



# Charger Enhancer

USER MANUAL

CE140



# 1 BASICS

## 1.1 Introduction to the Charger Enhancer CE140

Standard chargers that come included with most personal electric vehicles (PEV) generally fulfill their purpose effectively. However, they lack significant information and control over the charging process, requiring users to disconnect the charger manually once the process is complete. Failing to do so, among other risks, may lead to overcharging and premature decay of the batteries. If a standard charger malfunctions due to normal wear or a failure, the vehicle may have limited protection. Leaving a standard charger unattended, especially overnight, can result in personal injuries and/or property damage. Batteries constitute a significant portion of the cost of an electric vehicle, yet charger characteristics are often overlooked.

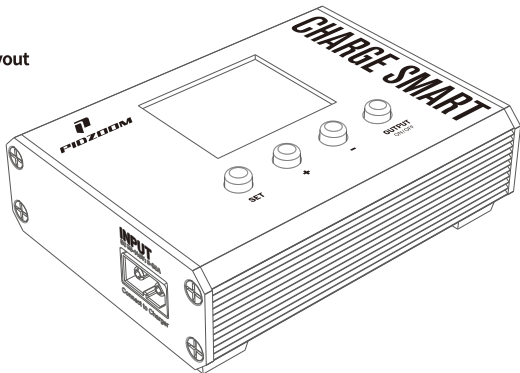
"Smart" chargers offer more information and control over the charging process, along with additional protection layers, providing a more convenient and safer experience. However, they are often expensive and require technical knowledge for proper operation.

Congratulations on your Charger Enhancer! This innovative device brings 'smart' functions and enhanced safety levels to your standard personal electric vehicle charger. Placed between the charger and the vehicle, it requires no external power supply. Designed for both novice and experienced users, Charger Enhancer analyzes the charging process, offering relevant information, additional protection features, and customization tools. This results in a more convenient and safer charging experience while potentially extending the lifetime of your vehicle's batteries.

## 1.2 Package Contents

- A Charger Enhancer CE140 unit.
- User Manual.

## 1.3. Device Layout



## **1.4 Product Features**

### **1.4.1 Information**

During the charging process, Charger Enhancer's display provides essential information, including incoming and outgoing voltage, charging current, power, time, and energy capacity. This display offers valuable insights into the charger, the charging process, and the overall battery condition of the vehicle.

A practical application of this feature involves measuring the current battery capacity (Wh or Ah) by completing a full charging cycle (0-100%). The ratio of this measured value (Wh or Ah) to the expected value (total capacity specified in the vehicle's manual) can be expressed as a percentage, representing the current condition of the battery relative to its original state. Understanding the extent of battery decay due to normal use or after accidents, can help mitigate risks and offer valuable information to determine when batteries may need replacement. Additionally, this feature is useful for assessing the condition of a preowned vehicle before purchase.

At anytime, you can toggle between normal and night display modes without interrupting its operation. Reducing the display's output to just the status indicator, Charger Enhancer does not interfere with your sleep.

## 1.4.2 Customization

Charger Enhancer provides a user-friendly interface with inbuilt buttons, allowing users to customize the 'automatic disconnection' feature to a preset cut-off voltage (a proxy of the percentage of charge) and the overcurrent protection. With this level of control, among other purposes, users can fine-tune the charging process to balance battery cells; set charge limits for short trips; help avoid stressing electric components; equalize multiple batteries for long-term storage; or, implement an optimized charging scheme aimed at extending the lifespan of the vehicle's battery.

## 1.4.3 Protection Features

- The charging process can be interrupted by simply pressing a button, without unplugging anything.
- Auto-disconnect occurs when the voltage reaches a preset value.
- Auto-disconnect if the current is higher than a user preset value.
- To not overcharge the batteries, CE140 automatically disconnects the output when the full charge condition is reached (as a lower than 300mA current).
- Feature to manually turn off most of the display to save energy and decrease heat emission.
- Auto-disconnect after 10 minutes if not charging (i.e. not properly plugged).
- The charging process is interrupted if the internal temperature of the charger enhancer exceeds 100°C (212°F).

