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TEST REPORT
IEC 62116
Test procedure of islanding prevention measures for utility-interconnected photovoltaic inverters

Report Number. .....:	200228042GZU-002
Date of issue .....:	11 Mar 2020
Total number of pages.....	17 Pages
Name of Testing Laboratory preparing the Report.....:	Intertek Testing Services Shenzhen Ltd. Guangzhou Branch Block E, No.7-2 Guang Dong Software Science Park, Caipin Road, Guangzhou Science City, GETDD, Guangzhou, China
Applicant's name.....:	Shenzhen Growatt New Energy Technology CO., Ltd
Address .....:	1st East & 3rd Floor of Building A, Building B, Jiayu Industrial Park, #28, GuangHui Road, LongTeng Community, Shiyan Street, Baoan District, Shenzhen, P.R.China
Test specification:	
Standard.....:	IEC 62116:2014
Test procedure .....:	Type approval
Non-standard test method.....:	N/A
Test Report Form No.....:	IEC62116B
Test Report Form(s) Originator.....:	TÜV SÜD Product Service GmbH
Master TRF .....:	Dated 2017-11-03

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General disclaimer:

The test results presented in this report relate only to the object tested.
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Test item description : PV Grid inverter

Trade Mark ..... : Growatt

Manufacturer ..... : Same as applicant

Model/Type reference : MIC 750TL-X, MIC 1000TL-X, MIC1500 TL-X, MIC 2000TL-X, MIC 2500TL-X, MIC 3000TL-X, MIC 3300TL-X

Ratings ..... :

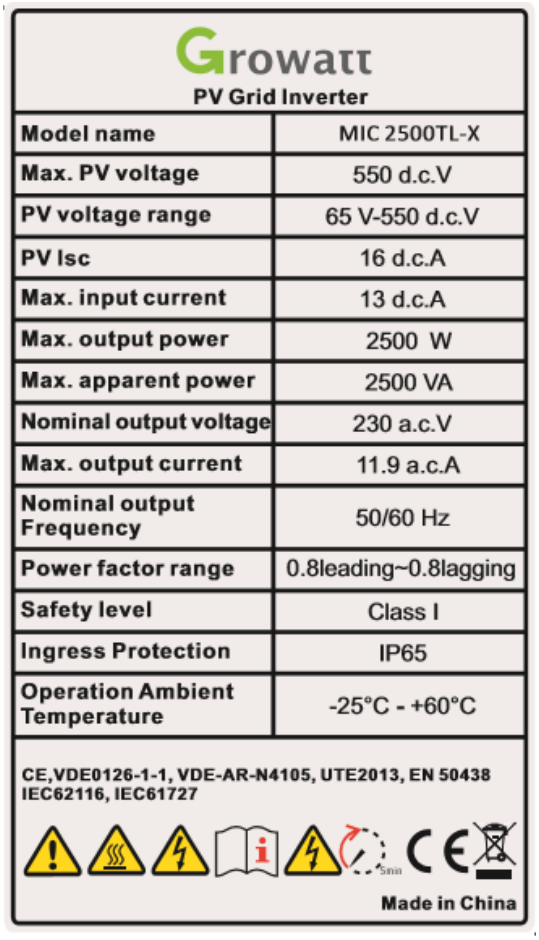
Model	MIC 750 TL-X	MIC 1000 TL-X	MIC 1500 TL-X	MIC 2000 TL-X	MIC 2500 TL-X	MIC 3000 TL-X	MIC 3300 TL-X
Max.PV voltage	500Vdc				550Vdc		
MPPT voltage	50-500Vdc				65-550Vdc		
Max.input current	13A						
PV Isc	16A						
Nominal output voltage	230Vac						
Nominal output Frequency	50/60Hz						
Max.output current	3.6A	4.8A	7.1A	9.5A	11.9A	14.3A	
Nominal output power	750 W	1000 W	1500 W	2000 W	2500 W	3000 W	3300 W
Max. apparent power	750 VA	1000 VA	1500 VA	2000 VA	2500 VA	3000 VA	3300 VA
Power factor range	0.8Leading~0.8Lagging						
Safety level	Class I						
Ingress Protection	IP 65						
Operation Ambient Temperature	-25℃ - +60℃						
Software version	GH1.0						

