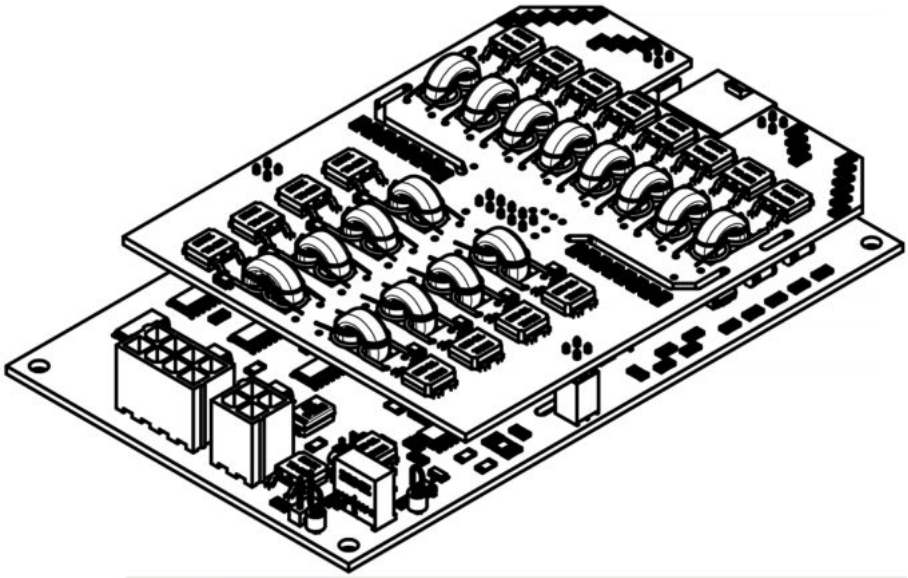
QBU-series Pockels cell drivers

User manual



Warning! This equipment may be dangerous.
Please read the entire user manual carefully before using the product.

Important note: please measure the output with symmetrical (differential) high voltage probe only. Measurement made with inappropriate equipment is a common cause of driver's failure.

