WCFCountry
West Central Florida Section

THE WCF EXPERIMENTER

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FROM THE EDITOR:

Once again I am happy to report that we have several great articles in the Summer Edition of The WCF Experimenter. Keep those articles coming!!!

An Electronic Variable Load by Dave Chute, KG4BZW

Need a variable load to test power supply output? There are lots of projects today that generally require power sources up to 30VDC (typically 5 to 24VDC) with a current output of 1 or 2 amps. Building these power sources is pretty straight forward. You can test the output voltage with a voltmeter and the current with an ammeter. One thing needed when checking current, is that the power supply circuit should be connected to a load. Take for example a power source of 12 VDC at 500 mA. The load resistor for this is 24 Ohms at a minimum of 6 watts. The higher the current or voltage, the higher the wattage of the load resistor will be required.

Here is a simple electronic DC current load that uses three components and will provide a load up to 2 Amps or more. The components are a 100Ω ½ W resistor (R1), a 10KΩ 5W linear potentiometer (R2), a 2N3055 Silicon Transistor (Q1), a heat sink, and a knob for the potentiometer (OK that's five components). The 2N3055 I used is a TO-203 (metal can) type that can handle 15A @ 60V). Figure 1 is the schematic for this variable load.

This is how the circuit works: Q1 acts as a pass transistor for current. R1 & R2 provide the bias for the transistor. Recalling that the emitter current = base current + collector current (Ie = Ib + Ic), varying R2 varies the base current thereby varying the emitter current, therefore providing a variable load for a device connected to the circuit. R1 will limit the base current when R2 = 0 (maximum load). Because of the high current capabilities of the 2N3055 transistor (high power dissipation), it needs to mounted on some type of heat sink. Any type of heat sink can be used as long as it will dissipate at least 100W. A common way to mount the 2N3055 is on the equipment chassis (which is generally ground). When mounting the 2N3055 on any conductive surface, a mica insulator and thermal compound should be used, as well as nylon screws and nuts (or other non-conducting types). This is because the collector of the 2N3055 is connected to its case. The heat sink I used is a repurposed 4 ½" X 3 1/8" X ¼" finned heat sink.

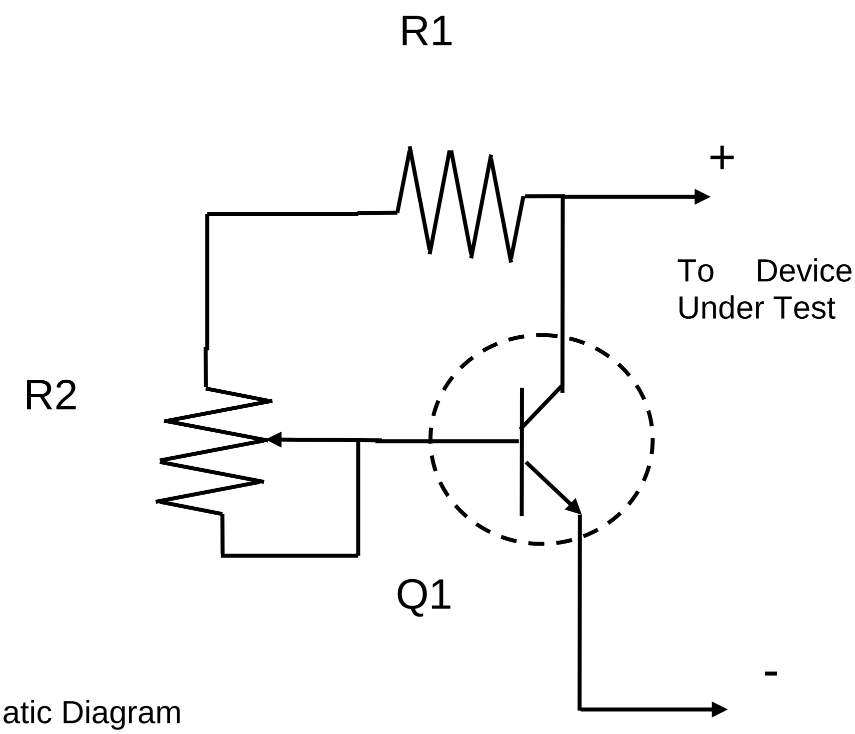
If higher current capability is desired, R1 will need to be of higher wattage. R1 at a 1/2W will allow up to 70 mA (current = square root of power ÷ resistance). At 3A of collector current in a 2N3055 will be realized with a base current of about 67 mA (the DC current gain (HFE) of a 2N3055 at 3A collector current is about 45). 5A of collector current will require 167mA base current (HFE ≈ 30). Therefore, R1 needs to be at least 3 watts. It is noted that as the pass current increases, the DC current gain decreases and the required base current also increases. One alternative would be to use a Darlington configuration for higher current loads. There are several Darlington Transistors with current ratings up through 10 Amps and above available. Using a Darlington configuration has the added benefit of being able to use 1/2 watt resistors for all resistors.

