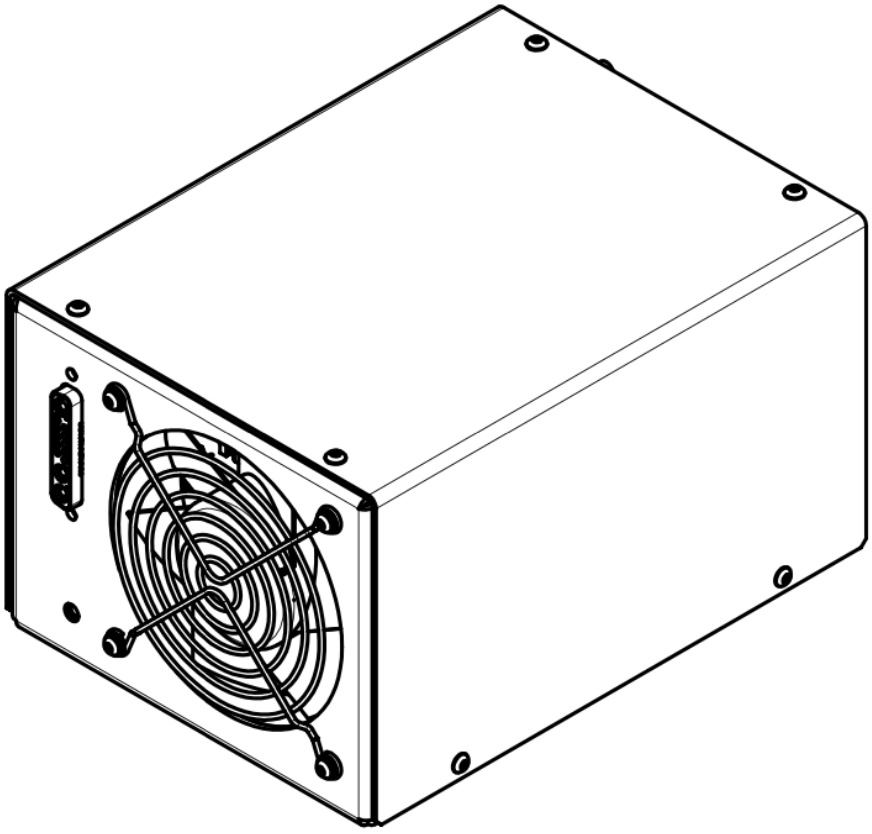
FLD-mini flashlamp driver

User manual



Warning! This equipment produces high voltages and can be dangerous.
Please read the entire user manual carefully before operating the product.

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Overview / Appearance

FLD-mini is a compact, all-in-one flashlamp driver specially designed to power solid-state lasers such as flashlamp-pumped Nd:YAG, Er:YAG, and similar types.

The driver includes a capacitor charging power supply, a small capacitor bank, an IGBT with its driver, protective circuits, simmer and trigger circuits, discharge resistors, and control electronics – in other words, everything required to generate quasi-rectangular pulses on a flashlamp using the energy stored in the embedded capacitor bank.

Driver's major features are:

- 24V DC input *(48V DC on request)*
- Maximum output power – 300W *(base version, up to 400W with 24V DC input, up to 700W with 48V DC input)*
- Maximum output voltage – 450V *(base version, up to 700V on request)*
- Built-in 2mF capacitor bank
- Flashlamp trigger and simmer circuits

The basic interface is the RS-232 (the RS-485 is available as an option). Simple PC software is supplied together with the controller.

Two operating modes are available for the flashlamp driver:

- **Internal synchronization mode**: In this mode, the flashlamp's operating frequency, pulse duration, and output voltage level can be programmed within the working range by the user via **RS-232** (**RS-485** is available upon request).
- **External synchronization mode**: Here, the pulse duration and output voltage level can still be programmed by the user via **RS-232**, but the operating frequency of the flashlamp is determined by an external pulse generator.

