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PIND Task Group Report Longer Shock Pulse Width Study

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September 14, 2021

1. Task Group Composition
2. Metrics
3. Longer shock pulse width and MIL-STD-750 Test methods Task Group Work efforts to improve particle detection
4. Status since May 2021 JEDEC meeting
    1. PIND test samples
    2. Status of PIND testing
5. Future plans

PIND Task Group Members

- PIND Task Group Work participant members represent the manufacturers, industry, and government agencies, and international partners:
  - Manufacturers such as: Microchip, Texas Instruments, IR Hi Rel/ Infineon, VPT Components, Semicoa, Teledyne Microwave Solutions, BAE Systems, Micropac Industries Inc.
  - Industry Test Laboratories – Hi Rel Labs, ORS Labs, Golden Altos
  - Government Agencies and their contractors – NASA, NSWC Crane Division, US Air Force, US Army, Aerospace Corporation, DLA Land and Maritime,
  - International Partners – ESA, NASAM, TESAT/ DLR

Metrics

- Conducted three (3) PIND Webex/ Teleconferences since May 2021 JEDEC meeting
- Meetings held on monthly basis
- Average meeting attendance was (10).

Longer Shock Pulse Width Task

- Background of particle detection in small packages discussion in Task Group Work
- Longer shock pulse width proposal – how did we get here?
- Longer shock pulse width particle detection test plan

Longer Shock Pulse Width Task Background

- MIL-STD-750 Test Methods Task Group Work
  - Task Group evaluated PIND particle detection as follows:
  - Three MIL-PRF-19500 suppliers performed controlled PIND testing of seeded and nonseeded devices.
  - Vibration frequencies >130Hz depending on package tested
  - location of device under test on transducer/ shaker.
  - Three component suppliers PIND tested a mix of UB, TO-18, TO-39, LCC-18, SMD-0.5, and TO-254 packages

Longer Shock Pulse Width Task Background

- Performed PIND at 130hz, 140hz, 150hz, and 200hz on 1x3 mil aluminum wire. One unit was tested 10 times in succession in the center of transducer.
  - 130hz 8/10 detect
  - 140hz 8/10 detect
  - 150hz 9/10 detect
  - 200hz 8/10 detect

Longer Shock Pulse Width Task Background

- For smaller cavity packages position on the transducer is very significant, as verified by multiple manufacturers. Smaller packages specifically need to be better centered to attain more accurate results.
  - PIND Test frequencies > 150Hz not beneficial
  - Large particles > 1mil in size more likely to be detected
  - Small packages with small particles – detection issue
  - Location of device under test affects particle detection results

Longer Shock Pulse Width Task Proposal

- Previous testing indicated need for improvements in particle detection.
- Spectral Dynamics proposed increasing shock pulse width during the May 2017 JEDEC meeting.
- Test method shock pulse width – 100µS maximum. Current shock pulse not close to maximum pulse width.
- Theory of longer shock pulse width – particle moves for a longer period of time potentially enhancing particle detection.

Longer Shock Pulse Width Task Proposal

Questions and more questions…

- How long is pulse width for one shock?
- Are equipment modifications needed?
- Is there a plan to verify this proposal?

Longer Shock Pulse Width Task Proposal Questions

- How long is pulse width for one shock currently? It depends on size of transducer/ shaker and varies between PIND equipment manufacturers.
  - Manufacturer X- 1 inch transducer/ shaker pulse width is ~ 40µS, 6-inch transducer/ shaker pulse width is ~ 100µS.
  - Manufacturer Y – pulse width is ~ 40µS, 6-inch transducer/ shaker pulse width is ~ 100µS.

Longer Shock Pulse Width Task Proposal Questions

- Are PIND equipment modifications needed for longer pulse width?
  - Yes, equipment modifications would be required on PIND test equipment at manufacturer facility.
- Is there a plan to verify this proposal?
  - A test plan has been developed and reviewed.

Longer Shock Pulse Width Task Proposal Test Plan

- Additional review of the test plan was recently completed with the following additions:
  - Sample parts are to be tested as received.
  - No pre-bake,
  - No pre-conditioning
  - No degaussing allowed
  - Deviate from the test method in that only 1 test pass will be run each day instead of maximum of 5 runs.

Longer Shock Pulse Width Task Proposal Test Plan

- Component supplier buy in – samples for testing
  - Discrete and microcircuit component suppliers are providing samples
  - Various package types for testing
  - Samples consist of nonseeded, seeded, and reject devices

Longer Shock Pulse Width Task Proposal Test Plan

- Facilities supporting PIND testing initially
  - NASA MSFC,
  - NSWC Crane,
  - Spectral Dynamics – standard and longer shock pulse width, and
  - B&W Engineering standard pulse width

Longer Shock Pulse Width Task Proposal Test Plan

- PIND testing will be performed as per the test method requirements for standard pulse width.
  - STU test
  - System noise verification
  - Shock pulse characterized at each test facility
  - Package cavity height determined

Longer Shock Pulse Width Task Proposal Test Plan Cont.'d

- PIND testing will be performed as per the test method requirements for standard pulse width.
  - Device serialization performed at Manufacturer or MSFC
  - Test frequency calculated per test method
  - Standard device handling precautions will be required.
  - Test samples are combination of seeded, non seeded, and PIND rejects
  - Characterize PIND test equipment to verify detection capability per package style

Longer Shock Pulse Width Task Proposal Test Plan Cont.'d

- PIND testing will be performed as per the test method requirements for standard pulse width.
  - Sample devices PIND testing on first day and record test results.
  - Test again on second day and record test results.
  - Package parts and ship to next test facility. Data recorded to be sent to MSFC.
  - Spectral Dynamics will test parts using standard PIND tester and record results

Longer Shock Pulse Width Task Proposal Test Plan Cont.'d

- PIND testing will be performed as per the test method requirements for standard pulse width.
  - Spectral Dynamics will test parts one time each day for 2 consecutive days using longer shock pulse and record results. Data sent to MSFC for compilation.
  - Spectral Dynamics to ship parts to B&W Engineering

Longer Shock Pulse Width Task Proposal Test Plan Cont.'d

- PIND testing will be performed as per the test method requirements for standard pulse width.
  - B&W Engineering to test parts using standard PIND tester and record results. Ship data and sample parts to MSFC.
  - MSFC will compile and evaluate test data. Publish test report results.

Longer Shock Pulse Width Task Proposal Test Plan Cont.'d

Test Facility Standard PIND test results												
Equipment manufacturer & model	Device part number	Package type	Serial Number	Cavity height In mils	PIND Freq (Hz)	Pulse Width in mS	Shock Pulse in g's	Vibration detection				P/F?
								Vib 1	Vib 2	Vib 3	Vib 4	

Table 1. Test facility PIND equipment setup log

Longer Shock Pulse Width Task Proposal Test Plan Cont.'d

Test Facility Standard PIND test results												
Equipment manufacturer & model	Device part number	Package type	Serial Number	Cavity height In mils	PIND Freq (Hz)	Pulse Width in mS	Shock Pulse in g's	Vibration detection				P/F?
								Vib 1	Vib 2	Vib 3	Vib 4	

Table 2. Test facility PIND detection results for standard shock pulse width (~40 µs)

Longer Shock Pulse Width Task Proposal Test Plan Cont.'d

Test Facility Longer Shock Pulse Width PIND test results												
Equipment manufacturer & model	Device part number	Package type	Serial Number	Cavity height In mils	PIND Freq (Hz)	Pulse Width in mS	Shock Pulse in g's	Vibration detection				P/ F?
								Vib1	Vib 2	Vib 3	Vib 4	

Table 3. Test facility PIND detection results for longer shock pulse width (~100μs)

Longer Shock Pulse Width Task Proposal Test Plan Cont.'d

Package type	quantity
121 Pin PGA part	2
8 pin CerDip part	2
8 pin Side Braze	2
20 pin LCC part	2
31 PGA part	1
32 CQFP	2
TO-5, 4LD Part	2
14 FP part	2
7-pin flatpack	3
16 pin flatpack	2
8 pin side braze	2
20 pin side braze	2
16 pin flatpack	1
DO-13	5
TO-18	5
UB	4
UA	4
TO-39	3
TO-254	20
U3	20
UB	12
UMC	3
Total Parts	101

