

**HAC RF E-Field GSM 1900 Middle****Date: 2018-10-12**

Electronics: DAE4 Sn1555

Medium: Air

Medium parameters used:  $\sigma = 0$  mho/m,  $\epsilon_r = 1$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature: 22.0°C

Communication System: DCS 1900; Frequency: 1880 MHz; Duty Cycle: 1:8.3

Probe: ER3DV3 - SN4060;ConvF(1, 1, 1)

**E Scan - ER3DV6 - 2011: 15 mm from Probe Center to the Device 2/Hearing Aid****Compatibility Test (101x101x1):** Interpolated grid: dx=0.5000 mm, dy=0.5000 mm

Device Reference Point: 0, 0, -6.3 mm

Reference Value = 18.21 V/m; Power Drift = 0.10 dB

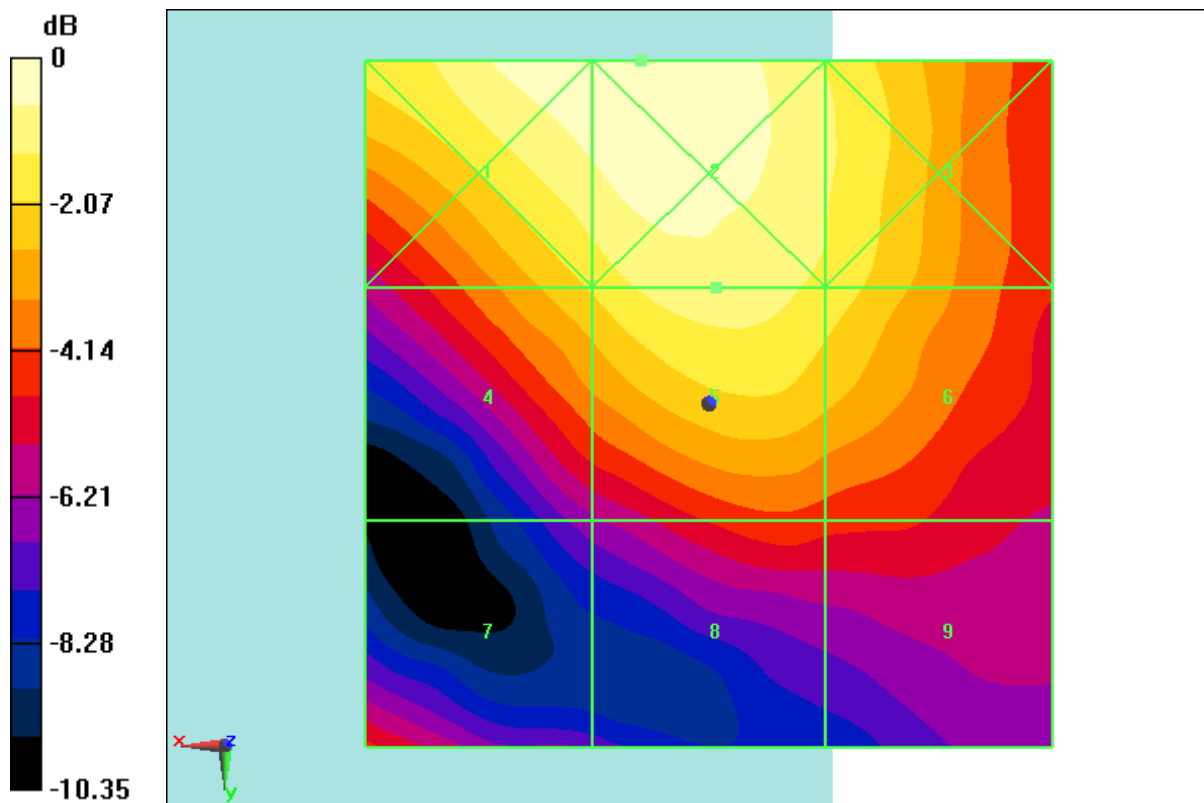
Applied MIF = 3.33 dB

RF audio interference level = 28.04 dBV/m

**Emission category: M4**

MIF scaled E-field

|                                        |                                        |                                        |
|----------------------------------------|----------------------------------------|----------------------------------------|
| <b>Grid 1 M4</b><br><b>28.84 dBV/m</b> | <b>Grid 2 M4</b><br><b>29.04 dBV/m</b> | <b>Grid 3 M4</b><br><b>27.8 dBV/m</b>  |
| <b>Grid 4 M4</b><br><b>27.08 dBV/m</b> | <b>Grid 5 M4</b><br><b>28.04 dBV/m</b> | <b>Grid 6 M4</b><br><b>27.44 dBV/m</b> |
| <b>Grid 7 M4</b><br><b>24.49 dBV/m</b> | <b>Grid 8 M4</b><br><b>24.77 dBV/m</b> | <b>Grid 9 M4</b><br><b>24.54 dBV/m</b> |



