SEITS

South East Iowa Technical Society
http://www.seits.org

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March 1998

March Meeting

The next meeting will be held on Saturday, March 21st in Muscatine, IA at the Muscatine Family Restaurant. (formerly the Sports Page) Located near the Muscatine Mall. Use the Mall parking lot. Lunch starts at noon followed by the regular meeting at 1:00pm. Please make plans to attend. I'm going to for go the map this month. I don't think any of our members would need it. The phone number is (319)263-6522 and the contact is Sally.

The February meeting was a fiasco and I have to take the blame for it. I am sorry for the inconvicence that I caused a lot of members by putting the wrong time of the meeting into the newsletter. All to often I realize the meaning of the word 'assume'. This month I hope will be better. Muscatine has been chosen for the meeting place because it's not to far for most of us to drive, its central to our area, and we haven't had a meeting there in a long time.

Also, try as I might, I wanted to get the newsletter out the door a lot earlier this month, but work has been preventing me do a lot of things lately. The newsletter was a bit rushed to finish this month so if you find any glaring mistakes, don't kill the messenger.

In this issue:

Sideband

Can I talk about the 'net for a paragraph or so. A lot has been happening in recent days. The *'Grill Bill'* campaign rages on and from what I understand he has a lot to be worried about. As Microsoft's empire gets bigger, more people are getting worried. All of this reminds me of the days of Ragan and AT&T. C-Span has some coverage and I have also found some articles on CNN's web site. If you have not been to http://www.cnn.com... believe me it's as good as the channel. Other news on this front can be found at http://www.cnet.com. Between the two sites I can pull down most of the news that I want or need.

Ever wonder about who runs the internet? Who makes the decisions about internet standards, domain naming, uses of protocols and emerging technology? Here a few url's that will point you in the right directions...

- **The IETF or Internet Engineering Task Force**, rfc's and internet drafts - http://www.ietf.org
- **W3C is the World Wide Web Consortium**, browser and server standards - http://www.w3.org
- **Network Solutions**, the InterNIC, domain name registration, top level dns servers, and whois servers - http://www.internic.net
- **The Internet Society**, proposed drafts on standards and government interaction. (currently proposing domain name suffixes like .store and .vend. Also text on the new proposal for taxing internet commerce) - http://www.isoc.org
- **The IAB or Internet Advisory Board**, works with the Internet Society on internet architectures for protocols and procedures. - http://www.iab.org

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Linear IC's & Better Repeater Audio Part II

By David Metz WA0AUQ

Last month you were introduced to the op-amp and the basic inverting amplifier circuit in the guise of a microphone pre-amp. The same circuit can be used over and over for different audio amplification applications simply by changing the resistance of R1 and R2. ***Figure 1.*** shows the basic inverting amplifier again. This time as a utility audio amplifier with a high impedance input.

As the value of R1 sets the amplifiers input impedance, this is the first value you must choose. For general purpose applications, I use 10K ohms. This is high enough that the amplifier places little load on the audio source. Its low enough so R2 (whose value sets the amplification) is not required to be excessively large. This ability to set input impedance is very useful as we will see later in the audio mixer circuit.

Before we look at the mixer, we need to look at one more permutation of the basic inverting amp. ***Figure two*** shows how to build a amplifier using a single polarity power supply. WA0KGH use to refer to this circuit as the "floating hemroid" circuit because it could be a "pain in the rear." What we are doing here is biasing the non-inverting input to one half of the supply voltage. This makes the output the same DC (and this is the important part) voltage, one half of Vc.

Note that the negative supply pin of the op-amp is grounded. Thus if the supply voltage is 12 volts, the voltage divider R2, R3 biases the non-inverting input to 6 volts (1/2 of 12). Capacitor C2 filters any AC voltage fluctuation off of this bias voltage. Remember that in an op-amp, the inputs mirror one another. The AC audio signal that is applied to the negative input appears on the positive as well and needs to be filtered off by C2.

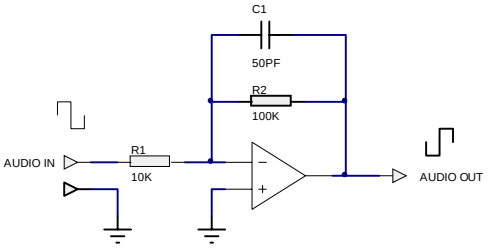


Figure 1. Showing the basic op-amp audio amplifier

Lets say for example that we have an audio input of .1V AC into the amp and a gain of ten. The output would be a 1 volt waveform superimposed on the 6 volt DC voltage the output pin is biased to by R2,R3,C2. That is the DC voltage on the output would vary at an audio rate from 5.5 to 6.5 volts! Add a coupling capacitor in series to strip off the DC, and you have your desired 1 volt AC audio waveform.

