



# ELECTRO-OPTICS & LASER ELECTRONICS



2021

All production units and offices move to the own **new 7000 square meters EKSMA Optics building** in Vilnius.



2015

**Establishment** of a CNC-based facility for **spherical, aspherical and conical lens production**. Commenced production of **ultrafast** electro-optical **pulse picking systems**.



2014

Establishment of dielectric coatings facility based on **Ion Beam Sputtering technology**.



2010

Commenced production of **Pockels cells**.



2007

**Investment** into and expansion of flat **optics production** and **nonlinear crystals polishing** facilities.



2006

**Establishment** of EKSMA daughter company **"EKSMA Optics"** for optical and laser crystal components business activities.



1992

State-owned company privatization and **EKSMA UAB** joint-stock company **establishment**.



1987

First-time participation at Munich laser Fair. EKSMA shows high pulse energy **picosecond Nd:YAG laser**.



1983

**Establishment** of experimental optics and opto-mechanics company **EKSMA**, a spin-off from the Vilnius Physics Institute



EKSMA Optics is a manufacturer of precision laser components, used in high power lasers, laser systems and various other photonic devices and optical instruments. Rooted in laser community and with more than 30 years of experience in lasers and photonic components EKSMA Optics is your partner for enabling photonics innovations, offering fast delivery components tailored to customer applications.

This electro-optical components catalog contains products dedicated to lasers and laser systems manufacturers, integrators, innovators, and scientists. The standard catalog components are available for fast off-the-shelf delivery. We also develop and customize our electro-optical components tailoring the parameters of the particular laser and its applications.

All components provided by EKSMA Optics are subject to performance and quality testing and certification in Quality Control laboratory. Through stringent inspection procedures, quality control assessments and commitment to new advanced technologies, we are continuously improving and delivering exceptional quality.

EKSMA Optics is an ISO 9001:2015 certified company.

## Your Partner in Photonics Innovations!



# Ordering Information

## PRICES

Prices are indicated F.C.A. Vilnius, Lithuania and are exclusive of any taxes, duties or freight. Quantity as well as research application discounts are subject to quote. EKSMA Optics reserves the right to change prices without prior written notice.

## PRODUCT DELIVERY TIME

Most of the standard products provided in catalogue are available for fast-off-the shelf delivery. Delivery time of the stock products can be estimated on the website. Estimated product delivery time is displayed on each product page. Search in our e-shop using product code.

If delivery term is indicated as "Request", please add the required items to the shopping cart and choose "Get Official Quotation". Our sales team will contact you soon and provide the estimated delivery time for the shopping cart.

## SHIPPING

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## CERTIFICATE OF ORIGIN

All items shown in this catalogue are of Lithuanian Origin (EU). Certificate of Origin is available under request.

## ORDERING

Purchase orders to EKSMA Optics can be placed using our e-shop, by e-mail or by fax. Customs paperwork and fees if any applied must be handled by customers.

## COMPANY DETAILS

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## PAYMENT OPTIONS

Standard payment is by wire transfer. We also accept payments by major credit cards using PayPal or SEB Bank money transfer systems.

## WIRE TRANSFER DETAILS

Account number (IBAN)	LT16 7044 0600 0577 4220
Bank name	AB SEB Bankas
Bank address	Gedimino Ave. 12, LT-01 103 Vilnius, LITHUANIA
SWIFT Code	CBVILT2X
Beneficiary	EKSMA Optics UAB

Please note that customer's bank transfer fee associated with payment service should be paid by customer.

## RETURN POLICY

30 days customer satisfaction warranty covers all standard products. Please contact EKSMA Optics if you are not satisfied with the product to arrange a refund. EKSMA Optics does not cover any costs associated with shipping.

## WARRANTY

All products are guaranteed to be free from defects in material and workmanship for a period of 1 year after delivery. EKSMA Optics does not assume liability from installation, labour or consequential damages.

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# Pockels Cells

Pockels cell is an electro-optical modulator for polarization control of the laser beam. The key element of the Pockels cell is an electro-optical crystal, which produces or changes birefringence, when high voltage is applied to it. Induced birefringence or refractive index modification in the material by the electric field is called electro-optic effect or Pockels effect. Electro-optic effect is observed only in non-centrosymmetric crystals.

Typical applications of Pockels cells are Q-switching of laser cavity, laser cavity dumping, pulse picking, light coupling into and from regenerative amplifier, continuous wave laser beam chopping.

## KTP / RTP POCKELS CELL – PCK / PCR

### Features

- Lower operating voltage required compared to other types of Pockels cells
- Operates at high duty cycles
- Very low piezo-electric resonances
- Standard apertures: 4x4 and 6x6 mm
- Thermally compensated double-crystal configuration

PCK/PCR series Pockels cells developed at EK SMA Optics are based on specially grown high resistivity KTP or RTP crystals. The outstanding feature is possibility to operate KTP/RTP Pockels cells at high duty cycles or even to keep at high voltage for longer.

KTP/RTP Pockels cells can be supplied in standard one inch housing or in open-type OEM mount when small footprint is required.



PCK4 / PCR4

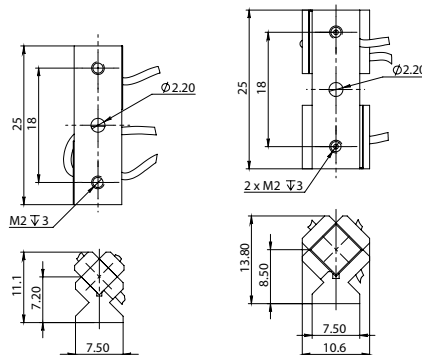
### Applications

- Q-switching for high repetition rate lasers 1 kHz – 6 MHz
- Pulse picking of high repetition rate lasers

### Specifications

MODEL	PCK4	PCK4-O	PCK6	PCK6-O
Clear aperture, mm	Ø3.5		Ø5.5	
Quantity of crystals	2			
Half-wave voltage (@ 1064 nm), kV DC	< 1.8		< 2.8	
Capacitance, pF (typical)	4		< 6	
Optical transmission	> 98 % at 1064 nm			
Contrast ratio	> 1:500			
Cell size, mm	Ø25.4x42.2	25x11.1x7.5	Ø25.4x42.2	25x13.8x10.6

Specifications are subject to change without advance notice.



PCK4-O drawing

PCK6-O drawing



PCK4-O / PCK6-O

## KD\*P PCKELS CELLS – PC / D-compact / D-mini

### Features

- Low absorption and high deuteration material
- High damage threshold dielectric AR coatings for requested wavelengths
- Operating voltage does not depend on crystal aperture, so large apertures are available
- Suitable for fs applications due to low GVD
- Single-crystal based three terminal design available upon request

### Applications

- Q-switching of flashlamp pumped high energy and low repetition rate diode pumped lasers
- Pulse picking
- Laser cavity dumping

KD\*P (DKDP) is one of the electro-optical crystals used for Pockels cells. The most popular application of KD\*P (DKDP) crystal based Pockels cell is Q-switching of laser cavity. DKDP Pockels cell can be used for lasers emitting in the range of 400 – 1100 nm.

High energy and short output pulse formation during Q-switching of laser cavity process is realized with KD\*P (DKDP) Pockels cell in the most of commercially available flashlamp pumped Nd:YAG and Ruby lasers, low repetition rate DPSS lasers like Nd:YAG, Nd:KGW, Nd:YLF, Nd:Glass and other lasers.

Electro-optical KD\*P (DKDP) crystals produced by EKSMA Optics have high damage threshold dielectric AR coatings (LIDT > 10 J/cm<sup>2</sup>, 10 ns, 10 Hz, 1064 nm), feature long lifetime without degradation of the coatings and show reliable operation with pulsed high energy lasers.

PC12SR, PC20SR, D-Compact, D-Mini and three terminal DKDP Pockels cells have AR-coated protective windows on both ends. Windows can be flat or wedged or in non-parallel, laser beam shift compensating configuration to eliminate etalon effects in the Pockels cell and laser cavity.

The rectangular shape PC5S, PC5D and PC10S DKDP Pockels cells are provided without protective windows and typically are used in hermetically sealed lasers.

Single-crystal based three terminal DKDP Pockels cell series are designed especially to be controlled by bipolar Pockels cell drivers. Ground connector is located in the center, positive and negative connectors are located on the sides.

EKSMA Optics offers wide range of HV drivers for the Pockels cells and power supplies for the drivers which are presented in the next chapter of this catalogue.



PC12SR

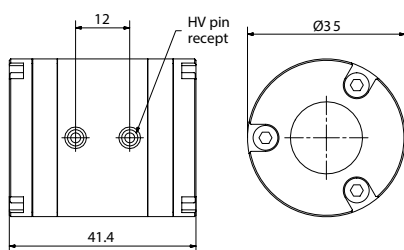
PC14x45SR

PC5S

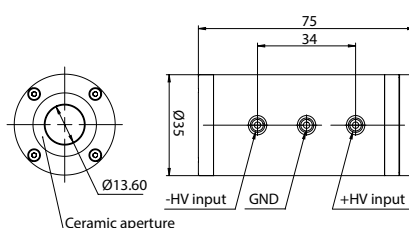
### Specifications

MODEL	PC20SR	PC14x45SR	PC12SR	D-compact/12	D-compact/9	D-mini/9	D-mini/8	PC10S	PC5S
Clear aperture, mm	Ø 18	Ø 13		Ø 11		Ø 8	Ø 7	9.5 × 9.5	4.5 × 4.5
Quantity of crystals	1								
λ/4 @ 1064 nm voltage, kV DC	< 3.4	< ±1.7						< 3.4	
Capacitance, pF (typical)	< 10			6			3	4	1.5
Optical transmission	> 97 % at 1064 nm								
LIDT of AR coatings	> 1 GW/cm <sup>2</sup> (10 J/cm <sup>2</sup> ), 1064 nm, 10 Hz, 10 ns								
Contrast ratio	> 1:2000								
Cell size, mm	Ø35x51	Ø35x75	Ø35x41.4	Ø25.4x39	Ø25.4x35	Ø19x25.4	Ø19x19	22x18x33	18x14x25

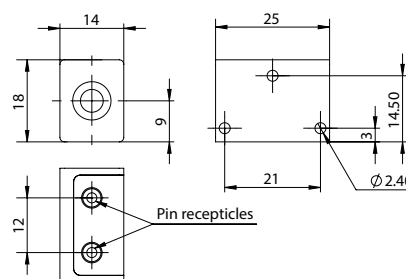
Specifications are subject to change without advance notice.



PC12SR drawing



PC14x45SR drawing



PC5S drawing

# BBO POCKELS CELLS – PCB

## Features

- Minimal piezoelectric ringing
- Very low absorption and suitability for high power laser applications
- Reliable design for operation up to 3 MHz HV pulse repetition rate
- Broad transmission rate from 200 to 2000 nm
- Pockels cell with active cooling available upon request

BBO Pockels cells are transverse field devices. Low electro-optical coefficient of BBO results in higher operating voltages. The operating voltage is proportional to the ratio of electrode spacing and crystal length. Double crystal design is employed to reduce required voltages and to allow operation in half-wave mode with fast switching times.

Low piezoelectric ringing makes these Pockels cells attractive for the control of high-power and high pulse repetition rate

lasers. Fast switching electronic drivers properly matched to the cell are available for Q-switching, cavity dumping and other applications.

Quatro BBO Pockels cell employs quadruple crystal design with an independent control of two sides, meaning this Pockels cell can be controlled by two synchronized sets of Pockels cell drivers enabling advanced polarization control.

## Applications

- High repetition rate Q-switching
- Pulse picking at up to 3 MHz rate
- Laser cavity dumping
- Pulses coupling into and from regenerative amplifier



PCB4D



PCB6.3D

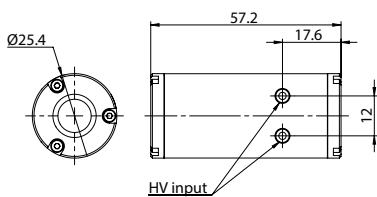


BBO Pockels cell with active cooling

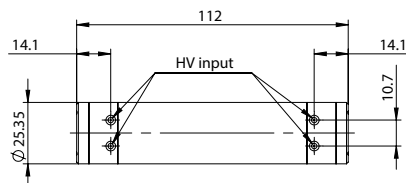
## Specifications

MODEL	PCB3S	PCB3D	PCB4S	PCB4D	PCB6.3S	PCB6.3D	PCB4Q
Clear aperture diameter, mm	2.5		3.5		5.8		3.5
Quantity of crystals	1	2	1	2	1	2	4
$\lambda/4$ voltage (@ 1064 nm), kV DC	< 3.5	< 1.8	< 4.6	< 2.3	< 7.5	< 3.8	$2 \times < 1.3$
Capacitance, pF (typical)	4	6	3	6	6	< 8	$2 \times < 6$
Optical transmission	> 98 % at 1064 nm						
LIDT of AR coatings	> 0.5 GW/cm <sup>2</sup> (5 J/cm <sup>2</sup> ), 1064 nm, 10 Hz, 10 ns						
Contrast ratio	> 1:1000	> 1:500	> 1:1000	> 1:500	> 1:1000	> 1:500	> 1:500
Dimensions, mm	Ø25.4×37.2	Ø25.4×57.2	Ø25.4×37.2	Ø25.4×57.2	Ø25.4×42.2	Ø35×68	Ø25.4×112

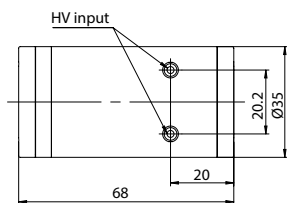
Specifications are subject to changes without advance notice.



