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3.5 Replacement of main circuit semiconductor modules

3.5.1 Measuring semiconductor condition from main connectors


The condition of an IGBT and an input bridge can be measured with a multimeter to ensure component functionality. In this section there are given the pass criteria for values measured from main connectors. In order to measure IGBT condition directly from IGBT pins, see section 3.5.2 *Measuring IGBT condition*. In the tables below the infinite value is OL = Over limit.

Note: Always make sure there is no voltage connected to input terminals. In case a permanent magnet motor is used, the motor axel must not rotate as it would feed voltage to drive side.

STEP 1	Input bridge diode measurement		
Performance	Use a multimeter to make sure that the measurements for the input bridge diodes are OK.		
Pass criteria	By using the diode measurement setting for the multimeter, you should get the following values: Note: In case of a controlled charging circuit, the input bridge measurement is not possible for all phases.		
	+ probe	- probe	Display
	L1	+DC	~1,1 Vdc
	L2	+DC	OL
	L3	+DC	OL
	+DC	L1	OL
	+DC	L2	OL
	+DC	L3	OL
	+ probe	- probe	Display
	L1	- DC	OL
	L2	- DC	OL
	L3	- DC	OL
	- DC	L1	~0,45 Vdc
	- DC	L2	~0,45 Vdc
	- DC	L3	~0,45 Vdc
Meaning of the test	To ensure that the input bridge diodes are OK.		

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STEP 2	IGBT freewheeling diode measurement																																										
Performance	Use a multimeter to make sure that the measurements for the output bridge freewheeling diodes are OK.																																										
Pass criteria	<p>By using the diode measurement setting for the multimeter, you should get the following values:</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 33%;">+ probe</th> <th style="width: 33%;">- probe</th> <th style="width: 33%;">Display</th> </tr> </thead> <tbody> <tr> <td>U</td> <td>+DC</td> <td>~0,4 Vdc</td> </tr> <tr> <td>V</td> <td>+DC</td> <td>~0,4 Vdc</td> </tr> <tr> <td>W</td> <td>+DC</td> <td>~0,4 Vdc</td> </tr> <tr> <td>+DC</td> <td>U</td> <td>OL</td> </tr> <tr> <td>+DC</td> <td>V</td> <td>OL</td> </tr> <tr> <td>+DC</td> <td>W</td> <td>OL</td> </tr> </tbody> </table> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 33%;">+ probe</th> <th style="width: 33%;">- probe</th> <th style="width: 33%;">Display</th> </tr> </thead> <tbody> <tr> <td>U</td> <td>- DC</td> <td>OL</td> </tr> <tr> <td>V</td> <td>- DC</td> <td>OL</td> </tr> <tr> <td>W</td> <td>- DC</td> <td>OL</td> </tr> <tr> <td>- DC</td> <td>U</td> <td>~0,4 Vdc</td> </tr> <tr> <td>- DC</td> <td>V</td> <td>~0,4 Vdc</td> </tr> <tr> <td>- DC</td> <td>W</td> <td>~0,4 Vdc</td> </tr> </tbody> </table>	+ probe	- probe	Display	U	+DC	~0,4 Vdc	V	+DC	~0,4 Vdc	W	+DC	~0,4 Vdc	+DC	U	OL	+DC	V	OL	+DC	W	OL	+ probe	- probe	Display	U	- DC	OL	V	- DC	OL	W	- DC	OL	- DC	U	~0,4 Vdc	- DC	V	~0,4 Vdc	- DC	W	~0,4 Vdc
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- DC	V	~0,4 Vdc																																									
- DC	W	~0,4 Vdc																																									
Meaning of this test	To ensure that the output freewheeling diodes are OK.																																										


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3.5.2 Measuring IGBT condition


The condition of an IGBT and an input bridge can be measured with a multimeter. Pass criteria given in this section are measured directly from the IGBT pins. A broken IGBT module can also be identified by measuring between udc+/udc- and output connectors. Therefore, please conduct the measurements described in section 3.5.1 *Measuring semiconductor condition from main connectors* before performing the measurements described here.

