**计量技术规范实验报告及不确定度**

LED总光通量标准灯检定规程

**实验报告及不确定度分析**

（2021.05.17）

1. 实验目的

使用副基准级别的LED总光通量标准灯（以下简称标准灯），对工作基准灯级别的LED总光通量标准灯（以下简称被测灯）进行检定，测试新制定的检定规程的可行性。

1. 实验地点及时间

中国计量科学研究院昌平园区14号楼2007室。2021年05月17日。

1. 环境条件

温度21℃，湿度50%。

1. 检定/校准设备

检定装置由设备组成：

1. 副基准级别的LED总光通量标准灯组；
2. 球形光度计，由2.0m 积分球，直流电源和电测仪表组成。
3. 检定/校准人：

 校准人：赵伟强 刘慧

1. 被检/校样品信息：

被测灯是工作基准灯级别的LED总光通量标准灯。

1. 检定/校准方法及结果：

检定方法见“LED总光通量标准灯”检定规程草稿。

该检定实验原始记录如下：

灯 号：GT158

灯电流：90.00 mA

|  |  |
| --- | --- |
| 检定项目 | 检定结果 |
| 外观检查 | 良好 |
| *k*v值 | 0.06231 V-1 |
| 规范灯电压值 | 66.3972 V |
| 相关色温 | 3961 K |
| 稳定性 | -0.017 % / 100h  |
| 规范灯电压下总光通量值 | 1168.2 lm |
| 备注 |

灯 号：GT159

灯电流：90.00 mA

|  |  |
| --- | --- |
| 检定项目 | 检定结果 |
| 外观检查 | 良好 |
| *k*v值 | 0.06141 V-1 |
| 规范灯电压值 | 66.4698 V |
| 相关色温 | 3959 K |
| 稳定性 | -0.013 % / 100h  |
| 规范灯电压下总光通量值 | 1172.8 lm |
| 备注 |

灯 号：GT162

灯电流：90.00 mA

|  |  |
| --- | --- |
| 检定项目 | 检定结果 |
| 外观检查 | 良好 |
| *k*v值 | 0.05762 V-1 |
| 规范灯电压值 | 66.4415 V |
| 相关色温 | 3939 K |
| 稳定性 | -0.017% / 100h  |
| 规范灯电压下总光通量值 | 1172.8 lm |
| 备注 |

