



**SCOPE OF ACCREDITATION TO ISO/IEC 17025:2005  
& ANSI/NCSL Z540-1-1994**

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**CALIBRATION & TESTING**

Valid to: June 15, 2011

Certificate Number: ACT-1272

**I. Electromagnetic DC / Low Frequency**

| PARAMETER / EQUIPMENT             | RANGE                                                                                                                                                   | BEST MEASUREMENT CAPABILITY [EXPRESSED AS UNCERTAINTY(+)]                                                                                                                   | REFERENCE STANDARD OR EQUIPMENT                                   | METHOD(S)     |
|-----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------|---------------|
| DC Voltage – Source <sup>3</sup>  | (0 to 220) mV<br>(0.22 to 2.2) V<br>(2.2 to 11) V<br>(11 to 22) V<br>(22 to 220) V<br>(220 to 1 100) V                                                  | 11.9 μV/V + 0.4 μV<br>5.8 μV/V + 0.7 μV<br>4.2 μV/V + 2.5 μV<br>4.1 μV/V + 4 μV<br>5.8 μV/V + 40 μV<br>7.6 μV/V + 400 μV                                                    | Fluke 5720A                                                       | OEM and GIDEP |
| DC Voltage – Measure <sup>3</sup> | (0 to 100) mV<br>(0.1 to 1) V<br>(1 to 10) V<br>(10 to 100) V<br>(100 to 1 000) V<br><br>(1 to 10) kV<br>(10 to 100) kV                                 | 7.8 μV/V + 0.8 μV<br>5.7 μV/V + 0.8 μV<br>5.6 μV/V + 1.0 μV<br>7.9 μV/V + 80 μV<br>7.9 μV/V + 150 μV<br><br>0.06 kV<br>0.6 kV                                               | Agilent 3458A OPT002<br><br>Hipotronics KVM-100                   | OEM and GIDEP |
| DC Current – Source <sup>3</sup>  | (0 to 220) μA<br>(0.22 to 2.2) mA<br>(2.2 to 22) mA<br>(22 to 220) mA<br>(220 to 2.2) A<br><br>(2.2 to 11) A<br>(11 to 20.5) A<br><br>(20.5 to 1 000) A | 118 μA/A + 6 nA<br>41.6 μA/A + 7 nA<br>40.7 μA/A + 40 nA<br>52.2 μA/A + 0.7 μA<br>92.8 μA/A + 12 μA<br><br>582 μA/A + 500 μA<br>1 211 μA/A + 750 μA<br><br>86 mA/A + 500 mA | Fluke 5720A<br><br>Fluke 5520A<br><br>Fluke 5520A w/ 50-turn coil | OEM and GIDEP |





| PARAMETER / EQUIPMENT            | RANGE                                   | BEST MEASUREMENT CAPABILITY [EXPRESSED AS UNCERTAINTY(+)] | REFERENCE STANDARD OR EQUIPMENT | METHOD(S)   |               |
|----------------------------------|-----------------------------------------|-----------------------------------------------------------|---------------------------------|-------------|---------------|
| AC Voltage – Source <sup>3</sup> | <b>(0 to 2.2) mV</b>                    |                                                           |                                 |             |               |
|                                  | (10 to 20) Hz                           | 2 351 $\mu\text{V/V} + 4 \mu\text{V}$                     |                                 |             |               |
|                                  | (20 to 40) Hz                           | 2 337 $\mu\text{V/V} + 4 \mu\text{V}$                     |                                 |             |               |
|                                  | (0.04 to 20) kHz                        | 2 170 $\mu\text{V/V} + 4 \mu\text{V}$                     |                                 |             |               |
|                                  | (20 to 50) kHz                          | 2 181 $\mu\text{V/V} + 4 \mu\text{V}$                     |                                 |             |               |
|                                  | (50 to 100) kHz                         | 2 244 $\mu\text{V/V} + 5 \mu\text{V}$                     |                                 |             |               |
|                                  | (100 to 300) kHz                        | 2 484 $\mu\text{V/V} + 10 \mu\text{V}$                    |                                 |             |               |
|                                  | (300 to 500) kHz                        | 2 705 $\mu\text{V/V} + 20 \mu\text{V}$                    |                                 |             |               |
|                                  | (0.5 to 1) MHz                          | 3 798 $\mu\text{V/V} + 20 \mu\text{V}$                    |                                 |             |               |
|                                  | <b>(2.2 to 22) mV</b>                   |                                                           |                                 |             |               |
|                                  | (10 to 20) Hz                           | 612 $\mu\text{V/V} + 4 \mu\text{V}$                       |                                 |             |               |
|                                  | (20 to 40) Hz                           | 555 $\mu\text{V/V} + 4 \mu\text{V}$                       |                                 |             |               |
|                                  | (0.04 to 20) kHz                        | 361 $\mu\text{V/V} + 4 \mu\text{V}$                       |                                 |             |               |
|                                  | (20 to 50) kHz                          | 418 $\mu\text{V/V} + 4 \mu\text{V}$                       |                                 |             |               |
|                                  | (50 to 100) kHz                         | 694 $\mu\text{V/V} + 5 \mu\text{V}$                       |                                 |             |               |
|                                  | (100 to 300) kHz                        | 1 293 $\mu\text{V/V} + 10 \mu\text{V}$                    |                                 |             |               |
|                                  | (300 to 500) kHz                        | 1 678 $\mu\text{V/V} + 20 \mu\text{V}$                    |                                 |             |               |
|                                  | (0.5 to 1) MHz                          | 3 351 $\mu\text{V/V} + 20 \mu\text{V}$                    |                                 |             |               |
|                                  | <b>(22 to 220) mV</b>                   |                                                           |                                 | Fluke 5720A | OEM and GIDEP |
|                                  | (10 to 20) Hz                           | 289 $\mu\text{V/V} + 12 \mu\text{V}$                      |                                 |             |               |
|                                  | (20 to 40) Hz                           | 132 $\mu\text{V/V} + 7 \mu\text{V}$                       |                                 |             |               |
|                                  | (0.04 to 20) kHz                        | 109 $\mu\text{V/V} + 7 \mu\text{V}$                       |                                 |             |               |
|                                  | (20 to 50) kHz                          | 238 $\mu\text{V/V} + 7 \mu\text{V}$                       |                                 |             |               |
|                                  | (50 to 100) kHz                         | 537 $\mu\text{V/V} + 17 \mu\text{V}$                      |                                 |             |               |
| (100 to 300) kHz                 | 1 045 $\mu\text{V/V} + 20 \mu\text{V}$  |                                                           |                                 |             |               |
| (300 to 500) kHz                 | 1 620 $\mu\text{V/V} + 25 \mu\text{V}$  |                                                           |                                 |             |               |
| (0.5 to 1) MHz                   | 3 276 $\mu\text{V/V} + 45 \mu\text{V}$  |                                                           |                                 |             |               |
| <b>(0.22 to 2.2) V</b>           |                                         |                                                           |                                 |             |               |
| (10 to 20) Hz                    | 279 $\mu\text{V/V} + 40 \mu\text{V}$    |                                                           |                                 |             |               |
| (20 to 40) Hz                    | 108 $\mu\text{V/V} + 15 \mu\text{V}$    |                                                           |                                 |             |               |
| (0.04 to 20) kHz                 | 55 $\mu\text{V/V} + 8 \mu\text{V}$      |                                                           |                                 |             |               |
| (20 to 50) kHz                   | 119 $\mu\text{V/V} + 10 \mu\text{V}$    |                                                           |                                 |             |               |
| (50 to 100) kHz                  | 130 $\mu\text{V/V} + 30 \mu\text{V}$    |                                                           |                                 |             |               |
| (100 to 300) kHz                 | 487 $\mu\text{V/V} + 80 \mu\text{V}$    |                                                           |                                 |             |               |
| (300 to 500) kHz                 | 1 158 $\mu\text{V/V} + 200 \mu\text{V}$ |                                                           |                                 |             |               |
| (0.5 to 1) MHz                   | 1 967 $\mu\text{V/V} + 300 \mu\text{V}$ |                                                           |                                 |             |               |
| <b>(2.2 to 22) V</b>             |                                         |                                                           |                                 |             |               |
| (10 to 20) Hz                    | 279 $\mu\text{V/V} + 400 \mu\text{V}$   |                                                           |                                 |             |               |
| (20 to 40) Hz                    | 108 $\mu\text{V/V} + 150 \mu\text{V}$   |                                                           |                                 |             |               |
| (0.04 to 20) kHz                 | 56 $\mu\text{V/V} + 50 \mu\text{V}$     |                                                           |                                 |             |               |
| (20 to 50) kHz                   | 119 $\mu\text{V/V} + 100 \mu\text{V}$   |                                                           |                                 |             |               |
| (50 to 100) kHz                  | 119 $\mu\text{V/V} + 200 \mu\text{V}$   |                                                           |                                 |             |               |
| (100 to 300) kHz                 | 321 $\mu\text{V/V} + 600 \mu\text{V}$   |                                                           |                                 |             |               |
| (300 to 500) kHz                 | 1 158 $\mu\text{V/V} + 2 \text{ mV}$    |                                                           |                                 |             |               |
| (0.5 to 1) MHz                   | 1 741 $\mu\text{V/V} + 3.2 \text{ mV}$  |                                                           |                                 |             |               |

