Understanding the Travato Pure3/Volta System
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The goal of this document is to give people a better understanding of the 2019 Lithium Travato (GL and KL) and the Pure3 Power Management system by Volta. A certain amount of technical knowledge is necessary to fully understand something this complex plus a working knowledge of RV systems is assumed.

One excellent source of information about the Travato is the Facebook Travato Owners and Wannabees group:
https://www.facebook.com/groups/466687086845930
And the TOWB Resource page:
https://travato.group/#

Winnebago has several educational and promotional videos on the Pure3 system at:
https://www.youtube.com/user/winnebagoind/search?query=pure3

There is an excellent Conceptual Power and Plumbing Systems Diagram provided by Bob Bedell on the TOWB Resource page and on the last page of this document. This diagram will help you better understand how things work together.

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RV Electric Basics

We have to start with a bit of a primer on electricity and RV electrical systems. There is a huge amount of information on the Internet if you want to do some reading but here are a few things that should help get you started. Feel free to

skip over any of the next few bits if you know them already. Just be aware that the systems we are dealing with may be different from what you have been used to in the past.

In an RV, we deal with two "types" of electricity, Alternating Current and Direct Current (AC and DC). AC power is what you have at home to run things like lights and appliances. AC may be seen referenced 110V, 115V or 120V (Vac) but you may also find 240Vac at home to run things like a dryer. A 120Vac line normally has three connectors which are referred to as Hot, Neutral (Common), and Ground. The most common type of electricity in a small RV is 12Vdc and powers the lights and things that work without need for a shore line or generator. A DC line has two connectors, Positive and Negative (Ground). DC is also what is produced by that battery in your flashlight and is stored in your chassis and coach (house) batteries.

Some people see the big plug on the shore power cord on a Travato and think it is a 240Vac line, but it's only 120Vac. At campgrounds there should never be any confusion because the 50A 240Vac outlets larger RV's use have 4 prongs while the 30A 120Vac outlets we use have three prongs. But on very rare occasions you may find an outlet at someone's house that is a three prong 240Vac outlet so just know what it is you are plugging into.

To understand the terms Volts and Amps, the analogy of a water hose is often used. Voltage is the amount of pressure the water is providing and Amperage is the volume of water. The other term we use a lot is Wattage which relates to an amount of work. In math terms Volts x Amps = Watts and it is at this point where it can get a bit confusing because most RV owners are used to talking about things in terms of Amperage load and the Voltage level of the battery while with the Volta system we generally deal with Wattage load and often ignore Voltage. If your eyes are starting to glaze over a bit, don't worry, even the more tech savvy people can get a bit confused. Think of it this way, discussing things in terms of Amp load may make sense for a 12Vdc system, but the Volta system is involved with both AC and DC and actually "transforms" power back and forth between those two and at 3 different voltages.

On a similar note, Amps don't work well for us because 1A @ 12Vdc and 1A @ at 120Vac are very different things. If you convert this to Wattage you will see that these two things represent 12 Watts in the first case and 120 Watts in the second. Also, appliances often have their electrical usage listed in Watts which makes it easier than having to constantly convert things back and forth.

It is common to speak of the DC voltages in the Volta system as 48Vdc and 12Vdc but the actual voltages are upwards of 58Vdc and 14.4Vdc. For the most part, we will stick with the common terms but in some cases the real numbers are important and will be used. Similarly, you sometimes see AC current referred to as 110V or 115V, but the generally accepted standard is 120Vac.

As an aside, you will also see the terms Amp Hour (AH or AHr) and Watt Hour (WH or WHr) used. For example, a standard Travato has two 100AH "deep cycle" batteries and 1 AH is a draw of 1 Amp for 1 Hr. I mention this only so you will be aware of what this refers to if you see it mentioned. Other than that, you don't really need to concern yourself with this.

What is so Special About the Pure3 System?

Many Travato owners and prospective buyers still think in terms of the standard Travato with an AGM battery and think of Lithium as just another kind of battery. Also, many people think in terms of Lithium Ion batteries you buy in the store for consumer electronics or in terms of the kind of Lithium Iron Phosphate (LiFePO4) systems you see in other RV's or in DIY setups. Even Volta refers to their systems as Lithium Ion some places. Much of the "accepted knowledge" found on the internet about Lithium batteries in RV's is based on the LiFePO4. While some of this carries over to the Volta system, some of it does not.

The Volta system uses automotive grade Lithium Nickel Manganese Cobalt Oxide (NMC) batteries. These batteries are a lot more durable and can handle higher voltages and more extremes of temperature than the types of Lithium battery

systems found in most RVs (both DIY and commercial). Also, other RVs systems are 12Vdc systems while the Volta system is 48Vdc (58Vcd max) and 58Vdc is about as close as you can get to a High Voltage rating while still being Low Voltage and that makes things more efficient. Think of it this way, for a 12Vdc system to produce 120Vac, you need to boost it by a factor of 10X so the currents (amps) are very high. For a 58Vdc system to get to 120Vac we are slightly over 2x boost. This means lower amperage which allows for smaller diameter (gauge) wires which will generate less heat and be more efficient as well.

The Pure3 Travato is NOT better, or superior, or any other such term. It is a different way to travel. It is NOT the best solution for everyone. If you stay at campgrounds with electric the majority of time, then it's probably not going to be of any great value to you. All RV's involve the tradeoffs between cost and comfort, size and features and the addition of the Pure3 system also involves a significant increase in cost.

The Pure3/Volta system is not an endless supply of electricity. The Volta battery has roughly 7.25 times the usable capacity as the two AGM's in a standard Travato, but it consumes more electricity during normal operation. In a standard T you cannot run the microwave or A/C without shore power or the generator which not only won't drain your AGM, it will actually help top if off. However, if you have a standard 2019 Travato then you have a 1000W inverter which does drain the battery so you have to watch yourself or risk running that AGM battery down too far. In a TL, you can run almost any 120V appliance you can carry without needing shore power but you drain the battery to do it. So, just like with the inverter in the standard T, you have to pay attention to what you are doing or you may run the battery down quickly and it will take some time to get that charge back up again.

