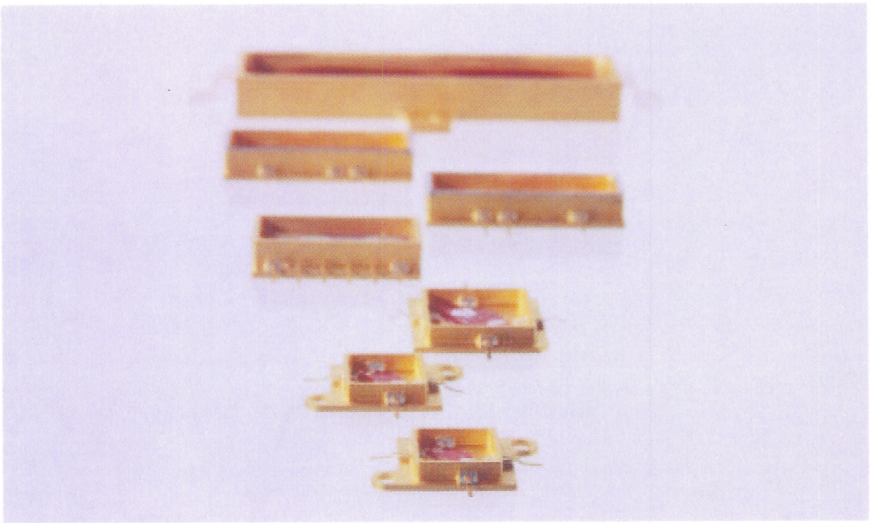
# Technology Flow Definition Norspace SAW Device Manufacturing for Space Application



| | Name | Sign | Date |
|---|---|---|---|
| Prepared by | Cecilie Berg | Cecilie Berg | 30/5 -2011 |
| Checked by | Øystein Johansen | Øystein Johansen | 31/5 -2011 |
| Approved by | Sigmund Bardal | Sigmund Bardal | 31/5 - 2011 |
| Approved QA | Harald Bjørn Hansen | Harald Bjørn Hansen | 31 May 2011 |

## CHANGE RECORD

| Date | Iss. | Page | Change |
|---|---|---|---|
| 30. May 11 | 1 | - | Initial issue |

## TABLE OF CONTENT

# 1. SCOPE AND OBJECTIVE

This document presents the Technology Flow Definition concerning the Norspace SAW device manufacturing for space applications. The document is prepared as part of WP1200 in the SAW Technology Flow Qualification (SAW TFQ) program.

# 2. Technology Flow Definition

**NORSPACE**

**Contact Information**

| Address | ESCC Chief Inspector |
|---|---|
| Norspace AS<br>Knutsrødveien 7<br>N-3189 Horten<br>Norway | Cecilie Berg<br>Tel: (+47) 3303 2700<br>Fax: (+47) 3303 2800<br>email: cecilie.berg@norspace.no |

**Initial Qualification**

| Qualification Certificate No. | Validity dates | Type designation |
|---|---|---|
| No. 303 | June 2011 –<br>June 2013 | SAW filters<br>(transversal band pass/resonator/notch/<br>low loss impedance element) |

**Maintenance of Qualification**

| Qualification Certificate No. | Validity dates | Comment |
|---|---|---|
| | | |

**Applicable documents**

ESCC Generic Specification 3502

ESCC Detail Specification 3502/002

Norspace PIDs:

PID534_3 SAW Device Assembly with flow NORSF-A1

PID630_4 SAW Crystal Manufacturing with flow NORSF-C1

**List of Qualified Components**

For each design a detail specification is produced by Norspace. Where the SAW component is not proprietary to the customer the detail specification is published in ESCIES as a supporting document. Available detail specifications are found in the table below.

| Detail specification | Component Type |
|---|---|
| ESCC 3502/002 | |

**Technology flow abstract**

1. Technology Flow

The Technology Flow covers the design, fabrication, assembly, screening, in-process control and testing of the Norspace SAW filters manufactured within the NORSF-C1 and NORSF-A1 processes. The design, crystal manufacturing, assembly, screening and testing is performed in the Norspace facility at Knudsrødveien 7 in Horten, Norway.

| Description | Scope |
|---|---|
| Design | Norspace specification Ko 03.00 |
| Crystal manufacturing | Process flow NORSF-C1 on purchased SAW-grade surface polished wafers.<br><br>Wafer materials:<br>Quartz ($SiO_2$), Lithium niobate ($LiNbO_3$), Lithium tantalate ($LiTaO_3$), Langasite ($La_3Ga_5SiO_{14}$)<br><br>Wafer dimensions:<br>3” diameter 0.5 mm thick<br>3” diameter 1.0 mm thick<br>4” diameter 1.5 mm thick |
| Assembly | Process flow NORSF-A1.<br><br>Crystal dimensions:<br>from 1.7 mm × 3.1 mm up to 8 mm × 76 mm.<br><br>Packages:<br>• Gold plated Fe-Ni-Co-alloy flat packs.<br>From 4 up to 50 leads with ceramic or glass feedthroughs. External wings for screw attach on some types.<br>Package dimensions:<br>From 8 mm × 8 mm up to 85 mm × 12 mm.<br><br>• Gold plated Fe-Ni-Co-alloy flat packs with Cu-W base, 4 or 6 leads and ceramic feedthroughs.<br>Package dimensions:<br>From 11 mm × 11 mm up to 7 mm × 21 mm.<br><br>• Gold plated ceramic Leadless Chip Carrier (LCC) package, 10 solder pads.<br>Package dimension:<br>5 mm × 7 mm. |

| | |
|---|---|
| Screening and test | • Incoming inspection<br>• In-process inspection<br>• 100% Wafer probe electrical test<br>• 100% Visual inspection<br>• Final production tests<br>• Customer Source Inspection<br>• Screening<br>• Burn-in and electrical measurements<br>• Test procedures<br>• External visual inspection<br>• Qualification testing<br>• Lot acceptance testing |

(a) Basic Information

The SAW devices are passive devices and typically require external tuning.

Frequency range: From 10 MHz up to 4 GHz.
Max operating temperature range: -30 / +85 °C (maximum), -20 / +70 °C (typical).
Input power: design sensitive.

(b) Component types

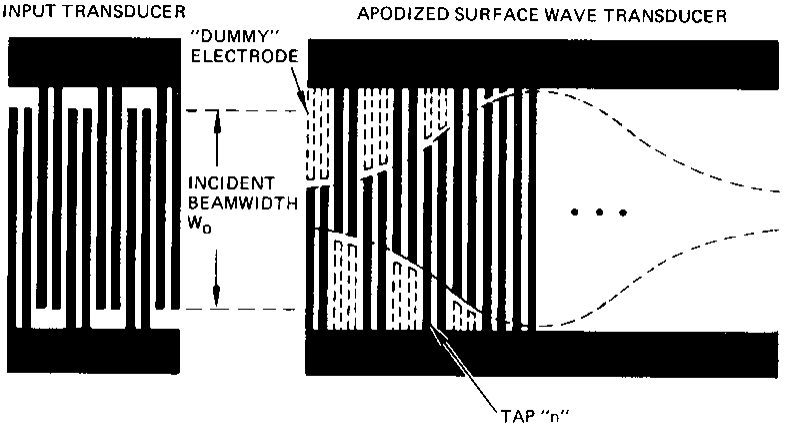
- Transversal band pass SAW filters with frequencies up to 4 GHz.
- SAW Resonator filters
- SAW Notch filters
- Impedance element filters with low loss

## 2. Design

The design programs are in-house developed procedures and libraries. Each new design is custom made for the application by Norspace design engineers. The design centre is in Horten, Norway.

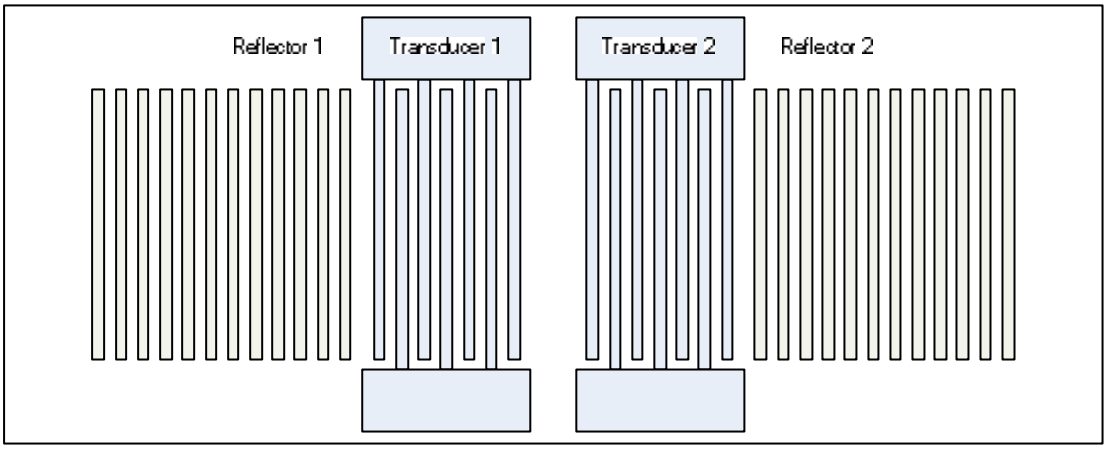
### *2.1 Transversal band pass SAW filters*

The transversal filters consist of one input transducer and one output transducer, see figure below. The transducers are interdigital transducers formed by a metal pattern on a piezoelectric material (wafer). The transducers can be withdrawal weighted and/or length (apodization) weighted. The detailed weighting functions are calculated in a dedicated filter synthesis software and used as input to the mask layout software. The simulation of the filter response is performed by a dedicated SAW Analysis software.




