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MODEL 5046SC
HIGH SPEED
ELECTRO-OPTIC GATING SYSTEM



SERIAL NUMBER:



MODEL: 5046SC

Serial No.:

Date:

This instrument conforms to the protection requirements of EMC Directive 89/336/EEC, specifically, EN 55011 Radiated and Conductive Emissions, and EN 50082-1 Immunity (IEC 801-2, -3, -4).

It is essential that the instrument be correctly connected, that the AC mains ground have a low impedance and that following precautions are observed:

1. Replacement Cables: Interconnecting coaxial cables must be matched to the impedance of the connectors used on the instrument, its input signal source and where possible, the output circuit load . Thus, 50 Ω BNC cable connectors must be attached to 50 Ω cable (RG58A/U OR RG55/U) and 75 Ω MHV cable connectors to 75 Ω cable (RG59/U). Impedance mismatches will cause ringing and radiated emissions. To reduce residual emissions due to impedance mismatch, aluminum foil may be wrapped around the cables or the cables may be enclosed in flexible braided copper tubing which is made for this purpose. In either case, the shielding must be well grounded.
2. Pockels cells which may be supplied as accessories to this instrument are passive components which are intended to be operated in the end-user's shielded enclosure. Failure to properly enclose the cell may result in electrically radiated noise.
3. As supplied, the Pockels cell light modulator and HV Pulse Modules are enclosed in a EMI shielded enclosure. This metal enclosure must be connected electrically to house ground. Because the modulator enclosure must have apertures to permit passage of the laser beam, these openings may be a source of low level RFI/EMI. If sensitive detectors or instruments are located in the immediate vicinity of the enclosure apertures, it may be necessary to provide additional shielding around the apertures in the form of a second grounded metal enclosure or a small cardboard carton covered with aluminum foil. The foil is grounded and two apertures are cut into the foil and cardboard. If the distance between the apertures in the modulator enclosures or cardboard box is 1 to 2 inches (25 to 50 mm) the residual radiation, if any, will be significantly attenuated .
4. This instrument generates internal voltages which can be hazardous. It is important to read and understand the operations manual provided with the instrument prior to connecting and applying AC line power or DC voltages. All cables must be connected to their mating connectors before application of any electrical power and turn-on of the power switches.

MODEL 5046SC HIGH VOLTAGE PULSE GENERATOR

Specifications and Data Sheet

Serial No. _____

DC POWER REQUIRED

Voltage +24 Volts DC at up to _____ Amperes

Power _____ Watts

TRIGGER INPUTS

“ON” Input (BNC) TTL,+5 Volts max, into 50 Ω , (50 ns min, 1 μ s max Width)

“OFF” Input (BNC) TTL,+5 Volts, max into 50 Ω (50 ns min, 1 μ s max Width)

Rise time of the Trigger pulses should be as fast as possible, preferably ≤ 3 nsec. Rising edge initiates output switching

Output Pulse Module (Model 8050)

Output Pulse Width Range _____ μ sec

H.V. Range, D.C. _____ kVolts

In/Out Delay, (ON or OFF) _____ nsec

Rise Time (ON) _____ nsec

Rise Time (OFF) _____ nsec

Extraction Rate, Single Shot to: _____ kHz

POCKELS CELL OPERATIONAL CHARACTERISTICS

Model Number: _____ S/N _____

Crystal Material: _____

Crystal Coatings: _____

Window Material: _____

Window Coatings: _____

Linear Aperture: _____

Index Matching Fluid: _____

Polarizer: _____

Analyzer: _____

Contrast Ratio: _____

Half Wave Voltage: _____ @ _____

Quarter Wave Voltage: _____ @ _____

Capacitance: _____

Comments: _____

Tested By: _____ Date: _____

**When requesting information on this device,
please reference model and serial number.**

WARNING

HIGH VOLTAGE

HV pulse amplifiers contain voltages which could be dangerous or lethal if contacted. All reasonable safety precautions have been taken in the design and manufacture of this instrument. **DO NOT** attempt to defeat the protection provided. The High Voltage Switching Modules used in 5046 Systems are filled and sealed with epoxy. Any attempt to drill into or remove the epoxy will void the module and system warranty.

Make all electrical connections before turning power on.

This equipment must be maintained only by qualified personnel who are familiar with high voltage components, circuits and measurement techniques. If qualified personnel are not available, the equipment should be returned to FastPulse for maintenance and repair.

Power must be removed and high voltage capacitors discharged prior to any maintenance work. Connect and disconnect all connectors only when AC line power is turned off and the power switch or AC line cord is disconnected.

