Single Pulse Selector

*pulse*Select

User Manual

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IMPORTANT – READ CAREFULLY BEFORE USE – KEEP FOR FUTURE REFERENCE

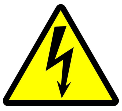
This user manual contains user information for the *pulse*Select . Read this manual carefully before operating the *pulse*Select , particularly Section 1 on safety instructions. The *pulse*Select is only to be used as described in this manual. Differing use may endanger safety and voids warranty.

CAUTION - USE OF CONTROLS OR ADJUSTMENTS OR PERFORMANCE OF PROCEDURES OTHER THAN THOSE SPECIFIED HEREIN MAY RESULT IN HAZARDOUS RADIATION EXPOSURE

Symbols Used in this Manual and on the Measuring System

This symbol is intended to emphasize the presence of important operating instructions.

This symbol is intended to alert the operator to the danger of exposure to hazardous visible or invisible laser radiation.



This symbol is intended to alert the operator to the presence of dangerous voltage within the product's enclosure that may be of sufficient magnitude to constitute a risk of electrical shock and to indicate possible risk of equipment damage.

Warranty

The warranty conditions are specified in the sales contract.

Any unauthorized modification (opening included) of the ***pulse*Select** system components or software will result in invalidity of the guarantee and service contract.

Disposal

The ***pulse*Select** fulfills the European Directive 2011/65/EU for reduction of hazardous substances in electrical and electronic equipment (RoHS).

All electrical and electronic products must be disposed separately from the standard municipal waste system. Proper disposal of your old appliance prevents potential negative consequences for the environment and human health.

Contents

1 Safety Instructions

The European Community requirements for product safety are specified in the "Low Voltage Directive" (2006/95/EC). The "Low Voltage Directive" requires that electronic products comply with the standard EN 61010-1:2010 "Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use". Compliance of this product is certified by the CE mark.

1.1 Optical Safety

Since the *pulse*Select is intended to be used with a laser all safety instructions relevant to the class of your laser have to be observed!

Laser light, because of its special properties, poses safety hazards not associated with light from conventional sources. The safe use of lasers requires that all laser users, and everyone near the laser system, are aware of the dangers involved. The safe use of the laser depends upon the user being familiar with the instrument and the properties of coherent, intense beams of light.

The greatest concern when using a laser is eye safety. In addition to the main beam, there are often many smaller beams present at various angles near the laser system. These beams are formed by specular reflections of the main beam at polished surfaces such as lenses or beam splitters. Although weaker than the main beam, such beams may still be sufficiently intense to cause eye damage.

Direct eye contact with the output beam from the laser can cause serious damage and possible blindness.

Laser beams can be powerful enough to burn skin, clothing or paint. They can ignite volatile substances such as alcohol, gasoline, ether and other solvents, and can damage light-sensitive elements in video cameras, photomultipliers and photodiodes. The laser beam can ignite substances in its path, even at some distance. The beam may also cause damage if contacted indirectly from reflective surfaces. For these reasons and others, the user is advised to follow the precautions below:

1. Observe all safety precautions given by the manufacturer of your laser.
2. All alignment procedures described herein shall only be done by qualified users who are familiar with laser safety practices and who are aware of the dangers involved.
3. Never look directly into the laser light source or at scattered laser light from any reflective surface. Never sight down the beam into the source.
4. Maintain experimental setups at low heights to prevent inadvertent beam-eye encounter at eye level.
5. As a precaution against accidental exposure to the laser beam or its reflection, those using the system have to wear laser safety glasses as required by the wavelength being generated.

Laser safety glasses can present a hazard as well as a benefit; while they protect the eye from potentially damaging exposure, they block light at the laser wavelengths, which prevents the operator from seeing the beam. Therefore, use extreme caution even when using safety glasses.

6. Avoid direct exposure to the laser light. The intensity of the beam can possibly cause flesh burns or ignite clothing.
7. Extreme care must be taken during alignment procedures with the free laser beam. Always start alignment with a beam attenuated to a level that allows for save handling.

Caution! When opening the optical head top cover a laser beam might emerge in upward direction if the input beam to the unit is not properly blocked nor the laser switched OFF.

1.2 Electrical Safety

The ***pulse*Select** uses DC voltages in the controller and in the optical head. All units are designed to be operated with protective covers in place.

The device complies with protection Class III / EN 61140:2007, degree of ingress protection IP20, according to EN 60529:2010.

For the connection of the controller and the optical head only the delivered cable may be applied. It is only allowed to run the *pulse*Select with the delivered mains adapter.

1.3 Electromagnetic Compatibility

The European requirements for Electromagnetic Compliance (EMC) are specified in the EMC Directive (published in 2004/108/EC). Conformance (EMC) is achieved through compliance with the harmonized standards EN 61000. Compliance of the ***pulse*Select** system with the (EMC) requirements are certified by the CE mark.

2 Description and Specifications

2.1 Description and Intended Use

Mode-locked lasers which are capable of generating very short laser pulses (e.g. picosecond or femtosecond pulses) have pulse repetition rates corresponding to the round trip time of the light in the laser cavity. This frequency is in the range around 80 MHz for many ion, dye and tunable solid state lasers used in scientific applications. It corresponds to a pulse separation time of 12.5 ns. For a number of applications like measurement of longer fluorescence delay times or some pump and probe experiments it is desirable, however, to have a lower repetition rate. This can be achieved with different methods acting inside or outside the laser cavity.

The A·P·E ***pulse*Select** is well suited for pulse selection of mode-locked lasers with repetition rates between 70 and 85 MHz (to be specified at time of order) outside the laser cavity. Its function is based on the acousto-optic effect. In a suitable crystal (e.g. quartz, TeO2) a modulation of density and thus of refractive index is introduced by applying an acoustic signal with high frequency. This acts as a threedimensional optical grating on a laser beam passing the crystal and leads to diffraction of the beam. The acoustic wave inside the crystal is generated by applying an electrical RF signal to a piezoelectric transducer cemented on the crystal. By using short RF pulses single laser pulses can be selected out of the pulse train and deflected to the first diffraction order. This way they are separated from the other pulses and are available for use in the experiment.

