FEATURE ARTICLE

John Taylor

Hand-Soldering Fine-Pitch QFP Devices

John walks us through the basics of working by hand and explains some techniques that can be used for replacing SMT devices or installing sockets. His practice exercise shows us that most components aren't too compact for hand soldering, at least not yet.

Surf ace-mount devices are typically used to minimize circuit board real estate. As a result, the boards give you little working space between components to rework anything. Component gaps are small and the leads (and lead pitches) are fine. If you're developing prototypes or working in a small board shop repairing boards populated with surface mount devices, you might not have the specialized equipment used for removing and mounting SMDs. Experience shows that you can, however, do the job by hand. All you need are basic hand-soldering skills for through-hole soldering and a set of hand-soldering equipment. It is possible to effectively replace SMT devices or install sockets and complete other reworking tasks without special manufacturing tools.

In this article, I'm going to show you an example of a reworking job. The project involves the removal, cleanup, and replacement of a typical component, a thin quad flat pack (TQFP). I'll provide a complete list of the hand-soldering equipment you'll need and a step-by-step explanation of one way to approach the task. If you have other equipment or other skills, you might choose a different approach.

I want to note how important safety is before getting into the project. In addition to the normal precautions associated with doing close work, such as wearing proper eye protection, always do circuit board rework in a well-ventilated area. Prolonged exposure to solder fumes and solvents can be hazardous. And remember, if you use solvents, don't work in areas where there are exposed sparks or flames.

EQUIPMENT LIST

Doing any work well requires that you have good tools. Based on my experience, the equipment list (available to download from the Circuit Cellar web site) should give you the right tools to get started. Other materials or tools may work fine, and for other types of components you might find other tools are needed. So, feel free to substitute and experiment. I recommend using organic solder, at least in part because of familiarity. The important thing is that you use a solder that you're comfortable with, one that will flow well and make good solder joints. Consistency is the critical factor.

In addition to the basics, you'll find it extremely useful to have a board vise to hold the circuit board steady. A dental pick, with a 90° bend, proves useful in positioning loose pads and general probing. Compressed dry air or nitrogen to dry the board speeds the work. And, to provide a truly careful inspection, it's wonderful to have an optical inspection stereo microscope of 30x to 40x magnification.

THE JOB AT HAND

The rework task breaks down into three major steps: part removal, board cleanup, and soldering in the new device. You will replace a TQFP device that has 48 pins and a 0.5-mm lead pitch. The device's leads are configured in the standard gull wing shape associated with JEDEC-standard quad flat packs (QFP).

The first step is to mount the board in some sort of holder or vise as shown in Photo 1. If you don't have a PCB vise, you'll need to firmly position it in some way that it is held steady while you work on it. This is extremely important considering the

small amount of room you'll have to work in and the narrow margin for error with a hot soldering iron. It will prove difficult to work carefully and accurately if the board is moving around; you can do more damage than good.

To finish preparations, warm up the soldering station to 700°F (370°C) and clean the solder tip. Make sure that you grounded the ESD mat and wrist strap. Because you'll be working with high heat that could easily damage the board or other components, it's a good idea to practice the following procedures on a piece of scrap before working with an expensive prototype. You'll quickly develop a sense of how fast to move the solder tip and how long it takes to make the solder flow. You want to develop a smooth touch and an intuitive sense of how quickly you need to move the solder tip over the leads.

