

# Protocol

## of environmental tests of the module TB-127-1.4-2.5HT(150), 139°C.

**Purpose of test:** reliability test of modules made by the approved technology.

**Place of carrying out:** Kryotherm company.

**Period of carting out:** 23.05.07-19.09.07.

**Testing object:** thermoelectric module TB-127-1.4-2.5HT(150), 139°C.

### Tests content:

1. High temperature storage +85°C, time-170 hours;
2. Low temperature storage -40°C, time-170 hours;
3. Temperature cycling: (-50+/-2)°C – (+45+/-2)°C, number of cycles – 3, time of isolation – 2 hours in the each chamber, time of transfer less than 5 min. The test carry out by method 205-1, GOST 20.57.406;
4. The isolation in the humidity chamber: RH=(98+/-2)%, T=(+25+/-2)°C, t=48 hours. The test carry out by method 207-2, degree of rigidity – 1;
5. Temperature cycling: - 40°C - +85°C, number of cycles – 25, time of isolation – 30 minutes in the each chamber.

### Tests method:

1. Tests carry out in the heat chamber STBV- 1000 and the environmental chamber 3522/51;
2. Control parameters: resistance R and figure of merit Z;
3. Measuring equipment – the automated complex AK;
4. The control method – Harman method;
5. Accuracy of dimensions +/- 1,0 %;
6. Index of successful tests – changing of R or Z less or equal 2%.

Table №1

|   | TEC parameters before tests |       | High temperature storage +85°C, time-170 hours. |                           |         |         | Low temperature storage -40°C, time-170 hours. |       |         |         | Temperature cycling: -50–+45°C, number of cycles – 3, time of isolation – 2 hours in the each chamber, time of transfer less than 5 min. |       |         |         |
|---|-----------------------------|-------|---|---------------------------|---------|---------|--|-------|---------|---------|--|-------|---------|---------|
| № | Zx10 <sup>-3</sup> , 1/°C   | R, Ом | Zx10 <sup>-3</sup> , 1/°C                       | Rx10 <sup>-3</sup> , 1/°C | ΔZ/Z, % | ΔR/R, % | Zx10 <sup>-3</sup> , 1/°C                      | R, Ом | ΔZ/Z, % | ΔR/R, % | Zx10 <sup>-3</sup> , 1/°C  | R, Ом | ΔZ/Z, % | ΔR/R, % |
| 1 | 2.601                       | 3.604 | 2.598   | 3.309                     | -0.11   | 0.15    | 2.598  | 3.314 | -0.1    | 0.3     | 2.602  | 3.318 | 0.04    | 0.4     |
| 2 | 2.597                       | 3.269 | 2.579   | 3.298                     | -0.69   | 0.89    | 2.594  | 3.278 | -0.1    | 0.4     | 2.600  | 3.281 | 0.1     | 0.37    |
| 3 | 2.598                       | 3.244 | 2.592   | 3.250                     | -0.23   | 0.18    | 2.599  | 3.254 | 0.04    | 0.3     | 2.594  | 3.259 | -0.2    | 0.5     |
| 4 | 2.559                       | 3.285 | 2.560   | 3.288                     | 0.04    | 0.09    | 2.554  | 3.295 | -0.2    | 0.3     | 2.559  | 3.299 | 0.0     | 0.4     |

Table №2

|   | The isolation in the humidity chamber: RH=98%, T=+25°C, t=48hours. |       |         |         | Temperature cycling: - 40°C - +85°C, number of cycles – 25, time of isolation – 30 minutes in the each chamber. |       |         |         | The isolation in the humidity chamber: RH=95%, T=+70°C, t=170hours. |       |         |         |
|---|--|-------|---------|---------|---|-------|---------|---------|---|-------|---------|---------|
| № | Zx10 <sup>-3</sup> , 1/°C  | R, Ом | ΔZ/Z, % | ΔR/R, % | Zx10 <sup>-3</sup> , 1/°C   | R, Ом | ΔZ/Z, % | ΔR/R, % | Zx10 <sup>-3</sup> , 1/°C   | R, Ом | ΔZ/Z, % | ΔR/R, % |
| 1 | 2.598  | 3.313 | -0.1    | 0.3     | 2.603   | 3.307 | 0.1     | 0.1     | 2.611   | 3.338 | 0.38    | 1.0     |
| 2 | 2.595  | 3.280 | -0.08   | 0.3     | 2.593   | 3.278 | -0.2    | 0.3     | 2.607   | 3.304 | 0.4     | 1.07    |
| 3 | 2.597  | 3.255 | -0.04   | 0.3     | 2.596   | 3.252 | -0.1    | 0.3     | 2.606   | 3.280 | 0.3     | 1.1     |
| 4 | 2.554  | 3.295 | -0,2    | 0.3     | 2.557   | 3.293 | -0.1    | 0.2     | 2.570   | 3.316 | 0.4     | 0.9     |

**Conclusion:** Figure of merit Z and resistance R after tests stand inside of limits of measurement accuracy. Modules passed successful tests.