



**Nordson SELECT**  
Headquarters  
3010 North First Street  
Spokane Valley, WA  
99216-5085 USA.  
[www.nordsonselect.com](http://www.nordsonselect.com)

**Nordson SELECT**  
Germany Office  
Perläckerstraße 11  
76767 Hagenbach  
Germany  
[www.nordsonselect.com](http://www.nordsonselect.com)

## Selective Soldering: A Cost-Effective Alternative to Wave Soldering

By Florian Strohmayer, Applications Development Manager, Nordson SELECT, Hagenbach, Germany

Wave soldering is an established technology and is commonly used where large unit volumes occur with low product variety. However, if a wave soldering machine is getting old or if technological changes or new PCB designs limits its manufacturing capabilities, consideration should be given to whether selective soldering would be a better choice.

Anyone who deals with soldering through-hole and surface mount mixed-technology printed circuit assemblies will quickly discover that a selective soldering machine is not only less expensive than wave soldering, but selective soldering also offers the opportunity to meet customer requirements with significantly more flexibility. One such company is Thomas Preuhs GmbH. Located in Geislingen, Germany, Thomas Preuhs GmbH manufactures a variety of electronic assemblies for solar and HVAC data systems, automotive and white goods products as well as electric drive systems.

### Wave Soldering

Wave soldering, also known as flow soldering, is normally performed in a protective gas atmosphere since the use of nitrogen offers an opportunity to reduce solder defects. While the wave soldering process can be designed to be more secure, it has distinct technological limitations. Selective soldering is also a form of flow soldering and offers the only possible soldering method where through-hole components must be soldered on both sides of a two-sided printed circuit board assembly.

Although wave soldering can be used successfully for large unit volume production, since it is a form of mass soldering it has several disadvantages including:

- Higher consumption of solder
- Higher consumption of flux
- Higher consumption of electricity
- Higher consumption of nitrogen
- Additional masking of sensitive points on PCBs
- Increased need for post-wave solder rework
- Additional cleaning of wave solder aperture pallets or masks
- Additional need for cleaning of the soldered assemblies

Because of these disadvantages the overall operating costs for a typical wave soldering machine can be as high as five times greater when compared to a selective soldering machine.

### Manual Soldering

In many respects, manual soldering has almost become an obsolete technique since more precise and robust processes have been created. While once a good technology, manual soldering has for good reason outlived its usefulness and has been for the most part been replaced by selective soldering.

While useful for small series production, today manual soldering is no longer used in mass production for reasons of quality assurance and is no longer even allowed in the automotive industry. Increasing complexity and ever higher quality standards have contributed to soldering by hand no longer being accepted as an adequate technique.

While still useful for genuine one-off solutions, or repair of individual solder joints, the manual soldering technique has several disadvantages including:

- Soldering result is only as good as the person who produces it
- Reproducibility is not guaranteed
- Extreme flux residues can result from manual soldering
- Higher localized thermal load due to small soldering tip and small contact area

In addition to the above factors, the primary disadvantage of manual soldering is the result is often inconsistent quality and unpredictable throughput. Furthermore, manual soldering is not authorized for use in the automotive industry or its supply sector as well as other high-reliability applications.

### **Selective Soldering**

Selective soldering is a variant of wave soldering used mainly for soldering printed circuit boards that are assembled partly or even entirely with through-hole components. With Nordson SELECT selective soldering machines, nitrogen inerting is standard and the solder pot is designed with titanium material to resist the corrosive effects of aggressive lead-free solder alloys.

Among the many advantages of selective soldering, the one that stands out supreme is greater process reliability and more consistent reproducibility of soldering results. This is due to the technical advantages of selective soldering in which specific soldering points can be individually programmed and monitored to selectively control flux volumes and soldering time. Definitely higher quality can be achieved at significantly lower cost with selective soldering and this can be done with considerable acceleration of the manufacturing process making selective soldering the technology of choice.

When printed circuit board assemblies have surface mount components mounted on both sides, wave soldering is not always possible for soldering of through-hole components and manual soldering is not a good compromise. Many through-hole components cannot be replaced by surface mount technology especially where high mechanical loads are involved as with connectors or switches. Power electronics also requires through-hole mounting on the printed circuit board to aid heat dissipation.

Often individual variants of printed circuit board assemblies consist of temperature sensitive components in combination with high thermal mass components on the same printed circuit board assembly. Manual intervention of either wave soldering or manual soldering often results in low or too high of a soldering temperature and therefore quality problems are inherent. These can be eliminated by using the selective soldering process.

Selective soldering in most cases consists of three stages; 1) fluxing or the application of liquid flux, 2) preheating or the printed circuit board assembly, and 3) soldering with a site-specific solder nozzle. Even the programming has been perfectly developed so that operators without any prior knowledge can setup a program within minutes thanks to the Nordson SELECT software.

