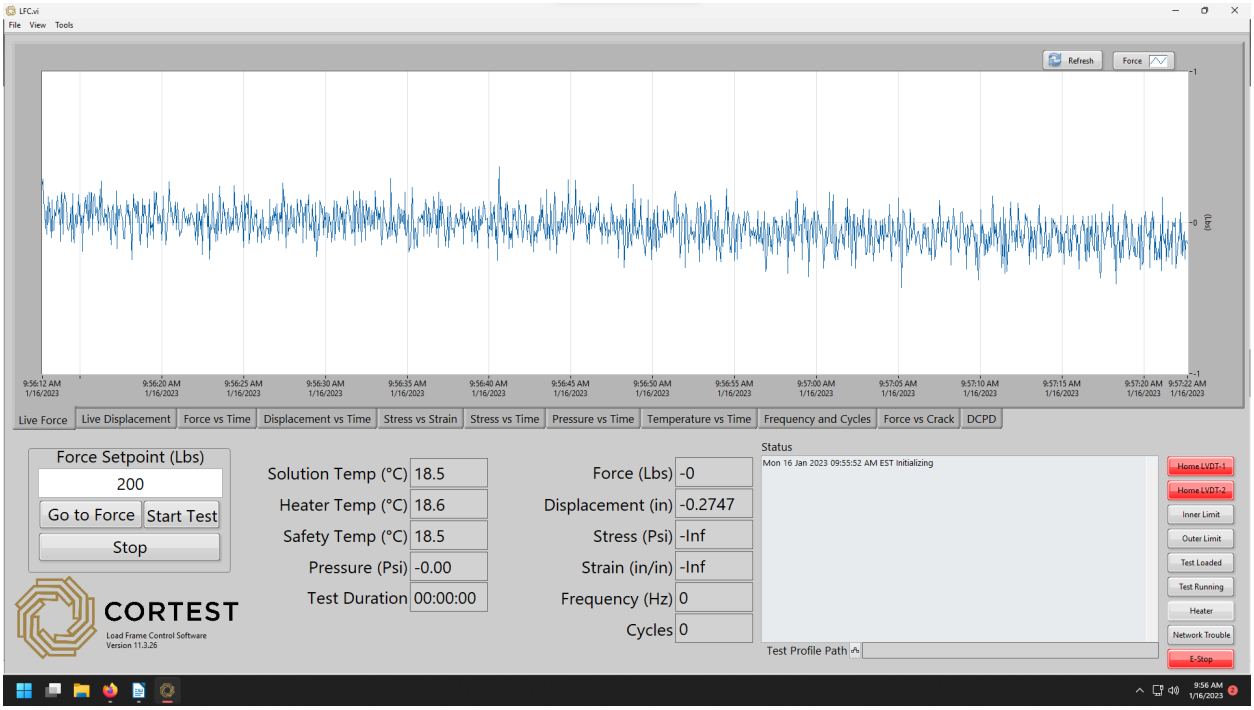
CORTEST

Load Frame Control Software Manual



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Contents

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Overview

Load Frame Control software or LFC is composed of several screens that can be accessed by using the pull-down menus at the top of the screen in the upper left-hand corner.

The File pull-down can:

- Create a new test.
- Open and review a previously run test.
- Save a test with a new filename.
- Save a test which will also update an already running test.

The View pull-down can:

- View the Graphs which is the main screen that can start and stop a test, Pre-Test Force, and present the data in both graph form and numerical form.
- View the Heater Control screen that resets the heater safety relay, toggles the heater on and off, as well as monitor the various thermocouple readings in both graph from and numerical form.
- View the Test Profile screen used to define tests.
- View the Configuration screen where units can be changed, and other variables can be modified.
- View the different Calibration screens.

Some important operator notes:

- Gray boxes are indicators and data should not be entered inside of them.
- When entering data in a white data entry box be sure to click outside of the box when done or hit enter.
- Wait at least three seconds before attempting another command.
- Jog buttons will not exceed by default 100 lbs. or Pre-test force setpoint. High speed jogging only occurs under 10 lbs.

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Configuration

View >> Configuration

Changing units

Prior to changing units make sure all motion is disabled and no load is present.

Use the selection box arrow to open the selection drawer and select the desired units.

Click Change Units.

Calibration on all instrumentation will need to be performed immediately after a unit change.

Heater PIDs

Heater PID This sets the Proportional, Integral, and Derivative for the heater PID loop. By default, the numbers are P of 10, I of 1, and D of 0.

Solution PID This sets the Proportional, Integral, and Derivative for the solution PID loop. By default, the numbers are P of 10, I of 20, and D of 0.

To achieve solution control in large vessels two PID controllers are used. One to control the temperature of the heater band and the other telling the heater band what temperature it should be targeting to get the solution temperature to target with minimal if any overshoot in temperature. It is otherwise known as a cascade PID loop.

Modification of these parameters should only be done by qualified personnel.

Velocity Adjustment

Velocity Multiplier This is the multiplication value for the pulse chain that steps the servo drive in a particular direction. Predetermined values should be to the right of the box for easy setup. For example, if you have a 3-ton jack screw then the Velocity Multiplier should be 520000000, if you have a 5-ton jack screw then the Velocity Multiplier should be 725000000, if you have a 10-ton jack screw then the Velocity Multiplier should be 800000000. Fine adjustment can be made if desired.

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Pressure Compensation

Pressure Interaction Area This is the cross-sectional area of the pull rod or pull rods that transverse the pressure boundary in the vessel.

Example 1:

The vessel is equipped with a single 0.435 in diameter pull rod.

Find the cross-sectional area of the pull rod.

$A = (\pi/4) \times D^2$

$A = 0.1486169675\ in^2$

The pressure interaction area is 0.1486169675.

Example 2:

Same Pull rod diameter but the vessel is a pull through vessel. Multiply A by 2. This gives you the total Pressure Interaction Area.

Click [Save Configuration] to commit changes.

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Calibration

LVDTs

Prior to Calibrating the LVDTs apply a load high enough so that the load components are ridged. If the LVDTs move during calibration accuracy will be diminished.

Click View >> Calibration >> LVDT.

Adjust the LVDT(s) So that the sliding indicator lines up with the stationary gray arrow. They do not need to be perfectly lined up just close. (Figure 1)

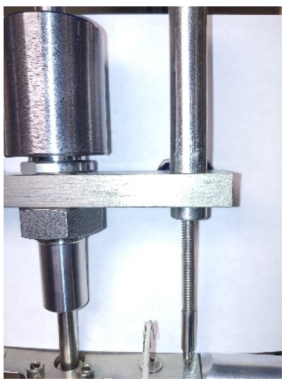

Figure 1

Click [Register LVDT-1(2) – Value]. (Note, you can do both at the same time assuming you have aligned both.

Lift the probe tip gently being careful not to let the prob tip spring into the target target and lead to inaccurate readings.

Place the gauge block supplied with the frame under the probe tip and carefully lower the probe tip. (Figure 2)

Figure 2

Click [Register LVDT-1(2) + Value]. (Note, only click this button with the block installed under the probe tip. You will have to move the block to calibrate the other LVDT.)

Remove the block and home the LVDTs. Using the home screen Home LVDT. Indicators.

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Load Cell

Prior to calibrating the load cell remove all load and dismantle the load train. Do not remove the load cell from the linear bearing. (Note, the load cell must always remain connected to the frame or the system will enter safe mode repeatedly until it can see the load cell again.)

Needed is the certificate of calibration for the load cell. Enter:

- Calibration Factor
- Shunt Calibration Factor
- Load Cell Capacity

Click View >> Calibration >> Load Cell.

(Note, the load cell capacity must be entered in the units that have been chosen to operate in within the configuration menu. For example, the units have been changed to SI, the force is now measured in Newtons. This means convert the load cell capacity from the units on the calibration certificate to the units being used. Certificate declares 10000 lbs. Units entered are 44482.216282509005 Newtons)

Once the information has been entered click [Apply and Update Graph].

If the two sliders on the top scale are not on top of each other adjustment is required.

Remove the flat head screw under the Z shown in (Figure 3).

Using a small flat head jeweler's screwdriver adjust the Z potentiometer until the small arrow on the top scale is centered over the larger arrow on the top scale.