Cooling

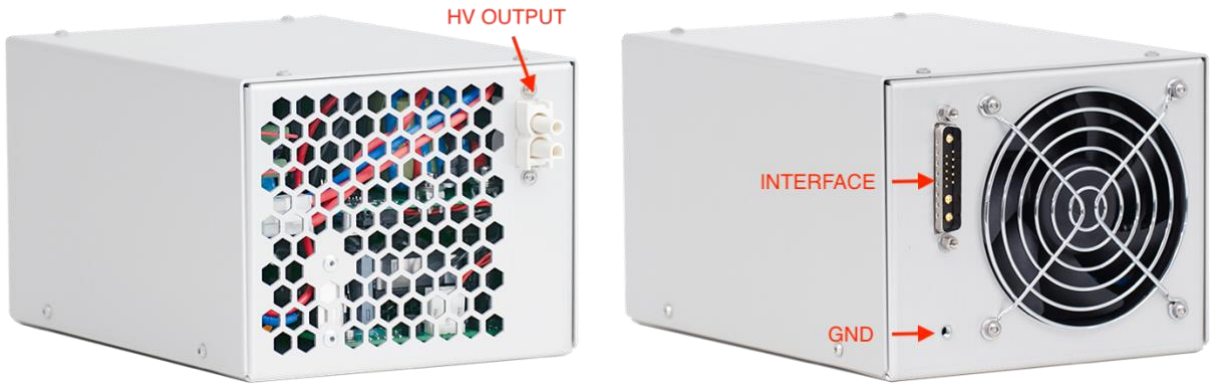
The module is cooled by a built-in fan. External cooling is not required.

Contents of delivery

By default, the delivery package contains the following parts:

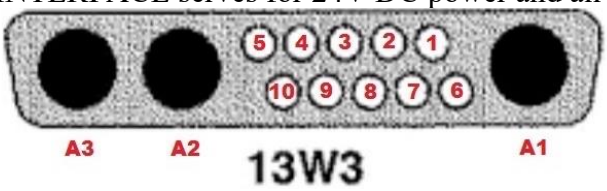
- FLD-mini flashlamp driver – 1pc
- Mating INTERFACE cable (50cm length) – 1pc
- Mating HV OUTPUT cable (50cm length) – 1pc

Connections, signals, signal descriptions



INTERFACE: 13 pin mixed D-SUB connector of 13W3 type

The INTERFACE serves for 24V DC power and all the control signals connection.



RS-232 modification:

PIN (color)	DESIGNATION	DESCRIPTION
1, 2 (transparent)	RS-232 GND	The control device connection (RS-232 interface).
3 (orange)	RS-232 RX	
4 (blue)	RS-232 TX	
5 (green)	IDC	Door-interlock connection. Should be pulled to the ground to allow the operations.
6 (violet)	Fault	Module internal failure indication. The module will indicate a fault in the following cases: - Overheating - Unable to charge capacitors - Unable to trigger flashlamp - Other failures
7 (white/blue)	Synchro IN	Incoming synchronization pulses should be applied to this pin if the module is running in external synchronization mode. Input impedance is approx. 1.6 kOhm
8 (white)	Synchro OUT	Synchro output signal coincided with pulse applied to the flashlamp (other on request)
9, 10 (black)	Interface Return	Common return of all interface circuits

A1 (yellow/green)	**GND**	This pin can be used for protective grounding instead of GND thread.
A2 (red)	**DC Input**	24V DC power supply connection. Maximum current consumption is 17A.
A3 (black)	**DC Input Return**	

RS-485 modification difference (other signals are identical to the RS-232 modification):

PIN (color)	DESIGNATION	DESCRIPTION
1, 2 (transparent)	**N/C**	-
3 (orange)	**RS-485 A**	The control device connection (RS-485 interface).
4 (blue)	**RS-485 B**	

HV OUTPUT: Proprietary connector by OEM Tech

The flashlamp is to be connected here.