In some cases, damage can be identified visually. Thus it is important to conduct a visual check on the IGBT modules as well. Sometimes the IGBT module might be broken or burned for example by an arc, which is caused by a short circuit inside the module.

STEP 1	Output IGBT freewheeling diode measurement		
Performance	Use a multimeter to make sure that the measurements for the output bridge freewheeling diodes are OK (see Figure 3.a-b for frame size R6 and figures 5.c-d for frame sizes R7-R9)		
Pass criteria	By using the diode measurement setting for the multimeter, you should get the following values:		
	+ probe	- probe	R6 display
	1	3	OL
	1	5	OL
	1	4	OL
	8	4	OL
	4	8	~0,4 Vdc
	4	1	~0,4 Vdc
	3	1	~0,4 Vdc
	5	1	~0,4 Vdc
	+ probe	- probe	R6 display
	2	3	~0,4 Vdc
	2	4	~0,4 Vdc
	2	5	~0,4 Vdc
	3	2	OL
	4	2	OL
	5	2	OL
	+ probe	- probe	R7-R9 display
	4	10/11	OL
	9	10/11	OL
	3	10/11	~0,4 Vdc
	10/11	4	~0,4 Vdc
	10/11	9	~0,4 Vdc
	10/11	3	OL
Meaning of the test	To ensure that the IGBT freewheeling diodes are OK.		

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STEP 2	IGBT gate measurement																														
Performance	<p>Use a multimeter to measure the condition of the IGBT gates. Please note that the ZGAD board is supposed to stay attached to the IGBT module. The condition of the IGBT gates can be measured, when the multimeter is turned to the Ohm measurement.</p> <p>NOTE! Having the correct IGBT gate - emitter resistance measurement does not automatically mean that the IGBT module is OK. If the IGBT gate - emitter has a slight leak, the measurements may show to be correct even with the faulty module in this case.</p>																														
Pass criteria	<p>The table below shows the resistance values for the IGBT gate – emitter measurement (see Figure 3.a-b for frame size R6 and figures 5.c-d for frame sizes R7-R9):</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 33%;">+ probe</th> <th style="width: 33%;">- probe</th> <th style="width: 33%;">R6 display</th> </tr> </thead> <tbody> <tr><td>17</td><td>5</td><td>10kΩ</td></tr> <tr><td>16</td><td>4</td><td>10kΩ</td></tr> <tr><td>14</td><td>3</td><td>10kΩ</td></tr> <tr><td>6</td><td>2</td><td>10kΩ</td></tr> <tr><td>10</td><td>2</td><td>10kΩ</td></tr> <tr><td>12</td><td>2</td><td>10kΩ</td></tr> </tbody> </table> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 33%;">+ probe</th> <th style="width: 33%;">- probe</th> <th style="width: 33%;">R7-R9 display</th> </tr> </thead> <tbody> <tr><td>7</td><td>10/11</td><td>10kΩ</td></tr> <tr><td>1</td><td>3</td><td>10kΩ</td></tr> </tbody> </table>	+ probe	- probe	R6 display	17	5	10kΩ	16	4	10kΩ	14	3	10kΩ	6	2	10kΩ	10	2	10kΩ	12	2	10kΩ	+ probe	- probe	R7-R9 display	7	10/11	10kΩ	1	3	10kΩ
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12	2	10kΩ																													
+ probe	- probe	R7-R9 display																													
7	10/11	10kΩ																													
1	3	10kΩ																													
Meaning of the test	To ensure that the IGBT gates are OK																														
STEP 3	IGBT module NTC-thermistor measurement																														
Performance	<p>Use a multimeter to measure the condition of the NTC-thermistor on the IGBT module. Turn the multimeter to the Ohm measurement for this test.</p> <p>See correct IGBT pins in Figure 3.a-b for frame size R6 and figures 5.c-d for frame sizes R7-R9.</p>																														
Pass criteria	<p>The correct resistance value for the NTC-thermistor measurement. Check the correct resistance value for the NTC thermistor from the IGBT manufacturer's datasheet.</p> <p>E.g. Correct resistance values with temperatures 20°C, 25°C and 30°C: $R_{20} \rightarrow \sim 6k\Omega$ $R_{25} \rightarrow \sim 5k\Omega$ $R_{30} \rightarrow \sim 4k\Omega$</p>																														
Meaning of the test	To ensure that the NTC-thermistor is OK.																														

