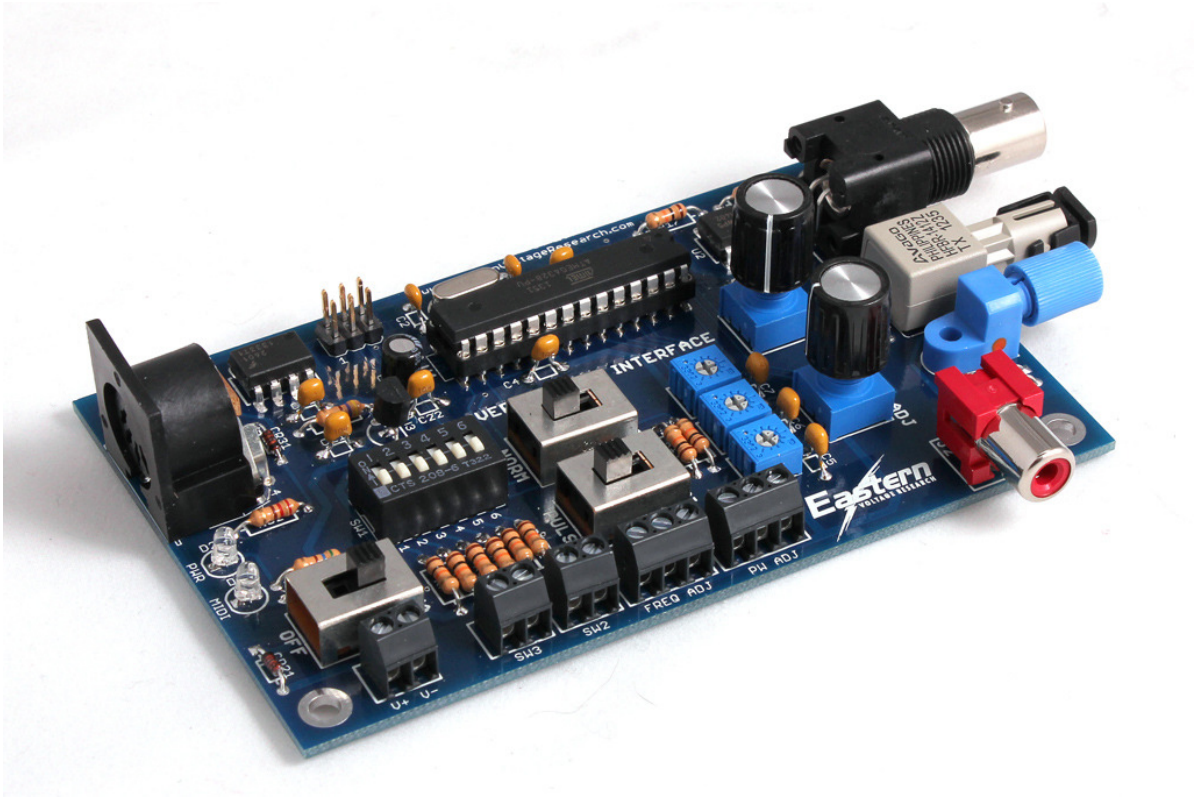
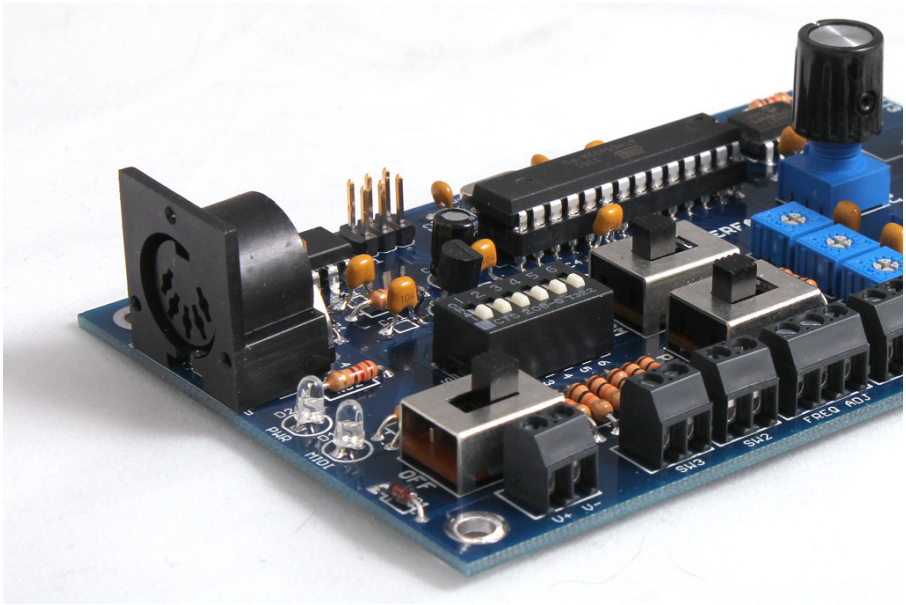
Universal MIDI 1.5 Interrupter

Now with Constant Duty Technology



Instruction Manual

Eastern Voltage Research, LLC



Introduction to the Universal MIDI 1.5 Interrupter

Thank you for purchasing the Universal MIDI 1.5 Interrupter. This kit has been one of our most requested Tesla Coil related kits and we are excited to finally bring it to you. What this kit provides is an easy way to convert your existing or your new Solid State Tesla Coil (SSTC) or Double Resonant Solid State Tesla Coil (DRSSTC) into a musical instrument. In otherwords, by connecting a keyboard or other compatible MIDI based instrument or sound source, you can use your Tesla Coil to generate musical tones. For example, if you play a MIDDLE C on your electronic keyboard, your Tesla Coil will be pulsed at the MIDDLE C frequency of 261 Hz and you will hear that audio frequency of 261 Hz. Pretty neat, eh? Our monophonic version will allow one to play single notes with their Tesla Coil while our polyphonic version will allow you to play two simultaneous notes! The ability to play more than one note at a time on your Tesla Coil will definitely up the coolness factor significantly.

And the Universal MIDI 1.5 Interrupter is more than a device that can simply converter and playback MIDI based music. It also has a standard Pulse mode output as well as high and low frequency modes of pulse based interruption and also a burst mode for spectacular and exciting arc effects.

The Universal MIDI 1.5 Interrupter is designed to be used for virtually any solid state Tesla Coil. It will work with the smallest SSTCs as well as the largest DRSSTCs which could be using full-bridge switching configurations of high power CM600 IGBT bricks. The Universal MIDI 1.5 Interrupter is fully customizable by the end user and can be configured very easily for practically any Tesla coil application.

This kit is also directly compatible with our microBrute, miniBrute, and Plasmasonic line of DRSSTCs as well as our Reference Design and Best DIY Tesla coils.

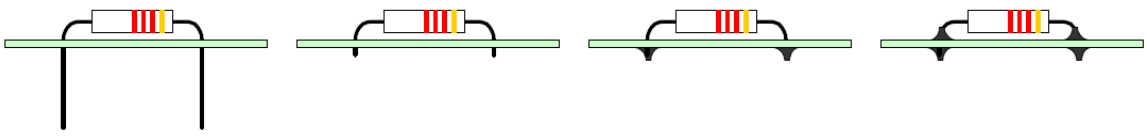
Please read this manual in its entirety before building, testing, or operating your kit!

Kit Building Tips

A good soldering technique is key! Let your soldering iron tip gently heat both the wires and pads simultaneously. Apply solder to the wire and the pad when the pad is hot enough to melt the solder. The finished joint should appear like a small shiny drop of water on paper, somewhat soaked in. If the pads have not heated up sufficiently, melted solder (heated only by the soldering iron itself) will form a cold solder joint and will not conduct properly. These cold joints appear as dull beads of solder, and can be easily fixed by applying additional heat to the pad and wire. All components, unless otherwise noted, should be mounted on the top side of the board. This is the side with the silkscreen printing.

When installing components, the component is placed flat to the board and the leads are bent on the backside of the board to prevent the part from falling out before soldering. The part is then soldered securely to the board, and the remaining lead length is clipped off. It is also extremely important to place the components as close to the board as possible. This is necessary for proper operation over the wide frequency range of the various kits we provide. Also be sure that component lead lengths are always as short as possible. This will avoid adding any stray capacitances or inductances that can be detrimental to circuit operation.

An alternative approach (which is actually the one I use) is to install the component into the board and then apply a piece of masking tape on the topside to the hold the component in place temporarily. The leads on the backside of the board are then trimmed leaving about 0.10” lead protruding through the backside of the board, and then soldered from the backside. You can then remove the masking tape, and finally apply a small amount of solder on the top to complete the joint on both sides. This is shown in the figure below.



Universal MIDI 1.5 Interrupter Parts List

RESISTORS

❒	1	56 ohm Resistor (green-blue-black), R16
❒	1	150 Resistor (brown-green-brown), R18
❒	1	220 Resistor (red-red-brown), R32
❒	1	470 Resistor (yellow-violet-brown), R31
❒	2	560 Resistor (green-blue-brown), R6, R21
❒	1	1k Resistor (brown-black-red), R13
❒	9	10k Resistor (brown-black-orange),R7,R8,R9,R10,R11,R12,R14,R15,R17
❒	3	Trimmer Potentiometer, 100k (marking 3362P, 104), R1,R2,R3
❒	2	Shaft Potentiometer, 100k (marking 3310Y, 104), R4,R5

CAPACITORS

❒	2	22pF Capacitor, Ceramic, C1,C2
❒	9	0.1uF Capacitor, Ceramic, C3,C4,C5,C6,C7,C8,C21,C22,C31
❒	1	10uF, 50V Capacitor, Electrolytic, C23

DIODES

❒	4	Diode, 1N4148, CR1,CR2,CR21,CR31
❒	2	LED, T-1, Blue, D1,D21

SEMICONDUCTORS

❒	1	Microcontroller, Universal MIDI 1.5, 28-Pin, U1 (Updated 1.5 firmware)
❒	1	HCPL2601 Optoisolator, U31
❒	1	TC4427 Gate Driver, U2
❒	1	MCP1702-5002 Voltage Regulator, U3
❒	1	Crystal Oscillator, 16MHz, XTAL1

MISCELLANEOUS

❒	1	MIDI, 5-Pin Connector, J31
❒	1	RCA Connector, Female, J2 (See Note 1)
❒	1	BNC Connector, Female, J3 (See Note 1)
❒	1	Fiber Optic Connector, HFBR1412, J1 (See Note 1)
❒	1	Fiber Optic Connector, IF-E96E, J4 (See Note 1)
❒	1	DIP Switch, 6-Position, SW1
❒	3	Slide Switch, SW2, SW3, SW21
❒	3	Terminal Block, 2-Position, TB1, TB2, TB21 (See Note 1)
❒	2	Terminal Block, 3-Position, TB4, TB5 (See Note 1)
❒	1	IC Socket, 28-Pin DIP, U1
❒	1	Universal MIDI 1.5 PCB Board (Marked 1.0)
❒	1	Universal MIDI 1.5 Schematic (Marked 1.0)

Note 1: The type of connector supplied with the kit is dependent on the particular kit you ordered.

