

New Features Application Note Of 3310G Series

New Generation Electronic Loads

Prodigit Electronics develops the latest 3310G Series electronic load.

The 3310G is a highly upgraded version of the successful 3310F series electronic load family.

The 3310G Series consist of the following models :

- **3310G** (60V / 30A, 150W)
- **3311G** (60V / 60A, 300W)
- **3312G** (250V / 12A, 300W)
- **3314G** (500V / 12A, 300W)
- **3315G** (60V / 15A, 75W)
- **3316G** (80V / 80A, 400W)
- **3318G** (500V / 20A, 400W)
- **3317G** (80V / 160A, 800W)
- **3319G** (500V / 40A, 800W)



The model table below highlights the different power and current capabilities for each model.

Model list of 3310G Series Electronic Load with Turbo mode

Model		3310G	3311G	3312G	3314G	3315G
Power	Turbo OFF	150W	300W	300W	300W	75W
	Turbo ON	450W (x3)*	900W (x3)*	900W (x3)*	600W (x2)*	300W (x4)*
Current	Turbo OFF	30A	60A	12A	12A	15A
	Turbo ON	90A (x3)*	180A (x3)*	36A (x3)*	24A (x2)*	60A (x4)*
Voltage		60V	60V	250V	500V	60V

Model		3316G	3317G	3318G	3319G
Power	Turbo OFF	400W	800W	400W	800W
	Turbo ON	800W (x2)*	1600W (x2)*	800W (x2)*	1600W (x2)*
Current	Turbo OFF	80A	160A	20A	40A
	Turbo ON	160A (x2)*	320A (x2)*	40A (x2)*	80A (x2)*
Voltage		80V	80V	500V	500V

* Turbo ON Power & Current Boost up 2 to 4 times

The 3310G series electronic load module can be used with the 3300G series mainframe, including single 3302G mainframe, dual 3305G mainframe and 4 channel 3300G mainframe. The 3317G/3319G is a stand-alone electronic load.

In addition to carrying over the outstanding performance of the 3310F series, the 3310G Series electronic Loads add a unique Turbo mode. This mode allows the load to support up to four times the rated current and power of a 3310F Series load for short periods of time.

Turbo mode is very valuable for enhanced protection testing of power products. Examples include power supplies, Battery Management Systems (BMS) and protection devices such as Fuses / Breakers or PTC Resettable fuses. In so doing, the 3310G Series can test and verify the actual trip current levels and response times under the abnormal operating conditions.

The current can be increased by 3 times during the test (2 to 4 times depending on the model), which can improve the test current shortage of electronic load.

The built-in test functions for Turbo mode include Short, OCP, OPP, BMS and Fuse tests.



The following example illustrates the ease of performing these kinds of test with the 3310G Loads.

1. Turbo mode ON/OFF indicator, Turbo mode includes Short, OCP, OPP, BMS and Fuse test functions, the others new functions are MPPT with CC and CR mode, CV response time setting, Battery discharge Batt1 ~ Batt3 in Config key.
2. Fuse (Current Protection Components) Test function key.
3. BMS (Battery Management System) test mode key.
4. Add CC+CV and CP+CV for battery discharge test.

In addition to the Turbo mode, the new loads also support NTC resistor simulation, which is an option on the 3310F/G series / 3302F/G mainframe. These load functions support of a wide range of battery discharge testing. Particularly useful for these applications are the new CC + CV and CP + CV operation modes, battery discharge capacity test and dynamic cycle discharge test.

Each of these new features are described in detail in the following paragraphs :

1. Overload Protection Testing of power supplies

This applies to AC/DC, DC/DC Power Supplies, DC/AC inverters, Power Adapters and Device Chargers. These products are not only designed to supply a stable voltage or current, they also need to protect load against abnormal conditions in order to ensure safe operation under all conditions. They are to prevent overheating or high temperature due to excessive current, which could result in a fire and other hazards.

Short circuit, Over Current and Over Power are all abnormal conditions. These conditions typically represent 125% to 150% of the normal rating and in some cases even more. Therefore, to simulate these abnormal conditions, the maximum current value and the maximum power value of the electronic load to perform these tests must be up to two times the normal rating. One solution is do use a load that is twice as big as needed for normal testing but this will cost more. A better alternative is to use the 3310G Series loads, which can provide up to four times rated power and current conditions with a 'normal' rated model.

