System Components

DT-505, Version 2.3

Latest Upgrade: November 1, 1996

DT-505

CU-505

Timer board: Version 1

HV 5.35 KV without booster

Front Panel + Back Panel FET (factory-adjusted)

110 VAC – 220 VAC

HVS-505, 5 stages DL, 5 stages PD, 5 Stages FET

Water cooled

Cable set 2+1

PC-100

KD*P, single, BBAR 800 nm

Patent pending

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DT-505 Solid-state Pockel cell driver, patent pending.

Contents

Graphic Symbols Explained

The following graphic symbols are used throughout this manual to draw your attention to situations or procedures that require extra attention. They warn of hazards to your eyesight, damage to equipment, and necessary performance specifications.

Performance Specifications. You should follow these instructions without deviation.

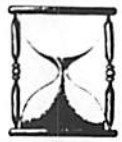
Eye protection required. Looking at laser beams can cause permanent eye damage.

Graphic to draw your attention to a warning or important note.

Wear protective gloves when handling optics. Skin oil *will permanently* **damage** the optical components.

Take care! This is an electrical hazard.

Wait — there is a warming-up period. Do yourself a favor and wait.



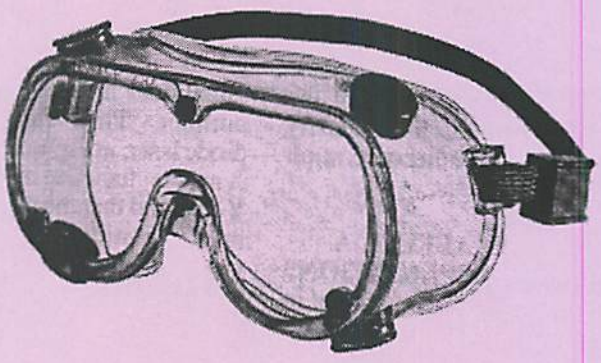
Post warning signs that alert others to the presence of laser radiation.

Authorized personnel only! Assemble and operate this system in an enclosed room.

1. Safety

The Clark-MXR DT-505 Pockels cell system does not generate any optical radiation on its own. However, the lasers you will be using with the DT-505 are sources of intense radiation. Their safe use depends on your being aware of their unique characteristics and treating them with the respect due to instrumentation that can cause serious bodily harm, including serious and permanent eye damage. You are advised to observe the following precautions:

- **When setting up or aligning the system or subsystems, KEEP ALL BEAMS BELOW EYE LEVEL. Never look in the plane of propagation of the beam. Wear Laser Safety Goggles.**



Remember that safety goggles *can be a hazard as well as a benefit*. To protect the eyes from the laser beam, the goggles must attenuate to the point where the beam is no longer visible. Therefore, the user can be exposed to **flesh burns** or **clothing fire** without seeing it happen. *Be aware of this potential!* Follow the specific recommendations called for in this manual at various stages during the alignment procedure.

- **Assemble and operate this system in an enclosed room. Periodically inspect the area for stray beams and reflections. Block those that propagate outside of the working area during assembly and alignment. Avoid uncontrolled reflections.**

- **When servicing the system do not wear jewelry (*for example*, rings, chains, etc.) that might pass through the laser beam line. Uncontrolled reflections may result!**

The laser beams used with the DT-505 can remain collimated over large distances and remain a hazard far from the original source. Clearly mark the door to the room with warning signs and interlocks connected to the two pump lasers to prevent accidental exposure to the beams.

■ **Post warning signs that alert others to the presence of laser radiation.**

Do **NOT** operate the system while untrained personnel are present. Warn anyone in the area where beams are located of the dangers associated with laser beams. **Verbal warnings** help ensure that others in the area are NOT injured by stray radiation.

■ **Limit access to the equipment to trained personnel who have a need to use it.**

The Eye Protection Required symbol warns you that **serious bodily harm** may result from exposure to radiation either present in the area, or radiation that may be created when doing the step detailed along side it (*see also*, Graphic Symbols Explained at the beginning of this manual).

■ **Observe and understand the symbol that follows.**

■ **Remember, safety is your responsibility! Follow these safety procedures when working with this product.**

2. Overview

The model DT-505 Pockels cell system manufactured by Clark-MXR, Inc. (see Figure 2-1) consists of three main subsystems:

- The control unit, model CU-505, includes the various power supplies required to power the full DT-505 system. The synchronization and timer board is also found in the CU-505.
- The high-voltage switching unit, model HVS-505.
- A Pockels cell assembly, model PC-100 (other models may also be available for specialized use).

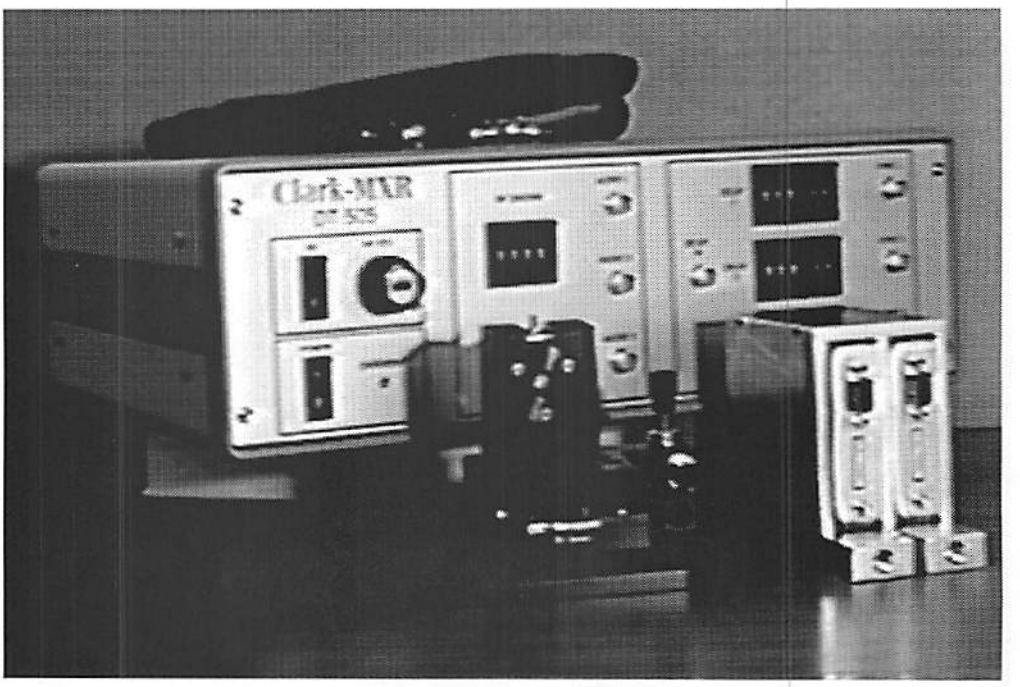


Figure 2-1 The Pockels cell system DT-505 includes the driver CU-505, the switching unit HVS-505, and a Pockel cell assembly (PC-100).

The model DT-505 is designed to operate only with Clark-MXR, Inc. laser systems.

The Pockels cell system DT-505 uses the Pockels effect (electro-optic effect) to modify the polarization stage of any optical beam propagating through the Pockels cell. When used in conjunction with polarizers, this system allows for the modulation of the optical beam of interest.

3. Sub-System Descriptions

3.1 CU-505

3.1.1 Control Unit CU-505 Function

The function of the CU-505 is to control the level and the sequence of the voltages applied to the Pockels cell assembly.

The electronic circuitry is divided between the CU-505 and the HVS-505. However, all operator-adjustable controls are located in the Control Unit CU-505.

3.1.2 Control Unit CU-505 Internal Layout

The Control Unit enclosure contains the synchronization and delay generators board, as well as various power supplies required to power the full DT-505 system.

Timing Board

The timing board contains the countdown circuitry which generates the user-selected repetition rate, as well as several digital delay generators and their associated synchronized outputs. The high voltage pulse sequence is fully controlled by the timer board.

Figure 3-1 shows a *flowchart* of the timer board logic.

Repetition Rate

The fundamental input is provided by a fast photodiode monitoring the laser of interest. (The repetition rate of this source must be in the 65 to 105 MHz range). The input level should be in the 50 to 200 mV range (50 Ω load).

The photodiode signal is filtered and amplified. This filtered signal (sinewave) forms the basic clock rate. (A fraction of this signal is available on the back panel of the CU-505.)

This RF signal is divided by 4, then transformed into a TTL compatible signal. This TTL-level signal is available at the back of the CU-505.

The clock rate is internally divided by 1000, then divided again by a user selected integer (selected from the front panel). The end signal repetition rate is available (in a TTL format) at the three outputs labelled *Audio 1*, *Audio 2* or *Audio 3*.

Digital Delay Generators

The CU-505 incorporates three independent digital delay generators and various auxillary synchronized output. Delay1 and Delay 2 control respectively the first high voltage step and the second high voltage step. A synchronized TTL level output is provided with these two delay generators.

Delay 3 is not tied to the high voltage circuitry. It is provided as a convenience to the user and is available for any additional synchronization needs.

"Zero" delay provides a non-delayed (early) output to which the delays are synchronized. Zero delay is normally used to trigger the pump laser for the regenerattive amplifier.

