2 port VNA that uses blue pill is working

2 port VNA that uses blue pill is working

by **profdc9** » Mon Dec 10, 2018 12:25 am

profdc9
Posts: 50
Joined: Mon Jun 11, 2018 11:20 am

Hello,

I have a working VNA. The github project is at

https://github.com/profdc9/VNA

A picture of the VNA is below. Currently it is accessible through the USB serial port. You can type commands to it and get results. A sample transaction is:

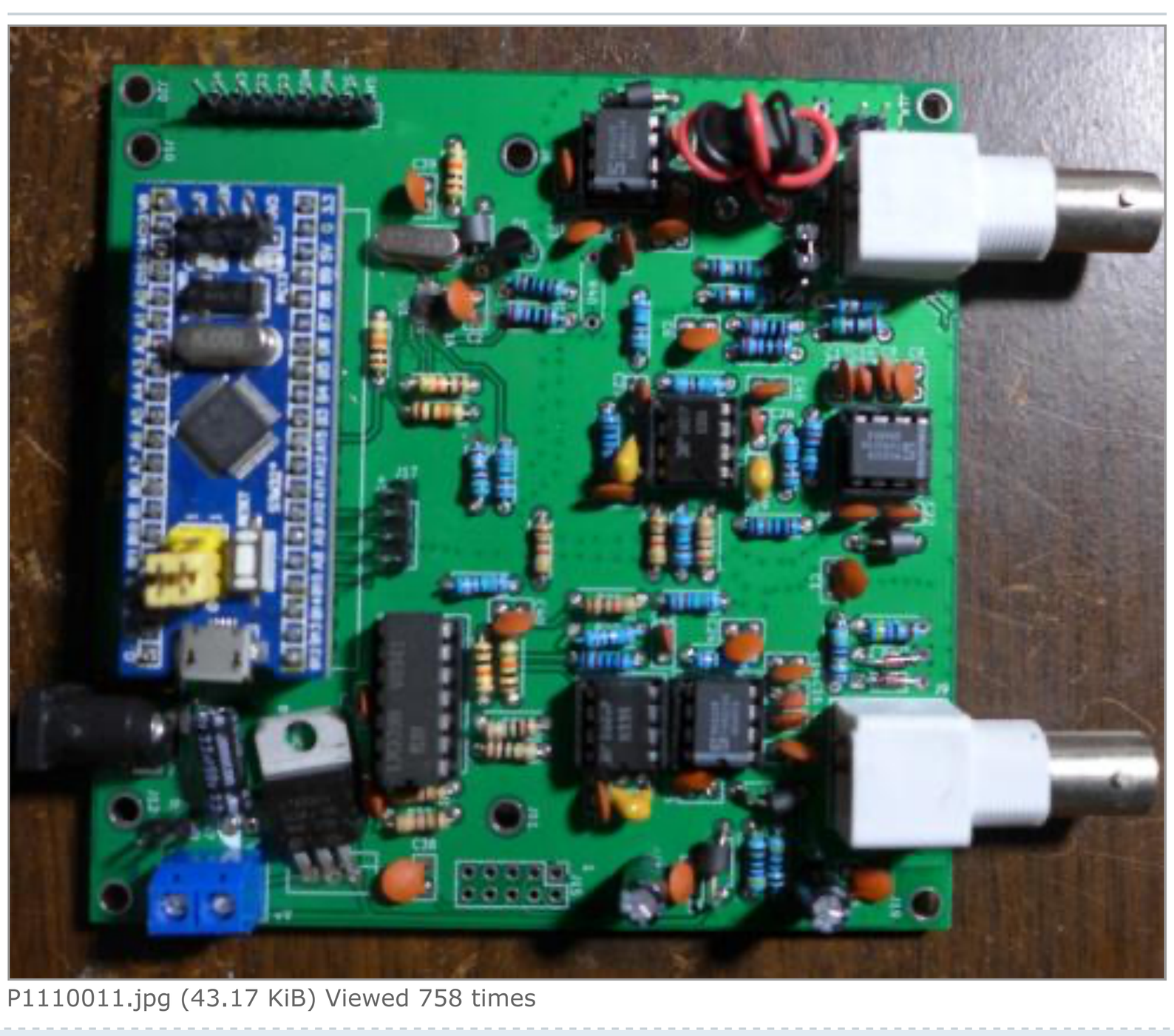
CODE: SELECT ALL
```
SETACQ 80 3000000 30000000       Set up acquisition of 80 frequencies between
                                 3 and 30 MHz.  Any existing calibration state in
                               RAM is invalidated.
OPEN                             Do an open circuit calibration (no load on port 1)
SHORT                            Do a short circuit calibration (short circuit load
                                 on port 1), also short port 2 as well.
LOAD 50                          Do a 50 ohm load calibration on port 1.  Connect
                                 50 ohm resistor for port 1.
                                 After this step, 1 port calibration is complete.
TWOCAL                           Do a two-port calibration.  Connect port 1 to port 2
                                 and execute the command.
                                 After this step, 2 port calibration is complete.
WRITECAL 1                       Write calibration state to flash slot 1
LISTCAL                          List all calibration states in flash to verify it is
```

