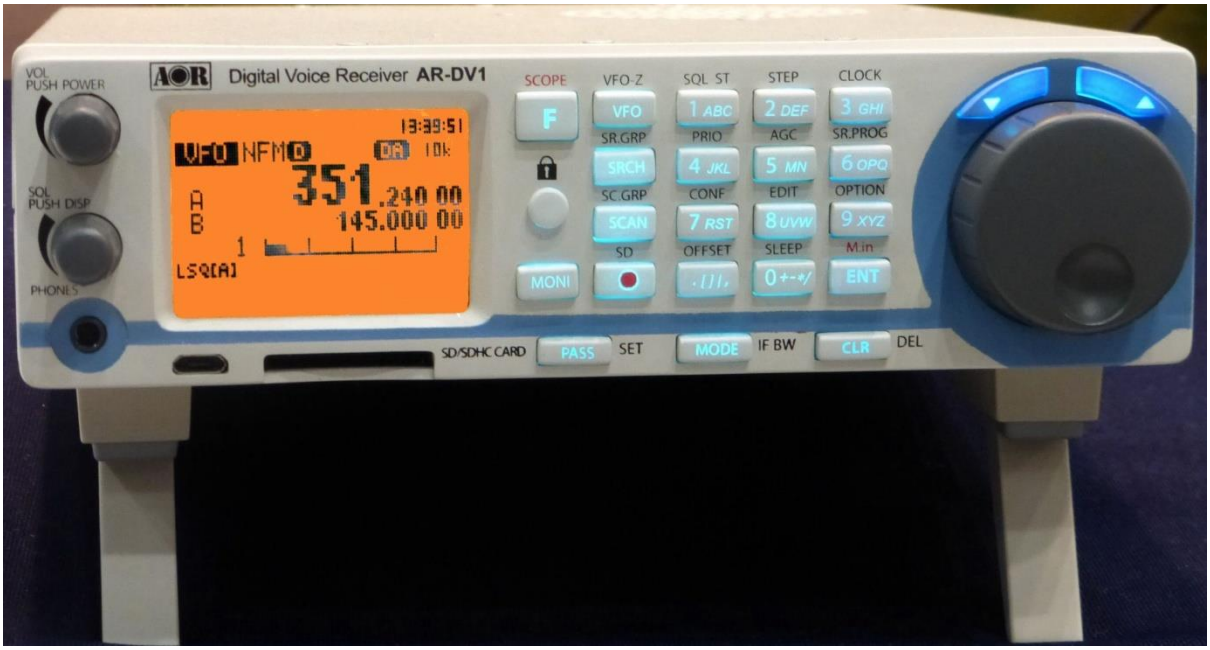
Review of the AOR AR-DV1 by David Norris Thursday, 24 December 2015



Introduction

I recall more than enough questions being asked on scanning forums and newsgroups such as “why are we still restricted to analogue signals on scanners when everything else is going digital?” Well it doesn’t have to be that way any longer - because AOR have broken new ground with the introduction of the aptly named AR-DV1 – the first fully integrated digital voice receiver which handles all common digital voice modes with no need to use a PC or other device for decoding (although a discriminator output is nonetheless provided). It uses SDR (software defined radio) technology which is fully contained within the receiver itself. I will try to keep technical terms to a sensible minimum, but have provided the specifications at the end for reference.

Please be advised that since the AR-DV1 is firmware updatable, I may as time allows, be adding to or amending this review as new features are added or bugs are fixed.

A long wait it’s been indeed! And indeed a few minor bugs have to be ironed out; it’s no mean feat to build so many modes and features into a receiver the size of a car radio. But the good news is that the AR-DV1 is firmware updatable, hence any bugs can be addressed by means of firmware updates, and potentially, new features (modes?) Added. For this reason, check back here from time to time as new sections might be added as bugs get fixed or new features or functionality added. As you can see below, lifting the lid reveals that AOR had a lot to pack into a relatively small space. I notice that the areas of the circuit which are susceptible to pick up internally generated signals are well screened; this helps to explain the lack of ‘birdies’. I remember over 20 years ago getting caught out the first time. I found what appeared to be a strong signal on about 52 MHz; I monitored it for ages but nothing happened. It turned out that the signal was still there even if the aerial was not connected! This was my first time to encounter a birdie. These are also a headache when you run a search, as they stop the search until you have found them and locked them out.

Extra coverage or, extra modes?

A reasonable enough question. There are scanners which go as high as 3GHz in coverage, and you might think there is a lot to listen to up there. In truth, most transmissions are digital in one form or another and also tend to be beamed in specific directions using high gain directional antennas. To stand a reasonable chance of hearing the transmission, you need to be 'in the beam' so to speak, or at any rate close to the transmitting site. You also need a receiver capable of decoding the transmissions. What I'm saying is that except for inside the 23 and 13cm amateur bands, there is little in the way of analogue voice signals above the 1.3 GHz which is traditionally where the coverage of most scanning receivers finishes. There are also some video signals particularly around 1.394, 2.4 and 5.8GHz, (and some illegal wireless cameras in the 1-2 GHz range), although obviously you will need a video capable scanner to receive these, and ranges are generally quite short.

The point is that having digital capability below 1.3 GHz is going to get you far more to listen to nowadays than having analogue only reception above this upper frequency. If you can't decode the transmission – then you cannot of course listen to the traffic!

Overview

Every once in a while, a new radio comes along which proves to be a game changer. New features have always given the hobby previously unknown functionality as manufacturers devise them. Examples would include synthesised receivers, non-volatile memory, computer control and cloning, trunk tracking, dynamic memory banks, close call and even the ability to connect to networks for remote control and monitoring. However, as new transmission modes come into use, scanning receivers need to keep up with the times, or they cannot monitor the communications, no matter what other advanced features they may have.

AOR have been known previously for being behind the times in terms of features. For example the AR8200 and AR8600 needed an expensive plug-in card to add CTCSS capability, and DCS ws not supported at all, for some years after other manufacturers included these as standard features.

For so many years the scanning community have lain in wait to bring their hobby into the 21st century. Scanner enthusiasts in the USA have had their needs met for many years, both in terms of trunk tracking scanners, and standalone APCO25 digital scanners. However, neither is of great use over here in the UK. Almost all of our trunked systems are of the MPT1327 type which has never been supported in any trunk tracking scanners other than in conjunction with a PC. I know of no Motorola Smartzone systems still in use in the UK, and EDACS and LTR have no UK users which I am aware of. As for APCO25, I am aware that some US bases use it, but unless you live within range of one your APCO25 capability is wasted.

However, regarding digital modes, there are certainly some newcomers on the UK scanning scene. D-Star on the amateur bands, digital PMR446 and – most crucially, DMR (Digital Mobile Radio) in use on both the amateur bands and by PBR users. Yes, these can be monitored using a PC again, although this is inconvenient and requires a discriminator output. Besides this, there is the option of using dedicated DMR handhelds, although these are not particularly cheap since they limit you to segments of either VHF or UHF unless you buy more than one.

