# SUMMARY

Calibration jig is a verification tool inside assembled fixtures to take the advantages of automated test systems. Jigs eliminate the need for a special setup for every new produced fixture to ensure that they are manufactured within predetermined tolerances, thereby facilitating the production, reducing costs, improving accuracy and maximize the safety. Application of the jig is to first verify the fixture internal adjustments, as an inevitable factor for alignment between connectors and product during the test, and then help suppliers to calibrate fixtures for those purposes. The jig is also used for PLC program checks inside test fixtures in parallel with mechanical verifications. Test fixtures are equipped with pneumatic systems which are controlled by a PLC program.

The calibration jig is provided by 3 main mechanical designed assemblies that are presented as modified versions of product specific testing parts which facilitate the design process. The design of the calibration jig addresses a major purpose, alignment between units and pallet. To achieve this goal, additional mechanics are applied to jig parts in the form of tower blocks on the pallet and L-shaped bars on units. These mechanics are positioned in a way to provide surface alignments towards each other as a requirement for fixture verification, thereby providing a reference for calibration. The jig also complies with manufacturing rules such as the use of lightweight, RoHS compliant, and easy machining material.

3D design of the jig is carried out in a CAD environment to follow up modelling, assembling, and technical drawings. Modelling of each assembly is implemented by adding specific features to each plate for use of jig specific mechanics and also standard components. Meanwhile blocks and bars are designed for pallet and units respectively, so that when jig parts are in fixed position inside the fixture, those bars are mated to the blocks by 2 mm of clearance. As a commitment, designers are also considered the machining rules in every step of the design process. It was anticipated that tolerance would affect the surface alignments between bars and blocks as there were numerous internal and external connections and dimensions between jig and fixture. The idea of tolerance scribe lines generated to support this concern in which, if the tolerance affects the surface alignments, then it is possible to verify the fixture calibration by checking the scribe lines within the cuts implemented on the blocks.

The idea of bars and blocks was initiated at the very first concept, as 2 rough parts that touch each other at some point and developed by the time to reach the final design which is applied to the jig. Also, for pneumatics, SMC provided all needed components,

with required specifications, which simplified the process of choosing pneumatics and adding them into the jig. For virtual prototype, the verification carried out according to the jig commitments which successfully passed the tests. Surface alignment between bars and blocks were satisfied while the scribe lines were also covered by the 2 mm cuts. On the other hand, pneumatics connected to the fixture PLC outputs and the function was successfully verified.

In overall, jig commitments can be inspected by addressing major questions of the thesis:
a) Taking advantage of Mechanical design principles to achieve acceptable results in modelling the jig which reflect to the virtual prototype and verified successfully. Use of standard Aluminium as a lightweight and compatible material. Accurate measurements to find the precise position of each base plate toward others. Bars and blocks implementation into the design for alignment purposes. Adding special features for various needs of handling, machining, and safety. Various types of holes (blind, threaded, clearance) according to the needs which eliminate over constraining, provide smooth assembling process, and thereby, leads to more accurate results of positioning. And finally define the measurements, features, and holes in technical drawings for manufacturing.

b) Valid application of tolerance scribe lines which fully verified on the actual product. By fitting the jig prototype inside the test fixture on resting position, tolerance lines are placed within the engraved cuts on the blocks and ensure the correct position.
c) By means of pneumatic components, jig functionality extended to check the outputs on test fixtures. As an outcome, it is possible to inspect 4 AUX, 2 Reset, and 2 Sensor outputs while calibrating the internal mechanics of the fixture.

Validated results according to thesis objectives shows that verification of the jig is passed successfully which present a standard calibration tool to easily verify and calibrate assembled test fixtures before integrating them into the production sites.
By extending the application area and also types of test fixtures, the need for design of various calibration jigs is generated. Thereby, Methods and ideas which were followed in this thesis are employed for future designs.