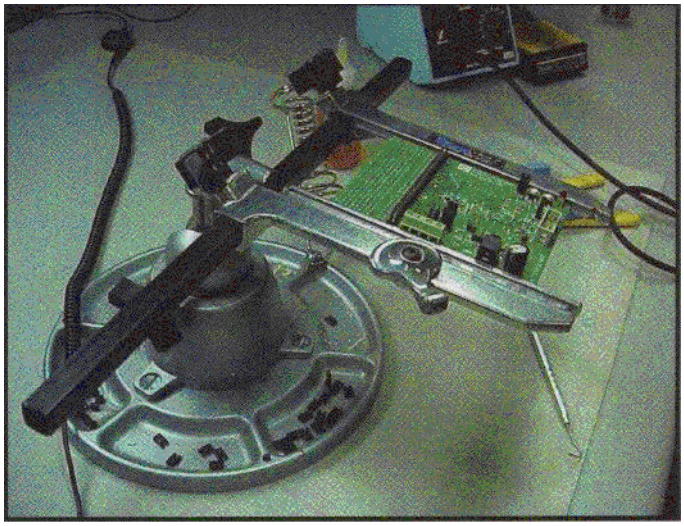

Photo 1-Securing the PCB in a board vise is the best

When you're comfortable with the process, begin by wetting all of the leads with flux to enhance the initial solder wicking cleanup. Now, wick up as much solder as possible from the QFP leads like you see done in Photo 2a. Be careful not to scorch the PCB with prolonged solder heat.

Next, strip approximately 3" of insulation from a 12" piece of 30-gauge wire wrap wire. The actual length of the wire is not critical, because this piece will simply serve as a tool for lifting leads. However, the wire needs to be long enough so that you can handle it easily. You'll want to experiment with different lengths of wire to see what works best for you. Feed the wire behind and under the leads (see Photo 2b) along one side of the IC, and then anchor it with a solder tack to a nearby via or component on the PCB (see Photo 2c).

The wire, with one end anchored, will serve as a pry bar that puts pressure on the leads as you apply heat. Grasp the unanchored end of the wire with your tweezers rather than your hand. The tweezers will provide more control and, besides, the wire is going to get hot. Make sure you grasp the wire close to the device. Apply the soldering iron tip to the device lead that is closest to your tweezers and begin pulling the wire away from the QFP, slightly upward from the surface of the board (see Photo 3a). As the solder melts, gently continue pulling the wire away from the QFP and move the solder iron tip to the next pin away from the tweezers. The wire will pull the leads free as the solder melts. As it melts, smoothly move the tip to the next lead, and then the next, making it a continuous process for the entire side of the IC.

Be sure not to hold the heat on any one lead longer than necessary. The first lead will take the longest to heat, but this also heats the wire, which will help melt the solder on the other leads. Excessive heat can damage both the IC device and PCB pads. You'll need to practice this technique to get a sense of how fast you can move the soldering iron tip. Removing the leads on one side of a 48-pin TQFP should take about 5 s.

While you are learning, watch for signs that you are using too much heat. The most common indications are melted plastic on the IC, brown scorch marks on the circuit board, or circuit board pads begin lifting.

After you've removed all of the Leads for one side, wet the leads on :he next side with flux and repeat the procedure. You'll find it a good idea to cut off the dirty part of the wire wrap wire or use a new piece for each side.

If you are removing a defective IC, x do not need to save the IC being removed, you can use a little more heat (800°F (425°C) in this example), Ignoring the fact that this results in some melted plastic and missing gull wing leads. You can see this kind of damage in Photo 3b. If you want to save the IC being removed, however, :hen you'll have to minimize the heat iiou apply to the leads to just barely enough to free the lead from the PCB.