Responsible Testing Laboratory (as applicable), testing procedure and testing location(s):			
☒	**CB Testing Laboratory:**	Intertek Testing Services Shenzhen Ltd. Guangzhou Branch	
Testing location/ address ..... :		Block E, No.7-2 Guang Dong Software Science Park, Caipin Road, Guangzhou Science City, GETDD, Guangzhou, China	
Tested by (name, function, signature) ..... :		Sunny Lin Engineer	Sunny Lin
Approved by (name, function, signature) .. :		Jason Fu Technical Team Leader	Jason Fu
☐	**Testing procedure: CTF Stage 1:**	N/A	
Testing location/ address ..... :		N/A	
Tested by (name, function, signature) ..... :		N/A	
Approved by (name, function, signature) .. :		N/A	
☐	**Testing procedure: CTF Stage 2:**	N/A	
Testing location/ address ..... :		N/A	
Tested by (name + signature)..... :		N/A	
Witnessed by (name, function, signature) . :		N/A	
Approved by (name, function, signature) .. :		N/A	
☐	**Testing procedure: CTF Stage 3:**	N/A	
☐	**Testing procedure: CTF Stage 4:**	N/A	
Testing location/ address ..... :		N/A	
Tested by (name, function, signature) ..... :		N/A	
Witnessed by (name, function, signature) . :		N/A	
Approved by (name, function, signature) .. :		N/A	
Supervised by (name, function, signature) :		N/A	

List of Attachments (including a total number of pages in each attachment): N/A	
Summary of testing:	
Tests performed (name of test and test clause): All applicable tests	**Testing location:** Intertek Testing Services Shenzhen Ltd. Guangzhou Branch Block E, No.7-2 Guang Dong Software Science Park, Caipin Road, Guangzhou Science City, GETDD, Guangzhou, China
Summary of compliance with National Differences (List of countries addressed): N/A ☒ **The product fulfils the requirements of IEC 62116:2014**	

Copy of marking plate:

The artwork below may be only a draft. The use of certification marks on a product must be authorized by the respective NCBs that own these marks.



Note:

1. The above markings are the minimum requirements required by the safety standard. For the final production samples, the additional markings which do not give rise to misunderstanding may be added.
2. Label is attached on the side surface of enclosure and visible after installation.
3. Other labels are identical to above, except the model name and ratings

Test item particulars.....:	
Classification of installation and use.....:	Fixed and outdoor use
Supply Connection.....:	Permanent connection
.....:	
Possible test case verdicts:	
- test case does not apply to the test object.....:	N/A
- test object does meet the requirement.....:	P (Pass)
- test object does not meet the requirement.....:	F (Fail)
Testing.....:	
Date of receipt of test item .....:	28 Feb 2020
Date (s) of performance of tests.....:	28 Feb 2020 to 11 Mar 2020

General remarks:

"(See Enclosure #)" refers to additional information appended to the report.
"(See appended table)" refers to a table appended to the report.
Throughout this report a ☐ comma / ☒ point is used as the decimal separator.

This report shall be used together with the report 200228042GZU-001.

Manufacturer's Declaration per sub-clause 4.2.5 of IECEE 02:

The application for obtaining a CB Test Certificate includes more than one factory location and a declaration from the Manufacturer stating that the sample(s) submitted for evaluation is (are) representative of the products from each factory has been provided ..... :	☐ **Yes** ☒ **Not applicable**

When differences exist; they shall be identified in the General product information section.

Name and address of factory (ies).....:	Shenzhen Growatt New Energy Technology CO.,Ltd 1st East & 3rd Floor of Building A, Building B, Jiayu Industrial Park, #28, GuangHui Road, LongTeng Community, Shiyan Street, Baoan District, Shenzhen, P.R.China

General product information:

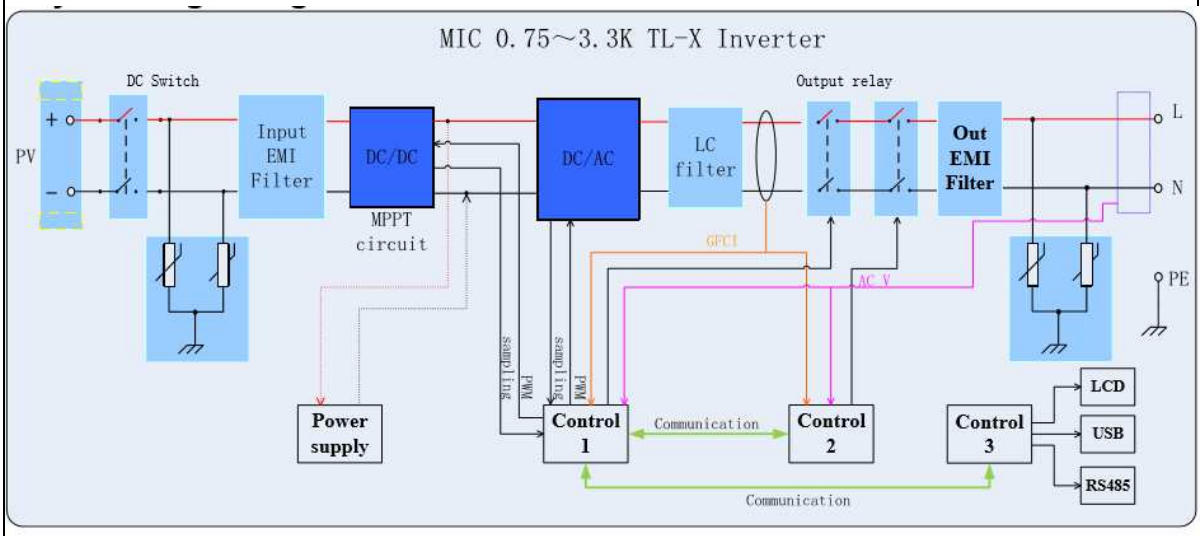
The unit is a single-phase PV Grid inverter, it can convert the high PV voltage to Grid voltage and feed into Grid network.

The internal control is redundant built. It consists of Microcontroller main CPU (1) and slave CPU (2). The main CPU control the relays by switching signals; measures the PV voltage, current and voltage, measures grid voltage, frequency, AC current with injected DC and the array insulation resistance to ground. In addition, it tests the current sensors and the RCMU circuit before each start up.
The CPU (2) is measures the grid voltage and residual current measuring, also can switch off the relays independently, and communicate with CPU (1) each other.

The current is measured by a current sensor. The AC current signal and the injected DC current signal are sent to the main CPU (1). The main CPU tests and calibrates before each start up all current sensors.

There are two versions of the unit output relay configuration: two relays or four relays. When single fault applied to one relay, alarm an error code in display panel, another redundant relay provides basic insulation maintained between the PV array and the mains. All the relays are tested before each start up.

The topology diagram as following:



Difference of models:

All models have identical mechanical and electrical construction except some parameter of the software architecture to control the max output power. The detailed difference as following:

Serial number	Difference items	Differential components	Models	Remark
1	Bus CAP	500V electrolytic capacitor * 2	MIC 0.75~2KTL-X	
		550V electrolytic capacitor *4	MIC 2.5~3.3KTL-X	
2	DC FAN	No	MIC 0.75~2KTL-X	
		Yes	MIC 2.5~3.3KTL-X	
3	INV IN	NPS 184060 1.8mm*1P*70Ts	MIC 0.75~2KTL-X	
		NPH 184060 1.4mm*2P*63Ts	MIC 2.5~3.3KTL-X	
4	AC HCT	10A HCT	MIC 0.75~2KTL-X	
		16A HCT	MIC 2.5~3.3KTL-X	

5	Out Relay	10A Relay	MIC 0.75～2KTL-X	compatible with 2 relays and 4 relay schemes, the models of the four relays are the same
		16A Relay	MIC 2.5～3.3KTL-X	

Other than special notice, the model MIC 3300TL-X was as the representative test model in this report.

