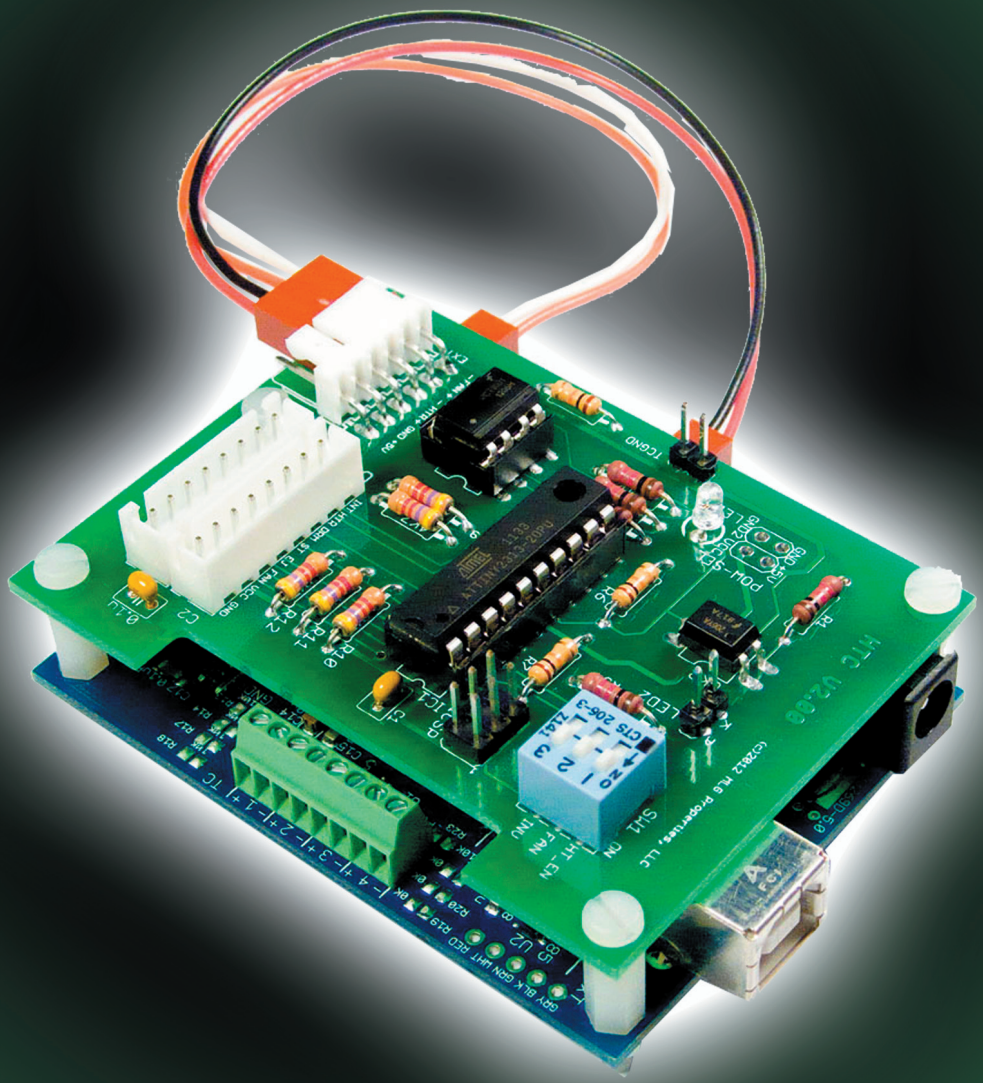
HT Coffee Roaster Interface

by MLG Properties, LLC



User's Guide

manual created by **FRCN Digital Imaging**

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I - Introduction

CAUTION: Be sure to read through all instructions before beginning. Assess your experience and ability to peform the necessary tasks. Read the repair procedure pages on the Hottop USA website linked in this document which can be helpful when disassembling and reassembling the machine. Be sure you understand all those instructions and are comfortable performing the described tasks before beginning. To lessen down time, try to have all the materials and tools on hand before beginning. A work area where the roaster can be safely left disassembled until the job is complete is also preferred.

Disclaimer

HT Roaster Interface devices are experimental electronics kits. They are intended to be used by electronics hobbyists and other persons similarly knowledgeable with electronic devices.

Installation of one of these devices into your roaster may disable important safety features built into the roaster. It may also void the warranty on your roaster.

HT Roaster Interface devices have not been reviewed, tested, or certified by UL Laboratories, CSA, or any other recognized testing agencies. Any insurance you have that might otherwise cover damages resulting from a roaster fire may become voided by the use of non-approved devices such as HT Roaster Interface devices.

Neither MLG Properties, LLC nor any other persons or companies that may have been involved in the testing or documentation of HT Roaster Interface devices may be held liable for any damages resulting in part or whole from the use of HT Roaster Interface devices. This limitation shall apply even in the event of damages resulting from flaws in the devices that are known or become known to MLG Properties, LLC or other persons or companies that may have been involved in the testing or documentation of HT Roaster Interface devices.

By installing and using an HT Roaster Interface device you are accepting any and all risks associated with its use.

If the conditions outlined above are unacceptable, you may return the device(s) unused for a full refund within 7 days of receipt.

While both Hottop roasters and Arduino microcontroller boards are mentioned in this reference manual, neither has endorsed nor is affiliated in any way with the HT Roaster Interface device. Hottop and Arduino are trademarked or copyrighted names owned by their respective companies.

Overview

The Hottop Coffee Roasters have offered great reliability, and more recently, excellent control over heater and fan output levels, and therefore the process of roasting coffee. But all models other than the various KN-8828B models lack recent user control, and all models have lacked user-control over repeatability. To a great extent, those difficulties have been overcome with the addition of small electronic circuit boards and RoastLogger software.

Three elements are required to provide the user with the control and repeatability desired by the serious home roaster:

1. Computer software to monitor bean and environmental temperatures, as well as provide overall control of heat and fan output levels;
2. An electronic temperature controller that reads thermocouple sensors, converts the readings to digital values, sends those digital values over USB to the host computer, and finally accepts instructions from the host computer for setting heater and fan output levels; and
3. An electronic interface between the temperature controller and the roaster that permits the heater and fan output levels to be controlled externally, rather than by the roaster's own control board, under certain conditions.

The HT Roaster Interface family of devices represents the 3rd element in the list above. And, while technically many different computer software systems and temperature controllers could be adapted for use, the following are strongly recommended and are referred to throughout this guide:

- RoastLogger computer software, written by Tom Coxon.
- The TC4 family of temperature controllers, developed by Bill Welch and Jim Gallt, and offered by MLG Properties, LLC.

HT Roaster Interface devices are available in two different form factors:

- The HTShield is an add-on "shield" compatible with Arduino Uno microprocessor boards and may be directly connected to those devices using stacking headers.
- The HTC may be used as a standalone device connected only by wires, or may be stacked onto MLG's TC4C microprocessor board.

All HT Roaster Interface devices include an AVR microcontroller with special firmware that is programmed to monitor and interpret signals from the roaster's own built-in controller, as well as heater and fan control signals from the external temperature controller.

A typical system that makes use of an HT Roaster Interface device might consist of:

- Hottop roaster*1
- Arduino Uno microcontroller board
- TC4 temperature controller shield
- HTShield electronic interface
- RoastLogger software running on a Linux, MacOS, or Windows computer

Alternatively, a physically more compact system can be achieved by stacking just two boards: a TC4C microcontroller board along with an HTC device, thereby eliminating the requirement to include an Arduino Uno in the system:

- Hottop roaster*1
- TC4C temperature controller board
- HTC electronic interface
- RoastLogger software running on a Linux, MacOS, or Windows computer

It is the above system that serves as the example in the assembly portion of this manual.

*1 - This manual has been created specifically for those installing the TC4C+HTC boards (and related styles of hardware). This system is designed to work with the following Hottop Coffee Roaster Models:
KN-8828D, KN-8828B, KN-8828B-2, KN-8828B-2K, KN-8828P, KN-8828P-2, and KN-8828P-2K

In addition, a standalone HTC device may be used in a system that employs neither the Arduino/TC4 nor the TC4C microcontroller boards mentioned previously. Any controller capable of providing 5V heater and fan/blower logic signals may be supported by HTC devices through external 6-wire cabling.

A system configured in one of the ways described above enables the user to both monitor and control their roaster. The degree of control available is limited only by the capabilities of the software running on the host computer and/or external temperature controller. RoastLogger software works especially well these systems and is highly recommended.

With the installation of this electronic system into your Hottop you are combining what is widely regarded as the most advanced home coffee roaster with the most advanced home roasting control available as an add-on system.

Organization of This Guide

Chapter II - Describes the behavior of the HT Roaster Interface devices during an actual roast. It is important that you read and understand this information so that you can effectively and safely use the new control system.

Chapter III - Detailed description of an example installation of a piggybacked HTC+TC4C configuration into a Hottop B roaster. This is required reading. If you have opted for the HTShield option, the information in Part III will still be of great value as you plan your installation.

Appendix A - Description of how your Hottop roaster must be configured or programmed to work properly with a HT Roaster Interface device. You must perform the setup and programming described in Appendix A prior to your first roast with the new controls.

Appendix B - Photos of the boards when configured for various roasters, as well as some of the more technical aspects of the design of the interface boards. It is probably safe to skim this information and return to it if you have any questions regarding the operation or configuration of the board.

Appendices C and D - How your system should be connected, identifies the various configurable features of the boards, and provides additional technical information for advanced users.

Appendix E - Information regarding the behavior of the firmware on an HT Roaster Interface device as determined by on-board DIP switch settings. This appendix also provides instructions for setting the DIP switch to match the specific Hottop roaster you own.

USEFUL LINKS

RoastLogger software site
(http://homepage.ntlworld.com/green_bean/coffee/roastlogger/roastlogger.htm)

HT Roaster Interface site
(http://www.mlgp-llc.com/htri/index.html)

TC4 Shields and Boards site
(http://www.mlgp-llc.com/arduino/public/arduino-pcb.html)

TC4 Project Open Source Code site
(http://code.google.com/p/tc4-shield/)

II - Roaster Interface in Operation

HT Roaster Interface devices are programmed to monitor both OEM*1 roaster control signals and external control signals. In most situations while a roast is progressing, the device will permit the external control signals to reach the roaster's power board and take over control of the heater and/or fan.

