

Cooking from Scratch: Designing and Building a Microwave SDR

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Why?

- We do R&D, and we've used commercial SDRs for more than a decade for many different projects
 - We've been happy with commercial SDRs for the cases they fit
- We designed and built our own 5-20 GHz, 160 MSPS SDR because:
 - ✓ We wanted to do things you can't do with commercial SDR's
 - ✓ We wanted a radio we could customize for different applications
 - Change the frequency band
 - Change the sample rate
 - Build single or multichannel systems
 - ✓ We thought it would be interesting and fun
 - ✗ We had time and cost estimates that were each about 3 dB low

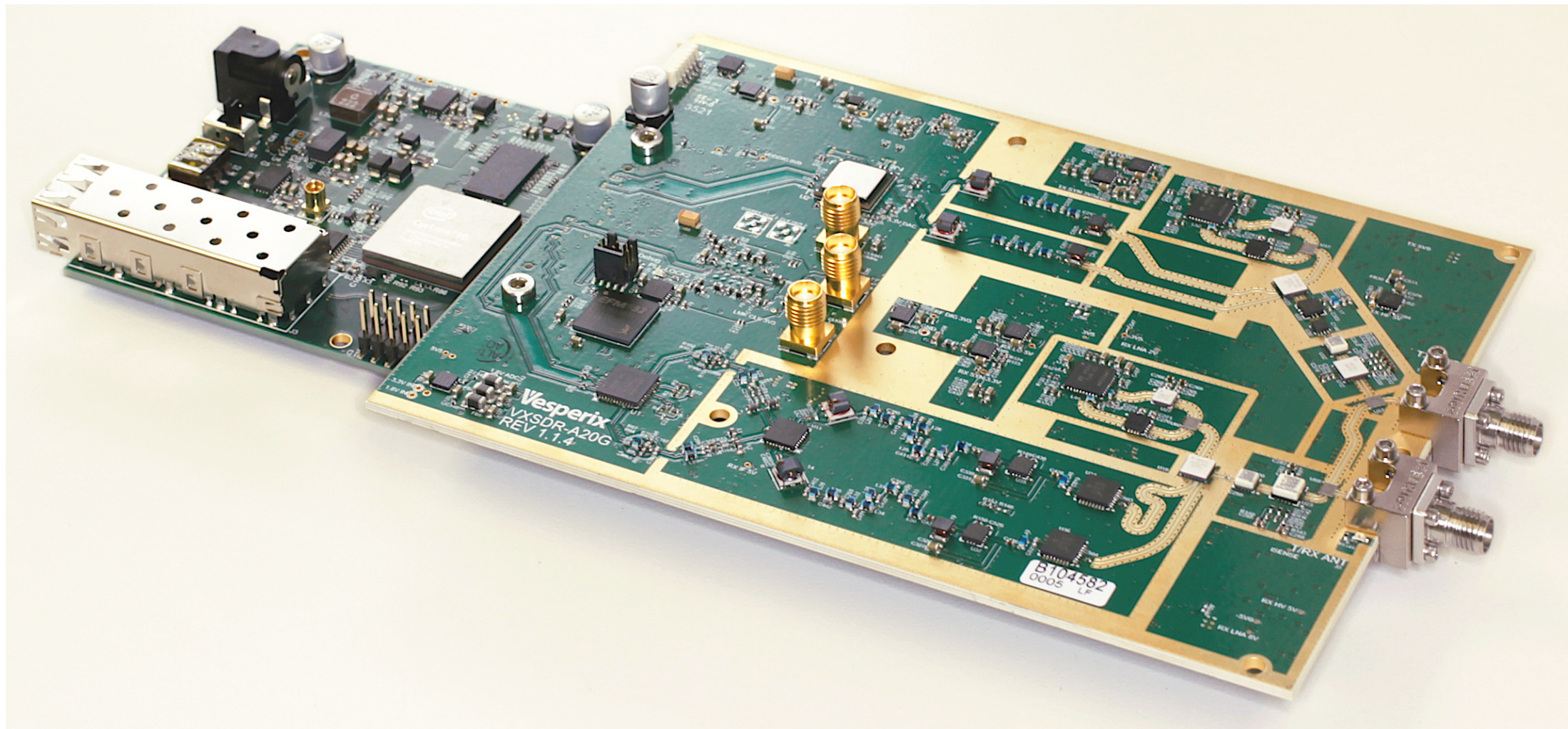


Our First From-Scratch SDR Design – the VXSDR-20

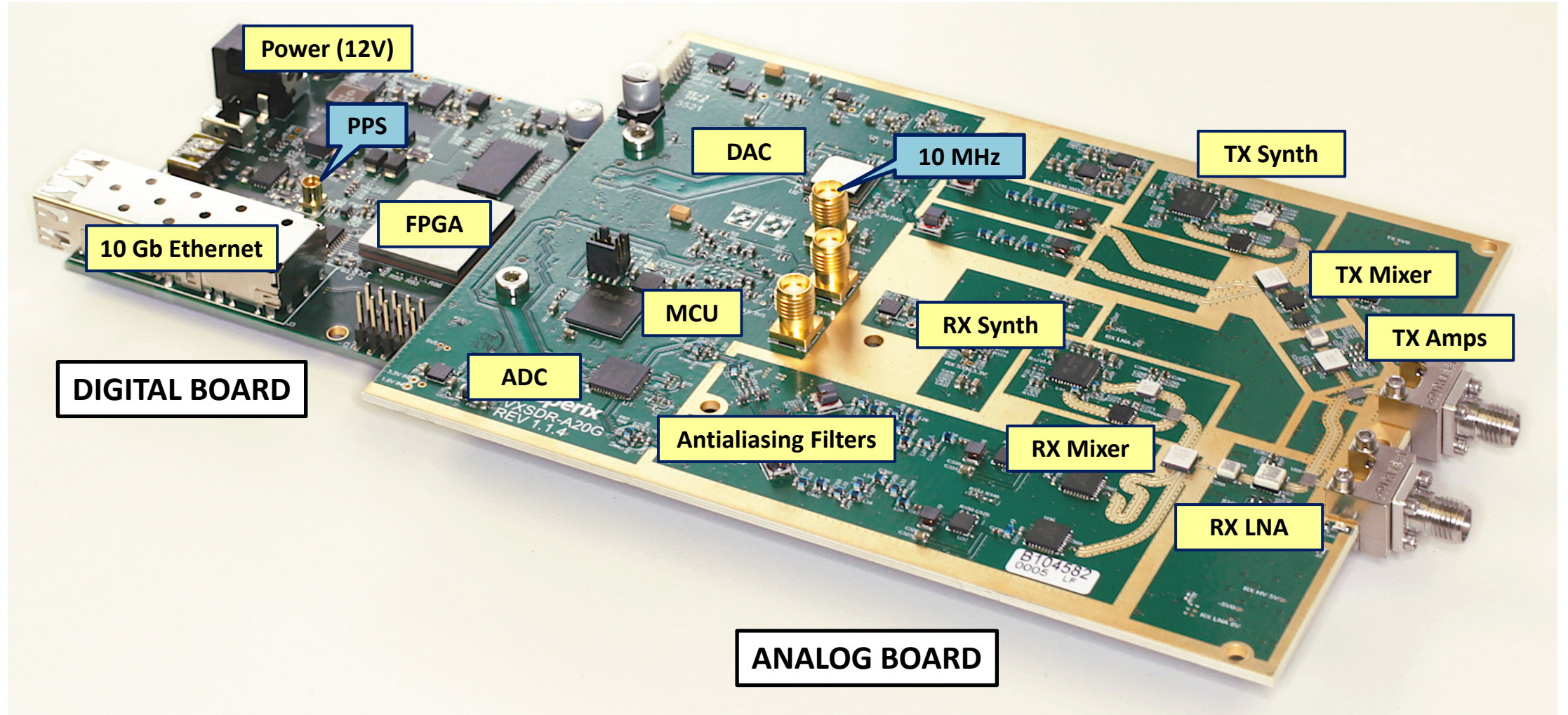
- We chose to separate the design into 2 sections:
 - Analog board with RF, IF, synthesizers, and converters
 - Digital board with FPGA and network interface
 - Using JESD in between gives us a lot of flexibility to mix and match!
- For our first implementation, we chose these design goals:
 - 5 - 20 GHz (higher than most commercial SDRs)
 - 160 MSPS each way, simultaneously
 - 10 gigabit Ethernet data transfer
 - PPS and 10 MHz synchronization
- 18 months, 2 subsystem prototypes, and 1 design rev later:
 - It works!