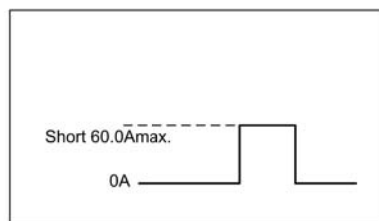


Model		3310G	3311G	3312G	3314G	3315G
Short / OCP / OPP Test Function						
Maximum Current	Turbo OFF	30A	60A	12A	12A	15A
	Turbo ON	90A	180A	36A	24A	60A
Meas. Accuracy		$\pm 1.0\%$ of (Reading + Range)				
Short Time	Turbo OFF	100ms~10 Sec. or Continue				
	Turbo ON	100~1000ms				
OCP Time (Tstep)	Turbo OFF	100ms				
	Turbo ON	20ms				
OPP Time (Tstep)	Turbo OFF	100ms				
	Turbo ON	20ms				

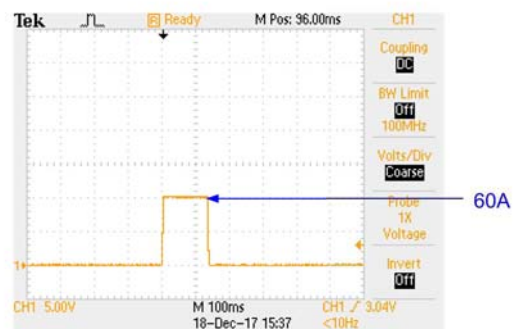
Model		3316G	3318G	3317G	3319G
Short / OCP / OPP Test Function					
Maximum Current	Turbo OFF	80A	20A	160A	40A
	Turbo ON	160A	40A	320A	80A
Meas. Accuracy		$\pm 3.0\%$ of (Reading + Range)			
Short Time	Turbo OFF	100ms~10 Sec. or Continue			
	Turbo ON	100~1000ms			
OCP Time (Tstep)	Turbo OFF	100ms			
	Turbo ON	20ms			
OPP Time (Tstep)	Turbo OFF	100ms			
	Turbo ON	20ms			



3311G Turbo mode OFF
Short test result screen



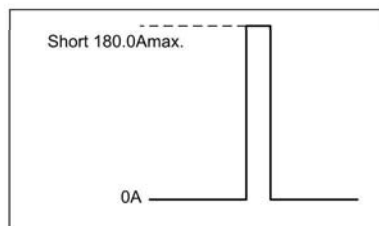
3311G Turbo mode OFF
Short test setting



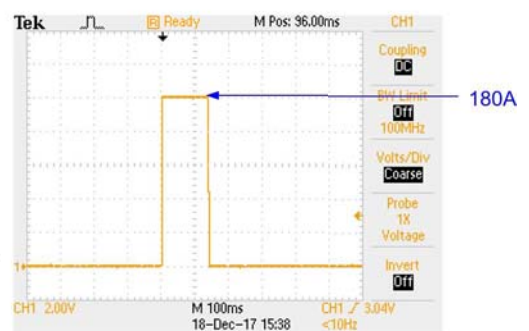
3311G Turbo mode OFF
Short real test waveform



3311G Turbo mode ON
Short test result screen



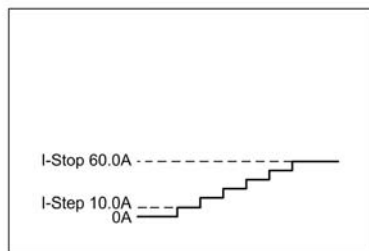
3311G Turbo mode ON
Short test setting



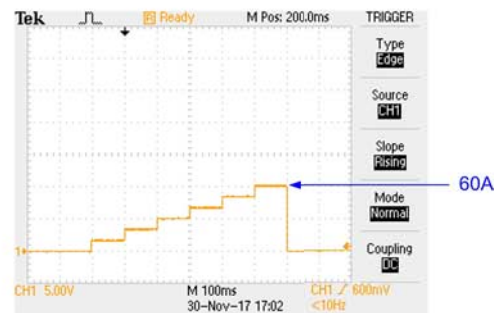
3311G Turbo mode ON
Short real test waveform



3311G Turbo mode OFF
OCP test result screen



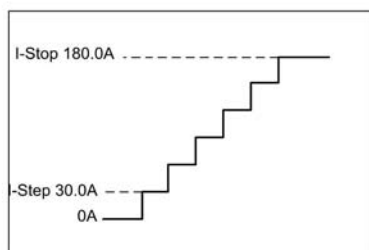
3311G Turbo mode OFF
Setting OCP Istep 10A, Istop 60A