Components of the Volta System

The Volta System is a package with four major components; the Power Pack, the Inverter/Charger, the DC-DC Converter, and the 2nd Alternator. Some of these components have similar counterparts in the 2019 non-Lithium Travato's but some components are unique to the Volta and some separate components in standard RV's are combined with others here.

The Lithium systems used in RV's are actually not a single battery; rather, they are a bunch of small batteries connected together and controlled by a Battery Management System (BMS). All larger Lithium batteries need some kind of BMS which can be fairly simple but it can also be quite complex (like the Volta). It's helpful to talk about the Pure3/Volta system as having "Storage Pack" or "Power Pack" rather than a battery. The BMS is a part of the Power Pack and it controls all power coming in and going out of the batteries. It determines if, when, and how the batteries charge and discharge and also takes into consideration a variety of environmental factors. This whole power pack is sealed and surrounded by padding, insulation, and a powered air duct which connects to the cabin to circulate room air.

The Inverter/Charger serves three functions: DC-AC Inverter, Charge Controller, and Automatic Transfer Switch (ATS) so it may help to discuss these three things by function rather than one big black box starting with the ATS. An automatic transfer switch does just what the name implies. In a standard Travato the ATS routes power to the 120V breaker panel (all outlets and the AC and Microwave) from shore power or the generator, depending on which one is available. It does basically the same thing in the Volta system. Shore power comes into the Inverter/Charger which monitors it to see if there is an acceptable 120Vac source. If there is, then that power is routed to the 120Vac panel; otherwise the Inverter is responsible for providing the 120Vac power. If shore power is available then the information display panel will say, "DEVICE STANDBY: OVERRIDE BY CHGR" if you press the Inverter On/Off button.

The Charge Controller interfaces with the BMS to supply a charge when needed. Sources include shore power, solar, and the 2nd Alternator. If no charging is needed then the message "CHG#1—OFF DISABLED BY JMPR" will appear on the information display panel.

The Inverter side of the system transforms the 58Vdc power to 120Vac. This isn't a particularly new technology but the devices in use today are a lot more sophisticated than they were at one time. Today's larger RV inverters are almost all Pure Sine Wave inverters which produces extremely "pure" electricity suitable for powering electronics or any other function. The Inverter in the Volta systems is a Magnum/Dimensions (Sensata Tech) 3600W inverter. If you do the math, you will see that this is the equivalent of a 30A shore power outlet which means you can run anything you could if you were plugged into shore power. This is very different than the Inverter in the standard 2019 Travato's which have a 1000W inverter (also Pure Sine) which only powers a few 120Vac outlets but not the microwave or A/C.

If you are not connected to shore power then the Inverter/Charger provides all the 120Vac power in the coach using the 48Vdc power supply. The Inverter can be turned on and off via the control panel. It's up to the user to control this and the Inverter does consume some electricity and produce some heat so the best policy may be to get into the habit of turning it off when you aren't using it. If you hear a fan running under the jump seat in the GL or the foot of the passenger bed in the KL, that is the Inverter/Charger. The fan runs whenever the Inverter is on and may or may not run while the Charger is working.

Those things in the coach that don't require AC current run on 12Vdc current. That includes things like the roof vents, USB ports, lights, refrigerator, awning, Truma fan, etc. The DC-DC Converter has the job of transforming the 48Vdc power on the bus down to 12Vdc for the coach. Unlike the Inverter which you can turn on and off, this converter is running whenever the Volta system is on. The Inverter and DC-DC Converter both draw power from the 48V DC bus (a bus is a common connection) which connects to the Power Pack.

There is a 2nd Alternator under the hood which provides power input for the Power Pack and the 48Vdc bus. This Alternator can put out DC electricity whenever the engine is running at greater than 1600RPM. This alternator puts out enough wattage that it can power all the AC and DC systems and still charge the Power Pack. In fact, this alternator provides more wattage than a 30A shore line which makes it the quickest way to recharge a low system. The alternator has a system to allow for a manual or automatic recharge cycle which will be covered elsewhere.

The whole Volta system is turned on and off by way of the button next to the "Speedometer" dial. This dial shows the Percent State of Charge (% SOC) and has colors to indicate the general SOC (Green, Yellow, Red). The dial and the button are illuminated with the appropriate color. Most of the time, unless you allow the Power Pack to deplete too far, the dial will be Green.

Owners will notice that the dial never goes all the way up to 100%, this is by design. Storing electricity in a battery produces a certain amount of heat and Lithium cells charge fairly quickly up to a point and then slow down. The closer to 100% the more heat which isn't good for the cells. If you are driving, then the system will get up to about 96% and stay there until you stop. If you are connected to shore power, the system will charge up to about 95% and then stop charging until it drops down to about 88% and then start charging back up again. This is all controlled by the BMS and is designed to keep from over charging and to prevent the system from constantly short cycling (use a little then recharge) while connected to shore power.

There is a similar thing that happens at the lower end. When the % SOC drops to around 18%, the system shuts down. It's not totally dead as there is still power there but the only thing it will operate is the circuitry needed to deal with recharging. This built in buffer top and bottom is why Winnebago lists the Pure3 Travato as having 8700 WattHrs as opposed to the 10,100 WattHrs that the Volta Power Pack is rated for.

As an aside, the % SOC dial is a simple way to show the level of the power pack charge, but it's not exact and there are a couple reasons for that. Basically, the BMS is constantly monitoring the voltage of the battery pack and the amperage in and out of the battery. Both the charge and discharge rate vary somewhat based on the battery pack voltage, temperature, environment, and load. As a result, the charge/discharge rates aren't linear. For example, it tends to drop from 95% down to about 85% a bit faster than it does from 85% down to 75%. It also takes longer to go up from 85% to

95% than it does from 75% up to 85%. This is all determined by the BMS which is a lot more complicated than the charge controller in a normal Travato.

There is also an auxiliary power source in the form of two solar panels totaling about 200W. These are connected to a MPPT solar controller which is different from the Zamp controller in non-L Travato's. There is more on this later in the document.

