

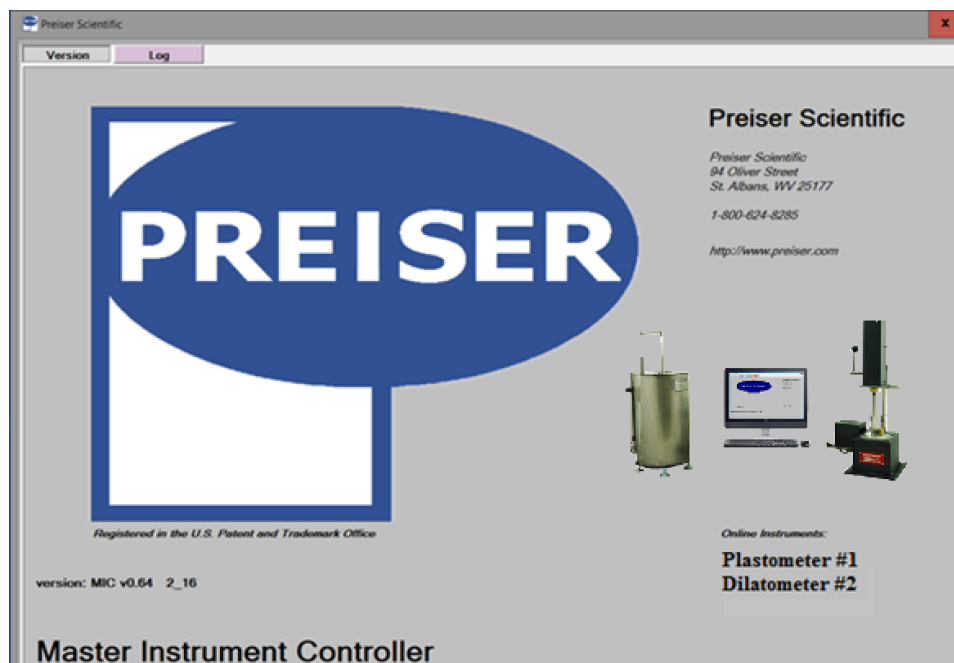
Dilatometer

User Manual

Version 2.0

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1.0 Installation Guide

It is Preiser Scientifics recommendation that a fume hood be installed over top of the instrument for normal and safe operation.

Unpack the upgrade kit and place components by the older instrument. Once the items are in position, a pre-use visual inspection needs to be completed to insure that no components or wired connection were damaged or dislodged during shipping. Remove the top cover of the control unit and visually inspect the interior of the controller cabinet for any loose connections.

Referring to the diagrams that follow connect the interface box to the Dilatometer assemblies.

This instrument utilizes a Windows® operating system. Clicking on the Interface Control program will automatically configure the attached interface boxes to the correct instrument types.

Although the MIC 5102 has been calibrated and thoroughly tested at the factory, it will be necessary to recalibrate the instrument once it is setup.

1.1 Single Dilatometer model 5000 Component Upgrade

- 1 Disconnect Dilatometer Furnace and LVDTs from the model 5000 controller.
- 2 Reconnect Dilatometer Furnace power and LVDTs amphenol connector into new interface box.
- 3 Replace Thermocouple (type J) with new Thermocouple (type K).
- 4 Connect Interface box to Control PC with supplied USB cable.

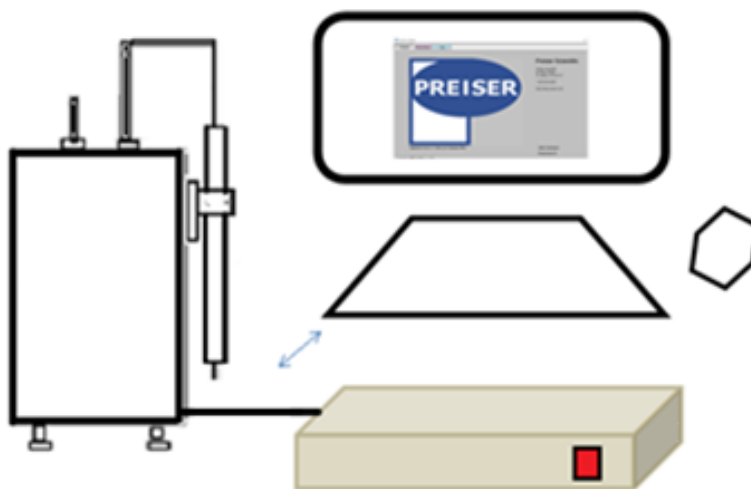


Figure 1 Control PC, Interface Box, Dilatometer Furnace/ LVDT Assembly

1.2 Single Dilatometer New Unit

- 1 Connect Dilatometer Furnace to powers source and LVDT assembly to interface box via a RJ45 either net cable (patch – straight cable).
- 2 Connect Thermocouple into the back of the interface box and place in sample tube.
- 3 Connect Control PC to interface box via USB cable.

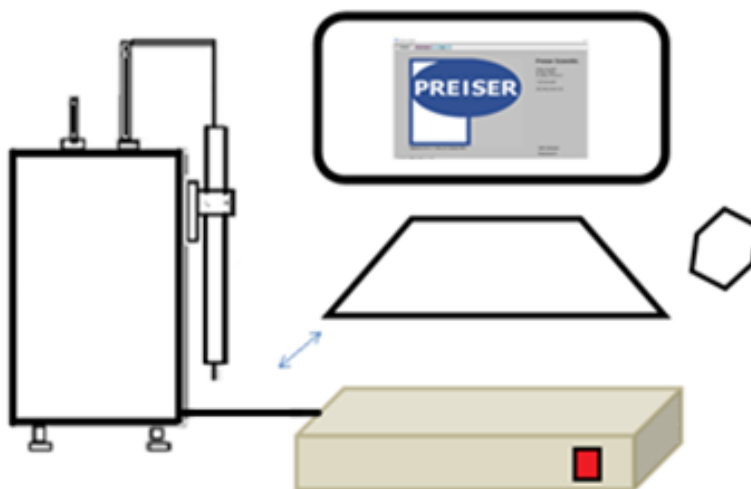


Figure 2 Control PC, Interface Box, Dilatometer Furnace/ LVDT Assembly

1.3 Combo Unit model 6000 Component Upgrade

(Plastometer/Plastometer, Plastometer/Dilatometer, Dilatometer/Dilatometer)

Combination units require the installation of two different interface boxes but will share a single PC controller. To upgrade, each half of the combo unit is treated as a single unit. Component installation for each of the two instrument sides of a combo are installed as described in the Plastometer and Dilatometer instructions.

The PC based control software will identify what units have been “Plugged” into the PC and will configure the control program.

A dual Plastometer/Dilatometer Unit will be upgraded as follows:

- 1 Disconnect Solder Pot and Head assembly from model 6000 controller.
- 2 Reconnect Solder Pot / Head Assembly into new interface box.
- 3 Replace Plastometer Thermocouple with new Thermocouple (type K).
- 4 Connect Interface box to Control PC with supplied USB cable.

- 5 Disconnect Dilatometer Furnace and LVDT assembly from model 6000 controller.
- 6 Reconnect Dilatometer Furnace and LVDT assembly into new interface box.
- 7 Replace Dilatometer Thermocouple with new Thermocouple (type K).
- 8 Connect Interface box to Control PC with supplied USB cable.