Only recommended replacement parts should be used. We suggest that you contact the factory before attempting to make repairs, replacements or internal adjustments. In many instances our engineers can provide information to help diagnose the problem and suggest an appropriate repair procedure.

5046SC OPERATIONAL AND CONTROL FUNCTIONS

5046SC Front Panel

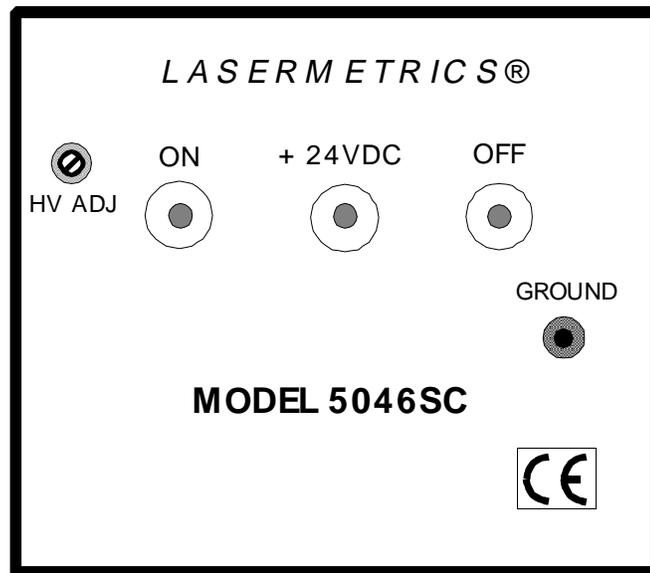
“ON” TRIGGER Input (BNC) Provides interconnection for positive trigger signal sources. Leading edge of this trigger pulse corresponds to the leading edge of the output voltage. This edge switches the output voltage on the Pockels cell (opens the gate).

“OFF” TRIGGER Input (BNC) Provides interconnection for positive trigger signal sources. Leading edge of this trigger pulse corresponds to the trailing edge of the output voltage. This edge turns off the output voltage on the Pockels cell (closes the gate).

+ 24 VDC (BNC) DC voltage for energizing the internal DC low voltage to DC High Voltage Power Supplies. This DC voltage source must have at least 1.5 amperes current capability and good voltage regulation over the full current range.

HV ADJUST Potentiometer adjustment for control of HV output level.

GROUND This is a common ground point for all internal ground connections. This connection should be used for wiring to the mounting surface which holds the 5046SC enclosure.



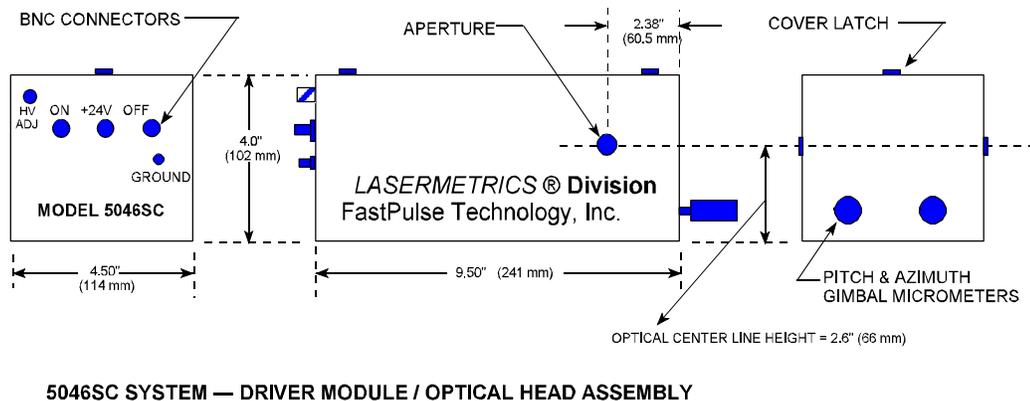
15046SC-FRONT PANEL

Figure 1 Front Panel of 5046SC Housing

5046SC SYSTEM SHIELDED ENCLOSURE

To remove the cover from the optical head assembly, use a coin or large blade screw driver to rotate the two latch screws on top of the head 90°. The latches are open when the screw slots are orthogonal to the cover's long dimension. Carefully pull the cover off in the vertical direction. The cover is tightly fitted for electrical contact with the baseplate and endplates and thus may require considerable initial force. The baseplate can be affixed to standard optical benches having 1 inch center to center mounting holes by means of two 1/4-20 bolts on a 4 inch center. Bolt hole slots are located on the baseplate and are enclosed by the cover.