Note that while this is not the best way to run the show, this trick does work and in many simple applications will save you the trouble and expense of a dual polarity power supply. There are even special op-amps such as the LM3900 that are specifically designed for single polarity applications. In the long run however, conventional dual supply designs are easier to build and work better.

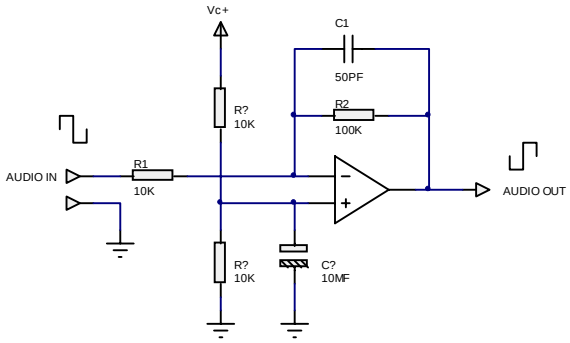


Figure 2. Showing a single polarity power supply audio amplifier. Note that the DC blocking capacitors for the input and output are not shown. These should be no smaller than 10mF electrolytics.

Repeaters are one of the few applications in Amateur radio where you have to mix different audio sources together. For a really good sounding repeater, you want each of the possible audio sources to be at the right level. For example, you don't want the IDer louder on the air than the repeated audio! If you simply tied all of the sources together through some pots, you would find that the pots interacted. That is, adjusting one would change the level of all the others.

The mixer circuit eliminates all of these problems. In our circuit, we're using 10K pots. That's a value that's easy to find and it gives a high input impedance that is easy to drive with preceding stages. Note that your mixer can have any number of pots (inputs) in it. ***Figure 3*** shows the basic mixer circuit. The 10K resistors between the wiper of the pots and the mix bus provides isolation. Without the resistors, adjusting one pot would affect the level of all the rest. With the resistor, no input sees less than a 5K input load. This is very important.

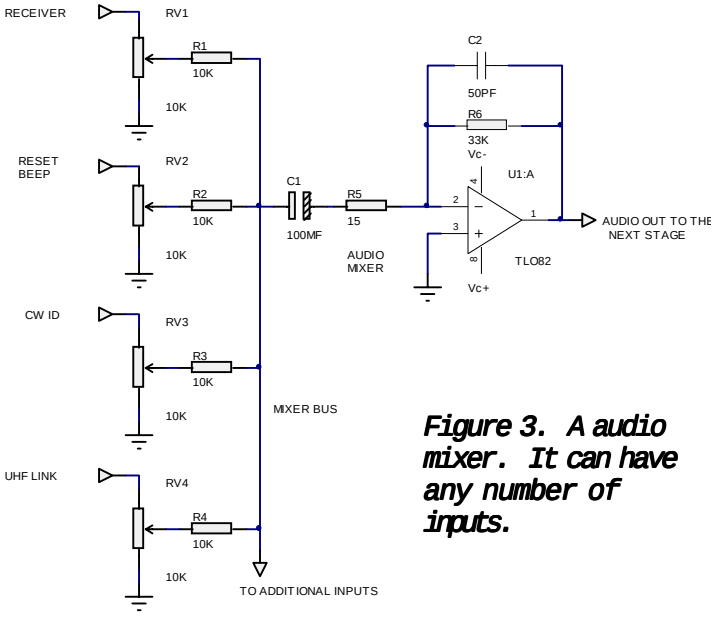


Figure 3. A audio mixer. It can have any number of inputs.

The 15 ohm resistor R2 of the mixer sets the input impedance. At 15 ohms input impedance, the input looks like a dead short compared to the 10K (R1) source resistance of the inputs to the mixer. This in affect, places all of the inputs to a virtual ground. Thus grounded, there is no audio passed from one input to the mixer back out through another. All are isolated.