Figure 3

Switch the Run Cal. Switch from run to Cal.

If the smaller arrow aligns over top of the larger arrow on the bottom scale, t does not. Remove the screw on the load cell under the S.

Using a small flat head jeweler's screwdriver adjust the S potentiometer until the small arrow on the bottom scale is centered over the larger arrow on the bottom scale.

Once complete, switch the Run Cal. Switch back to run and verify the two top arrows are still centered on top of each other.

Click [Save and exit].

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Pressure

Remove all pressure and media from the vessel and open the vessel.

Enter the capacity of the pressure transducer in the units that the software is set to run in as configured in the configuration screen.

Click [Set and Zero Pressure Trans Values].

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Motion Mode Definitions

Creep Motion is disabled and is the mode to use to record data prior to starting any motion modes.

Slow Strain Rate This motion mode applies a consistent RPM to the systems gear set and jack screw. Controlling profile parameters. – Velocity.

Constant Force Will hold the force entered in the (Peak) Force entry box.

Constant K (Stress) Holds a constant K on the specimen as entered in the (Peak) Stress entry box.

Delta K Over Delta Time Increments the K on the specimen as Stress / Second as entered in the entry box.

Delta Stress Over Delta Time Increments the Stress on the specimen as Stress / Second as entered in the entry box.

Delta Displacement Over Time Similar to a slow strain rate test but with much more accuracy as it uses the LVDTs as feed back. The motion mode eliminates frame complience.

Sinusoidal Force Control Is a more accurate but slower method of control for generating a fatigue waveform. It should be used at frequencies under 1 hz. High Speed Fatigue should be used from above 1 hz up to 5 hz.

High Speed Fatigue Force Control Fatigues the specimen using a sinusoidal waveform that can be varied by (Frequency), (Peak) Force, and (Ratio). Ratio being the amplitude of the waveform.

I.E. $Amplitude = [(Peak)Force] * [(Ratio)]$ 500 = 1000 * 0.5

Important. If changing frequency is desired, it may be necessary to change incrementally. If overshoot must be avoided enter a lower (Peak) Force.

High Speed Fatigue Stress Control Fatigues the specimen using a sinusoidal waveform that can be varied by (Frequency), (Peak) Stress, and (Ratio). Ratio being the amplitude of the waveform.

I.E. $Amplitude = [(Peak)Stress] * [(Ratio)]$ 500 = 1000 * 0.5

Important. If changing frequency is desired, it may be necessary to change incrementally. If overshoot must be avoided enter a lower (Peak) Stress. Proper configuration of specimen geometry is required for correct stress calculations.

Trapezoidal Force Control Slowly fatigues specimens in a triangle or trapezoidal waveform. Good for slow cycle rates. Uses the velocity, (Peak) Force, ratio, hold force, and dwell setpoints.

Trapezoidal Stress Control Slowly fatigues specimens in a triangle or trapezoidal waveform. Good for slow cycle rates. Uses the velocity, (Peak) Stress, ratio, hold force, and dwell setpoints.

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Rippled Strain Rate Starting as a slow strain rate test. After 0.2% yielding is detected, the test changes to a triangle wave. Oscillating from the force present at the time of the 0.2% offset and 80% of that force.

Incremental Force Increments to a percentage of Max. Force as entered in Step Force %. Dwells for an entered time.

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Pre-Test Force

Use the jog buttons to apply an initial force. Note that the jog buttons will not allow a force higher than 100 lbs. or the entered Pre-test force setpoint.

Enter a Pre-Test Force setpoint and click Start.

The controls will immediately begin applying the desired force and continue to hold that force until the stop button is clicked, the E-Stop is pressed, or power is not supplied.

This function is useful for heating as with heat comes thermal expansion. It allows for tests to have precise starting points to reports can be consistent and concise.

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Starting a Slow Strain Rate Test

Prerequisites.

- Install the tensile specimen.
- Charge the vessel with media if applicable. (Refer to vessel manual)
- Apply a force to the specimen using the jog buttons.
- Hold a steady force using Pretest force. (See Pre-Test Force section)

View >> Test Profile

Enter heating parameters if applicable.

Solution control Controls the solution when enabled. Otherwise, it controls the heater band temperature. (Recommended Enabled)

Target Temperature This is the target solution temperature when Solution Control is set to enabled. Or The heater band target temperature when Disabled.

Pressure High Limit Sets a safety threshold in which the heater safety relay shut down the heater.

Heater High Limit Defines a threshold in which the heater relay will shut down the heater.

Solution High Limit Defines a threshold in which the heater will shut down the heater.

Post Test Cooldown When enabled, the heater shuts off at the end of a test. Enabled, the heater stays on.

Motion Selection Use the arrow to open the selection drawer and select Slow Strain Rate test.

Specimen Selection Use the arrow to open the selection drawer and select Cylindrical.

Define the width and the length from shoulder to shoulder of the gauge length.

Sample Rate The default of 30 seconds can be used for most tests. However, if this creates too much data the value can be increased.

Test Duration Used to define the length of a test if necessary. Once the entered time elapses the test will stop.

Hold Force See Trapezoidal motion mode.

Dwell See Trapezoidal motion mode.

Min. Force Sets the threshold at which a test will stop if the force on the specimen is less than the setpoint. Its main use is to end a test when the specimen fails.

Max. Force Limits the force that can be applied to a specimen by stopping the test if exceeded.

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- Velocity Sets the speed at which a slow strain rate test will run.

(Peak) Stress Not applicable in Slow strain Rate mode. See other motion modes for more information.

(Peak) Force Not applicable in Slow Strain Rate mode. See other motion modes for more information.

(Ratio) Not applicable in Slow Strain Rate mode. See other motion modes for more information.

(Frequency) Not applicable in Slow Strain Rate mode. See other motion modes for more information.

Cycle Limit Not applicable in Slow Strain Rate mode. See other motion modes for more information.

DCPD See the DCPD section.

First If = This can be used to, for example, start a test when the temperature passes the entered threshold.

First Then = Acts on the First If. More can be found in the If, Then Section.

Once the test has been defined, click File >> Save as...

Enter a name.

Once entered the Test Loaded indicator will turn green.

Click View >> Graphs.

If Pre-Test Force is not running set a force above the Min. Force variable on the test profile screen and click [Start]. Typically, 200 lbs.

Home the LVDTs so that the Home LVDT indicators turn gray.

Click View >>Heater Control.

Click [Reset Heater Safety Relay] and wait 3 seconds.

Click [Toggle Heater]. The Heater indicator at the right of the screen will turn green and the Heater Duty % will show the duty cycle that the heater is operating at.

Once the heater has reached target temperature. Click [Start] under Test Control on the Graphs screen. If applicable. Alternatively, program the If and Then section to start the test automatically. See the If and Then section for more information.

Click [Start] under Test Control on the Graphs screen.

The test will start momentarily.

See the post test data review section for more information on acquiring the test data.

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Rippled Strain Rate

Prerequisites.

- Install the tensile specimen.
- Charge the vessel with media if applicable. (Refer to vessel manual)
- Apply a force to the specimen using the jog buttons.
- Hold a steady force using Pretest force. (See Pre-Test Force section)

View >> Test Profile

Enter heating parameters if applicable.

Solution control Controls the solution when enabled. Otherwise, it controls the heater band temperature. (Recommended Enabled)

Target Temperature This is the target solution temperature when Solution Control is set to enabled. Or The heater band target temperature when Disabled.

Pressure High Limit Sets a safety threshold in which the heater safety relay shuts down the heater.

Heater High Limit Defines a threshold in which the heater relay will shut down the heater.

Solution High Limit Defines a threshold in which the heater will shut down the heater.

Post Test Cooldown When enabled, the heater shuts off at the end of a test. Enabled, the heater stays on.

Motion Selection Use the arrow to open the selection drawer and select Rippled Strain Rate.

Specimen Selection Use the arrow to open the selection drawer and select Cylindrical.

Define the width and the length from shoulder to shoulder of the gauge length.

Sample Rate The default of 30 seconds can be used for most tests. However, if this creates too much data the value can be increased.

Test Duration Used to define the length of a test if necessary. Once the entered time elapses the test will stop.