The Kicad file is there if you want to make a board and try it. There is a connector on the board next to the Bluepill to attach a ILI9341 touchscreen.

Enjoy!

Dan

ATTACHMENTS



P1110011.jpg (43.17 KiB) Viewed 758 times

Re: 2 port VNA that uses blue pill is working

by **profdc9** » Wed Dec 19, 2018 9:35 pm

profdc9
Posts: 50
Joined: Mon Jun 11, 2018 11:20 am

There is a working touchscreen now that displays the results, so you can get SWR/S11–S21/and Z reflected/Z thru. You can look at the pictures on

https://imgur.com/a/5QKnA8I

The revised project is available at

https://github.com/profdc9/VNA

Enjoy!

Dan

Re: 2 port VNA that uses blue pill is working

by **profdc9** » Fri Jan 11, 2019 3:35 am

profdc9
Posts: 50
Joined: Mon Jun 11, 2018 11:20 am

I made a version of the 2 port VNA that except for a few parts and the Bluepill is surface mount. You can see the project at

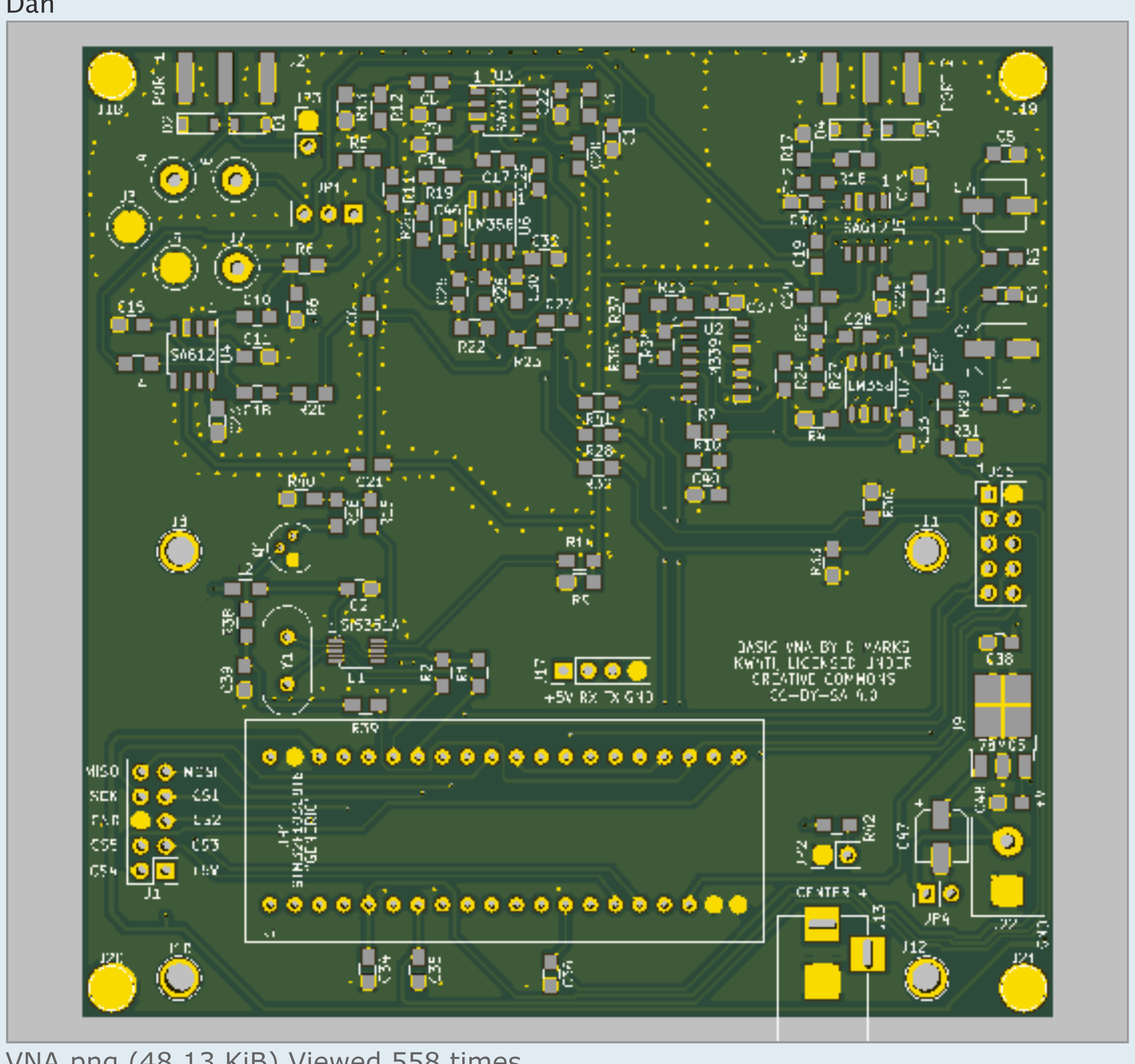
https://github.com/profdc9/VNA/tree/master/board–smt

