RF Exposure Lab

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http://www.rfexposurelab.com

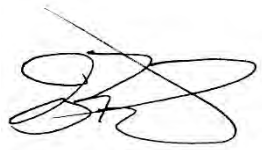
# CERTIFICATE OF COMPLIANCE
# RF EXPOSURE & NERVE STIMULATION EVALUATION

| | | | |
|---|---|---|---|
| InVue | | Dates of Test: | January 4, 2024 |
| 9201 Baybrook Lane | | Test Report Number: | SAR.20240110 |
| Charlotte, NC 28277 | | | |
| | | Lab Designation Number: US1195 | |

| | |
|---|---|
| FCC ID: | 2AFR8-P05BRLT |
| Model(s): | 2300-W |
| Serial Number: | Eng 1 |
| Equipment Type: | Wireless Power Transfer |
| Classification: | WPT Transmitter |
| TX Frequency Range: | 326.5 kHz, 1.778 MHz |
| Frequency Tolerance: | ± 2.5 ppm |
| Maximum RF Output: | 326.5 kHz – 36.99 dBm EIRP, 1.778 MHz – 36.99 dBm EIRP |
| Signal Modulation: | FSK and ASK |
| Antenna Type: | Internal |
| Application Type: | Certification |
| Standard(s): | KDB680106 v04 |
| Maximum E-Field: | 28.50 V/m for 326.5 kHz Transmitter, 5.58 V/m for 1.778 MHz Transmitter |
| Maximum H-Field: | 0.103 A/m for 326.5 kHz Transmitter, 0.134 A/m for 1.778 MHz Transmitter |
| Distance to Probe: | 0 mm |

This wireless mobile device has been shown to meet the requirements for RF exposure testing for uncontrolled environment/general exposure limits specified in above listed standards. The device has also been shown to meet the simultaneous requirements of each standard as well (See test report).

I attest to the accuracy of the data. I assume full responsibility for the completeness of these calculations and vouch for the qualifications of all persons making them.



Jay M. Moulton
Vice President

ACCREDITED
Testing Certificate # 2387.01

# Table of Contents

| Comment/Revision | Date |
|---|---|
| Original Release | March 26, 2024 |
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**Note: The latest version supersedes all previous versions listed in the above table. The latest version shall be used.**

# 1. Introduction

This report shows RF exposure evaluation of the InVue Model 2300-W Wireless Power Transfer with KDB680106 v04.

# 2. Radiation Sources

| Radio | Description | |
|---|---|---|
| FSK and ASK | Frequency (MHz) | 326.5 kHz |
| | Maximum Power (dBm) | 36.99 dBm (EIRP) |
| | Maximum Duty Cycle (%) | 100% |

| Radio | Description | |
|---|---|---|
| FSK and ASK | Frequency (MHz) | 1.778 MHz |
| | Maximum Power (dBm) | 36.99 dBm (EIRP) |
| | Maximum Duty Cycle (%) | 100% |

# 3. RF Exposure Classifications

| Device Types | |
|---|---|
| Fixed | A fixed device is defined as a device physically secured at one fixed location and cannot be easily re-located. |
| Mobile | A mobile device is defined as a transmitting device designed to be used in other than fixed locations and to generally be used in such a way that a separation distance of at least 20 centimeters is normally maintained between the transmitter's radiating structure(s) and the body of the user or nearby persons. |
| Portable | A portable device is defined as a transmitting device designed to be used so that the radiating structure(s) of the device is/are within 20 centimeters of the body of the user. |

| Exposure Categories | |
|---|---|
| Occupational / Controlled | Limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure. |
| General population / uncontrolled | Exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or cannot exercise control over their exposure. |

# 4. RF Exposure Limits

## FCC Requirements

ECFR CONTENT

Table 1 to § 1.1310(e)(1)—Limits for Maximum Permissible Exposure (MPE)

| Frequency range (MHz) | Electric field strength (V/m) | Magnetic field strength (A/m) | Power density ($mW/cm^2$) | Averaging time (minutes) |
|---|---|---|---|---|
| **(i) Limits for Occupational/Controlled Exposure** | | | | |
| 0.3–3.0 | 614 | 1.63 | *(100) | ≤6 |
| 3.0–30 | 1842/f | 4.89/f | *($900/f^2$) | <6 |
| 30–300 | 61.4 | 0.163 | 1.0 | <6 |
| 300–1,500 | | | f/300 | <6 |
| 1,500–100,000 | | | 5 | <6 |
| **(ii) Limits for General Population/Uncontrolled Exposure** | | | | |
| 0.3–1.34 | 614 | 1.63 | *(100) | <30 |
| 1.34–30 | 824/f | 2.19/f | *($180/f^2$) | <30 |
| 30–300 | 27.5 | 0.073 | 0.2 | <30 |
| 300–1,500 | | | f/1500 | <30 |
| 1,500–100,000 | | | 1.0 | <30 |

f = frequency in MHz. * = Plane-wave equivalent power density.

Note: For frequencies below 300 MHz, use the limits at 300 MHz.

# 5. General Conditions

- This report is only in reference to the item that has undergone the assessment.
- This report does not constitute or imply on its own an approval of the product by the Certification Bodies or Competent Authorities.

# 6. Environmental Conditions

The following limits were not exceeded during the test:

| | |
|---|---|
| Temperature | Min. = 15 °C<br>Max. = 35 °C |
| Relative Humidity | Min. = 30%<br>Max. = 60% |

# 7. Test Equipment

| | Serial Number | Last Cal. Date | Cal. Due Date |
|---|---|---|---|
| • Wavecontrol SMP2 | 19SN1179 | 04/13/2022 | 04/13/2024 |
| • WP400-3 | 19WP120054 | 04/13/2022 | 04/13/2024 |
| • WPH60 | 19WP110048 | 04/13/2022 | 04/13/2024 |
| • WPF6 | 19WP060233 | 04/13/2022 | 04/13/2024 |

- Positioning Apparatus used is a plastic tripod to hold the meter and probe at a specified position

# 8. EUT Description

The description of the antenna is listed below

- There is one antenna in the device
- The element is a 9 turn coil antenna with an impedance of 4 µH
- The shielding or field shaping is done with ferrite, aluminum and a copper e-shield
- The overall dimensions of the device is 26 mm diameter
- The distance from the antenna to the outside of the enclosure is 6 mm
- The position of the antenna in the device is located in the center of the device
- The enclosure over the antenna is POM – Celcon:MC90
- The two transmitters cannot operate simultaneously.
- The probes meet the requirements set forth in SPR-002 Issue 2 7.1.6.1, 7.1.6.2 and 7.1.6.3 as required by table A2

# 9. RF exposure Evaluation Results for 362.5 kHz

The measurements for the 2300-W was conducted at 20 mm distance from the device to the center of the probe diameter. A pre-scan of the entire side was conducted first by moving the probe across all areas of the side being tested. The movement was conducted at a very slow pace to find the peak value for each side of the device. Once the peak position was determined for each of the sides, the meter and probe were installed on the positioning apparatus for conducting the final measurements.