The four delay generators share a common input (labelled *Delay In*).

For standard operation, this input *Delay In* port is tied, via a short coaxial cable, to one of the three *Audio Out* ports.

The user can select each delay through the CU-505 front panel (switches labelled *Delay*). The desirable delay is selected by affixing a first integer (three digits) and a second integer (two digits). The first integer selects the number of clock cycles (X4) that will form the digital portion of the delay. The second integer corresponds to a small analog delay. Each unit corresponds to approximately 400 picoseconds. The analog delay counters are Hexadecimal based. The two portions (digital + analog) form the full delay.

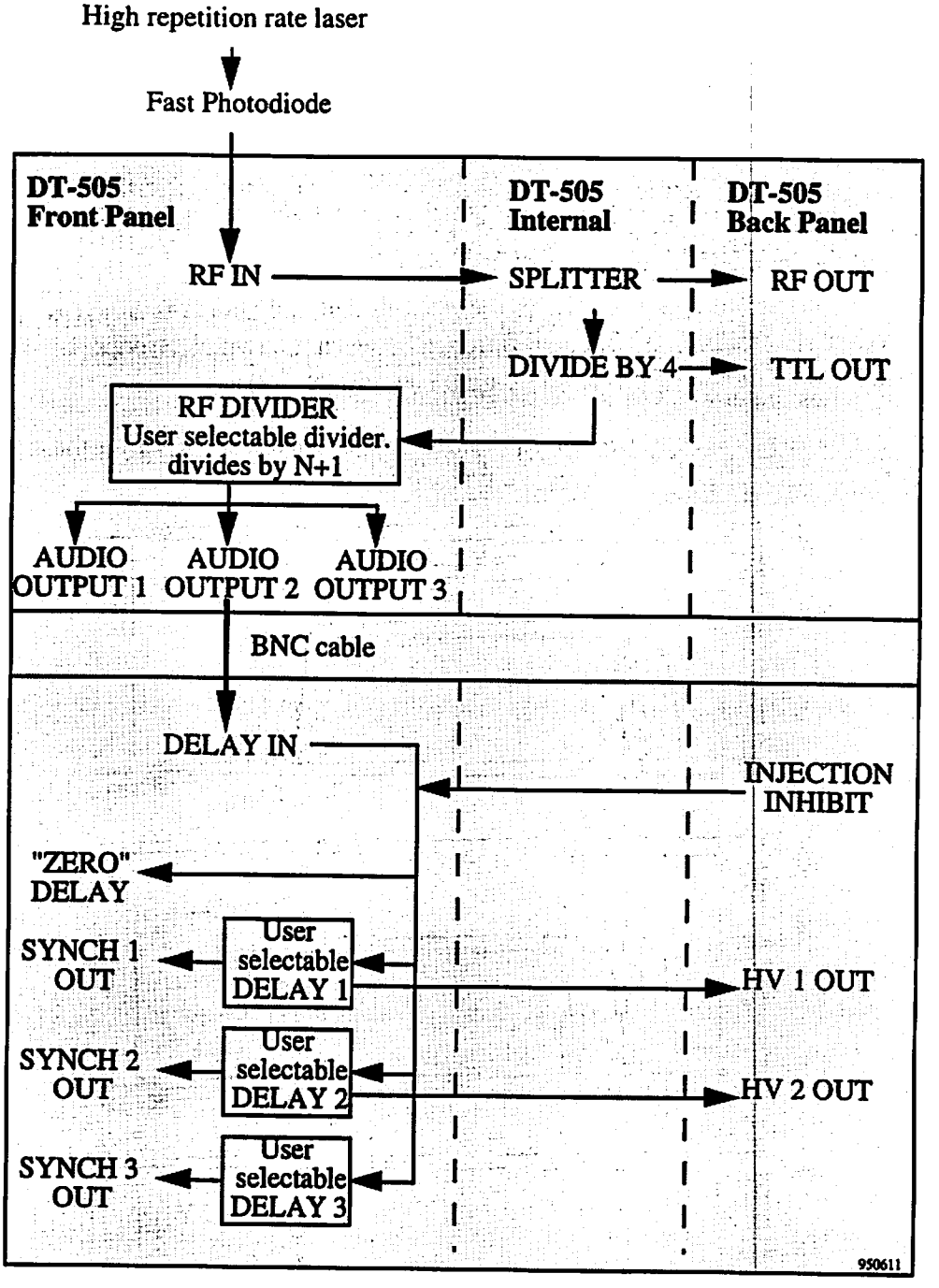
For example, assuming a laser operating at 100 MHz (round-trip time of 10 ns) the setting: •102•36• would correspond to a delay of 102 x 4 x 10 ns + (3 x 16 + 6) x 0.4 ns = 4101.6 ns

Injection Inhibit

*A safety feature to protect the amplifier has been added to the stretcher-injection inhibit. A pair of fiber couplers mounted within the stretcher are used to measure the width of the spectrum. If either or both of the fibers are NOT illuminated, the fast timing circuits within the CU-505 are disabled and injection is prevented.