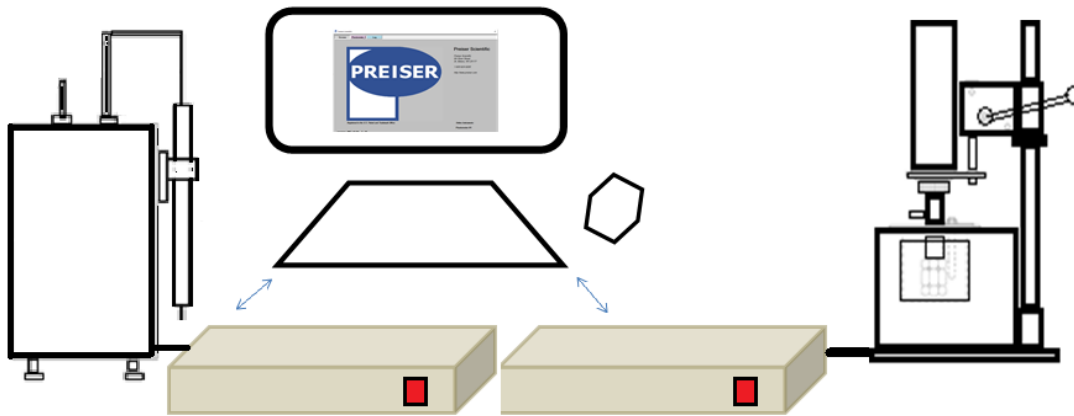


Figure 3 Combination Instrument Setup

1.4 Combo Unit - New

(Plastometer/Plastometer, Plastometer/Dilatometer, Dilatometer/Dilatometer)

Combination units will share both the PC controller and a single interface box. Component installation for each of the two instrument sides of a combo are installed as described in the Plastometer and Dilatometer instructions.

The PC based control software will identify what units have been “Plugged” into the PC and will configure the control program.

A dual Plastometer/Dilatometer Unit would be connected as follows:

- 1 Connect Solder Pot and Head assembly to interface box via a RJ45 either net cable (patch – straight cable). Furnace is connected directly to power source.
- 2 Connect Thermocouple from Solder Pot to interface box.
- 3 Connect Dilatometer Furnace to interface box via a RJ45 either net cable (patch – straight cable). Furnace is connected directly to the power source.
- 4 Connect Thermocouple from Dilatometer Furnace to interface box.
- 5 Connect Control PC to interface box via provided USB cable.

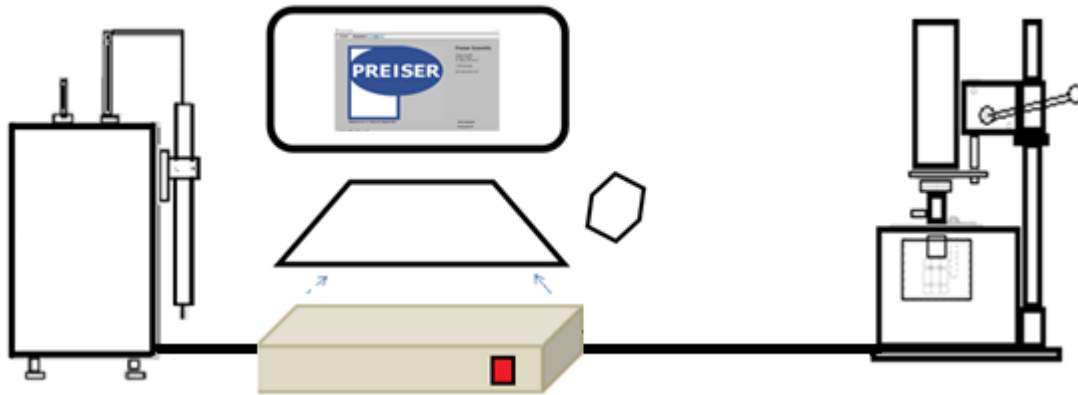


Figure 4 Combination Instrument Setup (Dilatometer - Plastometer)

1.5 Required Software

These files need to be preloaded for proper instrument operation:

C:\mic_2017\bin\MIC_2017 v2.1.exe
C:\mic_2017\bin\PdfSharp.dll

Using the install memory key, simply execute the installMic.exe program. All necessary file directories will be created and populated with required files.

Test reports will not be generated if PdfSharp.exe is not present, detailed results will only be stored in xxx.sce files

2.0 Dilatometer Operation

The Dilatometer screen tab select switches the visible form to either a Dilatometer Main Run Screen or Test Setup and Utilities screen.

The **Main Run Screen** is used for normal test run to test run operation.

The **Test Setup and Utilities Screen** allows the test profile to be set, thermocouple calibration, solder pot and communications monitoring. This screen is primarily used for initial test cycle definition and trouble shooting.

Various Dilatometer screens are illustrated below:

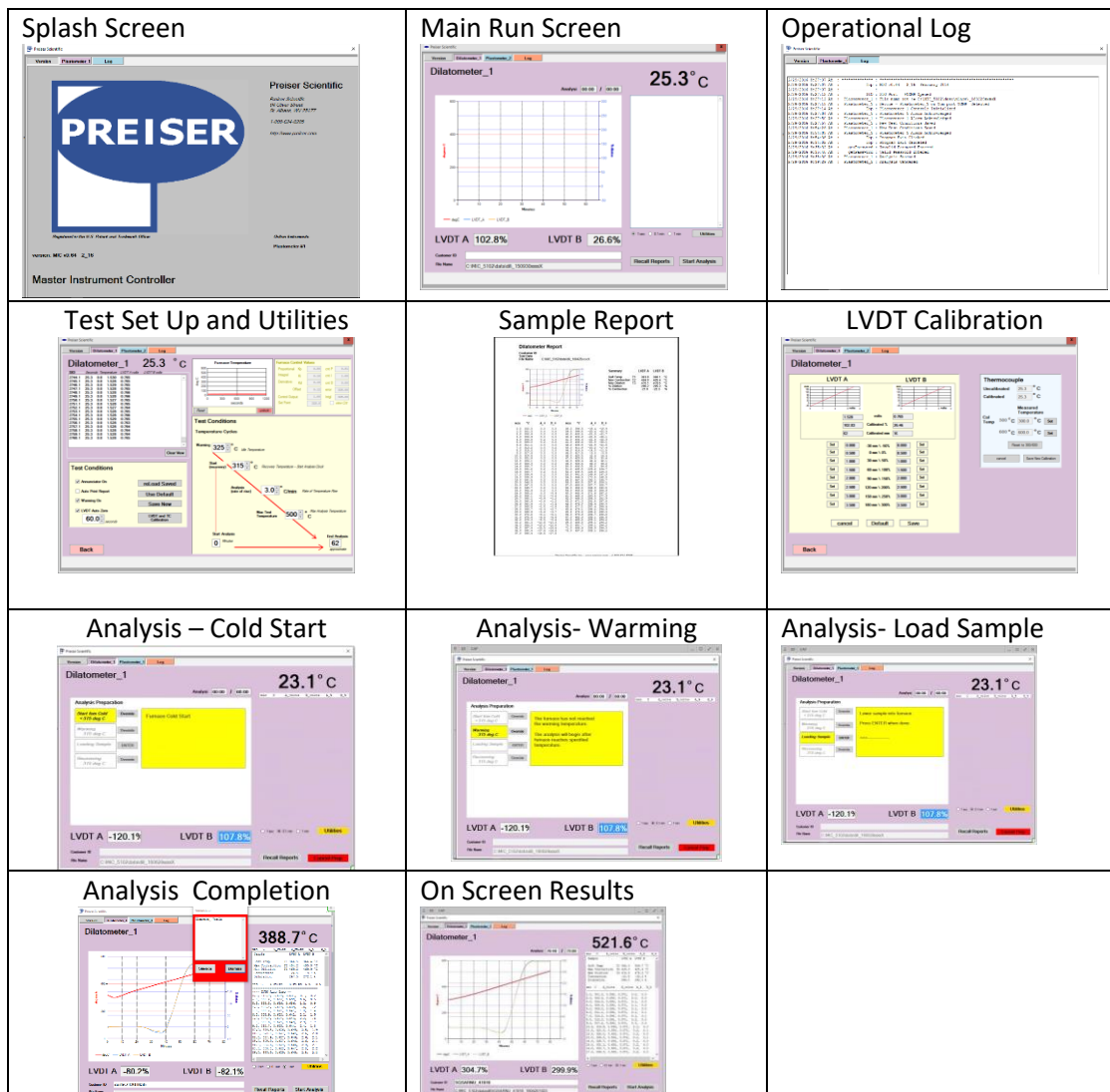


Figure 5 Dilatometer Screen Displays

2.1 Instrument Calibration

Thermocouple calibration LVDT adjustments are necessary for the correct operation of the Dilatometer. From the Main Screen, select the Utilities button to move to the Test Setup and Utilities Screen