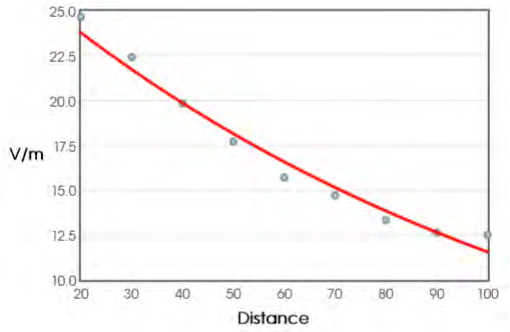
The highest value of all the sides at 20 mm was then tested every 10 mm moving away from the antenna. All the values were used to extrapolate to the 0 mm distance. The equation used to extrapolate the value to zero is $y = a * b^x$, where x is the distance and y is the measured value. Below are all the measured values for the e- and h-field.

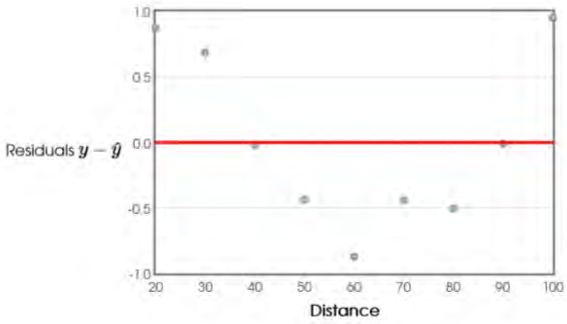
| E-Field | | H-Field | |
|---|---|---|---|
| Distance | Meas. Value | Distance | Meas. Value |
| 20 mm | 24.67 V/m | 20 mm | 0.102 A/m |
| 30 mm | 22.43 V/m | 30 mm | 0.101 A/m |
| 40 mm | 19.85 V/m | 40 mm | 0.101 A/m |
| 50 mm | 17.72 V/m | 50 mm | 0.099 A/m |
| 60 mm | 15.72 V/m | 60 mm | 0.099 A/m |
| 70 mm | 14.72 V/m | 70 mm | 0.099 A/m |
| 80 mm | 13.35 V/m | 80 mm | 0.099 A/m |
| 90 mm | 12.65 V/m | 90 mm | 0.098 A/m |
| 100 mm | 12.52 V/m | 100 mm | 0.098 A/m |

The regression equation for the E-Field calculates to be $28.4984 * 0.9910^{(mm)}$.
The correlation for the E-Field calculates to be r = -0.9957.
The R-square for the E-Field calculates to be $r^2 = 0.9716$.

The extrapolated value at 10 mm is 26.03 V/m.
The extrapolated value at 0 mm is 28.50 V/m.

Below is the scatter plot and residual plot for the E-Field measurements.

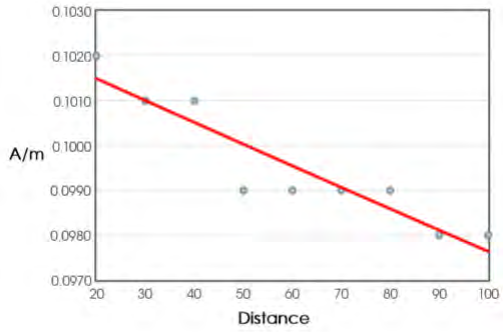


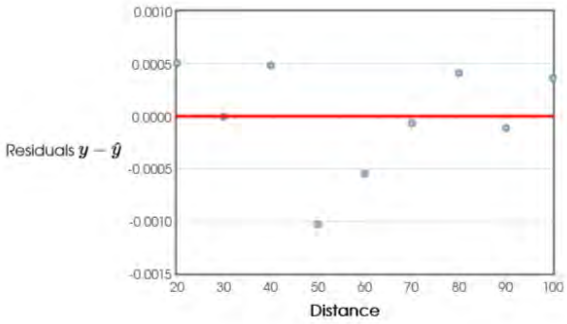



The regression equation for the H-Field calculates to be 0.1025 * 0.9995 (mm).
The correlation for the H-Field calculates to be r = -0.9304.
The R-square for the H-Field calculates to be $r^2$ = 0.8656.

The extrapolated value at 10 mm is 0.102 A/m.
The extrapolated value at 0 mm is 0.103 A/m.

Below is the scatter plot and residual plot for the H-Field measurements.




| Frequency | E-Field Measurement | Limit [V/m] | % Limit | Verdict |
|---|---|---|---|---|
| 326.5 kHz | 28.50 | 614 | 4.6 | Pass |

| Frequency | H-Field Measurement | Limit [A/m] | % Limit | Verdict |
|---|---|---|---|---|
| 326.5 kHz | 0.103 | 1.63 | 6.3 | Pass |

There is no simultaneous transmitters in the device. Only one of the transmitters is operating at one time. Therefore, TER was not required to be evaluated for this device.

# 10. RF exposure Evaluation Results for 1.778 MHz

The measurements for the 2300-W was conducted at 40 mm distance from the device to the center of the probe diameter. A pre-scan of the entire side was conducted first by moving the probe across all areas of the side being tested. The movement was conducted at a very slow pace to find the peak value for each side of the device. Once the peak position was determined for each of the sides, the meter and probe were installed on the positioning apparatus for conducting the final measurements.

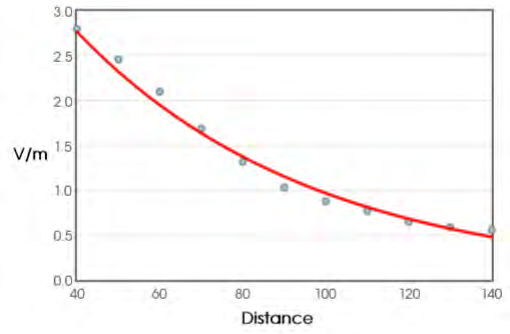
The highest value of all the sides at 40 mm was then tested every 10 mm moving away from the antenna. All the values were used to extrapolate to the 0 mm distance. The equation used to extrapolate the value to zero is $y = a * b^x$, where x is the distance and y is the measured value. Below are all the measured values for the e- and h-field.

