MTS Servo Hydraulic Test System (MTS Corporation)
Model: 810 system, FlexTest SE Controller – PLUS

Location of Machine: Composites Lab, INGR 1308

Location of SOP and Machine Operating & Safety Manual: Composites Lab website under resources; Composites Lab TRACS site; and Hardcopy near machine.

Emergency Contact:
- Call 911
- Call EHS & Risk Management at 512-245-3616
- Call Head Lab Technician, Dr. Ray Cook (office 512-245-2050)
- Call Dr. Jitendra S Tate (office 512-245-4872)

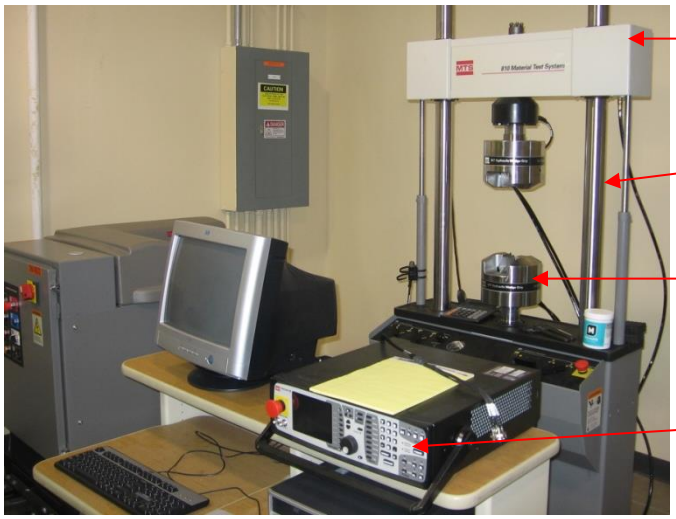
Before using this machine:
- You must have permission from Dr. Tate.
- You must have received formal training from technician or, trained research student (designated by Dr. Tate) related to machine safety and operation.
- You must read and understand **SOP and Machine Operating & Safety Manual.**
- You must use this machine under direct supervision of Dr. Tate or, Dr. Cook or, trained research student (designated by Dr. Tate).
- You must have signed "Lab Rules" document with Dr. Tate. This document must be signed every semester fall, spring, and summer (as applicable).
- If you do NOT follow above instructions you will be held responsible for your own safety and damages.

Safety Precautions:

Protective Equipment: Prior to performing this procedure, the following personal protective equipment must be obtained and ready for use: **Gloves, Safety Goggles, Lab Coat.**

Important Safeguards:

1. From lowermost position moving head moves 210 mm (~8 in) upward. Operator must make sure that, when moving head is at its extreme top position it is not touching to the crosshead.
2. Specimens can develop sharp edges as a result of testing, handling the specimens with unprotected hands can results in cuts.



MTS Machine

General information

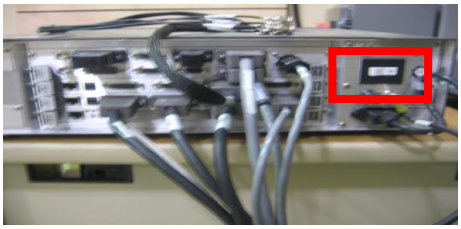
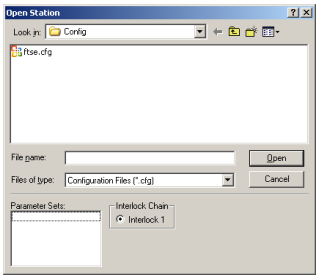
The MTS machine is used for all different types of Mechanical testing such as tension, compression, flexure, interlaminar shear strength, fatigue, fracture etc. MTS machine is controlled by advanced test design application software, **MultiPurpose Testware** (MPT). It is operated by hydraulic power unit. Different types of materials can be tested on this machine such as composites, plastics, and metals.

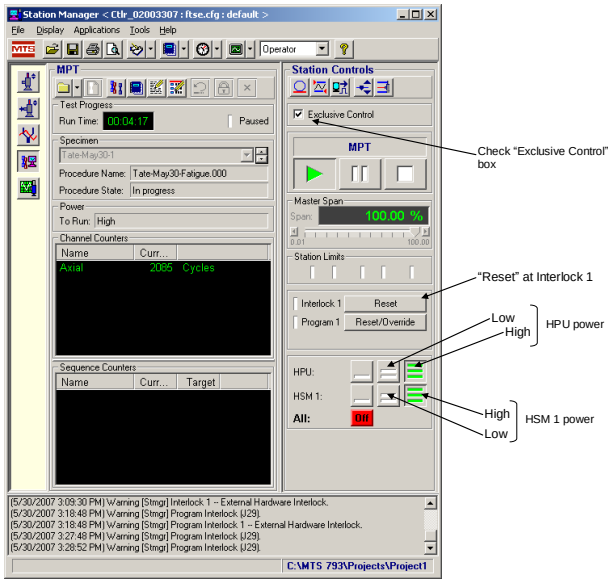
Specifications:

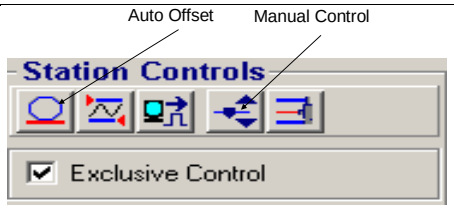
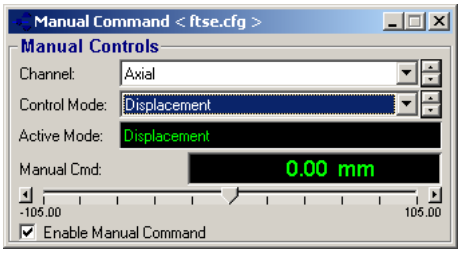
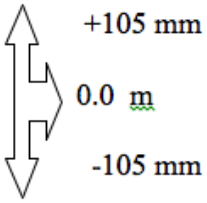
- Loading Capacity-100KN (22 kips)
- Clamping Pressure- 3000psi
- Range of Frequency- 0-100 Hz

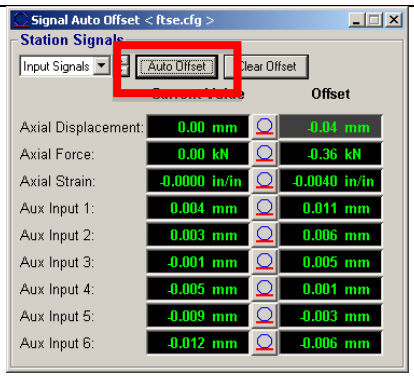
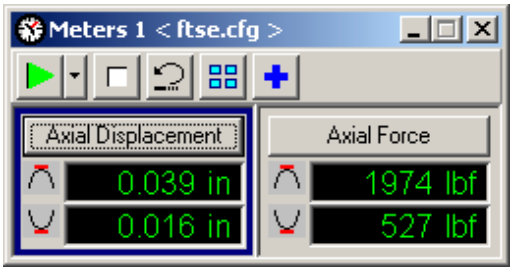
Accessories:

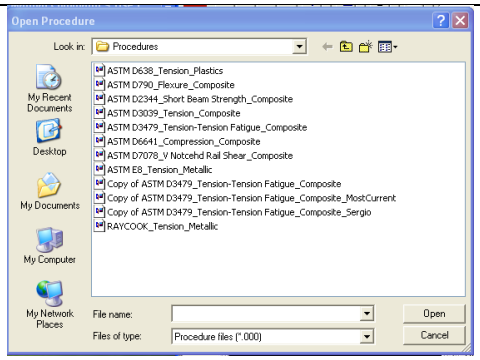
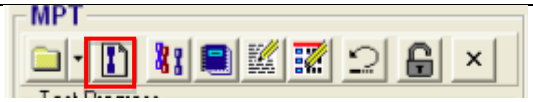
- **Fixtures:** ASTM Test Fixtures: Tension D3039; 1. Compression D6641; 2. V-notch rail shear D7078; 3. Flexure D790; Short Beam D2344; 4. Boeing Compression after Impact D7137; 5. Boeing Open Hole Compression D6484; 6. Climbing Drum Peel Test D1781.
- **Flat Grips**: 0-7.6mm; 7.1-14.2mm; and 11.7-19.1mm
- **Round Grips:** 12mm; 15mm; and 20mm
- **Extensometers:**
  - 0.5” gage length; Strain Range: +/- 9%
  - 1” gage length; Strain Range: 0 to 100 %

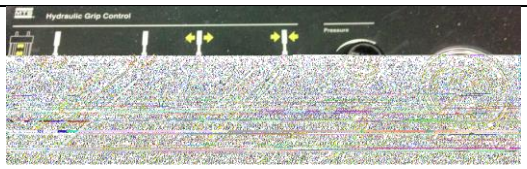
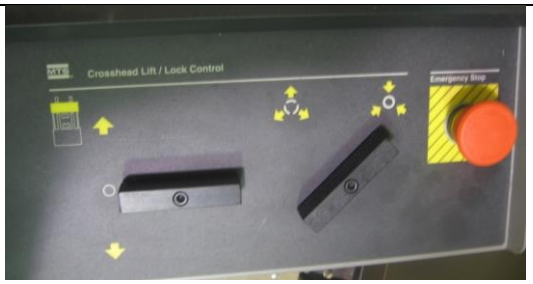
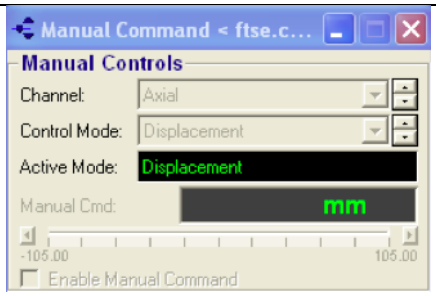
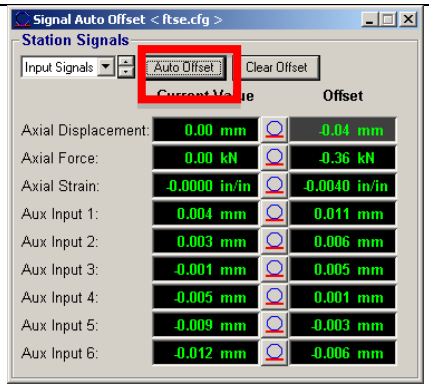
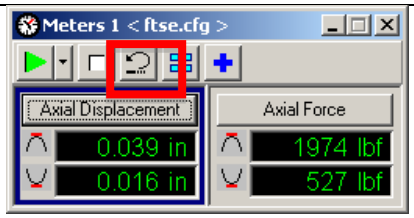
Turning and preparing the MTS for instrumented operation	
On the pump panel: 12. Locate the **red** circular switch and turn it on. 12. Locate and press the **blue** button label Reset. These 3 switches should turn off. 12. Verify that this switch is in LOW position	
On the controller: 12. Locate and turn on the white power switch located on the back of the controller.	
On the computer: 12. Turn on the machine. 12. Locate “Station Manager” icon on desktop and double click on it. 12. Select file ftse.cfg and click open 12. The	 

