4	5	6	7	8	9	10
Modules	Module 16		Module 12		Module 14		Module 26		Module 20		
Descriptions	Actual power		Actual Voltage		Actual current		Hard arc counter		Acknowledge Bits		
Values	0x10	0x00	0x0F	0xA0	0x0A	0x00	0x00	0x04	0x0D	0x00	0x01

It is easy to calculate from first six bytes that:
Actual power = integer value from module 16 * Pn / Pscale = 4096*25/10000 = 10,24kW,
Actual Voltage = integer value from module 12 * Vn / Vscale = 4000*800/8000 = 400 V,
Actual power = integer value from module 14 * In / Iscale = 2560*62.5/6250 = 25.6 A,

Next two bytes show that there were four hard arcs (module 26). Last three bytes belongs to module 20 – Acknowledge bits, which inform (according to the descriptions of this module) Profibus master take the control on magnetron power supply and switch on relays and power (first byte, 0x0D = binary 00001101), and unit works on Voltage regulator (third byte). This type of configuration (if module 8 is avoided) is the most basic for controlling magnetron power supply, because it allows setting and reading actual power, current or voltage. Additionally, module 1 admits to switching on the relays and power, module 26 and 20 show status of the unit.
However, in a process only one regulator is needed, as the configuration of Profibus should be different which is depicted in the next example.

Example 2:
This example shows how to control magnetron power supply by using only one regulator. When the following modules were selected: Module 6, Module 1, Module 16, Module 12, Module 14, Module 26, Module 20. The power was set to 12,5kW:
Integer value of power setpoint = Pscale * Pset / Pn = 10000*12.5 / 25 = 5000
The value of 5000 has a hex value of 0x1388h.
The created output frame, which Profibus master sends to the magnetron power supply, should be:

Bytes	0	1	2
Modules	Module 6		Module 1
Descriptions	Power setpoint		Control Bits
Values	0x13	0x88	0x0D

In this configuration, voltage and current are set to a nominal value automatically and only a power regulator controls the unit. Thus, it is easy to see that the output frame is much shorter than in previous examples (has only 3 bytes). In response the magnetron power supply sends the following input frame:

Bytes	0	1	2	3	4	5	6	7	8	9	10
Modules	Module 16		Module 12		Module 14		Module 26		Module 20		
Descriptions	Actual power		Actual Voltage		Actual current		Hard arc counter		Acknowledge Bits		
Values	0x13	0x88	0x10	0x68	0x0B	0x76	0x00	0x04	0x0D	0x00	0x04

It is easy to calculate from first six bytes that:
Actual Power = integer value from module 16 * Pn / Pscale = 5000*25/10000 = 12.5kW,
Actual Voltage = integer value from module 12 * Vn / Vscale = 422*800/8000 = 422 V,
Actual Current = integer value from module 14 * In / Iscale = 2943*62.5/6250 = 29.34 A,
The remaining bytes of input frame are similar to the previous example with the exception of the last byte, which notifies that power regulator is active (0x04 = binary 00000100). In the event that a process requires two kinds of regulators, another solution should be selected.

Example 3:
This example shows how to use module 9 (select control mode). This kind of module allows selecting the desired control mode and setting the setpoint at the same time. In this example the following modules were selected: Module 1, Module 9, Module 16, Module 12, Module 14, Module 20. The output frame which Profibus master sends to the magnetron power supply should be:

Bytes	0	1	2	3	4	5
Modules	Module 1	Module 9				
Descriptions	Control Bits	Select control mode – floating point format				
Values	0x0D	0x01	0x41	0xCC	0x8F	0x5C

The last four bytes describe a value of 25.57 in a floating-point format in Intel standard (corresponding with the descriptions above). The first byte in module 9 (and second byte in output frame) switch over unit to work in current regulator. Due to this, remaining setpoints (power and voltage) are set to their nominal values. Module 1 (first in output frame) assumes control of the unit and switches on the power and relays. In response, magnetron power supply sends following input frame:

Bytes	0	1	2	3	4	5	6	7	8
Modules	Module 16		Module 12		Module 14		Module 20		
Descriptions	Actual power		Actual Voltage		Actual current		Acknowledge Bits		
Values	0x0C	0xF0	0x0C	0xA8	0x09	0xFD	0x0D	0x00	0x02

It is easy to calculate from first six bytes that:
Actual power = integer value from module 16 * Pn / Pscale = 3312*25/10000 = 8.28kW,
Actual voltage = integer value from module 12 * Vn / Vscale = 3240*800/8000 = 324 V,
Actual current = integer value from module 14 * In / Iscale = 2557*62.5/6250 = 25.57 A,
This time the input frame is without a Hard Arc counter (and by this is two bytes shorter). Last byte (module 20) informs us that a current regulator is active (0x02 = binary 00000010).

Example 4:
This example shows how to use module 21 (set/read parameter in integer format) in order to create a faster interface with least amount of input and output bytes. For module 21, the upload packet sent from Profibus master to magnetron power supply contains the following information:

1	2	3	4
Data group	Channels	Integer value	
Out_Byte 0	Out_Byte 1	Out_Byte 2	Out_Byte 3

And the input bytes are:

1	2	3	4
Data group	Channels	Integer value	
In_Byte 0	In_Byte 1	In_Byte 2	In_Byte 3

According to the description of module 21 and module 22 (shown previously), an example of interface (outlined in steps) demonstrates how to control unit by using only one module.

Step 1: Taking control of the unit (data group 1, channel 3)

Request from PLC to magnetron power supply:

Data group	Channels	Integer value	
0x01	0x03	0x00	0x01

Reply received:

Data group	Channels	Integer value	
0x01	0x03	0x00	0x01

Step 2: selection of power regulator and assignment of 5kW of power (data group 2, channel 3)

Calculation for power setpoint:
Integer value of power setpoint = Pscale * Pset / Pn = 10000*5.0 / 25 = 2000
The value of 2000 has a hex value of 0x07D0h.
Request from PLC to magnetron power supply:

Data group	Channels	Integer value	
0x08	0x03	0x07	0xD0

Reply received:

Data group	Channels	Integer value	
0x08	0x03	0x07	0xD0

Step 3: enabling of long ramp (data group 30, channel 3)

Request from PLC to magnetron power supply:

Data group	Channels	Integer value	
0x1E	0x03	0x00	0x01

Reply received:

Data group	Channels	Integer value	
0x1E	0x03	0x00	0x01

Step 4: enabling dU and Imax criterions, disabling UxI criterion (data group 10, channel 3)

Last byte switches on dU and Imax criteria (for arc detection) and switches off UxI criterion. (0x05 = binary 00000101).
Request from PLC to magnetron power supply:

Data group	Channels	Integer value	
0x0A	0x03	0x00	0x05

Reply received:

Data group	Channels	Integer value	
0x0A	0x03	0x00	0x05

Step 5: set the dUoff parameters to 100V(data group 11, channel 3)

Last byte sets dUoff parameters to 100V. The value of 100 has a hex value of 0x0064h.
Request from PLC to magnetron power supply:

Data group	Channels	Integer value	
0x0B	0x03	0x00	0x64

Reply received:

Data group	Channels	Integer value	
0x0B	0x03	0x00	0x64

Step 6: Switch on Power (data group 1, channel 3)

Last byte switches on relays and power. (0x0D = binary 00001101).
Request from PLC to magnetron power supply:

Data group	Channels	Integer value	
0x01	0x03	0x00	0x0D

Reply received:

Data group	Channels	Integer value	
0x01	0x03	0x00	0x0D

Step 7: Readout of actual power (data group 2, channel 4)

Request from PLC to magnetron power supply:

Data group	Channels	Integer value	
0x02	0x04	N/a	N/a

Reply received:

Data group	Channels	Integer value	
0x02	0x04	0x11	0xD0

Last two bytes contain information about actual power (The value of 0x11D0 in hex has a decimal value of 4560). It is easy to calculate that:
Actual power = integer value from module 16 * Pn / Pscale = 4560*25/10000 = 11.4 kW,

Step 8: Readout of actual current (data group 4, channel 4)

Request from PLC to magnetron power supply:

Data group	Channels	Integer value	
0x04	0x04	N/a	N/a

Reply received:

Data group	Channels	Integer value	
0x04	0x04	0x06	0x22

Last two bytes contain information about actual power (value of 0x0622 in hex has a decimal value of 1570). It is easy to calculate that:
Actual power = integer value from module 16 * Pn / Pscale = 1570*62.5/6250 = 15.7 A,

Step 9: Readout of acknowledgement bits0 (data group 1, channel 4)

Request from PLC to magnetron power supply:

Data group	Channels	Integer value	
0x01	0x04	N/a	N/a

Reply received:

Data group	Channels	Integer value	
0x01	0x04	0x00	0x0D

Last byte informs us that relay and power is switched on (0x0D = binary 00001101).

We can observe that all parameters can be changed by using this one module.
An additional advantage of this configuration, is the handshake quality – in first two bytes of input frame an echo of last command is sent back. On account of this the PLC receives confirmation that command was accepted. Since a response to the request is generated automatically, (sometimes even 1 ms later) the entire communication process works exceptionally fast. If orders are sent one by one, then entire process can be achieved at an incredible speed. Only Profibus baud rate and number of slaves in field can limit this.

Example 5:
Last example shows how to use module 21 (set/read parameter in integer format) with other modules. The following modules were selected in this example: Module 6, Module 29, Module 21, Module 12, Module 14, Module 20. The output frame which Profibus master sends to the magnetron power supply is:

Bytes	0	1	2	3	4	5	6	7
Modules	Module 6		Module 29		Module 21			
Descriptions	Power setpoint		Current Ix threshold		Set/read parameter in integer format			

First two bytes set power and automatically switch unit to power regulator. Next two bytes allow to control the level of current threshold for UxI arc detection criterion. The control bits are available via module 21 (last four bytes in input frame). Other parameters are also accessible in this module if necessary. In response, magnetron power supply sends out the following input frame:

Bytes	0	1	2	3	4	5	8	9	10	11	12
Modules	Module 12		Module 14		Module 20			Module 21			
Descriptions	Actual Voltage		Actual current		Acknowledge Bits			Set/read parameter in integer format			

First four bytes show actual value of voltage and current (in an integer format). They can be used to calculate actual power (this is why the module of actual power is omitted). The next three bytes represent Acknowledge bits, which show status of magnetron power supply. Last four bytes belong to module 21. This example shows how different modules can replace other modules and maintain their usability as well as flexibility.

