QBU-nano 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! The measurements of the high voltage output of QBU-nano is a very complicated process. Please read pages 2-4 of this user manual carefully before doing any measurements of the driver's output.

Output measurements

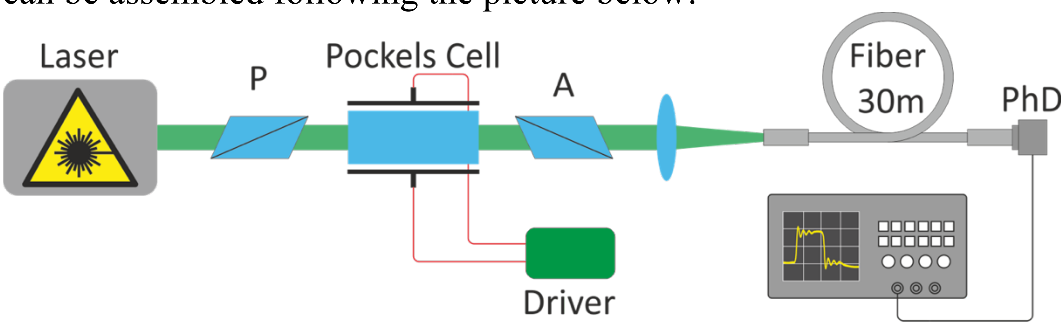
QBU-nano is a very fast driver. Rise time and fall time are as short as 1-3ns. Unfortunately, it was impossible to create such a fast driver without affecting the usability of the driver.

First of all, due to intrinsic limitations the high voltage output of QBU-nano is really sensitive to the load. As a result, unlike other drivers of QBU-series, the output voltage of QBU-nano depends significantly on the load capacitance. The dependence is pretty strong, around 100V per every 1pF of the load capacitance. This leads to the following limitations:

1) The driver should be located as close to the Pockels cell as possible.
2) Cable length should be also kept as short as possible. Even original cables, which are 15cm long, better to be shortened accordingly to the real distance between QBU-nano and the Pockels cell. The recommended cable length is 5-7cm.
3) Cable shouldn't be twisted or attached close to the metal parts.

4) **There is no electrical methods to measure the output voltage with good accuracy.** Every probe connected to the output adds 4-6pF to the total load capacitance and distorts the measured voltage for hundreds volts.

Truly correct measurements of the output voltage can be performed by indirect methods only, either optical or electrical. The typical 'optical' setup can be assembled following the picture below:



The recommended procedure is as follows:

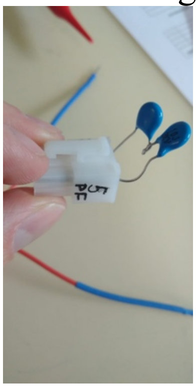
1) To calibrate optical transmission of the setup using a robust Pockels cell driver whose parameters don't depend on the load capacitance. Standard QBU (not QBU-nano) fits well for these purposes. The result of this step is Transmission-vs-Voltage curve.

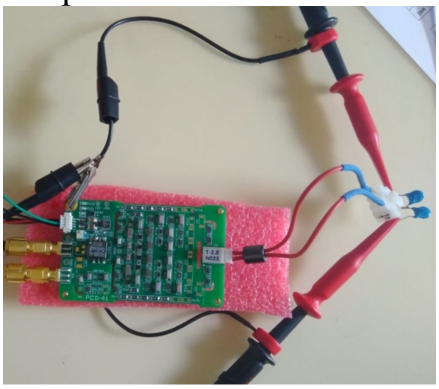
2) To connect QBU-nano to the Pockels cell and to measure the optical transmission of the setup. Then, by using Transmission-vs-Voltage curve to find the voltage corresponding to the optical transmission measured at this step.