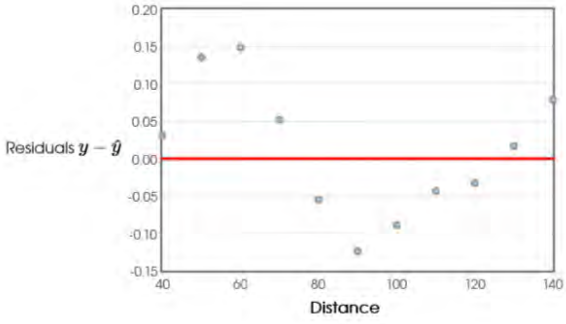
| E-Field | | H-Field | |
|---|---|---|---|
| Distance | Meas. Value | Distance | Meas. Value |
| 40 mm | 2.80 V/m | 40 mm | 0.079 A/m |
| 50 mm | 2.46 V/m | 50 mm | 0.067 A/m |
| 60 mm | 2.10 V/m | 60 mm | 0.061 A/m |
| 70 mm | 1.69 V/m | 70 mm | 0.053 A/m |
| 80 mm | 1.32 V/m | 80 mm | 0.049 A/m |
| 90 mm | 1.03 V/m | 90 mm | 0.044 A/m |
| 100 mm | 0.88 V/m | 100 mm | 0.037 A/m |
| 110 mm | 0.77 V/m | 110 mm | 0.032 A/m |
| 120 mm | 0.65 V/m | 120 mm | 0.029 A/m |
| 130 mm | 0.59 V/m | 130 mm | 0.025 A/m |
| 140 mm | 0.56 V/m | 140 mm | 0.022 A/m |
| | | 150 mm | 0.018 A/m |

The regression equation for the E-Field calculates to be $5.5769 * 0.9826^{(mm)}$.
The correlation for the E-Field calculates to be r = -0.9908.
The R-square for the E-Field calculates to be $r^2 = 0.9817$.

The extrapolated value at 30 mm is 3.29 V/m.
The extrapolated value at 20 mm is 3.93 V/m.
The extrapolated value at 10 mm is 4.68 V/m.
The extrapolated value at 0 mm is 5.58 V/m.

Below is the scatter plot and residual plot for the E-Field measurements.

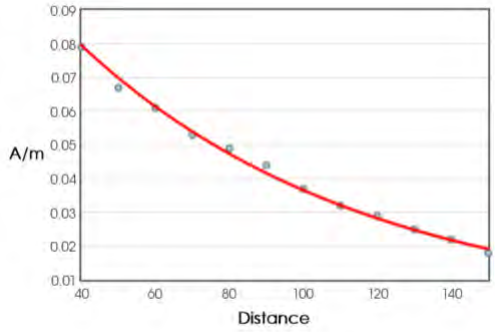


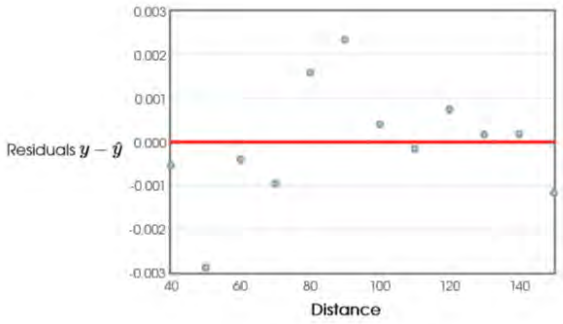



The regression equation for the H-Field calculates to be 0.1335 * 0.9871 $^{(mm)}$.
The correlation for the H-Field calculates to be r = -0.9977.
The R-square for the H-Field calculates to be $r^2$ = 0.9954.

The extrapolated value at 30 mm is 0.090 A/m.
The extrapolated value at 20 mm is 0.103 A/m.
The extrapolated value at 10 mm is 0.117 A/m.
The extrapolated value at 0 mm is 0.134 A/m.

Below is the scatter plot and residual plot for the H-Field measurements.




| Frequency | E-Field Measurement | Limit [V/m] | % Limit | Verdict |
|---|---|---|---|---|
| 1.778 MHz | 5.58 | 614 | 0.9 | Pass |

| Frequency | H-Field Measurement | Limit [A/m] | % Limit | Verdict |
|---|---|---|---|---|
| 1.778 MHz | 0.134 | 1.63 | 8.2 | Pass |

There are no other transmitters in the device. Therefore, TER was not required to be evaluated for this device.

# Appendix A – Calibration Certificates

# Certificate of Calibration

**ISO/IEC 17025:2017 and ANSI/NCSL Z540.1-1994**

**Certificate Number 220411-085519-f52052**

ACCREDITED ISO/IEC 17025 CALIBRATION LABORATORY AC-1498.20

| | |
|---|---|
| **Model Number** | WP400-3; SMP2 |
| **Manufacturer** | Wavecontrol |
| **Description** | Field Probe |
| **Serial Number** | 19WP120054; 19SN1179 |
| **Customer Asset No.** | N/A |

**Customer**
RF Exposure Lab, LLC
802 N. Twin Oaks Valley Rd
Suite 105
San Marcos, CA 92069
USA

| | |
|---|---|
| **Date of Calibration** | 04/13/2022 |
| **Temperature** | 23°C |
| **Humidity** | 48% RH |

**Location of Calibration**
Keysight Technologies Inc.
1346 Yellowwood Road
Kimballton, IA 51543
United States

This certifies that the equipment has been calibrated using applicable Keysight Technologies procedures and in compliance with ISO/IEC 17025:2017 and ANSI/NCSL Z540.1-1994 (R2002). The quality management system is registered to ISO 9001:2015.

**Calibration Standard(s)**
IEEE Std 1309-2013

**Calibration Method(s)**
Substitution

**Calibration Procedure(s)**
909579

**Calibration Software**
Probe Comparison 1.4.1

**As Received Conditions**
The measured values of the equipment were observed in specification at the points tested.

**Action Taken**
No action was taken.

**As Completed Conditions**
The measured values of the equipment were observed in specification at the points tested.

**Calibration Due**
Based on the customer's request, the next calibration is due on 13 Apr 2024

**Remarks or Special Requirements**

This calibration report shall not be reproduced, except in full. The documented results relate to the equipment calibrated only.

The test limits stated in the report correspond to the published specifications of the equipment, at the points tested.

