MachTach
Machine Tachometer

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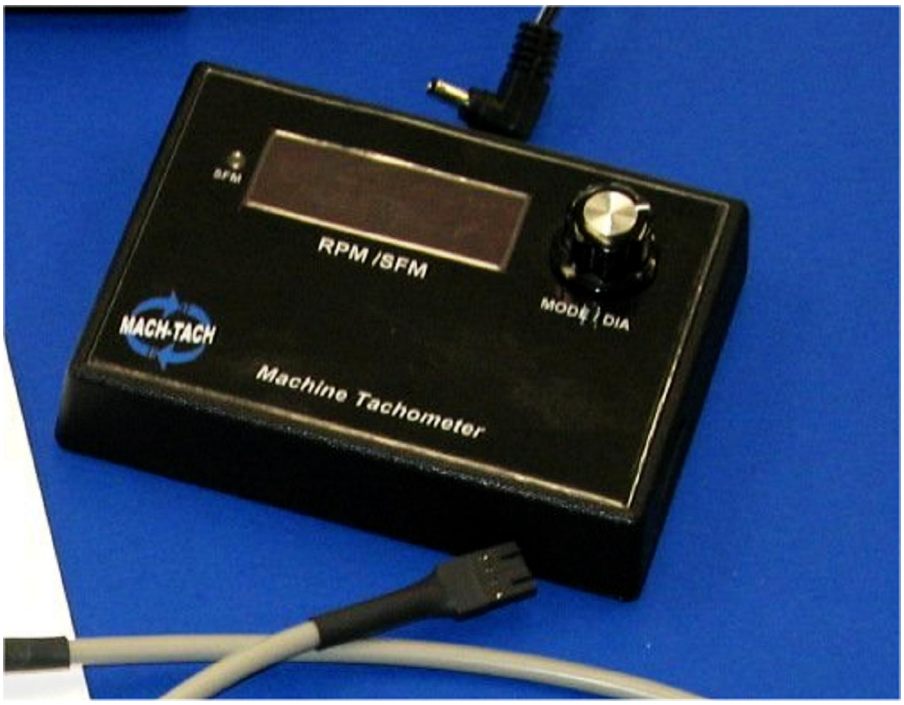
Rev 2.3/2.4 PCB 5-6-2011 Version 1.0
http://www.machtach.com

Overview

The MachTach is a machine tachometer which is used to display the speed of any machine tool. Machine speed is important because it determines how quickly you may remove material and fine the surface will be. Speed or surface feet per minute should be chosen based on the material, cutting tools to be used, and surface finish. The MachTach is capable of displaying either revolutions per minute (RPM) or surface feet per minute (SFM). It requires only a simple sensor to make its measurements.



Features:

Four Modes of Operation
- Revolutions per Minute mode - 0-9999 RPM
- Surface Feet per Minute mode - 0-9999 SFM
- Diameter Entry Mode for SFM - 0.1" - 99.9" (.1" increments)
- Slot Entry Mode - You can program any number of encoder slots/targets/magnets 1-60

1 second display update
Rotary encoder knob w/ push action switch for mode change and slot/diameter entry
The MachTach includes a socketed PIC microcontroller so it can be easily updated by replacing IC.
Four Module Configurations
- 3.3" x 2.75" x 0.5ò Bare Board that can be mounted in your own enclosure or Serpac SR031
- 3.3" x 1.375" x 1.0ò Bare Board turned into module that can be mounted in your enclosure
- Two 3.3" x 1.375" x 0.5ò boards which can be mounted separately with a 16 conductor cable connecting them
- 4.25ò x 2.75ò x 0.9ò Plastic Enclosure with laminated front panel

Slot and Diameter values are saved between sessions so they will not need to be re-entered
Power: 7-9V at ~ 200 ma

Example Installations

In its standard case the MachTach can be attached to any machine. Because of its small size, it is easy to mount it inside of your machine. Example internal installations are shown below. For restricted spaces the module can be cut in half and folded. For very tight installations, the display board and controller may be located in different spots within your machine and connected with wires or a ribbon cable.

Custom Installation on a Metal Lathe

Installation on a Wood Lathe

Custom Installation on a Milling Machine (half size module)

Using the MachTach

The MachTach powers up in RPM mode - turning the knob does nothing in this mode. Pushing the encoder knob switches back and forth between RPM and SFM modes. An LED at the left of the display indicates SFM mode In SFM mode, turning the knob automatically switches to diameter entry mode allowing the diameter 0.1" - 99.9" to be entered. Diameter entry mode exits automatically as soon as you stop turning the knob after a 1 second delay. Diameter mode exits back to SFM mode. In any mode, holding the knob in for greater than 5 seconds, puts the MachTach into slot entry mode. In slot entry mode, you can enter the number of slots 1-60 by turning the knob. The slot number is used to divide the pulse count to calculate RPM. You exit the slot mode by pushing the knob once. The slot entry mode is designed to not be entered easily since it should be needed only once when the MachTach is set up. Slot entry and diameter entry modes enter and exit differently. With slot entry mode, the user has to push the knob and hold it to enter the mode and again to confirm the number of slots which is permanently saved to EEPROM. With diameter entry mode, the user is able to turn the knob while the MachTach is displaying SFM without having to click to enter. This allows the user to continuously change the diameter on the fly by just turning the knob. When you stop turning the knob, it automatically switches to displaying SFM again. The diameter is saved each time you stop turning the knob and persists between power ups of the tach.

Setting the Slot Number

To set the initial number of slots, magnets, or reflective patches for your encoder, push in on the knob and hold it for greater than 5 seconds which will put it in slot entry mode. The center two digits will light up with a number like ñ01ò displayed and with no decimal place. Turn the knob to set the number of slots/magnets/targets to 1-60. Push the knob again to return. This will only need to be done once. The value you entered is stored in permanently until you enter a new number. This number is not lost when the MachTach is powered down. The slot number is used to for all calculations.

RPM is calculated using the following formula:

Revolutions per Minute:

RPM = (Number of pulses in one second x 60 seconds) / number of slots

Surface feet per minute is calculated using the formula:

SFM = (RPM x (diameter in tenths of inches) x 314) / 12000

Using the RPM Mode

The MachTach defaults to RPM mode when powered up. The SFM LED to the left of the display is off when in the RPM mode. In RPM mode, turning the knob will do nothing because the diameter does not matter for RPM calculations. Pressing the knob once will switch to SFM mode. Pressing the knob again will switch back to RPM mode.

Using the SFM Mode

To enter SFM mode, press the knob once and the SFM LED to the left of the display will be lit. In SFM display mode, turning the knob will set the diameter you want. Once you start turning the knob, the display will automatically switch to 3 digits with a decimal point (XX.X) which will allow you to set 0.1" through 99.9" as the diameter. Stop turning the knob and the display will automatically revert to SFM mode. Pushing the knob again will return to the RPM display mode which will be indicated by the SFM LED going out. In diameter entry mode turning the knob quickly will increase or decrease the diameter quickly while turning it slowly will change the diameter by tenths of inches.

Slot Entry Mode

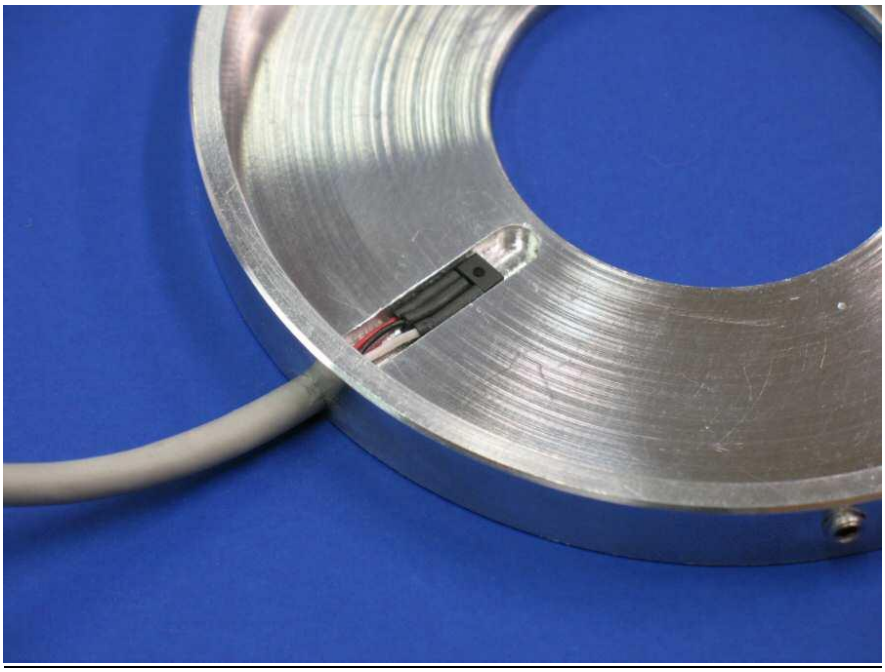
Pressing and holding the knob in for 5 seconds will enter the Slot Entry mode. This mode should only be needed once when you first set up your MachTach. Slot entry mode allows you to enter a number 01-60 which is the number of slots on your IR encoder wheel, or the number of magnets used with your Hall Effect sensor, or the number of black and white patches on your black target when using IR reflective sensors. The MachTach has not been tested with inductive type sensors but it should work. You would use slot mode to enter the number of gear teeth.

Using an Encoder Strip

The MachTach is supplied with a printed encoder strip. This strip can be cut to length and attached to almost any rotating object and used as a target for the reflective IR sensor. Once you install the strip, count the number of white spaces and enter that number into the slot entry mode of the MachTach. Mount the sensor close (about .15ò-.20ò) and you will be able to measure RPM and SFM. The kit also includes reflective tape which is of higher performance than the encoder strip. This tape can be cut into small patches and placed on a base of black electrical tape or flat black paint.

Using Hall Effect Sensors

The MachTach also works with Hall Effect sensors. If you make a cable and plan to use this sensor, install a jumper at the header labeled HALL. This will supply +5V to the sensor instead of the current limited voltage used for the IR LED. DO NOT use the MachTach with an IR type sensor with the HALL jumper in place. It will damage the IR LED with over current.



Hall Effect Sensor in its Housing

Hall Effect sensors are good for dirty environments where a reflective or slotted IR sensor might get fouled with oil or debris.

Assembling the MachTach *PCB Revision 2.3 & 2.4*

If you bought an assembled MachTach, please skip this section.