*Injection and amplification of short pulses (< 100 ps) may cause damage to the TRA-1000 series regenerative amplifiers.

Figure 3-1
Timer Board -Logic Flow Chart.



Power Supplies

Five power supplies are located within the CU-505. One 5 Volts/15 Volts DC supply (used to power the timer board), one ± 24 Volts DC supply, one 133V DC supply and two HV units.

The high voltage is adjustable from the front panel of the CU-505. Two test points, located on the back panel of the CU-505, provide a means of measuring the high-voltage (The voltage as measured at these two test points corresponds to $^1/_{1000}$ of the high-voltage provided by the HV power supply.)

3.2 HVS-505

3.2.1 High Voltage Switching Unit Function

The function of the High-Voltage Switching unit, model HVS-505, is to switch on and off the voltage applied to the Pockels cell. The HVS-505 is composed of two identical units. Unit A is controlled by the CU-505 through *Delay 1* and *HV 1* (located on the back panel of the CU-505). Unit B is controlled by the CU-505 through *Delay 2* and *HV 2*.

Unit A is attached to one electrode of the Pockels cell and Unit B is attached to the other electrode. The voltage difference between the two electrodes determines the amount of phase retardation (see Figure 3-2).

Note that there is a second *window* approximately 20 microseconds after the first one. The risetime and falltime are typically 8 ns.

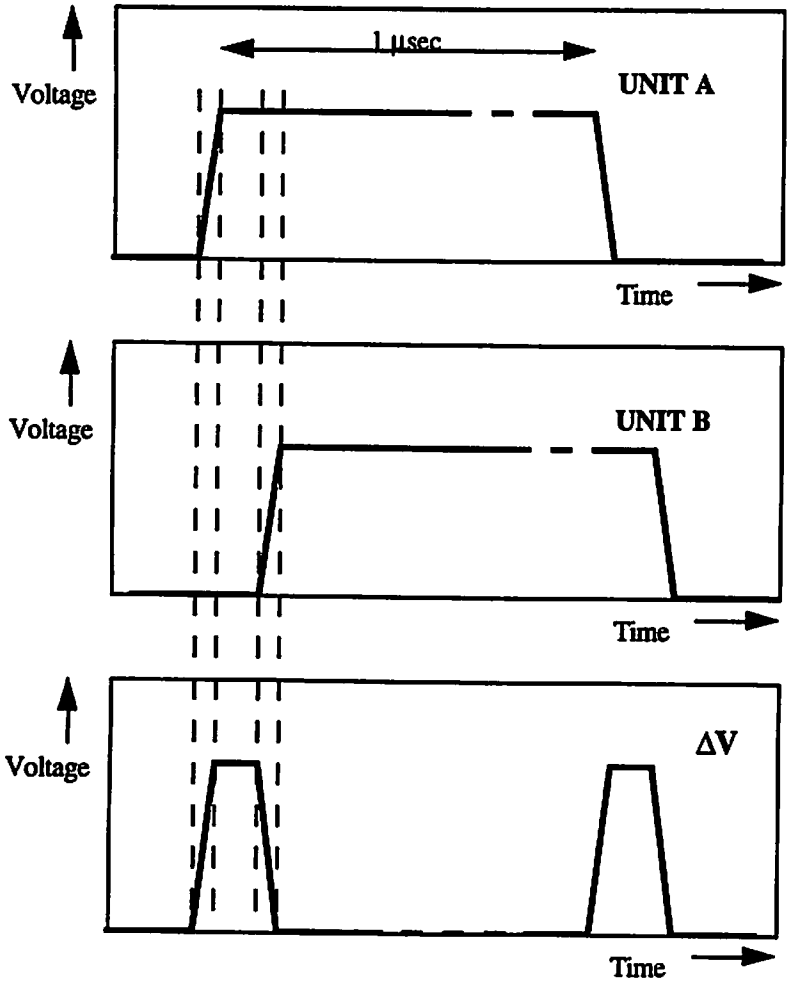


Figure 3-2
Voltage Sequence.

There are no user serviceable components in the HVS-505. For thermal management reasons the units A and B are potted in the factory and cannot be field-serviced.

3.2.2 Water cooling

The HVS-505 dissipates a large amount of heat. It is critically important that this unit be water-cooled when operated above 50 Hz.

