EXHIBIT No. 3 (CTD.)

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E.I. NO ... YM19 ...

SHEET NO ... 1 of 2 ...

TITLE GENERAL BUILD STANDARD - SAW DEVICES

BOND STRENGTH TEST

SCOPE To provide standard quality audit procedure for the monitoring of wire bonding.

PARTS Bonded devices.

EQUIPMENT

1. Bond strength microtester MCT 20 fitted with stereo zoom microscope X14 thru X60 magnification. For use refer to EI YR10.
2. Stereo zoom microscope - X20 thru X140.
3. Bond strength record sheet.

PRECAUTIONS

1. Use static lead when handling static sensitive devices.

PROCEDURE BOND STRENGTH TEST

1. Reset printer to Zero and load device in the appropriate chuck.
2. Set load rate knob and set machine to destruct mode.
3. Check load setting on machine is set to the required specification as shown in Table 1.
4. Adjust the microscope to focus on the centre of the device.
5. Determine the first wire to be tested. Carefully lower test hook until it is in focus, but still above the wire to be tested.
6. Lock chuck into position and using extreme care lower hook underneath wire by manipulating the paddle control and set lower limit.
7. Press test button and observe reading.
8. Repeat 5-7 on the specified number of wires to be pulled (See frequency)
9. Press print header switch to record details of device type. Batch number, Date, bonder machine number and results of print-out obtained from machine.
10. Inform Engineer/Technician if one or more wires fail on or below the load figure specified.

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SHEET NO 2 of 2

TITLE GENERAL BUILD STANDARD - SAW DEVICES
BOND STRENGTH TEST

PROCEDURE CONTINUED:-

11. Following re-setting or adjustments to bonding machine. Engineer to take further sample and re-test device with machine set to the destructive testing mode.

12. Repeat steps 5 - 9 and record details on record sheet.

13. When testing is complete remove device from chuck and reset machine to top limit.

14. Attach Bond Strength Record Sheet to PR Sheet.

NOTE:- If there is insufficient clearance under a wire to enable a pull test to be done a wire may be bonded with a loop on the same metalisation for a pull test.

FREQUENCY DESTRUCTIVE TESTING

a) 10% of devices per batch are to be tested unless specified differently in the appropriate device EI.

(N.B. this test can be performed on electrical reject devices.)

b) In addition destructive testing to be carried out following any re-setting of bonding machine by engineer/technician.

PROCEDURE VISUAL INSPECTION

1. For visual acceptance of wire bonding refer to EI AY3.

2. Samples must be taken on change of device number and following any re-setting or adjustments to bonding machine.

TABLE 1

WIRE MATERIAL	WIRE DIAMETER	MINIMUM LOAD
ALUMINIUM	.001"	2.5 GRAMS
GOLD	0.001"	2.5 GRAMS
GOLD	0.0007"	1.0 GRAM
GOLD	0.0005"	0.6 GRAM
GOLD	0.0003"	0.2 GRAM

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EXHIBIT No. 3 (CTD.)

GEC RESEARCH LABORATORIES

HIRST RESEARCH CENTRE

WEMBLEY MIDDLESEX HA9 7PP

Laboratory Report No: 17029/MS

Author: B R Brown

For : Piezoelectric Technology

Date : 19 April 1984

MATERIALS SCIENCE LABORATORY

MATERIALS CHARACTERISATION DIVISION

ORIENTATION DETERMINATION OF TWO LITHIUM NIOBATE SLICES

Abstract

Orientation measurements on lithium niobate substrate slices for SAW devices confirmed that the samples were Y-cut $\{10\bar{1}0\}$. A Hilger and Watts Y130 Quartz Crystal Goniometer was used.

Measurements on the edge perpendicular to the Z <0001> direction gave deviations within 20' for one slice and $1^{o}25'$ for the other slice. Accuracy would be limited by the flatness of the edge measured. A special stage could be constructed for the edge determination if required.

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MATERIALS SCIENCE LABORATORY

MATERIALS CHARACTERISATION DIVISION

Laboratory Report No: 17029/MS B R Brown

Date : 19 April 1984

For : Piezoelectric Technology

Approved by:
C Dineen

ORIENTATION DETERMINATION OF TWO LITHIUM NIOBATE SLICES

1 Introduction

Lithium Niobate of suitable quality is being assessed as a substrate material for SAW devices. Criteria affecting the electrical performance of the completed devices are being established. Samples are being characterised in order to study the influence of substrate quality and orientation on electrical parameters (Report to be issued).

Two lithium niobate slices were received; nominally Y-cut, with a flat edge cut perpendicular to the Z axis. The slices were later sectioned into rectangles with the long edge parallel to the Z axis.

It was required to check the orientation of the slice surface and the perpendicular to the flat.

2 Method and Results

Orientation measurements were made using a Hilger and Watts Y130 Quartz Crystal Goniometer calibrated to read to 1'. A standard stage was used to check the Y-cut orientation. Device material was then cut from the slices and the off-cuts used to determine the direction of the Z-axis relative to the appropriate edge. For this measurement the slice was supported on the standard stage by accurately right angled ($\pm$ 2') glass blocks. This measurement could only be made perpendicular to the long direction of the appropriate edge. Two further measurements perpendicular to each other and at 45^{o} to the long direction of the edge were made using a glass V-groove. Difficulties were encountered due to the shape of the slice.. The results are tabulated.