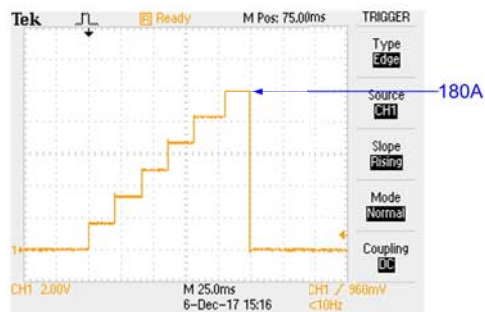
3311G Turbo mode OFF
OCP Istep 10A, Istop 60A real test waveform 波形



3311G Turbo mode ON
OCP test result screen



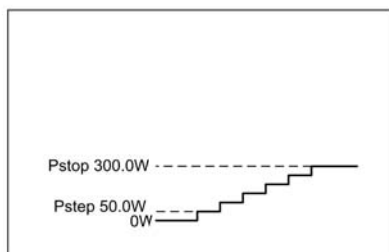
3311G Turbo mode ON
Setting OCP Istep 30A, Istop 180A



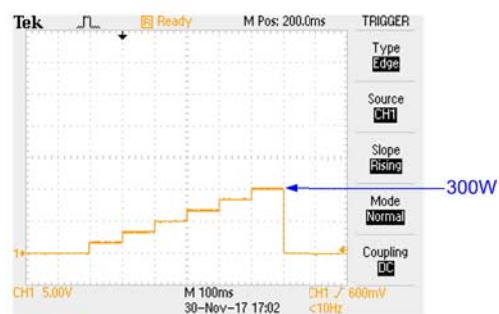
3311G Turbo mode ON
OCP Istep 30A, Istop 180A real test waveform



3311G Turbo mode OFF
OPP test result screen



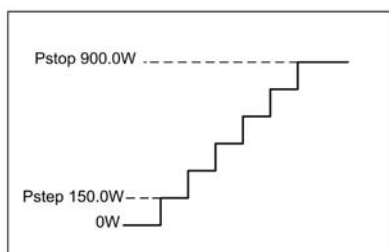
3311G Turbo mode OFF
Setting OPP Pstep 50W, Pstop 300W



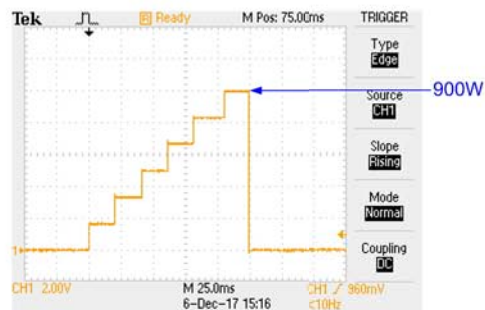
3311G Turbo mode OFF
OPP Pstep 50W, Pstop 300W real test waveform



3311G Turbo mode ON
OPP test result screen



3311G Turbo mode ON
Setting OPP Pstep 150W, Pstop 900W



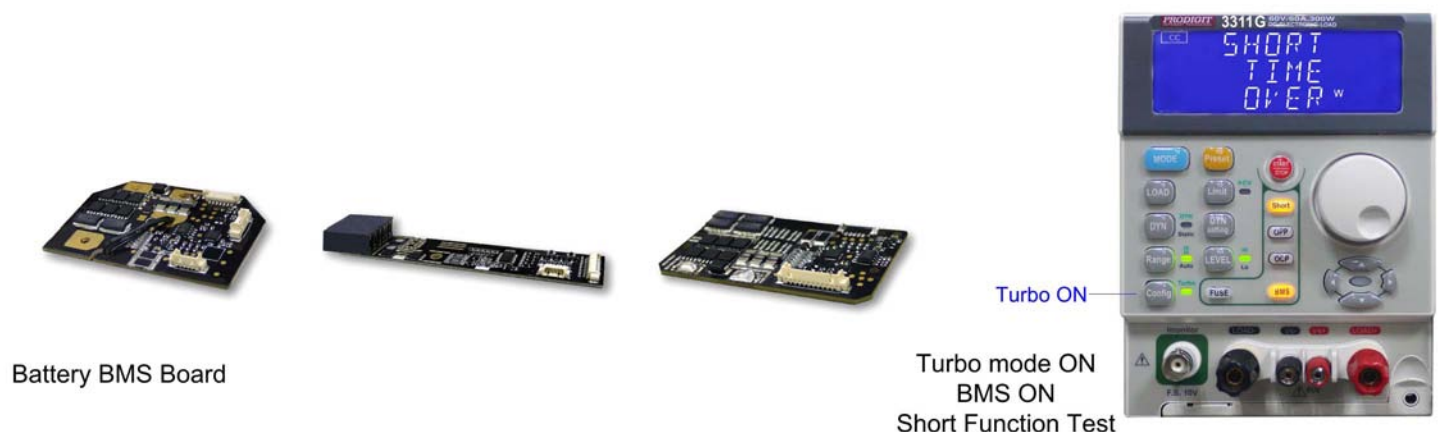
3311G Turbo mode ON
OPP Pstep 150W, Pstop 900W real test waveform