0 dB = 28.32 V/m = 29.04 dBV/m

**Fig B.5 HAC RF E-Field GSM 1900 Middle**

**HAC RF E-Field GSM 1900 Low****Date: 2018-10-12**

Electronics: DAE4 Sn1555

Medium: Air

Medium parameters used:  $\sigma = 0$  mho/m,  $\epsilon_r = 1$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature: 22.0°C

Communication System: DCS 1900; Frequency: 1850.2 MHz; Duty Cycle: 1:8.3

Probe: ER3DV3 - SN4060;ConvF(1, 1, 1)

**E Scan - ER3DV6 - 2011: 15 mm from Probe Center to the Device 3/Hearing Aid****Compatibility Test (101x101x1):** Interpolated grid: dx=0.5000 mm, dy=0.5000 mm

Device Reference Point: 0, 0, -6.3 mm

Reference Value = 19.67 V/m; Power Drift = -0.06 dB

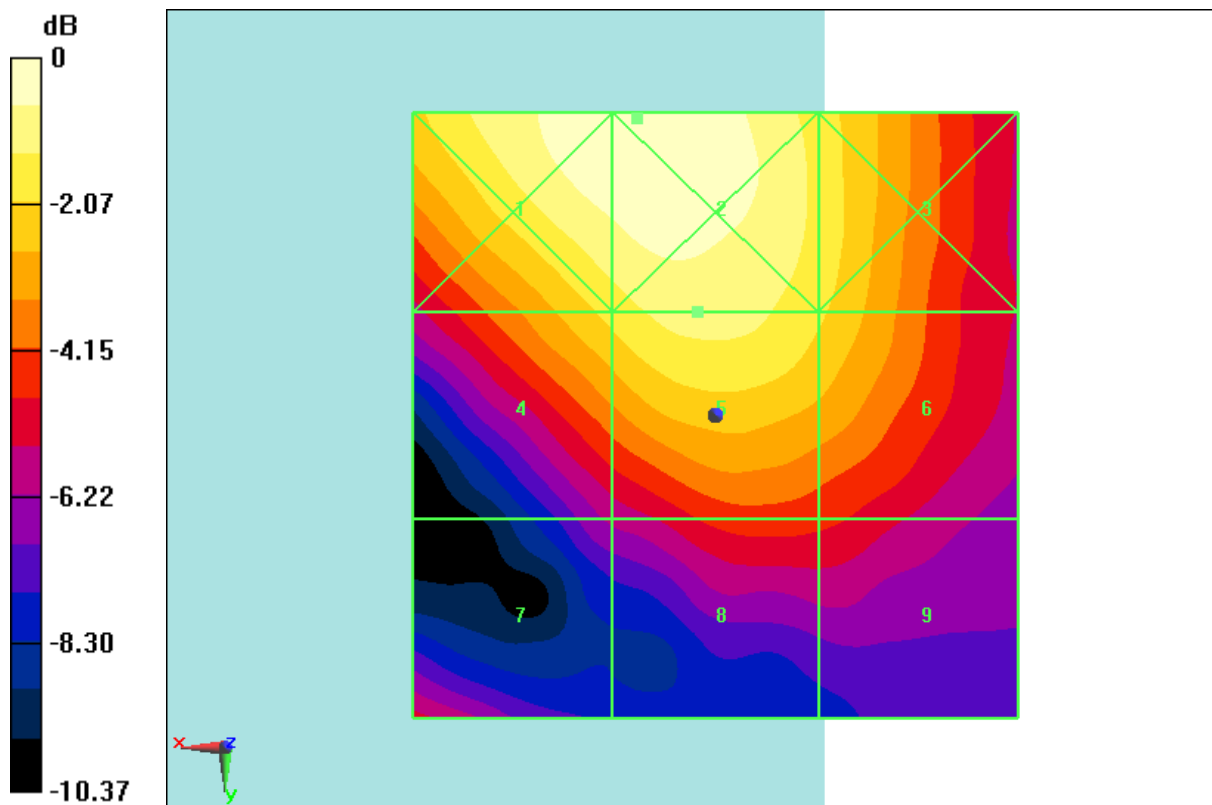
Applied MIF = 3.45 dB

RF audio interference level = 28.72 dBV/m

**Emission category: M4**

MIF scaled E-field

|                                        |                                        |                                        |
|----------------------------------------|----------------------------------------|----------------------------------------|
| <b>Grid 1 M4</b><br><b>29.81 dBV/m</b> | <b>Grid 2 M4</b><br><b>29.84 dBV/m</b> | <b>Grid 3 M4</b><br><b>28.27 dBV/m</b> |
| <b>Grid 4 M4</b><br><b>28.04 dBV/m</b> | <b>Grid 5 M4</b><br><b>28.72 dBV/m</b> | <b>Grid 6 M4</b><br><b>27.91 dBV/m</b> |
| <b>Grid 7 M4</b><br><b>24.68 dBV/m</b> | <b>Grid 8 M4</b><br><b>25.43 dBV/m</b> | <b>Grid 9 M4</b><br><b>25.25 dBV/m</b> |



