VIATEC

SMARTPTO

OPERATION MANUAL

Viatec SmartPTO – Document #: OPS-003-A01
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TABLE OF CONTENTS

1.0 INTRODUCTION AND SPECIFICATIONS

The VIATEC SmartPTO is world's first ever fully electric, universal, power take-off (PTO) unit that eliminates the need for idling by utility trucks. The SmartPTO is a quiet, environmentally-friendly, energy efficient power take-off, which can be used to power a truck-mounted hydraulic boom and an optional electric cab air conditioner simultaneously.

The SmartPTO is non-intrusive and can be mounted in the rear bed of the vehicle or it can be cabinet or chassis mounted. The easily connected hydraulic interface is compatible with open-center and closed-center hydraulics and is ideally suited for higher power and higher energy applications.

1.1. Terms and Abbreviations

Acronym/Term	Definition
AC	Alternating Current
BMS	Battery Management System
DC	Direct Current
GPM	Gallons per Minute
kW / kWh	Kilowatt / Kilowatt Hours
IPM-AC	Interior Permanent Magnet-Alternating Current (Motor)
Li-NMC	Lithium-Nickel Manganese Cobalt
Nm	Newton Meter (unit of torque)
Psi	Pounds per square inch (pressure)
SOC	State of Charge

1.2. System Specifications:

Please refer to the latest content on our website: www.viatec.us

2.0 NOTES, CAUTIONS, AND WARNINGS

This document contains embedded Notes, Cautions, and Warnings to convey important information to the reader. The use of each of these messages is defined in the following sections.

2.1. Notes

Notes are used to emphasize important information by visually distinguishing it from the rest of the text. Notes can contain any type of information except safety information, which must always be placed in cautions or warnings. The terms "Notice" and "Important" may be used in some instances to replace "Note".

Example:

Note: In all VIATEC manuals, notes point out something of special interest or importance to the reader. Failure to read the note will not result in physical harm to the reader, equipment, or data.

2.2. Cautions

Cautions draw special attention to anything that could damage equipment or cause the loss of data. The caution will describe what could happen if the caution is ignored.

Cautions will be placed before, or with the step it applies to. An 'attention' icon will be located beside a caution.

Example:

CAUTION! Do not turn the monitor off by unplugging it from the computer or wall socket. Severe damage to the monitor may result. Turn the monitor off before unplugging it.

2.3. Warnings

Warnings draw special attention to anything that could injure or kill the reader. Like cautions, they are always placed before, or with the step in the procedure they relate to, and are used with the 'attention' icon.

Example:

WARNING! Unplug the computer before removing the outer case. If you don't, severe electrical shock may result.

3.0 SAFETY

Provides critical safety information pertaining to the use of the vehicle.

- High-Voltage Safety
- Hydraulic System Safety
- Emergency Shutdown

3.1. High-Voltage Safety

3.1.1. Electrical Shock Hazard

The SmartPTO utilizes a direct current (DC) energy storage and power distribution system which typically operates at 120 volts. An electrocution hazard exists if humans come in contact with parts of this system.

3.1.2. Arc Flash Hazard

The energy storage system is capable of releasing large amounts of electrical energy which may result in a DC arc-flash event.

3.1.3. Fire Hazard

The energy storage system on this unit may contain substantial quantities of lithium, but there is no metallic lithium in a Viatec battery pack. You can use standard ABC fire extinguishers or water to put out a battery fire. You do not need to use a special Class D fire extinguisher for metal fires.

Do not attempt to extinguish a lithium-containing fire without correct personal protective equipment as hot metals may be ejected from the battery module.

All access and servicing of this unit must be performed by properly trained and qualified personnel who are equipped with personal protective equipment (PPE) appropriate to the task at hand.

3.1.4. High-Voltage Safety Basics

The following provides very basic high-voltage safety information and is not intended to be all-inclusive. Follow all required high-voltage safety precautions and your site-specific high-voltage safety procedures.

Some important High-Voltage Rules-of-Thumb:

- You MUST be trained and qualified in Lockout/Tagout and Arc Flash to work on high-voltage systems.
- Take refresher training to keep up with changes to high-voltage safety procedures and tools. Know the emergency procedures to follow in case of an accident.
- Understand the high-voltage system you are working on!
- If you don't know, or if you are the least bit unsure, ASK QUESTIONS!
- **Remember**.....a live circuit looks exactly like a dead circuit.
- Always assume the color orange means high-voltage!
- It is infinitely safer to work with high-voltage disconnected than with it on!
- NEVER assume the absence of high-voltage.
- ALWAYS test your voltage meter and then test for voltage before working on a high-voltage system!
  Remember ... "*Test before you touch*"!
- Turn off high-voltage power sources before connecting alligator clips to any circuit.
- Do NOT hold the test probe when circuits over 300 volts are tested.
- Do NOT work with high-voltage by yourself; have another person (a safety observer), present at all times. This individual, stationed nearby, should also know the circuits and location of the switches controlling the equipment, and should be given instructions to pull the switch immediately if anything unforeseen happens.

Figure 1. *Typical High-Voltage Warning Decals*

3.2. Hydraulic System Safety

The SmartPTO connects to the vehicle hydraulic system to operate the outriggers and to raise, lower, and maneuver the overhead boom. If the vehicle is configured with hydraulic connections to operate hydraulic tools or implements, this unit supplies the required hydraulic pressure.

The SmartPTO hydraulic system is capable of up to 3988 psi, adjusted down to the maximum operating pressure of the truck's hydraulic system. At this pressure, a fluid leak in the system could create a fluid flow rate of approximately 600 feet-per-second. A punctured, failed, or unintentionally disconnected hydraulic hose could cause contusions, abrasions, or lacerations from whipping hoses or ejected parts. The fluid itself can cause burns, or worse, high-pressure fluid injection into soft tissue requiring major surgery. During operation a failed hydraulic system component may result in crush hazards or possible dismemberment due to sudden and unexpected movement.

3.3. Emergency Shutdown

In case of emergency, the SmartPTO can be immediately shut down with all hydraulics and electronics disabled by pressing the Emergency Stop button located on the SmartPTO Control Panel.

Figure 2. *SmartPTO Emergency Stop Location*

Note: The Control Panel location and layout may be different than shown, based on the type of bracket used to integrate the Control Panel on the vehicle.

