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LASERMETRICS ® *Division*

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This is a typical Users Guide

USER'S GUIDE FOR

MODEL 5100ERW-10

HIGH REPETITION RATE

LASER PULSE GATING SYSTEM

(With Water Cooled Optical Head Assembly)

CE **RoHS COMPLIANT**

SERIAL NUMBER: 5321

WHEN CALLING OR CORRESPONDING ABOUT THIS INSTRUMENT,
ALWAYS MENTION THE MODEL & SERIAL NUMBERS

\MANUALS\5100ERW–10-Manual
REV.C 6 October 2014 / RLG

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15 Dec 1995 MODEL: 5100ERW SYSTEMS RoHS2

This instrument complies with EU Directive 2002/96/EG and 2011/65/EU(RoHS Compliant) and conforms to the protection requirements of EMC Directive 89/336/EEC, specifically, EN 55011 Radiated and Conductive Emissions, EN 50082-1 Immunity (IEC 801-2, -3, -4) and safety requirements of EN 60601-2-22 (IEC 601-2-22:1995).

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 Ohm BNC cable connectors must be attached to 50 Ohm cable (RG58A/U OR RG55/U); 75 Ohm MHV cable connectors to 75 Ohm cable (RG59/U). SHV connectors are available for mating to 50 to 75 Ohm cables. 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 EMI 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 an EMI shielded enclosure. This metal enclosure must be connected electrically to house ground and/or to a ground connector located on the front or rear of the Power Supply chassis, depending on the model. Because the modulator enclosure must have apertures to permit passage of the laser beam, these openings may be a source of very 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 output 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. All cables must be connected to their mating connectors before application of AC line power and turn-on of the power switch.

5100ERW SYSTEM COMPONENTS - MODEL NUMBERS

SYSTEM SERIAL NO.: 5321

POWER SUPPLY/TIMING GENERATOR (PS/TG):

❒ MODEL 5100ER-10 10 kHz Max. Repetition Rate, ~5 kVDC Max.*

❒ MODEL 5100ER-30 30 kHz Max. Repetition Rate, ~3.1 kVDC Max.

❒ MODEL 5100ER-100 100 kHz Max. Repetition Rate, ~2 kVDC Max.

OPTICAL HEAD ASSEMBLY (OHA):

5100EMW -, 2.0" OPTICAL CENTER LINE HEIGHT X 8.25" long

❒ -10 kHz ❒ -30 kHz, ❒-100 kHz

E-O MODULATOR, RTP MODEL: 11150-6-15-2X-355-Z

POLARIZER(S), MODEL: N/A

**ALTERNATE GIMBAL ASSEMBLY, MODEL: ❒ MG-145, ❒ MGC-145
(These gimbals produce a 2.6" Optical Center Line Height. They can be used only on the Special Order – Model 5100EW OHA)

Notes:

***High voltage may be limited to prevent arcing between electrodes on the Pockels cell crystals for any cell with electrode spacing of 4 mm or less. Application of voltages higher than approx. 4 kVDC may damage the cell.**

**For micrometer handles on the Pitch/Azimuth adjusting gimbal, the special order Model 5100EW Optical Head Assembly must be specified. The Gimbal device is Lasermetrics' Model MG-145 or MGC-145, these gimbals require a longer (9.5" long) OHA (type 5100EW) which has an optical center line height of 2.6".

The 5100EMW Optical Head Assembly has an optical center line height of 2.0 inches. This is attained by use of a Model PCH-1 Gimbal which does not have external micrometer adjusting handles. After removing the OHA cover, Pitch and Azimuth adjustments on the PCH-1 are made by means of a hex key wrench (Allen Head wrench). Position of the hex head screws can be locked and unlocked by means of the opposed screws with slotted heads.

MODEL 5100ERW LASER PULSE GATING SYSTEMS

Specifications and Data Sheets

Serial No. 5321

AC LINE

*Voltage, Frequency (Set For)	☑ 100-117 V, ❐ 230-240 V, 50/60 Hz (NOMINAL) ❐ 100 Volts, 60 Hz ❐ Refer to Addenda rear of manual
Power	Up to 110 Watts
Fuse	BUSS -- MDL-2 (2 Amps)

* **TO CHANGE LINE VOLTAGE SETTING:** **Before applying AC Line Power, check to insure that the voltage selector switch on the rear of the chassis is set for the line voltage you will be using.**

To change the line voltage setting, refer to the Addendum at the rear of this manual . CAUTION - operating the unit at 230-240 Volts with the switch in the 115 Volts position will result in damaged components. Change Line Voltage setting only when the AC line cord is detached from the mating chassis connector.

TRIGGER INPUT VOLTAGES - Nominal values

FUNCTION	SENSITIVITY POSITION	VOLTAGE @ 50 Ohms	
		E_{in}	E_{mon}
Photo or Negative	Max.	-55 mV	≥7 mV
	Min.	-650 mV	≥180 mV
Positive	Max.	55 mV	≥7 mV
	Min.	660 mV	≥180 mV

Test conditions: Trigger applied to either input:

1) The input polarity is as indicated.
2) External Gate FWHM pulse width is >5 ns and ≤ 1 μs.
3) The indicated voltage levels are typical thresholds that achieve a stable output pulse.
4) The maximum positive or negative input is 5 volts.
5) Input trigger pulse widths between 50 ns & 1 μs are acceptable, with rise time≤3ns.

MODEL 5100ERW LASER PULSE GATING SYSTEMS

Serial No. 5321 — Nominal Specifications

Power Supply / Timing Generator (PS/TG) 5100ER Cabinet)

Input/Output Delay Range	Delay "ON" side	110 ns to 1.2 μs
	Delay "OFF" side	110 ns to 1.2 μs

Pulse Width Monitor (PW) Range	0 to ~1.0 μs
PW Monitor Output, into 50 Ohm	1.2 Volts
High Voltage Range, DC	0 to ≈5 kV for 5100ER-10 (10 kHz Model)
(min. DC Voltage for min.	0 to ≈3.1 kV for 5100ER-30 (30 kHz Model)
rise/fall times is ≈ 500 Volts DC)	0 to ≈2 kV for 5100ER-100 (100 kHz Model)
Bias Voltage	800 VDC set point, typical (factory setting)
+24 VDC	Set for +24VDC
Trigger Output(s), into 50 Ohm	
On Trigger	5 V
Off Trigger	5 V
EXT GATE Input (Command Trigger)	1.5 V (5 ns min., 1 μs max.)

