DOCUMENT TITLE: PROCESS CONTROL SPECIFICATION WIRE BONDING

REVISION HISTORY

DATE	REV	BY	DESCRIPTION OF CHANGE	REVIEWED BY	APPROVED BY
21/10/2018	0	Manjunath.M.S	New Specification	Prof.MMN / Prof. KNB	Prof. NKB / Prof. RP

SPECIFICATION DETAILS

1.0 PURPOSE OF PROCEDURE

The reasons or grounds for documenting the procedure; the underlying basis or principles, or/ and use of the procedure.

1.1 To define the incoming devices material, surface quality, bond pad dimensions (bond pad opening and pitch) for successful wirebonding.

2.0 SCOPE OF PROCEDURE

The people, areas, documents, and processes to be covered/ affected/ influenced by the procedure.

2.1 This specification is applicable to all packages with wirebonding packaged at CeNSE.

3.0 APPLICABLE DOCUMENTS

Documents, which are quoted in the body of the procedure or documents which the procedure directly link to, such as, standards.

3.1 CENSE08001PKG Process Control Specification – WIREBOND

4.0 DEFINITIONS

Descriptions or explanation of specific terms, symbols used in the procedure at user level.

Substrate	Glass to Metal sealed Header or the PCB where the die is mounted
BPO	Bond pad opening
BPP	Bond pad pitch
NSOP	Non Stick On Pad
NSOL	Non Stick On Lead

Type of Bond

Ground Bond : Interconnection from die bond pad to substrate ground/power ring.

Normal Bond : Interconnection from die bond pad to substrate lead finger.

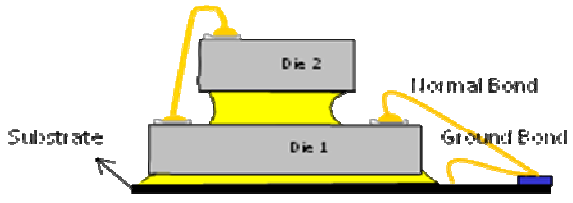


Fig. 01

5.0 SAFETY

List the safetly measures or precautions to be taken if any.

5.1 Contact with EFO electrode while machine is running should be avoided as electrical shock could occur.

5.2 Heater stage is hot and contact should be avoided as this would result in burns.

6.0 SPECIAL REQUIREMENTS

List specific or particular requirement(s) to be met or followed.

6.1 Wear finger cots, gloves and groundstrap when handling units or when operating machine.

7.0 EQUIPMENT/MATERIAL/RECORD

List the equipment (hardware)/material/record referenced in the body of the procedure.

7.1 Equipment

Vendor	Model	Capability		Bonding Mode	Wire/ribbon size
		BPO	BPP		
Hybond	626	>= 150µ	>200µ	Ball & Wedge	18-51 µ
TPT	HB16	>= 120µ	>200µ	Ball, Wedge, Ball bump, pick and place	17-75 µ 25x250 µ ribbon
	Staggered bonding	>= 100µ	>200µ	Ball, Wedge, Ball bump, pick and place	17-75 µ 25x250 µ ribbon

Table - 01

7.1 Gold wire

List of qualified Gold wire.

Vendor	Tool Specification	Wire dia
Heraeus	Au-HD2	Au 25 µ
Heraeus	Au-HD2	Au 25 x 250 µ ribbon
Microbonds Inc	AV032813-01	Au 30 µ insulated

Table - 02

7.2 Aluminum Wire

List of qualified Aluminum wire.