| PARAMETER / EQUIPMENT                                  | RANGE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | BEST MEASUREMENT CAPABILITY [EXPRESSED AS UNCERTAINTY(+)]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | REFERENCE STANDARD OR EQUIPMENT | METHOD(S)     |
|--------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|---------------|
| AC Voltage – Source <sup>3</sup><br>(cont.)            | <b>(22 to 220) V</b><br>(10 to 20) Hz<br>(20 to 40) Hz<br>(0.04 to 20) kHz<br>(20 to 50) kHz<br>(50 to 100) kHz<br>(100 to 300) kHz<br>(300 to 500) kHz<br>(0.5 to 1) MHz<br><br><b>(220 to 1 100) V</b><br>(15 to 50) Hz<br>(0.05 to 1) kHz                                                                                                                                                                                                                                           | 279 $\mu\text{V/V} + 4.0 \text{ mV}$<br>109 $\mu\text{V/V} + 1.5 \text{ mV}$<br>65 $\mu\text{V/V} + 0.6 \text{ mV}$<br>123 $\mu\text{V/V} + 1.0 \text{ mV}$<br>176 $\mu\text{V/V} + 2.5 \text{ mV}$<br>1 040 $\mu\text{V/V} + 16 \text{ mV}$<br>5 081 $\mu\text{V/V} + 40 \text{ mV}$<br>9 240 $\mu\text{V/V} + 80 \text{ mV}$<br><br>348 $\mu\text{V/V} + 16 \text{ mV}$<br>88 $\mu\text{V/V} + 3.5 \text{ mV}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Fluke 5720A                     | OEM and GIDEP |
| AC Voltage – Measure <sup>3</sup><br>Bandwidth < 2 MHz | <b>(0 to 10) mV</b><br>(1 to 40) Hz<br>(0.04 to 1) kHz<br>(1 to 20) kHz<br>(20 to 50) kHz<br>(50 to 100) kHz<br>(100 to 300) kHz<br><br><b>(10 to 100) mV</b><br>(1 to 40) Hz<br>(0.04 to 1) kHz<br>(1 to 20) kHz<br>(20 to 50) kHz<br>(50 to 100) kHz<br>(100 to 300) kHz<br>(0.3 to 1) MHz<br>(1 to 2) MHz<br><br><b>(0.1 to 1) V</b><br>(1 to 40) Hz<br>(0.04 to 1) kHz<br>(1 to 20) kHz<br>(20 to 50) kHz<br>(50 to 100) kHz<br>(100 to 300) kHz<br>(0.3 to 1) MHz<br>(1 to 2) MHz | 463 $\mu\text{V/V} + 13 \mu\text{V}$<br>348 $\mu\text{V/V} + 11.1 \mu\text{V}$<br>463 $\mu\text{V/V} + 11.1 \mu\text{V}$<br>1 271 $\mu\text{V/V} + 11.1 \mu\text{V}$<br>5 890 $\mu\text{V/V} + 11.1 \mu\text{V}$<br>46 $\mu\text{V/V} + 12 \mu\text{V}$<br><br>140 $\mu\text{V/V} + 4.5 \mu\text{V}$<br>143 $\mu\text{V/V} + 2.5 \mu\text{V}$<br>222 $\mu\text{V/V} + 2.5 \mu\text{V}$<br>407 $\mu\text{V/V} + 2.5 \mu\text{V}$<br>984 $\mu\text{V/V} + 2.5 \mu\text{V}$<br>3 525 $\mu\text{V/V} + 10.5 \mu\text{V}$<br>11.6 $\text{mV/V} + 10.5 \mu\text{V}$<br>17.4 $\text{mV/V} + 10.5 \mu\text{V}$<br><br>139 $\mu\text{V/V} + 45 \mu\text{V}$<br>139 $\mu\text{V/V} + 25 \mu\text{V}$<br>220 $\mu\text{V/V} + 25 \mu\text{V}$<br>406 $\mu\text{V/V} + 25 \mu\text{V}$<br>982 $\mu\text{V/V} + 25 \mu\text{V}$<br>3 523 $\mu\text{V/V} + 105 \mu\text{V}$<br>11.6 $\text{mV/V} + 105 \mu\text{V}$<br>17.4 $\text{mV/V} + 105 \mu\text{V}$ | Agilent 3458A OPT002            | OEM and GIDEP |

| PARAMETER / EQUIPMENT                                             | RANGE                                                                                                                                                             | BEST MEASUREMENT CAPABILITY [EXPRESSED AS UNCERTAINTY(+)]                                                                                                                                                                                                                     | REFERENCE STANDARD OR EQUIPMENT                                                                                                                                      | METHOD(S)     |                      |  |
|-------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|----------------------|--|
| AC Voltage – Measure <sup>3</sup><br>Bandwidth < 2 MHz<br>(cont.) | <b>(1 to 10) V</b><br>(1 to 40) Hz<br>(0.04 to 1) kHz<br>(1 to 20) kHz<br>(20 to 50) kHz<br>(50 to 100) kHz<br>(100 to 300) kHz<br>(0.3 to 1) MHz<br>(1 to 2) MHz | 139 $\mu\text{V/V} + 450 \mu\text{V}$<br>139 $\mu\text{V/V} + 250 \mu\text{V}$<br>220 $\mu\text{V/V} + 250 \mu\text{V}$<br>405 $\mu\text{V/V} + 250 \mu\text{V}$<br>982 $\mu\text{V/V} + 250 \mu\text{V}$<br>3.5 mV/V + 1.05 mV<br>11.6 mV/V + 1.05 mV<br>17.4 mV/V + 1.05 mV | Agilent 3458A OPT002                                                                                                                                                 | OEM and GIDEP |                      |  |
|                                                                   | <b>(10 to 100) V</b><br>(1 to 40) Hz<br>(0.04 to 1) kHz<br>(1 to 20) kHz<br>(20 to 50) kHz<br>(50 to 100) kHz<br>(100 to 300) kHz<br>(0.3 to 1) MHz               | 290 $\mu\text{V/V} + 4.5 \text{ mV}$<br>289 $\mu\text{V/V} + 2.5 \text{ mV}$<br>289 $\mu\text{V/V} + 2.5 \text{ mV}$<br>289 $\mu\text{V/V} + 2.5 \text{ mV}$<br>1 444 $\mu\text{V/V} + 2.5 \text{ mV}$<br>4.7 mV/V + 10.5 mV<br>17.4 mV/V + 10.5 mV                           |                                                                                                                                                                      |               |                      |  |
|                                                                   | <b>(100 to 1 000) V</b><br>(1 to 40) Hz<br>(0.04 to 1) kHz<br>(1 to 20) kHz<br>(20 to 50) kHz<br>(50 to 100) kHz                                                  | 520 $\mu\text{V/V} + 45 \text{ mV}$<br>520 $\mu\text{V/V} + 25 \text{ mV}$<br>751 $\mu\text{V/V} + 25 \text{ mV}$<br>1 444 $\mu\text{V/V} + 25 \text{ mV}$<br>3 522 $\mu\text{V/V} + 25 \text{ mV}$                                                                           |                                                                                                                                                                      |               |                      |  |
|                                                                   | <b>(1 to 10) kV</b><br>(50 to 60) Hz                                                                                                                              | 0.12 kV                                                                                                                                                                                                                                                                       | Hipotronics KVM-100                                                                                                                                                  |               |                      |  |
|                                                                   | <b>(10 to 100) kV</b><br>(50 to 60) Hz                                                                                                                            | 1.2 kV                                                                                                                                                                                                                                                                        |                                                                                                                                                                      |               |                      |  |
|                                                                   | Bandwidth > 2 MHz                                                                                                                                                 | <b>(0 to 10) mV</b><br>(0.045 to 100) kHz<br>(0.1 to 1) MHz<br>(1 to 4) MHz<br>(4 to 8) MHz                                                                                                                                                                                   | 1.18 mV/V + 6 $\mu\text{V}$<br>14.2 mV/V + 5.1 $\mu\text{V}$<br>82.8 mV/V + 7.1 $\mu\text{V}$<br>237 mV/V + 8.1 $\mu\text{V}$                                        |               | Agilent 3458A OPT002 |  |
|                                                                   |                                                                                                                                                                   | <b>(10 to 100) mV</b><br>(0.045 to 100) kHz<br>(0.1 to 1) MHz<br>(1 to 4) MHz<br>(4 to 8) MHz<br>(8 to 10) MHz                                                                                                                                                                | 1.12 mV/V + 60.5 $\mu\text{V}$<br>23.7 mV/V + 50.5 $\mu\text{V}$<br>47.3 mV/V + 70.5 $\mu\text{V}$<br>47.3 mV/V + 80.5 $\mu\text{V}$<br>177 mV/V + 101 $\mu\text{V}$ |               |                      |  |

| PARAMETER / EQUIPMENT                                             | RANGE                                                                                                         | BEST MEASUREMENT CAPABILITY [EXPRESSED AS UNCERTAINTY(+)]                                                   | REFERENCE STANDARD OR EQUIPMENT | METHOD(S)     |
|-------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|---------------------------------|---------------|
| AC Voltage – Measure <sup>3</sup><br>Bandwidth > 2 MHz<br>(cont.) | <b>(0.1 to 1) V</b><br>(0.045 to 100) kHz<br>(0.1 to 1) MHz<br>(1 to 4) MHz<br>(4 to 8) MHz<br>(8 to 10) MHz  | 1.12 mV/V + 605 μV<br>23.7 mV/V + 505 μV<br>47.3 mV/V + 705 μV<br>47.3 mV/V + 805 μV<br>177 mV/V + 1 005 μV | Agilent 3458A OPT002            | OEM and GIDEP |
|                                                                   | <b>(1 to 10) V</b><br>(0.045 to 100) kHz<br>(0.1 to 1) MHz<br>(1 to 4) MHz<br>(4 to 8) MHz<br>(8 to 10) MHz   | 1.14 mV/V + 6.1 μV<br>23.7 mV/V + 5.1 μV<br>47.3 mV/V + 7.1 μV<br>47.3 mV/V + 8.1 μV<br>177 mV/V + 10.1 μV  |                                 |               |
|                                                                   | <b>(10 to 100) V</b><br>(0.045 to 100) kHz                                                                    | 1.48 mV/V + 2.5 mV                                                                                          |                                 |               |
|                                                                   | <b>(100 to 1 000) V</b><br>(0.045 to 100) kHz                                                                 | 3.6 mV/V + 105 mV                                                                                           |                                 |               |
| AC Current – Source <sup>3</sup>                                  | <b>(0 to 220) μA</b><br>(10 to 20) Hz<br>(20 to 40) Hz<br>(0.04 to 1) kHz<br>(1 to 5) kHz<br>(5 to 10) kHz    | 299 μA/A + 16 nA<br>200 μA/A + 10 nA<br>156 μA/A + 8 nA<br>331 μA/A + 12 nA<br>1 286 μA/A + 65 nA           | Fluke 5720A                     | OEM and GIDEP |
|                                                                   | <b>(0.22 to 2.2) mA</b><br>(10 to 20) Hz<br>(20 to 40) Hz<br>(0.04 to 1) kHz<br>(1 to 5) kHz<br>(5 to 10) kHz | 313 μA/A + 40 nA<br>220 μA/A + 35 nA<br>153 μA/A + 35 nA<br>240 μA/A + 110 nA<br>1 273 μA/A + 650 nA        |                                 |               |
|                                                                   | <b>(2.2 to 22) mA</b><br>(10 to 20) Hz<br>(20 to 40) Hz<br>(0.04 to 1) kHz<br>(1 to 5) kHz<br>(5 to 10) kHz   | 319 μA/A + 400 nA<br>230 μA/A + 350 nA<br>151 μA/A + 350 nA<br>239 μA/A + 550 nA<br>1 273 μA/A + 5 000 nA   |                                 |               |
|                                                                   | <b>(22 to 220) mA</b><br>(10 to 20) Hz<br>(20 to 40) Hz<br>(0.04 to 1) kHz<br>(1 to 5) kHz<br>(5 to 10) kHz   | 299 μA/A + 4.0 μA<br>200 μA/A + 3.5 μA<br>153 μA/A + 2.5 μA<br>240 μA/A + 3.5 μA<br>1 273 μA/A + 10 μA      |                                 |               |

| PARAMETER / EQUIPMENT                       | RANGE                                                                                                                                            | BEST MEASUREMENT CAPABILITY [EXPRESSED AS UNCERTAINTY(+)]                                                                                                                                                                                                                                                                                       | REFERENCE STANDARD OR EQUIPMENT | METHOD(S)     |
|---------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|---------------|
| AC Current – Source <sup>3</sup><br>(cont.) | <b>(0.22 to 2.2) A</b><br>(20 to 1 000) Hz<br>(1 to 5) kHz<br>(5 to 10) kHz                                                                      | 309 $\mu\text{A}/\text{A} + 35 \mu\text{A}$<br>525 $\mu\text{A}/\text{A} + 80 \mu\text{A}$<br>8 087 $\mu\text{A}/\text{A} + 160 \mu\text{A}$                                                                                                                                                                                                    | Fluke 5720A                     | OEM and GIDEP |
|                                             | <b>(2 to 3) A</b><br>(10 to 45) Hz<br>(0.045 to 1) kHz<br>(1 to 5) kHz<br>(5 to 10) kHz                                                          | 2 097 $\mu\text{A}/\text{A} + 100 \mu\text{A}$<br>746 $\mu\text{A}/\text{A} + 100 \mu\text{A}$<br>6.9 mA/A + 1 mA<br>28.9 mA/A + 5 mA                                                                                                                                                                                                           | Fluke 5520A                     |               |
|                                             | <b>(3 to 11) A</b><br>(45 to 100) Hz<br>(0.1 to 1) kHz<br>(1 to 5) kHz                                                                           | 738 $\mu\text{A}/\text{A} + 2 \text{ mA}$<br>1 177 $\mu\text{A}/\text{A} + 2 \text{ mA}$<br>34.6 mA/A + 2 mA                                                                                                                                                                                                                                    |                                 |               |
|                                             | <b>(11 to 20.5) A</b><br>(45 to 100) Hz<br>(0.1 to 1) kHz<br>(1 to 5) kHz                                                                        | 1 407 $\mu\text{A}/\text{A} + 5 \text{ mA}$<br>1 744 $\mu\text{A}/\text{A} + 5 \text{ mA}$<br>34.6 mA/A + 5 mA                                                                                                                                                                                                                                  |                                 |               |
|                                             | <b>(20.5 to 1 000) A</b><br>(45 to 65) Hz                                                                                                        | 90 mA/A + 500 mA                                                                                                                                                                                                                                                                                                                                | Fluke 5520A w/ 50-turn coil     |               |
|                                             | <b>(20.5 to 150) A</b><br>(65 to 440) Hz                                                                                                         | 544 $\mu\text{A}/\text{A} + 500 \text{ mA}$                                                                                                                                                                                                                                                                                                     |                                 |               |
| AC Current – Measure <sup>3</sup>           | <b>(0 to 100) <math>\mu\text{A}</math></b><br>(10 to 20) Hz<br>(20 to 45) Hz<br>(45 to 100) Hz<br>(0.1 to 5) kHz                                 | 4 750 $\mu\text{A}/\text{A} + 30 \text{ nA}$<br>1 890 $\mu\text{A}/\text{A} + 30 \text{ nA}$<br>827 $\mu\text{A}/\text{A} + 30 \text{ nA}$<br>827 $\mu\text{A}/\text{A} + 30 \text{ nA}$                                                                                                                                                        | Agilent 3458A OPT002            | OEM and GIDEP |
|                                             | <b>(0.1 to 1) mA</b><br>(10 to 20) Hz<br>(20 to 45) Hz<br>(45 to 100) Hz<br>(0.1 to 5) kHz<br>(5 to 20) kHz<br>(20 to 50) kHz<br>(50 to 100) kHz | 4 844 $\mu\text{A}/\text{A} + 200 \text{ nA}$<br>1 890 $\mu\text{A}/\text{A} + 200 \text{ nA}$<br>827 $\mu\text{A}/\text{A} + 200 \text{ nA}$<br>473 $\mu\text{A}/\text{A} + 200 \text{ nA}$<br>827 $\mu\text{A}/\text{A} + 200 \text{ nA}$<br>4 844 $\mu\text{A}/\text{A} + 400 \text{ nA}$<br>6 616 $\mu\text{A}/\text{A} + 1 500 \text{ nA}$ |                                 |               |