Table of content

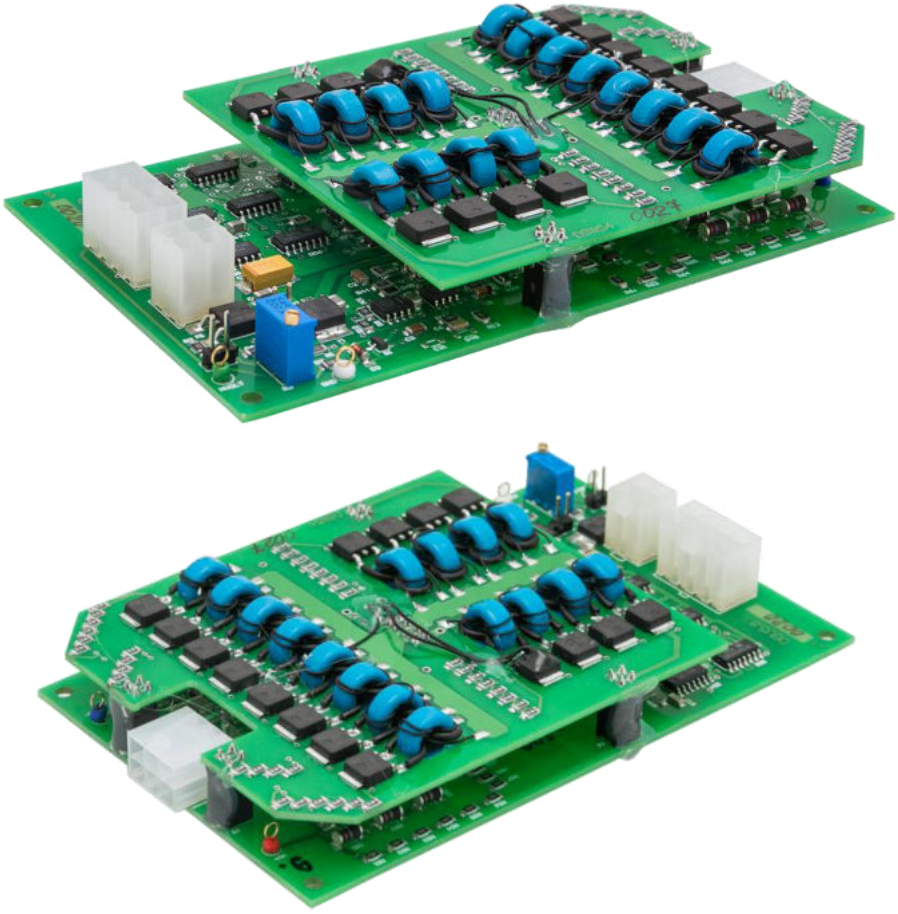
Overview / Appearance

QBU series Pockels cell drivers produce high voltage pulses with high repetition rates, fast rise and fall times, adjustable voltage amplitude and pulse width.

Unique feature of QBU-series is the possibility to produce extremely long pulses, up to DC. Driver just follows external TTL signals and keeps its state constant until TTL signal switches.

The modules require +24 V DC power supply and pulse generator to set an operating frequency and pulse width.

Two control types are available: manual and automatic, when an output voltage level can be programmed in working range by user either manually (through onboard configuration trimpot) or remotely (applying a DC voltage to the respective pin).



Cooling

No active cooling is required for low repetition rate operation. For full performance (up to three times higher repetition rates), forced air cooling with an external fan is needed. See the *Performance* section for details.

The “rule of thumb” is as follows:

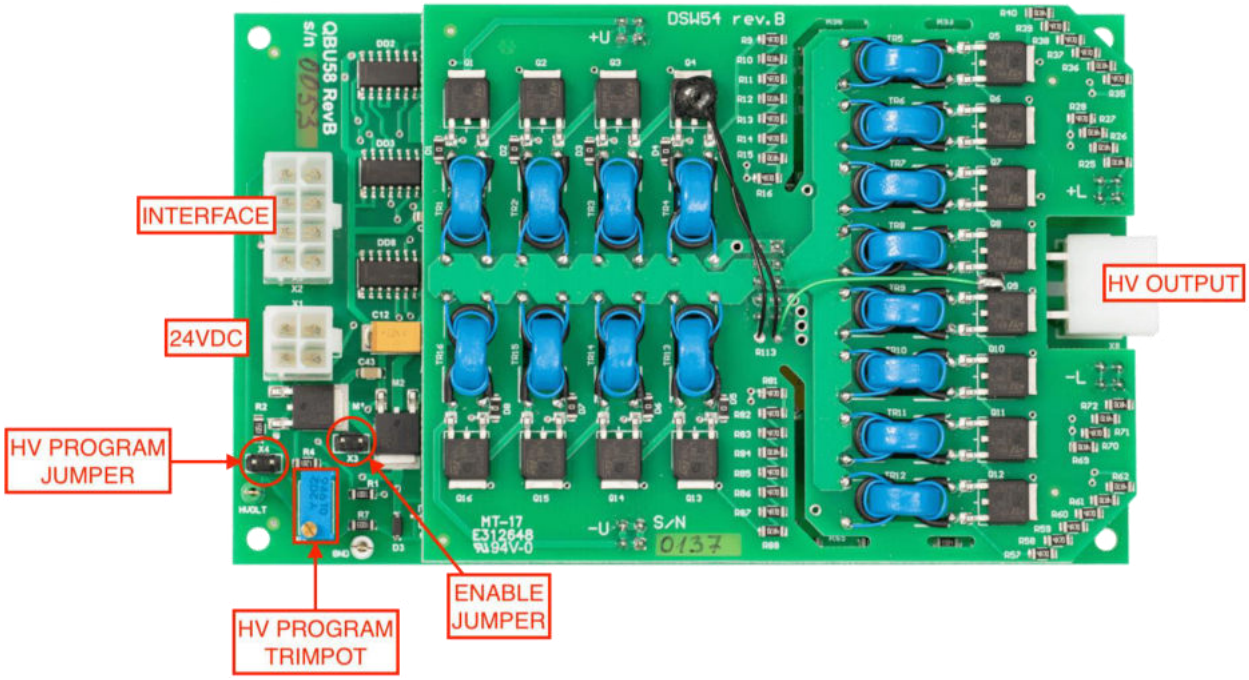
- Never exceed 24VDC current consumption of 350mA with conductive cooling
- Never exceed 24VDC current consumption of 900mA even with forced-air cooling