The power supply products under test must respond with the appropriate protection function but the abnormal situation duration is often quite short. To test for conditions, Prodigit's 3310G Series electronic load can increase the electronic load current and power in the new Turbo mode some period of time (within 1 second) up to 2 to 4 times the rated value. For example, the 3311G 60V / 60A / 300W in Turbo mode can increase its load current to 180A or power to 900W electronic load for up to one second. When verifying power products using Turbo mode in a production test environment, 3310G Series electronic loads offer greater test verification capability compared to conventional DC loads. Furthermore, the 3310G Series built-in measurement circuits can also measure the actual trip current value and protection response time under short-circuit or overload test conditions.

2. BMS Protective Devices

Lithium batteries are widely used in a variety of electronic products and electric vehicles and other devices. In order to protect the lithium battery from catching fire, exploding or any other dangerous condition, the lithium battery must be designed with a Battery Management System (BMS) protection circuit. The BMS ensures the charging voltage does not exceed the maximum safe value of the lithium battery (Over Voltage Protection or OVP) during charge cycles. It also monitors discharge to ensure battery does short-circuit or exceed its rated current (Over Current Protection or OCP). Finally, internal battery and cell temperatures are monitored for over or under temperature protection (OTP/UTP).

Previous Prodigit 3310F Series electronic loads were developed with BMS test functions back in 2015 as an option on the 3302F mainframe. The 3310G Series electronic now includes standard BMS test functions. Furthermore, the new Turbo mode allows the short circuit protection current and overcurrent protection to be 2 to 4 times larger depending on 3310G model.



MODEL		3310G		3311G		3312G	
Short / OCP / OPP Test Function							
Maximum Current	Turbo OFF	30A		60A		12A	
	Turbo ON*1	90A		180A		36A	
Meas. Accuracy		± 1.0% of (Reading + Range)					
BMS Test Mode ¹³		OFF	ON	OFF	ON	OFF	ON
Short Time	Turbo OFF	100ms~10Sec. or Continue	0.05mS~10ms	100ms~10Sec. or Continue	0.05mS~10ms	100ms~10Sec. or Continue	0.05mS~10ms
	Turbo ON*1	100~1000ms	0.05mS~10ms	100~1000ms	0.05mS~10ms	100~1000ms	0.05mS~10ms
Meas. Accuracy		NA	±0.005mS	NA	±0.005mS	NA	±0.005mS
OCP Time (Tstep)	Turbo OFF	100mS	0.05mS~10ms/11~1000ms	100mS	0.05mS~10ms/11~1000ms	100mS	0.05mS~10ms/11~1000ms
	Turbo ON*1	20mS	0.05mS~10ms/11~1000ms	20mS	0.05mS~10ms/11~1000ms	20mS	0.05mS~10ms/11~1000ms
Meas. Accuracy		NA	±0.005mS/±0.2mS	NA	±0.005mS/±0.2mS	NA	±0.005mS/±0.2mS
OPP Time (Tstep)	Turbo OFF	100mS	NA	100mS	NA	100mS	NA
	Turbo ON*1	20mS	NA	20mS	NA	20mS	NA
Meas. Accuracy		NA	NA	NA	NA	NA	NA