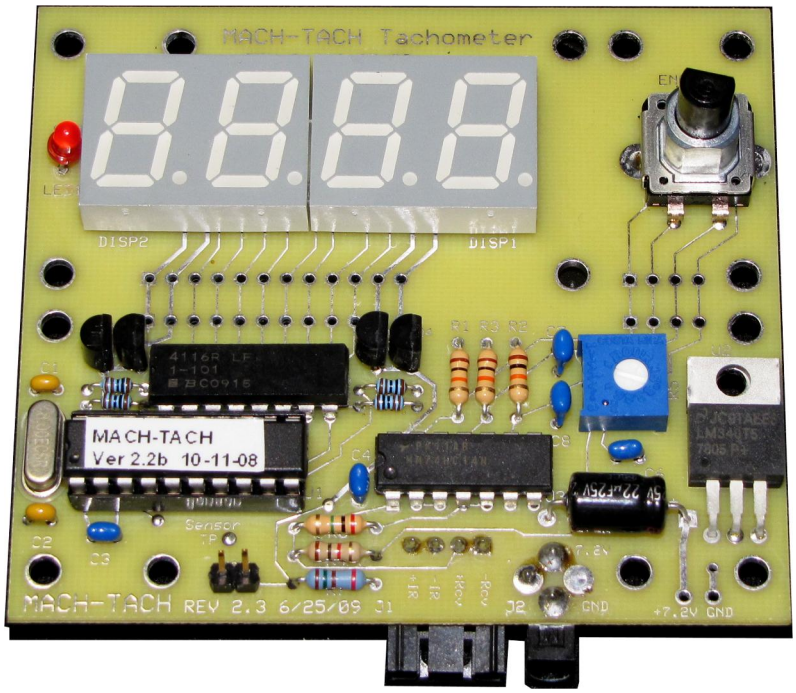
To assemble the MachTach PC board you will need the following tools:

Good Quality soldering iron with small tip
Needle nose pliers
Small diagonal cutters
Solder
Flux remover or appropriate cleaner
Old tooth brush

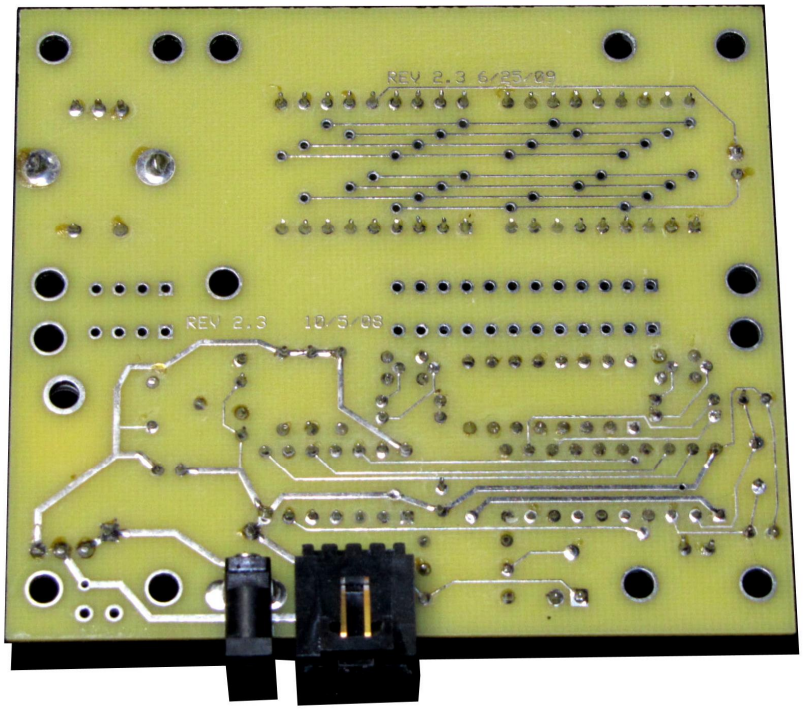
The following pages include a parts layout diagram, the schematic and the parts list to help you with placing parts. The parts layout diagram shows the top layer with the part designations and outlines. The board has no silk screen so be careful when installing parts to get them in the correct holes. Itôs a good idea to tack things in place until all parts are mounted and then solder all of the pins at once.

Note: Version 2.3 and 2.4 are virtually identical and use the same 2.2b software. The assembly pictures are also the same for both versions although the pictures show the version 2.3 PCB.

If your board has been cut in half, pay special attention to which side the parts go on. The ñMachTachò name is on the component side which faces out on each board. The solder sides face to the center of the stack. The cut and folded configuration requires 16 jumpers to make the connections that were PCB traces but were cut when the board was cut in half. Headers can be used for this connection but be warned that they are not flexible so it will be hard to access the back side of the boards. It may be better to use plain wire. The cut-offs from the resistors and capacitors work great for these jumpers.



The Completed MachTach PCB (V2.3 shown)



MachTach PCB Backside (V2.3 shown) – Backside Mounted Connectors

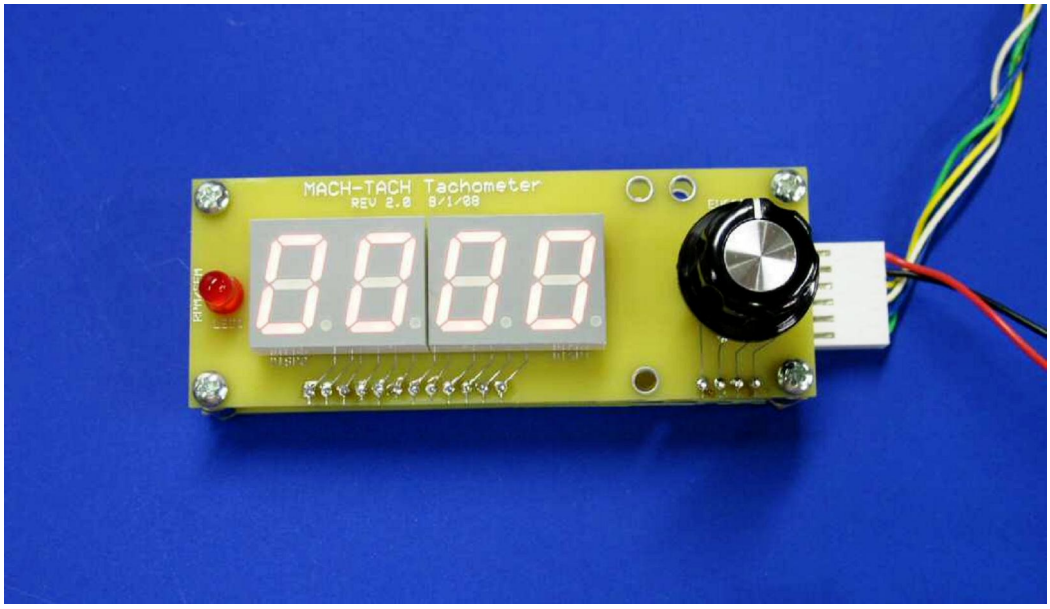
IMPORTANT NOTE:
If you are using the connectors for your sensor and the wall transformer jack, you may mount them on either side of the PCB. They should be mounted on the backside of the PCB if you plan to install the board in the Serpac SR31 enclosure. After mounting the connectors on one side or the other, make sure you use the correct diagram for your encoder cable wiring because the pin-out will be reversed if you mount the connectors on the top side of the board.

To assemble the PC board:

1. Install all the smaller parts like resistors and ceramic capacitors which are low to the board
2. Install the socket for U1, U3 the hex Schmidt Trigger, and the resistor network RN1.
3. Install the crystal, Y1. The crystal must be installed with the supplied insulator to avoid it shorting between the two pads. The insulator should be already on Y1.
4. Install R5, the hall header, and C5.
5. Install the two displays paying extra attention to make sure they go in with the decimal points towards the middle of the board and that they are aligned straight. Tack two pins first, check the alignment before soldering the rest of the pins.
6. For LED1, make sure the flat portion of the skirt is pointing in the direction shown on the layout which is towards the top edge of the board. The top of the LED should be level with the two displays and centered.
7. Install the four transistors Q1 ï Q4 as shown in the parts layout. Make sure that the tops of the transistors are level or lower than the displays. All parts should be the same height or lower than the two displays.
8. Install the regulator U2 first. The hole in the T220 Tab should line up with the hole in the PCB. You may add a screw to hold the tab to the PCB which is optional.
9. Install all remaining parts. Itôs best to install taller part like the displays and the encoder last.
10. If your board was delivered in a single un-split piece, do not fill the holes along the center with solder. Doing so will make it more difficult later if you decide to switch to the cut and folded half size configuration.
11. You will need to solder either wires or a connector at location J1 and J2 to connect the sensor and the power leads. The sensor and power connectors may be mounted on either side of the board but must be mounted on the back side for use with the standard Serpac SR31 plastic enclosure. If you decide to mount them on the top side, be sure to use the cable diagrams for the top side mounting where the pin outs are reversed from the back side mounting. You must wire your cable using the correct diagram for your connector mounting.
12. After the board is complete, use flux remover and toothbrush to clean it. Do this in a well-ventilated area. Clean and rinse the board three times.
13. Use compressed air to dry the board if available.
14. Install the microcontroller U1.
15. If you will be using the Hall Effect sensor, install the jumper on the HALL jumper header. **Do not install this jumper if you are using IR sensors. It will damage an IR sensor because it will apply 5V directly to the IR LED.**

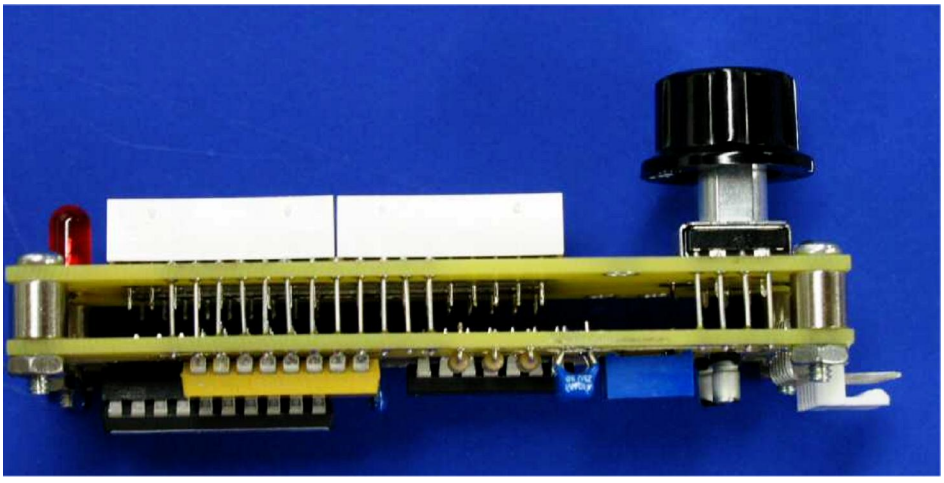
Assembling a Half Size Module

The MachTach PCB can be cut in half and assembled as a half size module. Cutting the boards disconnects 16 traces which are reconnected with jumpers as shown in the following pictures. The module will also need the supplied spacers to hold the boards apart.



Completed Half Size Module (older revision PCB with side connector)

A half size module may be built by cutting the board in half through the middle. Each side of the board is assembled the same as a full size module. The two boards are then mounted back to back using standoffs and then 16 connections jumper between the two boards.



Side View of a Completed Half Size Module

To jumper the module, just feed wire through all 16 pairs of holes and solder pads on both boards.

Powering Up the MachTach

The MachTach requires 7-9V DC for power. You may use the supplied DC wall transformer, a 9V battery, or other suitable DC supply. Be sure to get the polarity correct because there is no reverse polarity protection circuitry.

Checking Out the MachTach

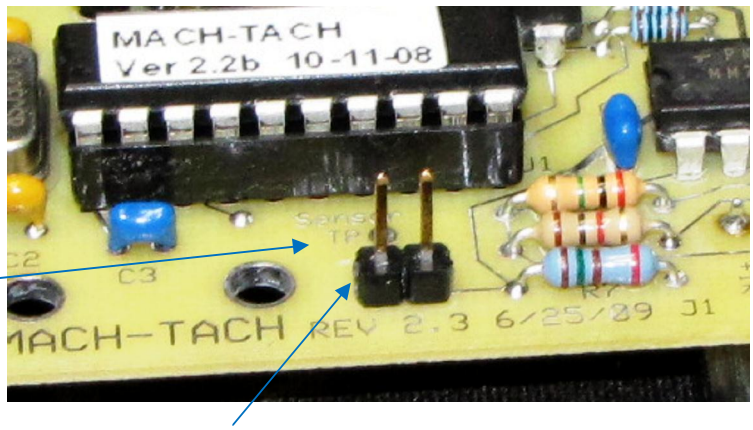
Once you power up the MachTach, it should display ñ0000ò and the SFM LED should be unlit. Try pressing the knob a few times and the SFM mode LED should go on an off. In SFM mode, try turning the knob. You should see the three left most digits light up with one decimal place. You should be able to enter diameters from 0.1ò through 99.9ò. Last, try holding the knob in for 5 seconds to see if can enter the Slot Entry mode.

Adjusting the MachTach

Once youôve checked the basic operation of the MachTach, you may connect a sensor.
<u>The following adjustment procedure is important for the correct operation of the MachTach.</u>

For IR sensors, refer to the schematic for sensor hook-up or the section on assembling the sensor cables. Set the R5 trim pot to mid position and wire up the sensor as shown. You will need a DVM to accomplish this task. Place the negative probe on the lower right hand pin labeled ñGNDò and the positive probe on the test point labeled ñSensor TPò which is near the controller. Set R5 fully counter clockwise. Once youôve powered it up, point the sensor at your planned dark and light patches or your slots and adjust the R5 trim pot so that the light or open slot gives you less than 1V out and with a dark spot or obstructed slot gives you greater than 4.0V. Make sure you are at the specified distance away which is 0.15 inches for the supplied IR sensor. You should be able to achieve these voltages with the supplied sensor. If you are using your own sensor and you canôt achieve these numbers by turning the pot, you will need to examine the values of R4 and R7 and select values that are appropriate for your sensorôs current range. For the supplied IR reflective sensor, R5 will usually be at about midpoint for the best setting.

