RCMU Protection in String inverter

1、Standard in IEC62109-2:2011

4.8.3.5 Protection by residual current monitoring

4.8.3.5.1 General

Where required by Table 30, the inverter shall provide residual current monitoring that functions whenever the inverter is connected to the mains with the automatic disconnection

means closed. The residual current monitoring means shall measure the total (both a.c. and d.c. components) RMS current.

As indicated in Table 30 for different inverter types, array types, and inverter isolation levels, detection may be required for excessive continuous residual current, excessive sudden changes in residual current, or both, according to the following limits:

a) Continuous residual current: The inverter shall disconnect within 0,3 s and indicate a fault in accordance with 13.9 if the continuous residual current exceeds:
   - maximum 300 mA for inverters with continuous output power rating ≤ 30 kVA;
   - maximum 10 mA per kVA of rated continuous output power for inverters with continuous output power rating > 30 kVA.

The inverter may attempt to re-connect if the array insulation resistance meets the limit in 4.8.2.

b) Sudden changes in residual current: The inverter shall disconnect from the mains within the time specified in Table 31 and indicate a fault in accordance with 13.9, if a sudden increase in the RMS residual current is detected exceeding the value in the table.

Table 31 – Response time limits for sudden changes in residual current

Residual current sudden change	Max time to inverter disconnection from the mains
30 mA	0,3 s
60 mA	0,15 s
150 mA	0,04 s

NOTE These values of residual current and time are based on the RCD standard IEC 61008-1.

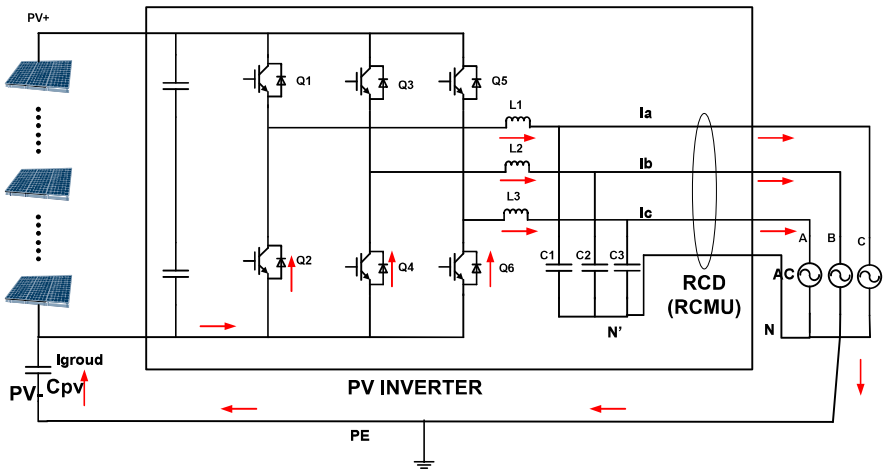
According to the standard, the continuous residual current of sun2000-100kTL is about 10 mA*100=1000 mA. This residual current is very big to the AC circuit breaker.

2、Operational principle for RCMU in string inverter

When the inverter is working in low voltage distribution network, Residual current is as following loop. We can get Residual current by add three phases current together. In TN system, Residual current much higher than IT system, because IT system Cy is very small. Residual current in inverter is AC current, so it can pass the capacitor. Normally it is frequency lower than 1 kHz.

Transformer type (delta or star) will not affect residual current.

Inverter output current is controlled by DSP, it is a 3 phase balance system. If the control system is not work, imbalance current will cause residual current protection.

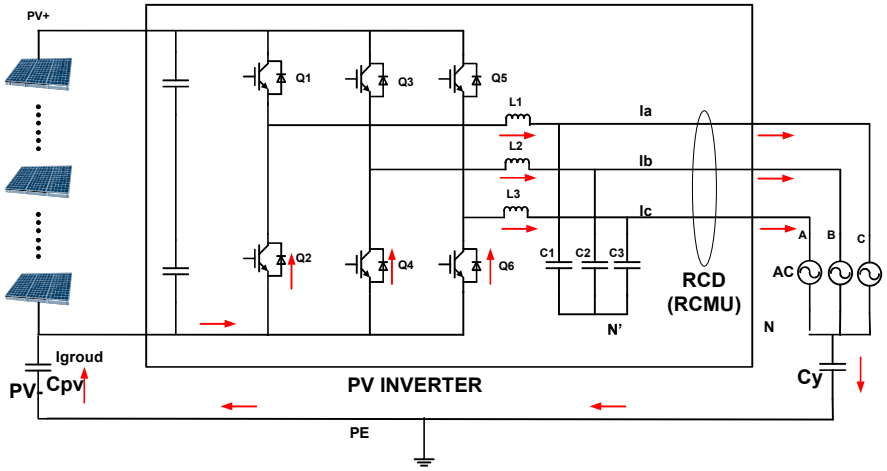


Residual current loop when inverter working in low voltage distribution network (TN system)

Cpv: PV panel to PE discrete capacitors, normally it will range from 100 nF to several uF.

N': Neutral inside the inverter, normally it constructed by 3 small capacitors. No current will go to this line. We need it for phase voltage detection at low voltage distribution network.

N: Neutral for low voltage distribution network.



Residual current loop when inverter working in IT system

Cy: AC line to PE discrete capacitors, normally it will be several nF, very small.

Form the circuit analysis we can find that residual current happens on the location which Neutral connected to the PE. In PV plant we recommend that IT grid, where residual current is very small.

3、Certification: IEC 62109-2

Test specification:	
Standard ..... :	IEC 62109-1:2010 (First Edition)
Test procedure ..... :	N/A
Non-standard test method ..... :	N/A
Test Report Form No. ..... :	IEC62109_1B
Test Report Form(s) Originator.... :	VDE Testing and Certification Institute
Master TRF..... :	Dated 2016-04

This report is not valid as a CB Test Report unless signed by an approved CB Testing Laboratory and appended to a CB Test Certificate issued by an NCB in accordance with IECEE 02.

Test item description ..... :	SOLAR INVERTER
Trade Mark..... :	HUAWEI
Manufacturer..... :	Huawei Technologies Co., Ltd.
Model/Type reference ..... :	SUN2000-90KTL-H0, SUN2000-90KTL-H1, SUN2000-95KTL-INH0, SUN2000-100KTL-H0, SUN2000-100KTL-H1, SUN2000-100KTL-H2
Ratings ..... :	See rating labels on page 4 – 5

7.3.8	Residual Current-operated protective (RCD) or monitoring (RCM) device compatibility	RCMU integrated for PV side protection, refer to IEC 62109-2(ed.1)/EN 62109-2:2011 test report	P
	RCD and RCM are used to provide protection against insulation faults in some domestic and industrial installations, additional to that provided by the installed equipment.	If an external RCD or residual current breaker is required, must follow with local regulation, type B should be used for main side.	P

4. Conclusion

According to the standard of IEC62109-2, the continuous residual current of sun2000-95kTL is about 10 mA*90=900 mA. This residual current is very big to the AC circuit breaker. The inverter can meet the RCMU requirement. It can protect maintenance people from DC side electrical hazard.

On the other hand, residual current happens on the location which Neutral connected to the

PE. In PV plant we recommend that IT grid, where residual current is very small.

At this condition, also no electrical hazard for the maintenance people. So we don’t recommend any RCD on AC side.