4.0 PRE-USE ACTIVITIES

- Thoroughly review and understand information provided in this operator's manual with particular attention given to safety procedures.
- Prior to use, always inspect hydraulic hoses and fittings for defects or leaks and to assure they are securely attached at connection points.
- If any portion of the hydraulic system fails inspection, immediately notify your supervisor or maintenance and remove the equipment from service.
- Annual hydraulic equipment training should be required and should include discussion of the SmartPTO hydraulic systems.

4.1. Operating Precautions

- Before operating equipment using the SmartPTO, visually confirm that people and obstructions are clear.
- Never walk beneath any component, attachment, implement, or tool that is supported by hydraulics.
- Always shut the SmartPTO off and relieve all hydraulic pressure before disconnecting hydraulic hoses or performing maintenance or repairs.
- Prior to performing any maintenance, repairs, or tool swaps, always use supports, jacks, stands, or blocks to prevent movement of hydraulic implements or components.
- When hydraulic systems are operating, hydraulic fluid temperatures can reach 185°F due to the high pressure and represent a potential burn hazard.
- Hydraulic oil is a fire hazard and when ignited can cause severe burns or fatalities.
- Never search for a leak by running your hand or finger along a hydraulic hose. Hot hydraulic oil at high pressure can penetrate gloves and be injected several inches into soft tissue. Major surgery will be required to remove hydraulic oil injected into tissue.
- If necessary, use a piece of cardboard or wood to search for pinhole leaks.
- Always lower hydraulic components to the ground before shutting off the SmartPTO.

4.2. Operational Limitations

The SmartPTO is designed to withstand normal operational treatment, but should be used within the following operational parameters:

- Never exceed the maximum load capacity of the overhead boom.
- Never move the vehicle without the overhead boom being fully secured in the down position.
- Do not operate on steep grades in a position other than climbing or descending vertically.
- Do not operate the SmartPTO in conditions where it could become submerged in water.

5.0 CONTROLS OVERVIEW

The SmartPTO operation is controlled primarily through the Main Control Panel, although some operations (such as deploying the outriggers and operating the boom) will be controlled through the independent truck-mounted operations panel(s). An example of the Main Control Panel location is shown below:

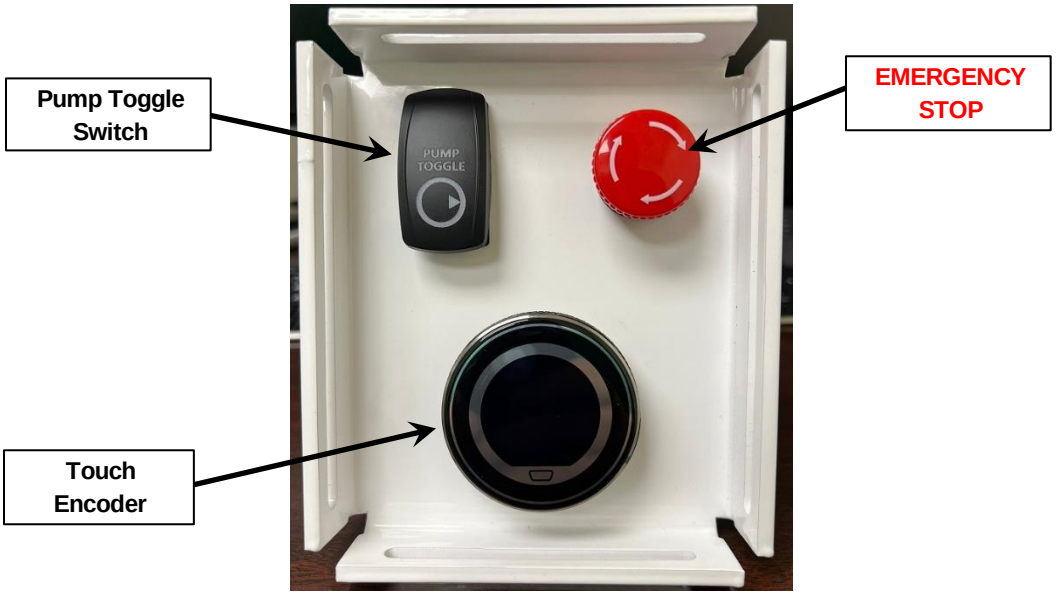


Figure 3. *Typical SmartPTO Main Control Panel Components*

Truck-mounted control panels will function in the same manner as when using the truck engine to provide hydraulic pressure. For most trucks you can easily switch between the SmartPTO or the engine. For some trucks, it may be required to cycle the ignition switch in the cab to restart the SmartPTO after the engine has been started. Some typical truck-mounted operations panels are shown below.