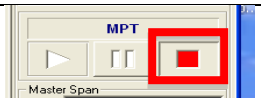
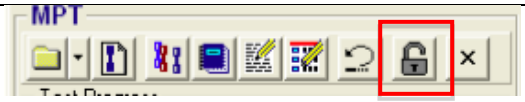
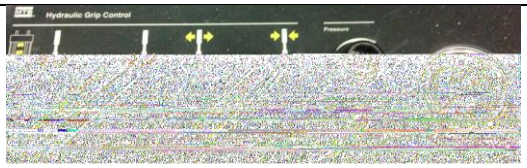
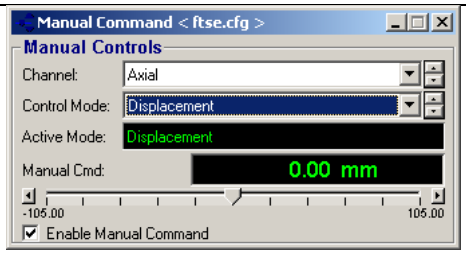
12. You should be able to see this window	
12. The mode should be in the "Operator" mode.	
12. **Check** "Exclusive Control" box. It means now the control of the machine is acquired by software.	
12. Click "Reset" at Interlock 1	
On HPU: 12. Click low power wait for 10 sec and then click high power	
On HSM 1: 12. Click low power wait for 10 sec and then click high power	

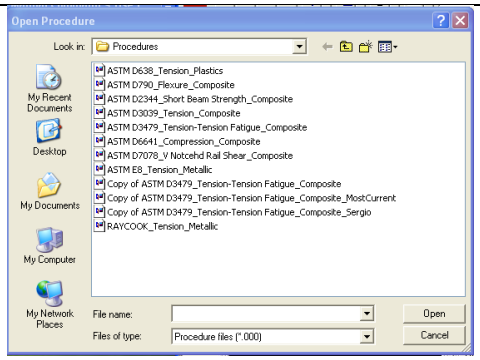
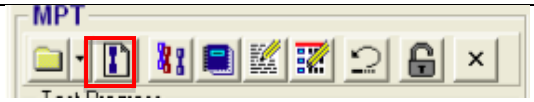
At the right side on the Load frame: 12. Unlock the upper head (cross head) by turning right lever to this position. 12. Turn left lever to upper position and crosshead will move upward.	
In "Station Control" window: 12. Click on Manual control. 12. Click on Auto Offset 12. Two dialogue boxes will pop up.	
In Manual Controls 12. Check 'enable manual command'. 12. Select the control mode displacement. 12. Bring the "Moving Head" to the zero position	
Now the "Moving Head" can be moved. *Note: If you give the negative value then the "Moving Head" goes up and if you give the positive value then the "Moving Head" goes down.*	

In Auto Offset 12. Click on “Auto Offset” to make all readings zero.	
In the station manager: 12. Open the meters. In this meter you can add Time, Axial displacement, Axial Force etc., and also you can change the dimensions here accordingly by clicking the ADD button (+).	

TENSION TEST	
In MPT window: 1. Go to open procedure	
2. Select appropriate ASTM procedure based on the type of material being tested. These procedures are labeled 'ASTM D638 Tension Plastics', 'ASTM E8 Tension Metallic', 'ASTM D3039 Tension Composite'.	
3. Click on new specimen, and name the specimen.	
On MTS: 4. Fix the desired grips onto the heads, according to the thickness of the specimen.	
5. Fix the specimen	

6. Locking the grips with hydraulic grip control.	
7. Lock the upper head (cross head)	
In Manual Control window: 8. Disable the manual command.	
In Auto Offset window: 9. Click on auto offset	
In Meters window: 10. Click on reset procedure.	
In Station Manager Window: 11. Click on program run	
12. A dialog box will pop up. 13. Complete all data and click save.	

14. Graph window will pop up.	
15. After specimen breaks click the **stop button**	
16. Unlock specimen to break the test	
17. Click New Specimen to save data.	
On MTS: 18. Unlock the grips. 19. Remove the specimen.	
In the Manual Control Window: 20. Enabling manual command. 21. Bring moving head to neutral position.	

COMPRESION TEST	
In MPT window: 1. Go to open procedure	
2. Select appropriate ASTM procedure based on the type of material being tested. '<u>ASTM D6641 Compression Composite</u>'.	
3. Click on new specimen, and name the specimen.	

Fixing the specimen in the compression fixture:

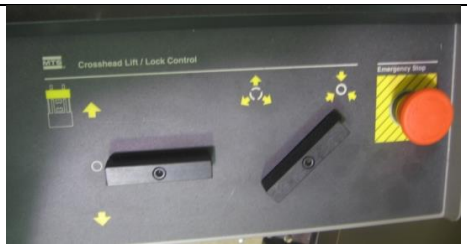
4. Insert one side of the specimen in the bottom half of the fixture until it touches at the bottom.
5. Tighten screws evenly.
6. Keep the distances between the two halves of the fixture as 12.5-25 mm as per the test.
7. Fix the specimen in the upper half.
8. Tighten screws evenly.

Note: Tighten screws accordingly with standard.

On MTS:

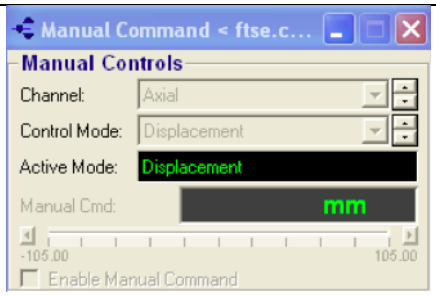
9. Place grips
10. Fix the cylindrical bases into the grips of moving head and cross head to support compression fixture.
11. Lock the grips with hydraulic grip control.

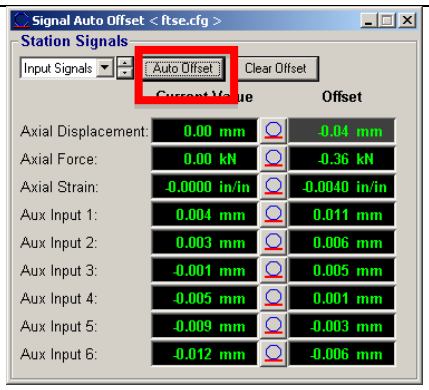
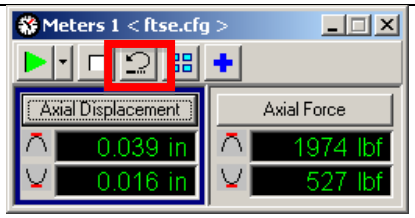
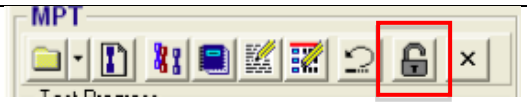
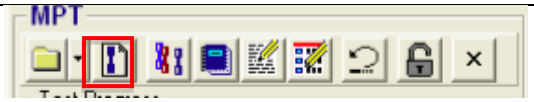
12. Fix the fixture on the cylindrical base.
13. Lock the upper head (cross head)

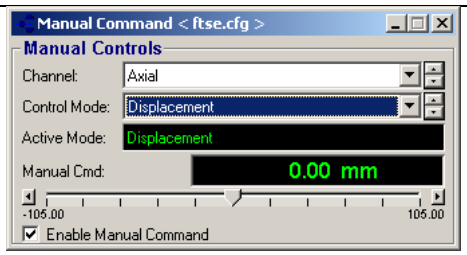


In Manual Control window:

14. Disable the manual command.



In Auto Offset window: 15. Click on auto offset	
In Meters window: 16. Click on reset procedure.	
In Station Manager Window: 17. Click on program run	
18. A dialog box will pop up. 19. Complete all data and click save.	
20. Graph window will pop up.	
21. After specimen breaks click the **stop button**	
22. Unlock specimen to break the test	
23. Click New Specimen to save data.	
On MTS: 24. Unlock the upper head (cross head) 25. Remove the Compression Fixture. 26. Loosen the screws and release the specimen	

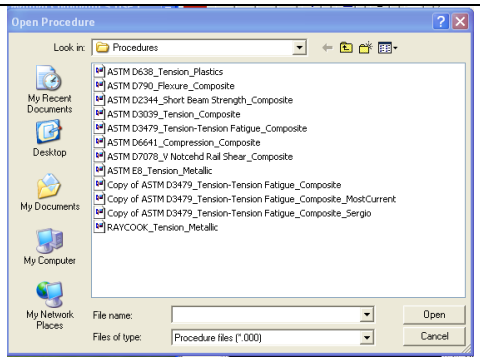
In the Manual Control Window: 27. Enabling manual command. 28. Bring moving head to neutral position.	

