3D PRINTING AND DESIGN REFERENCE DOCUMENT	
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REVISION HISTORY

Revision	Details of Modification(s)	Reason for modification	Date	By
0	Draft release	Document Essential References and Resource for Building a Kinetic Sandtable	2024/12/19 09:46	jattie

Kinetic Sand Table Design and Build

The objectives for the project is to 3D print as many of the parts as possible and to build low budget linear stages to construct the basic system and build it up from there.

- Electronics/Controllers
  - GRBL Controller
  - CNC Shield
  - Stepper Drivers for shield
- Linear Hardware
  - Stepper motors
  - Linear Stages
  - GT2 drive belts
  - GT2 Idlers
  - GT2 Stepper Attachments
  - Belt Clamp
- Playlist [1)]

Electronics

GRBL Controller

After some extensive research I discovered grblHAL[2)]. grblHAL is the updated version of GRBL. GRBL is an open-source firmware that converts G-code commands into motion control signals for CNC (Computer Numerical Control) machines. It's widely used for controlling CNC routers, mills, lathes, laser cutters, and other automated machinery.

grblHAL essentially makes it possible to use a wide range of low cost 32 bit microcontrollers. Some popular grblHAL supported microcontrollers are :

- RP2040: Raspberry Pi Pico
- ESP32: Popular for IoT projects
- STM32: Various models like STM32F1xx, STM32F3xx, STM32F4xx, STM32F7xx, and STM32H7xx
- LPC176x: Used in many embedded systems

- SAM3X8E: Found in Arduino Due
- Teensy 4.x: High-performance microcontrollers
- NXP iMXRT1062: Used in Teensy 4.x boards

This allows for a wide range of options to avail of to build a very low cost grbl interface. There are handy web based tools to select the controller of choice and build the firmware code for you.[3]. The alternative route is to build the code using VSCode. The full tutorial is here.

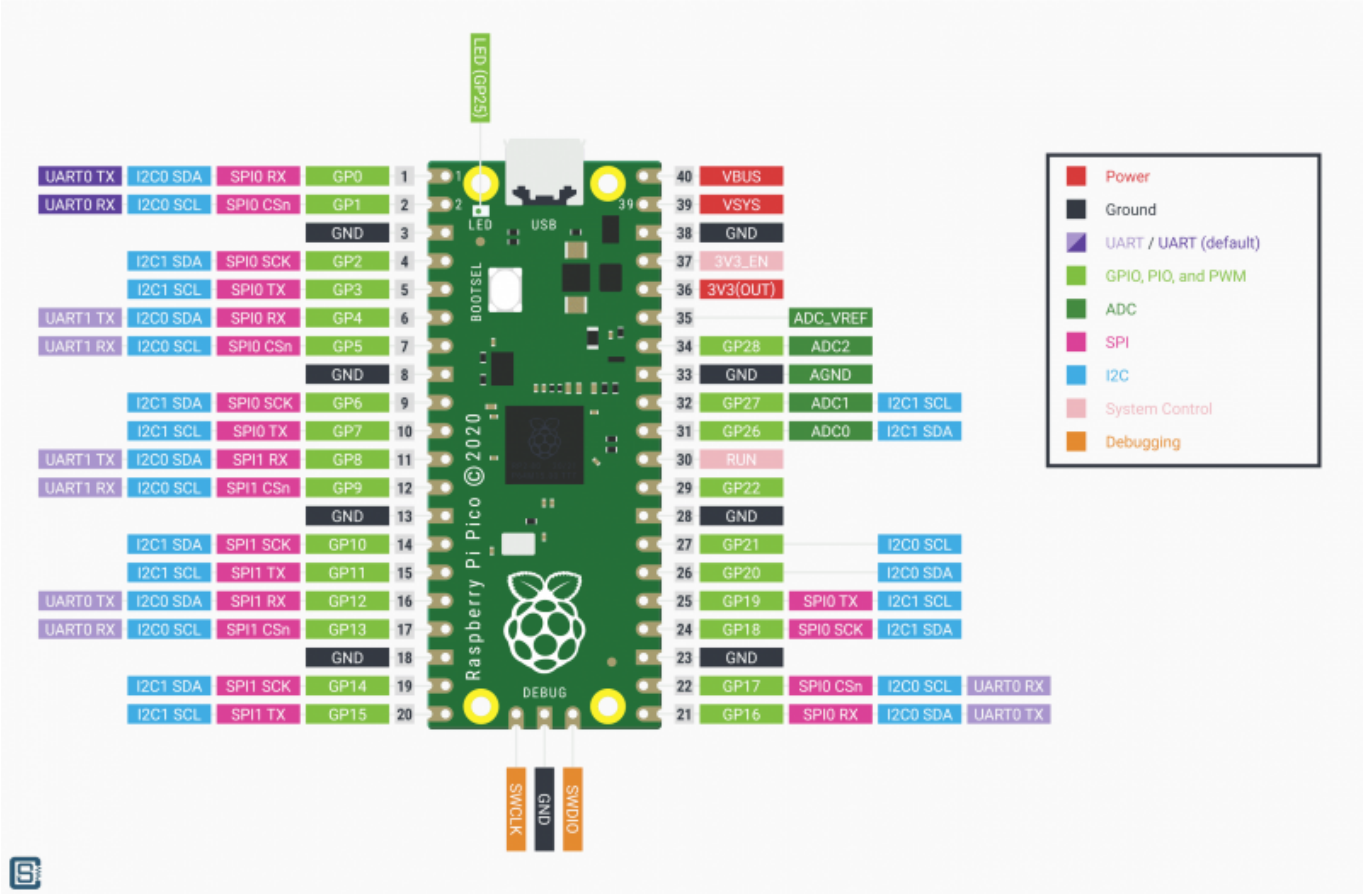
The basic steps are:

- Create firmware [4]
- Power off the Pico 2040 by unplugging the USB, hold in BOOTSEL and plug it back in. Upload the firmware.
- Connect to the unit using IOSender XL [5]

That's it, you now have a GRBL controller.