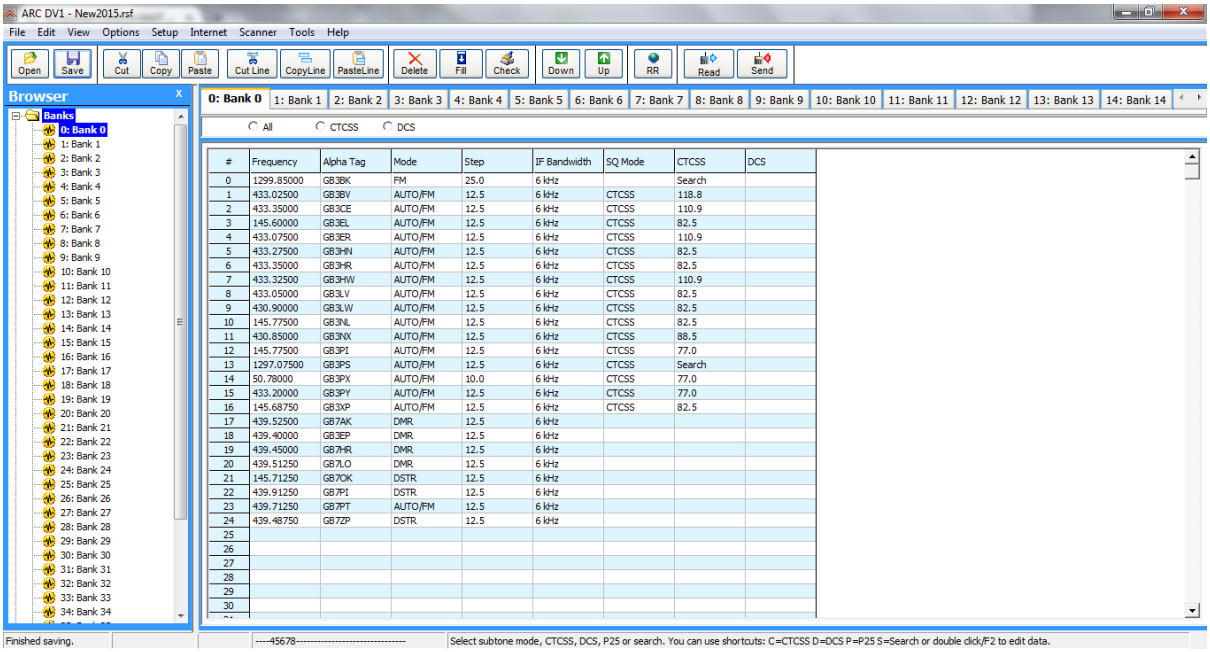
However, the long wait is finally over. Enter the AOR AR-DV1.

[I wonder at this point how many already have theirs (or more to the point, have placed their order and are still awaiting their delivery)? It comes as no surprise that right now they are selling out almost the moment stocks arrive]. The AR-DV1 like many other offerings from AOR was announced long before the public got the chance to buy one. I first learned of it in November 2014, it was launched in the United States in May 2015, but it was not until September when stocks arrived at UK dealers. In fact I finally took delivery of mine in mid-November, almost a year to the day since I first learned of its existence.

Granted, I'm not alone in that I had to save up (and sell off some other equipment) to buy mine. And unsurprisingly, due to the extreme demand, the wait was still not over. But worth it, now I have *finally* taken delivery. At the time I decided to write this review, I was 15th in the queue for mine, and had it a couple of weeks later. I can't believe I have it finally now and have actually unpacked it!

I have the beta version of ARC-DV1 from Butel (to be upgraded as soon as the full version is released of course), so when I had some spare time I could at any rate start programming in some memory

channels, so I would at any rate have something ready to upload and listen to when it arrived. Here is a screenshot; I'm going to start with my local amateur radio repeaters. There are analogue, DMR, D-Star and Fusion to choose from. That'll get me started.



Let's start in the meantime with a brief look at the basics which the manual and brochures alone could tell me in advance.

The unit is light grey in colour with light blue markings. It measures 178 X 50 X 215 mm, so it is a reasonably compact unit for base or mobile use. It runs on 10.8 to 16 volts DC (an AC mains adaptor is supplied), so it can be used in car as well as at home. It draws roughly 750 mA at 12V. In theory a 6AH dry lead acid battery would run it for 8 hours (powering equipment from 12V is a challenge in the field, so not ideal for taking to air shows and the suchlike; however digital modes are not required at air shows anyhow). I will look through the Maplin catalogues and choose the lead acid capacity which is the best compromise between weight and capacity for those odd occasions I would like to operate it away from a mains or car power supply. Maybe 4.5AH giving 6 hour's use is a good compromise between weight and battery life. This is the capacity I decided to go for anyhow; Maplin stock a range of dry lead-acid batteries and a suitable constant voltage charger.