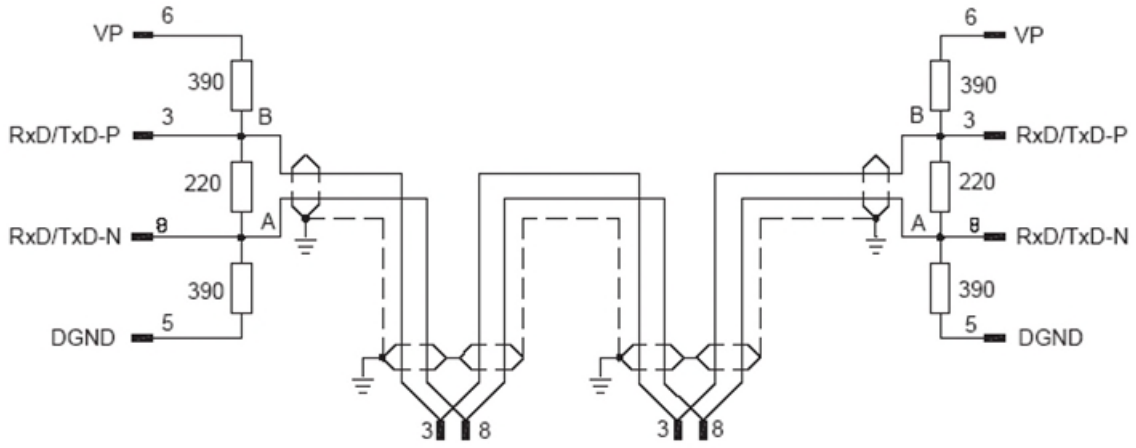
Remember – These are only several possible examples. The true combination of solutions is as endless as the user's imagination and we only attempt to provide you with the perfect tool to create your own personal profile for any specific processes.

Profibus safety

In the event that Profibus slave loses connection with master or when the master stops communicating, the power supply turns off its output power and waits until communication is restored or until another control source is selected.

Physical layer and configuration of TruPlasma DC

In order to connect the power supply with the Profibus, an isolated RS-485 interface (according to EN 50170) is required. Please make certain that termination resistors are affixed at both ends of the cable. If special Profibus connectors are being used, the resistors found inside the connector must be switched on. The cable shield should be firmly connected to ground in every device. Make sure that there is no potential difference between grounds in devices.



GSD files

GSD (Electronic data sheet of a device) files contain and describe the functions and character of the Profibus device. In order to use this unit in a PROFIBUS system, it needs to have a specific GSD file that is compatible with the unit.
Please be advised to only use the GSD file, which comes delivered with your power supply.

Specification for Profibus slave TruPlasma DC:

Configuration data: in accordance with GSD file (AC0A31.gsd)
Technology: ASIC
Physical separation fieldbus side: Standard
Baud rate for RS485: Automatic detection up to 12 Mbaud
Sync: Supported
Freeze: Supported
Primitive fieldbus ID: 120
Dipswitch: Supported

8.3. DeviceNet communication protocol

The DeviceNet interface is realized in accordance with ODVA DeviceNet Specification Release 2.0 Errata 5. The 1FH profile of the DC power supply was implemented.

Notice!
The power supply can only be controlled using DeviceNet if the interface configuration was set to DeviceNet beforehand.

This setting can be made:
- using the operator module
- using the RS232 interface with the aid of the terminal program

A 5-pin Microstyle socket is used for connection to DeviceNet. The pin assignment is in accordance with the DeviceNet specification as follows:

DeviceNet interface, assignment

Pin	Assignment
1	Screen
2	V+
3	V-
4	CAN_H
5	CAN_L

PASSIVE DEVICENET DISPLAY
For the version with the passive DeviceNet display, the power supply is equipped with 2 DeviceNet state LEDs: module state LED and network state LED.
The mode of operation of the LEDs complies with the DeviceNet specifications.

SETTING THE ADDRESS AND BAUD RATE
The ID number and DeviceNet speed is set via front panel console (if available) or through RS232. The software activates ID number and DeviceNet speed once after reset therefore, if ID number or speed has been changed unit must be restarted (powered-off completely and powered-on again). Baud rate can be set to 125, 250 or 500 kbaud.

DeviceNet LEDs
With the passive DeviceNet display, 2 LEDs indicate the device state and bus activity (see below). The following tables give the meaning of the various LED states.

Module LED

LED state	Meaning
OFF	No supply voltage
Green, steady	Power supply is in normal operating mode
Green, flashing	Power supply is in standby mode or: Power supply is not, incompletely or incorrectly configured
Amber, flashing	Fault which can be reset
Amber, steady	Fault which cannot be reset; power supply may be defective
Amber/green, flashing	Self-test

Network LED

LED state	Meaning
OFF	Power supply has no supply voltage or: DUP_MAC_ID test not completed
Green, steady	Power supply is online and has set up connection, group 2 devices are assigned to a master
Green, flashing	Power supply is online, but has not set up connection, Power supply has completed DUP_MAC_ID test, but has not set up connection to other nodes, group 2 devices are **not** assigned to a master
Amber, flashing	At least one I/O connection is in time-out state
Amber, steady	Fault which prevents communication with network, e.g. double device ID, bus is offline
Amber/green, flashing	Network access fault

PROTOCOL

Explicit and poll messages can be sent. The generator functions as a Group 2 Only server in accordance with the device profile "DC Power supply", Device Type 1FH (see DeviceNet Specification Volume II, Chapter 3, Section 3-30).

Data Units:

For Power: % and W
For Voltage: % and V
For Current: % and mA

Device Specific Settings:

Vendor ID: 464
Device Type: 31
Product Code: 1001

Notice!

When configuring the bus, make sure that a delay time of at least 30ms between two messages is provided (interscan delay time).

OBJECT OVERVIEW

Device Supervisor

Object: Device Supervisor / No. 30H			
Name	No.	Data length / no. of bytes	Access Rule
Instances			
Instance	1		
Class Attributes			
Revision	1	2	Get
Max Instance	2	2	Get
Subclass	99	2	Get
Instance Attributes			
Device Type	3	3	Get
SEMI Standard Revision Level	4	8	Get
Manufacturer's Name	5	21	Get
Manufacturer's Model Number	6	12	Get
Software Revision Level	7	4	Get
Hardware Revision Level	8	4	Get
Device State	11	1	Get
Exception State	12	1	Get
Exception Detail Alarm	13	8	Get
Exception Detail Warning	14	8	Get
Alarm Enable	15	1	Get
Warning Enable	16	1	Get
Subclass	99	2	Get
Subclass 01 – Power Generator Instance Attributes			
Energy Control Enabled	81	1	Set
Joules to Deliver [kJ]	82	4	Set
Joules Remaining [kJ]	83	4	Get
Active Target ID	84	2	Set
Active Target Life Counter Enable	85	1	Set
Active Target Life [kWh]	86	4	Get/Set
Output Power Enable	96	1	Set
Services			
Get_Attributes_Single	0x0e		
Set_Attributes_Single	0x10		
Reset	0x05		
Start	0x06		
Stop	0x07		
Abort	0x4b		
Recover	0x4c		

Object: Device Supervisor / No. 30H			
Name	No.	Data length / no. of bytes	Access Rule
Perform_Diagnosis	0x4e		

Exception Detail Alarm:

Data Component	**Bit7**	**Bit6**	**Bit5**	**Bit4**	**Bit3**	**Bit2**	**Bit1**	**Bit0**
Common Exception Detail Size	0	0	0	0	0	0	1	0
Common Exception Detail 0	0	0	0	0	0	0	0	0
Common Exception Detail 1	0	0	0	0	UF	0	0	0
Device Exception Detail Size	0	0	0	0	0	0	1	0
Device Exception Detail 0	0	0	0	0	0	TS	0	0
Device Exception Detail 1	0	0	0	0	0	0	0	0
Manufacturer Exception Detail Size	0	0	0	0	0	0	0	1
Manufacturer Exception Detail 0	0	FPGA	PHF	0	0	PF	0	0

Exception Detail Warning:

Data Component	**Bit7**	**Bit6**	**Bit5**	**Bit4**	**Bit3**	**Bit2**	**Bit1**	**Bit0**
Common Exception Detail Size	0	0	0	0	0	0	1	0
Common Exception Detail 0	0	0	0	ETL	EP	0	0	0
Common Exception Detail 1	0	0	0	0	0	0	0	0
Device Exception Detail Size	0	0	0	0	0	0	1	0
Device Exception Detail 0	0	0	0	0	0	TS	INTS	0
Device Exception Detail 1	0	0	0	0	0	0	0	0
Manufacturer Exception Detail Size	0	0	0	0	0	0	0	1
Manufacturer Exception Detail 0	GA	0	0	0	0	0	0	0

TS - Temperature Status
INTS - Interlock Status
EP - Eprom Error
UF - Voltage Failur
PF - Power Failure
PHF - PhaseFail
FPGA - FPGA Problem
GA - Global Alarm

