

# ***Battery Pack Test Report*** ***(Package Drop & UN38.3)***

Customer: Makita

Pack Model: BL1820

Nominal voltage: 18V dc

Nominal capacity: 36Wh/2.0Ah

Configuration: 5S1P

Celxpert P/N: 912900027

Cell Type: Sanyo RX 2000mAh

Feb.12 2014

Approved by \_\_\_\_\_

Reviewed by \_\_\_\_\_

Prepared by \_\_\_\_\_

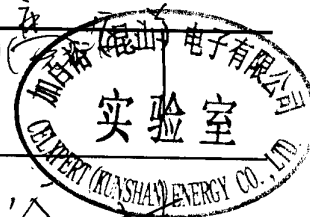


Figure photo of the pack.



# 1. Package Drop Test Report

Test Period	2013/01/10		Test Spec.	IATA A55 & QS-3Q-043	
Sample Level	Mass Production	Sample Mode	Finished Product	Quantity	2 PCS

## 1.1 DESCRIPTION OF TEST EQUIPMENTS

Kingdom Technology KD-128AS drop tester. Description of performance:

Payload capacity: 160 lbs. (72.6 kg)

Payload dimensions: Length: 61 cm / Width: 76 cm / Height: 90cm

Drop height range: 30 - 180 cm

Base Plate Material: Solid Steel (Std.)

Base Plate Size: 76.2x114.3x1.3cm

## 1.2 TEST CONDITION

Drop height: 120cm

Drop weight: 1.1Kg

Drop position: One corner, three edges and three faces with 1 time. (Total: 7 drops).

Drop Position and sequence: Ref. attachment 1

## 1.3 SUMMARY OF TEST

Concluding the follow check items, the result of the test is **pass**.

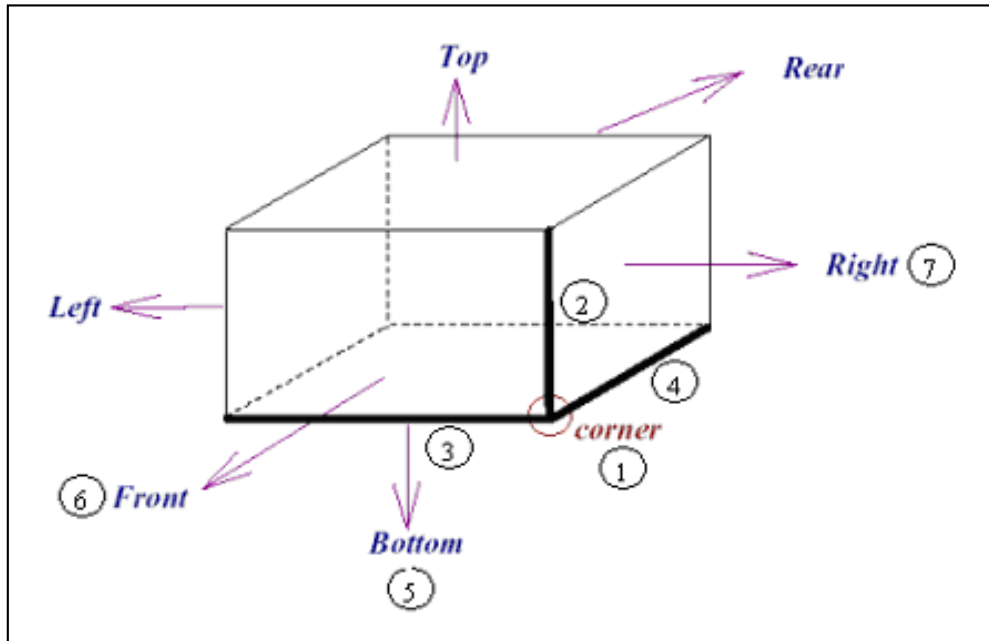
Check items	Before	After
Battery pack function	<input checked="" type="checkbox"/> Normal <input type="checkbox"/> Fail	<input checked="" type="checkbox"/> Normal <input type="checkbox"/> Fail
Battery pack appearance	<input checked="" type="checkbox"/> Normal <input type="checkbox"/> Fail	<input checked="" type="checkbox"/> Normal <input type="checkbox"/> Fail
Package internal status	<input checked="" type="checkbox"/> Normal <input type="checkbox"/> Fail	<input checked="" type="checkbox"/> Normal <input type="checkbox"/> Fail
Package outside status	<input checked="" type="checkbox"/> Normal <input type="checkbox"/> Fail	<input checked="" type="checkbox"/> Normal <input type="checkbox"/> Fail