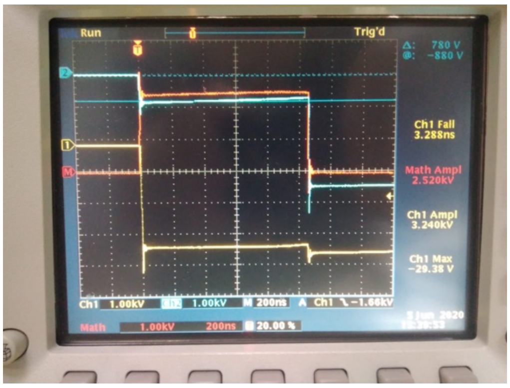
> Basing on the aforesaid, we recommend not to measure the output voltage in volts, but to adjust the output voltage of QBU-nano 'in vivo' accordingly to the best performance of the real equipment.

To make <u>approximate</u> suggestions about QBU-nano's output one of the following methods can be used:

1) [recommended] Pin 3 of X1 connector returns the signal linear with DC voltage produced inside QBU-nano board (1:10000)
2) [non-recommended] Pulse shape can be approximately recorded following the pictures below:







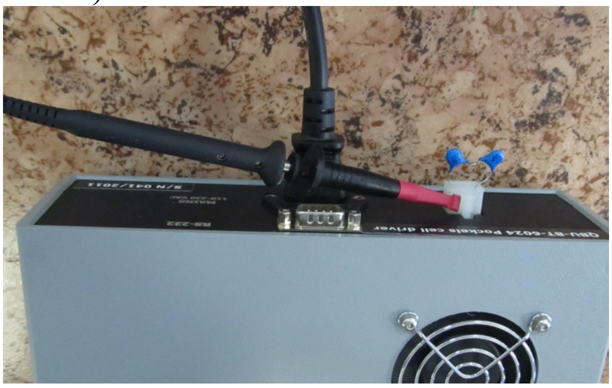
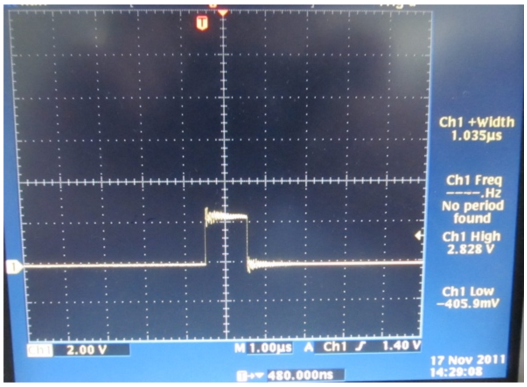
Important notes:

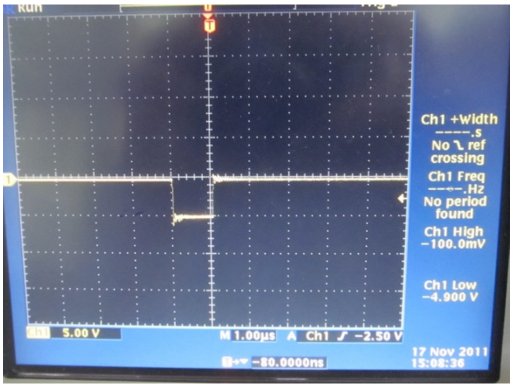
- Two identical probes must be attached to the output during the measurements. The only probe connected to the output is a non-symmetrical load which can damage the driver.
- The voltage rating of every probe should be equal or higher to the voltage rating of QBU-nano, e.g. two 4kV PPE4KV probes by LeCroy for QBU-nano of 3.8kV modification. The use of mismatched probe might lead to the electrical breakdown.
- The rated capacitance of every probe should be limited with 4-6pF.
- Ground of both probes should be connected to the common ground of QBU-nano board.
- Math should be used on oscilloscope, one channel to be extracted from the other.
- The pulse amplitude measured in this way will be slightly less than the expected value of the high voltage because of approx. 10pF extra capacitance added by two probes connected to the output.