3 Conclusions and Discussion

The samples were Y-cut $\{10\bar{1}0\}$ ($\pm$ 12').

The accuracy of the measurement of the Z direction is dependent on having a flat edge set perpendicular to the face of the slice and the Z direction. For slice A no deviation >12' was recorded, but for sample B a deviation greater than 1^{o} was obtained. It should be borne in mind that this could relate to the flatness of the edge.

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A special stage has been designed (Report No: 15511/MS) for the measurement of trapezium-shaped SAW α-quartz plates. A similar special mount could be constructed for measurements on standard size lithium niobate plate edges if required.

Head of Division: B P RICHARDS

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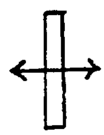
DB

TABLE EXHIBIT No. 3 (CTD.)

Sample	Nominal Orientation of face/edge	Measured deviation from nominal orientation ($\pm 5'$)
Circular Slice (No 3)	Y-cut $\{10\bar{1}0\}$	0° 5'
Circular Slice (No 4)	Y-cut $\{10\bar{1}0\}$	0° 7'
Cut piece (A) Pos 1	Z <0001>	⊥ 0° 8'
Cut piece (A) Pos 2	"	⊥ 0° 7'
Cut piece (A) Pos 3	"	* 0° 2'
Cut piece (A) Pos 4	"	* 0° 10'
Cut piece (A) Pos 5	"	* 0° 5'
Cut piece (A) Pos 6	"	* 0° 12'
Cut piece (B) Pos 1	"	0° 1'
Cut piece (B) Pos 2	"	0° 0'
Cut piece (B) Pos 3	"	1° 14'
Cut piece (B) Pos 4	"	1° 8'
Cut piece (B) Pos 5	"	1° 9'
Cut piece (B) Pos 6	"	1° 16'

⊥ Measurement ± to long direction of edge



* Measurement 45° to long direction of edge

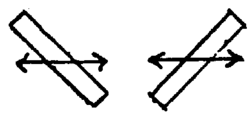


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EXHIBIT No. 3 (CTD.)

ORIENTATION MEASUREMENTS OF LITHIUM NIOBATE ($LiNbO_3$) AND α QUARTZ (SiO_2) SLICES FOR SAW DEVICES

Lithium Niobate Slices

The above Y-cut either rectangular or circular in shape. The long direction of the rectangle defines the Z-axis for the rectangular slices and the direction perpendicular to the flat for the circular slices. The requirement is to check the cut of the slice and the Z-axis direction.

α Quartz Slices

The slices were ST-cut. The requirement is to check the cut and the X-axis direction nominally parallel to one edge.

Orientation Measurements

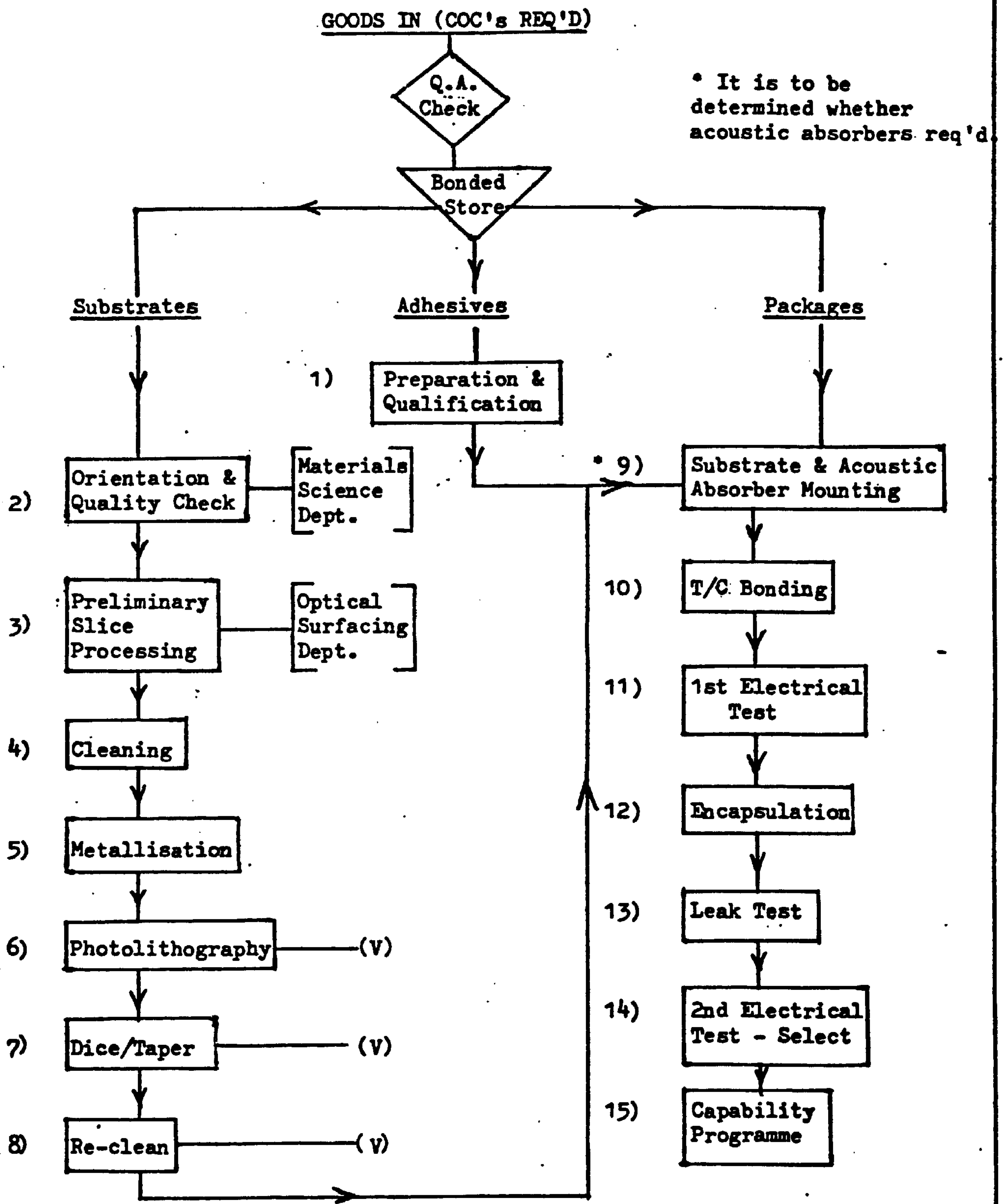
Angular deviations from the nominal orientation measured usinga Hilger & Watts Y130 Quartz Crystal Goniometer calibrated to read to one minute of arc. Determinations are made using a standard stage. For measurements on the edges the sample is supported by accurately right angled (<2′) glass blocks or a glass V-groove. Where the geometry of the slice allows measurements are made in two directions at right angles. The accuracy is dependant on the flatness and positioning of the edge. (Ref Report Numbers: 17029/MS and 1702[illegible])