ETL - End of Target Life

Analog Sensor

Object: Analog Sensor / No. 31H			
Name	No.	Data length / no. of bytes	Access Rule
Instances			
Power In	1		
Voltage In	2		
Current In	3		
Energy In (since Output Power was last turned On) [kJ]	4		
Class Attributes			
Revision	1	2	Get
Max Instance	2	2	Get
Instance Attributes			
Data Type	3	1	See Spec.
Data Units	4	2	See Spec.
Reading Valid	5	1	Get
Value	6	2/4	Get
State	7	1	Get
Services			
Get_Attribute_Single	0x0e		
Get_Attribute_Single	0x10		

Analog Actuator

Object: Analog Actuator / No. 32H			
Name	No.	Data length / no. of bytes	Access Rule
Instances			
Output Power	1		
Class Attributes			
Revision	1	2	Get
Max Instance	2	2	Get
Instance Attributes			
Data Type	3	1	See Spec.
Data Units	4	2	See Spec.
Override	5	1	Set
Value	6	2/4	Set
State	7	1	Get
Services			
Get_Attribute_Single	0x0e		
Get_Attribute_Single	0x10		

Register

Object: Register / No. 07H			
Name	No.	Data length / no. of bytes	Access Rule
Instances			
Operational State	1		
Interlock State	2		
Class Attributes			
Revision	1	2	Get
Max Instance	2	2	Get
Instance Attributes			
Bad Flag	1	1	Get
Direction	2	1	Get
Size	3	2	Set
Data	4	1/2	Get
Services			
Get_Attribute_Single	0x0e		
Get_Attribute_Single	0x10		

Single Stage Controller

Object: Single Stage Controller / No. 33H			
Name	No.	Data length / no. of bytes	Access Rule
Instances			
Output Power Regulation	1		
Output Voltage Regulation	2		
Output Current Regulation	3		
Class Attributes			
Revision	1	2	Get
Max Instance	2	2	Get
Subclass	99	2	Get
Instance Attributes			
Data Type	3	1	See Spec.
Data Units	4	2	See Spec.
Setpoint	6	2/4	Set
State	10	1	Get
Subclass	99	2	Get
Subclass 02 - DC Power supply Instance Attributes			
Output Max	85	4	Get
Output Limit	86	4	Set
Arc Counter	89	4	Get
Ramp Rate Increment	96	2	Set
Services			

Object: Single Stage Controller / No. 33H			
Name	No.	Data length / no. of bytes	Access Rule
Get_Attribute_Single	0x0e		
Get_Attribute_Single	0x10		

Selection

Object: Selection / No. 2EH			
Name	No.	Data length / no. of bytes	Access Rule
Instances			
Instance 1	1		
Class Attributes			
Revision	1	2	Get
Max Instance	2	2	Get
Instance Attributes			
state	1	1	Get
max_destinations	2	2	Get
number_of_destinations	3	2	Get
destination_list	4	21	Get
max_sources	5	2	Get
number_of_sources	6	2	Get
source_used	8	2	Set
algorithm_type	10	1	Get
object_source_list	13	1	Get
destination_used	14	2	Set
input_data_value	15	2/4	Set
Services			
Get_Attribute_Single	0x0e		
Get_Attribute_Single	0x10		

Application

Object: Application **/ No. 65H**			
Name	No.	Data length / no. of bytes	Access Rule
Instances			
Instance 1	1		
Class Attributes			
Revision	1	2	Get
Max Instance	2	2	Get
Instance Attributes			

Object: Application **/ No. 65H**			
Name	No.	Data length / no. of bytes	Access Rule
dU arc detection criterion enable	1	1 (Bool)	Get/Set
UxI arc detection criterion enable	2	1 (Bool)	Get/Set
Imax arc detection criterion enable	3	1 (Bool)	Get/Set
dU obsv arc detection criterion enable	4	1 (Bool)	Get/Set
Reset Alarm	5	1 (Bool)	Set
VoltageOn threshold for dU arc det. criterion	10	4 (Real)	Get/Set
Voltage Off threshold for dU arc det. criterion	11	4 (Real)	Get/Set
Voltage threshold for UxI arc det. criterion	12	4 (Real)	Get/Set
Current threshold for UxI arc det. criterion	13	4 (Real)	Get/Set
Current threshold for Imax arc det. criterion	14	4 (Real)	Get/Set
Ramp time for UxI criterion	15	4 (Real)	Get/Set
Ramp time for Imax criterion	16	4 (Real)	Get/Set
Break time for dU criterion	17	4 (Real)	Get/Set
dU Offset	18	4 (Real)	Get/Set
Break time for UxI criterion	19	4 (Real)	Get/Set
Break time for Imax criterion	20	4 (Real)	Get/Set
Voltage threshold for Ignition mode	30	4 (Real)	Get/Set
Current threshold for Ignition mode	31	4 (Real)	Get/Set
Master - Temperature T1	40	4 (Real)	Get
Master - Temperature T2	41	4 (Real)	Get
Master - Temperature T3	42	4 (Real)	Get
Master - Temperature T4	43	4 (Real)	Get
Slave1 - Temperature T1	50	4 (Real)	Get
Slave1 - Temperature T2	51	4 (Real)	Get
Slave1 - Temperature T3	52	4 (Real)	Get
Slave1 - Temperature T4	53	4 (Real)	Get
Slave2 - Temperature T1	60	4 (Real)	Get
Slave2 - Temperature T2	61	4 (Real)	Get
Slave2 - Temperature T3	62	4 (Real)	Get
Slave2 - Temperature T4	63	4 (Real)	Get
Slave3 - Temperature T1	70	4 (Real)	Get
Slave3 - Temperature T2	71	4 (Real)	Get
Slave3 - Temperature T3	72	4 (Real)	Get
Slave3 - Temperature T4	73	4 (Real)	Get
Slave4 - Temperature T1	80	4 (Real)	Get
Slave4 - Temperature T2	81	4 (Real)	Get
Slave4 - Temperature T3	82	4 (Real)	Get
Slave4 - Temperature T4	83	4 (Real)	Get
Pulse On Enable	90	1 (Bool)	Get/Set
Frequency	91	2 (Uint16)	Get/Set

Object: Application **/ No. 65H**			
Name	No.	Data length / no. of bytes	Access Rule
Pulse On Time	92	2 (Uint16)	Get/Set
Services			
Get_Attribute_Single	0x0e		
Get_Attribute_Single	0x10		

Assembly

Object: Assembly / No. 04H			
Name	No.	Data length / no. of bytes	Type
Instances			
Instance 1		5	Output
Instance 2		9	Input
Instance 3		1	Output
Instance 4		12	Output
Instance 5		9	Output
Instance 6		7	Output
Instance 7		5	Output
Instance 8		7	Output
Instance 9		13	Input
Instance 13		5	Output
Instance 14		7	Output
Instance 15		5	Output
Instance 16		7	Output
Instance 17		5	Input
Instance 18		5	Input
Instance 19		5	Input
Instance 20		1	Input
Instance 21		8	Input
Instance 22		8	Input
Instance 23		17	Input
Instance 24		1	Input
Instance 25		2	Input
Instance 26		4	Input
Class Attributes			
Revision	1	2	Get
Max Instance	2	2	Get
Data	3	See instance	Set
Services			
Get_Attribute_Single	0x0e		
Get_Attribute_Single	0x10		

I/O POLL CONNECTION

The assembly instances 1 and 2 (see below) are set as the poll connection by default. The poll connection can be changed:

- via the Connection Object,

Instance 1 (Output)

Byte	Low / High	Bit no.								Meaning
		7	**6**	**5**	**4**	**3**	**2**	**1**	**0**	
0	Low	7	6	5	4	3	2	1	0	Power Out 12 (0…4095 = 0…P_n)
1	High	---				11	10	9	8	
2	Low	7	6	5	4	3	2	1	0	Power Ramp (0 = Ramp off) (1…4095 = 1…100%/s Increment)
3	High	---				11	10	9	8	
4		---							0	0 Bit0 = Power On (with edge from 0 to 1) On each edge from 1 to 0, an error and warning reset is performed via the poll connection.

Instance 2 (Input)

Byte	Low / High	Bit no.								Meaning
		7	**6**	**5**	**4**	**3**	**2**	**1**	**0**	
0	Low	7	6	5	4	3	2	1	0	Power In 12 (0…4095 = 0…P_n)
1	High	---				11	10	9	8	
2	Low	7	6	5	4	3	2	1	0	Voltage In 12 (0…4095 = 0…U_n)
3	High	---				11	10	9	8	
4	Low	7	6	5	4	3	2	1	0	Current In 12 (0…4095 = 0…I_n)
5	High	---				11	10	9	8	
6	Low	7	6	5	4	3	2	1	0	Power Ramp (0 = Ramp off) (1…4095 = 1…100%/s Increment)
7	High	---				11	10	9	8	
8	Low				4	3	2	1	0	Op State Bit 0 = Power On State (1=On, 0=Off) Bit 1 = Set Point (1 = value is reached) Bit 2 = Temp. State (1=OK, 0=excess temp.) Bit 3 = Arc detected (1=On, 0=Off) Bit 4 = Interlock State (1=OK, 0=open) Bit 5,6,7 = reserved

Instance 3…26 see DeviceNet specification

9. Warning and alarm messages

Error codes description.