7.1（a）外观检查

依据规程，对三只被测灯进行了外观检查，结果良好。

7.1（b）*k*v值的实验结果

灯在点燃过程中的光电流和灯电压的关系数据，截取灯点燃60s后的数据，计算出*k*v如下：

|  |  |  |
| --- | --- | --- |
| GT158 | GT159 | GT162 |
| 运行时间/s | 探测器的光电流/A | 灯电压/V | 运行时间/s | 探测器的光电流/A | 灯电压/V | 运行时间/s | 探测器的光电流/A | 灯电压/V |
| 2.5  | 8.1096E-07 | 67.05613  | 2.5  | 8.1770E-07 | 67.1378  | 2.5  | 8.2394E-07 | 67.3757  |
| 7.5  | 8.0351E-07 | 66.86558  | 7.5  | 8.1027E-07 | 66.9465  | 7.5  | 8.1743E-07 | 67.1889  |
| 12.5  | 7.9792E-07 | 66.73402  | 12.5  | 8.0469E-07 | 66.8145  | 12.5  | 8.1193E-07 | 67.0436  |
| 17.5  | 7.9413E-07 | 66.64777  | 17.5  | 8.0092E-07 | 66.7280  | 17.5  | 8.0768E-07 | 66.9359  |
| 22.5  | 7.9158E-07 | 66.59092  | 22.5  | 7.9836E-07 | 66.6705  | 22.5  | 8.0445E-07 | 66.8562  |
| 27.5  | 7.8982E-07 | 66.55245  | 27.5  | 7.9660E-07 | 66.6317  | 27.5  | 8.0200E-07 | 66.7972  |
| 32.5  | 7.8861E-07 | 66.52618  | 32.5  | 7.9538E-07 | 66.6048  | 32.5  | 8.0014E-07 | 66.7532  |
| 37.5  | 7.8774E-07 | 66.50766  | 37.5  | 7.9450E-07 | 66.5858  | 37.5  | 7.9874E-07 | 66.7203  |
| 42.5  | 7.8711E-07 | 66.49426  | 42.5  | 7.9386E-07 | 66.5720  | 42.5  | 7.9766E-07 | 66.6953  |
| 47.5  | 7.8665E-07 | 66.48436  | 47.5  | 7.9337E-07 | 66.5618  | 47.5  | 7.9683E-07 | 66.6762  |
| 52.5  | 7.8628E-07 | 66.47671  | 52.5  | 7.9300E-07 | 66.5538  | 52.5  | 7.9617E-07 | 66.6613  |
| 57.5  | 7.8599E-07 | 66.47067  | 57.5  | 7.9271E-07 | 66.5476  | 57.5  | 7.9565E-07 | 66.6496  |
| 62.5  | 7.8575E-07 | 66.46569  | 62.5  | 7.9247E-07 | 66.5424  | 62.5  | 7.9524E-07 | 66.6403  |
| 67.5  | 7.8555E-07 | 66.46153  | 67.5  | 7.9226E-07 | 66.5381  | 67.5  | 7.9490E-07 | 66.6326  |
| 72.5  | 7.8538E-07 | 66.45794  | 72.5  | 7.9209E-07 | 66.5345  | 72.5  | 7.9462E-07 | 66.6263  |
| 77.5  | 7.8522E-07 | 66.45481  | 77.5  | 7.9193E-07 | 66.5312  | 77.5  | 7.9438E-07 | 66.6209  |
| 82.5  | 7.8509E-07 | 66.45201  | 82.5  | 7.9180E-07 | 66.5284  | 82.5  | 7.9417E-07 | 66.6163  |
| 87.5  | 7.8496E-07 | 66.44946  | 87.5  | 7.9168E-07 | 66.5258  | 87.5  | 7.9399E-07 | 66.6123  |
| 92.5  | 7.8485E-07 | 66.44713  | 92.5  | 7.9156E-07 | 66.5235  | 92.5  | 7.9383E-07 | 66.6088  |
| 97.5  | 7.8474E-07 | 66.44497  | 97.5  | 7.9146E-07 | 66.5213  | 97.5  | 7.9369E-07 | 66.6057  |
| 102.5  | 7.8465E-07 | 66.44295  | 102.5  | 7.9136E-07 | 66.5193  | 102.5  | 7.9356E-07 | 66.6028  |
| 107.5  | 7.8456E-07 | 66.44105  | 107.5  | 7.9127E-07 | 66.5174  | 107.5  | 7.9344E-07 | 66.6002  |
| 112.5  | 7.8446E-07 | 66.43928  | 112.5  | 7.9118E-07 | 66.5156  | 112.5  | 7.9333E-07 | 66.5978  |
| 117.5  | 7.8439E-07 | 66.43758  | 117.5  | 7.9110E-07 | 66.5139  | 117.5  | 7.9323E-07 | 66.5956  |
| 122.5  | 7.8431E-07 | 66.43598  | 122.5  | 7.9103E-07 | 66.5123  | 122.7  | 7.9313E-07 | 66.5935  |
| 127.5  | 7.8423E-07 | 66.43445  | 127.5  | 7.9095E-07 | 66.5108  | 127.5  | 7.9305E-07 | 66.5916  |
| 132.5  | 7.8417E-07 | 66.43298  | 132.5  | 7.9088E-07 | 66.5094  | 132.5  | 7.9297E-07 | 66.5898  |
| 137.5  | 7.8410E-07 | 66.43158  | 137.5  | 7.9082E-07 | 66.5080  | 137.5  | 7.9289E-07 | 66.5881  |
| 142.5  | 7.8403E-07 | 66.43027  | 142.5  | 7.9075E-07 | 66.5067  | 142.5  | 7.9282E-07 | 66.5865  |
| 147.5  | 7.8397E-07 | 66.42901  | 147.5  | 7.9069E-07 | 66.5054  | 147.5  | 7.9274E-07 | 66.5849  |
| 152.5  | 7.8391E-07 | 66.42782  | 152.5  | 7.9063E-07 | 66.5042  | 152.5  | 7.9267E-07 | 66.5834  |
| 157.5  | 7.8386E-07 | 66.42667  | 157.5  | 7.9058E-07 | 66.5030  | 157.5  | 7.9261E-07 | 66.5820  |
| 162.5  | 7.8380E-07 | 66.42556  | 162.5  | 7.9052E-07 | 66.5019  | 162.5  | 7.9254E-07 | 66.5806  |
| 167.5  | 7.8375E-07 | 66.42452  | 167.5  | 7.9047E-07 | 66.5008  | 167.5  | 7.9248E-07 | 66.5793  |
| 172.5  | 7.8370E-07 | 66.42352  | 172.5  | 7.9042E-07 | 66.4997  | 172.5  | 7.9243E-07 | 66.5780  |
| 177.5  | 7.8366E-07 | 66.42256  | 177.5  | 7.9037E-07 | 66.4987  | 177.5  | 7.9237E-07 | 66.5768  |
| 182.6  | 7.8361E-07 | 66.42165  | 182.5  | 7.9032E-07 | 66.4977  | 182.5  | 7.9232E-07 | 66.5757  |
| 187.5  | 7.8357E-07 | 66.42076  | 187.5  | 7.9027E-07 | 66.4967  | 187.5  | 7.9227E-07 | 66.5745  |
| 192.5  | 7.8353E-07 | 66.41991  | 192.5  | 7.9023E-07 | 66.4958  | 192.5  | 7.9222E-07 | 66.5734  |
| 197.5  | 7.8349E-07 | 66.41907  | 197.5  | 7.9018E-07 | 66.4949  | 197.5  | 7.9217E-07 | 66.5723  |
| 202.5  | 7.8345E-07 | 66.41828  | 202.5  | 7.9014E-07 | 66.4940  | 202.5  | 7.9212E-07 | 66.5713  |
| 207.6  | 7.8341E-07 | 66.41750  | 207.5  | 7.9010E-07 | 66.4932  | 207.5  | 7.9207E-07 | 66.5703  |
| 212.5  | 7.8337E-07 | 66.41675  | 212.5  | 7.9006E-07 | 66.4924  | 212.5  | 7.9203E-07 | 66.5693  |
| 217.5  | 7.8334E-07 | 66.41601  | 217.5  | 7.9003E-07 | 66.4915  | 217.5  | 7.9199E-07 | 66.5684  |
