

A typical feature piece for the *World Radio & TV Handbook*.

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## Receiver analysis -- Racal RA 1778



Last year we looked at the Racal RA1792 as an example of a professional communications receiver nowadays available second-hand. In this feature we consider the Racal RA1778, which is a variant of the iconic RA1772 and highly prized by the *cognoscenti*. Is it as good as they say?

The Racal RA1772 family set entirely new standards for professional and military-grade HF communications receivers when they were introduced in 1974. Racal's first receiver, the thermionic RA17 with Wadley-loop and film-strip tuning, had been ground-breaking when it was introduced in the 1960s. Unfortunately its semiconductor-based successors (the

RA1217 family) were nowhere near as good. Given the size of the market for high-grade point-to-point receivers in the 1970s, it was clear that a major re-design was required and the RA1772 was the result.

Featuring probably the most elaborate synthesiser ever incorporated in a receiver -- a beautifully designed cascade of multiplying loops and summing loops, all implemented in TTL with not a microprocessor in sight -- the RA1772 also made good use of a fine wideband preamplifier. It also embodied the then-new Rafuse switching mixer employing four high-current FETs and about +7dBm of local-oscillator injection, which seemed an incredible level to those brought up on bipolar-transistor mixers. Architecturally the RA1772 is a double-conversion superheterodyne with intermediate frequencies of 35.4 and 1.4MHz. Coverage is 15kHz to 30MHz in switched 1MHz bands. The beautifully made optocoupler-based tuning system with switchable fast and slow tuning rates remains a classic of its kind, and few receivers before or since have been more pleasant to use. The AGC in the RA1772 was a revelation when the receiver was first introduced and it remains formidably good by modern standards although that in the later RA1792 is even better. Fitted with the optional 9420 frequency standard, the stability is about 1 part in  $10^9$ .

The RA1772 was manufactured in large numbers and numerous versions for customers as varied as GCHQ and its military counterparts, the BBC Monitoring Service at Caversham and a variety of others. Indeed there is even pictorial evidence that RA1772s were used for monitoring purposes in some Soviet Bloc jamming stations! The UK military made extensive use of the RA1772 and often specified versions with voice-width filters on one sideband and data-width items (400 or 800Hz) on the other, which is

not ideal for general listening. Unfortunately these seem to be the most common examples found nowadays on the surplus market.

The RA1772 offers AM, FM, CW, USB and LSB modes. There is provision for an ISB board to be fitted and many ex-military examples have them. A wide variety of bandwidths is available, the most common seeming to be 300Hz, 1kHz, 3kHz and 6kHz. Most SSB filters seem to be 2.7kHz wide although there are others. The filters themselves were supplied from several manufacturers and in practice there seems to be little to choose between them. They are generally better performers than those in later Racal receivers such as the RA1792 and 370x series although they were astronomically expensive at about £330 each. This must equate to well over £1,000 today. Many ex-military receivers also have AFC fitted although in our experience this seldom seems to work particularly well unless the receiver has been recently overhauled and the facility correctly set-up.

Many people will have heard of the RA1772 and many of our professional readers may well have used them. But what is an RA1778? It is a late variant of the RA1772 with 12 memory channels together with a minor change to the tuning arrangements which in our view makes it even more delightful to operate. The switched 1MHz ranges are replaced by a continuous tuning system augmented by three switchable tuning rates. So the receiver is now continuously tunable between about 10kHz and 30MHz at whatever rate is desired by the operator. Since each memory channel is in effect tunable, the overall result is an extremely versatile and easy-to-use receiver.

It is not clear how many RA1778s were made or indeed who they were made for. From extant receiver serial numbers it appears that about 500 were manufactured before the introduction of the very similar RA1779

with 30 memory channels instead of twelve. It is known that about 100 were supplied to the Royal Air Force and that a few remained in service as late as 2012. Production of the RA1778 seems to have ceased in early 1981 although the RA1772 continued to be manufactured until mid-1983. Examples of the RA1779 are extremely rare but RA1778s occasionally appear on the surplus market -- although alas not very often.