If you are attaching a Hall Effect sensor which requires 5V power, GND, and the transistor output, insert a jumper at the header labeled HALL. This will make +5V available to pin 3 of the connector or pad if you arenôt using a connector. The adjustment of R5 is the same except that you will be using your magnet to check the on and off states. For the suggested Hall Effect sensor, setting R5 fully clockwise works best. If you canôt get lower than about 1V and higher than 4.0V you will need to check the data sheet for your sensor to see what current is recommended for your sensors output stage.



Sensor TP

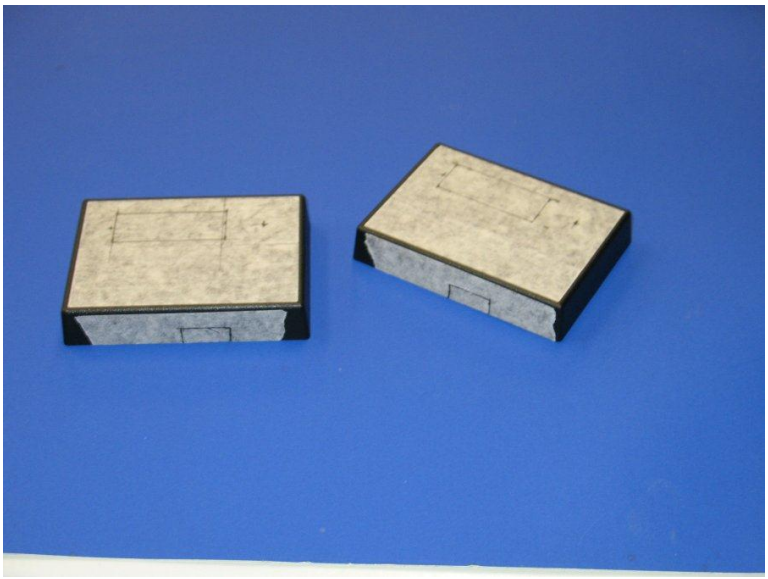
Hall Effect Sensor Jumper

Modifying the SR031 Enclosure

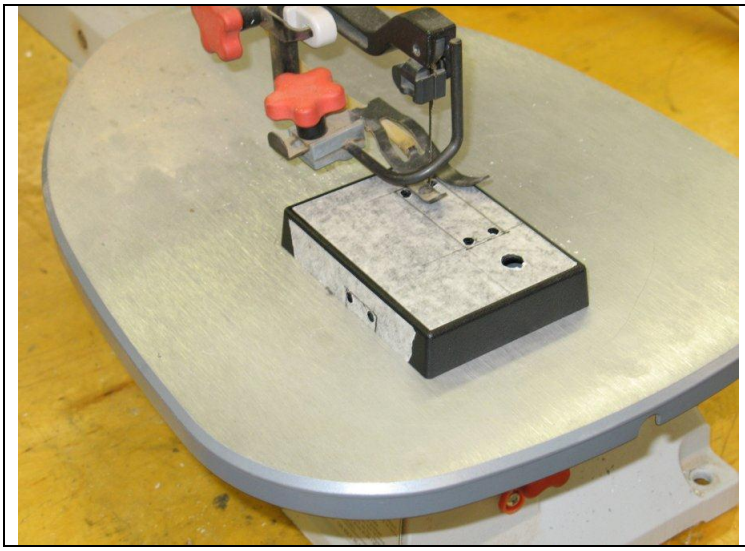
If you bought a kit, the plastic enclosure may have been included and needs to be modified for the MachTach PCB to fit within it. At the end of this document is a layout of the needed panel holes. Fill the recessed panel area with masking tape and transfer the layout to the tape. As an Alternative you may print the layout to sticky back paper and stick it within the recessed area of the box.

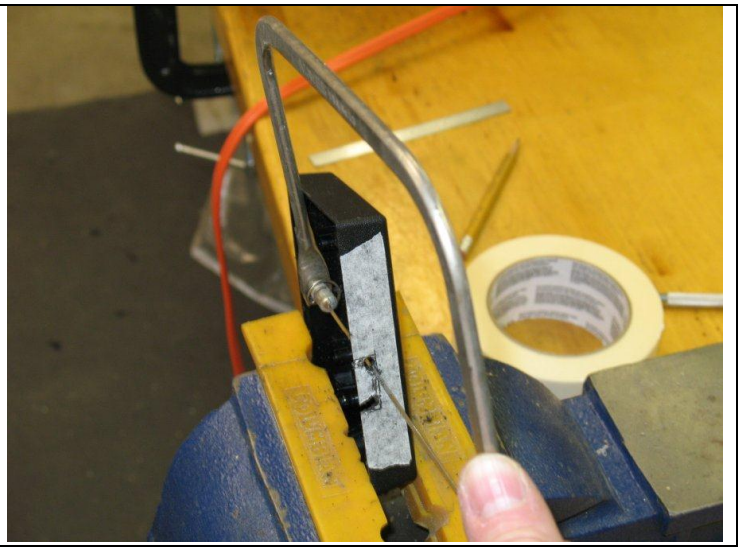
Drill a 3/8ò hole for the encoder and a .3/16ò hole for the LED first. Drill holes in the corners of the display and connector areas and use either a jigsaw or coping saw to carefully cut out this area. It is best to not cut right to the line but to use a file to bring the opening to the line.

The square hole for the sensor connector and power jack can also be marked by dropping the board into the enclosure and marking where the connectors hit. Cut a recess there to clear the connectors. The bottom lid will also need to be slightly notched just on the lip that fits into the bottom of the case.

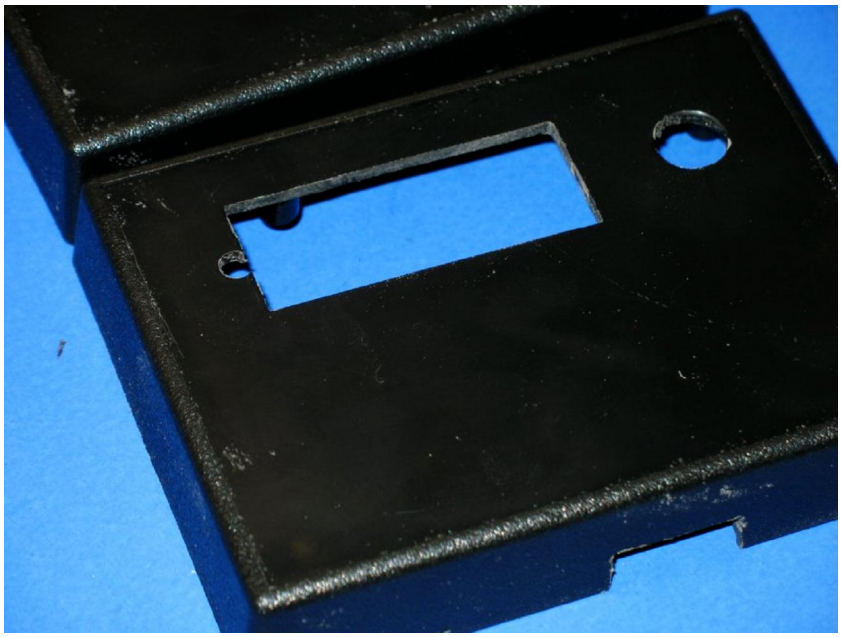


Plastic Enclosures with Masking Tape and Layout Lines

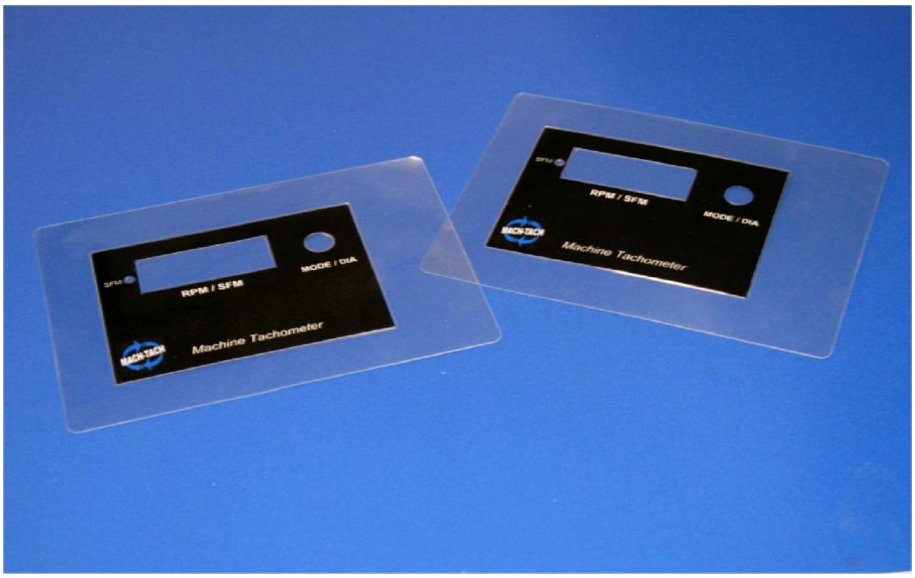




Cutting the Holes with a Jigsaw and Coping Saw



The Completed Enclosure Holes



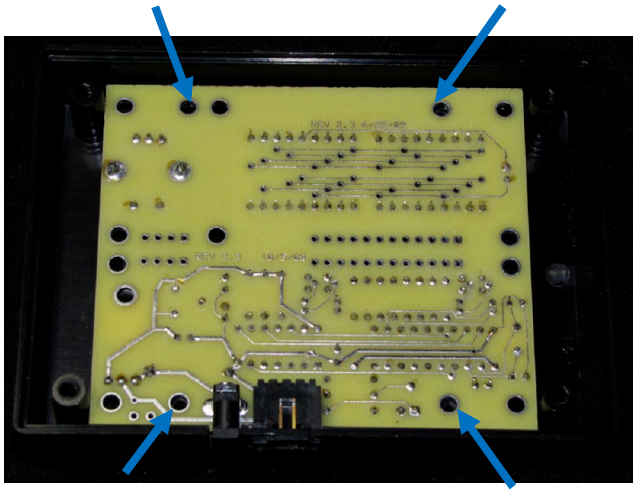
Laminated Plastic Front Panels

The plastic panel comes with excess plastic ears. These must be trimmed off to fit the recess of the enclosure. You must also provide a 3/8ò hole for the encoder shaft to stick through. This can be created either with a gasket punch or by carefully cutting the hole with a Xacto knife. The plastic panel can be mounted to the enclosure in one of two ways. You may use either double sided tape which is available in any drug store or you may use contact cement. Clean the enclosure recess and back of the plastic panel with rubbing alcohol. Fill the recessed area with double sided tape but do not overlap it or cover your display, LED, or encoder holes. Filling the area assures that the panel will not be loose in the middle.

Press the panel in place smoothing it firmly throughout the surface. The use of double sided tape is very effective. Iôve tried to remove a panel after installing it and it is impossible without ruining the panel.

Installing the MachTach PCB in the SR31 Enclosure

The MachTach PCB drops into the SR31 enclosure and can be screwed in place using self-tapping screws to posts within the enclosure indicated with the arrows. The connectors poke out from the bottom edge of the enclosure.

