Title: ***SDR ~ Software Defined Radio***
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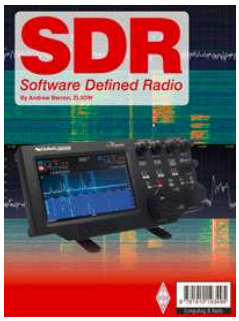

I have read and reviewed many books published for the amateur radio market and found that most have little or no value to the amateur radio astronomer. But I keep looking for good books, and while on my never-ending search I considered purchasing ***Software Defined Radio***. With a 15% member discount plus a modest Christmas holiday discount my total delivered price was reduced to less than 16 USD and I decided to buy. Shipping from RSGB in Britain to Anchorage, Alaska was relatively fast, about 2 weeks.

The following is stated on the RSGB order page {RSGB}; the remainder of this review will help you decide if it holds true:

> ***Software Defined Radio*** *is intended for radio amateurs, short wave listeners or anyone interested in radio technology. If you are interested in the technology of what was once, the domain of a few dedicated hackers and experimenters, the future of this exciting and fast developing area of radio or simply want to buy a SDR radio, this book is thoroughly recommended reading. Written by New Zealand based and acknowledged SDR expert Andrew Barron, ZL3DW, Software Defined Radio covers a huge range of material. The use of SDR by radio amateurs is growing rapidly in popularity as they become aware of the great features and performance on offer. Not only does this book cover how SDR works there are details* (on) *the different types of software that are available, what is different about them and even what is better. There is a wealth of useful information included and even guides to what to look for when you are buying equipment. There are guides to using SDR with CW, Digital Modes, Contesting, EME, Microwaves, Satellites and much more. You will find information on over 60 SDR radios that you can buy today featuring leading brands such as FlexRadio, Elecraft, Anan, Expert, Elad, Icom, WiNRADiO, SDRplay, FUNcube and many more.*

Software defined radio, or SDR for short, can be interpreted many ways depending on its context. Let us start with a formal definition provided by the International Telecommunications Union (ITU) in recommendation [SM.2152]:

> *A radio transmitter and/or receiver employing a technology that allows the RF operating parameters including, but not limited to, frequency range, modulation type, or output power to be set or altered by software, excluding changes to operating parameters which occur during the normal pre-installed and predetermined operation of a radio according to a system specification or standard.*

In contrast to ITU's open-ended yet succinct definition, the author spends about 50 pages trying to define just exactly what a software defined radio is. His actual definition is difficult to pin down, and I thought he spent far too much time trying to work this out. Unfortunately, he often contradicts himself. To further confuse matters, the author states several times that the definition is *unimportant* or *does not matter* but then continues on for several more pages about it. I was left wondering why he spent so much time and space on something that he says is not important. For my money, ITU's formal definition is sufficient, is free and gets the job done.

Part of the initial discussion in ***Software Defined Radio*** includes the author's breakdown of amateur SDRs by generation. He assigns generation numbers (1st generation, 2nd generation and so on) based on the type of mixer and point at which the analog RF signal is digitized but provides little information about the required software or computer platform. I would have defined the hardware generations differently. For example, I would say the 1st generation SDRs most often used the so-called *Tayloe mixer* (also called *Tayloe quadrature product detecto*r and *Tayloe quadrature sampling detector*), no or little RF preamplification, no preselection filtering and a PC or USB soundcard with about 24 kHz bandwidth. The 2nd generation added badly needed input filtering and maybe better amplification but still used a soundcard and had narrow bandwidths. Many early SDRs that used a USB interface suffered from poor filtering of that interface and were inherently noisy. On the software side, a number of applications were rolled out, but some were poorly implemented and some were better. Often the performance limitation came from the PC, and just about each new generation radio required a new generation PC to go with it.

As a practical matter, the only reason to categorize the SDRs by generation is to help buyers stay away from the early generation radios that now show up on the used market. The exception would be a buyer who would like to gain exposure to SDR but spend as little as possible. I think many early users turned away from SDRs simply because the early radios had very poor performance almost across the board and were good for little more than listening to AM or FM broadcast stations. However, you had to pay attention to and prevent input overloading. Of course, there were some vocal but delusional users who claimed "great results" and "superior performance", but most early SDRs did not come close to delivering on the promise of the technological concepts. There were some exceptions, for example, the RFSpace SDRs. PC and software performance almost always was a bottleneck that compounded the poor hardware performance. However, it is important to note that the inexpensive SDR technology had to pass through these early troublesome stages to get to where they are now. Each new generation was an improvement and a number of dedicated users figured out ways to modify, improve and advance these devices.