Table 4. PIND test samples

Longer Shock Pulse Width Task Proposal Test Plan Cont.'d

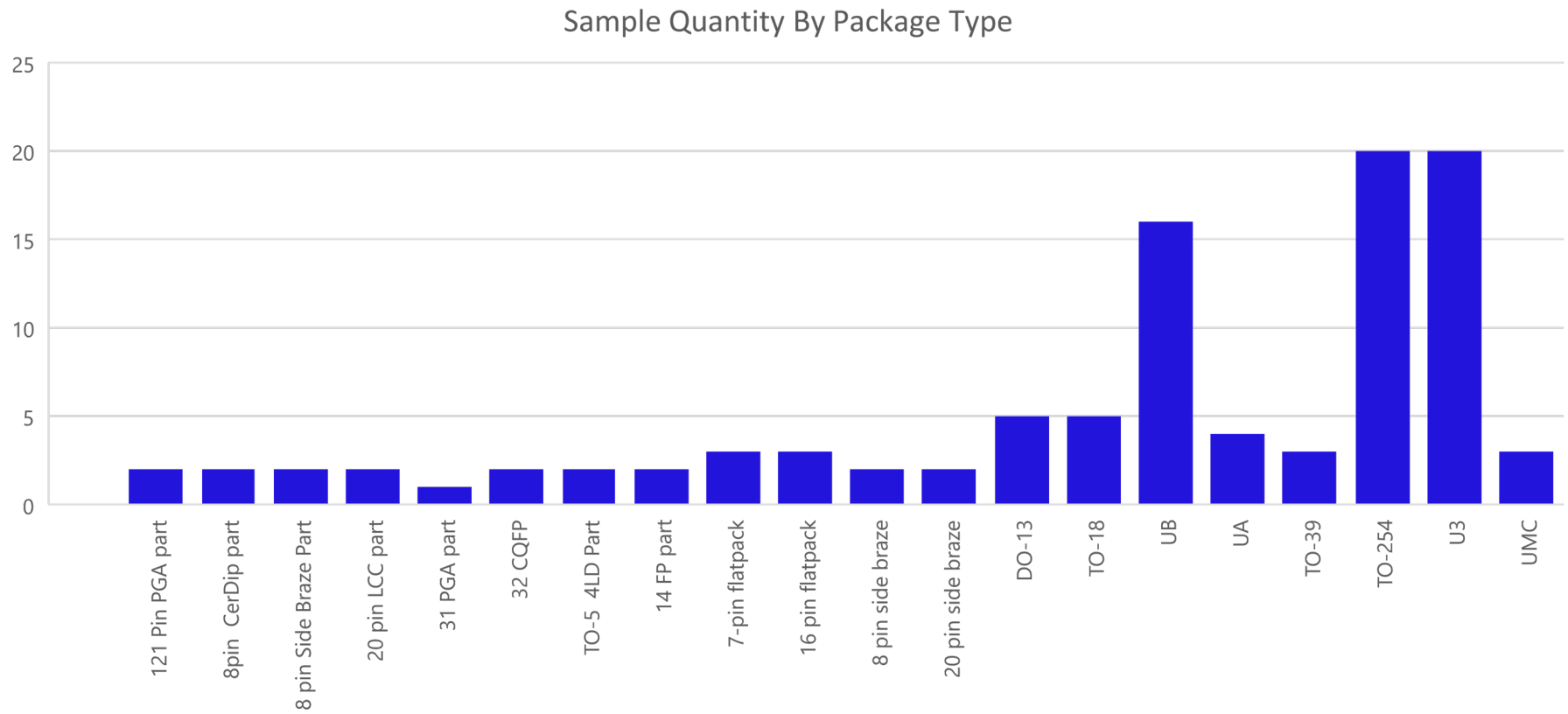


Chart 1. Sample quantity by package type

Longer Shock Pulse Width Task Proposal Test Plan Cont.'d

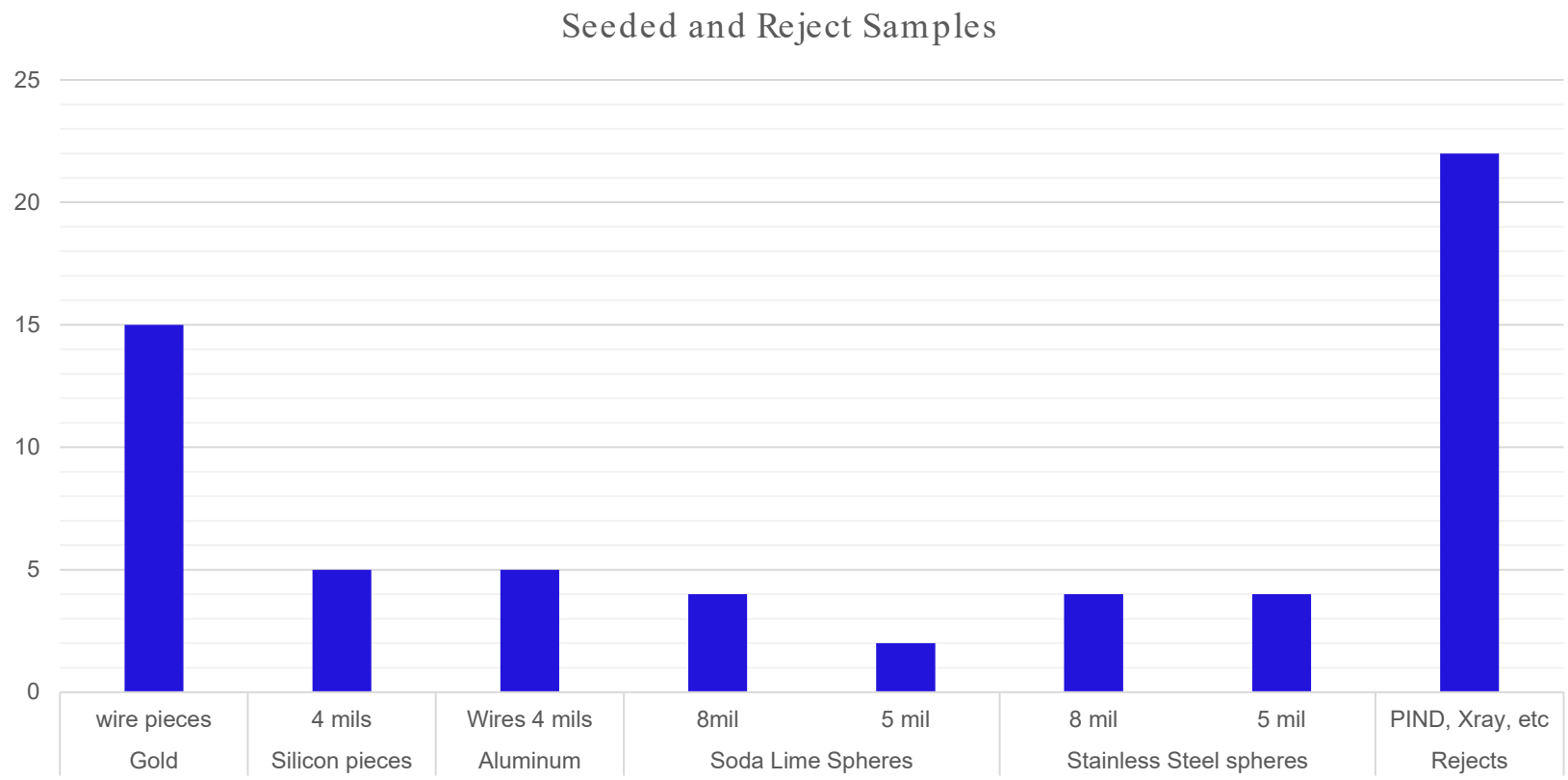


Chart 2. Particle composition

Longer Shock Pulse Width Task Proposal Test Plan Cont.'d

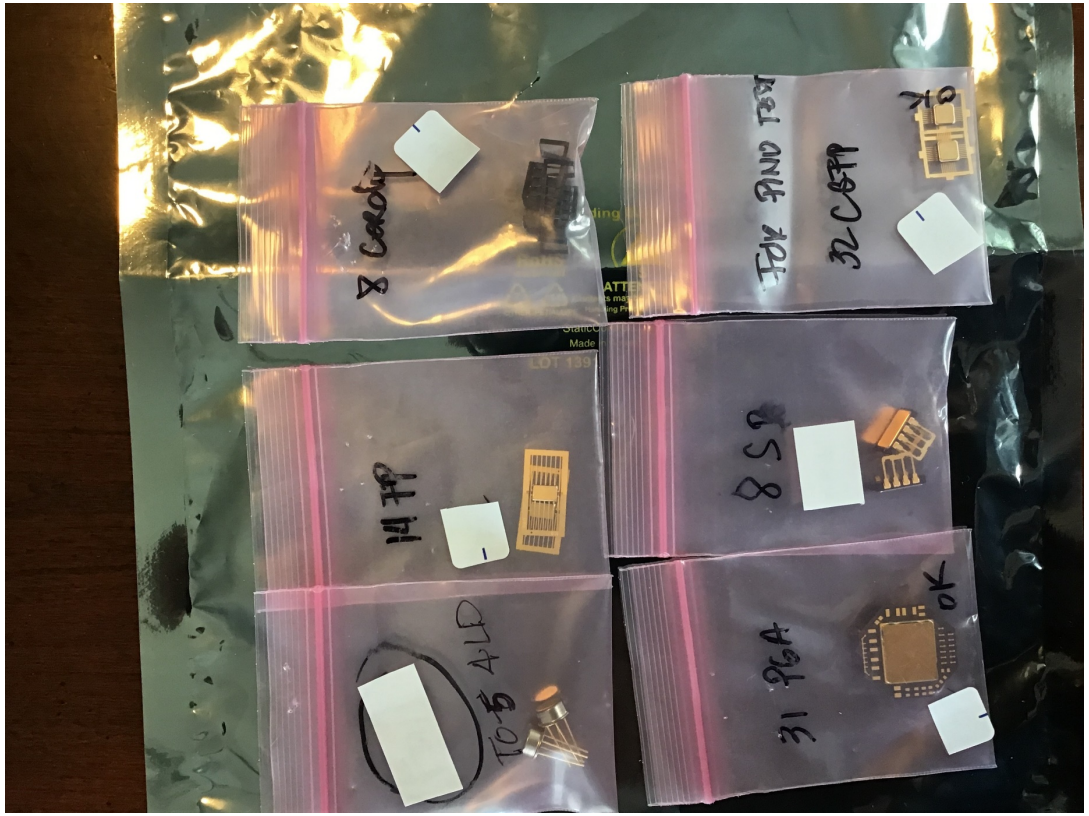


