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Press Fit Technology Roadmap and Control Parameters for a High Performance Process

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Abstract
Press-fit technology is a proven and widely used and accepted interconnection method for joining electronics assemblies. Printed Circuit Board Assembly Systems and typical functional subassemblies are connected through press-fit connectors.

The Press-Fit Compliant Pin is a proven interconnect termination to reliably provide electrical and mechanical connections from a Printed Circuit Board to an Electrical Connector. Electrical Connectors are then interconnected together providing board to board electrical and mechanical inter-connection. Press-Fit Compliant Pins are housed within Connectors and used on Backplanes, Mid-planes and Daughter Card Printed Circuit Board Assemblies. High reliability OEM (Original Equipment Manufacturer) computer designs continue to use press-fit connections to overcome challenges associated with soldering, rework, thermal cycles, installation and repair.

This paper investigates the technical roadmap for press fit technology, putting special attention to main characteristics such, placement and insertion, inspection, repair, pin design trends, challenges and solutions. Critical process control parameters within an assembly manufacturing are highlighted.

Key words: daughter card / backplane connectors, press fit, high complexity SMT connectors

Introduction
Press-fit technology is a solder free electrical assembly process. The press fit pin being inserted has a “compliant” section that is slightly larger than the plated PCB hole. When inserted into a PCB PTH (Plated through Hole), the compliant section is compressed and provides the “press-fit” connection. The compliant section dynamically adjusts to a controlled variance in hole sizes.

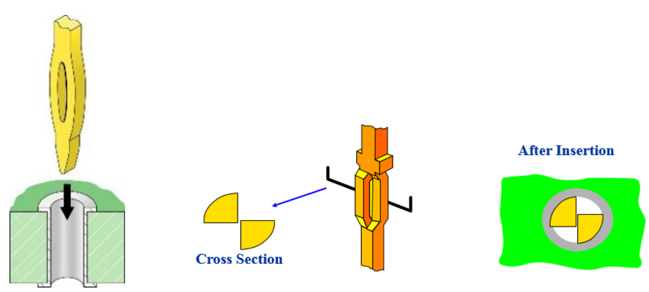


Figure 1 Press fit insertion and cross section

Press-Fit technology has several advantages over the SMT technology such as:

- Environmentally friendly
- No thermal stress on PCB or connector.
- Avoid solder defects such bridges, open, etc.
- Fast and simple assembly process
- Process requires less floor space
- Lead-free operation that does not require costly “hi-temp” plastics.
- Higher pin count per area for high pin count
- Easy and repeatable
- No need to use flux, heat, cleaning and defects of cupper dissolution or IMC.

Compliant Pin

The Press-Fit Compliant Pin is a proven inter connect technology to reliably provide electrical and mechanical connections from a Printed Circuit Board to an Electrical Connector. Electrical Connectors are then interconnected together providing board to board electrical and mechanical connection.

A Press-Fit Compliant Pin is typically formed via a flat sheet copper metal stamping and coining process using precision punch and die tooling set. The Compliant Pin section is designed to dynamically compress during press insertion into the PCB to adapt to a given finished hole diameter range as specified by the connector manufacturer. The Compliant Pin interference will create a gas tight mechanical interconnection to the PCB PTH thus providing a proven, dependable and reliable interface.

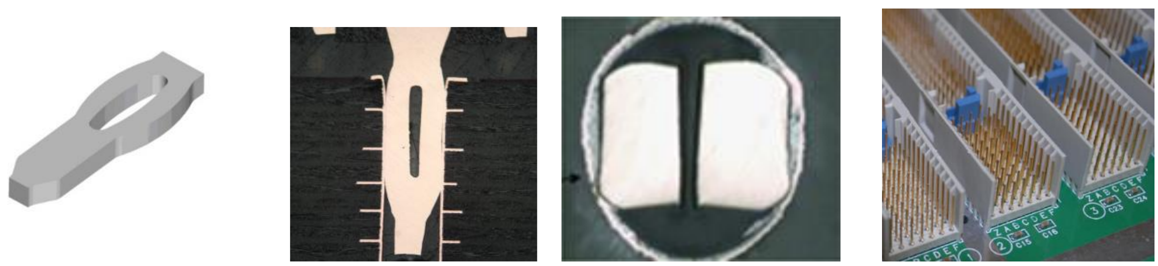


Figure 2. EON (Eye of the Needle) Style Compliant Pin and Cross Sectional View within PCB. Press Fit Connectors Installed on PCB

Compliant Press Pin Design Trends and Roadmap

Electrical Performance

- Higher Data Rate Solutions >10 Gbps (10-40 Gbps)

Mechanical Attributes

- Higher Density Connector Solutions
  - Pin Spacing and Signals
- Smaller Plated Through Holes
  - ~ 0.36mm finished hole size
- Shorter Compliant Pin Section
  - Length < 1.05mm in length

Table 1. Press fit Pin Connector Roadmap.

iNEMI Press Fit - Press Fit Pin Connector Roadmap				
item	**Electrical - Mechanical Features**	2015	2016	Comment
1	# of Differential pairs / inch (Backplane Press Fit Connectors)	>90dp/in	>90dp/in	
2	# of Differential pairs / inch (Mezzanine Press Fit Connectors)	>90dp/in	>90dp/in	
3	Press Fit Connector Data Rates	>25 Gbps	>40 Gbps	Connector Speed approaching to 40 Gbps
4	# Compliant Pins (max # of pins per one piece connector)	400	400	
5	PTH Diameter (Min. Finished Hole Size)	.012" (.3mm)	.008" (.2mm)	
6	PTH Tolerance Diameter (Min. Finished Hole Size Tolerance)	<0.0015" (0.038mm)	<0.0015" (0.038mm)	
7	Pin to Pin Pitch (Min.)	.043" (1.1mm)	.043" (1.1mm)	
8	Column to Column Spacing (Min.)	.071" (1.8mm)	.071" (1.8mm)	
9	Compliant Pin Tail Length (Min.)	>.060" (1.5mm) - .040" (1mm)	>.060" (1.5mm) - .040" (1mm)	
10	Power Pin - Compliant Pin Max Power Rating (Amps / Contact)	110 amps	110 amps	
11	Signal Pin - Compliant Pin Max Power Rating (Amps / Contact)	1 amps	1 amps	
12	Power Connector - Compliant Pin Max Power Rating (Amps / inch)	>400	>400	
13	RoHs Compliant Press Fit Sections Coating			
14	Press Fit Pin Coating Types			
15	Press Fit Compliant Pins in Same Hole (Front and Back Load)			
16	Interconnect with Embedded Capacitance			
item	**Equipment Technology Gaps (Process and Test)**	2015	2016	Comment
17	Automated Connector Pick, Inspect, Place and Press			
18	Automated X-Ray Inspection to Detect Bent Pins (x-Large PCB)			Tomosynthesis Methods being used with algorithms to automate X-Ray inspections.
19	AOI (Automated Optical Inspection) for Pin Tip True Position			
20	Automated Impedance Testing (Single Ended TDR)			
21	Automated Impedance Testing (Differential Pair TDR)			
22	Automated Impedance Testing (Differential Pair TDT)			Limited Development
23	Automated 3D Imaging Profiling			Limited Deployment
	Development			
	Implementation			
	Production Ready			

Smaller Compliant Pins

The general trend in compliant pin press fit designs has been toward smaller diameter vias and shorter pins to improve the electrical performance of the signal launch. As the market continued to require increased and improved signal integrity, system architects are faced with a choice between the signal integrity benefits of SMT and the manufacturing benefits of press-fit. By improving the compliant pin launch performance, the recent generation of connector systems has enabled the market to achieve the necessary electrical performance while maintaining the process benefits.

