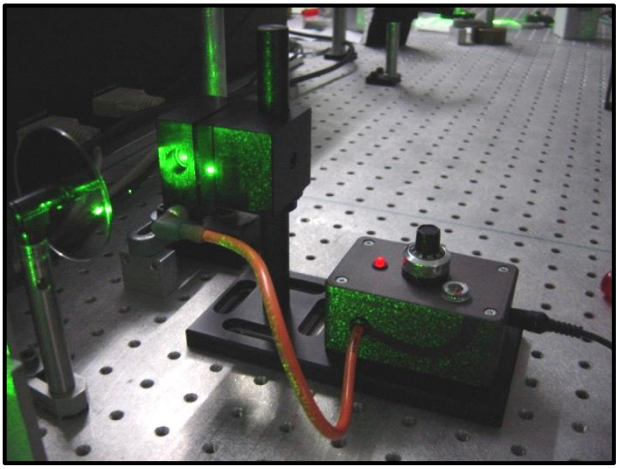
TEMPERATURE CONTROLLED LASER FILTER
TCF

Instruction manual



THE TABLE STABLE LTD.
Vibration Isolation &
JRS Optical Instruments

Im Grindel 6
8932 Mettmenstetten-Switzerland
Phone: +41 44 776 33 66
Fax: +41 44 776 33 65
E-Mail: info@tablestable.com
Internet: www.tablestable.com

Table of Contents

Safety Instructions

If you suspect the system to be in any way unsafe, unplug and prevent any possible accidental usage. Contact your nearest service centre.
Before switching on this apparatus, make sure that it is connected to the correct mains voltage. Do not remove any cover or allow any metal objects to enter the ventilation slits.

Disconnect from mains before removing any covers. Refer servicing to qualified personnel. Do not use in potentially explosive surroundings.

Make sure the ventilation slits in the power unit are not covered and that air can freely circulate. Blocking the slits can lead to overheating which could cause a fire.

For indoor use only.

Notes on equipment safety

The TCF device has been designed, manufactured, and tested to conform to the safety regulations for measurement- and control-equipment DIN EN 61010-1 (IEC 1010-1) and satisfies the relevant requirements of EEC Directive 73/23.

The system conforms to EEC Directive 89/336 (electro-magnetic compatibility).

The operator should read this manual, which contains important warnings and information.

The need for a laser filter

The TCF is a temperature stabilised etalon device, designed to reduce the intensity of spurious secondary laser modes found on many modern commercial solid-state laser light sources. These secondary modes are very weak, with an intensity typically 10^{-8} to 10^{-11} of the laser's main mode intensity, but unfortunately they lie in the region of interest for Brillouin spectroscopy measurements.

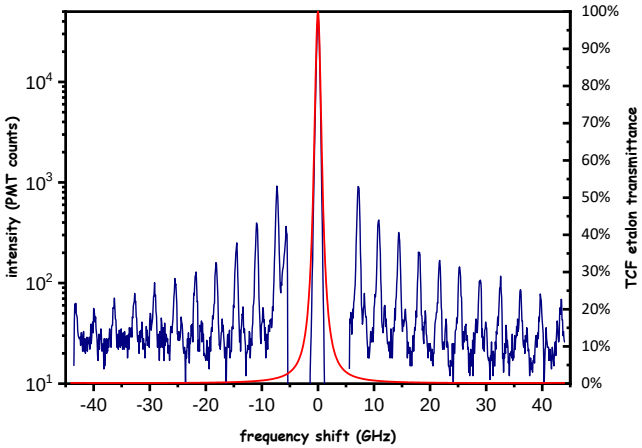


Fig. 1 : A dramatic need for a spectral cleaning. Violet curve shows the spectrum of a commercial laser source, showing several additional modes extending out as far as 100 GHz, as seen by means of a high contrast Fabry-Pérot interferometer. The red curve shows the theoretical transmission curve of a TCF unit.

Fig. 1. Shows the spectrum of a 532 nm solid state laser source measured using the JRS high contrast tandem interferometer TFP-1. The main laser peak has been strongly attenuated relative to the secondary peaks. A Brillouin spectrum measured in the presence of a strong elastic component will inevitably show these secondary peaks in the background, making interpretation of the spectrum difficult.
The TCF strongly attenuates these modes, in many cases reducing them below the detection threshold.