Test photographs please refer to Attachment 2

Function Check details please refer to Attachment 3

## Attachment 1:









### DROP POSITION









### DROP SEQUENCE

<b>DROP</b>	<b>IMPACT SURFACE</b>
1	Corner (2-3-4)
2	Edge 1 (2)
3	Edge 2 (3)
4	Edge 3 (4)
5	Bottom (Flat 5)
6	Front (Flat 6)
7	Right (Flat 7)

**Attachment 2:**

Drop Sequence	Test Setup	Test Result
1		
2		
3		
4		

Drop Sequence	Test Setup	Test Result
5		
6		
7		

**Open Package check for internal after drop test**



## 2. UN38.3 Test Report

Test Period	2014/1/15~2014/2/11		Test Spec.	ST/SG/AC.10/11/Rev.5 Amend.1	
Parts Name	Battery Pack	Application	NB	Quantity	Pack 16PCS/Cell 25pcs

### 2.1 Test Summary

Item	Test Item	Test Result	Details
T1	Altitude simulation test (UN38.3-1)	Pass	Page 9
T2	Thermal test (UN38.3-2)	Pass	Page 10
T3	Vibration test (UN38.3-3)	Pass	Page 11
T4	Shock test (UN38.3-4)	Pass	Page 12
T5	Short Circuit test (UN38.3-5)	Pass	Page 13
T6	Crush Test (UN38.3-6)	Pass	Page 13
T7	Overcharge test (UN38.3-7)	Pass	Page 14
T8	Forced discharge test (UN38.3-8)	Pass	Page 15

**The battery pack passes UN38.3 test.**

**2.2 Test sample list**

No.	Pack S/N	Test item	No.	Cell Num.	Test item
1	Sample No:1/16	38.3.1~5	1	Sanyo RX 2000mAh	38.3.6
2	Sample No:2/16	38.3.1~5	2	Sanyo RX 2000mAh	38.3.6
3	Sample No:3/16	38.3.1~5	3	Sanyo RX 2000mAh	38.3.6
4	Sample No:4/16	38.3.1~5	4	Sanyo RX 2000mAh	38.3.6
5	Sample No:5/16	38.3.1~5	5	Sanyo RX 2000mAh	38.3.6
6	Sample No:6/16	38.3.1~5	6	Sanyo RX 2000mAh	38.3.8
7	Sample No:7/16	38.3.1~5	7	Sanyo RX 2000mAh	38.3.8
8	Sample No:8/16	38.3.1~5	8	Sanyo RX 2000mAh	38.3.8
9	Sample No:9/16	38.3.7	9	Sanyo RX 2000mAh	38.3.8
10	Sample No:10/16	38.3.7	10	Sanyo RX 2000mAh	38.3.8
11	Sample No:11/16	38.3.7	11	Sanyo RX 2000mAh	38.3.8
12	Sample No:12/16	38.3.7	12	Sanyo RX 2000mAh	38.3.8
13	Sample No:13/16	38.3.7	13	Sanyo RX 2000mAh	38.3.8
14	Sample No:14/16	38.3.7	14	Sanyo RX 2000mAh	38.3.8
15	Sample No:15/16	38.3.7	15	Sanyo RX 2000mAh	38.3.8
16	Sample No:16/16	38.3.7	16	Sanyo RX 2000mAh	38.3.8
			17	Sanyo RX 2000mAh	38.3.8
			18	Sanyo RX 2000mAh	38.3.8
			19	Sanyo RX 2000mAh	38.3.8
			20	Sanyo RX 2000mAh	38.3.8
			21	Sanyo RX 2000mAh	38.3.8
			22	Sanyo RX 2000mAh	38.3.8
			23	Sanyo RX 2000mAh	38.3.8
			24	Sanyo RX 2000mAh	38.3.8
			25	Sanyo RX 2000mAh	38.3.8