Figure 1. PIND test samples

Longer Shock Pulse Width Task Proposal Test Plan Cont.'d

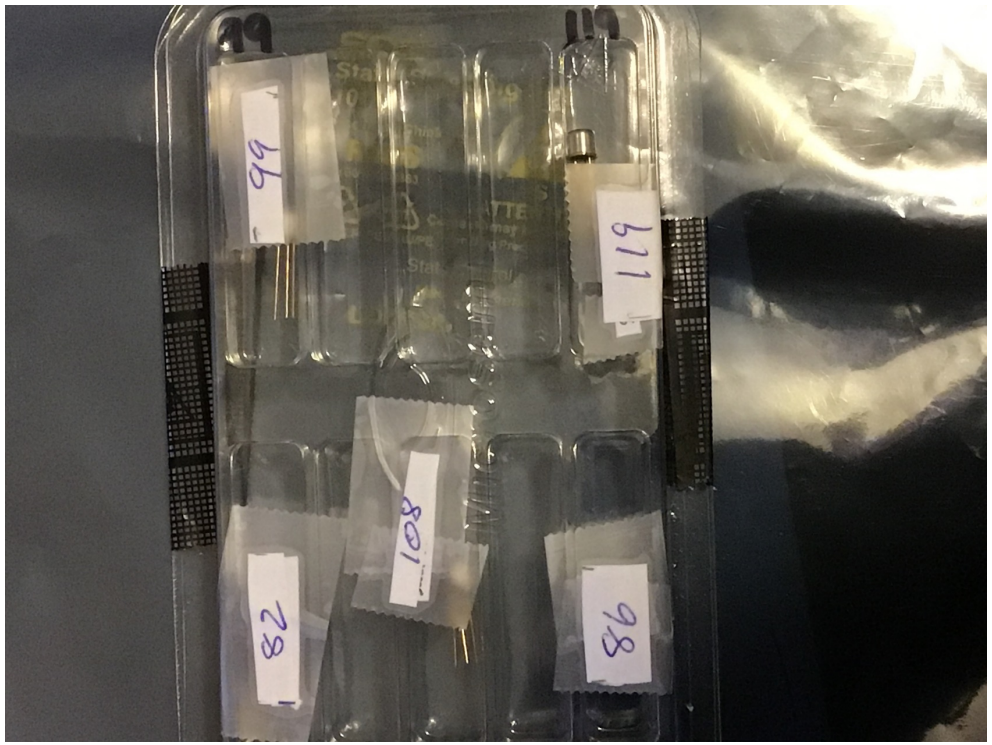
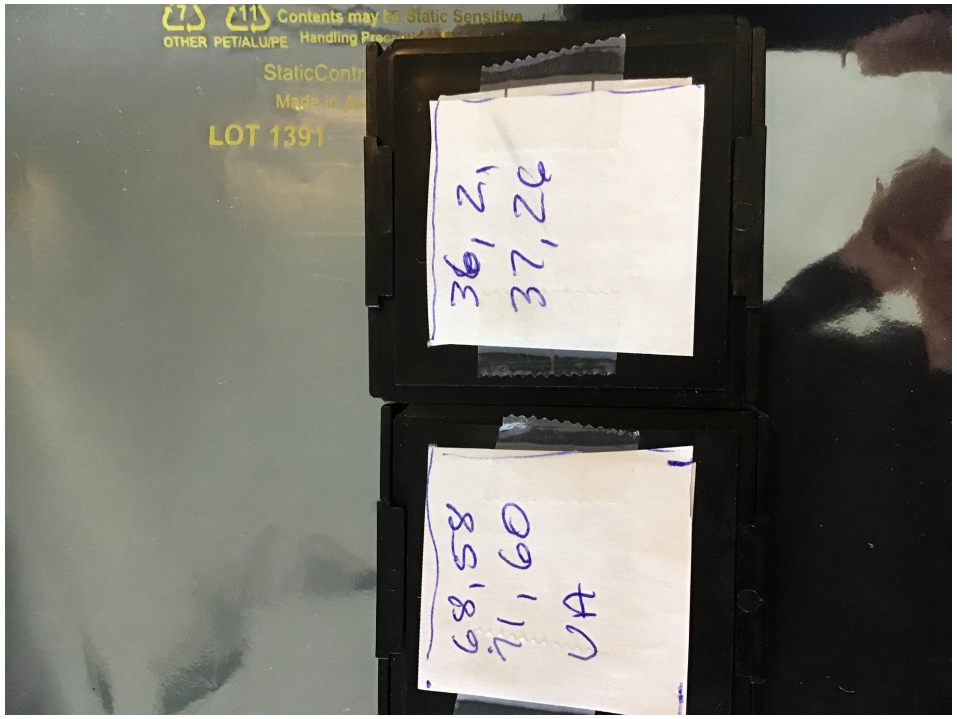


Figure 2. initial TO-39 and TO-18 PIND test samples

Longer Shock Pulse Width Task Proposal Test Plan Cont.'d



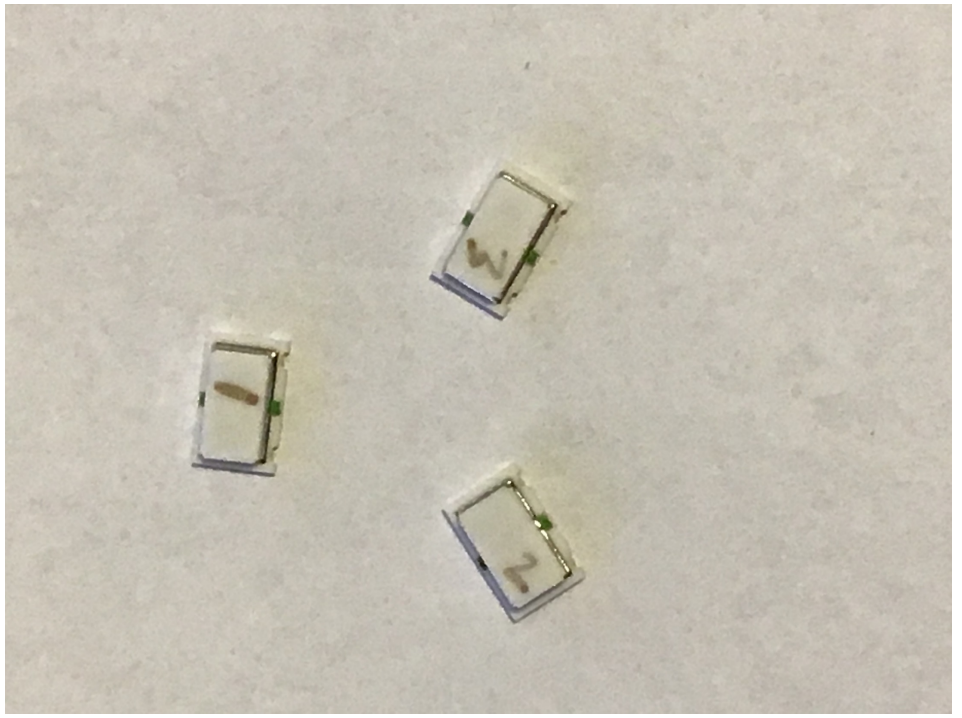
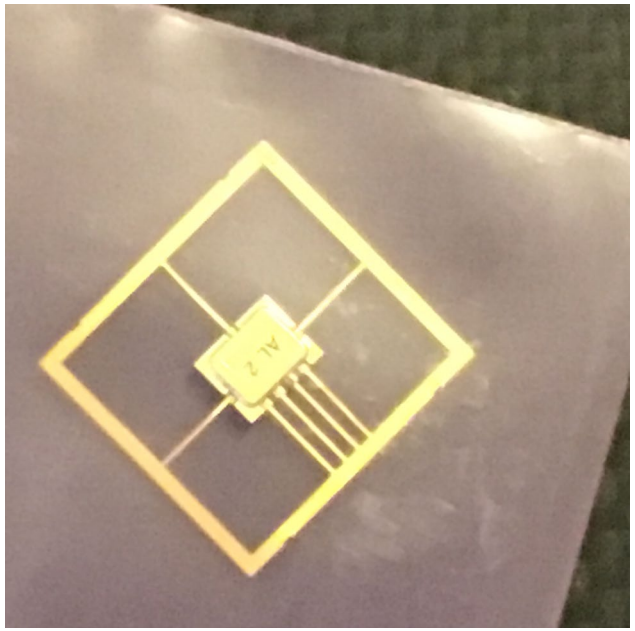