Thermal sensors located in the HVS-505 will shut down the full DT-505 system if the HVS-505 operating temperature exceeds a factory-preset value.

3.3 PC-100

3.3.1 Pockels cell assembly function

The Pockels Cell Assembly PC-100 is formed of the Pockels cell proper (*that is,* an electro-optic crystal enclosed in an optical cell) and a multi-axis mount designed to provide all of the degrees of freedom necessary for the alignment of the cell.

3.3.2 Cleaning of the Pockels cell

If the Pockels cell windows become contaminated, then standard cleaning techniques can be used to clean them. Use only methanol or acetone (spectroscopic grade) to clean the windows.

4. Operation

4.1 Control Unit CU-505

All of the DT-505 user-adjustable controls are located on either the front panel or the back panel of the Control Unit CU-505.

4.1.1 Front Panel Control (Figure 4-1)

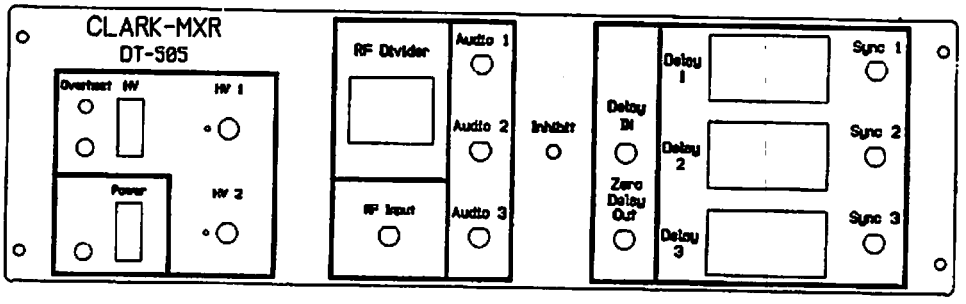


Figure 4-1
Front Panel of the CU-505.

The front panel is divided into three main sections (see Figure 4-1). The left-hand section contains the various power supply functions. The middle section contains the adjustments for setting the repetition rate. Finally, the right-hand section contains the various delay generators.

Power

This switch controls the power to the timing board. It must be set in the *on* position during operation.

HV

This switch controls the high voltage power supply. It must be set in the *on* position during operation of the Pockels cell. This switch should be set in the *off* position if you are not planning on using the Pockels cell, but need to use the timer.

■ **Do not turn on this switch without first connecting the CU-505 with the HVS-505 and the PC-100 using the appropriate sets of cables.**

HV1 ADJ and HV2 ADJ

These rotary dials are used to adjust the voltage level produced by the high voltage supply. The numeric indicators provide a relative reference. It does not provide an absolute calibration of the high voltage (see Section 4.1.2).

Overheat

The HVS-505 dissipates large amounts of heat when operating at high repetition rates. It must be water-cooled for proper operation. Several thermal sensors imbedded in the HVS-505 will shut down the DT-505 if

factory preset values are exceeded. The *overheat* light (on the front panel of the CU-505) is lit when this undesirable condition occurs.

If the *overheat* light indicates such a condition, then shut off the CU-505 (HV and POWER). Let the HVS-505 cool to room temperature, and take corrective measures to improve the cooling of the HVS-505 before turning it back on.

RF In

The photodiode monitoring the high-repetition rate laser should be attached through a 50 Ω coaxial cable to this input BNC connector.

The *source* frequency should be in the 65 to 105 MHz range. The input voltage (measured into a 50 Ω load) should be in the range of 50 mV to 200 mV.

RF Divider

The operating repetition rate is selected by the user through the *RF Divider*. The input clock rate is divided by a factor of 4000, then by the integer N+1 where N is the number affixed in the *RF Divider* window (*for example*, if the input clock is 100 MHz and the number 49 is affixed in the *RF Divider*, then the operating repetition will be 500 Hz).

■ **Note that the HVS-505 is NOT designed to operate above 5 kHz, even though the logic board can operate at higher repetition rates.**

Audio 1

A clock signal, with a repetition rate selected through the *RF Divider*, is available in a TTL format at the *Audio 1* output BNC. This output signal can be used to trigger the various delay generators present in the CU-505 or any user-provided loads (Z = 50 Ω).

Audio 2

Similar function as *Audio 1*.

Audio 3

Similar function as *Audio 1*.

Inhibit

The inhibit indicator lights up when the injection inhibit is active.

Delay In

One of the *Audio* outputs should be attached through a 50 Ω coaxial cable to this input BNC connector. The TTL-level signal provided through this port will serve as the trigger pulse for the three delay generators incorporated in each CU-505.

Zero Delay

The Zero Delay provides a signal to which Delay 1, Delay 2 and Delay 3 are synchronized. Zero Delay should be used to trigger the regenerative amplifier pump laser.