#### **1.4.4 Compatibility**

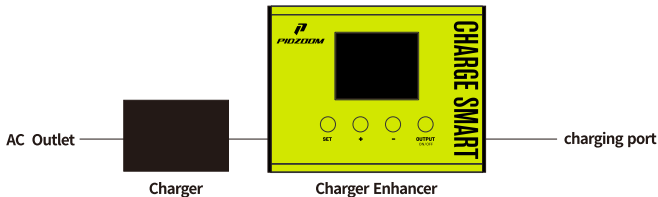
Charger Enhancer CE140 is compatible with a wide variety of chargers and personal electric vehicles (between DC 30 and 140V). The device can be adjusted according to the characteristics of the vehicles. Feel free to contact us if you have any doubts about compatibility with your vehicle.

## 2 USING CHARGER ENHANCER

### 2.1 Connecting and Basic Operation of CE140

Use the provided adapters as illustrated by the next image, to connect Charger Enhancer CE140 between the charger and the vehicle or a battery:

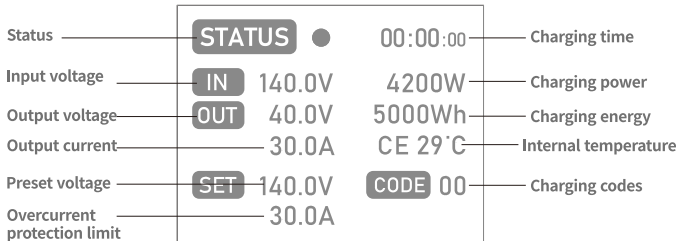
1. Connect the charger to the power outlet as usual.
2. Connect the charger's output plug to CE140's input port using a compatible adapter.
3. Press and hold the SET button to customize the voltage threshold and overcurrent protection, according to the vehicle's battery and user needs (see 2.3 & 2.4). The device remembers these settings for the next charging event.
4. Connect CE140's output port to the vehicle's charging port, using a compatible cable adapter.
5. Pulse the CE140's ON/OFF output button to start or stop charging and collecting information.  
The default setting is ON.





## 2.2 Display Information

The next image illustrates the layout of information and indicators provided by the CE140's display.



The next table describes the parameters shown the display.

Parameter	Description
<b>Status</b>	The small disk indicator shows the status of the charging process using color codes: white for standby (i.e. not connected output cable), red for charging, and green when the output is disconnected. The status indicator is also visible during Night Display mode (screen saver).
<b>Input voltage</b>	The input voltage indicates the tension being received by Charger Enhancer, supplied by the charger. Unless the output voltage can be adjusted on the charger, this parameter can help assess when a charger is abnormal.
<b>Output voltage</b>	The output voltage corresponds to the tension delivered by Charger Enhancer to the vehicle. It is normal to read a value close to zero if the output of Charger Enhancer is closed.
<b>Output current</b>	The output current corresponds to the 'intensity' of the charging process (in A), influencing the speed at which the battery is charged. It is normal to read a value close to zero if the output of Charger Enhancer is closed. This value should never exceed the vehicle's charging specifications, and a decrease is normal during the last phase of a charging session.
<b>Preset voltage</b>	The preset output voltage corresponds to the tension that will be used by Charger Enhancer as a threshold to stop the charging process and disconnect. By adjusting this value, the user can control the final relative percentage of charge. It can be as high as the input voltage.
<b>Overcurrent protection limit</b>	The overcurrent protection limit corresponds to the maximum current the user wants to allow to be transferred to the vehicle — a user-defined protection layer to avoid overcurrent, usually slightly higher than the charger's capacity.

<b>Charging time</b>	Charger Enhancer features a built-in timer to measure the duration of the charging process, resetting automatically the counter with each initiation of a new charging cycle.
<b>Charging power</b>	Charging power is the rate at which energy is transferred to the battery, calculated as the product of voltage and current and expressed in watts (W). It is normal to read a value close to zero if the output of Charger Enhancer is closed. Since the voltage is constant during the charging process, the charging speed is affected by adjusting the current to modify the charging power. A higher value for charging power indicates a shorter time taken to charge.
<b>Charging energy</b>	Charging energy refers to the total amount of electrical energy delivered to a device or a battery during the charging process. It is typically measured in watt-hours or ampere-hours (Wh or Ah) and represents the cumulative stored energy. When charging from 0 to 100%, this value indicates the effective battery capacity of the vehicle, and therefore its potential energy available for riding.
<b>Internal temperature</b>	The internal temperature indicator provides a reading to check whether the charging process is being conducted at an acceptable temperature. Charger Enhancer is affected by environmental temperature as well as the intensity of the current, similar to the charger and the vehicle itself. It is advisable to charge in an environment of at least 15°C (59°F), and Charger Enhancer has built-in overtemperature protection.
<b>Charging codes</b>	Charger Enhancer reports specific conditions through a set of codes for a more in-depth report of the charging process (see 2.5).