Changes from Standard G and K

Despite the floor plans and most of the outfitting being the same, the new Volta system is not an add-on to a standard T. It is an entirely new T, redesigned from the ground up, that is as different from the non-L T's as the T's are from other B's. If you tour a K and a KL or a G and GL you won't notice any differences other than a couple different panels and some changes in under-bed storage. But if look underneath the van you will see a number of changes and those are worth discussing.

The most obvious change is that a standard Travato has a generator behind the rear axle while the L's have a power pack. The power pack is larger than the generator but actually weighs about the same so there's no noticeable change in the vehicle weight. The other thing you will spot is that in addition to a Gray and Black waste tank, there is a Fresh Water tank. In a standard G and K the Fresh Water tank is inside the coach but that area in a Pure3 coach is taken up with the Inverter/Charger, DC-DC step down converter, and miscellaneous electronics. There has been some concern about the water tank possibly freezing but the tank is inside a double wall container that has a heat duct from the Truma and a heating pad so this should carry you through the shoulder seasons (a Travato isn't a 4 season RV).

Another difference is that the waste and water tanks have been resized. Some people have objected to this since the volume of two of these tanks have gone down but it's not a huge drop. The Gray tank capacity has not changed in either model but the Black tank went from 13 gal to 12 gal in the KL. The Fresh Water tank has the biggest change going from 21 gal to 18 gal in the GL and 23 gal to 18 gal in the KL. That does mean you may have to fill your fresh water tank more often but a number of people, myself included, already carry drinking water separately which helps.

Background Power Usage

Every RV has a certain amount of background power usage. This is sometimes referred to as "parasitic draw" because its electricity being lost for no apparent gain. A good example is the Jensen entertainment system. The Jensen is never truly off – rather it's in standby so it is always drawing a small amount of electricity. There are also things like the LP switch which is a solenoid which draws current whenever it is on but most people wouldn't be aware of that. The refrigerator cannot be called parasitic but it is still a background usage since it is probably running whenever the coach is in use.

In a standard Travato, there is a very small draw by various electrical components you are never aware of and that draw gets larger in a Pure3 Travato. The BMS, DC-DC converter, and other electrical components all consume a certain amount of power even when idle. There is enough background power used in a Pure3 system that even with the refrigerator and Inverter turned off, you can expect about an 8% drop over a 24hr period. This can go up to 12%-15% in the winter if the Power Pack is cold – more on that later. If you are going to be traveling every day then that's not an issue but keep that number in mind when we talk about storage.

James Adinaro at FitRV.com did a lot of work documenting how much electricity (both DC and AC) various components in a Travato use. He also did a major conversion of their Travato to a Lithium system that has nearly as much capacity as a Pure3 Travato. Some of his numbers are out of date for 2019 models but it's worth reading what he did and how they manage their electrical use.

Shore Power

The term shore power comes from the boating world and refers to connecting to an external electrical supply. This can be any 120Vac outlet from 15A to 30A. It is possible to make use of a 50A outlet at a campground by means of an adapter plug which uses one 120Vac "leg" of the 240Vac 50A outlet. When you connect to shore power that is less than 30A then it is important that you adjust the setting of the Power Control System (PCS) to the appropriate Amperage. This device monitors the AC load so that you don't exceed the amperage you have available. For example, if you set this to 15A then it might keep you from running the A/C, Microwave, and TV all at the same time.

There is one thing about shore power in a Pure3 system that can be rather confusing. Namely, what happens after you plug in is conditional on what the state of the system was when you plug in. In brief:

--If the Pure3 system was turned off, then when you plug in the system will power up and you will have both DC and AC power available. As mentioned above, the AC power will be provided by the shore power connection. If you unplug the shore power connection at this point, the Pure3 system will shut back down again.

--If the Pure3 system was turned on and the Inverter was ON, then when you plug in the system will power up and you will have both DC and AC power available. The only difference will be that shore power will take over providing the AC power. If you unplug the shore power connection at this point then the Inverter will resume providing AC power.

--If the Pure3 system was turned on and the Inverter was OFF, then when you plug in the system will power up but you will only have DC power available. To turn on the AC power you need to go to the Winnebago/Volta control panel and press the On/Off button which will turn on the AC power. If you disconnect shore power at this time, the Pure3 system will NOT revert to its prior state with the AC powered off, rather the Inverter will take over providing AC. If you don't want AC on at this time, then you need to go to the Winnebago/Volta control panel and press the On/Off button which will turn the AC power Off.

You will find that there is a Dimensions Owner's Manual in the Winnebago Supplement with details about the Winnebago/Volta control panel. It is important to know that this manual is generic in nature and not specifically about the Winnebago control panel which is configured differently. Many of the settings in this manual are either not available in the Pure3 system or function differently.

Max Branch Amps

This is one place where the exact usage of a feature has no clear cut "correct" answer. The Travato manual refers to this as both the Adjustable Charge Rate and the Battery Charger Current Limit while Volta refers to this as the even more cryptic Max Branch Amps. Basically, what this is for is to tell the Charge Controller the MAX Amps it can draw from your shore line <u>to use for charging</u>. When you first get your new Pure3 Travato, this will be set to 15A and you *may* want to change this. But…

When you are connected to shore power the charge controller will draw some current to recharge the power pack if and when needed. If you are at a campground the shore connection will probably be 30A so it would *seem* to make sense that you set this to match, but it's really not necessary. If you leave it at 15A it will still charge the power pack but not as fast – and that's probably OK because it would be rare to need to do a large fast recharge using a shore line. The upside to leaving it at 15A is that you would never risk tripping the breaker on any shore power connection even if you are just connected to a 15A house outlet at Uncle Bob's house. The down side is if for any reason your power pack is low when you connect to shore power then it will take longer to recharge and you will hear the fan running on the

Inverter/Charger more than you would otherwise. If decide you want to increase this to 20A or 30A, the instructions are in the Operators Manual.

Please don't confuse this with the Power Control System (PCS). In both the Pure3 and standard Travato, there is a PCS which you really should set to match your shore line amperage (see the manual). It may seem at first as if these are the same thing, but these are actually two separate systems. In the case of the Volta controls you are setting a limit for the Charge Controller, while the PCS serves to keep you from running too many AC devices for your shore power connection to handle.