Figure 3. UA & UB, and UMC PIND test samples

Longer Shock Pulse Width Task Proposal Test Plan Cont.'d



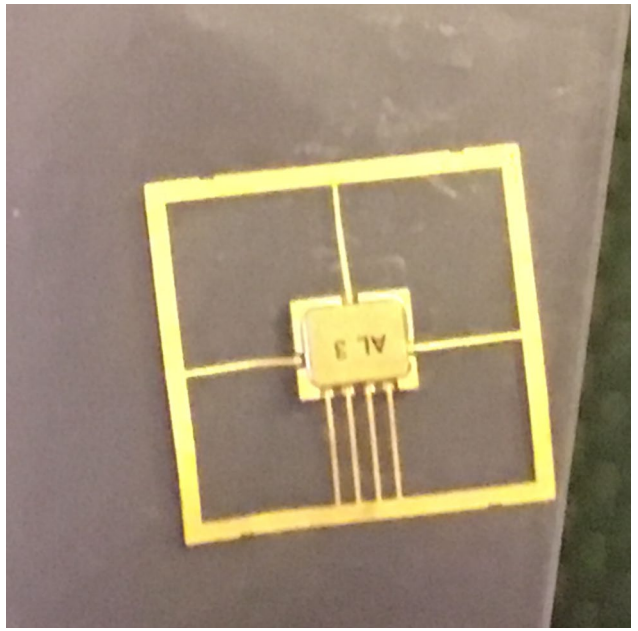
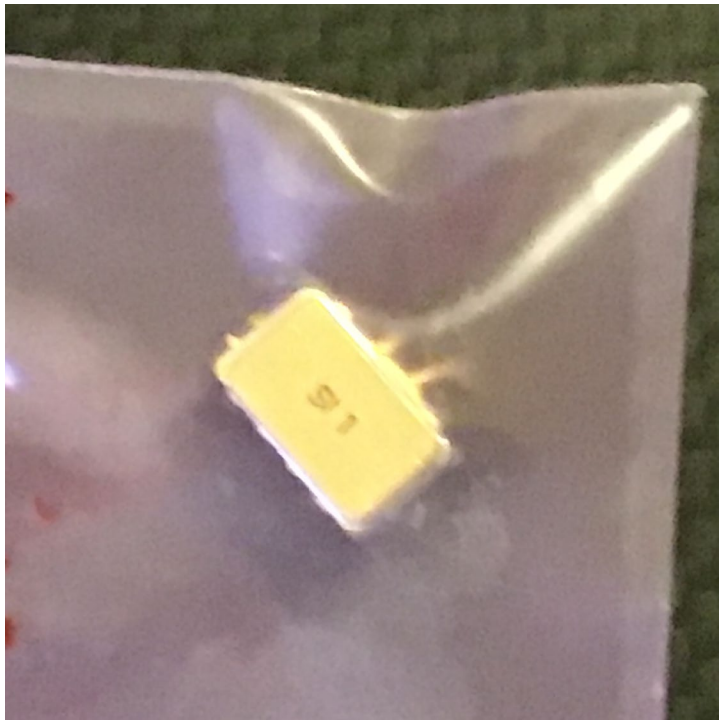


Figure 4. 7 pin flat pack PIND test samples

Longer Shock Pulse Width Task Proposal Test Plan Cont.'d



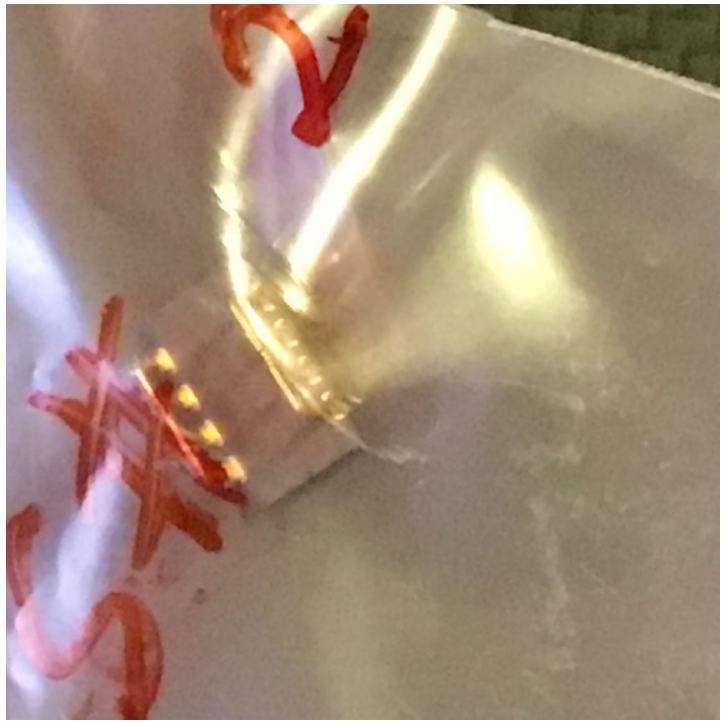
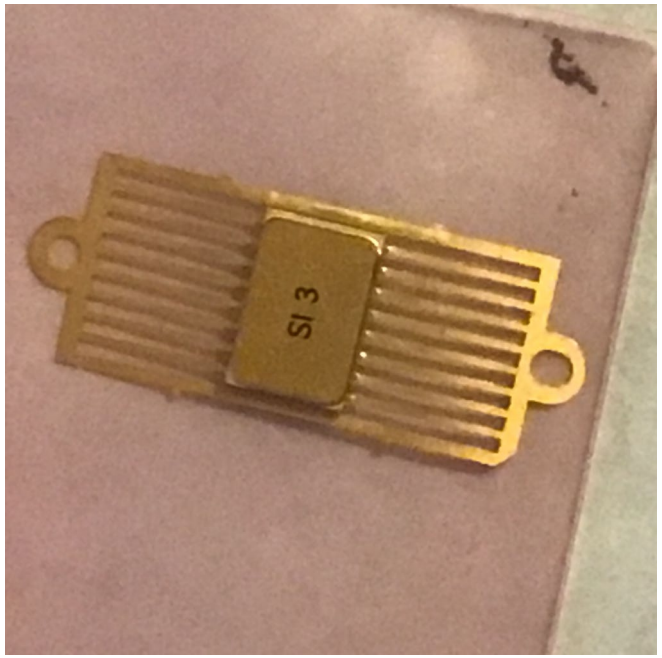
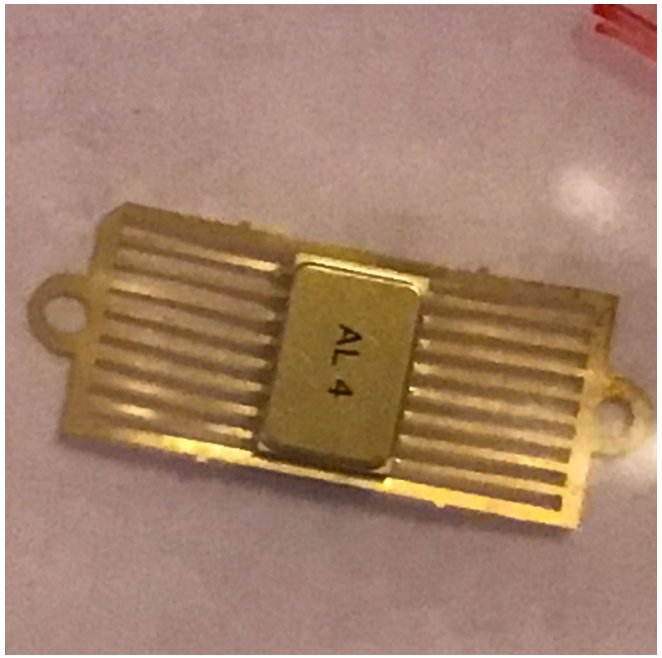