## 2.3 Button Panel

Charger Enhancer CE140 is provided with four push buttons to customize the charging process. Their labels and functions are described in the following table.

Button	Function
SET	<ul style="list-style-type: none"><li>● Press and hold for 2 seconds to enter the Setup mode. To save the set values and exit, press and hold for 2 seconds again.</li><li>● While in Setup mode, pulse to toggle the selected parameter (voltage, current or capacity unit).</li></ul>
+	<ul style="list-style-type: none"><li>● Pressing and holding the button for 3 seconds displays the device's hardware and software versions.</li><li>● Pressing it simultaneously with '-', toggles between the Normal and Night display modes. In Calibration or Setup mode (blinking):</li><li>● Pressing and holding the button increases the parameter value continuously.</li><li>● Pulsing the button increases the parameter value incrementally by 0.1 for higher precision.</li></ul>
-	<ul style="list-style-type: none"><li>● Pressing it simultaneously with '-', toggles between the Normal and Night display modes. In Calibration or Setup mode (blinking):</li><li>● pressing and holding the button, decreases continuously the parameter value.</li><li>● pulsing the button decreases the parameter value decrementally by 0.1 for higher precision.</li></ul>
OUTPUT ON/OFF	<ul style="list-style-type: none"><li>● Pulse the 'ON/OFF' output button to start or manually interrupt the charging process.</li><li>● To enter the voltmeters Calibration mode, hold down the 'ON/OFF' button for 10 seconds. To save the settings value and exit, hold down the 'ON/OFF' button for 10 seconds again.</li><li>● While in Calibration mode, pulse the 'ON/OFF' button to toggle the selected parameter for adjustment (IN voltmeter or OUT voltmeter).</li></ul>

## 2.4 Operation Procedures

### 2.4.1 Output Voltage Threshold

Charger Enhancer CE140 allows the vehicle or battery to receive the charger's total voltage output until reaching a complete charge (100%), automatically disconnecting the charger from the vehicle, which represents the simplest and most common use.

However, there are scenarios where a 100% battery charge may not be desired, and CE140 provides a feature to customize this threshold. Extended periods of a fully charged battery can decrease lifespan. In situations such as shorter trips than the vehicle's mileage capacity on a single charge, optimizing the charging scheme becomes essential to avoid extremes and extend battery life. Additionally, when storing battery packs for an extended period or checking them periodically to prevent capacity decay, setting a lower charging level, such as about 60%, may be preferable.

For these cases and more, CE140 allows you to set the battery charging level by defining the output voltage threshold, even when using a standard charger.

#### **To set up the Output Voltage threshold (cutoff voltage):**

- Connect the charger to the outlet and to CE140.
- Press and hold the 'SET' button for 2 seconds to access the Setup mode.
- Use short pulses on the 'SET' button as needed to select the voltage limit (indicated by blinking 'V' value).
- Adjust the output voltage threshold value using the '+' and '-' buttons.
- The selected value is automatically saved after 10 seconds of inactivity. Alternatively, press and hold the 'SET' button for 2 seconds again to exit the Setup Mode.

Notes: avoid setting a higher voltage level than the maximum output of the charger, which ranges between 30 and 140VDC. There is no need to interrupt the charging process with the output 'ON/OFF' button, to adjust the output voltage threshold. Also, a guide is provided to help converting between voltages and percentage of battery charge (see 6.1).

### **2.4.2 Overcurrent Protection**

CE140 can be adjusted to set a limit or threshold for the current directed towards the vehicle. Typically, it is advisable to adjust the overcurrent protection to a value slightly higher than the charger's output current (printed on the charger - A).

While increasing the current output is commonly used to achieve faster charging, it can potentially damage electronic components or reduce the battery lifespan if set excessively high. CE140 provides a safeguard against such issues by allowing you to set a limit to the current, as an overcurrent protection, and if the current exceeds the preset threshold, CE140 will automatically disconnect the output towards the vehicle.

