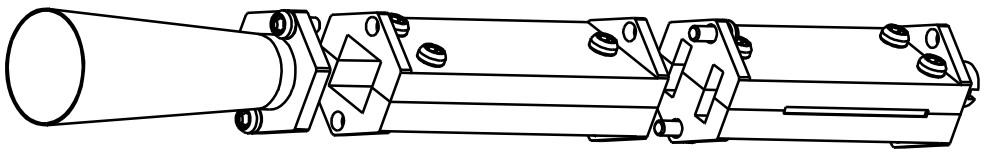
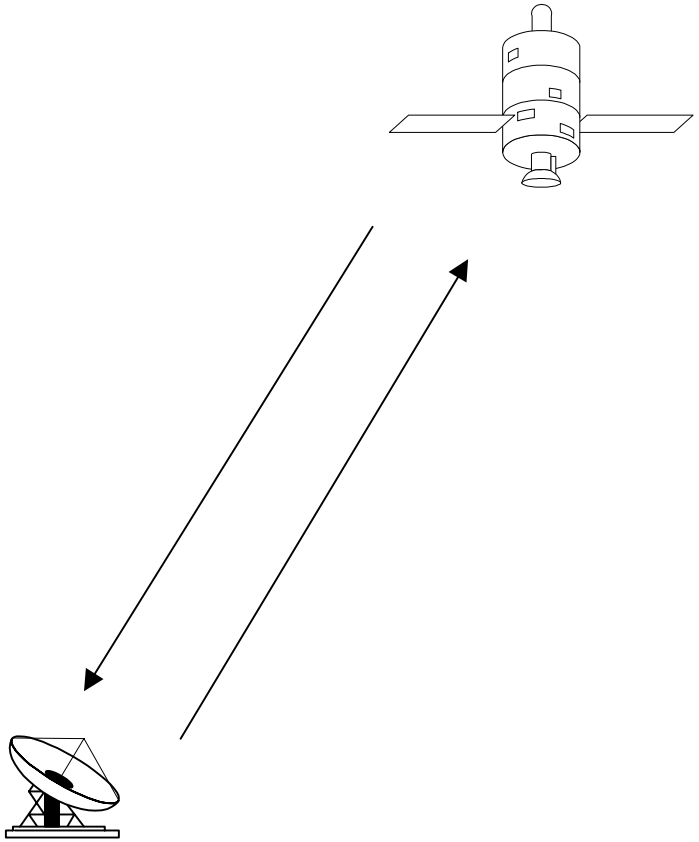
Low Noise Active Receiver Feeds for Multibeam Systems at Ka-Band

Outline:

1) Application
2) Feed Chain Cluster
3) Development programs
4) Key requirements
5) Active feed configuration
6) Related equipment



Application

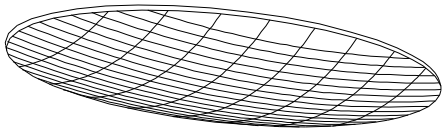


- Increasing demand on broadband capacity for Internet and multimedia applications is reflected in the development of satellite based systems.
- Ground terminals will have limited antenna sizes (~1 meter) and output power (~5 Watts)
- Uplink at 30 GHz
- Downlink at 20 GHz

Application

- The active receive feed is one of the key components of a satellite based multibeam system for wideband applications. The active feed is used in a cluster illuminating a reflector to obtain a multibeam antenna.

- The c-c spacing between the feeds together with the focal length of the reflector determines the footprint grid on the earth.



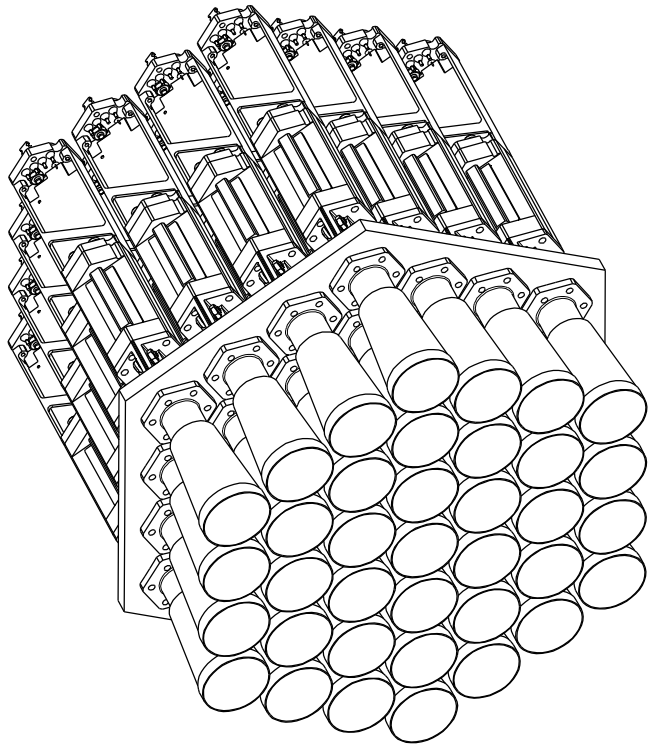
Feed Chain Cluster

The feeds are configured in a hexagonal grid.