Error Number	ID-Param	SNr-Param	Description
61602	0 - Main Control Board (CMPC24) 1 - HVPS1 module (inside DC Generator) 2 - HVPS2 module (inside DC Generator) 3 - HVPS3 module (inside DC Generator) 4 - HVPS4 module (inside DC Generator) 1x - Slave1 (Parallel work) 2x - Slave2 (Parallel work) 3x - Slave3 (Parallel work) 4x - Slave4 (Parallel work)	-	Wrong checksum of data stored in EEPROM
61603		-	FPGA configuration failed
61604		ID of HVPS module	Unexpected reset of HVPSx module
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
61610		1,2,3,4,0	no communication with HVPSx module
61611		1	no communication with SOP (Display)
		2	no RS232 communication available anymore
		3	no RS485 communication available anymore
		4	no DeviceNet communication available anymore
		5	no Profibus communication available anymore
		6	no communication with Analog interface
		7	no communication with EtherCAT interface
		9	no communication with EthernetIP interface
61612		ID of device, which are not responding 0x0000 - alarm reported on Slave device 0x0001 - slave No. 1 0x0002 - slave No. 2 0x0004 - slave No. 3 0x0008 - slave No. 4	no communication with generator(s) in Parallel Work
61613		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
61615		ID of detected device	Unexpected device detected on Parallel Bus
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

Error Number	ID-Param	SNr-Param	Description
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
61628		-	CLC shorted
61629		kind of unsupported parallel mode configuration	Unsupported Parallel Mode configuration
61630		-	Global Line Active.
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
61637		-	Parallel Mode Malfunction
61638		kind of parallel connection failed	Parallel connection failed
61639		-	User24 checksum error
61640		-	Unequal current in HVPS modules
61646		U500 voltage * 100	U500fast low
61647		U800 voltage * 100	U800fast low
61648		DP_ERROR_CODE	Profibus initialization failed
61649		-	One of Chopper transistor failed
61696		-	Water Delivery System Fault

Warning codes description.

Warning Number	ID-Param	SNr-Param	Description
61651	0 - Main Control Board (CMPC24) 1 - HVPS1 module (inside DC Generator) 2 - HVPS2 module (inside DC Generator) 3 - HVPS3 module (inside DC Generator) 4 - HVPS4 module (inside DC Generator) 1x - Slave1 (Parallel work) 2x - Slave2 (Parallel work) 3x - Slave3 (Parallel work) 4x - Slave4 (Parallel work)	-	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
61660		1, 2, 3, 4	CSPC_x communication fail
61661		1	No communication with z DA interface
		2	No communication with RS232 interface
		3	No communication with RS485 interface
		4	No communication with DN interface
		5	No communication with PB interface
		6	No communication with Analog interface
		7	No communication with EtherCAT interface
		9	no communication with EthernetIP interface
61662		ID of device, which are not responding	communication fail with other Power supplies in parallel operation
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
61668		5	No communication with current sensor on HVPS module
		2	No communication with voltage sensor on HVPS module
61669		-	Internal CAN bus configuration fail
61670		temperature value *100	Low temperature of inlet water
61671		position on recommended device	It is recommended that slave number # should work as a master

10. Interface software

10.1.PVD Power

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

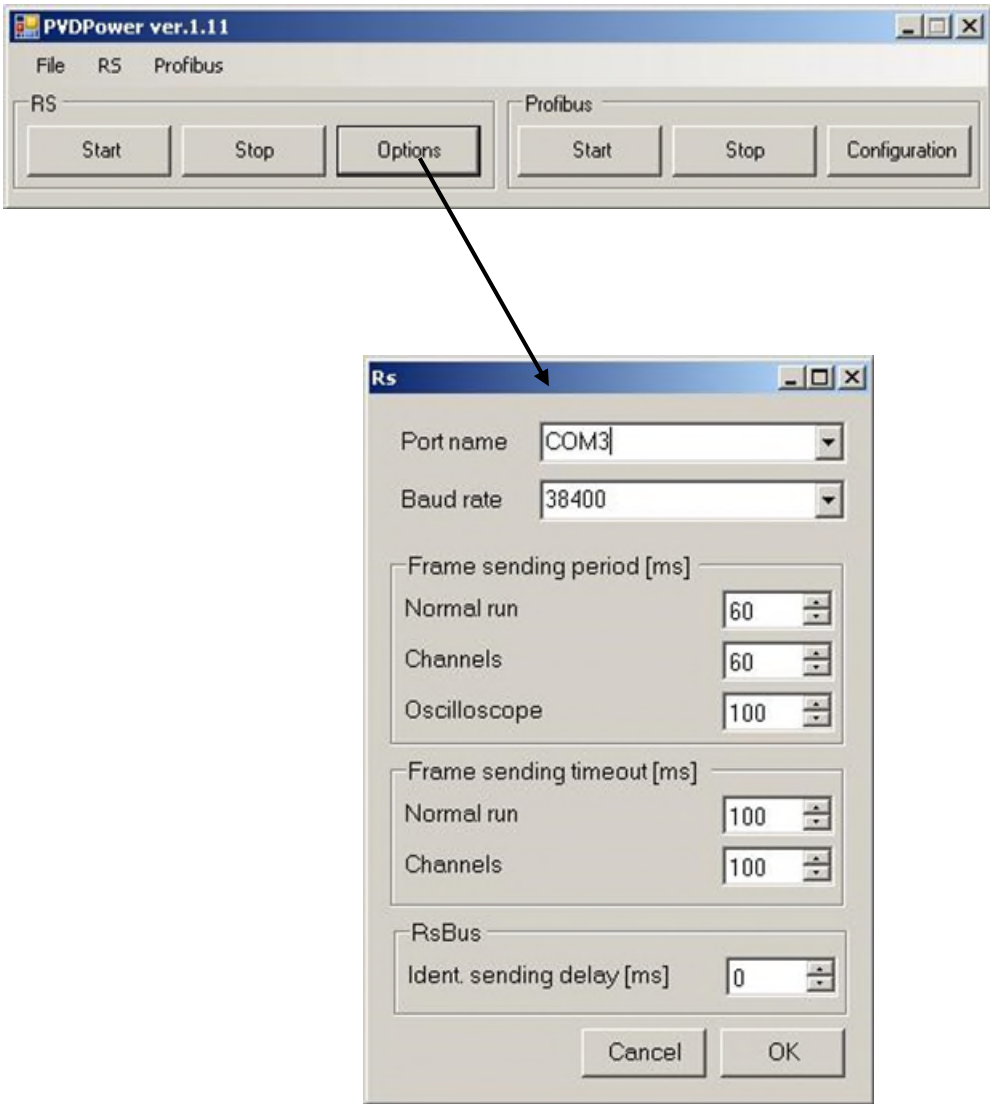
Supported operating systems:
- Windows XP SP3
- Windows Server 2003 SP2
- Windows Vista SP1 or later
- Windows Server 2008 (not supported on Server Core Role)
- Windows 7
- Windows Server 2008 R2 (not supported on Server Core Role)
- Windows 7 SP1
- Windows Server 2008 R2 SP1

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

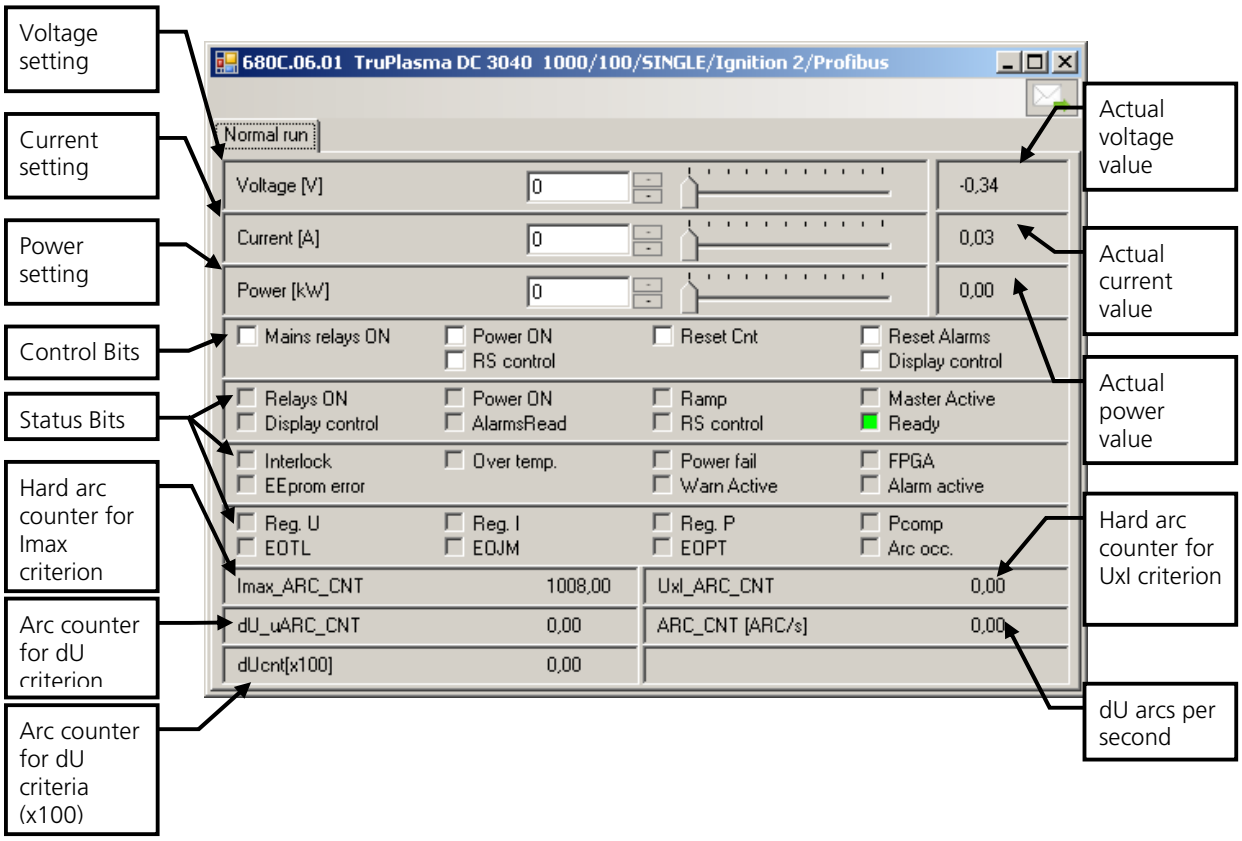
Prerequisites:
- Windows Installer 3.1 or later

In order to activate PVD Power software, "PVDPower_x.xx.exe" file must be running.
Press "options" button to configure RS232.
Please do not change the last six parameters or save their default settings. When RS232 is configured, push "start" button to initiate communication with **TruPlasma DC** unit.