The largest attenuation provided by this filter for the unwanted modes is close to 600. As shown also in Fig. 1, the device is expected to provide an extinction

factor of 2 for components as close as 1.8 GHz from the primary radiation and to reach 99% of the maximum attenuation already around a 9 GHz frequency shift.

The unit should not require any kind of maintenance, excluding occasional checks on the correct tuning to the laser source frequency.

Instrument layout

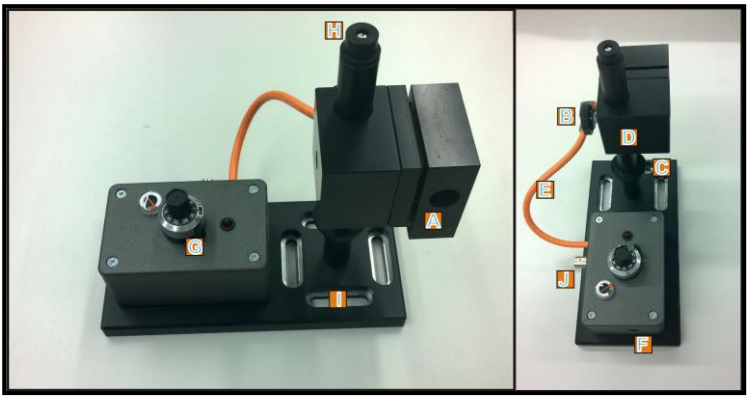


Fig. 2 : images of the TCF main body

Images of the device are shown in Fig. 2: the small etalon plate is sealed in a container, fixed inside a cylindrical cavity in the unit head (A). The head can be placed at a variable height by loosening the plastic screw (B) and sliding the block vertically along the 15 mm diameter post; a movable height-fixing ring (C) is provided to ease the adjustment. To move the support ring, use a small screwdriver to loosen or tighten the locking screw.

Rotation of the head around the horizontal axis is also possible, by loosening the screw (D) on the instrument back, and tightening again in the desired position. The active body is connected to the instrument control box by a wire and an M8 connector (E).

The Peltier module inside the head of the instrument (A) is very fragile. Please handle the head gently and do not remove it from the post if not strictly necessary. Falling or dropping the head will easily lead to unrecoverable damage of the thermoelectric device.

The power supply socket (F) is located on the backside of the control box, while the temperature control knob, the stability indicator and the power supply LED are located on the top of it (G). The stability indicator reports the activity of the instrument: when it is in the red part of the scale, the etalon head is heating up

while when in the green part, it is cooling down; a stable condition at the set point has thus been reached when the indicator is close to the middle line. The red LED is always lit when the instrument is correctly powered.
On most recent TCF units, the power supply LED and the analogue indicator have been replaced by a multicolour LED. The LED indicator is lit whenever the device is powered up; a red or blue colour indicates that the TCF head is being heated up or cooled down respectively; a green colour indicates that the temperature of the head is within a relatively narrow interval around the setpoint.
The BNC connector (J) on the right wall of the instrument can be used to input an external current (< 0.5 μA) to the device in order to dynamically change and control the equilibrium temperature. This is the input used for the stabiliser, please refer to Tablestable for detailed information on the use this input.
A small alignment and centring tool (H) is provided to help with initial alignment of the device with the laser beam. Before and after use, the alignment tool can be fixed on the top of the vertical post by means of an M2 screw. After alignment, always place back the centring tool over the post to prevent losses of laser power.

The device can be fixed to the optical workbench by clamping the base plate or using screws through the holes (I), with the longer side of the base plate either orthogonal or parallel to the beam direction.
The device plate is suitable for both metric and imperial optical breadboards.

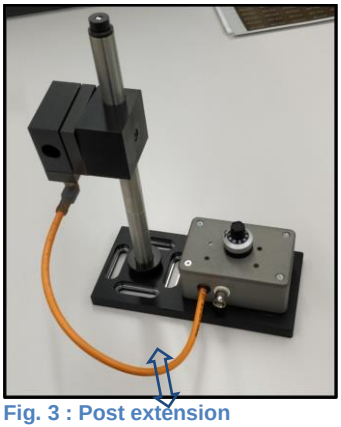


Fig. 3 : Post extension

The TCF is conceived for installation close to the laser source, so in most cases the post provided will be long enough.
For installation at larger height on the workbench, an additional post extender is provided. This will need to be mounted between the base plate and the ordinary post, using an M6 grub screw to connect them.
In order to align the extension correctly, fix it firmly to the base and then screw the post on top of it, paying attention to the handling of the TCF head. Do not tighten the post completely, just stay a turn away from the final position.
Slide the head to bottom, so that it sits around the joint. At this point, tighten the post completely. The obtained alignment will allow the head to slide up and down for the full length of the extended post.

