# Declaration for VDE-AR-N 4105_2018

| | | | |
|---|---|---|---|
| **Manufacturer's** reference number | X3-15.0P-T-N X3-15.0P-T-D<br>X3-12.0P-T-N X3-12.0P-T-D<br>X3-10.0P-T-N X3-10.0P-T-D<br>X3-8.0P-T-N X3-8.0P-T-D | | |
| **Micro-generator** technology | Photovoltaic Grid-tied inverter | | |
| **Manufacturer** name | SolaX Power Network Technology (Zhe jiang) Co. , Ltd. | | |
| Address | No.288 Shizhu Road,Tonglu Economic Development Zone,<br>Dongxing District,Tonglu City, Zhejiang Province, China. | | |
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| E-mail | info@solaxpower.com | Web site | www.solaxpower.com |

| | | |
|---|---|---|
| **Registered Capacity**, use separate sheet if more than one connection option. | Connection Option | |
| | 8.0 | kW three phase system |
| | 10.0 | kW three phase system |
| | 12.0 | kW three phase system |
| | 15.0 | kW three phase system |

**Manufacturer Type Test** declaration. - I certify that all products supplied by the company with the above **Type Tested** reference number will be manufactured and tested to ensure that they perform as stated in this document, prior to shipment to site and that no site modifications are required to ensure that the product meets all the requirements of VDE-AR-N 4105_2018.

| | | | |
|---|---|---|---|
| Signed | Guo Huawei | On behalf of | SolaX Power Network Technology (Zhe jiang) Co. , Ltd. |

Additional comments

| Clause | Test description | Verdict |
|---|---|---|
| 5.1 | Principles for determining the network connection point | P |

| | | |
|---|---|---|
| 5.2 | Rating of the network equipment | P |
| 5.3 | Permissible voltage change | P |
| 5.4 | Network Disturbances | P |
| 5.5.1 | General | P |
| 5.5.3 | Plug-in production plants | P |
| 5.6 | Three-phase converter systems | P |
| 5.7.1 | General | P |
| 5.7.2 | Static voltage maintenance / reactive power provision | P |
| 5.7.2.1 | General boundary conditions | P |
| 5.7.2.2 | Reactive power provision at Σ Semax | P |
| 5.7.2.3 | Reactive power supply below Pemax | P |
| 5.7.2.4 | Method for providing reactive power | P |
| 5.7.4.1 | General | P |
| 5.7.4.2 | Network Security Management | P |
| 5.7.4.3 | Active power adaptation for overfrequency and underfrequency | P |
| 5.7.4.4 | Voltage-dependent active power reduction | P |
| 5.7.5 | Short-circuit current contribution | P |
| 6.1 | General requirements | P |
| 6.2 | Central NA protection | P |
| 6.3 | Integrated NA protection | P |
| 6.5.2 | Protection functions | P |
| 6.5.3 | Islanding detection | P |

| | | |
|---|---|---|
| 8.3 | Connection conditions and synchronization | P |

| **Protection function** | **Setting value** | **Trip delay** | **Tripping value** | **Break time** |
|---|---|---|---|---|
| Voltage drop protection U<< | 0.45Un | ≤300ms | 104.4V | 296ms |
| Voltage drop protection U< | 0.8Un | ≤3s | 184.3 V | 2.95s |
| Rise-in-voltage protection U> | 1.1Un | ≤100ms | 253 V | 90ms |
| Rise-in-voltage protection U>> | 1.25Un | ≤100ms | 286.3 V | 20ms |
| Frequency decrease protection f< | 47.5Hz | ≤100ms | 47.5Hz | 98.8ms |
| Frequency increase protection f> | 51.5Hz | ≤100ms | 51.5Hz | 99.4ms |

| **Model** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **a) Q(U)** | | | | | | | | |
| as required for under voltage and over voltage condition | | | | | | | | |
| P, setpoint (%$P_{Emax}$) | V, setpoint | $U_{1+}$ (Vac) | $P_{1+}/P_{Emax}$ [%] Measured | Active power $P_{1+}$ (W) | Apparent power $S_{1+}$ (VA) | Reactive power $Q_{1+}$(Var) | Expected Q (Var) | shifting Q(Var) (dQ)[≤±4 % $P_{Emax}$ = var] |
| 20 | 0,91Vn | 209.3V | 19.90% | 2985 | 8048 | 7474 | 7500 | 26 |
| | 0,93Vn | 213.9V | 19.93% | 2989 | 8041 | 7465 | 7500 | 35 |
| | 0,95Vn | 218.5V | 19.90% | 2985 | 5002 | 4014 | 3750 | 264 |
| | 0,97Vn | 223.1V | 19.97% | 2995 | 3001 | -53.3 | 0 | 53.3 |
| | 0,99Vn | 227.7V | 19.98% | 2997 | 3002 | -51.3 | 0 | 51.3 |
| | 1,01Vn | 232.3V | 19.99% | 2998 | 3003 | -51.5 | 0 | 51.5 |
| | 1,03Vn | 236.9V | 19.99% | 2999 | 3004 | -51.1 | 0 | 51.1 |
| | 1,05Vn | 241.5V | 19.79% | 2968 | 4956 | -3969 | -3750 | 219 |
| | 1,07Vn | 246.1V | 19.53% | 2930 | 7960 | -7401 | -7500 | 99 |
| | 1,09Vn | 250.7V | 19.53% | 2930 | 7994 | -7438 | -7500 | 62 |
| 50 | 0,91Vn | 209.3V | 49.62% | 7443 | 10493 | 7396 | 7500 | 104 |
| | 0,93Vn | 213.9V | 49.61% | 7442 | 10517 | 7431 | 7500 | 69 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 0,95Vn | 218.5V | 49.95% | 7493 | 8496 | 4005 | 3750 | 255 |
| | 0,97Vn | 223.1V | 50.09% | 7514 | 7520 | -309 | 0 | 309 |
| | 0,99Vn | 227.7V | 50.11% | 7517 | 7524 | -311 | 0 | 311 |
| | 1,01Vn | 232.3V | 50.14% | 7521 | 7528 | -313 | 0 | 313 |
| | 1,03Vn | 236.9V | 50.11% | 7517 | 7524 | -319 | 0 | 319 |
| | 1,05Vn | 241.5V | 49.95% | 7493 | 8504 | -4021 | -3750 | 271 |
| | 1,07Vn | 246.1V | 49.67% | 7451 | 10529 | -7440 | -7500 | 60 |
| | 1,09Vn | 250.7V | 49.68% | 7452 | 10554 | -7473 | -7500 | 27 |
| 100 | 0,91Vn | 209.3V | 86.53% | 12980 | 14940 | 7398 | 7500 | 102 |
| | 0,93Vn | 213.9V | 87.01% | 13052 | 15000 | 7393 | 7500 | 107 |
| | 0,95Vn | 218.5V | 96.55% | 14483 | 14951 | 3711 | 3750 | 39 |
| | 0,97Vn | 223.1V | 99.37% | 14906 | 14913 | -465 | 0 | 465 |
| | 0,99Vn | 227.7V | 99.43% | 14914 | 14922 | -468 | 0 | 468 |
| | 1,01Vn | 232.3V | 99.32% | 14898 | 14906 | -478 | 0 | 478 |
| | 1,03Vn | 236.9V | 99.29% | 14893 | 14901 | -488 | 0 | 488 |
| | 1,05Vn | 241.5V | 95.99% | 14399 | 14903 | -3840 | -3750 | 90 |
| | 1,07Vn | 246.1V | 85.08% | 12762 | 14789 | -7473 | -7500 | 27 |
| | 1,09Vn | 250.7V | 84.86% | 12729 | 14779 | -7510 | -7500 | 10 |
| Remark: based on below curve | | | | | | | | |

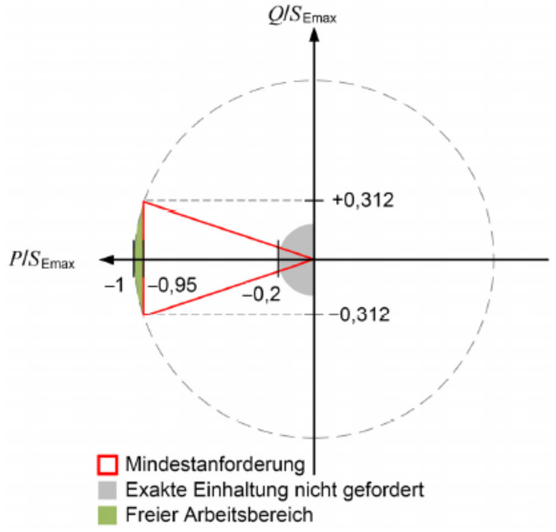


**Bild 5 – *P*/*Q*-Diagramm für Typ 2 $\sum S_{Emax} \leq 4,6\,kVA$ sowie Typ 1, Stirlinggenerator, Brennstoffzelle $\sum S_{Emax} > 4,6\,kVA$ an den Generatorklemmen im Verbraucherzählpfeilsystem**

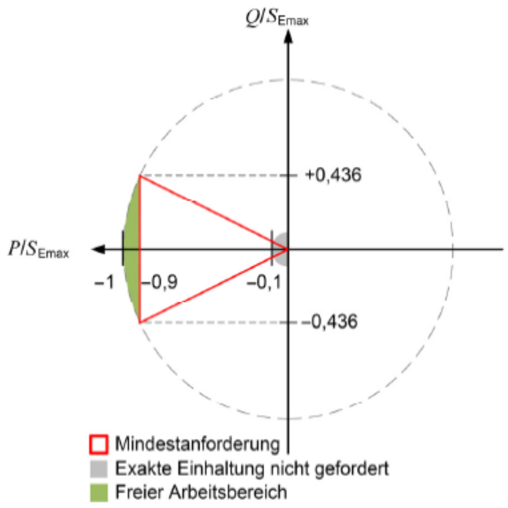


**Bild 6 – *P*/*Q*-Diagramm für Typ 2 (nur Umrichter) $\sum S_{Emax} > 4,6\,kVA$ an den Generatorklemmen im Verbraucherzählpfeilsystem**

## b) cos φ (P)

| Power step under applied cosφ(P)-curve setted through control panel | Measured cosφ | Active Power $P_{1+}$ (W) | Apparent Power $S_{1+}$ (VA) | Reactive Power $Q_{1+}$ (Var) | Deviation of Q (Var) | Limit of Q [≤±4%$P_{Emax}$ = Var] | Voltage $V_{1+}$ (V) |
|---|---|---|---|---|---|---|---|
| Point 1: P = 10%$P_{Emax}$; | 0.948 | 1412 | 1489 | -472 | 472 | ±4% | 230.3 |
| Point 2: P = 20%$P_{Emax}$; | 0.998 | 2901 | 2908 | 189 | 189 | ±4% | 230.4 |
| Point 3: P = 30%$P_{Emax}$ ; | 0.998 | 4419 | 4426 | 246 | 246 | ±4% | 230.5 |
| Point 4: P = 40%$P_{Emax}$ ; | 0.999 | 5937 | 5945 | -303 | 303 | ±4% | 230.5 |
| Point 5: P = 50%$P_{Emax}$ ; | 0.999 | 7474 | 7482 | -338 | 338 | ±4% | 230.6 |
| Point 6: P = 60%$P_{Emax}$ ; | 0.981 | 8967 | 9139 | -1764 | 64 | ±4% | 230.6 |
| Point 7: P = 70%$P_{Emax}$ ; | 0.961 | 10503 | 10930 | -3027 | 36 | ±4% | 230.7 |
| Point 8: P=80%$P_{Emax}$ ; | 0.941 | 11962 | 12711 | -4298 | 57 | ±4% | 230.7 |
| Point 9: P=90%$P_{Emax}$ ; | 0.921 | 13479 | 14642 | -5719 | 32 | ±4% | 230.8 |
| Point 10:P=100%$P_{Emax}$ ; | 0.918 | 13647 | 14858 | -5877 | 18 | ±4% | 230.8 |
| Point 11: P =90%$P_{Emax}$ ; | 0.921 | 13504 | 14666 | -5720 | 31 | ±4% | 230.8 |
| Point 12: P =80%$P_{Emax}$ ; | 0.941 | 12004 | 12762 | -4331 | 24 | ±4% | 230.7 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Point 13: P =70%$P_{Emax}$ ; | 0.961 | 10500 | 10928 | -3028 | 25 | ±4% | 230.7 |
| Point 14: P =60%$P_{Emax}$ ; | 0.981 | 8964 | 9137 | -1765 | 63 | ±4% | 230.6 |
| Point 15: P =50%$P_{Emax}$ ; | 0.999 | 7472 | 7480 | -335 | 335 | ±4% | 230.6 |
| Point 16: P =40%$P_{Emax}$ ; | 0.999 | 5933 | 5941 | -300 | 300 | ±4% | 230.5 |
| Point 17: P =30%$P_{Emax}$ ; | 0.999 | 4412 | 4419 | 244 | 244 | ±4% | 230.4 |
| Point 18: P = 20%$P_{Emax}$; | 0.998 | 2897 | 2904 | 189 | 189 | ±4% | 230.4 |
| Point 19: P = 10%$P_{Emax}$; | 0.950 | 1445 | 1521 | -472 | 472 | ±4% | 230.3 |

Reactive power transfer function – standard-cos φ-(p)-characteristic

| Active power $P/P_{Emax}$ [%] | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100* |
|---|---|---|---|---|---|---|---|---|---|---|
| cos φ | 0.949 | 0.998 | 0.999 | 0.999 | 0.999 | 0.981 | 0.961 | 0.941 | 0.921 | 0.918 |

"*":The maximum apparent power of the inverter is limited to $S_{Emax}$. If setting cos φ≠1, the maximum active power is reduced accordingly. The active power 100% $P/P_{Emax}$ is therefore only achieved when cos φ = 1.

Response time measurement: Standard characteristic curve for cos φ (P)

| Power step under applied cosφ(P)-curve setted through control panel | Voltage $V_{1+}$ (Vac) | Measured cosφ | Active Power (W) $P_{1+}$ | Apparent Power (VA) $S_{1+}$ | Reactive Power (Var) $Q_{1+}$ | Response time (s) |
|---|---|---|---|---|---|---|
| 20% $P_{Emax}$, cosφ=1,0 | 230.4 | 0.998 | 2945 | 2951 | 192 | |
| 50% $P_{Emax}$, cosφ=1,0 | 230.6 | 0.999 | 7435 | 7443 | -338 | 62s |
| 90% $P_{Emax}$, osφ=0,92 | 230.8 | 0.921 | 13467 | 14619 | -5689 | 80s |
| | | | | | | |
| 90% $P_{Emax}$, osφ=0,92 | 230.8 | 0.921 | 13468 | 2950 | -5688 | |
| 50% $P_{Emax}$, cosφ=1,0 | 230.6 | 0.999 | 7434 | 7441 | -336 | 80s |
| 20% $P_{Emax}$, cosφ=1,0 | 230.4 | 0.998 | 2944 | 14619 | 191 | 60s |

**c) fixed cosφ:**

| Default in system control | 0,900 ov | 0,910 ov | 0,920 ov | 0,930 ov | 0,940 ov | 0,950 ov | 0,960 ov | 0,970 ov | 0,980 ov | 0,990 ov | 1,000 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Measured value at | 0.902 | 0.912 | 0.922 | 0.932 | 0.942 | 0.952 | 0.961 | 0.971 | 0.981 | 0.991 | 0.999 |

| PGU terminals | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Default in system control | 0,900 uV | 0,910 uV | 0,920 uV | 0,930 uV | 0,940 uV | 0,950 uV | 0,960 uV | 0,970 uV | 0,980 uV | 0,990 uV | |
| Measured value at PGU terminals | 0.900 | 0.910 | 0.919 | 0.930 | 0.940 | 0.950 | 0.960 | 0.970 | 0.980 | 0.990 | |

| $P_{Emax}$ with fixed cosφ | cosφ | Active Power $P_{1+}$ (W) | Apparent Power $S_{1+}$ (VA) | Reactive Power $Q_{1+}$(Var) | Deviation of Q (Var) | Limit of Q (≤±4%$P_{Emax}$ =Var ) |
|---|---|---|---|---|---|---|
| cosφ = 0,900 over-excited | 0.902 | 13419 | 14873 | 6414 | 124 | ±4% |
| cosφ = 0,910 over-excited | 0.912 | 13586 | 14892 | 6100 | 119 | ±4% |
| cosφ = 0,920 over-excited | 0.922 | 13715 | 14874 | 5756 | 123 | ±4% |
| cosφ = 0,930 over-excited | 0.932 | 13883 | 14900 | 5410 | 103 | ±4% |
| cosφ = 0,940 over-excited | 0.942 | 14017 | 14884 | 5005 | 103 | ±4% |
| cosφ = 0,950 over-excited | 0.952 | 14179 | 14897 | 4571 | 113 | ±4% |
| cosφ = 0,960 over-excited | 0.961 | 14324 | 14900 | 4103 | 97 | ±4% |
| cosφ = 0,970 over-excited | 0.971 | 14480 | 14908 | 3549 | 98 | ±4% |
| cosφ = 0,980 over-excited | 0.981 | 14624 | 14908 | 2896 | 89 | ±4% |
| cosφ = 0,990 over-excited | 0.991 | 14781 | 14922 | 2047 | 69 | ±4% |
| cosφ = 1 | 0.999 | 14925 | 14932 | -438 | 438 | ±4% |
| cosφ = 0,990 under-excited | 0.990 | 14821 | 14976 | -2150 | 34 | ±4% |
| cosφ = 0,980 under-excited | 0.980 | 14641 | 14945 | -2996 | 11 | ±4% |
| cosφ = 0,970 under-excited | 0.970 | 14471 | 14923 | -3646 | 1 | ±4% |
| cosφ = 0,960 under-excited | 0.960 | 14312 | 14914 | -4197 | 3 | ±4% |
| cosφ = 0,950 under-excited | 0.950 | 14152 | 14900 | -4663 | 21 | ±4% |
| cosφ = 0,940 under-excited | 0.940 | 13985 | 14886 | -5098 | 20 | ±4% |

| | | | | | | |
|---|---|---|---|---|---|---|
| cosφ = 0,930 under-excited | 0.930 | 13829 | 14873 | -5473 | 40 | ±4% |
| cosφ = 0,920 under-excited | 0.919 | 13663 | 14861 | -5846 | 33 | ±4% |
| cosφ = 0,910 under-excited | 0.910 | 13519 | 14855 | -6157 | 62 | ±4% |
| cosφ = 0,900 under-excited | 0.900 | 13354 | 14839 | -6471 | 67 | ±4% |