MODEL		3314G		3315G		3316G	
Short / OCP / OPP Test Function							
Maximum Current	Turbo OFF	12A		15A		80A	
	Turbo ON*1	24A		60A		160A	
Meas. Accuracy		± 1.0% of (Reading + Range)				± 3.0% of (Reading + Range)	
BMS Test Mode ^{*3}		OFF	ON	OFF	ON	OFF	ON
Short Time	Turbo OFF	100ms~10Sec. or Continue	0.05mS~10ms	100ms~10Sec. or Continue	0.05mS~10ms	100ms~10Sec. or Continue	0.05mS~10ms
	Turbo ON*1	100~1000ms	0.05mS~10ms	100~1000ms	0.05mS~10ms	100~1000ms	0.05mS~10ms
Meas. Accuracy		NA	±0.005mS	NA	±0.005mS	NA	±0.005mS
OCP Time (Tstep)	Turbo OFF	100mS	0.05mS~10ms/11~1000ms	100mS	0.05mS~10ms/11~1000ms	100mS	0.05mS~10ms/11~1000ms
	Turbo ON*1	20mS	0.05mS~10ms/11~1000ms	20mS	0.05mS~10ms/11~1000ms	20mS	0.05mS~10ms/11~1000ms
Meas. Accuracy		NA	±0.005mS/±0.2mS	NA	±0.005mS/±0.2mS	NA	±0.005mS/±0.2mS
OPP Time (Tstep)	Turbo OFF	100mS	NA	100mS	NA	100mS	NA
	Turbo ON*1	20mS	NA	20mS	NA	20mS	NA
Meas. Accuracy		NA	NA	NA	NA	NA	NA

MODEL		3318G		3317G		3319G	
Short / OCP / OPP Test Function							
Maximum Current	Turbo OFF	20A		160A		40A	
	Turbo ON*1	40A		320A		80A	
Meas. Accuracy		± 3.0% of (Reading + Range)					
BMS Test Mode ^{*3}		OFF	ON	OFF	ON	OFF	ON
Short Time	Turbo OFF	100ms~10Sec. or Continue	0.05mS~10ms	100ms~10Sec. or Continue	0.05mS~10ms	100ms~10Sec. or Continue	0.05mS~10ms
	Turbo ON*1	100~1000ms	0.05mS~10ms	100~1000ms	0.05mS~10ms	100~1000ms	0.05mS~10ms
Meas. Accuracy		NA	±0.005mS	NA	±0.005mS	NA	±0.005mS
OCP Time (Tstep)	Turbo OFF	100mS	0.05mS~10ms/11~1000ms	100mS	0.05mS~10ms/11~1000ms	100mS	0.05mS~10ms/11~1000ms
	Turbo ON*1	20mS	0.05mS~10ms/11~1000ms	20mS	0.05mS~10ms/11~1000ms	20mS	0.05mS~10ms/11~1000ms
Meas. Accuracy		NA	±0.005mS/±0.2mS	NA	±0.005mS/±0.2mS	NA	±0.005mS/±0.2mS
OPP Time (Tstep)	Turbo OFF	100mS	NA	100mS	NA	100mS	NA
	Turbo ON*1	20mS	NA	20mS	NA	20mS	NA
Meas. Accuracy		NA	NA	NA	NA	NA	NA

The 3310G Series BMS test function for lithium batteries includes short circuit and over current protection modes, which provide a quick, easy and accurate test solution. For BMS short-circuit protection, there is about four times more current available for OCP current testing. This function responds instantaneously (µsecs) to ensure adequate protection. Using the 3311G model load, short circuit protection up to 180A can be tested.

The 3310G Series electronic load can also display additional BMS short circuit protection information such as BMS internal MOSFET switch off time and actual peak current value and response time.

For a typical BMS over current protection function, the difference between normal working current and short circuit current protection (OCP) is about 125% of rated current. The OCP must respond within a few hundred msecs.

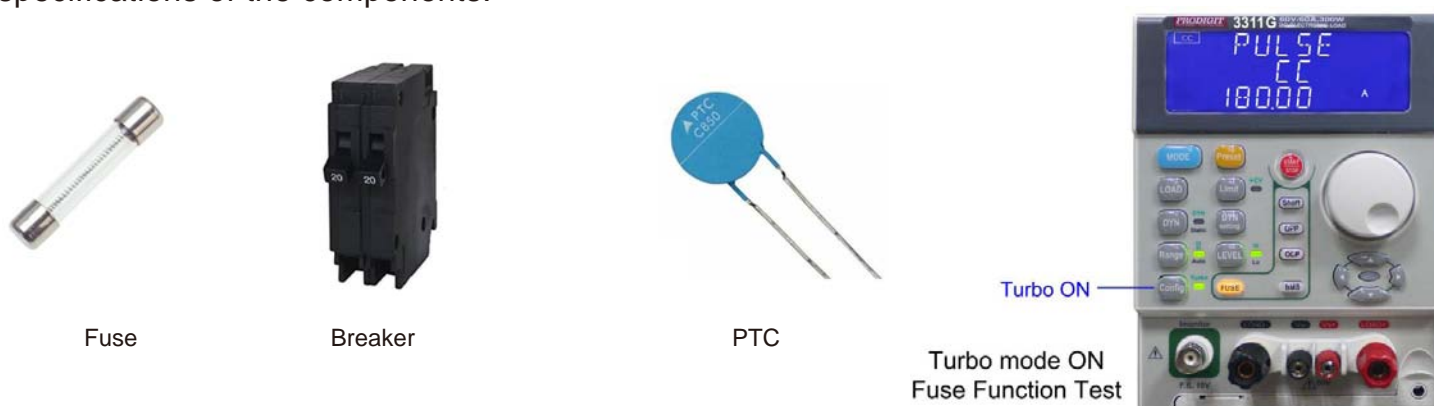
To test BMS over-current protection, the 3310G load starts to sink current (I start), then checks whether the BMS over-current protection is active. If the BMS over-current protection is not active, the load starts to increase the load current (I Step) and checks whether the BMS OCP is responds. This process continues until the BMS OCP activates. Thus, the BMS OCP test can determine both OCP function current trip level and response time.