If required a special stage could be constructed similar to that designed for trapezium shaped ST-quarter SAW plates (Report No: 15511/MS).

The side of the cut (ie AT, ST or BT) for α-quartz samples and correctness of the cut in relation to angular distance from the Z-axis (c-axis) are checked using a standard X-ray Diffraction back reflection Laue technique.

B. BROWN.

MANUFACTURING FLOWCHART



Narrow and thick film board component mounting sched[illegible]

charge No 21527

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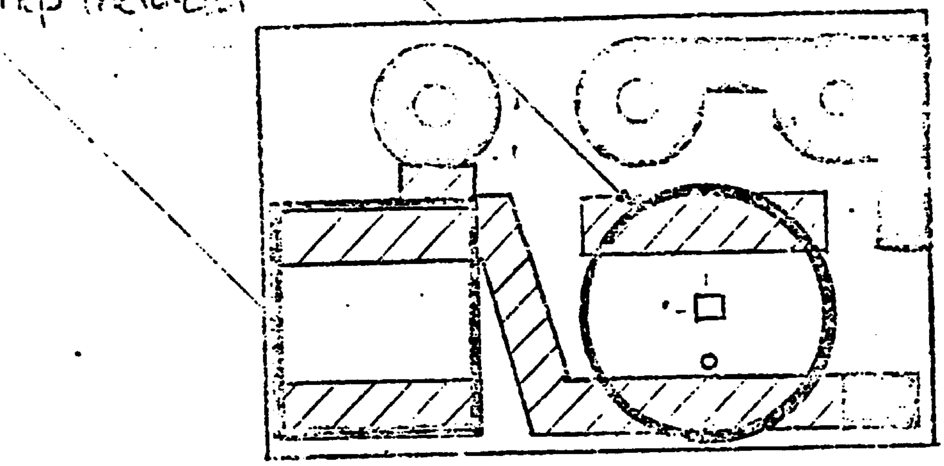

NOTES

1) Boards are supplied both fibre brushed & degreased.
2) Trimmer capacitor leads are to be clipped, using an appropriate tool to the shortest possible length.
3) Component mounting positions are indicated in thick red-line and should be strictly adhered to.
4) The trimmer capacitor must be mounted with the blue dot furthest from the circular contact pads
5) Particular care must be taken to avoid contact between the trimmer capacitor lead tab and the adjacent circular contact pads
6) Areas marked in ▭-shading must be kept free of solder and (as far as possible) flux
7) Minimum solder paste quantities are to be used to avoid 'clogging' of the capacitors and over-run of the block-shaded areas.

Handling :- Finger cots must be worn during lead trimmi[ng]
Handle only with clean tweezers at all other times

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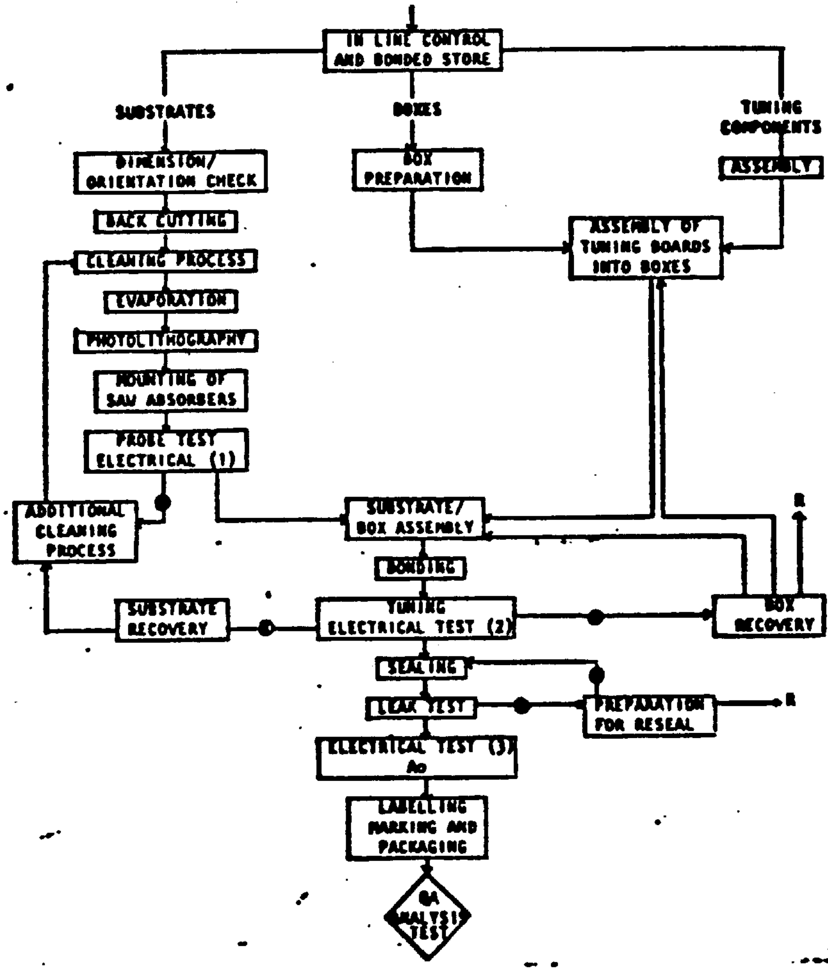
TITLE

MICROWAVE DIVISION - FLOW DIAGRAM - SAW DEVICES



NOTES

1) REFER TO MICROWAVE DIVISION FLOW CHART QAM 001 SECTION 9

2) QC/QA GATES ARE SET ON THE INDIVIDUAL LINE BATCH TRAVELLER.

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G.C. 45/18

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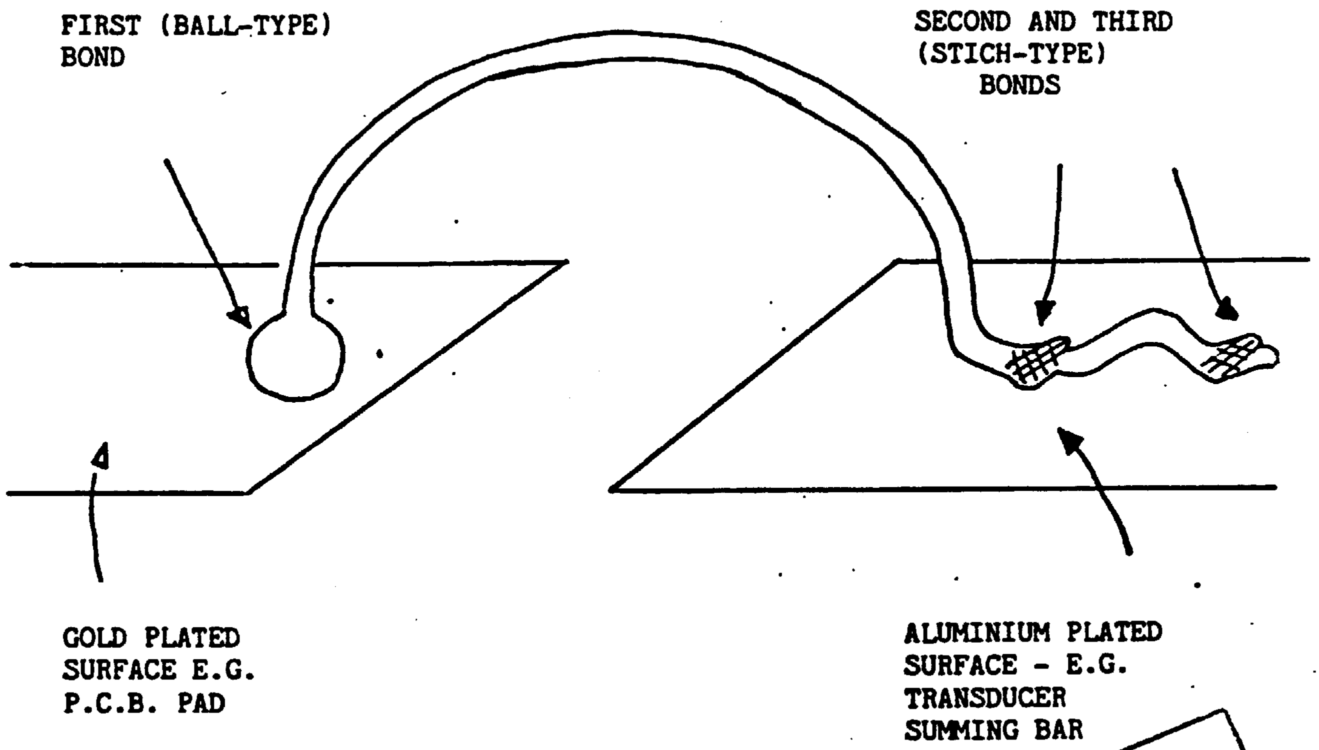
E.I. NO ..YM.11............

SHEET NO .Sheet.1of.3..

TITLE GENERAL BUILD STANDARD - SAW DEVICES THERMOCOMPRESSION BONDING

Electrical connections are made between the summing bars of the transducers and the gold plated circuit board pads by means of triple 0.001" dia.gold wires (a suitable gold wire is MK goldwire 25my available from Dage Intersem Ltd.). The positions and points of contacts of the required bonds are to be found in the device Engineering Instructions.



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TITLE GENRAL BUILD STANDARD - SAW DEVICES THERMOCOMPRESSION BONDING

PROCEDURE (Using Precima TCB21)

1) Switch on power supply at mains and press POWER ON button on machine.

2) Open nitrogen, hydrogen and vacuum supplies at taps, and press HYDROGEN and TOOL HEAT buttons on machine.

3) Set up the operating conditions as follows:-

a) Hydrogen flowmeter between 30 and 35 (no units indicated)
b) "Temperature" between 8 & 9 for both channels.

NB A tip temperature of 800 - 900°C as indicated by the panel meter should be obtained when bonding with these conditions.

c) "Power" between 8 and 9 for both channels. (No units are indicated)
d) "Time" between 5 and 9 for both channels. (No units are indicated).
e) "Vibration" on for channel 1 only . (See Note 3).
f) "Flame-Off Speed" to give a flame-off cycle time of about 1 second.

4) Ignite the hydrogen gas jet using suitable ignition (e.g. a peizoelectronic gas lighter). It may be useful to activate the flame-off control (the right hand lever) and press MOTOR STOP to make the jet nozzle more accessible.
5) Press NITROGEN button.

6) Place device to be bonded on a suitable mount on the supporting platform below the bonding tip. Ensure that the bonding tip has sufficient freedom of movement to make contact to the points to be connected by suitable adjustment of the left hand joystick control. (Coarse adjustment is achieved by releasing the vacuum to the joystick mount using the microswitch on the mount). Adjust the binocular microscope for optimum viewing conditions of the points to be connected.

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TITLE GENERAL BUILD STANDARD - SAW DEVICES THERMOCOMPRESSION BONDING

PROCEDURE

7) Ensure that the bonding tip is threaded, and that there is a ball of the correct size (about 3 times the diameter of the wire) at the end of the wire. If not, pull a length of wire through the tip using tweezers and flame-off so that the flame cuts the wire at about 3mm from the tip. Keep fingers well away from the flame and the tip.

8) When a suitable ball has been obtained, lower the bonding tip using the right hand lever, so that it comes into contact with the area to be connected. N.B. The first bond, or ball bond, is usually made to the gold plated connecting point. Sandwich the ball between the tip and the relevant area of the filter, and fully lower the right hand lever. The tip will now heat automatically, and the workstage illumination will dim for the duration of the bonding cycle. When the cycle is complete, raise the tip a few mm and move the device using the left hand joystick so that a second "stich" bond can be made to the relevant area on the relevant transducer. Again lower the right hand lever and sandwich the wire itself between the tip and the bonding point, allowing the bonding cycle to be completed as before. Raise the bonding tip by a few mm and after suitable manipulation of the joystick, make a second stich bond adjacent to the first. Finally, raise the bonding tip completely and flame-off the trailing gold wire by suitable manipulation of the right hand lever. The flame-off operation activates the "tail puller" which automatically removes the trailing lead emerging from the final stich bond. If this is not operating properly the tails may be carefully pulled manually using tweezers. If at any point in operation 8 the gold wire does not adhere to the relevant surface after the bonding cycle, carefully remove any wire remnants from the area and recommence at operation 7.

9) Repeat operation 8 as required for each electrical connection using new contact points on the relevant gold pad or transducer summing bar.

NB (i) It may be necessary to gently abraid the relevant gold plated surface prior to bonding using a suitable sharp implement, glass brush, or cleaning with an acetone impregnated tissue.

(ii) It may be necessary to periodically adjust the bonding conditions outlined in operation3. E.g. tip temperature or vibration may have to be adjusted according to surface conditions.

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ABSTRACT FOR INCLUSION IN PD 9002

EXHIBIT No. 3 (CTD.)

BRITISH STANDARD REFERENCE	:	BS9450 APPENDIX E, MIC-CQC 8
CERTIFICATE NUMBER	:	
MANUFACTURER	:	GEC LTD, HIRST RESEARCH CENTRE, EAST LANE, N WEMBLEY, MIDDLESEX, HA9 7PP TEL: 01-904-1262

BASIC TECHNOLOGY	Thin Film deposition and delineation
SUBSTRATES	Alumina and spinel
PATTERN FORMATION	Photolighography and etching
CONDUCTORS	Gold
ASSEMBLY	Delay line fitted into metal enclosure with suitable clamps, thin film tuning circuit included in required position and connected and tuned.
ENCAPSULATION	Gasket sealed lidded metal case
PACKAGE	Precision metal container fitted with microwave connector.

