Reliability Report – BFR391

Silicon NPN Planar RF Transistor

MIL-PRF-38534 CLASS K QUALIFICATION DATAPACK

Performed by Tandex Test Labs

TANDEX

15849 Business Center Drive, Irwindale, CA 91706, U.S.A.
Phone (626) 962-7166, Fax (626) 960-6896
www.tandexlabs.com

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DC Static Test Results:
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- Post Acceleration at -55°C, 25°C, 125°C
- Post HTRB at -55°C, 25°C, 125°C, Delta
- Post Burn-In at -55°C, 25°C, 125°C, Delta
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Dynamic Test Results:
- Post Seal at 25°C
- Post Stabilization Bake at 25°C
- Post HTRB at 25°C
- Post Burn-In at 25°C
- Post Steady-State Life Test at 25°C

Material Analysis:
- Scanning Electron Microscopy (SEM) including WLAT

Certificate of Conformance

TANDEX TEST LABS, INC.
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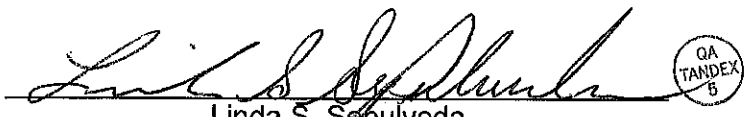
http://www.tandexlabs.com
e-mail: via web site

Certificate of Conformance

CUSTOMER:	**SILICON SUPPLIES LIMITED** **TRAFALGAR HOUSE, THARSTON INDUSTRIAL ESTATE WELLESLEY ROAD NR15 2PD UNITED KINGDOM, VAT GB#114 3513 56	** Revised Date: February 2, 2021 DATE: January 26, 2021	
TEST REPORT:	DDS-108-01-A	QUANTITY RECEIVED:	44
P.O. NUMBER:	SS550	QUANTITY REQUIRED:	22+2/10
DESCRIPTION:	NPN TRANSISTOR	QUANTITY PROCESSED:	22+2/10
PART NUMBER(S):	BFR391	QUANTITY PASSED:	22+2/10
P/N: AS RECEIVED / MFG. PART NUMBER:	BFR391	QUANTITY FAILED:	0
LOT / DATE CODE:	2032		
MANUFACTURE: CAGE CODE:	SILICON SUPPLIES **U1GU6	QUANTITY SHIPPING: *(22 +2 SPARES) (10 BOND PULL) DEVICES AND ALL SPARES	44*
TANDEX CAGE CODE:	1FE65		

METHOD OF TESTING: SOW TABLE I, MIL-PRF-38534, MIL-STD-750, 121200074 REV. B

I hereby certify that the subject components have been processed and inspected in accordance with instructions with specifications referenced in your purchase order. Physical records and/or data pertinent to applicable military, proprietary, and/or commercial specifications are on file and available upon request for inspection at this facility.



Linda S. Sepulveda
QUALITY ASSURANCE

Process Flow Chart + Mechanical Test Results

TANDEX TEST LABS INC.

QMF22B

15849 BUSINESS CENTER DRIVE, IRWINDALE, CA. 91706 PH: (626)962-7166 FAX: (626) 960-6896

PROCESS FLOW CHART

FLOW NUMBER: DDS-108-01-A REV. 0

CUSTOMER: SILICON SUPPLIES

P.O. NUMBER: SS550

PART NUMBER: BFR391

P/N AS RECEIVED: BFR391

PART TYPE: NPN TRANSISTOR

DRAWING: Statement of Work Table I, MIL-STD-750, MIL-PRF-38534, 121200074 REV. B

DUE DATE:

JOB NUMBER: DDS-108-01-A

LDC AS RECEIVED: 2032

QUANTITY RECEIVED : 100

QUOTE NUMBER: DDS15011 MFG: SILICON SUPPLIES

QUANTITY REQUIRED : 22+2/10

CAUTION: ESD REFER TO TTL DRAWING #P1025

SEQ	PROC	REF #	DESCRIPTION	QTY	REJ	ACCEPT	DATE	INSP.
01	FLO		FLOW PREPARED BY: LSS . ON: 7/04/20 . CONTRACTUAL AGREEMENT REVIEW Y / N / NOT SPECIFIED ☐ / ☑ / ☐ Q-CLAUSES ☐ / ☑ / ☐ DPAS ☐ / ☑ / ☐ DFAR ☐ / ☑ / ☐ ITAR ☐ / ☐ / ☐ OTHER _____ SPECIFIED					QA TANDEX 5
02	QCI		TANDEX QUALITY CONTROL INSPECTION. FLOW APPROVED BY: YCC . ON: 704/20 .					
03	RCV		VERIFY PART NUMBER. ENTER INTO INCOMING LOG. _X_ CUSTOMER COUNT	100			7/04/20	
04	VIS	P-1041	PERFORM 100% DIE VISUAL PER MIL-STD-750 METHOD 2072 AND MIL-PRF-38534 PARA C.3.3.2. EQUIPMENT USED:_____. ASSET #:_____.	100				
05	ASSY	P-4020	PACKAGE SUFFICIENT DEVICES FOR ELEMENT EVALUATION / ELECTRICAL AND BOND PULL PER MIL-PRF-38534 REFERENCE DIE GEOMETRY FOR ORIENTATION AND PIN – OUTS. DIE ATTACH: _____ Lot#:_____Exp. Date:_____ * **Package Type: MICRO-X** WIRE BOND: Utilize 1 Mil Au Wire (.001) 1 Mil Au bonder_____ Asset #:_____ Gold Wire: Lot#:_____Exp. Date:_____ * PERFORMED AT GOLDEN ALTOS SEE ATTACHMENT				*N/A	QA TANDEX 5
		P-4010	SCREENING BOND PULL SEM TRANSFER TO DDS-108-01-W MIL-STD-883 METHOD 2018					

 QA TANDEX 5

TANDEX TEST LABS INC.

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PROCESS FLOW CHART

FLOW NUMBER: DDS-100-01-A REV. 0

CUSTOMER: SILICON SUPPLIES

P.O. NUMBER: SS550

PART NUMBER: BFR391

P/N AS RECEIVED: BFR391

PART TYPE: NPN TRANSISTOR

DRAWING: Statement of Work Table I, MIL-STD-750, MIL-PRF-38534, 121200074 REV. B

DUE DATE:

JOB NUMBER: DDS-108-01-A

LDC AS RECEIVED: 2032

QUANTITY RECEIVED : 100

QUOTE NUMBER: DDS15011 MFG: SILICON SUPPLIES

QUANTITY REQUIRED : 22+2/10

CAUTION: ESD REFER TO TTL DRAWING #P1025

SEQ	PROC	REF	DESCRIPTION	QTY	REJ	ACCEPT	DATE	INSP.
06	VIS		PERFORM INTERNAL VISUAL INSPECTION PER MIL-STD-750 METHOD 2072 *PERFORMED AT GOLDEN ALTOS EQUIPMENT USED: _____, ASSET #: _____				*N/A	QA TANDEX 5
07	ELEC		PERFORM ELECTRICAL VERIFICATION PER MFG. DATA SHEET @ AMBIENT OPERATION TEMPERATURE. PRE SEAL +25°C POST SEAL +25°C EQUIPMENT USED: TESEC, ASSET#: 15053, TEST FIXTURE: 1471, SOFTWARE ID: BFR391 REV A, TEMPERATURE SOAK N/A SEC.	44	0	44	8/18/20	TTL29 QA TANDEX 5
08	SEL		SEAL DEVICES VACUUM BAKE: Pre Seal Bake: Temp: _____ Time: _____ Actual Time in: _____ Actual Time out: _____ Actual Temperature: _____ * PERFORMED AT GOLDEN ALTOS FURNACE LDC STAMP				*N/A	QA TANDEX 5

 QA TANDEX 5

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PROCESS FLOW CHART

FLOW NUMBER: DDS-108-01-A REV. 0

CUSTOMER: SILICON SUPPLIES

P.O. NUMBER: SS550

PART NUMBER: BFR391

P/N AS RECEIVED: BFR391

PART TYPE: NPN TRANSISTOR

DRAWING: Statement of Work Table I, MIL-STD-750, MIL-PRF-38534, 121200074 REV. B

DUE DATE:

JOB NUMBER: DDS-108-01-A

LDC AS RECEIVED: 2032

QUANTITY RECEIVED : 100

QUOTE NUMBER: DDS15011 MFG: SILICON SUPPLIES

QUANTITY REQUIRED : 22+2/10

CAUTION: ESD REFER TO TTL DRAWING #P1025

SEQ	PROC	REF #	DESCRIPTION	QTY	REJ	ACCEP	DATE	INSP.
09	SER		SERIALIZE S/N: 1-44	44	0	44	8/3/20	TTL51 QA TANDEX 5
			ESD MAT DUE DATE: 7/27/20					
10	SB		PERFORM STABILIZATION BAKE MIL-STD-750, METHOD 1032 S/N: 1-44 T = 340 HR @ t = +150°C BURN-IN BOARD # / DESC: N/A BURN-IN OVEN #: 10 #30085 , TEGAM 820A #31403	44 44	0 0	44 44	9/2/20 7:45A.M 9/16/20 1:00P.M	TTL48 TTL48 QA TANDEX 5
								DATE IN TIME IN DATE OUT TIME OUT
11	ELEC		PERFORM POST STABILIZATION AC AND DC ELECTRICAL PER SOW TABLE I WITH DWG 121200074 APPENDIX B @ AMBIENT, HIGH AND LOW OPERATING TEMPERATURES. READ AND RECORD WITH DELTAS COMPLETE WITHIN 96 HRS AFTER REMOVAL					
			ESD MAT DUE DATE: 10/27/20					
			$I_{CBO} = V_{CB}$ =5V, 1µA MAX +25°C	24	0	24	10/8/20	TTL29
			$I_{EBO} = V_{EB}$ = 1V, 1µA MAX +25°C	24	0	24	10/8/20	TTL29
			h_{FE} = V CE = 5V, IC =50mA 60 MIN, 150 MAX +25°C	24	0	24	10/8/20	TTL29
			f_r = DATA ONLY, NF = DATA ONLY, G_p = DATA ONLY +25°C	24	0	24*	10/12/20	SW
			*NF HIGH AS EXPECTED - 55°C	24	0	24	10/8/20	TTL29
			+125°	24	0	24	10/8/20	TTL29
			EQUIPMENT USED: TESEC , ASSET#: 15053 . TEST FIXTURE: 1471 . SOFTWARE ID: BFR391 REV A . TEMPERATURE SOAK 30 SEC.					QA TANDEX 5
12	TEMP		PERFORM TEMPERATURE CYCLING PER EMAIL DATED 11/25/19 MIL-STD-750 METHOD 1051 & MIL-PRF-38534 C.3.3.3. TEN (10) CYCLES t Cold = -55°C +0/-10 t Hot= +150°C +15/-0 10 MINUTES AT EXTREMES NO DWELL REQUIRED @+25°C	24 24	0 0	24 24	10/13/20 10:40A.M 10/13/20 3:20P.M	TTL48 TTL48
								DATE IN TIME IN DATE OUT TIME OUT
			EQUIPMENT USED: OYO#1 , ASSET #: 31874 . EQUIPMENT USED: , ASSET #: .					QA TANDEX 5
13	ACCE		PERFORM CONSTANT ACCELERATION PER MIL-STD-750, METHOD 2006 S/N: 5 7 8 9 10 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 29 30 Y1 DIRECTION ONLY @ 20,000 G's (min) EQUIPMENT USED: TRIO-TECH , ASSET #: 30260 .	24	0	24	10/14/20	TTL48 QA TANDEX 5

QA TANDEX 5

TANDEX TEST LABS
STAB BAKE MONITOR SHEET

JOB NUMBER DDS-108-01-A

PART NUMBER BFR391

TOTAL HRS 340 HRS

BOARD# N/A

TEMPERATURE 150°C

TEMP. METER # N/A

VOLTAGE N/A

OVEN# 10 #30085

TEMP METER TEGAM 820A # 31403

DATE	TIME	VOLTAGE	TEMP.	RH %	INITIAL/COMMENTS
9/2/2020	7:45A.M	N/A	150.9°C	N/A	ON AT 7:45 A.M TTL48
9/3/2020	8:46A.M	N/A	150.8°C	N/A	
9/4/2020	10:40A.M	N/A	150.9°C	N/A	
					WEEKEND
					WEEKEND
					HOLIDAY
9/8/2020	9:32A.M	N/A	150.6°C	N/A	
9/9/2020	11:46A.M	N/A	150.6°C	N/A	
9/10/2020	9:55A.M	N/A	150.3°C	N/A	
9/11/2020	6.35A.M	N/A	150.8°C	N/A	
					WEEKEND
					WEEKEND
9/14/2020		N/A	150.9°C	N/A	

QA TANDEX 5

TANDEX TEST LABS

STAB BAKE MONITOR SHEET

JOB NUMBER DDS-108-01-A

PART NUMBER BFR391

TOTAL HRS 340 HRS

BOARD# N/A

TEMPERATURE 150°C

TEMP. METER # N/A

VOLTAGE N/A

OVEN# 10 #30085

TEMP METER TEGAM 820A # 31403

DATE	TIME	VOLTAGE	TEMP.	RH %	INITIAL/COMMENTS
9/15/2020	9:10A.M	N/A	150.7°C	N/A	
9/16/2020	7:05A.M	N/A	150.6°C	N/A	
9/17/2020	1:00P.M	N/A	150.7°C	N/A	OUT 1:00P.M

TTL48 QA TANDEX 5

TANDEX TEST LABS INC.

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QMF22B

PROCESS FLOW CHART

FLOW NUMBER: DDS-108-01-A REV.0

CUSTOMER: SILICON SUPPLIES

P.O. NUMBER: SS550

PART NUMBER: BFR391

P/N AS RECEIVED: BFR391

PART TYPE: NPN TRANSISTOR

DRAWING: Statement of Work Table I, MIL-STD-750, MIL-PRF-38534, 121200074 REV. B

DUE DATE:

JOB NUMBER: DDS-108-01-A

LDC AS RECEIVED: 2032

QUANTITY RECEIVED : 100

QUOTE NUMBER: DDS15011 MFG: SILICON SUPPLIES

QUANTITY REQUIRED : 22+2/10

CAUTION: ESD REFER TO TTL DRAWING #P1025

SEQ	PROC	REF #	DESCRIPTION		QTY	REJ	ACCEP	DATE	INSP.
14	ELEC		PERFORM 100% ELECTRICAL VERIFICATION PER DWG 121200072 APPENDEX B AND MIL-PRF-38534 C.3.3.4.3 @ AMBIENT , HIGH AND LOW OPERATING TEMPERATURES. READ AND RECORD.						
	ESD MAT DUE DATE: 10/27/20.		STATIC AND FUNCTIONAL TESTS	+25°C	24	0	24	10/14/20	TTL29
				- 55°C	24	0	24	10/14/20	TTL29
				+125°C	24	0	24	10/14/20	TTL29
			EQUIPMENT USED: TESEC , ASSET#: 15053 .						
			TEST FIXTURE: 1471 .						
			SOFTWARE ID: BFR391 REV A .						QA TANDEX 5
			TEMPERATURE SOAK 30 SEC.						
15	HTRB		PERFORM HIGH TEMPERATURE RETURN BIAS BURN IN PER BURN IN CIRCUIT PER FIGURE 1 AND MIL-STD-750, METHOD 1039 COND. A						
	ESD MAT DUE DATE: 10/27/20.		V_{CB} = 6.4V TA = 150°C (min) T = 48 HRS (min)	DATE IN: TIME IN:	24	0	24	10/19/20 0930	TTL29
				DATE OUT: TIME OUT:	24	0	24	10/22/20 0630	TTL29
			BURN-IN BOARD # / DESC: 25C3356 HTRB BOARD .						QA TANDEX 5
			BURN-IN OVEN #: 31841 .						
16	ELEC		PERFORM POST HTRB ELECTRICAL VERIFICATION PER SOW TABLE I IN ACCORDANCE WITH DWG 121200072 APPENDIX B @ AMBIENT, HIGH AND LOW OPERATING TEMPERATURES. READ AND RECORD WITH DELTAS						
			COMPLETE WITHIN 16 HRS AFTER REMOVAL						
	ESD MAT DUE DATE: 10/27/20.		I_{CBO} = V_{CB} =5V, 1μA MAX	+25°C	24	0	24	10/22/20	TTL29
			I_{EBO} = V_{EB} = 1V, 1μA MAX	+25°C	24	0	24	10/22/20	TTL29
			h_{FE} = V CE = 5V, IC =50mA 60 MIN, 150 MAX	+25°C	24	0	24	10/22/20	TTL29
			f_t = DATA ONLY, *NF = DATA ONLY G_P = DATA ONLY	+25°C	24	0	24*	10/23/20	SW
			*NF HIGH AS EXPECTED	- 55°C	24	0	24	10/23/20	TTL29
				+125°C	24	0	24	10/23/20	TTL29
			EQUIPMENT USED: TESEC , ASSET#: 15053 .						
			TEST FIXTURE: 1471 .						QA TANDEX 5
			SOFTWARE ID: BFR391 REV A .						
			TEMPERATURE SOAK 30 SEC.						

TANDEX TEST LABS
BURN - IN MONITOR SHEET

JOB NUMBER DDS-108-01A
PART NUMBER BFR391
DATE CODE NA
BURN-IN TIME 48 hrs min
ΘJC= NA

TEMPERATURE +150°C min
TEMP. METER # 31479
VOLTAGE 6.4Vdc
VOLT METER# 31367
POWER SUPPLY# 31901
BOARD# 2SC3356 HTRB Board
OVEN# 31841

DATE	TIME	VOLTAGE	CURRENT	TEMP.	INITIAL	COMMENTS
10/19/20	0930	6.4V	0	+150.5°C	BF	ON@ 0930
10/20/20	0825	6.4V	0	+150.7°C	BF	
10/21/20	—	—	—	—	—	NO measurements taken
10/22/20	0630	6.4V	0	+150.6°C	BF	off@ 0630

8 No CHANGES QA TANDEX 5

TANDEX TEST LABS INC.

