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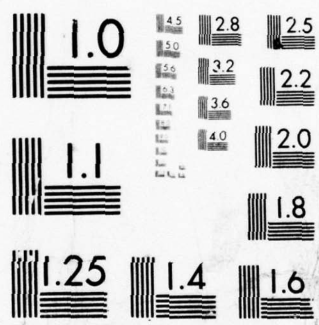
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LEVEL III

Research and Development Technical Report
DELET-TR-75-0044-F

PHOTOLITHOGRAPHIC TECHNIQUES FOR SURFACE ACOUSTIC WAVE (SAW) DEVICES

A. W. DOZIER

GROUND SYSTEMS GROUP
HUGHES AIRCRAFT COMPANY
FULLERTON, CALIFORNIA 92634

July 1975 to December 1978

Final Report: Volume 5 – Quality Assurance Plan

ERADCOM
US ARMY ELECTRONICS RESEARCH AND DEVELOPMENT COMMAND
FORT MONMOUTH, NEW JERSEY 07703

NOTICES

Acknowledgements

This project has been accomplished as part of the US Army Manufacturing and Technology Program, which has as its objective the timely establishment of manufacturing, processes, techniques or equipment to insure the efficient production of current or future defense programs.

Disclaimers

Disposition

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READ INSTRUCTIONS BEFORE COMPLETING FORM

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Bandpass Filters
Tapped Delay Line Filters
Pulse Compression Filters
SAW Processing
SAW Packaging

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The object of the program was the establishment of a production capability for surface acoustic wave devices of varied design and material for the purpose of meeting estimated military needs for a period of two years after the completion of the contract, and to establish a base and plans which may be used to meet expanded requirements. The primary requirement was the pilot line production of devices that are reliable, reproducible, and low cost.

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The first phase of this program required the design, fabrication and testing of a total of 60 prototype bandpass, tapped delay line and pulse compression SAW filters on both lithium niobate and ST-quartz. The First Engineering Phase (Phase I) clerical testing demonstrated that the device designs generally met the specifications imposed by the program. Deviations from specification, which required additional test to optimize the levels of padding and/or shunt resistance and capacitance, were resolved during the Second Engineering Phase (Phase II) for the PC-Q, PC-LN and TDL-200. Deviations from the insertion loss specification occurred with the BP-LN and TDL-100 designs. In the former case, a redesign excluding the program-specified multi-strip coupler, was theoretically evaluated, In the latter case, as pointed out in the Hughes proposal, a theoretical analysis precluded the possibility of a specification accommodation. It was necessary to revise the specification for both designs since the customer insisted on utilization of the multistrip coupler in the BP-LN.

Testing of modified semiconductor pin packages during Phase II demonstrated these to be suitable, cost-effective replacements for the machined chassis employed for Phase I. A Quartz orientation problem was highlighted in Phase I and negotiated during Phase II. The quartz vendor implemented an effective screening procedure for the off-orientation problem. However, problems with this vendor continued in the form of substrate surface defects. Other major yield problems encountered during these portions of the program resulted from the dicing and mask making operations. The Phase I and Phase II efforts resulted in a finalized layout, electrical specifications and test procedure for the Third Engineering Phase (Phase III).

Phase III involved fabrication of a larger quantity (50 ea.) of confirmatory devices which were sampled at a high rate and subjected to rigorous life and environmental testing. Phase III was successfully completed with delivery and acceptance of the confirmatory samples. The device configuration is detailed as it existed for Phase III along with assembly details, results and conclusions from the Confirmatory Sample production run (Phase III).

The Fourth Engineering Phase (Phase IV) of the program was pilot line production effort of 150 each of the devices scheduled to be delivered. Solder sealing was identified as a problem area during Phase IV for SAW devices in Phase III packages. New solder seal screening and processing procedures were investigated. In addition, alternative sealing approaches were evaluated. These procedures, Tungsten Inert Gas (TIG) and projection and seam welding were demonstrated to be more compatible with SAW processing. They are especially suitable for high volume production.

Phase IV pilot line production was completed with the delivery of approximately 150 of each of the device types. Some devices were shipped short due to the inability to locate a second source for projection welding, and the extended lead time in reprocurement of packages capable of being sealed by alternate procedures.

Data from Phases I through IV are presented in the Technical and Operational volume of the Final Report. Pilot Line process flow and related documentation are presented in the Process Specification Volume of the Final Report. All inspection positions and quality control procedures for Phase IV are presented in the Quality Control Volume of the Final Report. Cost analysis and labor distribution for all facets of the program are covered in a non-distributable volume of the final report.

The program will include preparation of a General Report, which will consist of an analysis of equipment and facilities required to produce SAW devices of the type produced in the Pilot Run at a rate of 500 per month. In addition, an Industry Demonstration was prepared which verbally and visually presented all facets of the MMT program through the Pilot Run.

CONTENTS

CONTENTS (Continued)

PURPOSE

This report presents the results of the three year effort in satisfying the requirements of a Manufacturing Methods and Technology Program devoted to a representative range of surface acoustic wave (SAW) device designs.

The objective of this program was to establish a production capability for the purpose of meeting estimated military needs for a period of two years after the completion of the contract, and to establish a base and plans which may be used to meet expanded requirements. The manufacturing method emphasized the photolithographic fabrication of SAW devices that are reliable and reprodicible at low cost.

Specific tasks included establishing and demonstrating a capability to manufacture the six SAW device designs on a pilot line basis using methods and processes suitable for a production rate of 150 devices per month for each type. In addition, engineering analysis and planning remains to be accomplished for expansion of the manufacturing capability which could accommodate the production of such devices at a rate of 500 each per month. This analysis and planning will be delivered in the General Report.

The program was divided into four phases. The first (Phase I First Engineering Sample) addressed the design, fabrication and analytical testing of six prototype SAW devices that are representative of the major current and potential application of the technology. While these device requirements did not represent the state-of-the-art in an R & D sense, they were of such complexity as to require a serious design effort in each case.

The second phase (Phase II – Second Engineering Samples) was performed to redesign those devices that failed the intended design specification. The net result of this effort was to be functional electrical specification adherence, based on a cost effective packaging commitment.

The third phase (Phase III – Confirmatory Samples) was to test and conform to specification for both the electrical and environmental commitment of the various devices. The final phase (Phase IV – Pilot Run) was to test the reproducibility of those predetermined electrical and environmental requirements in a high volume (500 per month) production environment. A key result of this phase was the establishment of meaningful manufacturing cost data on each device as well as a comparison of this data to the prior low volume efforts of the earlier phases. These data will then be extrapolated to a production rate of 500 per month with assumptions regarding facilities and equipment in the General Report.

GLOSSARY

SAW	–	Surface Acoustic Wave
BP-Q	–	Bandpass Filter – ST Quartz Substrate
BP-LN	–	Bandpass Filter – Lithium Niobate Substrate
TDL-100	–	Tapped Delay Line Filter – 100 MHz – ST Quartz Substrate
TDL-200	–	Tapped Delay Line – 200 MHz – ST Quartz Substrate
PC-Q	–	Pulse Compression Filter – ST Quartz Substrate
PE-Q	–	Pules Expansion Filter – ST Quartz Substrate
PC-LN	–	Pulse Compression Filter – Lithium Niobate Substrate
PE-LN	–	Pulse Expansion Filter – Lithium Niobate Substrate
ST	–	Quartz orientation, ST cut (42^o 45'), X propagating
YZ	–	Lithium Niobate orientation, Y cut Z propagating
TIG	–	Tungsten Inert Gas Welding
MSC	–	Multistrip Coupler
K^2	–	Electromechanical Coupling Constant
f_o	–	Center frequency
B	–	Bandwidth
T	–	Time Delay
TXB	–	Time Bandwidth Product
VSWR	–	Voltage Standing Wave Ratio
DUT	–	Device Under Test
L_{INS}	–	Insertion Loss
$S_{S.L.}$	–	Sidelobe Suppression
$S_{f.t.}$	–	Feedthrough Suppression
S_{Spur}	–	Spurious Suppression
TTS	–	Triple Transit Signal

HUGHES GROUND SYSTEMS GROUP MICROELECTRONIC TECHNOLOGY QUALITY SYSTEM

1.0 INTRODUCTION

The Hughes Aircraft Company Ground Systems Group Quality System is designed to meet and implement the requirements outlined in MIL-Q-9858A, Quality Program Requirements. Procedures described in the Hughes Aircraft corporate, group, and division Quality manuals establish effective organizations, programs and practices to assure timely and economic implementation of company Quality objectives and attainment of product quality consistent with contractual quality commitments. The following is a description of procedure to be implemented in the Microelectronics Technology (MELT) laboratory for specific application on the surface acoustic wave pulse compression, band-pass and tapped delay line filters. This description addresses the requirements established by the Hughes Aircraft Company Purchase Order Attachment Q-4-Q, Sellers Quality System.

