Taming iPad temperatures

Avoid an iPad meltdown, with these tip-top cooling ideas from **Dave James**

For most of us (unless you operate with an open cockpit), keeping our portable electronics kit from overheating in the cabin is sometimes a problem. I have had my iPad shut down on a very hot, sunny day because I had stupidly left it inside the cockpit while fine dining in *The Aviator* at Dunkeswell. We have all read or heard stories of in-flight over-heating on mobile phones and tablets.

We all know the basic things we should do to minimise excessive temperature rise in such devices, including, get some cabin air duct or window aperture airflow over the unit, shut down unnecessary background applications, try to avoid the need to recharge in flight, cover with light colour shade of some sort when leaving inside the cockpit, or better still, take it with you when leaving your aeroplane for a while.

Fig. 2 RAM EZ-Roll'r holders, 10.2in and 10.5in.

Fig. 1 X-Naut 10.2in cradle.

iPad exponents claim that overheating should never occur with minimal precautions in use, but I am not so sure. In any case, it is better for the longevity of battery, CPU etc that temperature excursions be curtailed.

My experience documented in this article might perhaps encourage others to try to make some modest effort to take this a little further, to get some degree of extra cooling at minimal cost and without the cabin looking like – to use a phrase inflicted on earlier PilotAware designs – 'an explosion in a Maplins store'. And, yes, yes, I know… Maplins has long gone now.

The default solution to this problem for tablets is to use one of the fairly well-engineered but bulky X-Naut cooling case/RAM-compatible cradles (Fig. 1).

This has four small computer fans, provision for batteries and has suitable control circuitry. If you change tablet size, as I did from 10.2in to 10.5in, you may need a new unit and each costs approximately £250! Apart from the cost, this approach adds considerably to the depth of the whole assembly and is relatively heavy when equipped with its batteries (although you can run it from an USB port).

I wanted an approach that cut down on the mechanical moment and bulk on my panel-mounted RAM base – and which was far less costly. My RAM tablet holder is a standard one, EZ-Roll'r type (Fig 2).

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Fig. 3 Peltier cooling pucks, 60mm and 100mm dia.

'Magnetic radiators' – what's in a name?

In my opinion this is perhaps one of the most stupid names for a very neat item of technology, aimed firmly at the enormous global gaming market, in particular to young people, for whom it is essential to operate the most sophisticated gaming applications for hours on end without their phone or tablet overheating.

These units are sold under a variety of names and pseudo-technical descriptions, but the technology and volume manufacture are, to me, most impressive. Each comprise an ABS puck containing a Peltier cooling stack, with the cold side arranged to be magnetically attached to a stick-on magnetic disc at the back of the phone or tablet, and the hot side shedding the heat via a computer-grade, quiet fan, clever heat sink finning, together with appropriate control circuitry.

Peltier? Back to your school physics. The Peltier effect is the opposite of the Seebeck effect, and uses a narrow band-gap semiconductor such as bismuth telluride. When voltage is applied to it, the material magically extracts heat from the cold side and transports it to the hot side. This thermoelectric (Peltier) cooling technology should not be confused with the heat pipes used in, for example, powerful high-end computers to wick away the heat from power hungry central and graphic processor devices.

These Peltier cooling pucks are readily available under outlandish names like *magnetic radiator* or *semiconductor radiator* – even *superconductor* cooler via eBay, Amazon and computer gaming sites, but my favourite is AliExpress (part of Alibaba). Prices are all over the place, with the smaller one I have used around £12 or so.

I tried to do some thermal modelling, but it is quite difficult without the right CAD tools, so after a few simple estimations I took a very straightforward approach and cut out a suitable square patch in my RAM holder (Fig. 4). To do this I tried a Draper multi-tool (oscillating head) but as this neophyte found the ABS difficult to work with, I changed to a Dremel-like rotary tool (TackLife). I might have done better with a drill and fine fretsaw, perhaps… For several reasons, it is slightly advantageous on current iPads to have the cooling puck on the left side (as viewed facing the tablet front screen).

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Fig. 4 Patch cut into RAM holder.

Results

Overall, I am quite pleased with this arrangement as is, but if I were more prone to flying in Death Valley rather than the Lorna Doone or Ogwen valleys, I would definitely choose a higher power rated puck e.g. the X42 (Plextone) of 100mm dia. rather than the 60mm dia. X1 model.