Readers can look forward to smoother sailing after the first 50 pages. The discussions are more organized and have fewer contradictions. The next major topic is how software defined radios may be used and their advantages over analog radios. Because they are mentioned often, the emphasis is on SDR transceivers, particularly the FlexRadio Systems series of transceivers used with PowerSDR software.

One of the myths furthered by this book has to do with firmware upgrades. Firmware upgrades are described as an advantage that SDRs have over analog radios. The myth is that features can be *easily* added by a simple firmware upgrade and that the SDR you just bought *never will become obsolete*. The fact is firmware in most SDRs may be upgraded but the results are quite limited. It has been my experience that firmware upgrades are primarily used by SDR developers to fix flaws in their earlier code and with very few exceptions actually add new features. Firmware upgrades seldom fix poor hardware design, particularly poor RF and interface design, or improve performance beyond the original claims. Before you know it, the developer has rolled out a new radio that, in fact, does add new features or delivers the performance originally promised but the original radio is no longer supported and is now obsolete. Invariably, the new radio introduces a new set of bugs and problems that need fixing. And so the cycle of *in with the new, out with the old* continues indefinitely or until the company or developer goes out of business. This is not to say that flawless analog radios always have been delivered to buyers but in many cases users can correct the flaws themselves. Now that is a real advantage.

There is no mention in ***Software Defined Radio*** of the various general coverage receivers such as the Icom PCR-1000, PCR-2500, R-8500, R-8600 and R-75. They apparently do not meet the author's definition of software defined radio, but one may easily argue that these radios do meet the ITU definition – their RF operating parameters may be *set or altered by software*. On the other hand, the author briefly describes several *SDRs with Knobs*, all of which are transceivers that can operate with or without software. Some of these predate the above Icom receivers, so I wondered why the Icom and similar radios were not included.

Software Defined Radio obviously is written for licensed radio amateurs who are interested in transmitters as well as receivers, but shortwave listeners (SWL) and other receiver users might find something useful. Radio astronomy is very briefly mentioned and the 1/2 page devoted to it is of no use to radio astronomers. However, that does not mean the book has nothing for that group. The general knowledge gained from this book could have some value. Some of the more popular SDR receivers used by amateur radio astronomers, such as the SDRPlay, AirSpy and RFSpace products are listed but the descriptions are far too brief and do not reflect the products available as of this writing in May 2018. Anything said about the earlier versions of these radios simply no longer applies. The SDRPlay RSP and AirSpy receivers currently being produced are more advanced than the models discussed in the book. Nevertheless, a comparison of these receivers would have been very helpful to buyers with an interest in radio astronomy. This raises the question of the book's shelf-life, which I discuss later.

This is not a book to be read cover-to-cover. Instead, after flipping through it, readers likely will go straight to sections of immediate interest, as I did. However, for this review I did read through the early chapters as noted above. Unfortunately, the chapters are not numbered, making it difficult to keep the content in perspective to say nothing of the inconvenience of trying to refer back to something. For example, there are extensive discussions of FlexRadio, PowerSDR software (about 40 pages) and a few other SDR software applications. Then the discussion immediately shifts to In-phase and Quadrature-phase (I and Q) signals, quadrature sampling and other hardware subsystems such as direct digital synthesis and analog-digital conversion (ADC). The source of this material may not be original and, if not, it is uncredited. Nevertheless, much of it is well done.

The book discusses SDR techniques and processes, but the author initially indicates that digital signal processing (DSP) applies only to audio signals and that RF and IF signal processing is different. Of course, this is not so because DSP is a generic concept common to any digitized signal that is manipulated or processed to achieve some end result such as bit rate reduction, filtering, noise reduction, modulation or demodulation. DSP is inherently based on mathematical processes but it is not covered in mathematical terms in this book. An important concept in DSP is the Fourier transform, especially the *fast Fourier transform* (FFT). It is unfortunate that the author of ***Software Defined Radio*** puts the fast Fourier transform in the context of *magic*. His discussion of this powerful and common mathematical technique is pretty weak but I suppose it is at a level that fits with his choice of the section title: *FFT Magic*. This section contrasts with a slightly later section on what the author calls a *new DFC (direct Fourier conversion) method*. The discussion of DFC is quite detailed in contrast to FFT. The techniques described may be new to amateur radio, perhaps enabled by cheap processing hardware such as PC graphics cards designed for video game playing and virtual reality viewing.