Typical Truck-Mounted Operations Panels

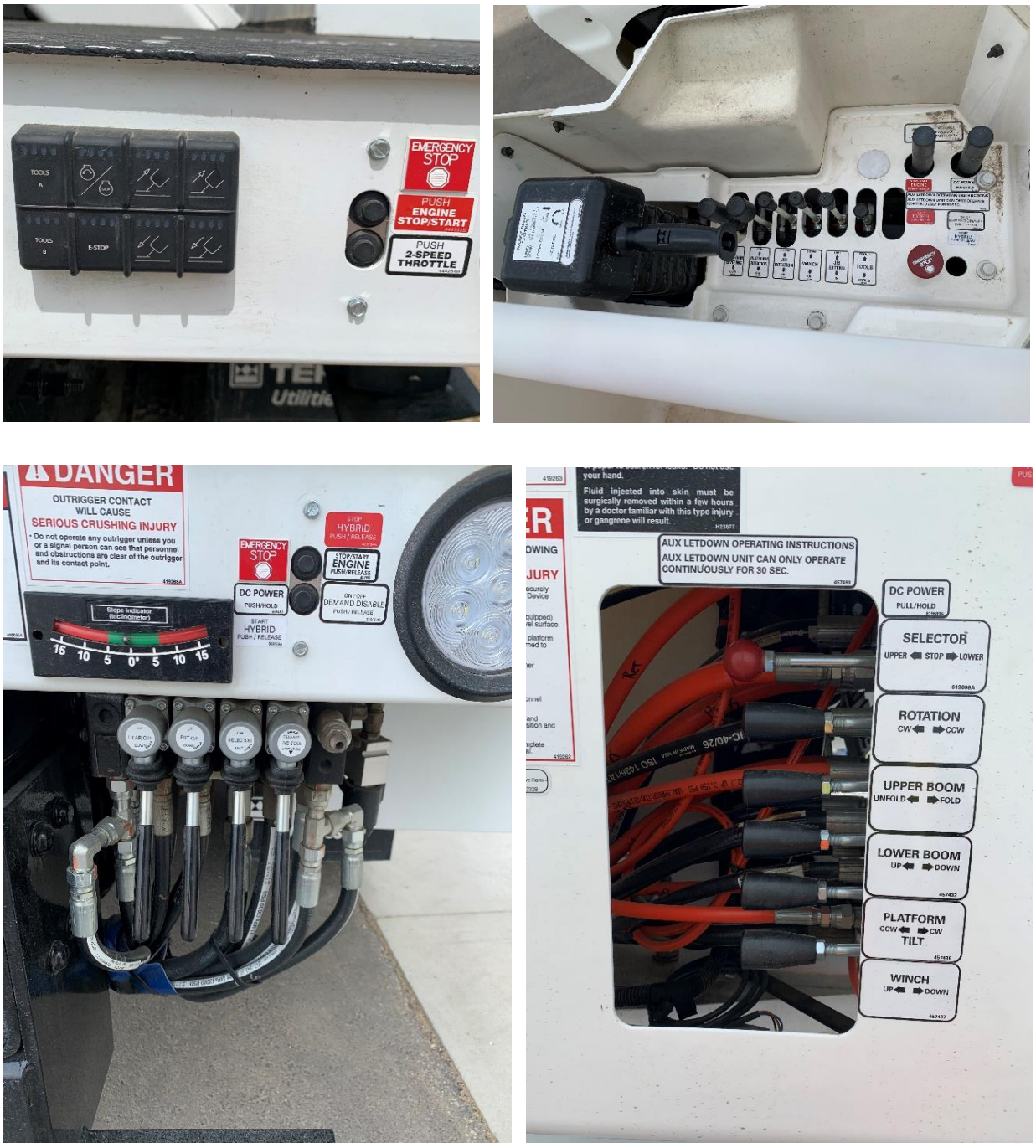


Figure 4. *Typical Truck-Mounted Operations Panels*

5.1. SmartPTO Controls

The SmartPTO Main Control Panel consists of a Pump Toggle switch, Emergency Stop pushbutton, and Touch Encoder.

5.1.1. Pump Toggle Switch

The Pump Toggle Switch is used to turn the SmartPTO system either ON or OFF depending on the current operational status. When the SmartPTO is powered up and ready to operate, the Pump Toggle switch will be illuminated.

- When the system is powered and the hydraulic pump is not running: PRESS and HOLD the switch for two seconds to activate the hydraulic system.
- When the system is powered and the hydraulic pump is running: PRESS and HOLD the switch for two seconds to deactivate the hydraulic system.

Figure 5. *Pump Toggle Switch*

5.1.2. Emergency Stop Pushbutton

The Emergency Stop Pushbutton (E STOP) is used to immediately shut down the SmartPTO system in case of emergency.

- In case of emergency: PRESS to immediately shut down the SmartPTO system.
- To reset the Emergency Stop: TWIST clockwise and PULL outward to allow the pushbutton to return to the OUT (reset) position.

5.1.3. Touch Encoder

During operation of the SmartPTO, the Touch Encoder will display the "Pump Status" screen (below). This is the default screen for the Touch Encoder display. When the hydraulic pump is activated using the Pump Toggle switch, the Pump Status screen shows operational status of the unit. The Screen Selector Ring can be used to switch to the other main screens, and the display will return to the Pump Status screen after a brief time.

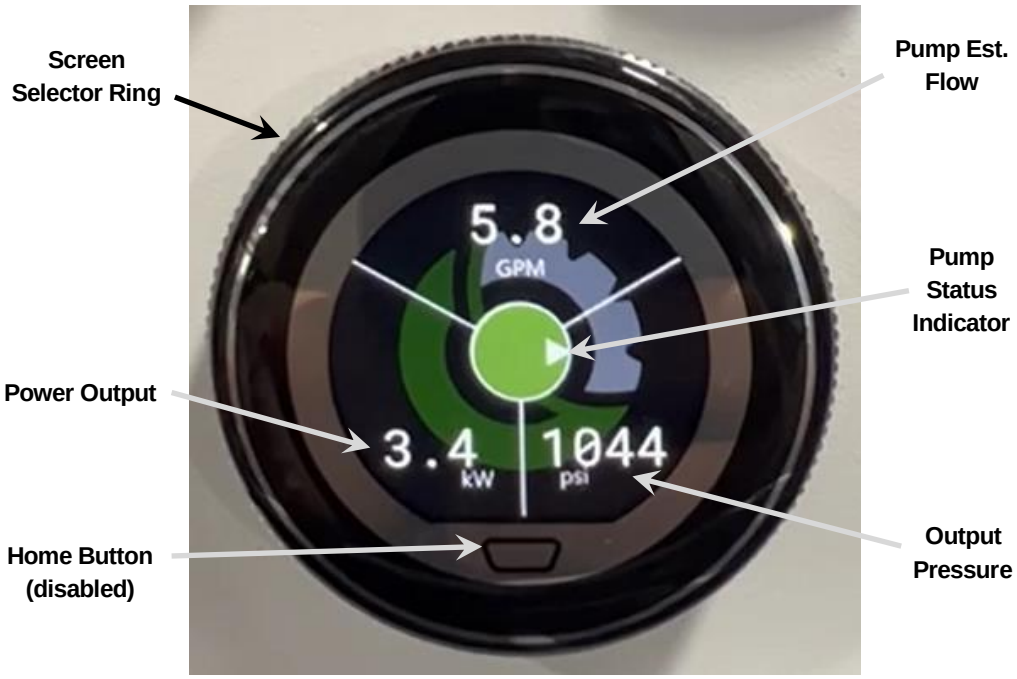


Figure 6. *Touch Encoder – Pump Status Screen*

When the Pump Toggle switch is pressed and held to start the hydraulic pump, the Touch Encoder will initially display the Pump Requested screen and then switch to the Pump Running screen when the pump activates.