To use this variable load, with R2 set at maximum resistance (minimum load), connect it in series with the power source to be tested and an ammeter.

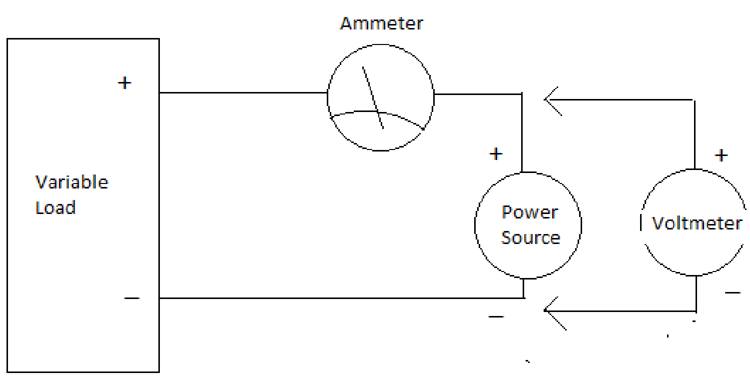
Figure 2 shows this setup. Slowly decrease R2 (increase the load) while observing the ammeter, until the desired current is indicated on the ammeter.

The power source voltage should also be monitored as well (place a voltmeter across the power source) to check the voltage sag as the load is increased.

I have found this simple circuit useful for testing several of my projects where a variable load is needed. I hope you may find this useful also. 73's and happy constructing.



Schematic Diagram



Setup for using Variable Load

Build A Buffered Compensated Wein Bridge Variable Audio Oscillator by KG4BZW

Do you have an audio oscillator in your shack? If not, this project may be a solution for you. There are several types of sine wave oscillators, Twin T, Phase shift, Colpitts, etc. Each has its own positives and negatives. I needed a relatively stable oscillator covering the audio spectrum. I remember , years ago, using a Hewlett Packard 200 audio generator. It was a Wein bridge oscillator and used vacuum tubes (remember them). So I searched around looking for an oscillator based on a Wein Bridge.

Wein bridge oscillators are quite stable but can have some problems. What I decided upon was a buffered compensated variable Wein bridge oscillator. This has temperature compensating diodes in the feedback path and a buffered output. The Oscillator uses a dual 741 OP AMP (NE5558). I built this utilizing a 4" X 5" X 6" Bud mini box. Most of the components were mounted on a perforated Vector board.

Figure 1 is the schematic diagram of the oscillator. Construction is pretty much straight forward with nothing critical as we are talking audio frequencies. The Range switch is a two pole six position rotary switch with only the first four positions used. C9 is mounted to J1 and is hard to see in figure 4.

The output is a clean sine wave at approximately 1mV p-p to 6v p-p from 14 Hz to 43 KHz. Above 43 KHz the 741 OP AMP shuts down.

In order for the Wein bridge oscillator to oscillate, the loop gain needs to be 3. Adjusting R1a provides this loop gain. Diodes D1 & D2 provide compensation in the feedback loop keeping the output stable. The frequency is determined capacitors C1 – C8 and resistors R4 – R7, selected by the range switch S2 to cover the 14Hz – 43KHz frequency range. In order to set up the oscillator and calibrate the frequency dial, an oscilloscope and a frequency counter are required.