How good are they? In terms of strong-signal handling, very few contemporary receivers come anywhere near an RA1778 especially if it has been fitted with the optional (and originally very expensive) preselector. Most seem to exhibit a close-in third-order performance of well over +30dBm with the preselector out of circuit, which is similar to a high-grade modern SDR. The MDS is likely to be about -133dBm in SSB bandwidths and our reference example easily hears a -140dBm carrier, which is as low as our IFR signal generator will go! As a receiver for weak PSK and MFSK transmissions, an RA1778 remains almost unsurpassable.

There is of course a price to pay for this order of performance. All the RA177x family are potentially excellent from an RF point of view but the youngest is now around thirty years old and most have led hard lives. Unfortunately some aspects of their mechanical and electrical design were not conducive to longevity. For example, the main wiring harness between the mains transformer, the rear-mounted PSU board, the reservoir capacitors and the rear heatsink carrying the PSU pass transistors was executed in PVC-insulated cable which in service became very hot. Over the years this caused the plasticizer to leach out and vigorously attack any copper it could find. The result is extensive radial cracking of the insulation and corrosion of the wiring and associated

terminals. The cure is to rewire the entire harness in modern PTFE cabling, which is a chore but not inordinately difficult and allows easy replacement of the reservoir capacitors at the same time. Several other electrolytics inside the unit will have dried out over time and need replacing, and some of them (e.g. C27 on the lower part of the memory board) are difficult to access without fairly extensive dismantling.

Another issue is that the printed-circuit boards in the RA177x family were not manufactured to modern standards and the tracks and pads are relatively fragile. It is all too easy to break them away from the substrate if too much heat is applied whilst soldering or desoldering. The PM335 first-mixer board is a particular case in point. The mixer amplifier output transistors (TR2 and TR5) have marginal heat-sinking and run very hot. They quite often fail if the receiver is mounted in a rack or case where there is inadequate cooling, and replacement almost always involves concomitant repairs to the PCB. A temperature-controlled soldering iron is mandatory for working on early Racal printed-circuit boards and careful use of good-quality wick is recommended for desoldering operations.

There are some other minor problems. Several of the ICs in these receivers can be difficult to find and exceedingly expensive, chiefly because some of them are long out of production. The memory-channel backup battery in the RA1778 was originally a 4.8V NiCd and several receivers have been encountered in which this has leaked. Unlike the RA1792 in which battery leakage almost always causes major damage to the A6A2 processor board on which it is mounted, a leaking battery in an RA1778 usually results in nothing more than unsightly staining of the vertical sub-panel on which the memory board resides. However, in extreme cases the wiring underneath the board can be damaged. The

best modern replacement battery is a 4.8V 150mAh NiMH which is pin-compatible with the original. The wonderful optocoupled tuning system in any of the RA177x family has a tiresome habit of drifting out of adjustment on a fairly regular basis, causing the display to freeze or exhibit a variety of bizarre characters when the tuning knob is turned. Happily it is easy to set up with an oscilloscope, although the wise user cleans the two internal potentiometers (R4 and R5) inside the shaft encoder with propanol whilst the front panel is lowered for access. This usually stops the drift for a further six months or so!

One final difficulty is that handbooks and service information for the RA1778 in particular are very hard to find although manuals for the RA1772 are widely available on-line. Unfortunately the tuning and memory arrangements in particular mean that there are significant differences, and some of the alignment instructions are different as well. If you are lucky enough to acquire an RA1778 we strongly suggest that you do your best to acquire the manuals for it at the same time.

No doubt all this sounds a little daunting, and in fairness we could not recommend that anyone buys one of these receivers without being willing to tackle some quite extensive restoration work. But the RA177x family are iconic classics of the pre-microprocessor receiver era and in our view no vintage radio collection is complete without one.