2.0 ORGANIZATION

Creating and implementing quality policy in the MELT laboratory is the responsibility of Product Assurance. Inspection supervision reports to the Microelectronic Project Quality Engineer, Mr. D.J. Davis, who is responsible for ensuring that contractual quality requirements are fulfilled. Mr. Davis, the Project Quality Engineer, Engineering Product Assurance Section, then reports to Mr. D.M. Martin, Head of Engineering Product Assurance. Mr. Martin reports to Mr. S.J. Goldberg, the Director of Product Effectiveness, who in turn is responsible to Mr. C.G. Carlson, Ground Systems Group Vice President and Group Executive (see attached organizational charts, Appendix A, B, and C).

3.0 QUALITY PLANNING

This Quality Plan is distributed to all cognizant supervisors and describes all contractually applicable quality and product effectiveness requirements.

During design reviews, Engineering Product Assurance along with Engineering Manufacturing, and other support activities, appraise design, processing, testing, and inspectability. Design review personnel initial the drawing package before it goes into the release cycle.

After initial design review, an assembly flow sheet is created. The assembly flow sheets outlines fabrication, inspection, test, screening, customer source inspection steps, Government Source inspection steps and traceability documents necessary in the production of surface acoustic wave devices. Each flow sheet also lists the governing work instruction(s), test specifications, military specifications, and traceability requirements with appropriate revisions that must be fulfilled at each processing step. Before release, these flow sheets are reviewed by engineering, production and test with final review by Quality. Concurrences are indicated by signatures in the approval block. During this review, the actual fabrication flow and specification revisions are reviewed for program accuracy (see Appendix D).

This Product Assurance Plan assures compatibility between contract requirements and manufacturing inspection, test, and documentation. This system implements general procedures described in Hughes Ground Systems Group Quality Practice (QP) 1.2.

4.0 WORK INSTRUCTIONS

The Ground Systems Group Quality System utilizes documented work instructions to specify fabrication, inspection, and test techniques as outlined on fabrication flow cards. Fabrication instructions, Process Engineering Instructions (PEI's) are indicated on each and every process step. These instructions provide clear and concise criteria for performing the work functions as well as indicating general acceptance requirements compatible with workmanship acceptance criteria consistent with military specifications.

These PEI's are controlled documents which are approved by both Engineering and Quality prior to general release and implementation. Quality concurrence is denoted by the signature of the Microelectronics Project Quality Engineering on every release PEI. An example of a PEI is shown in Appendix E.

To ensure that these documents are being followed, unannounced audits and supporting logs are maintained and monitored by Product Assurance personnel.

In addition to fabrication instructions, procedures which specifically identify Quality procedures utilized in the MELT laboratory which implement general Ground Systems policy (QP 1.3) are described in Quality Method Sheets (QMS's). These documents provide Quality personnel with requirements and procedures which may be process or program oriented and are in addition to military standard requirements. The QMS for SAW devices is shown in Appendix F.

5.0 RECORDS

The implementation of Hughes Ground Systems Group Quality Practice 1.4, Quality Data, Records and Reporting, is accomplished through the use of various documents.

As indicated in paragraph 3.0, the process flow is stated and controlled through the use of process flow cards which show the actual steps with referenced documentation which are used when fabricating surface acoustic wave devices. This document, originated by Engineering, indicates the date on which an operation was accomplished, who performs any given operation, and the approximate amount of time taken for each operation.

In addition to the process flow cards, all rework, retest and inspection deficiences are recorded on Quality History cards (see Appendix G). These cards are initiated by inspection personnel and record deficiencies found at each kit, visual, precap and final inspection. Also any rework cycles are noted for trend analysis at the completion of surface acoustic wave device fabrication. These documents then provide a record of objective evidence of the quality of each device.

Upon completion of a given circuit, documentation for each surface acoustic wave device is held for a minimum of three years in the Microelectronic Technology data files – not only providing for ease of retrieval, but also where a complete data bank is maintained for every surface acoustic wave device.

6.0 CORRECTIVE ACTION

Hughes Ground Systems Group Quality Procedure (QP 1.5) establishes a system for promptly detecting and correcting conditions which are adverse to quality.

To notify subtiered vendors of incoming material deficiencies, Hughes utilizes the Supplier Corrective Action Request (SCAR). Vendors are required to respond or action is taken which eliminates them from the Hughes Qualified Supplier Listing. A copy of a SCAR is attached in Appendix H.

Through the use of Quality History cards (see Section 5.0, Records), defects which are reworked to requirements shown in the process flow are recorded along with their subsequent disposition. On items which may not be reworked to the documented flow, a Nonconforming Material Report (NCMR) is initiated (see Appendix I). The use of the NCMR allows (1) analysis of deficiencies and disposition of defects, (2) analysis of trends in performance to isolate the causes of nonconformances and to initiate necessary steps to prevent recurrence, and (3) provides a vehicle to introduce and evaluate the adequacy of improvements and corrections.

7.0 COSTS RELATED TO QUALITY

Quality cost program has been audited by Hughes Ground Systems Group internal Quality organization and by AFPRO. It is satisfactory to the requirements of MIL-Q-9858A. This procedure implements policy described in Ground Systems Group Quality Practice 1.6, Quality Costs.

8.0 GOVERNMENT AND CUSTOMER SOURCE INSPECTION

Inspection of surface acoustic wave devices shall be performed at point of origin. Fifteen days prior to start of confirmitory sample testing, written notice shall be given to the customer so that government source inspection may witness testing if it so elects. Acceptance of surface acoustic wave devices will be at destination.

9.0 DRAWINGS, DOCUMENTATION AND CHANGES

All process, product, assembly, and test specifications and subsequent revisions thereof are controlled through the Ground Systems Group document release group (Configuration Data Management organization (CDMO). This organization implements the procedural requirements of MIL-STD-480, Configuration Control, Engineering Changes, Deviations and Waivers, and Hughes GSG Quality Practice 2.1. Documented procedures ensure that all purchasing, assembling, processing, inspection, testing, environmental screening, area environment controls, and modifications are controlled and are appropriate to the circumstances. Unannounced periodic audits conducted by Product Assurance personnel ensure that appropriate documentation is prepared, maintained, and complies with program requirements.

Only formally released drawings and specifications are used for fabrication of deliverable circuits. To document the as-built, as-inspected, and as-tested configuration, entries are made in designated areas on each individual process flow card. To preclude the use of unreleased drawings, a release control stamp indicates that documents are being distributed by the CDMO activity.

The mechanism by which drawings may be changed or revised is the Engineering Order (EO). EO's affecting any contractual requirements must be approved by the cognizant customer prior to release. All EO's are released, distributed and controlled in the same manner as the original released drawings.

10.0 MEASURING AND TEST EQUIPMENT

Ground Systems Group Quality Practices 2.2 and 2.3, Measuring and Testing Equipment and Tooling As A Media Inspection, respectively, detail the policy governing the calibration of equipment. This system conforms to the requirements outlined in MIL-C-45662, Calibration System Requirements, by providing certified measurement standards traceable to the National Bureau of Standards. This system also provides for periodic automatic recall of all electrical, mechanical, and other devices (tooling masters, templates, etc.) used as a media of inspection. The Physical and Electrical Standards Section of the Engineering Services and Support Division is responsible for operating the system of calibration and maintenance of all measuring devices as well as providing precision measurements whenever the known state-of-the-art is exceeded.

11.0 SPECIAL PROCESSES

Whenever required, Hughes Ground Systems Group performs processes such as welding, X-ray, magnetic particle inspection, plating or soldering in accordance with stipulated specifications or instructions which will be presented to customer representatives as required.

It should be of special note that the thermosonic wire bonding process is certified on a twice-daily basis, through the use of a destructive pull test. The requirements outlined in this process indicate that representative samples of thermosonic wire bonds shall be destructively pulled and that acceptance is based upon the mode of failure. Certification is given if all wires break before any bonds lift from the sample. In addition, to ensure that all wire bonds satisfactorily meet a minimum pull force, each bond on all deliverable circuits is pulled to a predetermined force of 1.5 grams for 1 mil gold wire.

12.0 CONTROL OF PURCHASES

Ground Systems Group Quality Practices 3.1 and 3.2, Supplier Control and Procurement Controls, respectively, establish the system for assuring that all supplier and services procured from sub-tier suppliers conform to contractual requirements. These procedures document a policy which (1) assesses a vendor's technical and quality capabilities that establish a qualified supplier, (2) allows the transmission of quality, design, and technical requirements, (3) permits a timely evaluation of procured items, and (4) makes available information feedback for the identification and correction of nonconformances.

To evaluate a supplier's technical and quality abilities, all vendors are surveyed by Hughes supplier quality survey teams. These teams evaluate vendors capabilities by reviewing objective evidence (procedures, instructions, etc.) as required by the various quality levels (I.E., MIL-Q, MIL-I, etc.). After this evidence has been reviewed, a supplier is certified to a certain level of quality and added to the Supplier Directory. To ensure that requirements are continually met, periodic surveys as well as information obtained from incoming receiving inspections are recorded.

The transmission of requirements is done through the use of purchase orders, which reference controlled specifications or other special requirements (Quality attachments outlining traceability requirements, as-built configurations, etc.). To ensure that the appropriate attachments or other references have been made, all purchase orders are screened by Quality representatives prior to release. Since the screener is on distribution for this Quality Program Plan which identifies special requirements, all outgoing purchase orders will conform to contractual requirements.

To guarantee that incoming items conform to appropriate specifications and purchase orders, a receiving inspection is performed on all items. Items which cannot be easily inspected by receiving personnel, an Inspection/Test Request (ITR) is prepared and forwarded to other activities who perform a verification procedure to specification requirements. See Appendix J. Upon acceptance, the results of this verification are entered upon the ITR and returned to Receiving Inspection for final acceptance and the closing of purchase orders. On all items or materials which are accepted, an appropriate identification or acceptance tag is attached. See Appendix K. As a minimum, these tags identify the item, references receiving reports or purchase number, and indicates the number, and indicates the number of items acceptable.

Those items which are rejected are returned to receiving, placed in a suspended material control (SMC) area and returned to suppliers with a corrective action document if appropriate. Data on rejected items is then fed into the supplier Rating System. If a certain number of lots or items fail, the vendor approval on the qualified supplier list is invalidated and it becomes an unacceptable supplier, until re-approval procedures are completed.

13.0 MATERIALS AND MATERIALS CONTROL

As indicated in Section 12.0, all supplies used in deliverable hardware is inspected upon receipt to the requirements of applicable specification referenced on procurement documents. When necessary for raw materials, mixtures or solutions, appropriate chemical or metallurgical analyses are performed. GSG Quality Practice 4.1, Receiving Inspection documents these procudures.

To identify those materials that have a limited useability, the Hughes Quality system utilizes shelf life controls. All items which require special storage or have limited useability are listed in the Hughes Shelf Life Manual. Procedures for identifying, recertifying, and control of these items are outlined.

14.0 PRODUCTION PROCESSING AND FABRICATION

The Microelectronics Technology quality system assures that all processing and fabrication of surface acoustic wave devices is accomplished under controlled conditions. To this end, existing procedures implement policy described in Ground Systems Group Quality Practice 4.2, Product Processing and Fabrication. This system of control is initiated through a control of purchases and receiving inspection (see Sections 12.0 and 13.0) and continues through complete fabrication, screening until the item has passed completed item inspection, test, and final acceptance.

Product Assurance through review of contractual documents establishes GSG inspection and test points, screening tests, and required customer inspection/test steps through the use of process flow cards (see Section 3.0).

On this program, the inspection points shall include as a minimum precap inspection, and final inspection. At each inspection point, the requirements of MIL-STD-883, Test Methods and Procedures for Microelectronics, Methods 2010 and 2017 will apply, Class A or Class B as applicable. Final external inspection will be to Method 2009.

In addition, each module will be tested and screened per the contractual specifications. Conformance screening will be performed where required, and qualification procedures will be implemented as stipulated. The results of all tests will be documented.

All processing will be documented on process flow cards and all defects and rework will be noted on Quality History forms. All drawings, specifications, and instructions used in the fabrication of these devices shall be controlled and released. Product Assurance shall perform periodic audits for conformance to all documentation requirements.

15.0 COMPLETED ITEM INSPECTION AND TEST

The Quality system of Hughes Ground Systems Group assures that all final inspection and test are accomplished on all deliverable devices. The procedures utilized in the MELT laboratory implement policies contained in Quality Practice 4.3, Final Inspection and Test. Before any circuit is accepted as a final device, Product Assurance confirms that all visual and electrical tests are fulfilled by performing a first article inspection and test. This testing provides a measure of overall quality for each circuit design and fabrication process. Whenever modifications, repairs, etc., are required, each device is completely re-inspected and retested.

Product Assurance will accept no completed devices until first articles have been completed. Data documented during first article tests are retained by Product Assurance. Additionally, Product Assurance performs unannounced Quality conformance inspections throughout the production life of a contract to guarantee continuing product quality.

16.0 HANDLING, STORAGE AND DELIVERY

Process Engineering Instructions provide documented procedures for handling, storage, packaging, and shipping which protect deliverable product. Additionally, procedures documented in Hughes Aircraft Quality Practice 4.4, Material Handling, Storage and Delivery define Ground Systems Group Policy. Other special handling procedures which are required are outlined in the Quality Program Plan, documented in Process Engineering Instructions, and implemented by production control personnel. As a final check, verification of packaging is performed by quality personnel assigned to shipping inspection.

17.0 NONCONFORMING MATERIAL

Quality Practice 4.5, Nonconforming Material Control, defines the procedures for controlling nonconforming supplies and services including methods of identification, segregation and disposition. Whenever a nonreworkable defect (one which cannot be corrected by a process step) is encountered in the MELT lab, the discrepancy is noted on a Nonconforming Material Report (NCMR). The NCMR is presented with documented cause and corrective action to a customer representative for disposition. Holding areas for items awaiting disposition are located in the inspection area and access is limited to Product Assurance personnel. All devices which are identified as nonreworkable conformances are clearly identified through the use of a "Hold" tag (see Appendix L). Upon request, data associated with scrap or rework costs are obtainable for customer review.

In order to ascertain the causes of electrical nonconformances, Hughes Fullerton has the capability to perform in-depth failure analysis. Capabilities include infra-red scanning and scanning electron microscope inspection as well as device sectioning and other standard techniques.

18.0 STATISTICAL QUALITY CONTROL

Statistical Quality Control procedures, defined in Quality Practice 4.6, are utilized whenever acceptable on a given program. If allowed, sampling plans from MIL-STD-105 or 414 are utilized.

In addition, failure trend data (available from Quality History forms) is gathered and retained to identify failure trends originating in fabrication, testing, inspection, screening, and qualification. Any significant failure trends noted during operations will be immediately investigated.

19.0 INDICATION OF INSPECTION STATUS

Quality Practice 4.7, Identification of Inspection Status, details Hughes policies which are used to identify device status. Inspection status is defined by using product flow cards, quality history tags, NCMR's (for nonconforming items), and hold tags. Identification is accomplished through the use of numbered stamps traceable to individuals performing special functions. All Quality stamps are controlled and periodically verified by Product Assurance audit personnel.