0 dB = 31.06 V/m = 29.84 dBV/m

**Fig B.6 HAC RF E-Field GSM 1900 Low**

## ANNEX C SYSTEM VALIDATION RESULT

### E SCAN of Dipole 835 MHz

Date: 2018-10-11

Electronics: DAE4 Sn1555

Medium: Air

Medium parameters used:  $\sigma = 0$  mho/m,  $\epsilon_r = 1$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Communication System: CW; Frequency: 835 MHz; Duty Cycle: 1:1

Probe: ER3DV3 - SN4060;ConvF(1, 1, 1)

**E Scan - measurement distance from the probe sensor center to CD835 Dipole = 15mm/Hearing Aid Compatibility Test (41x361x1):** Interpolated grid: dx=0.5000 mm, dy=0.5000 mm

Device Reference Point: 0, 0, -6.3 mm

Reference Value = 106.54 V/m; Power Drift = -0.03 dB

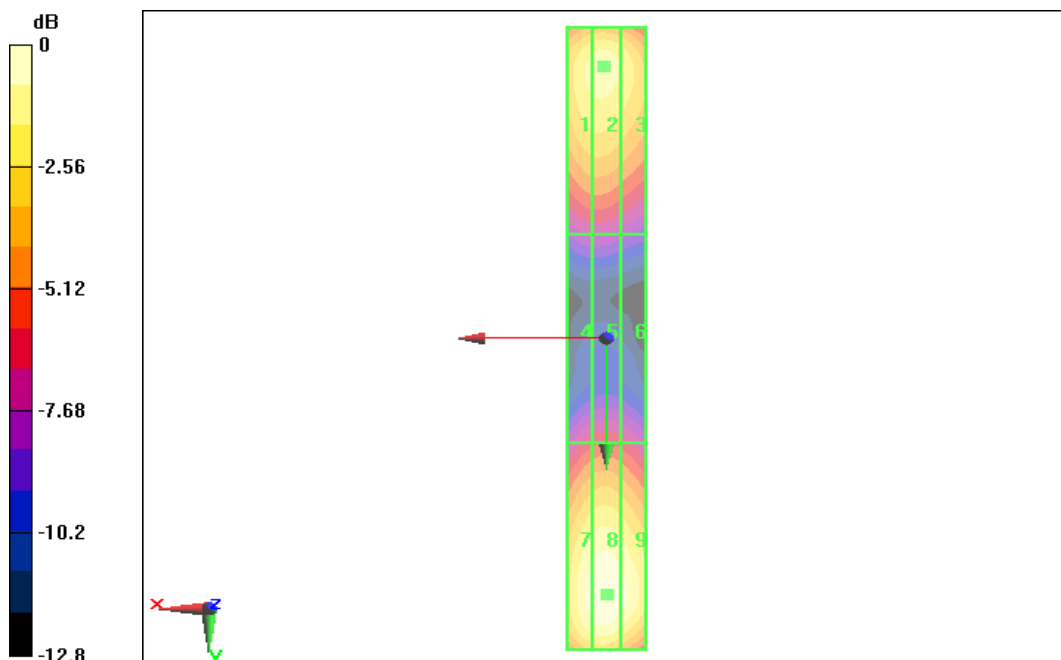
Applied MIF = 0.00 dB

RF audio interference level = 40.55 dBV/m

**Emission category: M3**

MIF scaled E-field

|                          |                          |                          |
|--------------------------|--------------------------|--------------------------|
| Grid 1M3<br>40.39 dBV/m  | Grid 2M3<br>40.51 dBV/m  | Grid 3M3<br>40.33 dBV/m  |
| Grid 4 M4<br>35.93 dBV/m | Grid 5 M4<br>36.04 dBV/m | Grid 6 M4<br>35.88 dBV/m |
| Grid 7 M3<br>40.34 dBV/m | Grid 8 M3<br>40.55 dBV/m | Grid 9 M3<br>40.46 dBV/m |



0 dB = 40.55 dBV/m

## E SCAN of Dipole 1880 MHz

**Date: 2018-10-12**

Electronics: DAE4 Sn1555

Medium: Air

Medium parameters used:  $\sigma = 0$  mho/m,  $\epsilon_r = 1$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Communication System: CW; Frequency: 1880 MHz; Duty Cycle: 1:1

Probe: ER3DV3 - SN4060;ConvF(1, 1, 1)