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QMF22B

PROCESS FLOW CHART

FLOW NUMBER: DDS-108-01-A REV. 0

CUSTOMER: SILICON SUPPLIES

PART NUMBER: BFR391

PART TYPE: NPN TRANSISTOR

DUE DATE:

LDC AS RECEIVED: 2032

QUOTE NUMBER: DDS15011 MFG: SILICON SUPPLIES

P.O. NUMBER: SS550

P/N AS RECEIVED: BFR391

DRAWING: Statement of Work Table I, MIL-STD-750, MIL-PRF-38534, 121200074 REV. B

JOB NUMBER: DDS-108-01-A

QUANTITY RECEIVED : 100

QUANTITY REQUIRED : 22+2/10

CAUTION: ESD REFER TO TTL DRAWING #P1025

SEQ	PROC	REF #	DESCRIPTION		QTY	REJ	ACCEP	DATE	INSP.
17	BI		PERFORM BURN-IN TEST PER SOW TABLE I WITH DWG 121200074 PER-BURN-IN CIRCUIT FIG. 2 INACCORDANCE WITH MIL-STD-750, METHOD 1039, 1042 AND 1038						
			T_C = 85°C (min) T_J = 135°C T = 240HRS (min)	DATE IN: TIME IN: DATE OUT: TIME OUT:	24 24	0 0	24 24	10/30/20 1000 11/9/20 1002	SW SW
									QA TANDEX 5
			BURN-IN BOARD # / DESC: 803035 . BURN-IN OVEN #: 15 .						
18	ELEC		PERFORM POST BURN-IN ELECTRICAL PER SOW TABLE I IN ACCORDANCE WITH DWG 121200072 APPENDIX B AND MIL-PRF– 38534 C.3.3.4.3@ AMBIENT, HIGH AND LOW OPERATING TEMPERATURES. READ AND RECORD WITH DELTAS						
			COMPLETE WITHIN 16 HRS AFTER REMOVAL						
			I_{CBO} = V_{CB} =5V, 1µA MAX	+25°C	24	0	24	10/22/20	TTL29
			I_{EBO} = V_{EB} = 1V, 1µA MAX	+25°C	24	0	24	10/22/20	TTL29
			h_{FE} = V CE = 5V, IC =50mA 60 MIN, 150 MAX	+25°C	24	0	24	10/22/20	TTL29
				+25°C	24	0	24*	10/23/20	SW
			f_t = DATA ONLY, *NF = DATA ONLY G_p = DATA ONLY						
			*NF HIGH AS EXPECTED	- 55°C	24	0	24	10/23/20	TTL29
				+125°C	24	0	24	10/23/20	TTL29
			EQUIPMENT USED: TESEC . ASSET#: 15053 . TEST FIXTURE: 1471 . SOFTWARE ID: BFR391 REV A . TEMPERATURE SOAK 30 SEC.						QA TANDEX 5

ESD MAT DUE DATE: 11/27/20

QA TANDEX 5

TANDEX TEST LABS
BURN - IN MONITOR SHEET

JOB NUMBER DDS-108-01-A

PART NUMBER BFR391

DATE CODE 2032

BURN-IN TIME 240hrs min

ΘJC= _____

TEMPERATURE 125°C

TEMP. METER # 31403

VOLTAGE V1=4.65, V2=-1.3

I METER KEITHLY 2110 31878

VOLT METER# FLUKE 179 31727

POWER SUPPLY# 30807 XANTREX LXQ-20-3

BOARD# 803035

OVEN# 15

*EG 301mA / 24 DEVICES = 12.5 mA PER DEVICE 2/2/21

QA TANDEX 5

DATE	TIME	VOLTAGE	* CURRENT	TEMP.	INITIAL	COMMENTS
10/30/2020	1000	4.65 -1.32	301mA	123	[signature]	START OF B.I.
10/31/2020	—	—	—	—	—	No data taken
11/1/2020	—	—	—	—	—	No data taken
11/2/2020	0640	4.65V -1.32V	299mA	124.2°C	BF	
11/3/2020	0810	4.65V -1.32V	301mA	124.9°C	BF	
11/4/2020	0750	4.65V -1.32V	300mA	124.7°C	BF	
11/5/2020	0745	4.65V -1.32V	300mA	124.6°C	BF	
11/6/2020	0800	4.65V -1.32V	300mA	124.3°C	BF	
11/7/2020	—	—	—	—	—	No data taken
11/8/2020	—	—	—	—	—	No data taken
11/9/2020	1002	4.66 -1.32	301mA	123	[signature]	END OF B.I.

TANDEX TEST LABS INC.

QMF22B

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PROCESS FLOW CHART

FLOW NUMBER: DDS-108-01-A REV. 0

CUSTOMER: SILICON SUPPLIES

PART NUMBER: BFR391

PART TYPE: NPN TRANSISTOR

DUE DATE:

LDC AS RECEIVED: 2032

QUOTE NUMBER: DDS15011 MFG: SILICON SUPPLIES

P.O. NUMBER: SS550

P/N AS RECEIVED: BFR391

DRAWING: Statement of Work Table I, MIL-STD-750, MIL-PRF-38534, 121200074 REV. B

JOB NUMBER: DDS-108-01-A

QUANTITY RECEIVED : 100

QUANTITY REQUIRED : 22+2/10

CAUTION: ESD REFER TO TTL DRAWING #P1025

SEQ	PROC	REF #	DESCRIPTION	QTY	REJ	ACCEPT	DATE	INSP.
19	SSL		PERFORM STEADY STATE LIFE PER SOW TABLE I IN ACCORDANCE WITH MIL-STD-750, METHOD 1026, 1037, 1042 AND 1038					
			DATE IN: TIME IN:	24	0	24	11/11/20 1500	SW
			T_C = 85°C (min) T_J = 125°C T = 1000 Hrs.					
			DATE OUT: TIME OUT:	24	0	24	12/23/20 0730	TTL29
			****READ AND RECORD** **DC LEAKAGE & CAP AT THE FOLLOWING INTERVALS**					QA TANDEX 5
			****250Hrs READ & RECORD DATE: N/A .** ****500Hrs. READ & RECORD DATE: N/A .**					
			BOARD# / DESC: 803035 . OVEN # / DESC: 15 .					
20	ELEC		PERFORM POST LIFE TEST ELECTRICAL PER SOW TABLE I IN ACCORDANCE WITH DWG 121200072 APPENDIX B AND MIL-PRF-38534 C.3.3.4.3 @ AMBIENT, HIGH AND LOW OPERATING TEMPERATURES. READ AND RECORD WITH DELTAS					
			COMPLETE WITHIN 24 HRS AFTER REMOVAL					
			I_{CBO} = V_{CB} =5V, 1µA MAX +25°C	22+2	0	22+2	12/23/20	TTL29
			I_{EBO} = V_{EB} = 1V, 1µA MAX +25°C	22+2	0	22+2	12/23/20	TTL29
			h_{FE} = V CE = 5V, IC =50mA 60 MIN, 150 MAX +25°C	22+2	0	22+2	12/23/20	TTL29
			+25°C	22+2	0*	22+2	1/4/21	SW
			f_T = DATA ONLY, NF = DATA ONLY G_P = DATA ONLY					
			*NF HIGH AS EXPECTED - 55°C	22+2	0	22+2	12/23/20	TTL29
			+125°C	22+2	0	22+2	12/23/20	TTL29
			EQUIPMENT USED: TESEC , ASSET#: 15053 . TEST FIXTURE: 1103 . SOFTWARE ID: BFR391 REV A . TEMPERATURE SOAK 30 SEC.					QA TANDEX 5

ESD MAT DUE DATE: 12/22/20.

PAGE 11 PAGE REVISED PER CUSTOMER EMAIL DATED 2/1/21 QA TANDEX 5

TANDEX TEST LABS
BURN - IN MONITOR SHEET

JOB NUMBER DDS-108-01-A

PART NUMBER BFR 391

DATE CODE 2032

BURN-IN TIME 1000 HRS

ΘJC= _____

TEMPERATURE 125°C

TEMP. METER # 31403

VOLTAGE V1 = 4.65, V2 = -1.3

I meter KEITHLEY 2110 31878

VOLT METER# FLUKE 179 31727

POWER SUPPLY# XANTREX LXQ 20-3 30807

BOARD# 803035

OVEN# 15

*E.G 301mA/24 DEVICES = 12.5mA PER DEVICE 2/2/21 QA TANDEX 5

DATE	TIME	VOLTAGE	* CURRENT	TEMP. °C	INITIAL	COMMENTS
11/11/2020	1500	4.65 -1.29	301 mA	125	dw	START OF LIFE TEST
11/12/2020	0910	4.65 -1.29	300mA	125.1	BF	
11/13/2020	0800	4.65 -1.29	300mA	124.8	BF	
11/14/2020	—	—	—	—	—	No data taken
11/15/2020	—	—	—	—	—	No data taken
11/16/2020	0830	4.65 -1.29	300mA	125.2	BF	
11/17/2020	0720	4.65 -1.29	299mA	124.7	BF	
11/18/2020	0740	4.65 -1.29	299mA	125.4	BF	
11/19/2020	0900	4.65 -1.29	299mA	124.6	BF	
11/20/2020	0805	4.65 -1.29	299mA	125.1	BF	
11/21/2020	—	—	—	—	—	No data taken
11/22/2020	—	—	—	—	—	No data taken
11/23/2020	0900	4.65 -1.29	299mA	125.4	BF	

TANDEX TEST LABS
BURN - IN MONITOR SHEET

JOB NUMBER DDS-10801-A

PART NUMBER BFR391

DATE CODE 2032

BURN-IN TIME 1000 hrs

θJC= _____

TEMPERATURE +125°C

TEMP. METER # 31403

VOLTAGE V1 = 4.65, V2 = -1.3

I meter Keithley 2110 31878

VOLT METER# Fluke 179 31727
30807

POWER SUPPLY# Xantrex LXQ20-3

BOARD# 803035

OVEN# 15

*EG 301mA/24 DEVICES = 12.5mA PER DEVICE 2/2/21 QA TANDEX 5

DATE	TIME	VOLTAGE	* CURRENT	TEMP.	INITIAL	COMMENTS
11/24/20	—	—	—	—	—	No data taken
11/25/20	0930	4.65 -1.29	300mA	124.9	BF	
11/26/20	—	—	—	—	—	No data taken
11/27/20	—	—	—	—	—	No data taken
11/28/20	—	—	—	—	—	No data taken
11/29/20	—	—	—	—	—	No data taken
11/30/20	1100	4.65 -1.29	300mA	125.6	BF	
12/1/20	0650	4.65 -1.29	299mA	124.9	BF	
12/2/20	1030	4.65 -1.29	299mA	124.7	BF	
12/3/20	1120	4.64 -1.29V	300mA	127.5	BF	
12/4/20	0700	4.64 -1.29	300mA	126.0	BF	
12/5/20	—	—	—	—	—	No data taken
12/6/20	—	—	—	—	—	No data taken

TANDEX TEST LABS
BURN - IN MONITOR SHEET

JOB NUMBER DDS-108-01-A

PART NUMBER BFR391

DATE CODE 2032

BURN-IN TIME 1000 hRS

ΘJC= _____

TEMPERATURE +125°C

TEMP. METER # 31403

VOLTAGE V1=4.65, V2=-1.3

I meter Keithley 2110 31878

VOLT METER# Fluke 179 31727

30807

POWER SUPPLY# Xantrex LXQ20-3

BOARD# 803035

OVEN# 15

*EQ. 301mA / 24 DEVICES = 12.5mA PER DEVICE 2/2/21

QA TANDEX 5

DATE	TIME	VOLTAGE	* CURRENT	TEMP.	INITIAL	COMMENTS
12/7/20	0715	4.58 -1.29	300mA	125.5	BF	
12/8/2020	0730	4.60 -1.29	300mA	126.7	BF	
12/9/2020	1100	4.61 -1.29	300mA	126.4	BF	
12/10/2020	0800	4.59 -1.29	300mA	127.0	BF	
12/11/2020	1015	4.58 -1.29	300mA	126.3	BF	
12/12/2020	—	—	—	—	—	No data taken
12/13/2020	—	—	—	—	—	No data taken
12/14/2020	0705	4.57 -1.29	299mA	125.3	BF	
12/15/2020	0710	4.57 -1.29	300 mA	125.0	BF	
12/16/2020	0830	4.57 -1.29	300mA	125.2	BF	
12/17/2020	0900	4.59 -1.29	300mA	127.0	BF	
12/18/2020	0930	4.59 -1.29	301mA	127.2	BF	
12/19/2020	—	—	—	—	—	No data taken

TANDEX TEST LABS
BURN - IN MONITOR SHEET

JOB NUMBER DDS-108-01-A

PART NUMBER BFR391

DATE CODE 2032

BURN-IN TIME 1000 hrs

θJC= _____

TEMPERATURE +125°C

TEMP. METER # 31403

VOLTAGE V1 = 4.65, V2 = -1.3

I Meter Keithley 2110 31878

VOLT METER# Fluke 179 31727

POWER SUPPLY# Xantrex LXQ20-3 30807

BOARD# 803035

OVEN# 15

2/2/21 QA TANDEX 5

*E.G. 301mA/24 Devices = 12.5mA Per Device

DATE	TIME	VOLTAGE	* CURRENT	TEMP.	INITIAL	COMMENTS
12/20/2020	—	—	—	—	—	No data taken
12/21/2020	0800	4.62 -1.29	300mA	125.7	BF	
12/22/2020	0750	4.63 -1.29	300mA	126.3	BF	
12/23/2020	0725	4.63 -1.29	300mA	126.0	BF	off @ 0730

TANDEX TEST LABS INC.

QMF22B

15849 BUSINESS CENTER DRIVE, IRWINDALE, CA. 91706 PH: (626)962-7166 FAX: (626) 960-6896

PROCESS FLOW CHART

FLOW NUMBER: DDS-108-01-A REV. 0

CUSTOMER: SILICON SUPPLIES

PART NUMBER: BFR391

PART TYPE: NPN TRANSISTOR

DUE DATE:

LDC AS RECEIVED: 2032

QUOTE NUMBER: DDS15011 MFG: SILICON SUPPLIES

P.O. NUMBER: SS550

P/N AS RECEIVED: BFR391

DRAWING: Statement of Work Table I, MIL-STD-750, MIL-PRF-38534, 121200074 REV. B

JOB NUMBER: DDS-108-01-A

QUANTITY RECEIVED : 100

QUANTITY REQUIRED : 22+2/10

CAUTION: ESD REFER TO TTL DRAWING #P1025

SEQ	PROC	REF #	DESCRIPTION	QTY	REJ	ACCEPT	DATE	INSP.
21	DBP		PERFORM WIRE BOND PULL PER MIL-SOW TABLE I IN ACCORDANCE WITH MIL-STD-750 METHOD 2011, & MIL-PRF-38534 C.3.3.3, C3.3.5. STAY BAKE FOR 1 HR @ 300°C					
			IN	10	0	10	1:05P.M	
			OUT	10	0	10	2:05P.M 1/11/21	TTL48
			TEN (20) WIRES,	10	0	10	1/11/21	TTL4
			EQUIPMENT USED: DELTA DESIGN , ASSET #: 30522 , TEGAM 820A # 30403 DAGE # 30785					QA TANDEX 5
22	SEM		PULLED 8 DEVICES *NOT REQUIRED –PERFORMED BY DDS DDS-108-01-W				*N/A	QA TANDEX 5
23	QCI	P-1073	TANDEX QUALITY CONTROL INSPECTION. QCI TO VERIFY CAR IN SEQ. 01 IS COMPLIANT *(22+2) SCREENED (10) BOND PULL	44	0	*22+2 10	1/26/21	QA TANDEX 5
24	PKG		USE ORIGINAL OR TANDEX PACKAGING.	44	0	22+2 10	1/26/21	QA TANDEX 5
25	QAR	P-1213	TANDEX QUALITY ASSURANCE REVIEW. *(22) SCREENED (10) BOND PULL (12) SPARES	*44			1/26/21	QA TANDEX 5
			SHIP / BILL TO: TRAFALGAR HOUSE, THARSTON INDUSTRIAL ESTATE WELLESLEY ROAD NR15 2PD UNITED KINGDOM VAT GB#114 3513 56					

 QA TANDEX 5

TANDEX TEST LABS TTL# DDS-108-01-A
BOND PULL
BOND STRENGTH TESTING

TTL Job No.	Part Number	Part Type	Date
DDS-108-01-A	BFR391	NPN TRANSISTOR	January 11, 2021
Lot Date Code	**Sample Qty.**	**Serial Numbers**	**Test Specifications**
	10	1, 31-39	Mil-Std-883 Method 2011 *Mil-Prf-38534, C.3.3.3., C.3.3.5.
Misc.	**Qty Accept**	**Qty Reject**	**Suspect**
	5	0	0

WIRE TYPE	PACKAGE/POST	BOND TYPE
Au	Au	BALL BOND
DIE METALIZATION	**WIRE SIZE**	**MINIMUM PULL STRENGTH**
Al	0.001	*1.0 gm

S/N 1			S/N 31			S/N 32			S/N 33			S/N 34			S/N 35		
WIRE NO	FORCE	CODE	WIRE NO	FORCE	CODE	WIRE NO	FORCE	CODE	WIRE NO	FORCE	CODE	WIRE NO	FORCE	CODE	WIRE NO	FORCE	CODE
1	2.4	H	1	2.5	H	1	2.5	H	1	2.8	H	1	3.1	H	1		
2	2.5	H	2	2.0	H	2	2.7	H	2	2.2	H	2	2.7	H	2		
3			3			3			3			3			3		

S/N 36			S/N 37			S/N 38			S/N 39			S/N			S/N		
WIRE NO	FORCE	CODE	WIRE NO	FORCE	CODE	WIRE NO	FORCE	CODE	WIRE NO	FORCE	CODE	WIRE NO	FORCE	CODE	WIRE NO	FORCE	CODE
1	2.2	G	1	3.3	H	1	2.3	H	1	2.0	H	1			1		
2	2.9	H	2	2.4	H	2	2.1	H	2	3.1	H	2			2		
3			3			3			3			3			3		

CODE INDEX

A. NO BREAKS UP TO _____gms.

B. BOND LIFTS FROM DIE.

C. BOND LIFTS FROM POST.

D. WIRE BREAKS AT SUBSTRATE/HEAL.

E. BOND REMOVES UNDERLYING METALLIZATION.

F. NO CONNECTION.

G. WIRE BREAKS AT DIE/HEAL.

H. WIRE BREAKS AT POST/HEAL.

J. WIRE BREAKS AT SPAN.

X. BOND DAMAGE PRIOR TO TESTING.

TTL 4

TECHNICIAN STAMP:

17 No CHANGES

QA TANDEX 5

Golden Altos CORPORATION

402 South Hillview Drive
Milpitas, CA 95035
Tel: (408) 956-1010

ErpJobNumber:1865

Lot Traveler No:200819 {1Z113767}

Device:BFR391

ISO 9001 Certified
DLA QML Listed
DLA Commercial Lab Suitability
ITAR Registered

Lot Traveler

Customer: TANDEX TEST LABS, INC. P.O.#: 14565 Date In: 6/30/2020
NOTE: Our Lot Traveler No: 200819 corresponds to Customer Lot No: 1Z113767
Process: Assembly_AE {Commercial} Device: BFR391 Package: 4LD Date Code: 2032
Customer # 936: Customer Spec #:N/A DPAS Rating:N/A
Original Count: 50

#	INCOMING DIE INSPECTION	qty in	date/time in	rejects	qty out	date/time out	oper	QA
1.00		60	07/15/2020 10:55	0	60	07/15/2020 11:05	001512	001512

Tools *Cal Due Date: 13050 *7/19/2020
Hp-1 *N/A LP-1 *N/A
Wafer Thickness in Mils: 6_ Glassivated:_Y_ Probed:_Y_ Inked_NA
Silicon:Y__ Others:_____

Description	Part Number	Lot Number	Quantity	Comments
DICE	BFR391	1Z113767	60	W#5

RECEIVED AUG 0 6 2020

Customer: TANDEX TEST LABS, INC. P.O.#: 14565 Date In: 6/30/2020
NOTE: Our Lot Traveler No: 200819 corresponds to Customer Lot No: 1Z113767
Process: Assembly_AE {Commercial} Device: BFR391 Package: 4LD Date Code: 2032
Customer # 936: Customer Spec #:N/A DPAS Rating:N/A
Original Count: 50

#	PACKAGE / FRAME INCOMING INSPECTION:	qty in	date/time in	rejects	qty out	date/time out	oper	QA
2.00		50	07/15/2020 11:07	0	50	07/15/2020 11:17	001512	001512

Tools *Cal Due Date: 13050 *7/19/2020
Hp-1 *N/A LP-1 *N/A
PKG Cavity (mils) L1:51___ W1:51___ D1:15 L2:NA___ W2:NA___ D2:NA L3:NA___ W3:NA___ D3:NA L4:N/
IQA Number: NA____ Expiration Date: NA_____

Description	Part Number	Lot Number	Quantity	Comments
PACKAGE	P004MP070S2	0003	50	

RECEIVED AUG 0 6 2020

Customer: TANDEX TEST LABS, INC. P.O.#: 14565 Date In: 6/30/2020
NOTE: Our Lot Traveler No: 200819 corresponds to Customer Lot No: 1Z113767
Process: Assembly_AE {Commercial} Device: BFR391 Package: 4LD Date Code: 2032
Customer # 936: Customer Spec #:N/A DPAS Rating:N/A
Original Count: 50

#	LID / CAP INCOMING INSPECTION:
3.00	

qty in	date/time in	rejects	qty out	date/time out	oper	QA
50	07/15/2020 11:19	0	50	07/15/2020 11:23	001512	001512

Tools *Cal Due Date: 13050 *7/19/2020
LP-1 *N/A
Cap Cavity Dimension:NA_mils

Description	Part Number	Lot Number	Quantity	Comments
LIDS	CD-367-2-50M	101188222	50	

RECEIVED AUG 0 6 2020

Customer: TANDEX TEST LABS, INC. P.O.#: 14565 Date In: 6/30/2020
NOTE: Our Lot Traveler No: 200819 corresponds to Customer Lot No: 1Z113767
Process: Assembly_AE {Commercial} Device: BFR391 Package: 4LD Date Code: 2032
Customer # 936: Customer Spec #:N/A DPAS Rating:N/A
Original Count: 50

#	
4.00	2ND OPTICAL 100%: COMMERCIAL Magnification (50X - 75X) SEPARATE MARGINAL UNITS: TREATS AS REJECTS STOP IF YIELD <90%, QC TO INFORM CUSTOMER.

qty in	date/time in	rejects	qty out	date/time out	Oper	QA
50	07/15/2020 12:00	0	50	07/15/2020 12:18	001444	

Good	50			Edge Die	
				Ink Splater	
				Bridging Metal	
				Foreign Material	
				Blister	
				Saw Defect	
		Metal Scratches		Missing Metal	
		Metal Voids		Diffusion Fault	
		Probe Defects		Oxide Fault	
		Metal Corrosion		Others	
		Glassivation Defects		mechanical	

Tools *Cal Due Date: Hp-5 *N/A
Hp-5 *N/A

Wafer Number	2nd Opt Good Die	2nd Opt Reject Die	Excess Die	Comments
	50	0	10	

RECEIVED AUG 0 6 2020

Customer: TANDEX TEST LABS, INC. P.O.#: 14565 Date In: 6/30/2020
NOTE: Our Lot Traveler No: 200819 corresponds to Customer Lot No: 1Z113767
Process: Assembly_AE {Commercial} Device: BFR391 Package: 4LD Date Code: 2032
Customer # 936: Customer Spec #:N/A DPAS Rating:N/A
Original Count: 50

#		qty in	date/time in	rejects	qty out	date/time out	oper	QA
5.00	2ND OPTICAL QA GATE: Commercial Magnification (50X - 75X) LTPD=7, SS=32, A/R=0/1	32	07/15/2020 13:00	0	32	07/15/2020 13:10	001512	001512

Tools *Cal Due Date: Hp-1 *N/A
Hp-1 *N/A

#		qty in	date/time in	rejects	qty out	date/time out	oper	QA
6.00	DIE ATTACH: EUTECTIC 80%AU, 20%SN Temperature: 320°C to 350°C Spec: PP-31217 Rev: P	50	07/16/2020 06:50	0	50	07/16/2020 10:15	001538	001512

Tools *Cal Due Date: 002 *N/A
LP-5 *N/A
IQA Number:8090-09N Expiration Date:N/A_____

Description	Set-up Qty	Comments

RECEIVED AUG 0 6 2020

Customer: TANDEX TEST LABS, INC. P.O.#: 14565 Date In: 6/30/2020
NOTE: Our Lot Traveler No: 200819 corresponds to Customer Lot No: 1Z113767
Process: Assembly_AE {Commercial} Device: BFR391 Package: 4LD Date Code: 2032
Customer # 936: Customer Spec #:N/A DPAS Rating:N/A
Original Count: 50

#	WIREBOND & VISUAL MONITOR	qty in	date/time in	rejects	qty out	date/time out	oper	QA
7.00	WIRE TYPE: 0.7 MIL AU WIRE	50	07/30/2020 10:05	5	45	07/30/2020 11:00	001657	001512

Tools *Cal Due Date: WB-20 *N/A
LP-11 *N/A LP-11 *N/A
IQA Number:30016___ Expiration Date:10-08-20

Description	Set-up Qty	Comments

RECEIVED AUG 0 6 2020

Customer: TANDEX TEST LABS, INC. P.O.#: 14565 Date In: 6/30/2020
NOTE: Our Lot Traveler No: 200819 corresponds to Customer Lot No: 1Z113767
Process: Assembly_AE {Commercial} Device: BFR391 Package: 4LD Date Code: 2032
Customer # 936: Customer Spec #:N/A DPAS Rating:N/A
Original Count: 50

#		qty in	date/time in	rejects	qty out	date/time out	Oper	QA
8.00	3RD OPTICAL INSPECTION: 100%: Commercial High Magnification: 50X - 75X, Low Magnification: 30X - 60X STOP if YIELD , <98%. QC to inform customer.	45	07/30/2020 10:05	1	44	07/30/2020 11:05	001693	

Good	44			Non-Sticky on Pad	
				Non-Stick on Post	
				Scratch	
		Bond Bridging		Smash Bond	
		Foreign Material	1	>10% Reworked	
		Tool Mark Bridging		2/O Escapees	
		Wrong Die Orientation		D/A Material on Die	
		Insufficient D/A Material		Bond on Foreign Material	
		Chips/Cracks		Lifted Metals	
		Package Defects		Others	
		Wrong Bonding		mechanical	

Tools *Cal Due Date: LP-11 *N/A
LP-11 *N/A

RECEIVED AUG 0 6 2020

Customer: TANDEX TEST LABS, INC. P.O.#: 14565 Date In: 6/30/2020
NOTE: Our Lot Traveler No: 200819 corresponds to Customer Lot No: 1Z113767
Process: Assembly_AE {Commercial} Device: BFR391 Package: 4LD Date Code: 2032
Customer # 936: Customer Spec #:N/A DPAS Rating:N/A
Original Count: 50

#		qty in	date/time in	rejects	qty out	date/time out	oper	QA
9.00	3RD OPTICAL QA GATE: Commercial High Magnification: 50X - 75X, Low Magnification: 30X - 60X LTPD = 5, SS=45 ACC/REJ = 0/1	44	07/30/2020 11:45	0	44	07/30/2020 12:10	001512	001512

Tools *Cal Due Date: Hp-7 *N/A
LP-16 *N/A

#		qty in	date/time in	rejects	qty out	date/time out	oper	QA
10.00	LID & PACKAGE CLEANING - AIR BLOW, 20 PSI MAX.	44	08/03/2020 06:45	0	44	08/03/2020 08:50	001581	

RECEIVED AUG 0 6 2020

Customer: TANDEX TEST LABS, INC. P.O.#: 14565 Date In: 6/30/2020
NOTE: Our Lot Traveler No: 200819 corresponds to Customer Lot No: 1Z113767
Process: Assembly_AE {Commercial} Device: BFR391 Package: 4LD Date Code: 2032
Customer # 936: Customer Spec #:N/A DPAS Rating:N/A
Original Count: 50

#		qty in	date/time in	rejects	qty out	date/time out	oper	QA
11.00	PRE-SEAL BAKE @ 150°C for 2 hr with Nitrogen(Solder Seal)	44	08/03/2020 09:00	0	44	08/03/2020 11:00	001581	

Tools *Cal Due Date: 13047 *8/6/2020

#		qty in	date/time in	rejects	qty out	date/time out	oper	QA
12.00	LID LOAD/LID CLIPPING 30X MAG., N2 blow (not to exceed 20 psi), inspect, clip	44	08/03/2020 06:45	0	44	08/03/2020 08:50	001581	

RECEIVED AUG 0 6 2020

Customer: TANDEX TEST LABS, INC. P.O.#: 14565 Date In: 6/30/2020
NOTE: Our Lot Traveler No: 200819 corresponds to Customer Lot No: 1Z113767
Process: Assembly_AE {Commercial} Device: BFR391 Package: 4LD Date Code: 2032
Customer # 936: Customer Spec #:N/A DPAS Rating:N/A
Original Count: 50

#	SEAL & VISUAL CHECK,	qty in	date/time in	rejects	qty out	date/time out	oper	QA
13.00	SOLDER SEAL	44	08/03/2020 13:00	0	44	08/03/2020 13:30	001581	

Tools *Cal Due Date: 1342 *N/A

DATE CODE: YY=20 WW=32

Description	Set-up Qty	Comments

RECEIVED AUG 0 6 2020

Customer: TANDEX TEST LABS, INC. P.O.#: 14565 Date In: 6/30/2020
NOTE: Our Lot Traveler No: 200819 corresponds to Customer Lot No: 1Z113767
Process: Assembly_AE {Commercial} Device: BFR391 Package: 4LD Date Code: 2032
Customer # 936: Customer Spec #:N/A DPAS Rating:N/A
Original Count: 50

#		qty in	date/time in	rejects	qty out	date/time out	Oper	QA
14.00	FINAL VISUAL INSPECTION, M2009, 100% (1.5X - 10X) MIL-STD-883 *Glass seal visual inspection Use: 7X min. *TO-Can visual inspection Use: 3X min STOP if YIELD < 95%. QC to inform customer. Spec: PP-31231 Rev: S	44	08/03/2020 14:03	0	44	08/03/2020 14:40	001632	

Good	44				
				Lead Defects	
				Marking Defect	
				Seal Defects	
				Package Chip/Crack	
				Contamination	
				Others	
				mechanical	

Tools *Cal Due Date: LP-25 *N/A

RECEIVED AUG 0 6 2020

Customer: TANDEX TEST LABS, INC. P.O.#: 14565 Date In: 6/30/2020
NOTE: Our Lot Traveler No: 200819 corresponds to Customer Lot No: 1Z113767
Process: Assembly_AE {Commercial} Device: BFR391 Package: 4LD Date Code: 2032
Customer # 936: Customer Spec #:N/A DPAS Rating:N/A
Original Count: 50

#	FINAL VISUAL QA GATE, M2009, (1.5X - 10X) MIL-STD-883	qty in	date/time in	rejects	qty out	date/time out	oper	QA
15.00	LTPD 7, SS=32, A/R=0/1 *Glass seal visual inspection Use: 7X min. *TO-Can visual inspection Use: 3X min Spec: QC-68002 Rev: P	32	08/04/2020 12:10	0	32	08/04/2020 12:51	001690	001690

Tools *Cal Due Date: LP-26 *N/A

RECEIVED AUG 0 6 2020

Customer: TANDEX TEST LABS, INC. P.O.#: 14565 Date In: 6/30/2020
NOTE: Our Lot Traveler No: 200819 corresponds to Customer Lot No: 1Z113767
Process: Assembly_AE {Commercial} Device: BFR391 Package: 4LD Date Code: 2032
Customer # 936: Customer Spec #:N/A DPAS Rating:N/A
Original Count: 50

#	PACKING, DOCUMENT PREPARATION & REVIEW	qty in	date/time in	rejects	qty out	date/time out	oper	QA
16.00	* GA C OF C * GA TRAVELER(s) * DIE SHEAR STRENGTH DATA * STUD PULL (Substrate Attach Strength) * BOND STREGTH DATA (Destructive Bond Pull Test) * NON-DESTRUCTIVE BOND PULL DATA * PARTICLE IMPACT NOISE DETECTION (PIND) DATA * RESISTANCE TO SOLVENT QC MONITOR * CSI REPORT (If Applicable) * RADIOGRAPHY (X-RAY) FILMS & REPORT(s)# OF FILM: _____ * PRE BURN-IN ELECTRICAL PARAMETERS * BURN-IN DATA * POST BURN-IN ELECTRICAL PARAMETERS * FINAL ELECTRICAL TEST (MIN & MAX) * JOB/MATERIAL INVENTORY * QA PLANT CLEARANCE CHEKLIST * SOLDERABILITY TEST (If Applicable) * XRF DATA * TEMPERATURE CYCLE CHART (If Applicable) * SERIAL LOG SHEET (If Applicable) * WAFER MAP (If Applicable) * PHOTO (If Applicable) * VENDOR C of C (If Applicable) * OTHERS: _____	44	08/04/2020 12:52	0	44	08/04/2020 12:54	001690	

RECEIVED AUG 0 6 2020

Customer: TANDEX TEST LABS, INC. P.O.#: 14565 Date In: 6/30/2020
NOTE: Our Lot Traveler No: 200819 corresponds to Customer Lot No: 1Z113767
Process: Assembly_AE {Commercial} Device: BFR391 Package: 4LD Date Code: 2032
Customer # 936: Customer Spec #:N/A DPAS Rating:N/A
Original Count: 50

#	SHIPPING	qty in	date/time in	rejects	qty out	date/time out	oper	QA
17.00		44	08/04/2020 12:54	0	44	08/04/2020 12:55	001690	

Golden Altos Corporation certifies that all processing has been in accordance with the purchase order and/or the methods specified above.
CONFIDENTIAL. For the exclusive use of the customer named herein. Please destroy or return to sender immediately if you are not the customer named.

Golden Altos CORPORATION
402 South Hillview Drive
Milpitas CA 95035
www.goldenaltos.com
Tel: 408-956-1010
Fax: 408-956-1212
Cage Code: 065N4

CERTIFICATE OF CONFORMANCE

ISO 9001 Certified
DLA QML Listed
DLA Commercial Lab Suitability
ITAR Registered
Serving the semiconductor
industry since 1984

Customer:	TANDEX TEST LABS, INC.	Purchase Order No.:	14565
Address:	15849 BUSINESS CENTER DRIVE IRWINDALE CA 91706-2053	Job No.:	1865
		Ship Date:	8/4/2020
		Lot Traveler No:	200819
Device No:	BFR391	Package Type:	4LD
Customer Lot No:	1Z113767	Date Code:	2032
Customer Spec #	N/A	Lot Quantity:	44

We certify that the articles listed and shipped herewith have been inspected and fully conform to the requirements of the Purchase Order listed above and to the drawings and specifications applicable to that order. We certify that inspection evidence, including test data, necessary to substantiate this certification is available from our files.

Tests and/or inspection have been performed utilizing equipment calibrated in accordance with the requirements of MIL-STD45662A, ANSI/NCSL Z540-1-1994, ANSI/NCSL Z540.3, and/or ISO/IEC 17025 as applicable per contractual agreement. All measurements are traceable to the National Institute of Standards and Technology (NIST) or a natural or physical constant and Golden Altos specification SP-11001 and ME-18011.

Devices were handled utilizing ESD controls based on the guidelines of MIL-STD-1686 and Golden Altos specification QA-65000

Remarks:

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Quality Assurance	Stamp	Date
1690/QC	QA 07 GAC	8/4/2020

Golden Altos CORPORATION

WIRE BOND TEST RESULTS BUY-OFF

MIL-STD-883, METHOD 2011, METHOD 2023

TRAVELER #:	200819	LOT QTY:	50	DEVICE #:	BFR391	DATE:	07/30/20
CUSTOMER #:	936	PKG TYPE:	4LD	LOT #:	1Z113767	OPERATOR #:	1693

WIRE SIZE .7 GOLD ALUMINUM

SAMPLE SIZE PER MIL PRF 38535

- ☐ **22 WIRES, 4 DEVICES PER TM 2011**
- ☐ **15 WIRES, 4 DEVICES PER TM 2011**
- ☐ **100 % OF WIRES, ALL DEVICES PER TM 2023**
- ☒ **OTHER:** 3 WIRES, 1 DEVICE

SAMPLE SIZE PER MIL PRF 38534

- ☐ **15 WIRES, 3 DEVICES PER TM 2011**
- ☐ **10 WIRES, 3 DEVICES PER TM 2011**
- ☐ **100 % OF WIRES, ALL DEVICES PER TM 2023**
- ☐ **OTHER:**

WIRE BONDER #: 20
PM/CAL. DUE DATE: 11-14-20

BOND PULL:
PM/CAL. DUE DATE: 11-14-20/12-03-20
☒ WESTBOND 70PTE #: 3
☐ OTHER:

METHOD 2011, DESTRUCTIVE PULL TEST	☒ PRE SEAL	☐ POST SEAL
DEVICE TEST READING, GRAM-FORCE (SEE ATTACHED DATA)	☒ PASS	☐ FAIL

NOTES:

> *All test readings are attached together with the traveler.*
> *Numerical Characters **0,1,2,3,4,5,6,7,8,9 denote wire break modes***
> *Failure Categories:* ***a*** *- For Internal Wire Bond*
> ***b*** *- For External Bonds connecting device to wiring board or substrate*

BREAK MODE

- **0** Wire broken or missing prior to test.
- **1** Wire break at neckdown point (reduction of cross section due to bonding process).
- **2** Wire break at point other than neckdown.
- **3** Failure in bond (interface between wire and metallization) at die.
- **4** Failure in bond (interface between wire and metallization) at substrate, package post, or other than die.
- **5** Lifted metallization from die.
- **6** Lifted metallization from substrate or package post.
- **7** Fracture of die.
- **8** Fracture of substrate.
- **9** Break in wire at neckdown on the substrate or package post.

After completion of bond pull, production shall forward results with destruct sample to Q.C. for validation buy-off:

QC Form Complete:	☑ YES ☐ NO	BREAK MODE CORRECT:	☑ YES ☐ NO

METHOD 2023, NON-DESTRUCTIVE PULL TEST

NON-DESTRUCT FORCE SET:

IN QTY	REWORK ALLOWED?	FAILED WIRE QTY:	% PDA:	REWORK WIRE QTY:	OUT QTY
	☐ YES ☐ NO				

TOTAL DEVICE REJECTED:

TOTAL WIRE QTY: VS TOTAL TEST QTY:

EXPLANATION OF VARIANCE BETWEEN "TOTAL WIRE QTY" vs "TOTAL TEST QTY":

a .QTY WIRES RETESTED: N/A
b. VOIDED TESTS: 7/30/20 #1-12
(no wires pulled, hook slipped)
c. RE-TEST TWICE:
d. MULTIPLE WIRES PULLED:
e. OTHERS (Specify):

NOTE: 1) TOTAL TEST QTY MUST EQUAL TO TOTAL WIRE QTY + a + b + c + d+ e
2) %PDA = [(# of rejects) / (total lot quantity X # of wires per unit)] X 100;
Reject the lot if PDA is >2% for class S

NOTE: Q.C. must check the form for any corrections or errors in data entry.

QC ACCEPT: 1512 REJECT (NOTICE ISSUED):

[Reference: PP-31006, PP-31240, QC-68004, PP-31253]

WEST BOND 70PT WIREPULL TESTER

DATE		7/30/2020
TIME		1000
TRAVELER_NO.		200819
DEVICE_NO.		BFR391
CUSTOMER_NO.		936
PACKAGE_TYPE		4LD
OPERATOR_ID.		1693
M/C_No.		20
(N)NON-DST/(D)DST		D
WIRE_DIAMETER(mil)		.7
SPEC_LIMIT(grms)		2.00
NUMBER_OF_WIRES_PULLED	3	
NUMBER_OF_VALID_TESTED	3	
NUMBER_OF_VOIDED_TESTED	0	
MEAN	3.77	
MAX	4.20	
MIN	3.00	
STD-DEV	0.67	
RANGE	1.20	
CPK Est. Value	0.88	

70PTE DATA

Wire_No.	Failure_Code	Gram_Force
1	a-9	3.0
2	a-9	4.2
3	a-9	4.1

WIRE PULL TEST MIL-STD-750, 2037.
WIRE PULL TEST MIL-STD-883, 2011.
WIRE PULL TEST MIL-STD883, 2023.