| PARAMETER / EQUIPMENT                        | RANGE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | BEST MEASUREMENT CAPABILITY [EXPRESSED AS UNCERTAINTY(+)]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | REFERENCE STANDARD OR EQUIPMENT             | METHOD(S)            |
|----------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------|----------------------|
| AC Current – Measure <sup>3</sup><br>(cont.) | <p><b>(1 to 10 mA)</b><br/>(10 to 20) Hz<br/>(20 to 45) Hz<br/>(45 to 100) Hz<br/>(0.1 to 5) kHz<br/>(5 to 20) kHz<br/>(20 to 50) kHz<br/>(50 to 100) kHz</p> <p><b>(10 to 100) mA</b><br/>(10 to 20) Hz<br/>(20 to 45) Hz<br/>(45 to 100) Hz<br/>(0.1 to 5) kHz<br/>(5 to 20) kHz<br/>(20 to 50) kHz<br/>(50 to 100) kHz</p> <p><b>(0.1 to 1) A</b><br/>(10 to 20) Hz<br/>(20 to 45) Hz<br/>(45 to 100) Hz<br/>(0.1 to 5) kHz<br/>(5 to 20) kHz<br/>(20 to 50) kHz</p> <p><b>(1 to 10) A</b><br/>(20 to 50) Hz<br/>(0.05 to 2) kHz</p> | <p>4 844 <math>\mu\text{A}/\text{A} + 2 \mu\text{A}</math><br/>1 890 <math>\mu\text{A}/\text{A} + 2 \mu\text{A}</math><br/>827 <math>\mu\text{A}/\text{A} + 2 \mu\text{A}</math><br/>473 <math>\mu\text{A}/\text{A} + 2 \mu\text{A}</math><br/>827 <math>\mu\text{A}/\text{A} + 2 \mu\text{A}</math><br/>4 844 <math>\mu\text{A}/\text{A} + 4 \mu\text{A}</math><br/>6 616 <math>\mu\text{A}/\text{A} + 15 \mu\text{A}</math></p> <p>4 844 <math>\mu\text{A}/\text{A} + 20 \mu\text{A}</math><br/>1 890 <math>\mu\text{A}/\text{A} + 20 \mu\text{A}</math><br/>827 <math>\mu\text{A}/\text{A} + 20 \mu\text{A}</math><br/>473 <math>\mu\text{A}/\text{A} + 20 \mu\text{A}</math><br/>473 <math>\mu\text{A}/\text{A} + 20 \mu\text{A}</math><br/>4 844 <math>\mu\text{A}/\text{A} + 40 \mu\text{A}</math><br/>6 616 <math>\mu\text{A}/\text{A} + 150 \mu\text{A}</math></p> <p>4.8 <math>\text{mA}/\text{A} + 200 \mu\text{A}</math><br/>2.0 <math>\text{mA}/\text{A} + 200 \mu\text{A}</math><br/>1.1 <math>\text{mA}/\text{A} + 200 \mu\text{A}</math><br/>1.3 <math>\text{mA}/\text{A} + 200 \mu\text{A}</math><br/>3.7 <math>\text{mA}/\text{A} + 200 \mu\text{A}</math><br/>11.8 <math>\text{mA}/\text{A} + 400 \mu\text{A}</math></p> <p>231 <math>\text{mA}/\text{A} + 10 \text{mA}</math><br/>36.7 <math>\text{mA}/\text{A} + 10 \text{mA}</math></p> | <p>Agilent 3458A OPT002</p> <p>Fluke 45</p> | <p>OEM and GIDEP</p> |
| Capacitance – Source <sup>3</sup>            | <p>(0.13 to 3.3) nF<br/>(3.3 to 11) nF<br/>(11 to 110) nF<br/>(110 to 330) nF<br/>(0.33 to 1.1) <math>\mu\text{F}</math><br/>(1.1 to 3.3) <math>\mu\text{F}</math><br/>(3.3 to 11) <math>\mu\text{F}</math><br/>(11 to 33) <math>\mu\text{F}</math><br/>(33 to 110) <math>\mu\text{F}</math><br/>(110 to 330) <math>\mu\text{F}</math><br/>(0.33 to 1.1) mF<br/>(1.1 to 3.3) mF<br/>(3.3 to 11) mF<br/>(11 to 33) mF<br/>(33 to 110) mF</p>                                                                                             | <p>5.8 mF/F + 10 pF<br/>2.9 mF/F + 10 pF<br/>2.9 mF/F + 100 pF<br/>2.9 mF/F + 300 pF<br/>2.9 mF/F + 1 nF<br/>2.9 mF/F + 3 nF<br/>2.9 mF/F + 10 nF<br/>4.7 mF/F + 30 nF<br/>5.3 mF/F + 100 nF<br/>1.0 mF/F + 300 nF<br/>6.0 mF/F + 1 <math>\mu\text{F}</math><br/>5.3 mF/F + 3 <math>\mu\text{F}</math><br/>5.3 mF/F + 10 <math>\mu\text{F}</math><br/>8.9 mF/F + 30 <math>\mu\text{F}</math><br/>13 mF/F + 100 <math>\mu\text{F}</math></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <p>Fluke 5520A</p>                          | <p>OEM and GIDEP</p> |

| PARAMETER / EQUIPMENT                      | RANGE                                                                             | BEST MEASUREMENT CAPABILITY [EXPRESSED AS UNCERTAINTY(+)] | REFERENCE STANDARD OR EQUIPMENT | METHOD(S)     |
|--------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------|---------------------------------|---------------|
| <b>Oscilloscopes<sup>3</sup></b>           |                                                                                   |                                                           |                                 |               |
| DC Voltage (50 Ω)                          | 1 mV to 6.6 V                                                                     | 2.9 mV/V + 40 μV                                          | Fluke 5520A SC1100              | OEM and GIDEP |
| DC Voltage (1 MΩ)                          | 1 mV to 130 V                                                                     | 544 μV/V + 40 μV                                          |                                 |               |
| AC Voltage (50 Ω)                          | 1 mV to 6.6 V                                                                     | 2.9 mV/V + 40 μV                                          |                                 |               |
| AC Voltage (1 MΩ)                          | 1 mV to 130 V                                                                     | 1.1 mV/V + 40 μV                                          |                                 |               |
| Leveled Sinewave<br>50 kHz to 1.1 GHz      | 5 mV to 5.5 V                                                                     | 50.7 mV/V + 100 μV                                        |                                 |               |
| Time Markers                               | 1 ns to 5 s                                                                       | 6.4 μs/s                                                  |                                 |               |
| Wave Gen. (50 Ω)                           | (0.0018 to 2.5) Vp-p                                                              | 34.6 mV/V + 100 μV                                        |                                 |               |
| Wave Gen. (1 MΩ)                           | (0.0018 to 55) Vp-p                                                               | 34.6 mV/V + 100 μV                                        |                                 |               |
| Pulse Generator Width                      | (4 to 45) ns<br>(45 to 500) ns                                                    | 57.8 ms/s + 500 ps<br>57.8 ms/s + 4 ns                    |                                 |               |
| Pulse Generator Period                     | 200 ns to 20 ms                                                                   | 57.8 ms/s + 200 ns                                        |                                 |               |
| Input Impedance Measure                    | (50 to 60) Ω<br>(0.5 to 1) MΩ                                                     | 1.2 mΩ/Ω<br>1.2 mΩ/Ω                                      |                                 |               |
| <b>Thermocouple Simulation<sup>3</sup></b> |                                                                                   |                                                           |                                 |               |
| Type K                                     | (-200 to -100) °C<br>(-100 to 120) °C<br>(120 to 1 000) °C<br>(1 000 to 1 372) °C | 0.98 °C<br>0.93 °C<br>0.95 °C<br>1.02 °C                  | Fluke 5520A                     | OEM and GIDEP |
| Type J                                     | (-210 to -100) °C<br>(-100 to 760) °C<br>(760 to 1 200) °C                        | 0.50 °C<br>0.44 °C<br>0.47 °C                             |                                 |               |
| Type E                                     | (-250 to -100) °C<br>(-100 to 650) °C<br>(650 to 1 000) °C                        | 0.67 °C<br>0.38 °C<br>0.41 °C                             |                                 |               |
| Type T                                     | (-250 to -150) °C<br>(-150 to 0) °C<br>(0 to 400) °C                              | 0.83 °C<br>0.48 °C<br>0.43 °C                             |                                 |               |

| PARAMETER / EQUIPMENT                                                                    | RANGE                                                                                               | BEST MEASUREMENT CAPABILITY [EXPRESSED AS UNCERTAINTY(+)]           | REFERENCE STANDARD OR EQUIPMENT | METHOD(S)     |
|------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|---------------------------------------------------------------------|---------------------------------|---------------|
| Thermocouple Simulation <sup>3</sup><br>(cont.)<br><br>Type S                            | (0 to 250) °C<br>(250 to 1 400) °C<br>(1 400 to 1 767) °C                                           | 1.82 °C<br>1.79 °C<br>1.81 °C                                       | Fluke 5520A                     | OEM and GIDEP |
| DC Power – Source <sup>3</sup>                                                           | (0.01 to 330) W<br>(0.33 to 3) kW<br>(3 to 20.5) kW                                                 | 267 μW/W<br>261 μW/W<br>815 μW/W                                    | Fluke 5520A                     | OEM and GIDEP |
| AC Power – Source <sup>3</sup>                                                           | 0.1 mW to 9 W<br>(9 to 33) W<br>(33 to 90) W<br>(90 to 330) W<br>(330 to 900) W<br>(900 to 2 200) W | 1.7 mW/W<br>1.2 mW/W<br>1.7 mW/W<br>1.2 mW/W<br>11 mW/W<br>4.6 mW/W | Fluke 5520A                     | OEM and GIDEP |
| Inductance – Source <sup>3</sup>                                                         | (1 to 10) mH<br>(10 to 100) mH<br>(100 to 1 000) mH<br>(1 to 10) H                                  | 22 mH/H<br>11 mH/H<br>6 mH/H<br>3 mH/H                              | General Radio 1490-D            | OEM and GIDEP |
| pH Meters <sup>3</sup>                                                                   | (4.01, 7.00, 10.00)<br>pH                                                                           | 0.02 pH                                                             | pH Buffer Solutions             | OEM and GIDEP |
| Conductivity Meters <sup>3</sup>                                                         | 12.85 mS/cm<br>1408 μS/cm                                                                           | 0.18 mS/cm<br>13.5 μS/cm                                            | Conductivity Solutions          | OEM and GIDEP |
| Sound Level – Generate <sup>3</sup><br><br>100 Hz, 250 Hz, 500 Hz,<br>1 000 Hz, 2 000 Hz | 114 dB                                                                                              | 0.6 dB                                                              | Gen Rad 1562-A                  | OEM and GIDEP |