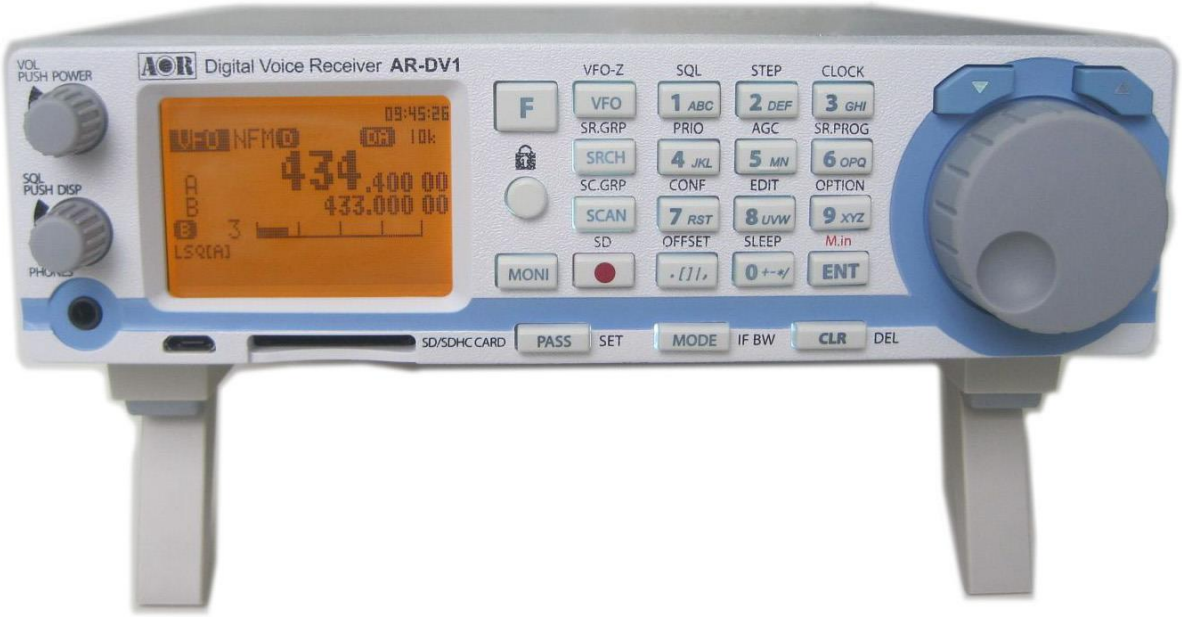


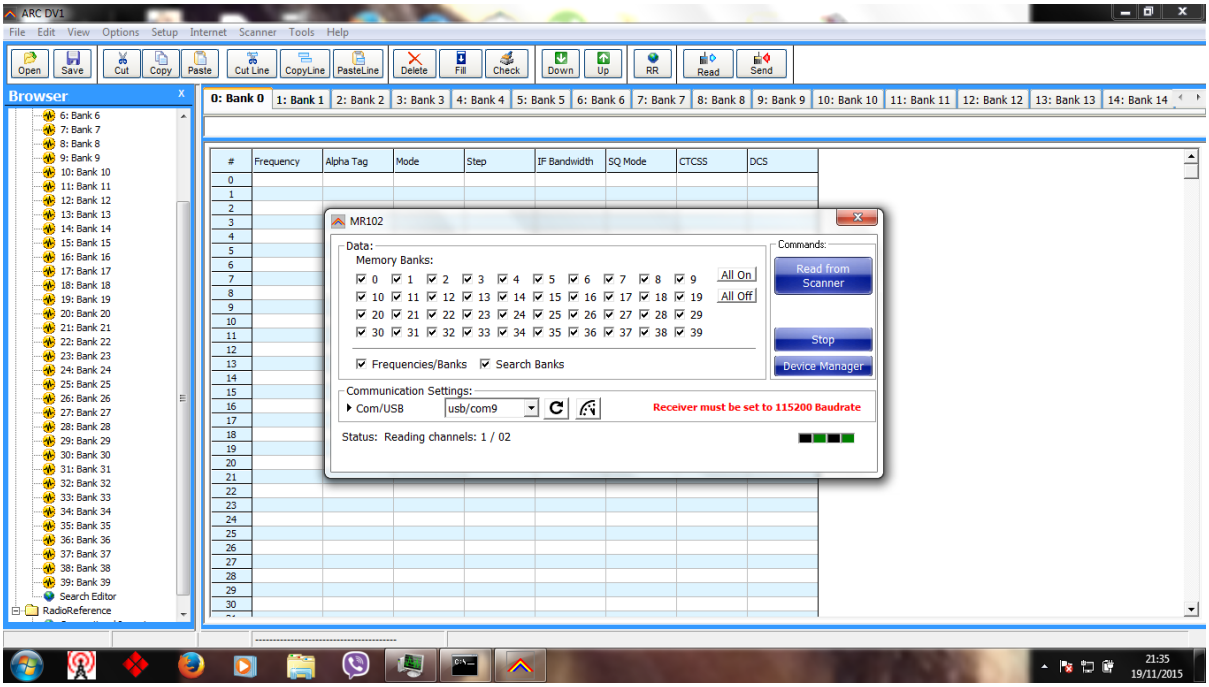
Fig. 1: front view of the AR-DV1. Note the micro-USB and SD/SHDC card sockets. Like many radios (for example the Realistic Pro 2006) it has folding feet. This allows it to present at a good viewing angle whether on a desk or a shelf. Vehicle mounting is often a challenge nowadays as few modern vehicles have any space spare in the dashboard.

Out of the box

Well first it's time to program it using the Beta version of the ARC-DV1 software. I loaded up my frequencies and so forth in advance, and now I have the radio programmed. After finding a suitable USB cable, I have found that there is a bug in the software which causes the CTCSS information not to be saved; I notified Butel and they replied. Not a big issue, it's a beta version I have so far. But everything else worked just fine and it sure beats having to enter up to 2000 memories by hand - {update: this bug has just been fixed in version 0.9, build 001, as of November 20th 2015}.

Manual tuning is accomplished by direct keypad entry in VFO mode. There are three VFO's provided. VFO A and B are an upper and lower limit to carry out a VFO search (for example, for the 70cm amateur band set VFO A and B to 430 and 440MHz respectively). Set the mode and tuning step using the mode key, and F+2. Then press SRCH to search. Alternatively, you can tune manually using the main dial or the up/down keys above the main dial. (I would have preferred these to be below the main dial to make access easier). This will get you started. There are also 40 search ranges you can program later.

So here is a screenshot of the software in use. It is somewhat slow to upload to/download from your DV1 but in half an hour the mission is accomplished (try programming it by hand in this time!). You can also sync the DV1 to your PC's clock (mine is NTP synchronised) and virtual control is available; I will give this a try when I have an outside aerial available, so I won't be listening to computer hash!



The keypad backlight colour can be changed, rather like the display of the Icom IC-R3 (Red, Green, Blue, Orange, Cyan and Magenta are available choices). The display can be dimmed, and contrast can also be adjusted to suit your needs. I haven't yet decided which keypad colour I like best, maybe blue? I'll get up and running first and later decide on the fancy settings later. In went the SD card (for audio recording, memory backup and firmware updates), and for now I'll test it using the supplied telescopic whip. An outside aerial solution is called for as soon as possible.

A quick glance through the manual to get the basics in mind and I'm good to go. Time to bring the hobby into the 21st century – and not before time!

Oddly enough the plug is two pin, although an adapter is supplied for our three-pin UK power sockets, clumsy though it may be. The power supply inputs at 230V AC and outputs 12V DC at a maximum of 800mA. So you can use it across Europe it would seem. As is sensible, this is a standard transformer/rectifier based conventional supply, not a ghastly switched mode supply which acts as a wideband noise generator 'from DC to daylight'.

First frequency up on powering on the DV1 for the very first time was 88 MHz in WFM mode; I must say that a quick tune up FM broadcast revealed very good audio given that this is a scanning receiver not a Hi-Fi.

As soon as the kids are in bed I'll have my first tune around. Here come my first pictures of it in use. It's quite late so I'm limited to transmissions available at 11pm, but I can't wait to try it on the newer digital amateur radio repeaters! I have D-Star and DMR repeaters in range from my QTH.

Sensitivity and selectivity

Analogue or digital, this is of paramount importance. (If your scanner is too deaf to hear a distant but active signal, neither can you!). A few simple tests on various amateur bands confirm that (except below medium wave broadcast, where specifications are not guaranteed) sensitivity and selectivity are in the same class as other receivers I consider good. It's worth remembering that judicious usage of the notch filter, noise reduction and of course, the optimal aerial for the band of interest will pay dividends.

Powering up takes a few seconds, as with most firmware operated equipment. As does powering down. A quick tune into London Volmet Main on 135.375MHz reveals good reception, as does Shannon Volmet on 5.505 MHZ USB. An outside HF aerial would help matters.

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A brief test on UHF reveals that DMR transmissions are recognised in under a second in Auto mode, a more comprehensive test will follow when the bands are busier. I have heard my first DMR audio though, so I'm off to bed in the knowledge that it works! Remember, digital modes are much less tolerant of weak signals or multipath reception than analogue as we found out when television was switching over.

No set bands

For those used to conventional scanners, there are no set bands as such; the coverage is continuous throughout the entire tuning range. Any mode, frequency and bandwidth can be selected anywhere you may tune, although there are defaults these can be overridden and are not reset during a search when a set band limit is passed as can happen on Icom receivers, for example. There are likewise no coverage gaps except for the cellular bands in the USA version only. So you won't feel you are missing anything due to gaps in the coverage. In the past I remember owning scanners with set bands which cannot usually be expanded (or if they can, performance falls off outside the set band). Frustrating, I always felt I was missing out on action.

