

# Electric Vehicle Battery Test

## PEL-5000C High Power Compact DC Load

### Electric Vehicle Charging Station Test Method

When charging electric vehicle batteries using an On-Board Charger or charging station, the battery represents a charger's load. During the charging process, the battery voltage will increase slowly.

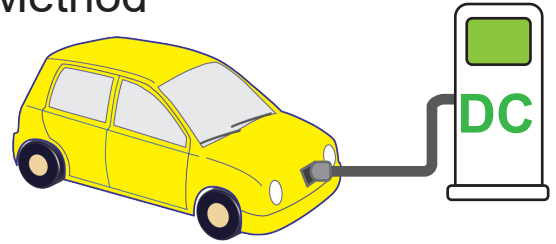
To enhance the charger's speed to detect the battery voltage, using an electronic load to simulate a battery and its impedance during charger design will enable better and faster test verification.

For battery simulation applications, the most commonly used Load operating mode is Constant Voltage (CV), which simulates the battery voltage, or Constant Resistive mode, which simulates the battery impedance.

In Constant Voltage (CV) mode load mode, the electronic load's terminal voltage is held at the CV setting voltage value. By adjusting the CV setting value, battery states ranging from a fully discharged state to a fully charged state can be simulated easily. In Constant Resistive (CR) mode, the electronic load's terminal voltage is held at the multiple charge current and the CR setting value. By changing the load's CR setting value, various battery impedance states can be simulated, ranging from fully charged to fully discharged.

As mentioned, Constant Voltage (CV) mode can be used to simulate different state of charge (SoC) conditions of a battery pack during charge and discharge cycles. This includes low battery voltage, increasing battery voltage during charging, and high voltage state when fully charged.

During each stage, the load monitors and displays important parameters such as voltage, power (Watt), and current. At the end of the charge cycle, the load will transition from CC mode to CV mode, which will be evident from the load display readouts. This approach is much more convenient than using actual batteries to test On-Board Chargers or charging station operation.

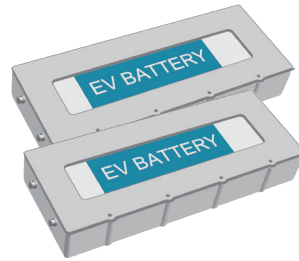
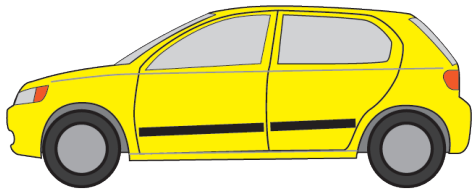


## PEL-5000C Series 150V/600V/1200V High Power DC Electronic Load



Model Name	Voltage	Current	Watts
PEL-5006C-150-600	<b>150V</b>	600A	6kW
PEL-5008C-150-800		800A	8kW
PEL-5010C-150-1000		1000A	10kW
PEL-5012C-150-1200		1200A	12kW
PEL-5015C-150-1500		1500A	15kW
PEL-5018C-150-1800		1800A	18kW
PEL-5020C-150-2000		2000A	20kW
PEL-5024C-150-2000		2000A	24kW
PEL-5006C-600-420	<b>600V</b>	420A	6kW
PEL-5008C-600-560		560A	8kW
PEL-5010C-600-700		700A	10kW
PEL-5012C-600-840		840A	12kW
PEL-5015C-600-1050		1050A	15kW
PEL-5018C-600-1260		1260A	18kW
PEL-5020C-600-1400		1400A	20kW
PEL-5024C-600-1680		1680A	24kW
PEL-5006C-1200-240	<b>1200V</b>	240A	6kW
PEL-5008C-1200-320		320A	8kW
PEL-5010C-1200-400		400A	10kW
PEL-5012C-1200-480		480A	12kW
PEL-5015C-1200-600		600A	15kW
PEL-5018C-1200-720		720A	18kW
PEL-5020C-1200-800		800A	20kW
PEL-5024C-1200-960		960A	24kW

# Electric Vehicle Battery Test Methods



Once an electric vehicle's battery is fully charged, it can be driven until almost depleted for a maximum driving range. In drive mode, the battery acts as a power source for the electric drive train.