Resistor R3 sets the overall gain of the mixer and as in our other examples, C1 rolls off the HF response preventing HF oscillation and RFI problems. Note that if the mixer does not provide enough gain, it can be followed by an identical inverting amplifier stage. In our example that is exactly what we're going to do to make up from the loss of the pre-emphasis network.

Edwin Armstrong, the inventor of FM modulation, incorporated into FM a simple method of noise reduction called pre-emphasis. In essence what is done is this: The high frequency of the audio transmitted are boosted on an ascending curve according to frequency. That is, the higher the frequency, the greater the modulation of the signal. The pre-emphasis is done by a simple resistor capacitor network with a time constant of 75 micro seconds shown in the center of Figure four.

On the receiving end a second network rolls off the audio highs with the same (but reversed) 75uS curve. This de-emphasis rolls off the level of the highs back to their normal amount. At the same time, the deemphasis also reduces the high frequency back ground hiss the same amount.

Proper pre-emphasis and deemphasis are not as critical with the narrow band width of amateur FM radios as it is with the 15Khz bandwidth of the commercial FM band. Proper audio shaping and pre-emphasis does help to keep radios from sounding muffled or tinny on the air. I cannot stress too much how vital it is to have flat audio response input to output on repeaters. Use of a simple pre-emphasis can restore lost high frequency response in your audio chain. For that reason I always include it in the audio chain.

In our example in ***Figure four***, R8 a 7.5K resistor and C3 a .01MF capacitor in parallel form the 75uS pre-emphasis network following the mixer stage. A 7.5K resistor can be made by placing two 15K resistors in parallel. Note that a simple R/C network like this does not boost anything. What it really does is roll off the lows. Thus passive networks like this attenuate all signals passing through them. In this case the lows more than the highs are attenuated at the desired rate.

You can also vary the values of R8 and C3 to give you a custom network to shape the audio for your specific repeater. Each repeater will have its own unique audio response curve that may or may not be close to flat. The response of the repeater can only be found through bench testing. Then the appropriate corrections can be made.

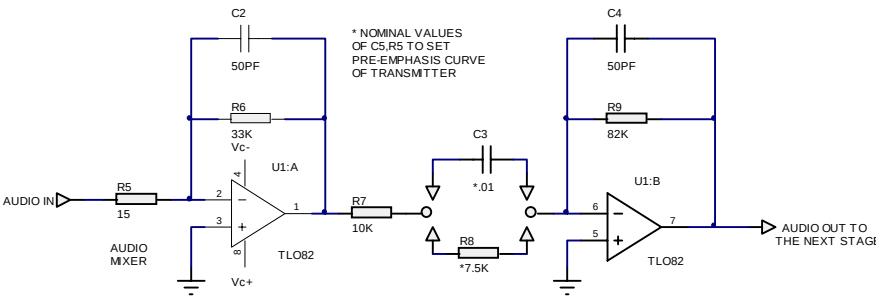


Figure four. Pre-emphasis added to the mixer out-

Op-amps can also be used for DC applications. ***Figure five*** shows a active audio clipper that I have used in all of my repeater's audio systems. This circuit has the great advantage that the clipping point can be set independently of the overall audio level. This makes adjustment of the system much easier. The circuit is uses two reverse biased small signal diodes. The bias voltage determines the voltage that the diode begins to conduct, that is clip the AC audio wave form.

Since the audio voltage is AC, two diodes must be used, one to clip the positive peak, and one to clip the negative. The op-amps provide a low impedance current source to bias the diodes. Note that the output of U1 drives U2 in an inverting configuration. Thus the positive output voltage of U1 will be exactly the same voltage coming from U2 but NEGATIVE polarity. Thus one adjustment pot (RV1) sets the diodes to the same clipping point.

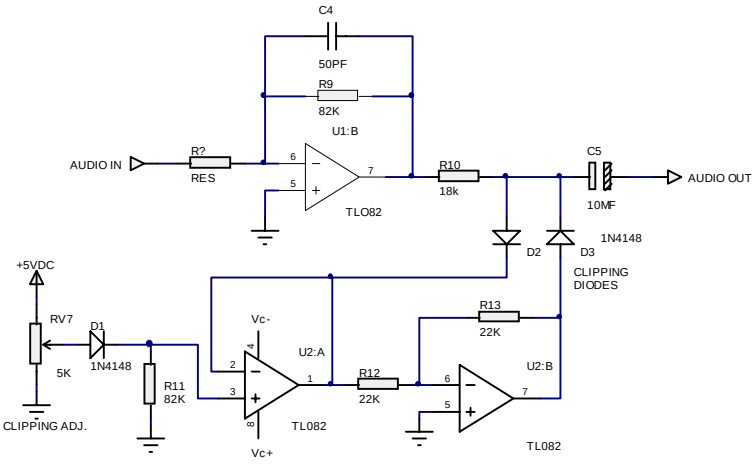


Figure five. A active clipper added after the pre-emphasis stage.