Red wire – HV OUTPUT positive (to the flashlamp anode)
Black wire – HV OUTPUT negative (to the flashlamp cathode)

GND: M4 threaded terminal

The module should be grounded using this threaded terminal before switching on.

Grounding policy

The HV OUTPUT negative and the 24V DC return are connected to each other, but are electrically isolated from the chassis ground and the control circuits.

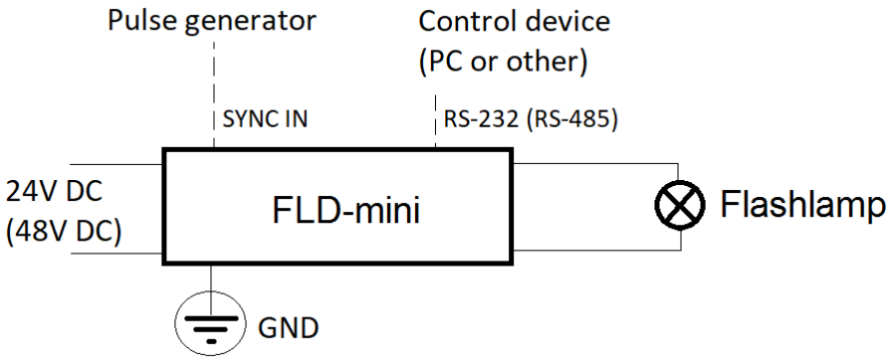
RS-232/485 and other Interface signals are isolated from each other and from the power circuits.
Other grounding policies are available upon request.

Safety

Warning! This equipment produces high voltages that can be very dangerous.
Be careful around the equipment.
Assemble the entire setup before powering up the device.

- The power supply enclosure must be protectively grounded via the provided grounding threaded terminal.
- Use a low-voltage power supply with a DC output galvanically insulated from the AC input (insulation strength of 4000VAC, 2500VAC or 1500VAC is selected in dependence on your application).
- Do not connect or disconnect the output cables while the driver is turned on.
- Do not operate with a disconnected load.
- Avoid casual contacts of personnel with the output cables and the load.
- Do not turn the power supply on if it has already been damaged by water, chemicals, or mechanical/electrical shock.
- Do not attempt to self-repair the power supply; there are no user-serviceable parts inside.

First-run procedure



1. Ensure the 24V DC power supply is turned off.
2. Connect the flashlamp, the 24 V DC power supply, and the controlling device to the FLD-mini. Ground the FLD-mini using the provided threaded terminal.
3. Organize your IDC connection or simply short-circuit the IDC using a choke.
4. Switch on the FLD-mini by turning on the 24V DC power supply.
5. Connect to the FLD-mini via the RS-232 interface (baud rate 38400; 8 data bit; 1 stop bit; no parity) or via the RS-485 interface.
6. Install and run the provided software to configure the driver parameters.
7. Your flashlamp driver is now ready for operation.

For more details see also *Software description* section, *RS-232 / RS-485 protocol description* section and then an extended example of operations in *Operations* section.

Operations (an extended example)

1. Connect the flashlamp, the 24 V DC power supply, and the controlling device to the FLD-mini. Ground the FLD-mini using the provided threaded terminal.
Organize your IDC connection or simply short-circuit the IDC using a choke.

2. Switch on the FLD-mini by turning on the 24V DC power supply.

3. Connect to the FLD-mini via the RS-232 interface (baud rate 38400; 8 data bit; 1 stop bit; no parity).

4. Check if the connection has been established successfully by sending some test commands (e.g. 'mF' or 'mV'). The response should be adequate to the command.