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Clause	Requirement + Test	Result - Remark	Verdict
4	**Testing circuit**		
	The testing circuit shown in Figure 1 is employed.		P
	Similar circuits are used for three-phase output.		P
	Parameters to be measured are shown in Table 1 and Figure 1. Parameters to be recorded in the test report are discussed in Clause 7.		P
5	**Testing equipment**		
5.1	**Measuring instruments**		**P**
	The waveform measurement/capture device is able to record the waveform from the beginning of the islanding test until the EUT ceases to energize the island.	Waveform caught from the switch open and the EUT cease to energize	P
	For multi-phase EUT, all phases are monitored.		P
	A waveform monitor designed to detect and calculate the run-on time may be used.		P
	For multi-phase EUT, the test and measurement equipment is recorded each phase current and each phase-to-neutral or phase-to-phase voltage, as appropriate, to determine fundamental frequency active and reactive power flow over the duration of the test.		P
	A sampling rate of 10 kHz or higher is recommended. The minimum measurement accuracy is 1 % or less of rated EUT nominal output voltage and 1 % or less of rated EUT output current		P
	Current, active power, and reactive power measurements through switch S1 used to determine the circuit balance conditions report the fundamental (50 Hz or 60 Hz) component.		P
5.2	**DC power source**		
5.2.1	**General**		**P**
	A PV array or PV array simulator (preferred) may be used. If the EUT can operate in utility-interconnected mode from a storage battery, a DC power source may be used in lieu of a battery as long as the DC power source is not the limiting device as far as the maximum EUT input current is concerned.	Topcon PV simulator used	P
	The DC power source provides voltage and current necessary to meet the testing requirements described in Clause 6.		P
5.2.2	**PV array simulator**		**P**

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Clause	Requirement + Test	Result - Remark	Verdict
	The tests are conducted at the input voltage defined in Table 2 below, and the current is limited to 1,5 times the rated photovoltaic input current, except when specified otherwise by the test requirements.	Topcon PV simulator used	P
	A PV array simulator is recommended, however, any type of power source may be used if it does not influence the test results.		P
5.2.3	**Current and voltage limited DC power supply with series resistance**		N/A
	A DC power source used as the EUT input source is capable of EUT maximum input power (so as to achieve EUT maximum output power) at minimum and maximum EUT input operating voltage.		N/A
	The power source provides adjustable current and voltage limit, set to provide the desired short circuit current and open circuit voltage when combined with the series and shunt resistance described below.		N/A
	A series resistance (and, optionally, a shunt resistance) is selected to provide a fill factor within the range: Output power: Sufficient to provide maximum EUT output power and other levels specified by test conditions of table 5. Response speed: The response time of a simulator to a step in output voltage, due to a 5% load change, results in a settling of the output current to within 10% of its final value in less than 1ms. Stability: Excluding the variations caused by the EUT MPPT, simulator output power remains stable within 2 % of specified power level over the duration of the test: from the point where load balance is achieved until the island condition is cleared or the allowable run-on time is exceeded. Power factor: 0.25 to 0.8		N/A
5.2.4	**PV array**		N/A
	A PV array used as the EUT input source is capable of EUT maximum input power at minimum and maximum EUT input operating voltage.		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
	Testing is limited to times when the irradiance varies by no more than 2 % over the duration of the test as measured by a silicon-type pyranometer or reference device. It may be necessary to adjust the array configuration to achieve the input voltage and power levels prescribed in 6.1.		N/A
5.3	**AC power source**		
	The utility grid or other AC power source may be used as long as it meets the conditions specified in Table 4. **Table 4 – AC power source requirements** Items: Voltage — Conditions: Nominal ±2,0 % Items: Voltage THD — Conditions: < 2,5 % Items: Frequency — Conditions: Nominal ±0,1 Hz Items: Phase angle distance [1] — Conditions: 120 ° ± 1,5 ° [1] Three-phase case only		P
5.4	**AC loads**		
	On the AC side of the EUT, variable resistance, capacitance, and inductance are connected in parallel as loads between the EUT and the AC power source. Other sources of load, such as electronic loads, may be used if it can be shown that the source does not cause results that are different than would be obtained with passive resistors, inductors, and capacitors.		P
	All AC loads are rated for and adjustable to all test conditions. The equations for Qf are based upon an ideal parallel RLC circuit. For this reason, non-inductive resistors, low loss (high Qf) inductors, and capacitors with low effective series resistance and effective series inductance are utilized in the test circuit. Iron core inductors, if used, are not exceed a current THD of 2 % when operated at nominal voltage. Load components are conservatively rated for the voltage and power levels expected. Resistor power ratings are chosen so as to minimize thermally-induced drift in esistance values during the course of the test.		P