Two cases of feed excitation can be identified:

1 Each feed contributes to one beam

2 Several feeds contribute to one beam by using a feed matrix after the active feeds (each beam can be optimised for best performance)



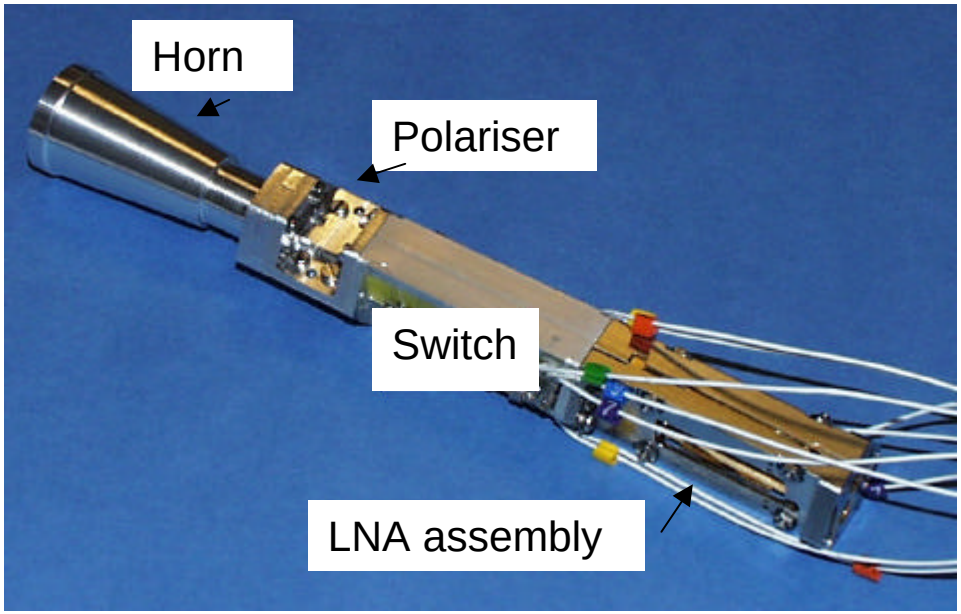
Feed Chain Development programs at Saab Ericsson Space

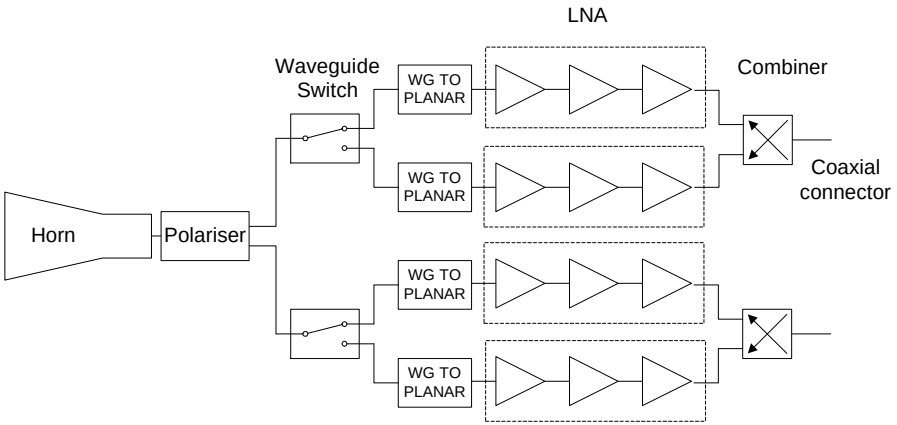
Reconfigurable Array Antenna

- ESA funded program
- Ka-band dual circular polarised active feed with dual redundant low noise amplifiers
- C-C spacing 23 mm
- Noise figure 3.1 dB (measured on LNA assembly)
- EQM tests to be finalised in October

Feed Chain Development programs at Saab Ericsson Space

Reconfigurable Array Antenna





Saab Ericsson Space

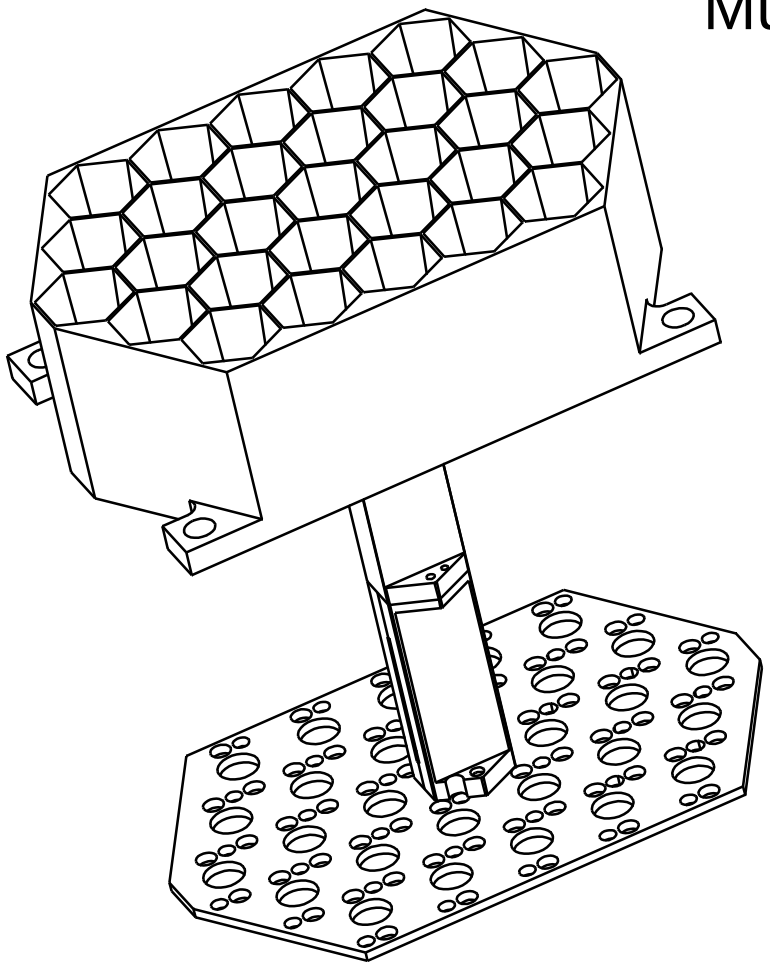
Feed Chain Development programs at Saab Ericsson Space

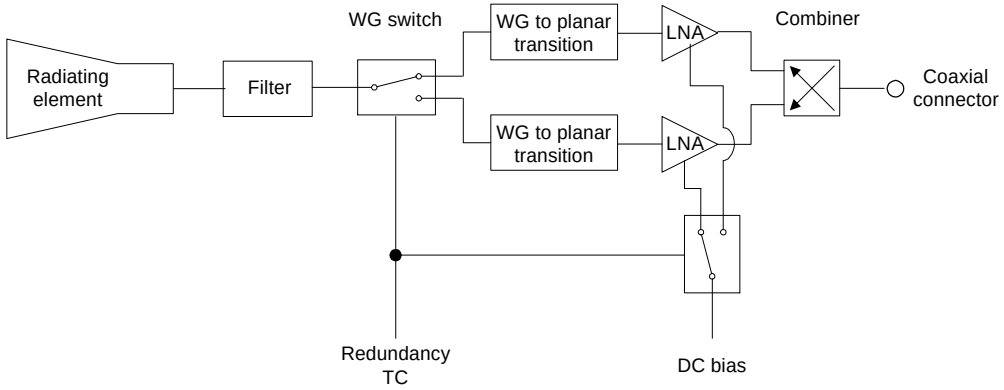
MultiKaRa

- Partially funded by EC. Saab Ericsson Space is responsible for the development of the active feed as member of a consortium of European companies coordinated by Alcatel Space Industries.
- Ka-band single linear polarised active feed with redundant low noise amplifiers
- C-C spacing 12.8 mm
- Noise figure 2 dB (goal)
- Elegant Breadboard with 7 active feeds surrounded by 22 terminated horns will be delivered mid 2001

Feed Chain Development programs at Saab Ericsson Space

MultiKaRa





Feed Chain Development programs at Saab Ericsson Space

Domino 2

- Partially funded by ESA. Saab Ericsson Space is responsible for the development and manufacturing of the Active Feed.
- Ka-band single linear polarised active feed with redundant low noise amplifiers.
- C-C spacing 12.8 mm
- Noise figure 2 dB (goal)
- 50 EQM´s will be delivered mid 2002
- The use of the receive feeds as part of a tracking system is also studied in Domino 2.

Key requirements

The main requirements driving the development of the active feed are:

a) The noise figure of the feed

b) The radiation efficiency of the horn

c) The center to center distance between the feeds

Active Feed Configuration

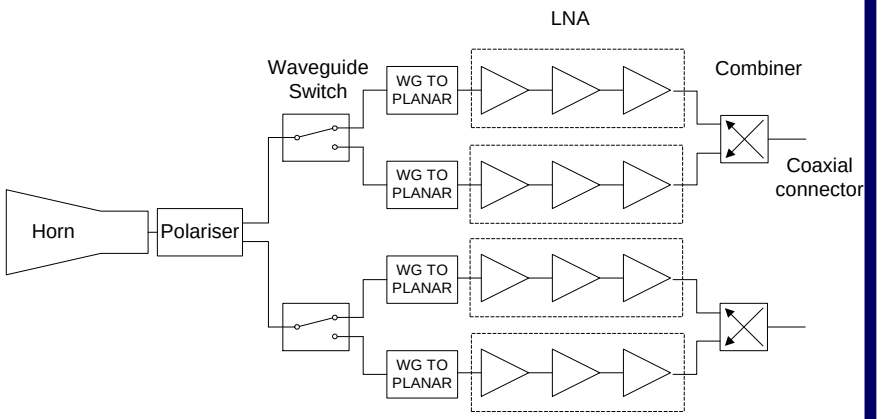
An active feed is composed of the following main blocks:

a) The radiating element which is a horn

b) A polariser if circular polarisation is required

c) Redundancy switch

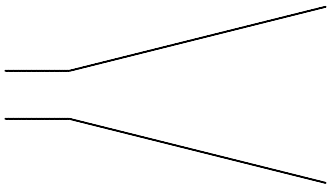
d) Low Noise amplifier assembly



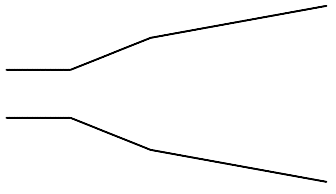
Radiating element

As the radiating element we use horns. The horn design depends on the c-c spacing. The design goals are normally to obtain an aperture efficiency as close as possible to 100%, small insertion loss and to minimise the crosspolar radiation. The solutions depends mainly on the diameter in wavelengths:

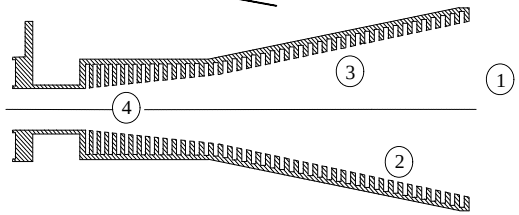
$Ø < 1.4\lambda \Rightarrow$ Smooth horn



$1.4\lambda < Ø$ and small bandwidth $\Rightarrow$ Potter horn



$5\lambda < Ø$ and large bandwidths $\Rightarrow$ Corrugated horn

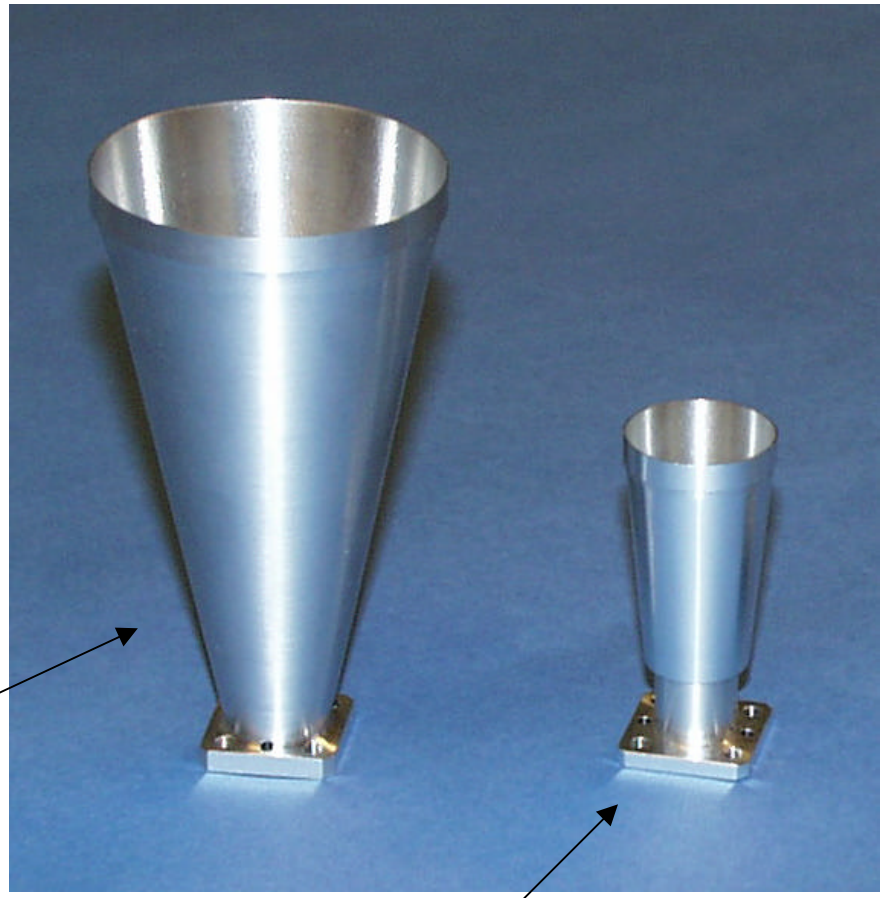


Radiating element

A variety of horns have been designed. The table below shows the type of horn, the diameter, the feed c-c spacing and the corresponding horn beamwidths.

	diameter	c-c spacing	-3 dB angle
potter horn	4.6 λ	4.8 λ	8.1
potter horn	2 λ	2.2 λ	18.5
conical horn	1.2 λ	1.2 λ	25.7
conical horn with dielectric rod	1.2 λ	1.2 λ	24.3
hexagonal horn	1.2 λ	1.2 λ	24.7

