Welcome to Vonnen Shadow Drive!
Congratulations on your purchase of the Vonnen Shadow Drive system for your Porsche! This document is a brief explanation of the Shadow Drive Performance Hybrid system, and how to experience it at its full potential. The system is designed and engineered to integrate perfectly with your OEM engine and drivetrain and increase the overall driving experience, by slotting the electric motor between the engine and transaxle, and supporting that motor with a powerful battery and intuitive controls. The liquid-cooled Shadow Drive eMotor delivers a serious punch of additional torque from idle through redline. Let's dive right in and learn more about the important specifics of the system that as a new owner you should become familiar with.

Quick Start:
Download App in Apple App Store
Connect Via Bluetooth
Select mode and drive!

Getting Started:
The first step is you'll need to download the Vonnen Shadow Drive App, available in the Apple App Store [*Android version not available at this time*] to then connect via Bluetooth to the VSD controller. To connect, simply cycle the ignition key to wake the system up. You'll see the settings gear icon in the top left corner: click this button and connect to the VSD Bluetooth transmitter shown there. Once connected you will see just how simple the interface is: 2 sweeping gauge readouts for Torque and Power, 1 main power on/off button directly in the center, and the 3 drive mode buttons for Stealth, Sport, and Overboost. At the bottom is a system capacity bar that can be expanded for a detailed view of the status of the primary components. See images at the end of this document. We'll give a rundown of the differences between the 3 drive modes and how each one operates in tune with the overall driving experience.

Stealth Mode ramps the applied torque from -40 to 110 Nm (-30 to 80 ft-lb) as the throttle position changes from 30-50%, with a gradual increase to 125 Nm (91 ft-lb) after that. It provides a perfect blend of additional power and battery longevity for everyday driving and an added boost of torque around town. It makes for a fun and spirited driving experience without having to unleash the full fury and noise of the engine, making a spirited drive more "stealthy". It is the default VSD mode when the system wakes up.

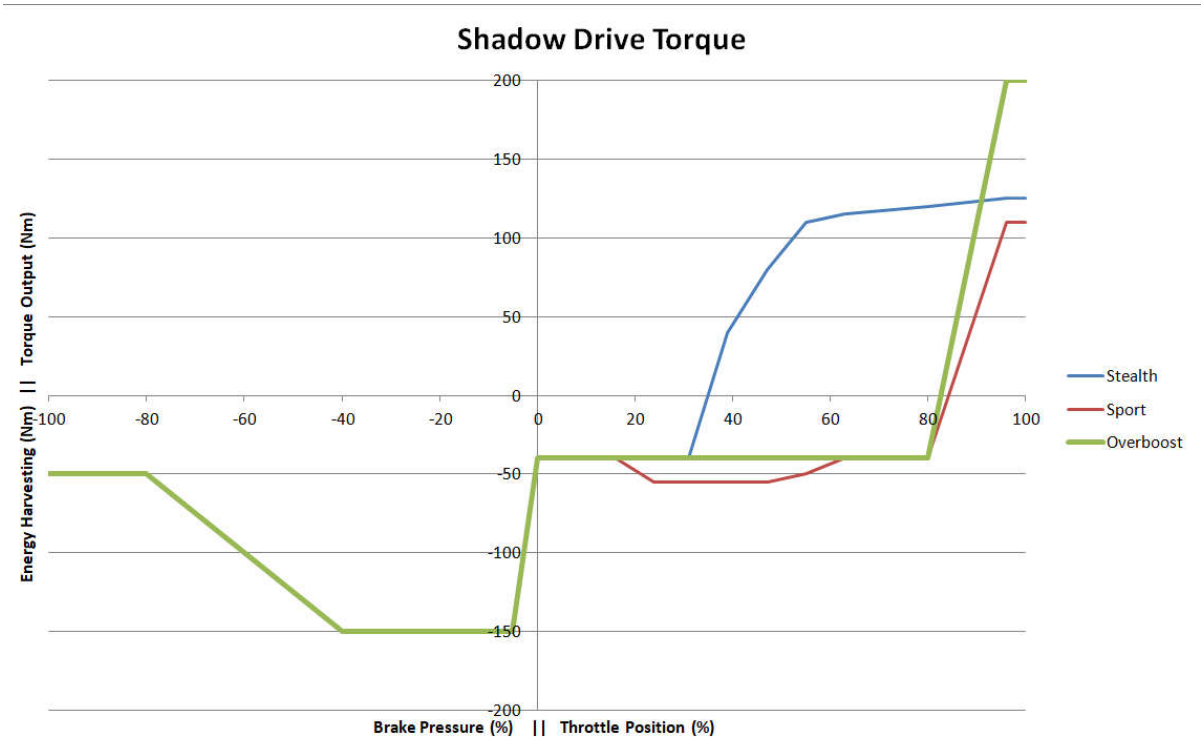
Sport Mode ramps the applied torque from -40 to 110 Nm (-30 to 80 ft-lb) as the throttle position changes from 80-95%. It also adds some additional regeneration in the mid-throttle range to help keep the battery charged up. It is made for exactly what it sounds like, ready for an exhilarating day of canyon carving. It is designed for the optimal balance of fun while conserving system thermal and energy resources. Applying the added torque at nearly full throttle reserves the Shadow Drive resources for when the driver wants more than the engine puts out.