The last section of the book is a 33 page *Catalog of Software Defined Radios*. At the beginning of this section the author provides advice to new buyers such as *Don't expect a $20 RTL dongle to perform as well as a high end conventional or software defined radio*. It is quite amazing that this even needs to be stated but it does. The table of contents and index lists all the SDRs mentioned in the catalog, so it is relatively easy to find those of

interest. Although the discussions are limited to about 1/2 page for each of the 60 or so radios, the information is quite useful for comparing the basic characteristics of the radios. Included is a short narrative that describes the particular SDR along with a list of frequency range, ADC resolution, data interface type, receiver filters, transmitter power (where applicable) and some other basic details. Some descriptions include dimensions and some include voltage, current or power requirements, but this information is not consistently presented.

Some but not all radio descriptions in ***Software Defined Radio*** indicate compatible software but they are not complete and not very helpful. For example, the software for a radio might simply say *PowerSDR and others*; a prospective buyer rightly wonders *what others*? Some SDRs require proprietary software and others have only limited software drivers that are compatible with specific applications. Given that software is a third of the problem in SDR performance (along with hardware and the platform on which the software runs), it would be nice to know about those limitations. Most of the catalog information appears to have come from online sources but, unfortunately, it is not consistently presented. Nevertheless, it is interesting to see in one place summaries of the vast number of SDRs that were or are available. The author acknowledges that his list is not complete, but it probably is the most complete list available at the time of the book's original publication.

Many SDR users prefer the Linux operating system and a number of the SDR manufacturers have Linux applications that support various computer platforms (for example, ARM processors used in the Raspberry Pi and x86 processors). I did not read every radio description but saw no mention of Linux anywhere. All software descriptions in this book apply only to Windows as far as I can tell.

The front cover and both sides of the back cover have advertisements for British suppliers of radio amateur equipment. Advertising in this way probably helps offset the production costs of the book, which for an unedited paperback like this one are nonetheless pretty minimal (a few dollars per copy). All illustrations are black-white. Some schematics and block diagrams are hard to read because they have been reduced in size so much that the text and labels are unbearably tiny. This problem is not limited to books for the amateur radio market and nowadays is seen in books for professionals as well. This book has many minor technical discrepancies but none that ruin it. Perhaps these problems reflect the author's sources – some extensive discussions read like product announcements.

What about shelf-life? Given that SDR technologies are advancing so quickly, I would expect many of the radios listed to be obsolete within a couple years of publication. Some already were when I ordered the book in late 2017. The book's shelf-life is further reduced because of the software aspect, especially where the discussion applies to specific software versions. I mentioned above that over 40 pages are devoted to the PowerSDR software. I suppose PowerSDR could represent what one can expect from typical SDR software. However, in my experience software such as PowerSDR, which is developed for general applications and modulation or demodulation of man-made signals, is not nearly as useful as software developed for a specific purpose such as data gathering for radio astronomy, spectrum analysis or weak signal work.

It should be apparent by now that, like many books written and published for the radio amateur market, ***Software Defined Radio*** suffers from the lack of editorial planning and review. Most of my criticisms of ***Software Defined Radio*** are structural – those characteristics that make reading the book cumbersome or difficult – but there are some problems with content. It is obvious a lot of work went into this book but I had the feeling that some of the material was simply copied from uncredited sources. The value in the book is having an extensive

list of SDR receivers and associated software in one place. A reader who is contemplating buying a new or used SDR may find needed information and some useful ideas, but this book will have limited life because of the very high pace of change in the SDR industry.

Readers interested in a much more expensive and technical book can investigate *Software Defined Radio for Engineers* {SDREng} published in 2018 (I do not have a copy of this book).

Citations:

{RSGB} http://rsgbshop.org/acatalog/Online_Catalogue_Computing___Radio_39.html

{SDREng} http://us.artechhouse.com/Software-Defined-Radio-for-Engineers-P1951.aspx

[SM.2152] Definitions of Software Defined Radio (SDR) and Cognitive Radio System (CRS), Report ITU-R SM.2152, 2009, available at: https://www.itu.int/pub/R-REP-SM.2152-2009

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