The ***pulse*Select** consists of the optics module and control electronics module. The optics contains the Bragg-cell as the most important part which selects single pulses from the laser beam basing on the acousto-optical effect. Further it contains the focusing mirror and the collimating mirror and the beam stop for the zero order beam. The driver electronics provides the modulated RF signal for the Bragg cell with a carrier frequency equal to the fivefold of the laser repetition rate and an output power of up to about 17.5 W (peak).
The standard range for the division ratio of the laser repetition rate is 1:20 to 1:5000 (optionally 1:2 to 1:260000). For synchronization the user must provide a seed signal with the laser repetition rate (for instance from a fast photodiode) and with an amplitude of 100 mV ... 1 V at 50 Ω. Instead of using the internal frequency divider pulses can be selected by external triggering with a TTL signal at the 50 Ω external trigger input.
Depending on the used modulator type (in dependence on the laser system and the application) diffraction efficiencies of > 60% (at 800 nm) can be achieved.

2.2 Optics

Figure 2.1 shows the optics of the ***pulse*Select** in top view.

The optics set up is designed for horizontal polarization of the laser. The beam goes through the input Brewster window onto the focussing mirror. From there it is reflected and focussed into the Bragg cell, which is arranged in Brewster angle to the beam. By applying the modulated RF signal from the driver electronics to the Bragg cell a part of the beam (selected pulses) will be deflected into the 1st diffraction order. Zero order and first order beam are recollimated by the collimating mirror and leave the optics module parallel to each other through the output Brewster window. The zero order beam can be suppressed by the adjustable beam stop.

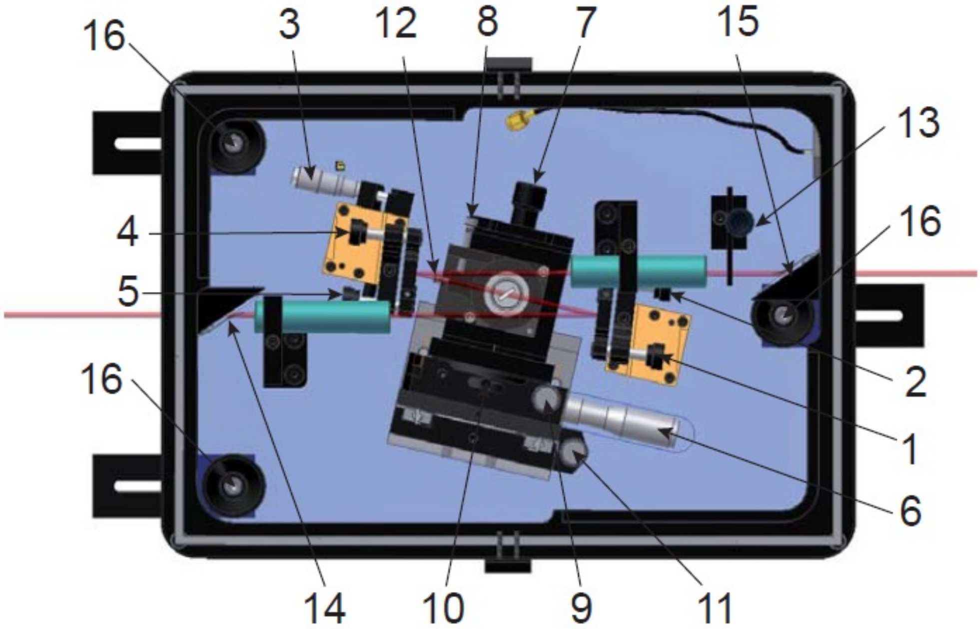


Figure 2.1: Top view of the optics of the ***pulse*****Select**

1	Focussing mirror, vertical tilt control
2	Focussing mirror, horizontal tilt control
3	Collimating mirror, horizontal position adjustment screw
4	Collimating mirror, vertical tilt control
5	Collimating mirror, horizontal tilt control
6	Modulator, horizontal Z-position adjustment screw
7	Modulator, horizontal Y-position adjustment screw
8	Modulator, Brewster angle control
9	Modulator, Bragg angle control
10	Modulator, rough Bragg angle lock screw
11	Modulator, vertical position adjustment screw
12	Modulator, rough Brewster angle lock screw
13	Beam stop adjustment screw

14 Beam input Brewster window
15 Beam output Brewster window
16 Height adjustment screws

2.3 Specifications

2.3.1 Optical Parameters

Version	**Standard**	**HP-Ti:Sa**	**HP-Ti:Sa Dualband**
Wavelength	500 ... 1600 nm (other ranges optional)	680 ... 1080 nm	680 ... 1080 nm 340 ... 540 nm
Max. laser input power (P_{AV})	< 2 W (SiO_2) [1] < 0.5 W (TeO_2) [1]	< 5 W (SiO_2) [1]	< 5 W (SiO_2) [1]
Diffraction efficiency	> 60 % (TeO_2)[2] > 50 % (SiO_2)[2]		
Contrast ratio	> 500:1 [3]		
Input frequency (f_{REP}) Option	70 ... 85 MHz 25 ... 100 MHz (others on request) (to be specified with $\pm$0.5 MHz accuracy at time of order)		
External trigger	single shot to 3 MHz input		
Input polarization	horizontal (polarization rotator optional)		
Division ratio	f_{REP}/20 ... f_{REP}/5000 (f_{REP}/2 ... f_{REP}/260000 optional) or externally triggered		

[1] These values depend on the laser spot diameter in the crystal or mirror coating and for the type of Bragg cell indicated and thus apply only for a certain system configuration. Please consult our technical staff to determine the maximum input power level as well as the appropriate focusing for the beam parameters applicable for your laser system setup.