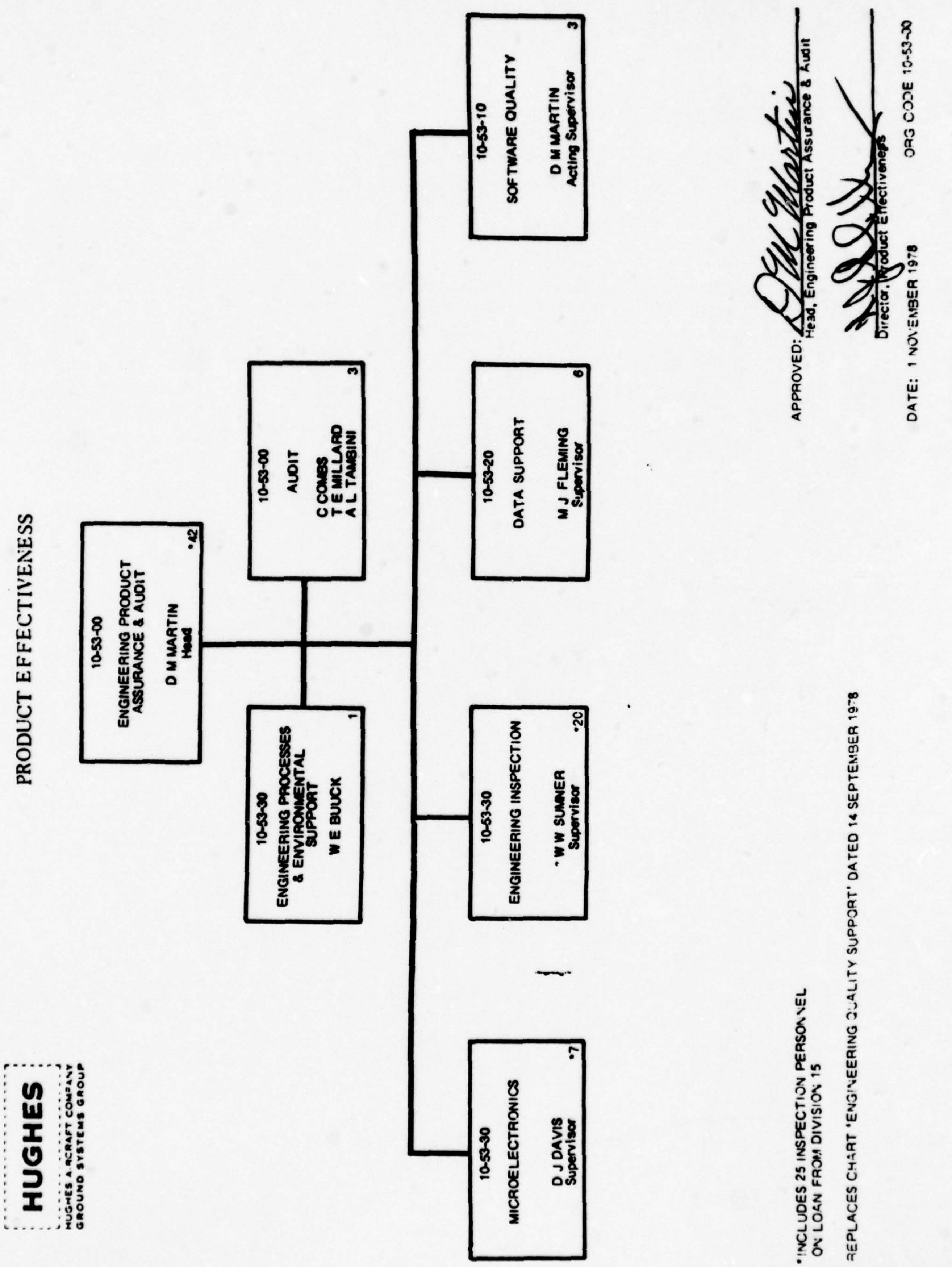
20.0 FABRICATION FLOW

Appendix M illustrates the processing flow which will be utilized for the surface acoustic wave devices. Fabrication, inspection, and test steps are indicated.

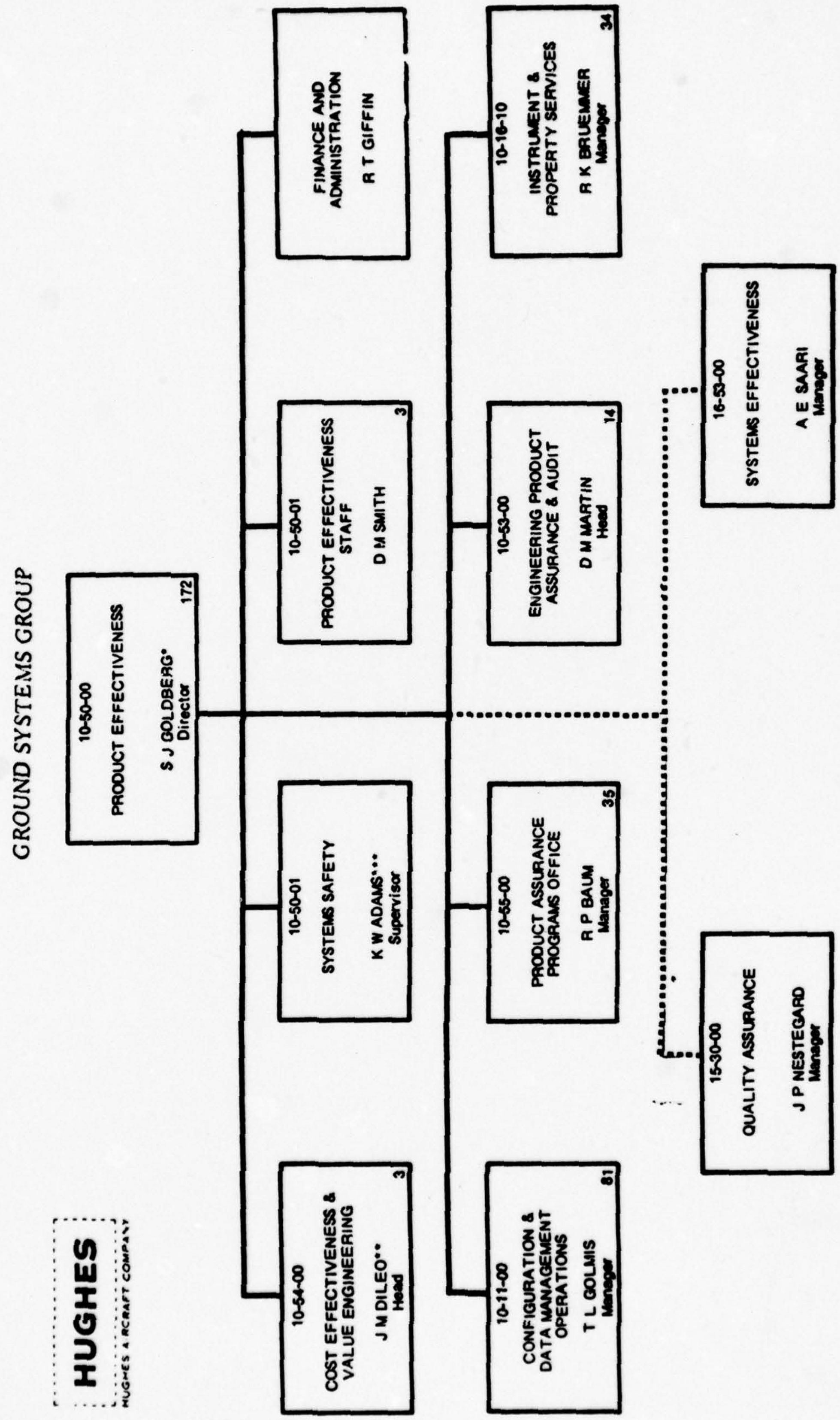
21.0 GENERAL

As indicated the Hughes Ground Systems Group Quality system enacted in the Microelectronics Technology Laboratory fulfills both policy defined in Hughes Quality Practice and MIL-Q-9858A. This system enables Hughes to build devices to contractual requirements with a minimum of cost while maintaining desired control.

APPENDIX A – ENGINEERING PRODUCT ASSURANCE ORGANIZATION CHART



APPENDIX B – PRODUCT EFFECTIVENESS ORGANIZATION CHART



*DIRECTOR – GSG PERFORMANCE IMPROVEMENT PROGRAM
**HEAD – GSG COST IMPROVEMENT AND VALUE ENGINEERING
CHAIRMAN – GSG VALUE ENGINEERING COMMITTEE
***CHAIRMAN – GSG SYSTEMS SAFETY COMMITTEE

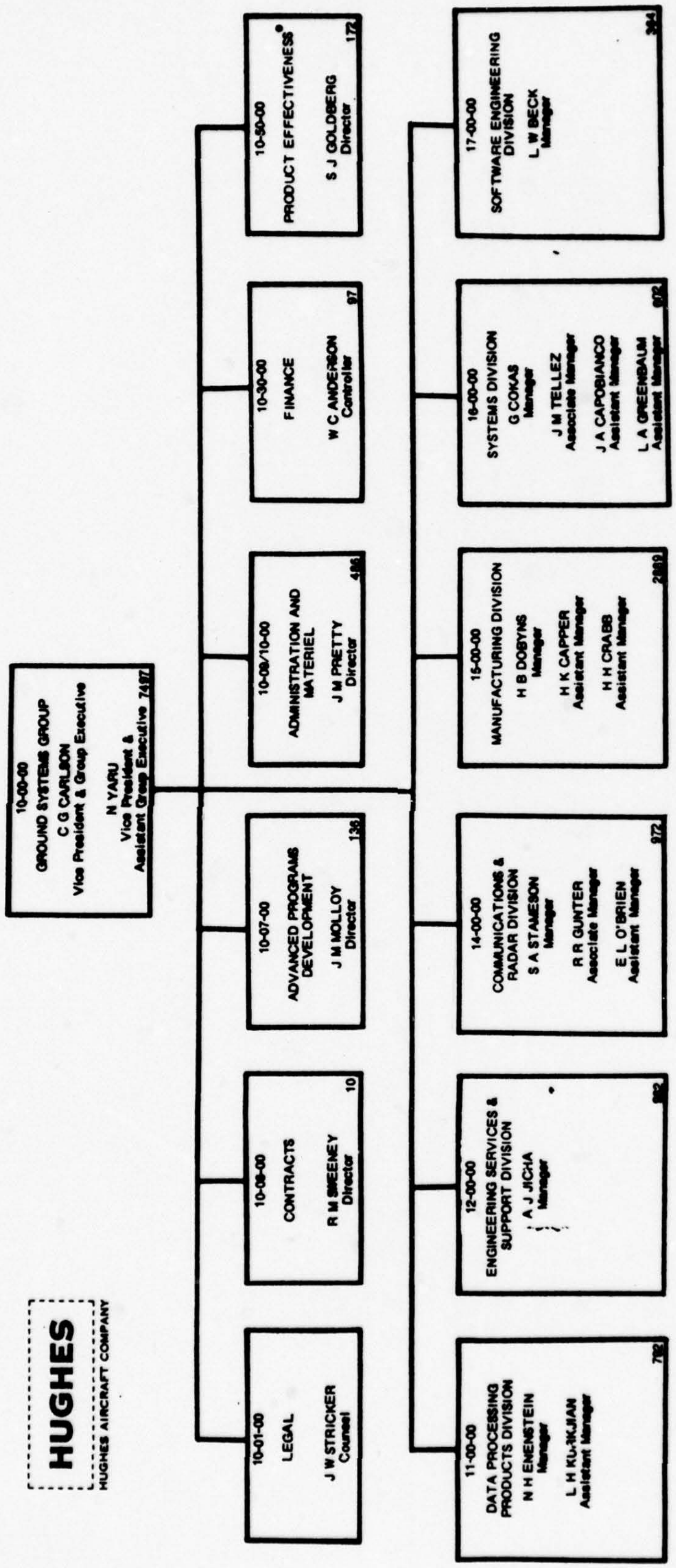
SECRETARY TO S J GOLDBERG: MARLISS SHEARER