Output stabiliser for TCF

The TCF-2 includes a stabiliser, not available in the first version of the device. The stabiliser provides additional stability of the output with respect to temperature and slow beam wavelength fluctuations. The stabiliser is already mounted on the device at arrival.

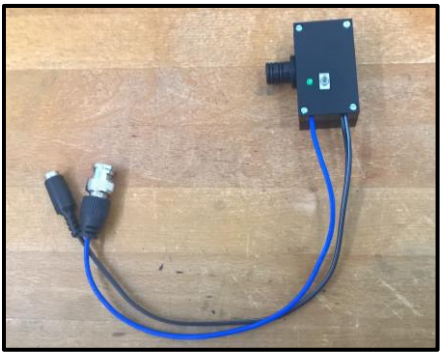


Fig. 4 : Output stabiliser

This little device is powered by means of the same supply adapter used for the TCF, adding a Y cable; its BNC output must be connected to the side socket on the TCF main box.

The stabiliser is on when the small switch on its side is pushed on the upper position (opposite to the wires). The green LED indicates the activity of the device.

If necessary, the TCF can be used without the stabiliser, either by switching the stabiliser off or disconnecting and uninstalling it completely.

To unmount the stabiliser, pull it gently and slowly outside, avoiding excessive stress on the TCF head. On more recent units, an additional grub screw on the TCF head keeps the stabiliser locked in position: in this case this must be loosened (1.5 mm hex key) before pulling the stabiliser out.

Device installation and tuning

In order to use the device, it is necessary to align it with the laser beam and regulate the temperature set point to get the best (strongest) output power. A power meter will be required to measure the device output.
It is generally advisable to install the TCF quite close to the laser source, so that its input is stable in intensity and position.

Proceed as follows:

1) With the device still off, unscrew the alignment tool from the top of the post and insert it in the etalon input hole as shown in Fig. 5.

Fig. 5 : use of the centering tool

2) Set the device head's position, height and rotation in such a way that the beam passes through the alignment tool. Slide the height-fixing ring as required to help you in this phase. The etalon can also be rotated around the horizontal axis by loosening and then tightening again the active head fixing screw (letter D in Fig. 2).

3) The etalon inside the TCF must be aligned as orthogonal as possible to the incoming beam. When close to this condition, you should see a reflected beam coming out of the alignment tool and travelling near the incoming beam. Finely adjust the device head's position and angles to have this back-reflection as close as possible to the incoming beam. Please note that some laser sources can be destabilised when a strong beam is sent back to their output: if you notice anomalies or if you want to avoid troubles, try to get the reflected spot as close as possible to the orthogonal position, still without entering back in the laser unit.

4) Fix the TCF on the workbench and remove the alignment tool. Connect the TCF main body and the stabiliser power cable to the supply Y cable. Turn on the device on by connecting the power supply adapter. The device will start heating or cooling the etalon towards the current set point (LED on).

5) If a calibration sheet is present in the package, it will suggest possible settings for the TCF. Different laser sources provide slightly different wavelengths: your setpoint will be different from the suggested one, even if could be close. Once the device is close to stable, try to change the setpoint manually in small steps to improve the output.

6) The stabiliser can be activated after about 8' from powering up. It will automatically start up if its switch is in the upper position, and walk the device towards the best setting.

Important recommendations

- The stabiliser is sensitive to sudden changes in laser beam intensity. In these cases, the stabiliser will drive the device off from maximum and the TCF will need quite long time to recover. If a change of power is needed, it is useful to switch temporarily off the stabiliser.

- If the power is removed completely while the stabiliser is active, the TCF may be permanently driven to high or small temperatures, with risk of damage. Switch off the stabiliser or the device when switching off the laser.

- Avoid the use of the TCF on transmission maxima very close to the lower end of the scale. Besides requiring more time and power to be reached, a low temperature operating point may induce condensation of water on the etalon head. This will in turn lead to bad performance and expose the device to risk of electric failure. If a transmission maximum is present at low temperature, another one will be reachable at a larger setting in the range of the instrument and should be preferred.