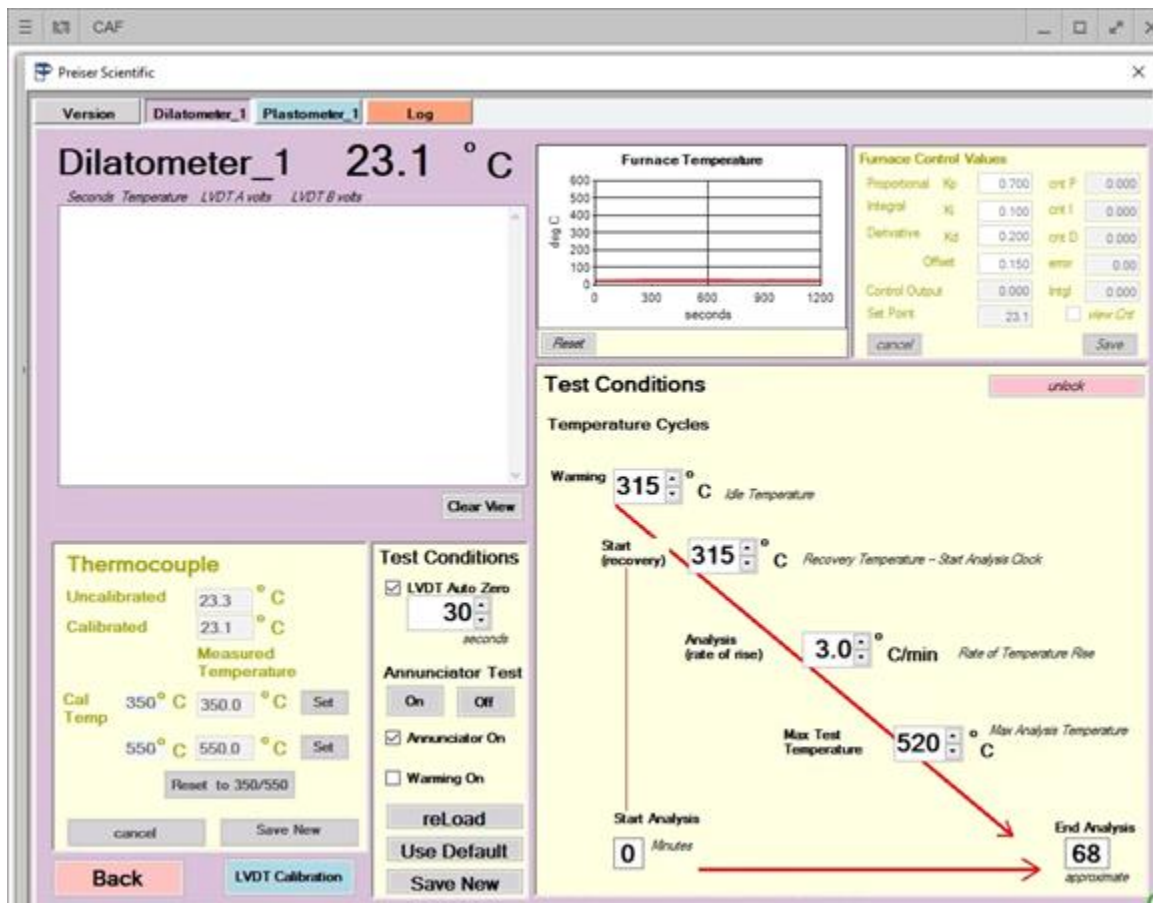


Figure 6 Test Setup and Utilities Screen

Thermocouple

Uncalibrated 300.0 °C

Calibrated 300.0 °C

Measured Temperature

Cal Temp 350 °C .0 °C Set

550 °C .0 °C Set

Reset to 350/550

cancel Save New

Figure 7 Thermocouple Calibration

The thermocouple is calibrated at two different temperatures. Applied a calibrated 350 degree input and “Set” the reading then apply a 550 degree calibration input and set the reading. Use Save New button to accept the new calibration.

2.2 Calibration of the LVDT's

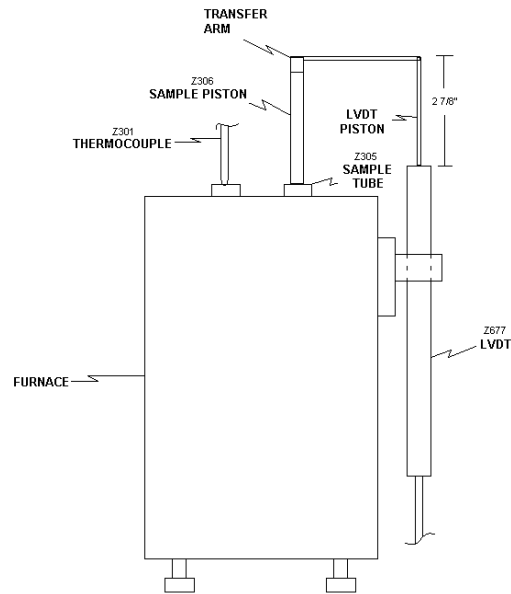
WARNING: *This procedure should not be performed while the furnace is hot. Please allow the furnace to cool to room temperature before proceeding.*

Note: *The calibration pencils should be placed in the holding block from smallest to largest, the smallest being –30mm on the block the next size being 0 mm and so on.*

- 1 Go to the Dilatometer Utilities screen and enter the units password (“mic”);
- 2 Enable the LVDT Calibration by pressing the “Calibration Disabled” button.
- 3 Insert the “0 mm” steel pencil (actual measurement of the pencil is 60 mm) into a Sample Tube. Place the Sample Piston on top of the steel pencil and insert it into furnace position “A”. Connect the Transfer Arm. Adjust the LVDT so that there is a 2 7/8” span between the top of the LVDT and the top of the LVDT Core Rod (Figure 16). Tighten the LVDT's in this position.

- 4 Touch the shaded box next to the “0 mm” tag with respect to the channel which is being calibrated (LVDT A). This calibrates the controller for the 0 mm position. You will notice the value in the shaded box will change corresponding to the voltage output from the LVDT.
- 5 Disconnect the Transfer Arm and remove the Sample Tube and Piston from the furnace. Remove the “0 mm” steel pencil from the Sample Tube.
- 6 Insert the “-30 mm” steel pencil into the Sample Tube. Place the Piston on top of the steel pencil and insert it into furnace position “A”. Connect the Transfer Arm.
- 7 Touch the shaded box next to the “-30 mm” tag with respect to the channel which is being calibrated.
- 8 Disconnect the Transfer Arm and remove the Sample Tube and Piston combination. Remove the “-30 mm” steel pencil.
- 9 Repeat steps 6 through 8 for the remaining steel pencils (+30 mm, 60 mm, 90 mm, 120 mm, 150mm, 180mm).
- 10 Repeat steps 3 through 9 to calibrate Channel B side. Be sure to insert the Sample Tube into the Channel B side of the furnace and touch the shaded boxes on LVDT B.
- 11 Press the “Save” button when finished.

Note: After Calibration is complete do not readjust the LVDT’s mounted on the side of the furnace. The adjustment described in step “3” should always remain 2 7/8” inches.



Dilatometer Furnace and LVDT ASSY.

