QBU-mini-SP
Pockels cell driver

User manual

> **Warning!** This equipment produces high voltages that can be very dangerous. Please read user manual before starting operations.

> **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-SP series Pockels cell drivers produce bipolar high voltage pulses with high repetition rate, fast rise time and fall time (< 10 ns), adjustable voltage amplitude and pulse width (from 100 ns to 2000 ns).
The series is a modification of QBU-mini.

The differences between QBU-mini and QBU-mini-SP modification

	QBU-mini-SP	QBU-mini
Pulse width	100 – 2000 ns	200 ns – ∞
Rise / fall time	< 10 ns, typ. ~7 ns	< 15 ns, typ. ~10 ns
Jitter	± 0.2 ns	± 2 ns typ.
Delay time	< 40 ns	< 160 ns

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!
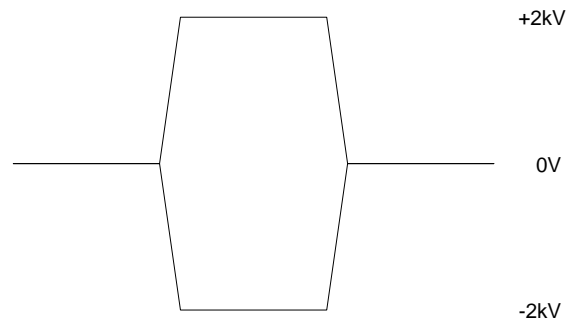
The modules require +24 V DC power supply and pulse generator to set an operating frequency and pulse width. An output voltage level can be programmed in working range by user either manually (through onboard configuration trimpot) or remotely (applying a DC voltage to the respective pin).

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.
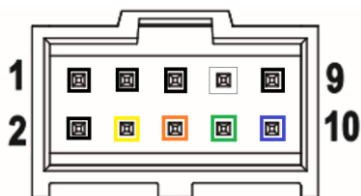
Appearance and layout