Battery charge and discharge times and associated battery life are important considerations for electric vehicle designs. Another critical design criterion is a safe operating area of the battery pack, which relates to minimum and maximum charge and discharge voltage levels. For example, a single lithium-ion battery cell's charging voltage cannot exceed 4.2Vdc to prevent overcharging, while the discharge voltage cannot drop below 2.5Vdc to avoid excessive discharge.

Both conditions can dramatically affect battery life. And quickly and permanently damage the internal structure of the battery cell. Therefore, careful attention must be paid to charging and discharging voltage levels to avoid permanent battery damage or deterioration during development and test.

GW Instek PEL-5000C series offers the following four operating modes to help avoid conditions during battery discharge testing that could result in the permanent battery due to over or under-voltage.

## CC + CV mode battery discharge test

The CC+CV mode, the discharging of the battery starts in the CC mode of operation by setting a current discharge level (CC set-point) and a discharge stop voltage level (CV set point), which determines the battery's full state of charge under test. When the battery voltage drops to the CV set-point level, the electronic load stops discharging so that the battery voltage is maintained at the CV set value.

The operation in CC+CV mode is very straightforward as the load automatically switches from CC constant current mode discharge mode to CV constant voltage mode. This prevents the battery from being damaged due to excessive discharging. This mode of operation is illustrated in Figure 4.

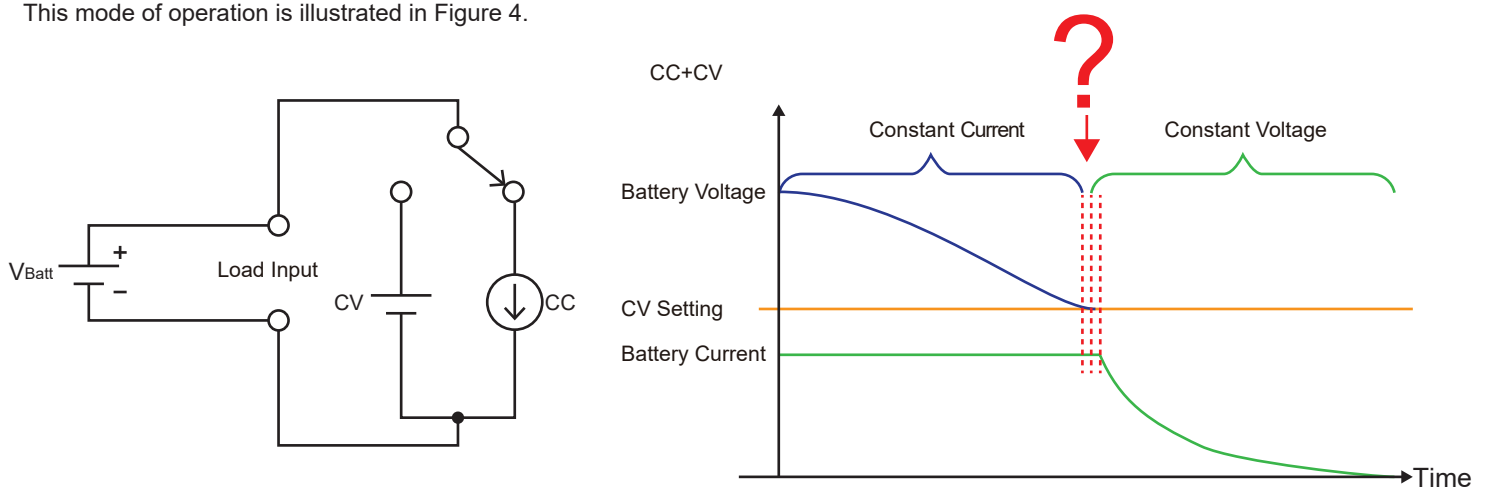


Figure 4 : Application of CC+CV operation mode

## CP + CV mode battery discharge test

In the CP + CV mode of operation, the electronic Load starts discharging the battery using a constant amount of power drain as determined by the CP set point.