Delay 1

The first delay generator is controlled by the user through the *Delay 1* control panel. The delay is selected by affixing a first integer (three digits) and a second integer (two digits). The first integer selects the number of clock cycles (X4) that will form the digital portion of the delay. The second integer corresponds to a small analog delay. Each unit corresponds to approximately 400 picoseconds. The analog delay switches are hexa-decimal-based. The two portions (digital + analog) form the full delay.

For example, assuming a laser operates at 100 MHz (round-trip time of 10 ns), the setting: •102•36• would correspond to a total delay of 102 x4 x10 ns + (3 x 16 + 6) x 0.4 ns = 4101.6 ns.

The delayed output is available: (a) on the back panel of the CU-505 (HV connector labelled *HV 1*), and (b) at the BNC connector labelled *Sync 1* located on the front panel of the CU-505.

Sync 1

A TTL level pulse synchronized with the first high voltage pulse is available at this connector.

Delay 2

The second delay generator is controlled by the user through the *Delay 2* control panel. Its operation is similar to that of *Delay 1*. The delayed output is available: (a) on the back panel of the CU-505 (HV connector labelled *HV 2*), and (b) at the BNC connector labelled *Sync 2* located on the front panel of the CU-505.

Sync 2

A TTL level pulse synchronized with the second high voltage pulse is available at this connector.

Delay 3

The third delay generator is controlled by the user through the *Delay 3* control panel. Its operation is similar to that of *Delay 1*. The delayed output is available only at the BNC connector labelled *Sync 3* located on the front panel of the CU-505.

Sync 3

A TTL level pulse synchronized with the third high voltage pulse is available at this connector.

4.1.2 Back Panel (Figure 4-2)

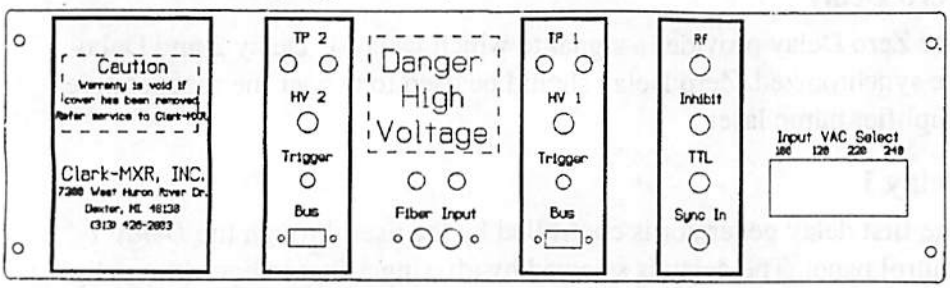


Figure 4-2
Back panel of the CU-505.

Vac Select

Fused power connection to line voltage. The CU-505 is generally set for 110 VAC ± 10%. Consult the factory for other operating voltages.

RF Out

This BNC connector provides a *sinewave* synchronized with the *RF In* photodiode signal. It can be used for synchronization with other CU-505s.

TTL Out

This BNC connector provides a TTL-level signal synchronized with the *RF In* photodiode signal. The TTL frequency is $^1/_4$ of fundamental *RF In* frequency.

1-HV/1-Trigger/1-Bus

These three connectors should be connected to one of the HVS-505 subunits.

■ **CAUTION! Lethal voltages are present at the HV connector when the HV switch (front panel) is ON.**

2-HV/2-Trigger/2-Bus

These three connectors should be connected to one of the HVS-505 subunits.

TP1

Test point 1 for the high voltage associated with side 1 (SYNC 1). The voltage corresponds to $^1/_{1000}$ of the voltage on HV side 1.

TP2

Test point 2 for high voltage associated with side 2 (SYNC 2). The voltage corresponds to $^1/_{1000}$ of the voltage on HV side 2.

Inhibit

This BNC connector provides a TTL high when inhibit is in operation.

Sync In

The CU-505 delay timing can be synchronized to an external TTL source. To choose this option, the INT/EXT jumper must be in the EXT position on the CU-505 timer board. The source input goes to the SYNC IN connector and is divided by the N+1, N>0 where N is the number on the RF Divider thumbwheel switch on the front panel. The delay timers and high voltage triggers are then synchronized to this external input. This option can be used, for example, when one desires to operate the CU-505 as a pulse selector.

Fiber Inhibit

These bayonet connectors are used for the input from the fiber cables provided for injection inhibit (see the CPA-1000 manual for details on the fiber placement within the system).

4.1.3 Connections

There should be two sets of three cables provided with each DT-505.

These two sets are used to connect the CU-505 (back panel) with the HVS-505. (These two sets are interchangeable. They can be connected to either subunit forming the HVS-505).

