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1. Introduction

The Grease Thief Analyzer (GTA) measures the consistency of in-service lubricating grease and compares it to the values obtained from a reference sample. A linear actuator is used to push a load cell which pushes the handle of a Grease Thief (GT). A second actuator moves a table holding a substrate. This substrate is moved at a speed proportional to the grease thief movement, so the extruded grease is captured as a thin-film along the length of the substrate. The die extrusion process conforms to the standard practice outlined in ASTM D7918. This practice will also address the additional tests that can be performed with the full grease thief, and with the thin-film substrate, including:

- Ferrous Density
- RULER/Linear Sweep Voltammetry
- Optical Spectroscopy/Grease Colorimetry
- Moisture by Relative Humidity Sensor
- Grease Particle Counting

The force required is measured as the grease is extruded through the extrusion die, which is threaded onto the other end of the GT. The test cycle includes 3 speeds and rapid transitions in grease pressure to provide insight into shear and non-Newtonian rheology, and the force data is averaged for each speed to calculate the "Grease Thief Index" or GTI. The GTI is the ratio of the used grease load to the reference load, reported as a percent.

Appendix III shows a list of terms used within this document. This can be referenced as needed throughout the analysis process.



2. Safety

1. General Operating Instructions

- For major instrument repairs and tear down, disconnect and lock out all power.
- Read all signs on instrument. Do not remove, modify, or deface any sign. Replace all damaged signs.
- If safety instructions are required in another language, please contact a local translator.
- Personnel should keep clear of the moving parts at all times.
- The functionality of the door closure interlock is extremely important for the safety of the personnel.
- All covers must be in place before operating the instrument.

WARNING

Please read carefully and strictly follow the instructions in this section. Failure to do so could result in instrument failure and/ or personal injury.

Changing the instrument's operating program and logic can present a hazard to the users of this instrument and will void the instrument warranty. If reprogramming is needed, please consult an authorized Grease Thief representative. Do not modify any drive parameters. Improper functioning of instrument may occur.

2. Maintenance

- Remove all debris from the surrounding area of the instrument and ensure that all personnel stay clear of the instrument operating parts.
- Keep work area uncluttered and well lit.
- To ensure proper instrument operation, use the specified power sources listed in Appendix V of this manual.
- Before any service is performed on this unit, turn power off and unplug from power source. Service should be provided only by trained and authorized personnel.



- Follow all maintenance and service instructions in this manual.
- The instrument should be inspected daily, and any worn or broken parts should be noted, and service scheduled for replacement and/or repair.

3. Moving Instrument Parts

- Disconnect power cord to isolate instrument from all power sources before cleaning and servicing unit or accessing the internal area of the enclosure to perform any action not specifically outlined as a normal operational step in this manual.
- When instrument is in operation, keep the enclosure door fully closed and stay away from the moving parts.
- Before operating this instrument, all covers and guards must be in place and all safety devices working.
- Never put any part of your body into the instrument enclosure or near any moving or electrically energized parts while the instrument is in operation or when electrical power is supplied to those electrical parts.
- Do not attempt to manually move any instrument parts that are normally mobile only under power and through the influence of the motors and gear units.

WARNING

Failure to utilize and ensure properly connected and functional interlocks can result in improper instrument operation and/or personal injury.

4. Instrument Installation

- All customer interlocks must be connected as shown in this manual's electrical drawings.
- Be familiar with the locations of safety interlocks, guards, and enclosure panels.
- Do not defeat any safety interlock or safety device.
- Do not operate instrument with any safety devices/guards removed.



- Before operating the instrument, ensure that all safety interlocks, guards, and enclosure panels are in place and operating properly.
- Always secure the instrument in place, on a level solid surface sufficient for the weight of the instrument and adjust feet to achieve a stable and level orientation before running the instrument.

5. Personal Protection

- To prevent back or other body injuries, your employer must provide proper lifting and/or handling instructions. Do not attempt to lift the instrument without help. Make sure to bend at knees and lift straight up.
- When operating or installing unit, always use proper Personal Protective Equipment (PPE) including appropriate gloves and goggles, in accordance with local procedures and the required PPE in the SDS for the product being handled.

6. Lockout/Tagout

- Follow local safety guidelines for instrument lockout procedures and other important lockout/tagout guidelines.
- Wear appropriate gloves when handling grease or other chemicals.
- Be familiar with all lockout sources on this instrument.
- Even after an instrument has been locked out, there may be stored energy in the system.
- Wait at least one minute before servicing electrical capacitors in order to ensure that all stored energy is relieved. Service this instrument, including electrical or electronic components should be performed only by trained and authorized personnel.
- Always turn unit off using the power switch and remove and lockout the power cable before servicing any internal components, including moving mechanical and electrical or electronic components.

7. Operating the Instrument

- Never operate this instrument in an explosive atmosphere.
- Be sure that all guards are in place and all safety devices are working properly.



DO NOT operate the instrument with any safety devices removed.

- Keep all unauthorized personnel away from the instrument operating area.
- For guidance on proper sampling taking procedures see ASTM Standard Practice D7718.
- Always use proper Personal Protective Equipment (PPE) while handling grease samples, including appropriate material gloves and goggles, in accordance with local procedures and the required PPE in the SDS for the product being handled.
- Ensure the instrument is wiped down between runs and to prevent cross contamination.
- Ensure that Grease Thief samplers, extrusion dies, and substrates are in good condition and undamaged prior to use. Do not utilize any separated or delaminated substrates, cracked or misshapen dies, or misaligned or damaged Grease Thief samplers.
- If a damaged or misaligned Grease Thief sampler is submitted for analysis, transfer the grease contents to a new Grease Thief sampler and conduct analysis after confirming the good condition of the sampler, die and substrates to be used.
- Do not reuse Grease Thief samplers, substrates or dies as this will result in contamination with grease from previous runs and will provide inaccurate data results.
- Reusing extrusion dies can result in over-pressurization and damage to the unit. Reusing substrates can cause separation of materials and damage to the instrument components. This could also compromise the quality of the sample being tested.

3. Instrument Initialization

Note: Before powering on your unit or accessories, consult Grease Thief Analyzer Power Statement for proper power and adapter configurations.

1. Plug in the Grease Thief Analyzer using the included power cord. The power connection is located above the name plate at the rear of the unit.
2. Place the VCM next to the unit, close enough that the ethernet cords can reach the rear of the unit. Use the power cord from the VCM box and plug in the VCM at the Power In connection (top left in Figure 1) and plug other side into wall faceplate.
3. Open the white box labeled “Ethernet Cords” and use the 3 colored cords to connect the VCM to the Grease Thief Analyzer using Figure 1 as a guide. The corresponding colored

cable should be used for each of these connections.

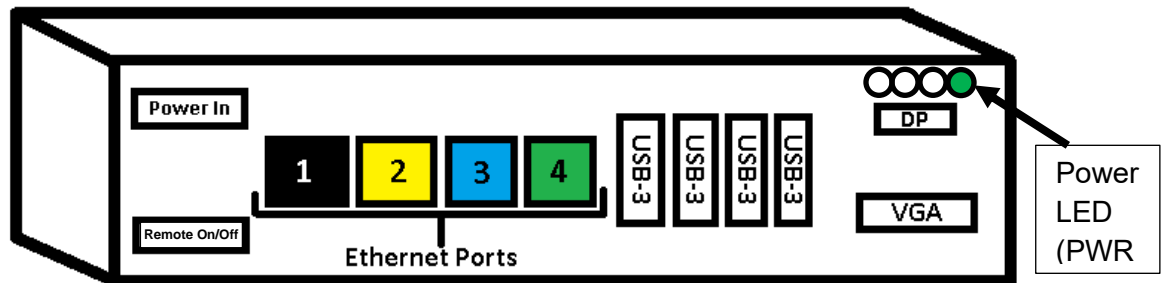


Figure 1 Block diagram of the Vector Control Module (VCM) with color-coded ethernet ports

- a. Use plug 1 (black) for connection to local server
- b. Use plug 2 (yellow) for the Grease Thief Canty Camera (Port 2 on rear of instrument)
- c. Use plug 3 (blue) for the LED controller (Port 3 on rear of instrument)
- d. Use plug 4 (green) for the Grease Thief Analyzer (Port 1 on front of instrument)
4. Open the monitor box and remove its contents. Plug in the monitor and use the included VGA cable to connect the monitor to the VCM into the connector labeled “VGA” in the lower right corner of Figure 1.
5. Open the keyboard/mouse combo box and remove its contents. Plug in the keyboard and mouse to the VCM using the USB-3 ports.

First Time Operation

****Warning** - When powering on the GTA, and whenever the imaging system is used, a strobe flash is emitted. Strobe flash can be problematic for some individuals with medical conditions. Verify no health issues with users before operation.**

6. Verify the VCM is powered on by checking the “PWR” LED is lit. (top right corner of Figure 1). If not, press the power button located on the right-facing side of the VCM when positioned in the same orientation as Figure 1.
7. Power on the Grease Thief Analyzer using the switch at the rear of the unit located directly below the power supply cord.
8. Power on the monitor by pressing the power button located on the far right of the



underside of the monitor.

9. Once everything is powered on, check the monitor. If you see a selection of profiles to log into, move on to step 5. If the screen looks like Figure 2, skip to step 7.
10. There will be four user options on the VCM startup screen:
 - a. Operator: No sign-in required; use this profile to run samples
 - b. User Admin: password - **cv12345**; used for modifying local properties
 - c. Canty Admin: **Remote access only**
 - d. VCM Admin: **Remote access only**
11. Sign into the Operator profile, and the VCM home-screen will display with options on the left side of the screen (Figure 2).

CANTY
Process Technology

JM CANTY EMBEDDED VISION MANAGEMENT
SYSTEM 500 VERSION 1.0.0

- Open CV Software**: Controls camera and LED strobe
- Data Communications**: Controls Grease Thief Analyzer
- File Explorer**: Provides access to files saved on VCM
- Display Settings**: **Admin Use Only**
- Internet Explorer**: Provides access to the internet
- Administrator**: **Admin Use Only**, used for technical support
- Virtual Keyboard**: Opens on-screen keyboard
- User Manual**: Opens manual PDF for VCM
- Remote Support**: Allows for remote technical support
- Reboot System**: Restarts VCM
- Shutdown System**: Shuts down the VCM

SYSTEM HEALTH

Current Runtime	0:44:47
WD Tickle Count	180
System Load	18 %
CPU Temperature	● ● ●
Watchdog Timer	STOP

PERFORMANCE AND TEMPERATURE. SYSTEM

Figure 2 VCM home- screen window with description of possible selections



12. The Canty Vision software should open automatically upon sign-in, but if not, click the “Open CV Software” button on the left side to launch Canty Vision. This program controls the camera and LED controller in the Grease Thief Analyzer.
13. Test the connectivity of the LED controller by selecting the “Tools” dropdown at the top, then “Hardware”, then “LED Controller”. This will open a window called “Canty LED Controller.”
14. Once the LED controller window opens, the LED in the unit should start flashing. If not, refer to the Troubleshooting section of this SOP to test connectivity of the LED controller.
15. Close out of the “Canty LED Controller” window using the red “X” in the top right corner to return back to the Canty Vision home page. Select “Live Image” from the Canty Vision homepage in the top left of the window. A new window will open called “Automated Background Adjustment.” This will show what the camera is seeing. Open the Grease Thief Analyzer and remove the cap from the camera. Wave something in front of the camera and check the monitor to make sure the camera is connected properly. If not, refer to the Troubleshooting section of this SOP to test connectivity of the Canty Camera.
16. Once the camera has been verified, close out of the Live Image window and return to the LED Controller window (Tools -> Hardware Settings -> LED Controller). Turn off the strobe light by selecting the “Output” box at the bottom under the “In Software” column and select “Disable”. Then, click “Send” in the top right corner, and the LED inside the unit should turn off. (See figure 3 below)