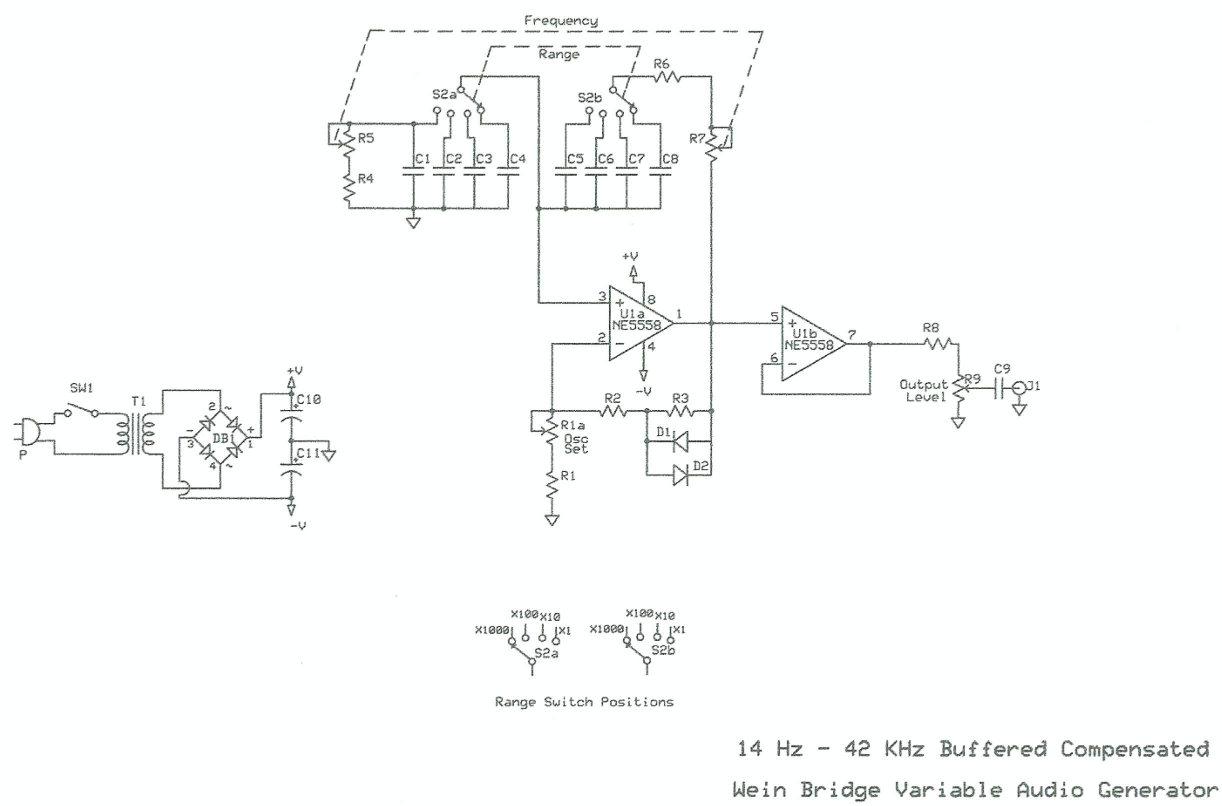
In order to adjust R1a, connect the output of the oscillator, set to around 2 KHz (a convenient frequency), to an oscilloscope and view the waveform. Adjust R1a until the sine wave flat- tops. Then slowly back off until a clean sine wave appears. Sweep through the frequency range checking for no flat-topping of the wave form, adjusting R1a if necessary. Then check all ranges using the same procedure.

To calibrate the frequency dial, you will need a frequency counter (you can also use an oscilloscope to measure frequency). I cut out a paper template for the dial and temporarily attached it to the front panel's frequency control. I chose to divide the circle into 16 equal parts. You can, of course, use any division you would like. I then chose the X10 range, set the frequency control at each line of rotation and noted the frequency at those settings. Since the capacitors used were in multiples of 10, the frequency of each range will vary by the same ratio, in theory, However, in real life they will vary slightly due to tolerances in the components. So, once one range is calibrated, check the other ranges and record the frequencies. Keep in mind that the values are approximates (but very close) and this is NOT a precision generator. Once this was done I used my word processor and made the front panel labeling, laminated it, then applied it to the mini box.