| 222.5  | 7.8330E-07 | 66.41528  | 222.5  | 7.8998E-07 | 66.4907  | 222.5  | 7.9195E-07 | 66.5675  |
| 227.5  | 7.8327E-07 | 66.41455  | 227.5  | 7.8995E-07 | 66.4900  | 227.5  | 7.9190E-07 | 66.5666  |
| 232.5  | 7.8323E-07 | 66.41384  | 232.5  | 7.8991E-07 | 66.4892  | 232.5  | 7.9186E-07 | 66.5657  |
| 237.5  | 7.8320E-07 | 66.41312  | 237.5  | 7.8987E-07 | 66.4884  | 237.5  | 7.9182E-07 | 66.5648  |
| 242.5  | 7.8317E-07 | 66.41245  | 242.5  | 7.8984E-07 | 66.4877  | 242.5  | 7.9179E-07 | 66.5639  |
| 247.5  | 7.8314E-07 | 66.41183  | 247.5  | 7.8980E-07 | 66.4870  | 247.5  | 7.9175E-07 | 66.5631  |
| 252.5  | 7.8310E-07 | 66.41120  | 252.5  | 7.8977E-07 | 66.4863  | 252.5  | 7.9171E-07 | 66.5623  |
| 257.5  | 7.8307E-07 | 66.41062  | 257.5  | 7.8974E-07 | 66.4857  | 257.5  | 7.9168E-07 | 66.5616  |
| 262.5  | 7.8305E-07 | 66.41001  | 262.5  | 7.8971E-07 | 66.4850  | 262.5  | 7.9164E-07 | 66.5608  |
| 267.5  | 7.8302E-07 | 66.40943  | 267.5  | 7.8968E-07 | 66.4844  | 267.5  | 7.9161E-07 | 66.5601  |
| 272.5  | 7.8299E-07 | 66.40885  | 272.5  | 7.8965E-07 | 66.4838  | 272.5  | 7.9158E-07 | 66.5594  |
| 277.5  | 7.8296E-07 | 66.40827  | 277.5  | 7.8962E-07 | 66.4832  | 277.5  | 7.9155E-07 | 66.5587  |
| 282.5  | 7.8293E-07 | 66.40771  | 282.5  | 7.8960E-07 | 66.4826  | 282.5  | 7.9152E-07 | 66.5580  |
| 287.5  | 7.8291E-07 | 66.40717  | 287.5  | 7.8957E-07 | 66.4820  | 287.5  | 7.9149E-07 | 66.5574  |
| 292.5  | 7.8288E-07 | 66.40664  | 292.5  | 7.8954E-07 | 66.4815  | 292.5  | 7.9146E-07 | 66.5568  |
| 297.5  | 7.8286E-07 | 66.40613  | 297.5  | 7.8952E-07 | 66.4810  | 297.5  | 7.9143E-07 | 66.5562  |
| 302.5  | 7.8283E-07 | 66.40563  | 302.5  | 7.8949E-07 | 66.4805  | 302.5  | 7.9141E-07 | 66.5556  |
| 307.5  | 7.8281E-07 | 66.40514  | 307.5  | 7.8947E-07 | 66.4800  | 307.5  | 7.9138E-07 | 66.5550  |
| 312.5  | 7.8279E-07 | 66.40465  | 312.5  | 7.8945E-07 | 66.4795  | 312.5  | 7.9135E-07 | 66.5545  |
| 317.5  | 7.8276E-07 | 66.40417  | 317.5  | 7.8943E-07 | 66.4791  | 317.5  | 7.9133E-07 | 66.5539  |
| 322.5  | 7.8274E-07 | 66.40371  | 322.5  | 7.8940E-07 | 66.4786  | 322.5  | 7.9131E-07 | 66.5534  |
| 327.5  | 7.8272E-07 | 66.40326  | 327.5  | 7.8938E-07 | 66.4782  | 327.5  | 7.9128E-07 | 66.5529  |
| 332.5  | 7.8270E-07 | 66.40281  | 332.5  | 7.8936E-07 | 66.4778  | 332.5  | 7.9126E-07 | 66.5523  |
| 337.5  | 7.8268E-07 | 66.40238  | 337.5  | 7.8934E-07 | 66.4773  | 337.5  | 7.9123E-07 | 66.5519  |
| 342.5  | 7.8266E-07 | 66.40197  | 342.5  | 7.8932E-07 | 66.4769  | 342.5  | 7.9122E-07 | 66.5514  |
| 347.5  | 7.8263E-07 | 66.40157  | 347.5  | 7.8930E-07 | 66.4765  | 347.5  | 7.9119E-07 | 66.5510  |
| 352.5  | 7.8262E-07 | 66.40118  | 352.5  | 7.8928E-07 | 66.4762  | 352.5  | 7.9117E-07 | 66.5505  |
| 357.5  | 7.8260E-07 | 66.40080  | 357.5  | 7.8926E-07 | 66.4758  | 357.5  | 7.9116E-07 | 66.5501  |
| 362.5  | 7.8258E-07 | 66.40043  | 362.5  | 7.8924E-07 | 66.4754  | 362.5  | 7.9114E-07 | 66.5497  |
| 367.5  | 7.8256E-07 | 66.40008  | 367.5  | 7.8923E-07 | 66.4750  | 367.5  | 7.9112E-07 | 66.5493  |
| 372.5  | 7.8255E-07 | 66.39972  | 372.5  | 7.8921E-07 | 66.4746  | 372.5  | 7.9110E-07 | 66.5489  |
| 377.5  | 7.8253E-07 | 66.39939  | 377.5  | 7.8919E-07 | 66.4743  | 377.5  | 7.9108E-07 | 66.5485  |
| 382.5  | 7.8252E-07 | 66.39908  | 382.5  | 7.8917E-07 | 66.4740  | 382.5  | 7.9107E-07 | 66.5481  |
| 387.5  | 7.8250E-07 | 66.39876  | 387.5  | 7.8916E-07 | 66.4736  | 387.5  | 7.9105E-07 | 66.5478  |
| 392.5  | 7.8248E-07 | 66.39846  | 392.5  | 7.8914E-07 | 66.4733  | 392.5  | 7.9103E-07 | 66.5474  |
| 397.5  | 7.8247E-07 | 66.39816  | 397.5  | 7.8913E-07 | 66.4730  | 397.5  | 7.9102E-07 | 66.5471  |
| 402.5  | 7.8246E-07 | 66.39790  | 402.5  | 7.8911E-07 | 66.4727  | 402.5  | 7.9100E-07 | 66.5467  |
| 407.5  | 7.8245E-07 | 66.39762  | 407.5  | 7.8910E-07 | 66.4724  | 407.5  | 7.9099E-07 | 66.5464  |
| 412.5  | 7.8243E-07 | 66.39735  | 412.5  | 7.8909E-07 | 66.4722  | 412.5  | 7.9097E-07 | 66.5461  |
| 417.5  | 7.8242E-07 | 66.39708  | 417.5  | 7.8907E-07 | 66.4719  | 417.5  | 7.9096E-07 | 66.5458  |
| 422.5  | 7.8241E-07 | 66.39683  | 422.6  | 7.8906E-07 | 66.4716  | 422.5  | 7.9094E-07 | 66.5455  |
| 427.5  | 7.8239E-07 | 66.39656  | 427.6  | 7.8905E-07 | 66.4714  | 427.5  | 7.9093E-07 | 66.5452  |
| 432.5  | 7.8238E-07 | 66.39634  | 432.5  | 7.8903E-07 | 66.4711  | 432.5  | 7.9092E-07 | 66.5449  |
| 437.5  | 7.8237E-07 | 66.39610  | 437.5  | 7.8902E-07 | 66.4709  | 437.5  | 7.9091E-07 | 66.5447  |
| 442.5  | 7.8236E-07 | 66.39587  | 442.5  | 7.8901E-07 | 66.4706  | 442.5  | 7.9089E-07 | 66.5444  |
| 447.5  | 7.8235E-07 | 66.39564  | 447.5  | 7.8900E-07 | 66.4704  | 447.5  | 7.9088E-07 | 66.5441  |