[2] Ratio of the diffracted pulse energy to the pulse energy incident into Bragg cell. Measured at 800 nm and division ratio f_{REP}/20. At division ratio f_{REP}/2 the efficiency is typically around 25 % (TeO_2 Bragg cell) and around 10 % (SiO_2), respectively.

[3] > 500:1 applies for non-adjacent pulses. Main pulse to adjacent pulse contrast ratio is > 75:1 (800 nm f_{REP}/20

2.4 Environmental Requirements

The *pulse*Select is intended for operation in indoor, dry and dust reduced rooms. It has to be firmly installed on an optical table or on a similar solid, vibration-free board.

During storage, transport, for the installation and during operation, the ambient conditions must be observed. Ensure reasonable transport conditions, free of major shocks, jolt or fall; protect against frost. Use original packing material for relocation. Before unpacking the device wait for at least six hours to allow for acclimatization of all components.

Ambient temperature during transportation:	- 30 ... + 50 °C
Relative humidity during transportation:	10 ... 80 %, no condensation
Ambient temperature during operation:	+ 18 ... + 27 °C
Relative humidity during operation:	< 60 %, no condensation

3 Installation

3.1 Receiving and Inspection

On receipt of the ***pulse*****Select** system:

1. Inspect the packing crate for signs of rough handling or damage directly at arrival. If you discover any irregularities:
   - Take photographs of the condition of the package, the labels and the inside of the box, if necessary.
   - List all defects on the shipping documents and let the delivery company countersign.
   - Inform your ***pulse*****Select** vendor immediately.
2. Use safe lifting practices.
3. Before unpacking the ***pulse*****Select** wait at least six hours to allow for acclimatization of all components.
4. Unpack the ***pulse*****Select** system.
5. Retain the packaging for future use.

3.2 Contents of Delivery

	Item	Amount
1	***pulse*****Select** - optic unit incl. Bragg cell, mirrors and Brewster windows	1
2	RF Pulse Driver - electronic unit	1
3	Power cord	1
4	RF cable (TNC - TNC)	1
5	Clamps	3
6	Screws	6
7	User manual	1
8	Test protocol	1

3.3 Installation of the *pulse*Select

Warning! All adjustments should first be done with attenuated laser beam! Pay attention to the safety rules according to the class of your laser! The installation and adjustment should only be done by personnel skilled in the handling of optics and lasers!

- Remove transportation locks.

- Before installation check if the optical parts (brewster windows, mirrors, crystal) are clean. If not they should be cleaned using common optics cleaning techniques and methanol as detergent. Make sure that the crystal is not connected to RF while cleaning.
- At the beginning of the basic adjustment described in the following paragraphs the Bragg cell has to be driven downwards out of the beam path by using the vertical position adjustment screw [11]. The Brewster angle adjustment screw of the Bragg cell holder [8] should be set to 0°. Set the horizontal translation stage of the collimating mirror [3] to a middle position.
- Place the ***pulse*Select** optics module in front of the laser. Depending on the distance of the ***pulse*Select** from the laser and on the laser beam parameters the performance can variate and may be improved by fitting the beam parameters. The laser beam must enter the optics module in the centre of the input aperture. Use the height adjustment screws [16] of the module to fit it to the height of the beam. The beam should afterwards fall on the centre of the focussing mirror. Once reached this position the optics module should be fixed on the table using the supplied foot clamps.
- Adjust the beam to fall onto the collimating mirror at middle height and about 2 mm right from centre. Use the tilt controls of the focussing mirror [1, 2]!
- Now the modulator crystal can be driven into the beam path with the vertical position adjustment screw [11]. While doing that, the horizontal position adjustment screw [7] should be in a middle position. Now the beam should fall into the centre of the collimating mirror. Use the tilt controls of the focussing mirror [1, 2] to correct!
- Check the beam path inside the crystal with an IR-viewer and correct the crystal position to get the beam to the centre (see Figure3.1).

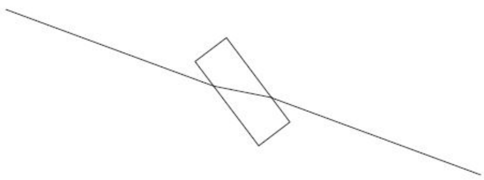


Figure 3.1: Beam path inside the crystal

- Direction and collimation of the output beam can be adjusted with the tilt controls [4, 5] and horizontal position control [3] of the collimating mirror.

3.4 Driver Electronics

Figure 3.2 and 3.3 show the front and back panel of the driver electronics module with controls and signal inputs and outputs. On the left top of the front panel there is a LCD graphic display.

