iQ ES Series

SERVO ULTRASONIC PRESS SYSTEMS

“Force Change” and “Force Rate” Weld Methods for Ultrasonic Servo Presses

Introduced in the ES Series firmware version 1.14.02 (late 2018), a couple of new, patented (US Patent # 10,746,703) weld methods were added for the servo ultrasonic presses: Force Change and Force Rate.

These methods were developed primarily for applications where the parts being welded come into rigid contact with each other at the end of the weld. One example of such parts is illustrated in Figure 1, where the goal of the weld is for the center sections of the parts to be flush against each other when the weld is complete. On applications such as these, there is a rapid increase in the force, and therefore a large force rate of change, as the parts come into rigid contact. This contact point can be reliably sensed using the Force Change and Force Rate weld methods.

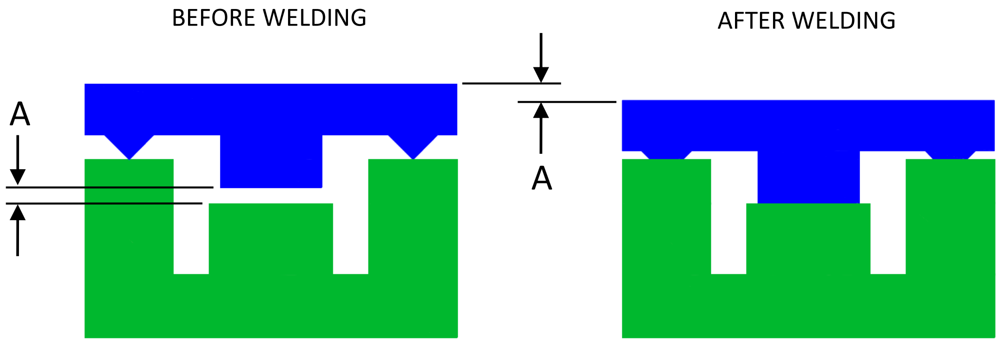

Figure 1

Other examples of where these methods are beneficial is the welding (inserting) of plastic dowels into composite materials, which is encountered in various industries. Traditional methods of Force trigger and Collapse Distance welding often cannot be used in these applications due to variations in the density of the composite materials. In addition, the overall dimensional tolerances of the composite parts are sometimes very large as illustrated in Figure 2, which makes welding by Position not practical. Both of these challenges can be overcome by using the Force Change or Force Rate methods.

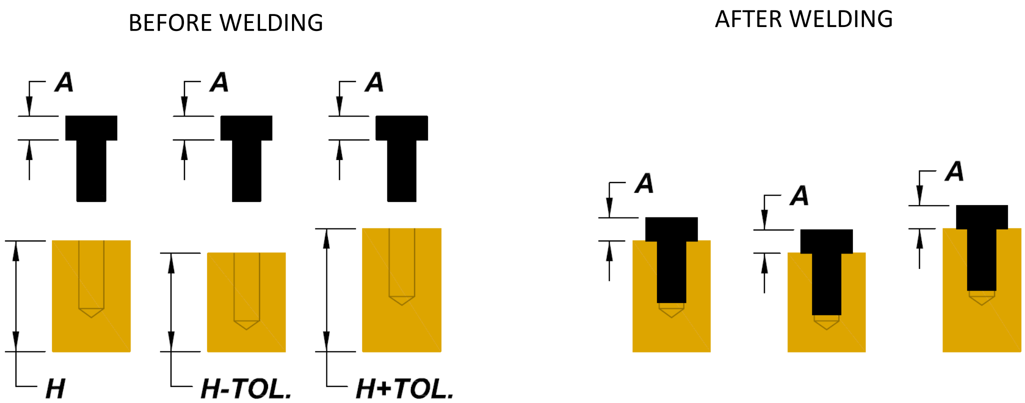

Figure 2

The selection between these two weld methods will depend on the specifics of the application. In general, it is best to start with the Force Change method since it is simpler to use. Sometimes, due to reasons such as inconsistencies in the part materials, the Force Change method may not yield the desired results. In such cases, the more advanced Force Rate method should be attempted, which has shown to produce consistent results in challenging applications.

Force Change Weld Method

When the “Force Change” method is selected in the setup, a couple of parameters must be programmed as shown in the iQ Explorer II screen capture in Figure 3: “Distance” and “Change in Force”.