| 452.5  | 7.8234E-07 | 66.39543  | 452.6  | 7.8899E-07 | 66.4701  | 452.5  | 7.9087E-07 | 66.5439  |
| 457.5  | 7.8233E-07 | 66.39522  | 457.6  | 7.8898E-07 | 66.4699  | 457.5  | 7.9086E-07 | 66.5436  |
| 462.5  | 7.8232E-07 | 66.39502  | 462.5  | 7.8897E-07 | 66.4697  | 462.5  | 7.9085E-07 | 66.5434  |
| 467.5  | 7.8231E-07 | 66.39483  | 467.5  | 7.8895E-07 | 66.4695  | 467.5  | 7.9084E-07 | 66.5432  |
| 472.5  | 7.8230E-07 | 66.39464  | 472.6  | 7.8894E-07 | 66.4693  | 472.5  | 7.9083E-07 | 66.5429  |
| 477.5  | 7.8229E-07 | 66.39445  | 477.6  | 7.8894E-07 | 66.4691  | 477.5  | 7.9082E-07 | 66.5427  |
| 482.5  | 7.8228E-07 | 66.39428  | 482.5  | 7.8893E-07 | 66.4689  | 482.5  | 7.9081E-07 | 66.5425  |
| 487.5  | 7.8227E-07 | 66.39410  | 487.6  | 7.8891E-07 | 66.4687  | 487.5  | 7.9080E-07 | 66.5423  |
| 492.5  | 7.8226E-07 | 66.39394  | 492.6  | 7.8891E-07 | 66.4685  | 492.5  | 7.9079E-07 | 66.5421  |
| 497.5  | 7.8226E-07 | 66.39378  | 497.5  | 7.8890E-07 | 66.4684  | 497.5  | 7.9078E-07 | 66.5419  |
| 502.5  | 7.8225E-07 | 66.39361  | 502.5  | 7.8889E-07 | 66.4682  | 502.5  | 7.9077E-07 | 66.5417  |
| 507.5  | 7.8224E-07 | 66.39346  | 507.5  | 7.8888E-07 | 66.4680  | 507.5  | 7.9076E-07 | 66.5416  |
| 512.5  | 7.8223E-07 | 66.39332  | 512.5  | 7.8887E-07 | 66.4679  | 512.5  | 7.9076E-07 | 66.5414  |
| 517.5  | 7.8223E-07 | 66.39317  | 517.5  | 7.8887E-07 | 66.4677  | 517.5  | 7.9075E-07 | 66.5412  |
| 522.5  | 7.8222E-07 | 66.39305  | 522.5  | 7.8886E-07 | 66.4676  | 522.5  | 7.9074E-07 | 66.5411  |
| 527.5  | 7.8221E-07 | 66.39291  | 527.5  | 7.8885E-07 | 66.4674  | 527.5  | 7.9073E-07 | 66.5409  |
| 532.5  | 7.8221E-07 | 66.39276  | 532.5  | 7.8884E-07 | 66.4673  | 532.5  | 7.9072E-07 | 66.5407  |
| 537.5  | 7.8220E-07 | 66.39263  | 537.5  | 7.8884E-07 | 66.4671  | 537.5  | 7.9072E-07 | 66.5406  |
| 542.5  | 7.8220E-07 | 66.39251  | 542.5  | 7.8883E-07 | 66.4670  | 542.5  | 7.9071E-07 | 66.5404  |
| 547.5  | 7.8219E-07 | 66.39239  | 547.5  | 7.8883E-07 | 66.4669  | 547.5  | 7.9070E-07 | 66.5403  |
| 552.5  | 7.8218E-07 | 66.39228  | 552.5  | 7.8882E-07 | 66.4667  | 552.5  | 7.9070E-07 | 66.5401  |
| 557.5  | 7.8218E-07 | 66.39215  | 557.5  | 7.8881E-07 | 66.4666  | 557.5  | 7.9069E-07 | 66.5400  |
| 562.5  | 7.8217E-07 | 66.39203  | 562.5  | 7.8881E-07 | 66.4665  | 562.5  | 7.9068E-07 | 66.5398  |
| 567.5  | 7.8217E-07 | 66.39192  | 567.5  | 7.8880E-07 | 66.4664  | 567.5  | 7.9068E-07 | 66.5397  |
| 572.5  | 7.8216E-07 | 66.39181  | 572.5  | 7.8880E-07 | 66.4663  | 572.5  | 7.9068E-07 | 66.5396  |
| 577.5  | 7.8215E-07 | 66.39170  | 577.5  | 7.8879E-07 | 66.4661  | 577.5  | 7.9067E-07 | 66.5394  |
| 582.5  | 7.8215E-07 | 66.39160  | 582.5  | 7.8878E-07 | 66.4660  | 582.5  | 7.9066E-07 | 66.5393  |
| 587.5  | 7.8214E-07 | 66.39149  | 587.5  | 7.8878E-07 | 66.4659  | 587.5  | 7.9066E-07 | 66.5392  |
| 592.5  | 7.8214E-07 | 66.39139  | 592.5  | 7.8878E-07 | 66.4658  | 592.5  | 7.9065E-07 | 66.5391  |
| 597.5  | 7.8213E-07 | 66.39129  | 597.5  | 7.8877E-07 | 66.4657  | 597.5  | 7.9064E-07 | 66.5390  |
| 602.5  | 7.8213E-07 | 66.39120  | 602.5  | 7.8876E-07 | 66.4656  | 602.5  | 7.9064E-07 | 66.5389  |
| 607.5  | 7.8212E-07 | 66.39110  | 607.5  | 7.8876E-07 | 66.4655  | 607.5  | 7.9064E-07 | 66.5388  |
| 612.5  | 7.8212E-07 | 66.39100  | 612.5  | 7.8875E-07 | 66.4654  | 612.5  | 7.9063E-07 | 66.5386  |
| 617.5  | 7.8211E-07 | 66.39092  | 617.5  | 7.8875E-07 | 66.4654  | 617.5  | 7.9063E-07 | 66.5386  |
| 622.5  | 7.8211E-07 | 66.39083  | 622.5  | 7.8875E-07 | 66.4653  | 622.5  | 7.9062E-07 | 66.5384  |
| 627.5  | 7.8211E-07 | 66.39076  | 627.5  | 7.8875E-07 | 66.4652  | 627.5  | 7.9061E-07 | 66.5384  |
| 632.5  | 7.8210E-07 | 66.39068  | 632.5  | 7.8874E-07 | 66.4652  | 632.5  | 7.9061E-07 | 66.5382  |
| 637.5  | 7.8210E-07 | 66.39061  | 637.5  | 7.8874E-07 | 66.4651  | 637.5  | 7.9061E-07 | 66.5382  |
| 642.5  | 7.8210E-07 | 66.39055  | 642.5  | 7.8873E-07 | 66.4650  | 642.5  | 7.9060E-07 | 66.5381  |
| 647.5  | 7.8209E-07 | 66.39047  | 647.5  | 7.8873E-07 | 66.4649  | 647.5  | 7.9060E-07 | 66.5380  |
| 652.5  | 7.8209E-07 | 66.39042  | 652.5  | 7.8873E-07 | 66.4649  | 652.5  | 7.9060E-07 | 66.5379  |
| 657.5  | 7.8209E-07 | 66.39036  | 657.5  | 7.8872E-07 | 66.4648  | 657.5  | 7.9059E-07 | 66.5378  |
| 662.5  | 7.8208E-07 | 66.39031  | 662.5  | 7.8872E-07 | 66.4648  | 662.5  | 7.9059E-07 | 66.5378  |
| 667.5  | 7.8208E-07 | 66.39027  | 667.5  | 7.8872E-07 | 66.4647  | 667.5  | 7.9058E-07 | 66.5377  |
| 672.5  | 7.8208E-07 | 66.39021  | 672.5  | 7.8871E-07 | 66.4646  | 672.5  | 7.9058E-07 | 66.5376  |
| 677.5  | 7.8207E-07 | 66.39017  | 677.5  | 7.8871E-07 | 66.4646  | 677.5  | 7.9058E-07 | 66.5375  |