Secondly, similarly to the output voltage, rise time and fall time are also very dependent on the load capacitance. This leads to the following limitations:

1) The driver should be located as close to the Pockels cell as possible. Cable length should be also kept as short as possible (see the details above).
2) **There is no good electrical methods to measure the transition times correctly.** Every probe connected to the output adds 4-6pF to the total load capacitance and distorts the measured pulse shape.

The ‘optical’ setup described above is a good option to measure rise and fall times. Another option to make suggestions about the transition times is the EMI measurements following the instructions below (at example of another driver):

Important notes:

- This method allows to measure transition times, but cannot be used to measure pulse amplitude or pulse shape.
- The direct contact to the any conductor of the output cable must be avoided. Best of all to insulate probe’s tip additionally.
- Probe and oscilloscope should have adequate bandwidth (at least 300-500MHz).

Concluding, we recommend:

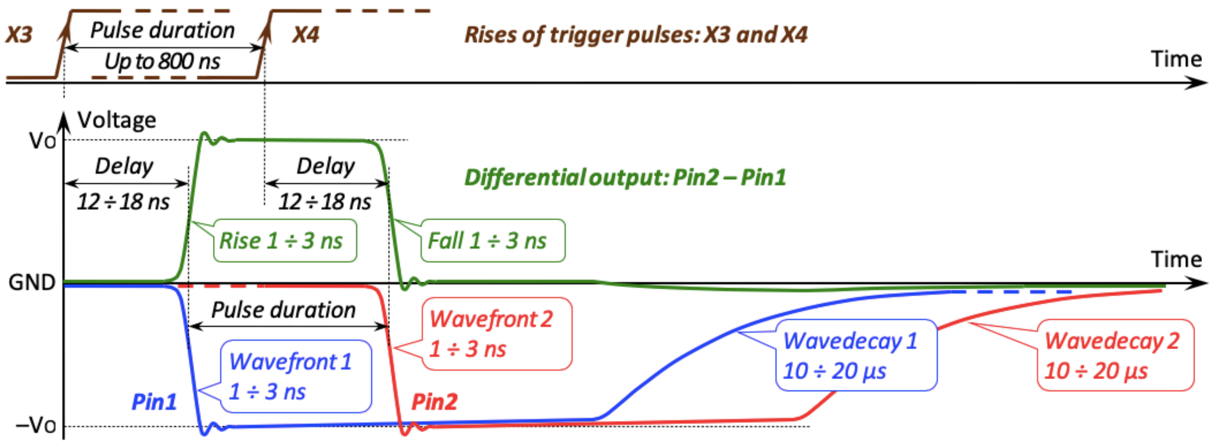
- To avoid any direct measurements of the output where it’s possible.
- To characterize output voltage either by optical methods or by DC reference signal, or by the performance of the real equipment.
- To characterize transition times either by optical methods or by EMI measurements.

Overview

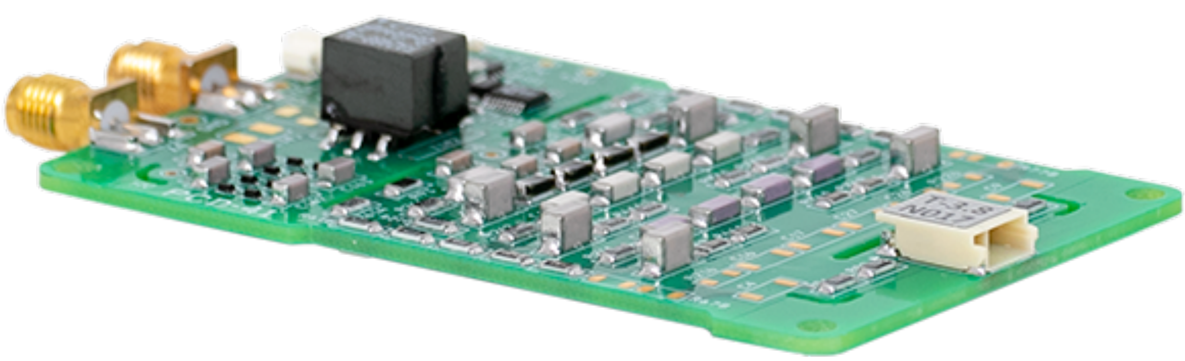
QBU-nano is a compact Pockels cell driver producing high voltage pulses with high repetition rates, fast rise and fall times and adjustable pulse duration and pulse amplitude. Wide temperature range of operation is another important feature.