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Clause	Requirement + Test	Result - Remark	Verdict
	Active and reactive power is calculated (using the measurements provided in Table 1) in each of the R, L and C legs of the load so that these parasitic parameters (and parasitics introduced by variacs or autotransformers) are properly accounted for when calculating Qf.		P
6	**Test for single or multi-phase inverter**		
6.1	**Test procedure**	**(see appended table)**	**P**
	The test uses an RLC load, resonant at the EUT nominal frequency (50 Hz or 60 Hz) and matched to the EUT output power.		P
	For multi-phase EUT, the load is balanced across all phases and the switch S1 as in Figure 1 opens all phases		P
	This test is performed with the EUT conditions as in Table 5, where power and voltage values are given as a percent of EUT full output rating.		P
	a)..Determine EUT test output power		P
	b) .Adjusting the DC input source		P
	c) .Turn off the EUT and open S1		P
	d) .Adjust the RLC circuit to have Qf = 1.0 ±0.05		P
	e)..Connect the RLC load configured in step d) to the EUT by closing S2		P
	f) ..Open the utility-disconnect switch S1 to initiate the test, Run-on time is recorded.		P
	g) .For test condition A, adjust the real load and only one of the reactive load components to each of the load imbalance conditions shown in the shaded portion of table 6. If any of the recorded run-on times are longer than the one recorded for the rated balance condition, then the non-shaded parameter combinations also require testing.		P
	h) For test condition B and C, adjust the only one reactive load components by approximately 1,0% per test, within a total range of 95% to 105% of the operating point. If run-on times are still increasing at the 95% or 105% points, additional 1% increments have to be taken until run-on times begin decreasing.		P
6.2	**Pass/fail criteria**		

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Clause	Requirement + Test	Result - Remark	Verdict
	An EUT is considered to comply with the requirements for islanding protection when each case of recorded run-on time is less than 2 s or meets the requirements of local codes.		P
7	**Documentation**		
	At a minimum, the following information is recorded and maintained in the test report.		P
	a) Specifications of EUT. Table 8 provides an example of the type of information that is provided.		P
	b) Measurement results. Table 9 provides an example of the type of information that is provided. Actual measured values is to be recorded.		P
	c) Block diagram of test circuit.		P
	d) Specifications of the test and measurement equipment. Table 10 provides an example of the type of information that is provided.		P
	e) Any test configuration or procedure details such as methods of achieving specified load and EUT output conditions.		P
	f) Any additional information required by the testing laboratory's accreditation.		P
	g) Specify the evaluation criterion from clause 6.2 that was utilized to determine if the product passed or failed the test.		P
Annex A	Islanding as it applies to PV systems(Informative)		--
A.1	General		--
A.2	Impact of distortion on islanding		--
Annex B	Test for independent islanding detection device (relay)(Informative)		--
B.1	Introduction		--
B.2	Testing circuit		--
B.3	Testing equipment		--
B.4	Testing procedure		--
B.5	Documentation		--

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Clause	Requirement + Test	Result - Remark	Verdict

5.3	TABLE: tested condition and run-on time	P

Model: Tested on model MIC 3300TL-X with frequency 60Hz

No.	P_{EUT} (% of EUT rating)	Reactive load (% of normal)	P_{AC}	Q_{AC}	Run-on time(ms)	P_{EUT} (KW)	Actual Q_f (Var)	V_{DC} （V）	Which load is selected to be adjusted (R or L)
Test condition A									
1	100	100	0	0	921	3.26	1.00	496	/
2	100	100	-5	-5	867	3.26	0.98	496	/
3	100	100	-5	0	936	3.26	0.96	496	/
4	100	100	-5	+5	861	3.26	0.94	496	/
5	100	100	0	-5	867	3.26	1.03	496	/
6	100	100	0	+5	870	3.26	0.98	496	/
7	100	100	+5	-5	806	3.26	1.09	496	/
8	100	100	+5	0	855	3.26	1.03	496	/
9	100	100	+5	+5	894	3.26	1.03	496	/
Test condition B									
10	66	66	0	0	782	2.18	1.00	382	/
11	66	66	0	-5	695	2.18	1.02	382	L
12	66	66	0	-4	775	2.18	1.01	382	L
13	66	66	0	-3	773	2.18	1.01	382	L
14	66	66	0	-2	765	2.18	1.01	382	L
15	66	66	0	-1	759	2.18	1.00	382	L
16	66	66	0	1	819	2.18	0.99	382	L
17	66	66	0	2	707	2.18	0.99	382	L
18	66	66	0	3	754	2.18	0.99	382	L
19	66	66	0	4	768	2.18	0.98	382	L
20	66	66	0	5	752	2.18	0.98	382	L
Test condition C									
21	33	33	0	0	475	1.07	1.00	309	/
22	33	33	0	-5	179	1.07	1.01	309	L
23	33	33	0	-4	231	1.07	1.01	309	L
24	33	33	0	-3	493	1.07	1.02	309	L
25	33	33	0	-2	470	1.07	1.01	309	L
26	33	33	0	-1	276	1.07	1.01	309	L
27	33	33	0	1	290	1.07	0.99	309	L
28	33	33	0	2	267	1.07	0.99	309	L
29	33	33	0	3	286	1.07	0.99	309	L
30	33	33	0	4	258	1.07	0.98	309	L
31	33	33	0	5	249	1.07	0.97	309	L