Note that you also have to have a resistor (Rx) in series with the audio source (Ux) and the diodes to provide a voltage drop. Without Rx, on peaks the diodes draw current right up to the limit of the op-amps output. The result would be distortion instead of clean clipping.

Clipping always produces second harmonic distortion. That is, the when you heavily clip a audio sine wave, you produce a square wave rich in harmonics. These would cause audible distortion of our audio an create an excessively wide signal on the air. For this reason clipper stages should always be followed by low pass filters to remove the resulting harmonics.

On the next page you will find ***Figure Six,*** a complete schematic showing all of the circuits elements discussed. If this all looks somewhat complicated compared to other repeater audio circuitry, please keep in mind that it follows commercial FM broadcast practice. My goal is to build repeaters that have virtually transparent audio so the input sounds exactly like the output. This takes a little more effort, but the on the air sound is worth it.

Next month we'll look at some passive R/C networks you can use and look at a op-amp low pass filter to follow our clipper. I will also show how these circuits are used in receivers as well. Till then, get out your experimenters board and try some of these useful circuits.

This means that when you use passive audio shaping networks, you may have to place a gain stage afterward to make up for the lost signal. Also note that you can design active filter circuits using op-amps that do not loose any signal. This type of circuit will be covered in later articles.

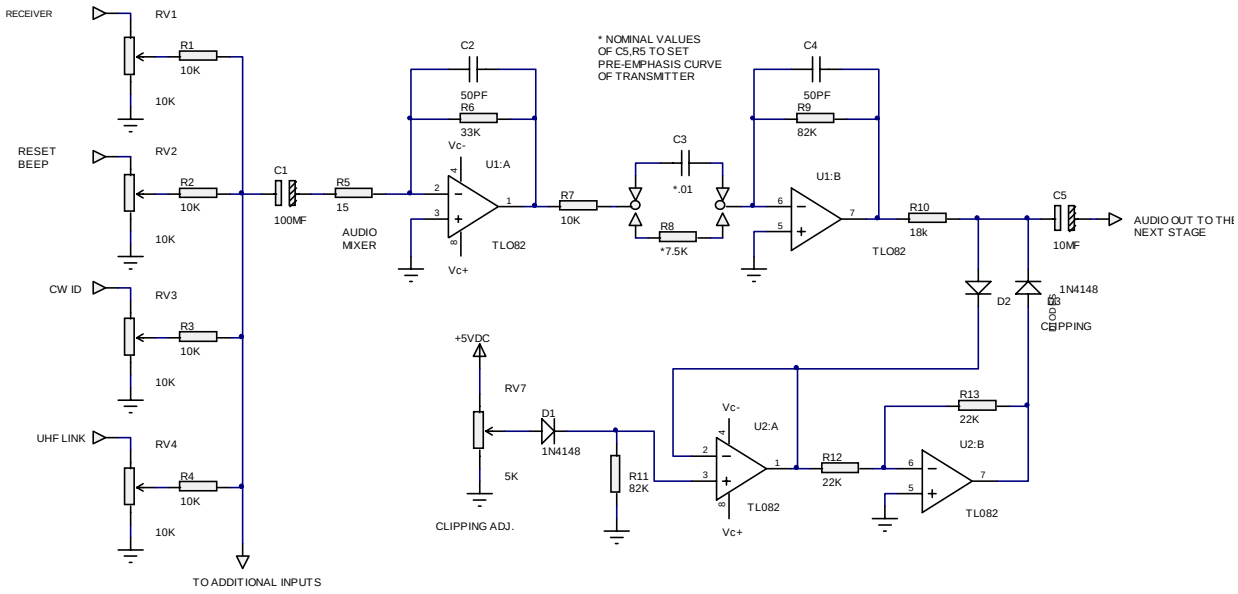
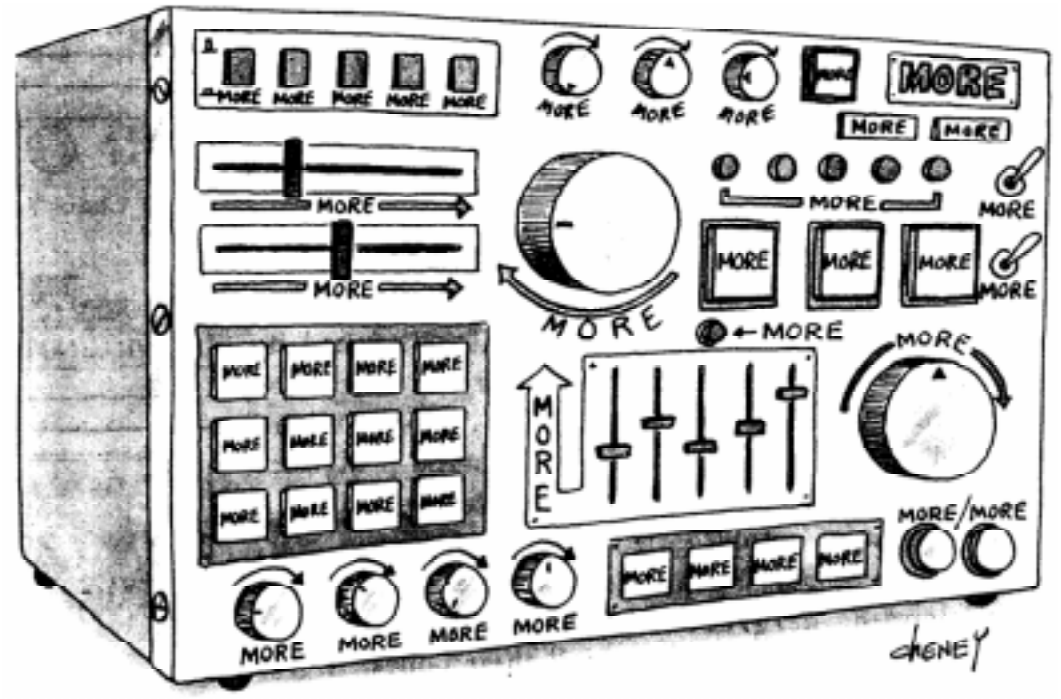