5. Setup the initial parameters following the sequence below:

- set the flashlamp impedance using '!k0' command (example '!k0 20.5'; '!k0 0' disables over-current and over-power protections)
- check if the flashlamp impedance has been set correctly using '!K0' command
- set the maximum current limit using '!i' command
- check if the current limit has been set correctly using '!I' command
- set the maximum power limit using 'h' command
- check if the power limit has been set correctly using 'H' command
- set the synchronization mode using 'x' command
- 'X' to check
- if necessary, set the synchronization edge using 't' command
- 'T' to check
- set the desired output voltage using 'v' command
- 'V' to check
- set the desired pulse width using 'p' command
- 'P' to check
- set the desired repetition rate using 'f' command
- 'F' to check

6. After the initial setup is done, start the internal sub-modules one-by-one:

- send 's 1' command for the flashlamp triggering
- after approx. 2s waiting time check the simmer arc status by sending 'mS' command
- on positive response received, send 'c 1' command for enabling the capacitor charging power supply
- after approx. 2s waiting time check if the capacitor bank is charged successfully either by sending 'mR' command or by sending 'mV' command (there might be some difference between set and measured value, usually 1-2% of V_{MAX}) or both
- on positive response received, send 'r 1' command to apply pulses to the flashlamp

7. The operating voltage, pulse width, and repetition rate can be changed in run mode. Synchronization parameters, however, cannot be modified while in run mode.

8. In run mode we recommend monitoring the internal state of the FLD-mini using the next commands:

- R – if the FLD-mini is in run mode
- mJ – error code

The recommended frequency for sending commands is 5Hz or less.

9. Shut down sequence:

- 'r 0' to stop pulses
- 's 0' to off the simmer
- 'c 0' to disable the capacitor charging

Note: the capacitor bank requires some time (15-20s) to discharge to a safe voltage level.

- disable the RS-232 connection
- remove the 24V DC power

Specifications

ELECTRICAL

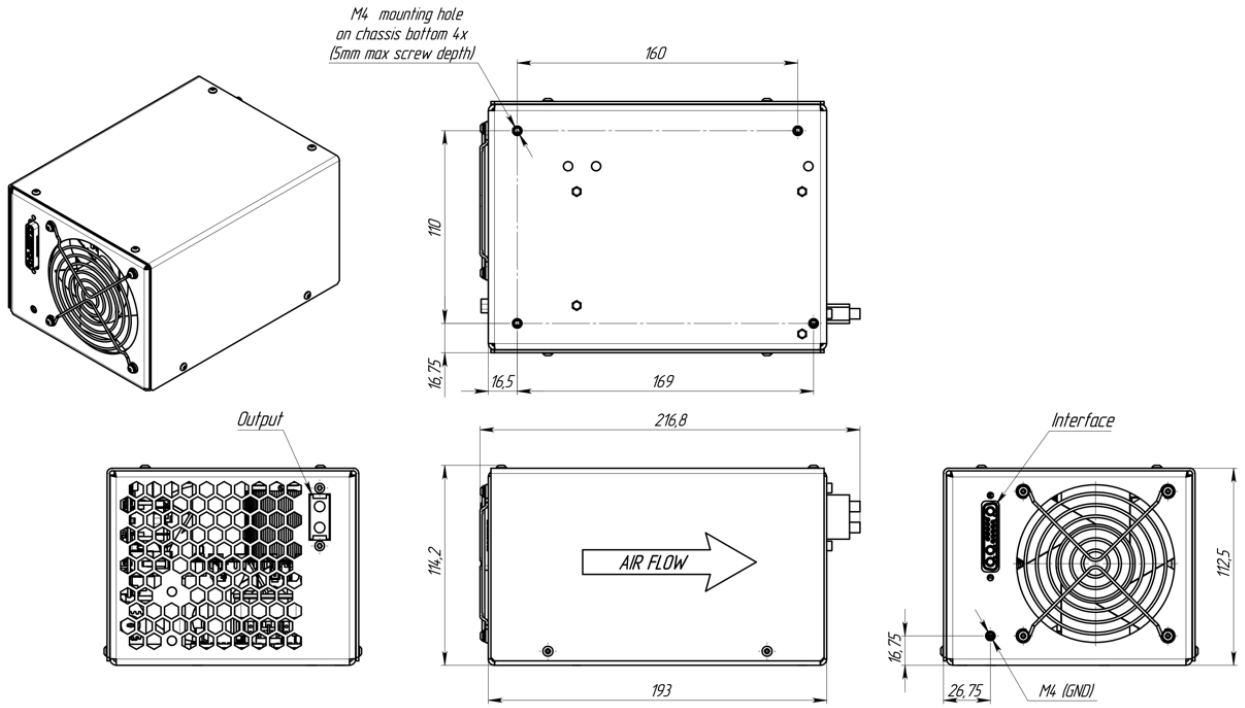
DC INPUT:	
Input voltage	+24V DC *(48V DC in optional high-power version which is available on request)*
Current consumption	17A max.
PULSE PARAMETERS:	
Max. voltage	450V *(base version, up to 700V on request)*
Max. discharge current	500A
Max. average power	300W *(base version, up to 400W with 24V DC input, up to 700W in optional high-power version with 48V DC input which is available on request)*
Pulse width	50us-1000us
Repetition rate	1-30Hz
WIRE INSULATION NOTE:	
For flashlamp connections	Due to series triggering with 10kV pulses additional insulation (e.g. with silicone tubing) or spacing (e.g. with spiral bundle hose) of L– wire is required
SIMMER PARAMETERS:	
Simmer current	500mA *(100-800mA on request)*
Max. output voltage	300V
Max. output power	100W
Open circuit voltage	1500V
FLASHLAMP TRIGGERING PARAMETERS:	
Triggering method	Series triggering with built-in transformer *(external triggering on request)*
Pulse energy / trigger voltage	~160mJ / 10kV negative to L– *(other on request)*
Trigger pulse width	~1 us
Restrike rate	A few Hertz (automatically adjusted)
COOLING	Forced air cooling with an integrated fan
PROTECTIONS	From overheating of internal components
ENVIRONMENT:	
Operation temperature	0…+40 °C
Storage temperature	-20…+60 °C
Humidity	0…90%, non-condensing

