THORLABS

PRL201
Automated Polyimide Recoater with Linear Proof Tester

User Guide

vytran®

Table of Contents

Chapter 1 Warning Symbol Definitions

Below is a list of warning symbols you may encounter in this manual or on your device.

Symbol	Description
	Direct Current
	Alternating Current
	Both Direct and Alternating Current
	Earth Ground Terminal
	Protective Conductor Terminal
	Frame or Chassis Terminal
	Equipotentiality
	On (Supply)
	Off (Supply)
	In Position of a Bi-Stable Push Control
	Out Position of a Bi-Stable Push Control
	Caution: Risk of Electric Shock
	Caution: Hot Surface
	Caution: Risk of Danger
	Warning: Laser Radiation
	Caution: Spinning Blades May Cause Harm

Chapter 2 Safety

CAUTION

Please save packaging material and pink anti-static bag for returning the unit to Thorlabs for service. These items will reduce the risk of damage during shipment.

WARNING

A crush hazard exits between the Die Mechanism and the Fiber Holding Block.

SHOCK WARNING

This unit MUST be grounded (earthed). The 3 prong power supply cord set MUST be connected to a grounded (earthed) outlet!

CAUTION

This unit is designed for indoor use.

Operating temperature range: 5°C to 40°C
Operating humidity range: 0% to 75% non-condensing
Operating pressure range: Sea level to 2000 meters
Storage temperature range: -20°C to 60°C
Storage humidity range: 0% to 90% non-condensing when stored in original packaging.

CAUTION

Be sure to keep product free from excessive dust and electrical interference.

CAUTION

The instrument should be placed on a sturdy surface which is not subject to excessive vibrations. Do not obstruct the ventilation or the fan openings.

CAUTION

If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

WARNING

Polyimide recoat materials can be hazardous to your health if not handled properly. Read the Material Safety Data Sheet provided in Chapter 9, and make sure to follow all precautionary guidelines when working with this material.

WARNING:

Always wear safety glasses when proof testing fiber. The fiber under test can shatter and send glass particles flying.

Chapter 3 Description

3.1. Introduction

CAUTION

If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

CAUTION

This unit is designed for indoor use.

Operating temperature range: 5°C to 40°C
Operating humidity range: 0% to 75% non-condensing
Operating pressure range: Sea level to 2000 meters
Storage temperature range: -20°C to 60°C
Storage humidity range: 0% to 90% non-condensing when stored in original packaging.

Thorlabs' Vytran® PRL201 is designed for recoating and proof testing polyimide coated fibers. It operates on a coat, cure and test recoat method, whereby a layer of polyimide is applied to the fiber through a die, followed by a filament heater to cure the polyimide and upon completing the recoat a linear proof test. When configured and operated properly, the PRL201 is capable of producing a high quality and a uniform polyimide recoat.

3.2. Parts Checklist

When unpacking the PRL201 for the first time, check to make sure that you have the following accessories: (refer to **Figure 1**)

- PRL201 Automated Polyimide Recoater with Linear Proof Tester
- 12.0 V Power supply (PSU)
- AC power cord
- DC power cable
- RS-232 communication cable
- Fittings kit
- Tool kit containing:
  - 1 oz. spare recoat bottle
  - Cotton swabs
  - 5/64" Allen key
  - 3/32" Allen key
  - 0.050" Allen key
  - 0.035" Allen key
- External vacuum pump with vacuum line
- Handset Controller

If you are missing any of the above or need replacements, please contact Thorlabs.

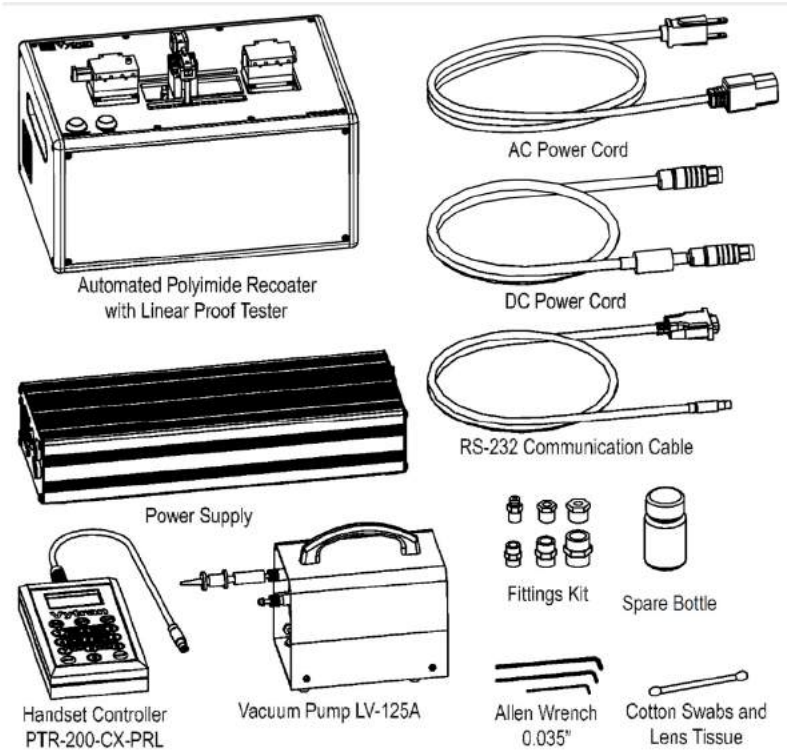


Figure 1 System Components

Chapter 4 Powering the PRL201

SHOCK WARNING

This unit MUST be grounded (earthed). The 3 prong power supply cord set MUST be connected to a grounded (earthed) outlet!

CAUTION

The instrument should be placed on a sturdy surface which is not subject to excessive vibrations. Do not obstruct the ventilation or the fan openings.

4.1. Powering Up

The PRL201's Power Supply Unit (PSU) accepts an AC input of 90 - 260 VAC; 47 - 63 Hz, 5.7 A. Connect both the AC power cord and the DC power cable to the external Power Supply. Connect the Handset Controller and the DC power cable to the unit.

Turn on the power supply and then turn on the PRL201 using the ON/OFF rocker switch located on the back of the recoater. The device will run an initialization process that includes homing the recoat die and tensioning motors and operating the recoat die (close/open). During the initialization process, the Handset Controller will display the status of the system. Once the homing process is completed, the Handset Controller displays the Main Menu screen and the PRL201 is ready for recoating.

4.2. Shutting Down

To shut down the unit:

1. Turn off the PRL201 using the on/off rocker switch located on the back of the recoater.
2. Turn off the power supply.

Chapter 5 Controlling the PRL201

The PRL201 is configured and controlled by Thorlabs' Handset Controller, which also provides feedback and status of the unit. If the operator does not need to change parameter settings or receive status prompts, the Handset Controller can be removed and the unit operated by pressing the blue RECOAT and TEST buttons.

The Handset Controller allows the user to interface with the unit and modify the settings. The Handset Controller is based on a three (3) menus: the Main Menu, Configuration Menu, and Options Menu.

Each menu and its contents are described below.

5.1. Main Menu

The Main Menu displays the unit's status. From this menu, press the "CFG" button to enter the Configuration Menu or press the "OPT" button to enter the Options Menu.

5.2. Configuration Menu

There are three (3) levels to the Configuration Menu. At level one the user can select from five (5) topics: Inject, Undercoat, Overcoat, Recoat Length, or Proof Test. Within each of these topics are the parameters which can be viewed and/or copied. Below is a description of the five (5) topics and each topics parameters.

5.2.1. Inject

Inject Rate (µl/sec): This parameter is the polyimide injection rate, in microliters per second (µl/s), into the die. The optimum Inject Rate will be dependent on polyimide deposit material.

Undercoat Qty. (µl): This parameter is the quantity of polyimide material, in microliters, injected into the die for the first loop of the head (the undercoat). The optimum Undercoat Qty will be primarily dependent on the bare fiber diameter, die size, and the recoat length.

Overcoat Qty. (µl): This parameter is the quantity of polyimide material injected into the die, in microliters, after the first loop of the head. The optimum Overcoat Qty will be primarily dependent on the die size, and the length of the recoat.

5.2.2. Undercoat

Head Sweep Vel.: This parameter is the velocity of the head, in steps/sec, for the first loop of depositing polyimide. The optimum Head Sweep Velocity will be dependent on the bare fiber diameter, die size, and deposit material.

Left Precure Temp (°C): This parameter is the approximate temperature, in degrees centigrade (°C), applied to the left heater during a polyimide deposition. The optimum Left Precure Temp will be dependent on the Head Sweep Velocity, and deposit material. The temperature is calibrated at the center of the heater while stationary. The Left Precure Temp is designed to evaporate the volatiles of the deposited polyimide.

Left Cure Temp (°C): This parameter is the approximate temperature, in degrees centigrade (°C), applied to the left heater during imidization (the pass after deposition). The optimum Left Cure Temp will be dependent on the Head Sweep Velocity and the polyimide material. The temperature is calibrated at the center of the heater while stationary. The Left Cure Temp is designed to imidize the polyimide after the volatiles have been evaporated.

Right Precure Temp (°C): This parameter is the approximate temperature, in degrees centigrade (°C), applied to right heater during a polyimide deposition. The optimum Right Precure Temp will be dependent on the Head Sweep Velocity, and deposit material. The temperature is calibrated at the center of the heater while stationary. The Right Precure Temp is designed to evaporate the volatiles of the deposited polyimide.

Right Cure Temp (°C): This parameter is the approximate temperature, in degrees centigrade (°C), applied to the right heater during imidization (the pass after deposition). The optimum Right Cure Temp will be dependent on the Head Sweep Velocity and the polyimide material. The temperature is calibrated at the center of the heater while stationary. The Right Cure Temp is designed to imidize the polyimide after the volatiles have been evaporated.

5.2.3. Overcoat

Number of Overcoats: This parameter is the number of loops the head will make. The optimum Number of Overcoats will be dependent on the polyimide thickness layer desired [which will be dependent on the undercoat layer thickness and the parameter settings for the overcoat(s)].

Head Sweep Vel (steps/s): This parameter is the velocity of the head, in steps/sec, for the first loop of depositing polyimide. The optimum Head Sweep Velocity will be dependent on the die size, and material being deposited.

Left Precure Temp (°C): This parameter is the approximate temperature, in degrees centigrade (°C), applied to the left heater during a polyimide deposition. The optimum Left Precure Temp will be dependent on the Head Sweep Velocity, and material being deposited. The temperature is calibrated at the center of the heater while stationary. The Left Precure Temp is designed to evaporate the volatiles of the polyimide being deposited.

Left Cure Temp (°C): This parameter is the approximate temperature, in degrees centigrade (°C), applied to the left heater during imidization (the pass after deposition). The optimum Left Cure Temp will be dependent on the Head Sweep Velocity and the polyimide material. The temperature is calibrated at the center of the heater while stationary. The Left Cure Temp is designed to imidize the polyimide after volatiles have been evaporated.

Right Precure Temp (°C): This parameter is the approximate temperature, in degrees centigrade (°C), applied to the right heater during a polyimide deposition. The optimum Right Precure Temp will be dependent on the Head Sweep Velocity, and material being deposited. The temperature is calibrated at the center of the heater while stationary. The Right Precure Temp is designed to evaporate the volatiles of the polyimide being deposited.

