

# SMF/CLC (SMF/PAPI Calibrator)

## Technical Specification

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# 1. INTRODUCTION

The present document illustrates the technical details of the apparatus SMF/CLC, devoted to the calibration of the SMF/PAPI instrument, pertaining to the SMF product family of Argos Ingegneria Spa.

The SMF/PAPI instrument allows to perform PAPI units beam elevation measurements with respect to the gravitational horizon, typically with accuracy inferior to 1 arc-minute; the measurement is made with the aid of an electronic inclinometer. Such precision, compared to that one of other instruments based on inclinometers, places the problem to use an apparatus still more accurate and stable for the calibration of the SMF/PAPI.

A CCD camera placed on the SMF/PAPI measurement head allows to visualize optical beams generated by full powered PAPI units, and is able to read without blinding a laser beam with power of the order of 1 mW that enters in its field of view. This property allows the use of laser levels for the calibration of the elevation measurement of the instrument; levels accuracy shall be inferior to 30 arc-seconds in order to be compared with the SMF/PAPI reading.

## 2. SMF/CLC LAYOUT

The SMF Collimated Laser Calibrator (SMF/CLC) is a tool for calibrating the SMF/PAPI instrument performance during the Elevation and the Chromaticity/Intensity Tests.

SMF/CLC is new generation laser level that guarantees the positioning of a laser beam with a stable and affordable inclination regarding the horizon; the accuracy of such elevation is below 15 arc-seconds at any environmental temperature. Laser levels with such precision must guarantee that the generated beam maintain the alignment with respect to the level mechanical axis.

The SMF/CLC generates two optical beams perfectly parallel to each other. Any misalignment between the SMF/CLC's laser beam and its mechanical axis is intrinsically converted into a misalignment of the two optical beams, which is easily detected by the SMF/PAPI measurement camera or by the operator himself.

In other words, the SMF/CLC and the SMF/PAPI instrument together are able to self-detect a loss of accuracy in testing the angle of elevation of an optical beam. The resolution of the self-test is limited below 15 arc-seconds.

Mechanics and optics are designed to be particularly robust to shocks and vibrations, in order to provide the required stability.

The optical beam elevation is measured by a high precision dual-axis electronic inclinometer placed in the same frame of reference as the generated laser beam.

The optical bench is enclosed by a covering with a heavy metal base that guarantees stability.

Both elevation (pitch) and horizontality (roll) angles are provided on a display placed on the SMF/CLC top cover, as well as by the SMF/PAPI system software.

Three external precision adjustment screws are used to position the SMF/CLC in horizontal position and to the proper elevation; this is achieved watching the elevation and horizontality angles provided in real time on the display. Screws are arranged two laterally and one behind the covering, on the opposite side with respect to the laser aiming.

The cover is closed watertight and equipped with one optical window for the escaping of the laser beam; the window possesses a warning label for class II laser. Laser is turned-on manually by a security button.

Fig. 2.1 outlines the electrical block diagram of the SMF/CLC. A power supply circuit ignites the laser subsystem and the 2 axes inclinometer, whose output signals are collected by a precision ADC converter and reported on the display as elevation and horizontality angles. Internal temperature is also reported for checking the inclinometer affordability.

An USB connection communicates with the same external notebook provided with the SMF/PAPI instrument; the provided software simultaneously detects the SMF/CLC elevation angle, horizontality and temperature conditions, as well as the SMF/PAPI instrument test results.

Fig. 2.2 shows the SMF/CLC enclosure. The 3 adjustment screws and the laser output window are evidenced.