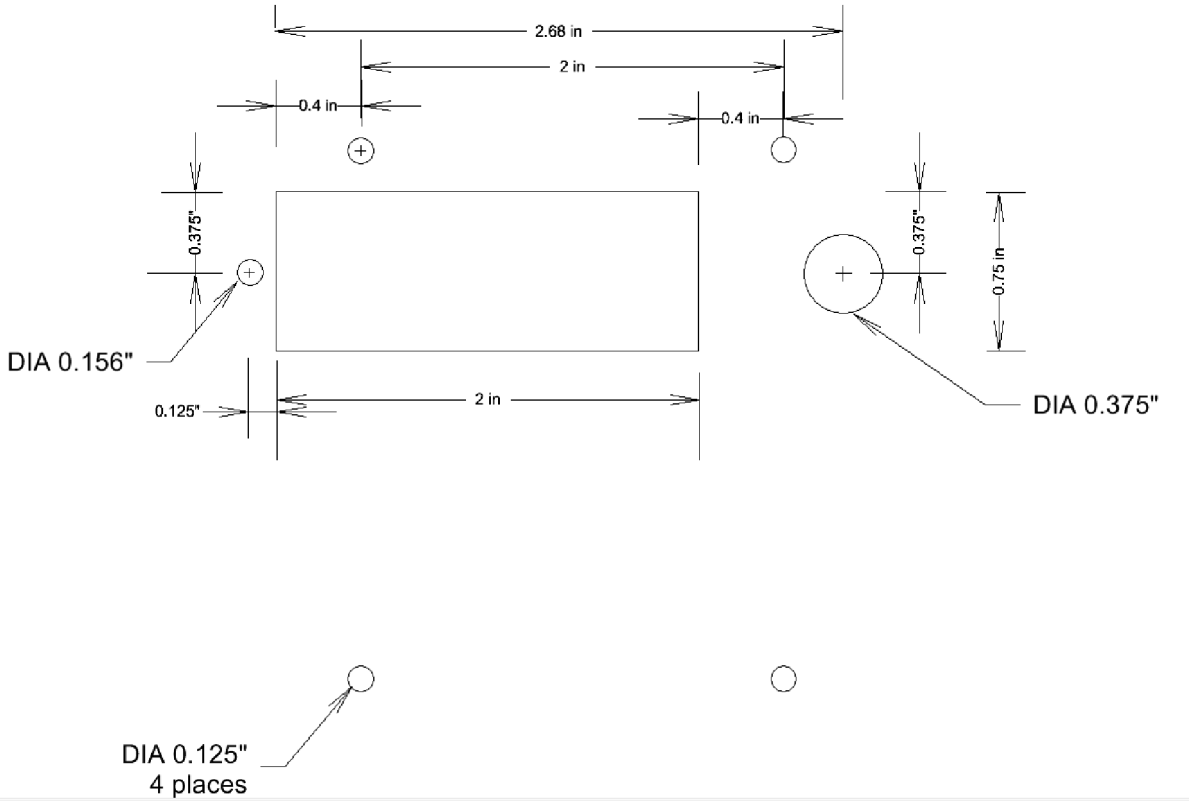


MachTach PCB Mounted inside Serpac SR31 Enclosure

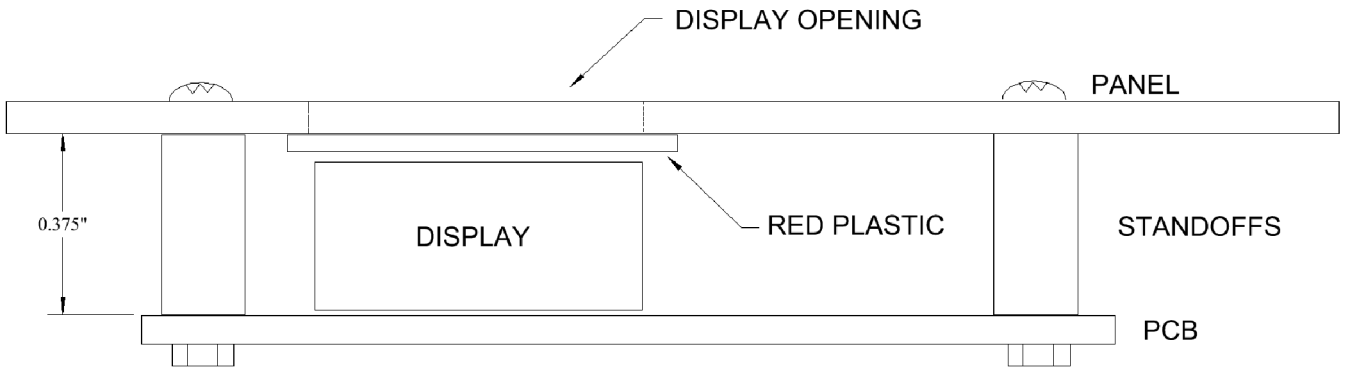
Completed MachTach in Enclosure

Installing the MachTach in Your Own Panel

If you decide to install the MachTach in your own enclosure or panel, use the following diagram to drill the holes and make the display window. The display opening is 2.0ò x 0.75ò. Add the 0.125ò mounting holes as shown. Add the 0.375ò hole for the control and the 0.156ò hole for the LED. Both of these holes are on the center line of the display.



Panel Layout Diagram



The MachTach may be mounted on 0.375ò standoffs using 4-40 screws. The display will be clearer if you mount a piece of translucent red plastic behind the opening. The red display plastic window should be attached to the back side of the panel with a little glue in the corners. You may also make the red plastic window flush by cutting it the same size as your panel opening and gluing it in place from the back. The standoffs can be as short as 0.3125ò for a flush installation.

Making the Sensor Cables

IMPORTANT: There are different diagrams depending on whether you installed your sensor connector on the front side or back side of the board. Be sure to select the correct diagram. If you mount your connector on the top side of the board with the other components, the numbering is reversed from a back side mounting. Use the supplied pin out tables to make sure you have the correct wiring.

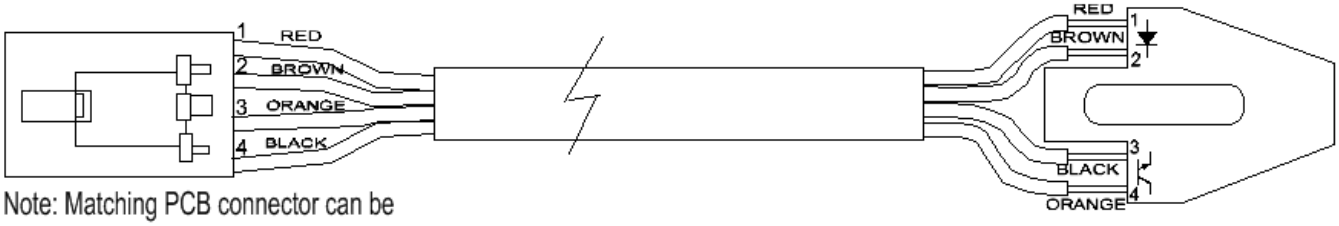
Making the IR Sensor Cable

Cut your cable to the desired length and strip the outer covering to reveal the wires. A length of 36ò is usually good. Slide two pieces of 3/8ò shrink wrap over the cable which will be used to protect the connector and the sensor. Slide the 1/8ò shrink warp over each of the wires which will connect to the sensor. Using needle nose pliers, make a small loop on each lead of the sensor. Solder each wire as shown in either the pictorial or table.

Diagrams for Connector Mounted on Backside of PCB

Conn Pin Number	Name	IR Sensor Pin Number	Suggested Wire Color
4	RCV Output -	3	Black
3	RCV Output +	4	Orange
2	IR LED -	2	Brown
1	IR LED +	1	Red

IR Reflective Sensor Wiring Table
CONNECTOR ON BACKSIDE OF PCB



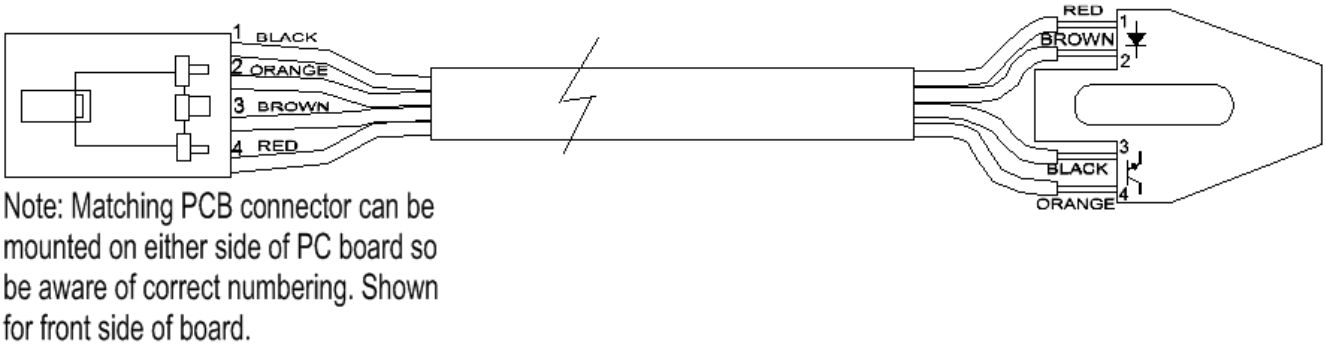
Note: Matching PCB connector can be mounted on either side of PC board so be aware of correct numbering. Shown for back side of board.

Pictorial Wiring Diagram for IR Reflective Sensor Cable –
CONNECTOR MOUNTED ON BACKSIDE OF PCB

Diagrams for Front Side Mounted PCB Connector

Conn Pin Number	Name	IR Sensor Pin Number	Suggested Wire Color
1	RCV Output -	3	Black
2	RCV Output +	4	Orange
3	IR LED -	2	Brown
4	IR LED +	1	Red

IR Reflective Sensor Wiring Table
CONNECTOR MOUNTED ON FRONTSIDE OF PCB



Note: Matching PCB connector can be mounted on either side of PC board so be aware of correct numbering. Shown for front side of board.

Pictorial Wiring Diagram for IR Reflective Sensor Cable –
CONNECTOR MOUNTED ON FRONTSIDE OF PCB

Slide the 1/8ò shrink wrap over each connection and shrink it using either a heat gun. Using either a crimping tool or needle nose pliers attach the connector pins to the other end of the cable. Using the diagrams push the pins into the connector housing in the correct order. Place the large 3/8ò shrink wrap over the end of the sensor but not over the slot and over the back end of the connector. Using a heat gun shrink the wrap into place.

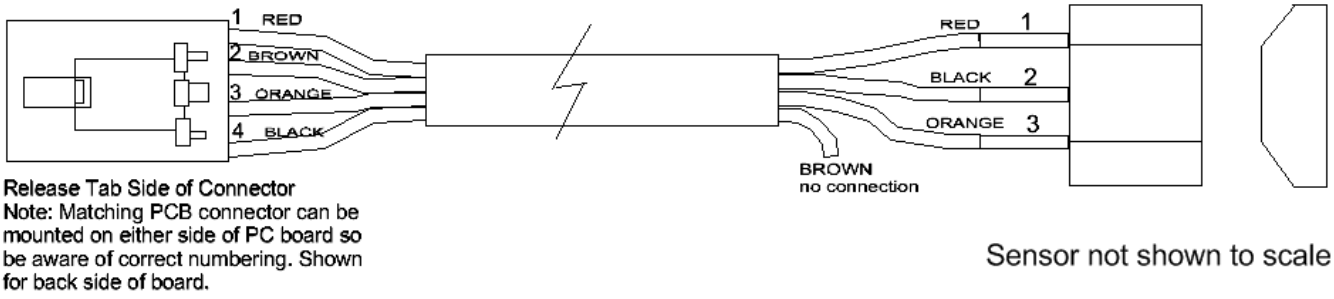
Making the Hall Effect Sensor Cable

Cut your cable to the desired length and strip the outer covering to reveal the wires. Slide one piece of 3/8ò shrink wrap over the cable which will be used to protect the connector. Slide three pieces of the 1/8ò shrink warp over each of the wires which will connect to the sensor. Using needle nose pliers, make a small loop on each lead of the sensor. Solder each wire as shown in either the pictorial or table.