3. Current Protection for Component Testing

Common current protection devices include Fuses, Breakers and newer PTC Resettable fuses etc. Their role is to disconnect a load when the actual current exceeds the rated current of the load to avoid overheating, even fire, and other dangerous conditions. Therefore, the current protection component is the last line of defense to ensure safety when the load current is abnormal. When an abnormality occurs, the protective device must be able to provide the protection capability for disconnecting the circuit. The protection of these components have their own function and different price points. For example, a fuse is a one-time use device while circuit breakers and PTCs are reusable.

The current rating of the current protection component usually has a product relationship with the protection response time. The greater the current through the current protection component, the faster the reaction time. That means it is related to the total energy into the protection component.

To test these protection devices, the 3310G Series of electronic loads are specifically designed for test verification of current protection components. A Fuse Test function that can be used with Turbo mode that provides 2 to 4 times the rated current and power for a short period of time. This allows testing and verification of these components with about 3 times the current and power specifications of the components.



Model		3310G	3311G	3312G	3314G	3315G
Short / OCP / OPP Test Function						
Maximum Current	Turbo OFF	30A	60A	12A	12A	15A
	Turbo ON	90A	180A	36A	24A	60A
Fuse Test Mode ^{*4}						
Trip & Non-Trip Time	Turbo OFF	r1 : 1~5999ms, r2 : 6~16383sec				
	Turbo ON ^{*1}	1~1000mS				
Meas. Accuracy		r1 : ±0.2mS (<200mS), ±20mS (>200mS), r2 : ±0.5S				
Repeat Cycle		0~255				

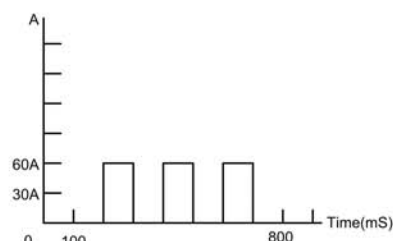
Model		3316G	3318G	3317G	3319G
Short / OCP / OPP Test Function					
Maximum Current	Turbo OFF	80A	20A	160A	40A
	Turbo ON	160A	40A	320A	80A
Fuse Test Mode *4					
Trip & Non-Trip Time	Turbo OFF	r1 : 1~5999ms, r2 : 6~16383sec			
	Turbo ON *1	1~1000mS			
Meas. Accuracy		r1 : $\pm 0.2\text{mS}$ (<200mS), $\pm 20\text{mS}$ (>200mS), r2 : $\pm 0.5\text{S}$			
Repeat Cycle		0~255			

Fuse Test functions are divided into two types, Trip (fuse) and Non-Trip (no fuse).

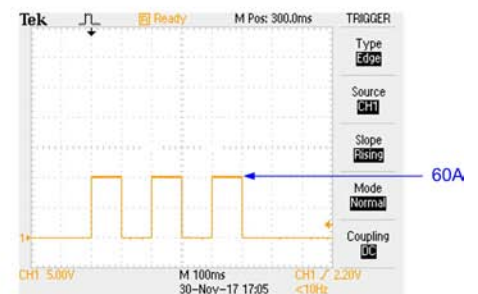
Fuse Test setting parameters include the test current (**Pulse CC**), the test time (**PULSE TIME**), the number of test repetitions **PULSE REPEAT** Cycles and the **Ith** or current threshold value.



