Z Lab Srl | S.U. soggetta a direzione e coordinamento di Tetractys
R.E.A. c/o C.C.I.A.A. Verona 376649
C.F./P.IVA 02984950788
Cap. Soc. € 80.000 i.v.

01046

**REPORT n°003-2025-CR EN**

# UNI EN ISO 354:2003
## ACOUSTIC ABSORPTION MEASUREMENT IN REVERBERATION ROOM

**Issue place and date:** Cerea (VR), 01st April 2025

**Customer:** Lapalma s.r.l.

**Address Customer:** Via E.Majorana,26 – 35010 - Cadoneghe (PD) - ITALY

**Sample delivery date:** 13th January 2025

**Sample provenance:** Lapalma s.r.l.

**Sample installation date:** 13th January 2025

**Sample installed in laboratory by:** Z Lab S.r.l. (sampling made by the committee)

**Test date:** 13th January 2025

**Test location:** Z Lab S.r.l. - Via Pisa ,7 - 37053 Cerea (VR) - Italy

**Mounting Type:** E135

**Sampling denomination:** WOD

| PREPARED | VERIFIED | APPROVED |
|---|---|---|
| Annunziata Bruno | Nicola Soriani | Annunziata Bruno |





Via Pisa, 7 – 37053
info@zeta-lab.it
www.zeta-lab.it
Tel. +39 0442 410280

Z Lab Srl | S.U. soggetta a direzione e coordinamento di Tetractys
R.E.A. c/o C.C.I.A.A. Verona 376649
C.F./P.IVA 02984950788
Cap. Soc. € 80.000 i.v.

01046

**REPORT n°003-2025-CR EN**

## Sample description

The test sample is composed of a double-sided thermoformed panel measuring 1800 x 370 mm and 36 mm thick, made of black FR polyester with a density of 1600 g/m$^3$, covered with 100% polyester Trevira CS fabric. (1)

**Figure 1_Sample**

(1) nominal data provided by the client
(2) data measured by test element sampling





Via Pisa, 7 – 37053
info@zeta-lab.it
www.zeta-lab.it
Tel. +39 0442 410280

Z Lab Srl | S.U. soggetta a direzione e coordinamento di Tetractys
R.E.A. c/o C.C.I.A.A. Verona 376649
C.F./P.IVA 02984950788
Cap. Soc. € 80.000 i.v.

01046

**REPORT n°003-2025-CR EN**

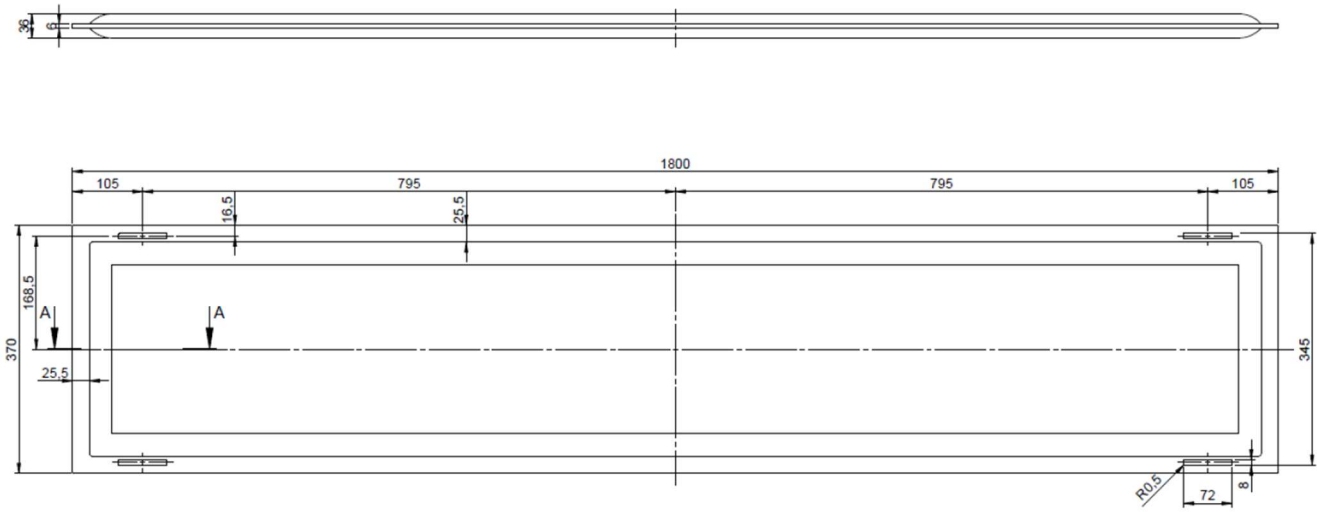



**Figure 2_ Technical Drawing(1)**

(1) nominal data provided by the client
(2) data measured by test element sampling