Contents of delivery

By default, the following items are supplied together with the driver:

- 24VDC input cable (50cm length) – 1pc
- INTERFACE cable (50cm length) – 1pc
- HV OUTPUT cable (50cm length) – 1pc

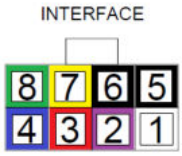
Connectors, pins, interface signals



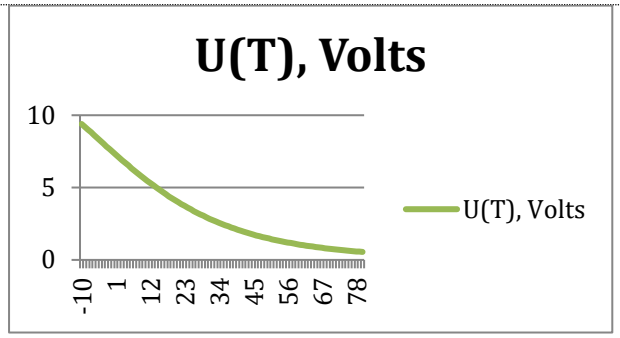
There are three Molex Mini-Fit connectors at Pockels cell driver board. Below is description of the corresponding cable receptacles supplied with the board as well as other controlling elements (jumpers and trimpots).

INTERFACE (Molex 39-30-1060):

Cable view:

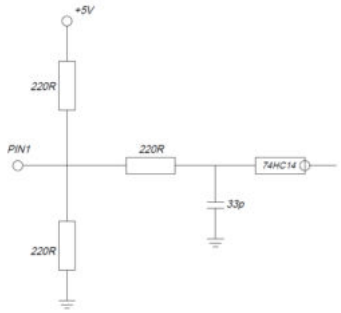
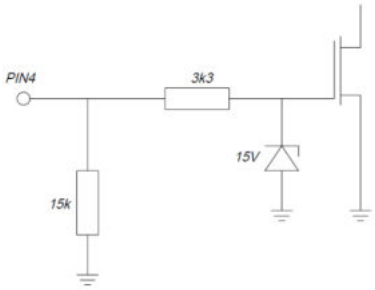


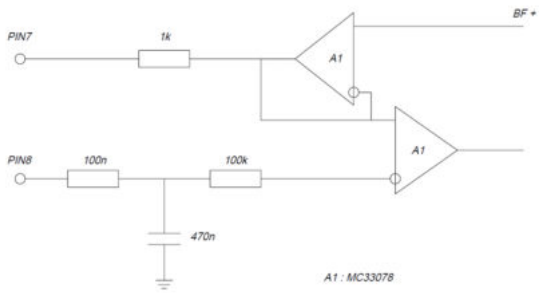
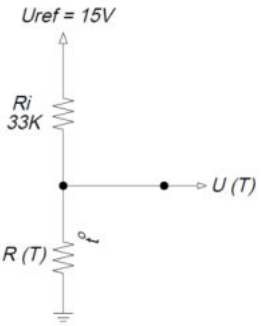
PIN (color)	DESIGNATION	DESCRIPTION
1 (white)	**Q-switch**	While “0” or ”1” is applied to PIN1 high voltage output is maintained correspondingly at 0V or **HV** level Sequences of triggering pulses with period less than approx. 1us are ignored by driver
2 (violet)	**Temp Monitor**	Returns output voltage corresponded to the internal temperature of the driver approximately by the following U(T) dependance:

		
3 (red)	**+15 V**	Provides auxiliary +15V DC voltage level
4 (blue)	**Enable**	Enables the high voltage output ("1" – enable, "0" – disable)
5, 6 (black)	**Interface Return**	PIN5 and PIN6 are connected to the circuit ground of all internal circuits
7 (yellow)	**HV Monitor**	The voltage value at PIN7 is a monitor signal proportional to the measured value of high voltage output **HV_{MAX}** corresponds to 10V at PIN7, **HV_{MIN}** corresponds to approx. 4V at PIN7
8 (green)	**HV Program**	Positive DC voltage applied to PIN8 sets up high voltage value **HV** **HV_{MAX}** corresponds to 10V at PIN8, **HV_{MIN}** corresponds to approx. 4V at PIN8