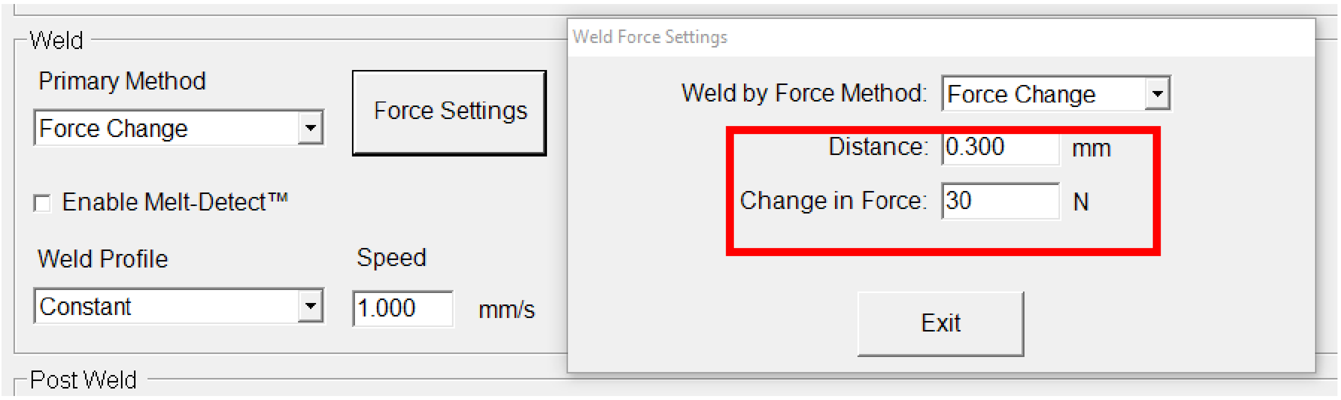

Figure 3

The sequence of this method is described below with reference to the graph shown in Figure 4.

1. The weld phase starts Time 0 s.
2. When the press has moved the amount programmed in the “Distance” field (from the start of the weld), the system takes a snapshot of the force and stores this value as a reference. In this example, the force is sampled after the press has traveled 0.300 mm, resulting in a reference of 50 N.
3. The weld ends when the current force exceeds the reference force from step 2 by the amount programmed in the “Change in Force” field. In the example below with the “Change in Force” being 30 N, the weld ends when the force reaches 80 N.

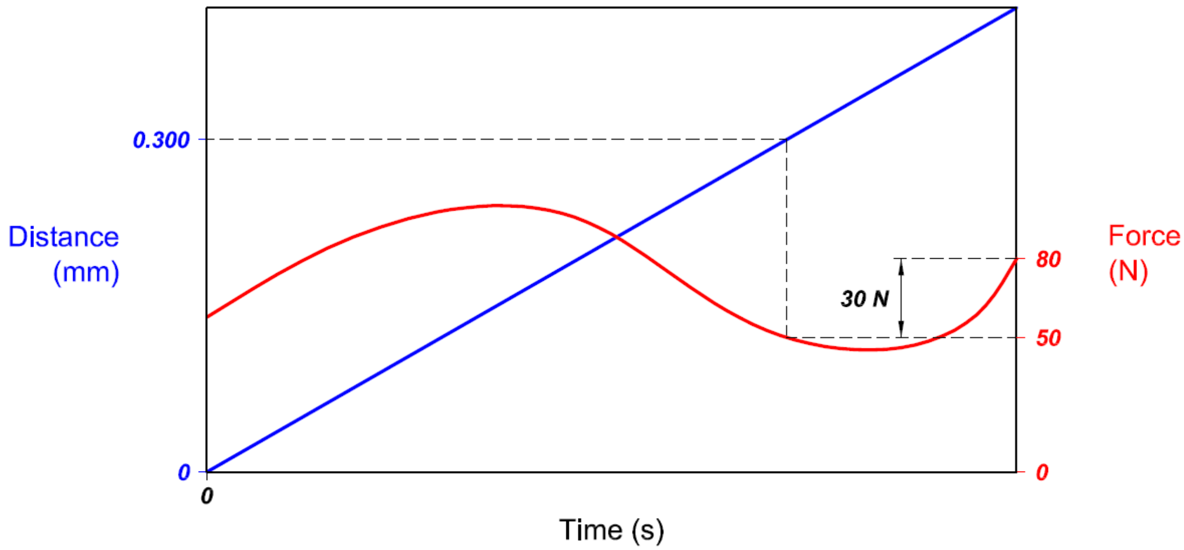

Figure 4

The purpose of the “Distance” parameter is to ignore the force during the initial part of the weld, so that the weld does not end prematurely (i.e., before reaching the amount of collapse programmed in the “Distance” parameter).

Force Rate Weld Method

The “Force Rate” method is similar to the “Force Change” method, but it involves monitoring the rate of change of force instead of a change in force. When the “Force Rate” method is selected in the setup, the parameters shown in Figure 5 must be programmed: “Distance”, “Change in Force”, and “Timespan”.

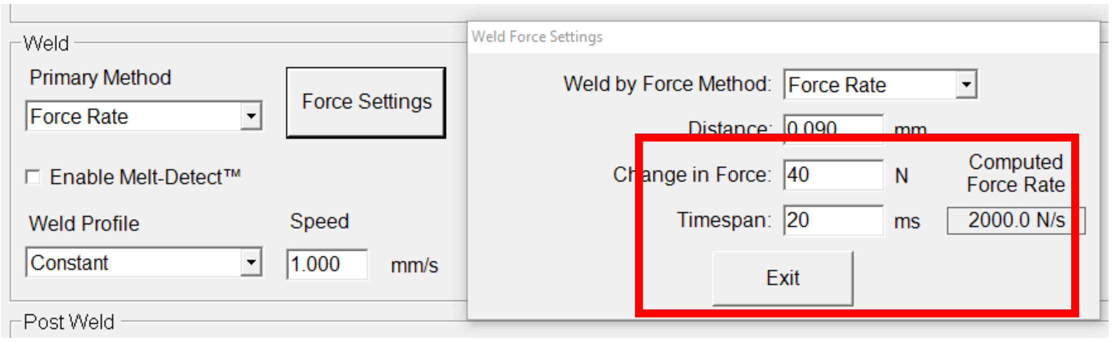

Figure 5

The sequence of this method is described below with reference to the graph shown in Figure 6.