Keysight Technologies, Inc.
1346 Yellowwood Road
Kimballton, IA 51543
United States

Brandt Langer Iowa Service Center Manager

# Certificate of Calibration

**ISO/IEC 17025:2017 and ANSI/NCSL Z540.1-1994**

**Certificate Number 220411-085519-f52052**

## Traceability Information

**Technician Name** Dave Grabill

Measurements are traceable to the International System of Units (SI) via national metrology institutes (www.keysight.com/find/NMI) that are signatories to the CIPM Mutual Recognition Arrangement.

## Calibration Equipment Used

| Manufacturer | Model Number | Model Description | Equipment ID | Cal Due Date | Certificate Number |
|---|---|---|---|---|---|
| Agilent Technologies, Inc. | 33250A | Function/Arbitrary Waveform Generator | 11101 | 06/03/2022 | 210602-130008-794ded |
| AR | 350AH1 | Amp | 11453 | NA | NA |
| Crown | 5002VZ | Amp | 11069 | NA | NA |
| EMCO | 5101 | TEM Cell | 10420 | NA | 2003121920 |
| Hewlett-Packard | 8564E | Spectrum Analyzer | 10029 | 06/02/2022 | 210527-143459-612042 |
| Combinova | FD1 | Field Detector | 10348 | 01/31/2023 | 220104-091355-ad0560 |
| Combinova | FD2 | Field Detector | 10347 | 02/28/2023 | 220201-110452-66d607 |
| Schwarzbeck Mess-Elektronik | FESP 5133-7/41 | Loop | 11285 | 10/31/2022 | 211018-135220-351697 |
| Schwarzbeck Mess-Elektronik | HHS 5204-12 | Helmholtz Coil | 11091 | NA | NA |
| Holaday | HI-3624 | ELF Magnetic Field Meter | 10569 | 09/30/2022 | 210901-094617-c4f116 |
| Holaday | HI-3627 | ELF Magnetic Field Meter | 10570 | 03/31/2023 | 220309-140426-5aaae9 |

## Compliance with Specification

Unless otherwise noted, the calibration results are reported without factoring in the effect of uncertainty on the assessment of compliance/specification.

### In Specification/Out of Specification Explanation

The standard criteria to determine the "In Specification/Out of Specification" status is based on one or more of the following conditions, as requested by the client:

1. If the manufacturer has a specified specification for the item being calibrated, then the calibration values are compared to this specification, and the values must fall within the manufacturer's specification. The specification may be obtained from the manufacturer's web site, data sheets, equipment manuals, etc.
2. Where specifications are called out in a published standard, the calibration results are compared to this specification, and the measured values must fall within the standard's specification.
3. In cases where the manufacturer, standard, or client does not identify any relevant specifications, applicable calibration results are compared to historical data with a +/- 3 dB specification.

## Uncertainty of Measurement

The uncertainty evaluation has been performed in accordance with ISO/IEC Guide 98-3:2008(GUM). The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k such that the coverage probability corresponds to approximately 95%. This probability corresponds to a coverage factor of k=2 for a normal distribution.

| Parameter | Range | MU (+/-) |
|---|---|---|
| Magnetic Field Strength Meters - AC | 0.20 mG to 20 G | 0.33% + 1.2 mG |

Customer Name: RF Exposure Lab, LLC
Probe Manufacturer: Wavecontrol
Probe Model: WP400-3; SMP2
Probe Serial No.: 19WP120054; 19SN1179
Notes:
CAL CERT #: 220411-085519-f52052

Electric Field

Linearity - 50Hz

| E Field (V/m) | X axis CF | X axis dB | Y axis CF | Y axis dB | Z axis CF | Z axis dB | Mean CF |
|---|---|---|---|---|---|---|---|
| 800 | 1.05 | 0.41 | 1.04 | 0.34 | 1.04 | 0.35 | 1.04 |
| 750 | 1.04 | 0.32 | 1.04 | 0.33 | 1.03 | 0.27 | 1.04 |
| 500 | 1.04 | 0.30 | 1.03 | 0.22 | 1.02 | 0.18 | 1.03 |
| 250 | 1.04 | 0.32 | 1.04 | 0.35 | 1.04 | 0.32 | 1.04 |
| 100 | 1.01 | 0.09 | 1.03 | 0.29 | 0.99 | -0.05 | 1.01 |
| 50 | 1.03 | 0.22 | 1.03 | 0.30 | 1.03 | 0.23 | 1.03 |
| 20 | 1.01 | 0.05 | 1.04 | 0.32 | 1.04 | 0.31 | 1.03 |

Frequency Response

25Hz-100kHz: 750V/m / 10Hz, 200-400kHz: 300V/m

| Freq Hz | X axis CF | X axis dB | Y axis CF | Y axis dB | Z axis CF | Z axis dB | Mean CF |
|---|---|---|---|---|---|---|---|
| 10 | 1.31 | 2.37 | 1.30 | 2.31 | 1.31 | 2.37 | 1.31 |
| 25 | 1.14 | 1.16 | 1.16 | 1.26 | 1.15 | 1.23 | 1.15 |
| 50 | 1.06 | 0.54 | 1.07 | 0.56 | 1.07 | 0.61 | 1.07 |
| 100 | 1.09 | 0.77 | 1.09 | 0.77 | 1.10 | 0.83 | 1.10 |
| 500 | 1.10 | 0.82 | 1.09 | 0.72 | 1.10 | 0.81 | 1.09 |
| 1000 | 1.10 | 0.82 | 1.09 | 0.71 | 1.10 | 0.83 | 1.10 |
| 2000 | 1.18 | 1.44 | 1.17 | 1.33 | 1.17 | 1.39 | 1.17 |
| 10000 | 1.07 | 0.57 | 1.05 | 0.45 | 1.07 | 0.57 | 1.06 |
| 100000 | 1.07 | 0.56 | 1.06 | 0.50 | 1.06 | 0.48 | 1.06 |
| 200000 | 1.00 | 0.04 | 1.00 | 0.03 | 1.00 | 0.02 | 1.00 |
| 300000 | 1.05 | 0.44 | 1.05 | 0.46 | 1.05 | 0.43 | 1.05 |
| 400000 | 1.06 | 0.51 | 1.03 | 0.27 | 1.06 | 0.48 | 1.05 |

Customer Name: RF Exposure Lab, LLC
Probe Manufacturer: Wavecontrol
Probe Model: WP400-3; SMP2
Probe Serial No.: 19WP120054; 19SN1179
Notes:
CAL CERT #: 220411-085519-f52052