Further testing reveals that scan speed varies hugely. As far as analogue modes are concerned, speeds of at least 30 channels per second are obtained; however it slows down considerably where digital modes are encountered, since they take time to decode. For example, in a bank filled with DMR channels, about three channels per second is about the limit. In auto mode (where the actual mode is set to FM and then changed where a digital modulation type is detected, a brief but annoying burst of digital noise is heard until the digital mode is detected. However, this does not

happen where the correct digital mode is already set. My recommendation would be to keep a bank or two to store newly found channels in auto mode, and then move them to a permanent bank once their mode (and your interest in monitoring the channel of course) is known. (A recent firmware update has reduced this to some extent). It's worth mentioning that scanning is faster in auto mode, although firmware update 1512A has now improved the scanning speed in general.

Incidentally, decoding DMR works well given that the signal quality is adequate, and audio recording also works well. (It seems that if at least 1dB above background is enough for reliable decoding of DMR if the reading is consistent; i.e. not fading in and out).

Once you know the procedure, backing up your memories to the CF card is easy and would appear reliable. Good news I am sure you will agree. I had my first listen to a local amateur radio DMR repeater today whilst getting Sunday dinner.

Audio is 1W via the speaker, a 3.5 mm headphone socket, auxiliary output, and discriminator outputs are provided. This should be adequate in most environments, such as my kitchen where there is a lot of background noise.

Antenna Socket

The antenna socket is a standard 50Ω BNC, so no concerns there. Except that maybe a separate BNC for HF and 30 MHz upwards might make sense; it might well save swapping plugs so often and hence wear on the sockets. This is the trouble with wide coverage – one aerial won't do it all, and you are forever changing BNC connectors unless you use a patch bay.

PC Connection

PC connection is via a micro-USB cable (AOR don't seem to provide any software to program via a PC yet, although at time of writing Butel in the Netherlands have their beta version available for testing. The DV1 can be controlled using a terminal program and typing the commands manually. This does mean that any computers having a USB interface and capable of running a terminal program could be used. By 'could' I mean that suitable software is of course required.

Fig. 2: Rear view showing connections.

Channels are 40 in 50 banks, giving 2000 alphanumeric memories in all. 40 search banks are provided (very good). Unwanted frequencies can be skipped during a search.

Using the bank linking feature during either a search or scan is challenging; it takes a great deal of manual reading and concentration since the procedure for setting up and actually using the feature are closely linked, and not separate procedures. The secret seems to be: having set the bank link you require, you need to start the scan from one of the banks included in the link.

Having mastered the job finally, the feature works quite well (if you are searching for a specific type of transmission, remember to set the mode to the type you are looking for, rather than using the 'AUTO' mode. There is provision to automatically store the frequencies found into memory bank 39, so use bank 39 for this purpose rather than as a regular storage bank). It does check whether the frequency is stored already in memory before storing it. I'm not sure yet whether he same frequency can be automatically stored a second time if the mode is different (or indeed the CTCSS or DCS tone for analogue channels); the most important thing is that auto store does not just fill up the bank with the same frequency stored multiple times!

Reception aides:

It has a notch filter, automatic noise reduction and (except in the USA version) an analogue voice inversion descrambler (occasionally used with PMR446). The inclusion of synchronous AM is useful on HF in particular, this mitigates against the effects of fading which are very noticeable with AM. The automatic gain control (very important with AM) appears to work well, which is good news for shortwave and air band listeners.

Coverage:

Coverage is from 100 KHz to 1300 MHz; this is nothing out of the ordinary these days. There are no gaps except for the obligatory cellular block for the USA version. This will give you your standard VHF/UHF listening, and coverage of HF for some alternative listening when VHF/UHF is quiet. It has all the required tuning steps also. Here is the complete list: 10 / 50 100 / 500 Hz / 1 / 2 / 5 / 6.25 / 7.5 / 8.33 / 9 / 10 / 12.5 / 15 / 20 / 25 / 30 / 50 / 100 / 500 KHz. So for example, UK CB channels can be correctly entered (offset by 1.25 KHz with a 10 KHz spacing), as can digital PMR446 channels on multiples of 3.25 KHz. To do this, choose a tuning step which is a sub-multiple of the offset required. For example, for UK CB, the 50Hz tuning step is a sub-multiple of the 1250Hz offset. Now you can cope with any bizarre offsets. Note that 6.25 KHz and 8 1/3 KHz are on the above list.

Analogue modes:

Of course it caters for all of the analogue modes you would expect (AM,NFM,WFM,USB,LSB, CW), so it will let you listen to all the things you already listen to on the bands. It has the (nowadays vital) CTCSS and DCS tone squelch of course. I will give a brief outline of the analogue performance later; however it is the digital performance I am sure readers will be primarily interested in! Suffice to say. Remember that analogue processing takes place before digital conversion, so analogue performance is still important even when you are listening to a digital mode.

Digital Modes:

And now onto the part which makes this receiver currently unique. What makes this receiver so special at time of writing is it's built in digital capability. It will let you monitor D-Star, Alinco Digital, Yaesu Digital, Digital CR, NXDN, APCO25, DPMR (digital PMR446), and – including the single most important but frequently neglected one – DMR. Not only that, it also is able to determine the mode in use if AUTO is selected (useful to determine the mode in use when you are uncertain). In digital modes, alphanumeric information such as the call sign can be displayed, so you know who you are listening to as soon as they transmit.

In terms of audibility, when the signal level is just 1-2 dB above the noise level, some echo effect (which we are used to experiencing from time to time on our mobile phones) can occur; above this level there should be no problem except under severe multipath conditions.

For the techies amongst you, the AR-DV1 uses an AMBE-3000F integrated circuit to provide digital signal processing, which is a good choice as it is a specialist chip designed specifically for this role.

Of course my own testing will depend on the transmissions in use in my area; it is also possible that more modes may be added by future firmware updates. It is worth pointing out that it cannot decrypt any encrypted digital modes, however this is only possible if the key is known anyhow. The table below (from the manual) lists the modes the AR- DV1 can monitor. It could not possibly decrypt any encrypted digital transmissions without knowing the values their keys are set to; however, for DMR just like APCO25 which is extensively used in the USA - although encryption is supported it is not an integral part of the standard as is the case with TETRA, but rather it is an optional extra which costs a lot of extra money, therefore in practice encrypted DMR signals are rare. At time of writing, I don't think I have encountered one as yet.

