

Feature article

Why future SMT placement needs absolute encoder feedback

Modern pick-and-place machines use high resolution verification cameras and fine adjustment systems, via precision linear encoders on each axis, to place electronic components accurately and quickly onto a PCB (Printed Circuit Board), prior to soldering. As electronic product complexity grows, the demand for high quality assurance in the SMT (Surface Mount Technology) placement processes is rising with implications for encoder feedback performance.

This article examines some of the future trends in SMT placement technology with a focus on the main drivers for near-term market growth between 2015 and 2020, as forecast by leading consultancy Frost and Sullivan, and the role of absolute optical encoder systems.

The global SMT placement equipment market generated revenues, in 2013, of US \$4 Billion from 19,000 machine shipments and is forecast to reach an estimated US \$6 Billion in 2020 - with the consumer electronics and computing and storage industries accounting for 42%. Demand from consumer electronics has increased significantly since the global recession, even though unit sales growth of smartphones, tablets and LCD TVs is expected to slow over the coming years.

The SMT placement equipment market is also facing the restrictions of declining price points, very high competition and a strong used-equipment market. As a result, while there is increasing demand for machine shipments, overall global revenue from SMT placement equipment sales is expected to average at 7.2% growth per annum during the period 2015-2020. Most SMT placement revenue generation will come from the consumer electronics, computing and storage, telecom and automotive industries.

Strongest growth is expected from the Asia-Pacific region, which accounts for nearly half of global SMT placement equipment market revenues, due in part to the consumer electronics industry and growing demand from developing markets.

Technology trends in SMT

SMT placement manufacturers are improving machine flexibility with larger feeder capacities and multi-functional placement heads, as the demand for high-mix and low to medium volume manufacturing environments continues to increase. Machine flexibility and placement speed, for greater throughput, will become two of the most important parameters in the SMT equipment marketplace. Furthermore, intelligent feeder technology is expected to become the norm - with increasing manufacturing complexity and changeovers.

Intelligent feeders communicate with the placement system controller and eliminate the effects of set up errors by storing information about the feeder type, any adjustable feeder parameters and the component fitted.

The main drivers for near-term market growth and the role of absolute encoding are summarised as follows:

Technology innovation

Technology will be a crucial driver for SMT equipment demand with manufacturers likely to emphasise the need for low cost-of-ownership and high return on investment. Product innovations and differentiators will be the ultimate decision factor in addition to price considerations for customers.

Customers will increasingly demand SMT placement equipment that can maximise throughput, communicate with other SMT equipment on the factory-line, and drive efficiencies so that their production processes continue to remain competitive and viable. The impact of this driver is expected to be high over the next five years, particularly in the medium to high speed SMT placement market segments as efforts are made to stabilise price declines.

Current innovations in SMT placement technology revolve around: production improvement across the vertical market, feeder technology, flexible and modular gantry systems, improved tracking to enhance first pass yields (FPY), superior factory management systems and inter-machine communication platforms.



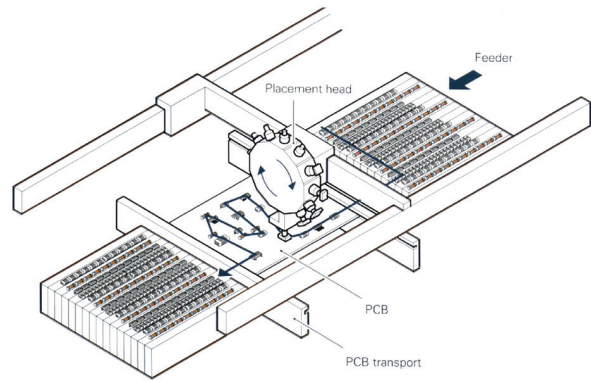
Example of an SMT (Surface Mount Technology) machine

The recent advent of high-accuracy absolute optical encoder systems creates new possibilities for innovations in SMT placement equipment. Absolute encoders allow improved performance with better reliability, faster initialisation, enhanced safety, lower running costs and the elimination of common crash risks.