Magnetic Field

Linearity - 50Hz

| B Field (uT) | X axis CF | X axis dB | Y axis CF | Y axis dB | Z axis CF | Z axis dB | Mean CF |
|---|---|---|---|---|---|---|---|
| 2000 | 1.00 | 0.02 | 1.00 | 0.00 | 1.00 | 0.00 | 1.00 |
| 1500 | 0.97 | -0.26 | 0.96 | -0.33 | 0.96 | -0.36 | 0.96 |
| 1000 | 0.97 | -0.26 | 0.97 | -0.23 | 0.97 | -0.28 | 0.97 |
| 750 | 0.96 | -0.37 | 0.96 | -0.35 | 0.95 | -0.40 | 0.96 |
| 500 | 0.96 | -0.35 | 0.96 | -0.32 | 0.96 | -0.37 | 0.96 |
| 250 | 0.97 | -0.30 | 0.97 | -0.24 | 0.97 | -0.29 | 0.97 |
| 100 | 0.95 | -0.41 | 0.96 | -0.35 | 0.95 | -0.41 | 0.96 |
| 50 | 0.97 | -0.30 | 0.97 | -0.23 | 0.97 | -0.28 | 0.97 |
| 10 | 0.97 | -0.25 | 0.98 | -0.18 | 0.98 | -0.22 | 0.98 |
| 5 | 0.98 | -0.20 | 0.98 | -0.15 | 0.98 | -0.19 | 0.98 |

Frequency Response

10Hz-2kHz: 100uT / 10-200kHz: 25uT

| Freq Hz | X axis CF | X axis dB | Y axis CF | Y axis dB | Z axis CF | Z axis dB | Mean CF |
|---|---|---|---|---|---|---|---|
| 10 | 0.93 | -0.67 | 0.93 | -0.65 | 0.93 | -0.63 | 0.93 |
| 30 | 1.02 | 0.15 | 1.02 | 0.17 | 1.02 | 0.19 | 1.02 |
| 50 | 0.95 | -0.46 | 0.95 | -0.44 | 0.95 | -0.43 | 0.95 |
| 100 | 0.98 | -0.17 | 0.98 | -0.15 | 0.98 | -0.14 | 0.98 |
| 500 | 1.01 | 0.08 | 1.01 | 0.12 | 1.02 | 0.13 | 1.01 |
| 1000 | 0.95 | -0.43 | 0.96 | -0.38 | 0.96 | -0.38 | 0.96 |
| 2000 | 0.94 | -0.52 | 0.95 | -0.49 | 0.95 | -0.49 | 0.94 |
| 10000 | 0.88 | -1.09 | 0.88 | -1.14 | 0.88 | -1.12 | 0.88 |
| 100000 | 0.87 | -1.16 | 0.87 | -1.25 | 0.87 | -1.26 | 0.87 |
| 200000 | 0.88 | -1.16 | 0.86 | -1.30 | 0.86 | -1.28 | 0.87 |

# Certificate of Calibration

**ISO/IEC 17025:2017 and ANSI/NCSL Z540.1-1994**

**Certificate Number 220411-083319-8bcddc**

| | |
|---|---|
| **Model Number** | WPF6; SMP2 |
| **Manufacturer** | Wavecontrol |
| **Description** | Field Probe |
| **Serial Number** | 19WP060233; 19SN1179 |
| **Customer Asset No.** | N/A |

**Customer**
RF Exposure Lab, LLC
802 N. Twin Oaks Valley Rd
Suite 105
San Marcos, CA 92069
USA

| | |
|---|---|
| **Date of Calibration** | 04/13/2022 |
| **Temperature** | 23°C |
| **Humidity** | 48% RH |

**Location of Calibration**
Keysight Technologies Inc.
1346 Yellowwood Road
Kimballton, IA 51543
United States

This certifies that the equipment has been calibrated using applicable Keysight Technologies procedures and in compliance with ISO/IEC 17025:2017 and ANSI/NCSL Z540.1-1994 (R2002). The quality management system is registered to ISO 9001:2015.

**Calibration Standard(s)**
IEEE Std 1309-2013 Section 4.1
IEEE Std 1309-2013 Section 5
IEEE Std 1309-2013 Section 8.2
IEEE Std 1309-2013 Section Annex A
IEEE Std 1309-2013 Section A.3

**Calibration Method(s)**
Substitution

**Calibration Procedure(s)**
287330

**Calibration Software**
Isotropy 1.0
Probe Comparison 1.4.1

**As Received Conditions**
The measured values of the equipment were observed in specification at the points tested.

**Action Taken**
No action was taken.

**As Completed Conditions**
The measured values of the equipment were observed in specification at the points tested.

**Calibration Due**
Based on the customer's request, the next calibration is due on 13 Apr 2024

**Remarks or Special Requirements**
A probe position document is included with this certificate. This calibration is valid only for the alignment/mounting position specified in this report.
Calibrated with Keysight Technologies' monitor and fiberoptic cable.

Keysight Technologies, Inc.
1346 Yellowwood Road
Kimballton, IA 51543
United States

Brandt Langer Iowa Service Center Manager

# Certificate of Calibration

**ISO/IEC 17025:2017 and ANSI/NCSL Z540.1-1994**

**Certificate Number 220411-083319-8bcddc**

This calibration report shall not be reproduced, except in full. The documented results relate to the equipment calibrated only.

The test limits stated in the report correspond to the published specifications of the equipment, at the points tested.

## Traceability Information

**Technician Name** Dave Grabill

Measurements are traceable to the International System of Units (SI) via national metrology institutes (www.keysight.com/find/NMI) that are signatories to the CIPM Mutual Recognition Arrangement.

### Calibration Equipment Used

| Manufacturer | Model Number | Model Description | Equipment ID | Cal Due Date | Certificate Number |
|---|---|---|---|---|---|
| AR | 15T4G18 | Amp | 10888 | NA | NA |
| Amplifier Research | 250W1000A | Amp | 11327 | NA | NA |
| AR | 500A100A | Amp | 10982 | NA | NA |
| EMCO | 5405 | GTEM | 10437 | 07/14/2022 | 200710-081647-4c6186 |
| AR | 75A220 | Amp | 11547 | 05/04/2022 | 210504-101836-230650 |
| AR | 80S1G4 | Amp | 11728 | NA | |
| Hewlett-Packard | 83640L | Signal Generator | 10039 | 11/30/2022 | 211109-082156-7fd7e6 |
| Agilent Technologies, Inc. | 8648D | Signal Generator | 11028 | 01/31/2023 | 220104-092226-e520b9 |
| Schwarzbeck Mess-Elektronik | BBHA 9120D | Horn | 10194 | 11/17/2022 | 201111-115541-0b3b6c |
| AR | DC3510A | Dual Directional Coupler | 10460 | 04/30/2023 | 220329-080254-362ae1 |
| AR | FI7000 | Interface | 11015 | NA | 700516 |
| AR | FL7006 | Isotropic Probe | 10946 | 12/08/2022 | 2021050080-1 |
| Mike Howard | MH-1 | TEM Cell | 10479 | NA | NA |

## Compliance with Specification

Unless otherwise noted, the calibration results are reported without factoring in the effect of uncertainty on the assessment of compliance/specification.