 - Specs are given later in the presentation, but we hit our performance targets



VXSDR-20 Boards



VXSDR-20 Boards



Measured Specs

- 5.0 to 20.0 GHz transmit and receive
 - usable to 22.0 GHz in both directions
- Receive noise figure 5 – 9 dB across the band
- Transmit power 15 – 10 dBm across the band
- Both TX power and RX sensitivity are reasonably flat (± 3 dB) across the band
- 160 MSPS bidirectional over 10 GbE
- 10 MHz and PPS work as designed
 - can be used standalone if synch not needed



Lessons Learned

- If you're going to build an SDR, do it to have unique capabilities
 - We can now do things you can't do with commercial SDRs
 - And we have a base design we can customize for future uses
- Software takes *at least* as much effort as hardware
 - Lessons from other examples during the design process (like UHD)
 - At least fixing software is easier (we spent months fixing hardware problems)
- Don't do it unless you can tolerate up to 3 dB of cost and schedule increase
- Try not to do it during a pandemic or a global semiconductor supply chain breakdown



Thank You

- We're here to get feedback from any interested listeners or potential users of a radio like this
- If there were significant interest, we'd be happy to consider a CrowdSupply project to make the radio available
- For questions, comments, or to get more info, you can contact us at vxedr@vesperix.io
- Questions?

