Solving the Pin-Zero problem

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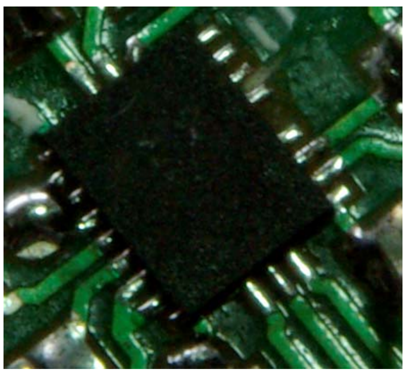
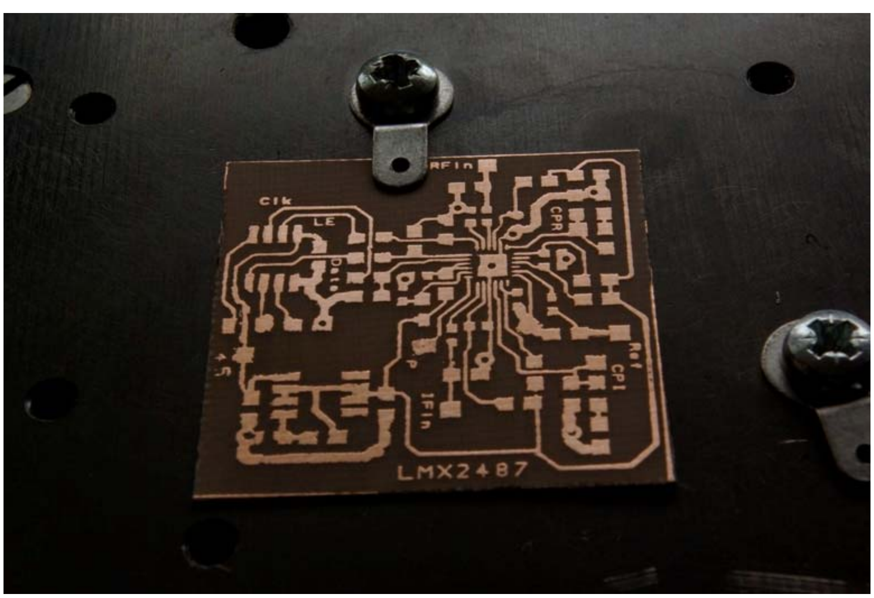
Or a few notes on homebrewing with small microwave chips

Many of the nice microwave ICs nowadays come in tabbed or leadless quad packages with a metallised pad on the underside that serves the dual purpose of allowing a direct low impedance connection to a ground plane and also behaving as a heat conductor. Data sheets usually refer to this as Pin 0 [1] The exposed pad is soldered to a copper area on the top side that is connected though to the underside via several plated though holes The pad is usually soldered using reflow techniques where the whole PCB is raised to just above solder melting point and pre-applied solder paste is allowed to melt and fill the gaps. For homebrew construction of such boards, a large soldering iron applied to the underside with flux and plenty of solder usually does the job – it is easy to see when the solder has flowed as it wicks up the plated though holes. When good flux is used [2] , solder shows the very satisfying property of flowing well and going just where it wanted