MECHANICAL

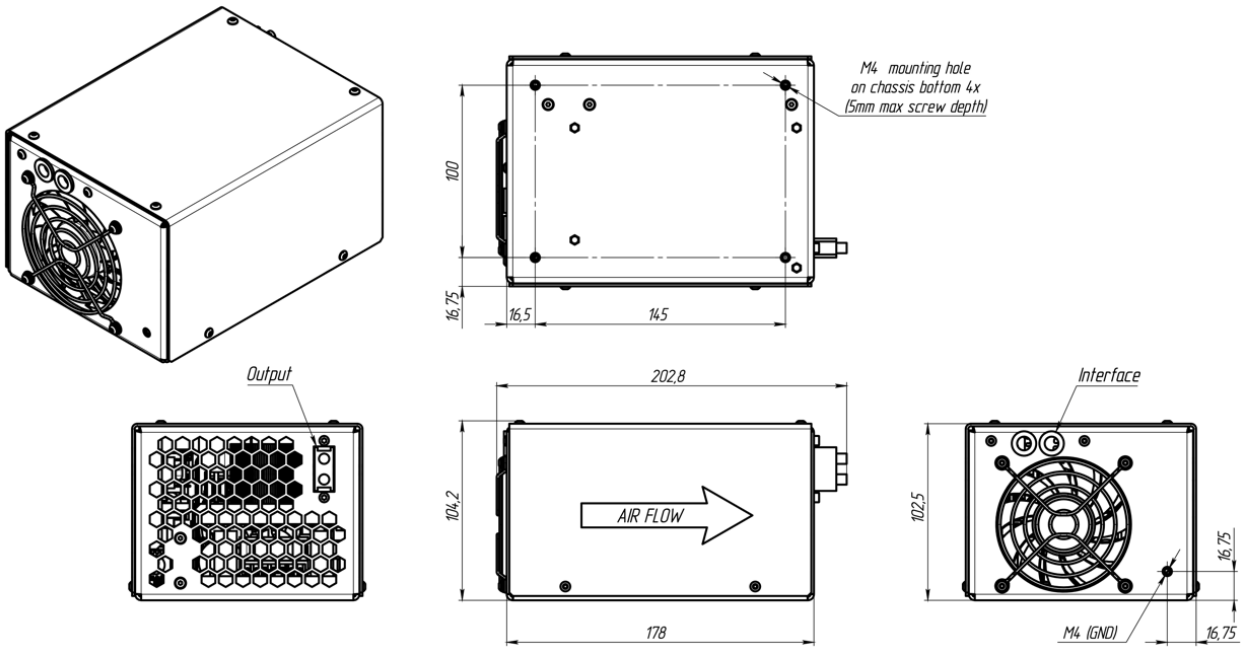
Size (LxWxH)	See dimensional drawings below
Weight	Approx. 2.0 kg (w/o cables)