REQUIRED, NOT SUPPLIED

❒	1	Power Supply, 9V, 1A (or similar)
❒	1	MIDI Cable
❒	1	MIDI Source (laptop, keyboard, etc…)

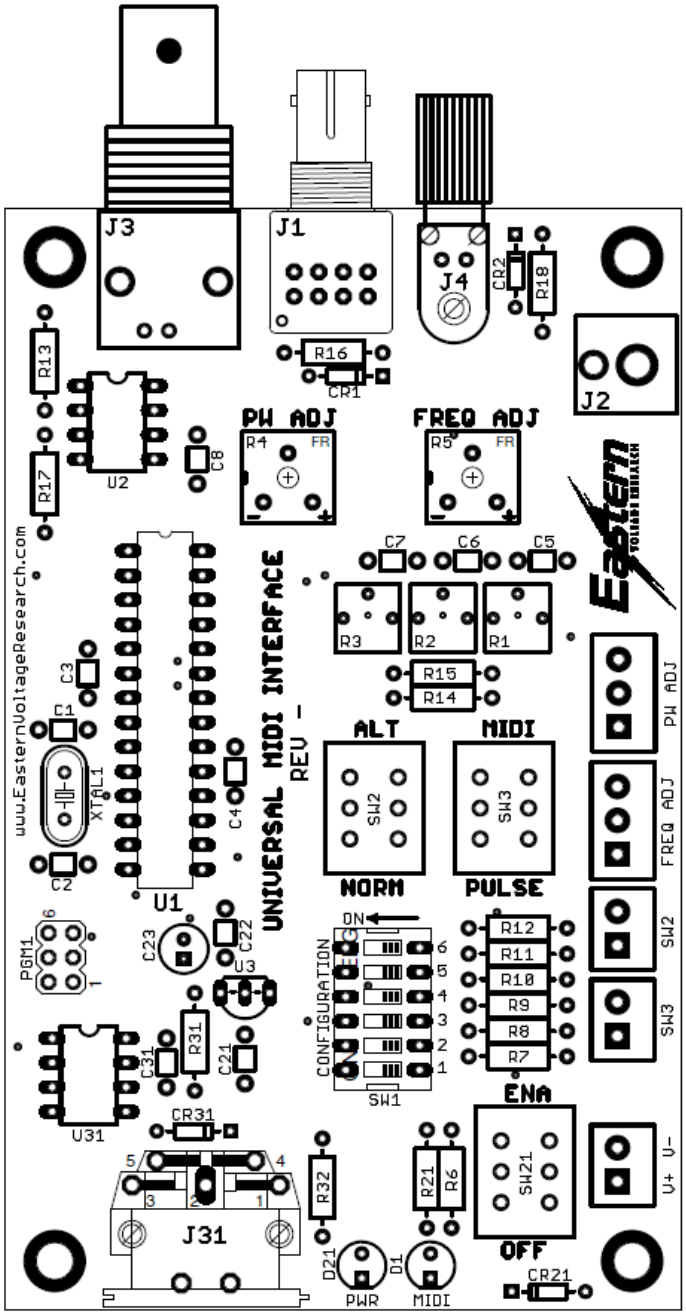
OPTIONAL, BUT RECOMMENDED

❒	2	8-Pin DIP Socket (See note 2)
❒	1	Speaker, 8 ohm, Small (See note 3)

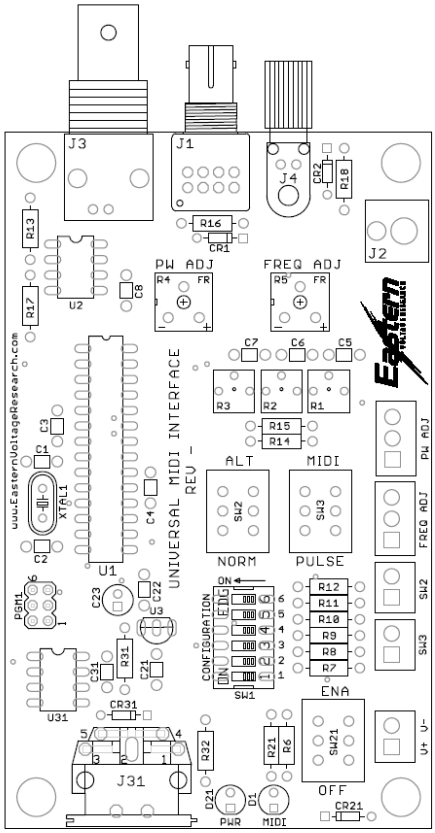
Note 2: The use of DIP sockets is not required, but it is recommended. Using DIP sockets for each and every IC will allow easy removal for troubleshooting and repair. DIP sockets may be purchased from any electronics supplier, including your local Radio Shack or similar electronics store, or can be purchased directly from us at our website under the components ordering pages.

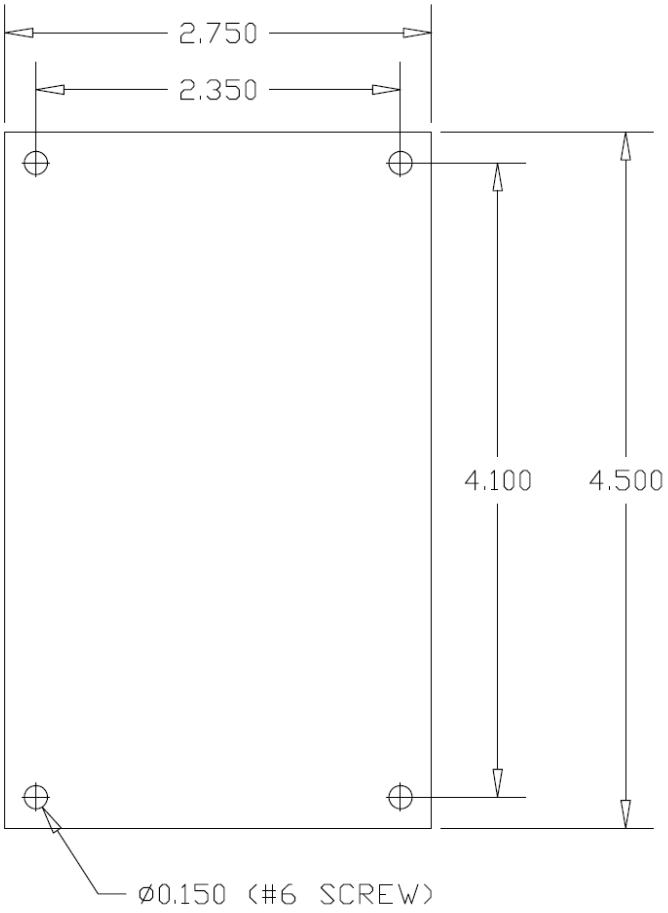
Note 3: The use of a small 8 ohm speaker is beneficial as it allows you to test the operation of your MIDI keyboard or similar equipment with your MIDI interface board. We recommend any small 8-ohm speaker. These are the small speakers typically found in computer cases or other small radios or toys. We also offer these speakers on our flexiBrute MIDI Interface website ordering page.

Universal MIDI 1.5 Interrupter - Component Layout Diagram



Universal MIDI 1.5 Interrupter – Mounting Provisions





Your Universal MIDI 1.5 Interrupter can be mounted directly to any flat surface using the four (4) mounting holes as shown above. Each mounting hole accepts #6 hardware and we recommend using 6-32 stand-offs and 6-32 screws to mount the board.

KIT Building Instructions

Now we will begin building the kit. There are just a few more important things to know before we install the first components.

For each component, the word "install" always means the following:

1. Pick the correct value to start with.
2. Insert the component into the correct printed circuit board (PCB) location.
3. Orient the component correctly – especially when there is a right and a wrong way to solder it in. (i.e. Electrolytic capacitors, diodes, ICs, transistors, etc…)
4. Solder all connections unless directed otherwise. Ensure enough heat is used to allow solder to flow for clean, shiny, and completed connections.

Also, please be sure to take us seriously when we say that good soldering is the key to the proper operation of your circuit!

- Use a 25W soldering pencil with a clean, sharp tip. DO NOT USE a high power soldering gun such as those trigger activated units.
- Use only rosin core solder intended for electronics use
- Ensure your work area is clean, and has plenty of bright lighting
- Build your kit in stages, taking breaks to check your work. Be sure to clean the board periodically with a brush or compressed air to remove any excess wire cuttings, etc…

Okay, so lets begin!

❒ 1. Install R16, 56 ohm resistor (green-blue-black)

❒ 2. Install R18, 150 ohm resistor (brown-green-brown)

❒ 3. Install R32, 220 ohm resistor (red-red-brown)

❒ 4. Install R31, 470 ohm resistor (yellow-violet-brown)

❒ 5. Install R6, 560 ohm resistor (green-blue-brown)

❒ 6. Install R21, 560 ohm resistor (green-blue-brown)

❒ 7. Install R13, 1k resistor (brown-black-red)

❒ 8. Install R7, 10k resistor (brown-black-orange)

❒ 9. Install R8, 10k resistor (brown-black-orange)

❒ 10. Install R9, 10k resistor (brown-black-orange)

❒ 11. Install R10, 10k resistor (brown-black-orange)

❒ 12. Install R11, 10k resistor (brown-black-orange)

❒ 13. Install R12, 10k resistor (brown-black-orange)

❒ 14. Install R14, 10k resistor (brown-black-orange)

❒ 15. Install R15, 10k resistor (brown-black-orange)

❒ 16. Install R17, 10k resistor (brown-black-orange)

❒ 17. Install CR1, 1N4148 diode. The cathode band on the diode must match that shown on the silkscreen.

❒ 18. Install CR2, 1N4148 diode. The cathode band on the diode must match that shown on the silkscreen.

❒ 19. Install CR21, 1N4148 diode. The cathode band on the diode must match that shown on the silkscreen.

❒ 20. Install CR31, 1N4148 diode. The cathode band on the diode must match that shown on the silkscreen.

❒ 21. Install D1, Blue LED. The short lead of the diode is the cathode and will install into the square pad on the PCB board.