Right Cure Temp (°C): This parameter is the approximate temperature, in degrees centigrade (°C), applied to the right heater during imidization (the pass after deposition). The optimum Right Cure Temp will be dependent on the Head Sweep Velocity and the polyimide material. The temperature is calibrated at the center of the heater while stationary. The Right Cure Temp is designed to imidize the polyimide after the volatiles have been evaporated.

Overlap Delta (mm): This parameter is the additional distance, in millimeters, the head will travel on each pass. This will effectively taper the transition from original polyimide to recoated polyimide. Recoat Length

Recoat Length (mm): This parameter is the desired bare fiber length, in millimeters (mm), to be recoated. The actual recoat length will be approximately 8 millimeters longer on each end in order to compensate for the width of the head and the fiber load position.

5.2.4. Proof Test

Proof Test Units: This menu allows the user to select the desired units for displaying the Proof Test Level. Unit selections are: Newtons, kpsi, and grams.

Proof Test Level (units): This parameter is the Proof Test Level, in units user selected, to be applied after the recoat has been completed.

Proof Test Rate (mm/sec): This parameter is the rate, in millimeters per second (mm/s), at which the Proof Test Level will be applied. The optimum rate is that which achieves the desired proof test level within 3 – 5 seconds of load applying time.

5.3. Options Menu

From the Options Menu, various system level configuration parameters and functions can be edited or executed.

Recoat Tension (Newtons): This parameter is the tension, in Newtons, applied to the fiber prior to initiating a recoat. The PRL201 also monitors the tension during the recoat and will automatically abort if the tension varies significantly from the Recoat Tension. The auto abort is intended to protect both the die and fiber.

Heater Settle Time (msec): This parameter is the amount of time, in milliseconds, allowed for the heater to stabilize when changing temperatures.

Die Close Time (msec): This parameter is the amount of time, in milliseconds, allowed for the die to close prior to execution of the subsequent process.

Fiber Unload Time (msec): This parameter is the amount of time, in milliseconds, allowed for the operator to unload the fiber prior to the device performing a system reset.

Inject to Die Qty (µL): This option is the quantity of polyimide material, in microliters, which will be injected into the die upon entering the quantity. This option is intended for use when changing materials or purging the system prior to storage.

Head to Home: This option performs a homing of the head and is useful as a diagnostic tool.

Tension Home: This option performs a homing of the proof test load cell and is useful as a diagnostic tool.

Move Head to Start: This option performs a movement of the head to the start position. The start position is calculated based upon the recoat length, overlap delta, and the number of overcoats. Use of the Head to Start and Head to Stop options enables the user to verify the correct recoat length has been entered.

Move Head to Stop: This option performs a movement of the head to the stop position. The stop position is calculated based upon the recoat length, overlap delta, and the number of overcoats. Use of the Head to Start and Head to Stop options enables the user to verify the correct recoat length has been entered.

Recoat Request State: This option enables or disables the request to input a recoat length each time the process is run. This option is primarily used when the length to be recoated varies significantly from recoat to recoat.

Set/Run Purge Cycles: This option is the number of recoat pump purge cycles that will be run upon entering the quantity.

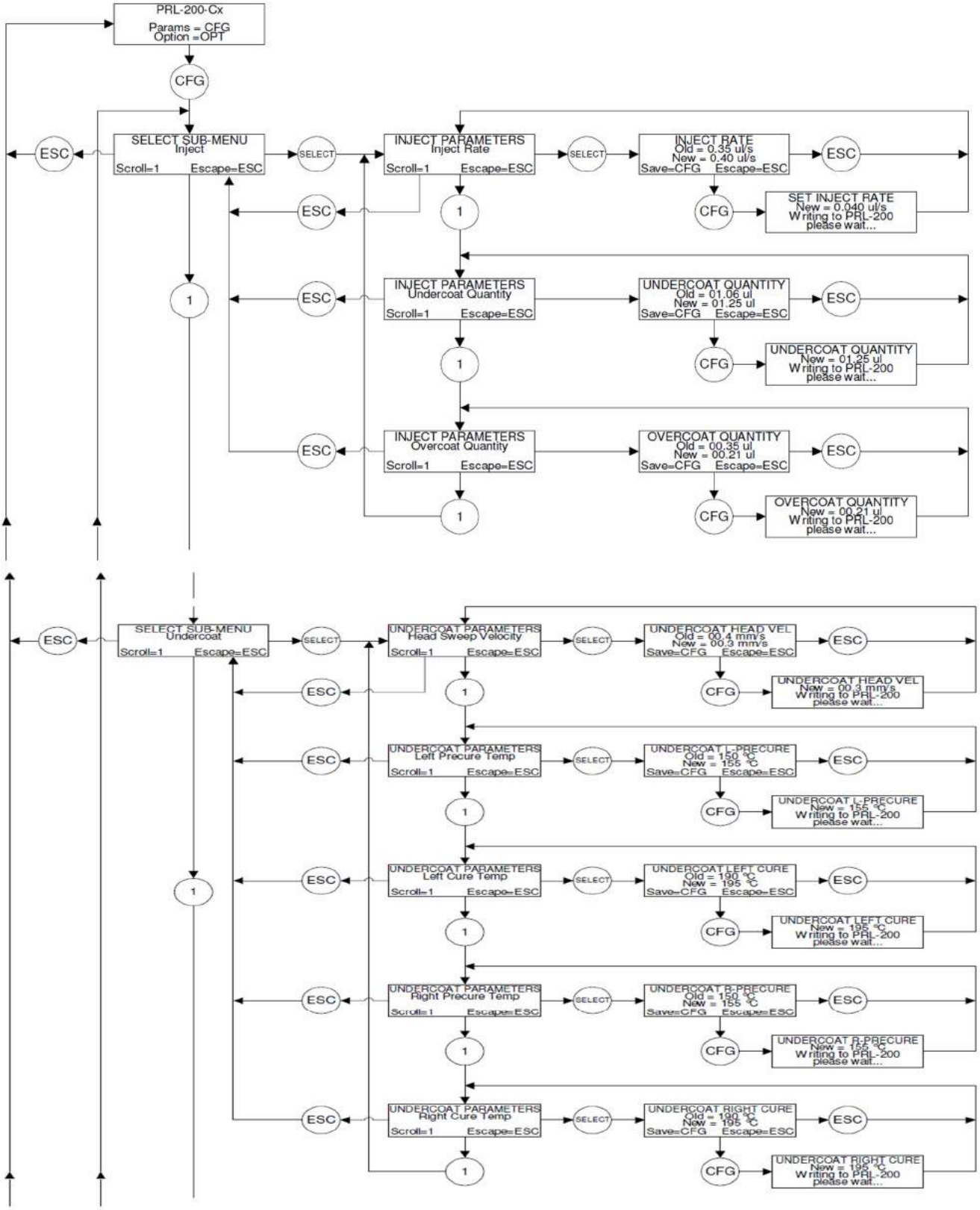
Recoat Tension This option is the amount of tension that will be applied to the fiber prior to the recoating.