## II. Electromagnetic – RF/Microwave

| PARAMETER / EQUIPMENT                                                             | RANGE                                                                                                                      | BEST MEASUREMENT CAPABILITY [EXPRESSED AS UNCERTAINTY(+)]                | REFERENCE STANDARD OR EQUIPMENT                                    | METHOD(S)     |
|-----------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------|--------------------------------------------------------------------|---------------|
| RF Power – Measure <sup>3,4</sup><br><br>(+20 to +30) dBm<br><br>(-20 to +20) dBm | 100 kHz to 3 GHz<br>3 GHz to 18 GHz<br>18 GHz to 26.5 GHz<br><br>100 kHz to 3 GHz<br>3 GHz to 18 GHz<br>18 GHz to 26.5 GHz | 0.369 dB<br>0.384 dB<br>0.395 dB<br><br>0.145 dB<br>0.182 dB<br>0.205 dB | Agilent N5531S<br>measuring receiver with<br>N5532A sensor modules | OEM and GIDEP |

| PARAMETER / EQUIPMENT                                       | RANGE                | BEST MEASUREMENT CAPABILITY [EXPRESSED AS UNCERTAINTY(+)]                           | REFERENCE STANDARD OR EQUIPMENT                                    | METHOD(S)     |
|-------------------------------------------------------------|----------------------|-------------------------------------------------------------------------------------|--------------------------------------------------------------------|---------------|
| Tuned RF Level<br>– Measure <sup>3,4</sup>                  |                      |                                                                                     |                                                                    |               |
| Absolute Level                                              |                      |                                                                                     |                                                                    |               |
| (+16 to +30) dBm<br>(-106 to +16) dBm<br>(-129 to -106) dBm | 500 kHz to 3.05 GHz  | 0.369 dB + 0.005 dB/10 dB<br>0.145 dB + 0.005 dB/10 dB<br>0.151 dB + 0.120 dB/10 dB | Agilent N5531S<br>measuring receiver with<br>N5532A sensor modules | OEM and GIDEP |
| (+20 to +30) dBm<br>(-90 to +20) dBm<br>(-114 to -90) dBm   | 3.05 GHz to 6.6 GHz  | 0.384 dB + 0.005 dB/10 dB<br>0.182 dB + 0.005 dB/10 dB<br>0.233 dB + 0.120 dB/10 dB |                                                                    |               |
| (+20 to +30) dBm<br>(-81 to +20) dBm<br>(-104 to -81) dBm   | 6.6 GHz to 13.2 GHz  | 0.384 dB + 0.005 dB/10 dB<br>0.182 dB + 0.005 dB/10 dB<br>0.233 dB + 0.120 dB/10 dB |                                                                    |               |
| (+20 to +30) dBm<br>(-70 to +20) dBm<br>(-93 to -70) dBm    | 13.2 GHz to 19.2 GHz | 0.395 dB + 0.005 dB/10 dB<br>0.205 dB + 0.005 dB/10 dB<br>0.245 dB + 0.120 dB/10 dB |                                                                    |               |
| (+20 to +30) dBm<br>(-62 to +20) dBm<br>(-85 to -62) dBm    | 19.2 GHz to 26.5 GHz | 0.395 dB + 0.005 dB/10 dB<br>0.205 dB + 0.005 dB/10 dB<br>0.239 dB + 0.120 dB/10 dB |                                                                    |               |
| Relative Level                                              |                      |                                                                                     |                                                                    |               |
| (-90 to +30) dBm<br>(-106 to -90) dBm<br>(-129 to -106) dBm | 500 kHz to 3.05 GHz  | 0.026 dB + 0.005 dB/10 dB<br>0.067 dB + 0.120 dB/10 dB<br>0.076 dB + 0.120 dB/10 dB |                                                                    |               |
| Relative Level                                              |                      |                                                                                     |                                                                    |               |
| (-90 to +30) dBm<br>(-113 to -90) dBm                       | 3.05 GHz to 6.6 GHz  | 0.026 dB + 0.005 dB/10 dB<br>0.067 dB + 0.120 dB/10 dB                              | Agilent N5531S<br>measuring receiver with<br>N5532A sensor modules | OEM and GIDEP |
| (-81 to +30) dBm<br>(-104 to -81) dBm                       | 6.6 GHz to 13.2 GHz  | 0.026 dB + 0.005 dB/10 dB<br>0.062 dB + 0.120 dB/10 dB                              |                                                                    |               |
| (-70 to +30) dBm<br>(-93 to -70) dBm                        | 13.2 GHz to 19.2 GHz | 0.026 dB + 0.005 dB/10 dB<br>0.056 dB + 0.120 dB/10 dB                              |                                                                    |               |
| (-62 to +30) dBm<br>(-85 to -62) dBm                        | 19.2 GHz to 26.5 GHz | 0.026 dB + 0.005 dB/10 dB<br>0.051 dB + 0.120 dB/10 dB                              |                                                                    |               |

| PARAMETER / EQUIPMENT                                                                                                             | RANGE                                                     | BEST MEASUREMENT CAPABILITY [EXPRESSED AS UNCERTAINTY(+)] | REFERENCE STANDARD OR EQUIPMENT                                                      | METHOD(S)     |
|-----------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|-----------------------------------------------------------|--------------------------------------------------------------------------------------|---------------|
| RF Power – Source <sup>3</sup><br>> -10 dBm                                                                                       | 250 kHz to 2 GHz<br>2 GHz to 20 GHz<br>20 GHz to 40 GHz   | 0.72 dB<br>0.96 dB<br>1.08 dB                             | Agilent E8257D                                                                       | OEM and GIDEP |
| (-10 to -70) dBm                                                                                                                  | 250 kHz to 2 GHz<br>2 GHz to 20 GHz<br>20 GHz to 40 GHz   | 0.89 dB<br>1.07 dB<br>1.19 dB                             |                                                                                      |               |
| (-70 to -90) dBm                                                                                                                  | 250 kHz to 2 GHz<br>2 GHz to 20 GHz<br>20 GHz to 40 GHz   | 0.95 dB<br>1.20 dB<br>1.21 dB                             |                                                                                      |               |
| RF Power Sensors-<br>Calibration Factor <sup>3,4</sup><br><br>(-20 to +14) dBm                                                    | 100 kHz to 10 MHz<br>10 MHz to 10 GHz<br>10 GHz to 18 GHz | 1.5 %<br>1.5 %<br>1.7 %                                   | Tegam 1827,<br>Agilent 3458A, Agilent<br>E8257D, Agilent<br>E4419B,<br>Agilent 3325B | OEM and GIDEP |
| Frequency Modulation<br>– Measure <sup>3</sup><br>Rate: 20 Hz to 10 kHz<br>Dev.: ≤ 40 kHz peak                                    | 250 kHz to 10 MHz                                         | 3.1 % of reading                                          | Agilent N5531S<br>measuring receiver with<br>N5532A sensor modules                   | OEM and GIDEP |
| Rate: 20 Hz to 200 kHz<br>Dev.: ≤ 400 kHz peak                                                                                    | 10 MHz to 3 GHz                                           | 3.1 % of reading                                          |                                                                                      |               |
| Rate: 20 Hz to 200 kHz<br>Dev.: ≤ 400 kHz peak                                                                                    | 3 GHz to 26.5 GHz                                         | 7.7 % of reading                                          |                                                                                      |               |
| Frequency Modulation<br>– Source <sup>3</sup><br><br>1 dB Rate: DC to 100 kHz<br>3 dB Rate: DC to 10 MHz<br>Dev.: ≤ (N X 800 kHz) | 250 kHz to 40 GHz                                         | 4.2 % setting + 20 Hz                                     | Agilent E8257D                                                                       | OEM and GIDEP |
| Amplitude Modulation<br>– Measure <sup>3</sup><br>Rate: 50 Hz to 10 kHz<br>Depths: 5 % to 99 %                                    | 100 kHz to 10 MHz                                         | 2.2 % of reading                                          | Agilent N5531S<br>measuring receiver with<br>N5532A sensor modules                   | OEM and GIDEP |
| Rate: 50 Hz to 100 kHz<br>Depths: 20 % to 99 %                                                                                    | 10 MHz to 3 GHz                                           | 1.2 % of reading                                          |                                                                                      |               |
| Rate: 50 Hz to 100 kHz<br>Depths: 5 % to 20 %                                                                                     | 10 MHz to 3 GHz                                           | 4.2 % of reading                                          |                                                                                      |               |
| Rate: 50 Hz to 100 kHz<br>Depths: 20 % to 99 %                                                                                    | 3 GHz to 26.5 GHz                                         | 3.5 % of reading                                          |                                                                                      |               |
| Rate: 50 Hz to 100 kHz<br>Depths: 5 % to 20 %                                                                                     | 3 GHz to 26.5 GHz                                         | 6.0 % of reading                                          |                                                                                      |               |