❒ 22. Install D21, Blue LED. The short lead of the diode is the cathode and will install into the square pad on the PCB board.

❒ 23. Install C1, 22pF capacitor (marking BC22 or 22J)

❒ 24. Install C2, 22pF capacitor (marking BC22 or 22J)

- ❒ 25. Install C3, 0.1uF capacitor (marking BC104 or 104)
- ❒ 26. Install C4, 0.1uF capacitor (marking BC104 or 104)
- ❒ 27. Install C5, 0.1uF capacitor (marking BC104 or 104)
- ❒ 28. Install C6, 0.1uF capacitor (marking BC104 or 104)
- ❒ 29. Install C7, 0.1uF capacitor (marking BC104 or 104)
- ❒ 30. Install C8, 0.1uF capacitor (marking BC104 or 104)
- ❒ 31. Install C21, 0.1uF capacitor (marking BC104 or 104)
- ❒ 32. Install C22, 0.1uF capacitor (marking BC104 or 104)
- ❒ 33. Install C31, 0.1uF capacitor (marking BC104 or 104)
- ❒ 34. Install C23, 10uF, 50V (or similar) electrolytic capacitor. C23 has "polarity." Polarity means the capacitor must be inserted a certain way. You may notice that one side of the capacitor, there is a black stripe with minus signs. This is the negative end. Looking at the PCB silkscreen, you will notice the positive side marked. Install this capacitor into the board ensuring the positive side of the capacitor installs in the hole that is marked positive on the PCB layout.
- ❒ 35. Install 28-Pin DIP Socket in the U1 location. Note that one end of the DIP Socket is marked by a dot, notch, or band; this end MUST be oriented as shown on the PCB layout.
- ❒ 36. Install U31, HCPL2601 Optoisolator (marking 2601). The HCPL2601 may be soldered directly to the PCB without worry, but you may use an 8-pin DIP socket (not supplied) if you prefer as this would aid in troubleshooting and repair. Note that one end of the IC is marked by a dot, notch, or band; this end MUST be oriented as shown on the PCB layout.
- ❒ 37. Install U2, TC4427 Gate Driver. The TC4427 may be soldered directly to the PCB without worry, but you may use an 8-pin DIP socket (not supplied) if you prefer as this would aid in troubleshooting and repair. Note that one end of the IC is marked by a dot, notch, or band; this end MUST be oriented as shown on the PCB layout.
- ❒ 38. Install U3, MCP1702-5002 Linear Regulator. This device is a 3-lead TO-92 packaged voltage regulator and must be installed with the proper polarity. You will notice that there is a flat edge on one side of the component. This flat edge must align with the flat edge as shown on the silkscreen on the PCB board.

❒ 39. Install SW1, 6-Position DIP Switch. Note that one end of the IC is marked by a dot, notch, or band; this end MUST be oriented as shown on the PCB layout.

❒ 40. Install XTAL1, crystal oscillator. Note there is no polarity on the crystal so the crystal may be installed in any orientation.

❒ 41. Install SW2, slide switch. Please note that if you are using external switches, do not install SW2 in this step. Please refer to the end of this manual for more information.

❒ 42. Install SW3, slide switch. Please note that if you are using external switches, do not install SW3 in this step. Please refer to the end of this manual for more information.

❒ 43. Install SW21, slide switch. Please note that if you are using external switches, do not install SW21 in this step. Please refer to the end of this manual for more information.

❒ 44. Install R1, 100k trimmer potentiometer (marking 3362P 104)

❒ 45. Install R2, 100k trimmer potentiometer (marking 3362P 104)

❒ 46. Install R3, 100k trimmer potentiometer (marking 3362P 104)

❒ 47. Install R4, 100k shaft potentiometer (marking 3310Y 104) Please note that if you are using external potentiometers, do not install R4 in this step. Please refer to the end of this manual for more information.

❒ 48. Install R5, 100k shaft potentiometer (marking 3310Y 104) Please note that if you are using external potentiometers, do not install R5 in this step. Please refer to the end of this manual for more information.

❒ 49. Install TB21, 2-position terminal block. This is the power input connector and is designated on the board by the “V+” and “V-“ markings. Ensure the open screw terminals face towards the outside of the board so that wires can be inserted.

❒ 50. Install J1, 5-Pin DIN MIDI connector

❒ 51. Install knob on the shaft of the R4 potentiometer.

❒ 52. Install knob on the shaft of the R5 potentiometer.

The following instructions will vary depending on which particular connector options you purchased with your individual kit.

❒ 53. Install J2, RCA female connector (if supplied). There are two black plastic tabs underneath connector that should be cut off to ensure the connector sits flat on the board.

❒ 54. Install J3, BNC female connector (if supplied).

❒ 55. Install J1, HFBR1412 fiber optic transmitter (if supplied).

❒ 56. Install J4, IF-E93E fiber optic transmitter (if supplied).

❒ 57. Install TB1, 2-position terminal block (if supplied).

❒ 58. Install TB2, 2-position terminal block (if supplied).

❒ 59. Install TB4, 3-position terminal block (if supplied).

❒ 60. Install TB5, 3-position terminal block (if supplied).

DO NOT install the 28-Pin Microcontroller IC at this time!

Congratulations! You have just completed your Universal MIDI 1.5 Interrupter kit. Please take a few moments to look over the board and ensure that all the components are installed properly with the correct orientation. Since some of the parts may be unfamiliar to you, you may want to be extra sure that they have been inserted correctly. After you are sure that everything seems to be properly installed, move on to the set-up and testing section.

Set-up and Testing

Okay, so lets begin!

RECOMMENDED TEST EQUIPMENT, NOT SUPPLIED

❒	1	Analog or Digital Multimeter
❒	1	Oscilloscope
❒	1	MIDI Keyboard (or similar)
❒	1	Speaker, 8-ohm, Small

Before connecting the Universal MIDI 1.5 Interrupter to any SSTC or DRSSTC Tesla Coil, be sure that you are completely familiar with the operation of the MIDI Interface as well as verified the operation of the interface card using an oscilloscope or similar device. It is important to ensure that the MIDI Interface pulsewidth ranges are programmed per the SSTC or DRSSTC it is being used for and that the proper settings are programmed before connecting to an SSTC or DRSSTC.

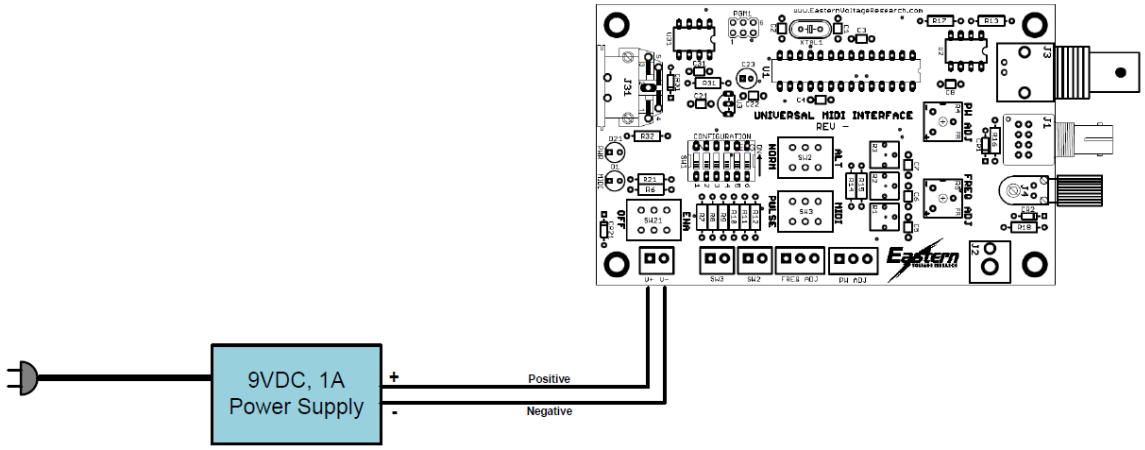
WARNING
Unplugging the MIDI connector while playing a note will result in this note being played indefinitely through the MIDI Interface Card. This is simply how the MIDI protocol operates, since the note will not stop until a stop-note command is sent by the MIDI device.

❒ 1. Hook-up a 7-12VDC, 1A power supply according to the figure below. We recommend using a 9V, 1A DC power supply which can be ordered from our website under the Universal MIDI 1.5 Interrupter ordering page. (A 9V battery can also be used, although operating run-times will be limited due to the life of the battery.)

First, use your multimeter to verify which lead from the power supply is the positive lead, and which lead is the negative lead. Reversing the leads to the MIDI Interface board may cause damage to the components.

Connect the positive lead to the TB21 terminal block screw labeled “V+”

Connect the negative lead to the TB21 terminal block screw labeled “V-”



❒ 2. Apply power to the Universal MIDI 1.5 Interrupter board.

❒ 3. Verify that +5V LED, D21, is illuminated.

❒ 4. Verify that the voltages are correct at the measuring points located below. All voltages should be measured with respect to GND. All of the four (4) screw mounting holes are connected to GND and provide an easy reference point to measure from.