Once the battery voltage sags to the CV set point, the load transitions from CP mode to CV mode to maintain the discharged state battery voltage.

The operation in CP+CV mode is very straightforward as the load automatically switches from CP constant power mode discharge mode to CV constant voltage mode.

This prevents the battery from being damaged due to excessive discharging. This mode of operation is illustrated in Figure 5.

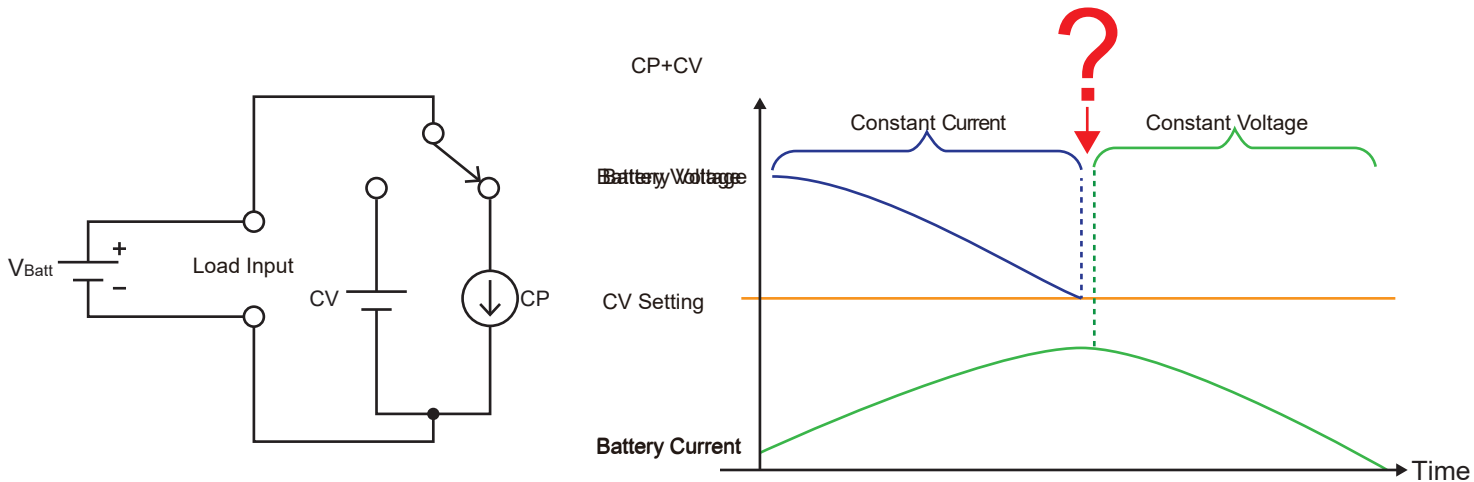


Figure 5: Application of CP+CV operation mode

## CC + UVP mode battery discharge test

In the CC + UVP (Under Voltage Protection) mode of operation, the electronic load starts discharging the battery using constant current mode with a current drain determined by the CC set point.

Discharging will continue until the battery reaches the Under voltage protection point as set by the UVP set point.

At this point, the total amount of Ampere Hours drawn from the battery will be displayed in AH, and no more discharging occurs.

Operation in CC + UVP mode is very straightforward as the load automatically switches from CC constant current mode discharge mode to OFF mode. This prevents the battery from being damaged due to excessive discharging. This mode of operation is illustrated in Figure 6.