And the whole project is at

https://github.com/profdc9/VNA/

Thanks to Roger for all the work he has put into the STM32duino over the years. It made this project much easier.

Dan



VNA.png (48.13 KiB) Viewed 558 times

Re: 2 port VNA that uses blue pill is working

by **RogerClark** » Fri Jan 11, 2019 6:48 am

RogerClark
Posts: 8416
Joined: Mon Apr 27, 2015 10:36 am
Location: Melbourne, Australia
Contact:

Hi Dan

Thanks for sharing

One of the things on my very long project list, is a antenna analyzer, and this looks very similar to what I was thinking of building

However, you use a Si5351 as your signal generator.

I noticed a few antenna analyzers uses that device, but my concern was always that it's a square wave generator, which would result in a lot of harmonic on the signal.
And since the amateur radio bands are deliberately on harmonics of each other, I thought that there could potentially be false readings generated if, For Example, and antenna was resonant on 7Mhz but the analyses was actually outputting on 3.5Mhz

I know low pass filtering can be used to solve this problem,but it would require multiple low pass filters.

But I presume that since you are now on version 2 or 3, that the harmonics generated by the Si5351 can't be a problem.

Re: 2 port VNA that uses blue pill is working

by **profdc9** » Fri Jan 11, 2019 3:45 pm

profdc9
Posts: 50
Joined: Mon Jun 11, 2018 11:20 am

The problem with the harmonics is exactly what I thought at first too, but I don't believe its actually a problem. In fact, the harmonics are actually useful for using the VNA at harmonics of the square wave, so this is actually an advantage, not a disadvantage. I realized this after having a question answered by someone working on the EU1KY analyzer.

Basically, lets say you are trying to measure at 7 MHz, so you set RF to 7 MHz and LO to 7.01 MHz to get an IF at 10 kHz. The even harmonics are not present in a 50% duty cycle square wave, so the 7 MHz consists of 7 MHz, 21 MHz, 35 MHZ, etc. and the 7.01 MHz consists of 7.01 MHz, 21.03 MHz, 35.05 MHz, etc. When mixed, you get

7.01 MHz – 7 MHz = 10 kHz (IF you want)
21.03 MHz – 7 MHz = 14.03 MHz (filtered by IF low–pass filter)
21 MHz – 7.01 MHz = 13.99 MHz (filtered by IF low–pass filter)
21.03 MHz – 21 MHz = 30 kHz (IF of 3rd harmonic, filtered by IF low–pass filter)
etc...

so that the IF at 10 kHz only contains the mixing of the first harmonic, and you filter out the 3rd harmonic IF at 30 kHz.