RATINGS

Max. power input	+20 dBM for 0.5 sec
Operating temperature range	-40°C to +85°C
Storage temperature range	-50°C to +90°C
Vibration (Operating)	10g 30 Hz to 2 kHz

INSPECTION AND TESTS

SCREENING — Reference 1.2.9 of BS9450

ENVIRONMENTAL

BS9450 REFERENCES

	TEST	TEST CONDITIONS
1.2.6.13	Rapid change of temperature	-26°C to +80°C
1.2.6.5	Damp heat, cyclic	12 cycles, 12 hours each
1.2.6.9	Acceleration, steady state	196 m/s^2
1.2.6.8.1	Vibration, swept frequency	20 to 2000 Hz, 98 m/s^2
1.2.6.6	Shock	490 m/s^2, 11 ms
1.2.6.14.2.1	Sealing	+80°C
1.2.7	Endurance	+85°C (non-operating)
	Bump	4000 bumps of 40g 6 ms

TYPICAL PERFORMANCE	Delay of 30 μs at reference frequency of 3 GHz with bandwidth of ±300 MHz and insertion loss of 26 dB.
LEVEL OR STAGE OF CUSTOMER PARTICIPATION IN DESIGN	
GUIDANCE TO CUSTOMER DOCUMENT	To be published

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E.I. NO ..YM21..........

SHEET NO ..1 of 1.....

TITLE GENERAL BUILD STANDARD - SAW DEVICES
DIMENSION AND ORIENTATION

A sample check (10%) must be carried out on external dimensions, polished surface quality and crystallographic orientation against relevant drawings. See device EI.

1. DIMENSIONS

Check each slice in the sample using an Etalon Micro-Rapid Micrometer (or equivalent), resolution 1 micron, the thickness dimension being checked to be within the specified tolerances. Check the length and width dimensions using a standard micrometer.

2. ORIENTATION

The orientation is checked using a suitable crystal X-ray goniometer using standard procedures to meet the specified requirements; (see device EI) these measurements are comparative about a mean figure and on that basis are self checking. Any possible discrepancies can be checked by reference to HRC's (Hirst Research Centre). Crystalography Department who have apparatus traceable to NPL standards.

N.B. (At present this process is carried out by HRC)

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HIRST RESEARCH CENTRE

DRAFT INSTRUCTION
OCTOBER 1983
A J BYRNE

OPERATION OF DAGE PRECIMA MASK DEEP UV. ALIGNER

The UV lamp power supply operates independently of the aligner controls. The power supply is located under the main aligner table on a separate stand. The aligner controls are situated on RH side of the table.

To switch the lamp on:-

DO NOT alter the variable power controls on the power supply front panel.

1. Switch on the power, using the front panel "power" switch.
2. Press in the red "ignition" button and release. The lamp will light. If it does not, call for help.
3. Allow the lamp to warm up for 15 mins.
4. Switch the meter to measure the voltage and then the current. Now adjust the variable power control carefully, using the fine control port, so that the product of the voltage and current readings is 350 watts or slightly less.

   NB: The adjustment required should be very small, if any.
5. The lamp is now ready for use. The adjustment should be repeated every hour or so of operation.

To operate the aligner:-

6. Switch on the aligner controls by pressing the RED button marked "POWER". With the "Mask Hold" off and the BLACK chuck control knob in the "OFF" position, ensure that there is a least 20 ins. (Hg) of vacuum reading on the gauge. DO NOT operate the aligner if this is not satisfied.
7. Fit a mask holding plate. A plate with a suitable aperture for the mask to be used must be chosen. The plate is removed by undoing the thumb screw at the front and the 2 Allen screws on the hinge piece at

the rear of the plate. Refitting is the reverse. Note that the small rubber tube must be refitted carefully to the plate tube.

8. Fit a substrate chuck. A chuck of suitable diameter must be chosen such that the rubber sealing ring of the chuck does not overlap the mask edges. However, the smallest chuck which just accommodates the substrate size, is most suitable.

   To remove the chuck - rotate the chuck control knob to "level", lift out the chuck with spherical bearing and vacuum and nitrogen lines attached. Carefully remove the lines, noting the position of the line with the red marker (nitrogen) ie. attached to the off-centred pipe. Clip the pipes into the guide pin location pins at the rear of the spherical bearing base to ensure that they do not fall into the central hole. Unscrew the spherical bearing from the chuck.

   Refitting of the new chuck is the reverse of the removal procedure. Ensure that the pipes are fitted the correct way round, and that the guide pin is located correctly. Also ensure that the spherical bearing moves freely. Adjust the air supply control on the main control panel to suit.

9. Note that the chuck centre must be adjusted to give the correct substrate surface height, ie. 1mm approximately above the outer metal rim. This is adjusted by slackening the 3 small Allen screws in the centre part of the chuck and rotating the centre with the special adjustable peg spanner. Then tighten the 3 Allen screws.

10. Load the mask. Ensure that the mask has been suitable cleaned. Position the mask, chrome side down, on the underside of the mask

holding plate, so that the vacuum groove is covered all round. Hold the mask in position with one hand and switch on the "mask hold" button. Ensure that the mask is held securely before removing the supporting hand.