Figure 5. 8 pin Side brazed package PIND test samples

Longer Shock Pulse Width Task Proposal Test Plan Cont.'d





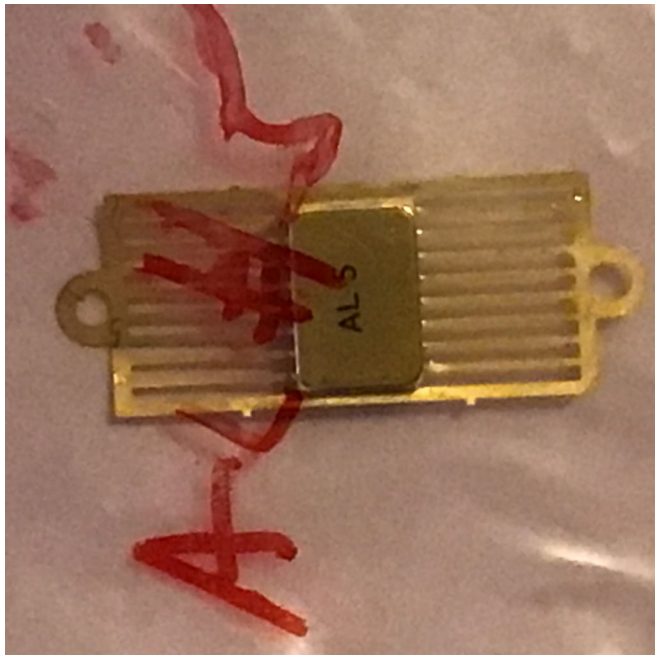
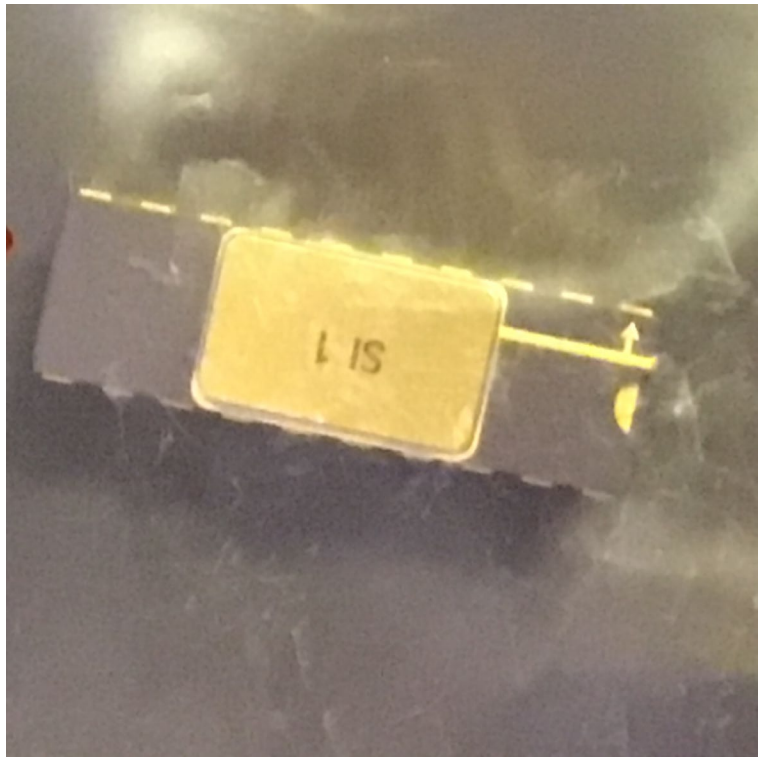