DIGITAL MODE	BANDWIDTH	MODE	VARIOUS	COMPATIBLE VOCODER	AR-DV1 VOICE DECODING
D-STAR	12.5kHz			AMBE	O
ALINCO DIGITAL	12.5kHz	EJ-47 (voice mode F1E)		AMBE	O
YAESU DIGITAL	12.5kHz	V/D mode		AMBE+2	O
	12.5kHz	Voice FR mode			X
DIGITAL CR	6.25kHz		NON-ENCRYPTED	AMBE+2	O
	6.25kHz		ENCRYPTED	AMBE+2	X
	6.25kHz	REGULAR MODE	NON-ENCRYPTED	AMBE+2	O
		REGULAR MODE			
	ENCRYPTED		X	NXDN	
	TRUNKING		X		
			X	12.5kHz	
		AMBE+2	O	6.25kHz	dPMR446
		AMBE+2	O	6.25kHz	TIER 1
DPMR			X		TIER 2
			X		TIER 3
	NON-ENCRYPTED	IMBE	O	6.25kHz & 12.5kHz	PHASE 1
P25	ENCRYPTED		X		PHASE 1
			X		PHASE 2
	NON-ENCRYPTED	AMBE+2	O		TIER 1
	ENCRYPTED	AMBE+2	X		
DMR	NON-ENCRYPTED	AMBE+2	O	12.5kHz	TIER 2
	ENCRYPTED	AMBE+2	X		
	TRUNKING	AMBE+2	X		TIER 3

Fig. 3: Digital mode compatibility table (from the manual supplied). I will update this review as and when I get the opportunity to test these modes, starting with those in use near my QTH. Not all of the above modes are even found in the UK.

Around the Spectrum

VHF Reception

The AR-DV1 performs very well throughout the 30 to 300 MHz region. Sensitivity is much easier to judge in analogue modes and certainly I am able to hear quite a number of signals which are touch and go on any radio. London City Airport ATIS on 136.35 MHz can be heard quite clearly using just the supplied telescopic whip, which is lost in the noise on many of my radios. In fact, I can hear all the 2m repeaters I would expect to hear from my QTH. I am rather restricted aerial wise right now (I live in a flat) so I cannot wait to take it somewhere high and in the clear and give it a real workout! Sky News have a couple of talkback frequencies on VHF low; these were easily received also as were a couple of amateur stations working simplex on 4m.

UHF Reception

This is where the majority of DMR activity lies, as well as the 70cm amateur band. GB7AK on 439.525 MHz was my first DMR test; using just the whip with the DV1 on my kitchen table (as previously mentioned) was clearly received at about 5DB above the noise level and easily audible without any echo effect. Once the repeater went silent I switched back to NFM and tested for sensitivity; without

a laboratory to carry out the test I would say it is as sensitive as on VHF and certainly in the same league as my IC-R20 which I always thought very sensitive (so long as it was not overloaded). Selectivity appears as good as or even better than for the IC-R20, where reducing the RF gain was often needed in a strong signal area to avoid adjacent channel interference or de-sensing.

In the old days, I would have tested it throughout the UHF television band to see how good it would be for TV DXing, as a sensitivity test under flat conditions or as a means of looking for tropospheric lift, but that's no longer possible since digital switchover (digital television signals just sound like wideband white noise to a scanner; on a spectrum analyser each multiplex shows up as a wide pulse).

Above the television band, it receives cordless audio devices on the next street as well as any of my other receivers; on 23cm there is only GB3BX in range from here on 1299.85MHz (not including GB3EN which is an ATV repeater), in the bedroom window facing the direction of the repeater its Morse idents can be heard on the whip when fully collapsed.

HF reception

An optional extra on scanning receivers, or a source of some alternative listening when VHF or UHF are quiet. Few would expect much from any other than higher end scanners on HF. Even the AR-8600 was not a good performer below 30MHz, overloading on anything more than a few feet of wire.

Well so far, a length of wire is the only HF aerial I have tested the DV1 with. The automatic gain control works quite well, as does the synchronous AM mode (SAM, used to compensate for fading signals); although the audio is still affected to some degree the fading is less annoying than it would otherwise be. USB, LSB and CW modes work well enough, although it is worth experimenting with the receive bandwidth setting to see which gives the best results. Although the defaults are certainly usable, the signal to noise ratio can be improved greatly by using a narrower setting, however you will need to use a correspondingly smaller tuning step in order to avoid missing many of the signals as you tune around the bands.

As a starting point, try listening for Shannon Volmet on 5.505, 8.957, 11.253 or 13.264 MHz USB, which broadcast 24 hours each day, RAF Volmet on 5.45 MHz, or of course any of the HF amateur bands (use LSB below 10MHz, USB above for voice on SSB).

I am glad to report that the AR-DV1 performs well on HF as wideband receivers go. The use of digital signal processing/sharp (high order) filtering techniques pays dividends in this part of the spectrum in particular.

MF reception

Well on my HF wire I can hear some amateur activity on top band (1.8 – 2MHz) on CW and LSB. On medium wave broadcast, I get my usual stations by day and some continental stations after dark. You will not hear many stations using just the whip supplied; a length of wire is needed here, longer the better. I would not be surprised if overloading occurred if a dipole for top band were used, but I have neither wire nor space enough to test this out!

LF reception

Well - the AR-DV1 will tune down to 100 KHz; however specifications are not guaranteed below 530 KHz (lower end of medium wave), so try if you can hear BBC Radio 4 long wave on 198 KHz. If you can't, give up. Not the best radio for 'DXing' navigation beacons in this part of the spectrum for this reason.

Features

Firmware Updatable:

The receiver is firmware updatable, allowing for bugs to be fixed and, potentially, for new functionality to be added by means of firmware updates as shown in the example below. The number format is YYMMX which gives the year, month and the chronological character. For example, 1512A means 2015, December, and A is first update of the month. This allows you to determine if an update is later than the version you currently have.

At first the squelch operation was somewhat noisy in auto mode; however this has improved since updating the firmware to version 1511B, released on November 6th, 2015. A further update, version 1512A improved the scan speed, as well as adding support for DMR colour codes (equivalent to CTCSS/DCS for analogue FM), so now co-channel DMR users can be screened out (I thought this would be added soon. DMR uses 16 'colour codes', without this feature enabled you will hear all DMR users in range; set the correct code and now you will hear only the desired user). Similarly, support for APCO25 network access codes (NAC's) and NXDN radio access numbers (RAN's) has just been added. Excellent! Now I have backed up the memory, installed the update and then restored the memory from the backup (unlike the last update, this one clears the memory so beware!), the DMR colour code is now displayed when a DMR channel becomes active, as shown below in the example, the amateur repeater GB7AK on 439.525MHz. The memory name is shown when the channel is quiet; the colour code 3 is shown when the repeater is on air. This is the DMR equivalent to using the 'search' setting with CTCSS or DCS tones on a good old analogue channel. I presume the same will happen for NAC's and RAN's for APCO25 and NXDN transmissions? I have not so far found any of these signals at my QTH so I can't try it out as yet. But well done AOR for adding this functionality. I wonder what firmware updates in 2016 will bring?

The AR-DV1 now displays the DMR colour code in use when receiving a transmission.

Updating the firmware is a matter of downloading the latest update from the AOR website, unzipping the file and copying the .dv1 file to the CF card (in the root directory). Having done this, re-insert the CF card into the DV1, and use the function + 7 keys to get into the configuration menu. Scroll down until the find the system update option; a list of updates will appear if more than one .dv1 file is present. Select the highest numbered one, press enter. The update process begins. As with any firmware based device, ensure that the power supply **is not interrupted during the update process** as this may damage the receiver. Once the update is complete, the receiver restarts. You will see the following screen during an update:

The update takes 3-4 minutes.