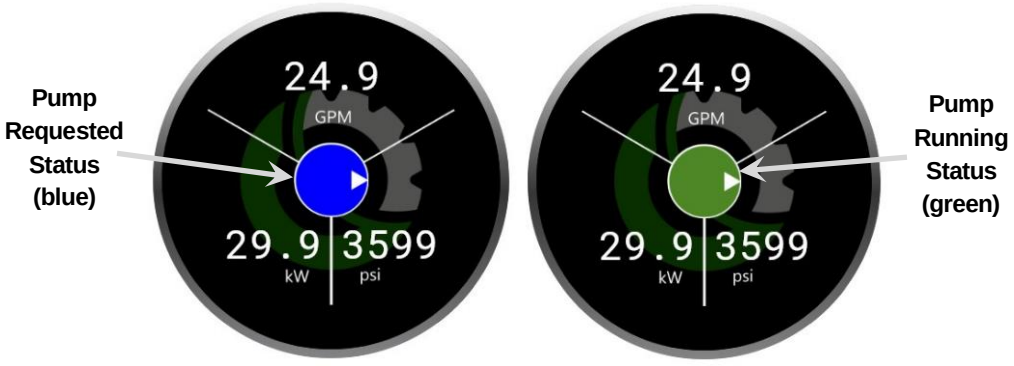


Figure 7. *Pump Requested and Pump Running Screens*

If faults are preventing the pump from starting, the screen will display a fault status.

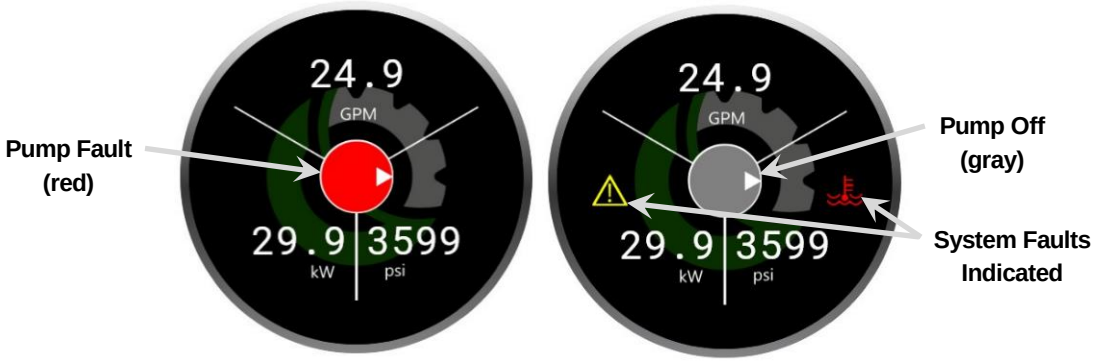


Figure 8. *Pump Fault Screens*

When the SmartPTO is plugged in to charge, the Touch Encoder display will switch to the “Charging” screen (below) which shows the estimated charging time remaining for the unit to be fully charged. The Screen Selector Ring can be used to switch to the other main screens, and the display will return to the Charging screen after a brief time when the unit is charging.

Figure 9. *Touch Encoder – Charging Screen*

6.0 Touch Encoder Selectable Data Screens

The Touch Encoder Screen Selector Ring is used to cycle through the five main data screens:

- HOME
- USE
- TEMPS
- FAULTS
- INFO

Figure 10. *Touch Encoder Screen Selector Ring and Display Area*

When powered ON, the SmartPTO will briefly display the “Splash” or logo screen, followed by the “HOME” Screen (below).

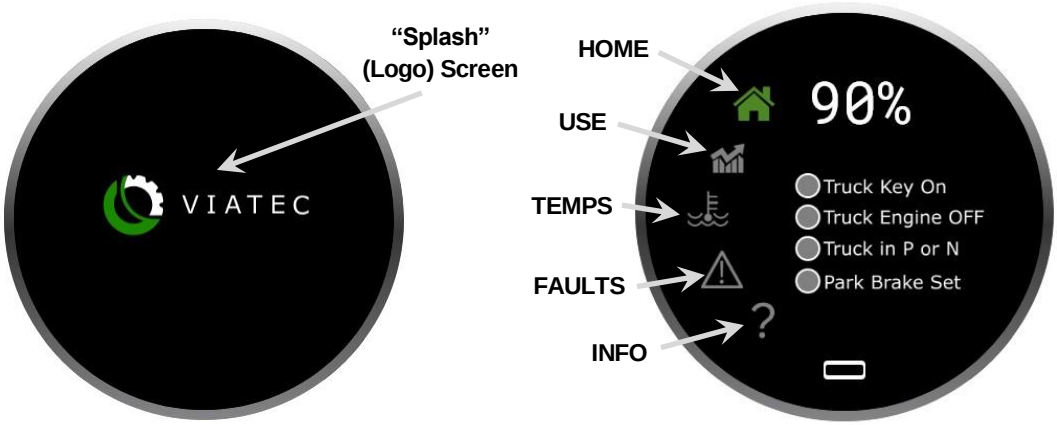


Figure 11. *Touch Encoder – “Splash” (Logo) Screen and Home Screen Display*

The indicators, icons, and screen selections which can be displayed on the Touch Encoder are identified in the following sections.

6.1.  Home Screen Display

6.1.1. Battery State-of-Charge (SOC)

The Battery State-of-Charge (SOC) readout displays the percentage of battery energy remaining in the battery pack.

6.1.2. Truck Key On

Indicates the status of the vehicle Ignition Switch. The indicator will switch from Gray to Green when status is “active”.

6.1.3. Truck Engine OFF

Indicates the status of the vehicle engine. The indicator will switch from Gray to Green when status is “active”.

6.1.4. Truck in P or N

Indicates the status of the vehicle transmission. The indicator will switch from Gray to Green when status is “active”.

6.1.5. Park Brake Set

Indicates the status of the vehicle Park Brake. The indicator will switch from Gray to Green when status is “active”.

6.2.  USE Screen Display

6.2.1. hrs Sys ON

Indicates total hours the SmartPTO is powered on and ready to operate.

6.2.2. hrs Idle Elim

Indicates total hours of engine idling eliminated by using SmartPTO.

6.2.3. kWh Used

Indicates total kilowatt hours of energy used by the SmartPTO.

6.2.4. gal Est. Saved

Indicates estimated gallons of fuel saved by using SmartPTO.

6.2.5. hrs Pump

Indicates total hours the hydraulic pump has been running.

6.3.  TEMPS Screen Display

6.3.1. Motor

Indicates current Motor temperature reading in degrees Celsius.

6.3.2. Controller

Indicates current Controller temperature reading in degrees Celsius.

6.3.3. Batt Lowest

Indicates lowest battery temperature reading in degrees Celsius.