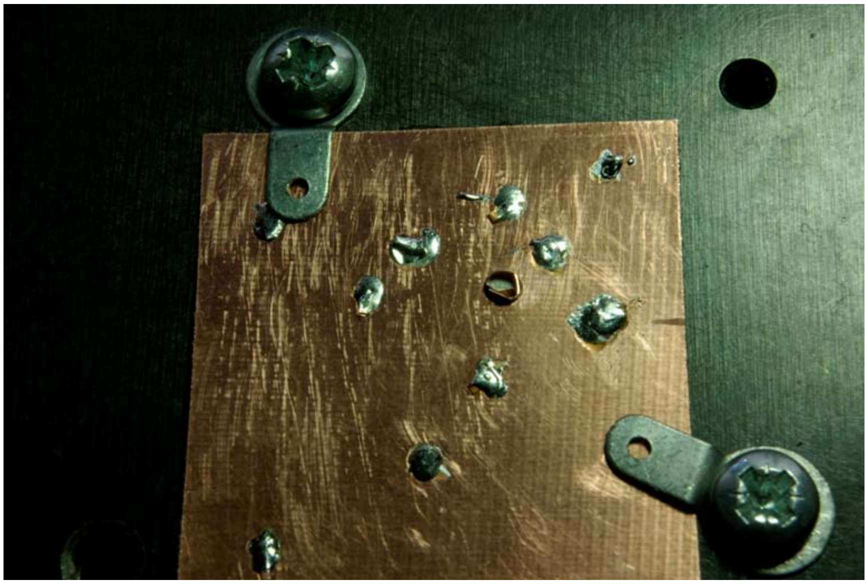


On the leadless (or tabless) TQFP and similar packages, soldering the pads on the topside is really easy using this flux. First very carefully align the IC on its pads, press down with a small screwdriver or scriber so it cannot move and drench the assembly in flux so it is clearly sitting in a pool of liquid. Load a clean soldering iron bit with solder and wipe it along one side of the IC, pushing solder into the gaps. Repeat on each side of the IC. If the flux evaporates before you get all the way round, apply more. Use a strong magnifier to check solder has flowed into the gap on every pad. Repeat the flux and solder-wipe as often as necessary. Don't be afraid of overheating the chip – it can survive this. For an electrical test method see [3]

With homebrew PCBs life isn't so simple when it comes to soldering Pin-Zero. Plated though holes do not exist. Originally, on the first version of those DDS boards, Dave Wrigley drilled one large hole and filled it with solder – it worked. But the AD9852 is a large IC with a big pad on the underside and 80 tabs around its periphery. These are enough to securely hold the chip when applying the heat.

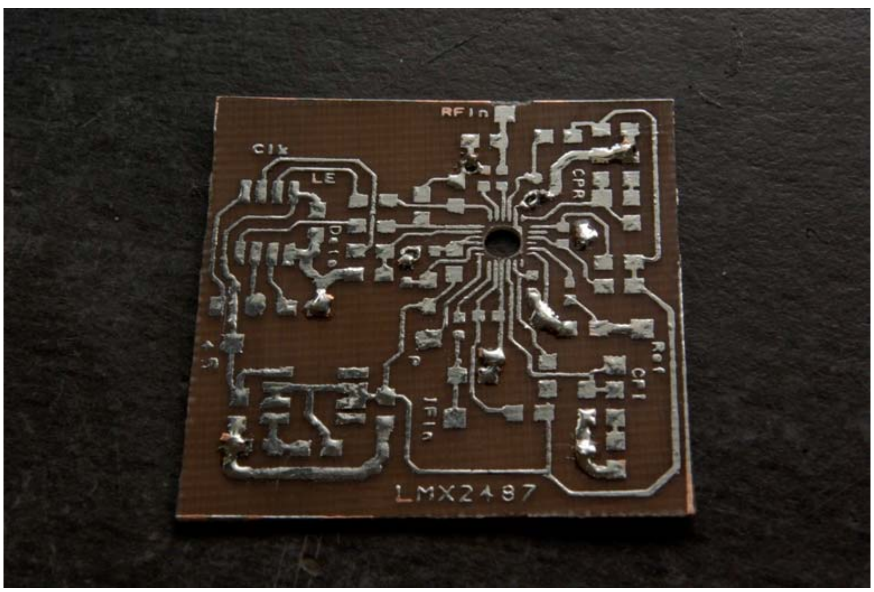


On the tiny 4mm square leadless packages many of the half-decent microwave synthesizers come in, the pad on the underside is only 2.5mm square. For the first one of these for which I tried to make a homebrew PCB, I drilled a 2.3mm hole (which was a bit too large, see photo) on the