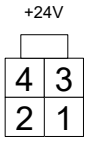
"0" means logical 0 low level (0V), "1" means logical 1 high level (5V)

INTERFACE CIRCUITS

Q-Switch	
Enable	

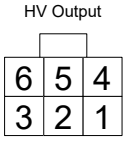
HV Program and HV Monitor	
Temp Monitor	

24VDC (Molex 39-30-1040):



PIN (color)	DESIGNATION	DESCRIPTION
1, 2 (red)	**+24V**	INPUT positive 24V DC for turn on the Pockels cell driver
3, 4 (black)	**RETURN**	Return from power supply producing +24V DC

HV OUTPUT (Molex 39-30-1060):



PIN (color)	DESIGNATION	DESCRIPTION
1, 4 (red)	**Positive**	HV Positive
2, 5	**N/C**	
3, 6 (blue)	**Negative**	HV Negative

ENABLE JUMPER:

On the customer's choice *ENABLE JUMPER* can be used instead of *ENABLE* signal of *INTERFACE*.

It isn't allowed to use *ENABLE JUMPER* and *ENABLE* signal at the same time.

HV PROGRAM JUMPER AND HV PROGRAM TRIMPOT:

On the customer's choice *HV PROGRAM JUMPER* can be used instead of *HV PROGRAM* signal of *INTERFACE.* If *HV PROGRAM JUMPER* is on, the output voltage is set accordingly to the state of *HV PROGRAM TRIMPOT.*

It isn't allowed to use *HV PROGRAM JUMPER* and *HV PROGRAM* signal at the same time.

Safety

Warning! This equipment produces high voltages that can be very dangerous. Be careful in a high-voltage appliances area.

- Assemble the entire setup before powering the device.
- Avoid casual contacts of personnel with output cables and with the load.
- Do not connect or disconnect cables while the driver is powered on.
- Do not operate with load disconnected.
- Be very careful when setting jumpers and using the HV PROGRAM trimpot; accidental contact with the board can be fatal; in the same sense, it's recommended not to control the driver manually, but remotely via the interface connector.
- Take care of the environment around the driver; do not place any objects close to any side of the driver.
- Do not turn on the driver if it has been damaged by water, chemicals, mechanical or electrical shock.
- Do not repair the driver yourself, there are no user serviceable parts inside.

Operations (manual control)

1. Connect 24V DC power supply, pulse generator and Pockels cell to *+24V*, *INTERFACE* and *HV OUTPUT* connectors respectively
2. Set up *HV PROGRAM JUMPER*
3. Turn on 24V DC power supply
4. Set up *ENABLE JUMPER*
5. Use *HV PROGRAM TRIMPOT* to set up required output voltage
6. Send driving pulses from pulse generator to *PIN1* of *INTERFACE*. Set both pulse length and distance between pulses not less than 1us
7. To power down the driver, turn off *+24V DC* power supply or remove *ENABLE JUMPER*

Operations (automatic control)

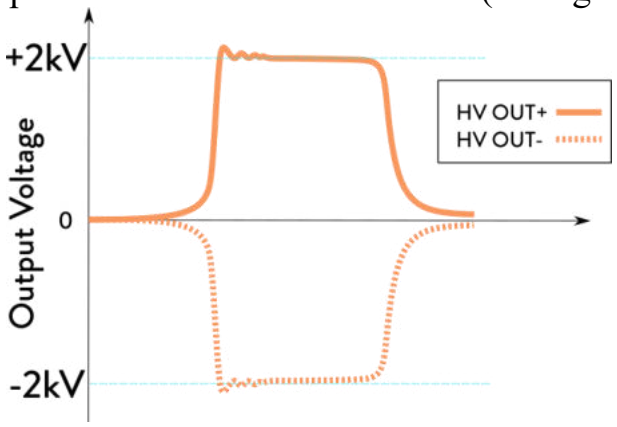
1. Connect 24V DC power supply, your controlling device and Pockels cell to *+24V*, *INTERFACE* and *HV OUTPUT* connectors respectively
2. Remove *HV PROGRAM JUMPER,* remove *ENABLE JUMPER*
3. *DISABLE* the high voltage output
4. Apply the correct nominal *DC INPUT* power to the module
5. Set up the required output voltage by applying a DC voltage to the *HV PROGRAM PIN8* of *INTERFACE*
6. *ENABLE* the high voltage output
7. Send driving pulses to *PIN1* of *INTERFACE*. Too short pulses will be processed as 200ns pulses
8. To power down the driver, remove *DC INPUT* power or *DISABLE* high voltage output

Technical notes

- **The performance of the module greatly depends on the load capacitance.**
  The best performance is achievable at load capacitance typical to Pockels cells used in laser industry (5-7pF).