FLEXURE TEST

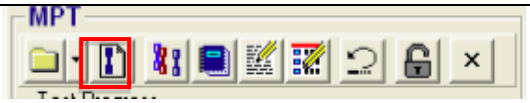
In MPT window:

1. Go to open procedure

2. Select appropriate ASTM procedure based on the type of material being tested. '<u>ASTM D790 flexure.</u>'



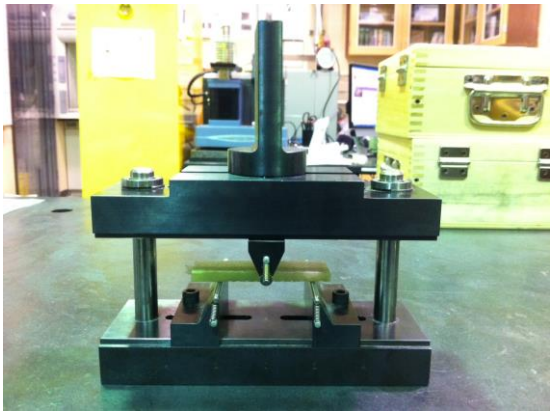
3. Click on new specimen, and name the specimen.



Fixing the specimen in the flexure fixture:

4. First select appropriate roller size from ASTM standard.
5. Find support span for the specimen from ASTM standard.
6. Fix the supporting rollers evenly on the both sides of loading nose at appropriate positions.

<u>Note: There is mark in the center on the base plate to fix the supporting rollers.</u>



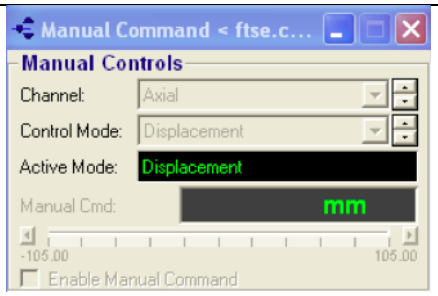
On MTS:

7. Place grips
8. Fix the cylindrical bases into the grips of moving head to support flexure fixture.
9. Mount upper plate into the crosshead.
10. Lock the grips with hydraulic grip control.

11. Fix the specimen
12. Lock the upper head (cross head)

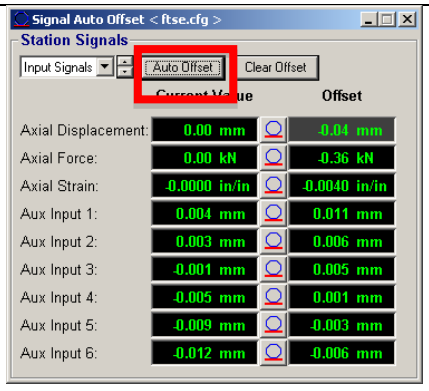
In Manual Control window:

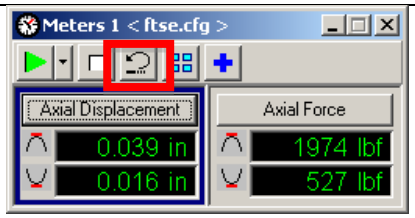
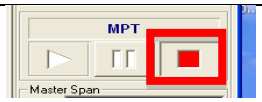
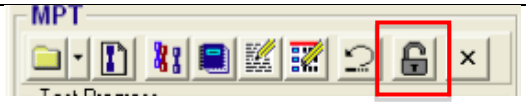
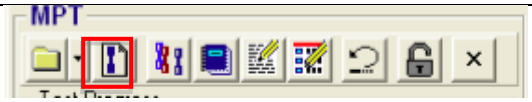
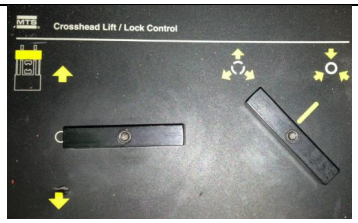
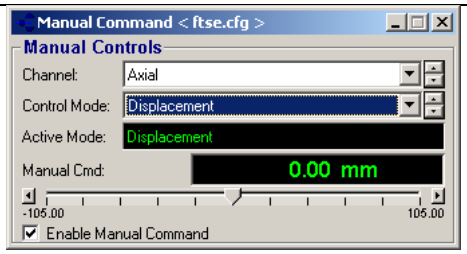
13. Disable the manual command.

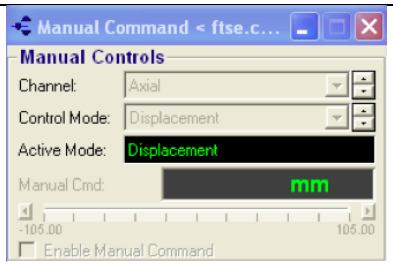
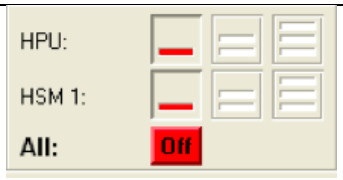
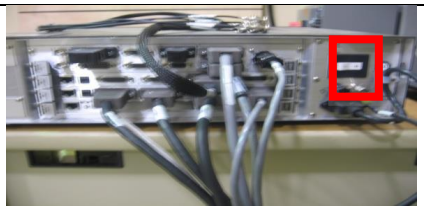


In Auto Offset window:

14. Click on auto offset



In Meters window: 15. Click on reset procedure.	
In Station Manager Window: 16. Click on program run	
17. A dialog box will pop up. 18. Complete all data and click save.	
19. Graph window will pop up.	
20. After specimen breaks click the **stop button**	
21. Unlock specimen to break the test	
22. Click New Specimen to save data.	
On MTS: 23. Unlock the upper head (cross head) 24. Remove the specimen.	
In the Manual Control Window: 25. Enabling manual command. 26. Bring moving head to neutral position.	

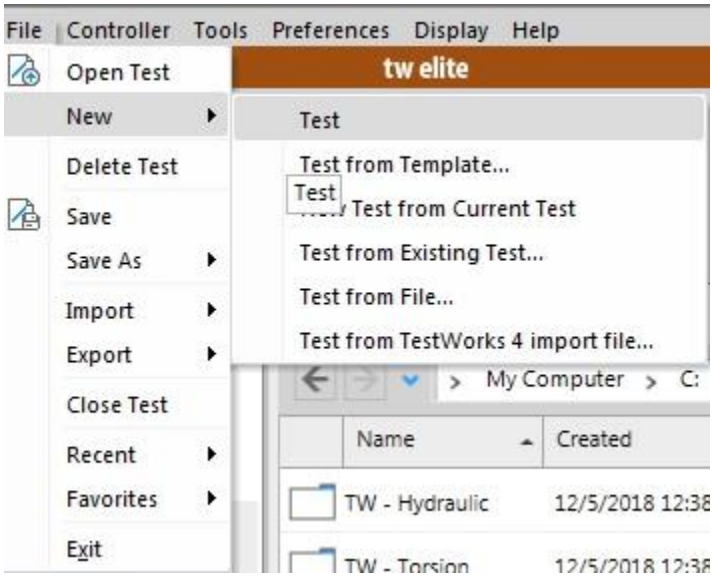
TO QUIT PROGRAM	
1. Bring the cross head to appropriate position.	
2. Disable the **manual command.**	
3. Uncheck **the exclusive station control.**	
4. Lock the upper head (cross head) by turning lever to this position.	
5. Click on '**Reset**' if interlock signal is red.	
6. Click on **HPU1** LOW…to… OFF.	
7. Wait for 10 seconds and then click on **HSM 1** LOW …to… OFF	
8. Go to **File**, and then click on **Exit**.	
9. Turn OFF Controller	

