

Heat Dissipation Testing Report for Power Modules with Blind Holes or Through Holes on Ground Plate

1. Testing Purposes

Compare the power modules with blind holes or through holes on the ground plate in respect of cooling effect.

2. Testing Method

Working lifetime (resistive load) testing method according to IEC60747-6 Semiconductor devices Part 6 Thyristors 6.2.1.

In the same thermal conditions, the same on-state current (I_{TAV}) shall flow through the modules with blind holes and through holes. The case temperature T_c and the blocking characteristics of the modules shall be detected. On the basis of these, it can be determined whether there are any significant differences in respect of thermal resistance R_{jc} between junction and case and thermal resistance R_{cs} between case and heat sink.

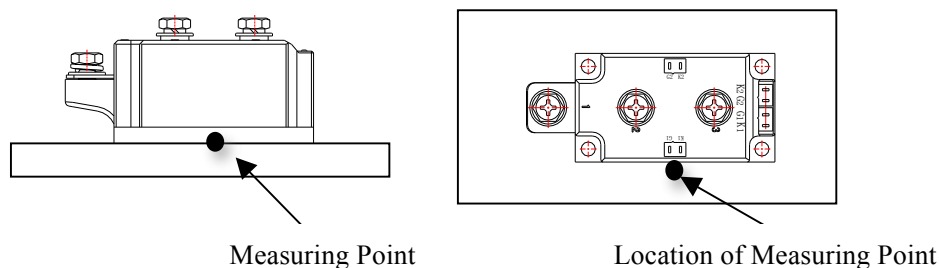


Fig. 1: Scheme of Measuring Point

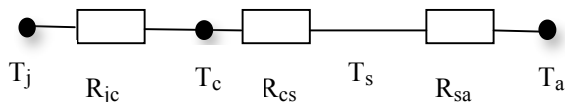


Fig. 2: Scheme of Cooling Topology

$$T_c = P \cdot (R_{cs} + R_{sa}) + T_a$$

By testing of T_c , the differences of R_{cs} for through-hole and blind-hole modules can be verified.

$$T_j = P \cdot (R_{jc} + R_{cs} + R_{sa}) + T_a$$

By testing of blocking characteristics of the different modules, the differences of T_j can be determined indirectly. The differences of R_{jc} then can be verified.

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3. Testing Program

The chips of the modules for comparison purposes are filtered with the more consistent parameters such as V_{TM} / I_{DRM} / I_{RRM} . Through measuring the leakage current, it can be determined whether T_j is basically the same. The difference of impact on thermal resistance for through holes and blind holes can be verified by measuring the T_c .

Product Name	Thyristor Module	Product Types	MTC250A/1600V 413F3 MTC500A/1600V 416F3 MT400A/1600V 417F2
Test Conditions	Monitor the case temperature T_c and test V_{DRM} / I_{DRM} in the same thermal conditions with the same on-state current (I_{TAV}): One side air-cooled heat sink; wind speed 2.0m/s; 180° half sine wave t_p = 10ms; frequency 50Hz; current duration 10min.		
Major Technical Parameters	Blocking Voltage: 1600V; Rated Current: 250A / 500A / 400A		
Testing Category	Comparative Test	Testing Sample	413F3* Through Holes: 2 Pcs. Blind Holes: 2 Pcs. 416F3* Through Holes: 2 Pcs. Blind Holes: 2 Pcs. 417F2* Through Holes: 1 Pc. Blind Holes: 1 Pc.
Testing Unit	Techsem Module Production Dept.		
Quantity of Sampling Base	10 Pcs.	Quantity of Samples	10 Pcs.
Date of Sampling	August 29, 2013	Date of Test	September 3, 2013

Fig. 3: Testing Conditions

* Code for different housings. Please refer to the article “*Technical Information Techsem Module*”.

4. Test Data

4.1. Test data of the modules ($V_{RRM}=1600V$) with housing type 413F3:

Sample No.		T _c (°C)	I _{DRM} /I _{RRM} @ (mA)	
Through Hole Ground Plate	6DTCM133871001	SCR 1	46.73	15.2/10.4
		SCR 2	47.06	16.6/12.8
	6DTCM133871002	SCR 1	45.83	15.4/10.6
		SCR 2	46.18	16.2/12.4
Blind Hole Ground Plate	6DTCM133881001	SCR 1	47.25	15.4/10.6
		SCR 2	46.35	16.4/12.6
	6DTCM133881002	SCR 1	44.46	15.2/10.4
		SCR 2	45.65	16.4/12.6

Fig. 4: Test Result of 413F3

Ground plate with through holes: measured average temperature of 46.28°C for SCR1; measured average temperature of 46.6°C for SCR2.

Ground plate with blind holes: measured average temperature of 45.85°C for SCR1; measured average temperature of 46°C for SCR2.

Based on the fact that T_c of the modules and I_{DRM}/I_{RRM} of the modules are basically the same, it can be deemed that R_{jc} and R_{cs} of the modules with through holes and blind holes also are basically the same.

According to the calculation, the total area of the holes amounts to approximately 1.9% of the total ground plate area.

4.2. Test data of the modules with housing type 416F3:

Sample No.		T _c (°C)	I _{DRM} /I _{RRM} @ 1600V	
Through Hole Ground Plate	6FTCM133873001	SCR 1	75.36	18.2/16.4
		SCR 2	73.65	20.6/15.8
	6FTCM133873002	SCR 1	70.76	18.4/16.6
		SCR 2	71.40	20.2/15.4
Blind Hole Ground Plate	6FTCM133882001	SCR 1	72.01	18.4/16.6
		SCR 2	71.60	20.4/15.6
	6FTCM133882002	SCR 1	76.50	18.2/16.4
		SCR 2	74.80	20.4/15.6

Fig. 5: Test Result of 416F3

Ground plate with through holes: measured average temperature of 73.68°C for SCR1; measured average temperature of 72.5°C for SCR2.

Ground plate with blind holes: measured average temperature of 74.25°C for SCR1; measured average temperature of 73.2°C for SCR2.

Based on the fact that T_c of the modules and I_{DRM}/I_{RRM} of the modules are basically the same, it can be deemed that R_{jc} and R_{cs} of the modules with through holes and blind holes also are basically the same.

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According to the calculation, the total area of the holes amounts to approximately 2% of the total ground plate area.

4.3. Test data of the modules with housing type 417F2:

Sample No.		T _c (°C)	I _{DRM} /I _{RRM} @ 1600V
Through Hole Ground Plate	OPMTM134120001	73.52	16.5/16.4
Blind Hole Ground Plate	OPMTM134120002	74.12	16.8/16.6

Fig. 6: Test Result of 417F2

The measuring shows that the temperature difference between the two modules amounts to 0.6°C.

Based on the fact that T_c of the modules and I_{DRM}/I_{RRM} of the modules are basically the same, it can be deemed that R_{jc} and R_{cs} of the modules with through holes and blind holes also are basically the same.

According to the calculation, the total area of the holes amounts to approximately 1.58% of the total ground plate area.

5. Conclusion

For the Thyristor modules MTC250A/1600V (housing type 413F3), MTC500A/1600V (housing type 416F3), and MT400A/1600V (housing type 417F2), regardless of testing the ground plate with through holes or blind holes, under the condition of the same on-state current I_{TAV}, no significant difference with regard to case temperature T_C or forward current I_{DRM}/I_{RRM} can be verified. Therefore, the impact of the difference between through holes and blind holes with respect to the thermal resistance R_{jc} and R_{cs} can be considered insignificant.