Dimensional drawings

STANDARD VERSION:



COMPACT VERSION:



How to order?

By default, the FLD-mini is supplied with the following parameters:

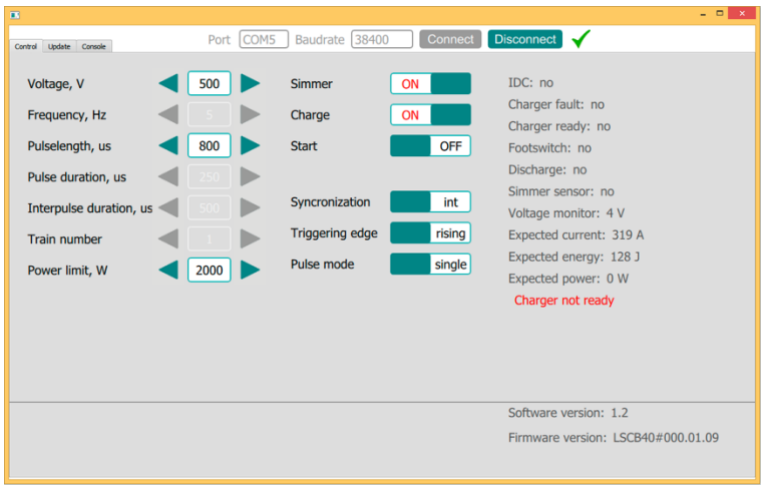
- 24V DC input voltage
- 450V maximum output voltage
- 2mF embedded capacitor bank (maximum rated voltage 450V)
- 300W maximum output power (achieved at voltages close to 450V)
- Series triggering
- RS-232 interface

If the default parameters are not suitable for your application, please complete the form below and send it to us.

Parameter	Options available (please select one)
Input voltage	☐ 24V DC ☐ 48V DC
Maximum output voltage	☐ 350V (embedded capacitor bank 2.7mF) ☐ 450V (embedded capacitor bank 2.0mF) ☐ 500V (embedded capacitor bank 1.5mF) ☐ 700V (embedded capacitor bank 0.7mF)
Maximum output power	With 24V DC input: ☐ 200W ☐ 300W ☐ 400W With 48V DC input: ☐ 500W ☐ 700W
Triggering	☐ Series ☐ External ☐ Both series and external
Interface	☐ RS-232 ☐ RS-485

Alternatively, you may provide a free-form description of your requirements.