Figure Six. The complete mixer, pre-emphasis and clipper circuit.



KE0BX's new HF rig

March 1998
Presidents Column

By Dave Metz, WA0AUQ

This month in the Presidents column I'm going to change direction and give you a bit of a travelog. I do a lot of business travel the spring of every year. I sell professional winery process equipment for a living, and this is when the trade shows occur. This year for the first time my company exhibited at the "VINMOLDOVA" trade show in Chisinau, Moldova.

Moldova is a former Soviet republic located between Rumania and Ukraine just north of the Black Sea. It gained its independence from the former Soviet Union in 1991. Since then, it has been the most reform minded of the former soviet captive nations. It has an area of 20,000 square miles or less then one forth the area of Iowa. Its primary industry is wine and food production.

Visiting the capitol Chisinau is a real eye opener. I had no chance to see if there is any amateur radio in the country while I was there. What I did see is a very poor country. Communism failed simply because there was nothing left for the communist party to steal from the people. The mismanagement of the economy and everything else is simply unbelievable. Its hard to imagine this, but almost everything in Moldova is worn out and needs to be replaced.

The Moldovan people are amazingly well educated and cultured. Much more so than the same average group of Americans would be. Although they are very poor by our standards, they are always well dressed in public and polite. The well dressed Moldovan wears a black leather jacket and carries a while plastic shopping bag. Woman of all ages seem obsessed with wearing platform shoes.

The first thing you notice is the deplorable condition of the buildings and transport system in the city. Most of the population lives in tall very shoddily built apartment blocks. Transport is by broken down electric buses or simply mostly by foot. While there are more private cars, most people cannot afford one so they simply walk everywhere.

We used cabs to get around. The cabs are a Russian built car called a Lada. These are a bad copy of a very bad Fiat design that the Italians sold to the Russians years ago. In the morning we would always find the same three cabs lined up outside our hotel. The drivers would interrupt their card game and politely indicate which one ran at that particular moment. We would then take our $2.00 cab ride to the expo.