Diagrams for Backside Mounted PCB Connector

Conn Pin Number	Name	Sensor Pin Number	Suggested Wire Color
4	Gnd	2	Black
3	Hall Out	3	Orange
2			Brown
1	Vcc	1	Red

Hall Effect Sensor Wiring Table
CONNECTOR MOUNTED ON BACKSIDE OF PCB

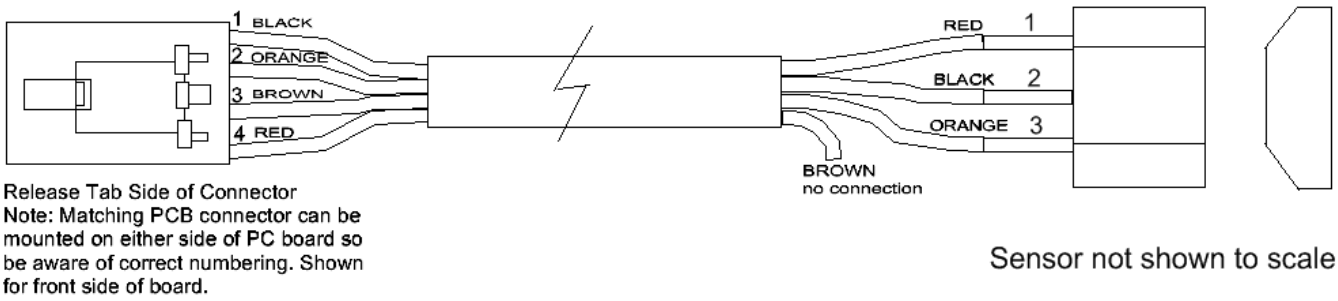


Pictorial Wiring Diagram for Hall Effect Sensor Cable
CONNECTOR MOUNTED ON BACKSIDE OF PCB

Diagrams for Front Side Mounted PCB Connector

Conn Pin Number	Name	Sensor Pin Number	Suggested Wire Color
1	Gnd	2	Black
2	Hall Out	3	Orange
3			Brown
4	Vcc	1	Red

Hall Effect Sensor Wiring Table
CONNECTOR MOUNTED ON FRONTSIDE OF PCB



Pictorial Wiring Diagram for Hall Effect Sensor Cable
CONNECTOR MOUNTED ON FRONTSIDE OF PCB

Slide the 1/8ò shrink wrap over each connection and shrink it using either a heat gun. Using either a crimping tool or needle nose pliers attach the connector pins to the other end of the cable. Using the diagrams push the pins into the connector housing. Place the large 3/8ò shrink wrap over the end of the connector. Using a heat gun shrink the wrap into place.

Making a Plastic Front Panel

You may have noticed that many of the installations shown is this document include a plastic panel with lettering. These panels are made by creating color artwork of the panel and then laminating with an office plastic laminator. Below is the one I use which can be purchased from Harbor Freight for $30. The part number is 92499. I do not recommend Harbor Freight lamination sheets. I suggest that you use Scotch brand plastic laminating pouches. Product TP5902-20. The plastic panels made with this process are very sturdy, impervious to oil and grease and look reasonably professional. They aslo create a clear plastic window that is integral to the panel.

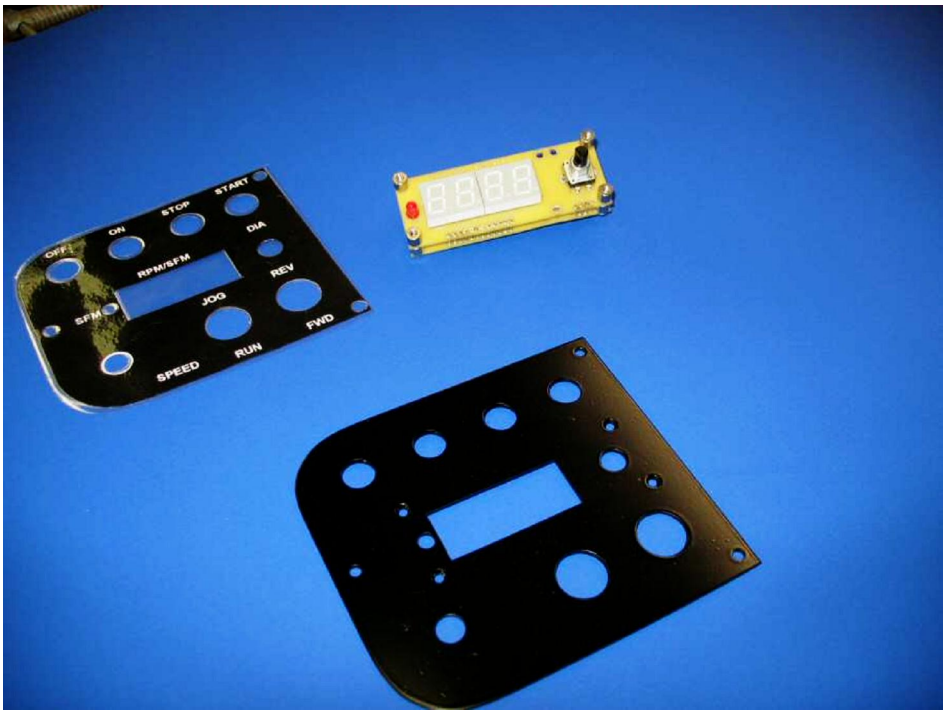
Plastic Laminator – Harbor Freight 92499

Example Plastic Laminated Panel

Here are a few tips on how to make a plastic laminated panel:

- Create your artwork and print it on quality thick photo paper. I use Paint Shop Pro but any photo editor will work.
- Make extra panels because not all of them will come out
- Cut out the overall panel, the display window, the LED hole, and the knob hole with a new Xacto knife.
- After you cut the panel from the photo sheet, color the edges of the paper with a black felt pin to avoid white edges. I color the display area and outside edges. This is cosmetic step but it does make the panel look nice.
- Heat the laminator up for 20 minutes to assure that it is of a uniform temperature
- Make sure your photo paper panel is clean and place it in the lamination pocket
- Run it through the laminator and immediately place it inside a heavy book to allow it to cool flat. I have had good luck running the pouch through bare. I do not use any carrier or paper around the laminate pouch.
- The panel will have clear windows over the display area, the knob hole and the LED hole. Leave the Display window and LED hole plastic in place. Trim a round 3/8ò hole where the knob hole is but leave some plastic so that the panel is still sealed.
- Trim the outside edges at the plastic but not to the paper so that the paper is still sealed in plastic.

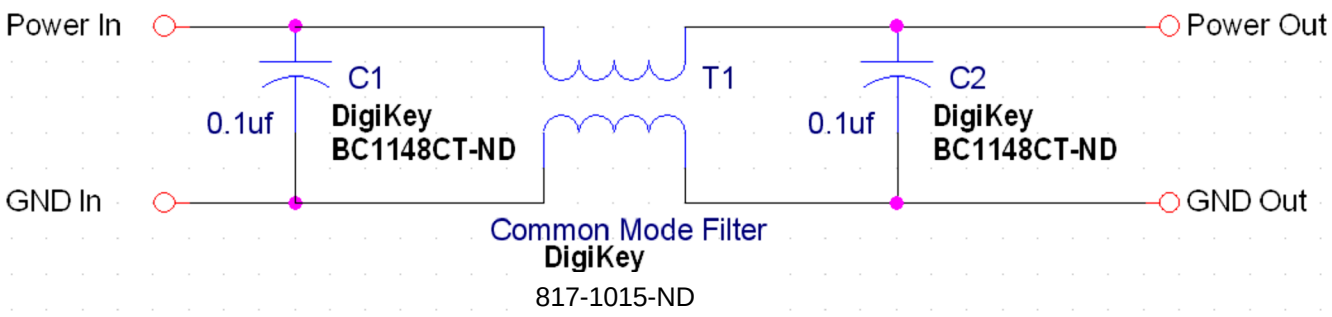
The panel can be attached using either contact cement or double sided tape. Make sure the tape or glue does not obscure the window or LED.



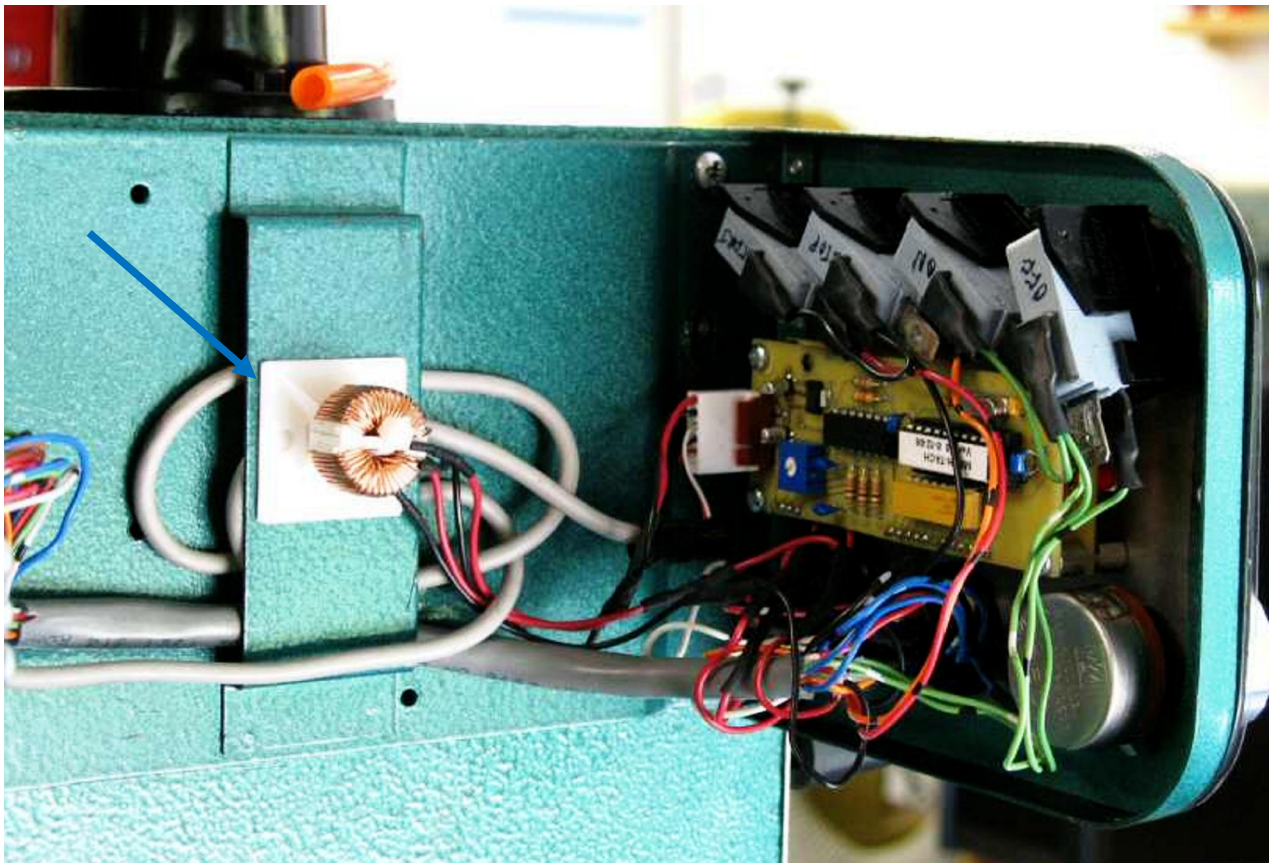
Another Example Plastic Panel

Using the MachTach with a VFD Powered Machine

If your machine tool uses a VFD motor speed control, you will probably need a power filter for the MachTach. This filter removes noise on the power line caused by the VFD. The symptoms of noisy power are a MachTach display that fluctuates or has very high RPM readings. The following schematic including part numbers should be added to the input power of MachTach. One easy way to determine if VFD noise is causing bad readings is to power the MachTach with a 9V battery. If the MachTach operates correctly with the battery but not with your wall transformer, then you will need this circuit.



Power Filter Circuit



Common Mode Filter installed on Milling Machine with VFD

Troubleshooting

You may find that after assembly the MachTach that it does not work. Here are some tips to get it going:

No Display

Recheck all of your soldering. It is easy to miss soldering a joint or to have a cold joint. Check that you have 7-9V coming into the board in the lower right corner. Check that 5V appears at pin 1 of the MachTach IC as referenced to the GND pin in the lower right corner.