The specific mode of operation of the HT Roaster Interface device is established by the positions of the three switches in SW1 on the HTC and HTShield boards.

In all modes of operation, the following requirements are imposed by the device firmware:

- When the OEM controller has activated the eject signal or the stir signal (EJ and ST pins in the CTL header) then the OEM controller is given full control over heater and fan. External heater and fan signals are ignored.
- When the OEM controller has not activated the roaster's drum (DRM signal in the CTL header) then the heater and fan are both forced to be off. External heater and fan signals are ignored.
- When no voltage has been detected coming from an external controller, the OEM controller is given full control over heater and fan. This allows use of the roaster in its native mode when the external controller is disconnected.

Depending on the mode of operation established by SW1, the HT Roaster Interface device will impose other requirements based on the status of the OEM controller heater and fan signals. See Appendix E for details.

While HT Roaster Interface devices may be used with other roasters, many of the features of the HTC and HTShield devices are targeted specifically at various models of the popular Hottop roasters. Some of the Hottop-specific features of these devices include safety checkpoints implemented on all "P" and "B" Hottop models currently available. The safety functions of these models are supported when the recommended switch configurations are used.

A special HT Roaster Interface device mode has been implemented for P and P-2 roasters which overcomes many of the shortcomings of that control panel.

*1 - "OEM" is an acronym for Original Equipment Manufacturer. Where used in this guide it refers to the components or operations of your roaster as provided by the manufacturer.

III - Hardware Installation

NOTE: This chapter documents the hardware installation in a Hottop roaster done by one owner. In particular, this chapter documents the installation of a HTC+TC4C combination in an Hottop roaster. It will be readily apparent to the reader how the installation would be different if installing an HTShield+Arduino/TC4 variant of the interface device. This chapter is NOT meant as a how-to guide, nor is it a step-by-step set of instructions. It is presented as one example and to help you decide if this type of installation is what you might desire and to decide if your skills, experience, and knowledge make you capable of such an installation.

Installation Basics

Materials

Your choice of components will dictate the materials and tools you may need for installation. The installation of just the TC4C installed externally will require different connection components. Some of the following may or may not be necessary.

- HT Roaster Interface devices (both HTC and HTShield) require a new 7-wire or 8-wire cable that is an exact duplicate of the original Hottop cable which connects the existing control panel to the existing power, or main, board. Hottop D models use a 7-wire cable; Hottop B and P models use an 8-wire cable. Be sure you have received the correct cable for your roaster.
- USB cable: B-male end to plug into HTC or the Arduino or HTShield installation.
- Two K thermocouples

Additional possibilities

- J.B. Weld or similar heat-resistant epoxy
- Taps for threading holes
- Files
- Assorted hardware (screws, washers, nuts, etc.) as necessary
- Heat Shrink tubing, insulating wire sleeves, tie wraps, etc.
- Sheet metal for mounting plate and related mounting brackets and hardware

Tools needed

- Screwdrivers which may include #1 (and possibly #2) Phillips, small slotted for thermocouple attachment
- Needle nose pliers
- Drill motor and drill bits (as needed)
- Center punch
- Ruler
- Other various hand and power tools for thermocouple and board installation (varies)
- Necessary safety items (gloves, eye protection, etc.)

Installation of the components of this system involves partial disassembly of the Hottop. For best performance the installation of the thermocouples involves drilling one or two holes in the rear wall of the Hottop's roast chamber.*1 The installation of the support bracket can involve drilling holes through the side frame. To access these areas and to avoid damaging existing components it is necessary get access to these areas so that the risk to components and flesh are diminished.

The steps necessary to remove the various parts are well documented on the Hottop USA website. Follow the procedures found there. The minimum disassembly will involve following all the steps to remove the Drum Motor.

NOTE: Because of variations over the years in Hottop internal design, be sure to refer to the correct repair area for your machine. Refer to this page http://www.hottopusa.com/repair.html to verify which machine you have and link to the correct procedures. Overall, all the Hottop machines are quite similar, but there are minor variations between early models (KN-8828 and KN-8828D) and the various iterations of the "P" and "B" models. The links below refer to the "2-K" and the photographs in this guide also show that model. Other models are very similar, but you should consider the specifics of your machine and the layout of internal components as you continue through this guide.

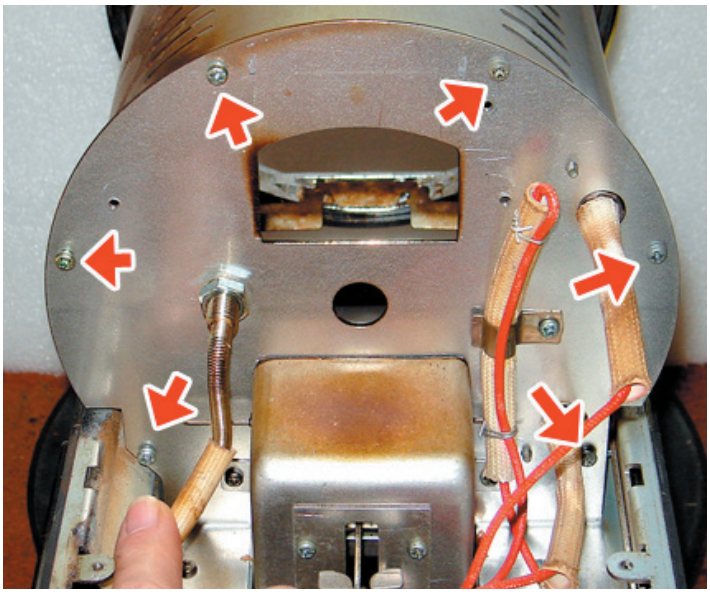
TIP: Before removing the roasting drum, take a long pencil or suitable scribe or scratch awl, and reaching into the drum, trace along the inner circumference of the drum on the back wall of the roasting chamber to assist in more accurately locating the thermocouples.

Links to the Hottop USA website:

- Begin with removal of drum motor: http://www.hottopusa.com/motor2.html
- Remove the Control Panel: http://www.hottopusa.com/panel2.html
- Once the control panel is out of the way, remove of the black plastic Side Panel on the side of the Control Panel: http://www.hottopusa.com/side2.html

CAUTION: For the "K" models (KN-8828B-2K and KN-8828P-2K), the insulation of the wires of the K thermocouple is fragile around the white connector where the cable plugs into the control panel. Use caution whenever manipulating the Control Panel or handling the sensor's plug. If exposed, be sure that the thermocouple's conductor wires are not touching each other nor the chassis.

While it is possible to drill the holes for the thermocouples with an extension drill or even from the rear of the panel, I prefer to work with the roast chamber's inner wall removed as well. Removing the roast chamber's inner wall is not documented on the Hottop website.



First, remove the six screws indicated here. A long screwdriver helps save knuckles. If the #1 Phillips doesn't grip well, try a #2 Phillips or a Pozidrive (possibly a PZ-2) bit if you have one.

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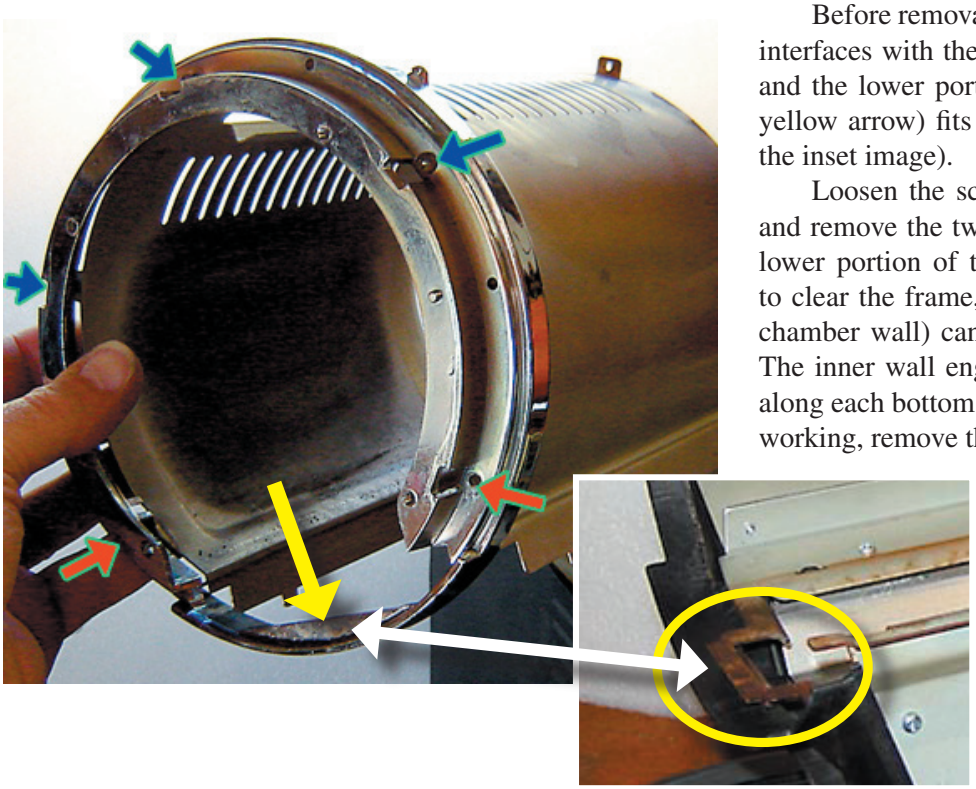
*1 - It is possible to use thermocouples installed through the the bean chute to avoid disassembling the roaster as well as avoiding the need to drill holes. This method makes it more difficult to locate the thermocouples so they report consistent readings and is better suited for using external electronics.