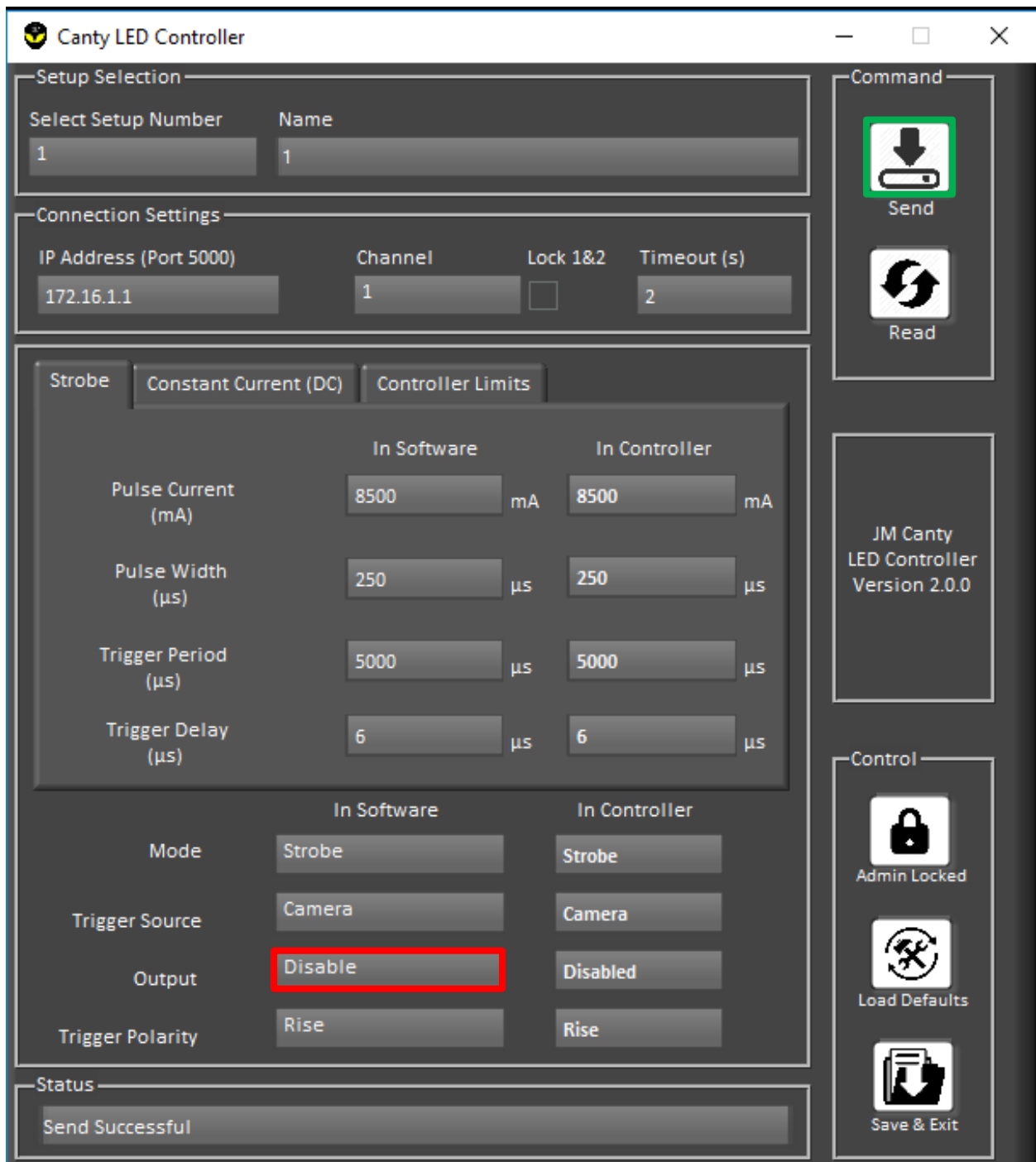


Figure 3 shows the LED Controller window. The red box shows the Enable/Disable function for the LED strobe light inside the Analyzer. The green box shows the “Send” button to click after changing settings in the LED Controller window.



17. Close out of the “Canty LED Controller” window by selecting the red “X” and close out of the Canty Vision software again using the red “X” to return to the VCM home-screen.
18. Select the second option from the window on the left labeled “Data Communications” to open the Grease Thief Analyzer software. This will be used to communicate from the VCM to the Grease Thief Analyzer and will store the die extrusion results of each test.
19. A Calibration Overdue window may pop up once the Grease Thief Analyzer software is opened. Click “OK” and the calibration menu will open. This screen will be used when ready to calibrate the instrument before running samples. Click on “Data” in the top left and then select “Samples” to return to the main sample menu of the Grease Thief Analyzer software.
20. To ensure the instrument is connected properly, click “Import from GTA” on the left side above the data table. Once the new screen appears, click “Connect” and a list of the 5 most recent tests will appear. If these tests show up, the unit is correctly connected to the VCM. If an error window pops up after clicking “Connect”, there is an issue with the connection between the unit and the VCM. Refer to the Troubleshooting section of this SOP to test connectivity of the Grease Thief Analyzer. If connected properly, the screen should look like figure 4.

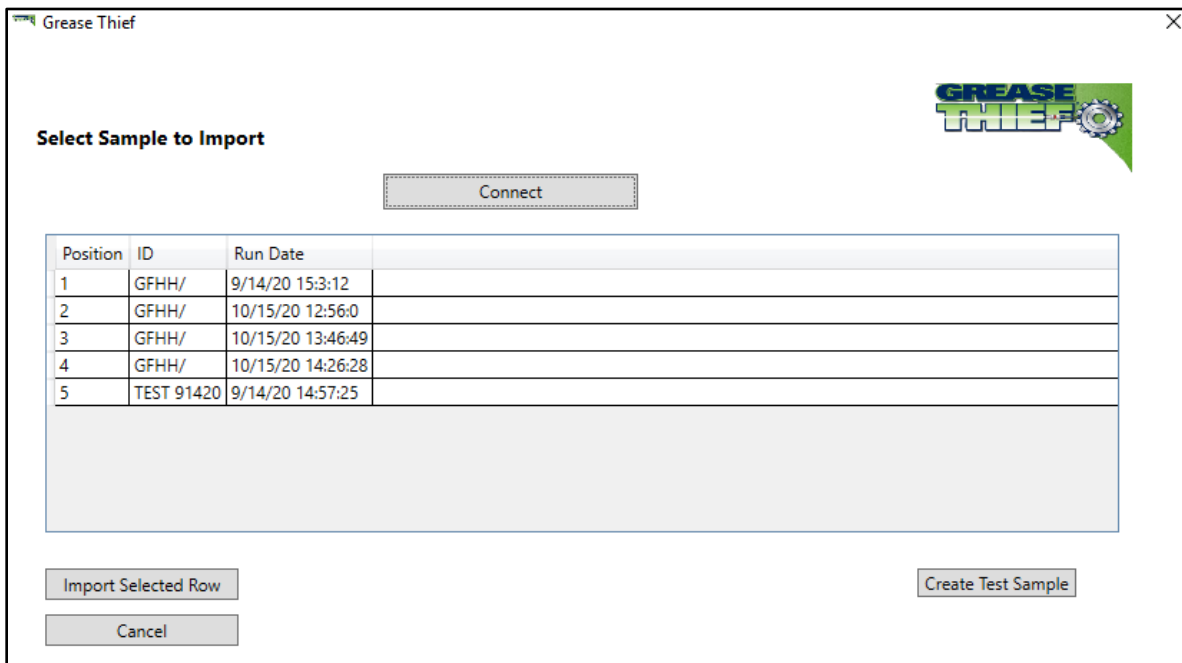
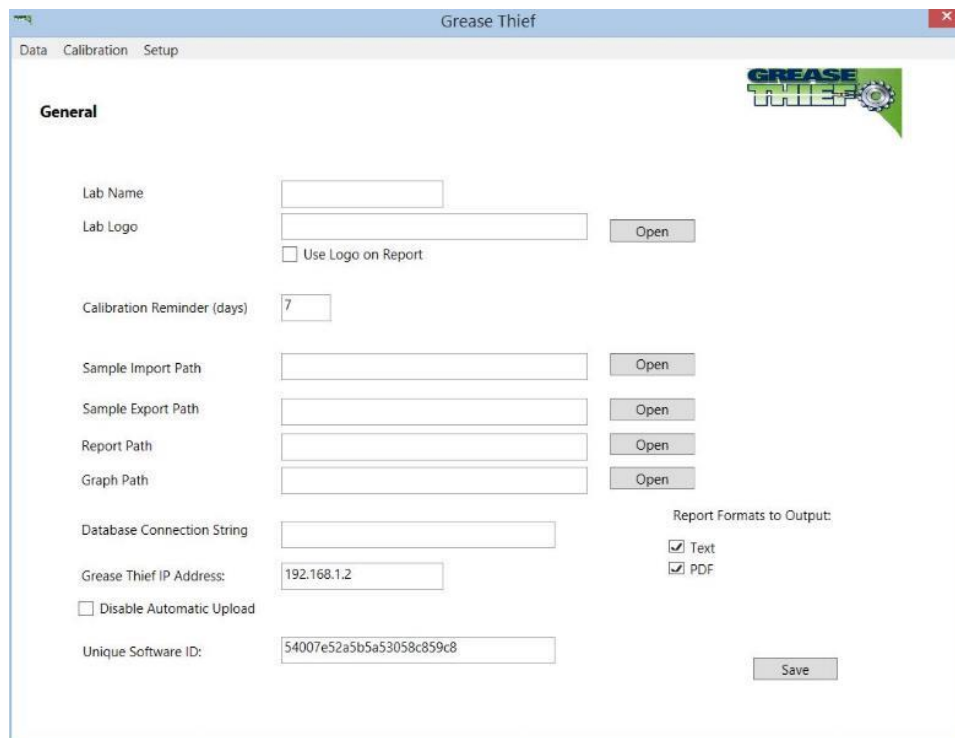


Figure 4 shows the sample “Import From GTA” screen with the five most recent tests. This should be what the screen looks like if the Grease Thief Analyzer is connected properly

21. Close out of the Grease Thief Analyzer software using the red “X” to return to the VCM home-screen.
22. If these steps were followed and all components are properly connected, the VCM and Grease Thief Analyzer are ready for sample analysis.
23. **Before operating the instrument for the first time and anytime the power is cycled, the actuator home position needs to be reset.** To do this navigate from the Menu to the Sample screen. This will be the screen the instrument boots to as well. The not homed error will be displayed at the top of the screen. Ensure the door is closed and the loading zone is clear. Press the “Start” button and the actuators will return to the home position sensors and set the home position.
24. Before running the instrument for the first time, perform a calibration check (covered in the **Calibration Checks** section). Perform daily calibration checks before use. The full standardization procedure is only necessary if the instrument fails a daily calibration check.

4. Software Setup

1. Open the “Data Communications” software program.
2. Under the Set-up → General menu set the default report, export, and import paths. Lab name and a Logo, which will appear on the .pdf reports, may also be changed here. These paths are necessary to save the report and image files. They can be the same folder, but should be filled in with enough information to identify the sample tested.
3. Leave the Database Connection String blank and the Disable Automatic Upload unchecked unless directed by technical support.
4. Under the Set-up → Lists menu you can set default entries for the sample identification fields. These lists can also up updated while naming samples.



The screenshot shows the 'General' tab of the Grease Thief software. The window title is 'Grease Thief' and it has a menu bar with 'Data', 'Calibration', and 'Setup'. The 'General' section includes the following fields and options:

- Lab Name: [Empty text box]
- Lab Logo: [Empty text box] with an 'Open' button and a checkbox for 'Use Logo on Report'.
- Calibration Reminder (days): [7]
- Sample Import Path: [Empty text box] with an 'Open' button.
- Sample Export Path: [Empty text box] with an 'Open' button.
- Report Path: [Empty text box] with an 'Open' button.
- Graph Path: [Empty text box] with an 'Open' button.
- Database Connection String: [Empty text box]
- Grease Thief IP Address: [192.168.1.2]
- Disable Automatic Upload
- Unique Software ID: [54007e52a5b5a53058c859c8]
- Report Formats to Output:
 - Text
 - PDF
- A 'Save' button is located at the bottom right.

Figure 5 General information tab of the Grease Thief Analyzer software

5. Calibration Checks

At the beginning of each working shift or daily, perform a calibration check to maintain the precision of the instrument. This procedure will compare the performance of the load cell to a known standard. If the results are beyond acceptable variations the full standardization procedure should be run to calculate a new K and Offset that account for load cell drift.