Hold Force See Trapezoidal motion mode.

Dwell See Trapezoidal motion mode.

Min. Force Sets the threshold at which a test will stop if the force on the specimen is less than the setpoint. Its main use is to end a test when the specimen fails.

Max. Force Limits the force that can be applied to a specimen by stopping the test if exceeded.

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- Velocity Sets the speed at which a slow strain rate test will run.

(Peak) Stress Not applicable in Rippled strain Rate mode. See other motion modes for more information.

(Peak) Force Not applicable in Rippled Strain Rate mode. See other motion modes for more information.

(Ratio) Not applicable in Rippled Strain Rate mode. See other motion modes for more information.

(Frequency) Not applicable in Rippled Strain Rate mode. See other motion modes for more information.

Cycle Limit Not applicable in Rippled Strain Rate mode. See other motion modes for more information.

DCPD See the DCPD section.

First If = This can be used to, for example, start a test when the temperature passes the entered threshold.

First Then = Acts on the First If. More can be found in the If, Then Section.

Once the test has been defined, click File >> Save as...

Enter a name.

Once entered the Test Loaded indicator will turn green.

Click View >> Graphs.

If Pre-Test Force is not running set a force above the Min. Force variable on the test profile screen and click [Start]. Typically, 200 lbs.

Home the LVDTs so that the Home LVDT indicators turn gray.

Click View >>Heater Control.

Click [Reset Heater Safety Relay] and wait 3 seconds.

Click [Toggle Heater] The Heater indicator at the right of the screen will turn green and the Heater Duty % will show the duty cycle that the heater is operating at.

Once the heater has reached target temperature. Click start test. If applicable. Alternatively, program the If and Then section to start the test automatically. See the If and Then section for more information.

Click Start under Test Control on the Graphs screen.

The test will start momentarily.

See the post test data review section for more information on acquiring the test data.

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DCPD

Prerequisites.

- An installed compact tension specimen with current wires, potential wires, and optionally reference wires and reference specimen installed.
- The DCPD addon electronics.
- Apply a force to the specimen using the jog buttons.
- Hold a steady force using Pretest force. (See Pre-Test Force section)
- Warmup the power supply and Nanovolt meter for at least an hour before attempting to acquire data.
- A stable vessel temperature.

View >> Test Profile

Enter heating parameters if applicable. An elevated temperature is recommended for DCPD testing as slight temperature changes affect crack length adversely. If temperature changes are inevitable use of a reference probe is highly recommended.

Solution Control Controls the solution when enabled. Otherwise, it controls the heater band temperature. (Recommended Enabled)

Target Temperature This is the target solution temperature when Solution Control is set to enabled. Or The heater band target temperature when Disabled.

Pressure High Limit Sets a safety threshold in which the heater safety relay shuts down the heater.

Heater High Limit Defines a threshold in which the heater relay will shut down the heater.

Solution High Limit Defines a threshold in which the heater will shut down the heater.

Post Test Cooldown When enabled, the heater shuts off at the end of a test. Enabled, the heater stays on.

Motion Selection Use the arrow to open the selection drawer and select a motion mode that will not grow a crack. Generally constant force is used as it allows you to check expected stress which verifies specimen geometry has been entered correctly. Fatigue can be used if the forces are low enough that it will not produce crack growth.

Specimen Selection Use the arrow to open the selection drawer and select Compact Tension.

Define the Initial ‘a’ or crack length, W, and B.

Sample Rate The default of 30 seconds can be used for most tests. However, if this creates too much data the value can be increased.

Test Duration Used to define the length of a test if necessary. Once the entered time elapses the test will stop. Set to zero the timer is disabled.

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Hold Force See Trapezoidal motion mode. Any motion mode can be used in conjunction with DCPD.

Dwell See Trapezoidal motion mode. Any motion mode can be used in conjunction with DCPD.

Min. Force Sets the threshold at which a test will stop if the force on the specimen is less than the setpoint. Its main use is to end a test when the specimen fails.

Max. Force Limits the force that can be applied to a specimen by stopping the test if exceeded.

- Velocity Sets the speed at which a slow strain rate test or trapezoidal test will run.

(Peak) Stress Used to set the peak stress applied to the specimen in any of the stress fatigue modes.

(Peak) Force Used to set the peak force applied to the specimen in any of the force fatigue modes.

(Ratio) Sets the amplitude of the waveform. See the Motion Mode Definitions section for more details.

(Frequency) Typically, 1 Hz is set. See other motion modes for more information.

Cycle Limit Not recommended for use with DCPD as it ends the test. See other motion modes for more information.

DCPD [Enabled] will enable the DCPD electronics and subroutines. Turning this on also adds an additional feature to the Pre-Test Force function. It also serves as a DCPD Pretest Warmup allowing current to flow in alternating directions and populating some of the parameters on the DCPD graph screen allowing you to check for proper voltages and current draw. This helps in making sure connections have been made correctly before starting the DCPD test.

Reference? Reads a set of optional probes on a dummy specimen wired in series with the current source placed inside the vessel. This cancels out unwanted variances in the crack length reading and over all makes the crack length reading more accurate.

Nano Volt Pool Size This is the quantity of readings averaged and used to fill the initial pool and the Crack length pool. The default is 30 and is appropriate for most tests and levels of interference.

Initial Pool Size This is the size of the averages to average from Nano Volt Pool Size output. The result of this pool is used as V original in the DCPD equation. It is important for this pool to be large enough to not have been affected by temperature swings or noise as this will affect the accuracy of the crack length at the start of the test. The default is 10 but may need to be higher for noisy signals.

Crack Pool Size The size of the pool used to calculate the live crack growth. The default is 3 and generally averages out enough noise so that any stalling or starting crack lengths are easily identifiable.

First If = This can be used to, for example, start a test when the temperature passes the entered threshold.

First Then = Acts on the First If. More can be found in the If, Then Section.

Once the test has been defined, click File >> Save as...

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Enter a name.

Once entered the Test Loaded indicator will turn green.

Click View >> Graphs.

If Pre-Test Force is not running set a force above the Min. Force variable on the test profile screen and click [Start]. Typically, 200 lbs. The fans on the power supply should raise in rpm. Verify you have current flow and are reading potential voltage and optionally reference voltage.

Home the LVDTs so that the Home LVDT indicators turn gray.

Click View >>Heater Control.

Click [Reset Heater Safety Relay] and wait 3 seconds.

Click [Toggle Heater]. The Heater indicator at the right of the screen will turn green and the Heater Duty % will show the duty cycle that the heater is operating at.

Once the heater has reached target temperature. Click [Start Test]. If applicable. Alternatively, program the If and Then section to start the test automatically. See the If and Then section for more information.

Once the test has started in a motion mode that is nondestructive the initial crack length will start to be acquired. Depending on the Nano Volt Pool Size and the Initial Pool Size this may take between a few minutes to days to complete. Using the default numbers, it takes less than an hour.

Once crack length no longer reports NaN or not a number make sure the value indicated is close to the entered initial crack length. If it is not, check all inputs and connections. Note vessel media must not be conducting to ground. Make sure Probe wires are also not grounded or shorted.

It is then up to the operator to create an environment that will be conducive to crack formation. If the specimen has not been pre-cracked this can be done now inside the vessel before starting any chemically induced cracking.

See the post test data review section for more information on acquiring the test data.

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Post Test Data Review

Completed Tests can be opened inside the LFC Review software. Or directly in Excel or similar programs by importing the *.dat file as a tab delimited file.

Review Tool

Run the LFC Review tool.

Use Open,

Select a *.dat file to view the data.