10. Turn OFF the pump switch.	

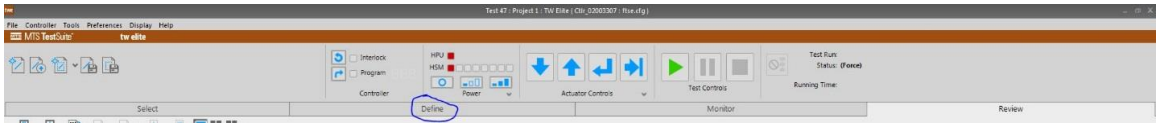
Fatigue Test Design in TWElite

1. Launch TWElite by double clicking the icon

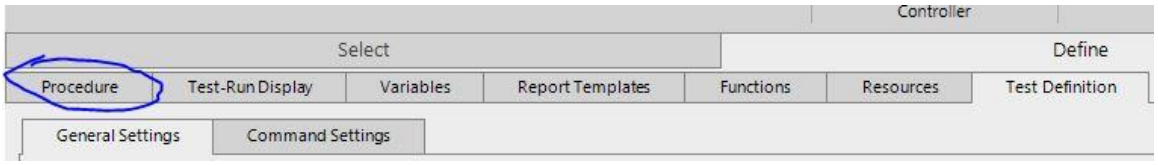
2. Go to File → New → Test



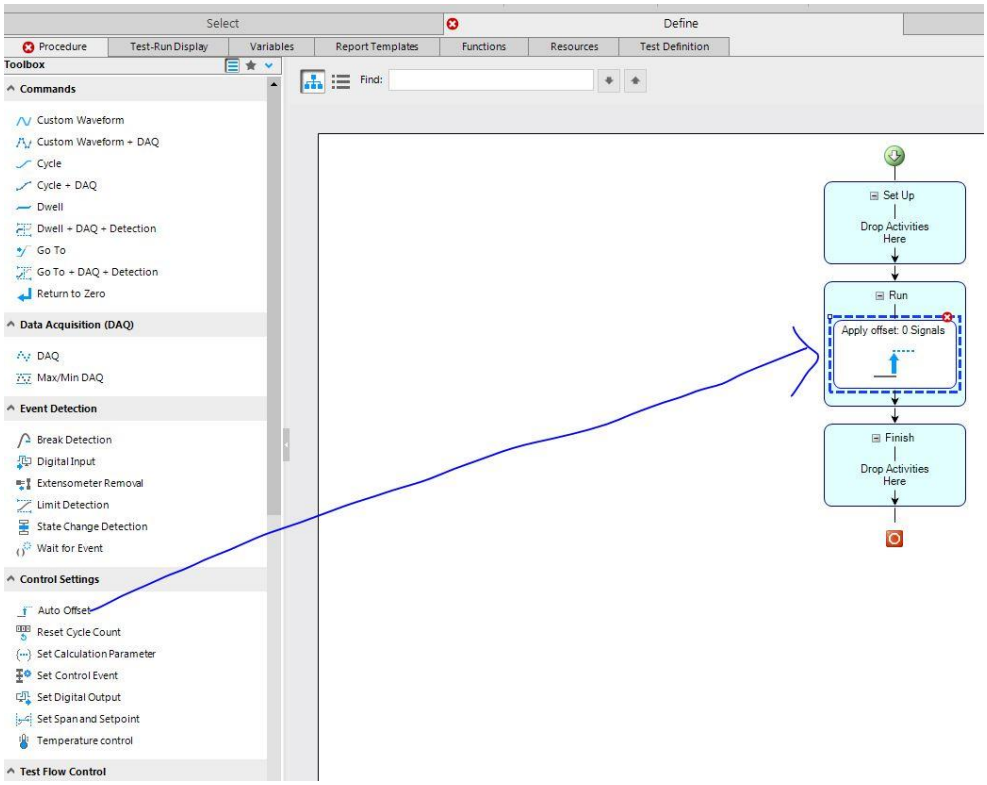
3. Click on Define Tab



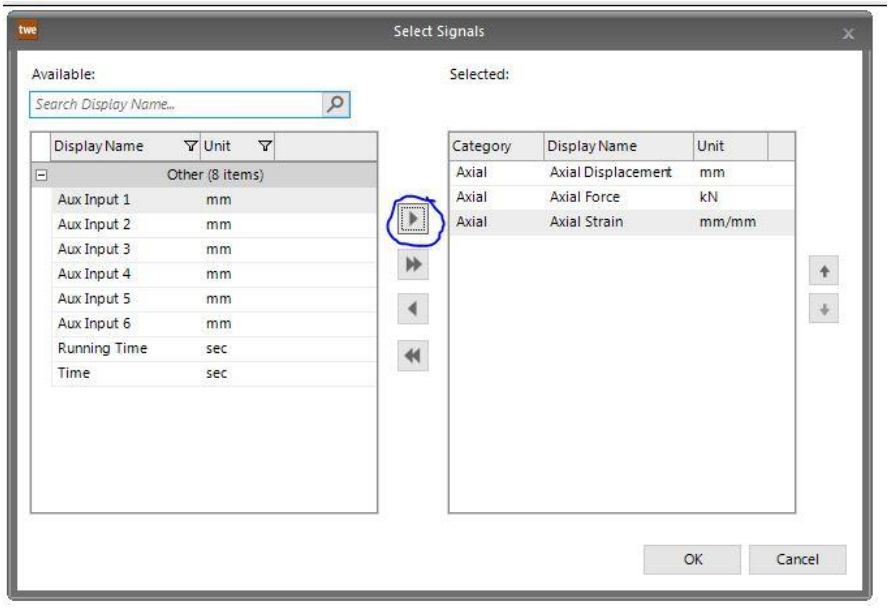
4. Click on Procedure Tab



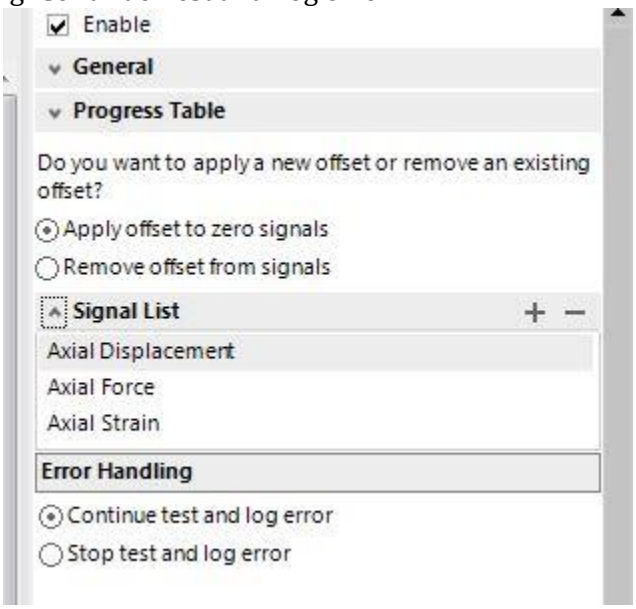
5. Drag the Auto Offset command from toolbox and drop it in the run section of test flowchart



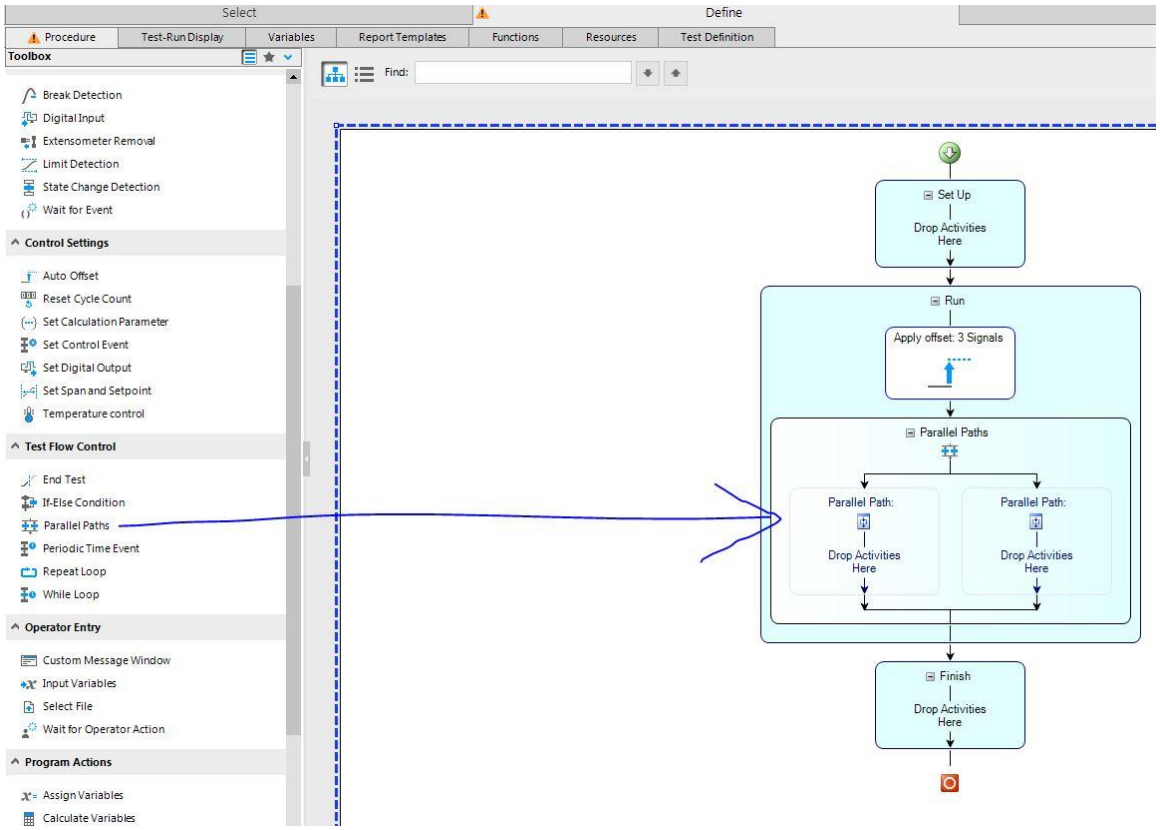
6. In the properties tab of the Auto Offset command on the right hand of the screen:
   a. Select Apply offset to zero signals
   b. Click the + sign next to Signals List, select Axial Displacement, Axial Force and Axial Strain from the Select Signals popup window and transfer them into the Selected signals box using the button with a single triangle, then click ok



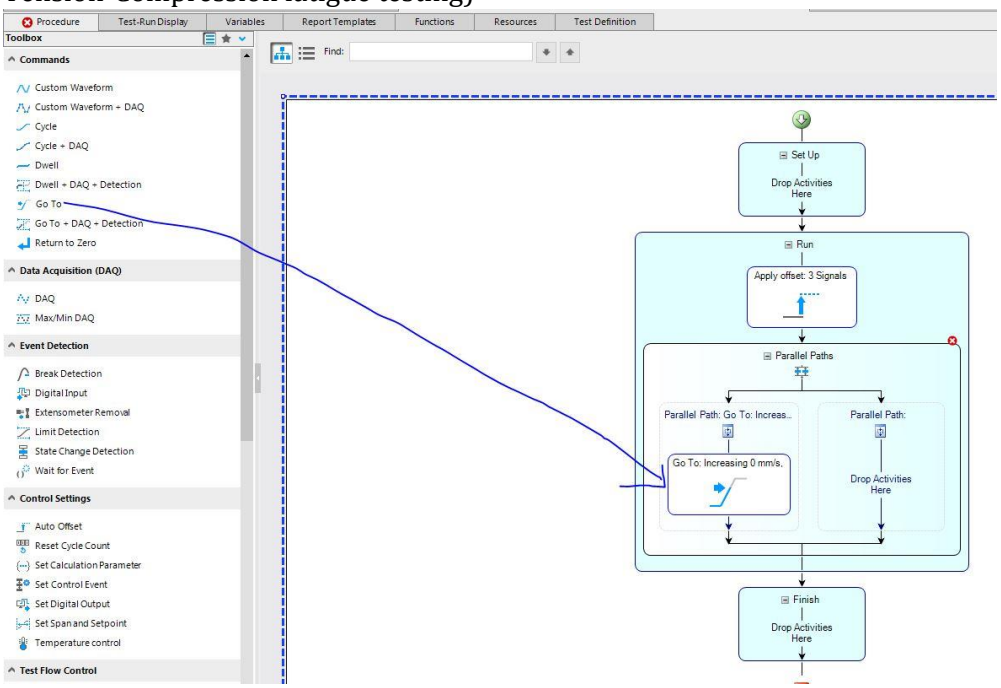
c. Error handling: Continue Test and Log error