Vendor	Tool Specification	Wire dia
Heraeus	ALW 29S	Al 33 µ

Table - 03

7.3 Capillary

List of qualified Capillary

Vendor	Tool Specification	Wire Material & Size	Tool length
Gaiser	1513-15-437GM	Au 25 µ	11 mm
Gaiser	1572-15-750GM-20D	Au 25 µ	20 mm

Table - 04

7.4 Wedge Tool

List of qualified Wedge Tool

Vendor	Tool Specification	Wire Material & Size	Tool length
Gaiser	4445-1520-3/4-CG-F	Au 25 µ	19 mm
Gaiser	4445-2530-3/4	Al 33 µ	19 mm

Table - 05

7.5 Optimization of bonding parameters:

The key parameters are Ultrasonic power (mW), Time (ms) and Force (mN) Temperature (^{o}C). for both first and second bond. The intention is to achieve bonding at the least possible parameters. Al wire wedge bonding happens without any temperature input. Au ball bonding requires a work holding temperature of 120^{o}C.

8.0 DETAILED PROCEDURES

This is the main body of the entire specification - a clearly written description of all action steps necessary to carry out the procedure. The steps must be laid out in a logical fashion, enabling the user to follow the process flow or timing of events.

8.1 REQUIRED PREREQUISITS FOR SUCCESSFUL WIREBONDING

Wirebonder is semiautomatic machine to establish connectivity between die and substrate using Au (25µm), Cu, Al (33µm) wire using Ultrasonic energy, Force and Time. Ball bonding, Wedge bonding and Ball Bump can be accomplished on this machine.

8.1.1 Prerequisites for incoming device /material

8.1.1.1 The device should be fabricated on silicon, silicon compounds or pyrex glass wafer. Bonding is difficult on normal glass slides.

8.1.1.2 The fabricated device should have minimum bond pad size of 120x120µm , pad pitch of 200µm and thickness of minimum >80 nanometers of Au/Al with a appropriate seed layer thickness of minimum >30 nanometers .

8.1.1.3 The above point should be taken care while designing the mask.

8.1.1.3 Surface roughness of not less than 0.05µm (roughness average) Ra value.

8.1.1.4 The device should be firmly attached to the chip carrier using suitable adhesive.

8.1.1.5 The parallelism of die to substrate not exceeding 0.025 mm for 5mm length of the die.

8.1.1.6 The distance between the first bond and second bond not to be more than 6mm.

8.1.1.7 In case of additional layers below the bond pad such as oxide, PZT, possibility of extending the contact pad away from the buried layers to be explored. If not very high thickness of metallization >150 µm is recommend.

8.1.1.8 Check to ensure device went through die attach cure operation.
8.1.1.9 Check whether bonding wire and tool used is correct against the required.
8.1.1.10 Clean the substrate using IPA ultrasonic cleaning to remove any traces of dirt and oil.

8.1.1.11 The devices should have been always stored appropriately in a dessicator without fail to avoid oxidation of metallization layers.

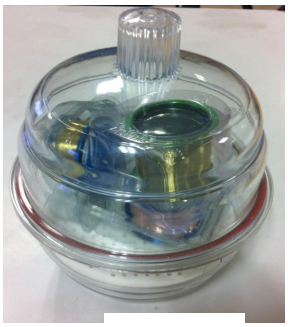


Fig. 02

8.1.1.12 Bondability Matrix

Bond pad Material	Type of wire	Type of bond	Parameters Power (mW), Time (ms), Force (mN) and Temp (^{o}C).
Chrome Gold	Au	Ball	310, 250, 308 (120^{0}C)
Chrome Gold	Al	Wedge	300, 250, 310
Titanium Platinum	Au	Ball	310, 250, 308 (120^{0}C)
Titanium Platinum	Al	Wedge	300, 250, 310
Aluminum	Au	Ball	310, 250, 308 (120^{0}C)
Aluminum	Al	Wedge	290, 250, 310
Copper	Au	Ball	290, 250, 295 (120^{0}C) With helium gas
Copper	Al	Wedge	300, 250, 310

Table - 06

8.1.1.13 Heater block temperature specification:

PACKAGE	BOND TEMP
Ball Bonding Au wire	120 +/- 5 C
Al wedge	Bondable at room temperature