| 682.5  | 7.8207E-07 | 66.39011  | 682.5  | 7.8871E-07 | 66.4645  | 682.5  | 7.9058E-07 | 66.5375  |
| 687.5  | 7.8207E-07 | 66.39006  | 687.5  | 7.8870E-07 | 66.4644  | 687.5  | 7.9057E-07 | 66.5374  |
| 692.5  | 7.8207E-07 | 66.39002  | 692.5  | 7.8870E-07 | 66.4644  | 692.5  | 7.9057E-07 | 66.5373  |
| 697.5  | 7.8207E-07 | 66.38997  | 697.5  | 7.8870E-07 | 66.4644  | 697.5  | 7.9057E-07 | 66.5373  |
| 702.5  | 7.8206E-07 | 66.38990  | 702.5  | 7.8869E-07 | 66.4643  | 702.5  | 7.9057E-07 | 66.5372  |
| 707.5  | 7.8206E-07 | 66.38985  | 707.5  | 7.8869E-07 | 66.4642  | 707.5  | 7.9056E-07 | 66.5371  |
| 712.5  | 7.8206E-07 | 66.38980  | 712.5  | 7.8869E-07 | 66.4642  | 712.5  | 7.9056E-07 | 66.5371  |
| 717.5  | 7.8206E-07 | 66.38974  | 717.5  | 7.8869E-07 | 66.4641  | 717.5  | 7.9056E-07 | 66.5370  |
| 722.5  | 7.8205E-07 | 66.38971  | 722.5  | 7.8869E-07 | 66.4641  | 722.6  | 7.9055E-07 | 66.5370  |
| 727.5  | 7.8205E-07 | 66.38967  | 727.5  | 7.8868E-07 | 66.4641  | 727.5  | 7.9055E-07 | 66.5369  |
| 732.5  | 7.8205E-07 | 66.38963  | 732.5  | 7.8868E-07 | 66.4640  | 732.5  | 7.9054E-07 | 66.5369  |
| 737.5  | 7.8204E-07 | 66.38957  | 737.5  | 7.8868E-07 | 66.4639  | 737.5  | 7.9054E-07 | 66.5368  |
| 742.5  | 7.8204E-07 | 66.38953  | 742.5  | 7.8868E-07 | 66.4639  | 742.6  | 7.9054E-07 | 66.5367  |
| 747.5  | 7.8204E-07 | 66.38949  | 747.5  | 7.8868E-07 | 66.4639  | 747.6  | 7.9054E-07 | 66.5367  |
| 752.5  | 7.8204E-07 | 66.38945  | 752.5  | 7.8867E-07 | 66.4638  | 752.6  | 7.9054E-07 | 66.5367  |
| 757.5  | 7.8204E-07 | 66.38941  | 757.5  | 7.8867E-07 | 66.4638  | 757.6  | 7.9053E-07 | 66.5366  |
| 762.5  | 7.8203E-07 | 66.38937  | 762.5  | 7.8867E-07 | 66.4638  | 762.6  | 7.9053E-07 | 66.5366  |
| 767.5  | 7.8203E-07 | 66.38935  | 767.5  | 7.8867E-07 | 66.4637  | 767.6  | 7.9053E-07 | 66.5365  |
| 772.5  | 7.8203E-07 | 66.38931  | 772.5  | 7.8867E-07 | 66.4637  | 772.6  | 7.9052E-07 | 66.5365  |
| 777.5  | 7.8203E-07 | 66.38927  | 777.5  | 7.8866E-07 | 66.4637  | 777.6  | 7.9053E-07 | 66.5364  |
| 782.5  | 7.8203E-07 | 66.38923  | 782.5  | 7.8866E-07 | 66.4636  | 782.6  | 7.9052E-07 | 66.5364  |
| 787.5  | 7.8203E-07 | 66.38920  | 787.5  | 7.8866E-07 | 66.4636  | 787.6  | 7.9053E-07 | 66.5364  |
| 792.5  | 7.8202E-07 | 66.38916  | 792.5  | 7.8866E-07 | 66.4636  | 792.6  | 7.9052E-07 | 66.5363  |
| 797.5  | 7.8202E-07 | 66.38913  | 797.5  | 7.8866E-07 | 66.4635  | 797.6  | 7.9052E-07 | 66.5363  |
| 802.5  | 7.8202E-07 | 66.38912  | 802.5  | 7.8866E-07 | 66.4635  | 802.6  | 7.9052E-07 | 66.5362  |
| 807.5  | 7.8202E-07 | 66.38907  | 807.5  | 7.8865E-07 | 66.4635  | 807.6  | 7.9052E-07 | 66.5362  |
| 812.5  | 7.8202E-07 | 66.38904  | 812.5  | 7.8865E-07 | 66.4635  | 812.6  | 7.9052E-07 | 66.5362  |
| 817.5  | 7.8201E-07 | 66.38901  | 817.5  | 7.8865E-07 | 66.4634  | 817.6  | 7.9051E-07 | 66.5361  |
| 822.5  | 7.8201E-07 | 66.38899  | 822.5  | 7.8865E-07 | 66.4634  | 822.6  | 7.9051E-07 | 66.5361  |
| 827.5  | 7.8201E-07 | 66.38896  | 827.5  | 7.8865E-07 | 66.4634  | 827.6  | 7.9051E-07 | 66.5361  |
| 832.5  | 7.8201E-07 | 66.38893  | 832.5  | 7.8865E-07 | 66.4634  | 832.6  | 7.9051E-07 | 66.5360  |
| 837.5  | 7.8201E-07 | 66.38892  | 837.5  | 7.8864E-07 | 66.4633  | 837.6  | 7.9051E-07 | 66.5360  |
| 842.5  | 7.8201E-07 | 66.38890  | 842.5  | 7.8864E-07 | 66.4633  | 842.6  | 7.9050E-07 | 66.5360  |
| 847.5  | 7.8201E-07 | 66.38887  | 847.5  | 7.8864E-07 | 66.4633  | 847.6  | 7.9050E-07 | 66.5359  |
| 852.5  | 7.8201E-07 | 66.38885  | 852.5  | 7.8864E-07 | 66.4633  | 852.6  | 7.9050E-07 | 66.5359  |
| 857.5  | 7.8201E-07 | 66.38884  | 857.5  | 7.8864E-07 | 66.4632  | 857.6  | 7.9050E-07 | 66.5359  |
| 862.5  | 7.8200E-07 | 66.38880  | 862.5  | 7.8864E-07 | 66.4632  | 862.6  | 7.9050E-07 | 66.5359  |
| 867.5  | 7.8200E-07 | 66.38879  | 867.5  | 7.8864E-07 | 66.4632  | 867.6  | 7.9050E-07 | 66.5358  |
| 872.5  | 7.8200E-07 | 66.38876  | 872.5  | 7.8864E-07 | 66.4632  | 872.6  | 7.9050E-07 | 66.5358  |
| 877.5  | 7.8200E-07 | 66.38876  | 877.5  | 7.8864E-07 | 66.4632  | 877.6  | 7.9049E-07 | 66.5358  |
| 882.5  | 7.8200E-07 | 66.38873  | 882.5  | 7.8863E-07 | 66.4631  | 882.6  | 7.9049E-07 | 66.5358  |
| 887.5  | 7.8200E-07 | 66.38871  | 887.5  | 7.8863E-07 | 66.4631  | 887.6  | 7.9049E-07 | 66.5357  |
| 892.5  | 7.8200E-07 | 66.38868  | 892.5  | 7.8863E-07 | 66.4631  | 892.6  | 7.9049E-07 | 66.5357  |
| 897.5  | 7.8199E-07 | 66.38866  | 897.5  | 7.8863E-07 | 66.4631  | 897.6  | 7.9049E-07 | 66.5357  |
| 902.5  | 7.8199E-07 | 66.38864  | 902.5  | 7.8863E-07 | 66.4631  | 902.6  | 7.9049E-07 | 66.5357  |
| *k*v值计算结果：GT158: 0.06231 V-1GT159: 0.06141 V-1GT162: 0.05762 V-1 |