3311G Turbo mode OFF
Fuse mode test result screen



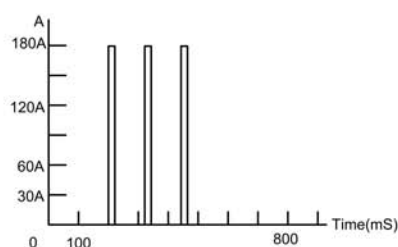
Setting : Turbo : OFF, Fuse ON,
CC pulse 60A, 100mS, repeat 3 cycles



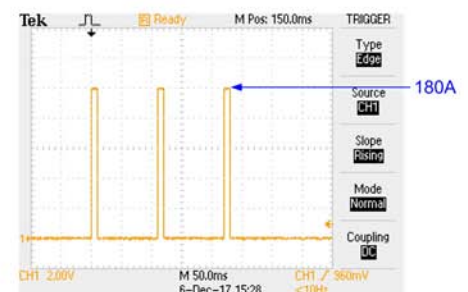
Turbo : OFF, Fuse ON, CC pulse 60A,
100mS, repeat 3 cycles real test waveform



3311G Turbo mode ON
Fuse mode test result screen



Setting : Turbo : ON, Fuse ON,
CC pulse 180A, 10mS, repeat 3 cycles



Turbo : ON, Fuse ON, CC pulse 180A,
10mS, repeat 3 cycles real test waveform

The fuse Trip test determines that when the current is too large the device can provide the protection of an open circuit. This means the current protection components need to have a fuse action. To test this, the test current needs to be greater than the fuse current specification. After the fuse blows or Circuit Breaker trips, the 3310G Series electronic load determines if the current is lower than the programmed Ith current threshold value. The load LCD will display the Repeat Cycle and the fusing time in ms.

For the Non-Trip test, the current protection component is required to achieve non-blown action, so the test current needs to be lower than the fuse current specification. To verify that at normal current levels the device does not trip, the 3310G Series electronic load checks that during the test time (Pulse Time) the device does not trip after repeating the number of repeat cycles. The load LCD will display the number of Repeat Cycles applied.

4. NTC Simulation Test (this feature is optional)

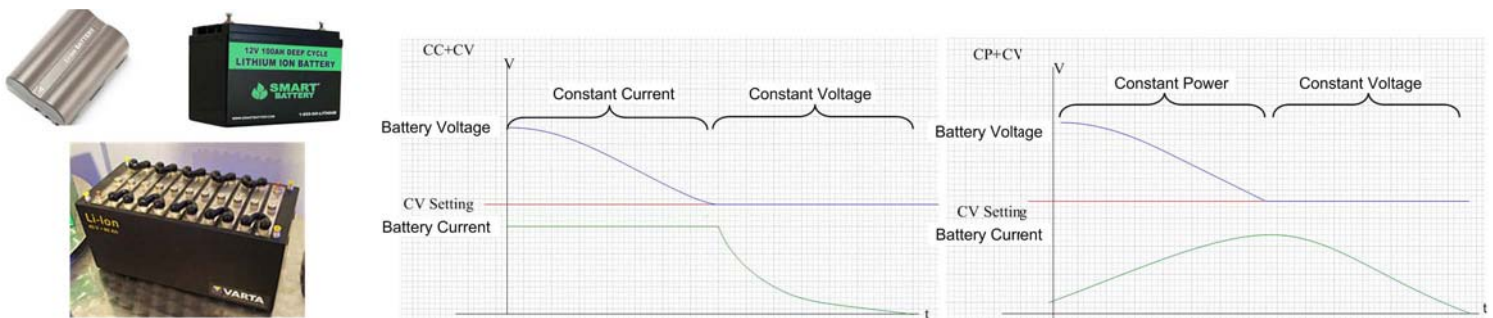
Based on the safety issues with lithium batteries and the effect of ambient temperature, lithium batteries and chargers must require a temperature protection mechanism to prevent causing danger under ambient low and high temperature conditions.



The 3310G Series electronic loads and 3302G mainframe support the NTC resistor simulator option. The 3310G Series can set NTC resistor values from 100Ω to $500K\Omega$, equivalent to $10K\Omega$ NTC resistance for a temperature range from -46°C to $+179^{\circ}\text{C}$. Changing the NTC resistance verifies if the lithium battery and charger temperature protection system operates correctly by either halting the charge or discharge cycle or by reducing the charge and discharge current. When the temperature returns to normal working temperature levels, the load checks if the protection action recovers and returns to the operational state, i.e. restores the normal charge and discharge.

5. Load operation mode supports CC + CV and CP + CV mode

The 3310G Series electronic loads not only include 3310F Series functions like CC, CR, CV, CP, Dynamic load mode, it also adds the new CC + CV and CP + CV operation modes.