**d) PT1 step response verification**

| | Time (s) | Active Power $P_{1+}$ (W) | Apparent Power $S_{1+}$ (VA) | Reactive Power $Q_{1+}$ (Var) | $Q_{1+}/P_{Emax}$ |
|---|---|---|---|---|---|
| 50% Pn, Q=0 → $Q_{max.}$ over-excited | 0 | 7427 | 7436 | -355 | -0.0237 |
| | 0.2 | 7429 | 7439 | -379 | -0.0253 |
| | 0.4 | 7430 | 7457 | 638 | 0.0425 |
| | 0.6 | 7429 | 7493 | 979 | 0.0652 |
| | 0.8 | 7428 | 7547 | 1330 | 0.0887 |
| | 1 | 7427 | 7616 | 1690 | 0.1127 |
| | 1.2 | 7426 | 7693 | 2012 | 0.1341 |
| | 1.4 | 7422 | 7777 | 2323 | 0.1549 |
| | 1.6 | 7422 | 7869 | 2613 | 0.1742 |
| | 1.8 | 7422 | 7964 | 2887 | 0.1925 |
| | 2 | 7418 | 8057 | 3144 | 0.2096 |
| | 2.2 | 7417 | 8153 | 3384 | 0.2256 |
| | 2.4 | 7413 | 8251 | 3623 | 0.2415 |
| | 2.6 | 7438 | 8374 | 3846 | 0.2564 |
| | 2.8 | 7490 | 8516 | 4053 | 0.2702 |
| | 3 | 7494 | 8613 | 4244 | 0.2829 |
| | 3.2 | 7494 | 8701 | 4421 | 0.2947 |
| | 3.4 | 7493 | 8797 | 4608 | 0.3072 |
| | 3.6 | 7489 | 8878 | 4767 | 0.3178 |

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|---|---|---|---|---|
| 3.8 | 7490 | 8951 | 4902 | 0.3268 |
| 4 | 7487 | 9034 | 5056 | 0.3371 |
| 4.2 | 7486 | 9110 | 5192 | 0.3461 |
| 4.4 | 7482 | 9179 | 5316 | 0.3544 |
| 4.6 | 7485 | 9249 | 5434 | 0.3622 |
| 4.8 | 7483 | 9307 | 5534 | 0.3689 |
| 5 | 7480 | 9373 | 5649 | 0.3766 |
| 5.2 | 7477 | 9445 | 5771 | 0.3847 |
| 5.4 | 7472 | 9480 | 5834 | 0.3889 |
| 5.6 | 7476 | 9536 | 5920 | 0.3946 |
| 5.8 | 7473 | 9582 | 5998 | 0.3999 |
| 6 | 7475 | 9636 | 6081 | 0.4054 |
| 6.2 | 7472 | 9673 | 6143 | 0.4095 |
| 6.4 | 7470 | 9728 | 6232 | 0.4155 |
| 6.6 | 7469 | 9788 | 6327 | 0.4218 |
| 6.8 | 7469 | 9801 | 6345 | 0.4230 |
| 7 | 7466 | 9851 | 6426 | 0.4284 |
| 7.2 | 7467 | 9877 | 6465 | 0.4310 |
| 7.4 | 7467 | 9921 | 6532 | 0.4355 |
| 7.6 | 7465 | 9967 | 6604 | 0.4403 |
| 7.8 | 7464 | 9970 | 6610 | 0.4407 |
| 8 | 7465 | 10012 | 6671 | 0.4447 |
| 8.2 | 7463 | 10047 | 6727 | 0.4485 |
| 8.4 | 7459 | 10065 | 6758 | 0.4505 |
| 8.6 | 7466 | 10093 | 6792 | 0.4528 |
| 8.8 | 7462 | 10102 | 6809 | 0.4539 |

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|---|---|---|---|---|
| 9 | 7462 | 10125 | 6844 | 0.4563 |
| 9.2 | 7460 | 10159 | 6896 | 0.4597 |
| 9.4 | 7461 | 10147 | 6877 | 0.4585 |
| 9.6 | 7461 | 10202 | 6958 | 0.4639 |
| 9.8 | 7461 | 10211 | 6972 | 0.4648 |
| 10 | 7460 | 10225 | 6993 | 0.4662 |
| 10.2 | 7460 | 10234 | 7006 | 0.4671 |
| 10.4 | 7457 | 10254 | 7038 | 0.4692 |
| 10.6 | 7458 | 10271 | 7062 | 0.4708 |
| 10.8 | 7458 | 10269 | 7060 | 0.4706 |
| 11 | 7457 | 10285 | 7083 | 0.4722 |
| 11.2 | 7458 | 10268 | 7058 | 0.4706 |
| 11.4 | 7455 | 10313 | 7126 | 0.4750 |
| 11.6 | 7461 | 10295 | 7094 | 0.4730 |
| 11.8 | 7457 | 10325 | 7141 | 0.4761 |
| 12 | 7457 | 10333 | 7153 | 0.4768 |
| 12.2 | 7457 | 10355 | 7185 | 0.4790 |
| 12.4 | 7456 | 10378 | 7219 | 0.4813 |
| 12.6 | 7455 | 10346 | 7174 | 0.4782 |
| 12.8 | 7456 | 10374 | 7213 | 0.4808 |
| 13 | 7457 | 10366 | 7201 | 0.4801 |
| 13.2 | 7455 | 10398 | 7250 | 0.4833 |
| 13.4 | 7455 | 10393 | 7242 | 0.4828 |
| 13.6 | 7457 | 10397 | 7245 | 0.4830 |
| 13.8 | 7455 | 10407 | 7262 | 0.4841 |
| 14 | 7455 | 10403 | 7256 | 0.4837 |

