



ref. TRIO-TM-50.0(60.0)-400(480) (Power-One\_UK G59-3 Type Verification Test Report)

## ***ENA Engineering Recommendation G59/3 Type Verification Test Report***

<b>Type Approval and manufacturer/supplier declaration of compliance with the requirements of Engineering Recommendation G59/3</b>			
Type Test reference number	TRIO-TM-50.0-400 TRIO-TM-60.0-480		
Generating unit technology	SOLAR GRID TIED INVERTER		
System Supplier name	Power-One Italy S.p.A.		
Address	Via S. Giorgio, 642 52028 Terranuova Bracciolini Arezzo - Italy		
Tel.	+39-055-91951	Fax	+39-055-9195248
E:mail	servicer.solarinverters@it.abb.com	Web site	www.abb.com/solarinverters www.abb.com
Maximum / Nominal rated capacity	Connection Option		
	TRIO-TM-50.0-400: 50.0 kW (kW three phases) TRIO-TM-60.0-480: 60.0 kW (kW three phases)		
<p>We, Power-One Italy S.p.A., as manufacturer/supplier of Generating Unit, certifies that all products manufactured/supplied by the company with the above Type Test 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 products meet all the requirements of G59/3.</p> <p>Attachment: Extract of Test Report Ref. <b>28110633 011</b>, released by TÜV Rheinland.</p>			

Terranuova B.ni, 2017 August 28

  
Marcello Berlingozzi  
(Leadperson Quality Control)

  
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Extract of Test report: 28110633 011  
 Engineering Recommendation G59 Issue 03 (September 2013)  
 13.1 Generating Unit Type Test Sheet  
 Type Tested Generating Unit (>16A per phase but ≤ 17 kW 1 phase)

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<b>Type of System:</b>	Solar Grid tied inverter							
<b>System Manufacturer:</b> <b>Manufacturer data:</b>	<b>Power-One Italy S.p.A.</b> Via S. Giorgio 642, 52028 Terranuova Bracciolini (AR) - Italy							
<b>Reference test report:</b>	<b>28110633 011</b> Issued by TÜV Rheinland Italia S.r.l.							
<b>Measuring period:</b>	From 12/06/2017 to 22/06/2016							
<b>Type Test reference number:</b>  <b>Pacr / Pacmax</b> <i>(Rated AC Power / Maximum AC output Power)</i>	<table border="1"> <thead> <tr> <th>Models</th> <th>Pacr / Pacmax</th> </tr> </thead> <tbody> <tr> <td>TRIO-TM-50.0-400</td> <td>50 kW / 50kW</td> </tr> <tr> <td>TRIO-TM-60.0-480</td> <td>60 kW / 60 kW</td> </tr> </tbody> </table>		Models	Pacr / Pacmax	TRIO-TM-50.0-400	50 kW / 50kW	TRIO-TM-60.0-480	60 kW / 60 kW
Models	Pacr / Pacmax							
TRIO-TM-50.0-400	50 kW / 50kW							
TRIO-TM-60.0-480	60 kW / 60 kW							
<b>Software version:</b>	Bundle Firmware Update Version*: <b>not less than:</b> <b>1726B for TRIO-TM-50.0-400</b> <b>1726C for TRIO-TM-60.0-480</b> standard selection: <b>UK G59</b>							
<b>Rated Voltage:</b>	3-phase device 230 V (Phase/ Neutral) <b>TRIO-TM-50.0-400</b> 277 V (Phase/ Neutral) <b>TRIO-TM-60.0-480</b>							
<b>Note *:</b>	<p>“Update version” identifies the Bundle Firmware Features by a sequential code: xxxxy where:</p> <ul style="list-style-type: none"> <li>• xxxx is a number indicates Year (two digits) and Week (two digits)</li> <li>• y is a letter from A to G indicates Day (form Sunday = A to Saturday=G)</li> </ul>							