Figure 8 Dilatometer Furnace

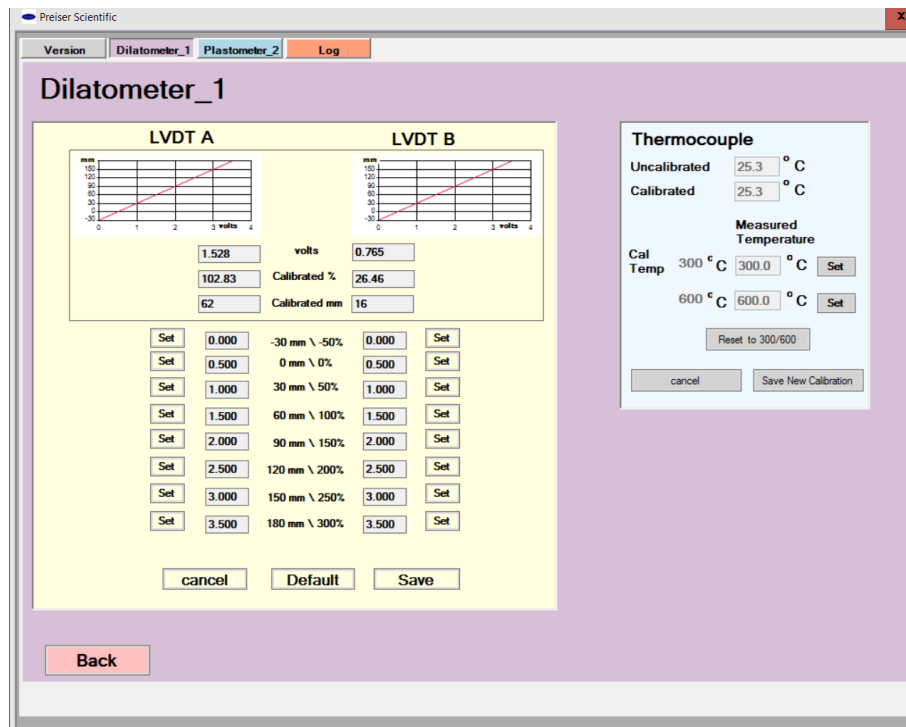


Figure 9 LVDT Calibration Screen

2.3 Test Cycle Setup

These controls are “locked” to prevent accidental changes during normal instrument operation. Unlock the control by using the “admin” button and entering the administrative password.

Once unlocked, the critical analysis temperatures can be entered and modified. Changes must be saved (Save New) in order to take effect. Note that the run time is an estimate only and is dependent on the temperature recovery time once the sample is placed in the solder pot. Generally the estimated time will be 10% greater than the actual time needed to achieve the final test temperature.

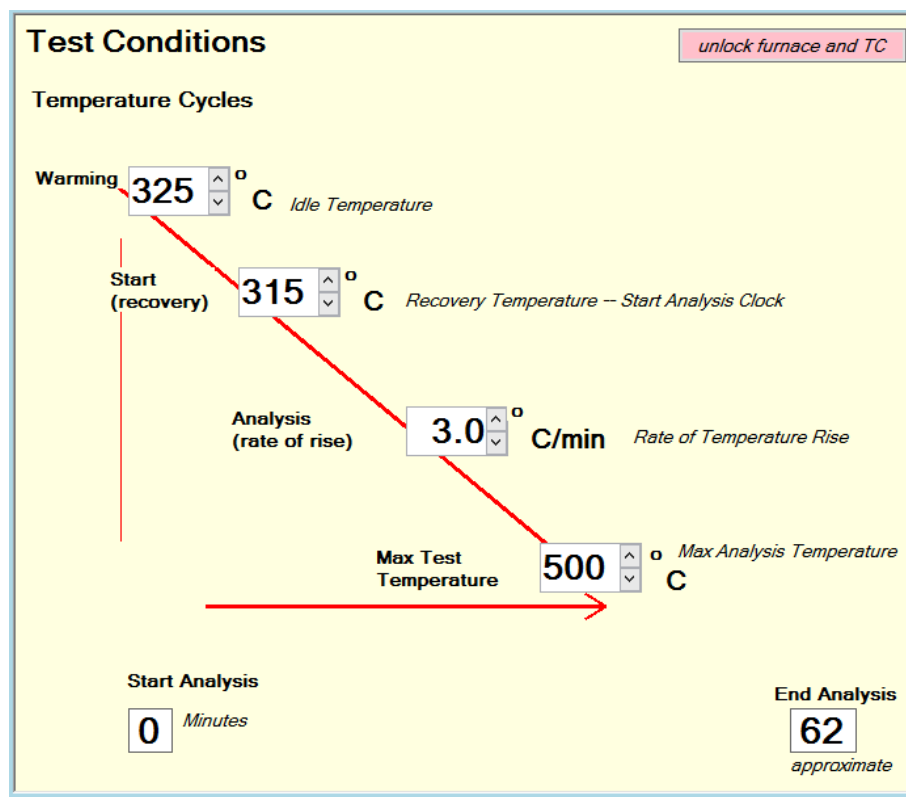


Figure 10 Test Cycle Setup

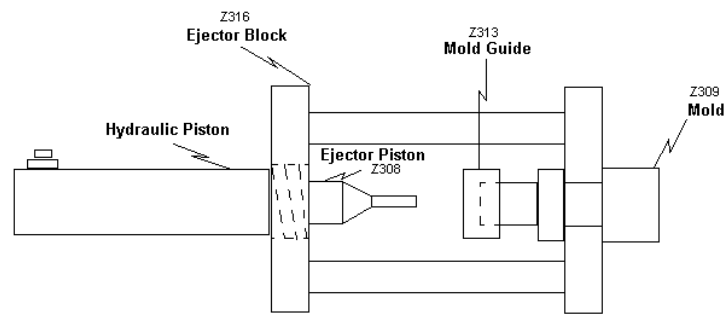
2.4 Packing & Loading the Dilatometer:

NOTE: Prior to loading the mold with coal it may be necessary to spray the interior of the mold with a Mold Release agent to ease the removal of the sample pencil during the ejection process.

Place the mold onto the mold support located in the packing device funnel side up. Poor some coal into the sample mold using a tamping pin to tamp the side of the mold to help the coal flow into the mold hole. Secure the mold in place with the Tamping Pin Guide as shown on page 55. Insert the tamping pin through the hole in the Tamping Pin Guide. Pack the sample by dropping the slide hammer onto the tamping pin until the pin no longer moves. Repeat until the mold is filled with packed coal.

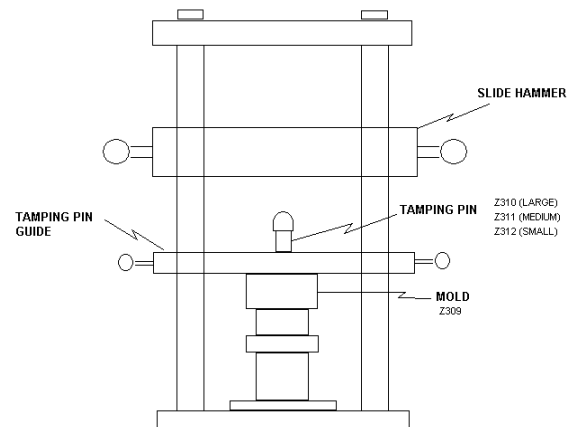
NOTE: If the upper end of the mold is packed more tightly with coal than the lower end, difficulty will be experienced in removing the sample.

Remove the mold from the packer assembly and place it with the Mold Guide in the Hydraulic Ejector Assembly as shown on page 56. Slowly pump the handle on the master cylinder, gradually applying more force as the ejector piston contacts the bottom of the sample pencil. The pencil will break loose from the mold and can be pushed $\frac{1}{2}$ " or so with the ejector. Loosen the knob on the master cylinder allowing the ejector piston to retract. Remove the mold and pencil from the ejector assembly. Remove the sample from the mold using a tamping pin and place it in the provided 60mm trim block. Shorten the sample pencil to 60mm $\pm$ 0.25mm by cutting off the thicker end as necessary. Insert the sample pencil into a clean sample tube, with the thicker end down and carefully slide the sample piston into the sample tube on top of the coal pencil. Repeat this process for the next sample. Insert both sample into the furnace at the same time as described in the running a test section.



EJECTOR PACKER ASSEMBLY

Figure 11 Ejector Pack Assembly



PACKER ASSEMBLY

Figure 12 Packer Assembly

2.5 Running a Dilatation Test

If not already on, turn the system power on. Allow the instrument to boot-up the main operating screen. If enabled, the furnaces will automatically heat up to the warming set-point temperature.