Check	Component	Measuring Point	Voltage
❒	U3, MCP1702-5002	Pin 2 (Input)	7-12V (9V nom)
❒	U3, MCP1702-5002	Pin 3 (Output)	5V ± 0.1V
❒	U1, Microcontroller	Pin 1 (MCLR)	5V ± 0.1V
❒	U1, Microcontroller	Pin 7 (Vcc)	5V ± 0.1V
❒	U1, Microcontroller	Pin 20 (Vcc)	5V ± 0.1V
❒	U1, Microcontroller	Pin 21 (Vcc)	5V ± 0.1V
❒	U31, Optocoupler	Pin 7	5V ± 0.1V
❒	U31, Optocoupler	Pin 8	5V ± 0.1V
❒	U5, TC4427	Pin 6 (Vcc)	5V ± 0.1V

Note: All voltages should be measured with respect to the GND

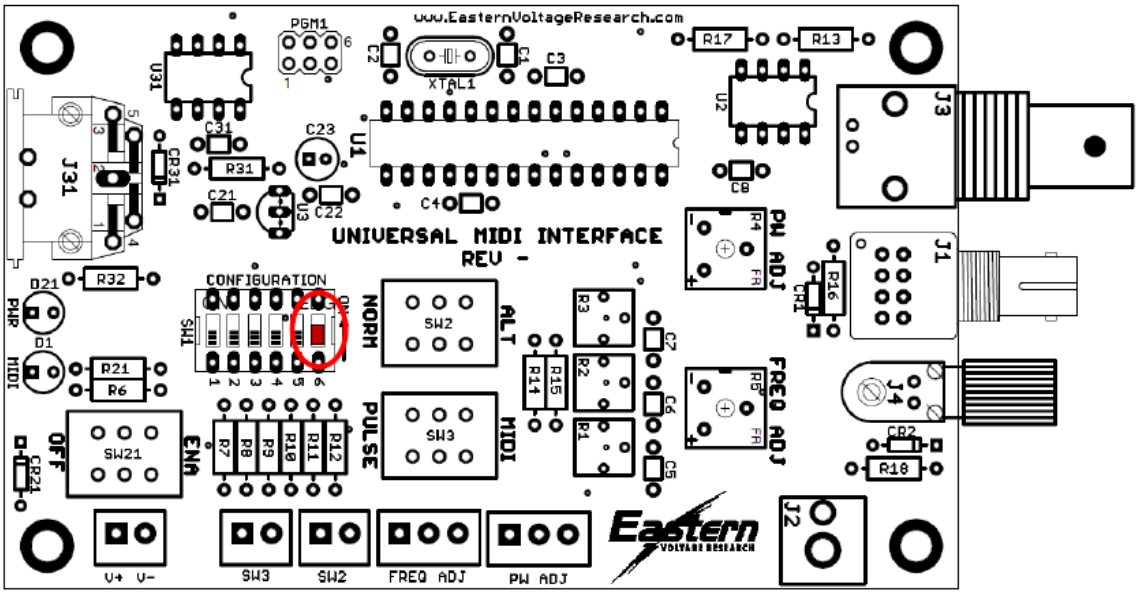
❒ 5. Disconnect power to the Univeral MIDI 1.5 Interrupter board

❒ 6. Install U1, 28-Pin Microcontroller. Note that one end of the IC is marked by a dot, notch, or band; this end MUST be oriented as shown on the PCB layout.

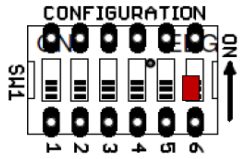
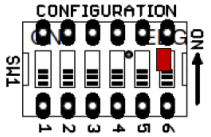
IMPORTANT

The next several steps involve setting the DIP switches for the MIDI interface board. It is very important to understand the operation of these DIP switches so that your MIDI interface board can be properly set-up for the equipment it is to be used for. Failure to properly set these DIP switches may cause permanent damage to your Tesla coil system.

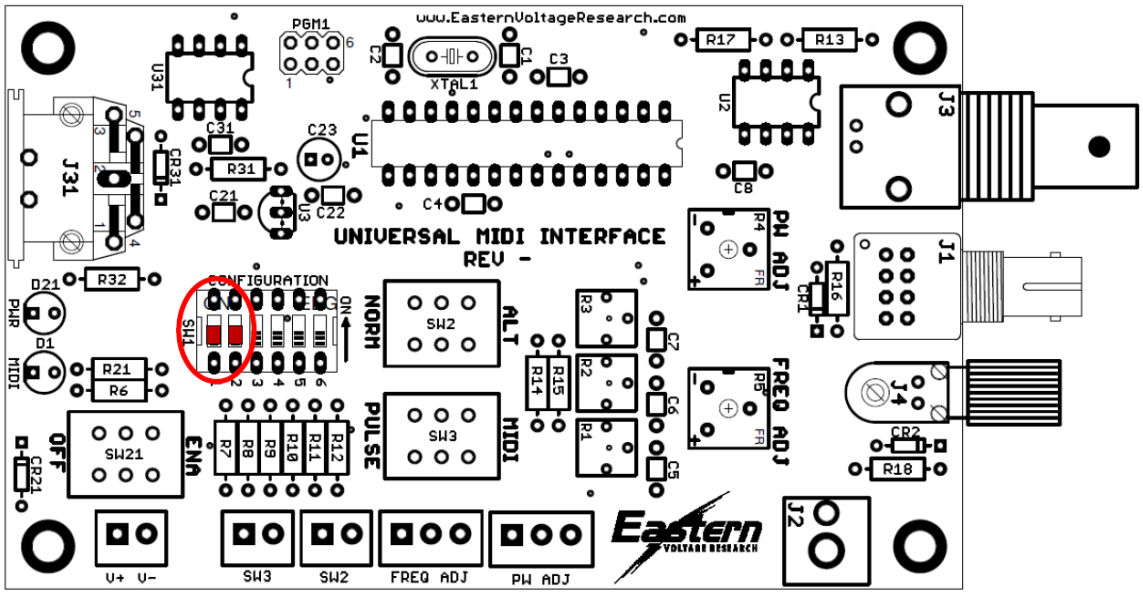
❒ 7. In this step, the DIP Switch PULSE Mode Operation (Position 6) will be selected. First, identify the proper DIP switch using the figure below:



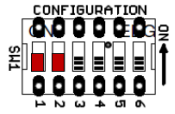
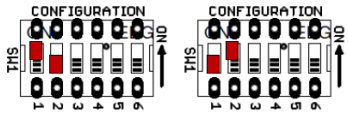
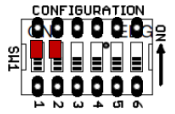
There are two settings for this switch as shown in the table below:

PULSE Mode Operation	Operation
 **(RECOMMENDED)**	When this switch is OFF, the output pulsewidth in PULSE MODE will be constant, regardless of output PRF (pulse repetition frequency) as selected by the user Frequency ADJ knob.
	When this switch is ON, notes at max. PRF (pulse repetition frequency) will have approx. 33% the pulseweidth of notes at the minimum PRF as selected by the user Frequency ADJ knob.

❒ 8. In this step, the DIP Switch MIDI Note Range Select (Position 1 and 2) will be selected. First, identify the proper DIP switches using the figure below:



There are three settings for this switch as shown in the table below. These two switches operate as a pair and are used to protect the Tesla coil from notes too high being played, which could cause damage to the coil due to the large on-times (high duty cycles) of high pitched notes.

MIDI Note Range Select	Operation
 **RECOMMENDED**	HIGHEST PROTECTION In this mode, MIDI notes above 74 will not be played.
 **OR**	LIMITED PROTECTION (Recommended) In this mode, MIDI notes above 92 will not be played
	NO PROTECTION In this mode, all MIDI notes up to 127 will be played.

Please note that the lowest note for any range is MIDI note 24.

IMPORTANT

We recommend using LIMITED PROTECTION for all applications.

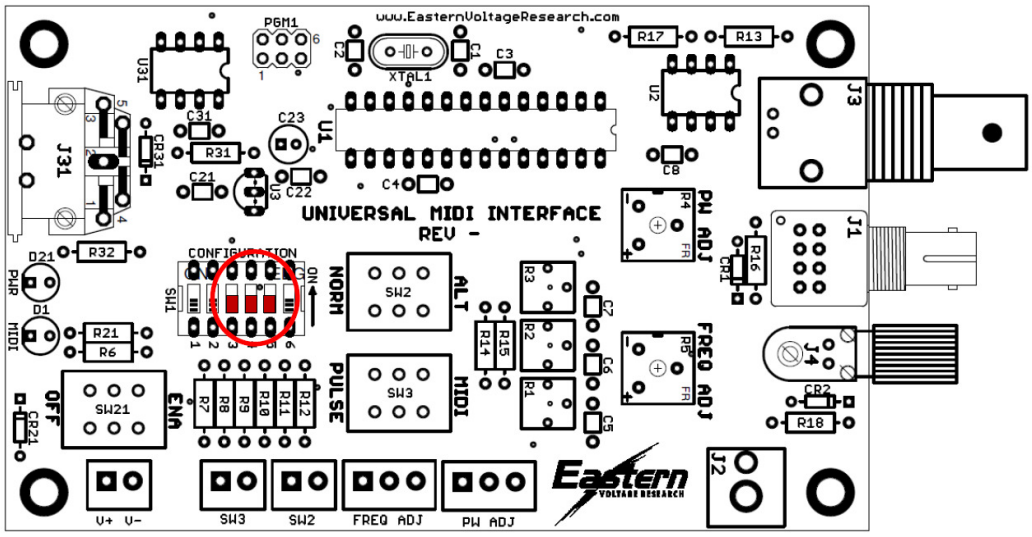
MIDI Note Range Select (Playable Notes) – HIGHEST PROTECTION

MIDI Note Range Select (Playable Notes) – LIMITED PROTECTION

MIDI Note Range Select (Playable Notes) – NO PROTECTION

(Note: The keyboard shown only includes notes up to MIDI note 108. In this mode, notes up to MIDI note 127 are also able to be played)

❒ 9. In this step, the DIP Switch MIDI Channel Select (Position 3, 4, and 5) will be selected. First, identify the proper DIP switches using the figure below:



These three (3) dipswitches are used to select the MIDI Channel that the interrupter will be reading and processing. MIDI Channels 1 through 8 can be selected via the onboard dipswitches as shown in the table below.

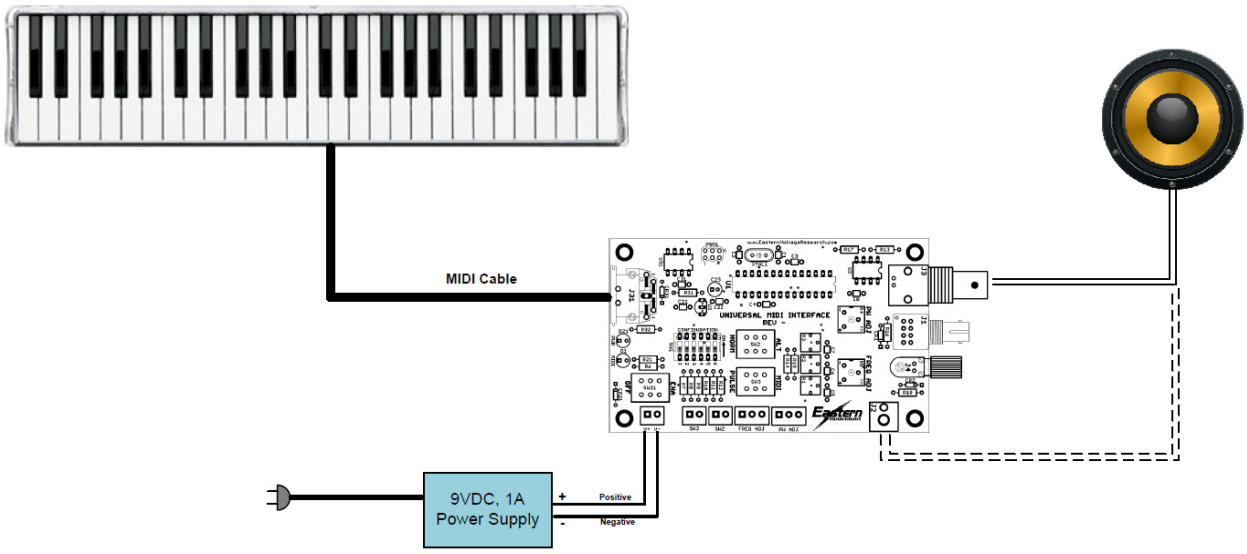
MIDI Channel	DIPSW 3	DIPSW 4	DIPSW 5
1	OFF	OFF	OFF
2	ON	OFF	OFF
3	OFF	ON	OFF
4	ON	ON	OFF
5	OFF	OFF	ON
6	ON	OFF	ON
7	OFF	ON	ON
8	ON	ON	ON

IMPORTANT

The MIDI Channel of your MIDI Instrument (Laptop, Keyboard, etc…) MUST have the same channel as which is set using the dipswitches on the interrupter or it will not work properly.