HV Output Pulse Modules (Located Inside the 5100EMW Optical Head Assembly)

Output Voltage Range (Pulsed)	500 Volts to ~5 kV, 0 to Pk
Output Pulse Width Range (Optical)	~5 ns to 1.1 μs
In/Out Delay, (ON or OFF)	<37 ns
Rise Time (ON) (Optical)	<3.0 ns
Rise Time (OFF) (Optical)	<3.0 ns
Extraction Rate	Single shot to Maximum kHz for given model

Cooling Water

Input & Output Hose Connectors: .... For 1/4" ID Hose
(Quick connects , Reference McMaster Carr # 5012K39 & 5012K46)
Flow Rate, at 22-27^{o}C nominal .... 0.5 to1 liter /minute,

Serial No. 5321 OHA & Rack Final Acceptance Test By: SD 30 June 2014

POCKELS CELL OPERATIONAL CHARACTERISTICS

Model Number: 1147-8-1550 Serial Number 5321

Crystal Material: RTP (Rubidium Titanyl Phosphate)

Window Material: Fused Silica

Window Coatings: AR/AR @1550 nm

Clear, Useable Aperture: 7.5 mm diameter

Index Matching Fluid: NA

Polarizer: N/A

Analyzer: N/A

Contrast Ratio: >1000:1 measured at 1550 nm

Half Wave Voltage: ~4500 kVDC @ 1550 nm

Capacitance: ~5.3 pf

Comments: We recommend that applied DC voltage be limited to <5 kVDC

Tested By: VAL/MP Date: 28 June 2014

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. **<u>DO NOT</u>** 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.

5100ER PS/TG OPERATIONAL AND CONTROL FUNCTIONS - Refer to Figure 1

AC ON (Switch) Controls AC Line Voltage (ON/OFF).

AC ON (Lamp) When lighted, indicates AC Line Voltage is applied.

INPUT-PHOTO (BNC)Provides for connection to an external, customer supplied PIN photo diode. The connector provides a bias level of +12 VDC thru an internal 50 ohm termination. If the external photo diode has its own, internal bias source, use the Trigger Input connector which has a blocking capacitor (instead of the PHOTO connector). Alternatively, negative (-) going pulses can be applied to the PHOTO connector if a capacitor is used to block the internal DC bias voltage.

INPUT-TRIGGER (BNC) Provides for connection to positive (+) polarity pulse signal sources.

INPUT-MON (BNC) Produces an output signal that allows verification of either PHOTO or TRIGGER input source to assure signal detection is possible. When a MON output pulse is present, the triggering signal level is satisfactory.

INPUT-SENS (Control) For threshold sensitivity adjustment of the PHOTO and TRIGGER inputs.

IN/OUT DELAY (Control) Allows adjusting the delay between input trigger detection and the generation of an output pulse.

PULSE WIDTH (Control) Allows adjusting the timing between the OFF trigger with respect to the ON trigger which corresponds to controlling Pulse Width.

GATE (BNC) Works in conjunction with IN/OUT DELAY. Provides connection to an external command trigger pulse that initiates extraction(s) from a mode-locked C-W pulse train. This function is not used with Q-Switched (Burst) extraction(s). The mode locked pulse train is applied to the INPUT-TRIGGER or INPUT-PHOTO connectors. The gating signal is applied to the EXT GATE connector

GATE Signal (Switch) When switched to EXTERNAL: used with CW Mode Locked Lasers for gating output pulses that are synchronized to the mode lock frequency. When switched to INTERNAL: disables EXT GATE connector; must use INPUT PHOTO or INPUT-TRIGGER connectors for gating Q-switched laser pulses and/or Q-switched envelope or for slicing a pulse out of a CW laser beam.

MONITOR (BNC) Provides a low level approximation of the output pulse width, and acts as a synch pulse prior to generating the output pulse. Also verifies that mode-locked pulse detection has occurred. Note that the waveform is not an exact representation of the output HV pulse.

HV ADJUST (Control) Provides adjustable DC HV to the HV Switching Modules located in the 5100EW or 5100EMW Optical Head Assembly (OHA).

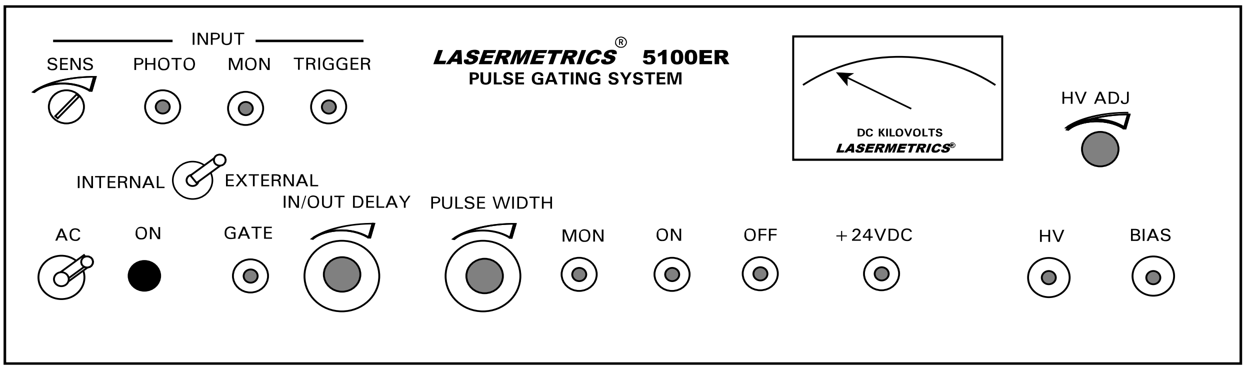
HV (SHV) DC High Voltage output applied to the Optical Head Assembly (OHA)

HV - HV Meter Indicates level of DC voltages (kV) at the HV output connector

BIAS (MHV) Provides a voltage for biasing circuits within the OHA. This voltage is factory set and is not field adjustable. This voltage is not related to light modulator bias.

"ON" & OFF" OUTPUTS (BNC) Connects the initiating trigger pulses (produced in the 5100ER PS/TG) to the HV "Switching modules within the Optical Head Assembly.

+24 VDC (BNC) For internal power boost at the OHA, enables HV switching.



CONNECTORS

PHOTO INPUT = BNC
MON INPUT = BNC
TRIGGER INPUT = BNC

GATE INPUT = BNC

MON (PULSE WIDTH) = BNC
ON = BNC
OFF = BNC

HV = SHV
BIAS = MHV

NOT TO SCALE

GRAPHICS\5100ERW-50kHz-FrontPanel.wpg Rev.1July2005 / RLG

Figure 1. 5100ERW SYSTEM POWER SUPPLY / TIMING GENERATOR FRONT PANEL

OPTICAL HEAD ASSEMBLY (OHA)

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 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 pulse. This edge turns off the output voltage on the Pockels cell (closes the gate).

+ 24 VDC (BNC) DC voltage for boosting switching current in the ON and OFF trigger circuits and to prevent HV switching if +24VDC is not present.

WATER (Quick connects) For attaching 1/4" ID vinyl or polyethylene water hose. Flow is non-directional. Flow rate should be 0.5 to1 liter per minute at 22-25^{o}C

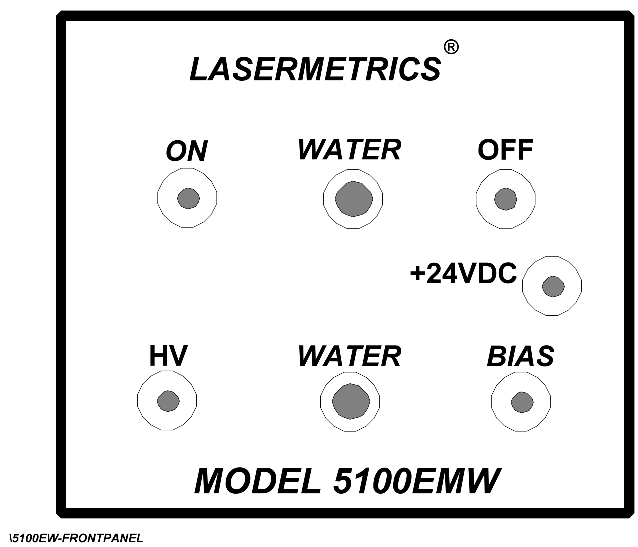
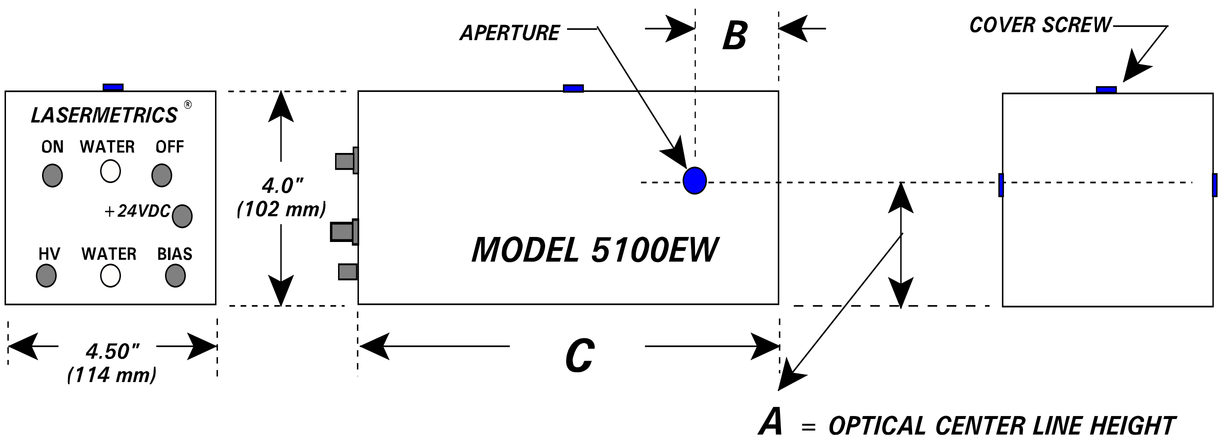


Figure 2 Front Panel of 5100EMW Housing (5100EW Panel is identical)

To remove the cover from the optical head assembly, remove the screw at the top center of the OHA.. Carefully pull the cover off in the vertical direction. The cover is tightly fitted for good 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.



DIMENSION	5100EW	5100EMW
A	2.6" (66 mm)	2.0" (50.8 mm)
B	2.4" (61 mm)	2.0" (50.8 mm)
C	9.5" (241 mm)	8.25" (210 mm)

GRAPHICS\5100EW&EMW-OHA.WPG

Figure 3 5100EW (shown) & 5100EMW Optical Head Assembly Dimensions & Locations

Important Notes:

1. The 5100EMW Optical Head Assembly has an Optical Center Line height of 2.0 inches. This is attained by use of a Newport Model PCH-1 Gimbal device which does not have external micrometer adjusting handles. Pitch and Azimuth adjustments on the PCH-1 are made by means of an hex key wrench (Allen Head wrench) afer removing the OHA cover. Do not attempt to use the slotted head screws to adjust gimbal position - they are factory set for proper tension on the movable parts.

2. 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 needs readjusting, 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.

1.0 GENERAL DESCRIPTION

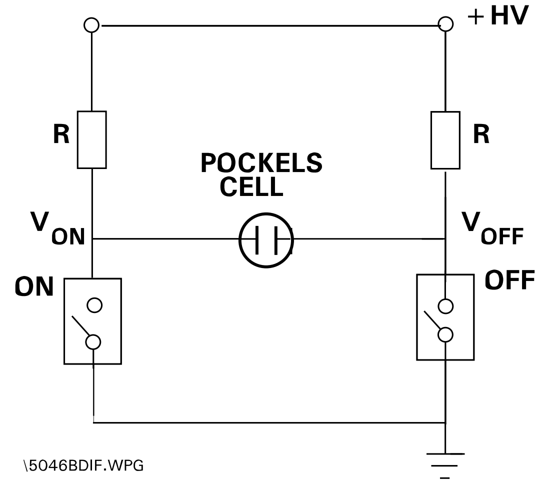
The Model 5100ERW Laser Pulse Extraction & Chopping System is an electro-optic instrument that operates on the basis of rotating the plane of polarization of optical beams propagating through an internal Pockels cell light modulator. The system is designed to selectively gate or chop light pulses from 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 5100ERW System incorporates a Pockels Cell light modulator and a high voltage electronic switching driver to produce nanosecond transition optical gating. All high voltages necessary for operation are provided by the Power Supply/Timing Generator (PS/TG). An additional connector on the PS/TG provides +24 VDC which is used in the OHA for enabling HV switching and power boosting the MOSFET triggering circuits. The system consists of a differential MOSFET amplifier (two modules located in the OHA) which are 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 used (optional element) 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 4. These elements are enclosed in the Optical Head Assembly (OHA).

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 MOSFET amplifier is switched to ground (leading edge = t_r) and the voltage V_{ON} becomes zero.



R = CURRENT LIMITING RESISTORS

Figure 4 Differential Configuration

Without an input trigger, 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 about 100 kHz Note that the static high voltage level can be adjusted for operation at 1/4 or ½ wave retardation (45^0 or 90^0 polarization rotation respectively) or at any level from zero to ½ wave retardation depending on system requirements. Refer to the user guides for RTP, BBO, Lithium Niobate & KD*P Q-Switches at rear of this manual or on website fastpulse.com for additional details.

1.1 OPTICAL SYSTEM

The active optical element of the Model 5100ERW 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 5100ERW 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 90^0 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 ½ wave optical retardation plate into the optical path. That is, a 90º 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 5100ER Power Supply/ Timing Generator (PS/TG).

2.0 SYSTEM OPERATIONAL DESCRIPTION

The 5100ERW System electronic circuits require an AC input voltage as indicated on Page 4 of this manual. All DC operating voltages are derived from this AC input. The system acts as a fast temporal gate having a open gate time corresponding to the time between the leading edges of the two trigger signals (ON & OFF) generated by the PS/TG. 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 given to trigger pulse characteristics.

Ideally, trigger signals should come from a 50 Ohm source to prevent ringing or false triggering.

Because all internal switching is referenced to the leading edge of the trigger signal, trigger rise time must be in the range of 1 to 5 ns 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 ns to 1 microsec. 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 ns wide pulse is recommended as a nominal value.

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 5100ERW PS/TG this delay between input and output is approximately 100 ns. Applying a trigger to the TRIGGER INPUT connector will result in the corresponding output level switching in the "ON" output about 100 ns later. If the DELAY has been set, for instance to 150 ns then the "OFF" output signal will occur about 150 ns later. There is an additional intrinsic propagation (input/output) delay of approximately 40 ns in the OHA. These propagation delays cannot be further minimized and must be taken into account for planning and setting up instrumentation and trigger sources.

A photodiode detector can be utilized to sample the rejected mode-locked laser pulse train. This rejected train of pulses is present in the beam exiting the side face of a polarizer which must be located at the output side (external to the Optical Head Assembly) of the Pockels cell when the system is in a blocking state. The detected mode-locked pulses are applied to the PHOTO Input signal jack and provide synchronizing pulses to the timing logic control circuit. Note that the PHOTO input jack provides a +12 VDC voltage for reverse biasing a PIN photo detector (customer supplied.) Alternatively the mode-locked synchronizing pulses can be supplied to the TRIGGER input from an external pulse source such as the reference output of the signal generator (mode locker driver) providing mode locking reference signals.

Refer to the timing diagram, Figure 5, for two modes of pulse operation. For chopping the output of a CW laser, operation is similar except that the 5100ERW System will gate an optical output pulse having a width which is a function of the front panel pulse width setting.

To gate out a laser pulse from a CW mode locked pulse train (see connection diagram Figure 6), the front panel switch is set to EXTERNAL and a user provided command trigger pulse is applied to the EXT GATE BNC input jack enabling an internal logic gate. The next occurring mode-locked synchronizing pulse (applied to either the PHOTO input or TRIGGER input connectors) propagates through the enabled logic gate and triggers an adjustable time delay circuit. After the time delay, an internal trigger pulse is launched to an adjustable Pulse Width Generator that produces the ON and OFF triggers which are applied to the HV Switching Modules located in the Optical Head Assembly.

High voltage pulses generated by the HV Modules are applied to the Pockels cell. The resultant optical gate will allow the transmission of one or more mode-locked laser pulses. The adjustable time delay allows centering the gate to straddle one or more mode-locked laser pulses depending on the front panel PULSE WIDTH setting. In the case of chopping a CW beam or narrowing a Q-switched pulse, the output pulse from the 5100ERW System can be adjusted from less than 10 nanoseconds to about 1 microsecond in width.

Extracting a pulse from a Q-Switched mode-locked laser follows the same sequences (see connection diagram Figure 7). Selecting the "EXTERNAL" mode disables the "INTERNAL" inhibiting gate thus allowing each occurrence of a Q-Switched mode-locked pulse train to synchronize the internal timing logic. The first pulse to exceed the SENS threshold pre-set level initiates this process.

Refer to the User's guide for KD*P, RTP & Lithium Niobate Q-Switches & Modulators ..... at rear of this manual or on website fastpulse.com for additional details on the operation of the Q-switch and differential drivers.

2.1 SYSTEM CONNECTIONS

NOTE: Before proceeding with system connection, insure that the AC power cord is disconnected, the Power Switch is in the "OFF" position and the HV Control knob are turned full counterclockwise.

2.1.1 Connect the desired trigger source to the PS/TG TRIGGER input BNC connector.

2.1.2 Connect the "ON" and "OFF" trigger outputs of the 5100ERW PS/TG to the corresponding BNC connectors on the 5100EW or 5100EMW OHA. Use 50 ohm cables (RG-58/U) with BNC connectors..

2.1.3 Connect High Voltage, Bias and the +24 VDC connectors on the PS/TG to the corresponding connectors on the OHA using the appropriate cable and connectors provided. Never apply +24 VDC to the trigger inputs -- this could damage the high voltage switching circuits.

2.1.4 Connect cooling water supply to the OHA using the 1/8"inch barbed nipples (See McMaster Carr # 5116K83) for 1/4" or 5/16" ID tubing reenforced plastic tubing. Input can be applied to either nipple.

2.2 INPUT FUNCTIONS

Two input jacks are provided to accommodate either positive or negative pulse sources. The TRIGGER jack is used for positive input signals. The PHOTO jack is used with a PIN Photo Diode where positive voltage reverse biasing is required (+12 VDC bias voltage is present at the BNC PHOTO connector). Output pulses from a positive voltage, reversed biased diode will be negative going, switching toward ground (0 volts). Negative going pulse signals may be applied directly to this input if capacitor coupling is provided (DC bias is blocked) to protect the pulse source. The positive TRIGGER jack is internally de-coupled (blocking capacitor) and positive going trigger signals with a DC level can be applied to this connector.

If externally divided CW modelocked synched pulses are available, they may be applied to the appropriate positive or negative input jack (PHOTO or TRIGGER). The divided extraction rate should not exceed the 5 kHz extraction repetition rate limits specified for the 5046. An" EXT GATE" CW command trigger input is not required and the Mode Selector switch must be set to "INTERNAL". Do not exceed the maximum extraction repetition rate indicated for the HV Output Module shown on the Specifications table. Higher repetition rates may cause overheating of resistive components resulting in premature failure.

The INPUT SENS sensitivity control, in conjunction with the INPUT MON (monitor) jack is used to verify that an input signal has sufficient level to be detected and to adjust the threshold for detection. Threshold sensitivity for either input is recorded in the specifications. Note that the indicated INPUT MON voltage level must be met or exceeded. To verify detection, slowly turn the SENS control clockwise until an output pulse is produced at the PULSE WIDTH MON connector. NOTE: To observe pulses at the PULSE WIDTH MON connector, the PULSE WIDTH control cannot be at the zero (max. counterclockwise) setting.

2.3 In / Out Delay Functions

An adjustable delay control is used to set the occurrence of the OUTPUTS output trigger pulses that produce the optical time window or pulse width. The IN / OUT DELAY adjustment range is recorded in the specifications. Final adjustments are made in conjunction with optical measurements of the laser energy waveform.