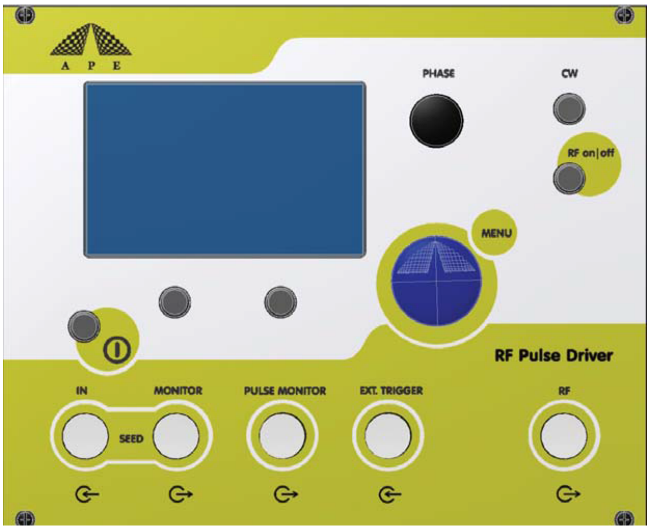


Figure 3.2: Driver unit front panel

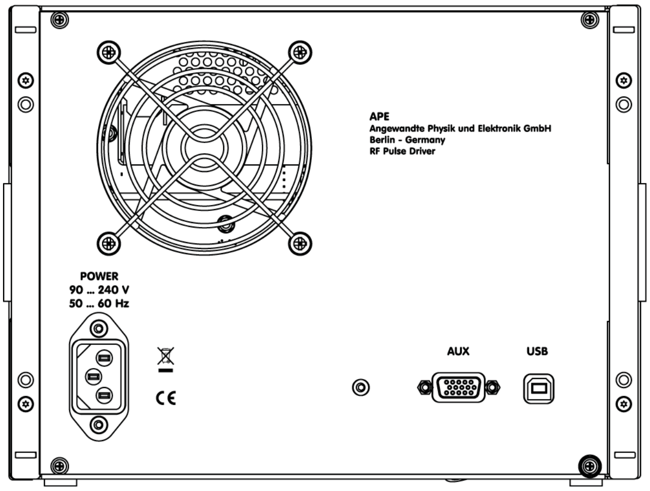


Figure 3.3: Driver unit rear panel

4 Cable connection and start up

- Connect the RF signal input cable of the optics module with the TNC output "RF" at the front panel of the driver electronics. You should only use the delivered RF connection cable without extension to ensure an optimum fitting of the RF components.
- Give the synchronization signal with laser repetition rate (for instance from a fast photo diode) to the „SEED" BNC input at the front panel of the driver electronics.
- At the "PULSE MONITOR" output pulsed signals (5 V) synchronously to the selected laser pulses are available. For precise triggering it is recommended to use a 50 Ω termination which causes the voltage level to slightly drop down.
- The "SEED MONITOR" output gives you a monitor signal of the seed input.
- The "EXT. TRIGGER" input can be used for external triggering up to 3 MHz with a TTL signal. In this case the laser pulse following the trigger signal will be selected. Choose the „EXTERN" operation mode at the controller in this case (see also paragraph "External triggering" in this manual). If you do not use the external trigger mode please leave the "EXTERN TRIGGER" input disconnected to avoid disturbances of the RF signal.
- Connect the power cord to the rear panel of the electronics and the wall socket.
- After having connected the signal cables the power can be switched on at the front panel. The „ON" state is indicated by a red LED in the „ON" button. The display will show you all settings and the measured oscillator repetition rate.
- For stable operation please allow the controller for 15 minute warm-up.
- The RF power can be switched on and off at the „RF ON" button. The „ON" state is indicated by the green LED in the RF button.

CAUTION! Connect or disconnect the RF-signal cables only when the RF power is switched off!

4.1 Function of buttons

- **RF on|off**
  RF button switches on and off the RF power. Green lightning button signalize RF power on. Green blinking or red signalize an error, RF output is disabled. See error messages for details.
- **CW**
  The CW button switch to a mode with a continues RF signal. To turn on the RF signal, the „RF ON/OFF" button should be pressed. The RF signal is generated by an internal oscillator without an external seed signal. The RF power in CW mode is about 400 mW.

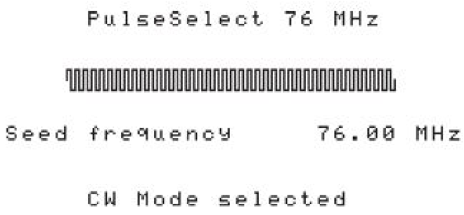


Figure 4.1: Display in CW mode

- **Softkey 1/2**
  The keys below the display has variable function (moving cursor or accept messages), depending on the menu state.
- **PHASE knob**
  Adjust the RF signal phase using the Phase knob.
- **MENU knob** Menu navigation and parameter adjustment is simply made with the menu knob.

4.2 Display

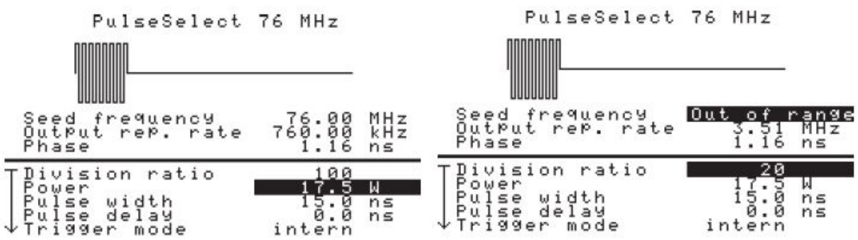


Figure 4.2

The Display shows in the upper a sketch of the RF-burst-pulse (Figure 4.2 left). Above this sketch the name of the unit and the predefined laser repetition rate (as ordered) is displayed. The seed frequency should be within a range of $\pm$ 1 MHz of this value.

- **SEED FREQUENCY** Below the pulse skectch the measured seed input frequency is displayed. The frequency is measured every second. When the frequency leaves valid range ($\pm$ 1 MHz of the predefined repetition rate given in the top line) a blinking message appear (Figure 4.2 right).
- **OUTPUT REPETITION RATE** When internal trigger mode is selected, repetition rate is calculated by deviding the seed frequency by the division ratio. During external trigger mode the frequency of the external trigger input is measured and displayed.
- **PHASE** The phase of the RF signal can be controlled by the separate phase knob. The phase shift causes a shift in the range from 0 to 3 ns.
- **PARAMETER SETTINGS** In the bottom half the menus for parameter setting are placed.

4.3 Setting the Operational Parameters

The operational parameters are chosen at the controller unit with the two button below the display and the blue rotary knob. To adjust the phase, there is separate the black knob. Parameters will be saved at power off and restored next power on. For safety reasons RF is always off directly after turning on the device.