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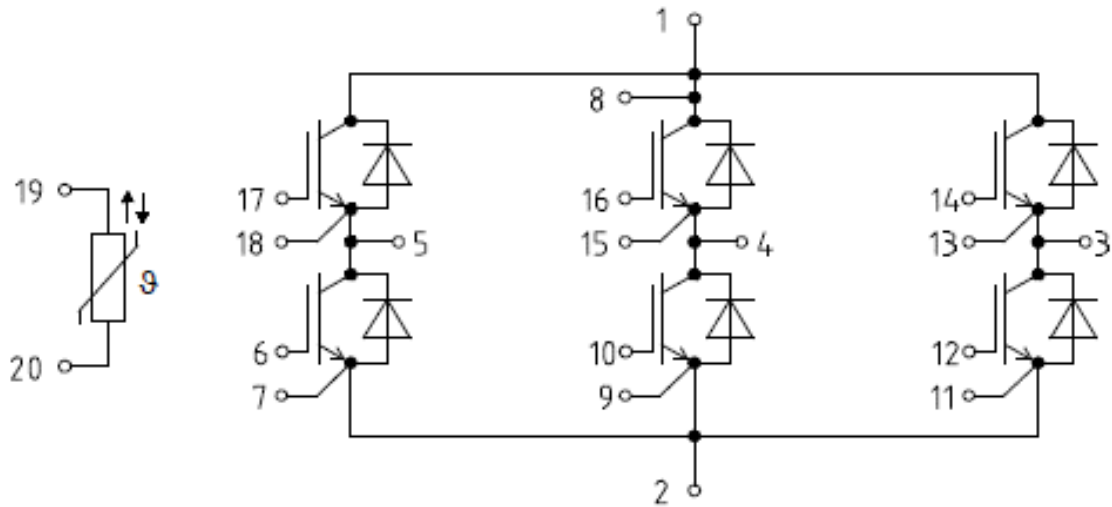


Figure 3.a: Frame R6 IGBT module: diagram of module's connectors.