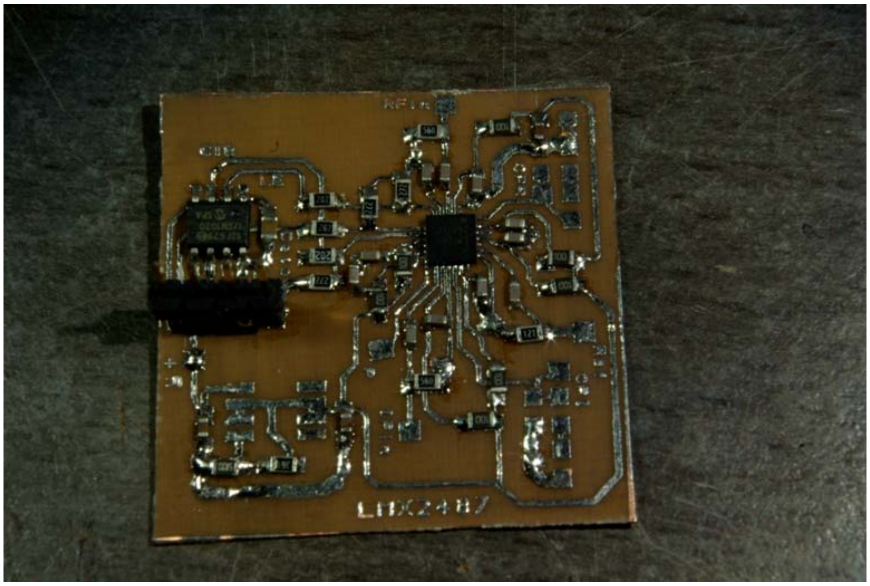


underside, smoothed off all edges, pretinned all copper surfaces top and bottom , applied plenty of flux and initially soldered the 24 pads – they looked good and I felt very satisfied at having done so.

I turned the board over, placed a small circle of copper foil into the hole to simulate a plated though hole, then applied heat and solder It flowed well, it all looked good. Until I turned the PCB over and looked at the top again. The action of soldering the underside had raised the whole IC to solder melting point, which had melted the tabs and the IC had moved and was badly misaligned on its tracks. The whole chip had to be removed the same way, by heating from the bottom and removing the tabs were all covered in solder making it even more difficult to align and redo. Eventually I did get the device properly soldered on , and in spite of the repeated overheating and severe abuse, the synthesizer module did work properly.



Hardly a satisfactory procedure though, so the next time I used a chip with a pad on the underside, I was determined to do it better, and applied a bit of forethought. The really important thing is to make sure the chip cannot possibly move when the bottom is heated with whole thing above the solder melting point. The way this was done was to make a clamping arrangement so when mounted upside-down for soldering the underside, the PCB was forced down onto a flat surface and the chip pushed hard against its pads. A thick metal plate with several M4 tapped holes was pressed into service. A couple of M4 solder tags made good clamps as shown in the photographs. (This arrangement was also a convenient way to hold the PCB for the conventional top side soldering operation). The first time I tried soldering the large pad using this arrangement it appeared to need an



awful lot of heat. Realisation struck. The top of the IC pressing onto the metal surface was conducting heat away too rapidly. For the next time I placed three thicknesses of paper between the top of the IC package and the metal to act as a heat insulator . Soldering the pad was now much easier.

Rather than bothering to make up a thin circle of copper foil to drop into the hole, I just made up a U-shaped piece with a width about the same as the hole diameter and dropped this in. So long as the bottom of the U drops though the hole and touches the pad itself, the sides are pressed onto the ground plane and after ensuring everything is drenched in good flux [1] solder will reliably flow onto and around everything it needs to.

Incidentally, both ADF4510 Fractional-N synthesizer PBCs – worked straightaway, immediately, from switch on. Very satisfying.

[1] Most data sheets call this *Pin-0* for ground. Analog Devices, just to be different, call it Pin 25 on a 24 pin chip. So I suppose , in that case, it should be called the *Pin-N+1* problem

[2] Kevin G3AAF sells small bottles of liquid flux at most µWave Roundtables. This is excellent stuff. Low viscosity, low residue and is absolutely superb at making solder flow just where it is wanted. It seems to have an almost magical ability to prevent annoying solder bridges. If these do form, usually though not having enough flux in the first place, or a dirty soldering iron bit, apply more flux and a quick wipe with a (clean) soldering iron bit is usually enough to remove the bridge.

[3] RadCom May 2012, Design Notes page 29, *Testing Complex ICs*