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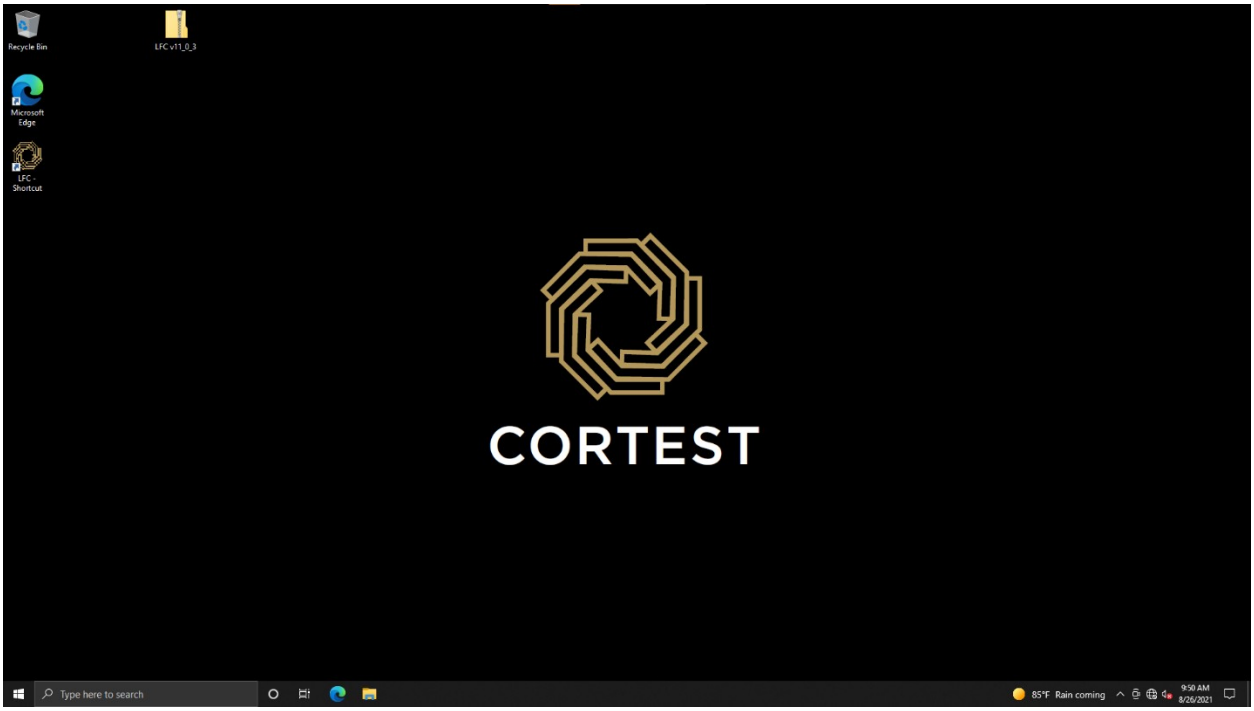
Network Settings

The computer must have all firewalls disabled and the Network Interface configured as 192.168.1.11.

Software Upgrade

To upgrade the system several steps must be completed. The critical ones being the installation of the software and the imaging of NI cRio located inside the frame. Confirming the load cell is reading correctly.

Step 1. Place the LFC v11.#.# file on the desktop of the machine that controls the frame.



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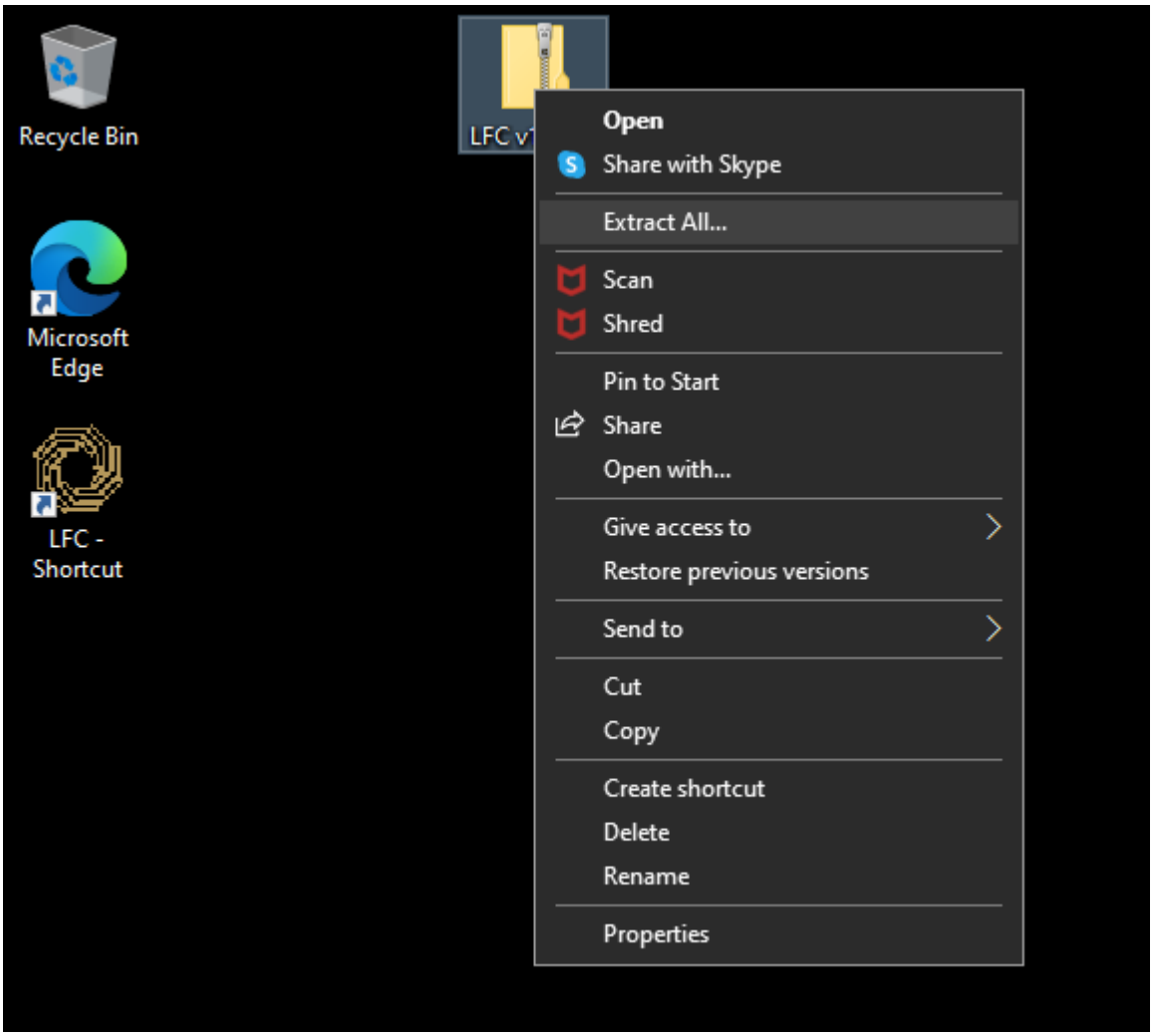
Step 2. Right click the LFC v11.#.#.zip file and click Extract All…