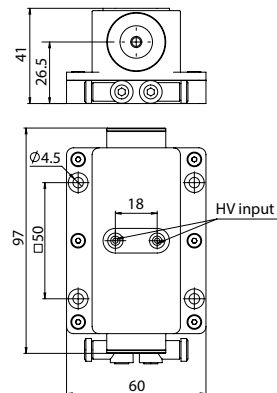
PCB3D, PCB4D drawing



PB4Q drawing



PCB6.3D drawing



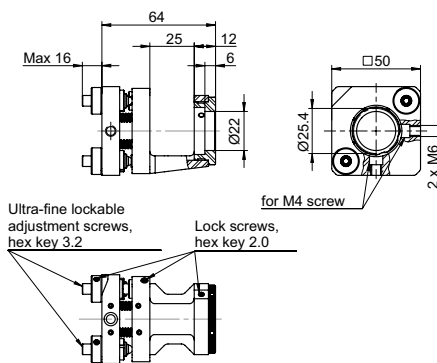
Drawing of BBO Pockels cell with active cooling

## MOUNTING STAGE FOR PCKELS CELLS OF Ø25.4 mm – PM1

PM1 series mounting stage is designed for holding and positioning of Ø25.4 mm Pockels cells. The mount has ultra-fine thread lockable adjustment screws.

### Specifications

MODEL	PM1
Adjusting angles, tilt and tip, deg	±3.5
Rotation along Z-axis, deg	180
Adjustment screw thread	M6×0.25
Screw sensitivity, µm	0.5

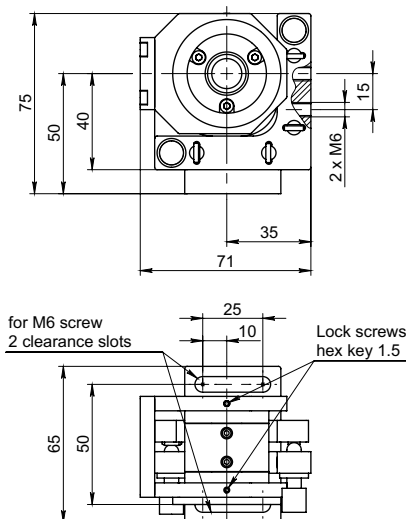


## MOUNTING STAGE FOR PCKELS CELLS OF Ø35 mm – HPR-35

HPR series mounting stage is designed for holding and positioning of Ø35 mm Pockels cells. HPR stages with fine or ultra-fine screws are available upon request.

### Specifications

MODEL	HPR-35
Adjusting angle along X and Y axis, deg	9
Rotating angle along Z-axis, deg	20
Beam height above breadboard, mm	50
Adjustment screw thread	M6×0.5
Screw sensitivity, µm	1.5





# Pockels Cells Drivers



OEM version of DP-SP series Pockels cell driver

Encased version of DPB2 series Pockels cell driver



## CAVITY DUMPING & PULSE PICKING PCKELS CELL DRIVERS – DP / DPB / DP-SP

### Features

- HV rise/fall time down to 6 ns
- HV pulse amplitude up to 9.8 kV
- Pulse repetition rate up to 6 MHz
- Output pulse jitter <60 ps if trigger pulse rise time <0.5 ns



Fig. 1. Control timing charts using two pulses trigger control



Fig. 2. Control timing charts using single pulse trigger control

Pockels cell drivers are designed for a wide range of applications and operating modes – pulse selection, Q switching, cavity dumping, CW beam chopping, burst modes, etc.

Different versions of the drivers are designed for variations of output voltage, repetition rate and rise/fall time of HV pulses. Those three parameters are mutually dependent: higher voltage means longer rise/fall time, and higher repetition rate is limited by output voltage.

Pockels cell drivers are available in two versions: “open frame” which is ideal for OEM manufacturers incorporating drivers in their own laser systems, or “encased” in aluminum housings. Encasing of Pockels cell driver in aluminum housing helps to solve two problems: shields both humans and electronics from high voltage impact from operating Pockels cell driver, and protects driver itself from accidental potentially harmful external contact – ensuring safe

operation of the driver. The encased option is especially handy for researchers and custom product manufacturers who use these drivers during their own systems build-up.

DP/DPBx series Pockels cell drivers operate safely with HV pulse duration from 100 ns to 5  $\mu$ s. Moreover, HV pulse duration can be extended to infinity using pulse regeneration technique.

Short pulse drivers (DP-SP series) feature safe operation with HV pulse duration from 15 ns to  $\sim$ 1  $\mu$ s. However, pulse regeneration technique does not work with short pulse drivers.

Operation control of all our drivers can be made by two trigger (sync) pulses (Fig. 1) or by single trigger pulse (Fig. 2), whereas rising edge of trigger pulse turns ON high voltage to Pockels cell and falling edge of the same trigger pulse turns high voltage OFF. Drivers have switchable option to be controlled by one or two trigger pulses.

### Pulse regeneration technique

Gives possibility to extend HV pulse duration. Pulse regeneration technique does not work with DP-SP or DPB series drivers. Pulse regeneration technique diagram is shown in Fig. 3.

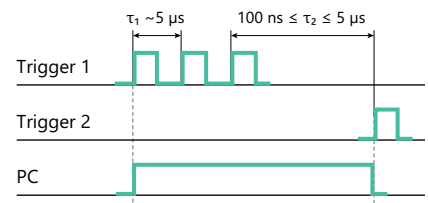
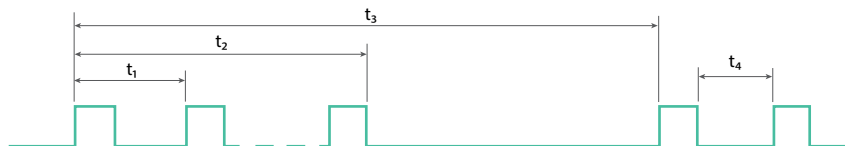


Fig. 3. Principle pulse regeneration diagram

## Burst mode operation

Certain laser applications, such as laser material processing, optical metrology and others require for relatively short sequence of high repetition rate of pulses with following pause, i.e. burst mode. All the EK SMA Optics Pockels cell drivers series DP/DPBx, DP-SP and DPB can operate up to 3 MHz bursts by reducing duty cycle and preserving below requirements.

Peak power capacity of HV power supply must be increased for burst operation. Contact EK SMA Optics for details and suggestions.



$t_1$  – pulse repetition period in burst, should be  $1/t_1 \leq 3$  MHz.

$t_2$  – burst duration.

$t_3$  – burst packet repetition period.

$t_4$  – minimal pause between two HV pulses, should be  $\geq 150$  ns for most of the drivers.

Duty cycle is determined as  $D = t_2/t_3$ , should be  $D \leq F * t_1$ .

Here  $F$  – maximal repetition rate specified for the driver.

## General specifications of Pockels cell drivers

DRIVER SERIES	DP/DPBx	DP-SP	DPB
Minimal HV pulse duration (FWHM)	100 ns	15 ns	30 ns
Maximal HV operation voltage	up to 7.2 kV	up to 3.6 kV	up to 9.8 kV
Maximal HV pulse repetition rate	6 MHz	1 MHz	10 kHz
HV pulse duration extension using pulse regeneration technique	Yes	No	
Triggering pulse duration requirement (For two-pulses triggering mode only)	$\geq 20$ ns		
Triggering pulse amplitude requirement	3.5 – 5 V (50 $\Omega$ )		
Triggering pulse rise & fall time requirement	$\leq 10$ ns	$\leq 5$ ns	$\leq 10$ ns
Maximal length of leads to Pockels cell	10 cm		
HV pulse delay	25 ns	30 ns	

Specifications are given for Pockels cells with capacity < 6 pF. Not all combinations of parameters are possible at the same time. Specifications are subject to change without advance notice.

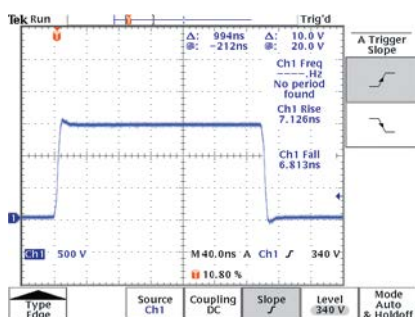


Fig. 5. Typical output pulse shape

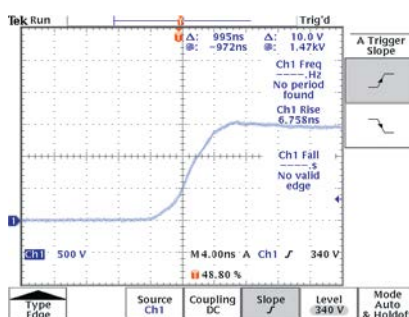


Fig. 6. Typical rising edge of output pulse

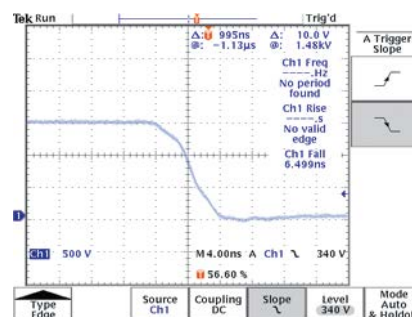
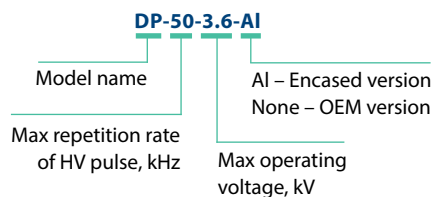


Fig. 7. Typical falling edge of output pulse

## Ordering / Part number information

Please provide following information about the driver:

- Operating voltage
- Repetition rate
- HV Pulse duration (range)
- Capacitance of Pockels cell
- OEM or Encased version



# HIGH VOLTAGE POKKELS CELL DRIVERS – DPB

## Features

- HV pulse amplitude up to 9.8 kV
- HV pulse amplitude doubling layout
- Repetition rate up to 10 kHz
- Easy integration with HV power supply
- Easy mounting on optical breadboard



DPB Pockels Cell Driver.  
OEM version with HV power supply



HVS-D2 Pockels Cell Driver.  
Encased version with HV power supply

## Configuration samples

CATALOGUE NUMBER OF DRIVER	DPB-10-4.2 HVS-D2-10-4.2	DPB-5-5.5 HVS-D2-5-5.5	DPB-3-8.6 HVS-D2-3-8.6	DPB-2.5-9.8 HVS-D2-2.5-9.8
Maximal HV operation voltage	4.2 kV	5.5 kV	8.5 kV	9.8 kV
Output polarity	bipolar			
HV pulse rise time, typical	6 ns	7 ns	10.5 ns	12 ns
HV pulse fall time, typical	6 ns	7 ns	9.5 ns	10.5 ns
HV pulse duration	30...3000 ns		35...2000 ns	
Maximal HV pulse repetition rate	10 kHz	5 kHz	3 kHz	2.5 kHz
HV pulse delay	30 ns			
Requirement for external triggering pulse amplitude	3.5...5 V (50 Ω load)			
Requirement for external triggering pulse rise time	≤ 10 ns		≤ 5 ns	
Requirement for external triggering pulse duration	See Fig. 8 for control by 1 pulse, see Fig. 9 for control by 2 pulses			

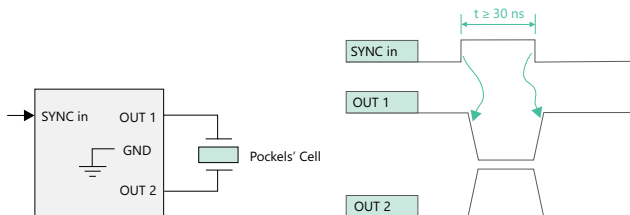


Fig. 8. Diagram of pockels cell connection to driver and timing charts of driver controlled by 1 sync pulse

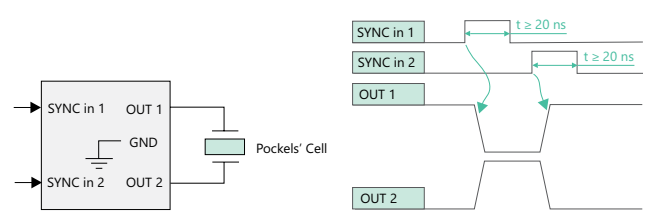


Fig. 9. Diagram of pockels cell connection to driver and timing charts of driver controlled by 2 sync pulses