Figure 2 5046SC Housing Dimensions & Locations



Important Note: When aligning the Optical Head Assembly and Pockels cell with respect to the laser beam, **make certain that the beam is centered in the Pockels cell aperture.** It is not sufficient to approximate the beam position, either in the Head Assembly or Pockels cell apertures. The positioning must be accurate to prevent optical damage. We recommend that the OHA cover be removed during the alignment process and temporarily while the laser is initially operating (at reduced power). This will permit tuning for maximum extinction ratio or pulse selection amplitude while observing that the beam is centered in the Pockels cell aperture. After alignment and tweaking, power should be turned off and the cover replaced and locked before re-applying power.

During operation and use, if the Pockels cell alignment micrometers are adjusted beyond a few thousandths of an inch, the above alignment procedure should be repeated. This will prevent the laser beam from impinging upon the aperture stops with subsequent burn damage to both the metal apertures and protective windows on the Pockels cell. We have noted that when careful alignment procedure is followed and maintained, there is little probability of damage to the Pockels cell.

Always wear eye protection when aligning the 5046SC

1.0 General Description

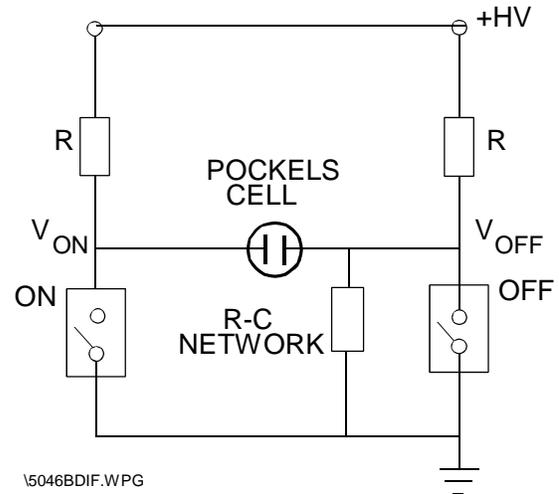
The Model 5046SC Laser Pulse Extraction & Chopping System is an electro-optic instrument that operates on the basis of rotating the plane of polarization of optical beams propagating through an internal Pockels cell light modulator. The system is designed to selectively gate or chop light pulses from a variety of lasers including, CW and pulse pumped, Q-switched, Q-switched / mode-locked and CW / mode-locked lasers. Extraction of a CW mode-locked pulse or a group of sequential pulses is accomplished at each command of an external signal. Pulse extracting from a Q-Switched mode-locked laser is also accommodated. Pulse extraction and chopping can be initiated by the output of a high speed photodetector as an external command signal to initiate the timing sequences.

The 5046SC Pulse Extraction System incorporates a Pockels Cell light modulator and a high voltage electronic switching driver to produce nanosecond transition optical gating. Electrical power required may be provided by a +24 Volt DC Power Supply with a current capability of at least 1.5 (2.0 preferred) amperes. All high voltages necessary for operation are internally generated within the 5046SC housing (Optical Head Assembly). The system consists of a differential FET amplifier (Two Model 8050 Modules located in the OHA) which is integrally mounted with a Pockels cell E-O Modulator. The Pockels cell mounts in a two axis gimbal to provide pitch and azimuth adjustment for optical system alignment. Typically, a Glan-Taylor, air spaced calcite polarizer is provided with the system to act as an output analyzer.

The equivalent circuit of the differential pulse amplifier and Pockels cell connection are shown in Figure 3. These elements are enclosed in the Optical Head Assembly.

When the system is connected and energized, the retardation voltage is applied equally to both electrodes of the Pockels cell modulator, i.e., both V_{ON} and V_{OFF} are high. This condition produces a zero differential voltage at the cell and no optical retardation occurs.

This corresponds to minimum transmission (blocking) when the Pockels cell is located between crossed polarizers. When an input trigger pulse is applied to the "ON" connector, the ON side of the differential avalanche amplifier is switched to ground and the voltage V_{ON} becomes zero.



R = CURRENT LIMITING RESISTORS

Figure 3 Differential Configuration

The "OFF" side amplifier remains in its original state (high). The low V_{ON} -- high V_{OFF} state produces a net differential retardation voltage across the modulator. When an input trigger pulse is applied to the "OFF" connector, V_{OFF} is switched to zero. This produces a net zero voltage across the Pockels cell terminals and the retardation is again zero - the cell polarizer combination blocks transmission.