Firmware updates are available from http://www.aorusa.com/support/firmware.html . See http://www.aorusa.com/support/firmware/AR-DV1_firmware_update_procedures.html for the update procedure.

Coverage:

Pretty standard in frequency terms by today's standards (100 KHz to 1300 MHz, although specifications are only guaranteed above 530 KHz); see 'Around the Spectrum' above. However in mode terms, this radio breaks new ground.

Audio: 1W into 8Ω at 10% THD (total harmonic distortion). Has 3.5mm connectors for headphones, extension speaker and discriminator output (discriminator output active only in FM mode).

Receiver System Types:

Specified as direct conversion below 18 MHz; Triple conversion super heterodyne above 18 MHz

All important I.F Frequencies:

100 KHz to 18 MHz: Direct conversion.
18 to 180 MHz: First 393 MHz, Second: 31 MHz
180 to 1300 MHz: First: 1705 MHz, Second: 393 MHz Third: 31 MHz

Above 18MHz, analogue super heterodyne techniques convert the received signals to the 31 MHz I.F which feeds the analogue to digital converter. This is 18 MHz wide. An automatic attenuator (fed directly at tuned input frequencies below 18MHz, making this a direct digital sampling receiver below 18MHz) ensures that the A-D converter is fed at a suitable signal level to avoid overloading. The judicious and carefully thought out choice of I.F frequencies (a crucial factor in receiver design) should ensure that you will have a listening experience free of false images and 'bleed over', ensuring that the only traffic heard is that actually transmitted on the currently tuned frequency. This is in complete contrast to the early cheap double conversion scanners with awful 10.7MHz first I.F's. (Ugh).

Trunk Tracking:

Not supported, but of little benefit in the United Kingdom anyhow. This is an issue for many in the USA in particular however as Motorola Smartzone, EDACS and LTR are widely used in the USA. The only common trunked network in the UK is MPT1327, which conversely is barely used in the USA!

Auto mode:

In this mode, the receiver is actually set to NFM and the signal analysed to determine if the modulation is digital, and if so, the encoding is analysed to determine the mode in use. (Deep down the digital modes are frequency modulated at base level). Unfortunately this takes a moment to achieve hence the pause (and possible digital noise from the speaker whilst this analysis takes

place). The best way to minimise this is to change the mode from auto to the correct mode in use once the mode in use on a given frequency is determined. This issue has improved since a firmware update (see 'Firmware Updatable' section below for details).

Scan speed:

One very important consideration after sensitivity, selectivity, mode options and coverage, is that since the AR-DV1 handles so many analogue and digital modes, the price to pay is the slow scan speed. This is because not only must the presence of a signal on the frequency be determined, but also the correct mode must be switched in. Whereas other scanners have only AM/NFM/WFM (perhaps with USB/LSB/CW in some cases), the AR-DV1 has the following possible modes from which to select [AM, NFM, WFM, USB, LAB, CW, DMR, dPMR, APCO P25, NXDN, Icom D-Star, Digital CR, Yaesu Digital, Kenwood, Alinco EJ-47U.

One very good feature is that all modes can be selected throughout the entire tuning range, independently of the frequency. Sure, there are for example no WFM signals below 30MHz (and few NFM signals except for CB radio), and CW/USB/LSB are never found above 30MHz except on the amateur bands, but it's still very future -proof and flexible. The same is true of the tuning steps, any step size or receive bandwidth can be selected no matter what frequency you enter into VFO; you are not stuck with any default settings which cannot be overridden. Take care to select correct values for the band of interest for best results of course.

Memory Banks:

Good and Bad. The good news is that 2000 memory channels are provided. This is just was well since you need somewhere to store all your digital channels not to mention your existing analogue ones. And all of these can be backed up to the SD/SDHC storage card, thank heavens. The bad news is that this is not a radio with dynamic memory banks as we have got used to in recent years (we can't have everything I suppose). The memories are arranged in 50 memories X 40 banks, giving 2000 in all. Planning them is going to be a challenge to say the least. You can lock out a maximum of 50 memory channels per bank.

Programmable search ranges:

Yes, it allows you to program up to 40 search ranges (and back them up). This should be adequate for virtually all users needs. You can lock out up to 50 spot frequencies which annoy you.

CTCSS/DCS

The AR-DV1 supports both CTCSS and DCS (an essential nowadays). This is operational in FM mode with a bandwidth of less than 30 KHz set. This prevents you from hearing co-channel users of the frequency you are monitoring (and digital noise from digital co-channel users, a common problem nowadays as there are likely to be co-channel digital users as well as other analogue users).

Like scanners such as the Uniden's, a 'search' feature is available, when set on a memory channel it displays the tone in use when a signal is heard. Very useful for 'UK Simple Light', short term hire and analogue PMR446, as well as when identifying newly found users. Also useful on amateur bands to

identify repeaters you can hear under 'lift' conditions. Note that these features must be enabled in the configuration menu (see page 53 of the manual). Unfortunately, you can only search for either CTCSS or DCS tones at any given time, not both as with the Uniden's.

DMR Timeslot/Colour Code setting

As of firmware update 1512A, the scan speed is much improved, and the AR-DV1 can be set to monitor one or both DMR timeslots (DMR divides each 12.5 KHz channel into two timeslots, either of which can carry voice or data), as well as allowing you to set the colour code (as explained above, DMR's equivalent of CTCSS or DCS, used to separate co-channel users or talk groups). This is not found in the manual as the manual pre-dates the firmware update, so I will explain the usage of the feature here. By default, the AR-DV1 will monitor both timeslots of a DMR transmission for voice communication. Where only one is currently carrying voice, it is selected automatically. Where both are carrying voice simultaneously, you will of course need a means to select one or the other. A user may use each timeslot for a different purpose. For example, a hospital may have security on slot one and porters on slot two, and you may wish to hear security only. By selecting slot one only, you won't hear the porters – select slot 1 alone for this channel. In another example, let's say your local football club has matchday stewards on slot 2, and catering on slot one. You want to hear both, but the stewards are of greater interest. So you would select option 2+1, as slot two is of higher priority.

To use the feature, whilst on a DMR channel:

Press the main dial. This allows for selection of timeslot 1, timeslot 2, 1+2 (priority slot 1) or 2+1 (timeslot 2 priority):

This now sets your choice of timeslot. Now the colour code feature will screen out co-channel users of the frequency, if any are in range (which is highly likely if you are in a large city). Having chosen your timeslot, pressing the dial a second time allows selection of the colour code feature, on/off:

To hear all users, leave the feature off. If you know the correct colour code for your chosen user, select on, and then press the dial a third time:

You now can enter the correct code, from 00 to 15 using the keypad, then press ENT to store. Alternatively press CLR to cancel. If you don't know the colour code, leave the feature off until your chosen user transmits; the code is displayed for the duration of the transmission. Neat I'm sure you will agree!

If you cannot hear any traffic despite the signal meter indicating transmission, check the timeslot and colour code setting. This is stored per memory channel.