11. Load the substrate.
Move the control knob to "load". Place the resist coated, pre-baked substrate in the centre of the chuck. If the substrate does not cover all the vacuum - hold down grooves - then they must all be covered with insulating tape (sticky side down); however, no vacuum hold for the substrate will then be available. Similarly, if the substrate is 'back cut', the vacuum groove must be covered.
The substrate must have its propagation direction aligned approximately with the direction of the mask pattern. (SAW only)

12. Screw up the mask holder support screw (located at the front LH side of centre of the table) so that the ball bearing is well proud of the support pillar.

13. Lower the mask holder(it is held on an automatic catch and must be raised first). The orange indicator light (next to the chuck control knob) will come on, indicating that the mask is not in contact with the substrate.
IF the pattern to be printed is the first or only layer, proceed as follows:-

14. Using the coarse X,Y and θ micrometer controls, and observing with the naked eye, position the substrate carefully so that the propagation direction of the substrate material is lined up precisely with the propagation direction of the mask pattern (SAW only) and so that the pattern is

EXHIBIT No. 3 (CTD.)

suitably placed on the substrate, usually centred. (This is usually achieved by lining up a 'bus' bar of the mask pattern with one of the substrate edges which has been kept carefully oriented with the material propagation direction during previous substrate machining. Then move the pattern to the chosen position on the substrate).

15. Lower the mask holder steadily by screwing down the support screw. When the rubber ring of the chuck just comes into contact with the mask, move the chuck control knob to the 'level' position. Lower the mask holder a little more so that the rubber makes good contact with the mask, but ensure that the orange light is still on - ie. the mask is not in contact with the substrate. Check that the pattern is still correctly aligned on the substrate. Lower the mask completely so that the orange light goes out.
16. Observe the contact fringe pattern and, with light finger pressure, load the mask holder to note the fringe pattern changing. The fringe pattern indicates the quality of contact.
17. Move the chuck control knob to "Align". The fringe pattern should show no more than 6 fringes across the main pattern area. More fringes than this inidcate very poor contact and advice should be sort.
18. Move the chuck control to "Expose". The fringe pattern should show no more than 4 fringes across the mask pattern area.
19. Swing the lamp housing over the mask holder, using the red handle attached to the lamp housing arm.

20. Adjust the exposure timer to a suitable time for the resist coating on the substrate.
21. Press the RED button next to the chuck control knob. The shutter will open for the preset time.
22. After the shutter closes swing the lamp away.
    Rotate the chuck control knob to "Align".
23. Screw up the mask holder support screw so that the mask is clear of the substrate (orange light on). If the substrate sticks to the mask, raise the holder slightly and gently tap it down onto the support pillar. If the mask still sticks, carefully pull the substrate off the mask ....

    DO NOT: Push the substrate along the surface of the mask.
    Dig tweezers between mask and substrate
24. Raise the mask holder onto the automatic catch.
25. Remove the substrate from the chuck. If the substrate is held down by vacuum, rotate the chuck control to "LOAD".
26. Develop the substrate immediately - referring to the suitable process schedule.
27. Repeat from 11. for next substrate.
28. After the final device has been printed, remove the mask, remembering to support mask before switching off "MASK HOLD" vacuum.
29. Switch off lamp power supply but do not alter the variable controls.
30. Switch off the aligner power. Leave the mask holder and chuck in place with the mask holder in the raised position.

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4 ABSTRACT FOR INCLUSION IN PD 9002

British Standard Reference	:	B9450 Appendix E, full assessment level
Certificate Number	:	
Manufacturers	:	GEC Research Laboratories, Hirst Research Centre, East Lane, Wembley, Middlesex, HA9 7PP Tel No: 01-904-1262

Basic technology	:	Thin film using Rayleigh mode theory
Substrate	:	Quartz or lithium niobate
Pattern formation	:	Photolithography and etching
Conductors	:	Interdigitated transducers, aluminium
Assembly	:	SAW element flexibly fitted in metal enclosure with a suitable adhesive. Add-on components such as printed circuit boards and inductors included in box where required by design
Encapsulation	:	Lidded box, compression or seam welded (hermetic)
Package	:	Precision metal enclosure (welded sealed)
Ratings	:	Maximum power dissipation : 10 mW Maximum operating temperature range: -26°C to +80°C Operating temperature : +40°C Storage temperature : -40°C to +85°C

Inspection and tests

Screening	:	Reference 1.2.9 of BS9450
Environmental	:	Tests, inspection levels as for full assessment level in 1.3.3.1 of BS9450

BS9450 reference	Test	Test condition
1.2.6.1.3	Rapid change of temperature	-26°C to +80°C
1.2.6.5	Damp heat cyclic	6 cycles
1.2.6.9	Acceleration, steady state	196 m/s^2
1.2.6.8.1	Vibration, swept frequency	55 to 2000 Hz, 98 m/s^2
1.2.6.6	Shock	490 m/s^2, 11 ms
1.2.6.1.4	Sealing	As in BS2011, test Qk
1.2.7	Endurance	+85°C (non-operating)

Typical performance : Fast cut-off SAW bandpass filter up to 200 MHz centre frequency. Fractional bandwidth: Quartz : 0.3%; Lithium niobate: 10% approx

Level or stage of customer participation in design:

Guidance to customer document: To be published

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CERTIFIED TEST RECORDS

Component manufacturer : GEC Research Laboratories

Place of manufacture : Hirst Research Centre, East Lane, Wembley, Middlesex HA9 7PP

TEL NO: 01-904-1262

Detail specification and issue number: BS9450 - SAW-CQC5 - Issue 1

Description of component : Wideband surface acoustic wave filter on lithium-niobate substrate in hermetic seal metal case. Centre frequency 120 MHz. Full assessment.