At this time, both amplifiers are turned off thus allowing the Pockels cell capacitance to charge to the high voltage setting in preparation for the next Input pulse. The recharge time is the primary limitation on repetition rate. Typical recharge times limit repetition rates for this type of circuit to ≤ 5 kHz. Note that the static high voltage level can be adjusted for operation at 1/4 or 1/2 wave retardation (45° or 90° polarization rotation respectively) or at any level from zero to 1/2 wave retardation depending on system requirements. Refer to the user guides for Lithium Niobate & KD*P Q-Switches and Differential Drivers at rear of this manual for additional details.

1.1 OPTICAL SYSTEM

The active optical element of the Model 5046SC System is a Pockels cell light modulator. When subjected to an electric field, the Pockels cell crystal induces a phase shift (or retardation) between the ordinary and extraordinary light rays propagating through the cell. It is assumed that

linearly polarized laser light is input to the cell or that a linear polarizer will be used at the input. The 5046SC system is designed to accept a horizontally or vertically polarized beam. To operate as a shutter, an analyzer (polarizer) must be placed at the Pockels cell output and its polarizing direction set at 90° to the polarization plane at the input to the Pockels cell. The analyzer acts as a polarization discriminator. Unless otherwise specified, a calcite Glan-Laser (Glan-Taylor) Q-Switch type polarizer is used. A similar polarizer is required on the input side of the Pockels cell if the incident laser beam is not linearly polarized.

Relative phase change is a linear function of the applied voltage. When the halfwave retardation voltage is applied to the Pockels cell, an effect is produced on linearly polarized light that is similar to the effect obtained by inserting a $1/2$ wave optical retardation plate into the optical path. That is, a 90° rotation of the plane of polarization of the propagating light. **The value of the halfwave retardation voltage is dependent on the type of Pockels cell utilized and the operating wavelength, and is specified in the data sheet supplied with the system. The value given is a reference DC voltage level. Pulsed operation requires higher voltages and actual power supply voltage settings must be determined by observing the output optical signal. When the pulsed optical output signal is maximized, the voltage across the Pockels cell is the half wave voltage.** The system can also produce $1/4$ wave retardation by appropriate adjustment of the voltage control potentiometer on the front panel of the 5046SC.

2.0 SYSTEM OPERATIONAL DESCRIPTION

The 5046SC System electronic circuits require only +24 volts DC power and two trigger signals to generate or pass an output optical pulse. The system acts as a fast temporal gate having an open gate time corresponding to the time between the leading edges of the two trigger signals. Typical timing sequences are shown on the following page for CW Mode Locked and Pulse Pumped-Q-switched-Mode Locked Lasers. Trigger signals are provided by the user and they may be generated by laboratory type pulse generator(s), photodetectors, computer, an external timing event or command signals. Since the timing of the output gate is critically dependent on the trigger signals, attention must be paid to the trigger pulse characteristics.

The trigger signals should come from a 50Ω source to prevent ringing or false triggering. Because all internal switching is referenced to the leading edge of the propagating signal, trigger rise time must be in the range of 1 to 5 nsec to minimize input-output jitter. Slower rise times will result in somewhat greater jitter range. Trigger voltage amplitude should be limited to a range of +2 to +5 volts to insure reliable triggering. Trigger pulse width must be in the range of 5 nsec to 1 μ sec. Shorter pulse widths may not trigger the internal trigger detection circuits and longer pulse widths may cause internal circuit saturation and prevent re-triggering, particularly when operating at higher trigger repetition rates. a +5 volt, 50 nsec wide pulse is recommended as a nominal.

Applying a trigger signal does not result in an instantaneous change in output. There is an intrinsic propagation delay associated with most circuits and in the case of the 5046SC this delay between input and output is approximately 50 nsec. Applying a trigger to either "ON" or "OFF" inputs will result in the corresponding output level switching (in the "ON" or "OFF" outputs) about 50 nsec later. This delay must be taken into account for planning and setting up instrumentation and trigger sources.

