QBU-mini Pockels cell driver

User manual

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.

Overview

QBU-mini-series Pockels cell drivers produce bipolar high voltage pulses with high repetition rate, fast rise time and fall time (typically ~ 10 ns), adjustable voltage amplitude and pulse width (from min. 200 ns to CW).

The module is bipolar. This means that e.g. 4 kV pulse is physically formed by applying +2 kV to the positive output wire and –2 kV to the negative (see figure).
All mentions of HV output are given in terms of voltage differences. Please, keep this in mind!

+2kV

0V

-2kV
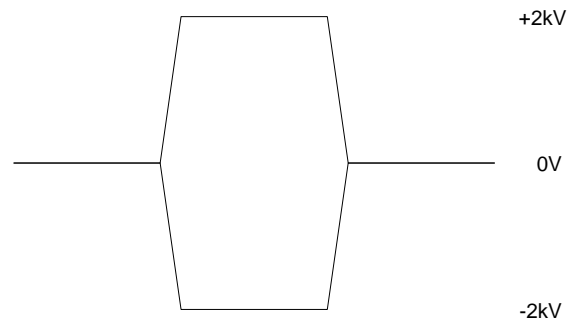
The modules require +24 V DC power supply and pulse generator to set an operating frequency and pulse width. An output voltage level can be programmed in working range by user either manually (through onboard configuration trimpot) or remotely (applying a DC voltage to the respective pin).
Triggering by an external low voltage arbitrary TTL signal allows to set any output mode – base voltage (zero or HV), user-defined non-periodic pulses.

## Interfaces / signals / descriptions
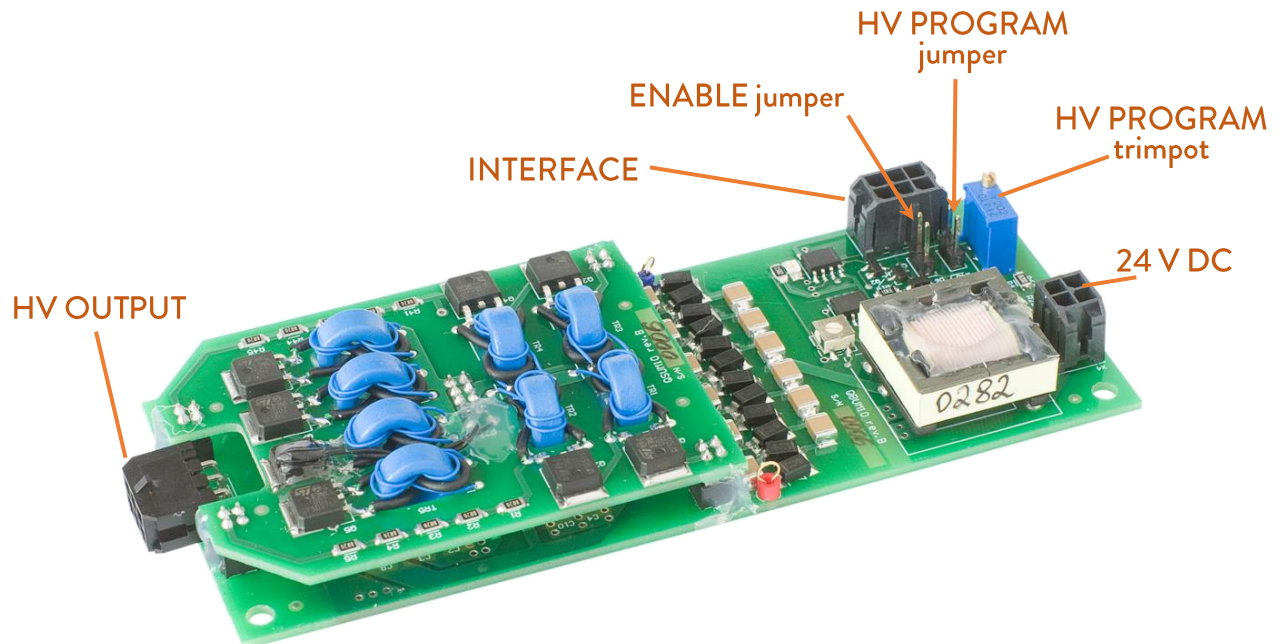
ENABLE jumper:

One can use ENABLE jumper instead of ENABLE signal of INTERFACE to enable the HV output. It's not recommended to use ENABLE jumper and ENABLE signal at the same time.

HV PROGRAM jumper and HV PROGRAM trimpot:

One can use HV PROGRAM jumper instead of HV PROGRAM signal of INTERFACE. If this jumper is set on, the output voltage is defined with HV PROGRAM trimpot state. It's not recommended to use HV PROGRAM jumper and HV PROGRAM signal at the same time.

INTERFACE (Molex microfit 2x3):

Interface

```
6 5 4
3 2 1
```
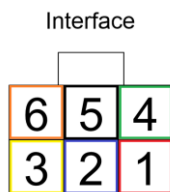
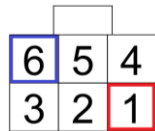| PIN (color)	DESIGNATION	DESCRIPTION
1 (red)	+15 V	Provides +15V DC output level; maximal current capability is 100mA
2 (blue)	Enable	Enables / disables HV output ("1" – enable, "0" – disable)
3 (yellow)	HV Monitor	The voltage at PIN3 is a monitor signal proportional to the measured value of the high voltage output **HVmax** corresponds to 10V at PIN3, **HVmin** corresponds to 4V at PIN3
4 (green)	HV Program	Positive DC voltage applied to PIN4 sets up high voltage level **HV** **HVmax** corresponds to 10V at PIN4, **HVmin** corresponds to 4V at PIN4
5 (black)	Interface Return	PIN5 is connected to the driver's ground circuit
6 (orange)	Pulse	While "0" or "1" is applied to PIN6 high voltage output is maintained correspondingly at **0V** or **HV** level Sequences of incoming pulses with period less than approx. 200ns will be ignored by the driver