Radiating element



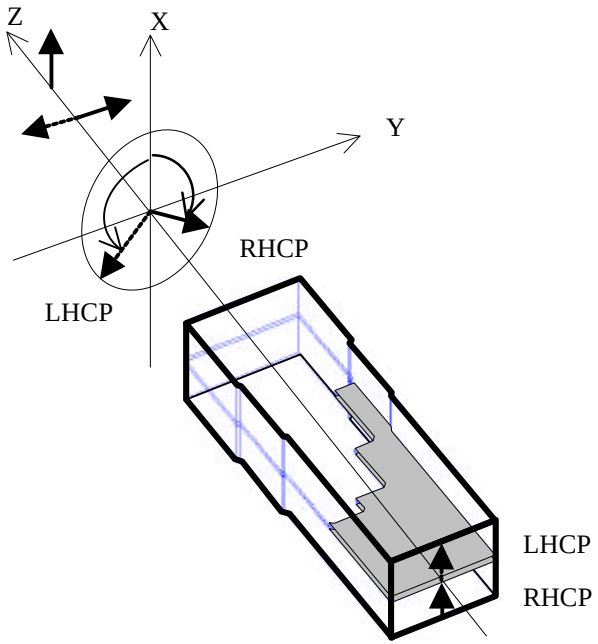
50 mm

4.6λ Potter horn

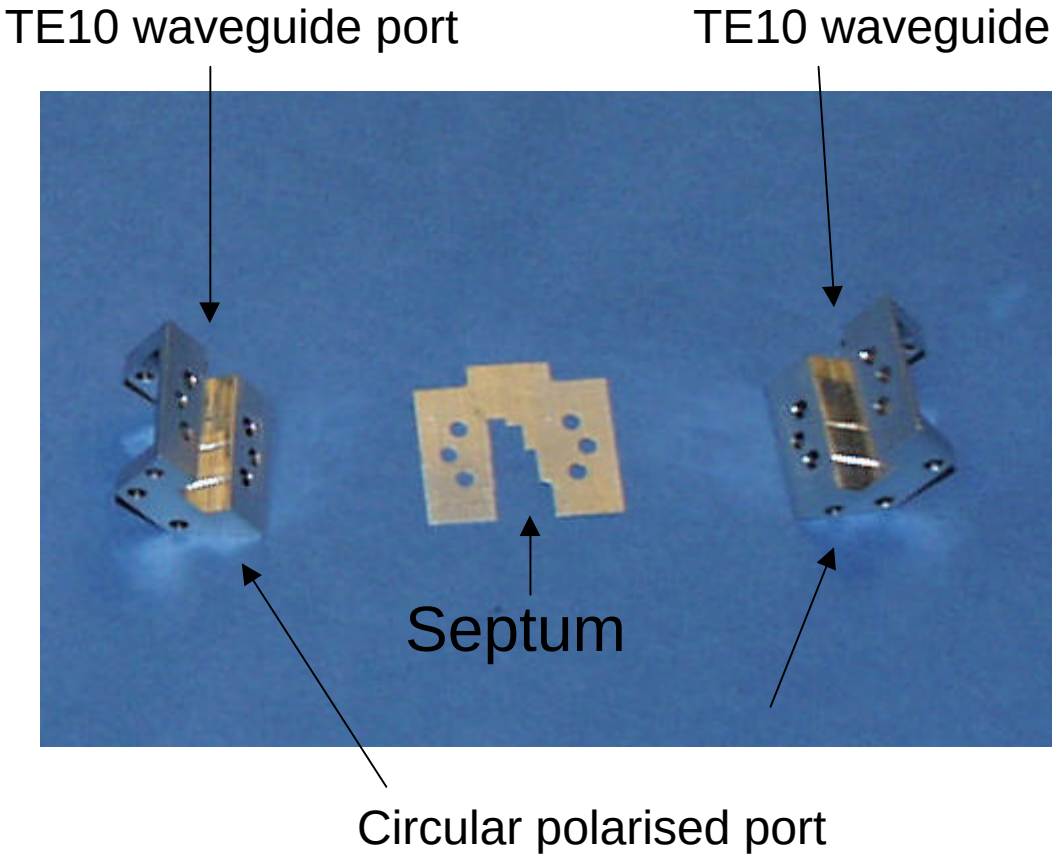
2λ Potter horn

Polariser

A polariser is required when circular polarised signals are used. The design used at Saab Ericsson Space is a Septum polariser. The advantages are short length and that both left & right polarisations are easily accessible (two separate ports).