1. If this is the first time running the instrument or after cycling power, set the home position of the actuator and check the IP address in the Set-up→General page of the analysis software. If instrument set-up has been completed, this step may already have been completed. See **Instrument Initialization** and **Software Set-up** for more details.
2. Enter the Calibration Screen (shown below in Figure 6) from Navigation Menu by pressing the “Calibration” button on the touch screen. To return to the Navigation Menu at any time press the “Menu” button at the bottom left corner. See Navigation Map in
- 3.
4. **Appendix I - Navigation Menu Map.**

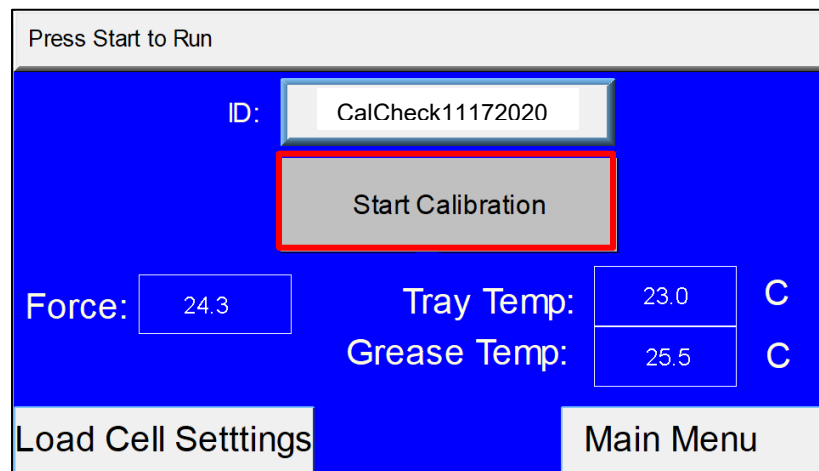


Figure 6 Calibration Screen

5. Go to the Load Cell Settings screen and confirm the Speed and Time values shown below in 7. To change a value, select the field on the touch screen and input the desired value using the keypad, then press “Enter” to confirm.

Flow	0.25 mm/sec
------	-------------

Time	70 sec
------	--------

Figure 7 Load Cell Settings

6. If this is the first time running the instrument, the load cell K and Offset will have been set by the factory calibration. If the standardization procedure has been performed, the values in these fields should match those determined in the most recent standardization.
7. Load the spring cell calibration device into the instrument and screw down the placement bracket with the black knob. Ensure the body of the spring cell is seated centered in the bracket and the shaft lines up with the center of the load cell well, by holding the spring cell above the bracket yolk and pushing down and back firmly. Tighten the bracket clamp until it doesn't move. Loading a substrate onto the table under the spring cell can help maintain proper alignment.

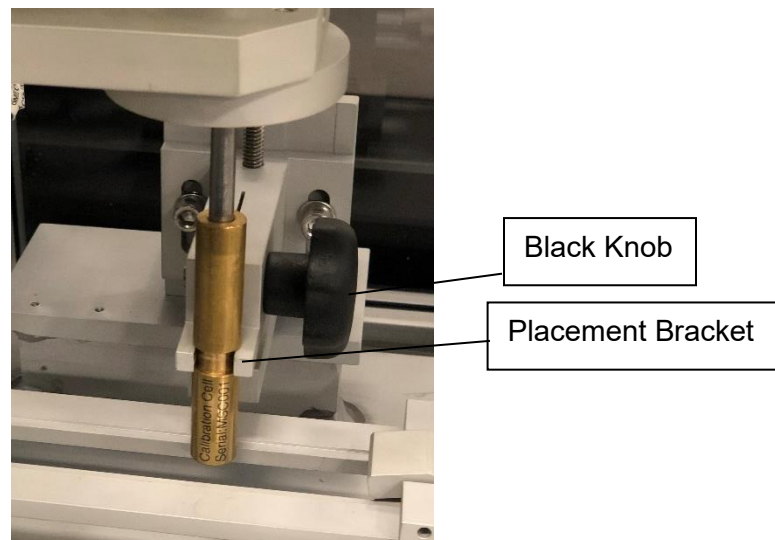


Figure 8 Spring Can in bracket

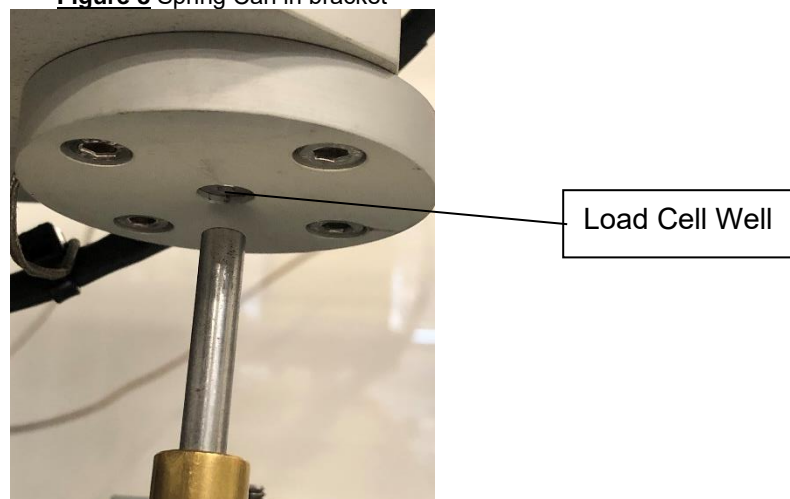


Figure 9 Spring Can aligned with load cell

8. To enter or edit the sample ID, select the sample name field on the Calibration screen (shown below in **Figure 10**) using the touch screen. Use the alpha-numeric keypad to enter the sample name and press “Enter” to confirm. This name should uniquely identify the run being performed. For example cal or calck followed by the date and a sequence identifier if multiple runs are performed on the same day. (e.g. calck0714a) Use the alt key on the keypad to cycle through the pages of characters.

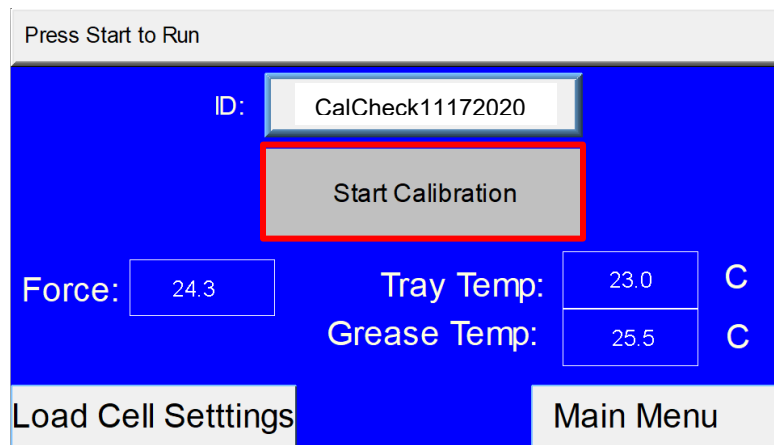


Figure 10 Calibration Screen

9. Press the “Start Calibration” button to begin the test. The trial should take 70 seconds and will consist of only the vertical compression of the spring cell. The calibration check does not need to be performed at a set temperature, so it can still be run if the low temperature error is displayed.
10. When the test is complete, press the “Stop/Return” button on the touch screen to reset the instrument and then remove the spring cell.
11. Open the Grease Thief Analysis software on the VCM. This software will be used to find the new Load cell K and Offset digital correction factors.
 - 11.1. Open the Data Communications program.
 - 11.2. Under the Calibration menu select “Calibration Check.”
 - 11.3. Click the “Get Data from Grease Thief” button, then click the “Connect” button, and select the file corresponding to the calibration trial you ran. Click the “Import Selected Row” button to transfer the trial.
 - 11.4. Click the “Calibration” button and the software will display at pass/fail rating based on a comparison of the calibration check trial to the known profile for the provided spring cell.

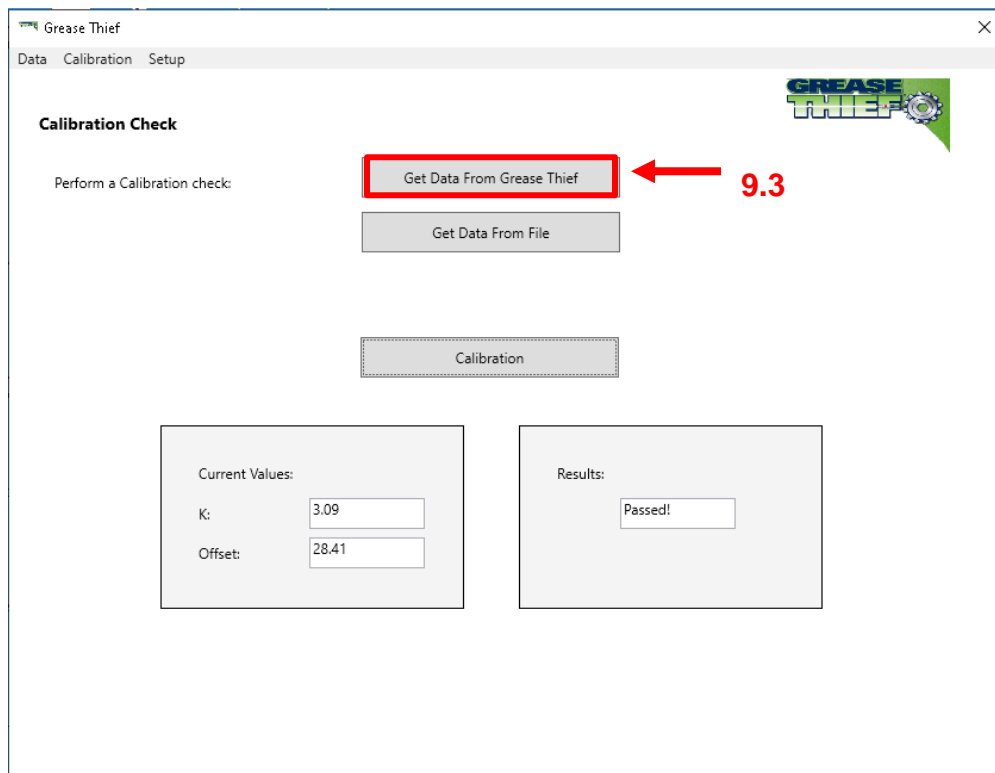


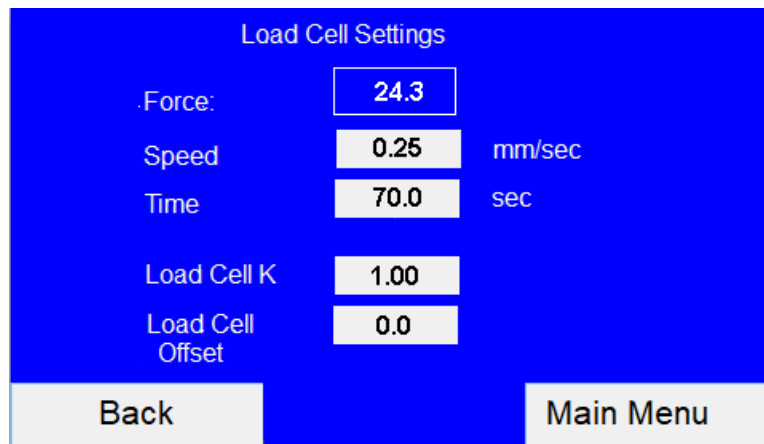
Figure 11 Software Calibration Screen

12. If the calibration check passes, continue to use the instrument as normal. If the calibration check fails, attempt to re-run the check procedure. If multiple checks fail consecutively, the standardization procedure should be run.

6. Standardizing the Instrument

The force sensor analogue output is governed by a user set K and Offset. These values are set by comparison to a spring with known force response. Perform daily calibration checks to maintain the precision of the instrument and perform this full calibration procedure if the instrument fails a check.

1. If this is the first time running the instrument or after cycling power, set the home position of the actuator and check the IP address in the Set-up→General page of the analysis software. See **Instrument Initialization** and **Software Set-up** for more details.
2. Access the Load Cell Settings Screen (shown below in 12) from Navigation Menu by pressing the “Calibration” button on the touch screen, then the “Load Cell Settings” button. To return to the Navigation Menu at any time, press the “Menu” button at the bottom right corner.



Load Cell Settings	
Force:	24.3
Speed	0.25 mm/sec
Time	70.0 sec
Load Cell K	1.00
Load Cell Offset	0.0
<div style="display: flex; justify-content: space-between;"> Back Main Menu </div>	

Figure 12 Load Cell Settings

3. Confirm the Speed and Time values shown below in **Figure 13** into the Load Cell Settings screen. To change a value, select the field on the touch screen and input the desired value using the keypad, then press enter to confirm.