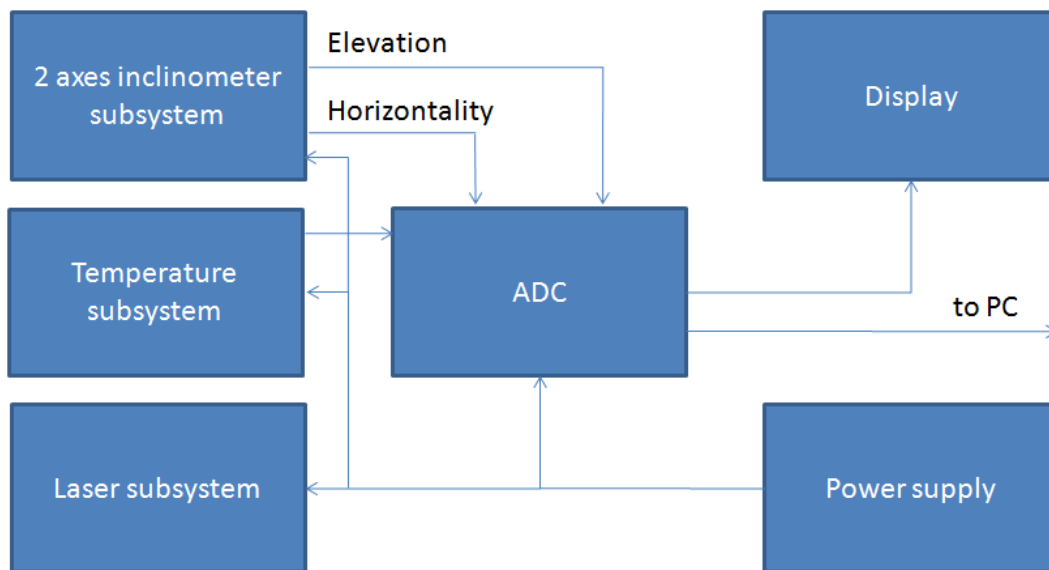


Fig. 2.1 SMF/CLC block diagram



Fig. 2.2 SMF/CLC enclosure

### 3. SMF/CLC OPERATIONS

In order to re-calibrate the SMF/PAPI, a 2 step automatic elevation test is required, measuring the laser beam at 3° and 6° approximately (proper values are displayed by the system software). The provided calibration software executes the tests automatically and calculates new calibration parameters for the SMF/PAPI instrument.

The calibration of a SMF/PAPI instrument is preferably performed indoor. It follows these steps:

- SMF/CLC is positioned on a stable plane (preferably on the floor), at environmental temperature between 0°C and 35°C and turned on.
- The SMF/CLC horizontality is adjusted acting on the two side adjustment screws and observing the display placed on the SMF/CLC cover. Roll angle must fall between  $\pm 0.2$  degrees of arc.
- The desired SMF/CLC elevation angle is set acting on the back adjustment screw and observing the display.
- The SMF/PAPI instrument is positioned on the same plane, in front of the SMF/CLC, at a distance of approximately 2.0 meters.
- The SMF/PAPI instrument calibration software is started and the “Calibrate” operation is selected (available for SMF/CLC owners).
- The Operator is prompted by the system software to adjust the SMF/CLC angle to a proper value and turn-on the laser beam. The test will continue automatically.
- SMF/PAPI software will read automatically the calibrator elevation angle and adjust the measurement head position in order to properly collect the calibrator laser beam.
- The operator is prompted to adjust the SMF/CLC angle to a second value. Test will continue automatically.
- After the 2-angle test is terminated, software will update the SMF/PAPI calibration files, and will back-up the old ones.

Table 3.1 shows the parameters supplied by the SMF/CLC and the relative accuracies for environmental temperature between 0°C and 35°C.

Angles are measured with respect to the gravitational horizon, not with respect to the local ground.

Measured Parameter	Accuracy
Laser Elevation Angle	15 arc-seconds
SMF/CLC Horizontality Angle	0.1 degrees

**Tav. 3.1 Parameters measured by the SMF/CLC**

The error suffered by the provided angles is composed by:

- Calibration error: 10 arc-seconds
- Inclinator nonlinearity error: 7 arc-seconds maximum
- Temperature drift error: 8 arc-seconds maximum.

The overall SMF/CLC accuracy is the squared sum of the above given, equal to 15 arc-seconds.

## 4. STAND-ALONE USE OF THE SMF/CLC

The SMF/CLC is substantially a high precision laser level with USB connectivity and proprietary software that permits the automatic calibration of a SMF/PAPI instrument.

SMF/CLC can also be employed as a stand-alone high precision instrument for aligning surfaces or machine beds at slope angles between  $\pm 10^\circ$  with respect to the gravitational horizon.

The reading of both roll and pitch angle is performed by electronic clinometers with thermal stabilization, permitting to maintain the measurement accuracy below 15 arc-seconds at any environmental temperature between  $0^\circ\text{C}$  and  $35^\circ\text{C}$ .

The unique double-laser beam feature guarantees the maintenance of the factory alignment between the laser beam and the clinometers active axis.

SMF/CLC is an extremely portable and yet affordable alternative to traditional leveling methods like theodolites or transits. The use of the SMF/CLC requires no more than 1 day of training; compared with optics where training can last up to 2 weeks, the SMF/CLC can significantly reduce the time technicians are out of action when being trained.

## 5. SPECIFICATION

Beam elevation range (continuous regulation)	0° to 10°
Accuracy on beam elevation	+/- 15 arc-seconds = 0.0052 deg
Working temperature	+0 °C to +35 °C
Storing temperature	+4 °C to +70 °C
Power supply	110/220 V AC
Power consumption	less than 16 W
Laser output	Class II, visible red dot, 630 nm
Pointing accuracy	+/- 0.1 mm/m
Instrument size	295 mm long x 230 x 165
Weight	3 kg
Warranty	Full 12 months parts & labour

SMF/CLC mechanical parts are composed mainly by precision-machined anodized aluminium.  
Electronic parts are compliant to directive 2002/95/CE (RoHS: Restriction of Hazardous Substances Directive).

SMF/CLC kit comprises of:

- SMF/CLC device
- Power supply cord and adaptor
- USB cord
- Padded protective case with carrying handle
- Calibration software license (software is provided with the SMF/PAPI instrument)
- Instruction & safety manuals.

SMF/CLC software is installed into the SMF/PAPI notebook itself, permitting the simultaneous control of both the SMF/CLC and the SMF/PAPI instrument in order to improve the tests automation.