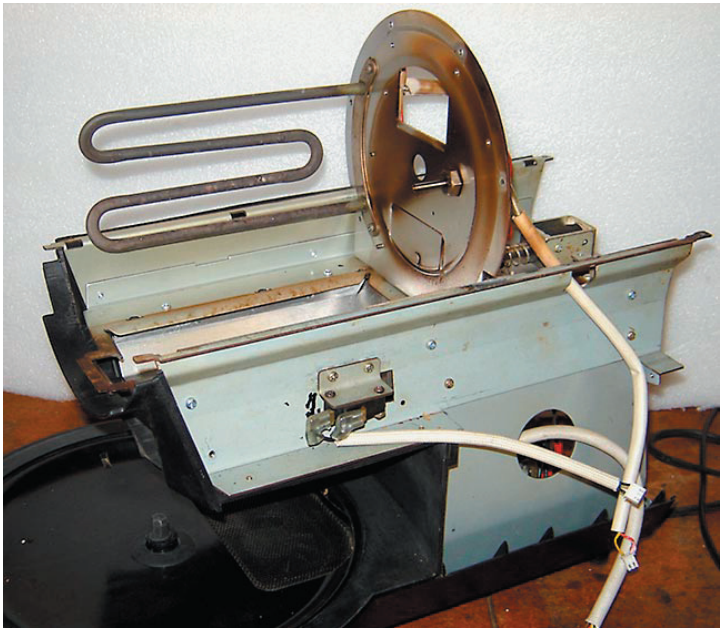


Before removal, note how the bottom of the Bezel interfaces with the frame. There is a lip on the frame and the lower portion of the Bezel (indicated by the yellow arrow) fits under the framework (indicated in the inset image).

Loosen the screws indicated by the blue arrows and remove the two indicated by the red arrows. The lower portion of the bezel has to be pulled forward to clear the frame, and then the assembly (bezel and chamber wall) can be lifted up and off the machine. The inner wall engages with the frame by three tabs along each bottom edge of the sheet metal. If this isn't working, remove the bezel completely.

TIP: Having another pair of hands to hold the inner wall in place while replacing the bezel during reassembly can be very helpful, particularly if the bezel has been completely removed.

Finally, it can help to remove the bean loading chute. But before doing so, use a pencil and trace along the outer edge of the chute and its mounting tab along the side where the thermocouples will be mounted. This will aid in choosing a location for the thermocouples.



Here is the stripped Hottop ready for installation of the thermocouples

Is it necessary to disassemble the machine to this extent? No. But as long as you are here, you might as well go all the way to make the process as easy and accurate as possible. It is also a good time to do a thorough cleaning of the removed parts.

Installation of Thermocouples

Once the machine is stripped of the components as described in the previous chapter, installation work can commence. The first task is install the thermocouples. There are so many various types and sizes of K thermocouples that it is difficult to precisely describe the locations or method for installation. Some thermocouples bolt through and some need to be epoxied into place.

Choosing a thermocouple can be complicated. We recommend using bare-wire style thermocouples that expose the sensing junction to the area they are measuring. These react faster and generally are more accurate than the enclosed type sensor where the junction is contained inside a metal tube. The trade-off is that even though the exposed style of thermocouple is more accurate, they are more prone to wear and damage.

Whichever type you choose, insulating the thermocouples from the roaster is essential, both for performance and for safety reasons. Thermocouple lead wires with any kind of exposed conductor, including metal shielding, must be insulated with suitable sleeving to ensure there is no possibility of coming into contact with high voltage connections within the roaster.

In addition, insulating the thermocouples can not only eliminate potential ground problems but also provide more accurate readings as much less heat will then be conducted away from the sensing tip to the rear wall of the roaster.

A simple mounting method is to use a short length of stainless or brass tubing epoxied through the back wall. The thermocouple wire can be inserted through the tube and held in place with a short length of small-diameter silicone tubing. Creative sourcing of these materials and taking your time in their design can go a long way towards making installation as well and maintenance in the future a lot easier. Check hobby stores for the metal tubing and if you can't find silicone tubing, some aquarium tubing is made of silicone so a pet store may be a resource for that.

NOTE: Thermocouples with metal braiding/shielding are not recommended. While probes of this type are common and inexpensive on online auction sites, the metal shielding makes it almost impossible to isolate the thermocouples from the roaster frame. A great many ground loop and interference problems have been reported by users of this style of probe.

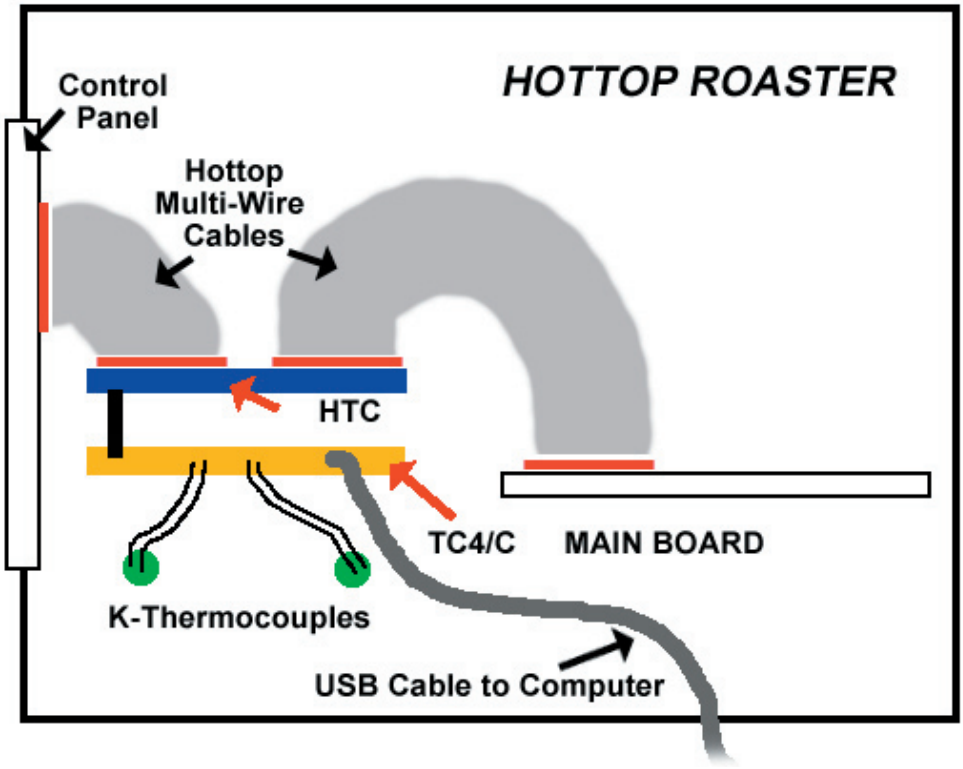
Tips to Assist You Before You Begin:

- Be patient. If you need it, take a day or two to layout the locations for the thermocouples before drilling. "Measure twice. Cut once," is an understatement here.
- Take into account the location of the Bean Loading Chute, the Drum Motor, the motor's mounting bracket, and your chosen routing of the thermocouples' leads as well as any other factor that may apply when deciding how to mount the thermocouples.
- The design of the roasting drum has changed many times over the years. Some have fins that extend very close to the edge of the drum. More recent models have a good amount of space. Examine the drum closely before deciding on a thermocouple location.
- Do not try to locate the thermocouples excessively close to the drum. The Bean Temperature (BT) thermocouple, if located too near the drum can give false readings and can cause beans to get jammed between the thermocouple and the drum putting a strain on the drum motor and this may damage the thermocouple. If the Environmental Temperature (ET) thermocouple is too close to the drum it may read a higher temperature from the metal mass of the drum rather than the atmosphere in the drum.
- Use a compass and mark the backside of the Rear Wall (in the area of the electronics) of the roasting chamber to indicate the radius of the inside of the Drum. By holding a piece of stiff cardboard against the opposite side of the chamber wall, the compass's point can be located in the center of the hole for the drum's drive shaft making it easy to mark the radius accurately on both sides of the wall.
- Refit the Bean Loading Chute before drilling to be sure that there is enough space between the thermocouple and the chute. For instance, if you are using epoxy you must leave enough room for the epoxy to spread.
- Be wary of inexpensive thermocouples, particularly the ones which are enclosed in a tube or other metal "chamber." These are often poorly made and use thick metal which dramatically slows response. These will frustrate you and you could very well end up replacing them later forcing you to do this job twice.

Routing of the Thermocouple Leads

In much the same way that variations in the selection of thermocouples affects how to mount them, it is difficult to say which routing possibility is best for the leads. Regardless of the routing you choose, the leads need to be protected. Some are covered with a stainless steel mesh which needs to be covered with insulation to protect against short circuits. Electronics stores sell insulating sleeves in various diameters. These are a good idea on all thermocouple wires since some of the insulation used on them is fragile and a short circuit will give false readings, may damage components, or may cause a safety issue.

Basic Electrical Schematic



Here is a basic schematic diagram of the hardware installation showing the HTC stacked on a TC4C installed inside a Hottop roaster, to be monitored by an external computer. The connections are as follows:

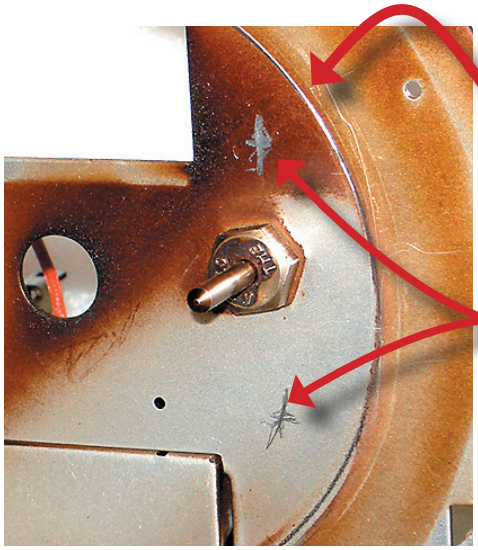
- The two boards (the HTC and the TC4C) piggyback together. The assembly is held together by the included nylon standoffs (M3 threads).
- One multi-wire cable goes from the Control Panel to the HTC board
- An additional multi-wire conductor (duplicate of original Hottop cable) goes from the HTC board to the Hottop's Main Board.

NOTE The connection headers (male) on HT Roaster Interface devices for the multi-wire cables vary depending on which model Hottop roaster you have. The D models use a 7-wire cable, and the B and P models use an 8-wire cable. In addition, the polarity notches on the male header blocks are opposite on the 7-wire cable vs the 8-wire cable. When you order your HT Roaster Interface device the appropriate male header block will be soldered to your board before shipping. See Appendix B for photos• A USB cable for logging and graphing goes from the TC4C or Arduino/TC4 USB socket to the computer.

- The leads from the K thermocouples connect to the TC4C or Arduino/TC4 board

No external power source is required. The HTC is powered by the Hottop and theTC4C or Arduino/TC4 is powered through the USB cable.