7. Drag the Parallel Paths command from toolbox and drop it below Auto Offset in the run section of test flowchart

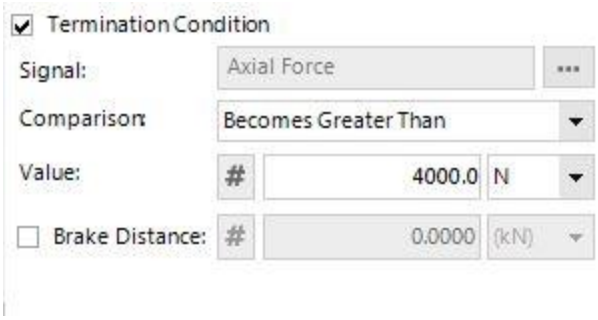


8. On the left-hand path:
    a. Drag and drop Go To from commands toolbox on the left side of the screen inside the run portion of the test flowchart (Skip steps a through f for Tension-Compression fatigue testing)

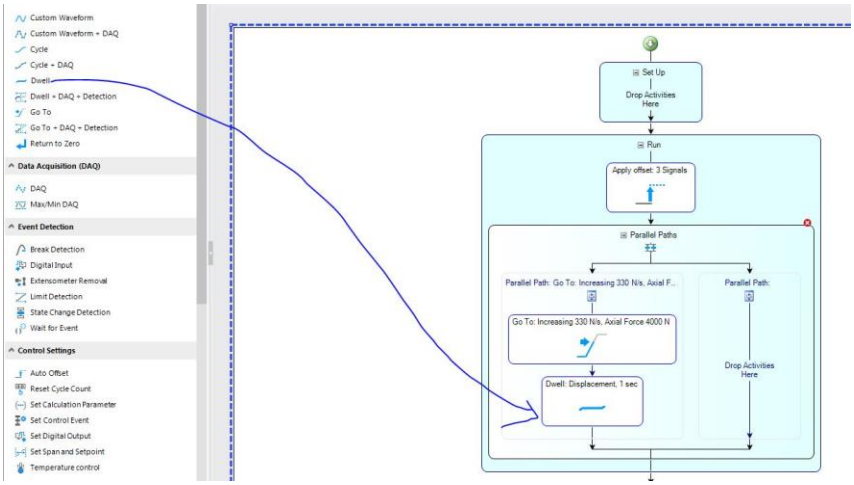


    b. In the properties tab of the Go To command on the right hand of the screen
        i. Channel: Axial
        ii. Control Mode: Force
        iii. Direction: Increase
        iv. Rate: 330 N/s

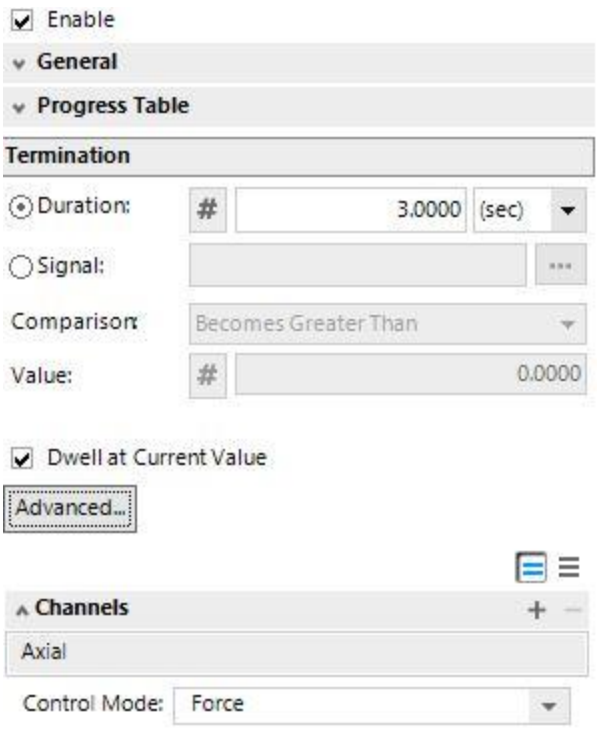
    c. Click on the tiny box near Termination Condition so that a tick mark appears
    d. Select:
        i. Signal: Axial Force by clicking on the more button (button with three dots)
        ii. Comparison: Becomes greater than
        iii. Type in your calculated F_{avg} number for value



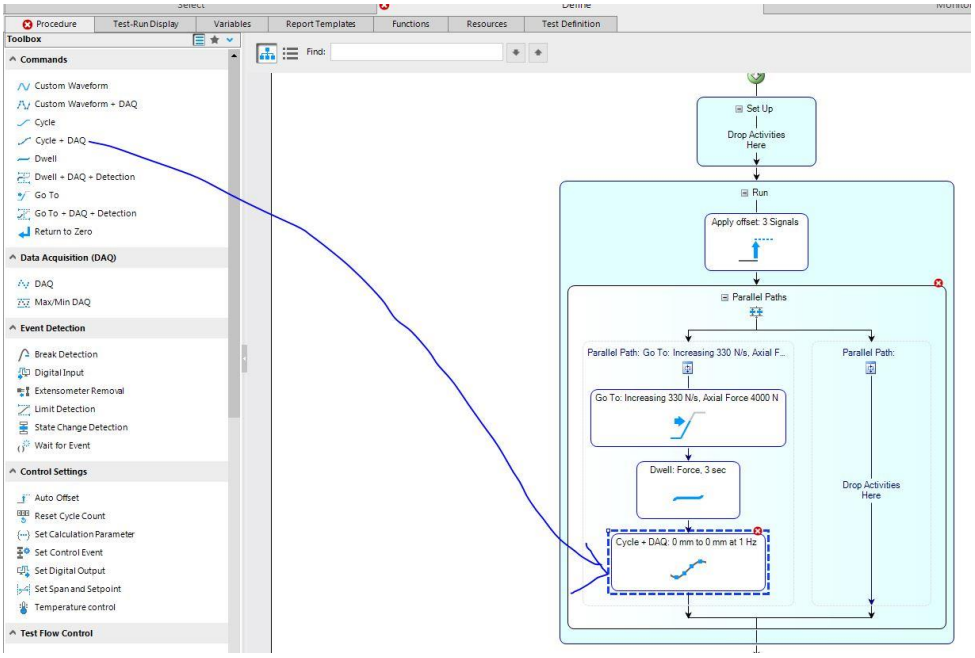
e. Drag dwell from commands toolbox and drop in below Go To in the run section of test flowchart



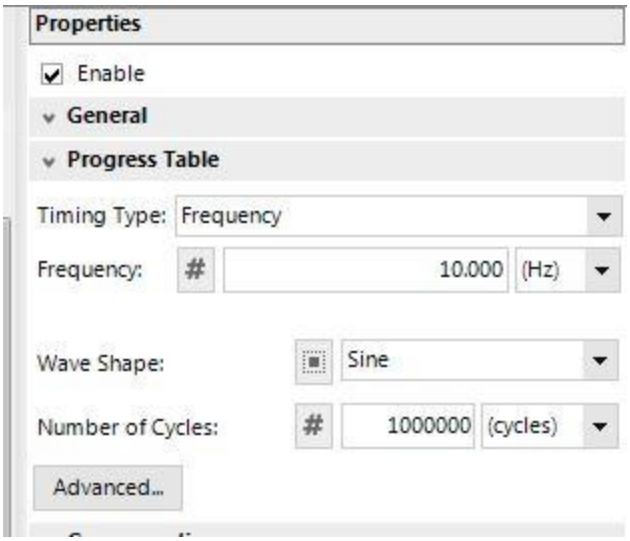
f. In the properties tab of the dwell command on the right hand of the screen, type in the appropriate time for dwell (3 seconds usually) and change control mode to force



g. Drag Cycle+DAQ from commands toolbox and drop in below Dwell in the run section of test flowchart

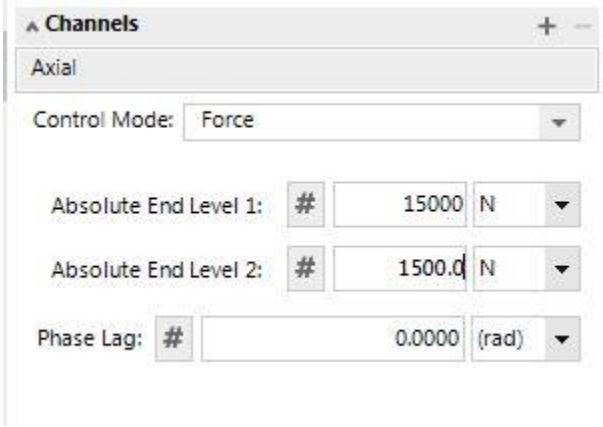


h. In the properties tab of the cycle+DAQ command on the right hand of the screen:
   i. Timing Type: Frequency
   ii. Frequency: As needed (usually 2 Hz or 5 Hz or 10 Hz)
   iii. Wave Shape: Sine
   iv. Number of Cycles: 1 million