| <b>PARAMETER / EQUIPMENT</b>                                                                                                                                                                                                                                                                                                   | <b>RANGE</b>                                                                                                                                       | <b>BEST MEASUREMENT CAPABILITY [EXPRESSED AS UNCERTAINTY(+)]</b>                                                                         | <b>REFERENCE STANDARD OR EQUIPMENT</b>                             | <b>METHOD(S)</b> |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------|------------------|
| Amplitude Modulation<br>– Source <sup>3</sup><br><br>Rate: DC to 100 kHz<br>Depths: 0 % to 100 %                                                                                                                                                                                                                               | 250 kHz to 40 GHz                                                                                                                                  | 7.1 % setting + 1 %                                                                                                                      | Agilent E8257D                                                     | OEM and GIDEP    |
| Phase Modulation<br>– Source <sup>3</sup><br>Rate: DC to 100 kHz                                                                                                                                                                                                                                                               | 250 kHz to 40 GHz                                                                                                                                  | 5.9 % setting + 0.1 rad                                                                                                                  | Agilent E8257D                                                     | OEM and GIDEP    |
| Pulse Generation<br>– Measure <sup>3</sup><br>DC to 225 MHz<br>Pulse Width<br>Rise/Fall Time                                                                                                                                                                                                                                   | 5 ns to 10 <sup>5</sup> s<br>5 ns to 10 <sup>5</sup> s                                                                                             | 1.1 ns<br>1.1 ns                                                                                                                         | Agilent 53132A                                                     | OEM and GIDEP    |
| Pulse Generation<br>– Source <sup>3</sup><br><br>Repetition Frequency:<br>0.024 Hz to 14.28 MHz<br>Period: 70 ns to 42 s                                                                                                                                                                                                       | 10 ns to 42 s                                                                                                                                      | 17.3 ns                                                                                                                                  | Agilent E8257D                                                     | OEM and GIDEP    |
| Phase Modulation<br>– Measure <sup>3</sup><br><br>Rate: 200 Hz 20 kHz<br>Dev.: > 0.7 rad<br><br>Rate: 200 Hz 20 kHz<br>Dev.: > 0.3 rad<br><br>Rate: 200 Hz 20 kHz<br>Dev.: > 2.0 rad<br><br>Rate: 200 Hz 20 kHz<br>Dev.: > 0.6 rad<br><br>Rate: 200 Hz 20 kHz<br>Dev.: > 2.0 rad<br><br>Rate: 200 Hz 20 kHz<br>Dev.: > 0.6 rad | 100 kHz to 6.6 GHz<br><br>100 kHz to 6.6 GHz<br><br>(6.6 to 13.2) GHz<br><br>(6.6 to 13.2) GHz<br><br>(13.2 to 26.5) GHz<br><br>(13.2 to 26.5) GHz | 1.2 % of reading<br><br>3.6 % of reading<br><br>1.2 % of reading<br><br>3.6 % of reading<br><br>1.2 % of reading<br><br>3.6 % of reading | Agilent N5531S<br>measuring receiver with<br>N5532A sensor modules | OEM and GIDEP    |
| Pulse Modulation<br>– Source <sup>3</sup><br>Level<br><br>Rise/Fall Time                                                                                                                                                                                                                                                       | (0 to 9) dBm<br><br>(0.010 to 40) GHz                                                                                                              | 0.59 dBm<br><br>11.5 ns                                                                                                                  | Agilent E8257D<br><br>Agilent E8257D                               | OEM and GIDEP    |

### III. Optical Radiation

| PARAMETER / EQUIPMENT                                                 | RANGE            | BEST MEASUREMENT CAPABILITY [EXPRESSED AS UNCERTAINTY(+)] | REFERENCE STANDARD OR EQUIPMENT                         | METHOD(S)     |
|-----------------------------------------------------------------------|------------------|-----------------------------------------------------------|---------------------------------------------------------|---------------|
| Optical Power<br>– Measure <sup>3</sup><br>(800 to 1650) nm           | (+20 to -70) dBm | 0.03 dB/dBm                                               | Agilent 8153A, 81533B,<br>and 81525A                    | OEM and GIDEP |
| Optical Power<br>– Source <sup>3</sup><br>1310 nm, 1550 nm            | (0 to -60) dB    | 0.05 dB/dB                                                | Agilent 81554SM,<br>8153A, 81533B,<br>81525A, and 8158B | OEM and GIDEP |
| Optical Attenuation<br>– Generate <sup>3</sup><br>(1 200 to 1 650) nm | (0 to 60) dB     | 0.04 dB/dB                                                | Agilent 8158B                                           | OEM and GIDEP |

### IV. Time and Frequency

| PARAMETER / EQUIPMENT            | RANGE                           | BEST MEASUREMENT CAPABILITY [EXPRESSED AS UNCERTAINTY(+)]        | REFERENCE STANDARD OR EQUIPMENT                                             | METHOD(S)     |
|----------------------------------|---------------------------------|------------------------------------------------------------------|-----------------------------------------------------------------------------|---------------|
| Time Interval <sup>3</sup>       | (1 to 86 400) s                 | 0.00045 s                                                        | Agilent 53132A &<br>Spectracom 8197B                                        | OEM and GIDEP |
| Frequency - Measure <sup>3</sup> | DC to 225 MHz<br>DC to 26.5 GHz | 2.4 parts in 10 <sup>-11</sup><br>2.4 parts in 10 <sup>-11</sup> | Agilent 53132A,<br>Spectracom 8797B<br>Agilent N5531S,<br>Spectracom 8197B  | OEM and GIDEP |
| Frequency - Source <sup>3</sup>  | 10 MHz<br>DC to 40 GHz          | 2.4 parts in 10 <sup>-11</sup><br>2.4 parts in 10 <sup>-11</sup> | Spectracom 8197B<br>Agilent 3325B, Agilent<br>E8257D, & Spectracom<br>8197B | OEM and GIDEP |
| Tachometers <sup>3</sup>         |                                 |                                                                  |                                                                             |               |
| Contact                          | (1 to 6 500) RPM                | 0.08 % of reading                                                | King Nutronics 3711-B                                                       | OEM and GIDEP |
| Non-Contact                      | (500 to 40 000) RPM             |                                                                  |                                                                             |               |
| Non-Contact                      | Up to 100 000 RPM               | 0.005 % of reading                                               | Fluke 5520A                                                                 |               |

## V. Thermodynamic

| PARAMETER / EQUIPMENT              | RANGE           | BEST MEASUREMENT CAPABILITY [EXPRESSED AS UNCERTAINTY(±)] | REFERENCE STANDARD OR EQUIPMENT | METHOD(S)     |
|------------------------------------|-----------------|-----------------------------------------------------------|---------------------------------|---------------|
| Temperature - Source <sup>3</sup>  |                 |                                                           |                                 |               |
| Immersion Probes                   | (-30 to 600) °C | 0.03 °C                                                   | Hart Scientific 9011 with PRT   | OEM and GIDEP |
| Infrared                           | (122 to 932) °F | 0.9 °F                                                    | Hart Scientific 9132            |               |
| Surface Probes                     | (35 to 400) °C  | 1.24 °C                                                   | Hart Scientific 2200            |               |
| Temperature - Measure <sup>3</sup> | (-30 to 600) °C | 0.03 °C                                                   | Hart Scientific 1502 with PRT   | OEM and GIDEP |
| Thermo-Hygrometers                 |                 |                                                           |                                 |               |
| Temperature                        | (0 to 70) °C    | 0.2 °C                                                    | Thunder Scientific 2500         | OEM and GIDEP |
| Humidity                           | (10 to 98) %RH  | 0.9 %RH                                                   |                                 |               |