Current five month period : 30th September 1983 to 28th February 1984

Date of commencement of current 3 year period : 30th September 1983

This certified test record is a complete and accurate record of the tests carried out on accepted lots in accordance with the specified procedures.

CHIEF INSPECTOR :

SUPERVISING INSPECTOR:

DATE: 28/2/84

SUBGROUP OR TEST	Similar devices during current five months: Tested	Defective
A2 (i) Reference frequency (ii) Bandwidth (iii) Insertion loss (iv) Ripple	3 3 3 3	0 0 0 0
B2 (i) Rapid change of temperature (ii) Fine leak test (iii) Damp heat cyclic	3 3 3	0 0 0
B4 (i) Acceleration, steady state	3	0
B5 Endurance - 200 hours	3	0
C1 (i) Vibration Shock (ii) Damp heat, steady state	3 3 3	0 0 0

Spare for 13 ...

THE GENERAL ELECTRIC COMPANY LIMITED

HIRST RESEARCH CENTRE

WEMBLEY, MIDDLESEX

HA9 7PP

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MATERIALS SCIENCE DIVISION

MATERIALS CHARACTERISATION DEPARTMENT

Department Report No. 1511/MS

C. Dineen

Date:

Approved by:
B.J. Isherwood

For: D.A.S.

Orientation Measurements on large ST-Cut α-Quartz plates for Surface Acoustic Wave Device Application

1. Introduction

A requirement has arisen for a facility to be established which will permit orientation measurements to be made on large single crystal plates of ST-cut α-quartz. The plates, which are 2.5mm thick and 15mm wide have a 7.6° bevel at each end (trapezium shaped) and a maximum length of 205mm.

These measurements are required for quality assurance purposes in connection with the manufacture of Surface Acoustic Wave Dispersive Delay Lines. The orientation specifications for these plates are as shown in the figure.

The standard procedures which would normally be employed to determine the orientation of large blocks of single crystal material cannot be applied directly in this instance because of the size and shape of the crystal plates. A modification to the basic procedure has therefore been devised to facilitate the determination of the ST-cut, whilst a new specimen-mounting jig has been designed and manufactured to permit measurement of the position of the x-axis.

This report describes the revised measurement procedures and illustrates the methods employed with results obtained on a large ST-cut α-quartz plate (Z140SK413254, Serial No. 145).

2. Equipment

The equipment used to make the orientation measurements was a Hilger and Watts Y130 quartz crystal orienter, calibrated to read to one minute of arc. The ST-cut determination was made using a standard specimen-mounting stage whilst to facilitate the determination of the angular position of the x-axis a new specimen stage was designed and manufactured. The new specimen stage supports the crystal in a horizontal position and allows the crystal to be rotated about an axis parallel to the long edge of the crystal. Measurements carried out by the Inspection and Calibration Service

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at H.R.C. indicate that the angular errors introduced into the orientation determination by a rotation of the plate through 180° are less than 0.3' (minutes) of arc.

3. Orientation Determination

3.1 General Considerations

A number of problems exist with the manufacture and preparation of large single crystal plates. Amongst the more important, from the point of view of the orientation specification are those associated with the distortion of the plate which occurs during the manufacturing process. The effect of this distortion may be illustrated by the consideration of the two extremes which may occur in practice. These are

1. The crystal lattice is undistorted, but the reference surface and edges of the plate do not conform to the flatness specifications.

2. The surface and edge flatness specifications are satisfied, but the crystal lattice is distorted.

The nature of the distortion may vary from a simple uniform deviation of the surface from the desired orientation to a uniform curvature of the crystal lattice or reference surface and edge. The possibility that both forms of distortion may be present must also be considered. The effect of these distortions range in complexity from a simple misorientation angle, which is characteristic of the whole plate, to an angular orientation function which describes the local relationship of adjacent parts of the crystal lattice to the reference surfaces.

This latter measurement is, since it necessitates a detailed study of the entire surface of the crystal, a lengthy procedure. In the context of the present requirement is is proposed that the orientation determination be confined to measurement of the misorientation of the crystal lattice with respect to the reference surface at each end of the plate. Local variations in the orientation of the plate will not be observed, however this procedure should detect excessive curvature or twist, the most likely problems to occur in practice. It should be noted that the orientation error associated with the maximum permissible deviation from flatness specified for these plates would be of the order of 0.5' (minutes) of arc.

In view of the size of these plates and the requirements listed in item 2.1 (1) of the quality assurance specifications it is strongly recommended that an X-ray topographical or other such technique, capable of revealing twinning and other lattice defects, be used to examine these crystals.

3.2 Proposed Experimental Procedure

It will be assumed in the sections which follow that the basic orientation of the plate is correct i.e. that the sense of rotation of the cut is correct and that the angle of rotation is approximately correct. The Laue X-ray diffraction technique may be used to establish the basic orientation of the plate.

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