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**Power Quality. Harmonics.**  
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Phase R								
Order	P/Pn=0.3	P/Pn=0.6	P/Pn=1	P/Pn=0.3	P/Pn=0.6	P/Pn=1	Limits	Result
	[A]	[A]	[A]	[%]	[%]	[%]	Rsce33	
1	21.816	43.540	71.385					
2	0.025	0.045	0.065	0.115%	0.103%	0.091%		
3	0.122	0.141	0.114	0.559%	0.324%	0.160%		
4	0.043	0.046	0.066	0.197%	0.106%	0.092%		
5	0.098	0.095	0.060	0.449%	0.218%	0.084%	10.700	PASS
6	0.021	0.035	0.041	0.096%	0.080%	0.057%		
7	0.091	0.092	0.064	0.417%	0.211%	0.090%	7.200	PASS
8	0.024	0.013	0.021	0.110%	0.030%	0.029%		
9	0.001	0.013	0.023	0.005%	0.030%	0.032%		
10	0.009	0.004	0.016	0.041%	0.009%	0.022%		
11	0.078	0.131	0.101	0.358%	0.301%	0.141%	3.100	PASS
12	0.001	0.001	0.009	0.005%	0.002%	0.013%		
13	0.050	0.107	0.083	0.229%	0.246%	0.116%	2.000	PASS
14	0.011	0.006	0.007	0.050%	0.014%	0.010%		
15	0.001	0.006	0.015	0.005%	0.014%	0.021%		
16	0.002	0.005	0.004	0.009%	0.011%	0.006%		
17	0.083	0.078	0.080	0.380%	0.179%	0.112%		
18	0.000	0.000	0.017	0.000%	0.000%	0.024%		
19	0.076	0.049	0.071	0.348%	0.113%	0.099%		
20	0.000	0.001	0.004	0.000%	0.002%	0.006%		
21	0.000	0.001	0.007	0.000%	0.002%	0.010%		
22	0.000	0.000	0.002	0.000%	0.000%	0.003%		
23	0.045	0.041	0.047	0.206%	0.094%	0.066%		
24	0.000	0.000	0.003	0.000%	0.000%	0.004%		
25	0.038	0.034	0.044	0.174%	0.078%	0.062%		
26	0.000	0.000	0.003	0.000%	0.000%	0.004%		
27	0.000	0.003	0.013	0.000%	0.007%	0.018%		
28	0.000	0.000	0.002	0.000%	0.000%	0.003%		
29	0.017	0.027	0.040	0.078%	0.062%	0.056%		
30	0.000	0.000	0.003	0.000%	0.000%	0.004%		
31	0.032	0.024	0.035	0.147%	0.055%	0.049%		
32	0.000	0.000	0.001	0.000%	0.000%	0.001%		
33	0.000	0.004	0.010	0.000%	0.009%	0.014%		
34	0.000	0.001	0.004	0.000%	0.002%	0.006%		
35	0.038	0.029	0.033	0.174%	0.067%	0.046%		
36	0.000	0.001	0.013	0.000%	0.002%	0.018%		

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Phase R								
Order	P/Pn=0.3	P/Pn=0.6	P/Pn=1	P/Pn=0.3	P/Pn=0.6	P/Pn=1	Limits	Result
37	0.033	0.029	0.033	0.151%	0.067%	0.046%		
38	0.000	0.000	0.007	0.000%	0.000%	0.010%		
39	0.001	0.009	0.023	0.005%	0.021%	0.032%		
40	0.000	0.001	0.008	0.000%	0.002%	0.011%		