## Specifications of OEM type DPB series Pockels cell driver

CATALOGUE NUMBER OF DRIVER	DPB-10-4.2	DPB-5-5.5	DPB-3-8.6	DPB-2.5-9.8
Control	by 1 or 2 external triggering pulses, switchable			
External powering requirements:				
Low voltage DC supply	15 – 25 V, 150 mA (0.5 A inrush current)		24 – 25 V, 150 mA	
HV power supply (not included, should be purchased separately)	2.1 kV, 5 W	2.8 kV, 5W	4.4 kV, 5W	5.0 kV, 5W
DC Connectors	Molex Micro-Fit 3.0			
Dimensions (L x W x H):				
Driver board	135 × 65 × 30 mm		135 × 75 × 30 mm	
Driver board mounted with PS-5 power supply	See Fig. 10		See Fig. 11	

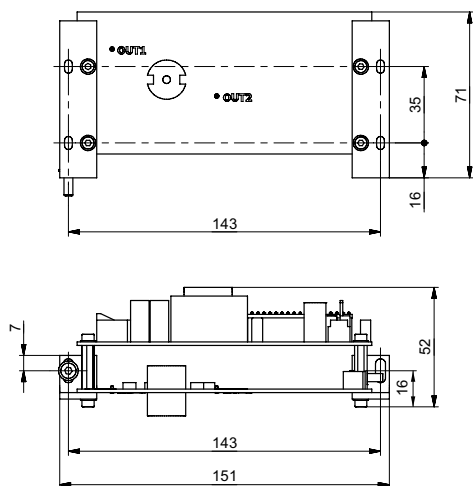


Fig. 10. Outline drawing of OEM version DPB-10 and DPB-5 drivers with PS-5 power supply

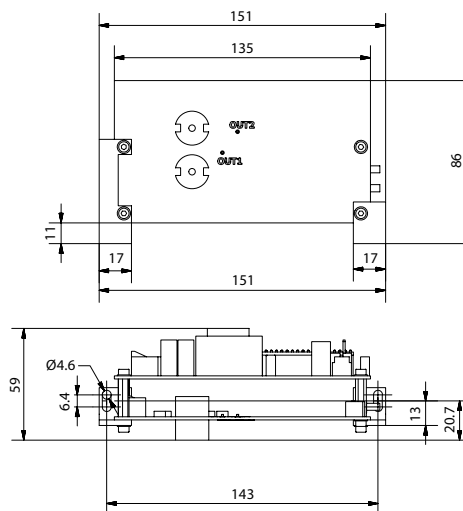


Fig. 11. Outline drawing of OEM version DPB-3 and DPB-2.5 drivers with PS-5 power supply

## Specifications of encased type HVS-D2 series Pockels cell driver with HV Power supply

CATALOGUE NUMBER OF DRIVER	HVS-D2-10-4.2	HVS-D2-5-5.5	HVS-D2-3-8.6	HVS-D2-2.5-9.8
Control	by 1 or 2 external triggering pulses, factory preset			
HV Power supply (integrated)	2.1 kV, 5 W	2.8 kV, 5W	4.4 kV, 5W	5.0 kV, 5W
Voltage control limits	$U_{max} - 1 \text{ kV to } U_{max}$ (internal trimmer); $40\% U_{max}$ to $U_{max}$ (CAN)			
Output voltage control options	Internal trimmer potentiometer or CAN interface (requires CAN-USB converter)			
Mains voltage	90 to 264 V AC, 47 – 63 Hz			
Dimensions (W x L x H)	80 × 120 × 225 mm (see Fig. 12)			

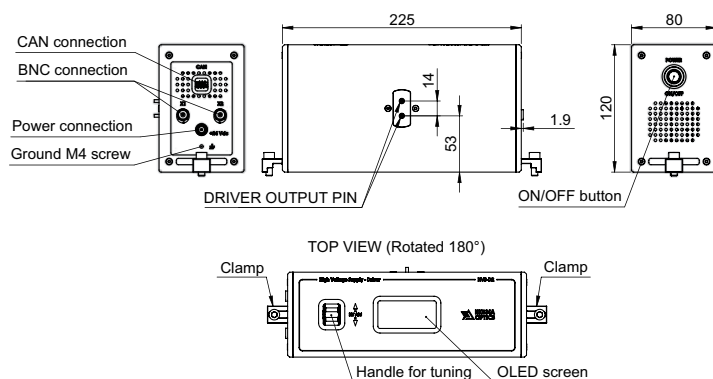


Fig. 12. Outline drawing of encased type HVS-D2 driver with HV power supply

# HIGH VOLTAGE PCKELS CELL DRIVERS – DPBx

## Features

- HV pulse amplitude up to 7.2 kV
- Repetition rate up to 1 MHz
- HV pulse duration extension using pulse regeneration technique
- OEM version available upon request



Encased version of DPB2 series Pockels cell driver

## Configuration samples of DPBx series drivers

CATALOGUE NUMBER OF DRIVER	DPB1-1000-3.0-AI	DPB1-300-4.6-AI	DPB1-250-5.2-AI	DPB2-1000-3.8-AI	DPB2-250-7.0-AI	DPB3-500-7.2-AI
Maximal HV operating voltage	3.0 kV	4.6 kV	5.2 kV	3.8 kV	7.0 kV	7.2 kV
Maximal HV repetition rate	1000 kHz	300 kHz	250 kHz	1000 kHz	250 kHz	500 kHz
Pulse duration	100 – 5000 ns					
HV pulse rise time, typical	<7.5 ns	<8 ns	<8.5 ns	<6 ns	<9.5 ns	<10 ns
HV fall rise time, typical	<7.5 ns	<8 ns	<8.5 ns	<6 ns	<9.5 ns	<10 ns
Output polarity	Bipolar					
HV power consumption	<120	<100 W	<100 W	<230 W	<200 W	<375 W
24 V power consumption	<9 W	<4 W	<3 W	<9 W	<9 W	<7 W
Recommended HV power supply model	PS2-60 or HVS100-2x60			HV-2x200		
Dimensions	See Fig. 13			See Fig. 14		See Fig. 18
Cooling	Water					

Driver needs to be mounted on heatsink unless it is cooled by water. Driver's base plate temperature needs to be lower than 35 °C in all regimes of operation. Power consumption for 6 pF load. Voltage or repetition rate derating is necessary if capacitance of your Pockels cell is higher. Contact vendor for details.

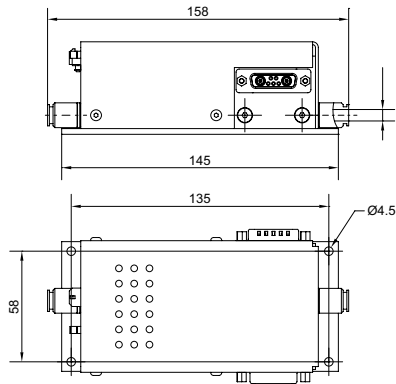


Fig. 13. Outline drawing of encased version DPB1 series Pockels cell drivers

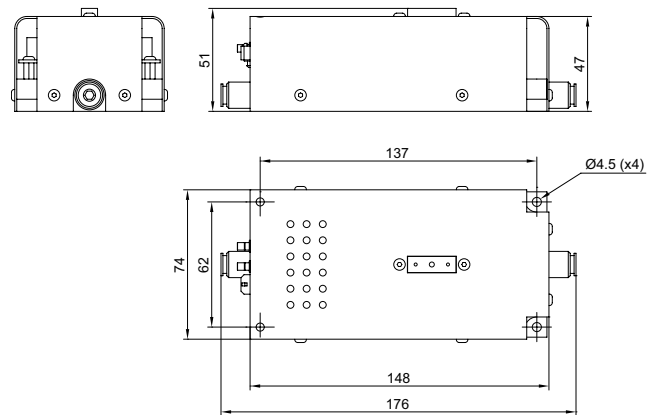


Fig. 14. Outline drawing of encased version DPB2 series Pockels cell drivers

# LOW VOLTAGE PockELS CELL DRIVERS – DP

## Features

- HV pulse amplitude up to 3.6 kV
- Repetition rate up to 2 MHz
- HV pulse duration extension using pulse regeneration technique
- Alternative aluminum case option featuring conductive cooling possibility and relocated water and HV output connectors
- OEM version available upon request



Standard of DP/DP-SP series Pockels cell driver

## Configuration samples of DP series drivers

CATALOGUE NUMBER OF DRIVER	DP-50-3.6-AI	DP-250-3.6-AI	DP-500-2.6-AI	DP-1000-1.8-AI	DP-2000-1.5-AI
Maximal HV operating voltage	3.6 kV	3.6 kV	2.6 kV	1.8 kV	1.5 kV
Maximal HV repetition rate	50 kHz	250 kHz	500 kHz	1000 kHz	2000 kHz
Pulse duration	100 – 5000 ns				
HV pulse rise time, typical	< 7 ns	< 7 ns	< 6.5 ns	< 6 ns	< 7 ns
HV pulse fall time, typical	< 7 ns	< 7 ns	< 6.5 ns	< 6 ns	< 7 ns
Output polarity	Positive				
HV power consumption	< 20 W	< 75 W	< 90 W	< 80 W	< 120 W
24 V power consumption	< 1 W	< 4 W	< 6 W	< 9 W	< 12 W
Recommended HV power supply model	PS-40 or HVS100-40	PS-80 or HVS100-80	PS-120 or HVS100-120	PS-80 or HVS100-80	PS-120 or HVS-120
Dimensions	Standard - see Fig. 15, alternative – see Fig. 16 <sup>1)</sup>				
Cooling	Water <sup>2)</sup>				

<sup>1)</sup> If alternative aluminum case is required, please add note “option 1” when ordering, for e.g., “Pockels cell driver DP-250-3.6-AI option 1”.

<sup>2)</sup> Standard aluminum case is suitable for water cooling. Alternative aluminum case (option 1) is suitable for both, conductive and water cooling.

Driver needs to be mounted on heatsink unless it is cooled by water. Driver’s base plate temperature needs to be lower than 35 °C in all regimes of operation. Power consumption for 6 pF load. Voltage or repetition rate derating is necessary if capacitance of your Pockels cell is higher. Contact vendor for details.

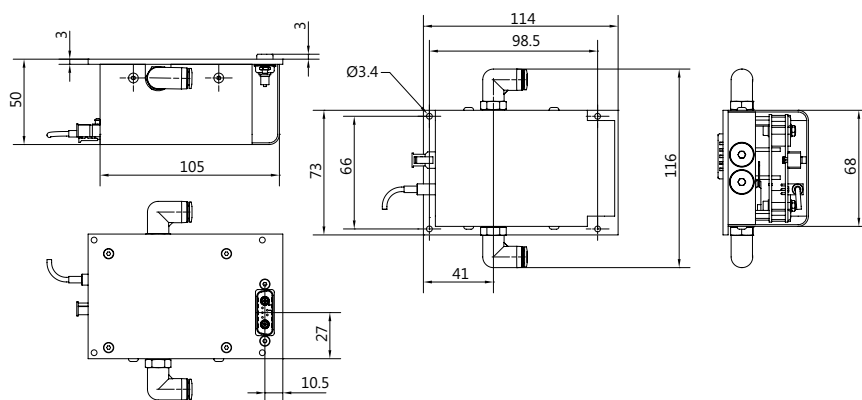


Fig. 15. Outline drawing of standard encased version DP/DP-SP series Pockels cell drivers

## SHORT PULSE POCCKELS CELL DRIVERS – DP-SP

### Features

- HV pulse amplitude up to 3.6 kV
- Repetition rate up to 1 MHz
- HV pulse duration down to 15 ns
- Short circuit protection at driver output
- Driver pad overheat sensor stops operation when overheated
- Overheat optocoupled output signal
- LED for error indication (overheat and short circuit)
- Alternative aluminum case option featuring conductive cooling possibility and relocated water and HV output connectors
- OEM version available upon request

### Configuration samples of DP-SP series drivers

CATALOGUE NUMBER OF DRIVER	DP-SP-50-3.6-AI	DP-SP-250-3.6-AI	DP-SP-500-2.6-AI	DP-SP-1000-1.8-AI
Maximal/minimal HV operating voltage	3.6 kV / 1.8 kV	3.6 kV / 1.8 kV	2.6 kV / 1.3 kV	1.8 kV / 0.9 kV
Maximal HV repetition rate	50 kHz	250 kHz	500 kHz	1000 kHz
Pulse duration	15 – 5000 ns	15 – 1000 ns	15 – 500 ns	15 – 250 ns
HV pulse rise time, typical	< 7 ns	< 7 ns	< 6.5 ns	< 6 ns
HV pulse fall time, typical	< 7 ns	< 7 ns	< 6.5 ns	< 6 ns
Output polarity	Positive			
HV power consumption	< 20 W	< 75 W	< 90 W	< 80 W
12 V / 24 V power consumption	1 W	4 W	< 6 W	9 W
Recommended HV power supply model	PS-40 or HVS100-40	PS-80 or HVS100-80	PS-120 or HVS100-120	PS-80 or HVS100-80
Dimensions	Standard - see Fig. 15, alternative – see Fig. 16 <sup>1)</sup>			
Cooling	Water <sup>2)</sup>			

<sup>1)</sup> If alternative aluminum case is required, please add note "option 1" when ordering, for e.g., "Pockels cell driver DP-SP-250-3.6-AI option 1".

