A FEEDER CONTROL FOR THE SMT MOUNTER USING LON CHIP

Eung-Kyu Lim, Sung-Chan Rho, Yoon-Ho Kim
Power Electronics Lab., Dept. of Electrical Eng.,
Chung-Ang University

Abstract

SMD mounter is necessary in PCB assembling line. To feed SMD components to the mounter, high performance feeders are needed. Until now, mechanical air feeders have been mainly used. However, in these days, electrical feeders with network are developed. There are many kinds of feeders with various control techniques. In this paper, a feeder with BLDC motor and LON chip is designed and implemented. And, the experimental results are presented.

1. INTRODUCTION

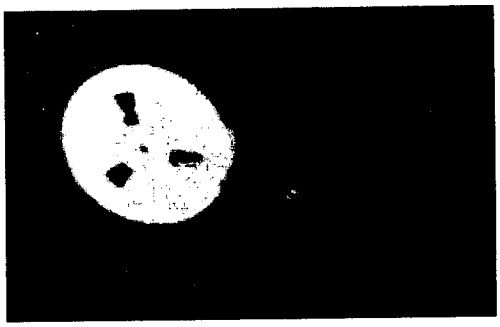
SMD (Surface Mount Device) or SMT (Surface Mount Technology) mounter is a PCB assembling machine. A SMD mounter system consists of a solder printer, three or four mounters, and an oven. The solder printer prints cream solder to the PCB corresponding to an etching stencil. The conveyer carries the PCB to the mounter. Then, the components from the feeders are moved to the placement position and the program corrects its placement data. When the mounter finishes its job, conveyer moves PCB to the oven. Finally, oven makes hard cream solder at an appropriate temperature.

The SMD mounter requires high technologies. The accuracy and speed determine the performance of the mounter. The conventional feeder is just a mechanical air feeder, which presses its cylinder before the mounter head picks up the component. However, mechanical feeders could provide only a small range of components. Also, adding additional options are impossible. Nowadays, a new intelligent feeder with microprocessor is introduced, which could provide various functions. The Feeding distance and speed are controlled according to the component type and size. As a result, the intelligent feeder could handle a wide range of components. It could also alarm component shortage and missing operation. [1]-[3]

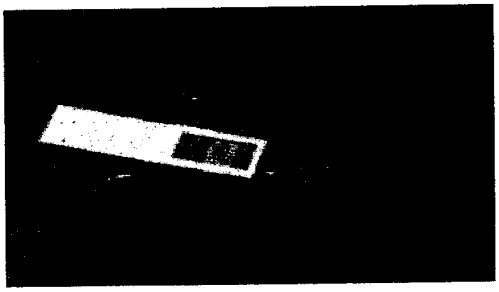
In this paper, LON chip, CPU for a networking, is used for an efficient feeder control. Also the PID controller is used for the BLDC motor control.

2. Types of feeders

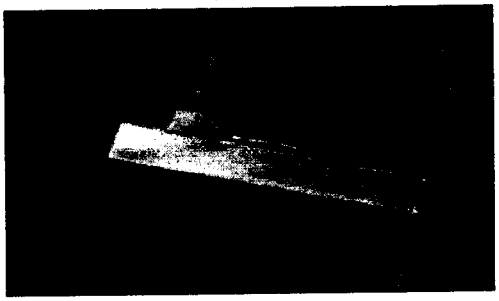
There are many types of feeders depending on the component size, feeder style, and component packing style. Tape feeders are used to feed reel components. (Fig. 1a) Stick feeders are used to feed components supplied in tubes. (Fig. 1b) Bulk feeders are used to feed chip components delivered in bulk containers. (Fig. 1c) Tray feeders are used to feed large components supplied in trays. (Fig. 1d)



(a) Tape feeder



(b) Stick feeder



(c) Bulk feeder

(d) Tray feeder

Fig. 1. Feeder types

Table. 1. Tape feeder types

TYPE	PITCH (mm)	REEL DIAMETERS (mm)
8mm for 1005	2 ,4	178
8mm PAPER	4	178
8mm EMBOSS	4	178
8mm PAPER L	4	178, 254, 330, 360, 382
8mm EMBOSS L	4	178, 254, 330, 360, 382
12mm EMBOSS	4, 8, 12	178, 254, 330, 360, 382
16mm EMBOSS	4, 8, 12	178, 254, 330, 360, 382
24mm EMBOSS	4, 8, 12, 16, 20	178, 254, 330, 360, 382
32mm ADHESIVE	12	300, 382
32mm EMBOSS	4, 8, 12, 16, 20, 24, 28, 32, 36, 40, 44, 48	300, 360, 382
44mm EMBOSS	4, 8, 12, 16, 20, 24, 28, 32, 36, 40, 44, 48	300, 360, 382
56mm EMBOSS	4, 8, 12, 16, 20, 24, 28, 32, 36, 40, 44, 48	300, 360, 382