## VI. Mechanical

| PARAMETER / EQUIPMENT               | RANGE                          | BEST MEASUREMENT CAPABILITY [EXPRESSED AS UNCERTAINTY(±)] | REFERENCE STANDARD OR EQUIPMENT        | METHOD(S)             |
|-------------------------------------|--------------------------------|-----------------------------------------------------------|----------------------------------------|-----------------------|
| Mass                                | 10 lb                          | 135 mg                                                    | Class 1 weights and analytical balance | Modified Substitution |
|                                     | 5 000 g                        | 46.0 mg                                                   |                                        |                       |
|                                     | 3 000 g                        | 30.3 mg                                                   |                                        |                       |
|                                     | 2 000 g                        | 23.2 mg                                                   |                                        |                       |
|                                     | 1 000 g                        | 17.7 mg                                                   |                                        |                       |
|                                     | 500 g                          | 16.1 mg                                                   |                                        |                       |
|                                     | 300 g                          | 15.7 mg                                                   |                                        |                       |
|                                     | 200 g                          | 1.74 mg                                                   |                                        |                       |
|                                     | 100 g                          | 0.89 mg                                                   |                                        |                       |
|                                     | 50 g                           | 0.47 mg                                                   |                                        |                       |
|                                     | 30 g                           | 0.32 mg                                                   |                                        |                       |
|                                     | 20 g                           | 0.25 mg                                                   |                                        |                       |
|                                     | 10 g                           | 0.194 mg                                                  |                                        |                       |
|                                     | 5 g                            | 0.182 mg                                                  |                                        |                       |
|                                     | 3 g                            | 0.175 mg                                                  |                                        |                       |
| 2 g                                 | 0.174 mg                       |                                                           |                                        |                       |
| 1 g                                 | 0.173 mg                       |                                                           |                                        |                       |
| Bench and Floor Scales <sup>3</sup> | Up to 120 lb<br>Up to 5 000 lb | 0.08 lb<br>1 lb                                           | NIST 105 Class F weights               | NIST Handbook 44      |
| Analytical Balances <sup>3</sup>    | Up to 13 kg                    | 28 mg                                                     | ASTM E617 Class 1 weights              | NIST Handbook 44      |

| PARAMETER / EQUIPMENT                         | RANGE                                | BEST MEASUREMENT CAPABILITY [EXPRESSED AS UNCERTAINTY(+)] | REFERENCE STANDARD OR EQUIPMENT | METHOD(S)                        |
|-----------------------------------------------|--------------------------------------|-----------------------------------------------------------|---------------------------------|----------------------------------|
| Hardness Testers <sup>3</sup><br><br>Rockwell | HRA Low<br>HRA Med<br>HRA High       | 1.22 HRA<br>1.24 HRA<br>0.75 HRA                          | Rockwell Test Blocks            | Indirect comparison per ASTM E18 |
|                                               | HRB Low<br>HRB Med<br>HRB High       | 1.39 HRB<br>1.39 HRB<br>1.33 HRB                          |                                 |                                  |
|                                               | HRC Low<br>HRC Med<br>HRC High       | 1.22 HRC<br>1.22 HRC<br>0.70 HRC                          |                                 |                                  |
|                                               | HRE Low<br>HRE Med<br>HRE High       | 1.28 HRE<br>1.42 HRE<br>1.34 HRE                          |                                 |                                  |
|                                               | HRF Low<br>HRF Med<br>HRF High       | 1.43 HRF<br>1.43 HRF<br>1.42 HRF                          |                                 |                                  |
|                                               | HRH Low<br>HRH Med<br>HRH High       | 1.35 HRH<br>1.35 HRH<br>1.35 HRH                          |                                 |                                  |
|                                               | HR15N Low<br>HR15N Med<br>HR15N High | 1.51 HR15N<br>1.24 HR15N<br>0.90 HR15N                    |                                 |                                  |
|                                               | HR30N Low<br>HR30N Med<br>HR30N High | 1.31 HR30N<br>1.25 HR30N<br>0.93 HR30N                    |                                 |                                  |
|                                               | HR45N Low<br>HR45N Med<br>HR45N High | 1.34 HR45N<br>1.26 HR45N<br>0.95 HR45N                    |                                 |                                  |
|                                               | HR15T Low<br>HR15T Med<br>HR15T High | 1.95 HR15T<br>1.40 HR15T<br>1.47 HR15T                    |                                 |                                  |
|                                               | HR30T Low<br>HR30T Med<br>HR30T High | 1.99 HR30T<br>1.51 HR30T<br>1.33 HR30T                    |                                 |                                  |
|                                               | HR45T Low                            | 1.95 HR45T                                                |                                 |                                  |



| <b>PARAMETER / EQUIPMENT</b>                      | <b>RANGE</b>                                                     | <b>BEST MEASUREMENT CAPABILITY [EXPRESSED AS UNCERTAINTY(±)]</b> | <b>REFERENCE STANDARD OR EQUIPMENT</b>         | <b>METHOD(S)</b>                  |
|---------------------------------------------------|------------------------------------------------------------------|------------------------------------------------------------------|------------------------------------------------|-----------------------------------|
| Hardness Testers <sup>3</sup><br>Rockwell (cont.) | HR45T Med<br>HR45T High                                          | 1.33 HR45T<br>1.42 HR45T                                         | Rockwell Test Blocks                           | Indirect comparison per ASTM E18  |
| Brinell                                           | (1 to 7) mm                                                      | 0.026 mm                                                         | Brinell Test Blocks & Brinell Scope            | Indirect comparison per ASTM E10  |
| Knoop                                             | (1 to 200) µm                                                    | 0.25 µm                                                          | Knoop & Vickers Test Blocks                    | Indirect comparison per ASTM E384 |
| Vickers                                           | (1 to 200) µm                                                    | 0.17 µm                                                          |                                                |                                   |
| Durometers <sup>3</sup>                           |                                                                  |                                                                  |                                                |                                   |
| Spring Force<br>Indenter Angle                    | (0.1 to 45.0) N<br>(20 to 40) °                                  | 0.044 N<br>0.07 °                                                | Triple Beam Balance<br>Video Measuring Machine | Per ASTM D2240                    |
| Indenter Length<br>Indenter Radius                | (0.049 to 0.198) in<br>(0.05 to 0.1) in                          | 333 µin<br>337 µin                                               | Gage Blocks<br>Gage Blocks                     |                                   |
| Pressure <sup>3</sup>                             | (-13 to 300) psi<br>(300 to 1 000) psi                           | 0.10 psi<br>1.3 psi                                              | Pressure Calibrator                            | OEM and GIDEP                     |
|                                                   | (1 000 to 10 000) psi<br>(10 000 to 30 000) psi                  | 3.9 psi<br>35.2 psi                                              | Pressure Transducers                           |                                   |
| Pressure                                          | (0.2 to 500) psia<br>(500 to 3 000) psi<br>(3 000 to 16 000) psi | 1.3E-05 psi/psi<br>3.0E -05 psi/psi<br>2.0E-04 psi/psi           | Ruska 2465<br>Ruska 2470<br>Budenburg 380      | OEM and GIDEP                     |
| Force <sup>3</sup>                                | Up to 200 lb                                                     | 0.05 % of reading                                                | Dead Weight                                    | OEM and GIDEP                     |
|                                                   | (200 to 10 000) lb                                               | 0.073 % of reading                                               | Load Cell                                      |                                   |
|                                                   | (10 000 to 50 000) lb                                            | 0.1 % of reading                                                 | Load Cell                                      |                                   |
| Torque – Generate <sup>3</sup>                    | Up to 250 lbf-ft<br>(250 to 2 000) lbf-ft                        | 0.05 % of range<br>0.06 % of range                               | Torque Arms & Dead Weight                      | OEM and GIDEP                     |
| Torque – Measure <sup>3</sup>                     | 4 lbf-in to 2 000 lbf-ft                                         | 0.2 % of reading                                                 | CDI Torque System                              | OEM and GIDEP                     |
| Accelerometers<br>1 g reference<br>1 g reference  | 20 Hz to 2 kHz<br>(2 to 15) kHz                                  | 1.7 % of reading<br>2.6 % of reading                             | PCB 9150C                                      | OEM and GIDEP                     |