REPLACES CHART 'QUALITY ASSURANCE' DATED 14 SEPTEMBER 1978

APPROVED: Director, Product Effectiveness

DATE: 26 OCTOBER 1978 ORG CODE 10-50-00

APPENDIX C – GROUND SYSTEMS GROUP ORGANIZATION CHART



*DIRECTOR – PERFORMANCE IMPROVEMENT PROGRAM

REPLACES CHART DATED 24 AUGUST 1978

APPROVED: [signature]
Vice President and Group Executive

DATE: 24 OCTOBER 1978 ORG CODE 10-00-00

APPENDIX D – SURFACE ACOUSTIC WAVE DEVICE STANDARD FLOW SHEET

Part No: __________
Serial No: __________
Charge No: __________
Revision: NC

STANDARD FLOW SHEET
SAW DIE FABRICATION

	Date	Appr.	Dept.
Assy.	9-5-77	[illegible]	[illegible]
Test	8-5-77	[illegible]	[illegible]
Proc. Mgr.	[illegible]	[illegible]	[illegible]
QA	8-5-77	[illegible]	[illegible]

Step	Operation	Spec/PEI Ref. #	In	Out	By	Dte	Hrs.
1.	Crystal material inspection	7.18.01A					
2.	Crystal clean	7.18.14					
3.	Metallization	7.18.16					
4.	Photoresist application	7.18.17					
5.	Pattern exposure	7.18.18					
6.	Photoresist development	7.18.19					
7.	Etch	7.18.20					
8.	Optical inspection	7.18.08A					
9.	~~QC inspection~~	~~Method 2010/2017~~					
10.	Protective coating	7.18.17					
11.	Dice wafer	7.18.22					
12.	Clean	7.18.14					
13.	~~Final QC die inspection~~	~~Method 2010/2017~~					

NOTE: All methods are per MIL-STD 883
All rework to be documented, retested, and reinspected before continuing assembly.

REWORK

Step	Operation & explanation	Requested by	In	Out	By	Date	Hrs.

Part No:	
Serial No:	
Charge No:	
Revision:	NC

STANDARD FLOW SHEET
FOR
SAW DEVICE ASSEMBLY

	Date	Appr.	Dep
Assy.	8-5-77	[illegible]	[illegible]
Test	8-5-77	[illegible]	[illegible]
Proc. Mgr.	8-5-77	[illegible]	[illegible]
QA	8-5-77	[illegible]	[illegible]

Step	Operation	Spec/PEI Ref. #	In	Out	By	Dte	Hrs.
1.	~~Kit Inspection~~	~~Method 2010/2017~~					
2.	Pre-tin package (header & cover)	7.15.03					
3.	Clean package	7.18.14					
4.	Toroid attach	7.18.23					
5.	Ground attach	7.15.06					
6.		7.15.~~23~~ 06					
7.	Clean package	7.18.14					
8.	Crystal attach	7.18.24					
9.	Wire bond	7.15.25					
10.	Electrical tune	7.18.26					
11.	Electrical test	7.16.05					
12.	Clean/inspect	7.18.14					
13.	QC Precap	Method 2010/2017					
14.	Symbolization	7.15.11					
15.	Seal	7.15.03					
16.	Fine leak	7.16.10					
17.	Gross leak	7.16.08					
18.	High Temp. Storage	7.17.01					
19.	~~Temp Cycle (cycles - °to °C)~~	~~7.17.02~~					

REWORK

Step	Operation & Explanation	Requested by	In	Out	By	Date	Hrs.

HUGHES

HUGHES AIRCRAFT COMPANY
GROUND SYSTEMS GROUP

ENGINEERING DIVISION
PROCESS ENGINEERING INSTRUCTION
MICROELECTRONICS

instruction

Subject			
SUBSTRATE DICING	Page 1 of 9	Number 7.18.22	
	Issue 11-2-78	Revision –	
	Approved [signature]	Date 10/30/78	
	Approved [signature]	Date 11/1/78	

1.0 SCOPE

1.1 This instruction describes the dicing of substrates into individual die.

2.0 EQUIPMENT AND MATERIAL REQUIRED

2.1 Equipment.

2.1.1 Dicing saw with accessory tools; Electroglass Model 106; or equivalent.

2.1.2 Hot plate, 100°-300°F temperature range.

2.1.3 Petri dishes, 4 to 5 inch diameter.

2.1.4 Vacuum system capable of maintaining 26 inches of mercury.

2.1.5 Photoresist spinner.

2.2 Materials.

2.2.1 Deionized water.

2.2.2 Dry nitrogen gas.

2.2.3 Optical mounting pitch; R. Howard Strausberg; or equivalent.

2.2.4 Double back tape; 3M; or equivalent.

2.2.5 Detergent; Dynatex KERF-AID; or equivalent.

2.2.6 Acetone; reagent grade or better.

2.2.7 Lubricant; KERF-AID 101, 102; or equivalent.

2.2.8 Photoresist; AZ1350J; or equivalent.

DICING

3.0 GENERAL REQUIREMENTS OR INSTRUCTIONS

3.1 Wafers with multiple circuit patterns are to be cut to yield individual die of single circuit patterns.

3.2 The operator shall receive a minimum of 4 hours training from Supervision or Process Engineering in the operation of this equipment and the operational process in accordance with this document.

3.3 If the machine malfunctions, notify the supervisor immediately.

4.0 PROCEDURE

4.1 Start-up

4.1.1 Saw blade replacement and installation.

4.1.1.1 The following tools (supplied with the dicing saw) are required to replace the saw blade.

1. Spindle Nut Wrench Part No. 106122
2. Blade Handler Part No. 106123
3. Blade Stand Part No. 106418
4. Guard Removal Tool Part No. 060952

4.1.1.2 Remove the two plastic covers from the front of the spindle housing.

4.1.1.3 Turn the nozzle retractor screw full clockwise to retract the nozzle away from the blade area.

4.1.1.4 Remove the spindle nut with the Spindle Nut Wrench. Hold the exterior knurled tube, and rotate the handle clockwise.

4.1.1.5 Connect the Blade Handler tool to the VACUUM outlet on the right front cover of the machine.

4.1.1.6 Place the Blade Handler over the front of the spindle, firmly against the face of the saw blade to form a vacuum seal.

4.1.1.7 Slowly pull the blade from the spindle.

NOTE: If blade is tight on the spindle, rock the handler up and down or to the side while removing the blade from the spindle.

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4.1.1.8 Place the blade on the Blade Stand and release the vacuum by pressing the vacuum release button on the end of the handler.

4.1.1.9 If the blade is to be saved, place a plastic guard ring on it and remove it from the stand. Damaged blades should be discarded.

4.1.1.10 Clean the flange face and spindle shaft surfaces of all debris. These surfaces must be clean to insure proper alignment of the blade with the shaft.

4.1.1.11 Place a new blade on the Blade Stand with the white guard ring facing up.

4.1.1.12 Remove the guard ring by firmly holding the blade hub against the stand and gradually prying the ring off by working the Guard Removal Tool around the outside edge of the ring.

<u>CAUTION</u>: Do not touch the blade. It is very fragile and can be easily damaged.

4.1.1.13 Lower the Blade Handler over the Blade Stand against the blade hub to make a vacuum seal.

4.1.1.14 Remove the blade from the Blade Stand.

4.1.1.15 Place the blade on the spindle shaft. Make sure it is seated against the spindle flange.

4.1.1.16 Release the vacuum by holding the Vacuum Switch button and remove Blade Handler.

4.1.1.17 Make sure the face of the spindle nut is free of debris. Place it on the end of the spindle with the large-diameter face against the blade.