Due to its inherent process flexibility, selective soldering can be used successfully for soldering a wide range of printed circuit board assemblies and has several distinct advantages including:

- Process optimization can be obtained securely and quickly
- Ensures reliable solder joints without overheating components
- Process reproducibility is guaranteed
- Eliminates use of expensive aperture wave solder pallets or masks

### **Drop-Jet Fluxing**

All Nordson SELECT selective soldering machines have a MicroDrop flux dispenser that ensures fluxing of liquid flux precisely to the individual droplet processing both individual points and entire lines for connectors in a single pass. The volume of flux in every single droplet is adjusted to the requirements of each soldering point. And because of this selective fluxing of the printed circuit board, contamination is minimized and consumption of flux is drastically reduced. Monitoring of the jet of flux ensures that flux has been applied with the data being read and processed in an on-board data recorder.

The advantage of drop-jet technology is that it provides complete control of an adjustable droplet size together with low consumption of the liquid flux being applied. Because no-clean flux residues are completely consumed when using selective soldering, a drop-jet flux applicator is a distinct advantage of selective soldering over wave soldering using aperture wave pallets since no-clean flux residues cannot become entrapped underneath wave pallets.

The distinct advantages of using a drop-jet flux applicator for selective soldering include:

- Eliminates entrapped flux residues
- Allows for true no-clean processing
- Mitigates need for post-soldering rework and repair

Current and new technologies such as the MicroDrop drop-jet flux dispenser, combined with optional flux jet monitoring automatic wave height monitoring and closed-loop process control, provides the Nordson SELECT selective soldering machines with unparalleled process capability.

### Economic Feasibility

Once an economic analysis of through-hole component soldering is conducted, it can be determined that by using a selective soldering machine one cannot only save money compared to wave soldering, but simultaneously react more flexibly to the needs of customers often with an identical cycle time when considering all secondary operations.

Beginning with operating costs, selective soldering compared to wave soldering will reduce the average running costs by as much as five times because of the following reasons:

- Reduced solder consumption because of less dross
- No cleaning of solder pallets or masks
- Less use of electricity
- Reduced flux consumption because of selective MicroDrop fluxing
- No additional taping or masking to protect critical areas
- Less rework compared with wave soldering
- No cleaning of soldered PCBs

Utilizing selective soldering with Nordson SELECT technology saves the typical user valuable resources, reduces their operating costs and ensures process repeatability and production reproducibility (Table 1).

<u>Category</u>	<u>Notes</u>	<u>Wave Soldering</u>	<u>Selective Soldering</u>	<u>Annual Savings</u>	<u>Comments</u>
Solder Cost	Solder alloy make-up cost due to dross	€29,400	€840	€28,560	Wave = 31.8 kg/month Selective = 1.0 kg/month
	Cost for safe dross disposal	€8,500	€150	€8,350	Estimated, actual costs vary
Solder Pallets	Cost to maintain pallets	€1,600	€0	€1,600	Estimated, actual costs vary
Floor Space	Approx. €100/sq. meter/year	€1,200	€160	€1,040	Estimated, actual costs vary
Electrical Power	Approx. €0.09/kWh	€6,240	€2,080	€4,160	Estimated, actual costs vary
Flux Usage	Approx. €12/liter	€4,320	€540	€3,780	Estimated, actual costs vary
Nitrogen	Approx. €6.35/ cubic meter	€18,720	€1,445	€17,275	Wave = 14.5 cu. m <sup>3</sup> /hour; selective = 1.1 m <sup>3</sup> /hour
	Annual operating costs without nitrogen on wave =	€51,260	€5,215	€46,045	Wave solder usage without nitrogen
	Annual operating costs with nitrogen on wave =	€69,980	€5,215	€64,765	Wave solder usage with nitrogen

**Table 1:** Comparison of estimated annual wave soldering and selective soldering operating costs

- Notes: 1) Operating costs based on SAC305 alloy and 460mm wide PCB capability  
 2) Cost of consumables including solder, flux, electricity and nitrogen will vary per region  
 3) Operating costs based on 40-hour work week, multiply accordingly for 2 or 3 shifts

Based on numerous case histories including the positive experience of Thomas Preuhs GmbH, selective soldering has been determined to be a cost-effective alternative to wave soldering providing increased flexibility, faster time to market and increased ability to meet changes in customer demands.

**Contact:** Nordson SELECT, Inc., Perläckerstraße 11, 76767 Hagenbach, Germany  
 Phone: +49 (0) 7273 949466 0  
 E-mail: [florian.strohmaye@nordsonselect.com](mailto:florian.strohmaye@nordsonselect.com)  
 Web: [www.nordsonselect.com](http://www.nordsonselect.com)