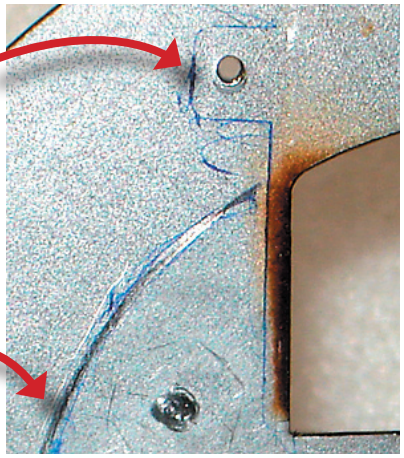
Images to assist in mounting the thermocouples.



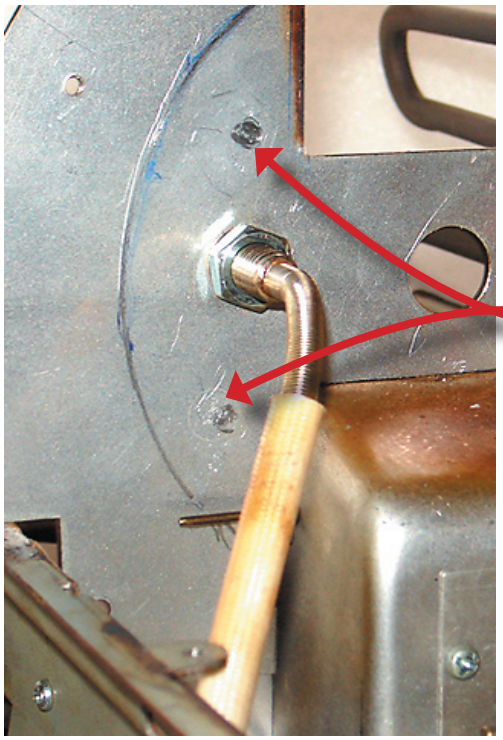
The line scribed to mark the inner wall of the roast chamber...

...makes it a lot easier to decide where the thermocouples will be located.

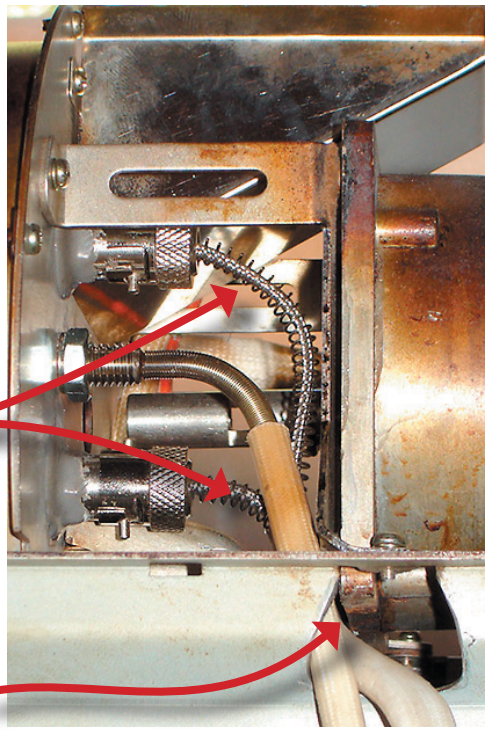
Be sure to mark the location of the bean loading chamber to assist in locating the ET thermocouple. It also helps keep epoxy away from the area occupied by the chute making assembly easier later.



Marking the backside of the Chamber Wall assists in locating the thermocouples..



Mark the proposed location of the thermocouples on both sides of the chamber wall and consider all factors before drilling.



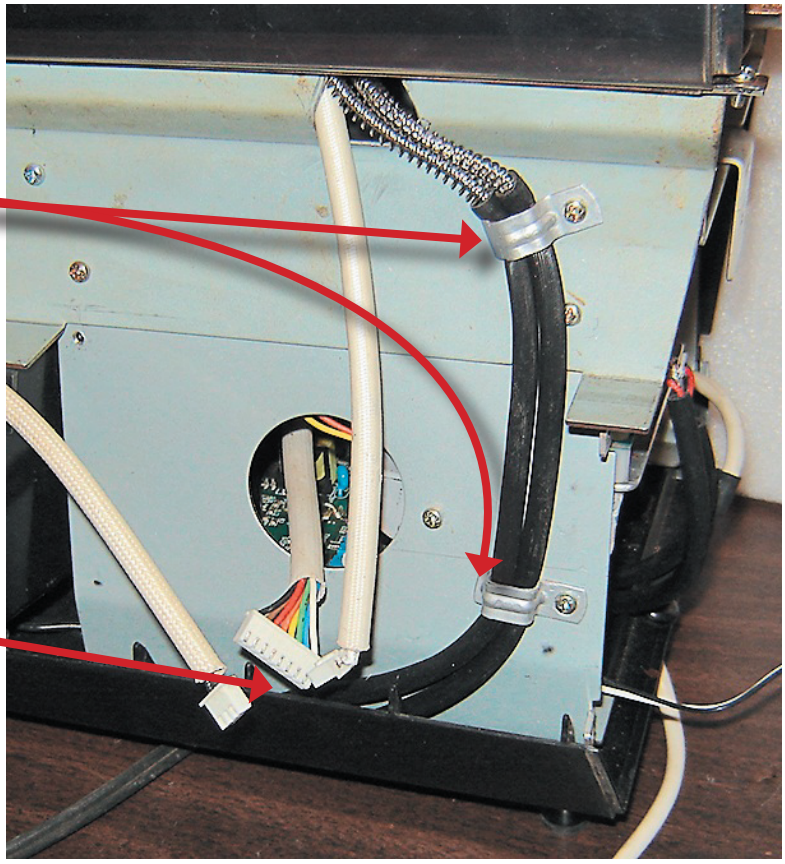
Besides interference from components, the routing of the thermocouple leads must be considered when choosing a location for the thermocouples.

Note the enlarged hole to make routing of the thermocouple leads easier. Just one of the many possibilities that makes specific recommendations difficult..

Keeping various wires protected and secure is one of the challenges. Here a user has fabricated some simple clamps using 1/4" hose clamps which were reshaped in a vise. These can be found in hardware stores for holding down copper tubing used for plumbing. This arrangement holds the thermocouple leads out of the way of the control panel. The upper clamp is held by an existing screw. The lower clamp by a new screw in a hole which was drilled and tapped.

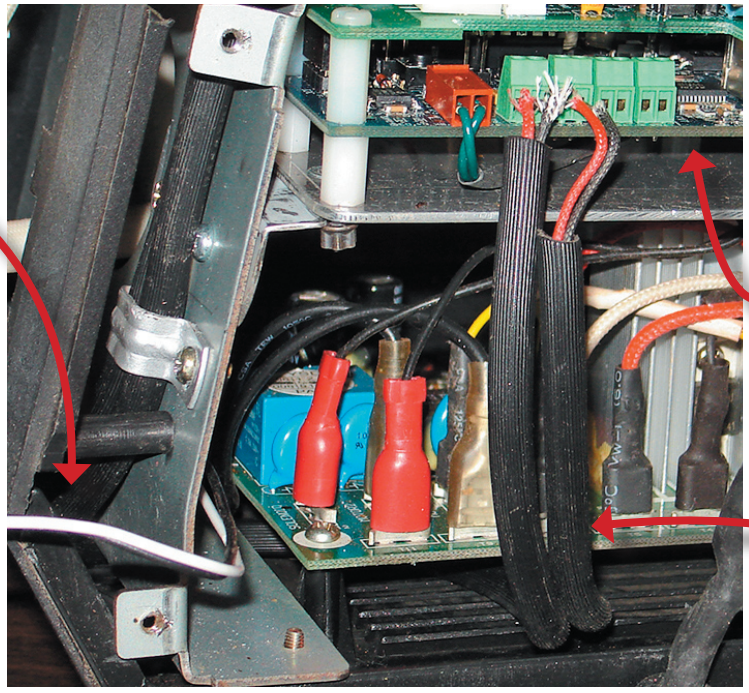
The thermocouple leads have been protected by heavy tubing. It is recommended to use protection made from heat-resistant materials like fiberglass or silicone.

The cables run under the side portion of the framework and then under the main power board.



WARNING: The H**T Roaster Interface components may only be connected into low voltage systems**. Inside the roaster, however, are exposed high voltage connections. Installation of any hardware inside the roaster should only be done by competent persons and ensure that the new hardware and cabling is fixed and insulated so there is no possibility of it moving into contact with exposed high voltage sources. Failure to do this will result in high (mains) voltage being conducted outside the roaster where it may cause damage to equipment or death. If in doubt please seek expert help.

The thermocouples leads go under the side panel here



NOTE: The boards are shown mounted here. That will be covered on the next two pages. This photo is to merely assist you in planning the routing of the thermocouple leads.

And come up from under the main board here to connect to the TC4C.

HTC and TC4C Installation

The procedure has two basic parts: first decide on the location and method of mounting the electronic boards, and the second being the routing of the electrical cables and their connections. The later must be considered when deciding on the former.

Assembling

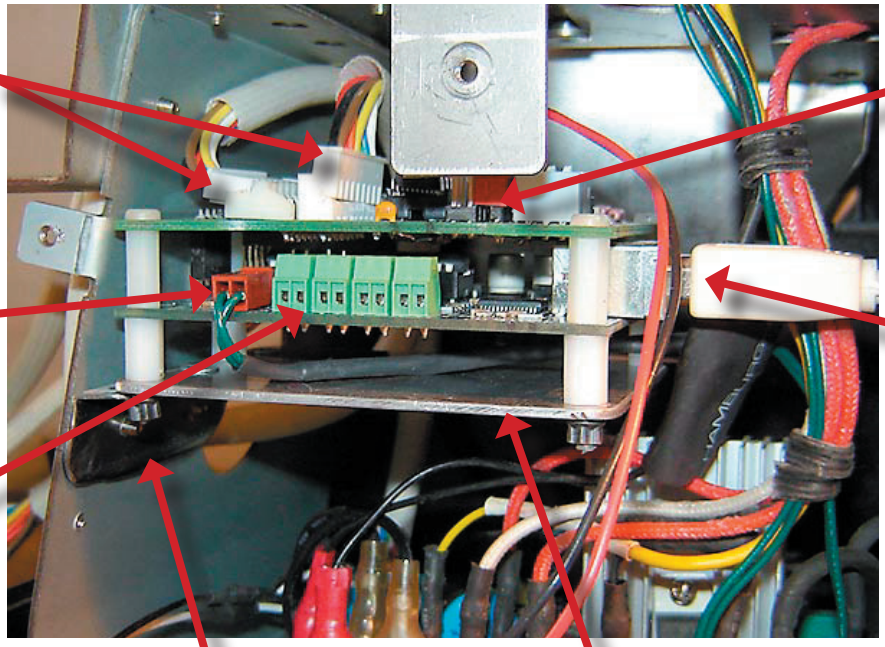
The boards should arrive assembled. If your mounting choice requires you to separate them it is best to begin by taking some photographs for later reference. A few of the electrical connections are friction fit and easily dislodged. Having a visual record of all the connections will reduce stress later.