The driver would indicate to you what door worked so you could get in. Then sitting on seats covered with floor carpeting and peering through a broken window, we would lurch to the expo center. Note that the gears in the transmissions had long since lost their synchronizers and you get the idea of what the ride was like. The cabs were sometimes equipped with a FM UHF radio about the size of a Maxar but with a handset instead of a mic.

An added hazard is that with economic recovery Chisenau now has traffic, something it never had before. That coupled with streets being pock marked with huge (I mean like nothing you ever saw before) holes made for an interesting ride.

There are few retail stores and the ones that have goods like you would expect to buy locally are special "hard currency" stores. These accept payment only in Western hard currencies such as U.S. dollars, Italian Lira or German Marks. They will not take the local money and prices are twice what they are in the U.S. Couple that with a average income of $3,000 U.S. a year and you begin to understand the difficult situation the people are in.

Many of the stores operate out of rented space on the first floor of public buildings. It would be the same as if your local county court house rented out its first floor to Panasonic. State agencies do this to obtain hard currency to support their own operations. There are few tax dollars available so you get money anyway you can.

Chisinau is served by two local TV stations and Rumanian TV as well. I watched the X Files with Rumanian sub-titles along with several U.S. movies. Some U.S. programs were simply overdubbed in

Rumanian. You could hear the English sound track in the back ground with the translators voice in the foreground. It sounded like two people talking at once, but it worked.

As the phone service is erratic, most serious international business communication is by the INTERNET. You can get a private (this means it works all the time) leased phone line installed for $1,000 and $360 per month. I have not been able to get ISP fees or baud rates yet. Almost every serious enterprise in Eastern Europe has E-Mail or they simply can't function.

As for normal phone service, the Chisinau switch is so over loaded that you get a busy signal at least 50% of the time. International calls can be direct dialed maybe 30% of the time. When the system does work, it works well.

This leads me to the story of the Russian voltmeter. The machine we planned to display at the trade show refused to run. I suspected that the 380 volt three phase power was not connected properly to the machine. That is, one phase was missing.

The trade show electrician insisted he had connected the machine properly. When I ask him to check the connections, he produced his voltage tester, a small pistol shaped device with two LEDs. No matter how he connected it, both LEDs lit, leading me to question its accuracy. I resolved to find a real voltmeter the next day.

Fortunately Sylvia our interpreter knew of a the cities only electronic shop. The shop occupied a long narrow portion of the first floor of a government building and sold TV's and stereos. At one end they sold electronic parts. There I found a sales area that looked like a hamfest table only larger. Hanging on the walls were an assortment of UHF TV antennas. On the floor were rolls of Russian RG-58/59 coax. It was poor looking stuff, like what we had thirty years ago. I don't think they worried about line loss much.

A glass display case held an assortment of electronic parts taped to little slips of paper with the prices written on them. There were IC's, used horizontal output tubes, resistors, Russian military surplus bathtub capacitors and other near useless things. An assortment of light bulbs (sold singly) and extension cords completed the display.

In one corner of the case I found several small digital voltmeters. The clerk assured us they were of the highest quality made in Russia and proceeded to demonstrate on one that all of the functions actually worked. Satisfied that I had indeed found a working meter, I paid the princely sum of 70 Lie for it ($14 U.S.) and we departed.

Back at the trade show, it took only a few minutes to locate the wiring problem and get the machine running. I then decided to check the voltage one last time before closing the machines control panel. Having Sylvia hold the meter up for me to see, I stuck the probes into the 380 volt power input.

The meter responded by exploding... The tip of the red probe in my hand acted as a fuse and turned to vapor. Fire shot out of the meter case. To my amazement our ever faithful interpreter Sylvia stood next to me like a statue, her hand still holding the smoking remains of the voltmeter. Strong woman these Moldovans, she never even flinched.

The noise and the flash attracted some attention. Across from our display sat a hot dog stand and the first aid station. A large woman ran over from the first aid station equipped with a honest to god Russian army first aid kit. Seeing that no one was injured, she retired. I took the smoking remains of the meter from Sylvia and dropped it in our trash can. So ended that part of my little adventure.

All in all I have to say I enjoyed my visit to Moldova. If you want to learn more about this country they are well represented on the web.

As for the world of SEITS, things continue much as they have all winter. KD0YU has started working on the software for the service monitor. I've been answering a steady stream of technical questions arising from our web site. Some day I'm going to have to write a repeater FAQ!