4.1.1.18 Tighten the spindle nut with the Spindle Nut Wrench.

4.1.1.19 Turn the nozzle retractor screw counterclockwise until the nozzle strikes the adjustment setscrew.

4.1.1.20 Turn the spindle on and check for correct water flow.

4.1.1.21 Readjust the height indicator as described in Section 4.1.5.

4.1.1.22 Replace the plastic covers.

DICING

4.1.2 Fill lubricant tank with KERF-AID as required.

4.1.3 Apply a protective coating of AZ1350J photoresist to wafer per PEI 7.18.17.

4.1.4 Mounting substrates to glass mounting plate.

4.1.4.1 Mount quartz substrates using optical mounting pitch as described below:

a. Preheat hot plate to 125 ± 5°C.

b. Place the glass mounting plate or the hot plate and allow 3-5 minutes for temperature stabilization.

c. Apply the mounting pitch to the mounting plate and spread with the rod end of a Q-tip.

d. Place the quartz substrate on the mounting pitch and press the substrate with a wooden probe in circuit free areas for intimate contact.

e. Remove and allow to cool to room temperature.

4.1.4.2 Mount lithium niobate substrates to a glass mounting plate using double back masking tape.

4.1.5 Perform blade height adjustment as described below after approximately 5 hours of cutting time, dressing the blade or changing the blade.

4.1.5.1 Rotate the HEIGHT ADJUST knob clockwise to maximum height.

4.1.5.2 Set BLADE to ON and set HEIGHT ADJUST/RUN switch to HEIGHT ADJUST. This will allow the blade to come down without the water being on.

4.1.5.3 Set AUTO/MAN switch to AUTO.

<u>CAUTION</u>: Do not cut fast or deep while in HEIGHT ADJUST or the blade will be damaged due to the lack of cooling water. Do not cut deeper than 0.001 inch or faster than 0.3 inches per second without water.

DICING

4.1.5.4 Place the MODE selector in CUT and turn the SPEED ADJUST valve fully clockwise (closed).

4.1.5.5 Press the START/STOP button. Slowly turn the SPEED ADJUST VALVE counterclockwise (open) until the wafer is under the saw blade. Close the SPEED ADJUST valve, stopping the X-axis carriage.

4.1.5.6 Slowly lower the blade by turning the HEIGHT ADJUST knob counterclockwise while observing the distance between the blade and the wafer.

4.1.5.7 Lower the blade until it just clears the wafer.

4.1.5.8 Open the SPEED ADJUST valve slightly so that X-axis will cycle slowly back and forth. Lower the blade in 0.0005-inch steps per pass until a scratch is made across the wafer. If necessary, use the microscope to determine when contact has been made.

4.1.5.9 Turn the MODE selector to LOAD. Press the START/STOP botton.

4.1.5.10 Lower the blade height to the desired depth of cut.

4.1.5.11 Set the HEIGHT ADJUST/RUN switch to RUN.

NOTE: These processes are to be performed only with the concurrence of your supervisor or a process engineer.

An alternate visual method is to use the above procedure but contact the top of the chuck. Do not put a wafer on the chuck. Once contact is made, adjust the height up a distance equal to thickness of the material that is to remain below the cut.

A third visual method is to make contact with a shim equal in thickness to the material that is to remain below the cut.

4.1.6 Final setup adjustments.

4.1.6.1 Prior to making a production run, the following adjustments should be made. They are used to set up a programmed sequence for a particular wafer geometry. New adjustments must be made for each new wafer geometry.

DICING

4.1.6.2 Wafer size: Three wafer size limits are selected by the WAFER SIZE switch. Use Wafer Size 2 for wafers up to 2 1/4 inches in diameter. Size 3 is for wafers between 2 1/2 and 3 1/4 inches in diameter. Size 4 is for wafers between 3 1/4 and 4 1/4 inches. Select the proper setting as specified on the Standard Flow Sheet and dial it in on the WAFER SIZE switch.

4.1.6.3 Speed: Adjust the speed as specified on the Standard Flow Sheet. Speed in the cutting direction (left-to-right) is controlled by the SPEED ADJUST knob and displayed in inches per second. Speed is only sampled once per X-axis cycle; therefore, it must be adjusted while the X-axis is cycling back and forth. For a correct reading do not adjust speed during the cutting pass. The speed indication is a timed pulse rate from a linear encoder and it latches the readouts to results of the last pass. The reading remains until another X-axis pass is completed.

4.1.6.4 Index settings: Index settings are determined by following the procedure outlined below.

1. Select an identifiable mark on the wafers so they can always be palced on the chuck in the same direction.

2. Set the chuck to the Phase A position and place a wafer on it.

3. Dial in the A index distance as specified on the Standard Flow Sheet for the horizontal streets.

4. Dial in the B index distance as specified on the Standard Flow Sheet for the vertical streets.

5. Verify index settings by first jogging the center of a street to the microscope reticle and then make one index. It should index to the center of the next street.

6. To check the B index settings, release the chuck lock and rotate the chuck to Phase B position. The wafer should index from the center of one street to the next as it did in Phase A.

7. If the street spacing in unknown, dial in .0100 inch (0.100 mm) on the Phase A index switch.

DICING

4.1.6.4 Index settings: (Continued)

8. Align a wafer street center with the microscope reticle in Phase A. Continually index, counting the number of indexes until the reticle crosses the center of the next street. Jog back to realign the reticle with the original street. Dial the number of counted indexes times 0.0100 into the INDEX DISTANCE digitswitch.

9. Make a single index and observe the relationship to the next street.

10. Return one index to the center of the original street and add a few mils (less than 10) to the index setting and repeat Step 9.

11. Readjust the index settings until one index moves the wafer exactly one street.

    NOTE: Always return to the original street before changing the index setting in order to eliminate jogging each time.

12. Rotate the chuck to the Phase B position and repeat the above procedure. (Steps 7-11).

    This method is recommended over the simple trial and error method which may easily result in index settings that are hard-to-detect multiples of the true street spacing.

4.2 Process instructions.

4.2.1 Place a wafer on the vacuum chuck.

4.2.2 While observing through the microscope, rotate the wafer until a street is roughly aligned with the cross hair. Set the CHUCK VACUUM to ON.

4.2.3 Set the MODE selector to ALIGN and press the START/STOP button. The chuck will cycle from side-to-side under the microscope.

4.2.4 Observe the relation of the street to the crosshair and adjust the Theta knob until the street runs parallel to the crosshair.

4.2.5 Jog the Y-axis until the crosshair is in the center of a street.

4.2.6 Turn the MODE selector to CUT. The blade will automatically go to the rear of the wafer, the blade will lower, the cooling water will start flowing, and the X-axis will travel to the right, cutting the wafer. When the blade reaches the end of the wafer, it will lift and the Y-axis will index to the next street while the X-axis returns to the left at high speed. This entire cycle will repeat until the wafer is completely scribed in one axis. When the entire cycle is complete, the blade will then return to its Home position. To vefify alignment, the cycle can be stopped at any time by pressing the START/STOP button. The cycle can be restarted by pressing the START/STOP button a second time and the cycle will continue. Each time it is restarted, however, the chuck will go the the Home position, at the far left, before completing the previous cut. The operator can, therefore, stop the cutting at any time, then restart to move the chuck to the far left and then stop it a second time as desired under the microscope to observe the cut. By repeatedly starting and stopping, the operator can observe any desired location on the street. When stopped in the Auto-Cut mode, the manual controls are reactivated to allow jogging or indexing as required. Always return the Y-axis to the street that it was stopped on in order to ensure cutting of all streets.

4.2.7 Press and hold the CHUCK RELEASE button while rotating the chuck to the 90° detent. Release the button and the chuck will lock in place. The system's electronic circuitry will atuomatically switch to the Phase B index switch.

4.2.8 Set the MODE selector to ALIGN and press the START/STOP button.

4.2.9 Check the Theta alignment and readjust if necessary.

4.2.10 Scan or jog the crosshair to the center of a street.

4.2.11 Turn the MODE selector to CUT. The saw will automatically cut all the streets at the Phase B index spacing in the same manner as it cut during Phase A.

4.2.12 Press and hold the CHUCK RELEASE button while rotating the chuck back to its original position. Release the button to lock the chuck in the starting position (Phase A) for the next wafer.

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DICING

4.2.13 Turn the CHUCK VACUUM OFF and remove the wafer.

NOTE: If vacuum is removed while Theta is still in Phase B cut position, an alarm will sound to warn that the chuck is not in the correct starting position for the next wafer.

4.2.14 If the wafer cannot be removed easily because of suction caused by the wafer under it, then press the WAFER AIR button to inject air pressure into the chuck, thus, lifting the wafer and releasing the suction.

4.3 Shut-down.

4.3.1 Not applicable.

5.0 REFERENCES

5.1 Government standards and specifications.

5.1.1 Not applicable.

5.2 Internal specifications and instructions.

5.2.1 PEI 7.18.17, Photoresist Application (Spinning).

QUALITY ASSURANCE QUALITY METHOD SHEET MICROELECTRONICS	Page 1 of 3 Date 12/28/77	Number M-035 Revision Orig

Crystal Circuits, Visual Inspection of

APPROVED [signature]

1.0 PURPOSE

To provide instructions for the visual inspection of Surface Acoustic Wave (SAW) devices manufactured on metallized crystalline substrate material by a deposition, photolithographic exposure, and chemical etch process.