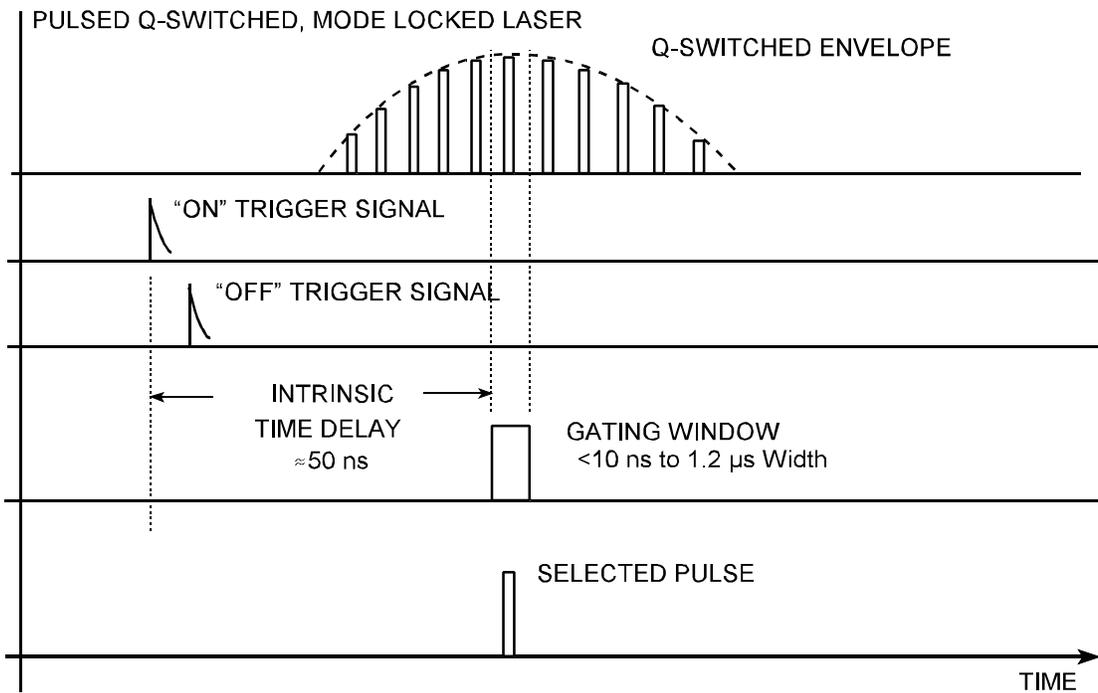
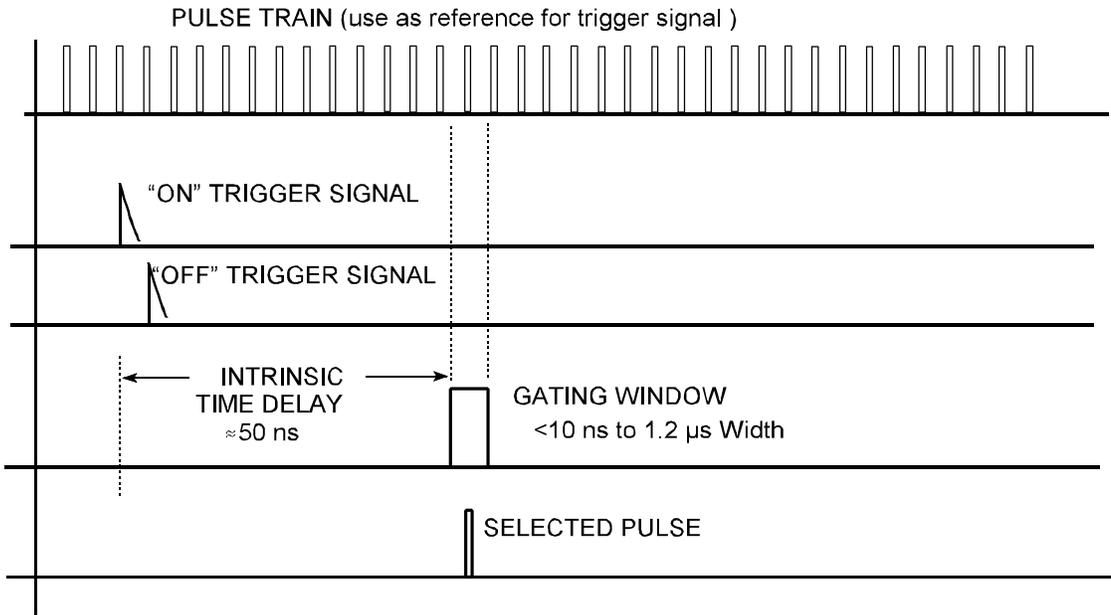
2.1 SYSTEM CONNECTION

NOTE: Before proceeding with system connection, insure that the DC Power Supply's AC power cord is disconnected, its Power Switch is in the "OFF" position and the Voltage Control knobs are turned full counterclockwise.

2.1.1 Connect the "ON" and "OFF" trigger inputs of the 5046SC to the trigger signal source(s). Use 50 ohm cables (RG-58/U) with BNC connectors. The left hand (facing the front panel) trigger input is the "ON" connector and the right hand connector is for the "OFF" input.

