The Micro Wave Revolution

by Mark Cannon*

The first „revolution“ in hand soldering took place somewhere around 3000 BC when the Egyptian goldsmiths invented a method to connect silver and gold. This new science evolved over the centuries and opened the door to new inventions and revolutions which shaped the destiny of our civilization. Aside from refining the process and experimenting with various alloys, however, nothing extraordinary took place in the science of hand soldering itself until just over 4900 years after its inception. In 1921, Ernst Sachs invented, patented, and marketed the first electric soldering iron for industry. Although evoking skepticism at first, the ERSA (ERnst SAchs) soldering iron and methodology rapidly became an integral part of the technological advancement of such young and growing electronic enterprises as Siemens. Today, three quarters of a century after this monumental feat, the electronic, temperature controlled soldering iron is common place and in most cases taken for granted. Although there have been improvements in shape, form, in output, heating efficiency, and in temperature regulation, nothing really „revolutionary“ has occurred in the science of hand soldering. Until now.

The pioneering spirit of its founder flourishes, encouraging the current at ERSA „Hand SolderWell Revolution“. This extraordinary technology is designed to provide its users a vastly improved working environment and their employers a distinct competitive advantage in global markets. ERSA‘s two most important concerns, your worker‘s job satisfaction and your bottom line, ultimately depend on each other and drive our R & D.

Relating specifically to the ever growing job area of hand installation and touch up of fine-pitch SMD‘s, the ERSA Hand SolderWell Revolution can be summed up in three words: **better, faster, cheaper!**

A technology that can increase the quality, increase the productivity, and decrease the cost of an installation will have a direct and positive effect on your profitability. A Cost and Investment Justification Analysis must be made to properly evaluate productivity and operational costs. Quality will be addressed separately and must incorporate the aspects of process control.

Process control and quality, interchangeable expressions, both relate back to the fundamental principals of the soldering process. The pretinned copper pins of the fine-pitch SMD are connected to the pre-tinned copper pads using tin and lead (solder), flux and heat. The quality of the process is dependent on several production parameters: the solder alloy, wetting action, flux, temperature and time. All things being equal, the two most critical parameters which directly effect the quality of the fine-pitch solder joint are time and temperature. Ideally a soldered connection should be made at approx. 220 °C (428 °F) for 2 seconds. The chemical diffusion reaction between copper and tin will produce under these conditions the optimal amount, 0,5 µ, of the intermetallic bonding material Cu^3Sn, and Cu6Sn5. Insufficient intermetallic, as seen in a „cold solder joint“ or a joint that has not been raised to the proper temperature, can result in a shearing at this interface. In contrary, too much intermetallic, as seen in a joint that has been overheated or is held too long at temperature, can result in a drastic weakening of the tensile strength of the joint. (see fig. 1).

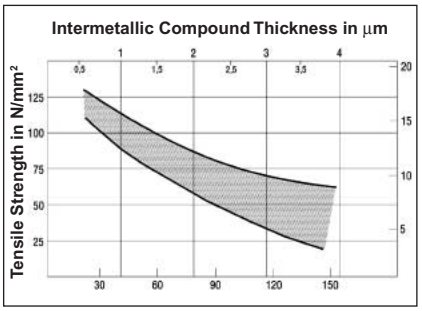

Fig. 1: Tensile strength and intermetallic compound thickness

Due to the fact that the relative size of the joint and bonding interface is extremely small in a fine pitch SMD, as much as 1000 times smaller than in a conventional joint, it is paramount to make a proper and lasting connection. By respecting these ideal time-temperature parameters, is it possible to achieve an acceptable life-cycle for the electronic assembly containing such components.

Over the last several years many methods, including semi-automated hot air or IR systems, have been tried and tested but have failed to offer acceptable quality and repeatability. Additionally, such systems are often very expensive (10 - 20 K US$) and are therefore not available to the masses. It is for this reason that the vast majority of operators working with fine and ultra fine pitch (20 mil [0.5 mm] pitch and below), rely on the method they can best control: pin by pin soldering under a microscope with a needle nose soldering tip and ultra-thin (0,28 mm to 0,35 mm) (0,010 in - 0,014 in) solder wire. Besides being very tedious, time consuming, and expensive, this commonplace method allows for only marginal process control and quality. The thermal transfer area of a needle nose tip is extremely small and such a tip will generally not

INVESTMENT JUSTIFICATION

II. INVESTMENT ANALYSIS:

Savings/worker = DM 1115.27 / month

Investment/worker = DM 345.00 (ERSA TWIN 40 AS)

After 1 month, return on investment has been realized - with additional savings of DM 770.27

Yearly savings, based on 10 month working year (standard method versus Micro Well):

DM 10,807.70 / worker / year

Savings/worker	x	total no. workers	=	total savings
?	x	?	=	???

IT IS WORTH **15 MIN**. OF YOUR TIME TO FILL OUT THE BLANKS. MAKE THE EFFORT AND

STOP WASTING MONEY!

INVESTMENT JUSTIFICATION FORM

I. COST ANALYSIS / TASK (3 COST FACTORS):

Task: Hand installation of PQFP 208, 20 mil pitch SMD
* (Standard method: pin-by-pin installation under microscope with thin solder and a thin tip)

1. Worker costs:

(per worker)	Time/task [min]	Cost/min. [DM]	Cost/task [DM]	Tasks/month [pcs]	Cost/month [DM]
*Standard method	20	1.85	37.00	30	1110.00
MicroWell technology	1	1.85	1.85	30	55.50
Your data					

Savings / worker cost / month:	(Standard method versus MicroWell)	[DM]	1054.50
	Your data versus MicroWell	[DM]	

2. Solder wire consumption:

(per worker)	Spool solder wire required for task	Cost/month [DM]	Spools/month [pcs]	Cost/month [DM]
*Standard method	63/37, 0.33 mm, 100 gr.	67.50	0.5	33.75
MicroWell technology	63/37, 1.50 mm, 100 gr.	4.50	0.5	2.25
Your data				

Savings / solder wire / worker / month:	(Standard method versus MicroWell)	[DM]	31.50
	Your data versus MicroWell	[DM]	

3. Tip consumption:

(per worker)	Soldering tips required for task	Cost/month [DM]	Tips/month [pcs]	Cost/month [DM]
*Standard method	0.4 mm conical tip	10.00	4	40.00
MicroWell technology	MicroWell tip	32.50	0.33	10.73
Your data				

Savings / solder tips / worker / month:	(Standard method versus MicroWell)	[DM]	29.27
	Your data versus MicroWell	[DM]	

Total savings / worker / month:	(Standard method versus MicroWell)	**[DM]**	**1115.27**
	Your **savings** versus **MicroWell**	**[DM]**	

Fig 2: Investment justification form

permit a thermal bridge of solder. This forces the user to use a very high set temperature of 400 °C (752 °F) to 450 °C (842 °F). Additionally, the very small and inefficient thermal transfer area of the tip causes unequal and non-uniform heating of the joint.

The outer most portion of the pin and pad is heated first. Solder will be drawn, via capillary action, in between pin and pad and will form an exterior meniscus (fillet) immediately. The operator often does not dwell long enough on the pin with the tip until the entire pin and pad are heated, or does not „push“ enough solder wire into the joint. The result will be an insufficient, „cold“, or non-existent interior or heal fillet. It is a fact that 90 % of the mechanical strength of an SMT solder joint is dependent on the heal fillet. The aspects of exceedingly high set temperatures, insufficient heating, and solder amount on the heal result in non-uniformity, poor joint integrity, mechanical instability, and inferior wetting. In short, the quality of this method is questionable and process control is clearly not guaranteed.

The productivity and operational costs of this widely used process, however, are most alarming. When conducting a hand installation of a PQFP 208, 20 mil (0.5 mm) pitch SMD, a cost analysis of the three key cost factors, labor cost, solder wire cost, and solder tip cost, reveals the following: for the above mentioned task, the average worker will take 20 minutes for the installation under a microscope, using 0,28 to 0,33 mm wire, and a needle nose tip. The cost per worker per month, given that this worker only performs 30 installations, is € 570 (DM 1,115.27)! (see fig 2). Questionable quality, low productivity, and high operational costs – this is the acceptable standard today!

The ERSA Hand SolderWell Technology must be the standard of tomorrow. Founded on the production process of wave soldering, this technology is designed to provide maximum process control. Superior wetting via capillary action, proper intermetallic formation based on ideal time/temperature profile, uniform joint integrity and guaranteed interior fillet production via the ERSA SolderWell, optimal thermal linkage and efficient heat transfer are all inherent to this revolutionary technology.

The 6-step ERSA Process description „Fine-Pitch Installation“ reveals the ease of this process (see fig. 3). A cross-section, SEM, or x-ray reveal the superior quality which, in many cases, exceeds original production quality achieved in the IR or convection ovens. But quality is only one aspect of „better, faster, cheaper“.