Placement and Insertion

The industry continues to rely on slow, human manual placement methods to load connectors onto the PCB before the press operation. An optimized process is employed using a poke-yoke method where the operator is guided either by a light station and/or simply uses a visual diagram or drawing to locate and place the connector correctly.

Manual hand insertion has become increasingly more difficult as Compliant Pins are getting smaller, shorter and having higher density. Cycle time for manual placement has increased by an estimated 20% and requires experienced operators with an ability to sense correct placement.

The use of automated machines to perform Compliant Pin stitching, comb block loading press, pin tip true positioning / straightening, Connector pick, place and press steps are all unique highly customized machines. Equipment Manufacturers return on investment to create these types of machines is low so few sources and options exist.

Currently there are a limited number of equipment vendors and/or high cost robots to automate the connector placement onto the boards. One reason for the lack of equipment is the lack of connector package standardization of connector trays. Connector manufacturers tend to use trays that match their connector design and packaging. A collaborative effort has not yet been made in the industry to standardize connector trays. This standardization will go a long way towards having machines that can automatically place parts for the press operation.

As cost pressures increase and compliant pin size density decrease, throughput will become more of a focus, and there will be more demand for automatic placement machines provided they can do some (if not all) of the following steps: pick connector from package, pre-optical or laser inspection of the pin tails for true position verification, placement onto the PCB and inspection before the press fit operation.

The actual connector pin tail's size, alignment, true position and average offset of the wafers play a role in the ability to properly place a connector. Use of automated optical inspection (AOI) process for pin tail alignment and true positioning would provide some assurance that the connector pins are placed into the holes without stubbing against the PTH wall.

The insertion and press step is the most critical portion of the press-fit process. Use of proper press equipment, insertion tooling, support fixtures, compliant pins and PCBs that comply to the drill and finished hole size conditions ensure a sound process with reliable results.

The need for a market standard system for the automatic pick and placement of connectors has been requested and understood for over 10 years. Equipment Manufacturers report that different platforms to address this need in the assembly of PCBs were released to the market, but due to market conditions, sales were very weak. One solution was specifically tailored to the pick and place (not press) of connectors in order to work with equipment in the manufacture of large backplanes. This system loads connectors onto the PCB and feeds the PCB into a press system for the press fit operation. The second solution was a complete pick, place and press system. This inline system represented a single machine solution for the application of compliant pin connectors. The second solution was limited in board size (18 x 30) and force (3 tons), which focused it more on small backplane \ mid-plane and daughter card applications. Note that both systems offered inspection of the connector pin tips after it was picked from a tube or vibratory feeder to assure that pins were present, in the proper arrangement, and that they were not bent outside of a defined tolerance. Both systems have been withdrawn from the market due to low demand.

Current systems on the market range from semi-automatic presses through fully automatic press systems. However, the automation only pertains to the actual press cycle. Loading of the connectors onto the PCB is still manual by human hands.

A re-evaluation of the need for a pick and place solution has been expected with the recovery of the telecommunications and networking industry. Also, the move to smaller pins and denser pin fields is expected to further drive the need for a pick and place option. As the market evolves, one potential solution is modifying an existing automatic press system to act as pick and place and/or a pick, place and press solution. Another potential solution is to take an existing odd form pick and place system and modify it for use with connectors.

Inspection

Inspection is one of the most critical areas of the press operation. Regardless of the type of Pin deformation (crushed, bent-under, broken-off, smashed, etc), the primary concern is a connection that may pass an open/short electrical test but fail subsequently in the field due to either loss of signal integrity or the connection opening up. This can occur if the pin shorts to the top of the barrel and passes the electrical test.

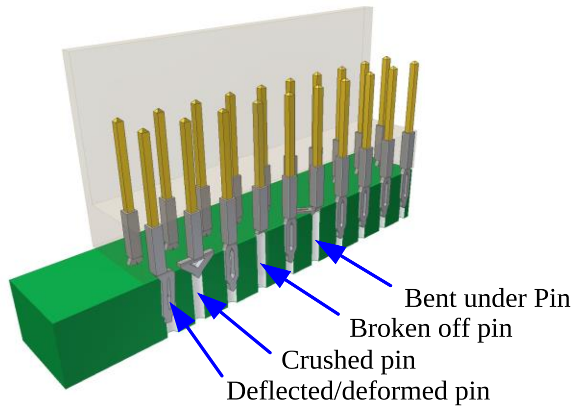


Figure 3. Typical Press-fit Compliant Pin Faults

If the pins are long enough to protrude through the board, inspection can catch a pin that has not protruded through the board by AOI or visual inspection. However, if the pin is short and the PCB is thick, the pin is not visible thus limiting defect detection. AOI (Automated Optical Inspection) Equipment can easily inspect Pin Tip True Position measurements but is challenged to detect presence of a pin tail buried in a thick PCB PTH. Alignment of Pin Tip True Position measurement location (data or reference point) and equipment method is encouraged between the Connector Manufacturer, Customer and Contract Manufacturer