2.4 Pulse Width Generator

The Pulse Width generating process incorporates a high speed switching circuit which, when triggered, produces an output pulse whose duration can be adjusted by a front panel control. The ON and OFF output trigger pulses (derived from the Pulse Width front panel setting) are applied to the output differential amplifier in the OHA which generates high voltage pulses that are applied to the Pockels cell. This produces an optical time gate whose leading and trailing edges correspond to the leading and trailing edges of the trigger output pulses. The range of the gate's width is recorded in the specifications. The PULSE WIDTH MON connector signal allows the user to pre-set an approximate pulse width (time difference between ON and OFF trigger pulses) by measuring pulse duration as displayed on an oscilloscope. The ON and OFF output trigger pulses can also be observed directly and their separation measured. Note that the output signal from the PULSE WIDTH MON connector is an approximation of the HV output pulse width since its rise and fall times may be slower than the actual HV output rise and fall times.

2.5 Unsynchronized CW Mode Operation - Relation to Jitter

For lowest jitter performance, in the range of 1 nanosecond, the TRIGGER Input and EXT GATE signals must be synchronous. When these signals are not in synchronism, jitter will increase and may become random, depending on signal characteristics. For instance:

Assume a TRIGGER input signal of 20 MHZ and an EXT GATE signal of 4 kHz with a pulse width of 50 nanoseconds. With no synchronization between the two signals, the EXT GATE can be energized randomly at any time during the 20 MHZ period (1/f). The repetition period of a 20 MHZ signal is 50 nanoseconds. Therefore, the maximum jitter could approach 50 nanoseconds for that frequency. As frequency increases, the repetition interval (period) becomes smaller so that at 100 MHZ the maximum expected jitter would be 10 nanoseconds.

For stable operation, the TRIGGER Input signal should be a positive pulse having a rise time not greater than 2 nanoseconds. A sine wave will not provide proper, jitter-free operation.