Mounting

Much as with the installation of the thermocouples, there are various ways to mount the boards. Some folks disdain drilling holes in their Hottop so they have created mounting panels of aluminum or steel that use existing screws and holes or use some sort of clip or clamp system to mount them. Others have come up with clean, simple mounting solutions that allow easy access. The boards can be mounted in any orientation.

If you choose to screw a bracket through the frame in the area of the control panel, carefully consider the location of the screws. Try to locate them where they will be accessible through the opening of the side panel after the Control Panel is removed. In that way the black plastic Side Panel will not need to be removed if servicing or removal of the HTC assembly becomes necessary.

The pictured mounting variation was done by a user. This orientation choice was made based on the fact that it places the thermocouple wires at the rear of the machine making the four thermocouple wires easy to access. Since these are the only ones that need a tool to connect or disconnect, this orientation made more sense to the owner of this machine. It also gives plenty of room to route the USB cable. While it may look a little crowded in there, thee is more than enough room for this orientation.



There are various considerations to keep in mind before committing to a mounting system:

- The location of the USB connection needs to leave room for the cable to exit.
- The thermocouple connections will need to be accessed if you ever want to change the thermocouples.
- Leave room for the two Hottop interface cables on the HTC. They do not all route like the ones shown above. Examine your boards carefully and consider the routing before committing to a mounting location.
- Locate the boards so that there is no chance of them becoming loose nor touching any other electronic parts or metal conductive surfaces.
- Leave room for cables to go through the side frame, and so the mounting does not interfere with fitting the Rear Cover.

Electrical Wiring

Thermocouple Wires

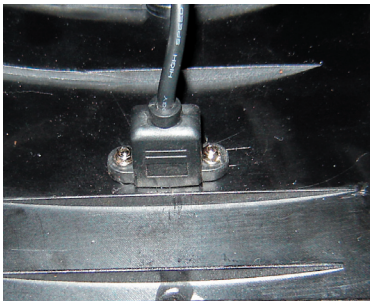
These can be the biggest challenge because the wires can be quite stiff. You need to consider their direction and later access for servicing as well. Be aware that thermocouples are polarity sensitive. The connection points on the board are marked "+" and "-" on the circuit board. Some suppliers do not adhere to standard coloring of the thermocouple wires, so check before installing. It is a good idea to slip some sort of protective covering over the thermocouple wires for their protection, and this becomes critical if the wires have braided metal cover.

NOTE: US standards for thermocouple lead polarity have established that RED is always the negative lead. The positive lead for US standard type K thermocouples is always YELLOW. International standards vary, however, so be sure you know which lead is which. If you hook up your system and the displayed temperature begins to drop when the heater is turned on then you have connected the leads with the wrong polarity

USB

There are a lot of ways to run the USB cable. One of the easiest is to use might be a "CablesToGo" brand, panel-mount cable like the 28071(12"). The female panel-mount can be attached to the back cover and an opening created in the cover to access the socket. This allows the rear cover to be removed and then the male end disconnected from the TC4/C board.

Regardless as to what method you choose, the location and orientation of the boards inside the Hottop and thus the location of the USB port on the TC4/C needs to leave room for the USB cable to be connected and routed to the desired location.



NOTE: Do not connect the USB cable to the computer until instructed to do so later in these instructions.

WARNING: Be aware that it is important to make sure that the male end of the cable remains connected to the TC4C board. If the connection is dislodged and metal portion of the USB male "B" falls and comes into contact with the power board, it can send damaging current to the computer... or you! There are connection pads on the TC4C board and it is recommended to use them to permanently solder the USB wires to them instead of using the USB connector socket. While most of the material in this guide applies equally to both TC4C boards and TC4 shield boards, the TC4 shields do NOT have pads for soldering USB lead wires.

When finished with the installation, reassemble the Hottop, generally in the reverse order from disassembly, but leave the rear cover off. Plug the fan in and place it off to the side where it cannot be damaged or cause injury when it starts.

Double check all wires and be sure all screws are properly tightened. Hold the roaster with the glass viewing widow pointing upwards and give the roaster a shake to be sure that there are no loose parts inside (screws, bits of wire, tools, etc.).

At this point the roaster should be ready to operate. Verify that the main fan is safely located so it nor you will be damaged when it starts. Plug the roaster in and press the Power button. The fan may run momentarily (approximately .25 seconds). Try to start a roast as you normally would using the Hottop Control Panel. The red LED on the long wire connected to the HTC should illuminate as soon as the roasting cycle begins which indicates that power is going to the heating element. As soon as this is verified, stop the roast by hitting eject. The fan should run momentarily.

Once you have verified that the roaster is operating correctly without the USB cable connected to a computer, disconnect the power cord from the wall outlet, and complete assembly. A small hole can be drilled and the red LED heating element activity indicator can be moutnted in the location of your choice.

Recheck all electrical connections and check for loose hardware, lost screws, and other foreign objects in the roaster. Complete the assembly of the Roster . It is now time to move on to the RoastLogger manual.

Appendix A - Hottop Roaster Setup

WARNING: NEVER leave an operating roaster unattended.

Regardless as to which model of Hottop you are using, for proper external control using either the HTC or HTshield system, it is necessary to set up your roaster so that external heater and fan control is optimal. It is important that the roaster OEM control board maintains both the fan and heater output levels in the way that the HT Roaster Interface requires for the particular Hottop roaster model. This section details how to accomplish that.

KN-8828B

With all the KN-8828B models (KN-8828B, KN-8828B2, and KN-8828B-2K), you should start with a "blank" saved profile which keeps the fan as well as the heating element at 100% throughout the entire roast. If not, even when RoastLogger displays that the settings at 100%, the Hottop can lower the temperature in its own program. If RoastLogger shows 100% in its interface and the Hottop's heating element is at 0%, you will only be achieving 100% of the Hottop's 0% setting (which will be 0% heat, because 100% of 0% is 0).

1. Connect the Hottop to your computer via the USB cable start RoastLogger and the Arduino Controller and set the heater slider to 100% and fan sliders to 0%.
2. Select a Hottop program (AD1, 2 or 3) and set maximum target time and target temperature (see Hottop manual for details). It will be easier if you can select a previously unused Hottop program as this will not change the settings during the following.
3. Start the program and let the Hottop preheat.
4. Once preheat is complete turn the control panel heater and fan settings to full on and watch the Hottop panel carefully and ensure they stay full on. Use the up down arrow keys if necessary to keep them at these values. If you wish you can turn the RoastLogger heater slider to 0% at this stage so that the Hottop does not actually heat up.
5. Let it run for five minutes or more whilst carefully following step 4 above, then press eject on the control panel.
6. After it completes it's cooling cycle save the program to AD1, 2 or 3 and note the program number used. When you select this program for future roasts it will continue to display 100% heater and fan throughout the roast even though you ejected it after five minutes, and even when other values are set using RoastLogger.
7. You must select this new program for all roasts using external control, i.e. all roasts with a computer connected to your Hottop.

KN-8828P

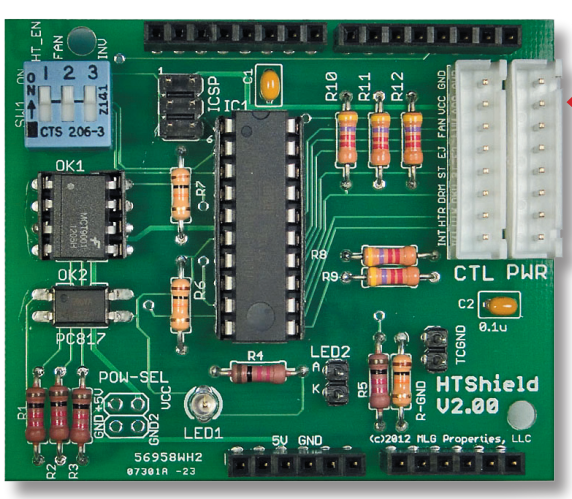
Review the Hottop manual section on modifying and saving an existing program if you are not familiar with how to do this.

1. Select an existing program and set the segment times to achieve a total time of 22 minutes, this is the maximum it will allow. How you achieve this is not important, one way is to set all segments except one to 3 minutes duration and the last one to one minute duration.
2. Set the fan to off in all segments. This is important for the correct operation of this mode. It is suggested you verify all segments have the fans set to off before saving. Please note you do not need to change the maximum temperature settings in any segments.
3. Set the name for the new program "HTC" is suggested.
4. Save the new program to your chosen program number and note the number used.
5. You must select this new program for all roasts using external control, i.e. all roasts with a computer connected to your Hottop.