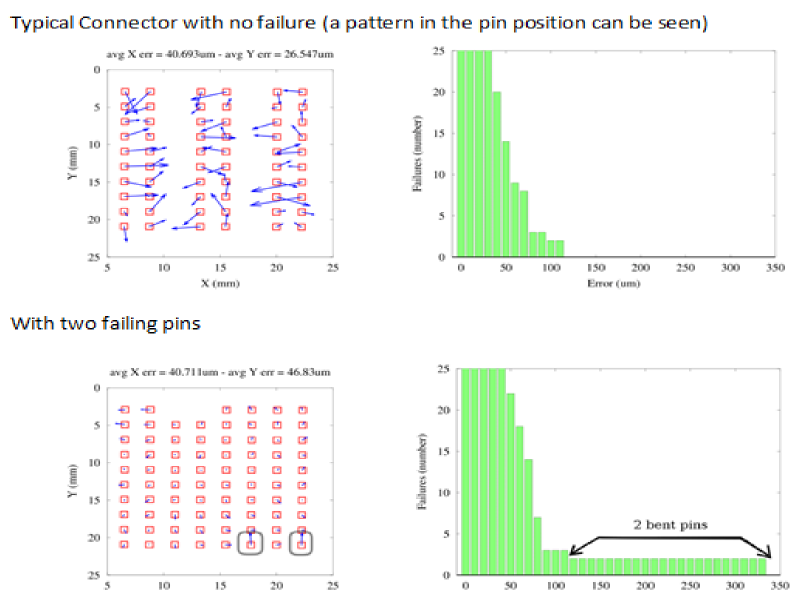


Figure 4. Showing the test result of pin alignment test

The most difficult and elusive inspection of all in the press-fit connector process remains when two connectors are pressed from both sides of a board with pins from each connector going into the same hole. New robotic X-Ray inspection techniques now exist as a routine production test that is scalable to test the largest backplanes and will detect these press-fit defects even in situations like this where two compliant pins share the same plated through hole. An automated X-Ray slice is performed below the PCB surface to detect for pin presence. While inspection methods to detect Bent Pins under the connector base remain a challenge, automating X-Ray algorithms to validate a pin is present within a PTH (plated through hole) have proven successful.

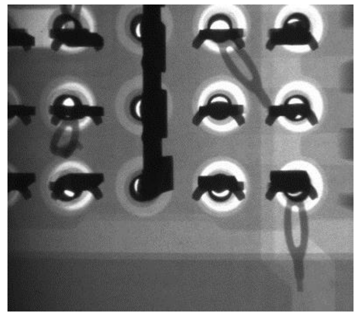
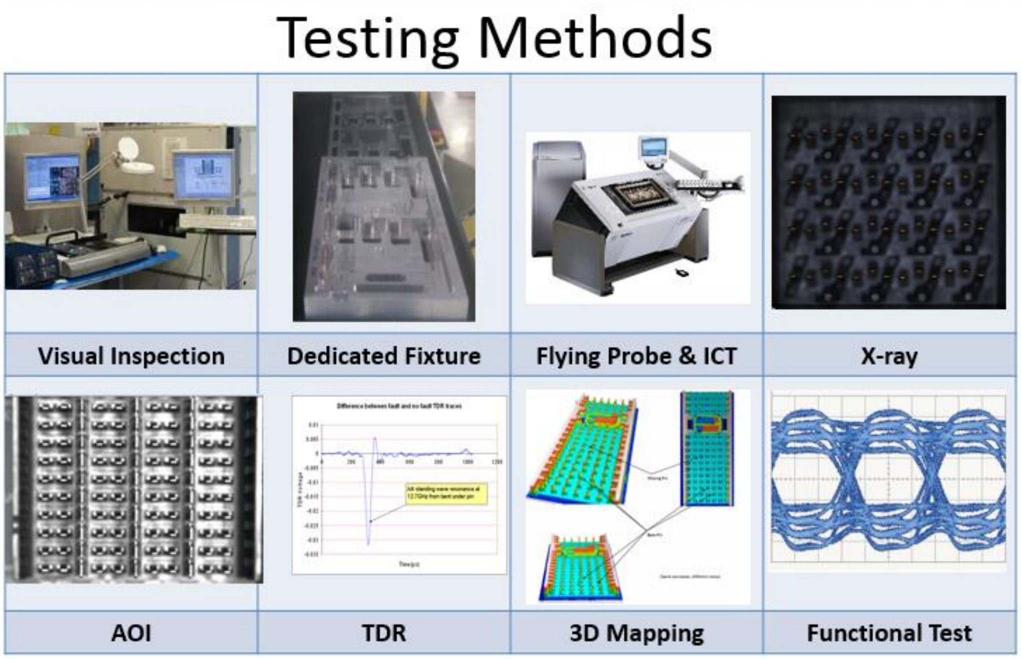
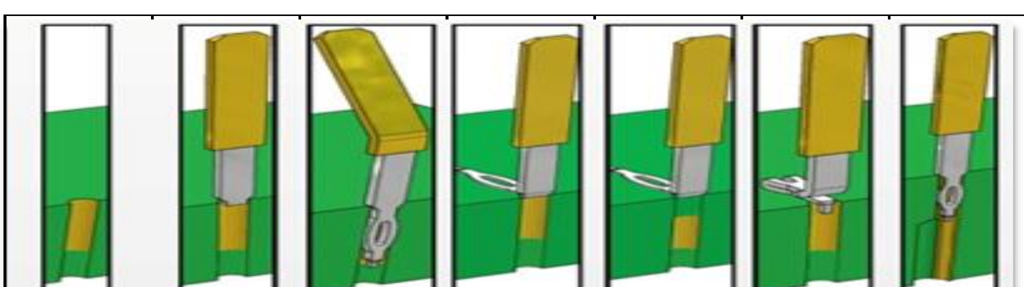


Figure 5. Bent-under and crushed EON pins on a backplane

Testing Methods.

These are the most common and effective test methods to test and measure press fit technology and its performance.





	Missing Pin	Missing Compliant Pin	Bent Pin	Bent Pin (with contact)	Bent Under pin (no contact)	Crushed Pin	Backdrilled Hole Fault
Visual Inspection	✓		✓				
Dedicate fixture			✓				
ICT	✓				✓	✓	
X-ray	✓	✓	✓	✓	✓	✓	✓
AOI	✓		✓			✓	
TDR	✓			✓	✓	✓	✓
3D-Mapping	✓		✓				
Functional	✓	✓	✓	✓	✓	✓	

Figure 6. Different Test methods for Press Fit technology and its main Test Coverage.

Orthogonal Systems

A related trend in the connector industry has been toward systems utilizing an orthogonal architecture. These systems feature pin headers, pressed on both sides of the board, which share signal vias when used on an orthogonal mid-plane. This represents a growing market segment particularly in backplane designs for high speed digital communications, shared-via mid-plane architecture creates a unique challenge for inspection of the press fit interface. Vision inspection of the compliant pins is not possible. Electrical testing can be unreliable, as certain press fit failures may pass this test by contacting the top of the PTH barrel. Modern robotic X-ray inspection methods are now much more effective, but can still be dependent upon the manner and resultant shape of the press fit failure.

Connector Compliant Pin Continuity and Resistance:

Bed of Nails, Flying Probe and Fixtures remain the predominate method to check electrical continuity and isolation resistance for press fit connections onto the printed circuit boards.