**E Scan - measurement distance from the probe sensor center to CD1880 Dipole = 15mm/Hearing Aid Compatibility Test (41x181x1):** Interpolated grid: dx=0.5000 mm, dy=0.5000 mm

Device Reference Point: 0, 0, -6.3 mm

Reference Value = 93.86 V/m; Power Drift = 0.02 dB

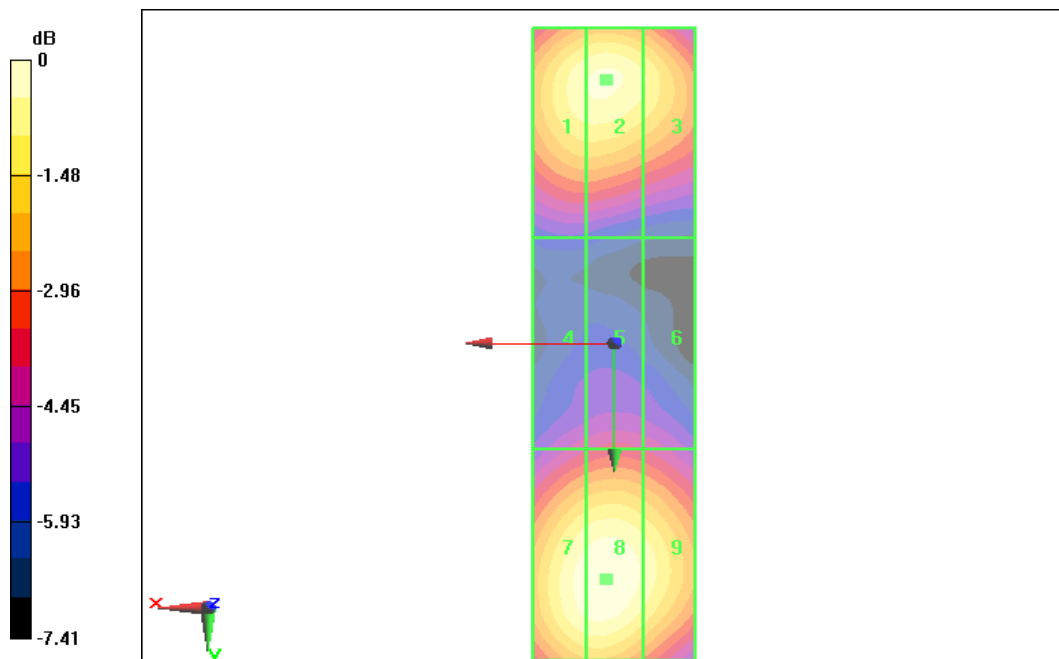
Applied MIF = 0.00 dB

RF audio interference level = 39.45 dBV/m

**Emission category: M2**

MIF scaled E-field

|                         |                         |                         |
|-------------------------|-------------------------|-------------------------|
| Grid 1M2<br>39.21 dBV/m | Grid 2M2<br>39.45 dBV/m | Grid 3M2<br>39.36 dBV/m |
| Grid 4M2<br>37.22 dBV/m | Grid 5M2<br>37.36 dBV/m | Grid 6M2<br>37.26 dBV/m |
| Grid 7M2<br>38.78 dBV/m | Grid 8M2<br>39.05dBV/m  | Grid 9M2<br>38.98 dBV/m |



0 dB = 39.45 dBV/m

## ANNEX D PROBE CALIBRATION CERTIFICATE

**Calibration Laboratory of**  
**Schmid & Partner**  
**Engineering AG**  
Zeughausstrasse 43, 8004 Zurich, Switzerland



**S** Schweizerischer Kalibrierdienst  
**C** Service suisse d'étalonnage  
**S** Servizio svizzero di taratura  
**S** Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS)  
The Swiss Accreditation Service is one of the signatories to the EA  
Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

Client **CTTL-BJ (Auden)**

Certificate No: **EF3-4060\_Jun18**

### CALIBRATION CERTIFICATE

Object **EF3DV3 - SN:4060**

Calibration procedure(s) **QA CAL-02.v8, QA CAL-25.v6**  
Calibration procedure for E-field probes optimized for close near field evaluations in air