- **Menu** By turning the blue menu knob you can navigate via the menus. To change a parameter, select the corresponding line and press the blue knob. When you see a blinking cursor square, the corresponding dezimal position of parameter can be changed by turning the menu knob. With the two buttons below the display you can shift the cursor left or right to control more raw or fine. Changes will be set immediately. To leave edit mode press menu knob again.
  To enter a submenu (identified by $\rightarrow$) also press the menu knob. To move back to the upper menu, select the last line containing "Back $\leftarrow$" and press menu knob.

Main Menu	Division ratio
	Power
	Pulse width
	Pulse delay
	Trigger mode
	Display
	LCD Backlight
	Default values
	Settings
Settings Menu	Seed trigger lev.
	Beep
	Factory defaults
	Firmware update
	Back

Figure 4.3: Menu structure

4.3.1 Main Menu

- **Division Ratio ("DR")** Division ratio of the internal frequency divider for the laser repetition rate, the synchronization signal of which is connected to the „SEED“ input. It determines the repetition rate of the output signal of the pulse selector shown in the upper part of the display. When set to „20“, for instance, every 20th laser pulse is diffracted to the 1st order, when set to „30“ every 30th pulse is diffracted and so on.

Range:	20 ... 5000	
	10 ... 5000	optional
	2 ... 260000	optional

- **Power** Range: 0.5 ... 17.5 W
  This is the output RF power in Watts with 50 Ω load. At division ratios smaler than 1:20 the maximum possible setting is automatically limited to a value to avoid damage of the crystal (also depending on pulse width setting). This is indicated by „!!“ on the display (see Figure 4.4). To unmark selection go to power value and press menu knob. The actual limit also depends on the chosen setting of the pulse width. Adjust this parameter while watching the output laser pulses with a fast photodiode and an oscilloscope and optimise for high diffraction efficiency and high pulse to pulse contrast ratio!

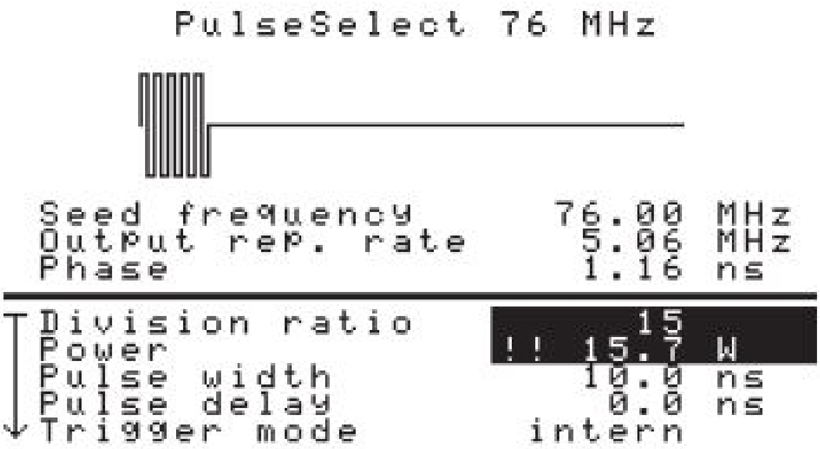


Figure 4.4

- **Pulse Width** Width of the single RF pulses in ns.

  Range: 4.0 ... 15.0 ns
  4.0 ... 25.0 ns optional

  Adjust this parameter while watching the output laser pulses with a fast photodiode and an oscilloscope and optimize for high diffraction efficiency and high pulse to pulse contrast ratio! For the 25 ns pulse width option and high repetition rates the pulse width may be reduced automatically to get a minimum „OFF” time of 7 ns betwen two output pulses. In this case the pulse width is marked by "!!". To unmark item go to pulse width and press menu knob.
- **Pulse Delay** Delay of the RF output pulse relative to the synchronization pulses („SEED“).
  Range: 0 ... 50.0 ns
  Adjust this parameter while watching the output laser pulses with a fast photodiode and an oscilloscope and optimize for high diffraction efficiency and high pulse to pulse contrast ratio!
- **Trigger Mode** Range: intern/extern
  Synchronization of the RF pulse can be achieved by internal or external trigger signal. Internal trigger signal is generated by the internal frequency divider for the laser repetition rate. The repetition rate is controlled by the division ratio.

When selecting external trigger mode the "EXT. TRIGGER" input must be used for external triggering with a TTL signal (see Figure 4.5). In this case the laser pulse following the trigger signal will be selected.
If you do not use the external trigger mode, the "EXTERN TRIGGER" input should be left open, otherwise the RF pulse quality could be affected.
The maximum repetition rate achievable with external triggering is 3 MHz. If the frequency of the external trigger exceed 3 MHz the message "Limited!!" appears at the output repetition rate display.

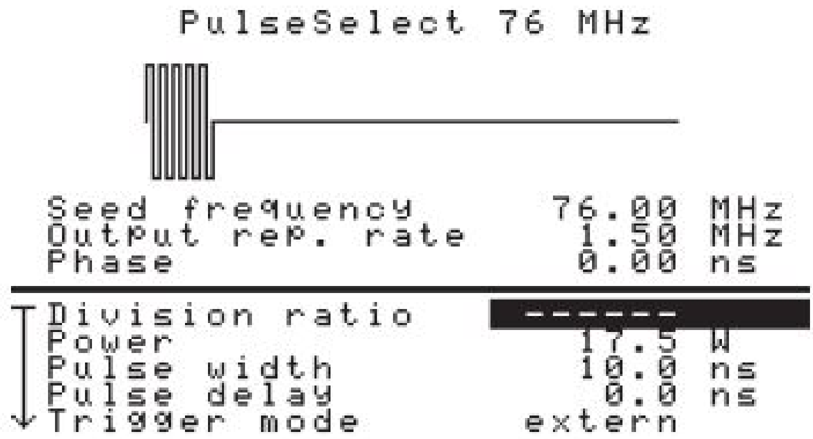


Figure 4.5

- **DISPLAY** Range: ON/OFF
  The display light can be switched ON/OFF by pressing the menu knob.
- **LCD BACKLIGHT** Range: 10 .. 100 %
  The Display backlight can be dimmed down to 10 % to avoid unintentional light.
- **DEFAULT VALUES** This item is used to set the parameters Division ratio, Pulse delay, Pulse Width, Trigger mode and RF Power to default value.
- **SETTINGS** Switches to the submenu SETTINGS