Repair

Contract Manufacturers are challenged by many different connector types and rework methods required to remove pins, wafers and connectors. Many assembly sites use pliers to pull the pins, wafers or housings even though most connector companies sell repair tooling. The need for connector manufacturers to design in unique features to allow easy removal, while preventing damage to the PCB, is encouraged, and common tooling to rework connectors is suggested. Connector bodies need to be designed for removing the connector, as well as placing it. Strategically located tooling holes or features for removal tools need to be designed into the housing. Also, the mechanical strength of the body should be sufficient to allow removal of all pins at once without mechanical failure of the body. Compliant Pin Press Fit rework remains at 2 max insertions of a new pin after the initial press.

Finished Holes Sizes

Press Fit Compliant Pins require a highly controlled drill and FHS (finished hole size). A narrow FHS (Finished Hole Size) tolerance of +/- 0.002" (.05mm) is typically required. Trends for smaller FHS tolerance are being seen. The PCB drilled and finished holes sizes are specified by the connector manufacturer and must be strictly followed. PCB PTH drill and FHS variances to accommodate different Surface Finish types must be studied, validated and reported by the connector manufacture. Failure to comply with connector manufacturer drill and FHS recommendations will impact compliant pin insertion and retention forces.

Table 2. Examples of Reduced Finished PTH Size, Tail Length and Higher Speed

Example of High Speed Connector System Attributes	Finished PTH Diameter	Compliant Pin Length	Speed
AirMax	.5mm	1.6mm	12.5 Gbps
Aptera	.46+-.05mm	1.6mm	6.25 Gbps
Crossbow	.46mm	2.1mm	20Gbps
ExaMAX	0.36mm (signal) 0.50mm (ground)	1.4mm	25-40 Gbps
GbX	.46+-.05mm	2.1mm	8 Gbps
GbX I-Trac	.46+-.05mm	2.1mm	12 Gbps
HDM	.65-.8mm	3.5mm	3 Gbps
Impact	.37mm & .5mm	1.25mm & 1.6mm	25 Gbps
Impel	0.36mm and 0.46mm (two options)	1.3mm	40 Gbps
Multugig RT	.46mm & .56mm	1.2mm	10 Gbps
VHDM/HSD	.51-.61mm	2.8	10 Gbps
VHDM-HSD	.51-.61mm	2.8mm	5 Gbps
Whisper	.244mm	1.45mm	25 Gbps
Xcede	.41-.51mm	2	25 Gbps
ZDHD	0.46mm	1.6mm	25 Gbps
ZipLine	.5mm+-.05mm	1.6mm	12.5 Gbps
Z-Pack HM-Zd	.6mm+-.05mm	2.5mm	10 Gbps
Z-Pack HS3	.6mm +-.05mm	3.7mm	10 Gbps
Z-Pack Tin Man	.46+-.05mm	1.8mm & 2.5mm	12 Gbps

Challenges and Issues

The development of smaller compliant pins, while providing necessary electrical improvements and enabling increased density, also poses a number of design and manufacturing challenges:

- Smaller component die set tooling required – more fragile, more maintenance
- Smaller PCB vias required – board thickness / aspect ratio limitations
    - Smaller holes in thicker backplanes drive higher plating Aspect ratios
    - Smaller PCB holes and Pins with less positional tolerance make part placement more difficult.
- Alignment of Connector Manufacturer to OEM Equipment Manufacturer to specify recommended PCB Drill and Finished Hole Size requirements.
        - PCB Fab drawings must reflect the Connector Manufacturer PTH Drill and Finished Hole Size requirements.
        - Allowance of PCB vendors to adjust drill sizes that differ from the Connector specified requirements may create Pin insertion and retention variance.
- PCB Fab Process of Controlling PTH requirements (tolerances, drill diameter, plating thickness and true position)
- Counter boring or back drilling holes
- Smaller lines and spaces
- Board Assembly capabilities (press machine: manual or computerized)
- Smaller / shorter compliant pin sections
- Pins have reduced PTH compliance, less energy available, lower insertion and retention forces. Lower Pin Insertion Forces. Limited Bent Pin detection.
- Column strength - pin buckling. Pins are much easier to bend or damage
- Manual loading of Connector onto PCB more difficult due to density and pin size
- Bent Pin detection more difficult
    - Inspection capability of Pin Tail presence via X-Ray or AOI
- Pin Tip Location - Board Assembly capabilities; alignment of measurement plans
- Commitment and investment in new equipment technology
- Uniform set of requirements for PTH for industry
- RoHS and new plating compositions

Solutions

- Improved inspection Equipment capabilities required:
    - Repeatability and Reproducibility of data with low false defect call rates
    - AOI or Laser: need equipment manufacturers to create automated optical inspection machines with ability to:
        - Look into a PTH from the bottom side to validate pin presence and insertion depths.
        - Check pin tip true position and alignment
    - X-Ray: need equipment manufacturers to create automated X-ray inspection equipment to easily measure pin insertion depths and detect bent pins under Connector housing...
        - Large PCB Equipment with PCB size >508mm (20") x 609mm (24")
        - Create inspection algorithms to automatically detect bent pins
- Identifying process capabilities: Cpk / Process control
- Use of statistical tolerance analysis in system design
- Improvement in tooling fabrication and process development
- Plastic technology using a transparent housing to aid inspection of pin presence seems to be a viable option using Polycarbonates, Polyethersulfones or Polyetherimides. While these plastics may provide visibility to pin insertion effectiveness, mold ability and heat exposure limits may need enhancement.

Environmental Requirements

Despite the current RoHS exemption allowing lead in compliant pins, the marketplace remains largely divided between tin-lead and pure tin for connector pin plating. This market division requires connector manufacturers to maintain dual part numbers (and inventories) for tin and tin-lead. Additionally, the removal of lead from PCBs has posed challenges for press fit pins. While a tin-lead PCB surface finish continues to be common on those products not required to be RoHS compliant, many OEMs have migrated to the use of Immersion Tin, Immersion Silver and OSP surface finishes. While pin insertion and withdrawal forces vary slightly with the type of surface finish used, lead-free plating types tend to cause an increase in the compliant pin insertion forces. These increased forces due to the surface finish can reduce connector installation success, particularly with FHS below the nominal specified diameter.

Tin whiskers so far have not been a primary concern on products using the Immersion Tin surface finish.

Cross Cutting: Press Fit Pin Testing Forecast

High Speed Communication and Signal Integrity

There are many press-fit problems that would not be detected using a DC contact resistance measurement but would still represent a huge connection loss on a multi gigabit per second digital signal. The expected trend is for the digital transmission speed requirements to continue their increase. This is a current, very real and growing problem for the industry. Some of these can be detected using X-ray inspection (such as bent under pins), others are not.