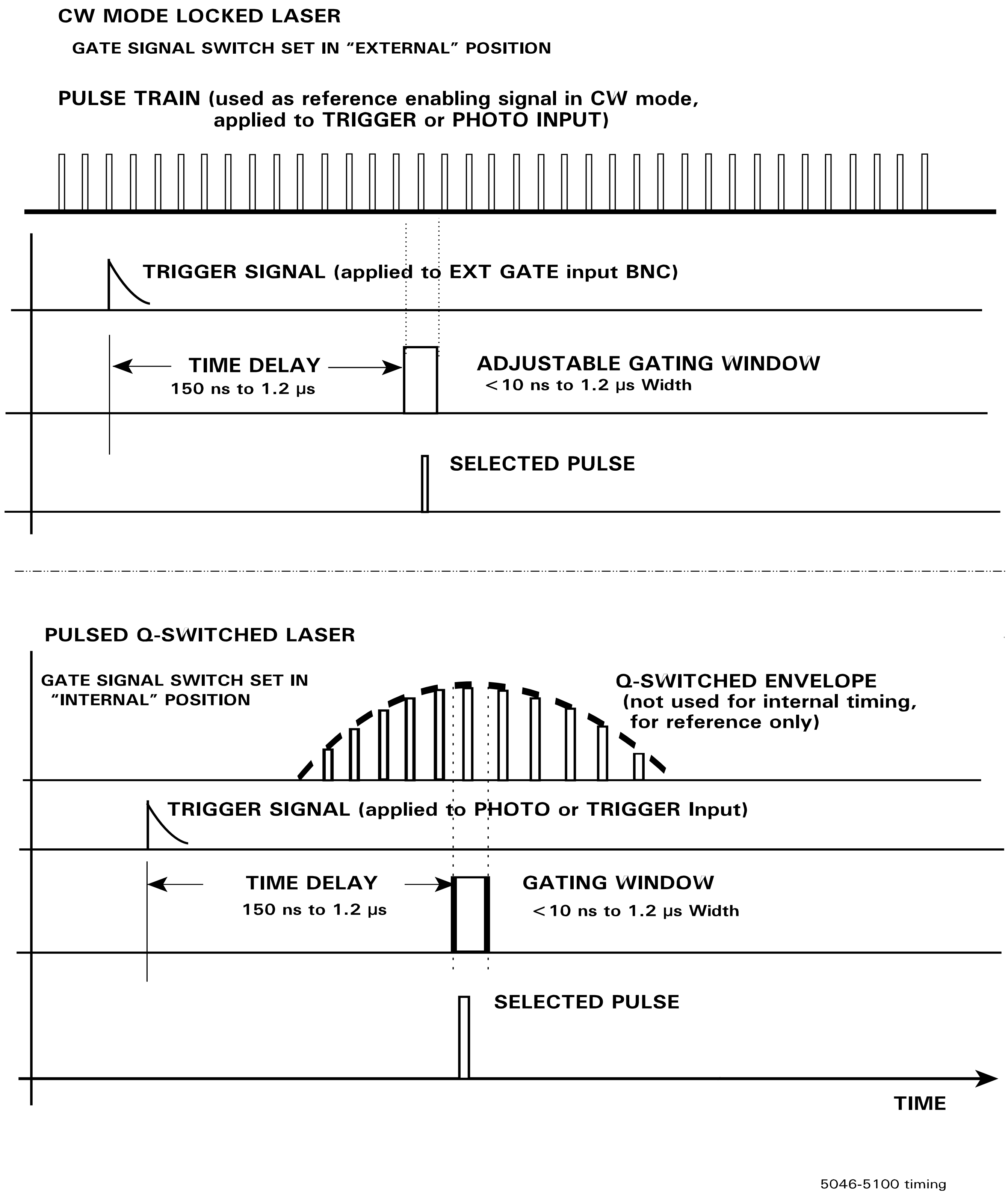


FIGURE 5 TIMING DIAGRAM PULSE & CW MODE LOCKED LASERS

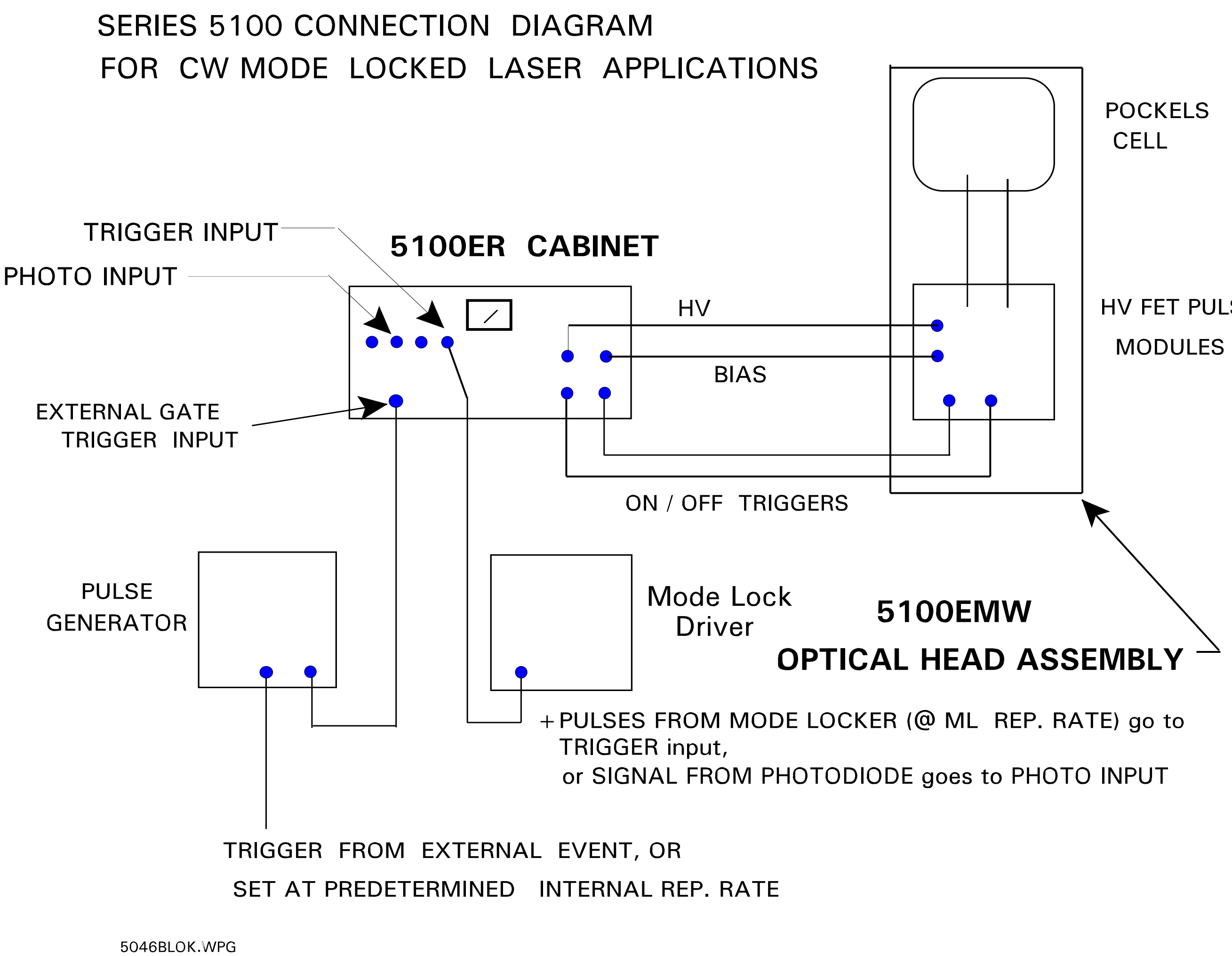


Figure 6: CONNECTIONS FOR USE WITH CW MODE LOCKED LASERS

Set the front panel switch to EXTERNAL. A reference signal (positive going pulses), from the mode locker driver (monitor or reference output) is applied continuously to the TRIGGER connector. Alternatively, the PHOTO input connector may be used with a fast photodiode. A convenient +12 volt bias voltage is present at this connector for reverse biasing the photodetector. The TRIGGER and PHOTO inputs are internally connected in parallel. To use the PHOTO input with a source (negative going pulses) other than a photodiode, a blocking capacitor must be connected to prevent DC voltage from effecting the source. The TRIGGER input circuit incorporates a DC blocking capacitor and may be used with either AC or DC level pulse signals. By application of a command or gating pulse to the EXT GATE connector, obtained from a pulse generator or some external event, the internal trigger circuits are enabled. The next reference pulse generates the optical gating signal that activates the Pockels cell. The reference pulse should arrive 5 nanoseconds or more after the command trigger for proper operation.

Refer to paragraph 2.5 for CW Mode operation with unsynchronized signals.