**2.3 Test result**

Item	Test Item	Test specification	Judge criteria	Sample(s)							
T1	Altitude Simulation (UN38.3-1)	1-1. 4 batteries are standard charged. 4 batteries are 1C cycled 50 times, ending in fully charged state. All batteries weight is measured. The charged batteries voltage are measured and recorded. 1-2. Batteries shall be stored at a pressure of 11.6Kpa or less for at least six hours at ambient temperature 20+/-5 °C. 1-3. Vacuum is released. All cells weight is measured. The charged cell voltage are measured and recorded.	No mass loss (<0.1%), no leakage, no venting, no disassembly, no rupture and no fire. Battery voltage drop < 10%. Battery resistance change < ±10%.	4 packs are standard charged (Pack#1~4) 4 packs 50 cycled ending in fully charged states (Pack#5~8)							
Test Period	Start: 2014/01/15                      End:2014/01/15										
Test Equipment	數位電表 Q153, 電子天平 Q090, 真空烘箱 Q146										
Major Problem	-										
Warning Point	-										
Recommendation	The battery packs pass the test.										
Raw Data	<b>Altitude Simulation Test on Charged Packs</b>										
		Before			After			Difference			
	No.	OCV (V)	Resistance(mΩ)	Weight (g)	OCV (V)	Resistance(mΩ)	Weight (g)	Volt (%)	Resistance(%)	Weight (%)	Result
	1	20.9812	65.53	359.47	20.981	65.83	359.46	0.00%	0.46%	0.00%	Pass
	2	20.9816	65.62	358.77	20.981	65.92	358.76	0.00%	0.46%	0.00%	Pass
	3	20.9814	65.43	360.25	20.979	65.23	360.24	-0.01%	-0.31%	0.00%	Pass
	4	20.9804	65.38	359.35	20.978	65.88	359.35	-0.01%	0.76%	0.00%	Pass
	5	20.9802	65.56	358.86	20.978	65.96	358.85	-0.01%	0.61%	0.00%	Pass
	6	20.9783	65.46	359.65	20.975	65.96	359.65	-0.01%	0.76%	0.00%	Pass
	7	20.9792	65.69	358.57	20.978	66.09	358.56	0.00%	0.61%	0.00%	Pass
8	20.9784	65.48	359.69	20.978	65.78	359.68	0.00%	0.46%	0.00%	Pass	

Item	Test Item	Test specification	Judge criteria	Sample(s)								
T2	Thermal test (UN38.3-2)	2-1. Packs are stored for 6 hours at $72\pm 2^{\circ}\text{C}$ , followed by storage for 6 hours at $-40\pm 2^{\circ}\text{C}$ . The maximum time interval between test temperature extremes is 30 minutes. 2-2.Repeat 2-1 for 10 times. Then store the packs at ambient for 24 hours. All packs weight are measured. The charged battery voltage are measured and recorded.	No mass loss (<0.1%), no leakage, no venting, no disassembly, no rupture and no fire. Battery voltage drop < 10%. Battery resistance change < $\pm 10\%$ .	4 packs are standard charged (Pack#1-4) 4 packs 50 cycled ending in fully charged states (Pack#5-8)								
Test Period		Start: 2014/01/16                      End:2014/01/23										
Test Equipment		數位電表 Q153, 電子天平 Q090, 冷熱衝擊機 Q336										
Major Problem		-										
Warning Point		-										
Recommendation		The packs pass the test.										
Raw Data		<b>Thermal Test on Charged Packs</b>										
		No.	Before			After			Difference			Result
			OCV (V)	Resistance(m $\Omega$ )	Weight (g)	OCV (V)	Resistance(m $\Omega$ )	Weight (g)	Volt (%)	Resistance(%)	Weight (%)	
		1	20.9812	65.83	359.46	20.912	66.33	359.35	-0.33%	0.76%	0.03%	Pass
		2	20.9806	65.92	358.76	20.905	66.42	358.65	-0.36%	0.76%	0.03%	Pass
		3	20.9794	65.23	360.24	20.904	65.63	360.13	-0.36%	0.61%	0.03%	Pass
		4	20.9784	65.88	359.35	20.904	66.28	359.24	-0.35%	0.61%	0.03%	Pass
		5	20.9782	65.96	358.85	20.907	66.56	358.75	-0.34%	0.91%	0.03%	Pass
		6	20.9753	65.96	359.65	20.900	66.36	359.55	-0.36%	0.61%	0.03%	Pass
		7	20.9782	66.09	358.56	20.910	66.69	358.47	-0.32%	0.91%	0.03%	Pass
8	20.9784	65.78	359.68	20.903	66.28	359.59	-0.36%	0.76%	0.03%	Pass		

Item	Test Item	Test specification	Judge criteria	Sample(s)							
T3	Vibration test (UN38.3-3)	3-1. Packs are firmly secured to the platform of the vibration machine without distorting the packs in such a manner as to faithfully transmit the vibration. The vibration shall be a sinusoidal waveform with a logarithmic sweep between 7 and 200 Hz and back to 7 Hz traversed in 15 minutes. This cycle shall be repeated 12 times for a total of 3 hours for each of 3 mutually perpendicular to the terminal face. 3-2. The logarithmic frequency sweep is as follows: 7-18 Hz → 1gn 18-50 Hz → 0.8mm amplitude 50-200 Hz → 8gn 3-3. All packs weight are measured. The charged packs voltage are measured and recorded.	No mass loss (<0.1%), no leakage, no venting, no disassembly, no rupture and no fire. Battery voltage drop < 10%. Battery resistance change < ±10%	4 packs are standard charged (Pack#1~4) 4 packs 50 cycled ending in fully charged states (Pack#5~8)							
Test Period	Start: 2014/01/24      End:2014/01/25										
Test Equipment	數位電表 Q153, 電子天平 Q090, 振動測試機 Q300										
Major Problem	-										
Warning Point	-										
Recommendation	The packs pass the test.										
Raw Data	<b>Vibration Test on Charged Packs</b>										
		Before			After			Difference			
	No.	OCV (V)	Resistance(mΩ)	Weight (g)	OCV (V)	Resistance(mΩ)	Weight (g)	Volt (%)	Resistance(%)	Weight (%)	Result
	1	20.9122	66.33	359.35	20.905	66.93	359.33	-0.03%	0.90%	0.01%	Pass
	2	20.9046	66.42	358.65	20.898	67.02	358.63	-0.03%	0.90%	0.01%	Pass
	3	20.9044	65.63	360.13	20.896	66.13	360.10	-0.04%	0.76%	0.01%	Pass
	4	20.9044	66.28	359.24	20.896	66.98	359.22	-0.04%	1.06%	0.01%	Pass
	5	20.9072	66.56	358.75	20.899	67.26	358.73	-0.04%	1.05%	0.01%	Pass
	6	20.9003	66.36	359.55	20.894	66.86	359.53	-0.03%	0.75%	0.01%	Pass
	7	20.9102	66.69	358.47	20.901	67.09	358.44	-0.04%	0.60%	0.01%	Pass
8	20.9034	66.28	359.59	20.896	66.88	359.56	-0.03%	0.91%	0.01%	Pass	

Item	Test Item	Test specification	Judge criteria	Sample(s)							
T4	Shock test (UN38.3-4)	4-1. Packs shall be secured to the testing machine by means of a rigid mount, which will support all mounting surfaces. 4-2. Packs shall be subjected to a half-sine shock of peak acceleration 150gn and pulse duration of 6 milliseconds. Each pack shall be subjected to 3 shocks in the positive direction followed by three shocks in the negative direction of three mutually perpendicularly mounting positions of the pack for a total of 18 shocks. 4-3. All batteries weight are measured. The charged cell voltage are measured and recorded.	No mass loss (<0.1%), no leakage, no venting, no disassembly, no rupture and no fire. Battery voltage drop < 10%. Battery resistance change < ±10%.	4 packs are standard charged (Pack#1~4) 4 packs 50 cycled ending in fully charged states (Pack#5~8)							
Test Period	Start: 2014/01/26                      End:2014/01/26										
Test Equipment	數位電表 Q153, 電子天平 Q090, 衝擊測試機 Q154										
Major Problem	-										
Warning Point	-										
Recommendation	The packs pass the test.										
Raw Data	<b>Shock Test on Charged Packs</b>										
	No.	Before			After			Difference			Result
		OCV (V)	Resistance(mΩ)	Weight (g)	OCV (V)	Resistance(mΩ)	Weight (g)	Volt (%)	Resistance(%)	Weight (%)	
	1	20.9052	66.93	359.33	20.899	67.43	359.32	-0.03%	0.75%	0.00%	Pass
	2	20.8976	67.02	358.63	20.893	67.52	358.62	-0.02%	0.75%	0.00%	Pass
	3	20.8964	66.13	360.10	20.891	66.53	360.10	-0.02%	0.60%	0.00%	Pass
	4	20.8964	66.98	359.22	20.890	67.28	359.21	-0.03%	0.45%	0.00%	Pass
	5	20.8992	67.26	358.73	20.895	67.76	358.72	-0.02%	0.74%	0.00%	Pass
	6	20.8943	66.86	359.53	20.887	67.26	359.52	-0.03%	0.60%	0.00%	Pass
	7	20.9012	67.09	358.44	20.895	67.69	358.43	-0.03%	0.89%	0.00%	Pass
	8	20.8964	66.88	359.56	20.891	67.38	359.56	-0.02%	0.75%	0.00%	Pass