Overboost Mode ramps the applied torque from -40 to 200 Nm (-30 to 150 ft-lb) as the throttle position changes from 80-95%. Pulling out all the stops for the most aggressive driving experience. This mode is intended for short-duration use only as it consumes the thermal and energy resources the fastest. And like in Sport mode, the added torque is applied at nearly full throttle to reserve the Shadow Drive resources for when the driver wants more than the engine provides.

Sport Plus Mode applies 40% more torque than Sport Mode for 0.5 second then ramps down to Sport Mode torque. This gives the feel of the extra kick without a significant increase in motor heating. To enter this "secret" mode, tap the Sport Mode button 3 times in less than one second. The text in the center of the gauge will change to Sport Plus.

Future Modes: Over time Vonnen will release software updates which may enhance the number of drive modes or their characteristics.

In all drive modes, the system applies a mild negative torque from zero throttle position until the selected ramp point to capture energy to recharge the battery. When the brakes are applied this negative torque is increased, creating higher "engine braking" to slow the car and capture even more energy as long as the transmission gear is still engaged. However, if the brakes are applied at a very high level the regenerative torque is reduced to a mild level to not upset the car's braking balance. See the plot below which illustrates the behavior in all 3 modes.



As you start driving the two main bars for torque and power (Nm/kW or ft-lb/hp) will sweep clockwise as the torque and power increase showing you exactly how much torque is being applied and the added power output. Simply double-tap the displayed units to alternate between metric and US units. To add the engine's output to the display (currently only for model year 2013+ cars), swipe left or right on the bars to alternate. (Both of these can be toggled in the app settings as well.)

The Capacity bar readout on the bottom of the screen will fluctuate depending on how hard the system has been worked. Hard driving affects the system's capacity rapidly as Shadow Drive is designed for short bursts of torque lasting a few seconds at a time. By tapping the up arrow you will be able to expand the Capacity Bar and dive deeper into the metrics that affect the system capacity. You will notice Battery State of Charge (SOC), Battery Temperature, eMotor Temperature, and Inverter Temperature readout bars. Each component has a maximum operating temperature and the system is designed to protect itself, ramping down output to zero as required. Once the maximum temperature is reached for one or more components, the relevant detail bars will turn from green to blue while the system is in a recovery period. After partially cooling down the detail bar will turn green again and the system will be fully operational and ready to provide boost when you want it. This is the main reason why we created different driving modes, so you can select how much torque is applied and how long that torque lasts through the boost.

Additional notes: If the vehicle is turned off when the electric motor is still above 100*C (212*F) the cooling pumps will continue to run for 1-8 minutes. After key off, the system will go to sleep after 30 minutes when the system's "timer relay" turns off.

Shadow Drive Component Details:

Battery Pack: The 400V battery pack is self contained and requires no external charging in order to drive as the battery is charged through regenerative braking during driving. The State of Charge (SOC) will cycle up and down during normal operation as the system determines is appropriate for the current driving. It is liquid cooled with its own coolant loop to maintain the desired operating temperature. It is made with a battery cell type with an extremely high power to weight ratio and exceptional safety characteristics.

Electric Motor: The electric motor is a high torque axial flux type motor that is capable of adding torque through the entire engine RPM range. It functions both as a boost motor and as a generator. It is bolted directly to the crankshaft as a replacement to the factory flywheel and acts in harmony with the engine's output. It is liquid cooled for rapid recovery.

Inverter: The inverter converts the battery's direct current output into 3-phase alternating current that drives the electric motor to produce the required torque output. The inverter is also liquid cooled with the motor to maintain the required temperatures.

Vonnen Control Unit (VCU): The VCU monitors all driver inputs, component temperatures, battery state of charge, and communicates with the Shadow Drive app. It decides the appropriate output from the VSD system based on all of this information and the system mode that the driver has selected.

HVIL/Crash Sensor: The VSD system has a high voltage safety system that includes a High Voltage Interlock Loop (HVIL). If any of the HV components are unplugged, the battery's contactors (high power relays) will not close, putting the rest of the system into a safe state within a few minutes from when the system was last energized. Additionally, this HVIL circuit includes a crash detection sensor near the vehicle's 12V battery. If a crash of sufficient force occurs the HVIL circuit the loop will be broken and must be manually reset by pressing the red button when the vehicle has been examined for any HV safety issues.

Backup Battery Charger: The VSD battery will still have enough capacity to start the engine even when it is discharged all the way to the indicated "0% SOC". In the unlikely event that it is further discharged so completely that the engine will not start and then recharge it (and it is not possible or desired to push start the engine), a trickle charger is built into the battery and an auxiliary cord was included with the vehicle that can be plugged into the side of the battery pack and to a local AC power source (100-240V AC). When the switch by the plug port is toggled ON and the key has been cycled to energize the system's timer relay, the charger will slowly recharge the battery and engine start should be possible within 30 minutes if there are no other issues. Note that it is not intended or necessary to leave this trickle charger on indefinitely during vehicle storage as it will fully charge the battery and it is not ideal to store the battery for long periods at this resting voltage. The battery will hold any normal SOC for extremely long periods with no further attention. When this charge switch is in the ON position, engine start is prohibited to remind you to unplug the charger.

App screenshot images: