

# Calibration Certificate

Model: Focus S 150      Serial Number: LLS081710941      Certificate Number: LLS10941-2024-0301-US      Certification Date: 01-Mar-2024

## Measurement Items Used, Traceable to National Standards

<b>Laser Tracker</b> Model: Vantage-E	Serial No.: VZ0003806910	Cert. No.: V06910-23102023	Cert. Date: 23-Oct-2023
<b>Reflectance Targets</b> Model: SRS-50-020	Serial No.: TQ3333	Cert. No.: C13090903	Cert. Date: 28-Feb-2023
Model: SRS-10-020	Serial No.: TQ3347	Cert. No.: C13090602	Cert. Date: 28-Feb-2023
Model: AckerMagicBlack	Serial No.: TQ3238	Cert. No.: C13080814	Cert. Date: 28-Feb-2023

## Calibration Results

### 3D Position Accuracy

Target 1	Target 2	Zone	Distance [m]	Uncertainty, k=2 [mm]	Scanner [m]	Deviation [mm]	Spec., k=1 [mm]	Spec., k=2 [mm]	Result
ZK45	ZK47	10 m	2.77194	0.20	2.77180	-0.14	1.5	2.0	pass
ZK45	ZK46	10 m	1.84315	0.20	1.84205	-1.09	1.5	2.0	pass
ZK45	ZK48	25 m	17.14584	0.20	17.14694	1.11	1.5	2.0	pass

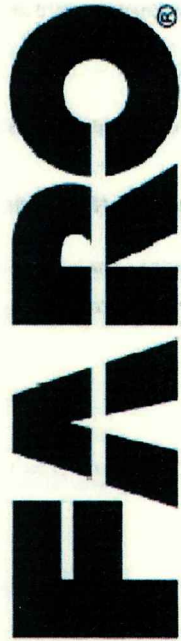
### Ranging Noise

Reflectance	Distance	Uncertainty, k=1 [mm]	Scanner	Specifications	Result
90%	10 m	0.067	0.1	0.1	pass
	25 m	0.067	0.1	0.2	pass
10%	10 m	0.067	0.2	0.3	pass
	25 m	0.067	0.3	0.5	pass
2%	10 m	0.067	0.4	0.9	pass
	25 m	0.067	0.7	1.6	pass

This certificate shall not be reproduced, except in full, without permission of FARO Technologies, Inc. It invalidates all other certificates generated before the certification date.  
The results of this certificate relate only to the items calibrated or tested.  
The calibration is done at FARO or FARO Scanner Production sites according to FARO test protocols integrating guidelines defined in the Joint Committee for Guides in Metrology guidance document JCGM 100:2008 - Evaluation of measurement data - Guide to the expression of uncertainty in measurement, and the requirements for readability according to the International Vocabulary of Basic and General Terms in Metrology (VIM) and the National Institute of Standards and Technology (NIST).

Note: Data in this section is required only if amendments are made to the calibration certificate.  
Amendment to report: NO  
Previous Certificate #: \_\_\_\_\_  
Reason for Amendment: \_\_\_\_\_

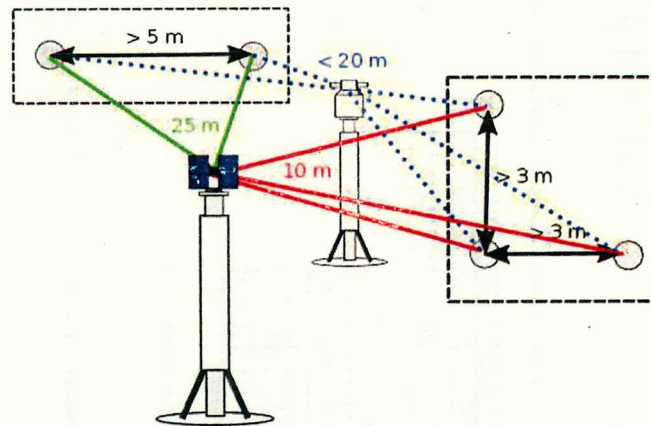
Approved by: \_\_\_\_\_ Date: \_\_\_\_\_



Authorization: Stanley Simski  
Calibration Technician      Date: 01-Mar-2024

### 3D Position - Uncertainty Budget

The 3D Position calibration is performed by scanning spheres in distances of ca. 10m and 25m and comparing the distances between these spheres measured with the scanner to the distances between these spheres measured with a reference laser tracker.



### Uncertainty Contributors

Absolute position of the spheres:

FARO Vantage Tracker: Point to Point Accuracy (20m max):

$$u_{ref} = 0.085 \text{ mm}$$

Repeatability of tactile determination of sphere center:

$$u_{tact} = 0.06 \text{ mm}$$

SMR center error:

$$u_{SMR} = 0.007 \text{ mm}$$

### Combined Uncertainty

Combined standard uncertainty  $u_{c3DPosition-k1}$  for  $k = 1$ :

$$u_{c3DPosition-k1} = \sqrt{u_{ref}^2 + u_{tact}^2 + u_{SMR}^2} = 0.1 \text{ mm}$$

Combined standard uncertainty  $u_{c3DPosition-k2}$  for  $k = 2$ :

$$u_{c3DPosition-k2} = 2 * u_{c3DPosition-k1} = 0.2 \text{ mm}$$

Further details regarding the uncertainty budget are available on request.

### Ranging Noise Measurement - Uncertainty Budget

Ranging noise is defined as a standard deviation of values of the best-fit plane.

Combined standard uncertainty  $u_{cNoise}$ :

$$u_{cNoise} = 0.067 \text{ mm}$$

All measurements for this calibration certificate were made with a measurement speed of 122,000 points/sec.