Figure 6. 16 pin flat pack PIND test samples

Longer Shock Pulse Width Task Proposal Test Plan Cont.'d



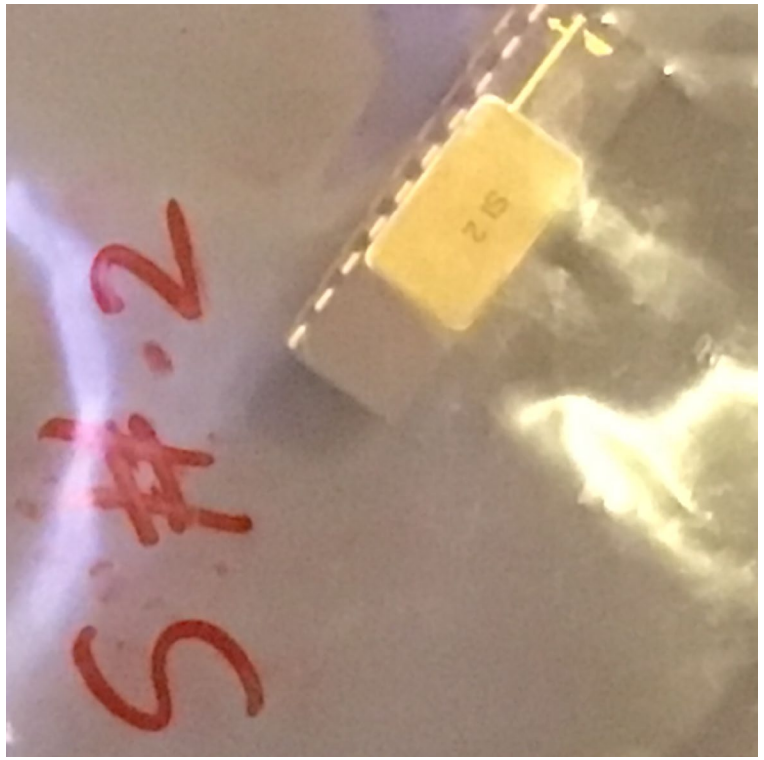


Figure 7. 20 Pin Side Braze PIND test samples

Longer Shock Pulse Width Task Proposal Test Plan Cont.'d

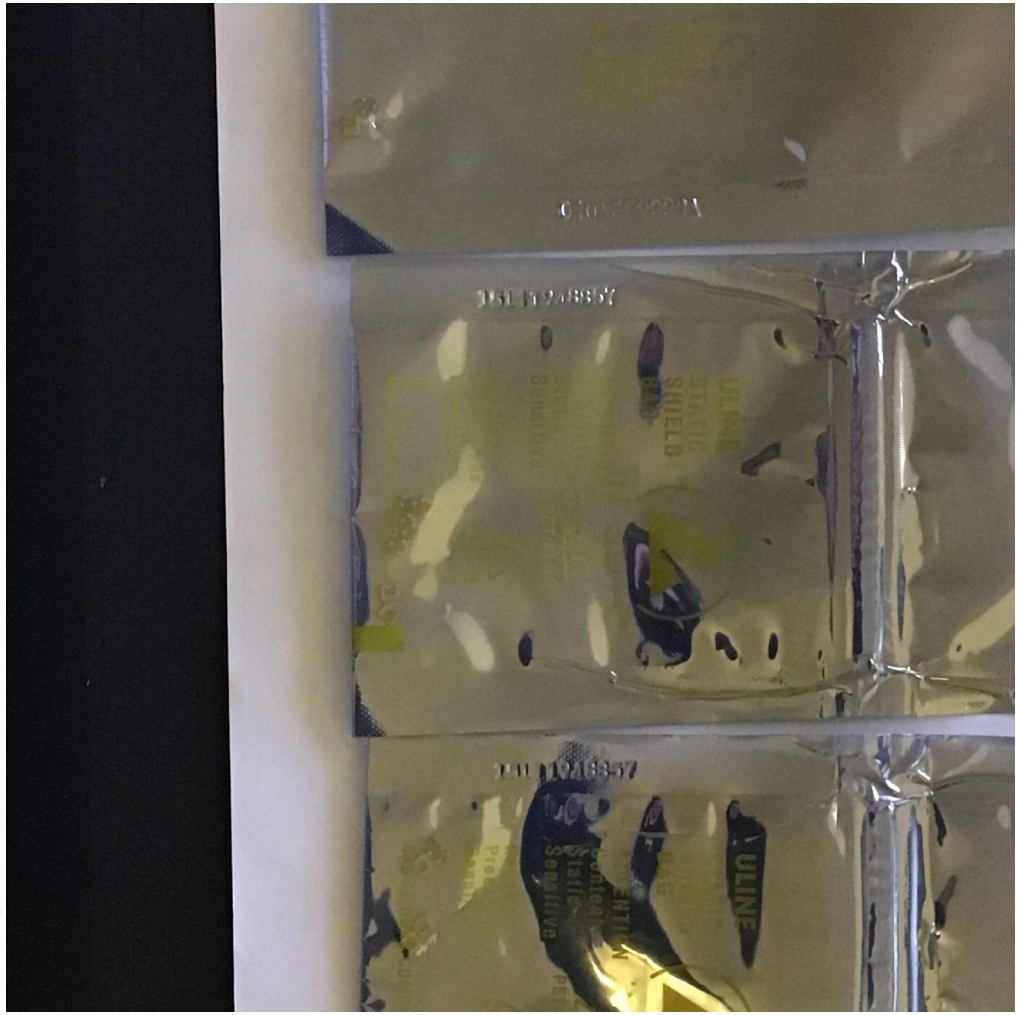


Figure 8. UB PIND test samples

Longer Shock Pulse Width Task Proposal Test Plan Cont.'d

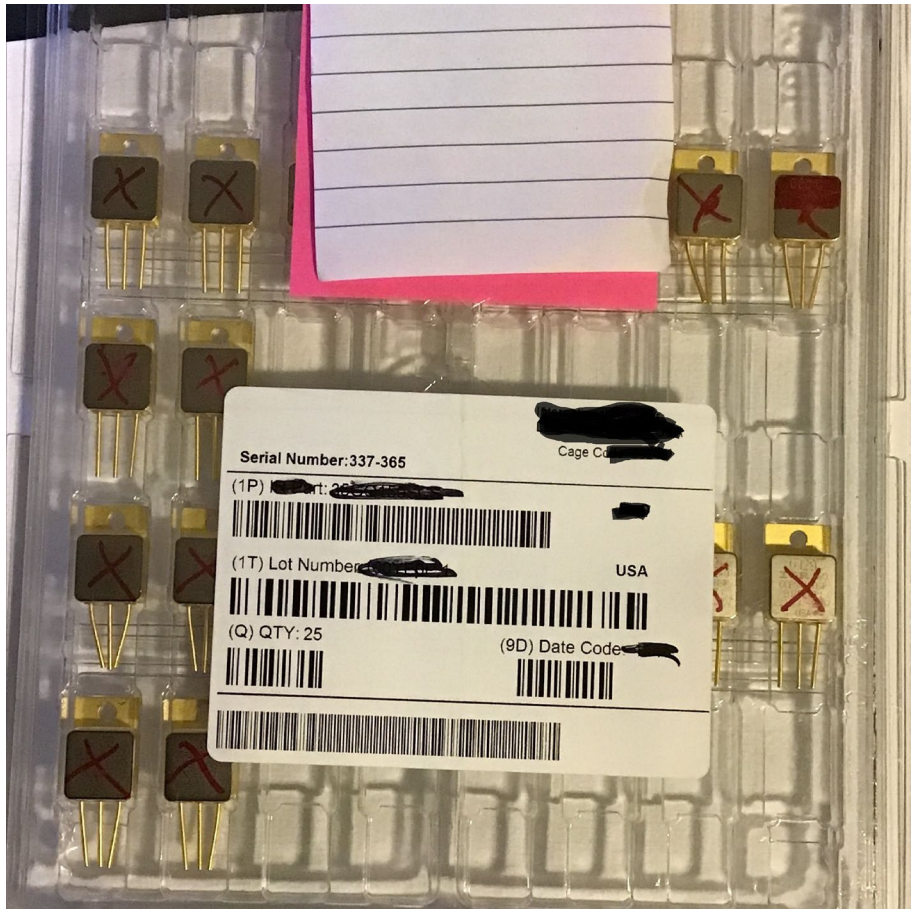


Figure 9. TO-254 and U3 PIND test samples

Longer Shock Pulse Width Task Proposal Test Plan Cont.'d

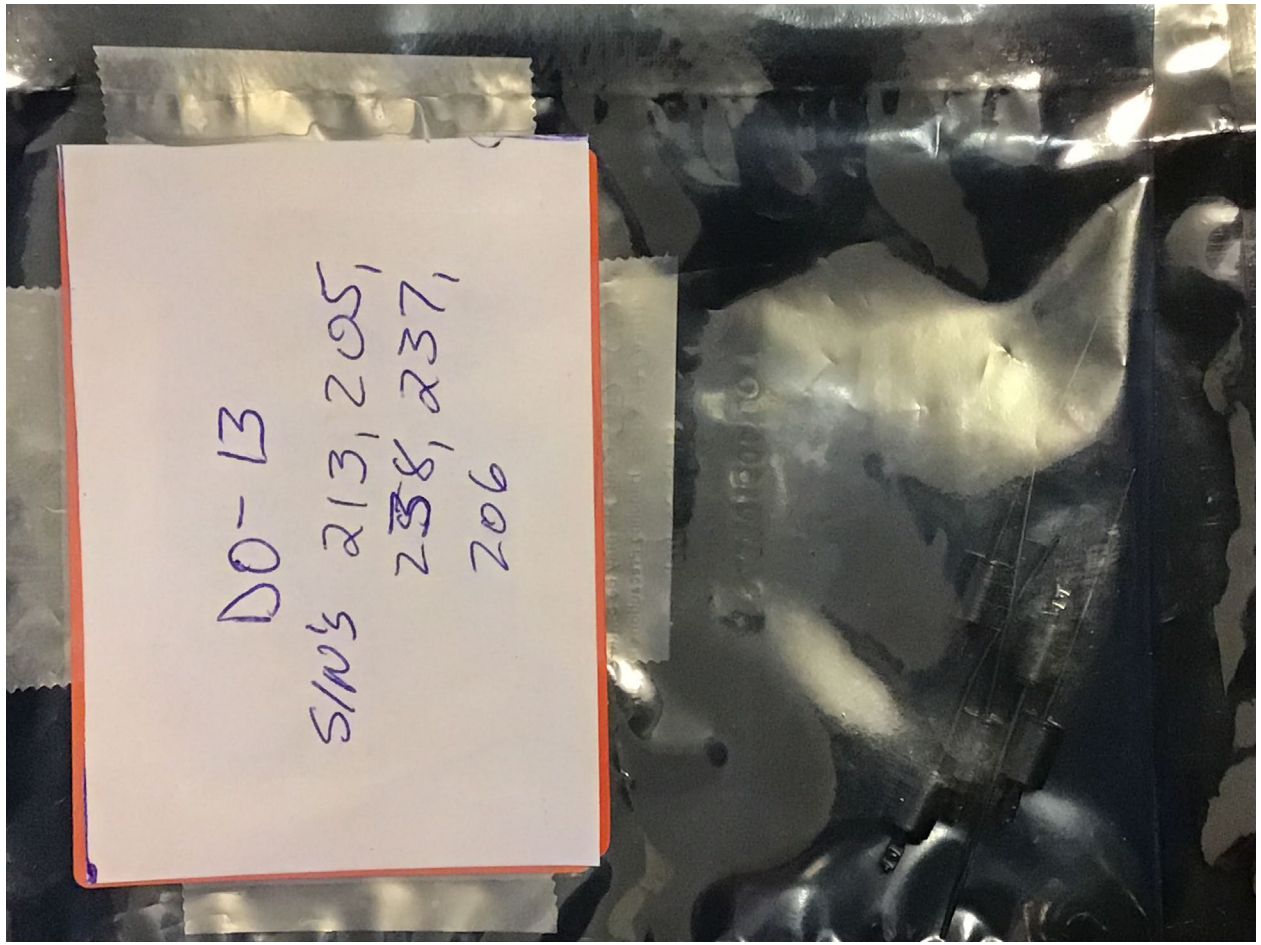


Figure 10. DO-13 PIND test samples

Longer Shock Pulse Width Task Proposal Test Status

- NASA MSFC Covid19 status is stage 2 which means this effort has been temporarily suspended, so…..,
- 39 PIND samples have been sent to NSWC Crane for the first PIND testing.
- NSWC Crane has created test travelers, determined cavity heights for the 39 devices and calculated test frequencies to use.
- Plan to send samples received since May 2021 to NSWC Crane for PIND testing.
- Still need additional samples for some package types…

Longer Shock Pulse Width Task Proposal Test Status

TRAVELER NO.	TRAVELER TEMPLATE REV.	PROGRAM	TEST TRAVELER DESCRIPTION
JDC150SPT	N/A	JEDEC PIND Test	Special PIND Test of Various Seeded Packages from Manufacturers

TEST REQUIREMENTS PLAN	TEST REQUIREMENTS PLAN REV.	DRAWING NO.	DRAWING REV.
N/A	N/A	N/A	N/A

PART TEST PROCEDURE	PARAGRAPH / APPENDIX	ESD SENSITIVE (Check all that apply)
CT Scan: OP-103-028 or OP-103-062 PIND: OP-108-002	N/A N/A	☐ YES ☑ NO ☐ CLASS 0

MANUFACTURER	PART NO.	ADD'L PROGRAM INFORMATION
Microchip Technology	PKG TYPE - DO-13	N/A