Table - 07

9.1 WIREBOND OPERATIONS PROCEDURE:

9.1.1 Machine setup flow

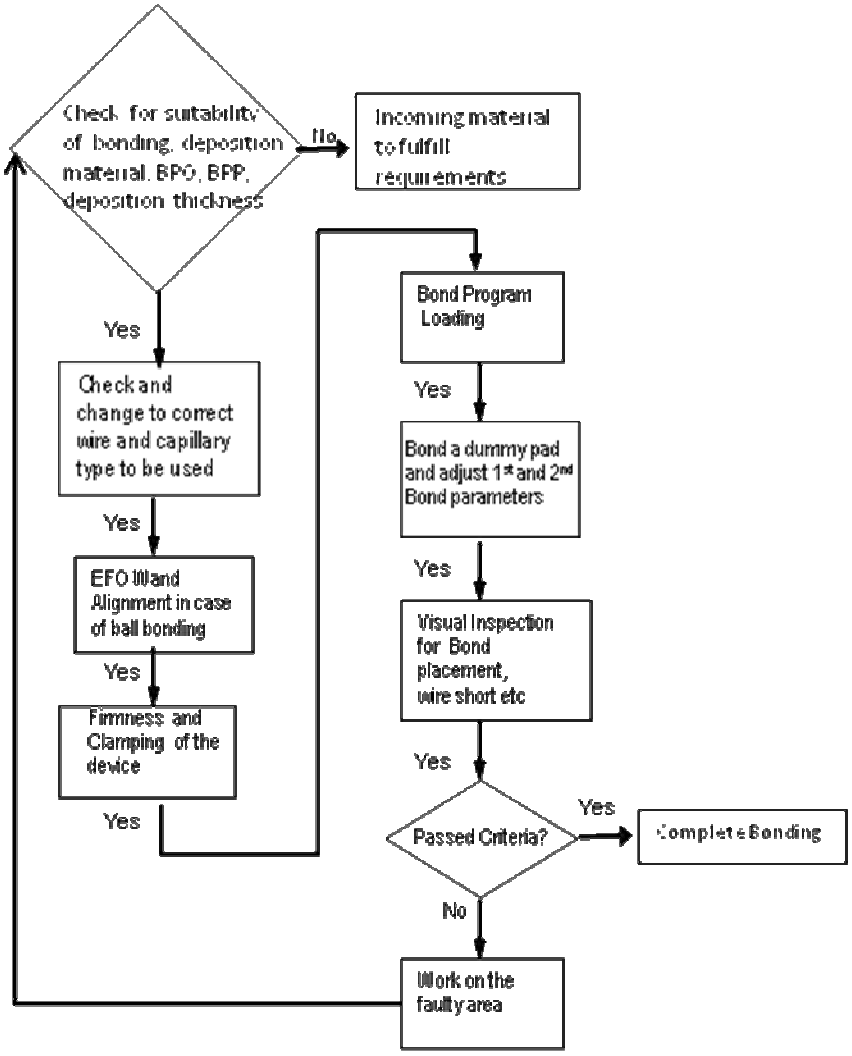


Fig. 03

9.1.2 Capillary change procedure

9.1.2.1 Capillary change procedure.

9.1.2.2 Use a torque wrench to loosen the capillary screw then use a tweezer to remove the capillary.

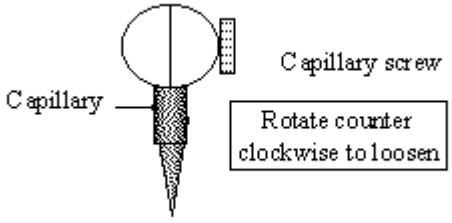


Fig. 04

9.1.2.3 Insert the new capillary into the transducer until it flushes the surface.

9.1.2.4 Tighten the capillary set screw using the torque wrench and wait for the click. With the torque set at 2.48 N-m

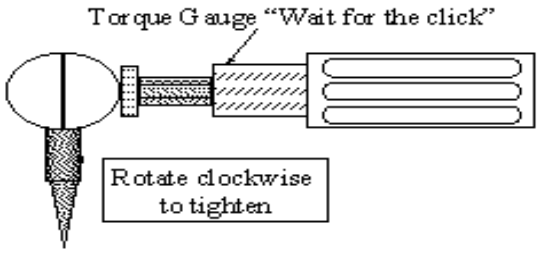


Fig. 05

9.1.2.5 Calibrate the EFO height during set-up.

9.1.2.6 Set the EFO wand to the capillary tip gap approximately to 1mmto 1.5mm

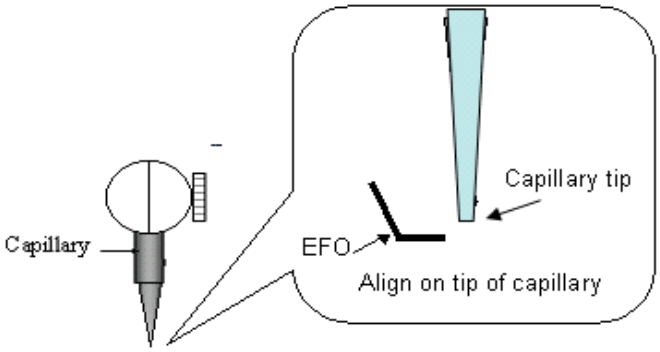


Fig. 06

9.1.3 Wire path cleaning (Monthly basis)

9.1.3 .1 Using IPA and lint free cloth, clean the wire path at least once a month.