Flow	0.25 mm/sec
Time	70 sec

Figure 13 Load Cell Settings

4. Load the spring cell calibration device into the instrument and screw down the placement bracket with the black knob. Ensure the body of the spring cell is seated in the bracket and the shaft lines up with the center of the load cell well, by holding the spring cell above the bracket yolk and pushing down and back firmly. Tighten the bracket clamp until it doesn't move. Loading a substrate onto the table under the spring cell can help maintain proper alignment.
5. Return to the Calibration screen (shown below in Figure 14) by pressing the "Back" button or the "Calibration" button from the Navigation Menu. To enter or edit the sample ID, select the sample name field using the touch screen. Use the alpha-numeric keypad to enter the sample name and press "Enter" to confirm. This name should uniquely identify the run being performed. For example, cal or calck followed by the date and a sequence identifier if multiple runs are performed on the same day. (e.g. calck0714a)

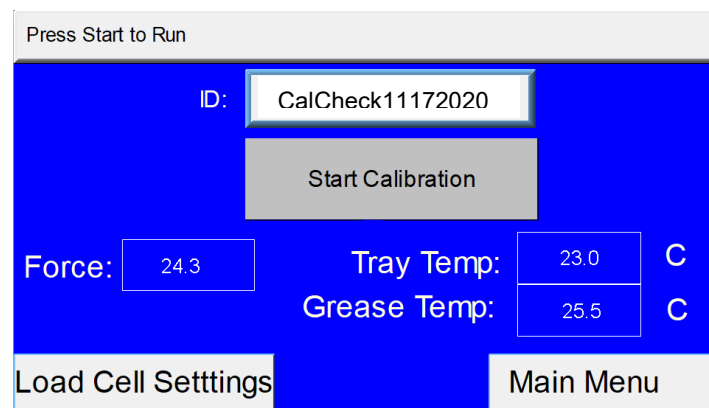


Figure 14 Calibration Screen

6. Press the "Start Calibration" button to begin the test. The trial should take 70 seconds and will consist of only the vertical compression of the spring cell. The horizontal table will not move. The calibration check does not need to be performed at a set temperature, so it can still be run if the low temperature error is displayed.
7. Monitor the live force reading displayed on the screen. If it remains unchanged for the duration of the test the shaft alignment may be incorrect. Check the alignment and restart the test if necessary.
8. When the test is complete, press the "Stop/Return" button on the touch screen to reset the instrument and then remove the spring cell.
9. Now open the Grease Thief Analysis software on the VCM. This software will be used to find the new Load cell K and Offset digital correction factors.

- 9.1. Open the Data Communications program.
- 9.2. Under the Calibration menu select Standardization.
- 9.3. Click the “Get Data from Grease Thief” button, then click the “Connect” button, and select the file corresponding to the calibration trial ran. Click the “Import Selected Row” button to transfer the trial.

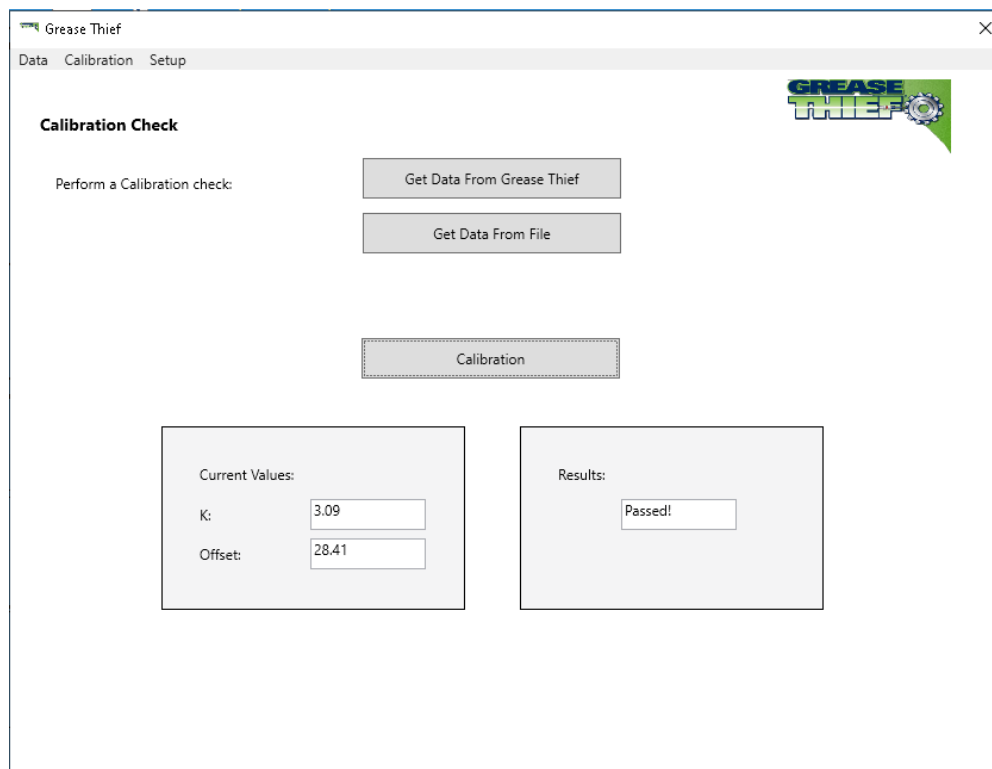


Figure 15 Software Calibration Screen

- 9.4. Check that the current values for the K and Offset match what are shown on the Load Cell Settings screen when the trial was run. Correct the values in the software to match the ones on the instrument if necessary.
- 9.5. Click the “Standardize” button and the software will calculate and display a new K and Offset based on the calibration trial input.
- 9.6. Input the new K and Offset into the Load Cell Settings screen.



10. This completes the standardization procedure. Press the “Menu” button on the instrument control panel to return to the Navigation Menu. Run a calibration check to confirm the passing status of the instrument. If calibration passes, the instrument may now be used to analyze samples.

Note: If several consecutive checks fail directly following a standardization, the standardization procedure may need to be repeated. If this occurs multiple times or only a few tests are able to be run between standardizations, the instrument may need to be serviced.

7. Running a Test (Sample or Baseline)

Grease Thief Analyzer

This test is a consistency comparison between in-service grease samples and a referenced baseline provided by the customer. To complete the analysis procedure, this test must be run on the sample as well as the new reference baseline. The test procedure is the same for samples and baselines, except for importing into the Data Communication software for comparison.

1. Before analysis, the specimen must be packed into a Grease Thief (GT)
2. Screw an extrusion die onto the open end of the GT.
3. Turn the heater in the sample rack to on.
 - 3.1. To set the temperature, navigate to the Temperature Control screen (shown below in Figure.) from the Navigation Menu by pressing the “Temperature Control” button on the touch screen.

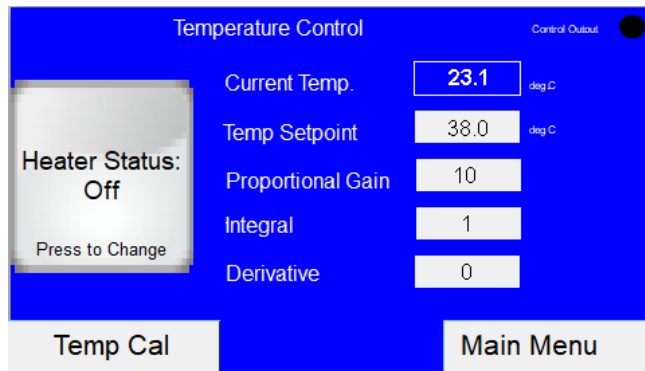


Figure 16 Temperature Control Screen

3.2. Press the “Heater Status” button to turn the heater on and off.

Note: The “Temp Cal” button is for calibrating the Temperature sensors and will not be used during routine use. Use this feature only if instructed by technical support.

3.3. The “Heater Status” button displays the current state on it. If it shows on, the heater is on, and pressing the button will toggle the heater off.

3.4. The temperature set point should be set to 31°C for routine samples.

3.5. The PID settings control the set-point tracking response of the temperature controller. The default PID values and Temperature Set-Point are shown below in **Figure 7**.

Temp SP	31
P	10
I	1
D	0

Figure 17 Default Temperature Controller PID settings

4. Samples must be loaded into the sample tray with the temperature control turned on for 15 min prior to testing, to allow them to reach the appropriate temperature.
5. Return to the Sample screen (shown below in Figure 18).

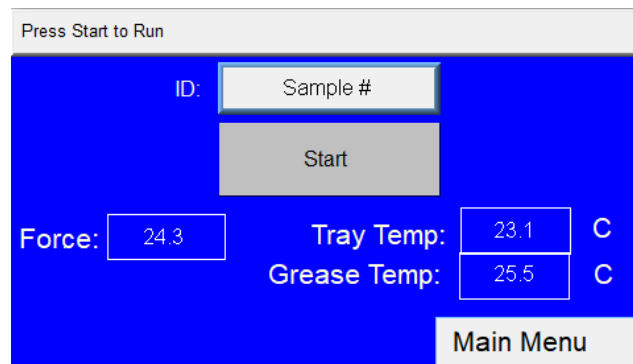


Figure 18 Sample Screen

6. To edit the sample ID field, touch the button and enter the sample ID using the keypad. Then press “Enter” to confirm the selection.

7. Once the sample has been allowed to reach the required temperature, open the door and place one substrate on the table as shown in the Figure 19 below. The substrate should sit loosely in the tray with the clear plastic side facing up, and overhang no more than 3/4” at either end.

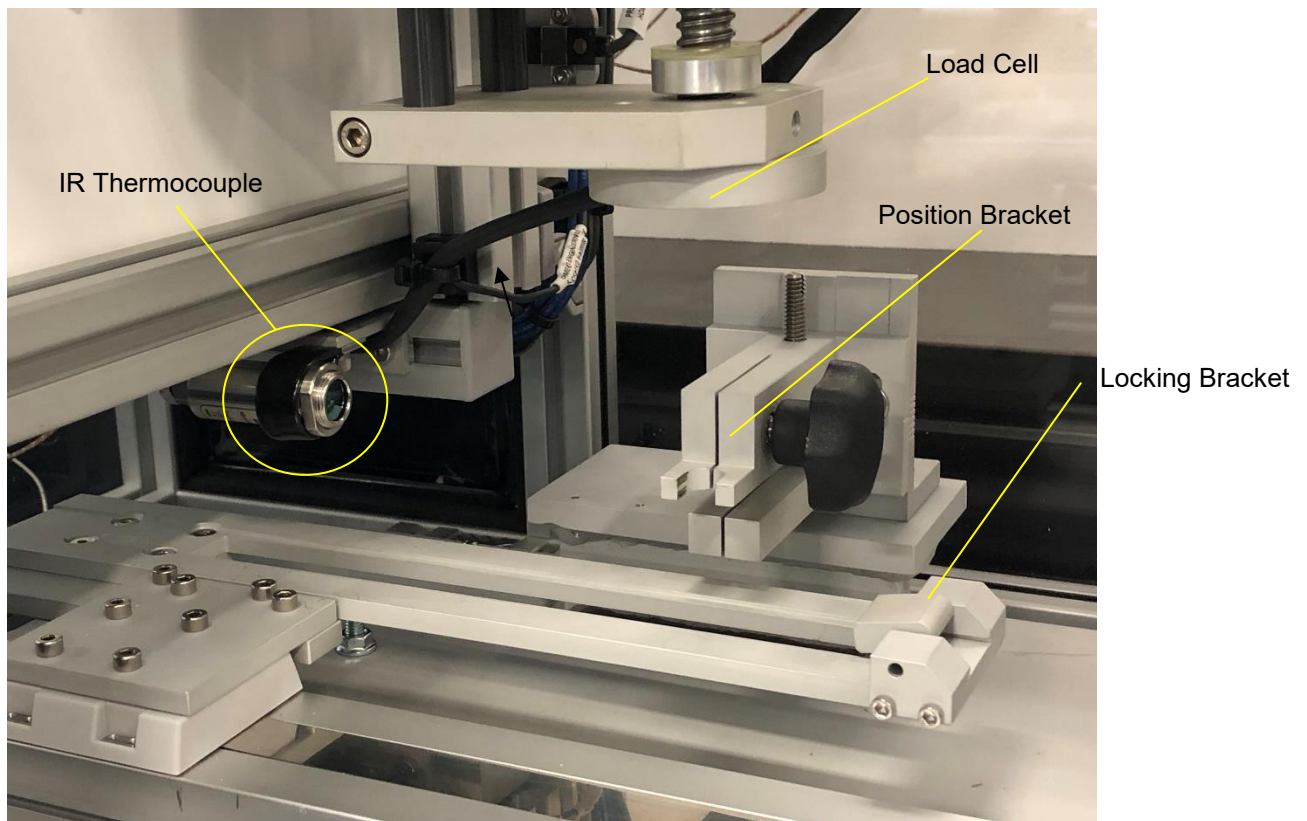


Figure 19 Infrared sensor, the load cell, and the position bracket

8. Hold the substrate by the edges and avoid touching the clear plastic side where the grease film will be captured.
9. Flip the locking bracket on the right to secure the substrate to the table.
10. Take the sample and place it in the position bracket, making sure that the narrow slot opening of the die faces the exit direction (right) as shown in the **Figure** below. Again, avoid touching the areas that the grease makes direct contact with (such as the exit slit on the die) to prevent cross contamination of the sample.
11. Take care when positioning the sample so the shaft of the Grease Thief will align properly with the load cell well. Hold the Grease Thief above the bracket and press gently downward and push the head of the die against the guide block before screwing the bracket clamp tight.
12. Depending on the fill of the GT, the shaft may need to be manually advanced slightly for it to

fit within the load cell well.

