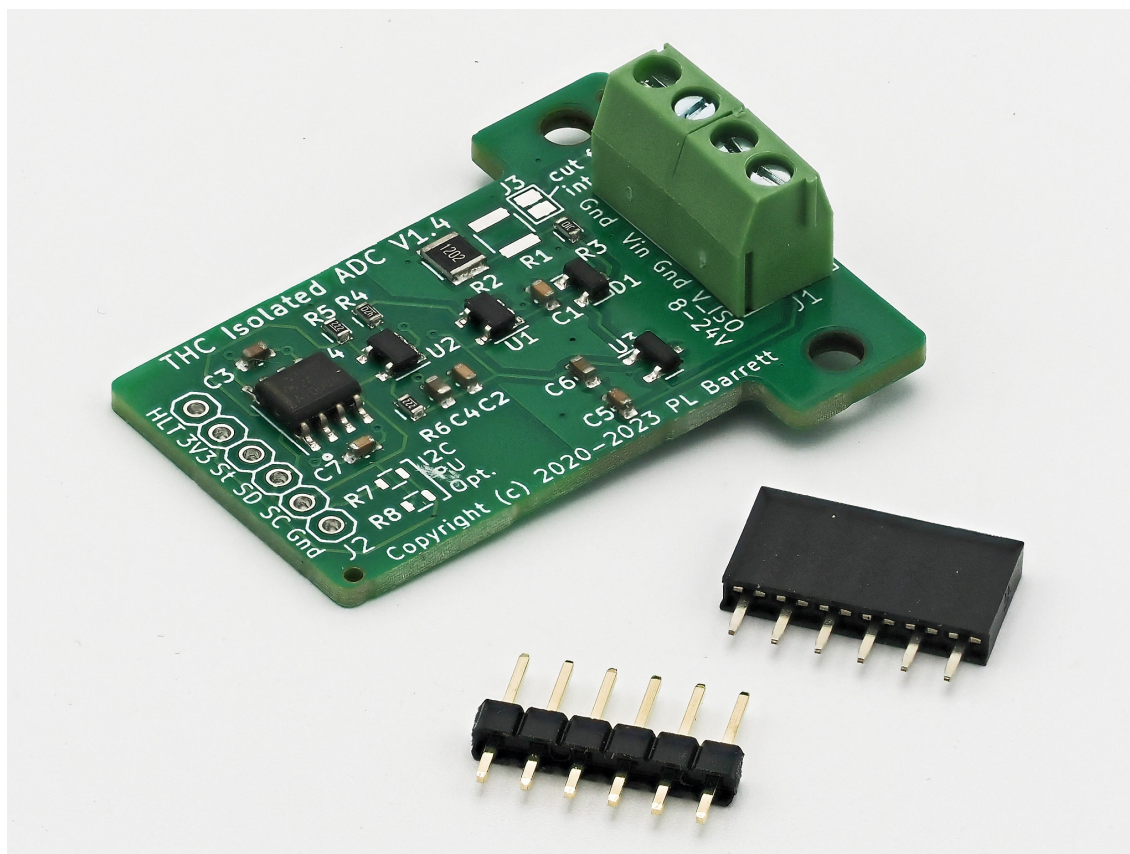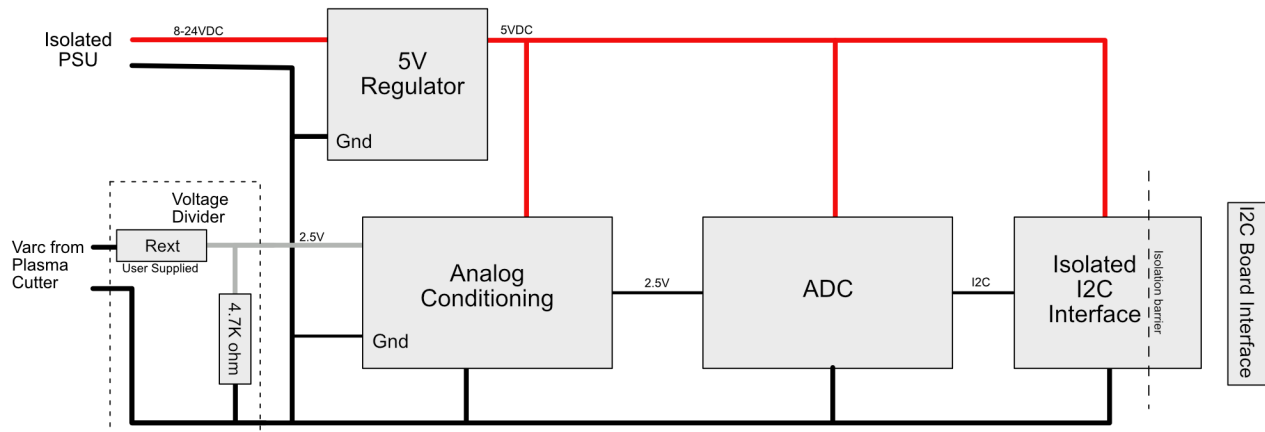# GrblHAL THC Isolated ADC for Torch Height Control User Manual