Using the Inverter

If there is no shore power connection, then the Inverter can provide 120Vac to all outlets in the coach. The Inverter, even if there is no load on it, consumes a certain amount of electricity (parasitic load). The total parasitic load of the combined Inverter/Charger and DC-DC converter is ~300W and the Inverter is about half of that so it makes sense to turn it off when you aren't using it.

You will probably have to check to see if the Inverter is on or off at certain points.

--If the system is totally off and you turn it on with the SOC switch, the Inverter will automatically come on and unless you want to use it, you need to turn it off.

--If you connect to shore power then the inverter will automatically turn off (if it was on) and shore power will take over providing your 120Vac power.

--When you disconnect from shore power, your inverter will automatically come on regardless of whether it was off or on when you connected to shore power. This is the one I always forget about. This is also important to be aware of if you are using the A/C or the Truma on EL at night. If you are using one of these two things at night and shore power is lost for any reason then the Inverter will take over and your power pack will start to drain. If this happens then you may find yourself VERY low on power come morning. Unfortunately, there's no way to avoid this.

One question that comes up is whether it is possible to operate the Inverter and power AC devices while you are driving. The short answer is sure you can. As long as the engine is doing at least 1600 RPM, the 2nd Alternator is putting out current. One caution is that if you are driving slowly then the alternator will not be putting out full power so it may not be able to charge the battery as fast if you are running a heavy load like the A/C.

2nd Alternator Charging

There is a second alternator under the hood that is part of the Volta system. This alternator will output up to 6000W which is enough to fully recharge the Power Pack in about 1.5 hr of driving if you keep the engine above 1600RPM so slow or stop and go driving isn't very efficient. The Promaster engine can be rather efficient so you may find yourself doing 45 MPH down a flat country road and notice that the Tachometer is only at 1400 RPM. The alternator will still be putting out some current so you will be charging but it's not going to match what you get at highway speeds.

According to Volta, it's all about pulley ratios. Every alternator has an RPM that it 'turns on' at and there is an upper limit on RPM's as well. It's a balancing act to produce enough energy at a relatively low RPM but not over spin the alternator at extremely high RPM. At high-idle (1600 RPM), it's about 2000W of the 6000W max.

Solar Charging

With a standard Travato, having 200W of solar when boondocking can help keep the battery topped off but that's not quite so true when it comes to the Pure3 system. The reason is the relation between the output of the solar vs the capacity of the battery. The fact is that a one hour high-idle cycle will exceed what a days' worth of solar can provide.

Some say it might be better if WGO just put in the solar ports and the MPPT (solar) controller and let the buyer decide what kind of solar they wanted. The route that one owner (Ron Merrit) has taken is to replace his 200W with 400W wired as two pairs of 100W panels in series. Each pair produces around 40Vdc which is a far more efficient way to charge the power pack and the 400W should be enough (on a sunny day) to offset the base usage of the electronics and maybe the refrigerator as well. On the other hand (there's always a caveat) two panels in series are more susceptible to shading than two panels in parallel.

The Solar Charge Controller in the Volta system is different than the Zamp controller in a standard Travato. It doesn't display any voltages, just two blinking lights. This MPPT controller has proven to be one of the more confusing things in the Pure3 system because no one can figure out what the blinking lights mean. This is probably something best ignored. The reason is that this panel provides three different charging profiles (Constant Current, Constant Voltage, and Float) which have different light patterns and interfaces with the BMS which may or may not want or need any solar charging at any given time. Also, the BMS won't start to draw on the controller until the charge has dropped somewhere below 88% so it may be off completely sometimes which leads people to wondering if it is working or not.

High-Idle Recharge (Auto-Start)

The Volta system is also equipped with a High-Idle recharge capability. This can be activated either manually or automatically. To use this, you must first "arm" the system by putting it into Monitor Mode. This can be done using the ignition key or via the key fob.

There is no way to know exactly how much charge will be added by running a recharge cycle because conditions vary so much. If you are running the A/C at the time then that will consume a portion of the output. While the recharge cycle is running, the engine will alternate between high and low idle to keep the engine from heating (when you are driving there is air blowing across the radiator but while stationary it's up to the fan to keep the engine cool). This reduces the total time the Alternator is charging – the hotter it is outside, the more it will cycle and the less charge you will get. Field tests have shown people average a 10%-15% gain so this is not the same as driving at highway speed for 1 hr. As an aside, when the engine comes on, so will the lights and the radio so turn these off when you engage Monitor Mode.

<u>Ignition Key (Stealth) Monitor Mode Engage</u>

1. Ensure parking brake is engaged and hood closed
2. Turn key in ignition to run position and press Silver Auto-Start button 2-3 seconds to engage*
   No horn or lights flash
   Silver Auto-Start button will turn Red
3. Turn the ignition off and remove the key – the dash will stay illuminated for 20-30 seconds then go off

<u>Key-Fob Monitor Mode Engage</u>

1. Ensure parking brake is engaged and hood closed
2. Press (middle) Lock button 3 times to engage*
   Horn will sound and headlights will flash
   Silver Auto-Start button will turn Red

<u>Monitor Mode Disengage</u>

1. Key Fob - Press (top) Unlock button 3 times to disengage
2. Cab - Press Silver Auto-Start for 2 seconds (light goes out) to disengage
3. Monitor mode <u>will not</u> disengage if you start the engine.

<u>Manual Start to Recharge</u>

1. To begin a recharge cycle manually, put the system in Recharge Monitor Mode then press the Silver auto-start button 3 times.

2. While in recharge mode, all electrical systems (including the Inverter) will continue to operate. However, the higher the load the longer it will take to fully charge.
3. Recharge mode will continue until one of the following occurs:
    a. 60 min has elapsed
    b. Battery charge reaches 90%
    c. Engine coolant reaches 219F
    d. Gas tank falls below 25%
4. When in recharge mode, engine may cycle between high-idle and low-idle with the cooling fan running to cool motor. The hotter the external temperature the more often this will happen.
5. Press the Silver auto-start button 3 times to stop charging sooner if you want. High-Idle recharge and monitoring MUST be stopped before attempting to start the vehicle. Stepping on the brake while a recharge is running will shut the engine off for 5 minutes to prevent a driveaway.