Prepare the sample per the sample preparation, loading and packing instructions.

Enter desired Sample Tag by pressing the shaded box next the Sample Tag indication.

Once proper furnace temperature is reached, press the “START” button on the Dilatometer side of the screen. Insert the sample tube and piston combinations into the furnace assembly and connect the LVDT’s to the Sample Pistons with the LVDT transfer arms. Acknowledge by pressing the “OK” button on the screen. The Dilatometer side is now in run mode and the screen will automatically change to the Dilatometer plot screen. The cooler sample assembly will cause the furnace to drop in temperature. The controller will heat the furnace up until the “start” temperature is once again reached. The furnace will continue to heat up at the selected Rate of Rise.

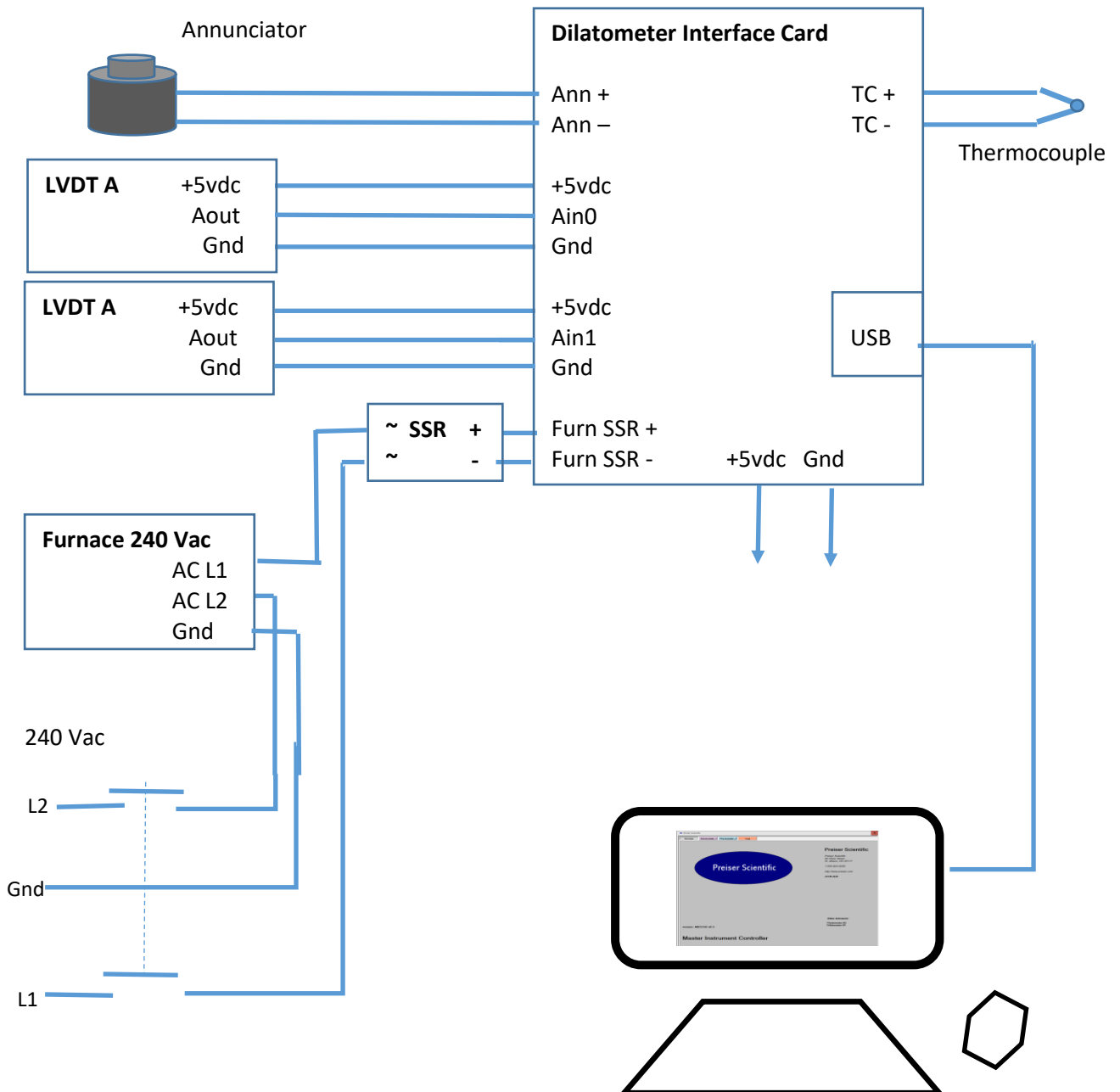
Once the “stop” temperature is reached the system automatically goes into an alarm condition letting the operator know that the test is complete. Press the “Ann. Off” button to silence the alarm.

Remove the Sample Tube and Piston combination from the furnace and clean for the next run.

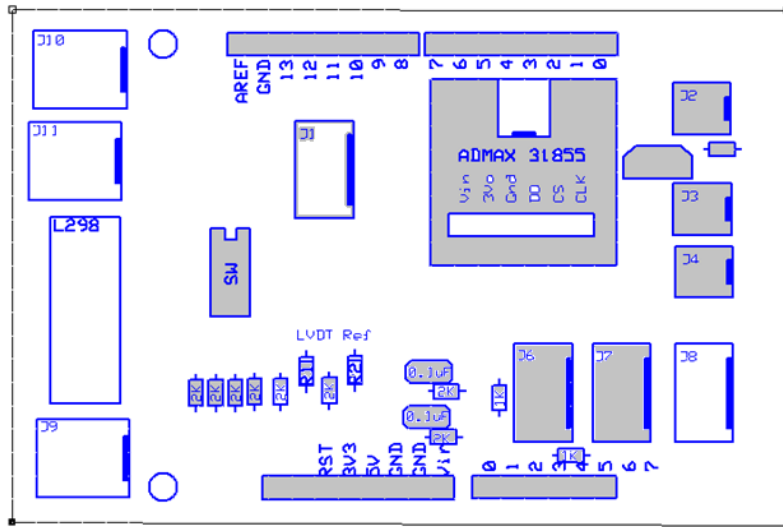
The test is now complete and the system is ready for another test run. The next test cannot be started until the furnace temperature decreases to the “start” temperature.