❒ 10. At this point, the DIP switch settings should all be set up and you are ready to begin testing and setting the potentiometer settings for your Universal MIDI 1.5 Interrupter board. Connect your MIDI keyboard (or similar) to the MIDI interface as shown in the figure below. Connect a small 8-16 ohm speaker, if it is available, as shown as well. A speaker will be especially helpful in that you will be able to hear the tones being played while testing and also give you an idea of how the MIDI interface card operates prior to connecting to an actual SSTC or DRSSTC Tesla coil.

Note: The speaker can be connected directly to either the RCA or BNC connector or can also be soldered to the terminals / pads on the board for either connector. Polarity is not important for this connection.



❒ 11. With everything connected properly, apply power the MIDI interface board.

❒ 12. Turn the MIDI keyboard ON.

❒ 13. Ensure that the MIDI output channel of the keyboard is set to the same MIDI channel as was selected via the dipswitches in step 9 above.

❒ 14. Try playing a few notes on the keyboard. If everything is connected and operating properly, you should begin to hear notes playing through your connected speaker.

❒ 15. Verify that the MIDI LED illuminates when notes are played on the keyboard. Note that the MIDI LED changes state every time a valid MIDI command is received from the sending instrument. When a single note is played, the MIDI LED will illuminate, however, if you play a second note, while the first note is still being held, the MIDI LED will turn off.

❒ 16. In the next few steps, we will adjust the potentiometers for the operation of the MIDI interface board. **For this step, first disconnect the audio speaker from the MIDI interface board.** Then connect an oscilloscope to the output BNC of the MIDI interface board or use an oscilloscope probe and look at the output by monitoring U5 (TC4427), Pin 5. The ground clip of the oscilloscope can be attached to one of the mounting holes at the corners of the board. (Note: If an oscilloscope is not available, you can adjust the potentiometers using the figures below to get approximate pulsewidth settings.)

❒ 20. In this step, you will set the MIDI maximum pulsewidth.

The MIDI playback algorithm works as following under constant duty technology. When a MIDI note is played, the controller will first attempt to play the note at the maximum pulsewidth as set by the potentiometer, R1. The controller will then calculate the operational duty cycle by comparing the audio frequency to the maximum pulsewidth. If the maximum operational duty cycle is greater than the programmed maximum duty cycle, then the pulsewidth will be truncated or shortened until the maximum duty cycle is met.

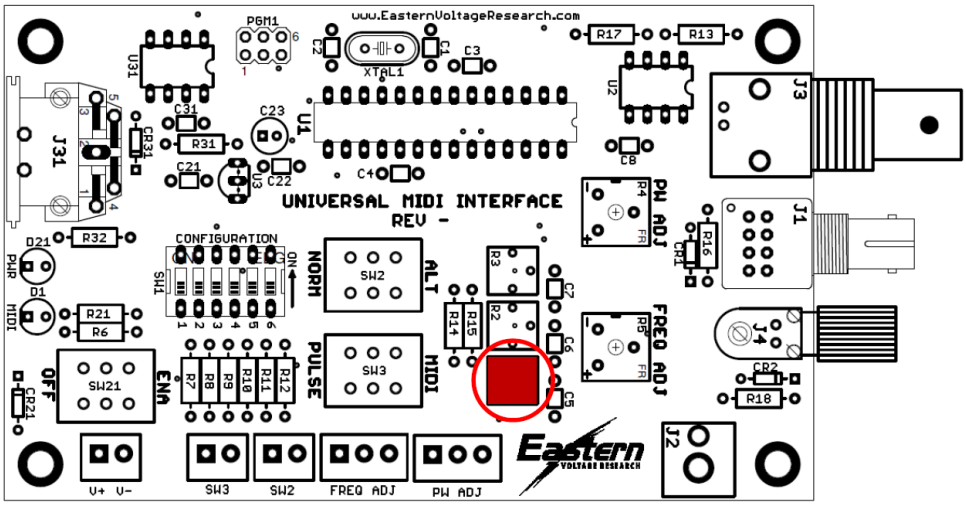
It is easiest to use a MIDI keyboard to set this pulsewidth. Select the lowest note that the keyboard will play given the DIP switch note range settings, and set your maximum MIDI pulsewidth using potentiometer, R1, by viewing the output pulsewidth on an oscilloscope.

The range for MIDI maximum pulsewidth is 0 to 1000us.

For our Reference Design 1.0, Best 6.0 DIY, Best 8.0 DIY, and Best 12.0 DIY we recommend a max. pulsewidth of 300us.

WARNING

Using maximum pulsewidths greater than 300us may cause damage to your Tesla coil.



❒ 21. In this step, you will set the MIDI maximum duty cycle.

Again, the MIDI playback algorithm works as following under constant duty technology. When a MIDI note is played, the controller will first attempt to play the note at the maximum pulsewidth as set by the potentiometer, R1. The controller will then calculate the operational duty cycle by comparing the audio frequency to the maximum pulsewidth. If the maximum operational duty cycle is greater than the programmed maximum duty cycle, then the pulsewidth will be truncated or shortened until the maximum duty cycle is met.

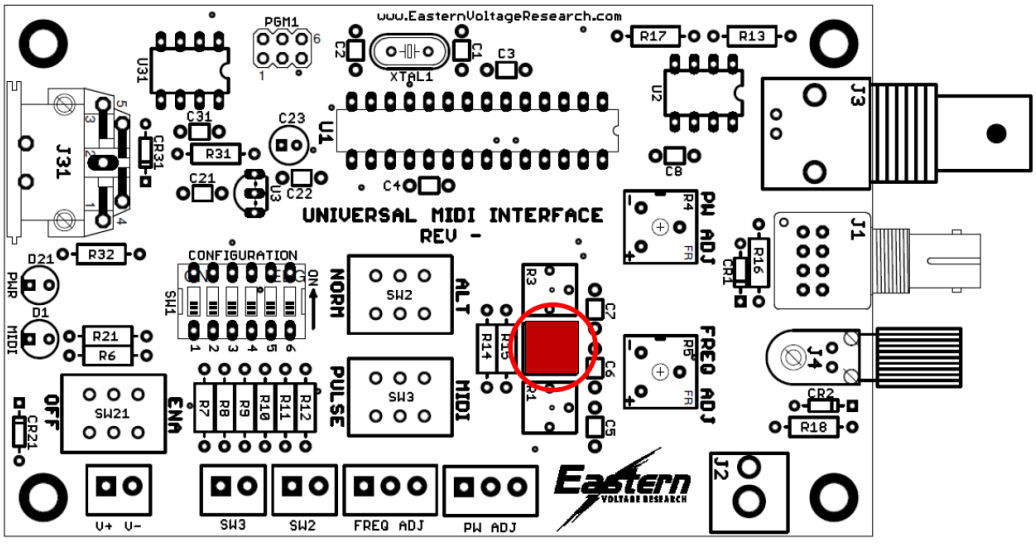
It is easiest to use a MIDI keyboard to set this duty cycle. Select the highest note that the keyboard will play given the DIP switch note range settings, and set your maximum MIDI duty cycle using potentiometer, R2, by viewing the output pulsewidth on an oscilloscope.

The range for MIDI maximum duty cycle is 0 to 10%.

For our Reference Design 1.0, Best 6.0 DIY, Best 8.0 DIY, and Best 12.0 DIY we recommend a max. pulsewidth of 5%.

WARNING

Using maximum duty cycle values greater than 5% may cause damage to your Tesla coil. Power levels get significant for duty cycles exceeding 5%.

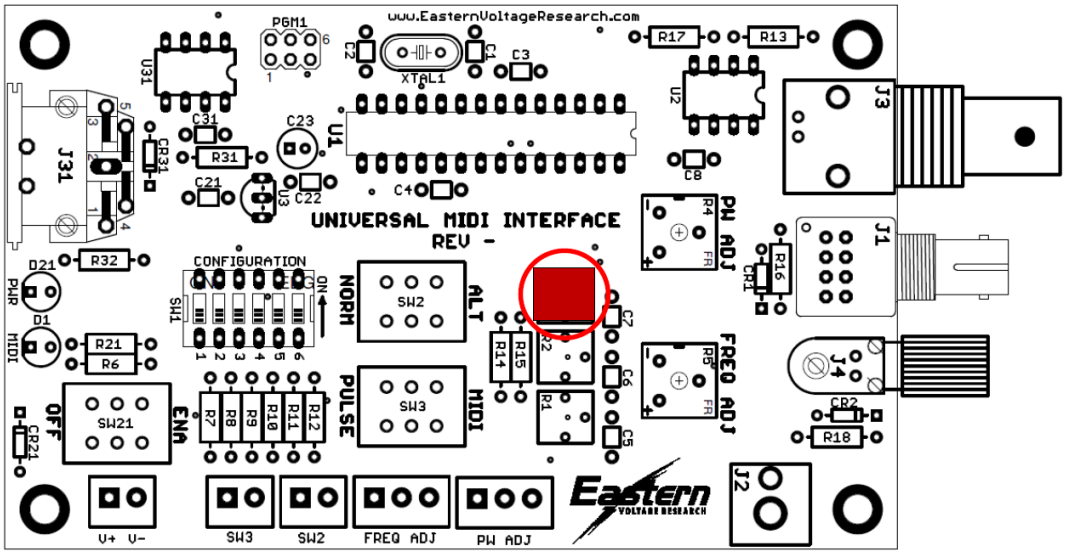


❒ 22. In this step, you will set the PULSE mode maximum pulsewidth. This will set the maximum pulsewidth the interrupter will output during PULSE mode operation. The potentiometer, R3, as shown below, is used to set the PULSE mode maximum pulsewidth. The range of adjustment for this potentiometer is 0-2.5ms.