9.1.4 Wire clamp cleaning(Monthly basis)

9.1.4.1 Open the wire clamp then insert a lint free paper strip wet with IPA.

9.1.4.2 Close the wire clamp and gently move the lint free paper / lapping paper up and down to clean.

9.1.5 Gold wire change procedure and storing:

9.1.5.1 Check the correctness of gold wire spool.

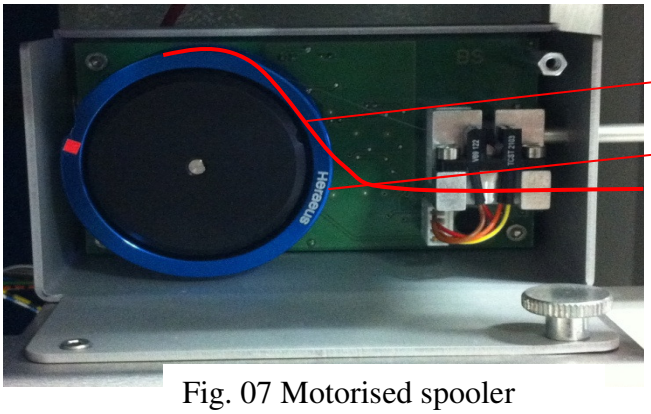


Fig. 07 Motorised spooler

Fig. 08 wire path

9.1.5.2 Read the label on the wire spool, the wire part number, wire size and the "start wire" sticker color.

9.1.5.3 Gently remove the wire cover on a flat surface and remove carefully the wire spool. Refer to attachment below.

9.1.5.4 Ensure that there are two stickers on the wire spool before removing the "start wire" sticker using a tweezer.

9.1.5.5 Mount the wire spool on the spool holder and start threading the wire.

*Note : Use the wand to draw the wire into the glass tube

9.1.5.6 The used Bonding Wires always have to be stored in a desecrator without fail.

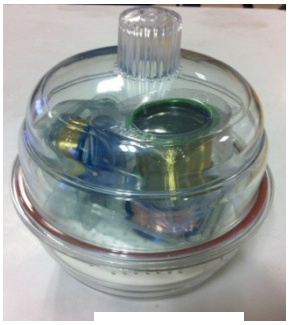


Fig. 09

9.1.6 Wire bonding procedure

9.1.6.1 Select Manual mode and Ball Bond/Wedge Bond/Ball Bump option as required.

9.1.6.2 Adjust the job holder fixture such that it holds the substrate firmly.

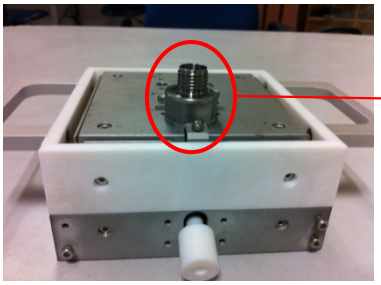


Fig. 10

9.1.6.3 Focus the microscope such that the device is clearly visible.

9.1.6.4 Select height set-up and point to first and second bond.

9.1.6.5 Use 'Z' axis control and maneuver using the X-Y axis control to find the first bond and touch down the 'Z' to bond the first bond, similarly reach to the second bond and touch down the tool using the 'Z' to complete the second bond.