Main parameters are as below:

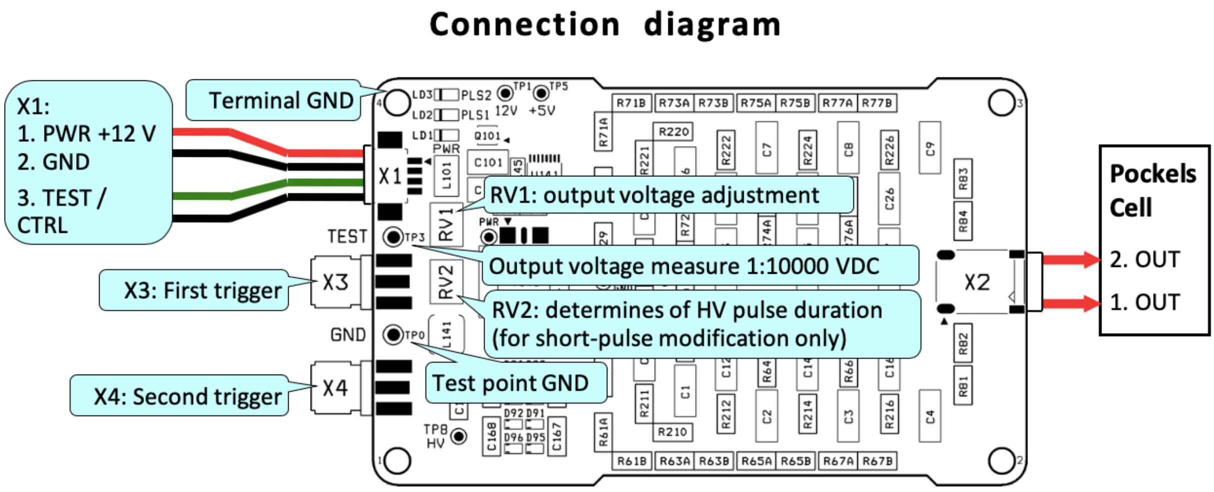
- Input – 12VDC
- Output – unipolar pulses of high voltage (see also the picture below)
- Pulse amplitude – several models up to 5800V
- Pulse width – adjustable up to approx. 800ns
- Rise time – 1-3ns (depends on load and pulse amplitude)
- Maximal repetition rate – up to 2kHz (depends on load and pulse amplitude)
- Operating temperature – -40...+60C



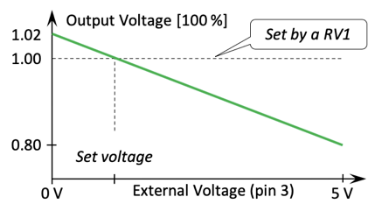
Appearance



Connections, signals, signal descriptions



X1 (INTERFACE): 53261-0471 (Molex)

PIN (color)	DESIGNATION	DESCRIPTION
1 (red)	**PWR +12V**	Power supply +12VDC to be connected here Recommended current capability >500 mA
2 (black)	**PWR GND**	Power supply GND
3 (green)	**Test / Control**	Main purpose of PINS 3 and 4 is a test signal repeating the HV output. DC voltage scale 1:10000. Alternatively if the control voltage is applied between PINS 3 and 4 they can be used to adjust the pulse amplitude: • 0V – output voltage is completely defined with the state of RV1 trimpot • 5V – output voltage is approximately 20% lower that set point of RV1 trimpot  • Input impedance of PIN 3 is 45 kOhm
4 (black)	**Test / Control GND**	Return of Test / Control signal

Important note! Laboratory power supply used to power up QBU-nano might be a subject of EMI from QBU-nano's output resulting in incorrect voltage or current measurements.