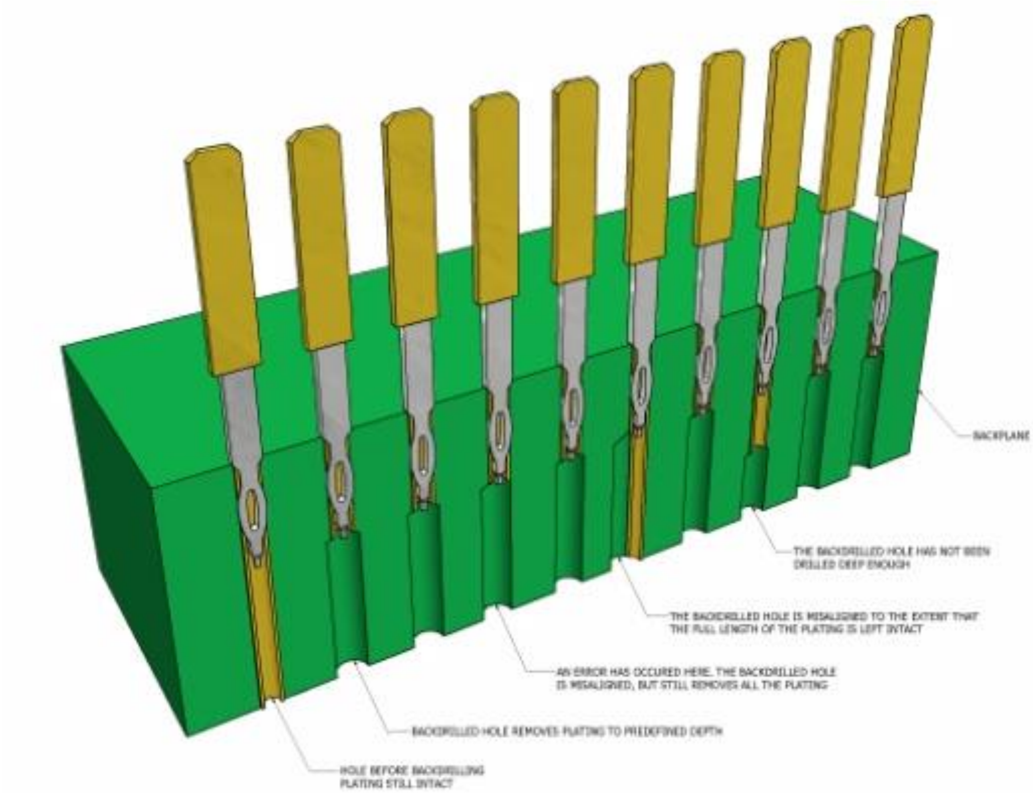


Figure 7. Transversal cut view of press fit technology.

It is well established and widely published that TDR and S parameter measurement can easily detect press fit faults such as the three examples above. An example of this is in Figure 8 which shows the TDR reflection from a single bent under pin on a press-fit connector.

Systems do exist for automatic testing of bare board traces and sample coupons using TDR. But these systems cannot currently be used for routine automatic testing of fully assembled boards.

The industry need is for an automatic production test method for backplane PCBs, including orthogonal and mid-plane nets, that is fully scalable to deal with large samples.

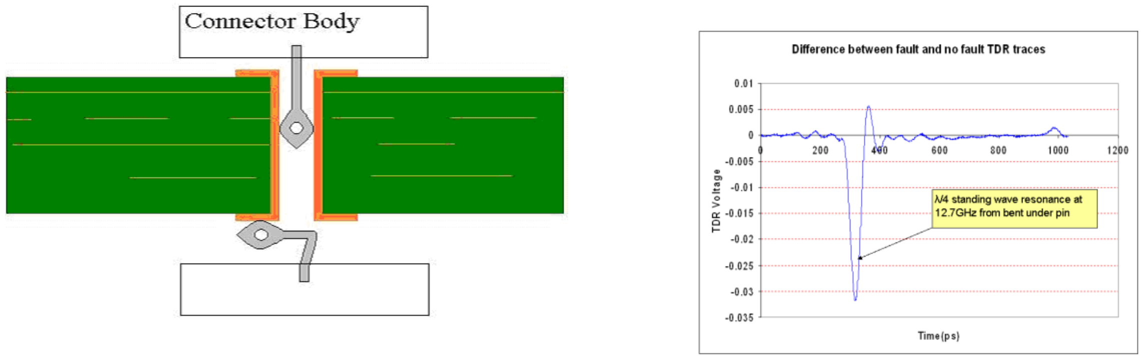


Figure 8. Bended pin Illustration and TDR expected signal to detect this abnormality.

3D Automated Press Fit Pin Profiling Inspection:

A new system has recently been introduced which provides a metrology based inspection of press fit pins on Backplane / PCBA assemblies up to 127cm x 76cm, (50" x 30"). The system uses a non-contact confocal line sensor to scan across the backplane, creating a 3d profile of the connector, pins and holes. Measurement density is typically 200,000 points per cm2 up to 500,000 points per cm2, depending on desired resolution / production throughput. This method enables detection of Bent Pins, Missing Pins and Pins Crushed under a Connector Housing.

The Confocal technology has been available for quite some time, but was previously unusable for pin inspection due to taking hours to profile a single backplane. However, recent product developments have increased the density of the confocal line sensor to such that the technology is now capable of meeting production throughput requirements. Today, the typical time to profile and inspect a high density 2cm x 25cm connector is approximately 18 seconds.

The advantage of using a metrology based system is that the pass / fail criteria is based on quantitative values, creating a more robust test / inspection platform than qualitative image based systems. In actuality, test program creation and pass/fail decisions are closer in nature to In-Circuit test rather than AOI / X-Ray. This new Press Pin Inspection method providing the ability to find Bent and Missing Press Fit Pins is now available for inspecting PCBA and Backplanes.