Version 1.41

Introduction

The THC Isolated ADC is designed to plug into the I2C port on either the T41U5XBB or PicoCNC. It contains an isolated 12 bit ADC, 5V voltage regulator, voltage divider and analog conditioning circuitry.

THC Isolated ADC block diagram.

User Supplied Resistor

The THC Isolated ADC uses a voltage divider to reduce the Plasma Arc Voltage (Varc) down to approximately 2.5V so that the signal may be conditioned and converted to digital. This uses 2 resistors in a voltage divider configuration. The lower of the two is mounted on the PCB and has a value of 4.7K Ohms. The upper one is user supplied and the value is dependent on the Plasma Cutter output voltage (Varc). Consult the following table for the correct value

Varc (volts)	Rext (ohms)	Resistor Wattage
100V	183.3K	½ W
50V	89.3K	½ W
20V	32.9K	½ W
10V	14.1K	½ W
5V	4.7K	½ W

You may substitute the nearest standard 1% resistor value. If your Plasma Cutter has an Arc Voltage that is not in the table, you may use the following formula to calculate the value of Rext:

$$Rext = 4700 * (Varc/2.5 – 1)$$

Select the nearest standard value 1%, 1/2W resistor.

Note: you do not need better than 1% accuracy because you can adjust the expected value in the Plasma THC plug-in in grblHAL.

A SMD pad for an on-board external resistor is provided. (yes, we get the irony of that.) You may solder a 1206 SMD resistor on the R1 footprint and avoid having the external resistor. Use the same above process for selecting the value of the external resistor. You will need to cut the trace between pads labeled J3 where it says "cut for internal R1".

Note, allowing a Varc higher than 10V onto the PCB may bring EMI onto the ADC board. This can result in ADC disruption and possibly damage. Because of that, we do not recommend use of an internal R1.
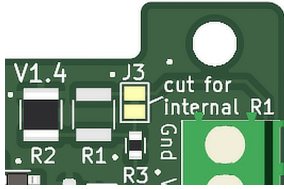
Installing and Testing

Insert and solder the proper connector (6x1 pin header or 6x1 socket) on the ADC, depending on what you have soldered in the I2C header on the breakout board PCB. Insert the ADC board onto the breakout board.

Use the following diagram to make a test jig. The 2K Ohm pot and 2.7K resistor form a voltage divider to bring 12V down to 5V, at most. You can use any combination of resistor and potentiometer that make the Vin voltage no higher than 5V.
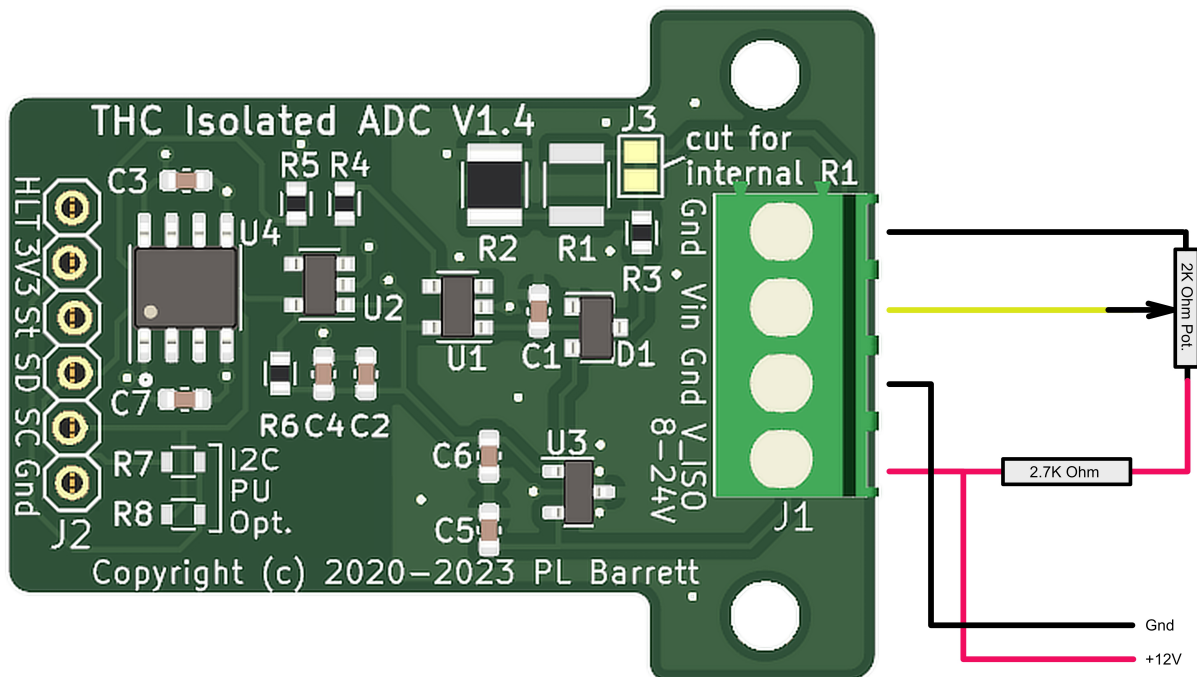
Test set up for ADC input