Phase S								
Order	P/Pn=0.3	P/Pn=0.6	P/Pn=1	P/Pn=0.3	P/Pn=0.6	P/Pn=1	Limits	Result
	[A]	[A]	[A]	[%]	[%]	[%]	Rsce33	
1	21.759	43.485	71.359					
2	0.026	0.061	0.071	0.119%	0.140%	0.099%		
3	0.077	0.087	0.087	0.354%	0.200%	0.122%		
4	0.019	0.034	0.046	0.087%	0.078%	0.064%		
5	0.096	0.08	0.057	0.441%	0.184%	0.080%	10.700	PASS
6	0.018	0.036	0.02	0.083%	0.083%	0.028%		
7	0.079	0.083	0.061	0.363%	0.191%	0.085%	7.200	PASS
8	0.015	0.021	0.024	0.069%	0.048%	0.034%		
9	0.008	0.017	0.023	0.037%	0.039%	0.032%		
10	0.026	0.003	0.032	0.119%	0.007%	0.045%		
11	0.076	0.134	0.101	0.349%	0.308%	0.142%	3.100	PASS
12	0.001	0.001	0.021	0.005%	0.002%	0.029%		
13	0.05	0.105	0.083	0.230%	0.241%	0.116%	2.000	PASS
14	0.009	0.005	0.015	0.041%	0.011%	0.021%		
15	0.001	0.003	0.017	0.000%	0.007%	0.024%		
16	0.005	0.011	0.005	0.023%	0.025%	0.007%		
17	0.083	0.079	0.081	0.381%	0.182%	0.114%		
18	0.001	0.001	0.004	0.000%	0.000%	0.006%		
19	0.075	0.05	0.069	0.345%	0.115%	0.097%		
20	0.002	0.001	0.003	0.009%	0.000%	0.004%		
21	0.001	0.001	0.009	0.000%	0.002%	0.013%		
22	0.003	0.003	0.004	0.014%	0.007%	0.006%		
23	0.045	0.039	0.047	0.207%	0.090%	0.066%		
24	0.001	0.002	0.005	0.005%	0.005%	0.007%		
25	0.038	0.037	0.044	0.175%	0.085%	0.062%		
26	0.003	0.003	0.012	0.014%	0.007%	0.017%		
27	0.001	0.006	0.019	0.000%	0.014%	0.027%		
28	0.001	0.002	0.008	0.005%	0.005%	0.011%		
29	0.019	0.026	0.04	0.087%	0.060%	0.056%		
30	0.004	0.002	0.005	0.018%	0.005%	0.007%		
31	0.031	0.03	0.036	0.142%	0.069%	0.050%		
32	0.002	0.008	0.004	0.009%	0.018%	0.006%		
33	0.002	0.008	0.018	0.009%	0.018%	0.025%		
34	0.030	0.016	0.019	0.138%	0.037%	0.027%		

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Phase S								
Order	P/Pn=0.3	P/Pn=0.6	P/Pn=1	P/Pn=0.3	P/Pn=0.6	P/Pn=1	Limits	Result
35	0.038	0.031	0.035	0.175%	0.071%	0.049%		
36	0.041	0.023	0.028	0.184%	0.053%	0.039%		
37	0.033	0.035	0.037	0.152%	0.080%	0.052%		
38	0.031	0.017	0.021	0.138%	0.039%	0.029%		
39	0.005	0.019	0.029	0.023%	0.044%	0.041%		
40	0.002	0.005	0.014	0.009%	0.011%	0.020%		

Phase T								
Order	P/Pn=0.3	P/Pn=0.6	P/Pn=1	P/Pn=0.3	P/Pn=0.6	P/Pn=1	Limits	Result
	[A]	[A]	[A]	[%]	[%]	[%]	Rsce33	
1	21.759	43.485	71.359					
2	0.026	0.061	0.071	0.119%	0.140%	0.099%		
3	0.077	0.087	0.087	0.354%	0.200%	0.122%		
4	0.019	0.034	0.046	0.087%	0.078%	0.064%		
5	0.096	0.080	0.057	0.441%	0.184%	0.080%	10.700	PASS
6	0.018	0.036	0.020	0.083%	0.083%	0.028%		
7	0.079	0.083	0.061	0.363%	0.191%	0.085%	7.200	PASS
8	0.015	0.021	0.024	0.069%	0.048%	0.034%		
9	0.008	0.017	0.023	0.037%	0.039%	0.032%		
10	0.026	0.003	0.032	0.119%	0.007%	0.045%		
11	0.076	0.134	0.101	0.349%	0.308%	0.142%	3.100	PASS
12	0.001	0.001	0.021	0.005%	0.002%	0.029%		
13	0.050	0.105	0.083	0.230%	0.241%	0.116%	2.000	PASS
14	0.009	0.005	0.015	0.041%	0.011%	0.021%		
15	0.000	0.003	0.017	0.000%	0.007%	0.024%		
16	0.005	0.011	0.005	0.023%	0.025%	0.007%		
17	0.083	0.079	0.081	0.381%	0.182%	0.114%		
18	0.000	0.000	0.004	0.000%	0.000%	0.006%		
19	0.075	0.050	0.069	0.345%	0.115%	0.097%		
20	0.002	0.000	0.003	0.009%	0.000%	0.004%		
21	0.000	0.001	0.009	0.000%	0.002%	0.013%		
22	0.003	0.003	0.004	0.014%	0.007%	0.006%		
23	0.045	0.039	0.047	0.207%	0.090%	0.066%		
24	0.001	0.002	0.005	0.005%	0.005%	0.007%		
25	0.038	0.037	0.044	0.175%	0.085%	0.062%		
26	0.003	0.003	0.012	0.014%	0.007%	0.017%		
27	0.000	0.006	0.019	0.000%	0.014%	0.027%		
28	0.001	0.002	0.008	0.005%	0.005%	0.011%		
29	0.019	0.026	0.040	0.087%	0.060%	0.056%		
30	0.004	0.002	0.005	0.018%	0.005%	0.007%		
31	0.031	0.030	0.036	0.142%	0.069%	0.050%		
32	0.002	0.008	0.004	0.009%	0.018%	0.006%		