Additional information

Optimal performance condition
In order to obtain the best performance, the etalon plate needs to be aligned as close as possible to orthogonal to the laser beam. It is important that the laser beam waist is as small as possible when passing inside the device: using the device with a beam diameter larger than 2 mm will decrease the throughput. A low beam divergence is also required to obtain the best transmittance, which will decrease otherwise.
The best performance is usually obtained when the TCF unit is close to the laser source.

Effects of reflected beams going back in a laser source
When the alignment of the etalon is perfect and the back-reflected beam from the etalon goes straight to the laser source, bad effects could be noticed on some laser, such as large and quick power fluctuations on the output: if this happens, rotate slightly the head so that the back reflected beam does not fool the laser source feedback circuitry.
In case the output aperture of the laser source is large, a useful trick is to add a screen immediately after the source, carrying a hole just sufficient for the

beam to pass through. The back reflected beam can then be safely adjusted to get close to the input beam without actually entering in the laser source.
This problem can also be solved using an optical isolator (Faraday isolator) immediately after the laser source, so that the back-travelling beam can be stopped and the TCF can be set perfectly orthogonal to the beam.

Number of accessible transmission maxima
The etalon is such that the temperature interval among transmission maxima is about 17.5 °C. Given the temperature range accessible to the device, at least one but not more than two maxima can be reached.
The position of the transmission maxima (in terms of temperature and with reference to the knob scale) and their transmission intensity, as measured at factory after production, are reported in the calibration sheet provided. The position of the maxima will change slightly using a different laser source due to small differences in the wavelength. For this reason, the user should consider the reported values as a first guess and will likely need find the final maxima positions for his own source.

Start-up delay in the stabiliser
When the stabiliser is powered on, independently by the stabiliser's switch position, it will remain idle and with LED off for about 8 minutes. This delay is intended to allow the TCF to reach the set point determined by the knob position after power up, and to grant that the laser is also stable when the stabiliser is activated.
After the start-up delay, the stabiliser will react immediately to the switch and will start to operate automatically if the lever is in the top position. When the stabiliser is active, a slow sinusoidal modulation of the TCF head temperature will take place, and the laser power output will be driven to maximum. When the maximum is reached, the effect of the modulation on the light output is negligible.

Best maximum position
The efficiency of the stabiliser is lower when the set point is close to the limits of the TCF scale (i.e. very hot or very cold temperature of the head). In these conditions, the time required to optimise the output is longer: it is thus advisable to use the set point closer to room temperature (approximately 4 on the device scale).

Change in the indicator when the stabiliser is active
It is possible that the RGB LED indicator turns red or blue if the correction voltage provided by the stabiliser is relatively large: this is not an indication of problems in the TCF; the maximum in transmission will likely still reached. In this case, however, it could be a good idea to temporarily disable the stabiliser and adjust the static set point position.

Etalon replacement

Some different types of etalon are available at Tablestable. It is possible to replace the TCF etalon in order to use the same device alternatively on different laser wavelengths.

In the case of a TCF-2 unit, it is often necessary to remove the stabiliser unit in order to access the etalon. See the previous section on the stabiliser for removal.

Once the stabiliser is removed, use a M1.5 hex key to loosen the retaining grub screw on the TCF head, whose pressure keeps the etalon container in position. Pull the etalon container by means of a soft tip and slide it out from the TCF head; store the etalon container appropriately.

To insert the new etalon, reverse the previous process. The orientation of the etalon holder is not relevant. Pay attention that enough space is left free for the stabiliser. Plug the stabiliser slowly and gently, rotating if necessary. The stabiliser can only be installed on the head side opposite to the connector.

Beam power limitations

The TCF is expected to work correctly for laser power up to 300 mW. Over this limit, the etalon transmission may start to reduce significantly due to laser heating; the device performance will be severely limited at power comparable or higher than 3W.

The stabiliser should not be used with a beam power larger than 1.8 W; over this limit, the performance may degrade and there is a possibility of damage in the stabiliser electronic circuit.

In order to overcome these limitations, a high power version of the stabiliser and special coated etalons have been prepared. Please ask Tablestable if you need to have your TCF upgraded for high power use.

Specifications

Etalon material:	fused silica
Etalon thickness:	1.509 ± 0.001 mm
Surfaces reflectance (at design wavelength)	94 ± 1 %
Typical effective *finesse*:	38
Typical contrast:	~ 590
Maximum transmittance:	> 80 %
Maximum power consumption:	2 W
Power supply voltage range:	6 ÷ 8 VDC