For our Reference Design 1.0, Best 6.0 DIY, Best 8.0 DIY, and Best 12.0 DIY we recommend a max. pulsewidth of 300us.

WARNING

Using maximum pulsewidths greater than 300us may cause damage to your Tesla coil.



At this point, your Universal MIDI 1.5 Interrupter is properly set-up and configured. You are now ready to connect the Universal MIDI 1.5 Interrupter to your Tesla coil!

Operation with a Tesla Coil

Okay, so lets create some arcs and music!

IMPORTANT NOTICE

Before connecting the Universal MIDI 1.5 Interrupter to any SSTC or DRSSTC Tesla Coil, be sure that you are completely familiar with the operation of the Universal MIDI 1.5 Interrupter as well as verified the operation of the Universal MIDI 1.5 Interrupter using an oscilloscope or similar device. It is important to ensure that the Univeral MIDI 1.5 Interrupter pulsewidth ranges are programmed per the SSTC or DRSSTC it is being used for and that the proper settings are programmed before connecting to an SSTC or DRSSTC.

WARNING

Unplugging the MIDI connector while playing a note will result in this note being played indefinitely through the MIDI Interface Card. This is simply how the MIDI protocol operates, since the note will not stop until a stop-note command is sent by the MIDI device.

Interrupter Output Specifications

Please use the following table to determine the proper interface between the Universal MIDI 1.5 Interrupter board and your DRSSTC or SSTC system.

Output Connector	Specification
J2, RCA	RCA connector (female) TTL 5V logic compatible 0V = OFF 5V = ON
J3, BNC	BNC connector (female) TTL 5V logic compatible 0V = OFF 5V = ON
J1, Fiber Optic	HFBR1412T Transmitter (ST connector) Compatible with HFBR 2412T Receiver (ST connector) Light OFF = OFF Light ON = ON
J4, Fiber Optic	IF-E96E Transmitter (Bare fiber connector) Compatible with IF-E96E Receiver (Bare fiber connector) Light OFF = OFF Light ON = ON

MIDI Channel

The Universal MIDI 1.5 Interrupter will only read the MIDI channel that it was set-up with using the dipswitches in instruction step 9 above.

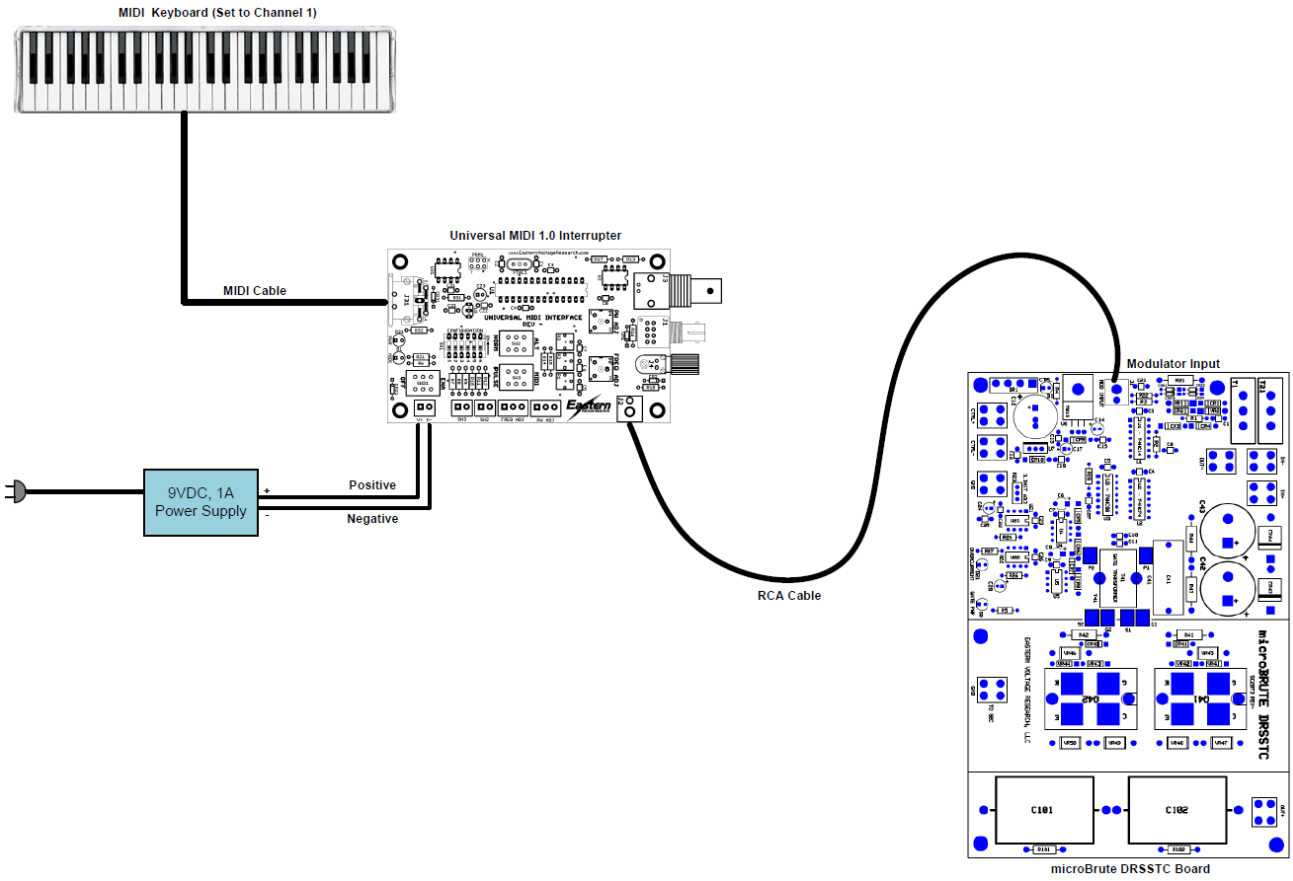
MIDI Board LED Status

The follow table lists the MIDI interface board status LEDs and their functions.

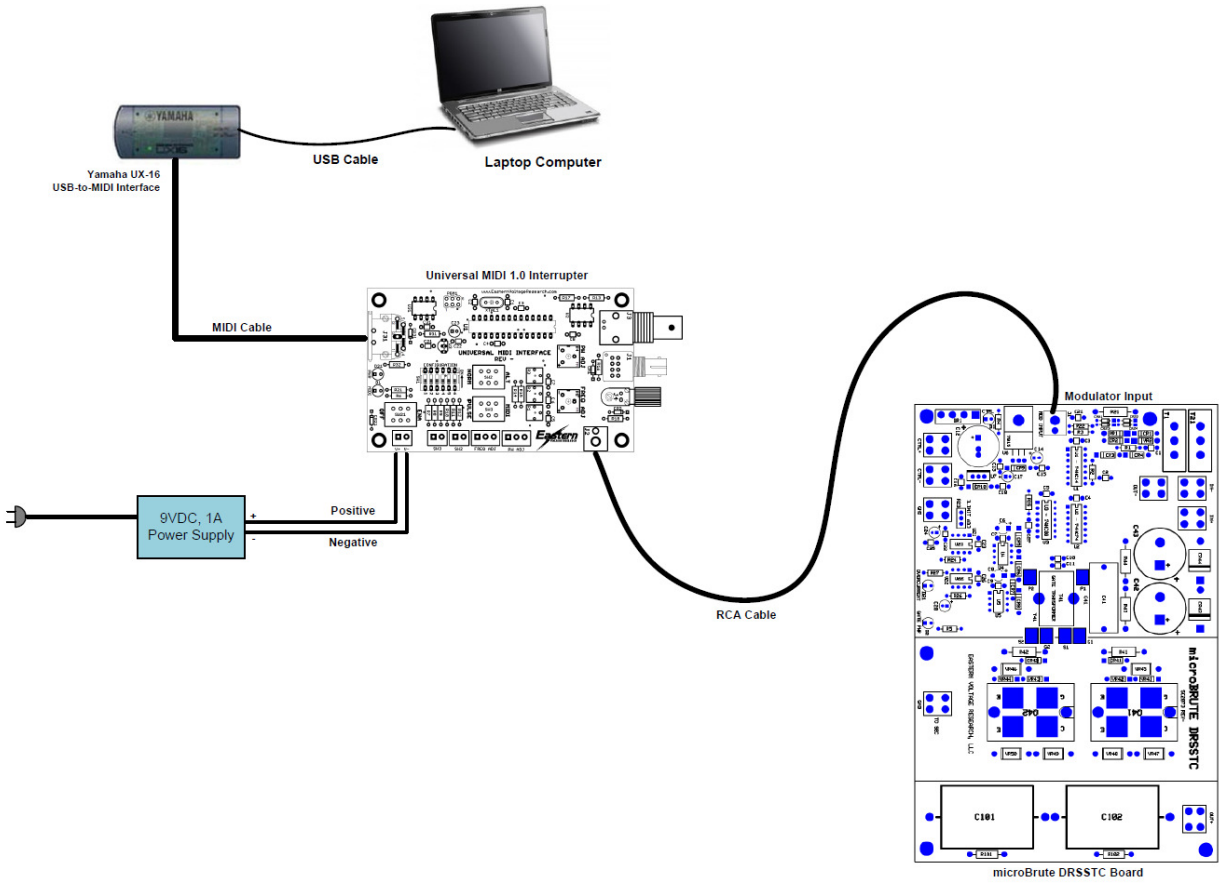
Status LED	Function
+5V, D21	This LED will illuminate when there is input power and the 5V logic power is present.
MIDI, D1	This LED will illuminate whenever a valid MIDI command is received by the MIDI interface board. Sample valid commands would be MIDI note ON, and MIDI note OFF. Note that this LED will toggle ON/OFF (change state) on each valid MIDI command received. So for example, if you press a key, the MIDI LED will illuminate. If you continue holding that key and press a second key, the MIDI LED will turn off.