—73— David WA0AUQ

SEITS

Microcontrollers

The PIC12C508

South East Iowa Technical Society

By Dave Helton, KD0YU

Last month I mentioned a new controller from Microchip, the 12C50X series. These are 8 pin, 4Mhz clock rate, programmable micro's. Well, they were news to me too. I didn't know that much about them other than the single page promo description, so I went looking for more information on Microchip's web site. I found the full 76 page section in PDF format. Printed it looks just like it came from the 2 inch thick manuals. I had worked with the 16C5X series before and the 12C50X instruction set and layout looked a lot like it so it was easy to jump right into the nitty-gritty. I started thinking this would be a fun project. But what would I have it do? Maybe a repeater ID'er or data collection device, or just a simple generic controller with enough features on the board to be used in a few different applications. The '508 doesn't have a lot of on-board storage for an elaborate program or for data collection so I needed something else. My criteria was a small storage chip that I could read/write on the fly, program with just a couple of data lines, and was small. The 93CXX series of serial eeproms could work but they would not run off of batteries. Back to Microchip's web site... this time I found the 93AAXX series of eeproms that will operate as low as 1.8VDC, perfect for battery operation, got the PDF. I also noticed that Microchip has released a new version of their assembler/editor software, grabbed that too. Data could be stored to the external device during data collection or I could program it before hand so that the controller could read the data while running or... both.

Off to Digikey to order the parts. Digikey has a state-of-the-art web site! The entire catalog is on-line in PDF format if you need it. I pulled out my recent copy of the catalog and wrote down the part numbers and quanities that I needed. If you need one of something... order two! The on-line ordering experience was great. I did not have a customer number, no matter, just plug in your shipping information and a credit card number (yes it's safe), tell the system how to ship it to you, UPS Ground, next day..etc. I was very impressed with the order forms, if I made a mistake it told me and allowed me to correct it easily. After I finished I was given a page with my entire order on it and was told to print it. With the customer ID number I was given and the order number, I was able to track my shipment via UPS's on-line tracking system. "Is this a great time or what?" --MCI

Later that evening I started a design that ended up as *Figure 1* and laid out a board design just as small as I pack it together. I had to settle for the DIP version of the '508, it was the only one that was an erasable and reprogrammable EPROM type. All the SOIC versions are OTP (one time programmable), not good for program development. For the serial eeprom, capacitor and resisters I used the surface mount types. All of the circuit board traces had to be on one side, the top. None of us in SEITS has figured out a way of doing double sided

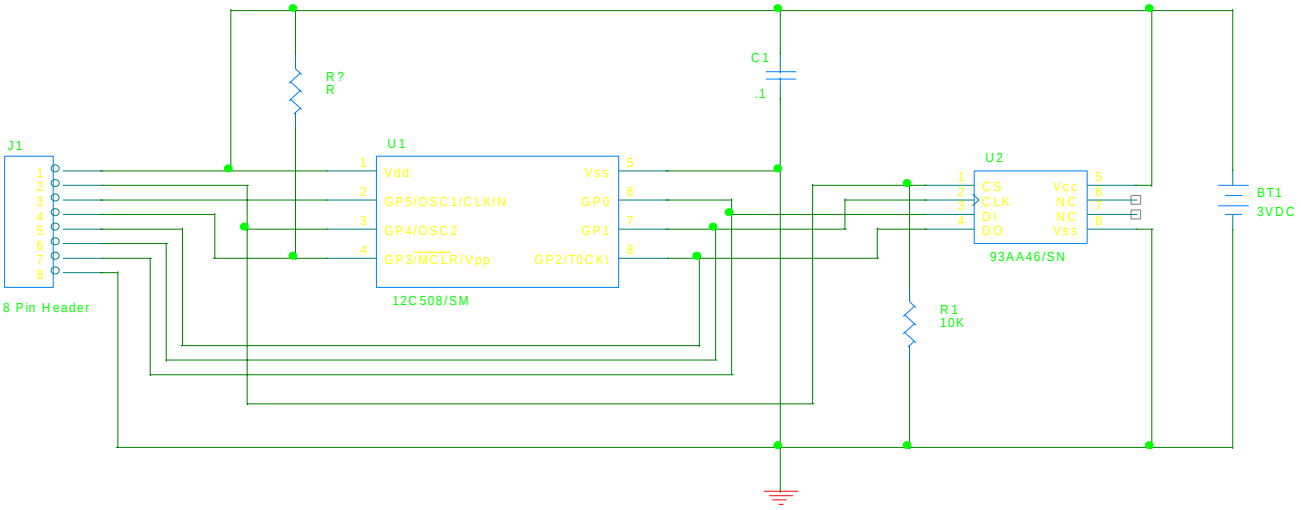


Figure 1. The Microchip 12C508 Mini-controller.