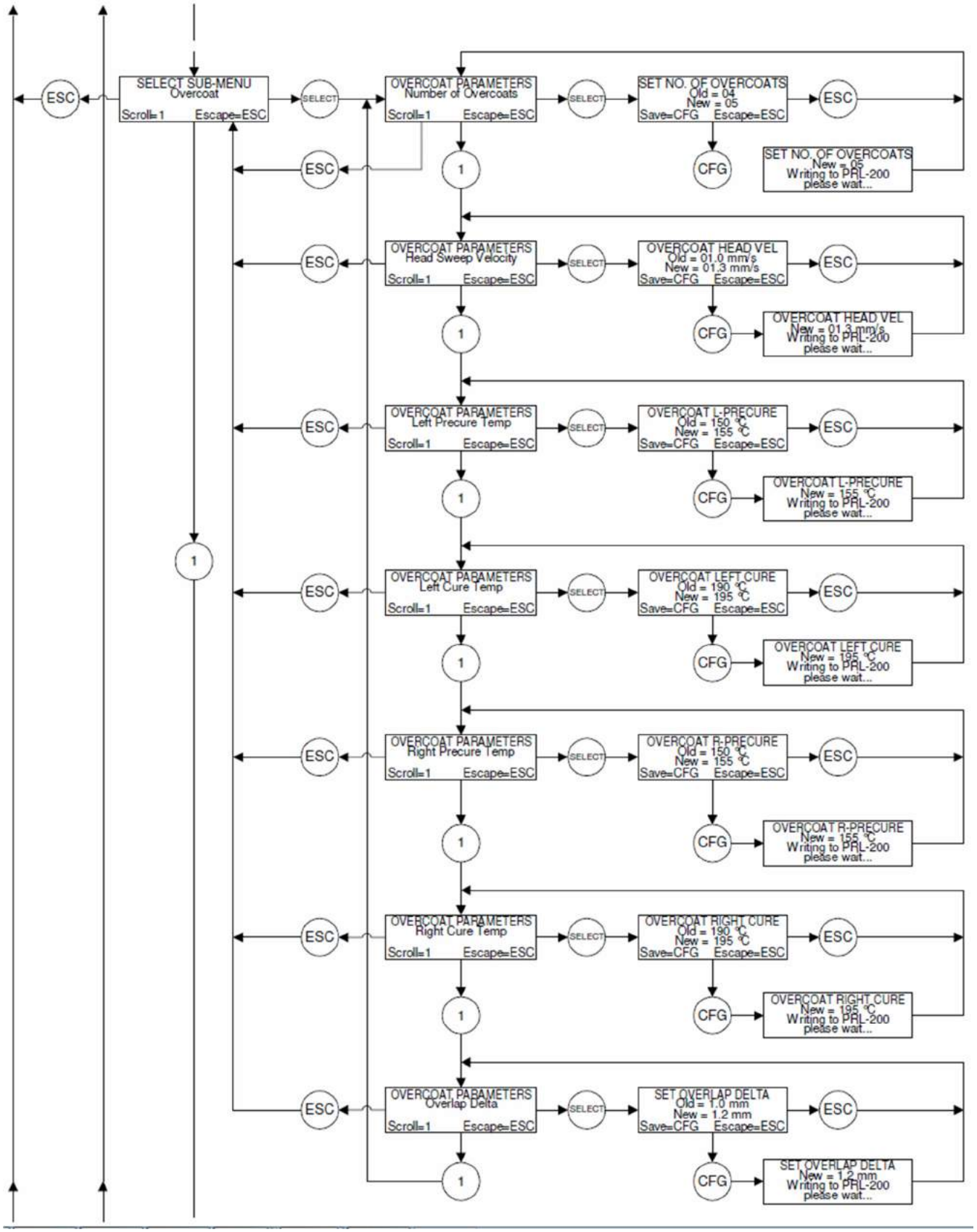
5.4. Parameter Limits

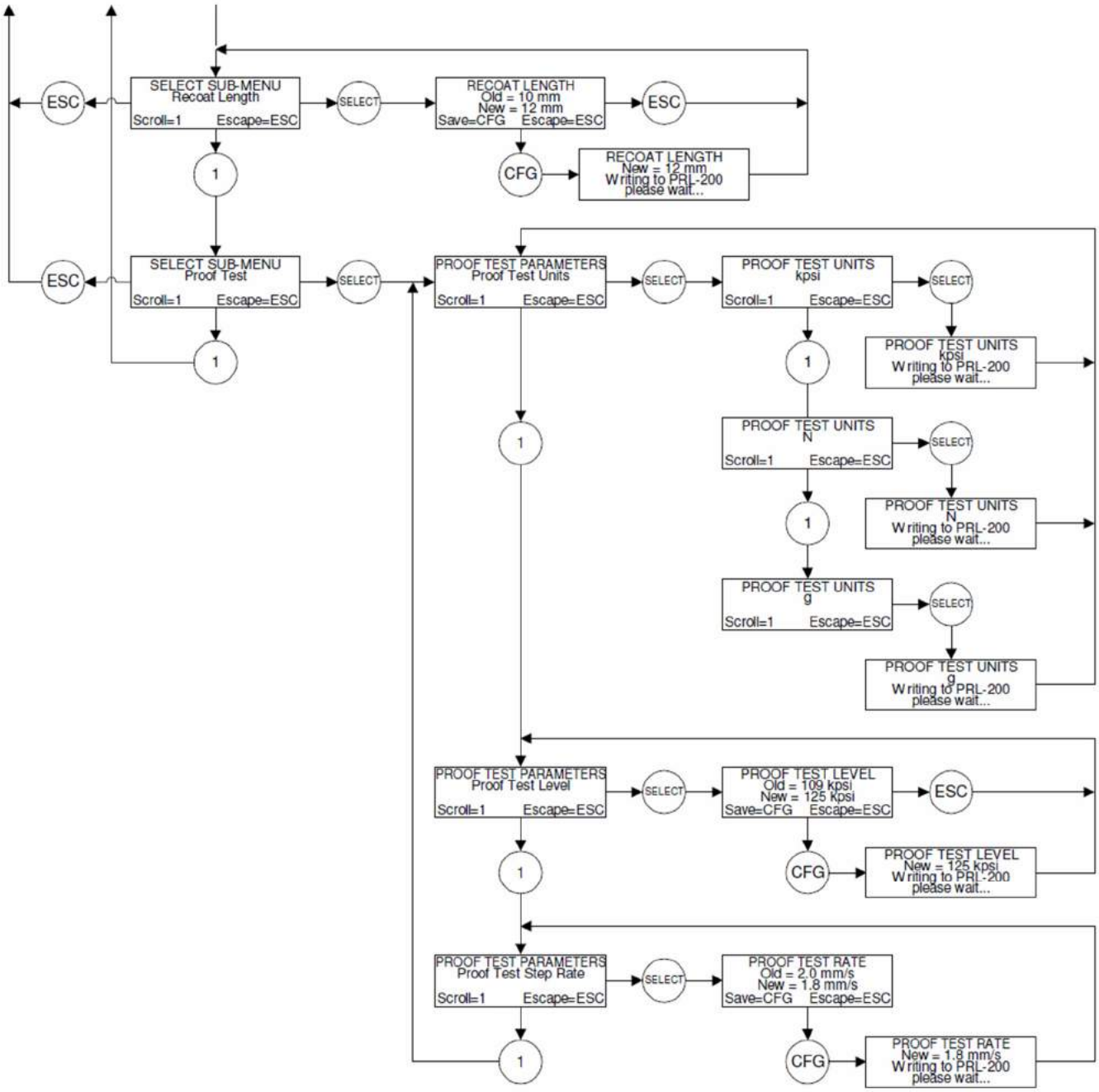
Parameter	Min	Max
Inject Rate (µL/sec)	0.01	2.00
Undercoat Qty (µL)	0.01	10.00
Overcoat Qty (µL)	0.01	10.00
Undercoat Head Sweep Vel (mm/sec)	0.01	20.00
Undercoat Left Precure Temp (°C)	100	200
Undercoat Left Cure Temp (°C)	100	300
Undercoat Right Precure Temp (°C)	100	200
Undercoat Right Cure Temp (°C)	100	300
Number of Overcoats	1	10
Overcoat Head Sweep Vel (mm/sec)	0.01	20.00
Overcoat Left Precure Temp (°C)	100	200
Overcoat Left Cure Temp (°C)	100	300
Overcoat Right Precure Temp (°C)	100	200
Overcoat Right Cure Temp (°C)	100	300
Overlap Delta (mm)	100	200
Recoat Length (mm)	0	2
Proof Test Level (Newtons)	0	20
Proof Test Rate (mm/sec)	0.1	5.0
Recoat Tension (Newtons)	2	10
Heater Stabilize Time (msec)	1	10000
Die Close Time (msec)	250	2500
Fiber Unload Time (msec)	5000	30000
Heater Stabilize Time (msec)	1	10000
Inject to Die Qty (µL)	1	100

5.5. Configuration Menu Flow Chart

This flowchart is a guide for navigating through the Configuration Menu, and shows the display prompts and button key presses for viewing and editing the Configuration Parameters.