Make sure you have built grblHAL with the Plasma/THC plugin and enabled the MCP3321 I2C ADC. If using the Web Builder, check Plasma THC on the Plugins tab and enable the MCP3321 I2C ADC option on the Optional inputs tab. See the screenshots below. Note: the below screenshots are current as of Nov 2024. The appearance may change as grblHAL and Web Builder evolve.

grblHAL Web Builder v0.9g - work in progress

Clicking *Generate and download firmware* will output selected options to the console in addition to generate the firmware. Use F12 to open if of interest.
The firmware needs to be verified by those having access to boards, please report failures and suggestions in this discussion.
NOTE: a new tab *3rd party plugins* has been added, options selected there may not work and/or may cause compilation failures!

Updated to grblHAL build 20241120.

The ESP32 driver takes a relatively long time to build, expect 2 minutes or more.

NOTE: Builds 20240222 and later has moved the probe input to the ioPorts pool of inputs and will be allocated from it when configured.
The change is major and *potentially dangerous*, it may damage your probe, so please *verify correct operation* after installing this build.

Driver: iMXRT1062 (Teensy 4.x) ▾ [Homepage]
Board: T41U5XBB ▾ [Homepage] [Board map]
Notes: [   ]

[Generate and download firmware] [Save board] [Load board]
How to flash the firmware   First time user? Check out this Wiki page!

General **Plugins** Network/WebUI Advanced features 3rd party plugins Optional inputs

G & DRO mode: [Disabled ▾]
tings EEPROM: [No ▾]
☐ EEPROM is FRAM
SD card: [Disabled ▾]
Fans: [Non ▾]
Keypad: [Disabled ▾]
Macros: [Disabled ▾]
mber of macros: [1 ▾]
Bluetooth: [Disabled ▾]
☐ Laser PPI
☐ LightBurn cluster
☐ Laser coolant
☐ Odometer
☐ OpenPNP
☑ Plasma/THC
☐ Embroidery

grblHAL Web Builder v0.9g - work in progress

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Notes: [   ]

[Generate and download firmware] [Save board] [Load board]
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| General | Plugins | Network/WebUI | Advanced features | 3rd party plugins | Optional inputs |

☐ Safety door
☐ Limits override
☐ Single step G-code blocks
☐ Block delete
☐ Optional stop disable
☐ Probe disconnected
☐ Motor fault
☐ Motor warning
☑ MCP3221 I2C ADC

