# Open Source THC Requirements

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# Overview

This document provides the requirements/features for the open source Torch Height Controller. This is targeted at Arduino Mega 2560 hardware for use with the Power Plasma 50.

While it may work with other plasma cutters, it is not currently intended to be a general solution.

# Hardware Requirements

The following are the features/requirements for the hardware of the THC.

## Hardware Platform

The goal of this effort is to create a low cost THC that can be constructed out of readily available components and electronic parts.

Proper isolation of the hardware is necessary for safe and continued operation. It is a goal of this design to address isolation at a system level, as much as possible, to simplify the THC hardware.

* The hardware platform shall be an Arduino Mega 2560.
* The system shall include a display that is at least two lines of sixteen characters.
* A simple push button interface shall be provided that includes:
  + A “Mode” button (used for setting the mode of operation)
  + An “Up” button (used for setting voltage or manipulating menus)
  + A “Down button (used for setting voltage or manipulating menus)
  + A “Select” button (used with the menu system)
  + A “Cancel” button (used with the menu system)
* The system shall have a relay to drive the plasma unit torch on trigger.
* To support the plasma unit torch voltage, the system shall have a voltage divider with over voltage protection that will limit the input voltage to the Arduino analog input to a maximum of +5 volts.
* The system shall have an analog hardware filter for the torch voltage signal.

## Hardware Interface – CNC System to THC

To support THC operation, there are a number of interfaces that must be provided between the CNC system and the THC.

* THC Input: the THC shall have an input signal “Torch On” to indicate when it should start the plasma unit.
* THC Output: the THC shall have an output signal “Arc Good” when a cutting arc is active on the plasma.
* THC Output: the THC shall have an output signal “Torch Up” when the torch should be raised.
* THC Output: the THC shall have an output signal “Torch Down” when the torch should be lowered.
* It is desirable to have the CNC interface signals electrically isolated from the Arduino

## Hardware Interface –THC to Plasma Unit

To support THC operation, there are a number of interfaces that must be provided between the THC and the Plasma Unit.

* THC Output: the THC shall provide a dry contact output (a relay) “Torch On” to start the torch on the plasma unit.
* The “Torch On” signal shall be interrupt based for priority handling.
* THC Input: the THC shall have an input signal from dry contacts (a relay) “Arc Good” when a cutting arc is active on the plasma.
* The “Arc Good” signal shall be interrupt based for priority handling.
* THC Input: the THC shall have an input signal that is the undivided analog voltage of the torch.

## *[Optional / Future]* Hardware Interface –THC to PC

To support advanced capability, it is desired that the THC have an isolated bidirectional serial interface to the PC. The intent of the interface is to provide a mechanism to save groups of settings for different cutting situations (different metals, different thicknesses, etc.).

* Settings that would be available by this interface include:
* Reading and writing the cutting voltage set point
* Reading and writing configuration data
* Reading the usage data
* Resetting the usage data
* Enabling/disabling the THC

## Hardware Isolation

An underlying assumption is that the Plasma unit provide an isolated torch voltage. If all other inputs and outputs to the Arduino are isolated, then the system should operate properly even if the analog torch voltage input is not isolated.

# Feature Requirements

The following are the feature level requirements for the THC system, particularly as they apply to software.

## THC Control Modes

The Torch Height Controller will have to have a number of different modes of operation to enable all possible uses of the THC and Plasma system. It shall support the following modes of operation:

* Normal – this is the mode of operation where the device will provide torch height control while cutting
* Bypass – this mode of operation is to allow the use of the plasma system without any THC functionality. It is necessary since the triggering of the torch and reporting of the arc status goes through the CNC and the system cannot work without these signals being relayed.
* Disabled – this mode will prevent the operation of the plasma system by the THC not relaying any command signals.
* Cruise Mode – this mode will allow operation of the CNC/Plasma system without torch height control. However, once commanded, the THC will begin torch height control based on the current voltage.

## Controlling Tip Height

Controlling the tip height on the plasma unit it the fundamental function of a THC. Requirements in support of this are:

* Allow the user to set a voltage to use as the target cutting voltage.
* Issue a “Torch Up” signal to the CNC if the voltage is (how much) less than the target cutting voltage.
* Reset an active “Torch Up” signal to the CNC once the voltage is within (what) of the target cutting voltage.
* Issue a “Torch Down” signal to the CNC if the voltage is (how much) greater than the target cutting voltage.
* Reset an active “Torch Down” signal to the CNC once the voltage is within (what) of the target cutting voltage.
* The user shall have the ability to change the voltage setting while the plasma unit/THC is in operation (cutting).

## Usage Data Maintained

The system shall maintain data across power cycles that will be valuable to the user or can be used to improve operation of the overall system. The data maintained shall be:

* The amount of use time of the plasma unit’s cutting tip.
* The number of pilot arc starts of the system (determined by torch on’s).
* The number of pierce operations performed (determined by arc good’s).

## Non Volatile Data

To support system operation, it is necessary to save key data in EEPROM across power cycles. The data maintained shall include:

* Cutting voltage set point
* Tip use time
* Number of pilot arc starts (detected by torch on signal sent to plasma cutter)
* Number of pierces (detected by arc good signal from plasma cutter)

EEPROM has a limited number of writes before failing. The EEPROM on the Arduino Mega 2560 supports 100,000 writes per location.

* The system shall track the number of writes to the EEPROM locations holding the saved data. (Tracked at the overall block level, not the individual element level.)
* Once the data block has been written 95,000 times, it shall be relocated to a fresh block of EEPROM memory.

## System/Device Diagnostics

Commands shall be available to support verification of proper system operation. These commands shall include:

* The ability to turn the Plasma torch on and off
* The ability to send the CNC an Arc Good signal
* The ability to send the CNC a Torch Up command
* The ability to send the CNC a Torch Down command

## Primary Display

If the THC is enabled, the primary operating display shall include:

* Mode of operation
* Target cutting voltage
* Current cutting voltage
* Torch on signal status
* Arc good signal status
* Torch up signal status
* Torch down signal status

## User Interface Menu

The system shall provide a simple user interface menu using the display and push buttons. The menu structure shall be:

