

5 **QUALIFIED TECHNOLOGY FLOWS**

The following technology flows are qualified.

5.1 **FILTERS (05)**

5.1.1 **KONSBERG NORSPACE, Norway: SAW FILTERS**

5.1.1.1 **Contact Information**

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

5.1.1.2 **Qualification**

| Current Qualification Certificate No. | In QML since: | Type Designation |
|--|---------------|--|
| 313B | Aug. 2011 | SAW filters (transversal band pass/resonator/notch/low loss impedance element) |

Applicable ESCC Documents:

ESCC Generic Specification No. [3502](#)

ESCC Detail Specification Nos. [3502/002](#)

Norspace Process Identification Documents:

PID534 SAW Device Assembly with flow NORSF-A1

PID630 SAW Crystal Manufacturing with flow NORSF-C1

5.1.1.3 **List of Qualified Components**

For each design, a detail specification is produced by Kongsberg 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 |
|----------------------|---|
| 3502/002 | SAW Filters, Hermetically Sealed, Surface Mount, Frequency Range 10 MHz - 4 GHz |

5.1.1.4 Technology Flow Abstract

General features

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

| Technology Flow | Scope |
|-----------------------|--|
| Design | Norspace specification Ko 03.00 |
| Crystal manufacturing | <p>Process flow NORSE-C1 on purchased SAW-grade surface polished wafers.</p> <p><u>Wafer materials:</u> Quartz (SiO₂), Lithium niobate (LiNbO₃), Lithium tantalate (LiTaO₃), Langasite (La₃Ga₅SiO₁₄)</p> <p><u>Wafer dimensions:</u> 3" diameter 0.5 mm thick 3" diameter 1.0 mm thick 4" diameter 1.5 mm thick</p> |
| Assembly | <p>Process flow NORSE-A1.</p> <p>Crystal dimensions: from 1.7 mm x 3.1 mm up to 8 mm x 76 mm.</p> <p>Packages:</p> <ul style="list-style-type: none"> -Gold plated Fe-Ni-Co-alloy flat packs. From 4 up to 50 leads with ceramic or glass feedthroughs. External wings for screw attach on some types <u>Package dimensions:</u> From 8 mm x 8 mm up to 85 mm x 12 mm. -Gold plated Fe-Ni-Co-alloy flat packs with Cu-W base, 4 or 6 leads and ceramic feedthroughs. <u>Package dimensions:</u> From 11 mm x 11 mm up to 7 mm x 21 mm. -Gold plated ceramic Leadless Chip Carrier (LCC) package, 10 solder pads. <u>Package dimension:</u> 5 mm x 7 mm. |

| Technology Flow | Scope |
|--------------------|--|
| Screening and Test | <p>Process flow NORSF-A1.</p> <ul style="list-style-type: none"> — Incoming inspection — In-process inspection — 100% Wafer probe electrical test — 100% Visual inspection — Final production tests — Customer Source Inspection — Screening — Burn-in and electrical measurements — Test procedures — External visual inspection — Qualification testing |

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.

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

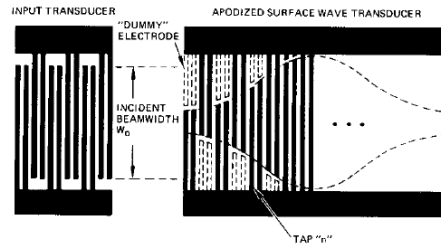
5.1.1.5 Technology Flow definition

1. **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.

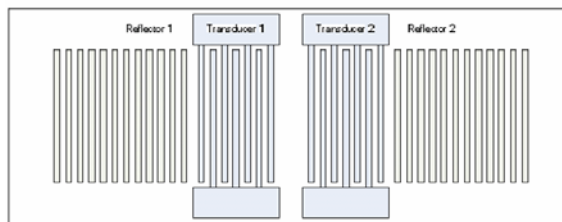
Transversal band pass SAW filters

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.



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 $1/4$ wide etched grooves or metal fingers. The same software is used for simulation of the transducers and reflectors.

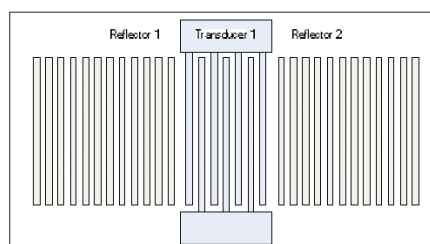


SAW Notch filters

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

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.



2. Fabrication

The NORSF-C1 process at Norspace comprises:

- SAW crystal manufacturing on SAW grade polished single crystal wafers from quartz, LiNbO₃, LiTaO₃ and La₃Ga₅SiO₁₄ (langasite)
- Externally purchased SAW wafers
- SAW wafer thickness between 0.5 mm and 1.5 mm
- Photolithography with line widths down to 0.3 μ m. No upper limit. Metallization performed with Al or Cr/Al. Metal thickness 400 to 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.

3. 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 μ m Au wire | Resistance seam sealing. N ₂ atmosphere. | Au plated |

4. 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.

5. 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 LiNbO₃, LiTaO₃ and Langasite.

Qualified wafer materials: Quartz, LiNbO₃, LiTaO₃, Langasite (La₃Ga₅SiO₁₄)