Appendix 1: Software description



Voltage – sets the desired output voltage (V)

Frequency – sets the desired repetition rate of flashes (Hz)

Pulse length – sets the desired pulse width (us)

Charge – turns the capacitor charging module on and off

Simmer – turns the simmer supply on and off

Start – enables and disables flashes at the HV output

Synchronization – selects the synchronization mode – **Internal synchronization** / **External synchronization**

In the **Internal synchronization mode** flashes are defined by the internal MCU

In the **External synchronization mode** flashes are defined by an external signal applied to the SYNC IN signal of the INTERFACE connector

Triggering edge – in **External synchronization mode** defines the triggering edge of the synchronization signal – either the rising edge or the falling edge

IDC – status of the Door Interlock (IDC signal of INTERFACE connector) – flashes are prohibited if the IDC loop is open

Charger fault – internal fault status of the capacitor charging power supply

Charger ready – READY signal of the capacitor charging power supply

Discharge – status of the discharge resistors

Voltage monitor – the actual voltage on the built-in capacitor bank

Expected current – the calculated current through the flashlamp (calculations are based on Voltage and Flashlamp impedance K0 values)

Expected energy – the calculated flash energy (calculations are based on Voltage, Flashlamp impedance K0 and Pulse length values)

Expected power – the calculated power through the flashlamp (calculations are based on Voltage, Flashlamp impedance K0, Pulse length and Frequency values)

Lamp impedance K0 – should be set in accordance with the flashlamp datasheet

Appendix 2: RS-232 / RS-485 protocol description

RS-232/485 connection parameters: 38400 bps, 8 data bit, 1 stop bit, no parity
Command format is: {command} {data (optionally)} {end-of-line}

- Command is 1 to 4 character long (see the list below)
- Data is an ASCII-string, the command and data must be separated by a space (space symbol)
- End-of-line symbols are \n or \r\n

List of available commands:

#	Command	Description	Possible values			
			Min	Max	Inc	Def
1	sn	Sets the device's serial number (example «sn 123»)	0	65535	1	0
2	SN	Returns the device's serial number (ID)	0	65535	1	
37	*	Returns the firmware version	ASCII string up to 15 characters long			
40	!J	Returns the pulse counter	0	~4.29 10^9	1	0
41	#J	Resets the pulse counter	-	-	-	-
3	v	Sets the desired output voltage (in volts, example «v 300»)	100	450	1	100
4	V	Returns the voltage set point (*not voltage monitor*)	100	450	1	
5	p	Sets the desired pulse width (in us, example «p 250»)	50	1000	1	50
6	P	Returns the pulse width set point	50	1000	1	
7	f	Sets the desired pulse repetition rate (in hz, example «f 0.5», 0 means single shot)	0, 0.05	30	0.01	1
8	F	Returns the repetition rate set point	0, 0.05	30	0.01	
9	x	Sets the synchronization mode («x 0» – internal, «x 1» – external)	0	1	-	0
10	X	Returns the synchronization mode	0	1	-	
11	t	Sets the triggering edge in external synchronization mode («t 0» – rising, «t 1» – falling)	0	1	-	0
12	T	Returns the triggering edge	0	1	-	
35	xo	Defines how the synchro output is generated when the module operates in external synchronization mode («xo 0» – the synchro output is generated by the MCU. If necessary, it may differ from the incoming pulse, though at the cost of an additional delay; «xo 1» – the external synchronization pulse is directly repeated at the synchro output, so the delay is minimal)	0	1	-	0
36	XO	Returns the mode	0	1	-	
13	s	Turns the simmer supply on and off («s 1» – on, «s 0» – off)	0	1	-	0
14	S	Returns the simmer supply set point (*not simmer monitor*)	0	1	-	
15	c	Turns the capacitor charging module on and off («c 1» – on, «c 0» – off)	0	1	-	0
16	C	Returns the capacitor charging module set point	0	1	-	
17	r	Enables / disables the output («r 1» – enables)	0	1	-	0
18	R	Returns the corresponding set point	0	1	-	
19	h	Sets maximum power limit (in watts, example «h 200», 0 disables the protection)	0	400	1	300
20	H	Returns the maximum power limit	0	400	1	

21	!i	Sets the maximum current limit (in amps, example «!i 1000», 0 disables the protection)	0	650	1	650
22	!I	Returns the maximum current limit	0	650	1	
23	!k0	Sets the flashlamp impedance used for calculations (in $VA^{-1/2}$, example «!k0 28», 0 disables both over-power and over-current protections)	0	50	0.1	0
24	!K0	Returns the flashlamp impedance	0	50	0.1	
25	mV	Voltage monitor (volts)	0	500	1	-
26	mF	Returns the fault state (0 – no fault, 1 – fault). Once a fault has been occurred, the module: - Stops pulses (“r 0”) - Stops the charger (“c 0”) - Stops the simmer (“s 0”) - Sets the fault code (mJ) Once the fault cause disappears, the Fault state is automatically removed. The information about the last fault is stored in the error code (mJ).	0	1	-	0
27	mR	Returns the ready state (status of the capacitor charging module, 0 – not ready, 1 – ready)	0	1	-	-
28	mI	Returns the IDC state (0 – closed, 1 – open)	0	1	-	-
29	mS	Returns the simmer sensor state (0 – off, 1 – on)	0	1	-	-
38	sw	Sets the simmer sensor timeout (is seconds, example «sw 1», 0 disables the protection); if the simmer arc is lost for the time lesser than the timeout value, this situation is not considered as a fault	0	5	0.1	3
39	SW	Returns the simmer sensor timeout	0	5	0.1	
30	mD	Returns the state of the built-in discharging resistors (0 – no discharge, 1 – discharging)	0	1	-	-
31	mJ	Returns the error code *0 – No error* *1 – IDC is open* *2 – Charger’s internal fault* *3 – Simmer triggering failed on start (“s 1”)* *4 – Simmer arc has been lost in run mode* *5 – PC connection error (i.e. watchdog error, see wdg command)* *6 – Power too high (exceeds the limit set with h command)* *7 – Current too high (exceeds the limit set with !i command)* The error code will be cleared (set to 0) on the next successful start (“r 1”)	0	7	1	0
32	mP	Returns the expected power (watts)	0	65535	1	-
33	mC	Returns the expected current (amps)	0	65535	1	-
34	mE	Returns the expected energy (jouls)	0	65535	1	-
		Service commands				
42	^c	Calibrates the output voltage (in volts, one point calibration)	V_{MAX}-10 to V_{MAX}+10		1	-
43	^C	Returns the corresponding value			1	-
44	^k	Calibrates the voltage monitor (in volts, one point calibration)	V_{MAX}-10 to V_{MAX}+10		1	-
45	^K	Returns the corresponding value			1	-
46	_R	Resets calibrations (both voltage and monitor)	-	-	-	-
49	wdg	Sets the watchdog timeout (in seconds, for example “wdg 5”, “wdg 0” means that the timeout is disabled); if no command is received via RS-232 interface within this time, it is considered as a communication error	0	10	0.1	5
50	WDG	Returns the watchdog timeout	0	10	0.1	
51	vm	Sets the capacitor charger’s calibration (V_{MAX})	0	500	1	450
52	VM	Returns V_{MAX}	0	500	1	

53	widc	Sets the IDC waiting time (ms)	1	6000	1	200
54	WIDC	Returns the IDC waiting time (ms)	1	6000	1	
55	ss	Sets the slow-start time (in seconds, 0 – disabled)	0	60	1	0
56	SS	Returns the slow-start time	0	60	1	
57	mvp	Sets the HV power supply calibration constant	0	10	0.1	7
58	MVP	Returns the HV power supplycalibration constant	0	10	0.1	
47	#R	Resets the EEPROM (sets all parameters to the default values)	-	-	-	-
48	boot	Switches the MCU to the bootloader mode	-	-	-	-
55	#SM	Saves all parameters to the EEPROM	-	-	-	-
-	@, %, ?	Service commands left for compatibility purposes (not recommended to use)	-	-	-	-
-	^V, !R, #f	Service commands left for compatibility purposes (not recommended to use)	-	-	-	-