3.0 Dilatometer

3.1 Signal Paths (not a wiring diagram)



3.2 Dilatometer Interface PCB v4.0

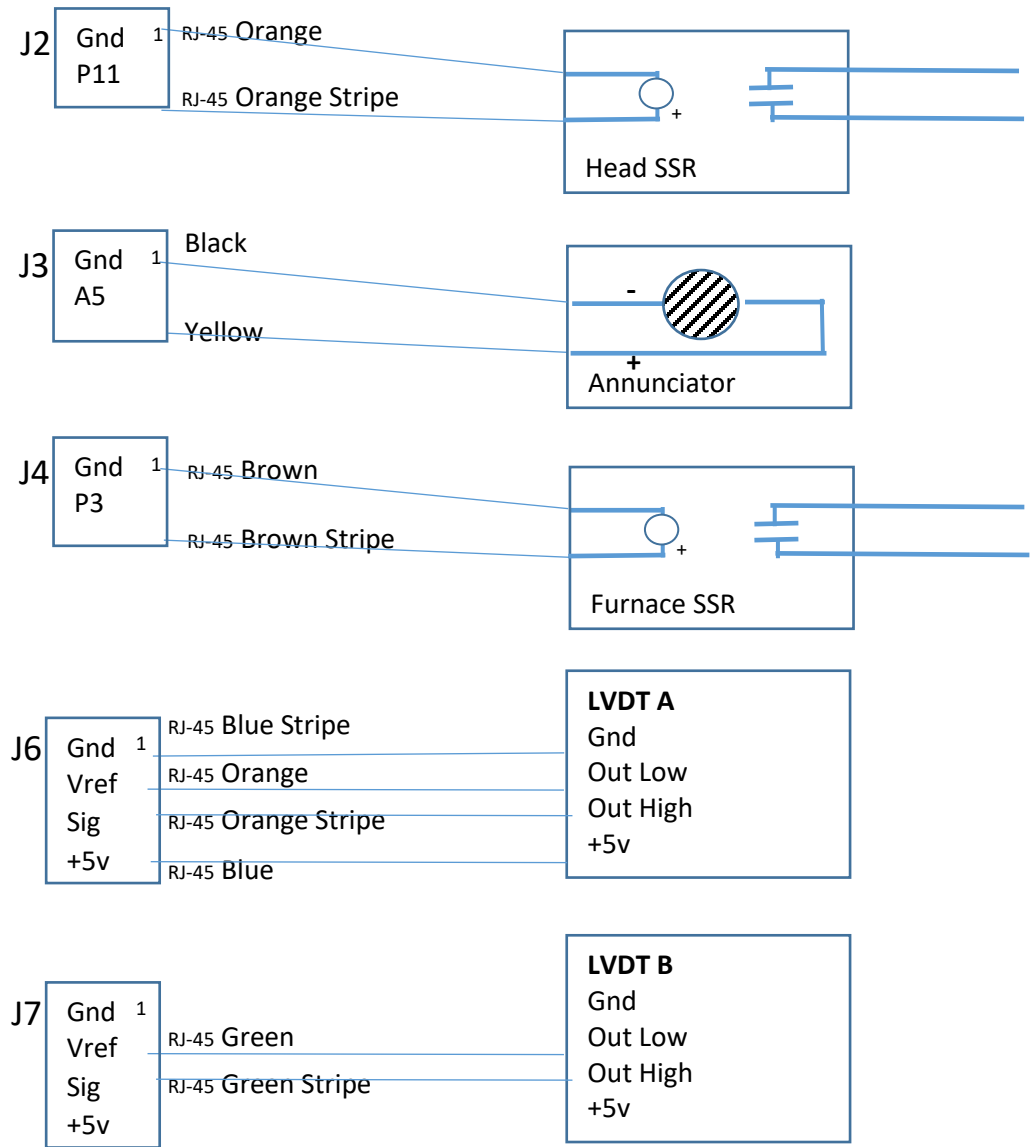


R1= 2000, R2 = 680

Dilatometer / Arduino I/O Pin Name

PIN	Header	Function
0		
1		
2	J1	
3	J4	Furnace
4	ADMAX	PINSC
5	ADMAX	PINCS
6	ADMAX	PINSO
7	L298	SW1
8	L298	SW2
9	L298	SW3
10	L298	SW4
11	L298 / J2	
12	L298	
13	J1	
A0	J6	LVDT A
A1	J7/J8	LVDT B
A2	J8	
A3	J8	
A4		
A5	J3	Annunciator

3.3 Dilatometer Header Cable Wiring Diagrams



3.4 RJ45 Cabling

Control Box to Dilatometer LVDT's

Dilatometer	Interface Box	RJ-45 Pin #	RJ-25 Color	Head Assembly Signal Name	LVDT Colors
LVDT A	J6-2	1	Orange Stripe	Out High	Green
	J6-3	2	Orange	Out Low	Black
	J6-4	4	Blue	+5vdc	Yellow
	J6-1	5	Blue Stripe	Gnd	Blue
LVDT B	J7-2	3	Green Stripe	Out High	Green
	J7-3	6	Green	Out Low	Black
	J7-4 (NC)		Blue (Connect Head Side Only)	+5vdc <i>(from LVDT A)</i>	Yellow
	J7-1 (NC)		Blue Stripe (Connect Head Side Only)	Gnd <i>(from LVDT A)</i>	Blue
Furnace	J4-2	7	Brown Stripe	Furn SSR	
	J4-1	8	Brown	Gnd	

