Thermal Interface Material Tester Manual

# Safety

There are multiple pinch points throughout the lead screw system. While machine is operating, hands should not be near the lead screw as the platform moves. No loose articles of clothing or long hair should be near the system while operating as it could get trapped inside the moving mechanisms. Do not place hands on the martial sample area as the bars could crush hand. The top bar is being heated with a heat cartridge, use caution when touching the bar as it could be extremely hot.

# Intended Usage

The TIM Tester is an apparatus which allows the user to measure the thermal conductivity of a thermal interface material under a certain pressure. There are two different experiments which can be run. The first is keeping the material under constant pressure where the machine should be left for a prolonged period of time. The second is cyclical pressure where the machine will be cycling between low and high pressure by raising and lowering the platform. The TIM Tester is meant to provide low pressure (< 10 PSI) to the system and should not be used to test the effects of high pressure.

# Mechanical Parts

|  |  |  |
| --- | --- | --- |
| **Part Name** | **Spec Sheet** | **Purchase Link** |
| Stepper Motor  NEMA 23, 237 in.-oz. | Appendix A | <https://www.mcmaster.com/6627T54/> |
| lc101/lcm101 Beam Load Cell, 100lbs | Appendix B | [Link](https://www.omega.com/en-us/force-strain-measurement/load-cells/lc101/p/LC101-100) |
| Cold Plate |  |  |
| Lead Screw, Right Hand, 3/4"-16 | N/A | <https://www.mcmaster.com/99030A177/> |
| End Support for Lead Screw, 15/32" ID | N/A | <https://www.mcmaster.com/60755K13/> |
| XL Series Timing Belt | N/A | <https://www.mcmaster.com/6484K232/> |

# Mechanical Assembly

## Frame

The frame of the TIM Tester was assembled using 1” aluminum T-Slotted bars. This allows for a modular build and makes the rig easy to repair.

## Lead Screw and Timing Belt System

The TIM Tester is composed of two lead screws which rotate in sync using a timing belt pulley system. The two lead screws are supported on the bottom by end supports which reduce lateral and shear loads. The top of the screws run through a bearing mount which reduce the turning friction and have timing pulleys mounted to the top. These pulleys are connected with a timing belt that is driven by the motor. There are two idler poles which spin freely at the top of the frame, allowing the adjusting the tightness of the belt.

## Moving Platform

The moving platform consists of the base waterjet cut piece. This piece is supported by the lead screw flange which attached to the lead screw nut, allowing the platform to move when the lead screws are turned. Attached to the bottom of the base is the load cell. There is a wooden insulator between the load cell and the aluminum rod. The rod has an insert at the top for the heating cartridge and three holes along the side for the thermocouples to be attached to. The heating cartridge wire should run through the wooden insulator and out the side to connect to a power source. The aluminum rod is covered with spray foam insulation to ensure the heat is kept in the system and the thermocouples are taking accurate data.

# Electronic Parts

|  |  |
| --- | --- |
| **Part Name** | **Link** |
| Arduino Uno | N/A |
| Load Cell Amplifier | [Link](https://learn.sparkfun.com/tutorials/load-cell-amplifier-hx711-breakout-hookup-guide?_ga=2.80896343.1727918057.1660233504-648992784.1660233504) |
| Microstep Driver DM556 | [Link](https://www.amazon.com/Jusnboir-Printer-Accessories-STEPPERONLINE-Stepper/dp/B09KN3H7VG/ref=sr_1_23?crid=320EG6EJM9OPR&keywords=microstep%2Bdriver%2B8A&qid=1659637951&s=industrial&sprefix=microstep%2Bdriver%2B8a%2Cindustrial%2C42&sr=1-23&th=1) |
| Thermocouple Amplifier MAX31850 | [Link](https://learn.adafruit.com/adafruit-1-wire-thermocouple-amplifier-max31850k/wiring-and-test) |
| Bi-Directional Level Shifter | [Link](https://www.adafruit.com/product/757) |
| Thermocouple Type K | N/A |
| Heat Cartridge | N/A |

# Electronic Assembly

Diagram

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## Central System

The Arduino Uno is the central component which connects and runs al of the other electronic components. The Uno will take and store the data samples we need and output the data in a usable form. The Uno will also run the machine when taking test samples by intaking the force data and notifying the motor to move to reach the input pressure.

## Load Cell

The load cell takes an input of 5V and outputs a range of 0 to 100 mV. The load cell can sense up to 100lbs of force, however for our application we only need to read a maximum of 10lbs of force. This makes the output voltage range about 0-10mV. The output voltage is to small for the Uno to read directly. The Load Cell amplifier is used to increase the output voltage to a range readable by the Uno. The circuit diagram shows how to connect the load cell and amplifier to be read by the Uno.

## Thermocouples

The TIM Tester uses 6 thermocouples to take temperature samples at 3 different locations in each aluminum rod. Each thermocouple needs to be attached to a thermocouple amplifier. These amplifiers can be chained through one data channel. This data channel is sent to the level shifter which sends the signal to the Arduino making the multiple data points taken readable. The connections between the thermocouple amplifiers and the level shifter are seen in the circuit diagram.

## Motor

The motor is a stepper motor which runs on 24V and 6A. This motor requires a motor driver to regulate the amount of power it is receiving and the pulsed per revolution is outputs. The motor is connected to the motor driver as shown in the circuit diagram. The motor driver can be manually configured to the settings the user desires. The driver also receives input from the Arduino where the speed and direction can be controlled. The motor driver must be connected to an external 24V or higher power source.

# Code Library

# Experimental Setup

# Running a Test

# Appendix

## NEMA Motor Specs

A picture containing diagram

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## Load Cell Specs

Diagram

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