Receiver Review : Drake SW2

Year Introduced: 1997
Power: 12.6 VDC, AC Mains Adaptor provided
Size: 276 x 111 x 194 mm (10-7/8" x 4-3/8" x 7-5/8") HWD
Weight: 3 kg (6.8 lb)
Price US$400, optional remote control $50
Coverage: 0.1-30 MHz, AM, USB, LSB

Value Rating

Radio Netherlands Receiver Test Laboratory

Full Review

This review was compiled independently. The Medium Wave Circle and Radio Netherlands has no financial connection with R.L. Drake, the manufacturer of this receiver.

The US company of Drake has recently put a new receiver onto the market. It has been out in the USA for a little while and it is now filtering onto the shelves of selected dealers in Europe. We tested an off-the-shelf example in the course of September 1997 and these are our findings.

The SW 2 is a microprocessor controlled receiver, covering 100 kHz - 30 MHz. It cannot be tuned under 100 kHz, so if you are interested in VLF reception, you will have to choose another set. The keypad makes it possible to type in the frequency in kHz. If the up- or down button is pressed directly after entry, the receiver tunes directly to the given frequency. You can also wait two seconds and then the switching is automatic.

Frequencies can be only entered in steps of 1 kHz. For finer tuning the main tuning knob can be used, which runs smoothly and offers steps of 50 Hz. More accurate tuning is not possible. We find 50 Hz steps somewhat coarse for some types of data and SSB reception; other sets in this price class offer smaller tuning increments. One single press on the up- or down button changes the frequency by 5 kHz. If you keep the buttons depressed, the tuning steps get larger to a point that is easy to change by a few hundred kiloHertz. During tuning, each step is heard as a click. Providing the volume control remains low, this clicking sound is not really annoying.

Display

The SW 2 uses a very bright light-emitting diode (LED) display with 6 large orange-coloured figures, offering a frequency read-out to the nearest 100 Hz. The display can be dimmed and shows the real carrier frequency, so no re-tuning in USB or LSB is required. Two extra figures (green) indicate the metre band. If the receiver is tuned in the 7100 - 7600 kHz segment, the green figures show 41 metres. Outside the broadcast bands this display is switched off. This display is coupled to the mode, so in SSB it shows the amateur bands (USA band allocations, for instance 80 metres is displayed between 3.4 - 4 MHz). During memory mode tuning, the display shows the chosen memory channel.

Memories and remote control

The SW 2 cannot be computer controlled. There is also no "2nd VFO", or rather an extra memory which allows to jump quickly between two different frequencies. You have to use one of the 100 memories. Each memory stores the frequency and mode. It is very easy to write, clear and re-write the memory channels.

Drake has already programmed 32 memory channels with the frequencies of a number of short-wave broadcasters. These are channels used by international broadcasters such as the BBC and Radio Netherlands to serve North America. But if frequencies change, the memories can be easily changed. A memory channel can be selected by typing in its number, with the up-down buttons or the main tuning knob. In contrast to normal tuning, the up-down buttons step slowly through the channels, whilst the tuning knob makes fast changes possible. Memory tuning has to be done by hand, there is no facility to scan automatically through the channels.

An infra-red remote controller is supplied with the SW 2. It makes it possible to control all the functions of the SW 2 from a few metres away, except volume, which can be only muted. The SW 2 has no built-in timer.

Modes and synchronous detector

The SW has buttons for AM/AM synchronous and SSB, so it is not necessary to step through a menu, like the R 8. Pressing the SSB button again toggles between upper and lower sideband. For a low-cost receiver, the AM synchronous detector is real wonderful. Drake uses a phase-locked loop detector, which offers not only the possibility to listen in full bandwidth, but also to the upper of the lower sideband once the detector is locked. In full bandwidth or in the sideband mode, it is possible to re-tune the receiver by approximately 4.5 kHz, before it falls out of lock. This large re-tuning range is of great help to reduce sideband splatter from adjacent stations!