I found this variable audio oscillator a useful addition to my testing equipment. I hope you will also.

I built this audio oscillator several years ago and I recently decided to increase the frequency range above 43 KHz. I replaced U1 with TL082 dual OP AMP (pin compatible with the dual 741 OP AMP). I was able to extend the frequency range to over 100 KHz. The only thing I had to do was to recalibrate the frequency control. Happy constructing

73's Dave, KG4BZW

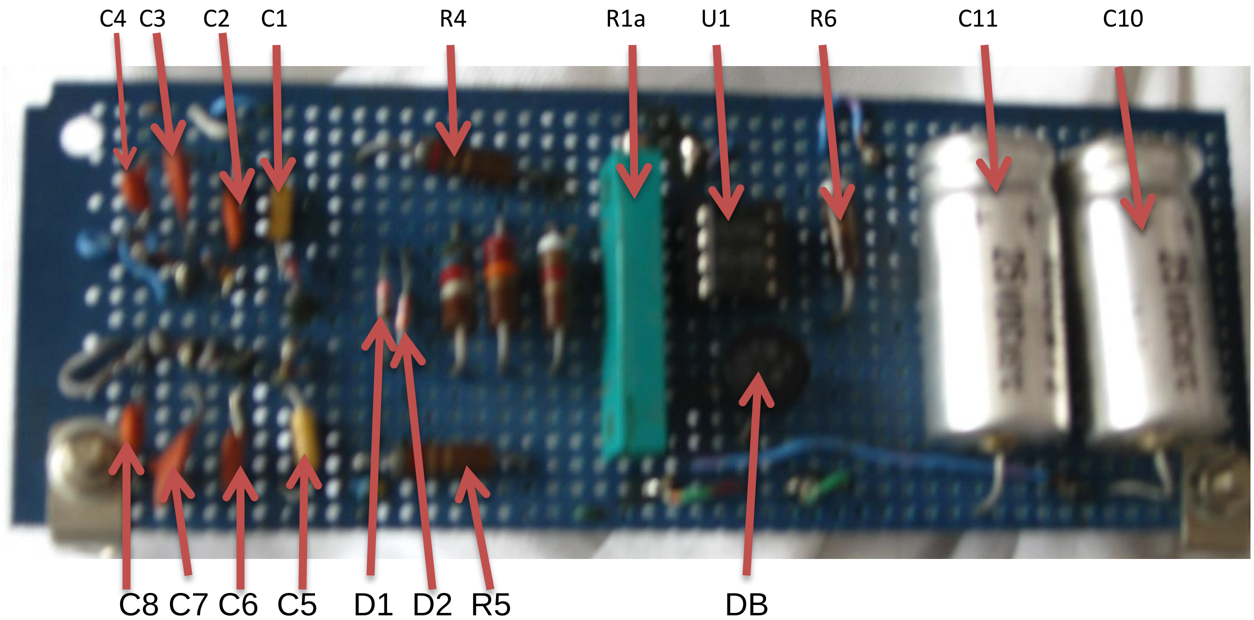


Schematic Diagram Figure 1

Electronics Parts List:

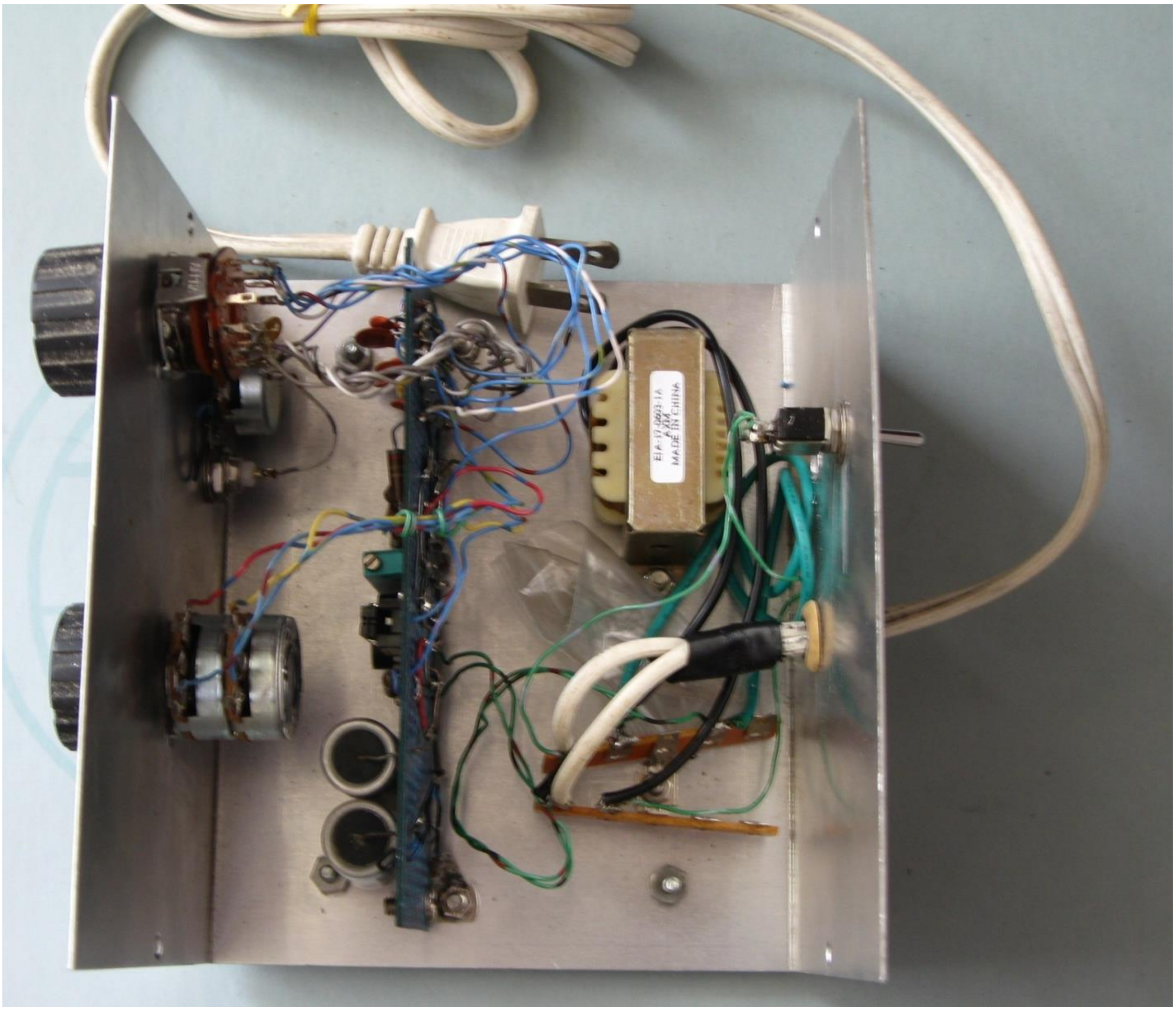
C1, C5 – 1uF, 5%, 10V capacitor
C2, C6 – .1uF, 5%, 100V disc capacitor
C3, C7 – .01uF, 5%, 100V disc capacitor
C4, C8 – .001uF, 5%, 100V disc capacitor
C9 - 10uF, 10%, 10V tantalum capacitor or equal
C10, C11 – 1000 uF, 25V electrolytic capacitor
D1, D2 – silicon diode, 1N914 or equal
DB – full wave diode bridge, 50V, .5A or equal
J1 – RF jack, BNC, chassis mount
R1 – 9.1K 1/2W, 5% resistor
R1a – 5K 10 turn trim potentiometer
R2 – 22K 1/2W, 5% resistor
R3 – 5.6K 1/2W, 5% resistor
R4, R6 – 8.2K 1/2W, 5% resistor
R5/R7 – 10K dual potentiometer audio taper
R8 – 910 Ω 1/2W, 5% resistor
S1 – SPST toggle switch

S2 – 2 pole 6 position rotary switch (positions 5 & 6 not used)
T1 – 12V, 150mA transformer
U1 – Dual OP AMP, NE5558 or equal



Parts Location on Vector Board Figure 2

Front Panel Figure 3 **Page 7**



Inside View Figure 4

BITS AND BYTES – All About Microcontrollers
By Darrell Davis KT4WX
ARRL WCF Section Manager and ARRL Technical Specialist

Welcome back to our next installment of *Bits and Bytes*. I now have some time at time being my paying job, driving a school bus, is over now the school year just ended. I am hoping for some more shop time now. Let us look at some devices you can use in your next project.