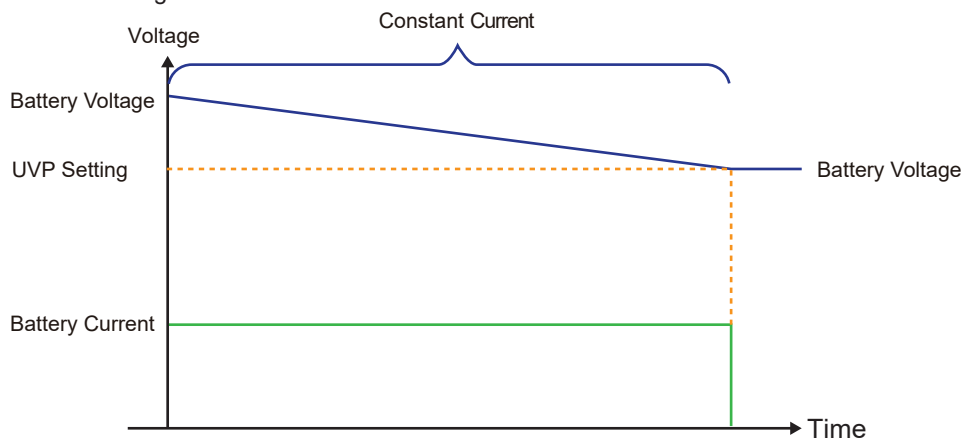


Figure 6: CC + UVP mode battery discharge test

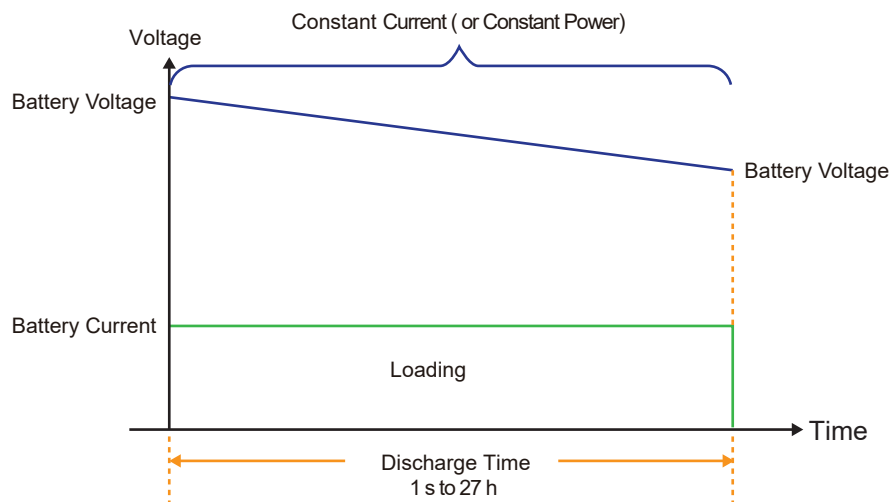
## Time period discharge, Pulse discharge, RAMP Ramp mode discharge

In addition to the four battery discharge test modes described above, the PEL-5000C electronic loads also support pre-set discharge time interval setting and pulse current discharge modes.

Discharge current can also be programmed to follow a set step or ram pattern as needed. A sample discharge current waveform is shown below. These specific discharge profiles can be used to simulate actual driving conditions dependent on battery discharge profiles to test and evaluate battery performance and life-span.