13. If the GT is underfilled, the handle may not initially rest within the well. If this is the case line the handle up with the load cell visually and preform the rest of the test normally.

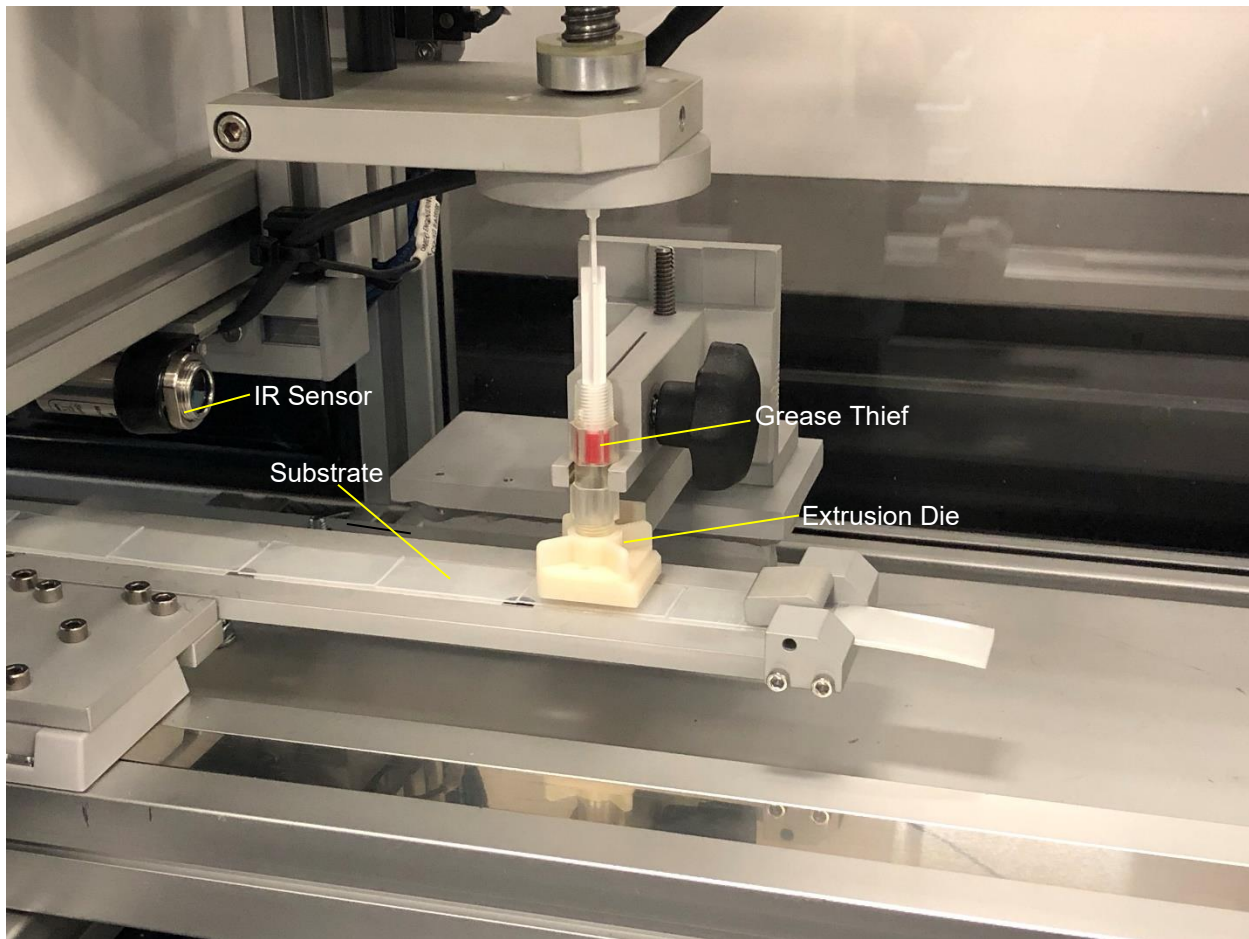


Figure 20 Grease Thief, extrusion die, substrate, and IR sensor in the analyzer

14. A non-contact IR thermometer is used to monitor the temperature of the sample and when the temperature control is turned on will state “Press Start to Run” if the sample is at the appropriate temperature. If the message says “Low Temperature” remove the sample from the GT holder and place it back on the heating tray. If the message says “High Temperature” wait for the sample to cool before running the test.
15. Press the “Start” button on the touch screen Main menu to start the test.



16. When the test is complete, open the door of the unit and unclip the substrate from the table.

Caution: The instrument interlock will not allow the position to be reset until the door has been opened to remove the substrate and empty Grease Thief. Resetting the position before performing this step will wipe the extruded film off of the substrate.

17. Remove the GT from the bracket and remove the substrate from the table by unclipping it and sliding it to the left.

18. Close the door and press the “Stop/Return” button and prepare the unit for another run.

Caution: The basic internal memory holds only 5 tests. As more tests are run, the oldest on the internal memory will be overwritten. Transfer tests to permanent disk space after each trial to prevent accidental data loss.

19. The results are stored on internal memory until they are downloaded by the VCM. At that time runs are named and identified as a sample or a baseline. See **Importing and Analyzing Data** for more information.

Canty Particle Counting System

1. Load the Canty Vision Intelligent Analysis by clicking “Open CV Software” from the VCM home screen.
2. Open the configuration file by going to **File->Load Config**. The default configuration file can be found under **C:\Canty Configuration**
 - a. Open the **Grease Thief_Configuration** file.
 - b. A prompt to open a classification file will also appear.
 - c. Open the **MRG_Classification.clf** file.
3. The LED display screen should open automatically and send a signal to the LED.
 - a. In the case that it does not automatically open, turn on the LED display by navigating to **Tools->Hardware->LED Controller**.
 - b. Under the “Output” setting, select “Enable” and then hit the “Send” button.
 - c. This should turn the LED on.
4. Exit the LED controller window.
5. Run normal grease extrusion method, but **do not return** the tray and sample.
6. Remove the now-empty Grease Thief™ from its bracket, **do not to bump the load cell**.
 - a. For samples that are already extruded or are being run multiple time make sure to cycle the GTA door to allow the actuator to return to the home position.
7. If necessary, move the substrate so that the maximum length of extrusion will be

recorded by the Canty system.

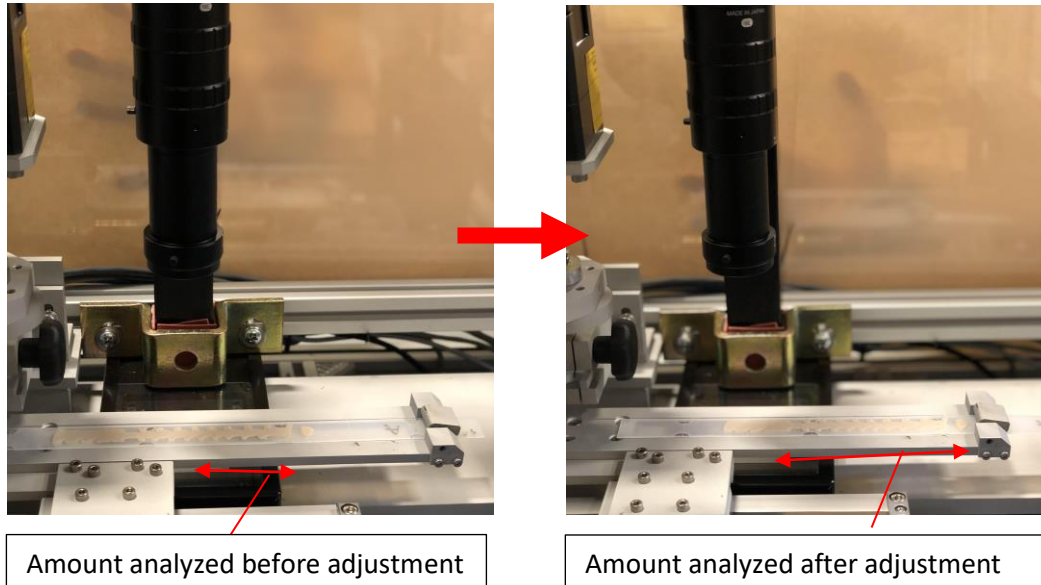


Figure 21 shows the position of the substrate before and after repositioning to run particle count

8. Click the “Live Analysis” button in the bottom left of the CVIA software seen in the image below. The “Analysis and Record” can also be pressed in place of “Live Analysis” if the user wants to record a video of the particle counting.
 - a. This should bring up an auto-adjustment screen that will change the pulse and gain on the camera and LED for ideal imaging.

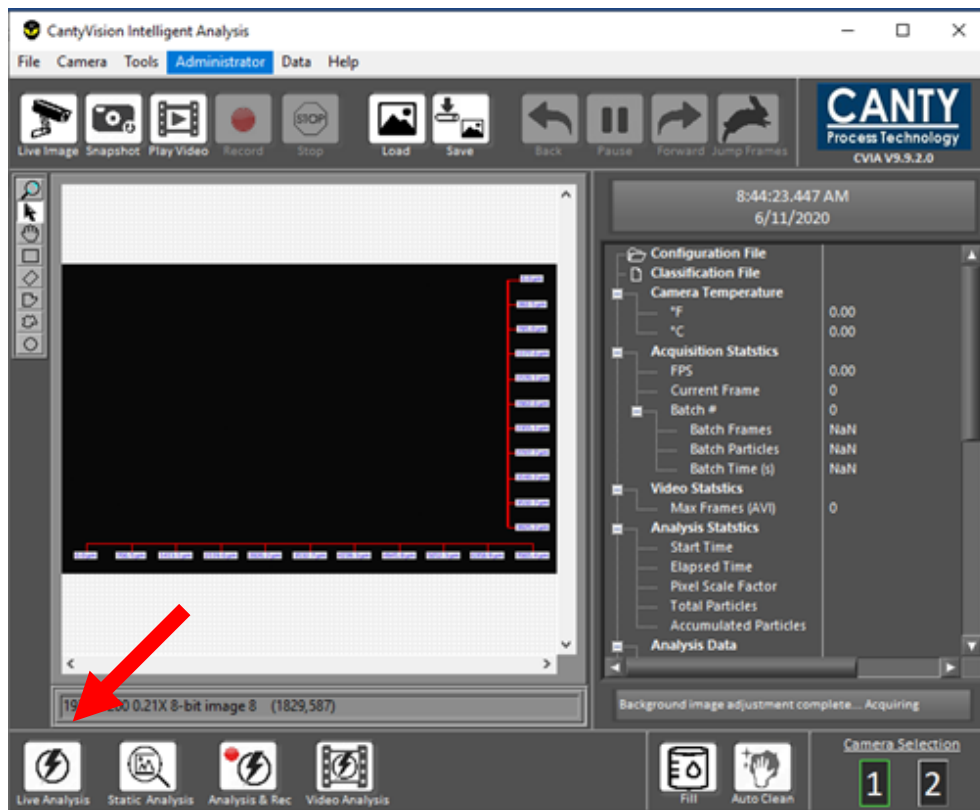


Figure 22 shows the sample analysis screen with an arrow pointing to the “Live Analysis” button

READ STEPS 9-11 BEFORE PROCEEDING

9. Enter your sample ID and press okay. **Be prepared to return the GTA tray as soon as “okay” as pressed.**
10. **As soon as the auto-adjustment screen indicator light in the top left corner changes from yellow to green to indicate completion press the “Stop/Return” button on the GTA touchscreen.**
 - a. Auto-adjustment can take anywhere from 15 seconds to 3 minutes.
 - b. It is important that the tray is already moving by the time that the analysis begins, if it is not rerun the sample.