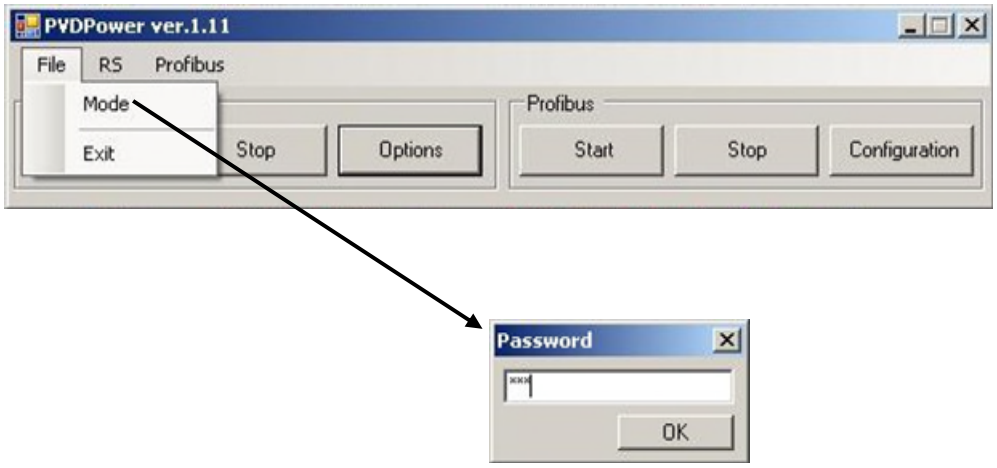


Normal run

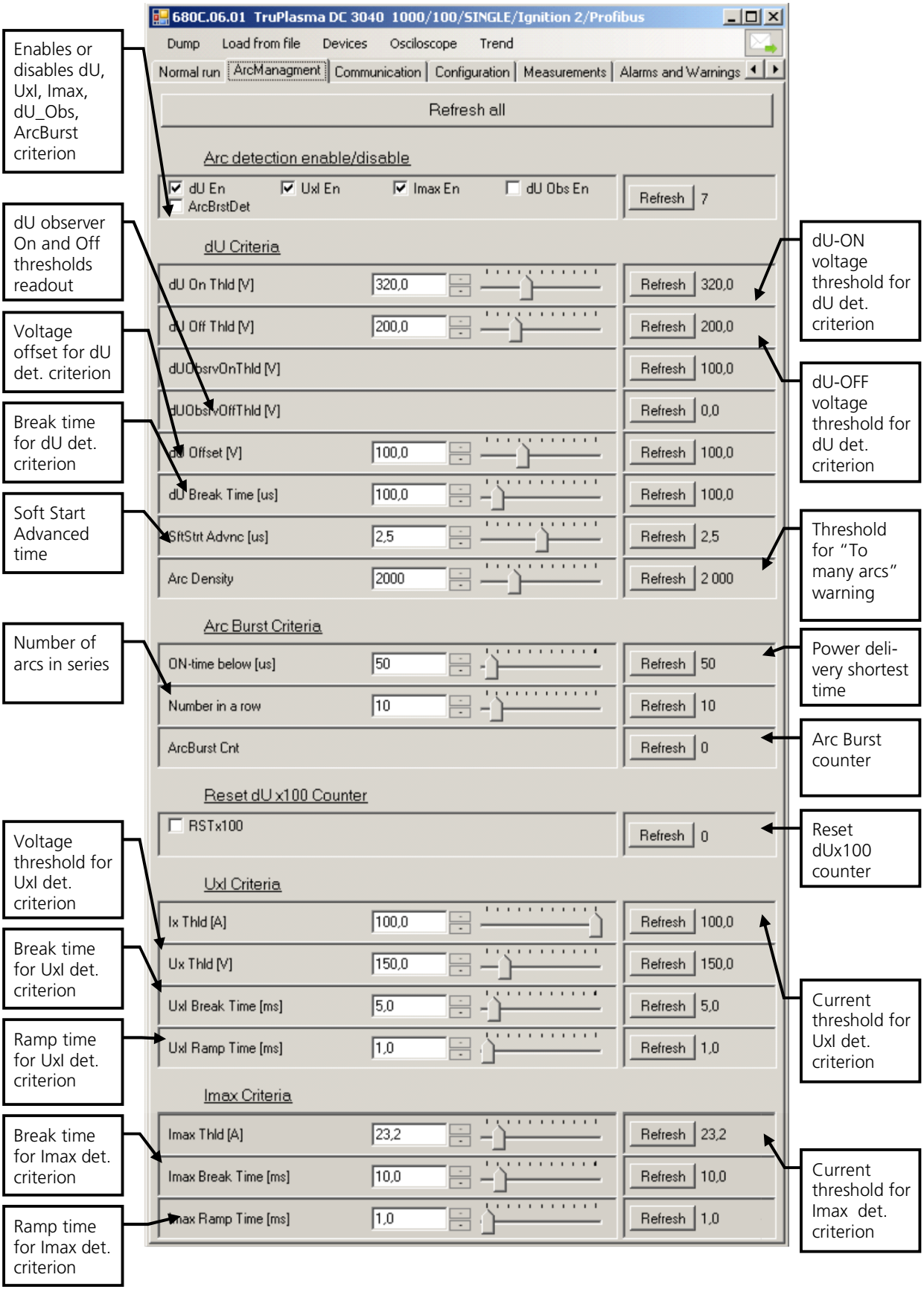
Normal run tab contains basic controls and readouts.



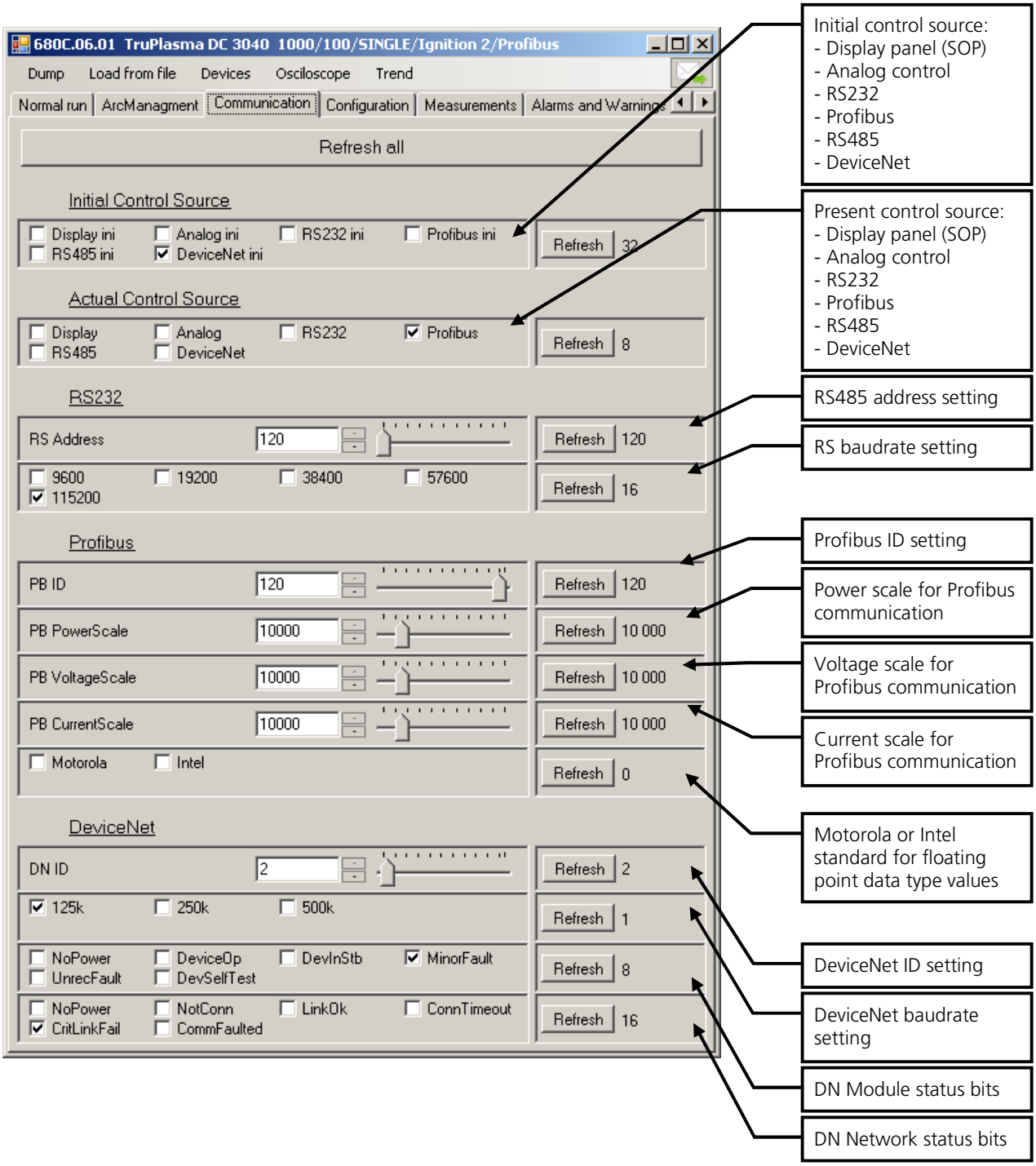
Other tabs are available after entering the password – **321**.