#### **To set up the Overcurrent Protection threshold:**

- Connect the charger to the outlet and to CE140.
- Press and hold the 'SET' button for 2 seconds to access the Setup mode.
- Use short pulses on the 'SET' button as needed to select the overcurrent threshold (indicated by blinking 'A' value).
- Use the '+' and '-' buttons as needed to set the overcurrent threshold value as desired (between 2A and 30A), usually set slightly higher than the current output of the charger.
- The selected value is automatically saved after 10 seconds of inactivity. Alternatively, press and hold the 'SET' button for 2 seconds again to exit the Setup mode.

### 2.4.3 Capacity Unit Selection

Charging energy can be measured in watt-hours (Wh) or ampere-hours (Ah), to toggle between those two units:

- Connect the charger to the outlet and to CE140.
- Press and hold the 'SET' button for 2 seconds to access the Setup mode.
- Pulse on the 'SET' button until selecting the capacity field, indicated by blinking 'Wh' or 'Ah' value.
- Use the '+' and '-' buttons to toggle the capacity unit as desired.
- The preset capacity unit is automatically saved after 10 seconds of inactivity. Alternatively, press and hold the 'SET' button for 2 seconds again to exit the Setup mode.

### 2.4.4 Device Version

Charger Enhancer is continually improved based on user feedback. To check the version of the device and its internal software, follow these steps:

- On the main display, press and hold the '+' button for 3 seconds to display hardware and firmware versions.
- The display will automatically exit after 10 seconds of inactivity. Alternatively, you can manually exit by pressing and holding the '+' button for 3 seconds again.

<b>STATUS</b>	●	00:00:00
<b>IN</b>	140.0V	4200W
<b>OUT</b>	40.0V	5000Wh
	30.0A	CE 29°C
<b>INFO:</b>	Software:V1:1:03	
	Hardware:V1:0:04	

### 2.4.5 Voltmeters Calibration

Upon connection to a charger, CE140 automatically detects the charger's output voltage. The voltmeters come pre-calibrated from the factory and typically do not require adjustment. Nevertheless, over time, the voltmeters' calibration may deviate, resulting in a slight variance from the directly measured output voltage at the charger connector. Charger Enhancer allows you to calibrate either the IN or OUT voltmeters within the range of 90% to 110% of the auto-detected value.



## To calibrate the CE140's voltmeters:

- Connect the charger to the outlet and use a 'multitester' to measure the output voltage at the DC connector. Record this value.
- Connect the charger to CE140, and proceed with the calibration if you read a different voltage on the display.
- Press and hold the 'ON/OFF' button for 10 seconds to access the Calibration mode.
- While blinking, use short pulses on the 'ON/OFF' button to toggle/select either 'IN' or 'OUT' voltage. Select 'IN' to fine-tune the voltmeter that reads the voltage sent by the charger into CE140. Choose 'OUT' to adjust the voltmeter that reads the voltage sent by CE140 to the vehicle.
- Use the '+' and '-' buttons as needed to set the voltage value to match the charger's indicated output. Most chargers have a sticker displaying the output DC voltage. CE140 allows you to set it within the range of 90% to 110% of the auto-detected voltage value. CE140 is compatible with chargers that have outputs between 30 and 140VDC.
- Press and hold the 'ON/OFF' button for 10 seconds to exit the Calibration mode.

Notes: the ideal voltmeter calibration occurs when both voltages display a similar value under the condition of the charger being connected, the output 'ON/OFF' of CE140 is set to ON, and the device is not physically connected to the vehicle through the cable adapters yet (current at 0A ). Also, if you notice CE140 displays a lower IN voltage than the expected output from the charger, it may be totally normal. It is common practice in the industry that chargers deliver a slightly lower than expected voltage output.

## 2.5 Charging Codes

Charging Code	Code Meaning	Description
E00	Normal	Charge Enhancer is in standby mode.
E01	Manual Interruption	The "ON/OFF" button was pulsed to interrupt the charging process manually.
E02	Voltage Limit	After a preset voltage threshold was reached, the charging process is stopped automatically.
E03	Current Protection	The charging process was interrupted upon reaching the current protection limit.
E04	Temperature Protection	The charging process was interrupted due to high internal temperature.
E05	Charging Completed	The charging process concluded and has been stopped because the current is $< 300\text{mA}$ .
E06	Current Sensor Fault	The device has detected a problem when attempting to measure the current.
E07	MOS Fault	The device has detected problems attributed to a damaged internal transistor.

# 3 SPECIFICATIONS

Model	CE140
Voltage Range	DC 30-140
Current Range	DC 0-30 A
Voltage & Current Accuracy	±1%
Display	TFT LCD
Input Interface	XT60-M
Output Interface	XT60-F
Dimensions	95x72x26 mm
Weight (without cables & adapters)	175g
Humidity Operating Range	0-90%
Temperature Operating Range	-10 to 50 °C

## 4 SAFETY AND PRECAUTIONS

- Avoid exposing the device to rain or moisture; as the charger, CE140 should not be used in damp environments.
- When using Charger Enhancer, ensure connecting the plugs properly. Checking both, the current direction and the connectors fastened accordingly.
- Use only the provided cable and connector adapters. If requiring additional or different adapters, do not hesitate to contact PIDZOOM.
- During the charging process, the device case may become hot. Avoid direct contact to prevent burns, longtime direct sun exposure, as well as locating it over thick carpets, cushions, pillows or any material that can prevent it from cooling.
- Limiting the charging level can result in an increased battery lifespan. However, most batteries balance their cells voltage during the last step of the charging process . Balanced cells are needed to prevent premature failures. Therefore, if you adjust a lower level of charge by limiting the output voltage threshold to extend the battery lifespan, be aware of allowing a full cycle (100% charge level) every 20 cycles or at least every two months, to ensure your battery cells are properly balanced.
- As with any electronic device, avoid exposing it to crashes, falls or hits.
- Verify periodically the status of the cable adapters, and replace them if any insulation layer damage is noticed.
- Do not disassemble, modify or use the device for other than the intended use, without prior PIDZOOM authorization.

## 5 COMMON QUESTIONS

### Q1. How do I turn on the device?

Charger Enhancer activates automatically once a charger is plugged into its Input connector. The output ON/OFF button on the device is not related to powering Charger Enhancer; instead, it enables or disables the function of delivering energy through its output connector towards the vehicle.

### Q2. How do I reset the timer?

Charger Enhancer resets the counter automatically with each initiation of a new charging cycle. This occurs each time the input cable is reconnected to the Charger Enhancer or when the output cable is reconnected to the vehicle, and you press the output 'ON/OFF' button to start delivering energy to the vehicle again. Also, if you press the output 'ON/OFF' button to interrupt the charging process, the timer will reset to zero the next time you press it to continue, as it signifies the beginning of a new charging cycle.

### Q3. Why does the charger show no current (0A) when plugged into CE140?

As soon as CE140 is connected to a charger, it can measure its voltage (IN). However, to measure the current, energy needs to flow towards the vehicle. It is normal to read 0A until connecting CE140 to the vehicle or battery and pulsing the output "ON/OFF" button.

#### **Q4. How does Charger Enhancer adapt to chargers with different output voltages?**

Charger Enhancer autodetects the voltage of the charger as soon as it is connected to it. However, the user can fine-tune CE140's voltmeters if needed (see 2.4.5).

#### **Q5. Why does the display show different voltages when connected to one charger?**

The voltage value in front of 'IN' corresponds to the charger's output connected to Charger Enhancer's input port. It is the maximum voltage that can be delivered to the vehicle. The voltage value in front of 'SET' corresponds to the user-set output voltage threshold for its auto-disconnect feature.

#### **Q6. What value should I set for overcurrent protection?**

Check the output current value indicated on the label on the vehicle's original charger. Usually, a slightly higher value is recommended for the overcurrent protection feature, unless otherwise specified by the manufacturer.

#### **Q7. If I turn ON the output of Charger Enhancer, I read different IN and OUT voltages on the display despite Charger Enhancer not being connected to the vehicle yet. Is this normal?**

Ideally, both voltages should be similar. A slight difference is normal, but higher than 1V differences may suggest a voltmeter calibration is needed (see 2.4.5).

**Q8. I connected the charger and the vehicle to CE140, but it does not charge. What can be wrong?**

Check if the charger is plugged into the 'IN' connector of CE140, and the vehicle to the 'OUT' port. Verify you pressed the 'ON/OFF' output button to initiate the charging process.

**Q9. I started the charge but noticed I prefer to set CE140 to stop automatically at a lower voltage. Should I restart the process?**

Not at all. Use the SET button to adjust the output voltage threshold without needing to interrupt the charging process.