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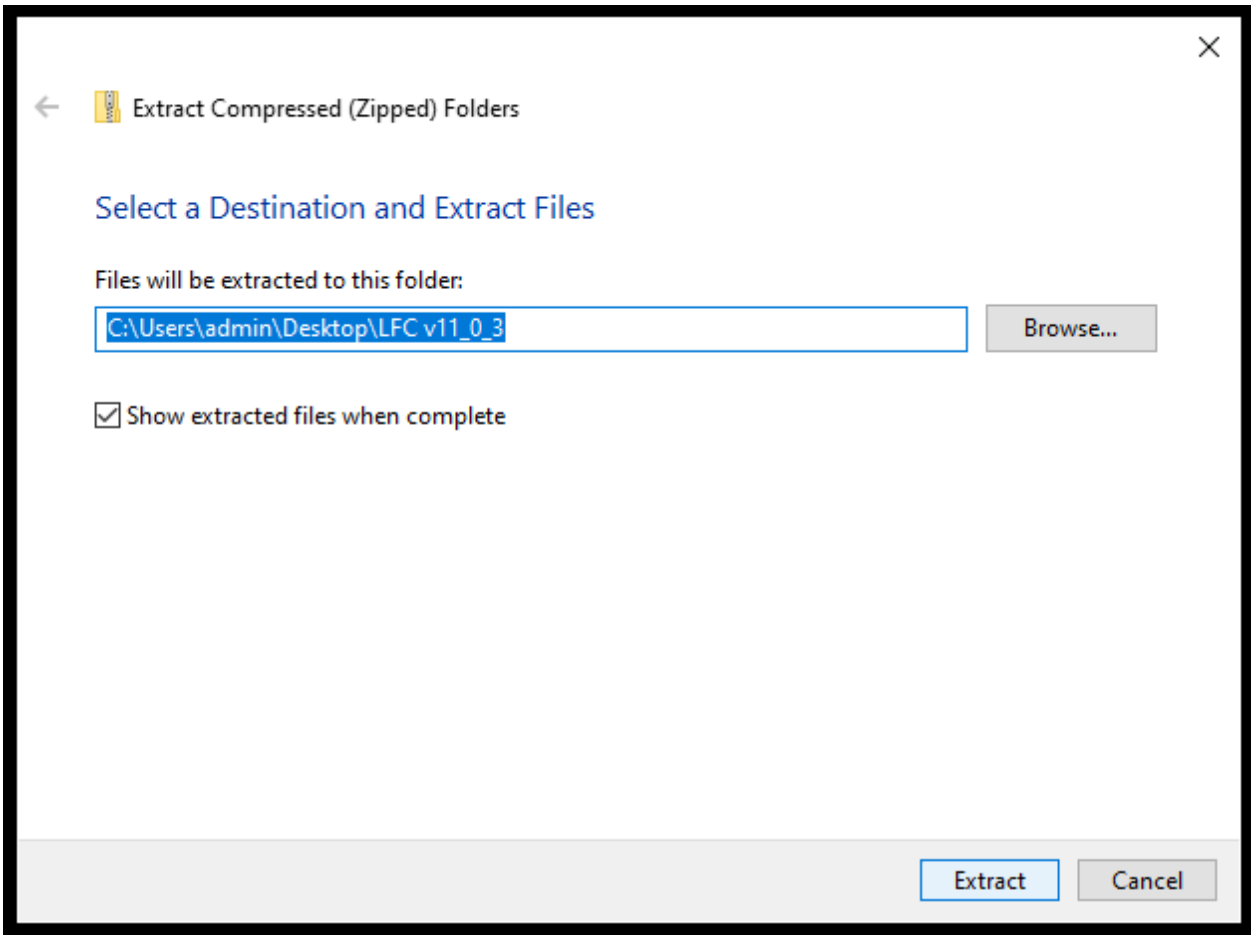
Step 3. Click Extract.



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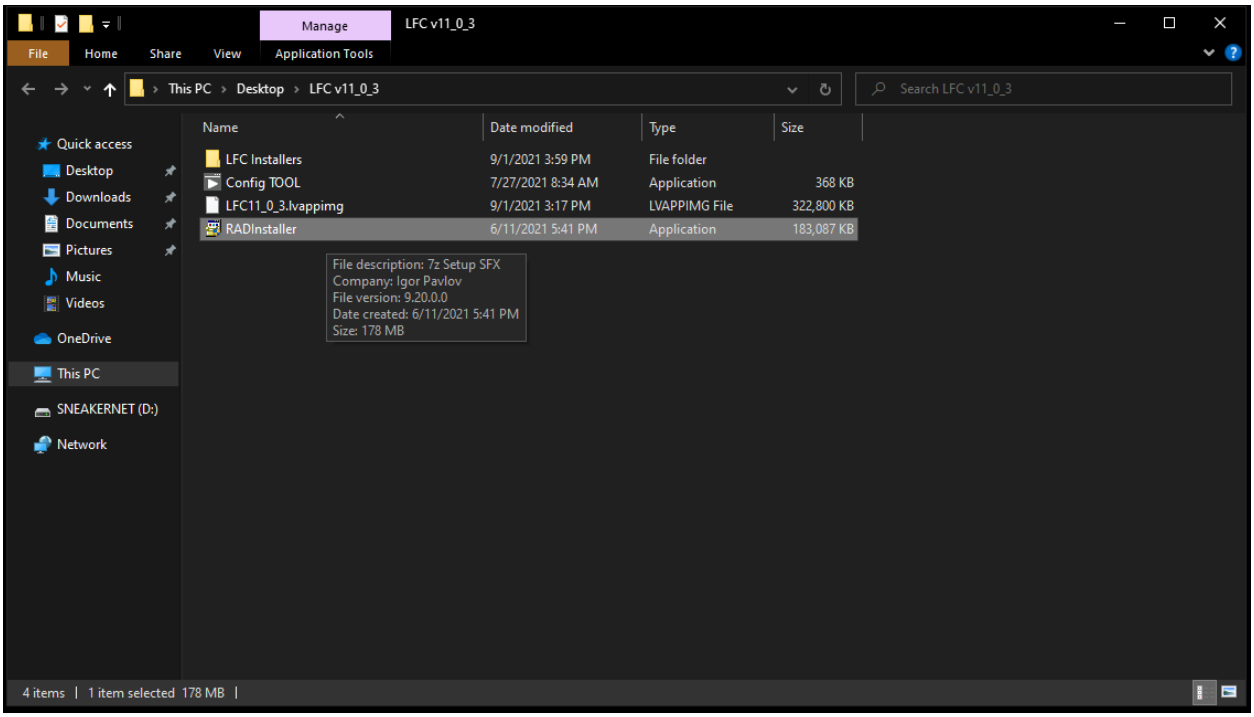
Step 4. Open the LFC v11.#.# folder and double click on the RADInstaller.



Follow the prompts to install the software with the default options. When prompted to reboot, do so.

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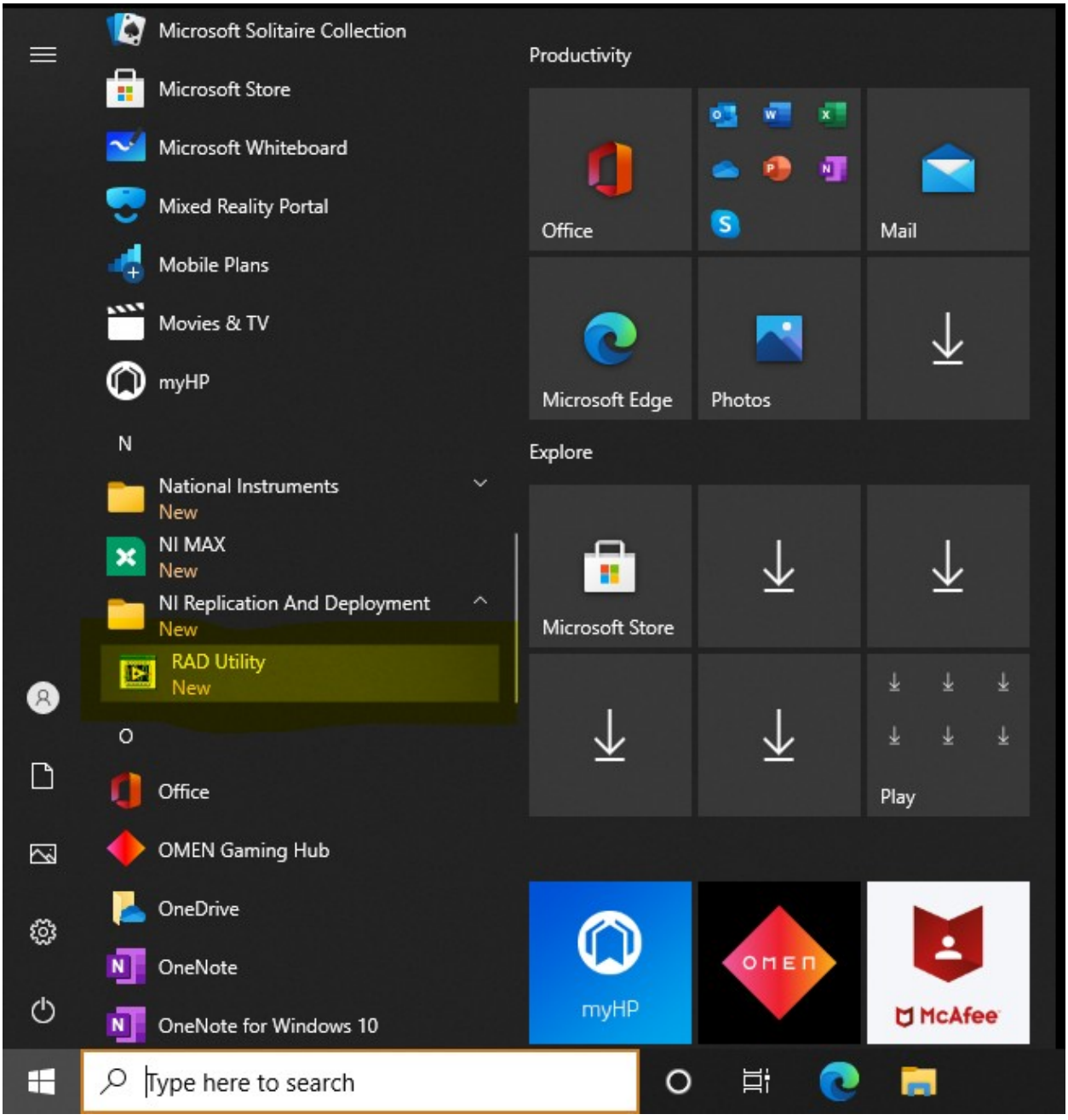
Step 5. Once the computer has booted. Find the NI Replication and Deployment section and click the RAD Utility. (You can also tap the windows key and type ‘rad’ then tap enter)