6.3.4. Batt Highest

Indicates highest battery temperature reading in degrees Celsius.

6.3.5. Sys ECU

Indicates current System ECU temperature reading in degrees Celsius.

6.3.6. Oil

Indicates current hydraulic oil temperature reading in degrees Celsius.

6.4.  FAULTS Screen Display

6.4.1. PT Err Code-

Displays a Powertrain Error Code number if there is a Powertrain fault.

6.4.2. Batt Fault

Indicates a Battery Fault with Battery Module 1.

6.4.3. Batt Fault

Indicates a Battery Fault with Battery Module 2.

6.4.4. SPTO Fault

Indicates a SmartPTO Fault has occurred.

6.5. INFO Screen Display

6.5.1. SN:

SN:PT3-012 Displays the SmartPTO unit Serial Number (SN).

6.5.2. SW Version:

SW Version:R01.23.45 Displays the software version currently running on the SmartPTO.

6.5.3. IQAN Connect Key

IQAN Connect Key WIUY876G Displays the key number used to connect to the Telematics Gateway inside the SmartPTO.

6.5.4. Viatec Contact Information

833-4-VIATEC viatec.us/support Displays the Viatec Contact phone number and support email address.

7.0 SMARTPTO STATE-OF-CHARGE (SOC) ALARM BUZZER

During normal operation (SmartPTO is active, the vehicle is keyed On with the vehicle engine Off, and SmartPTO not plugged in for charging) the SmartPTO utilizes an alarm buzzer to notify the operator when the battery state-of-charge (SOC) is getting low. When the SOC falls below 10%, the alarm buzzer is activated and will sound for 2 seconds and then stay quiet for the "% of SOC" seconds as the state of charge decreases. Initially, the alarm will sound for 2 seconds and then stay quiet for 9 seconds. As the SOC continues to decrease the alarm will sound more frequently until SOC reaches approximately 1%, when it will be sounding for 2 seconds and quiet for 1 second.

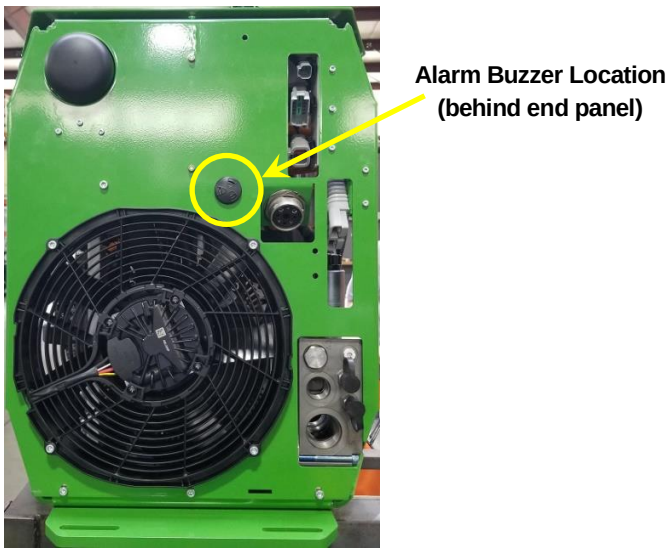


Figure 12. *Alarm Buzzer Location (End Panel Removed)*

8.0 SMARTPTO LED ARRAY INTERPRETATION

The SmartPTO enclosure has two LED Arrays located on the upper sloped front and rear surface. This location allows the LEDs to be viewed from the ground or from the bucket. Both LED Arrays provide the same status information.

Figure 13. *LED Arrays*

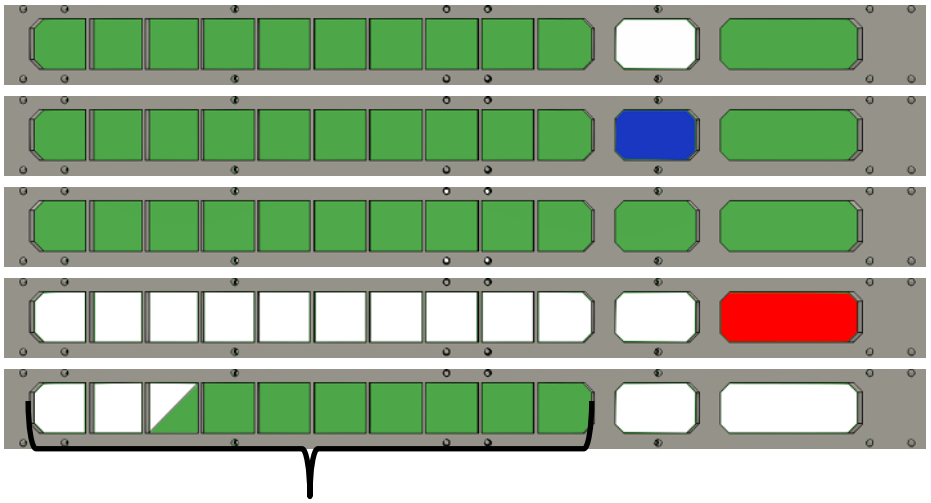


Figure 14. *LED Light Interpretation*

9.0 OPERATION

The following sections describe how to properly power up, perform functional checks and operate the SmartPTO Unit.

9.1. Power On at Work Site

To properly turn on power and energize the SmartPTO, perform the following:

Step 1. Turn off the vehicle ignition and allow the engine to stop running. After the engine is shut down, turn the ignition key back to the ON position, without starting the engine.
Note: This allows all accessory equipment (strobes, work lights, etc.) to operate normally.

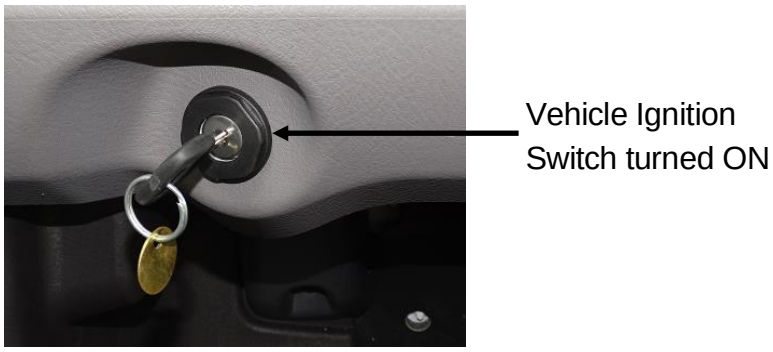


Figure 15. *Vehicle Ignition Turned ON*

Step 2. Ensure the vehicle PTO switch is enabled prior to exiting the cab.
Note: Some installations require using the dash-mounted display to activate the SmartPTO, shown as the *Alternate Activation Method*.