1. The weld phase starts at Time 0 s.
2. The weld continues for at least the amount of time programmed in the “Timespan” parameter, which occurs at Time 0.02 s.
3. After step 2 is completed, the system starts monitoring how fast the force is increasing by comparing the present force reading with the reading obtained earlier in time by the amount programmed in “Timespan”. For example, in the graph below at Time 0.10 s, the force is 50 N. Since “Timespan” is set to 0.02 s, this force value is compared to the force at Time 0.08 s, which was 30 N, yielding a force rate of 1000 N/s (20 N in 0.02 s).
4. The weld ends when the following 3 conditions are satisfied:
    a. The duration of the weld is longer than the value in “Timespan”.
    b. The weld collapse is larger than the value in “Distance”. This condition is satisfied at Time 0.06 s, where the weld collapse was 0.060 mm.
    c. The force rate reaches the rate programmed in the “Change in Force” and “Timespan” parameters. This occurs at Time 0.16 s, where the change in force is 40 N in the previous 0.02 s, which equals the 2000 N/s setting (40 N in 0.02 s).

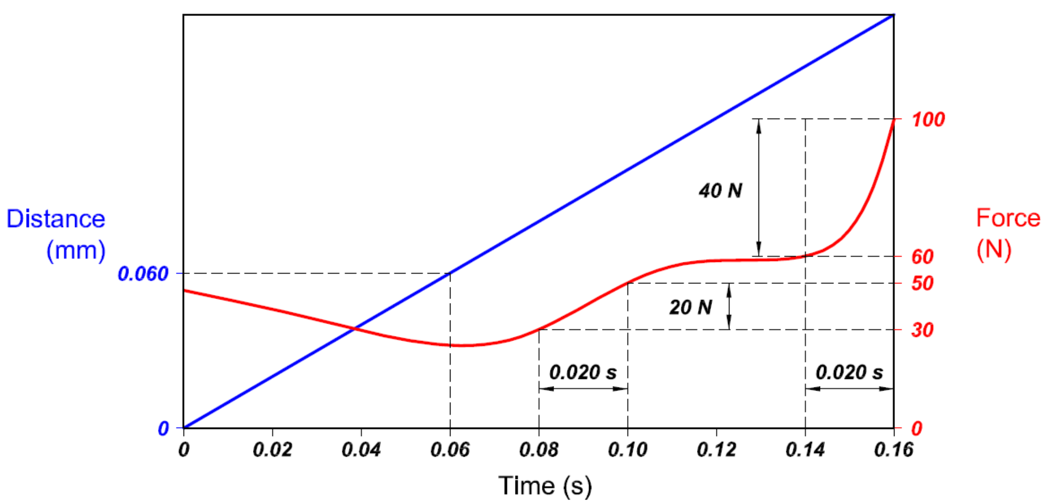

Figure 6

The purpose of the “Distance” parameter is to ignore the force rate during the initial part of the weld, so that the weld does not end prematurely (i.e., before reaching the amount of collapse programmed in the “Distance” parameter).

Part and Tool Design Considerations

To benefit from the Force Change and Force Rate methods, the parts being welded should be designed to have feature(s) that come into contact with each other at the end of the weld as illustrated in the examples of Figures 1 and 2. Alternatively, if the parts lack such features but must be welded to achieve a particular protrusion distance, the horn can be designed with a relief that matches this distance as shown in Figure 7. When the horn contacts the base part, the resulting rapid rise in the force or force rate are detected and used to end the weld.

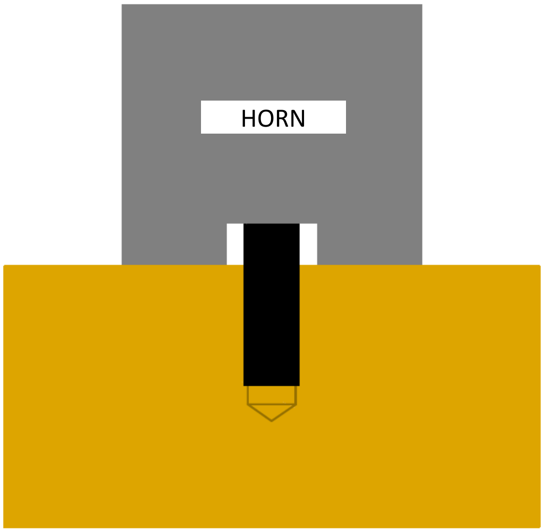

Figure 7

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