Golden Altos CORPORATION

JOB/MATERIAL INVENTORY

CUSTOMER #: 936	TRAVELER #: 200819	DEVICE #: BFR391	LOT QTY: 50	ITAR: ☐ YES ☐ NO
IQC INSPECTOR:	PKG TYPE:	LOT #: 1Z113767	IQC LOC:	

FOR IQC USE ONLY

DESCRIPTION	PART #	LOT #	Received Date	QTY
WAFERS/ DIE Sharing with				

Remarks:

DIE PLATING

W #	Plated Qty	Plated Ink die for set-up	OPTR #

Excess die keep at GAC ☐

2ND OPTICAL

Good Die	2nd opt Reject Die	Excess Die	OPTR #	Comments
50	0	10	1444	

QC BUY-OFF

FINAL VERIFICATION FOR EXCESS MATERIALS:

Die/Wafer	QTY
Wafer:	
Wafer Skeleton:	
Excess die:	10
2nd Opt reject die:	

DESCRIPTION	PART #	LOT #	Received Date	QTY	Comments	Sharing Material with Traveler #	QTY
PACKAGE HEADER BASES							
FRAMES							
LIDS/ CAPS							

Materials	QTY
Package/Header:	0
Base:	
Lead Frame:	
Lid/Cap:	8
Empty Waffel Pack	1
CLIP	16
CARRIERS	16
SET-UP & REJECTS	QTY
Die Shear:	
Stud Pull:	
Die Attach Reject:	
Wire pull:	
3rd opt reject:	1
Set-up:	5
Checked by:	*Date:*
1581/1690	8/04/20

Original Tray	Use same tray for loading ☐ YES ☐ NO	Remarks:

[Reference: QC-68009]

GAF # 1118 Rev. 08

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Golden Altos CORPORATION

QA PLANT CLEARANCE CHECKLIST

TRAVELER #: 200819
CUST. #: 936
DEVICE #: BFR391
PACKAGE TYPE: _____

TOTAL QTY. SHIPPED: 44
COMPLETE SHIPMENT: ☒
PARTIAL SHIPMENT : ☐
BALANCE TO COMPLETE: ☐

REJECTS:		QTY.
2ND OPTICAL REJECTS	☐	
3RD OPTICAL REJECTS	☒	1
4TH OPTICAL REJECTS	☐	
OTHERS: _____	☐	
SET UP	☒	5
	☐	
EXCESS MATERIALS:		
INKED DICE	☐	
EXCESS WAFERS	☐	
WAFER CONTAINER	☐	
REMNANT WAFERS	☐	
EXCESS PACKAGES	☐	
EXCESS LIDS/CAPS/BASE	☒	8
EXCESS DICE/GOOD DICE	☒	10
TUBES/TRAYS	☐	
OTHERS: CLIP	☒	16
Empty Waffel Pack	☒	1
CARRIERS	☒	16
DOCUMENTATION:		
DIE SHEAR REPORT	☐	
STUD PULL REPORT	☐	
WIRE PULL REPORT	☒	
C OF C	☒	
X-RAY FILM/REPORT	☐	
OTHERS:	☒	

SHIPPED LOTS

LOT NO.	QUANTITY

QC: 1690

DATE: 8/04/20

[Reference: QA 65009]

GAF-1018, Rev. 04

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Post Seal Test Results at 25°C

TEST#		2	3	4	5
SYMBOL		HFE	SAME	ICBO	IEBO
COND.1		5.00 V	2	5.00 V	1.00 V
COND.2		50.0mA			
MAX LIMIT			150	1.000uA	1.000uA
MIN LIMIT		60			
SER #	BIN			A	A
1	1	98.52	98.52	157.0p	612.7p
2	1	98.97	98.97	101.1p	598.1p
3	1	99.38	99.38	185.0p	636.5p
4	1	101.70	101.70	487.0p	384.0p
5	1	98.40	98.40	290.0p	578.0p
6	1	102.00	102.00	35.00p	660.5p
7	1	101.70	101.70	430.0p	482.5p
8	1	97.16	97.16	743.0p	366.0p
9	1	101.50	101.50	160.0p	176.5p
10	1	98.48	98.48	408.0p	619.5p
11	1	103.20	103.20	198.0p	484.5p
12	1	101.40	101.40	419.0p	825.0p
13	1	102.60	102.60	248.0p	826.0p
14	1	97.14	97.14	132.0p	526.9p
15	1	97.27	97.27	69.00p	567.7p
16	1	100.20	100.20	189.0p	663.5p
17	1	101.80	101.80	396.0p	760.0p
18	1	102.00	102.00	181.0p	892.0p
19	1	104.20	104.20	441.0p	925.2p
20	1	96.74	96.74	478.0p	855.5p
21	1	101.50	101.50	452.0p	449.2p
22	1	97.65	97.65	587.0p	654.0p
23	1	101.70	101.70	213.0p	766.0p
24	1	100.10	100.10	609.0p	254.7p
25	1	98.42	98.42	696.0p	520.5p
26	1	101.90	101.90	311.0p	707.7p
27	1	99.10	99.10	561.0p	492.0p
28	1	99.26	99.26	166.0p	518.5p
29	1	98.25	98.25	24.00p	890.2p
30	1	96.26	96.26	506.0p	560.2p
31	1	97.90	97.90	359.0p	757.0p
32	1	103.00	103.00	421.0p	764.0p
33	1	101.20	101.20	304.0p	612.5p
34	1	101.00	101.00	520.0p	676.5p
35	1	95.95	95.95	407.0p	576.0p
36	1	101.50	101.50	540.0p	521.5p
37	1	102.30	102.30	360.0p	699.0p
38	1	102.20	102.20	219.0p	483.9p
39	1	101.80	101.80	73.00p	822.0p
40	1	103.70	103.70	401.0p	202.5p
41	1	98.46	98.46	290.0p	758.5p
42	1	100.40	100.40	19.00p	659.5p
43	1	101.60	101.60	4.000p	916.5p
44	1	101.90	101.90	127.0p	698.5p

Post Stabilization Bake Test Results at -55°C

TEST#		2
SYMBOL		HFE
COND.1		5.00 V
COND.2		50.0mA
MAX LIMIT		150
MIN LIMIT		60
SER #	BIN	
5	1	72.61
6		---
7	1	73.23
8	1	70.82
9	1	73.14
10	1	71.77
11	1	74.54
12	1	71.53
13	1	71.63
14	1	69.68
15	1	69.16
16	1	74.59
17	1	73.09
18	1	72.23
19	1	73.95
20	1	70.62
21	1	74.18
22	1	72.51
23	1	74.58
24	1	71.89
25	1	72.20
26	1	74.63
27	1	74.34

Post Stabilization Bake Test Results at 25°C

TEST#		2	3	4	5
SYMBOL		HFE	SAME	ICBO	IEBO
COND.1		5.00 V	2	5.00 V	1.00 V
COND.2		50.0mA			
MAX LIMIT			150	1.000uA	1.000uA
MIN LIMIT		60			
SER #	BIN			A	A
5	1	98.25	98.25	170.0p	813.0p
6		---	---	---	---
7	1	101.30	101.30	109.0p	966.0p
8	1	96.82	96.82	95.00p	892.0p
9	1	101.40	101.40	21.00p	778.6p
10	1	98.13	98.13	127.0p	922.2p
11	1	103.00	103.00	75.00p	766.7p
12	1	101.40	101.40	105.0p	932.0p
13	1	102.60	102.60	97.00p	996.0p
14	1	97.18	97.18	59.00p	862.5p
15	1	97.12	97.12	63.00p	855.0p
16	1	100.10	100.10	227.0p	852.0p
17	1	101.90	101.90	69.00p	808.0p
18	1	102.10	102.10	39.00p	762.0p
19	1	104.30	104.30	82.00p	822.0p
20	1	96.95	96.95	41.00p	802.0p
21	1	101.60	101.60	37.00p	900.0p
22	1	97.84	97.84	38.00p	960.0p
23	1	101.90	101.90	169.0p	636.5p
24	1	100.20	100.20	164.0p	781.5p
25	1	98.46	98.46	72.00p	820.0p
26	1	102.30	102.30	29.00p	102.6p
27	1	99.40	99.40	129.0p	877.5p

Post Stabilization Bake Test Results at 125°C

TEST#		2
SYMBOL		ICBO
COND.1		5.00 V
COND.2		
MAX LIMIT		1.000uA
MIN LIMIT		
SER #	BIN	A
5	1	186.0p
6		---
7	1	164.0p
8	1	147.0p
9	1	316.0p
10	1	231.0p
11	1	229.0p
12	1	261.0p
13	1	218.0p
14	1	326.0p
15	1	569.0p
16	1	356.0p
17	1	37.00p
18	1	52.00p
19	1	320.0p
20	1	47.00p
21	1	79.00p
22	1	97.00p
23	1	290.0p
24	1	119.0p
25	1	300.0p
26	1	291.0p
27	1	111.0p

Post Temperature Cycle & Acceleration Test Results at -55°C

TEST#		2
SYMBOL		HFE
COND.1		5.00 V
COND.2		50.0mA
MAX LIMIT		150
MIN LIMIT		60
SER #	BIN	
5	1	77.94
6		---
7	1	76.84
8	1	74.39
9	1	77.00
10	1	75.35
11	1	79.84
12	1	78.25
13	1	77.95
14	1	75.26
15	1	74.85
16	1	78.11
17	1	79.17
18	1	78.45
19	1	78.98
20	1	74.57
21	1	77.59
22	1	75.01
23	1	78.18
24	1	76.89
25	1	76.79
26	1	77.83
27	1	78.23

Post Temperature Cycle & Acceleration Test Results at 25°C

TEST#		2	3	4	5
SYMBOL		HFE	SAME	ICBO	IEBO
COND.1		5.00 V	2	5.00 V	1.00 V
COND.2		50.0mA			
MAX LIMIT			150	1.000uA	1.000uA
MIN LIMIT		60			
SER #	BIN			A	A
5	1	98.01	98.01	108.0p	906.7p
6		---	---	---	---
7	1	101.20	101.20	132.0p	904.0p
8	1	96.73	96.73	5.000p	826.0p
9	1	101.20	101.20	80.00p	497.5p
10	1	98.00	98.00	65.00p	339.0p
11	1	102.90	102.90	134.0p	723.2p
12	1	101.20	101.20	137.0p	954.0p
13	1	102.50	102.50	100.0p	756.2p
14	1	97.03	97.03	166.0p	632.7p
15	1	97.06	97.06	185.0p	637.0p
16	1	100.10	100.10	945.0p	841.2p
17	1	101.70	101.70	29.00p	887.0p
18	1	101.90	101.90	273.0p	759.0p
19	1	104.30	104.30	385.1p	893.0p
20	1	96.88	96.88	168.0p	749.6p
21	1	101.60	101.60	193.0p	701.2p
22	1	97.69	97.69	187.0p	770.2p
23	1	101.80	101.80	894.0p	912.5p
24	1	100.10	100.10	18.00p	112.9p
25	1	98.42	98.42	200.0p	848.0p
26	1	102.00	102.00	152.0p	852.1p
27	1	99.02	99.02	644.2p	910.0p

Post Temperature Cycle & Acceleration Test Results at 125°C

TEST#		2
SYMBOL		ICBO
COND.1		5.00 V
COND.2		
MAX LIMIT		1.000uA
MIN LIMIT		
SER #	BIN	A
5	1	336.0p
6		---
7	1	322.0p
8	1	248.0p
9	1	417.0p
10	1	496.0p
11	1	551.0p
12	1	787.0p
13	1	761.0p
14	1	739.0p
15	1	764.0p
16	1	814.0p
17	1	856.0p
18	1	752.0p
19	1	601.0p
20	1	776.0p
21	1	830.0p
22	1	588.0p
23	1	593.0p
24	1	320.0p
25	1	571.0p
26	1	734.0p
27	1	651.0p

Post HTRB Test Results at -55°C

TEST#		2
SYMBOL		HFE
COND.1		5.00 V
COND.2		50.0mA
MAX LIMIT		150
MIN LIMIT		60
SER #	BIN	
5	1	76.95
6		---
7	1	76.89
8	1	73.93
9	1	77.18
10	1	74.85
11	1	78.91
12	1	77.20
13	1	77.73
14	1	75.17
15	1	73.36
16	1	77.55
17	1	77.84
18	1	77.73
19	1	78.43
20	1	73.41
21	1	76.61
22	1	74.70
23	1	78.34
24	1	76.37
25	1	74.99
26	1	77.39
27	1	77.17

Post HTRB Test Results at 25°C

TEST#		2	3	4	5
SYMBOL		HFE	SAME	ICBO	IEBO
COND.1		5.00 V	2	5.00 V	1.00 V
COND.2		50.0mA			
MAX LIMIT			150	1.000uA	1.000uA
MIN LIMIT		60			
SER #	BIN			A	A
5	1	97.84	97.84	56.00p	757.5p
6		---	---	---	---
7	1	101.10	101.10	370.0p	736.0p
8	1	96.59	96.59	90.00p	703.0p
9	1	101.00	101.00	383.0p	592.0p
10	1	97.86	97.86	57.00p	820.2p
11	1	102.90	102.90	29.00p	700.4p
12	1	101.10	101.10	567.0p	964.7p
13	1	102.30	102.30	411.0p	515.0p
14	1	96.88	96.88	122.0p	729.0p
15	1	96.91	96.91	255.0p	719.0p
16	1	99.86	99.86	37.00p	939.0p
17	1	101.50	101.50	22.00p	926.0p
18	1	101.70	101.70	151.0p	838.5p
19	1	104.10	104.10	22.00p	977.0p
20	1	96.74	96.74	348.0p	653.0p
21	1	101.20	101.20	65.00p	734.2p
22	1	97.35	97.35	156.0p	885.0p
23	1	101.40	101.40	312.0p	776.5p
24	1	99.84	99.84	181.0p	457.1p
25	1	98.01	98.01	79.00p	868.5p
26	1	101.50	101.50	53.00p	931.2p
27	1	98.63	98.63	74.00p	928.5p

Post HTRB Test Results at 125°C

TEST#		2
SYMBOL		ICBO
COND.1		5.00 V
COND.2		
MAX LIMIT		1.000uA
MIN LIMIT		
SER #	BIN	A
5	1	212.5p
6		---
7	1	260.0p
8	1	282.0p
9	1	179.0p
10	1	505.0p
11	1	132.0p
12	1	376.0p
13	1	486.0p
14	1	211.0p
15	1	439.0p
16	1	169.0p
17	1	271.0p
18	1	309.0p
19	1	313.0p
20	1	322.0p
21	1	607.0p
22	1	426.5p
23	1	133.0p
24	1	242.0p
25	1	150.0p
26	1	368.0p
27	1	110.0p

Post HTRB Test Results – Delta Results

NO.	T#	ITEM	PRE HTRB (TP 0)	POST HTRB (TP 1)	DELTA	DELTA %	
5	2	HFE	98.01	97.84	-170.0m	-0.17 %	
	4	ICBO	108.0pA	56.00pA	-52.00p	-48.15 %	
	5	IEBO	906.7pA	757.5pA	-149.2p	-16.46 %	
6	2	HFE	---	---			
	4	ICBO	---	---			
	5	IEBO	---	---			
7	2	HFE	101.20	101.10	-100.0m	-0.10 %	
	4	ICBO	132.0pA	370.0pA	238.0p	180.30 %	F
	5	IEBO	904.0pA	736.0pA	-168.0p	-18.58 %	
8	2	HFE	96.73	96.59	-140.0m	-0.14 %	
	4	ICBO	5.000pA	90.00pA	85.00p	1700.00 %	F
	5	IEBO	826.0pA	703.0pA	-123.0p	-14.89 %	
9	2	HFE	101.20	101.00	-200.0m	-0.20 %	
	4	ICBO	80.00pA	383.0pA	303.0p	378.75 %	F
	5	IEBO	497.5pA	592.0pA	94.50p	18.99 %	
10	2	HFE	98.00	97.86	-140.0m	-0.14 %	
	4	ICBO	65.00pA	57.00pA	-8.000p	-12.31 %	
	5	IEBO	339.0pA	820.2pA	481.2p	141.95 %	F
11	2	HFE	102.90	102.90	0.00	0.00 %	
	4	ICBO	134.0pA	29.00pA	-105.0p	-78.36 %	F
	5	IEBO	723.2pA	700.4pA	-22.80p	-3.15 %	
12	2	HFE	101.20	101.10	-100.0m	-0.10 %	
	4	ICBO	137.0pA	567.0pA	430.0p	313.87 %	F
	5	IEBO	954.0pA	964.7pA	10.70p	1.12 %	
13	2	HFE	102.50	102.30	-200.0m	-0.20 %	
	4	ICBO	100.0pA	411.0pA	311.0p	311.00 %	F
	5	IEBO	756.2pA	515.0pA	-241.2p	-31.90 %	
14	2	HFE	97.03	96.88	-150.0m	-0.15 %	
	4	ICBO	166.0pA	122.0pA	-44.00p	-26.51 %	
	5	IEBO	632.7pA	729.0pA	96.30p	15.22 %	
15	2	HFE	97.06	96.91	-150.0m	-0.15 %	
	4	ICBO	185.0pA	255.0pA	70.00p	37.84 %	
	5	IEBO	637.0pA	719.0pA	82.00p	12.87 %	
16	2	HFE	100.10	99.86	-240.0m	-0.24 %	
	4	ICBO	945.0pA	37.00pA	-908.0p	-96.08 %	F
	5	IEBO	841.2pA	939.0pA	97.80p	11.63 %	

17	2	HFE	101.70	101.50	-200.0m	-0.20 %
	4	ICBO	29.00pA	22.00pA	-7.000p	-24.14 %
	5	IEBO	887.0pA	926.0pA	39.00p	4.40 %
18	2	HFE	101.90	101.70	-200.0m	-0.20 %
	4	ICBO	273.0pA	151.0pA	-122.0p	-44.69 %
	5	IEBO	759.0pA	838.5pA	79.50p	10.47 %
19	2	HFE	104.30	104.10	-200.0m	-0.19 %
	4	ICBO	385.1pA	22.00pA	-363.1p	-94.29 % F
	5	IEBO	893.0pA	977.0pA	84.00p	9.41 %
20	2	HFE	96.88	96.74	-140.0m	-0.14 %
	4	ICBO	168.0pA	348.0pA	180.0p	107.14 % F
	5	IEBO	749.6pA	653.0pA	-96.60p	-12.89 %
21	2	HFE	101.60	101.20	-400.0m	-0.39 %
	4	ICBO	193.0pA	65.00pA	-128.0p	-66.32 % F
	5	IEBO	701.2pA	734.2pA	33.00p	4.71 %
22	2	HFE	97.69	97.35	-340.0m	-0.35 %
	4	ICBO	187.0pA	156.0pA	-31.00p	-16.58 %
	5	IEBO	770.2pA	885.0pA	114.8p	14.91 %
23	2	HFE	101.80	101.40	-400.0m	-0.39 %
	4	ICBO	894.0pA	312.0pA	-582.0p	-65.10 % F
	5	IEBO	912.5pA	776.5pA	-136.0p	-14.90 %
24	2	HFE	100.10	99.84	-260.0m	-0.26 %
	4	ICBO	18.00pA	181.0pA	163.0p	905.56 % F
	5	IEBO	112.9pA	457.1pA	344.2p	304.87 % F
25	2	HFE	98.42	98.01	-410.0m	-0.42 %
	4	ICBO	200.0pA	79.00pA	-121.0p	-60.50 % F
	5	IEBO	848.0pA	868.5pA	20.50p	2.42 %
26	2	HFE	102.00	101.50	-500.0m	-0.49 %
	4	ICBO	152.0pA	53.00pA	-99.00p	-65.13 % F
	5	IEBO	852.1pA	931.2pA	79.10p	9.28 %
27	2	HFE	99.02	98.63	-390.0m	-0.39 %
	4	ICBO	644.2pA	74.00pA	-570.2p	-88.51 % F
	5	IEBO	910.0pA	928.5pA	18.50p	2.03 %

Post Burn-In Test Results at -55°C

TEST#		2
SYMBOL		HFE
COND.1		5.00 V
COND.2		50.0mA
MAX LIMIT		150
MIN LIMIT		60
SER #	BIN	
5	1	71.60
6		---
7	1	72.39
8	1	72.49
9	1	73.58
10	1	71.85
11	1	75.51
12	1	72.75
13	1	73.60
14	1	75.15
15	1	72.93
16	1	74.18
17	1	75.64
18	1	74.99
19	1	75.32
20	1	73.89
21	1	74.59
22	1	71.88
23	1	73.99
24	1	72.72
25	1	72.05
26	1	73.95
27	1	73.31