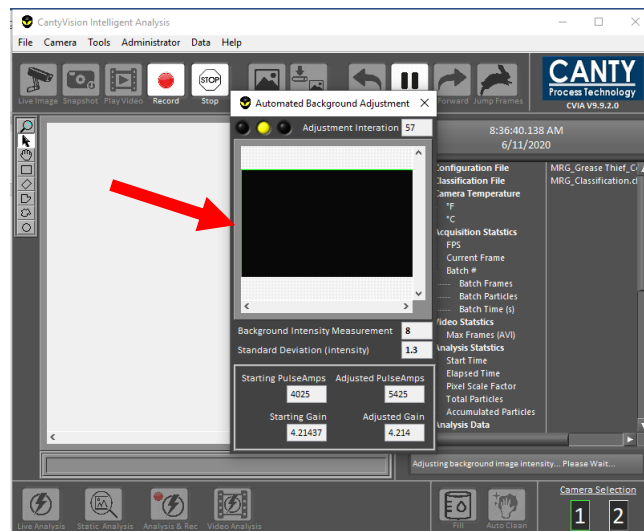


Figure 23 shows the “Automated Background Adjustment” window

11. Once the run is finished hit the “Stop” button to stop canty recording.
 - a. This will automatically save a report of the sample tested to **C:\Users\Operator\Documents\Reports.**

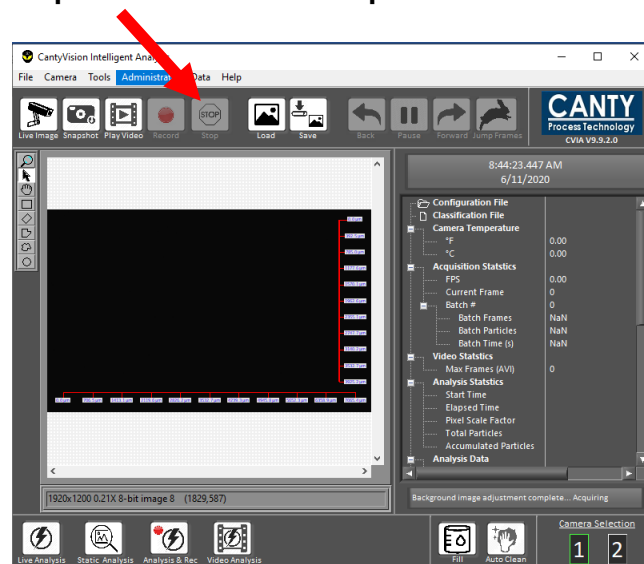


Figure 24 shows the sample analysis screen with an arrow pointing to the “Stop” button. This should be pressed when the full substrate moves through the camera’s view.

Clean-up

12. Turn off the LED by navigating to **Tools->Hardware->LED Controller**.
13. Under the “Output” setting, select “Disable” and then hit the “Send” button.
 - a. This should turn the LED off.

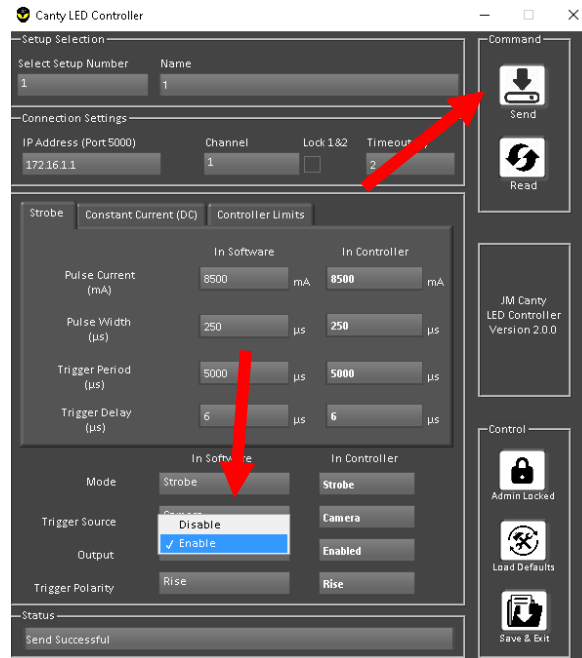


Figure 25 shows the “LED Controller” window with arrows pointing at the “Enable/Disable” LED setting and the “Send” buttons

14. Close out of the CVIA software.

8. Importing and Analyzing Data

1. If this is the first use of the software, set the default file paths for saving reports and Importing samples. See **Software Set-up** for more information. If the instrument has already been calibrated, this step may have previously been completed.

- To retrieve data from the instrument, open the Grease Thief Analysis software. Go to the Samples page in the Data menu and click on the “Import from GTA” button.

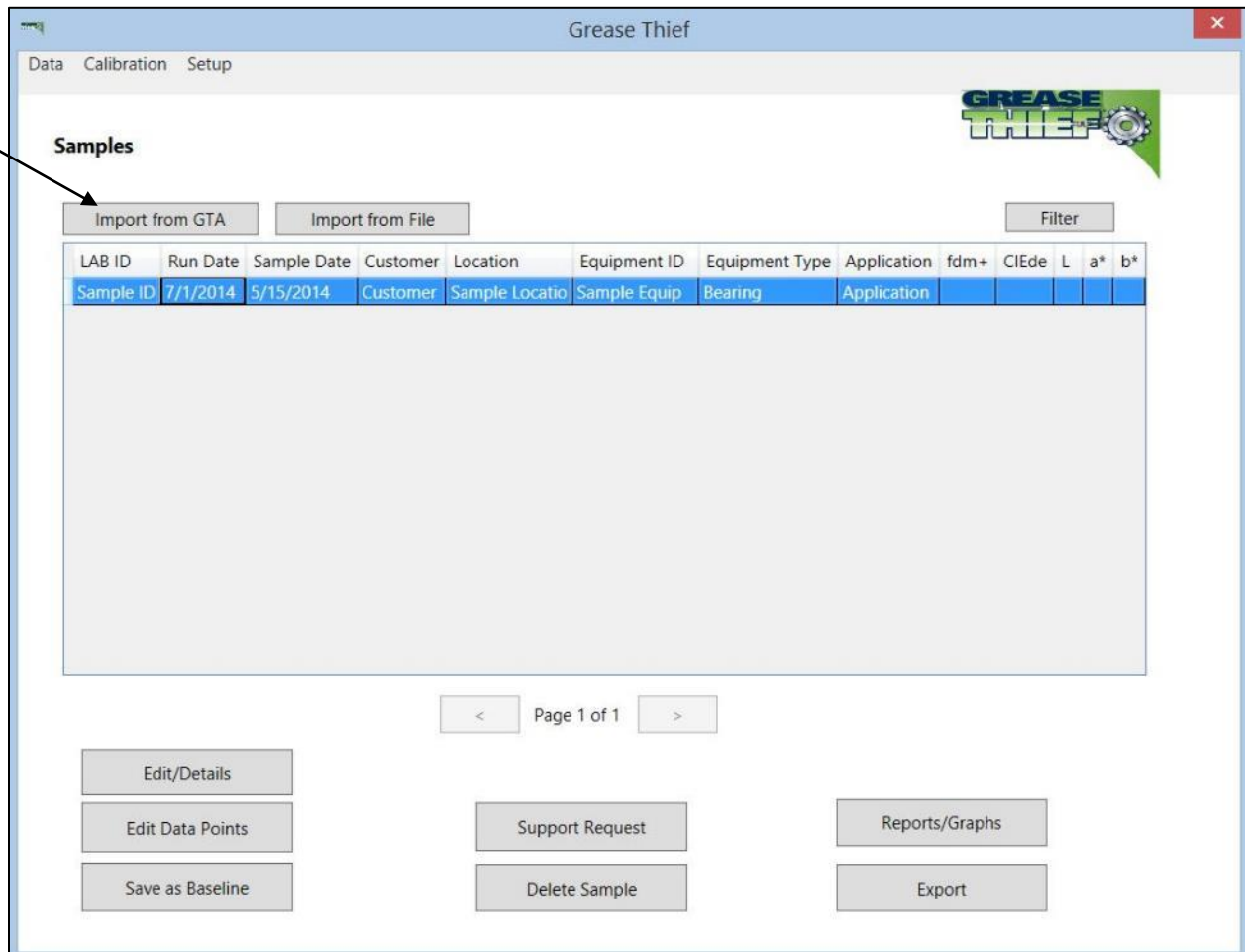


Figure 26 Import option in the Grease Thief analyzer software

3. Click the “Connect” button.
4. Select the desired sample from the grid.
5. Click the “Import Selected Row” button.

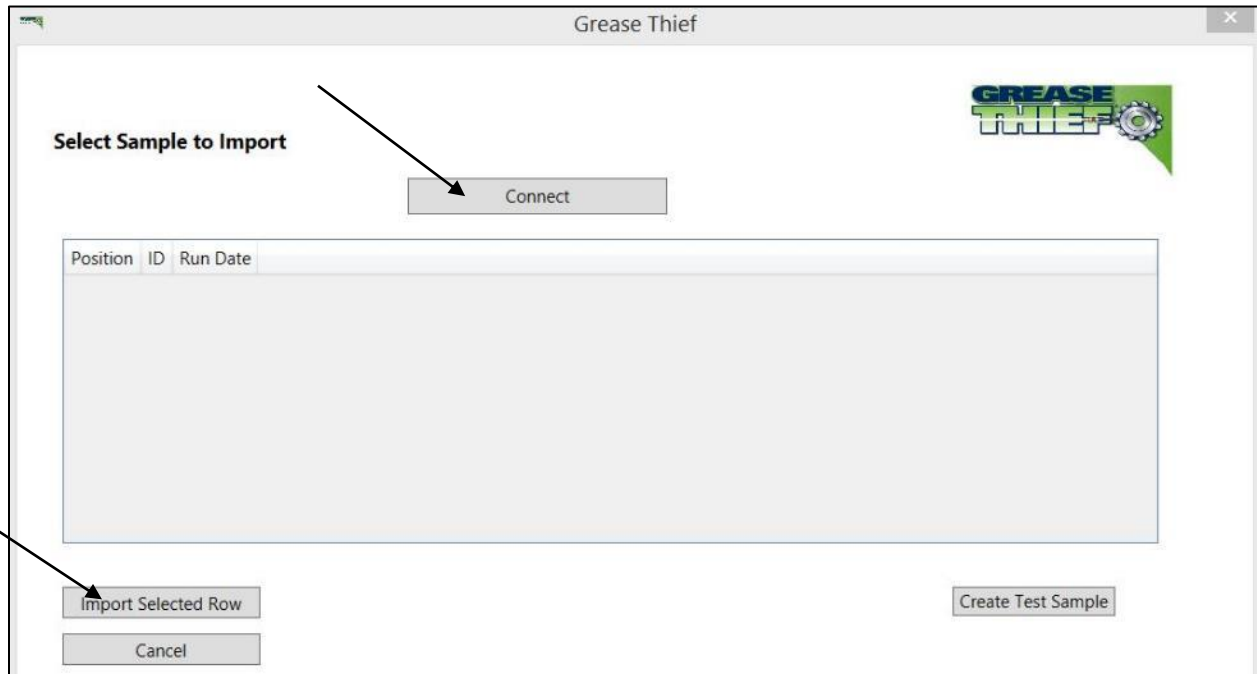


Figure 27 Connect option and import data from selected row in Grease Thief software

6. Enter all known identifying information for the sample on the details page and click “Save.” These fields can be left blank and/or modified later if desired. This page can be returned to from the Samples page by clicking the “Edit/Details” button.