4.3.2 SETTING MENU

- **SEED TRIGGER LEVEL** Range: 30 ... 300 mV
  In some cases it can be necessary to adjust the trigger level for the seed input.
- **BEEP** Range: ON/OFF
  When on, a buzzer signalize errors and warnings. Also if you reach the end of parameter rrange a signal sound will be emitted.
- **FACTORY DEFAULTS**
  When this item is selected the seed trigger level can be reset to the factory calibration value. The value will be reset only when the appearing message was accepted with OK.
- **FIRMWARE UPDATE**
  For future use the device firmware can be updated. Only available in agreement with service personnel.

- **BACK**
  Leave the Settings menu, go back to main menu. Setting the Operational Parameters

4.4 **Error Signal "Fault"**

The electronics of the ***pulse*Select** has an integrated safety circuit that prevents the system from putting out high RF power levels that could damage the modulator crystal. A „FAULT“ message on the screen indicates a cw output power level exceeding 0.8 W. In this case the RF output will be switched off automatically and the LED turns to the colour red at the top.
Possible reasons for this fault can be, for instance, unstable triggering conditions at the „SEED“ input or loose cable connections at RF OUT to the optics and following back refl ections and defective electronics.
If the „FAULT“ lights up during operation, check the system for possible error sources (for instance external triggering with high frequency, unstable seed input signal, loose cable connections) and eliminate them, switch on the RF. Confirm the „FAULT“ message on the display. Then it is possible to switch on the PR power signal again. If still no normal operation is possible („FAULT“ is signalled again after switching on RF output) or the error occurs repeatedly during operation with the internal frequency divider, please contact the service personnel of your supplier for technical support.

4.5 **Fine Adjustment of the Optics**

After basic adjustment (see chapter 3.3 in this manual) and connection of the optics module to the driver electronics the power can be switched on at the electronics. Choose cw mode by pressing the „CW“ button in the right top of the display and press “RF ON/OFF”. Now a cw RF signal of about 400 mW amplitude is given to the modulator crystal.

You will need the following equipment to further optimize the adjustment of the modulator crystal:

- fast oscilloscope (min. 200 MHz)
- fast photodiode (risetime min. 10 ns)
- Powermeter
- Uncoated substrate in mirror mount

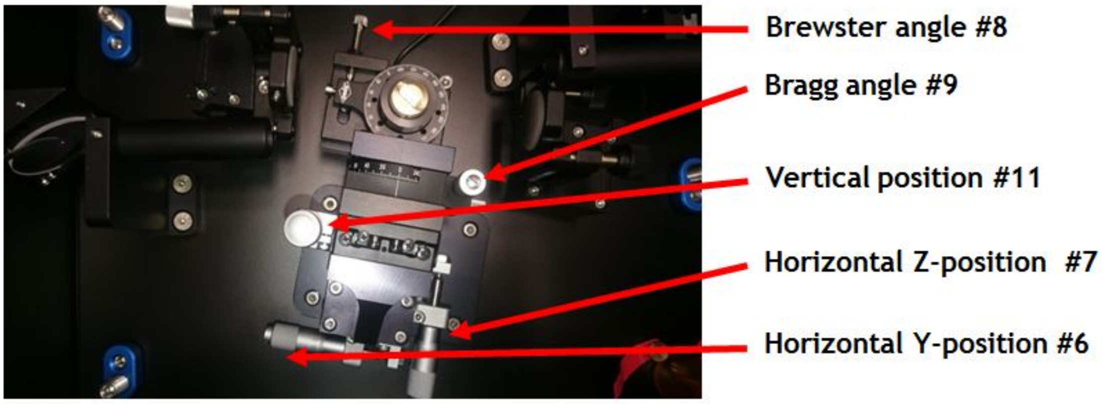
Always reduce the laser power to a minimum and use appropriate laser safety goggles. Please refer to Chapter 1 of this manual for more information on laser safety measures. High input power can also lead to damage in the instrument.

The pulseSelect is designed for horizontal input polarization; please rotate the polarization to horizontal if needed. There is no polarization rotator included in the standard delivery. Please contact your local sales partner if you are interested in obtaining one.

When using a tunable laser, set the laser wavelength to 800 nm if possible, else the shortest laser wavelength of the specified range. Please note that all specifications refer to a wavelength of 800 nm unless otherwise stated.

1. Align the input laser beam horizontally and vertically for the correct height of the input aperture and parallel with respect to the laser table.