### 5.1 Time period discharge

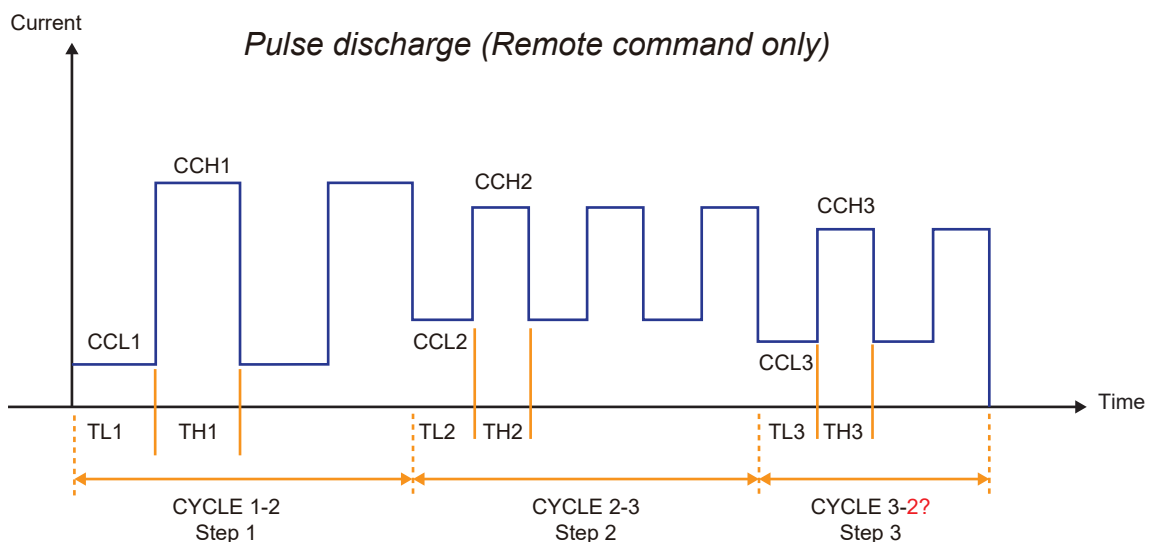
In Time period discharge mode, the total discharge time is programmed on the load by the user as shown in Figure 8. When the discharge time reaches zero, discharging is stopped and the discharge time and end of discharge battery voltage will be displayed. The programmable range for discharge time interval ranges from 1 second to 99999 seconds or 27 Hours.



*Figure 8 : Setting discharge time battery discharge test*

### 5.2 Pulse discharge (Remote command only)

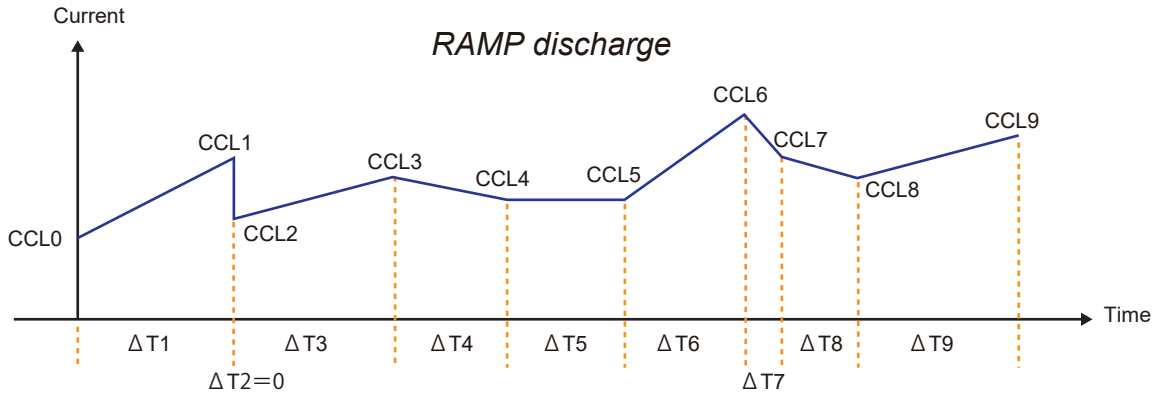
The battery's pulse discharge test utilizes the pulse current method using the Dynamic mode and the counting function. During the test, the electronic load executes LOAD ON, DYN ON until the count reaches zero. then the electronic load will activate LOAD OFF, DYN OFF. (Cycle range: 1~2000; Step: 1~3; Repeat setting value: 0~9999).



### 5-3 RAMP discharge

RAMP Mode, Slew rate load on and Repeat function, as below Figure Show.

Setting "STEPn" n-1~9, CC0, CC1,  $\Delta T1$ , CC2,  $\Delta T2$ .....CC9,  $\Delta T9$ , Repeat, Load on mode, Increased or Decreased current values by every second.



Specify a fixed time range to increase or decrease the load current. The time range can be set from 0~6000 s, STEP: 1~9, Repeat: 0~9999.

Pre-setting the LOAD OFF voltage will stop the discharge when the battery voltage drops, even if the preset discharge time has not been reached, to prevent the battery from over-discharging and prevent damage to the battery.