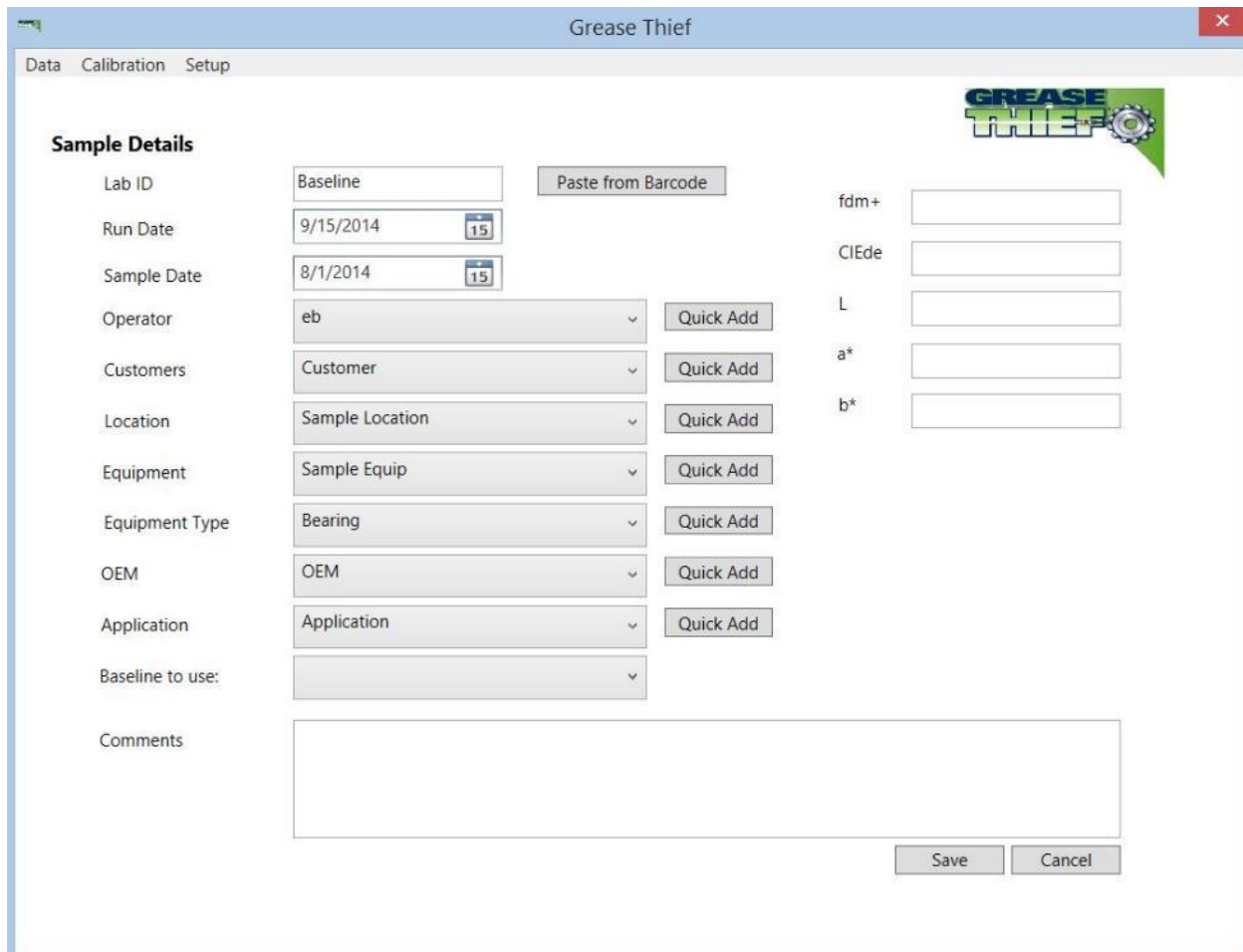


Figure 28 Sample details page of the Grease Thief software

7. The baseline list is populated with the records you have designated as baselines or references.
 - 7.1. If the baseline is unknown, you can leave this field blank, but the GT Index cannot be calculated without a reference.
 - 7.2. If the grease run is a baseline, leave this field blank. The entry can be designated as a baseline by selecting it on the Samples page and clicking the “Save as Baseline” button at the bottom of the screen. Ensure air bubbles/gaps are taken out of the baseline



spectrum before saving. See **Modifying Data Points** for more information.

8. The lists for the sample identifiers can be managed in the Set-up→Lists menu or use the quick add buttons to add new labels from this screen.

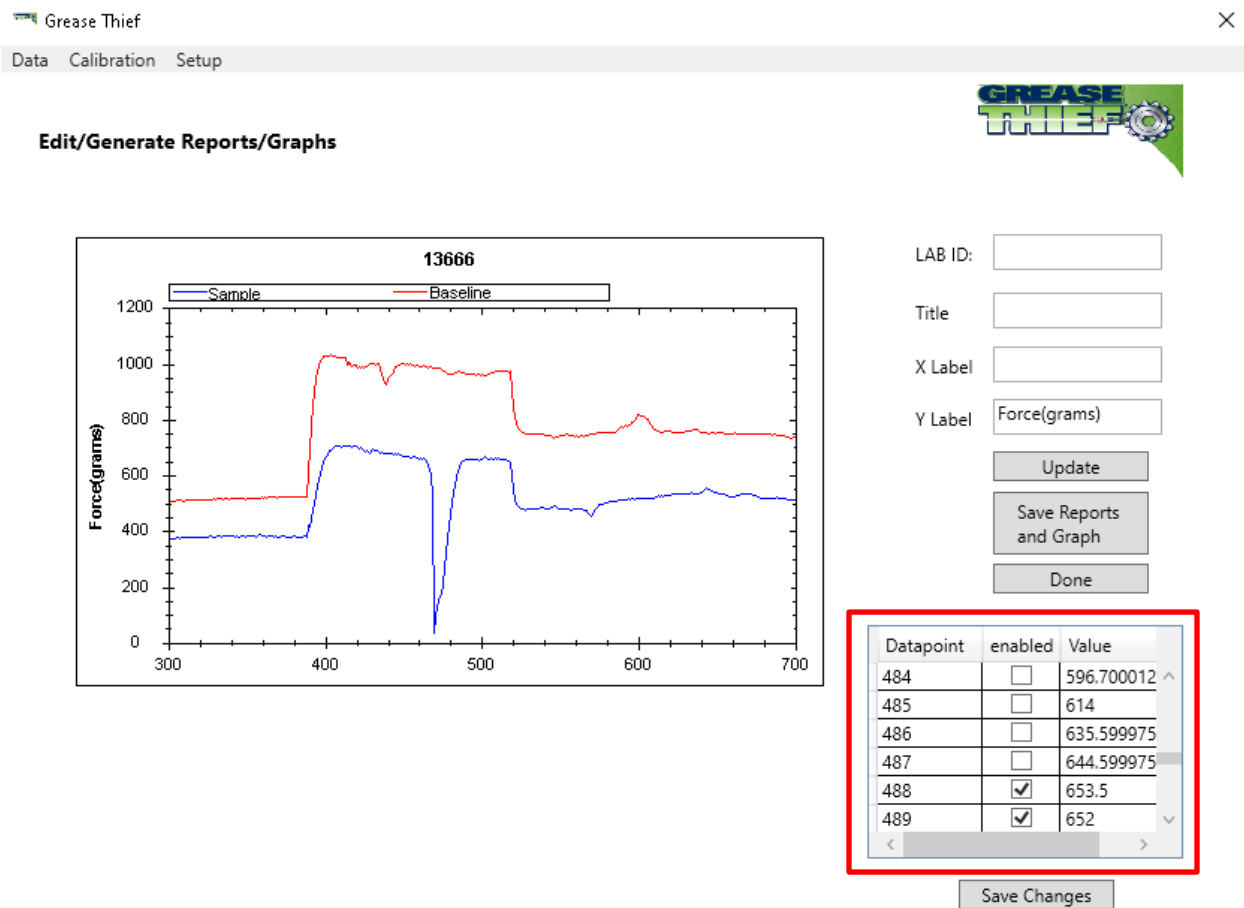
Printing Reports

9. To review the result of the test, select the entry for the desired sample from the samples screen and click the “Reports/Graphs” button. This will display the graphical depiction of the trial.
10. To generate the GT Index and save the results to file, click the “Generate Reports and Image” button. The graph will be saved in a .jpg format and the calculated results will be saved in both a .pdf and a .txt format. Ensure a Baseline is assigned before the reports are generated or the GTI will show as zero. See **Importing and Analyzing Data** Steps 6 and 7.
11. Use the General page under the Setup menu to enter save locations for the reports and graphs. See the **Software Set-up** section for more information.
12. The calculations take average force values from the 3 different speeds the test is run at. Due to hard particles or an air bubble/gap in the grease, parts of this data may deviate from the stable values. In these cases, the data points that deviate will need to be manually selected to be ignored from the calculations. To do this see the **Modifying Datapoints** section.
13. Click the “Save” button to store changes and return to the Samples page.

9. Modifying Data-points

1. The calculations take average force values from the three different speeds the test is run at. Due to hard particles or an air bubble/gap in the grease, parts of this data may deviate from the stable values. In these cases, the data points that deviate will need to be manually selected to be ignored from the calculations.
2. There are two places the data-points that make up the trial results can be modified.
 - 2.1. From the Samples page select the desired entry and click the “Edit Data Points” button.
 - 2.2. From the Samples page select the desired entry and click the “Reports/Graphs” button.

3. Make note of the data points to be removed from the calculations.
4. In the Calculated Data grid, checked boxes indicate points that are included in the calculations. To ignore data points or a range of data points uncheck the boxes next to the desired points. Multiple points may be selected at one time on the Edit Data Points screen
5. Use the drop-down menu to apply simple operations to the selected data set (ex. Enable and disable points). The original data will be preserved, but calculations will be performed on the modified data set.



The screenshot shows the 'Edit/Generate Reports/Graphs' screen in the Grease Thief software. On the left is a line graph titled '13666' with 'Force(grams)' on the y-axis (0 to 1200) and an unlabeled x-axis (300 to 700). Two lines are plotted: a blue 'Sample' line and a red 'Baseline' line. The blue line shows a sharp dip to near zero around x=480. The red line shows a step increase from ~500 to ~1000 between x=400 and x=500. On the right, there are input fields for 'LAB ID', 'Title', 'X Label', and 'Y Label' (set to 'Force(grams)'). Below these are 'Update', 'Save Reports and Graph', and 'Done' buttons. A table with a red border is highlighted, containing data points for modification:

Datapoint	enabled	Value
484	<input type="checkbox"/>	596.700012 ^
485	<input type="checkbox"/>	614
486	<input type="checkbox"/>	635.599975
487	<input type="checkbox"/>	644.599975
488	<input checked="" type="checkbox"/>	653.5
489	<input checked="" type="checkbox"/>	652 v

Below the table is a 'Save Changes' button.

Figure 29 shows the Reports/Graph screen. The red box indicates the table used to modify the graph and remove unwanted data points.

10. Temperature Sensor Calibration

In the event of damage or during troubleshooting it may be required to recalibrate the IR thermocouple used to monitor the grease temperature at the point of measurement.

1. Fill a clean grease thief with a known new grease.
2. Screw on the extrusion die and remove the white handle from the back of the GT.



Figure 30 Filled Grease Thief without piston

3. Embed a calibrated thermocouple in the grease entering through the back of the GT. The red piston may need to be removed as well to allow this. Select a grease medium that will not easily run out of the GT when the piston is removed if this is required.



Figure 31 Omega thermocouple embedded in Grease Thief

4. Turn the preheating rack on and preheat the grease to $\sim 40^{\circ}\text{C}$. This should take about 15

minutes.

5. Check the embedded thermocouple and confirm temperature is sufficiently above 35°C. Several measurements will need to be taken as this grease cools to room temperature. If the GT is not above 35°C, put it back on the rack and continue preheating.
6. Put the GT in the position block and ensure the IR thermocouple is aimed at the GT perpendicular to a flat surface on the GT.



Figure 32 Thermocouple embedded in Grease Thief to test with IR sensor

7. As the grease cools, take readings from the embedded thermocouple and the IR thermocouple on the instrument display every 10 seconds or every 0.5°C.
8. The embedded thermocouple temperature will be the x values and the IR display temperature will be the y values in a coordinate system.
9. Plot the points. Results should follow a linear relationship. If they do not, consider rerunning the trial or the sensor is potentially damaged.
10. The line should follow the equation $y=mx+b$, where in a properly calibrated sensor m is 1 and b is 0. $y=(1)x +0$. If the best fit trend line for the trial does not fall within acceptable tolerances $0.90<m<1.1$ and $-2<b<2$. Recalculate the K and offset values for the instrument and input them into the Temp Cal screen. Main->Load Cell->Flow->Temp->Temp Cal.

10.1. To calculate the new Gain and offset values take the equation from the best fit line: $y=mx+b$ and the current values for the Gain and offset in the instrument Temp Cal screen: GainCurrent, Offsetcurrent and put them into the equation below.

10.2. New Gain= (GainCurrent) / (m)

10.3. New Offset= $-b/m$ +OffsetCurrent

11. After the new K and Offset values have been set, rerun the original trial with the embedded thermocouple starting at step 3, taking data pair points and graphing again. The m and b of the best fit trend line of the new plot should fall within the acceptable range stated in step 9, or the sensor may be damaged.

11. Recipes and Speed Profile Set-up

The default speed profile has been tuned to be appropriate for the majority of grease samples NLGI grades 1-3. For very thin/thick grease samples or special cases, the speed profile can be modified for testing purposes. The recipe menu can be used to develop and save preset configurations, which includes the speed profile, cycle between them and back to the default.

This procedure is used in troubleshooting and customization applications. This function will not be used in routine use.