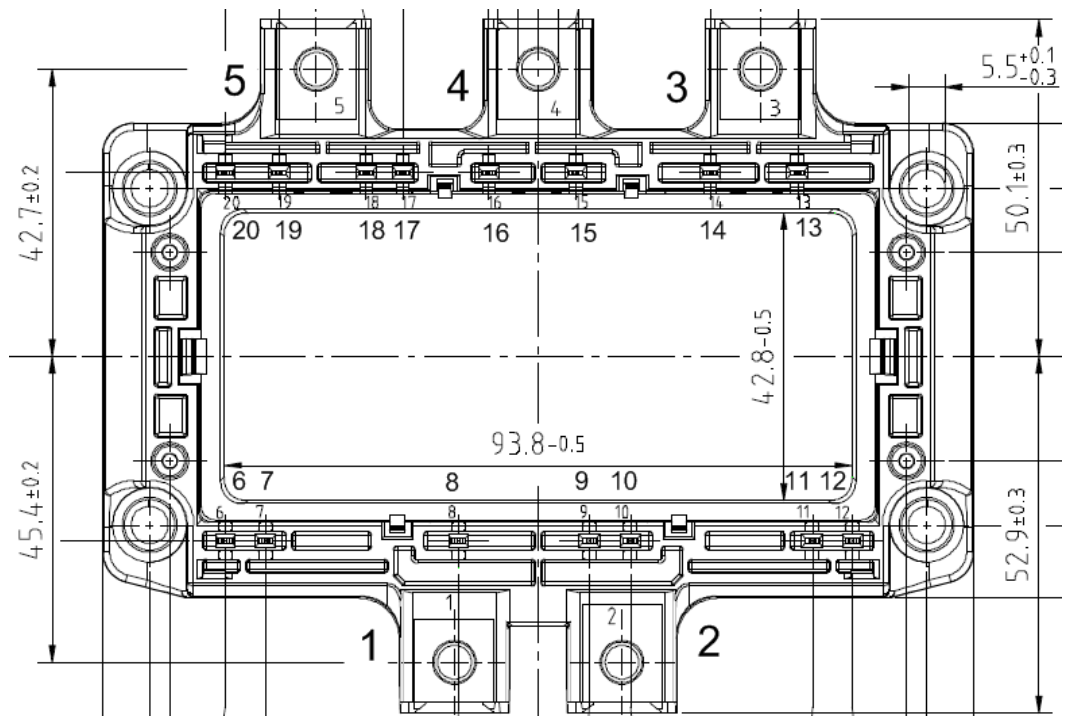


Figure 3.b: Frame R6 IGBT module: picture of module's connectors.

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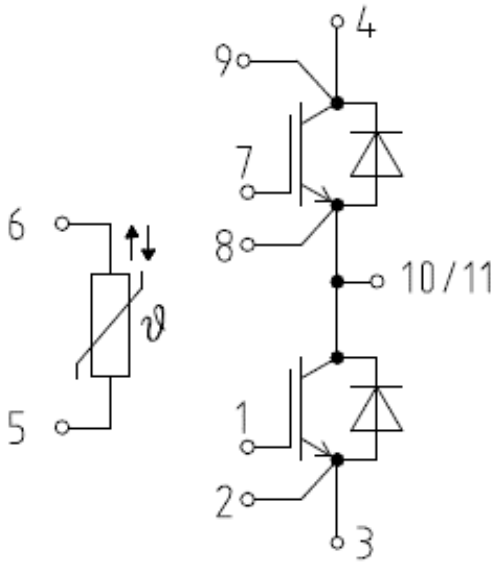


Figure 3.c: Frames R7-R9 IGBT module: diagram of modules connectors

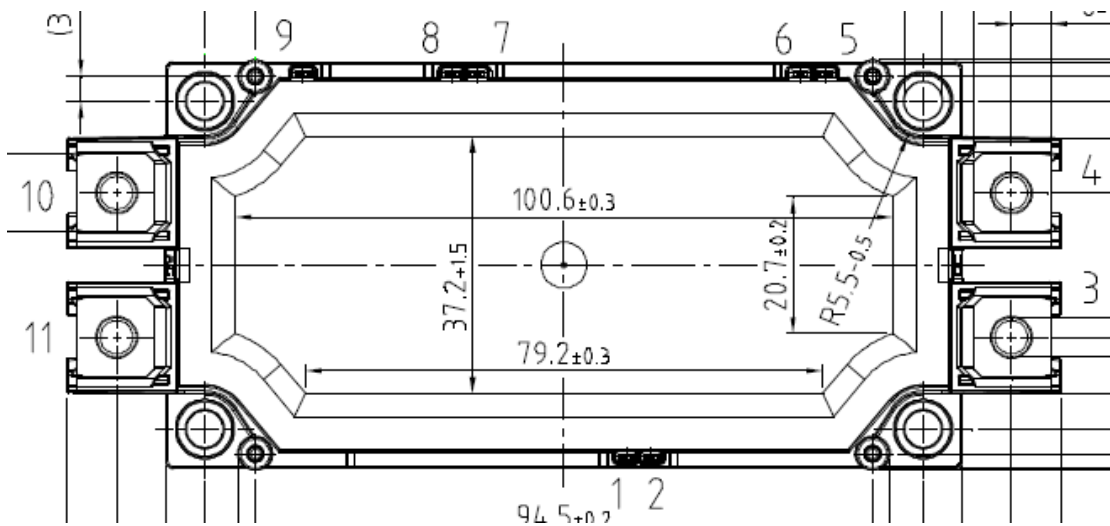


Figure 3.d: Frames R7-R9 IGBT module: picture of modules connectors.