Manual Start and Lock to Recharge

If you want to start a manual recharge then lock the vehicle so you can leave, follow a modified version of the above procedure. Be certain that all doors are closed then from the driver seat, press the lock button on the center console to lock all doors (the red light should come on). Place the system in Recharge Monitor Mode as above. Get out of the cab on the driver side and leave the driver door open. Reach in and press the Silver auto-start button 3 times to start the charge cycle. Immediately close the driver door and quickly press the key-fob lock button 2-3 times. If it doesn't lock, you didn't do it quickly enough.

Auto-Start to Recharge

1. In Monitor Mode, if the battery charge gets down to 25%-35%, the engine will start in high-idle to recharge the battery. The exact percent can vary depending on the load on the system.
2. Recharge will operate the same as it does with a manual start.
3. As long as Monitor Mode remains on and there is at least ¼ tank of gas, the system will continue to auto-start to recharge if the charge drops to 25%-35%.

One question that arises is how "noisy" is the High-Idle charging. Ron Merrit (aka Wincrasher) did some tests on his GL and he found that at its loudest it's 70dB at the front bumper, 60dB at the rear, and 56dB @ 50'. A regular T generator is around 85dB up close. Technically, the TL high-idle is roughly half as loud as a regular generator however people may find it more annoying because it alternates between high and low idle whereas a generator (particularly with a resonator) is a constant sound.

There is also the rather tricky question of idling the engine to recharge the battery. As a general rule, you should be able to do this any place and time you can run the generator. However, you could not or would not want to do that if you are someplace where it's not allowed (like 4 am in a campground). Also, be aware that some towns or locations may have rules against idling a vehicle. As an example, I have seen a sign at a campground that stated "No Engine Idling". I can only guess at the reason, but like most things it pays to know the rules in advance. One place where you will likely see such a sign is at a highway rest stop. I have seen this both with and without a caveat regarding the size of the vehicle or whether or not it is a diesel.

*There is one other side issue with the auto-start that turned up unexpected when I was testing. One condition that can initiate an auto-start is a low chassis (Promaster) battery. If the van has been in storage then the chassis battery may be a bit low. If you then put the Pure3 system into monitor mode, it will start up about 10 seconds later. As I said, I only ran across this in testing and I'm hard pressed to think of a situation where this might happen while traveling. In the event it does, just let the engine run 10 min and shut it off and you should be able to re-engage monitor mode.

How Long Can I Run {fill in the blank} …

The single most frequently asked questions are, "What can I run" and "How long can I run it" using the Pure3. Well, basically, if it's 120Vac and draws less than 30A (3600W) then you can run it. As to how long, well that depends. People hate those answers because they aren't exact and definitive enough but most of the time there is no definite answer. Let's look at the most asked example, the Air Conditioner…

To figure out how long you can run the A/C, you have to know how much current it draws. That will vary with the fan speed (High or Low) and the "thermostat" setting. The Coleman Mach 10 doesn't have a true thermostat but it does have a dial with a color indicator for temperature. I'm not sure if anyone has done a real study but the Mach 10 spec sheet indicates that it will draw somewhere between 1350W to 1625W. With the dial set at half, the compressor would come on and go off to regulate the temperature; but the percent of the time it will stay on is going to depend on how hot and humid it is outside.

If you assume the worst-case then the math would tell you that 8700W / 1625W would give you 5.3 hr of run time. But in one rather unscientific test I did, I ran the A/C at the mid-way setting on Low speed for roughly 5 hrs and the SOC went from 90% down to 40% or about 10% per hr. So clearly there are a lot of variables at work.

Your best bet is to use common sense and keep and eye on the SOC. Several people have talked about replacing the gas cook top with an Induction cooker, using a slow cooker, or using the Truma on EL or MIX. You can do that if you wish but you have to watch your electrical usage if you don't want to run out of power at 3am. You can do the math yourself on the cooking appliances but you should read Daniel Senie's excellent Truma primer before trying to run it on EL or Mix. Electric heating can use more electricity than the A/C and is less efficient than LP so unless you are really low on LP, you should use it rather than the Volta power supply.

Truma Combi Eco Plus (4E) Operation and Settings

<u>Fuel Sources and Modes</u>
The Truma Combi in the Pure3 Travato is identical to the one in a standard Travato and operates in exactly the same way. However, it is possible to use electric heating while not connected to a shore line in the Pure3 and that raises some issues. To explain the issues, it is necessary to understand how the Combi works.

As the name Combi implies, this system supplies both hot water and hot air to the Travato. It can use either LP gas alone, 120Vac electric alone, or it can combine (Mix) the two. The 12Vdc power supply does not power the electrical heating elements but it is always used for the fan.

- *Electric (EL)*: The Truma has two electric elements which produce 850 watts each

- *Propane (Gas)*: The Truma produces 7,500 BTU/hour with the burner on low, or 14,300 BTU/hour on high. You do not have control over this. The Truma selects what it needs. LP usage is 5.3 oz/hr for low and 10.0 oz/hr for high.

- *Combined Electric/Propane (Mix)*: In mixed mode, the gas burner is on the lower setting, and one or two electric elements are used.

Heat Modes (ranked by output):

EL 1 - 1 element electric only (850W / 2890 BTU)
EL 2 - 2 element electric only (1700W / 5780 BTU)
Low Gas - LP gas only (2206W / 7,500 BTU)
Mix 1 - 1 element electric + Low LP (3056W / 10,390 BTU)
Mix 2 - 2 element electric + Low LP (3906W / 13,280 BTU)
High Gas - LP gas only (4206W / 14,300 BTU)

Notes:
1. The Truma manual lists output by BTU for gas and Watts for electric. The above numbers are a mix of published data and calculated estimates.
2. If you are using mix mode and 120Vac is lost then the Truma will report a warning but will keep working using LP only until 120Vac is restored.

Room Heating
Settings: When flame icon is showing, furnace is on
Icon will flash until set temperature is reached

Gas and Mix will heat the room faster while EL will conserve your LP supply. If you are connected to shore power, then the natural tendency is to use EL1 or EL2 to heat the room. There is nothing wrong with that choice but if you look at the BTU output, it doesn't take long to realize that EL2 may not keep the cabin very warm if it's really cold outside - Mix2 may be the better choice if you have shore power and it's really cold out.