3.5 Dilatometer Control Box component and cable placement .

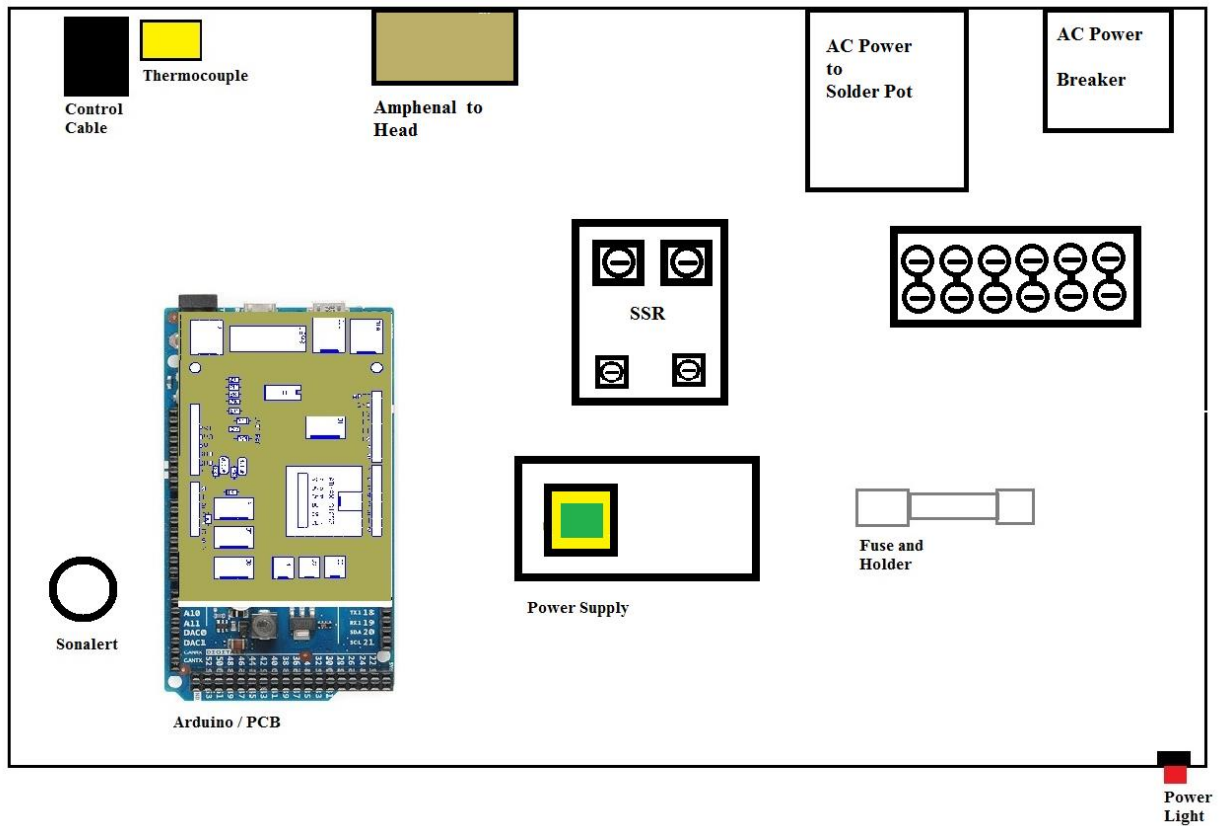


Figure 13 Dilatometer Upgrade Component Placement

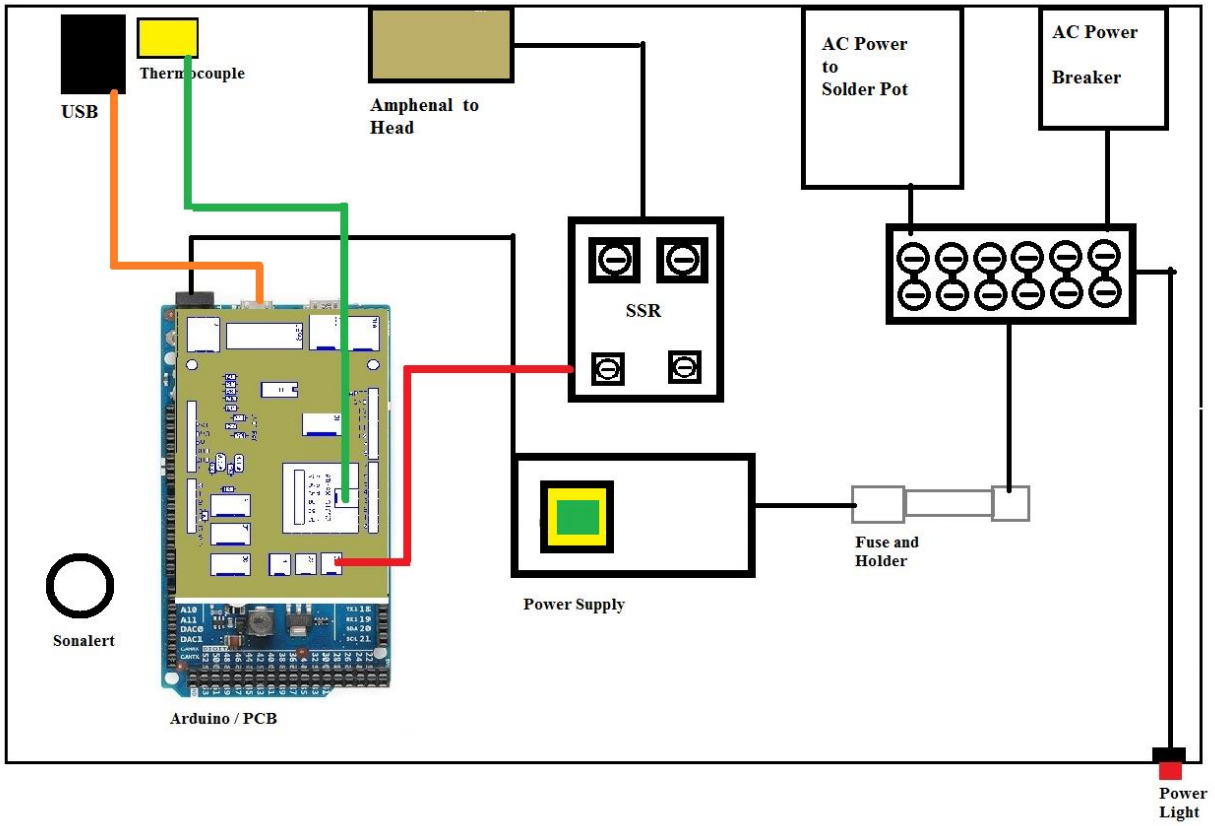


Figure 14 Dilatometer Component Placement

3.6 Configuration Switch Settings

PCB Switch

	SW1	SW2	SW3	SW4	
On	[x]	[x]	[x]	[x]	"0"
Off	[]	[]	[]	[]	"1"

SW1 off Dilatometer
 on Plastometer

SW2 SW3 Unit Number
on on _01
on off _02
off on _03
off off _04

SW4
off Upgrade
on New

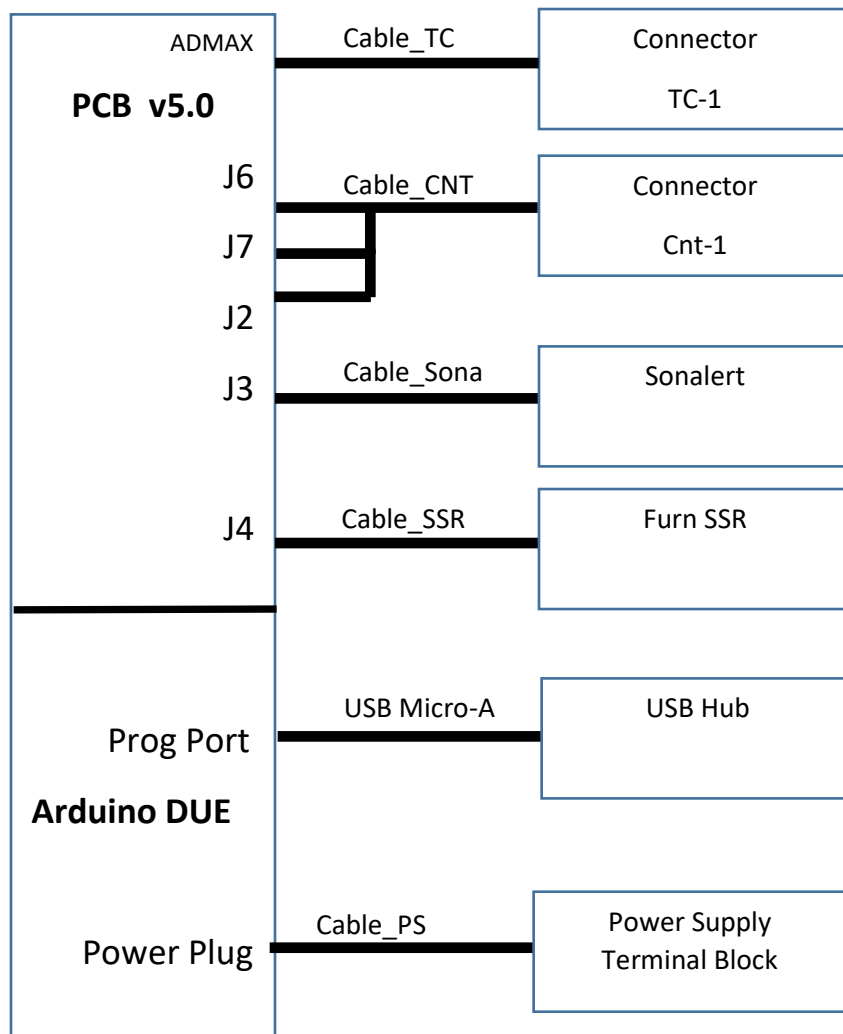
Example

Dilatometer _03 Upgrade

SW = 0101 (On Off On Off)

	SW1	SW2	SW3	SW4	
On	[]	[]	[x]	[]	"0"
Off	[X]	[x]	[]	[x]	"1"

3.7 Cable Diagram – Dilatometer Single Interface Box



7.0 Cable Definitions

J1,J2, J4 to RJ-45 Control Cable

USB_Cable		
9 inches	USB Micro	USB A

DC Power Cable

Power Cable		PCB 1
Power Terminal Block		
	Pos Terminal	Red – 12” 24 AWG
	Neg Terminal	Black – 12” 24 AWG
Power Socket		Inner Lead from red wire (pos)
		Outer Lead from black wire (neg)

DC Power Socket to Bare Wire, 24AWG. DC plug diameter: 5.5mm outer / 2.1mm inner.
One cable per PCB.

AC Power

Panel Mount Male AC Connector			
Black 20 AWG 9 “	Line	To Fuse	ring terminal
White 20 AWG 8 “	Neutral	Terminal Block	ring terminal
Green 20 AWG 2 “	Ground	Chassis	ring terminal

DC Power Supply

Supply Connections			
--------------------	--	--	--

AC – Line 1	From Fuse	20 AWG 4 "	Black
AC - Line 2	From Terminal Block	20 AWG 6"	White
Ground	To chassis	20 AWG 4"	Green
DC - Positive	To Terminal Block	20 AWG 6"	Red
DC Positive	To Terminal Block	20 AWG 6"	Black

Sonalert Cable

Molex, .1 inch KK, up, 2 pin	Sonalert	
J3-1	Neg Terminal (spade lug)	24 AWG Black
J3-2	Pos Terminal (spade lug)	24 AWG Yellow

Amphenol Signal Interface (Internal to PCB)

Pin	Signal	24 AWG	
A	Encoder B (+5vdc)	Brown	
B	Encoder A (gnd)	Green	
C	Encoder E (phase B)	Orange	
D	Encoder D (phaseA)	Yellow	
E	NC		
F	NC		
H	Head Motor	Blue	
J	Head Motor	Black	
K	Head Motor	Red	
L	NC		
M	NC		
N	NC		

Control Cable	Interface	RJ-45 Pin #	RJ-45 Color
Cat5 Cable 24 AWG 9"			
Molex, .1 inch KK, up, 2 pin	J2-2	1	Orange Stripe
	J2-1	2	Orange
Molex, .1 inch KK, up, 4 pin			pin
	J1-4	4	Blue
	J1-3	3	Green Stripe
	J1-2	6	Green
	J1-1	5	Blue Stripe
Molex, .1 inch KK, up, 2 pin	J4-2	7	Brown Stripe
	J4-1	8	Brown