Via Pisa, 7 – 37053
info@zeta-lab.it
www.zeta-lab.it
Tel. +39 0442 410280

Z Lab Srl | S.U. soggetta a direzione e coordinamento di Tetractys
R.E.A. c/o C.C.I.A.A. Verona 376649
C.F./P.IVA 02984950788
Cap. Soc. € 80.000 i.v.

01046



## Mounting conditions

The mounting type is E135 in accordance with Annex B.4 of UNI EN ISO 354.
The test objects have been laid on a special structure, leaving a back gap of 100 mm. This gap is measured from the floor of the test chamber.
The support structure used is aluminum, while the edges are made of plasterboard panels.

The test sample characteristics are listed below (1):

| *n° panels* | *Single panel Length (mm)* | *Single panel Width (mm)* | *Structure Thickness (mm)* | *Maximum panel thickness (mm)* | *Panel surface mass* (kg/m²) (2) |
|---|---|---|---|---|---|
| 16 | 1800 | 370 | 100 | 36 | 3,40 |

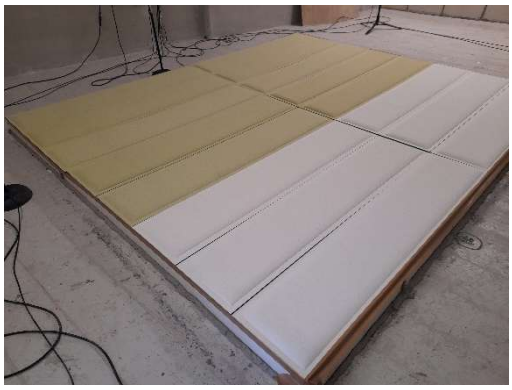


**Figure 3_ Sample detail**

(1) nominal data provided by the client
(2) data measured by test element sampling





Via Pisa, 7 – 37053
info@zeta-lab.it
www.zeta-lab.it
Tel. +39 0442 410280

Z Lab Srl | S.U. soggetta a direzione e coordinamento di Tetractys
R.E.A. c/o C.C.I.A.A. Verona 376649
C.F./P.IVA 02984950788
Cap. Soc. € 80.000 i.v.

01046



## Test sample illustrations

**Figure 4_ Reverberation Room Empty with structure**

**Figure 5_ Reverberation Room with Sample**

The test has been made as soon as the sample installation was completed.





Via Pisa, 7 – 37053
info@zeta-lab.it
www.zeta-lab.it
Tel. +39 0442 410280

Z Lab Srl | S.U. soggetta a direzione e coordinamento di Tetractys
R.E.A. c/o C.C.I.A.A. Verona 376649
C.F./P.IVA 02984950788
Cap. Soc. € 80.000 i.v.

01046



## Standards references

| | |
|---|---|
| UNI EN ISO 354:2003 | *Acoustic - Absorption measurement in reverberation room.* |
| UNI EN ISO 11654:1998 | *Acoustics - acoustic absorbers for buildings - Rating of sound absorption.* |

## Test environment description

The test structure is made of reinforced concrete, completely insulated from the floor of the laboratory with anti-vibration supports. It is made up of a reverberating room of irregular shape and free of partition parallel to each other. In the room there are  diffusers in glossy painted plasterboard for a total area of 25 $m^2$.