Polariser

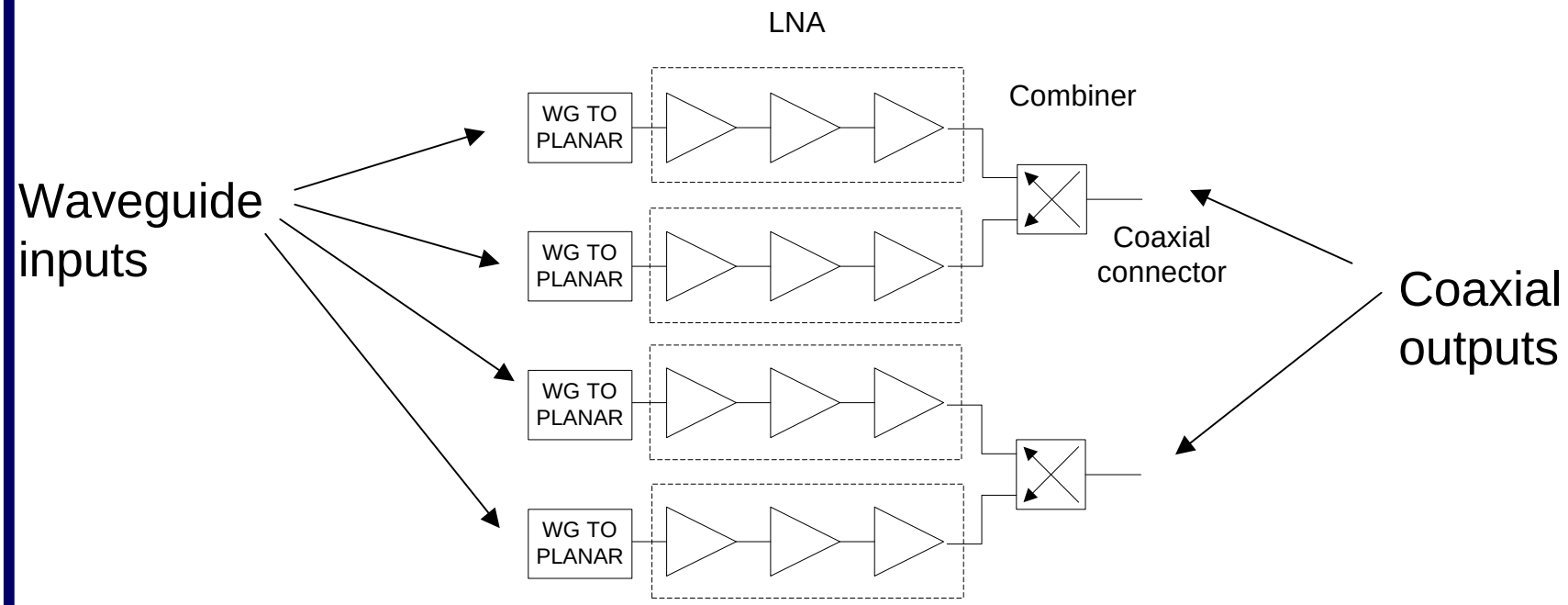

TE10 waveguide port
TE10 waveguide port
Septum
Circular polarised port

Redundancy switch

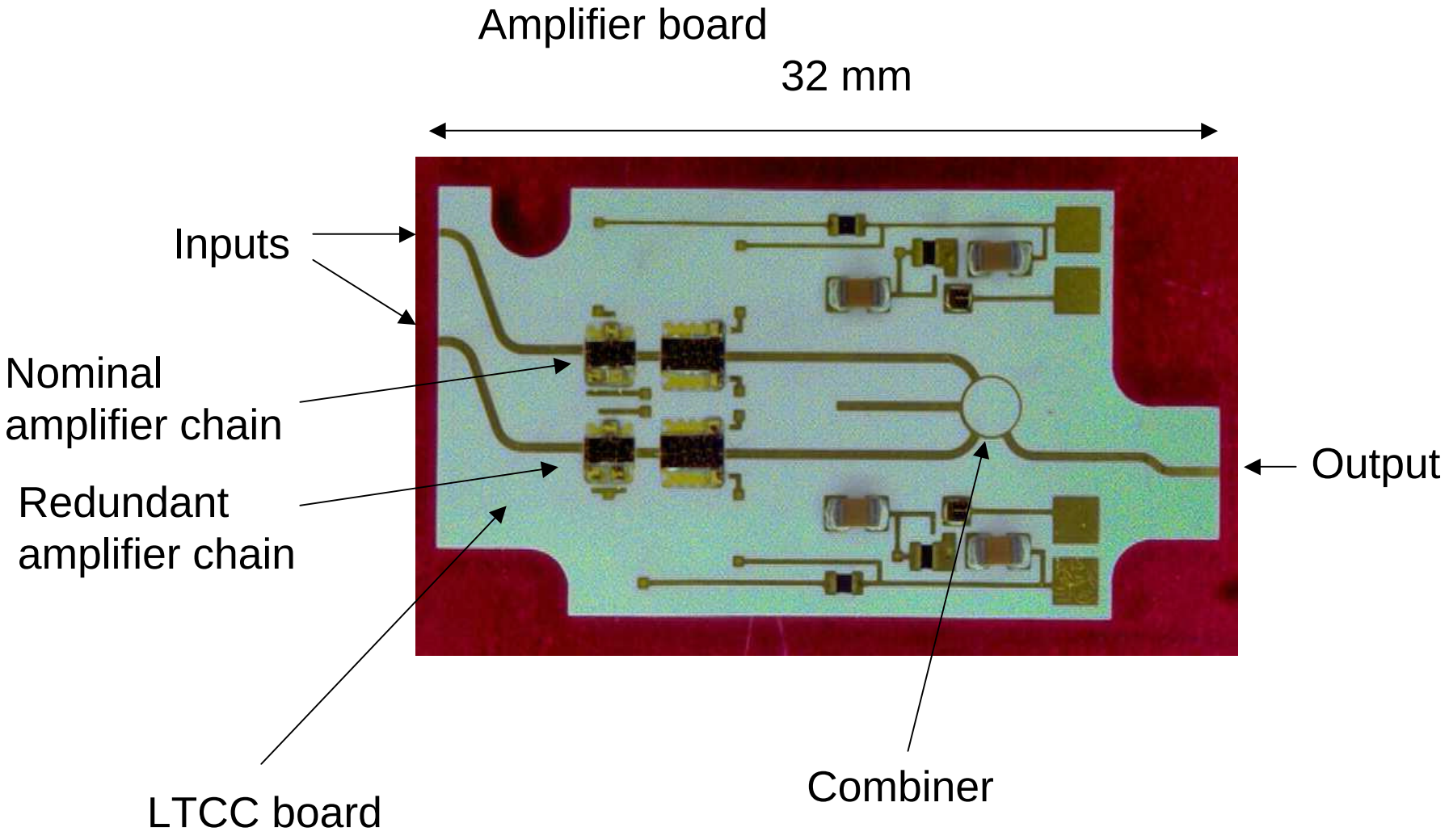
A redundant amplifier is required as the Active feed is crucial for the system performance. The loss of one feed may otherwise lead to the loss of a specific geographical area. The switch shall be low loss not to detoriate the overall noise figure of the feed and has to have a high reliability. For the active feeds designed by Saab Ericsson Space a waveguide switch is beeing employed. This switch is designed and delivered by TRAK in Dundee, Scotland.