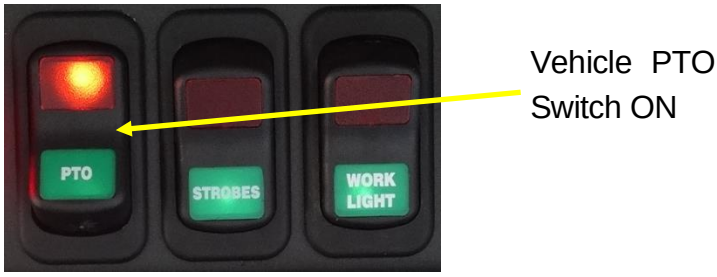


Figure 16. *Vehicle PTO Switch ON (Method 1)*

Alternate Activation Method:
Turn ON the PTO pressing the PTO button on the dash-mounted display.

System OFF - "Detected" **System ON - "E-PTO" Pump On**

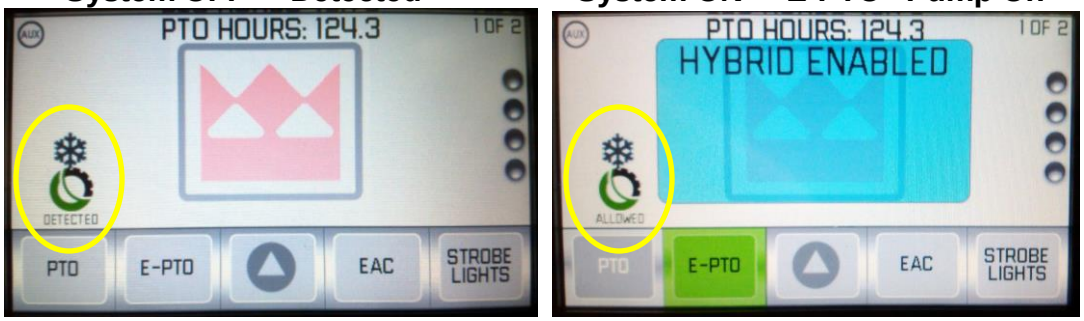


Figure 17. *Vehicle PTO Switch ON (Alternate Method)*

The dash-mounted display screen will change based on the SmartyPTO status:

A. The "Viatec" Logo will change from "Detected" to "Allowed" if the engine is off, indicating that the SmartPTO system is ready. The "HYBRID ENABLED" box also activates and flashes on and off on the display screen. If the SmartPTO "Detected" is not present, the system is likely disabled at the Emergency Stop located on the SmartPTO Control Panel.

B. Once "Allowed", the system will start to charge the chassis batteries, indicated by the screen's Voltage measurement increasing to approximately 13.5V.

Step 3. Ensure the Emergency Stop pushbutton is reset on the SmartPTO Control Panel. To reset the Emergency Stop, TWIST clockwise and PULL outward to allow the pushbutton to return to the OUT (reset) position.

Figure 18. *SmartPTO Emergency Stop*

Step 4. Press and HOLD the Pump Toggle switch for 2 seconds to activate the SmartPTO hydraulic pump. When the hydraulic pump is activated, the Touch Encoder display will switch to the “Pump Status” screen (below) which shows operational status of the unit. Verify the Pump GPM and the Pump Pressure on the Touch Encoder display.

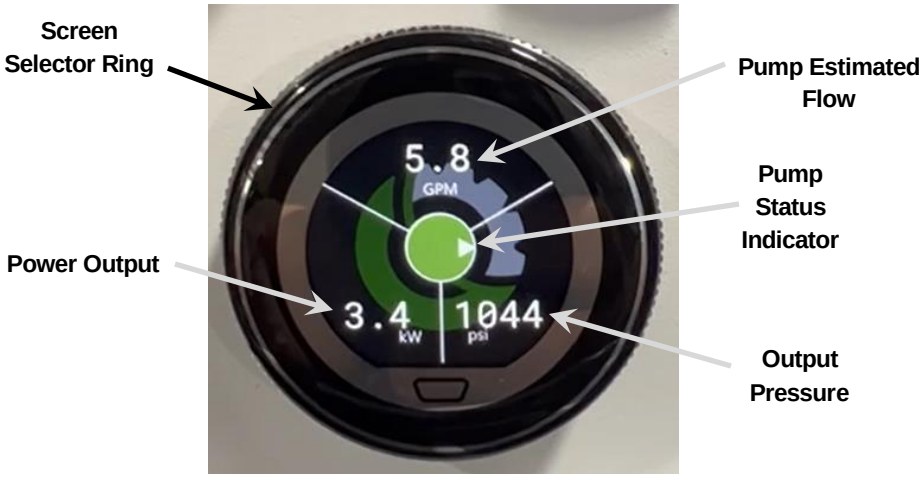


Figure 19. *Touch Encoder – Pump Status Screen*

Step 5. Rotate the Touch Encoder screen selector ring to access the HOME screen and verify the Battery State-of-Charge percentage on the Touch Encoder display.

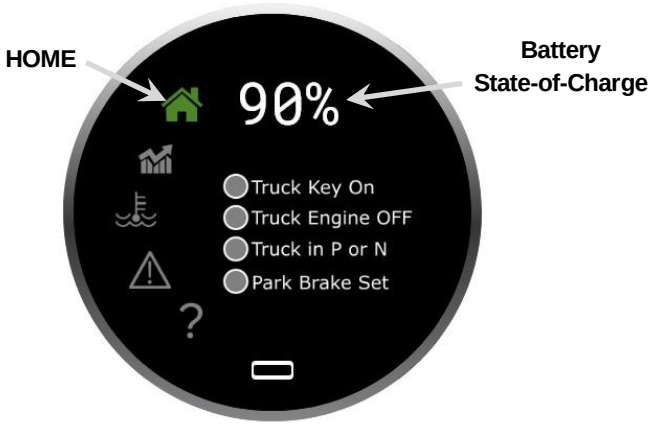


Figure 20. *SmartPTO Touch Encoder Display – HOME Screen*

Step 6. Deploy the vehicle Outriggers per normal operational sequence.