Higher load capacitance decreases maximum allowed repetition rate

- **Module's output is bipolar.**
  This means that e.g. 4kV pulse is physically formed by producing +2kV on one output wire and -2kV on the other (see figure below).



  Nevertheless, all descriptions of HV output are given in terms of voltage differences. Please keep this in mind!

- **Sometimes output is delayed.**
  If no switching of the output voltage occurs for a long time (about 100us) the driver needs to refresh its state. During refreshment, the driver cannot switch the output, so if it receives a command to switch at such a time, it delays the transition until the end of refreshment.

  As a result, if the pulse width is more than 100us, or the distance between two sequential pulses is more than 100us, the switching of the high voltage output may sometimes be delayed. The delay time is approximately 150ns.

- **Output voltage measurement.**
  Please measure the output with symmetrical (differential) high voltage probe only. Measurement made with inappropriate equipment is a common cause of driver's failure.

In terms of performance, please keep in mind, that differential probes have significant capacitance, which should be counted as a part of the load capacitance.

Specifications

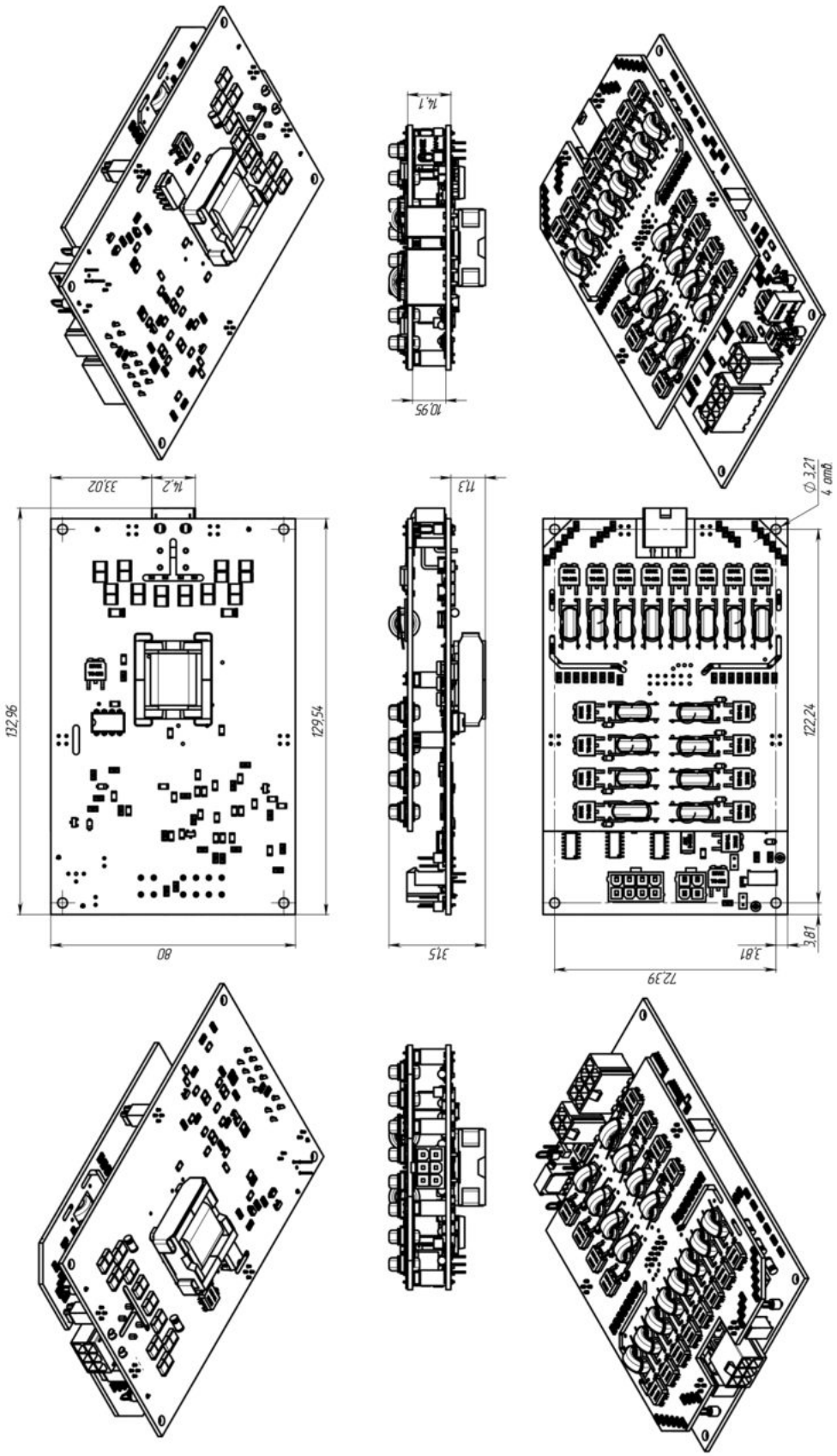
ELECTRICAL SPECIFICATION

Input:	+24V DC; 0.8A max
Output:	
Working mode	repetition of the input TTL signal 
HV high level (pulse amplitude)	adjustable in HV_{MIN} – HV_{MAX} range (see also *How to order?* section)
HV low level (pulse basement)	fixed, 0V
Pulse width	200ns – DC
Max. repetition rate	see *Performance* section
Rise time / fall time	<15ns (10-90% level, guaranteed at load capacitance 11pF and below)
Jitter	±1ns in LJ-modification ±10ns in low-cost version
Delay time	<100ns in LJ-modification <1us in low-cost version
Cooling:	forced air cooling at high repetition rates
Protections	from overheating (approx. 72 °C)