boards with the iron on film easily or reliably yet. For J1, the off-board connector I placed 8 .60x.180" pads on the edge of the board spaced .100" apart. These are similar to card-edge connectors. I soldered a standard 8 pin single row .100" gold header connector on top of the pads so the pins stick out parallel to the board. These will work well when used with a bread board to do testing and programming. To assemble the board I needed a VERY small pointed soldering iron, a pair of tweezers, a magnifing glass, .022 low temp solder, and lots of patience. I found myself holding my breath while soldering so my hand wouldn't quiver as much. After all, this board was about the same size as a postage stamp.

The '508 uses one of four crystal arrangements, one of which is the internal 4Mhz clock source. I chose it because it was one less part on the board and timing right now was not that critical. There is a register on the '508 that is used for fine tuning the clock source for more accurate timing functions, we'll use that later. The pin to pin arrangement in *Figure 1* was used for a reason. Grounding pin 4 of the '508 would keep the controller in constant reset. Pins 1,2,3 and 4 of the 93AA46 are used to read or program the device while the '805 is in check. The same is true of the '805, put a logic low on pin one of the 93AA46 to keep it from being selected and program the '805 while its in circuit. This arrangement will work well with the prototype. I went back to Microchip's web site and downloaded a source code program called SEEVAL, and acronym for Serial Eprom EVALuation, everything you need to read/write any of the Microchip serial eeproms. I modified the code to use the resources of the '805 and it seems to be working fine. GP5 is really the only I/O line on the controller that is used to work with real world signals. All other pins perform dual functions and cannot be used to connect to an external signal that you wish to control or monitor. External interference of the eeprom read/write cycles preclude it. If the eeprom was removed and the support code written out, then all lines could be used for external I/O.

Now the board is done, this is the easier part of the process. Next you have to write the program that runs inside of it. It's not easy but it can be just as much fun if you have done your homework. Learning any language is difficult. The opcodes for the PIC controllers are a lot different than those of other micros from say Intel or Motorola. The learning curve is steep and you can get frustrated very fast. When I was about to pull the rest of my hair out, I always told myself that there are others doing this and it works for them. You crawl before you can walk, walk before you can run, and the mile is made one step at a time. A few keyboards paid the price before I learned that.

To program the '805 you need the Microchip PICSTART board or something like it. A lot of third party companies and individuals are producing developement boards like it and can be found for very little money. I had to order some identity cards for my device programmer. They are not cheap but will program a bigger selection of the Microchip family. A lot of developers are making parallel port programmers aimed at one or two flavours of the Microchip line. These programmers are a great way to get into the fun for under $50.

The new assembler that I downloaded was the Microchip MPLAB. It is an easy to use graphical interface to the assembler/editor and runs under Windows95 or Windows NT. With MPLAB you can get online help with assembly syntax or how to use the various functions of the program. By breaking up your source code into smaller parts you can edit only the code module that needs changing. Group them together into a 'project' and you have an easy to manage developement environment. MPLAB is a multi-document interface meaning you can edit more than one file at a time, compile it, and see the results and error codes in a different window, all with out ever leaving MPLAB. I found it very easy to use. Microchip put a lot of time and effort into this program and it shows. Once your satisfied with your code, believe it should run.. and has compiled without errors it's time to burn the chip.

MPLAB produces a 'hex' file that follows standard formats to represent your program. All supporting device programmers can use this hex file to place your program onto the chip. (Secret tip... apply power to your board without the controller chip plugged in. If there is any magic smoke to be let out of the other parts... you can do it right away) Now, plug your controller chip in and place a finger on it while applying power. Turn it off right away if it gets to warm. (We want the controller to keep it's magic smoke in... thats what makes it work) Blink a couple of LED's or watch with an oscilliscope, you will develope your own ways of debugging your circuit.

Next month, we'll look at some uses and programs for this board. Until then you can check progress on my web site at http://www.kd0yu.com. The board layout and new code will be posted through out the month. I enjoy email and your feedback is always welcome.

73's -- Dave, KD0YU