7.1 (c) 规范灯电压值的实验结果

根据规程规定，控制室内环境温度，使得球内环境温度处于（25±1）℃，在2.0m积分球内测试了被测灯的灯端电压值，在预热15分钟后，记录灯端电压值。实验结果记录如下：

GT158: 66.39721 V

GT159: 66.46979 V

GT162: 66.44150 V

7.1(d) 相关色温测试的实验结果

根据规程规定，使用光谱总辐射通量标准灯定标带光谱辐射计的球形光度计（积分式光谱辐射计），被测灯按规定的工作电流依次在积分球内点燃，测量其平均颜色温度。相关数据如下：

|  |  |  |  |
| --- | --- | --- | --- |
|  | GT158 | GT159 | GT162 |
| CCT [K] | 3961.139312 | 3959.320727 | 3939.002441 |
| ColorCoordinates/x | 0.385610572 | 0.38575597 | 0.385731682 |
| ColorCoordinates/y | 0.390029924 | 0.390299317 | 0.387469296 |
| ColorCoordinates/z | 0.224359504 | 0.223944713 | 0.226799022 |
| ColorCoordinates/u | 0.223246706 | 0.223235829 | 0.224322332 |
| ColorCoordinates/v1976 | 0.508061837 | 0.508196364 | 0.506998894 |
| PeakWavelength [nm] | 447.9646886 | 447.4406209 | 447.9325118 |
| CentroidWavelength [nm] | 564.9496771 | 564.8990839 | 564.9756648 |
| DominantWavelength [nm] | 577.0542821 | 577.0301399 | 577.6521666 |

因此，可得GT158、GT159和GT159相关色温的测试结果分别是3961K，3959K和3939 K。

7.1（e）长期稳定性的实验结果

依据规程，测试灯的长期稳定稳定测试数据如下：

|  |
| --- |
| GT158 |
| 测试次数 | 灯电压/V | 规范灯电压下的总光通量/lm | 累计点燃时间/h |
| 1 | 66.3972  | 1168.7 | 0 |
| 2 | 66.3955  | 1168.0 | 209 |
| 3 | 66.3884 | 1167.8 | 452 |

按规程规定的计算可得

$$η\_{100}=\frac{1167.8−1168.7}{1168.7}∙\frac{100}{452}×100\%=−0.017\%$$

|  |
| --- |
| GT159 |
| 测试次数 | 灯电压/V | 规范灯电压下的总光通量/lm | 累计点燃时间/h |
| 1 | 66.4698 | 1178.9 | 0 |
| 2 | 66.4741 | 1178.1 | 209 |
| 3 | 66.4661 | 1178.2 | 452 |

按规程规定的计算可得

$$η\_{100}=\frac{1178.2−1178.9}{1178.9}∙\frac{100}{452}×100\%=−0.013\%$$

|  |
| --- |
| GT162 |
| 测试次数 | 灯电压/V | 规范灯电压下的总光通量/lm | 累计点燃时间/h |
| 1 | 66.5412 | 1174.9 | 0 |
| 2 | 66.5454 | 1174.3 | 209 |
| 3 | 66.5381 | 1174.0 | 452 |

按规程规定的计算可得

$$η\_{100}=\frac{1174.0−1174.9}{1174.9}∙\frac{100}{452}×100\%=−0.017\%$$

7.1（f）规范灯电压下总光通量值的检定结果

依据检定规程，被测灯在规范电压下总光通量的检定结果 GT158是1168.2 lm, GT159是1172.7 lm, GT162是1169.9 lm。原始记录如下：

|  |
| --- |
| LED总光通量检定原始记录（二） |
|  |  |  |  |  |  |  | 共 页 第 页 |
| 检验类别 | 检定 |
| 技术依据 | 本检定规程草稿 |
| 检测主要设备 | 标准灯组及其级别：GT133等副基准级别的LED总光通量标准灯 |
| 积分球系统装置：2.0 m积分球系统 |
| 光度测量系统：Inphora光度探头、CAS140D光谱辐射计 |
| 供电电源：吉时利 2430、2460、2200 |
| 实验条件 | 系统预热时间：30 mins |
| 标准灯光通量常数 | 基本信息 | 标准值相关参数 | 实验结果 |
| 灯号 | 灯电流/mA | 规范灯电压值/V | 总光通量-电压温度系数*k*v/V-1 | 规范灯电压下的总通量值/lm | 灯电压/V | 光电流计读数 | 光通量常数*C* | 相对偏差 |
|
| GT133 | 90.00  | 66.5417  | 0.05464  | 1157.0  | 66.6353  | 7.7909E-07 | 1.4927E+09 | -0.02% |
| GT138-HX | 90.00  | 65.6709  | 0.06830  | 1001.3  | 65.7687  | 6.7508E-07 | 1.4931E+09 | 0.02% |
| GT140 | 90.00  | 66.3639  | 0.06397  | 1176.4  | 66.4545  | 7.9244E-07 | 1.4931E+09 | 0.02% |
| GT141 | 90.00  | 66.3243  | 0.06543  | 1173.5  | 66.4128  | 7.9056E-07 | 1.4930E+09 | 0.01% |
| GT143 | 90.00  | 66.3530  | 0.06237  | 1148.6  | 66.4486  | 7.7416E-07 | 1.4925E+09 | -0.02% |
| GT157 | 90.00  | 66.3780  | 0.05948  | 1175.5  | 66.4706  | 7.9175E-07 | 1.4929E+09 | 0.00% |
|  |  |  |  |  |  | 平均 | 1.4929E+09 |  |
| 光通量常数平均值= 1.4929E+09 ，最大相对偏差 +0.02% |
| 备注 |  |
| 检定员：赵伟强 核验员： 刘慧 温度： 21 ℃ 湿度： 50 %RH |
| 实验地点： 昌平-14-2007 实验日期： 2021年05月17日 |