Nothing happens when you push the knob or turn it

Check that 5V appears at pin 14 of U3. Make sure that R1, R2, R3 have 5V on one pin. With a DVM connected to GND at the lower right corner and pins 9 and 11 of U3, make sure that as you turn the knob you see the voltage switching from approximately zero to 5V. Do the same at pins 8 and 10 of U3. With a DVM connected to GND at the lower right corner and pins 13 of U3, make sure that as you push the knob you see the voltage switching from approximately zero to 5V. Do the same at pin 12 of U3.

Display reads all zeroes but no RPM

Recheck your sensor wiring. This is easy place to make a mistake.
Check that 5V appears at pin 14 of U3. With a DVM at Sensor TP, turn your machine to activate the sensor slowly. Do this by hand if possible. Make sure that Sensor TP is switching between less than 1 V and greater than 4 V. If you find this is OK, check for the same at pins 2, 4, and 6 of U3. Check for switching between less than 1 V and greater than 4 V at pin 17 of the MachTach IC (pin 17)

Erratic results

If your RPM display is erratic, check the distance of the sensor. Check the wiring of the cable. Try operating the MachTach with a 9V battery. If it works normally, your power has noise possibly from a VFD or other noise in your shop environment. Install a common mode filter described in an earlier section.

Wrong RPM

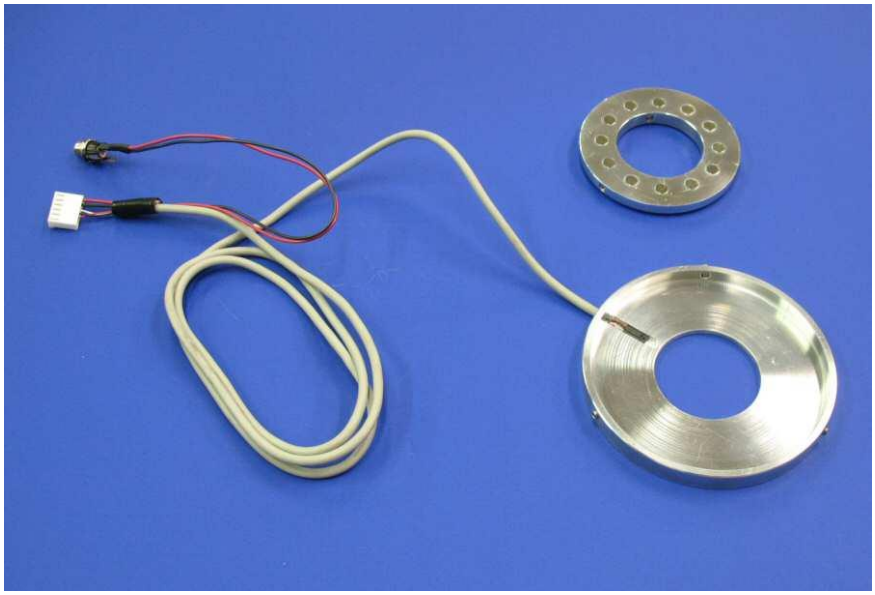
Recheck that you have entered the correct number of slots/patches/magnets. Try running from a 9V battery. If it works correctly, add the filter described earlier in this manual. Make sure your sensor is the correct distance from the target. If you are reading double the expected RPM with a Hall Effect sensor, enter twice the number for the magnets. Hall Effect sensors can see double the number of flux changes when the magnets are close together.

Most MachTach Problems are caused by a missed or cold solder joint or a bad or miss wired cable. Erratic operation is usually caused by a misadjusted sensor or noise from a VFD or other source.

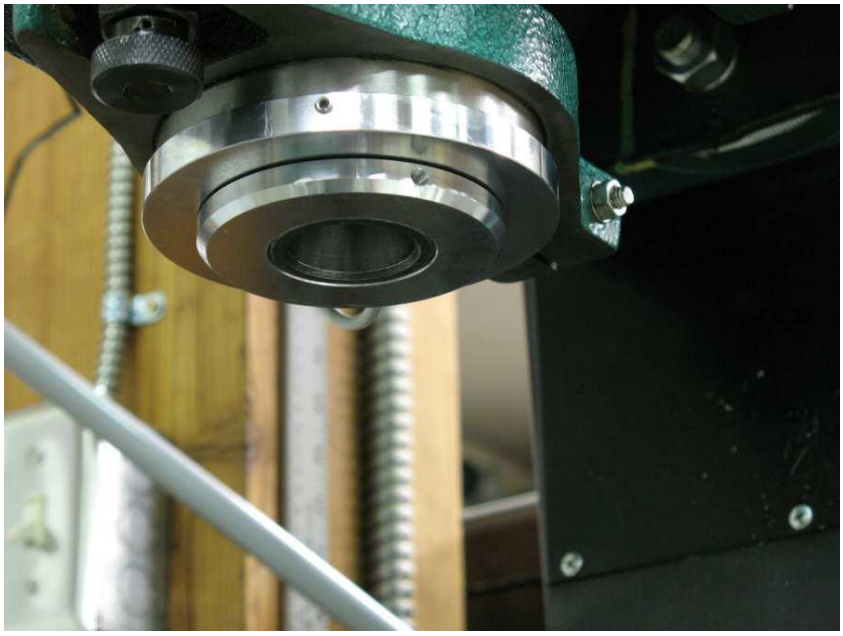
Sensor Selection

The MachTach will work with many types of sensors including IR reflective, IR slotted Hall Effect, and probably others. The question is which one is best for your machine. Here are a few suggestions on selecting a sensor:

Hall Effect Sensors are good in a harsh environment where there is dust oil or other liquids. I used a Hall Effect sensor on my milling machine because I wanted to sense the spindle speed which is near where cutting oil or debris might hit it. I still enclosed it in an enclosure which protects it but it would have been more difficult to mount an IR sensor in the same location

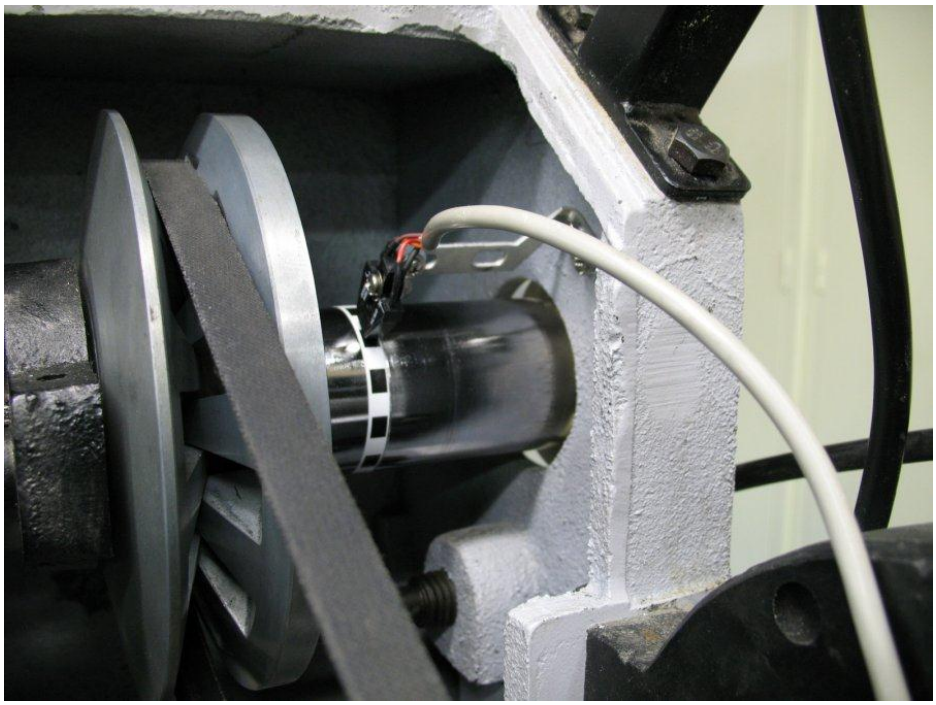


Hall Effect Sensor for Bench Top Milling Machine

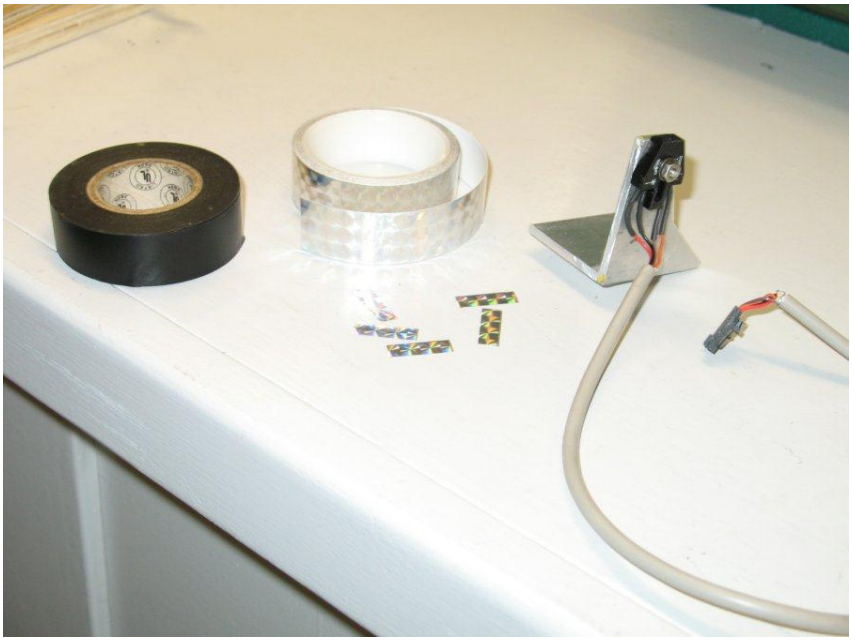


Hall Effect Sensor Installed on Bench Top Milling Machine

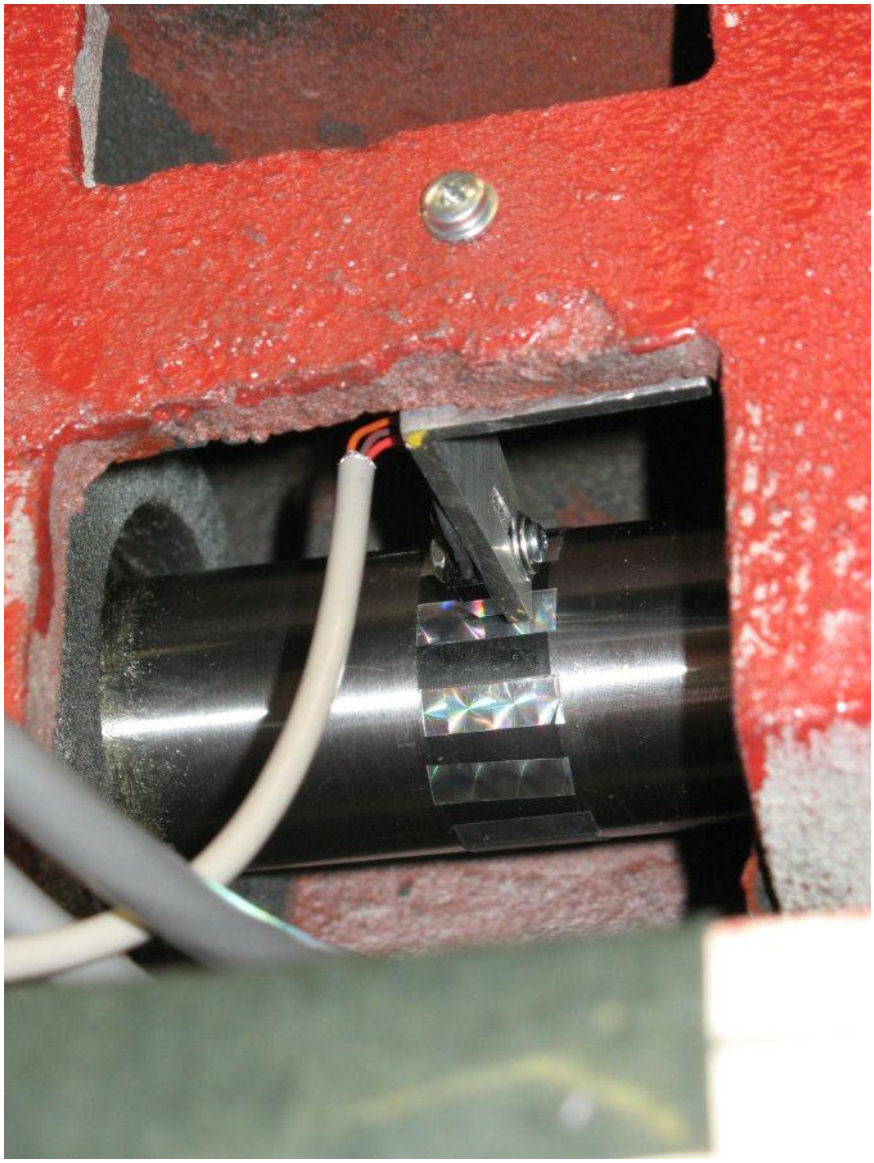
IR Reflective Sensors work well in relatively clean environment where dust will not affect their operation. They are easy to install using a simple bracket and reflective tape on a dark background. I have used IR reflective sensors inside of machine boxes which do not have oil spray or dust entering the enclosure.