2.1.2 Connect the DC Power Supply output to the +24 VDC connector on the OHA using BNC connectors and RG-58/U cables provided. Never apply +24 VDC to the trigger inputs -- this could damage the high voltage switching circuits.

CW MODE LOCKED LASER



OPERATION OF 5046SC SYSTEM WITH CW MODE LOCKED AND PULSED Q-SWITCHED, MODE LOCKED LASERS.

Figure 4 Timing Diagram - Pulse and CW Mode Locked Lasers

3.0 Optical System Alignment

NOTE: It is recommended that alignment be performed with a low power (<5 milliwatt He-Ne laser). Focusing optics may be needed to concentrate the beam visibility. These focusing optics must be removed from the system when a high power laser is used. If a high power laser to be used in the final application is also used in setting up, its power level should be reduced or attenuated to levels commensurate with eye safety considerations. Refer to the User Guide for KD*P & Lithium Niobate Q-Switches & Modulators at the rear of this manual for detailed information on alignment and cautionary practices.

Initial set up does not require application of power to the 5046SC. The object here is to pass the laser beam through the center of the aperture and insure that the beam does not impinge on the aperture stops. Once this is done, it is necessary to confirm the polarization directions of the laser beam, the modulator axes and any polarizers utilized. The most efficient method, in terms of time and accuracy, is to follow the procedure detailed in the Users Guide mentioned above. If this is not possible, the simplified procedure described below may be followed.

To achieve maximum modulation efficiency or extinction ratio, it is necessary that the electric vibration vector (polarization plane) of the incident light coincide with the proper crystallographic axis or axes of the Pockels cell crystal. Lasermetrics Pockels cell modulators utilized in the Model 5046SC are normally aligned for a vertical or horizontal plane polarized input beam. The input plane of polarization must be aligned to the X or Y axes of the modulator crystal to an angular tolerance of one degree maximum. In KD*P modulators and Q-switches (typically models within the 1050 and 1040 Series), the X and Y axes are optically identical and may be interchanged. As long as the input plane of polarization is parallel to either the X or Y axes, and the output polarizer (analyzer) is at 90° to the input plane, the combination of the two polarizers and modulator will act as a closed shutter.

Careful alignment is necessary to realize the maximum attainable extinction ratio (contrast ratio). The laser beam must transit the modulator crystal parallel to the direction of

the crystal's Z (optical axis). To attain positioning accuracy in pitch and azimuth with respect to the laser beam and crystal Z axis, a precision gimbal (Model MG-145) is provided to tilt the modulator in the X and Y planes (X=azimuth, Y=pitch). To achieve proper orientation, the modulator pitch and azimuth position must be carefully tuned to obtain the best contrast ratio. Positioning accuracy to within 1 minute of arc is a prerequisite. The input plane of polarization (the laser or the polarizer plane) must be either 0° or 90° with respect to the plane of the mounting base plate. The polarizing plane of the analyzer must be orthogonal to that of the input plane.

As a starting point in the mechanical alignment, remove the cover from the optical head assembly after 90° rotation of two large latch screws on top of the head. The latches are open when the screw slots are orthogonal to long dimension of the cover. The head baseplate can be affixed to a mounting surface by means of two 1/4-20 bolts on a 4 inch center. Bolt holes are located on the baseplate.

Insure that the laser beam is centered in the Pockels cell aperture. The reflected image (from the Pockels cell) of the incident beam must be coincident with the laser source. A grouping of return images may exist, especially when polarizing optics are integrally mounted. Rotate the analyzer to attain a minimum in intensity. Utilize pitch and azimuth adjustments until the intensity is further minimized through the complete system of polarizer, modulator and analyzer is obtained. Care must be taken to insure that the intensity minimum is not caused by vignetting at the aperture end plates. Continue adjusting the analyzer and gimbal position in small increments to obtain the best possible null.

CAUTION Misalignment of the Pockels cell with respect to the incident beam of a high power laser may cause catastrophic damage to the crystal element. Such misalignment may permit the metallic electrodes to be irradiated by a high energy optical pulse with subsequent vaporization of small areas of the electrodes. The metallic vapor deposits unevenly on the optical surfaces and can drastically reduce transmission. The deposit usually appears to radiate from the edges of the electrodes into the clear aperture. Damage can also result from irradiating the external aperture stop of the stainless steel window holders. Metallic

particles can be deposited on the external surfaces of the windows. These particles act as low threshold damage sites which will burn the antireflection coatings and the fused silica window material. If a laser beam does not clear the aperture edges by at least 1 mm, and the Pockels cell must be tilted, it is recommended that an aperture stop be located between the high energy laser source and the cell to reduce beam diameter. A distance of several inches from the Pockels cell is usually reasonable. This is especially important when the diameter of the beam is nearly equal to the clear aperture of the cell.