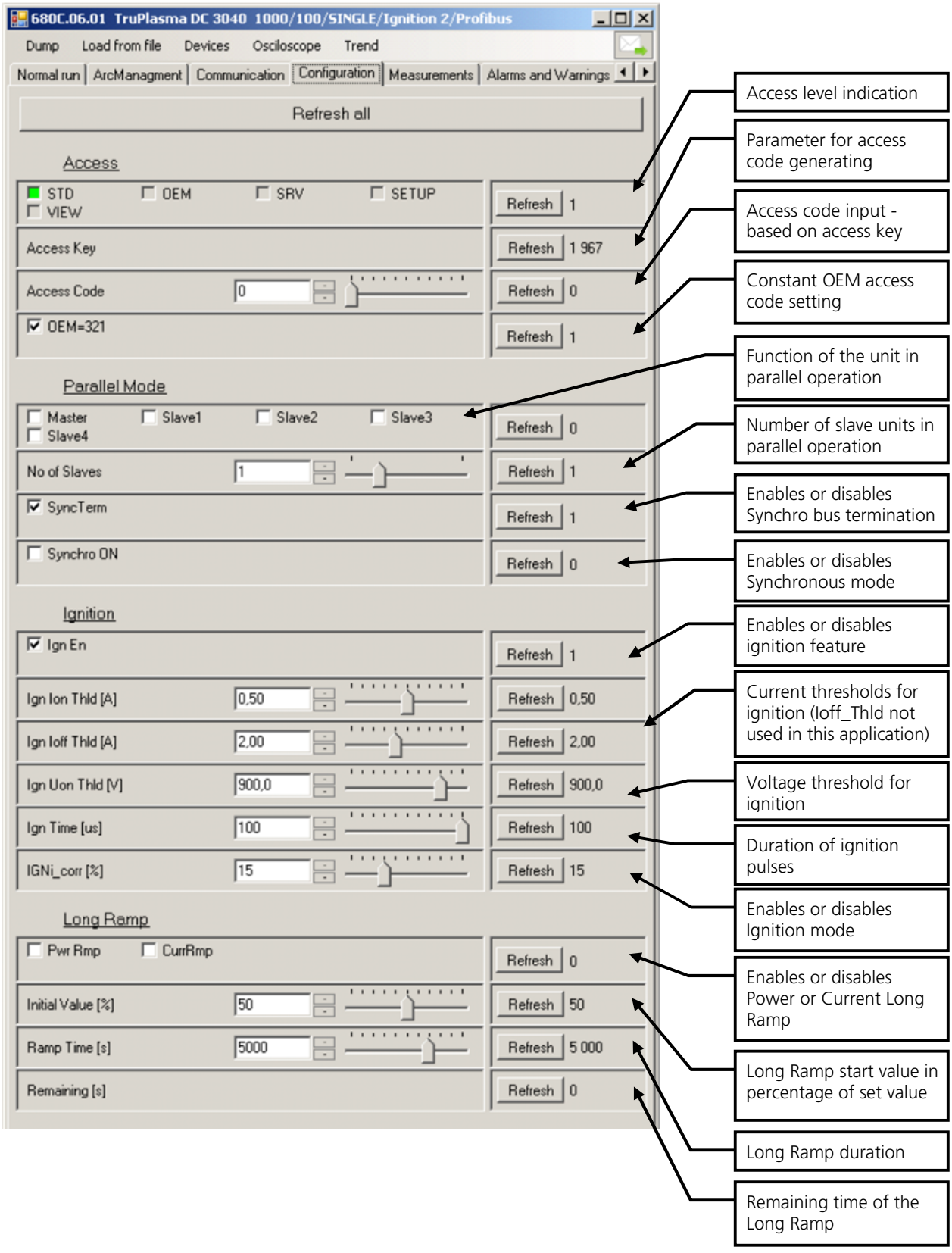
Arc Management



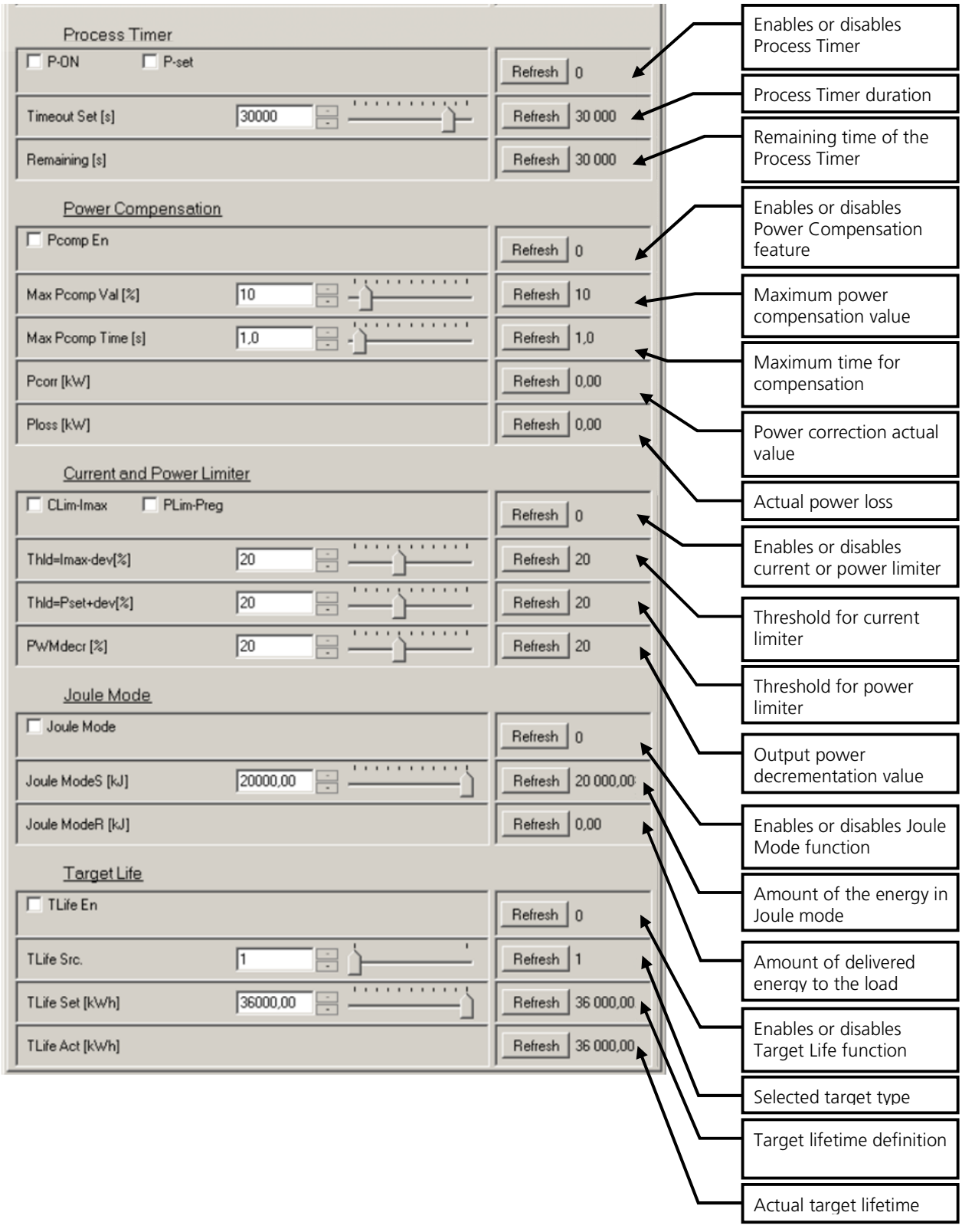
Communication



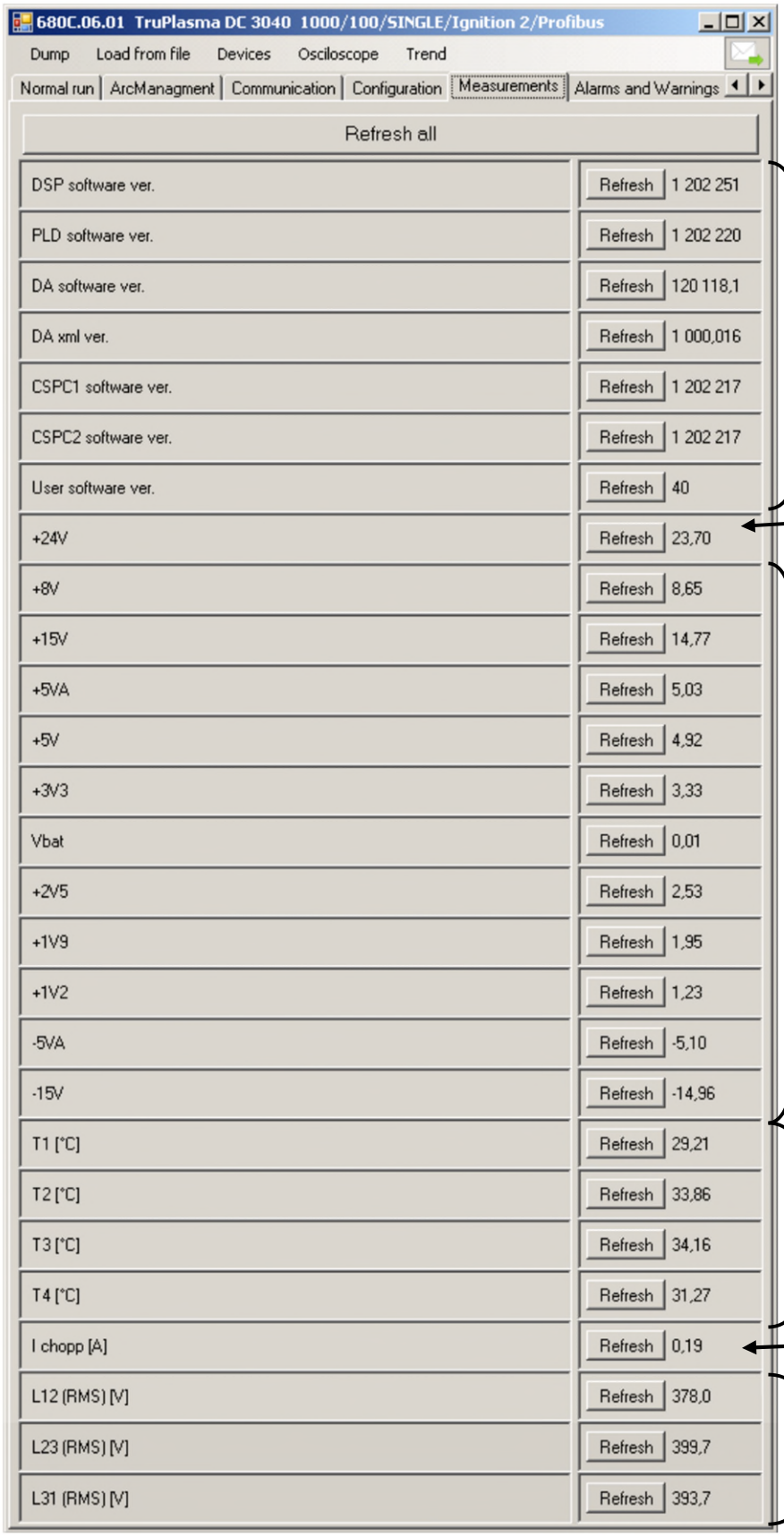
Configuration



Configuration (continued)