2.0 SCOPE

This instruction covers the visual inspection requirements for all SAW devices made by the deposition of a metallized conductor on a crystalline substrate and then using either a selective etch or liftoff process to remove all but the desired pattern.

3.0 INSPECTION

3.1 Materials - All materials utilized in the processing of crystal circuits are described in Process Engineering Instruction (PEI) 7.18.00, Acoustic Wave Processing.

3.2 Equipment - All equipment required for the fabrication of SAW devices is described within the appropriate sections of PEI 7.18.00, Acoustic Wave Processing.

3.3 Procedure - Unless otherwise specified, the process sequence shall be performed as outlined on SAW process followers, and processed according to the appropriate PEIs referenced thereon.

3.3.1 Handling - Crystals shall remain in protective containers until process and inspection operations are to be performed. Finger cots or other hand protection shall be worn at all times to prevent damage and contamination. Devices shall be handled only on the sides and never by the metallized surface. Device packages (headers) shall be handled by non-sealing surfaces only.

3.3.2 Crystal Cutting and Sorting - Wafers shall be separated into individual circuit crystals before visual inspection. After separating, crystals shall be cleaned in a manner sufficient to remove all foreign material. Crystals shall be sorted into lots and properly identified by the use of a standard process follower.

3.3.3 Adhesion - Crystals shall exhibit uniform adhesion. There shall be no evidence of separation of the metallization from the crystal substrate when tested with adhesive tape. The adhesion test shall be performed for process certification on production circuits. A length of commercial, clear, or translucent plastic tape shall be applied to the metallized, etched substrate. The tape shall cover an area of at least 1/2 inch and shall be set by rubbing with a finger. The tape shall be pulled back at an angle of approximately 90° to the crystal using one smooth motion. The metallized layers shall not show any evidence of separation when examined at 30 to 100 power magnification.

3.3.4 Process Control - Described in Quality Method Sheet (QMS) M-001, Microelectronics Process Surveillance.

3.4 Quality Assurance Provisions

3.4.1 Responsibility - The Quality Assurance Group Office (QAGO) shall be the cognizant Quality organization exercising control over all processing heretofore described.

3.4.2 Inspection - Crystals produced shall be inspected to the requirements of the device engineering drawing and workmanship standards contained in Section 3.5 and Table I of this QMS.

3.5 Workmanship

3.5.1 General - Crystals shall be visually examined under 30 power magnification (minimum) for conformance to the workmanship requirements contained herein. Transmitted light shall be used where applicable. Crystals not conforming to the requirements contained herein shall be rejected unless they can be reworked to conform to the specified requirements. Reworked crystals are to be resubmitted for verification of conformance to the electrical and visual requirements specified herein.

3.5.2 End Product Requirements - SAW devices shall conform to the visual requirements of the appropriate engineering drawing, device specification, and workmanship standards contained herein. The following irregularities and those shown in Table I of this QMS shall be cause for rejection.

a. Chips or cracks in the crystal material which come closer than 25 microns (1 mil) to any active metallization.
b. Scribing edge of the crystal material that is closer than 25 microns (1 mil) to any metallization.
c. Any crack which extends into or points toward and comes within 127 microns (5 mils) of active metallization.
d. Scratches, voids, or holes which reduce the bonding pad to transducer finger interconnect to less than 50 percent of original design width.
e. Scratches, voids, or holes which reduce bonding pads to less than 50 percent of original design width.
f. Attached opaque contamination which cannot be removed by cleaning procedures and appears to be shorted to adjacent transducer fingers that are not connected to the same pad.

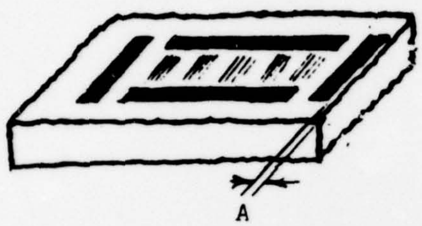
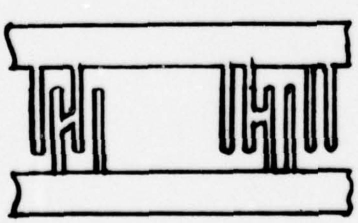
Crystal Circuits, Visual Inspection of

g. Shorts between transducer fingers not connected to the same pad which cannot be blown during device test.
h. Lifting or peeling metallization.

NOTE: Opens, voids, or scratches on transducer fingers which do not affect electrical characteristics are acceptable.

D. J. Davis
Quality Assurance

TABLE I

Illustration	Requirement
	Reject - A is less than 1 mil (25.4 microns or .001 inch) between metallization and chips or cracks in crystal substrate material.
	Reject - Scribing edge of crystal material comes closer than 25 microns (1 mil) to active metallization.
	Reject - Any crack which extends into or points toward and comes within 127 microns (5 mils) of active metallization.
	Reject - Scratches, voids, or holes which reduces any bonding pad or transducer interconnect to less than 50 percent of original design width.
	Reject - Shorts between transducer fingers that are not connected to the same interconnect pad which cannot be removed during test.

APPENDIX G – QUALITY HISTORY SHEET

92511-1

QUALITY HISTORY

LOT	PRG
P/N	

S/N	REWORK CYCLES 1	2	3	4	5	6

STEP	REQD BY	DATE	DISCREPANCY AND ACTION REQUIRED	PERFMD BY	DATE	HRS	ACCEPT BY	DATE

STEP	REQD BY	DATE	DISCREPANCY AND ACTION REQUIRED	PERFMD BY	DATE	HRS	ACCEPT BY	DATE

HUGHES
HUGHES AIRCRAFT COMPANY

SUPPLIER CORRECTIVE ACTION REQUEST

(INSTRUCTIONS ON BACK)

35757

92511-2

SUPPLIER NO. ____________ DATE ____________

SUPPLIER ____________ PART NO. ____________ S/N. ____________

ADDRESS ____________ PART NAME ____________

____________ P. O. NO. ____________

ATTENTION ____________ REC'V'G. RCPT. NO. ____________

PREVIOUS CORRECTIVE ACTION REQUESTS ____________ PROGRAM I. D. NO. ____________

QTY RCVD. ____________ LOT SIZE ____________ QTY INSP. ____________ QTY DISCREPANT ____________

QTY SUSPENDED ____________ SUSPENSION/REJECTION DOCUMENT NO. ____________

1. DISCREPANCIES:

____________ QUAL./PROD. ASSURANCE ____________ DATE

2. THE DISCREPANCIES NOTED ABOVE:

A ☐ CONCERN ITEMS THAT HAVE RECEIVED GOVERNMENT SOURCE INSPECTION AT YOUR PLANT.

B ☐ CONCERN PARTS THAT HAVE BEEN REVIEWED AND SUSPENDED BY QUALITY. ☐ MATERIAL BEING RETURNED ☐ MATERIAL NOT BEING RETURNED

C ☐ REQUIRE THAT YOU TAKE IMMEDIATE CORRECTIVE ACTION TO PRECLUDE FUTURE NON-CONFORMING DELIVERIES.

D ☐ REPLY IS TO BE SUBMITTED NOT LATER THAN ____________

TO: ____________ ADDRESS: ____________

BUYER ____________

DEPT. ____________ BLDG. ____________ M/S. ____________

E ☐ SEE OTHER COMMENTS ON ATTACHED PAGE

3. SUPPLIER REPLY (See reverse side for instructions)

IF REQUIRED – SEE 2A ABOVE

GOV'T REPRESENTATIVE'S SIGNATURE ____________ DATE ____________

SIGNATURE ____________ TITLE ____________ DATE ____________

4. TO BE COMPLETED BY HUGHES QUALITY/PRODUCT ASSURANCE

ACTION SATISFACTORY	YES	NO	FURTHER FOLLOW-UP REQUIRED	YES	NO	NEW SCAR NO.
SIGNATURE DATE			SIGNATURE DATE			

DISTRIBUTION: White – Supplier Returns to Buyer; Canary – Supplier Retains; Pink – Buyer Retains; Blue – Scar Retains; Goldenrod – Originator

805A CS JUN 70

APPENDIX I – NONCONFORMING MATERIAL REPORT

92511-4

HUGHES
HUGHES AIRCRAFT COMPANY

NONCONFORMING MATERIAL REPORT (NCMR)

NO. 278882
DATE ____
PAGE ____ OF ____

PROGRAM ID ____

PART NO.	S/N	ENG. CHANGES	NOMENCLATURE

WORK ORDER DOC NO.	LOT SIZE	QTY. SUSP.	SUSPENDED IN	HARDWARE I.D. NO.	REF. DOCUMENTS

SUPPLIER	DIV. OR LOCATION	SUPPLIER CODE	P.O. NO.	ITEM NO.	R.R. NO.