We recommend that all power supplies be disconnected but that electrical connections to the 5046SC front panel be made before attempting to optically align the Pockels cell. Alignment accuracy is critical to obtaining good performance; twisting or pushing connectors onto the assembly may cause substantial shifting of position unless the base plate is firmly fixed to the mounting substrate or optical table.

4.0 OPERATION REVIEW

Energize the 5046SC by applying +24 VDC power and adjust HV to the required output level. NOTE: on Unit with Serial No. 2348 HV is adjusted by first removing the OHA cover. This value will generally be the half-wave voltage of the Pockels cell. Consult the Pockels cell data sheet for the DC test voltage measured at 633 nanometers. The voltage setting required to attain half wave retardation with a voltage pulse will be between 15% to 50% higher than the DC test voltage due to the lower AC electro-optic coefficient and switching circuit voltage drops. Required voltage is directly proportional to wavelength and if operation at a wavelength other than 633 nm is required, the Pulsed Output voltage will have to be adjusted accordingly by increasing or decreasing the HV level, i.e., required voltage is directly proportional to wavelength.

To trigger the system, apply a 2 to 5 volt pulse with 1 to 5 nsec rise time and between 5 to 1000 nsec pulse width to the ON TRIGGER connector input. Consult the "Specifications and Test Data" to confirm input limits.

To optimize optical performance of the system, recall that with no input trigger signals applied to the 5046SC, transmission is at a null level. Output pulses will be gated only when trigger signals are applied. View the output polarizer's transmitted laser pulse with a fast photo detector or power meter. Adjust the HV control for maximum amplitude of the detected laser pulse. For initial set up, we suggest that only the ON TRIGGER be utilized. This will result in a longer output pulse or gate width which will make detection of the transmitted pulses easier to view. Once the output pulses are detected, the HV adjustment potentiometer can be fine tuned to maximize pulse amplitude. Turn off all power, connect the OFF TRIGGER cable, and then turn power on again. With both trigger signal connected, timing between trigger pulses may be adjusted to generate the gate width desired.

Another method of optimizing does not require application of any voltages. In this case, (Figure 5) a photodetector monitors the rejected beam exiting from the analyzer side exit surface when no triggering pulses or DC voltage is applied (the gate is closed and all the energy is in the rejected beam). In this way, throughput from the input polarizer, modulator and analyzer can be viewed and maximized. Generally, when the output of the rejected beam is maximized without applied voltage, the output in the direct beam path direction will be maximized when voltage is applied (assuming 1/2 wave voltage pulses).

REMINDER: FastPulse Technology Pockels cell Q-switches are fabricated so that either the X or Y crystal axis (they are identical and interchangeable) is parallel to the plane defined by the cell's electrical terminals. Refer to Figure 5 on following page.

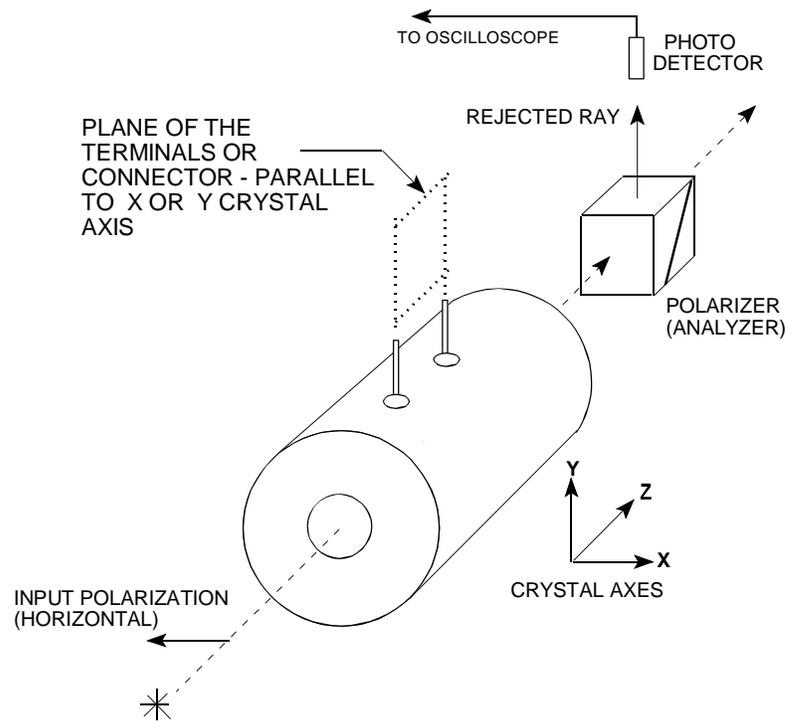


Figure 5. Arrangement of elements for detecting laser pulses with no voltages applied. Shows orientation of Pockels cell terminals with incoming plane of polarization. If the polarizer is rotated 90° around the optical axis, the incoming plane of polarization can also be rotated 90° without effecting performance. The X and Y crystallographic axes are equal and interchangeable.