9.1.6.6 The above procedure is repeated for other bonds.

9.1.6.7 Bond parameters for first and second bond are optimized accordingly.

Parameter	Bond 1	Bond 2
Ultrasonic (mW)	0-2000	0-2000
Time (ms)	15-1500	15-1500
Force (mN)	15-2000	15-2000

Table - 08

9.1.6.8 Bondability Matrix

Bond pad Material	Type of wire	Type of bond
Chrome Gold	Au	Ball
Chrome Gold	Al	Wedge
Platinum	Al	Wedge
Aluminum	Al	Wedge
Copper	Au	Ball

Table - 09

8.1.4 Select the right size of Clamping for the Job, so that the substrate is firmly held on to the clamper.

8.1.10.9 Heater block temperature Specification:

PACKAGE	BOND TEMP
Ball Bonding Au wire	120 +/- 5 C
Al wedge	NA

Table - 10

9.1.7 Wirebond quality testing

Wire pull procedure

9.1.7.1 Check the wirepull hook, for any damages. Faulty readings will be obtained if damage hooks are used.

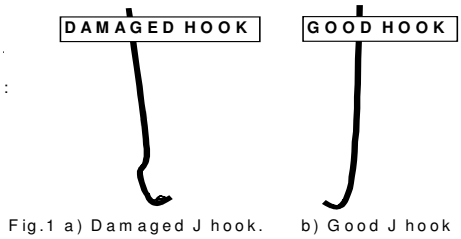


Fig. 11

9.1.7.2 Hook placement during Wirepull measurement:

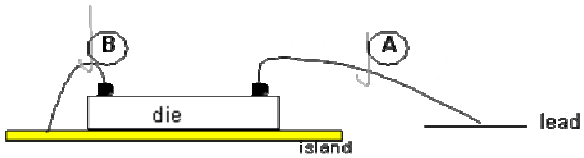


Fig.12

9.1.7.3 Wirepull instrument set up during wirepull measurement:

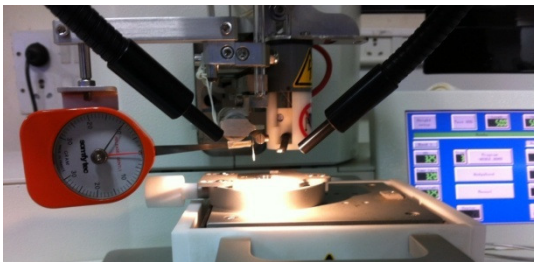


Fig.13

9.1.7.4 Minimum Wirepull measurement requirement is 7 gm

9.1.8 Visual Inspection Procedure

9.1.8.1 Follow below inspection procedure to ensure defect will be captured during the monitoring.

9.1.8.1 Bonded ball inspection - Inspect for NSOP, Aluminum peel, bond placement, ball short, golf ball, undersized ball, etc.

9.1.8.2 Wedge bond inspection - Inspect for NSOL, edge bond, wedge bond size, etc.

9.1.8.3 Die / Die attach related defect - Inspect for epoxy on die, epoxy on lead, insufficient epoxy, chip out, die scratch etc.