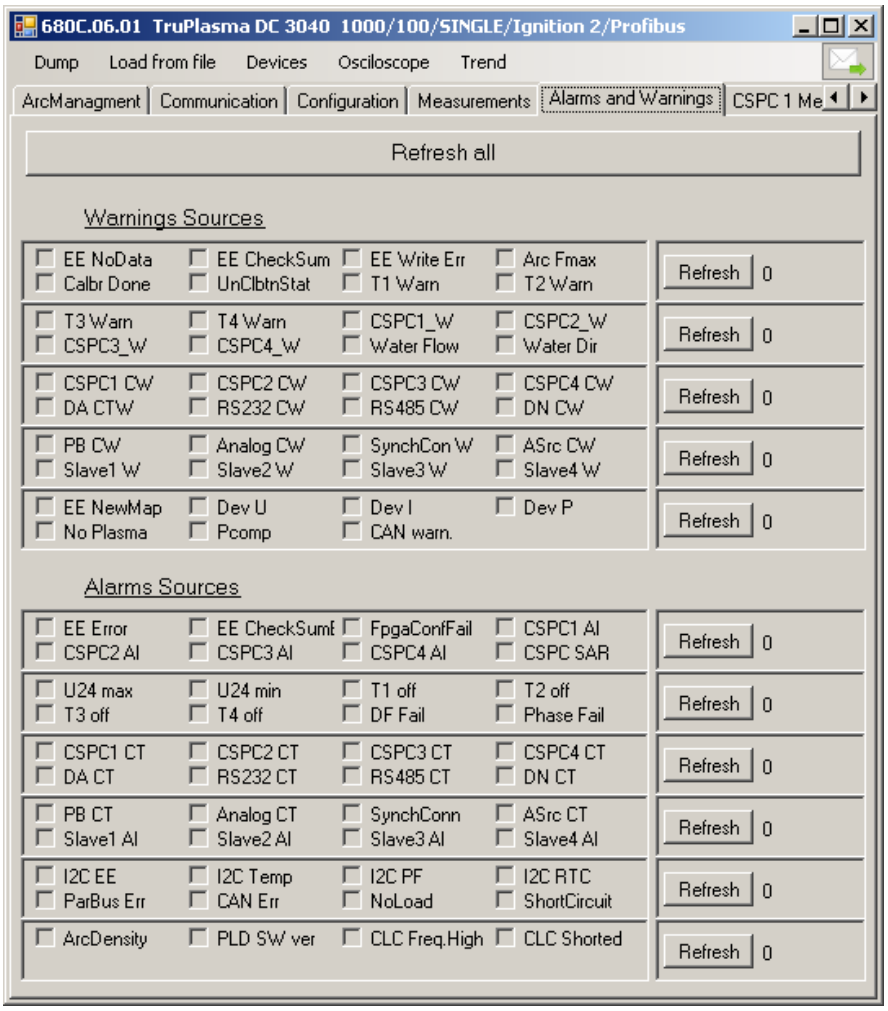


Measurements



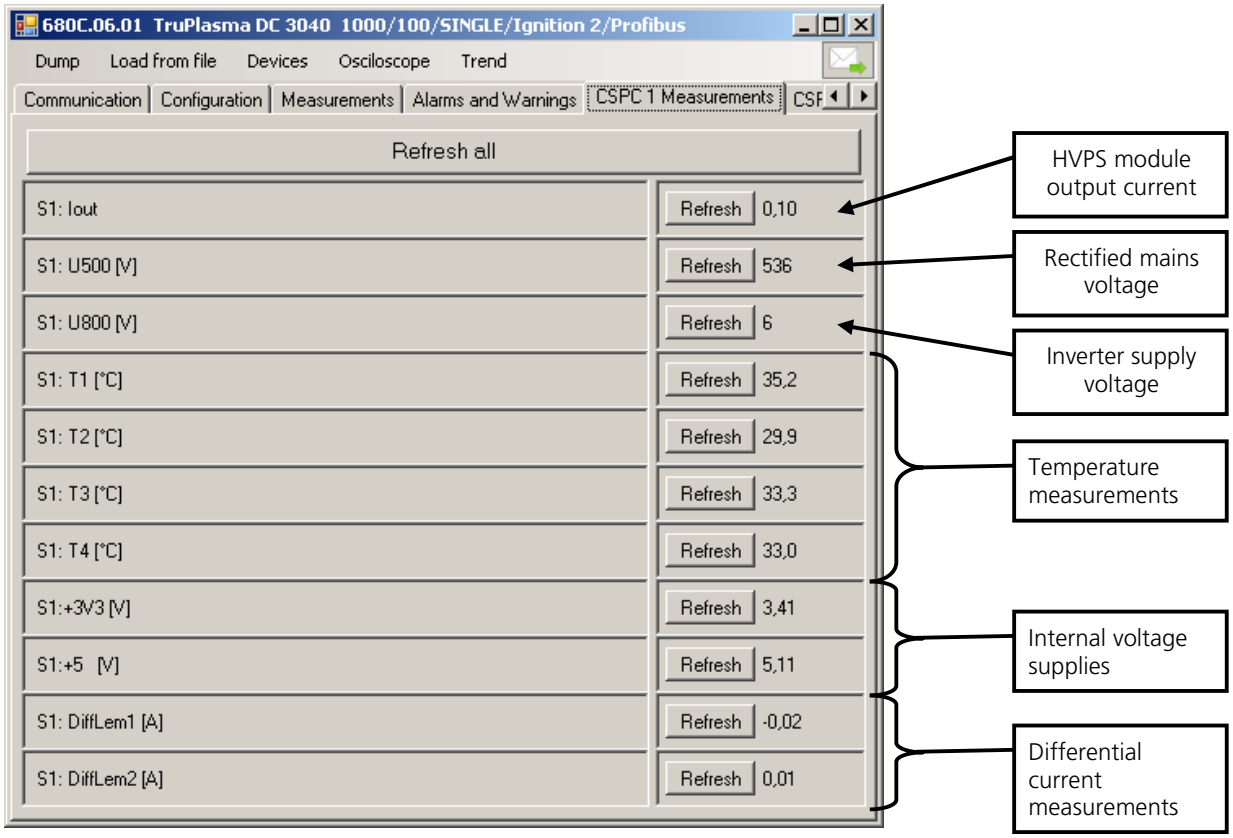
Alarms and Warnings

Alarms and Warnings indicators.



CSPC 1…4 Measurements

CSPC is an internal module of **TruPlasma DC**.



Normal run				
Parameters	**Range**	**Description**	**Adjustable?**	**Defaults**
Voltage [V]	0-Un [V]	Value of set or actual voltage	YES	nd
Current [A]	0-In [A]	Value of set or actual current	YES	nd
Power [kW]	0-Pn [kW]	Value of set or actual power	YES	nd
Control Bits:	Bits: Mains relays ON Power ON Reset Cnt Reset Alarms Display control RS control	 Mains relays ON (1), OFF (0) Power ON (1), OFF (0) Reset arcs counters (1) Reset occurred alarms (1) Display control ON (1), RS control ON (1),	YES	nd
Acknowledge Bits	Bits: Relays ON Power ON Ramp Master Active Display control RS control Ready	 Relays ON ack. (1), or OFF (0) Power ON (1), INHIBIT (0) When long ramp is active (1) When unit works as a Master in parallel Operation is active (1) Front display panel control acknowledge (1) PC control acknowledge (1) Power supply is ready to switch power on (1).	NO	nd
Failure informations	Interlock Over temp. Power fail FPGA EEprom error Warn active Alarm active	Interlock (1), no interlock (0) OverTemp Bit: 1=Overtemp PowerFail (1), power OK (0) Control circuit Fail(1), OK(0) EEprom data sum error (1), OK (0) Warning Active (1), inactive (0) Alarm Active (1), inactive (0)	NO	nd
Information Bits	Reg. U Reg. I Reg. P Pcomp EOTL EOJM EOPT Arc occ.	Voltage regulator active(1), inactive(0) Current regulator active(1), inactive(0) Power regulator active(1), inactive(0) Power compensation active(1), inactive(0) End of Target Life active(1), inactive(0) End of Joule Mode active(1), inactive(0) End of Process Timer active(1), inactive(0) Arc occurrence active(1), inactive(0)	NO	nd
Imax_ARC_CNT	0...65535	Imax arc counter	NO	nd
UxI_ARC_CNT	0... 65535	UxI arc counter	NO	nd
dU_uARC_CNT	0... 65535	dU arc counter	NO	nd
ARC_CNT	0...10000	dU arcs per second	NO	nd
dUcnt[x100]	0…10000	dU arc counter x 100	NO	nd