The dimensional data are listed below:

| | |
|---|---|
| Average reverberation room dimensions (L x W x H) | 700 X 560 X 370 cm |

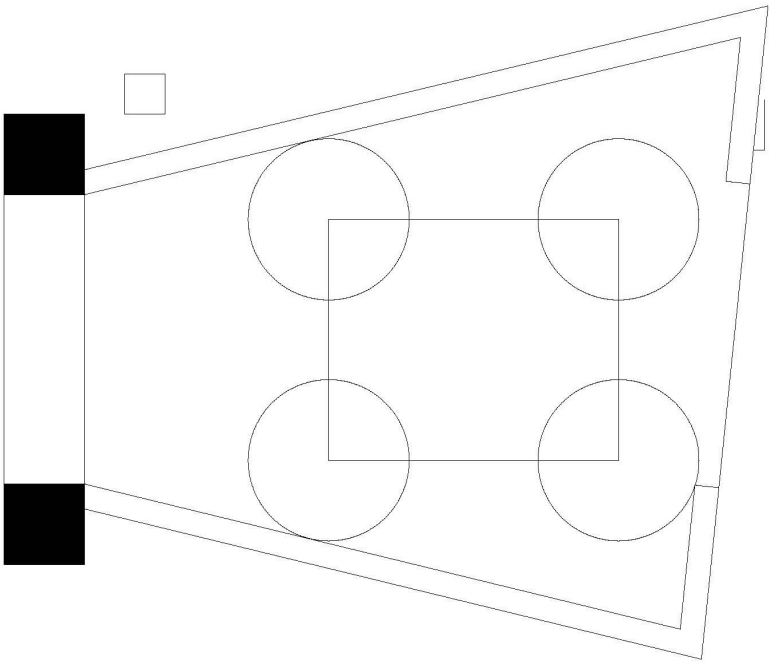


**Figure 6_ Reverberation Room Scheme**





Via Pisa, 7 – 37053
info@zeta-lab.it
www.zeta-lab.it
Tel. +39 0442 410280

Z Lab Srl | S.U. soggetta a direzione e coordinamento di Tetractys
R.E.A. c/o C.C.I.A.A. Verona 376649
C.F./P.IVA 02984950788
Cap. Soc. € 80.000 i.v.

01046



## Test equipment and instruments

| Instrument | Model | Serial number |
|---|---|---|
| Sound Level Meter | Sinus GmbH Expander | 9154 |
| Microphone | G.R.A.S. 146AE | 357193 |
| Microphone | G.R.A.S. 146AE | 337435 |
| Microphone | G.R.A.S. 146AE | 485744 |
| Microphone | G.R.A.S. 146AE | 346626 |
| Microphone | G.R.A.S. 146AE | 337677 |
| Microphone | G.R.A.S. 146AE | 337675 |
| Calibrator | GRAS 24AG | 281783 |
| Omnidirectional source | Lookline D301 + DL301 | AO900163+DO900159 |
| Temperature and humidity sensor | DeltaOHM HD35AP.E +HD35ED1NTV | 17008603+16037651+16037652 |
| Tape | Stanley 33 - 442 | 13/946 |

## Environmental data during the test

| | Reverberation room |
|---|---|
| Volume | 161,3 $m^3$ |
| Total surface | 188,5 $m^2$ |
| Average temperature during $T_1$ | 15,3 ± 1,0 °C |
| Average relative humidity during $T_1$ | 35,2 ± 2,0 % |
| Average temperature during $T_2$ | 15,3 ± 1,0 °C |
| Average relative humidity during $T_2$ | 35,2 ± 2,0 % |
| Sample surface | 10,80 $m^2$ |

Where:
- $T_1$: Empty room reverberation time
- $T_2$: Room reverberation time with test specimen





Via Pisa, 7 – 37053
info@zeta-lab.it
www.zeta-lab.it
Tel. +39 0442 410280

Z Lab Srl | S.U. soggetta a direzione e coordinamento di Tetractys
R.E.A. c/o C.C.I.A.A. Verona 376649
C.F./P.IVA 02984950788
Cap. Soc. € 80.000 i.v.

01046



## Measurement method

The measurement of the sound absorption in the reverberation room is based on the principle of the difference between
the reverberation times measured in the reverberation room without and with test specimen. The sound in the reverberation room is generated by a sound source in 2 different positions while the microphones are located in 6 different positions.

Measurements are taken in third octave band within the range 100 to 5000 Hz using the integrated impulse response method.
The reverberation time in both rooms is calculated by arithmetic mean of the total number of reverberation time measurements in each frequency band. The mean reverberation time without and with test specimen, respectively $T_1$ and $T_2$, is expressed with two significant digits.