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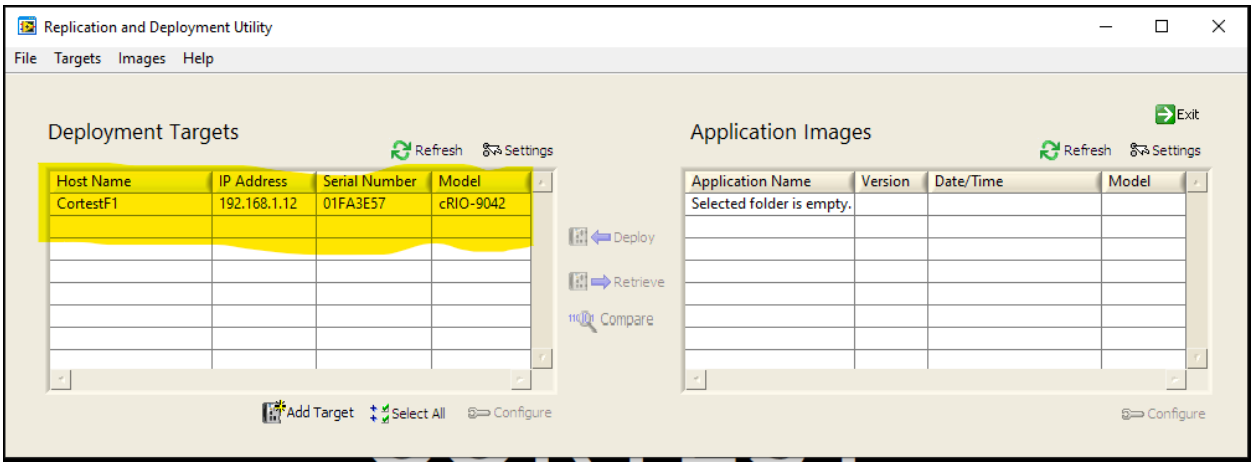
Step 6. Make sure the cRio has been detected. If it has not, see the troubleshooting section.



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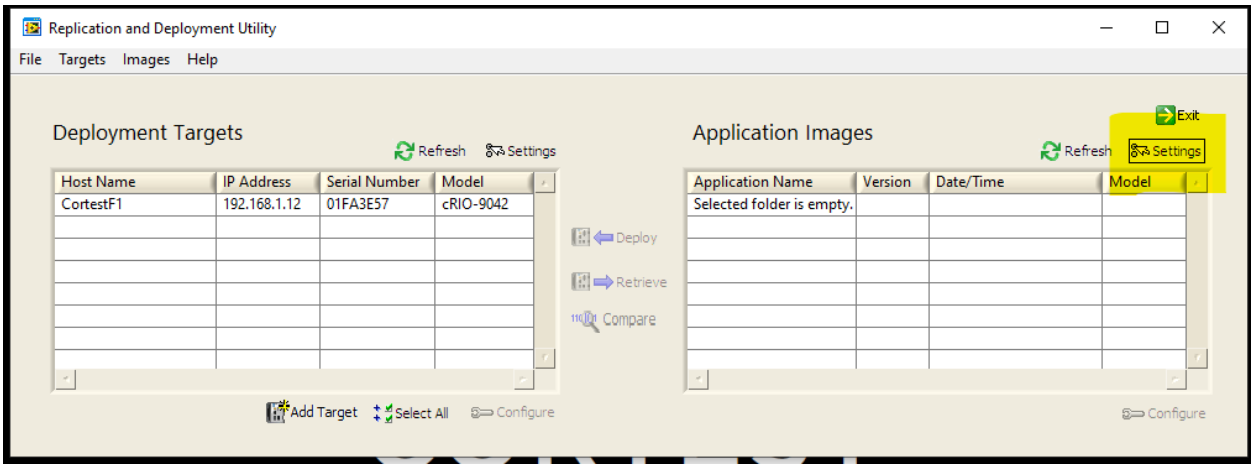
Step 7. Click Settings (Highlighted in yellow)



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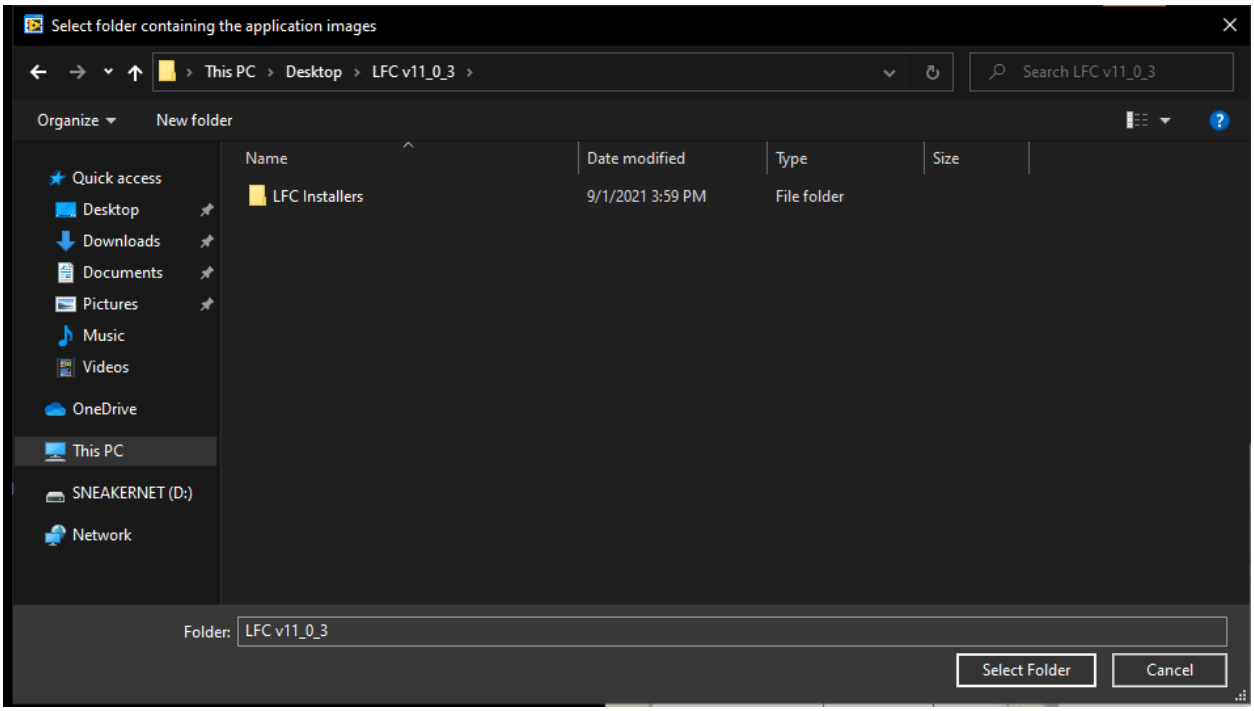
Step 8. Navigate to the path seen in the screenshot shown below and click Select Folder.