Flexible and responsive manufacturing

Demand volatility in the electronics industry further necessitates lean manufacturing and fast production response-times with a focus on flexible and responsive manufacturing lines. Demand for highly-flexible production gives rise to multiple-head, multiple-axis machines with dual or quad-gantries and flexible conveyors requiring coordination of complex placement paths. Incremental encoder systems require that all axes home to a reference position (reference return) when restarting production after stoppages - only in this way is the control system able to detect the actual position of the axes. The homing of multiple-heads from an undefined location on an axis is a significant source of additional machine downtime. If the operator has not analysed the crash paths first and selected the reference travel cycle accordingly, the installations can suffer considerable damage as a result of the collision of placement heads or even of the gantries themselves. This leads to longer unproductive times, unnecessary costs and uneconomical downtimes of the entire machine in the event of a crash.

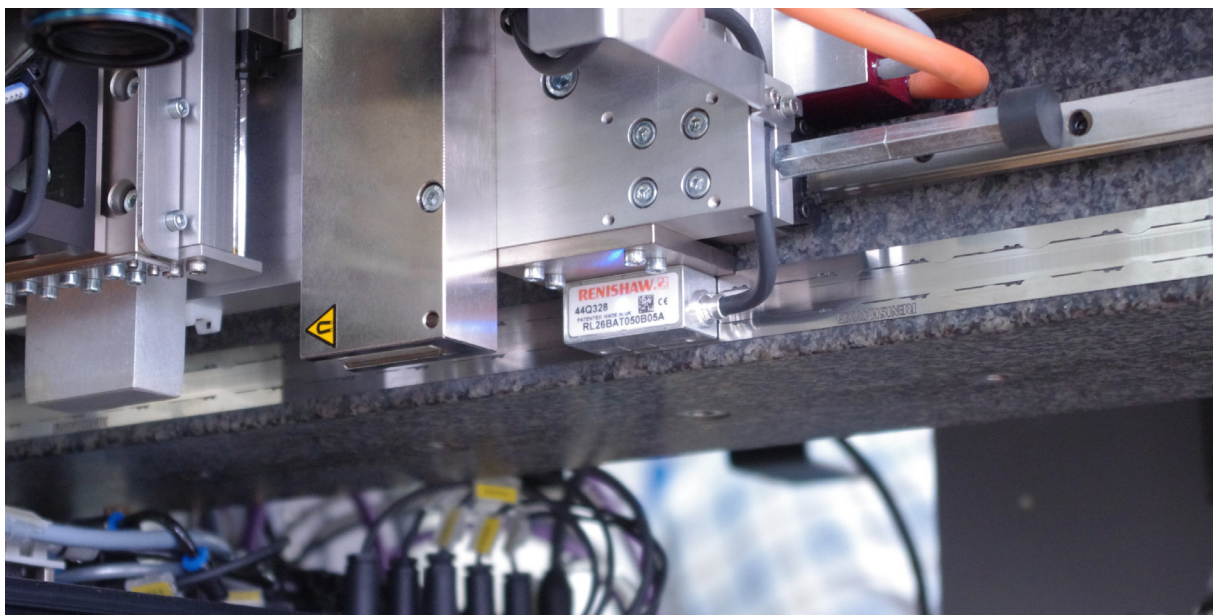
Another advantage of absolute encoder systems is that they calculate position on demand and Renishaw's RESOLUTE™ encoder is the first to combine this feature with built-in error checking algorithms that instantly flag any misreading of scale. This protects against uncontrolled movements and related crash risks by eliminating scale miscounting, position drift and count runaway, with benefits to yield, throughput and safety. Absolute encoders, therefore, improve process reliability, reduce unproductive time and prevent expensive crashes.