2. Place the optical head on your table and make sure that the laser beam enters the aperture centered and hits the first curved mirror (focus mirror CM1) in the horizontal center of the mirror surface. Fix the optical head to the table with the clamps that came with your ***pulse*****Select** .
3. Adjust the height of the feet of the optical head until the input aperture and CM1 are hit centrally in the vertical direction – now lock the screws of the feet.
4. Double check the alignment up to this point. Please use external beam routing mirrors if corrections are required.
5. Now Adjust the beam centrally through the exit aperture using the second curved mirror (CM2)
6. Connect the cables of the RF pulse driver:
   - RF cable from control electronics to optical head (TNC cable – included in delivery)
   - Seed cable from the laser or a fast photodiode (showing a trace of the pulse train of the laser) to the Seed input of the control electronics (BNC cable – not included in delivery, customer supplied)
   - Trigger cable from pulse monitor exit of the control electronics to the oscilloscope (BNC cable – not included in delivery, customer supplied)
   - Power cable for control electronics to wall plug
7. Switch on the control electronics, activate „CW“ and switch on “RF”



8. Use screw “Horizontal Z-position“ (#7) to find the 1st Bragg order.
9. If the 1st Bragg order cannot be found, use screw „Bragg angle“ (#9) to change the Bragg angle by 1°and try again to find the 1st Bragg order using screw “Horizontal Z-position “ (#7). Repeat with a change of max ± 4°
10. If still no 1st Bragg order can be found, use screw “Vertical position” (#11) for a slight adjustment and repeat the previous steps with “Horizontal Z-position“ (#7) at different Bragg angles using screw „Bragg angle“ (#9) to find the 1st Bragg order.
11. When the 1st Bragg order has been found, direct the 0th order onto the fast photodiode
12. Connect the photodiode to the oscilloscope and adjust accordingly.

    Attention! Applying the following steps may lead to reflexes of laser radiation leaving the housing - please wear suitable laser safety goggles.

13. Move the Bragg cell upwards using the screw “vertical position” (#11) until the laser beam is clipped by the transducer, and the photodiode signal on the oscilloscope drops – then move the Bragg cell downwards until the laser beam does not clip any longer at the transducer.
14. Switch off „RF“ and deactivate „CW“
15. Adjust the translation stage of CM2 such that the exit beam is collimated
16. Now put the laser in normal operation mode with its „standard“ output power and in pulsed mode
17. The control electronics should now indicate the repetition rate of the laser, if not, check the cable connection, adjust the trigger level, and try using a BNC attenuator.
18. Use the following settings for the control electronics
    - Division Ratio (DR): 20
    - RF Power (PO): 17.5 W
    - Pulse width (PW): 8.0 ns
    - Delay (DE): 25.0 ns
19. Switch on „RF“, the 1st order should be visible right away.
20. On the oscilloscope, use the channel that is showing the pulse monitor as trigger source, else the drop in the 0th order (due to the diffracted portion of the pulse) in the pulse train will not be visible.
21. Adjust the vertical position:
    - The drop in the amplitude of one pulse should be clearly visible
    - The pulse which is deflected here is the first pulse as viewed from the transducer
    - Move the Bragg cell downwards using screw „vertical position“ (#11) – the pulse with the drop in amplitude moves from left to right – please count the number of reflected pulses
    - Keep moving the Bragg cell downwards until the 4th pulse is the deflected pulse
    - Use screw „Bragg angle“ (#9) to minimize the drop of the pulse
    - Also use screw „Horizontal Z-position“ (#7) and “Vertical position” (#11) to minimize the drop
    - Check the beam on the photodiode and adjust the alignment for maximum signal on the oscilloscope
22. Adjust of the „Horizontal Y-position“ (#6) as follows:
    - On the oscilloscope, put a horizontal cursor onto the full amplitude signal, and a second horizontal cursor on the top position of the drop pulse for marking
    - Move the focus screw „Horizontal Y-position“ (#6) in any one direction by 0.1 mm (but remember the direction!)
    - Minimize the drop using the screw „Horizontal Z-position” (#7)
    - If the drop is lower than the horizontal cursor, continue to turn the screw focus position (#7) by 0.1 mm, and minimize the drop by using screw “Horizontal Z-position” (#7)
    - If the drop is larger than the cursor, turn the focus screw in the opposite direction by 0.2 mm, and minimize the drop using the screw „horizontal z-position“
    - Now turn the screw „Horizontal Y-position“ (#6) iteratively in 0.1 mm steps to find the minimal drop

23. Adjust the Brewster angle as follows:
    - The scale shows divisions of 2° Check the cursor positions and that they still mark the amplitude and the amplitude of the drop
    - Turn the screw „Brewster angle“ (#8) by 1° in any one direction (remember the direction!)
    - Correct the beam deviation by adjusting the CM2 mirror. Alternatively use an external substrate to still hit the photodiode properly
    - Minimize the drop by using the screw „Horizontal Z-position“ (#7)
    - If the drop is smaller than the position indicated by the cursor, continue to turn the screw „Brewster angle“ (#8) in the same direction by 1°and correct the beam deviation using the external substrate (or CM2) and minimize the drop by using the screw “Horizontal Z-position” (#7).
24. If the drop is larger than indicated by the cursor, turn the screw „Brewster angle“ (#8) in the opposite direction by 1° and correct the beam deviation using the external substrate (or CM2)and minimize the drop by using the screw “Horizontal Z-position” (#7)
25. Now iteratively turn the screw „Brewster angle“ (#8) until you find the minimal drop
26. Check again using the screws „Vertical position“ (#11) and “Horizontal Z-position” (#7)
27. In the menu of the control electronics adjust the settings „delay (DE)“ and phase (PH) to minimize the drop.
28. Now, route the beam of the 1st order onto the fast photodiode
29. Block the 0th order using the shutter, and move the shutter upwards until the 1st order signal on the oscilloscope has reached a maximum signal
30. Place vertical cursers on the oscilloscope so that one marks the pre pulse and one the post pulse of the drop
31. Zoom into the amplitude of the pulse traces on the oscilloscope to show only the amplitude of the drop.
32. Improve the contrast ratio by the following procedure:
    - Adjust „DE“ until only one post pulse is visible
    - If no post pulse is visible, increase the „PW“ setting
    - Optimize the setting „PH“ for best contrast (i.e. best suppression of the pre and post pulse)
33. Measurement of the contrast ratio using the beam of the 1st Bragg order
    - Measure the intensity of the main peak (main pulse), e.g. with a value of 600 mV
    - Measure the intensity of the post pulse, please use amplitude zoom to do so, e.g. with a value of 8 mV
    - This would correspond to a contrast using these example values of 600:8 = 75, i.e. a contrast ratio of 75:1
34. Measurement of the efficiency using the 0th order (please adjust the beam onto the photodiode first to display the signal on the oscilloscope)
    - Place the 1st horizontal cursor onto the base line of the pulse train
    - Use the 2nd cursor to mark the amplitude of the pulse train
    - Measure the difference, e.g. to a value of 600 mV