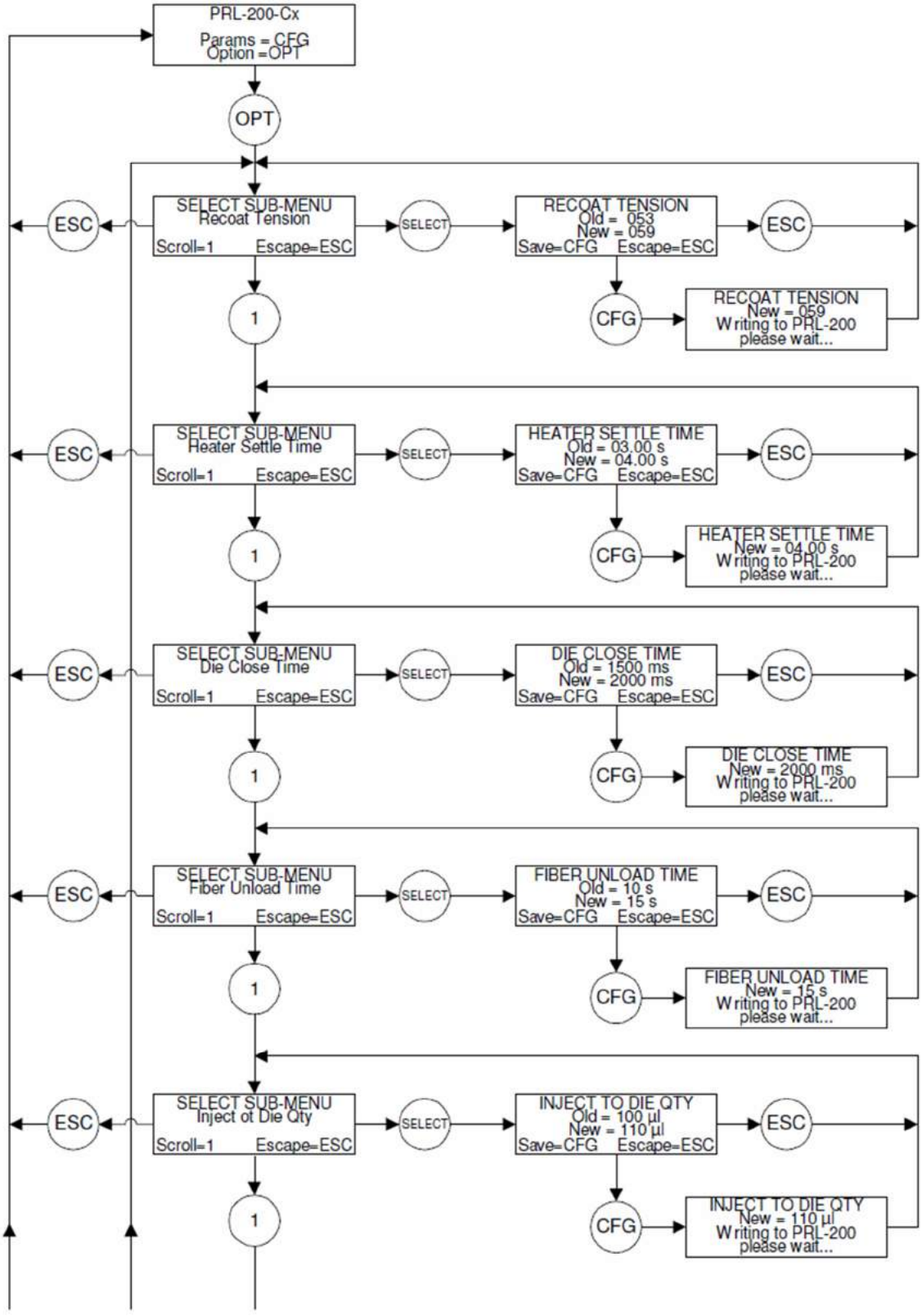


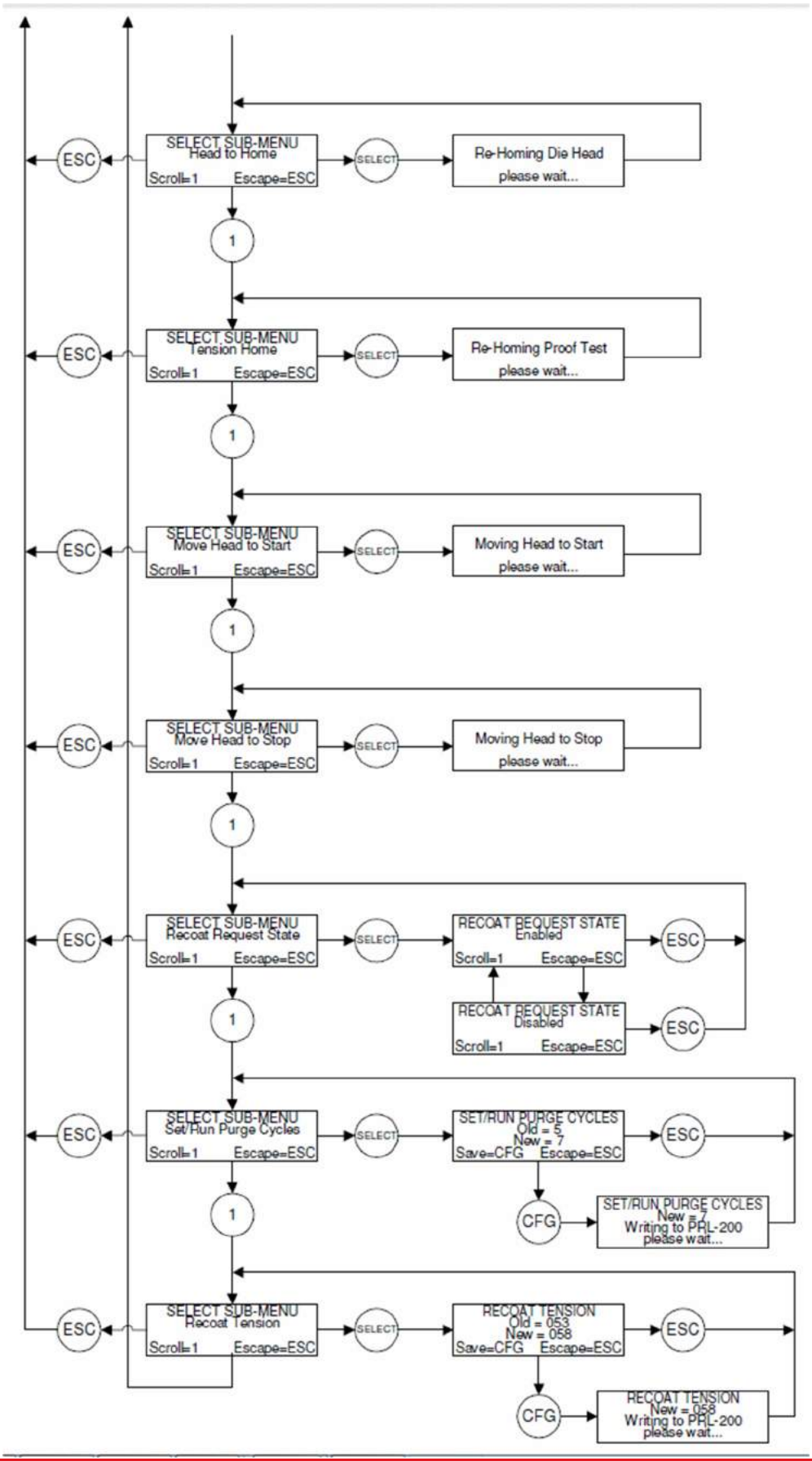

ESC
SELECT SUB-MENU
Overcoat
Scroll=1 Escape=ESC
SELECT
OVERCOAT PARAMETERS
Number of Overcoats
Scroll=1 Escape=ESC
SET NO. OF OVERCOATS
Old = 04
New = 05
Save=CFG Escape=ESC
CFG
SET NO. OF OVERCOATS
New = 05
Writing to PRL-200
please wait...
1
OVERCOAT PARAMETERS
Head Sweep Velocity
Scroll=1 Escape=ESC
OVERCOAT HEAD VEL
Old = 01.0 mm/s
New = 01.3 mm/s
Save=CFG Escape=ESC
OVERCOAT HEAD VEL
New = 01.3 mm/s
Writing to PRL-200
please wait...
OVERCOAT PARAMETERS
Left Precure Temp
Scroll=1 Escape=ESC
OVERCOAT L-PRECURE
Old = 150 °C
New = 155 °C
Save=CFG Escape=ESC
OVERCOAT L-PRECURE
New = 155 °C
Writing to PRL-200
please wait...
OVERCOAT PARAMETERS
Left Cure Temp
Scroll=1 Escape=ESC
OVERCOAT LEFT CURE
Old = 190 °C
New = 195 °C
Save=CFG Escape=ESC
OVERCOAT LEFT CURE
New = 195 °C
Writing to PRL-200
please wait...
OVERCOAT PARAMETERS
Right Precure Temp
Scroll=1 Escape=ESC
OVERCOAT R-PRECURE
Old = 150 °C
New = 155 °C
Save=CFG Escape=ESC
OVERCOAT R-PRECURE
New = 155 °C
Writing to PRL-200
please wait...
OVERCOAT PARAMETERS
Right Cure Temp
Scroll=1 Escape=ESC
OVERCOAT RIGHT CURE
Old = 190 °C
New = 195 °C
Save=CFG Escape=ESC
OVERCOAT RIGHT CURE
New = 195 °C
Writing to PRL-200
please wait...
OVERCOAT PARAMETERS
Overlap Delta
Scroll=1 Escape=ESC
SET OVERLAP DELTA
Old = 1.0 mm
New = 1.2 mm
Save=CFG Escape=ESC
SET OVERLAP DELTA
New = 1.2 mm
Writing to PRL-200
please wait...


ESC
SELECT SUB-MENU
Recoat Length
Scroll=1 Escape=ESC
SELECT
RECOAT LENGTH
Old = 10 mm
New = 12 mm
Save=CFG Escape=ESC
ESC
1
CFG
RECOAT LENGTH
New = 12 mm
Writing to PRL-200
please wait...
ESC
SELECT SUB-MENU
Proof Test
Scroll=1 Escape=ESC
SELECT
PROOF TEST PARAMETERS
Proof Test Units
Scroll=1 Escape=ESC
SELECT
PROOF TEST UNITS
kpsi
Scroll=1 Escape=ESC
SELECT
1
PROOF TEST UNITS
kpsi
Writing to PRL-200
please wait...
1
PROOF TEST UNITS
N
Scroll=1 Escape=ESC
SELECT
1
PROOF TEST UNITS
N
Writing to PRL-200
please wait...
PROOF TEST UNITS
g
Scroll=1 Escape=ESC
SELECT
PROOF TEST UNITS
g
Writing to PRL-200
please wait...
PROOF TEST PARAMETERS
Proof Test Level
Scroll=1 Escape=ESC
SELECT
PROOF TEST LEVEL
Old = 109 kpsi
New = 125 kpsi
Save=CFG Escape=ESC
ESC
1
CFG
PROOF TEST LEVEL
New = 125 kpsi
Writing to PRL-200
please wait...
PROOF TEST PARAMETERS
Proof Test Step Rate
Scroll=1 Escape=ESC
SELECT
PROOF TEST RATE
Old = 2.0 mm/s
New = 1.8 mm/s
Save=CFG Escape=ESC
1
CFG
PROOF TEST RATE
New = 1.8 mm/s
Writing to PRL-200
please wait...

5.6. Options Menu Flowchart

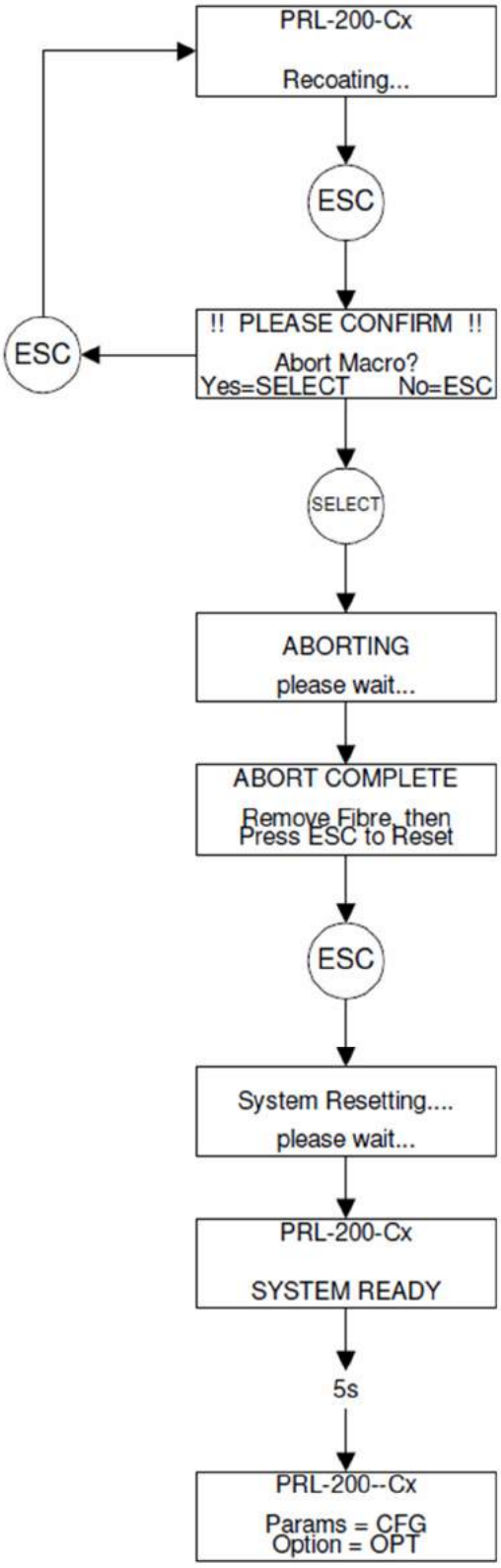
This flowchart is a guide for navigating through the Options Menu, and shows the display prompts and button key presses for editing parameters and executing system related functions.




SELECT SUB-MENU
Head to Home
Scroll=1 Escape=ESC
SELECT
Re-Homing Die Head
please wait...
ESC
1
SELECT SUB-MENU
Tension Home
Scroll=1 Escape=ESC
SELECT
Re-Homing Proof Test
please wait...
ESC
1
SELECT SUB-MENU
Move Head to Start
Scroll=1 Escape=ESC
SELECT
Moving Head to Start
please wait...
ESC
1
SELECT SUB-MENU
Move Head to Stop
Scroll=1 Escape=ESC
SELECT
Moving Head to Stop
please wait...
ESC
1
SELECT SUB-MENU
Recoat Request State
Scroll=1 Escape=ESC
SELECT
RECOAT REQUEST STATE
Enabled
Scroll=1 Escape=ESC
RECOAT REQUEST STATE
Disabled
Scroll=1 Escape=ESC
ESC
ESC
1
SELECT SUB-MENU
Set/Run Purge Cycles
Scroll=1 Escape=ESC
SELECT
SET/RUN PURGE CYCLES
Old = 5
New = 7
Save=CFG Escape=ESC
CFG
SET/RUN PURGE CYCLES
New = 7
Writing to PRL-200
please wait...
ESC
1
SELECT SUB-MENU
Recoat Tension
Scroll=1 Escape=ESC
SELECT
RECOAT TENSION
Old = 053
New = 058
Save=CFG Escape=ESC
CFG
RECOAT TENSION
New = 058
Writing to PRL-200
please wait...
ESC

5.7. Abort Flowchart

Even after the recoat process has been initiated it is possible to abort the process if required. The Abort Flowchart shows the display prompts and button key presses to abort a recoat process.



Chapter 6 Recoat Injection System

CAUTION

Be sure to keep product free from excessive dust and electrical interference.

The PRL201 has an automatic recoat injection pump fitted inside the unit. The pump is based on an automated syringe and distribution valve that can select one of three ports (Fill, Purge, or Inject) through which it can either draw or inject recoat material (see Figure 3). A bottle containing recoat material is installed directly on the pump, with the pump “Fill” tube inserted into the bottom of the bottle. A “Purge” tube runs from the pump to the top of the recoat bottle, and is used for cycling material back into the bottle. An “Inject” tube runs from the pump to the inject port of the die, which is located in the center of the lower right die. Once all air is purged from the injection system, the pump provides very accurate control of the volume and velocity of recoat material injection.

The recommended recoat material for use in the PRL201 is Pyralin PI2525, which is manufactured by HD MicroSystems. This is a fast imidizing at lower temperature coating. Do not attempt to use alternate recoat materials without first consulting Thorlabs on compatibility with the PRL.

Note: Pyralin PI2525 recoat material does have a limited shelf life of approximately 24 months from date of manufacture when stored at 0 to 18 °C. PI2525 is stable at room temperature (21 °C) for approximately 4 weeks with no significant change in properties. Using material that has passed its expiration date may cause both pump performance and recoat quality issues.

6.1. Priming the Injection System

It is very important to remove all air from the recoat injection system prior to performing a recoat. When operating the system for the first time, the pump must be filled with recoat material and cleared of all air in the pump and tubing. In order to clear the inject tube, recoat material must be injected out through the mold inject port and collected and disposed of. Make sure to have cotton swabs and NMP (1-Methyl-2- pyrrolidinone) available for this purpose prior to starting this procedure. NMP is the recommended solvent for cleaning uncured polyimide recoat material.

WARNING

Polyimide recoat materials can be hazardous to your health if not handled properly. Read the Material Safety Data Sheet provided in Chapter 9, and make sure to follow all precautionary guidelines when working with this material.