Be aware that not every DMR transmission is a voice transmission, so if the above settings are correct and no voice is heard, the transmission is probably data, such as user location data or system data. It does not mean that the AR-DV1 is faulty! This is why you may find that the signal meter indicates the presence of a signal, but the receiver remains silent.

The update also provides equivalent functionality for APCO25 and NXDN systems, although these are little used in the UK and I will add a section to document these if and when I encounter a suitable signal.

Computer Control:

A micro-USB port allows for computer control. A command list is supplied, although for now we will have to use a terminal program and type the commands manually. Although Butel are shortly going to release software for PC backup (and maybe later control, in Beta stage currently), and hopefully

AOR may eventually release their own software for PC control as they did all those years ago for the AR-3000. I will update this as and when the software is released. The command list is available here:

http://www.aorja.com/support/manuals/AR-DV1_COMMAND_LIST.html

See also the documentation provided with firmware updates; these may from time to time add more commands as new functionality is added.

Voice Recording:

Like the Icom IC-R20 before it, the DV1 has a built in digital voice recorder. Unlike the IC-R20, the recordings are in standard .wav format, and are stored to a CF card, so the only limitation on recording time is the capacity of the storage card (According to AOR, you get roughly 7 hours of recording per GB. Nice. Recording can also be timed, see timer/sleep/alarm below). Recording can also be timed to start at a particular time and date. So, perfect if you are at work or even on holiday and don't want to miss the action whilst you are away. Recording can be continuous or stop when the squelch closes. (Why would you want to go on recording when the squelch is closed?! Beats me.).

Backup:

Your memory channels are backed up to the storage card. The storage card is also used to perform firmware updates. Firmware update files have a .dv1 extension.

Memory backups are in CSV format. The filenames are as follows:

- SRCHBK.CSV – Search banks you have programmed
- SRCHGRP.CSV – Search Groups (you can link search banks together; for instance you may wish to search several amateur bands in this way).
- MEMCH.CSV – Your memory channels
- SCANGRP.CSV – memory banks you have linked for scanning
- SYSTEM.CSV – System settings you have programmed

Remember as with all data, back it up. Do this often. How often? I would suggest that anything taking half an hour to program by hand is well worth backing up as it takes only seconds. The backups are saved in the root directory of the SD card. You can of course send these by email to allow another DV1 owner to program their own receiver.

Timer/Sleep/Alarm:

A sleep timer can power off the receiver after 30, 60, 90 or 120 minutes. Has a clock with an alarm, which can also schedule recording (can be daily, weekly or once only. So - no more missing anything when you are at work or even on holiday. I have now tried this and it appears to work well once you understand its operation fully.

Audio Output

The 1W speaker is accompanied by a standard 3.5mm headphone socket, an extension speaker output and a non switching auxiliary output doubling as a discriminator output in FM mode. So good for connecting to your sound card for data decoding.

If you are new to digital voice modes, you may find the transmissions are rather electronic or even robotic sounding (but nowhere near as harsh sounding as a dalek!). This is due to the way AMBE coding/decoding works. In communications, intelligibility and spectrum efficiency are far more important than fidelity. [AMBE stands for Advanced MultiBand Excitation, a coding scheme used by the vast majority of digital two way radio modes].

Beep

It has one; it can be easily turned on or off as required. The beep can be informative when you first learn to program a radio; after this I usually turn them off so as to avoid disturbing others.

Priority

Any one of the 2000 memory channels can be designated as the priority channel; this can be checked at intervals of up to one minute for activity. A feature I only use sparingly on any radio as it does slow down scanning and interrupt the monitoring of other channels.

Shift

The offset for duplex operation is stored in individual memory channels - but must be selected from one of 40 offsets. Some of these have been factory programmed, others can be user programmed. This is a strange way of operation, although at least the AR-DV1 has this feature which is important where duplex is in use but talk through is off, allowing one to hear the mobile station provided that it is in range. Unfortunately this must be programmed by hand at present, as the software from Butel (ARC-DV1) does not currently support the feature at time of writing. This is tedious, and I hope a future version supports the offset function!

For example, for 2m amateur repeaters, an offset of -0.6 MHz allows you to check the input of the repeaters to determine if the mobile station is in simplex distance. Offset 0 and 20-39 are factory programmed and mostly not of much use in the UK, but at least 1-19 can be programmed. You may need +1.6, +7.6 and +9 MHz for the 70cm amateur repeaters; +4.6MHz for the duplex channels on the marine band, to name a few examples.

Monitor

Opens the squelch to check for weak signals below squelch level. Straightforward enough.

Search Pause

Determines how long the scan will stop on a busy channel. Can be set between 0 to 60 seconds; when off, the scan halts until the squelch closes. I only use this occasionally to get a feel for what is happening after switching on.

Lockout (pass)

Memories can be locked out as would be expected. Particularly useful for channels having continuous transmission and which you only listen to manually. Press a second time to undo.

Bandwidth Selection

In analogue receive modes; the bandwidth can be altered to best suit the transmission being received. This is in contrast with most cheap scanning receivers which have a narrowband FM filter which is somewhat of a compromise, typically around 15-20 KHz wide.

FM: 200 100 30 15 6 (kHz) – Use 200 for FM broadcast, 50 or 100 for wideband radio microphones and talkback, 30 for weather satellite reception, 15 for marine radio, 6 for most contemporary two way radio such as analogue PMR446.
AM: 15 8 5.5 3.8 (kHz) – Use 15 for MW broadcast, 8 or for HF broadcast, 3 for AM signals with low modulation or where there is an adjacent strong station.
SAH, SAL: 5.5 3.8 (kHz) – as above for AM
USB, LSB: 2.6 1.8 (kHz) – choose the one which gives best results.
CW: 500 200 (Hz) – choose for best results.

Remember to set the tuning step appropriately. When monitoring digital modes, the bandwidth selection is set automatically.

Display

The display contrast and key colour can be adjusted to suit your requirements. The display can be dimmed if you are in a dark room or at night. The characters are clear and easy to view from most angles (a common failing for some LCD displays). The signal strength is displayed as well as the frequency, mode, bandwidth and tuning step, as well as the tone/code in use (dependent on mode), as well as the time and squelch mode. The volume and squelch levels are displayed for two seconds following adjustment.

Analogue voice descrambler

The AR-DV1 can descramble signals using analogue voice inversion scrambling. It is rare in the UK to encounter this in use; I have heard a handful of analogue PMR446 users using this from time to time. This feature is not included in the USA version of the AR-DV1.

CF card slot

This is found on the front panel. AOR supply a 4GB CF card, although I understand that the AR-DV1 supports cards up to 32 GB. The card supplied is pre-formatted.

Baud Rate Setting

The default setting is 115200 bits per second. Although this can be changed, ARC-DV1 will only run on the default setting. Only change this if you have good reason to be doing so.

My Overall Appraisal?

So now we got this far, it's time to take a look at the scoreboard and see how many marks AOR get for this ground-breaking receiver. AOR have made up for their years in the wilderness (for many years they were somewhat behind the times feature wise) but have suddenly taken the lead with the AR-DV1. They have suddenly pulled out all the stops with this one. It was never going to be cheap (at least in the first instance), but all other scanner manufacturers had better sit up and take note of how AOR have suddenly brought the hobby into the 21st century and recognised that digital modes really are in widespread use outside the United States.