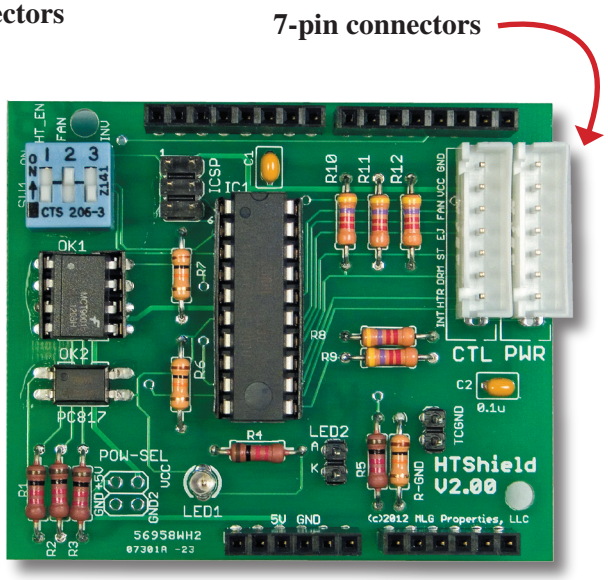
Appendix B - HTC & HTShield Board Description and Variations

Board Photographs

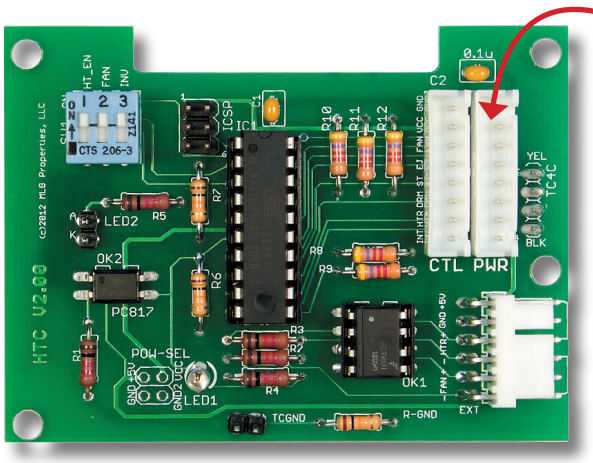
Because of the variations in Hottop Coffee Roasters over the years there are variations in the CTL and PWR headers on the HTShield and HTC boards. These images will help you make sure that your board has the appropriate CTL and PWR headers soldered in place. Note that the boards for the D model has 7-pin headers, and that boards for the B and P models have 8-pin headers. The header orientations are reversed for the 7-pin and 8-pin cables as well. Each HTC and HTShield board is configured to be used for either 7-wire or 8-wire headers -- it is only the headers themselves that vary depending on your roaster model.



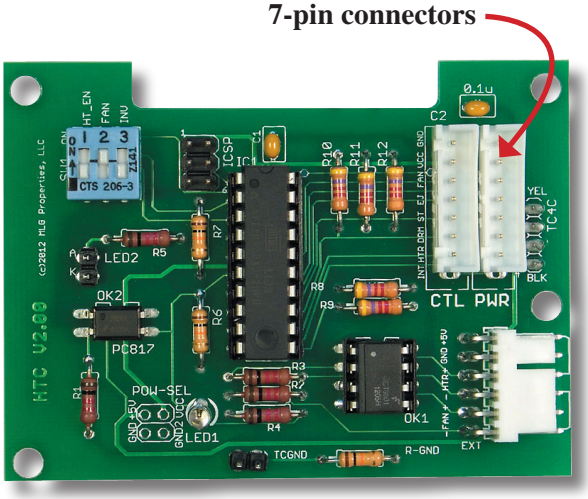
HTShield for "B" and "P" models



HTShield for the "D" model



HTC for "B" and "P" models



HTC for the "D" model

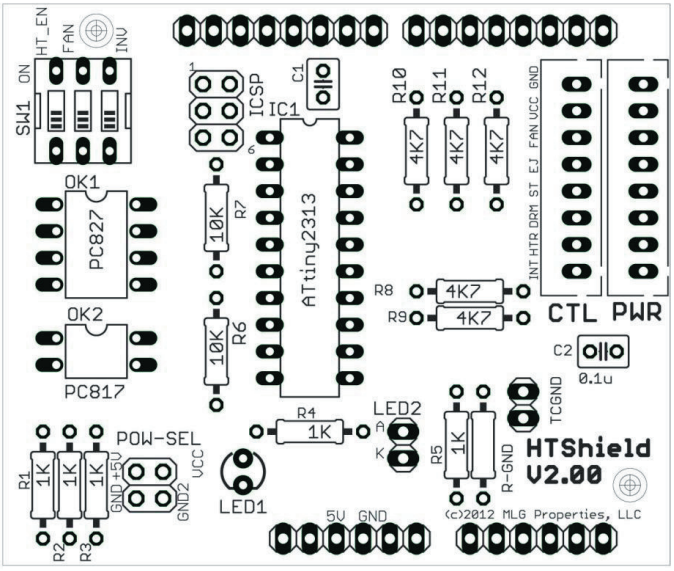


Figure 1 - HTShield board for B and P models

Every HT Roaster Interface device includes an 8-pin male CTL header and an 8-pin male PWR header. (Depending on the target roaster, however, either 7 or 8 pins may actually be connected to the roaster).

Incoming signals from the roaster's OEM controller are received on the CTL header and read by the AVR microcontroller. Depending on both the state of the roaster and on the commands received from an external controller, the HT Roaster Interface device will either pass through or modify the heater and fan signals. The passed-through or modified signals are sent to the roaster's power board via the PWR header.

The HT Roaster Interface device must be powered at 5VDC and should share a common ground with the roaster's OEM control and power boards.

Heater and fan control logic signals from an external controller are optically isolated from the HT Roaster Interface device. (External signals should be nominally 5VDC, but higher or lower voltage external signals may be used with properly sized resistors R1, R2, and R3).

For HTShield devices (see Figure 1), external control signals are received directly from an Arduino microcontroller board through the stacking header. Arduino pin D9 carries the heater control signal and Arduino pin D3 carries the fan control signal.

For HTC devices (see Figure 2), external control signals must be provided on the male pins of the EXT cable connection header. Aside from the manner in which the devices receive external control signals, the HTShield and HTC devices treat external heater and fan signals identically.

PWM frequencies for heater and fan control up to approximately 2kHz have been successfully tested on HT Roaster Interface devices.

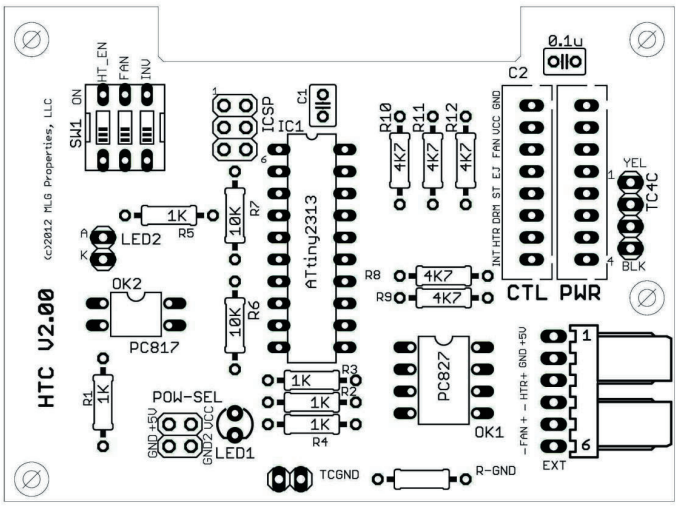


Figure2 - HTC board

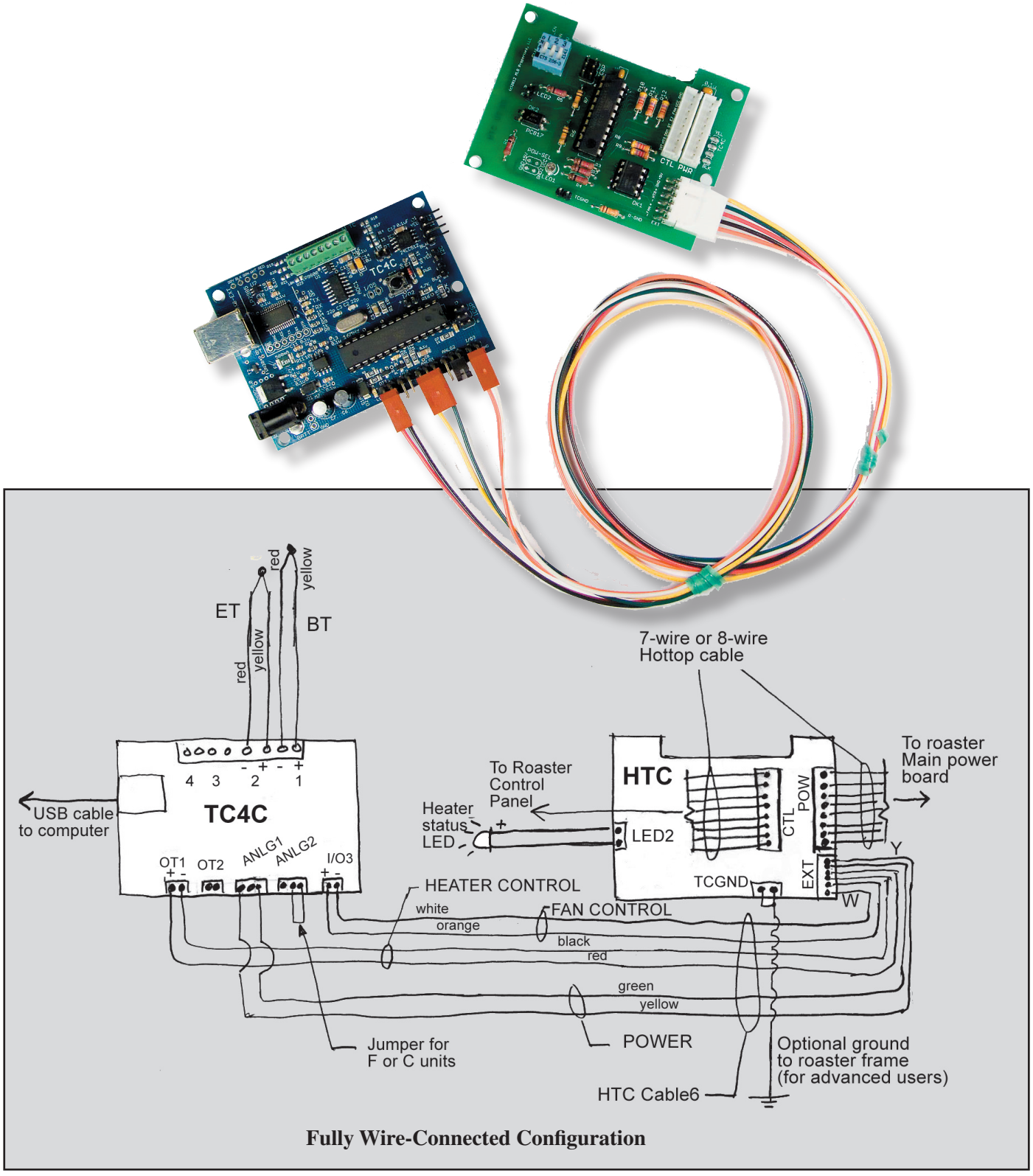
Each HT Roaster Interface device has a block of DIP switches (SW1). These three switches are used to configure the behavior of the device. Complete descriptions of the modes of operation and associated switch positions are provided in Appendix C.

Each HT Roaster Interface device includes on-board LED1. This green LED will illuminate when power is supplied to the HT Roaster Interface device and a 5V (nominal) voltage is detected coming from the external controller. If LED1 is not illuminated, then the HT Roaster Interface device will pass through all OEM control signals and will not permit external heater or fan control.

HTC devices detect the presence of an external controller through either the TC4C header or through the +5V and GND pins on the EXT cable connection header. HTShield devices detect the external controller directly through the Arduino stacking headers.

In addition to LED1, every device also provides a 2-pin header for the attachment of panel-mounted LED2. The firmware in the HT Roaster Interface device's MCU is programmed to illuminate LED2 any time the roaster's heater is on.

Appendix C - HTC Configuration & Connection Guide



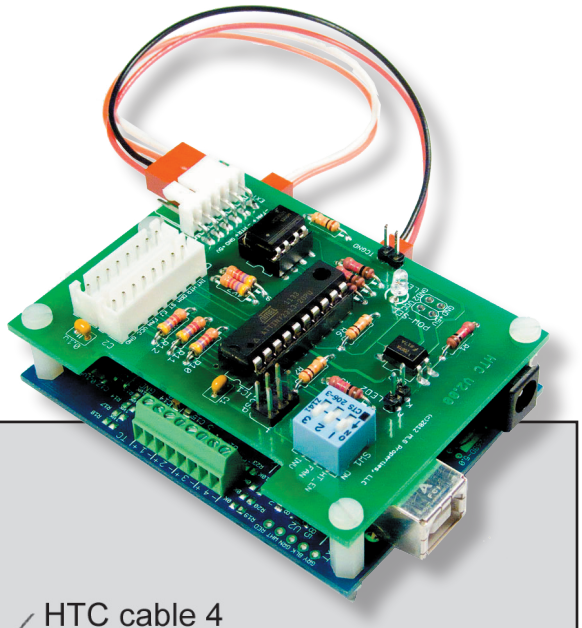
Fully Wire-Connected Configuration

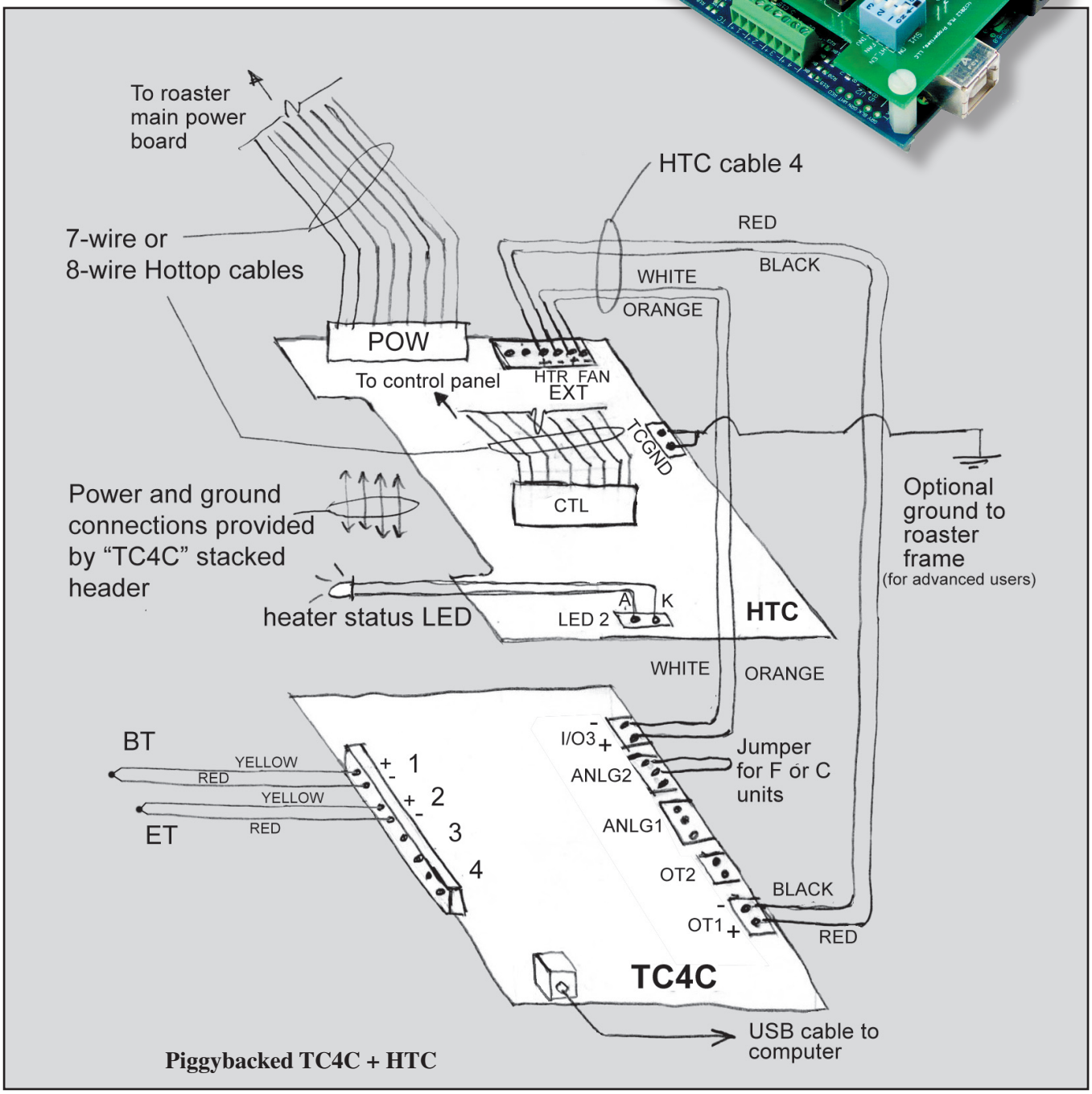
Mounting Option A: HTC as a standalone board

This mounting option uses a 6-wire cable to carry the necessary power, ground, fan control, and heater control signals from an Arduino/TC4 system or from a TC4C system to the HTC. The HTC may be mounted inside the roaster, or it may be mounted externally.

Mounting Option B: HTC piggybacked on to TC4C board

This mounting option uses a 4-wire cable to carry the necessary fan control and heater control signals from the TC4C system to the HTC. Compared to Mounting Option A, two fewer wires are required since the +5V and GND signals are provided directly by the stacking 4-pin header (labeled TC4C on the board).