<sup>2)</sup> Standard aluminum case is suitable for water cooling. Alternative aluminum case (option 1) is suitable for both, conductive and water cooling.

Driver needs to be mounted on heatsink unless it is cooled by water. Driver's base plate temperature needs to be lower than 35 °C in all regimes of operation. Power consumption for 6 pF load. Voltage or repetition rate derating is necessary if capacitance of your Pockels cell is higher. Contact vendor for details.

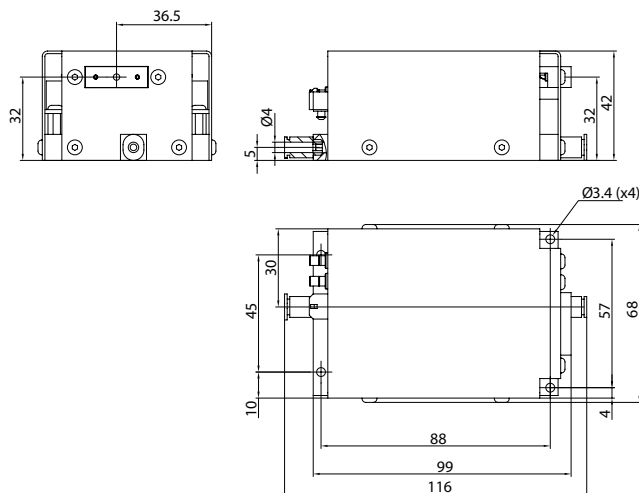


Fig. 16. Outline drawing of alternative encased version DP/DP-SP series Pockels cell drivers with relocated water and HV output connectors (option 1)

# HIGH REPETITION RATE PCKELS CELL DRIVERS – 2DP / DPB3

## Features

- HV pulse amplitude up to 3.1 kV
- Repetition rate up to 6 MHz
- HV pulse duration down to <1 ns
- HV pulse duration extension using pulse regeneration technique



Encased version of DPB3 series Pockels cell driver

CATALOGUE NUMBER OF DRIVER	2DP-1000-2.4-A1	2DP-2000-1.6-A1	DPB3-2500-3.1-A1	DPB3-3000-2.6-A1	2DPB3-4000-1.7-A1	2DPB3-6000-1.3-A1
Maximal HV operating voltage	2.4 kV	1.6 kV	3.1 kV	2.6 kV	1.7 kV	1.3 kV
Maximal HV repetition rate	1000 kHz	2000 kHz	2500 kHz	3000 kHz	4000 kHz	6000 kHz
Pulse duration	0 – 5000 ns		100 – 5000 ns		0 – 5000 ns	
HV pulse rise time, typical	< 6.5 ns	< 6 ns	< 9.5 ns	< 8.5 ns	< 10.5 ns	< 8.5 ns
HV fall rise time, typical	< 6.5 ns	< 6 ns	< 9.5 ns	< 8.5 ns	< 10.5 ns	< 8.5 ns
Output polarity	Positive		Bipolar		Positive	
HV power consumption	< 180 W	< 130 W	< 360 W	< 325 W	< 360 W	< 330 W
24 V power consumption	< 14 W	< 18 W	< 10 W	< 10 W	< 6 W	< 10 W
Recommended HV power supply model	HV-200 or HVS100-2x120		HV-2x200		HV-400	
Dimensions	See Fig. 17			See Fig. 18		
Cooling	Water					

Driver needs to be mounted on heatsink unless it is cooled by water. Driver's base plate temperature needs to be lower than 35 °C in all regimes of operation. Power consumption for 6 pF load. Voltage or repetition rate derating is necessary if capacitance of your Pockels cell is higher. Contact vendor for details.

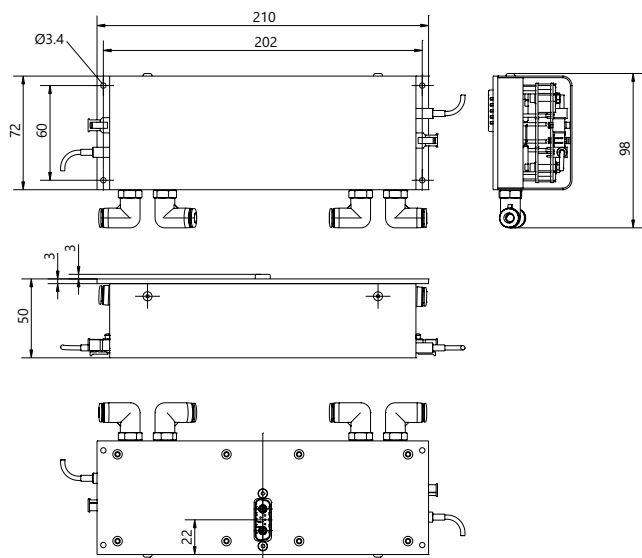


Fig. 17. Outline drawing of encased version 2DP series Pockels cell drivers

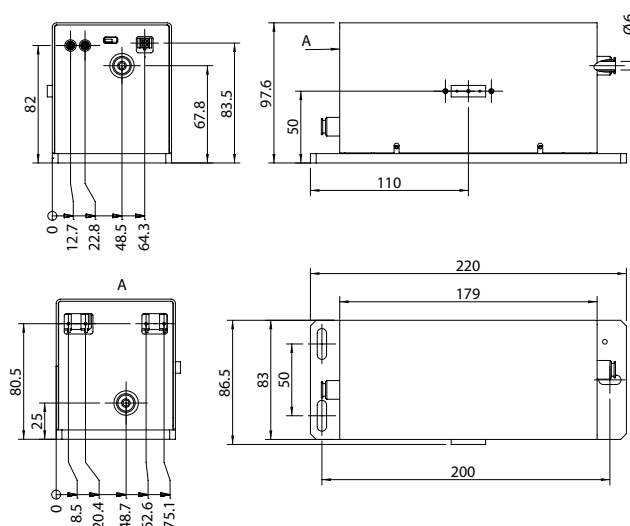


Fig. 18. Outline drawing of encased version 2DPB3/DPB3 series Pockels cell driver



# HIGH VOLTAGE DRIVERS WITH FAST AMPLITUDE MODULATION – DP-FAM

## Features

- HV pulse repetition rate up to 500 kHz
- Fast amplitude modulation of HV pulses
- Output HV pulse amplitude ranges from 0.1 kV to 2.5 kV

DP-FAM series drivers allow to control the amplitude of each HV output pulse with specific user-defined amplitude levels. The control is realized by one or two trigger-sync pulses and analog signal for amplitude modulation (HV program).

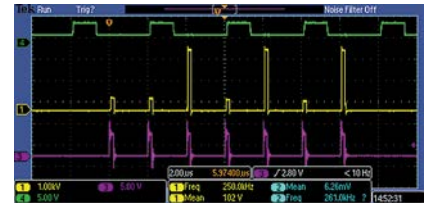


DP-FAM Pockels cell driver

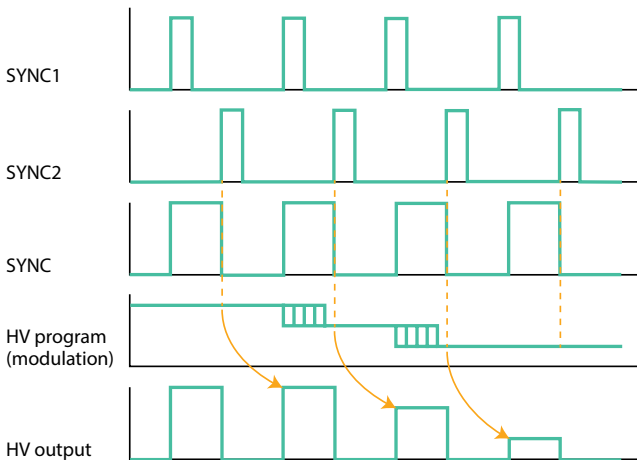
## Configuration samples of DP-FAM series encased drivers

CATALOGUE NUMBER OF DRIVER		DP-FAM-250-2.5-AI	DP-FAM-500-2.5-AI
HV operation voltage range		0.1 - 2.5 kV	
HV program input signal range		0.1 - 4.9 V	
Maximal HV repetition rate		250 kHz	500 kHz
HV pulse duration		70 – 3000 ns	70 – 1000 ns
HV pulse rise time, typical <sup>1)</sup>		< 26 ns	
HV fall time, typical <sup>1)</sup>		< 13 ns	
Output polarity		positive	
External trigger pulse requirements	Amplitude on 50 Ω	3.5 – 5 V	
	Rise/fall time	< 10 ns	
HV power consumption		60 W	120 W
24 VDC power consumption		< 12 W	
Recommended HV power supply model		PS-80-2.6 (OEM type) HVS100-80-2.6 (lab type)	PS-120-2.6 (OEM type) HVS100-120-2.6 (lab type)
Dimensions		139 × 69 × 57 mm (Fig. 19)	
Cooling <sup>2)</sup>		conductive or water	
Control interface <sup>3)</sup>		CAN	

<sup>1)</sup> All specifications are given for 6 pF Pockels cell load.  
<sup>2)</sup> Heat sink temperature must not exceed 35 °C (95 °F) in all regimes of operation.  
<sup>3)</sup> Requires USB-CAN converter for computer control that is sold separately.



**Example of driver operation.**  
 Green trace – modulated analog input signal, purple trace – trigger signal SYNC (single pulse control mode), yellow trace – HV pulse.



Operation timing charts.

SYNC1 and SYNC2 are used for 2-pulses control operation mode. HV program input amplitude is readout at SYNC2 rising edge and is used to set HV output amplitude for next HV output pulse which is started with SYNC1 rising edge. SYNC is used for single pulse control mode. HV program input amplitude is readout at SYNC falling edge and is used to set HV output amplitude for next HV output pulse which is started with SYNC rising edge.

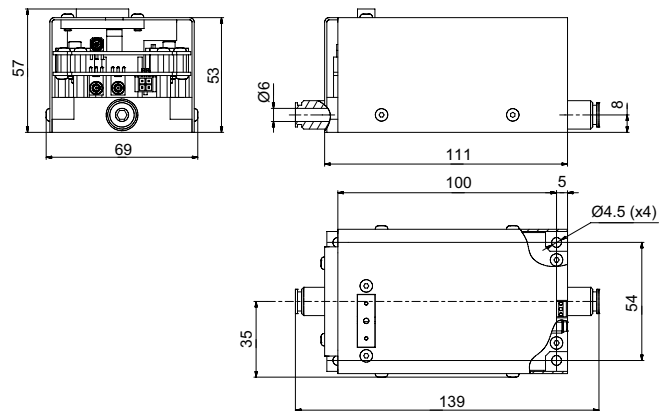


Fig. 19. Outline drawing of DP-FAM series drivers.

## HIGH REPETITION RATE PCKELS CELL DRIVER FOR Q-SWITCHING OF DIODE PUMPED LASERS – DQ

### Features

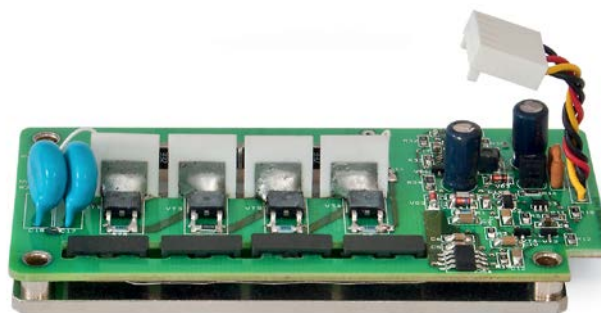
- Pulse repetition rate up to 100 kHz
- Fast HV rise time <7 ns for 4 kV pulse
- HV pulse amplitude up to 4 kV

DQ series high repetition rate Pockels cell driver has been designed for use in mode-locked lasers for cavity dumping or for cavity Q-switching of solid-state nanosecond lasers. Fast HV edge ensures excellent pre- and post-pulse contrast.

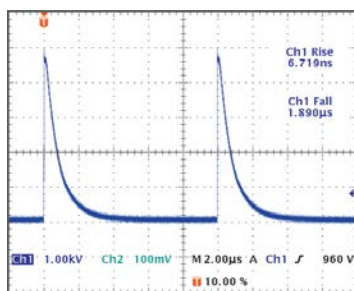
Ability to operate at high pulse repetition rates makes this driver perfect fit for most of diode-pumped nanosecond lasers. For pulse repetition rates up to 10 kHz heatsink

is not required. For high repetition rates the driver should be attached to the heatsink with thermal resistance of at least 0.4 °C/W for room temperature (25 °C) operation.

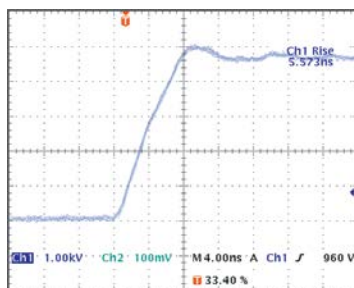
The driver should be mounted into dielectric box (not provided) providing electrical insulation. Low voltage power supply is required to internal triggering circuit, while tuning of HV power supply voltage.



DQ series Pockels cell driver



Oscillogram of DQ-100-4 driver operation



Fast edge of HV pulse in detail

### Specifications

CATALOGUE NUMBER	DQ-100-4
Maximum high voltage (HV) pulse amplitude	4.0 kV
Polarity	Positive
HV pulse rise time	< 7 ns
HV pulse fall time	~2 μs <sup>1)</sup>
HV pulse duration	180 ns <sup>1)</sup>
Maximum HV pulse repetition rate	100 kHz
HV pulse jitter	< 0.5 ns
External triggering pulse duration requirement	100 – 1000 ns
External triggering pulse amplitude requirement	3 – 5 V (50 Ω)
External triggering pulse rise & fall time	< 10 ns
HV pulse delay	35 – 40 ns
External powering requirements:	
high voltage supply	0 – 4.0 kV, 9 mA max <sup>2)</sup>
low voltage DC supply	9 – 24 V, 500 mA max <sup>2)</sup>
Operating temperature	0 – 35 °C <sup>3)</sup>
Size	104 × 52 × 25 mm

<sup>1)</sup> Typical value.

<sup>2)</sup> Test conditions: PRR = 100 kHz, C = 6 pF, U = 4 kV.

<sup>3)</sup> Heat sink temperature must not exceed 35 °C (95 °F) in all regimes of operation.

## POCKELS CELLS DRIVER FOR Q-SWITCHING OF FLASHLAMP PUMPED LASERS – DQF

DQF drivers are designed for Q-switching of nanosecond lasers without use of phase retardation plate. High voltage is applied to Pockels cell in order to inhibit oscillation. Pockels cell is opened by negative polarity pulse allowing laser to radiate.

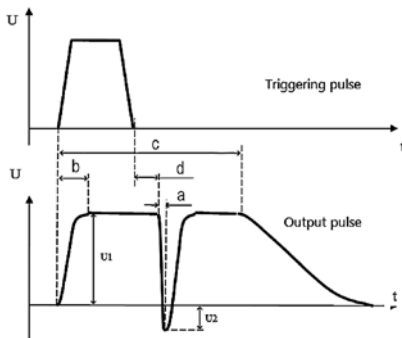
Driver DQF-0.1-8D is integrated with  $\pm 4$  kV HV power supply. High voltage can be controlled either by onboard trimmer potentiometer or by using CAN interface. Control by CAN requires USB-CAN converter for computer control that is sold separately.



DQF-0.2-5 Pockels cell driver



DQF-0.1-8 Pockels cell driver with integrated HV Power supply



Timing diagram of DQF driver

### Specifications

CATALOGUE NUMBER	DQF-0.2-5D	DQF-0.1-8D
Maximum high voltage to cell (HV) pulse amplitude ( $U_1 + U_2$ )	5 kV	7.5 kV
$U_1$ value	equal to HV powering voltage	
$U_2$ value	equal to $0.25 \times U_1$	equal to $0.3 \times U_1$
HV pulse fall time (a)	< 15 ns	< 12 ns
HV pulse rise time, typical (b)	60 $\mu$ s	120 $\mu$ s
HV pulse duration, typical (c)	300 $\mu$ s (1200 $\mu$ s optionally)	650 $\mu$ s
HV pulse repetition rate	$\leq$ 250 Hz	$\leq$ 100 Hz
HV pulse delay (d)	40 ns	25 ns
External triggering pulse duration	100 – 1200 $\mu$ s	120 – 650 $\mu$ s
External triggering pulse amplitude	3 – 5 V (50 $\Omega$ )	3.5 – 5 V (50 $\Omega$ )
External triggering pulse rise & fall time	< 20 ns	
Board dimensions <sup>1)</sup>	92 x 76 x 21 mm	92 x 72 x 33 mm
Mounting holes location for M3 studs	84 x 62 mm	
External powering requirements:		
DC supply	12 – 24 V, max 200 mA	12 V, max 80 mA
HV supply	4 kV, 1 mA	integrated in the driver

<sup>1)</sup> Keep safety distance at least 5 mm from any side of board or any component to surrounding conductive parts.

## POCKELS CELL AND PCKELS CELL DRIVER SELECTION GUIDE

Suggested Configuration samples. Please contact our sales engineers for a complete solution tailored to your application.

### For operation at 515 – 532 nm wavelength

Material	Max repetition rate, kHz	Ø CA, mm	Phase retardation	HV pulse duration	Pockels cell	Driver	HV Power supply
BBO	1000	2.5	λ/4	100 – 5000 ns	PCB3S	DP-1000-1.8-AI	PS-80-1.8 or HVS100-80-1.8
BBO	500	3.5			PCB4S	DP-500-2.6-AI	PS-120-2.6 or HVS100-120-2.6
DKDP	10	11		30 – 3000 ns	PC12SR or D-compact/12	DPB-10-4.2	PS-5-2.1
KTP / RTP	2000	5.5	λ/2	0 – 5000 ns	PCK6 / PCR6	2DP-2000-1.6-AI	HV-200-1.6 or HVS100-2x120-1.6
BBO	500	3.5	0 – λ/2	70 – 1000 ns	PCB4D	DP-FAM-500-2.5-AI	PS-120-2.6 or HVS100-120-2.6
DKDP	5	11	λ/2	30 – 3000 ns	PC12SR or D-compact/12	DPB-5-5.5	PS-5-2.8

### For operation at 780 – 800 nm wavelength

Material	Max repetition rate, kHz	Ø CA, mm	Phase retardation	HV pulse duration	Pockels cell	Driver	HV Power supply
BBO	6000	2.5	λ/4	0 – 5000 ns	PCB3D/25	2DPB3-6000-1.3-AI	HV-400-1.5
BBO	1000	5.8		100 – 5000 ns	PCB6.3D	DPB1-1000-3.0-AI	PS2-60-1.6 or HVS100-2x60-1.6
DKDP	10	11		30 – 3000 ns	PC12SR or D-compact/12	DPB-10-4.2	PS-5-2.1
KTP / RTP	1000	5.5	λ/2	0 – 5000 ns	PCK6 / PCR6	2DP-1000-2.4-AI	HV-200-2.4
KTP / RTP	500	5.5	0 – λ/2	70 – 1000 ns	PCK6 / PCR6	DP-FAM-500-2.5-AI	PS-120-2.6 or HVS100-120-2.6
DKDP	3	11	λ/2	35 – 2000 ns	PC12SR or D-compact/12	DPB-3-8.6	PS-5-4.4

### For operation at 1030 – 1064 nm wavelength

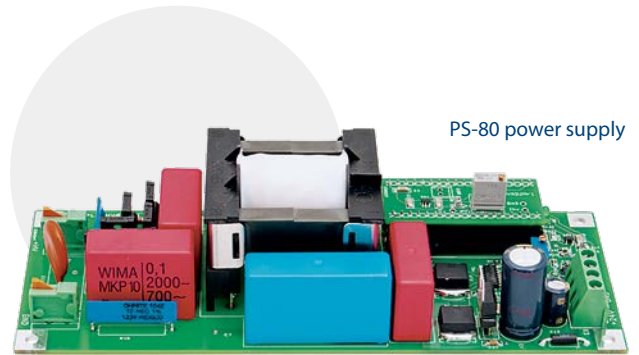
Material	Max repetition rate, kHz	Ø CA, mm	Phase retardation	HV pulse duration	Pockels cell	Driver	HV Power supply
KTP / RTP	4000	5.5	λ/4	0 – 5000 ns	PCK6 / PCR6	2DPB3-4000-1.7-AI	HV-400-2.0
BBO	600	3.5		15 – 400 ns	PCB4D	DP-SP-500-2.6-AI	PS-120-2.6 or HVS100-120-2.6
DKDP	5	11		30 – 3000 ns	PC12SR-1/1, D-compact/12	DPB-5-5.5	PS-5-2.8
KTP / RTP	1000	5.5	λ/2	100 – 5000 ns	PCK6 / PCR6	DPB1-1000-3.0-AI	PS2-60-1.4 or HVS100-2x60-1.4
BBO	300	3.5			PCB4D	DPB1-300-4.6-AI	PS2-60-2.6 or HVS100-2x60-2.6
DKDP	2.5	11		35 – 2000 ns	PC12SR-1/1, D-compact/12	DPB-2.5-9.8	PS-5-5.0

### For operation at 1550 – 1560 nm wavelength

Material	Max repetition rate, kHz	Ø CA, mm	Phase retardation	HV pulse duration	Pockels cell	Driver	HV Power supply
BBO	1000	3.5	λ/4	100 – 5000 ns	PCB4D	DPB2-1000-3.8-AI	HV-2x200-2.0 or HVS100-4x60-2.0
KTP / RTP	500	5.5			PCK6 / PCR6	DP-500-2.6-AI	HVS100-120-2.6
BBO	250	3.5			PCB4D	DP-250-3.6-AI	HVS100-80-3.6
KTP / RTP	2500	3.5	λ/2	100 – 5000 ns	PCK4 / PCR4	DPB3-2500-3.1-AI	HV-2x200-2.0
BBO	500	3.5			PCB4D	DPB3-500-7.2-AI	HV-2x200-3.6
BBO	300	2.5			PCB3D/25	DPB1-300-4.6-AI	PS2-60-2.6 or HVS100-2x60-2.6

All combinations of Pockels cell, driver and HV power supply can be integrated into a single pulse-picking system UP2 or MP1.

# HV Power Supplies



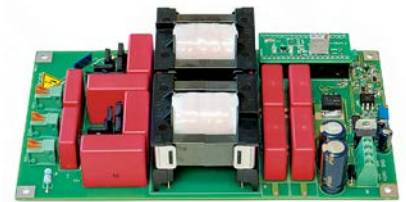
PS-80 power supply

## OEM TYPE HIGH VOLTAGE POWER SUPPLY – PS

PS series Power supplies are designed for powering Pockels cell drivers with required power and voltage. Due to its performance and reliable design, PS is good choice for OEM customers. It features high stability low ripple output together with convenient voltage

control by internal trimmer or CAN computer interface.

Power supplies PS-120 and PS2-60 are equipped with overheat protection and LED indicator that stops operation and lights if ambient temperature exceeds 55 °C.



PS-120, PS2-60 power supply

## Specifications

MODEL	PS-5	PS-40	PS-80	PS-120	PS2-60	PS-170	PS-2x85
Maximal high voltage output options <sup>1)</sup>	1.8 kV	1.3 kV	1.8 kV	1.8 kV	±1.4 kV	1.8 kV	±1.5 kV
	2.8 kV	1.8 kV	2.6 kV	2.6 kV	±2.0 kV	2.6 kV	±1.8 kV
	4.0 kV	2.5 kV	3.1 kV	3.1 kV	±2.6 kV	3.6 kV	
	4.4 kV	3.6 kV	3.6 kV	3.6 kV	±3.6 kV		
	5.0 kV	4.0 kV	4.0 kV				
Maximal output power at maximal output voltage <sup>2)</sup>	5 W	40 W	80 W	120 W	2 × 60 W	170 W	2 × 85 W
Voltage control limits	U <sub>max</sub> –1 kV to U <sub>max</sub> (internal trimmer); 40% U <sub>max</sub> to U <sub>max</sub> (CAN)					40% U <sub>max</sub> to U <sub>max</sub>	
Output voltage control options <sup>3)</sup>	CAN interface <sup>4)</sup> , internal trimmer potentiometer						
External powering	24 V DC, <15 W	24 V DC, <50 W	24 V DC, <90 W	24 V DC, <150 W	24 V DC, <150 W	24 V DC, <200 W	
Dimensions (L × W × H)	135 × 70 × 30 mm	160 × 70 × 40 mm	175 × 70 × 45 mm	175 × 110 × 45 mm		152 × 80 × 58 mm	
Mounting holes Ø3.4 mm location	125 × 35 mm	150 × 60 mm	165 × 60 mm	165 × 100 mm			

<sup>1)</sup> Matching to Pockels cell driver voltage requirement is necessary by ordering.

<sup>2)</sup> Maximal power is proportionally lower by tuning to lower HV output.