6.0 EMI CONSIDERATIONS

5046SC Systems meet US and European EMC standards for EMI/RFI radiation limits.

5046E Systems utilize a shielded enclosure for the high voltage power supplies, high voltage pulse modules and Pockels cell. This instrument is constructed to provide shielding of internally generated electrical noise and immunity from external noise and transients. It is essential that the instrument be correctly connected and that the AC power mains ground have a low impedance. Further, the chassis of the 5046SC enclosure must be grounded (by means of the grounding terminal on the front panel) to a "house" ground. If the instrument is placed on a typical metal optical bench, a low impedance ground must be connected to the bench ground.

5046SC Systems utilize a two part aluminum optical head assembly which contains the HV

power supplies, 8050 Modules and Pockels cell. All electrical connections are made through appropriate cables to the connectors mounted on the head assembly. All seams in this housing are closed by conductive gasketing or contact fits to prevent radiated emissions. The only openings in this assembly are the apertures through which the laser beam propagates. These apertures cannot be blocked and are thus potential sources of radiated electrical noise. Detailed measurements have shown that this radiation is well below regulatory limits and is generally insignificant.

Interconnecting coaxial cables must be matched to the impedance of the connectors used on the instrument. Thus, 50Ω BNC connectors must be mated to 50Ω cable and 75Ω MHV connectors must be mated to 75Ω cable. Severe impedance mismatches due to using improper cables will cause ringing and radiated emissions.

WARRANTY

Each standard component and instrument manufactured by FastPulse Technology is guaranteed to be free from defects in material and workmanship for a period of one (1) year from the date of shipment to the original purchaser. This warranty is voided if such equipment is operated beyond its safe operation limits, without proper routine maintenance, or under unclean conditions so as to cause optical or other damage; or if it is otherwise abused, connected incorrectly electrically, exposed to power line or other electrical surges, or modified in any way.

Our liability under this warranty is restricted to, at FastPulse Technology's option, replacing, servicing or adjusting any instrument returned to the factory for that purpose, and to replacing any defective parts. Indicator lamps; vacuum, gas and vapor tubes; fuses, batteries, optical coatings, components in lasers and laser systems such as: focusing lenses and other optical components external to the laser cavity, expendable items such as flash lamps and water filters and the like are specifically excluded from any liability. FastPulse Technology does not assume liability for installation, patent violation claims, labor, injuries, or consequential damages.

Major parts and subsystems manufactured by other companies which are integrated in FastPulse Technology equipment are covered by the original manufacturers' warranty.

Equipment must be returned to the factory with transportation charges prepaid and with advance notice to FastPulse Technology. Repaired equipment will be returned to the purchaser with shipping charges prepaid. If it is deemed impractical to return the equipment to the factory, the purchaser may request the dispatch of a FastPulse Technology service engineer whose service will be provided at no charge, but whose travel and living expenses will be charged to the purchaser.

This warranty does not imply and is expressly in lieu of all other liabilities, obligations, or warranties. FastPulse Technology neither assumes nor authorizes any other person or organization to assume on behalf of FastPulse Technology any other liability in connection with these products. FastPulse Technology disclaims the implied warranties of merchantability and fitness of such products for a particular purpose.

In many instances, equipment problems can, with the user's assistance, be resolved through brief communications with a factory engineer either by telephone or FAX. Should, in FastPulse Technology' opinion, the problem be caused by a component or subassembly failure, the Company shall at its discretion ship a replacement to the user, and/or request that the failed component or subassembly be returned to the factory for analysis or repair.

CLAIM FOR DAMAGE IN SHIPMENT

The equipment should be tested as soon as possible after receipt. If it fails to operate properly, or is damaged in any way, a claim should be filed with the carrier. A full report of the damage should be obtained by the claim agent and this report should be forwarded to FastPulse Technology. We will then advise the disposition to be made of the equipment and arrange for repair or replacement.

**ALWAYS !! Include model number and serial number
when referring to this equipment for any reason.**