- Now place the 1st cursor onto the amplitude of the drop (i.e. the remainder of the picked pulse), e.g. with a value of 280 mV Calculate the difference of the two values, in this example (600 – 280) mV = 320 mV This would correspond to an efficiency using the numbers in this example of 320 / 600 * 100 = 53 %

5 Installation of the Bragg Cell

Caution! Do not touch the modulator crystal! The modulator is very sensitive against all kinds of pollution, scratching, and mechanical shock.

Set the Brewster angle adjustment screw [8] to a middle position. Unlock the lock screw for the rough Brewster angle adjustment [12] with a hex key and rotate the modulator holder to 0 degree. Lock the screw [12].

There are two small screws [16, 17] accessible through two holes in the side of the modulator holder with a 0.9 mm hex Allen key [16, 17]. These two screws hold the modulator socket. Loosen the screws so far that the modulator socket fits into the 1 inch hole of the modulator holder. Remove the modulator again. Thread the modulator RF cable from the bottom side through the 1 inch hole of the modulator holder. Screw the SMA connector of the cable tightly to the SMA connector of the modulator socket by hand. Do not use a tool! Try to leave the cable stress-free when holding the modulator in its later direction. The correct direction is given by the line mark at the modulator socket [18]. This line must be rightangled to the beam direction. This is given when the line points to the hole near the 140° mark. Set the modulator into the holder and fix it with the two screws [16, 17].

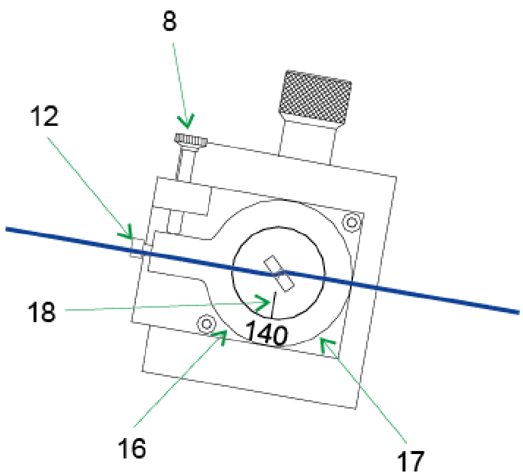


Figure 5.1: Modulator assembly

8	Brewster angle control
12	Rough Brewster angle adjustment lock screw
16, 17	Modulator lock screws, access holes
18	Mark for modulator direction

6 Maintenance and Troubleshooting

6.1 Maintenance

6.1.1 Cleaning

Do not use any aggressive solvents to clean the *pulse*Select components! Switch the laser OFF or block the input beam and unplug the mains power adapter from the wall power socket for cleaning!

Use a soft lint-free dry or only slightly moist cloth to clean the covers of the ***pulse*Select** components.
Use dry methanol and lens cleaning tissue applying common optics cleaning techniques.

6.2 Technical Support

For technical questions or problems within Germany, please contact:

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To contact our international distributors, please have a look at our website:

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Germany

Declaration of Conformity to EU RoHS

Products listed below that are manufactured by A·P·E Angewandte Physik & Elektronik GmbH are in compliance with Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (also known as “RoHS Recast”). In addition, this declaration of conformity is issued under the sole responsibility of A·P·E Angewandte Physik & Elektronik GmbH. Specifically, products manufactured do not contain the substances listed in the table below in concentrations greater than the listed maximum value.

Substance	**Maximum Limit (ppm)**
Lead (Pb)	1000
Cadmium (Cd)	100
Mercury (Hg)	1000
Hexavalent Chromium (Cr6+)	1000
Poly Brominated Biphenyls (PBB)	1000
Poly Brominated Diphenyl ethers (PBDE)	1000

Product Identification:
Product

Single Pulse Selector ***pulse*Select** Standard (division ratio 1:20 . . . 1:5000)
A·P·E Id: 108211

Single Pulse Selector ***pulse*Select** HP-Ti:Sa (division ratio 1:20 . . . 1:5000)
A·P·E Id: 119456

Single Pulse Selector ***pulse*Select** HP-dualband-Ti:Sa (division ratio 1:20 . . . 1:5000)
A·P·E Id: 130014

Single Pulse Selector ***pulse*Select** Dual (serial) (division ratio 1:20 . . . 1:5000)
A·P·E Id: 114505

Single Pulse Selector ***pulse*Select** HP-Ti:Sa Dual (serial) (division ratio 1:20 . . . 1:5000)
A·P·E Id: 122964

Single Pulse Selector ***pulse*Select** Dual HP-dualband-Ti:Sa (serial) (division ratio 1:20 . . . 1:5000)

A·P·E Id: 139483

Single Pulse Selector ***pulse*Select** Dual parallel with two AOMs (division ratio 1:20 . . . 1:5000)
A·P·E Id: 133577

Single Pulse Selector ***pulse*Select** HP-Ti:Sa Dual parallel with two AOMs and HP-Ti:Sa mirrors (division ratio 1:20 . . . 1:5000)
A·P·E Id: 133575

Single Pulse Selector ***pulse*Select** HP-dualband-Ti:Sa Dual parallel with two AOMs and HP-dualband-Ti:Sa mirrors (division ratio 1:20 . . . 1:5000)
A·P·E Id: 133578

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