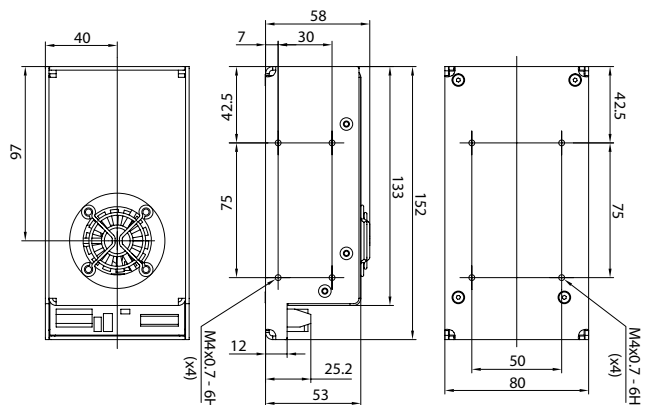
<sup>3)</sup> Needs to be indicated by ordering.

<sup>4)</sup> Requires USB-CAN converter for computer control that is sold separately. Voltage control limits from 40% U<sub>max</sub> to U<sub>max</sub>.

Output ripple is 0.5% typically at maximal power for all models of HV power supplies. External filter can be used to reduce that value if certain application requires smoother output. All Pockels cell drivers have integrated ripple filter and usually do not require additional one. Contact us for suggestions if your specific application needs lower ripple voltage.



PS-170, PS2-85 HV power supply



Outline drawing of PS-170, PS2-85 HV power supply

## LABORATORY TYPE HIGH VOLTAGE POWER SUPPLY – HVS100

Laboratory type HVS100 series high voltage power supply is especially designed for powering of drivers of Pockels cells. However, it can be used as general purpose high voltage power supply for other electronic devices and different applications in the laboratory. HVS100 features two voltage output channels – adjustable high voltage output channel and 24 V DC output channel.

Required high voltage value can be set and adjusted in the limits from 40% of maximal specified voltage to maximal specified voltage (40%  $U_{max}$  to  $U_{max}$ ).

HVS100 has 2.4 inch OLED display for high voltage control and current consumption monitoring at the output channel.



Front panel of HVS100 power supply



Rear panel of HVS100 power supply

### Specifications

CATALOGUE NUMBER	HVS100-2x60	HVS100-120	HVS100-5	HVS100-40	HVS100-80	HVS100-150
Maximal high voltage output options	$\pm 1.4$ kV $\pm 2.5$ kV	1.8 kV 2.6 kV 3.1 kV 3.6 kV	1.8 kV 2.8 kV 4.0 kV 4.4 kV 5.0 kV	1.3 kV 1.8 kV 2.5 kV 3.6 kV 4.0 kV	1.8 kV 2.6 kV 3.1 kV 3.6 kV 4.0 kV	1.8 kV 2.6 kV 3.1 kV 3.6 kV 4.0 kV
HVS100 Maximal output power at maximal output voltage	2x60 W	120 W	5 W	40 W	80 W	150 W
Voltage control limits	40 % $U_{max}$ to $U_{max}$					
Remaining power at the output of 24 V DC for external needs	55 W	55 W	190 W	150 W	100 W	Not available
Mains voltage / DC supply	90 to 264 V AC, 47 – 63 Hz					24 V DC
Dimensions (W x L x H)	230 x 245 x 53.5 mm					
Weight	2.5 kg					

Output ripple is 0.5% typically at maximal power for all models of HV power supplies.  
Maximal power is proportionally lower by tuning to lower HV output.

## HIGH VOLTAGE POWER SUPPLY – HV

### Features

- Up to 400 W and 4 kV at the output
- Single polarity HV and bipolar HV-2x versions
- Computer control through CAN and RS232
- 48 V DC powering
- Auxiliary 24 V DC output for Pockels cell drivers

OEM type HV series power supply modules are designed to be used with high power and high repetition rate Pockels cell drivers that require >120 W power from HV source. To extend the versatility of possible applications we offer both single (positive) polarity and bipolar HV series power supplies.

HV power supplies can also be used as universal HV power supplies for different applications where up to 200 – 400 W high voltage source is required. HV series module provides maximal power (200 W or 400 W) at the indicated maximal rated voltage only.

Therefore, the required rated voltage should be noted when ordering (possible options are listed in the specifications table).

The input of HV series power supply is 48 VDC. 24 VDC auxiliary output is a convenient feature to use the module as a single power source (high plus low voltage) with one of EK SMA Optics Pockels cell drivers. The output voltage can be tuned from zero to maximal value using an internal trimmer potentiometer, CAN or RS232 interfaces. Analog control (0 – 10 V) is possible under request.



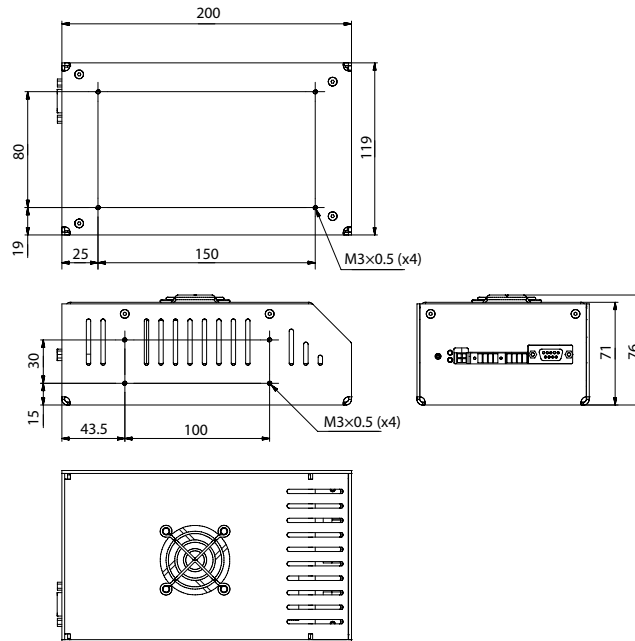
Front and rear view of HV power supply module

### Specifications

MODEL	HV-200	HV-400	HV-2x200
Maximal HV options	1.8 kV 2.6 kV 3.6 kV 4.0 kV <sup>1) 2)</sup>		± 1.5 kV ± 2.0 kV ± 2.6 kV ± 3.6 kV
Maximal output power	200 W <sup>1)</sup>	400 W <sup>2)</sup>	2 × 200 W
Voltage control range	0 – U <sub>max</sub>		
Auxiliary output	24 VDC, 1.2 A		
Controls	CAN, RS232, internal trimmer potentiometer		
Powering requirement	48 V, 4.5 A	48 V, 9 A	
Dimensions	200 × 118 × 75 mm		

<sup>1)</sup> Maximal output power of 4 kV HV-200 version is limited to 180 W.

<sup>2)</sup> Maximal output power of 4 kV HV-400 version is limited to 360 W.



Outline drawing of HV power supply module.

# Q-Switching Kits

## KD\*P POCKELS CELL Q-SWITCHING KIT – QKD

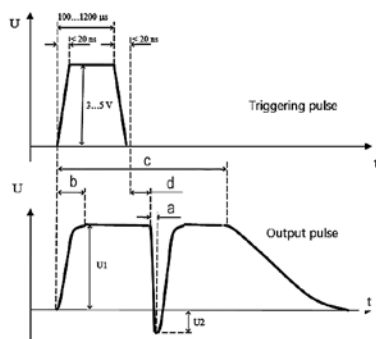
### Features

- Pulse repetition rate up to 200 Hz
- Q-switching without retardation plate

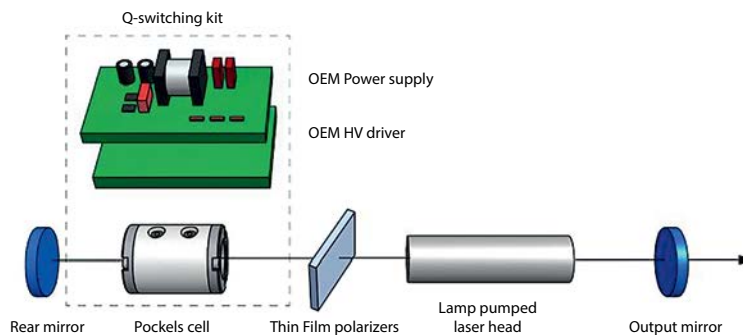
OEM QKD series Pockels cell kits are designed to be used with lamp pumped nanosecond lasers. High voltage is applied to DKDP (KD\*P) Pockels cell through DQF Pockels cell driver in order to inhibit oscillation. Pockels cell is opened by negative polarity pulse allowing laser to radiate.

### DKDP Pockels cells Q-switching kit includes:

- Low repetition rate Pockels cell driver (see page 18)
- High voltage power supply for Pockels cell driver (see page 20)
- KD\*P Pockels cell (see page 5)



Timing diagram of DQF Pockels cell driver



Typical Q-switching with DKDP Pockels cell in  $\lambda/4$  scheme

### ORDERING INFORMATION

MODEL	QKD-01	QKD-02	QKD-03
Wavelength	1064 nm		
Operation	quarter wave ( $\lambda/4$ )		
Repetition rate	up to 200 Hz		
Clear aperture	4.5 × 4.5 mm	Ø 8 mm	Ø 11 mm



## BBO PCKELS CELL Q-SWITCHING KIT – QKB

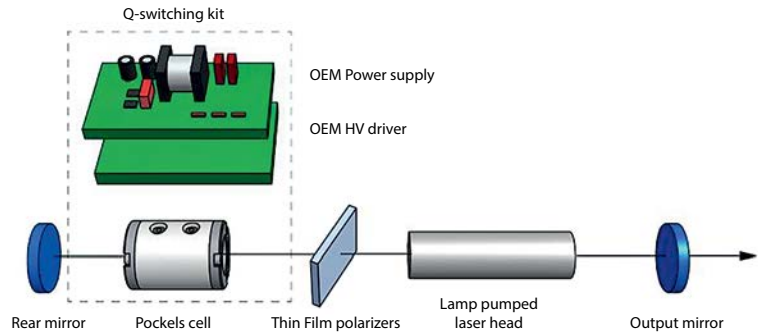
### Features

- Pulse repetition rate up to 100 kHz
- Up to 10 kHz no external cooling is required
- Fast HV rise time <7 ns

OEM QKB series Pockels cell kit is designed for Q-switching of high repetition rate nanosecond lasers and mode locked lasers.

### BBO Pockels cells Q-switching kit includes:

- High repetition rate Pockels cell driver (see page 17)
- High voltage power supply for Pockels cell driver (see page 20)
- BBO Pockels cell (see page 6)



Typical Q-switching with BBO Pockels cell in  $\lambda/4$  scheme

### Ordering information

MODEL	QKB-01	QKB-02
Wavelength	1064 nm	
Operation	quarter wave ( $\lambda/4$ )	
Repetition rate	up to 100 kHz	
Clear aperture	Ø 2.5 mm	Ø 3.5 mm

# Ultrafast Pulse Picking Systems

Digital synchronization and delay pulse generator pMaster 4.2



## DIGITAL SYNCHRONIZATION AND DELAY PULSE GENERATOR – pMaster 4.2

### Features

- Synchronization with pulsed lasers emitting laser pulses at up to 100 MHz repetition rate
- Control of ultrafast pulse picking units operating at up to 2 MHz repetition rate
- Single shot, burst or normal operation modes
- 4 output channels for full control of Pockels cells drivers with 100 ps resolution
- Touch screen for setting operation parameters and monitoring of HV current
- Communication via USB port
- Integrated over-temperature protection
- Protection installed in order to prevent damage if control cables are connected incorrectly
- Possibility to use asynchronous gate input signal

pMaster 4.2 is a timing generator with four output channels used for the full control of operation of high voltage Pockels cells drivers which are built-in in UP2 or MP1 pulse

picking units. pMaster 4.2 also has built-in high voltage power supplies for Pockels cells drivers powering.

### Specifications of pMaster 4.2 timing generator

MODEL		pMaster 4.2
Control modes		Internal pulse generator, External trigger, External RF source
Internal Pulse generator	Operation modes	Single shot, burst, normal
	Delay range	1.1 nanoseconds to 140 milliseconds
	Resolution	100 ps
	Accuracy	25 ps + 0.000001 × delay
	Time base	100 MHz, 0.2 ppm
	RMS jitter	< 100 ps
	Channel to channel jitter	< 30 ps
External synchronization	Synchronization source	External trigger, SYNC IN input
	Rate	1 Hz to 20 MHz
	Min pulse width	10 ns
	Threshold	1.3 V
	Input level	LVTTL, tolerates 5 V
	Impedance	0.2 mA pulldown
External RF source, CLK IN input	Slope	rising
	Rate	10 MHz to 100 MHz
	Min pulse width	300 ps
	Input level	0.5 V to 3.3 V
Outputs	Impedance	50 Ω
	Output level	4.5 V
Communication, powering and physical specifications	Output impedance	50 Ω
	Communication	USB
	Power	230 V AC 50 Hz or 110 V AC 60 Hz
	Dimensions	482 × 387 × 88 mm

### Ordering information

Digital synchronization and delay pulse generator pMaster 4.2 should be matched with pulse picker MP1 or UP2. Please contact our sales engineers for a complete solution tailored to your application.