**In Specification/Out of Specification Explanation**

The standard criteria to determine the "In Specification/Out of Specification" status is based on one or more of the following conditions, as requested by the client:

1. If the manufacturer has a specified specification for the item being calibrated, then the calibration values are compared to this specification, and the values must fall within the manufacturer's specification. The specification may be obtained from the manufacturer's web site, data sheets, equipment manuals, etc.
2. Where specifications are called out in a published standard, the calibration results are compared to this specification, and the measured values must fall within the standard's specification.
3. In cases where the manufacturer, standard, or client does not identify any relevant specifications, applicable calibration results are compared to historical data with a +/- 3 dB specification.

## Uncertainty of Measurement

The uncertainty evaluation has been performed in accordance with ISO/IEC Guide 98-3:2008(GUM). The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k such that the coverage probability corresponds to approximately 95%. This probability corresponds to a coverage factor of k=2 for a normal distribution.

| Parameter | Range | MU (+/-) |
|---|---|---|
| RF Laser E-Field Probes - GTEM Cell - Frequency Response | 10 kHz to 1000 MHz | 0.81 dB |
| RF Isotropic E-Field Probes - TEM Cell - Frequency Response | 5 kHz to 800 MHz | 0.91 dB |
| RF Isotropic E-Field Probes - Anechoic Chamber - Frequency Response | (450 to 18,000) MHz | 1.1 dB |
| RF Isotropic E-Field Probes - TEM Cell - Linearity | 5 kHz to 800 MHz | 0.91 dB |

Customer Name: RF Exposure Lab, LLC
Probe Manufacturer: Wavecontrol
Probe Model: WPF6; SMP2
Probe Serial No.: 19WP060233; 19SN1179
Notes:
CAL CERT #: 220411-083319-8bcddc

Correction Factors

10V/m Actual Field

| Freq | X Axis | | Y Axis | | Z Axis | |
|---|---|---|---|---|---|---|
| in MHz | Mult | dB | Mult | dB | Mult | dB |
| 0.1 | 1.92 | 5.69 | 1.72 | 4.70 | 1.71 | 4.66 |
| 0.3 | 1.20 | 1.58 | 1.23 | 1.83 | 1.23 | 1.81 |
| 0.5 | 1.04 | 0.31 | 1.06 | 0.54 | 1.05 | 0.40 |
| 1 | 1.02 | 0.20 | 1.04 | 0.37 | 1.02 | 0.14 |
| 10 | 1.06 | 0.47 | 1.07 | 0.59 | 1.03 | 0.29 |
| 30 | 1.05 | 0.44 | 1.07 | 0.56 | 1.03 | 0.26 |
| 100 | 1.04 | 0.32 | 1.05 | 0.42 | 1.01 | 0.12 |
| 200 | 1.14 | 1.10 | 1.18 | 1.46 | 1.20 | 1.58 |
| 400 | 1.04 | 0.32 | 1.02 | 0.19 | 1.03 | 0.24 |
| 600 | 0.87 | -1.22 | 0.84 | -1.50 | 0.81 | -1.82 |
| 700 | 1.05 | 0.40 | 1.07 | 0.61 | 1.12 | 1.02 |
| 800 | 1.07 | 0.59 | 1.07 | 0.56 | 1.11 | 0.89 |
| 1000 | 1.03 | 0.22 | 1.00 | -0.03 | 1.05 | 0.40 |
| 1200 | 0.97 | -0.25 | 1.01 | 0.07 | 1.00 | -0.04 |
| 1400 | 0.99 | -0.07 | 0.97 | -0.28 | 0.93 | -0.63 |
| 1600 | 0.93 | -0.66 | 0.90 | -0.93 | 0.84 | -1.55 |
| 1800 | 0.94 | -0.54 | 0.97 | -0.27 | 0.95 | -0.45 |
| 2000 | 0.99 | -0.08 | 1.01 | 0.06 | 0.95 | -0.42 |
| 2200 | 1.02 | 0.21 | 1.00 | 0.02 | 0.92 | -0.73 |
| 2400 | 0.96 | -0.34 | 1.02 | 0.18 | 0.96 | -0.38 |
| 2600 | 0.98 | -0.18 | 1.06 | 0.50 | 0.98 | -0.17 |
| 2800 | 0.89 | -0.99 | 0.86 | -1.36 | 0.80 | -1.98 |
| 3000 | 0.86 | -1.26 | 0.88 | -1.16 | 0.83 | -1.60 |
| 3200 | 0.88 | -1.09 | 0.87 | -1.20 | 0.83 | -1.60 |
| 3400 | 0.83 | -1.67 | 0.77 | -2.22 | 0.73 | -2.74 |
| 3600 | 0.81 | -1.88 | 0.75 | -2.53 | 0.72 | -2.84 |
| 3800 | 0.77 | -2.30 | 0.78 | -2.14 | 0.77 | -2.32 |
| 4000 | 0.99 | -0.09 | 0.93 | -0.67 | 0.91 | -0.81 |
| 4250 | 0.95 | -0.48 | 1.09 | 0.77 | 1.00 | -0.01 |
| 4500 | 1.14 | 1.10 | 1.12 | 1.00 | 1.11 | 0.88 |
| 4750 | 0.85 | -1.46 | 0.79 | -2.07 | 0.79 | -2.09 |
| 5000 | 1.14 | 1.12 | 0.96 | -0.35 | 0.93 | -0.59 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 5250 | 0.98 | -0.21 | 0.92 | -0.73 | 0.91 | -0.78 |
| 5500 | 0.92 | -0.75 | 1.02 | 0.15 | 0.93 | -0.66 |
| 5750 | 1.03 | 0.29 | 1.07 | 0.58 | 1.10 | 0.85 |
| 6000 | 0.84 | -1.47 | 0.83 | -1.59 | 0.83 | -1.64 |