|  |
| --- |
| LED发光强度检定原始记录（三） |
| 共 页 第 页 |
| 基本信息 | 标准值相关参数 | 实验结果 |
| 灯号 | 灯电流/mA | 规范灯电压值/V | 总光通量-电压温度系数*k*v/V-1 | 轮次 | 灯电压/V | 光电流计读数 | 总光通量测试值/lm | 规范灯电压下的总光通量值/lm | 两轮偏差 |
|
| GT158 | 90.00 | 66.3972 | 0.06231 | 第一轮 | 66.3886 | 7.8199E-07 | 1167.4 | 1168.0 |  |
| 第二轮 | 66.3927 | 7.8235E-07 | 1168.0 | 1168.3 | 0.020% |
| 第三轮 |  |  |  |  |  |
| 平均 | 66.3907 |  | 1167.7 | 1168.2 |  |
| GT159 | 90.00 | 66.4698 | 0.06141 | 第一轮 | 66.4631 | 7.8863E-07 | 1177.3 | 1172.5 |  |
| 第二轮 | 66.4723 | 7.8930E-07 | 1178.3 | 1172.8 | 0.028% |
| 第三轮 |  |  |  |  |  |
| 平均 | 66.4677 |  | 1177.8 | 1172.7 |  |
| GT162 | 90.00 | 66.4415 | 0.05762 | 第一轮 | 66.5357 | 7.9049E-07 | 1180.1 | 1169.9 |  |
| 第二轮 | 66.5419 | 7.9072E-07 | 1180.5 | 1169.8 | -0.009% |
| 第三轮 |  |  |  |  |  |
| 平均 | 66.5388 |  | 1180.3 | 1169.9 |  |
|  |  |  |  | 第一轮 |  |  |  |  |  |
| 第二轮 |  |  |  |  |  |
| 第三轮 |  |  |  |  |  |
| 平均 |  |  |  |  |  |
| 备注 |  |
| 检定员： 赵伟强 核验员：刘慧 温度： 21 ℃ 湿度： 50 %RH |
| 实验地点：昌平-14-2007 实验日期： 2021年05月17日 |  |  |  |  |  |

|  |
| --- |
| LED总光通量检定原始记录（四） |
| 共 页 第 页 |
| 灯号 | 灯电流/mA | 规范电压值/V | 总光通量-电压温度系数*k*v/V-1 | 当前灯电压/V | 当前总光通量测试值/lm | 规范灯电压下的总光通量值/lm | 前次规范灯电压下的总光通量值/lm | 年变化率 | 外检检查 | 结论(定级) |
| GT158 | 90.00 | 66.3972 | 0.06231 | 66.3907 | 1167.7 | 1168.2 |  |  | 良好 | 首检 |
| GT159 | 90.00 | 66.4698 | 0.06141 | 66.4677 | 1177.8 | 1172.7 |  |  | 良好 | 首检 |
| GT162 | 90.00 | 66.4415 | 0.05762 | 66.5388 | 1180.3 | 1169.9 |  |  | 良好 | 首检 |
|  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |

|  |
| --- |
| 检定员： 赵伟强 核验员： 刘慧 温度： 21 ℃ 湿度： 50 %RH |
| 实验地点：昌平-14-2007 实验日期： 2021年05月17日 |  |  |  |  |  |

1. 测量不确定度评定实例：

对副基准的LED总光通量标准灯组，在球形光度计里标定工作基准LED总光通量标准灯组，进行不确定度评定。

8.1 检定方法

上一级已标定的副基准LED总光通量标准灯组（下面简称标准灯）和被检定的工作基准LED总光通量标准灯（下面简称被测灯），在球形光度计里按照本检定规程的相关规定顺序点燃，将它们各自的光电读数相互比较，计算出被测灯的在规范电压下的总光通量量值。

标准灯和被测灯的种类、外形、相关色温、功率及光分布均接近，无需要作V(λ)失配修正、非线性修正和吸收修正。检定过程中系统稳定，无需作不稳定性修正。实验室环境温度稳定在22℃附近。

8.2 数学模型

用球形光度计测量，被测灯总光通量量值计算模型：

$$Φ\_{dut}\left(V\_{nor, dut}\right)=\frac{\sum\_{}^{}Φ\_{dut}\left(V\_{ nor, dut , j}\right)}{q} （8.1）$$

式中： $Φ\_{dut}\left(V\_{nor, dut}\right)$——被测灯在规范电压下的总光通量值；

$Φ\_{dut}\left(V\_{ nor, dut , j}\right)$——第*j*次测量所得的被测灯在规范电压下的总光通量值，由(G.2)式计算得；

$$Φ\_{dut}\left(V\_{ nor, dut , j}\right)=m\_{dut, j}∙\overbar{C}∙\left(1+k\_{V, dut}\left(V\_{nor, dut}−V\_{t, dut , j}\right)\right) （8.2）$$

$q$——被测灯的测量次数；

$k\_{V, dut}$ ——该被测灯的光电读数电压系数值；

$V\_{nor, dut}$——该被测灯的规范电压值；

$V\_{t, dut , j}$——该被测灯第*j*次测量时的当前电压值；

$\overbar{C}$——标准灯光通量常数$C\_{i}$（*i* =1，2，…，*n*）的平均值，由（G.3）式计算可得；

$$\overbar{C}=\frac{\sum\_{}^{}C\_{i}}{n}=\frac{\sum\_{}^{}\frac{Φ\_{std}(V\_{nor, std , i})\left(1+k\_{V, std, i}\left(V\_{t,std , i}−V\_{nor, std , i}\right)\right)}{m\_{std, i}}}{n} （8.3）$$

$Φ\_{std}(V\_{nor, std , i})$ ——第i支标准灯在规范电压下的总光通量值；

$V\_{t,std , i}$——第*i*支标准灯的测量电压值；

$V\_{nor, std , i}$——第*i*支标准灯的规范电压值；

$k\_{V, std, i}$——第*i*支标准灯的$总光通量−电压温度$系数值；

$m\_{std, i}$ ——第*i*支标准灯的光电读数值；

$n$ ——标准灯数量；

8.3 $\overbar{C}$引入的不确定度分量评定

根据经验，$\overbar{C}$的不确定度主要包含四个分量。

1. 上一级已标定的LED总光通量标准灯组的不确定度。根据校准结果为$U\_{rel}(Φ\_{std})=0.4\%$，*k*=2。相应的标准不确定度是

$u\_{rel,1}(Φ\_{std})=0.20\%$，B类方法评定。

1. 因当前使用的电测系统与标定标准灯量值时的电测系统不同，因此供给电流存在差异。估计最大的差异为0.03%。对直流LED，在小范围，光通量对电流的灵敏系数接近1。因此电测系统中电流的变化，带入的不确定度分量是

