

## Information about the Production line

Contacting is Station 3, PCB assembly is Station 6, Ring assembly is Station 9.

The production line under investigation manufactures ultrasonic sensors for measuring the distance between vehicles and surrounding objects. It operates seven days a week in a three-shift system. The entire line consists of a total of 13 workstations, with station 1 out of service, leaving only 12 active cells.

At station 2, a membrane is first mounted on the rubber housing of the sensor, then the membrane is attached using laser welding. After one of the subsequent leak tests, 48 parts are placed on a 'collection boat', which leaves the station via a conveyor belt.

At station 3, individual wires are punched from a long wire chain with a diameter of less than 0.1 mm, which is fed into the station by machine. At the same time, a rod of pins is also inserted into the machine. The system places 2 punched wires on each pin. After the machine removes a housing from the collection boat, it places two such pins in a housing. These are then secured by laser soldering, after which a camera inspection of the solder joint takes place. Finally, the housing is placed on a workpiece carrier, which is transported to the next station with six components at a time.

In cell 4, three workpieces are removed from the carrier and then hot-caulked. To do this, plastic is melted onto the pins using a laser. The pins are then connected and the workpieces are placed back on the carrier. Once all workpieces have completed this step, the carrier leaves the station again.

Next, the carrier moves on to station 5, the foaming system. Here, two workpieces are processed in parallel. An injection syringe fills the housings with foam, which is then foamed and cured. The cell is air-conditioned to ensure optimum conditions for the foam. After all 6 workpieces on the carrier have been processed, the carrier leaves the cell again via a conveyor belt.

Cell 6 is used for assembling the circuit boards. The workpieces are placed on a turntable (capacity: 8) and processed individually one after the other. In each case, a circuit board is inserted into the housing and assembled. After all parts have been processed and placed back on the workpiece carrier, it leaves the cell for the first buffer.

Station 7 is the thermal cell. Here, the workpieces are first stored in a buffer until approximately 2,000 workpieces have accumulated. These are then loaded into one of a total of 10 furnaces and the processing step begins. For a period of 18 hours, the sensors are exposed to changing temperatures of +120°C and -80°C. This serves to identify and sort out sensors with low reliability due to stress. The number of furnaces ensures that there are no excessively long dwell times in the upstream buffer. After completing the entire cycle, the workpieces are removed again and placed back on workpiece carriers, which deliver them to the next cell via a conveyor belt.

In station 8, the sensors are placed on a turntable with a capacity of 12 places. First, plastic covers are mounted on the housing and fused. The sensors are then checked using a vacuum pump. Six parts are processed at a time. Here, too, the workpieces are ultimately transported in groups of six on a carrier via conveyor belt to the next station.

In cell 9, a decoupling ring is attached to the sensor housing. Two workpieces are processed in parallel, after which the filled workpiece carrier leaves the station again.

Cells 10 and 11 are a double station, the final inspection station. Here, cameras are used to perform an initial visual inspection of the sensors. The sensors are also checked to ensure that they can send and receive signals. The two cells each process 3 of the 6 sensors on a workpiece carrier. First, station 10 performs the tests on the front three sensors of the carrier. The carrier is then transported to station 11, which tests the rear three sensors of the carrier.

After further transport by conveyor belt, the carrier reaches cell 12. Here, various information, such as the customer number, is engraved onto the sensors using a laser. This takes place simultaneously on all 6 sensors.

At the last station, another visual inspection is carried out to identify scratches, for example. The inspection is carried out on all 6 workpieces in parallel. They are then packed and ready for transport to the customer. Each package contains 24 sensors.