Environment	
Operation temperature	+10...+40ºC
Storage temperature	-20...+60ºC
Humidity	0…90%, non-condensing

MECHANICAL SPECIFICATION

Size (LxWxH)	130x80x32mm (see also the dimensional drawing below)
Weight	<0.1kg

Dimensions


14,1
10,95
33,02
14,2
13
Ø 3,21
4 отв
132,96
129,54
122,24
80
31,5
72,39
3,81
3,81

How to order?

QBU-XXYY-[ZZ], where:
- XX codes the maximum output voltage (HV_{MAX}, user selectable up to 6000V),
- YY codes the minimum output voltage (HV_{MIN}, 40% of V_{MAX}),
- [ZZ] codes options:

  LJ – low jitter option (mandatory for 6kV modification, optional for others). In LJ version of the driver jitter is as low as ±1ns, delay time is shorter than 100ns. Without LJ option specified a low-cost version of the driver (with ±10ns jitter and <1us delay) will be supplied instead.

Examples (the most popular modifications):

Part number	**HV_{MAX}**	**HV_{MIN}**
QBU-6024-LJ	6000V	2400V
QBU-5020-LJ QBU-5020	5000V	2000V
QBU-4016-LJ QBU-4016	4000V	1600V
QBU-3012-LJ QBU-3012	3000V	1200V
QBU-2008-LJ QBU-2008	2000V	800V
QBU-1004-LJ QBU-1004	1000V	400V

Other modifications are available on request.

Performance

The table below contains the maximum repetition rate in dependence on output voltage and cooling conditions. Other setup parameters – total load capacitance 11pF, ambient temperature 25 °C:

Output voltage, kV	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0
Repetition rate, kHz (conductive cooling)	>40	>25	>20	>15	>11	>9	>7	>5
Repetition rate, kHz (*appropriate* forced-air cooling)	>115	>80	>60	>45	>35	>30	>25	>15

In the burst mode (= short time operation) the performance increases approximately twice and can greatly exceed 100kHz value at low operating voltage and low load capacitance.

Higher load capacitance and higher ambient temperature decreases the performance.

Output oscillograms

Product: QBU-6024-LJ
Load: 11pF HV capacitor + HV Probe (approx. 13pF)
Regime: 6kV pulses