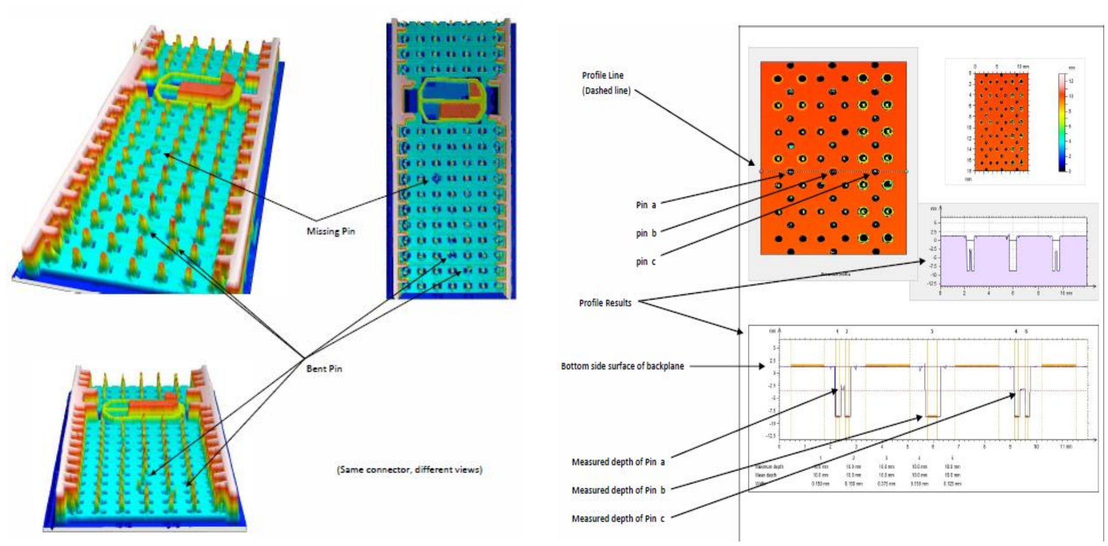


Figure 9 3D image and data of Press Fit Pin Connector when viewed from the top and bottoms side of the Board.

Automatic Connector / Pin Placement and Pin Tail inspection

The need remains for automatic machines to provide connector pick, pin inspect, place and press process steps. Accurate pin placement and tail inspection of the connectors is needed. As the industry becomes even more cost competitive, connector pins and PCB PTHs get smaller, this need will become more pronounced in order to improve throughput and yields. One of the first steps in automating the process is to standardize the connector trays between companies for the machine.

Press Fit Process Control

Having a Press fit operation with process controls is really important. Performing a proper analysis of key input variables that are based on experience can prevent the wrong defect occurring.

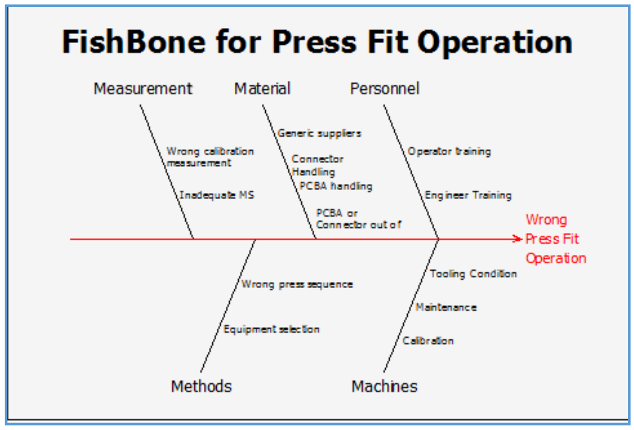


Figure 10. Fishbone diagram showing potential causes of wrong press fit operations

Necessary actions are suggested, based on top contributors.

1. **Component Connector Handling**. Handing of component is a critical factor, to prevent bent pins, wrong connector assembly or reversed connector polarity. In order to do that, we need to have material identification at all times, manage one piece flow and always use the connector original packaging material which are key elements. If several connectors need to be inserted it is recommended to use an assembly mask to show the connector positions to be inserted.

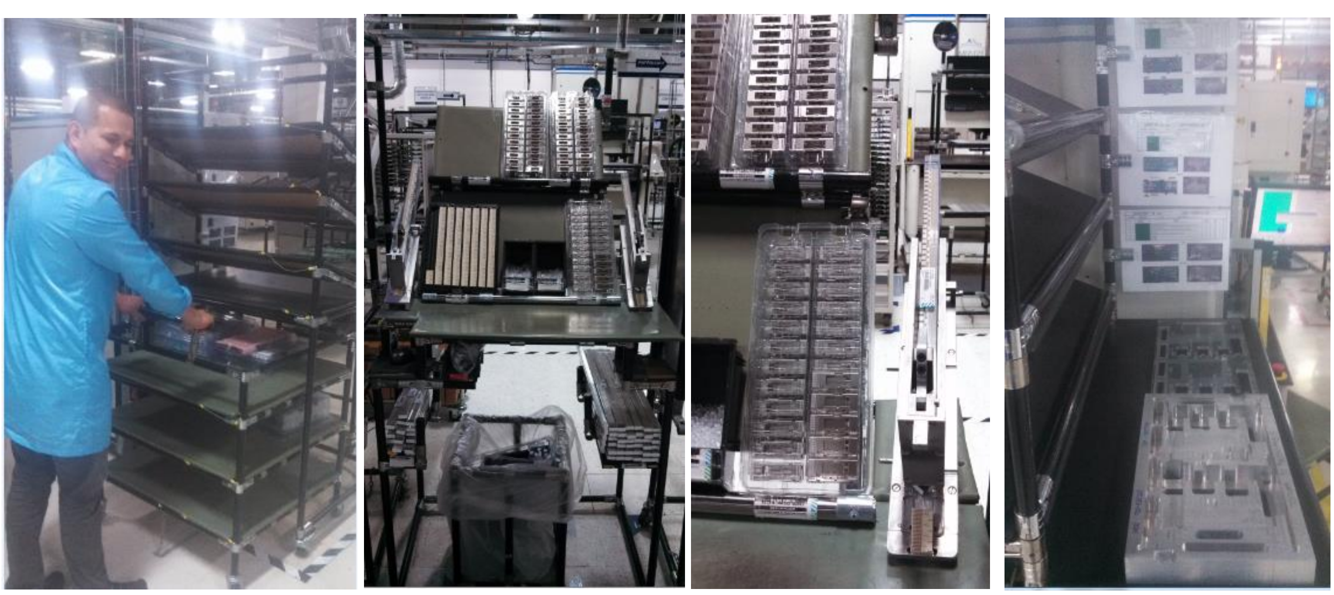


Figure 11. Correct handling using original packing, assembly table using one piece flow and single dispenser and mask used to show locations to insert the press fit connectors.

2. **Equipment**
   a. **Press type**. In this section will be described the most common press equipment technologies used with a contract manufacturing environment.

      i. Manual Arbor Press
         1. The cheaper method to press the connector and widely used on the lower end product.

2. Control dependent on operator to apply manual hand force by the operator. High potential to damage the board or connector due to the high pressure.
3. Low maintenance cost

Figure 12. Manual arbor press

ii. Pneumatic Press
1. Pressure applied to press head via air cylinder.
2. A conversion table is required to correlate the air-supply pressure and the press-in pressure from the pneumatic cylinder.
3. Air fluctuations within a factor may vary force and equipment performance.

Figure 13. Pneumatic press

iii. Hydraulic Press
1. Similar to the pneumatic press but uses hydraulic power.
2. Provide stable pressure to the connector.
3. Hydraulic fluid leaks are common and require preventive maintenance.