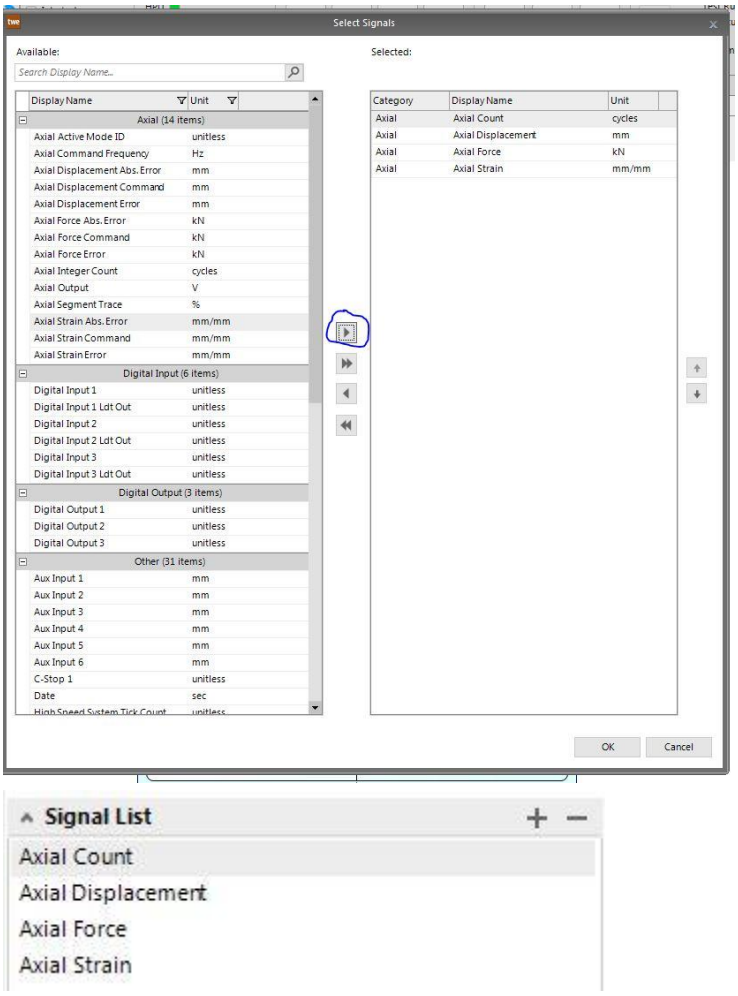


v. Expand compensation by clicking the arrow nest to it: Peak Valley Amplitude Control

vi. Control Mode: Force
vii. Absolute End Level 1: F_{max}
viii. Absolute End Level 2: F_{min}



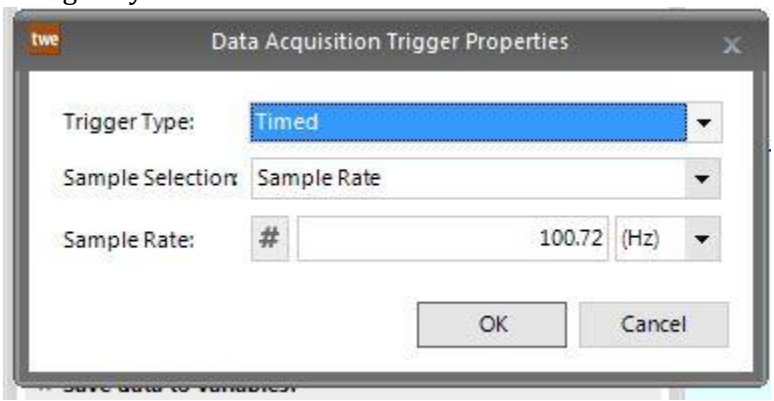
ix. Click on the + Sign next to Signal List select Axial Count, Axial Displacement, Axial Force, Axial Strain from the Select Signal popup window and transfer them into the Selected signals box using the button with a single triangle, then click ok



x. Click on the + sign next to Data Accusation List.

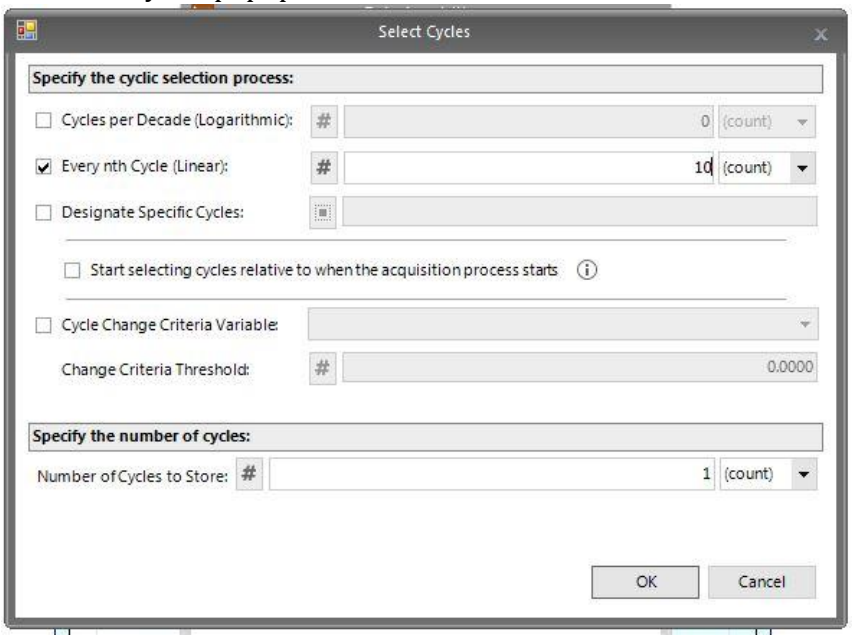
xi. Click on the + sign next to the trigger list in the Data Accusation popup window

xii. In the Data Accusation Trigger Properties popup window do not change any values and click OK

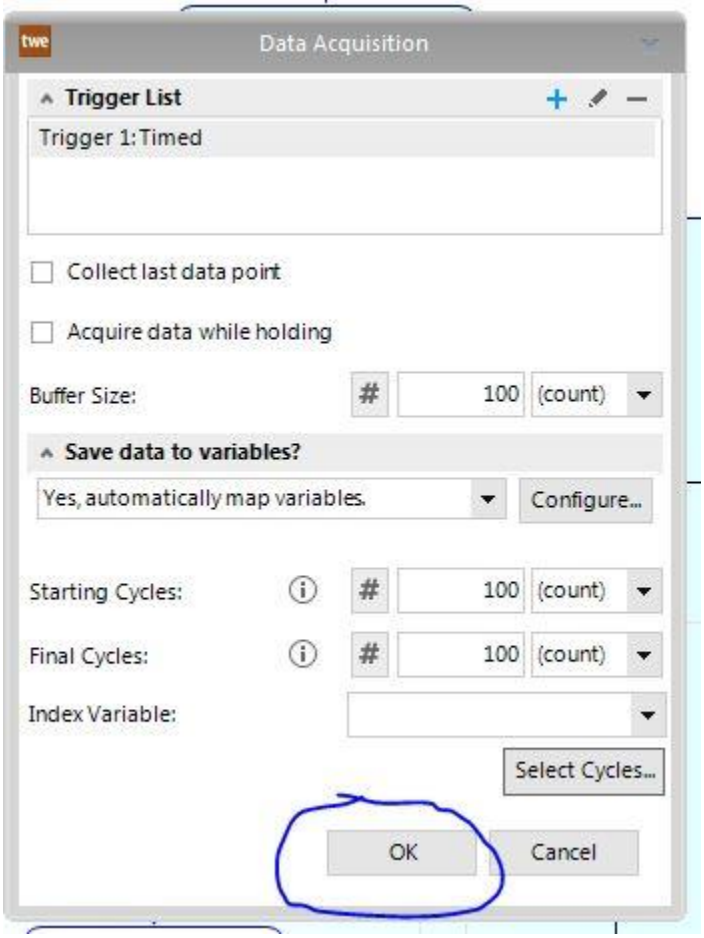


xiii. Click on select cycles In the Data Accusation popup window

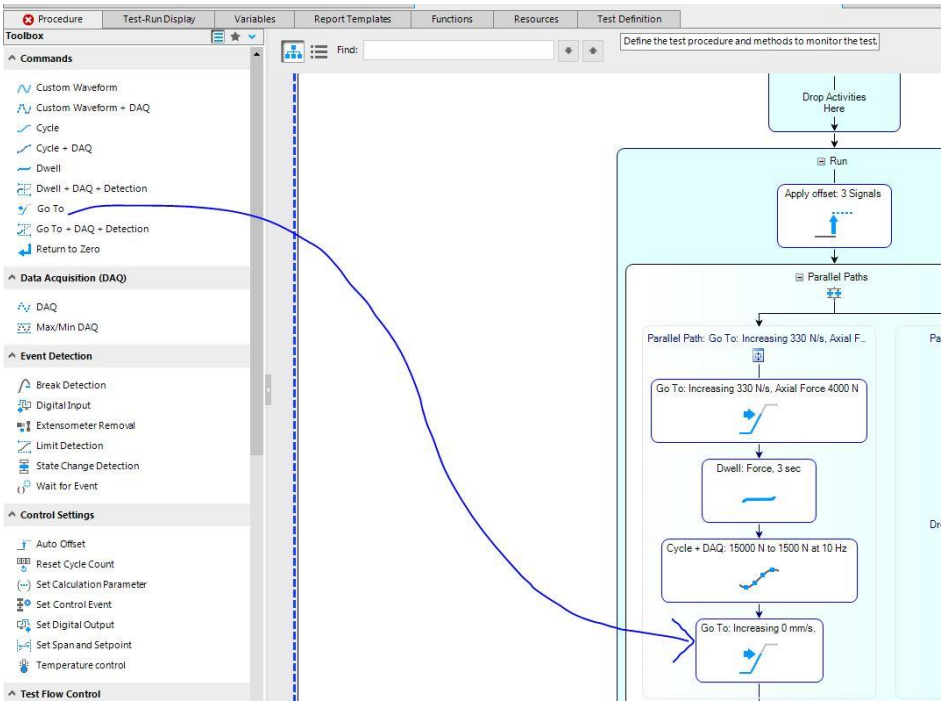
xiv. Click on every nth cycle(linear) and type in 10 in the dialog box in the Select Cycles popup window and click ok.