9.1.8.2 Magnification of 10X-30X to be used, for visual inspection under low power scope or machine monitor.

9.1.8.3 If found marginal defects under low power scope and cannot clearly differentiate good or rejects, verify under high power scope.

9.1.9 Visual Inspection Criteria

9.1.9.1 Non Stick On Pad (NSOP) - Reject if ball fails to stick on the pad.

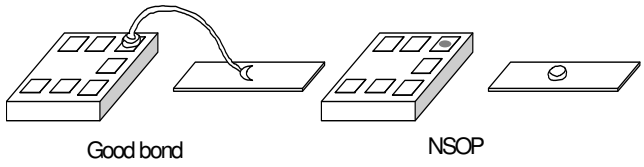


Fig 14

9.1.9.2 Non Stick On Lead (NSOL) - Reject if wedge fails to stick on the ring / bondfinger.

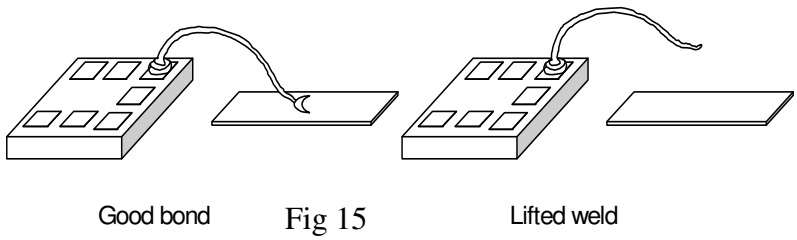


Fig 15

9.1.9.3 Aluminum peel -Reject if there is any bond pad with aluminum peel.

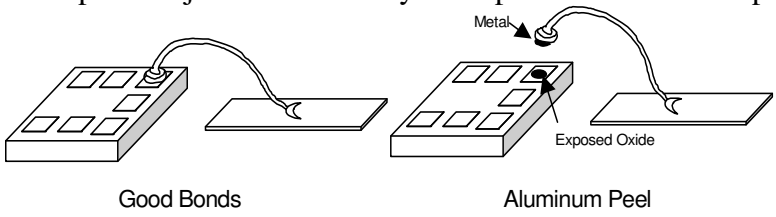
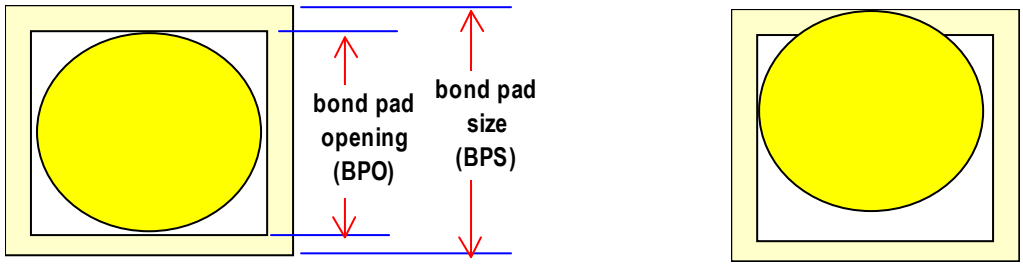


Fig. 16

9.1.9.4 Bond placement

8.1.17.4.1 The ball has to be inside the BPO.

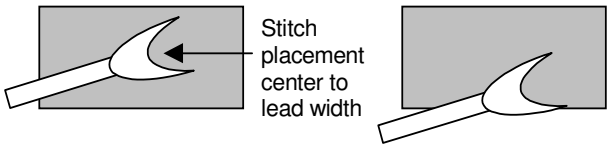


Accept Reject

Fig. 17

9.1.9.5 Ball short - Reject if there is any bridging of ball with adjacent pads. Need to use high power scope, > 75x mag, for ball short inspection on bond pad pitch equal to or less than 55um.