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| 14.2 | 7454 | 10414 | 7273 | 0.4849 |
| 14.4 | 7452 | 10410 | 7269 | 0.4846 |
| 14.6 | 7459 | 10425 | 7284 | 0.4856 |
| 14.8 | 7455 | 10420 | 7279 | 0.4853 |
| 15 | 7454 | 10431 | 7297 | 0.4865 |
| 15.2 | 7455 | 10399 | 7251 | 0.4834 |
| 15.4 | 7456 | 10441 | 7309 | 0.4873 |
| 15.6 | 7456 | 10419 | 7277 | 0.4852 |
| 15.8 | 7455 | 10435 | 7301 | 0.4867 |
| 16 | 7454 | 10441 | 7311 | 0.4874 |
| 16.2 | 7455 | 10442 | 7312 | 0.4875 |
| 16.4 | 7454 | 10448 | 7321 | 0.4881 |
| 16.6 | 7454 | 10443 | 7314 | 0.4876 |
| 16.8 | 7454 | 10462 | 7341 | 0.4894 |
| 17 | 7453 | 10442 | 7313 | 0.4875 |
| 17.2 | 7453 | 10457 | 7334 | 0.4890 |
| 17.4 | 7451 | 10462 | 7345 | 0.4896 |
| 17.6 | 7457 | 10453 | 7325 | 0.4884 |
| 17.8 | 7454 | 10462 | 7341 | 0.4894 |
| 18 | 7455 | 10458 | 7334 | 0.4889 |
| 18.2 | 7454 | 10458 | 7335 | 0.4890 |
| 18.4 | 7453 | 10466 | 7347 | 0.4898 |
| 18.6 | 7455 | 10470 | 7350 | 0.4900 |
| 18.8 | 7453 | 10460 | 7339 | 0.4892 |
| 19 | 7454 | 10467 | 7347 | 0.4898 |
| 19.2 | 7454 | 10466 | 7347 | 0.4898 |

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|---|---|---|---|---|
| 19.4 | 7456 | 10471 | 7352 | 0.4901 |
| 19.6 | 7454 | 10459 | 7338 | 0.4892 |
| 19.8 | 7455 | 10456 | 7331 | 0.4888 |
| 20 | 7454 | 10469 | 7352 | 0.4901 |
| 20.2 | 7454 | 10462 | 7341 | 0.4894 |
| 20.4 | 7452 | 10477 | 7364 | 0.4909 |
| 20.6 | 7457 | 10468 | 7347 | 0.4898 |
| 20.8 | 7454 | 10464 | 7344 | 0.4896 |
| 21 | 7455 | 10460 | 7337 | 0.4891 |
| 21.2 | 7453 | 10473 | 7358 | 0.4906 |
| 21.4 | 7454 | 10461 | 7340 | 0.4893 |
| 21.6 | 7454 | 10471 | 7353 | 0.4902 |
| 21.8 | 7455 | 10458 | 7334 | 0.4890 |
| 22 | 7454 | 10470 | 7352 | 0.4901 |
| 22.2 | 7455 | 10469 | 7350 | 0.4900 |
| 22.4 | 7455 | 10471 | 7354 | 0.4902 |
| 22.6 | 7454 | 10462 | 7341 | 0.4894 |
| 22.8 | 7453 | 10460 | 7339 | 0.4893 |
| 23 | 7454 | 10474 | 7359 | 0.4906 |
| 23.2 | 7454 | 10480 | 7367 | 0.4911 |
| 23.4 | 7454 | 10481 | 7369 | 0.4913 |
| 23.6 | 7457 | 10480 | 7363 | 0.4909 |
| 23.8 | 7454 | 10473 | 7356 | 0.4904 |
| 24 | 7454 | 10465 | 7345 | 0.4897 |
| 24.2 | 7453 | 10499 | 7394 | 0.4929 |
| 24.4 | 7453 | 10474 | 7359 | 0.4906 |

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|---|---|---|---|---|
| 24.6 | 7454 | 10467 | 7348 | 0.4899 |
| 24.8 | 7455 | 10467 | 7348 | 0.4898 |
| 25 | 7456 | 10457 | 7333 | 0.4888 |
| 25.2 | 7455 | 10475 | 7358 | 0.4905 |
| 25.4 | 7454 | 10450 | 7324 | 0.4883 |
| 25.6 | 7455 | 10492 | 7383 | 0.4922 |
| 25.8 | 7454 | 10467 | 7348 | 0.4898 |
| 26 | 7454 | 10446 | 7319 | 0.4879 |
| 26.2 | 7455 | 10466 | 7346 | 0.4897 |
| 26.4 | 7450 | 10477 | 7366 | 0.4911 |
| 26.6 | 7458 | 10476 | 7356 | 0.4904 |
| 26.8 | 7454 | 10464 | 7344 | 0.4896 |
| 27 | 7455 | 10465 | 7345 | 0.4897 |
| 27.2 | 7456 | 10467 | 7345 | 0.4897 |
| 27.4 | 7454 | 10478 | 7363 | 0.4909 |
| 27.6 | 7455 | 10460 | 7337 | 0.4891 |
| 27.8 | 7455 | 10473 | 7356 | 0.4904 |
| 28 | 7454 | 10469 | 7351 | 0.4900 |
| 28.2 | 7454 | 10459 | 7337 | 0.4891 |
| 28.4 | 7455 | 10478 | 7363 | 0.4909 |
| 28.6 | 7454 | 10458 | 7336 | 0.4891 |
| 28.8 | 7454 | 10477 | 7362 | 0.4908 |
| 29 | 7454 | 10456 | 7332 | 0.4888 |
| 29.2 | 7455 | 10471 | 7353 | 0.4902 |
| 29.4 | 7453 | 10474 | 7360 | 0.4907 |
| 29.6 | 7458 | 10469 | 7348 | 0.4898 |