Connecting Steppers to the GRBL controller

The pinouts for a Pico 2040 are as follow:



Following the grblHAL software mapping for the firmware [6] we deduce the following map to actual pinouts:

GRBL Function	Pico GP Pin
Step Output X	2
Step Output Y	3
Step Output Z	4
Direction Output X	5
Direction Output Y	6
Direction Output Z	7
Steppers Enable	8
Limit X	9
Limit Y	10
Limit Z	11

Stepper Drivers

There are a few projects for Pico specific shields, however they are costly to get hold of and the Arduino community has very low cost and mature products that is compatible, or at least I believe it is and will explore this and test it for this purpose.

I will explore the CNC Shield that is discussed in detail here [7)]

As an alternative we explored TB6600. [8)9)10)] These units are very low cost and available on Amazon.

The different models of these types of units are tabled below for comparison.

Feature/Driver	TB6600	DM556	DM556T	DM542	ERP60	DM860H	DM860S	DM860T
Input Voltage	9-42V	20-50V	20-50V	20-50V	20-50V	20-50V	20-50V	20-50V
Output Current	0.5-4A	0.5-5.6A	1.8-5.6A	1.8-5.6A	1.8-5.6A	1.8-5.6A	1.8-5.6A	1.8-5.6A
Microsteps	1, 2/A, 2/B, 4, 8, 16, 32	1, 2, 4, 8, 16, 32	1, 2, 4, 8, 16, 32	1, 2, 4, 8, 16, 32	1, 2, 4, 8, 16, 32	1, 2, 4, 8, 16, 32	1, 2, 4, 8, 16, 32	1, 2, 4, 8, 16, 32
Control Interface	Digital	Digital	Digital	Digital	Digital	Digital	Digital	Digital
Protection Features	Overcurrent, Overheat	Overcurrent, Overheat	Overcurrent, Overheat	Overcurrent, Overheat	Overcurrent, Overheat	Overcurrent, Overheat	Overcurrent, Overheat	Overcurrent, Overheat
Applications	General use, CNC machines	General use, CNC machines	General use, CNC machines	General use, CNC machines	General use, CNC machines	General use, CNC machines	General use, CNC machines	General use, CNC machines

Feature/Driver	STSPIN820	DRV8834	A4988	MP6500	A5984	TB67S249	DRV8434	TMCM-1260
Operating Voltage	7-45V	2.5-10.8V	8-35V	8-40V	8-40V	8-40V	8-40V	8-40V
Max Output Current	1.5 Arms	1.5 A	2 A	2.5 A	2.5 A	2.5 A	2.5 A	2.5 A
Microstepping	Up to 1/256	Up to 1/32	Up to 1/16	Up to 1/16	Up to 1/16	Up to 1/16	Up to 1/16	Up to 1/16
Protection Features	Overcurrent, Overtemperature, Short-circuit, Undervoltage lockout, Thermal shutdown	Overcurrent, Short-circuit, Undervoltage lockout, Overtemperature, Low-power sleep mode	Overcurrent, Short-circuit, Thermal shutdown	Overcurrent, Short-circuit, Thermal shutdown	Overcurrent, Short-circuit, Thermal shutdown	Overcurrent, Short-circuit, Thermal shutdown	Overcurrent, Short-circuit, Thermal shutdown	Overcurrent, Short-circuit, Thermal shutdown
Package Type	QFN 4×4 mm	HTSSOP/VQFN 24-pin	DIP-16	DIP-16	DIP-16	DIP-16	DIP-16	DIP-16

Applications	3D printers, Medical equipment, Industrial printers, Robotics	Toys, Printers, Cameras, Robotics	3D printers, CNC machines, Robotics	3D printers, CNC machines, Robotics	3D printers, CNC machines, Robotics	3D printers, CNC machines, Robotics	3D printers, CNC machines, Robotics	3D printers, CNC machines, Robotics

The TMC2208 and TMC2209 are particularly known for their silent operation due to their StealthChop technology.

Linear Hardware

1)
https://github.com/texx00/sandypi
2)
https://github.com/grblHAL/core/blob/master/README.md
3) , 4)
http://svn.io-engineering.com:8080/?driver=RP2040
5)
https://github.com/terjeio/ioSender/releases/
6)
https://github.com/grblHAL/RP2040/blob/master/boards/generic_map.h
7)
https://all3dp.com/2/arduino-cnc-shield/
8)
https://www.amazon.co.uk/gp/product/B07SBZ9SM5/ref=ox_sc_act_title_1?smid=A3G751PYK8M98N&psc=1
9)
https://www.makerguides.com/wp-content/uploads/2019/10/TB6600-Manual.pdf
10)
https://www.watelectronics.com/tb6600-stepper-motor-driver-module/