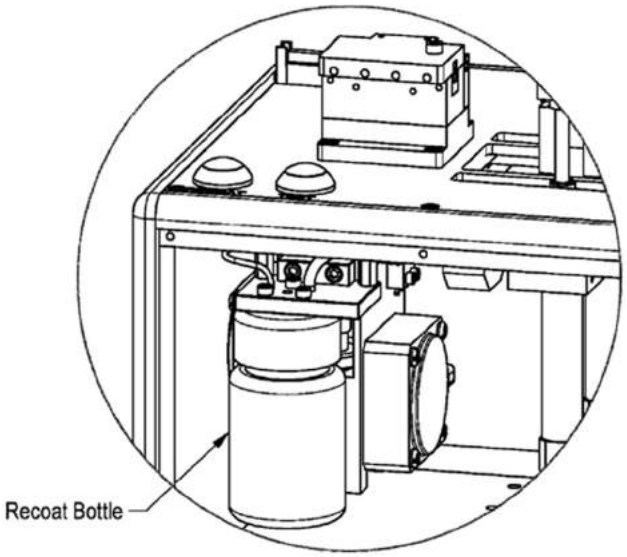


Figure 2 Recoat Bottle Access

The process is as follows:

1. Turn off power to the unit.
2. Remove the front plate of the PRL201 by using the 3/32" Allen wrench provided in the tool kit to remove the four (4) socket-head cap screws located at the corners of the plate.
3. The recoat pump is located on the left side of the device as shown in **Error! Reference source not found.**. Unscrew the brown recoat bottle located at the front of the pump and remove by angling out through the front opening. The red Fill tube will flex to allow removal.
4. For new systems, replace the empty recoat bottle shipped with the unit with a new bottle of recoat material. For systems that have previously been run with recoat material, the recoat injection system should be flushed clean prior to adding new material (see 8.5).
5. Screw the new recoat bottle into place and replace the front panel and the four (4) socket head cap screws.
6. Turn on power to the PRL201 and wait for the system to initialize.
7. Execute five (5) Purge cycles (Options menu on Handset Controller). Each purge cycle will draw 100 microliters of recoat material from the bottom of the recoat bottle through the red Fill tube and inject material back into the top of the recoat bottle through the green Purge tube (see Figure 3). Five (5) Purge cycles are required to fill the pump with recoat material and force any air out of the pump system. This will take approximately 15 minutes to complete.
8. After the pump has completed its Purge cycles, the Inject tube that runs from the pump to the die must also be filled with recoat material and purged of air. Have cotton swabs and cleaning solution (NMP) available prior to proceeding.
9. Set the Inject to Die Qty to 100 µl (Options menu on Handset Controller).

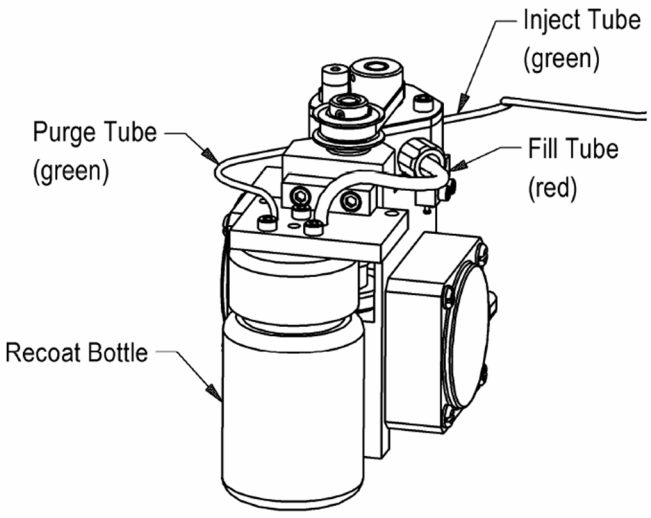


Figure 3 Recoat Material Flow

10. Execute the inject command (press “Select” on the Handset Controller).
11. Watch for recoat material to emerge from the die inject port located at the center of the center of the bottom right die (see Figure 5). Make sure to collect the recoat material with a cotton swab as it comes out of the die injection port. Do not allow recoat material to run down between the die.
12. Execute three (3) additional “Inject 100” sequences to purge air completely from the inject tube. **Note:** Because the injection pump holds 100 µl of recoat material, there will be a delay of approximately one minute between the second and third inject sequences while the pump refills.
13. After purging the inject tube, the recoat material should run freely from the die without bubbles. If bubbles are still present, run additional inject sequences.
14. Once the pump and the inject tube are purged, clean the die of all excess recoat material (see 6.2).

6.2. Cleaning the Die

The recoat head assembly contains two die sets (left and right), each with a semi-circular channel running longitudinally down the center of their mating surfaces. When closed, the die form a circular mold cavity around the section of fiber to be recoated. In order for the die to mate flush together, they must be free of all dirt and/or coating particles.

The die should be cleaned with a cotton tipped applicator wetted with NMP (1-Methyl-2-pyrrolidinone). NMP is the solvent for PI2525 and can be used to soften and lift away any residual recoat material. Wipe the top and both sides of the die using very light pressure only. Wipe both the left and right and top and bottom of the die set. If the die does have an accumulation of recoat material stuck to it, allow the cleaning solution time (60-90 seconds) to soften and lift any material. After cleaning the die gently blow clean (canned) air across the die to thin out the NMP.

NOTE: When cleaning the die be cautious not to contact or damage the heaters.

NOTE: The mating surfaces of the die are precision machined. Use only a soft cotton tipped applicator to clean the die. Do not rub any hard objects across the surface of the die as this could scratch or chip the edges of the die channel and degrade the quality of the recoat.

Chapter 7 Recoat and Proof Test Process

7.1. The Polyimide Recoat Process

The PRL201 utilizes two Fiber Holding Blocks (FHB's) to securely clamp and position the fiber prior to recoating. The right-hand FHB has a linear drive mechanism for applying tension to the fiber. A load cell is incorporated into the linear drive mechanism for monitoring recoat tension. Once the fiber is positioned and securely clamped in the FHB's, pressing the recoat button will initiate an automated recoat process. The right-hand FHB will move to the right until the Recoat Tension is reached. With the fiber held under tension, the right die is closed and the handset controller will await input from the operator verifying the correct fiber position in the die. Upon confirming the correct fiber position to the handset the process will continue. The Undercoat Quantity of material is then injected into the die and the right heater is set to the Precure Temperature. The recoat head will move to the left depositing material while the right heater will precure the material. Upon reaching the appropriate length, the left die will close and additional recoat material will be injected into the die. The left heater is set to the Precure Temperature and the right heater to the Cure Temperature. The recoat head moves to the right depositing material while the right heater fully cures the previously precured material and the left heater precures the newly deposited material. Returning to the start position is defined as one loop or pass as the material initially deposited has been fully imidized.

This process is repeated until the desired recoat thickness has been achieved. A tension test can be performed at the conclusion of the recoat process to verify fiber integrity. The recoated fiber is unloaded and the unit resets itself in preparation for the next recoat.

7.2. The Fiber Holding Blocks, V-Grooves, and Inserts

WARNING

A crush hazard exits between the Die Mechanism and the Fiber Holding Block.

The FHBs are designed to accommodate a range of fiber buffer and cladding sizes through the use of changeable, bottom, FHB inserts. The top insert is spring loaded and does not require any change for 80 or 125 micron fibers. The bottom inserts are V-groove, and incorporate vacuum feed to assist in loading the fiber. The V-groove provides mechanical alignment to the recoat die. V-groove inserts are labeled according to clamping diameter in microns. Beyond the V-groove inserts are rubber inserts. The rubber inserts provide the clamping force and surface area required for tensioning and tension testing.

7.3. Stripped Fiber Requirements

The fiber to be recoated should be free of debris and have a smooth, continuous transition in the jacket strip region. The jacket interface should not extend beyond the original coating diameter.

7.5. Loading

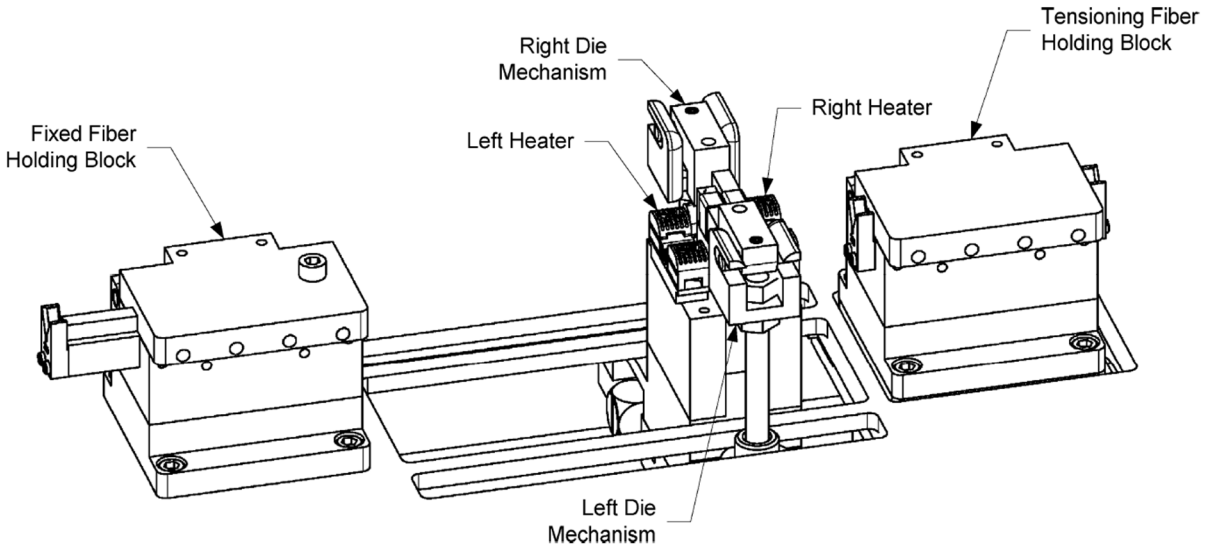


Figure 4 Recoat and Proof Test Components

To load the fiber for recoating:

1. If the Fiber Holding Block (FHB) tops are closed, open the FHB tops (see Figure 4). The head will move to the start position and vacuum will be applied to the V-grooves to aid in loading the fibers.
2. If the FHB tops are open, the load fiber process can be initiated, by either pressing the blue RECOAT button or by closing and reopening both left and right FHB tops.
3. Check that the correct FHB inserts (top and bottom) are installed and that they are free from debris. Position the fiber in the left-hand FHB V-groove, with the stripped section to the left of the left heater. Lower the fiber into the right-hand FHB V-groove. The FHB vacuum should hold the fiber in place.
4. Manually position the fiber in the FHBs so that the right jacket interface is in line with the left edge of the recoat head (see Figure 5). Verify that the fiber is centered in the left and right die. **Note**: Damage to the die may occur if the fiber is not centered in the die when they close.

