

1POS
copy

APPLICATION FOR REPUBLIC OF SINGAPORE LETTERS PATENT

FOR

MODULARIZED IN-LINE TRIM AND FORM SYSTEM

Inventor: Hornisch Frank

Prepared by:

David D. Chung of
LAWRENCE Y D HO
30 Bideford Rd.
#07-02/03
Thongsia Building
Tel: 734-8523
Fax: 734-8521

MODULARIZED IN-LINE TRIM AND FORM SYSTEM

FIELD OF THE INVENTION

5 The present invention relates to the field of semiconductor packaging, and particularly to a modularized in-line trim and form system for trimming and forming leads on a semiconductor package with high throughput, precision, and reliability.

10 BACKGROUND OF THE INVENTION

Trim and form systems are well known in the semiconductor packaging industry. It is a system used near the end of the semiconductor packaging process where the packaged semiconductor devices are removed or trimmed from the
15 leadframe and the leads are shaped. Hence the name "trim and form."

Many improvements have been made over the years to increase the throughput rate, reliability, precision, ease of use, versatility, and other qualities which are deemed highly desirable in the industry. Since there is no foreseeable limit to these improvements, the industry players continue to make changes to the
20 existing designs to produce a system which can perform faster and better than the existing designs.

One of the most noticeable shortcomings of the prior art designs is the failure to achieve an in-line system where the feeder rail move up and down during a trim and form process. One serious consequence of this is that it creates greater
25 tendency for the delicate leadframe to be damaged by the excessive movement. In addition, it causes additional tolerances as the system needs to precisely track the movement of the rail. Furthermore, it reduces the overall throughput because the system requires additional time to place the rail in position for the press.

This Sheet Has Been Replaced



THIS SHEET HAS BEEN
REPLACED

Hence, in light of these shortcomings, it would be highly desirable to have an in-line trim and form system which overcomes the stated shortcomings while improving the overall throughput, reliability, precision, ease of use, versatility, and other desirable qualities.

5

OBJECT OF THE INVENTION

It is therefore the object of the present invention to improve upon the existing trim and form system designs to provide an in-line system having improved
10 reliability, flexibility, ease of use and service, precision, throughput rate, modularity, and overall productivity and quality.

SUMMARY OF THE INVENTION

15 A modularized in-line trim and form system includes an on-loader module, infeed module, a press module, and an off-loader module. The press module includes a twin-cam servo drive which moves simultaneously and independently to facilitate high-throughput in-line process. The on-loader and off-loader modules include a pick and place apparatus with suction pads and storage magazine, where
20 the pick and place apparatus can load and unload a leadframe without excessive rotating movements. The components of the present system are highly integratable and replaceable for easy modification and repair.

25 BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an perspective diagram of the in-line trim and form system.

This Sheet Has Been Replaced



THIS SHEET HAS BEEN
REPLACED

FIG. 2 is pictorial illustration of the in-line system.

FIG. 3 is a block diagram illustrating the in-line system.

5 FIG. 4 is a symbolic representation of the in-line system.

FIG. 5A is a side view of the on-load module in open position with leadframes having small semiconductor packages.

10 FIG. 5B is a side view of the on-load module in open position with leadframes having large semiconductor packages.

FIG. 6A is a side view of the on-load module in closed position with leadframes having small semiconductor packages.

15

FIG. 6B is a side view of the on-load module in closed position with leadframes having large semiconductor packages.

FIG. 7 is a perspective view of the pick and place apparatus for the on-loader.

20

FIG. 8 is a perspective view of the unloader components.

FIG. 9 is a perspective view of the unloader components.

This Sheet Has Been Replaced



25 FIG. 9.1 is a perspective view of the infeed components.

FIG. 10 is a side view of the press module.

THIS SHEET HAS BEEN
REPLACED

FIG. 11 is a perspective view of the bottom cam of the press module.

FIG. 12 is a perspective view of the press mechanism of the press module.

5 FIG. 13 is a plan view of the press module.

FIG. 13.1 is a perspective view of the upper cam of the press mechanism.