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Phase T								
Order	P/Pn=0.3	P/Pn=0.6	P/Pn=1	P/Pn=0.3	P/Pn=0.6	P/Pn=1	Limits	Result
33	0.002	0.008	0.018	0.009%	0.018%	0.025%		
34	0.030	0.016	0.019	0.138%	0.037%	0.027%		
35	0.038	0.031	0.035	0.175%	0.071%	0.049%		
36	0.040	0.023	0.028	0.184%	0.053%	0.039%		
37	0.033	0.035	0.037	0.152%	0.080%	0.052%		
38	0.030	0.017	0.021	0.138%	0.039%	0.029%		
39	0.005	0.019	0.029	0.023%	0.044%	0.041%		
40	0.002	0.005	0.014	0.009%	0.011%	0.020%		

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<b>Power Quality. Voltage fluctuations and Flicker.</b> The requirement is specified in section 5.4.2, test procedure in Annex A or B 1.4.3								
<b>TRIO-TM-50.0-400</b>	Starting			Stopping			Running	
	dmax	dc	d(t)	dmax	dc	d(t)	Pst	Plt 2 hours
Measured Values at test impedance	0.06%	0.07%	0.000%	0.06%	0.07%	0.000%	0.345	0.345
Limits set under BS EN 61000-3-11	4%	3.3%	3.3% 500ms	4%	3.3%	3.3% 500ms	1	0.65
<b>TRIO-TM-60.0-480</b>	Starting			Stopping			Running	
	dmax	dc	d(t)	dmax	dc	d(t)	Pst	Plt 2 hours
Measured Values at test impedance	0.06%	0.08%	0.000%	0.06%	0.08%	0.000%	0.328	0.328
Limits set under BS EN 61000-3-11	4%	3.3%	3.3% 500ms	4%	3.3%	3.3% 500ms	1	0.65

*In the table above, the worst case measure of the 3 phases is reported.*

<b>Power quality. DC injection.</b>				
<b>TRIO-TM-50.0-400</b>				
Test power level		10%	55%	100%
Recorded value		10 mA	20 mA	17 mA
as % of rated AC current		<0.05%	<0.05%	<0.05%
Limit		0.25%	0.25%	0.25%
<b>TRIO-TM-60.0-480</b>				
Test power level		10%	55%	100%
Recorded value		19 mA	18 mA	10 mA
as % of rated AC current		<0.05%	<0.05%	<0.05%
Limit		0.25%	0.25%	0.25%

*In the table above, the worst case measure of the 3 phases is reported.*

<b>Power quality. Power Factor.</b>				
Voltage value	260V	277V	305V	Measured at three voltage levels and at full output. Voltage to be maintained within ±1.5% of the stated level during the test.
Measured value	0.999	0.999	0.999	
Limit	>0.95	>0.95	>0.95	

*In the table above, the worst case measure of the 3 phases is reported.*

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#### Protection. Frequency tests.