**Q10. I would like to make, with my 3D printer, a piece to attach Charger Enhancer to the charger. Is there a problem with it?**

Not at all. We do like this setup but it would be difficult to provide such piece since chargers vary in their dimensions. Charger Enhancer has built-in feet designed to provide space for airflow. As long as it is located on a flat surface, air flow will help cool it.

**Q11. Do I have to set up the overcurrent protection and output voltage threshold every time I charge?**

Not at all. Charger Enhancer remembers the settings for next time.

## **Q12. Can I measure the battery capacity of my vehicle or a battery pack?**

Yes. The capacity of a battery is typically specified in terms of ampere-hours (Ah) or watt-hours (Wh). Measuring the energy during the charging process can provide valuable information about the capacity of your vehicle's battery and its decay over time. However, be aware that the usable capacity of a battery might be less than the total capacity specified by the manufacturer, as some batteries should not be fully charged or discharged to maximize their lifespan. Therefore, it is advisable to measure with Charger Enhancer the effective battery capacity of your vehicle as close to its original status as possible to produce a reference value to compare with along the time. Simply use your vehicle until it drains its battery to its limit. Then, charge it with Charger Enhancer until the process is fully completed, and read the charging energy (Wh). In this case, the obtained value is equal to the effective battery capacity.



# 6 ADDITIONAL GUIDE

## 6.1 Voltage to Percentage Conversion

Lithium-ion batteries typically have a nominal voltage of around 3.7 volts per cell. Batteries are assembled in series to form packs, and these packs can be assembled in parallel to create larger batteries. To convert voltages into a percentage battery level, the number of cells in each pack (denoted as "s") is crucial.

### For example, with a 20s4p configuration:

- Nominal Voltage (average voltage that the cell outputs when fully charged):  
 $20 \text{ cells} \times 3.7 \text{ V/cell} = 74 \text{ V}$
- Fully Charged Voltage:  $20 \text{ cells} \times 4.2 \text{ V/cell} = 84 \text{ V}$

The State of Charge (SOC) refers to the amount of usable energy stored in a battery relative to its full capacity, designed by the manufacturer applying safety margins depending on the purpose of use of the vehicle. SOC is typically expressed as a percentage, ranging from 0% (fully discharged) to 100% (fully charged). The linear relationship between voltage and state of charge (SOC) is a common approximation for simplicity and, unless you have more specific information from the vehicle's manufacturer, it is common to assume anything below 3.125V as 0% and anything above 4.125v as 100%. The formula allows for a conversion based on the measured voltage:

$$\text{SOC} = (\text{Voltage} - 3.125) / (4.125 - 3.125)$$

Applying this criteria, the next chart is provided as a general guide to help assign the output voltage threshold of Charger Enhancer to automatically stop the charging process at an approximate percentage of charge, depending on your lithium-ion battery pack configuration.

<b>Full voltage (V)</b>	67.2	84.0	100.8	126.0	134.4	142.8	151.2
<b>Nominal voltage (V)</b>	59.2	72.0	88.8	111.0	118.4	125.8	133.2
<b>Pack configuration</b>	16s	20s	24s	30s	32s	34s	36s
<b>SOC (%)</b>	<b>Voltage (V)</b>						
<b>100%</b>	66.0	82.5	99.0	123.75	132.00	140.8	148.5
<b>80%</b>	62.8	78.5	94.2	117.75	125.6	133.45	141.3
<b>60%</b>	59.6	74.5	89.4	111.75	119.2	126.65	134.1
<b>40%</b>	56.4	70.5	84.6	105.75	112.8	119.85	126.9
<b>20%</b>	53.2	66.5	79.8	99.75	106.4	113.05	119.7
<b>10%</b>	51.6	64.5	77.4	96.75	103.2	109.65	116.1

Please note that this is a general estimate, and the actual state of charge (%) for your vehicle may vary.

## **7 WARRANTY**

This product is covered by a one-year warranty from the date of purchase against manufacturing defects. Please retain the proof of purchase document and contact us if you have any questions.

## **8 CONTACT**

Please reach out to us at [support@pidzoom.com](mailto:support@pidzoom.com) for help.



***PIDZOOM***

[www.pidzoom.com](http://www.pidzoom.com)