Figure 14. Hydraulic press

iv. Servo Electric Press

Is the preferred equipment technology because its precision control of the press head. Critical key process parameters can be controlled in different ways to achieve a fixed press force, applied force per pin, press pins to height and stroke termination schemes. Examples are press to height, percent of a maximum force, above a range sample and force gradient.

1. From bench top 2 tons pressing capacity to 12 tons.
2. Electric Press controlled by the computer and delivers a controllable/repeatable pressing force to the connector. Preferred Choice because of the precision control of the head.
3. It can be controlled in different ways: Fixed Force, Fixed Force per Pin, and Press to Height, Percent, Above Range Sample, and Force Gradient.
4. The program for pressing which is called a profile is precisely defined by the user to control force, speed and distance as the connector pressed.
5. SPC control software provides real time data on the pressing force on each connector.
6. Ability to stop in mid press cycle if errors are detected to reduce or eliminate requirement for re-work.

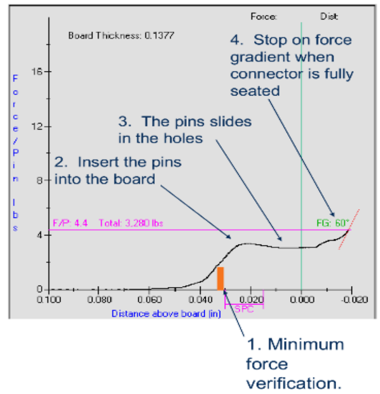


Figure 15. Press force vs distance chart

7. It is recommended that the Servo Electric Press machine is a standard press fit equipment.

Figure 16. Servo Electric Press 12 tons

v. Automated Electric Press
   1. As above.
   2. Automatic pressing operation.
   3. Automatic tool changeover.
   4. Floating tool holder.

Figure 17. Automated Electric Press.

Approximately equipment costs in Table 3 as a reference.

Table 3. Press Equipment cost comparison.

	Manual Press	**Pneumatic Press**	**Hydraulic Press**	**Electric Press**	**Automated Press**
Cost	From $100 ~ $3000 depending on the tonnage requirement of the press	Approx. $30,000	From. $10,000 built by machine shop	$30,000 ~ $90,000 based on the capacities	$150,000

b) **Tooling and Fixtures**.
   i) OEM Tools are first and must be used for precision designs. Due to understanding of critical dimensions and evaluation the OEM tools are preferred insertion tools especially for precision components.
   ii) Best Practices on tool design.
   Tools for insertion, PCBA base and connector support need to follow standardization in their design and maintenance to assure correct operation, some key elements to consider are:

- Fixture Identification with barcode, preferred on both sides of fixture.
- Standardization on fixture depth
- PCBA guide pines.
- Open areas on frame to be able to insert and remove the PCBA
- Remove excess material from fixture to reduce weight.
- Enough clearance on fixture for bottom components.
- Enough clearance on fixture for pins if connector pins will pass through.
- Smooth edges
- Material selection needs to meet ESD requirements. Prefer to use Aluminum or SS.
- Press tool need to consider physical differences between connectors suppliers.
- Maximum tolerance base to press bar 3mils

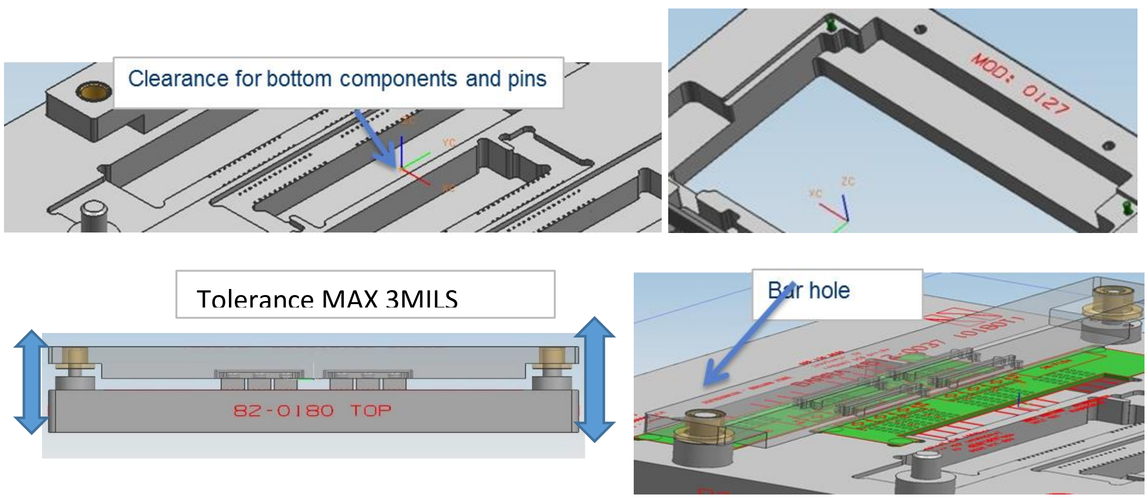
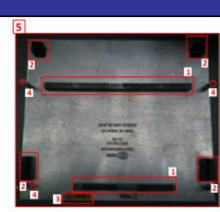
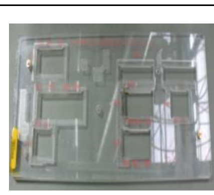


Figure 18. Fixture design guidelines.

Table 4. Example Maintenance table for Press fit plate, press tool and PCBA mask.

Picture	Fixture Description	Actions
	**Press fit plate**	1) Valida que no exista alguna malformación o ruptura de la superficie donde sientan los conectores 2) Verifique que los dados de sujecion esten alineados y esten en buen estado 3) Ver que la etiqueta de identificación este correcta y en buen estado 4)Valida la existencia de todos pines guía en el fixture (si se encuentra flojos utilice desarmador para apretarlos) 5) Revision general del estado fisico (Raspones, Ralladuras, Golpes, y/o abolladuras) 6) Valida que la fixtura este limpia 7) Verifica que la PCB sienta correctamente en el fixture. 8) Valida que la etiqueta de mantenimiento correctivo este correcta y en buen estado y actualiza la fecha.
	**Press tool**	1-Revision general del estado fisico 2.-Revisa que no tenga desgaste 3.-Verifica que no tenga golpes o malformaciones 4.-Limpieza general del dado 5.-No olvides colocar la etiqueta de mantenimiento con su respectiva fecha en que fue realizado y firma del tecnico quien lo realizo.
	**PCBA Mask**	1) Valida que no exista alguna malformación o ruptura en la superficie 2) Verifique que los barrenos de sujecion esten alineados y esten en buen estado 3) Ver que la etiqueta de identificación este correcta y en buen estado 4)Valida la existencia de todas las aperturas para los conectores 5) Revision general del estado fisico (Raspones, Ralladuras, Golpes, y/o abolladuras) 6) Valida que la contra-mascara este limpia 7) Verifica que la contra-mascara siente correctamente en el fixture. 8) Valida que la etiqueta de mantenimiento correctivo este correcta y en buen estado y actualiza la fecha.