Arc Management				
Parameters	**Range**	**Description**	**Adjustable?**	**Defaults**
Control Bits:				
dU En	0-1	dU arc detection criterion enable(1), disable(0)	YES	nd
UxI En	0-1	UxI arc detection criterion enable(1), disable(0)		
UxI Obs En	0-1	UxI Observer arc detection criterion enable(1), disable(0)		
Imax En	0-1	Imax arc detection criterion enable(1), disable(0)		
dU Obs En	0-1	dU observer arc detection criterion enable(1), disable(0)		
ArcBrstDet	0-1	Arc burst detection enable(1), disable(0)		

dU Criteria				
dU ON Thld [V]	50-800V	Voltage "On threshold" for dU criterion. If voltage is higher than this parameter, then dU criterion is armed. Min. = dU OFF Thld + dU_OFFSET.	YES	400
dU OFF Thld [V]	0-750V	Voltage "Off threshold" for dU criterion. If dU criterion is armed (as explained above) and voltage is lower than this parameter, dU arc is detected.	YES	100
dU ObsrvOnThld [V]	50-800V	Readout of automatically set Voltage "On threshold" for dU_observer criterion.	NO	nd
dU ObsrvOffThld [V]	0-750V	Readout of automatically set Voltage "Off threshold" for dU_observer criterion.	NO	nd
dU_OFFSET [V]	50-200V	Voltage offset for dU criterion.	YES	100
dU Break Time [µs]	1000.0µs	Break time for dU/dU_obs criterion	YES	30µs
SftStrtAdvnc [µs]	0-5µs	Softstart Advance Time for dU/dU_obs criterion	YES	0
Arc Density	0-8000	Threshold for "Too many arcs" warning 0 - disabled	YES	0
Arc Burst Criteria				
ON-time below [us]	1-1000µs	Output power time releasing threshold for Arc Burst detection	Yes	50
Number in a row	1-100	Number of arcs occurring in sequence	Yes	10
ArcBurst Cnt	10000	Arc Burst Counter	NO	nd
Reset dU x100 Counter				
RST x100	0-1	Reset dUcnt[x100] counter	YES	nd
UxI Criteria				
Ix Thld [A]	(0.05-1)I_n	Current threshold for UxI arc det. criterion	YES	I_n
Ux Thld [V]	0-900V	Voltage threshold for UxI arc det. criterion	YES	200
Ux Offset [V]	10-200V	Offset value for Ux level in observer mode	YES	100
UxI Break Time [ms]	0.1-80ms	Break time for UxI criterion	YES	5
UxI Ramp Time [ms]	0-100ms	Ramp time for UxI criterion	YES	5
Imax Criteria				
Imax Thld [A]	(0.1-1.3)I_n	Current threshold for Imax arc det. criterion	YES	I_n
Imax Break T [ms]	0.1-80ms	Break time for Imax criterion	YES	5
Imax Ramp T [ms]	0-100ms	Ramp time for Imax criterion	YES	5

Communication

Parameters	**Range**	**Description**	**Adjustable?**	**Defaults**
Initial Control Source				
Display ini, Analog ini, RS232 ini, Profibus ini, RS485 ini, DeviceNet ini	-	This parameter decides what takes control on **TruPlasma DC** after turning on device.	YES	nd
Actual Control Source				
Display, Analog, RS232, Profibus, RS485, DeviceNet	-	Indicates current control source of **TruPlasma DC**.	YES	nd
RS232				
RS Address	0-65535	RS485 address	YES	255
9600, 19200, 38400, 57600, 115200	-	RS232/485 baudrate	YES	19200
Profibus				
PB_ID	0-125	Profibus ID	YES	120
PB Power/Voltage/Current Scale	0-65535	Scaling factor of Power/Voltage/Current for Profibus communication	YES	10000
Motorola, Intel	-	Motorola or Intel standard for floating point data type values	YES	0
DeviceNet				
DN_ID	0-63	DeviceNet ID	YES	2
125k, 250k, 500k	-	DN baudrate setting	YES	250k

Communication				
Parameters	**Range**	**Description**	**Adjustable?**	**Defaults**
NoPower, DeviceOp, DevInStb, MinorFault, UnrecFault, DevSelfTest	-	DN Module status bits	NO	nd
NoPower, NotConn, LinkOk, ConnTimeout, CritLinkFail, CommFaulted	-	DN Network status bits	NO	nd

Configuration				
Parameters	**Range**	**Description**	**Adjustable?**	**Defaults**
Access				
STD, OEM, SRV, SETUP, VIEW	-	Access level indicator	NO	nd
Access Key	-	Parameter for access code generating	NO	nd
Access Code	-	Access code input	NO	nd
OEM=321	0-1	Sets the OEM code to constant value - 321	YES	1
Parallel Mode				
Master, Slave1..4	-	Describes function of the unit in parallel operation.	YES	nd
No of Slaves (Par.Mode)	0-4	Number of Slave units in parallel operation.	YES	nd
SyncTerm	0-1	Synchro bus termination enable(1), disable (0)	YES	nd
Synchro ON	0-1	Synchronous mode enable(1), disable (0)	YES	0
Auto Conf.	0-1	Enalbes auto configuration in parallel mode	YES	0
Ignition				
Ign En	0-1	Ignition mode enable(1), disable (0)	YES	0
Ign Ion Thld[A]	(0-0.01)I_n	Current threshold for Ignition mode. Ignition starts when Ign_En is set to 1 and Iout<Ign_Ion_Thld and Uout>Ign_Uon_Thld	YES	0.5
Ign Ioff Thld[A]	(0-0.05)I_n	Not used in this application	YES	2
Ign Uon Thld[V]	(0.05-1)U_n	Voltage threshold for Ignition mode	YES	800
Ign Time [us]	0-100 µs	Duration of ignition pulses	YES	50
IGNi_corr [%]	0-50 %	Ignition current booster	YES	10
Long Ramp				
Pwr Rmp	0-1	Power Long Ramp enable(1), disable(0)	YES	0
CurrRmp	0-1	Current Long Ramp enable(1), disable(0)	YES	0
Initial Value [%]	0-100	Start value of power expressed in a percentage of set value	YES	50
Ramp Time [s]	7200s	Long Ramp duration	YES	60
Remaining [s]	7200s	Remaining time of the Long Ramp	NO	nd
Process Timer				
P-ON	0-1	Process Timer enable(1), disable (0). Process Timer starts after switching output power on	YES	0
P-set	0-1	Process Timer enable(1), disable (0). Process Timer starts when output power is equal to set value	YES	0
Timeout Set [s]	36000	Process timer duration. This parameter is represented in seconds.	YES	30000
Remaining [s]	36000	Remaining time of the Process Timer	NO	nd
Power Compensation				
Pcomp En	0-1	Power Compensation enable(1), disable(0)	YES	0
Max Pcomp Val [%]	0-100	Maximum value for power compensation	YES	10
Max Pcomp Time [s]	0-25	Maximum time for power loss compensation	YES	0
Pcorr [kW]	-	Actual power compensation value	NO	nd
Ploss [kW]	-	Actual uncompressed output power	NO	nd
Current and Power Limiter				
CLim-Imax	0-1	Current Limiter feature enable(1), disable(0)	YES	0
PLim-Preg	0-1	Power Limiter feature enable(1), disable(0)	YES	0
Thld=Imax-dev[%]	0-50	Threshold for current limiter expressed in Imax	YES	20

Configuration				
Parameters	**Range**	**Description**	**Adjustable?**	**Defaults**
		setting reduced by dev value in percentage		
Thld=Pset+dev[%]	0-50	Threshold for power limiter expressed in Pset setting incremented by dev value in percentage	YES	20
PWMdescr [%]	0-50	Output power reduction in percentage in the moment of crossing threshold for current or power limiter	YES	30
Joule Mode				
Joule Mode	0-1	Joule Mode enable(1), disable(0)	YES	0
Joule ModeS [kJ]	0-20000	Energy set value	YES	20000
Joule ModeR [kJ]	-	Amount of energy delivered to the load	NO	nd
Target Life				
TLife En	0-1	Target Life enable(1), disable(0)	YES	0
TLife Src.	1-8	Target source	YES	1
TLife Set [kWh]	0-36000	Target lifetime	YES	36000
TLife Act [kWh]	-	Actual target lifetime	NO	nd

Measurements				
Parameters	**Range**	**Description**	**Adjustable?**	**Defaults**
Software ver.	-	Software versions readout	NO	-
+24V, etc.	-	Internal Power Supply output voltage and other internal voltages	NO	-
T1	0-100°C	Temperature of inlet water	NO	-
T2	0-100°C	Temperature of heat exchanger	NO	-
T3	0-100°C	Temperature of air at control PCB	NO	-
T4	0-100°C	Temperature of outlet water	NO	-
I chopp [A]	-	Internal current measurement.	NO	-
L12, L23, L31 (RMS) [V]	-	Mains voltage actual RMS value	NO	-

CSPC1..4				
Parameters	**Range**	**Description**	**Adjustable?**	**Defaults**
Iout	-	HVPS module output current	NO	-
U500	-	Rectified mains voltage	NO	-
U800	-	Inverter supply voltage	NO	-
T1	0-100°C	Temperature of output chopper	NO	-
T2	0-100°C	Temperature of heatsink	NO	-
T3	0-100°C	Temperature of air at control PCB	NO	-
T4	0-100°C	Temperature of main transformer	NO	-
+3V3; +5V	-	HVPS module voltages at control board	NO	-
DiffLem [A]	-	HVPS differential current measurement	NO	-

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11. Scope of delivery

Contents of the box:

- TruPlasma DC 3010 power supply
- Dummy plug for analog control socket (interlock removal)
- Output terminals cover
- Mains terminals cover
- Quick connect water pipe adapters (2 pieces)
- Inlet air pipe adaptor with stopper
- Lifting handgrips (4 pieces)
- User Manual
- Final Quality Report or Certificate of Conformity
- CD (software and manual)

TruPlasma DC 3010 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).