## PULSE PICKER – MP1

### Features

- Pulse picking rate up to 1 MHz
- Fast Amplitude Modulation version available

MP1 pulse picker consists of built-in fast driver and a Pockels cell. This unit is able to select pulses at up to 1 MHz rate. MP1 is operated by pMaster 4.2 generator which provides sync pulses for driver control and has built-in HV power supply. MP1 can be synchronized with a laser generating pulse train with max 60 MHz repetition rate for single pulse picking task when it is in setup with pMaster 4.2 generator.

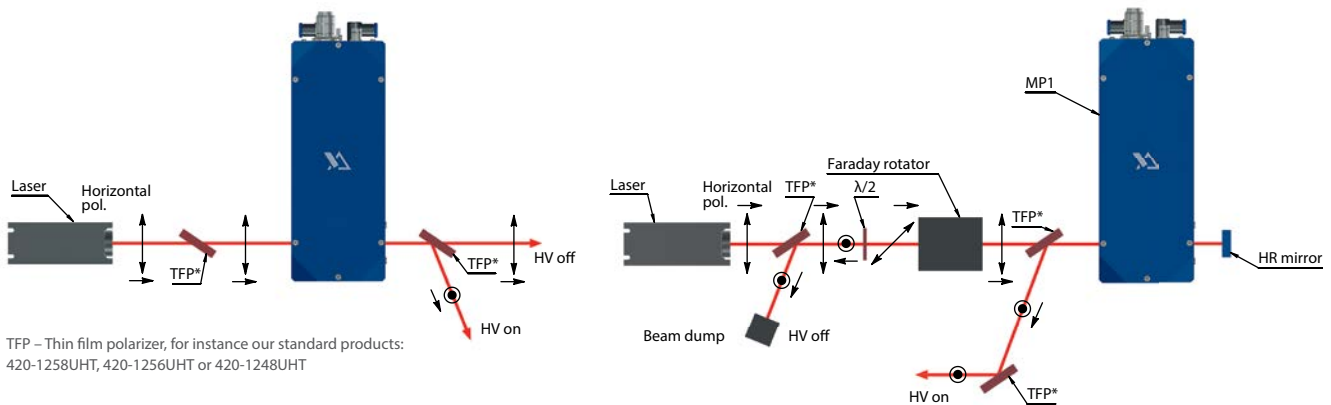


### Samples of suggested MP1 pulse picker configurations

PULSE PICKER	MP1-DKDP-11	MP1-BBO-5.8	MP1-BBO-2.5	MP1-FAM-KTP-5.5
Built-in-driver, max operating rate	up to 5 kHz	up to 250 kHz	up to 1 MHz	up to 500 kHz
Max laser repetition rate for single pulse picking	40 MHz	60 MHz		10 MHz
HV power supply	provided in pMaster 4.2			
Operation	quarter-wave, $\lambda/4$			0 to $\lambda/2$
HV pulse duration	30 – 3000 ns	15 – 1000 ns	15 – 250 ns	70 – 1000 ns
HV pulse rise time, typical	< 7 ns			< 26 ns
HV pulse fall time, typical	< 7 ns			< 13 ns
Pockels cell contrast ratio, VCR	1 : 500			
Pockels cell transmission	> 97 % at 1064 nm	> 98 % at 1064 nm		
Clear aperture	Ø11 mm	Ø5.8 mm	Ø2.5 mm	Ø5.5 mm
Cooling	conductive	water		
Dimensions (L x W x H)	230 x 90 x 69 mm			

MP1 can be set for operation at standard laser wavelengths (1064 nm, 1030 nm, 800 nm) or at any specific laser wavelength in the range from 500 to 2000 nm.

### Suggested operation schemes



Single pass (half-wave) operation scheme

Double pass (quarter-wave) operation scheme

### Suggested configurations

CODE	DESCRIPTION
MP1-DKDP-11 + pMaster 4.2	Ultrafast pulse picker for up to 5 kHz operating rate, DKDP clear aperture Ø11 mm, $\lambda/4$ operation at 1064 nm. Pulse synchronization and delay generator, 4 output channels for trigger pulses with built-in High Voltage supply
MP1-BBO-5.8 + pMaster 4.2	Ultrafast pulse picker for up to 250 kHz operation, BBO clear aperture Ø5.8 mm, $\lambda/4$ operation at 1064 nm. Pulse synchronization and delay generator, 4 output channels for trigger pulses with built-in High Voltage supply
MP1-BBO-2.5 + pMaster 4.2	Ultrafast pulse picker for up to 1 MHz operation, BBO clear aperture Ø2.5 mm, $\lambda/4$ operation at 1064 nm. Pulse synchronization and delay generator, 4 output channels for trigger pulses with built-in High Voltage supply

## ULTRAFAST PULSE PICKER – UP2

### Features

- Pulse picking rate up to 2 MHz

UP2 pulse picker consists of built-in drivers, Pockels cell, high contrast ratio polarizers, beam dump and other optical components necessary for pulse picking application. The UP2 pulse picker in setup with pMaster 4.2

generator is able to select pulses at up to 2 MHz rate from max 100 MHz repetition rate pulse train. UP2 comes with BBO or KTP Pockels cell which are set for quarter wave or half wave voltage operation depending on the laser wavelength and required minimal clear aperture of the Pockels cell.

KTP Pockels cell's usage is limited by the average power of the laser beam – up to 2 W and contrast ratio is typically >1:500. While BBO Pockels cells operate at much higher power levels and feature higher contrast ratio – typically >1:1000.

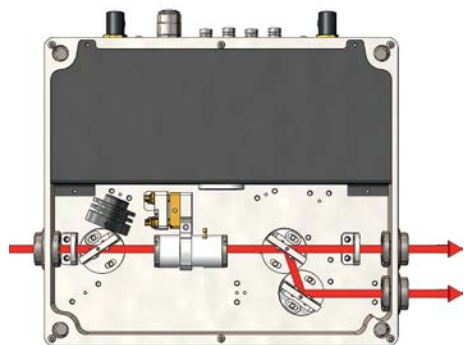


### Specifications of UP2 pulse picker units

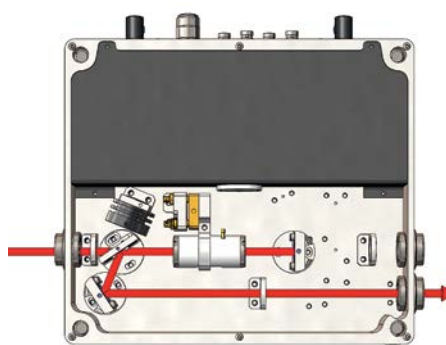
PULSE PICKER	UP2-BBO-3.5	UP2-BBO-2.5	UP2-KTP-5.5	UP2-KTP-3.5
Built-in-driver, max operating rate	up to 1 MHz	up to 2 MHz	up to 1 MHz	up to 2 MHz
Max laser repetition rate for single pulse picking	100 MHz			
HV power supply	provided in pMaster 4.2			
Operation	quarter-wave, $\lambda/4$		half-wave, $\lambda/2$	
HV pulse duration	0 – 5000 ns			
HV pulse rise time, typical	< 7 ns			
HV pulse fall time, typical	< 7 ns			
Pockels cell contrast ratio, VCR	1 : 500			
Pockels cell transmission	> 98 % at 1064 nm		> 98 % at 800 nm	> 98 % at 1064 nm
Clear aperture	Ø3.5 mm	Ø2.5 mm	Ø5.5 mm	Ø3.5 mm
Cooling	water			
Dimensions (L x W x H)	240 x 275 x 59 mm			

UP2 can be set for operation at standard laser wavelengths (1064 nm, 1030 nm, 800 nm) or at any specific laser wavelength in the range from 500 to 2000 nm.

### Suggested operation schemes



Single pass (half-wave) operation scheme



Double pass (quarter-wave) operation scheme

Note. Additional components – Faraday rotator,  $\lambda/2$  waveplate and polarizer are required for safe operation of the laser when pulse picker is used in double pass configuration. See suggested scheme at page 26 .

### Suggested configurations

CODE	DESCRIPTION
UP2-BBO-3.5 + pMaster 4.2	Ultrafast pulse picker for up to 1 MHz operation, BBO clear aperture Ø3.5 mm, $\lambda/4$ operation at 1064 nm. Pulse synchronization and delay generator, 4 output channels for trigger pulses with built-in High Voltage supply
UP2-BBO-2.5 + pMaster 4.2	Ultrafast pulse picker for up to 2 MHz operation, BBO clear aperture Ø2.5 mm, $\lambda/4$ operation at 1064 nm. Pulse synchronization and delay generator, 4 output channels for trigger pulses with built-in High Voltage supply
UP2-KTP-5.5 + pMaster 4.2	Ultrafast pulse picker for up to 1 MHz operation, KTP clear aperture Ø5.5 mm, $\lambda/2$ operation at 800 nm. Pulse synchronization and delay generator, 4 output channels for trigger pulses with built-in High Voltage supply
UP2-KTP-3.5 + pMaster 4.2	Ultrafast pulse picker for up to 2 MHz operation, KTP clear aperture Ø3.5 mm, $\lambda/2$ operation at 1064 nm. Pulse synchronization and delay generator, 4 output channels for trigger pulses with built-in High Voltage supply

# Timing Generators

Laboratory type timing generator TG10



OEM version of TG10 timing generator SY4000-OEM

## TIMING GENERATOR FOR APPLICATIONS WITH LASERS AND LASER COMPONENTS – TG10

### Features

- Ultra-stable internal clock 0.2 ppm
- Precise delay control in range 2 ns to 150 ms
- 25 ps timing resolution
- Hi-accuracy synchronization to the external pulse train
- DAC output
- Frequency divider for photodetectors
- Measurement of:
  - Optical clock frequency
  - Triggering frequency
  - Delay

### Applications

- Passive or active mode locked, Q-switched lasers, pulsed or QCW
- Data acquisition system triggering
- General purpose pulse generator
- Precise system clock source
- Laser pulse train converting to the clean clock source
- All functions listed above simultaneously at once!

The TG10 is a timing generator dedicated to the synchronization of laser systems and laser components: Pockels cell drivers, acousto-optical modulator drivers, laser diode and flash lamp drivers, detectors, data acquisition systems, laser pulse pickers, etc. The TG10 is designed to create up to 8 delayed output sequences precisely synchronized to the internal or external clock. A photodetector or electrical signal can be used as the input source to be synchronized with.

The timing generator can be used as a standalone unit with a touch screen interface (TG10) or installed as an optional add-on PCB board (SY4000-OEM). The TG10 device has an LCD touch screen for the manual control and a tunable knob for the adjustment of selected values set on the touch screen. Instructions of required actions are always displayed at the bottom of the screen. Besides, the timing generator has a digital control interface via CAN bus. Communication protocol with description for CAN is provided on request. CAN to USB converter is also available from EK SMA Optics.

### Key features of the TG10

The key features of the TG10 module in addition to standard pulse generator features:

- Ability to lock to an external clock source, usually photo-diode pulse train. The triggering system is locked to the laser oscillator then, and trigger time is always in phase with the optical pulse.
- Instant switch between two configurations in delay blocks. Burst counter, gate input, frequency divider, or software commands may serve as the configuration switching signal sources. Configuration switch is used to control optical pulse pickers (EOM or AOM) in a highly flexible manner.

- Low jitter sync pulse output is used for high-speed acquisition systems like streak camera triggering. The typical jitter is 3...5 ps to the optical pulse.
- Control connector. The software-controllable multiplexer may divert any of the output signals to this connector to sniff what is on other connectors without disturbing them.
- Clock output: 1:1, 1:2 frequency.
- Up to 4 pulse outputs can be combined to single signals by OR, AND, NOT logical operations.
- DAC output, controlling, e.g. AOM pass through.