If you are dry camping then there is a potential trap for the Pure3 Travato in using any electric for heating. The electric elements can draw as much or more electricity as the air conditioner does so it is almost never a good idea to use EL or Mix if you don't have a shore power connection. The reality is that if it is cold out then you will only use a small amount of LP overnight while you stand a chance of running the power pack down far enough to shut down if you use EL or Mix overnight.

Hot Water
Settings: Boiler icon indicates hot water generator is on
Icon will flash until set temperature is reached
Eco - temperature set for 104 F
Hot - temperature set for 140 F
Boost - heating priority goes to hot water at 144 F
Room heating will stop for up to 40 min while water is maintained at 144 F
After 40 min, room heating will resume

One aspect of the Truma to bear in mind is that while this one unit provides both room heat (furnace) and hot water you don't have to turn both on at the same time. You can only turn on room heat or hot water if that's all you need.

Another thing to remember is that while you set these functions separately, you cannot use one fuel source for one function and a different fuel source for the other. But you can switch heat sources to suit what you want to give priority to right now. As with room heat, the most conservative approach for hot water may be to use EL2 if you have shore power. The water may take a bit longer to heat on EL2, but you won't use any LP. If you are in a rush for hot water, then switch to LP and switch back to EL2 for heat when you are finished with the water.

As to water temperature, the Eco (104 F) setting may be too low to be practical for hot water because soap works best around 120-125F. Hot (140 F) mixed with some cold will make the 2.6-gal tank last longer but may take a bit longer to heat up. If you have shore power available, and aren't restricted on amperage, then you *could* set it for Hot and leave it there, but it's best to maintain a consistent habit and just turn the hot water on when you need it.

One "mysterious" thing is how the Truma heats both water and air with the same heating elements. If you were to look at a cutaway diagram you would see that whenever heat is on it is heating both an air chamber and a water chamber. IOW, when you heat one, you heat the other. The difference is, when you set a water temperature it "concentrates" on getting the water to the correct temperature and may ignore the room temp and shut off the room air fan to do that. Boost in particular does this. If you don't have a water temp set, then it "concentrates" on room temperature.

While all these decisions sound a bit confusing, it doesn't have to be. If you have shore power available, then EL2 will work if it's not too cold out and Mix2 will give you the most heat while conserving LP. Hot water just requires that you plan about 30 min ahead. If you don't have shore power then make it simple and just use LP – it's the most efficient and you will be surprised at how little LP you use. And remember, there is almost NO reason to use EL or Mix if shore power isn't available.

Be sure to download and read the Truma Primer by Daniel Senie from the Travato Facebook Group files section or from the informational site: https://travato.group .

General Cold Weather Considerations

Caution: All Lithium batteries have some limitations when it comes to weather and the Pure3/Volta system is no exception. The information that has been gathered here has come from a number of sources and is as accurate as I can make it. HOWEVER, as with all things, the owner MUST assume the responsibility for using this system wisely. The Pure3/Volta system will do everything it can to keep the user from damaging the power pack, but that is not to say that the system cannot be damaged. Remember Murphy's Third Law – "You cannot make anything foolproof because fools are too ingenious."

This section is somewhat complicated by the fact that it does not involve simple yes/no or right/wrong propositions. Please read it carefully and consider how it impacts you where you live. And always bear in mind that all marketing hype aside, the Travato was designed to be a 3-season coach. You should expect complications in deep winter conditions.

Before getting into the technical issues involved with using the Pure3/Volta system in the winter, it's worth taking a few minutes to talk about the Travato as a whole. In particular it's worth remembering the design changes involved in making room for various components of the Pure3 system and the fact that the fresh water tank is now underneath the coach rather than inside. This potentially makes winter travel more of a challenge and at this point we have limited practical experience to determine how well this will work.

The price list on the GL and KL have a manually controlled heated drainage system as an option. Anyone who lives in a colder climate and expects to travel in the winter should consider this mandatory. In a K this option covers heating pads on the black and grey waste tanks and the G adds a heating strip on the grey tank macerator pump as well. Regardless of whether or not a Travato has the optional waste tank heating pads, there is a heating pad on the fresh water tank in both the GL and KL that is standard equipment.

The tank heaters all operate on 12Vdc so you do not have to use the Inverter to power them. On page 7-14, the manual has a caution about not running the tank heaters "…for an extended time unless you are providing a supplemental 12-Volt power source to recharge the Pure3 battery." The combined draw for all heating pads is about 225Watts but that is not continuous as the pads are regulated with thermostats. This caution was carried over from the standard Travato (AGM battery) and while this would not seem to be a burden on the Pure3 system, WGO chose to leave it in since this is a "quiet" load[1] that is easy to forget about.

In addition to the water tank heating pad, the fresh water tank is double walled and there is a Truma heat duct that circulates air into the empty space. This will help keep that tank warm even when the tank heater is off. It is unfortunate that there isn't a temperature probe in the fresh water tank to help the user know when the tank heater might be needed.

Cold Weather Power Pack Considerations

All lithium batteries have a temperature range that they operate best in. In the case of the Pure3/Volta Power Pack there is a set of parameters that the Battery Management System (BMS) enforces that are designed to protect that

battery by keeping it from charging or discharging outside certain temperature limits. The stated temperatures refer to a measurement taken inside the power pack which may be different than the outside temperature.

Most notably, below 37° F /3° C the Power Pack will not charge. This is controlled by the BMS and is done to protect the battery cells from damage. If the Power Pack goes below 37° F /3° C then it must climb up to 42.6° F /6° C before it will start charging again. These temperatures are not that cold for a lot of the country and it doesn't take many days to "cold soak" the batteries which can result in them taking longer to warm up again.

The bad news is that there is no visual indicator when the power pack temperature is below the level to accept a charge. The good news is that the Power Pack will discharge down to about -4° F /-20° C so even when it is really cold you can probably start the system.

Cold Weather Storage

Unless you live someplace that is warm all the time you will have to winterize your Travato. This is done the same way as with a non-L Travato and that information is well covered elsewhere already so we can skip that.