3. Total System Structure

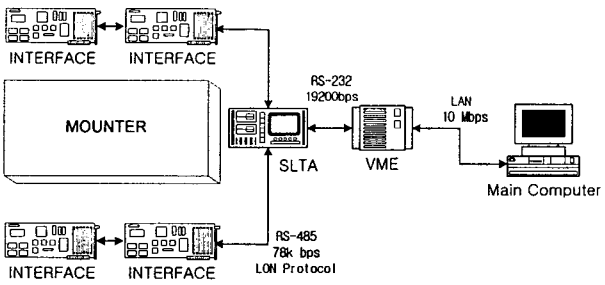


Fig. 2. Feeder system structure

The main computer provides user-friendly interface GUI (Graphic User Interface) for the operator under robust Windows NT OS system. The total mounter controller is VME system. The main computer and VME are connected by LAN, and SLTA (Serial LON Talk Adaptor) is use to connect VME to feeder. VME has RS-232 network, and feeder has LON protocol. Therefore, SLTA converses RS-232 to LON protocol and LON protocol to RS-232. The LON protocol has multi drop network without maser. The interface board provides power and absolute address to the feeder, and it also checks for status of the feeder. At last, the feeder locates last point of the mounter system.

4. Feeder Structure

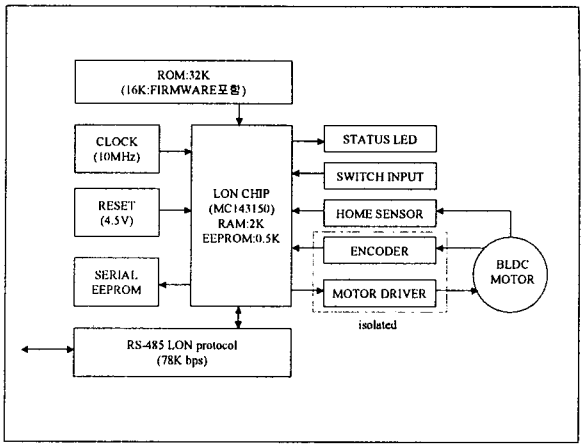


Fig. 3. Feeder board block diagram

If cream solder printed PCB arrives to the mounter; the mounter checks the PCB location by the camera. The mounter checks if the picking component exists. Then, it picks up the component from the feeder. Also, position of the component is examined. And next, mounter head carries the component to the PCB. At this time, mounter compensates for its location and angle.

The mounter is equipped with eight heads to reduce mounting time. Eight heads of the mounter pick up eight components at the same time. So, feeder must be located correctly on the feeder base.

The feeder accuracy should be 50micron at a minimum. The size of 1005 SMD component (1mm by 0.5mm) is very small. Due to vibration problem of the feeder in the reel pocket and limited size for picking nozzle, the accuracy of the feeder becomes more important.

In the feeder technology, feeder width is very important factor because mounter has many feeders at a time. Mounter head interval is 16 mm. So feeder width cannot be over 15mm. The major problem is motor size. The motor size must be small, but it should have enough power. Mostly stepping motor and DC motor are used. However, in this experiment, a specially designed BLDC motor is utilized.

For the feeder CPU, a network chip is used for this

study since nowadays network systems became very important factor in the industrial machine.

LON (Local Operation Network) chip has firmware for the network. Unlike LAN, LON could process short commands and sensor network status. It is easy to construct new network using LON. It is also very stable, and it could handle real time network data. But, it has weak points such that it is 8-bit machine and has no floating-point unit. In this study, a LON chip is used since we placed more emphasis on the network.

5. Feeder Control

In this study, a PID controller is used for the BLDC motor control. And, 4mm standard pitch is selected for reel component. The feeder has 320 encoder pulses for 4mm feeding. The SANYO BLDC motor driver is used. Two motor drivers are compared each other - LB1824 and LB1620. (Fig.5 ~ Fig.8) In experiment results, the LB1620 chip is not pertinent for feeder control because of suddenly rising motor speed in some area. And then, LB1824 is selected for the motor driver in this study.