X2 (HV OUTPUT): SM02B-BHSS (JST)

PIN (color)	DESIGNATION	DESCRIPTION
1 (red)	**HV OUT 1**	High voltage output #1
2 (red)	**HV OUT 2**	High voltage output #2

Trigger pulses at X3 and X4 are fully interchangeable. First in time pulse initiates rising edge of HV output pulse while the second one initiates falling edge of HV pulse.

X3, X4 (INPUTS): SMA-J-P-H-ST-EM1 (Samtec)

Trigger pulse input +5 V; impedance 50 Ω; rise time 2ns (recommended).

Important note! Fast rise time of the pulse generator might really important, please try to keep it as fast as possible.

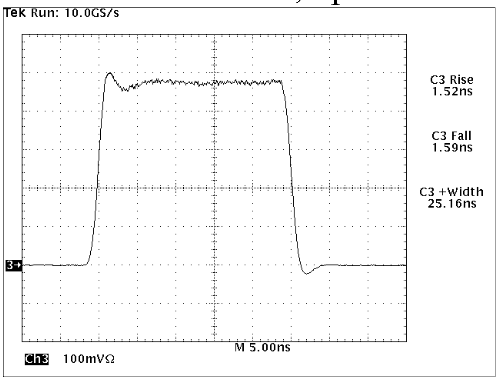
Important note! To avoid cross-interference between driver's outputs and inputs we strictly recommend to use shielded input cables, similar to those supplied by us together with the driver.

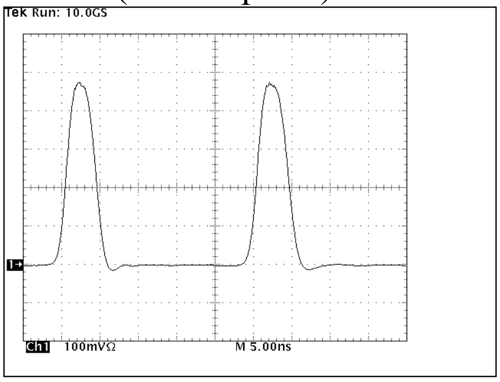
RV1 (HV ADJUST) TRIMPOT:

Pulse amplitude is adjustable with this trimpot in 70-100% of V_{MAX} range.

Typical output / Options

Standard waveform, optional waveforms (double-pulse):





Specifications

ELECTRICAL SPECIFICATION

Input	+12VDC (8V-16V); 500mA max
Output	
Type	Unipolar
HV pulse amplitude	Adjustable approx. in range: 1300V-2000V for 2000V modification 1800V-2800V for 2800V modification 2600V-3800V for 3800V modification 3600V-4800V for 4800V modification 4400V-5800V for 5800V modification
Repetition rate [1]	2kHz max for 2000V, 2800V, 3800V modifications 1kHz max for 4800V modification 500Hz max for 5800V modification
Pulse width	Up to 800ns adjustable
Rise time [1]	1-3ns
Fall time [1]	1-3ns
Delay [2]	15-20ns typ.
Jitter [2]	0.1-0.2ns typ.
Pulse-to-pulse stability	<1%
Load capacitance	5-7pF recommended, 10pF max for most of modifications 3pF recommended, 5pF max for 5800V modification
Environment	
Operation Temperature	-40...+60C

[1] depends on load capacitance and pulse amplitude
[2] depends on triggering signal parameters

MECHANICAL SPECIFICATION

Size (LxWxH)	80x50x20 mm^3
Weight	0.1 kg