It is rather difficult to discuss winter storage because we all live in different climates and have different ideas as to when and how we want to store our Travato. On Page 6-13 of the Travato GL/KL manual WGO recommends shutting the entire Pure3/Volta system down for storage. However, on the following page there are some Notices that state that Volta recommends that the system be plugged into shore power for storage and that warn against allowing the battery voltage to drop too low for an extended period of time. These warnings are slightly out of context and are confusing.

Here is the best information I have been able to assemble from Winnebago and Volta on this:

1. As a general rule, if your Travato is going to be sitting unused for more than a day or two then make sure it is charged up to at least 50% (80% is better), disconnect from any external power source, and shut the whole Pure3/Volta system down.[2] Think of it like your parent nagging you to "Turn off the lights when you leave the room."

2. If you are storing your Travato with the Pure3/Volta system shut down, then you should periodically (at least by 90 days) turn it on and make sure that the SOC shows you are still in the Green. If the reading is less than 50% then you should consider plugging it in for a while or going for a drive to get it back up above 50% before shutting it down again.

3. If you are only going to be storing your Travato for a week or so, then you can leave it plugged into shore power. If temperatures are getting cold and you expect to use it soon then it might be prudent to put the Truma on EL2. At this time, I do not have a consensus on what temperature to set the Truma, but 50° F /10° C seems like it should be enough to keep the power pack warm.

4. One major caution if you are going to be leaving your Travato plugged in with the Truma on EL – consider what will happen if your shore power connection is lost! If you refer back to the section on Shore Power you will see that if your Pure3 system was on at the time you plugged in then it will switch to the Inverter if power is lost. This could drain your power pack fairly quickly. The solution is to turn the Pure3 system Off before plugging in. In that case, if shore power is lost, the Pure3 system will shut down. You will end up with a cold coach in the morning but won't have drained the power pack.

5. As a general rule, it's not a good idea to leave your Pure3/Volta Travato plugged into shore power as a means of long term storage. What happens is that the systems stay on and draw power and the power pack constantly goes through a discharge/recharge cycle between 80% to 95% which isn't good for the batteries.

6. The one thing you should never do is to leave the whole system on without shore power for an extended period of time so that it runs down completely. The Pure3/Volta system will use 10%-15% per day, depending on environmental factors. This can slowly run the power pack down after a few days. If you let the power pack go into the Red it will "shut down" but it will not be able to go into sleep mode and will continue to use some electricity till it gets down to a point where damage is possible (page 6-14 in the Operators Manual).

7. In a worst-case scenario, the power pack can withstand overnight temperatures as low as -40° F /-40° C during storage as long as the *average* temperature for any 3-month time period does not go below the baseline of -4° F /-20° C. This *should* mean that in most areas of the US you can safely store a Travato L in the winter if you follow the rules.

Cold Weather Operation

It is worth pointing out here that there is a big difference between getting a Travato L that has been sitting in freezing temperatures for 2 months ready for a trip and actually going camping in that kind of weather. Everyone is different in what they expect to be able to do so there are almost no blanket assumptions that can be made other than to say that at some point people will want to warm up the cabin enough to make it livable. And if you can do that you can probably use the Pure3/Volta system.

As previously mentioned, if the outside temperature has been low for several days then the power pack may be "cold soaked" in which case you would need to get the power pack up to about 43° F / 6° C. If you are somewhere with an electrical supply then you could start with a space heater under the Power Pack. This can help a lot but you really have to keep an eye on it because it's possible to overheat some things under the chassis. As long as the Pure3/Volta system will turn on, you can use the Truma to provide heat inside. Using LP will produce the most heat but if you have shore power then you could conserve LP by using either EL2 or MIX2.

There is a fan that circulates coach air through the Volta Power pack when it's cold so the goal here is to get the inside of the coach warmed up so that the fan can circulate warm air down into the power pack from the coach which will heat the battery. Once you reach the 43° F / 6° C point inside the power pack then the battery will begin to charge and you will be ready to go.

As an alternative, if the system will turn on but you don't have shore power then you could just start driving. This would allow the cab heater to add to the overall coach heat. Set the Truma to LP^3 and turn up the heat. This would be a really handy way to boot strap because once the temperature is up high enough, the 2nd Alternator will start charging the power pack.

As a purely practical matter, not too many people would consider camping if the cabin temperature were below 43° F so it would seem as if charging would not be a problem. But it's not the cabin temperature that is at issue, rather it is the temperature of the power pack which is under the chassis where it is a lot colder. But most people are going to look to get the cabin temperature up to at least 60° F and at that point the Pure3/Volta system *should* be able to take care of itself – but that is part of the assumptions we owners are making at this point.

The take-away is this… While it may be possible to just get in and start driving and "bootstrap" the system into operation, L owners who plan on traveling in winter may want to consider trying to warm things up before they leave. There is no one right or wrong answer here. The Pure3/Volta system is smart enough to protect the power pack from damage from too cold a temperature, but that leaves the owner with a bit of a problem. If you start on a trip with a cold system and *hope* it warms up enough to start charging, then you need to keep an eye on the SOC gauge.

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Notes:

1. Winter time will see an increase in electrical usage for "quiet" loads – that is loads that are there but you don't think about much. Shorter days means more lights; LP solenoid and Truma fans; Volta air fans; tank heaters; etc. This stuff all

adds up so just because you aren't running the A/C doesn't mean you don't have to watch the SOC and make sure it doesn't drop too far.
2. When shutting down the Volta system for storage, be sure to turn everything off first. That includes the lights, LP, Truma, fan, refrigerator, everything that draws power. The reason is that you want all this stuff off when you power back up again. When you turn the Volta system on, the Inverter will automatically come on. If you are on battery power, be sure to turn that off as you don't need that drawing power.
3. Never use EL or Mix to provide heat unless you have shore power or are absolutely certain you can charge the battery or you will rapidly use up your available charge.