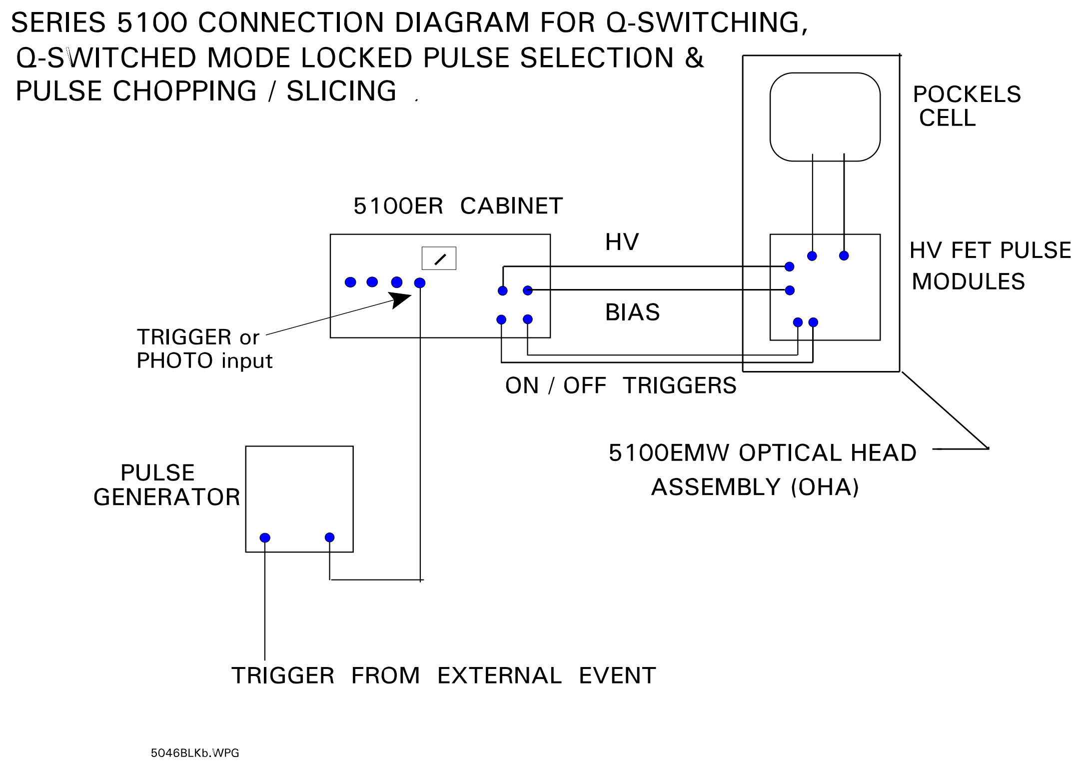


Figure 7: CONNECTIONS FOR USE WITH PULSE PUMPED Q-SWITCHED, Q-SWITCHED/MODE LOCKED AND CW LASERS

For selecting a particular mode locked pulse from a Q-switched-mode locked envelope or chopping/slicing a portion of a Q-switched or a conventional laser pulse, set the front panel switch to INTERNAL Apply positive going trigger pulses (typically derived from the Q-switch drive signal) to the TRIGGER input connector. Alternatively, trigger signals from a photodetector can be applied to the PHOTO input. This input provides a +12 volt bias for the photodetector. The PHOTO input can be also be used with other low impedance sources (pulse generator) and negative going trigger pulses provided a blocking capacitor is utilized to decouple the trigger source from the internal bias. The TRIGGER input circuit employs a blocking capacitor and either DC or AC level pulses may be applied to this input. The SENS (sensitivity) control is adjusted to set the level on the envelope at which the system will be activated. The IN/OUT DELAY sets the time delay before an output pulse (gating window) is generated by the HV Pulse Module. The SENS and IN/OUT controls can be used together to optimize the selection of a particular mode locked pulse in the envelope. The PULSE WIDTH control determines the length of the output time window, and thus either the complete Q-switched pulse and its mode locked contents or a given number of pulses may be selected.
Note that the Figure 7 configuration is also used for chopping of a CW or pulsed laser beam. Width of the gated beam is controlled by adjustment of the PULSE WIDTH control.

Refer to the Specifications Tables for input levels and ranges.

Figure 8: SERIES 5100 CONNECTION DIAGRAM FOR
DIRECT TRIGGERING OF THE
“ON” and “OFF” TRIGGER INPUTS

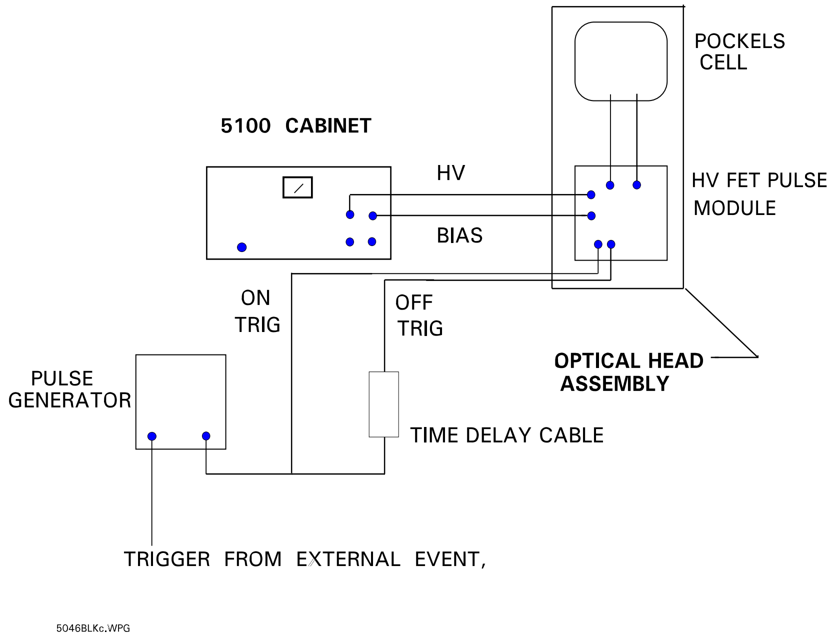


Figure 8 DIRECT TRIGGERING OF HV MODULES (In the 5100EMW Optical Head Assembly)

This configuration may be used if the minimum delay introduced by the PS/TG internal timing circuits is excessive for a particular application, the HV modules within the Optical Head Assembly (OHA) can be triggered directly. To operate in this manner, it will be necessary to disconnect the "ON" & "OFF" trigger cables between the 5100ER-VC PS/TG and the 5100EW or 5100EMW OHA which contain the HV modules.

The ON and OFF connectors on the OHA panel are utilized, and, from an external pulse generator, apply two trigger pulses - one for the leading edge (ON) of the desired optical window, and one (OFF) for the trailing edge. For gating narrow time windows (≈5 to 20 ns), the "ON" trigger pulse can be delayed through a length of 50 ohm cable and applied to the "OFF" trigger input. This delay is ≈1.5 nanoseconds per foot of cable. Note that the ≈3 to 4 nanosecond rise and fall times will limit the minimum attainable pulse width. Maximum pulse width, and thus the time between the the ON and OFF trigger pulses is 2 microseconds.

When direct triggering of the HV Pulse Modules is used, note that the delay time between TRIGGER inputs and HV output is nominally 40 ns and is slightly dependent upon the HV operating level, trigger input level, and repetition rate. This is the intrinsic propagation delay time of the internal electronic elements. Propagation delay for the modules has been minimized for the type of high voltage elements used.

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 ..... & ... 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 5100ERW System. 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 5100ERW systems 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 within 6 arc minutes or less if the full extinction ration capability is to be attained. In KD*P modulators and Q-switches (typically models within the 1145, 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 90^0 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 0^0 or 90^0 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 by unscrewing the knurl screw fully. The head baseplate can be affixed to a mounting surface by means of two 1/4-20 or M6 bolts on a 4 inch (100-101.6mm) 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 or ceramic apertures. 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 5100ERW 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

Set the HV control knob full counter-clockwise (minimum voltage). Energize the 5100ERW by applying +24 VDC, Bias and adjust HV to the required output level. This value will generally be the 1/4 or ½-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. Retardation 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 ns rise time and between 5 to 1000 ns 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 5100ERW, 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 6) 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 ½ wave voltage pulses).

REMINDERS:

1. FastPulse Technology Pockels cell Q-switches are fabricated so that either the X or Y crystal axis is parallel to the plane defined by the cell's electrical terminals. Refer to Figure 6 on following page. The X and Y crystal axes are optically interchangeable.

2. Any photo detectors (PD) used to monitor or view the optically gated output of the 5100ERW System must have <1 nanosecond rise time and good response at the laser wavelength.. The output of the PD must drive into the 50 Ohm input of the monitoring device (oscilloscope). If the PD output is applied to the usual 1 MOhm input, the waveform will not show the true rise and fall times or width of the optical pulse.