9.1.9.6 Edge bond - Reject if wedge is not 100% inside the lead.



Good stitch Shutdown the machine

Fig. 18

9.1.9.7 Wireshort

9.1.9.1 Wire to wire short - Rework if wire is shorting to another wire.

9.1.9.2 Wire to die edge short - Rework and put masking tape if distance between wire is shorting to die edge.

10.0 RESPONSIBILITIES

Name specific job titles of those who are responsible for the procedure once effective.

9.1 It is the responsibility of the machine owner to

9.1.1 Maintain the health of the equipment.

9.1.2 Perform daily, weekly and monthly maintenance.

11.0 SYSTEM FLOW CHART

Display system flow graphically to allow user enhanced visibility and understanding of the process (es) within.

NA

12.0 RECORD RETENTION

The specification generated is a Live document for continuous updating.

NA

13.0 APPENDIX

Add as attachment related form, parameter, drawing, diagram, etc, Reference in particular to a specific device.

CENSE/NPMA30/LTE400PKG Wirebonding Process Control Specification – MEMS 400 bar Pressure sensor

13.1 Pressure sensor Wirebonding

13.1.1 400 Bar pressure sensor

13.1.1 Machine used: TPT HB16

13.1.2 Tool wedge tool

Vendor	Tool Specification	Wire Material & Size	Tool length
Gaiser	4445-2530-3/4	Al 33 µ	19 mm

Table - 11

13.1.3 Bonding wire Al 33 microns

Vendor	Tool Specification	Wire dia
Heraeus	ALW 29S	Al 33 µ

Table - 12

13.1.4 Header clamping procedure, as shown in the picture below.

13.1.1.4.1Header assembly drawing no: MAT-13-10-00-308A

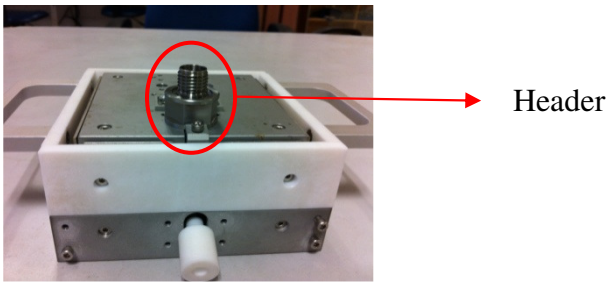


Fig. 19

13.1.5 Optimized First and second bond parameters.

13.1.6 Wire pull minimum requirement 8-10 gm

Parameter	Bond 1(Die)	Bond 2 (LTE Header)
Ultrasonic (mW)	320	455
Time (ms)	350	350
Force (mN)	325	440

Table - 13

13.2 PMUT (Meera) Wirebonding

13.2.1 400 Bar pressure sensor

13.2.1 Machine used: TPT HB16

13.2.2 Tool wedge tool

Vendor	Tool Specification	Wire Material & Size	Tool length
Gaiser	4445-2530-3/4	Al 33 µ	19 mm

Table - 14

13.2.3 Bonding wire Al 33 microns

Vendor	Tool Specification	Wire dia
Heraeus	ALW 29S	Al 33 µ

Table - 15

13.2.4 Header clamping procedure, as shown in the picture below.

13.2.1.4.1Header assembly drawing no: MAT-13-10-00-308A

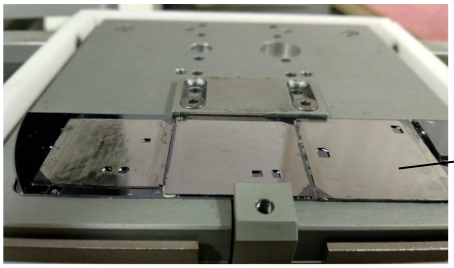


Fig. 20

13.2.5 Optimized First and second bond parameters, with Pt metallization of thickness 130nm. Bonding to be done as daisy chain bonding to connect each segment of the individual die.

Parameter	Bond 1(Die)	Bond 2 (PCB)
Ultrasonic (mW)	315	308
Time (ms)	250	250
Force (mN)	312	310

Table-16