Connecting the Universal MIDI 1.5 Interrupter to a DRSSTC / SSTC

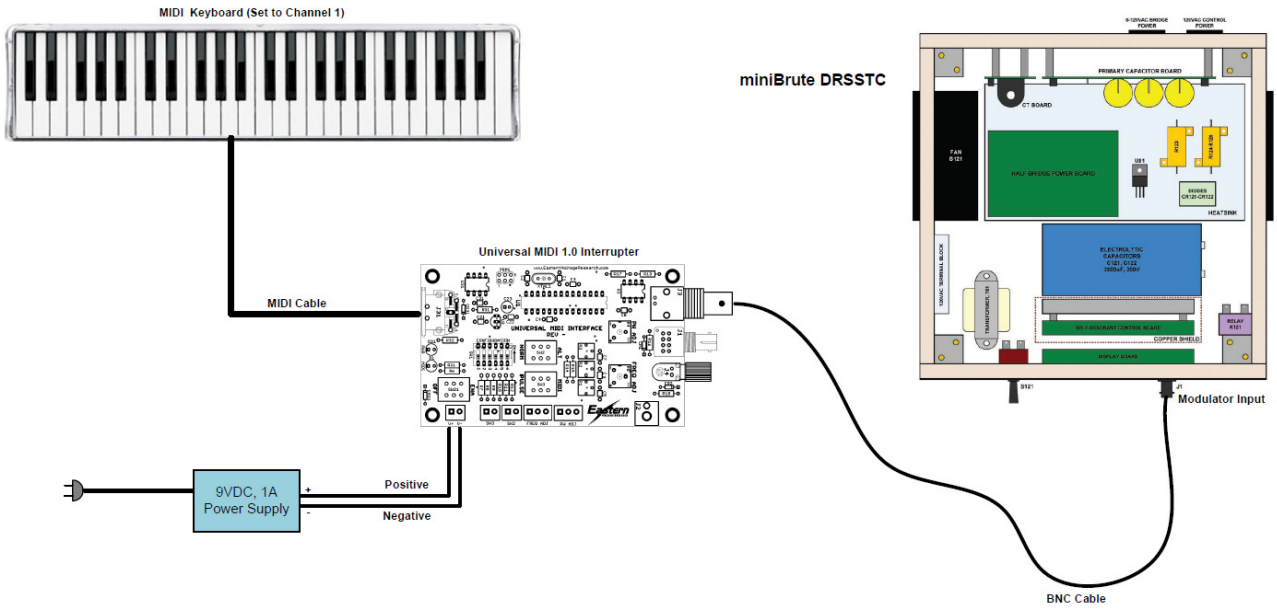
The follow figures show sample hook-up diagrams for the Universal MIDI 1.5 Interrupter board:



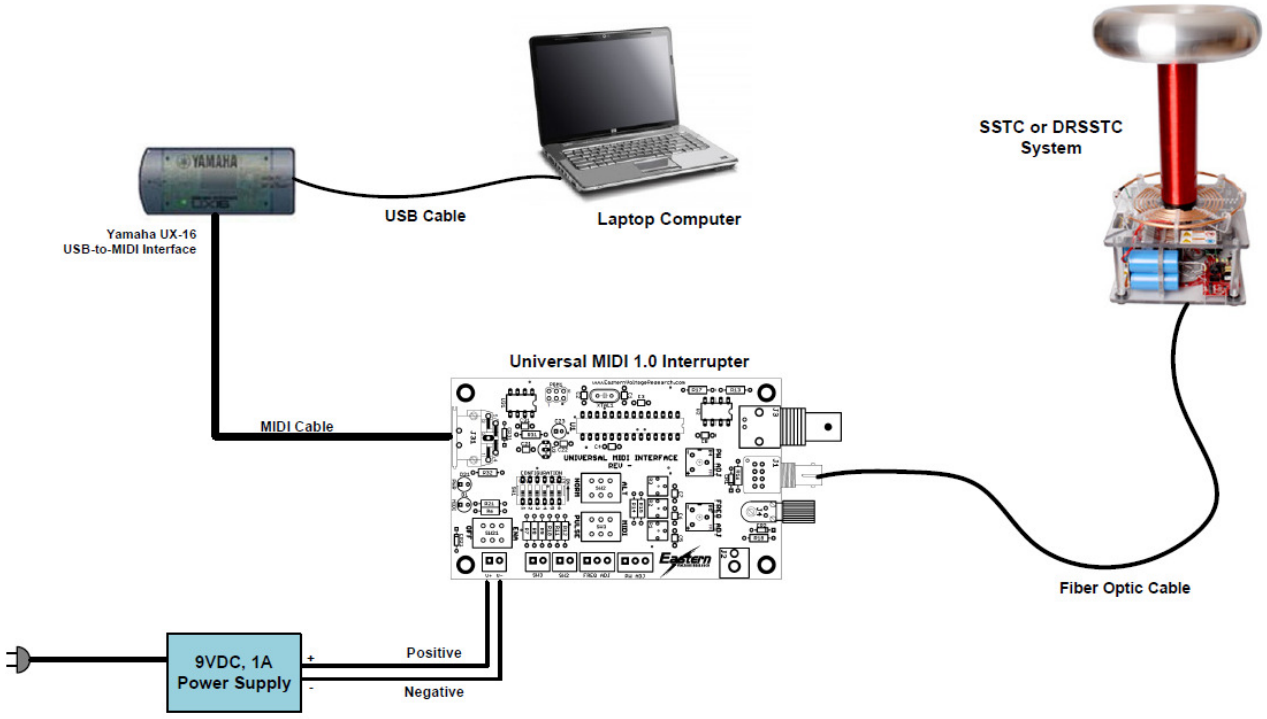
microBrute DRSSTC (using MIDI keyboard) – Hook-up Diagram



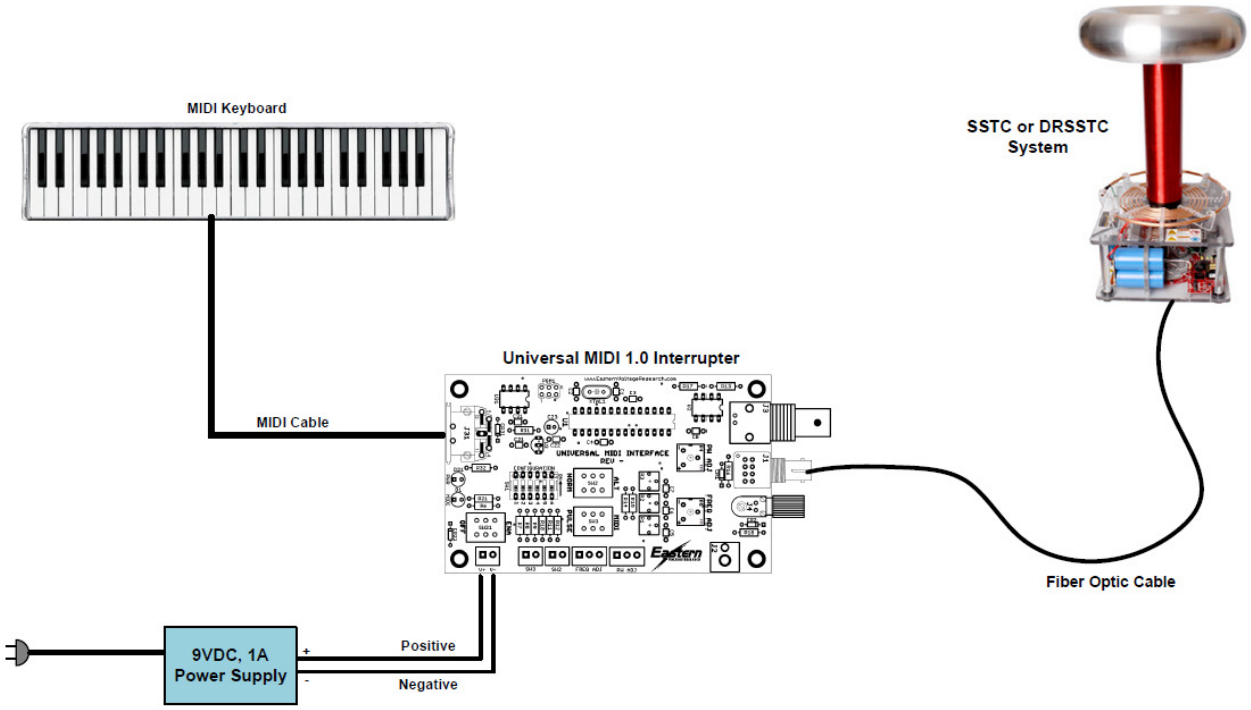
microBrute DRSSTC (using Laptop Computer) – Hook-up Diagram



miniBrute DRSSTC – Hook-up Diagram



Typical DRSSTC or SSTC (using Laptop Computer) – Hook-up Diagram



Typical DRSSTC or SSTC (using MIDI keyboard) – Hook-up Diagram

Operation

There are four (4) distinct modes the Universal MIDI 1.5 Interrupter will operate in. These are as follows:

- PULSE Mode – Standard pulse output interrupter operation
- MIDI Mode – Standard MIDI playback operation
- LOW FREQ Mode – Low frequency pulse output interrupter operation
- BURST Mode – Pulse burst operation

Mode Selection

Two onboard switches are utilized to select the desired operational mode. The following table shows how each mode is selected via the position of the two selection switches.

Mode	SW2 (NORM / ALT)	SW3 (MIDI / PULSE)
PULSE	NORM	PULSE
MIDI	NORM	MIDI
LOW FREQ	ALT	PULSE
BURST	ALT	MIDI

PULSE Mode Operation

This mode of operation provides a standard pulse interrupter action. The output of the controller is a low duty cycle pulse which has a pulsewidth and pulse repetition frequency (PRF) that can be varied in real time by the user. In this mode of operation, the Pulsewidth ADJ knob adjusts the output pulsewidth, and thus output power, of the SSTC or DRSSTC system, while the Frequency ADJ knob controls the output pulse repetition frequency (PRF), and thus duty cycle, of the Plasmasonic DRSSTC system.

In PULSE mode, the two user potentiometers have the following function:

- PW ADJUST – This adjusts the output pulsewidth of the interrupter. The adjustment range is from 0 to the maximum pulsewidth as set with the PULSE mode maximum pulsewidth trimmer, R3.
- FREQ ADJUST – This adjusts the output pulse repetition frequency of the interrupter. The adjustment range is from approx. 50Hz to 150Hz.

LOW FREQ Mode Operation

This mode is identical to the PULSE mode with the exception that the frequency adjust range is from 1Hz to 50Hz. This provides a low frequency output which is really cool, especially around 10-20Hz.

BURST Mode Operation

This mode outputs bursts of pulses and is very useful for simulating actual lightning for demonstrations, especially in the classroom. Each burst of pulses is separated by a delay of approx. 1 second and the total number of pulses per burst can be varied from 1 to 10.

In BURST mode, the two user potentiometers have the following function:

- PW ADJUST – This adjusts the output pulsewidth of each pulse in the burst. The adjustment range is from 0 to the maximum pulsewidth as set with the PULSE mode maximum pulsewidth trimmer, R3.
- FREQ ADJUST – This adjusts the total number of pulses per burst. The adjustment range is 1 pulse to 10 pulses.