Calibration date: **June 12, 2018**

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).  
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature ( $22 \pm 3$ )°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards          | ID               | Cal Date (Certificate No.)        | Scheduled Calibration  |
|----------------------------|------------------|-----------------------------------|------------------------|
| Power meter NRP            | SN: 104778       | 04-Apr-18 (No. 217-02672/02673)   | Apr-19                 |
| Power sensor NRP-Z91       | SN: 103244       | 04-Apr-18 (No. 217-02672)         | Apr-19                 |
| Power sensor NRP-Z91       | SN: 103245       | 04-Apr-18 (No. 217-02673)         | Apr-19                 |
| Reference 20 dB Attenuator | SN: S5277 (20x)  | 04-Apr-18 (No. 217-02682)         | Apr-19                 |
| Reference Probe ER3DV6     | SN: 2328         | 10-Oct-17 (No. ER3-2328_Oct17)    | Oct-18                 |
| DAE4                       | SN: 789          | 2-Aug-17 (No. DAE4-789_Aug17)     | Aug-18                 |
| Secondary Standards        | ID               | Check Date (in house)             | Scheduled Check        |
| Power meter E4419B         | SN: GB41293874   | 06-Apr-16 (in house check Jun-18) | In house check: Jun-20 |
| Power sensor E4412A        | SN: MY41498087   | 06-Apr-16 (in house check Jun-18) | In house check: Jun-20 |
| Power sensor E4412A        | SN: 000110210    | 06-Apr-16 (in house check Jun-18) | In house check: Jun-20 |
| RF generator HP 8648C      | SN: US3642U01700 | 04-Aug-99 (in house check Jun-18) | In house check: Jun-20 |
| Network Analyzer HP 8753E  | SN: US37390585   | 18-Oct-01 (in house check Oct-17) | In house check: Oct-18 |

|                       | Name          | Function              | Signature                                                                             |
|-----------------------|---------------|-----------------------|---------------------------------------------------------------------------------------|
| Calibrated by:        | Michael Weber | Laboratory Technician |  |
| Approved by:          | Katja Pokovic | Technical Manager     |  |
| Issued: June 12, 2018 |               |                       |                                                                                       |

This calibration certificate shall not be reproduced except in full without written approval of the laboratory.

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**Glossary:**

|                          |                                                                                                                                                         |
|--------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|
| NORM <sub>x,y,z</sub>    | sensitivity in free space                                                                                                                               |
| DCP                      | diode compression point                                                                                                                                 |
| CF                       | crest factor (1/duty_cycle) of the RF signal                                                                                                            |
| A, B, C, D               | modulation dependent linearization parameters                                                                                                           |
| Polarization $\phi$      | $\phi$ rotation around probe axis                                                                                                                       |
| Polarization $\vartheta$ | $\vartheta$ rotation around an axis that is in the plane normal to probe axis (at measurement center),<br>i.e., $\vartheta = 0$ is normal to probe axis |
| Connector Angle          | information used in DASY system to align probe sensor X to the robot coordinate system                                                                  |

**Calibration is Performed According to the Following Standards:**

- IEEE Std 1309-2005, " IEEE Standard for calibration of electromagnetic field sensors and probes, excluding antennas, from 9 kHz to 40 GHz", December 2005
- CTIA Test Plan for Hearing Aid Compatibility, Rev 3.0, November 2013

**Methods Applied and Interpretation of Parameters:**

- NORM<sub>x,y,z</sub>**: Assessed for E-field polarization  $\vartheta = 0$  for XY sensors and  $\vartheta = 90$  for Z sensor ( $f \leq 900$  MHz in TEM-cell;  $f > 1800$  MHz: R22 waveguide).
- NORM(f)<sub>x,y,z</sub>** = NORM<sub>x,y,z</sub> \* frequency\_response (see Frequency Response Chart).
- DCP<sub>x,y,z</sub>**: DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- PAR**: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- A<sub>x,y,z</sub>; B<sub>x,y,z</sub>; C<sub>x,y,z</sub>; D<sub>x,y,z</sub>; VR<sub>x,y,z</sub>**: A, B, C, D are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the maximum calibration range expressed in RMS voltage across the diode.
- Spherical isotropy (3D deviation from isotropy)**: in a locally homogeneous field realized using an open waveguide setup.
- Sensor Offset**: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- Connector Angle**: The angle is assessed using the information gained by determining the NORM<sub>x</sub> (no uncertainty required).



EF3DV3 – SN:4060

June 12, 2018

# Probe EF3DV3

## SN:4060

Manufactured: March 13, 2018  
Calibrated: June 12, 2018

Calibrated for DASY/EASY Systems  
(Note: non-compatible with DASY2 system!)

EF3DV3 – SN:4060

June 12, 2018

## DASY/EASY - Parameters of Probe: EF3DV3 - SN:4060

### Basic Calibration Parameters

|                                              | Sensor X | Sensor Y | Sensor Z | Unc (k=2)     |
|----------------------------------------------|----------|----------|----------|---------------|
| Norm ( $\mu\text{V}/(\text{V}/\text{m})^2$ ) | 0.76     | 0.71     | 1.33     | $\pm 10.1 \%$ |
| DCP (mV) <sup>B</sup>                        | 95.7     | 94.8     | 94.0     |               |

### Modulation Calibration Parameters

| UID | Communication System Name |   | A<br>dB | B<br>dB $\sqrt{\mu\text{V}}$ | C   | D<br>dB | VR<br>mV | Unc <sup>E</sup><br>(k=2) |
|-----|---------------------------|---|---------|------------------------------|-----|---------|----------|---------------------------|
| 0   | CW                        | X | 0.0     | 0.0                          | 1.0 | 0.00    | 178.2    | $\pm 2.2 \%$              |
|     |                           | Y | 0.0     | 0.0                          | 1.0 |         | 166.5    |                           |
|     |                           | Z | 0.0     | 0.0                          | 1.0 |         | 136.4    |                           |

Note: For details on UID parameters see Appendix.