IR Reflective Sensor Installation inside the Head of a Wood Lathe – Uses L Bracket



Example IR Reflective Bracket Mounting and Tape Patches



IR Reflective Sensor inside of Head of Metal Lathe

Slotted IR Sensors are good where you can drill some small holes in an existing flange or pulley. For example, Iôve seen people drill small holes in the edge of a pulley. Slotted sensors can also be used with a small slotted wheel mounted on the end of a shaft or spindle. Some people add these to a lathe spindle inside the pulley/gear box of the lathe.

Other Sensors ï The MachTach is designed to use any sensor with a transistor output. It is able to supply 5V to the sensor and it can also accept a 0-5V input signal. Almost all sensors fit these requirements. The MachTach is able to deal with noisy signals because it has a noise conditioning front end with hysteresis. There are sensors which can detect gear teeth. As long as the selected sensor has a transistor output that can swing at least 1-4V, it will probably work with the MachTach.

Suggested SFM Settings for Various Materials

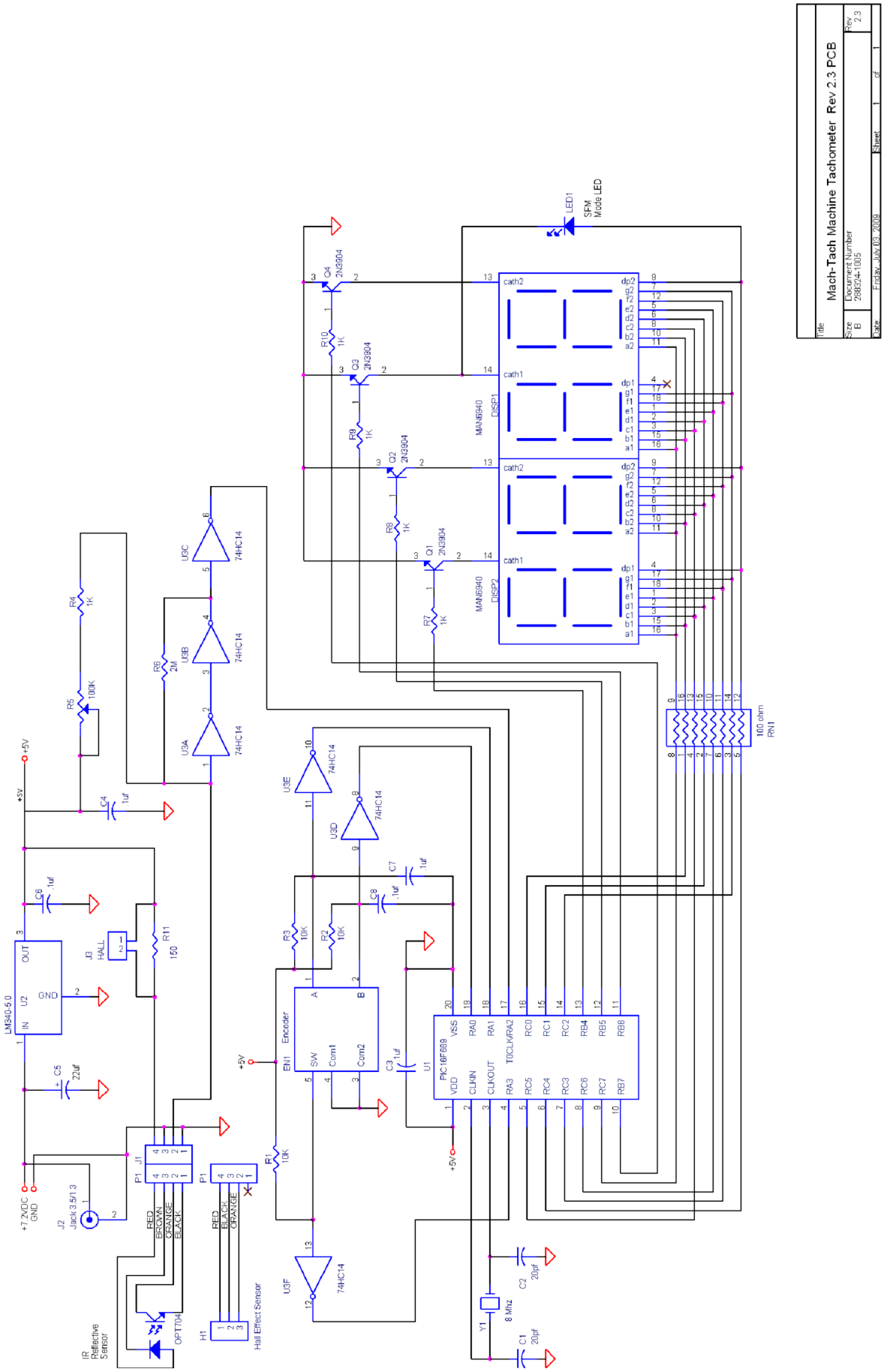
The reason for being concerned about RPMs and SFMs is that for certain materials, speed of material removal and desired finish the speed is important. You might say that you are satisfied to go slow but in some cases going too slow can cause problems like work hardening on stainless steel or poor surface finish on aluminum. Aluminum machines cleaner at the appropriate speed. Just knowing the speed is not enough because larger diameter work or tools cause higher speeds than small diameter work or tools. This is why we need to know how many surface feet per minute are being used. The following table lists the suggested SFM values for various materials. Many types of tooling whether carbide or high speed steel have suggested SFM values for best results.

MATERIAL (HSS tool)	SFM
Soft Aluminum	300
Copper	200
Yellow Brass	100
Mild Steel (leaded)	125
Steel, mild	100
Steel, Alloy 4XXX	90
Tool Steel unhardened	80
Malleable Cast Iron	80
Grey Iron Cast	60
Cast Steel	50
Titanium	25
The following multipliers can be used with the above information for other cutting tool materials:	
Cobalt steel tools 1.2	
Carbide inserted tools 2 to 3.5 depending on coating	

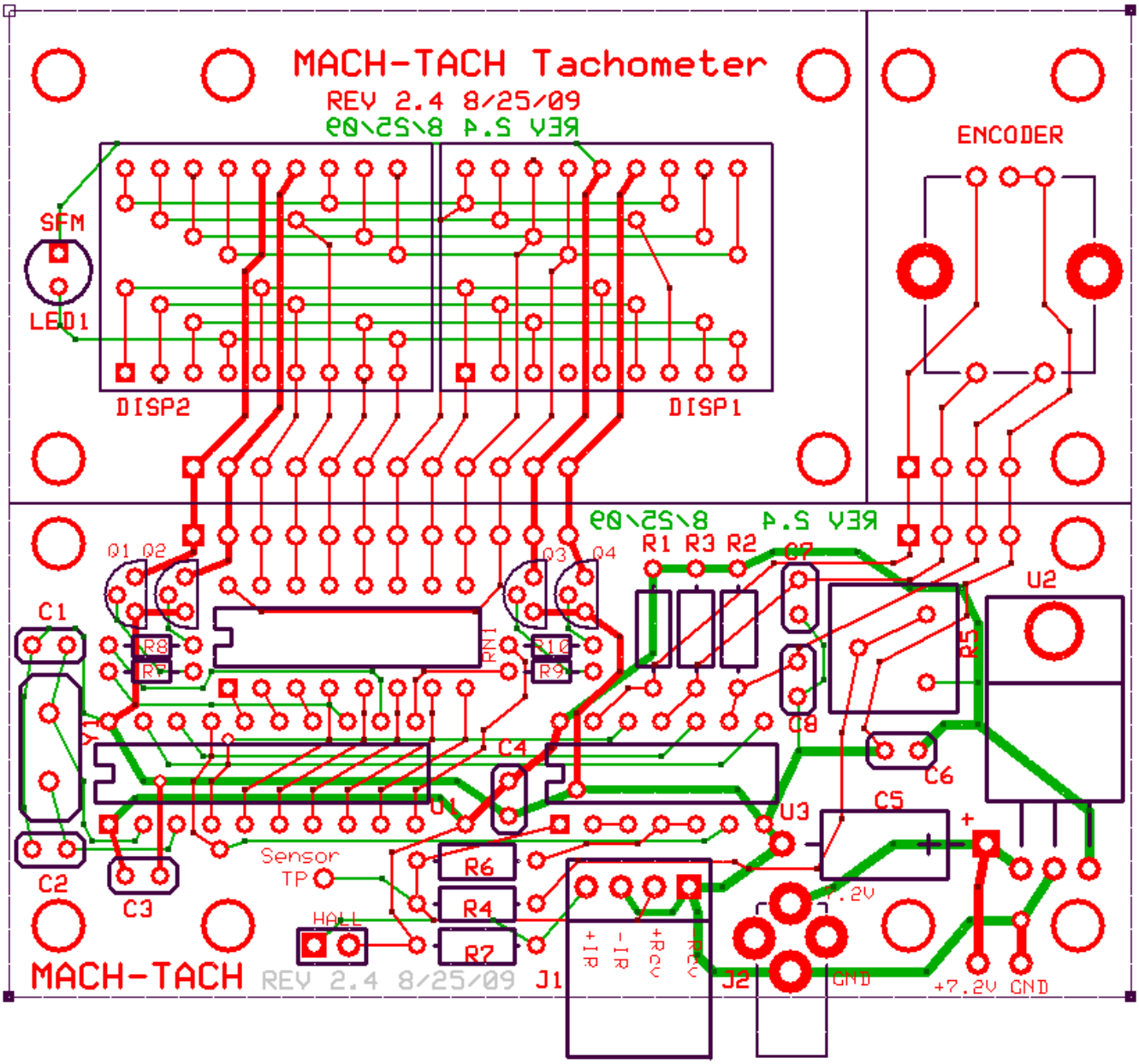
Suggested SFM Settings for Various Materials

An interesting thing to note is that SFM applies to either the diameter of work spinning on a lathe or the diameter of an end mill turning on a Mill spindle. This allows us to use the MachTach with both lathes and mills by entering either the work diameter for lathes or the tool diameter for Mills. The MachTach will also work with band saws by entering the diameter of the wheel and sanders by entering the diameter of the drum. In each case we are concerned with the speed at the rim of a circle. The MachTach can take the RPM of any turning object along with the diameter of the turning object to calculate SFM.

