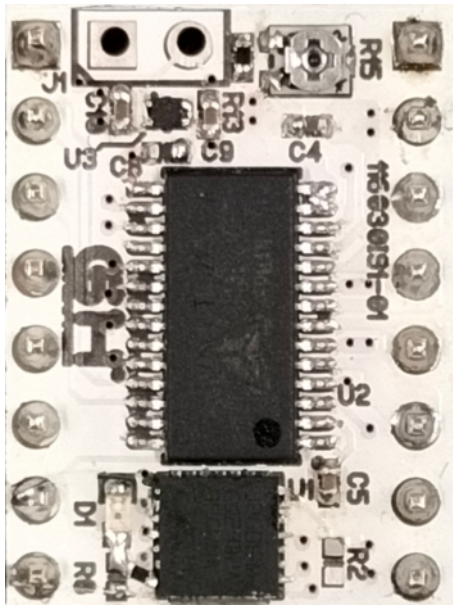


ENGLISH

User Manual



NAME: SMART SHAPER
MODEL: 116030-01

INDEX:

1. INTRODUCTION.....3

2. REQUIREMENTS.....3

3. RESONANCE FREQUENCY MEASUREMENT.....4

 3.1. PRINT CALIBRATION MODEL 4

 3.2. FREQUENCY MEASUREMENT 5

4. BOARDS CONFIGURATION.....6

 4.1. G-CODE CONFIGURATION SEQUENCE 6

 4.2. SEQUENCE GENERATOR 7

 4.3. PRINT MODEL WITH INPUT SHAPING 8

 4.4. STATUS LED INFORMATION 8

1. Introduction

Input shaping algorithms are designed to suppress the vibrations characterized by a particular frequency and dumping ratio.

Dumping ratio is difficult to estimate and it's usually assumed to be 10%.

Frequency should be estimated experimentally for both axes.

The measure of the axes frequencies requires the following steps:

- Print of a reference model (see 3.1.)
- Measurement of distance between ringing peaks (see 3.2.)
- Frequency calculation by given formula (see 3.2.)

Next it will be explained how to configure the boards with the frequencies previously found and the preferred Input Shaping algorithm (see 4.)

Finally It will possible to print again the reference model but with Input Shaping Enabled (see 4.3.) in order to verify the correct values of frequencies and the performance of the algorithm.

2. Requirements

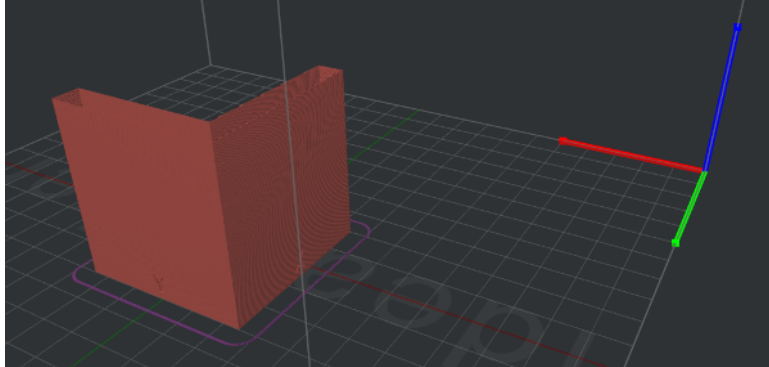
The following instructions are intended for the following setup:

- Cartesian printer
- X/Y axes driven by Smart Shaper Boards
- X/Y axes resolution 80 steps/mm
- TMC2225 configured with 16 microsteps resolution and interpolation
- TMC2225 configuration can be done via UART or bootstrap pins.

3. Resonance Frequency Measurement

3.1. Print Calibration Model

The calibration model prepared for frequency estimation consists in a simple L Model printed with the walls aligned along X and Y axes.



The printed part has one wall marked with X label and another one marked with Y label. The X Label is on the wall aligned along the Y axes and the Y Label is on the wall aligned along the X axis. The reason is that the ringing due to Y acceleration/deceleration are visible on X axis and vice-versa.

The walls are printed at 100 mm/s. Acceleration is linearly increased from 500 mm/s² (Bottom) to 18000 mm/s² (Top) in order to increase the vibrations.