Post Burn-In Test Results at 25°C

TEST#		2	3	4	5
SYMBOL		HFE	SAME	ICBO	IEBO
COND.1		5.00 V	2	5.00 V	1.00 V
COND.2		50.0mA			
MAX LIMIT			150	1.000uA	1.000uA
MIN LIMIT		60			
SER #	BIN			A	A
5	1	97.80	97.80	69.00p	777.0p
6		---	---	---	---
7	1	100.90	100.90	136.0p	772.0p
8	1	96.35	96.35	97.00p	812.0p
9	1	100.90	100.90	41.00p	854.5p
10	1	97.77	97.77	163.0p	371.0p
11	1	102.60	102.60	134.0p	592.0p
12	1	100.80	100.80	788.5p	330.0p
13	1	102.00	102.00	63.00p	832.0p
14	1	96.58	96.58	206.0p	103.7p
15	1	96.76	96.76	121.0p	808.0p
16	1	99.64	99.64	19.00p	810.5p
17	1	101.30	101.30	19.00p	928.5p
18	1	101.30	101.30	155.0p	615.0p
19	1	104.00	104.00	123.0p	792.0p
20	1	96.48	96.48	239.0p	659.0p
21	1	101.10	101.10	76.00p	981.5p
22	1	97.21	97.21	54.00p	836.0p
23	1	101.30	101.30	97.00p	883.0p
24	1	99.72	99.72	151.0p	766.5p
25	1	97.98	97.98	22.00p	860.0p
26	1	101.50	101.50	26.00p	218.9p
27	1	98.56	98.56	135.0p	826.2p

Post Burn-In Test Results at +125°C

TEST#		2
SYMBOL		ICBO
COND.1		5.00 V
COND.2		
MAX LIMIT		1.000uA
MIN LIMIT		
SER #	BIN	A
5	1	416.5p
6		---
7	1	101.0p
8	1	134.0p
9	1	107.0p
10	1	182.0p
11	1	193.0p
12	1	245.0p
13	1	317.0p
14	1	198.0p
15	1	181.0p
16	1	146.0p
17	1	423.0p
18	1	220.0p
19	1	135.0p
20	1	392.0p
21	1	101.0p
22	1	109.0p
23	1	218.0p
24	1	308.0p
25	1	209.0p
26	1	445.0p
27	1	127.0p

Post Burn-In Test Results - Delta Results

NO.	T#	ITEM	POST HTRB (TP 1)	POST BURN-IN (TP 2)	DELTA	DELTA %
5	2	HFE	97.84	97.80	-39.99m	-0.04 %
	4	ICBO	56.00pA	69.00pA	13.00p	23.21 %
	5	IEBO	757.5pA	777.0pA	19.50p	2.57 %
6	2	HFE	---	---		
	4	ICBO	---	---		
	5	IEBO	---	---		
7	2	HFE	101.10	100.90	-200.0m	-0.20 %
	4	ICBO	370.0pA	136.0pA	-234.0p	-63.24 % F
	5	IEBO	736.0pA	772.0pA	36.00p	4.89 %
8	2	HFE	96.59	96.35	-240.0m	-0.25 %
	4	ICBO	90.00pA	97.00pA	7.000p	7.78 %
	5	IEBO	703.0pA	812.0pA	109.0p	15.50 %
9	2	HFE	101.00	100.90	-100.0m	-0.10 %
	4	ICBO	383.0pA	41.00pA	-342.0p	-89.30 % F
	5	IEBO	592.0pA	854.5pA	262.5p	44.34 %
10	2	HFE	97.86	97.77	-90.00m	-0.09 %
	4	ICBO	57.00pA	163.0pA	106.0p	185.96 % F
	5	IEBO	820.2pA	371.0pA	-449.2p	-54.77 % F
11	2	HFE	102.90	102.60	-300.0m	-0.29 %
	4	ICBO	29.00pA	134.0pA	105.0p	362.07 % F
	5	IEBO	700.4pA	592.0pA	-108.4p	-15.48 %
12	2	HFE	101.10	100.80	-300.0m	-0.30 %
	4	ICBO	567.0pA	788.5pA	221.5p	39.07 %
	5	IEBO	964.7pA	330.0pA	-634.7p	-65.79 % F
13	2	HFE	102.30	102.00	-300.0m	-0.29 %
	4	ICBO	411.0pA	63.00pA	-348.0p	-84.67 % F
	5	IEBO	515.0pA	832.0pA	317.0p	61.55 %
14	2	HFE	96.88	96.58	-300.0m	-0.31 %
	4	ICBO	122.0pA	206.0pA	84.00p	68.85 %
	5	IEBO	729.0pA	103.7pA	-625.3p	-85.78 % F
15	2	HFE	96.91	96.76	-150.0m	-0.15 %
	4	ICBO	255.0pA	121.0pA	-134.0p	-52.55 % F
	5	IEBO	719.0pA	808.0pA	89.00p	12.38 %
16	2	HFE	99.86	99.64	-220.0m	-0.22 %
	4	ICBO	37.00pA	19.00pA	-18.00p	-48.65 %

	5	IEBO	939.0pA	810.5pA	-128.5p	-13.68 %
17	2	HFE	101.50	101.30	-200.0m	-0.20 %
	4	ICBO	22.00pA	19.00pA	-3.000p	-13.64 %
	5	IEBO	926.0pA	928.5pA	2.500p	0.27 %
18	2	HFE	101.70	101.30	-400.0m	-0.39 %
	4	ICBO	151.0pA	155.0pA	4.000p	2.65 %
	5	IEBO	838.5pA	615.0pA	-223.5p	-26.65 %
19	2	HFE	104.10	104.00	-100.0m	-0.10 %
	4	ICBO	22.00pA	123.0pA	101.0p	459.09 % F
	5	IEBO	977.0pA	792.0pA	-185.0p	-18.94 %
20	2	HFE	96.74	96.48	-260.0m	-0.27 %
	4	ICBO	348.0pA	239.0pA	-109.0p	-31.32 %
	5	IEBO	653.0pA	659.0pA	6.000p	0.92 %
21	2	HFE	101.20	101.10	-100.0m	-0.10 %
	4	ICBO	65.00pA	76.00pA	11.00p	16.92 %
	5	IEBO	734.2pA	981.5pA	247.3p	33.68 %
22	2	HFE	97.35	97.21	-140.0m	-0.14 %
	4	ICBO	156.0pA	54.00pA	-102.0p	-65.38 % F
	5	IEBO	885.0pA	836.0pA	-49.00p	-5.54 %
23	2	HFE	101.40	101.30	-100.0m	-0.10 %
	4	ICBO	312.0pA	97.00pA	-215.0p	-68.91 % F
	5	IEBO	776.5pA	883.0pA	106.5p	13.72 %
24	2	HFE	99.84	99.72	-120.0m	-0.12 %
	4	ICBO	181.0pA	151.0pA	-30.00p	-16.57 %
	5	IEBO	457.1pA	766.5pA	309.4p	67.69 %
25	2	HFE	98.01	97.98	-30.01m	-0.03 %
	4	ICBO	79.00pA	22.00pA	-57.00p	-72.15 % F
	5	IEBO	868.5pA	860.0pA	-8.500p	-0.98 %
26	2	HFE	101.50	101.50	0.00	0.00 %
	4	ICBO	53.00pA	26.00pA	-27.00p	-50.94 % F
	5	IEBO	931.2pA	218.9pA	-712.3p	-76.49 % F
27	2	HFE	98.63	98.56	-70.00m	-0.07 %
	4	ICBO	74.00pA	135.0pA	61.00p	82.43 %
	5	IEBO	928.5pA	826.2pA	-102.3p	-11.02 %

Post Steady-State Life Test Results at -55°C

TEST#		2
SYMBOL		HFE
COND.1		5.00 V
COND.2		50.0mA
MAX LIMIT		150
MIN LIMIT		60
SER #	BIN	
5	1	74.41
6		---
7	1	72.80
8	1	72.07
9	1	78.69
10	1	75.86
11	1	78.53
12	1	77.58
13	1	77.71
14	1	75.16
15	1	75.05
16	1	78.26
17	1	78.92
18	1	77.10
19	1	78.15
20	1	74.07
21	1	78.57
22	1	75.61
23	1	78.07
24	1	76.63
25	1	75.88
26	1	77.95
27	1	76.49

Post Steady-State Life Test Results at 25°C

TEST#		2	3	4	5
SYMBOL		HFE	SAME	ICBO	IEBO
COND.1		5.00 V	2	5.00 V	1.00 V
COND.2		50.0mA			
MAX LIMIT			150	1.000uA	1.000uA
MIN LIMIT		60			
SER #	BIN			A	A
5	1	96.50	96.50	197.0p	566.0p
6		---	---	---	---
7	1	100.60	100.60	12.00p	880.0p
8	1	95.98	95.98	135.0p	727.5p
9	1	100.50	100.50	85.00p	718.0p
10	1	97.42	97.42	83.00p	821.5p
11	1	102.20	102.20	75.00p	776.0p
12	1	100.60	100.60	60.00p	791.0p
13	1	101.70	101.70	148.0p	774.0p
14	1	96.20	96.20	16.00p	530.0p
15	1	96.33	96.33	136.0p	757.5p
16	1	99.20	99.20	150.0p	833.0p
17	1	100.90	100.90	89.00p	764.7p
18	1	101.00	101.00	43.00p	668.1p
19	1	103.40	103.40	132.0p	144.8p
20	1	96.22	96.22	99.00p	794.0p
21	1	100.60	100.60	93.00p	768.0p
22	1	96.80	96.80	237.0p	166.7p
23	1	100.80	100.80	75.00p	774.2p
24	1	99.18	99.18	275.0p	423.0p
25	1	97.38	97.38	11.00p	749.5p
26	1	100.90	100.90	74.00p	618.2p
27	1	97.92	97.92	33.00p	864.0p

Post Steady-State Life Test Results at 125°C

TEST#		2
SYMBOL		ICBO
COND.1		5.00 V
COND.2		
MAX LIMIT		1.000uA
MIN LIMIT		
SER #	BIN	A
5	1	236.0p
6		---
7	1	160.0p
8	1	376.0p
9	1	158.0p
10	1	210.0p
11	1	176.0p
12	1	316.0p
13	1	159.0p
14	1	207.0p
15	1	357.0p
16	1	143.0p
17	1	284.0p
18	1	245.0p
19	1	162.0p
20	1	114.0p
21	1	256.0p
22	1	175.0p
23	1	214.0p
24	1	186.0p
25	1	105.0p
26	1	113.0p
27	1	367.0p

Post Steady-State Life – Delta Results

NO.	T#	ITEM	POST BURN-IN (TP 2)	POST SSL (TP 3)	DELTA	DELTA %
5	2	HFE	97.80	96.50	-1.30	-1.33 %
	4	ICBO	69.00pA	197.0pA	128.0p	185.51 % F
	5	IEBO	777.0pA	566.0pA	-211.0p	-27.16 %
6	2	HFE	---	---		
	4	ICBO	---	---		
	5	IEBO	---	---		
7	2	HFE	100.90	100.60	-300.0m	-0.30 %
	4	ICBO	136.0pA	12.00pA	-124.0p	-91.18 % F
	5	IEBO	772.0pA	880.0pA	108.0p	13.99 %
8	2	HFE	96.35	95.98	-370.0m	-0.38 %
	4	ICBO	97.00pA	135.0pA	38.00p	39.18 %
	5	IEBO	812.0pA	727.5pA	-84.50p	-10.41 %
9	2	HFE	100.90	100.50	-400.0m	-0.40 %
	4	ICBO	41.00pA	85.00pA	44.00p	107.32 % F
	5	IEBO	854.5pA	718.0pA	-136.5p	-15.97 %
10	2	HFE	97.77	97.42	-350.0m	-0.36 %
	4	ICBO	163.0pA	83.00pA	-80.00p	-49.08 %
	5	IEBO	371.0pA	821.5pA	450.5p	121.43 % F
11	2	HFE	102.60	102.20	-400.0m	-0.39 %
	4	ICBO	134.0pA	75.00pA	-59.00p	-44.03 %
	5	IEBO	592.0pA	776.0pA	184.0p	31.08 %
12	2	HFE	100.80	100.60	-200.0m	-0.20 %
	4	ICBO	788.5pA	60.00pA	-728.5p	-92.39 % F
	5	IEBO	330.0pA	791.0pA	461.0p	139.70 % F
13	2	HFE	102.00	101.70	-300.0m	-0.29 %
	4	ICBO	63.00pA	148.0pA	85.00p	134.92 % F
	5	IEBO	832.0pA	774.0pA	-58.00p	-6.97 %
14	2	HFE	96.58	96.20	-380.0m	-0.39 %
	4	ICBO	206.0pA	16.00pA	-190.0p	-92.23 % F
	5	IEBO	103.7pA	530.0pA	426.3p	411.09 % F
15	2	HFE	96.76	96.33	-430.0m	-0.44 %
	4	ICBO	121.0pA	136.0pA	15.00p	12.40 %
	5	IEBO	808.0pA	757.5pA	-50.50p	-6.25 %
16	2	HFE	99.64	99.20	-440.0m	-0.44 %
	4	ICBO	19.00pA	150.0pA	131.0p	689.47 % F
	5	IEBO	810.5pA	833.0pA	22.50p	2.78 %

17	2	HFE	101.30	100.90	-400.0m	-0.39 %
	4	ICBO	19.00pA	89.00pA	70.00p	368.42 % F
	5	IEBO	928.5pA	764.7pA	-163.8p	-17.64 %
18	2	HFE	101.30	101.00	-300.0m	-0.30 %
	4	ICBO	155.0pA	43.00pA	-112.0p	-72.26 % F
	5	IEBO	615.0pA	668.1pA	53.10p	8.63 %
19	2	HFE	104.00	103.40	-600.0m	-0.58 %
	4	ICBO	123.0pA	132.0pA	9.000p	7.32 %
	5	IEBO	792.0pA	144.8pA	-647.2p	-81.72 % F
20	2	HFE	96.48	96.22	-260.0m	-0.27 %
	4	ICBO	239.0pA	99.00pA	-140.0p	-58.58 % F
	5	IEBO	659.0pA	794.0pA	135.0p	20.49 %
21	2	HFE	101.10	100.60	-500.0m	-0.49 %
	4	ICBO	76.00pA	93.00pA	17.00p	22.37 %
	5	IEBO	981.5pA	768.0pA	-213.5p	-21.75 %
22	2	HFE	97.21	96.80	-410.0m	-0.42 %
	4	ICBO	54.00pA	237.0pA	183.0p	338.89 % F
	5	IEBO	836.0pA	166.7pA	-669.3p	-80.06 % F
23	2	HFE	101.30	100.80	-500.0m	-0.49 %
	4	ICBO	97.00pA	75.00pA	-22.00p	-22.68 %
	5	IEBO	883.0pA	774.2pA	-108.8p	-12.32 %
24	2	HFE	99.72	99.18	-540.0m	-0.54 %
	4	ICBO	151.0pA	275.0pA	124.0p	82.12 %
	5	IEBO	766.5pA	423.0pA	-343.5p	-44.81 %
25	2	HFE	97.98	97.38	-600.0m	-0.61 %
	4	ICBO	22.00pA	11.00pA	-11.00p	-50.00 %
	5	IEBO	860.0pA	749.5pA	-110.5p	-12.85 %
26	2	HFE	101.50	100.90	-600.0m	-0.59 %
	4	ICBO	26.00pA	74.00pA	48.00p	184.62 % F
	5	IEBO	218.9pA	618.2pA	399.3p	182.41 % F
27	2	HFE	98.56	97.92	-640.0m	-0.65 %
	4	ICBO	135.0pA	33.00pA	-102.0p	-75.56 % F
	5	IEBO	826.2pA	864.0pA	37.80p	4.58 %

Post Seal Dynamic Test Results at 25°C

19-Aug-2020

Preliminary BFR391 RF Data

Serial No.	f_T (GHz)	G_P (dB) 1 GHz	Noise Figure (dB)
1	14.9	16.8	2.1
2	14.9	16.8	2.1
3	14.6	16.8	2.1
4	14.8	16.7	2.1
5	14.9	16.9	2.1
6	14.8	16.8	2.1
7	14.8	16.8	2.1
8	14.8	16.8	2.1
9	14.8	16.7	2.1
10	14.8	16.8	2.1

Notes:

1. f_T testing performed on 8/18/2020.
2. f_T and G_P performed with Vce=5V, Ic=50 mA.
3. $f_T = h_{21}$ at 2 GHz * 2 GHz.
4. NF performed with Vce=5V, Ic=50 mA. Performed on 8/10/2020.
5. f_T minimum = 13 GHz, so all parts passed.
6. G_P typical is 17.5 dB (no limits)
7. NF maximum is 1.8 dB, so all parts failed (expected in the un-matched fixture).

Post Stabilization Bake
Dynamic Test Results at 25°C

BFR391 RF Test Data

12 Oct 2020-09:37:53

S. White

S/N	G_P (dB), 1 GHz	fT (GHz)	Noise Figure (dB)
5	16.9	15.8	2.1
7	16.8	15.8	2.0
8	16.9	15.6	2.1
9	16.8	15.8	2.0
10	16.9	15.8	2.1
11	16.9	15.8	2.1
12	16.9	15.9	2.1
13	16.8	15.8	2.1
14	16.9	15.8	2.1
15	16.8	15.8	2.0
16	16.8	15.5	2.1
17	16.9	15.9	2.1
18	16.9	15.6	2.1
19	16.9	15.7	2.1
20	16.9	15.8	2.1
21	16.9	15.8	2.1
22	16.8	15.7	2.1
23	16.9	15.8	2.1
24	16.8	15.7	2.1
25	16.9	15.8	2.1
26	16.9	15.9	2.1
27	16.8	15.3	2.1

NF reading expected due to the un-matched test fixture.

Post HTRB Dynamic Test Results at 25°C

BFR391 Post-HTRB RF Test Data

29 Oct 2020-09:37:53

S. White

S/N	G_P (dB), 1 GHz	fT (GHz)	Noise Figure (dB)
5	16.9	15.2	2.1
7	16.8	15.1	2.1
8	16.8	15.1	2.1
9	16.8	15.1	2.1
10	16.8	15.1	2.1
11	16.8	15.1	2.1
12	16.9	15.1	2.1
13	16.7	15.0	2.1
14	16.8	15.1	2.1
15	16.8	15.0	2.1
16	16.8	14.9	2.1
17	16.9	15.2	2.1
18	16.8	15.0	2.1
19	16.9	15.1	2.1
20	16.9	15.0	2.1
21	16.9	15.2	2.1
22	16.8	15.1	2.1
23	16.9	15.1	2.1
24	16.8	15.0	2.1
25	16.9	15.1	2.1
26	16.9	15.2	2.1
27	16.8	14.6	2.1

NF reading expected due to the un-matched test fixture.

Post Burn-In Dynamic Test Results at 25°C

BFR391 Post-Burn-In RF Test Data

09 Nov 2020-09:28:38

S. White

S/N	G_P (dB), 1 GHz	fT (GHz)	Noise Figure (dB)
5	16.9	16.3	2.1
7	16.8	16.1	2.1
8	16.8	16.1	2.1
9	16.8	16.2	2.1
10	16.9	16.1	2.1
11	16.9	15.9	2.1
12	16.9	16.0	2.1
13	16.8	16.0	2.1
14	16.8	15.9	2.1
15	16.8	16.1	2.1
16	16.8	15.8	2.1
17	16.9	16.2	2.0
18	16.8	16.1	2.1
19	16.9	16.1	2.1
20	16.9	16.0	2.1
21	16.9	16.2	2.1
22	16.8	16.1	2.1
23	16.8	16.1	2.1
24	16.9	16.0	2.1
25	16.9	16.2	2.1
26	16.8	16.2	2.1
27	16.8	15.6	2.1

NF reading expected due to the un-matched test fixture.

Post Steady-State Life
Dynamic Test Results at 25°C

BFR391 Post-Life Test RF Test Data

04-Jan-21

S. White

S/N	G_P (dB), 1 GHz	fT (GHz)	Noise Figure (dB)
5	16.9	15.6	2.1
7	16.9	16.0	2.1
8	16.9	15.9	2.1
9	16.9	15.9	2.1
10	16.9	15.9	2.1
11	16.9	15.8	2.1
12	16.9	16.1	2.1
13	16.8	15.7	2.1
14	16.9	16.0	2.1
15	16.9	16.1	2.1
16	16.9	15.6	2.1
17	16.9	16.1	2.1
18	16.9	16.0	2.1
19	16.9	15.8	2.1
20	16.9	15.9	2.1
21	16.9	16.1	2.1
22	16.9	15.9	2.1
23	16.9	15.9	2.1
24	16.8	15.9	2.1
25	16.9	15.9	2.1
26	16.9	16.0	2.1
27	16.9	15.5	2.1

NF reading expected due to the un-matched test fixture.

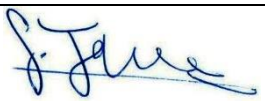
DIE CONSTRUCTIONAL ANALYSIS REPORT

Spur Report No: L.2010.4259

Part No: BFR391
Lot No: 1Z113767, W-5
Customer: Die Devices

Report Prepared by:

SPUR ELECTRON Ltd. - LABORATORY SERVICES

Analysed and Prepared By:	Alex Paulson	**Signature:** 	Date & QC Stamp:	24/02/2021	
Approved By:	Fergus Jackson	**Signature:** 	Date & QC Stamp:	25/02/2021	

Sample Details;-

Customer P.O: #SS688
Manufacturer: Silicon Supplies
Lot No: 1Z113767, W-5
Log: 5360
Data Code: 3/21

Analysis

The dice were tested IAW the requirements of MIL-STD-883K, Method 5007.8 (Wafer Lot Acceptance Test). An additional requirement of testing IAW MIL-PRF-38534L, Para C.3.3.6 was confirmed by the customer. These standards & specifications refer to MIL-STD-750-2A, Method 2077.5 for SEM analysis of dice of this type.

a) Detailed surface examination
b) Optical inspection
c) SEM
d) Material analysis
e) Technology and description

Summary

a)
- No evidence of scratching present.
- Evidence of mechanical damage was seen on all sample die examined.
- No cracking or corrosion was identified.
- No process related faults were identified.

b) An electronic record was made of the inspection and the images are presented in this report.
c) EDX analysis confirmed the materials identified in the manufacturer's datasheet. .
d) The die analysed are 16.5GHz fT Wideband NPN chips with Aluminium "front side" bond pads & metallisation, and Gold "backside" metallisation.

Conclusion

- A batch related fault was identified on all dice during initial inspection & SEM analysis. Tooling marks were present on the Emitter bond pad edge of all dice. However, MIL-STD-750-2A, Method 2077.5, Para 3.7 Accept/reject criteria confirms "Rejection of dice shall be based upon batch process oriented defects. Rejection shall not be based upon workmanship and other type defects such as scratches, smeared metallization, or tooling marks." Therefore all damage seen is considered acceptable.
- The construction of the BFR391 dice manufactured by Silicon Supplies; was found not to conform to the manufacturer's datasheet due to the bond pad dimensions being ~5-15µm less than the allowed tolerance. However, all other measurements & results were satisfactory.

The 16 die submitted for constructional analysis; (part no; BFR391, lot no; 1Z113767, W-5) were found to be satisfactory.

The photographic plates contained within this report represent examples of typical, or, where applicable, worst case views of the samples under analysis.

Detailed Surface Examination/Optical Inspection

All the die were optically inspected using a high powered microscope with magnification up to x400, inspection was carried out at magnifications between 100x and 400x.

Test/Analysis		Result
Die surface	Integrity	See comments
	Scratching	No scratching seen
	Contamination	No contamination seen
	Corrosion	No corrosion seen
	Cracking	No cracking seen
	Voiding	No voiding seen
Glassivation	Material	Silicon Nitride
	Integrity	Satisfactory
Die Identification	*N/A*	

Comments: Damage to the Emitter bond pad edge was observed on all dice. However, MIL-STD-750-2A, Method 2077.5, Para 3.7 Accept/reject criteria confirms “Rejection of dice shall be based upon batch process oriented defects. Rejection shall not be based upon workmanship and other type defects such as scratches, smeared metallization, or tooling marks.” Therefore all damage seen is considered acceptable.

External Visual Inspection

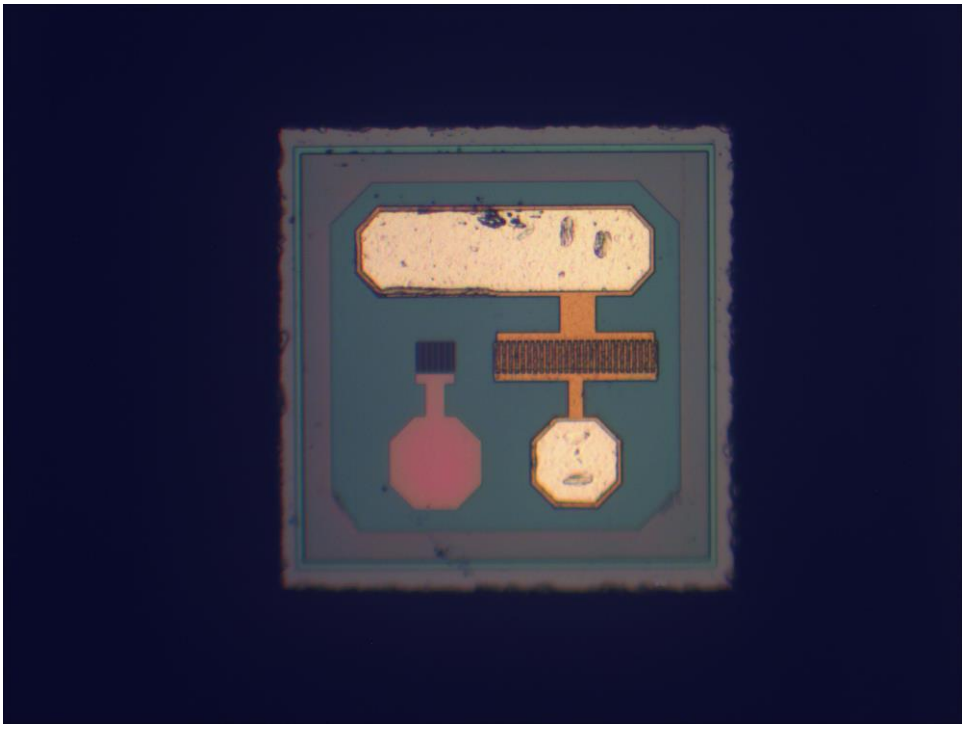


Plate	1	Initial Optical Inspection
Magnification	X200	Overall view of die
Serial No.	1	Disturbed perimeter of Emitter bond pad observed, this is acceptable IAW MIL-STD-750-2A, Method 2077.5, Para 3.7

External Visual Inspection (Cont.)

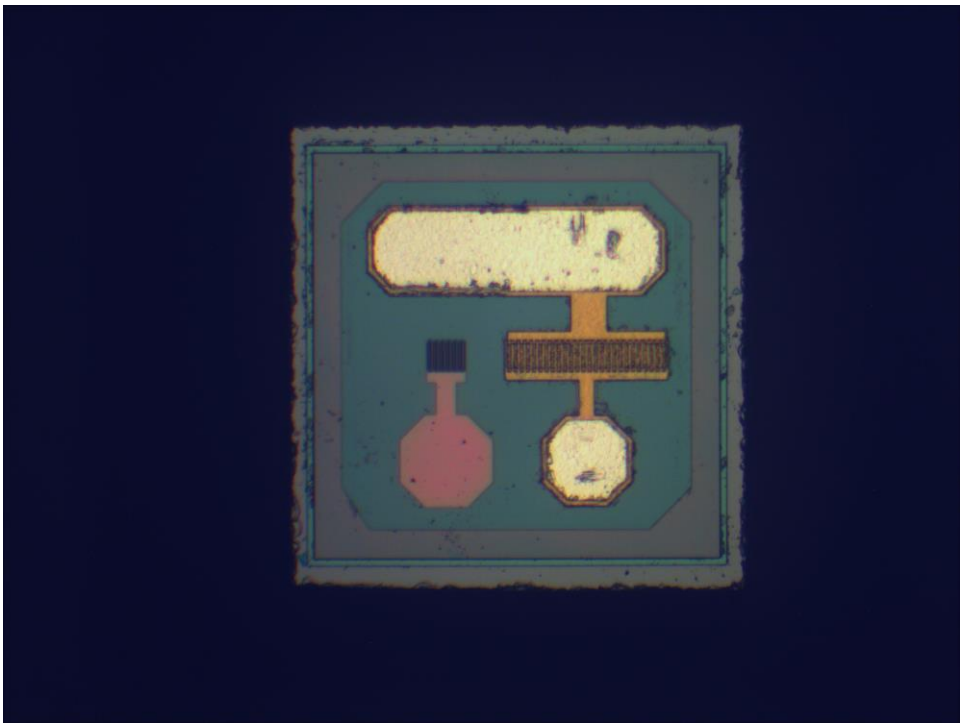


Plate	2	Initial Optical Inspection
Magnification	X200	Overall view of die
Serial No.	5	Disturbed perimeter of Emitter bond pad observed, this is acceptable IAW MIL-STD-750-2A, Method 2077.5, Para 3.7

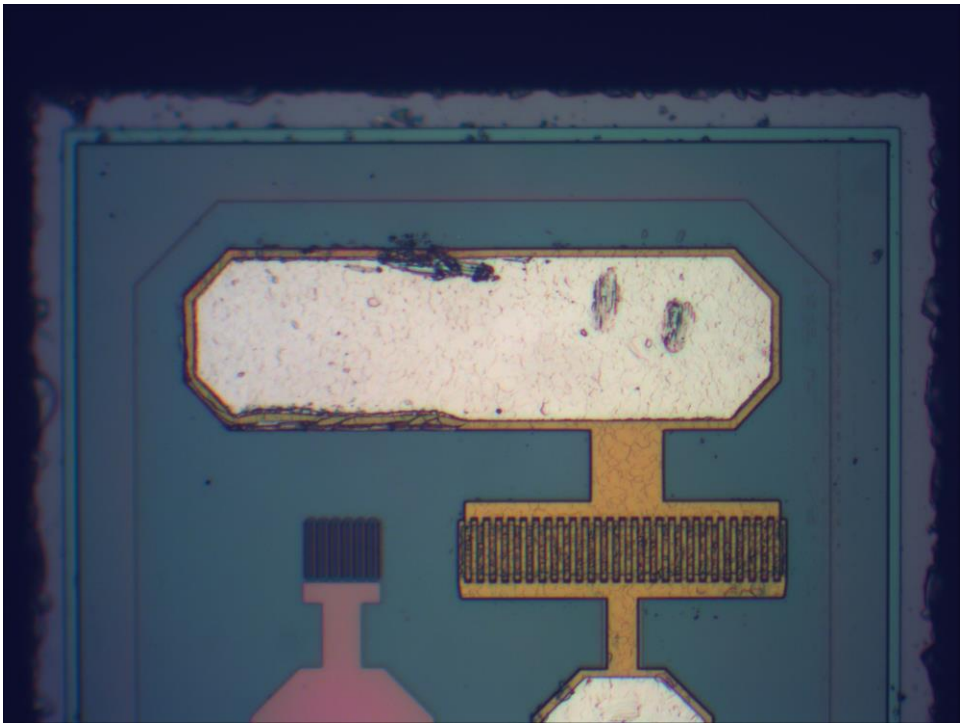


Plate	3	Initial Optical Inspection
Magnification	X400	Detailed view of die topography
Serial No.	3	Disturbed perimeter of Emitter bond pad observed, this is acceptable IAW MIL-STD-750-2A, Method 2077.5, Para 3.7

SEM Inspection

- A SEM inspection was carried out on the die topography.
- The calibrated measurement facility of the SEM was used to confirm the dimensions IAW the manufacturer's datasheet.
- 2 dice was prepared for microsection by potting in a slow thermosetting epoxy resin and sectioned to a point approximately half way through the die (to confirm construction of metallisation) & to a point approximately half way through the Emitter bond pad, respectively.
- The EDX facility of the SEM was used for material analysis.

Results of SEM Inspection

Inspection Criteria	**S/no and Results**
	1 - 16
Oxide steps - oxide steps are defined as metallisation on all four directional edges of every type of oxide step. The metallisation shall be unacceptable if thinning and one or more defects such as voids, separations, notches, cracks, depressions, or tunnels reduce the cross sectional area of the metal at the directional edge to less than 50% of the metal cross sectional area on either side of the directional edge.	Pass
General metallisation - general metallisation is defined as metallisation at all locations except at oxide steps, and shall include metallisation (stripes) in the actual contact window regions. Any metallisation pulling or lifting (lack of adhesion) shall be unacceptable.	Pass
General metallisation - any defects such as voids which reduce the cross sectional of the metallisation (stripe) by more than 50% shall be unacceptable.	Pass

Table of Results for Measurements and Material Analysis

		Manufacturer's Datasheet	**Actual Measurement**	**Material**
Die	Width	350µm (unsawn)	311µm	Silicon
	Length	350µm (unsawn)	302µm	
	Thickness	150 (±20) µm	145µm	
Emitter Bond Pad	Width	65µm	60µm	Aluminium
	Length	210µm	195µm	
Base Bond Pad		65µm	60µm	
Glassivation Thickness**		0.6µm	816nm	Silicon Nitride / Silicon Oxide
Metallisation Thickness		0.6µm	1.04µm	Aluminium
Backing Metallisation Thickness**		0.6µm	913nm	Gold

Notes No information regarding minimum glassivation thickness is available in the die datasheet. Minimum thickness of glassivation is measured with reference to MIL-PRF-38535, Para A.3.5.8.**

The Base & Emitter bond pad dimensions are 5-15µm less than specified in the datasheet. However, all other results were satisfactory.

SEM Inspection (Cont.)

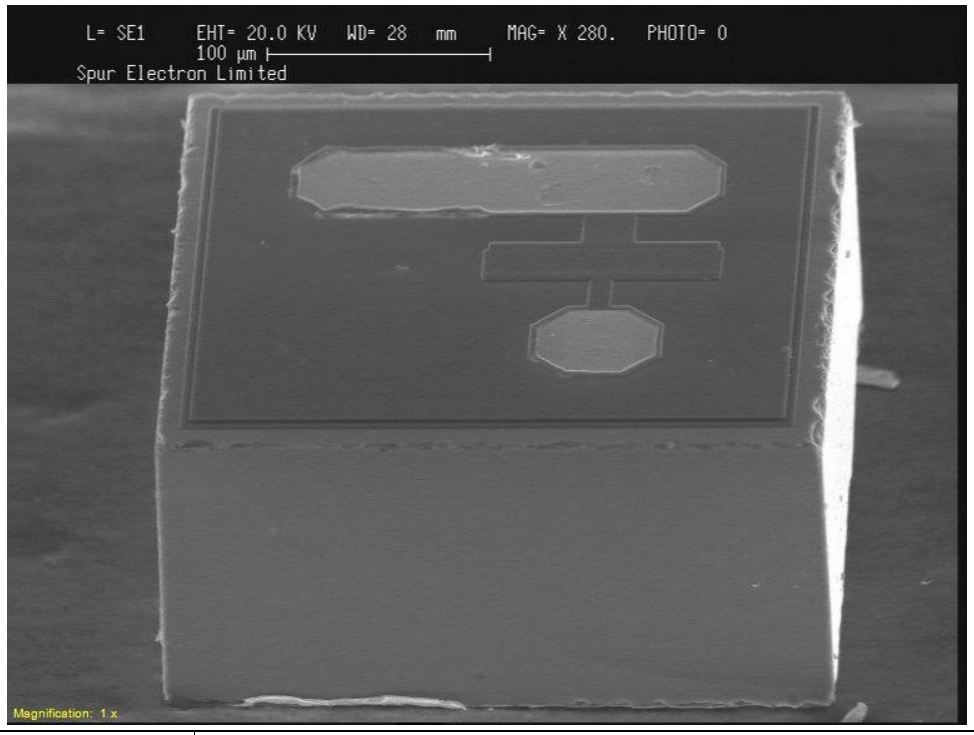


Plate	4	SEM Inspection
Magnification	X280	Overall view of die
Serial No.	2	Disturbed perimeter of Emitter bond pad observed, this is acceptable IAW MIL-STD-750-2A, Method 2077.5, Para 3.7

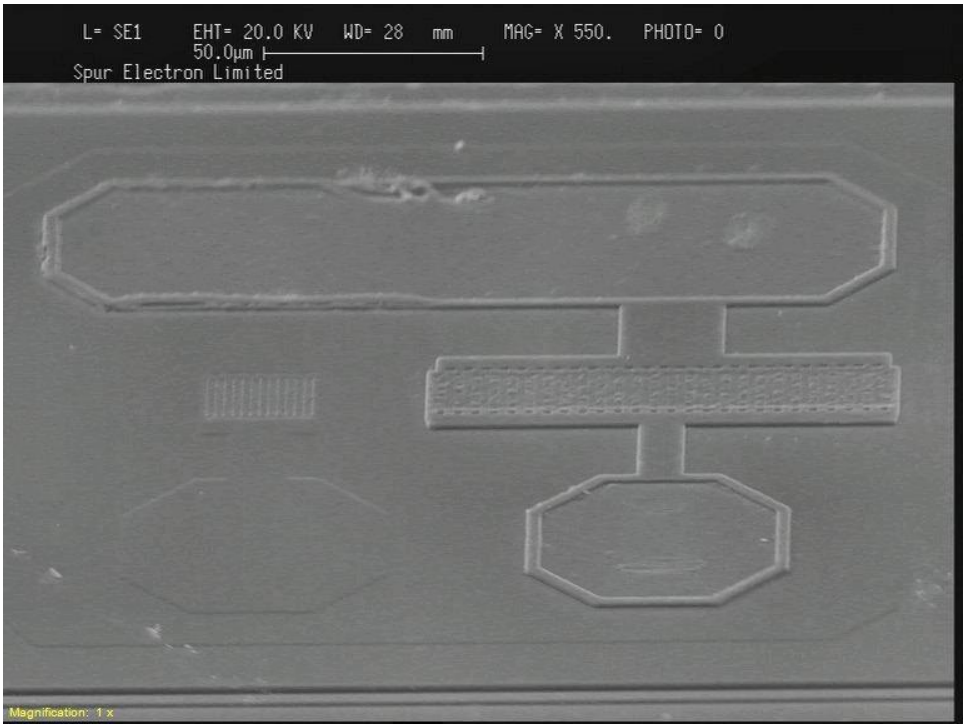


Plate	5	SEM Inspection
Magnification	X550	General metallisation overview
Serial No.	4	Disturbed perimeter of Emitter bond pad observed, this is acceptable IAW MIL-STD-750-2A, Method 2077.5, Para 3.7

SEM Inspection (Cont.)