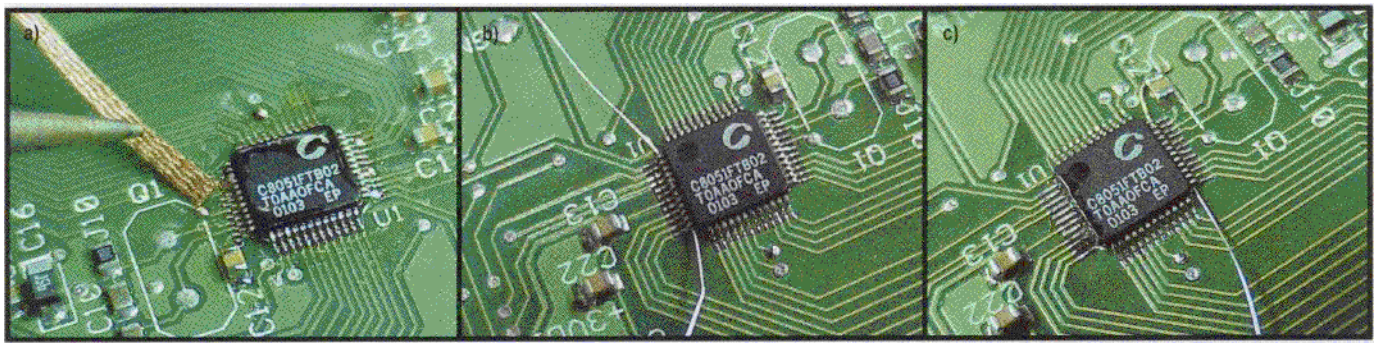

Photo 2a-Apply solder flux and then wick the excess solder from the pins, b-Feed the stripped wire wrap wire behind and under the QFP leads. c-Anchor one coo of the wire to a nearby component or via.

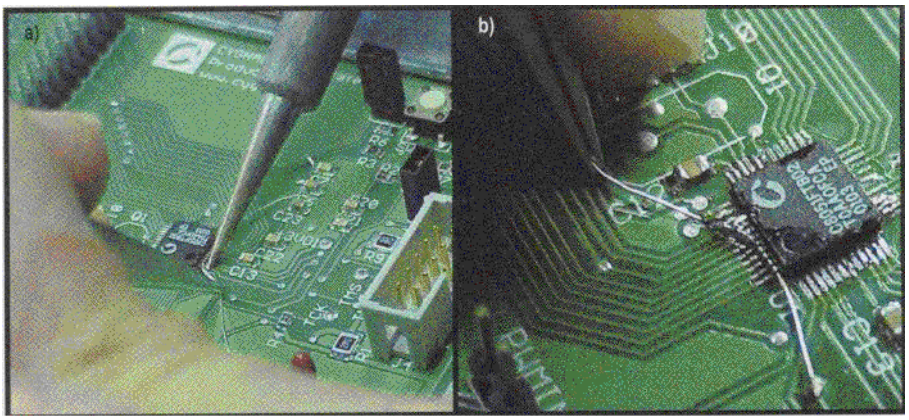

Photo 3a-Hold the tweezers close to the device and begin heating the lead closest to the tweezers. b-Removing the device quickly can damage it because of the high heat.

CLEANING UP THE PCB

Even if you are careful, removing the IC leaves the PCB in a bit of a mess. Although installing an IC on a new PCB would require little more than brushing the pads with isopropyl alcohol and drying the board, with this project, you have other work to take care of first. Excess solder and flux have to be removed and any damage you've inadvertently done to the PCB needs to be repaired.

The first step is to clean the solder pads. You want them to be flat. A clean solder pad will be a dull silver color, so you should solder wick the pads until they are flat and dull. When you're done, inspect them carefully. You might notice some that have become loose from the PCB (see Photo 4). Here is where the dental pick comes in handy. Use a pick or some other pointed object to carefully realign the pad.

A large number of loose pads or lifting of a trace indicates that you are using too much heat, leaving the soldering tip on a lead for too long a time, or are pulling too hard on the wire. Again, practice and experimentation will tell you what are doing wrong.

SOLDERING A NEW QFP

With the pads cleaned and aligned, you can begin aligning the new IC. Carefully place the QFP device on the PCB. You can use tweezers and a probe to align it or use any other tools that suit you. Make sure not to drop the part while you position the chip. Dropping it can easily damage the leads. Also, bear in mind the dangers of ESD on the IC. Double check the pin orientation to make sure pin 1 is in the right spot, and then align the part over the pads as accurately as you can.

Now, you need to secure the package in place or it will move around while you're soldering it. You don't need as much heat for this operation, so first adjust the soldering station temperature down to 700°F (370°C). Put a small amount of solder on the tip of the soldering iron. Hold the aligned QFP in place by applying pressure straight down with a pick or other pointed tool, and add a small amount of solder flux to the corner leads on two opposite corners of the QFP. After that, solder just those two leads. For the moment, don't worry about any excess solder or whether or not you have created shorts between the leads. All you want to do is carefully anchor the aligned chip with solder so that it doesn't move.