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

+24V (Molex microfit 2x2):

+24V

```
┌──┬──┐
│ 4│ 3│
├──┼──┤
│ 2│ 1│
└──┴──┘
```

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

HV OUTPUT (Molex microfit 2x3):

```
┌──┬──┬──┐
│ 6│ 5│ 4│
├──┼──┼──┤
│ 3│ 2│ 1│
└──┴──┴──┘
```

PIN (color)	DESIGNATION	DESCRIPTION
1 (red)	Positive	HV Positive
6 (blue)	Negative	HV Negative

> **Warning!** This equipment produces high voltage that can be very dangerous. Be careful around the device!

- Avoid casual contacts of personnel with output cables and with the load
- Do not connect / disconnect cables while driver is turned on
- Do not operate with disconnected load
- Be very careful setting jumpers on and off and using HV PROGRAM trimpot; accidental contact to the board may be fatal; from the same point of view, it is recommended to control the driver not manually, but remotely via Interface connector
- Be careful with driver's neighborhood; do not store disordered items close to any side of the driver
- Do not turn the driver on if it was already damaged with water, chemicals, mechanical or electrical shock; do not self-repair the driver

Operations (Manual control)

1. Connect +24 V DC power supply, pulse generator and Pockels cell to the QBU-mini driver
2. Set up HV PROGRAM jumper
3. Turn on +24 V DC power supply
4. Set up ENABLE jumper
5. Use HV PROGRAM trimpot to set up the required output voltage
6. Send driving pulses from pulse generator to PIN6 of INTERFACE. A time between switching (driving pulse width and interpulse interval) should be more than 200 ns. Faster logic signal changes will not be proceeded correctly
7. To shut down the driver, turn off +24 V DC power supply or remove ENABLE jumper

Operations (Automatic control)

1. Connect +24 V, INTERFACE and HV OUTPUT connectors to the board
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 PIN4 of INTERFACE
6. ENABLE the high voltage output
7. Send driving pulses to PIN6 of INTERFACE. A time between switching (driving pulse width and interpulse interval) should be more than 200 ns. Faster logic signal changes will not be proceeded correctly
8. To shut down the driver, remove DC INPUT power or DISABLE high voltage output

Technical notes

- **Performance of the module greatly depends on load capacitance.** Full performance is achievable at load capacitance < 11 pF.

<div style="border:2px solid red; background:yellow">

Higher load capacitance decreases maximum possible repetition rate

</div>

- **At middle and high operation frequencies (more than 5-10 kHz) forced air cooling is required.** The driver has internal protection from overheating – it automatically shuts down at ~70℃

Kept cool enough with forced air cooling, at low load capacitance and low operating voltage modules may achieve a performance up to 30 kHz (continuous mode) or 50 kHz (burst-mode). At the full load (3.5 kV, 11 pF) repetition rate is higher than 8 kHz.

- **Sometimes output is delayed.** If no switching of the output voltage occurs for a long time (about 100 us) the driver needs to refresh its state. During refreshment it's prohibited to switch the output.

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

Specifications

ELECTRICAL SPECIFICATION

Input	+24V DC; 0.5A max
Output	
Working mode	repetition of the external TTL signal
HV higher level [1]	adjustable in HVmin – HVmax range (see *How to order?* on p.9)
HV lower level [1]	0 V, fixed
Pulse width	200 ns – ∞
Max. repetition rate	> 8 kHz at the full load (3.5 kV, 11 pF)
Rise / fall time	< 15 ns, typ. ~10 ns
Jitter	± 2 ns typ.
Delay time	150 ns typ.
Protections	from overheating (approx. 72 °C)
Environment	
Operation temperature	+10...+40 °C
Storage temperature	-20...+60 °C
Humidity	90%, non-condensing

[1] In terms of bipolar output
[2] 10-90% level, guaranteed at load capacitance 11 pF and below

We have also a short pulse modification of QBU-mini which is able to provide pulses with 100-2000 ns width, with much lower jitter (< 0.2 ns), small delay time (< 40 ns) and faster rise /fall (< 10 ns, ∼7 ns typ.) Please, ask us or find **QBU-mini-SP** on our web site.

MECHANICAL SPECIFICATION

Size (LxWxH)	140 x 50 x 20 mm
Weight	< 0,1 kg

How to order?

QBU-mini-XXYY, where:
- XX codes the maximum output high voltage level (HVmax)
- YY codes the minimum output high voltage level (HVmin)

Examples (the most popular modifications):

Part number	HVmin	HVmax	Description
QBU-mini-4016	4000V	1600V	4.0-1.6 kV high voltage adjustment range
QBU-mini-3514	3500V	1400V	3.5-1.4 kV high voltage adjustment range
QBU-mini-3012	3000V	1200V	3.0-1.2 kV high voltage adjustment range
QBU-mini-2008	2000V	800V	2.0-0.8 kV high voltage adjustment range
QBU-mini-1004	1000V	400V	1.0-0.4 kV high voltage adjustment range

Other modifications are available on request.

Performance

For continuous operation **without any additional cooling** a performance table is:

11 pF load capacitance							
Voltage, kV	1.0	1.5	2.0	2.5	3.0	3.5	4.0
Max. rep. rate, kHz	70	35	23	15	10	7	5.5

In the burst-mode (= short time operations) if cooled properly, the performance increases approximately twice and may achieve 100 kHz value at low operating voltage and low load capacitance.

Higher load capacitance decreases the performance.

Note: modules with the higher performance are available on request