Make sure you have at least version 2.0.44 of ioSender installed (or edge version 2.0.44p4). Load the new firmware onto the breakout board and start ioSender. Note that V_ISO must be connected when powering up the grblHAL board otherwise the ADC will not initialize and grblHAL will see it as unpowered. A THC Monitor fly-out will appear on the right edge of the ioSender window. Click on it and you should see something similar to the screen shot below:
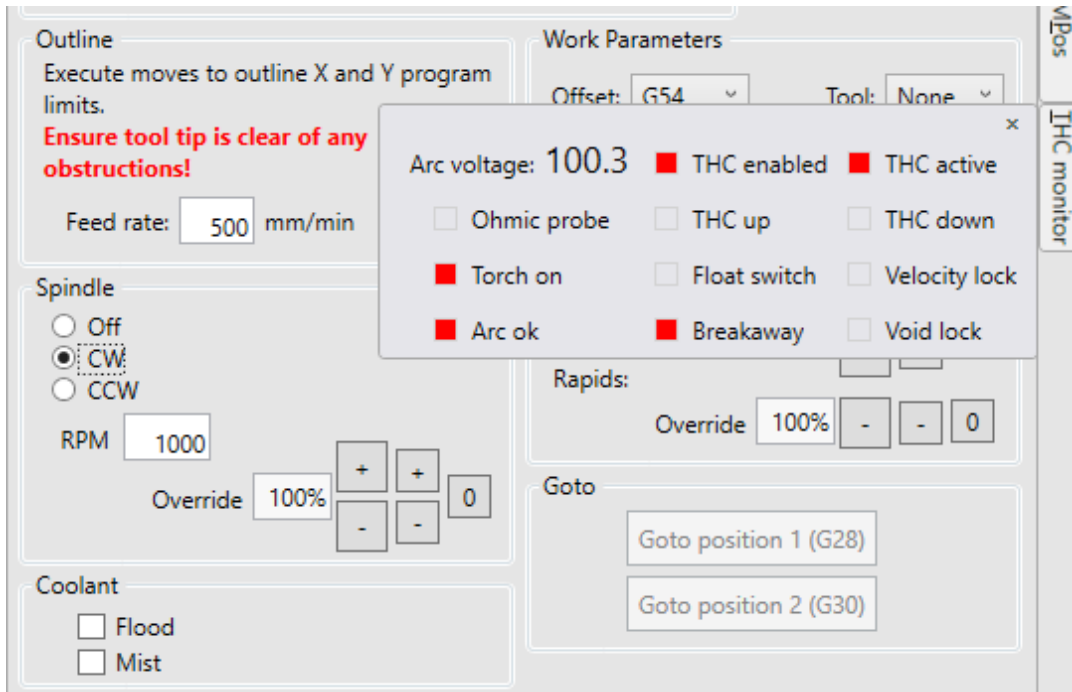
Adjust the potentiometer and the Arc voltage will change. If you have an Arc voltage of 0, verify the voltage going into the Vin pin. You may need to adjust several of the Grbl plasma settings

Mode ($350) set to 1, external arc voltage
Voltage Scale ($361) set to a value that displays 100V in the THC monitor flyout in ioSender. We have been using 0.1 in our testing for a 2.5V input at the Vin terminal of the ADC board.

For other settings, look at the THC/Plasma plugin github repo (https://github.com/grblHAL/Plugin_plasma/).

The THC Isolated ADC is part of the evolving grblHAL plasma capabilities. As such, things may change. The github Plugin_plasma repo has Issues and Discussions pages. These are the best places to get questions answered and report bugs or other problems.

Connecting to Plasma Cutter.

The external resistor needs to be connected between the Plasma Cutter's Arc Voltage output and the Vin pin on the ADC. You need to use shielded wire and insulate the resistor pins (shrink tubing is a good choice). The 8-24V power supply only needs to deliver 25 mA and can be from any suitable supply including a wall wart style power supply.
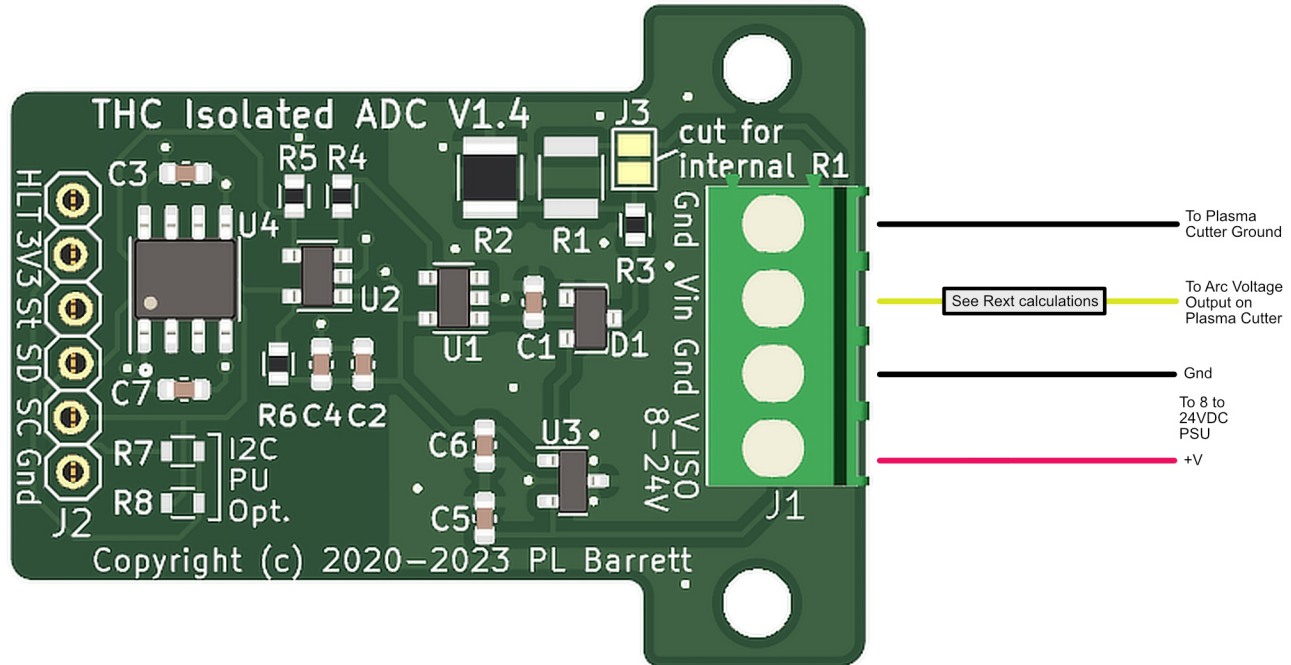
Plasma Cutter ADC input Connections