### Sensor Model Parameters

|   | C1<br>fF | C2<br>fF | $\alpha$<br>$\text{V}^{-1}$ | T1<br>$\text{ms}\cdot\text{V}^{-2}$ | T2<br>$\text{ms}\cdot\text{V}^{-1}$ | T3<br>ms | T4<br>$\text{V}^{-2}$ | T5<br>$\text{V}^{-1}$ | T6    |
|---|----------|----------|-----------------------------|-------------------------------------|-------------------------------------|----------|-----------------------|-----------------------|-------|
| X | 37.27    | 249.6    | 37.86                       | 6.092                               | 0.115                               | 4.959    | 0.368                 | 0.148                 | 1.000 |
| Y | 36.09    | 241.8    | 37.76                       | 8.234                               | 0.000                               | 5.006    | 0.000                 | 0.039                 | 1.010 |
| Z | 34.42    | 234.1    | 38.89                       | 6.204                               | 0.000                               | 4.988    | 0.000                 | 0.063                 | 1.006 |

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor  $k=2$ , which for a normal distribution corresponds to a coverage probability of approximately 95%.

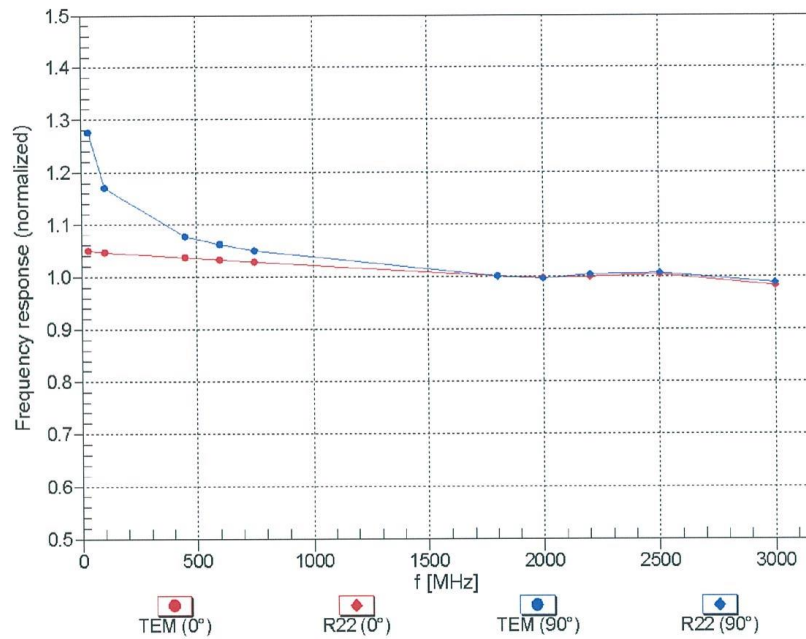
<sup>B</sup> Numerical linearization parameter; uncertainty not required.

<sup>E</sup> Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

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### Frequency Response of E-Field (TEM-Cell:ifi110 EXX, Waveguide: R22)

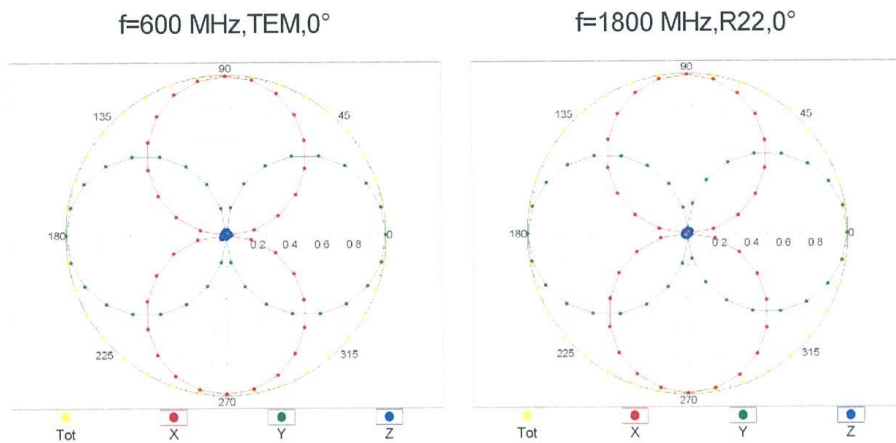


Uncertainty of Frequency Response of E-field:  $\pm 6.3\%$  (k=2)