LNA assembly

Block diagram



LNA assembly



LNA assembly

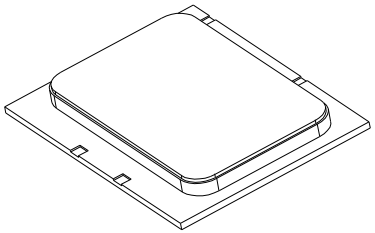
Technologies

The LNA assembly includes LTCC substrates with sealring to provide hermeticity necessary for the naked MMIC´s

The LTCC substrates are bonded directly into the housing machined in a CTE matched material with good heat conductivity.

LNA assembly

Technologies



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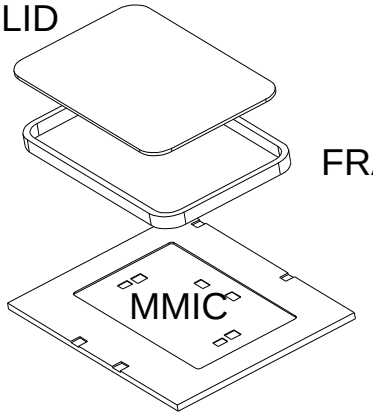

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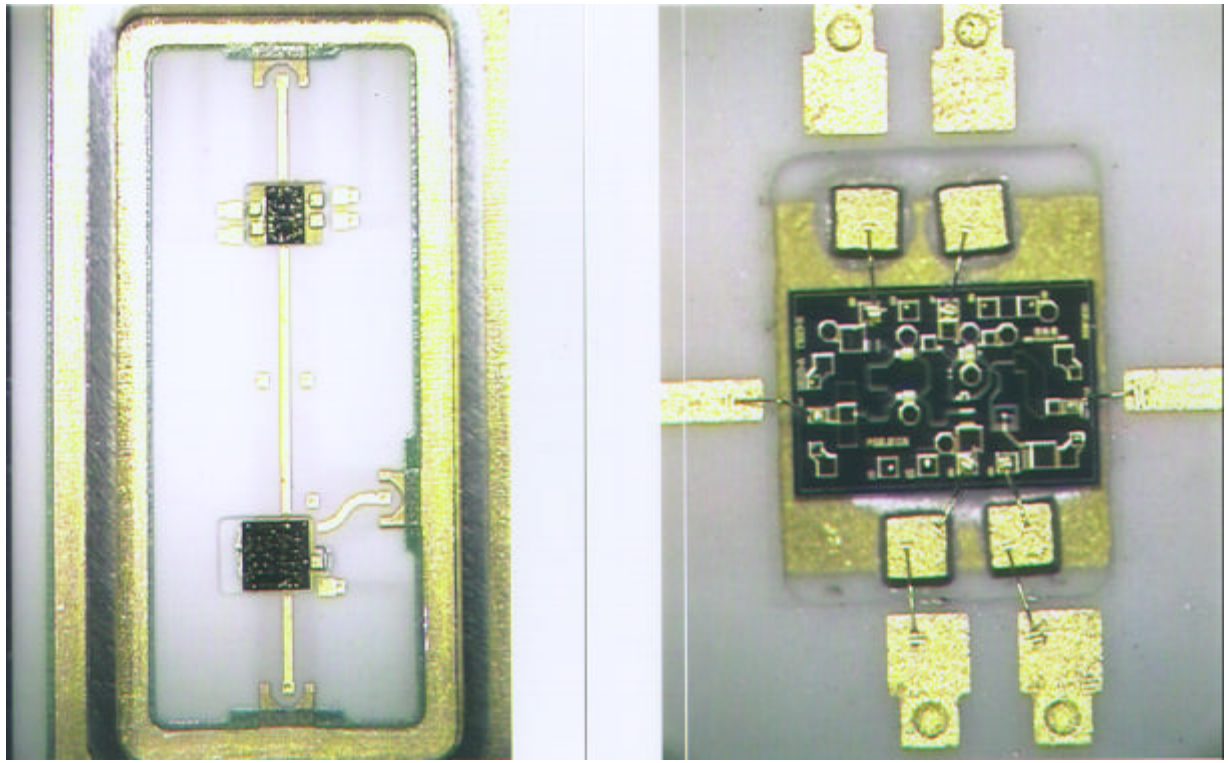
LNA assembly