FIG. 13.2 is a perspective view of the lower cam of the press mechanism.

10

FIG. 14 is a prior art sensor implementation in the press area.

FIG. 15 is a sensor implementation in the press module for the present invention.

15 FIG. 16 is a side view of the off-load module in open position with leadframes having small semiconductor packages.

FIG. 17 is a side view of the off-load module in open position with leadframes having large semiconductor packages.

20

FIG. 18 is a perspective view of the off-loader components.

This Sheet Has Been Replaced



FIG. 19 is a perspective view of the pick and place apparatus for the off-loader.

25

DETAILED DESCRIPTION OF THE INVENTION

THIS SHEET HAS BEEN
REPLACED

The present invention is an improved modularized in-line trim and form system having many improvements and advantages over the existing trim and form systems. FIGS. 1 through 4 illustrate the overall trim and form system. As better shown in FIG. 2, the system is modularized into 4 main sections, magazine onload module 5, infeeder module 10, press module 15, and magazine offload module 20. As illustrated in FIG. 3, the press module can include multiple modules, here marked FORM 1, FORM 2, FORM 3, FORM 4, where each of the press modules performs a different function. Although in this figure four press modules are indicated, of course there may be fewer or greater number of modules depending on the needs and the desires of the user. For instance, FIG. 4 illustrates a system where only three press modules are used.

The system is controlled by a microcontroller preferably with a monitor display and an optional touch screen. The monitor is suitably located for viewing with proper consideration to the operator's ergonomics. An EPROM is preferably provided with the controller to protect against sudden memory loss.

To better elucidate the way to make and practice the preferred embodiment of the present system, several of the improvements and their corresponding structure shall be described below. In summary, the features of the improved trim and form system includes, among others, the following: higher intergratability; greater range of applications; lower cost; higher precision; more user friendly approach; greater flexibility; higher throughput; shorter movement of essential parts; better ability to accommodate custom applications; more user friendly open architecture software libraries; better modular design; less need for maintenance; design adapted for easier repair and replacement of parts.

One of the important advantages of the present invention is its in-line feeder rail. This feature greatly improves the quality of the entire system by minimizing the undulating movement of the delicate leadframes, while greatly improving the rate at which a leadframe can be processed, known as the throughput of the system. These

This Sheet Has Been Replaced



THIS SHEET HAS BEEN
REPLACED

two features are extremely important considerations for a trim and form system. Obviously, a system which can produce higher throughput without compromising quality is highly desirable. Currently, the highest throughput which can be achieved by the existing trim and form system without compromising quality is approximately
5 120 units per minute. The present invention, however, can achieve up to 220 units per minute.

Several factors contributed to the slow down in the throughput in the prior art designs which were overcome in the present invention. For ease of understanding and to better explain the improved features and the structure of the modules and its
10 contribution to the overall system shall be described individually.

FIGS. 5A through 9 illustrate the on-loader module. The basic function of the on-loader module is to quickly and accurately load the leadframes from the storage magazine to the feeder rail. To load the leadframe onto the feeder rail, the leadframe is first lifted up near the level of the feeder rail by a lifter. The pick and
15 place apparatus, illustrated in detail FIG. 7, lowers the suction pads until they make contact with each of the semiconductor packages in the leadframe. The feeder rail is opened to make room for the leadframe and the pick and place apparatus raises the leadframe until it is above the feeder rail. The feeder rail is then closed such that the outer edges of the leadframe is aligned properly in the feeder rail.

20 The pick and place apparatus, as illustrated in FIG. 7, includes a mounting frame and a plurality of suction valves. At the end of each valve is a suction pad which makes contact with the semiconductor devices. A partial vacuum is achieved through the suction valve which allows the suction pad to lift the leadframe.

This on-loader design offers many advantages as compared to the previous
25 designs. The prior on-loaders had cumbersome designs which required complex movement of the leadframe. The leadframe often had to rotate into position and waste valuable time. In contrast, the present off loader does not require any rotating movement of the leadframe, and uses only the minimum number of movements

This Sheet Has Been Replaced



THIS SHEET HAS BEEN
REPLACED

where the leadframe moves directly from the magazine to the feeder rail. The simplicity in the transfer from the magazine to the feeder rail greatly reduces possibility of damage to the leadframe. In addition, it reduces the on-loading time. This reduction in time is important because the rate at which the leadframe is loaded onto the feeder rail is a factor which can determine the throughput for the entire system.

After the leadframe is loaded onto the feeder rail, it is transferred to the infeeder module via transfer belt and wheels, as generally illustrated in FIG. 2, and illustrated in detail in FIG. 9.1. The function of the infeeder module is to index the leadframe such that the position of the leadframe is perfectly synchronized with the rest of the system, and especially, in relation to the press module. The main components of the infeeder module is the indexing wheel, or the indexer, and the sensors. The indexer is servo-cam driven and it generally covers the range of 5 mm to 60 mm movement according to a minimum leadframe length of 150 mm and a maximum length of 280 mm, with minimum of four packages on the leadframe in a single row. The indexer movement will be set automatically by the parameters set for a particular product. The indexer preferably includes a measuring system which is as similar as possible to the transport tongs of the press module to control the actual movement according to the settings and any adjustments which need to be made. The indexer rail can be easily opened up when the tool is in home position for maintenance purposes, or for removing or correcting the leadframe after a misfeed. All parts of the indexer preferably should not scratch plastic devices or damage the molded or plated strips and pilot pin holes of the leadframes.

After the leadframe is indexed, it is moved into the press module. As shown in Figs. 1 to 4, a series of press modules or just a single module is possible. Because the general structure of every press module is the same, only one shall be used to illustrate the function and the overall structure.

This Sheet Has Been Replaced



THIS SHEET HAS BEEN
REPLACED

FIGS. 10 through 13.2 illustrate the press mechanism for the press module. The present invention employs two independently servo-driven cams, termed the "twin-cam" design, to drive the lower and upper die both simultaneous and independently. This dual movement is important as it facilitates the in-line process.

5 In the previous trim and form systems, one of the dies, usually the bottom, did not move. To properly place the leadframe in position to trim or form, the feeder rail had to move up and then lowered into the lower die. This type of system has a number of disadvantages. First, the throughput is limited because there is a limit to how fast the feeder rail can be moved up and down. Second, the continual
10 undulating movement creates potential for damage to the delicate leadframe. And third, any misalignment of the leadframe may result in severe damage to the leadframe and the semiconductor package as it may crash against a component of the pressing mechanism such as the sensor. As illustrated in FIG. 14, the prior art "undulating" feeder rail design often required that the sensor be placed between the
15 semiconductor packages to properly function.

But as illustrated in FIG. 15, the present invention encounters no such danger as the feeder rail remains constant, and the sensor detects the moving die, not the leadframe. In addition, the present design, as illustrated in detail in FIGS. 13.1 and 13.2, offers other advantages. It is fully modular so that many pressing mechanism
20 can be added in series. The pressing mechanism employs a pair of tongs which work in conjunction with the indexer to position the leadframe. Unlike the prior art systems which use rollers to perform this function, the use of tongs offers the advantage in that the greater surface area of the tongs puts less stress on the siderail of the leadframe. The pressing mechanism is also easily repaired and
25 replaced because the components can be easily removed and replaced, and there is ample working clearance. In addition, because of the servo drive, the entire mechanism can be stopped in an instant when a misalignment or other problems are detected so that damage to the leadframe and the tool can be avoided.

This Sheet Has Been Replaced



THIS SHEET HAS BEEN
REPLACED

Furthermore, dies of different applications, e.g. a die for trimming or for forming, are interchangeable so that the press module can be used as either a trimming tool or a forming tool. Hence, the present system offers greater throughput with greater flexibility and reliability.

5 After the press module, the leadframe is transferred to the offloader so that the leadframe can be stored in a magazine. The offloader of the present system employs similar design as the on-loader and therefore, it can be made to interchange with the on-loader if such a need arises.