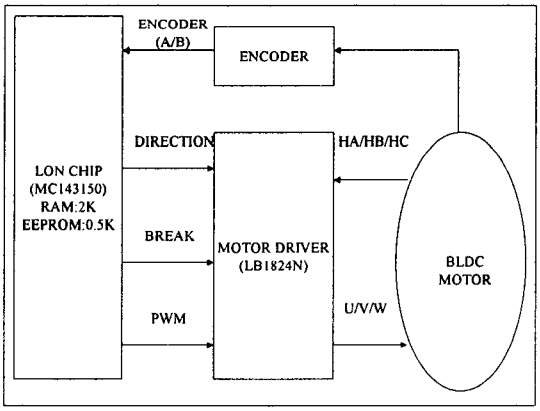


Fig. 4. Motor control block diagram

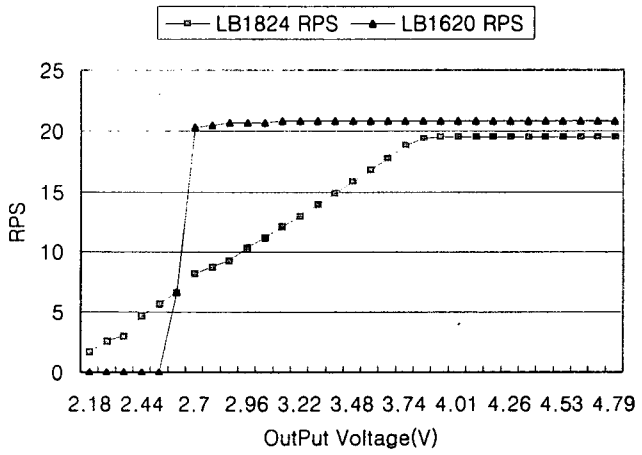


Fig. 5. Output voltage vs. RPS

Figure 5 shows chip output voltage vs. motor RPS. In this graph, the LB1620 chip is suddenly rising motor speed, when drive output voltage is 2.61 [V] area. So, the LB1620 chip is not proper to motor speed control.

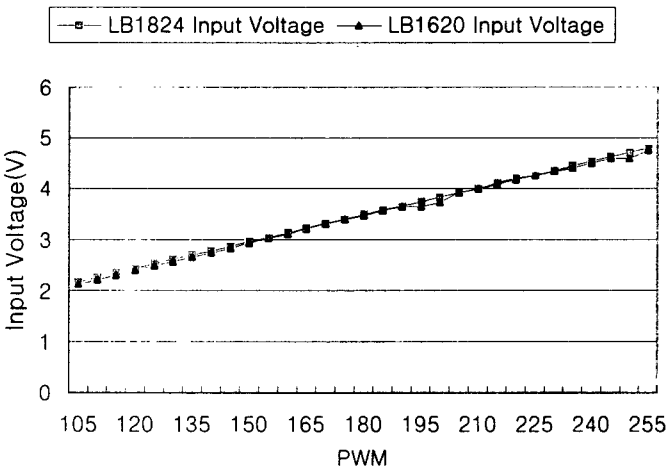


Fig. 6 input voltage vs. PWM

Figure 6 shows CPU PWM and input. Both signal show good results

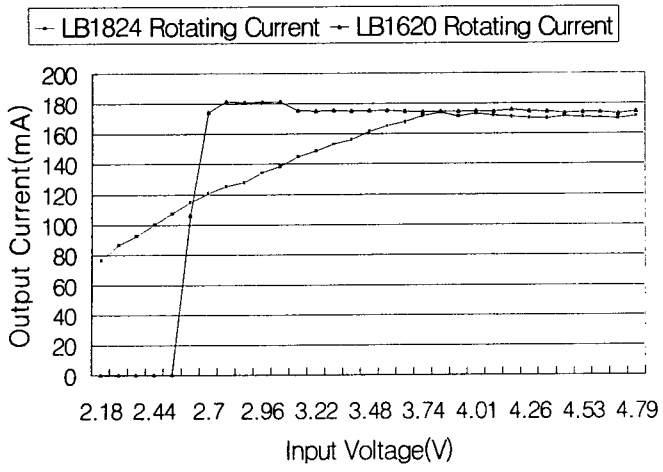


Fig. 7. Input voltage vs. RPS

Figure 7 shows input voltage vs. RPS of normal condition. In this graph, the LB1620 is suddenly rising output current, when drive input voltage is in 2.61 [v].