| | | | | | |
|---|---|---|---|---|---|
| | 29.8 | 7454 | 10471 | 7353 | 0.4902 |
| | 30 | 7455 | 10489 | 7380 | 0.4920 |
| 50% Pn, Q=0 → $Q_{max.}$ under-excited | 0 | 7512 | 7521 | -357 | -0.0238 |
| | 0.2 | 7514 | 7523 | -369 | -0.0246 |
| | 0.4 | 7513 | 7540 | -629 | -0.0420 |
| | 0.6 | 7513 | 7577 | -988 | -0.0659 |
| | 0.8 | 7486 | 7607 | -1349 | -0.0899 |
| | 1 | 7431 | 7622 | -1696 | -0.1130 |
| | 1.2 | 7422 | 7696 | -2033 | -0.1355 |
| | 1.4 | 7417 | 7780 | -2348 | -0.1565 |
| | 1.6 | 7416 | 7873 | -2643 | -0.1762 |
| | 1.8 | 7410 | 7968 | -2928 | -0.1952 |
| | 2 | 7416 | 8073 | -3189 | -0.2126 |
| | 2.2 | 7410 | 8171 | -3442 | -0.2295 |
| | 2.4 | 7408 | 8272 | -3679 | -0.2453 |
| | 2.6 | 7405 | 8366 | -3892 | -0.2595 |
| | 2.8 | 7402 | 8465 | -4107 | -0.2738 |
| | 3 | 7399 | 8561 | -4307 | -0.2871 |
| | 3.2 | 7396 | 8651 | -4487 | -0.2991 |
| | 3.4 | 7395 | 8751 | -4679 | -0.3120 |
| | 3.6 | 7393 | 8831 | -4830 | -0.3220 |
| | 3.8 | 7389 | 8910 | -4979 | -0.3319 |
| | 4 | 7389 | 8993 | -5126 | -0.3417 |
| | 4.2 | 7386 | 9076 | -5275 | -0.3516 |
| | 4.4 | 7384 | 9146 | -5396 | -0.3597 |
| | 4.6 | 7384 | 9220 | -5520 | -0.3680 |

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|---|---|---|---|---|
| 4.8 | 7379 | 9288 | -5641 | -0.3760 |
| 5 | 7383 | 9353 | -5742 | -0.3828 |
| 5.2 | 7403 | 9440 | -5858 | -0.3905 |
| 5.4 | 7456 | 9522 | -5922 | -0.3948 |
| 5.6 | 7460 | 9596 | -6035 | -0.4024 |
| 5.8 | 7460 | 9675 | -6161 | -0.4107 |
| 6 | 7461 | 9689 | -6182 | -0.4122 |
| 6.2 | 7458 | 9759 | -6295 | -0.4196 |
| 6.4 | 7457 | 9783 | -6333 | -0.4222 |
| 6.6 | 7458 | 9837 | -6413 | -0.4276 |
| 6.8 | 7456 | 9870 | -6466 | -0.4311 |
| 7 | 7454 | 9919 | -6545 | -0.4363 |
| 7.2 | 7454 | 9953 | -6595 | -0.4397 |
| 7.4 | 7453 | 9976 | -6631 | -0.4421 |
| 7.6 | 7453 | 10030 | -6713 | -0.4475 |
| 7.8 | 7449 | 10032 | -6720 | -0.4480 |
| 8 | 7453 | 10077 | -6782 | -0.4521 |
| 8.2 | 7449 | 10111 | -6837 | -0.4558 |
| 8.4 | 7448 | 10126 | -6860 | -0.4573 |
| 8.6 | 7449 | 10162 | -6912 | -0.4608 |
| 8.8 | 7449 | 10168 | -6921 | -0.4614 |
| 9 | 7447 | 10199 | -6969 | -0.4646 |
| 9.2 | 7447 | 10221 | -7001 | -0.4667 |
| 9.4 | 7447 | 10230 | -7014 | -0.4676 |
| 9.6 | 7447 | 10262 | -7061 | -0.4707 |
| 9.8 | 7445 | 10271 | -7076 | -0.4717 |

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|---|---|---|---|---|
| 10 | 7444 | 10292 | -7108 | -0.4738 |
| 10.2 | 7444 | 10312 | -7136 | -0.4757 |
| 10.4 | 7443 | 10324 | -7154 | -0.4769 |
| 10.6 | 7445 | 10337 | -7172 | -0.4781 |
| 10.8 | 7441 | 10335 | -7173 | -0.4782 |
| 11 | 7445 | 10357 | -7199 | -0.4799 |
| 11.2 | 7443 | 10373 | -7225 | -0.4817 |
| 11.4 | 7441 | 10387 | -7248 | -0.4832 |
| 11.6 | 7442 | 10396 | -7260 | -0.4840 |
| 11.8 | 7443 | 10402 | -7267 | -0.4845 |
| 12 | 7443 | 10405 | -7272 | -0.4848 |
| 12.2 | 7441 | 10421 | -7296 | -0.4864 |
| 12.4 | 7441 | 10432 | -7311 | -0.4874 |
| 12.6 | 7442 | 10421 | -7295 | -0.4863 |
| 12.8 | 7441 | 10446 | -7331 | -0.4887 |
| 13 | 7442 | 10448 | -7334 | -0.4889 |
| 13.2 | 7442 | 10460 | -7350 | -0.4900 |
| 13.4 | 7441 | 10457 | -7346 | -0.4898 |
| 13.6 | 7440 | 10471 | -7369 | -0.4912 |
| 13.8 | 7438 | 10455 | -7347 | -0.4898 |
| 14 | 7443 | 10486 | -7386 | -0.4924 |
| 14.2 | 7439 | 10474 | -7373 | -0.4916 |
| 14.4 | 7441 | 10496 | -7402 | -0.4935 |
| 14.6 | 7441 | 10513 | -7427 | -0.4951 |
| 14.8 | 7439 | 10502 | -7412 | -0.4942 |
| 15 | 7439 | 10498 | -7407 | -0.4938 |