Revolver-head placement machine: a relatively new technology designed to maximize the placement speeds of flexible gantry systems. Credit: Handbook of Electronic Assembly and Guide to SMTA Certification. 2014. SMTA

Miniaturising SMT component sizes

Another area of focus includes the need to address the smaller footprint and lower cost per board aspects. Consumer products are becoming extremely densely populated and physically smaller, leading to demand for automated and highly-accurate placement requirements. The electronics industry is reducing end-product dimensions with increasing use of smaller passive components, such as the 01005, with size factors approaching <0.5 mm, ultra-fine 0.3 mm pitch / high pin count Quad Flat Packages (QFPs) and flip-chips with 150 µm pitch. Higher assembly densities will increase demand for automating SMT placement equipment that reduces the cost per board with advanced software and feeder technology, enhanced placement accuracy and higher speed. Furthermore, rising numbers of customers are choosing to upgrade either legacy SMT placement equipment or the complete software platform, which should also help to drive market growth over the coming years.



RESOLUTE absolute optical encoder on a linear axis within a SMT machine

High-performance devices are likewise expected to drive demand for state-of-the-art SMT software platforms. As product complexity continues to grow, the demand for high quality assurance in high speed placement processes is rising and overhead-gantry type and revolver head systems, whereby a revolving placement head is mounted on a gantry beam that moves in the X and Y directions, will increasingly dominate.

Machines must be capable of placing many thousands of components at high speed, >100,000 components placed per hour (CPH) for chip shooters, with high accuracy positional (X,Y) and rotational (θ) alignment to ensure increasingly exacting quality standards. Modern pick and place gantry systems require encoders to be capable of high speed (for increased throughput) and high resolution (for placing small components). Digital incremental encoders have a maximum speed that is determined by the maximum input frequency (MHz) of the receiving electronics along with the desired resolution. Consequently, as the maximum receiving electronics frequency is fixed any increase in resolution will result in a corresponding decrease in maximum speed and vice versa. Absolute encoders do not suffer from this compromise and allow for both high speed and high resolution operation. This is due to the position being determined on demand and the use of serial communications, allowing gantry designers the freedom to operate at both high speeds and high resolutions.

SMT placement machines are also increasingly using linear motors on the X and Y axes, to enhance accuracy, speed, and servo-loop stiffness. Absolute optical encoders output reliable signals of high fidelity that permit higher servo-loop gain levels. High servo-loop gain allows increased axis acceleration and deceleration, faster settling times and reduced induction motor heating - enabling the machine to run harder and for longer while reducing the number of scheduled stoppages required for cooling. Absolute encoders further allow correct commutation to be found immediately without reference returns; enabling simpler servo-design and a reduction of assembly complexity when compared with incremental encoder-based systems, which require additional sensors, e.g. Hall effect sensors, to commutate the linear motor. Moreover, the error checking algorithms of the RESOLUTE encoder enhance placement reliability by reducing board misplacements, which helps to maximise yield (FPY) and lower the total cost-of-ownership.

The future of SMT placement.

Fast-moving commercial markets, which demand a succession of sophisticated high-technology products, are dominating the electronics manufacturing scene. This trend is compelling manufacturers to keep pace with the continuous miniaturisation and convergence of different technologies by developing increasingly flexible, modular SMT placement equipment. In addition, the use of wireless technology in medical devices is growing rapidly – requiring high-mix production, with smaller batch sizes, and resulting in heightened demand for flexible SMT placement equipment.

Increased complexity of printed circuit boards (PCB) due to the miniaturisation trend across multiple industries is further boosting demand levels. The SMT placement equipment market is experiencing significant new growth opportunities within Central and Eastern Europe for consumer electronics, telecom and automotive electronics manufacturing. The region is also attractive for low-cost manufacturing locations for the top global providers, which is further expanding demand for SMT production equipment. The Asia-Pacific region remains the largest generator of SMT revenues and leads demand for high-speed SMT placement equipment.

The wider adoption of high-performance absolute encoder systems will allow SMT placement equipment manufacturers to keep up with the increasing technological demands of the electronics industry. Encoder technology employed within SMT placement equipment is directly responsible for improving placement accuracy and repeatability as well as increasing the speed of each axis, thereby boosting machine throughput to higher levels.

For more information, visit
www.renishaw.com/encoders

Renishaw would like to thank Prof Ronald C. Lasky Ph.D., PE, from the Thayer School of Engineering, Dartmouth College, for his expert advice.