FEATURED MICROCONTROLLER – ARM Cortex M Devices**:** Last time we introduced the Raspberry PI. The Raspberry PI is a 32 Bit ARM Microcontroller based full fledged microcontroller based computer that is designed to run a full operating system. However there are other ARM processor that have less horsepower than a Raspberry PI but more than an Arduino or PIC microcontrollers. These processors range from approximately 20-120 MHz bus speeds and are all 32 bit microcontrollers. Again ARM is an architecture that is licensed to various semiconductor manufacturers that produce microcontrollers. For detailed information about the ARM Cortex M series there is an excellent Wikipedia article at ***https://en.wikipedia.org/wiki/ARM_Cortex-M***. I will mention two devices that the experimenter that is new to these devices can use for evaluation of these devices and can even be implemented into another project quite easily:

➓ **TI Tiva C Launchpad** – Manufactured by Texas Instruments for prospective developers to evaluate the TI Tiva C Microcontollers and uses one of the TI TM4C Series, an ARM Cortex M4 controller: The TM4C123G. It has a bus speed of 80 to 120 MHz, 256 K of program memory storage, 32K of RAM and 2K of non-volatile RAM (which can come in handy). It has standard headers for external interface and a built in USB based programmer and the software to program it can be obtained from the Texas Instruments website free of charge. The device only costs approximately $12 dollars and can be ordered from the Texas Instruments E-Store, or Digikey. For more information about the Tiva C Launcpad you can go to the Texas Instruments website at http://www.ti.com/ww/en/launchpad/launchpads-connected-ek-tm4c123gxl.html#tabs. There are other Launchpad's in that series.

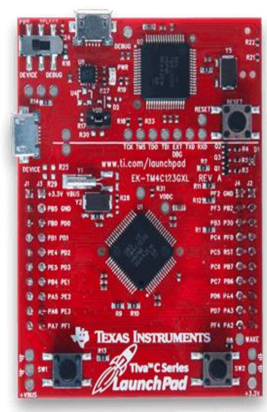


Figure 1 – Tiva C Series Launchpad

➓ **STM32 MCU Discovery Kits –** Manufactured by ST Microelectronics. There are quite a wide range of ARM Cortex M series processors that ST Microelectronics makes and there is a wide sampling of devices available. I will highlight just one: the 32F401C Discovery Board. It has similar characteristics as the Tiva C Launchpad but with a little more memory, more headers for external interface and even a built DAC (Digital to Analog) converter with a Class D audio amplifier (for driving a set of headphones). You can download all the data sheets and programming software at the ST Microelectronics website. This can be purchased for approximately $17. For more information you can go to the product page at http://www.st.com/content/st_com/en/products/evaluation-tools/product-evaluation-tools/mcu-eval-tools/stm32-mcu-eval-tools/stm32-mcu-discovery-
kits.htmlquerycriteria=productId=LN1848

Figure 2 – ST 32F401C Discovery Board

There is a trend that has developed in the last few years with all the microcontroller manufacturers to produce an evaluation board that is very inexpensive ($5-$20) so potential developers can evaluate the devices very quickly without having to buy the chips, solder them onto a board to be evaluated, which would be time consuming. For the home experimenter this may be fine, but for a development team, time creates delays to marketing a device and time is money. The secondary effect is that schools can use these devices to train future engineers. So you as the amateur radio experimenter benefit from this as well.

As I stated before, you can incorporate these devices right into your own project if you wish saving a lot of construction time.

That is all for this installment of *Bits and Bytes.* Until next time, keep your soldering iron hot and your microcontroller code coming.

Well, that's all for this edition of the Experimenter. Please keep those articles coming. There is a lot of talent in our section, not just from the RF pros but also from hams like you and me who have built a gadget or other device that makes their enjoyment of amateur radio that much better. Share your projects with others in the section. Don't forget the DCC in September in St. Petersburg!