## VII. Dimensional

| PARAMETER / EQUIPMENT                                             | RANGE                              | BEST MEASUREMENT CAPABILITY [EXPRESSED AS UNCERTAINTY(+)] | REFERENCE STANDARD OR EQUIPMENT                      | METHOD(S)     |
|-------------------------------------------------------------------|------------------------------------|-----------------------------------------------------------|------------------------------------------------------|---------------|
| Gage Blocks                                                       | Up to 8 in<br>(8 to 20) in         | $(4.6 + 1.6L) \mu\text{in}$<br>$(7.7 + 1L) \mu\text{in}$  | P&W Labmaster<br>OKM OPAL 600                        | ASME B89.1.9  |
| Length Standards                                                  | Up to 9 in<br>(9 to 24) in         | $(39 + 0.4L) \mu\text{in}$<br>$(16 + 0.9L) \mu\text{in}$  | P&W Supermicrometer<br>OKM OPAL 600                  | OEM and GIDEP |
| Cylindrical Rings                                                 | (0.025 to 12) in                   | $(33.9 + 1.7D) \mu\text{in}$                              | OKM OPAL 600                                         | ASME B89.1.6  |
| Cylindrical Plugs <sup>3,5</sup>                                  | (0.01 to 8) in                     | $(21.7 + 0.3D) \mu\text{in}$                              | OKM OPAL 600                                         | OEM and GIDEP |
| Thread Rings<br>Pitch Diameter<br>Minor Diameter                  | (0.01 to 8) in<br>(0.03 to 8) in   | $(236 + 0.3 D) \mu\text{in}$<br>122 $\mu\text{in}$        | Setting Plug Gages<br>ID Bore Gages                  | ASME B1.2     |
| NPT Rings<br>Standoff and Basic Length                            | (0.0625 to 6) in                   | 244 $\mu\text{in}$                                        | NPT plugs and P&W<br>Labmaster                       | ASME B1.20.5  |
| NPT Plugs<br>Standoff and Basic Length                            | (0.0625 to 6) in                   | 488 $\mu\text{in}$                                        | NPT rings and P&W<br>Labmaster                       | ASME B1.20.5  |
| Threaded Plugs <sup>3,5</sup><br>Pitch Diameter<br>Major Diameter | (0.01 to 10) in<br>(0.01 to 10) in | $(73 + 0.9D) \mu\text{in}$<br>$(40 + 1.2D) \mu\text{in}$  | P&W Supermicrometer<br>and Thread Measuring<br>Wires | ASME B1.2     |
| Thread Wires                                                      | (0.005 to 0.5) in                  | $(19.8 + 0.7D) \mu\text{in}$                              | OKM OPAL 600                                         | ASME B89.1.17 |
| Calipers <sup>3</sup>                                             | Up to 40 in                        | $(382 + 15L) \mu\text{in}$                                | Gage Blocks                                          | OEM and GIDEP |
| Dial Indicators <sup>3</sup>                                      | Up to 4 in                         | $(36 + 10L) \mu\text{in}$                                 | Indicator Checker                                    | OEM and GIDEP |
| Test Indicator <sup>3</sup>                                       | Up to 0.06 in                      | 232 $\mu\text{in}$                                        | Indicator Checker                                    | OEM and GIDEP |
| OD Micrometer <sup>3</sup>                                        | Up to 24 in                        | $(62 + 20L) \mu\text{in}$                                 | Gage Blocks                                          | OEM and GIDEP |

| <b>PARAMETER / EQUIPMENT</b>                       | <b>RANGE</b>                                | <b>BEST MEASUREMENT CAPABILITY [EXPRESSED AS UNCERTAINTY(+)]</b> | <b>REFERENCE STANDARD OR EQUIPMENT</b> | <b>METHOD(S)</b> |
|----------------------------------------------------|---------------------------------------------|------------------------------------------------------------------|----------------------------------------|------------------|
| ID Micrometer <sup>3</sup>                         | (1.5 to 24) in                              | (64 + 6L) μin                                                    | Gage Blocks                            | OEM and GIDEP    |
| Height Gages <sup>3</sup>                          | Up to 40 in                                 | (375 + 11L) μin                                                  | Gage Blocks                            | OEM and GIDEP    |
| Bore Gages <sup>3</sup>                            | (0.25 to 12) in                             | 351 μin                                                          | Cylindrical Rings                      | OEM and GIDEP    |
| Crimpers <sup>3</sup><br>Die Check<br>Crimp Height | (0.011 to 0.5) in<br>(0.01 to 0.5) in       | 233 μin<br>0.0012 in                                             | Pin Gages<br>Micrometer                | OEM and GIDEP    |
| Profilometer <sup>3</sup><br>Ra                    | (2 to 300) μin                              | 2.2 μin                                                          | Roughness Specimen                     | OEM and GIDEP    |
| Profilometer Reference<br>Specimens<br>Ra          | (0.01 to 300) μin                           | 2.1 μin                                                          | Profilometer                           | OEM and GIDEP    |
| Surface Plates <sup>3</sup><br>Repeatability       | (4 to 34) in Diagonal                       | (30 + 0.2D) μin                                                  | Repeat – O – Meter                     | OEM and GIDEP    |
| Flatness                                           | (34 to 175) in Diagonal                     | (66 + 0.2D) μin                                                  | Electronic Levels                      |                  |
| CMM Calibration <sup>3</sup><br>Volumetric         | (5 to 40) in                                | (12 + 14L) μin                                                   | Ball Bars                              | B89.4.1          |
| Linearity                                          | (1 to 60) in                                | (7 + 14L) μin                                                    | Step Gage                              |                  |
| Linearity                                          | Above 60 in                                 | (20 + 0.4L) μin                                                  | Renishaw Laser System                  |                  |
| Optical Comparator <sup>3</sup><br>Linearity       | Up to 12 in                                 | (97 + 12L) μin                                                   | Glass Scale / Precision<br>Balls       | OEM and GIDEP    |
| Magnification                                      | 10x, 20x, 31.25x, 50x,<br>62.5x, 100x, 200x | 0.000463 in                                                      | Calibration sphere                     |                  |
| Roundness Testers <sup>3</sup><br>Axial Error      | All                                         | 0.153 μm                                                         | Test Sphere                            | OEM and GIDEP    |
| Radial Error                                       |                                             | 0.153 μm                                                         |                                        |                  |
| ULM <sup>3</sup><br>Length                         | (1 to 100) mm                               | 0.19 μm                                                          | Gage Blocks                            | OEM and GIDEP    |
| Film Thickness Gage <sup>3</sup>                   | (0.01 to 0.06) in                           | 382 μin                                                          | Film Thickness<br>Standards            | OEM and GIDEP    |
| Brinell Scope <sup>3</sup>                         | (1 to 6) mm                                 | 11 μm                                                            | Stage Micrometer                       | OEM and GIDEP    |

### VIII. Fluid Properties

| PARAMETER / EQUIPMENT            | RANGE                            | BEST MEASUREMENT CAPABILITY [EXPRESSED AS UNCERTAINTY(+)] | REFERENCE STANDARD OR EQUIPMENT                  | METHOD(S)                   |
|----------------------------------|----------------------------------|-----------------------------------------------------------|--------------------------------------------------|-----------------------------|
| Refractometers <sup>3</sup>      | (0.0, 18.0, 29.7) BRIX           | 0.24 BRIX                                                 | Refractive Index Solutions                       | OEM and GIDEP               |
| Viscosity Rotational Viscometers | 500 cP<br>5 000 cP               | 0.02 cP/cP                                                | Viscosity Solutions, Temperature Bath            | OEM and GIDEP               |
| Viscosity Cups                   | 17.82 cP<br>65.28 cP<br>231.0 cP | 0.03 cP/cP                                                | Viscosity Solutions, Temperature Bath, Stopwatch | OEM and GIDEP<br>ASTM D4212 |

### IX. Dimensional Inspection / Measurement

| PARAMETER / EQUIPMENT  | RANGE                 | BEST MEASUREMENT CAPABILITY [EXPRESSED AS UNCERTAINTY(+)] | REFERENCE STANDARD OR EQUIPMENT | METHOD(S)         |
|------------------------|-----------------------|-----------------------------------------------------------|---------------------------------|-------------------|
| Dimensional Inspection |                       |                                                           |                                 |                   |
| Volumetric             | 28 in x 40 in x 24 in | 323 μin                                                   | CMM                             | Customer Drawings |
| Linear                 | 24 in x 18 in x 6 in  | (332 + 38L) μin                                           | Video Measuring Machine         |                   |
| Surface Finish (Ra)    | (0.01 to 300) μin     | 2.1 μin                                                   | Profilometer                    | Customer Drawings |

**Notes:**

1. Best Measurement Uncertainties (Expanded Uncertainties) are based on approximately a 95% confidence interval, using a coverage of k=2
2. This laboratory provides field (on-site) and depot-level calibrations. Since field (on-site) conditions are typically more variable than those in the laboratory, larger measurement uncertainties are expected in the field (on-site) than what is reported on the accredited scope.
3. On site capability offered for this parameter.
4. Uncertainties do not include inaccuracies due to sensor mismatch.
5. On site capability for this parameter using plug gage comparator only. Gages up to 4 inches.
6. For uncertainties expressed as b + mL, L = Length in inches.
7. For uncertainties expressed as b + mD, D = Diameter or Diagonal in inches.
8. Where ranges overlap, the uncertainty for the overlapping specifications will be the lower of the two uncertainties.
9. This scope is part of and must be included with the Certificate of Accreditation No. ACT-1272



Vice-President