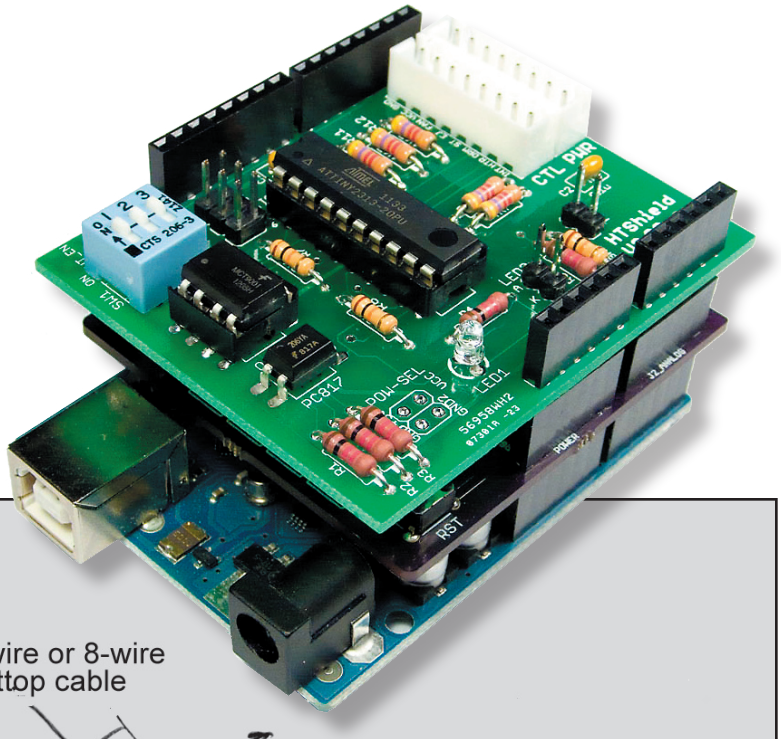


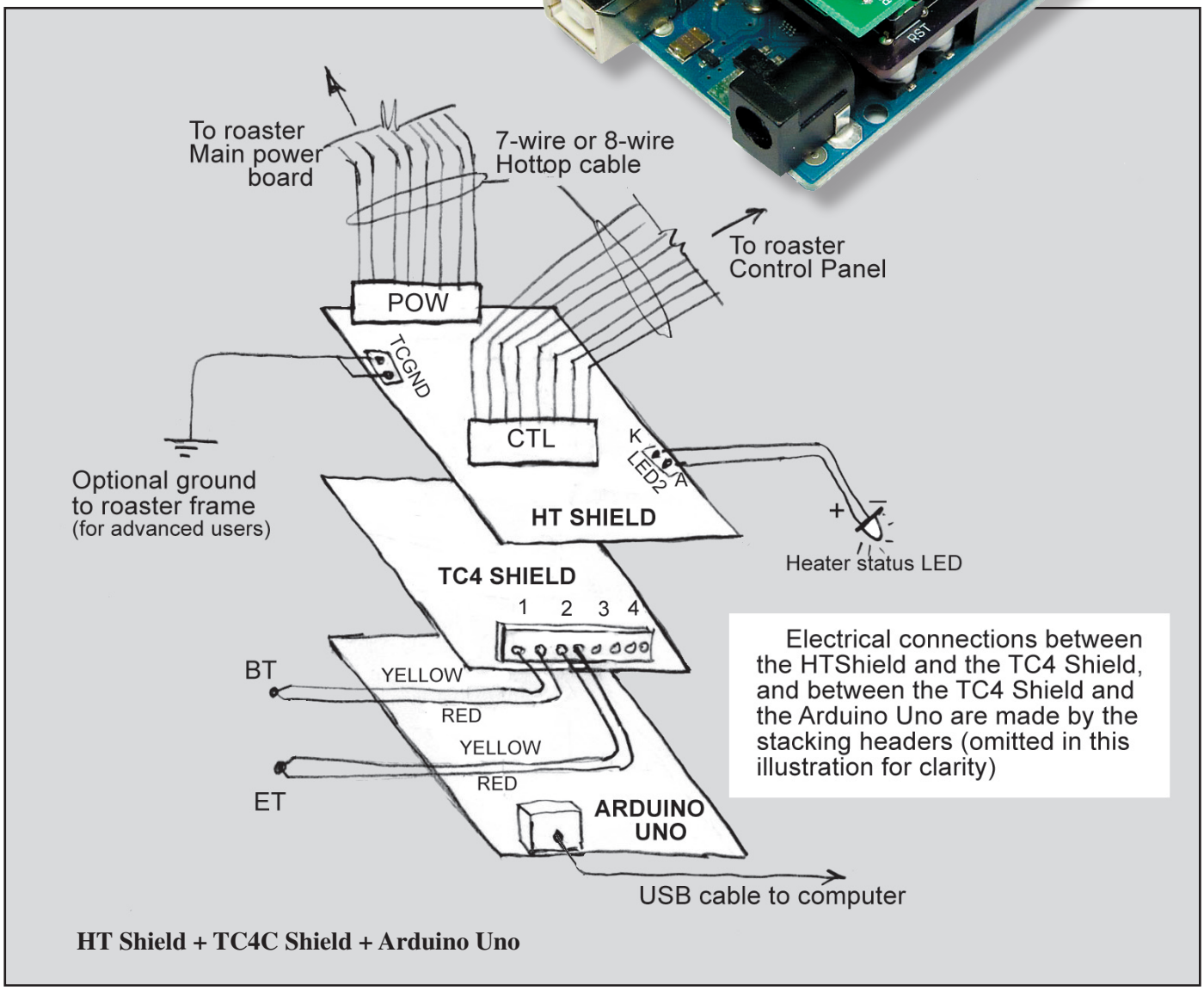
Piggybacked TC4C + HTC

HTC Board Components and Headers

Item	Hottop D	Hottop B	Hottop P	Comments
SW1 (3-pos dip switch)	HT_EN = OFF FAN = ON INVERT = OFF	HT_EN = ON FAN = ON INVERT = ON	HT_EN = OFF FAN = OFF INVERT = ON	Set FAN switch to OFF if external fan control is not desired (D and B only).
LED 2 (2-pin header)	Connector for remote LED to indicate heater status (1K series resistor provided on HTC board)	Connector for remote LED to indicate heater status (1K series resistor provided on HTC board)	Connector for remote LED to indicate heater status (1K series resistor provided on HTC board)	Use is optional, but *highly* recommended. LED 2 will illuminate when heater is receiving power.
ICSP (6-pin header)	In-circuit programming header for IC1	In-circuit programming header for IC1	In-circuit programming header for IC1	Advanced users only
LED 1	On when external control has been detected	On when external control has been detected	On when external control has been detected	This provides confirmation that the Arduino/TC4 or TC4C has been detected by the HTC interface.
TCGND (2-pin header)	Ties roaster ground to TC4 system ground	Ties roaster ground to TC4 system ground	Ties roaster ground to TC4 system ground	Optional. May be needed if grounded thermocouples are in use. Use with R-GND (see below)
R-GND	(see TCGND)	(see TCGND)	(see TCGND)	Optional. If used, values between 1K and 10K usually work. May also use a jumper here.
POW-SEL (4-pin header)	Supplies power to TC4 device from roaster	Supplies power to TC4 device from roaster	Supplies power to TC4 device from roaster	Optional. For advanced users.
CTL (8-pin header)	7-wire cable to Hottop OEM control panel	8-wire cable to Hottop OEM control panel	8-wire cable to Hottop OEM control panel	Note that polarities are different for the 7-wire cable vs the 8-wire cable.
PWR (8-pin header)	7-wire cable to Hottop OEM power board	8-wire cable to Hottop OEM power board	8-wire cable to Hottop OEM power board	Note that polarities are different for the 7-wire cable vs the 8-wire cable.
TC4C (4-pin header)	Stacking connector for TC4C	Stacking connector for TC4C	Stacking connector for TC4C	Optional for TC4C (Use with Mounting Option B). Not applicable to Arduino/TC4.
EXT (4-pin header)	4- or 6-wire cable connector to TC4C or Arduino/TC4.	4- or 6-wire cable connector to TC4C or Arduino/TC4.	4- or 6-wire cable connector to TC4C or Arduino/TC4.	Use 6-wire cable for Mounting Option A; use 4-wire for Mounting Option B (TC4C only).

Appendix D - Configuration and Connection Guide for HTShield





HT Shield + TC4C Shield + Arduino Uno

The HTShield+Arduino/TC4 shield combination is best mounted inside the roaster. However, use of custom length 7- or 8-wire Hottop cables would allow the HTShield+Arduino/TC4 shield combo to be mounted external to the roaster.

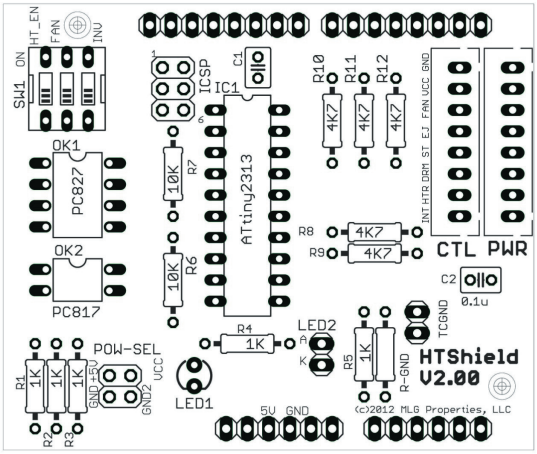


Figure 2 - HTShield board for B and P models

HTShield Components and Header

Item	Hottop D	Hottop B	Hottop P	Comments
SW1 (3-pos dip switch)	HT_EN = OFF FAN = ON INVERT = OFF	HT_EN = ON FAN = ON INVERT = ON	HT_EN = OFF FAN = OFF INVERT = ON	Set FAN switch to OFF if external fan control is not desired (D and B only).
LED 2 (2-pin header)	Connector for remote LED to indicate heater status (1K series resistor provided on HTShield board)	Connector for remote LED to indicate heater status (1K series resistor provided on HTShield board)	Connector for remote LED to indicate heater status (1K series resistor provided on HTShield board)	Use is optional, but *highly* recommended. LED 2 will illuminate when heater is receiving power.
ICSP (6-pin header)	In-circuit programming header for IC1	In-circuit programming header for IC1	In-circuit programming header for IC1	Advanced users only
LED 1	On when Arduino/TC4 has been detected	On when Arduino/TC4 has been detected	On when Arduino/TC4 has been detected	
TCGND (2-pin header)	Ties roaster ground to TC4 system ground	Ties roaster ground to TC4 system ground	Ties roaster ground to TC4 system ground	Optional. May be needed if grounded thermocouples are in use. Use with R-GND (see below)
R-GND	(see TCGND)	(see TCGND)	(see TCGND)	Optional. If used, values between 1K and 10K usually work. May also use a jumper here.
POW-SEL (4-pin header)	Supplies power to TC4 device from roaster	Supplies power to TC4 device from roaster	Supplies power to TC4 device from roaster	Optional. For advanced users.
CTL (8-pin header)	7-wire cable to Hottop OEM control panel	8-wire cable to Hottop OEM control panel	8-wire cable to Hottop OEM control panel	Note that polarities are different for the 7-wire cable vs the 8-wire cable.
PWR (8-pin header)	7-wire cable to Hottop OEM power board	8-wire cable to Hottop OEM power board	8-wire cable to Hottop OEM power board	Note that polarities are different for the 7-wire cable vs the 8-wire cable.

Appendix E - HTC/HTShield Switch Configuration for Hottop Roasters

Hottop Model	HT_EN Switch Setting	FAN Switch Setting	INVERT Switch Setting	OEM Program Setting	Safeguards	Cooling Between Back to Back Roasts	Comments
D	OFF	ON (see com-ments)	OFF	Max. time	1. HTRI monitors drum, stir, eject signals 2. OEM fusible link	Fully user-controlled through HTRI	Similar behavior if FAN switch set to OFF, except that fan is OEM-controlled.
B	ON	ON	ON	Max. time, 100% heat, 100% fan	1. HTRI monitors drum, stir, eject signals 2. Factory programmed safety points 3. OEM fusible link	User must control fan through HTRI; heater is OEM-controlled	May also be used for Hottop P models, but poor roast performance may result from the limitations of the OEM programming. This can result in turning the heater off during some segments and/or ending the roast prematurely on P roasters.
P	OFF	OFF	ON	Max. time, 0% fan	1. HTRI monitors drum, stir, eject signals 2. Factory programmed safety points 3. OEM fusible link	OEM-controlled (not changed by HTRI)	Special mode for Hottop P model roasters: HTC will force the heater to turn off any time the OEM controller enables the fan signal. May also be used for Hottop B model.

Mode	HT_EN	FAN	INVERT	Comments
0	OFF	OFF	OFF	Recommended for Hottop D model if user control of fan is *not* desired
1	OFF	OFF	ON	Special mode recommended for Hottop P roaster. May also be used for Hottop B model.
2	OFF	ON	OFF	Recommended for Hottop D model if user control of fan is desired
3	OFF	ON	ON	Recommended for advanced users with custom applications only!
4	ON	OFF	OFF	Recommended for advanced users with custom applications only!
5	ON	OFF	ON	Recommended for advanced users with custom applications only!
6	ON	ON	OFF	Recommended for advanced users with custom applications only!
7	ON	ON	ON	Recommended for Hottop B model. May also be used for Hottop P model, subject to limitations of OEM roast programs.

HT_EN switch:

ON = HTRI controller will enable heater ONLY when OEM controller has enabled heater
OFF = HTRI controller may enable heater whether or not OEM controller has enabled heater

FAN switch:

ON = user may control fan through HTRI during roast
OFF = fan is controlled by OEM controller at all times (all modes except mode 1)
OFF = In Mode 1 user control of fan through HTRI during roast; OEM fan signal causes heater to be turned off by HTRI

INVERT switch:

ON = OEM controller logic signals are inverted (1 = OFF, and 0 = ON)
OFF = OEM controller logic signals are not inverted (1 = ON, and 0 = OFF)