Customer Name: RF Exposure Lab, LLC
Probe Manufacturer: Wavecontrol
Probe Model: WPF6; SMP2
Probe Serial No.: 19WP060233; 19SN1179
Notes:
CAL CERT #: 220411-083319-8bcddc

Linearity

| Freq | Applied Field | X Axis | | Y Axis | | Z Axis | |
|---|---|---|---|---|---|---|---|
| MHz | V/m | Mult | dB | Mult | dB | Mult | dB |
| 100 | 1.0 | 1.10 | 0.81 | 1.07 | 0.55 | 1.10 | 0.79 |
| 100 | 2.5 | 1.07 | 0.59 | 1.07 | 0.59 | 1.03 | 0.23 |
| 100 | 5.0 | 1.05 | 0.39 | 1.05 | 0.46 | 1.01 | 0.11 |
| 100 | 10.0 | 1.05 | 0.39 | 1.06 | 0.48 | 1.02 | 0.18 |
| 100 | 20.0 | 1.05 | 0.44 | 1.06 | 0.52 | 1.05 | 0.46 |
| 100 | 30.0 | 1.08 | 0.70 | 1.10 | 0.79 | 1.09 | 0.73 |
| 100 | 40.0 | 1.07 | 0.61 | 1.09 | 0.71 | 1.08 | 0.64 |
| 100 | 50.0 | 1.08 | 0.66 | 1.09 | 0.73 | 1.08 | 0.68 |
| 100 | 60.0 | 1.09 | 0.77 | 1.10 | 0.86 | 1.10 | 0.80 |
| 100 | 80.0 | 1.10 | 0.84 | 1.11 | 0.93 | 1.11 | 0.87 |
| 100 | 100.0 | 1.09 | 0.78 | 1.11 | 0.88 | 1.10 | 0.81 |

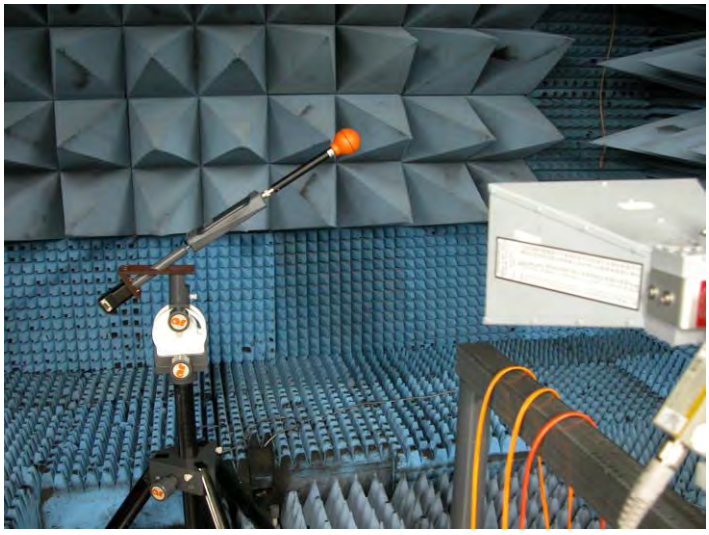
# Probe Alignment/Mounting Position

**TEM Cell & GTEM Cell**

Probe was calibrated at the Critical Angle (35.3°) position

**Chamber**

Probe was calibrated at the Critical Angle (35.3°) position,
Parallel to Source, 1meter separation distance.



# Certificate of Calibration

**ISO/IEC 17025:2017 and ANSI/NCSL Z540.1-1994**

**Certificate Number 220411-090352-04e850**

| | |
|---|---|
| **Model Number** | WPH60; SMP2 |
| **Manufacturer** | Wavecontrol |
| **Description** | Field Probe |
| **Serial Number** | 19WP110048; 19SN1179 |
| **Customer Asset No.** | N/A |

**Customer**
RF Exposure Lab, LLC
802 N. Twin Oaks Valley Rd
Suite 105
San Marcos, CA 92069
USA

| | |
|---|---|
| **Date of Calibration** | 04/13/2022 |
| **Temperature** | 23°C |
| **Humidity** | 48% RH |

**Location of Calibration**
Keysight Technologies Inc.
1346 Yellowwood Road
Kimballton, IA 51543
United States

This certifies that the equipment has been calibrated using applicable Keysight Technologies procedures and in compliance with ISO/IEC 17025:2017 and ANSI/NCSL Z540.1-1994 (R2002). The quality management system is registered to ISO 9001:2015.

**Calibration Standard(s)**
IEEE Std 1309-2013 Section 4.1
IEEE Std 1309-2013 Section 5
IEEE Std 1309-2013 Section 8.2
IEEE Std 1309-2013 Section Annex A
IEEE Std 1309-2013 Section A.3

**Calibration Method(s)**
Substitution

**Calibration Procedure(s)**
287330

**Calibration Software**
Isotropy 1.0
Probe Comparison 1.4.1

**As Received Conditions**
The measured values of the equipment were observed in specification at the points tested.

**Action Taken**
No action was taken.

**As Completed Conditions**
The measured values of the equipment were observed in specification at the points tested.

**Calibration Due**
Based on the customer's request, the next calibration is due on 13 Apr 2024

**Remarks or Special Requirements**
A probe position document is included with this certificate. This calibration is valid only for the alignment/mounting position specified in this report.
Calibrated with Keysight Technologies' monitor and fiberoptic cable.

Keysight Technologies, Inc.
1346 Yellowwood Road
Kimballton, IA 51543
United States

Brandt Langer Iowa Service Center Manager

# Certificate of Calibration

**ISO/IEC 17025:2017 and ANSI/NCSL Z540.1-1994**

**Certificate Number 220411-090352-04e850**

ACCREDITED ISO/IEC 17025 CALIBRATION LABORATORY AC-1498.20

This calibration report shall not be reproduced, except in full. The documented results relate to the equipment calibrated only.

The test limits stated in the report correspond to the published specifications of the equipment, at the points tested.

## Traceability Information

**Technician Name** Dave Grabill

Measurements are traceable to the International System of Units (SI) via national metrology institutes (www.keysight.com/find/NMI) that are signatories to the CIPM Mutual Recognition Arrangement.