PRODUCT DESCRIPTION	MATRIX NO.	MATRIX REV.
Diode	N/A	N/A

QTY	DATE CODE(S)	SERIAL NUMBER(S)
5	N/A	205, 206, 213, 237, 238

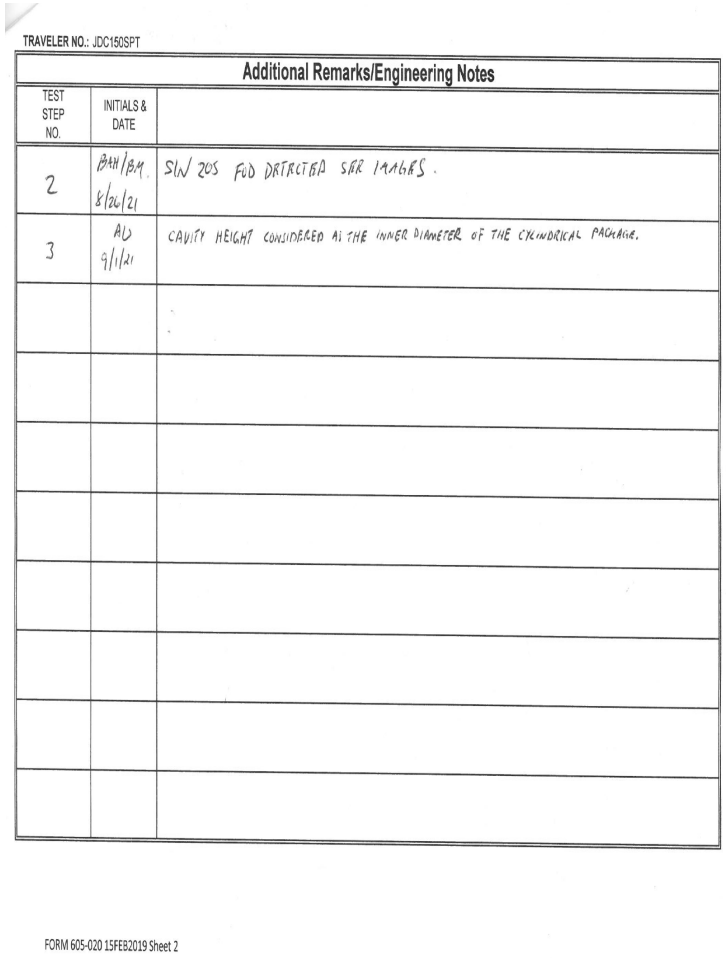
TEST STEP NO.	TEST TITLE		TEMP	% HUM	START DATE	FINISH DATE	TEST OPERATOR	TEST FAILURES
1	QA Release Parts		N/A	N/A	8/23/21	8/23/21		N/A
2	CT Scan - Measure max inner diameter of case.	Cavity Height in Inches: .1620 ~~.1904~~ AL 9/1/21	N/A	N/A	8/25/21	8/26/21	BM/BAH	N/A
3	Calculate PIND Frequency (CA Test Lead)	PIND Frequency: 49 Hz	N/A	N/A	9/1/21	9/1/21	BU	N/A
4	PIND, Run 1 - TEST PART ON SIDE	* Fill blanks in Table 1 of attached spreadsheet. * Run full test cycle (4X; 3 shock + 1 vib) * Turn off auto-stop when impact is detected. * Failure verification cycle not requied.	N/A	N/A	9.7.21	9.7.21	BF	If particle impact is detected, fill out Vibration Dectection section in Table 2 of attached spreadsheet.
5	PIND, Run 2 - Perform 24hrs after Run 1 - TEST PART ON SIDE		N/A	N/A	9.8.21	9.8.21	BF	
6	NDPA Data Review (CA Test Lead)		N/A	N/A				N/A
7	QA Verification		N/A	N/A				N/A

GXM equipment, fixtures & boards SHOULD be scanned for recording in iPDM.
Software NOT required to be scanned.

FORM 605-020 15FEB2019 Sheet 1 of 3

Table 5. PIND test traveler

Longer Shock Pulse Width Task Proposal Test Status



TRAVELER NO.: JDC150SPT

Additional Remarks/Engineering Notes

TEST STEP NO.	INITIALS & DATE	
2	BHH/BM 8/26/21	SN 205 FLD DETECTED SAR IMAGES.
3	AU 9/1/21	CAVITY HEIGHT CONSIDERED AS THE INNER DIAMETER OF THE CYLINDRICAL PACKAGE.

FORM 605-020 15FEB2019 Sheet 2

TRAVELER NO.: JDC150SPT

TEST EQUIPMENT, FIXTURES & BOARDS USED

GXM equipment, fixtures & boards SHOULD be scanned for recording in iPDM.
Software NOT required to be scanned.

TEST STEP NO.	DESCRIPTION	MANUFACTURER	MODEL OR CM IDENTIFIER	S&C NUMBER OR REVISION	CAL DUE DATE OR SERIAL NUMBER(S)

Table 6. Engineering notes and fixture forms used for standard pulse width PIND test

Longer Shock Pulse Width Task Proposal Test Status

TABLE 1. Test Facility PIND Equipment Setup Log

Test Facility NSWC Crane PIND Equipment Initial Setup

Equipment Manufacturer	Model Number	Shaker Drive System Callibrated MIL-STD-750-2 TM 2052, Para 3.2.1 (Enter each callibration date)	Visual displacement monitor utilized per MIL-STD-750-2 TM 2052, Para 3.2.1?	Initial setup System noise 20 mV or greater peak to peak detected? (Y/N)	STU test (Pass/Fail)
B&W	BW-LPD-DAQ4000	Yes Cal. Due: 11/02/2021	No	N	PASS

TABLE 2. Test Facility PIND Detection Results for Standard Shock Pulse Width (~40 µs)

Test Facility NSWC Crane Standard PIND Test Results

Equipment Manufacturer & Model & SN	Device Part Number	Package Type	Cavity Height (mils)	PIND Freq. (Hz)	Pulse Width (mS)	Shock Pulse (g)	Serial Number	Vibration Dection (Fill with "X" if particle is detected)				
									VIB1	VIB2	VIB3	VIB4
B&W BW-LPD-DAQ4000 6083	PKG TYPE - DO-13	DO-13	162	49	40	1000	205	RUN 1	X	X	X	X
								RUN 2	X	X	X	X
							206	RUN 1				
								RUN 2				
							213	RUN 1	X	X	X	X
								RUN 2	X	X	X	X
							237	RUN 1	X	X	X	X
								RUN 2	X	X	X	X
							238	RUN 1	X	X	X	X
								RUN 2	X	X	X	X

Table 7. Test Facility Equipment Setup log and PIND detection results for standard pulse width