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|---|---|---|---|---|
| 15.2 | 7439 | 10490 | -7396 | -0.4931 |
| 15.4 | 7439 | 10508 | -7422 | -0.4948 |
| 15.6 | 7439 | 10509 | -7423 | -0.4949 |
| 15.8 | 7439 | 10508 | -7422 | -0.4948 |
| 16 | 7439 | 10522 | -7441 | -0.4960 |
| 16.2 | 7438 | 10518 | -7437 | -0.4958 |
| 16.4 | 7437 | 10531 | -7457 | -0.4971 |
| 16.6 | 7438 | 10515 | -7433 | -0.4955 |
| 16.8 | 7436 | 10520 | -7441 | -0.4961 |
| 17 | 7441 | 10529 | -7449 | -0.4966 |
| 17.2 | 7439 | 10553 | -7486 | -0.4990 |
| 17.4 | 7438 | 10528 | -7451 | -0.4968 |
| 17.6 | 7438 | 10530 | -7454 | -0.4969 |
| 17.8 | 7438 | 10531 | -7455 | -0.4970 |
| 18 | 7437 | 10532 | -7458 | -0.4972 |
| 18.2 | 7437 | 10534 | -7460 | -0.4973 |
| 18.4 | 7440 | 10527 | -7447 | -0.4965 |
| 18.6 | 7437 | 10575 | -7518 | -0.5012 |
| 18.8 | 7440 | 10536 | -7460 | -0.4973 |
| 19 | 7439 | 10544 | -7473 | -0.4982 |
| 19.2 | 7437 | 10544 | -7474 | -0.4983 |
| 19.4 | 7437 | 10539 | -7467 | -0.4978 |
| 19.6 | 7437 | 10538 | -7467 | -0.4978 |
| 19.8 | 7435 | 10548 | -7482 | -0.4988 |
| 20 | 7440 | 10542 | -7469 | -0.4979 |
| 20.2 | 7438 | 10543 | -7473 | -0.4982 |

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|---|---|---|---|---|
| 20.4 | 7438 | 10551 | -7483 | -0.4989 |
| 20.6 | 7438 | 10548 | -7479 | -0.4986 |
| 20.8 | 7438 | 10548 | -7479 | -0.4986 |
| 21 | 7439 | 10550 | -7480 | -0.4987 |
| 21.2 | 7439 | 10552 | -7484 | -0.4989 |
| 21.4 | 7440 | 10548 | -7477 | -0.4984 |
| 21.6 | 7438 | 10547 | -7478 | -0.4985 |
| 21.8 | 7439 | 10547 | -7477 | -0.4984 |
| 22 | 7438 | 10565 | -7504 | -0.5003 |
| 22.2 | 7439 | 10553 | -7485 | -0.4990 |
| 22.4 | 7438 | 10549 | -7481 | -0.4987 |
| 22.6 | 7440 | 10548 | -7478 | -0.4985 |
| 22.8 | 7435 | 10537 | -7467 | -0.4978 |
| 23 | 7442 | 10559 | -7490 | -0.4993 |
| 23.2 | 7440 | 10538 | -7463 | -0.4975 |
| 23.4 | 7439 | 10544 | -7471 | -0.4981 |
| 23.6 | 7438 | 10545 | -7474 | -0.4983 |
| 23.8 | 7437 | 10560 | -7497 | -0.4998 |
| 24 | 7436 | 10550 | -7484 | -0.4989 |
| 24.2 | 7437 | 10555 | -7490 | -0.4994 |
| 24.4 | 7438 | 10542 | -7470 | -0.4980 |
| 24.6 | 7439 | 10559 | -7493 | -0.4996 |
| 24.8 | 7438 | 10545 | -7476 | -0.4984 |
| 25 | 7438 | 10554 | -7487 | -0.4991 |
| 25.2 | 7438 | 10555 | -7489 | -0.4993 |
| 25.4 | 7438 | 10551 | -7484 | -0.4989 |

| | | | | | |
|---|---|---|---|---|---|
| | 25.6 | 7439 | 10569 | -7507 | -0.5005 |
| | 25.8 | 7434 | 10556 | -7495 | -0.4997 |
| | 26 | 7441 | 10534 | -7457 | -0.4971 |
| | 26.2 | 7438 | 10556 | -7490 | -0.4993 |
| | 26.4 | 7438 | 10542 | -7471 | -0.4981 |
| | 26.6 | 7437 | 10551 | -7483 | -0.4989 |
| | 26.8 | 7438 | 10549 | -7481 | -0.4987 |
| | 27 | 7439 | 10545 | -7473 | -0.4982 |
| | 27.2 | 7440 | 10545 | -7473 | -0.4982 |
| | 27.4 | 7439 | 10543 | -7472 | -0.4981 |
| | 27.6 | 7438 | 10551 | -7482 | -0.4988 |
| | 27.8 | 7437 | 10541 | -7470 | -0.4980 |
| | 28 | 7439 | 10563 | -7499 | -0.5000 |
| | 28.2 | 7440 | 10539 | -7465 | -0.4976 |
| | 28.4 | 7437 | 10543 | -7473 | -0.4982 |
| | 28.6 | 7438 | 10562 | -7499 | -0.4999 |
| | 28.8 | 7435 | 10531 | -7458 | -0.4972 |
| | 29 | 7441 | 10571 | -7508 | -0.5006 |
| | 29.2 | 7439 | 10550 | -7481 | -0.4987 |
| | 29.4 | 7438 | 10557 | -7491 | -0.4994 |
| | 29.6 | 7438 | 10542 | -7471 | -0.4981 |
| | 29.8 | 7439 | 10555 | -7488 | -0.4992 |
| | 30 | 7438 | 10551 | -7483 | -0.4989 |

| Harmonic current emission (X3-8.0P-T-D) | | | | | P |
|---|---|---|---|---|---|
| Harmonic | At 100% of rated output | | | Maximum permissible harmonic current as per EN 61000-3-2, Class A (A) | |
| | Measured Value MV in Amps(L1/L2/L3) | | | Odd harmonics | Even harmonics |
| 2 | 0,025 | 0,051 | 0,039 | - | 1,08 |
| 3 | 0,160 | 0,069 | 0,091 | 2,30 | - |
| 4 | 0,011 | 0,008 | 0,009 | - | 0,43 |
| 5 | 0,126 | 0,164 | 0,158 | 1,14 | - |
| 6 | 0,004 | 0,003 | 0,003 | - | 0,30 |
| 7 | 0,122 | 0,113 | 0,105 | 0,77 | - |
| 8 | 0,003 | 0,004 | 0,003 | - | 0,23 |
| 9 | 0,021 | 0,014 | 0,022 | 0,40 | - |
| 10 | 0,004 | 0,006 | 0,005 | - | 0,184 |
| 11 | 0,120 | 0,132 | 0,120 | 0,33 | - |
| 12 | 0,004 | 0,004 | 0,005 | - | 0,153 |
| 13 | 0,096 | 0,077 | 0,095 | 0,21 | - |
| 14 | 0,006 | 0,004 | 0,002 | - | 0,131 |
| 15 | 0,035 | 0,010 | 0,035 | 0,15 | - |
| 16 | 0,005 | 0,002 | 0,003 | - | 0,115 |
| 17 | 0,070 | 0,079 | 0,071 | 0,132 | - |
| 18 | 0,003 | 0,003 | 0,005 | - | 0,102 |
| 19 | 0,049 | 0,038 | 0,050 | 0,118 | - |
| 20 | 0,004 | 0,004 | 0,002 | - | 0,092 |
| 21 | 0,014 | 0,004 | 0,005 | 0,107 | - |
| 22 | 0,003 | 0,002 | 0,003 | - | 0,084 |
| 23 | 0,018 | 0,019 | 0,016 | 0,098 | - |
| 24 | 0,004 | 0,002 | 0,004 | - | 0,077 |
| 25 | 0,009 | 0,006 | 0,011 | 0,090 | - |
| 26 | 0,002 | 0,002 | 0,003 | - | 0,071 |
| 27 | 0,013 | 0,004 | 0,002 | 0,083 | - |
| 28 | 0,003 | 0,002 | 0,002 | - | 0,066 |
| 29 | 0,010 | 0,014 | 0,009 | 0,078 | - |
| 30 | 0,002 | 0,001 | 0,002 | - | 0,061 |
| 31 | 0,009 | 0,006 | 0,009 | 0,073 | - |