Figure 21. *Typical Outrigger Deployment*

Step 7. Switch to overhead boom and operate the overhead boom per normal operational sequence.

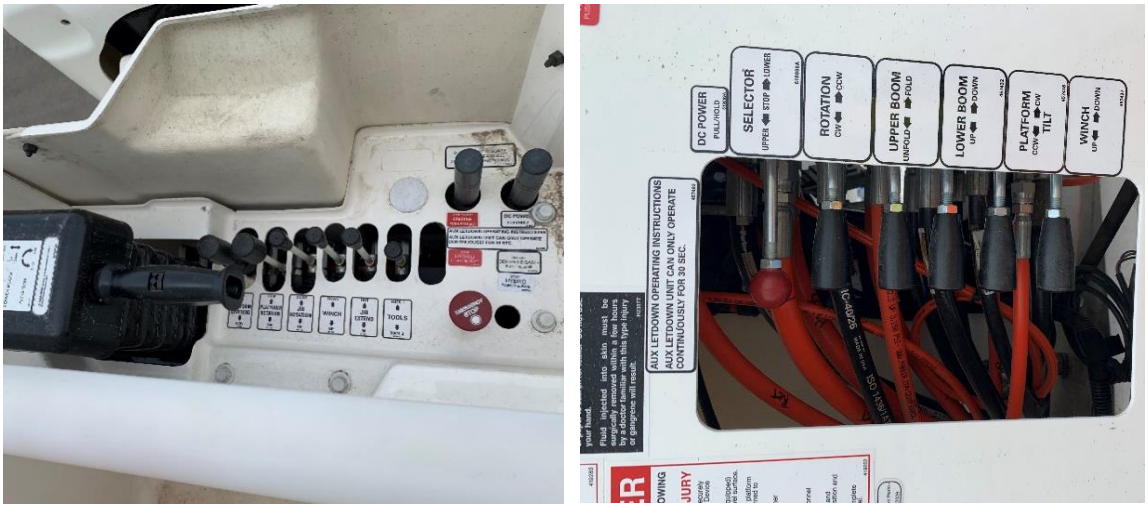


Figure 22. *Typical Overhead Boom Operations Panel*

9.1.1. **Operations from the overhead boom bucket:**

- To switch from SmartPTO to diesel engine for hydraulics operation, press the STOP HYBRID plunger and release (also labeled “Stop/ Start Engine”), to disable SmartPTO and restart truck engine

- To switch from diesel engine to SmartPTO for hydraulics operation, press and release the STOP/ START ENGINE plunger, and then press the START HYBRID plunger and release to enable SmartPTO for hydraulic system operation.

Figure 23. *Typical Bucket Mounted Engine Start-Stop Controls*

9.1.2. Turning off the SmartPTO:

Step 1. Stow the Overhead Boom per normal operational sequence.

Step 2. Stow the vehicle Outriggers per normal operational sequence.

CAUTION! Shut off the SmartPTO Pump as soon as possible after retracting the outriggers.

Figure 24. *Typical Outrigger Operation*

Step 3. Access the SmartPTO Control Panel and PRESS and HOLD the Pump Toggle switch for 2 seconds to turn OFF the hydraulic system.
Note: Verify Pump GPM has dropped to 0 (zero).

Figure 25. *Pump Toggle Switch*

Note: Operating the SmartPTO Powertrain for 10 minutes AFTER completing operations can easily waste 10% or more of the system available energy (depending on hydraulic system load).

Step 4. Disable the vehicle PTO control switch/display button, if desired.

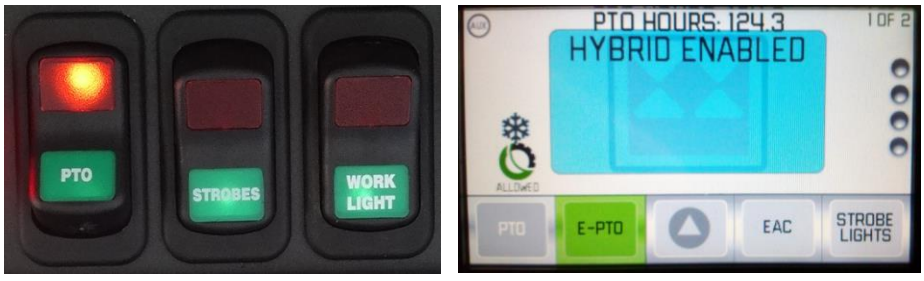


Figure 26. *Cab PTO Switch/Display*

Step 5. Operate the vehicle per normal operating procedures.

9.2. Recommended Functional Checks

After allowing the SmartPTO to power up and complete startup status checks, perform the following operational function checks prior to operating the SmartPTO system.

- **Battery System Status**

  On the Touch Encoder Display, verify the status of the SmartPTO system State of Charge (SOC) on the HOME screen.

- **Hydraulic System Status**

  On the Touch Encoder Display, verify the status of the hydraulic system. Use the Pump Toggle switch to turn the hydraulic pump on and ensure that pump GPMs and hydraulic pressure are in the proper operational range.

9.3. Hydraulic Output Panel

The truck-mounted hydraulic output panel, if provided, supplies hydraulic connections for external tools and equipment. With the SmartPTO in operation, this hydraulics output panel can be used per normal operation.

Figure 27. *Typical Truck-Mounted Hydraulic Output Panel and Switch*

10.0 CHARGING THE SMARTPTO SYSTEM

Charging the SmartPTO System is as simple as plugging the SmartPTO charge connection into a properly rated 120-Volt outlet. Plug into the SmartPTO charging connection using a properly rated electrical cord. The cord should be rated for a minimum of 15 Amps continuous draw. The SmartPTO will draw approximately 10-11 Amps for the duration of the charge cycle.