HV OUTPUT

24VDC

PULSE

INTERFACE
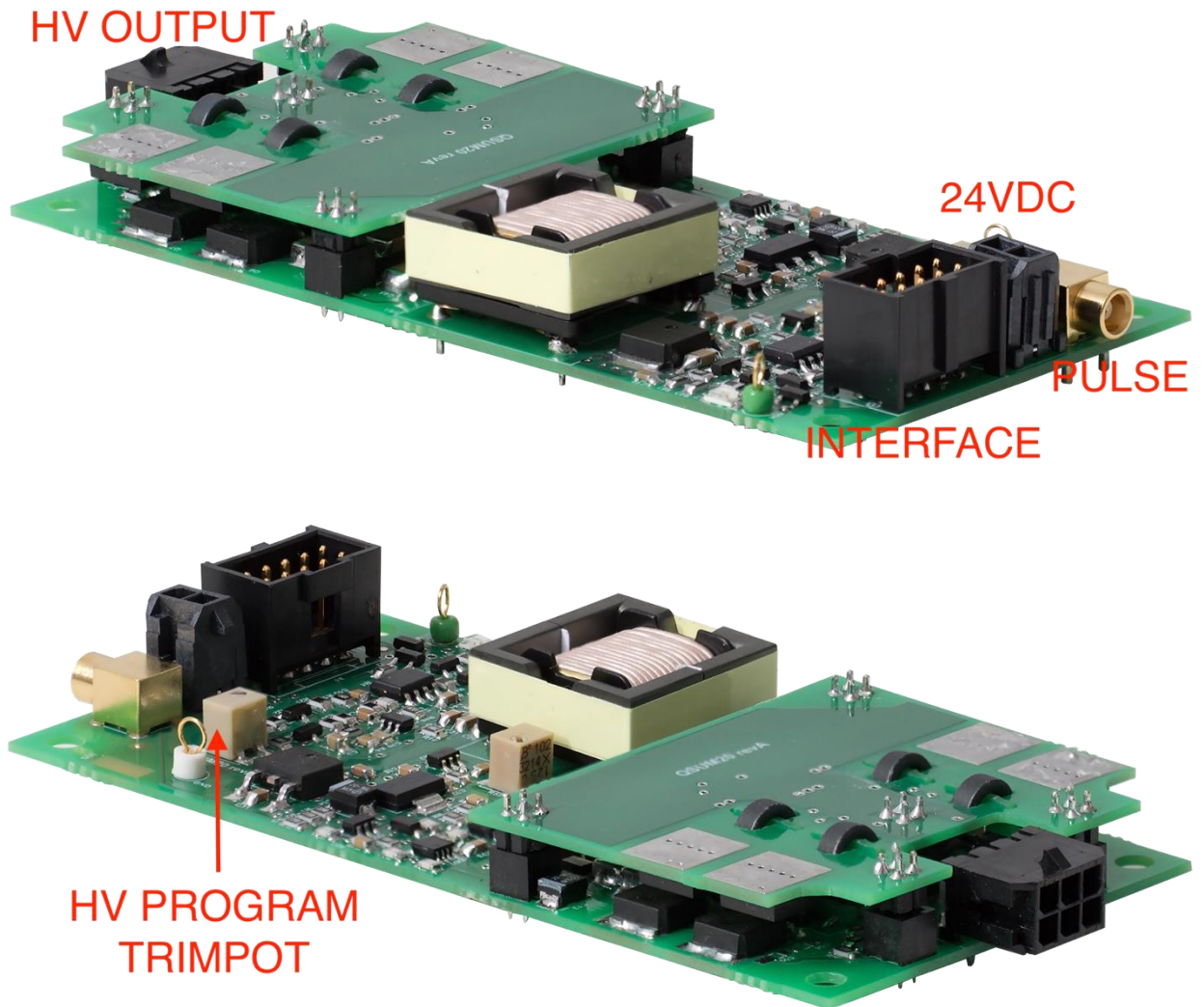
HV PROGRAM
TRIMPOT

Interfaces / signals / descriptions

**ENABLE jumper, HV PROGRAM jumper
and HV PROGRAM trimpot**

QBU-mini-SP can be controlled in manual regime. In this case, ENABLE jumper
should be used instead of ENABLE signal, HV PROGRAM jumper together with
HV PROGRAM trimpot should be used instead of HV PROGRAM signal.

ENABLE jumper is set between PINs 10 and 9 of INTERFACE connector.
HV PROGRAM jumper is set between PINs 8 and 7 of INTERFACE connector.

INTERFACE (Molex C-Grid III 0901301210):

PIN (color)	DESIGNATION	DESCRIPTION
1, 2, 3, 5, 9 (black)	**GND**	Driver's ground
4 (yellow)	**HV Monitor**	The voltage at PIN4 is a monitor signal directly proportional to the measured value of the high voltage output **HVmax** corresponds to 10V at PIN4, **HVmin** corresponds to 4V at PIN4
6 (orange)	**Fault**	0V if fault occurred, 5V otherwise. Fault state is set in the next cases: • Overheating of QBU-mini Fault state is additionally indicated with a red LED onboard
7 (white)	**HV Program Trimpot output**	PINs 7 and 8 should be interconnected with jumper to use the driver in manual regime. In this case output voltage is defined with HV PROGRAM trimming potentiometer Clockwise rotation increases **HV** value Counterclockwise rotation decreases **HV** output value
8 (green)	**HV Program**	Positive DC voltage applied to PIN8 sets up high voltage output value **HV** **HVmax** corresponds to 10V at PIN8, **HVmin** corresponds to 4V at PIN8
9 (black)	**Enable Jumper (GND)**	PINs 9 and 10 should be interconnected to use QBU-mini-SP in manual regime
10 (blue)	**Enable**	PIN 10 should be pulled to the ground to enable the driver's output. Output is disabled while TTL high level is applied to PIN 10 or PIN 10 is left unconnected To use QBU-mini-SP in manual regime, PIN 10 should be short-circuited with one of Interface return pins (e.g. PIN 9)

PULSE (Linx Technologies CONMCX002**):**

PIN (color)	DESIGNATION	DESCRIPTION
1 (black)	**PULSE**	Driver's output repeats TTL signal applied to this pin. Minimal pulse width is 100ns, maximal pulse width is 2000ns. Input impedance is 50Ohm. Signal amplitude delivered to the switch should be +5V DC assuming divider of switch's input impedance and pulse generator output impedance.

+24V (Molex Micro-Fit 43045-0212):

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

HV OUTPUT (Molex Micro-Fit 43045-0600):

PIN (color)	DESIGNATION	DESCRIPTION
1, 4 (red)	**Positive**	**HV** Positive
3, 6 (blue)	**Negative**	**HV** Negative

Safety

- 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's recommended to control the driver not manually, but remotely via Interface connector
- Do not turn the driver on if it was already damaged with water, chemicals, mechanical or electrical shock; do not self-repair the driver

Technical notes

- **Performance of the module greatly depends on load capacitance.** Full performance is achievable at load capacitance <7 pF.

Higher load capacitance decreases maximum possible repetition rate

- **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 ~95 ℃

Kept cool enough with forced air cooling, at low load capacitance and low operating voltage modules may achieve tens of kHz performance (continuous mode) or nearly twice more (burst-mode). At the full load (4.0 kV, 7 pF) repetition rate is higher than 10 kHz.

Operations (Manual control)

1. Connect +24 V DC power supply, pulse generator and Pockels cell to the QBU-mini-SP driver
2. Set up HV PROGRAM jumper between PINs 8 and 7 of INTERFACE connector
3. Turn on +24 V DC power supply
4. Set up ENABLE jumper between PINs 10 and 9 of INTERFACE connector
5. Use HV PROGRAM trimpot to set up the required output voltage
6. Send driving pulses from pulse generator to PULSE connector.
   A time between switching (driving pulse width and interpulse interval) should be more than 100 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. Remove HV PROGRAM jumper from PINs 7 and 8, remove ENABLE jumper from PINs 9 and 10 of INTERFACE connector
2. Connect +24 V, INTERFACE, PULSE and HV OUTPUT connectors to the driver
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 PULSE connector.
   A time between switching (driving pulse width and interpulse interval) should be more than 100 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

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	100 ns – 2000 ns
Max. repetition rate	> 10 kHz at the full load (4.0 kV, 7 pF)
Rise / fall times	< 10 ns
Jitter	< ±0.2 ns
Delay time	< 40 ns
Protections	from overheating (approx. 95 °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 7 pF and below

QBU-mini-SP is a modification of QBU-mini with short pulses and some other changes. Please, find all the differences on page 2 of the manual.

MECHANICAL SPECIFICATION

Size (LxWxH)	102 x 50 x 20 mm
Weight	< 0,1 kg

How to order?

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

Other modifications are available on request.