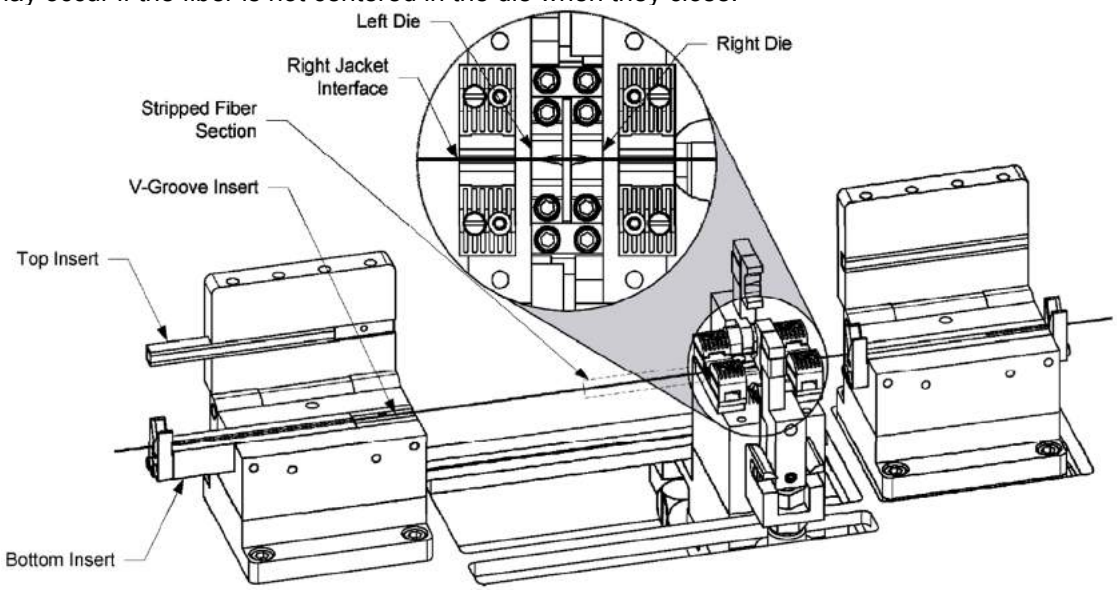


Figure 5 Fiber Position

5. Gently close the FHB lids. This will capture the fiber and turn off the external vacuum pump.
6. The fiber is now ready to be recoated.

7.6. Recoating

To recoat the fiber:

1. Visually confirm that the fiber is loaded properly, if not reload the fiber.
2. Initiate the recoat process by pressing the blue RECOAT button on the unit or the START button on the Handset Controller. The recoat process is fully automated as follows:
    a. The right-hand FHB will begin moving to the right, applying tension to the fiber.
    b. Once the Recoat Tension is reached, the right-hand block will stop moving.
    c. The handset controller will await input from the operator verifying the correct fiber position in the die. Upon confirming the correct fiber position to the handset the process will continue.
    d. The right die will close and the Undercoat Qty will be injected at the Inject Rate into the die. The right heater will be set to the Right Precure Temp and the head will pause for the Heater Stabilize Time.
    e. The head will move to the left at the Undercoat Head Sweep Vel depositing material while the right heater evaporates the volatiles.
    f. Upon reaching the appropriate length, the left die will close and the Undercoat Qty will be injected at the Inject Rate into the die. The right heater will be set to the Right Cure Temp, the left heater will be set to the Left Precure Temp and the head will pause for the Heater Stabilize Time.
    g. The head will move to the right at the Undercoat Head Sweep Vel depositing material. The right heater will be imidizing the previously precured material while the left heater is evaporating the volatiles from the freshly deposited material. The head will complete at the initial start position plus the overlap delta. This is defined as one loop or pass as the material initially deposited has been fully cured.
    h. The process is repeated (using the Overcoat parameters) until the desired thickness has been achieved by the Number of Overcoats (loops or passes).
    i. A tension test can be performed at the conclusion of the recoat process to verify fiber integrity. The tension is applied to the specified Level at the specified Rate and released.
3. Proceed to Unloading the Fiber.

7.7. Proof Testing

The Peak Tension should be set to ensure that the recoat meets the minimum strength requirement for its intended application. If using units of tension (kpsi), make sure to enter the correct fiber diameter (e.g. 125 microns) and not the coating diameter.

WARNING:

Always wear safety glasses when proof testing fiber. The fiber under test can shatter and send glass particles flying.

To perform a Proof Test:

1. Load the fiber in the fiber holding blocks (see 0).
2. Check that the proof test parameters are set correctly.
3. Press the “TEST” button on the top of the unit.
4. Upon completion of the Proof Test, raise the fiber holding block tops and remove the proof tested fiber.

NOTE: It is not possible to abort a Proof Test once it has been started.

7.8. Unloading

To unload the fiber after recoating:

1. After the fiber is recoated, the external vacuum pump will turn on to assist in holding the fiber during the unloading process.
2. Hold the fiber securely and lift the left-hand FHB lid. The fiber will be free to move after lifting the lid, so it is important to keep the fiber secured (the V-groove extension is ideal for this).
3. Carefully lift while guiding the recoated fiber though the heaters.

   Note: Raising the FHB top will re-initiate the vacuum pump timer for an additional 15 seconds, after which time the unit will perform a homing routine. The recoated fiber should be removed within this 15 second window.
4. Raise the right-hand FHB top and remove the recoated fiber.
5. Check that no debris is left behind in the FHB V-grooves or on the top clamping surfaces.

After a recoat has been removed (or even if there is a recoat failure), an automatic homing routine will be run 15 seconds after the left FHB top is raised. This homing routine will re-set the position of the right-hand FHB, and the head. The system waits for the FHB top to be opened to ensure that the fiber is in the process of being unloaded. If both FHB tops are closed prior to the 15-second time-out, the homing routine will be run immediately.

If the PRL201's homing process is interrupted or fails, all system functionality is disabled to prevent possible damage to the equipment. Remove any fiber from the FHB's and cycle the power OFF then ON. The unit will initialize and attempt to run the homing process again. If any further difficulty is experienced, contact Thorlabs Technical Support for assistance.

Chapter 8 Maintenance

CAUTION

Please save packaging material and pink anti-static bag for returning the unit to Thorlabs for service. These items will reduce the risk of damage during shipment.

8.1. Planned Maintenance

The PRL201 is designed for a production environment to give trouble-free operation provided normal planned maintenance is adhered to. Maintenance and repair procedures should be performed only by trained personnel. Improper service and/or repair could result in the safety features being disabled and can also lead to damage that will not be covered under warranty.

Planned Maintenance Schedule

Maintenance	Every Shift	Daily	Monthly	12 Months
Inspect / Clean Fiber Holding Blocks[1]	✓	✓	✓	✓
Inspect / Clean die[2]	✓	✓	✓	✓
Flush recoat System[2] (as needed)			✓	✓
Purge Recoat System[2] (as needed)			✓	✓
Replace Recoat Material[2] (as needed)			✓	✓
Check Load Cell Calibration / Re-Cal[3]				✓

8.2. Inspecting the Fiber Holding Blocks

The Fiber Holding Blocks (FHB's) should be inspected daily for debris and/or damage, which may prevent the tops from closing properly and the fiber from being clamped fully. It is particularly important to make sure that the bottom V-groove insert surfaces, and the top insert clamping surfaces are free of debris and oils. This will help to ensure that the fiber will not break or slip during tensioning. Cleaning the metal insert surfaces is best accomplished using a cotton-tipped applicator wetted with acetone or alcohol. For embedded debris, a soft cleaning brush may be used. Cleaning the rubber insert surfaces is best accomplished using a cotton-tipped applicator wetted with alcohol. Do not use acetone; this will dry the rubber causing it to become brittle and crack.

8.3. Inspecting and Cleaning the Dye

The die of the recoat head should be inspected daily for debris and/or damage which may result in suboptimum recoat performance.

The recoat head assembly contains two die sets (left and right), each with a semi-circular channel running longitudinally down the center of their mating surfaces. When closed, the die forms a circular mold cavity around the section of fiber to be recoated. For the die to mate flush together, they must be free of dirt or coating particles.

The die should be cleaned with a cotton-tipped applicator wetted with NMP. NMP is the solvent for PI2525 and can be used to soften and lift away any residual recoat material. Wipe the top and both sides of the die using very light pressure only. Wipe both the left and right and top and bottom of the die set. If the die does have an accumulation of recoat material stuck to it, allow the cleaning solution time (60-90 seconds) to soften and lift any material. After cleaning the die gently blow clean (canned) air across the die to thin out the NMP.

NOTE: When cleaning the die be cautious not to contact or damage the heaters.

NOTE: The mating surfaces of the die are precision machined. Use only a soft cotton tipped applicator to clean the die. Do not rub any hard objects across the surface of the die as this could scratch or chip the edges of the die channel and degrade the quality of the recoat.

[1] *Maintenance Operations can be Performed by the Operator*
[2] *Maintenance Operations can be Performed only by Trained Maintenance Personnel*
[3] *Thorlabs Certified Technician Only*

8.4. Load Cell Calibration

The load cell calibration should be checked every twelve (12) months to ensure that accurate recoat and proof test tension is applied to the fiber. This task must be performed by a Thorlabs certified technician.

8.5. Flush Recoat System

The recoat injection system should be flushed clean every 1 month as part of the recoat material replacement procedure. Before flushing the system, make sure to have cotton tipped applicators and cleaning solution (NMP) available prior to proceeding. To flush the system:

1. Remove the internal recoat bottle and clean all exposed tubing and fittings with NMP.
2. Install a bottle filled 1/4 full with NMP on the pump.
3. Run 5 purge cycles.
4. Remove the bottle, dispose of contaminated NMP. Refill 1/4 full with clean NMP and reinstall.
5. Run 5 more purge cycles.
6. Run several inject 100 µl sequences until NMP runs clear from the die inject port.

NOTE: Make sure to collect material as it comes out of the die inject port. Do not allow material to run between the left and right die.

7. Remove the bottle of NMP from the pump.
8. Run several more inject 100 µl sequences until no more NMP exits the die injection port.
9. Run one purge cycle. Make sure to collect any NMP that comes out of the green purge tube at the top of the bottle fitting.
10. Clean all bottle tubing and fittings with NMP.
11. Install an empty bottle for storage, or a new bottle ¾ filled with fresh recoat material for use. If installing fresh material, proceed to section 6.1 Priming the Injection System.

8.6. Purge Recoat System

The purge cycle is a process of emptying the recoat material of the Automatic Injector back into the recoat material bottle and refilling the pump with fresh recoat material drawn from the bottom of the bottle. Running 5 purge cycles is sufficient to entirely fill the pump with fresh recoat material.

If the system has not been used for an extended period (over 1 week), it is recommended that a single purge cycle be run to fill the pump with fresh material.

8.7. Replacing Recoat Material

Recoat material has a finite shelf life and should be replaced every 1 month. To replace the recoat material, first flush the system as outlined in Flush Recoat System (above). Once the system is flushed, fill a clean recoat bottle 3/4 full with fresh recoat material and follow the procedures in Purge Recoat System (above).

NOTE: The one-ounce internal recoat bottle holds approximately 30,000 µl when full. The number of recoats per fill and the approximate time before the material needs to be refilled can be determined based on the volume of material per recoat and the number of recoats per month. For most applications the material will need to be replaced before it runs out. Even if fresh material is added to the internal bottle prior to the Planned Maintenance schedule, the material should still be replaced since mixing of the old and new materials occurs.

8.9. Replacing a Heater

If a heater is sufficiently damaged such that a quality recoat cannot be performed, then replacement is required. The left and right heaters are identical and DO NOT need to be replaced as a pair. The heaters are comprised of a body which houses a graphite filament. When installed in the PTR201, the heater is held in place by electrical contacts at the base of the heater body. This is a pin/socket contact compression fit.

To remove the heater:

1. Remove any fiber from the unit, clean the die, and shut the unit down. This will relieve the air pressure to the die open/close cylinder.
2. Manually open the die sets. This will allow additional access to the heaters.
3. Remove the 2-56 × 1.4" socket head cap screws (2 per heater) using a 5/64" Allen key included in the tool kit.
4. Grab the body of the filament and using a front to back rocking motion, gently lift the filament body (pins) out of the contacts.