### Calibration Equipment Used

| Manufacturer | Model Number | Model Description | Equipment ID | Cal Due Date | Certificate Number |
|---|---|---|---|---|---|
| AR | 600A400 | Amplifier, 10KHz-400 MHz, 600W | 624658 | NA | |
| Agilent Technologies, Inc. | 8648D | Signal Generator | 11028 | 01/31/2023 | 220104-092226-e520b9 |
| AR | DC3510A | Dual Directional Coupler | 10460 | 04/30/2023 | 220329-080254-362ae1 |
| AR | FI7000 | Interface | 11015 | NA | 700516 |
| AR | FL7006 | Isotropic Probe | 10946 | 12/08/2022 | 2021050080-1 |
| Mike Howard | MH-1 | TEM Cell | 10479 | NA | NA |

## Compliance with Specification

Unless otherwise noted, the calibration results are reported without factoring in the effect of uncertainty on the assessment of compliance/specification.

**In Specification/Out of Specification Explanation**

The standard criteria to determine the "In Specification/Out of Specification" status is based on one or more of the following conditions, as requested by the client:

1. If the manufacturer has a specified specification for the item being calibrated, then the calibration values are compared to this specification, and the values must fall within the manufacturer's specification. The specification may be obtained from the manufacturer's web site, data sheets, equipment manuals, etc.
2. Where specifications are called out in a published standard, the calibration results are compared to this specification, and the measured values must fall within the standard's specification.
3. In cases where the manufacturer, standard, or client does not identify any relevant specifications, applicable calibration results are compared to historical data with a +/- 3 dB specification.

## Uncertainty of Measurement

The uncertainty evaluation has been performed in accordance with ISO/IEC Guide 98-3:2008(GUM). The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k such that the coverage probability corresponds to approximately 95%. This probability corresponds to a coverage factor of k=2 for a normal distribution.

| Parameter | Range | MU (+/-) |
|---|---|---|
| RF Isotropic E-Field Probes - TEM Cell - Frequency Response | 5 kHz to 800 MHz | 0.91 dB |
| RF Isotropic E-Field Probes - TEM Cell - Linearity | 5 kHz to 800 MHz | 0.91 dB |

Customer Name: RF Exposure Lab, LLC
Probe Manufacturer: Wavecontrol
Probe Model: WPH60; SMP2
Probe Serial No.: 19WP110048; 19SN1179
Notes:
CAL CERT #: 220411-090352-04e850

Linearity

| Freq | H field | X Axis | | Y Axis | | Z Axis | | Mean |
|---|---|---|---|---|---|---|---|---|
| MHz | A/m | Mult | dB | Mult | dB | Mult | dB | CF |
| 2 | 0.03 | 0.98 | -0.16 | 0.94 | -0.54 | 0.98 | -0.19 | 0.97 |
| 2 | 0.05 | 1.00 | 0.01 | 0.95 | -0.43 | 1.01 | 0.05 | 0.99 |
| 2 | 0.10 | 1.02 | 0.14 | 0.96 | -0.32 | 1.02 | 0.17 | 1.00 |
| 2 | 0.20 | 1.02 | 0.21 | 0.97 | -0.23 | 1.03 | 0.24 | 1.01 |
| 2 | 0.30 | 1.05 | 0.42 | 1.00 | -0.03 | 1.05 | 0.45 | 1.03 |
| 2 | 0.40 | 1.08 | 0.65 | 1.02 | 0.20 | 1.08 | 0.67 | 1.06 |
| 2 | 0.50 | 1.08 | 0.64 | 1.03 | 0.23 | 1.08 | 0.67 | 1.06 |
| 2 | 0.70 | 1.09 | 0.75 | 1.04 | 0.30 | 1.09 | 0.79 | 1.07 |
| 2 | 1.00 | 1.03 | 0.30 | 0.94 | -0.53 | 1.04 | 0.34 | 1.01 |

# Probe Alignment/Mounting Position

**TEM Cell**

Probe was calibrated at the Critical Angle (35.3°) position

Customer Name: RF Exposure Lab, LLC
Probe Manufacturer: Wavecontrol
Probe Model: WPH60; SMP2
Probe Serial No.: 19WP110048; 19SN1179
Notes:
CAL CERT #: 220411-090352-04e850

Frequency Response - 0.265 A/m

| Freq | X Axis | | Y Axis | | Z Axis | | Mean |
|---|---|---|---|---|---|---|---|
| in MHz | Mult | dB | Mult | dB | Mult | dB | CF |
| 0.3 | 1.43 | 3.10 | 1.36 | 2.68 | 1.44 | 3.16 | 1.41 |
| 0.4 | 1.17 | 1.36 | 1.12 | 0.96 | 1.18 | 1.46 | 1.16 |
| 0.5 | 1.07 | 0.59 | 1.02 | 0.17 | 1.08 | 0.67 | 1.06 |
| 0.6 | 1.04 | 0.35 | 0.99 | -0.06 | 1.05 | 0.42 | 1.03 |
| 0.7 | 1.04 | 0.30 | 0.99 | -0.12 | 1.04 | 0.31 | 1.02 |
| 0.8 | 1.03 | 0.22 | 0.98 | -0.19 | 1.03 | 0.24 | 1.01 |
| 1 | 1.03 | 0.29 | 0.98 | -0.14 | 1.04 | 0.31 | 1.02 |
| 2 | 1.05 | 0.42 | 1.00 | -0.03 | 1.05 | 0.45 | 1.03 |
| 5 | 1.06 | 0.49 | 1.01 | 0.05 | 1.06 | 0.52 | 1.04 |
| 10 | 1.05 | 0.46 | 1.00 | 0.04 | 1.06 | 0.49 | 1.04 |
| 15 | 1.07 | 0.62 | 1.02 | 0.16 | 1.08 | 0.68 | 1.06 |
| 20 | 1.10 | 0.79 | 1.05 | 0.46 | 1.10 | 0.83 | 1.08 |
| 23 | 1.11 | 0.91 | 1.06 | 0.51 | 1.12 | 0.95 | 1.10 |
| 25 | 1.12 | 0.97 | 1.07 | 0.56 | 1.12 | 1.02 | 1.10 |
| 28 | 1.14 | 1.10 | 1.09 | 0.78 | 1.14 | 1.12 | 1.12 |
| 30 | 1.14 | 1.17 | 1.10 | 0.86 | 1.15 | 1.20 | 1.13 |
| 35 | 1.17 | 1.37 | 1.12 | 0.98 | 1.17 | 1.38 | 1.15 |
| 40 | 1.20 | 1.60 | 1.17 | 1.35 | 1.20 | 1.61 | 1.19 |
| 50 | 1.24 | 1.90 | 1.19 | 1.54 | 1.23 | 1.81 | 1.22 |
| 60 | 1.26 | 2.02 | 1.19 | 1.53 | 1.23 | 1.77 | 1.23 |