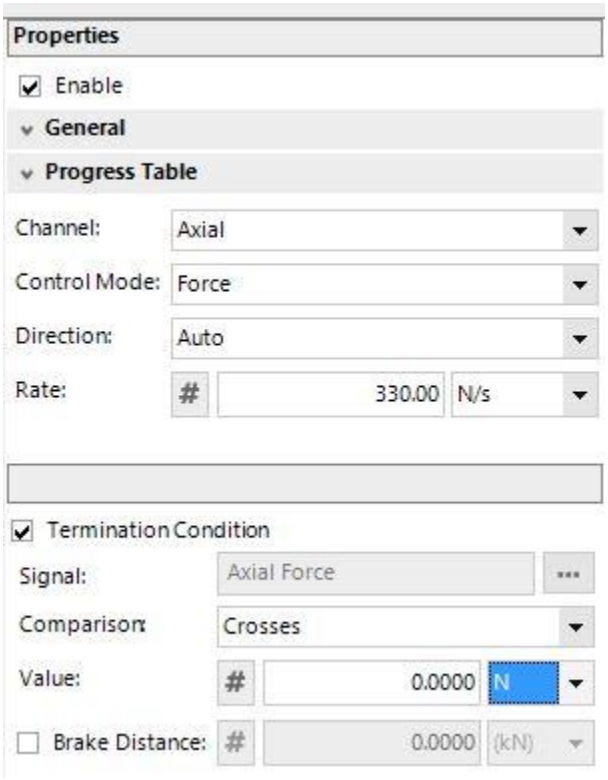
xv. Click ok on the data accusation popup window



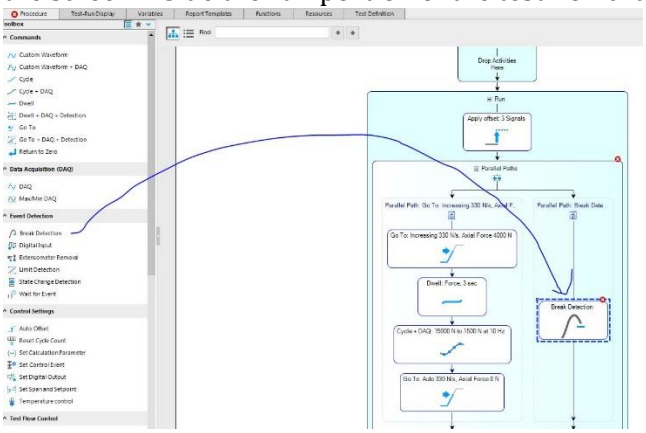
i. Drag Go To from commands toolbox and drop in below Cycle+DAQ in the run section of test flowchart



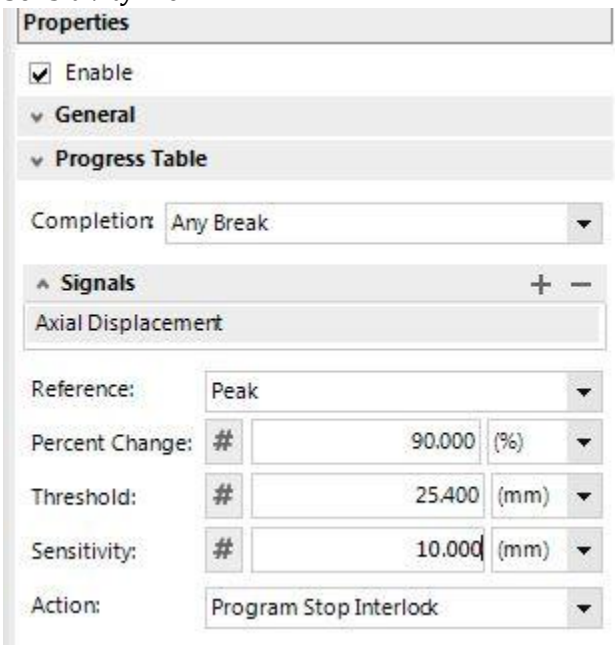
j. In the properties tab of the Go To command on the right hand of the screen:
   i. Chanel: Axial
   ii. Control mode: Force
   iii. Direction: Auto
   iv. Rate: 330 N/s
   v. Termination condition: checked
   vi. Signal: Axial Force by clicking on the more button (button with three dots)
   vii. Comparison: Crosses
   viii. Value: 0 N



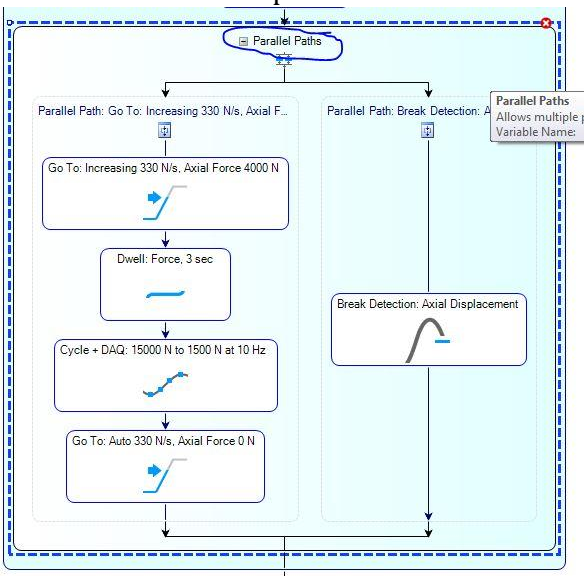
9. On the right-hand path:
   a. Drag and drop Break Detection from commands toolbox on the left side of the screen inside the run portion of the test flowchart

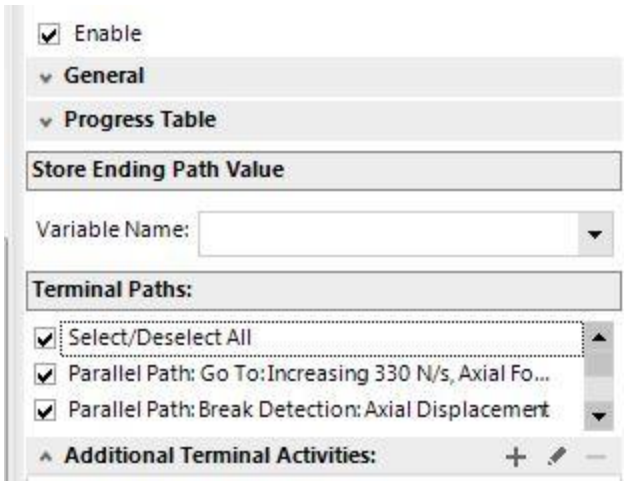


b. In the properties tab of the Break Detection command on the right hand of the screen:
   i. Completion: Any Break
   ii. Click the + sign next to signals and select axial displacement from the Select Signals popup window and transfer it into the Selected signals box using the button with a single triangle, then click ok
   iii. Action: Program Stop Interlock
   iv. Reference: Peak
   v. Percentage Change: 90%
   vi. Threshold: 25.4 mm
   vii. Sensitivity: 10 mm