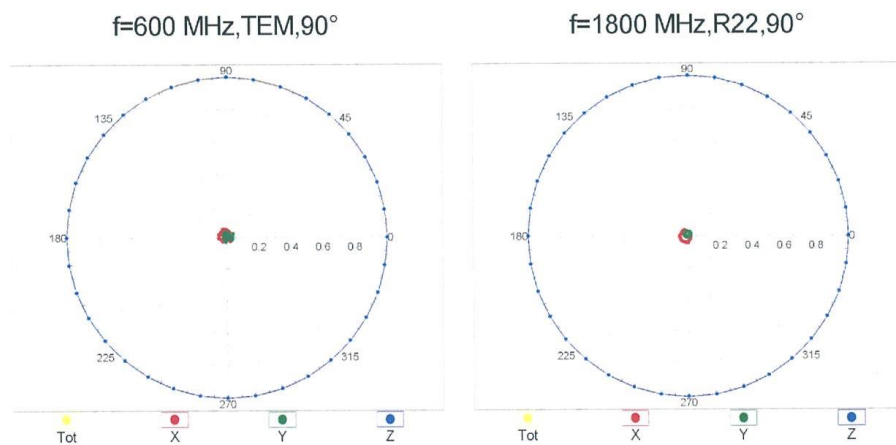
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### Receiving Pattern ( $\phi$ ), $\vartheta = 0^\circ$



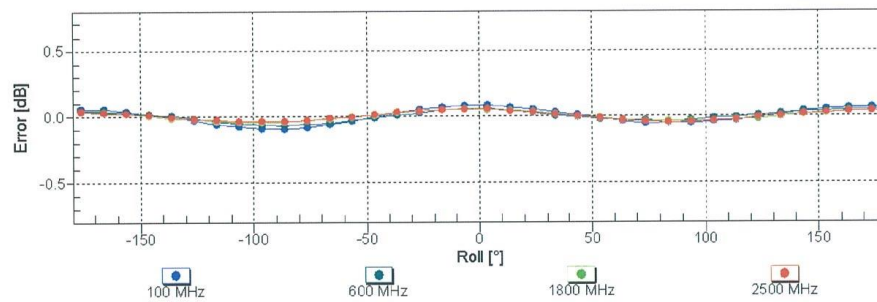
### Receiving Pattern ( $\phi$ ), $\vartheta = 90^\circ$



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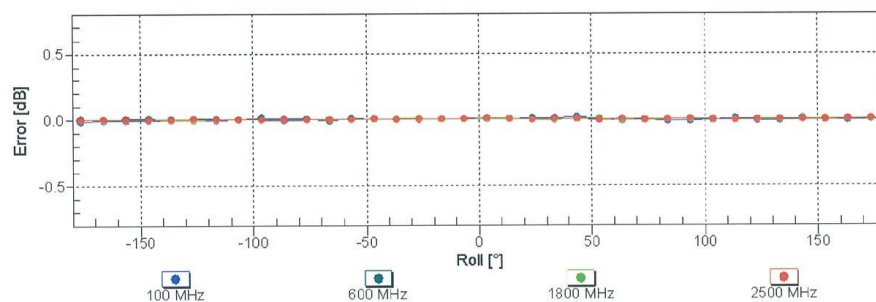
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### Receiving Pattern ( $\phi$ ), $\vartheta = 0^\circ$



Uncertainty of Axial Isotropy Assessment:  $\pm 0.5\%$  ( $k=2$ )

### Receiving Pattern ( $\phi$ ), $\vartheta = 90^\circ$

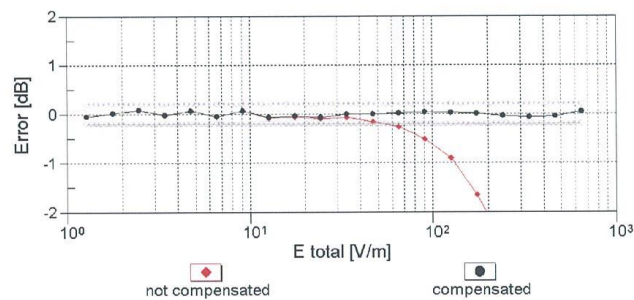
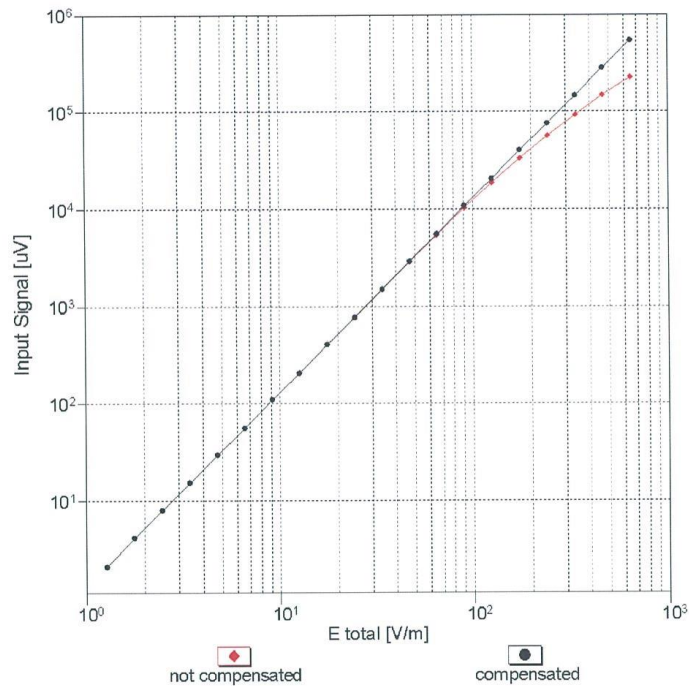