$u\_{rel,2}(m\_{std})=1×u\_{rel}(I)=1×\frac{0.3\%}{2}×\frac{1}{\sqrt{3}}≈0.01\%$，B类评定。

1. 因当前使用与标定标准灯量值时的环境温度存在不同，受环境温度影响，标准灯的量值存在变化，采用规范电压法进行量值修正。本实例环境温度是22℃，与规范值的环境温度相差3℃。根据经验，其修正量相对光通量值的百分比值是0.51 %。估计测量电压差异最大约0.01%。且*k*v值自身的不确定度约10 %。估计规范电压法的光通量修正值，引入的相对不确定度是$0.51\%×0.10= 0.05\%$ ，估计均匀分布，则修正后的环境温度差异带来的光通量常数不确定度是

$u\_{rel,3}(m\_{std})=\frac{0.05\%}{2}\frac{1}{\sqrt{3}}≈0.015\%$，B类评定。

1. 测量过程中，由于各种随机因素的影响，使得各只标准灯的光通量常数不一致。本次测量用了6只标准灯，它们的常数$C\_{i}$（*i* =1，2，…，*n*）分别是1.4927E+09、1.4931E+09、1.4931E+09、1.4930E+09、1.4925E+09和1.4929E+09，平均值是1.4930E+09。使用极差法计算的光强常数平均值的相对实验室标准差，用A类方法评定$\overbar{C}$的相对标准不确定度为

$u\_{rel,4}(\overbar{C})=\frac{1}{2.53}\frac{1.4931−1.4925}{1.4929}×100\%=0.02\%$，A类评定

G.4 被测灯量值$\overbar{m}\_{dut}$引入的不确定分量评定

根据经验，$\overbar{m}\_{dut}$的不确定度主要包含四个分量。

1. 由于各种随机因素的影响，被测灯量值$\overbar{m}\_{t}$的读数的重复性。被测灯测量12个读数$m\_{dut, j }$（*j* =1，2，…，*p*）,为7.8201E-07、7.8201E-07、7.8200E-07、7.8200E-07、7.8200E-07、7.8200E-07、7.8200E-07、7.8200E-07、7.8200E-07、7.8199E-07、7.8199E-07、7.8199E-07。7平均值为7.8200E-07。使用贝塞尔公式计算的光通量常数平均值的相对实验室标准差，用A类方法评定$\overbar{m}\_{t}$的相对标准不确定度为

$$u\_{rel,5}(\overbar{m}\_{dut})\leq 0.01\%$$

1. 灯在重复点燃，其实际光通量有一定起伏，根据经验，对于被测灯，其灯量值变化范围不超过0.03%，均匀分布。因此认为灯光通量量值分散性引入的不确定度是

$$u\_{rel,6}(\overbar{m}\_{dut})=\frac{0.1\%}{2}×\frac{1}{\sqrt{3}}≈0.01\%$$

1. 因当前使用的电测系统测量供给电流值存在偏差。估计最大的差异为0.03%，均匀分布。对直流LED，在小范围，光通量对电流的灵敏系数是1。因此电测系统中电流的变化，带入的不确定度分量是

$u\_{rel,7}(\overbar{m}\_{dut})=1×u\_{rel}(I)=1×\frac{0.03\%}{2}×\frac{1}{\sqrt{3}}≈0.01\%$，B类评定。

1. 测量过程中，LED总光通量标准灯的空间分布接近均匀，但依然存在微小的差别，由于积分球内部空间响应的不一致，使得光通量读数存在一定起伏。根据经验，对于LED总光通量标准灯，该起伏不超过0.1%，认为均匀分布，因此积分球不均匀性带来的不确定度分量是

$u\_{rel,8}(\overbar{m}\_{dut})=\frac{0.1\%}{2}×\frac{1}{\sqrt{3}}≈$0.03%，B类评定。

8.5 被测灯量值规范电压法修正引入的不确定分量评定

1. 因当前的被测灯量值时的环境温度与规范电压测量温度值存在不同，受环境温度影响，被测灯的量值存在变化，采用规范电压法进行量值修正。本实例环境温度是22℃，与规范值的环境温度相差3℃。根据经验，其修正量相对光通量值的百分比值是0.51 %。估计测量电压差异最大约0.01%。且*k*v值自身的不确定度约10 %。估计规范电压法的光通量修正值，引入的相对不确定度是$0.51\%×0.10=$ 0.051%，估计均匀分布，则被测灯规范电压法修正引入的不确定分量是

$u\_{rel,9}(C\_{temp})=\frac{0.051\%}{2}×\frac{1}{\sqrt{3}}≈0.015\%$，B类评定。

8.6 标准不确定度分量评定结果

表8.1 相对标准不确定度分量表

**表8.1 LED标准灯总光通量值标准不确定度来源的评定值**

|  |  |  |  |
| --- | --- | --- | --- |
| 不确定度来源 | 相对标准不确定度 | 灵敏系数 | 类别 |
| 标准灯组 | 上一级标准灯光通量值 | 0.20% | 1 | B |
| 电测系统（电流） | 0.01% | 1 | B |
| 温度修正（系数和电压） | 0.015% | 1 | B |
| 标准灯的测量重复性 | 0.02% | 1 | A |
| 被测灯 | 被测灯的测量重复性 | 0.01% | 1 | A |
| 被测灯重复点燃时的分散性 | 0.01% | 1 | B |
| 电测系统（电流） | 0.01% | 1 | B |
| 积分球空间响应 | 0.03% | 1 | B |
| 被测灯规范电压法修正（系数和电压） | 0.015% | 1 | B |

8.7. 单支被测灯校准结果的相对合成标准器不确定度

上述各不确定度来源独立，不相关。相对合成标准不确定度的计算公式简化为

$$u\_{c,rel}=\sqrt{\sum\_{i=1}^{9}u\_{rel,i}^{2}} =0.205\%$$

8.8 扩展不确定度的评定

取包含因子*k*=2，则扩展不确定度为

$U\_{rel}=0.205\%×2=0.41\%$ $(k=2)$

8.9 测量不确定度报告

用LBDT-200型副基准灯，在2.0 m积分球内标定LBDT-200型工作基准灯的z总光通量值的测量结果不确定度为：

$$U\_{rel}=0.41\% (k=2)$$

结论：不确定度符合规程草稿中表2中工作基准灯的要求

1. 结论：

实验数据表明，本规程草稿所规定的检定操作原理正确，实际可行。