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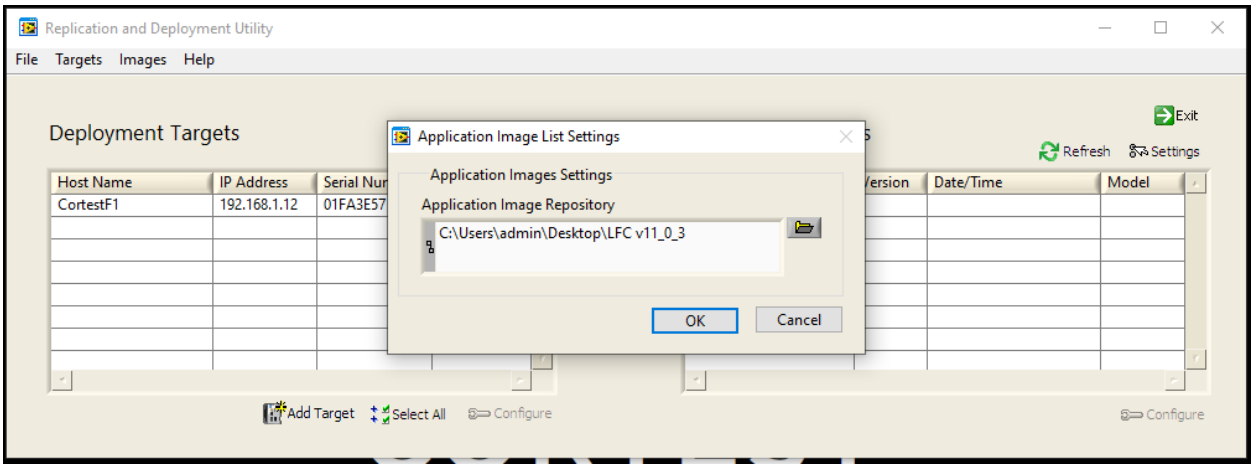
Step 9. The path for the Application Image Repository should look the same as the screenshot.

Click OK if it does.



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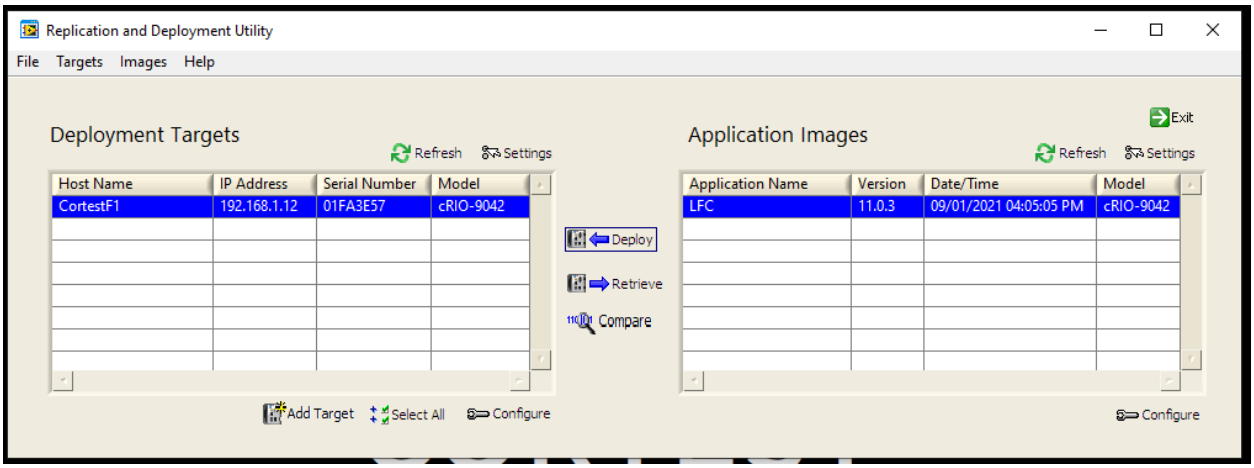
Step 10. Click the Deployment Target and the Application Image, then click Deploy.



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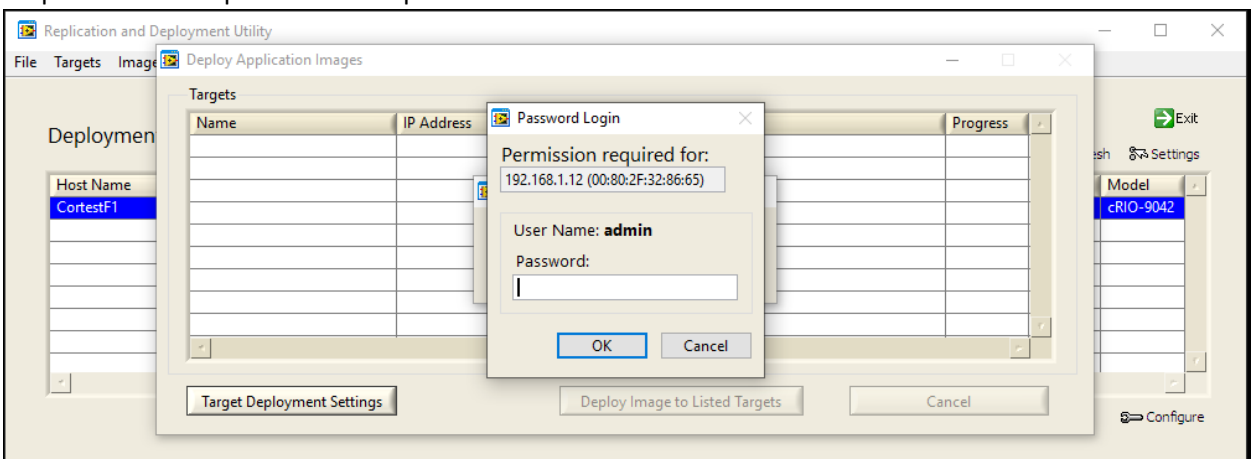
Step 11. Enter the password. The password is ‘cortest’



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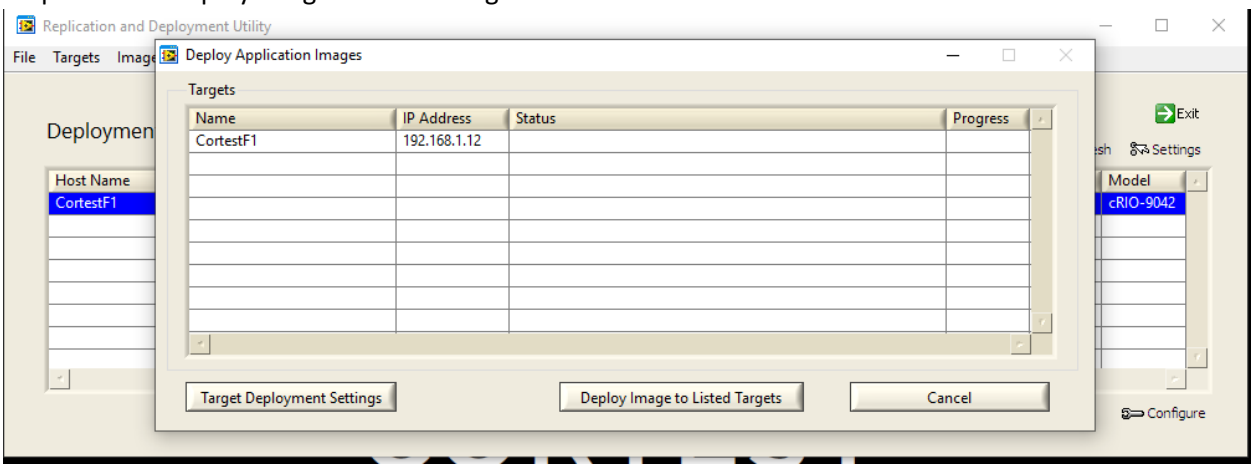
Step 12. Click Deploy Image to Listed Targets.