1. From the navigation Menu go to the Speed Profile page by pressing the “Speed Profile” Button.
2. The normal test procedure goes through 4 steps. A pre-fill followed by 3 measurement steps.
3. The speed and duration of these steps are listed and modifiable from this page.
4. Consult OEM before making changes to these setting. Profiles that run outside of overtravel sensors will not provide the desired results.
5. Changes to the Speed Profile or any other of the settings fields are saved to a recipe profile. The default initial profile is 1.
6. To cycle between recipes or save the current settings to an existing recipe go to the Recipe page from the navigation Menu by pressing the “Recipe” button.
7. Use the “Next Recipe” and “Previous Recipe” buttons to select your recipe profile.

- 7.1. Press the “Save Current to Recipe” button to save your current settings to the recipe selected.
- 7.2. Press the “Load Recipe” button to fill all the settings fields with the values saved in the selected recipe.
- 7.3. Do not load from an empty recipe as this will erase the values in all the settings fields.
8. Default values for all speed profiles can be retrieved from the **Appendix II** section at the back of the manual.

12. Manual Actuator Adjustment

Under some circumstances it may be desirable to adjust the position of the actuators manually outside of the preset routines. This can be achieved from the Jog Actuator screen. **This procedure is used in troubleshooting and customization applications. This function will not be used in routine use.**

1. From the navigation Menu press the “Jog Actuator” button.
2. Use the “Jog” buttons to move the desired actuator to the desired position.
 - 2.1. X is the horizontal table and Z is the vertical shaft.
 - 2.2. The + and – buttons refer to the direction of the test procedure. Z + is the down direction.
3. The default home position is governed by position sensors and is set in step 23 of the **Instrument Initialization** section.
4. If you manually move the actuators after the home has been set, you can return to the home position by going to the Sample screen from the navigation Menu and pressing the “Stop/Return” button.
5. To clear the home position and set the current position as Home, press the “Force Home” button on the Jog Actuator page.

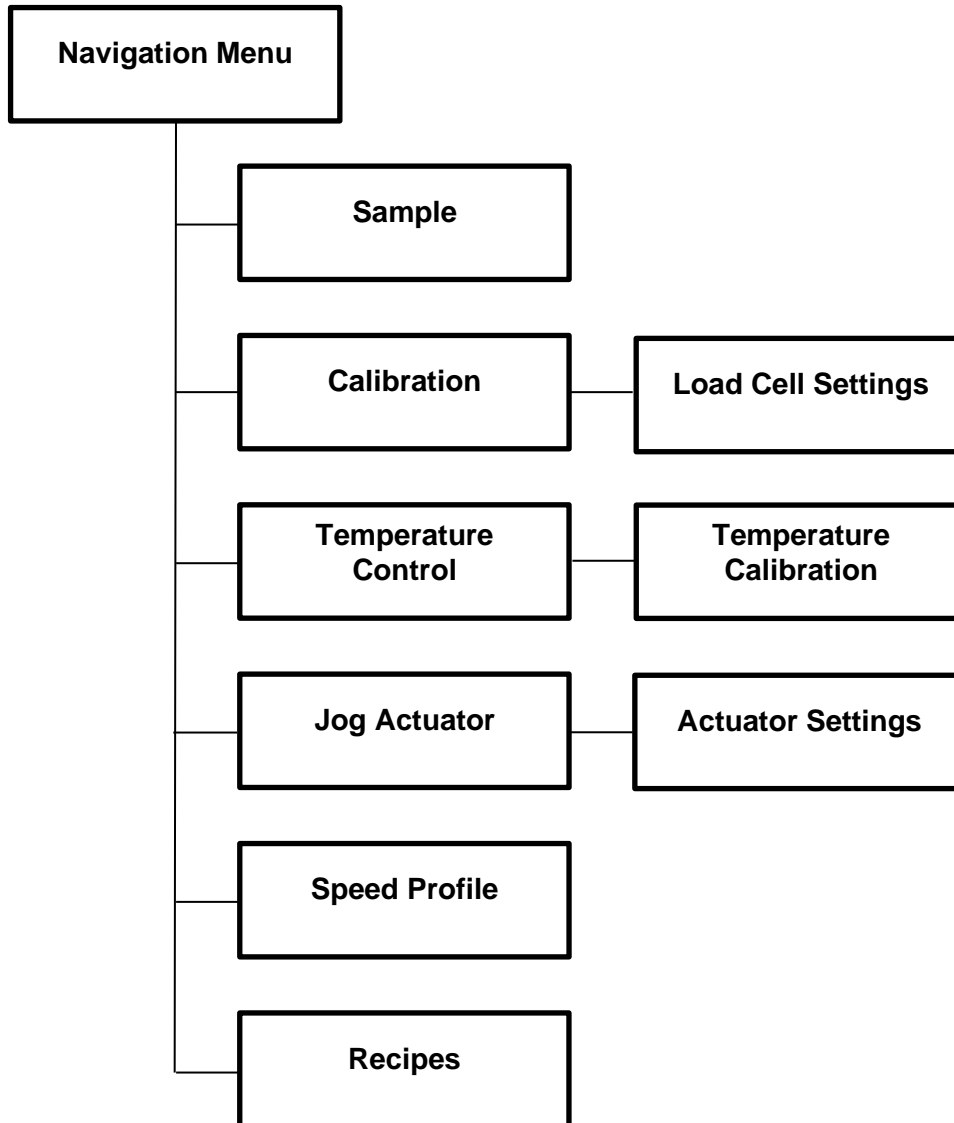
13. Troubleshooting

1. To test connectivity of the LED Controller:
 - a. Log into the User Admin profile using password: cv12345
 - i. Press “Ctrl-Alt-Delete” and select “Switch User”
 - ii. Select User Admin and use the password above
 - b. Navigate to the Control Panel and select “Network and Sharing Center”
 - c. Under “Connections” click on “LED Controller”
 - d. It may ask for the password again, use: cv12345
 - e. Select “Properties” and double click “Internet Protocol Version 4” from the list of properties
 - f. Under the “General” tab, ensure the “Use the Following IP Address” button is checked and fill in the following:
 - i. IP Address: 172.16.1.11
 - ii. Subnet Mask: 255.255.255.0
 - g. Once these changes are made, return to step 5 in the “Installation” section of this SOP to test the connectivity of the LED controller.
 - h. If this change does not work, contact MRG Laboratories for technical support.
2. To test connectivity of the Cauty Camera:
 - a. Log into the User Admin profile using password: cv12345
 - i. Press “Ctrl-Alt-Delete” and select “Switch User”
 - ii. Select User Admin and use the password above
 - b. Navigate to the Control Panel and select “Network and Sharing Center”
 - c. Under “Connections” click on “Camera”
 - d. It may ask for the password again, use: cv12345
 - e. Select “Properties” and double click “Internet Protocol Version 4” from the list of properties.
 - f. Under the “General” tab, ensure the “Use the Following IP Address” button is checked and fill in the following:
 - i. IP Address: 192.168.4.11
 - ii. Subnet Mask: 255.255.255.0



- g. Once these changes are made, return to step 7 in the “Installation” section of this SOP to test the connectivity of the Canty Camera.
 - h. If this change does not work, contact MRG Laboratories for technical support.
3. To test connectivity of the Grease Thief Analyzer:
- a. Log into the User Admin profile using password: cv12345
 - i. Press “Ctrl-Alt-Delete” and select “Switch User”
 - ii. Select User Admin and use the password above
 - b. Navigate to the Control Panel and select “Network and Sharing Center”
 - c. Under “Connections” click on “Instrument”
 - d. It may ask for the password again, use: cv12345
 - e. Select “Properties” and double click “Internet Protocol Version 4” from the list of properties
 - f. Under the “General” tab, ensure the “Use the Following IP Address” button is checked and fill in the following:
 - i. IP Address: 192.168.1.30
 - ii. Subnet Mask: 255.255.255.0
 - g. Once these changes are made, return to step 10 in the “Installation” section of this SOP to test the connectivity of the Grease Thief Analyzer.
 - h. If this change does not work, contact MRG Laboratories for technical support

Appendix I - Navigation Menu Map



Appendix II - Default Values

Load Cell Settings

Speed	0.25
Time	70
Load Cell K	1
Load Cell Offset	0

Actuator Settings

X Limit	300
Accel/Decel	0.5
X-Z Ratio	6.6
Data Rate	0.1

Temperature Control

Temp SP	31
P	10
I	1
D	0

Speed Profiles

NLGI 1-2	Speed	Time
1	0.58	20.0
2	0.15	19.0
3	0.73	13.0
4	0.44	21.0

NLGI 3	Speed	Time
1	0.058	200.0
2	0.015	190.0
3	0.073	130.0
4	0.044	210.0



Appendix III - List of Terms

1. Data Communications Program – Software provided with the instrument and used to store the results and print reports.
2. Spring Cell – Silver or Gold colored cylinder used to provide a known force profile to calibrate the load cell with.
3. Grease Thief Analyzer – The instrument is comprised of a large temperature controlled chamber, a moving horizontal table to facilitate the smooth extrusion of the grease samples, and a 1 Kg load cell to measure the force profile over the testing sequence.
4. Grease Thief Index – The ratio of the force required to extrude the sample grease to the force required to extrude the new reference baseline.
5. Grease Thief – The sampling device used to collect the in-service grease and used to extrude the sample during the test procedure.
6. Extrusion Die – A device that attaches to the Grease Thief and creates a thin film of grease to be used for testing in the Grease Thief analyzer.
7. Load Cell Scale (K) and Offset – Variables calculated during load cell calibration that govern the conversion of the analogue signal to real values with force units.
8. Baseline – New grease used for comparison purposes. The test procedure is purely a comparative process and the in-service samples should be compared the new reference grease from the same product.
9. Non-Contact IR Thermocouple – This thermocouple monitors the sample uses an infrared beam to ensure the test is run at the set temperature.
10. Position Bracket – The silver block in the instrument chamber that holds the Grease Thief in place during extrusion. Adjust the clamp with the large black knob.
11. Vertical/Horizontal Actuator – The controller moves the horizontal table ratioed to the vertical extrusion to produce a smooth ribbon on the substrate and a consistent load profile.
12. Vector Control Module (VCM) – Acts as the data transfer system for the instrument. This box uses ethernet cables to connect the Grease Thief Analyzer, Camera, and LED Controller to each other and uses a VGA cable to connect the monitor to the instrument.
13. Particle Counting Camera – Black camera inside the Grease Thief Analyzer used to count particles in the extruded grease samples. This is controlled using the Cauty Vision software.
14. LED Controller – Black box inside the Grease Thief Analyzer used to control the LED light underneath the camera. This is controlled using the Cauty Vision software.



Appendix IV - Grease Thief® Consumables and Products

Can be purchased online at www.greasethief.com

Description	Part Number
Grease Thief Analyzer Supplies	
Grease Thief Consumables Kit	MGT-02-001
Sampling kits and accessories for your customers to sample and submit for analysis	
Pillow Block Bearing Grease Sampling Kit (this kit can be kept on hand in lab to process non-standard sample container submittal)	MGT-01-008
MOV Gearbox Grease Sampling Kit	MGT-01-014
Electric Motor Bearing Grease Sampling Kit	MGT-01-012
Robot Drive Gear Grease Sampling Kit	MGT-01-081
Wind Turbine Grease Sampling Kit	MGT-01-067
Grease Sampler Adjustable T-Handle	MGT-01-018
Grease Sampler Metal Double Extension T-Handle	MGT-01-001



Appendix V - Grease Thief[®] Analyzer Specifications

Specifications	
Size (length x width x height)	31 x 19 x 29 in (82 x 49 x 74 cm)
Weight	125 lbs (57 kg)
Power Requirement	110 VAC; 60 Hz; 5.8 A 240 VAC; 50 Hz; 2.7A
Operating Temperature	15 to 40 °C (60 to 104 °F)
Storage Temperature	0 to 50 °C (32 to 120 °F)
Sampling methods supported	ASTM D7718 – Grease sampling
Environmental Controls	Programmable PID microprocessor controller Thermocouple and non-contact radiometer temperature sensors Continuous preheat for up to 12 standby samples
Data output	Ethernet
Display	4.3" 480x272 pixels LCD display with touch screen

* Three (3) outlets needed for operation

MRG Labs
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York, PA 17403
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www.mrgcorp.com
www.greasethief.com

Grease Thief is a registered trademark of York Laboratories, LLC, and is protected by US patent 7,984,661. The Grease Thief complies with ASTM D7718 Standard Practice for Obtaining In-Service Samples of Lubricating Grease, ASTM D7918 Standard Test Method for Measurement of Flow Properties and Evaluation of Wear, Contaminants, and Oxidative Properties of Lubricating Grease by Die Extrusion Method and Preparation, and AWEA Recommended Practice RP-813 and RP-814. ©2013