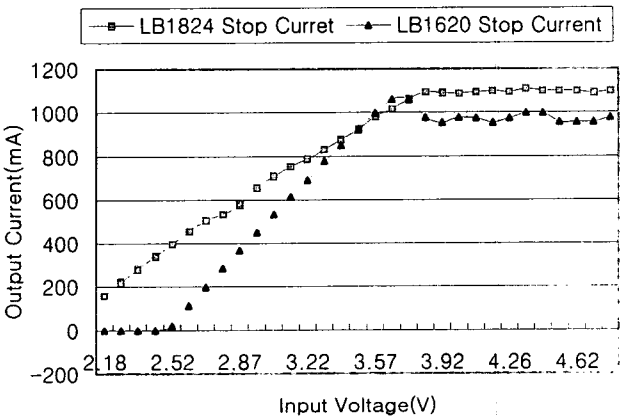


Fig. 8 Input voltage vs. stop output voltage

Figure 8 shows input voltage vs. output current in holding condition of the motor.

To find the optimal gain value for the feeder, it is analyzed using PC simulation. Table 2 summarizes its results.

Table 2. Simulation Gain Range

GAIN	Range	Degree
P gain	1 ~ 10	1
I gain	1 ~ 10	1
D gain	10 ~ 500	10

In the beginning, a velocity control mode is used for the first 30% encoder values. Then, it is switched to the position control mode. Accuracy range is +/- 3 pulses.

Case: velocity control mode
P gain: 250
I gain: 120
D gain: 50
Case: position control mode
P gain: 7
I gain: 7
D gain: 420

6. Experimental Results

The experimental results are shown in fig. 9. For this experiment, time step of 3.5msec is chosen. The starting value should be ignored since it is collected before initialization. This graph in fig.9 is based on 4mm pitch feeding. Motor is rotating to input torque. Input torque is alternating, but motor is continuously rotating, because of rotor inertia. Motor stops when motor encoder pulse is 340, because motor potion is in the target value. Table 3 summarizes the feeding time with or without the load for various pitch values. From the results, it is found that moderate load helps the control due to its rotator inertia effects.

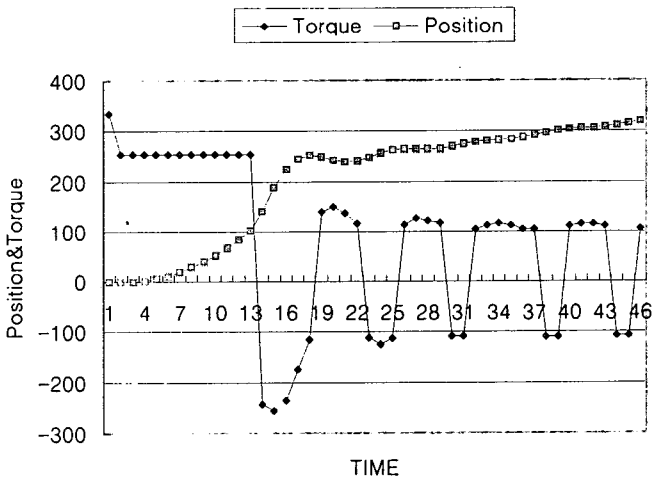


Fig. 9 Experimental results of the system

Table 3. Feeding Time for various pitch types

Feeding Pitch (mm)	No load (msec)	Some load (msec)
4	175	170
8	220	210
16	290	280
24	340	340
32	390	380
44	450	450
56	510	510

7. Conclusion

In this paper, an electrical feeder of the SMD mounter with BLDC motor is designed and implemented. A network using CPU and LON chip with PID controller is also designed and utilized. The experimental results indicate that the design system works as expected. The designed system could be directly applied to the practical system. It is expected that a further research to reduce a system error by the gear backlash is needed.

References

[1] Yu Nakayama, Kiyoshi Fujikawa, Hirokazu Kobayashi, "Motor Control Methods for Torsional Drive System with Backlash", Proceedings of the IPEC-Tokyo, Vol. No 1-2, pp 602-607, 2000, April.

[2] Mutuwo Tomita, Tomonobu Senjyu, Shinji Doki, Shigeru Okuma, "Sensorless Control of Brushless DC Motors Using Disturbance Observers With an Adaptive Velocity Estimation", Proceedings of the IPEC-Yokohama, pp 328-333, 1995

[3] Kiyoshi Ohishi, Yoshihiro Nakamura, "Robust Self-Tuning Speed Control Based on Speed Observer and Disturbance Observer", Proceeding of the IPEC-Yokohama, pp 699-704, 1995

[4] Echelon Corporation, "Neuron C Programmer's Guide", Revision 4

[5] Echelon Corporation, "Neuron C Reference Guide", Revision 2