There is one small disadvantage: even if you re-tune 50 Hz (one step) it takes about 2 seconds before the detector locks, but there is no growling sound during the lock-time as long as you stay within the 4.5 kHz range. PLL synchronous detectors can drop out of lock, but Drake has worked hard on this detector and it is very well designed. If the receiver is re-tuned, the received signal can drop to -122 dBm (0.17 µV) before it loses lock. The readability is already zero before that point is reached. There is a long time constant, so even during longer deep fading periods, lock is usually maintained. However, if the fading is so deep that the station is totally lost, there is a small problem. If the receiver is re-tuned to reduce sideband splatter, the detector drops out of lock. If the signal of the station recovers, the detector doesn't lock again, but remains in the AM mode, even though the indicator on the front panel show that AM sync with USB or LSB is switched in. You have to push the AM sync button again to regain the lock. It would have been nicer if the receiver showed (by a flashing indicator) that lock has been lost.

Apart from these minor disadvantages, we like the sync detector of the SW 2 very much indeed: it really helps to reduce sideband splatter and distortion due to selective fading.

Filters

For SSB the SW 2 uses the more or less standard Murata CFJ 455 K (5) good quality ceramic filter, with a static selectivity of approx. 2.5 kHz at the - 6 dB points and less than 6 kHz at the - 60 dB points. For the AM wide filter another good quality ceramic filter in a metal housing is used, type M 455 H (k), offering a 6 kHz bandwidth at the - 6 dB points and less than 12 kHz bandwidth at - 60 dB. There is no provision to add an extra filter, such as a 1 kHz filter for data reception.

Sensitivity

Drake specifies the SW 2 with a sensitivity of less than 2 µV for 10 dB S+N/N with a 30 % AM modulated signal, 1 kHz tone and less than 0.5 ?V for 10 dB S+N/N in SSB. Both these figures are valid over the complete frequency range from 100 kHz - 30 MHz.

Since AM signals in the broadcast band are modulated much higher than 30% in the 1990's, at Radio Netherlands we measure with 60 % modulation depth. So we should come to values of 1 µV or less in AM wide. Our test model was a little less sensitive. For 10 dN S+N/N, with for AM 60% modulation depth, 1 kHz tone and for SSB a carrier for a 1 kHz tone, we measured:

Frequency Range	AM wide	AM sync	SSB
100 kHz - 250 kHz	5 - 2	5 - 2	1 - 0.5
250 kHz - 550 kHz	2 - 1.6	2 - 1.6	0.5 - 0.32
550 kHz - 1.79 MHz	1.5	1.45	0.33
1.8 MHz - 17.0 MHz	1.4	1.37	0.32
17 MHz - 30 MHz	1.5	1.45	0.35

The double figures require some explanation. At 100 kHz there is still some oscillator noise, resulting in a decreased sensitivity. On higher frequencies the noise is less, so the sensitivity rises: from 5 µV at 100 kHz to 2 µV on 250 kHz. As you can see, the sensitivity in AM sync is nearly equal to AM wide. Only the audio level rises by 3 dB, so it sounds louder, but the signal to noise ratio remains the same. The sensitivity figures are roughly equal over the range, because the SW 2 has no RF bandpass filters.

Although we do not have sufficient documentation (in the handbook not even a block diagram is printed), we measured that above 1792 kHz a multi pole highpass filter is switched in to reject medium wave stations. This explains the very little increased sensitivity above 1.8 MHz.

Although the sensitivity in AM is less than, for instance, the JRC NRD-345, the SW 2 is sensitive fine. The atmospheric noise is so high (especially near cities and in villages) that it is not the sensitivity of the receiver that determines if you can hear a station. The ratio between the signal strength of the received station and the atmospheric- and man-made noise received by your antenna determines if you hear the station or not.

Signal to noise ratio, AGC and RF gain control

There are measurements that are more important than the 10 dB sensitivity. For instance, how strong must a signal be to give good readability (20 dB S+N/N) or even better. Here are results measured on 6.51 MHz in AM wide, with a 60% modulated, 1 kHz tone signal (for SSB a single carrier, representing a 1 kHz tone) in µV across 50 Ohms:

Signal to noise ratio	AM wide	SSB
10 dB S+N/N	1.41	0.3 2
20 dB S+N/N	4.73	1.0 8
30 dB S+N/N	15.6	3.5 5

These figures are adequate and show that the SW 2 has sufficient IF gain. This is also influences the automatic gain control (AGC), which keeps the detected audio volume constant, despite varying signal strengths. With a signal strength of 1 milliVolt, we set the audio volume on 100 mW into 8 Ohms. This is called 0 dB. First at a signal strength of 0.7 µV, generating a signal to noise ratio of 7 dB, the audio level drops just 1 dB. A 3 dB drop in signal level is obtained with a signal strength of 0.48 µV, but then the signal to noise ratio of the modulation of the received station is already degraded to 5 dB, so the modulation is not longer readable.

