Multi-band THz source

TeraCascade 1000 series

The high-performance solution of the TC series range

Powerful with >1 mW average power garanteed

Up to six (6) electronically switchable bands

Select frequencies between 2 and 5 THz

Fully automated vacuum system

Powerful QCL technology

Cryogen-free cooling

The TeraCascade 1000 series is an award-winning THz source based on state-of-the-art quantum cascade laser technology. It is the perfect tool to explore the supra-THz frequency range. With up to 6 chips at select frequencies between 2 to 5 THz in one system and a guaranteed average output power of more than 1 milliwatts in CW or QCW for each band, it is a flexible and powerful tool for any supra-THz applications. The unit is fully integrated and with its automated vacuum control loop and cryogen-free cooling system it is truly plug and play. The integrated custom QCL driver provides instantaneous electronic switching between the frequency bands and is fully programmable using a user-friendly graphical user interface on a 4.3" capacitive touchscreen or remotely via a USB connection to a PC. With the integrated signal generator and output signal connector, electronic chopping is possible and requires no external device. Beam collimators and beam extenders can be provided as standard components or tailored for a specific application. An automated beam collimator module for multi-band operation is available separately.

Application note

Laser stabilisation and stability in QCW mode

The Plug&Play aspect of the TeraCascade 1000 ensures a short laser output power stabilization time to allow the user to expect a highly stable laser soon after it has been switched on. Moreover, a high level of stability over long time spans is obtained, with deviation levels lower than 1% over hours.

The following characterizations have been realized in a non-controlled environment displaying temperature variations higher than 1°C, variations of the hydrometric level up to 5% over the typical measurement's times and ambient lightning in order to reproduce typical operating conditions.

A calibrated THZ 20 Pyroelectric detector from Sensor und LaserTechnik (sensitivity of 65.9 V/W calibrated at PTB, Berlin) paired with a collection HRFZ-Si lens aligned at the output of the laser have been used to perform those measurements on a 2.5 THz QCL chip. A lock-in amplifier is used to recover proper signals and sensitive amplitude variations.

- Emission scheme in QCW Mode

In order to reach high performances levels with the TeraCascade 1000 QCL chips, a Quasi Continuous Wave (QCW) driving signal is generated thanks to a pulsed square signal at high frequency (typically around 10 KHz) with an adjustable duty cycle (see figure 1). For most kind of THz thermal detector, this modulation frequency remains completely un-detectable, therefore, tuning the duty cycle parameter only sets the averaged emitted power.

An overmodulation of typically 5-1000 Hz is then used to electrically chop the optical signal into a square signal (fixed 50% duty cycle).

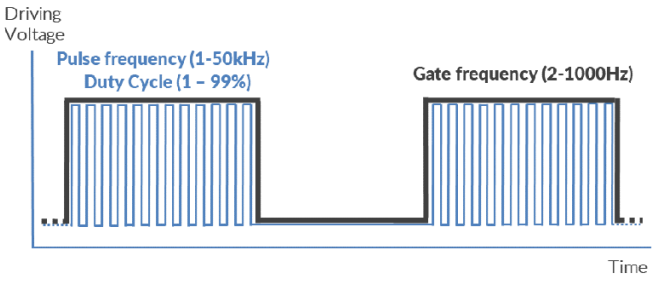

Figure 1 Driving signal scheme for QCL chips in QCW mode

- Stabilization characteristics

The TeraCascade 1000 source reaches instantaneously a nominal output level once turned on without gradual rise time. A short oscillatory stabilization time yet needs to be taken into account to reach a perfectly stable regime (see figure 2 below that displays a typical output power evolution during the stabilization phase).

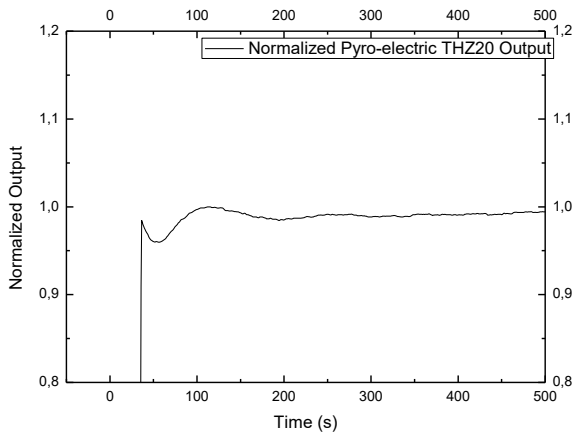

Figure 2 Stabilisation regime for a 50% duty cycle sub-modulation corresponding to 1.7 mW output power on a 2.5 THz QCL

The following table indicates the typical duration of this oscillatory phase as a function of the duty cycle and the corresponding emitted power.

Specifications		TC1000
Duty Cycle	Emitted power	Stabilisation time
10%	0.5 mW	150 s
25%	1.1 mW	200 s
50%	1.7 mW	300 s
80%	2.2 mW	2000 s

The the stabilization time increase regarding the emitted power is due to the longer thermal stabilization of the cryogenic cooling system. Indeed, QCL emission power is highly sensitive to the operating temperature of the chip. The larger the required optical power, the more heat will be generated by the QCL chip that needs to be overcome by the close loop cooling system to stabilize the cold tip temperature.

Nevertheless, power fluctuations during this stabilization phase should not exceed 10% of the nominal emitted power.

- High stability performances

Once the stabilization phase is completed, the stability of the TeraCascade 1000 enables any sensitive measurement over long periods of time thanks to very low fluctuation levels in the emitted power. Indeed, the TeraCascade 1000 maintains nominal power deviations lower than 1% over 1 h and lower than 2% over 12 h in a standard non-controlled environment.

The signal obtained from a typical stability measurement of the laser output power is showed in figure 3 and have been performed on a 2.5 THz QCL chip.

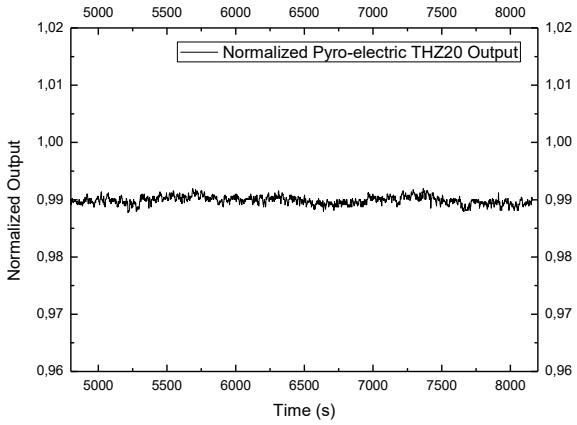

Figure 3 Stable regime for a 25% duty cycle sub-modulation corresponding to 1.1 mW output power on a 2.5 THz QCL

Typical values for the absolute variation over one hour as a function of the duty cycle and the corresponding output powers are displayed in the table below.

Specifications		TC1000
Duty cycle	Emitted power	Stability deviation over 1h
10%	0.5 mW	0.55%
25%	1.1 mW	0.27%
50%	1.7 mW	0.42%
80%	2.2 mW	0.63%

This reliability is ensured by the accurate thermal stabilization capabilities of the integrated Stirling Engine cooling system and the long-term stability of the power supply when used under normal operating conditions.

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