Uncertainty of Axial Isotropy Assessment:  $\pm 0.5\%$  ( $k=2$ )

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### Dynamic Range f(E-field) (TEM cell , f = 900 MHz)

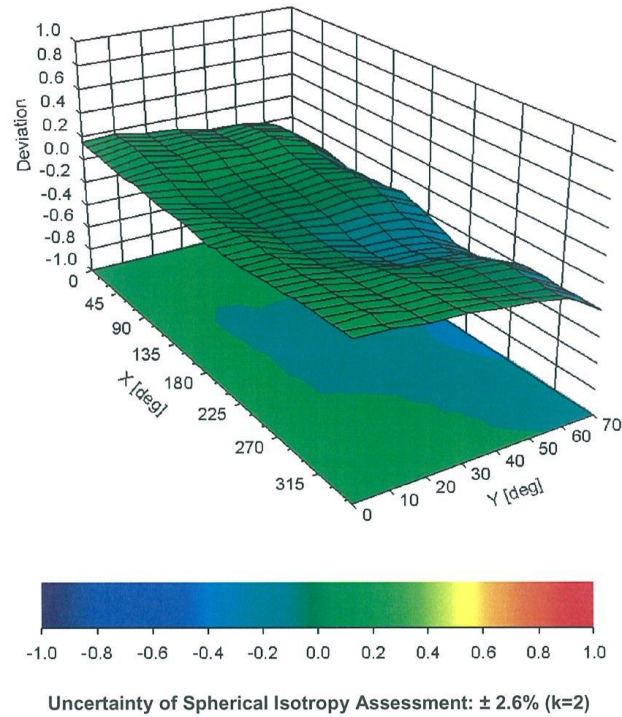


Uncertainty of Linearity Assessment:  $\pm 0.6\%$  (k=2)

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June 12, 2018

### Deviation from Isotropy in Air Error ( $\phi$ , $\theta$ ), $f = 900$ MHz





EF3DV3 – SN:4060

June 12, 2018

## DASY/EASY - Parameters of Probe: EF3DV3 - SN:4060

### Other Probe Parameters

|                                         |             |
|-----------------------------------------|-------------|
| Sensor Arrangement                      | Rectangular |
| Connector Angle (°)                     | 143.6       |
| Mechanical Surface Detection Mode       | enabled     |
| Optical Surface Detection Mode          | disabled    |
| Probe Overall Length                    | 335 mm      |
| Probe Body Diameter                     | 12 mm       |
| Tip Length                              | 25 mm       |
| Tip Diameter                            | 4 mm        |
| Probe Tip to Sensor X Calibration Point | 2.5 mm      |
| Probe Tip to Sensor Y Calibration Point | 2.5 mm      |
| Probe Tip to Sensor Z Calibration Point | 2.5 mm      |

EF3DV3 – SN:4060

June 12, 2018

## Appendix (Additional assessments outside the scope of SCS 0108)

### Calibration Parameters for 3-4 GHz

|                                                    | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|----------------------------------------------------|----------|----------|----------|-----------|
| Norm ( $\mu\text{V}/(\text{V/m})^2$ ) <sup>x</sup> | 0.79     | 0.75     | 1.35     | ± 10.1 %  |
| DCP (mV) <sup>B</sup>                              | 95.7     | 94.8     | 94.0     |           |

### Calibration Parameters for 5-6 GHz

|                                                    | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|----------------------------------------------------|----------|----------|----------|-----------|
| Norm ( $\mu\text{V}/(\text{V/m})^2$ ) <sup>x</sup> | 0.86     | 0.81     | 1.48     | ± 10.1 %  |
| DCP (mV) <sup>B</sup>                              | 95.7     | 94.8     | 94.0     |           |

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.

<sup>B</sup> Numerical linearization parameter; uncertainty not required.

<sup>x</sup> Calibration procedure for frequencies above 3 GHz is pending accreditation.