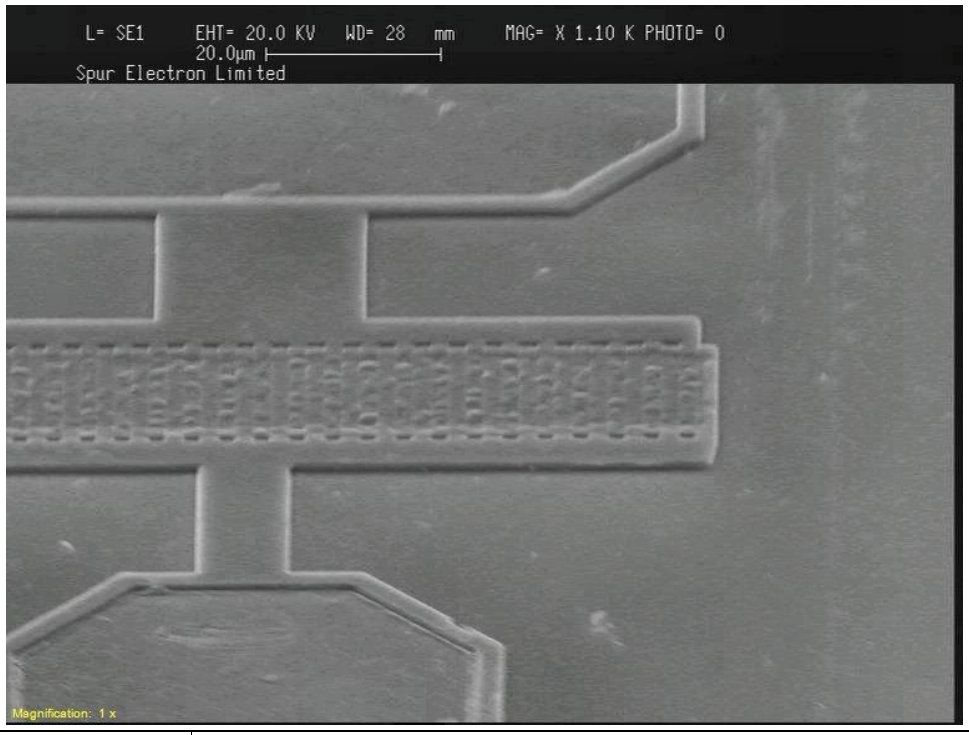


Plate	6	SEM Inspection
Magnification	X1.10k	Detailed view of metallisation
Serial No.	3	Pre-glassivation removal

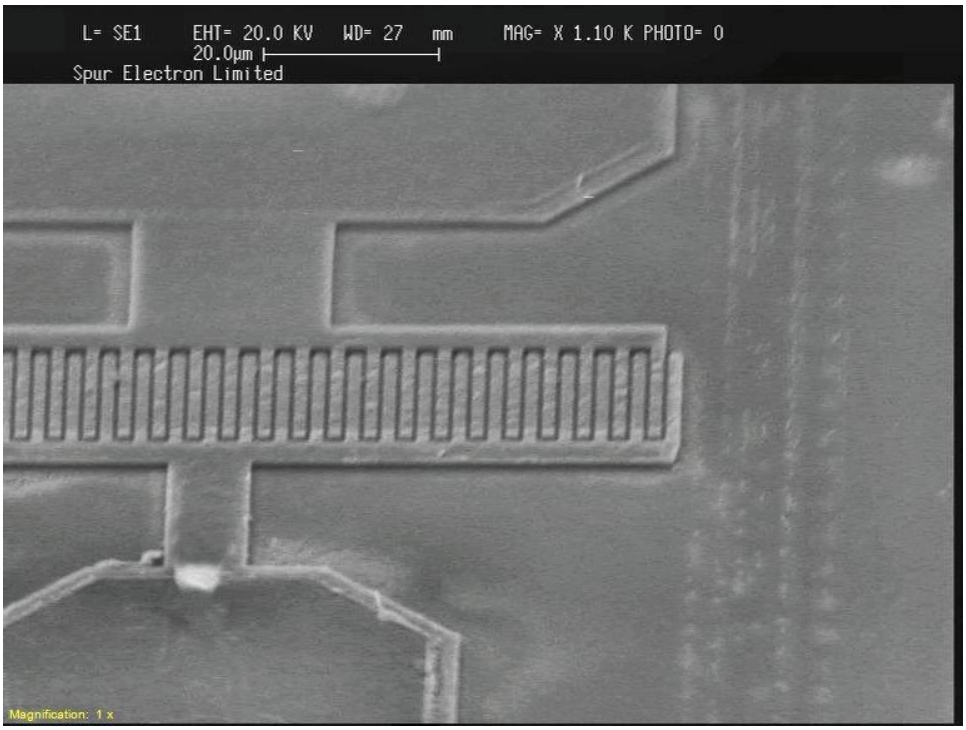


Plate	7	SEM Inspection
Magnification	X1.10k	Detailed view of metallisation
Serial No.	8	Post-glassivation removal,

SEM Analysis (Cont.)

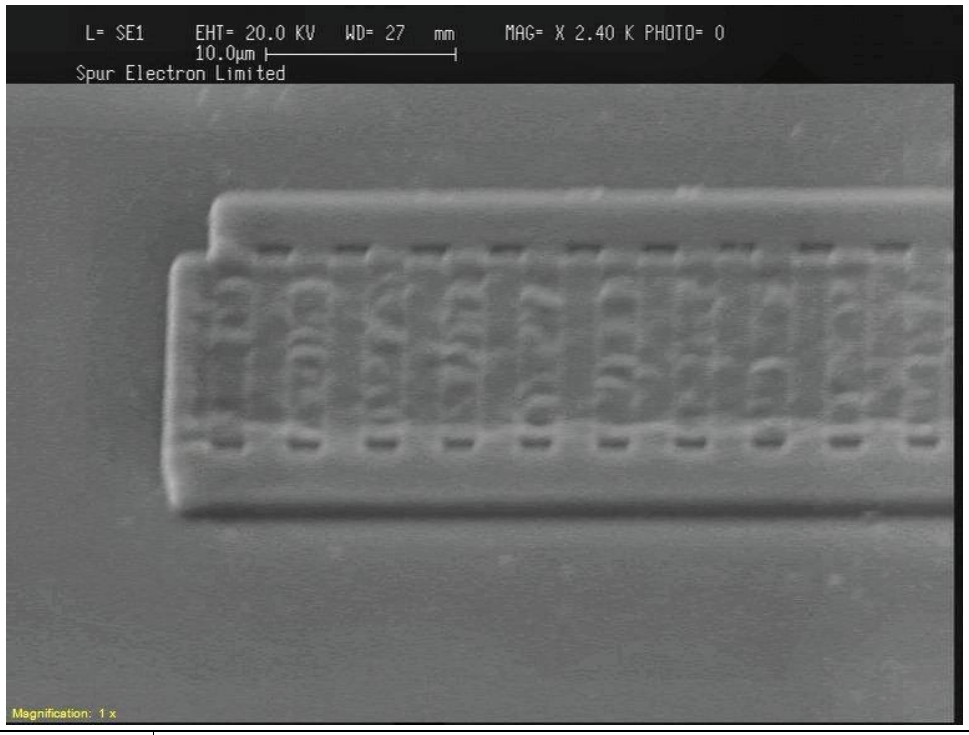


Plate	8	SEM Inspection
Magnification	X2.40k	Detailed view of metallisation
Serial No.	1	Pre-glassivation removal

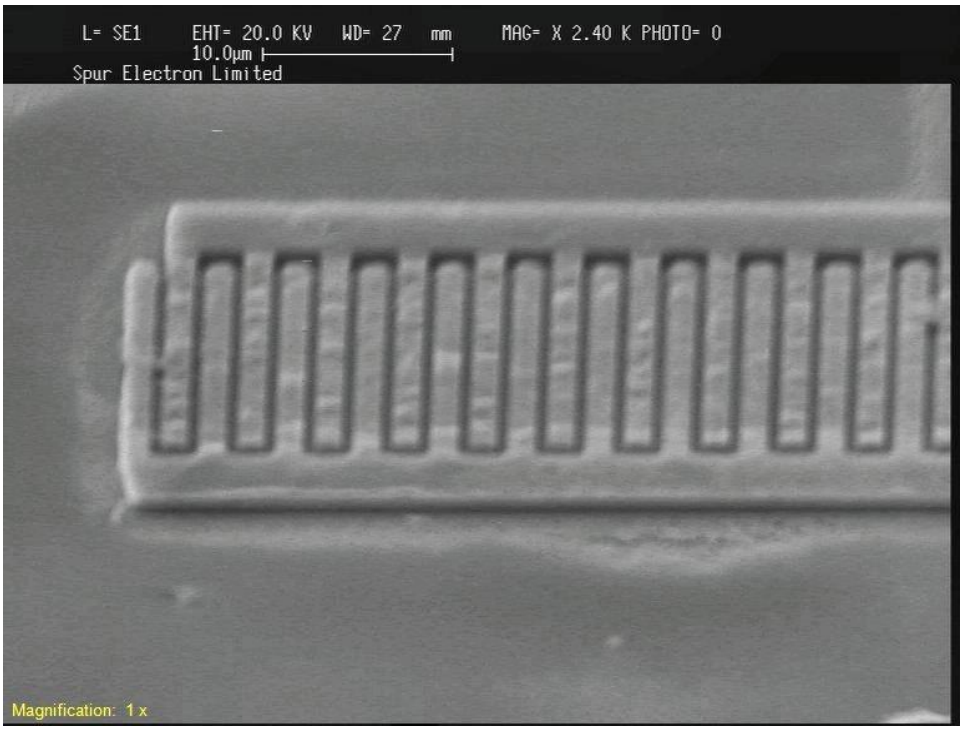


Plate	9	SEM Inspection
Magnification	X2.40k	Detailed view of metallisation
Serial No.	8	Post-glassivation removal

SEM Inspection (Cont.)

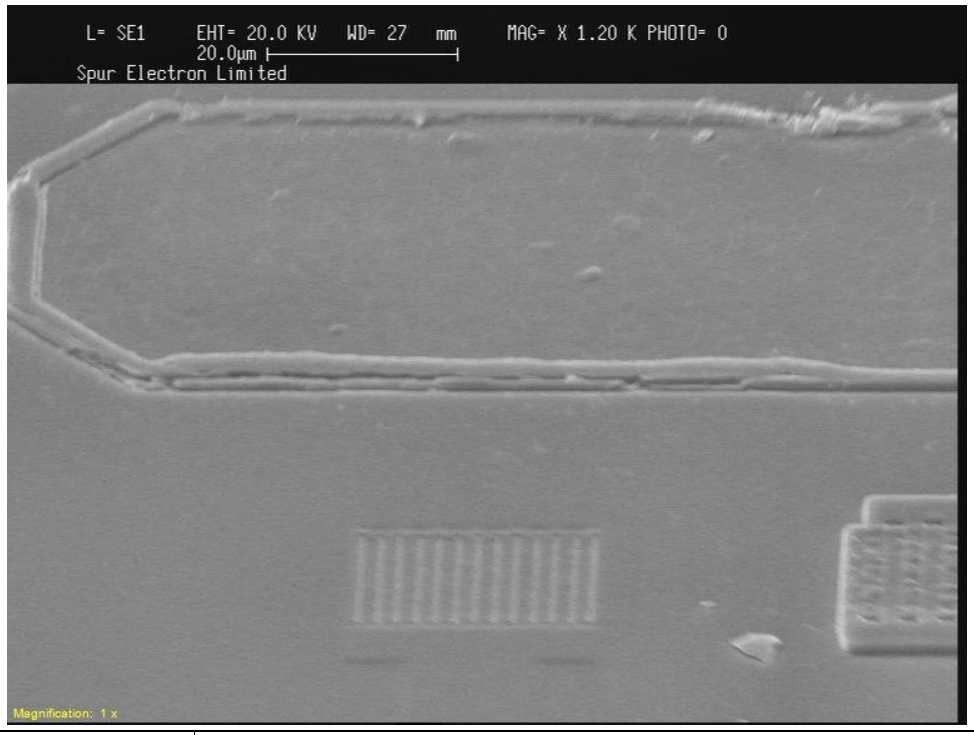


Plate	10	SEM Inspection
Magnification	X1.20k	Overall view of damage to bond pad edge
Serial No.	6	Disturbed perimeter of Emitter bond pad observed, this is acceptable IAW MIL-STD-750-2A, Method 2077.5, Para 3.7

Plate	11	SEM Inspection
Magnification	X1.80k	Detailed view of damage to bond pad edge
Serial No.	6	Disturbed perimeter of Emitter bond pad observed, this is acceptable IAW MIL-STD-750-2A, Method 2077.5, Para 3.7

SEM Analysis (Cont.)

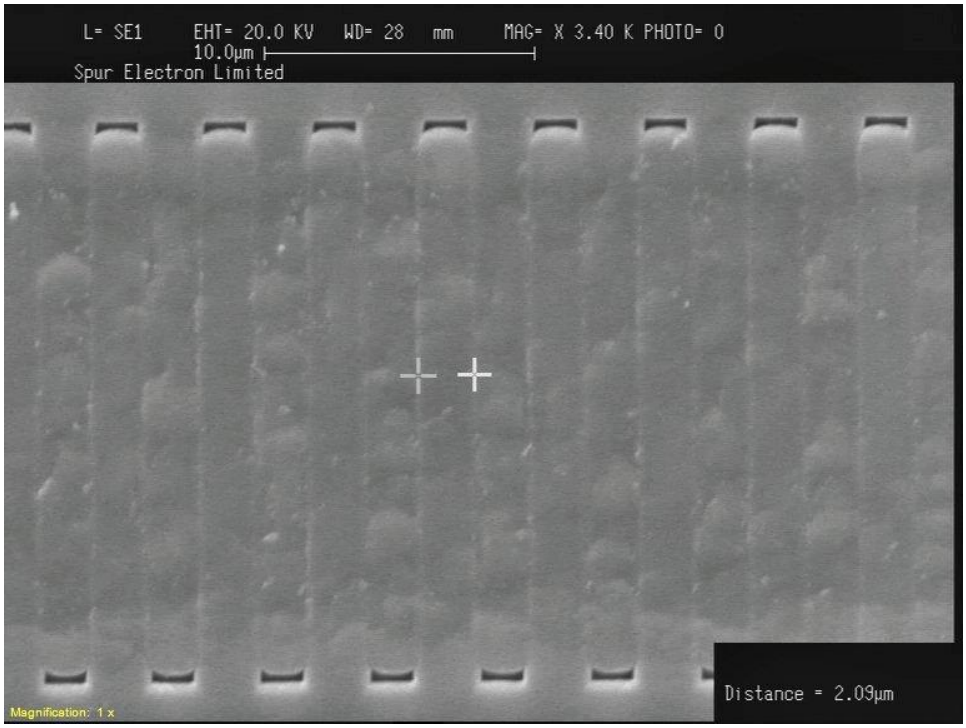
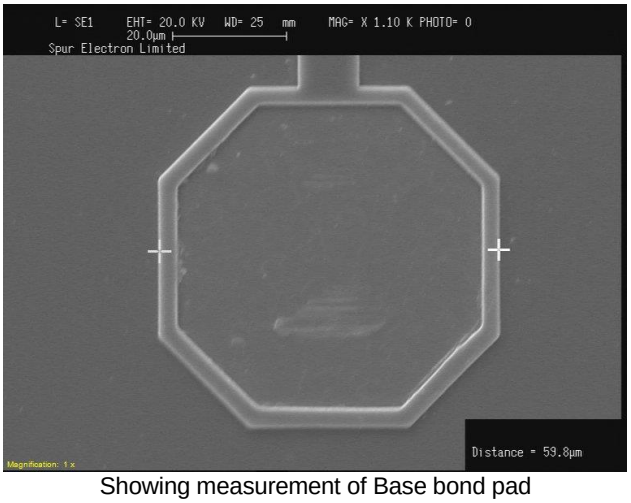
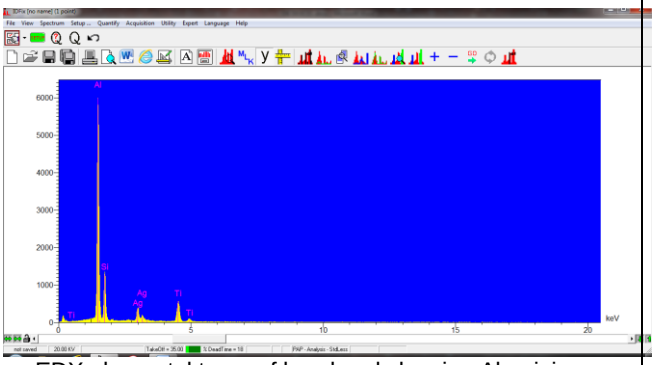


Plate	12	SEM Inspection
Magnification	X3.40k	Showing measurement of thinnest metallisation track
Serial No.	4	Width of thinnest metallisation track is ~2µm



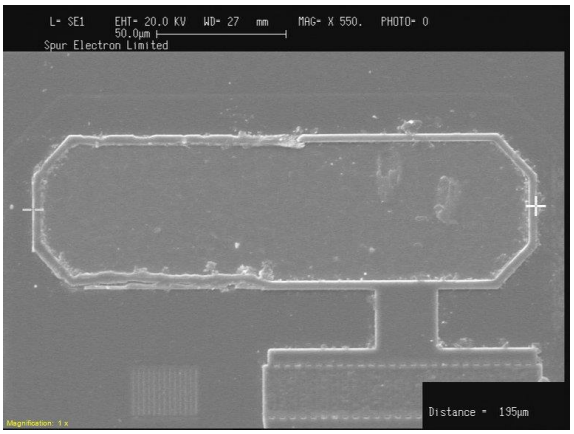
Showing measurement of Base bond pad



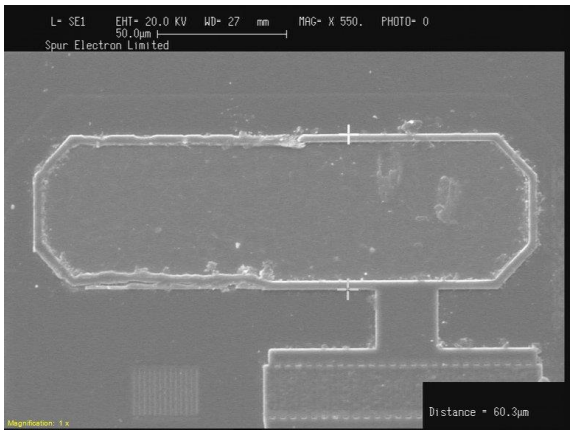
EDX elemental trace of bond pad showing Aluminium, background traces of Silicon, Titanium & Silver (Silver due to sample preparation)

Plate	13	SEM Inspection
Magnification	X1.10k	Showing Base bond pad measurement of ~60µm
Serial No.	6	EDX of bond pad showing Aluminium, background traces of Silicon & Titanium (Silver due to sample preparation)

SEM Analysis (Cont.)

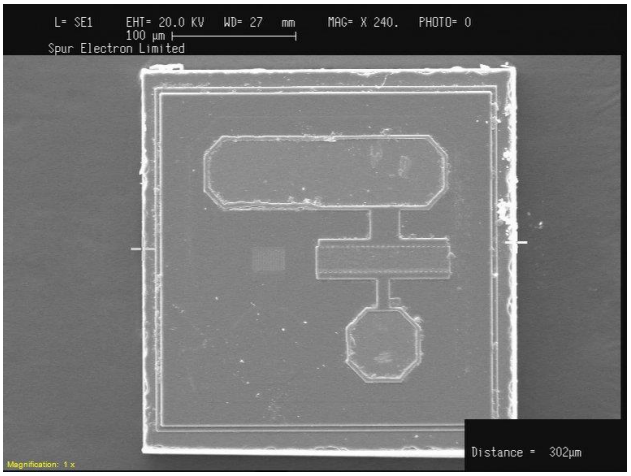


Showing length measurement of Emitter bond pad

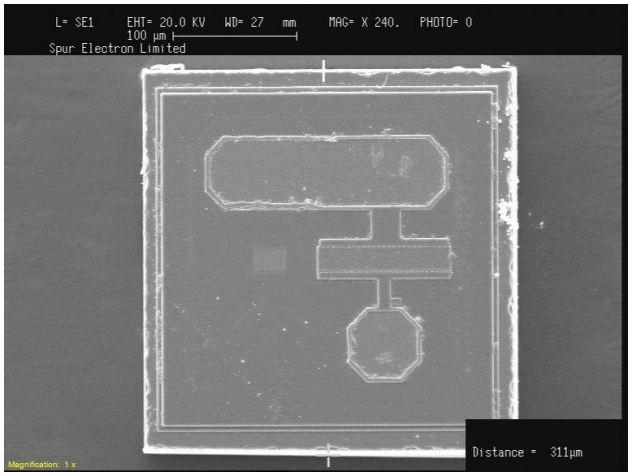


Showing width measurement of Emitter bond pad

Plate	14	SEM Inspection
Magnification	X550	Showing Emitter bond pad measurement
Serial No.	5	Length= 195µm & Width=60.3µm



Showing length measurement of die



Showing width measurement of die

Plate	15	SEM Inspection
Magnification	X240	Showing measurement of the die
Serial No.	5	Length= 302µm & Width=311µm

SEM Analysis (Cont.)