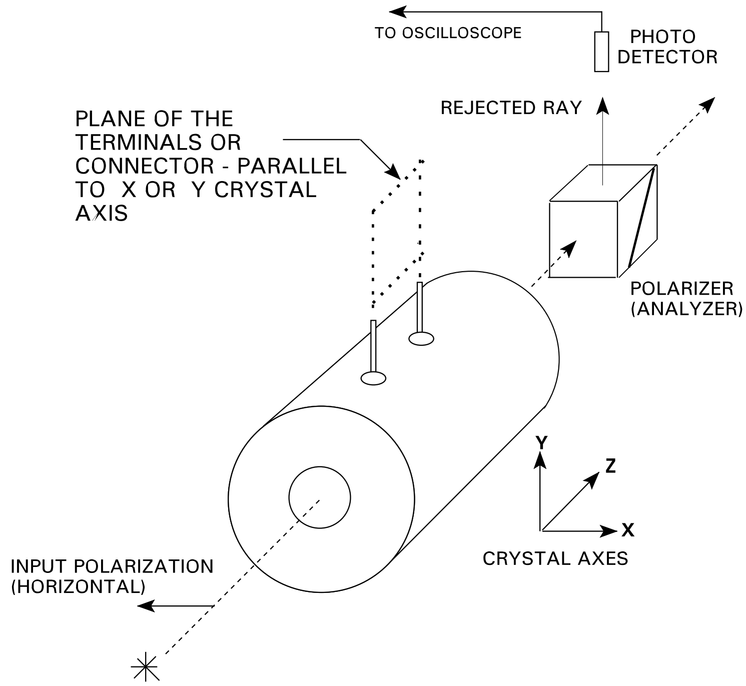


Figure 9. Arrangement of elements for detecting laser pulses with no voltages applied. Shows orientation of Pockels cell terminals with incoming plane of polarization. If the input plane of polarization is vertical and the cell is not rotated, the output polarizer (analyzer) can be rotated 90^0 around the propagation axis and operation will be identical. Typically, the X and Y crystallographic axes are optically equal and interchangeable.

6.0 EMI CONSIDERATIONS

5100ERW Systems meet US and European EMC standards for EMI/RFI radiation limits. 5100ERW 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 5100ERW 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.

5100ERW Systems utilize a two part aluminum optical head assembly which contains the HV power supplies, pulse 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, 50 Ohm BNC connectors must be mated to 50 Ohm cable and 75 Ohm MHV connectors must be mated to 75 Ohm cable. Severe impedance mismatches due to using improper cables will cause ringing and radiated emissions.

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WARRANTY

Each standard component and instrument manufactured by FastPulse Technology and/or its **LASERMETRICS** ® **Division** 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 does not apply to non-standard equipment or equipment modified to meet customer special requirements; for modified or specially produced instruments the warranty period shall not exceed 90 days after date of invoice. All warranties are voided if any instrument or equipment is operated improperly or 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. Specifically excluded from any warranty liability are 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 internal or external to the laser cavity, expendable items such as flash lamps, water filters and the like. FastPulse Technology does not assume liability for installation, patent violation claims, labor, injuries, or consequential damages.

Equipment under warranty 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 services, travel and living expenses will be charged to the purchaser at the then current rates.

In many instances, equipment problems can, with the purchaser’s assistance, be resolved through brief communications with a factory engineer either by telephone, FAX or e-mail. Should, in FastPulse Technology's 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.

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. It is the purchaser’s responsibility to insure that the products are suitable for the purchaser’s application.

CLAIM FOR DAMAGE IN SHIPMENT

The equipment must be tested within 10 days after receipt. If it fails to operate properly, FastPulse Technology, Inc. must be promptly notified. If there is external damage to the packaging or there is internal damage, a claim must 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.

Include model number and serial number when referring to this equipment for any reason

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Changing AC Line Voltage Connections - Rack Mounted Configuration ONLY

The 50100ERW incorporates special AC Power Line Voltage Selectors and EMI Filter Assemblies which are located on the rear of the chassis. The Selector permits changing the AC line voltage settings at which the 5100ERW will operate. Two different models are used. One model has 2 usable positions: 120 and 240 VAC. The 240 Volts setting will accommodate AC line voltage inputs from 220 - 240 Volts. The second model (shown below) has positions for: 100 Volts, 120 Volts, 230 Volts and 240 Volts. The procedure for changing to any other settings is as follows:

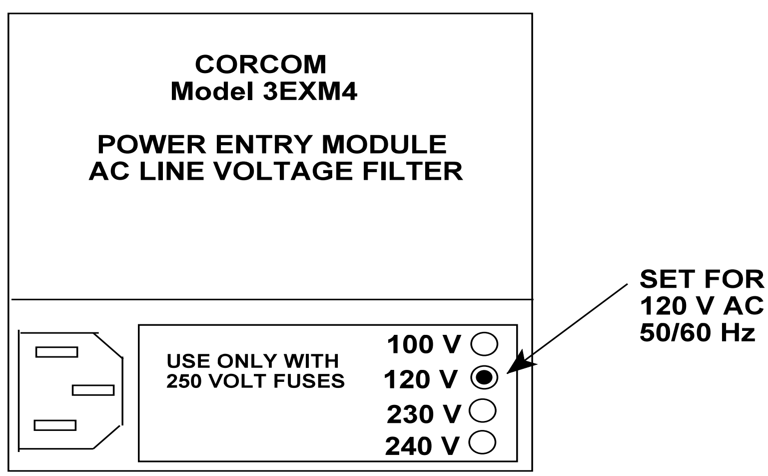
1. Disconnect the AC line voltage by pulling the plug from the wall socket and also remove the plug from the rear of the chassis.

2. In the rear of the rack unit chassis there is a black AC line cord socket assembly. Refer to figure below. The left side has a socket and on the other side has a plastic cover that can be opened with a knife point or screwdriver. On one side of this cover, a small white plastic point protrudes out of one of four (4) holes. Each hole has a voltage marking (100 V, 120 V, 230 V, 240 V).*

3. To change the voltage setting to 240 V, pry the cover off. This will expose a white plastic part (with the point) attached to a tiny printed circuit board. Pull the board out of its socket. Note that the plastic part can be repositioned on the board by sliding it in the slotted areas and around the edge of the board.

4. To select 240 V, the PC board must be rotated until the side marked "240" and its associated arrow are on the side opposite the plastic piece. The PC board is then plugged back into the socket - with the 240 V side going in first. Note that the white plastic piece has an arrow head that points to small arrow heads on the black socket assembly. The arrow head points must face each other when the pieces are mated.

5. When the cover (the one that was removed) is put back on, note that the white point will now stick out of the hole next to "240 V". The AC Line socket is now set for 240 Volts AC operation. This is the MAXIMUM AC RMS line voltage that should be used. Likewise, if the voltage selector is set to "100 V", this should be the maximum applied voltage. If the AC line plug is thereafter connected to 120 Volts or 240 Volts, the internal circuits may be damaged.



AC LINE FILTER FOR RACK MOUNTED SERIES 5000 SYSTEMS