In addition, there should be two high-voltage cables used to connect the HVS-505 with the PC-100.

■ **CAUTION! The two sets of three cables should be connected to the CU-505 and HVS-505 only after turning OFF the CU-505 (Power and HV). Lethal voltages are present at the HV connectors when the HV switch (front panel) is on.**

Two fiber cables are also provided for injection inhibit.

The locations of the various cable connectors are shown in Figures 4-3, 4-4, and 4-5. The input/output of the cables can be inverted.

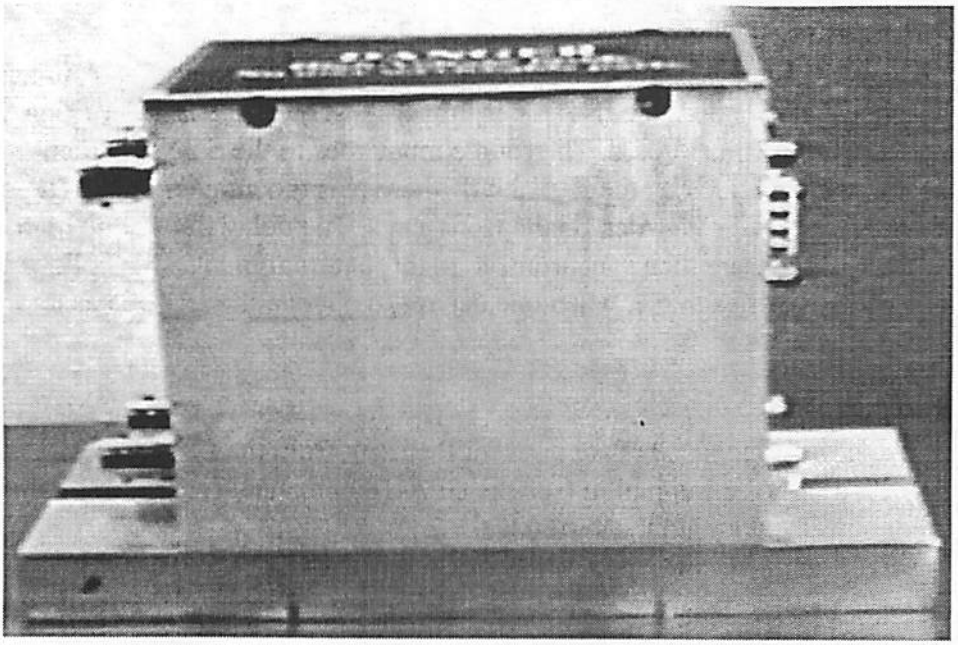


Figure 4-3
HVS-505. The HV connectors located on the top left should be electrically tied to the PC-100. The other connectors are attached to the CU-505.

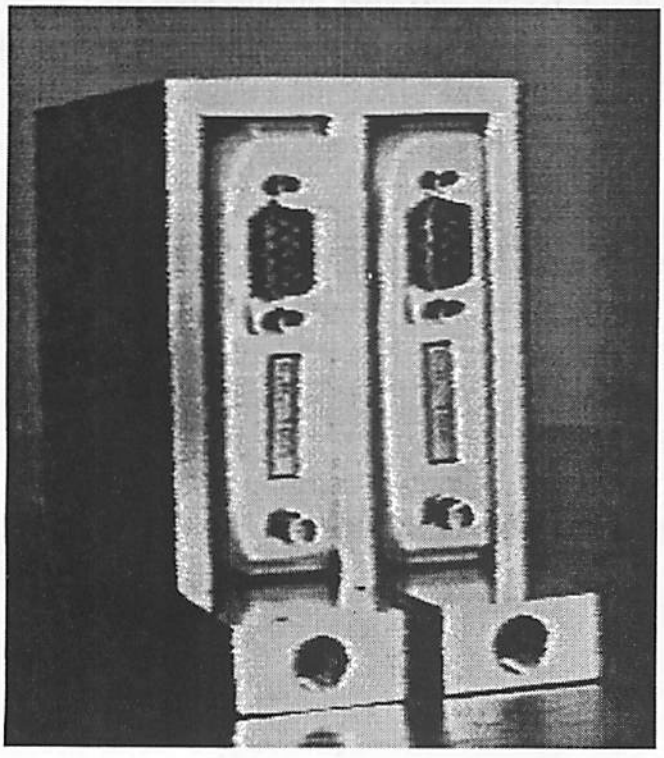


Figure 4-4
HVS-505. The connectors located on the side showed here should be connected to the back panel of the CU-505.