| | | | | | |
|---|---|---|---|---|---|
| 32 | 0,002 | 0,002 | 0,002 | - | 0,058 |
| 33 | 0,002 | 0,002 | 0,007 | 0,068 | - |
| 34 | 0,003 | 0,002 | 0,002 | - | 0,054 |
| 35 | 0,010 | 0,013 | 0,008 | 0,064 | - |
| 36 | 0,001 | 0,001 | 0,001 | - | 0,051 |
| 37 | 0,009 | 0,006 | 0,008 | 0,061 | - |
| 38 | 0,001 | 0,002 | 0,001 | - | 0,048 |
| 39 | 0,002 | 0,002 | 0,002 | 0,058 | - |
| 40 | 0,002 | 0,001 | 0,001 | - | 0,046 |
| THD | 2,575% | 2,545% | 2,420% | 5% | |

| **Harmonic current emission (X3-15.0P-T-D)** | | | | | **P** |
|---|---|---|---|---|---|
| Harmonic | At 100% of rated output | | | Maximum permissible harmonic current as per EN 61000-3-2, Class A (A) | |
| | Measured Value MV in Amps(L1/L2/L3) | | | Odd harmonics | Even harmonics |
| 2 | 0,077 | 0,106 | 0,089 | - | 1,08 |
| 3 | 0,149 | 0,092 | 0,056 | 2,30 | - |
| 4 | 0,019 | 0,013 | 0,018 | - | 0,43 |
| 5 | 0,121 | 0,167 | 0,166 | 1,14 | - |
| 6 | 0,004 | 0,005 | 0,006 | - | 0,30 |
| 7 | 0,142 | 0,139 | 0,128 | 0,77 | - |
| 8 | 0,006 | 0,005 | 0,004 | - | 0,23 |
| 9 | 0,033 | 0,015 | 0,027 | 0,40 | - |
| 10 | 0,005 | 0,008 | 0,009 | - | 0,184 |
| 11 | 0,107 | 0,113 | 0,107 | 0,33 | - |
| 12 | 0,006 | 0,006 | 0,007 | - | 0,153 |
| 13 | 0,092 | 0,074 | 0,088 | 0,21 | - |
| 14 | 0,006 | 0,005 | 0,004 | - | 0,131 |
| 15 | 0,020 | 0,013 | 0,033 | 0,15 | - |
| 16 | 0,011 | 0,007 | 0,009 | - | 0,115 |
| 17 | 0,118 | 0,130 | 0,123 | 0,132 | - |
| 18 | 0,007 | 0,007 | 0,012 | - | 0,102 |
| 19 | 0,091 | 0,080 | 0,092 | 0,118 | - |

| | | | | | |
|---|---|---|---|---|---|
| 20 | 0,006 | 0,006 | 0,004 | - | 0,092 |
| 21 | 0,006 | 0,010 | 0,016 | 0,107 | - |
| 22 | 0,009 | 0,007 | 0,006 | - | 0,084 |
| 23 | 0,083 | 0,090 | 0,081 | 0,098 | - |
| 24 | 0,006 | 0,007 | 0,011 | - | 0,077 |
| 25 | 0,059 | 0,048 | 0,060 | 0,090 | - |
| 26 | 0,006 | 0,008 | 0,004 | - | 0,071 |
| 27 | 0,014 | 0,010 | 0,012 | 0,083 | - |
| 28 | 0,006 | 0,004 | 0,003 | - | 0,066 |
| 29 | 0,032 | 0,036 | 0,031 | 0,078 | - |
| 30 | 0,005 | 0,005 | 0,007 | - | 0,061 |
| 31 | 0,023 | 0,020 | 0,022 | 0,073 | - |
| 32 | 0,003 | 0,004 | 0,005 | - | 0,058 |
| 33 | 0,011 | 0,007 | 0,012 | 0,068 | - |
| 34 | 0,004 | 0,004 | 0,003 | - | 0,054 |
| 35 | 0,012 | 0,008 | 0,010 | 0,064 | - |
| 36 | 0,003 | 0,003 | 0,003 | - | 0,051 |
| 37 | 0,006 | 0,006 | 0,007 | 0,061 | - |
| 38 | 0,004 | 0,003 | 0,004 | - | 0,048 |
| 39 | 0,022 | 0,016 | 0,021 | 0,058 | - |
| 40 | 0,007 | 0,005 | 0,006 | - | 0,046 |
| THD | 1,591% | 1,560% | 1,551% | 5% | |

| **Voltage fluctuations and flicker (X3-15.0P-T-D)** | | | | | **P** |
|---|---|---|---|---|---|
| Value | Pst | Plt | d(t) - 500ms | dc | dmax |
| Limit | 1,0 | 0,5 | 3,3% | 3,3% | 4% |
| Test value | 0,23/0,16/0,22 | 0,19/0,14/0,18 | 0,23/0,19/0,15 | 0/0/0 | 0,49/0,48/0,44 |
| Supplementary information: | | | | | |