Function	Setting		Trip test		"No trip tests"	
	Frequency	Time delay	Frequency	Time delay	Frequency /time	Confirm no trip
U/F stage 1	47.5Hz	20.05s	47.45 Hz	20.127s	47.7Hz/ 25s	No Trip
U/F stage 2	47.0Hz	0.55s	46.95 Hz	0.576s	47.2Hz/ 19.98s	No Trip
					46,8Hz/ 0,48s	No Trip
O/F stage 1	51.5Hz	90.00s	51.51 Hz	90.072s	51.3Hz/95s	No Trip
O/F stage 2	52.0Hz	0.50s	52.00 Hz	0.563s	51.8Hz/ 89.98s	No Trip
					52,2Hz/ 0,48s	No Trip

#### Protection. Voltage tests.

Function	Setting		Trip test		"No trip tests"	
	Voltage	Time delay	Voltage	Time delay	Voltage/Time	Confirm no trip
U/V stage 1	240.99V	2.55s	240.60V	2.552s	244.99V/3.5s	No Trip
U/V stage 2	221.60V	0.55s	221.70V	0.558s	225.60V/2.48s	No Trip
					221.60V/0.48s	No Trip
O/V stage 1	315.78V	1.05s	316.40V	1.065s	311.78V/2.0s	No Trip
O/V stage 2	329.63V	0.55s	330.10V	0.555s	325.63V/0.98s	No Trip
					329.63V/0.48s	No Trip

*In the table above, the worst case measure of the 3 phases is reported.*



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**Protection. Loss of Mains test and single phase test.**

Note as an alternative, inverters can be tested to BS EN 62116. The following sub set of tests should be recorded in the following table.

No.	P <sub>EUT</sub> <sup>1)</sup> (% of EUT rating)	Reactive load (% of Q <sub>L</sub> in 6.1.d)1)	P <sub>AC</sub> <sup>2)</sup> (% of nominal)	Q <sub>AC</sub> <sup>3)</sup> (% of nominal)	Run on time (ms)**	P <sub>EUT</sub> (W)	V <sub>DC</sub> (V)	Remarks <sup>4)</sup>	Verdict
1	100	100	0	0	700.75	60000.0	777.0	Test A at BL	P
2	66	66	0	0	750.75	39600.0	685.0	Test B at BL	P
3	33	33	0	0	759.75	19800.0	593.0	Test C at BL	P
4	100	100	-5	-5	617.55	60000.0	777.0	Test A at IB	P
5	100	100	-5	0	733.95	60000.0	777.0	Test A at IB	P
6	100	100	-5	+5	605.55	60000.0	777.0	Test A at IB	P
7	100	100	0	-5	609.75	60000.0	777.0	Test A at IB	P
8	100	100	0	+5	610.20	60000.0	777.0	Test A at IB	P
9	100	100	+5	-5	636.15	60000.0	777.0	Test A at IB	P
10	100	100	+5	0	721.95	60000.0	777.0	Test A at IB	P
11	100	100	+5	+5	596.95	60000.0	777.0	Test A at IB	P
12	66	66	0	-5	620.00	39600.0	685.0	Test B at IB	P
13	66	66	0	-4	607.95	39600.0	685.0	Test B at IB	P
14	66	66	0	-3	634.15	39600.0	685.0	Test B at IB	P
15	66	66	0	-2	665.20	39600.0	685.0	Test B at IB	P
16	66	66	0	-1	652.15	39600.0	685.0	Test B at IB	P
17	66	66	0	1	665.85	39600.0	685.0	Test B at IB	P
18	66	66	0	2	634.75	39600.0	685.0	Test B at IB	P
19	66	66	0	3	610.95	39600.0	685.0	Test B at IB	P
20	66	66	0	4	617.95	39600.0	685.0	Test B at IB	P
21	66	66	0	5	609.55	39600.0	685.0	Test B at IB	P
22	33	33	0	-5	647.55	19800.0	593.0	Test C at IB	P
23	33	33	0	-4	654.35	19800.0	593.0	Test C at IB	P
24	33	33	0	-3	668.35	19800.0	593.0	Test C at IB	P
25	33	33	0	-2	676.15	19800.0	593.0	Test C at IB	P
26	33	33	0	-1	790.35	19800.0	593.0	Test C at IB	P
27	33	33	0	1	743.00	19800.0	593.0	Test C at IB	P
28	33	33	0	2	703.75	19800.0	593.0	Test C at IB	P
29	33	33	0	3	654.55	19800.0	593.0	Test C at IB	P
30	33	33	0	4	647.35	19800.0	593.0	Test C at IB	P
31	33	33	0	5	632.55	19800.0	593.0	Test C at IB	P
32	100	100	-10	-10	623.75	60000.0	777.0	Test A at IB	P
33	100	100	-10	-5	613.55	60000.0	777.0	Test A at IB	P
34	100	100	-10	0	710.55	60000.0	777.0	Test A at IB	P
35	100	100	-10	+5	608.15	60000.0	777.0	Test A at IB	P