To install the heater:

1. Inspect the new heater for any deformation of the filament. If deformation is noted do not install nor use the heater.
2. Hold the filament body (not the graphite filament) and locate the pins into the electrical sockets.
3. To fully seat the heater, gently push down on the electrical contacts (located on the top of the heater).
4. Reinstall the 2-56 × 1/4" socket head cap screws (2 per heater) using a 5/64" Allen key included in the tool kit.

8.10. Changing the Fiber Holding Block V-Grooves

To change a FHB V-groove inserts:

1. Loosen the two (2) set screws accessible from the front of the FHB base using the 0.035" Allen key included in the PRL201's tool kit. **Do NOT** remove the set screws completely; one full turn counter-clockwise should be sufficient to release the insert.
2. Remove the FHB V-groove and replace with the desired size. For dual sided inserts, the label for the desired size should face right side up and be readable. Make sure the vacuum feed ports are clear of debris by holding the insert up to a light and checking from behind to make sure light passes each of the ports. Clean if necessary.
3. Make sure the new insert is fully seated and flush with the inside face of the FHB. **NOTE:** The inside face of the FHB is the side closest to the head
4. Re-tighten the set screws until they are snug. **Do NOT** over tighten.

8.12. Replacing the Die

If the die are sufficiently damage such that a quality recoat cannot be performed, then a replacement is required. The top and bottom die are a matched set and are replaced as a pair. The top die are spring loaded which enables a slight pivoting during closure, while the bottom die are fixed mounted to the head.

To replace the top die:

1. Remove any fiber from the unit, clean the die, and shut the unit down. This will relieve the air pressure to the die open/close cylinder.
2. Manually open the die set to be replaced. The top die pivots about a center pin which is pressure loaded with two (2) small springs. Remove the top die retainer clip (be sure to retain it for reuse later), this will expose the springs. Using the die, gently compress the springs. This will allow a rotation of the die by ~45° and the removal of the die from the clamp. Remove and retain the springs for reuse later.
3. Locate and clean the new top die to be installed.
4. Insert the two (2) springs into the clamp. With the die rotated ~45°, gently collapse the springs with the die. Align the die pin with the clamp and rotate the die to 0° to install.
5. Reinstall the die retainer clip.

To replace the bottom die (ensure the right bottom die contains the inject port):

1. Remove any fiber from the unit, clean the die, and shut the unit down. This will relieve the air pressure to the die open/close cylinder.
2. Manually open the die set to be replaced. Remove and retain the two (2) 0-80 x 3/16" socket head cap screws that secure the die to the head using a 0.050" Allen key, included in the tool kit. Gently begin to remove the die from the head. An inject tube will be attached to the die. This tube will limit the distance the die can be removed from the head. Gently pull the die with the inject tube until resistance is felt.
3. Locate and clean the new bottom die to be installed.
4. Seat the die into the head and insert the two (2) 0-80 x 3/16" socket head cap screws that secure the die to the head using a 0.050" Allen key included in the tool kit. Gently tighten the screws.

Chapter 9 Appendix

9.1. Appendix A: MSDS PI2525

HD MicroSystems™
An Enterprise of Hitachi Chemical and DuPont Electronics

MATERIAL SAFETY DATA SHEET

***** IDENTIFICATION *****

NAME: PI2525 SYNONYMS: POLYIMIDE COATING.
CHEM.FAMILY: Pyralin® Polyimide Coating. FORMULA: Proprietary.

MANUFACTURER:
HD MicroSystems™
Cheesequake Road
Parlin, NJ 08859

INFORMATION & EMERGENCY TELEPHONE NOS:
INFORMATION: Product: (800) 441-7515
EMERGENCIES: Medical: (800) 441-3637
Transport (CHEMTREC): (800) 424-9300

All Ingredients in This Product Are TSCA Listed/Reported.

***** PHYSICAL DATA *****

FORM: Viscous Liquid. ODOR: Aromatic.

APPEARANCE: Colorless to Amber. SOLUBILITY IN WATER: Slight.

***** COMPONENTS *****

Material(s):	CAS#	V.P. mm Hg @ 20C	Weight %
N-Methyl-2-Pyrollidone.	872-50-4	0.29	> 60%
Polyamic acid of Benzophenone Tetracarboxylic Dianhydride/4,4-Oxydianiline/m-Phenylenediamine (Polymer).	31942-21-9		10 - 30%

PI2525/AH1
05/19/98

***** HAZARDOUS REACTIVITY *****

INSTABILITY:
The product is normally stable.

INCOMPATIBILITY:
Avoid contact with:
Reducing agents; Oxidizing agents; Bases; Acids; Strong acids; Strong oxidizers.

DECOMPOSITION:

Decomposition products at high temperature may include:
Carbon monoxide (CO); Nitrogen oxides; Carbon monoxide, carbon dioxide, water.

POLYMERIZATION:
The product may polymerize endothermically if exposed to temperatures over 90 F, ultraviolet light or free radical initiators. This may increase viscosity.

***** FIRE & EXPLOSION DATA *****

FLASHPOINT: 194 F Seta CC

FIRE & EXPLOSION HAZARDS:
The product is not an unusual fire or explosion hazard.

EXTINGUISHING MEDIA:
Water spray, dry chemical or carbon dioxide.

SPECIAL FIREFIGHTING INFORMATION:
Toxic decomposition products may form under fire conditions. (See Decomposition Section.);
Wear full protective clothing and a full facepiece, positive pressure, self-contained breathing apparatus (SCBA); Decontaminate contaminated clothing and equipment with soap and water. Dispose of residues per federal, state, and local regulation. (See Waste Disposal Section.).

OVERVIEW: The most likely routes of overexposure to this

PI2525/AH1

***** HEALTH HAZARD INFORMATION *****

product are skin contact and inhalation. Skin irritation and/or other effects of skin contact are easily avoided by using proper gloves (see section titled GLOVES) and washing affected areas immediately if contact occurs. Volatile solvents will start evaporating during room temperature use of the product, such as thinning, pouring from jar to dispensing machine, and spin coating. Mist and solvent vapors will evolve if spray application is used. During wafer drying, 125 - 150 C, and final curing, 350 - 450 C, the remaining solvent(s) will evaporate. Potential overexposure to other chemicals used in the operation such as wafer etchants and cleaners should also be considered. Well designed area and personal air sampling and analysis can show if exposures are within established limits. Properly designed local ventilation and process enclosure are effective ways to limit employee exposure where needed.

In addition to meeting exposure limits, it is always prudent to use all practical means to minimize employee exposure to chemicals. A significant difference in overall exposure can be made with practical measures such as:

* Inhalation - minimizing by keeping jars of product covered
* Eye - avoiding contact by wearing chemical splash goggles where there is splash potential
* Ingestion - avoiding by washing hands before eating, drinking or smoking, and restricting these activities to outside the work area.

PRINCIPAL HEALTH EFFECTS:

>>>N-Methyl-2-Pyrollidone
****Toxic effects described in animals include: BY SKIN OR EYE CONTACT: Mild skin irritation; No skin sensitization; BY INHALATION: Respiratory effects. Toxic effects of repeated or prolonged animal exposures include: BY INHALATION: Respiratory effects; Bone marrow effects; Lymph system effects; Testicular effects; ****Additional animal tests have shown: No carcinogenic activity; No developmental toxicity; No genetic damage in bacterial or mammalian cell cultures; No reproductive toxicity. ****Human health effects of overexposure may include: By contact with liquid or vapor: Eye irritation with discomfort, tearing, or blurring of vision; BY SKIN OR EYE CONTACT: Eye irritation with discomfort, tearing, or blurring of vision; Skin irritation with itching, burning, redness, swelling or rash; BY INHALATION: Runny nose; Sore throat; Sneezing; Irritation of the nose and throat; Nonspecific discomfort, e.g., nausea, headache or weakness. ****Human effects of higher level

PI2525/AH1

acute, repeated or chronic overexposure may include: BY SKIN OR EYE CONTACT: Skin reddening; Skin irritation with discomfort or rash; Dermatitis; Swelling; Burning. ***In addition: BY SKIN OR EYE CONTACT: There are inconclusive or unverified reports of human sensitization.

>>>Polyamic acid of Benzophenone Tetracarboxylic Dianhydride/4,4-Oxydianiline/m-Phenylenediamine (Polymer) ****Toxic effects described in animals include: BY SKIN OR EYE CONTACT: Skin irritation; Skin sensitization; Eye irritation.

ANIMAL DATA:

>>>N-Methyl-2-Pyrollidone
Inhalation 4 hour ALC: 1.7 mg/L in rats (Moderately toxic)
Skin absorption LD50: > 8,000 mg/kg in rabbits (Slightly toxic)
Oral LD50: 4,320 mg/kg (Slightly toxic).

CARCINOGENICITY LISTING:

No ingredients of this product are designated by IARC, NTP, OSHA, ACGIH or Dupont as potential carcinogens.

EXPOSURE LIMITS:
Workplace exposures should be kept below the following limits:

.	AIHA		ACGIH		OSHA	
Name/Units	8hr	15min	8hr	15min	8hr	15min
PARTICULATES (N.O.S.), respirable						
Units: mg/m3					5	
PARTICULATES (N.O.S.), total						
Units: mg/m3			10		15	
N-METHYL-2-PYRROLIDONE						
Units: ppm	10					

Also, DuPont has established and observes the following limits:

Name/Units	12 hr	8hr	15min	Ceiling
N-METHYL-2-PYRROLIDONE				
Units: ppm		25		

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NOTES ON EXPOSURE LIMITS:
PELs - OSHA Permissible Exposure Limits - 29 CFR 1910.1000, Subpart Z, or specific substance standards;
TLVs - ACGIH Threshold Limit Values - published by American Conference of Governmental Industrial Hygienists, 6500 Glenway Avenue, Cincinnati, OH 45211;
WEELs- AIHA Workplace Environmental Exposure Limits - published by the American Industrial Hygiene Association, 2700 Prosperity Avenue, Suite 250, Fairfax, VA 22031;
AELs - Dupont Acceptable Exposure Limit. Where governmentally imposed occupational exposure limits are lower than AEL in effect, government limits shall take precedence;
(C) = "ceiling", limit not to be exceeded for any time period;
(S) = "skin" , skin absorption may contribute significantly to the ingredient's internal toxicity.

***** FIRST AID INSTRUCTIONS *****

Skin Contact: For skin contact, immediately wash skin with soap and water. Wash contaminated clothing before reuse.
Eye Contact: For eye contact, immediately flush eyes with plenty of water for at least 15 minutes. Call a physician.
Inhalation: If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Call a physician.
Ingestion: If swallowed, do not induce vomiting. Immediately give two glasses of water. Never give anything by mouth to an unconscious person. Call a physician.

***** PROTECTION INFORMATION *****

Adequate local ventilation should be used to keep exposures below applicable limits;

Other engineering controls such as totally enclosed handling systems are also preferred;
Respiratory protection will be needed if exposures can not be kept below applicable limits by other means.