### *2.2 Resonator filters*

The resonator filter consists of input and output transducers as described above. These are normally unweighted. The transducers are backed by reflectors, see figure below. The reflectors are l/4 wide etched grooves or metal fingers. The same SW is used for simulation of the transducers and reflectors.

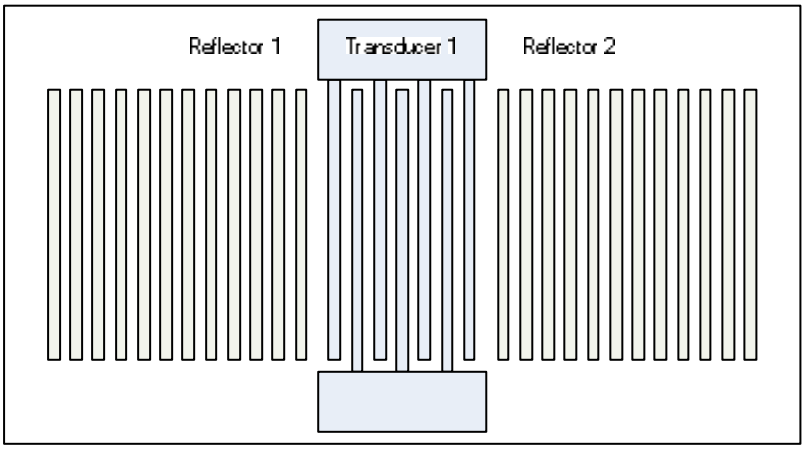



*2.3 SAW Notch filters*

The notch are based on single port resonator elements, so called impedance elements (see below).

*2.3.1 Impedance element filters with low loss*

Impedance element filters are constructed from one port SAW resonators. The one port SAW resonators consist of one interdigital transducer backed by one reflector on each side, as shown in the figure below.




3. Fabrication

The NORSF-C1 process at Norspace comprises

- SAW crystal manufacturing on SAW grade polished single crystal wafers from quartz, $LiNbO_3$, $LiTaO_3$ and $La_3Ga_5SiO_{14}$ (langasite).
- Externally purchased SAW wafers
- SAW wafer thickness between 0.5 mm and 1.5 mm.

- Photolithography with line widths down to 0.3 µm. No upper limit.
- Metallization performed with Al or Cr/Al. Metal thickness 400 – 10 000 Å.

The process can manufacture SAW elements of band pass, resonator or notch type with centre frequencies in the range 10 MHz to 4 GHz.

## 4. Assembly

Norspace assembly flow NORSF-A1 technology flow covers the following capabilities:

| Package | Die Attach | Wire Bond | Lid Seal | Leads |
|---|---|---|---|---|
| Flatpack/LCC. Au plated. CuW base/ Fe-Ni-Co alloy or ceramic with Fe-Ni-Co alloy seal ring. | Silicone rubber | Ultrasonic ball-wedge, 25 µm Au wire | Resistance seam sealing. $N_2$ atmosphere. | Au plated |

## 5. Test

Measurements are performed using a Vector Network Analyzer (VNA),

All equipment in the electrical test set-up shall have the same characteristic impedance. The S-parameters are measured on the VNA and transferred to a PC for post-processing and analysis. Before testing the VNA and its test cables must be calibrated as specified in the manual for the instrument (full 2-port calibration).

Test vehicles used for qualification: SQF-3800, SLC-4320.

Test vehicles used for maintenance: SQF-3800, SLC-3900, or similar devices.

## 6. Radiation

- The devices are regarded as radiation insensitive within a small drift in centre frequency and phase allowed for in the design margins.
- Radiation testing has been performed successfully up to 50 MRad(Si) for quartz and 1 MRad(Si) for $LiNbO_3$, $LiTaO_3$ and Langasite.

Qualified wafer materials: Quartz, $LiNbO_3$. $LiTaO_3$, Langasite ($La_3Ga_5SiO_{14}$).