But also notice that if you set the frequencies at RF = 7 MHz, IF = 7.003333 MHz, you get a first harmonic IF at 3.333 kHz and a third harmonic at 10 kHz so you can use the same IF low–pass filter. So now by digitally filtering the signal at 3.3333 kHz, you can isolate the IF at 10 kHz and measure at the third harmonic at 21 MHz. So this is why the SI5351A chip, which can produce frequencies at 8 kHz – 220 MHz, can be used on the third harmonic up to 660 MHz, 5th harmonic up to 1100 MHz, etc. The SA612 mixer works mostly below 500 MHz though so I have not really thought to try this, but it could be done.

To be able to get by with the low processing power of the Bluepill, I sample the IF at exactly 4 times the IF frequency, at 40 kHz, by generating a clock signal using a comparator at the IF frequency and using a timer to clock at 4 times that rate. At 4 times the IF, you can filter the IF frequency for the in–phase and quadrature using simple additions/subtractions, because the discrete Fourier transform coefficients at 1/4 Nyquist frequency at 1, j, –1, –j, which means you are just adding/subtracting samples.

But I thought exactly as you did about the harmonics but I realized the harmonics are actually useful here.

Dan

Re: 2 port VNA that uses blue pill is working

by **RogerClark** » Fri Jan 11, 2019 7:52 pm

RogerClark
Posts: 8416
Joined: Mon Apr 27, 2015 10:36 am
Location: Melbourne, Australia
Contact:

Dan

Thanks for the explanation

I didn't realise that that your analyser used a Local Oscillator. I can see that with a LO things are a lot different to the systems that don't have one.

BTW. One idea I had about the harmonics was possibly to connect 2 of the outputs of the clock generator chip, via a resistor network, so that their values could be summed (added) together. Then delay one of the outputs by quarter of a phase to produce a stepped form of sine wave .

But I would need to double check if the clock generator can do phase control of the clocks with reference to each other

And as you have explained, harmonics may be beneficial in your application so this technique may not help in this case

Re: 2 port VNA that uses blue pill is working

by **profdc9** » Sat Jan 12, 2019 5:01 pm

profdc9
Posts: 50
Joined: Mon Jun 11, 2018 11:20 am

The SI5351 can vary the relative phase of the clocks but not the duty cycle so I am not sure how one could do this. Depending on the frequency range, probably a bank of low pass filters would work better, like the ones used on many SDRs and QRP rigs.

Re: 2 port VNA that uses blue pill is working

by **RogerClark** » Sun Jan 13, 2019 6:05 am

RogerClark
Posts: 8416
Joined: Mon Apr 27, 2015 10:36 am
Location: Melbourne, Australia
Contact:

OK.