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36	100	100	-10	+10	608.35	60000.0	777.0	Test A at IB	P
37	100	100	-5	+10	595.75	60000.0	777.0	Test A at IB	P
38	100	100	0	+10	598.15	60000.0	777.0	Test A at IB	P
39	100	100	+5	+10	594.15	60000.0	777.0	Test A at IB	P
40	100	100	-5	-10	635.55	60000.0	777.0	Test A at IB	P
41	100	100	0	-10	615.75	60000.0	777.0	Test A at IB	P
42	100	100	+5	-10	613.55	60000.0	777.0	Test A at IB	P
43	100	100	+10	-10	607.55	60000.0	777.0	Test A at IB	P
44	100	100	+10	-5	611.75	60000.0	777.0	Test A at IB	P
45	100	100	+10	0	747.75	60000.0	777.0	Test A at IB	P
46	100	100	+10	+5	605.55	60000.0	777.0	Test A at IB	P
47	100	100	+10	+10	608.75	60000.0	777.0	Test A at IB	P

<sup>1)</sup> P<sub>EUT</sub>: EUT output power

<sup>2)</sup> P<sub>AC</sub>: Real power flow at S1 as in Figure 1. Positive value means the power from EUT to utility. Nominal value is the 0% test condition value.

<sup>3)</sup> Q<sub>AC</sub>: Reactive power flow at S1 as in Figure 1. Positive value means the power from EUT to utility. Nominal value is the 0% test condition value

<sup>4)</sup> BL: Balance condition, IB: Imbalance condition

\*: Needs to be measured if any of the recorded run-on times at imbalanced condition are longer than the one recorded for the rated balance condition at test condition A

\*\* "Run on time" must be < 2s

The filled out switch-off time values the highest among the three phase

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**Protection. Frequency change, Stability test.**

	Start Frequency	Change	End Frequency	Confirm no trip
Positive Vector Shift	49.5Hz	+9 degrees		No trip
Negative Vector Shift	50.5Hz	- 9 degrees		No trip
Positive Frequency drift	49.5Hz	+0.19Hz/sec	51.5Hz	No trip
Negative Frequency drift	50.5Hz	-0.19Hz/sec	47.5Hz	No trip

**Protection. Re-connection timer.**

Time delay setting	Measured delay	Checks on no reconnection when voltage or frequency is brought to just outside stage 1 limits of table 1.			
25s	30.02s	At 320.4V	At 236.2V	At 47.4Hz	At 51.6Hz
Confirmation that the SSEG does not re-connect.		No reconnection	No reconnection	No reconnection	No reconnection

*In the table above, the worst case measure of the 3 phases is reported.*

**Fault level contribution.**

Time after fault [Seconds]	PhaseR		PhaseS		PhaseT	
	[Volts]	[Amps]	[Volts]	[Amps]	[Volts]	[Amps]
0.02	58.357	34.352	60.431	33.444	36.085	6.870
0.10	33.061	15.558	33.788	15.195	27.078	4.109
0.25	27.293	10.516	27.561	10.306	24.101	4.539
0.50	25.074	8.188	25.141	8.049	22.968	4.697
Time to trip	In seconds					

**Self-Monitoring solid state switching. The requirement is specified in section 5.3.1. no specified test requirements.**

N/A

Mechanical contactor used.

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