When you have the device anchored, recheck its alignment. If the device has moved, use a pick or similar tool to adjust it, or if necessary remove it and start over. Now is a good time to be fussy. Any misalignment at this point will cause problems later on. If the alignment is fine, then you are ready to solder the rest of the leads.

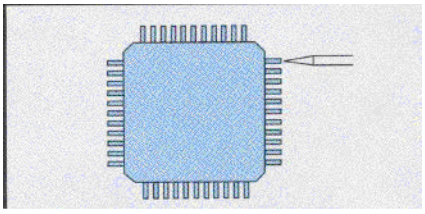

Figure 1-Keeping the iron tip parallel to the pins being soldered reduces solder bridges.

First, add a little more solder to the tip of the soldering iron and dispense additional flux over all the leads to get them wet. Touch the soldering iron tip to the end of each lead until solder begins to run up the lead. Holding the soldering iron tip parallel to the pins being soldered helps reduce the frequency of solder shorts, or lead-to-lead bridging (see Figure 1). But again, don't worry if you see some solder bridging. You can clean that up later, but, of course, there will be less to clean up if you're careful. There's always going to be a trade-off between how careful you can be and how quickly you want to work.

As you go, periodically add small amounts of solder to the soldering iron tip. After you've soldered all of the leads, wet them with flux again. This will enhance the solder wicking cleanup. Use the solder wick wherever you see shorts and bridging.

It's time to inspect the board closely. You'll need at least 4x magnification to identify shorts and marginal solder joints. A good solder joint will have a smooth melt transition between the device pin and PCB trace. Look for irregularities and rework any pins with defects. This is where it is convenient to have a 40x stereo zoom inspection station.

After the board passes the visual inspection, it needs to be cleaned again. Dip the bristle brush into isopropyl alcohol and wipe in the direction of the leads. Use the alcohol liberally, brushing well between the device leads until the flux disappears. When it is clean, dry the board with compressed dry air or nitrogen. If you don't have

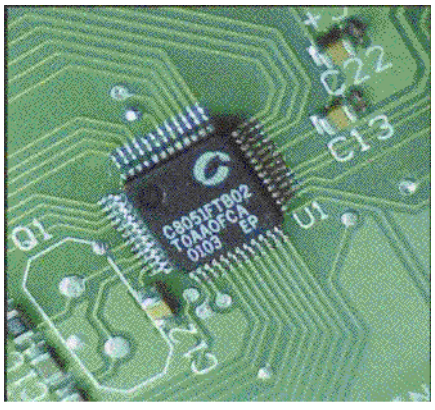

Photo 5-When you are done cleaning, the QFP leads should be bright and shiny

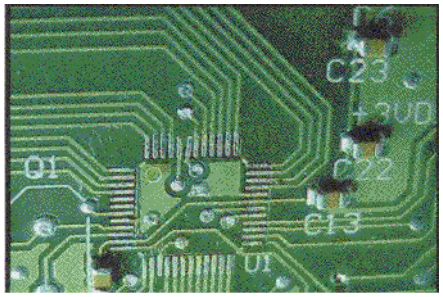

***Photo** 4-Make sure that you inspect the pads to look for any that have come loose.*

either available, shake off excess liquids and let the board air-dry for at least 30 mm to give the alcohol under the QFP a chance to evaporate. When dry, the QFP leads should look bright and there should be no flux residue. Clean again if any flux remains. When you're satisfied with your cleaning job, inspect the board for workmanship. It will be easier to spot any problems on the clean board. Do any rework that appears necessary and clean the board one more time. When you are finished, your reworked IC and the surrounding PCB should look as clean and pristine as components installed in a standard manufacturing process (see Photo 5). Don't worry if your efforts fall a little short at first, your rework will improve with practice.

John Taylor graduated from ITT Technical Institute in Austin, Texas with an AAS in Electronic Engineering Technology. He is a product test engineering technician for Cygnal Integrated Products. His technical interests cover a wide arena. You may reach him at jtaylor@cygnal.com.

PARTS LIST

To download the equipment list, go to ftp.circuitcellar.com/publ Circuit_Cellar/2002/l42/.

SOURCE

EC12O1A Soldering station
Weller (408) 878-9000
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