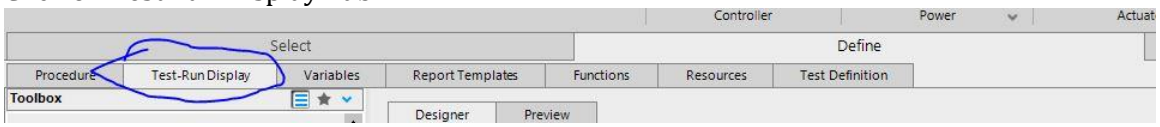


10. Click on parallel paths in the properties tab on the right hand of the screen check select all for terminal paths.

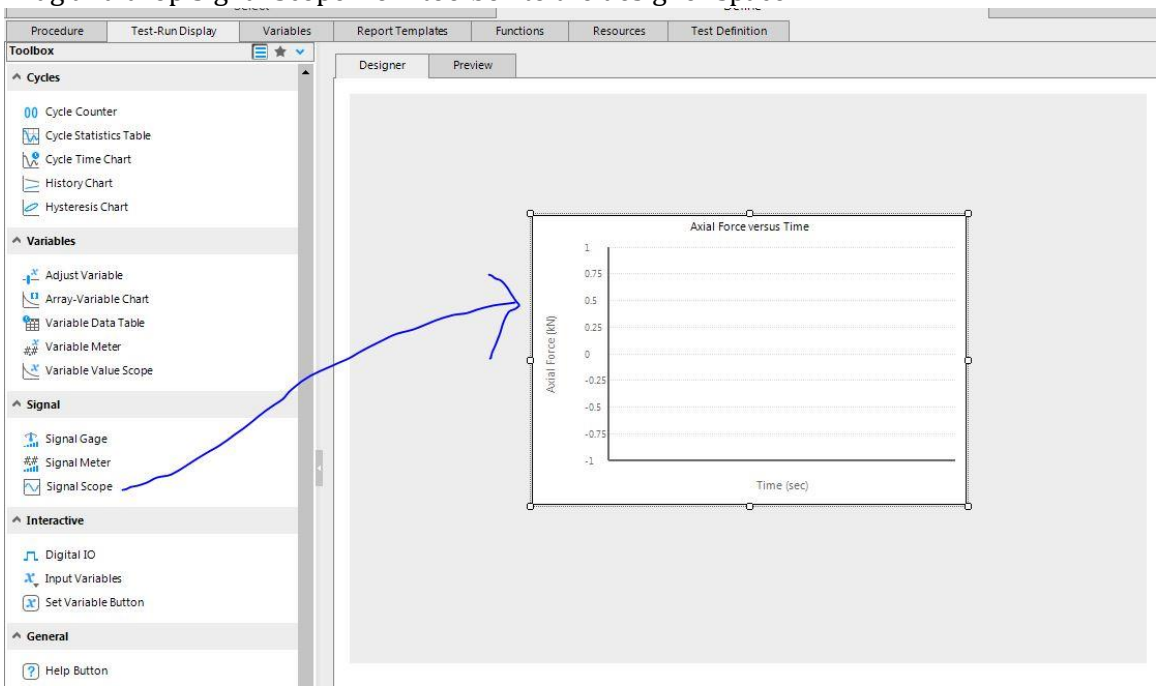




11. Click on Test-run Display Tab

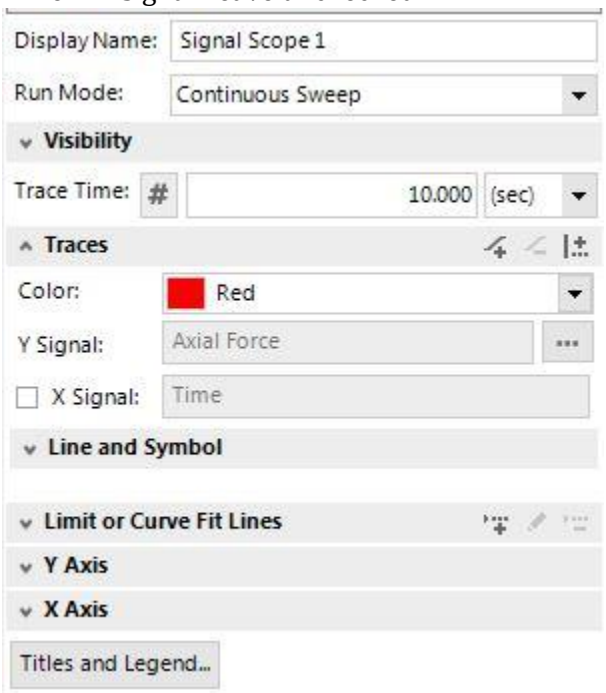


12. Drag and drop Signal Scope from toolbox to the designer space

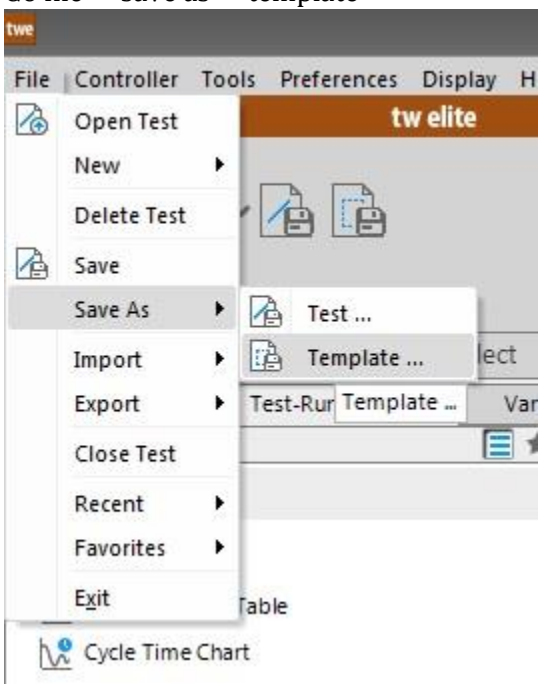


13. In the properties tab of the Signal Scope command on the right hand of the screen:

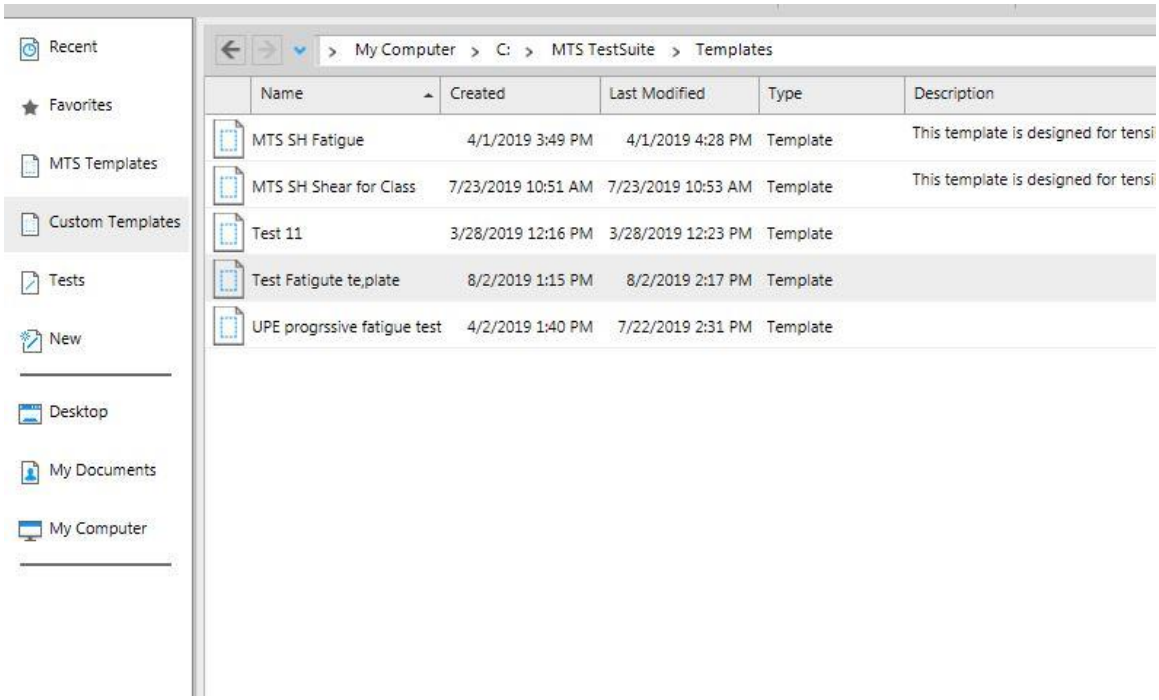
a. Run Mode: Continuous Sweep
b. Trace Time: 10 Seconds
c. Color: Any
d. Y Signal: Axial Force
e. X signal: leave unchecked



14. Go file → save as → template



15. Template will be available under custom templates


Recent
Favorites
MTS Templates
Custom Templates
Tests
New
Desktop
My Documents
My Computer
My Computer > C: > MTS TestSuite > Templates
Name
Created
Last Modified
Type
Description
MTS SH Fatigue
4/1/2019 3:49 PM
4/1/2019 4:28 PM
Template
This template is designed for tensi
MTS SH Shear for Class
7/23/2019 10:51 AM
7/23/2019 10:53 AM
Template
This template is designed for tensi
Test 11
3/28/2019 12:16 PM
3/28/2019 12:23 PM
Template
Test Fatigute te,plate
8/2/2019 1:15 PM
8/2/2019 2:17 PM
Template
UPE progrssive fatigue test
4/2/2019 1:40 PM
7/22/2019 2:31 PM
Template

MTS Tuning in TWE

The MTS EM Tuning Template Example is configured for a tension test using the Load Control Mode. To run a compression test, invert the polarity on the Load and Crosshead Float Signals.

1. Verify that the Advanced Rate Control software option is installed:

    A. Go to Start > All Programs > MTS TestSuite > License Administrator.

    B. Under Other Features, ensure that Custom.AdvancedRateControl appears.

2. Open the MTS TestSuite application.

3. Go to MTS Templates > TW-EM > Tuning > MTS EM Tuning Template Example.

4. Double-click the MTS EM Tuning Template Example to create a new test.

5. Install the specimen.

6. Clear the interlocks.

7. Click the run button.

8. Enter values for the Material Name, specimen dimensions, and Command activity variables. The Material Name is used to name the XML file containing the PID and tuning parameter values. Subsequent test runs will overwrite this file if the Material Name is not changed. To run a constant load test, set End Level 1 and End Level 2 to the same value and increase the Dwell Duration.

Name	Value	Unit
Material Name	Material 2011	
Width	12.700	mm
Thickness	3.175	mm
GoTo End Level 1 Rate	20.000	N/s
End Level 1	600.000	N
Dwell Duration	5.000	sec
GoTo End Level 2 Rate	20.000	N/s
End Level 2	100.000	N

9. Observe that initially the Load (blue line) does not respond to the Load Command (red line) until the kP_Load variable is increased.

Note: The maximum speed for metals is about 1 mm/min. The maximum speed for rubber is about 10 to 100 mm/min.

11. Increase the value of kP_Load by a factor of 10 and click OK until a response is seen. Then increase the value more gradually.

For example: 0.0010 OK; 0.010 OK; 0.1 OK, 0.2 OK

Name	Value	Unit
ExitVariable	Continue	
kP_Load	0.00010	unitless
kI_Load	0.0000	unitless
kD_Load	0.000	unitless
DerivativeInterval	2.000	sec
MaximumSpeed	1.000	mm/min
MaximumIntegral	30.000	mm/s

12. Increase kI_Load.
13. 12. Increase kD_Load if necessary.
14. 13. When tuning is complete, change the Exit Variable to "Done" and click OK to exit. The values and chart are results on the Review page. The PID and tuning parameter values are saved to an XML file in the Data Export Directory.

Name	Value	Unit
ExitVariable	Done	
kP_Load	1.20000	unitless
kI_Load	0.0020	unitless
kD_Load	0.000	unitless
DerivativeInterval	2.000	sec
MaximumSpeed	10.000	mm/min
MaximumIntegral	30.000	mm/s

MTS static mechanical test with MPT