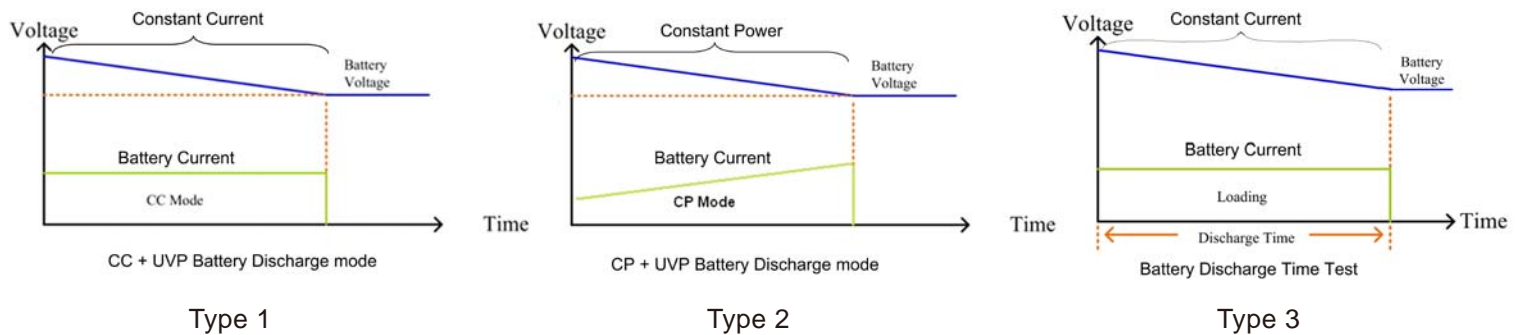


During discharge testing of batteries, special attention should be paid to avoid over-discharge. This will cause the battery voltage to drop too low and cause permanent damage.

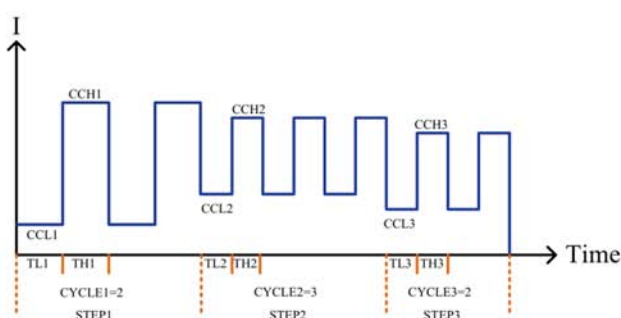
When using the CC + CV or CP + CV mode of the 3310G Series electronic load, the battery will respond to constant current (CC) or constant power (CP) mode set by the electronic load to discharge. When the minimum allowable discharge voltage of the battery is set as the CV voltage value - the lowest voltage of the discharge test - the CC + CV and CP + CV modes can ensure the battery will not be damaged due to over discharge, resulting in battery loss.

6. Battery test function

The 3310G Series load also supports five new battery discharge tests, TYPE1 ~ TYPE5. You can select the appropriate battery test mode and test results can be directly displayed on the LCD display showing the battery AH capacity, the discharge voltage value, the cumulative discharge time data etc.

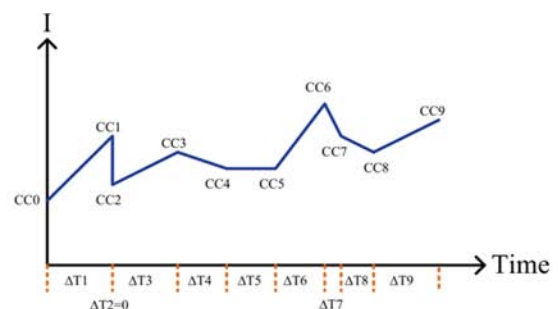


There are also CC pulse cycle life test and CC Ramp Cycle life test types (Type 4, Type5 provides remote operating only). These can be used to simulate the battery in actual use by using a variety of load current changes and cycle variations. The user can verify and simulate the performance and life during actual use of batteries.



Pulse discharge cycle current of Battery Discharge Test

Type 4



Ramp discharge cycle current of Battery Discharge Test

Type 5

7. Battery real discharge current simulation and test

The 9923 Current Waveform Generator can be added as needed to provide battery real discharge current waveform simulation.



The new Model 9923 Current Waveform Generator (Option) provides real battery discharge current waveform simulation. This option installs in Model 9923 to 3302G, 3305G and 3300G Series load mainframes and can simulate real battery discharge current waveforms.

Please refer to the [Model 9923 Current Waveform Generator application](#) for details.