MIDI Mode Operation

This mode of operation will take an incoming MIDI data stream and convert it to an output pulse of the appropriate musical frequency of the note being read in the MIDI data stream and output it to an SSTC or DRSSTC Tesla Coil and thus produce an output arc that has the frequency of that particular musical note. The controller MIDI interface supports polyphonic reproduction therefore can produce up to 3 notes at a single time.

Prerequisites for MIDI Mode Operation

The following equipment and software is required prior to using your Universal MIDI 1.5 Interrupter system in MIDI mode:

- MIDI Source – Laptop Computer (if using MIDI files for playback)
- MIDI Source – Keyboard with 5 pin standard DIN MIDI connector
- MIDI Cable
- MIDI Software (we recommend Anvil Studio Pro – available as free download)
- MIDI Files (we offer several free MIDI files available as a download on our website to get you started.)
- Yamaha UX-16 USB-to-MIDI interface (required if you are using a laptop to playback MIDI files)
- MIDI Solutions Quadra Thru Splitter (required if you plan to use dual channel outputs to drive two (2) or more Plasmasonic DRSSTC simultaneously)

Please note that the only device that we recommend as a USB-to-MIDI interface and a MIDI splitter are the Yamaha UX-16 and MIDI Solutions Quadra Thru Splitter respectively. We have not evaluated any other hardware at this time and only the devices aforementioned are recognized by us as SSTC or DRSSTC compatible devices. The use of any other devices must be done at your own risk.

MIDI Mode Operation – Additional Information

The following paragraphs provide important additional information regarding the playback of MIDI based instruments using the Universal MIDI 1.5 Interrupter.

Recommended MIDI Playback / Editing Software

For playing MIDI files through a PC or MAC computer, we recommend using the Anvil Studio Pro MIDI software. This software is available as a free download from the internet. If you plan on editing MIDI files, we recommend purchasing the Anvil Studio Pro Combo Pack 1 which to date retails for $59.99 USD.

Recommended USB-to-MIDI Interface

When using a computer to playback MIDI files, we recommend using the Yamaha UX-16 USB-to-MIDI interface. Although other USB-to-MIDI interfaces may work satisfactorily, we have not evaluated any other interfaces, so we can only recommend this one specifically at this time.

Recommended MIDI Splitter

If using multiple SSTC or DRSSTC Tesla Coils in a demonstration set-up, you will need a proper MIDI splitter to split the single stream from the computer to multiple handheld controller units. For this purpose, we recommend the MIDI Solutions Quadra Thru 4-Way Splitter. This is a passive device that will split the incoming MIDI stream into four (4) identical output streams.

Recommended MIDI Keyboard

As there are literally thousands of different keyboards, synthesizers, and dedicated MIDI keyboards available on the market, we cannot recommend a single brand / model which is fully compatible with your SSTC or DRSSTC system. That said, we have found that many of the inexpensive MIDI keyboards found the market can pose problems in that they tend to lock-up or interrupt their respective output MIDI streams which in turn causes the handheld controller MIDI interface to lock-up. Our suggestion here is to simply try a few MIDI keyboards until you find satisfactory results, or simply use a laptop computer.

Using an IPAD as MIDI Playback Device

To date, we have learned that there are several IPAD to MIDI interfaces available on the market. Although these devices look promising, we have not yet tested the compatibility of those interfaces with the Universal MIDI 1.5 Interrupter and cannot provide a recommendation.

Compatible MIDI Files

We have several examples of DRSSTC compatible MIDI files available as free downloads on our Plasmasonic DRSSTC ordering page on our website.

Creating MIDI Files

We will not cover the specifics of how to create and edit MIDI files for your SSTC or DRSSTC system here, but will cover some basics which should be followed when creating and editing your own MIDI files.

- Download MIDI Files from the internet – There are literally millions of them for almost any piece of music you can think of !
- Download Anvil Studio Pro and purchase the Combo Package 1 for $59.99. This will provide you a very inexpensive way of editing your own MIDI files. The free version of Anvil Studio Pro is also an alternative, but it is difficult as you can only view one channel at a time using the free version of the software package. (Please note that Eastern Voltage Research is in no way affiliated with Anvil Studio Pro and our recommendation is for convenience only.)
- If you are using a single Tesla Coil for playback, you will only want to use a single track of audio. For dual Tesla Coils, you will want to have two playback tracks – one for each MIDI channel.
- Use multiple notes sparingly. Although the handheld controller can decode and playback up to three (3) notes simultaneously, multiple notes does increase the power output and duty cycle of the system considerable and may blow the input fuse.
- Transpose the musical piece to the lowest frequency possible. Not only is lower frequencies more pleasing to the ear, it also reduces power consumption of the system and places less stress on all the components. High notes operate at relatively high duty cycles and place greater stress on the various components.
- If using dual channels, try keeping the high frequency or melody notes on one channel, and the bass tones on the other channel.
- When testing MIDI files, the best way is to test them first on the laptop computer. When ready to test them using a Plasmasonic, simply keep the Pulsewidth ADJ to a minimum (almost to the point where you can't even see an output arc, but still hear audio), just to hear the tones and hear that they are playing back properly.

Playback of MIDI Files – Special Considerations

When playing back MIDI files using your SSTC or DRSSTC system, please take into account the following considerations:

- When playing back MIDI files or using a MIDI keyboard, please keep the Pulsewidth ADJ setting to a minimum level to get the desired performance you are looking for. This is especially important with a MIDI piece that has many high frequency notes or multiple notes as high notes and multiple notes can greatly increase the power consumption of the system.

- If you find that your Tesla Coil suddenly stops working during the playback of a MIDI song, it is most likely due to a blown input fuse. Recognize that the playback of high notes and especially multiple notes will greatly increase power consumption of the Tesla Coil and may cause this fuse to blow. If the Tesla Coil does stop working, please follow the shutdown instructions as outlined in the previous instruction steps and inspect the fuse.
- The instantaneous playback of a single MIDI note, especially high frequency tones, can present a very high step load to the Tesla Coil and may cause a very high electrical gradient that may cause output arcs to occur between the secondary coil and primary coil / strike rail, or cause the output arcs to strike near the base of a Tesla Coil assembly. If this occurs, simply lower the Pulsewidth ADJ knob until this effect disappears or use a strike target. A strike target is simply a grounded object that the arcs can strike to as opposed to randomly flying through the air.

MIDI Playback Latch-up Issues

An issue that sometimes arises is one where during the playback of a MIDI instrument, a note will simply latch up and continue to play on your SSTC or DRSSTC system. To understand this issue, it is first important to understand the nature of how the MIDI output works. For each note played, there are two commands. One command is a NOTE ON command, while to release the note, a second NOTE OFF command is sent by the output MIDI device. We have found that with some MIDI keyboards, this stream can sometimes get disrupted when playing either very fast or by playing multiple notes. If this occurs, you can sometimes release the latched note by playing the same note again on the keyboard, or simply resetting the handheld controller. In either case, if you find this to be an issue that repeats itself frequency, we strongly recommend finding a higher quality MIDI playback instrument. Also, note that when using a computer to playback MIDI files, this problem practically never exists.

Use of External Switches / Potentiometers

The Universal MIDI 1.5 Interrupter allows for the easy connection of external switches and potentiometers if desired. As an option, there are four (4) terminal blocks which can be installed to facilitate off board connection of three (3) switches and two (2) adjustment potentiometers. This is an excellent solution for those wanting to install this board into their own enclosure and use their own special switches and potentiometers.

If external switches and potentiometers are being used, please not install the two onboard switches or two onboard shaft potentiometers.

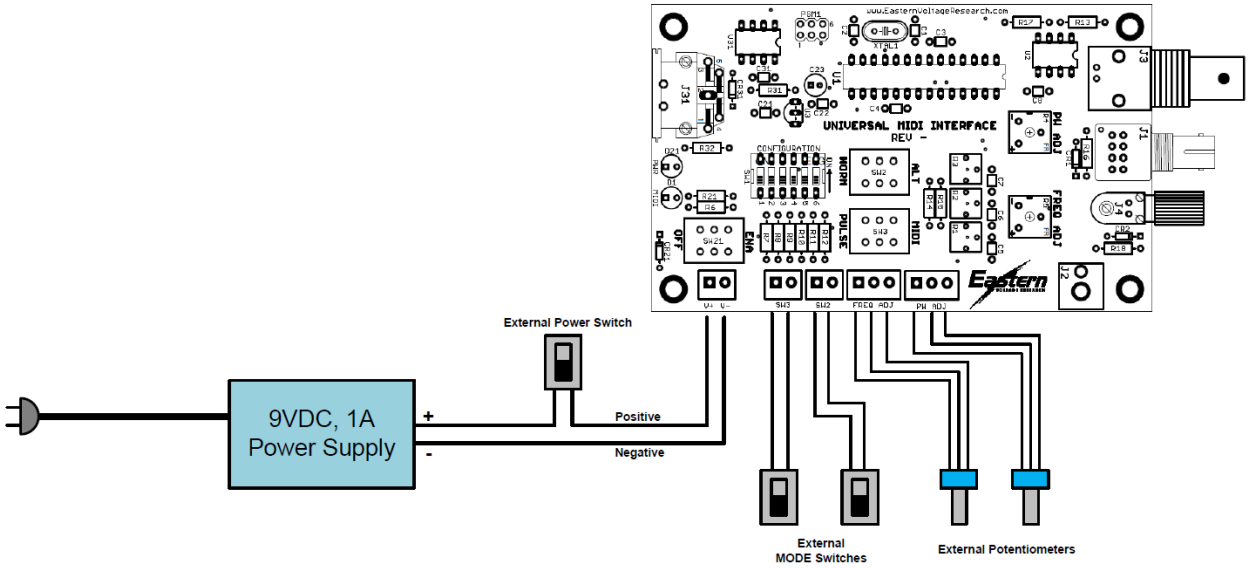


Figure – Externally mounted user controls

Troubleshooting

PROBLEM: There is no output on the MIDI interface board and the MIDI interface LED does not illuminate.
SOLUTION: Verify that the instrument and MIDI interface board are both set to the identical MIDI channel.

Conclusion

We sincerely hope that you have enjoyed the construction of this Eastern Voltage Research Kit. As always, we have tried to write this instruction manual in the easiest, most "user friendly" format that is possible. As our customers, we value your opinions, comments, and additions that you would like to see in future publications. Please submit comments or ideas to:

Eastern Voltage Research, LLC

Technical Support
support@easternvoltageresearch.com

Thanks again from the people here at Eastern Voltage Research.

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