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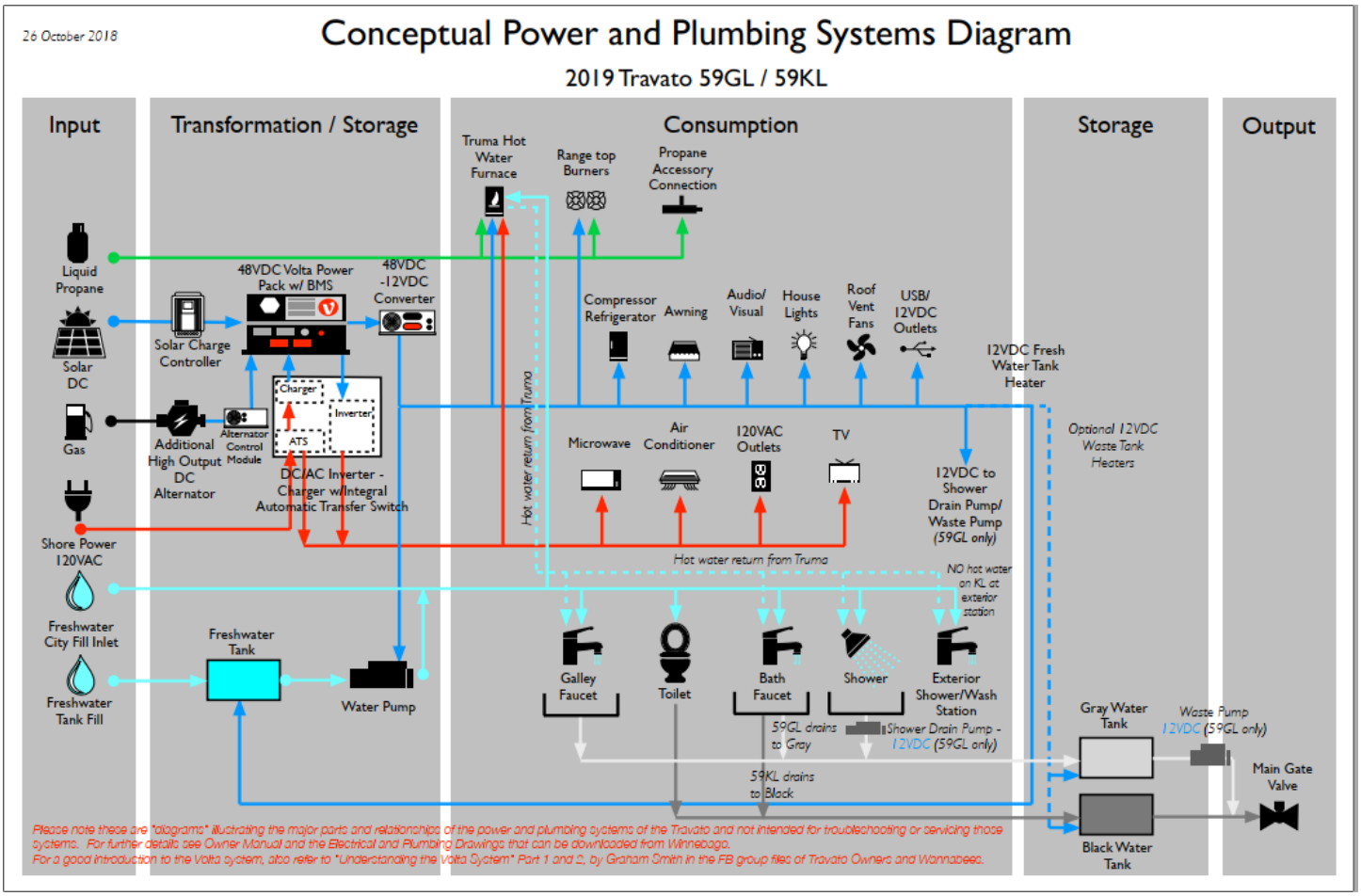
Corrections:
--It was previously stated that the SOC would flash Red if it was too cold to charge. This is incorrect and is due to a mistaken understanding on my part regarding "error conditions".
--Corrected tank heating pad wattage to include fresh water tank which had been left out of the calculation.
--Auto-start Monitor Mode will not disengage if you start the engine. The result is the engine will shut down when you step on the brake to put it in gear. If this happens, remove the key and press unlock 3 times which turns Monitor Mode off.
--It has only recently (as of Jan 2019) become clear that the 2nd Alternator doesn't reach full power (6000W) until you reach highway speeds. Driving at low speed or running high-idle may only output around 2000W. This means you get less charge going to the batteries than previously thought.


26 October 2018
Conceptual Power and Plumbing Systems Diagram
2019 Travato 59GL / 59KL
Input
Transformation / Storage
Consumption
Storage
Output
Liquid Propane
Solar DC
Gas
Shore Power 120VAC
Freshwater City Fill Inlet
Freshwater Tank Fill
48VDC Volta Power Pack w/ BMS
48VDC -12VDC Converter
Solar Charge Controller
Charger
Inverter
ATS
Additional High Output DC Alternator
Alternator Control Module
DC/AC Inverter - Charger w/Integral Automatic Transfer Switch
Freshwater Tank
Water Pump
Truma Hot Water Furnace
Range top Burners
Propane Accessory Connection
Compressor Refrigerator
Awning
Audio/ Visual
House Lights
Roof Vent Fans
USB/ 12VDC Outlets
12VDC Fresh Water Tank Heater
Microwave
Air Conditioner
120VAC Outlets
TV
12VDC to Shower Drain Pump/ Waste Pump (59GL only)
Optional 12VDC Waste Tank Heaters
Hot water return from Truma
Hot water return from Truma
NO hot water on KL at exterior station
Galley Faucet
Toilet
Bath Faucet
Shower
Exterior Shower/Wash Station
59GL drains to Gray
Shower Drain Pump - 12VDC (59GL only)
59KL drains to Black
Gray Water Tank
Waste Pump 12VDC (59GL only)
Main Gate Valve
Black Water Tank
Please note these are "diagrams" illustrating the major parts and relationships of the power and plumbing systems of the Travato and not intended for troubleshooting or servicing those systems. For further details see Owner Manual and the Electrical and Plumbing Drawings that can be downloaded from Winnebago.
For a good introduction to the Volta system, also refer to "Understanding the Volta System" Part 1 and 2, by Graham Smith in the FB group files of Travato Owners and Wannabees.