The sample equivalent absorption area, $A_T$ is then calculated using the formula:

$$A_T = A_2 - A_1 = 55{,}3 \cdot V \cdot \left(\frac{1}{c_2 T_2} - \frac{1}{c_1 T_1}\right) - 4 \cdot V \cdot (m_2 - m_1)$$

where:
$A_1$: is equivalent sound absorption area of the empty reverberation room
$A_2$: is equivalent sound absorption area of the reverberation room containing the test specimen
V: is the empty room volume, in $m^3$;
$c_1$: is the propagation speed of sound speed in the air of the empty reverberation room, in m/s;
$c_2$: is the propagation speed of sound speed in the air of reverberation room with test specimen, in m/s;;
$T_1$is the reverberation times, in seconds, of the empty reverberation room
$T_2$: is the reverberation times, in seconds, of the reverberation room after test specimen has been introduced
$m_1$ e $m_2$: are the power attenuation coefficients, depending on climate rooms conditions during the measurements.

The acoustic absorption coefficient, $\alpha_s$, of plane absorbers or of an array of objects is calculated with the formula:

$$a_s = \frac{A_T}{S}$$

where:
S: is the sample area, in $m^2$.

According to UNI EN ISO 11654, the values of the sound absorption coefficient depending on the frequency can be converted into a single evaluation index, the weighted acoustic absorption coefficient$a_w$.This coefficient is calculated using the values of the practical acoustic absorption coefficient $\alpha_{pi.}$





Via Pisa, 7 – 37053
info@zeta-lab.it
www.zeta-lab.it
Tel. +39 0442 410280

Z Lab Srl | S.U. soggetta a direzione e coordinamento di Tetractys
R.E.A. c/o C.C.I.A.A. Verona 376649
C.F./P.IVA 02984950788
Cap. Soc. € 80.000 i.v.

01046



The practical absorption coefficient, $\alpha_{pi}$, for any octave band "*i*", is the arithmetic average of the three absorption coefficients for any one-third octave band in the octave band of interest:

$$a_{pi} = \frac{a_{i1} + a_{i2} + a_{i3}}{3}$$

The mean value is calculated to the second decimal digit, rounded by 0.05 steps, and limited to $a_{pi}$ = 1.00 for rounded average values> 1.00.

The $a_{pi}$ values are used to calculate the $a_w$ weighted acoustic absorption coefficient starting from the reference curve which is translated at steps of 0.05 to the measured value until the sum of unfavorable deviations is less than or equal to 0.10. The $a_w$ weighted acoustic absorption coefficient is defined as the value of the reference curve transposed at 500 Hz.
If a practical acoustic absorption coefficient $a_{pi}$ exceeds the value of the referenced reference curve of 0.25 or more, add one or more shape gauges to the αw value by bringing them back into parentheses. If the excess absorption occurs at 250 Hz, the notion L is reported, if the excess occurs at 500 Hz or 1000 Hz, the indicator M is used, and if the excess occurs at 2000 Hz or 4000 Hz the notion H.

Via Pisa, 7 – 37053
info@zeta-lab.it
www.zeta-lab.it
Tel. +39 0442 410280

Z Lab Srl | S.U. soggetta a direzione e coordinamento di Tetractys
R.E.A. c/o C.C.I.A.A. Verona 376649
C.F./P.IVA 02984950788
Cap. Soc. € 80.000 i.v.

01046

**REPORT n°003-2025-CR EN**

## Measured values

| f [Hz] | $T_1$ [s] | $T_2$ [s] | $A_T$ [$m^2$] |
|---|---|---|---|
| *Frequency* | *Empty room reverberation time* | *Sample room reverberation time* | *Equivalent absorption area* |
| 100 | 4,23 | 2,96 | 2,65 |
| 125 | 3,84 | 2,97 | 2,01 |
| 160 | 5,27 | 2,92 | 4,02 |
| 200 | 5,41 | 2,32 | 6,48 |
| 250 | 6,33 | 2,18 | 7,87 |
| 315 | 6,13 | 2,01 | 8,74 |
| 400 | 5,82 | 1,73 | 10,67 |
| 500 | 5,40 | 1,68 | 10,75 |
| 630 | 5,44 | 1,73 | 10,32 |
| 800 | 5,06 | 1,71 | 10,12 |
| 1000 | 4,23 | 1,65 | 9,67 |
| 1250 | 3,91 | 1,65 | 9,14 |
| 1600 | 3,70 | 1,61 | 9,20 |
| 2000 | 3,24 | 1,54 | 8,88 |
| 2500 | 2,73 | 1,38 | 9,35 |
| 3150 | 2,18 | 1,23 | 9,25 |
| 4000 | 1,69 | 1,07 | 8,96 |
| 5000 | 1,33 | 0,90 | 9,47 |





Via Pisa, 7 – 37053
info@zeta-lab.it
www.zeta-lab.it
Tel. +39 0442 410280

Z Lab Srl | S.U. soggetta a direzione e coordinamento di Tetractys
R.E.A. c/o C.C.I.A.A. Verona 376649
C.F./P.IVA 02984950788
Cap. Soc. € 80.000 i.v.

01046

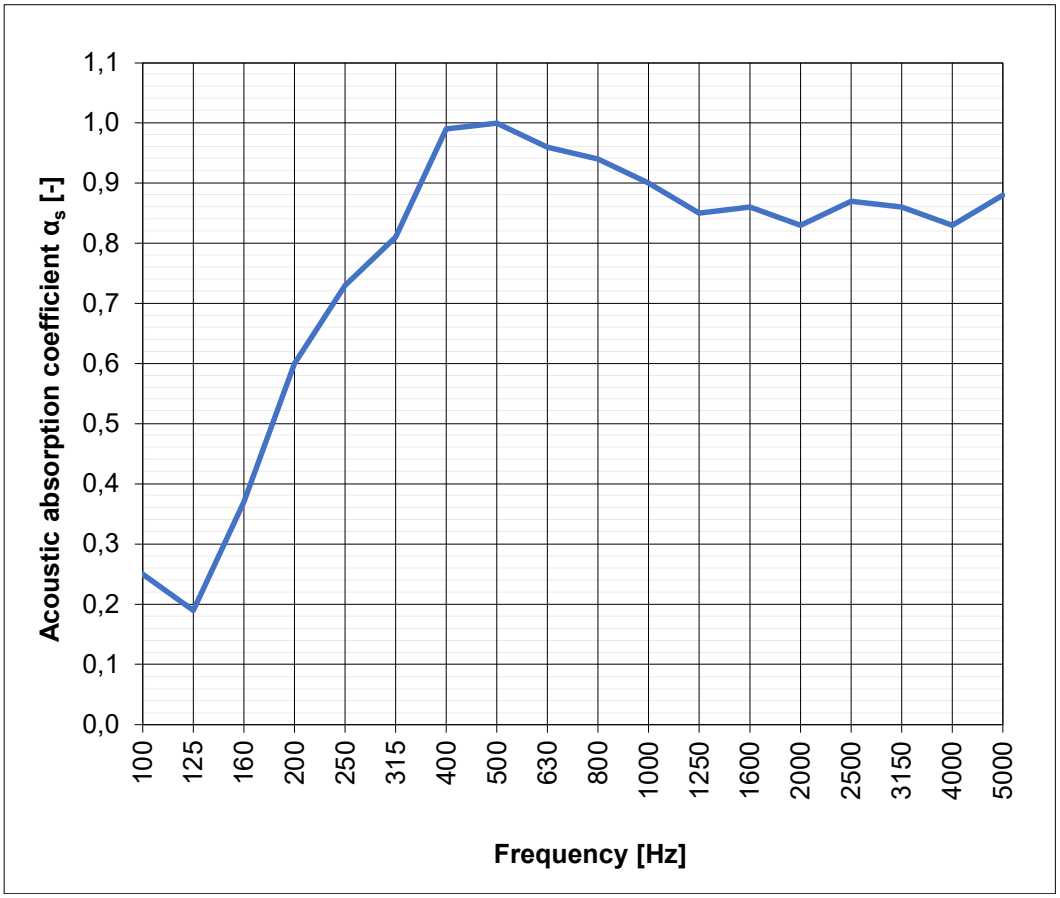
# REPORT n°003-2025-CR EN

*Acoustic absorption calculation in reverberation room according to UNI EN ISO 354:2003*

Sample description: WOD
Mounting Type: E135

Sample area: 10,80 $m^2$
Reverberation room volume: 161,3 $m^3$

| f [Hz] | $\alpha_s$[-] |
|---|---|
| *Frequency* | *Acoustic absorption coefficient values* |
| 100 | 0,25 |
| 125 | 0,19 |
| 160 | 0,37 |
| 200 | 0,60 |
| 250 | 0,73 |
| 315 | 0,81 |
| 400 | 0,99 |
| 500 | 1,00 |
| 630 | 0,96 |
| 800 | 0,94 |
| 1000 | 0,90 |
| 1250 | 0,85 |
| 1600 | 0,86 |
| 2000 | 0,83 |
| 2500 | 0,87 |
| 3150 | 0,86 |
| 4000 | 0,83 |
| 5000 | 0,88 |




Evaluation based on laboratory measurement results by means of a technical method.