The cost analysis for a hand installation of a PQFP 208, 20 mil (0.5 mm) pitch SMD (see fig. 2) compares the standard pin-for-pin method with the ERSA Hand SolderWell Technology. An average worker, with little or no practice, will perform the same installation with 100 % solder joint integrity, in 60 seconds, using 1,5 mm solder wire. The cost per worker per month, given the same 30 installations is € 28 instead of € 570! This comparative analysis of the standard versus ERSA Hand SolderWell Technology shows a **savings of more than € 500,00 per worker per month!**

ERSA's concerns for your plants' profits are clearly expressed with the ERSA Hand SolderWell Revolution we are spearheading (leading). Better, faster, cheaper are just the beginning. Your worker's job satisfaction is critical to maintaining a consistently high level of quality and productivity. Our new technology reduces your operator's time under the microscope for a Fine Pitch installation from 20 minutes to 60 seconds! In addition, the ERSA line of high power low temperature soldering irons are some of the lightest, smallest, and „coolest" irons on the market. Soldering temperature as low as 235° C (455° F) can be used for the majority of fine-pitch applications. Operator eye strain and hand stress will no longer incapacitate your workers. With the ERSA Hand SolderWell Technology, everyone wins!

Increased quality, increased productivity, and decreased operating costs – that's ERSA's commitment for your bottom line.

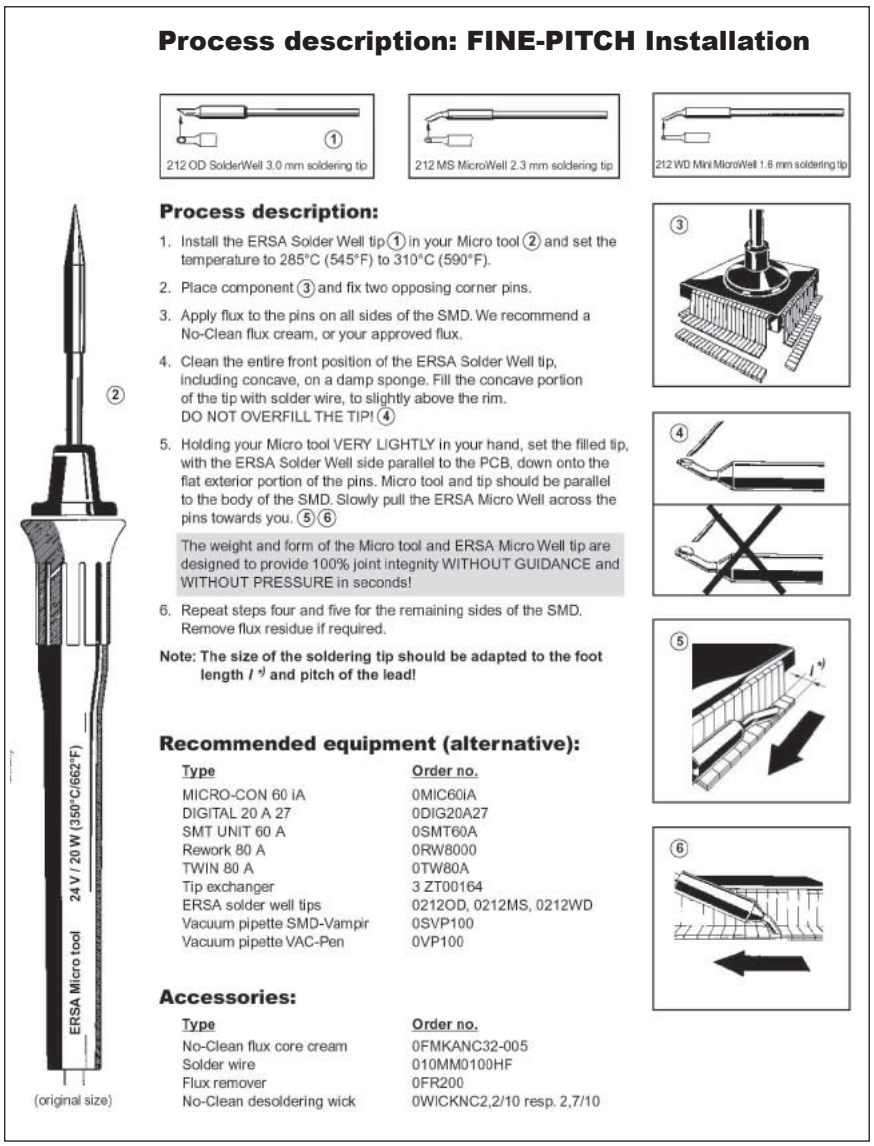

Fig. 3: ERSA process description: Fine-Pitch installation

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