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Clause	Requirement + Test	Result - Remark	Verdict

Supplementary information:
For test condition A:
If any of the recorded run-on times are longer than the one recorded for the rated balance condition, then the non-shaded parameter combinations also require testing.
For test condition B and C:
If run-on times are still increasing at the 95 % or 105 % points, additional 1 % increments is taken until run-on times begin decreasing.

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Clause	Requirement + Test	Result - Remark	Verdict

5.3	TABLE: tested condition and run-on time	P

Model: Tested on model MIC 3300TL-X with frequency 50Hz

No.	P_{EUT} (% of EUT rating)	Reactive load (% of normal)	P_{AC}	Q_{AC}	Run-on time(ms)	P_{EUT} (KW)	Actual Q_f (Var)	V_{DC} （V）	Which load is selected to be adjusted (R or L)
Test condition A									
1	100	100	0	0	1067	3.27	1.00	492	/
2	100	100	-5	-5	977	3.27	0.98	492	/
3	100	100	-5	0	1005	3.27	0.96	492	/
4	100	100	-5	+5	1067	3.27	0.93	492	/
5	100	100	0	-5	1039	3.27	1.03	492	/
6	100	100	0	+5	1033	3.27	0.98	492	/
7	100	100	+5	-5	1028	3.27	1.08	492	/
8	100	100	+5	0	1097	3.27	1.05	492	/
9	100	100	+5	+5	854	3.27	1.03	492	/
Test condition B									
10	66	66	0	0	914	2.17	1.00	387	/
11	66	66	0	-5	828	2.17	1.01	387	L
12	66	66	0	-4	869	2.17	1.01	387	L
13	66	66	0	-3	876	2.17	1.01	387	L
14	66	66	0	-2	799	2.17	1.00	387	L
15	66	66	0	-1	870	2.17	1.00	387	L
16	66	66	0	1	889	2.17	0.99	387	L
17	66	66	0	2	827	2.17	0.99	387	L
18	66	66	0	3	898	2.17	0.98	387	L
19	66	66	0	4	903	2.17	0.98	387	L
20	66	66	0	5	897	2.17	0.97	387	L
Test condition C									
21	33	33	0	0	332	1.07	1.00	312	/
22	33	33	0	-5	268	1.07	1.02	312	L
23	33	33	0	-4	273	1.07	1.02	312	L
24	33	33	0	-3	304	1.07	1.01	312	L
25	33	33	0	-2	301	1.07	1.01	312	L
26	33	33	0	-1	308	1.07	1.00	312	L
27	33	33	0	1	342	1.07	1.00	312	L
28	33	33	0	2	691	1.07	1.00	312	L
29	33	33	0	3	502	1.07	0.99	312	L
30	33	33	0	4	693	1.07	0.99	312	L
31	33	33	0	5	723	1.07	0.98	312	L

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Clause	Requirement + Test	Result - Remark	Verdict

Supplementary information:
For test condition A:
If any of the recorded run-on times are longer than the one recorded for the rated balance condition, then the non-shaded parameter combinations also require testing.
For test condition B and C:
If run-on times are still increasing at the 95 % or 105 % points, additional 1 % increments is taken until run-on times begin decreasing.

--- End of test report---