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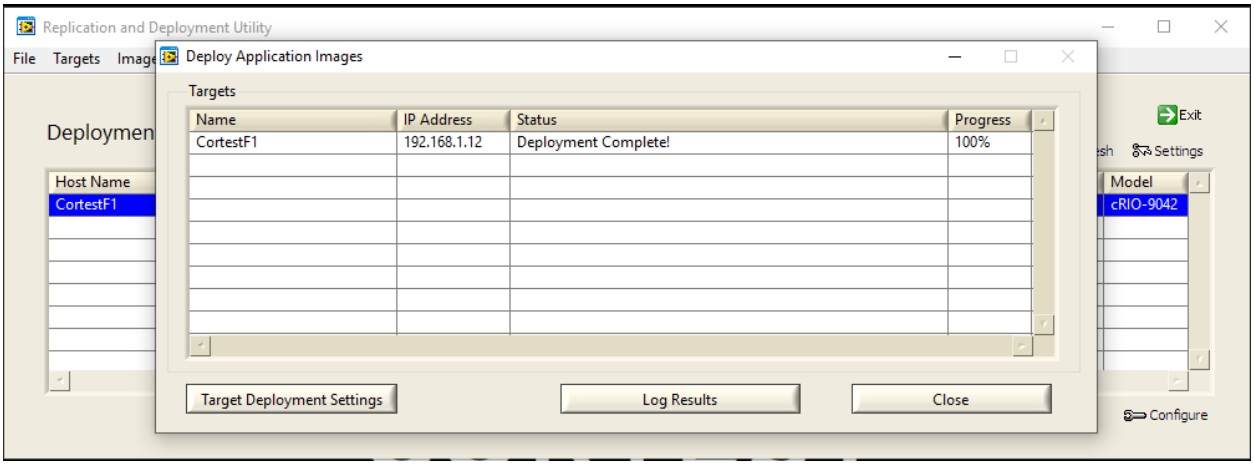
Step 13. Once the status reads Deployment Complete and the Close button appears, click Close and then close the program.



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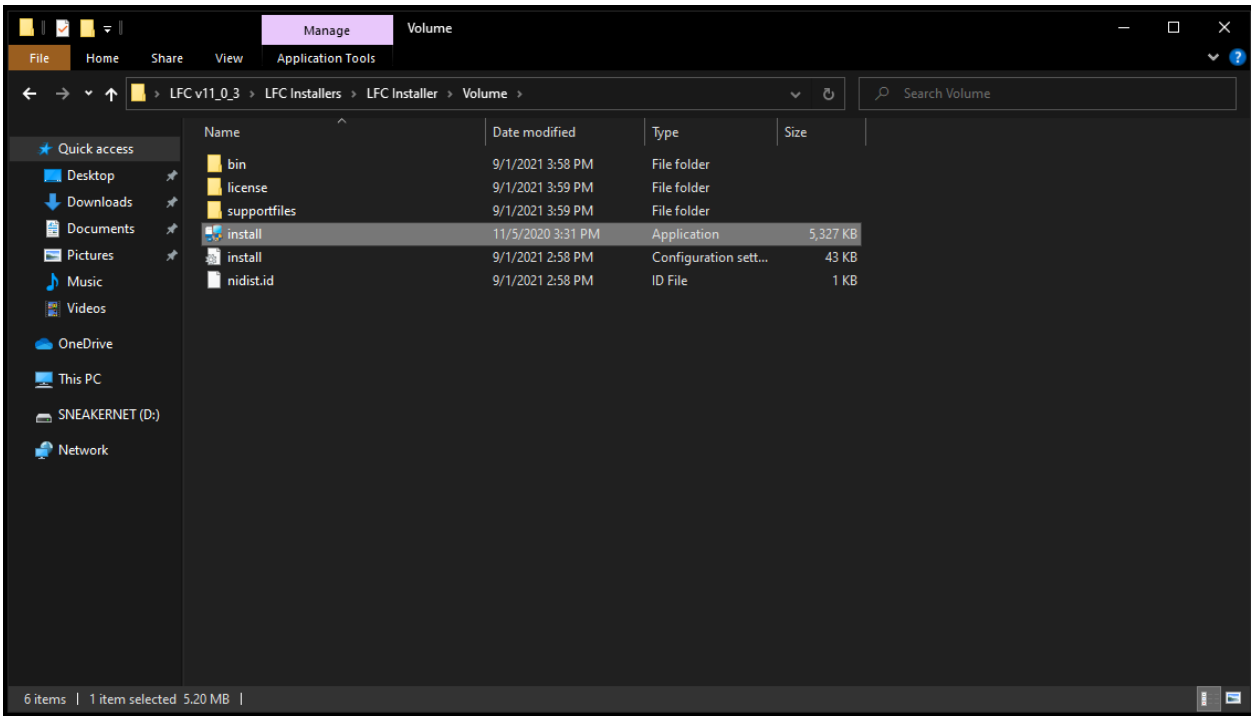
Step 14. Navigate to the path shown below and double click install.



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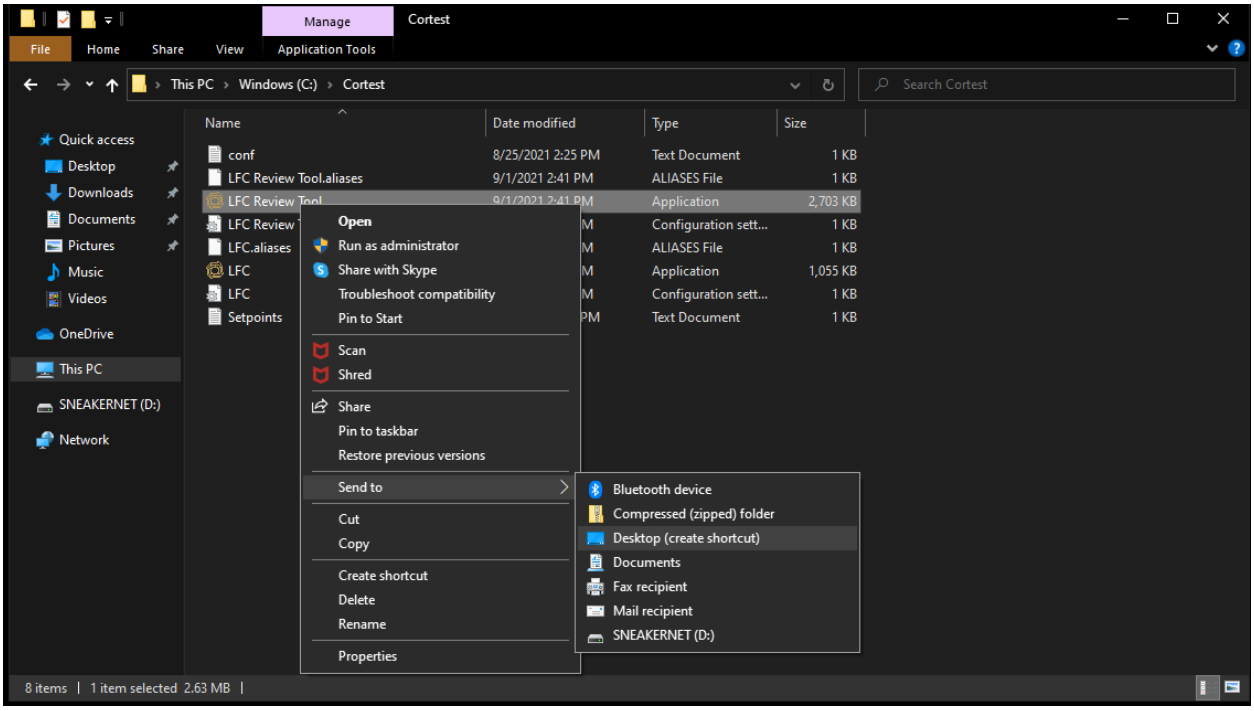
Step 15. Create a desktop shortcut by navigating to the Cortest Directory on the C drive. Right click, Send to, Desktop (Create Shortcut) (shown below)



Step 16. Reconfigure and recalibrate the system in the LFC software before using.

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Network Connections

The ip address of the network interface card that is used to connect to the frame should be 192.168.1.11. The subnet mask should be 255.255.255.0. All other fields can be left blank.

All firewalls on the computer must be disabled.

Use NI-MAX to verify connection to the NI-9042 cRio.

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Troubleshooting

Issue	**Solution**
Network Trouble light flashing on LFC software.	See the Network Connections section
Frame unresponsive	Power down the computer and frame for at least 30 seconds and repower. Not that the frame takes a moment to boot. To confirm the frame is booted before starting the software press the estop. The light will illuminate once the frame has booted.

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