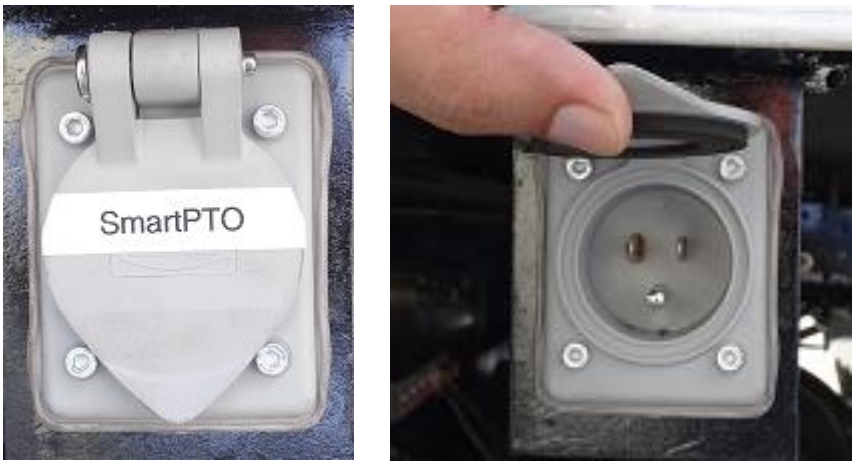
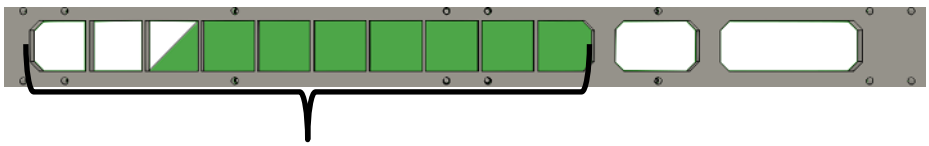


Figure 28. *SmartPTO Charge Connection*

WARNING! Using an improperly rated electrical cord could cause the cord to heat up, melt, or start a fire.

When charging, the SmartPTO LED Array will be activated to indicate charging and the battery state-of-charge can be monitored. Each segment indicates a 10% increment in the battery state-of-charge. The segment will switch from “flashing” to solid when that 10% has completed and the next 10% segment will begin “flashing”. The image below indicates the unit is at least at 70% state-of-charge and the “flashing” (half) segment indicates the charger is working to bring the state-of-charge from 70% to 80%.



LED Array – System Charging 10% per Block

Charging Status 10% per Segment (flashing block indicates current charging level, solid block indicates completed percentage)

Figure 29. *LED Light Interpretation when Charging*

10.1. Optional Level 2 Charging (J1772 EVSE, 240-Volt)

Charging the SmartPTO System using the optional J1772 EVSE Charge Receptacle (Level 2 Charging) requires availability of a Level 2 Charger with a J1772 Charging Connector. This connector type is required to properly connect to and communicate with the optional internal SmartPTO Fast Charger.

Figure 30. *SmartPTO J1772 EVSE (Level 2) Charge Receptacle*

WARNING! Using an improperly rated electrical cord/cable could cause the cord/cable to heat up, melt, or start a fire.

Step 1. Plug into the SmartPX J1772 EVSE (Level 2) charging port using a properly rated J1772 Charging Connector.

Figure 31. *Connecting to J1772 EVSE (Level 2) Charge Receptacle*

Step 2. Press and HOLD the Fast Charge “Start” button to initiate the charge session.

Fast Charge “Start” Button

Figure 32. *Fast Charge “Start” Button*

Step 3. Verify the unit is charging by checking the Touch Encoder Display or by monitoring the LED Array.

11.0 IMPORTANT GUIDELINES FOR CHARGING AND OPERATION

The SmartPTO's robust design can operate under all normal temperatures and environmental conditions. Nevertheless, lithium-ion batteries, such as those used in the SmartPTO battery pack, will wear based on usage and time. Aging may be accelerated by high temperatures and long-term storage of the battery pack at a high state-of-charge (SOC). To maximize the life of the SmartPTO battery pack and support worry free operation of your SmartPTO, VIATEC has established the following guidelines for proper charging and operation.

11.1. Charging and Storage

To maximize the life or your SmartPTO battery pack and maintain healthy batteries, it is important to follow these guidelines:

- Once your SmartPTO has been charging for 24 hours, we recommend that you disconnect the charger. The battery pack will self-discharge extremely slowly over time. If the SmartPTO has not been operated for a while and it requires topping off to 100% SOC, plug the SmartPTO into an outlet for a few hours. Unplugging the SmartPTO when not needed ensures the best long-term health of your SmartPTO battery pack.

CAUTION! Never store your SmartPTO at a low state of charge (below 30%). Leaving the SmartPTO battery pack at a low state of charge for a prolonged period could damage it and void your warranty.

- For long term storage (>30 days) of your SmartPTO, you should reduce its state of charge to approximately 60% prior to storage. Do not keep it connected to an outlet. The battery pack will self-discharge slowly over time. Monthly, the state of charge should be checked and if it falls below the lower storage limit of 30% state of charge, it is recommended to charge the battery pack up to the upper limit of 60%. When ready to remove your SmartPTO from storage, charge the battery pack for 24 hours to ensure optimal battery balance is restored. *Reference the table on Environmental Conditions for additional parameters.*
- To ensure optimal performance of your SmartPTO over its lifetime, be certain that the SmartPTO firmware is up to date. If you have questions, please contact VIATEC Customer Service.

11.2. Cold Weather Operation

Cold weather (< +10°C (+50°F)) operation of the SmartPTO has no permanent impact on its battery pack. However, the operator may notice a temporary reduction in power and operating time due to the effect cold temperatures have on the amount of energy the battery pack can release. The colder the weather, the greater the effects on the SmartPTO battery pack.

Hydraulic fluids are also affected by temperature and lower fluid temperatures also can increase energy usage drain on the system.

11.3. Hot Weather Operation

Hot weather (> +35°C (+95°F)) should not result in any noticeable SmartPTO performance changes. However, should the battery pack temperature rise above the upper operational limit, the operator may notice a temporary reduction in power.

Note: The Battery Management System (BMS) will not allow SmartPTO operation and its associated battery pack discharge above a battery pack temperature of 60°C (140°F).

Also, for battery pack temperatures greater than 43°C (109°F), the SmartPTO charger will reduce the available charge current to the battery pack, increasing charge time accordingly. The hotter the ambient temperature, the greater the effects on the SmartPTO battery pack.

11.4. Environmental Conditions

Full performance temperature range for SmartPTO system:	+10°C (+50°F) to +40°C (+104°F) Ambient
All functionality for operation is maintained:	-20°C (-4°F) to +50°C (+122°F) battery pack temperature
All functionality for charging is maintained:	0°C (+32°F) to +50°C (+122°F) battery pack temperature
SmartPTO operation is prevented at battery pack temperature:	Below -20°C (-4°F) and above +60°C (140°F)
Recommended SmartPTO storage temperature range:	-20°C (-4°F) to +35°C (95°F) Ambient