Item	Test Item	Test specification	Judge criteria	Sample(s)																																								
T5	Short Circuit Test (UN38.3-5)	5-1.Packs are placed in to a 55±2°C oven, and exterior packs temperature are monitored 5-2.When packs exterior reach 55±2°C, they are shorted by connecting terminals with a copper wire of resistance less than 100m Ohm. 5-4. The short was continued for more than 1hour or the cell temperature return to 55°C. The packs are observed for a further 6 hours.	No rupture, no disassembly, no explosion, no fire, no smoke. Packs exterior peak temperature <170°C.	4 packs are standard charged (Pack#1~4) 4 packs 50 cycled ending in fully charged states (Pack#5~8)																																								
Test Period		S Start: 2014/01/27                      End:2014/02/07																																										
Test Equipment		數位電表 Q153, 資料收集器 Q075, 烘箱 Q171																																										
Recommendation		The packs pass the test.																																										
Raw Data		<table border="1"> <thead> <tr> <th colspan="4">Short Circuit Test on Charged Packs</th> </tr> <tr> <th>No.</th> <th>Max. Temp.(°C)</th> <th>Visual</th> <th>Result</th> </tr> </thead> <tbody> <tr><td>1</td><td>55.2</td><td>OK</td><td>Pass</td></tr> <tr><td>2</td><td>55.3</td><td>OK</td><td>Pass</td></tr> <tr><td>3</td><td>54.9</td><td>OK</td><td>Pass</td></tr> <tr><td>4</td><td>54.5</td><td>OK</td><td>Pass</td></tr> <tr><td>5</td><td>55.7</td><td>OK</td><td>Pass</td></tr> <tr><td>6</td><td>55.1</td><td>OK</td><td>Pass</td></tr> <tr><td>7</td><td>55.0</td><td>OK</td><td>Pass</td></tr> <tr><td>8</td><td>55.6</td><td>OK</td><td>Pass</td></tr> </tbody> </table>			Short Circuit Test on Charged Packs				No.	Max. Temp.(°C)	Visual	Result	1	55.2	OK	Pass	2	55.3	OK	Pass	3	54.9	OK	Pass	4	54.5	OK	Pass	5	55.7	OK	Pass	6	55.1	OK	Pass	7	55.0	OK	Pass	8	55.6	OK	Pass
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3	54.9	OK	Pass																																									
4	54.5	OK	Pass																																									
5	55.7	OK	Pass																																									
6	55.1	OK	Pass																																									
7	55.0	OK	Pass																																									
8	55.6	OK	Pass																																									
Item	Test Item	Test specification	Judge criteria	Sample(s)																																								
T6	Crush test/ Impact test (UN38.3-6)	6-1.Cell's diameter > 20mm, Execution impact test. (A 9.1 Kg mass is to be dropped from a height of 61±2.5cm onto the sample.) 6-2.Cell's diameter < 20mm, Execution crush test (The cells are crushed with a 13 KN with the crush tester. Once the force is obtained it is to be released.)	External temperature of cell does not exceed 170°C and there is no disassembly and no fire within 6 hours of the test.	5 cells are 50% charged (Cell #1~5)																																								
Test Period		Start: 2014/02/06                      End:2014/02/07																																										
Test Equipment		數位電表 Q153, 資料收集器 Q152, 擠壓試驗機 Q437																																										
Recommendation		The Cells pass the test.																																										
Raw Data		<table border="1"> <thead> <tr> <th colspan="4">Crush Test on 50% Charged Cells</th> </tr> <tr> <th>No.</th> <th>Max. Temp.(°C)</th> <th>Visual</th> <th>Result</th> </tr> </thead> <tbody> <tr><td>1</td><td>76.89</td><td>OK</td><td>Pass</td></tr> <tr><td>2</td><td>84.55</td><td>OK</td><td>Pass</td></tr> <tr><td>3</td><td>92.37</td><td>OK</td><td>Pass</td></tr> <tr><td>4</td><td>91.28</td><td>OK</td><td>Pass</td></tr> <tr><td>5</td><td>87.43</td><td>OK</td><td>Pass</td></tr> </tbody> </table>			Crush Test on 50% Charged Cells				No.	Max. Temp.(°C)	Visual	Result	1	76.89	OK	Pass	2	84.55	OK	Pass	3	92.37	OK	Pass	4	91.28	OK	Pass	5	87.43	OK	Pass												
Crush Test on 50% Charged Cells																																												
No.	Max. Temp.(°C)	Visual	Result																																									
1	76.89	OK	Pass																																									
2	84.55	OK	Pass																																									
3	92.37	OK	Pass																																									
4	91.28	OK	Pass																																									
5	87.43	OK	Pass																																									