Respiratory Protection:
A NIOSH/MSHA approved full-face mask equipped with chemical cartridges approved for methylamine may be permissible under certain circumstances where airborne concentrations are expected to exceed exposure limits. Protection provided by air purifying respirators is limited. Use a positive pressure air supplied respirator if there is any potential for an uncontrolled release, when exposure levels are not

PI2525/AH1

known, or in any other circumstances where air purifying respirators may not provide adequate protection;
For most conditions, no respiratory protection should be needed; however, if handling at elevated temperatures without sufficient ventilation, use an approved air-purifying respirator. In dusty atmospheres, use an approved dust respirator;
Selection of a suitable respirator will depend on the properties of the contaminant(s) and their actual or expected air concentration(s) versus applicable limits. Consult ANSI Standard Z88.2 for decision logic to select appropriate NIOSH/MESA approved respirators;
A NIOSH/MSHA/OSHA approved air purifying respiratory with a dust/mist cartridge or canister may be permissible under certain circumstances where airborne concentrations are expected to exceed limits. Protection provided by air purifying respirators is limited. Use a positive pressure air supplied respirator if there is any potential for an uncontrolled release, exposure levels are not known or any other circumstances where air purifying respirators may not provide adequate protection;
Use a positive pressure air-supplied respirator if concentrations may exceed exposure limits. Air-purifying respirators are inadequate for this material;
If respirators are needed to meet applicable limits, a respiratory protection program up to the level of OSHA Standard 29 CFR 1910.134 is mandatory. This includes air monitoring, selection, medical approval, training, fit testing, inspection, maintenance, cleaning, storage, etc;
An OSHA/NIOSH respirator for protection against Nuisance Dust is recommended.

Gloves:
Gloves should be used when the possibility of skin contact exists;
The suitability of a particular glove and glove material should be determined as part of an overall glove program. Considerations may include chemical breakthrough time; permeation rate; abrasion, cut and puncture resistance; flexibility; duration of contact; etc.

Other Protection Practices:
Appropriate eye protection such as chemical splash goggles should be used if the possibility of eye contact exists;
Protective outer clothing should be used where the possibility of body contact exists. Contaminated work clothing should not be allowed out of the workplace;
Do not smoke, consume or store food or drinks in areas

PI2525/AH1

where the product is handled or stored. After handling the product, wash hands thoroughly before leaving the work area;
Additional engineering controls, work practices and training may be required depending on exposure levels. These are discussed in the OSHA Respiratory Protection Standard (29 CFR 1910.134) and OSHA Hazard Communication Standard (29 CFR 1910.1200);
Do not breath dust. Avoid contact with eyes, skin, or clothing. Wash thoroughly after handling.

***** DISPOSAL INFORMATION *****

Spill, Leak or Release:
FOR SMALL SPILLS, absorb on rags, sand or other absorbent material;
FOR LARGE SPILLS, get workers out of affected area. If flammable liquids or vapors may be present, turn off electrical devices or other sources of sparks or flames. WEAR PROTECTIVE EQUIPMENT. Use supplied-air respiratory protection if vapor concentrations are not known;
Contain spill at source by diking or absorbing with sand. Do not allow spill to spread to or intentionally flush to sewer or ground. Wash area thoroughly. Adequately ventilate area;
Spill residue, cleaning rags and absorbent may be considered hazardous. (See Waste Disposal Section.).

Waste Disposal:
Components of this product may be considered hazardous;
Consult applicable Federal, State, and local regulations for allowable disposal methods.

***** PRODUCT INFORMATION *****

Contaminated Items:
Empty product containers, contaminated clothing and cleaning materials, etc. should be considered hazardous until decontaminated or properly disposed of. (See Waste Disposal Section.).

Storage:
Store product in a refrigerated location (0-4F), away from sunlight or ultraviolet light to ensure product viscosity stability.

PI2525/AH1

***** ADDITIONAL INFORMATION *****

The following ingredients are subject to the reporting requirements of section 313 of Title III of the Superfund Amendment and Reauthorization Act of 1986 and 40 CFR part 372:

INGREDIENT(S)	Weight %
N-Methyl-2-Pyrrolidone	> 60%

CALIFORNIA PROPOSITION 65: WARNING: This product does not contain chemical known to the state of California to cause cancer, birth defects, or other reproductive harm.

This product is a physical mixture. The health effects information about this product is based on the individual ingredients;
The data in this Material Safety Data Sheet relates only to the specific product designated herein and does not relate to its use in combination with any other material or in any process.

Date of latest MSDS revision: 05/19/98

Person Responsible for MSDS:

Safety Coordinator - MSDS
DuPont P&EM / MCM
14 Alexander Drive
Research Triangle Park, NC 27709-4425
Telephone: (800) 284-3382
Outside U.S.: (919) 248-5775

9.2. Appendix B: MSDS NMP

Material Safety Data Sheet

1-Methyl-2-pyrrolidinone

ACC# 08690

Section 1 - Chemical Product and Company Identification

MSDS Name: 1-Methyl-2-pyrrolidinone
Catalog Numbers: AC127630010, AC127630025, AC222080025, AC222085000, AC326930010, AC326931000, AC326932500, AC354890025, AC354900025, AC364380010, AC364380025, AC364381000, AC368450010, AC368450025, AC368451000, AC610411000, BP1172-4, BP11724LC, BP1172N119, BP2619-100, NC9749337, O3688-4
Synonyms: NMP; N-Methylpyrrolidone; N-Methylpyrrolidinone; N-Methyl-2-pyrrolidone; N-Methyl-2-pyrrolidinone; M-Pyrol; 1-Methyl-2-pyrrolidone; solvent in paint strippers.
Company Identification:

Fisher Scientific
1 Reagent Lane
Fair Lawn, NJ 07410

For information, call: 201-796-7100
Emergency Number: 201-796-7100
For CHEMTREC assistance, call: 800-424-9300
For International CHEMTREC assistance, call: 703-527-3887

Section 2 - Composition, Information on Ingredients

CAS#	Chemical Name	Percent	EINECS/ELINCS
872-50-4	1-Methyl-2-pyrrolidinone	99	212-828-1

Chapter 10 Compliance

EU Declaration of Conformity

in accordance with EN ISO 17050-1:2010

We: Thorlabs Inc.

Of: 56 Sparta Avenue, Newton, New Jersey, 07860, USA

in accordance with the following Directive(s):

2006/42/EC	Machinery Directive (MD)
2014/30/EU	Electromagnetic Compatibility (EMC) Directive
2011/65/EU	Restriction of Use of Certain Hazardous Substances (RoHS)

hereby declare that:

Model: ***PTR201, PTR203, PTR203B, PTR204, PTR204B, PTR206, PTR206B***

Equipment: ***Recoater (w/ Halogen lamps), Linear Proof tester and combinations***

is in conformity with the applicable requirements of the following documents:

EN ISO 12100	Safety of Machinery. General Principles for Design. Risk Assessment and Risk Reduction	2010
EN 61326-1	Electrical Equipment for Measurement, Control and Laboratory Use - EMC Requirements	2013
EN 62471-1	Photobiological Safety of Lamps and Lamp Systems	2008

and which, issued under the sole responsibility of Thorlabs, is in conformity with Directive 2011/65/EU of the European Parliament and of the Council of 8th June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment, for the reason stated below:

does not contain substances in excess of the maximum concentration values tolerated by weight in homogenous materials as listed in Annex II of the Directive

I hereby declare that the equipment named has been designed to comply with the relevant sections of the above referenced specifications, and complies with all applicable Essential Requirements of the Directives.

Signed: *On:* 01 August 2016

Name: Ann Strachan

Position: Compliance Manager

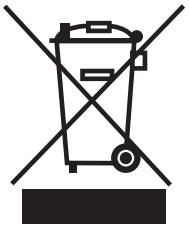
EDC - PTR201, PTR203, PTR203B, PTR204,...

CE

Chapter 11 Regulatory

As required by the WEEE (Waste Electrical and Electronic Equipment Directive) of the European Community and the corresponding national laws, Thorlabs offers all end users in the EC the possibility to return “end of life” units without incurring disposal charges.

- This offer is valid for Thorlabs electrical and electronic equipment:
- Sold after August 13, 2005
- Marked correspondingly with the crossed out “wheelie bin” logo (see right)
- Sold to a company or institute within the EC
- Currently owned by a company or institute within the EC
- Still complete, not disassembled and not contaminated



Wheelie Bin Logo

As the WEEE directive applies to self-contained operational electrical and electronic products, this end of life take back service does not refer to other Thorlabs products, such as:

- Pure OEM products, that means assemblies to be built into a unit by the user (e. g. OEM laser driver cards)
- Components
- Mechanics and optics
- Left over parts of units disassembled by the user (PCB’s, housings etc.).

If you wish to return a Thorlabs unit for waste recovery, please contact Thorlabs or your nearest dealer for further information.

11.1. Waste Treatment is Your Own Responsibility

If you do not return an “end of life” unit to Thorlabs, you must hand it to a company specialized in waste recovery. Do not dispose of the unit in a litter bin or at a public waste disposal site.

11.2. Ecological Background

It is well known that WEEE pollutes the environment by releasing toxic products during decomposition. The aim of the European RoHS directive is to reduce the content of toxic substances in electronic products in the future.

The intent of the WEEE directive is to enforce the recycling of WEEE. A controlled recycling of end of life products will thereby avoid negative impacts on the environment.

Chapter 12 Thorlabs Worldwide Contacts

USA, Canada, and South America
Thorlabs, Inc.
56 Sparta Avenue
Newton, NJ 07860
USA
Tel: 973-300-3000
Fax: 973-300-3600
www.thorlabs.com
www.thorlabs.us (West Coast)
Email: sales@thorlabs.com
Support: techsupport@thorlabs.com

Europe
Thorlabs GmbH
Hans-Böckler-Str. 6
85221 Dachau
Germany
Tel: +49-(0)8131-5956-0
Fax: +49-(0)8131-5956-99
www.thorlabs.de
Email: europe@thorlabs.com

France
Thorlabs SAS
109, rue des Côtes
78600 Maisons-Laffitte
France
Tel: +33 (0) 970 444 844
Fax: +33 (0) 825 744 800
www.thorlabs.com
Email: sales.fr@thorlabs.com

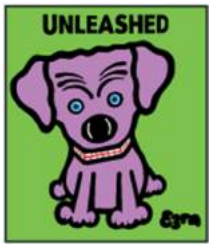
Japan
Thorlabs Japan, Inc.
Higashi-Ikebukuro Q Building, 2F
2-23-2, Higashi-Ikebukuro,
Toshima-ku, Tokyo 170-0013
Japan
Tel: +81-3-5979-8889
Fax: +81-3-5979-7285
www.thorlabs.jp
Email: sales@thorlabs.jp

UK and Ireland
Thorlabs Ltd.
1 Saint Thomas Place, Ely
Cambridgeshire CB7 4EX
Great Britain
Tel: +44 (0)1353-654440
Fax: +44 (0)1353-654444
www.thorlabs.com
Email: sales.uk@thorlabs.com
Support: techsupport.uk@thorlabs.com

Scandinavia
Thorlabs Sweden AB
Bergfotsgatan 7
431 35 Mölndal
Sweden
Tel: +46-31-733-30-00
Fax: +46-31-703-40-45
www.thorlabs.com
Email: scandinavia@thorlabs.com

Brazil
Thorlabs Vendas de Fotônicos Ltda.
Rua Riachuelo, 171
São Carlos, SP 13560-110
Brazil
Tel: +55-16-3413 7062
Fax: +55-16-3413 7064
www.thorlabs.com
Email: brasil@thorlabs.com

China
Thorlabs China
Room A101, No. 100
Lane 2891, South Qilianshan Road
Putuo District
Shanghai
China
Tel: +86 (0) 21-60561122
Fax: +86 (0)21-32513480
www.thorlabschina.cn
Email: chinasales@thorlabs.com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