Via Pisa, 7 – 37053
info@zeta-lab.it
www.zeta-lab.it
Tel. +39 0442 410280

Z Lab Srl | S.U. soggetta a direzione e coordinamento di Tetractys
R.E.A. c/o C.C.I.A.A. Verona 376649
C.F./P.IVA 02984950788
Cap. Soc. € 80.000 i.v.

01046

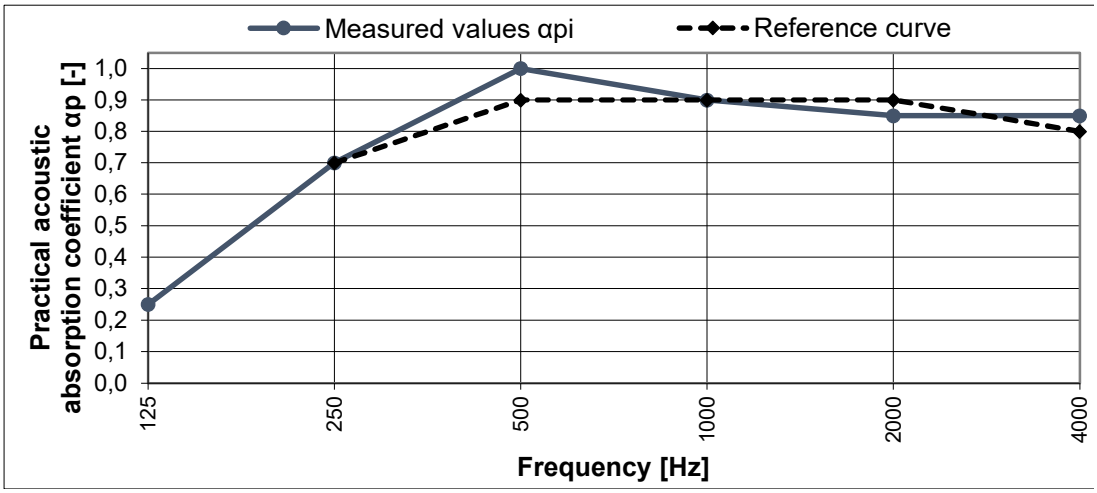
# REPORT n°003-2025-CR EN

*Acoustic absorption calculation in reverberation room according to UNI EN ISO 11654:1998*

Sample description: WOD
Mounting Type: E135

Sample area: 10,80 $m^2$
Reverberation room volume: 161,3 $m^3$

| f [Hz] | $\alpha_p$[-] |
|---|---|
| *Frequency* | *Practical acoustic absorption coefficient values* |
| 125 | 0,25 |
| 250 | 0,70 |
| 500 | 1,00 |
| 1000 | 0,90 |
| 2000 | 0,85 |
| 4000 | 0,85 |




Standard evaluation index:

| | | | |
|---|---|---|---|
| $\alpha_w$ | **0,90 Class A** | *Weighted acoustic sound absorption coefficient Sound Absorption Class* (4) | *UNI EN ISO 11654:1998* |

Evaluation based on laboratory measurement results by means of a technical method.

(4) Classification of acoustic absorbers: The unique αw evaluation index is used to calculate the absorption class according to the following table:

| CLASSE | $\alpha_w$ |
|---|---|
| A | 0,9 - 0,95 - 1,00 |
| B | 0,8 - 0,85 |
| C | 0,6 - 0,65 - 0,7 - 0,75 |
| D | da 0,3 a 0,55 |
| E | 0,15 - 0,2 - 0,25 |
| NC | 0,00 - 0,05 - 0,1 |

**Test report digitally signed**

**Eng. Annunziata Bruno**
**Laboratory Manager Z LAB Srl**

----------END OF TEST REPORT----------





Via Pisa, 7 – 37053
info@zeta-lab.it
www.zeta-lab.it
Tel. +39 0442 410280