External Resistor Value

ADCI_1 uses a voltage divider to drop the Plasma Cutter's Arc Voltage output to a usable level. This uses 2 resistors. One, the lower resistor, is on the ADCI board and the other, the upper resistor, must be supplied by the user. This allows support for any Arc Voltage value. The user supplied resistor should be in series with the signal cable running from the Plasma Cutter to the ADCI board. It should be outside the electronics box where the ADCI is mounted so that high voltage does not enter. To find the right value of the user supplied resistor, refer to the following table or use the formula after the table. It is acceptable to use the nearest 1% tolerance resistor.

Arc Voltage	Resistor Value	Resistor Wattage
100V	183.3KΩ	½ W
50V	89.3KΩ	½ W
20V	32.9KΩ	½ W
10V	14.1KΩ	½ W
5V	4.7KΩ	½ W

For an Arc Voltage not listed in the table, compute the resistor value via this formula:
$$4700 * ((Arc\_Voltage/2.5) - 1)$$
Round up to the nearest 1% tolerance resistor value. Use a ½ Watt resistor.

I2C Resistors

The THC Isolated ADC has pads for I2C Pullup Resistors (R7 and R8). These are for the interface to the processor on the breakout board. They are not needed for use with the T41U5XBB. If you need them, consult with the manufacturer of the processor to which you are interfacing for help in determining their values.

Using the ADC with other host boards

The THC Isolated ADC can be used with boards other than the T41U5XBB and PicoCNC. It uses a 3.3V I2C interface. The host processor must have an I2C interface. The following diagram shows the connections. The ADC is a Microchip Technologies MCP3221 12-bit A/D Converter with an I2C interface. The datasheet is available here. The isolator chip on the ADC board is transparent and simply passes through the I2C signals.

I2C Interface Connections

Schematic

Using External Voltage Divider.
To use an internal R1, cut the
shorting trace between the two
pads of J3. R2 is 4.7K – use
the following calculation to
determine R1:
R1 = 4700*(Varc/2.5 – 1)
Use next higher standard
value resistor.
(note to self – verify the
recommended 1/2 Watt
target ADC input voltage?)

Cut between J3 pads
if mounting R1 on PCB
(not recommended for
plasma arc voltage)

PVIN

J3
GS2
R1 DNP

R2 4K7

GNDA

R3 10K

D1
BAT54S

C1 1n

U1
LMV321
V– V+

VCC_ISO

PVIN
V_ISO_IN
GNDA

J4 J1

V_ISO_IN

GNDA

C5 100n

U3
78L05
IN   OUT
GND

C6 1uF

VCC_ISO

R4

U2
MCP3221
VCC SDA
AIN SCL
VSS

VCC_ISO
GNDA
C2 100n
C3 100n GNDA
C4 10uF GNDA
GNDA

VCC_ISO

R5 2K2
R6 2K2

U4
ISO154x
VCC2 VCC1
SDA2 SDA1
SCL2 SCL1
GND2 GND1
isolation barrier

C7 100n
R7 DNP
R8 DNP

J2
HLT   Halt (n/c)
3V3   +3.3V
STRB   Strobe (n/c)
SDA   SDA
SCL   SCL
GND   Gnd

I2C Pull Up Resistors.
Populate only if needed

Ground Plane Consideration.
Maintain ground on bottom of
board to prevent EMI from
radiating to breakout board
below.