Appendix A Directory Structure

```
#####
Directory Structure
#####
Directory      Path                                File Name
//-----
// C:\mic_5102
//      \configuration
//      \data
//          \dil
//          \plast
//      \help
//      \log
//
//
//-----
//Directory File Contents
//-----
// C:\mic_5102
//      \configuration
//          \Dilatometer_1.txt
//          \Dilatometer_1_LVDTcal.cal
//          \Plastometer_1.txt
//      \data
//          \dil
//              \tag1_tag2YYMMDDhhmm.pdf
//              \tag1_tag2YYMMDDhhmm.sce
//          \plast
//              \tag_YYMMDDhhmm.pdf
//              \tag_YYMMDDhhmm.sce
//      \help
//          \Manual.mht
//      \log
//          \YYYY_MMM_DD.dat
//
//
// C:\Program Files (x86)\Adobe\Reader 11.0\Reader\AcroRd32.exe
// C:\Windows\system32\osk.exe"
```

Appendix B Configuration File

```
//--6/22/2016 1:47:30 PM
/-- Dilatometer_1 Instrument Parameters -----
instrumentName = Dilatometer_1
Start_Temperature = 315
Stop_Temperature = 500
Rate = 3
Warming = 325
maxRunTime = 61.6666666666667
Sample_Rate = 6
warmingON = True
AnnunciatorEnabled = True
AutoPrintReportON = True
LVDTAutoZero = True
AutoZeroDelay = 60
Kp = 0.5
Kd = 0.1
Ki = 0.1
Offset = 0.12
Ts = 0.166666666666667
cal_350 = 300
cal_550 = 600
slope_m = 1
intercept_b = 0
MotorRPM = 1800
Standard = ASTM
LVDTAzero = 0
LVDTBzero = 0
LVDTAmmZero = 0
LVDTBmmZero = 0
encryptedPassWord =

//*****
// Config File Notes:
//-----
// 1. Commented and blank lines are ignored
// 2. White spaces are ignored
// 3. Parameter format is:
//
//      parm = value // end of line comments
//
//-----
// Optional comments
//-----
```

Appendix C LVDT Calibration File

```
//--4/11/2016 1:49:33 PM
//-- C:\MIC_5102\configuration\Dilatometer_1_LVDTcal.cal LVDT Parameters -----
--
A_minus_30 = 0
A_plus_0 = 0.4714
A_plus_30 = 0.9429
A_plus_60 = 1.4143
A_plus_90 = 1.8857
A_plus_120 = 2.3571
A_plus_150 = 2.8286
A_plus_180 = 3.3
B_minus_30 = 0
B_plus_0 = 0.4714
B_plus_30 = 0.9429
B_plus_60 = 1.4143
B_plus_90 = 1.8857
B_plus_120 = 2.3571
B_plus_150 = 2.8286
B_plus_180 = 3.3
```

Appendix D Collected Data .SCE File

```
instrumentType = Dilatometer;
//-----
// Preiser Scientific      5/5/2016 10:00 PM
//-----
Company      = 'Preiser Scientific';
CustomerID   = 'test';
fileName     = 'C:\MIC_5102\data\dil\test_160505xxxxX.sce';
dateStamp    = '';
//-----

/-- Dilatometer_1 Instrument Parameters -----
instrumentName = Dilatometer_1;
Start_Temperature = 315;
Stop_Temperature = 500;
Rate = 3;
Warming = 325;
maxRunTime = 61.66666666666667;
Sample_Rate = 6;
warmingON = True;
AnnunciatorEnabled = True;
AutoPrintReportON = False;
LVDTAutoZero = True;
AutoZeroDelay = 60;
Kp = 0.5;
Kd = 0.1;
Ki = 0.1;
Offset = 0.12;
Ts = 0.1666666666666667;
cal_350 = 300;
cal_550 = 600;
slope_m = 1;
intercept_b = 0;
MotorRPM = 1800;
Standard = ASTM;
LVDTAzero = 0;
LVDTBzero = 0;
LVDTAmmZero = 0;
LVDTBmmZero = 0;
encryptedPassWord = ;
/-- Dilatometer_1 Calibration -----
A_minus_30 = 0;
A_plus_0 = 0.4714;
A_plus_30 = 0.9429;
A_plus_60 = 1.4143;
A_plus_90 = 1.8857;
A_plus_120 = 2.3571;
```

Appendix D Sample Dilatometer Collected Data .SCE File (cont)

```
A_plus_150 = 2.8286;
A_plus_180 = 3.3;
B_minus_30 = 0;
B_plus_0 = 0.4714;
B_plus_30 = 0.9429;
B_plus_60 = 1.4143;
B_plus_90 = 1.8857;
B_plus_120 = 2.3571;
B_plus_150 = 2.8286;
B_plus_180 = 3.3;
```

```
//-- Test Run Results-----
```

```
//--LVDT A -----
```

```
t1_temperatureA = 300.1;
t2_mmA          = 0.99;
t2_percentA     = 1.7;
t2_temperatureA = 404.9;
t3_mmA          = 96.38;
t3_percentA     = 160.6;
t3_temperatureA = 478.1;
```

```
//--LVDT B -----
```

```
t1_temperatureB = 401.8;
t2_mmB          = -0.92;
t2_percentB     = -1.5;
t2_temperatureB = 405.4;
t3_mmB          = 100.07;
t3_percentB     = 166.8;
t3_temperatureB = 478.6;
```

```
;
```

```
//-----
```

```
//--LVDT A -----
```

```
t1_temperatureA = 300.1;
t2_mmA          = 0.99;
t2_percentA     = 1.7;
t2_temperatureA = 404.9;
t3_mmA          = 96.38;
t3_percentA     = 160.6;
t3_temperatureA = 478.1;
```

```
//--LVDT B -----
```

```
t1_temperatureB = 401.8;
t2_mmB          = -0.92;
t2_percentB     = -1.5;
t2_temperatureB = 405.4;
t3_mmB          = 100.07;
t3_percentB     = 166.8;
t3_temperatureB = 478.6;
```

Appendix D Sample Dilatometer Collected Data .SCE File (cont)

```
//-----
//seconds, deg C, LVDTA_v  LVDTB_v   LVDTA_%  LVDTB_%
//-----
data=[
1, 300.1, 0.590, 0.571, 7.546, 6.337
2, 300.1, 0.590, 0.571, 7.546, 6.337
3, 300.1, 0.590, 0.571, 7.546, 6.337
4, 300.1, 0.590, 0.571, 7.546, 6.337
5, 300.1, 0.590, 0.571, 7.546, 6.337
6, 300.2, 0.590, 0.571, 7.546, 6.337
7, 300.2, 0.590, 0.571, 7.546, 6.337
8, 300.2, 0.590, 0.571, 7.546, 6.337

...

4370, 499.9, 1.989, 2.048, 96.574, 100.329
4371, 499.9, 1.989, 2.048, 96.574, 100.329
4372, 500.0, 1.989, 2.048, 96.574, 100.329
4373, 500.0, 1.990, 2.048, 96.638, 100.329
4374, 500.1, 1.990, 2.047, 96.638, 100.265

];
```

Appendix E Data File Naming Convention

Data files:

Tag1_Tag2_YYMMDDhhmmWx.pdf

Tag1_Tag2_YYMMDDhhmmWx.sce

.pdf One page report with graph and analysis results

.sce One second readings plus operating parameters and analysis results

YY 2 digit year

MM 2 digit month

DD 2 digit day

HH 2 digit hour

mm 2 digit second

Wx Unit number (D1, D2, D3, D4)

Example:

Tag1 = 'DigDeep21';

Tag2 =" Deeper"

dateStamp = 'Feb 11, 2014 11:44';

Unit = Dilatometer 1

DigDeep21_Deeper_1402111144D1.pdf

DigDeep21_Deeper1402111144D1.sce