TMC2225 is configured in current mode to support high acceleration through G-code sequence.

X and Y Coordinates will not exceed 145 mm.

Material should be PLA (using a red color improves the measurement of ringings) and nozzle diameter 0.4 mm.

Print the model. It's possible that at some height the printer start to loose steps because acceleration is too high to be tolerated by mechanics. If it happens just stop the printer.

Now extract the printed part from the printer and analyze it.

3.2. Frequency Measurement

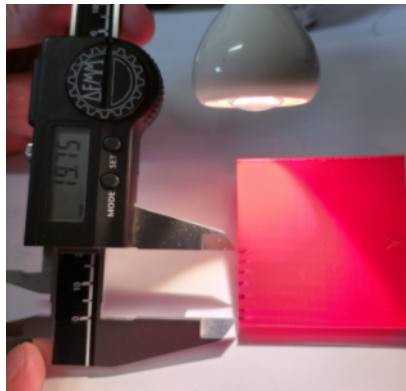
To find the ringing frequency it should be measured the distance between two peaks of the oscillations.

The easiest way is:

- put the part under a light beam parallel to the surface



- mark each visible oscillation peaks
- measure with a caliper the total distance D in mm between the first mark and last mark



- calculate the oscillation frequency (Hz) using the formula

$$f = \frac{V(N-1)}{D}$$

where

- V = 100 mm/s
- N is the number of marks

Example of a Y axis oscillation frequency measurement.

We marked 7 oscillation peaks. The measured distance was about 19.8 so the frequency was:

$$f = \frac{100(7-1)}{19.8} \approx 31 \text{ Hz}$$

4. Boards Configuration

4.1. G-Code configuration sequence

Each Smart Shaper board can be programmed via a specific G-Code sequence generated by the spreadsheet **SmartShaperGCodeGenerator.ods** (see 4.2.).

An example of such sequences can be found in the file **SmartShaperCalibration.gcode** (lines 32-129). In this case they have been inserted two sequences, one for X driver and one for the Y driver, that **DISABLE** the Input Shaping filter **to detect ringings**.

4.2. Sequence Generator

The spreadsheet **SmartShaperGCodeGenerator.ods** is the tool to generate the G-Code configuration sequence.

	A	B	C	D	E
1	Shaping Algorithm	DISABLED		CONFIG OK	
2	Vibration Freq [Hz]	30	IGNORED		
3	Vibration Freq Multiplier	1	IGNORED		
4	Max Feed Rate [mm/s] considering 80 steps/mm	600	Default: 600 mm/s		
5	Damping Ratio [%]	10	Default: 10%		
6	Start Position [mm]	100			
7	Cartesian Axes	Y			
8		CURRENT			

Damping Ratio
Range: 0-99

Start Position
Position along the relative axis where the G-Code sequence is executed.

Cartesian Axis
X to Select Driver on X Axis
Y to Select Driver on Y Axis

Driver mode
Current or Voltage

Shaping Algorithm
Select DISABLED to bypass Input Shaper or (ZV,MZV,ZVD, EI) to ENABLE the relative Shaping Algorithm

Vibration Freq
Insert the frequency measured found previously

Vibration Freq Multiplier
Leave to 1.

Max Feed Rate
Leave to 600 mm/s

Open the spread sheet and fill all the fields as indicated in the picture. Check that configuration is valid (Config OK green label).

4.3. Print with Input Shaping

Generate a G-Code configuration sequence for each axis according to the measured frequencies.

Replace the two original sequences in the **SmartShaperCalibration.gcode** (lines 32-129) with the new generated ones. Print the modified G-Code.

Just after homing procedure the two configuration sequence will be executed.

4.4. Status Led Information

A red led is placed on each Smart Shaper board. The blinking frequency provide some information about the board.

Just after the startup the Led will blink as many times related to the version of the installed firmware (Ex. Firmware is 1.3 will blink 3 times).

After startup the Led will indicate the current status of the board as shown in the following table.

Frequency (Hz)	Meaning
0.5	Input Shaper Off
1	Input Shaper On
2	Configuration Failed (wrong parameters)
4	Input Step Rate too high

Led can be used to verify that the configuration has been correctly received and processed by the board.