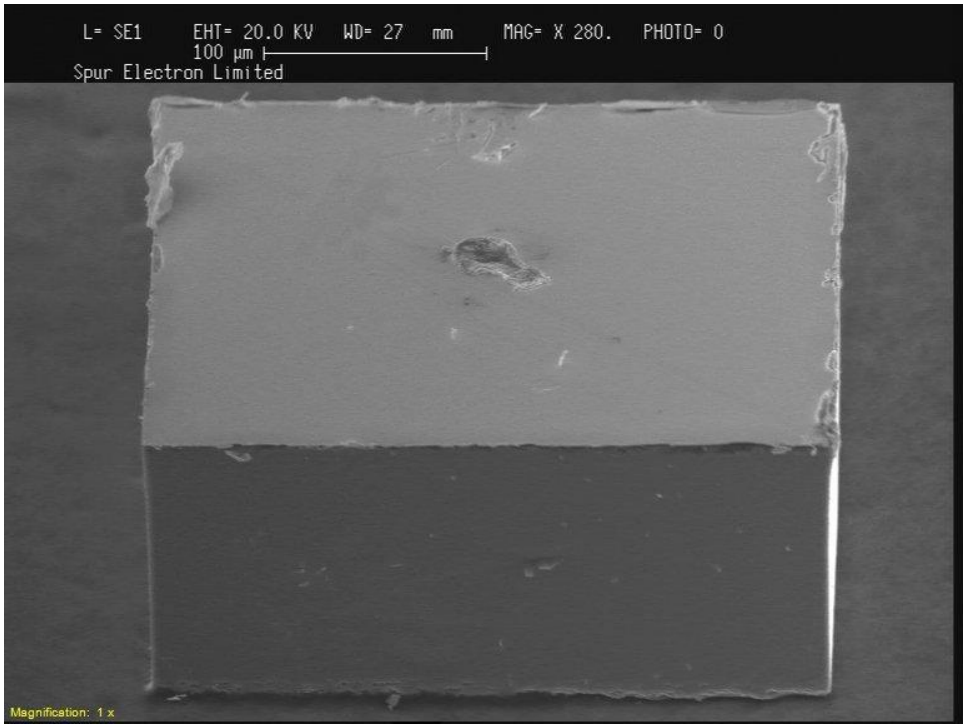
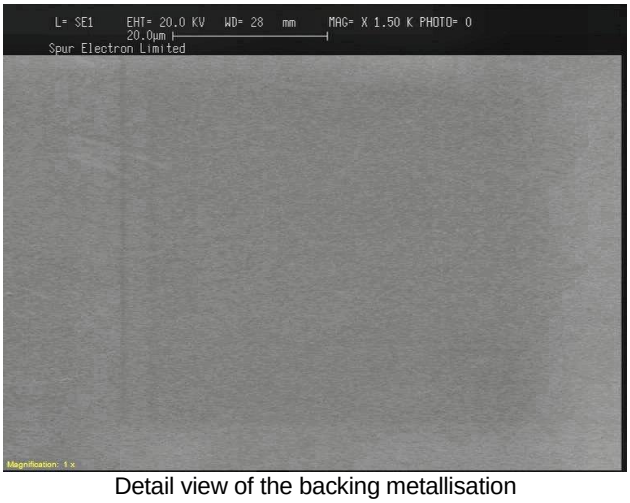
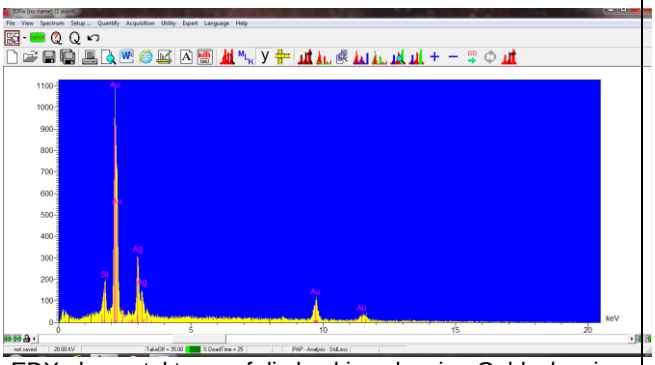


Plate	16	SEM Inspection
Magnification	X280	Showing the die backing metallisation
Serial No.	7	Silicon debris observed on die backing surface



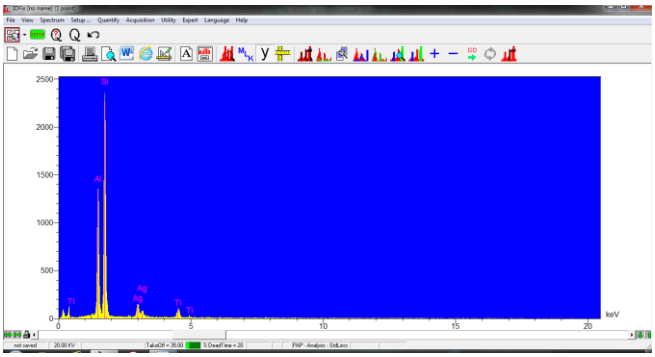
Detail view of the backing metallisation



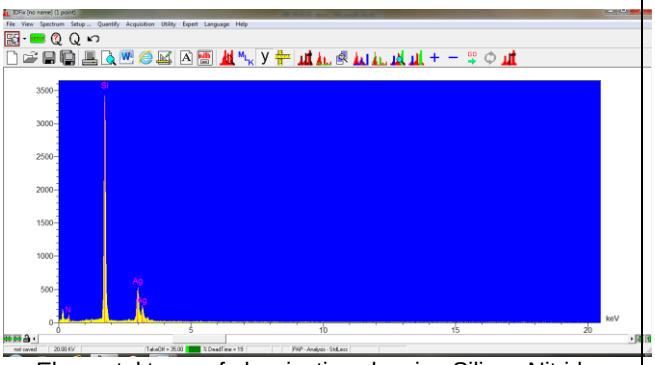
EDX elemental trace of die backing showing Gold, showing background traces of Silicon & Silver (Silver due to sample preparation)

Plate	17	SEM Inspection
Magnification	X1.50k	Showing die backing metallisation
Serial No.	7	EDX of die backing metallisation showing Gold, background traces of Silicon & Silver (Silver due to sample preparation)

SEM Analysis (Cont.)



Elemental trace of metallisation showing Aluminium



Elemental trace of glassivation showing Silicon Nitride

Plate	18	EDX Analysis
Magnification	-	Showing elemental traces for metallisation & glassivation
Serial No.	-	Silver (Ag) trace observed due to sample preparation

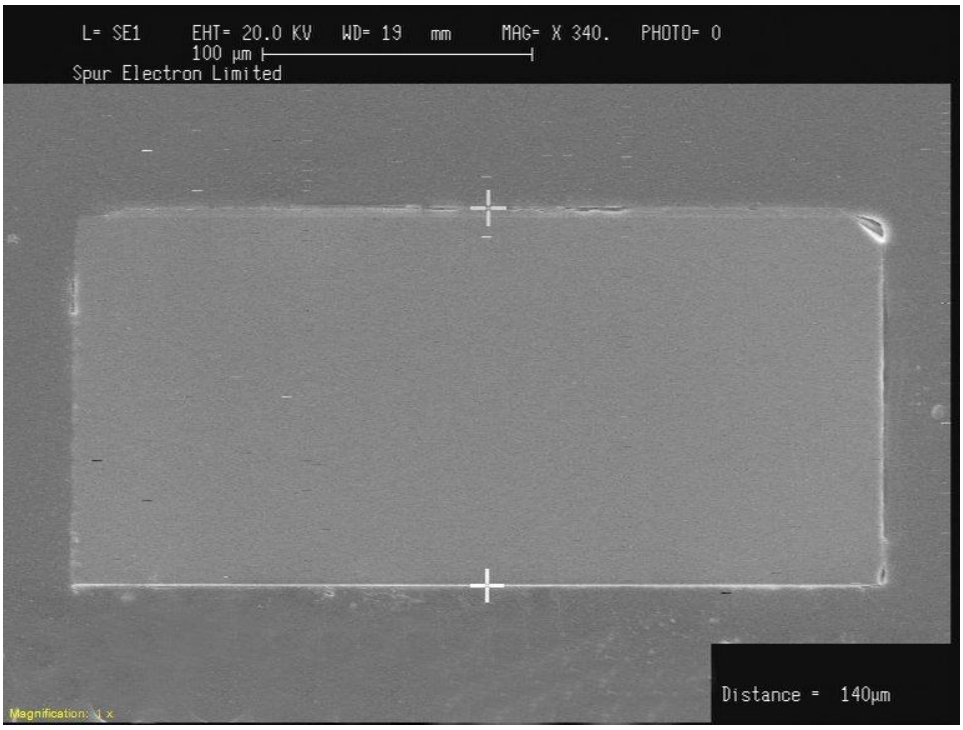


Plate	19	Microsection Analysis
Magnification	X340	Showing overall of die in microsection
Serial No.	10	Showing die thickness of 140µm

SEM Analysis (Cont.)

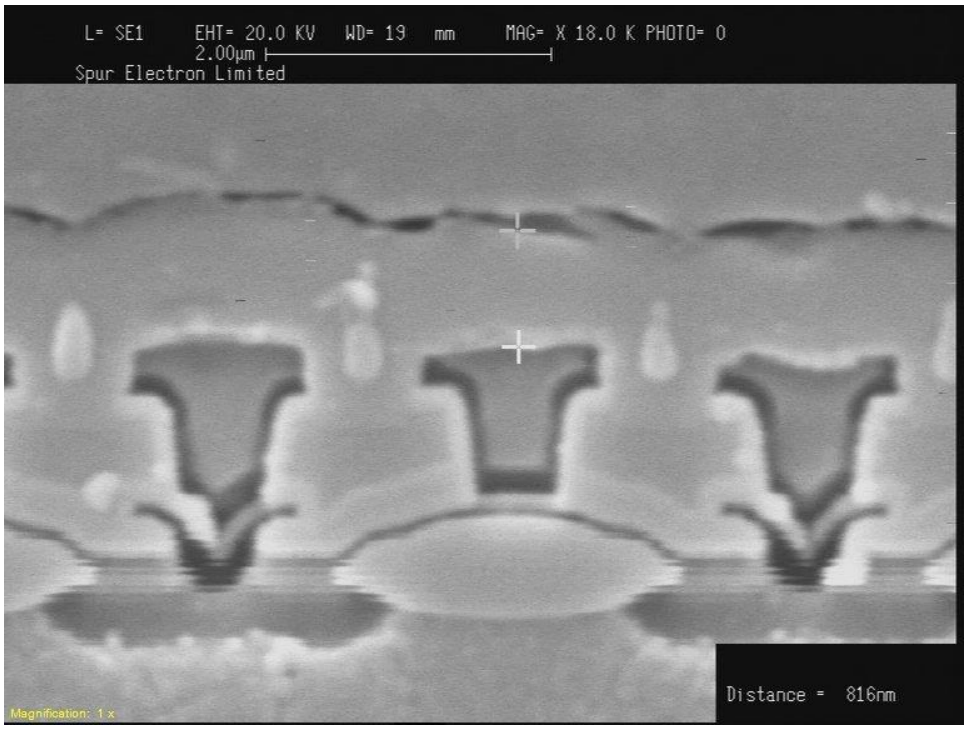


Plate	20	Microsection Analysis
Magnification	X18.0k	Showing single metallisation layer (M1) covered by glassivation layer (G1)
Serial No.	10	Glassivation (G1) thickness of 816nm

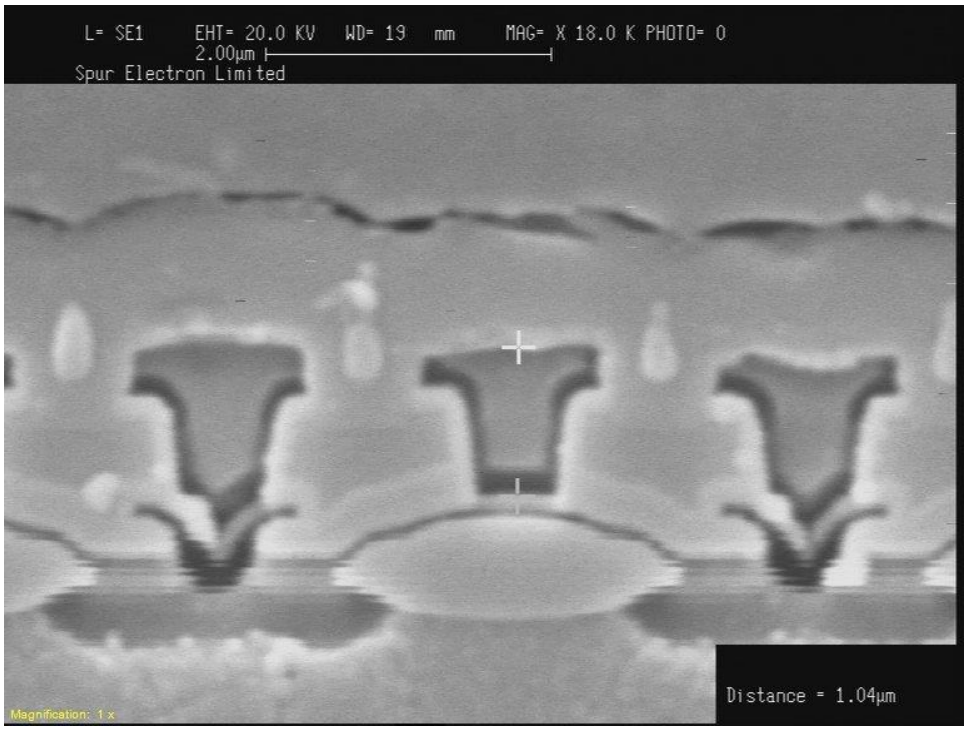


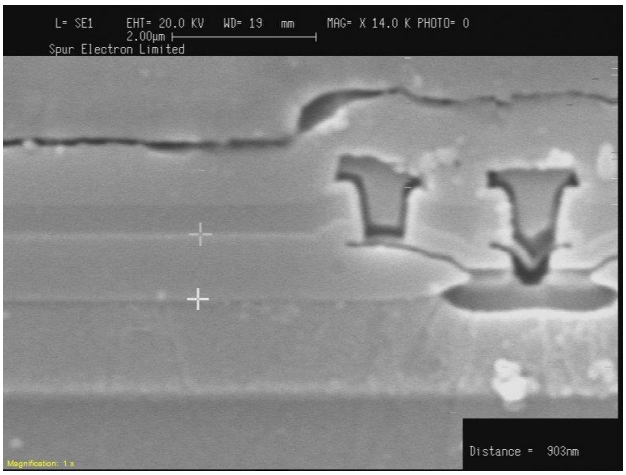
Plate	21	Microsection Analysis
Magnification	X18.0k	Showing single metallisation layer (M1) covered by glassivation layer (G1)
Serial No.	10	Metallisation (M1) thickness of 1.04µm

SEM Analysis (Cont.)

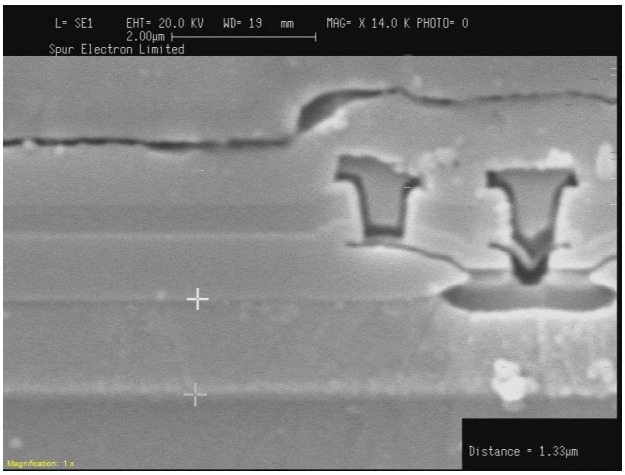
Plate	22	Microsection Analysis
Magnification	X12.0k	Showing bond pad Aluminium metallisation thickness
Serial No.	10	Metallisation thickness of 816nm

Plate	23	Microsection Analysis
Magnification	X12.0k	Showing bond pad passivation thickness, damage to upper bond pad edge caused during chemical etching
Serial No.	10	Passivation thickness of 934nm

SEM Analysis (Cont.)



Showing passivation layer



Showing passivation layer

Plate	24	Microsection Analysis
Magnification	X14.0k	Showing passivation layers
Serial No.	10	Passivation thickness =903nm & 1.33µm

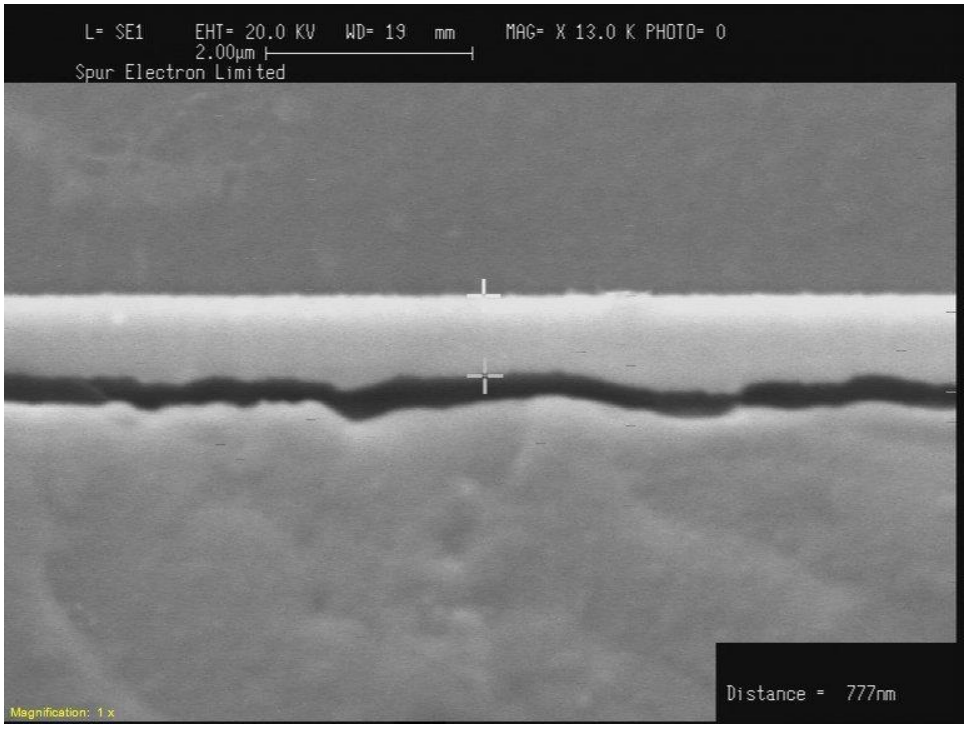


Plate	25	Microsection Analysis
Magnification	X13.0k	Showing gold backing metallisation layer. Dark line in image is separation from the epoxy mould caused during chemical etching
Serial No.	10	Gold backing metallisation layer thickness of 777nm