In practice this means that the volume of the received stations is constant as soon as the modulation is readable; very good!

There are also some minor points of criticism though; you cannot choose between slow and fast AGC settings. This is done automatically: in AM it's moderately fast, in SSB it's slow. The AGC cannot be switched out of operation either and that's a pity, because the SW 2 is equipped with a RF gain control. This gain control influences the IF gain between the first and second mixer, so it can help to prevent the second mixer from overload, but this does not influence the intermodulation level of the first mixer. The gain adjustment range is not linear, but in crowded bands with many strong signals it makes reception quieter by reducing 2nd mixer intermodulation and overload.

S-meter

The SW 2 has a bar-type S-meter. There are 10 bars. The 4th bar indicates S9, the 6th is labelled as S9 + 10 dB and so on. As with many low cost receivers, the S-meter of the SW 2 is just an indicator. The total range is large. The first bar (S1) lights with 0.7 µV and the last bar (s9+60 dB) lights from 7 mV and up. But there is no calibration: a S5 signal (3.2 µV) is indicated as S9, an S7 (12.5 µV) as S9 + 10 dB and a real S9 signal (50µV) is indicated as S9 + 20 dB.

Antenna inputs and attenuator

The SW 2 is equipped with a SO 239 connector for 50 Ohm antennas. The SWR is 3:1 or better. The antenna input has a leakage path of 10 k-ohm to ground, combined with a neon-lamp. This combination protects the receiver against static charges from thunderstorms in the vicinity. That's nice.

The SW 2 has also two terminals for the connection of a single wire antenna and ground. But these terminals are just connected in parallel with the SO 239 connector. This means that the input impedance is also 50 ohms; not so nice! This is too low for a short single wire antenna. We know that the SW 2 is a low cost receiver (at least in the USA), but we think that a transformer to make a proper high impedance antenna input is a necessity.

We can be brief about the attenuator: there isn't one... and that is also a pity. A good antenna delivers signal strengths in the order of 20 - 100 milliVolts in the short-wave broadcasting bands to the receiver. No low or medium cost receiver can handle this kind of signal strength without producing intermodulation or overloading effects. An attenuator with preferably a 10 and 20 dB step can reduce these effects and makes reception much quieter, especially in the early evening hours. So if you decide to buy this receiver, think seriously about a step attenuator as an accessory.

Phase noise of the local oscillators

The SW 2 uses a conventional phased locked loop synthesiser. The overall phase noise is given in dB with respect to the carrier in 1 Hz bandwidth, measured at 3.2 MHz in SSB.

At 5 kHz from the carrier :	89 dBc/Hz
At 10 kHz from the carrier :	97 dBc/Hz
At 20 kHz from the carrier :	121 dBc/Hz
At 50 kHz from the carrier :	136 dBc/Hz

This is not more than average. Especially close to the carrier the phase noise is rather high, but at 50 kHz distance it's better than from the JRC NRD-345.

Dynamic selectivity

The dynamic selectivity is the suppression in dB's (at a specified frequency distance) of a 60 %, 1 kHz modulated signal, which deteriorates the signal to noise ratio of the signal to which the receiver is tuned from 20 dB S+N/N to 14 dB S+N/N.

Frequency Separation	AM wide	AM sync	SSB
5kHz	-	0	36
10kHz	43	45	63
15kHz	45	46	80
20kHz	50	58	86
30kHz	52	60	93
50kHz	55	63	94

These values are perfectly OK for a low cost receiver, but the influence of phase noise and leakage around the filters is clearly shown as the slow increasing attenuation for signals at larger frequency separations. Compare also the selectivity in SSB at 5 kHz distance between the SW2 and the NRD-345. They use the same SSB filter! There is no better proof of the importance of phase noise!

Intermodulation free dynamic range

As the SW2 synthesiser is noisy close to the carrier, we also use 50 kHz frequency distance between the carriers of the 2-tone signal. For an 3rd order intermodulation product equal to the -126 dBm noise floor in SSB of the SW2, the level of the 2-tone signal must be: 2 x - 37 dBm (2 x 3.16 mV). This results in an intermodulation free dynamic range of 89 dB.