ITEM NO.	QTY INSP.	QTY SUSP.	DESCRIPTION OF NONCONFORMANCE	RESP. DEPT.	PRIOR OCCUR	M.R. LEVEL	CODE

ORIGINATOR	DATE	QUALITY	DATE	ENGINEERING	DATE

ITEM NO.	DISP. CODE	DISPOSITION/INSTRUCTIONS	STAMP

ENGINEERING	DATE	QUALITY	DATE	CUSTOMER	DATE

RESULTS OF CORRECTIVE ACTION INVESTIGATION

ITEM NO.	CAUSE OF NONCONFORMANCE	CORRECTIVE ACTION

SIGNATURE	DATE	SIGNATURE	DATE

RESPONSIBILITY		DEBIT VENDOR		DISP.CODE	VENDOR PACKING SHEET	QTY. R.T.V.	QTY. SCRAP	BUYERS SIGNATURE	DATE	COPY
VENDOR ☐	HAC ☐	YES ☐	NO ☐							

11628 CS OCT 77

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92511-5

58471

HUGHES
HUGHES AIRCRAFT COMPANY

INSPECTION/TEST REQUEST

(SEE INSTRUCTIONS ON REVERSE SIDE)

DATE OF REQUEST ____________

Page ________ of ________

6. CHARGE TO	GLA	COST ACCT.	BREAKDOWN

1. To | Dept. #

Bldg. (Insp./Test., Lab.; etc.) M/S

2. Requested by | Dept.

Approval Signature

Bldg. | M/S | Phone

3. Drawing/Spec. No. | Part Name or Type Material

Cat. and Stock No.

Contract No. or Name

4. Alloy | Heat No.

5. Quantity to be inspected/tested

7. **INSTRUCTIONS – INSPECT OR TEST PART/MATERIAL DESCRIBED IN BLOCKS 3, 4, & 5 TO ITS DRAWING OR SPECIFICATION.**

Please Complete Tests and Return to Requestor By ____________

Additional Instructions ____________

8 GSI – APPLIES ☐ DOES NOT APPLY ☐

CALL ____________ (Name) ____________ (Tel. No.) To Witness Test

DO NOT REPAIR OR MODIFY FAILED ITEMS

9. Total Lot Quantity Received:

Supplier:

10. Documentation and Data Held by Originator Pending Return of Insp./Test Reports

Purchase Order/R.R. No. ____________

Receiving Memorandum No. ____________

Work Order No. ____________

11. Action on Material Inspected/Tested

SLR No. ____________

Other ____________

12. REQUIRED INSPECTION OR TEST	13. QUANTITY Accepted	Rejected	14. SIGNATURE OF INSP. OR TESTER	15. COMMENTS - SPECIFY REASONS FOR NON-ACCEPTANCE
(a)				
(b)				
(c)				
(d)				
(e)				
(f)				
(g)				
(h)				

16. Quantity Inspected/Tested | 17. Date/Inspected/Tested | **DO NOT REPAIR OR MODIFY FAILED ITEMS**

18. Sig. of Person Performing Insp/Test | 19. Quality Acceptance | 20. Customer Acceptance

12-250 GS 11/73

21. DISTRIBUTION – BEFORE INSPECTION/TEST
white - with material
yellow – with material
green – with material
blue – with material
pink – to finance
goldenrod – originator

22. DISTRIBUTION – AFTER INSPECTION/TEST
white – to originator
yellow – with material to stores
green – to finance
blue – activity conducting inspection test

APPENDIX K – QUALITY CONTROL ACCEPTANCE TAG

HAC GSG **QUALITY CONTROL**

ACCEPTANCE TAG

PART NUMBER/IDENTIFICATION			DRAWING CHG. LTR.
PART/ASSEM. NAME		PLANNING REV.	EOs/PDAs INCORP.
SHOP ORDER NUMBER			
PURCHASE ORDER NUMBER	REC. REPORT NUMBER		
QUANTITY ACCEPTED		INSP./TEST STAMP	
DATE	CURE DATE		GOVT. INSP. STAMP

5073 GS 3/70

APPENDIX L – QUALITY CONTROL HOLD TAG

QUALITY CONTROL **HOLD TAG**

92511-3

PART NUMBER	SER. NO.	QUAN.	DEPT. SUSP.

REFERENCE DOCUMENT			DOCUMENT NO.	PAPERWORK HELD IN
HRT	IDR	SLR		REC INSP ☐ SMC ☐ MRB ☐ OTHER ☐

REMARKS:	MATERIAL HELD FOR

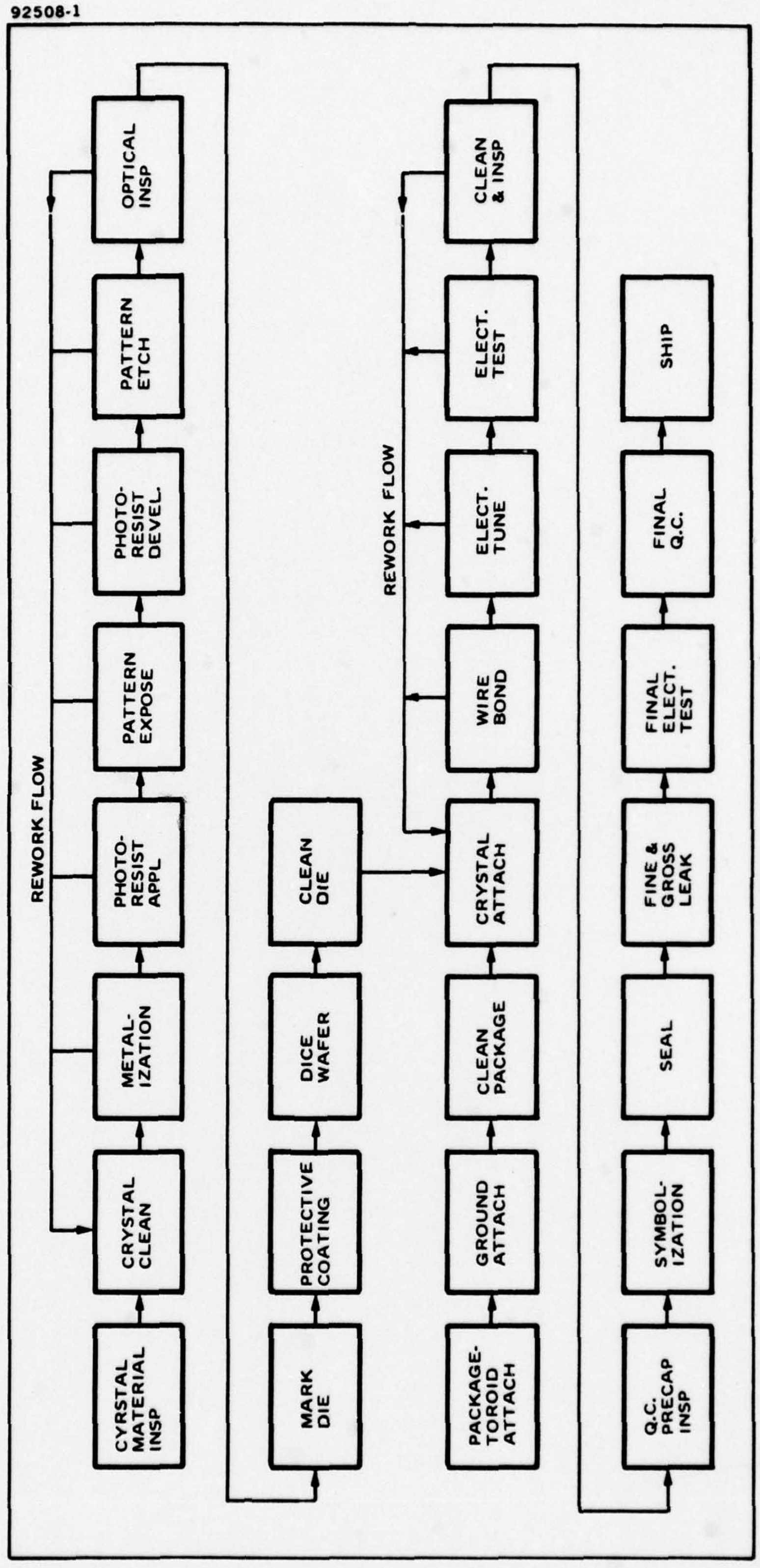
SIGNATURE	DATE

NO WORK OR TRANSPORTATION PERMITTED UNTIL DISPOSITIONED BY ERB/MRB.

12-217 GS 5/69

APPENDIX M – SURFACE ACOUSTIC WAVE DEVICE PROCESS FLOW

92508-1



SAW Device Process Flow

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1 DELET-DT
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1 DELSD-D
1 Originating Office DELET-MM

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