FIGS. 16 through 18 illustrate the off-loader module. The basic function of the
10 off-loader module is to quickly and accurately unload the leadframes from feeder rail to the storage magazines. To unload, the pick and place apparatus, illustrated in FIG. 19, lowers the suction pads until they make contact with each of the semiconductor packages in the leadframe. The feeder rail is opened to release the leadframe and the pick and place apparatus lowers the leadframe into the storage
15 magazine

The pick and place apparatus, as illustrated in FIG. 19, includes a mounting frame and a plurality of suction valves. At the end of each valve is a suction pad which makes contact with the semiconductor devices. A partial vacuum is achieved through the suction valve which allows the suction pad to lift the leadframe.

20 This off-loader design offers many advantages as compared to the previous designs. The prior off-loaders have cumbersome designs which require complex movement of the leadframe. The leadframe often had to rotate into position and wasted valuable time. In contrast, the present off loader does not require any rotating movement of the leadframe, and uses only the minimum number of
25 movements where the leadframe moves directly from the feeder rail to the storage magazine. The simplicity in the transfer from the feeder rail to the magazine greatly reduces possibility of damage to the leadframe. In addition, it reduces the off-loading time. This reduction in time is important because the rate at which the

This Sheet Has Been Replaced



THIS SHEET HAS BEEN
REPLACED

leadframe is loaded off the feeder rail is an important factor which can determine the throughput for the entire system.

This Sheet Has Been Replaced



THIS SHEET HAS BEEN
REPLACED

CLAIMS

I Claim:



- 1 1. A modularized in-line trim and form system comprising:
 - 2 an on-loader module for loading a leadframe from a storage magazine onto a
 - 3 feeder rail without rotating said leadframe;
 - 4 an infeeder module for indexing and sensing said leadframe;
 - 5 a press module for trimming and forming said leadframe, said press module
 - 6 including a twin-cam press mechanism;
 - 7 an off-loader module for off loading said leadframe from said feeder rail to a off-
 - 8 loading storage magazine without rotating said leadframe;
 - 9 a micro-controller for controlling said system, said micro-controller
 - 10 communicably and controllably coupled to each of said modules;
 - 11 wherein said feeder rail is in-line during a trim and form process and said
 - 12 leadframe is processed quickly and precisely.
- 1 2. The system as recited in claim 1 wherein said twin-cam press mechanism has
 - 2 independent servo drives.
- 1 3. A modular on-loader apparatus for a modularized trim and form system with an
 - 2 in-line feeder rail, said apparatus comprising a storage magazine, a pick and place
 - 3 apparatus with suction pads, and a means for controllably opening and closing said
 - 4 feeder rail, whereby a leadframe is loaded onto said feeder rail from said storage
 - 5 magazine by said pick and place apparatus by placing said leadframe onto said
 - 6 feeder rail without rotating said leadframe.
- 1 4. A modular off-loader apparatus for a modularized trim and form system with an
 - 2 in-line feeder rail, said apparatus comprising a storage magazine, a pick and place
 - 3 apparatus with suction pads, and a means for controllably opening and closing said
 - 4 feeder rail, whereby a leadframe is loaded off said feeder rail by said pick and place

This Sheet Has Been Replaced

THIS SHEET HAS BEEN
REPLACED



5 apparatus by placing said leadframe off said feeder rail and into said storage
6 magazine without rotating said leadframe.

1 5. A modular twin-cam pressing apparatus for a modularized trim and form
2 system with an in-line feeder rail, said apparatus comprising an upper cam and a
3 lower cam, said upper and lower cam independently driven by a servo-drive,
4 whereby said upper and lower cam can simultaneously and independently move up
5 and down in a precise, controlled sequence.

1 6. An modular infeed apparatus for indexing and sensing a leadframe for a
2 modularized trim and form system with an in-line feeder rail, said infeed apparatus
3 comprising an indexer and a sensor, said indexer adapted for precisely and
4 controllably indexing said leadframe and said sensor adapted for sensing a precise
5 location of said leadframe.

This Sheet Has Been Replaced



THIS SHEET HAS BEEN
REPLACED

THIS SHEET HAS BEEN
REPLACED