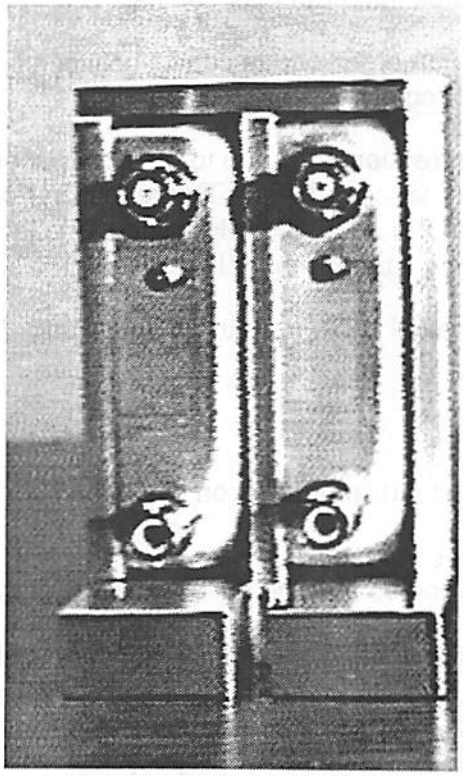


Figure 4-5
HVS-505. The lower connectors located on the side showed here should be connected to the back panel of the CU-505. The top connectors located on the side showed here should be connected to the PC-100

4.2 Initial Checkup Procedure

All DT-505s are fully tested before integration into our laser systems. The following procedure has been devised to familiarize the user with the DT-505.

Test Equipment Required

The following equipment is required to test the DT-505:

- One high repetition rate source operating in the 75 to 105 MHz range. The source may be a sinewave generator or a short pulse laser monitored by a fast photodiode.
- One oscilloscope with bandwidth greater than 250 MHz.
- A couple of 50 Ω coaxial cables with BNC connectors.
- A voltmeter.
- A flashlight or light source to defeat the injection inhibit.

Procedure

1. Unplug the CU-505.
2. Connect the two (2) three-cable sets to the CU-505 back panel and the HVS-505.
3. Connect the fiber cables to the back of the CU-505.

4. Shine the light source into both fiber cables.

5. Connect the two short high voltage cables between the HVS-505 and the Pockels cell assembly PC-100.

6. Connect your high frequency source to the front panel of the CU-505. (the BNC connector labelled *RF In*). The repetition rate of this test source should be in the 75 to 105 MHz range. The level should be in the 50 mV to 200 mV range with no DC offset.

7. Connect a 50 Ω coaxial cable from the output *Audio 1* to your oscilloscope.

8. Turn the *Power* on.

9. Verify that the inhibit indicator turns on when the fiber cables are not illuminated

10. Adjust the light source so that the inhibit indicator is off.

You should now observe a TTL-level signal on your oscilloscope. The repetition rate is adjustable through the CU-505 front panel *RF Divider.*

11. Check that the *RF Divider* operates properly.

12. Briefly check that *Audio 2* and *Audio 3* operate in a manner similar to *Audio 1.*

13. Connect the short coaxial cable provided with each unit between any of the *audio* outputs and the *Delay In* BNC connector.

To test the various delay generators, we recommend that you trigger your oscilloscope with one of the unused *audio* outputs. A synchronized output is provided with each delay generator. These synchronized outputs will be used to check that each of the delay generators operate properly.

14. Connect *Sync 1* to your oscilloscope (50 Ω). You should see a TTL level pulse. Adjust this pulse position with respect to the trigger by using the *Delay 1* switches.

15. Check that all digits affect the delay. The three left digits control the digital parts of the delay. (Each unit corresponds to four basic clock periods.) The two outmost right digits control the analog portion of the delay. (Each unit corresponds to approximately 400 picoseconds.)

16. Repeat this procedure with *Delay 2* and *Delay 3* observing these channels respectively at the *Sync 1* and *Sync 2* outputs.

Finally, you may want to check the high voltage setting.

■ **Note: Write down what the factory set high voltage is before changing it! The high voltage value was carefully set in the factory to maximize the contrast ratio of your laser.**

17. Connect your voltmeter between the two test points located on the back panel of the CU-505 (DC voltage). The voltage available between these test points corresponds to $^{1}/_{10,000}$ of the voltage generated by the high-voltage power supply.

18. Use the rotary knob (located on the front panel of the CU-505) to modify the voltage.

After testing this feature, set the voltage back to its factory-set value.

5. Electrical Schematics

Due to the presence of lethal high-voltages at several locations within the CU-505, the HVS-505, and the PC-100, electrical schematics are not included in this manual. For additional information, please contact Clark-MXR Inc. at our main office at (313) 426-2803.

TRP-1000 Cm882

ORC-1000 Cm884

DT-505 170