### Input and output channels

CHANNEL	DESCRIPTION
OUTx	five digital general-purpose output channels (4.5 V @ 50 Ω)
AN OUT	analog output with 12-bit resolution (1 V @ 50 Ω)
COM TRIG	common trigger output. Configurable source (2.5 V @ 50 Ω)
PRE TRIG	precise trigger output channel. Configurable source (>1.5 V @ 50 Ω)
GATE IN	configuration switch and burst control input. (LVTTTL, tolerates 5 V. 0.2 mA pull-down)
SYNC IN	trigger input for DC to 20 MHz frequencies. (LVTTTL, tolerates 5 V. 0.2 mA pull-down)
CLK IN	clock input for 10 MHz to 100 MHz frequencies. (0.5 V to 3.3 V @ 50 Ω pk-pk, sine or pulses)

## General specifications

PARAMETER	SPECIFICATION
<b>TIME BASE</b>	
Internal source	100 MHz 0.2 ppm TCXO
External source, Optical clock	20... 100 MHz
<b>INTERNAL RATE GENERATOR</b>	
Sources	100 MHz clock, Optical clock, SYNC IN, Software command
Rate (T0 period)	50 ns...100 s (0.01 Hz to 20 MHz)
Resolution	10 ns or 1 Optical period or 1 SYNC IN period
RMS jitter	< 350 ps
<b>EXTERNAL TRIGGER, SYNC IN INPUT</b>	
System modes	Direct SYNC IN, SYNC IN re-clocked to Optical clock
Rate	DC to 20 MHz
Threshold	1.3 V
Input range	0...5 V
Trigger slope	rising edge
RMS jitter, Direct SYNC IN	< 120 ps
RMS jitter, SYNC IN re-clocked	< 5 ns
Insertion delay	< 80 ns
<b>DELAY GENERATORS</b>	
Channels, total	8
High res channels	5
High res channels, resolution	25 ps
Low res channels	3
Low res channels, resolution	< 10 ns
Delay	0 ... 150 ms
Pulse width	2 ns ... 150 ms
Accuracy, High res channel	2.5 ns + 0.000001 setpoint
Accuracy, Low res channel	≤ 10 ns + 0.000001 setpoint
Time base, Internal clock	100 MHz, 0.2 PPM TCXO
RMS jitter, channel to channel	< 30 ps TTL output, < 4 ps PRET output
<b>CONFIGURATION SWITCH</b>	
System modes	Single shot, burst, continuous, frequency divider, GATE IN, inverted GATE IN
Burst counter	1 ... 65535
Frequency divider	1 ... 32767
<b>OUTPUTS, TTL/COMS</b>	
Voltage @50 Ω load	2.5 V or 4.5 V
Voltage @1 MΩ load	5 V or 9 V
Voltage selection 5V/9V	internal jumper
Impedance	50 Ω
Rise time	1.5 ns typ
<b>OUTPUT, PRET</b>	
Pulse amplitude @50 Ω load	> 1 V
Impedance	50 Ω
Rise time	200 ps typ
<b>OUTPUT, DIFFERENTIAL</b>	
Type	LVPECL
<b>OUTPUT, ANALOG</b>	
DAC resolution	12 bit
Max amplitude @50 Ω	1 V
<b>POWER</b>	
Voltage	12 V ± 10%
Power	15 W max

# Crystal Ovens

Many of widely used nonlinear crystals are susceptible to ambient humidity, for example KD\*P, BBO, LBO. Protective coatings applied to the surface can reduce degradation to some extent only. To improve the protection of surfaces of the crystals from the degradation it is desirable to keep the crystals at higher than ambient temperature, which helps avoid condensation on the crystal surfaces.

In addition, if the crystal is used for harmonics generation, the phase-matching angle depends on crystal temperature. For example, the output power of second harmonics generator based on KD\*P crystal can decrease by 50 % if the crystal temperature changes just by one degree, hence for good laser stability precise crystal temperature stabilization is necessary.

## TEMPERATURE CONTROLLER TC2 WITH OVEN CO1 – TC2 / CO1

TC2 and CO1 is high temperature set (up to 200 °C) consisting of thermocontroller TC2 and crystal oven CO1. TC2 has two independent outputs and can control two CO1-30 ovens simultaneously. Controller is equipped by LAN and USB computer control interfaces.

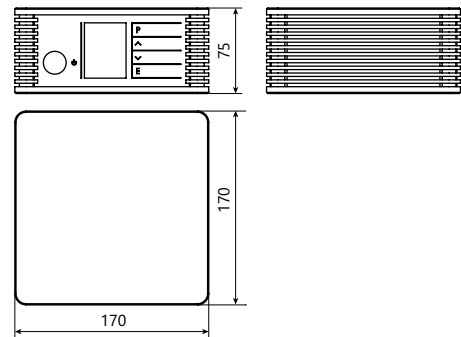
The nonlinear crystal is mounted into adapter before insertion into oven CO1. Such design facilitates handling and replacement of the crystal. The nonlinear crystal can be sealed with fused silica windows in order to provide extra protection. The standard adapters are 30 and 50 mm length with apertures of 3x3, 4x4, 5x5, 6x6 mm and up to 12x12 mm size. Oven is delivered with one, customer's specific size of adapter. Adapters for different sizes can be ordered separately.



### Specifications

MODEL	TC2 + CO1-30	TC2 + CO1-50
Quantity of ovens possible to connect to one controller TC2	2	
Temperature tuning range	RT – 200 °C	
Maximum crystals dimensions	12x12x30 mm	12x12x50 mm
Sealing (optional)	FS windows (operation wavelength must be specified before ordering)	
Temperature tuning step	0.05 °C	
Accuracy	± 0.5 °C	
Long-term stability	± 0.05 °C	
Control interfaces	LAN, USB	
Mains	90–264 V, 47–66 Hz	
Power consumption	< 50 W	
Dimensions, DiaxD	Ø52x52 mm	Ø52x72 mm

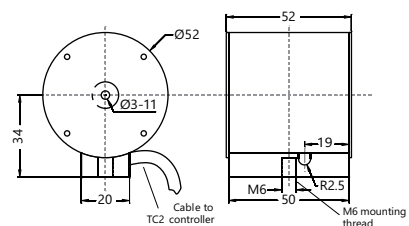
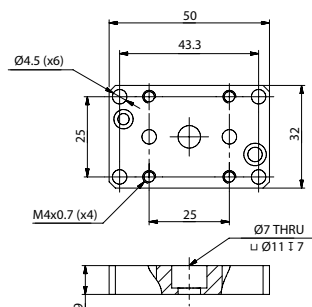
Specifications are subject to changes without advance notice.



Temperature controller TC2 outline drawing

### Related products

Adapter MS-4 for CO1 mounting on tilt stage



Crystal oven CO1-30 outline drawing

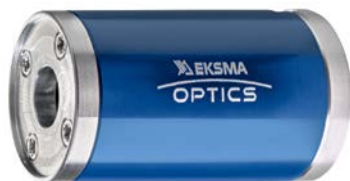
## COMPACT OVEN FOR NONLINEAR CRYSTALS – Heatpoint

Heatpoint is a compact round oven designed for heating and thermo-stabilization of humidity sensitive nonlinear crystals. Temperature of the oven can be adjusted in 25 – 70 °C range using a small thermocontroller attached on a wire. Heatpoint ovens exhibit precise long-term stability and are ideal for keeping nonlinear crystals at their optimal operational temperature, preventing moisture condensation on crystal's faces.

Because of their compact design, Heatpoint ovens can be easily installed into tight spaces. These ovens can be mounted in any standard one-inch optics positioning mount.

Heatpoints are available in two sizes: HP15 accepts crystals up to 15 mm in length, while slightly longer HP30 fits crystals up to 30 mm in length. The exact aperture of the crystal must be specified when ordering, as a special adapter is made for the installation.

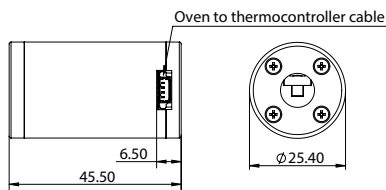
Each oven is made exactly for specific crystal aperture size, so it cannot be used for different size crystals.



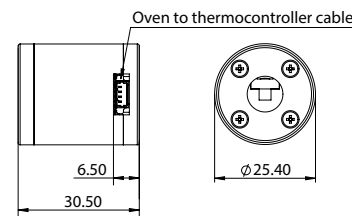
Heatpoint HP30



Heatpoint HP15



HP30 dimensions



HP15 dimensions

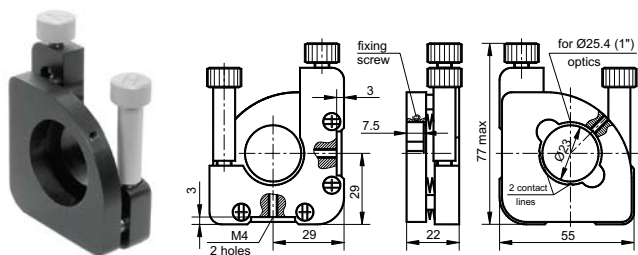


Heatpoint HP30 with thermocontroller

### Specifications

MODEL	HP15	HP30
Crystal length (max)	15 mm	30 mm
Crystal aperture (max)	6 × 6 mm	
Temperature tuning range	25 – 70 °C	
Temperature tuning step	0.1 °C	
Long-term stability	± 0.1 °C	
Temperature ramp rate	3 °C/min	
Powering requirements	12 V DC	
Power consumption (P <sub>MAX</sub> )	6 W	
Power connector	2.1/5.5 mm	
Power adaptor (included)	90 – 264 V AC, 47 – 66 Hz, 12 V DC	
Dimensions (oven)	∅ 25.4 × 30.5 mm	∅ 25.4 × 45.5 mm
Dimensions (thermocontroller)	60 × 14 × 7.5 mm	
Distance (wiring length) from oven to thermocontroller	250 mm	

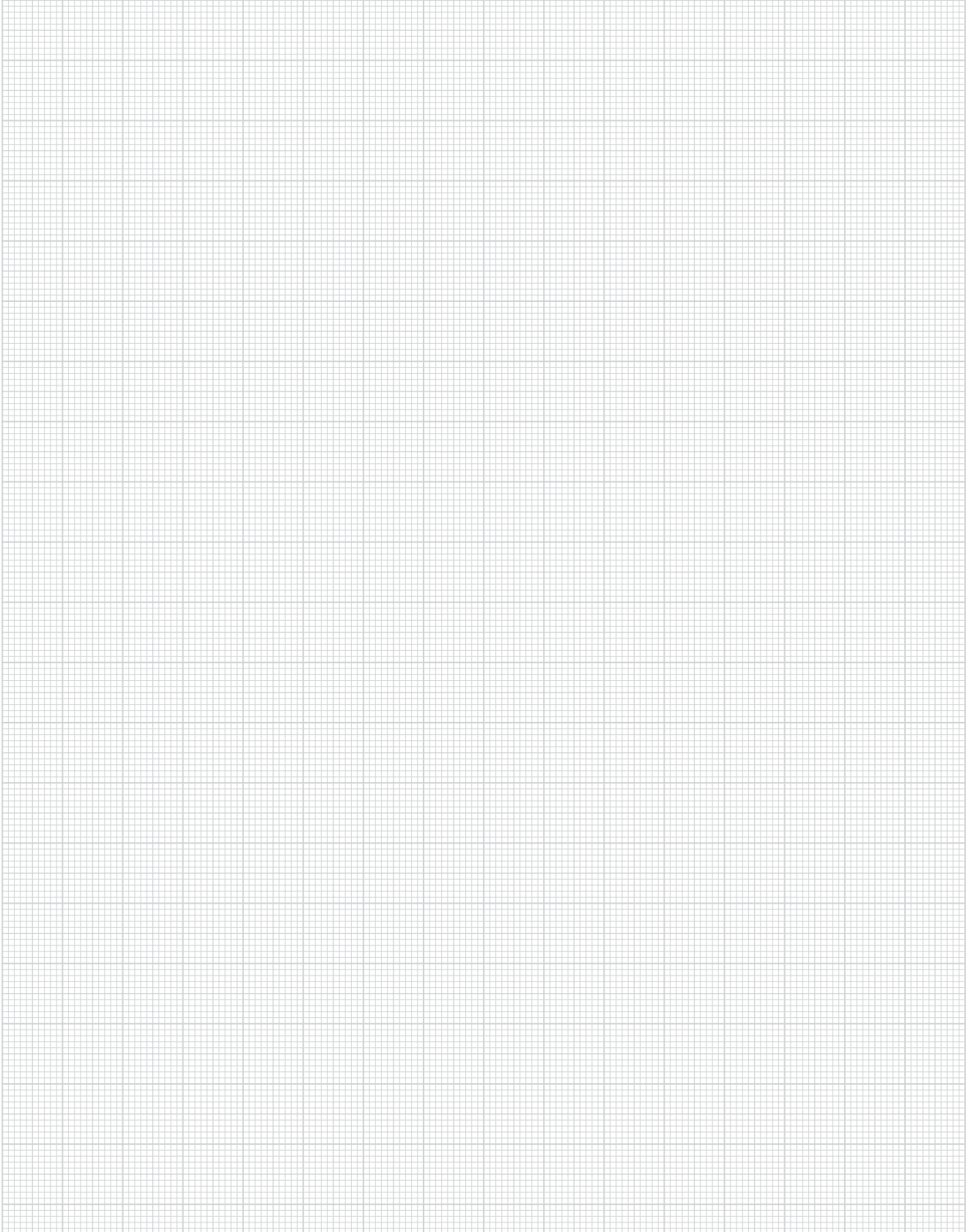
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# Notes





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