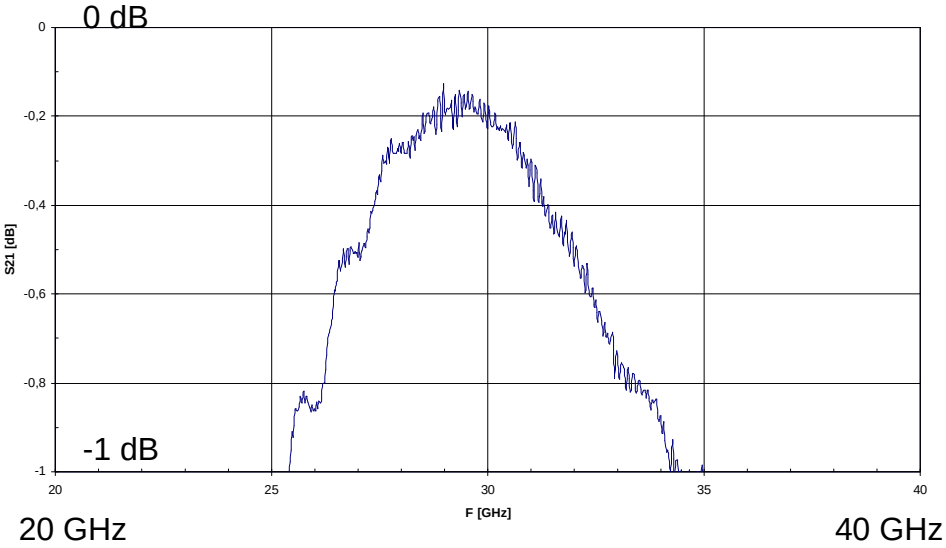
Technologies



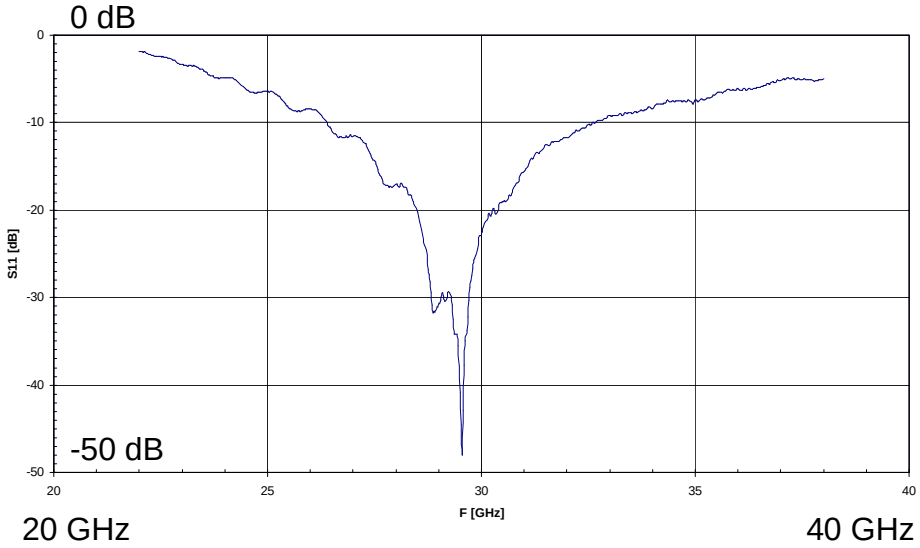
LNA assembly

Waveguide to microstrip transition

A compact low loss transition between the LTCC board and the waveguide has been developed.



20 GHz 40 GHz



20 GHz 40 GHz

Related Development programs at SE

Saab Ericsson Space is to supply Ka-band converters for the Spaceway satellites. These will include 18 upconverters and 32 downconverters. The deliveries will take place beginning May 2001