Intercept points

Refer to the 1997 World Radio TV Handbook for a full explanation of the intercept point measurement. We are pleased to note that our standard of intercept point measurement has been supported by other independent laboratories over the past twelve months.

Two-tone level	Intermodulation product	3rd order intercept point
2 x - 37 dBm (2 x 3.16 mV)	- 126 dBm	+ 8 dBm
2 x - 25 dBm (2 x 12.6 mV)	1 mV	+ 16 dBm

The IP 3 for a 10 µV signal could not be measured, because the required input level was so high, that the receiver was heavily overloaded. For a low cost receiver these figures are very good, even better than for the NRD 345!

As the SW 2 doesn't have bandpass filters, the F1 and F2 signals which produce 2nd order intermodulation products (F1 + F2 and F2 - F1) are not suppressed. This is reflected in lower IP2 figures.

Two-tone input level	Intermodulation (F1 + F2)	2nd order IP
2 x - 40 dBm (2 x 2.24 mV)	- 126 dBm	+ 46 dBm
2 x - 31 dBm (2 x 6.3 mV)	1 mV	+ 64 dBm

Blocking

With blocking we look how strong a station with large frequency separation has to be before the signal to noise ratio of an easily readable station (S+N/N 20 dB) is degraded to moderately disturbed (S+N/N 14 dB). The signal level of the unwanted station is an indication just what levels a receiver can handle before it is overloaded.

Frequency separation	Level of unwanted transmitter
50kHz	- 38.5 dBm (2.66 mV)
100kHz	- 30.5 dBm (6.7 mV)

Despite the lack of input bandpass filters, the SW2 is actually a very good receiver in its price class when it comes to intermodulation and overloading. If you compare the Drake SW 2 against the JRC NRD-345 you should not forget, that the NRD 345 is twice as sensitive (noise floor in SSB is -132 dBm instead of -126 dBm), resulting in much higher susceptibility to overload and intermodulation. In fact a comparison is only fair if you compare the JRC NRD 345 using a 6 dB attenuator at the antenna input against an non-attenuated SW 2. In that case the NRD 345 can handle much stronger signals and the difference is not as large as it seems. It must be emphasised though, that even the SW 2 needs a step attenuator. Remember that overloading effects occur with signal levels larger than 7 mV and a good antenna brings-in much higher signals.

Other measurements and features

The SW 2 is a very basic receiver. It is equipped with a headphone output on the left side of the cabinet (!) and an external speaker output. There is no recorder- or data output. If you use the headphone output or the ext. LS. output to connect a decoder or recorder you will have a serious problem. Not only the internal speaker is switched off, but both outputs are floating! Drake has used an IC audio amplifier in a bridge configuration, which means that there is not a ground and a signal

With a 1 mV RF signal, 60 % modulation depth, 1 kHz tone the SW 2 produced 1.3 Watts into a 8 Ohm external speaker. The internal speaker produces more than enough volume. With 100 mW audio output power, the distortion in AM wide and AM sync was 1 %, and 0.8 % in SSB, and that is also good.

There are some birdies on the receiver. These are internally generated signals. Most of them are quite low in level. The strongest are on 812, 3215, 3650 and 6399 kHz but the majority are outside the broadcast bands.

The Drake SW 2 comes with a mains adapter which converts AC mains to 12 V DC. Note that the SW 2 has a diode bridge inside, which ensures you always have right polarisation if you are feeding the receiver from an external battery. The receiver draws a lot of current, up to 1 Amp at high volume. Even when the receiver is switched off, it still uses 0.4 amps. Our US version mains adapter got rather warm. When the receiver is on standby, an indicator on the front panel shows that the adapter is plugged into the mains.

And so to price. In Europe, there is 13% import duty and 17 and a half percent value added tax. Bearing in the dollar exchange rate is quite high at the moment, that puts the radio at around 1800 Dutch Guilders (around 550 pounds sterling). In the UK the set is retailing at £499. In the US, the set is much cheaper at US$499 and offers excellent value for that price. But in short, this is a good value receiver for shortwave listeners.

This review first appeared on the Radio Netherlands website.