Of course many reviews are far too diplomatic in their reviews of scanning and amateur radio equipment. Since I have no vested interests, I am free to be entirely honest and truthful about both the good points and the bad points – as is of maximum benefit to a prospective buyer naturally. In the case of the AOR AR-DV1, there is plenty to talk about regarding its good points! As to the bad points, there are very few to be honest, as reflected in the score above - and hopefully due to the ability to update the firmware easily and frequently, there will be even fewer bad points as time goes by.

There are perhaps a few minor issues regarding ergonomics (in particular relating to the keypad), although I personally do not find these enough of a hindrance to stop me getting the most from this radio. Also, computer programming and control could be easier, although this issue will no doubt be addressed given time for software development to take place.

I have only given a brief mention of the more normal features; I wanted to dedicate the majority of this review to those features currently unique to the AR-DV1, as these were my reason for writing it after all (and of course, my reason for saving up my hard earned cash for this radio in the first place!).

Otherwise, I believe that AOR are onto a winner with the AR-DV1. It takes a brave manufacturer to be first to design something new. In time, the DV1 may become the standard that future base or mobile scanning receiver designers have to work to?

Coverage: 90% (Coverage of the areas of most importance, particularly 25-1300MHz without gaps, and pretty reasonable performance below 30MHz for added value).

Mode Options: 100% (What other score can I give the DV1 in this department?!) And all modes are available on any frequency you can tune to.

Sensitivity: 95% (Not *quite* up to the AR-3000's standard but better than most others; Not quite as forgiving of a pre-amp as the AR3000, although I am in a very busy city area). Certainly on a par with other scanners, such as the Icom IC-R20 and (possibly) the Yupiteru MVT-7100.

Selectivity: 95% (Again, not quite up to the AR3000 but that was a tough act to follow). Better than the Icom IC-R20 in this area.

Computer programming/backup/control: 75% (Well it has the capability, backup is good but AOR supply no software for control or programming as time of writing. May go up if software is released).

Cosmetic Appearance: 85% (No real faults here, a few minor ergonomic enhancements may be possible).

Ease of use: 80% (Even an old hand like me needed to practice a few things such as getting the bank linking feature to work at first. But given the features this receiver has, I cannot come down too hard here; it's no Realistic/RadioShack entry level model). Maybe not a good beginner's radio but well suited to advanced and experienced users. Would have preferred the up/down arrow keys in a more accessible position. The keys are an acceptable size for me (although may be slightly small for someone partially sighted perhaps, particularly given that the DV1 is not a handheld).

Owner Manual: 85% (Well written and translated for the most part although some functions could have been better explained. Notwithstanding that firmware updates may add functionality which post dates the manual).

Overall: 87.5% (Which is a better score than would be given to anything else on the market right now).

My wishes for 2016

And next time around? How about a hand held equivalent? The only real shortcoming of the AR-DV1 is that it is not that convenient as a 'go anywhere' scanner. Although it's excellent as a base or mobile scanner, a handheld version is the next logical step. As the DV1 is selling so well it appears that the development costs have been justified, so maybe a go-anywhere version would also be well received?

AOR have certainly brought our hobby wholeheartedly into the 21st century with this one. And I wouldn't be at all surprised if government monitoring bodies (like GCHQ in the UK) have bought some AR-DV1's of their own. All I can say is that if it's good enough for government use then it should be good enough for hobbyist use also. Well done to AOR for taking the plunge and boldly going where no scanner manufacturer has gone before.

Needless to say, if you are thinking of investing in the AR-DV1 and have any questions, then you know where to find me. If you own one already, then by all means let me know your views on it! Not cheap but well worth the investment since it certainly gives you value for your hard earned cash you had to save up.

Remember to check http://www.aorusa.com/support/firmware.html for firmware updates!

David Norris, 24 December 2015

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Specifications – as per the manual: {May possibly change somewhat following firmware updates in future}

Frequency range:
100 kHz ~ 1300* MHz (Note: Specifications guaranteed above
530 kHz)
(Cellular frequencies blocked for US consumer version)
Digital receive modes: D-STAR (GMSK), ALINCO (GMSK), YAESU (C4FM), DIGITAL
CR (C4FM), NXDN (C4FM), dPMR (C4FM), P25 (Phase 1)
(C4FM), DMR (4FSK). (**)
Analogue receive modes: FM, AM, Synchronous AM (SAH, SAL), USB, LSB, CW
Receiver system:
100 KHz ~ 18 MHz: Direct conversion
18 MHz ~ 180 MHz: Double conversion super hétérodyne
(1st IF: 393 MHz, 2nd IF: 31.0 MHz)
180 MHz ~ 1300 MHz: Triple conversion super heterodyne
(1st IF: 1705 MHz, 2nd IF: 393 MHz, 3rd IF: 31.0 MHz)
IF filter bandwidths: 200 Hz, 500 Hz, 1.8 kHz, 2.6 kHz, 3.8 kHz, 5.5 kHz, 6 kHz, 8 kHz,
15 kHz, 30 kHz, 100 kHz, 200 kHz
Receive assisted functions: Auto notch, Noise reduction, Analogue voice descrambler (not
Available for the US consumer version), AGC, Step adjust, Offset
Receive, Priority
Squelch modes: Level squelch, Noise squelch, Voice squelch, Tone squelch, DCS
Frequency stability: Less than +/- 2.5 ppm after warm-up (5 minutes)
Sensitivity:
530 KHz ~ 17.99999 MHz: 0.71μV typ. (12dB SINAD)
18 MHz ~ 1300 MHz: 0.32μV typ. (12dB SINAD)
Number of VFO's: 3
Memory channels: 2,000
Memory banks: 40
Search banks: 40
Priority channel: 1
Pass frequencies: 50 per bank or VFO
Audio outputs:
Internal speaker & speaker-out: min.1.0 W @ 8 Ω, 12 V DC
Input. 10% THD.
3.5mm jacks for headphone, speaker-out and discriminator (FM Only)
Recording/playback media: SD/SDHC, 1 channel, 19 kHz sampling in wav format. Approx. 7
Hours recording for 1 GB.
Timer functions: Sleep timer 30, 60 90, 120 min., alarm and timer recording (once,
Daily, weekly)
PC connection: Micro-USB for receiver control with command list.
Antenna input: BNC, 50 Ω
Max. Antenna input level: +0dBm
Power requirements: 10.8 ~ 16.0 V DC, approx. 750 mA (at 12V DC)
Operating temperature: 0 ~ 50 °C, 32 ~ 122 °F
Dimensions:
Approx. 178 mm (W) x 50 mm (H) x 215 mm (D) (proj.excl.)
7 (W) x 1.97 (H) x 8.46 (D) inches
Weight: Approx. 1.5 kg (3lb 5oz)
Supplied accessories: AC power adapter, Telescopic antenna, 4GB SDHC card, printed
manual including command list. PC Software not supplied.

Manual available here: http://www.aorja.com/support/manuals/AR-DV1_MANUAL.pdf