Item	Test Item	Test specification	Judge criteria	Sample(s)		
T7	Overcharge test (UN38.3-7)	7-1. The charge current shall be twice the Spec's recommended maximum continuous charge current. 7-2. The minimum voltage of the test shall be as follows: (a) When the Spec's recommended charge voltage is not more than 18V, the minimum voltage of the test shall be the lesser of two times the maximum charge voltage of the battery or 22V. (b) When the Spec's recommended charge voltage is more than 18V, the minimum voltage of the test shall be 1.2 times the maximum charge voltage. 7-3. Tests are to be conducted at ambient temperature. The duration of the test shall be 24 hours.	No disassembly, no fire within seven days after the test.	4 packs are fully charged (Pack#9~12) 4 packs are 50 times cycled ending in fully charged state (Pack #13~16)		
Test Period	Start: 2014/02/06      End:2014/02/10					
Test Equipment	數位電表 Q153, 資料收集器 Q078, 電源供應器 Q148/Q149/Q150					
Major Problem	-					
Warning Point	-					
Recommendation	The packs pass the test.					
Raw Data	<b>Overcharge Test on Charged Packs</b>					
	No.	Charge Voltage(V)	Charge Current(A)	Max. Temp.(°C)	Visual	Result
	9	25.2 V	2.7	22.3	OK	Pass
	10			21.7	OK	Pass
	11			20.8	OK	Pass
	12			22.2	OK	Pass
	13			21.4	OK	Pass
	14			21.8	OK	Pass
	15			20.9	OK	Pass
	16			20.5	OK	Pass

Item	Test Item	Test specification	Judge criteria	Sample(s)					
T8	Forced discharge test (UN38.3-8)	Cell shall be forced discharged at ambient temperature by connecting it in series with a 12 V D.C. power supply at an initial current equal to the maximum discharge current Specified by the manufacturer.	No disassembly, no fire within seven days after the test.	10 cells are first cycle in fully discharged states (Pack#6~15) 10 cells are after 50 cycles ending in fully discharged states (Pack #16~25)					
Test Period		Start: 2014/01/27                      End:2014/02/11							
Test Equipment		數位電表 Q153, 資料收集器 Q160, 電源供應器 Q147/Q236/Q237							
Major Problem		-							
Warning Point		-							
Recommendation		The packs pass the test.							
Raw Data		<b>Forced discharge are first cycle in fully discharged</b>				<b>Forced discharge are after 50 cycles ending in fully discharged</b>			
		No.	Max. Temp.(°C)	Visual	Result	No.	Max. Temp.(°C)	Visual	Result
		6	82.35	OK	Pass	16	93.16	OK	Pass
		7	78.94	OK	Pass	17	95.68	OK	Pass
		8	64.33	OK	Pass	18	98.24	OK	Pass
		9	92.34	OK	Pass	19	88.51	OK	Pass
		10	81.12	OK	Pass	20	84.36	OK	Pass
		11	85.63	OK	Pass	21	102.34	OK	Pass
		12	79.45	OK	Pass	22	100.45	OK	Pass
		13	80.53	OK	Pass	23	99.87	OK	Pass
		14	77.47	OK	Pass	24	84.17	OK	Pass
		15	91.24	OK	Pass	25	86.29	OK	Pass