If it is a mobile phone you wish to cool, the X1 puck will be adequate for Arizona-type climates, I estimate, and that's even assuming one is using the phone to simultaneously run SkyDemon for navigation, interface with SkyEcho2 for traffic, run SafeSky for enhanced EC and make cellular mobile calls in flight (I'm not recommending this!). Each of these pucks has its own small two-digit temperature display, which from IR and thermocouple measurements I have done, seems accurate to the nearest °C. Surprisingly, there seems no handy iOS application that permits easy real-time monitoring of battery or cpu temperatures. On recent hot days I have seen a consistent cooling of most of the iPad back by some 10-13°C. This is with typical in-flight iPad

Fig. 5 Magnetic disc affixed to iPad back.

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loading, which is nowhere near as much as that demanded of hard-stressed tablets by obsessive gamers.

If you want to experiment, there are also intermediate-sized pucks, but all larger than the X1 which I am now using, which require a higher input power than the standard 5V at 2A max. The latter supply is readily available these days from essentially any aircraft cigar-lighter adaptor, using an USB-A cable to USB-C at the puck end, or from a small power bank, aka rechargeable battery. So, for the larger pucks one needs a QC or PD type ('fast charge') USB supply. The X42, for example, is rated at 3A at 9V, and mass increases from ~60g for the X1 to ~120g.

The removed ABS material for the aperture in my iPad holder, by the way, equated to ~30g reduction. In addition to the temperature display, each puck features a small push button switch for selection of either of two 'speeds' or off / on. And, of course, it features a mesmerising, slowly changing multi-coloured LED display visible through the internal rotating fan blades – a seemingly essential feature for gamers, but not for us, especially as it's visible only behind the phone or tablet (Fig. 6). Isolated, running 100% thermally unloaded, each of these pucks can achieve a back surface temperature below 0°C within a minute or so.

If you use a phone that features wireless (inductive) charging, you can even get a similar cooling puck which additionally includes wireless charging, but note that, for obvious reasons, this feature will work only if the back of the phone, and your holder, is not metallic (i.e. non-conductive).

6 **Fig. 6** X1 puck on 10.5in iPad holder.

Fig. 7 Thin spreader magnetic plate.

Fig. 8 'Magnetic' USB cable connection. Effective and usable up to ~ 3A.

Fig. 9 Lanyard mounted fans.

To achieve a little performance gain, the cooling puck can be used with a separately purchased, larger 'd-shaped' magnetic sheet (heat spreader) affixed to the back of the phone or tablet instead of the supplied circular disc (Fig. 7). If you do this for an iPad with one of the standard EZ-Roll'r cradles (like mine), you will find that it is necessary to make a suitably matching larger aperture in the cradle back, as otherwise the already tight roller fit at the top gets even tighter due to the extra spreader thickness.

My iPad now has an anti-glare, separate protective film applied to its screen, and this had already forced me to use the rotary tool to carefully remove ABS material from the bottom corners and top roller – which despite the name, never afforded an EZ fit from the outset (a good basic design, but poor manufacturing implementation by RAM).

Another product I have found useful here, and not just in the cockpit, is the USB cable-type featuring a 'magnetic connection' at one end (Fig. 8). This provides a form of frangible arrangement, especially in a cramped aircraft cabin where it is easy to accidentally side swipe a cable connecting portable devices to, say, a panel charging source.

The arrangement also serves to help preserve the life of the device's connector e.g. Lightning on an iPad. But I'd advise against using the charging only (no data) types that feature a circular interface at the break point. I recommend the non-rotating types such as that shown in Fig. 8, since the rotating types (which although provide faster charging) are most often incompatible with the foldable protective cases, used by many for our phones and tablets. The little insert stays firmly in the device, acting as connector-saver.

A further product, which is sort of related, is the pocket-sized portable fan which can be used in the cockpit, especially on a hot day before or at engine start on the ground. These fans have an internal rechargeable Li battery and three speeds – on the fastest speed it lasts more than two hours. One such type is shown in Fig.9. I have found this more useful to keep the human occupants cool as opposed to the iPad. A neat, easily de-coupled lanyard makes this very easy to hang around your neck and remove for storage after a short while.

Again, AliExpress and others sell these for about £5. ■

Executive summary OK, ignore the techno-babble...

1 Cut a hole in your EZ-Roll'r RAM £30 cradle. (But don't forget to allow space for the USB-C cable end to be easily inserted into, and removed, from the cooling puck and also for the push button switch to be accessible by finger once the puck is installed).

2 Stick the magnetic disc to the bottom of your iPad.

3 Magnetically attach the cooling puck.

4 Connect the cable.

5 Switch on for a reassuring 10-13°C local cooling at the tablet's back, even under high loading.

The approach seems as effective as an X-Naut £250 cooling case, and a lot less bulky, with similarly tolerable power consumption via USB.