MachTach Schematic



Parts Layout



Mach-Tach Parts List

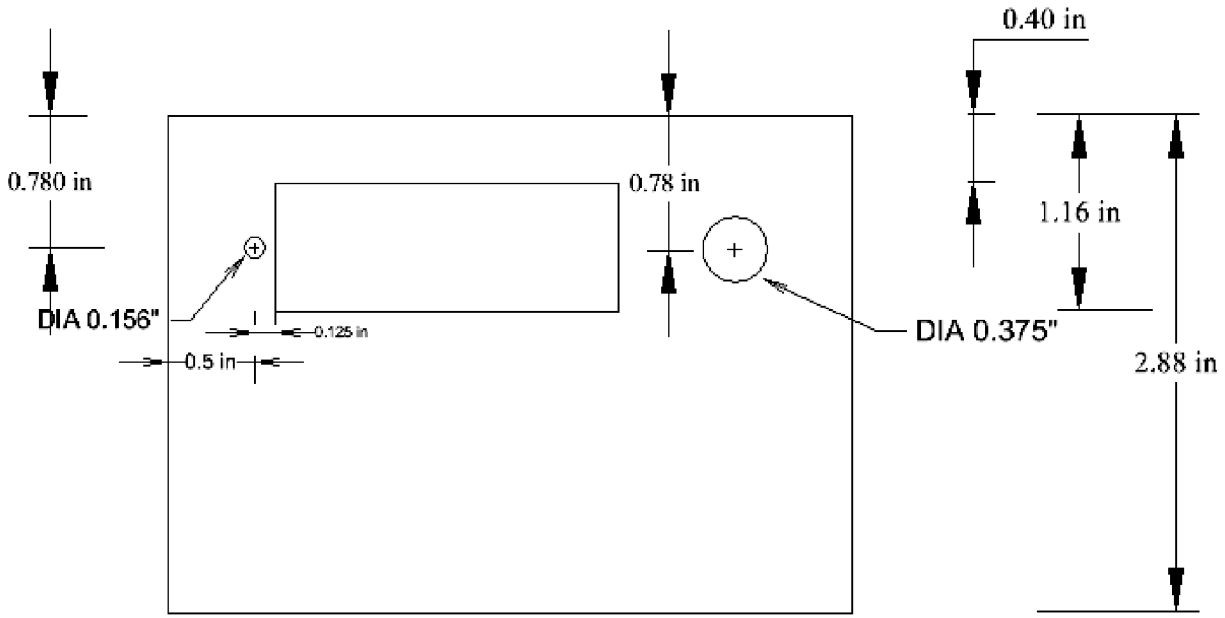
Mach-Tach PCB Rev 2.3 & 2.4

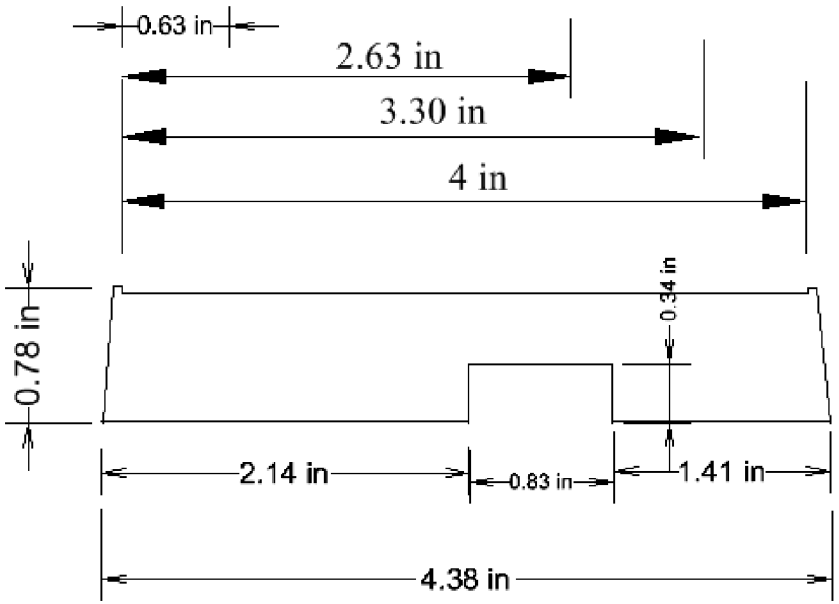
Last Revised 5-4-2011

Quantity	Reference	Description	Manufacturer	Dist Part Number	Distributor	Price Each	Total	Discount Price Each	Total
1	PCB1	Printed Circuit Board Rev 2.4	www.expresspcb.com	NA	expresspcb	$16.00	$16.00	$10.00	$10.00
1	U1	MachTach IC	www.machtach.com	MachTach_V2.2b	machtach	$6.00	$6.00	$6.00	$6.00
1	ENCODER	ENCODER ROTARY w/ SW	Panasonic	P12336-ND	DigiKey	$1.57	$1.57	$1.38	$1.38
5	C3,C4,C6,C7,C8	Cap, Ceramic, 0.1uf		BC1148CT-ND	DigiKey	$0.07	$0.35	$0.05	$0.25
1	C5	Cap, Electrolytic,22uf Axial 25V		199268	Jameco	$0.19	$0.19	$0.15	$0.15
2	DISP1,DISP2	LED 7-SEG Dual Display		516-1207-5-ND	DigiKey	$1.63	$3.26	$1.49	$2.98
4	Q1-Q4	Transistor, 2N3904		2N3904FS-ND	DigiKey	$0.42	$1.68	$0.12	$0.48
1	U2	Regulator, 5V LM340-5.0, T220		900017	Jameco	$1.25	$1.25	$0.85	$0.85
2	C1,C2	Cap, Ceramic,22pf		399-4162	DigiKey	$0.28	$0.56	$0.15	$0.30
1	R5	Var Resistor, 100K		3386F-104LF-ND	DigiKey	$1.29	$1.29	$1.18	$1.18
1	RN1	DIP Resistor Pack, 100 ohm		4116R-1-101LF-ND	DigiKey	$0.60	$0.60	$0.52	$0.52
1	Opto1	IR Reflective Sensor		365-1091-ND	DigiKey	$3.63	$3.63	$3.63	$3.63
1	D1	LED, Red, 1 3/4		511-1264-ND	DigiKey	$0.33	$0.33	$0.14	$0.14
1	R7	Resistor, 1/4 W, 150 ohm		150QBK-ND	DigiKey	$0.06	$0.06	$0.02	$0.02
1	U3	74HC14 Hex Schmidt Trigger		296-1577-5-ND	DigiKey	$0.56	$0.56	$0.27	$0.27
1	Y1	Crystal, 8 Mhz		X165-ND	DigiKey	$0.58	$0.58	$0.32	$0.32
4	R7,R8,R9,R10	Resistor, 1/8 W, 1K		CF18JT1K00CT-ND	DigiKey	$0.09	$0.36	$0.07	$0.28
1	R1,R2,R3	Resistor, 1/4 W, 10K ohm		10KQBK-ND	DigiKey	$0.06	$0.06	$0.02	$0.02
1	R4	Resistor, 1/4 W, 1K ohm		1.0KQBK-ND	DigiKey	$0.06	$0.06	$0.02	$0.02
1	R6	Resistor, 1/4 W, 2M ohm		2.0MQBK-ND	DigiKey	$0.06	$0.06	$0.02	$0.02
1	ENCODER	Knob, 1/4" shaft		264990	Jameco	$0.86	$0.86	$0.73	$0.73
1	U1	20 Pin Socket		AE9998-ND	DigiKey	$0.59	$0.59	$0.37	$0.37
1		2 Pin Jumper		A26228-ND	DigiKey	$0.21	$0.21	$0.14	$0.14
1		crystal insulator		XC1750-ND	DigiKey	$0.11	$0.11	$0.06	$0.06
					TOTAL		$40.22		$30.11

Optional Parts

Quantity	Reference	Description	Manufacturer	Dist Part Number	Distributor	Price Each	Total	Discout Price Each	Total
1	J1	connector, jack	Waldom	WM4902-ND	DigiKey	$1.31	$1.31	$0.60	$0.60
1	P1	connector, plug	Waldom	WM2902-ND	DigiKey	$0.43	$0.43	$0.35	$0.35
1	J2	power jack 3.5mm x 1.3 mm		CP-031D-ND	DigiKey	$0.50	$0.50	$0.40	$0.40
1	Plastic Panel	Custom Panel made from artwork using plastic laminator	from artwork at www.machtach.com		HA	$5.00	$5.00	$5.00	$5.00
1	Case	Plastic Enclosure	Serpac	SR031-IB-ND	DigiKey	$5.64	$5.64	$5.64	$5.64
4	J1	Pins - Connector	Waldom	WM2510CT-ND	DigiKey	$0.12	$0.48	$0.09	$0.36
1	L1	Choke Common Mode Filter		817-1015-ND	DigiKey	$2.82	$2.82	$2.56	$2.56
1	Opto1	Slotted Optical Sensor		365-1101-ND	DigiKey	$4.02	$4.02	$4.02	$4.02
1	Hall1	Hall Effect Sensor		480-1999-ND	DigiKey	$1.82	$1.82	$1.18	$1.18
4		Spacers - PCB Mount, 0.3125" x 1/4"dia		393290	Jameco	$0.10	$0.40	$0.09	$0.36
1		Wall Transformer - 9.0V		T981-P7P-ND	DigiKey	$6.98	$6.98	$6.98	$6.98
1		red plastic lens		PRD250R-ND	DigiKey	$1.71	$1.71	$1.71	$1.71
4'		4 conductor shielded cable		644383	Jameco	$1.15	$1.15	$0.93	$0.93
4		pcb screws			McMaster-Ca				
					TOTAL		$32.26		$30.09





TITLE

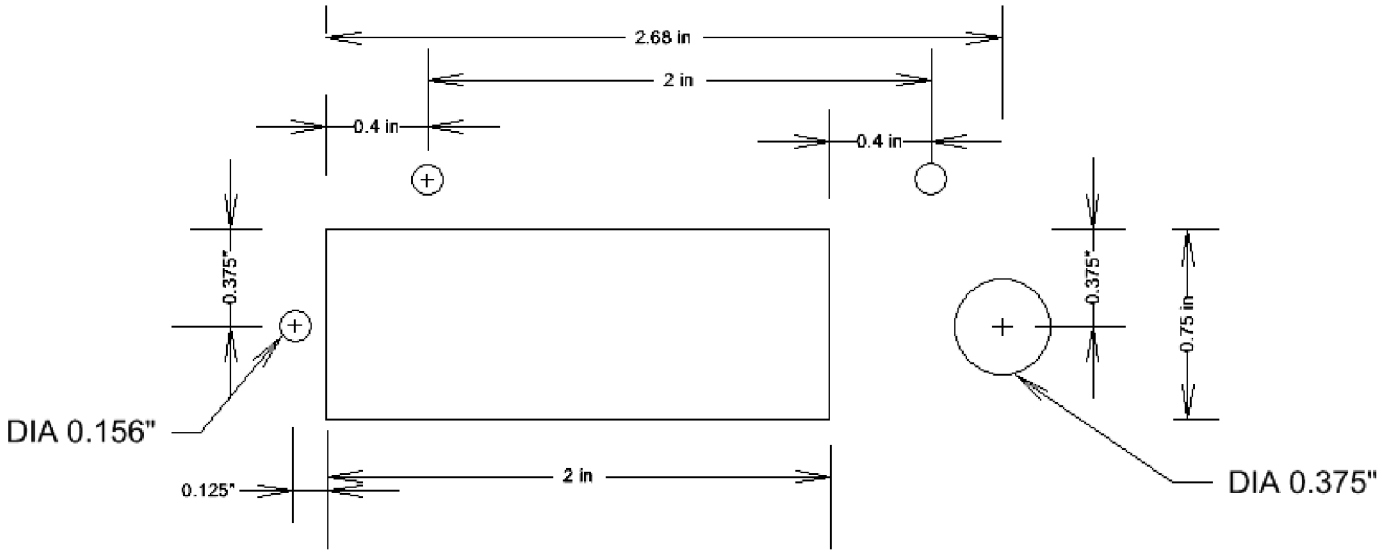
MACH-TACH Panel Cutouts

For Rev 2.3/2.4 PCB and Serpac SR031-IB Enclosure

All Dimensions in inches

SIZE	CAGE CODE	DWG NO	REV
A			B

SCALE		SHEET
1:1	H. Arnold 5-6-11	



TITLE: **MachTach** **Custom Panel Cutouts** All Dimensions in inches			
SIZE: A	CAGE CODE:	DWG NO:	REV: B
SCALE: 1:1	H. Arnold 4-24-11	SHEET:	