3. **Press Profile and program generation.** Gang Press Limits should be carefully evaluated, pressing profile generation is a key process, below are the main sequence and important points to consider to generate a good set up.
    1. Have the connector and PCBA mechanical specification. Use of calibrated scale to validate dimensions.
    2. Input tooling to be used.
    3. Input data of connector to be used and press parameters associated to connector specification.
    4. Input board, PCBA fixture information and connectors sequence.

During building the program it is important to use press fit equipment controls to make sure that the correct operation is enforced such as (use if available):

1. Use of password protected level (administrator, Engineer and Operator)
2. Ask to validate tooling by enabling the scanning of fixture and press tool.
3. Use of laser function to sense the distance and expected results otherwise stop operation.
4. Use of SPC to control the force and distance profile

Table 5. Summary table of mechanical characteristics for Press tools, press fit plate and connector.

DOCUMENTO:		PRODUCTO:	PROYECTO:	Generador :	20/Jun/2013
NO. DE DOCUMENTO:	GIING-93-XXXXXX	REVISIÓN:	Página 1 de X	OPERACION o	MPI de Referencia:
Área: Igenieria de Procesos					
TÍTULO: Matriz de Press fit Nave 3					

PLATO DE PRESS FIT	TICKNESS	DADO PRESS FIT	ID	TOOL HEIGHT	TOOL WIDTH	TOOL LENGTH	CONNECTOR	N/P	PINES	BASE THICKNESS	UNSEATED TOP	HEIGHT
	1.472 in		694-3589000	2.002	0.351	0.84		JNT2H 450-021450	55	0.114	0.7	0.639
			450-016814	0.5445	0.8035	2.6665		JNT2H 450-016814	72	0.494	0.598	0.494
PCB 710-020310	0.223		694-2755-000	2	0.918	1.813		JNT2H 450-021453	275	0.1065	0.7015	0.6435
								JNT2H 450-021451	275	0.1112	0.6925	0.64
	1.4625		694-2975-000	2	0.918	0.721		JNT2H 450-020689	110	0.1065	0.709	0.6435
								JNT2H 450-011284	110	0.107	0.7155	0.64
								JNT2H 450-021452	1452	0.1165	0.6995	0.644

Figure 19. Different connector style and press tool used. Non – Flatrock and Flatrock

4. **Maintenance, storage and administration of plates and press fixture.**

It is important that the plates are properly stored that allow them to be easily finding and to avoid contact between them, with the press tool needing to be stored over soft material.

Figure 20. Handling of plates and press tooling.

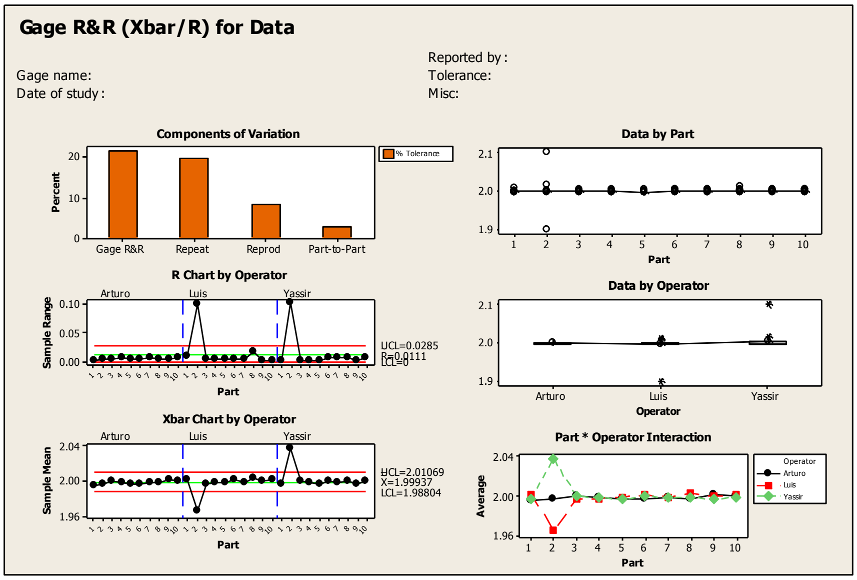
5. **Operator and Engineer Certification.**

Operator certification it is necessary to assure the equipment operation is understood, with a preferred user validation of equipment used installed with password protection.

Figure 21. Operator certification into shop floor data collection system validating their training records.

6. **Calibration and Measurement System.**

   Calibration on press equipment for force, distance, time, flatness and GR&R performed to measurement system for calibration and measurement equipment for mechanical dimensions are necessary to warranty correct data is input to the system.



Gage R&R Study - XBar/R Method

Process tolerance = 0.2

Source	StdDev (SD)	Study Var (6 * SD)	%Tolerance (SV/Toler)
Total Gage R&R	0.0071007	0.0426042	21.30
Repeatability	0.0065367	0.0392203	19.61
Reproducibility	0.0027733	0.0166399	8.32
Part-To-Part	0.0008735	0.0052411	2.62
Total Variation	0.0071542	0.0429254	21.4

Figure 22. P/T Ratio performed to Measurement system with 21.3% which is an acceptable level.

7. **Shop Floor Control.**
   In order to provide tight operations control an appropriate use of Shop Floor Data Collection System (SFDCS) is needed. SFDCS could be used to track below points:
   - Use of correct PCBA plate,
   - Use of correct Press tool.
   - Operated by Certified Operator,
   - Use of correct program (match program vs PCBA SN)
   - Track of PCBA flow
   - Track of rework cycles.
   - Parametric data for SPC implementation.

Summary

In this document was shown the technical roadmap for press fit technology, putting special attention to main characteristics such as placement and insertion, inspection, repair, pin design trends, challenges and potential solutions.
It mentioned the main advantage versus solder and SMT technologies and critical parameters to be considered during the manufacturing process such as: Connector Handling, Pin Compliance, insertion force and insertion tooling.

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The engineering and production teams of the company at Penang Malaysia and Guadalajara Mexico, engineering support from PCB manufacturer Multek and engineering support of Press fit connectors technology such FCI, Molex and Tyco. We would also like to acknowledge Charles Santhakumar, John Fisher, Mageswaran Arunasalam, David Mendez, John Thompson, Peter Soupir, Zach Bradford, Lorenzo Trojan, Nagadeven Karunakaran, Hector Silva, Manuel Escobedo and Napoleon Torres.

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