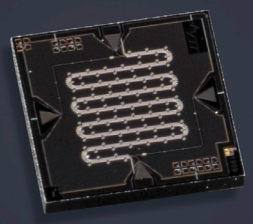

Josephson Traveling Wave Parametric Amplifier (TWPA)

VTT has been developing superconducting quantum devices since the 1990s. We operate the largest research clean room in the Nordic countries, with wafer-level processing equipment and 250+ researchers focusing on microelectronics and quantum technologies.

Our activities in superconducting quantum hardware include the development and fabrication of resonators, qubits, Josephson parametric amplifiers, SQUID-based current amplifiers and magnetometers, superconducting nanowire single-photon detectors (SNSPD), solid-state cooling technology, qubit-compatible 3D integration techniques and photonic integrated circuits.

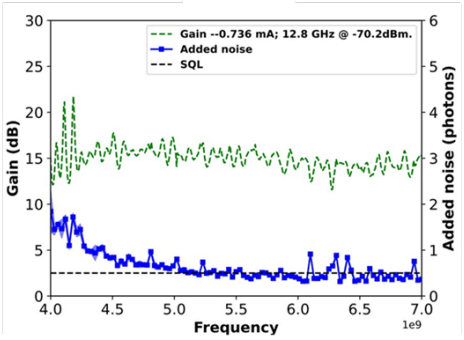

Figure 1. Measured noise and gain from a typical VTT TWPA, referenced to a bypass line. Magnetic flux bias current, pump frequency, and pump power are indicated in the legend. Added noise is estimated using the method in DOI:10.1063/5.0028951 and should be considered indicative. Estimated error bars of added noise due to systematic sources is work in progress.

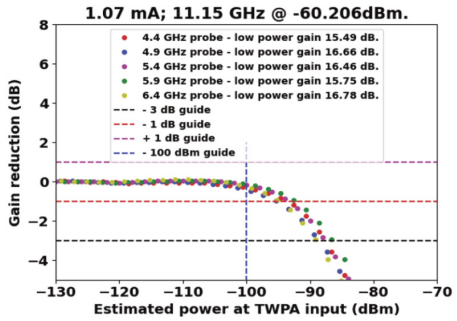

Figure 2. Gain compression at several example signal frequencies, demonstrating excellent dynamic range performance, with 1-dB compression point higher than -100 dBm.

VTT TWPA

Our state-of-the-art traveling wave parametric amplifiers are suitable for signal bands between 4 - 8 GHz, and our unique three-wave mixing approach places the pump frequency between 9 - 13 GHz, safely outside of the signal band, but conveniently within the bandwidth of commercial circulators.

Flux bias is provided by a patented on-chip bias line that minimizes fringing fields outside of the chip, enabling denser integration than competing solutions using external coils.

Typically, a device is operated at constant magnetic flux bias current, pump frequency, and pump power values. In principle, pump parameters can also be modulated on qubit-experiment-compatible timescales.

A single TWPA can be used for the read-out of signals from multiple frequency-multiplexed qubits.

Typical performance and other key metrics of VTT TWPAs are shown in Figs. 1 & 2, and in Table 1.

Table 1. TWPA specifications

General parameters	**Typical**	**Min.**	**Max.**
Signal bandwidth	2 GHz	1.5 GHz	
Gain @ 5.5 GHz	15 dB	11 dB	
Signal-to-noise ratio improvement @ 5.5 GHz (*)	10 dB	7 dB	
Dynamic range (input signal power at 1-dB compression point of 15 dB gain)	-95 dBm	-105 dBm	
Biasing requirements		**Min.**	**Max.**
DC current in the magnetic flux line	700 µA	600 µA	1100 µA
RF pump frequency	11 GHz	9 GHz	13 GHz
RF pump power (**)	-60 dBm	-65 dBm	-50 dBm

(*) The reference is measured with the TWPA bypassed and the noise dominated by a high-performance HEMT amplifier: Low Noise Factory LNF-LNC4_8A/LNF-LNC4_8C.
(**) An estimate of the power entering the TWPA input.

Availability of VTT TWPAs

We have a track record of successfully delivering over 100 TWPAs to commercial partners globally. Each TWPA undergoes individual cryo-testing and calibration to meet your requirements. With proprietary packaging, optional magnetic shielding, and cabling, they're ready for seamless integration into your experiment right out of the box.

Amplify your quantum development, with help from VTT!

Contact:

Kaj Nummila
Solution Sales Lead
kaj.nummila@vtt.fi

Tommi Suni
Customer Account Lead
tommi.suni@vtt.fi

Note that a minimum order quantity may apply.