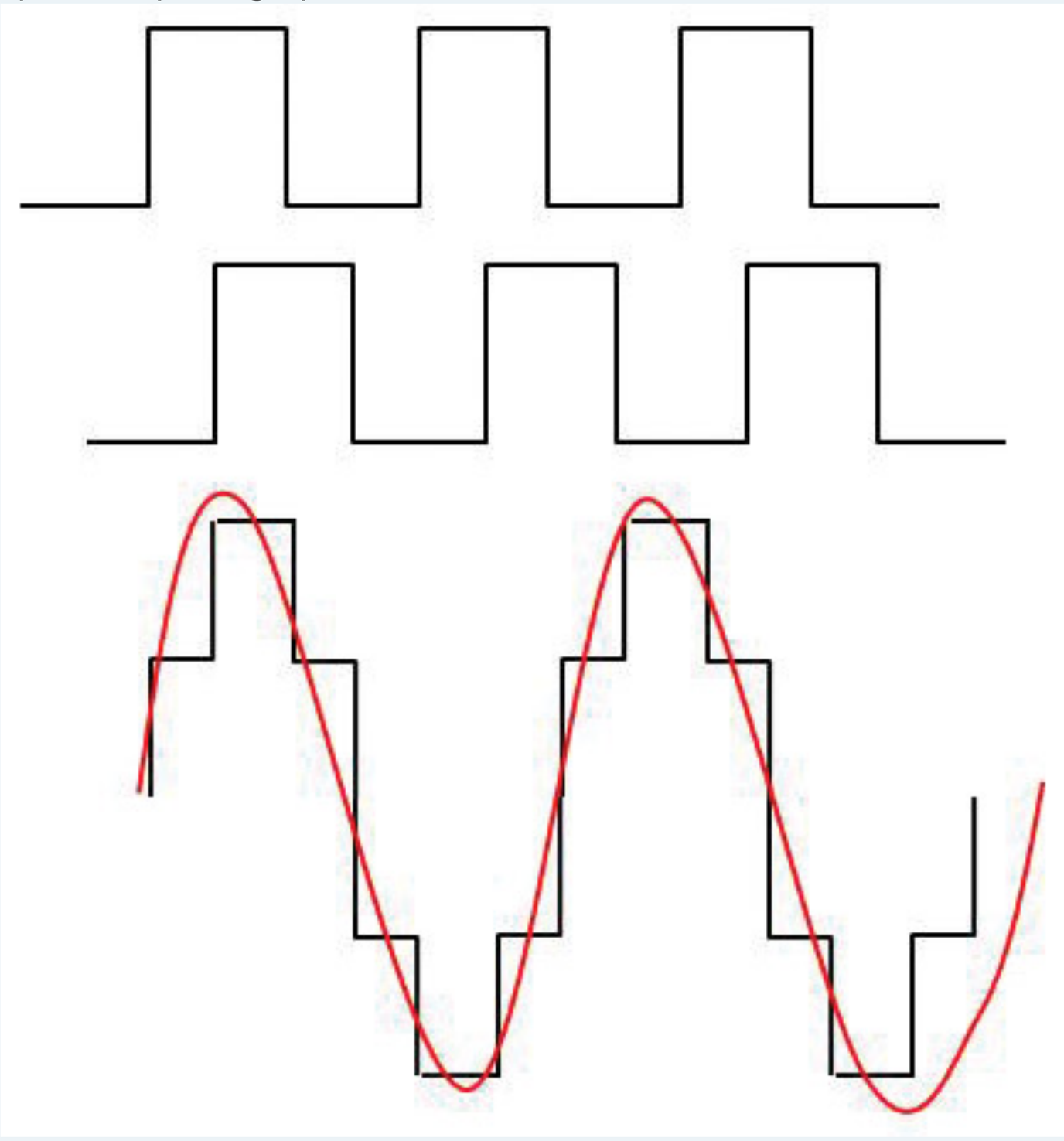
The duty cycle doesnt need to change, only the phase.

I think, If you sum two square waves, where one is 90 deg out of phase, you end up with a stepped pyramid shape, with 3 possible voltage levels.

I found it explained here

https://www.nutsvolts.com/magazine/arti ... –sine–wave

Specifically this graph



Re: 2 port VNA that uses blue pill is working

by **profdc9** » Sun Jan 13, 2019 5:21 pm

profdc9
Posts: 50
Joined: Mon Jun 11, 2018 11:20 am

I hadn't really thought of that, but it should be possible then since you can generate two outputs at the same frequency that are delayed relative to each other. So this would be a good way of reducing the harmonic content.

I do not have this feature in the VNA but I have some features I intend to add which include some primitive spectral analysis and frequency counting using the second transmission port.

Re: 2 port VNA that uses blue pill is working

by **RogerClark** » Sun Jan 13, 2019 8:33 pm

RogerClark
Posts: 8416
Joined: Mon Apr 27, 2015 10:36 am
Location: Melbourne, Australia
Contact:

Ok...

BTW. I Think the graph is a bit deceptive, as it's showing 5 distinct output voltage levels, when there are only 3 possible levels, but even with 3 levels there would be less harmonics