Longer Shock Pulse Width Task Proposal Test Status

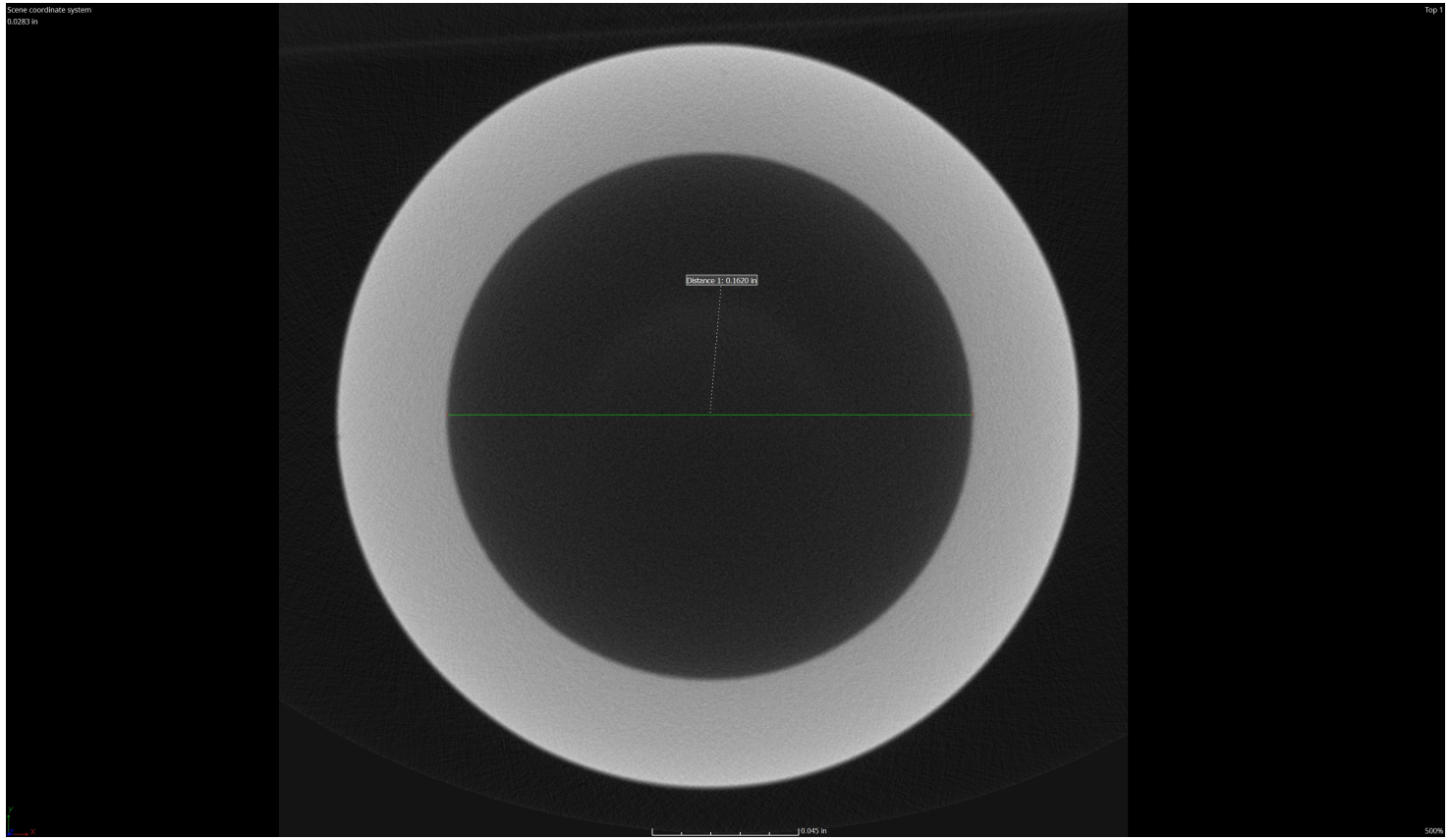


Figure 11. CT scan of DO13

Longer Shock Pulse Width Task Proposal Test Status

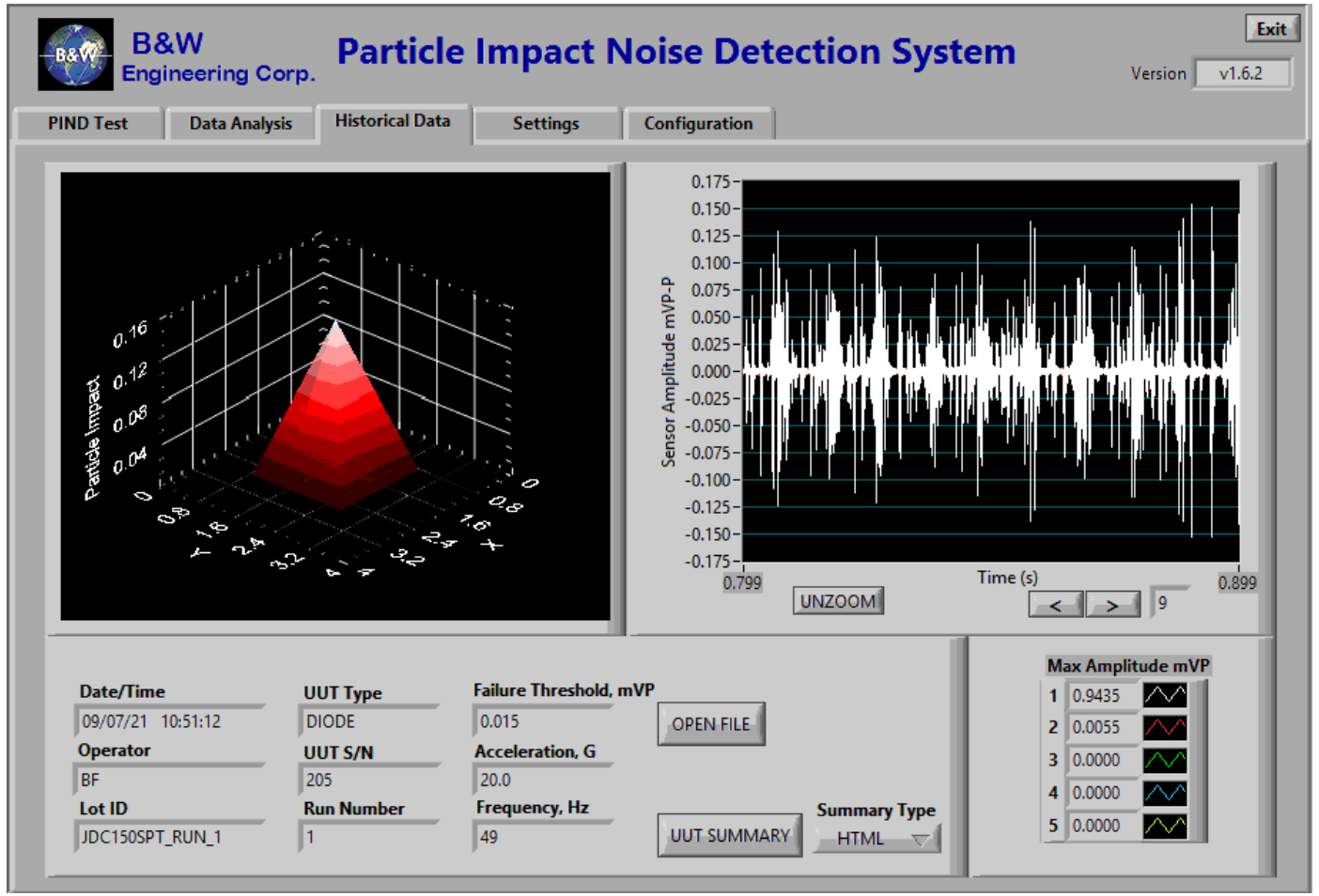


Figure 12. Captured scope data sample for run 1 of a DO13, SN205

Longer Shock Pulse Width Task Proposal Future Plans

- Continue PIND testing of samples at NSWC Crane. Then send samples to MSFC for testing.
- Will ask manufacturers for specific quantities for some of the 1- or 2-piece samples received.
- Potentially roll this task into a new task group with closure of PIND task group JC13 TG17-01.

Thank you!

- We would like to express our appreciation to the task group members, NASA NEPAG and SLS programs, Government Working Group, and TTM Technologies for their continued support of this effort.

- Contact information:

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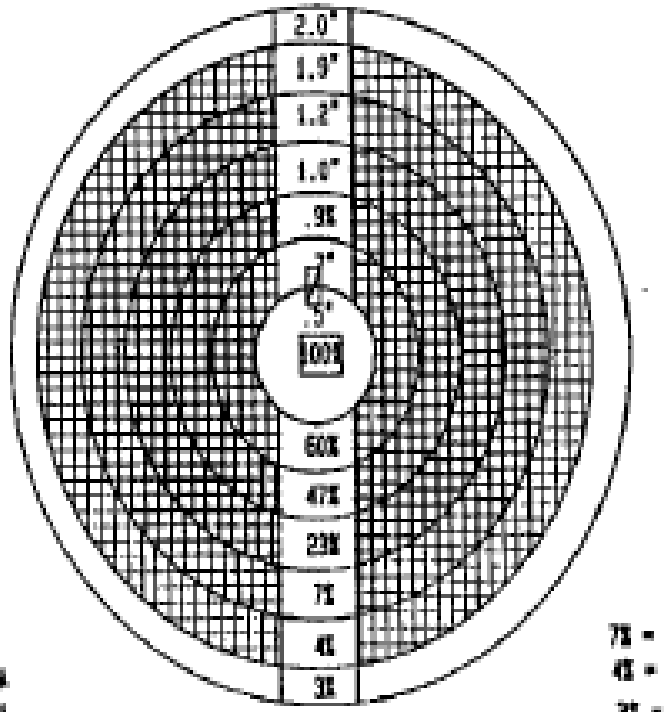
Acronyms

- DLA – Defense Logistics Agency
- DLR – German Aerospace Center
- DPA – Destructive Physical Analysis
- ESA – European Space Agency
- ESD – Electrostatic Discharge
- JEDEC – JEDEC Solid State Technology Association
- NASA – National Aeronautics and Space Administration
- MSFC- Marshall Space Flight Center
- NSWC Crane – Naval Surface Warfare Center, Crane Division
- PIND – Particle Impact Noise Detection
- STU – Sensitivity Test Unit

- Backup Data

Longer Shock Pulse Width Task Proposal

- Copy of transmissibility response of a PIND Transducer Test Platform performed by Steward J. Slykhous of Spectral Dynamics. As can seen by his evaluation the center of the transducer produces more repeatable results.



TRANSMISSIBILITY RESPONSE

100% = 0 - 0.5 IN DIA AREA
60% = 0.5 - 0.7 IN DIA AREA
47% = 0.7 - 0.9 IN DIA AREA
23% = 0.9 - 1.0 IN DIA AREA

7% = 1.0 - 1.2 IN DIA AREA
4% = 1.2 - 1.9 IN DIA AREA
3% = 1.9 - 2.0 IN DIA AREA